An Roinn Fiontar,
Trádála agus Fostaíochta
Department of Enterprise,
Trade and Employment

Submissions to the Public Consultation on the Development of a National Semiconductor Strategy

May 2025

The Department of Enterprise, Trade and Employment invited submissions from the public to inform the development of a National Semiconductor Strategy in March 2024. In total 45 submissions were received.

Original Notice

Public consultation on the development of a National Semiconductor Strategy

21st February 2024 | Closed Consultations

The Department of Enterprise, Trade and Employment is seeking the views of stakeholders to inform the development of a national semiconductor strategy.

The strategy will aim to capitalise on opportunities for the semiconductor sector at EU level and set an ambition and direction for activity in the sector. The Minister for Enterprise, Trade and Employment, Simon Coveney, invites you to partake in this public consultation process, which focuses on the measures and initiatives Ireland can introduce to take full advantage of the opportunities presented by the European Chips Act, and to meet ambitions for the sector.

Background

Semiconductors ('chips') are ubiquitous in our daily lives, and they are needed in almost every vital sector and service. The brains of modern electronics, semiconductors are crucial components in the production of nearly all electronics and machinery we rely upon on a day-to-day basis, including mobile phones, computers, cars and servers, as well as being essential for other sectors of the economy, such as the production of ICT equipment, for medical devices, in aeronautics and so on.

Due to their use as inputs in manufacturing, semiconductors are at the core of a large proportion of economic activity, making the sector's performance integral to the outlook for the global economy. Furthermore, demand for semiconductors is set to soar over the coming years for their use in artificial intelligence, electric vehicles, and cloud computing. Semiconductors will also be critical for the green transition due to their role in the provision of green energy and the electrification of industry.

It is within this context that the Department of Enterprise, Trade and Employment is launching a stakeholder consultation to inform a national semiconductor strategy. The focus of this consultation will be on the measures and initiatives Ireland can introduce to take full advantage of the opportunities posed by the EU Chips Act, and to meet ambitions for the sector.

Key themes

Stakeholder views are welcome from interested parties, including manufacturing industry, SMEs, the research community, and other interested stakeholders. Submissions should be structured according to the themes outlined below, responding to one or more of the themes as appropriate:

- **Aspirations for the sector** – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?
- **Opportunities for the sector** – What do stakeholders identify as key opportunities for the sector to further develop?
- **Challenges facing businesses and the sector** – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?
- **Access to talent for businesses** – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?
- **Barriers to development** – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?
- **Mitigation** – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

Submissions

Views from stakeholders and interested parties are requested no later than **5pm Friday, 15 March 2024**.

Submissions should be marked 'National Semiconductor Strategy Consultation' and emailed to chips@enterprise.gov.ie.

Freedom of Information Act 2014 and publication of submissions

The department will make public on its website all submissions received under this consultation. Your attention is also drawn to the fact that information provided to the department may be disclosed in response to a request under the Freedom of Information Act 2014. Therefore, should you consider that any information you provide is commercially sensitive, please identify same, and specify the reason for its sensitivity. The department will consult with you regarding information identified by you as sensitive before publishing or otherwise disclosing it.

General Data Protection Regulation

Respondents should note that the General Data Protection Regulation (GDPR) entered into force in Ireland on 25 May 2018 and it is intended to give individuals more control over their personal data. The key principles under the regulation are as follows:

- lawfulness, fairness and transparency

- purpose limitation
- data minimisation
- accuracy
- storage limitation
- integrity and confidentiality
- accountability

The Department of Enterprise, Trade and Employment is subject to the provisions of the regulation in relation to personal data collected by it from 25 May 2018. Any personal information which you volunteer to this department, will be treated with the highest standards of security and confidentiality, strictly in accordance with the Data Protection Acts 1988 to 2018.

The following submissions have been reviewed and personal data redacted including personal email addresses, personal phone numbers and home addresses. Full names have been redacted in the case of individual submissions.

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AMD

Department of Enterprise,
Trade and Employment
23 Kildare Street,
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25 March 2024

Public Consultation on the Development of a National Semiconductor Strategy by the Department of Enterprise, Trade and Employment

Advanced Micro Devices (AMD) welcomes the opportunity to provide feedback to the public consultation on the Development of a National Semiconductor Strategy of the Department of Enterprise, Trade and Employment (DETE). We support Ireland's vision to proliferate and strengthen the country's semiconductor ecosystem that supports and relies on vibrant enterprises, more high-quality employment including improved talent and skill development, and fair workplaces.

We would like to thank the Irish government for their relentless focus on nurturing a business-friendly environment in particular for the high-tech sector. A key element in that engagement is IDA Ireland. Without the IDA's commitment to supporting the Irish tech sector our combined efforts in further developing the Irish national semiconductor sector wouldn't be possible.

With more than 50 years of innovation and experience in the semiconductor industry, AMD architects designs and delivers semiconductor products that help solve the world's biggest challenges. Over the next decade, high-performance and adaptive computing will be the enabling technology to support the adoption and responsible implementation of Artificial Intelligence and will be at the centre of nearly every major trend shaping the future. Intelligent, energy efficient semiconductor design will be crucial to the success of these ambitious goals.

With the acquisitions of Xilinx and Pensando Systems in 2022, and Mipsology, a French based leader in AI software in 2023, AMD now offers the industry's strongest ecosystem of high-performance and adaptive computing products spanning central processing units (CPUs), graphics processing units (GPUs), field programmable gate arrays (FPGAs), data center processing units (DPUs), and adaptive systems on chips (Adaptive SOCs). Bringing our intellectual property portfolio and leadership in the industry ecosystem, AMD collaborates with our customers and partners to advance innovation for Data Centre and Communications, Aerospace and Defence, Industrial, Test and Measurement, and Automotive. We see emerging workloads from artificial intelligence to smart networking and software-defined infrastructure.

Building an environment for a highly skilled workforce and engineering talent is the foundation for the successful development of next-generation silicon solutions in Ireland. AMD is investing in people, workforce skills and talent development in Ireland and other EU member states and is an employer of hardware and software engineers in the highly specialised field of high-end semiconductor design.

As Ireland is an important node in our global operations and a hub for semiconductor design excellence, we focus our comments on our shared interests on these topics:

1. *Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?*
2. *Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?*
3. *Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?*

1. *Aspirations for the Sector*

Embracing an open ecosystem focusing on research and innovation

AMD considers global industry standards a foundation for successful collaboration among stakeholders. Globally, AMD is known for its stewardship in promoting, developing, and driving harmonised standards that enable interoperability, fair competition, and innovation for the benefit of citizens and industry alike. We would encourage the Irish National Semiconductor Strategy to embrace an open ecosystem built on open standards for collaboration among partners to help foster chip design innovation for the benefit of end-users preventing lock-in and enabling competition.

Specifically, these are areas we would recommend the Irish government could focus on:

- Setting a national research agenda: We support the Irish government's initiative to developing a National Semiconductor Strategy that focuses not only on Ireland's strong manufacturing base, but also on advanced semiconductor research programmes. It is only by investing in world-leading capabilities in semiconductor product R&D and the associated ecosystem that the Irish semiconductor industry can be globally competitive and a leader in Europe.
- Building broad coalitions: Industry stakeholders and government organisations should team up to share the benefits of good jobs and educational opportunities.
- Focusing on education and the future workforce: We recommend that a portion of investment funds go towards creating advanced semiconductor research programmes at universities, fostering diverse student populations and creating national microelectronics training networks.
- Nurturing innovation: We recommend that investments are used to provide startup companies and academic researchers with financial support and essential access to state-of-the art prototyping tools and facilities.

With the European Chips Act, Europe is making available considerable funds for investments in semiconductor R&D initiatives and is creating platforms for work force training, skill and talent development. We believe that the Irish national semiconductor strategy should complement these priorities by creating a strong semiconductor R&D infrastructure, educating and training the next-generation semiconductor workforce, and driving a national research and innovation agenda.

Specifically, the Irish National Semiconductor Strategy should ensure allocation of a significant portion of available funding to directly fund a national research agenda. The research agenda should be broad in scope and address the following areas:

- energy-efficient computing architectures and domain-specific accelerators
- packaging and interconnect technologies
- design automation tools and methods
- semiconductor and system security
- materials, process, and manufacturing technologies
- semiconductors and life sciences.

Practical examples of applications include:

New HPC and AI Design

The combination of leading-edge silicon, advanced packaging, new interconnects, and new memories require new design approaches for the highest-performance HPC and AI systems. Focus is needed to evolve traditional processing elements like CPUs and GPUs to maximally extract performance from this new set of technologies. Additional research and development are required to further develop capabilities for other accelerators such as FPGAs and AI engines.

Application-driven Design Methods and Architectures

To enable the design of dependable and efficient systems that can handle the workloads of the post-Moore era, future architectures have to scale-up and -down, be secure, highly performant, and energy efficient. Testability, trust, and security should be considered, as well as the support of different levels of criticality. Models, tools, and methods supporting the system lifecycle, from requirements capture to design, emulation, test, programming, operation, and decommissioning are essential to unleash the full potential of the post-Moore compute architectures.

Advanced Packaging Technologies

Leadership capabilities in advanced packaging will be crucial for the integration of multiple silicon die or heterogeneous technologies to compensate for the slowing down of Moore's Law. Three-dimensional die stacking (in particular utilising hybrid bonding technologies) along with advanced high-density planar/wafer-level fan-out enable multiple silicon die, each optimised for specific functions, to be synthesised into a coherent computing solution with superior performance than could otherwise be achieved with a monolithic chip built from a single silicon process. Investments in advanced packaging are also necessary to ensure that the highest-performance silicon devices can be supported with matching power-delivery, cooling capabilities, and integrated memory solutions. We advocate for the establishment of additional capabilities in advanced packaging, assembly, and supply-chain security. A public-private model would require that a manufacturing partner be at the centre of this effort to ensure that the facility is properly focused on development of solutions capable of commercial-scale manufacturing.

New Interconnect Technologies

Leadership-class HPC and AI systems span thousands of discrete processor components, and the interconnect between the components threatens to limit the realised performance of future systems. Research and development are required to ensure low-friction data movement between components throughout the entire system. Silicon photonic and related optical technologies enable the massive composition of processors to offset the deacceleration of traditional silicon scaling. Investment in advanced interconnect within a processor package is likewise critical to enable multiple dies integrated with advanced packaging to function as a single logical high-performance component.

New Memory Technologies

The highest performance processors are already integrating advanced memory capabilities into the processor package. However, further enhancements are needed to enable memory to keep pace with the computational elements. Key technology needs include the development of hybrid bonding and aggressive stacking for denser memories, augmented and smarter memory architectures blending traditional data storage and delivery with new logic functions, and new memory devices to complement and potentially supplant conventional DRAM technologies.

Data Infrastructure, 5G/6G

Sustained focus is required for long-term competitiveness in wireless technologies such as 5G/6G and associated infrastructure. Strategic national compute capabilities, national security, and nearly all aspects of modern commerce and society depend on widespread and reliable access to high-performance data infrastructure. Research is needed in the underlying high-speed wireless circuits and electronics, advancements in wireless network architecture and management, edge computing, and new AI and Machine Learning (ML) capabilities to optimize increasingly complex networks.

Security

National security is dependent on the national compute infrastructure. Each link in the semiconductor design chain starting from initial design through deployment and usage represents potential risks to the security and integrity of computational capabilities. The increase in heterogeneity of systems, complexity of opaque AI and ML solutions, enormous volumes of data, and ever-evolving adversaries necessitate continued and expanded research efforts to research and develop new security standards and capabilities.

2. *Access to talent for businesses*

STEM education and skills development

Talent and skill development is one of the most critical elements of enabling innovative strength and growth opportunities for the national semiconductor ecosystem, particularly in semiconductor design. We welcome Ireland's focus on initiatives to foster workforce development. These programs can complement industry efforts.

We believe that diverse student populations and curricula focusing on advanced semiconductor research are crucial to making Ireland's workforce and future engineers fit for embracing the challenges but also harvesting the tremendous opportunities of the next decades of advanced computing.

For example, AMD in Ireland maintains university and school programmes as well as internships to foster and promote STEM skills among students. Examples include:

- Local extensive internship programmes at the AMD Ireland site
- University programmes, at many Irish universities:
  - Partnership with Maynooth University Foundation to encourage girls to study STEM courses - girls who complete the program earn a level 6 college accreditation.
  - Funding for a mobile computer lab to support the "Passport to STEM Program" which provides a pathway to STEM education for underrepresented girls.
  - 800 students were hosted in the AMD Dublin office part of the STEM Passport for Inclusion mentoring program. Over 30 AMD staff volunteers are participating as mentors.
- Membership in the Irish network Connecting Women in Technology (CWiT)[1] since 2018 which aims to attract, retain and promote women in the technology sector. As part of CWiT, AMD engages in the following educational programmes:
  - *Digital Futures*, a programme developed to raise secondary students' awareness of the diverse nature of career opportunities in the technology sector and promote STEM careers throughout Ireland. In the current academic year to date, AMD has helped deliver this programme in 19 schools reaching 1500 students.
  - *STEM Teacher Internship programme*, an initiative where pre-service teachers (both at primary and secondary level) are placed in technology companies for 12-week paid internships over the summer holidays where they can experience careers in STEM first-hand and return their experience to the classroom. Launched in 2016 in partnership with DCU, to date, 180 alumni STEM interns have completed the internship programme and, in turn, interacting with about 600,000 primary- and secondary-level students. In 2022,

[1] CWiT is a voluntary organisation that comprises of over 20 of the largest technology companies based in Ireland. The objective is to help provide employment for future generations but also support the growing tech workforce.

six colleges (DCU, MU, UCD, NUIG, UCC and UL) were part of the programme and it is to be expanded to nine colleges by 2025. Typically, a company will support one to two interns per year. In 2023, AMD hosted two intern students (one in engineering and one in Information Technology), and in 2024 AMD will host one intern student in engineering.

As highlighted above, industry in Ireland currently supports many valuable initiatives aimed at attracting and creating awareness of careers in the technology sector. However, industry is limited in the number of students that can be reached as many initiatives depend upon the location of participants who may not be physically nearby. We recommend that a National Semiconductor Strategy identifies and promotes impactful initiatives into the educational curriculum nationwide such as the establishment of a STEM-specific national career guidance counsellor pool that would be available to support secondary schools across the country. Industry continues to be available to share input from our experience but does not have nationwide reach, and such initiatives would provide more students access to STEM education independent of where they live or what school they attend.

Student preparedness and practical experience

From our company's experience in new college graduate recruitment and engagement with our technical employees in their first three years of post-college employment, we highlight the importance of students' experience and preparedness in practical, real-world applications of the theories learned in school. Toward this need, AMD sees value in internships and similar opportunities for "professional experience year" programs. If designed and implemented effectively, these initiatives can simultaneously create opportunities for advancing student skills in real-world situations while promoting the business value of diversity, belonging and inclusion in employer workplaces, among other benefits. We encourage a National Semiconductor Strategy to emphasise practical skills training.

Semiconductor workforce skills to enable the larger ecosystem

The semiconductor industry plays a critical role in enabling other industries, as well as advancing associated research, economic development and societal progress through digitalisation. Semiconductors have driven advances in communications, computing, health care, national security, transportation, clean energy, and countless other applications. And semiconductors are giving rise to new technologies that hold the promise to transform society for the better, including virtual reality, the Internet of Things, energy-efficient sensing, automated devices, and artificial intelligence. A highly specialised workforce represents a supportive pathway towards Ireland's global competitiveness in semiconductor technologies.

For a successful semiconductor R&D strategy, we encourage a focus on fostering education programmes in disciplines relevant to semiconductor design. For example, high-performance and adaptive computing requires engineers trained in software / compiler development, hardware and electronics as well as field application engineers. Interns and new graduates are often recruited from fields like computer and electronics engineering and science, software development, data science (especially machine learning), mathematics and physics.

AMD

3. Barriers to development

Access to and availability of skilled workforce and talent

We would encourage a National Semiconductor Strategy to also support and complement the EU's Proposal for the Creation of an EU Talent Pool which is intended to help facilitate international recruitment and providing job opportunities for jobseekers from third countries residing outside the EU having the skills required to work in shortage occupations including those for the high-tech sector. Specifically, the intended national contact points for the practical implementation at a national level and the registration of employers should be reflective of Ireland's strengths in the semiconductor industry and should focus on talent critical to semiconductor R&D as per above.

Thank you for your consideration of our input. I remain available to you.

Best,

Brendan Farley

Brendan Farley
AMD Corporate Vice President

About AMD in Ireland

AMD was established in Ireland as the result of the acquisition of Xilinx in 2022. Xilinx Ireland was established in Ireland in late 1994. It was the first company to take up residence in Citywest Business Campus in early 1995 which, at that time, was a brand new 'green field' location. During 1995/1996 the Company built and established its own 100,000 sq. ft. facility. It later expanded to 220,000 sq. ft. in 2003/04. At that time, it operated manufacturing, operations support, engineering, and administration services. Over the last 2 decades, Xilinx Ireland re-positioned its strategic direction to focus specifically on (a) sales and business development of the EMEA market and its teams; (b) its engineering capability through the development of its R&D teams, its XLABS research team, its design services and product application engineering teams; and (c) on corporate services for the EMEA region via its IT, Finance, Facilities, HR, and Legal functions.

Submission to Public Consultation on the Development of a National Semiconductor Strategy

March 2024

Background

Established in 2013, AMBER is the Science Foundation Ireland (SFI) Research Centre for Advanced Materials and BioEngineering Research hosted by Trinity College, University of Dublin, with researchers in 8 additional partner institution around Ireland: RCSI, UCC, Tyndall, DCU, University of Galway, University of Limerick, TUS and UCD.

The AMBER mission is ‘to partner with our member companies to deliver world-class materials innovations and translate these into impacts for economic, environmental, health and societal impacts, providing solutions through collaborative research’

AMBER mission

The Centre’s strategy reflects the three main pillars:

I. World-class materials innovation resulting from the excellence of our research which underpins everything we do,
II. Partnership and engagement with industry not only on collaborative research, but also to contribute to the ethos of the centre in terms of governance & strategy, emerging research challenges and researcher development, and
III. Impact with a focus on ensuring efficient translation of our research for economic, environmental, health and societal impacts.

We are at the forefront of driving advances in materials science and bioengineering and translating research excellence into new discoveries and devices. Our research develops technology to address industrial and global challenges from novel data processing and memory applications, energy storage and energy-efficient devices, regenerative medicine, and drug delivery systems through to plastics sustainability and supporting key national targets such as our zero-carbon 2050 target.

AMBER delivers a unique, integrated capability for materials research to accelerate innovation:

- Brings together Irelands leading researchers across nine higher education institutions
- Provides access to advanced facilities
- Provides a gateway to significant European funding
- Has a team of professional supports to scope, build, and ensure completion of projects to the highest standards, with IP and knowledge transfer capability.

In the area of semiconductors, AMBER scientists are established leaders in the area of nanoscale materials development for novel semiconducting, magnetic and spintronic devices. The centre has a long-established collaborative partnership with Intel, supporting the early-stage scientific breakthroughs which have enabled some of the technologies which are deployed in Intel chips today. More recently AMBER has added Analog Devices and Applied Materials to its partner portfolio and are actively growing these research programmes.

- **Aspirations for the sector** – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

The Irish semiconductor sector is strong, and we have two major chip manufacturers in Intel and Analog Devices servicing two distinct sectors. Intel at the highest performance chips for computing, artificial intelligence and future quantum computing devices. and Analog Devices at the semiconductors and integrated circuits for a range of applications from autonomous driving to smart gird infrastructure to digital health, these chips have a feature sizes and performance some 3-4 generations behind Intel chips. Coupled to this we have a growing number of fabless indigenous companies that use foundries to build their chips to design specifications. However, the move of Intel into Germany at scale for the highest specification integrated circuits is an issue. The move towards an Intel foundry at Leixlip is welcome but whether these will serve an Irish growing sector is unknown. There are therefore potential issues.

The potential and opportunities for the Irish semiconductor sector are significant. The priority must be anchoring and providing for growth at Intel and Analog Devices (ADI). It is critical that the Leixlip plant is maintained at the state of the art, producing the highest quality ICs. If the Irish semiconductor industry could be supported through investment in the building of a development IC fabrication facility (FAB) in Ireland capable of handling the next generation of silicon wafers and the ability to fabricate and characterise devices at the nanometre (nm) and sub-nanometre scale this would ensure growth and future investment. This would need to be supported by a strong research and higher education environment. This would have relevance to our current US multinationals Intel and ADI and our indigenous semiconductor design industry. Innovation and Growth of our indigenous sector would be further accelerated through access to enabling infrastructure with an Irish based foundry providing access to state-of-the-art chip design, silicon prototyping, advanced packaging and heterogeneous integration. This would augment the current capability based at Tyndall and is a pre-requisite if we are to scale Irish industry by a factor of 2-4 (which is entirely possible with a national fabrication facility) that we make investment. This would:

A) Attract new companies especially smaller growing companies
B) Position Ireland to be a leader in the development and manufacture for next generation semiconductor chips which underpin the rapid deployment of AI technologies and future quantum applications
C) Attract new researchers in academia and industry
D) Be a magnet for new engineers, students

With appropriate investment across infrastructure, associated facilities, research, and innovation we could scale both local and international industry.

- **Opportunities for the sector** – What do stakeholders identify as key opportunities for the sector to further develop?

As above it is possible to compete within both the advanced integrated circuit space (which in turn develops an entire value chain from users to customers through to material suppliers) and at the fabrication for application space. Both are needed. High grade manufacture attracts talent, catalyses the academic environment in terms of innovation and research and generates the entrepreneurs to exploit a potential foundry.

- **Challenges facing businesses and the sector** – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

  Challenges can be listed

1. Competition, internationally countries such as India are investing in semiconductor manufacture. In response to the US Chips Act the IBM led American Semiconductor Innovation Coalition brings together a consortium of companies to drive and focus federal investment in facilities including the $1bn investment in the Albany Nanotech Complex in upstate New York. Similarly the UK Semiconductor Infrastructure Initiative plans to invest £1 billion in the next decade to boost academic research and commercial innovation for start-ups/SMEs in providing access to design tools & IP, silicon prototyping, compound manufacturing and advanced packaging. Unless we make similar investments, these will become the preferred locations for foreign direct investment and nucleate an industry of foundry users attracting Irish nascent talent.
2. Providing enough well-trained engineers and scientists to feed a growing sector. This is already a critical issue for the wider science research and innovation sector nationally.
3. Providing the academic research to support a vibrant semiconductor economy. The research providers provide the talent that drives both FDI and indigenous industry. E.g. the AMBER Centre at Trinity have supplied more than 50 PhD graduates to Intel and Analog over the last 15 years. This is an industry that requires high-level training. Academia also supports industry R&D through collaborative work, access to facilities, consultancy, research networks, EU funding etc. E.g. AMBER scientists have been continually funded by Intel Ireland and Intel US for over 30 years. It is vital that exchequer funding to research institutes is improved to allow the research sector to compete at the highest level. The country should ensure that centres such as Tyndall and AMBER are funded continually and at a scale to compete with international centres such as IMEC, Cranfield (UK), Leti (France) to deliver the seamless transfer of talent and research between industry and academia. The focus on both areas of pilot scale manufacture (Tyndall) and fundamental materials research and characterisation (AMBER) that drives next generation devices is critically needed. The obsolescence profile of our research infrastructure means that Ireland will struggle to meet the needs of our companies such as Intel for research output which is relevant to their current technology needs with a risk of losing this investment to other countries.
4. The ability of the education and research providers is challenged by lack of access to the complex fabrication and characterisation tools needed to develop the skills required. The lack of investment in infrastructure at 3rd Level has eroded our ability to meet these needs. In this critical sector, appropriate training is pivotal. As above, good infrastructure attracts the best students and professors to maintain a robust talent pool.
5. Critical expertise in skills in sustainability, the circular economy, measurement and assessment of environmental damage are needed. This is an area poorly developed in Ireland and the greatest challenge to the industry (see below). The biggest challenge to

sector is the sustainability of semiconductors and their manufacture. Current estimates show the semiconductor and ICT industry account for up to 5% of all global emissions and that is likely to quadrupole to 20%+ by 2050.

- **Access to talent for businesses** – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

Skills across engineering, electrical engineering, chemistry, physics, materials science and sustainability are all needed. Since the 1990s more and more Integrated Circuit (IC) fabrication has been based around chemical processes rather than engineering and this will continue as more sustainable methods are delivered. Physics is needed for fundamental learning and materials science to develop ever more functional materials such as magnetics.

Training levels are normally graduate, post-graduate and post-doctoral. Investment in PhD, MSc and diploma courses are needed and built around the required levels of infrastructure. Courses need to be earmarked for funding to develop graduates that are informed of industry needs. Dedicated courses need to be developed and funded. The education sector lacks the vital tools for this.

- **Barriers to development** – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

These have been addressed above.

- **Mitigation** – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

The Government must make a clear decision to provide the funding to drive the scaling of the semiconductor economy in Ireland:

1) Create a stakeholder group of industry, academia, Government issues to guide decision making, set priorities and goals
2) Invest in or co-invest in an innovation linked foundry for designer IC manufacture
3) Proved education funding aimed at CPD, diploma, MSc and PhD levels. The current numbers of these need to be at least doubled to meet current demand
4) Provide research funding to develop world class centres in fabrication and materials research
5) Create an earmarked funding for work in these areas
6) Task the Expert Group on Future Skills Needs to review current landscape regarding education, workforce, and make recommendations on needs to improve to reach the goal of making Ireland a leader within the Semiconductor sector
7) Review the National Training Fund to allow for allocation of funding for training (and infrastructure vital to this) to facilitate this strategy

We welcome the opportunity to contribute to this consultation on the Development of a National Semiconductor Strategy, which we hope will be the first of many engagements with stakeholders and experts as Ireland seeks to establish this vital strategy.

Submission by: Professor Mick Morris AMBER Director, Dr Lorraine Byrne AMBER Executive Director and Amy Sweetman Communications & Public Affairs Manager on behalf of the AMBER Centre.

www.amcham.ie @americanchamber

Public consultation on the development of a National Semiconductor Strategy

Submission from American Chamber of Commerce Ireland (AmCham) to the Department of Enterprise, Trade and Employment.

March 2024

The American Chamber of Commerce Ireland
The Voice of US-Ireland Business

The American Chamber of Commerce Ireland (AmCham) is the collective voice of US companies in Ireland and the leading international business organisation supporting the Transatlantic business relationship. Our members are the Irish operations of all the major US companies in every sector present here, Irish companies with operations in the United States and organisations with close linkages to US-Ireland trade and investment.

The American Chamber of Commerce Ireland (AmCham) welcomes the opportunity to make a submission to the Department of Enterprise, Trade and Employment in relation to the development of a national semiconductor strategy. The focus of this submission is on key areas in the semiconductor industry and aims to provide insights and recommendations to support the growth and development of the semiconductor sector in Ireland.

AmCham believes Ireland has the potential to serve as a global hub for innovation, research, and development. This would further solidify Ireland's position as a leading destination for semiconductor companies, attracting investment, fostering collaboration, and driving technological advancements that benefit both our economy and wider society.

US MNCs in Ireland regularly site access to talent, necessary infrastructure, and global competition as important aspects to enable them to expand in Ireland. At the overarching level, Ireland's semiconductor sector must specifically address barriers related to skill shortages, regulatory complexities, and infrastructure constraints to sustain growth and competitiveness in the long term.

Economic Opportunity

The European Chips Act presents a significant economic opportunity for Ireland, positioning the country to capitalise on its strengths within the semiconductor industry. As a hub for major multinational semiconductor companies, Ireland is well-positioned to leverage the Act's substantial public and private investments, estimated at over €43 billion, to bolster its semiconductor ecosystem. The Act's focus on fostering innovation, enhancing technological capabilities, and addressing supply chain vulnerabilities aligns with Ireland's strategic goals of promoting research, development, and innovation. By tapping into these investments, Ireland can further develop its semiconductor sector, create high-skilled jobs, attract talent, and strengthen its position as a global leader in semiconductor technology. Additionally, Ireland's established infrastructure, supportive regulatory environment, and skilled workforce make it an attractive destination for semiconductor companies looking to expand their operations within the EU.

Talent

The semiconductor industry in Ireland is a significant contributor to employment, with over 20,000 individuals employed in this sector. Among these, approximately 6,500 are engaged in highly skilled technical roles, while another 3,000 are dedicated to research and development activities.[1] Investing in Ireland's talent and human capital is vital to unlocking the full potential of the semiconductor sector within the country. AmCham

[1] https://www.tyndall.ie/contentFiles/Tyndall_Ireland's_Role_in_the_Global_Semiconductor_Industry.pdf

members consistently identify talent attraction as one of the three foremost challenges to growth and investment in Ireland. Upskilling and lifelong learning is crucial in future-proofing the global talent pipeline, ensuring that Ireland remains competitive in the evolving semiconductor landscape.

Collaboration between industry and academia is important for nurturing world-class talent, facilitating knowledge exchange, and addressing emerging skills needs. Ireland's highly educated talent pool, coupled with extensive engagement with tertiary education, positions it favourably in attracting and retaining international talent. As Ireland ranks first globally for knowledge diffusion and absorption, it is evident that the country is well-equipped to foster a dynamic and innovative semiconductor ecosystem through continued strategic investments in talent development and collaboration initiatives.

The evolving nature of the semiconductor industry necessitates a focus on skills needs across training, education, and research. A coordinated STEM agenda for schools and universities, developed in collaboration with industry stakeholders, will be important in supplying a pipeline of skilled professionals for the semiconductor sector in Ireland. AmCham recommends appointing a National Champion for STEM to support talent development, build awareness of career opportunities, and support collaboration between industry and academia.

Research, Development and Innovation (RD&I)

Ireland's potential in Research, Development and Innovation (RD&I) for semiconductors is substantial. While the feasibility of funding a competitive fabrication facility may be limited due to cost and scale constraints, Ireland can capitalise on its strengths in R&D. Certain US MNCs have already demonstrated this potential by heavily investing in the development of RD&I centres in Ireland. Ireland's robust infrastructure, skilled workforce, and supportive regulatory environment position it as an ideal location for further RD&I investment within the semiconductor sector. By focusing on R&D, Ireland can continue to drive innovation, attract talent, and strengthen its position as a leading player in the global semiconductor landscape.

The European Chips Act is designed to stimulate innovation and bolster technological capabilities within the EU. This legislation aims to enhance Europe's competitiveness and resilience in semiconductor technologies, facilitating the transition towards both digitalisation and sustainability. The allocation of additional EU funding to support RD&I endeavours represents an avenue where the Chips for Europe initiative could substantially enhance Ireland's sectoral development, propelling advancements in chip design and manufacturing capabilities.

International Supply Chains

Semiconductor supply chains extend far beyond fabrication facilities, encompassing critical stages such as testing and packaging. Given their global reach, Ireland must engage in collaborative efforts with like-minded governments to craft comprehensive strategies. Attempting to independently establish fabrication facilities in every country is impractical; instead, a holistic approach that addresses the entirety of the ecosystem is essential. By joining forces with other nations, Ireland can pool resources, prevent duplication of efforts, and capitalise on collective strengths to further develop the semiconductor industry.

Furthermore, the existing supply chain, encompassing chip design, production, and distribution across Europe, must be expanded and refined within the broader European ecosystem. AmCham advocates for a regulatory framework that fosters collaboration among businesses of varying sizes and functions within this ecosystem, ensuring optimal outcomes and innovation.

As the European Chips Act focuses on regional development, it is crucial to acknowledge the global nature of supply chains, highlighting the significance of the transatlantic relationship. Collaboration through entities like the EU-US Trade and Technology Council presents opportunities to fortify supply chains and mitigate vulnerabilities.

Key Recommendations

- Prioritise talent attraction and retention efforts to address skill shortages, regulatory complexities, and infrastructure constraints, ensuring Ireland's semiconductor sector remains competitive and sustainable in the long term.
- Implement a coordinated STEM agenda for schools and universities in collaboration with industry stakeholders to cultivate a pipeline of skilled professionals for the semiconductor sector, supported by the appointment of a National Champion for STEM to drive talent development and collaboration initiatives.
- Capitalise on Ireland's potential in Research, Development, and Innovation (RD&I) for semiconductors by focusing on R&D investments, leveraging existing strengths in RD&I clusters.
- Strengthen collaboration and partnerships with like-minded governments to develop complementary strategies and avoid duplication of efforts in semiconductor development, recognising the global nature of semiconductor supply chains and the importance of coordinated action at an international level.
- Improve infrastructure and facilities to support semiconductor manufacturing, testing, and packaging operations, ensuring that Ireland has the necessary capabilities and resources to support the growth of its semiconductor sector in the years to come.

Analog Devices International: Response to the Department of Enterprise, Trade and Employment's Public Consultation for the development of a National Semiconductor Strategy for Ireland.

Analog Devices in Ireland

Analog Devices Inc. (ADI) is a global semiconductor leader that bridges the physical and digital worlds to enable breakthroughs at the Intelligent Edge. ADI combines analog, digital, and software technologies into solutions that help drive advancements in digitised factories, mobility, and digital healthcare, combat climate change, and reliably connect humans and the world.

ADI has been a key player in the Irish FDI and semiconductor ecosystem for almost five decades, employing over 1,800 people in Ireland. Our fully integrated marketing, design, wafer fabrication and quality facility has been operating in Raheen Business Park, Limerick, where our EMEA HQ is located, since 1976.

In 2015, ADI launched its European Research and Development Centre, which develops technology and includes the assignment of more than 1,000 patents. In 2022, our company announced its intention to invest €100 million in ADI Catalyst, our custom-built Limerick facility for innovation and collaboration.

Most recently, in 2023, the European Commission, in conjunction with the Irish Government, announced a proposed €630m investment to construct a new, state-of-the-art Research & Development and manufacturing facility at our Limerick site, which will support the development of next-generation signal processing innovations, designed to accelerate the digital transformation of a number of sectors. The investment, made possible through the Important Projects of Common European Interest in microelectronics (IPCEI-me) initiative. It is also expected to triple our European wafer production.

"Semiconductor technology is the bedrock of important applications in medicine, energy, communications, and automation. Essentially, the strides that we need to make in improving the health and welfare of humans and the planet will rely on continued advances in this critical foundational domain. It is expected that the semiconductor industry will double in size over

the next decade to $1 trillion, and the US and EU Chips Acts are an essential step in this growth. ADI's recent investment of €630 Million in a next-generation semiconductor R&D and manufacturing facility in Limerick is our latest commitment to strengthening the future of innovation in Ireland.[1]*"*

- *Vince Roche, CEO and Chair of Analog Devices;* Launch of Tyndall Institute's White Paper on 'Ireland's role in the global semiconductor industry'

Semiconductor Industry in Ireland

The semiconductor industry is critical to Ireland's economic success – and therefore, the Irish Government should strive to create an optimal environment and strategy, given the sector's vital importance.

On an industry wide basis, the semiconductor sector employs over 20,000 people in Ireland – and is responsible for €13.5 billion of exports annually (approximately 7% of Ireland's GDP in 2023). To put this figure in context – in 2023, the semiconductor sector's worldwide revenue reached $601.7 billion, marking a significant 100.6% rise since 2012. Despite the industry's cyclical nature, market analysis indicates that the aggregate annual growth rate could potentially average between 6% and 8% per year until 2030.

However, while the Irish semiconductor industry has returned strong figures for the Irish and broader European economy, there can be no doubt that further action is required to strengthen Ireland's position in the sector.

ADI supports the Tyndall National Institute's suggestion that *'Ireland can and must build on its strengths in chip design, deep-tech, smart manufacturing and chip fabrication to strengthen and grow its technology sector.*[2]*'*

ADI believes that several key factors contribute to a country's success in attracting semiconductor and microelectronic investments:

- A continued focus on Sustainability with a particular focus on advanced manufacturing sustainability while aligning to Europe's 'Net Zero Industrial Act'
- A high quality education system with sufficient availability of digital natives and technological graduates;
- A Strong academic research environment with the necessary funding of excellent research;

[1] https://www.tyndall.ie/news/tyndall-calls-for-a-chips-strategy-for-ireland/
[2] https://www.tyndall.ie/contentFiles/Tyndall_Ireland's_Role_in_the_Global_Semiconductor_Industry.pdf

- A comprehensive national industrial policy that allows for the recruitment of skilled staff to manufacture and to export;

- The availability of technology transfer mechanisms which allows academic research to develop into commercial products and solutions – based on solid interactions between the public and private sectors;

- A framework that encourages investments in innovation; and

- A flexible and speedy regulatory framework combined with a solid R&D budget that allows for fast uptake of new technologies.

This success can only be achieved by having a clear and long-term vision of how these building blocks fit together to create an environment for semiconductor competitiveness, where Ireland not only attracts FDI but also has the best chance of retaining it. Therefore, ADI welcomes the commitment of the Irish Government to taking full advantage of the opportunities offered by the European Chips Act – and to meet ambitions for the sector.

Semiconductor Industry in Europe

Europe is critically important for ADI as a manufacturing and innovation hub within our global supply chain. ADI believes that the European Chips Act, which entered into force in September 2023, is an enormous leap towards building critical European strategic autonomy and resilience, while ensuring that EU Member States can partner with companies like ADI to co-fund, co-innovate and rapidly scale up Europe's advanced technology and engineering capacity.

We believe that this will allow the EU to increase technological leadership and further develop an ecosystem around the semiconductor industry – including research and development, and training for talented and skilled European workers. For example, ADI is already sharing the benefits of collaboration with partners such as Fraunhofer, the Interuniversity Microelectronic Centre (IMEC), KU Leuven, CEA Leti, and University of Limerick as part of our own dynamic ecosystem, which includes co-innovation we're undertaking with some of Europe's leading companies.

Furthermore, ADI has a strong working relationship with the Tyndall National Institute and the University of Limerick which enables us to collaborate on core technologies of mutual interest for communications, energy, agri-tech and advanced manufacturing along with Software and AI talent to enable the Intelligent edge. The semiconductor industry requires the pooling of knowledge and expertise between academia and industry – including research, intellectual property development and talent acquisition. Therefore, we believe that the creation of semiconductor strategy can lead to further instances of greater collaboration, innovation, investment and a bright future for the Irish and European semiconductor sectors.

National Semiconductor Strategy for Ireland

ADI respectfully submits that any national strategy needs to be centred around growing the microelectronics and semiconductor sector by harnessing Ireland's world-famous innovation environment; build Ireland's supply-chain resilience; create a pipeline of skilled talent.

ADI therefore calls on the Government to consider the inclusion of the following action points into the national strategy:

Establish a cross-departmental/agency group

While the Department of Enterprise, Trade and Employment is conducting this particular consultation, ADI believes that a cross-departmental/agency group should be established to oversee the development and implementation of this strategy.

ADI believes that the creation of such a group will allow for greater collaboration between government, industry and academia to ensure that any strategy will be as robust and ambitious as possible. Possible stakeholders could include high-level representatives from both Departments, key semiconductor companies with a presence in Ireland; public research representatives, IDA Ireland and Enterprise Ireland.

ADI believes that any strategy needs to be supplemented by realistic action plans – set out with clear timeframes and dedicated owners for each action point.

Increased investment in R&D

The establishment of the new Department for Further & Higher Education, Research Innovation, and Science presents a significant opportunity. By consolidating a department dedicated to positioning Ireland at the forefront of global scientific and technological progress, we can leverage our foundation of world-class research more effectively. This will enable us to optimise current R&D efforts to better serve the semiconductor sector's needs and align with the goals of a new semiconductor strategy.

All efforts should be made for Ireland to join Belgium, Denmark, Finland and Sweden in the 'Innovation Leader' category within the European Innovation Scorecard. To improve performance, Ireland needs to improve on Government support for business R&D, business R&D expenditures, employment in innovative enterprises, sales of innovative products and environment-related technologies.

Ireland must meet its target to invest 2.5% of the value of the domestic economy in research and innovation. In this regard, Ireland could be more engaged in providing financial support under Pillar I of the EU Chips Act, the Chips for Europe Initiative. Ireland must first push for its champions to play a proactive role in the upcoming Chips Joint Undertaking pilot lines; and further non-initiative calls. Such an effort must be bolstered by strong financial contributions for Irish organisations taking part in Chips Joint Undertaking calls.

Create a pipeline of skilled talent in Ireland and the EU
Skills are a fundamental building block underpinning the semiconductor sector at every stage from research, development, and innovation, through to commercialisation and industrial scale up. However, from our engagement with industry it is clear that Ireland needs to do more to sustain and grow the pipeline of talent available to industry so that the sector has the people it needs to scale up.

The semiconductor sector depends on a pool of highly skilled intellectual talent, typically at a postgraduate level (including doctoral or masters qualifications), as well as positions at the operator and technician levels. Addressing the demand for skills and potential shortages is multifaceted and usually requires vocational studies in addition to graduate and postgraduate qualifications. The industry is increasingly reliant on foreign talent, posing several challenges in a market with high global demand. As the sector expands worldwide, this challenge is expected to intensify with heightened competition.

Harnessing Digital, Ireland's Digital Strategy, has committed to raising the base level of digital skills of the next generations to enter the workforce – as well as ensuring adequate reselling of the current workforce. By doing this, Ireland can maximise the use of existing, acknowledged routes to increase the number of people ready to get well-paid jobs in the semiconductor sector, programmes such as the Immersive Software Engineering Masters course in the University of Limerick is a testament to innovative think and should be replicated where possible while maintaining it's exceptional quality.

ADI is similarly supportive of the proposed competence centres set out under Pillar I of the EU Chips Act, the Chips for Europe Initiative. ADI believes that Europe must promptly allocate resources towards innovation initiatives to tackle shortages in semiconductor skills. This will facilitate the development and subsequent dissemination of course content and materials aimed at bolstering skills, talent, and training within semiconductor manufacturing and supply chains. By doing so, we can raise awareness of the opportunities within the semiconductor industry and bridge crucial gaps in Europe's workforce talent and training capacities.

Adequate funding and reskilling within the Irish higher/further education sector
Ireland needs to ensure that it continues to increase heavily in the further and higher education sector to support high quality teaching and facilities in higher education. Support for engineering, physics, and electronics needs to form a central part of this funding in order to allow Ireland to boost the pipeline of talent available to the semiconductor sector.

The Government needs to also continue to ensure that the apprenticeship sector is fully supported and that capacity restraints are resolved. This will ensure that occupational standards for apprenticeships and other higher technical qualifications required by ADI and other employers in the semiconductor sector are met.

Explore measures to incentivise/fund increased capacity of semiconductor manufacturing in Ireland
ADI believes that the Government needs to establish dedicated funding streams that will promote the expansion of enterprises within the semiconductor sector that possess innovative capabilities.

European industry needs reliable access to a wide spectrum of semiconductors, including those made by ADI, which will power industry 4.0. It is important that the EU builds capacity right across the spectrum – and Ireland needs to play its role in achieving this.
However, the development of semiconductor technology requires substantial capital investment. Challenges in accessing software tools and manufacturing equipment for designing, prototyping, piloting, and producing innovations pose significant barriers to the sector's expansion.

The Irish Government should provide support to firms as laid out under Pillar II of the EU Chips Act, which focuses on security of supply and resilience. Where firms successfully obtain the status of "integrated production facility" (IPF) or "open EU foundry" requisite financial support should be made available to cover any potential funding gap faced by firms.

Furthermore, it is no secret that the EU Single Market is evolving at pace – as is the European investment environment. ADI is proud to call Ireland 'home' – given our strong Irish workforce and location of our EMEA operations – however, we believe that Ireland has the potential to be a European and global hub for the wider semiconductor industry. Many companies often view Ireland as an attractive location for FDI – but this does not necessarily mean that Ireland is always seen as the *most* attractive, which could make the difference in terms of adding new and expanded investments.

ADI believes that the Government needs to carefully examine ways to ensure that Ireland's competitiveness continues to grow and evolve in line with the global economic environment. Therefore, as part of this strategy, the Government and the IDA should carry out a strategic review of recent European semiconductor announcements outside of Ireland to understand ways in which to improve its competitiveness – in terms of infrastructure requirements, provision of key utilities, and a roadmap towards ensuring low-barrier access to affordable and low-carbon energy.

Examine additional ways to mitigate against supply chain risks

As evidenced by the shortages experienced during the COVID-19 pandemic, disruptions in chip supply have significant economic ramifications across various high-tech sectors. Hence, ADI believes that the Irish government should establish a collaborative forum with industry stakeholders to assist these vital sectors in safeguarding their supply chains and ensuring uninterrupted access to chips. This will serve to complement the monitoring and crisis response mechanism set up under Pillar III of the EU Chips Act.

This proactive approach will enable companies to enhance their preparedness for future disruptions. The government should explore the development of specific guidance on semiconductor resilience to enhance the Irish industry's comprehension of potential risks to semiconductor supply chains and strategies to mitigate such risks. Such measures may include enhancing supply chain transparency, and streamlining components to minimize exposure to risks.

Of particular importance to ADI in Ireland is the facilitation of a secure and reliable supply of semiconductors on industrial nodes (higher geometry nodes) with a rich suite of capabilities to address the requirements of real-world signal processing. These integrated circuits help support the delivery of clean, efficient, sustainable, and fully automated manufacturing at scale. They will also support leading EU companies working to improve the smart technology that lowers energy emissions from electric vehicles, supports the delivery of digital healthcare and underpins next generation 5G telecommunications, among other challenges.

Keeping sustainability high on the agenda for the semiconductor sector

ADI has an excellent story to tell in terms of our global sustainability efforts. Given that national and international climate targets have been set by policy and decision makers, it is only right that sustainability, decarbonisation and clean green technology are to the fore in all areas of a national semiconductor strategy. The Government and the IDA need to continue encouraging and incentivise sustainable thinking in terms of how raw materials and water are sourced; in terms of minimising greenhouse gas emissions and waste; in terms of how local ecosystems can be protected and preserved; in how its suppliers and wider supply chains are impacted; and in terms of its wider corporate responsibility.

The introduction **of streamlined application and collaboration processes to build Ecosystems at scale** would be a key innovation to consider for Ireland to enhance the semiconductor area . With the removal of funding barriers and easier cross-sectoral collaboration, Ireland can promote innovation and accelerate the translation of research outcomes into tangible societal benefits.

Introduction to Atlantic Bridge

Atlantic Bridge is the leading seed to growth capital deep tech investor in Ireland having invested in over 100 deep tech companies globally. Atlantic Bridge has over €1 billion assets under management across 8 funds raised from leading institutional investors including the Ireland Strategic Investment Fund, Enterprise Ireland, and the European Investment Fund. Our senior team of 30 professionals is underpinned by a global investment platform across 5 offices in Europe and the US.

Atlantic Bridge has consistently been at the forefront of building and scaling cutting-edge semiconductor companies over the last three decades, investing in more than 30 semiconductor companies in Europe, the UK and the US. This includes investing in highly successful Irish semiconductor companies and Irish entrepreneurs such as Decawave acquired by Qorvo and Movidius acquired by Intel. We have invested in several other successful semiconductor companies including Navitas, IPO on Nasdaq, Lion Semiconductor acquired by Cirrus Logic, Nuvia acquired by Qualcomm, Glonav acquired by NXP and SambaNova Systems, an AI chip company, that's raised over $1bn to date.

The Atlantic Bridge investment team has unique semiconductor expertise with decades of extensive executive and engineering experience in the semiconductor sector at companies such as Parthus, Philips, Texas Instruments and Analog Devices. Atlantic Bridge is also a founding member of DETECT, a network of deeptech VC investors in Europe with a mission to nurture and scale deep tech startups in Europe.

Importance of Semiconductors to Ireland and the €43Bn EU Chips Act

Global semiconductor chip sales reached well over $500bn in 2023 and semiconductors could become a trillion-dollar industry by the end of the decade, according to consultants McKinsey[1]. Chips are strategic assets driving the proliferation of AI across industries and are the building blocks upon which fast-growing sectors rely including autonomous vehicles, quantum computing, cloud computing, internet of things, high-speed connectivity, space and defence. New innovations in chip design for power efficiency are incredibly important to enable the green transition of many industries. The EU's ambition from the €43Bn Chips Act is to grow Europe's share of the global chip market from 10% to 20%, underpinned by its commitment to investing in next-generation manufacturing/fabrication facilities and innovative start-ups, scale-ups and SMEs that strengthen Europe's research and technology leadership towards smaller and faster chips.

The semiconductor sector in Ireland employs over 20,000 people, many of these jobs are in highly skilled technical and R&D engineering roles. Estimates from the Tyndall National Institute suggest the Irish semiconductor sector generates €2Bn in economic activity, with R&D spend of c.€450m[2], or approximately 10% of Gross Expenditure on R&D across all sectors in Ireland in 2023.[3] In addition, Ireland exports €13.5 billion worth of semiconductor products annually.[4] Given

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[1] https://www.mckinsey.com/industries/semiconductors/our-insights/the-semiconductor-decade-a-trillion-dollar-industry
[2] https://www.tyndall.ie/contentFiles/Tyndall_Ireland's_Role_in_the_Global_Semiconductor_Industry.pdf
[3] https://www.gov.ie/en/press-release/36f2c-minister-harris-welcomes-record-levels-of-spending-for-research-and-developmentrd/
[4] https://www.gov.ie/ga/preasraitis/f0b8b-minister-coveney-welcomes-the-european-commissions-approval-of-government-supported-semiconductor-investment/

the strategic importance of semiconductor chips to so many sectors, Ireland has a unique opportunity to build on its strengths in design, smart manufacturing and chip fabrication to strengthen and grow its technology sector. This will have a positive impact on the broader innovation activity across multiple industries.

Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

- 'Fabless' chip companies design, develop and market semiconductors for various high-value market applications, but do not fabricate/manufacture them. Some of the largest fabless chip companies in the world include Nvidia, AMD, Qualcomm and Broadcom, worth a combined $3.5 trillion in market capitalisation. Fabless chip companies can be established with investment from tens to hundreds of millions of euros rather than billions needed for manufacturing and fabrication, which is dominated by multi-billion dollar companies with high barriers to entry. This level of capital requirement means the only viable business model for a vibrant indigenous semiconductor sector is fabless.
- Silicon Valley is the main driver of innovation in semiconductors which is primarily driven by new fabless chip startup companies. They form an important part of the overall semiconductor ecosystem alongside the larger more established fabrication companies, such as Intel and TSMC, and are the main engine of innovation and value creation. Outside Silicon Valley, Ireland is recognised as one of the strongest semiconductor clusters, but for this to continue to be the case innovative new fabless chip startup companies must be funded to flourish and grow. Supporting investment in the fabless sector will facilitate the creation of the next generation of fabless chip companies, empowering a new generation of entrepreneurs and creating high calibre engineering jobs with deep roots in Ireland. This will also benefit the broader semiconductor ecosystem in the country because having a vibrant startup industry is important to drive innovation and attract young talent into the industry.
- Historically there has been a strong base of successful indigenous semiconductor companies in Ireland, many of whom were backed by Atlantic Bridge, including Parthus Technologies - $2Bn IPO on Nasdaq, Movidius acquired by Intel, Decawave acquired by Qorvo and GloNav acquired by NXP. These companies grew to create hundreds of high-tech jobs in Ireland and shipped millions of products to global customers. Employment at Movidius grew by approximately 3 times following the acquisition of the company by Intel. Indigenous semiconductor companies are the lifeblood of the sector's innovation. For example, Movidius' low power edge processors, the Myriad range of vision processing units, continues to drive revenue in Intel's AI computer vision product line. Similarly Decawave's ultra-wideband chip technology for precise location in mobile devices remains a core product of acquirer Qorvo, a leading global semiconductor company with over $3Bn in revenue.
- Disruptive industries such as Artificial Intelligence and Quantum Computing are underpinned by the semiconductor industry and it is vital that Ireland stays at the forefront of these emerging industries. Startups are the main drivers of this innovation globally. Ireland needs to nurture and develop new startups as well as the entrepreneurs, engineers and scientists that are key to their success. This in turn benefits the multi-national companies based in Ireland creating a virtuous circle of new innovations that can be acquired by larger companies, as well as the potential to grow some of these startups into large multi-national businesses themselves.

Opportunities for the sector – What do stakeholders identify as key opportunities for the sector to further develop?

- Chip manufacturing is necessary but not sufficient on its own to build a buoyant indigenous semiconductor industry. The smartphone industry, the 4G/5G telecoms industry and the massive growth in the AI sector has been possible because of the fabless model. The EU and UK combined represent less than 1% of the world's fabless chip companies by turnover, according to a European Commission JRC Technical Report on the position of the EU in the semiconductor value chain, published in 2022[5]. This is in stark contrast to Europe's share of the global fabless chip market in 2000 of almost 20%, according to a report from consultancy firm Kearney[6]. Ultimately it is the fabless chip companies that create the most value and unique IP in the semiconductor value chain and where strategic autonomy is most important.
- Creating and scaling the next-generation of semiconductor fabless chip companies in Ireland is a significant market opportunity. Many of the world's most valuable semiconductor companies today are fabless chip companies built and scaled in the US including Nvidia, AMD, Qualcomm and Broadcom. Over the past 30 years, the primary driving force for the semiconductor industry has been the fabless chip model. Fabless chip companies are the core of an indigenous semiconductor industry.
- There is significant opportunity to leverage the knowledge and skills within the Irish semiconductor sector to dramatically grow an indigenous fabless industry. The fact that Ireland has such a vibrant multinational semiconductor sector, underpinned by a well-established publicly funded research ecosystem with centres of excellence such as Tyndall, IPIC, MCCI, CONNECT and AMBER, puts Ireland in a very strong position. Having a research community that understands the key challenges for the sector is a big advantage in the creation of viable semiconductor start-ups addressing large market problems.
- Ireland could create a world-class start-up fabless semiconductor cluster through replicating needs-led innovation programmes like BioInnovate in the Healthcare sector, which has been very successful generating more than 30 new start-ups, attracting investment of almost €300m and training 150 highly skilled individuals/fellows. Now is an opportune time to create and scale new Irish semiconductor companies from a world-class research base, a highly supportive ecosystem for researchers, leading technical talent, advanced manufacturing facilities and specialist venture capital investors with unique sectoral expertise.
- There are already examples in Europe of where this approach to building an ecosystem of semiconductor multinationals, start-ups, research and investors has been highly successful. Imec in Belgium has unique infrastructure that includes a €2.5Bn semiconductor pilot line, more than 5,500 expert scientists and over 600 world-leading industry partners. Imec has created approximately 30 new deep tech ventures in the last 5 years alone, raising over €350m. Ireland has the building blocks to replicate this model of creating a highly supportive ecosystem for fabless semiconductor start-ups.

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[5] https://joint-research-centre.ec.europa.eu/system/files/2022-04/JRC129035.pdf
[6] https://www.kearney.com/industry/technology/article/-/insights/europes-urgent-need-to-invest-in-a-leading-edge-semiconductor-ecosystem

Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

- The number of Irish semiconductor start-ups that have been founded and reached global scale has declined in recent years, an opposite trend to what Atlantic Bridge is seeing in other parts of Europe and the US. Whilst Ireland has a very strong ecosystem of fabrication plants (fabs) and research centres of excellence with core expertise in chip integration, sensing and photonics, Ireland needs more investment in creating and scaling indigenous semiconductor companies to take advantage of the significant opportunity in the global supply chain and Europe's expansion of semiconductor capacity through the EU Chips Act. Ireland can play a key role in this highly strategic sector for Europe, not only through its base of multinational semiconductor companies but also the start-up ecosystem.

Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

Access to Funding

- A key challenge for semiconductor start-ups is raising sufficient funding, particularly at the early-stage of a company's development, to de-risk the chip development pathway before a company has customers. For example, several prototype runs in a fab can require millions of euros in capital expenditure. Getting access to production within large multi-national fabs and chip design tools is also a key challenge for start-ups and SMEs. Having a supportive funding environment from both public and private sources, is crucial to the development of new innovations and growth of fabless chip start-ups. An indigenous base of experienced semiconductor investors is also critical for the future potential of the start-up semiconductor sector.

New Technology Development

- The journey for semiconductor businesses can take longer cycle times to establish business models, build commercial teams and demonstrate customer traction than is the case for businesses in other sectors. Semiconductor companies have a higher barrier to entry and building defensible IP and R&D is resource intensive. Getting access to chip design tools, test services, packaging and product qualification is also a significant challenge and cost for start-ups and SMEs.

Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

1) Supporting venture capital funds with an expertise in semiconductors to invest in Irish fabless chip startups is critical to enable the next generation of startups to emerge. Government agencies such as Enterprise Ireland, through the Seed and Venture Capital Scheme, and the Ireland Strategic Investment Fund, are important anchor investors alongside the European Investment Fund. Additional financing can also be leveraged through the EU's planned €2bn 'Chips Fund' to increase the amount of funding available.
2) Direct equity investments through Government agencies such as Enterprise Ireland and Ireland Strategic Investment Fund, R&D funding and enhanced tax credits and incentives will play a crucial role in developing the national semiconductor sector in Ireland. We are

seeing significant capital being invested in deep tech venture capital funds and directly in semiconductor start-ups in countries like the UK, France, Germany and Netherlands, Belgium, and Finland.

3) Multinational companies continue to invest billions in their facilities and operations in Ireland with substantial support from the State. Allocating a portion of those investments to support the start-up fabless sector, through proof-of-concept funding directly to start-ups, and/or investments in venture capital funds investing in Irish fabless companies, is a key action that could be taken and incentivised by Government, including agencies such as IDA and Enterprise Ireland. Providing access across Europe to design tools and pilot lines for the prototyping, testing and experimentation of cutting-edge chips is one of the key proposals in the EU Chips Act.
4) Research centres of excellence in semiconductors, for example Tyndall in Cork, can set-up entrepreneurial fellowship and incubation programmes where funding is provided to high potential individuals that have the firm intention of creating a fabless semiconductor start-up. This funding would be provided solely for the purpose of developing the technology and commercial potential to create a spin-out company. This may be funded by the research centre itself and/or centrally funded by Government agencies such as Enterprise Ireland or Research Ireland. There are successful models of this happening elsewhere in Europe. For example at CEA, a French Government funded research and technology organisation that has created a venture builder programme for semiconductor start-ups where funding is provided for 3 years before spinning-out the company.
5) Attracting more leading semiconductor academics and subject matter experts with a track record of creating successful semiconductor start-up companies and spin-outs, such as SFI-funded Full Professor Bogdan Staszewski at University College Dublin and co-founder of Irish quantum computing company Equal1, is an important consideration for the likes of Research Ireland going forward.

Bringing these key elements and recommendations together will ensure Ireland builds and scales more indigenous semiconductor companies, creating high calibre jobs and developing unique talent and skills to drive Ireland's innovation-led economy.

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Mike Keaveney, ME-IC/PAR-IR

Response to the Public Consultation on the Development of a National Semiconductor Strategy

12 March 2024

Ladies and gentlemen,

Please find our response to the public consultation according to the themes as outlined below.

Aspirations for the sector *– What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?*

> Bosch hope to find Ireland to be a key location for talent and capability for integrated circuit design and development into the future. We would like to be in a situation where we have a ready supply of high quality engineering talent coming from the universities and research institutes, allowing ourselves and competing companies to progress from the current state of having to poach talent from each other.

Opportunities for the sector – *What do stakeholders identify as key opportunities for the sector to further develop?*

> Ireland already has a strong semiconductor base; with broad capability across academia/research institutes, industry R&D + product development and wafer fabs. The industry has shown its support for advancing the sector through support for MIDAS and MCCI. Professors Kennedy and Staszewski in UCD are well known in integrated circuit research worldwide and are both IEEE fellows. This can be an attraction for foreign students coming here to pursue PhD as well as training local talent. With Ireland now being the only native

English speaking country in the Eurozone, we should be in pole position to attract the best students from outside the EU. However we are losing out on the best students to research institutes and universities in Belgium (e.g. KU Leuven) and the Netherlands (e.g. to TU Delft, TU Eindhoven and U. Twente). These universities have professors such as Bram Nauta, Patrick Reynaert, Kofi Makinwa etc. leading world class research but also have other attractions as outlined in the sections below.

Embedded software or Firmware is a subset of Computer Science/Software Engineering that is closely linked to integrated circuit / system on chip development. Knowledge of RF, analog/digital signal chains as well as digital signal processing (DSP), as well as software programming is important for this role. We find the best source of this sort of talent is electronics engineers who specialize in software but this combination is in short supply. The University of Limerick has a world class Immersive Software programme but this is confined to Computer Science students. If this could be expanded to include the ECE (Electronics and Computer Engineering) faculty as well then UL could be a compelling source for this supply of talent.

The cost of silicon prototypes and test chips are getting more and more expensive and are a challenge for industry as well as research institutes. If we could devise a scheme to provide lower cost access to the more advanced CMOS nodes for circuit design research undertaken in Ireland then then could attract more R&D activity locally and also encourage more Irish start-ups in this sector. An emerging area of focus could be around the silicon technologies and circuits needed for 6G, which aspires to combine sensing as well as communication. Another possibility is a research cluster focusing on semiconductor technologies and circuits for AI.

Challenges facing businesses and the sector – *What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?*

Our biggest challenge is the supply of suitably qualified talent. There isn't enough coming through the Irish academic system and we end up poaching form one another. The lack of housing makes it difficult to attract talent from abroad or even from outside the region. The Netherlands seem to have overcome these challenges and furthermore they seem to be able to avail of attractive government grants for research. These factors make this region a more attractive place for a global company to expand in this sector.

Access to talent for businesses – *What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?*

There is a great need for a lot more talent educated to PhD level with high quality circuit design and systems architecture skills. The introduction of the 5 year masters programs in the universities seems to have resulted in fewer engineering students going on to do PhDs in Ireland. We had a healthier situation when we had just the 4 year BE degree courses as more of them then decided to stay on to do PhDs. We are at a disadvantage compared to the Netherlands and Belgium when it comes to attracting top engineering students from outside of Europe to do PhDs. The stipend available in these other EU countries is much higher than it is here and the fact they are employees of the research institutes there, means that foreign students can build up years of residency while doing their PhD in the competing European countries. This is an attractive option for the top students from places such as Iran, India and China.

Barriers to development – *What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?*

Transport links for business travel from the Limerick region to Germany and the EU are very poor. This is a disadvantage we face compared to other development sites that have direct transport links to Germany.

Mitigation – *What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?*

Increase the availability of high quality circuit design engineering talent by:

1. Increasing the stipend available to PhD students to a competitive level versus other EU countries. (Dept. of Education)
2. Provide a means for low cost access to silicon shuttles on advanced CMOS technology for research institutes and universities in Ireland. The foundries in the Far-east tend to be reluctant to make their most advanced FinFET nodes available to university research but perhaps Intel Ireland may be open to participating in such a scheme. (Dept. of Education / Enterprise, Trade and Employment)

3. Encourage the provision of air transport links from Shannon to the main business and industrial bases in the EU. (Dept. of Transport)
4. Expand the UL Immersive Software program to include ECE students (Dept. of Education)

Yours sincerely

Robert Bosch Ireland Ltd

Mike Keaveney, Radar Architect and Limerick Design Centre Manager,

Vincent Heffernan, Embedded Software Lead,
Fergus Downey, Hardware Design Lead,

Cadence Design Systems Ireland: Responses

Aspirations / Opportunities for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

Cadence Ireland has a strong desire to grow significantly beyond its current operational size. Since starting the current phase of growth in 2020 we have scaled operations in Ireland ~5X & we would anticipate significant further growth in the coming years.

There are semiconductor hardware & software companies in Ireland, but the population is relatively small & is strongly represented by Foreign Direct Investments such as Cadence. This (FDI) sector is serviced well by the IDA, in the attraction of new investment. However, beyond the initial pitch made to generally large companies, sectorial growth across all categories of companies is currently and historically lacking.

A significant aspiration for the sector, therefore, should be to

- Provide compelling opportunities to establish and scale business presence, across all related semiconductor and related software disciplines, in the small medium and large company categories. The aim being to generate a well-represented and recognized self-sustaining eco system that provides companies and individuals alike multiple opportunities to grow, develop and pivot within the industrial sector, within Ireland.

  Good examples of this model exist – for example, aside from the obvious Silicon Valley example, Israel as a small country has developed a highly entrepreneurial economy and also attracted and retained very large companies, despite relatively high costs.

- Put in place significant measures to provide a compelling case for individuals and companies alike to return to Ireland, having developed key skill & business abroad.

- Provide significant, easily accessed and administered incentives at the individual and company level, for key talent to stay in Ireland

Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

Our Key Challenges, when addressing our business landscape are as follows

- Lack of qualified, applicable talent in Ireland.

  Generally, we have a relevant engineering skills shortage i.e., talent with real applicable skills. Consequently, companies, when recruiting in Ireland are all focused on the same small pool of people. This leads to the perception of a local "Talent War", with consequential escalation for all parties.

Whilst we have many young people in 3rd level education, there are few educational opportunities that provide the real skills needed to operate in the semiconductor sector.

Further, the volume such students is very low – for example talent, wishing to study electrical engineering & joining UCC in 2023, have a class size of 30, with a very low % of female students.

Many young people who do come to engineering, move towards chemical engineering after the initial common year1, as there is a perception that the opportunities are more widespread.

- Housing

Due to the point above, direct sourcing from abroad is a key strategy for us. However, the ubiquitous and well know problems around the housing sector are a major challenge.

In particular, the rental sector is extraordinary weak and becoming weaker. Consequently, individuals cannot source accommodation, without very significant help.

We have real examples of skilled personnel not relocating because of this issue – at huge cost and inconvenience to the recruitment process.

We also have examples of skilled people who have relocated, exiting Ireland due to the high costs involved.

Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

- In existing engineering education we need practical, useful skills in graduates.

  If we take Electrical engineering as an example, academic education at 3rd level provides the fundamentals of the skills needed to understand the fundamentals of what semiconductor design is, however is does nothing to address how we design semiconductors.

  There is a broad opportunity to establish skills based courses (likely at the Msc level, but also BSc.) such that graduates entering the market understand how semiconductors are actually designed, what tools are available to design them and how those tools are applied to create the final result – from concept to final device.

  This approach would yield a cohort of highly attractive, skilled engineering talent that can be deployed usefully on engineering projects.

- Setting the stage : Secondary school agendas that are engineering focused.

  We attend careers fairs and try to educate junior cert (TY) and leaving cert students on the opportunities in our sector. Our goal is to have them consider engineering as an option.

The key challenge here is that junior cert subject selection has already happened and the key decisions on overall direction already made for many young people – so reaching students in the pre-university phase is actually too late.

Engineering influence needs to be present at the start of the junior cycle & taught as a career option, with serious consideration given to a structured national program of engineering education.

- Untapped resources : Women in engineering - A key talent deficit area

  In Ireland, many girls schools do not offer any form of engineering oriented options at the various choice points throughout their school career. Consequently, very few females enter the industry or engineering in general. Changes to the early aspects of the education system are required in order to provide a channel for this talent pool to emerge.

Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

<u>Corporate finance structures</u>
Globalized engineering operations, when looking to expand ask 2 key questions;

1. Can I hire the people I need in that location?
2. What's it going to cost, relative to other geographies?

#1 Is covered in the previous points. #2, however, is focused on global competitiveness & in the absence of any other compelling reason to establish an operation, Irelands cost base is fundamentally too high.

Whilst there are incentives in place for companies (Such as the Revenue R&D tax credit & the (RD&I grant schemes from the IDA) is still very challenging to make the argument.

R&D execs do not look at the silicon valley cost of talent and compare it to Ireland – they look at India or other low cost locations such as South America & make the comparison.

Taking all the incentives into account, Ireland still looks expensive.

Further, company structures often do not provide any incentives for those reliefs to be applied to the actual P&L business entities – they are frequently channeled to corporate.

Consequently, global business leaders find Ireland a very difficult sell, as, despite the fact that incentives exist, it does not help them in the running of their P&L business.

<u>Individual Finaces</u>
People behave as they are compensated. There are a number of share related schemes that are intended to mitigate / reduce taxation for individuals, IF the company adopts them (examples : *SAYES(save as your earn a.k.a salary forgone) and APSS(Approved profit sharing scheme a.k.a bonus to shares).*

However many companies do not adopt these schemes (particularly multinationals), despite the potential benefits in talent retention and employee benefits, they are administratively infeasible.

Personal taxation is also very high relative to other locations. Combined with the cost of living, the reality of relocating to and working in Ireland can be a challenge – particularly for early stage career engineers.

Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

- Rental housing market : Improve availability of rental stock
    - The RTB & measures in place to control the rental market do not favor landlords in any form.

    - The existing measures and assurances for tenants should remain, and are welcome, however to make being a landlord an attractive option and promoting investment, significant landlord tax incentives would make a big difference to the availability of rental housing stock.

- Housing purchase : Provide more flexibility with lending rules or tax breaks to make purchasing houses actually affordable
    - If a young couple with well paid jobs cannot afford a 3 bed semi in a reasonable distance of their work, whey would they stay ?

- Education Programmes starting at the junior cycle level that are engineering career focused.

- 3rd Level Education : Practical hands on education to develop real world semiconductor design manufacturing and coding skills.

    - Provide universities with incentives to develop or have a national strategy for the development of semiconductor design skills. Many companies would be happy to participate and contribute to such schemas – for example Cadence could provide tooling.

- Equal opportunities for females to take engineering subjects as males
    - This refers to the previous point on secondary educational opportunities for girls, with engineering being actively introduced into the curriculum.

- Incentives for individuals to stay in Ireland : provision via individual tax breaks and /or share schemes that are easily adopted by companies [as the current schemes are not easily implementable and have very low adoption] to provide a compelling financial incentive to engineering talent to be attracted to and to stay in Ireland.

National Semiconductor Strategy - Key Themes – CONNECT submission

- **Aspirations for the sector** – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

The EU Chips Act presents an important opportunity for Ireland, as a country which already has major semiconductor fabrication facilities, and has two generations of experienced engineers, technicians, scientists, support staff and managers some of whom have risen to the highest levels of their companies globally. Europe aims to double its global market share in semiconductors by 2030. The European Chips Act also emphasises sustainability and societal challenges. Nurturing a skilled workforce is critical. By attracting and retaining talent, Ireland can maintain its R&D prowess. Strengthening ties with European counterparts will enhance Ireland's position in the semiconductor landscape.

Ireland should aspire to be one of the leading economies in Europe in the new wave of "Made in Europe" semiconductors, as strategic semiconductor manufacture is pulled back into Europe. Allied to that, semiconductor device design IP is a long-term strength in Ireland (e.g. the Parthus Technologies success story) and this strength should be leveraged as IP is a significant part of the value of an integrated circuit.

Not all chips are silicon. That is especially true in network technologies, relying on photonic devices and rf power amplifiers among other chip sets, all of which are compound semiconductor based.

Ireland should seek opportunities to develop its photonic and rf chip manufacturing capabilities to match its silicon capabilities. Qorvo's continued expansion in Ireland in the wake of its 2020 takeover of Decawave is exactly the type of opportunity that we should develop. Likewise, Ireland has successful indigenous photonic and rf device companies which have found a niche for themselves, over the past five decades. Ireland should be looking to scale indigenous companies in both sectors of the non-silicon semiconductor industry. The establishment of a suitable scale compound semiconductor epitaxial wafer foundry in Ireland should be a key aspiration to allow us to convert design intellectual property into epitaxial device material for onward device fabrication. An ambitious strategy would seek to have a complete design to packaged device vertically integrated supply chain in Ireland. We have, or have had at some time in recent decades, companies representing most elements of this, and research facilities providing the remainder on small scale.

Ireland has, in the form of the world-leading photonic chip packaging facility established under the leadership of Prof. Peter O'Brien at Tyndall National Institute, a unique advantage which could be leveraged to attract high end chip packaging plants here. Europe needs a full vertically integrated supply chain, including packaging, if it is to enjoy digital sovereignty.

Quantum computing and internet related chips are another emerging high-end opportunity for Ireland. Very few companies have a lead in this sector at present, and most aspects of quantum technology are at research stage, in low technology readiness levels.

Think about the time frame from the first electromechanical computers around 1942, to the transistor in c. 1957, to the integrated circuit in c. 1965, to the foundation of Intel in 1968, to the arrival of the first Intel engineers in Ireland in 1989 to set up the first Intel fab in Ireland. That's a 47-year journey, albeit in slower economic and technological times over much of which Ireland was not at the races. Now ask: with viable IBM quantum chips emerging on the market in the past few years, and the quantum internet in research infancy, can Ireland get into this sector on the ground floor, before it builds up?

- **Opportunities for the sector** – What do stakeholders identify as key opportunities for the sector to further develop?

Ireland has a strong and growing base of digital innovation platforms such as Smart Docklands and Cork Smart Gateway, which are award winning and playing a leadership role in international forums such as the World Economic Forum (WEF_Dublin_Case_Study_2023.pdf (weforum.org)) and the UN (Dublin Digital Rights in Action! - smartdocklands). Novel semiconductors and semiconductor systems will be a major source of innovation for such platforms, providing sensing, communication and computing at scale. Sustainability is a key focus here and specific programs that link semiconductor device and system research in Ireland to these Smart Community platforms will accelerate growth and continue to position Ireland in a leadership role in Europe's digital transformation.

The strategic semiconductor supply chain encompasses all semiconductor production, not just the higher performance chips which are perceived as security sensitive.

Control of our own (thinking of "us" both as Ireland and as EU) semiconductor supply chain is essential to Europe's ability to produce most products, given the pervasiveness of embedded chips for control, edge data processing, and communications (including cloud links). There is a wide security and digital sovereignty agenda here. Third country (non-EU) chips come with often onerous, and always non-negotiable terms and conditions of use, dictated by their country of origin, its laws and geo-political concerns. Data privacy and the freedom of agency of Europe's citizens is best assured by EU chips under EU-compliant licence and legal terms.

Therefore, all use case sectors are opportunities for us as a nation. There are the obvious opportunities. AI chips will be an area of expansion, as will chip sets for 6G communications, and embedded control chips (witness the effect of any automotive chip shortage on production). There are also less obvious opportunities. Internet of Things technologies for professional and consumer electronics should not be neglected. In the consumer market, vast numbers of low-end products are being embedded with WiFi cloud chips of non-EU origin, having click-through onerous licence conditions around data use that in effect cede control of household products, to overseas governments and corporations. The co-development by Ireland, with our EU partners, of "sovereignty cloud" chips for IoT applications could prove to be a big opportunity for us.

Ireland should be aspiring also to have second tier chip plants, more run-of-the-mill foundries, as well as the top tier foundries – e.g. to serve the automotive/consumer industry.

The Tyndall National Institute eSIP power supply in a chip technology and decades of research in embedded systems there and at MTU's Nimbus Centre and at UCC is a strength within the CONNECT centre which has potential for exploitation for Ireland's benefit.

As discussed under the Ambition heading, many key sectors of the economy rely on high added value compound semiconductor devices including photonic devices and rf power amplifiers among other chip sets. The compound semiconductor market is structured differently from the silicon semiconductor market. Silicon wafer production, other than strained silicon and silicon-in-insulator wafers, is a bulk materials play, and the silicon device fabs do all the device engineering. Compound semiconductor devices are engineered into the very wafer material, such that a large proportion of the device intellectual property has already been realised in the so-called device material wafer, with a very high added value. Much of what is called "front-end-of-line" (FEOL) in silicon CMOS technology already arrives with the wafer into the compound semiconductor fab. Attempts have been made before to establish an epitaxial wafer foundry in Ireland. This would allow rf and photonic device design companies to have product made to wafer level in Ireland (therefore in Europe).

Ireland should map its wireless and photonics domestic (including MNC) industry, and do a gap analysis of the supply chain below it.

Ireland should develop its photonic and rf chip manufacturing capabilities to match its silicon capabilities, both at MNC and indigenous level (e.g. Qorvo's continued expansion in Ireland and takeover of Decawave. Ireland should be looking to scale indigenous companies in both sectors of the non-silicon semiconductor industry.

There is also an environmental opportunity for Ireland, recognised by many of our European partners, and articulated variously as "responsible electronics" (words of one of the CONNECT Centre PIs), or "sobriety" (used by our French collaborators). Simply, this means addressing the entire life cycle of chips and sensors for use in the trillion sensor IoT which is envisaged. The parallel (and often neglected) manufacture of printed electronics (while mostly non-semiconductor) offers a relatively lower threshold cost of entry route for Irish SMEs, which is also potentially green, by using additive electronic production, and developing the manufacture of compostable sensors and energy harvesting devices.

In that context, the passage through the European Parliament of the measure to improve the energy efficient of buildings offers a major opportunity for wireless control networks in buildings. Energy efficiency of buildings: MEPs adopt plans to decarbonise the sector | News | European Parliament (europa.eu). It is estimated that 97% of Europe's buildings, that is, the legacy buildings, will require retrofits if the Paris Accord targets for 2023 are to be achieved. From an economic point of view, it has been proven that wireless control networks cost less than wired controls in legacy building refits, simply due to the lack of requirement for physical routing, rendering and making good of walls, floors and ceilings.

This is a major opportunity to develop secure European comms chips for consumer products, e.g. lighting and smart device control, cloud WiFi, Zigbee, Thread etc, to supplant non-EU comms chips which come with onerous data insecurity contract clauses and are becoming pervasive.

- **Challenges facing businesses and the sector** – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

Ireland needs to encourage more students to take up the broad range of engineering, materials and physical sciences, both hardware and software. Our US colleagues place huge emphasis on the term "Engineering Workforce Development" (EWD) in a systematic way. Most Transition Year students (the year when career choices and university planning firms up) continue to think of the traditional professions, or general degrees, and lack insight into the lucrative career opportunities in emerging engineering sectors. They also fail to appreciate the demand for such graduates.

Perceptions of difficulty of engineering and science need to be challenged.

Both software and hardware engineers are in great demand. The salary opportunities for software engineers are well known. We also know many hardware engineers who are paid very well, and we have examples where they are in very high demand and we can't keep them to finish degrees even.

Access to rare materials is a global challenge for this sector (thinking again of Ireland as a part of Europe), which like most engineering sectors, is heavily reliant on materials science to realise its intellectual property into products. Ireland (also in the EU context) needs to look strategically at its strengths and weaknesses in key materials supply. Ireland as a State enjoys particularly strong constitutional powers over its own natural resources, including metal mining, under Article 10 of the Constitution, and we may need to leverage this control of what Ireland has in abundance, in order to secure what Ireland and Europe needs from elsewhere.

