Building blocks for the Future

Components and Circuits R&D Roadmap
for Innovation Contract
Top Sector HTSM

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1. Introduction

1.1 Our role in society

The incredible flow of products from the Information, Communication and Consumer industries has changed our lives dramatically over the last 40 years. At the basis of these innovations is a continuous drive for smaller, better, cheaper and more efficient electronic components and circuits [1]. The cost-effective scaling of integrated circuits (ICs) and the resulting exponential growth of IC components is named after Gordon Moore. Moore’s law has sparked innovations in adjacent fields such as: displays, antenna, sensors, packaging techniques and energy sources.

This progress in Components and Circuits development has created many high-tech innovations. The resulting volume production is described with overwhelming numbers: 110 million laptops per year, 1.2 Billion mobile phones in 2011, a world-wide turnover of 6300B$, etc. Also in the field of medical and professional applications tremendous progress is realized. All of these innovations require improvements in RF components, high-voltage devices, digital circuits, sensors and actuators, and skillful combinations of components into high-performance mixed-signal circuits.

Europe requires major contributions from the field of Components and Circuits to tackle the Grand Challenges of the 21st century as outlined by the European Commission [2]. Based on the technological progress anticipated in the near future, there are excellent opportunities to realize break-throughs that will benefit society.

1.2 Dutch perspective

The Netherlands is one of the most important European Components and Circuits design and manufacturing countries. Some of the world’s major players in this field have here their headquarters or subsidiary: Broadcom, Dalsa, Dialog, Maxim, Neways, NXP, ST-Ericsson, STM, Synopsys, TDK-EPCOS, Thales, TI, Yageo, etc. Many Dutch SMEs companies operate on the forefront of application, design and technology. The production value represents a major portion of the total HTSM sector of 74 BEuro[3]. Dutch universities (TU Delft, TU Eindhoven and University of Twente) and institutes (ASTRON, CTIT, CTWe, Cobra, DIMES, ESI, Holst Centre, MESA+, SRON, TNO) rank amongst the most productive. The good position of Dutch industry is due to a long-lasting collaboration between industrial laboratories, research institutes and academia in the domains of technology, design and application. A huge informal network allows the effective utilization of resources, resulting in joint product development, roadmaps (e.g. Point-One [4]) and ecosystems around processing, circuit design, sensors and packaging.

This roadmap has the ambition to expand this position in the next decade and outlines the necessary research directions. Two perspectives are essential: technological development and applications’ focus. The crossings of these axes yield the most promising implementations.

2 Technological development

Moore’s law has generated a large number of innovations in the field of integrated components and circuits technology. The International Technology Roadmap for Semiconductors (ITRS) [5] refines the specific steps needed to fulfill the projected progress in IC technology. These innovations are required
in fields like lithography, metrology, device physics, chemistry, process technology, circuit design, EDA (Electronic Design Automation), embedded systems, etc.

Any roadmap for projecting potential technological innovations in the field of Components and Circuits is necessarily linked to these worldwide developments. On the other hand, all Dutch innovation activities within the scope defined by the ITRS, will be leveraged on a worldwide scale. This means that the multiplication factor for money spent on research innovation in this field is huge.

For a Dutch roadmap the developments in the field of Moore's law, the innovations in the neighboring field often described as "More than Moore" and the progress in various forms of packaging are crucial.

2.1 Implications of Moore's law.

The main line of technology development under Moore's law is focused on digital CMOS scaling. Today most commercial integrated circuit production is on 200 mm and 300 mm diameter wafers with line widths ranging from 0.5 um down to 28 nm. Ten years ago only half a dozen elements of the periodic system were used in manufacturing technology, today nearly half of all elements are applied in integrated circuits[6]. The understanding of all consequences is crucial: ranging from the physics of thin layers to interconnection variants. A better understanding leads to improved component and circuit performance (linearity, noise etc) and hence better, cheaper and more reliable systems.

Still following Moore's law new hardware/software building blocks for advanced signal processing functions target mobile, consumer and automotive applications. The challenge is to deal with design complexity, product configurability and performance aspects (including power). This requires smart hardware/software (multi-core) architectures in conjunction with new hardware/software verification technologies to master design complexity under stringent performance and reliability constraints.

