Skånes semiconductor value chain and directions for the future, in relation to the European Chips Act

Semiconductor Challenges for Europe

In 2021 and 2022 there has been a global shortage of semiconductors, caused in part by the Covid - 19 pandemic. Shortages of semiconductors have, however been recurring events over the past decades, that have occurred when demand has expanded ahead of the expansion of production resources.

Semiconductors are critical components in, for example, computers, smart phones, vehicles, machinery, and electric appliances. In a large variety of ways, they make modern life possible.

From the 1980's to the present the European share of global semiconductor sales has decreased from 20 to 9 percent. During the same period the share of producers in Asia has increased to 75%, dominated by China and Taiwan.[1]

Semiconductors are of strategic importance for society at large and EU has decided to support the development through A Chips Act for Europe, which was passed in the spring of 2022. The Chips Act consists of three "pillars:"

Pillar 1: The Chips for Europe Initiative – an investment programme for the development of key European resources for semiconductor development.

Pillar 2: A Framework to Ensure Security of Supply – a framework to speed up investment and make sure that investments are directed towards key strategic areas of the market.

Pillar 3: Monitoring and Crisis Response – the implementation of mechanisms for the monitoring of semiconductor markets to facilitate rapid response and action when crises appear in the future.

So far, the Swedish Government has not joined the Chips Act.

The Semiconductor Intensive Industry in Skåne

In November of 2021 Region Skåne started activities with the aim of contributing to the European Chips Act by engaging the region's semiconductor intensive industry. In this document we will refer to companies that either develop semiconductor materials and devices or companies who themselves design integrated circuits as 'Semiconductor Intensive Industry'. The region has a strong track record in the semiconductor industry, much due to semiconductor research established early in the 1980's at Lund University

The now historic establishment by Ericsson of its Mobile Phone Division in Lund was driven by the then leading research and competence at Lund University in the field of semiconductors, radio technology and automatic control. Over time, Ericsson has built a world-class organisation for circuit-design with several hundred developers that work in the field. In Lund there is also Axis that uses advanced semiconductors in their network cameras and security systems. Large international corporations like Bosch, Volvo and Saab are active in the region. In addition to these anchor companies, there are several start-ups and scale-ups offering cutting-edge technical solutions for coming generations of semiconductors.

According to the study by RISE[2] two areas of strength are represented by the companies in Skåne. One is advanced materials and components and the other is system-on-chip. There is also a cluster

[1] A Chips Act for Europe, The EU, May 2022

[2] Report "Sverige i halvledarvärlden," RISE January 2022

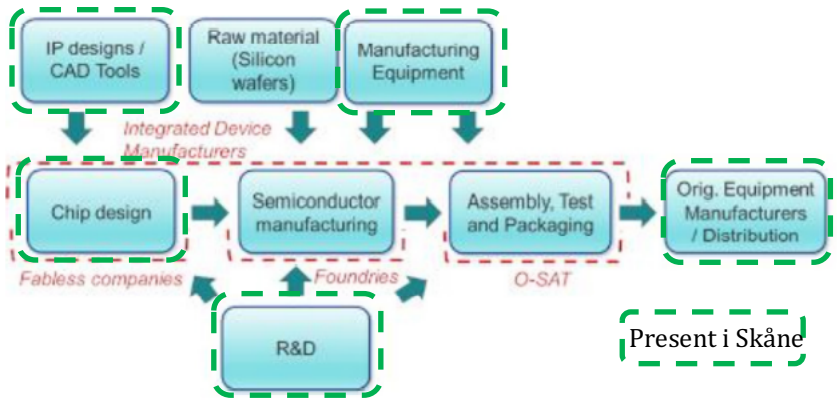
around Stockholm with companies focusing on advanced materials and components and one around Linköping in the field of system-on-chip.
In addition to the areas of strength that are present in Skåne, RISE, in their study found two additional areas in other parts of Sweden. These are microelectromechanical systems around Stockholm and sensors and millimetre wave and teraherz components around Stockholm and Gothenburg.[2]