Strategically, the situation where most European semiconductor chip supply is dependent on fabrication plants in the far east, especially TSMC in Taiwan, cannot continue. Add to that the number of packaging (back end) plants in the far east, and it points to a supply chain risk that has existed for a long time and which is prone to shock of the economic and geological sense. The Kobe earthquake of 1995 alone had a disruptive effect on global semiconductor packaging material supply. Europe's digital sovereignty is not merely a software matter, but depends on its ability to fully manufacture and package its own semiconductors (mainstream and niche including photonic and quantum chip) at will, within the EU. TSMC is itself a major risk – given its location, and given the demand on its resources. Anecdotally, it can take 12-18 months to get a lower volume chip into the line there, which can be a barrier to entry for Europe's small companies, regardless of how good is their intellectual property.

Who has semiconductor fabrication facilities very quickly becomes a king in the event of a major global supply chain shock. The Intel campus is obviously Ireland's major strategic asset in this field, and makes us a serious player on a global level. The same can be said of other key semiconductor manufacturers such as Analog Devices. Systems manufacturers further up the value chain depend on semiconductor supply. Europe in general will be looking to strengthen its manufacturing capability and has the players on the field to build on (ST, Infineon, Nordic, AMD, and the Intel plants including the new German Intel plant, to name a few). Europe also has ASML – strategically that is important.

- **Access to talent for businesses** – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

There is a case to be made for the university system to produce the equivalent of Master's level engineers on a large scale <u>as primary undergraduates</u>, in the mould of the Dutch Ir. ("engineer") titled degree, or the German Dipl. Eng. / Dipl. Phys. titled degrees, with paid industry internships designed into the degrees. Exposure to real world engineering outside the teaching environment makes graduates work-ready.

Postgraduate degrees and postdoctoral fellowships having an element of industry placement often lead to the trainee being hired by the industry partner, providing high end engineering research workforce for small and large companies.

- **Barriers to development** – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

The single biggest challenge as ever is trained engineers, not just in research but the wider manufacturing workforce, <u>and retaining them here in Ireland</u>.

- **Mitigation** – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

Housing costs and allowing engineers to buy rather than rent their property (key in Ireland, meaning access to affordable credit at a single early career salary) are the biggest risk mitigation here, followed by career choices at Transition Year stage in the school system. Women entering careers in this field could be the biggest opportunity/solution. Programmatic Engineering Workforce Development in all secondary schools up to TY year and into Leaving Cert would attract more people into engineering.

Executive Summary

Decisions about selecting FDI locations for semiconductor manufacturing depend on five factors; scale, support, skills, sites and services. This note addresses the last two factors.

The objective of this note is to contribute to the formulation of a National Semiconductor Strategy by discussing how sites could be identified and developed to allow Ireland to continue its position as a leading destination for FDI projects in Europe that could include chip foundries.

Such sites are beyond the scale of any existing Irish precedence The utility requirements for one such site are comparable to all of Galway city's daily water-treatment and water supply capacity and all of Moneypoint's existing electricity generating capacity

Additionally, there is now international competition, both from the EU and US, to try to attract chip foundry projects. Ireland is unlikely to be able to match the subsidies and supports offered by these large economies.

In this new international order, Ireland will need to develop other competitive advantages in fields other than subsidies. The most plausible Irish advantages that could be developed and marketed could be the availability of the skills of a long-established cluster combined with a high-speed permitting route.

Ireland could project a further international competitive advantage by providing locations that anticipate and accommodate the complexity and time required for permitting while also accommodating the need for the rapid building of these projects.

Soft skills and experience in delivery and operation, such as this, are critical confer competitive advantages on Ireland that are rarely articulated.

Irish spatial policy appears to take little account of significant regional differences that affect the viability and sustainability of large-scale industrial development. Unless challenged, this has the potential to be self-limiting for Ireland's capacity to successful compete for very large-scale projects.

Concern is emerging at the lack of capacity of existing institutions and agencies to deliver major critical infrastructure projects.

The un-met need is for Irish infrastructure including electricity, gas, telecoms, water supply, wastewater treatment and sustainable mobility to be available, appropriate and affordable.

Recommendation 1; *Decide Go/No Go?*
IDA Ireland to carry out a risk appetite assessment to determine whether or not the continued pursuit of large-scale chip manufacturing foundry manufacturing represent the best use of resources in light of an increasingly competitive international marketplace that will be dominated by large economies.

Recommendation 2: *Adopt a Competitive Advantage Strategy*
- Making a case for Ireland to be regarded and supported as a European 'Preferred Location' status
-Promoting Ireland's competitive advantages as a skill-rich cluster with pre-approved sites
-Identifying and acquiring suitable sites and services and pre-permit at least 3 sites

Recommendation 3 *Adopt Big Dumb Box [BDB] property implementation*
Identify not less than 3 Sites for large-scale chip manufacturing foundry manufacturing with a BDB project on each

Recommendation 4 *Bring forward Optimum Sites*
Prepare BDB applications for three national strategic sites, having regard to the relative preparedness of each

HYPERSCALE SITES – *A PREAMBLE*

The Submission

This submission has been prepared by Conor Skehan who has over 30 years of experience as a consultant on planning and environmental issues associated with sites and services large-scale manufacturing processes in Ireland. He also has considerable experience of both consultancy on large-scale projects and plans for industry, infrastructure and associated economic development.

The Objective

A chip foundry [‘Fab’] is a facility where semiconductor devices are manufactured on a large-scale – often for a range of end-users.

A new development in this sector has seen the emergence of a demand for large-scale chip manufacturing facilities – are commonly referred to as ‘foundries’. Recently, there has been a growing international recognition of these as key global strategic activities.

This realisation has recently led to unprecedented reversals of established free-trade policies. Led by the United States, the past two years have seen the introduction of a combination of subsidies and restrictions[1] that have aimed to change the operations and geographical locations of large-scale leading chip manufacturing.

Five conditions need to be met to attract FDI projects in this sector namely. ‘the five S factors’ of scale, support, skills, sites and services. This note addresses the last two factors. These facilities have site area and service requirements that are significantly larger than those previously required to attract and sustain large Foreign Direct Investment [FDI] projects in Ireland.

How and whether to compete?

The objective of this note is to discuss *how* such sites could be identified and developed to allow Ireland to continue its position as a leading destination for FDI projects in Europe that could include chip foundries.

The question of *whether* Ireland should pursue such developments lies outside the scope of this report, except to note that the scale of the investment required will require significant funding to be diverted from other manufacturing and enterprise FDI sectors that have a much higher potential for success.

It is arguable that investment should be proportionate to results, noting in particular that two other sectors, pharmaceutical products and organic chemicals, continue to account for over half of Ireland’s total goods exports – compared to electrical equipment that accounts for less than 10%.

A Note of Caution about Reputation

Reputation is a further matter that needs to be considered. Ireland has recently made it clear to international investment markets that it is not open for further Data Centre projects – due to utility constraints. This problem has been recently amplified by statements by government ministers that access to water, road access will be regionally curtailed to enforce policies to achieve balanced regional development. A similar decision, to opt out of, or fail, in competition for large-scale chip manufacturing, has a strong potential to amplify a message to potential international investors about Ireland’s increasing lack of capacity.

[1] CHIPS for America Act; August 2022 and the EU Chips Act April 2023

An Outlier Approach?

An outlier concept, beyond the scope of this note, might be for the Department and the IDA to attempt to argue that Ireland should be given a European 'Preferred Location' status, with appropriate funding and regulatory support. This would be justifiable on account of its long history of successfully developing and operating some of the world's largest Fab developments. The subsides would target dedicated utilities and the regulatory support would declare that such site constitute locations where IROPI[2] conditions apply.

The Challenges

Recent experience of attempting to secure investment in Ireland by large-scale foundry operations have pinpointed gaps in Ireland's offering to Ultra Large-Scale inward investment, namely;

- Scale of utility needs for ultra high-tech are well outside Ireland's capacity now and well outside a credible time frame for delivery to support inward project requirements
- 3 key utilities water-in, wastewater-out and electricity are controlled by semi-state bodies without the mandate, finance or skillsets to match the pace of inward investment projects
- Scale of utilities and resources in serious conflict with government current sustainability and environmental policies, therefore vulnerable to legal delays

The utility requirements for one such site are comparable to all of Galway city's water-treatment and water supply capacity and all of Moneypoint's existing electricity generating capacity

[2] IROPI stands for Imperative Reasons of Overriding Public Interest – a term used in the implementation of the Habitats Directive

'Sx5'- How to make a site attractive for the next scale of inward investment??

The objective is to develop an offering that will allow Ireland to succeed in international competition for at least one Chip Foundry project. The following 5 'S' Factors all need to be available, these are Scale, Support, Skills, Sites and Services.

Scale

Land Area

The site will need to be large enough to accommodate the eventual development of a cluster of up to eight modules. On the basis of precedence this appears to require a site with a developable area of approximately 400 hectares [1,000 acres].

Utilities

The site will also need services of a similar scale. This would require the following

- Electricity 500 to 1,000 MW power
- Water supply 55,000 m^3 per day
- Wastewater treatment capacity 50,000 m^3 per day
- Transport with a capacity to support up to 5,000 movements per day – in each direction
- Specialist Support – especially off-site storage for large quantities of specialist chemicals and gasses probably 30 hectares located within 20 to 30 km of the Fab

Support

On the basis of reported subsidies by Germany to the intel site in Magdeburg, it appears that a precedent expectation has been established for subsidies in the region of €10 bn. Bloomberg report that, to date, the German government has committed €6.8 billion ($7.5 billion) to the Intel's planned builds — about 40 percent of the project's original €17 billion ($19 billion) price tag. Latest reports are that Intel pushed for an additional €4-5 billion in subsidies.

Skills

Ireland already has an established position as a location that has successfully built and operated a number of Fab investments for Intel. This means that there is an op-tap pool of skills in all sectors from design, project management and contractors to operators as well as support and sustaining contractors and suppliers. A foundry site may have a site population of up to 10,000[3] people who will need to live within 30 – 45 minutes of the site. This will need to draw from a catchment of about 350,000 people.

Ideally this location will be within a 40 minute of an international airport and a major settlement that offers a full spectrum of social supports – including housing, high-level education, health and cultural/leisure opportunity as well as quality of life.

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[3] 10,000 workers are drawn from 3% of the work-force to allow for skills, experience and 'churn' of staff every 5-7 years as well as providing equivalent employment opportunities for spouses and families.

Ireland is the leading EU country in terms of the proportion of STEM graduates per 1,000 of population aged 20-29 in (39.9 in 2020), compared with 21.0 per 1,000 of population for the EU as a whole. Ireland was also the leading country in 2015 with 29.8 STEM graduates per 1,000 of population, compared to the EU average of 19.4.

In 2021, 11.3% of the active population in Ireland were classified as scientists and engineers compared to EU (8.1%) and euro area (8%).

Sites

Sites with a developable area of approximately 400 hectares [1,000 acres] are required adjacent to a dense network of power and water infrastructure as well as a range of mobility and transport options.

Ideally, the site will be located in an area with the following characteristics

- 25km to water supply
- 20km to sea outfall
- Use of Sustainable Public Transport
- Large population catchment
- Size of available sites

Services

Utilities

The site will also need services of a similar scale. This would require the following

- Electricity 500 to 1,000 MW power
- Water supply 55,000 m3 per day
- Wastewater treatment capacity 50,000 m3 per day
- Transport with a capacity to support up to 5,000 movements per day – in each direction
- Specialist Support – especially off-site storage for large quantities of specialist chemicals and gasses probably 30 hectares located within 20 to 30 km of the Fab

The Challenges in Context

International Context 1- Subsidies

Starting in the 1960s Ireland adopted a policy of economic growth by attracting foreign direct investment. Ireland's share of this market has grown, particularly in the last decade, despite the fact that this his strategy has been widely copied.

According to the OECD, the top recipients of FDI inflows worldwide in Q3 2023 were the United States (USD 73 billion), and Ireland (USD 26 billion); Canada and Brazil both equally ranked as third largest FDI recipient (USD 15 billion).

Ireland is now one of the world's leading destinations for FDI. Current emphasis about Ireland's high GDP per capita and tax surpluses can mask two important considerations. The first is that Ireland, despite its success, remains only the tenth-largest contributor contributing 2.8% of the EU GDP – it is a very small part of the EU's economy.

International competition for strategic industrial FDI will see the emergence of high levels of funding from other EU Member States that Ireland will be unable to match. Thes subsidies will include actors such as energy subsidies – such as Germany's recent announcement that the government is considering an 80% subsidy for the energy-dependent industries.

In this new international order, it may emerge that Ireland's only unique selling proposition may be a unique track record of project delivery and operation. If properly presented, this can be marketed as a European advantage that can successfully compete with more nimble Asian models in South Korea and Taiwan.

International Context 2 – Social Expectations

Social expectations play a major part in establishing the conditions for the community consent needed to permit large projects. Though the process and timelines vary, this is true in any jurisdiction.

This arises on account of regulatory requirements for land use planning and local participation as well as concerns to protect human health and safety as well as the environment.

There is a complex contradiction at the heart of large-scale high-tech projects.

In general, a society that has the high levels of education and skills necessary to support the development and operation of high-tech projects – such as chip foundries - are those that are most likely to have a society that demands high-quality protection of health, rights and the environment.

In general, the speed of technological development, especially in the chip sector, means that projects are often commenced before the product and associated processes are fully developed. This fact, combined with the need to maintain market leadership means that such projects need to be built very quickly.

This will be an international competitive advantage for attracting and successful permitting large high intensity projects for locations that anticipate and accommodate the complexity and time required for permitting while also accommodating the need for the rapid building of these projects.

National Context Supports

This leadership position may be challenged because the recent introduction of a combination of subsidies and restrictions that have aimed to change the operations and geographical locations of large-scale leading chip manufacturing.

This new circumstance will mean that very large economies will now begin to deploy very large funding to attract and subsidise large-scale strategic industries – with chip foundries being the most sought-after type of targeted industries.

Ireland will need to develop other competitive advantages in fields other than subsidies. The most plausible Irish advantages that could be developed and marketed could be the availability of the skills of a long-established cluster combined with a high-speed permitting route.

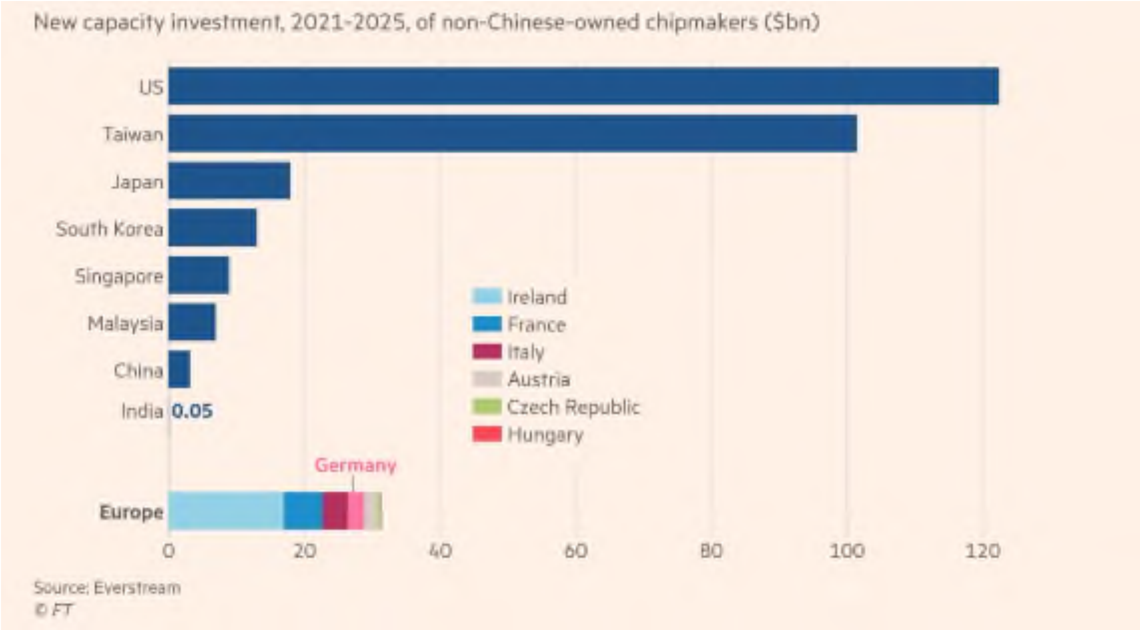

Figure 2 Ireland *The location Europe's biggest chip manufacturing investment.*

National Context Skills & Labour

Skills and labour are not expected to be major challenges for a project of the type envisaged. A relatively small part of the overall site population consists of specialists who are unique to the sector. The majority are employees have a broad range of skills – in all stages from construction through to operations – that are commonly available within this and related sectors in Ireland.

Ireland can reasonably and credibly argue that it already possess an internationally unique cluster of the upstream skills need for the rapid design, construction and support of major Fab projects. This skillset is already recognised by companies such as Intel who regularly deploy Irish expertise to deliver or troubleshoot major Fab project in other companies. For example, it is noteworthy that Intel's proposed foundry project in Magdeburg, Germany is being run by a senior management team from Leixlip.

Soft skills and experience in delivery and operation, such as this, are critical. They confer competitive advantages on Ireland that are rarely articulated.

National Context Spatial

National planning policies aimed at ensuring 'balanced regional development' seek to drive new employment and enterprise opportunities out of the east Leinster Region toward western and southern areas. This policy is creating significant difficulties on account of the lower population density and associate urban infrastructure and restricted environmental capacity.

Moreover, much of the rational for this policy now appears to be based on out-of-date assumptions about a lack of regional development opportunities. In 2021, Ireland is reported[4] to have the EU's lowest dispersion of regional unemployment, by a significant measure. This points to a near uniformity of employment opportunities throughout Ireland.

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[4] Source: Eurostat, Dispersion of regional unemployment rates by NUTS 3 region

Notwithstanding this uniformity of employment prospects, The Greater Dublin Region, that contains over 40% of the national population, continues to have the highest level of disposable income per person at €27,686 per person. The Midlands has the lowest disposable income at €19,076. Both the Midlands and Border regions have a lower concentration of industry and manufacturing, and are more reliant on public sector employment compared to other regions. These regions respectively contain 6.1% and 8.3% of Ireland's population

Factors such as population density, urbanisation, farm and field size as well as proximity to environmental sensitivities and designations all combine to create highly contrasting areas of opportunity for very large-scale development that has a high dependency on large labour force, infrastructure and large land holdings.

Irish spatial policy appears to take little account of significant regional differences that affect the viability and sustainability of large-scale industrial development. Unless challenged, this has the potential to be self-limiting for Ireland's capacity to successful compete for very large-scale projects.

National Context Institutions

Institutional capacity is recognised as an essential pre-condition for economic growth and associated social betterment. This is particularly critical for infrastructure for which the timely delivery of infrastructural projects relies on an efficiently functioning planning and development system.

Improving the quality of infrastructure is essential to ensure a country has the capacity to achieve sustainable long-term growth and plays a key role in enhancing productivity. The capacity of the relevant institutions and agencies to delivery of current commitments is a key consideration, and the timely delivery of infrastructural projects relies on an efficiently functioning planning and development system. For example, Ireland has only managed to deliver 7 working off shore wind turbines during the same period that the UK has delivered over 11,500.

Concern is emerging at the lack of capacity of existing institutions and agencies to deliver major critical infrastructure projects.

National Context Decision-making

'Delays caused by the Planning System' is a well-established trope when seeking was to improve delivery of major development projects in Ireland. This claim has led to many attempts to change the Planning and Development Acts. All such changes have been the result of lobbying by the development sectors and their relevant support agencies. All of these changes are characterised by two features

> 1/. They have all created new structures, roles and procedures – all of which seek to remove or reduce opportunities to object
>
> 2/. All have reduced the certainty of outcomes, increased delays , increased JR risk and further reduced public trust in the planning system.

The reason for these repeated failures is that changes attempt to address the symptoms [the delays] instead of the causes [poor administrative and legal systems]. This matters that cause the problems are always discounted as being 'outside the remit of the review' because these are always carried out by actors within development [planning] and economic agencies and department.

Causes of delays in Courts usually caused by loss of 'curial deference' whereby courts are now making decisions about matters of substance versus process. Lack of technical know-how about the environment by both lawyers and judiciary. Poor quality of case management and prioritisation by judiciary.

Much of the problems arise from very poor original legislation caused by poor, rushed and inexpert transposition of EU Directives by non-technical legal drafters. Furthermore these problems lie within a general court system that is internationally recognised as requiring significant, overdue and fundamental reform.

Irish legal system is internationally recognised as being in urgent need of significant reform, with the OECD among others, including the European Commission for the Efficiency of Justice, calling for a substantial programme of change and improvement initiatives to implement procedural, operational and organisational improvements and investment to modernise case management.

The establishment of a new environmental and planning court is widely regarded as being a step that has a potential to worsen many of these problems because of the continuing lack of technical expertise leading to increasing tendency for judgements to indulge in in-expert and sometimes un-pleaded opinions on highly technical matters. Many other member states employ tribunals that include expert decision-makers – such as the envisaged, but unrealised, Assisted Decision-Making Capacity Act.

Similarly, there is widespread recognition that the revised Planning and Development Bill 2023 will make most of these problems worse and will further increase delays, risk and uncertainty.

The biggest causes of delay to permitting in Ireland are caused by failures in the Irish legal system. Until these are addressed these delays will continue to erode Ireland's competitiveness.

National Context Infrastructure

The availability of competitively priced world-class infrastructure and related services is critical to support competitiveness. Well-developed infrastructure can reduce financial, administrative and time costs and, by playing a key role in determining quality of life, it enhances the attractiveness of place (a key factor in terms of attracting high-skilled, internationally mobile workers).

Infrastructural constraints are undermining Ireland's current competitiveness performance which has led to a situation where Ireland has the 3rd highest domestic electricity prices in the EU and this problem is growing. Ireland's industry producer prices have increased at a significantly faster rate than those in the euro area. Increasing by over 40% since 2015, while euro area industry producer price levels rose by under 15% in the same period.

The un-met need is for Irish infrastructure including electricity, gas, telecoms, water supply, wastewater treatment and sustainable mobility to be available, appropriate and affordable.

Strategies & Solutions

Strategic Options

On the basis of these considerations, the following strategic options emerge

1. Withdraw from international competition for ultra-scaled chip manufacturing because of disproportionate carrying costs for a small country.
2. Base Ireland's offer on inward-investor building their own utility facilities, including;
    - On site electricity generation
    - On site wastewater re-cycling
    - On site inward water purification
3. Scale down high-tech offering to the utility needs that can be delivered within government policies (for example "reasonable" percentage of Dublin's catchment water and electricity usage). This may be appropriate to Second Tier Fab companies.
4. Legislate, fund, permit and build "strategic sites" reserved for ultra-high intensity users as part of a new National Economic Strategy to Ring-Fence of utility works to provide the suitability scaled utilities to an IDA site. Designate these sites as 'IROPI' to pre-empt requirements of the Habitats Directive.
5. As (4) above but restrict the strategy to "paper only". Present a fully permitted 'BDB'[Big Dumb Box] solution that is made available to inward investors' [

Strategic Scenarios

If it is decided to continue to attempt to pursue and attract ultra-scaled chip manufacturing, then three scenarios exist.

These are proposed to address the two biggest challenges, namely the need for very large sites and providing an option to avoid dependency on the supply of utilities by current suppliers. All three scenarios are compatible with the BDB approach proposed above.

SCENARIO 1 Business-as-usual – Slow & High-Risk FAB Supplied by Public Utilities
This scenario requires a large site to accommodate large buildings. It needs to be beside large-capacity public utilities that have enough existing and future capacity. This scenario carries a high risk of delivery delay or failure by existing utility providers. It also risks loss of future capacity due to competition from other emerging/ growing nearby settlements and enterprises.

SCENARIO 2 Hyper-scale FAB On-site self-served Utilities
This scenario requires a very large site [at least 400 hectares [1,000 acres]. It envisages that the applicant will permit and build large on-site electrical generation and waste water treatment systems. While large-scale on-site generation is a well-understood technology, it carries with it the cost using local air emission assimilative capacity that could reduce the emission capacity of the main operation. The on-site wastewater treatment plant, which are very expensive to build and operate with high performance challenges, are likely to be used to obtain high levels of water -recovery.

SCENARIO 3 Hyper-scale FAB Off-site self-served Utilities
This scenario is similar to Scenario 2 but the user supplied utilities are not built on the same site – to reduce site area requirement and to improve the site emission capacity – especially for air.

Both scenario 2 and 3 could also be provided by a specialist partner on a build/lease/operate basis. This could help with a core concern of many industries who are averse to capital and current expenditure and management for non-core activities.

Recommendations

On the basis of the considerations set out here, then the following four actions are recommended to maximise Ireland's opportunity to attract a large-scale chip foundry as part of a National Semiconductor Strategy

Recommendation 1; Decide Go/No Go?

IDA Ireland to carry out a risk appetite assessment to determine whether or not the continued pursuit of large-scale chip manufacturing foundry manufacturing represent the best use of resources in light of an increasingly competitive international marketplace that will be dominated by large economies who will offer very high levels of direct and indirect financial support and subvention.

Recommendation 2: Adopt a Competitive Advantage Strategy

Adoption and of a National Semiconductor Implementation Strategy, following a decision to continue to compete for large-scale chip manufacturing foundry manufacturing, that will have the four following components

1. Making a case for Ireland to be regarded and supported as n a European 'Preferred Location' status
2. Promoting Ireland's competitive advantages as a skill-rich cluster with pre-approved sites
3. Identification, acquisition of suitable sites and services
4. Pre-permitting of at least 3 sites

Recommendation 3 Adopt Pre-Approved Site Strategy

Commence property implementation projects, by following the following five actions

- Identify not less than 3 Sites for large-scale chip manufacturing foundry manufacturing
- Introduce statutory recognition of these as sites of Overriding Public Interest
- Obtain 'best-spec' data on most likely needs of 5 biggest foundry companies
- Design and Permit a BDB project on each optimum site
- Identify and engage with potential specialist partner on a build/lease/operate basis to implement off-site utility self-serve Scenario 3

Pre-Approved Site Strategy using the *Big Dumb Box* [BDB]

The permitting of large industrial projects is complex and time-consuming. Though the process and timelines vary, this is true in any jurisdiction, though it will generally be more difficult in advanced societies who have higher expectation for environmental and social protection.

A potential solution to this challenge is to design and fully permit a large generic chip manufacturing plant. This is known as a ‘Big Dumb Box’ after a successful experiment to put such a permission in place for an advanced pharma plant at an IDA site at Oranmore in County Galway.

The design of the BDB would be informed by IDA Ireland conducting a survey of the top 5 leading large-scale chip manufactures to confirm the outline specification of their needs.

Once a client has committed to Ireland, then the commencement of the project and associated services could begin at once by using the permission. In general, this allows some of the slowest works – excavation and utility supplies to begin at once.

While the site works and site servicing are progressing then the existing permission could be modified to take account of the actual needs of the specific client.

This approach confers large savings of time, and associated costs, as well as conferring time advantage on the client’s efforts to be first-to-market.

Executive Summary

The establishment of a national strategy for semiconductors is of crucial importance – the importance cannot be overstated. The European Chips Act is an essential and long overdue initiative to develop electronic sovereignty in Europe in a world that is transitioning quickly from a unipolar to a multi-polar organisation, and is an act that I wholly endorse. It is essential that member states act both independently and in unison to address areas of great vulnerability in the semiconductor space in order to safeguard and defend their vital interests.

Ours is no longer a unipolar world. The global village is no more. Semiconductors, being such a vital cog in modern society and economic activity are highly dependent on the geo-political climate. There are many ways in which bad actors, whatever their motives, may exercise huge leverage and cripple semiconductor supply chains with enormous and painful effects on other countries. These real risks must be acknowledged, and it is imperative that individual countries and the EU take urgent steps to develop electronic sovereignty and reduce their vulnerability to semiconductor supply disruption.

The main point in my submission is that Ireland should establish a National Semiconductor Security Centre. This would be akin to existing centres, (e,g, National Cyber Security Centre), where a national semiconductor strategy is owned, managed, monitored, funded and tracked.

Aspirations

Development of a National Semiconductor Security Centre (NSSC) with significant influence (not unlike NAMAs powers during past economic crisis), to urgently drive a national semiconductor strategy. This body would be responsible for definition of a national strategy, for driving its execution, for establishment of critical semiconductor infrastructure, including wafer fabrication facilities, electronic design automation capability, know how in material science, silicon test, packaging – and end-to-end capability for silicon design, manufacture, test and production.

Review existing links between industry and research and development organisations, and foster tighter integration, including with the national strategy (NSSC) itself.

Ireland (and the EU) should be seeking to create a climate where indigenous semiconductor powerhouse companies may emerge. It is a matter of EU and national security that stability of semiconductor supply, and production capacity is available in all key product areas during times of geo-political uncertainty or crisis, and to survive in a rapidly emerging multi-polar world.

Ireland should be seeking to have indigenous, end-to-end semiconductor design, manufacture, test and packaging capability in the semiconductor space.

Opportunities

The European Chips Act should act as a catalyst to spur the creation of a National Semiconductor Security Centre in Ireland.

I would like to highlight a case study of some recent activity by own employer, Vishay, which contributes to its own electronic independence. Vishay is a significant manufacturer of MOSFET devices for power delivery solutions. While the company has previously worked closely with third party wafer fabrication facilities, it has recently announced the acquisition of a wafer fab facility in Newport, Wales, where it plans to invest so as to secure the capacity and the technology to produce its own devices. (Newport Vishay – Securing jobs and new investment at the Fab). Individual electronic companies are reducing their dependence on external factors. Ireland (and by extension, the EU) needs to be looking at every opportunity to do likewise. Are there existing wafer fabrication facilities in Ireland that are open to partnership, expansion, or even acquisition?

Hardware security is a relatively new subject of fast-growing importance. An opportunity exists to create a state-sponsored cluster to drive the development of know-how in the design of secure semiconductor chips, including topics such as encryption, compression and embedded software security among others. Functional Safety is another important area for the development of integrated circuits for the automotive sector. Other certifications may be relevant for the energy sector where there is an enormous opportunity for the development of off-shore wind-energy.

Access to Talent

Talent is difficult to come by. It is imperative that in Ireland we develop our own talent. Careers in electronics must be seen to be exciting, attractive, and financially rewarding. The education system must incorporate strands that allow for development of exceptional students – it is often that those students of exceptional ability can drive major activity in the economy and bring benefits to many. In my opinion, the second level syllabus has been eroded over time such that there is no differentiation for exceptional performers.

Can electronics be taken as a dedicated subject elective at secondary level education leading to the Leaving Certificate Exam?
Is there scope for a dedicated, third level, electronics college?

Mitigation

Ireland and the EU are already quite vulnerable to supply chain, or geo-political shocks in semiconductor supply. To address this, either we reduce our dependence on semiconductors, or we increase or semiconductor sovereignty.
It is unlikely that our dependence on semiconductors is going to reduce. Accordingly, we need semiconductor sovereignty – fast.
There is no time to lose.

Ireland & the Semiconductor Opportunity

Submission by Darren Hobbs (GM/Snr Director Advanced Mixed-Signal ASIC Group, Renesas; MCCI Steering Committee member)

Introduction

This document is a response to a call from the DETE for consultation on the National Semiconductor Strategy. I am submitting this response in a consultative capacity, in order for Ireland Inc to take advantage of the unprecedented opportunity presented by the Semiconductor market at this unique point in time.

Aspirations for the Sector

The aspiration should be to have total P&L ownership of semiconductor businesses in Ireland. We need to aspire to having more vertically integrated businesses operating in Ireland, such as Analog Devices. Ultimately Ireland should "own" the end customer. This would lead to significantly greater attributable sticky taxable revenue, but more importantly lead to a wider, richer, more experienced commercial eco-system that would nurture successful, indigenous, entrepreneurial business creation.

The focus of this submission is the fabless model. Fabless companies design, market, and supply semiconductor products but they outsource all physical manufacture (semiconductor fabrication, packaging, and production test). A fabless company still has a significant operation to manage the supply chain and order fulfilment. This is a model that requires a significantly lower capex requirement but that is readily scalable. Pillar one of the EU Chips ACT initiative is aligned to this model. Examples of companies that operate a fabless model are Qualcomm, Xilinx (prior to AMD) and Nvidia. All our Irish SME's are fabless entities.

Opportunities for the Sector

The projected growth of the semiconductor market is predicted to increase from $0.5B to $1T by 2030. There is no other sector has this growth potential. We need to not just ride that wave but own a significant piece of it. Semiconductors are the new oil!

Of the top 10 semiconductor companies internationally, 50% are fabless. They outsource manufacture to fabrications such as TMSC and packaging/test to OSATs, such as ASE.

In a semiconductor product, typically 10% to 20% of the value goes to the semiconductor foundry, 10% to the packaging and test, and the remaining 60% is apportioned to the design and marketing of the part. It is the 60% that is key here and it is owned and extracted by the fabless business model. This is the area that Ireland Inc needs to target.

Capex Investment in a fabless model is minuscule compared to those that run physical fabrication facilities. Development headcount is where the major cost arises, as manufacture is outsourced. Fabless models are readily scalable, and result in a greater ROI than those with fabrications.

As a direct response to the fracturing of the lean semiconductor supply-chains, exposed over the Covid period, together with the escalation of US-China competition, regions now are looking to build out their own semiconductor frontend and backend factories. The US, EU, China, India have opened the funding gasket. This will lead to a global overcapacity, which fabless companies can and will exploit. We should do also. As mentioned earlier we need to be ready to ride this wave.

Pillar one of the EU Chips ACT initiatives directly supports the fabless model, the Design Platform. We should exploit. But we (Ireland Inc) need to be proactively engaging with the Chip Design Accelerator (CDA) and the Platform Coordination Team (PCT). The CDA selects the programs (SME chip programs) that enter the funding pipe-line. It is crucial that Ireland Inc is an active voice in the CDA. The PCT will have control on negotiation and selection of foundry, backend, IP, design service providers and EDA. Again, we Ireland Inc need to have an active voice in the PCT, as it will have implications on our DETs ambitions (Design Enablement Teams, that Tyndall & perhaps others in Ireland are looking to host). I am very keen to support this initiative and represent Ireland Inc on both of those panels, utilising my extensive and broad active global network in the semiconductor industry.

Irelands design & IP eco-system now is at the cutting edge. The largest IP suppliers have significant bases here (Synopsys & Cadence), and both companies have teams working at the frontier of next generation process nodes. Our product companies continue to develop advanced mixed-signal and RF products that continue to challenge & upskill our designers here in Ireland.

With the march towards geo-political isolationism, we can expect to see Europe exercising trade protectionism. Market sectors that will be key to protect in Europe will be industrial, automotive, green energy and communications. We need to ensure that our Ireland Inc policies and investments are aligned and take advantage of these trade protections that will ensue.

Challenges facing businesses and the Sector

Fundamentally Ireland has become a design R&D location for semiconductor products. The exceptions are ADI and Intel who also operate fabs here. Irish governmental policies have in large facilitated this achievement. It is important that we now acknowledge the changing landscape, seeking now to evolve and take more share of that 1T$ market. Ireland Inc can evolve beyond an R&D cost centre.

India has both talent and scale in IC design. Considering their lower cost (Indian salaries are typically at 30% of ours), we are starting to see commoditization of design, not just in digital frontend and backend design but also in high-value analog and RF design. With the West actively dis-engaging China as a trading partner, together with the stellar growth of the Indian middle-class this is leading to a huge amount of inward investment into India, leveraging from India's own Chips ACT initiative championed by Modi nationalism. Every week we see another announcement of semiconductor FDI into India. India's indigenous semiconductor design sector is progressing from servicing the West to now developing its own products. India's "overcommits and under-delivers" perception is growing old, a perception that we need to deprecate. The reality is that India has huge design talent scale that we cannot compete on, so we need to be smarter, closer to the application and own the end customer. Developing and nurturing more chip architects with end-application knowledge and building a bench-strength in technical marketing skill with get us there.

AI enabled design is today promoting quicker development cycles, but it will also create redundancy of certain design functions. Education, via training on how AI can speed up and augment developments can protect redundancy. Cadence are championing this approach, and it should be a colossal opportunity for us. It should be leveraged across the entire R&D ecosystem (both commercial and academic), via targeted state sponsored training.

Unfortunately, we are in danger of losing significant numbers of R&D positions with FDI companies here, over the medium term, due to the attractiveness of India and AI accelerated design.

Ironically, in the short term, we do need talent. However, this is a temporary demand spike before the industry adjusts to the next phase, post global ChipsACTs and AI-enabled design ramp. Companies currently are recruiting from outside the state. VISAs are quickly processed which is good, but housing remains the key concern for foreign staff.

China is poised to flood the market with cheaper semiconductor products built on older planar technology (28nm and above). This is an existential threat to western semiconductor companies that do not operate in protected markets. Again, both our policies and EU policies need to be cognisant of this clear and present danger. Otherwise, we sleepwalk into a zero-sum game, where Europe loses. Ireland Inc is small and flexible and can and should adjust policy accordingly to capitalise on these changes.

Access to talent for businesses

The technical skills that we need are those that are already identified through the excellent MIDAS skillsnet program. That covers the contemporary industry needs. Moving forward we will need to augment that with courses that instruct how to use AI to accelerate & improve development.

As indicated above as we drive towards more vertically integrated customer facing businesses, we will need to skill up on system design and architecture. We will need to select application spaces that align with market segments that are in growth mode and can be defended by EU trade protectionism. Those include industrial, automotive, communications and green energy.

We need to develop a bench-strength in technical marketing, developing people that can connect our R&D expertise to the market, or looking at it another way, making our R&D relevant to the market. This is a vital skill in need of nurturing now, that is more important that developing further R&D staff.

Incentivisation of senior semiconductor commercial executives to choose Ireland as a base would be a significant boon. Could Ireland consider a period of lower personal taxation on all earnings relating to their employment, for say a period of 4 years?

Barriers to Development

Development of semiconductor products can be expensive, depending on the application. Regardless of application the categories of cost are Design (R&D headcount), MPW (multi-project-wafers used to prototyping), EDA, 3rd party IP, production maskset, package development and production test. The table below is illustrative of the typical costs in getting to production of a sample of 3 different end-applications. The 0.18um would be a typical sensor chip, with/without a processor core. 3rd party IP would be limited to circuits like PLLs, LDOs, low-speed converters. The 22FDX, which is largely becoming the anchor node for RF+SoC, again would assume 3rd party IP like HS SerDes, HS converters, and advanced processors such as Arm A55 or R-series. The 12n ff would be for bigger digital SoCs assuming you need DDR IO IP, and likely a multi-core processor.

Process Node	**0.18um**	**22FDX**	**12n ff**
MPW	40K	200K	>500K
Production Maskset	60K	1.9M	2.8M
ATE test h/w + s/w	200K	260K	300K
Package NRE	15K	110K	200K
3rd Party IP	50K to 250K	50K to 4M+	2M to …5M+
EDA	>300K	>>1M	>>>1M
Design (internal)	800K	1M to 4M	>>5M
Qualification	120K	150K	200K
Typical application	**Mixed-signal chip for Sensors**	**Analog/RF embedded SoC for Comms**	**Large Digital SoC for neural processing**

Whilst the larger FDI based semiconductor companies will budget and execute on roadmap products, the SME will be challenged. The purpose of the Design Platform, Pillar One of the EU Chips ACT initiatives is to support these costs. Again, Ireland Inc needs to be front and central in that initiative for this very reason.

Mitigation

Focus on fabless model and exploit Pillar One of EU Chips ACT

The fabless model provides a scalable, flexible business, limited in capex needs, leading to a greater ROI. Fabless models can and will exploit excess-capacity in backend and frontend semiconductor manufacturing that is currently been built into the global system. Pillar one of the

Chip ACTs initiatives targets fabless SMEs and start-ups. Let's ensure that Ireland Inc are front and centre in that development.

Zealot focus on building local managed P&L business & own the customer

To mitigate against semiconductor design commoditisation and AI redundancy it is critical that we evolve to own and run the P&L. This means the creation of vertically integrated business from sales to marketing to supply operations to system architecture to applications to design. We build lean. This will create a broader skilled eco-system that will nurture more entrepreneurial pursuit. It will also attract in a more diverse workforce, as the jobs won't be just design jobs, which despite concerted efforts by the industry are still fundamentally male dominated.

From an FDI perspective, the pitch to new potential semiconductor companies needs to include not just our R&D capabilities, but also our commercial, supply chain, P&L ownership. We should not be shy in directly promoting our competitive corporate tax rate and the IP knowledge box benefit. We should insist on P&L ownership, not just an R&D location.

From an indigenous SME or start-up perspective, and specifically the creation of such, we need to find a way to incentivise technology executives with commercial expertise to engage. The supports from the state that are currently there are perhaps not enough to entice that talent to take the plunge into a new venture. It maybe worth investigating a scheme where previous years personal tax paid is used to support the executive in the new venture.

Develop Technical Marketing Talent Relevant to the Market

We need to develop a bench-strength in technical marketing. This is the gap that we need to fill, it gets us closer to the customer and connects our R&D directly to the market. This is the most crucial skill that Ireland Inc needs to develop and grow now.

AI assisted IC-Design training

Can we consider targeted state sponsored training on use of AI for design acceleration. I am sure that Cadence would be very willing to support this initiative for Ireland Inc.

Create a Semiconductor Technical roadmap for Ireland

Whilst the semiconductor industry participants in Ireland as a cabal are good at socialising, we are less good at exchanging business and technical ideas. We need to break this hesitancy. Understandably staff are duty-bound to keep sensitive company information confidential, however I am certain that we can create safe environments to promote and facilitate the exchange of ideas. The Israeli's do it, they do it very well!

To that end, we could create a Semiconductor Ireland Inc panel. The panel would consist of senior Irish executives, balanced between technical and commercial. The panel would map out a sustaining technology roadmap for Ireland, a roadmap that would provide a steer on what technologies we nurture, and the application and markets we target, in order to deliver our growth goals, remaining cognisant of the geo-political forces. For such sessions, the panellists leave their company badges at the door and put on the Green Jersey!

In summary we are in a unique period, in which “quantitative easing” meets semiconductors, globally! As a nation we have the technical talent in abundance, now lets evolve, develop our commercial strength and take ownership of a significant piece of that $1T market.

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Full Professor in the School of Physical Sciences, DCU

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Associate Dean for Research Faculty of Science and Health
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Introduction:
Ireland's semiconductor industry is at a crucial juncture, balancing burgeoning demand with significant challenges. With a robust ecosystem encompassing both industry and research, Ireland is well-positioned to boost its competitive edge in chip manufacturing. Capitalising on emerging opportunities is crucial for sustained prosperity. Furthermore, Ireland has a unique opportunity to act as a bridge between the US and EU Chip Acts.

Aspirations for the Sector:
Stakeholders within Ireland's semiconductor industry aspire to elevate the nation's standing as a pivotal player in global chip manufacturing, research and innovation. The sector drives continual technological progress and fosters collaboration between industry and academia, thereby making substantial contributions to Ireland's economic growth and international competitiveness. Moreover, the sector is closely linked with significant foreign direct investment and associated economic benefits for the nation, including the creation and development of many Irish SMEs.
In this context, it is important to highlight that there is still significant untapped potential in Ireland. This becomes obvious in OECD data for gross domestic spending on R&D. Ireland performs well below the OECD average, as shown in Figure 1. It is evident from the data that there is more than an opportunity for Ireland to improve.
The figure illustrates the most relevant countries concerning chip manufacturing. All relevant countries are leaders in investment in research, and they are experiencing impressive returns for their economies, largely driven through the chip manufacturing sector. This particularly emphasises the significant potential for research investment in this specific area for Ireland.

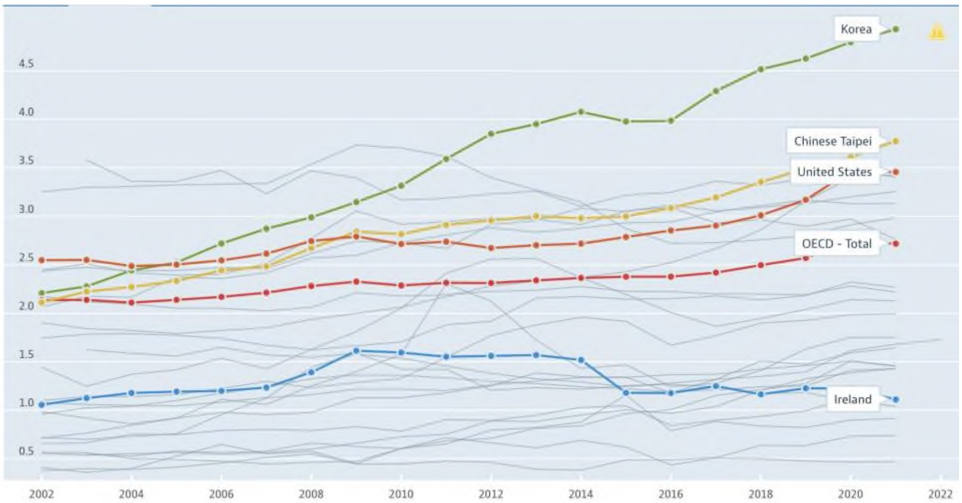

Fig. 1 Percentage of Gross Domestic Product (GDP) vs Year. A few of the most relevant countries in the chip manufacturing sector are highlighted. OECD Data, 15/03/2024. It is realised that GDP can be a somewhat skewed measure in Ireland due to foreign direct investment. Nevertheless, in this particular context it is relevant, as the same companies largely contribute.

Opportunities for the Sector:

Improvements in nano-electronic chips are essential for AI progress, particularly in data centres. Ireland is well-placed to benefit from this three-way connection. The imperative for the sector to address the increasing technological demands of faster, better, and more, has never been more pressing.

There is a recognition for a step-change transition, emphasising the necessity for pioneering next-generation research across applied sciences, technologies, and engineering domains, surpassing incremental methodologies. Achieving this cannot be done in isolation; collaboration and co-innovation is essential.

With its prominent position as a bridge between the US and EU Chip Acts, Ireland, home to leading US companies, serves as a strategic intermediary linking the initiatives of both regions. This positioning not only strengthens Ireland's influence in the global chip landscape but also cultivates collaboration and synergy among key stakeholders, promoting innovation and growth within the sector. Such a strategic positioning creates opportunities for collaborative efforts like cross-country partnership funding, fostering deeper integration and mutual benefit in research and development.

Challenges Facing Businesses and the Sector:

Individual enterprises in the semiconductor sector encounter challenges such as talent acquisition and retention, technological complexities, and intense global market competition – see figure 1.

On a broader scale, overarching challenges encompass restricted access to funding for research and development and limitations in infrastructure. Disruptions in the supply chain and geopolitical tensions also pose risks to the sector's stability and growth trajectory.

To keep up with demand, improved high performance semiconductor technology is required. Given the intricate nature of chip manufacturing and increasing technological complexities, a multifaceted approach that integrates exploratory innovative research from academia with progressive incremental research conducted in industry is essential.

Access to Talent for Businesses:

The semiconductor sector requires a diverse range of skills, particularly at high levels such as PhD level. Investments in training initiatives, with specialised programmes such as industrial PhD internships are crucial for attracting and nurturing talent. Investments in training tailored to these advanced levels are key, for example, a dedicated Centre for Research Training. Collaboration between universities and industry is key in achieving this goal, ensuring that the talent pipeline remains robust and well-equipped to meet the evolving demands of the semiconductor chip industry.

Barriers to Development:
Developing sustainable device manufacturing at extreme scales requires a delicate balance between pushing scientific boundaries and ensuring cost-effective and reliable production.
Many scientific and technological challenges exist, requiring integrated efforts in plasma science and engineering, sensor technology and metrology, process engineering, materials, and device design. For example, plasma processes play a crucial role in nearly half of all steps in computer chip manufacturing, with increasing complexity and miniaturisation amplifying their significance and challenges.
A significant challenge facing the sector is the growing disparity between the demand for skilled professionals and the available talent pool. Addressing this requires targeted investment in supporting a research and development ecosystem, fostering collaboration between industry and educational institutions to nurture a proficient workforce.

Mitigation Strategies:
To tackle the identified challenges and barriers, collaborative actions involving government, industry, research, and academic institutions are essential. Potential mitigation actions include establishing public-private partnerships for research and development, investing in infrastructure upgrades, strengthening graduate and postgraduate training programmes, and promoting international collaboration. By proactively addressing these challenges and leveraging available opportunities, stakeholders can ensure the continued growth and success of Ireland's semiconductor chip industry. Toward these goals, an integrated research effort is needed, spanning from fundamental applied science to advanced manufacturing technologies, enabling co-design of processes to advance innovation concepts to manufacturing lines.

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Esteemed committee,

I am writing this email in a personal capacity rather than representing a group (well, except perhaps my own group called Embedded.Systems@UCC. I have more than 25 years of experience in microelectronics as a masters(Dipl Ing), PhD student and then as a lecturer. I covered many aspects of digital design and integrated circuits with a myriad of applications which received wide recognition worldwide (more than 60 awards and distinctions, including even a medal for Urban Planning and Design from the Institution of Civil Engineers in London (awarded for using semiconductor circuits to monitor air pollution for bikers), startups, patents, etc. Pretty much all I can say that my microelectronics activity was 100% Irish, despite coming from the other side of the EU. I was even the first lecturer in the newly created Microelectronics Department at UCC, a unique venture in Ireland created in partnership with the NMRC (the National Microelectronics Research Centre). Both are now defunct, although NMRC morphed into Tyndall. I am also an early academic member of MIDAS Ireland (and some of my experience was shared with colleagues in MIDAS Ireland).

I have taught and taught modules such as Electronic Design Automation, Test and Testability, HDL Synthesis, System Level Design, Digital IC and Digital IC Design, and Embedded Systems, and I graduated (thesis and final year reports) more than 150 students. We also built digital chips for AI, security/cryptography, communications, medicine and even financial accelerators. We went from boom to bust, and now we are called to boom again. One particular aspect is phenomenal about Ireland, and that is the companies and the ecosystem they bring. This ecosystem at the industry/enterprise level, I believe, is top-notch and also unique in Europe. Most of the companies that I interacted with were US multinationals. There are many interactions, but at the end of the day, there are only a few that really helped and really made a big difference when it comes to attracting a higher number of students. Some critical help included licenses for state-of-the-art tools used in industry, gifts that allowed lab equipment to be equipped, scholarships for students, outreach, etc.

We have a paradox in Ireland. On the one hand, we have these top technologies developed in the companies around us, and on the other hand, we have students who are trained using 20-year-old technologies. Also declining numbers across the country, particularly in EEE, despite the demand being huge. Companies help allowed us to bring the numbers up(double from an all-time low), but this is still a far cry from times when Ireland started the microelectronics journey (or even since I started my microelectronics journey). The key thing, in my view, is how to increase the number of students. This cannot be achieved with zero funding from the government (such as was the case for most of the 25 years I have worked with students). The real cost of training in microelectronics is very large (and definitely greater than 0). I have discussed with colleagues in other universities that their budgets amount to hundreds of thousands of euros per microelectronics programme per year.

There is a whole infrastructure required at the national level (and here I mention only the academic sector) to be able to increase the numbers. An acceptance also at the local university level that microelectronic costs are higher than of any other degree.

Despite the generosity of companies with regard to licenses, we do not have EDA/CAD engineers and technicians and IT admin to install those licenses and maintain the various updates, etc. This is a serious problem for us in academia, but it is also a serious problem shared by small microelectronics start-ups, etc. Computing across the board is also very demanding and not available in many cases etc. Fabrication is still very, very expensive and cannot be rolled up for undergraduate programmes. Yet, despite the shortcomings, we still have some outstanding students coming through the programmes mostly driven by a huge demand in industry for this skillset. The way it stands, the industry has most skilful personnel trained elsewhere, not in Ireland. The main questions are if we want to do something that is outstanding or if we want to be only afloat and pretend that the status quo is sustainable.

Here are some key gaps which I see still:

- digital is very small in Ireland in academia despite major digital companies around us (Qualcomm, AMD, ARM, Intel,...). As someone in a university that George Boole once taught, I find it very difficult to understand. And yes, it is a digital company that is making waves at the moment due to GPUs, in the AI space, even quantum, etc. Here, I might also be biased as my speciality is digital. Why not a Centre for Digital Electronics (CDE)?
- how can we make digital and analog IC interesting again? Can we fabricate more? Can we build circuits in undergraduate courses? Can we have more hands-on labs?
- how can industry and government help the programmes which are suffering throughout the country? Baiscally what you cannot do with money, you can do with lots of money and a very good strategy...
- would tax-free salaries of EEE graduates from Irish Universities and their teachers work? See medicine where even in academia, the salaries are double and see also example Romania where there was no tax for graduates in the IT sectors.
- How could R&D grants to industry also benefit Academia?
- How could we make SFI/EI invest in hardware research more? Can we have a national facility for Universities and small enterprises that look after IT issues/Computing/Licensing ?

  - How can Ireland become the new Taiwan? Definitely, more hardware makes this sector more stable in the long run. For example, companies which have fabs or major hardware investments in Ireland are here for the long term and contribute enormously to the economy. Also, the model of Singapore would be a good one for Ireland, etc.

  - what if all chips funding goes to Universities? Would we create an over-capacity or even better dynamic for future investment in Ireland? It would allow Universities to catch up or even be at the forefront of new developments. An industry informed distribution of fund to Universities? Tyndall should be also strongly supported to get a new fab which can be at the centre of teaching semiconductor fabrication.

- How can we get more Europe into Ireland? Increase the semiconductor manufacturing footprint of European companies here? Taking advantage perhaps of a great EU workforce in Ireland to attract also EU companies in Ireland?

Given the ecosystem I mentioned earlier, I think Ireland is positioned very well to drive the agenda of semiconductors in Europe. We also need to bring investment in education. A significant slice of the programme funding has to reach the University, and here I mention the undergraduate/taught programmes. Often, in finding resources, the thought programmes have to fight with the research programmes on the same shrinking financial pool. Taught programmes need to be at the forefront of funding schemes for maximum impact. By funding taught programmes everyone benefits (industry, research, economy, etc). Investment in the education sector is key to a sustainable future. We have to recognise that microelectronics education also has a high cost. Digital has to be featured also big on the agenda of chips! Also, bring to Ireland a few Quantum computers or allow academia access to quantum computers to create a related skill! Only very bold moves would lead to success in this area. And yes, this journey has to be done in the industry together with academia for the best outcomes in the long run. The industry is our greatest lobby. Chips Act is one of the greatest opportunities for Electrical and Electronic Engineering in Ireland (at least for the last 2 decades).

Best wishes,

Emanuel

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12th March 2024

Department of Enterprise, Trade and Employment
23 Kildare Street
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D02 TD30

Re: National Semiconductor Strategy Consultation

Engineers Ireland welcomes the opportunity to put forward our thoughts on the development of a National Semiconductor Strategy and would like to take this opportunity to focus on the development of a framework for promotion of the Irish Semiconductor Engineering and Construction (SEC) organisations.

Ireland has a strong history in the attraction of semiconductor device manufacturers, suppliers and original equipment manufacturers (OEM's) to establish bases of operations within the country. The establishment of these facilities has resulted in an employment base of approximately 20,000 full time employees and the establishment of a semiconductor ecosystem.

We believe that we have missed a significant opportunity to address one of the key factors required in the semiconductor supply chain, that of the SEC organisations.

Aspirations for the Semiconductor Engineering and Construction (SEC) Sector

Our recent construction of the most advanced semiconductor facility in Europe has resulted in the organic development of a specialised workforce of over 15,000 direct and 10,000 indirect employees. We have become the most qualified Semiconductor Builders in Europe and we are in danger of losing this position as the current building cycle comes to a conclusion.

Engineers Ireland believes that we should not give up this position and we should instead promote this to the European Semiconductor clients and maintain our capability in this critical area.

Our aspiration is to position Ireland as a global supplier of Semiconductor Construction and Engineer specialists with the following three goals;

1. The outward promotion of Ireland's SEC companies as Global Semiconductor facility specialists.
2. The retention and development of existing SEC skills and organisations.

3. The attraction of additional inward investment based on the strength of the SEC capabilities.

Opportunities for the sector

As the need for semiconductor grows, Integrated Device Manufacturers (IDM) across the globe are currently building or developing plans for the construction of a range of semiconductor facilities. These range in size and complexity but all require specialist SEC's to design, build and operate their facilities. We believe that Ireland is in a unique position to not only offer the skills required to construct these facilities but also to attract potential Semiconductor Manufacturers to locate in Ireland.

Irish SEC's have a long history of designing and building semiconductor facilities starting with Analog Devices in 1976 right up to the present with the build of F34 for Intel Ireland. Irish SEC's have been responsible for the design, engineering, construction and commissioning of the most advanced 300mm semiconductor facility in Europe.

Historical considerations for locating in a country or a region include access to funding, available land, power, water & utilities. Now, due to the multiple announcements of new facilities, the lack of skilled construction workers is becoming a significant challenge for the announced projects and a consideration when determining a location for new facilities.

The promotion of this capability will drive additional employment, growth opportunities within existing companies and potentially drive additional opportunities for attracting additional semiconductor manufacturers to locate in Ireland.

Challenges for the sector

Intel and TSMC have stated that there is a lack of skilled design, engineering and construction resources to construct their facilities. Within Europe, seven companies are preparing to build this type of facility, (Intel, TSMC, Globalfoundries, ST Micro, Wolfspeed, IMEC and Infineon), which has driven a Europe wide shortage of skilled semiconductor specialists and put all projects at risk.

For the Irish SEC industry, the fragmentation of the industry and the lack of a cohesive strategy to develop and promote the strengths of the SEC organisations have resulted in a haphazard approach to developing and utilising their capabilities.

Due to the speciality of the semiconductor construction industry, a number of organisations within this sector lack the business development skill sets required to promote themselves and to expand beyond their existing footprint due to not having access to relevant semiconductor support and structures.

Finally, due to the international location of these projects, the challenges for the SEC suppliers to gain an international foothold can be beyond their existing capabilities.

Access to Talent for business

Ireland SEC's have built a unique, transferable and in demand skill set that sets us apart from many of our competitors in Europe. We currently have a SEC workforce well in excess of 20,000 resources consisting of designers, construction managers, engineers and specialist providers that we are at risk of losing unless we develop a strategy for ongoing development, promotion and utilisation of these companies.

Barriers to development and Mitigation

One of the key barriers to development is the lack of a unified strategy to promote the ability of the SEC organisations in Ireland to the global Semiconductor Device manufacturers.

We believe that Ireland urgently needs to invest in;

a. The development of a programme to promote the existing skills of Irish based semiconductor Engineering and Construction organisations
b. The development of a national framework for the enhancement of skills specific to the semiconductor engineering and construction industry.
c. The development of a programme to attract inward investment of a number of mid scale Semiconductor Manufacturers to Ireland,

To that end, we propose the addition of a Semiconductor Engineering and Construction (SEC) strand to the National Semiconductor Strategy with the specific objectives of promoting the existing Irish Semiconductor Engineering and Construction capability and to utilise this unique skill set to attract additional Semiconductor Manufacturers to locate their facilities in Ireland.

Yours faithfully

Damien Owens

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Director General
Engineers Ireland

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Enterprise Ireland submission to the Department of Enterprise Trade and Employment on the National Semiconductor Strategy Consultation

Enterprise Ireland warmly welcomes the initiative of a National Semiconductor Strategy and will endeavour to support this important work as appropriate.

The semiconductor industry in Ireland has played an important role in the development of indigenous businesses for many years. The strong Multinational presence has been complimented by a local supply chain that has grown with the sector providing a range of activity such as design services, technical equipment and construction services.

As a result Irish companies have developed an expertise in the semiconductor industry which has opened up export market opportunities for these companies. The research ecosystem has also thrived with leading activity now anchored in Irish Research Performing Organisations.

With aggressive growth of the global industry forecast in the next ten years this creates an opportunity for these companies to expand further internationally and create export supported jobs in Ireland.

To date Enterprise Ireland has supported these companies through direct investment, financial supports and a suite of offerings designed to enhance the capability of these companies to grow and compete in world markets. The Disruptive Technologies Fund administered by Enterprise Ireland has also supported projects from companies in this sector.

Case Study: High Tech Construction

Enterprise Ireland construction sector clients employ over 40,000 people in Ireland with exports reaching almost €3bn in 2022. The sector has grown very strongly with double digit annual export growth for the last number of years. Enterprise Ireland has worked very closely with the construction sector through this growth period making key sector and company level interventions to encourage and support the internationalisation of these businesses.

The export markets served, and the nature of the business delivered has changed dramatically in the last 15 years. Historically the Irish construction sector was focused on the UK market. This market is now a minority share of construction sector exports with markets such as Germany, Sweden, The Netherlands and Italy demonstrating rapid growth.

Driving this growth is the expertise of Irish contractors in the delivery of High Tech Construction projects such as data centre, bio pharma, power and renewables. Irish companies are now viewed as having world class capabilities in these projects, particularly in the data centre vertical.

The genesis of this journey into the delivery of international construction services started in Ireland through the delivery of projects for FDI clients. From this experience Irish companies developed the competencies required to deliver complex projects at the highest level.

In short, exploiting domestic construction experience has been a highly successful internationalisation strategy for the Irish construction sector that has resulted in export led job creation in Ireland.

International Semiconductor Construction Opportunities

Enterprise Ireland believes that Irish construction and engineering companies can establish themselves as global leaders in the delivery of semiconductor manufacturing facilities.

The scale of investment being made into semiconductor manufacturing facilities globally is unprecedented. The nature of these projects requires highly specialised skills and company capabilities. As such, companies that have experience in delivering these facilities are and will be highly sought after for these projects. This presents a large addressable opportunity for the Irish companies that have worked on similar projects in Ireland e.g. the recently completed Intel Fab 34 in Leixlip.

While Irish construction and engineering companies currently have a very strong pipeline of work on international data centre and bio pharma projects it is important for these companies to have a diverse range of customers and sectors to insulate from sector specific shocks or downturns. This adds greater importance to the opportunity in semiconductor construction.

It is also important that Ireland maintains these skills so that they can be available for deployment on future semiconductor projects that may be considering Ireland as a location.

There is growing demand for offsite construction and engineering on High Tech projects. A potential model for delivery is the design and manufacture of modules in Ireland that are then exported and installed on site in export markets such as Europe. This has the potential to create regional design and manufacturing jobs in Ireland.

Enterprise Ireland has been exploring these opportunities and is supporting its clients to understand how these international investments may present the potential for the export of products and services. Enterprise Ireland will support client companies through its international and Irish offices. Internationally, highlighting the Irish supply chain and connecting Irish companies with partners and buyers will be key activities. As there is the potential for Irish companies to export to new markets, guidance on local market operations and considerations will be provided. In Ireland, part of this strategy is to ensure that Enterprise Ireland clients have the technical capabilities to deliver on the demands of the semiconductor sector. Upskilling in areas such as lean project management, digital systems for construction and manufacturing capability are important elements to be addressed. Enterprise Ireland will work directly with companies and wider stakeholders to identify further skills needs to be addressed.

We are happy to contribute further to the strategy development and execution and look forward to working with the DETE team on this.

Ross O Colmain

Head of High Tech Construction and Housing

Enterprise Ireland

Public Consultation on the Development of a National Semiconductor Strategy

An SME's Perspective

Prepared: March 2024

Author: Dr J.D. Lambkin
Managing Director, Founder

Introduction

Firecomms (www.firecomms.com) is a group comprising of Firecomms Ltd, an SME incorporated in Ireland, and Zhejiang Firecomms Ltd an SME incorporated in China. The Firecomms group designs and manufactures optoelectronic modules for use in power electronics applications. Firecomms Ltd, based in Cork, is responsible for (i) product research & development, (ii) integrated circuit (IC) design and IC supply and (iii) global sales & marketing functions, while Zhejiang Firecomms Ltd is a manufacturing facility located in Zhejiang province, China. Firecomms Ltd. was spun-out from the Tyndall National Institute in 2001 and subsequently sold to Chinese investors in 2012. Today the Firecomms group has revenues of $10's million per annum employing 28 persons in Cork.

Firecomms manufactures a range of optoelectronic transceivers, passive components and cable assemblies for use in industrial, utility and medical applications which are then supplied to global leaders in electrification, industrial automation, rail transport and medical scanners. The Company's competencies includes the design and manufacture of mixed-signal analog integrated circuits (ICs), visible and infra-red light emitting diodes (LEDs) and the mechanical design of packages, housings and connectors.

Firecomms Ltd. designs custom application specific 0.35 um CMOS ICs for use in its own transceiver module products. The IC are manufactured using a European fabrication foundry whose facilities are located in both Europe and Malaysia, wafers are subsequently wafer-level tested in Cork. The LEDs that Firecomms Ltd designs are fabricated using a supply chain in China. Zhejiang Firecomms Ltd is responsible for the packaging of the semiconductor components.

General Comment

The IC or chip shortage that occurred in the course of 2020 to 2023, (and which also affected Firecomms due to the imposition of allocated chip supply from the fabrication foundry), brought to the world's attention the geopolitical risks and supply chain vulnerabilities associated with the production of ICs worth over $500 billion per annum. Only three companies in the world — Intel, Samsung and TSMC — are capable of mass producing chips powerful and small enough for today's most advanced mobile technologies and only one company – ASML- capable of manufacturing the processing equipment need for the smallest geometry ICs. The security of supply and geographical location of the manufacture of these high-end ICs are very much the focus of attention for US Chips and Science Act and Ireland has an important role to play at this level as it hosts one of Intel's fabrication facilities in Leixlip (Fab 34).

However, beyond the headline stories of tensions between China and Taiwan and new investments in manufacturing facilities for high-end ICs, Ireland should also pay special attention to the market for *application specific integrated circuits* (ASICs) and their relevance to SMEs across a wide range of technology sectors.

Virtually all products that consume electricity will have within them ICs. Many of these are digital ICs that can be considered general purpose (processors, memory) and are designed and marketed for use in a variety of disparate applications. However the class of ICs known as ASICS are designed to meet specifications and functions that are targeted to a particular application or task such as sensing or control. Such ASICs are often designed with significant analog circuit content as these chips sit at the interface between the 'real' anaolg world and the world of digital processing. In 2022 the market size for ASICs was USD 15.469 billion and is expected to grow to USD 25.807 billion by 2027, at a compound annual growth rate (CAGR) of 8.9%.

Opportunities for the SME sector

Some may assume that custom ASIC design and ASIC production are the domain of multinationals and outside the scope of small and medium sized SMEs. However, this not correct and instead it should be a targeted and measurable goal of Ireland's semiconductor strategy to increase the number of SME's which have the capacity to design and produce their own custom ASICs.

The commercial advantage for SMEs derived from developing and producing custom ICs can be illustrated by way of an example. When Firecomms was spun out from the Tyndall National Institute its core technology was in a specific high-speed LED designed for use in industrial optical communication. However, to convert this compound semiconductor device into a commercially useful product which allows the end customer implement a useful optical link in their systems required the addition of driver ICs to drive and modulate the optical signal from the LED as well as optical receiver ICs to convert the optical signal back into an electrical signal that the customer can then access in their system; both these ICs are examples of ASICs. Of course all these semiconductor components then needed to be packaged, housed and connectorized to form the final product. It was the Company's original plan to purchase 'off-the-shelf' ASICs however it became quickly apparent that the available ASICs on the market did not fully meet our requirements. More importantly however, as the cost of the ASICs proved to be a significant proportion of the bill-of-materials of the end products it was not feasible to add a significant margin to these 'off-the-shelf' ASICs without the cost of the final product becoming prohibitively expensive and uncompetitive. For our business we quickly reached the conclusion that Firecomms needed to bring these ASICs in-house. As a result the Company invested in its own IC design group and design tools and then took responsibility for the manufacture of the ASICs through a combination of using an external foundry to fabricate the wafers (front end) and investing in wafer level test and packaging capabilities (back end). Today Firecomms' custom ASICs account for the majority of the company's intellectual property and enable us to apply margins to our products commensurate with those enjoyed by semiconductor industry.

As an SME, Firecomms' experience has been that with an appropriate business case and sufficient investment, the ability to design and manufacture custom analog ASICs can be critical in developing a successful high-value product. From this perspective we consider ourselves to have built a fully integrated value chain for which we are responsible for all design aspects from the semiconductor level (silicon and compound semiconductor) up to the final transceiver module sold to the end customer. For Firecomms we were able to transitioned from a low-margin component supplier to a high-margin module manufacturer. Regardless of the sector or the nature of an SME's core technology; MedTech, ICT, Biotechnology or agri-food etc., the adding of a custom ASIC can provide significant added value, enhanced functionality, improved performance, increase barrier to competition and ultimately realise the maximum potential and profitability of the product and core technology.

Challenges facing SME businesses and the sector

Ireland strives to be a knowledge based economy that aspires to support a broad based of technology SMEs producing products and services with high added value for international sale. For some hardware based SMEs the addition of ASICs within their products could be a means to provide significant added value and differentiation. However three fundamental challenges must be overcome to take advantage of this opportunity.

1. The first challenge is one of awareness and education. The addition of custom designed ASICs into an SME's product is not a panacea and must be carefully investigated and justified by a coherent business plan; in many situations this strategy may be of no value. Nevertheless the question remains as how many SME's would even consider evaluating this approach particularly from technology sectors with no direct experience of ASIC design? There is therefore a requirement for increased awareness and education.
2. Custom ASIC design and ASIC chip supply requires significant investment in money, time and human resources and hence financial endurance and patience is required from investors and stakeholders together with a clear understanding of the full process and risks. In the case of Firecomms the time taken from the decision to invest in an ASIC design team to delivering production batches of wafers of ICs was in the region of six years and required significant commitment from the investors. It is important to note however that the access to the R&D tax credit scheme was, and remains, critical in supporting Firecomms R&D process.
3. However the third and arguably most significant challenge that has emerged over the last 5 years or so has been access to talent or rather the lack of access to talent.

Access to talent for businesses

To take full advantage of the opportunity to embed ASIC design and production into a broad range of SMEs it is absolutely essential that Ireland has access to highly trained engineers:

Analog IC designers, IC layout engineers, device characterisation & test engineers, wafer-level test engineers, packaging engineers, product engineers, quality engineers and applications engineers.

From Firecomms' own experience over the last 24 months in attempting to hire engineers into some of these positions it is clear that there is a major deficit of talent resident in Ireland compared to the demand. Using multiple recruitment companies it took almost 12 months to hire an experienced analog IC designer and over 8 months to hire two test engineers one of whom had to come from abroad. The Munster region has a number of well-established multinational semiconductor companies and the recent addition of Cadence's centre of excellence in Cork in 2020 means that there is now significant competition for local talent. For SMEs to compete they must have access to experienced engineers as they do not, by virtue of their size, have the luxury of providing long training programmes for graduate intakes. Nevertheless it is still essential for both SMEs and multinationals that there is a sufficient and steady supply of engineers from the regional colleges and universities entering into the ecosystem of semiconductor design & test to enable a critical mass of talent to be established.

To exacerbate matters the non-functioning housing and rental markets makes it an almost impossible to find attractive accommodation for staff relocating to Cork and is particularly difficult when recruiting engineers from abroad. As is now well understood by all concerned that this has become a significant brake on the entire economy. The lack of talent is an extremely serious impediment to fostering growth and proliferation of the semiconductor ecosystem.

Barriers to development

There are several additional obstacles facing an SME that wishes to design and supply custom ASICs in-house.

It is feasible that an SME can outsourced all the stages of the ASIC design and IC production through third parties; IC design houses, wafer fabrication foundries, wafer-level test houses and Outsourced Semiconductor Assembly and Test (OSAT) vendors. It is always the case that an external fabrication foundry service must be used as no foundry services exist in Ireland. However, in Firecomms' case we also came to the conclusion that outsourcing the design and back-end functions was expensive and that significant practical obstacles also arose when engaging with wafer-level test houses and OSATs where low-volume high-mix business are not well supported and the costs prohibitively high.

As with many new hardware technology businesses a major challenge for the company is to firstly bridge the gap from prototypes-to-low volume and then from low-volume to high-volume. In the low-volume phase it is often the case that product design is still fluid and modifications and re-spins are required – this is particularly hard and expensive to manage with a fully outsourced model, while having these functions in-house can provide a high level of flexibility to respond to customer requirements. The semiconductor industry is in general geared for the production of high-volume standard products in standard packages and hence it can be difficult to find vendors who can economically support low-volume high-skew manufacturing. Again to take Firecomms as an example we found it necessary to develop in-house the Company's own wafer-level test capability to meet the modest wafer demands as we ramped up production. It is only now at hundreds of wafers per annum does it make sense to look to outsource this test function to achieve lower costs.

Mitigation

A number of high profile investments have been made by EU countries and into EU counties, the latest being Singapore chipmaking start-up Silicon Box which plans to invest €3.2 billion in Italy for producing chips for AI, electric vehicles, and high-performance computing. Spain has also approved a €12.25 billion investment plan to strengthen its semiconductor industry with an emphasis on manufacturing and packaging and as part of this initiative Broadcom has also announced a $1 billion investment into Spain. In Spain's case a significant portion of this investment has been directed from their COVID recovery budget. Ireland has, on the other hand, been delinquent in quickly responding with a coherent strategy to take full advantage of the opportunities arising from the EU's €42 billion Chip Act which is particularly disappointing given the importance of the semiconductor industry in Ireland.

In addition to any large scale infrastructure investments into semiconductors that may support foreign direct investments (FDI) a key goal of Ireland's national strategy should be to invest and support the proliferation of high-tech SMEs that both use their own custom ASICs and SMEs that provide design and production services for custom ASICs. The ultimate goal should be the scaling of some of these indigenous companies to create companies of size and stature competing on the global market with an international customer base. These companies should be a combination of service providers as well as SMEs who have the capacity to design and produce ICs entirely in-house. This requires (i) engineering talent, (ii) seed and follow-on capital and (iii) an extended ecosystem that includes multinationals (Analog Devices Inc., Infineon, Microchip, etc.), SMEs and the third level institutions to support growth and deployment of leading edge technology across a broad range of sectors. Without creating and maintaining a critical mass in all these areas even the continued presence of the multinationals is placed at risk.

As significant intellectual property and value resides in the design of ASICs it makes compelling sense that a focus should be placed on stimulating and scaling companies in Ireland that undertake custom IC design for both sale of IP and design services; it should be recalled that it was only a team of twelve employees that produced the design of the first ARM microprocessor between 1983 and 1985. However, for SMEs across a wide gamut of technology sectors ASIC design alone is not sufficient - the chip also need to be productised; it is essential therefore that the national semiconductor strategy must also focus upon and promote the back-end functions of wafer-level test and packaging either within the companies themselves or provided as external services.

Regardless of the sector or the nature of an SME's technology the adding of a custom ASIC can help realise the maximum potential and profitability of the product and core technology. To do so successfully requires a strategy to invest sufficient time and money to create a semiconductor ecosystem with critical mass.

It should be a target and measurable goal of Ireland's semiconductor strategy to increase the number of SME's which have the capacity to design and produce their own custom ASICs.

Consultation Response

DETE Consultation on the development of a National Semiconductor Strategy

Date: 15/03/2024

Important notice and disclaimer

Freedom of Information

In the event that the Department of Enterprise, Trade and Employment (DETE) or any other Government Department receives a request for records pursuant to the Freedom of Information Act 2014 (the "FOI Act"), we trust that the Department would refuse a request for the content of this document on grounds that it is exempt, and that the public interest would not, on balance, be better served by granting than by refusing the request, having particular regard to sections 35(1)(a), 36(1)(b) and 36(1)(c) of the FOI Act. We trust that the DETE would in any event consult us in respect of any such requests in respect of the information submitted to you by Fuinneamh Sceirde Teoranta in advance of determining them.

Overview of Corio & FST

Corio Generation is a specialist offshore wind business dedicated to harnessing renewable energy worldwide. With our leading industrial expertise and deep access to long-term capital, we work closely with our partners in the creation and management of projects from origination, development and construction, and into operations.

Corio Generation is a portfolio company of Macquarie Asset Management operating on a standalone basis, with a project pipeline of over 30 GW.

Corio Generation is developing the **Sceirde Rocks Offshore Windfarm** off the West Coast of Galway, through the Irish and Gaeltacht based company, **Fuinneamh Sceirde Teoranta** (FST). FST is a joint venture owned by Corio and global infrastructure investor Ontario Teachers' Pension Plan.

This project will be one of the largest ever infrastructure projects in the Connemara region. Once built, it will be the first commercial-scale offshore windfarm on Europe's Atlantic margin, set on Connemara's Gaeltacht coast. Sceirde Rocks Windfarm is set to generate enough clean electricity to power more than 350,000 homes. **The project will help Ireland to achieve its goal of generating 80% of energy through renewable sources by 2030.** Once operational, the project will generate enough renewable electricity to avoid an estimated 550,000 tonnes of CO_2, which is the equivalent to taking 180,000 petrol cars off the road. In terms of additional benefits, a multi-million-euro Community Benefit Fund will be available over a 20-year period to support a range of sustainable community initiatives locally, with €3.5 million to be invested annually once the windfarm is operational.

Fuinneamh Sceirde Teoranta welcomes the opportunity to respond to the Department of Enterprise, Trade and Employment's public consultation on the development of a National Semiconductor Strategy.

Consultation Response

Aspirations for the sector *– What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?*

- As a Offshore Wind project developer, delivering the 450 MW Sceirde Rocks Project on the West Coast of Ireland, we are **keen to see electrification of industry and increased offtake loads on the western seaboard. This will benefit an evolving grid network, support grid reinforcements and provide wider system benefits i.e., reduced curtailment and constraints on the system.**

Opportunities for the sector *– What do stakeholders identify as key opportunities for the sector to further develop?*

- As a Phase 1 fixed-bottom offshore wind project on Ireland's West Coast that was successful in the ORESS 1 auction, we can **provide competitive solutions to support green energy/ decarbonisation solutions this decade**, in alignment with national decarbonisation targets for 2030.

Challenges facing businesses and the sector *– What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?*

- Power requirements in Ireland are challenging to meet, but fixed-bottom offshore wind projects with high-capacity factors such as the Sceirde Rocks project can **provide sustainable delivery solutions to enterprises with large offtake requirements**.