From a functional perspective, more and more functions are integrated on one single CMOS die. Digital functions are extended with memories, input-output drivers, analog-to-digital interface, wireless interfaces and power management. Further functional integration will lead to system solutions with a minimum number of external components, thereby reducing the system cost and the energy consumption.

As the non-recurring costs for a product increase with more advanced technologies, the choice for a technology is not trivial, and depends heavily on expected volumes, limits in die size, packaging, system partitioning etc. Nevertheless many products with Dutch design contributions will require exploiting the smallest possible dimensions. Enabling the down-scaling of dimensions implies:

Extremely small dimensions require advanced physics concepts in the description of behavior of the components. Advances in fundamental insight in new components (metal-gate, graphene, etc) result in descriptive models and in new software tools used for the design of complex circuits. The balance between effects will change for every process node: new phenomena increase in importance and old worries disappear. Specifically slow degradation over life time, radiation hardness, reliability of components and the inherent variability will require more attention. Future RF, analog and also digital design methodology will need to adapt to these boundary conditions.

Topics in the Dutch context: modeling of advanced devices and structures, incorporation in EDA tools, testing, advanced libraries and DSP architectures.

Due to constraints such as reliability of layers, down-scaling has direct consequences for allowable power supply voltages and currents. Inside the integrated circuit this demands for the design of circuitry
operating at (very) low voltages and power levels. New insights in circuit design, new technology options and the possibility to design intelligent analog and digital calibration mechanisms will still push many limits and allow new system partitioning. Dutch industry and academia have an excellent reputation improving the performance of communication, automotive and signal-processing circuits.

Research is needed on new components and circuits for wireless networks, extended with wire line communication for security, sensor networks and high-performance information conversion.

On a longer horizon: Terabertz (THz) applications for imaging, communication, space instruments and health applications, operating circuits under extreme conditions (engine temperature, car tire vibration)

Today's choice of energy sources comprises battery chemistry, energy scavenging sources, photovoltaic cells, and mains supplies. The corresponding voltages are not in line with the boundary conditions of advanced circuits. Transformation of energy is one of the fastest growing scientific areas with a worldwide economic relevance. Optimization of the entire power chain is crucial to optimum energy usage. Topics in the Dutch context: power conversion and energy collection, improvement of the energy efficiency of functions and wireless energy transfer.

The potential impact of these technological developments on application domains such as communication, security, defense, and energy conservation is obvious.

2.2 More than Moore

Moore's law has set the pace for advanced CMOS development. Many neighboring technological fields have developed their own innovation rhythm. As the technological progress still continues, more advances in these "More than Moore" areas can be expected. Dutch industrial parties, in combination with institutes (like Holst Centre) and academia have made very relevant contributions and are exploiting innovations in the market. Many "More than Moore" technologies exist because they stretch the performance of components and circuits to a level beyond CMOS performance:

Sensors and Micro-Electro-mechanical systems (MEMs) are often coined as the eyes, nose and ears of a system. The results from ongoing developments suggest that in the future systems will be able to outperform our human senses. Apart from the omnipresent RF sensors (antenna and electronics), it is clear that the list of potential usage models is close to infinite. MEMS are applied in domains ranging from car-safety to efficient medical diagnosis. The technology for micro actuators is a young and unexplored area, in the long term this could grow to an important area. The leading position of Dutch academia, institutions and industry is mainly based on an excellent education, combined with a number of active pioneers in this field. For the creation of new semiconductor-based integrated components and devices (System-in-Package), the facilities at the Dutch technical universities play an essential role (DIMES and MESA+).

Medium term topics are detectors for various gasses (Micro-Gas Chromatography to monitor nutrition quality or health care application), image sensors for imaging technologies.

On a longer term: lab-on-a-chip for low-cost chemical analyses (microfluidics, micromembrane), sensors to detect objects and motions at various ranges, combinations of biological actuators and sensors, photon detectors.

