Boosting Electronics Value Chains in Europe

A report to Commissioner Gabriel

19 June 2018

Executive Summary

In today's world, semiconductors have become essential components of virtually all aspects of our daily lives, so much so that the business of producing semiconductors is of key strategic importance to all major regions. Two notable disruptions make it imperative for Europe to act to make electronics value chains fit for the future, to continue to fuel innovation in key sectors of our economy, and create new products, new jobs and new industries:

- The emergence of artificial intelligence, its impact on how data will be processed, analysed and shared is redefining the way data will impact our lives. We are entering an era of connected intelligence that will make new demands on semiconductor technology at all levels of the supply chain.
- At the same time, the growing strategic importance of semiconductor components, coupled with the massive investments in very advanced know-how and technology needed to produce them, has made them the object of a rapid succession of mergers and acquisitions, and escalating levels of government support.

As representatives and major actors of the semiconductor sector in Europe, we are putting forward an ambitious proposal which aims at delivering digital technologies essential to the future prosperity of the European economy and European industry. We believe that the digital transformation to which Europe is committed needs technology that is trusted, secure, energy-efficient and accessible. Our industry is investing heavily both in research and innovation, and in manufacturing, with more than €50 billion planned up until 2025, to make this a reality.

This report sets out our proposal to combine strengths and resources at European and national levels, in partnerships that reinforce the industry's capacity to deliver highly innovative digital technologies and components to essential sectors of the economy, amongst others in automotive, logistics, energy, communications, aerospace, defence and security.

Our capacity to deliver requires first and foremost a strong electronics value chain, from materials and equipment, through design, chip production and systems integration, to end-product. To this end these partnerships will cover the full research and innovation value chain. We will also seize new opportunities to close the gap with leading regions in the world, by aligning our efforts towards developing the next generation of advanced computing technologies. We call for recognition of the importance of such efforts in addressing Europe's societal challenges, from electrification and automation of cars, to digitalisation of the power grid and industry, as well as European sovereignty needs.

Transforming ideas into products calls for design. The proposal includes a call for specific support to catalyse the industry's efforts in design of components and solutions in order to facilitate access to design by SMEs and shorten innovation cycles along value chains in essential sectors. The creation of a task force is also called for to address the pressing need for more electronics designers in Europe.

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1. Setting the stage

On 23 May 2013, the European Commission announced an EU-wide strategy for micro- and nano-electronic components and systems, with the objective to reverse the declining European share of the world market, and to ensure that Europe makes the best of this technology to boost innovation, growth and jobs creation across the economy. Responding further to a challenge by the European Commission, in the following year an Electronics Leaders Group (ELG) made the strategy actionable with a roadmap and implementation plan[1]. Since then, industry and Research & Technology Organisations (RTOs) have made measurable progress towards this strategy in impactful partnerships with the EC, Member States and regions as well as with deep cooperation along the value chains[2].

In support of the strategy, two new instruments were launched at the European level in 2014: The ECSEL Joint Undertaking and the IPCEI instrument (Important Project of Common European Interest). While the former has become a success model for a public-private partnership in the digital arena, the latter was initiated in recognition of the fact that a new qualitative and quantitative approach was needed in order to allow industry to invest again in Europe as is done in the rest of the world. Industry and RTOs have both strongly and positively responded to the opportunities offered by ECSEL and the IPCEI. As a result, the micro- and nanoelectronics sector is now able to serve European value chains much better than it could do five years ago.

Then and now, boosting the application-driven value chains has been the central argument to encourage private and public investments in R&D&I within the semiconductor supply chain as well as in component manufacturing across Europe. Micro- and nanoelectronics never was and never will be an end in itself; rather it is a true key enabling technology providing users along value chains with relevant solutions that have great leverage across all industries and sectors.

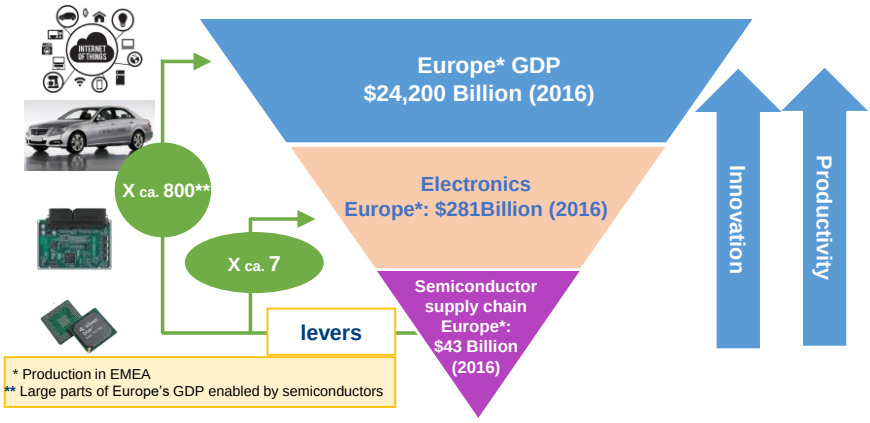

Figure 1. Semiconductors are levers for innovation, productivity and economic growth in Europe[3]