The Structure of the Industry

The different areas of strength in Sweden represent different parts of the semiconductor value chain and they face different development and business challenges.
The companies that work with advanced materials and components develop the basic building blocks of chips, e.g novel substrate materials or low-dimensional structures. For these companies to grow their innovations need to be adopted by chip manufacturers and become implemented in the manufacturing plants, or "fabs," of the future. It may take ten years until the technologies or material solutions of one of these companies becomes implemented in a fab and used on a large scale in end-user products. To succeed with this, several steps need to be taken over the next few years for the technologies to become implemented in the fabs of one or more of the global chip producers.
Micro-electromechanical systems, or MEMS, are systems of micro- or millimetre size that perform certain functions in vehicles, machinery, computers, or other devices. These companies, as e.g Silex, Comsol, Bosch and others within the MEMS category, may be users of the technologies and processes developed by the materials and components companies. Micro-electromechanical systems are used by Original Equipment Manufacturer, OEM, companies in the design of products and systems for various end-user markets.
The case is similar for the companies that develop sensors and millimetre wave and teraherz components. These companies, such as Beammwave and Acconeer may use advanced materials and components to develop and produce products and systems that may be sold to OEM companies.
The fourth category of companies, e.g. Ericsson and Axis are the ones that develop technologies and solutions for system-on-chip. As chips are now designed and produced at nanoscale many different functionalities that were previously built as systems, using individual chips for different purposes, such as memory chips, processors, graphics chips, and chips with other functionality, can now be integrated on one and the same chip. This ability to integrate many functionalities on a chip creates an opportunity for leading companies to design their own chips with specific functionality and gain advantages over companies that build systems from standardized chips.
The end-customers of these different categories of companies are to a large extent OEM-companies, that use the solutions in various types of end-user products, such as vehicles, electronic devices, machinery, defence systems, and for many other purposes. The OEM companies that are present in Skåne, are for example Ericsson, Axis, Volvo Cars, and Tetra Pak. These exist at different points of the spectrum of OEMs from Ericsson that design their own chips, via Volvo Cars that have competitors that design their own chips, such as Tesla, BYD Auoto, SAIC Moter, to companies that use standard chips in their products. The strategies and development needs in the semiconductor area are likely to differ between these different types of OEM companies.
All these categories of companies make up different parts of the ecosystem for semiconductors, electronics products, and machinery. It is the rapidly developing demand for OEM-products with increasing capabilities at competitive prices that drive the competition and development throughout the semiconductor value chain. The companies belonging to the different categories are in different ways dependent on one another. While they belong to the same ecosystem, they perform different functions, and face different challenges. They could, however, benefit from collaboration in a network.

The semiconductor-related companies in Skåne are at different stages of their development. Some are developing their technology and market offering, waiting for their first order. Others are already generating revenue, waiting for growth to take off.
Ericsson and Axis are leaders in their respective industries and rely on Lund University to train students and PhD's in the latest technologies and provide a stream of graduates and PhD's to hire. They, to a large extent, recruit from the same pool of candidates as the start-ups and scale-ups and sometimes the companies recruit from each other as well. They also rely on industrial partners to develop and commercialise new technologies that move semiconductor development forward and facilitate development of new generations of mobile communication technologies and corporate security systems.
At Lund University research and training of students in relevant fields have been going on since the 1960's. Out of the seven profile areas of Lund University¨s Faculty of Engineering, two are relevant in this context: AI and the Pillars of Digitisation and Nano Science & Semiconductor Technology[3]. The main areas of research in the field of semiconductors are semiconductor nano structures, power electronics, nanoelectronics, neuromorphic systems, and quantum technologies. In the fields of artificial intelligence and digitisation, the strengths are in the design of electronic circuits, communication technology (5G/6G), software development, artificial intelligence, and autonomous systems.
Figure 1 visualises the semiconductor value chain and the parts that are present in Skåne based on a visulaisation by the European Commission[4].