Access to talent for businesses *– What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?*

- The Semiconductor industry could align with the ambitions to establish a sustainable workforce and skills pipeline for offshore wind in the Powering Prosperity – Ireland's Offshore Wind Industrial Strategy. The Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) is taking action to address the skills required to develop offshore wind in Ireland, and should take a similar approach for the Semiconductor industry.

We hope that you consider our response provided and would be happy to engage at any point to discuss.

Comhairle Chontae na Gaillimhe
Galway County Council

Galway County Council Submission to Public Consultation on the Development of a National Semiconductor Strategy

Introduction

Galway County Council wish to make a Submission to Public Consultation on the Development of a National Semiconductor Strategy. The county has standing in this matter because, within in the last 12 months, we have hosted site search visits by two very large international semi-conductor manufacturers.

These experiences have provided the County Council with first hand evidence about the needs of very large international semi-conductor manufacturers that may be of assistance in the preparation of a Development of a National Semiconductor Strategy.

Galway County Council have long-anticipated the need for such development by their identification, adoption and development of a strategic economic development corridor that lies to the east of Galway city.

The strategic economic corridor encompasses regionally scaled infrastructure – energy, telecoms, adjacent settlements, zoned lands as well as high-capacity road, commuter and mainline rail connectivity.

The site visits within this corridor involved detailed meetings with the representatives of these companies. These consisted of presentations about the wider strategic provisions and opportunities that the combined city and county could offer. The company also met established industries in the area.

General Requirements *Skills, Services and Sites*

In the first instance, it is important to understand the scale of the requirement for these companies. The current reality if that there are a small number of very large companies that manufacture semi-conductors.

The ICT sector has several stages ranging from semi-conductor manufacturing to test and assembly to device manufacturing. For advanced, high-cost economies, such as Ireland, only the manufacturing is economically viable – with all other stages now being carried out in low-wage, low cost economies.

Skills

The manufacturing sector requires access to very high-quality human resources of two types, namely construction and operation expertise. Ireland possesses both of these due to the very high number of STEM graduates per capita as well as a large population of construction and operation personnel who are already present to serve Ireland's large-high-tech sector.

These sites need to be able to access up to 6,000 suitable employees from a 40-60 minute catchment.

These sites also need access to a wide range of suppliers and support services in nearby office, warehousing and industrial estates.

Services

Large-scale manufacturing for the Semiconductor needs to have regionally-scaled utilities for energy, water-services, and mobility – these need to be reliably, sustainably and affordably supplied at scales comparable to a small city. These large sites have capacity for on-site waste-water treatment, parking and public transport facilities as well as energy generation – however ideal sites share the capital and current costs for these items with other users, suppliers and agencies.

Sites

Large-scale manufacturing for the Semiconductor manufacturing requires large sites – up to 300 ha [about 750 acres]. The size is required for the following reasons:

- To accommodate large buildings, offices and associated utility and site support services,
- To accommodate transport access for trucks parking and public transport – periods when an operational plant is being extended may require on-site parking for up to 10,000 vehicles.
- To accommodate construction and laydown areas during construction
- Set-backs for sensitivities – for SEVESO activities.
- To accommodate future expansion [four to six time bigger]

GCC Submission

Based on our experience we can offer input and advice, following the suggested topics, as follows:-

Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

On the basis of the meetings/site visits and interaction, we have learned that the sector needs to have security to be able to continue to grow and develop on the site for decades after the initial investment. This means that site and its environs need to be able to continue to supply skills and services as well as meeting increased demands for utilities and mobility.
Based on the meetings, we have learned that these needs extend well beyond the manufacturing site. The companies were very encouraged by the proximity to other developed and zoned land. They also saw the proximity of other established high-tech businesses as evidence of a local marketplace of talent.

Opportunities for the sector – What do stakeholders identify as key opportunities for the sector to further develop?

Companies see opportunities where the 'Three S' exist – as set out above. Skills, Services and Sites.

We learned that the participation of a supportive local authority mattered a lots to them. We received feedback that they were particularly appreciative of meeting local officials who seemed to understand their needs – especially 'off-site support – such as nearby facilities.

Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector?
Financial investment

Regional and local opportunities

What are the overarching challenges facing Ireland's semiconductor sector as a whole?

Energy
Overseas competition

Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?
The best-received parts of our presentations were these that addressed the issue of talent and skills. They reported that it was very convincing when we provided official statistics on skills, educational attainment, employment rates, age-profiles. The local presence of the equivalent industries, that they met – albeit at a much smaller scale – was a key. The local presence of the third level educational facilities-Atlantic technological University (ATU) and University of Galway (UG) were very important to them. Access and transportation were important because they could envisage employees travelling from many of the smaller and larger local settlements – as far as Ballinasloe, Tuam and Gort.

Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

Access to affordable and reliable energy and water services are the biggest reported potential barriers to development. They worried about finding sites near large settlements of sufficient size without excessive nearby residential sensitivities. The next concern is access to good transport links – both during construction and operations.

Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

The companies appreciated frankness when briefed on challenges and barriers. They confided that they were very familiar with issues of local objections and anxieties together with challenges of 'booking' such large amounts of land and utilities. 'we worry if you didn't share these difficulties with us' was a memorable and reassuring quote. They expressed the view that a good, constructive working relationship with local officials was the best mitigation measure.

The identified as access to data as an important mitigation measure. They find that their application documentation is much more reliable when they have ready access to good official local data about everything from traffic and air quality to groundwater and ecology . FDI companies who are new to an area expressed their need for 'local introductions' to help them to make early progress on both community and local NGO engagement.

Liam Hanrahan

Director of Services - Economic Development & Planning / Stiúrthóir Seirbhísí - Forbairt Eacnamaíoch agus Pleanáil

Comhairle Chontae na Gaillimhe | Galway County Council

Áras an Chontae | Prospect Hill | Galway | H91 H6KX

The Development of a National Semiconductor Strategy for Ireland

SUBMISSION TO THE DEPARTMENT OF ENTERPRISE, TRADE AND EMPLOYMENT

James C Sexton,
IBM Fellow, Future Computing Systems
IBM Research – Ireland

March 2024

IBM is a leading provider globally of hybrid cloud and AI, and consulting expertise. We help clients in more than 175 countries capitalize on insights from their data, streamline business processes, reduce costs, and gain the competitive edge in their industries. More than 4,000 government and corporate entities in critical infrastructure areas such as financial services, telecommunications and healthcare rely on IBM's hybrid cloud platform and Red Hat OpenShift to effect their digital transformations quickly, efficiently, and securely.

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INTRODUCTION

IBM welcomes the opportunity to contribute to the Department's development of a National Semiconductor Strategy. In this paper we set out our comments on the consultation paper circulated on February 21, 2024.

For further information, please contact Barry O'Brien: barry_obrien@ie.ibm.com

BACKGROUND

Semiconductors have been responsible for fundamental transformations of the world since the first demonstration of the transistor in 1947. In the 75 years since then, we have seen remarkable advances in all aspects of human endeavor underpinned by equally remarkable advances in semiconductor technology, and the capabilities enabled by that technology.

Today, we are experiencing an extraordinary inflection point in the application of semiconductors. Advances in raw digital computing power and the emergence of new technologies such as Artificial Intelligence and Quantum Computing are enabling unprecedented capabilities. Semiconductors are now omnipresent in practically all forms of technology from the smallest devices to the very largest.

In the recent past, the semiconductor sector has experienced shortages which forced factory closures in a range of sectors, from automotive to healthcare, highlighting the need for a robust, geographically diverse supply chain for semiconductor technology. In response to these challenges, leading countries have established very significant investment programmes to expand their semiconductor technology capabilities. The U.S. announced $53B of investment through the CHIPS and Science Act in semiconductor manufacturing, research and development, and workforce. The impact of this investment is already significant and is presented in detail in a White House Report[1]. The European Union has launched its own Chips Act with €43B of investment to support the development of a state-of-art European semiconductor ecosystem[2]. Other countries and regions around the world have similarly invested.

IBM has welcomed both the U.S. and EU Chips Acts as important initiatives to strengthen leadership in semiconductor technologies. Together they will spur advanced semiconductor

[1] *Fact Sheet: One Year after the CHIPS and Science Act, White House Report*

[2] *European Chips Act, European Commission Strategy and Policy*

R&D, rebalance global manufacturing capacity, help to overcome supply chain challenges and boost long-term security and resilience.

We strongly support the EU Chips Act's provisions aimed at promoting advanced R&D in sub-2 nanometre nodes, energy-efficient processors, quantum chips, and 3D integration.

On both sides of the Atlantic, we recommend that investments in semiconductor research and manufacturing capacity should be coordinated and aimed at ensuring a steady and secure supply of chips for now and long into the future. To avoid a subsidy race and the duplication of efforts, IBM supports action by the EU/US Trade and Technology Council to coordinate semiconductor investments between Europe and the U.S., and to increase transparency in the semiconductor value chain so that we can anticipate – and be prepared for – future supply chain shocks.

IBM believes that transatlantic collaboration should go beyond manufacturing and prototyping, to include deep and sustained cooperation between researchers, laboratories, academia, and industry, including joint R&D facilities, collaboration on R&D projects, and mechanisms for the exchange of U.S. and EU researchers that would help resolve a severe shortage of qualified semiconductor workers.

Such cooperation would require strong public-private partnerships developed between the U.S. and EU and should include likeminded allies such as Japan. For example, the American Semiconductor Innovation Coalition (ASIC)[3], with more than 240 members provides a possible model.

[3] *The American Semiconductor Innovation Coalition, https://asicoalition.org*

1. ASPIRATIONS FOR THE SECTOR

What are our aspirations for Ireland's semiconductor industry in the coming years?

The Chips Acts in the U.S. and EU present very clear strategy and policy goals for investment in the semiconductor sector. IBM commends the Department of Enterprise, Trade and Employment's intent to capitalize on opportunities for the semiconductor sector that have emerged at the EU level and to develop a national strategy for the sector in Ireland. We note that Ireland has a strong ecosystem supporting the silicon technology sector developed over very many years. We recommend that Ireland continue its long-term investment in the sector.

We note further that, with the emergence of Artificial Intelligence (AI) and Quantum Computing use cases both within data centers and at "the edge" in intelligent devices for every imaginable application, demand for silicon technology solutions is expected to expand enormously. The directed Chips Act activities around the world will significantly expand silicon fabrication capabilities and capacities in support of this demand and in support of supply chain robustness and sovereignty. These enhanced silicon fabrication facilities will need a robust pipeline of new products and designs to sustain their operation. We believe that Ireland is in a strong position to become a leading developer and supplier of capabilities and services for the rapid, cost-effective design of solutions needed to underpin this new world-wide expansion of silicon technology activities.

We therefore recommend:

- That Ireland seeks to become a key international location for the provisioning of skills, capabilities, and services for the development, design, and packaging of semiconductor solutions.
- That Ireland targets its development activities to supporting emerging silicon technical fabrication facilities within Ireland and in Europe, the U.S., and Japan given Ireland's strong connections to these regions.
- That Ireland particularly targets its development activities to support leading-edge technologies such as heterogeneous packaging and chiplet-based design[4] that deliver agile, cost-effective and technology-agnostic solutions.

[4] *SEMI Advanced Packaging and Heterogeneous Integration:* https://semi.org/en/packaging-central

2. OPPORTUNITIES FOR THE SECTOR

What do we identify as key opportunities for the sector to further develop?

International Chips Act Opportunities:

The materials referenced above concerning Chips Act activities in the EU and the U.S. provide a comprehensive view of the opportunities arising internationally. Ireland already has a very strong semiconductor sector and a range of activities that align with both Chips Acts and is particularly advantaged by its access both to European and U.S. activity. Ireland should continue to support those activities going forward.

It is clear from the scale of investments arising from the Chips Acts that one can expect a significant growth in deployment of silicon fabrication locations in Europe and the US in the next few years. For example, companies including Infineon, STM, Global Foundries, Samsung, Intel, Texas Instruments, Micron Technology, and TSMC have all announced plans for new or expanded facilities in the U.S., the EU or both. The level of capital investment is significant and to survive and prosper, all of these facilities will need strong pipelines of products to be fabricated. Developing such pipelines now becomes a critical challenge for the semiconductor sector.

We suggest that a key opportunity for Ireland in the emerging ecosystem is to address this critical challenge to develop robust pipelines of product for fabrication. To this end, we suggest Ireland should seek to establish itself as a leading location for the development and provisioning of skills, capabilities, and services to design and package leading-edge semiconductor solutions that will soon be enabled by all the new fabrication capabilities being developed.

Design Opportunities

Leading edge semiconductors have become very complex systems in their own right. For example, the chips that are expected to support Advanced Driver Assistance Systems (ADAS for self-driving cars) will increasingly integrate compute, artificial intelligence, sensor, and control functions into complex chiplet-based modules with 2.5D and 3D packaging. Design, development, and test for these modules requires an extraordinary ecosystem. Similarly complex modules will be required across many industrial sectors including health, robotics, manufacturing, and information technology in general.

Chiplet-based approaches to semiconductor manufacture are the expected future approach to building complex semiconductor chips. Chiplets allow development of "building blocks" that can be assembled as needed for application-optimized chips. The early roll-out of chiplet-based designs have been largely in high performance applications (for example AI) where chip complexities have gotten very difficult to manage and physical device manufacturing limits for traditional single chip approaches are being reached. The more significant advantages of chiplets across the whole of the semiconductor industry will be for more mundane but very impactful advancements such as reduced Non-Recurring Engineering design costs, design reuse, faster time to market (at the chip level and at end-product levels etc.) and game changing integration schemes (e.g. Digital + Radio Frequency). There is a clear need to build an infrastructure that can make chiplets accessible across a broad swath of the industry and be technology-provider agnostic in its adoption. It does not appear that the need is being adequately addressed at this time, and thus there is a significant opportunity available.

An additional issue that has emerged is that chiplet approaches today can only be implemented within single vertically integrated fabs. For smaller, innovative players it is essential to be able to flexibly integrate chiplets and IP-blocks sourced from a broad ecosystem and marketplace into new solutions. This requires a flexible choice of chiplet fabrication sources, the ability to independently package those different chiplets, and the possibility to validate, verify and test the resulting chips. Focusing on optimizing logistics and supply chain integration could play an additional important role, and maybe even consolidating manufacturing and outsourced services. This would involve the entire ecosystem, including fabless design companies, CMOS manufacturing, package manufacturing, assembly, test and validation. Currently, the design phase alone can take 9 to 12 months, followed by 4 to 5 months of fabrication and additional months for packaging and assembly. The total cycle can take 1.5 years or even more, particularly for companies that do not receive priority treatment in the very large fabs.

A new ecosystem approach more suited to chiplet-based design is now needed. Such an ecosystem would require investment in setting up the suggested design capabilities. However, this investment is at a more modest level than that required to support new fabrication facilities. The development focus needed includes design expertise in integrating complex outsourced IPs to build advanced chiplet functions, high-performance system-in-package design expertise to assemble chiplets into modules, and advanced design tools (with AI) for chiplet-based system design, simulation, verification, and virtual bring-up. There is a broad spectrum of research opportunities in this space to develop consumable methodologies and to integrate AI to accelerate development capabilities.

The key to success for such an approach will be to adopt and integrate digital capabilities spanning chip design, validation, verification, and testing at scale and speed. Development and integration of AI capabilities to accelerate design processes is an additional differentiator that Ireland should actively invest in for success in the sector. Examples of AI enhancement opportunities are described in the referenced IEEE article[5] which discusses how AI will change Chip Design.

[5] IEEE Spectrum Article: How AI Will Change Chip Design

3. CHALLENGES FACING BUSINESSES AND THE SECTOR

What are the key challenges facing individual businesses in the semiconductor sector?

What are the overarching challenges facing Ireland's semiconductor sector as a whole?

Supply Chain and Silicon Fabrication Challenges

A feature of the current silicon technology ecosystem is the dominance of the vertically integrated foundries from Intel, Samsung, TSMC, and Global Foundries, optimized for high-volume production. This presents both opportunities and challenges to participation from smaller players in the ecosystem spanning fabrication, packaging, and design who do not have the scale to expect prioritized access to these very large foundries.

On the positive side, the various Chips Act activities in the U.S., the EU, and Japan are supporting investment in multiple leading edge fabrication capabilities. These fabs, once operational, will be hungry for business, and will actively recruit smaller scale players to use their capabilities.

To be successful though, these potential smaller scale players must, themselves, be able to execute chip designs efficiently, quickly, and at reasonable cost. That will be possible only if there is a well formed, integrated ecosystem of Intellectual Property (e.g. component designs), design, packaging, and verification tools in place that is accessible, and of reasonable cost. This ecosystem should of course support the large foundry methodologies, but it must also support access to smaller foundries so smaller-scale players can have cost effective access to the best technologies to meet their needs.

We suggest that Ireland is in a special position to champion the development of such an ecosystem. It will be to Ireland's benefit if smaller and bigger players alike can be active, collaborate and compete in the silicon technology sector. For that reason, Ireland should support the development of advanced chip design capabilities that would underpin such an ecosystem.

Climate and Sustainability Challenges

Because of its scale, complexity, technology requirements, and environmental impact, the semiconductor industry is now facing very significant challenges across the complete spectrum of its activities. With current technologies, it is hard to see how continuing growth in digitalization can be managed in ways that support global climate change targets. An essential approach to addressing the rapidly growing demand for computing is to innovate on new technologies that can deliver orders-of-magnitude power reductions for future computing and data processing systems. New materials, new technologies to reduce power utilization, new tools to optimize designs for best power / performance, new production methods, and new computing approaches will be essential in such innovation.

In addition to the power challenges involved in their deployment, current silicon technology manufacturing methods impose very significant materials production and disposal burdens on the world. Climate and sustainability challenges impact all aspects of semiconductor technology. For individual businesses participating in the semiconductor sector, delivering cost-effective products that provide innovation, while addressing supply chain challenges (either directly or indirectly), climate and sustainability targets, and meeting regulatory requirements is now a significant burden.

Ireland can support development of future silicon technology capabilities addressing these challenges by continuing or adding investments in:

- Development of more sustainable materials and processes for application in the semiconductor sector.
- Development of design capabilities that support improved, more energy efficient designs.
- Development of AI capabilities for research and development to improve the design processes and tools.
- Development of a complete design ecosystem that supports state-of-art development capabilities while addressing climate and sustainability challenges.

Dear Sir / Madam,

In response to the request for stakeholder input, please see some comments below -

Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years? For semiconductor manufacturing amongst the key skills are science and engineering, combined with digital skills and problem solving. For the key staff within the semiconductor sector, these skills and expertise are required at a high level, in order to address key manufacturing and developmental issues, such as the processing of semiconductors at the angstrom level, while addressing yield and performance issues. Some employees can gain their experience by working in the semiconductor sector, however in order to ramp-up the development of this sector in Ireland, it is essential to train additional PhD students with backgrounds in mechanical and electrical engineering, as well as materials science, or physics. Within the I-Form Centre some of our PhD's have the combined digital with engineering research skills, which would meet the requirements of the semiconductor sector. Going forward however, a Doctoral Centre targeting semiconductor manufacturing would add enormous value, by specifically targeting projects which meet the semiconductor developmental requirements, of this manufacturing sector, in Ireland.

Best regards,
Denis

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Proposal for DETE

Re: Public Consultation on a National Semiconductor Strategy

Due date: 15.03.24

Submission by: Infineon Semiconductor Technologies Ireland

Aspirations for the Sector

Around 25,000 people are employed in Semiconductors in Ireland. The dominant employment is in both R&D and in manufacturing (Intel, ADI fabs). Ireland has developed/attracted significant R&D expertise over the past five decades and this should continue to be strongly supported with additional educational support at 2nd and 3rd level to feed the pipeline of engineers.

With experienced semiconductor manufacturing talent in Ireland it should be a goal to leverage that and further expand the number of fabs. We need to focus on developing more business competence in electronics in Ireland (e.g. Sales, Marketing) to drive product lines and even leverage local technology companies to grow business and partner. Ireland should be seen as a place to do business and not just a place to put a vertically integrated R&D facility.

Opportunities for the Sector

The carbon neutral transformation provides for huge opportunities within semiconductors. The electronic content required for **Green Energy** solutions and **xEVs** is enormous, where previously two microcontrollers were needed for engine management alone in cars there are now ~10 chips required for battery management. Luxury vehicles can have over 100 microcontrollers. Green mobility is an umbrella term that also impacts 2/3 wheelers, trucks, buses and drones - so the opportunities are large. New EV architectures are also seeing an important move from 12V to **48V** in the low voltage domain of the car. This is a safety critical domain and the industry needs 48V devices/technology to replace the existing 12V devices, again a potential high growth sector within mobility.

The proliferation of **AI/ML** and the huge success of NVIDIA with AI accelerator chips is another market that is growing strongly. AI is enabled by hardware but we need both competence in using AI and competence enabling AI with hardware. Once Quantum computers become more cost effective (~5 yrs) it will change the impact of AI and even challenge/threaten existing security concepts. Development of new post quantum security mechanisms is another key area of innovation.

The Chips act focuses on both competence centres and semiconductor manufacturing. Backend manufacturing and packaging are areas that have not been extensively developed in Ireland. The trend toward **Chiplets** (multiple die in a package) requires packaging innovation. Given the presence of supply chain/logistics talent in Ireland we could combine this with grants for local backend manufacturing to provide a complete backend manufacturing/logistics/ support infrastructure at the edge of Europe.

Challenges facing business and the sector

Talent attraction is a key challenge for both companies and research institutions.

The challenges facing business is that many companies are engineering focused and vertically integrated to parent companies. Some companies have multiple sites in Ireland that never interact. Ireland needs to be seen as a place to “do business” in electronics. Given Ireland has a significant semiconductor community it feels like this could change and entities within Ireland could start working together at a business level. If we can upskill/attract business talent (sales/marketing) and create that business community / network it could make Ireland a semiconductor business hub. Start-ups may also proliferate with that blend of business acumen and engineering R&D.

While seed capital to get a start-up moving is available in Ireland, significant investment (10s of millions is needed to move companies to the next level). If Ireland wants to promote the next big technology success we need to think big and provide a financial base to support this.

Access to talent for businesses

Talent is always an issue. We need more electronics students entering 3rd level. This starts in secondary school promoting/marketing electronics as a valued career. One proposal is to update the leaving certificate physics and computer science curricula to have electronic hardware content. As an industry we need to market ourselves better toward secondary school students and show vast variety of roles in electronics and opportunities for personal/professional growth.

Maths is a key skill for engineers and we should examine how it is taught in schools. How it is applied is more valuable than learning maths tools. Maths education in Ireland has been compared to learning music through theory without ever singing/playing a note. Effort is needed to remove the stigma associated with Maths being perceived as “hard” and it needs to be seen as a practical life skill.

Attracting Masters/PhD students is also a difficulty. Improved stipends and removal of housing challenges is needed but we also must explore improved benefits for students compared to graduate employment. A hybrid working/part-time student scheme such as exists in Europe could encourage people to continue education and feed our post graduate innovation pipeline. Some programs in Ireland today do bring the student into the workplace after 2 years for some months. The German model has the student work 20 hours per week while in college.

Streamlining the VISA application and renewal process for foreign applicants would encourage more talent to move to Ireland. Other barriers exist in attracting talent compared to another jurisdiction's within Europe. The job market is booming in tech and pharmaceuticals but opportunities are not as great outside these areas for partners who decide to move to Ireland. Transport is over dependant on owning a car. Obtaining a license also incurs a long waiting list (~12 months). Public transport is still not reliable outside Dublin. More investment in rail is needed to keep pace with cities around Europe. Pre-school is oversubscribed and therefore difficult to get places. Our health care system is seen as sub-standard compared to the European norm.

Barriers to development

Further growth as a semiconductor community comes if we focus on application spaces and developing talent/business in those spaces (e.g. Green Energy, xEVs, AI, Chiplets etc.). Proficiency in AI/ML, as an example, could lead to improved R&D methods: "Agile" Analog design could use machine learning to optimise circuits and speed up cycle times. ML assisted layout – which could dramatically change the speed at which we can design chips especially for FinFET geometries where transistor layout takes significantly more effort than on standard CMOS technologies. The demand for hardware to perform AI also means the tools/infrastructure to create and validate those devices needs to be developed

Mitigation (of those challenges)

Around talent:

1. Pivoting engineers from other areas to Technology through training/upskilling.
2. Encouraging more 2nd level students to adopt electronics at 3rd level.
3. For business courses to focus on the semiconductor industry to developing future business talent.
4. We need to look at travel as another bottleneck. As we try to grow business people need to travel more. While Dublin is well served with direct flights to multiple destinations (even multiple flights per day) the same is not true for Cork and Shannon. Better transport links between airports is important. Infineon held a product line workshop in Cork with over 50 attendees from across the globe and the only complaint was around how difficult it was to travel to Cork.

Intel Ireland response to the Public Consultation on the Development of a National Semiconductor Strategy

Leonard Hobbs
Director Government Affairs
Intel Ireland

Contents

Executive Summary

- The semiconductor industry should be recognised as a distinct sector in Ireland due to its unique complexities and manufacturing requirements that set them apart from less manufacturing-intensive industries.

- Ireland should look to bolster and build upon its employment intensive semiconductor manufacturing capacity as a corner stone of the sector in Ireland. Competitiveness will remain a differentiating factor in maintaining current capacity and attracting new investment. The cost of electricity, level of incentives and planning uncertainties are current limiters which need to be addressed.

- The Irish semiconductor strategy should respond to and reflect the ambitions of the EU Chips Act and look to double the size of the sector in Ireland by the end of the decade.

- Key attributes will include pipeline activities such as semiconductor R&D and the provision of talent, investment in leading edge manufacturing and collaboration across an integrated cluster.

- A high level Semiconductor Advisory Council, comprising industry, academia and government actors, should be appointed to oversee the implementation of the strategy and advise government on current challenges and future trends in this fast moving and highly competitive global industry.

- As well as looking to double the number of university graduates for the industry, action should be taken within the strategy to attract overseas talent to Ireland, in reflecting Ireland's ambitions to be the 'silicon isle' of Europe and the place where Europe's leading edge semiconductor industry is thriving.

- The strategy should ensure that the role of 'manufacturing technician' SOC code 3113 is included on the Critical Skills Occupation list.

- While the focus of the EU Chips has been on semiconductor manufacturing, the other elements of the incoming supply chain, including semiconductor equipment suppliers, materials and chemicals suppliers, along with other support functions should be supported with a view to build out the Ireland semiconductor manufacturing ecosystem

- The Ireland strategy should look to establish a leading voice in Europe, both in policy discussions and governance organisations, such as the Chips JU[1], European Semiconductor Board etc

[1] https://www.chips-ju.europa.eu/

Key Themes of Consultation

Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

Over three decades ago, when the young semiconductor industry entered a strong growth phase, largely driven by developments in personal computers, the US and Europe were at the forefront of the industry, enjoying market shares of 37% and 44% respectively. As the industry expanded and cost pressures emerged, manufacturing moved east with the US share dropping to just 12% and Europe to 8% today[2]. As the industry is projected to double to €1trillion by the end of the decade, there is real risk that Europe's share of this market, and hence influence, could drop to less than 5% if nothing is done to address the downwards trajectory.

As such Intel welcomed the EU Chips Act ambition, as launched in February 2022 to "build and reinforce its own capacity to innovate in the design, manufacturing and packaging of advanced chips, and turn them into commercial products while putting in place an adequate framework to increase substantially its production capacity to 20% by 2030"[3]

We believe that the recent milestone reached with the opening of Fab 34 is also of particular significance for Europe, as it is essential to building a more secure and resilient global supply chain for semiconductor chips. Intel is committed to helping Europe realize its technological ambitions as has been expressed in the EU Chips Act. Last September's opening of one of the most advanced factories in the world at the Leixlip campus puts us one step closer to achieving the goal to have 50% of the world's semi manufacturing in the U.S. and the E.U. by 2030. Indeed, the launch intel's latest node, Intel 4, in high volume is also a key win in demonstrating European technological capability as the manufacturing of these tiny devices is enabled by complex EUV machines, developed by Dutch company, ASML. This is the first time that these hugely complex machines will be used in Europe in production.

The Irish semiconductor strategy should respond to and reflect the ambitions of the EU Chips Act and look to double the size of the sector in Ireland by the end of the decade. With the establishment of the Fab 34 facility, we have already doubled the size of our manufacturing capacity and we look forward to many more years of leading edge manufacturing at the Leixlip campus, subject to a favourable investment climate.

Opportunities for the sector – What do stakeholders identify as key opportunities for the sector to further develop?

In support of the publication of the Tyndall National Institute paper[4], "Ireland's role in the global semiconductor industry" Intel CEO Pat Gelsinger wrote that " *the global semiconductor industry has never been more important and is poised to reach revenues of one trillion dollars by the end of this*

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[2] Semiconductor Industry Association

[3] Communication from the Commission: A Chips Act for Europe: https://ec.europa.eu/newsroom/dae/redirection/document/83086

[4] https://www.tyndall.ie/contentFiles/Tyndall_Ireland's_Role_in_the_Global_Semiconducto r_Industry.pdf

decade. Intel's plans in Europe build on our investment in Ireland of over €30 billion since 1989, and we are looking forward to seeing these strategic investments contribute to an end-to-end semiconductor manufacturing value chain across the region. The launch of the Chips Acts in the US and EU underpins this growth. It also presents an important opportunity for Ireland to further build its ecosystem and participate in the future evolution of the semiconductor industry."

The Ireland strategy should bolster and build upon its existing employment intensive semiconductor manufacturing capacity as a corner stone of the sector in Ireland. In so doing it should fully exploit the strategies within both Pillar 1 and Pillar 2 of the EU Chips Act[3]

In regards to Pillar 1, the Ireland strategy should actively engage with the plans under the Chips JU[1] to increase the number of start ups who create design IP, such as Movidius, which was acquired by Intel in 2016. It should quickly implement a Competence Centre to be the hub for a vibrant ecosystem which currently is composed of 100 semiconductor companies[5], and look for pathways to connect with the EU pilot lines. A commendable goal would be to double the number of semiconductor related companies, across the spectrum from chip design software providers to material and chemical providers to assembly to component assembly.

This semiconductor strategy should also 'dovetail' with strategy for Quantum Computing[6] as developments on the latter will emerge from the former.

In regards to Pillar 2, the Ireland strategy should ensure that it has a comprehensive and competitive incentive program so that Ireland can continue to attract and retain the employment and innovation intensive semiconductor manufacturing industry.

While the focus of the EU Chips has been on semiconductor manufacturing, the other elements of the incoming supply chain, including semiconductor equipment suppliers, materials and chemicals suppliers, along with other support functions should be supported with a view to build out the Ireland semiconductor manufacturing ecosystem. Such a focus will not only support the competitiveness of the existing manufacturing companies but also offers the opportunity to grow employment within the sector in Ireland.

The development of the related construction industry, which has demonstrated an expertise and world class competence in the completion of the €17bn Fab 34 project during the pandemic years, will position Ireland for future opportunities. Assistance should also be offered to promote the export and further development of this competence to European projects, of which there are many, particularly in Germany.

Current employment levels for the semiconductor sector in Ireland at 20000[5] representing 10% of total employment for the sector in Europe. Coupled with Ireland's leading-edge credentials, particularly in Intel's manufacturing technology, which is the most advanced in Europe, the Ireland strategy should look to establish a leading voice in Europe, both in policy discussions and governance organisations, such as the Chips JU[1] and European Semiconductor Board.

[5] The Semiconductor Industry in Ireland- an IDA publication
[6] Quantum 2030, A national quantum technologies strategy for Ireland, November 2023

Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

Utility Costs
It is essential that Ireland remains competitive if Intel is to continue its level of investment in the country in the years ahead. This competitiveness is currently under threat, particularly in regard to the cost of electricity. We continue to be concerned that electricity prices in Ireland have not recovered to 'post war' levels and remain at almost 1.8X where they had been, which is 2-3X what we pay for electricity in other parts of the world.

The so called fixed charges associated with the grid and which currently make up 29% of the total cost, have increased by 72% from 2019 and indications are that there may be further increases in the future as the CRU look to levy the costs of the development of the grid on existing users.

Incentives
The level of incentives which are available to semiconductor companies has become a key attractor in countries across the globe and the public supports available in some Asian countries, where the level of incentive intensity can be as high as 40%, has been the motivation by the US government and the EU Commission to develop their respective Chips Acts.

The Ireland strategy should ensure that Ireland has a comprehensive and competitive incentive program so that Ireland can continue to attract and retain the employment and innovation intensive semiconductor manufacturing industry, not just for new facilities but also for upgrading existing facilities.

Planning
When making investment decisions into our Fabs, Intel typically commits large amounts of capital which is intended to deliver manufacturing capacity to intercept specific market opportunities. Predictability of execution is a key factor in these scenarios. However, in recent times we have been experiencing increasingly large delays in receiving planning and licensing decisions, which have included lengthy judicial reviews. There are three types of delays, the shortest are at local authority level that can last for up to 8 weeks, An Bord Pleanála now routinely take a year to reach a decision while Judicial Reviews have taken up to four years. This lack of certainty and consistency in planning is becoming a major barrier to future development in Ireland. A series of national and international reviews have repeatedly drawn attention to the need for a substantial programme of change and improvement initiatives to implement procedural, operational and organisational improvements and investment to modernise case management in the Irish legal system.

Chemicals
Ireland should look to influence Europe to avoid blanket bans on necessary chemical substances Europe must provide lead times to ensure continued access to chemical substances and materials essential to semiconductor manufacturing and, ultimately, the entire technology ecosystem. It is critical that existing legislative frameworks (such as REACH, RoHS, F-Gas Regulation) avoid double regulation both at EU and national levels. One chemical assessment should lead to one chemical substance being regulated through one chemical framework only. In addition Ireland should use its influence to;

- Avoid blanket bans on chemical substances as they won't serve Europe's industrial ambitions. Critical use cases that support the EU's goals should be exempted until alternatives are available, such as with PFAS[7]
- Provide industry with sufficient time to develop innovations and alternatives as semiconductor R&D cycles are long and complex, both for legacy and state-of-the-art manufacturing.
- Direct EU research funding towards the semiconductor industry's collaborative research into chemical substance substitution, alternatives' development, advancing capture technologies, and analytical techniques

[7] Per- and Polyfluorinated Substances (PFAS) The per-and polyfluoroalkyl substances (PFAS) are a group of chemicals used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water

Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

It is estimated that the required number of employees in Europe's semiconductor sector will grow from 200,000 today to 600,000 by 2030[8]. The current estimated gap due to a lack of talent in the region is estimated at 350,000[8]. If Ireland is to achieve its potential and look to double the size of the sector here by 2030, then it is likely that Ireland's growth will also be constrained by a lack of talent. During its meeting with the 3rd level sector in April of 2023, MIDAS Ireland[9], the representative association of the microelectronics industry in Ireland, the universities explained that the number of students who choose electronic engineering, having completed the common entry year, is typically only 20% of the available numbers. The capacity of the universities to increase their intake, and for industry to market itself as an exciting pathway for career development, needs to be addressed. In addition, both the physical space and the academic staffing levels needs to be increased. A concern was also expressed that there is not enough 'younger' academics are being recruited to replenish those who are retiring.

The Ireland strategy should look for innovative ways to attract more engineers into the sector. As well as doubling the capacity of the system to educate engineers, a number of initiatives would need to be coordinated across the industry to attract this additional capacity to the semiconductor sector. One such initiative would be a comprehensive internship program which offers placements across the sector, including SMEs[10] and MNCs[11]. Another initiative would be to implement a number of courses, specifically focused on educating engineers in the semiconductor industry, with a similar design as the 'bachelor/masters of science in immersive software engineering' at the University of Limerick which includes five paid residencies in companies.

In its report 'Electronics Sector Resources and Skills Needs' of January 2021[12], MIDAS Ireland showed that during the previous 3 years, over 900 people have been recruited, with over one third of these being graduate engineers at a rate of over 100 annually. In addition, a further one third was recruited from outside of Ireland with an equal split between European and non European hires. Larger projects, such as wafer fabs, require a large injection of talent over a shorter timeframe can drive graduate numbers to greater than 300 annually for periods of up to 3 years. Thus for Ireland to achieve a 2X ambition, graduate numbers in the range of 200 to 600 would be required, with a similar number required from overseas talent. Action should be taken within the strategy to attract overseas talent to Ireland to fuel the 2X ambition.

The role of the manufacturing technician is an essential one in our semiconductor manufacturing team, in which the technicians operate in tandem with the engineering team to deliver safety, operational and quality results in a leading-edge semiconductor manufacturing. Manufacturing Technicians are extremely difficult to source. There are limited numbers of skilled and experienced Manufacturing Technicians available in the European market. Attracting foreign skilled talent to Ireland can be challenging and if a potential candidate's family is unable to accompany them immediately or if their spouse is unable to work due to the candidate only being eligible for a

[8] SEMI ISS 2023
[9] MIDASIreland.ie
[10] Small and Medium Enterprises – Ireland's indigenous semiconductor companies
[11] Multi National Companies
[12] 'Electronics Sector Resources and Skills Needs' a report for MIDAS Ireland, supported by Skillnet

General Employment Permit, then this could result in Intel losing out on the crucial talent. The strategy should address this issue by having that role of 'manufacturing technician' SOC code 3113, be included on the Critical Skills Occupation list.

While Ireland is fortunate to have two excellent 3rd level research institutions in this field, including the CRANN institute at Trinity College Dublin and the Tyndall National Institute at University College Cork, the investment in semiconductor research would also need to double. In particular the number of "Principal Investigators"(PI) in topics related to the semiconductor industry needs to be greatly increased. This PI resource is a key one in the system as it ensures that the graduates are instructed on the latest technologies, the number of PhD students are increased and the possibility of spin out companies are enhanced to drive greater activity in the indigenous sector.

Support should also given to programs which connect to and exploit the emerging pilot lines of the EU Chips Act. A notable example here is Tyndall's plans to collaborate with the proposed 2nm pilot line at Belgium's IMEC[13] facility while having further ambitions to expand its local piloting capabilities of advanced materials. Research programs which address new more sustainable materials will support Europe's ambitions to be both green and digital.

In launching the Quantum 2030[6], Irelands strategy for quantum technologies, the Minster for Department of Further and Higher Education, Research, Innovation and Science, Simon Harris, said that *" Ireland can build on our existing successes in information and communication technologies to become a global leader in research, development and innovation that underpins the quantum revolution and to become the hub for realising and exploiting the new opportunities in quantum technologies, in particular in quantum computing and communications."* This strategy largely focuses on the support for research in Ireland and the development of talent for this emerging technology. Given the similarities of the quantum and semiconductor technologies, with innovation for the former building on knowledge of the latter, this semiconductor strategy should be developed with a view to nurturing talent that will be consistent with and complement both existing and emerging technologies.

Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

As detailed in previous sections above, there a number of barriers, both soft and hard, which could impede Ireland from achieving its full potential in an industry sector that it is projected to double in size before the end of the decade.

Hard barriers include;

The provision of adequate space with supporting infrastructure and utilities to accommodate a modern semiconductor manufacturing facility. A key requirement for future such factories will access, preferably by direct wire grid connections to a supply of green energy.

- Competition for these 'mega factories' amongst nations continue to be intense, with many offering various packages to attract the investment. These opportunities, coupled with the large capital cost of these facilities, which can exceed €30bn, can have a huge influence on

[13] https://www.imec-int.com/en

where companies will position future investments. The Ireland strategy should ensure that it has a comprehensive and competitive incentive program so that Ireland can continue to compete in attracting new facilities and/or supporting the upgrading existing facilities in a rapidly evolving industry.

- As described previously, the provision of talent, at graduate and postgraduate levels, along with the ability to attract overseas talent will be key enabler for the sector's growth in Ireland. Semiconductor manufacturing can at times require a large injection of talent as new factories are established or new projects initiated.

- Competitiveness, especially in the cost of electricity, which represents a significant percentage of the operational cost of these electricity intensive facilities, can have a dominant influence in investment decisions. Access to affordable green energy will be a differentiating factor in future years.

- Uncertainty and delays within the planning process can put large investments at risk, as these large capital spends are committed based on market projections which opportunities for products at specific points in time have been identified.

Soft barriers include;

- A lack of awareness and understanding amongst policy makers as to the strategic nature of this 'deep tech' industry within the broader information technology sector, may result in a lack of support for its unique needs.

- A lack of coordination and clustering activities can fail to develop all elements of the full supply chain from construction skills to product design to material supply to SME engagement to start ups.

- The absence of a leading voice in Europe, both in policy discussions and governance organisations, such as the Chips JU[1] European Semiconductor Board etc, can place Ireland on the "back foot" when new initiatives are under development.

Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

The mitigation actions for the hard barriers identified in the previous sector lie mostly with government departments and agencies including Enterprise, Energy, Environment and Higher Education. For its part, Industry should look to actively engage with government to keep it abreast of the rapid pace of change from its global viewpoint and to take advantage of government initiatives to develop and grow the sector in Ireland in a sustainable fashion.

To facilitate this cross department and industry engagement, Intel propose that a high-level Semiconductor Advisory Council, comprising industry, academia and government actors, be would appointed to oversee the implementation of the strategy and advise government on current challenges and future trends in this fast moving and highly competitive global industry. The strategy should include stretch goals, in areas such as graduate numbers, number of new companies and start -ups, employment levels etc, reflecting an ambition in Ireland to double the size of the industry here.

About Intel in Ireland

Intel Ireland's Leixlip campus, located in County Kildare, began operations in 1989. Since then, Intel has invested €30bn billion in turning the 360-acre former stud farm into one of the most technologically advanced manufacturing locations in Europe. This facility is the largest private investment ever made in the history of the Irish State. Today, more than 5,000 people work at the campus in Leixlip.

The Leixlip campus is home to a semiconductor wafer fabrication facility and Intel has consistently invested in upgrading the factories as the industry continues to innovate and deliver new technologies in pursuit of Moore's Law[14]. Starting in 1993 with 90nm[15] technology, the site would go on to build new facilities with Fab 10, Fab 14 and Fab 24, while upgrading existing facilities, progressing to 65nm in 1998 and 14nm in 2004.

In September of last year, we celebrated the opening of Intel's latest facility at the Leixlip campus, Fab 34, which doubled the size of the manufacturing footprint and heralded the arrival of its Intel 4 technology, which uses extreme ultraviolet (EUV) technology[16]. This is the first use of EUV in high-volume manufacturing (HVM) in Europe. The arrival of this important moment ushers in the future for products like Intel's Intel® Core™ Ultra processors (code-named Meteor Lake), which will pave the way for AI PCs, as well as future-generation Intel® Xeon® processors coming in 2024 and produced on the Intel 3 process node.

The building of Fab 34 has supported more than 8,000 construction jobs over the past few years and when fully ramped, the new facility will add over 1,500 new Intel roles at Leixlip, bringing our total direct employment in Ireland to more than 6,500 people, thus enabling Intel in Ireland to continue and indeed to increase its economic impact of contributing close to >€2.5bn annually to the Irish economy.

The opening of Fab 34 in Leixlip, Ireland, combined with Intel's planned wafer fabrication facility in Magdeburg, Germany, and planned assembly and test facility in Wrocław, Poland, will help create a first-of-its-kind end-to-end leading-edge semiconductor manufacturing value chain in Europe. As the home for industries at the vanguard of technology – AI, telecommunications, data center, automotive and others – Europe needs a resilient leading-edge semiconductor supply chain. Intel is committed to helping Europe realize its technological ambitions and, in turn, to building a global semiconductor supply chain that is resilient and geographically balanced.

In September 2016, Intel announced the acquisition of Movidius, a Dublin founded company that is transforming the future of computer vision and Artificial Intelligence (AI) to accelerate innovation for the next generation of smart and connected devices. The Movidius team has progressed to become

[14] https://www.intel.com/content/www/us/en/newsroom/resources/moores-law.html
[15] One nanometer (nm) = 10^{-7} cm
[16] https://www.asml.com/en/products/euv-lithography-systems

an integral part of Intel's CPU[17] designs, focusing specifically on IP for NPUs[18] which are essential building blocks for AI.

Additionally, there's a dedicated team of Intel employees involved in Silicon Nanoelectronics Research. This team collaborates with research institutes such as the CRANN Nanoscience Research Centre in Trinity College Dublin, which hosts SFI Research centre AMBER (Advanced Materials and Bioengineering Research), and the Tyndall National Research Institute in Cork.

[17]Central Processing Unit https://www.youtube.com/watch?v=ZjTZgM_aNEE
[18] Neural Processing Units – https://www.linkedin.com/pulse/intel-refines-its-computing-vision-bob-o-donnell-8vymc/

National Semiconductor Strategy Consultation
Department of Enterprise, Trade and Employment
23 Kildare Street
Dublin 2
D02 TD30

15th March 2024

To whom it may concern

IPIC Overview

IPIC, the SFI Research Centre for Photonics was established in 2013 with the mission to deliver world-leading research and advanced PhD training in photonic semiconductor technology in collaboration with Ireland's semiconductor, and semiconductor enabled, companies. The Centre's capabilities range from novel light emitting materials and devices, integration methodologies for manufacturing compound semiconductor and silicon integrated circuits, advanced packaging and fabrication technologies, through to the demonstration of advanced semiconductor systems in cutting-edge testbeds together with end-users. IPIC's focus is on developing solutions for next generation communications, consumer electronics, carbon neutrality and medical technology. Successes include establishing and leading Europe's first photonics packaging pilot line, PIXAPP, the completion 210 collaborative research projects with industry (28% with Irish SMEs), the establishment of 4 Spin-Out companies, and training over 350 PhD students and Postdocs, 68% of whom have joined industry, illustrating the high demand for trainees. At the current time, IPIC incorporates over 200 researchers from across Tyndall, DCU, MTU, TCD, UCC and UL and has more than 40 active industry partners.

In 2015, IPIC established the Photonics Ireland National Technology Platform within which we have worked closely with companies to support them to grow their activities in Ireland, including organising the Photonics Ireland pavilion at the world's largest photonics trade show, Photonics West. Relevant Irish SMEs and start-ups, such as Eblana Photonics and mBryonics, join us on stand to engage with customers from across the globe. We were also invited to join DETE and IDA's semiconductor focused East Coast Trade Mission in Sept 2023. From our experience, we have identified measures and initiatives that would help Ireland to take full advantage of the opportunities posed by the EU Chips Act, and to help achieve the vision to double Europe's, and especially Ireland's, share of the growing semiconductor market.

Setting the Scene

Today, Ireland is home to a thriving semiconductor industry which supports 20,000 high value jobs, is in the top two in Europe for installed capacity and includes Europe's most advanced fabrication facility, representing a sustained investment totalling over €30 Billion by Intel. However, the semiconductor industry is now at a critical juncture where weaknesses in global supply chains, highlighted during the Covid pandemic, and global geopolitical tensions have led to a renewed focus in the sector, with both the EU and US setting ambitions to double their share of the market by 2023, with an emphasis on advanced manufacturing market share, as embodied in the new Chips Acts. Achieving this ambition will not only deliver economic gains in the semiconductor industry, but also in the many sectors that utilise semiconductor-based devices and systems.

Given the advanced technology nature of the sector, to remain at the leading edge requires large scale investments in research and development, as well as a highly-skilled workforce. This need is clearly called out in the Chips Acts, and although the primary focus is on investment in manufacturing, there have been many parallel large scale R&D and PhD training investments, including at national level, as illustrated by just two of many recent examples:

- US - Announcement in Feb 2024 by the US government to invest $5 Billion in a National Semiconductor Technology Center to *"accelerate the pace of new innovations, lower barriers* *to participation in semiconductor R&D and directly address fundamental needs for a skilled, diverse semiconductor workforce*"'

- Spain – A country which has only a modest semiconductor sector today, aims to invest €12.25 Billion to develop this by attracting existing companies to build factories in Spain and by creating a national R&D ecosystem. Steps include a new state-of-the-art foundry for Compound Semiconductor-based photonics called SPARC and the announcement in 2023 that IMEC is going to open a specialized chip technology pilot line – IMEC Fab 5 – in Malaga.

In parallel to the rising critical importance of the sector, disruptive technological advances are required to address the era-defining end of the Moore's Law scaling of silicon chips. The continuous reduction in transistor size, has underpinned the semiconductor sector for decades, however the manufacturing complexity and escalating costs of this approach mean that it is no longer scalable. The emerging solution, which has gained the backing of global sector leaders such as Intel, Meta and Samsung, and others, is to transition to a modular design approach based on 'chiplets' where separate circuit building blocks are used to create a System-in-Package (SiP). This new architecture enables the required functionality to be achieved through a combination of chiplets with each optimised for an individual function, and based on different materials and feature size. This architecture requires new integration technologies, such as heterogeneous integration and advanced packaging solutions, combined with new device level technologies, such as integrated magnetics, photonic integrated circuits and quantum devices. Not only will this approach be critical to realise the semiconductor systems of the future, but it is also likely to impact the future structure of the semiconductor industry itself.

Aspirations and Opportunities

The key technology areas of heterogeneous integration and advanced packaging required to realise the chiplet vision are key strengths of IPIC, which has established Ireland as a leader in research and development in this area, and also, through our industry partnerships, the deployment of the technology into global markets. As a result, there is a significant opportunity for Ireland to leverage this existing expertise and talent and the associated infrastructure base at Tyndall to grow Ireland's semiconductor activities and market share, and to compete with other countries seeking to either establish or build their market share.

The dependence of semiconductor manufacturing activity on innovation and R&D is one that we have observed locally within Ireland since the formation of IPIC in 2013. One example being the development and deployment of nanophotonics at Seagate's wafer manufacturing plant at Springtown, NI, which has involved research and training collaborations with IPIC. A second and more direct example is Spin-Out company, InfiniLED, which was acquired by Meta, and today is one of their small number of global Reality Labs sites with over 100 scientists and engineers developing future AR/VR devices in Cork. These are just two examples of how Ireland's investment in semiconductor research and PhD training through IPIC, and many other investments in Tyndall and our partner RPOs, has led, and continues to lead, to growth of industry-based R&D and manufacturing activities in Ireland. Based on this evidence, and indeed similar patterns observed in other countries, investment in academic-based semiconductor research can lead to local investment and sustainability of semiconductor design, development and manufacturing activities.

With this evidence we recommend that the National Semiconductor Strategy includes the following measures and initiatives:

- Investment in international scale semiconductor research and PhD training programmes, such as SFI Research Centres, EI Technology Centres and DTIF awards that engage industry in the development and deployment of next generation semiconductor technology and manufacturing, and enhance collaboration across Ireland's RPOs. Including measures that encourage and enhance Irish SME engagement.

- Investment in advanced semiconductor research infrastructure, open access foundries and advanced manufacturing pilot lines that are readily accessible by industry, leveraging Ireland's leadership in heterogenous integration and advanced packaging technologies.
- National matching funding to enable Irish entities (industrial and academic) to participate in large EU semiconductor-based programmes, such as IPCEI's.
- Schemes to enable increased international collaboration on research and training, such as SFI's US/Ireland partnership programme and Centres for Doctoral Training.
- Investment in activities that stimulate the development of semiconductor-based start-up companies, including a national semiconductor incubator and increased funding (€10M plus) availability for scaling SMEs.
- Establish a National Semiconductor Advisory Committee comprising government, industry and academic representatives to work together to grow Ireland's semiconductor sector, improve its sustainability and to ensure that it is leveraged to the advantage of semiconductor enabled industry sectors, e.g. Agri-Tech, ICT, MedTech and Space, and emerging sectors such as Quantum Technology.

We appreciate the opportunity to contribute to the consultation exercise and hope that our inputs will be helpful to the Department. You are welcome to contact us should you require any further information.

Yours sincerely,

P.D. Townsend

Professor Paul Townsend

Director of the IPIC SFI Research Centre in Photonics, Head of Photonics at the Tyndall National Institute, and Professor of Photonic Systems Research in the School of Physics at University College Cork

National Semiconductor Strategy Consultation

Ireland South East Development Office Submission

15/03/2024

On behalf of:
South East Regional Enterprise Plan, Chair, Patsy Carney, and
South East Offshore Wind Partnership, Chair, David Dempsey

Summary: This brief submission argues that the close proximity of the proposed wind farms off the South Coast of Ireland to Great Island Power Station and available IDA-owned industrial at Port of Waterford, serves as a possible solution to a key barrier faced by the semiconductor industry. Green energy provided by the wind farms and landing at Great Island can be utilised to power a large energy user such as semi-conductor manufacturing at the Port of Waterford. This solution will be in line with stated Government strategy documents including the National Industrial Strategy for Offshore Wind and the National Hydrogen Strategy and in line with identified best practice globally.

National Semiconductor Strategy – Key Themes

- **Barriers to development** – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

A key barrier to the development of the semiconductor industry in Ireland will be the drive for businesses in this space to decarbonise their activities.

- **Mitigation** – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

Utilising 2GW non-grid OWE to decarbonise industry

The National Industrial Strategy for Offshore Wind points to a target to generate 2GW of OWE for non-grid limited purposes by 2030 'presenting an opportunity to advance Ireland's objective of decarbonising the industrial base and developing new green industries of the future.'

This 2GW of non-grid OWE presents an opportunity for the South East region and a solution for the semiconductor industry:

- The location of the wind farms that will generate this 2GW OWE will be off the South Coast of Waterford.
- The nearest power station to those wind farms will be Great Island Power Station where 450MW of OWE for grid use will also land.
- There are 185 acres of serviced land, zoned for industry and owned by IDA Ireland available at the Port of Waterford, Belview, a 3 kilometre distance from Great Island Power Station.

Port of Waterford Infrastructure
The Port of Waterford, Belview, Co. Kilkenny is a strategically important site regionally and nationally, evidenced through a number of variables, namely;

- the proximity of the sites to a critical mass of skilled workers
- public transport
- the level of critical infrastructure provision at each location
- proximity to Great Island Power Station (3km) where 450 MW of Offshore Wind Energy will land

The Port provides an ideal location for large-scale industries and manufacturing companies and is the nearest major Irish port to mainland Europe providing a saving to shippers of both time and fuel while being a natural hub for the integration of port, shipping, road and rail freight services.

The Ferrybank Belview Local Area Plan provides circa. 260 hectares zoned land for large scale industries, which is serviced and available for development. The Port has all the necessary infrastructure for high volume production and is supported by significant water, waste water and gas capabilities.

Alignment with National Strategy

The National Hydrogen Strategy has highlighted the potential for the co-location of large energy users with renewable energy generation as a means of helping to decarbonise large industry, in addition to addressing other energy supply and storage challenges.

The National Industrial Strategy for Offshore Wind states: ‘This concept is consistent with the approach being adopted by several countries around the world who are developing a variety of models for industrial areas around sites central to the production of green energy. For example, GreenLab36 in Denmark; The Smart Green Industrial Complex at Saemangeum,37 South Korea;

Ventspils Industrial Park,38 Latvia; and Haraholmen Green Industrial Park39, Sweden all represent different scales of green industry parks designed to achieve the co-location of renewable energy supply and demand, and in many cases these also serve as test beds for technological innovation.'

Benefits for the semiconductor industry

The possible use of surplus ORE for large energy users at Port of Waterford should be considered to deliver on the proposal for co-location of renewable energy supply and demand from end-users. Semiconductor manufacturing is a good example of a large energy user and utilising OWE as their power source would serve as a good solution to their decarbonisation.

This strategic approach to co-location of renewable energy supply and demand, if utilised at Port of Waterford, would serve as a strong incentive to the semiconductor industry and other sectors that are dependent on significant energy supplies. Integrated green energy parks would cater for their requirements without placing significant new capacity requirements on our electricity grid.

For further info contact: richard@irelandsoutheast.com

County Kildare Chamber
Advancing business together

Department of Enterprise, Trade and Employment
via website

Date: 15th March 2024

Dear Sir/Madam,

RE: Public Consultation- Development of a National semiconductor Strategy

1.0 INTRODUCTION

County Kildare Chamber is the business organisation in Kildare, proactively working to identify and progress developments that are facilitative of economic and sustainable growth. Representing an employer base of 400 businesses and over 42,000 employees across the county, County Kildare Chamber is the largest business organisation in the mid-east region of Ireland.

Given the significant breadth and depth of our membership, and our representation on various bodies at local and national level, County Kildare Chamber constitutes the representative voice for business in Kildare.

2.0 SUBMISSION

The Semiconductor industry in Ireland has deep roots tracing back to Analog Devices' establishment in Limerick in 1976. However, it wasn't until 1989, when Intel's European manufacturing & technology Headquarters, in Leixlip, Kildare came into being, that Ireland truly asserted itself as a key player in the global semiconductor landscape.

Over nearly four decades since the inception of 'Silicon Ireland,' the industry has flourished into a dynamic ecosystem of innovation and collaboration. This ecosystem encompasses seasoned engineers, skilled graduates, researchers, and a mix of multinational and indigenous companies, actively engaged across every stage of the semiconductor value chain, from initial design to fabrication.

Furthermore, bolstering this ecosystem is the steadfast support of local, regional and national stakeholders, which champion the semiconductor industry's growth and development. With their backing, Ireland is well-positioned to capitalise on the European

Commission's ambitious investment plans for microchip production and R&D. This strategic initiative not only presents an unprecedented opportunity for the industry's expansion but also underscores Ireland's pivotal role in driving semiconductor innovation on a global scale.

In February 2023, County Kildare Chamber wrote to the Minister of Enterprise, highlighting the significant opportunities presented by the European Chips Act. This ambitious plan, announced by the European Commission, aims to invest in microchip production, research, and development within the semiconductor sector. The timing of this initiative was crucial, given the concerns across member states, including Ireland, regarding the lack of secure microchip supply within the Union.

Under the European Chips Act, a substantial fund exceeding €45 billion is earmarked for member states. The objective is to double chip production by 2030, positioning Europe as a formidable competitor against key players such as Taiwan, Japan, South Korea, and the United States. This initiative is particularly timely amid geopolitical tensions, notably between China and Taiwan, underscoring the importance of securing a resilient supply chain.

Opportunities and Challenges:

A secure supply of semiconductor chips is integral to Europe's digitalisation and green strategies, impacting various sectors ranging from transportation to healthcare. Microchips play a pivotal role in driving technological advancements, including artificial intelligence, 5G/6G communications, and the Internet of Things. County Kildare Chamber advocates for maximising Ireland's participation in the funding stream to bolster research, innovation, and workforce development within the semiconductor industry.

Kildare is strategically positioned to emerge as a key player in Europe's semiconductor landscape. The success of Intel in the northern region of the county, supported by an ecosystem of sectoral service contracting industries, underscores Kildare's potential. With abundant zoned land and a skilled workforce, Kildare is poised to establish advanced chip design and production facilities, leveraging its proximity to a world-class university in Maynooth.

Establishing Ireland as a semiconductor manufacturing powerhouse requires collaborative efforts among governments, technology owners, manufacturers, and end-users. Kildare stands ready to capitalise on its existing expertise, available land, and talent pool to drive innovation and economic growth within the semiconductor industry.

3.0 CONCLUSION

County Kildare Chamber is the largest business organisations outside of our cities. Our membership base is diverse and unique as Kildare is a growing county with a talented population that is attractive for foreign direct investment and indigenous companies to locate/relocate to.

Our proximity to Dublin, its port and airport ensures Kildare continues to welcome investment. This ensures that the Chamber along with all key stakeholders in the region continue to work and collaborate, meaning business has every opportunity to thrive and success in Kildare.

County Kildare Chamber emphasises the imperative of seizing the opportunities presented by the European Chips Act to propel Ireland, and particularly Kildare, to the forefront of semiconductor manufacturing in Europe. Through strategic investments and partnerships, Ireland can solidify its position as a leading member state in semiconductor innovation, with Kildare serving as a key beneficiary of this transformative endeavor.

County Kildare Chamber looks forward to working with the Department of Enterprise, Trade and Employment to deliver a successful outcome for Kildare and the country, and we are available at all times for consultation, discussion and support.

Yours faithfully,

Sinéad Ronan
Chief Executive
County Kildare Chamber
www.countykildarechamber.ie
045 894074

Submission by Kilkenny County Council to the Department of Enterprise, Trade and Employment in relation to the Public Consultation on the Development of a National Semiconductor Strategy

Kilkenny County Council recognises the critical importance of semiconductors in our daily lives, and every sector and service of the economy. It is acknowledged that demand for semiconductors will increase exponentially in the years ahead, especially given advances in artificial intelligence, electric vehicles and cloud computing, as well as the green transition of energy and industry.

Global chips shortages due to soaring demand in recent years has caused supply chain disruption, product shortages and in extreme cases factory closure in Europe.

One of the key identified challenges associated with the semi-conductor industry that the EU Chips Act will look to address is the establishment of the necessary manufacturing capacity to meet demand.

To capitalize on the opportunities that the demand for semiconductors will create, this and other challenges will need to be addressed in the National Semiconductor Strategy.

This submission addresses the themes of access to talent, challenges facing businesses and the sector and mitigation; with focus on the capability and capacity within the South East Region.

Access to talent for businesses:

The South East Region is well placed to provide an educated and multi-disciplinary workforce to meet the demands of growth in the semiconductor industry in the region.

The South East Regional Technological University was established in May 2022 and published its first Five Year Strategic Plan in 2023.

With 125,000 square metres of Campus space and almost 20,000 students enrolled, the university aims to be a global technological leader by 2028.

Manufacturing, renewable energy and specialized engineering are three key areas of emphasis within the Strategic Plan along with the transformational elevation of capacity and capability in new and existing areas.

The commitment to establishing the South-East as a UNESCO Learning Region was demonstrated through the successful collaboration across bodies in the South East including Kilkenny County Council to achieve UNESCO Learning City Designation for Waterford in February this year.

The South East Technological University has four Enterprise Ireland Technology Gateways - SEAM, ICS and Walton Institute, PMBRC, and DesignPlus.

These gateways - all centres of excellence in research, support and innovation - are uniquely placed to assist new and existing industries s in developing and enhancing their capability, capacity and product.

Challenges facing businesses and the sector:

One of the 5 key objectives of the EU Chips Act will be the building and reinforcing of Europe's capacity to design, manufacture and package advanced chips.

This objective is in response to a growing gap in capacity to meet demand for semi-conductors that is expected to continue to grow in the coming years.

Electricity supply – in particular clean electricity supply - to power the manufacture of semiconductors is a critical requirement to allow the development of the sector.

In the South East Regional context, a study commissioned by the then 3 Counties Energy Agency (Carlow, Kilkenny, Wexford) in 2022 examined the current and future electricity transmission infrastructure need in the South East region, considering the future electricity demand growth, renewable generation pipeline, programme of transmission network reinforcements and new ways of using and managing electricity.

Demand in the Irish electricity system is forecast to increase significantly in the coming decade due to data centres and the electrification of the heat and transport sectors to achieve the 2021 Climate Action Plan targets. EirGrid's Shaping our Electricity Future Roadmap and SEAI's National Heat Study indicate the total electricity requirement could grow by c.60-65% out to 2030.

The 2022 study referenced above (*Transmission Network Study in the South-East of Ireland*) extrapolated the 2019 CSO metered electricity county data to 2030 and 2050 by applying the average nationwide increase in electricity demand between 2019-2030 and 2019-2050 from the SEAI National Heat Study.

Excluding growth from data centres, this study concluded that the South-East electricity demand could increase from c.2TWh in 2019 to c.2.67TWh in 2030 and c.5.1TWh in a net zero carbon system in 2050.

Mitigation:

Eirgrid as part of their 'Shaping Our Offshore Energy Future' plans to develop offshore electricity substations and associated undersea electricity cables to bring the power generated by offshore windfarms into the national electricity grid.

The Government as part of the Climate Action Plan has an ambition to develop offshore wind energy infrastructure over a four-phase process. The first phase of this process saw 6 projects participate in the first Offshore Renewable Electricity Support Scheme auction (ORESS 1 auction) off Ireland's East and West coasts and will provide upwards of 3GW of renewable electricity. The second phase will see up to 900MW of electricity supplied from wind farms off Ireland's south coast. In this regard, Eirgrid have plans to develop offshore substations off the coast of Waterford or Wexford.

Stakeholders in the South East, including Enterprise Ireland, the 4 Local Authorities (Waterford, Wexford, Kilkenny and Carlow) and the Port of Waterford and Rosslare Port, have established a Task Force to progress the creation of offshore wind energy and to overcome any barriers to its development.

The South East Region is positioning itself to take full advantage of the offshore wind energy opportunities which will in turn lend themselves to the support of the National Semiconductor Strategy through manufacturing capacity generation.

The Port of Waterford, Belview, Co. Kilkenny is a strategically important site regionally and nationally, evidenced through a number of variables, namely;

- the proximity of the sites to a critical mass of skilled workers
- public transport
- the level of critical infrastructure provision at each location
- proximity to Great Island Power Station (3km) where 450 MW of Offshore Wind Energy will land

The Port provides an ideal location for large-scale industries and manufacturing companies and is the nearest major Irish port to mainland Europe providing a saving to shippers of both time and fuel while being a natural hub for the integration of port, shipping, road and rail freight services.

The Ferrybank Belview Local Area Plan provides circa. 260 hectares zoned land for large scale industries, which is serviced and available for development.

The Port has all the necessary infrastructure for high volume production and is supported by significant water, waste water and gas capabilities.

In November 2022, Port of Waterford submitted a Strategic Infrastructure Development (SID) planning application to An Bord Pleanala for a 200 – 250m quay extension and ancillary works to house an Offshore Renewable Energy (ORE) terminal. This application is currently pending.

The eco-system in the South East Region as a whole is ready and structured to support and facilitate the challenges and opportunities that the evolution of the semiconductor industry will bring.

Perspectives and insights

The proposed National Semiconductor Strategy for Ireland

KPMG Strategy Ireland

—

March 2024

Who we are

KPMG Strategy is Ireland’s largest strategy practice.

With a team of over 25 professionals spanning disciplines of economics, management and chartered accountancy, technology, engineering, and business operations we strive to provide actionable insights for Irish industry. Our work varies from corporate strategy and economic perspectives, to technical thought leadership and analysis of key cross-industry trends.

To date we have directly supported over 300 clients across industry, not-for-profits, government agencies and financial institutions. Our wider work as part of the KPMG Ireland team has brought us in to contact with thousands of clients and industry stakeholders, affording our team significant insights which we use to shape our work.

A key element of our outreach activity is in providing insights on growth industries and assisting industry and governmental bodies in nurturing robust industrial development. We deliver perspectives that aid the realisation of wider value and job creation across the island of Ireland.

Prepared by KPMG Strategy, Stokes Place, Dublin 2

Overview

The semiconductor industry in Ireland remains vibrant, supporting over 20,000 jobs.[a] Key investments in recent years across industry leaders including AMD, Analog Devices and Intel seek to further bolster Ireland's position as a significant player in the European semiconductor sector. There has been increased investment from research and development (R&D) and support organisations with a specific focus on semiconductor operations, both tied to larger multinational corporation investments and indigenous industry.

KPMG Ireland welcomes the opportunity to provide perspectives and insights. From our extensive work globally across the semiconductor industry; and particularly built upon our local expertise in electronics and advanced manufacturing strategy, we hope to offer some high level insights that may aid the Department of Enterprise, Trade and Employment in formulating this strategy.

We present our submission under the key headings requested by the Department of Enterprise, Trade and Employment:

1. **Aspirations for the sector** – What are **stakeholders' aspirations** for Ireland's semiconductor industry in the coming years?

2. **Opportunities for the sector** – What do stakeholders identify as **key opportunities** for the sector to further develop?

3. **Challenges facing businesses and the sector** – What are the **key challenges** facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

4. **Access to talent for businesses** – What **skills needs** (across the spectrum of training, education and research) will arise for the sector in the coming years?

5. **Barriers to development** – What **barriers** might prevent both individual businesses and the sector as a whole from meeting its aspirations?

6. **Mitigation** – What are potential **mitigating actions** that could be taken (and by whom) to address the challenges and barriers identified?

We are open to further consultation on the National Semiconductor Strategy for Ireland, or other semiconductor and microelectronics strategy activities with the Department of Enterprise, Trade and Employment or any other industry stakeholders.

Sources: [a] Tyndall [Link]

Our Viewpoint [1/3]

1. Aspirations for the sector [a]

Industry stakeholders across manufacturing, R&D and support organisations are noting that Ireland is at a **cusp of either growth or stagnation**, largely depending on wider policy and global growth.

Ireland has been pivotal in the European growth of semiconductor manufacturing and R&D over the last three decades. To continue this trajectory, a **proactive governmental led strategy may be required to secure future investment and nurture innovation.**

While the potential for the semiconductor industry in Ireland is difficult to size. Our recent market sizing activity suggests that the European semiconductor manufacturing environment may **scale to five times its current value by 2040**. Opportunities exist across the entire value chain, particularly within R&D, foundry and OSAT / advanced packaging segments. Commentary from industry stakeholders and those involved in R&D and academic research have highlighted significant opportunities in areas including **optoelectronics and advanced materials.**

The European semiconductor industry may increase fivefold by 2040

2. Opportunities for the sector [a] [b]

Industry trends support increased R&D focus with **51% of European industry stakeholders noting that optoelectronics will be the leading growth area**. Based on our understanding of the existing market and potential R&D pipelines, Ireland has capability in this area.

Expanding OSAT and advanced packaging facilities in Europe as a diversification strategy may also be key for Ireland, strengthening the existing eco system. Indigenous and FDI investment, building upon existing workforce expertise, will support a broader desire to enrich other areas of the value chain – specifically R&D and foundry operations.

To achieve **EU Chips Act goals of a doubling of semiconductor manufacturing capacity** within ten years, increased foundry construction will be required. The ability for Ireland to compete for additional FDI, as well documented in the media, may **be tethered by a need for specific initiatives to make available land and infrastructure** as well as incentives within the confines of broader European regulations. These constraints are not seen as long term, with probable renewable / hydrogen initiatives offering potential resolution to electricity volatility concerns.[c]

Photonics R&D and advanced packaging are areas of significant opportunity

Sources: [a] Industry commentary across academic, research, commercial organisations SMEs and MNCs. **[b]** KPMG Global Semiconductor Survey 2023 **[c]** KPMG sector economic modelling based on consumer trends, EU Chips Act and actual market construction and R&D activity. **[d]** KPMG insights garnered from desktop research.

Our Viewpoint [2/3]

3. Challenges facing businesses and the sector [a] [b]

Many of the issues facing the semiconductor industry are global and not tied specifically to Ireland or Europe. Talent and **skills risk** is the key concern (69% European, 53% global industry stakeholders).

Nationalisation of supply chains, intellectual property restrictions and controls are also seen as a concerning factor for the industry (54% European, 45% global industry stakeholders).

Other factors which may temper the industry in the next three years include **global inflation** (and individual government responses), **excess capacity** (especially outside of the US and Europe) and the increased **high costs of operating manufacturing facilities.**

In an Ireland context, consideration should also be given to specific challenges related to **land, water and power use**, especially in the manufacturing space. Whilst common concerns across many countries across Asia, Europe and the United States, some regions are addressing industry concerns proactively through integration with their national **sustainability strategies.**

69% of European stakeholders see skills as a key concern

4. Access to talent for businesses [a] [b] [d]

Talent is universally recognised as the leading constraint for semiconductor stakeholders, with job creation outstripping the pace of automation. Activities **stakeholders are addressing concerns by**:

- Offering remote/hybrid work (56%)
- University partnerships (56%)
- Workforce re-training (34%)
- Apprenticeship schemes (29%)

Discussions with stakeholders located within Ireland have highlighted the potential benefits of **expanding education programmes**, specifically within senior cycle, post leaving certificate and university education to **support skilling the Irish and Northern Irish workforce for employment** in the semiconductor and wider microelectronics industries.

Globally **cross training between industries can be helpful**, however in an Ireland context, target industries would include pharmaceuticals and aerospace where there are also talent and labour shortages. The most robust suggestions offered by industry are to **build skills at every education level** to support R&D, manufacturing and support functions.

56% of global stakeholders are engaging in university partnerships

Sources: [a] Industry commentary across academic, research, commercial organisations SMEs and MNCs. [b] KPMG Global Semiconductor Survey 2023 [c] KPMG sector economic modelling based on consumer trends, EU Chips Act and actual market construction and R&D activity. [d] KPMG insights garnered from desktop research.

Our Viewpoint [3/3]

5. Barriers to development [a][b]

While the semiconductor sector in Ireland is broadly scaled to European wide sector employment, there are **gaps within the industry, in particular related to OSAT, advanced packaging and end product deployment**. These have been limited by the global availability of lower cost labour and production environments. This imbalance is expected to be partially offset at a European level through EU Chips Act initiatives.

With specific focus on **indigenous enterprises**; the availability of talent is a concern, but so too is the **availability of suitable supports to enable international growth as scaling R&D.** Commercialisation investment this sector is normally a matter of tens of millions of euro of capital investment. **R&D in particular is an area with a specific need for targeted support**, through direct intervention, encouraging of global investment or combined investment and industry research support.

Indigenous enterprises often struggle to scale to be global players

6. Mitigation [a] [b] [d]

Per our industry outreach, **Ireland should seek to strengthen the existing semiconductor ecosystem**, notwithstanding the significant effort to nurture a semiconductor industry in Ireland, **a cohesive all-island strategy should seek to:**

- Create an **adequately funded educational framework** for second level, vocational training and university education. This must be **driven by, and adapted to, industry needs**.
- Form **R&D and innovation clusters for areas of expertise** in Ireland's semiconductor industry, with a specific focus on facilitating **optoelectronics and advanced packaging**.
- Work with industry stakeholders to **refine the wider offering** for MNCs and indigenous organisations, with specific focus on **infrastructure, labour and ancillary industry factors**.
- Fully **comprehend Ireland's place within the European and global ecosystem** through international partnership, especially with regions that **compliment Ireland's offering**.

Ireland must create a more robust semiconductor ecosystem

Sources: [a] Industry commentary across academic, research, commercial organisations SMEs and MNCs. **[b]** KPMG Global Semiconductor Survey 2023 **[c]** KPMG sector economic modelling based on consumer trends, EU Chips Act and actual market construction and R&D activity. **[d]** KPMG insights garnered from desktop research.

Glossary

EU Chips Act

A broad term encompassing European wide grant, tax and skillset initiatives. The European Chips Act aims to bolster Europe's competitiveness and resilience in semiconductor technologies and applications, and aims to help achieve both the digital and green transition. It aims to do this by strengthening Europe's technological leadership in the field.

Foreign Direct Investment (FDI)

An investment made by an enterprise primarily, or exclusively, located outside of the targeted region which it is investing in. The investment may typically take the form of the establishment of a local subsidiary or the full or partial acquisition of an existing entity within the targeted region.

Foundry

A facility where semiconductors are manufactured, usually encompasses manufacturing phases from blank silicon wafer to completed wafer, which may or not be shipped onwards to an outsourced assembly and test (OSAT) facility.

Indigenous organisations

Companies originally or primarily located on the island of Ireland.

Integrated Circuits

IC's, semiconductors, chips, microchips are often used interchangeably to broadly describe an electronic device comprising numerous functional elements such as transistors, resistors, condensers which is used to enable computerised processing of data and inputs.

Multinational corporations (MNCs)

Companies originally or primarily located outside of the island of Ireland.

OSAT

Outsourced Assembly and Test; a facility which provides outsourced testing of integrated circuits (semiconductors). Often located outside of Europe and the United States for cost reasons, there is increasing focus in locating facilities within Europe and the US for geopolitical and supply chain reasons.

R&D

Research and development within the semiconductor industry usually encompasses integrated circuit (IC's) / "chip" design, mechanisms, technologies and equipment to produce IC's and developing end applications for IC's, including software and hardware applications in automotive, aerospace, consumer devices, defence, medical devices, telecommunications; amongst many other applications.

US Chips Act

Similar in concept to the EU Chips Act, the CHIPS and Science Act(s) aim to bolster US semiconductor R&D, manufacturing and security of local supply chains.

Prepared by KPMG Strategy, Stokes Place, Dublin 2

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NATIONAL SEMICONDUCTOR STRATEGY

Input from Mary Finegan

Mary Finegan
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www.linkedin.com/maryfinegan

I have spent the past 33 years working in the Semiconductor Industry in Italy, Germany, France, USA, Australia, Taiwan, Singapore and in Ireland. I've held multiple roles from ASIC design engineer, to program manager, business development director, head of engineering operations, … and I was part of the Movidius Leadership team. I am very enthusiastic about microelectronics. I feel that it has been a bedrock of Irelands high tech development over the last 30 years and provides very interesting and varied career opportunities.
I am currently on a career break having worked more recently with Movidius, Intel and Taoglas. I'm chair of the Engineering advisory board in Maynooth University, a member of the Engineering advisory board in UCD and an active Midas contributor. I also visit secondary schools and universities promoting Engineering as an excellent career with a particular focus on raising awareness among young women as to merits of engineering as a career.
As a Senior Semiconductor leader I feel the need to make the following short observations in support of the public consultation process and I'm available for follow-up should you have any questions:

• Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

- This sector in Ireland is very heavily driven by US and European multinationals such as ADI, Intel, Qualcomm, Synopsys, Cadence, Bosch, OnSemi, Infineon,… (Many are here due to the depth of semiconductor design talent build up by S3, Dect, ADI, Parthus over the years)

- I would like to see growth of the indigenous sector along the lines of what was achieved in the past by S3 Group, Parthus, Decawave, Movidius, Equal1 and create a greater array of chip and product development companies.

- I would like to see Ireland become a centre of excellence for Quantum, AI hardware and software, Automotive, medical device and perhaps also packaging and test.

- I would also like to see an increase in Electronic engineering graduates from Irish Universities. When I graduated in 1990 there were 60 Microelectronic graduates from Trinity and 100 from UCD. These numbers are now halved. (I do not agree with the Universities push for a 5 year degree, this is only going to provide additional barriers to entry)

- The sector does not provide a very female welcoming environment. They are many initiatives working to improve this but progress is slow and there is a lack of female mentors in the industry. Every year I see excellent females leave the sector due to an unfriendly environment. Its hard to get them in but even harder for them to progress to the top.

• Opportunities for the sector – What do stakeholders identify as key opportunities for the sector to further develop?