[1] https://ec.europa.eu/digital-single-market/en/electronics-roadmap-europe

[2] Some examples: GF Dresden announcement of USD 250 million investment in FDSOI development (July 2015); Carl Zeiss SMT and ASML announcement of USD 760 million investment in development and production of high-numerical aperture optics (November 2016); German Research Ministry's € 350 million support to Forschungsfabrik Mikroelektronik Deutschland (FMD) (April 2017); Bosch announcement of new 300mm fab in Dresden (June 2017); Infineon announcement of new 300mm fab in Villach (May 2018); Prime Minister of France announcement of €800 million support for a total investment of €5 billion from industry for the 5 years programme Nano2022 (May 2018).

[3] Source of data in the pyramid: IMF, DECISION

When the European strategy was drafted more than five years ago, it was understood that micro- and nanoelectronics would not only provide the indispensable underpinnings for downstream innovations but would also offer smarter, more effective ways to address the societal challenges of the 21st century[4]. While this is still the case, and while industry and RTOs have advanced Europe's technological capabilities and manufacturing capacities over the past five years, two highly disruptive forces have since then taken the world by storm: one in the technology realm itself, the other in the geopolitical arena. Europe is in the midst of answering both challenges, and this report is intended to provide further input into the ongoing policy process as it relates to micro- and nanoelectronics which are prerequisites for innovation, progress, and growth.

The first disruptive force is best labelled as pervasive digital transformation [5] which is driven by rapid advances in Artificial Intelligence (AI) opening the door to autonomous mobility, machine learning for the next levels of robotics and other industrial use-cases, breakthroughs in personalized healthcare, (cyber)-security, and sustainable energy management to name just a few application areas across industry and society. Pervasive digital transformation will leave no industrial sector and no societal issue untouched. More than any other "new frontier" technology before, AI can truly improve our chances for solutions as we address our persistent societal challenges. Therefore, AI is the new opportunity as well as the new challenge in Europe. It calls for deep, sustained partnerships beyond the current levels of cooperation up and down the value chains in concert with the European Commission, Member States and regions. The challenges are simply too big, the risks of failure too high, and the costs prohibitively large for any public or private entity to address it alone. While Europe is known for its deliberate approach and adversity to ad-hoc actions, speed, determination and staying power are now of the essence. Nobody is waiting for Europe to muster its strengths when it comes to exploiting AI for the betterment of societies and competitiveness of industries.

The second disruptive force is the increased recognition of micro- and nanoelectronics as an essential strategic technology with potential huge impact in both economic and political playing fields. At one end of the spectrum, we see the use of microelectronic components in the build-up of trade wars[6]. At the other end, we see the unprecedented concentration of the global semiconductor industry via mergers and acquisitions[7], the effects of the CFIUS instrument in the US, as well as China's pursuit of closing the last gap in its electronics value chains – semiconductors[8].

In light of these trends and developments in the semiconductor world, Europe needs to maintain and extend its ability to act for the benefit of its societies and industries which provide employment and perspectives. In 2018, this calls for instituting a core digital sovereignty, that is, an area where Europe can pursue its strategies avoiding dependence on outside actors and without outside interference. This needs to be done without resorting to protectionism, let alone striving for autarky. Europe's place is in the world, not behind walls.

[4] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges

[5] "Digital transformation is characterised by a fusion of advanced technologies and the integration of physical and digital systems, the predominance of innovative business models and new processes, and the creation of smart products and services." https://ec.europa.eu/growth/industry/policy/digital-transformation_en

[6] https://www.commerce.gov/news/press-releases/2018/06/secretary-ross-announces-14-billion-zte-settlement-zte-board-management

[7] https://www.eetimes.com/author.asp?section_id=40&doc_id=1333179

[8] National Integrated Circuit Industry Development Promotion Outline, a sub-programme of "Made in China 2025"

The creation of the first ever Digital Europe Program is very good initiative of the European Commission. We strongly believe that the electronic components and systems industry can play a crucial role in achieving its goals[9]. Let us make "all matters digital" is the new unifying theme to better the lives of Europeans every day and to make the European economy more innovative, competitive and productive and, with that, European society more just. It is within our reach to take full advantage of our tremendous micro- and nanoelectronics potentials when we are working together to make the manifold European value chains fit for the future in an uncertain world.