Figure 1 – The semiconductor value chain



Source: European Commission, SWD(2021)352. CAD: computer assisted design. IP designs: intellectual property designs (reusable components designs or 'IP blocks'). O-SAT: outsourced assembly and test firms.

A Semiconductor Network in Skåne

The present description of Skånes semiconductor value chain is written as part of a pre-study financed by Region Skåne in 2022. Due to the shortage of semiconductors in 2021 and 2022 Region Skåne sees a need to take measures to drive development forward and secure access to advanced chips in the coming decades. Even if there are limited possibilities for the establishment of major semiconductor manufacturers in the region, the competence in research and design are crucial for the region to remain competitive. Being responsible for supporting industrial development and driving economic growth in the region, Region Skåne assigned Mobile Heights and IUC Syd with the task of

[3] https://www.lu.se/artikel/lth-lanserar-profilomraden-starkare-svar-pa-samhallsutmaningar
[4] The EU chips act (europa.eu)

describing the semiconductor value chain in Skåne, with a Swedish and Global Perspective and include suggestions for future directions.
Nationally, Business Sweden have started to develop a network for companies from all parts of Sweden, including Skåne. They have been working with semiconductors since 2021 and have concluded that there is likely to be a need for several networks with different focus. Their activities focus on international sales opportunities and making the Swedish semiconductor-related industry better known in international markets. Business Sweden have concluded that there may be a need for more than one additional network, each perhaps focusing on different levels of the TRL scale.
Regionally, the network could drive the development of the semiconductor ecosystem in Skåne and take a national, European, and global perspective of the challenges and needs of the actors. The regional network can also be merged with a future national network. This would strengthen the network substantially, as more companies and other actors need to be added to reach critical mass.
The organisation structure and activities will be based on the needs and goal from the actors of the network defined in this roadmap. This will be identified and initiated in next phase of the project.

The Strategic Goals from actors in Skåne

The leading actors in the semiconductor-related industry in Skåne have clear goals for their development. These goals together form the basis of a future strategy for Skåne´s development in the semiconductor industry.
Region Skåne have taken and will take the lead in the first phase of the development towards starting up joint initiatives. The different participants contribute to the realisation of the goals, both by driving their own development and by contributing to the joint efforts of the actors (semiconductor companies, researchers, and support organisations).
The goals of the different actors have been stated in documents and interviews and they can be summarised as follows.

Lund University and Its Faculty of Engineering and RISE

These research organisations have formulated the following goals to strengthen the local, national and european semiconductor ecosystem.[5]

Communication:

- Improve the ability to explain the benefits of semiconductor development to external parties
- Formulate a vision for Skåne and Sweden in the field of semiconductor research and development

Cooperation:

- Improve cooperation between universities, research organisations[6], and Swedish industry
- Improve cooperation between universities
- Increase participation in European research programmes
- National support for the joint competencies of Swedish semiconductor research centres
- Increased mutual understanding for the circumstances and challenges of academia and industry
- Include the contribution of more research teams to the total of Swedish research
- Achieve advantages of scale and cooperation across Sweden

[5] The goals were identified at a workshop by representatives of Lund University at a meeting organised by Region Skåne, Lund University, Business Sweden, RISE and Smartare Elektroniksystem in January 2022.
[6] This primarily refers to RISE.

Basic training of students:

- Increasing the number of engineers in training
- Focus on life-long learning
- Focus on mobility
- Create a base for broad recruitment
- Further develop international master programmes
- Recruit inspiring teachers with excellent competence from industry
- Initiate close cooperation between industry and academy around recruitment, visibility, curriculum, and practice

Research:

- Strengthen research programmes that combine system, software and circuit design based research.
- Combine the above research efforts with the one going in materials and component based research.
- Develop Swedish research based on a European context, focus depth and excellence towards the needs of Swedish industry
- Strengthen resources for system design, heterogeneous integration, and green transformation
- Build basic financing for researchers and stability
- Strengthen access for universities to state-of-the-art technology.