- European Chips Act removes many barriers to entry but also gives larger geos such as Germany, Italy and France a bigger advantage. Ireland will have to 'fight smart' to retain its advantage and needs to focus on high value areas such as chip architecture design and building domain expertise.
- Developments in AI, Robotics, Automotive, 5G/6G/IOTG, Quantum and also medtech miniturisation offer great opportunities for the sector.
- Strive for carbon and power reduction offers great opportunities but I'm not sure who the players are here.
- There may be opportunities also in Photonics and new material development and there is considerable investment in Tyndall and Crann in these areas.
- Shift from using Asian low cost geos for Manufacturing, packaging and testing provides really good opportunities also.

• Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

No 1 issue is access to engineering excellence and building innovative engineering teams
No 2 Irelands skillset is being diminished, ie growing old and not been replaced
No 3 persuading talented stem students to become electronic engineers
No 4 Competition from other European geos such as Germany, France and Italy. I've worked extensively in all of these countries and Irish Engineers are way more pragmatic but we are losing our edge as our engineers are becoming very comfortable and static
At a national level, the media is doing us a dis-service. Recent downscaling in the Software sector has been misrepresented as a downturn in the semiconductor industry. The media (and public)needs to be educated.

• Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years? ——

- Solid engineering and problem solving skills are key. We can build upon these to address excellence in new emerging technologies such as Quantum, AI, ...
- Excellence in Project and People Management
- Business Acumen

• Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

- Microelectronic industry in Ireland is aging and is not being back filled. We need to incentive our young people to take engineering at University level by offering incentives to graduates (cf Romania)
- Would be founders/leaders are gainfully employed in the Multinational sector and have no incentive to leave or to disrupt
- Critical mass is starting to slip, we could find ourselves in similar situation to Australia where they've had to import the capability
- Chip design is very expensive. Leading Edge Masks can cost up 20 Million so important that this sector is better supported. (The Chips act will help with lower cost access to leading edge EDA tools but it may not be enough)

• Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified

- We need to heavily market engineering, especially Microelectronic engineering as career
- We need to encourage the development of more indigenous SMEs
- We need to massively target Primary schools to encourage young boys and girls onto a STEM track
- We need to ensure that our research centres such as SFI centres, Crann, Tyndall, NMRC are world class and provide good return on investment (KPIs need to be clear and aligned with an Ireland Inc strategy for the sector)
- Universities need to provide graduates that have a strong engineering ethos but not lose sight of innovation and differentiation.
- We need to improve how science is taught at secondary schools especially to girls and make sure labs are more hands on and practical
- We need to ensure that women who become engineers stay in the sector. With so few female peers it becomes a very hostile environment for a senior female engineer.

SOLVE THE IMPOSSIBLE

Microelectronics Circuits Centre of Ireland

Consultation: National Semiconductor Strategy

Enhancing Ireland's National Semiconductor Strategy Though MCCI's Microelectronics Research

John Morrissey, MCCI Executive Director

Date: 15/03/2024

Table of Contents

Microelectronic Circuits Centre Ireland (MCCI), Lee Maltings, Dyke Parade, Cork, Ireland. T12 R5CP

Department of Enterprise, Trade and Employment
23 Kildare Street
Dublin 2
D02 TD30

15h March 2024

To whom it concern's

RE: National Semiconductor Strategy Consultation

Introduction

Ireland's National Semiconductor Strategy development stands as a crucial roadmap for advancing the country's technological prowess and economic resilience. Recognizing the importance of semiconductor technology in driving innovation and competitiveness across all sectors, and coupled with the EU CHIPS Act, it is imperative to align national efforts with cutting-edge research initiatives and talent development. MCCI (Microelectronics Circuits Centre Ireland) emerges as a pivotal player, leveraging its microelectronics research strategies and activities to propel Ireland to the forefront of semiconductor development.

Background Overview for Strategy Development:

Microelectronics Globally

The global microelectronics technology market has witnessed significant growth over the last 20 years, playing a pivotal role in enabling modern electronics. Microelectronic technology is the essential cornerstone of the modern digital age as witnessed during the COVID-19 global pandemic, where global and regional lockdowns did not prevent the world of business and consumerism from turning - in fact the opposite was the case. Very strong consumer growth occurred across online e-markets, putting enormous pressure on global manufacturing supply-chains as people adjusted to working and living remotely during the pandemic. The semiconductor market witnessed step function growth in 2021 ($550B) and 2022 ($575B) vs pre-COVID times in 2019 ($412B), levels un-forecasted due to the sudden growth in digital e-commerce and online working from home. The global semiconductor market is projected to grow from $575B in 2022 to over a Trillion USD by 2030, exhibiting a CAGR of ~**9%** during this period with growth expectations fuelled by increasing demand for advanced electronic devices across all global industry and service sectors.

Key trends and factors shaping the global microelectronics technology market include:

IoT and Connectivity: The Industrial Internet of Things (Industrial IoT) and smart IoT is a major driver for microelectronics, as it requires a proliferation of sensors, processors, and communication devices to connect everyday objects to the cloud.

Artificial Intelligence (AI) and Machine Learning: Microelectronics are at the core of AI and machine learning applications, as it provides the hardware processing platforms and power required for complex algorithm execution and analysis. This area is growing at a rocket pace since 2022 across all sectors with the evolution of ChatGPT and Chatbots AI applications.

Sustainability: Green technologies are gaining prominence, encouraging manufacturers to develop eco-friendly microelectronics and reduce the environmental impact of production.

Miniaturization: The demand for smaller and more powerful electronic devices continues to drive innovation in microelectronics, pushing manufacturers to develop even smaller, energy-efficient devices across all applications.

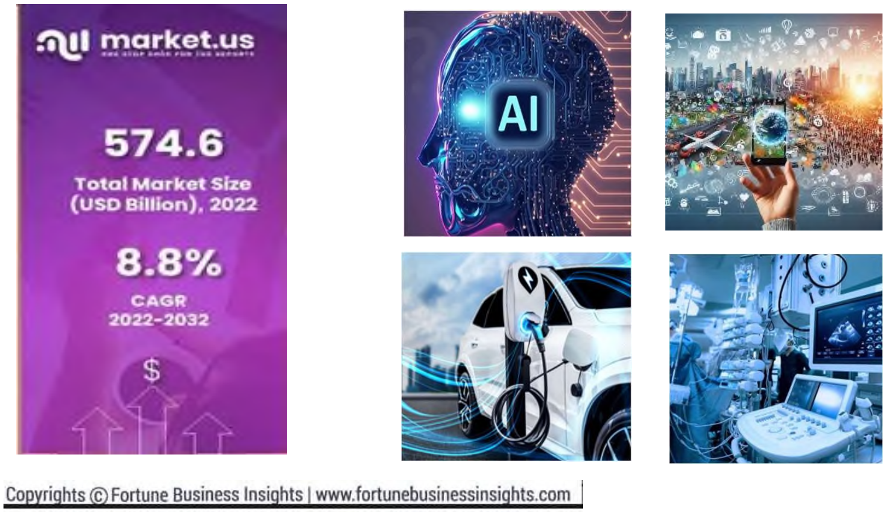

FIGURE 1 SEMICONDUCTOR REVENUE GROWTH PROJECTION, BY FORTUNE BUSINESS INSIGHTS

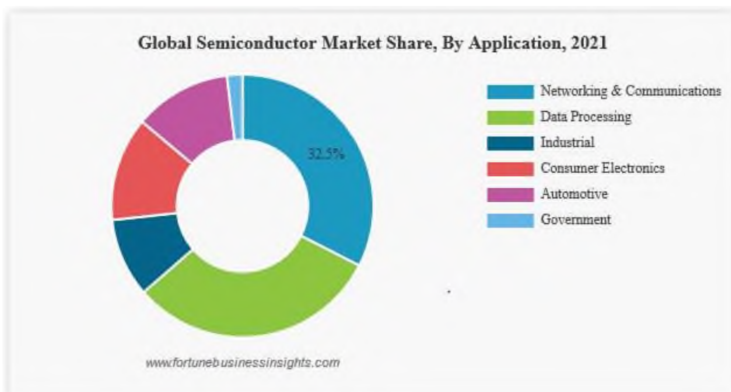

FIGURE 2 GLOBAL SEMICONDUCTOR MARKET/ APPLICATION SHARE

The largest application of semiconductors are broadband communications and data processing, i.e. cloud computing, data services and artificial intelligence (AI). These represent more than 65% of the market applications given the recent upsurge in AI applications across many sectors. The remaining applications are the traditional consumer, automotive, and Industrial IoT, which includes medical tech devices. Cloud computing and data processing are expected to grow exponentially, accelerated by AI and machine learning. This growth presents challenges for rapid technology innovation. The growth curve is clear and happening but the most important point is that the major growth drivers are changing fast. Digitalization, AI & automation across all sectors are driving the number of global semiconductors required upwards in a non-linear trend. Therefore semiconductor technology is fundamental to, and underpins the wider ICT sector.

Global Microelectronics Challenges

Key Challenges: The industry faces technical challenges related to sustainability, supply chain disruptions, and cybersecurity. Researchers and manufacturers are actively working on sustainable materials, new circuit design architectures, design practices, diversification of supply chains, and enhanced security measures and more recently the rapid evolution and deployment of Artificial Intelligence across many applications where microelectronics is the key enabler.

Societal Impact: Semiconductor research will continue to focus on significant societal impact challenges, including the development of wearable health monitoring devices, IoT solutions for food production and industry, contributions to 6G wireless communication, Energy conservation, and sustainable production of Energy. Innovations in these areas are vital grand challenges for improving the quality of life and economic growth of all societies.

Geo-Political Tensions: The modern world has seen unprecedented levels of geo-political tensions across the globe which is causing energy and supply chain issues and shortages. This is a major influencer resulting in strategic geographical policy change and company decision-making in terms of global supply chains being refactored to "near shore" into Europe and US. Industry supply chain investments aligned with government funding policy through the "CHIPS Acts" (US, EU, Korea, Japan and India) are being made to address the location imbalance of semiconductor manufacturing in the east and relocate these back to USA and EU. These activities are creating a climate that is a stimulant for growth in both manufacturing and development of IP. At US federal level, the CHIPS Act incentives consist of $200 billion for scientific R&D and commercialization, $39 billion for semiconductor manufacturing, $13 billion for semiconductor R&D and workforce development, $24 billion for a 25 percent investment tax credit. The EU Chips Act €43bn in funding to develop the chip industry in the EU has introduced a new dimension to the semiconductor industry in Ireland and EU.

Global Research Centres: Prominent research centres worldwide, including the Semiconductor Research Corporation (SRC) in the United States, IMEC in Belgium, Fraunhofer in Germany, Tyndall National Institute and MCCI in Ireland, are at the forefront of microelectronics research and innovation. With the US and EU CHIPS Acts passed into law in 2022/3, the semiconductor sector and the research development happening within the sector in these regions has never been as critical to economies' growth in this digital age - hence the strong revenue forecast for the global Semiconductor Industry to reach over USD 1Trillion by 2030.

The sector has passed the tipping point, from one driven by manufacturing advancements (Moore's law) to something new. The something new requires significant research advancements across broad applications and requires newer strategic investments and full on collaboration.

Microelectronics Ireland

Over the past four decades, Ireland has experienced significant growth and transformation in the field of microelectronics technology. In the early 1990s, Ireland embarked on a strategic mission to diversify its economy and reduce its dependence on traditional agriculture and industry sectors. The government recognized the potential of the emerging microelectronics industry and actively pursued policies to attract global technology companies. Today approximately 65 companies have design centres in Ireland developing new products, for the global market and adding major economic impact to the Irish economy with over 20,000 people directly employed. These companies are spending over €450M annually in R&D, generating over €15B in exports. Semiconductor companies are a subsection of the broader ICT sector in Ireland employing 80,000 people.

Foreign Direct Investment (FDI): Ireland's pro-business environment and skilled workforce attracted numerous multinational corporations, including Analog Devices, Apple, Intel, and Xilinx (AMD), leading to a substantial influx of foreign direct investment in the microelectronics sector such as Qualcomm, Cypress, U-Blox, On Semiconductor and Infineon. This has been a driving force behind Ireland's ICT growth. This growth has been driven by a combination of multinational corporations and innovative start-ups growing into SMEs (small/medium enterprises). Ireland has become a global location for leading multinational corporations in the microelectronics industry, contributing significantly to the country's economic development and technological advancement.

Establishment of Multinational R&D Centres: Several global giants, including Analog Devices, Intel, Apple Xilinx established research and development (R&D) centres in Ireland as far back as the mid 1980’s. These facilities focus on cutting-edge semiconductor research, design, and manufacturing, and spend €450M annually on R&D while also collaborating closely with research institutes in Ireland and abroad. Key reasons for success were an EU based English speaking population of educated young talent, with an appetite to work, learn and develop, and assisted with favourable government pro-business strategy and policies.

Medtech sector: Microelectronics and nanoelectronics: Microelectronics and nanoelectronics are foundational to the modern medical industry, driving the development of devices that are smaller, smarter, and more efficient. In Parallel to the semiconductor industry, Ireland hosts many of the leading Life sciences companies with 18 of the world’s top 25 here. Medical Devices/Diagnostics has been highlighted as a National Research Priority Area. Microelectronics is a key enabler in medical/diagnostic equipment, e.g. medical imaging such as endoscopy, CT scans, MRI, PET are systems containing complex microelectronic sensing and data processing. Other examples of robotic surgery and electroceuticals have microelectronic systems at their core. The future of medical technology lies in enabling microelectronics, e.g. imaging, robotic surgery, the emerging field of electroceuticals and implantable devices etc. Medtech presents a significant opportunity for Irish start-up companies to combine clinical and electronics expertise to develop clinical systems. Some example already exist in Ireland will play a pivotal role in the future indigenous economy combining microelectronics and medical tech.

Job Creation: The influx of multinational corporations has resulted in the creation of thousands of highly-skilled, high value jobs in Ireland sustained over 4 decades. These companies employ a highly educated English-speaking workforce on the edge of the EU, contributing to the nation's prosperity.

Education and Skills: Ireland's education system, particularly its emphasis on science, technology, engineering, and mathematics (STEM), has produced a highly skilled workforce that has contributed to the success of the microelectronics industry. Education and training programs tailored to industry needs have further supported talent development. However, as we head towards 2030, we approach a critical time to enable the establishment of a new generational growth in the Irish semiconductor sector. Ireland needs to acquire larger numbers of young undergraduate and post graduate students to train and develop in our universities to serve the microelectronics industry and research institute's needs.

Research and Development: Ireland's past commitment to fostering research innovation is very evident through substantial investments from the Irish exchequer in R&D infrastructure and programs. Institutions like Tyndall National Institute, MCCI (Microelectronics Circuits Centre Ireland), and funded research across Irish universities have all played a pivotal role in growing research collaboration with industry.

However, given the future growth projections for the sector and in light of the serious global competitive headwind challenges, a very significant investment strategy is required across the board to up our game or the future potential will evaporate and find its home in other jurisdictions.

Clusters and Innovation Ecosystems: Multinationals have played a pivotal role in nurturing an ecosystem of ICT innovation by collaborating with all the Irish universities and research institutions, e.g. Tyndall National Institute and Technology Centres such as MCCI. This has fostered research activity, knowledge transfer and skills development. The creation of Technology Centres and clusters, such as MCCI, the Silicon Docks in Dublin, and the National Technology Park in Limerick, has facilitated collaboration, knowledge sharing, and innovation within the microelectronics ecosystem. These hubs have fostered a culture of innovation and entrepreneurship and has attracted. This important strategic activity needs significant support and strategic investment to scale up to centre levels seen in EU and other global regions in this sector.

MIDAS Ireland was established in the mid noughties by leading semiconductor/Industry members as a support group/network organisation of volunteers, to gather, understand, discuss and tackle many of the diverse challenges facing the Industry at the time. The industry was facing many diverse challenges similar to today albeit at a lower scale. MIDAS Ireland has growth in size, strength and driven by Industry member's on a voluntary basis and is now essential to the sector. Today MIDAS Ireland helps bring all the sectors members together on a very regular basis, as an essential forum for collective discussion, challenge analysis and actions to help the Industry as a whole with the "Irish green jersey on" rather than just individuals companies.

Knowledge Transfer: Collaboration between multinationals, start-ups, and academia has facilitated knowledge transfer, resulting in a highly skilled and adaptable workforce. Ireland's expertise in microelectronics and pro-business strategy has bolstered its international reputation, attracting further investments and partnerships.

Regulatory and Policies: Ireland's support policies and regulatory framework have been instrumental in attracting global tech giants. IDA Ireland has been a significant partner in facilitating the growth of microelectronics companies followed closely by Enterprise Ireland business support to help these fledging company bases grow organically.

Sustainability and Green Initiatives: Recent years have seen a growing emphasis on sustainability and green technology in microelectronics. Irish companies have been quick to adapt, leading to a reputation for eco-friendly practices in the industry.

Global Market Presence: The growth of the microelectronics sector in Ireland has allowed the country to establish a prominent presence in global markets. Irish-made components and technologies are widely integrated into a variety of products, from consumer electronics to industrial equipment. While multinational corporations have undoubtedly fuelled Ireland's microelectronics sector, the growth of start-ups and SMEs has been equally influential over the last 20 years. Ireland's thriving start-up ecosystem has given rise to numerous innovative microelectronics start-ups, demonstrating the entrepreneurial spirit of the nation. These SMEs have focused on diverse applications of microelectronics, ranging from IoT devices, sensors to healthcare technology and renewable energy solutions.

Capital Support: Start-ups and SMEs have benefited from access to venture capital, accelerator programs, and government grants via Enterprise Ireland, encouraging innovation and risk-taking.

The establishment of collaborative networks and innovation clusters has allowed these start-ups to leverage collective resources, fostering a vibrant ecosystem. In pre-2015, there were 22 established indigenous companies, e.g. Decawave, Arralis, Excelsys, Silansys, Adesto Technologies, Powervation, Movidius, Commergy, Firecomms, GloNav, ChipSensors, Redmere and IC Mask to name a few. They represented a vibrant tier of highly innovative high-potential Irish IC design start-up companies. Irish start-ups in the semiconductor sector had raised over €184M in venture funding since 2015, and by the end of 2022, many acquisitions of these indigenous companies by larger multinational firms had occurred, resulting in only a handful of such SMEs remaining. This dynamic led to an expansion of existing multi-national design centre capability or drew in new multi-national entrants to Ireland. Examples, S3 Semi was ultimately acquired by Renesas and Decawave was acquired by Qorvo. Both demonstrated that Irish microelectronics start-ups were attracting increasing interest from significant global players. However the current climate for start-ups in microelectronics has changed dramatically. In recent years, there are very few on the horizon mainly due to a higher barrier cost of entry accessing very expensive advanced technology and CAD tools aided by lower venture capital appetite for investment in microelectronics hardware as they focus on higher application level impact and software applications with a potentially quicker return on investment.

In Summary, Ireland's microelectronics technology sector has witnessed remarkable growth and transformation over the last 40 years punching way about our weight. A combination of factors, including favourable government policies, an educated and skilled workforce, R&D investments, and a commitment to sustainability, has made Ireland an EU-based location for microelectronics innovation and manufacturing.

New Challenges and Opportunities: Despite unpreceded future growth forecasts, the microelectronics industry faces significant challenges, such as the global competition for talent, upskilling existing talent, geopolitical stresses and uncertainties. However, ongoing strategic investments in research, innovation, and diversification across the ecosystem open doors for future opportunities and sustained growth.

As the industry continues to grow, Ireland remains well-positioned to play a vital role in shaping the future of this critical technology sector. This can be seen by major job announcements in 2023 from IBM, Analog Devices, AMD, Qualcomm, On-Semi and Microchip - showing this tech sub-sector remains a vibrant part of the overall ICT sector in Ireland. The future looks bright for the sector globally, largely driven by the pace of digital transformation across all business sectors accelerated by the COVID-19 crisis. There is a great platform to build on for the next wave of multi decade growth in the sector in Ireland. However Ireland needs to address the serious challenges that exist in making bolder strategic investments in planning, infrastructure and talent development, e.g.

“educate the influencer’s” i.e. primary/secondary school science teachers, re microelectronics enabled opportunities, continue STEM, sector awareness campaigns and incentives, increasing University resources focused on microelectronics education, helping to attract new diverse young talent, both domestic and from abroad into Irish Universities. There is a critical need to increase the focus and funding to research institutes to increase size and scale i.e. build an impactful critical mass of staff and PhD population/ programs. This must include addressing the inequity that still exists of low PhD student stipends and general rights vs cost of living pressures or adopt a more successful EU based model for PhD student where students are given research staff rights terms and conditions.

The Microelectronic Circuits Centre Ireland (MCCI):

Hosted at Tyndall National Institute, UCC campus Cork, MCCI is Ireland's National Research Technology Centre dedicated to advancing microelectronics technology and talent. MCCI has built up a critical mass and scale of coordinated funded researchers and stakeholders across Ireland producing high-impact industry-led research in microelectronics which has a strong international reputation that attracts industry cluster locations close to MCCI. MCCI has exceled in various aspects, achieving significant research excellence driven milestones and fostering impactful Industry collaborations. Following MIDAS Ireland thought discussions, MCCI was founded in 2010 under Enterprise Ireland's (EI) Tech Centre Program, is core funded by EI core grants leveraged to attract other associated funding, SFI and EU and collaborative funding from Industry.

Mission and Research Focus:

MCCI's mission centres on pioneering state-of-the-art microelectronics research through collaboration with industry and academic institutions. Our research spans diverse areas of RF and mixed-signal analog microelectronics which includes RF-mmWave, precision data converters, ultra-low power multi-sensor interfaces, integrated power management, and Cryo-CMOS, with a strong emphasis on achieving ultra-low power efficiency and smaller silicon areas for applications like biomedical implantable devices, medical technology, and next-gen wireless communications.

Research Achievements: Over 14 years, MCCI researchers have demonstrated remarkable success, surpassing key performance indicators. Notably, publishing 183 research articles to date in tier one IEEE microelectronics journals and conferences and represents close to 50% of the research publication output from Ireland in microelectronics. Industry reports that MCCI has reinvigorated microelectronics research in Higher Education Institutions (HEIs) in Ireland as well as dramatically improving industry-academic collaboration with rapid and easy commercialisation of IP. Significant individual accomplishments have been achieved with multiple PhD students and Prof's winning Industry competition awards in the EU region. MCCI continues to expand its industry membership collaborations, establishing partnerships with key semiconductor multinational corporations (MNCs) in Ireland, including Analog Devices, AMD, Qualcomm, Infineon, Cadence Boston Scientific and many others including new entrants. The centre engages extensively with Irish-based SME's in the fields of biomedical, medical, and Quantum computer applications, fostering collaborations with companies such as Altratech, LumaVison, BCON Medical, Equal1, and IC Mask Design.

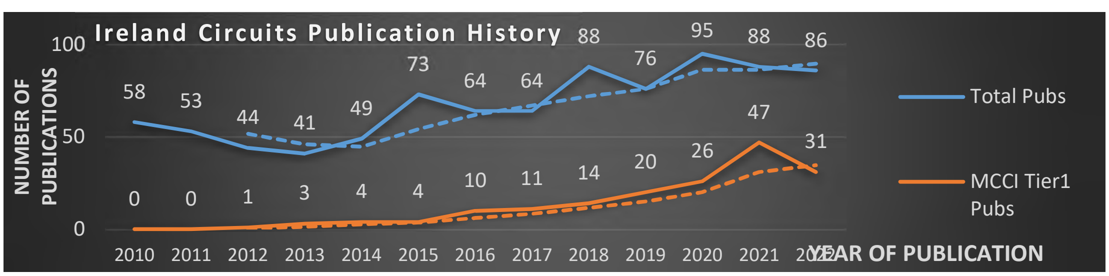

FIGURE 3 IMPACT OF MCCI ON IRELAND'S MICROELECTRONIC RESEARCH PUBLICATIONS

Industry & Academic Partnerships: MCCI collaborates closely with many of the global semiconductor companies located in Ireland and abroad. We assist in their research innovation across many applications. MCCI Industry membership has broadened to include non-semiconductor tech companies, including medtechs, which require microelectronics for applications such as medical devices, industrial IoT and smart agriculture.

MCCI plays an integral role in Ireland's research ecosystem, collaborating closely with our host Tyndall National Institute on Integrated Magnetics, Power Management, Sensor interfaces and Cryo-

CMOS and with other thematic centres, such as SFI IPEC (Photonics), SFI Insight (Data Analytics), SFI CONNECT (Future Networks and Communications), and Health Holland (Life Sciences & Health). MCCI is an active MIDAS Ireland member and part of the MIDAS advisory board.

MCCI taps into a technical steering advisory group (TSG) which consists of International world-renowned senior research professors and Industry technologists which help steer on strategic direction. MCCI has networking activities with many EU research institutes, e.g. IMEC, TU Delft, KU LEUVEN, Queens University Belfast (QUB) and Universities in USA, i.e. Princeton, San Diego, Stanford, and recently Universities in Mexico.

Tyndall National Institute has Gov approved plans to significant scale up and double in size by 2030 and MCCI welcomes this greatly. <u>It's important for Ireland's semiconductor sector that MCCI is approved to scale up accordingly in the next phase of grant funding in 2025 to allow a leverage multiplicity with Tyndall to maximize the return on investment.</u>

Talent Acquisition & Development:
MCCI sources much of its research talent globally, due to the lower number of indigenous Irish electronic engineers available. 70% of our research talent are of international origin, and upon graduation approx. 70% of MCCI's alumni are employed in Irish based tech companies in the semiconductor sector. This is a very significant impact for the sector.
The global demand for engineering talent is very competitive, however MCCI's ability to demonstrate an existing diverse international team culture is a big advantage in attracting new people. MCCI has goals to improve the gender balance with our current status at approx. 15% which is low. Plan/activity to address the imbalance has started. Tyndall National Institute has very active outreach programs to develop improved diversity and gender balance as part of Tyndall 2025 Strategy Goals. MCCI now plays an active part in these outreach programs to promote STEM and microelectronics as a career choice. More MCCI activity and plans need to be executed.
During 2023, a notable milestone was achieved where MCCI celebrated its 110th person transferring to industry since its foundation, highlighting the centre's commitment to nurturing/training larger numbers of IC design talent. MCCI is therefore populating expert IC design talent into Ireland's tech sector who are very capable of conducting world-class R&D. MCCI's Industry transfers, stay in Irish based companies and over time develop into future technology leaders/ decision makers in the sector. History has shown that <u>once MCCI's talent and research strategies are growing and world-class,</u> these senior technology leaders/alumni will easily return to MCCI and Tyndall for further research collaboration expansion and new talent. It is therefore vital that these research Institutes are allowed to expand and are a key component of the National Semiconductor strategy. This is a big competitive and sustainable advantage for Ireland's semiconductor sector. Success breeds success.

Knowledge Transfer Events and Achievements: Every year MCCI is very active hosting many outreach events, webinars and workshops e.g. Annual Technical Conference (MTC) at Tyndall National Institute attracting large attendances from semiconductor member companies and academics. During 2023, MCCI successfully relaunched and organised the IEEE Distinguished Lecturer Series with four hybrid talks at Tyndall National Institute. The series featured distinguished speakers from the leading Universities in the world of microelectronics, Professor Bram Nauta, University Twente, Prof Michael Flynn, University of Michigan, Prof Tom LEE, Stanford University, and Prof Robert Henderson, University of Edinburgh, covering topics such as RF transceiver roadmaps, Analog computing with reRAM, The History of the transistor, its 75th anniversary, and Biomedical Sensing with CMOS SPAD sensors, emphasizing MCCI's commitment to fostering strong connections and knowledge transfer between academia and the semiconductor industry.

Infrastructure and Funding: The centre is setup to provide our researchers with direct funding support to win other funding, and industry network connections and management. The centre provides access to state-of-the-art circuit design infrastructure, CAD tools, design methodologies, and access to advanced foundry wafer fabrication and package assembly technology that is aligned with our industry partner's interests. Furthermore, we provide access to fully equipped design measurement laboratories for test and measurement validation of research test chips. MCCI continues to apply and win various Irish state agency funded capital funding calls for the provision of capital investment in state-of-the-art infrastructure, i.e. CAD tools, test and measurement laboratory equipment for RF to analog Power management and Cryogenic-CMOS at Tyndall National Institute, University College Dublin (UCD) and at other smaller Institutes across Ireland. These facilities are available for small Industry partners -SME's and start-ups to access during collaborative research projects.

In summary, MCCI's has an established very successful track record of delivering results which are very hard earned, and hugely valuable to members companies who have given numerous testimonials of impact value over the years. MCCI's broad achievements to date underscore its pivotal role in advancing microelectronics research, sourcing and training new talent, fostering industry collaborations, and contributing to the growth of Ireland's semiconductor landscape. However all is not rosy, MCCI constantly experiences many operational and technical challenges in its operations. Recruiting new high quality research talent, is a constant struggle due to competition and opposing hindering forces within Ireland's control and some outside our control. Career pay scales and career progression development paths, gender balance within Institutes is difficult and slow, therefore talent retention is an ongoing issue for the centre. To become a larger more significant contributor in the 2X growth story for the Industry, these current challenges and hindrances will need to be seriously addressed for future successful impact. Most of these will be addressed further in the document.

MCCI continues to help position Ireland as a global location of choice for microelectronics companies leading to a larger and more vibrant microelectronics industry in Ireland and is actively involved in MIDAS Ireland, supporting Enterprise Ireland and IDA Ireland's FDI activity with potential new client visits and meetings.

MCCI's Role in Developing Ireland's National Semiconductor Strategy:

MCCI (Microelectronics Circuits Centre Ireland) through its research activity and performance plays a pivotal role with Tyndall National Institute and other Universities in advancing Ireland's National semiconductor strategy. It's important to align these activities within the National Semiconductor strategy.

Proposed Key Pillars of Ireland's National Semiconductor Strategy:

Innovation and Research Excellence:

MCCI's extensive research capabilities and publication's record in tier1 IEEE's semiconductor journals and conferences contribute to the strategy's core objective of fostering innovation and research excellence in semiconductors.

Collaborative initiatives between MCCI and industry partners amplify Ireland's global standing in semiconductor R&D.

Talent Development and Education:

MCCI's commitment to sourcing global talent, IC design training and skill development aligns seamlessly with the strategy's emphasis on nurturing a skilled workforce in microelectronic design.

Collaborative programs with academic institutions such as Tyndall National Institute, University College Dublin (UCD) and others at home and abroad foster a pipeline of engineering talent critical for the Irish semiconductor industry growth.

Industry Collaboration and Ecosystem Development:

MCCI's partnerships with Tyndall, UCD, and other Universities but most important industry leaders (MNC's), SME's and start-ups strengthen Ireland's semiconductor ecosystem promoting collaboration and knowledge exchange and talent.

Initiatives like shared research facilities and collaborative projects bolster the competitiveness of Irish based semiconductor companies and researchers on the global stage.

How MCCI's Microelectronics Research Strategies Contribute:

Cutting-Edge Research Facilities:

MCCI's state-of-the-art research facilities at Tyndall and UCD provide an ecosystem platform for high impact research, driving innovation and pushing the boundaries of semiconductor technology. These facilities enable SME Industry clients in accessing specialized test and measurement equipment to benefit their advancements in product developments through Research collaboration which has a positive impact of their revenue growth. These facilities need to have continuous capital investment in funding mechanisms through state agencies to keep up-to-date with rapid Technology development.

Cross-Disciplinary Collaboration:

MCCI's approach emphasizes cross-disciplinary collaboration, fostering synergies between various sectors, i.e. medical, pharma and industrial automation to address complex challenges in technology and semiconductor development. Tyndall National Institute plays a key enabling role in cross-disciplinary collaboration across broader Industry sectors.

Technology Transfer and Commercialization:

MCCI's commitment to technology transfer accelerates the translation of research into commercially viable intellectual property (IP) and products, directly contributing to the strategy's goal of enhancing Ireland's semiconductor industry. This facility is managed through Technology Transfers offices (TTO) at UCC and UCD.

Global Partnerships:

MCCI's collaborations with International Universities and multi-national companies, helps to amplify Ireland's presence in the global semiconductor landscape, facilitating knowledge exchange and access to global markets.

Summary Recommendations for Future Alignment:

Increased Strategic Funding Support: Ireland's microelectronics technology sector has witnessed remarkable growth and transformation over the last 40 years. A combination of factors, including favourable government policies, a skilled workforce, R&D investments, and a commitment to sustainability, has made Ireland an EU-based location for microelectronics innovation and manufacturing.
Despite remarkable growth, the Irish based microelectronics industry faces serious challenges, such as the global competition for talent, upskilling existing talent, geopolitical stresses and uncertainties. However, ongoing significant investments in research, innovation, and diversification across the ecosystem will open doors for future opportunities and sustained growth as the industry continues to grow. The National Semiconductor strategy with significant investment commitment is a critical requirement. Only then will Ireland be well-positioned to play a vital role in shaping the future of this critical technology sector.

Advocate for a significant focus and increase in Gov funding support in microelectronic to enhance our research capabilities, training and development needs, PhD student welfare and attract top-tier talent, reinforcing Ireland's position as a hub for semiconductor research innovation and excellent talent.

Expanded Industry Engagement:
Encourage deeper collaboration between MCCI and industry stakeholders in the eco-system to ensure that research aligns with the evolving needs of the semiconductor market, fostering industry growth. One notable area interest sub-sector for Ireland is medical technology (MEDTECH).

Educational Outreach Programs:
Expand educational outreach programs to inspire and train the next generation of semiconductor professionals, aligning with the strategy's goal of talent attraction and development at secondary school, university and post graduate levels.

In conclusion, under a National Semiconductor Strategy, a bigger collaborative effort between the public and private sectors, academia, and research institutions, with MCCI playing a pivotal role, will contribute to overcoming challenges and unlocking the full potential of Ireland's semiconductor sector. This approach will position Ireland as a leading player in the global semiconductor industry, fostering further economic development and innovation and growth for years to come.

Dept. of Enterprise, Trade & Employment, Questions for Strategy Development: Challenges and Opportunities in Ireland's National Semiconductor Strategy

Aspirations for the Sector:

The Irish semiconductor sector has always punched about its weight in terms of success and impact. The sector wants/needs to build on this momentum and aspire to be a global leader in innovation, research, and development. The goal is to foster a much larger thriving ecosystem that attracts significant strategic investment, attract, train and nurture higher volume of high quality talent, encourages and supports new indigenous start-ups in a real way and contributes significantly to the semiconductor sector and the nation's economic value and growth.

Opportunities for the Sector:

The semiconductor sector in Ireland has huge potential for both multinationals, SME's and start-up companies to capitalize on the growing global demand for advanced technologies in emerging applications in Communications, Industrial IoT, AI, Automotive, and Medical/Biomedical (MedTech) and Sustainable Energy production.

Hugh growth opportunities exist for Ireland because of the established, hard earned successful track record in the semiconductor sector. Due to a well-educated, well-supported, sustainable and competitive environment that attracts multinational companies, fosters local collaboration and innovation with research Institutes, SME and Start-ups. Ireland has developed a strong Design/IP presence already. This position needs to be defended and strengthen with impactful scale and investment. Very few other EU locations have the experience, know-how and talent needed for this industry.

This is an opportunity to create a larger centre of excellence in microelectronic design and it must include new start-up business creation. This need to be strategically supported by Gov given the EU CHIPS -Pillar1 activity under the Design Platform and EU Chips Competence Centres. With strong state support for Gov agencies that exists already for innovation, through Tyndall, MCCI, other Tech Centres and Universities, there is an unprecedented opportunity to grow new Irish indigenous semiconductor businesses to a new level. Without this support, start-ups and SME's in semiconductors will cease due to the expensive setup costs and longer TTM return on investment (ROI). All of the above strengthens the overall value chain producing more high value and long term well paid sustainable jobs in the sector while contributing to the higher level of European ambition to have a larger share of semiconductor technology ecosystems and manufacturing located in EU.

Challenges facing Businesses & the Sector:

a. Global Competition: Intense global competition poses a threat to the Irish semiconductor industry, necessitating strategies to enhance competitiveness in a time when the cost of living in Ireland is one of the highest across the EU.
b. New competition with serious funding incentives and activities in other EU regions playing catch-up in the semiconductor success trying to replicate what Ireland achieved to date.
c. Geo-political tensions causing west vs east global alliances, directly effecting energy costs.
d. Supply Chain Disruptions: The sector faces challenges related to external (non EU) supply chain disruptions, affecting production and time-to-market.
e. Regulatory Environment: Adherence to evolving international regulations and geo-political situations adds complexity and cost to businesses operations.
f. Application process for work permits/ visa is bureaucratic and very slow resulting in slow recruitment or loosing talent. Needs fast track-streamlining or visa waiver/residence for favoured countries to allow quicker recruitment of a large number of essential talent.

g. Inadequate Infrastructure: Regional planning strategy supporting growth and infrastructure development required, i.e. significant increase in domestic housing capacity in all regions, road/rail/ networks upgrades, lower cost of greener energy supply storage and management, and finally broadband communication remains a big challenge outside the major cities or regions to support the new working from home hybrid work model.
h. High barrier to entry for microelectronic Start-ups –very expensive investments required, for tools and technology access and longer time to market (TTM) for IP/product revenue.
i. Lower appetite for venture capital in hardware vs software. Long term vs short term ROI.

Access to Talent:
Ireland has always produced a good quantity of well-educated hardworking workforce. However the semiconductor sector struggles from a shortage of diverse young skilled professionals, particularly female at a time when the sector looks to expand for significant future growth. This requires a concerted long term effort to attract young people into STEM, microelectronics at undergrad level, followed by post grad training, and retention of a diverse pool of research talent. Continuous strategic government policy, funding and collaboration between department of education-primary/secondary school, 3rd level academia and industry are essential to bridge this gap. This needs to be a long term goal with a coordinated investment and activity plan spanning many years and decades.

Barriers to Development:

a. Funding Constraints: Limited budgets and physical resources in 3rd level Universities related to microelectronics and research Institutes is hindering higher levels of available talent, research staff career development, staff retention, research, and infrastructure expansion.
b. Start-up Support constraints: The barrier to entry for microelectronic start-ups is higher than ever due to high setup costs to access tools and advanced foundry technology. Hence a very low semiconductor start-up activity exists today. Needs a new tangible support model, offing financial, business and training to allow for more start-ups in the sector.
c. Research Profile gaps: Ireland's Universities and Institutes needs more high profile Prof's and principle Investigators (PI's) involved in research. Higher profiles raise all ships, attracting the very best talent achieving higher quality outputs in both talent and research excellence.
d. Technological Gaps: Addressing the technological disparities/scale of funding in Ireland's research Institutes versus global leaders is crucial for sustained growth. e.g. AI, "Edge AI" and Quantum computing.

Mitigation to address Challenges & Barriers:

a. **Public-Private Partnerships:** Foster larger collaboration between government, industry, and academia to address funding constraints and facilitate shared resources. "Go big or go home attitude" should exist for the partnerships, if Ireland's ecosystem is to truly compete with larger scale Institutes in EU. Create a high level steering/management group to drive and coordinate this collaboration across all groups with Gov/ Dept participation.
b. **Talent and Skills Development Programs:** Expand Investments in all Irish University programs in microelectronics with adequate numbers of training staff to develop a skilled workforce, ensuring a continuous talent pipeline into research and Industry. Provide faster research career development progression in Universities and Institutes which helps research talent retention, thereby increased the profiles of Institutes, Universities and staff through longer term research roadmaps and results.

c. **Increase Research Talent:** Implement the recommendations in full as outlined in the DFHERIS commissioned independent report on the National Review of State Supports for PhD Researchers in June 2023. Help attract more talent into research.
d. **Research and Development Incentives:** Implement higher incentives with lower bureaucracy for companies engaging in research and development, encouraging higher levels of innovation.
e. **EU Chips Acts -** Pillar 1, in particular, needs commitment at Gov level to support the creation of microelectronics competence centre to support Ireland's microelectronics start-ups and SME's base, providing tools, services and business training almost free of charge to potential start-ups. Use equity model/royalty as ROI for Innovation Centre. This would encourage more spin-outs from academia and private sector.
f. **With regard to EU CHIPS Design Platform** and EU Chips Competence Centres, I believe because of its planned new scale and reputation, Tyndall National Institute is ideally suited to host such a centre assisted by MCCI, MIDAS Ireland-Skillnet and SME's involved in the provision of specialized design training and services.
g. **Agile Regulatory Framework:** Establish a flexible regulatory environment that supports innovation while ensuring compliance with international standards.

I would like to thank the Dept. for having the opportunity to provide feedback and information related to MCCI in this consultation on the development of the National Semiconductor Strategy.

I hope this information is valuable to the Department post consultation.
I can be consulted further if needs be, to discuss any further details or inputs as required.

Yours faithfully,

John Morrissey

John Morrissey, MCCI, Executive Director

MCCI Hosted Start-Up and SME Chip Support Centre

Version draft: authored Séamus O'Driscoll, MCCI, 15th March 2024. Note that this document will require further internal group discussion and further refinements.

Startup/ SME Support Addendum to MCCI Submission, by John Morrissey.

Start-up & SME Chips Support Centre

The MCCI is dedicated to advanced CMOS circuits research across the full swathe of technology applications for chips, medtech, e-mobility, smart sensing, communications and energy, through research tracks ranging from to RF coupling to cryo-CMOS and spanning technology readiness levels, TRL 3-7. There is a very strong motivation for a dedicated Irish group to support and be a central point-of-contact for prospective start-ups and SMEs, offering higher TRL *guidance, support and business incubation services for start-ups or SMEs* whose products are fundamentally based on an integrated circuit, IC. These services would generally cover TRL 7-9 and support start-ups and SMEs through their commercialisation journeys from research and technology through to open-market supply of products based on semiconductor IP, CMOS circuits IP or silicon chips. These IPs or chips are generally an intrinsic part of advanced systems-on-chip, SoCs, which in turn are a part of a highly integrated packaging system. The support centre envisaged would enable the required associated vertical supply chain linkages such as through the PIXAPP integrated packaging pilot line at Tyndall, [16] and the Tyndall/ Europractice MEMS (miniature electro-mechanical system) and chiplet integration services, [17].

The European Chips Act and SMEs

European Chips Act: The Chips for Europe Initiative, [2], has as one of its main operation objectives, *setting up a Chips Fund to facilitate access to debt financing and equity, in particular for start-ups, scale-ups, SMEs and small mid-caps.*

In this regard, its objectives are:

- Setting up a Design Platform
- Enhancing existing and developing new advanced pilot lines
- Building capacities for accelerating the development of Quantum chips and associated semiconductor technologies

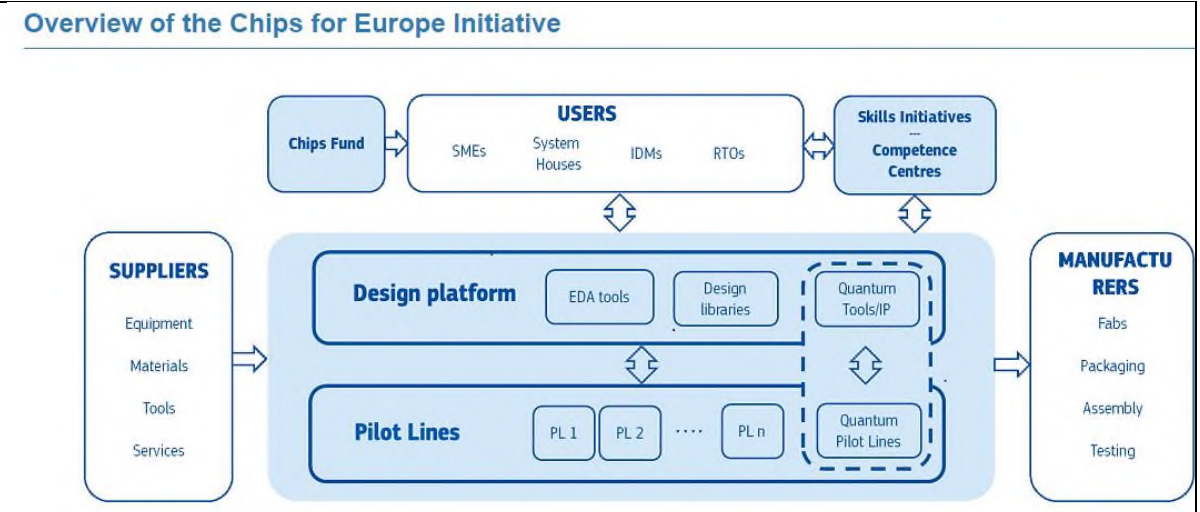

Figure 1 **Design Platform**

The design platform proposed in the Chips Act is a cloud-based virtual environment to be made available across the Union, integrating a wide range of design facilities, from IP libraries to Electronic Design Automation (EDA) tools, as well as support services. The platform will be accessible in an open, non-

discriminatory and transparent way. It will stimulate wide cooperation between users and key actors of the ecosystem and reinforce Europe’s chip design capacity.

Pilot Lines

The Chips for Europe Initiative includes a number of pilot lines for the purpose of process development, test and experimentation, as well as small-scale production. These will serve as a platform for European research and development with an industrial perspective to bridge the gap from lab to fab.

Competence centres and skills

Competence centres in semiconductors play an essential role in the Chips for Europe Initiative. The centres will provide access to technical expertise and experimentation in the area of semiconductors, helping companies, SMEs in particular, to approach and improve design capabilities and developing skills. Competence centres will provide services to semiconductor stakeholders, including start-ups and SMEs.

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Figure 2 Competency Centres as envisaged by the Eu Chips Act and are targeted at SMEs in particular.

Chips fund

To develop a thriving semiconductor ecosystem, easier access to finance and investment opportunities for SMEs are needed. To this end, the Chips for Europe Initiative sets up the Chips Fund in order to facilitate access to debt financing and equity, ***in particular for start-ups, scale-ups, SMEs and small mid-caps in the semiconductor value chain, through a blending facility under the InvestEU Fund and via the European Innovation Council.***

Figure 3 Chips Fund

“First-of-a-kind” facilities are new or substantially upgraded semiconductor manufacturing facilities providing a dimension of innovation not yet present in the EU. Such facilities can apply to obtain the status of “integrated production facility” (IPF) or “open EU foundry” (OEF).

- Integrated production facilities are vertically integrated semiconductor manufacturing facilities, which are involved in front-end manufacturing, in the production of equipment or key components for such equipment predominantly used in semiconductor manufacturing in the Union as well as in the design of integrated circuits or the provision of back-end services, or both.

- Open EU foundries are semiconductor manufacturing facilities which dedicate at least a certain extent of their production capacity to produce chips according to the design of other companies, in particular fabless companies.

Figure 4 ***First-of-a-kind facility, [3]***

The Commission may award a label of "design centre of excellence" to design centres established in the Union that significantly enhance the Union's capabilities in innovative chip design through their service offerings or through the development, promotion and strengthening of design skills and capabilities.

Figure 5 Thin film Pilot Line Centre of Excellence Possibility for Tyndall and MCCI to create PwrSoC – power system-on chip offering 3X electronics powering performance

MCCI Can Host the SME Support Centre

MCCI is well positioned to host such a centre. MCCI is currently in its third 5-year growth phase and has well-established research tracks across all of the key circuit technologies required in a silicon chip. MCCI has "taped-out" perhaps over 100 silicon chips, covering CMOS geometry nodes from power and analog appropriate 360 nm through to *deep sub-micron* less than 28 nm and on most of the world's major foundries, including TSMC, STMicroelectronics, IHP, XFAB and Global Foundries, either through direct interface or through the Europractice multi-project-wafer, MPW, aggregator, [13]. Many of these test chips highlight competencies at world leading level in areas such as data converters and signal processing, as exemplified recently at ISSCC, the world's premier conference for CMOS circuits research, and recently, with a paper lead-authored by Prof. Peter Kennedy of MCCI and in collaboration with Analog Devices, [10].

Tyndall's deep-tech research themes span *atoms-to-systems.* The associated systems are nearly always required to be implemented on a silicon chip. In recent years, MCCI has been migrating more of its research from excellence in core CMOS circuit blocks through to the development of complete systems-on-chip. MCCI now has deep collaborations with many of Tyndall research groups, in areas such as bio-photonics, energy-harvesting MEMS, RF, electrochemical sensing and integrated magnetics. The interdisciplinary benefits deriving are now driving ambitious full-system-on-chip developments, for areas such as implantable RF coupled medical devices and surgical catheters with advanced photonics and magnetic tracking. A collaborative project underway with a UCC start-up, [11], is currently exploring commercialising next generation surgical catheter guidance, through integrating its technologies onto an advanced system-on-chip, SoC.

Advanced implantable medical devices are now beginning to achieve FDA approval, and generally on the cusp of rapid growth. In April 2023, Neuspera Medical announced first-of-a-kind- FDA approval for an implantable system, which delivers drug free pain management through peripheral nerve stimulation (PNS) through a wireless platform, managed on an IPad App., [14]. Every real world system relies on analog sensing interface, energy transduction, storage, signal processing, wireless communications, system intelligence and system actuation. MCCI has research themes excelling in all of these areas. It could be expected that they will offer a strong support technology IP base to start-ups in areas such as medtech, which will create systems, which are substantially chip based. Neurobell is a recent startup, which will require advanced integration across the range of MCCI technologies, for its edge-AI powered neo-natal wireless brain monitor, [12]. Medtech is an extremely important SME cluster in Ireland, [18]. In the area of medical molecular diagnostics, altratech's products, [19], were fundamentally underpinned by an MCCI/ EI ADC/ signal chain Innovation Partnership and IP license.

MCCI has recently developed a first-in-kind CRYO-CMOS test laboratory in Ireland, through an EI Centre Capital Equipment Grant. There is the ability to test CMOS circuits at temperatures close to zero kelvin. This capability is anticipated to be of central importance to UCD based SME, equal1, who are developing an entire quantum system-on-chip – QSoC – to enable breakthrough data centre servers. This company achieved EIC Accelerator grant of €10M, [20].

MCCI enabled SMEs, such as SensL and S3 Group, availed of MCCI-EI Innovation Partnership developments to support their successful technology development phases. These in turn were acquired by multinationals, Onsemi and Dialog Semiconductor/ Renesas respectively, contributing to Ireland's FDI.

There are some very significant DTIFs currently underway in MCCI, enabling consortia of multinationals and SMEs. The "Perceive" DTIF will crucially benefit SMEs, such as the Irish-German based Lumavision with implantable piezo ultrasound array PMUT based cardiac imaging. The "Trident" DTIF activities at MCCI are helping SMEs with developments in balance-of-system power electronics hardware to enable prosumers based virtual microgrid of integrated renewables and green battery storage chemistries.

All of the activities described in this section are at research level, below TRL-7.

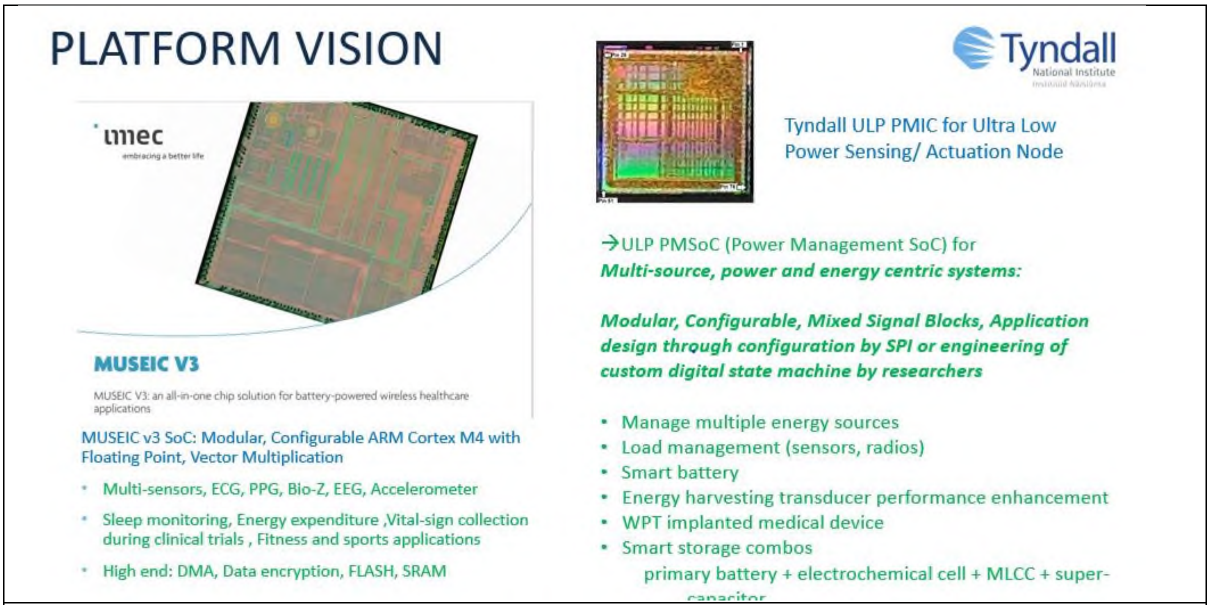
Roles for the Proposed MCCI SME Support Centre (New roles covering TRL7-9 Support)

- Facilitate startup and SME services as per the EU Chips Act envisaged *Figure 1* **Design Platform** in Figure 1
- Facilitate startup and SME linkages to integrated system level *Pilot Lines* as per EU Chips Act envisaging in Figure 1. Pilot lines, such as Tyndall Europractice and PIXAPP. SoC ICs are intrinsically linked with their integrated packaging system and all of its associated electrical parasitic components, such as routing inductances, ball current density restrictions, RF impacts and trace-to-trace capacitances and other electrical quality factor impacts such as eddy current dissipations in metallic planes and casings.
- Facilitate access to technical expertise and experimentation in the area of semiconductors, helping companies, as envisaged in the Eu Chips Act competency centres and specifically targeting SMEs, as per Figure 2, to approach and improve design capabilities and developing skills. Competence centres will provide services to semiconductor stakeholders, including start-ups and SMEs.
    - facilitating access to pilot lines and to the design platform,
    - providing training and skills development, support to finding investors and reaching out to the relevant verticals.
    - Provide linkages with a European network of competence centres in semiconductors and should act as an access point to other nodes of the network.
    - Increase the visibility and the attractiveness of semiconductor sector

- Facilitate easy access and adoption of the new supports offered by the EU Chips Act (Chips JU, Chips Fund, Competence Centres)
- Operate an easy access point for startups and SMEs to understand and avail of Eu Chips Initiative grant aid and equity stake supports, as per Figure 3, through InvestEu and EIC schemes
- Liaise with SMEs to assess possibilities for "First-of-kind" facilities, as per Figure 4. The nature of many of the Irish developments in medtech and space, would lead one to envisage that there are a number of SME applicable possibilities. Tyndall integrated magnetics group, for instance, has licenced unique magnetics-on-silicon technology to Apple Inc. Apple in conjunction with TSMC, is the only commercialistion of this technology in the world. There is possibility for Tyndall and MCCI to create a "first-of-a-kind" facility in PwrSoC (power supply on chip). The technology is known to enable a revolutionary 3X solution area advantage and a 2X energy savings advantage to powered devices, ranging from mobile phones through to AI accelerators. This is one example of a possibility and there

is an MCCI based startup, currently exploring options. There is OpenFoundry, as per Figure 4, possibility for Tyndall with thin-film magnetics and with access possibly being a future Europractice offering. There are associated SoC design services offerings for a CMOS chips based support centre. This centre would have a high probability of achieving “centre-of-excellence” categorisation, as per Figure 5.

- Provide necessary integrated system linkages for access to expertise compound semiconductors used for communications, sensing, medical imaging, integrated magnetics, power devices and lighting – through all of the country’s and EU research groups and RPOs, such as IMEC, Fraunhofer, Holst.
- Provide start-ups/ SMEs with lowered financial barrier to entry access to chip design, layout and tape-out EDA tools. This area represents a huge barrier to entry for SMEs. CAD costs may represent 20 to 30% of the costs associated with getting to a first chip, with charges per CAD seat, per annum, being, on average, in the range €20k to €80k.
- MCCI is well positioned to provide reduced barrier access to laboratories, with laboratories, such as Cryo, RF and Integrated Power and for physical analyses and diagnostics through Tyndall Speciality Services. As a next stage, this new proposed startup/ SME support centre through MCCI could consider creating access to a fully supported semiconductor industry IDM (integrated design manufacturer) level IC tester equipment. This equipment is hugely intensive and beyond the reach of most startups/ SMEs. Training on 6-sigma test and parametric performance methodologies would be invaluable to startups/ SMEs and accelerate their ramp to revenue with commercial grade ICs/ SoCs.
- Many of today’s startups/ SMEs requiring an SoC /chip are not traditional silicon companies, who created generic standard products. Today’s startups and SMEs are generally from other sectors, such as medtech, agritech, emobility, IoT or edge AI etc., but who crucially depend on an ASIC or custom SoC to protect their IP and bring their product to market. These startups/ SMEs have core competencies outside of silicon design but yet need easier and enabling access to commercial grade ASIC/ SoC. Traditionally they sought the services of an ASIC design house, such as S3 Group in Cork, but such design houses are becoming more rare. The S3 group in Cork was acquired by Dialog Semi and then Renesas and has now closed. There is a void regarding availability of high TRL product chip design service. This proposed group could help fill the gap, by a number of means, including creating standard SoC design platforms and IPs or providing the linkages to other ASIC design houses, through Europe, such as Dolphin, Silicon Gate, Canovatech or Catena. There is opportunity for a new Irish startup providing such services. This centre might envisage creating the support services, so that such a new startup might organically emerge over time, as a future spinout.
- Create flexible, programmable SoC/ ASIC platforms, targeted at specific sectors, such as medtech. The greatest example of such a platform to enable medical devices has been in development by IMEC and the Holst Centre – the MUSEIC IC, [8]. For instance, the Tyndall Mischief IC Platform for the energy harvesting smart sensor node could create an equivalent Ultra Low Power – Power Management flexible generic SoC, appropriate for all startups creating smart sensing applications at IoT-edge, in tomorrow’s trillion sensor economy. New IP interface blocks can be created for SoC startups, as required. There are IP and Platform licensing models. NetFeasa Ltd., is an example of a startup which would really benefit from such a platform, but its development to commercial reliability grade should ideally be shared across multiple startups and SMEs. A large percentage of an given SoC is generic. All applications require data conversion blocks, power management blocks, battery charge blocks, RF/ Bluetooth blocks, BIST (built-in-self-test) and chip management/ housekeeping blocks. The development could be shared across multiple startups/ SMEs and facilitated by this proposed centre. There would be versions for various segments, such as implantable with base FDA approval, energy harvesting smart-agri for animal welfare, smart-city or Industry 4.0, for example.



IMEC MUSEIC Generic Platform for medtech and MCCI/ Tyndall's Proposed Generic IoT Energy Harvesting Smart Sensing Node SoC Platform for tomorrow's trillion sensor economy

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MIDAS IRELAND

National Semiconductor Strategy Consultation

MIDAS Ireland Submission

March 22nd, 2024

Contents

Executive Summary

MIDAS Ireland welcomes the opportunity to respond to the Department of Enterprise Trade and Employment's call for submissions to the National Semiconductor Strategy Consultation.

Ireland currently has a leading position in semiconductors. The EU Chips Act and expected continued growth of the Global Semiconductor Market open up very significant future opportunities for Ireland that need to be capitalised on.

MIDAS Ireland is delighted that a National Semiconductor Strategy soon will be in place.

The following is a high-level summary of the key recommendations that are described in more detail later in this document under *Theme 6 – Mitigation*.

1. **Semiconductor Advisory Council to Oversee Sector Strategy & Implementation**
   Following on from the creation of a National Semiconductor Strategy, MIDAS Ireland proposes that a high-level Semiconductor Advisory Council, comprising industry, academia and government actors, would be appointed to oversee the implementation of the strategy and advise government on current challenges and future trends in this fast moving and highly competitive global industry.
2. **Semiconductors to be Recognized as a Separate Sector**
   MIDAS Ireland believes that semiconductors should be recognised as an individual hardware sector, as it currently can get lost in the larger mostly software focused ICT sector.
3. **Addressing the Sector Talent Needs through Education and other Initiatives**
   The sector talent needs are not being met today, and the expectation is that the gap may actually grow into the future. As part of the mission of the Semiconductor Advisory Council, MIDAS Ireland proposes the immediate setting up of a Future Skills Taskforce comprising of all relevant and needed stakeholders to develop a plan urgently to close the talent gap.
4. **Making Ireland Attractive to New Semiconductor Manufacturing Investments**
   JU Pillar 2 of the EU Chips Act allows for increased state funding for the semiconductor industry, so Ireland needs to respond accordingly in support of these strategic investments.
5. **Continued Expansion and Growth of the Chip Design Sector**
   While several of the major multinationals have chip design teams in Ireland, there is the opportunity to attract more from all over the world.

There is also the opportunity to grow the teams are already here through broadening and deepening their operations in Ireland, with where possible, the ultimate goal of customer and P&L ownership and business / strategic decision making happening here.

6. **Significantly Expand the Pipeline of Start-Up Activity in the Sector**

   There have been some very significant success stories in the Ireland's semiconductor SME sector during the past few decades, however the opportunity exists to significantly grow this pipeline, which should be at least doubled in the short term with continued growth beyond that.

7. **Building Research Capability**

   During the last half-century, Ireland has built significant research capability in the semiconductor area. However, to capitalise on the opportunities becoming available through the EU Chips Act and the future Global Semiconductor Market growth, this investment needs to be taken to the next level, so that Ireland's research ecosystem can take its place among the best in Europe and beyond.

   This will require increased investment in Ireland's current leading semiconductor research centres, along with investments in new opportunities as they emerge (e.g. AI, Quantum and Photonics today, and there will be more in the near future.)

8. **Government Policy**

   MIDAS believes that semiconductors should be recognised as an individual hardware sector, as it currently can get lost in the larger mostly software focused ICT sector.

9. **Engagement in Europe**

   The EU Chips Act opens up significant opportunities for Ireland, but currently Ireland is not engaged at the level that it needs to be. Addressing this gap requires government, it's agencies and all parts of the sector, including MIDAS Ireland, to step up and engage so we can capitalize fully on these opportunities.

10. **Cluster Support for Ireland's Semiconductor Sector**

    Recognizing and funding MIDAS Ireland as a Cluster supporting the Semiconductor sector in Ireland would be a significant and positive step forward.

About MIDAS Ireland

MIDAS Ireland champions Ireland's micro and nano-electronics system solutions industry with a key mission of ensuring the sector continues to be one of the most attractive to work in. Innovation is the lifeblood of our industry and MIDAS Ireland is keenly focused on enhancing the infrastructure to ensure innovation is thriving. Our country's FDI and indigenous companies are leading the world in innovation, with the essential support of our research organisations and educational system.

MIDAS Ireland, established in 1999, is an industry led partnership consisting of FDI and indigenous companies, educational organisations, research institutions and government agencies working together addressing common challenges within the sector in Ireland.

Our main focus areas are:

1. Indigenous / SME
2. Education & Outreach
3. Training
4. Research
5. European Cluster Partners
6. Publicity
7. Links to Government Policy

Some key activities of MIDAS are:

- Promote research activities to ensure new technology capabilities and advanced skillsets are developed.
- Enhance under-graduate and post-graduate training to achieve an education system that supplies the quality engineers that the industry needs.
- Support the collective training needs of engineering staff within our sector.
- Help companies to fill jobs vacancies (through website, government, agencies).
- Support new industry start-ups.
- Build links with other industry sectors in Ireland and in mainland Europe.
- Engage with Government & State Agencies to support industry needs.
- Promote through publicity the very positive story concerning our sector (including outreach to second level students).
- Network among the sector through regular meetings and events.

The strength of MIDAS and the value it brings to its membership is intrinsically linked to the active involvement of the whole sector. We are stronger when we collaborate. The more people, companies and organizations that contribute to the collaborations, the more successful we all are. MIDAS has achieved a lot over the years for the sector and will continue to do so as a vibrant organisation.

MIDAS has about 70 member organisations from around Ireland, including multinational companies such as Analog Devices, Intel, AMD, Bosch, Cypress Semiconductor, Infineon, Microchip, onsemi and Qualcomm, along with indigenous SMEs such as Adama Innovations, Altratech, Mbryonics, Movano Healthcare and Firecomms Technologies. The membership extends to the third level institutes including NUIG, UCC, UL, UCD, SETU, TCD, TUS and QUB and the Tyndall National Institute, Ireland's largest dedicated research institute in the ICT space.

www.midasireland.ie

The Global Semiconductor Market

The term semiconductor refers to a material which conducts electricity better than an insulator like glass, but not as good as a conductor like a metal such as copper. Since the electricity flow through a semiconductor can be controlled in a precise manner and individual transistors made incredibly small, multiple semiconductor components can be designed together to perform a complex function in an integrated circuit (IC), commonly referred to as a 'Chip' or 'Silicon Chip'

The semiconductor market refers to the design, manufacture and usage of these integrated circuits or chips in electronic systems that have become ubiquitous in today's world. They are the foundations of virtually all modern electronics and technologies, from automobiles and medical devices to smartphones and computers, with new applications like artificial intelligence, green energy, electric vehicles, etc, appearing all the time.

Because of this cycle of new applications that use semiconductors that come along continually, the overall market has historically seen strong growth and is set to double during the rest of this decade from $500B today to $1T in 2030, at a compound annual growth rate of about 9% (CAGR).

The growth in semiconductors is underpinned by very significant new research happening continually, with the performance of semiconductors increasing, cost and size reducing, and new semiconductor technologies like photonics, quantum, etc, being developed that enable new applications.

This growth requires a steady and growing flow of high-skilled people with an ever-expanding range of skillsets. There is a worldwide shortage of talent in this space, so satisfying this demand is an opportunity in itself.

The Semiconductor Sector in Ireland

Ireland is well positioned in the European and global semiconductor ecosystem thanks to its strong ICT industrial base and R&D excellence in the sector. Ireland has played a central role in the European semiconductor landscape for almost 50 years.

The birth of the semiconductor sector in Ireland goes back to the mid 1970's when Analog Devices established a semiconductor manufacturing facility and chip design team in Limerick, with a local supply of talent from the then NIHE Limerick (now UL).

The next major company to arrive was Intel who established a major semiconductor manufacturing facility in Leixlip in the late 1980's.

Microchip's history in Ireland in both manufacturing and R&D also dates back to the 1980's.

Silicon & Software Systems (S3) was the first Irish semiconductor SME which started a chip design team in the late 1980's, with support from UCD and Philips.

Parthus was the next significant SME which started in the early 1990's.

On the research side, the National Microelectronics Centre (now the Tyndall National Institute), hosted by UCC, was established in the early 1980's.

In parallel with these developments, an ample pipeline of highly-skilled talent was coming from the various universities around Ireland.

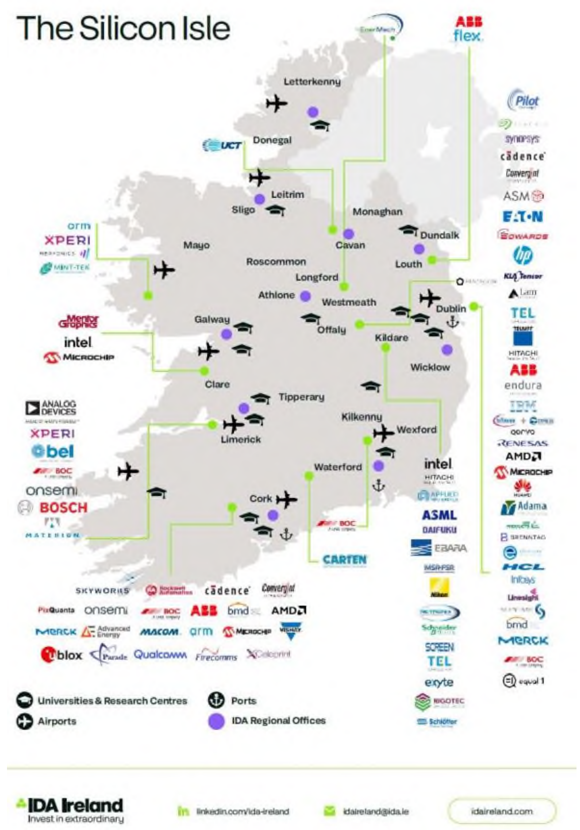
With these foundations in place, and strong support from IDA Ireland and Enterprise Ireland, the industrial landscape has significantly expanded during the ensuing decades through many new FDI and SMEs in this space.

Today, Ireland has a strong semiconductor ecosystem, hosting key players along the semiconductor value chain (see 'Silicon Isle' graphic below, courtesy of IDA Ireland). A large proportion of the major worldwide semiconductor companies have a presence in Ireland, including Cadence, Synopsys and Siemens EDA in Design Tools and IP, with Qualcomm, AMD, onsemi, Bosch and Infineon in Chip

Design, Analog Devices, Intel and Microcip in semiconductor manufacturing. SMEs include Movidius (acquired by Intel), Decawave (acquired by Qorvo), SensL (acquired by onsemi), Altratech, Adama Innovations, BlackBox, Emdalo, Equal1 and yieldHub to mention a few. The sector continues to be supported by research teams in Tyndall, CRANN and MCCI along with the 3rd level education sector.

The semiconductor sector in Ireland employs over 20,000 people today, with the vast majority of the jobs in highly skilled technical roles. Companies in this sector invest significant amounts in R&D and chip design (typically 10% to 20% of revenue) with a total annual R&D spend in the sector in Ireland approaching €500m annually. In addition, annual revenue from activity in the Irish sector in the manufacture of semiconductor products is currently about €15bn. Taking into account the support services and industries, there is an estimated 2x multiplier of the total numbers for employment

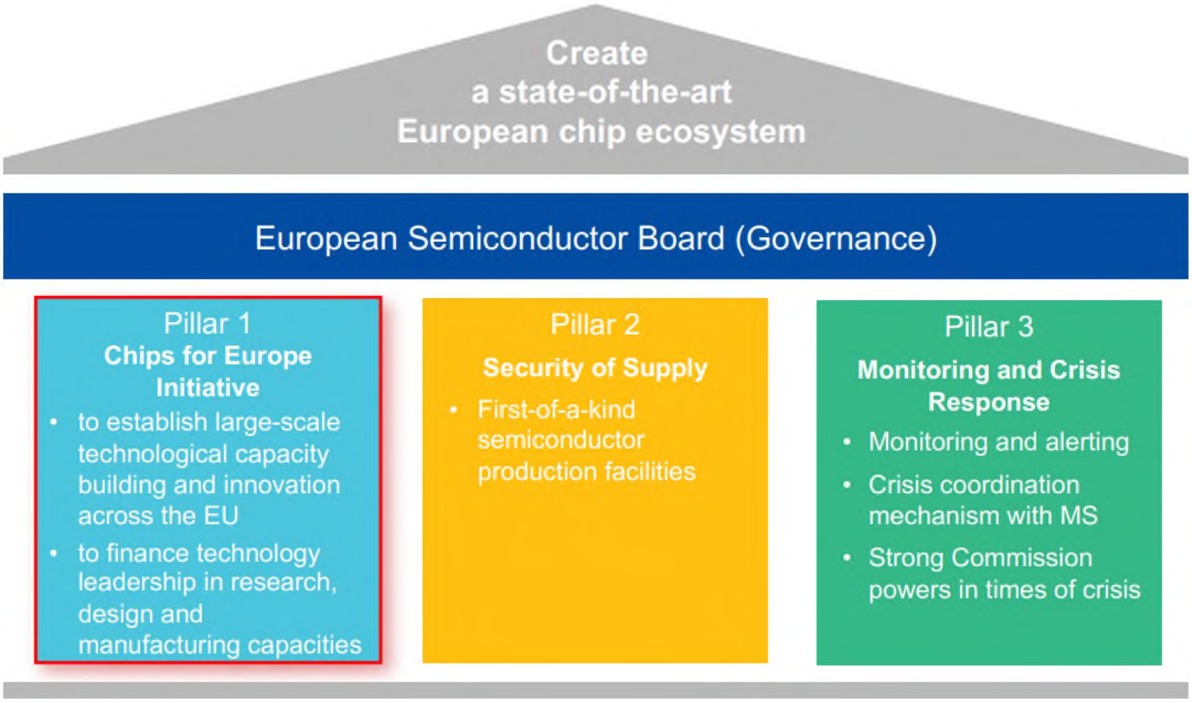
The net result of all this is that over the past half-century Ireland has built a broad-based capability that compares favourably with pretty well any location worldwide and is ahead of most other locations in Europe, and so is ideally placed to support the aspirations of the EU Chips Act and further expected growth of the Global Semiconductor Market.



EU Chips Act (an Ireland / MIDAS perspective)

The EU Chips Act comprises of 3 Pillars:

- Pillar 1: Chips for Europe Initiative
- Pillar 2: Security of Supply
- Pillar 3: Monitoring and Crisis Response



While Pillar 3 is very important for some of the MIDAS members, in particular those that are operating globally, the MIDAS Ireland submission focusses primarily on Pillars 1 and 2.

It is noted however that a number of individual company submissions have significant commentary on Pillar 3.

Pillar 1:

Pillar 1 is focussed on supporting a growing innovation in the semiconductor space, which means building the research ecosystem and the support of SMEs.

There are specific Pilot Line, Design Platform and Competence Centre initiatives that are being proposed to give researchers access to the infrastructure and facilities needed to support their advanced research projects and to provide SMEs with access to prototyping facilities, advanced design tools, training and other supports that are needed to accelerate the establishment of their new businesses. Its critical that Ireland engages effectively with these initiatives.

The "Chips Joint Undertaking" will mobilise €4.175 billion of EU funding, plus matched funding from Member States, so €8.35 billion in total.

Pillar 2:

Pillar 2 is about Europe rebuilding its share of the global semiconductor manufacturing capacity, with a target to more than double it to 20%, as its share has been falling during recent decades.

As Ireland has demonstrated that it has the most advanced support structure in Europe for state-of the-art semiconductor manufacturing, there is a real opportunity to build on this capability.

Pillar 2 allows for increased state funding for the semiconductor industry, so Ireland needs to respond accordingly in support of these strategic investments.

Process behind this Submission

MIDAS Ireland has been aware of and discussing the opportunities and challenges associated with the EU Chips Act since it was first proposed a number of years ago. MIDAS and a number of its members contributed submissions to European Chips Act consultation in 2022.

When the call for submissions to the National Semiconductor Strategy Consultation was announced on February 21st, 2024, there was an immediate mobilisation across the sector to put together an appropriate response, with direct submissions from several MIDAS members. These and other members' contributions form the basis of this overall submission from the sector.

While a significant focus of the consultation is in respect of the EU Chips Act and what Ireland's strategy in this area needs to be, this submission also includes significant commentary on what MIDAS believes needs be included in an overall National Semiconductor Strategy.

For Theme 6 - Mitigations, we have included 10 high-level recommendations that we believe are the primary actions needed to set Ireland up to be able to capitalize on the opportunities coming from the EU Chips Act and the projected growth of the Global Semiconductor Market. However, there is a lot more detail in this and the other submissions to this consultation that need to be understood and should be taken into account in a National Semiconductor Strategy implementation plan.

Scope of the Semiconductor Sector

Semiconductors encompass a wide range of technologies, including silicon and digital technology, compound semiconductors used for communications, sensing, medical imaging, power devices, quantum, lighting and more.

Traditionally semiconductor's primary technology has been silicon with advances in CMOS, according to Moore's Law, enabling a doubling in performance every 2 years. In recent years the technological challenges of maintaining this trajectory have resulting in alternative technologies to pure CMOS being developed and adopted. This is commonly referred to as 'More than Moore' with more functions like sensors, RF, power electronics, lighting and quantum being enabled through either, alternatives to silicon like compound semiconductors (SOI, GaN, SiC, etc) or including multiple chips in a single package (chiplets). Research and advances in semiconductor packaging is happening in parallel with the semiconductor technology advances to enable the realisation of what's being made possible through 'More than Moore'. Examples being photonics, sensors, power electronics and many more.

The chips, or integrated circuits that are designed using these semiconductor technologies are used in many applications from computing to communications, medical devices to artificial intelligence, and green energy to electric vehicles with new applications being enabled all the time.

The semiconductor space is comprised of many disciplines, including but not confined to, material science, electrical engineering, electronics, physics, chemistry, process engineering, circuit and system design, design verification, evaluation & test, packaging engineering, reliability engineering, equipment maintenance, facilities, etc.

So, in summary the semiconductor scope is broad and in made up of multiple interconnected pieces. As such, other national strategies, for example those that already exist in Quantum Computing and Artificial Intelligence, should be seen as part of and supporting an overall National Semiconductor Strategy.

National Semiconductor Strategy - Key Themes

Theme 1: Aspirations for the Sector

What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

In Ireland today, there are about 20,000 highly skilled people directly employed in the semiconductor sector contributing up to €15B annually to the Irish economy. Ireland as a location for the semiconductor sector compares favourably with any other location around the world. It has Europe's most advanced manufacturing facility, chip design teams from most of the leading multinationals and a successful SME sector. This is all based on excellent research teams and facilities and a locally sourced highly talented professional community coming from a great education system, which has been supplemented by leading talent from around the world.

At the highest level, MIDAS Ireland's aspiration for the sector is that it continues to grow, and that this growth at least matches, but preferably exceeds, the growth of the global semiconductor market and the aspirations of the EU Chips Act.

In the short term, this means doubling the size of the sector in Ireland by 2030 to keep up with the global market growth and more than that to match the targets of the EU Chips Act. There needs to be continued growth in the years and decades after that, with Ireland's share of the global market growing, while contributing in a meaningful manner to the growth of the sector in Europe.

Ireland should have the capability to compete for investment across the entire semiconductor sector value chain, including for large scale manufacturing projects. The EU Chips Act sets out one of its primary goals to increase Europe's share of global semiconductor manufacturing. As a preferred location for future major manufacturing investment, Ireland compares favourably with any other location as it has recently demonstrated the country's ability to support the construction of Europe's most advanced semiconductor manufacturing facility. However, these mega investments require significant infrastructure support that Ireland Inc needs to proactively and actively sign up for.