2. New frontiers for the electronic industry

Driven by strong growth in the memory market, the worldwide semiconductor revenue totalled USD 420.4 billion in 2017[10]. Looking ahead, the semiconductor supply chain is forecast to reach USD 1 trillion by 2030[11].

In this general context, among the major market segments, components for automotive and industrial electronics are growing at the highest rate, driven *inter alia* by electrification and automation of vehicles, digitalisation of industry, and of electrical power grids (see figure below).

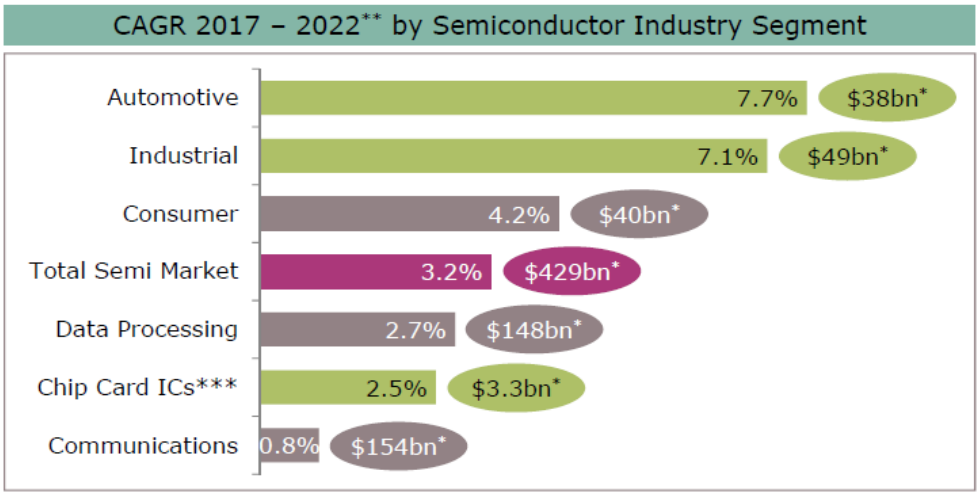

Figure 2. Main markets for electronic components

These growing markets provide clear opportunities for electronic components, but speed of innovation and its uptake by markets is becoming increasingly important. Value chains are becoming shorter and more interconnected. Systems companies need a stable supply of affordable, energy-efficient and trusted components well-matched to the needs of their customers.

While the steady miniaturisation of semiconductor transistor technology will remain relevant, new paradigms beyond scaling are emerging and new computing architectures beyond the traditional von

[9] http://europa.eu/rapid/press-release_IP-18-4043_en.htm
[10] https://www.gartner.com/newsroom/id/3872763
[11] http://www.semi.org/en/turbulent-times-ahead-trade

Neumann architecture will be needed. These relate, in particular, to new approaches required for AI deployment, as well as new energy-efficient architectures, e.g. in-memory processing. These approaches are also essential to extract value from electronic components while non-recurrent engineering costs continue along an exponential growth path with higher integration density.

New opportunities are arising which come from the transition to autonomous driving, the digitalisation and electrification of cars, the digitalisation of industry and of electrical power grids. These evolutions will be enabled by AI, improved cybersecurity, reinforced connectivity through 5G, edge computing, low-power components, sensors, power management. Such trends will disrupt value chains, calling for more distributed supply and tighter cooperation across different value chains.

The insatiable need to transfer, store and analyse vast amounts of data generated in the context of AI, autonomous driving and the Internet-of-things (IoT), drives a continuous demand for advanced semiconductor technologies. This is leading to a new "Era of Connected Intelligence" where the impact of data and its processing on our lives is expected to grow substantially[12].

3. Situation of the European industry and technology

Since the definition of the European strategy on electronics in 2013, the European ecosystem for research and innovation in semiconductor devices has been extended to research, development and manufacturing of electronic components and systems (ECS), comprising the whole supply chain from RTOs to system houses. Over the 4 years of its existence the ECSEL Joint Undertaking has been instrumental in extending the ecosystem in this respect. To date €2.6 billion has been invested in 51 projects involving more than 1,600 research, development and end-user organisations in collaborative research and innovation.

In 2015 the European Commission also launched the "Smart Anything Everywhere" (SAE) initiative as part of the digital transformation of industry in Europe implemented through Digital Innovation Hubs (DIH). With a specific focus on networked electronic components and systems, the initiative (through 88 hubs in 23 Member States) provides SMEs with easier access to RTOs to support them in adopting digital technologies to innovate their products.