Infrastructures:

- Make university labs more accessible to industry
- Utilise the 4 labs that are part of Myfab out of which one is located in Skåne
- Invest in research infrastructure and testbeds for research at higher TRL levels
- Invest in Nanolab Science Village to prolong development projects within the academic labs
- Make sure that the large investments in MAX IV and ESS are used to its full potential.

Financing:

- Develop synchronised support from financing bodies.
- Perform mappings of the companies within the semiconductor-related sector that illustrate that universities are the hub of the Swedish ecosystem for semiconductor-related technology.

Start-up companies

Communication:

- Build the insight within Swedish investment and venture capital firms that semiconductor-related development requires large-scale financing for the longer term.
- Inform decision makers about the need to participate in large European programmes to secure the future of Swedish industry.

Cooperation:

- Secure Swedish participation in large EU programmes so support the semiconductor industry.
- Gather the Swedish ecosystem and value chain for semiconductors in a network.
- Build and maintain cooperation with international clusters and networks of semiconductor companies, also including participants from the US and Asia and strengthen the profile of the Swedish semiconductor industry.

Competencies:

- Develop competencies in electronic system design in various fields, such as digital, analogue, RF, and mixed signal systems.
- Strengthen resources for the modelling and simulation of components and circuits.
- Reduce the bureaucracy around recruitment and citizenship for international employees.
- Develop knowledge about industrial requirements for specialised markets, such as Information Communication Technology (ICT) and vehicles, that will be valuable for research and training.

Infrastructure:

- Build infrastructure for industrialisation and pilot production for upscaling of innovations related to semiconductors.
- Develop an environment with equipment and competence for intellectual property and chip verification that fulfils requirements by industry for industrialisation.
- Build a test and demo resource for new designs and intellectual property.
- Create access to expensive tools for chip design, verification, and software licenses through a close relationship to international fabs.

Development areas:

- Development in the areas of Swedish strength, such as wide bandgap semiconductors, power electronics, radio frequency technology, new digital GaN-circuits, space electronics etc.
- Heterogeneous integration, such as combinations between different technology areas, for example Si CMOS+GAN, Si CMOS+III-V, high frequency electronics/optoelectronics.

Financing:

- Access to long-term risk capital in Sweden for semiconductor and electronics related innovation.
- Simplify the rules for setting up large projects with Swedish financing, together with foreign partners. Test and demo facilities can only become useful if they can be used without the participation of large Swedish OEMs.
- Start up large Swedish industrialisation projects with foreign partners.
- Simplify international co-financing efforts based on public financing.

OEMs and SME's

Communication:

- Make the semiconductor value chain visible.

Competencies:

- Secure access to people with the right skills.
- Offer attractive positions for key talents.

Cooperation:

- Coordinate efforts.
- Collaborate internationally, for example in joint ventures in India where the government subsidises up to 55 percent.

Development Areas:

- Continue development in many areas, for example system design, wide bandgap semiconductors and power electronics.
- Bring home electronics production, also with respect to manufacturing of circuit boards and other types of printed electronics.

Financing:

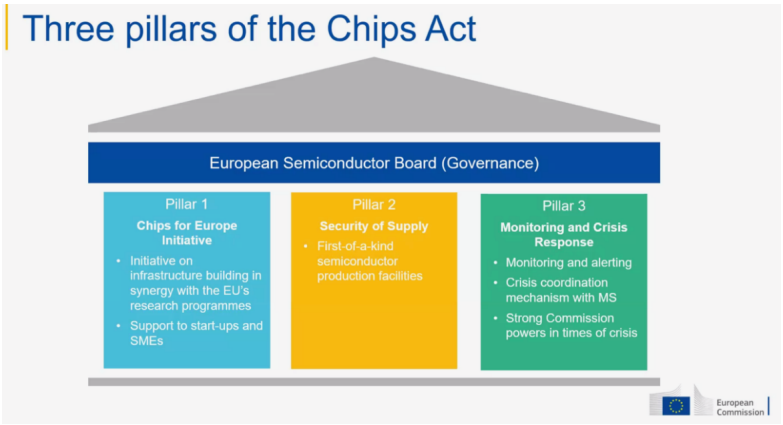
- Identify sources of financing.