The chip design teams within the multinational companies currently located here should continue to grow, with their capabilities expanding into adjacent technologies and the teams owning more of the product development life cycle from product definition, through design and development, to system design so complete application solutions can be offered to end customers. Ultimately these teams should aspire to have total P&L ownership of their businesses in Ireland, and “own” their end customer. Ireland should also have the capability to attract more of the world’s leading companies in this space.

The SME sector needs to be expanded from its current state with a significantly increased pipeline of start-ups and spin-outs from RTOs. The support infrastructure of pilot lines, funding, mentoring, etc, needs to be significantly enhanced and expanded. The business models of these SMEs could vary from straight semiconductor product companies, to semiconductors going into a system product, to services, etc. The ambition of these SMEs to have no limits on their ability to grow needs to be supported and we need to cultivate a thriving ecosystem that supports semiconductor startups in Ireland.

Today Ireland has some excellent research teams and infrastructure, however these need to be taken to the next level and be at the scale and capability of those elsewhere in Europe and beyond. There are some specific Pilot Line, Design Platform and Competence Centre initiatives coming directly from the EU Chips Act that Ireland needs to proactively engage with to ensure Ireland builds the infrastructure that is needed. Research teams and infrastructure in developing areas like Photonics, Quantum Computing, the Green Economy, etc, need to be scaled to the level required to be successful and best-in-class. As new research opportunities come along, these also need to be proactively supported. The aspiration here is that Ireland becomes a globally recognized hub for advanced semiconductor research.

The supply of talent required to support the growth of the sector needs to be significantly expanded, with a broader and deeper range of skillsets. While continuing to attract leading talent from around the world will always be needed and is desirable, Ireland should be setting itself the goal of sourcing an increasing percentage of its talent locally. This will require significant targeted investment in the education system at all levels from Primary to PhD and beyond.

The semiconductor ecosystem (Cluster) in Ireland needs to evolve from what it is today, so it can offer the necessary and improved support services to all parts of the sector, allow everybody to collaborate seamlessly in areas of common interest and be a collective voice for the sector that benefits all. This ecosystem should develop links locally in Ireland to discover and grow business opportunities with other sectors that use semiconductor products, like FinTech, MedTech, the Green

Economy (PV, Wind, EV), AgriFood, etc, and become a testbed for innovations that can be marketed worldwide.

Theme 2: Opportunities for the Sector

What do stakeholders identify as key opportunities for the sector to further develop?

Manufacturing

There is a critical need for Ireland to both maintain and broaden its leading-edge capability in semiconductor manufacturing.

The EU Chips Act talks about attracting 'first-of-a-kind' semiconductor manufacturing operations to Europe. Ireland has proven capability in this area, ahead of other locations in Europe, so we should target some of the major semiconductor manufacturers, who are currently based in Sout East Asia (Taiwan, Korea, China, Japan and Singapore).

MIDAS believes that a new-build state-of-the-art wafer fabrication facility from any of the major players in the industry should easily meet the 'first-of-a-kind' threshold while significantly contributing to the EU's 20% semiconductor market share target. However, there are also opportunities in emerging semiconductor technologies (e.g. GaN, High Voltage / Power for EVs and Green Energy, Compound Semiconductors, etc) that should be explored.

The recent announcement of a Foundry Services business by a major semiconductor manufacturer with a presence in Ireland opens up the possibility of a foundry services support sector being developed and located here. There is supply chain / logistics talent in Ireland that can be built on to realize this opportunity to provide a complete backend manufacturing / logistics / support infrastructure at the edge of Europe. This might be targeted in emerging opportunities (e.g. optical and chiplet test and packaging) that requires significant research and engineering expertise to put in place.

Chip Design

There is an opportunity to continue the aggressive growth seen in recent years in the chip design capability in Ireland, with new FDI investment opportunities coming along.

While Ireland has a significant number of major semiconductor multinationals with chip design teams in Ireland, there are several others that don't have a base here, so there is the opportunity to attract more, in particular those that are active in fast growing emerging markets, e.g. AI, Green Energy, EVs, etc. Being the only remaining English speaking country in the EU should be a distinct advantage in that regard. Of course, some of these opportunities might be in parts of the world outside of Ireland's traditional FDI base, and some even within Europe itself.

It's important to note that some of the biggest chip design companies in the world are 'fabless', i.e. they don't have their own 'in-house' manufacturing, which they subcontract to the large semiconductor manufacturing foundries, which are mostly in Asia today.

Within chip design teams there is the opportunity and need to broaden and deepen their capabilities by expanding into adjacent technologies (e.g. quantum, photonics, AI, etc) and the teams owning more of the product development life cycle from product definition, through design and development, to system design to offer complete application solutions to end customers. There are already examples of customer system solution design teams in Ireland that can be duplicated by others. Ultimately these teams should aspire to have total P&L ownership of their businesses in Ireland, and "own" their end customer. This of course means broader and new skillsets will be required by the sector. Cross-over skills can help broaden and deepen the chip design offering into adjacent technologies and more end applications, e.g. green economy, photonics, quantum, generative AI, security, etc.

There are also opportunities to build local relationships with certain market segments that are already strong in Ireland, e.g. Pharmaceutical, Medtech, FinTech, the Green Economy (PV, Wind, EV), AgriFood, etc, to grow business opportunities with these other sectors that use semiconductor products and become a testbed for innovations that can be marketed worldwide.

SME

There is the opportunity and need to significantly grow the SME sector in Ireland. This sector needs a significant 'shot-in-the-arm' to change its growth trajectory from its current rate through incentivising more start-ups and spin-outs, reducing the barriers to entry and putting the necessary financial supports in place with paths to access the required funding at the various stages of growth.

The EU Chips Act has Pilot Line, Design Platform and Competence Centre initiatives that have the capability to be game-changing for the start-up environment. These can significantly lower the barrier for entry for start-ups by making common infrastructure and training available that today each SME has to mostly figure out for themselves through trial and error.

The semiconductor sector in Ireland has built up some very significant local expertise and technology / IP during the past 50 years. Some of the highly-skills individuals, in both companies and RTOs, should be incentivised to take the risk of starting a new venture and significantly increase the pipeline of new SMEs.

The SMEs might have a variety of business models, from straight semiconductor product companies, to semiconductors going into system products, to services, and more.

With the very significant research base built up with Ireland's RTOs during the past few decades, MIDAS believes there are opportunities for an increased pipeline of spin-outs if the right incentives and supports are in place.

Developing synergies between the semiconductor sector and the other key economic sectors in Ireland such as agriculture and food processing, medical devices, pharmaceuticals, financial services and within the information and communications technology (ICT) sector generally should be another ripe area of opportunity for emerging SMEs.

Leveraging our existing facilities and talents to ensure that we establish a critical mass in emerging technology and application areas such as the 6G communications, artificial intelligence (AI), quantum computing, autonomous navigation, and healthcare.

Cross-over skills can broaden and deepen the R&D offering into adjacent technologies and more end applications, e.g. the green economy, compound semiconductors, photonics, quantum, generative AI, security, software, etc.

EDA is one of the core technologies that underpin semiconductor device design. New toolchains need to be developed to model and simulate the effect of the emerging technologies in this space if designs are to continue to innovate. These include GaN, Graphene, GAA GateAllAround (3nm) technologies.

Ireland has a highly accomplished and world class R&D base in photonics and quantum technologies. There is the potential for startup ecosystems in these spaces.

Research

There is the opportunity for the research capability in the sector to expand into broader new growth areas like Quantum Computing, Photonics, Artificial Intelligence, etc, in line with the National Strategies in these areas.

Ireland needs to put the necessary supports and connections in place to the overall EU Chips Act infrastructure in terms of Pilot Lines, Design Platforms and Competence Centres and ensure that the appropriate amount of this infrastructure is physically located in Irish RTOs. These RTOs (e.g. Tyndall, CRANN, etc) need to be supported to build up their research capability and infrastructure so that they are best in class and compare favourably to anywhere in the world.

The fact that the US, UK and Europe all have the same aspirations to develop National Semiconductor Strategies means that there is potential for initiatives to collaborate between centres of excellence funded by DARPA, NSF, EPSRC, etc.

Education

In the Education area, there are opportunities to assist the sector needs, for example through the EU Pact for Skills and EU Advanced Digital Skills, and in particular where these initiatives have specific supports for the semiconductor sector.

Ireland also needs to consider targeted education supports that recognize the unique needs of the semiconductor sector to dramatically increase the pipeline of talent with the required skillsets.

Theme 3: Challenges facing Businesses and the Sector

What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

Common Challenges across the Sector

Access to talent is probably the most significant common issue for all areas of the sector (Manufacturing, Chip Design, SMEs, RTOs and Universities). Further discussion on this challenge is included in Theme 4.

A related challenge is the lack of visibility of the semiconductor sector in Irish society with the consequence that it may not always be viewed as a desirable industry to work in, leading to poor interest from school-leavers, resulting in low graduate numbers from relevant university programmes.

The fast pace of change of technology is always a challenge to keep up with. This then translates into a high cost of maintaining the state-of-the-art. This is the case across the board in all areas from manufacturing facilities, to EDA tools, lab infrastructure (industry & academia), etc.

International competition is increasing, as is evidenced in recent 'Chips Acts' from every country worldwide that has an interest in this sector, including new entrants. In particular, aid provided by some other states, e.g. India & China, is a major challenge. Allied to this are the threats from other nations adopting nationalist / protectionist stances and investing in semiconductor fabs and companies, potentially reducing Ireland's competitiveness in the sector. Ireland's semiconductor sector is heavily reliant on foreign investment and multinational corporations, which can pose risks in terms of dependency and vulnerability to external economic and geopolitical factors.

A more open tech transfer environment from Universities and Research Organisations is necessary. A restrictive, short-sighted approach can result in a higher percentage of nothing for the Institution, rather than the birth of a successful business or product which can have more positive returns for Ireland overall.

The lack of and high cost of housing is an ongoing issue across the whole sector, which of course is in common with all other aspects of Irish society. However, it a particular extra challenge for our sector when coupled with hiring talent from overseas.

Costs are high in Ireland. The marginal tax rate is too high, commercial rents, insurance, transport, utilities and childcare all need to be addressed (cost-of-doing-business-2019.pdf (enterprise.gov.ie)).

The cyclical nature of the industry is a constant challenge.

Manufacturing

Semiconductor manufacturing is capital intensive and requires specialised skills, where the cost of a new 'first-of-a-kind' semiconductor manufacturing investment could be €20B plus with corresponding enormous challenges on planning and access to local support services, electricity infrastructure and talent.

Ireland is unique in Europe in that it has recent demonstrated capability in this area, which of course is exactly in line with the headline aspiration of the EU Chips Act to increase Europe's share of the soon to be $1T global semiconductor market.

However, there would need to be coordinated and committed support from Ireland Inc (government, state agencies, planning, energy, construction, education, the general public, etc) to be able to exploit the enormous opportunity in this area.

The cost of energy is an ongoing challenge, with the increases in energy costs during the past few years a particular concern.

Chip Design

For the Chip Design teams, the common challenges listed about are all particularly relevant.

An extra challenge facing these teams is that in many cases their operations in Ireland are engineering focused and vertically integrated to parent companies, with the executive and business level decision making residing elsewhere. Some companies even have multiple sites in Ireland that have little interaction with each other.

Ireland needs to be seen as a place to “do business” in electronics. Given Ireland has a significant semiconductor community, this should change and entities within Ireland need to broaden and deepen their operations with the goal of full P&L responsibility and ownership of the customer relationships. Companies could start working together at a business level and make Ireland a semiconductor business hub. Start-ups could also proliferate with that blend of business acumen and technical talent.

Another challenge is that chip design is becoming increasingly difficult and costly as the complexity of each design increases continually.

SMEs

One of the primary challenges for SMEs is access to funding, at all stages of their development.

The barriers to entries for SMEs in this sector are very high for some business models (e.g. some recent examples needed 10 to 15 years spending €100M or more to reach successful ‘exits’).

Today’s fabless semiconductor startup typically requires funding rounds of €10M, €50M, €200M (A, B, C rounds respectively) to reach IPO stage. Or double those amounts if designing on the latest semiconductor processes.

Chip design costs may be lower in Automotive and Industrial – however the barriers to entry for a startup are higher, due to speciality technology needs, and much more extensive quality and regulatory requirements.

The SME path in this sector requires significant investment in money, time and human resources and hence financial endurance and patience is required from investors and stakeholders and a clear understanding of the process.

While seed capital to get a start-up moving is available in Ireland, significant investment (10s of millions) is needed to move companies to the next level. If Ireland wants to promote the next big technology success, we need to think big and provide a financial base to support this.

The slow access to capital is a major impediment to Ireland's progress in establishing itself as a player in the EU Chips Act, particularly compared to other European countries that are committing further capital to ensure their place in the market. Even where funding is available, the application processes can be lengthy and bureaucratic, hindering SME companies' ability to act swiftly and capitalise on opportunities.

There is a lack of support for startups in this sector in terms of access to fabrication facilities or funding for design resources and logistical barriers to prototyping and new product development

An additional and key challenge is to have a strong technical customer-facing capability fronting the company effort in the market place.

Theme 4: Access to Talent for Businesses

What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

The semiconductor sector is a multidisciplinary industry. Individual businesses face shortages in their areas but overall, the industry needs scaling up across a broad spectrum, both in numbers and range of disciplines and skillsets. In fact, addressing the talent shortage is highlighted as probably the biggest challenge across the board for this sector. Every company, university and research team across the sector mentions it as a primary concern and limiter on achieving their goals.

As Europe makes progress to achieving its EU Chips Act aspirations, the talent needs of the semiconductor sector will more than double, with a very significant gap anticipated. Ireland is in the same situation and if is to achieve its potential to more than double the size of the sector here by 2030, then it is certain that Ireland's growth will also be constrained by a lack of talent.

The MIDAS Skillnet, supported by Skillnet Ireland, provides excellent support to the sector in training and upskilling the engineers in industrial roles within the MIDAS member companies. This team produced a report, 'Electronics Sector Resources and Skills Needs', which was published in January 2021. This report showed that during the previous 3 years, over 900 people were recruited into chip design roles, with over one third of these being graduate engineers at a rate of over 100 annually. In addition, similar numbers were recruited from outside of Ireland with an equal split between European and non-European hires. This report just covered the chip design needs. When semiconductor manufacturing needs are added in, the numbers likely double. If the sector grows as per the aspirations described above, it will likely double again, suggesting a graduate hiring need in the 400 per year range, with a similar number required from overseas talent.

Currently, the Irish 3rd Level sector is just not set up to support these numbers with the skillsets that will be required. This suggests a radical overhaul of how we supply talent from our education system to the semiconductor sector is urgently needed.

A corresponding urgent action should be taken to attract increased overseas talent to Ireland, if the sector's aspirations are to be supported. Streamlining the VISA application and renewal process is also needed to support this action.

In terms of the range of skills that are needed, they are broadening and deepening. The 2021 report referred to earlier goes into some detail on the requirements, but that is now 3 years old, so likely the needs have also moved on with new skillsets in software, artificial intelligence, quantum computing (to mention a few) becoming more in demand in the meantime. The various submissions to this National Semiconductor Consultation from across the sector go into some significant detail on the broader sector skill needs that are too numerous and varied to summarise effectively here.

In terms of education level, there is demand all the way from Operater to Level 7 (Technician) through Levels 8 & 9 to Level 10 (PhD) and to Post Doc. Growing significant capacity across the board is urgently needed.

The various submissions also make many excellent suggestions on how to make improvements. These range from undergraduate level to Master’s & PhD, to the deep skills being learned in the RTOs, as well as broad-based training initiatives to support the whole sector.

To move towards a solution, MIDAS suggests the setting up of a Semiconductor Future Skills Taskforce comprising of all relevant and needed stakeholders to develop a plan urgently. The stakeholders, at a minimum, include representatives from the various parts of the industry, 3rd level education sector, the semiconductor research sector, government and the state agencies.

There is no doubt that any solution that works and makes a difference will require significant investment.

Another aspect to the talent challenge is how as an industry, we market ourselves. Low numbers entering 3rd level engineering courses, a low percentage of these choosing electronics or other engineering disciplines that feed into the semiconductor sector, students often choosing other sectors to work in and very low female participation in our sector are all challenges that could be helped with more effective promotion of the sector at all education levels. We need to show the wide variety of roles in the sector and opportunities for personal / professional growth, while also addressing the current lack of female participation. This effort should connect with other National initiatives on STEM that have the same goals.

Theme 5: Barriers to Development

What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

Some of the barriers have been dealt in some detail in Themes 3 and 4, so this section details some of the extra barriers that the sector faces. Again, there is significant extra detail in the many other excellent submissions from the organizations across the sector.

Common Barriers

High costs in Ireland are challenging when competing for investment with other lower cost locations in Asia, South America and other regions of Europe.

High personal taxes can be a barrier, particularly when trying to attract highly-skilled experienced talent to Ireland. There are SAYE and APSS share incentive schemes available in Ireland which when used can be attractive, but their usage seems not to be at the level that it could be, especially for the larger businesses.

The lack of and high cost of housing is an ongoing issue across the whole sector, which of course is in common with all other aspects of Irish society. However, it a particular extra challenge for our sector when coupled with hiring talent from overseas.

Transport links from Irish regions (e.g. Limerick, Cork, Galway) to Europe are poor. Invariably one needs to fly from Dublin or via London to get to most destinations in Europe and beyond.

Access to talent is a significant barrier, but has been discussed in detail in Theme 3.

Manufacturing

The planning process in Ireland for large infrastructure projects is a significant barrier, especially the length of time involved and uncertain outcomes.

The rise of electricity prices in recent years is challenging and going forward, there needs to a viable path to access affordable green electricity, which corporate ESG strategies now demand.

Chip Design

Corporate financial structures and processes can be a challenge for remote teams as the strategic, financial and business decision-making is happening elsewhere. Sometimes local incentives (e.g. R&D Tax Credits) appear in Corporate P&Ls and can be difficult to use to support local investment decisions.

Access to skillsets in emerging spaces (e.g. new end applications (MedTech, FinTech, etc)), new disciplines (ML assisted layout, business & customers skills) or new skills (e.g. AI, Quantum, etc).

SME

Ireland's lack of a cohesive strategy tailored to SMEs in the semiconductor sector can impede their ability to access resources and support needed for innovation and expansion.

SMEs often have very limited access to finance to fund the business at all stages of their journey. There is a need to strengthen Ireland's venture capital ecosystem to better support semiconductor startups, providing early-stage funding and mentorship.

There can be limited local collaboration opportunities for SMEs. There is a need to promote increased collaboration between industry, government, and academia to address infrastructure needs and reduce barriers to entry for semiconductor startups.

The high cost of prototype development and access to / cost of EDA tools is a significant barrier for start-ups in the semiconductor space. Then there is the challenge on how to bridge the gaps from prototypes-to-low volume and from low-volume to high-volume, especially in niche low volume applications (e.g. an ASIC going into a system product). The Pilot Line, Design Platform and Competence Centre initiatives coming from Pillar 1 of the EU Chips Act are a critical piece of infrastructure to help in this area. There needs to be a viable path for local SMEs to access these resources with a significant local voice in decision making.

SMEs can find it difficult to compete with the larger multinationals for talent.

Personal financial challenges for those starting out on the SME journey can be a big issue. Where does the money come from to pay your own personal bills after you have chosen to walk away from your salaried position in a company or academia?

Education

There is a significant lack of awareness of the semiconductor sector by the general public (parents and students) and within the primary and secondary educations systems / syllabi.

A severe shortage of funding at 3rd level to support the needs of this sector (e.g. labs, staff, leading professors, etc) is limiting the pipeline of talent flowing to the industry and research teams. There is no recognition that it costs more to educate a graduate for the semiconductor space that it does for many other areas. This is allied to a mis-match between course content (this can also be funding related) and the sector skills needs.

There is insufficient engagement between industry and universities on educations issues.

Research

Funding constraints are resulting in insufficient investment in university research.

There is a lack of ringfencing of funding for pure semiconductor research. A lot of research calls are broad. While that means the semiconductor piece can be part of a project proposal, in practice it can be hidden with the net result of a reduced research focus at the semiconductor level.

There are research profile gaps. Ireland’s Universities and Institutes need more high-profile Professors and Principal Investigators (PI’s) involved in research. Higher profiles raise all ships, attracting the very best talent achieving higher quality outputs in both talent and research excellence.

There is a need to address the technological disparities / scale of funding in Ireland's research institutes versus global leaders which will be crucial for sustained growth. e.g. AI, "Edge AI", Photonics and Quantum Computing.

Cluster

Currently there is a lack of coordination and clustering activities at the semiconductor sector level. This is resulting in a failure to develop all elements of the full supply chain from construction to support services to material supply to product design to SME engagement to start ups. MIDAS Ireland does what it can with very limited resources, but a lot more is needed that would benefit all.

Government / Policy

There is a lack of awareness with policy makers as to the strategic nature of this 'deep tech' industry within the broader information technology sector, that can lead to a lack of support for its unique needs.

Government policy is focused on the broader Engineering and ICT disciplines, so the strategic benefits of enhancing the semiconductor skill base specifically is missing out.

Europe

Despite Ireland having a presence and capability in the semiconductor space that compares favourably with and is arguably ahead of any other European location, Ireland's voice in Europe is currently very weak. Ireland has very limited engagement, both in policy discussions and governance organisations, such as the Chips JU European Semiconductor Board, etc. This can place Ireland on the "back foot" when new initiatives are under development and subsequently rolled out.

Theme 6: Mitigation

What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

1. **Semiconductor Advisory Council to Oversee Sector Strategy & Implementation**

- Following on from the creation of a National Semiconductor Strategy, MIDAS Ireland proposes that a high-level Semiconductor Advisory Council, comprising industry, academia and government actors, would be appointed to oversee the implementation of the strategy and advise government on current challenges and future trends in this fast moving and highly competitive global industry. The strategy should include clear goals, in areas such as graduate numbers, number of new companies and start-ups, employment levels etc, reflecting an ambition to double the size of the industry in Ireland during the short term, and growing Ireland's share of the Global Semiconductor Market on a sustainable basis beyond that.

2. **Semiconductors to be Recognized as a Separate Sector**

- MIDAS Ireland believes that semiconductors should be recognised as an individual hardware sector, as it currently can get lost in the larger mostly software focused ICT sector.

3. **Addressing the Sector Talent Needs through Education and other Initiatives**

- The sector talent needs are not being met today, and the expectation is that the gap may actually grow into the future. As part of the mission of the Semiconductor Advisory Council, MIDAS Ireland proposes the immediate setting up of a Future Skills Taskforce comprising of all relevant and needed stakeholders to develop a plan urgently to close the talent gap. The expectation is that the work of this group will recommend some significant new initiatives, and possibly structural changes, that will make a material difference to the pipeline of talent that the sector will need going forward. The results should be visible in terms of doubling numbers across all education levels and the ever-evolving skillsets.
- In parallel to building the education infrastructure the sector, through MIDAS Ireland, needs to do a better job in articulating the sector talent needs and where the employment opportunities are to all. This includes the sector story of how semiconductors and the products and services that they enable feed into all parts of our lives and are central to

addressing all the world's great challenges, in the environment, green energy, healthcare, transport, sustainable food, communications, entertainment, etc.

- Beyond the 'standard' 3rd level education process the sector needs to continue to build out the training infrastructure to develop the talent needed for all disciplines ranging from operator to technician, engineering and research levels. This includes the supports and upskilling required to facilitate talent to transfer from other areas.
- The sector will continue to require a steady flow of the highly-skilled talent from overseas, so streamlining the Critical Skills Employment Permit process would be of great benefit and then incentives for these individuals to stay in Ireland.
- Any and all initiatives in this area need to address the sector's diversity needs and in particular the equal opportunities for females, who are severely under-represented in the sector today.

4. Making Ireland Attractive to New Semiconductor Manufacturing Investments

- Investments in this area can be huge, some up to could be €20B plus, with corresponding enormous challenges in planning and access to local support services, electricity infrastructure and talent.
- JU Pillar 2 of the EU Chips Act allows for increased state funding for the semiconductor industry, so Ireland needs to respond accordingly in support of these strategic investments.
- There needs to be coordinated and committed support from Ireland Inc (government, state agencies, planning, energy, construction, education, the general public, etc) to be able to exploit the enormous opportunity in this area.
- Ireland needs to address the cost of energy and going forward, there needs to a viable path to access affordable green electricity, which corporate ESG strategies now demand.

5. Continued Expansion and Growth of the Chip Design Sector

- While several of the major multinationals have chip design teams in Ireland, there is the opportunity to attract more from all over the world.
- There is also the opportunity to grow the teams are already here through broadening and deepening their operations in Ireland, with where possible, the ultimate goal of customer and P&L ownership and business / strategic decision making happening here.
- IDA Ireland, in partnership with MIDAS Ireland, needs to work on a plan to fully realize this opportunity.

6. Significantly Expand the Pipeline of Start-Up Activity in the Sector

- There have been some very significant success stories in the Ireland's semiconductor SME sector during the past few decades, however the opportunity exists to significantly grow this pipeline, which should be at least doubled in the short term with continued growth beyond that.
- This starts with encouraging more individuals or teams from industry and academia to embark on their start-up journey and then having all the supports and incentives like tax breaks, grants, and funding available, which are sufficiently tailored to specifically empower small and medium-sized enterprises (SMEs) in this sector.
- Start-ups in this sector have significant infrastructure hurdles to get over, so the Pilot Line, Design Platform and Competence Centre initiatives, as proposed by the EU Chips Act, need to be fully supported by Ireland. This infrastructure then needs to be open to and easily accessible to Irish semiconductor players and in an affordable manner.
- Enhancing collaboration between SMEs and larger corporations, facilitating knowledge exchange, and ensuring equitable access to infrastructure investments are also critical steps. By fine-tuning existing incentives and bolstering support structures, Ireland can better foster SME growth, promoting a more resilient and sustainable semiconductor industry ecosystem.
- Establish semiconductor-focused venture capital funds or accelerators to provide targeted support for startups in the sector.
- A more open tech transfer environment from Universities and Research Organisations is necessary to make it easier to spin-out and commercialise new technology.
- Enable and advocate for access to the Chips Act €2B "Chips for Europe" "Chips Fund" for Ireland based startups and SMEs and the €8.1B "Important Project of Common European Interest in microelectronics and communication technologies" to which Ireland contributes.
- Enterprise Ireland, in partnership with MIDAS Ireland, needs to work on a plan to fully realize this opportunity.

7. Building Research Capability

- During the last half-century, Ireland has built significant research capability in the semiconductor area. However, to capitalise on the opportunities becoming available through the EU Chips Act and the future Global Semiconductor Market growth, this investment needs to be taken to the next level, so that Ireland's research ecosystem can take its place among the best in Europe and beyond.

- This will require increased investment in Ireland's current leading semiconductor research centres, along with investments in new opportunities as they emerge (e.g. AI, Quantum and Photonics today, and there will be more in the near future).
- Investment in Pilot Line, Design Platform and Competence Centre initiatives, as proposed in the Chips Act, is a must, as it sends a strong message that Ireland is 'open-for-business'.
- Ring-fencing pillars of Research funding through RI / SFI / DTIF targeted for semiconductors is required. Currently under all government funding programs, semiconductors are not called out as a foundational industry. Most programs are broad enough to allow for semiconductor participation but these programs advance often solutions for other industries, while not directly addressing the research issues within the semiconductor industry.
- MIDAS Ireland would like to see at least a doubling of the Principal Investigators (PIs) whose primary focus is in the Semiconductor space.

8. Government Policy

- The strategic importance of the semiconductor sector to Ireland, it's unique needs and the opportunities from the EU Chips Act and sector growth, need to be recognised at the highest levels of government, it's departments and agencies.
- The creation of a National Semiconductor Strategy is a significant step forward in terms of the recognition that is needed and MIDAS Ireland hopes that the strategy will be supported so that its targets can be realized.
- Several of the mitigations identified in this submission rely on active support from government departments and agencies including Enterprise, Energy, Environment and Higher Education. For its part, MIDAS Ireland and the Irish Semiconductor Sector will look to actively engage with government to keep it abreast of the rapid pace of change from its global view point and to take advantage of government initiatives to develop and grow the sector in Ireland in a sustainable fashion.
- The EU Chips Act allows for increased state funding for the semiconductor industry. A government commitment to the EU Chips Act demonstrates to other players that Ireland is serious in regard to further incoming and home-grown semiconductor investment, i.e. we are open for business.
- Other areas that Government policy can offer significant support to the sector are in housing, for both availability and affordability, and in tackling Ireland's costs to Ireland can maintain its competitiveness versus other locations.

9. Engagement in Europe

- The EU Chips Act opens up significant opportunities for Ireland, but currently Ireland is not engaged at the level that it needs to be. Addressing this gap requires government, it's agencies and all parts of the sector, including MIDAS Ireland, to step up and engage so we can capitalize fully on these opportunities.
- We need to ensure Irish representation and influence on the European Semiconductor Board proposed in the EU CHIPS Act and a designate a fit for purpose "national competent authority" as required by the Act.
- We need to enable and advocate for access to the Chips Act €2B "Chips for Europe" "Chips Fund" for Ireland based startups and SMEs and the €8.1B "Important Project of Common European Interest in microelectronics and communication technologies" to which Ireland contributes.

10. Cluster Support for Ireland's Semiconductor Sector

- Support for the semiconductor sector in Ireland needs to be significantly stepped up.
- This starts with recognising the Semiconductor sector in its own right, independent but part of, the larger ICT Technology sector.
- There needs to be a policy developed and put in place to support this sector as a Cluster.
- MIDAS Ireland does a lot today to offer support to the sector with very limited resources, but it needs to significantly expand its role and contribution to better represent and advocate for the Semiconductor Sector in Ireland more effectively.
- Recognizing and funding MIDAS Ireland as a Cluster supporting the Semiconductor sector in Ireland would be a significant and positive step forward.

Submissions made by the following Businesses, Organizations, RTOs, Universities and Individuals within the Sector

Adama Innovations

Analog Devices

Firecomms

Infineon Semiconductor Technologies Ireland

Intel Ireland

Microelectronics Circuits Centre of Ireland

MIDAS SME Sub-Committee

Movano Health

Qualcomm Technologies International Limited

Robert Bosch Ireland Ltd

SETU – South East Technical University

Skillnet Ireland / MIDAS Electronic Systems Skillnet

TCD - Trinity College Dublin / CRANN

TUS - Technological University of the Shannon

Tyndall National Institute

UCC - University College Cork

UCD – University College Dublin

UL – University of Limerick

Other Contributions to this Submission from the following Organizations within the Sector

Cadence Design Systems

Mint Tek

O'Carroll BizDev

onsemi

yieldHUB

Enquiries related to this Submission

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Submission

of the

MIDAS Small and Medium Enterprise (SME) subgroup

in response to

the National Semiconductor Strategy Consultation

Tom O'Dwyer, MIDAS SME Subgroup leader

14th March 2024

Aspirations for the SME sector:

At present MIDAS Ireland has 33 SMEs in its organization. We believe that with appropriate strategies and a suitable commercial environment we can double this number by 2030 in line with the aspirations outlined in the European Chips Act.

These SMEs are likely to come about in three ways:

1. New enterprises setting up in Ireland which are part of existing NMCs. These NMCs could be existing semiconductor companies who currently have no new product design presence in Ireland, or alternatively, those in the broader electronics market seeking to vertically integrate by investing in their own proprietary designs.
2. Spin-outs from university or institute research in the semiconductor field.
3. Start-ups founded by experienced industrial personnel, who are attracted by the risk/reward of forming their own enterprise.

Given the right conditions, MIDAS believes Ireland has the potential to become a highly desirable location in a world context for new SMEs in the semiconductor design sector, to build on our already-strong reputation for semiconductor manufacturing.

Opportunities for the sector:

With regard to SME growth, we see opportunity in the following areas:

1. The strongest growth prospects lie in the design of new semiconductor devices. Referring to the semiconductor design process flow primer in Appendix A, we have seen the emergence of so-called "Fab-less" startups in Ireland and we expect similar companies to provide the backbone of future growth in SMEs. Due to the prohibitive capital cost in setting up wafer fabrication and packaging process steps, these companies rely on foundry services to provide these functions.
2. New specialized production companies may emerge from pilot lines within research organisations. To date these types of startups have been somewhat limited in number, due to financial barriers, but with the funding proposed under Pillar 1 (Chips for Europe Initiative) of the European Chips Act, we expect to see more vigorous activity in this area.
3. Finally, service providers are expected to emerge in support of increased semiconductor design activity. These may include increased number of Irish-based companies providing mask layout services, prototype packaging services, testing and other characterization-related services.

Challenges facing businesses and the sector:

1. <u>Continuation of Moore's Law</u>. The smallest building block of modern semiconductors is a switching device known as a *transistor*. The dramatic increase in complexity and reduction in cost, which has driven the industry and provided growth, were due to a consistent reduction in since of the basic transistor element. The measure of size is usually referred to as "*gate length*", which refers to the size of the input which controls the switch. The most advanced production plants for microprocessors and memory ("digital") semiconductors are in the 12-20nm range, with real-world ("analog") versions at 40nm-130nm. Advanced research is currently in the 1-10nm range. This trend towards smaller nodes has been known as Moore's Law, which predicted a doubling of computing power every 18 months. However, in recent years, improvement has hit limitations caused by the

laws of physics, and it has become increasingly difficult to maintain the trend. This represents a real challenge for the industry. However, despite this difficulty, silicon and related technologies are expected to be by far the most popular production technologies for many years to come.

2. Quantum technology. Partly in response to the pending limitations of Moore's Law, the new field of quantum computing has emerged. This new technology represents both a concern for continued growth for traditional technology but also an exciting growth opportunity. Indeed, MIDAS Ireland has one SME member active in the field. Traditional computers use transistors as the basic compute element, which have two states – ON or OFF. Quantum computers, on the other hand, use a *qubit* as the basic element which has many states, and therefore can pack much more computing power into a much smaller space than traditional transistors. Quantum computers have their own limitations – to prevent random noise interfering with computations, it is necessary to run them at cryogenic temperatures close to absolute zero (-273°C). Despite this drawback, quantum computers are expected to be the dominant technology for several types of vital computing tasks which are currently impossible on traditional silicon technology, such as drug discovery, and encryption/decryption. However, they are unlikely to surpass silicon in the mainstream PC and phone markets, unless there is a major breakthrough in the temperature barrier.

3. Artificial intelligence technology. Another area which poses both a limitation and also a potential opportunity for growth is in the area of artificial intelligence. Traditional computers such as PCs have excelled at computations based on fixed algorithms. In more recent years, there has been in increasing trend towards adaptive algorithms, which have the ability to learn and adapt, and are described as artificial intelligence (AI). In the last couple of years, there has been tremendous developments in so-called "generative artificial intelligence", where the compute engine learns from massive amounts of internet data in order to generate genuinely novel material in such fields as language, images and music. ChatGPT is the most famous example. More recently, there have been developments towards "artificial general intelligence" (AGI), which more closely matches human intelligence, with independent reasoning capability. This AI trend is likely to place a limitation on the market growth of traditional algorithmic-type computing. However, it also presents an important opportunity. The speed at which generative AI operates can be strongly optimized with tailored hardware. Traditional graphics processors used for video games, for example, have proven to be an efficient solution, and there is likely to be explosive growth in this sector of semiconductor design. In addition, traditional players are likely to pivot towards hardware optimized for the new trend, which will enable artificial AI to occur locally on a PC for example, rather than the current cloud-based approaches. Finally, there may be opportunity in the recently-announced aspiration to begin to develop fully-optimised hardware from scratch for AI. A massive $5-7 trillion dollars has been proposed for this development, and perhaps the Irish industry and academia may well have opportunity to pay a role.

Access to talent for businesses:

SME growth cannot take place without talent, and a doubling of SME numbers would require a corresponding doubling of available skilled engineers. It makes sense for Ireland to focus investment on building skills in this area of expertise because:

- Designing a new semiconductor device requires extremely highly skilled engineers, earning high salaries and making significant contribution to the national economy.
- There is a worldwide shortage of semiconductor design engineers. Building a strong national talent pool will not only encourage growth of the SME sector, but also become a national asset in attracting international design companies to Ireland.

- If we succeed in building up a strong talent base, it should remain robust as a national advantage. Training of electronic engineers for semiconductor design is seen as relatively expensive in terms of laboratories and equipment, and for this reason, it is likely that other jurisdictions, particularly emerging economies such as India, will continue to focus on training engineers for other sectors such as software.
- Candidates with the qualifications required for semiconductor design are highly sought after, not only by semiconductor design companies, but also by many other sectors. For example, the qualifications provide ready access to alternative careers in the consultancy, actuary, software, and financial markets. This is an important advantage as it provides career robustness against economic cycles.
- The underlying skills required for software engineering, such as science and mathematics, are similar to those required for electronic engineering. Given the recent announcements of downsizing in the software sector in Ireland, there is merit in providing cross-training for those interested to become proficient in semiconductor skills.

Ireland already has a strong base of educational and research capability for the sector in many of our leading colleges, and in the Tyndall National Institute. In addition, we also have specialized training for the sector being propagated through the Skillnets program, for example. We have the educators and facilities, but these need to be expanded in line with target numbers and students must be attracted to the sector, if we are to achieve our growth targets.

Barriers to development:

Although Ireland has several important advantages in establishing itself as a base for semiconductor design SMEs, such as the English language, and relatively attractive tax regime, there are nonetheless several barriers to development:

1. The primary concern for semiconductor design SMEs relates to the high cost of entry. The SME will typically carry out the design and simulation steps themselves. However, this requires the use of very sophisticated software running on powerful server hardware. There are only a few companies which provide the necessary software, and commercial licenses for a single user would typically run to six figures per year. Although these simulation software companies endeavour to provide lower introductory license fees for the first couple of years of SME operation, nonetheless it is usually the dominant outgoing for a start-up company. As regards hardware, the SME may provide the costly servers themselves, but a new option has recently emerged in the form of cloud-based hardware services provided by the simulation software companies. In addition to the software licenses, the cost of generating masks, even on a shared wafer basis (see Appendix A), can amount to a six-figure sum, depending on the particular target manufacturing process.

2. Facilities and infrastructure also provide barriers. Once the first prototypes are available, the SME needs access to expensive test equipment, costing in excess of half a million euro, to carry out testing over a wide range of temperatures, and environmental conditions. In addition, there is a need to access equipment known as probe stations to examine internal design signals in the event of unexpected device operation, and access to specialized equipment for carrying out simple repairs to correct minor errors. It is usually beyond the financial means of a SME to provide this equipment onsite, and so access to third party equipment is a vital service.

3. Talent is also a significant barrier. Students having the required skill set at second level, are typically drawn towards careers in software due to the current popularity of social media, search engines, and other software platforms. As a result, the annual pool of graduating electronic engineers has dwindled over the last decade, resulting in staffing shortages for the SME sector.

Mitigation:

To maximise growth of the semiconductor SME sector, it will be important to address the barriers highlighted above, particularly the initial cost of entry. Accordingly, we would suggest the following recommendations:

1. That the Irish government supports immediate implementation of the report of the Design Platform Working group set up by the EU commission under the European Chips Act. A copy of the report is included in Appendix B. This recommendation addresses the first two barriers mentioned in the previous section. It envisages the setting up of a pan-European Design Platform, which semiconductor SMEs can use as a service. The MIDAS SME membership considers this to be a well-considered report which shows good understanding of the key concerns. It lays out clear guidelines for management structures and strategy, as well as timelines for its implementation. The EU commission have given it consideration and have moved ahead with public education and awareness meetings. However, it is disappointing to observe that the implementation plan has moved at least one quarter behind schedule already, but hopefully no further delays will occur. Specifically related to Ireland, there are three specific recommendations.
Firstly, we would strongly urge the government to support the setting up of a national Design Enablement Team (DET in Appendix B) within Ireland. This could be centred on existing expertise at the Tyndall National Institute for example. The envisaged role of the DET is to act as interface to foundry services, and in addition to provide pooled equipment and facilities such as test equipment to be used by SMEs, particularly at the characterisation step when physical prototypes have been manufactured.
Secondly, we would strongly recommend that the government support the placing of Irish individuals on the management teams envisaged in the report – namely the Platform Coordination Team (PCT) which will establish standards for the Design Platform and negotiate licenses and other services on behalf of European SMEs, and secondly, the Chip Design Accelerator (CDA), which will coach SMEs on the options available, and select certain projects for financial assistance based on published criteria. We believe these management groups should be populated by individuals who are experienced in corporate industry negotiation and are familiar with best pricing, and also by individuals who have been through a successful semiconductor startup process. There are a cohort of individuals based in Ireland who can meet these criteria.
Finally, we would ask the government to continue to monitor the emerging financial support mechanisms proposed under the Design Platform. It is disappointing from an SME point of view that the plan appears to envisage use of existing EU financial support mechanisms. However, these are not suitable for proprietary SME start-up developments because they focus on *collaborative* research. This represents a major barrier for an unproven start-up with no existing connections to other EU entities, and secondly, it requires the SME to reveal their development plans and potentially expose their intellectual property. The yet-to-be-announced Design Platform management group may take the view that support for such startup-stage, commercially-focused, proprietary SME developments will be the responsibility of national governments. Accordingly, we would urge the

Irish government to consider support mechanisms in the event that the proposed Design Platform does not address these situations. This could be done by providing grant aid for a small number of CAD licenses and silicon mask supports each year. Candidates for support could be selected by a neutral advisory body or institute assisting the appropriate government department.

2. To address the skills shortage in the semiconductor sector, it is recommended that the government continue its work in the promotion of STEM subjects at second level, especially among females. Secondly, preferential consideration should be given by the government to immigrants seeking Irish work visas who are proficient at engineering and who could be cross-trained to a career in semiconductors. Thirdly, the government should assist in making recently-redundant software engineers aware of the exciting prospects being opened by the EU Chips Act in the field of semiconductors, and providing detailed direction to cross-training facilities currently available.

Conclusion:

The EU Chips Act has opened up exciting opportunities for massive expansion in the SME semiconductor sector, and we strongly believe that doubling of the workforce is entirely achievable in the 2030 timeframe. We are already leaders in a European context in terms of NMC wafer fabrication and new product development thanks to key international players such as Intel, Analog Devices, and many others. As a result, we have a very strong base of experienced industrial professionals and academics in all required disciplines. The national challenge is to build on these advantages and translate them into a vibrant, thriving SME sector. The key enabler will be the rapid deployment of the proposed Design Platform envisaged in the EU Chips Act to ease the path to first prototypes. Proven prototypes are the key enabler for onward VC finance to grow to scale.

Append A

SME Semiconductor new product development flow

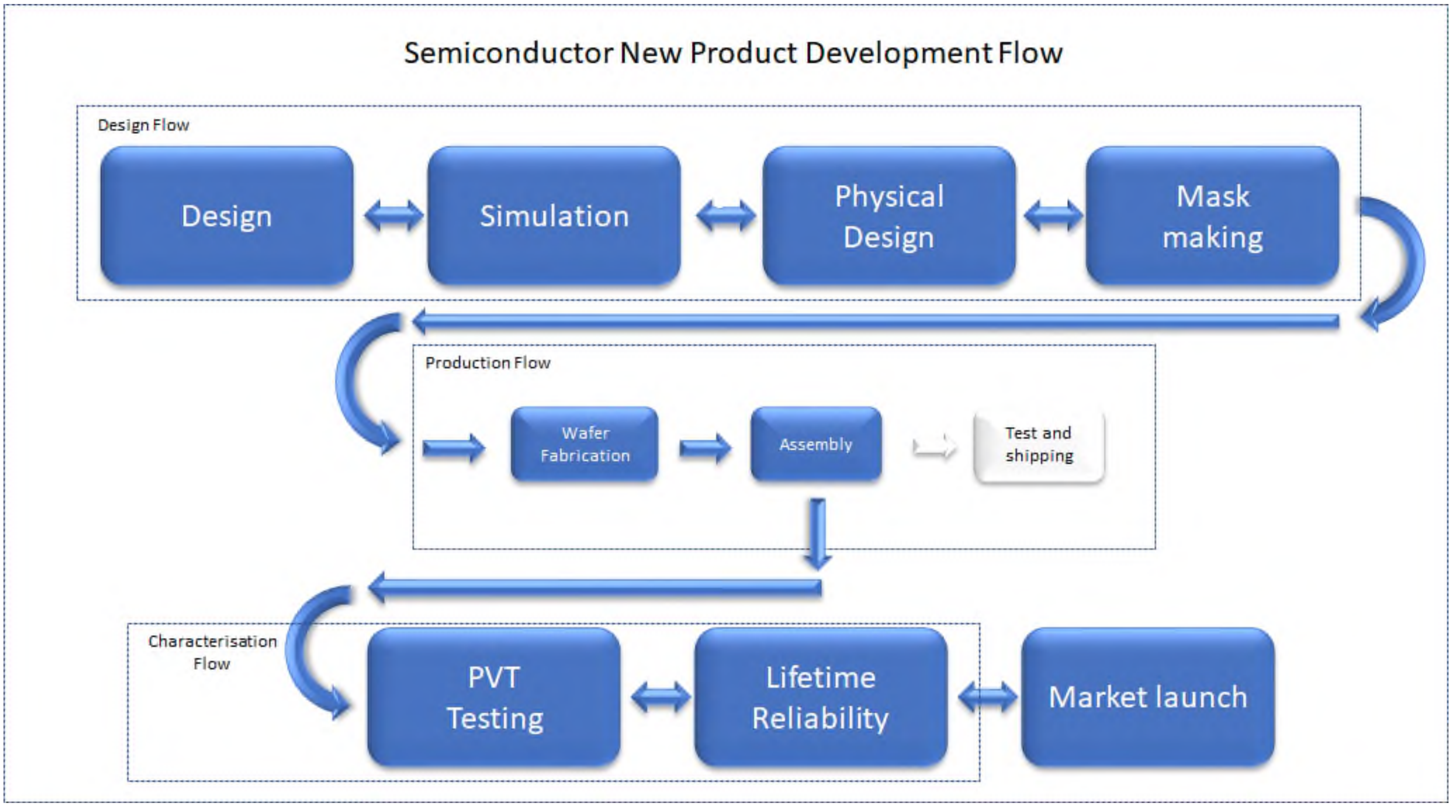

Figure 1: Semiconductor new product development flow

Design Flow:

The process of developing a new semiconductor device begins with the Design Flow. The Design step involves inventing a suitable circuit to implement the intended function and generating the appropriate schematic. This schematic is then sent to a simulator, which attempts to predict how the circuit will function once manufactured. The simulator relies heavily on models which emulate the performance of the target production process. The output from the simulator is a wide range of predicted results for the new design over the range of typical process spreads, applied voltages, and temperatures. The designer iterates the design until the desired results are achieved.

The next phase is to generate layer mask information corresponding to the new design. Semiconductor devices are manufactured by carrying out various optical masking steps to selectively introduce various materials into a planar semiconductor wafer. The process of generating the mask information requires specialized software and skill set. The output from this step is a digital file.

This file then goes to a specialist service which generates the physical masks, which are then transferred to the target wafer fabrication plant, who then manufactures the first prototypes.

Production flow:

Wafer fabrication plants are typically multi-billion euro operations. In the case of MNC's, the fabrication plants are often used exclusively for their own internal corporate products. However, some of them have set up to provide a foundry service, and these are the type used by SMEs. To minimize costs for the SMEs, the foundries will typically provide an amalgamation service which integrates multiple mask sets on a single wafer. The Europractice service is an example of such an amalgamation service.

Once the first prototypes are available, the thin wafer is sawn into individual rectangular 'die', typically a few square mm in size, each of which is a fully-working semiconductor device. Each die is then encapsulated in a package ("Assembly"), which contains robust connections to the outside world, and protects the die from its external environment.

Characterisation Flow:

The final packages are then returned to the SME, who then performs thorough characterisation of the device's performance. It is stressed over a wide array of conditions of operating voltage, speed, temperature, and so on ("PVT testing"). Long-term life-expectancy is also typically verified using accelerated life tests. The data gathered during the measurements than provides the basis of the device data sheet, which is then used at subsequent market launch.

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Appendix B

Report of the EU Commission's Design Platform Working Group

"Recommendations and Roadmap for a Design Platform in the context of the European Chips Act"

Recommendations and roadmap for a Design Platform in the context of the European Chips Act

Design Platform Working Group

June 2023

Disclaimer

Table of Contents

ACRONYMS

AI	Artificial Intelligence
ASIC	Application Specific Circuit
ATPG	Automatic Test Pattern Generation
CAGR	Compound Annual Growth Rate
CDA	Chip Design Accelerator
CPU	Central Processing Unit
DET	Design Enablement Team
DFT	Design for Test
EC	European Commission
EDA	Electronic Design and Automation EU
	European Union
FDSOI	Fully Depleted Silicon on Insulator
FTE	Full Time Equivalent
GDP	Gross Domestic Product
IC	Integrated Circuit
IDM	Integrated Device Manufacturer
I/O	Input/Output
IoT	Internet of Things
IP	Intellectual Property
LSF	Load Sharing Facility
MEMs	Micro-Electromechanical Systems
MPW	Multi Project Wafer
OSAT	Onsite Assembly and Training
PCT	Platform Coordination Team
PDK	Process Design Kit
PPA	Power Performance Area
RAK	Rapid Adoption Kit
RISC	Reduced Instruction Set Computer
RTO	Research and Training Organisation
SME	Small and Medium Enterprise
SW	Software
US	United States
V&V	Verification and Validation
WG	Working Group
6G	Sixth Generation Wireless Communications

EXECUTIVE SUMMARY

The Design Platform Working Group, set-up by the European Commission following a workshop in September 2022, comprised of key players from the European semiconductor industry, has met and held workshops with key stakeholders to identify how Europe can realise a Design Platform as foreseen in Pillar 1 of the European Chips Act. The main motivation behind the platform is to make the process of going "from lab to fab" easier and more accessible for EU companies, especially fabless SMEs, by both simplifying and accelerating the process, and in turn increase chip design activities in Europe. This is a challenging goal and there is a need to address current and future requirements within an initial reference timeframe up to 2030. This report provides a "deep dive" into how a vendor neutral Design Platform can be put together and operated to support European Industry.

In the process, the Working Group has carefully addressed the requirements of fabless SMEs (the primary customer of the Design Platform) as well as other potential users such as academia, systems companies, and systems houses. Workshops have been held with SMEs and cloud vendors and there has been direct interaction with key stakeholders. The working group considered the Design Platform in the context of the broader design ecosystem in Europe and its potential impact in synergy with other ongoing initiatives such as EuroPractice and complementary elements of the Chips for Europe Initiative, such as competence centres and pilot lines.

The Working Group has considered operational aspects of the Design Platform in terms of provision of centralised services to create a one-stop access point for SMEs which are either new to chip design or with some previous experience, to guide them to the most appropriate design flow instances that provide support, training and reference design flows as well as a route to manufacturing. The Working Group proposes that this is accompanied by more localised design enablement assistance to enable users to customise their experience to suit their particular needs based on level of experience, application and technology.

The development of the platform presents a host of technical challenges. Integration flexibility is essential to allow the platform to scale and grow to provide a wide range of services and design flows. The needs for scalability and flexibility naturally lead to a secure cloud solution. A key challenge will be in providing these services via a cloud infrastructure and here a solution is proposed that provides security of the IP within the platform. The model presented by the Working Group foresees advantages for both users and vendors, whereby the former get access to the resources required for rapid design whilst the latter would benefit from a wider European ecosystem and thus new business opportunities/customers for tools and IP.

Training of the next generation of chip designers is also essential and here opportunities to use the Design Platform for training and support services on the latest technologies have been identified. Notably strategic links with the proposed EU-wide Network of Competence Centres to provide advice, training, and help with skills challenges are encouraged.

Finally, the Working Group presents a Strategic Roadmap of how the Design Platform can be created and grown over the next few years. This has been developed to ensure that the platform services provide "quick wins" in the shorter term to give confidence and provide real near-term impact to the community as other enhanced functionalities are developed.

1 INTRODUCTION

Semiconductors are at the heart of any digital society and the need for Europe to be at the forefront of chip design is clear. Recent events have highlighted the need to increase the EU's resilience by strengthening its semiconductor ecosystem. The European Commission has identified a number of gaps and dependencies within the European supply chain. A key area is the design of new chips and here there is a need to create a strong design ecosystem within Europe. Currently, there are high entry barriers and a low share of investment in Europe. In response, the European Commission has proposed the EU Chips Act package which covers research, design, testing and production. The vision is to strengthen and build upon excellence in the area with the aim of creating energy efficient, secure chips and products. A substantial production capacity will be required by 2030. At the same time there is a need to address the skills shortage in design.

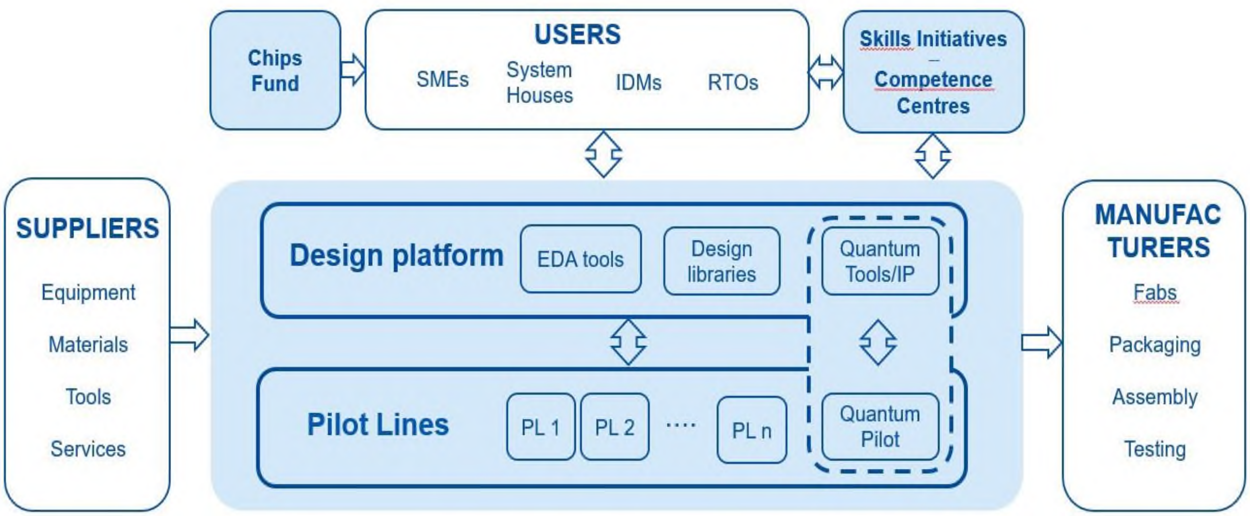

Figure 1. Lab to Fab Concept (*Source: European Commission*)

The aim is to create a design platform in Europe that will provide users with design tools and an IP library for various technologies as well as PDKs to access the fabs. In addition, there will also be a need for training and support services. To this end, the European Commission set-up a Working Group in September 2022 as a forum for the relevant stakeholders in industry and research institutions to propose ideas on implementation of this platform. This was also complemented by a workshop with European start-ups and SMEs to define potential user requirements. This report presents the views of the members of the Working Group and will serve as a basis for further discussions within the Chips Joint Undertaking.

The goal of this initiative is to support building a strong design ecosystem in Europe supported by a strong set of design tools and IP to maintain sovereignty in key areas in Europe such as automotive, industrial, communications, IoT, edge computing, health and aerospace. Other key technological markets such as Quantum, which has many potential applications, and photonics, which is likely to impact advanced processing in applications such as datacentres, also need to be addressed. These are all areas that have been identified as being strategically important.

The report is structured as follows:

- Chapter 2 gives an overview of the design ecosystem in Europe.
- Chapter 3 presents a proposed framework of implementation, as developed by the Working Group. This chapter covers the main objectives of the design platform, the approach taken by the group, and the identified user requirements. Furthermore, it outlines the mission and concept of the design platform, including the proposed common services and design enablement services.
- Chapter 4 focusses on training and the synergies established with competence centres.
- Chapter 5 dives into the technical aspects of the design platform, discussing integration, cloud computing, and the validation and verification processes for new IP and tools.
- Chapter 6 presents the Working Group's recommended roadmap for the implementation of the design platform.

2 IMPORTANCE OF SEMICONDUCTOR DESIGN IN EUROPE

2.1 Market for Design

According to the Semiconductor Industry Association in 2021 the global chips market was USD 550 billion.[1] Key demand areas are in communications, including mobile handsets and network infrastructure (32%), computing infrastructure (31%), consumer electronics (12%), industrial (12%) and automotive (12%) as shown in Figure 2. The growth rate is high in segments which were historically dominated previously by analogue and mechanical technology, such as automotive and industrial manufacturing[2].

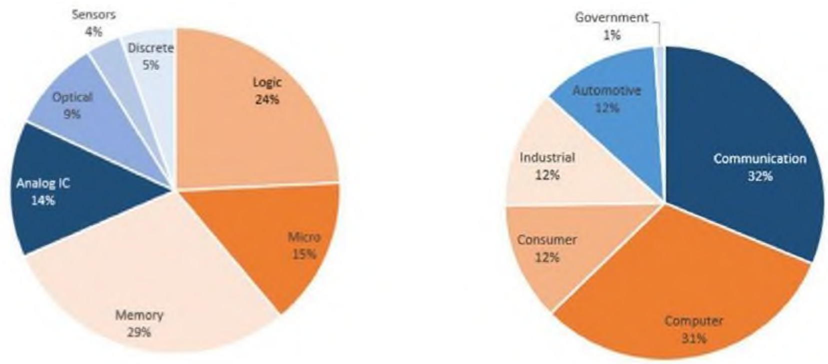

Figure 2. Semiconductor market segments, by device type and by end-user sector demand[3]

At the European level the automotive and industrial market segments are particularly strong (see Figure 3). The Microprocessor market is driven by computing and communication, however the embedded market, a key European strength, currently estimated to be 21% of this, is growing rapidly[2].

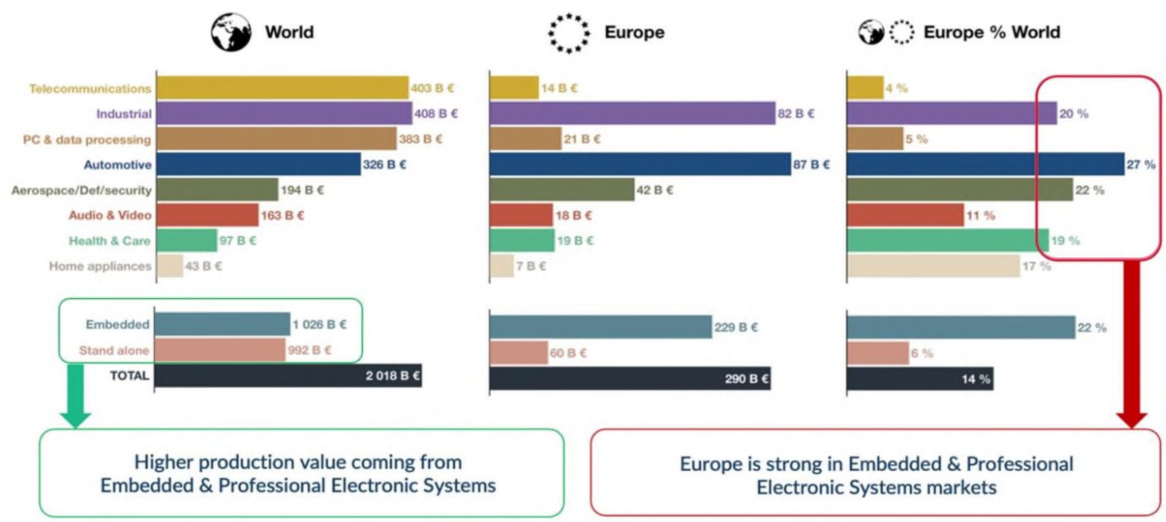

Figure 3. World & Europe Production of Electronics Systems by Application Domain

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[1] Semiconductor Industry Association, February 14, 2022. https://www.semiconductors.org/global-semiconductorsales-units-shipped-reach-all-time-highs-in-2021-as-industry-ramps-up-production-amid-shortage [2] Semiconductor Industry Association Factbook 2021 (figures for 2020) [3] Source SIA / WSTS, IC insights.

[2] https://epsnews.com/2020/09/14/total-microprocessor-sales-to-edge-slightly-higher-in-2020/

In the semiconductor value chain, the stage of **chip design** is extremely important and captures over 30% of the full semiconductor market value. The European share of the design market is generally estimated to be around 7%, but most of this capacity lies with the Integrated Device Manufacturers and partly with some system companies. Indeed, fabless companies in Europe unfortunately represent just a small share of the relative market, below 2%; no EU fabless company appears in the global top 40 in terms of revenues. Because of high entry barriers and lack of access to venture capital, the EU market is very fragmented, composed of a large amount of small fabless companies that fail to grow and focus on mature technologies, or development of IP. It is therefore of fundamental importance to address this issue, supporting the growth of the design ecosystem and particularly of fabless companies in the EU.

2.2 Key European Markets Driven by Design

Automotive – The automobile industry accounts for 6.6% of EU jobs and produces 8% of its GDP.[3] A challenge for vehicles is to maintain advanced computing power for safety technology such as autonomous driving, yet to provide this at reasonable design costs. The transition to electric mobility is further accelerated by the EU plan for zero emissions by 2035, requiring advanced power electronics components. The cost share of electronic components in relation to the total value of the car will grow from currently around 16 % to around 35 % by 2025[4].

Industrial Electronics - Key technology drivers in this market are the development of digital platforms, digital twins, implementation of AI and Machine Learning and condition monitoring. Predictive maintenance, additive manufacturing, augmented and virtual reality are important areas of growth for semiconductor components.

Communication and Networking - The communication and networking market is projected to grow at significant CAGR with the increasing demand for smartphones and smart devices around the world. This has been further accelerated by remote working. 6G and Wifi7 are growth opportunities for the semiconductor market in this domain.

Avionics - The avionics market has a strong safety, security and certification culture. A common challenge is to deploy multicore in a safe and secure manner, so that strict real-time deadlines are met, such as prescribed by US and European guidelines, e.g. CAST-32A.[5]

Healthcare - Healthcare is already key to the European economy: 10% of the EU's gross domestic product is spent on this area and 10% of this spend is on medical technologies. Healthcare institutions are integrating technology to make medical treatment more sophisticated, dependable, and accurate. Semiconductor usage is expected to grow in many applications such as clinical diagnostics and therapy, medical imaging, magnetic resonance imaging, ultrasound equipment, blood pressure monitors and pacemakers. The strongest growth areas are in remote patient monitoring and wearable devices for health monitoring and well-being.

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[3] ACEA. "Economic and Market Report: First Three Quarters of 2021," n.d. https://www.acea.auto/files/Economic_and_Market_Report-First_three_quarters_of_2021.pdf.

[4] https://www.rolandberger.com/en/Insights/Publications/The-car-will-become-a-computer-on-wheels.html

[5] Agirre, Irune, Jaume Abella, Mikel Azkarate-Askasua, and Francisco J. Cazorla. "On the Tailoring of CAST-32A Certification Guidance to Real COTS Multicore Architectures." In 2017 12th IEEE International Symposium on Industrial Embedded Systems (SIES), 1–8. Toulouse: IEEE, 2017. https://doi.org/10.1109/SIES.2017.7993376.

3 DESIGN PLATFORM CONCEPT AND FUNCTIONALITIES

3.1 Main Objectives of the Design Platform

In the first instance, a set of objectives for the Design Platform were put forward by the EC in consultation with industry. These are to:

1. Develop a virtual platform offering easy cloud-based access to tools, library and support services to accelerate development and reduce time-to-market, involving all key players.
2. Reduce burden and barriers for companies engaging in IC design, so they can focus on innovation.
3. Integrate leading PDKs to support existing development and foundries, and potentially in the future integrate access to pilot lines and fabs for prototyping, including libraries for virtual prototyping to quickly evaluate design trade-offs and create realistic implementations.
4. Foster collaboration among EU stakeholders, including on development of open-source IP and tools.
5. Support the development of IC design skills by offering training and support services to user companies via the Design Platform with additional support from a network of competence centres.

To address these objectives and develop the concept of the Design Platform, consultation meetings were first held with industry to gauge interest and then a Working Group was set up with volunteers from key industrial players and relevant interested parties. Overall, the ambition is that through the aggregation of demand and the efficiencies of scale made possible by the cloud, the Design Platform will enable user companies, especially fabless start-ups and SMEs, as well as academia, systems companies and design houses, to access an infrastructure that is similar, in terms of tools, IP and computing resources, to what is currently accessible exclusively to large players.

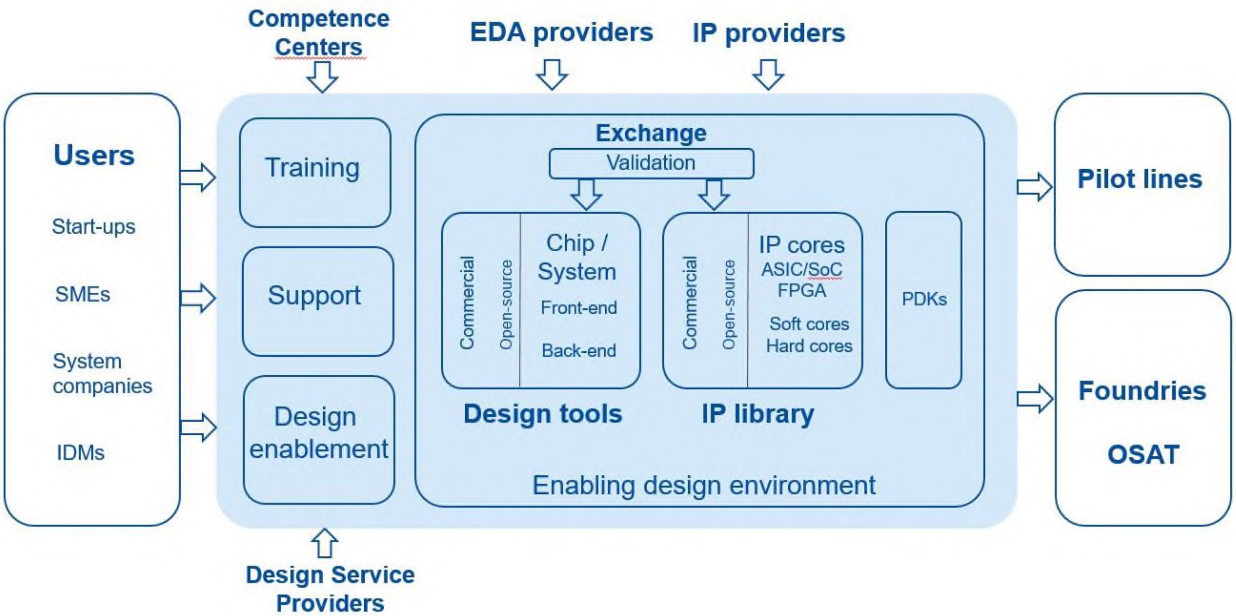

Figure 4: Design Platform

3.2 Working Group and Approach

The Working Group Members are given in Appendix C. The members include a mix of key players consisting of tool providers, IP providers, RTOs, manufacturers and system companies providing a wide coverage of the semiconductor design ecosystem. The purpose of the WG was to discuss and recommend the high-level requirements for the Design Platform that will serve as the basis for more detailed specifications by technical experts when the eventual call for the Platform development is launched through the Chips JU.

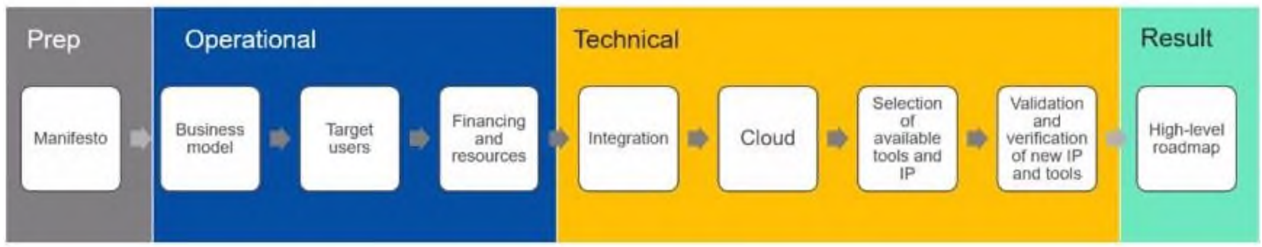

Figure 5. Key Operational and Technical Aspects Identified for Discussion by WG

A series of Working Group meetings were held, as well as specialist sub-group meetings, to address a range of topics with respect to Operational and Technical Aspects of the platform. These are broken down into key areas as shown in Figure 5. This has been used as a guideline for topics of discussion, and members of the Working Group have put forward their positions for each. Additionally, target user groups were consulted to ensure that the Design Platform meets potential user expectations.

3.3 User Requirements

The platform is expected to support a range of users from companies to academia to enable training, produce prototypes and to scale up to production. Start-ups and SMEs, however, are the primary customer for the Design Platform and to gather the views of the community a *Chips Act for SMEs* workshop was held in November. In this meeting, the lack of fabless companies within Europe was highlighted. This combined with the lack of venture capital to get to market were considered to be key challenges.[15] To encourage new players to venture into chip design there is a need to reduce the design cost barrier and support start-ups and SMEs in overcoming the crucial period before a viable demonstrable prototype is available. In particular, the costs of design tools can represent a barrier for SMEs especially for digital design. The complexity of designing leading edge node chips, in terms of both access to tools, resources and skills is also a barrier. The existing tools represent decades of development, and many times require long licensing negotiations, however, there is scope for making access to tools and IP easier. Complementary activities such as the clever use of open-source IP and software may also be used to Europe’s advantage.

Providing a “One-Stop Shop” Design Platform and IP repository, bringing together commercial and academic IP (which can be matured via validation) was welcomed. Multivendor toolchain flows are needed, e.g. integrating EDA tools from different vendors and having these available via a single entity would be beneficial. A hybrid IP source/tool-licensing system needs to be put in place as well.

With respect to the key characteristics of the Design Platform, it was noted that:

- The platform should provide affordable solutions to lower the entry costs for users. Currently licenses are provided for a fixed period of time, e.g. one year, but an SME with limited personnel may only use these for a few weeks. A flexible and appropriate business model must be pursued that addresses the needs of the users and is affordable for them.

- The focus of the platform is on tools from the main vendors, especially for digital, analogue, and mixed signal. However, the need to also include tools for MEMs and photonics technologies is recognised. Notably the photonics area is very fragmented and photonics packaging, design, materials and testing can be distributed across many partners.
- Quantum chip design is still very young and relies on public research. There is an opportunity to develop IP in this area. Open-source tools already exist for the simulation and basic mask layout of quantum chips. These are available and courses are being run for university groups. This is something the platform could support in the longer term.

3.4 Design Platform Mission

The overarching mission for the Design Platform is "to provide a European Design Platform that creates and stimulates a thriving European design ecosystem for high volume exploitation markets".

In the EU there are no large fabless companies, and the design ecosystem is highly fragmented. The key objective here is to enable these smaller players to scale-up and accelerate their progress via the Chips Act. The key challenge in creating the platform is in bringing together key players within the same platform which will be provided in the cloud. This needs to accommodate existing activities within the various ecosystem players in the market while ensuring that it does not affect their commercial positions. In particular, engagement with the platform should enhance their commercial position by providing new customers and business opportunities in a win-win for both the users as well as tool and IP providers, design houses, training and support centres and foundries.

3.5 Platform Concept

The EC will not directly operate the infrastructure or the platform. The implementation of the programme will be executed via the Chips Joint Undertaking, with dedicated budget from both the Horizon Europe and Digital Europe programmes. The operational aspects of the platform include the value proposition, the target user segmentation, role of the partners, the platform costs, ownership and governance. A key aspect which will have a strong influence on the implementation of the Design Platform is the **level of integration**. This concerns which parts of the infrastructure and services must be included in the core part of the platform, and which parts can be distributed among various partners.

It is clear that SMEs would prefer an experience akin to a single one-stop-shop with which to engage, as this would ease the process of accessing various technologies and services. Furthermore, the project would be in line with the objectives and aims of the Chips Act regulation, it will be easier to manage, and the European scope of the activities is retained. Resources required can be dynamically allocated according to need and the platform can also scale with need. By having certain aspects centralised it is possible to update and upgrade them and then pass them to the relevant implementation hubs.

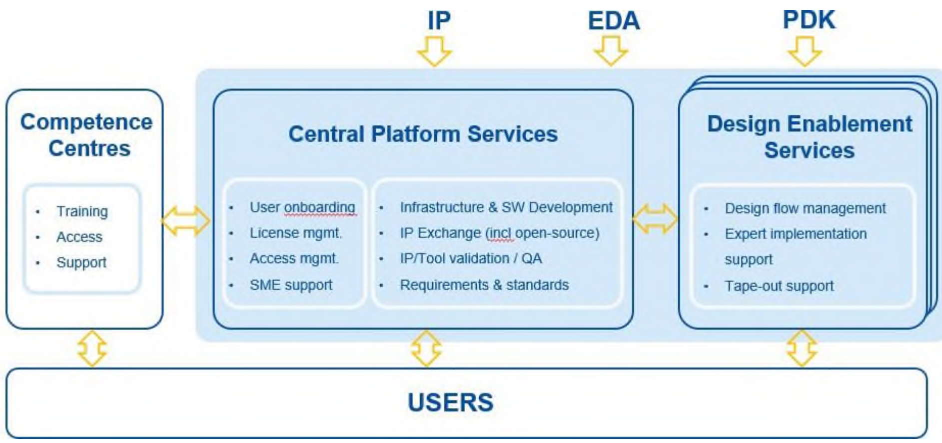

Figure 6. High-level block diagram

The Working Group identified four main design platform roles:

1. **Competence Centres** in _most Member States_ which among other things facilitates access to the Design Platform and Pilot Lines.
2. **Platform Coordination Team (PCT)** is _one central entity_ in Europe that coordinates the platform.
3. **Chip Design Accelerator (CDA) programme** is _one central programme_ managing the selection of SME projects for enhanced access to the platform, including support for licensing and IP costs as well as prototyping expenditures.
4. **Design Enablement Team (DET)** - several _DETs may emerge across the Union_, providing instantiations of the design environment that is specific to certain technology, application, and foundry. The DET will be able to provide targeted assistance on designing systems and design flows as well as expert support. This includes supply chain support for the complete cloud-based Design Environment from virtual prototyping via tape-out and engineering samples to high volume production.

The Working Group agreed on an implementation with a central platform services hub coordinated via a Platform Coordination Team (PCT) as shown in Figure 7 integrating access to most services while also offering access to different design flow instances and separate services via Design Enablement Teams (DET)

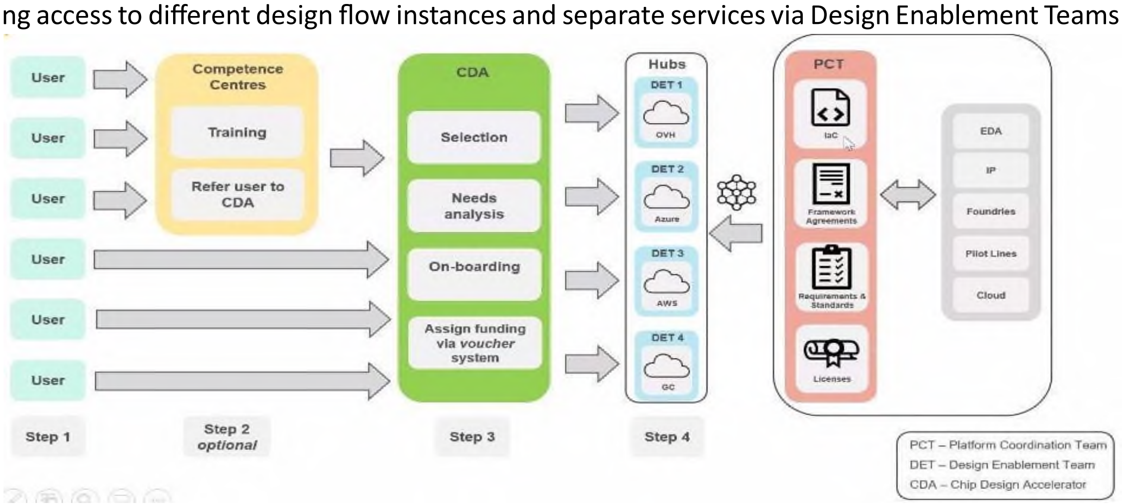

Figure 7. Design Platform Stages and Roles

each dealing with specific foundries and pilot lines. Indeed, up to a certain extent on a virtual platform it is possible to integrate separate services and offer a uniform and seamless experience to end-users. To accelerate the deployment of a first version of the Design Platform, it is important to concentrate on essential flows first, with supporting PDKs. Each of these flows targeting specific applications and design methodologies can form a design flow instance. Each of these can target a specific technology/application area. Whilst acknowledging that implementing the platform will be challenging, it is nevertheless technically feasible, already EDA and cloud vendors have managed to realise similar platforms and large customers integrate different tools on their cloud. A key benefit is that the platform can aggregate demand and dynamically allocate resources, making it easier for users to scale up or down the resources as needed.

Contract Negotiation - A key bottleneck is the issue of dealing with contract negotiations for access to all the needed resources, covering infrastructure, support, PDK, EDA tools and IP licenses. To ease engagement, the existence of some standardised model contracts based on framework agreements negotiated by the PCT, e.g. as for design tool licences in EuroPractice, corresponding to the different classes of users and stages of development, would be highly beneficial for the SMEs. Users would access these via "standardised electronic forms" to contracts that had been agreed beforehand between the PCT and the tool providers. The key advantage of this is that it reduces the need for legal support that SMEs often cannot afford. From the customer's perspective they would be able to work with the central PCT simplifying the contractual process.

There is a need to identify the different types of contracts required to then enable the possibility to have a standardised approach for different classes of users, based on common criteria, such as the level of funding (seed, series A, etc.) or development stage, e.g. proof-of-concept and commercial tape-out. Whenever possible the contracts between EDA, IP, foundry, OSAT, design house and user should be standardised, so that the effort to create a contract is reduced to a minimum. However, there will be cases, which are non-standard and will need extra negotiations or legal agreements between user and the companies. Offers would need to adhere to the negotiated legal frameworks of the PCT and the DET will coordinate with EDA, IP vendors, 3rd party design service providers, foundries, OSAT and PCT to facilitate a complete offering to the users. Although the goal of creating more standardised contractual agreements is recognised, attaining it will be challenging because contracts (1) are closely tied to the value proposition of industry participants; (2) are often confidential in nature; (3) evolve with market and technology practices; and (4) incorporate varied and evolving legal considerations.