ECSEL and initiatives such as SAE continue to be essential catalysts for additional investments and support at the national and regional levels, where financial contributions and other forms of support have been forthcoming. In addition, the EUREKA clusters (such as PENTA, EURIPIDES, and ITEA), funded by a large set of Member States and associated countries, are an important complementary element to implement the strategy and form an integral part of the ecosystem of partnerships across Europe.

An important step towards the necessity to invest at least €35 billion by 2025 as set out in the ELG implementation plan[13] has been the first IPCEI in microelectronics currently under pre-notification

[12] Data Age 2025: The Evolution of Data to Life-Critical, IDC, April 2017

[13] https://ec.europa.eu/digital-single-market/en/news/european-industrial-strategic-roadmap-micro-and-nano-electronic-components-and-systems-0

involving a number of companies and several Member States. This represents a strong commitment by both industry and Member States towards the implementation of the strategy.

A focused semiconductor manufacturing base and a strong research and innovation network are essential for Europe to maintain a competitive high-tech electronics ecosystem. Intense global competition requires a constant updating of semiconductor equipment and efforts to sustain high capital investments as well as investments in R&D&I in dedicated areas. The level of investment required for a new semiconductor fabrication plant is on the order of billions of euros and keeps growing with each generation of products. The semiconductor industry ranks among the highest of all industry sectors when it comes to investment levels, with around 15% of annual revenues invested in manufacturing equipment and fabrication plants, and close to another 20% in R&D.

Despite those huge investments, a number of macro-economic and technological factors have had a negative impact on the European position in the global scene in the last 5 years.

The installed fab capacity in Asia has grown thanks to massive investments (e.g. “Made in China 2025”), mostly with heavy support of local governments. Currently, the growing costs of design, packaging and testing are unaffordable for most SMEs, considered as the backbone of the European economy. Europe is also lacking strong design capacities and “fabless” players. In recent years, consolidation of the market accelerated. We now have a smaller number of players after an unprecedented wave of mergers and acquisitions worth hundreds of billions of euros.

Nevertheless, the markets are evolving and they open up new opportunities for:

- world-class technologies and innovations originating in Europe;
- mid and low-volume components, with requirements matching the know-how of the European industry; and
- a steady increase in automation reducing the impact of the labour cost gap in production.

Thanks to the supporting and coordinating role of the European Commission, European industry is now in a position to respond proactively to this challenging scenario. In addition to co-investments through European partnership programmes such as the ECSEL JU, the key players of the electronics value chain in Europe have invested around €13.6 billion in R&D between 2013 and 2017. These investments focused mostly on essential components for selected application areas, and on advanced semiconductor manufacturing technologies: low-power technology, sensor systems, power management for automotive and industrial automation, as well as extreme ultra-violet lithography equipment and new semiconductor materials for power technology (like GaN and SiC).

The same entities have invested over €8 billion of their own capital in manufacturing equipment and fabrication plants during the same period, and recently important fab extensions and greenfield plants have been announced. Those greenfield plants are the first to be realized in Europe in 18 years. All of this has made the European micro-nanoelectronics sector more competitive in key sectors on a global scale. It has also reinforced existing strengths in Europe's semiconductor equipment and materials industries.

4. Strategy and proposed actions for Europe to move forward

To face the upcoming wave of disruptions and opportunities, new directions are required for the partnerships. While it is important to protect and enhance the strengths built, it is as important to develop enabling components and systems for the digital transformation and the related evolution in terms of data handling and connected intelligence. Through evolved partnerships, the semiconductor industry in Europe wishes to deliver AI and other solutions to the automotive, logistics, energy, security, medical and healthcare sectors. This will be achieved through the development of embedded AI and other solutions enabling secure, autonomous systems, along with the necessary connectivity technologies.

The digital transformation of society and economy is introducing an exponential growth of data traffic, in many cases unmanageable through the available infrastructure. A paradigm change is required for the deployment of AI in many applications, so that data can be processed locally enabling meaningful information to be extracted, transmitted, stored or acted upon (e.g. a connected autonomous car must be able to take swift decisions without waiting for an answer from a remote server). In the era of connected intelligence, fast information and decision-making are important. A number of solutions will be required for secure, embedded, portable, low-power, peripheral and edge AI. The European semiconductor manufacturers are not active in central processing units for computers or in mass storage memory, but have the necessary know-how and technology for developing such solutions including “edge AI”. However the race is on, and Europe needs to act fast to capture this window of opportunity to stay in this game (proposed action 8).