Region Skåne

Region Skåne supports the industrial development in Skåne with the goal of increasing economic growth. In the semiconductor industry they see a need to help secure the access to semiconductors for companies that use them in their products and to do this they need to support the development of the semiconductor related companies and organisations in the region.
Region Skåne sees an opportunity to start up a regional network and initiatives- with the ambition to strengthen the development of the semiconductor industry in Skåne, and to merge with a future national network to strengthen the whole of Sweden.

Relationship to the Document “A Chips Act for Europe”

Commission President Ursula von der Leyen set the vision for Europe’s chip strategy for the digital decade in her state of the Union speech of 15 September 2021. A Chips Act for Europe has since then been developed and EU countries reached a common position on the Chips Act the 1st of December. The European Chips Act (ECA) describes the challenges for the entire semiconductor value chain. It contains a broad description of the development challenges for semiconductors and the various application areas ranging from computers and smartphones to vehicles, medical equipment, and military technologies. In each of these areas there are specific challenges and the most important of these are discussed in ECA There are three pillars of development described:



The actors in Skåne focuses on a set of specialities important for the region and for Europe:

- Systems for mobile communication, as represented by Ericsson and researchers at Lund University
- Cameras and security systems, as represented by Axis and researchers at Lund University
- Advanced materials and components, as represented by start-ups, researchers at Lund University, and RISE

- Semiconductor design and software for embedded systems, as represented by start-ups, OEM's, researchers at Lund University, and RISE

The regions actors are primarily within pillar 1 and can contribute to the semiconductor value chain via their strengths.

Suggestion of direction for the Development of the Semiconductor Industry in Skåne

The semiconductor actors in Skåne includes world leading companies, like Ericsson and Axis, strong research organisations like Lund University and RISE, and several start-ups and scale-ups at various stages of development.
One approach is to let a network of companies develop a strategy based on the goals set up by the actors described in this document, starting initiatives with different activities.
Finance for the activities can be applied for from various sources, based on the strategy for the network. The strategy can be further developed to become more specific as the network takes shape and development activities are initiated.

Activities of the network may include:

- Organisation of international workshops and seminars.
- Developmentof specialised task forces with the assignment of initiating activities in a particular area of key importance for semiconductor-related development.
- Financing of training courses for participating companies at international universities.
- Study tours to research facilities and centres of competence abroad.
- Organizing delegations to participate at conferences or exhibitions abroad, possibly with stand exhibiting the network, its companies, and resources.
- Organizing conferences or exhibitions in Sweden in collaboration with partners in the innovation system.
- Organizing training courses in collaboration with partners.

Appendix 1 – The Development of a Network

The Case for A Network

In interviews with 10+ directors of companies in the semiconductor industry in Skåne, all respondents have expressed an interest in participating in a network. Different companies have expressed different needs, for example:

- Organizing workshops and seminars where participants from companies and research centres in other parts of Europe and the world could be invited. This could facilitate the forming of partnerships, identification of pilot customers and development partners, and it could speed up growth for companies in Skåne.
- Workshops and seminars around financing issues, with the aim of meeting investors and setting up financing solutions.
- A few companies have as their main interest identified the need to recruit qualified employees from other parts of the world to their facilities in Lund. The activities organised by a network can make Lund better known in other centres of semiconductor development around the world, strengthen the brand of Lund, and help attract employees.