Engagement Stage - It is proposed that Competence Centres could provide some initial training to users and also refer them to the Chip Design Accelerator program (CDA) that would be run as part of the central services and potentially be funded by the Chips JU. The role of the CDA program would be to select projects, identify needs and deal with the on-boarding of users in the platform in close collaboration with vendors. The development of certain functions required by the Design Platform, for instance the IP exchange, could be outsourced through procurement or via specific calls.

As seen in Figure 7, in step 1 Users, typically SMEs, formulate the requirements for their system. SMEs, particularly less-experienced and early-stage start-ups, can initially engage with the platform via an appropriate Competence Centre in step 2; access to platform services and potentially financial support will be provided in step 3 through the CDA programme. Users may also be able to interact with the Design

Platform directly. Users will also be guided, if necessary, to the most appropriate tools and design flows, and in step 4 they can select one of the design enablement service providers to support them in the implementation of the design flows.

Platform Coordination Team (PCT)	Design Enablement Team (DET)	Chip Design Accelerator (CDA) program
• Impartial advisory team • Cloud-based system software infrastructure development • Definition of common look and feel to access the Design Platform from DETs • Support and maintenance of the platform • Development of legal framework agreements with vendors • Definition of common building blocks and IP • Definition of interfaces (IP/Design Flows) • Definition of common IP QA process • Development of common IP meta description to provide standard interfaces between different instances of the platform and central services.	• Application engineering team to help with implementing design • Support user with their design environment and design flows • Supply chain management for prototypes and volume products • Yield/product engineering for volume products • Expert support for validation/characterization and qualification of IP and volume products	• Select users through competitive calls • Conduct a needs analysis to be shared with DETs, who would in turn present their proposal to the user • On-board users and guide them through their agreements with vendors and DETs • Assign funding to the user based on the needs analysis and available resources

Table 1 Services Provided by Central PCT and Design Enablement Team Hubs

An overview of the potential services identified by the Working Group that would need to be provided by the Platform Coordination Team and the Design Enablement Team Hubs is given in Table 1. The PCT will place requirements on the DET Hubs which will need to be met in order for them to become part of the platform.

3.6 Common Services

The following 5 **key considerations** provide the framework for the Common Services of the Design Platform.

- **Resources** – upkeep of the platform requires the relevant expertise to constantly monitor and optimise.
- **Complexity** – the platform needs to support interoperability of different products from multiple vendors into technology specific workflows combined with the management of EDA and IP licenses

as well as the foundry interface with multiple different technologies. Access to different cloud providers is needed.

- **Security** – the platform must host sensitive user data and IP alongside foundry PDKs amongst other resources.
- **Accessibility** – equal access must be ensured across all Member States and a high-quality user experience throughout. The platform should be accessible to novel and experienced users alike, with support services adapted accordingly.
- **Neutrality** – the platform must be vendor neutral and open.

A **Platform Coordination Team (PCT)** comprises a consortium of neutral institutions from at least three Member States, with the aim of establishing a legal entity that can operate beyond the limits of the multiannual financial framework of the EU budget. The PCT is a neutral entity that is responsible for managing and coordinating the activities of the Design Platform, as well as ensuring the long-term structural stability of the organization. An Executive Team and Steering Committee will provide guidance and input. This will need representation from platform players including the DETs and the relevant industry stakeholders. The PCT also ensures that foreground and background intellectual property management within the consortium follows the standard rules for Horizon Europe projects. An important aspect of the PCT's responsibilities is to ensure that the design platform becomes commercially self-sustaining over the long term, and that scalability is a primary requirement for platform growth over time. The PCT is responsible for the development and maintenance of the platform, as well as the definition of clear rules for the use of the platform. The PCT will also assess the fulfilment by the Design Enablement Teams of a minimum set of technical requirements, and eventually sign a service-level agreement based on agreed frameworks with the PCT.

The PCT will need a Steering Committee that is responsible for strategic planning, decision-making, risk management, oversight and monitoring of progress and communication with stakeholders. The committee is responsible for communicating with stakeholders, including shareholders, investors, and employees, about the Design Platform progress and goals. The PCT will also be responsible for evaluating the performance of the Design Platform and adjusting as needed to ensure that it is meeting its goals. The composition of the Steering Committee should include representatives from the DET, Member States and DG CNECT. An Executive Team will be required for leadership, decision making, strategic planning, financial management, recruitment of personnel, risk management, communication with stakeholders and to ensure the success and sustainability of the DP. This should be made up from one person from each institution that make up the Platform Coordination Team (PCT) consortium.

The **Chip Design Accelerator (CDA)** is a central programme, proposed by the Working Group, that would serve as a supporting instrument to selected start-ups and SMEs making use of the design platform. The CDA would enable a select number of SME projects to have access to dedicated support through open calls of the Chips JU. Selected users would get enhanced access to the services of the platform including support for licensing and IP costs as well as prototyping expenditure until a Multi-Project Wafer (MPW) tape-out. Access to the platform would not be contingent on selection by the Accelerator Programme. The Working Group suggested that the CDA should fall under the governance of the Joint Undertaking. Operations may be either directly managed by the PCT or potentially delegated to a dedicated team. Input from key stakeholders, in particular EDA and IP vendors, would be facilitated through an advisory board which would be integral to this process. The CDA could organise regular open calls to select the most promising innovative projects by SMEs that deserve additional support to accelerate development towards their “proof of concept” chip prototype. Users could also be guided towards the most suitable set of tools and design flows and select the appropriate Design Enablement Teams (DETs) that could meet their specific requirements.

3.7 Design Enablement Services

Professional design enablement will be a key element of the intended design platform. It will allow for more rapid design and allow users to have a more customised environment that better suits their needs, depending on the application at hand. The Design Enablement Teams (DET) that will be needed to support this will be independent undertakings, which provide different cloud-based design environments specific to technology, application, and foundry. Each DET will provide support for the configuration of the design environment, especially when it comes to the deployment of multi-vendor flows. Support at this level would include supply chain management for the complete cloud-based Design Environment from virtual prototyping via tape-out and engineering samples (Integrated Circuitry) to high volume production. Examples of Design Enablement Teams can be ASIC design houses, Research and Technology Organisations, and other qualified design tool and services providers. These companies and organisations are often already acting as Foundry Interfaces to selected semiconductor fabs.

To become design enablement organisations affiliated with the Design Platform, companies and organisations must meet certain requirements defined and reviewed by the Platform Coordination Team. As Design Enablement Teams these companies and organisations will bring in their experience in realising integrated circuits during the on-boarding process with the Chip Design Accelerator (CDA). In the analysis phase for the technical aspects they will arrange the contact to a suitable foundry and OSAT partner for the business case, make estimates for the need of necessary EDA tools, licenses, cloud resources and required IPs, as well as design services. The DET coordinates the technical aspects together with the users, EDA, IP vendors, Design Service providers and Foundries to facilitate a complete offering to the users. We expect that in the initial roll-out phase a limited number of DETs (3 to 5) will be integrated in the platform, and that this number may gradually grow. A consistent quality of service must be ensured across the different DETs, while a broader offer will guarantee freedom of choice for the users in terms of combination of tools, access to foundries, cloud implementation and additional services being offered.

Design Environment and Methodology Tasks

The design enablement teams will have the necessary resources and experience to build a turnkey design environment for the foundry technologies supported by the dedicated design platform hub. This must be aligned with the centralised design platform development. The PCT will define the requirements that the Design Enablement Teams must meet including:

1) **Facilitate access to PDKs and Foundation IP from foundries.** This requires a close collaboration and ongoing communication with the foundries to ensure that the used PDKs and Foundation IPs are always up-to-date and are used in the recommended way.
2) **Contribute to the development and maintenance of technology specific reference design flows.** The overall target is to support optimised single or multi-vendor EDA flows on each design platform hub. The definition of the related requirements will be defined as part of the centralised design platform development. Reference flows for different design tasks are very often specific for the used foundry technology and foundation IP. These flows will be developed, maintained, and integrated into the design environment by the Design Enablement Teams in close collaboration with the EDA vendors and foundry partners.

To ensure the successful execution of a chip design project the design enablement teams will support the design platform users with:

- Initial setup of design project configured for a specific foundry technology, related IPs and EDA tools selected by the platform users with appropriate access control and data permissions
- In-project expert support for specific design flow tasks to help users to solve blocking issues
- Support for project specific EDA tool issues (e.g. generation of test cases)
- Support for project specific PDK and foundation IP issues
- Tape-out handling and communication with the foundries
- Support for packaging, test, validation, and qualification tasks

It should be noted that the effort of design project related tasks scales with the number of executed projects.

3.8 Business Model

The design platform needs to ensure that different actors can engage with a business model that provides a win-win scenario, stimulating the growth of the full ecosystem in synergy with related initiatives in Europe. The value proposition of the platform needs to be attractive to the users who primarily want a faster route to market, access to expert services and lower costs for using design tools and IP. At the same time, it must also be attractive to the various tool and IP providers, the main driver being that a growing European design ecosystem will result in new business opportunities. This can be through an increased number of designs in the EU as well as new user companies that may also scale up and become recurrent customers. Other potential stakeholders, e.g. organisations in charge of pilot lines and Competence Centres, would also have important roles, being part of the common strategy in the context of the Chips for Europe initiative.

EuroPractice currently provides training, support and access to foundries for Multi-Project Wafers mainly to academia, and several university spin-outs. The EU Chips Act Design Platform instead is meant to address commercial types of users, focusing particularly on SMEs whilst also being open to any eligible EU-based company who would like to make use of the service. Therefore, there will be several differences, certainly when it comes to the type of licensing agreement with vendors, but also the types of services and relations with the different actors of the ecosystem. However, it will be necessary to specify the relation of the platform with EuroPractice, also in consideration of the important role it can play in fostering collaboration amongst industry, universities and competence centres to offer **training** and support services addressing the critical gap in skilled designers in the EU.

The ownership of the infrastructure and the platform will not be held by the European Commission or Member States. The implementation of the Design Platform will require the creation of a consortium that is prepared to procure the necessary base infrastructure, develop the back-end and front-end software, integrate the tools, ensure compatibilities, coordinate Design Enablement Teams and provide support services to users. It is necessary to ensure the long-terms stability of the project to maintain its structural stability and allow for continuous progress. This could be achieved for instance through a specific type of consortium devised specifically for EU infrastructure[6].

Through a multitude of Design Enablement Teams (DETs), who will each have the responsibility to interact directly with the user, the Design Platform can scale dynamically depending on demand. At the same time DETs will tackle the technical implementation of a design environment that is customised to the needs of each user. For governance, an Executive Team and Steering Committee (PCT) will be needed to provide guidance and input. The structures of the consortium should incorporate and integrate the different entities necessary to realise the platform, to ensure cohesion and consistency in the interest of the end user.

Availability of IP is fundamental to ensure that users can focus their time on differentiating aspects of their design. Considering the management of IP libraries, commercial IP agreements need to be put in place with the provider of that IP, taking advantage of the special terms for start-ups and academia these commercial entities already offer. Fast time to market is important and this requires reusable designs and support for systems design into the final product. The platform should also offer a wide selection of opensource IP, which can be shared easily. If this is used widely it can also be tested, verified and validated by the user community. In case the right level of maturity and support is achieved, IP should be properly validated by a trusted entity before a commercial grade label is granted to be included in the platform library.

An important aspect to be considered is the possibility for the Design Platform to become economically self-sustainable in the long-term. It is therefore necessary to consider the running costs for maintenance and updates, in addition to user services, that the platform will have to bear once it will be in full operation. This needs to be balanced against the costs that some users can pay for the various services in addition to the direct costs for licensing, training, etc.

Furthermore, R&I projects under the Chips JU can both benefit from and contribute to the platform. Potentially, members of the consortia of these projects can be given access to the platform for their design activities. It is also foreseen that R&I projects working on IP blocks or innovative EDA tool solutions can supplement the resources available on the platform.

3.9 Target User Segmentation

The Working Group has discussed three primary categories of target users. These are Non-Commercial, Start-ups and Commercial users. Below the different categories are outlined.

Non-Commercial – Although SMEs are the primary target of the Design Platform access should also be possible to universities, students, researchers and RTOs. Already very clear rules are in place from vendors with non-commercial licensing agreements and there are triggers for spin outs, etc. In the EU this community is presently served by EuroPractice.

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[6] To support this, the Chips Act regulation offers the possibility to use a new legal instrument, the "European Chip Infrastructure Consortium" (ECIC), for the creation of a consortium with legal personality, involving entities from at least 3 Member States, which can go beyond the 7-year time constraints of the Multi-annual Financial Framework of the EU budget. An alternative is the use of a "European Digital Infrastructure Consortium" (EDIC) foreseen in the Digital Europe Programme, which requires the direct participation of at least 3 Member States in the consortium.

Commercial – 'Standard' licenses are in place in this sector for volume production (system companies, large enterprises, fabless and IDMs). Larger companies already have their preferred tools and IP and may not be interested in using the platform. An area where there may be interest, however, is in training for new projects and in collaboration for new IP and open-source IP.

Start-ups - The start-up segment belongs to the commercial segment but is more complex as there are several types of start-ups which can be funded in different ways and at different levels. The various EDA/IP vendors may use different approaches for their classification, such as level of funding, stage of development, or size of the team, and therefore offer each different licensing terms. In general, the following categories are considered:

> **Seed** – These are companies that have just got their seed funding and are before Proof of Concept or before first Multi Project Wafer (MPW). Support for this segment can include provision of tools, IP and assistance in cloud costs.
>
> **Early Stage** -These are companies that are at a stage before production or are producing products for non-commercial usage with an MPW run with the aim of attracting investors or customers. Support for this segment can include provision of tools, IP and assistance in cloud costs.
>
> **Growth Stage** – Companies at growth stage are already producing commercial products and since these entities should have sufficient funding, they would be expected to finance their tools and IP.
>
> **Scale-ups** – For expansion of commercial activities, companies would be expected to finance their tools and IP.

Some companies might be in between some of these categories and therefore overall, considering that classification is ambiguous, it is foreseen that as a general principle well-financed companies pay commercial prices for the tools they use.

In selecting users for support, vendors should be involved to determine the sort of license required for each particular user. However, this process can be accelerated and simplified if there is agreement with the participating partners on the above-mentioned categories. **Overall, clear rules are needed for access to the platform backed by some simple metrics that can be easily applied, ensuring speedy on-boarding and deployment of tools is of utmost importance to the functioning of the platform.**

4 TRAINING AND SYNERGIES WITH COMPETENCE CENTRES

It was noted by the group that in order to meet the goal to boost design activities in smaller companies there is also a need for people with **design skills**. Currently there is a shortage of people with design competence in the market and there is a need to reduce training barriers in universities. For instance, it was highlighted that there are now only a handful of universities in Germany that can do chip design. Although EuroPractice offers training for some skills, more is needed for competence on design flows or the ability to design systems. Ideally designers should also get training in industry to get practical experience of a flow working on a real project.

There was general agreement in the group that **training and education** are important, not only in universities, but also for users of the Design Platform. Training classes and workshops should therefore be included in Design Platform proposal and mission. A strong relationship is expected with EuroPractice in the provision of support and training.

The Chips Act foresees the creation of a network of Competence Centres in Member States to provide expertise and support skill development across Europe. It is expected that there will be up to 27 of these. The aim is to get a wide geographic distribution with one or more Competence Centres being nominated per Member State serving local communities. These can link with other centres to provide other competences if needed. The Competence Centres will be formed by mostly research and technology organisations with competences in areas such as microelectronics, analog electronics, photonics, etc. The services to be provided by these is still under discussion. A Competence Centre could hold multiple expertise domains, but the network itself will ensure that each Competence Centre can give initial advice to its local ecosystem.

Specifically for the Design Platform, the following activities and interactions with the Competence Centres can be listed:

- The Competence Centre can provide initial advice in alignment with the CDA program to help onboarding of first users on to the platform. In order to be able to do this, the specialists of the Competence Centres will need to be trained as well according to the individual needs, where appropriate a vendor certification will be attained. In doing this, the Competence Centres should bring 'neutrality' towards potential users of the platform, such that there is no bias with regards to selection of tools and technologies.
- The Competence Centres should also provide advice with respect to available training in the entire ecosystem. It is important to link the existing training activities in Europe. In order to do so, a central portal will have to be created similar to the Metis4Skills initiative where a summary of existing training courses (in particular for IC design) is listed. This could include some complimentary training and support that cannot be provided by the tool vendors.

An important opportunity may be in reskilling, e.g. of software developers, physicists, etc. through provision of training on electronics skills via specialised courses. Training could also be provided in design tools to create a short 1-2 year pipeline that could also tie in with IC apprenticeships from companies. A "train the trainer" programme is required.

5 TECHNICAL ASPECTS

5.1 Integration

The platform needs to be scalable in terms of design and cost and should provide the right tools to get to manufacturing as soon as possible. This requires a flexible approach to integration that can be tailored to new implementation design flows being added. From the outset, the design platform infrastructure should be as vendor-neutral as possible . Hosting different tools from different vendors is feasible although there are a number of technical challenges that would need to be addressed to ensure compatibility and seamless operation.

In the first instance the platform needs to address existing design processes so that SMEs can get up and running with new projects as soon as possible. This will require connection to key semiconductor fabs and foundries via the Design Enablement Teams. In a second phase of longer-term integration new design flows can be considered based on the linkage with the pilot lines, e.g. for FDSOI, etc.

5.2 Cloud

A key aim of the Design Platform is to “simplify and accelerate” the process of designing chips. Already there is an existing ecosystem that companies can engage with and a range of design tool flows supporting the design process. The Design Platform thus should not compete with existing design flows but rather it should serve as an enabler to get tools, IP and services in the hands of users as fast as possible. For this to be realised, vendor-neutrality is key.

Provision of “Off-the-Shelf” Design Flows - A key bottleneck is in the selection of an appropriate design flow. To accelerate the design flow selection process for SMEs, the Design Platform should provide a neutral view on available design flows, with their supported features and service levels.

As a starting point a central cloud-based repository should be created that can be used to support the identification and selection of possible design flows. This should allow different options for the choice of the products and services. The Design Platform needs to make neutral recommendations on the options.

More experienced users may choose to engage directly with the Design Platform, while less experienced SMEs could engage with the network of competence centres for advice and user training of the Design Platform. It is important to ensure that the network of competence centres is “acting as one” to enable collaboration and efficient resource utilization. The CDA and network of competence centres should be open to project proposals that are not covered by their predefined supported scope.

Cloud Platform – The Design Platform considers cloud as an important success factor and intends to encourage the adoption of cloud-based design environments as:

1. an efficient, competitive, and secure infrastructure that can scale according to the needs of the design and verification teams and workflows.
2. a proven method for collaboration across design, verification, tape-out and manufacturing.
3. an enabler for faster innovation of marketplace services and solutions thanks to increased scale, thus reducing costs and security risks.
4. a forum for collaborative design through open-source development and also by integrating different domains using methods for heterogeneous integration, interoperability, and integration of chiplets. This is complemented by access to other users for validation and verification of IP.

It is recommended that the PCT sets up a governance structure to define process and methodology standards for implementation, testing and monitoring of cloud-based design environments. Each DET would host an instance of the platform on a cloud service that is set-up by each team. The PCT will establish platform standards encompassing various aspects, such as but not limited to:

- Documentation for utilising and administering the design environment and its associated services. This will include development and setting of requirements of terraform templates for a joint "look and feel" that will be supported by DETs.
- Service levels outlining availability and performance standards for both interactive and batch workloads, including the hosting of common central licenses.
- Security management, comprising vulnerability management and incident response protocols.
- Access controls governing the processing, transmission, or storage of data (including the option to wholly store and process data within Europe).
- Criteria ensuring the ability to verify compliance with legal and contractual terms, including those pertaining to intellectual property rights and licensing.
- Requirements specifying the means to validate adherence to legal and contractual obligations, including IP and licensing terms.

The Design Platform is open to third-party cloud service providers that comply with these standards as defined by the PCT. The Design Enabling teams (DET) will need to meet these requirements, and these may evolve over time. Furthermore, the PCT shall establish a common license server for users that have access to licensing support.

Currently, a limited number of cloud vendors have experience in the semiconductor industry and partnerships with the major EDA vendors and foundries, but no European cloud vendor is in this situation. Nevertheless, the open nature of the platform will ensure that should European cloud vendors launch dedicated solutions for the semiconductor industry, integration into the platform will be possible. The Design Platform should not exclude the use of on-premise or hybrid-cloud design environments.

5.3 Validation and Verification of New IP and Tools

The platform will offer both commercial grade IP and also other IP contributed by academia and the opensource community. There is a need to partner with existing industry to manage and support commercial IP. Support will also be required to manage open-source mature IP so that companies will feel more confident to utilise it. A neutral party is required that is capable of defining the listing requirements for new IP and manage its listing on the platform. The more an IP block is used, tested and improved, the more maturity it gains, and this is useful information for the users. However, there are many different types of IP, digital and analog IP, etc., and each IP is different. A critical area identified is the verification of I/O IP. Linked with this is the ability to be resilient to other people's poor specifications as if something does not work an SME will not be able to debug it. It is important to understand the difference between Verification and Validation.

- **Verification** is the process of checking that something has been built correctly against a specification.
- **Validation** is the process of ensuring that the right thing is being built with respect to functionality, e.g. safety requirements. The aim of validation is to prove that the system meets the requirements. Generally, validation can be considered to be the activities performed after silicon has been created.

Early validation is seen as very important to reduce the number of requirements changes which can seriously affect project timescales and cost.

Verification and Validation of New IP

The process for verification and validation is very complex and diverse for different IPs. It would not be possible to support V&V within the Design Platform due to the resources and effort required. It is also the case that providers of IP are best placed to perform these tasks. The proposed approach is thus that providers of IP to the Design Platform do their own self-assessment of their IP. To enable this the PCT must define Gold, Silver and Bronze standards for V&V. Within these standards there may also be subdivisions if required. This would define the necessary activities and required documentation that is required to support IPs that are submitted to the platform. Typically, the information would need to cover the three main stages of verification and validation of new IPs:

- Set up of Qualification Templates and Configurations for qualification levels to standardise the qualification process.
- Identify Target Objects to qualify and possible dependencies according to qualification context specifications.
- Monitoring of the qualification state and progress, with specific progress views and reports, for visibility and traceability of decisions along the development cycle.

It is also important to qualify the IP for a specific usage. For instance, for functional safety it is possible to speed up the process via setting up templates to gather the appropriate evidence data to qualify IPs and objects as quickly as possible. It is also possible to monitor the status of a new IP against the qualification process. This provides feedback on when a new IP will become available for a future system. This can also be used for reuse of IP in other applications to check that a given IP is qualified for the same context.

Community-sourced IP Requirements

- Templates should be defined for self-assessment of the IP quality and ranking against a quality scale (Bronze/Silver/Gold).
- Templates should be defined for self-assessment of the quality of EDA tools provided to the platform by small vendors.
- A set of metadata should be defined to qualify each IP and enable search/ranking. These criteria would be given by the provider and may include description, standard compliance, Power Performance Area (PPA) information, supported processes, type of deliverables provided, software drivers provided, type of license, link to provider, link to documentation, etc. If functional safety is an aspect of the potential use of the IP, then templates for evidence collection will be required to meet the needs of different certifications (e.g. automotive, aerospace, nuclear). This should be sufficient to provide a design project with the necessary documentation required for design gates and certification.
- The platform would generate additional metadata like usage statistics on usage of the IP (reuse is an indicator of quality) and quality feedback from users.
- A challenge is that often designs use Non-European IP. Here it is important that the database of IP also records in the metadata the country of origin and any restrictions on use.
- On the front-end side, the platform should feature functionalities such as IP search, discussion/support groups, IP feedback, example/reference designs, and notification services (bugs, workarounds, new version alert, …)

- On the back-end side, the platform should feature administration capability, policing (ability to remove IP/providers), IP input portal (for providers), etc.

A critical starting point for this is to agree on templates for submission of data to the database. It should be noted that additional activities with respect to V&V may also be required such as physical characterisation. This is important for product release and cannot be done by the Design Platform as physical measurements are needed. The PCT will need to provide connection to players who can do this in an efficient way.

Open-Source IP and tools

With respect to open-source hardware, the Open Hardware Working Group set-up by the Commission has produced a strategic roadmap and are creating a RISC-V IP repository. Here the aim is to build on Europe's strengths and to produce a set of IP blocks based on the RISC-V ISA.[7] In particular, the OpenSource roadmap identifies the need for European chiplets, tool support, and key processor cores and peripherals. These developed blocks can be provided to the Design Platform within a repository. These IP blocks will require appropriate metadata as described previously, such as licensing, usage and other V&V data. Potential users will need to make their own decisions on potential usage based on the data provided and need.

Further, there are interesting developments in open-source design tools, especially at academic level but also in dedicated projects (e.g. by Google). These are normally used with designs at mature nodes (110nm and above), however, they are relevant vehicles of innovation also when it comes to realising novel features. While open-source tools are not typically seen as direct substitutes for commercial offerings, the design platform can offer collaborative spaces open to researchers to bring new tools to a higher level of maturity through the engagement of the design community.

Resources and Cost

The expectation is that a small team of engineers will be required to support the V&V activities within the Design Platform. Their role will be to define a common process with appropriate checklists to meet the Gold, Silver and Bronze standards. Additionally, they will need to create and maintain the searchable database of IP. Further the database will need to be curated, with regular updates and new entries to the metadata on usage, bug alerts, etc., adding to the provenance of the IP being made available. Going beyond this, activities may include the creation of reference subsystem designs based upon IP building blocks (e.g. to support IoT applications, etc. - see Annex A), that SMEs or other platform users can easily adopt in their designs.

5.4 Activities and Resources

The costs for the development of the platform as well as for maintenance and support will be funded by the Chips Joint Undertaking. The costs of the Platform can be distinguished in terms of fixed platform costs and variable costs. The necessary resources to enable this depends on fixed platform costs and variable costs based on the number of projects being supported.

[7] Recommendations and roadmap for European sovereignty on open source hardware, software and RISC-V Technologies: https://digital-strategy.ec.europa.eu/en/library/recommendations-and-roadmap-europeansovereignty-open-source-hardware-software-and-risc-v

Fixed Platform Costs

The fixed costs include the initial set-up costs associated with procurement of infrastructure, the development of the software to operate and access the platform and the setting up of services. Running fixed costs are related to the maintenance of the platform and services, core technical support services, fixing bugs and managing updates.

The platform will start with a limited number of services and technology implementation design flows addressing core areas, then it will gradually expand. A number of baseline fixed costs have been identified to provide management of the Design Platform and to create and support the cloud services. Further, over time the tools need to evolve to remain competitive which requires constant monitoring and evolution. Therefore, operational fixed costs are destined to grow over time as the platform scales up, not only in terms of capacity and functionalities, but also in terms of the number of foundries and of the related technologies that are supported.

The main activities related to the platform development that will require financial support are:

- Platform Development ○ User management, access control
    - License management ○ Portal development ○ IP repository ○ Integration ○ Security ○ Workflow
- Platform Management ○ Operational maintenance ○ System and tool updates and upgrades ○ Monitoring and support 24/7
- Cloud Infrastructure ○ Login server
    - Security operations: authentication, access, encryption, integrity, geofencing ○ Remote desktop software
    - Resource management, provisioning, load balancing and calibration ○ IT maintenance/support
    - Development of "*infrastructure as code"* to be deployed locally by DETs
- Legal Support, contract management
- Acceleration programme management
- IP/Tool Exchange and Validation services
- Design Enablement ○ Design methodology, design process
    - Reference flow maintenance (per foundry technology)
- Design System ○ PDK/IP installations and design system configuration ○ EDA installations and license server setups
- Rapid adoption kits e.g. for chiplets *(see Annex A)*
- Integration of training and support services

Variable Costs

Variable costs are dependent on the number of users being served and the intensity of use. The capacity of the platform is expected to grow over time, therefore scalability is a primary requirement. Part of the variable costs are pertaining to the central platform, but also some costs for the integration with design enablement services must be taken into account.

The plan is to have a first release of platform around mid-2024: beyond the pilot phase with a limited set of test users, it would be expected that the platform could support around 20 projects, to start with. The intention is to rapidly ramp up platform so that it is able to support about 100 projects or more. According to market analyst IBS, in Europe there are around 1350 design starts per year. It is therefore reasonable to expect that under the platform there can be around 50 projects/year, each of them lasting from 2 to 4 years depending on complexity. The level of support required is difficult to estimate as it depends heavily on the complexity of the project and the chosen technologies. Further, if the company is relatively new to chip design, it is likely that more effort will be required in terms of design services.

The main activities related to the project development that will require financial support are:

- Design Enablement ○ In-Project design enablement ○ Expert design flow support ○ Tape-out support
- Design System ○ Project setup/configuration ○ management of access rights ○ customer data in/out
- Cloud Infrastructure ○ Compute machines (pay per hour) ○ Project storage (pay per TB)
- Licensing of tools, IP, PDK
- Training services
- Prototyping services

6 ROADMAP

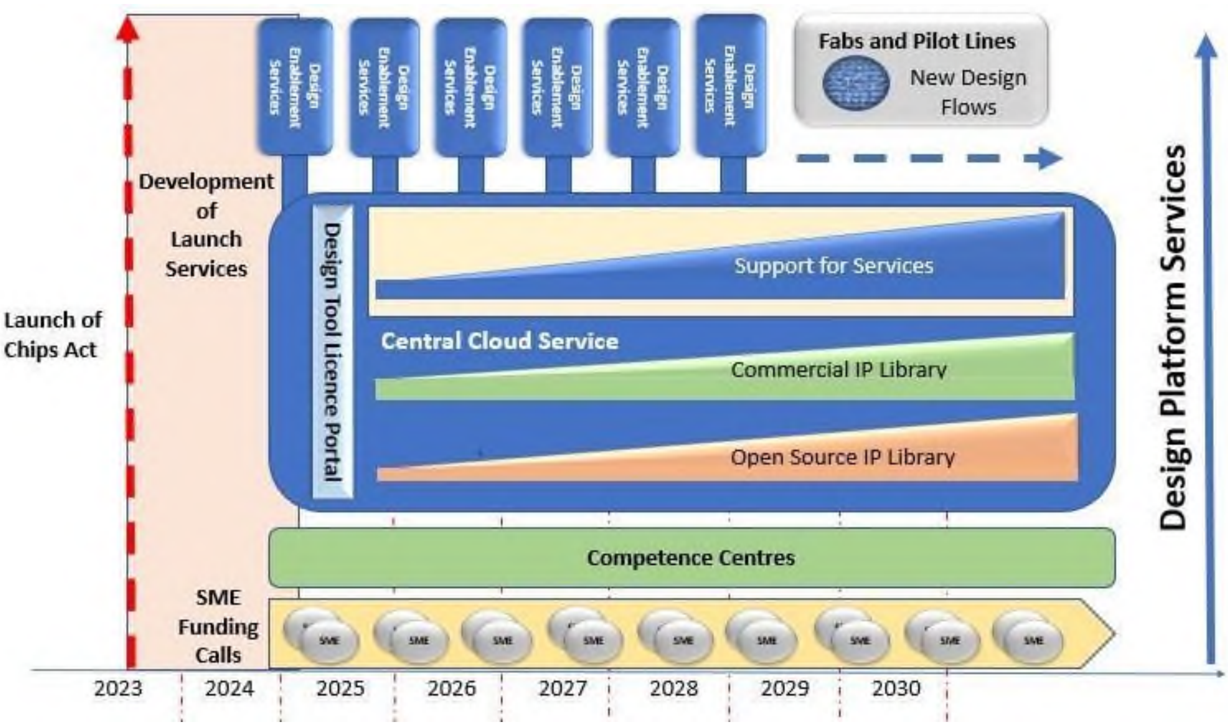

Figure. 8 Design Platform Roadmap

The Working Group has considered development of a high-level roadmap to implement the Design Platform. This required agreement on the manifesto and aims of the Design Platform and consideration of both technical and operational aspects of implementation as shown in Figure 8.

In this section a roadmap for development of the Design Platform is presented. Work on the provision of the centralised services will take time and so in parallel with this it is proposed that a number of Design Enablement Teams are supported to create Technology Design Flows. This allows the community to quickly begin serving the community with specific flows for key applications. Over time the number of supported Design Flows will increase encompassing the community eventually extending to cover pilot lines and other technology areas.

The Working Group recommends a 3-phase approach to development, this is outlined in the following sections.

6.1 Phase 1 - Initial Development and Validation

In phase 1, the Working Group proposes that following the formal adoption of the Chips Act in 2023, a consortium for the implementation of the Design Platform is selected through an open process. Initial work would concentrate on creating a first version of the design platform that could be quickly deployed. Here the aim would be to bootstrap the service with a set of core functions and to port the common code on different cloud instances with pre-existing design flows supported by Design Enablement Teams. The first DETs fulfilling a specified set of requirements would also be selected. Each DET would run an implementation of the platform code that can provide an integrated environment with PDKs from foundries and EDA tools on the cloud.

During this phase, the Platform Coordination Team should ensure the development of the platform including the core functionalities for the central services and for the design enablement services, also engaging with key stakeholders and potential users for testing and validation through an agile process. Furthermore, the PCT should conclude framework agreements with IP/EDA vendors and set-up the legal framework under which DETs and users would operate. In parallel, a *Chip Design Accelerator* programme could be set-up to prepare calls that would select the first users for funding. Finally, the PCT would liaise with the Network of Competence Centres to ensure that users on the Platform can access the right competence centre for support and training.

The initial version of the central cloud service should incorporate a user authentication mechanism, an EDA tool licence server and IP. The initial toolset access will include support for the initial technology design flows. Additionally, to test these flows, a series of proof-of-concept use cases will be used. Once validated, the Design Platform will be formally cleared for use by the consortium.

6.2 Phase 2 - Formal Launch of Platform

The second phase could focus on the formal launch of a Design Platform that is mature enough to onboard the first users. This is expected to be towards the end of 2024. User companies based in the EU would be able to apply for access to the Design Platform, by contacting either the Competence Centre of reference first, or the PCT directly. Once their application is approved, in order to make use of the required tools and IP, users would need to sign licensing agreements based on standard model contracts with simple standardised electronic forms, where pre-defined terms and conditions apply are based on the characteristics of the user company (e.g. development stage, level of funding, etc.).

Potentially, the CDA programme could be launched during this phase. Through the CDA, calls for proposals would be published regularly for start-ups and SMEs to submit projects for additional support. Calls may be relatively wide in scope, whilst also incorporating thematic elements to align with the policy priorities set by the Chips JU. Considering the financial constraints of the target users, it is fundamental that a prospective CDA programme is designed in such a way as to allow for agile and rapid selections followed by immediate deployment of support.

After selection, users can engage with the selected DETs that will support them through the development process and design flows as required. Feedback from users in this first phase is crucial input for the following development stages, to ensure that the platform fulfils its intended purpose.

6.3 Phase 3 - Consolidation and Growth of Design Platform

After launch, the PCT should continue to engage with the community and, under the policy direction of the Chips JU, identify new candidate implementation areas where specific toolsets and design flows could be provided. An open exchange for new tools and IP, including open-source, should be a key feature of the platform. As new tools and IP become available for integration, the PCT must have a continuously ongoing testing and validation process that would enable an expansion of the services portfolio provided by the platform across all DETs. Other service providers that fulfil the requirements could be approved by the PCT to become official DETs of the platform. The scale-up of the Design Platform infrastructure will be driven also by the number of platform users, the target should be to support at least 100 user companies at any given time.

In essence, the platform will require constant maintenance, with frequent updates of software and tools to keep it running, as well as continuous upgrades in terms of functional capabilities and number of integrated services. With the proper execution, such a platform will represent a real game-changer for the design ecosystem in the EU.

Evolution of DP Project – Working Group proposal

Time	Action
Q3/Q4 2023	Launch of Design Platform call.
Q1 2024	Consortium selected.
Q2 2024	Design Platform kick-off.
Q3 2024	Framework agreements by PCT with vendors. PCT publishes requirements for DETs.
Q4 2024	DETs launch. CDA programme launch – first call for SMEs/start-ups.
Q1 2025	Onboarding of first users.

Evolution Design Platform functionalities

Time	Action
Immediate term	Central license server, basic IP repository, click-through licensing. Establish trainings and support services for potential users via competence centres and PCT. Development of common code infrastructure for the cloud. DET instantiations running.

Medium term	Development of standard design flows by PCT. Community-based verification and validation of IP. Open-source IP exchange.

7 CONCLUSIONS

This report presents a development route for a Design Platform which is expected to lead to creation of a design ecosystem within Europe. It has been constructed with input from potential SME users as well as from a wide range of European stakeholders including, academia, commercial users, tool vendors, IP providers, RTOs and initiatives such as EuroPractice. Operational aspects of the Design Platform have been discussed in depth. Provision of centralised services to create a single access point for SMEs to guide them to the most appropriate technology implementation design flows to provide necessary support, training and reference design flows is advocated. A Business Model for the platform is put forward that allows for easy engagement for SMEs while meeting the contractual requirements for protection of IP and licensing of the tools. Financing and resourcing requirements for the platform have also been considered.

Many technical challenges have been identified. There are needs for integration flexibility to allow the platform to scale to provide new services and design flows. The adoption of a cloud infrastructure also presents security and IP requirements, but these are manageable. Despite these challenges there is considerable interest in engaging with the platform as it is seen as a means of generating new business opportunities/customers for tools and IP.

Opportunities for using the Design Platform for training on the latest technologies have also been identified. This is seen as essential to create the next generation of Chip Designers and here strategic links with the proposed Competence Centres and EuroPractice have also been identified.

Finally, a roadmap for development in three phases is presented with an early release designed to give “quick wins” in the shorter term to provide real near-term impact to the community as other enhanced functionalities are developed.

ANNEX A - RAPID ADOPTION KITS

A number of companies and foundries provide design kits or reference designs to help companies design new chips. These aim to support design acceleration via optimised tool flow performance and implementation acceleration through provision of preconditioned structures and preconfigured, pretested elements. This allows a sub-block of a chip to be developed quickly. The design and reference kits are called a variety of things in the industry, e.g. design discovery kit, reference kit, development kit, design database, IP subsystems, etc. The incorporation of these within the Design Platform would be very beneficial to provide “Rapid Adoption Kits” or RAKs. In addition, it would also be possible to develop reference design flows or different applications. These RAK designs can be used by the platform users as a blueprint for their specific chip design developments. A challenge is that the effort of design environment and methodology tasks infinitely scales with the number of supported foundry technologies, EDA tools and RAK designs and so significant investment is required. However, it would be possible to consider the development of RAKs to cover different packaging concepts (e.g. wire-bond, flip-chip and 2.5D chiplet systems), which will be developed together with European OSAT partners. In addition to established packaging technologies, this could also include a close collaboration with the new European pilot lines to enable early access for the platform users to the next generation of advanced packaging technologies.

ANNEX B - EXAMPLES OF DESIGN PROJECT COSTS

Factors that Affect Development Costs

It must be emphasised in these estimated costs that the actual cost per project can vary hugely dependent on the application and technology used. There are a number of things which can affect cost significantly:

Application Drivers

- Is it an Application Specific product?
- Is it a standard product for many applications? As a rule, a more flexible solution for many different applications leads to technically more complex solutions with increased development costs
- Is it for the Automotive sector?
- Does it need to meet a Functional Safety Grade (QM; A; B; C; D)?
- Can the product be realised on a standard process node, or are special metal stacks required in the technology nodes due to technical requirements (non-volatile memory, different and higher voltages)?
- How much embedded and driver Software (SW Stack) is required for different applications?
- How many design iterations are needed before Product release (On average, 1.5 to 2 iterations can be assumed)?

Maturity of Team and Technology

- Are the developers experienced in chip design and the technologies to be used?
- Is the Design and IP ecosystem complete and mature?
- Is a next generation platform or completely new platform being developed?
- Are Advanced Heterogeneous Integration 3D / Chiplets required?

Volume

- The larger the number of products, the more intensively the IP costs are charged via license costs leading to greater IP costs.
- The selection of the technology node results from an optimum of development costs and the targeted number of units in series production. The higher the number of units, the more profitable the investment is in smaller technology nodes.

Different application device types can be allocated to different implementation technology categories as shown in Table B1.

Device / Node	≤ 7 nm	10/16 nm	22/28 nm	40/45 nm	55/65 nm	80/90 nm	≥ 100 nm
Discretes							MOSFETs Rectifier Power Diode
Analog/Mixed-Signal				ASIC	Motor Driver IC	DC-DC Switching Converter LIN Transceiver Clock / Timing IC	DC-DC Switching Converter LIN Transceiver Clock / Timing IC Signal Sensor Conditioning
Logic and MCU / MPU	SoC FPGA	SoC FPGA	Microcontroller (32-bit) SoC	Display Driver	Ethernet Switch Ethernet Physical Layer Transceiver	Voltage Level Translator Microcontroller	Voltage Level Translator Microcontroller

Source: Omdia (1Q 2022); SEMI WFF (March 2022); expert interview; project team. McKinsey 2022

Table B1 Device/Node Types and Typical Implementations

These are expected areas where projects may be submitted. Based on this categorization it is possible to estimate the typical ranges of project cost based on the device type and node type as shown in Table B2.

Device / Node	≤ 7 nm	10/16 nm	22/28 nm	40/45 nm	55/65 nm	80/90 nm	≥ 100 nm
Analog/Mixed-Signal e.g. incl. Bipolar-CMOS-DMOS (BCD)				7 Mio - 20 Mio	4 Mio - 15 Mio	2 Mio - 9 Mio	400k - 5 Mio
Logic and MCU / MPU	150 Mio - 450 Mio	25 Mio - 250 Mio	10 Mio - 50 Mio	5 Mio - 20 Mio	3 Mio - 10 Mio	2 Mio - 5 Mio	200k - 2,5 Mio

Table B2 Development Costs for Typical Devices

The values include engineering efforts for Technical Project Management, Architecture / Front-End Design & Verification, RTL2GDS and Sign-Off, DFT/ATPG/Test Development, Package Co-Design, Validation and Qualification, 3rd Party Costs (MPW, Full-Mask Set, Package, Test) and IP Licenses. The values are based on individual publications and experience from within the Working Group.

It is clear from the figures that there is a wide range of costs so each project will need to be costed based on its own peculiarities. Notably there can also be reductions in overall costs if companies have already performed some previous development. For instance, companies may have already spent €30 million on the development of a radio chip with a corresponding software stack in 130 nm. Here, the validation costs can be reduced significantly with only needs for basic software development. Thus, the above values can be used as rough “ballpark” estimates, however, the reality may be that some projects may be significantly more expensive.

Supporting Development of IP Components.

In addition to project costs there will also be a need to support inclusion of new IP components within the Design Platform. It is not possible for the design platform to support the verification and validation of all the different types of IP, so a self-certification scheme is proposed whereby companies submitting IP have to do so against a set of gold, silver and bronze standards defined by the PCT. However, there may still be some additional support costs if additional verifications are required to integrate IP.

Element / Tool	Descriptions
Design Environment	Enable "Secured Clouds" to be "available on demand"
Tools and EDA tools	Shall be available to users with flexible license and support models * Pay-on-demand (per hours or per project)
IPs	Shall favor "standard" or "common interfaces";
IP licensing	Shall encourge pay-on-use model.
Local supply chain	Shall encourage local suppliers.
Resources	Shall incentive trainees willing to be trained.

Table B3. Keys Aspects That the Design Platform Should Address

The expectation is that V&V and IP management activities will require a small team within the Design Platform.

ANNEX C - MEMBERS OF WORKING GROUP

Working Group Members

Ansys - Babis Bakolias, Christophe Bianchi, Alan Deeter
Arm - Neil Parris, Eric Lalardie
Cadence - Anton Klotz
Codasip - Karel Masarik, Jamie Broome, Mike Eftimakis
Dassault Systèmes - Manuel Rei, Sophie Batas, Smriti Joshi
Dolphin - Philippe Berger
Fraunhofer-Gesellschaft- Christoph Kutter, Andreas Brüning, Thorsten Edelhäußer
imec - Romano Hoofman, Maarten Burssens
Infineon - Holger Schmidt
Racyics - Holger Eisenreich, Jens-Uwe Schlüßler
Siemens - Jean-Marc Talbot, Thomas Heurung
SiPearl - Philippe Notton, Yang Yngchih, Vincent Casillas
STMicroelectronics - Roberto Zafalon
Synopsys - Steve McDonald, Alec Vogt

Rapporteur

Haydn Thompson THHINK

National Semiconductor Strategy Consultation: Movano Health response V0.3

This note is in response to the request for input from stakeholders to inform the development of a national semiconductor strategy.

Movano Health, a publicly traded startup company (NASDAQ:MOVE) headquartered in Pleasanton California is developing a suite of purpose-driven healthcare solutions to bring medical-grade, high-quality data to the forefront of consumer health devices. Featuring modern form factors, Movano Health's devices capture a comprehensive picture of a person's vital health information and uniquely translate the data into personalized and intelligent insights that empower consumers to live healthier and more balanced lives. Movano Health's end-to-end solutions enables consumers, caretakers, and healthcare professionals to utilize daily medical-grade data as a tool to proactively monitor and manage their health. For more information on Movano Health, visit https://movanohealth.com/.

Movano Health's Evie Ring, a smart ring which is specifically designed to address women's health concerns, was launched for purchase in November 2023. Visit https://evieringcom/ for more information.

A key differentiator for Movano Health as a vertically integrated OEM is our custom Integrated Circuits that enable our proprietary mmWave Blood Pressure and Glucose measurements. Movano Health founded an Irish subsidiary, Movano Ireland Ltd. in 2021 to lead the development of Movano Health's CMOS custom Integrated Circuits that allow for non-invasive Continuous Glucose Monitoring and Blood Pressure measurements using mmWave technology. Ireland's rich vein of talent and innovative semiconductor ecosystem motivated that decision.

The chips act has a high level ambition to double the EU Semiconductor market share to 20% by 2030. With projected Semiconductor CAGR of 12% over 6 years giving overall market growth of 2X it implies a quadrupling of Irelands Semiconductor sector just to stand still within Europe. Our planning and ambition must reflect this. A summary from the Chips Act Fact sheet shows what is proposed:

The Chips Act proposes:

- **Investments in next-generation technologies**
- Access across Europe to **design tools and pilot lines for the prototyping, testing and experimentation of cutting-edge chips**
- **Certification procedures for energy-efficient and trusted chips** to guarantee quality and security for critical applications
- A more **investor-friendly framework** for establishing manufacturing facilities in Europe
- **Support for innovative start-ups, scale-ups and SMEs** in accessing equity finance
- **Fostering skills, talent and innovation in microelectronics**
- Tools for **anticipating and responding to semiconductors shortages and crises** to ensure security of supply
- Building **semiconductor international partnerships** with like-minded countries

Our national strategy must allow Semiconductor Stakeholders within Ireland to access and leverage these supports. Ireland punches above its weight in the Semiconductor ecosystem but if complacent this advantage can be squandered. Need to compare to clusters such as Silicon Valley / Bay area, the North Carolina Research Triangle, Taiwan, Shenzhen, Rhein-Main-Neckar and Israel.

1. **Aspirations for the Sector:**
   - Increase the number of graduates choosing semiconductor-related fields, ensuring a steady pipeline of talent for the industry. Encourage STEM subjects in Primary and Secondary Education and educate Career Guidance Counsellors on the opportunities in the sector.
   - Cultivate a thriving ecosystem that supports semiconductor startups in Ireland, fostering innovation and entrepreneurship in the sector utilizing incubator centres such as the Rubicon or DCU Alpha along with access to a design platform, as envisioned in the EU chips act with access to free or heavily discounted CAD/EDA tools and semiconductor building block IP design libraries (schematic, layout, RTL,cdl,gdsII) to allow startups to focus on their differentiator and value add as envisaged in the CHIPS act under design tools and pilot lines. Govt could support free shuttle runs/multi-project-wafers for SME companies in EU fabs for prototype developments.
   - Foster collaboration between Semiconductor companies based in Ireland at a local business unit level through organizations such as MIDAS and also with users of semiconductors such as data-centres/PV/electronic design/manufacturers and other deep tech.
   - Support the ambition of semiconductor startup companies to scale to $B multinational level, rather than looking for earlier stage exits or acquisition, where growth may not happen in Ireland as IP developed in Ireland may result in benefits (hiring, corporate tax etc.) accruing abroad. it is important to not only encourage FDI through the acquisition of indigenous companies, but also provide support for local SMEs to grow both domestically and globally. This support should include increased government funding and access to European Union funding, allowing microelectronic companies based to Ireland or to establish their headquarters in Ireland to grow, scale and play a key role internationally.
   - Improve Ireland's position as a hub for semiconductor R&D both in Academic institutions such as MCCI, Tyndall etc. through targeted Govt. investment and in Industry, leveraging Ireland's R&D tax credits and other supports.
   - Utilize Ireland's strong semiconductor cluster to enable and accelerate our transition to a Green Economy by incentivizing development of chips for EVs, PV and other necessary technologies, and the take up of such technologies in Irish Solar and EV deployments
   - In addition to supporting "soft" RF/analogue/digital design and verification activities for domestic companies, also consider investing in manufacturing/packaging facilities in Ireland, operated by indigenous enterprises, to facilitate local production and increase local expertise.
   - The indigenous ecosystems of SMEs and startup not should only focus on IC design/verification or EDA fields, but solid fundamental research on semiconductor technologies and material technology. It extends to exploring new types of circuits and their development.
2. **Opportunities for the Sector:**
   - In general there is a huge opportunity for the Industry with the advent of Generative AI and the Green Transition mandating a surge in demand for semiconductors along with the continuing growth in Communications with Open RAN 6G and

Satellite/New-Space. With ageing populations and the health crisis, semiconductors will become even more ubiquitous and vital in MedTech.
  - Collaborate with educational institutions to promote semiconductor-related disciplines and create targeted programs to attract students, through institutions such as Tyndall/MCCI and SFI Research Centre for Future Circuits.
  - Capitalize on Ireland's reputation as a tech hub and its skilled workforce to attract semiconductor startups and investments.
  - Leverage government support and industry partnerships to address funding gaps and facilitate access to resources for semiconductor startups. Educate VC firms on semiconductor companies and bridge funding gaps. VCs struggle to understand or make a business case for the need for high expenditure on mask sets and wafers, CAD software and IP at early stage for even a proof of concept.
  - The EU Chips act (article 30) allows for R & D & I supports through the R & D & I state aid framework from member states up to 90% for small enterprises and 80% for medium enterprises as "design centres of excellence". Ireland should take advantage of this.
  - Ireland needs to consider how it could take advantage of the "Open EU foundry" opportunity envisioned in the Act.

3. **Challenges Facing Businesses and the Sector:**
   - Lack of graduates choosing semiconductor-related fields, preferring finance or higher level software careers rather than deep tech semiconductor/microelectronics.
   - Barriers to semiconductor startups, including limited venture capital ecosystem and high initial investment requirements.
   - Threats from other nations adopting nationalist/protectionist stances and investing in semiconductor fabs and companies, potentially reducing Ireland's competitiveness in the sector.
   - A more open tech transfer environment from Universities and Research Organisations is necessary. A restrictive short sighted approach can result in a higher percentage of nothing for the Institution, rather than the birth of a successful business or product which can have more positive returns for Ireland overall.
4. **Access to Talent for Businesses:**
   - Implement targeted recruitment initiatives to attract graduates to semiconductor-related fields, highlighting the industry's opportunities and rewards.
   - Develop specialized training programs and internships in collaboration with industry partners to bridge the skills gap and prepare graduates for semiconductor careers.
   - Offer competitive salaries, career development opportunities, and incentives to retain talent within the semiconductor industry. Govt can incentivize semiconductor sector career choices for young people through income tax incentives for semiconductor positions.
   - Standardized Visa process for Semiconductor Design/Fab Engineers to enter EU on a fast track can allow for growth in the Industry. Chip design is on the "critical skills" list and processing has improved since 2021/2022, however bottlenecks should be avoided.
   - Infrastructure in terms of Education, Healthcare and Housing is critical to underpin any growth.
   - Core education in RF/Analogue and DSP/Digital techniques and theory along with communication and computer science theory on top of a strong background of physics and maths is vital.

- Revise university courses to provide graduating engineers with a solid foundation in the tools used for IC design and verification, ensuring that fresh graduates are well-prepared to embark on IC development roles. Additionally, include fundamental electronics concepts as part of the curriculum to facilitate a smooth transition into the field.

5. **Barriers to Development:**
    - Strengthen Ireland's venture capital ecosystem to better support semiconductor startups, providing early-stage funding and mentorship.
    - Advocate for policies and incentives that encourage investment in semiconductor research, development, and manufacturing.
    - Promote collaboration between industry, government, and academia to address infrastructure needs and reduce barriers to entry for semiconductor startups.
    - The EU Chips Act focuses on “leading edge” and “first of a kind”technology but does not specify on what dimension the technology is leading edge. It could result in a focus on GAA (Gate All Around, not Gaelic Athletic Association) or FinFet advanced nodes which might not be advantageous in all applications such as for RF/mmWave or Analog. Other dimensions of innovation should also be supported through a “more than Moore” framework. Ireland could lead here. Paragraph 32 in the act does discuss this but it should be emphasised.
    - The supports available through the CHIPS act in Ireland should be broadly available and not focused on one specific application area or technology; not just e.g. A.I. or Quantum in danger of falling prey to the hype cycle. Should focus on the Semiconductor sector more generally as a foundational and enabling technology for many applications over broad areas.
6. **Mitigation:**
    - Establish semiconductor-focused venture capital funds or accelerators to provide targeted support for startups in the sector.
    - Ensure an Irish member and influence on the European Semiconductor Board proposed in the CHIPS act and a designate a fit for purpose “national competent authority” as required by the act.
    - Ensure the semiconductor competence centre as proposed in the Chips act is open and accessible to Irish semiconductor players and on a cost plus reasonable margin basis to allow lower cost, with preferential access and reduced prices for SMEs as stated in the chips act.
    - Enable and advocate for access to the Chips Act €2B “Chips for Europe” “Chips Fund” for Ireland based startups and SMEs and the €8.1B “Important Project of Common European Interest in microelectronics and communication technologies” to which Ireland contributes.
    - Develop a shared infrastructure, available in an incubator, specifically tailored for IC development dedicated to Irish startups and SMEs. This cloud-based environment would provide startups and SMEs with a ready-to-use, complete set of tools for design and verification, minimizing delays and reducing operational costs. Encourage new software companies to join the ecosystem, diversifying the IC development landscape beyond the dominant EDA players. This turnkey solution enables faster time-to-market and fosters collaboration, contributing to the growth and competitiveness of the semiconductor sector.
    - Establishing a dependable, cost-effective, and efficient IC development platform is a key means of government financing and institutional support for startups and SMEs involved in IC development and software development for IC EDA. This platform will

serve as a vital resource to foster innovation and facilitate the growth of these companies in the semiconductor industry.

- Favourable access to EU based OSAT could be important in developing Irish and European semiconductor supply chains, to be competitive with facilities in Taiwan/Malaysia/Philippines.
- Educational/career pathway re-skilling from CompSci/Software to Digital/DSP Design and/or Verification through an educational Institution.

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7th March 2024

Qualcomm Incorporated's response to Dept. for Enterprise, Trade & Employment's Consultation on Developing a National Semiconductor Strategy for Ireland

Qualcomm Incorporated[1] (together with its subsidiaries, "Qualcomm") is the world's leading wireless technology innovator. Our engineers developed the standards that sit behind 5G technology, and we are now doing the same for 6G, the next generation of mobile internet.

We are also one of the world's largest semiconductor design companies, and our innovations power many of world's best-known products and brands across mobile, wearables, IoT, XR/AR, infrastructure and automotive.

Qualcomm's position at the forefront of the development of these technologies means that we invest significantly in R&D. We were one of the first semiconductor companies to move to an entirely fabless business model to focus our resources on inventing and designing semiconductors, Since 1985, we have invested over $90bn on R&D globally to develop the innovative technologies of the future.

[1] Qualcomm Technologies, Inc., a subsidiary of Qualcomm Incorporated, operates the Qualcomm CDMA Technologies ("QCT") semiconductor business, which develops and supplies integrated circuits and system software based on 3G/4G/5G and other technologies for use in mobile devices, wireless networks, devices used in the Internet of Things, broadband gateway equipment, consumer electronic devices, and automotive systems for telematics, connectivity, and digital cockpit (also known as infotainment). Qualcomm Incorporated includes Qualcomm's licensing business, Qualcomm Technology Licensing ("QTL"), and the vast majority of its patent portfolio.

Qualcomm

Our site in Ireland plays an important part of our global operations and over recent years Qualcomm has invested heavily in expanding it, including our recent announcement that we are investing additional $127m, which will create approx. another 150 high skilled engineering jobs. This investment and the additional jobs we are creating make Ireland one of Qualcomm's fastest growing locations in Europe.

We welcome the opportunity to respond to the Department for Enterprise, Trade and Employment's public consultation on developing a national semiconductor strategy for Ireland and highlight the ways in which we believe the Irish Government can help deliver a more diverse semiconductor supply chain, while supporting the growth of the sector in Ireland.

Semiconductors have become an area of intense geopolitical interest, and we have seen significant policy interventions from the U.S. Government and European Commission to help develop a more diverse and resilient supply chains.

Qualcomm believes that Ireland is well-positioned to support efforts to diversify the supply chain, while also supporting the growth of the domestic sector and ensuring Irish firms have access to chips, they need to help fuel Ireland's further digital transition.

In our response below we make some general recommendations on the areas we believe Irish policymakers should prioritise when looking to at developing a national semiconductor strategy. This includes promoting a geo-diversified supply chain, opportunities for Ireland and supporting the semiconductor design sector.

Yours sincerely,

Tom Corcoran
Head of Government Affairs, UK & Ireland

Background

Semiconductors are ubiquitous in today's economy. They are the foundations of virtually all modern electronics and technologies, from automobiles and medical devices to smartphones and computers, while powering advances in virtual worlds and the AI revolution.

Accordingly, the demand for semiconductors continues at pace, thanks to digitisation and the growth of 5G connected IoT devices and the AI revolution. By the end of the decade, it is predicted that IoT alone could enable up to $12.6 trillion in global economic value by 2030, while 5G could generate more than $13.2 trillion in global economic activity by 2035.

1. Promoting a geo-diversified supply-chain

The semiconductor supply chain is highly interdependent through a collaborative manufacturing process, with many essential partners such as foundries, Outsourced Assembly and Test (OSAT) firms, and Electronic Design Automation (EDA) firms based in countries across the globe.

As such, since the supply chain is so integrated and globalised, it is essential that in an effort to develop a national strategy, the Irish Government must work in close partnership with its allies to develop a coordinated plan that helps diversify supply chains, while also strengthening the Irish semiconductor sector's ability to compete.

The main areas for cooperation include.

- **Increasing foundry capacity:** Ireland must work with its allies to look at ways to incentivise foundry capacity across the globe, particularly for communications devices, which will be integral to unlocking the economic value of 5G, IoT and AI.

- **Leading edge and legacy nodes:** In a similar vein, Ireland must work with its allies to ensure access to leading-edge and legacy nodes and a resilient long-term semiconductor supply chain. Semiconductors produced on leading and legacy process technology nodes continue to power thousands of critical technologies. For example, of the roughly 169 semiconductors in a typical smartphone, approximately 73% are made using legacy node processes.

Qualcomm

Coordination and cooperation amongst allies will be essential to creating a resilient long-term semiconductor ecosystem that helps meet future demand and an environment where the Irish semiconductor sector can compete.

2. Opportunities for Ireland

Ireland has played an important role in the design and fabrication of semiconductors for a number of years, with several of the leading players in the sector locating facilities on the island, which has helped create a successful indigenous sector.

Considering Ireland's existing sector and its leading academic institutions coupled with those efforts made by other jurisdictions including in the U.S. and E.U. to fund new foundries, we believe that Ireland's national semiconductor strategy should focus on how it can further develop and support the semiconductor design sector, which we believe represents the best opportunity for growth.

Semiconductor design companies, such as Qualcomm, are at the forefront of technological progress and provide the foundations for the entire semiconductor supply chain. This includes the most advanced innovations that power many in demand technologies, such as 5G, AI, IoT, cloud and edge computing, to name but a few.

3. Supporting Semiconductor design

Semiconductor design is highly capital intensive and requires significant investment in long-term R&D, often without the guarantee of a return, so in order to best develop and support the sector, it is important that policymakers focus on ways in which they can:

- **Reward risky R&D:** incentivise investment in risky R&D. This includes but is not limited to looking at further tax incentives such as more R&D tax credits and ways to facilitate collaborative research within the semiconductor industry.

- **Support innovation**: look at ways in which they can help strengthen intellectual property rights ("IPRs"), including patents, trade secrets, and standards protections, all of which are vital to a vibrant innovation ecosystem.

Accordingly, the need for talent globally has increased dramatically as the sector has grown and the demand for semiconductors has rocketed. So, it's important that the Irish Government works in partnership with the industry to ensure it has access to the talent it needs now but also in order to build a sustainable pipeline of future homegrown talent.

- **Accessing talent now:** As indicated, the competition for STEM talent has increased dramatically and firms' ability to attract the people they need, particularly from abroad, depends not solely on salary but also quality of life.
  - **Housing** – The availability and cost of accommodation in Ireland remains a significant challenge, so it is essential that policymakers pursue policies that help speed up the availability of high-quality housing for both rental and sale.
  - **Transport** – While ensuring international air connections remain important, it is also essential that policymakers look at improving Ireland's public transport infrastructure to make it easier and faster for people to commute or move between our towns and cities.
  - **Diverse communities** – Retaining talent requires individuals to be happy both at work and at home, so policymakers need to look at ways in which they can promote more diverse communities, particularly to help support those coming from abroad to feel safe, welcome, and supported,

- **Homegrown talent:** Developing a homegrown pipeline of future talent will be essential for building a sustainable semiconductor design sector that benefits Ireland.
  - **Promoting STEM** – In partnership with industry, policymakers need to do more to promote STEM subjects and careers, particularly to girls and those in under-represented communities.
  - **National plan for STEM** – Policymakers and educational institutions need to work in partnership with the sector to understand their needs to develop a coordinated national plan for STEM, which starts right at early years education, carrying through primary and secondary education and into second level

Conclusion

Qualcomm believes that because of its existing semiconductor sector, its strong academic institutions and its generally pro-business policy environment, Ireland has the potential to support and develop a strong semiconductor design sector, which can help play an integral role in driving a more geo-diversified supply chain.

Public consultation on the development of a National Semiconductor Strategy

Science Foundation Ireland (SFI) welcomes the opportunity to feed into this consultation.

Amongst other existing and future research investments, SFI has made significant investments through Research Centres where the National Semiconductor Strategy will be of particular importance. SFI have encouraged the Research Centres to participate in this consultation directly. As the strategy develops further, SFI would be delighted to make any necessary introductions between those developing the strategy and our research community if required.

SFI's input focuses on providing the Department of Enterprise, Trade and Employment with background information on research funded by SFI already on-going in the area and identifies funding mechanisms available in Ireland to meet the needs of the sector identified through this Strategy development process.

Please contact us if you need any further information.

In this document we provide information on:

1. National context summary

The EU Chips Act aims to double the EU global market share of semiconductors to 20% in 2030. Pillar 1 of the EU Chips Act establishes the Chips for Europe Initiative which aims to support technology capacity building and innovation across the EU to develop and deploy next generation semiconductor and quantum technologies at scale. In November 2023, Quantum 2030, the National Quantum Strategy for Ireland[1] was published. The strategy outlines a path for Ireland to be an internationally competitive hub for quantum technologies by 2030. To achieve this, we need to strengthen work in Ireland in fundamental and applied quantum research; nurture and develop a pipeline of agile, innovative, and highly skilled science and engineering talent; strengthen national and international collaboration; foster innovation, entrepreneurship and economic competitiveness and build awareness of quantum technologies and real-world benefits.

Ireland is mandated to meet EU 2030 climate action targets for greenhouse gas emission reductions, renewable energy, energy efficiency and electricity interconnection[2]. Therefore, there is a need to address energy consumption of semiconductors and sustainability in the technology sector. SFI is committed to climate action and sustainability[3], through conducting research sustainably and investing in research, for example, focusing on reducing energy consumption and the sustainable manufacturing, production, and packaging of materials and chips.

- SFI Climate Action Strategy[3]
- Climate Action Plan 2024[4]
- Irelands Draft National Energy Climate Plan (NECP) 2021-2030

2. Response to the thematic areas

2.1 **Aspirations for the sector** - *"What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?"*

- Ireland needs to continue investing in semiconductors to ensure it retains a competitive edge and stays at the forefront of research, innovation, and advanced manufacturing and achieves economic gains.
- Ireland must invest significantly into the research talent pipeline to provide the necessary research-level talent for the private and public sectors, This will build national capacity in this sector, will develop intellectual property, will increase national competitiveness, and will attract international investment. SFI has proven world-leading mechanisms standing ready to make this investment.

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[1] Quantum 2030: A National Quantum Strategy for Ireland. https://www.gov.ie/ga/foilsiuchan/126b4-quantum-2030-a-national-quantum-technologies-strategy-for-ireland/

[2] Irelands Draft National Energy Climate Plan (NECP) 2021-2030. https://www.gov.ie/en/publication/1d2c1-irelands-draft-updated-necp-2021-2030/

[3] Science Foundation Ireland Climate Action Strategy 2024-2027. https://www.sfi.ie/research-news/publications/SFI-Climate-Strategy.pdf

[4] gov - Climate Action Plan 2024 (www.gov.ie)

2.2 **Opportunities for the sector** – *"What do stakeholders identify as key opportunities for the sector to further develop?"*

- **EU Chips Act Investment.** The aim of the EU Chips Act is to double the EU global market share of semiconductors to 20% in 2030. To achieve this the EU will mobilise more than €43 billion of public and private investments. There is an opportunity for investment in R&D activities, PhD training and pilot lines[5] for Ireland to retain its research, innovation, and advanced manufacturing strategic strengths.
- **US CHIPS and Science Act.** The US CHIPS and Science Act announced in 2022 will provide $52.7 billion dollars in federal funding over five years for semiconductor research, development, manufacturing, and workforce development[6]. This package also authorises a $20 billion investment over five years into public R&D under the Strategic Translation initiative to accelerate the development of emerging technologies, such as artificial intelligence, quantum computing, advanced manufacturing and 6G communications. The National Science Foundation (NSF) Technology Directorate will direct the funds with similar investments happening across Europe, with governments seeking to secure a leading position in the sector, in new emerging technologies, so that they can benefit from the resulting economic growth.
  SFI have a long-standing collaborative partnership with the NSF[7]. There may be opportunities for future partnerships in semiconductor research.
- **SFI has a range of programmes to strengthen and build collaboration and partnerships between the public and private sector, examples include:**
  - *US-Ireland R&D Partnership Programme[8].*The US-Ireland R&D partnership programme is a unique initiative involving funding agencies across three jurisdictions: USA, Republic of Ireland and Northern Ireland.
  - *SFI Strategic Partnership Programme[9].* The Strategic Partnership Programme is a flexible mechanism for academic researchers to build strategic collaborations with key stakeholders including industry and other funding agencies.

2.3 **Access to talent for businesses** – *"What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?"*

- **SFI have a range of programmes to strengthen and build the skills pipeline for businesses now and in the future, for example:**

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[5] Ireland's role in the global semiconductor industry. https://www.tyndall.ie/contentFiles/Tyndall_Ireland's_Role_in_the_Global_Semiconductor_Industry.pdf
[6] The US CHIPS and Science Act. https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/
[7] €7 million joint investment for US-Ireland Research Programme. https://www.sfi.ie/research-news/news/us-ireland-programme/
[8] US-Ireland R&D Partnership Programme. https://www.sfi.ie/funding/funding-calls/us-ireland-rd-partnership/
[9] SFI Strategic Partnership Programme. https://www.sfi.ie/funding/funding-calls/sfi-strategic-partnership/index.xml

- *SFI Centres for Research Training*[10] build on research excellence to provide cohorts of academically outstanding research leaders with the skills and knowledge required to address the future challenges of an ever-changing work environment.
- *SFI Industry RD&I Fellowship Programme*[11] supports academia-industry interactions to address industry-informed challenges.
- *SFI-NSF I-Corps@SFI Entrepreneurial training Programme*[12] supports research teams based at eligible research bodies to participate in the NSF I-Corps Teams programme.

3. Semiconductor and related research funded by SFI

National Research Priority areas covered by SFI funded semiconductor and related research include Manufacturing and Novel Materials; Advanced & Smart Manufacturing; Future Networks, Communications & Internet of Things; Digital Platforms, Content/Applications & Augmented/Virtual Reality; Data Analytics, Management, Security, Privacy, Robotics & Artificial Intelligence (including Machine Learning); Therapeutics (Pharmaceutical) and Decarbonising the Energy System.

A) SFI Research Centres

Listed below are SFI Research Centres where semiconductor-based technology research or related areas is carried out. Of note, are the material Manufacturing SFI centres: IPIC, I-Form and AMBER.

IPICs core research programme is focused on integrated photonics, with key elements being the development and fabrication of discrete components through Tyndall Institute's semiconductor fabrication facility.

AMBER's research is focused on four thematic areas one of which is material for ICT. The primary focus of AMBER's materials for ICT research is on a materials roadmap and future process development to enable vertical stacking of compute, memory, and communications functionalities in a single chip.

The main goal of I-Form is to shape the future of manufacturing through high impact research into the application of digital technologies to materials processing.

"No Chips, No Digital". Semiconductor chips are ubiquitous with digital products and services and are essential to the digital and green transition. The CONNECT, Confirm, INSIGHT, Lero, ADAPT and SSPC SFI Research Centres perform research relating to ICT, Digital, Data Analytics and Pharmaceutical.

SFI Research Centre Name	Centre Director / CEO Name	Centre Contact Details
IPIC Irish Photonic Integration Research Centre	Prof Paul Townsend	

[10] SFI Centres for Research Training. https://www.sfi.ie/funding/centres-research-training/
[11] SFI Industry RD&I Fellowship Programme. https://www.sfi.ie/funding/funding-calls/sfi-industry-fellowship-programme/
[12] SFI-NSF I-Corps@SFI Entrepreneurial training Programme. https://www.sfi.ie/funding/funding-calls/i-corps@sfi/

I-Form Advanced Manufacturing Research Centre	Prof Denis Dowling	
AMBER Advanced Materials and Bioengineering Research Centre	Prof Michael Morris	
CONNECT: The Centre for Future Networks & Communications	Prof Dan Kilper	director@connectcentre.ie
Confirm Centre for Smart Manufacturing	Prof. Conor McCarthy	
INSIGHT - Irelands Big Data and Analytics Research Centre	Prof Noel O'Connor	
Lero - the Irish Software Research Centre	Prof Brian Fitzgerald	
ADAPT: Centre for Digital Content Platform Research	Prof Vincent P Wade	
SSPC Synthesis and Solid-State Pharmaceutical Centre	Prof Damien Thompson	

B) Research Infrastructure

The SFI Research Infrastructure Programme supports the research community in building and sustaining the required infrastructural capacity to accomplish high-quality, high-impact and innovative research. Through this programme, SFI has funded core (national) infrastructure including fabrication facilities, an Irish Quantum technology facility at the Tyndall National Institute; *in situ* transmission electron microscopy for observing material structure and dynamics at the nm-scale in environmental conditions and under external stimuli at the University of Limerick and infrastructure for Atomic scale visualisation and characterisation facilities at University College Cork, Maynooth University and Dublin City University respectively.

More details of these awards can be found here: https://www.sfi.ie/research-news/news/25-million-six-projects/ and here: https://www.sfi.ie/research-news/news/transformative-research/

C) National Challenge Fund

The National Challenge Fund[13] managed by SFI, is supporting research and innovation teams to develop transformative solutions for the green and digital transition. This €65 million programme is part of the Government's National Recovery and Resilience Plan and is funded through the EU's Recovery and Resilience Facility.

D) Individual Led Research (ILR) Awards

SFI funds semiconductor and related research across the Frontiers for the Future (FFP), Industry RD&I Fellowship Programme, Research Professorship Programme, EPSRC Partnership and Royal Society Fellowship Programmes. As part of the SFI Research Professorship Programme, Professor Seamus Davis joined University College Cork to spearhead a pioneering research programme to study Quantum Materials for Quantum

[13] Science Foundation Ireland Challenge based funding. https://www.sfi.ie/challenges/about-challenges/

Technology, in a joint appointment with the University of Oxford[14].Prof Davis is a world-renowned expert and leader in the field of quantum physics, who performs research in the area of quantum computing, who was awarded the prestigious O.E Buckley Physics Prize in 2023[15].

Further details can be provided on any of our other Individual Led Research awards in the area of semiconductors.

[14] World-Leading Experimental Quantum Physicist Joins University College Cork. https://www.sfi.ie/research-news/news/prof-seamus-davis-ucc/
[15] UCC Professor named first Irish winner of prestigious international physics award. https://www.sfi.ie/research-news/news/international-physics/

Submission to the Department of Enterprise, Trade and Employment public consultation on the development of a National Semiconductor Strategy

Scope of Submission

Skillnet Ireland welcomes the opportunity to make a submission to the Department of Enterprise, Trade and Employment public consultation on the development of a National Semiconductor Strategy, to help inform the measures and initiatives Ireland can introduce to take full advantage of the opportunities posed by the EU Chips Act, and to meet ambitions for the sector.

In inviting submissions, the Department of Enterprise, Trade and Employment has asked for stakeholders' views according to a number of themes. Skillnet Ireland has limited its submission to the theme of accessing talent for business and skills needs, as this is the area in which it can add the most value, insight, and expertise.

Response

Theme: Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

Introduction

The key aim of the European Chips Act is to boost Europe's technological sovereignty, competitiveness, resilience, and to contribute to the digital and green transitions. Talent is at the very forefront of the digital and green transitions, and one of Ireland's major competitive strengths is its highly skilled workforce. It is therefore the collective task for Government, industry, and workers to continue to develop the array of necessary skills to achieve, and benefit from, a digital and low-carbon future.

As the national talent development agency of the Government of Ireland, Skillnet Ireland is engaging widely with industry to develop the skills that will boost Ireland's capacity to accelerate the digital and green transitions, build sustainable businesses, and fuel innovation through our Skillnet Business Networks and national upskilling initiatives. Skillnet Ireland's deep roots with enterprise allows us to respond to policy and skills challenges in a proactive and agile manner. Our enterprise-led approach is a cornerstone of our success, facilitating cohesive enterprise networking and the flexibility to respond to ever-changing skills demands across all sectors.

MIDAS Electronic Systems Skillnet

Skillnet Ireland has a number of Business Networks focussed on developing digital, technology and manufacturing skills in the workforce. MIDAS Electronic Systems Skillnet (MIDAS Skillnet) is specifically focussed on meeting the training and upskilling needs for businesses and employees in the semiconductor sector. MIDAS Skillnet is a key component of Ireland's semi-conductor ecosystem and its role in enhancing the attractiveness of Ireland for Foreign Direct Investment is recognised by the IDA and other key industry stakeholders.

MIDAS Skillnet, promoted by MIDAS Ireland, aims to provide industry-led high-quality training locally and to support professionals in the sector who wish to learn the latest technical, managerial, and other skills, which are required in the highly competitive and evolving electronics industry.

In 2023, MIDAS Skillnet provided training and upskilling programmes for over 450 employees in 35 companies within the electronics sector in Ireland. The MIDAS Skillnet is enterprise led, supporting the semiconductor and electronics ecosystems in Ireland, servicing talent development to meet the needs of businesses within this growing sector, and helping achieve the stated goals of the EU Chips Act.

Programmes delivered by MIDAS Skillnet range from specialised technical programmes such as Digital and Analog IC Design courses, SystemVerilog and UVM language for IC Verification, C Programming for Embedded Systems, Python for data analytics, to management and leadership development training.

Continuous Professional Development (CPD) Modules

Where a skills gap is identified, Skillnet Ireland facilitates industry and higher education institutions (HEIs) to work together to design new upskilling programmes and new educational qualifications that ensure Ireland's talent pipeline is appropriately skilled to maintain a thriving national economy. These co-created programmes ensure that students, learners, researchers and innovators are equipped with the necessary skills to progress in their chosen specialisms and pathways.

MIDAS Skillnet is a collaboration between semiconductor and electronic system companies based in Ireland to meet their mutual needs of world-class cost-effective training held locally for skilled employees in the sector. CPD modules act as a foundation, or as induction courses, for various areas of specialisation within IC design, IC Verification and testing.

MIDAS Skillnet has increased collaboration between member companies to identify skills gaps and scope CPD modules to bridge those gaps, and to select the best training partner to deliver each CPD module. The MIDAS Skillnet acts as a catalyst to make HEIs aware of the sector's training needs and to collaborate with the best HEI to partner with industry and address that training requirement, thereby growing and supporting the semiconductor ecosystem in Ireland.

To date, MIDAS Skillnet has partnered with three HEIs to create four level 9 accredited CPD modules:

CPD Module	HEI Training Partner
Digital IC Design CPD Module	TU Dublin
Digital IC Verification CPD Module	TU Shannon
Analog Test & Measurement CPD Module	University of Limerick
Digital Test CPD Module	University of Limerick

Midas Skillnet is also developing two additional programmes in development, which are set to launch in 2025:

CPD Module	HEI Training Partner
Advanced Digital IC Design CPD Module	TU Dublin
Embedded Systems CPD Module	TBD

Skillnet Ireland's co-creation model plays a vital role in facilitating engagement between industry and the tertiary education sector to develop cutting-edge programmes designed to meet future skills needs across a range of sectors, including the semiconductor sector. It allows industry to identify and proactively address future skills needs and emerging gaps in existing provision. Co-created programmes are delivered at varying NFQ levels, ranging from postgraduate programmes to specialist micro-credentials.