The speed of innovation currently required to maintain competitiveness depends on the capability of various actors from various levels of the value chain to interact directly and cooperate to define, develop and test new solutions that properly respond to customer needs. At the same time, a wide number of technologies must be considered for integration at various stages of the design and manufacturing process. In practice, the standard electronics value chain must be shortened (vertically) and extended (horizontally) with direct connections among various players, so as to become a “value network”. This will foster and accelerate innovation, generate new opportunities and shorten the time-to-market. Such objectives can be achieved by extending the current model of public-private-partnerships, a type of cooperative arrangement where Europe excels already, that can be further exploited to ensure a wider and stronger cooperation among all key players (proposed action 1).

Furthermore, Europe should make serious efforts to increase the number of valuable deep-tech start-ups and SMEs that can be successfully scaled to bring more innovations to the market. In order to achieve this, we propose actions to reduce the entry barrier on IP, design, manufacturing and access (proposed action 4). Further, the electronics industry in Europe is facing an acute shortage of engineers with design skills (proposed action 7). In order to improve our ability to differentiate, we propose to put in place a number of actions aiming at strengthening our design competence, supporting the growth of SMEs and building up a design ecosystem in Europe (proposed actions 5 and 6).

In terms of planning, continued investment in Europe from companies supporting this report is on the radar with at least €21 billion targeted for manufacturing and a further €29 billion in R&D&I from

2018 to 2025, in addition to investments supported through partnerships. Mastering highly-automated manufacturing is an opportunity for Europe that will impact not just the semiconductor industry, but in the context of "Industry 4.0"[14] will enable the delivery of trusted components made in Europe (proposed action 2). It is worth noting that manufacturing in Europe is not an end in itself, but it is an important prerequisite to maintaining crucial know-how and expertise built up over many decades for the benefit of independence of Europe and associated sovereignty (proposed action 3).

Moving forward, if Europe's industry and RTOs are to play a key role in technology (r)evolution, it will be imperative to fortify value chains to serve those markets important for Europe and important for our sector.

This report presents a set of strategic priorities that focus on reinforcing European strengths in the wake of new technological developments, identifying the emerging opportunities, addressing current gaps, and preparing our companies and workforce for the future.

It is the result of meetings amongst representatives of the electronics sector (see Annex 1) in Europe and 6 workshops[15] with invitees from industrial sectors representing key European electronics value chains.

5. Reinforcing European strongholds

The strategic alignment between the European Commission, national and regional authorities, industry and research organisations, under the ECSEL JU has enabled the development of essential technologies nurtured in Europe that have been very successful in the market, including FDSOI[16] technologies, extreme ultraviolet lithography equipment, sensor systems, and power electronics. It is of the utmost importance to continue to advance these technologies and capitalise on the opportunities, taking into account the following needs:

- The potential for electronic components and systems (ECS) to leverage innovation and opportunities for growth in sectors of application can be considerably enhanced if specific use cases and application requirements are taken into account much earlier in the development process. Sectors of particular relevance for Europe’s competitiveness are: automotive (electrification of vehicles and autonomous mobility), Industry 4.0, IoT devices and systems, 5G, energy, healthcare, aeronautics and space. Key programs have been already identified at the European scale[17].

[14] https://en.wikipedia.org/wiki/Industry_4.0

[15] On the following topics: Connected and autonomous driving; Energy management, including electrification of cars and smart grids; Essential technologies for aerospace, defence and cybersecurity; Robotics, automation and autonomous systems (industry 4.0 and beyond); Health, well-being and medical technologies; and Artificial intelligence, low-power computing and acceleration.

[16] Fully-Depleted Silicon On Insulator

[17] http://www.europarl.europa.eu/RegData/etudes/ATAG/2017/603943/EPRS_ATA%282017%29603943_EN.pdf; https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0015; http://www.defense-aerospace.com/articles-view/verbatim/4/192836/fcas%2C-male-and-maws%3A-france-details-advances.html; http://www.airbus.com/space/telecommunications-satellites/oneweb-satellites-connection-for-people-all-over-the-globe.html

- AI is an overarching disruptive force impacting technology developments as well as manufacturing and application domains. Essential emerging technologies for AI like cognitive, neuromorphic and quantum computing, should be fostered, without neglecting the European portfolio of differentiating technologies, e.g. system integration, novel sensor technologies, power electronics, holistic lithography and packaging.
- Other key enabling technologies such as photonics and software, and innovations such as flexible and structural electronics are now routinely co-integrated with chip-level ECS to build complex systems and open up new avenues of application. Such co-innovation has the potential to impact all industrial sectors; it will also be crucial to many industries undergoing digital transformation.

Addressing these needs will broaden the scope and deepen the impact of ECS technologies.