Building networks and clusters to support development has become common practice by authorities and this is based on sound research and real-life experience.
In his seminal book, first published in 1989, "The Competitive Advantage of Nations" Professor Michael E Porter put forward the conclusion that clusters of companies that are present in a country, or often in a region, to a large extent explain the success and dominance over time by certain countries and regions. Porter studied, for example, the ceramic tile industry and the cluster of companies, organisations, research facilities around the town of Sassuolo in Italy. He also studied the Swedish clusters of, for example, mining equipment and heavy trucks. He found that the different organisations of a cluster interact in a multitude of different ways that contribute to the long-term development and success of the participants. The development of clusters and networks has become a key tool for national and regional governments in their efforts to support economic growth and industrial development.
Region Skåne supports nine cluster organisations that focus on particular areas[7]. Among them are Mobile Heights that focus on the tech industry and IUC Syd that support the development of manufacturing companies in the region.
The idea of developing a network for companies, research organisations, and other organisations in the semiconductor industry resonates well with the experiences made from the development of these clusters. In addition to the nine clusters Region Skåne has also supported the development of a network of suppliers to big science facilities, like CERN, ESS, and Max IV, which developed into a national network for Sweden organised as Big Science Sweden.
Region Skåne have made the experience that these cluster and network organisations contribute to the development in their respective areas of focus and to economic growth and development in the region overall.

The Vision and Goal of a Network

Vision:

[7] Regionalt klusterutvecklingsprogram 2017-2021, Region Skåne

- Strengthen the long-term innovation and competitiveness of Skåne's companies in the semiconductor area.
- That regional actors such as academia, start-ups, SMEs and industry get wider and more networks within the EU and internationally to solve challenges together.
- That actors in Skåne are seen as strong cooperation partners in the global cooperation for a more sustainable world.
- That actors in Skåne are seen as a strong cooperation partner and that the region is seen as an innovative region and an important player in the global cooperation for a more sustainable world.
- The long-term vision is that the semiconductor network should, based on the needs of industry, SMEs, start-ups and academia, initiate and drive initiatives that drive development forward.

Goal:

- Establish a semiconductor network that brings together industry, academia, institutes, and other stakeholders to continuously define and work based on their needs.
- Concretize efforts based on the regional semiconductor strategy.
- Identify funding that can realize the efforts.
- Participate in a national semiconductor network, alternatively, create the national network of nodes.
- Make Skåne's strengths within the semiconductor area visible to create collaborations, attract and retain companies and investments, as well as competences.

Financing Strategy

The financing of the network will be a key aspect of the development. There are several different opportunities, but each opportunity will have to be carefully prepared and planned to materialise. Region Skåne are financing the start-up of the network until the first half of 2023. To continue operation, the network will apply for financing from EU sources, sources of Swedish national and regional financing, co-financing from participating companies, and other financing sources. Possible sources of financing and their requirements will be further investigated as the development of the network progresses.

Pre-Study

Region Skåne finances the pre-study from June 2022 to June 2023. They have also indicated that the financing could be extended to include co-financing of further development activities, in combination with financing from EU or Swedish sources.

Financing from July 2023 and Onwards

For July 2023 and onwards there are several opportunities.
One would be to apply for financing via the European Regional Development Fund (ERDF/ERUF).
Other alternatives are:

- Applying in the next call in ERUF Skåne Blekinge, presumably closing in the spring of 2023. This programme is ideal, provided that innovation-related topics will be supported in the call. Projects can be focused on development in the Skåne region, partners can all come from Skåne and the development of a network to support innovation and business development in the semiconductor industry can be supported.

- Vinnova – No relevant calls available.
- Interreg programme applications. It could be possible to finance the development of a semiconductor network via an Interreg project. The challenge is that this then has to be done in collaboration with partners in other countries within the chosen Interreg programme.
    - Example: For the South Baltic programme the partnership must consist of partners in the parts of Denmark, Germany, Poland, and Lithuania that are included in the programme. For the other Interreg programmes there is the same requirement, that partners from different countries in the programme have to be represented in the project.
    - It normally takes 3-4 months to develop a project idea, identify partners, discuss the project with partners, and write the application.
- Applying for funding outside of programmes. This may be possible, but it requires in-depth dialogues with possible financing bodies. Time frame uncertain.