Electronics Sector Resources & Skills Needs Research Report

In 2021 MIDAS Ireland and MIDAS Skillnet published a Skillnet Ireland-funded report, ***Electronics Sector Resources & Skills Needs***. The report provides a comprehensive overview of the skills and talent needs for the future success of the sector in Ireland, identifying the specific critical skills the electronics sector will require over the coming years to take full advantage of growth opportunities.

The report is based on data collected from almost 70 companies within the electronics sector with a specific focus on companies carrying out R&D activities in Ireland. Those companies range from some of the world leaders in the sector to small Irish-based SMEs.

Following an analysis of the survey results and extensive consultation with industry, the report sets out a number of findings and recommendations and suggested actions across four categories: (1) Skills / Training, (2) Resources – Graduates, (3) Resources - Increase Talent Pool, (4) Sector Image.

Future Skills Needs for the Semiconductor Sector

One of the five strategic objectives of the European Chips Act is to address the skills shortage and attract talent into the EU semiconductor ecosystem. The 2021 MIDAS Skillnet report found that availability of talent has the potential to constrain growth in the semiconductor sector and the need to upskill the existing workforce remains critical for future competitiveness.

This report also signalled that the semiconductor sector in Ireland could hire more than 100 electronic engineering graduates per year if they were available from Ireland, emphasising the need to attract and upskill existing engineers within the Irish workforce to increase the talent pool in the semiconductor sector.

MIDAS Skillnet has seen very strong growth in demand for training for Embedded Systems designers since 2021 and the MIDAS Skillnet Steering Group, comprised of eight managers from the sector, have prioritised the need to develop a Level 9 Embedded Systems CPD Module in 2024-25. MIDAS Skillnet has found the highest demand and fastest growth rate in 2024 for upskilling is in Digital IC Verification engineering.

Additionally highlighted in the 2021 MIDAS Skillnet report, skills in areas such as critical thinking, problem solving, and resilience will play a crucial role in Ireland's competitiveness in the semiconductor sector. Skillnet Business Networks upskilling programmes cater to the breadth of specialist skills needed for the technology and manufacturing sectors, but also the transversal skills and leadership development supports needed to support the workforce, and particularly Irish-based SMEs.

Other Skillnet Ireland Supports

Companies within the sector can also avail of upskilling supports from other Skillnet Business Networks, including **Technology Ireland ICT Skillnet** and **Cobotics Skillnet,** which offer upskilling programmes in technical areas such as artificial intelligence and mechatronics engineering, as well as project management and leadership development programmes.

Conclusion

Talent and skills for business must form a key consideration in the development of a National Semiconductor Strategy. Continuing to strengthen the workforce skills and talent pipeline is crucial for an industry that is experiencing talent shortages and where demand is set to increase in the coming years, due to semiconductor use in artificial intelligence and machine learning, electric vehicles, cloud computing, and their role in the provision of green energy and the electrification of industry.

Engaging enterprise in the design of new upskilling programmes and new educational qualifications, including the re-design of existing programmes, will be critical to ensure Ireland's workforce is appropriately skilled to meet the existing and future needs of companies working within the semiconductor sector. Skillnet Ireland's co-created model, which facilitates engagement between industry and HEIs when designing upskilling programmes, can help to equip students, learners, researchers, and innovators develop the necessary skills to progress in their chosen specialisms and pathways, and facilitate better employment outcomes in this sector.

As Ireland's national talent development agency, Skillnet Ireland and its Business Networks and schemes will continue to work closely with industry and HEI partners to identify and address skills gaps within the semiconductor sector to support workforce development, and to enhance the productivity, competitiveness, and sustainability of businesses in Ireland and the Irish economy.

About Skillnet Ireland

Skillnet Ireland is the national talent development agency of the Government of Ireland. In partnership with industry and the education and training sector, Skillnet Ireland offers training and upskilling programmes and business supports to companies through 70 Skillnet Business Networks, and three national initiatives: Skillnet Climate Ready Academy, Skillnet Innovation Exchange and MentorsWork. These upskilling programmes and initiatives are designed to support and enhance the productivity, competitiveness, and sustainability of Irish businesses and the Irish economy.

Skillnet Ireland makes a substantial contribution to the national workforce agenda. We provide upskilling services to over 24,500 businesses annually through our Skillnet Business Networks and national upskilling initiatives. Our cost-sharing approach with employers has been a cornerstone of the success of Skillnet Ireland, and has earned international recognition from the EU, the OECD, and the ILO, amongst others, as a best practice model for workforce development.

Skillnet Ireland's network-based approach captures the spirit of collaboration that lies within the Irish business ecosystem and enables cohesive enterprise networking and the flexibility to respond to ever-changing skills demands through both formal and informal learning. Fostering the sharing of intelligence and insights among industry partners to ensure training interventions are relevant to the needs of enterprise, which drives excellence in learning, innovation and knowledge transfer, and supports businesses in developing their competitive advantage.

Skillnet Ireland's collaborative approach also ensures a cohesive response to government policy. Skillnet Ireland delivers on a range of actions assigned to it across major cross-Government strategies, including the National Skills Strategy, National Digital Strategy, the Climate Action Plan, Housing for All, National Competitiveness Plans and Regional Development Plans.

Skillnet Ireland is funded from the National Training Fund through the Department of Further and Higher Education, Research, Innovation and Science.

Ollscoil Teicneolaíochta an Oirdheiscirt
South East Technological University

Department of Enterprise,
Trade and Employment
23 Kildare Street,
Dublin 2,
D02 TD30

15th March 2024

Re: Submission from South East Technological University (SETU) on the National Semiconductor Strategy Consultation.

Dear Mr. Hughes,

Silicon Chips are key enablers of digital technology and thus are essential to industries such as communications, space, automotive, medical and defence [1]. The Faculty of Engineering at SETU educates highly skilled graduates for the sector and is acutely aware of the current demand for engineers and tradespersons of all engineering disciplines. Moreover, a recent survey by the South East Regional Skills forum, of which SETU is a member, has indicated that demand for future skills in the field is expected to increase in derivative fields such as AI, Robotics, Cybersecurity [2].

Recent shortages regarding the supply of silicon chips have affected the lives of citizens across Europe and the wider world. This disruption has been acutely felt by the automotive industry with silicon chip shortages resulting in the inability of car manufacturers to complete new-car builds. This has led to severe delays in the supply chain. These silicon chip shortages have been a ‘traffic jam’ for global industry - which runs on semiconductors - and a wake-up call. However, this also brings an opportunity to learn from this stress-test and to examine more closely the tiers of the supply chain in order to make the system more robust and prevent such shocks in the future [3].

In response to these critical issues the EU has moved to pass the European Chips Act (2022). This important act seeks to reinforce the semiconductor ecosystem to ensure the future resilience of supply chains and reduce external dependencies. It is a key step in restoring the EU’s technological sovereignty. Therefore, the Chips Act is not simply another investment package, but a recognition from the EU administration of the importance of semiconductor technologies. It is the EU stepping-in to support and rebalance activity in the industry back towards Europe in order to underpin technological sovereignty. This precipitates a set of opportunities for the semiconductor landscape in both Ireland and the EU.

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SETU is a long-standing member of MIDAS (Microelectronics Industry Design Association of Ireland), and continually collaborates with other centres of excellence and institutions (MCCI, Tyndall etc). The Faculty of Engineering has the highest number of IC designers of all the HEIs in the country with expertise in areas such as Analogue, Mixed Signal, Digital Design and Verification, RF, Artificial Intelligence and Machine Learning. Our activities support industrially aligned R&D activities from HPSUs through large MNCs. Engineering students at SETU are educated using industry standard ASIC and FPGA design tools from leading EDA providers such as Cadence, Synopsys and AMD/Xilinx. Our graduates are regularly recruited by leading integrated circuit design and manufacture companies such as Intel, ADI and Maxim. Our undergraduates have won the All-Ireland MIDAS Final Year Project competition numerous times and SETU provides courses in IC Design through *Skillnet Ireland*.

From this standpoint, proposals from SETU to support the ambitions of the EU Chips Act and in accordance with the outlined themes from the Department of Enterprise Trade and Employment are as follows:

access to talent for businesses / barriers to development

1) In educating graduates to meet the needs and growth of the sector, SETU proposes the creation and delivery of a new specialist Integrated Circuit Design Apprentice/Fellowship programme. This programme will leverage existing SETU expertise and proven track record in delivering traditional apprenticeship programmes. Apprentices on this programme will receive specialist training in IC Design, Verification, Test and Application Development. Paid employment, whilst achieving NFQ Level 8 (Bachelors) and Level 9 (Masters) industry supported qualifications, will entice much needed talent to the sector. The calibre of those completing the apprenticeship will be equipped to be the future leaders in Ireland's semiconductor industry.

2) Novel semiconductor and integrated circuit research is a critical but challenging area, and competes for research funding with related application technologies such as MedTech and Social Media. In recognition of semiconductors as a critical technology and a key enabler of other advancements; and to develop, nurture, encourage and retain post-graduate talent in the field, it is proposed that additional research funding be provided by the relevant bodies to support a pipeline of semiconductor research projects, and Post-doctoral, PhD and Masters -level candidates. The IRC Employment Based Postgraduate funding model is inherently compatible with this aspiration and further allocations under this scheme could only help develop much needed talent for the sector.

aspirations for the sector

3) In order to maximise the impact in research activity and output, efforts should be made to retain the candidates of successful and suitable postgraduate programmes. SETU proposes the creation of roles for specialist *Adjunct Fellows*, recruited from those who have a recognised, proven-industry track record in the semiconductor field. These Fellows are to act as advisors, mentors in both technical/engineering and business capacities. The positions are proposed to harness the years of experience of "*industry veterans"* to maximise the commercial viability of suitable research outputs.

   Moreover, a successful model in Ireland for the MedTech sector has been the Bioinnovate programme, which is modelled and officially affiliated with the Stanford University Biodesign programme [4,5]. A similar programme could be developed and run with IC design and manufacture as the focus.

opportunities for the sector

4) The Chips Act not only provides opportunities for a strategic *ground-up* approach, but also for *top-down* alignment, i.e. large, overarching, national-level actions that can advance the technological eco-system. The 're-patriation' of technologies such as advanced chip packaging should be considered under the ambitions of the Chips Act. Such technologies require expertise beyond the obvious manufacturing requirement and would require advanced design/simulation capabilities supported by areas such as electromagnetic and finite element analysis. The impetus for the Chips Act has been to address the loss of EU technological sovereignty. This loss is due to many important manufacturing techniques moving to geographies in the East. Thus, top-down, national-level endeavours should include efforts to address the re-balancing of manufacturing, supply and design, back towards the EU and Ireland. This is one of the bigger, and unique opportunities afforded by the Chips Act, which should not be overlooked in a national strategy.

challenges facing businesses and the sector

5) One of the pillars of the Chips Act, relates to monitoring semiconductor supply chains in order to provide an early warning of potential supply chain issues and avoid large scale disruptions as impacted the automotive industry in 2021. It is not initially clear how such monitoring systems would operate for the entire ecosystem. However, given the volume of semiconductor parts that Ireland is responsible for and our leadership role in the International Financial Services Industry, we are better placed than many other areas in the EU to deliver such a capability. Furthermore, skilled graduates in Global Supply Chain Management are available to support the endeavour.

mitigation

6) The Irish semiconductor industry has been hugely successful over the past number of decades and the phenomenal work of the IDA and Enterprise Ireland is responsible for attracting large MNCs and growing indigenous companies. Over time, market forces have caused a shift in the centre of gravity of the manufacturing base away from Europe, resulting in the need for the Chips Act to attempt to redress the balance.

   Typically, a successful indigenous HPSU progresses from growth phase to acquisition by MNC, whereupon post-acquisition/merger locale of the former may no longer be EU-based. In order to retain the technological expertise and innovations, new models of growth, funding and operating HPSUs could be investigated and supported. The impetus is for strong and sustained growth coupled with the aim to retain businesses, people and expertise within the EU [6].

Pat Gelsinger, the current CEO of Intel, is quoted as saying "the world runs on semiconductors." We have seen the evidence of the truth of this statement in recent years as the semiconductor chip shortage was felt by citizens from all demographics throughout the world. In the home, electronic devices which had supported our daily activities became more difficult to obtain, cars lay unfinished in automobile factories and even electronic components for student projects in HEIs were no longer readily available.

Thus, the importance of bolstering the European chip industry and its supply chains has become a top priority for the EU, with the vanguard of the response being the EU Chips Act 2022. Our proposals are a response to this call for action on the part of Ireland and the EU. We have outlined a *ground-up* and *top-down* (dual) industry-academic collaborative approach to address the national- and EU- level imperative to further develop and harness skills and investment in the semiconductor eco-system.

The societal impact from this dual response would be (i) enhanced security of EU technological sovereignty for integrated circuits and industries reliant thereon, (ii) citizens being able to obtain the devices they require in a timely manner, and (iii) an integrated approach from regional to national to EU economic growth as a whole.

SETU welcomes the opportunity to make this submission and looks forward to further engagement with the Department.

Yours sincerely,

Dr. Leon Cavanagh,
IC Design & Verification Lead

Dr. Donnacha Lowney,
Head of Department: Electronic Engineering & Communications

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Pathway to double: Expanding the footprint of Ireland’s semiconductor sector

Contents

About Technology Ireland

Technology Ireland is the leading representative body for the technology sector in Ireland consisting of the ICT, Digital and Software industry. The Association is a proactive membership organisation with companies located throughout Ireland. With origins dating back to 1968, the association was formed in 2017 by the merger of ICT Ireland and the Irish Software Association. We advocate on behalf of Ireland's indigenous and foreign direct investment (FDI) technology companies to Government and policy makers.

Pathway to Double: Expanding the footprint of Ireland's semiconductor sector – Technology Ireland's submission to the Department of Enterprise, Trade and Employment's consultation on a National Semiconductor Strategy

Introduction

Technology Ireland, the Ibec group representing the technology industry, welcomes the Department of Enterprise, Trade and Employment's public consultation on a National Semiconductor Strategy. We welcome the Department's stated aim to take full advantage of the opportunities posed by the EU Chips Act and future ambitions for the sector. We hope this submission will prove helpful and informative in delivering a framework which unlocks the world-leading potential of Ireland's semiconductor industry. As this paper will outline, Technology Ireland's vision for the semiconductor industry in Ireland is for it to be recognised as a strategic sector of the Irish economy and that a National Semiconductor Strategy would put in place a resource-backed action plan to double its size; taking an ambitious approach across talent & skills, investment, Research & Innovation (R&I) and Ireland's role in the EU.

As the Department recognises in the consultation's preamble, the *National Semiconductor Strategy* comes at an important time for the industry as new technological advancements are set to drive demand for semiconductor manufacturing in the industry in future years. Now is an opportune moment for Government to recognise the strategic importance of the sector to the Irish economy. Along with the EU's 2030 Digital Decade targets, the ambition set out in Government's National Digital Strategy, *'Harnessing Digital: the Digital Ireland Framework'* across the areas of the digital transformation of business, public service and equipping Ireland with modern digital infrastructure will only be accomplished if resourced by a scaled-up and thriving semiconductor manufacturing sector.

Technology Ireland supports Tyndall National Institute's suggestion that *"Ireland can and must*
build on its strengths in chip design, deep-tech, smart manufacturing and chip fabrication to

strengthen and grow its technology sector".

Ireland's semiconductor manufacturing creates a supply niche of strategic value Europe and to the wider world. On an industry wide basis, the semiconductor sector employs over 20,000 people in Ireland – and is responsible for €13.5 billion of exports annually (approximately 7% of Ireland's GDP in 2023). As the global semiconductor industry is set to reach $1tn by 2030, and as Ireland and the EU look to accelerate the twin green and digital transitions, it is the semiconductor sector itself that will underpin the realisation of these ambitions. Technology Ireland supports efforts to advance the twin transition, developing Ireland's digital leadership in the EU and wider world while maintaining market openness, access, innovation and choice.

1) A whole-of-Government plan with resources to match: aspirations for Ireland's semiconductor industry in the coming years & opportunities for the sector to further develop

Semiconductor manufacturing and design is a strategic sector for Ireland's economy; responsible for driving exports and fostering a knowledge base of high-skilled employment and research collaboration. Ireland's semiconductor industry is a dynamic ecosystem of innovative multinational and indigenous enterprises, with activities ranging from semiconductor design to manufacturing, to research and development. Many of the major global technology companies are headquartered in Ireland, which coupled with excellence in research & development gives us a strong position globally to seize the opportunities available to the sector in coming years.

Recent years have seen countries around the world consider their security of supply in relation to chips, particularly given the importance of chips to underpinning everything from communication to financial infrastructure. The importance of this became even more apparent during the COVID-19 pandemic when business activity and social lives became remote and increasingly reliant on technology. Recent global instability has increased attention on security of supply across numerous critical resources and materials. The EU Chips Act sought to develop a framework for security of supply, addressing Europe's capacities and developing production in chips manufacturing. Technology Ireland has continually encouraged the EU to reflect Ireland's open, globalised and pro-enterprise approach, reinforcing the importance of international partnerships, the complexity, interconnectedness and interdependence of the broader technology industry. The semiconductor sector is no different, and while ensuring we maintain resilient supply chains is prudent and essential to Europe's ambitions, so too is an approach that avoids inward-looking, protectionists policies and that recognises that being a digital leader is about working in tandem with global partners. Ireland's semiconductor ecosystem is also unique, a leader in niche areas and with vibrant activities cross-border and as such opportunities should be considered on an all-island basis.

To advance Ireland's ambitions, a National Semiconductor Strategy should:

- **Recognise the strategic importance of the semiconductor sector for Ireland and realise its possibilities with a whole-of-Government plan with the resources to match.** A National Semiconductor Strategy will only be as good as the tools at disposal to implement it. Ensure the

Strategy has a strong chance by backing it up with an action-led Advisory Council to drive it, keeping Government informed and aware of progress and competitive developments in the global semiconductor sector.

- **Take a whole of Government approach to implementing the aims of the strategy.** Too often, the onus for digital policy competence is spread out between myriad Government departments and agencies. Technology Ireland has long called for cohesion and coordination in order to ensure Ireland not only leads on digital but also maintains a reputation in the EU for being a reliable digital regulator. This is integral for Ireland to maintain existing and attract new digital business. The National Semiconductor Strategy should spell out how a coherent and joined-up approach will be taken to its implementation.
- **Aim to double the footprint of Ireland's semiconductor sector.** As this paper will set out, this means doubling the ambition and focus on the sector by Government. This will mean doubling down on a renewed focus across talent, skills, attracting investment and promoting innovation and the development of a startup ecosystem. The nation has the potential to be both a hub for semiconductor innovation and to become a powerhouse in supplying products designed and manufactured in Ireland. In 2023, Ireland's semiconductor industry was estimated to employ approximately 20,000 people and generated an estimated revenue of 15.5bn. With the industry itself set to reach $1trn by 2030, it can be considered as a significant contributor to both the national and global economy.

Ireland has the potential to be a European and global hub for the wider semiconductor industry. Government needs to carefully examine ways to ensure that Ireland's competitiveness continues to grow and evolve in line with the global economic environment.

- **Consider that a National Semiconductor Strategy should be a flexible framework**, agile enough to respond to geopolitical uncertainty and global developments; a living strategy that positions Ireland's semiconductor sector where its interests are best served at pace with international shifts.

- **Recognise that the wider economy is reliant on a policy framework which advances research and innovation in the semiconductor sector.** In the next few years, semiconductor manufacturing will be critical to advancing the green and the digital transitions, both of which Ireland wishes to a leader in, but both of which can only be met through innovation in the semiconductor sector. Advancements in AI as well as requirements for data storage will only be as good as innovations in the semiconductor industry, meaning an innovation-led policy framework and plan for investment in this industry is of critical and strategic importance. Ireland should invest in manufacturing facilities and design to propel the growth and scale of the industry in Ireland so it can continue to compete globally.
- **Consider Ireland's strategic position as opportunity within the global semiconductor industry.** Ireland's semiconductor sector focuses on niche areas, meaning other parts of the world are reliant on us to power their economies. We should continue to carve out a space in strategic niches. As geopolitical instability causes other countries to review the security of their supply chains, the availability of critical materials for technological advancement and their energy resources,

Ireland has an opportunity to present evidence of itself to the world as a stable and reliable economy with the skills, capacity and knowhow to supply the rest of the world.

- **Aside from manufacturing, design is a critical part of Ireland's niche offering on semiconductors.** Ensuring Ireland further strengthens its position in this niche will require continued investment in R&I, in fostering design talent and other areas. Moreover, other elements of the incoming supply chain, including semiconductor equipment suppliers, materials and chemicals suppliers, along with other support functions should be supported with a view to developing a world-class semiconductor manufacturing ecosystem in Ireland. The National Semiconductor Strategy should embrace an open ecosystem built on open standards for collaboration among partners to help foster chip design innovation for the benefit of end-users preventing lock-in and enabling competition. It can do this by:
    - Setting a national research agenda: We support the Irish government's initiative to developing a National Semiconductor Strategy that focuses not only on Ireland's strong manufacturing base, but also on advanced semiconductor research programmes. It is only by investing in world-leading capabilities in semiconductor product R&I and the associated ecosystem that the Irish semiconductor industry can be globally competitive and a leader in Europe,
    - Building broad coalitions: Industry stakeholders and government organisations should team up to share the benefits of good jobs and educational opportunities,
    - Focusing on education and the future workforce: We recommend that a portion of investment funds go towards creating advanced semiconductor research programmes at universities, fostering diverse student populations and creating national microelectronics training networks,
    - Nurturing innovation: We recommend that investments are used to provide startup companies and academic researchers with financial support and essential access to state-of-the art prototyping tools and facilities.

- **Embed a global outlook in the National Semiconductor Strategy.** Consider how Government will engage at EU level, with the US, and further afield to promote the Irish semiconductor sector's interests. Place Ireland at the centre of international developments on semiconductors.
    - **Ensure Ireland's voice is heard internationally with an Irish voice on the European Semiconductor Advisory Board.**
    - **Make a push at an EU level for greater access to talent.** Outsize the possibilities for Ireland's semiconductor sector by attracting talent across the continent.

2) Maintain and enhance the competitiveness of Ireland's semiconductor sector

The growth of the sector as so far outlined can only be achieved by having a clear and long-term vision of how these building blocks fit together to create an environment for semiconductor competitiveness, where Ireland not only attracts FDI but also has the best chance of retaining it. Ensure Ireland does not fall behind other global competitors by addressing challenges faced by the semiconductor sector, including:

- **Ensure an agile, responsive and fit-for-purpose planning system which meets strategic and important investments with predictability**. Support, rather than hinder, strategic sectors of the Irish economy such as semiconductors which underpin our digital transformation. Companies cannot seize market opportunities if they are slowed down by unpredictable and burdensome planning delays. Lack of certainty and consistency in planning decisions is a barrier to the future development of the semiconductor sector in Ireland. There is a need for a substantial programme of change and improvement initiatives to implement procedural, operational and organisational improvements and investment to modernise case management in the Irish legal system.
- **Ensure a secure energy supply for Ireland and its semiconductor sector.** A doubling in size of Ireland's sector will lead to greater energy demands. This means Government has to be future focused on ensuring security of supply. A strategy for onshoring is required to ensure the ambitions of the industry are met. Moreover, consider how the industry itself, such as with photonics, can reduce energy demand in other areas of the economy. The cost of electricity is an ongoing threat to Ireland's relative competitiveness. Ireland's current electricity prices are more expensive than prices in competitor countries.
- **Encourage and incentivise sustainable thinking in terms of how raw materials and water are sourced**; in terms of minimising greenhouse gas emissions and waste; in terms of how local ecosystems can be protected and preserved; in how its suppliers and wider supply chains are impacted; and in terms of its wider corporate responsibility.
- **We share the view that Ireland has significant potential for the development of offshore renewable energy, particularly offshore wind, that can aid in the delivery of our long-term climate goa**ls, provide clean and competitive power to ensure Irelands' energy security, fuel economic growth and power the twin transition of decarbonisation and digitalisation. Renewable energy is critical to the semiconductor sector's ability to grow and thrive in Ireland. We share Government's ambitions for the clean energy transition and consider ourselves partners in the country's goal to reach net-zero greenhouse gas emissions and 80% renewable energy on the system by 2030. To reach these goals the deployment of new renewable energy supply needs to be rapidly accelerated.
- **Avoid being outpaced by global competitors on incentives. Ireland requires a strategy for maintaining investment**. Design a comprehensive and competitive incentive program so that Ireland can continue to attract and retain the employment and innovation intensive semiconductor manufacturing industry, not just for new facilities but also for upgrading existing facilities. With the European Chips Act, the EU is making available considerable funds for investments in semiconductor R&I initiatives and is creating platforms for work force training, skill and talent development. We believe that the Irish national semiconductor strategy should complement these priorities by creating a strong semiconductor R&I infrastructure, educating and training the next-generation semiconductor workforce, and driving a national research and innovation agenda. Specifically, the Irish National Semiconductor Strategy should ensure allocation of a significant portion of available

funding to directly fund a national research agenda. The research agenda should be broad in scope and address the following areas:

- energy-efficient computing architectures and domain-specific accelerators,
- heterogeneous packaging and interconnect technologies,
- design automation tools and methods,
- semiconductor and system security,
- materials, process, and manufacturing technologies,
- semiconductors and life sciences.

3) A talent pipeline for a growing and strategic sector:

To address skills needs across the island, a National Semiconductor Strategy should:

- **Invest in a workforce fluent in semiconductors, which fuels breakthroughs and will propel Ireland ahead of competitors in the sector**. Promote advanced R&I capabilities and encourage industry-academic partnerships on an international and all-island basis. Establish collaborative relationships with global semiconductor technology hubs, universities and research institutions, as well as with governments and industry associations, to promote knowledge sharing, technology transfer, and market access.
- **Aim to double Ireland's R&I capacities in semiconductors on an all-island basis**, leveraging a partnership approach with industry, researchers and academia. Consider talent on an all-island economy basis, creating linkages cross-border in both industry and academia. Take an all-island approach to the semiconductor sector, recognising that research and innovation activity as well as the activity of the industry itself happens on an all-island, cross-border basis and that its ambitions are best served by a joined-up approach, e.g. linking activities to Northern Ireland's photonics cluster.
- **Maintain and enhance Ireland's position in the global semiconductor industry by continuing to attract top global talent.** A significant portion of semiconductor manufacturing workforces are hired from overseas. Ensuring that talent hired from abroad stays in Ireland and continues to come here, along with increasing the talent pipeline here is key to attracting new investments as well as scaling investments which are already here. A National Semiconductor Strategy should take measures to ensure Ireland remains an attractive location for overseas talent, which the sector here relies on for high-skilled roles as well as research and innovation. Addressing the demand for skills and potential shortages is multifaceted and usually requires vocational studies in addition to graduate and postgraduate qualifications. The industry is increasingly reliant on talent from abroad, posing several challenges in a market with high global demand. As the sector expands worldwide, this challenge is expected to intensify with heightened competition. 'Harnessing Digital', Ireland's Digital Strategy, has committed to raising the base level of digital skills of the next generations to enter the workforce – as well as ensuring adequate reskilling of the current workforce. By doing this, Ireland can maximise the use of existing,

acknowledged and diverse routes to increase the number of people ready to get well-paid jobs in the semiconductor sector.

- **Efforts to address persistent challenges around housing and infrastructure across the island must be expedited if Ireland's footprint in the broader technology industry is to be sustained into the future.** It is essential that ongoing lack of supply in housing is addressed to ensure long-term housing options are available and that joined-up transport options are developed across the island. Persistent challenges in this space impact the ability of companies to attract and retain talent as well as impeding their access to high-quality research.
- **A National Semiconductor Strategy should also support and complement the EU's Proposal for the Creation of an EU Talent Pool** which is intended to help facilitate international recruitment and providing job opportunities for jobseekers from third countries residing outside the EU having the skills required to work in shortage occupations including those for the high-tech sector. Specifically, the intended national contact points for the practical implementation at a national level and the registration of employers should be reflective of Ireland's strengths in the semiconductor sector.
- **Talent and skill development is one of the most critical elements of enabling innovative strength and growth opportunities for the national semiconductor ecosystem**, particularly in semiconductor design. We welcome Ireland's focus on initiatives to foster workforce development. These programs can complement industry efforts.
- **We believe that diverse student populations and curricula focusing on advanced semiconductor research are crucial to making Ireland's workforce and future engineers fit for embracing the challenges but also harvesting the tremendous opportunities of the next decades of advanced computing**. We highlight the importance of students' experience and preparedness in practical, real-world applications of the theories learned in school. Toward this need, we see value in internships and similar opportunities for "professional experience year" programs. These initiatives can simultaneously create opportunities for advancing student skills in real-world situations while promoting the business value of diversity, belonging and inclusion in employer workplaces, among other benefits. We encourage a National Semiconductor Strategy to emphasise practical skills training.
- **The semiconductor industry plays a critical role in enabling other industries, as well as advancing associated research, economic development and societal progress through digitalisation**. Semiconductors have driven advances in communications, computing, health care, national security, transportation, clean energy, and countless other applications. And semiconductors are giving rise to new technologies that hold the promise to transform society for the better, including virtual reality, the Internet of Things, energy-efficient sensing, automated devices, and artificial intelligence. A highly specialised workforce represents a supportive pathway towards Ireland's global competitiveness in semiconductor technologies. For a successful semiconductor R&I strategy, we encourage a focus on fostering education programmes in disciplines relevant to semiconductor design. For example, high-performance and adaptive computing requires engineers trained in software / compiler development, hardware and electronics as well as field application engineers. Interns and new graduates are often recruited from fields like computer and electronics

engineering and science, software development, data science (especially machine learning), mathematics and physics.

4) Challenges and barriers to the semiconductor sector meeting its goal for growth and how this may be overcome:

To address future challenges the semiconductor sector may face, a National Semiconductor Strategy should:

- **Work with European and global partners on initiatives to increase manufacturing capacity.** Other countries with greater resources and larger economies have made strategic investments in their semiconductor sectors which Ireland has not. Ireland should consider the sector on an all-island basis as well as work to develop partnerships with other European countries, particularly on a Research and Development basis. As the transatlantic bridge within the EU, Ireland should encourage EU-US collaboration and coordination among industry, government, and academia, especially in research. The EU-US Trade and Technology Council (TTC) provides an ideal platform on which to agree suitable topics for research cooperation and coordination, and to build a deep understanding of semiconductor supply chains and how partnerships can facilitate a steady and secure supply of chips. This is even more important at a time of geopolitical instability.

  As evidenced by the shortages experienced during the COVID-19 pandemic, disruptions in chip supply have significant economic ramifications across various high-tech sectors. We believe that the Irish government should establish a collaborative forum with industry stakeholders to assist these vital sectors in safeguarding their supply chains and ensuring uninterrupted access to chips. This proactive approach will enable companies to enhance their preparedness for future disruptions. The government should explore the development of specific guidance on semiconductor resilience to enhance the Irish industry's comprehension of potential risks to semiconductor supply chains and strategies to mitigate such risks. Such measures may include enhancing supply chain transparency and streamlining components to minimize exposure to risks.
- **Promote global trade,** e.g. make concerted efforts to address and resolve damaging trade and other disputes; encourage the dismantling of existing trade barriers within the EU, North America and Asia. While efforts to increase its resilience are very welcome, the global semiconductor supply chain will remain highly complex and interdependent. Global trade will remain essential for any region or geography to maintain a significant semiconductor capability.
- **Promote opportunities for SMEs and startups/scaleups, recognising that Ireland's strong track-record in the semiconductor sector presents possibilities for knowledge transfer between FDI and indigenous industry.** This will ensure Ireland maintains an ecosystem where players of all sizes benefit from a policy framework which incentivises entrepreneurship.

Conclusion

Ireland is in a unique position to be a leading hub for the global semiconductor industry. Now is the time to double the size of the sector here. With the concerted will of all stakeholders and a coherent and properly-resourced strategy, Ireland can ensure it continues to have a world-leading semiconductor industry into the future, one with the potential to expand and attract further investment. Now is the time to pursue strategic initiatives aimed at fostering innovation, strengthening research and development capabilities, and enhancing industry-academic collaborations. Ireland as a digital leader in the EU can encourage collaboration between government, industry and international partners which will be instrumental in unlocking the potential of our existing semiconductor sector as well as safeguarding its supply chain resilience.

National Semiconductor Strategy Consultation

15/3/2024_b

A submission by

Tim Cummins

Semiconductor designer and serial entrepreneur

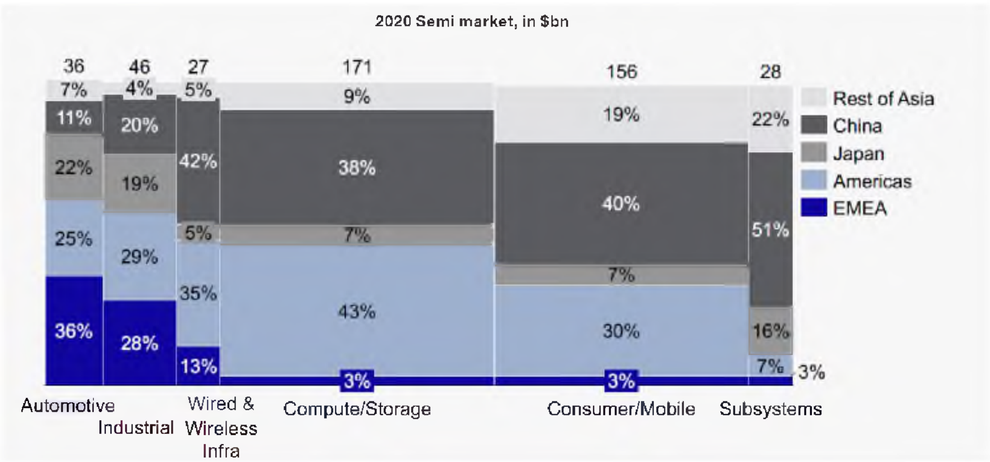
Aspirations for the Semiconductor sector in Ireland:

I'd like to see Ireland Inc set a high-level goal to achieve a handful of Irish HQ'd SME tech and semiconductor fabless startup IPO's on Nasdaq over the next 5 to 10 years (similar to ARM in UK and Nordic-Semiconductor in Norway).

I think this can be achieved in one or more of a few niche market areas where Ireland already has huge expertise in people, companies, infrastructure, and technical/marketing/business leadership. Some sector examples are Medtech, AgriTech, Quantum, automotive semiconductors, 5G/6G wireless communication chips, and fintech-blockchain. Existing Irish-based expertise in these areas can aid strong market-led chip architecture and product definition. This is a vital component of ensuring successful market adoption of a new semiconductor chip, and scale-up of a high-risk fabless semi startup.

We have done this before. 25 years ago, the IPO flotations on Nasdaq of Dublin-based Parthus and Trintech were a high-point for semiconductors and electronics in Ireland. Trintech led the way in the fintech area with the first secure on-line card-payment chips in 1999. Parthus led in wireless communications with advanced 2G/3G semiconductor IP in 2000.

The IDA's winning in recent years of 15 of the world's top 20 semiconductor companies to locate in Ireland has been a stellar success, and provides a strong bedrock of semiconductor experience and infrastructure. But at a time of major world volatility, together with the recent launch of the EU-Chips act, and its relaxation of various aid rules and audit requirements for SME's, the time is now appropriate to re-invigorate the Irish semiconductor startup and SME sector, with renewed focus and funding supports.



Semiconductor markets by region (Gartner, April 2021 and ASML analysis)

A snapshot of the semiconductor industry (2020).

Europe has a strong position in Automotive and Industrial – dominated by Bosch, ST, Siemens etc.

An aim of the EU Chips Act is to bolster EU startups, not just in these areas, but also in computing, AI, storage, and consumer/mobile.

Opportunities for the semiconductor sector in Ireland:

Expanding on the opportunities mentioned above, and existing Irish expertise in the these areas:

- **Quantum Computing:** This is an emerging high-risk and potentially very high reward area. It has a specific focus in one stream of the Chips-Act and EIC-Accelerator, also in the Irish Governments Quantum-2030 strategy, and in many Irish Universities, e.g. C-QuEST in UCD, and Tyndall Institute's Cryo-lab facility. Fabless semiconductor startup Equal-1 (Dublin) is flying the SME flag, with €10M already raised (including H2020 and EIC grants), and an announced €50M B-round fundraising in its plans.
- **Medtech**: De-centralised healthcare and telemedicine are becoming ever more important, and present many opportunities for innovation, including in semiconductors and wireless sensors. Ireland has huge expertise in this area, in academia and in industry. e.g. two of the world-leading wireless-glucose sensors are being manufactured in Ireland (by Dexcom in Galway and Abbott in Kilkenny). A third US player in glucose sensors (Movano) has set up a semiconductor R&D design centre in Cork. The Irish-based health-group of Analog Devices Inc has recently launched ADI's first medical device, a home cardiopulmonary telemedicine management system.

[My startup company Altratech is currently a player in Medtech semiconductors, applying for EIC-Accelerator and matching next-stage funding, having also raised €10M to date, including Enterprise Ireland and H2020 support].

- **AgriTech**: Dozens of innovative Agritech startups can be seen every September at Enterprise Ireland's Innovation Arena at the annual Ploughing. In the electronics area, Dairymaster and Moocall are notable examples of Irish SME success stories. They have developed sensor systems for calving and heat-detection, and export these worldwide. There is huge scope for semiconductors to offer integration, miniaturization and next-generation features in this sector.
- **Automotive Semiconductors**: This is predicted to be one of the highest growth areas (> 16% CAGR) in semiconductors over the next five years. There are active R&D groups in Irish multinational corp (MNC's) in ADI (battery and power-management), Bosch (radar and Lidar sensors), On-Semi (Optical and Lidar sensors), and in Infineon (sensors and MCU's). Enterprise Ireland has sponsored the Future Mobility Campus in Shannon, as a test-bed to assist next-generation EV's and driverless cars, for the MNC's already in Ireland (e.g. Valeo, Kostal, Jaguar-Land-Rover), and to support emergent SME's.
- **Wireless Semiconductors**: Much of this activity has shifted to the Far East and China, e.g. to MediaTek, Huawei, ZTE. However, Europe aims to reverse this with the recently launched COREnect Roadmap "towards Leadership in Chips for 6G". Irish academia has a strong publication record in this area, e.g. the recent UCD/Tyndall/MCCI wireless PLL paper at ISSCC2024. This, together with the many wireless-chip designers currently in Irish MNC's (ADI, Bosch, Qualcomm, Qorvo), is a nascent talent-pool of expertise in Ireland to leverage the EU's COREnect initiative and the next-generation of wireless-semiconductors.
- **Fintech/Blockchain/Web3.0**: Ever since the launch of the Irish Financial Services Centre (IFSC) in the 1980's, and introduction of Ireland's 12.5% tax rate in the 1990's, Ireland has been a leader in Financial Technology (Fintech). This is boosted by the presence in Dublin of many of the world's major banks, law firms, the major IT and internet companies, all supported by a strong legal and regulatory framework. The IDA's winning of Coinbase's European crypto Regulatory Hub (Nov 2023) is the most notable recent example of this. There is also a thriving ecosystem of hundreds of local fintech startups and SME's. This unique combination is a fertile environment to seed another Irish IPO like Trintech in the 2020's.
  Europe currently has a strong position in the semiconductor chips underlying this Fintech activity, e.g. NFC secure payment chips from Philips, NXP, Infineon, ST-Micro, Nordic-Semiconductor. However this EU position is at risk, due to the emergence of next generation Web3.0 blockchain financial security chips, dominated by Bitmain and MicroBT (China) and Nvidia (US). BitFury (a Netherlands startup, €80M raised), an EU fabless-semi startup currently addressing this area. The multi-nationals semi-co's are beginning to dip their toe in this area, e.g. Infineon's NFC-CryptoChip, and AMD-Taiwan's fintech semiconductor initiative. IMHO Ireland has huge potential to define and create some world-leading semiconductor solutions in this area.

Challenges facing the (Irish SME) semiconductor sector:

Funding.

Today's fabless semiconductor startup typically requires funding rounds of €10M, €50M, €200M (A, B, C rounds respectively) to reach IPO stage. Or double those amounts if designing on the latest 5nm and 3nm 'bleeding-edge' semiconductor processes. See Table 1 in Appendix, where the top-15 most recent world semiconductor startup investment rounds are all in excess of $100M. The majority of these are in US, with only Graphcore (UK, $222M) and IQM-Quantum (Finland, $140M D-round) from this side of the Atlantic appearing on the list.

Chip design costs may be lower in Automotive and Industrial – however the barriers to entry for a startup are higher, due to speciality process requirements, and much more extensive quality and regulatory requirements.

Access to talent for businesses in the semiconductor sector;

This has been an ongoing issue for the semiconductor industry for at least two decades. The number of school-leavers choosing electronics and semiconductors declined significantly after the tech-bubble bust of 2000. It hasn't recovered fully since then, despite valiant STEM-promotion in schools and colleges by many MIDAS members, especially to girls, whose numbers in the semiconductor industry remain stubbornly low, at < 10%. Immigrant visas for foreign students and engineers has relieved the shortage somewhat. But this is becoming an increasingly difficult option due to the rental and housing shortages – and is not a long-term solution since many of these may return to their home countries. There is an associated issue that many of these immigrants from certain countries are precluded from accessing the latest generation of nanometer-level Electronic Design Automation (EDA) chip-design tools and Process Development kits (PDK's).

I believe that a renewed focus on local Irish SME semiconductor startups, in some of the exciting new computer, medtech, and fintech areas listed above, led by highly visible role models (especially girls and women), can help to encourage a next generation of local graduates into the semiconductor industry. Strong promotion of the societal benefits enabled by semiconductors can also help. As an example, Medtech is an attractive career area for girls, e.g. in Altratech Ltd we have a near 50:50 gender balance.

Barriers to (SME) semiconductor development:

- Scale-up funding (pre-IPO B, C, D rounds especially): - see 'Challenges' above.
  - Strong EU and government public funding supports will increasingly be required, if Europe is to produce a fabless semiconductor company like Qualcomm or Nvidia. The AI fabless-semi startup SiPearl (France) is an example, receiving €15M EIC equity and €15M French government support alongside private VC investors in its recent €90M fundraising round.
- SME lack of access to PDK's (Process Design Kits), especially for advanced nanometer nodes.
  - It is to be hoped that the Design-Enablement-Teams (DET's) in each EU country proposed in the EU-Chips Act will help solve this. The initial proposals seem to be for PDK's at 14nm nodes.
  - It is vital that that these DET's are 'service-and-support' oriented only, i.e. with no "IP clauses" (such as Joint IP ownership or joint-publication rights) which can make an SME un-investable to VC's.
  - SME access to PDK's for < 5nm may remain difficult. Collaboration with a multinational may be the only way to enable this, e.g. by joint-development agreement, by equity investment, or in joint consortia projects (e.g. Horizon-Europe project consortia, or DTIF projects in Ireland).
- SME lack of access to prototype testing equipment and facilities:
  - It is to be hoped that the 'pilot-lines' proposed in the EU Chips Act will assist this issue.
  - Some European governments are stepping in with direct funding support for local fabrication, prototyping, and testing facilities, e.g. Netherlands government funding Smart-Photonics (foundry), or UK funding of Pragmatic (flexible electronics foundry).
- Onerous financial and audit grant terms:
  - This has long been a bugbear for SME's trying to pull down R&D credits and other grants, e.g. the need for detailed cost accounting and audited reports (to the level of student timesheets and consumables invoices). Another obstacle and deterrent to many startups has been the over-strict pre-financing requirements, e.g. and 12-to-18-month projections with reserved secure matching capital.
  - The EU is to be applauded for its recent (Jan 2024) decision to eliminate this detailed cost-reporting-auditing process, and move instead to an up-front 'lump-sum' method of 50% to 60% pre-financing (with milestone reviews by external evaluators during the project lifetime).
- State-aid rules: The EU is also to be applauded for going straight to 100% public funding for the DET's (50% EU, 50% member-country government). Some of the proposals in discussion to co-fund/subsidise EDA tools and IP cores for SME's, up to 80% levels, is also very encouraging.
- R&D Tax-credit disparities (particularly for SME's): OECD reports show Ireland lags far behind France, Portugal, Poland, and other EU countries in R&D support e.g. TaxFoundation.org reports that France effective tax-subsidy rate for R&D is 36% for profitable companies, and 36% for pre-revenue loss-making SME's. Whereas in Ireland it is much lower, at 27% (for profitable co's) and even lower again at 22% for pre-revenue loss-making SME's (who don't have profits or Patent-boxes to offset against).

Mitigations: What are potential mitigating actions (and by whom) to address these challenges and barriers?

The EU has begun addressing many of the barriers and challenges listed above, with:

- Relaxation of state aid, audit, and pre-financing rules for SME's, as noted above.
- The EIC-Accelerator program of €2.5M grant and up to €15M equity for SME's is a very welcome development – even if it remains 'out-of-reach' to many well-qualified SME's, due to a success-rate of <5%.
- The EIB is proposing a 'fund-of-funds' to seed new European VC semiconductor funds, and also to provide debt financing to fabless semiconductor startups at the scale-up stage.
- The DET and Pilot-Line supports proposed in the EU Chips Act are also to be welcomed and supported.

Ireland Inc now has an opportunity to similarly address these challenges, with:

- **IR-Gov** matching 50% support to EU 50% for one or two DET's in Ireland over 5 years. Note that these DET's are expected to be commercially self-sufficient after 5 years.

- **MIDAS/IR-Gov**: Aim to get some senior Irish representation onto the key EU-Chips Platform Coordination Team (PCT). e.g. a seasoned semiconductor industry veteran with strong technical, business, and negotiating experience. This is the committee which will set many of the design-tool standards and negotiate with the EDA vendors.
- **IR-Gov** relaxation of the RD&I and DTIF state aid rules and onerous audit and pre-financing requirements: e.g.
    - Eliminate the cost-accounting requirement for SME's, and move to 50% up-front lump-sum pre-financing, just like EIC/Horizon-Europe has done in Jan 2024.
    - Increase the SME funding rate in DTIF from 50% to at least 70% (like EIC) or 80%.
- **ISIF/IR-Gov**: provide seed fund-of-funds support to enable a new generation of semiconductor VC's in Ireland, including preferential terms for the corporate VC arms of the MNC semico's (e.g. NVidia, Qualcomm Ventures, etc) if they co-invest in Irish SME fabless startups. The DTIF scheme can be an excellent vehicle for facilitating more MNC-SME collaboration, as happens a lot in silicon valley
- **Enterprise-Ireland:** Significant enlargement of the CRCP budget model to allow engagement with the much higher co-funding requirements of pre-revenue HPSU fabless startup companies.
- **DETE/Revenue:** Increase R&D credits for SME's in particular, to redress the imbalance versus profitable MNC's. Also relax some of Revenue's over-strict interpretation of the R&D legislation, e.g. the disallowance of patent fees & R&D travel expenses, to name a few obvious ones, which are actually essential elements of an R&D SME.

TC background:

- I have designed over 20 silicon chips, in multinationals Analog Devices Inc (ADI) and Silicon Laboratories Inc, and also in my own startups Altratech Ltd (a semiconductor chip for medical diagnostics), and ChipSensors Ltd (environmental wireless sensor chips – acquired by Silicon Laboratories Inc). These startups were kindly supported by Enterprise Ireland, by EU H2020 grants, - and also by IDA (after ChipSensors acquisition by Silicon Labs Inc).
- I attend MIDAS meetings regularly, and I am also the SME representative on the board of MCCI (Microelectronics Circuits Centre Ireland). I have given inputs to, and am fully supportive of, the research and SME support proposals in the MIDAS and MCCI submissions to this call. However this submission is to expand on some personal thoughts and suggestions, for the indigenous SME sector in particular.

Table 1:

2022/23 Top Semiconductor Startup deals *(Source: EETimes etc)*

			Series	$M
Ampere Computing	AI-Server chips	Santa Clara, USA	D	$ 340 M
Cerebras Systems	AI-wafer-scale chips	Sunnyvale, USA	F	$ 250 M
GraphCore	AI	UK	D	$ 222 M
Sima.ai	AI-machine-learning	San-Jose, CA, USA	D	$ 200 M
Ayar Labs	AI-photonics	Santa Clara, USA	C	$ 155 M
Lightmatter	AI-Hi-Perf-Computing	Boston, MA, USA	C	$ 155 M
Astera Labs	Datacenter ICs	Santa Clara, USA	D	$ 150 M
IQM-Quantum	Quantum	Finland	D	$ 140 M
Celestial AI	AI-photonics	Santa Clara, USA	B	$ 100 M
D-matrix	AI chiplets	Santa Clara, USA	B	$ 100 M
TensTorrent	AI/RISC-V chips	Toronto	D	$ 100 M
Smart Photonics	Foundry - Photonics	Netherlands	Gov	$ 100 M
Si-Pearl	AI-Hi-Perf-Computing	France	C	$ 90 M
BitFury	Blockchain/Crypto	Netherlands	C	$ 80 M
Pragmatic	Foundry - Printed chips	UK	C	$ 80 M
Aleida	MicroLED chips	France	D	$ 80 M
Edge-Q	4G/5G SOC's	Santa Clara, USA	B	$ 75 M

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Response to public consultation on the development of a National Semiconductor Strategy

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Introduction

Semiconductors have roles in computation, security, sensing and interfacing which reflect their use in both digital and analogue domains. The recent surge in AI technology has fuelled interest in chips (of the digital kind) which are able to satisfy the increased demand for computational power, but semiconductors are also core resources for electrification, communication and medical sensing in both their analogue and digital manifestations. In addition, the success of the array processors (e.g. GPUs) due to the prevalence in a particular type of neural network (DNNs) may be lending importance to that architecture which will be deposed by alternative architectures or even analog processing in the future. Since 2020 it has been widely acknowledged that Moore's law (predicting the increase of computing power with increasing integrated circuit miniaturization) is ending[1]. That means computing power can no longer benefit from increasing miniaturization. The rising emphasis on system level innovation in chip design has begun to offset that decline. That means chips now integrate many more large computational elements on the same silicon real estate[2]. This then places demands on Electronic Design Automation tools (EDA), electrical power supply, heat removal and software engineering to extract the most from these devices. There is therefore a larger ecosystem of related technologies which enable semiconductor design, fabrication, supply and efficient deployment. A two tiered system of semiconductor platform awareness has emerged : the widely publicised, high throughput AI/Media platform processor and the lesser well known but equally valuable lower throughput microcontrollers found in every electrical device including phones, home appliances, EVs and power sources.

As with Electronic and Electrical Engineering Departments across Ireland and Europe, we have noted the decline in interest from the undergraduate student population in Electronic and Electrical hardware design technologies. This reflects the perceived (but not necessarily real) salary gap between software and hardware engineering employment[3], the perceived difficulty of the topic and the much shorter design cycle of software compared with hardware designs. It also reflects the much lower level of startup activity in the hardware design sector than in the late 1990s and certainly

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[1] We're not prepared for the end of Moore's Law, D. Rotman, MIT Technology Review, Feb 24 2020

[2] AMD's Next GPU Is a 3D-Integrated Superchip, S. Moore, IEEE Spectrum, Dec 6 2023

[3] Glassdoor 2024 : 40-60K Analogue Designer versus 50 - 80 K Software Engineer

compared to the current level of startup activity in software underpinned applications. We believe the national semiconductor strategy must acknowledge that protecting our supply chain of skilled engineers in this sector is a key deliverable. In order to supply the demand for skilled engineers and researchers in this sector we need to reverse this decline in interest. In our Department we have responded by changing emphasis from education in device fabrication to education in EDA toolchains, reconfigurable hardware design and computational engineering, shifting to a systems focus instead of a device focus coupled with new medical device application areas.

To take advantage of the EU Chips Act we would see a successful national strategy increasing startup activity specifically in this sector, supporting the surrounding ecosystem of technologies also with regard to electrification, and co-funding industry to work with Universities directly to create foundational appointments in the area of future semiconductor design. We address the key consultation themes below.

Aspirations for the sector – *What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?*

- Industry will source more of its hardware design talent from Ireland (x3 from today's fraction)
- There will be an increase in the number of startups (x2) that will design or deploy hardware as part of their USP
- The local semiconductor industry will realise value in collaborating with local Universities in R&D
- There will be increased government support for EDA tool access for startups
- We will have established a recognised technological base in tooling for application specific integrated hardware/software systems that exploit emerging architectures and devices.

Opportunities for the sector – *What do stakeholders identify as key opportunities for the sector to further develop?*

- The fact that the US, UK and Europe all have the same aspirations to develop National Semiconductor Strategies[4] means that there is potential for initiatives to collaborate between centres of excellence funded by DARPA, NSF, EPSRC, Enterprise Ireland
- The ongoing EU Advanced Digital Skills Initiative is now co-funding efforts to increase education at Level 9 for skills in semiconductor design. This can be leveraged by Irish industry to upskill incoming graduates or upskill through microcredential programmes. The infrastructure for these programmes in Ireland have been recently bootstrapped by the HCI (Human Capital Initiative). We need to develop closer interaction between Industry and Universities to deploy advanced modules in cloud EDA, software reconfigurable hardware, micro-architecture design of complex VLSI systems, analog and mixed signal design.
- Ireland has a highly accomplished and world class R&D base in Photonics and Quantum technologies. There is the potential for a startup ecosystem in this space.

[4] US Gov't Subcommittee on Research and Technology, Prof Erica Fuchs, Carnegie Mellon University, June 9th 2021; UK National Semiconductor Strategy March 9th 2023

- Ireland has a strong and growing base of award winning digital innovation platforms such as Smart Docklands and Cork Smart Gateway, which are playing a leadership role in the UN and World Economic Forum[5]. Novel semiconductors and semiconductor systems will be a major source of innovation for such platforms, providing sensing, communication and computing at scale. Sustainability is a key focus here and specific programs that link semiconductor device and system research in Ireland to these Smart Community platforms will accelerate growth and continue to position Ireland in a leadership role in Europe's digital transformation.
- In the earlier 1980's semiconductor/microelectronics 'revolution' Ireland had significant success in industrial development of companies in circuit and software based solutions for problems in signal processing and communications. These technology applications have at their core digital signal processing, DSP, algorithms. Recent developments in quantum computing have been shown to enable massive enhancements in core DSP algorithms through applications of the quantum Fourier transform and the construction of a Kalman filter model for quantum systems. So the DSP community in universities and industry need to plan for a new environment with high performance AI and quantum processing. This work does not require huge investment in fabrication to be sustainable yet will add huge value and implied jobs growth to the sector.
- "Security by Design" is of key interest in terms of cyberphysical security and this will extend to "Security by Hardware design" in order to protect critical infrastructure from compromise.
- The development of new semiconductor technology which satisfies the demand for compute power at the same time as lowering power consumption and emissions, is seeing more emphasis on application specific semiconductor (ASIC) design. But ASIC design is not easy to access and exploit by those skilled in software design hence there is an opportunity to improve the ecosystem of tools that unlock this potential.
- Ireland has one of the highest penetrations of renewable energy into its electricity supply grid in Europe. There is an opportunity for innovation in the design and supply of electrical control systems for the smart grid.
- EDA is one of the core technologies that underpin semiconductor device design. New toolchains need to be developed to model and simulate the effect of the emerging technologies in this space if designs are to continue to innovate. These include GaN, Graphene, GAA GateAllAround (3nm) technologies.
- Electrification is driving the need for large scale integrated power electronics systems. That supply in terms of design and deployment needs to be protected. This implies an opportunity for Ireland to exploit its large penetration of renewable electrical energy to innovate in this space.
- "Sustainability by design" is driving hardware manufacturers to consider power consumption and heat dissipation effects in terms of climate change and managing energy costs. All chip and systems designers at Intel, Nvidia, Qualcomm, Dell and others are being driven to consider packaging and system level issues to realise net-zero objectives.

[5] WEF Web Forum https://www3.weforum.org/docs/WEF_Dublin_Case_Study_2023.pdf, UN Pilot https://smartdocklands.ie/dublin-digital-rights/

Challenges facing businesses and the sector – *What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?*

- From our perspective, one of the key challenges is the lack of graduates skilled in this area emerging from the University sector in Ireland. Both industry and universities have a role to play in reversing this trend. This needs better alignment between academia and industry.
- To stay at the forefront of innovation in the AI sector, it is becoming more important for application designers to engage with hardware architecture and design. The access to that knowledge remains difficult.
- There is a lack of support for startups in this sector in terms of access to fabrication facilities or funding for design resources. Access to fabrication has been traditionally supplied by Europractice but there are very few Universities or startups performing any tapeout of designs today. Access to funding is difficult because the funding scale needed for a startup intending to exploit hardware designs is larger than for a software underpinned application and also requires a longer timescale.
- With the huge interest in development of chips to satisfy the demand for AI acceleration, there is the risk that there is less financial support for the development of the much larger volume of semiconductor design in microcontrollers, analog and mixed signal design, sensors and power electronics (e.g. for EVs and Generation).

Access to talent for businesses – *What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?*

- We see Education and Research in this sector as closely related. We can categorise the main developmental areas as follows
    - Complex VLSI System Design and Characterisation: Cloud based EDA Design Workflows, New material technologies (GaN, Graphene), GateAllAround modeling, Hardware accelerated AI with custom ASICS, System Verification
    - Security and Sustainability by Hardware Design
    - Software Reconfigurable Hardware design tools and methodologies for computational acceleration
    - Power Electronics and Analog System Design for Electrification and Sensing
    - Hardware accelerated computational engineering
    - Quantum computing, Quantum devices and Photonics
    - Photonic Integrated Circuits and calibration and testing of Photonic ICs
    - Verification and testing for VLSI/Reconfigurable Hardware/ASICS in general
- One particular issue is the misalignment of company needs with advanced University education. We need to better align the later education stages with industry design skills.

Barriers to development – *What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?*

- The sector is not able to reverse the trend in student interest which drives recruitment and by implication jobs further afield.
- A large fraction of the activity in Ireland in the sector is based around multinationals coping with wider geopolitcial pressures. Some of these pressures may already be causing investment to move elsewhere.
- If costs and resources to fabricate and test devices remain high, startup activity will continue to be suppressed
- Lack of investment in university research and education in this sector implies continued lack of talent pipeline

Mitigation – *What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?*

- Addressing the Talent challenge
  - Enterprise Ireland/IDA could set up an initiative to co-fund academic appointments in this sector in partnership between universities and Industry. SFI had a scheme like this circa 2009. This could be focussed on funding 5 year research and innovation developments at TRL levels 3-7 in particular semiconductor development areas. The idea is to bootstrap the attraction of new academic/industry talent in the sector to inspire the next generation of students at undergraduate and postgraduate level. The appointments could hold for example a 20% leadership role in a startup or existing enterprise while developing an 80% role in evolving the academic and research curriculum. Why not consider also the reverse split which could fund senior design engineering teams in industry to co-develop education initiatives directly with a partner university?
  - HEA/EI can co-fund successful applications to the EU-Advanced-Digital-Skills initiative allowing Universities to partner directly with industry in this sector to address the skills gap.
  - Funding from EI/HEA to unlock the ECSEL programme to industry and university sector. See for example https://www.infineon.com/cms/en/product/promopages/power2power/
  - Enterprise Ireland/IRC could set up fully funded PhD or MSc scholarships for students to undertake parttime degree programmes at Level 9 or 10 in this area while hosted directly in local industry teams. Stipend arrangements which allow stipend payments to be treated separate to taxable income is only available to full-time research students. Bringing the part-time research student tax regime under the same regime as the full-time research student would be a boost for the sector.
  - A new Skillnet or HCI initiative specifically in this area to fund development of new modules in collaboration with Industry.
  - The NSF for a time in 2011 - 2017 had set up a "Hollywood Science Salon" initiative to bring together creatives (especially writers) writing for big budget productions in Hollywood with researchers / academics / industry designers in new technology. The idea was to inspire new content that is rooted in "real science" but improves the representation of science in the movies. Ireland has a booming film industry. Why not DETE/EU team up with CreativeSkillNet to fund workshops for writers like this

around emerging areas e.g. Quantum devices, Photonics, Hardware for AI design and so on? The outcomes would manifest over 5 years.

- Addressing the research and innovation challenge
    - Larger grants to startups in this space to support design, fabrication and test cycles for hardware
    - A new DTIF initiative for hardware enabled applications in high value sectors e.g. Medical, Security, Power/Electrification, Communications, Media, AI.
    - Rollout of https://globalambition.ie/innovators-initiative/ to specifically address this sector
- Specific long term strategies
    - Investment in new national fabrication facilities is unlikely to have the same impact over a short timespan as support for a new value chain in system level hardware integration. That requires much less investment for a much greater impact on jobs creation and GDP. Establish an Enterprise Ireland Technology Centre or Cluster specifically in the space of system level hardware design and integration including the ecosystem of design and simulation tools. The centre should have a remit to provide advanced training and support research/innovation in security by hardware design, tooling for system level semiconductor design as well as high value applications (e.g. AI, Media, Biomedical, Communications, Power) that exploit reconfigurable hardware, analog components and novel neural architectures e.g. mixed-signal components[6] . The centre should be bootstrapped to develop funded strategic links with key European technology centres like IMEC Belgium.
    - The technologies in this space are evolving : set up a short lived industry/academic task force with the specific objective to advise on the call topics and technology areas for the centre and the education initiatives. This task force has a life of perhaps 1 year. The task force can identify the key components required for maintenance and support of strategically important national infrastructure (e.g. energy grid and communications) and design value supply chains which are less sensitive to geopolitical stresses as much as is feasible. It may even consider the feasibility of smaller volume fabrication facilities for components of key strategic value e.g. electrical power components to support smart grid and electrical distribution infrastructure.
    -

In closing, we very much welcome this timely Governmental initiative and would be delighted to participate in supporting the National Strategy in this area.

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5/03/2024

[6] https://research.ibm.com/blog/analog-ai-chip-inference

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Institiúid Náisiúnta

National Semiconductor Strategy Consultation
Department of Enterprise, Trade and Employment
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15th March 2024

To whom it may concern

Tyndall National Institute is Ireland's flagship research organisation for semiconductor research, innovation and graduate training. For over 40 years, since our foundation as the National Microelectronics Research Centre (NMRC), we have been working with Irish industry, FDI companies and many other partners to underpin the nation's success in this sector. With the emergence of the EU Chips Act, and the opportunities associated with it, as a recognised European centre of excellence in semiconductors we have been proactively seeking to further Ireland's interests in the global semiconductor industry.

There are more than 20,000 people employed in the Irish semiconductor industry, most of whom are in high technology roles. Ireland currently has two large industrial semiconductor manufacturing facilities – the Intel facility in Leixlip and the Analog Devices facility in Limerick, and there is also the major Seagate facility in Northern Ireland. In 2023, Ireland was in the top 2 locations in Europe for installed semiconductor capacity.

With the recent opening of Intel's Fab34, a €17bn investment, Ireland now hosts the most advanced node semiconductor manufacturing facility in Europe with the creation of 1600 additional full-time, high technology roles. Analog Devices, with more than 1500 people in its Limerick design and manufacturing operation, has recently announced an investment of €630m, adding 600 jobs to its Irish workforce.

In addition to semiconductor fabrication facilities, Ireland is now host to a diverse range of integrated circuit (IC) design companies and a growing list of electronic design automation (EDA) companies. These include AMD, Analog Devices, Bosch, Cadence, Infineon, Intel, MaCom, Microchip, onsemi, Parade Technologies, Qorvo, Qualcomm, Synopsys and u-blox, just to mention a few.

In August 2023, Tyndall called for a *"Chips Strategy for Ireland"* through the publication of a comprehensive position paper that was endorsed by the global CEOs of both Analog Devices and Intel, two of the major employers in the semiconductor sector in Ireland. (https://www.tyndall.ie/news/tyndall-calls-for-a-chips-strategy-for-ireland/).

Therefore, Tyndall very much welcomes the opportunity to comment further on the matter through this public consultation on the development of a national semiconductor strategy. Our response here should be read in conjunction with our August 2023 position paper which provides much more detail and analysis of the global semiconductor industry, Ireland's semiconductor industry and Tyndall's role in Ireland as the predominant research and innovation organisation and public research infrastructure. Furthermore, the position paper clearly articulates the strategic goals that we still believe should form the basis of the national strategy: ***providing direction***; ***mobilizing the innovation ecosystem***; ***creating a sustainable knowledge workforce***; ***sustaining research and innovation capacity***; and ***catalysing innovation***. Hence, our responses below to the specific headings outlined in the consultation document are to be considered in addition to and/or are complementary to our position paper.

A Note on Scope
Semiconductors should encompass not just silicon and digital technology but all semiconductor technologies, including photonics and compound semiconductors used for communications, sensing, medical imaging, integrated magnetics, power devices and lighting. Likewise, all disciplines and activities associated with semiconductors should be within the scope, including but not confined to, material science, electrical engineering, electronics, physics, chemistry, process engineering, circuit and system design, electronic design tools and automation, design verification, evaluation and test, packaging engineering, reliability engineering, equipment maintenance, facilities, etc. The semiconductor sector also encompasses the research and development of new computing platforms such as neuromorphic computing and quantum information processing as well as associated emerging technologies, most notably advanced AI processors and multiferroics for high density data storage.

Aspirations for the sector – *What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?*

- The Irish Semiconductor Sector needs to more than double in size by 2030 if we are to retain our leading European position in Semiconductors and remain globally relevant.
- Ireland should be capable of competing for investment across all semiconductor sectors, including large scale manufacturing projects.
- Ireland should be seen as a global research and innovation leader across the semiconductor value chain and in the application of semiconductors in the green and digital transitions.

Opportunities for the sector – *What do stakeholders identify as key opportunities for the sector to further develop?*

- Since Ireland has an existing ecosystem that covers almost the entire semiconductor industry, we are strongly positioned to continue to grow and compete from our position of strength across all sectors of the industry for future investment.
- With some large-scale players, our existing manufacturing ecosystem has created a sizeable, experienced workforce across many disciplines, ranging from facilities to process engineering to R&D. Ireland has a track record in delivering reliable output from these facilities. This existing base should be attractive to other players to consider setting up manufacturing facilities provided we can scale the talent pool. Very few other locations have the scope of talent needed for this industry.
- With Intel's recent opening of Fab34, Ireland now hosts the most advanced node semiconductor manufacturing facility in Europe. Given Intel's strategic move into the foundry business, there is therefore an opportunity to build on these developments and to proactively develop a new foundry services support business sector in Ireland (as has been grown around TSMC in Taiwan).
- Ireland should seek to leverage its competitive advantage of having a significant portfolio of well-established US multinationals in semiconductors and related sectors (medtech, pharma, ICT platforms) and also being on the doorstep of the major industrial consumers of semiconductor technologies in Europe, from Automotive to Energy and Communications/Data/AI, operating as a dynamic, English-speaking economy within the EU trading bloc and providing direct access to those markets for global semiconductor supply-chain partners.
- Ireland is developing a large Design/IP presence. This is an opportunity to become a centre of excellence for design related activities, including new businesses facilitated by the EU Design Platform and the planned Chips Competence Centres.
- Given the new supports offered by the EU Chips Act (Chips JU, Chips Fund, Competence Centres), the existing strong state support for innovation (Tyndall, MCCI, SFI Centres such as IPIC, Connect and Amber) and excellent support offered through EI, there is an unprecedented opportunity to grow new businesses in this sector which has traditionally required higher levels of investment and longer timescales to market. This opportunity spans the whole semiconductor value chain.
- Enhanced levels of Irish research and innovation (including the associated intellectual capital) in semiconductors can also be used to anchor major application sectors in Ireland through product innovation (FDI) and for nurturing the growth of indigenous companies (start-ups and SMEs).

- Through strong participation in the EU Chips Act Pillar 1 activities, such as the recent call for R&D Pilot Lines and the Chips JU project funding, Ireland can meaningfully contribute to the European ambition for large-scale technological capacity building and strengthening innovation, while at the same time strengthening the research and innovation levels and capacity within the Irish ecosystem. Note that Tyndall plans to participate in several European Pilot Lines and we are currently formal partners in two Pilot Line applications under consideration by the Commission.
- With our industrial and research profile, Ireland could establish a global lead in minimising environmental footprint impacts of semiconductor technologies through new fabrication routes and modular device integration approaches that reduce Global Warming Potential (and other impacts) and also enable increases in useful lifetime or utilisation.
- Ireland should strengthen its own unique positioning in the global semiconductor research and innovation domain building on our strengths in semiconductor materials, novel materials processing and integration, wafer-scale and heterogeneous integration. This will require a step up in public investment in cleanroom and fabrication facilities with appropriate metrology and forensics capabilities and should be focused on the prioritisation of developments in sustainable materials, wafer processing and energy efficient devices and systems. With our unique proposition, an investment of sufficient scale in such a European Centre of Excellence would be a significant attractor / anchor for global semiconductor companies and their subsequent co-investment, as has been demonstrated elsewhere in Europe.
- While semiconductors are the foundation of all technology-based innovations and application sectors, and they enable all manufacturing and service industries, there may be specific new cross-sector opportunities that could be prioritised for Ireland. These could be in areas such as, but not limited to, sustainable data centres (energy efficient AI processors, high speed photonics interconnects and high density storage; renewables and grid technologies), the realisation of quantum technologies (computing, communications and sensing), automotive (electrification, autonomy and sensing), space (sensing, communication, vehicles and launchers) and cybersecurity (hardware security, network security, biometrics and identity systems).

Challenges facing businesses and the sector – *What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?*

- **Access to talent** is a major challenge for the global semiconductor industry and this is at all levels from operators to technicians to engineers to researchers. Deloitte has predicted that an additional 100,000 skilled workers will be needed **each year** to meet the industry growth trajectory expected out to 2030. To put this in perspective, there are fewer than 100,000 graduates annually in electrical engineering and computer science in the US. This demand for talent remains a major challenge for Ireland's success in semiconductors.
- **Energy** cost and limited access to green energy is a major factor for the expansion of the semiconductor manufacturing sector in Ireland. This is not unique to the sector; it is also a major challenge for others such as the data centre industry.
- The **cyclical nature** of the semiconductor industry means that the overall market experiences regular fluctuations in demand growth and often capital investment cycles are out of phase with the supply-demand timing. The main drivers for this pattern are economic, technological, and geo-political. While overall growth of the industry is set to continue with analysts predicting a market of over $1Tn by 2030, individual companies may face short-term challenges in terms of their own investments.
- **Aggressive incentives** and associated substantial investments (e.g., into R&D infrastructures) provided by other states who are now seeking to replicate Ireland's hard-won success. Particularly in Europe, many governments have seized the opportunity to invest heavily to develop their own semiconductor sector despite coming from a low, or even zero, base.
- **Access to research and technology infrastructures and expertise** is a challenge for deep-tech start-ups and SMEs seeking to scale in the semiconductor sector. The cost of R&D equipment, test-before-invest capabilities, and access to expertise for proof-of-concept development, prototyping, etc. is more difficult for smaller businesses than it is in other sectors such as fintech or software.

Access to talent for businesses – *What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?*

- The semiconductor industry is a multidisciplinary industry. Individual businesses face shortages in their area but overall, the industry needs the talent pipeline scaled up across a broad spectrum. There are relevant programs at present, but the scale / intake (and hence output) is too low to meet both current and future needs of the sector. There needs to be a scale up across the board from manufacturing operator to PhD levels. Any country or region that can offer relatively higher levels of available skills and talent (or rapid routes to same) will have a competitive advantage and will be more likely to retain and grow existing companies.
- There are training and skills development needs for process engineers, operators, maintenance technicians in manufacturing, including digital manufacturing, automation, and data analytics – again, while some relevant programmes exist in Ireland today, these need to be both scaled and interlinked.
- The chip design industry has specific, specialist training and up-skilling needs that are somewhat covered by the MIDAS-led Electronic Systems Skillnet and this should continue to be developed and scaled based on the evolving mix of companies and their focus.
- Degree level programmes (including MSc/MEng) exist throughout the country in underpinning disciplines, but more focus could be placed on linking engineering (e.g., EE, process engineering, mechanical engineering) and science (e.g., physics, chemistry, materials science) with an emphasis on semiconductor technology and applications. The overall number of graduates, for example in EE, remains insufficient for even the existing needs of the sector. Given Ireland's already high level of participation in, and limited funding for, the university sector, fully-funded specialist MSc programmes and the sector-specific targeting of overseas students may offer the most effective routes to increasing numbers.
- Research training in semiconductors is needed for industry R&D activities and to seed new innovations and start-ups. This is currently provided by organisations like Tyndall (over 160 postgraduate students), MCCI and some of the current SFI Centres and is funded through SFI, EU Programmes including CHIPS JU, IPCEI and industry itself. However, the number of research trainees also needs to be significantly scaled.

Barriers to development – *What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?*

- The most significant barriers to development of businesses and the sector as a whole are outlined above. The following are some additional barriers to development from Tyndall's perspective.
- There is limited coordination and coherence across the ecosystem with many different agencies and organisations connecting where and when possible (e.g., MCCI, IPIC, MIDAS, Technology Ireland, Photonics Ireland, AmCham, various other SFI and EI Centres). The recognition by IDA that semiconductor is a unique sector was an important first step here and the expected establishment of a Chips Competence Centre in Ireland will also help, especially with wider EU connectivity, but some sort of high-level national level coordination is missing.
- It is widely accepted that the level of public support for research and innovation is far too low in Ireland and there is recognition that this needs to be addressed across the whole economy, as identified in Impact 2030.
- The implications of the establishment of Taighde Éireann for this particular sector and the intersection with DTIF, EI Innovation programmes and other state supports remains unclear. It would seem important to have a clear research and innovation plan for semiconductors given the high degree of focus and investment on semiconductor innovation in other major economies, not least to be positioned to avail of trans-national funding opportunities, particularly for SMEs.

Mitigation – *What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?*

- Establish a high-level group, with senior public and private representation to be an "*Irish Semiconductor Office*". The group should not only aid the national strategy implementation but would also be the national voice/presence in the global semiconductor community. This office and key individuals would need to be seen and heard as a potent lobby in the political circles of the EU and US and on the most influential global strategy panels affecting the industry.
- Plentiful supply of cost competitive, reliable, zero carbon electricity, i.e., offshore wind, hydrogen, and the necessary grid to support it. The semiconductor industry takes a long view and a whole of government commitment/ambition to putting sufficient infrastructure in place as soon as possible would ease immediate concerns and be a significant factor for future investment decisions, including FDI opportunities.
- Ring-fenced pillars of research and innovation funding supports for public organisations and companies through RI/EI/DTIF targeted for semiconductors. Currently under all government funding programs, semiconductors are not called out as a foundational industry. Most programs are broad enough to allow for semiconductor participation but these programs advance solutions for other industries, and do not address research issues within the semiconductor industry.
- Strong Irish government commitment and stated ambition level in relation to Pillar 1 of the EU Chips Act. This pillar will provide significant Horizon and Digital Europe funding for industry driven research and innovation programmes (Joint Undertaking) and the establishment of R&D Pilot Lines and Chips Competence Centres. The European component of this funding will go elsewhere unless Ireland is strategic, well organised, and ambitious. This should include plans for significant scale-up investment in the national R&D infrastructure for semiconductors to ensure that Ireland has a Centre of Excellence of scale.
- Likewise, Pillar 2 of the EU Chips Act allows for increased state funding of the semiconductor industry. A strong Government commitment to these pillars of the EU Chips Act will demonstrate to other global players that Ireland is serious regarding further incoming and home-grown semiconductor investment, i.e., Ireland is open for business.
- Strong consideration should be given to an all-island approach, given how Ireland's position of strength could directly be leveraged to advance the sector in Northern Ireland, particularly in relation to photonics, data storage and semiconductor applications in medtech, smart manufacturing and cybersecurity.
- The policies in education, infrastructure and inward direct investment support which have, over the last 40+ years, secured Ireland's place in the global semiconductor market should be enhanced and the ambition level significantly increased in the face of aggressive growth of EU competition. Competing nations can promise easy access to talent and resources which will prove as difficult to deliver as any apparent deficit in the Irish landscape.

Talent Related Mitigations

- Fast-tracked and favoured-nation visa/residency programs which enable large, targeted recruitment similar to those employed in the health sector but which deliver immediate economic returns in private sector jobs growth.

- Establishment of a National Semiconductor Training Centre to cover all disciplines ranging from operator to technician, engineering, and research levels.
  - Coordination with existing 3rd Level courses and other training providers and building on the success of existing, but isolated, programmes and provision.
  - Incorporation of a national scale, possibly all-island, Centre for Research Training in Semiconductors and Chip Technologies.
  - Appropriate level of funding and with targets that match both current needs and the opportunity ahead. The most direct approach would be to unlock the National Training Fund given its explicit purpose and the scale of the contributions that would be associated with the semiconductor sector.
  - Tyndall could lead the National Centre which should include a new modern cleanroom facility for hands-on training, education and up-skilling at sufficient scale.
  - Coordinate all outreach programs, including primary and secondary levels, to achieve scale in attracting talent into industry, particularly amongst females.
  - International cooperation in training would enhance such a Centre, would be consistent with the multinational make-up of the sector and would also strongly signal Ireland's competitive offering. This could include all-island and UK-Ireland co-operation. There are on-going discussions and draft proposals currently under development that are directly motivated by the possibility of significant associated private investments.

We appreciate the opportunity to contribute to the consultation and hope that the above points will be of value to the Department. We would be happy to discuss these inputs further, to provide more detail or further information as may be required.

Finally, we look forward to the subsequent publication of a meaningful and ambitious national strategy for semiconductors and to playing our role in its delivery for Ireland.

Yours faithfully,

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CEO

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National Semiconductor Strategy Consultation

Submission on behalf of the School of Engineering at University College Cork

UCC's Role and Interest in a National Semiconductor Strategy

This submission, on behalf of the Discipline of Electrical and Electronic Engineering in the School of Engineering at University College Cork, is in response to the public consultation on the development of a National Semiconductor Strategy as issued by the Department of Enterprise, Trade and Employment on 21st February 2024[1].