To tackle those challenges, the following is proposed:

1 **Extend Europe's partnership success model**

We are calling for a significant extension of scope under a future ECSEL partnership to:

- Improve strategic technology access and deployment to:
  - allow fast-track access to engineering, development and prototyping of essential cross-cutting technologies for strategic sectors with support from appropriate European partnerships; and
  - exploit synergies with the respective communities and ecosystems in other European partnerships; agree, plan and programme joint test-beds up-front.
- Accelerate market readiness of AI solutions and other emerging technologies by:
  - enabling ECSEL to further strengthen RTOs as providers of emerging technologies; and
  - extending the scope of ECSEL to also address lower technology readiness levels (TRLs), including support for fundamental engineering projects with industry guidance.
- Enable new avenues of application for ECS by:
  - involving the related communities and industries needed to co-create innovation for electronics value chains; and
  - expanding the scope of ECSEL to include development and co-integration of other key digital technologies.

Industry and research organisations would be prepared to contribute 50% towards a total budget of a €10 billion partnership. The partnership should be (i) mandated and supported to attract and blend various funding streams; and (ii) appropriately resourced to build up dedicated technology intelligence.

Beyond reinforcing research and innovation value chains, it is essential to ensure effective transfer of results to market. The IPCEI instrument provides a general framework that can trigger industrial investment in manufacturing of innovative technology in Europe. The first IPCEI in microelectronics is currently under construction involving a number of companies and several Member States.

Further investments will be required to meet the continued drive for improvements in performance and energy-efficiency of semiconductor technologies, including on AI, low-power computing, connectivity, sensor technologies, and power management. At this stage, the focus of a future IPCEI is not mature enough for a detailed presentation. However, several options could form the basis of such a strategic project as indicated below.

To further accelerate the transfer of innovation to markets, the following action is proposed.

2 **Continue investment towards a strong microelectronics manufacturing industry**

We are calling for an extension and enhancement of the IPCEI framework beyond 2020, leading to:

- better support for enabling technologies and their spill-over across European electronics value chains by:
  - amending the current framework to extend its validity beyond 2020 and to take into account lessons learned until 2020; and
  - making use of the Strategic Forum on IPCEIs to this end.
- substantial industrial investment by 2025 and beyond mainly supported by national authorities and complemented by setting aside budget at European level. A budget at European level would have a catalysing effect.

Industry is continuing its engagement towards manufacturing in Europe and is constantly investing with the goal to strongly exceed €35 billion of investment until 2025. Several options could form the basis of a future strategic project of European interest. It could address the fast-track uptake of very innovative component technologies by a number of electronics value chains, further strengthen the semiconductor ecosystem to deliver on the digital transformation, or provide the base for development of a dedicated foundry of relevance to the European value chains.

Even though the electronic components industry is highly global, Europe needs to secure its sovereignty in key value chains such as aerospace, defence and security as well as in key infrastructures including power grids, transportation, water, telecommunications/Internet, and HPC. Our increasing reliance on semi/fully autonomous and smart systems increases the need for secure, safe and reliable components supported by trusted design and manufacturing sources.

European industry has recognised strengths in the area of electronic components for defence, aerospace and cybersecurity. However the associated markets are small and specific, hampered by particular requirements for materials, manufacturing and design. The requirements on the electronic components also follow the pace of the general technological progress of these end-user industries.

Although European semiconductor companies already invest on average more than 15% of their revenues in R&D, additional major efforts are needed at the European level to create an ecosystem encompassing all steps from development of technologies to manufacturing of innovative components. This requires powerful RTOs and experienced design houses, underpinned by state-of-the-art fabrication facilities, to provide the capability to develop and manufacture strategically important and trusted components for European systems in domains where sovereignty is essential.

3 **Create a strategic component sovereignty programme**

We call for a specific 'sovereignty' programme to be put in place to support and develop essential assets for critical electronic components, leading to guaranteed access to and control over secure and trusted components for strategic European infrastructure and systems, by:

- drawing on measures put in place by *inter alia* the European Defence Agency (such as the Captech programme[18]), the European Space Agency (such as European Synergies and Innovation), and the European Commission (such as the Cybersecurity Strategy[19]) while serving their objectives, perhaps through major use-cases; and
- targeting essential technologies, components and product lines for aerospace, defence, security and critical infrastructures[20].

To ensure sufficient impact, this transversal programme should reach a critical mass commensurate with budgets put in place worldwide, on the order of billions of euros.

6. Accelerating innovation

Effective and efficient architectures, as well as design and integration technologies, are essential for transforming ideas and requirements into innovative, high-quality, testable and deployable products at all levels of the value chain. Continued development of these technologies is a prerequisite to the realisation of the ever more complex systems required to meet Europe's societal challenges. There are numerous impediments in Europe - not least the fragmented nature of electronics value chains - but there are significant strengths in both chip-level and systems design. It is estimated that in order to achieve sufficient impact, the following proposed actions would require a co-investment at a European scale on the order of a few billion euros.