The Structure of a Network

To drive development in an industry forward, many different organisations need to network and contribute. Some can be seen as core members of the network, while others are more peripheral. These could be divided into different categories with different roles and functions:

- Core members
- Support organisations
- Partner organisations
- Network administrators
- Advisory/Reference groups

Each of these categories will consist of sub-categories:

Core Members

The core members of the network are the organisations that are engaged in network activities on a regular basis, have employees responsible for participating in activities and for interacting with the network in the planning and preparation of activities. Core members are the key stakeholders of the network and can be divided into the sub-categories of:

- Companies
    - Anchor companies
    - SME's
- Universities, research organisations, and development and test facilities
- National, regional, and local development organisations
- Investors and financing bodies

The core members will appoint a Steering Committee that will provide guidelines for the activities of the network and monitor progress based on strategies and plans.
Each core member will appoint a person responsible for the contacts between the network and the core member's organisation. These contact persons will belong to a Reference Group and they will be invited to meetings, workshops, and other activities together with colleagues and partners.

Support Organisations

The support organisations are involved in events, participate at meetings, seminars, and workshops, provide support around specific issues. They can be divided into the sub-categories of:

- National, regional, and local authorities and agencies
- Universities and research organisations
- Financing bodies and networks of investors

Partner Organisations

A large number of partners will be more loosely connected to the network, participate at events, participate in development projects together with core members, or in other ways contribute to network activities. They could be, for example:

- Present and potential customers of core members
- Present and potential suppliers of core members
- Present and potential development partners of core members
- Swedish, European, and international universities and research organisations
- Semiconductor clusters and networks and clusters and networks of electronics companies, or users of electronics components and technologies
- Investors and financing bodies outside of the core of the network

Network Administrators

These are the organisation or organisations that administrate the network, are responsible for achieving the goals, and for planning and organizing activities.
The network administrators are responsible for developing the network strategy and a budget, setting up an agenda of activities on an annual basis, and for organizing these activities. The responsibilities include, for example, booking venues for events, planning the agenda overall and in detail, inviting participants, when relevant receiving payments for participation at events, paying speakers, and marketing the network to extend membership and generate interest.
The network administrators are also responsible for the communication of network activities, the development and administration of a web site, a newsletter, a roster of members, and other administrative and communication related tasks. They are also responsible for reporting to the bodies that finance the network and its activities.
Within the pre-study Mobile Heights and IUC Syd have by Region Skåne been assigned the role of network administrators.
The network administrators will appoint a management team with clearly defined roles and responsibilities with a Project Manager that is responsible for reporting to the Steering Committee.

Network Activities

The activities of the network will be developed based on the demands and requirements of the core members, as expressed at meetings, workshops, and seminars that will be organised for the planning and execution of the network's agenda.
As the network is currently in the start-up phase the activities for the first year of operations need to be determined. The agenda for later years can be set up according to a "wheel of annual activities" with recurring activities, adding or taking away some when relevant.