University College Cork has a long tradition of educating engineers, scientists and mathematicians who contribute widely to the development of Information and Communications Technologies. Indeed, UCC's first professor of mathematics was George Boole[2] whose seminal work "An Investigation of the Laws of Thought" laid the foundation for Boolean Algebra, which is fundamental to the operation and design of digital computers and systems to the present day. UCC has a significant track record in semiconductor research, beginning with a semiconductor/microwave research laboratory in the Department of Electrical Engineering in the late 1970s that led to the establishment of the National Microelectronics Research Centre in 1981[3], Ireland's first dedicated centre for semiconductor research. With the increasing diversity of semiconductor research and the growing importance of photonic systems, the Tyndall National Institute[4] was established at UCC in 2004, and is now one of Europe's flagship centres for semiconductor and photonics research. While Tyndall is a National Centre, drawing researchers and graduate students from around Ireland and internationally, a significant number of its PhD students still come from the undergraduate base at UCC and are supervised or co-supervised by UCC academic members. Furthermore, many faculty members actively undertake research within the Institute's framework, in addition to the research activities in the School itself.

In addition to its research portfolio, the School of Engineering and Architecture[5] at UCC considers the development of highly-skilled and work-ready graduate engineers to be fundamental to its mission. To this end, it admits approximately 150 students each year into a common-first-year engineering programme and these students graduate with either a

[1] https://enterprise.gov.ie/en/consultations/consultation-on-national-semiconductor-strategy.html
[2] https://georgeboole.com/
[3] https://www.irishtimes.com/business/nmrc-extension-in-cork-is-opened-1.67663
[4] https://www.tyndall.ie/history
[5] https://www.ucc.ie/en/soe/

Bachelors (BE) degree after 4 years, or a Masters (ME) degree after 5 years, across the core disciplines of Electrical and Electronic Engineering, Energy Engineering, Process and Chemical Engineering and Civil, Structural and Environmental Engineering. To ensure adherence to international best practice in engineering education, all of these programmes are accredited by Engineers Ireland[6], with the ME programmes meeting the educational requirements of Chartered Engineer[7]. In addition, the School of Engineering has a wide range of specialised postgraduate programmes to serve specific industry requirements. The School of Engineering maintains very strong connections with local, national and international stakeholders across the full range of disciplines. Considering the electronics, ICT and semiconductor sectors, two very important stakeholders are CEIA[8] (Cork's Technology Network) and MIDAS Ireland[9]. It is a source of pride to the School of Engineering that many of our graduates have achieved leadership positions in semiconductor technology such as Dr Ann Kelleher, Executive Vice President in Intel[10].

Focusing on the circuit design aspects of semiconductor technology, the multi-institution MCCI Technology Centre[11] has in recent years contributed to a huge increase in the impact of circuit design research and educational opportunities in Ireland. This centre, backed by IDA[12], Enterprise Ireland[13] and MIDAS Ireland is hosted across multiple institutions throughout Ireland and has a large footprint in the Tyndall National Institute, with active participation by academics from Electrical and Electronic Engineering at UCC who co-supervise a number of research students there.

With such a long history in technology and semiconductor research and education, the School of Engineering at UCC has a deep interest and commitment to the further development of the ICT and semiconductor sectors in Ireland and strongly supports the recent European Chips Act[14] and the Department of Enterprise, Trade and Employment's public consultation in response to this. We present some opinions from our perspective to the public consultation below, which align closely with many of the positions already outlined by the Tyndall National Institute in its comprehensive document "Ireland's role in the global semiconductor industry"[15]. We note that other research and educational institutions across Europe are also taking an active role in responding to the act, with one example being the position outlined by the MICAS group at KU Leuven (a world-leading research centre for integrated circuit design) entitled "The European Chips Act: no solving the chip shortage without solving the chip talent shortage"[16].

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[6] https://www.engineersireland.ie/Professionals

[7] https://www.ucc.ie/en/soe/news/school-of-engineering-receives-full-accreditation-from-engineers-ireland-for-the-eight-programmes-in-the-school.html

[8] https://www.ceia.ie/

[9] https://www.midasireland.ie/

[10] https://www.siliconrepublic.com/business/intel-ann-kelleher-appointed-intel-executive-vice-president-cork

[11] https://www.mcci.ie/

[12] https://www.idaireland.com/

[13] https://www.enterprise-ireland.com/en/

[14] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en

[15] https://www.tyndall.ie/contentFiles/Tyndall_Ireland's_Role_in_the_Global_Semiconductor_Industry.pdf

[16] https://www.esat.kuleuven.be/mc_chips/afbeeldingen/chips-act-micas-opinion.pdf

Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?

Ireland currently has two large industrial semiconductor manufacturing facilities – the Intel[17] facility in Leixlip and the Analog Devices[18] facility in Limerick which is receiving major investment[19]. These state-of-the-art facilities represent multi-billion dollar investments over several decades. Due to the relentless pace of semiconductor technology development, driven by the need to maintain the progress predicted by "Moore's Law"[20], such fabrication plants need to be continually upgraded and renewed to remain at the leading edge of technology and hold their competitiveness in a very demanding marketplace. As Europe works to increase its share of the global semiconductor market to 20% as part of the European Chips Act, we hope, and expect, that these existing facilities in Ireland will continue to benefit from investment and further expansion.

If Ireland is to contribute significantly to the overall goal of the EU Chips Act to double the EU's market share of the world's semiconductor market by 2030, then Ireland should also aim to double its semiconductor footprint in the same timeframe. As well as silicon fabrication, it should broaden its search for manufacturing into emerging technologies such as gallium nitride (GaN), gallium arsenide (GaAs) and application areas such as semiconductors for highly integrated power management systems and reconfigurable RF systems.

Semiconductor facilities depend on access to a highly skilled workforce with qualifications across a range of engineering and scientific disciplines. The School of Engineering at UCC sees opportunities in the European Chips Act and the Irish Government's response, to increase the number of engineering graduates to help fill this need for a growing and more highly-skilled workforce.

Currently Ireland has one major semiconductor research facility, the Tyndall National Institute at UCC, and a major nanoscience institute, CRANN[21], based at Trinity College Dublin. Due to cost, university-based semiconductor research fabrication facilities find it increasingly difficult to replicate industrial set-ups for the most advanced semiconductor process nodes - for instance an ASML extreme ultra-violet (EUV) lithography system has a reported cost of up to $200 million[22] and that is just one item (albeit the most critical item) of equipment in the most advanced silicon fabrication plants. However, university-based semiconductor research centres have the flexibility to work on innovative new devices and technologies that are needed to feed the pre-competitive development pipeline of semiconductor companies in areas such as silicon, GaAs (gallium arsenide), sensors, photonics and novel materials. Such research level nanoscale devices can be conceived, and developed using techniques such as electron beam lithography, which can

[17] https://www.intel.ie/content/www/ie/en/company-overview/intel-leixlip.html
[18] https://www.analog.com/en/who-we-are/corporate-information/regional-headquarters/directions-to-analog-devices-international.html
[19] https://www.breakingnews.ie/business/analog-devices-to-create-600-jobs-with-e630m-investment-in-new-limerick-plant-1475746.html
[20] https://www.intel.ie/content/www/ie/en/newsroom/opinion/moore-law-now-and-in-the-future.html
[21] https://www.tcd.ie/crann/
[22] https://www.cnbc.com/2022/03/23/inside-asml-the-company-advanced-chipmakers-use-for-euv-lithography.html

be translated to EUV systems for commercial scaling. Continued innovation is needed in these and other areas to guarantee the future growth and success of the semiconductor industry. We hope, therefore, that the critical investment into Irish-based research centres such as Tyndall will continue at the level needed to produce the innovations required for the next generation(s) of semiconductor technology.

These research centres, in turn, depend on recruiting highly trained engineering and science graduates to fill their PhD and post-doc research positions. These graduates at bachelor and masters levels, need to be trained as undergraduates with world-class resources and by world-class academics. We hope, therefore, that increased resources can be provided for undergraduate and masters-level programmes, such as those offered by the School of Engineering at UCC. There are also opportunities for increased collaboration between the research centres and the undergraduate programmes such as sharing cleanroom facilities for fabrication training and sharing high-performance test facilities for chip and system measurements. Such specialist “hands on” training is expensive to provide, and to do properly requires dedicated funding streams to achieve.

In addition to semiconductor fabrication facilities, Ireland is now host to a diverse range of integrated circuit (IC) design companies and a growing list of electronic design automation (EDA) companies. These include AMD, Analog Devices, Bosch, Cadence, Infineon, Intel, Microchip, onsemi, Parade Technologies, Qorvo, Qualcomm, Synopsys and u-blox, just to mention a few. These companies have a substantial critical mass of expertise in this area, and give a broad, diverse base upon which further growth in Ireland can be leveraged, through expansion in the existing companies and attraction of further inward investment. At UCC our aim is to support them as part of our response to the European Chips Act.

We believe that these companies should be encouraged and helped to further diversify their footprint in Ireland by bringing other aspects of their semiconductor activities to the jurisdiction such as test, high-performance packaging, customer solutions development and support, etc. ***A critical factor for the success of these companies in Ireland is the availability of highly skilled engineering, mathematics and science graduates*** and, again, UCC will play a central role in the training of such graduates.

As well as hosting a wide range of foreign direct investment (FDI) semiconductor companies, we hope that Ireland can greatly expand and develop the number of indigenous start-up companies, many of which (such as SensL[23] and InfiniLED[24]) developed as spin-outs from 3rd-level institutions and research centres. This requires the availability of investment capital and the participation of experienced investors and entrepreneurs who have already been involved in successful start-ups and who can help to guide new start-ups through the critical early years.

Opportunities for the sector – What do stakeholders identify as key opportunities for the sector to further develop?

There are many opportunities for Ireland to participate in the growth of the semiconductor sector, and for this sector to contribute to the Irish economy providing increased employment and wealth creation. Some of these include:

[23] https://vehicle-electronics.biz/sites/default/files/VE54Jun18.pdf
[24] https://www.siliconrepublic.com/business/infiniled-oculus-vr

- Increasing the size and number of semiconductor fabrication facilities in Ireland.
- Continuing to develop Ireland as an important semiconductor innovation hub with appropriate research centre support.
- Increasing the number of international companies with IC design and design-support activities in Ireland.
- Supporting the development of home-grown semiconductor companies (especially design and design/EDA related). This will involve expanding the existing pathways and developing new pathways for innovation and SME support.
- Developing synergies between the semiconductor sector and the other key economic sectors in Ireland such as agriculture and food processing, medical devices, pharmaceuticals, financial services and within the information and communications technology (ICT) sector generally.
- Leveraging our existing facilities and talents to ensure that we establish a critical mass in emerging technology and application areas such as the 6G communications, artificial intelligence (AI), quantum computing, autonomous navigation, and healthcare.

Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?

There are many challenges facing the semiconductor sector in general and some facing Ireland in particular including:

- **Cost and maintaining the state-of-the-art:** The cost of building a new semiconductor fabrication plant for the most advanced process technology nodes can be in the range of $10 billion to $30 billion[25]. With such high costs, only a very small number of companies can afford to build these plants, and have the customer base to justify the enormous up-front costs. In addition, new fabrication plants and the supporting infrastructure require huge tracts of unencumbered land e.g. Samsung has located a new $17 billion plant near Austin, Texas on a 1,200-acre site[26]. Fabrication plants like these also require vast quantities of water, and stable energy supplies such as electricity and gas. Ireland does not have an indigenous company with a large enough market share of the semiconductor business to justify such costs, so any expansion of the existing plants or development of a new plant can only be done in partnership with an FDI company.
- **Logistical barriers to prototyping and new product development**: Large and small companies and research centres in Ireland that need to develop prototypes of new products in the form of printed-circuit-boards (PCBs) or integrated circuits (ICs) all face the issue that most of the low-cost PCB prototyping organizations, and all of the IC foundries are overseas (predominantly in East Asia) and this gives rise to extra delays and costs. The timely sourcing of components and equipment has also been

[25] https://silicon-saxony.de/en/why-are-semiconductor-factories-so-expensive-2/
[26]https://www.cnbc.com/2023/07/20/texas-becomes-chip-hub-with-47-billion-investment-from-samsung-and-ti.html#:~:text=On%20a%201%2C200%2Dacre%20plot,build%20a%20semiconductor%20fabrication%20plant.

complicated by Brexit. Thus, continuing to ensure a flourishing semiconductor technology innovation sector in Ireland will require enhanced supports and creative solutions for product prototyping, both at PCB and IC levels.

- **Highly-skilled workforce**: A highly skilled employee base is required across all aspects of the semiconductor value-chain whether it is the building and commissioning of new semiconductor plants, the on-going operation of the plants, the development of advanced process technology, the design of leading-edge integrated circuits, the development of software embedded in the designs themselves, application software to enable the products to be used by customers, test and development and a range of other support roles. These skills are needed across a range of disciplines including engineering, physics, chemistry, materials science, mathematics and computer science, and there is growing recognitions of the importance of interdisciplinary skills and the ability to work with diverse teams. While the bulk of employees in the sector have traditionally be trained to the bachelor's level, qualification at a master's level is increasingly seen as the desired entry level, especially considering integrated circuit design, and there is a high demand for graduates at a PhD level for process and product development roles. There is also now a growing recognition of the importance of bringing in talent to the semiconductor industry through other routes such as apprenticeships and the need for employees to continue to develop and deepen their skills through continuing professional development (CPD) and other part-time or block-release training opportunities. Despite the variety of entry routes for employees into the semiconductor industry, it is still generally accepted that there is a shortfall of suitably-qualified candidates[27] in most geographic regions, and the availability of potential employees in sufficient numbers is now seen as a competitive factor when choosing the location of a new facility.
- **International competition:** The Covid-19 pandemic was a "wake-up" call for many countries into the complexities of the semiconductor supply chain[28] and into the critical role played by semiconductor technology in the supply chain for several other sectors such as automobiles and healthcare products, many of which were badly impacted by delays in semiconductor manufacturing and development. As a result, many counties now consider the ability to manufacture the most advanced semiconductor technologies as being critical to both their economic self-sufficiency and their defence self-sufficiency, and as a result are making efforts to bolster advanced manufacturing capabilities in their own countries. This is partly the reason why there has been a range of "Chip Acts" or other incentives for semiconductor

[27] https://www2.deloitte.com/us/en/pages/technology/articles/global-semiconductor-talent-shortage.html
[28] https://www.rabobank.com/knowledge/d011371771-mapping-global-supply-chains-the-case-of-semiconductors

manufacturing in major socio-economic regions such as the USA[29], EU[14], UK[30], Italy[31], France[32], Germany[33], Japan[34], China[35], Taiwan[36], South Korea[37] and India[38]. Thus, increased international competition and a partial pull-back from manufacturing globalization could be a barrier to further expansion of the semiconductor sector in Ireland. However, the fact that Ireland ensured that all FDI facilities operated smoothly during Covid-19 and did not place any barriers to exports in the high-technology, food or pharmaceutical sectors during the pandemic shows our commitment to an open international economy and should reassure potential FDI partners of our commitment to open trade agreements.

Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?

As previously mentioned, access to suitably trained potential employees will be critical for the further development of the semiconductor sector both in Ireland and internationally. Enhanced training and skills will be needed across virtually all engineering, scientific and business domains including:

- **Engineering:** The semiconductor sector has a huge need for engineering talent across all domains of engineering including Electrical and Electronic Engineering, Process and Chemical Engineering, Manufacturing Engineering, Energy Engineering, Civil & Environmental Engineering and others. While a bachelor's level qualification was typically viewed as the entry-level requirement, this is increasingly changing to the master's level with an increased demand for PhD-level graduates as well. To satisfy this need, there needs to be an increased opportunity for the current generation of engineering students to continue their studies to a master's level with as few barriers (including cost) as possible. Furthermore, the investment in the infrastructure to provide student engineers with the practical experience that is relevant to industry has not kept up with the sector need. Major refreshment and modernization of engineering teaching laboratories and equipment across the Third

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[29] https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/

[30] https://www.gov.uk/government/news/uk-research-investment-to-boost-uk-semiconductor-industry#:~:text=Two%20new%20'Innovation%20and%20Knowledge%20Centres%20(%20IKC%20)'%20will,%C2%A31%20billion%20semiconductor%20strategy.

[31] https://decode39.com/7390/italy-bolster-national-chip-industry/#https://www.reuters.com/markets/europe/italy-plans-measures-support-key-sectors-including-microelectronics-2023-08-04/

[32] https://www.france24.com/en/europe/20230605-france-to-invest-nearly-%E2%82%AC3-billion-in-semiconductor-factory-to-boost-local-production

[33] https://silicon-saxony.de/en/european-chips-act-germany-is-leading-the-way-now-it-is-up-to-europe/

[34] https://www.reuters.com/technology/japans-efforts-foster-chip-sector-are-impressive-research-org-head-2023-11-09/

[35] https://finance.yahoo.com/news/china-prepares-27-billion-chip-095143578.html

[36] https://www.trendforce.com/news/2024/01/16/news-taiwans-chip-act-takes-effect-in-february-tsmc-to-benefit-from-historic-tax-incentives/

[37] https://koreapro.org/2023/04/how-south-koreas-k-chips-act-balances-strategic-priorities-and-foreign-affairs/

[38] https://www.emsnow.com/india-injects-15-billion-into-semiconductors/#:~:text=The%20government%20has%20approved%201.26,as%20a%20strategically%20critical%20industry.

Level sector is needed to ensure that the next generation of engineers are being trained with industry-standard equipment and protocols, allowing them to be work-ready on graduation. Further innovation in curriculum design paying particular attention to interdisciplinary skills and practical hands-on opportunities for electronic circuit design, including at the integrated-circuit level, is also a priority.

- **Physics, Chemistry and Materials Science:** The development of new semiconductor technology and the on-going operation of semiconductor facilities cannot be undertaken without the support of many scientific disciplines, especially physics, chemistry and materials science. Just as with engineering, there needs to be increased opportunities for students to purse these areas to the masters and PhD levels, and the third level infrastructure supporting the practical elements of the courses has many of the same issues alluded to for Engineering above.
- **Mathematics and Computer Science:** The media frenzy in the past year about generative artificial intelligence[39] (AI) such as ChatGPT[40], has shown the importance of mathematics and computer science to a whole spectrum of economic activity including business, medicine and healthcare and semiconductor technology. While it is too early to say that "AI will take your job"[41], it is reasonable to speculate that "the technology expert (computer scientist or engineer) using AI will take your job"[42]. Therefore it is critical that Ireland develops a large cohort of experts in AI, and, even more importantly, experts on how to deploy AI to maintain competitiveness in areas where we already excel such as integrated circuit design.
- **Interdisciplinary/transdisciplinary skills:** The world of technology and semiconductors is experiencing at least three paradigm shifts at the moment – (i) the move to atomic level transistor dimensions (the so-called Ångstrom generation of technology[43]), (ii) the development of quantum computing technology (the so-called second quantum revolution[44]) and (iii) the incorporation of artificial intelligence (AI) and machine learning (ML) into device, process and product development cycles. As with any paradigm shift, the likely winners will be the companies and individuals who can successfully combine knowledge from a range of fields – for instance we need electronic design engineers to master the new paradigms of quantum computing[45] and AI/ML[46] andwe need physicists and mathematicians who can deploy their quantum and AI/ML knowledge to the new semiconductor devices and the design-EDA ecosystem around these devices. This creates a demand for graduates with

[39] https://cloud.google.com/use-cases/generative-ai
[40] https://openai.com/blog/chatgpt
[41] https://time.com/6565026/ai-job-replacement-mit-study/
[42] https://www.linkedin.com/pulse/ai-wont-steal-your-job-those-learning-use-frank-lazaro#:~:text=So%2C%20people%20who%20learn%20AI,optimized%20using%20machine%20learning%20algorithms.
[43] https://siliconangle.com/2021/07/26/angstrom-era-intel-unveils-ambitious-semiconductor-roadmap-goes-beyond-1nm-chips/
[44] https://www.nist.gov/physics/introduction-new-quantum-revolution/second-quantum-revolution#:~:text=The%20second%20quantum%20revolution%20is,an%20experimental%20NIST%20atomic%20clock.
[45] https://utilitiesone.com/quantum-computing-and-electrical-engineering-a-paradigm-shift
[46] https://resources.pcb.cadence.com/blog/2022-machine-learning-electronic-design-automation-unlocking-new-designs

interdisciplinary training such as a physics graduate who undertakes an electronic design masters or vice-versa.

- **Greater opportunities for apprenticeships, continued professional development, back-to-work opportunities, and increased diversity**: While the availability of graduates at the bachelor, masters and PhD levels is critical for the continued development of the sector, a significant pipeline of talent can also be found by opening up other routes such as increasing the opportunities for apprenticeship roles in the industry and embedding continued professional development activities much more deeply. An increased focus should also be placed on opening up opportunities to a greater diversity of potential entrants, whether gender, ethnicity or socio-economic. While every organization with an interest in engineering and science in Ireland has worked hard to attract more female students into engineering in the past 25 years, the female participation in engineering is still relatively low (25% or less[47]), thus losing a vast amount of creativity to the engineering and semiconductor domains.

Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?

The main barriers to development have already been outlined in the previous section on "**Challenges facing businesses and the sector**". These include:

- The cost of new fabrication plants and keeping up with the state-of-the-art.
- Access to a highly skilled workforce.
- International competition for facilities and workforce.

Two significant additional barriers are:

- **The availability and cost of housing for new workforce entrants**: in recent years, the availability of suitable housing to purchase or to rent has become a severe problem especially for foreign-nationals coming to Ireland to take up employment or for overseas students wishing to pursue their studies here.
- **The high cost of prototype development**: start-up companies in Ireland who wish to develop new integrated circuit designs must use a semiconductor foundry service such as Europractice[48] or engage directly with a foundry such as TSMC[49]. The EDA tools required to develop these designs are very expensive and the cost of prototypes from the foundries themselves are expensive. Companies can often struggle with finding employees with sufficient experience of using the EDA tools efficiently and to their maximum capabilities. Similarly, gaining access to high-performance test and measurement equipment to verify that a new design and product meets its intended operational targets can be very expensive and time-consuming. While research centres such as Tyndall and MCCI have helped greatly in

[47] https://www.engineersireland.ie/News/women-significantly-less-likely-than-men-to-view-engineering-as-a-suitable-career-stem-forum-hears#:~:text=Furthermore%2C%20according%20to%20the%20Higher,courses%20then%20choosing%20alternative%20careers.

[48] https://europractice-ic.com/

[49] https://www.tsmc.com/english/dedicatedFoundry/services/cyberShuttle

recent years in overcoming these obstacles, further support is needed to ensure a healthy integrated circuit design start-up ecosystem in Ireland.

Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?

In the context of the European Chips Act, there is a great opportunity to expand Ireland's footprint in the semiconductor manufacturing, design and innovation areas so that we can play our part in doubling the EU's share of the worldwide semiconductor market by 2030. To ensure that Ireland can make the most of these opportunities, we will need to overcome many of the challenges described earlier. As a university with embedded world-class research centres and a strong track record in education, research and enterprise-creation we offer the following suggestions for mitigating these challenges, with an emphasis from our perspective on ensuring a healthy pipeline of new talent for the industry, significant expansion in the country's research footprint in semiconductors and expansion of the opportunities and supports for start-up companies in the area; specifically we recommend:

- Support for students to complete the new 5-year integrated ME programmes. In common with many third level institutions offering Bachelor of Engineering (BE) qualifications, UCC has now introduced successful 5-year integrated masters programmes (5-year ME) where students on the BE programmes can choose to remain in their studies for one additional year and graduate with an ME instead of a BE. This is in line with the Professional Standards recognition of Engineers Ireland for Chartered Engineer status that was implemented about 10 years ago. Feedback from industry has been very positive regarding these programmes and a masters-level qualification is increasingly being regarded by the industry as the desirable entry level for new recruits rather than the bachelor level. However, the Government does not cover the student fees for the 5th year so students have to cover this themselves which acts as a disincentive for students to continue to the ME level. We therefore strongly urge the Government to fund student fees of the 5th year of the integrated ME programmes (and other programmes to Masters level) to ensure that we have a strong pipeline of talented graduates meeting the professional accreditation standards of the field.
- Development of new semiconductor-specific masters programmes with an inter-disciplinary nature and focusing on emerging semiconductor technologies and emerging IC design techniques to prepare graduates to enter semiconductor manufacturing and design enterprises or to enter PhD-level semiconductor research programmes. In these we can be guided by the structure and resourcing of existing world-class and highly respected programmes such as the "MSc Electrical Engineering" at TU Delft[50]. The development of these new programmes would be enhanced by the investment in academic faculty at all levels, including professorial level, who already have an established track record of leadership in education, research (both academically and with industry) and international collaboration.

[50] https://www.tudelft.nl/onderwijs/opleidingen/masters/ee/msc-electrical-engineering

Potential funding avenues for the development of these new courses should be explored via the National Training Fund[51] and other sources.

- Enhancement and upgrading of undergraduate and post-graduate training laboratories. Most employers rate “work readiness” as a highly desirable attribute when recruiting engineering and science graduates. In order to be “work ready” students need to be trained on at least near state-of-the-art equipment and software at third level similar to what they will use in industry and in research centres. The performance of standard electronics “tools of the trade” such as oscilloscopes, power supplies, logic analysers, spectrum analysers and radio frequency and communications test sets have advanced enormously in industrial and research settings in the past decade together with the introduction of new test and development paradigms that rely on extensive use of field-programmable-gate-arrays[52] (FPGAs) and embedded operating systems such as Linux[53]. Most undergraduate laboratory facilities have not kept up with this changing industrial and research environment and we consider that many electronics programmes in Ireland are in need of substantial re-investment in laboratory facilities to allow our students to be “work ready” with industry-standard equipment. It is likely that such an investment can be partially leveraged from industry if managed appropriately.
- Co-ordinated support for access to state-of-the-art Electronic Design Automation (EDA) toolsets and access to low-cost prototype manufacturing for both printed circuit board (PCB) prototypes and integrated circuit (IC) prototypes. These supports would be equally beneficial to educational programmes, research organizations and start-up companies. A centralised system in Ireland for EDA toolsets and prototyping along the lines of the existing Europractice[48] scheme would be very beneficial but with much enhanced user-support and with consideration being given to hosting the toolsets on a central cloud-based system to eliminate the need to duplicate scarce expertise in system installation, licensing and security management.
- Continued and expanded support for existing research centres. Many research entities in Ireland already have very well developed short- and long-term development plans. For instance, the Tyndall National Institute has published “Tyndall 2025”[54] wherein it sets out its ambition to double in size compared to its 2018 baseline in terms of research staff, researchers in residence and postgraduate student numbers. It also sets out its ambitions for gender balance and transfer of staff and graduates to industry. The interest in semiconductors and the increase in investment at both research and industrial levels sparked by the European Chips act should provide motivation in Ireland to fully support the development plans of the existing centres such as Tyndall and even to consider more ambitious goals for these centres than outlined in the existing plans. It should also serve as a motivation to continue to support the more overarching development plans of SFI as outlined in their document “Shaping Our Future – Science Foundation Ireland Strategy 2025”[55].

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[51] https://www.cedefop.europa.eu/en/tools/financing-adult-learning-db/search/national-training-fund-ntf#:~:text=The%20fund%20provides%20for%20expenditure,skills%20needs%20for%20the%20economy

[52] https://www.electronicdesign.com/blogs/altembedded/article/21147660/electronic-design-fpgas-emerge-everywhere

[53] https://www.seeedstudio.com/blog/2021/01/20/beginners-guide-to-embedded-linux/

[54] https://www.tyndall.ie/contentfiles/documents/tyndall-2025-strategic-plan.pdf

[55] https://www.sfi.ie/strategy/SFI-Strategy-2025.pdf

- IC design and IC application-focused centres such as MCCI[11] should also continue to be supported and expanded. A key mission of MCCI is to produce "industry ready" graduates in collaboration with the existing 3rd-level institutions and because IC design is one of the most mobile aspects of the semiconductor industry, design centres follow the availability of design talent and Ireland needs to continue to be seen internationally as a key location for design talent.
- Expanded support for start-up companies and SMEs in the semiconductor space through Enterprise Ireland[13] and the Local Enterprise Offices[56] and their interaction with university-based start-up supports such as UCC's IGNITE[57] programme.
- Extra supports for the teaching of mathematics and science subjects at second-level, especially to Higher Level Leaving Certificate standard should be introduced. There is still a wide variation among secondary schools in Ireland regarding the availability of teachers to teach some STEM subjects such as Mathematics, Physics and Applied Mathematics, especially to the Higher Level Leaving Certificate level. This is especially the case with Physics and Applied Mathematics. Considering that these subjects are so critical to the development of future engineering students, and indeed many other discipline areas critical to the Irish Economy where a high level of mathematical understanding is necessary, we consider that further supports to develop teachers and encourage student participation in these subjects should be implemented.

In conclusion, we would like to thank the Department of Enterprise, Trade and Employment for the opportunity to contribute to policy in this area through this consultation and the School and Discipline at UCC would be happy to contribute to, and support , any further discussions the Department plan to have.

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15th March 2024

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56 https://www.localenterprise.ie/About-Us/
57 https://www.ucc.ie/en/ignite/

Response to the Public Consultation on the development of a National Semiconductor Strategy

University College Dublin

March 2024

1. *Aspirations for the sector – What are stakeholders' aspirations for Ireland's semiconductor industry in the coming years?*

The revenue of the global semiconductor industry is expected to exceed a trillion dollars in 2030, and more than one million additional skilled workers will be needed to meet demand in the semiconductor industry. Ireland has developed a strong domestic and international semiconductor industry and R&D ecosystem, with over 130 indigenous and foreign subsidiary companies across the microelectronics value chain. There are over 20,000 people currently employed in Ireland's semiconductor industry, exporting €13.5bn worth of products annually. Most stakeholders want the semiconductor industry to continue its significant contribution to Ireland's economy, including creating high-value jobs, driving innovation, and attracting foreign investment.

Given recent global disruptions to semiconductor supply chains, to remain globally competitive and facilitate the growth and sustainability, Ireland's semiconductor industry needs to increase infrastructure investment, enhance its manufacturing capabilities and ensures resilience and stability in the supply of critical components. As the semiconductor industry evolves with advancements in technology, Ireland must develop a highly skilled workforce equipped with the knowledge and expertise needed to excel in semiconductor design, manufacturing, and related fields. As semiconductor technology increasingly permeates various sectors, stakeholders aspire to deeper integration between Ireland's semiconductor industry and other key industries such as healthcare, automotive, telecommunications, and renewable energy, fostering cross-sector innovation and growth.

Over the past fifty years, Ireland has built a strong reputation in semiconductor manufacturing and design. Underpinning this has been its international leadership in specific areas of microelectronics research and education.

Semiconductor manufacturing

On the manufacturing front, Intel has one of the most advanced fine-line geometry facilities in Europe, while Analog Devices leads in "more than Moore" fabrication. Such facilities require huge investment, a pipeline of highly skilled staff, and a supply of products to keep them full. As the demand for semiconductors is expected to double by 2030, Ireland should aspire to double the capacity (and employment) of these facilities and associated subcontractors.

Tyndall National Institute (a research facility) is a world leader in photonics packaging, which is a growing area. Ireland could develop commercial manufacturing capability in this area once demand grows sufficiently.

Semiconductor design

In terms of design, companies such as Analog Devices, AMD and Intel already lead internationally in domains such as radio frequency (RF) electronics, data converters, power electronics, hardware accelerators, and vision processing units (VPUs). Emerging areas such as hardware for quantum computing, space applications, and AI-assisted EDA offer the prospect of significant additional growth.

Semiconductor companies that historically designed components are focussing increasingly on application-driven subsystems and even complete systems. This offers endless possibilities for vertical integration in terms of developing electronic solutions to a wide range of problems from healthcare and the environment to energy systems.

Ireland should plan to double employment in the semiconductor design sector and to grow its application-focussed systems development industry.

Research and Education

Educational institutions, particularly universities, play a crucial role in the national semiconductor ecosystem.

Universities conduct fundamental and applied research in semiconductor technology, materials science, device physics, and related fields. Their research efforts can contribute to technological advancements, innovation, and the development of new semiconductor materials, processes, and devices. Universities collaborate with industry partners to facilitate technology transfer, knowledge exchange, and collaborative research projects. These partnerships bridge the gap between academia and industry, fostering innovation and facilitating the commercialization of research outcomes. University College Dublin has provided consulting services and intellectual property to industry, as well as engaging in collaborative basic and applied research, and spinning out SMEs in the semiconductor design and semiconductor-based quantum computing domains.

Universities play a vital role in addressing skills shortages and developing a skilled workforce for the semiconductor industry. They are responsible for educating and training the next generation of semiconductor professionals. They offer undergraduate and graduate programmes in semiconductor engineering, materials science, electronic engineering, and related disciplines, providing students with the knowledge, skills, and expertise needed to excel in the semiconductor industry. They also can offer specialised training programmes for engineers working in industry. University College Dublin trains engineers and computer scientists in all of the technical domains that are required by the industry.

Overall, educational institutions are core contributors to the national semiconductor strategy by leveraging their research capabilities, educational programmes, and collaborative networks to drive innovation, talent development, and industry growth. Their contributions are essential for building a vibrant and sustainable semiconductor ecosystem that supports long-term economic prosperity and technological advancement.

2. *Opportunities for the sector – What do stakeholders identify as key opportunities for the sector to further develop?*

Demand for semiconductors will continue to grow. The value of sales worldwide is predicted to double in size by 2030.

Semiconductor manufacturing

Investing in advanced manufacturing technologies such as advanced packaging, 3D integration, and automation can enhance efficiency, reduce production costs, and increase competitiveness in the global market.

It is easier to build the next generation of semiconductor manufacturing plant in an existing location than to start on a greenfield site. Ireland should be able to grow its manufacturing capability in advanced digital processes (Leixlip) and “more than Moore” (Limerick). An opportunity exists to build commercial photonics packaging capability based on know-how and personnel at Tyndall National Institute.

This will require a supply of engineers from many disciplines (electrical, electronic, chemical, manufacturing, materials, mechanical, etc.) to install and maintain the plant and equipment.

Semiconductor design

RF electronics, data converters and specialised digital processing units will continue to be in high demand as they are required in almost all application domains. There is also a growing need for systems on chip and in package. Employment in this area could easily double.

UCD has spun out a startup company, Equal1 Labs, aiming to build scalable semiconductor-based system-on-chip (SoC) quantum computers. Quantum computers hold massive disruptive potential. Their development is evolving quickly and will have multiple use cases across various sectors including artificial intelligence and machine-learning solutions where optimisation problems scale exponentially (e.g., financial modelling and logistics optimisation), computational chemistry, drug development, cybersecurity and cryptography to name a few.

Ireland has a history in Electronic Design Automation (EDA) with industry leaders such as Synopsys and Cadence developing products and intellectual property here. This field is experiencing a revolution as the need to increase the productivity of designers grows. Artificial Intelligence and Machine Learning are playing a greater role in design automation. There are opportunities for Synopsys and Cadence to grow their EDA and intellectual property (IP) activities in Ireland.

Diversification of Markets and Applications: Diversifying into new markets and applications such as automotive electronics, healthcare devices, renewable energy systems, and industrial automation can mitigate risks associated with market volatility and drive revenue growth for Ireland's semiconductor companies. Identifying and capitalizing on emerging technologies such as artificial intelligence (AI) and quantum computing that can create new market opportunities and drive growth in the semiconductor sector.

Focus on Sustainability and Green Technologies: Embracing sustainability initiatives and developing green technologies can not only reduce environmental impact but also open new market opportunities and enhance the competitiveness of Ireland's semiconductor industry in a rapidly evolving global market. Investing in infrastructure, including semiconductor manufacturing facilities, research labs, and digital infrastructure, can create an enabling environment for semiconductor sector growth, attracting investment and fostering innovation-led economic development.

3. *Challenges facing businesses and the sector – What are the key challenges facing individual businesses in the semiconductor sector? What are the overarching challenges facing Ireland's semiconductor sector as a whole?*

Semiconductor manufacturing

Semiconductor manufacturing is capital intensive and requires specialised skills. Ireland has built expertise and facilities over several decades. The fabrication facilities (fabs) at Intel and Analog Devices are truly world class. Tyndall National Institute does an excellent job of training personnel for work in the manufacturing sector.

Semiconductor designs will be produced in the most cost-effective fabs. The challenge with fabs is to keep them full and up-to-date. This requires a steady supply of designs for high added value products.

Semiconductor design

Chip design is becoming increasingly difficult as the complexity of each design increases. The productivity gap can be closed through education and upskilling, and the greater use of design automation tools. The cost of prototyping a chip is ever increasing and the need to verify designs before manufacture is critical. Ireland does not train enough specialists in verification or layout so people with these skills are being recruited from overseas, or those functions are being carried out in other locations.

There is an opportunity for Ireland to carry out significantly more design verification and layout work.

Each new generation of chip requires innovation in circuit design. It doesn't matter where the ideas come from, but those countries that source ideas have abetter chance of securing design jobs locally. Ireland has historic expertise in RF electronics, data converters, power electronics, signal processing, and hardware accelerators. Academic research in these areas and emerging areas such as a quantum electronics and AI-assisted design automation should be supported.

Diversification and Innovation

Ireland's semiconductor sector is heavily reliant on foreign investment and multinational corporations, which can pose risks in terms of dependency and vulnerability to external economic and geopolitical factors. Encouraging diversification and innovation within Ireland's semiconductor sector beyond traditional areas such as manufacturing and assembly can help mitigate risks associated with market volatility and enhance the sector's resilience and competitiveness.

4. *Access to talent for businesses – What skills needs (across the spectrum of training, education and research) will arise for the sector in the coming years?*

The semiconductor design industry relies heavily on highly skilled engineering talent, mostly Electronic Engineers educated to Masters level. Since value is generated through innovation, there is a growing demand worldwide for graduates with doctoral qualifications in relevant areas such as circuit design and design automation.

Electronic Engineers who work in the sector need to know circuit design, verification, software, and machine learning.

The supply of graduate Electronic Engineers at Bachelor and Masters levels is currently provided by the third-level sector. The demand from the semiconductor industry has historically been cyclical, with supply sometimes outstripping demand. This means that undergraduate students often choose other specialities within Engineering that are perceived as less risky. Identifying semiconductors as a national priority for the economy and raising the profile of the sector will potentially encourage more students to choose a career in the area.

Shortages in talent supply have been met through inward migration for engineers from other countries. It is important that the State continues to make it possible for highly skilled non-native engineers to work in the sector in Ireland. One pathway that has proven effective is internships at the Microelectronic Circuits Centre Ireland (MCCI) Technology Centre. MCCI provides a rich training ground for Electronic Engineers to gain experience in industry-relevant projects and EDA software, preparing them for employment.

MCCI is ideally placed to become the national training site for EDA tools so that both students and SMEs can get the training needed to enter the field of circuit design.

Doctoral education and advanced research is carried out within research groups that receive the bulk of their funding through individual grants from Science Foundation Ireland. In the field of circuit design, the leading academics (based on publications in the leading conferences and journals in the field) are in University College Dublin.

Ireland does not have a national doctoral training programme in circuit design. Nor does Ireland have an SFI Centre in the area of circuit design. It needs both. Due to the small size of third-level institutions, there are seldom more than three or four academics in any individual institution who have an interest in carrying out research in circuit design. Doctoral training requires input from the best academics in the country who are inevitably in different institutions. Co-ordination at a national level is required.

In light of the increased awareness of the need for circuit design training at doctoral level, countries such as Italy, Sweden, Finland, have developed national doctoral schools in circuit design. Ireland needs to fund a doctoral training programme that leverages the best educational modules that are available and a research centre that optimizes the research impact in the field.

Employees in the semiconductor design industry are in constant need of upskilling as technology and methods evolve. MIDAS Electronic Systems Skillnet has been extremely successful in meeting the needs of the industry. With additional funding, it could grow even further the skill levels of those already in the sector and stimulate additional activity in areas such as layout and verification.

In terms of employee development and retention, it is important that learners in full-time employment should be able to bundle microcredentials from multiple higher education institutions into certificates, diplomas, and degrees, where appropriate. The microcredentials system nationally needs to accommodate bundling of best-in-class contributions that will inevitably come from a diversity of education providers, some of which might be outside Ireland.

In the coming years, the semiconductor sector will likely experience increasing demand for talent across various disciplines, from advanced semiconductor materials and fabrication, to integrated circuit (IC) design and packaging. Proficiency in EDA tools and software used for IC design and verification will remain essential. Skills in Artificial Intelligence (AI) and Machine Learning (ML) will be increasingly important for developing intelligent semiconductor systems, optimizing manufacturing processes, and enhancing design automation and verification.

Proficiency in data analytics, big data processing, and data-driven decision-making will be essential for optimizing semiconductor manufacturing processes, analysing semiconductor test data, and improving yield and quality. Understanding of environmental sustainability principles and practices will be important for developing environmentally friendly semiconductor materials, processes, and technologies, as well as minimizing the environmental impact of semiconductor manufacturing operations. Skills in interdisciplinary collaboration and communication will be increasingly valuable for semiconductor professionals to work effectively across diverse teams and domains, integrating expertise from areas such as engineering, physics, materials science, and computer science.

5. *Barriers to development – What barriers might prevent both individual businesses and the sector as a whole from meeting its aspirations?*

The semiconductor industry operates in a highly complex and rapidly evolving technological landscape. Keeping pace with advancements in semiconductor design, manufacturing processes, and materials can be challenging and require significant investment in research and development. Establishing and operating semiconductor manufacturing facilities requires substantial capital investment. High upfront costs for equipment, infrastructure, and technology can be a barrier for both new entrants and existing businesses seeking to expand or upgrade their facilities.

The semiconductor industry is also characterized by intense global competition and market volatility. Fluctuations in demand, pricing pressures, and changes in market dynamics can pose challenges for businesses in terms of revenue stability and profitability. Semiconductor businesses rely on complex global supply chains for raw materials, components, and equipment. Disruptions in the supply chain, such as shortages, delays, or geopolitical tensions, can impact production schedules, increase costs, and affect business continuity.

Recruiting and retaining skilled talent in areas such as semiconductor engineering, design, and manufacturing is a persistent challenge for businesses. Skills shortages and gaps can hinder innovation, slow product development cycles, and impact competitiveness. Third-level institutions have a key role to play.

Academic freedom means that academics in Ireland are free to work on whatever topics they choose. The choice of topic affects the areas in which their doctoral, masters, and bachelors students are trained. Twenty years ago, many academics were working the field of circuit design in Cork, Limerick and Dublin. Their students have contributed to the growth of Analog Devices in Limerick and Cork, Qualcomm and Infineon in Cork, Intel, AMD and Qorvo in Dublin.

The landscape has changed in recent years with retirements of experienced academics and newer staff working in areas other than semiconductors. As a result, the supply of graduates who have been exposed to project work in circuit design is decreasing. UCD has consolidated its academic expertise in semiconductor design, trains the largest number of graduates at doctoral level, and has the potential to underpin further growth in the sector. Currently, there are more doctoral graduates from UCD than job opportunities and these highly trained graduates therefore contribute to the semiconductor sector in other countries rather than Ireland. To stop this brain drain, the design sector needs to grow in Dublin as it has already done in Cork and Limerick.

Companies need more Masters level graduates than PhDs. The best way to interest an undergraduate in circuit design is to have them work on a project. Exposure to EDA tools for circuit design happens primarily in classes and research groups in UCD and MCCI. More students could be exposed to circuit design if a cloud-based EDA infrastructure were made available (as is envisioned in Pillar 1 of the EU Chips Act). More faculty would work in the area if thematic research funding were available, for example via an SFI Centre.

6. *Mitigation – What are potential mitigating actions that could be taken (and by whom) to address the challenges and barriers identified?*

To address the challenges and barriers identified in the semiconductor industry, various stakeholders, including businesses, governments, academia, and industry associations, can take several mitigating actions:

Increase Investment in R&D and Infrastructure: Businesses should allocate sufficient resources for R&D to drive innovation, develop new technologies, and improve product performance and competitiveness. Government shall provide funding and incentives for R&D initiatives, collaborative research projects, and technology development in the semiconductor sector. Invest in infrastructure upgrades, modernize manufacturing facilities, allocate funding for research facilities, and digital infrastructure development to support semiconductor industry growth and innovation.

Enhance Supply Chain Resilience and Ensure Sustainability: Diversify supply chain sources, establish strategic partnerships with reliable suppliers, and implement risk management strategies to mitigate supply chain disruptions. Support initiatives to enhance supply chain resilience, promote domestic manufacturing capabilities, and reduce dependency on single-source suppliers through incentives and policies. Adopt sustainable manufacturing practices, invest in energy-efficient technologies, and implement waste reduction and recycling programs to minimize environmental impact.

Market Diversification and Innovation: Explore new markets, applications, and customer segments, invest in product innovation and diversification, and leverage emerging technologies to create new opportunities and revenue streams. Provide support for innovation hubs, technology clusters, and startup ecosystems to foster entrepreneurship, innovation, and market diversification in the semiconductor sector.

Skills Development and Talent Acquisition: Invest in training programmes, apprenticeships, and continuous learning opportunities to upskill existing workforce and attract new talent. Specific actions that will deliver short-term wins and address long-term needs include:

- Provide additional funding via MIDAS Electronic Systems Skillnet to support talent development in layout and design verification [DETE].
- Refine the microcredentials system to incentivise best-in-class contributions from a diversity of providers [DFHERIS].
- Provide national cloud-based EDA infrastructure to make it easier for students, university faculty, and SMEs to do projects and carry out research in semiconductor design [EI/IDA].
- Fund a national doctoral school in electronic design [SFI].
- Fund an SFI Research Centre and Research Professorships to underpin fundamental research in circuit design and design automation [SFI].
- Increase to the stipend for PhD students to EUR 25k to alleviate difficulties in recruitment [SFI]

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Dublin, 15 March 2024

National Semiconductor Strategy

University of Limerick

Public Consultation Response

1. Introduction

University of Limerick appreciates the opportunity to contribute to the national discussion on the future of Ireland's semiconductor industry. Our institution is at the forefront of semiconductor education and research, supports the local semiconductor industry and has a strong commitment to addressing the strategic objectives of the European Chips Act and in particular to:

- strengthen research and technological leadership,
- build and reinforce Europe’s capacity to innovate in the design, manufacturing and packaging of advanced chips,
- addressing the skills shortage and attracting new talent and
- developing an in-depth understanding of the global semiconductor supply chains.

This response focuses on the themes of **'Access to talent for businesses'** and **'Barriers to development'** as outlined in the consultation document.

2. Growing the R&D Ecosystem

Ireland is one of the leading semiconductor clusters in Europe and at this juncture it is critical that investment in R&D and in particular PhD training is forthcoming in order to retain and grow our position.

There are a number of research areas in which Ireland can build upon existing strengths, these include: sustainability with the use of new materials (beyond silicon) in power circuits, which is expected to grow significantly in line with EV and other power-oriented applications[1], research

[1] *Strong research area for Bernal Institute, UL through the Molecular Nano Materials group led by Prof Kevin Ryan* [Molecular Nano Materials | University of Limerick]

into software and data science including the use of AI in automated digital design[2], semiconductor remanufacturing and circularity[3].

SFI centres have become recognised as a successful model for publicly-funded research centres which seeks to create critical mass by harnessing strengths at a national level[4]. In addition, the recent CRT programmes which involve partnerships with industry and HEIs to deliver high quality doctoral training have generated a pipeline of highly motivated researchers with strong fundamental research skills and multidisciplinary capacity. It is important to recognise, in continued and future investment in semiconductor talent and R&D, the advantages of geographic spread and harnessing of strengths across the sector have been demonstrated to bring significant benefits to the Irish economy and society.

Recommendation 1: Recognition of the geographic spread of companies and HEI's in Ireland[5] supporting the semiconductor industry to be reflected in further sustainable investment for the ecosystem.

3. Access to Talent for Businesses

3.1 Talent development

The capacity of universities to provide a talent pipeline for the semiconductor sector is of fundamental importance to each of the objectives of the EU Chips Act and must be a foremost consideration in the National Semiconductor Strategy. With both staff and students active in semiconductor processing, materials and devices, especially in link with companies located in Ireland, Europe, USA and Asia, UL through its Department of Electronic & Computer Engineering and Department of Physics can make even more significant advances in developing international talent pool, top designers, trouble shooters as well as problem solvers in this industry.

The core semiconductor dimension of many Electronic Engineering and Physics courses has diminished as more ICT focussed topics such Artificial Intelligence, Edge Computing, Robotics & Cybersecurity have grown in popularity with students and in prominence from a research funding perspective. Similarly, BSc and MSc Applied Physics courses generate graduates for manufacturing, engineering and R&D of semiconducting devices with specialisations in semiconductor processing, nanotechnology, advanced analysis techniques, instrumentation and quantum mechanics. This capacity could be furthered through investment to support joint research projects in materials, process, PAT, sensorics, characterization, data analytics, learning and intelligence among others.

Consideration needs to be given to the challenges in the development of talent in this area. The recruitment of suitably qualified staff in many key areas such as Digital and Mixed Signal Integrated Circuit Design has become extraordinarily difficult due to a combination of factors including the rapid pace of technological advancement, a shortage of professionals with the necessary specialised skills, and intense competition with industry for the top talent.

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[2] *Lero – Irish Software Research Centre HQ in Limerick, Prof Conor Ryan, Professor of Machine Learning*
[3] *See information on DTIF project XBat+: Advanced Robotics & Artificial Intelligence for Critical Raw Materials Recycling in the Circular Economy led by Prof Colin Fitzpatrick, Disruptive technologies funding for University of Limerick-led research project | University of Limerick (ul.ie)*
[4] *Mulligan et al (2022) Harnessing the science base: Results from a national programme using publicly-funded research centres to reshape firms' R&D https://doi.org/10.1016/j.respol.2021.104468*
[5] *Limerick has a hub of companies around GaAs/GaN circuit design with Arralis, Provisio and Celtonn as well as Analog Devices.*

Moreover, ensuring access to state-of-the-art practical lab experiences and critically necessary technical support for the sophisticated tools used in semiconductor education proves to be a significant challenge. This difficulty in sourcing the right resources for key areas of study is a major hurdle for institutions aiming to provide a comprehensive education in the semiconductor field.

For example; while circuit design is covered within core Electronic & Computer Engineering Degree/Masters programmes at UL, licence costs for design tools can be significant. At present universities cannot use the design tools to collaborate with industry as they are academic only licences and many have restrictions on using them to collaborate with industry.

There is also acute pressure to compete for high quality students of a suitable profile with other programmes of study such as computer science, and biomedical engineering gaining greatly in popularity. Since publication of EU chips act, some activity in this area has been stimulated to part address this challenge; an example of this is a new MSc in IC and Intelligent Systems Design which is currently in development at UL. This novel programme involves an inter-institutional collaboration with an internship component. However, while this innovation is welcome, the semiconductor industry's rapid pace of change requires more agile responses from educational institutions. We are committed to fostering an adaptive learning environment where curricula are regularly reviewed and updated in consultation with industry stakeholders, ensuring that our programs remain relevant and responsive to technological advancements. However, while acknowledging our commitment to continuously updating our electronics, physics and related engineering curricula to incorporate cutting-edge semiconductor design and manufacturing, this is increasingly difficult in the face of challenging student numbers, recruitment of staff, and the need to replace and update equipment.

Recommendation 2: Provide a dedicated stimulus package to hire core academic and technical staff, and to resource lab development including access to EDA tools and silicon prototypes. These would be specifically to support talent development in key identified areas relevant to semiconductors and could be facilitated through the Higher Education Authority with its Human Capital Initiative programme[6]. To include:

2.1) The enhancement of components of existing taught programmes directly relevant to the National Semiconductor Strategy

2.2) The development of new undergraduate programmes in Semiconductor Engineering which cut across electronic engineering, materials science, applied physics, and manufacturing *inter alia*. This could also take the form of industrial apprenticeships where school leavers go straight to work in the semiconductor sector with a block release scheme over several years to acquire their academic qualifications. This should be accompanied by a significant promotion of engineering and physics programmes equivalent to SFI-funded Science Week.

2.3) The development of new taught master's programmes which can be targeted at recruiting highly talented international students to come to Ireland. These should include industrial internships which would greatly increase the appeal of our programmes to the best students around the world and can begin to embed them in Irish-based industry.

[6] https://hea.ie/skills-engagement/human-capital-initiative-pillars-1-2-and-3/

2.4) The provision of upskilling, and other professional development opportunities for people already working in the semiconductor sector, or those who would like to reskill or change career.

2.5) An initiative to support circuit design tools costs and other lab hardware is needed to bring labs up to state of the art and to support engagement with industry.

4. Research

A vibrant university has an environment where there is a culture of generation and imparting of knowledge and an international reputation for excellence. This attracts top-calibre people who want to become part of it and exposes students to the forefront of thinking in the area, inducting them into this culture of exploration and learning which is vital for a knowledge economy. In other words, high quality teaching and research are two sides of the same coin and need to be considered together and the availability of research funding becomes a catalyst for high-impact teaching. However, the word semiconductor does not appear in the Dept of Enterprise Trade and Employment Research Priority Areas 2018-2023 documentation[7] and funding opportunities are limited as a result.

Therefore, the National Semiconductor Strategy should explicitly call for an increase in academic research funding and other opportunities directly in the semiconductor space to create an excitement about dynamic academic careers, encourage students to undertake PhDs, and create more University startups in this area, all of which form part of the ecosystem needed to propel the semiconductor talent pipeline.

The semiconductor industry is continually evolving, driven by the demand for smaller (subnano), faster (e.g. for 5G+) and more efficient electronic devices (e.g. autonomous application, quantum computing and AI).

While, advanced materials characterization techniques are highly crucial for enabling the development (failure analysis) and optimization (performance) of such semiconductor materials and devices. Potential future trends and advancements in materials/device characterization techniques within this industry will likely focus more on:

1. The development of advanced imaging techniques, atomic force microscopy with magnetic field detection and field mapping capabilities, high-resolution TEM analysis with sub-nanometre to atomic level analytical capabilities, In-situ (in vacuum/inert) based-analysis, surface characterizations (e.g., XPS) etc.
2. The development of these techniques must parallel the integration of machine learning tools, AI and failure modelling & software.
3. The development of materials for thermoelectrics, high entropy, or fundamental understanding of metal diffusion (at different temperatures studied using heating stages on XRD, TEM etc) and material passivation is always relevant particularly with a push to wider range of elements in use on chips. Other areas include metrology, fault analysis etc, delayering by FIB, TOFSIMS with characterization by

[7] https://enterprise.gov.ie/en/publications/research-priority-areas-2018-to-2023.html

HRSEM, HRTEM, XPS .Expertise and competence here is crucial for accurate and reliable fault analysis

One important area to develop is instrumentation for semiconductor processing. Ireland has produced some of the best physicists and engineers whose talents can be appropriately utilised in developing new instruments, process equipment, methodologies and metrological tools relevant to semiconductor and supporting industry (e.g. photonics, magnetics and dielectrics). We can also significantly contribute to the sustainability of the industry and supply chain. For example, sustainable dielectrics are important as a move from state-of-the-art fluorine and lead-based materials will be needed in semiconductor packaging and multilayer capaciors due to European regulation. The Department of Physics at UL leads some of these initiatives internationally.

- strengthening research and technological leadership;
- building and reinforcing Europe's capacity to innovate in the design, manufacturing and packaging of advanced chips;
- putting in place an adequate framework to increase production by 2030;
- addressing the skills shortage and attracting new talent;
- developing an in-depth understanding of global semiconductor supply chains.

Further investment will realise enhanced benefits for the semi-conductor industry.

Recommendation 3: <u>The development of a comprehensive programme of funding for semiconductor related research in Irish HEIs. To include:</u>

3.1) Semiconductors outlined as a Research Priority Area

3.2) The development of more opportunities for funded research projects through the funding agencies of the state.

3.3) Specific consideration should be given to the establishment of a SFI Centre for Research Training in the area of semiconductors which should be inclusive of all Universities on the island of Ireland.

3.4) Equitable stipend rates for PhD students of at least €25,000 per annum and revised in line inflation.

5. Barriers to Development

While one of the key motivations of the EU Chips Act is to enhance the EU's strategic autonomy by diversifying semiconductor manufacturing from a limited number of companies and geographies, our National Semiconductor Strategy should also take into consideration other key EU flagship policies and agendas, including the Critical Raw Materials Act, the Circular Economy Action Plan and European Climate Law in order to maximise its impact.

Recommendation 4: <u>The National Semiconductor Strategy should mandate funding support for research at Irish Universities to inform the development of a thriving and sustainable semiconductor manufacturing sector which is complimentary to a wide range of national and EU policy goals.</u>

Sample research topics include:

4.1) Development of a national collective picture of critical raw materials usage in semiconductor manufacturing in Ireland with an accompanying action plan to mitigate exposure to supply chain interruption based on innovation, trade, recycling and domestic/EU based mining. (Critical Raw Materials Act)

4.2) A exploration of a semiconductor re-manufacturing sector based on novel design techniques, technologies and business models to enable chip recovery, re-qualification and resale (Circular Economy Action Plan)

4.3) Detailing of infrastructure requirements including renewable electricity and water for different scales of semiconductor manufacturing. Would national energy policy need to adapt to the significant ramp-up of semiconductor manufacturing, avoiding the difficulties that datacentres have encountered, and how could the potential of offshore wind energy provide support to semiconductor manufacturing (European Climate Law)

4.4) Semiconductors occupy a complex space in cybersecurity. While their intricate design and globalized production can introduce vulnerabilities like hardware attacks and supply chain compromises, they also offer immense potential for security. By embedding features like secure enclaves and tamper-resistant designs, semiconductors can act as shields against cyber threats. Therefore, prioritising research and development in securing these chips is crucial. Mitigating vulnerabilities through rigorous testing and secure coding practices, while simultaneously fostering advancements in security features, is essential for building a robust and trustworthy foundation for our increasingly technology-reliant world (EU Cybersecurity Act).

6. Conclusion

The EU Chips Act, and the development of a National Semiconductor Strategy are hugely exciting times for people involved in this sector, and the country at large. Our track record of industrial development aligned with educational provision, coupled with our potential for abundant carbon-free electricity and fresh water makes this a truly significant moment in industrial development. University of Limerick is dedicated to playing its role in developing the talent and innovations necessary for the future success of Ireland's semiconductor industry and we look forward to engaging further with the Department of Enterprise, Trade and Employment, industry partners, and other stakeholders to realise the ambitions of the national semiconductor strategy.

7. Submission contributors

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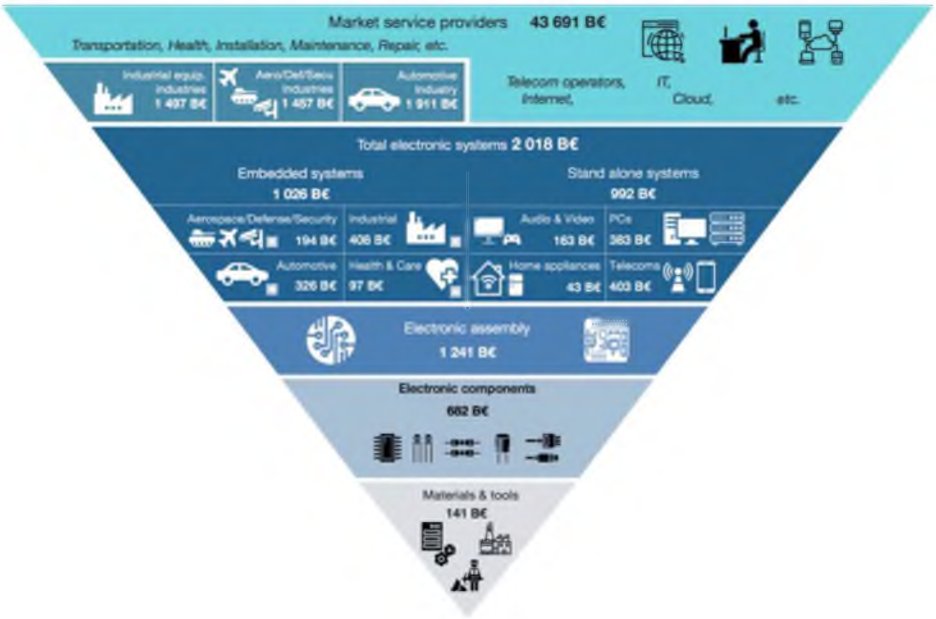
NATIONAL SEMICONDUCTOR STRATEGY CONSULTATION

OPPORTUNITY

The electronic components market, encompassing microelectronics, photonics, sensors, passive and interconnections has a global revenue of €700B supplying into an electronics industry of €2000B consisting of electronic products and cyber-physical systems. This in-turn generates revenue of over €5,000B from cars, trains, ships, airplane, defence, and industrial equipment. The diagram below illustrates how microelectronics and related disciplines are foundational skills to the sustainability of this Electronic Components and Systems (ECS) value chain.

GLOBAL ELECTRONIC COMPONENTS AND SYSTEMS (ECS) VALUE CHAIN IN 2018



Source: DECISION Etudes & Conseil (Emerging Technologies in Electronic Components and Systems, 2019

The Irish semiconductor industry directly employs over 20,000 people, with about 9,500 in highly skilled technical roles or in research and development (R&D), generating economic activity at the value of €2bn. The related R&D spend contributes about 10% to Ireland's overall R&D expenditure. Revenue from the activity of the sector towards ICT manufacturing was c€15.5bn in 2023. In addition, related support industries contribute more in terms of employment and economic activity.

The European workforce in microelectronics is characterised largely by R&D activities and fabless design with manufacturing of the semiconductors carried out by chip foundries Asia. This is particularly the case for digital semiconductors under 22 nanometres (the exception being Intel in Lexlip). Consequently, European manufacturing and research is focused on the integration of complex innovative systems such as MEMS, RF and photonics. This industry needs knowledge and skills in semiconductor design, embedded systems, microsystems, assembly, and packaging, complemented by key enabling technologies such as AI, automation, cybersecurity, connectivity etc. Furthermore, emerging computing technologies will require new skills from different fields of study in data science, materials science, chemistry, physics etc. There is almost an insatiable demand for STEM skillsets creating FDI opportunities for regions with the right talent pool and support structure.

There are three semiconductor clusters in Ireland, some more mature than others. The most extensive cluster is based in Munster, stretching from Cork to Limerick consisting of the Tyndall National Institute (Tyndall), University College Cork (UCC), the Munster Technological University (ATU), Analog Devices, Farran Technology and several fabless semiconductor and optical design companies.

The second cluster is in greater Dublin consisting of Intel Corporation, Trinity College Dublin (TCD), TU Dublin, University College Dublin (UCD) and several successful fabless semiconductor design companies. This cluster has recently been enhanced by Tyndall who have established a 6G research centre in Dublin as part of its plan to double the size of Tyndall and increase its national impact.

The third cluster is in the Northern Ireland, centred around the Seagate plant in Derry, the world's leading manufacturer in hard disc drive heads. The company has invested £4B into the site since it was established in 1993, it is the most advanced nanotechnology facility in the UK, as well as being one of just five facilities of its kind worldwide. The production of these HDD heads is similar to a semiconductor manufacturing process, relying on many of the same specialist tools, raw materials and the same talent pool. After an extensive period of R&D, in collaboration with knowledge providers in the island of Ireland, the company introduced the next generation of data storage in 2023, known as heat-assisted magnetic recording (HAMR) which uses a semiconductor light source with a scale of less than 50 nanometres. This is significant to the region because it raises the prospect for Seagate to create a Photonics Foundry in response to the UK National Semiconductor strategy published in May 2023 which is needed to break the reliance (and bottleneck) that UK and EU start-ups have on Asian foundries. A photonics chip foundry would present opportunities for the North-West through direct employment (from technician to highly skilled engineers and researchers) and the creation and/or development of businesses both supporting the foundry (facilities, maintenance, automation) and using the foundry for their own photonic and compound semiconductor chip designs.

Today, the NW cluster is the smallest of the three clusters, formalised in Northern Ireland under a consortium called Smart NanoNI, consisting of Seagate, Queens University Belfast (QUB), the University of Ulster (UU), the NW Regional College (NWRC) and 5 SMEs in the greater Belfast area. When considered as a cross-border region it has several strengths that would allow it to respond to the stimulus of a high-tech, high-skill investment in chip technologies. With the recent launch of the Atlantic Technological University (ATU) and growth of UU in Derry there are now two universities in the region. The takeover of E & I Engineering by Vertiv Corporation has also created a growing industrial ecosystem with attendant support companies. There are other companies in Donegal and Sligo in Factory Automation, Medtech and FinTech that contribute to the technology cluster.

Therefore, the EU Chips Act creates an opportunity for sustainable high-skill employment growth and FDI into the Northwest of Ireland if we can enhance the ecosystem that produces the skills needed for the semiconductor manufacturing and photonics sector.

Skills Development

In October 2023 METIS (Microelectronics Training Industry and Skills) published a report on a 4-year project involving 19 partners from 13 countries representing industry (Start-ups, SMEs, Large Firms) on the trends, challenges and opportunities associated to the skills needs in the European microelectronics industry *(Microelectronics Training, Industry and Skills (METIS) project number 612339-EPP-1-2019-1-DE-EPPKA2-SSA-B under the action Sector Skills Alliances in vocational educational education and training Grant Agreement number 612339-EPP-1-2019-1-DEEPPKA2-SSA-B)*

The report outlines the skills needs of the European microelectronics industry and makes 25 best practice recommendations on how industry and third level institutions can work together to fill the skills-gap facing the European Microelectronics Industry. Among these are a number that include funding by industry:

- Industry endowed professorships.
- Sandwich degrees with one year spent in industry.
- Company undergraduate scholarships.
- Group based student internship programme into microelectronic industry.
- Creation of flexible vocational training modules in microelectronics and nanotechnologies in collaboration with industry needs
- Industry experts invited to deliver teaching and training in Universities, funded by industry.
- Summer schools, example of the Dresden Microelectronic Academy, funded by industry.
- Company sponsorship of laboratories.
- Specialised training program for career changers into the microelectronics industry. Example of SBH Sudost GmbH and Dresden Chip academy who provide a 6-8 month practice orientated training for manufacturing technicians followed by a 6-8 moth industrial internship.

Another category highlighted in the report is integrated circuit prototyping services for SMEs provided by Research and Technology Organisations (RTOs), up to small volume production.

Included is the example of NORFAB – the Norwegian Infrastructure for Micro and Nanofabrication. NORFAB, launched in 2011, provides access to state-of-the-art laboratories for Norwegian researchers independent of their academic institution or company affiliation. The laboratories include three nodes: NTNU NanoLab in Trondheim; SINTEF MiNaLab and UiO MiNaLab in Oslo; and the University of South-Eastern Norway's MST-Lab in Horten. NORFAB offers more than 2000m^2 of cleanroom laboratories with advanced synthesis and analytical equipment.

Another example to consider is how photonic research is organized in the North-East of the United States. The lead research centre in photonics is a national centre called the "American Institute for Manufacturing Integrated Photonics (AIM Photonics) led by The State University of New York, established in 2015. (https://www.aimphotonics.com/). The mission of AIM Photonics is to advance integrated photonic circuit manufacturing technology development in the United States by providing access to state-of-the-art integrated photonics fabrication, packaging, and testing facilities and services to industry, academia and the United States government. AIM Photonics operate in TRL 4-7.

In this NE USA photonics cluster AIM Photonics is complemented by another organisation that provides higher TRL prototypes (TRL 7-9), training and skills. These are delivered by LEAP (Lab for Education & Application of Prototypes) led by Worcester Polytechnic Institute (WPI), (https://www.wpi.edu/research/core-research-facilities/leap). LEAP was established to "promote an open environment for ongoing education and hands-on training to enhance the regional technical workforce with the skills needed to support and grow the emerging photonic integrated circuit ecosystem and related fields". They have facilities to create and test prototypes that utilize photonic integrated circuit technologies essential for manufacturing advancement in areas related to: Medical devices; 5G and 6G wireless datacom; Chemical and biological sensors.

These are two examples of national semiconductor research centres pursuing a distributed model to create a critical mass of functions that have regional and national impact. In a similar vein it is proposed that the Tyndall National Research Institute establishes a presence in the NW through collaboration with the ATU to realise the ambition of a NW Cluster in photonics and microelectronic technologies.

This proposal would see the development of additional capacity on the island that will support and complement the work of Tyndall. Photonics have been identified as a critical part of the EU response to the global challenge in semiconductors with application in health, communications, sensor technology and the Internet of things[1][2]. Tyndall are leaders in European provision in photonics and microelectronics and have worked with related groups across the globe. A common thread in industry feedback is the need for increased capacity in design, manufacturing, and advanced packaging as well skills development in the semiconductor sector[3][4]. An applied research facility in the North West will help boost the region and strengthen the capacity and capability of the semiconductor industry on the island. Importantly, a fully integrated photonics eco-system has the potential to seed, support and sustain indigenous and FDI "first-of-a-kind" investment in new microelectronic production as envisaged in the EU Chip Act.

This necessitates the following interventions.

The first is an all-island research-led Photonics and Semiconductor Pilot line for manufacturing, product development and training and involving both ATU and Tyndall. The second is a Smart Manufacturing Research Facility in the North West region targeting the photonics and semiconductor sector and based in ATU in Donegal and UU in Derry. The third is connection into an All-Island Centre for Research Training in Semiconductor and Chip Technologies (Chips-CRT) to support and maintain the supply of PhD graduates in semiconductors.

1. Pilot line

In response to both regional development and to the EU Chips Act it is proposed that a photonics and microelectronics pilot line facility be developed in ATU and that a full packaging pilot line be developed in Tyndall. The concept of the Pilot Line is to create a highly disruptive research and commercialisation

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[1] https://digital-strategy.ec.europa.eu/en/policies/photonics

[2] The health of photonics (2018) An Institute of Physics Report. https://www.iop.org/sites/default/files/2018-10/health-of-photonics.pdf

[3] European Chips Act: Public Consultation Report (May 2022), Department of Enterprise, Trade and Employment. https://www.enterprise.gov.ie/en/publications/publication-files/european-chips-act-public-consultation-report.pdf

[4] John Durcan, IDA (2023) "2023 will be the year of the semiconductor", https://vmblog.com/archive/2023/01/06/ida-ireland-2023-predictions-the-year-of-the-semiconductor.aspx#.ZAiTax_P238

service, providing a well-coordinated pipeline for companies to develop and de-risk advanced technologies and manufacturing processes as well as providing a skills training platform.

The Photonics Manufacturing and Training Pilot Line investment will enable the WISAR Lab[5] in ATU to help develop products that utilise photonics, and to provide rapid prototyping, and testing, i.e., to move up the value chain. This will include device characterisation and reliability testing. This will provide regional SMEs and high-potential start-ups access to state-of-the-art integrated photonics technology and equipment supervised by skilled ATU technical staff to prototype, test, and implement new product designs that incorporate photonics technology.

The investment at ATU will allow the North West to contribute to the all-island response to the goals of the EU Chips Act and to help the all-island economy respond to the wider global challenges in future-proofing semiconductor and microelectronic supply chains. It will allow ATU to expand its industry interactions in a natural extension of its existing provision of Edge to Cloud solutions in medical devices, industrial sensing, and control etc.

2. Smart Manufacturing Research Facility in the North West

The pilot line proposed for ATU will be part of a joint ATU/UU Smart Manufacturing research centre located at ATU and at UU in Derry.

ATU will establish a cleanroom facility suitable for non-photolithographic semiconductor operation on its Donegal campus to enable the operation of the proposed pilot line for prototyping, testing and industry training.

The proposed pilot line depends on data driven precision manufacturing such as AI, IOT, Industrial Digitalisation, Robotics, Automation, Machine Learning approaches to fault analysis, process optimisation, digital twins, augmented/virtual reality systems for manufacturing. This research expertise is aligned with the ATU Precision Engineering for Manufacturing Research Centre (PEM), The ATU Wireless Sensor Applied Research Centre (WiSAR) and two UU innovation projects: the Centre for Industrial Digitalisation, Robotics and Automation (CIDRA) and the Cognitive Analytics Research Laboratory (CARL).

3. All-Island Centre for Research Training in Semiconductor and Chip Technologies (Chips-CRT)

A core element of the research and innovation investment will be a PhD-level training programme focused on semiconductor and chip technologies, including research into the next generation optical technologies embedded into novel platforms, devices and systems providing innovative solutions in areas such as Biophotonics, LIDAR sensing, wireless communications, and wireless-optical convergence. In particular, the involvement of ATU will promote an enhanced research culture at the new university, and deliver significant additional research output in terms of high-quality publications and PhD graduates, enhanced technology transfer activity ensuring the commercialisation of outputs including possible PhD led spinouts, and further success via the partnership in obtaining additional competitively allocated funding.

[5] The WiSAR Lab is an applied research centre and Technology Gateway working at high TRL levels and is an interface between research and industry with particular strengths in SME sector. It has a 15 year track record of industry engagement utilising expertise in RF, wireless networks and the IOT technology stack.

It is critical that the pilot line strand is matched with a high-level skills programme such as the proposed All-Island Centre for Research Training in Semiconductor and Chip Technologies (Chips-CRT) to support and maintain the supply of PhD graduates in semiconductors. The CRT research will look at all stages of the Semiconductor Value Chain, including processing, devices, packaging and hybrid integration, monolithic and heterogeneous integration. The centre will also promote research in application areas such as biomedical, the Internet of Things, optical communications, and data science. Tyndall will lead this strand to leverage their experience with large scale cohort PhD training, semiconductor value-chain expertise, and extensive academic/industry relationships.

The Chips-CRT will follow well established models, including the Centre for Doctoral Training (CDT) in Photonic Integration and Advanced Data Storage (PIADS) which includes Tyndall and QUB. The proposed Chips-CRT would also include MCCI, QUB, UCD, MTU, TUD and UU. The research profile of each partner maps onto different parts of the semiconductor value chain. Crucially, all of the Chips-CRT partners have strong track records across the application areas of semiconductor and chip technologies, such as data-storage and processing, MedTech, agri-foods, 5G/6G, among others.

By learning and researching together these cohorts of researchers will forge relationships and networks that will build as their careers progress. These doctoral graduates will form the leadership of the next phase of industry research and development in the All-Island photonics and semiconductor industry.

Skills Impact

1. Impact of the Pilot Line on Training and Education

The pilot line investment will incorporate explicit workforce training and development for the North West region and on an all-island basis. Led by ATU but involving all the HEI partners in the North West, the consortium will work with industry to identify and address skills needs in integrated photonics technology. The training element will provide education for undergraduate and postgraduate students, and for industry engineers [at Level 7/8+] focusing on photonic devices, their applications, and application-specific photonic device packaging challenges. ATU will also integrate these modules into existing engineering programmes to develop a new photonics stream at ordinary and honours degree level. There will also be provision of certified skills training for students and industry technicians [at Level 6+] through hands-on workshops that focus on practical skills required in integrated photonics packaging and testing.

Smart Manufacturing also involves the use and integration of a range of advanced technologies varying across sensors, robotics, data collection, data storage, data analytics, automation, machine learning, and artificial intelligence. To support smart manufacturing, workers need advanced skills in at least one or preferably more of these areas with a good overall understanding of how each of the stages and technologies fit together. At a more advanced level workers will need to develop advanced and deep skills in a range of specialist areas. Ultimately, this will provide an economic boost to the region as well as to the island as a whole.

These programmes will include short, skill-focused training on the proposed pilot line equipment. This will expose students to industry standard equipment and techniques. This training will also be made available to industry partners for operators and technical staff.

More structured programmes will be developed in partnership with industry for the professional development of technicians and engineers. These will enable the upskilling of existing industry workers and the reskilling of others wishing to enter the semiconductor industry. All training will be certified at an appropriate level from Level 6 to Level 8.

Continuous Learning: The rapidly changing and developing nature of this field means that there is a need for continuous training and skills development. Therefore, it is envisaged that there will be a rolling need for re-certifications, new training, seminars, and conferences aligned to the levels at which people are working.

Photonics and Chip Technologies: This is a specialist subset of skills within the wider smart manufacturing eco-system. The specialist skills in this field include:

- Technical Training in Photonics and Chip Technologies in areas such as lithography, etching, deposition, and bonding.
- Cleanroom Training to give workers with the knowledge and skills to operate in a cleanroom environment, including wearing cleanroom clothing and following cleanroom protocols.
- Design and Simulation training in tools used in photonics and chip manufacturing. Workers need to understand how to use design and simulation software to design and optimize photonics and chip devices.

2. Impact of Chips-CRT

Central to the PhD research is a structured training programme which will enable researchers to tackle an increasingly complex and multi-faceted area of research. Researchers will gain both domain knowledge and transferable skills which will enable them to enter industry and contribute to the growth of the sector on the island.

The programme will follow models successfully established by previous and current programmes. There will be a four-year integrated doctoral training programme with skills training being distributed across research years.

Research skills training will provide fundamental knowledge of photonics as well as practical skills informed by industry best practice. Researchers will also conduct an initial research project that will inform the development of specific doctoral projects.

These will be a mix of classroom, online, and laboratory-based teaching supported by a range of seminars and project work.

All researchers will have access to the advanced facilities and expertise of the project academic and industry partnership. It is envisaged that each researcher will have an opportunity of an industry placement.

Certified transferable skills training will be provided throughout the 4-year programme in areas such as Leadership, Strategy, Entrepreneurship, and Management.

The supply of skills training for industry and PhD trained photonics and chip technology graduates in the North West will ensure the consolidation of industries such as Seagate but will also provide an enhanced environment for new start-up companies to emerge, specialising in advanced technologies related to the fast growing photonics industry.

Conclusion

The North West cross-border region is the fourth-largest city region on the island of Ireland. However, the region has faced several historic challenges in terms of its development, lagging behind other regions in both Ireland and Northern Ireland, as well as experiencing unemployment, poverty, and deprivation[6]. A significant investment in research in a high-value area such as photonics and chip technologies would provide a strong foundation for the new university to build on and to provide regional economic impact.

The impact of decades of government investment in Tyndall on the economy of Munster is clear. It has led to a thriving microelectronics cluster that provides direct high skill employment as well as an extensive support industry, attracting massive foreign direct investment. The funding of a photonics and microelectronics pilot line and research centre in the North West region would be a major boost to the region. It would act as an attractor for other companies to either use the services provided in the North West or to relocate or invest in the region. It would also help drive the launch of indigenous start-ups in the region, contributing to the national GDP.

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[6] Caitríona Mullan (2022) "Exploring Shared Opportunities in the North West: Findings from Focus Groups", National Economic & Social Council, Research Paper 25 October 2022