Key requirements and opportunities are set out in the following:

- European markets for electronics devices are generally lower volume. They serve diverse industry sectors with quite specialised requirements and generally low reusability across applications. This need for specialisation is a barrier for SMEs and mid-cap companies in particular. Producing lower volumes is economically unattractive in a business that is geared to support large volumes. There is a growing demand for specialised devices in industrial, medical, and automotive applications. Taken together with the digital transformation in Europe and the call for action set out in the Digitising European Industry initiative, there is an urgent need to put in place a mechanism that better connects value chains and helps pave the way for innovative designs to reach these and other markets. This can be done by using and connecting existing platforms for easy technology access such as the European network of multi-project wafer services, and other open-access semiconductor technology platforms and services.

[18] https://www.eda.europa.eu/industry-info/research-technology
[19] http://eeas.europa.eu/archives/docs/policies/eu-cyber-security/cybsec_comm_en.pdf
[20] E.g. smart grids, telecommunications, and transport infrastructures

4 **Create a smooth innovation path from IP to Products**

We are calling for support of low-volume projects on advanced and speciality semiconductor technologies, in order to boost the number of prototypes from European SMEs and mid-cap companies for diverse industrial sectors, by:

- pooling the expertise of design houses, in a European Design Alliance, in order to offset the cost of creation and reuse of design IP blocks, first silicon and licensing of design tools through a suitable financial arrangement (e.g. by offsetting initial costs against royalty payments); and
- securing close collaboration between the European Design Alliance and semiconductor technology providers, test houses, design tool providers.

In order to support a fraction of the costs associated with the set-up, roll-out and execution of this initiative, namely de-risking the financial exposure for design houses in the European Design Alliance, a budget should be secured at the European level. This proposed action can find a natural synergy with the Digital Europe Programme[21] where support will also go to small and medium-sized enterprises to engage in digital transformation, notably in areas like Artificial Intelligence, without compromising a simple funding scheme for the European Design Alliance.

- Chip design is fundamental for realising the promise of microelectronics: increasing productivity, reducing development costs and speeding up time-to-market, whilst at the same time meeting the increasing demands for providing new functionalities, higher quality, better system level performance, lower cost, increased energy-efficiency, improved safety and security, and better reliability. The ongoing diversification of markets and products presents both an opportunity and a challenge. There is a need to start and support strategic design initiatives targeting specific European challenges and strategic application areas, such as the lack of design capacity in analogue, MEMS, power and RF, to provide innovations to the market, e.g. for integrated photonics, edge-computing and digital industry.
- 90% of all innovations within a car are ECS-based[22]. This is more than just a matter of putting many individual components and systems into a car. Rather, it is a matter of well-engineered systems based on excellent system design-thinking. Europe´s strength in systems engineering has to be further developed to improve collaboration along the value chain, in particular the functional knowledge of the system at the ECS provider. Commercial 'first-time right' design is an essential prerequisite for innovation leadership and for being the first to bring a new product to the market. This holds true across many other application domains including digital industry, smart energy systems and 5G.

The following actions address electronic components design and design tools to accelerate the innovation flow in electronics value chains. Both actions will be strongly funded by industry and the public support will help steer the actions in the European interest.

[21] http://europa.eu/rapid/press-release_IP-18-4043_en.htm
[22] http://www.eenewseurope.com/news/innovation-car-90-comes-electronics-and-software

5 **Pursue strategic design initiatives**

We are calling for support to strategic design initiatives for essential areas, leading to faster and coordinated development efforts as products and markets diversify, by:

- targeting innovative applications in essential areas, e.g. telecommunications infrastructure for 5G, connected and automated driving, defence and space applications, medical, etc.; and
- strengthening links between the ECS community and stakeholders from application sectors (OEMs and system houses).

A budget at European level should be dedicated to co-funded projects on supporting design initiatives in order to stimulate a renewed dynamic European electronics design ecosystem.

6 **Create design tools for electronics value chains**

We are calling for support for the creation of virtual design environments and platforms, leading to significant increases in system performance and reliability, and shortened development cycles, through:

- creation of design IP and technology blocks which can be (re)used in an easy plug-and-play approach for new system designs; and
- provision of a complete design tool environment along the whole value chain to enable fast and reliable validation of the system before realisation in hardware and software components.

This will also reinforce the Electronic Design Automation ecosystem. This initiative should be stimulated and supported financially at European level.