Appendix 2 – Development Challenges and Cycles of Development

Development Challenges of Semiconductors

Semiconductors, the base-material in computer chips, have been developing since the beginning of the computer era. The success of computers is to a large extent due to the trend of miniaturization that has progressed with an astonishing regularity, described by Moore's Law, which states that the number of transistors that can be fitted on a certain area of a chip doubles every two years.
The density of transistors on a chip is now so high that 100,000 transistors can be fitted on the area with the diameter of a human hair. Several layers of transistors can then be stacked on top of one another. This density of transistors offers the opportunity to compress what used to fit on a number of different chips onto one. Chip designers need to design processors, memory units, and other functions that used to be separate onto one and the same chip.
Production processes are now at nanoscale, meaning that production is done almost on an atom, or molecular, scale. Processes are similar to those of additive manufacturing, which is however done on a macro scale. Chips are "grown" from the bottom and up, using nanoscale layers of silicon, gallium nitride, and other materials. The manufacturing processes of the semiconductor industry are the most advanced of all production processes on the planet. For the most advanced processes, it takes up to six months from the start of the production of a chip until it is finished, and the process may involve several hundred, unique manufacturing steps.
A new car in 2022 contains some 1,500 chips, worth around 500 USD and the number is expected to increase to 3,000 by 2030 and the value will be 1,200 USD[8]. To a large extent electronics is taking over the control of functions that were earlier performed by mechanical solutions. In the process new functionality is added while the production cost and prices go down.
Electric cars require more advanced systems for controlling the engine and battery and optimising charging and electricity use, which will require innovation over the coming decades. Another area that will require innovation is the development of autonomous vehicles. At present 1,000 autonomous cars generate a similar amount of information from radars, cameras, and sensors, as all users of Facebook. On an autonomous vehicle a very large amount of calculation, analysis, and decisions will have to be made on-board vehicles, but substantial amounts of data will also be transmitted to computer centres in the cloud. Handling this amount of information will require breakthroughs in chip design and communication solutions.
The further development of electric and autonomous vehicles will require heat resistant chips for power electronics, chips with lower latency for rapid decision making in autonomous vehicles, using gallium nitride (GaN) and other advanced materials to improve upon the present functionality. The trend towards a line width of only two or three nm will contribute to increasing the capacity of chips, adding functionality, and reducing the cost of chips and of the OEM products in which they are used. The start-up and scale-up companies in Skåne and in Sweden are working on solutions that will contribute to driving the trend towards smaller chips with higher capacity forward over the coming decades.

Long Cycles of Development

The cycles of development in the semiconductor industry are long. In the EU document "A Chip Act for Europe" the authors summarise the time frame:

"Today's efforts will shape the type and scale of production capacity available in the EU in 2030. A semiconductor fabrication plant typically requires two years to build and another one to two years to

[8] A Chip Act for Europe

optimise production processes. Investments now will allow increasing production capacity in the EU as of 2025-26 in more mature nodes. And investments now in leading-edge nodes, starting with advanced pilot lines, are needed to develop knowledge and skills and be able to translate such investments in new production capabilities at 2 nm or below around 2028-2030 in Europe."

All chips used at a given point in time are not based on the latest technology. Leading actors with the highest demands are at the cutting edge of development, formulate the requirements, and develop the solutions together with their suppliers. Ericsson is a leading player in the digital communication systems industry. To make it possible to use smart phones and tablets for all kinds of purposes, such as entertainment, taking photos and recording video, accessing business systems, searching the Internet for all kinds of information, doing payments, and using the devices for many other purposes, the systems that transmit the information need to be based on the latest technology.
It is a telling example that the first production run in a new fabrication plant started by one of the leading chip suppliers was a batch of chips that had been developed by Ericsson, not by the chip supplier themselves. In the car industry, Tesla and some Chinese companies take the lead by applying the latest technology, forcing incumbents to follow and rapidly develop capabilities to compete with these newcomers.
For less demanding purposes chips with micrometre linewidth are still used and all sizes in between are used for different purposes, depending on requirements and cost. The trend, however, advances steadily towards increasingly small designs, requiring that companies that want to remain competitive constantly develop their capabilities. The former CEO of Intel, Andy Grove, wrote a book published in 1988 with the title "Only the Paranoid Survive." If not paranoia, then definitely a strong drive to constantly develop and improve seems to be the best recipe for survival in the semiconductor world and companies like Ericsson and Intel depend on the constant flow of innovation coming from start-up and scale-up companies, like the ones in Sweden and in Skåne.

Persons Interviewed

Björk, Mikael – CEO Hexagem
Ebefors, Torbjörn ”Toby” – Director Smartare Elektroniksystem
Ekelund, Björn – Corporate Research Director, Ericsson
Eriksson, Magnus – CEO Stockholms affärsänglar
Hammarlund, Bo – Owner and Founder, Epiluvac
Kizeri, Gezim – Business Development Manager, Invest in Skåne
Linke, Heiner - Professor, Lund University
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