Investing in R&D&I, design and manufacturing is not enough. It is necessary to also invest in a sufficiently broadly skilled workforce. There are already many excellent activities being pursued across Europe aimed at attracting and guiding young women and men towards technical/scientific studies at a national level. However, despite national initiatives, more needs to be done across Europe to raise the interest of the next generation of engineers in electronics design. The industry sees the need to cooperate with the European Commission to identify and support effective initiatives addressing education and skills and for further sharing best practices across Europe.

7 **Create a Task Force for electronics education and skills**

We are calling for immediate action to address the specific skills mismatch of the European electronics industry, leading to the establishment of a dedicated Task Force for electronics education and skills, that:

- brings together human resource specialists from industry and RTOs, the electronics manufacturing industry association SEMI, the European Commission and Member States, the European Institute of Innovation and Technology, and entities active in the "Digital Skills and Jobs Coalition" initiative; and
- reviews existing instruments, quantifies the specific domain of required competences and skills, analyses offers for internships and provides recommendations for best practices and multiplication of those via flagship educational projects.

These would be implemented through existing initiatives at the European, national and regional levels.

7. Seizing new opportunities

New computing paradigms, such as neuromorphic/quantum computing accelerators and complex integration, present new opportunities for developing the next generation of distributed/edge computing as well as centralised computing for the cloud (HPC) supporting the digital transformation of Europe. ***Europe must, therefore, take a leadership role in the development of these technologies.***

8 **Create a pan-European research infrastructure for advanced computing technologies**

We are calling for the creation of a pan-European infrastructure for developing, testing, experimenting and innovating in advanced computing technologies, leading to delivery of a digital hardware computing toolbox for European industries. A "moon-shot", mission-driven approach will be needed to achieve this European next-generation computing platform exploiting ultra-low power technologies and neuromorphic/quantum accelerators. This will require:

- the set-up of a joint state-of-the-art technological platform at European RTOs to design, manufacture and test prototype devices of future-generation processors and accelerators in order to prepare for an industrial uptake of these new technologies in European systems houses;
- the commitment of leading European micro-/nanoelectronics RTOs to forge a strategic alliance in close alignment with European semiconductor manufacturers, IDMs and foundries, as well as system houses to reach this goal.

Key European RTOs, including CEA, Fraunhofer and imec, are committed to forming a strategic alliance to deliver this European next-generation computing platform. The current microelectronics equipment / tools park across the three RTO's is estimated at €4 billion and a combined workforce of over 5000 researchers. Such a unique world-leading collaboration with a focus on technology, engineering and manufacturing, will allow Europe to be a major supplier of hardware for new computing infrastructure.

The RTOs will commit to alignment of their process technologies with European semiconductor manufacturers to ensure a seamless transition from engineering prototype to full-scale manufacture. They have already taken a first step in this direction within a research-innovation action with both a European foundry and IDM. This action plans to deliver, for the first time in decades, European hardware for advanced computing technologies.

Direct support at European level has been costed at €2.5 billion (CAPEX and OPEX).

8. Next Steps

This set of 8 actions is our proposal to strengthen electronics value chains in Europe. This will be a major challenge and will require deep cooperation with many stakeholders across industry, research organisations and the public sector.

As a follow-up step we intend to, in collaboration with those other stakeholders, draw out, agree and present a plan of implementation to the European Commission before yearend 2018.

Annex 1 – List of company CEOs presenting this report

- Paul Boudre, CEO, SOITEC
- Jean-Marc Chéry, President and CEO, STMicroelectronics
- Rudi De Winter, CEO, X-FAB Silicon Foundries
- Jens Knut Fabrowsky, Executive Vice-President, Robert Bosch
- Hubert Lakner, Chairman of the Board of Directors, Fraunhofer Microelectronics Group
- Thomas Morgenstern, Senior Vice-President & General Manager, Globalfoundries
- Terry Nisbet, CEO, United Monolithic Semiconductors
- Reinhard Ploss, CEO, Infineon Technologies
- Emmanuel Sabonnadière, CEO, CEA-LETI
- Luc Van den hove, President and CEO, imec
- Peter Wennink, President and CEO, ASML

Annex 2 – List of contributors

- José Bériot, SOITEC
- Gabriel Crean, representing CEA-LETI
- Roger De Keersmaecker, imec
- Jens Drews, Globalfoundries
- Didier Floriot, United Monolithic Semiconductor
- Gabriel Kittler, X-FAB Silicon Foundries
- Michael Offenberg, Robert Bosch
- Joachim Pelka, Fraunhofer Microelectronics Group
- Ina Sebastian, Infineon Technologies
- Thierry Tingaud, STMicroelectronics
- Joost van Hees, ASML
- Peter van Staa, Robert Bosch