Some domains of interaction between advanced CMOS and the physical world are less suited for integration. Interfaces related to high voltage and applications that require connection to mains, car batteries or even lithium based batteries for mobile phones, require technologies that can handle safely the nominal voltages with the incidental overshoots. Special structures (LDMOST) or processes (BiCMOS) enable high-voltage handling in a huge range of applications. This field has benefited from some technological advances in CMOS, however a lot of specific development is still needed to create innovative products. Many new developments can be expected to
reduce the costs of the power chain.
Medium term research focuses on efficiency improvement of various energy conversion, transmission and storage. For a longer term all sorts of energy scavenging with efficient conversion is expected.

Techniques developed for silicon processes are often equally applicable to other material systems. Gallium-Nitride (GaN) has a considerably higher mobility and GaN based components are seen as the most relevant innovation for power switching as well as RF power design. Very diverse application areas, such as electrical vehicles and telecom base stations, depend crucially on this rapidly evolving technology. Large scale investments enable more break-throughs in this field.

On the opposite site of the speed spectrum, reside the various activities in low-cost large-area electronics. This technology, where several players are active in the Netherlands (Holst Centre, Polymer Vision), promises at least three orders of magnitude lower cost per unit area. This goal is reached using large area, high throughput processes borrowed from the printing domain, together with novel materials based on carbon (polymers and small molecules) and metal oxides (ZnO, IGZO) enabling low-temperature processing. Electronics functions such as digital and mixed-signal electronics, displays, physical and chemical sensors, lighting (OLEDs) and solar cells (OPVs) will be produced through printing techniques and allow a further penetration of electronic functionality in daily life. Still, many hurdles must be tackled, but this technology is clearly a candidate to replace customary electronics, sensor and lighting systems that are now produced in the Far East by local manufacturing.

The focus of research in the coming years is on novel applications and economically relevant performance improvements.

2.3 Supporting technologies

Components and circuits for High-tech Systems need supporting technologies to package dies, mount them on carriers, connect to displays, antennas, etc., and wrap in suitable cabinet of fashionable format and color. In the past a packaged IC had dimensions tenfold of the functional die inside. Today ultra-thin packages are required for slim gadgets. This trend has also led to new problems, like stress, and heat dissipation. New techniques are necessary to improve present day 2-dimensional and 3-dimensional multi-die packaging (Through Silicon Via). Inside a package a small substrate with an additional level of interconnects allows largely unexplored applications.

System-in-Packages (SiP) assemble various combinations of components [4, p 37]. Especially the addition of sensors and actuators poses an additional challenge on the packages. On one hand the sensor must be exposed to the material it should sense, but that should not lead to malfunction of the rest. Packaging costs for Sensors and MEMs often form more than 50% of the component costs. A cost break-through can be expected from techniques as film assisted molding, transfer wafer molding and molded via’s. Testing of the individual components as well as the total SiP poses a big challenge due to limited accessibility and difficult to detect failures in Through Silicon Via (TSV) interconnects.

Special package technology will also enable interesting combinations of photonic and electrical components for extremely high speed data manipulation.

Antennas can be seen as electromagnetic transducers. Their crucial role in all forms of wireless communications has resulted in many innovations. With silicon technology running at increasingly higher frequencies, the application range of antennas grows (pulse-based UWB). Besides the traditional point-to-point arrangement, antenna arrays allow position-aware transmission and reception. Very high frequencies allow small antennas inside a package or on a die.
2.4 Technology advances are a must!

The advances in all fields of technology and the challenging requirements of novel applications are the fertilizers of progress in the domain of components and circuits. Here the circuit designer must seek the most optimum solution. Often this requires the combination of various knowledge disciplines into intelligent, self-adapting, self-calibrating solutions of combinations of RF (Radio Frequency), mixed-signal, power circuits and digital-signal processing blocks. This optimization process of the entire chain of functions requires thorough knowledge of the trade-offs at the system level, but also on the available margins of components. This approach will allow coping with the flexibility as demanded by advanced systems, the extreme spread and aging of nanometer components and the quest for low-cost, low-energy equipment.

For the medium term, the implementation of more system functions in advanced CMOS will be a strong driver, next to the exploitation of the options provided by “More than Moore” technologies. For a longer term (5-10 years) many more options are coming to maturity. Known solutions are no answer to the future challenge where too many boundary conditions have changed fundamentally. Ample room should be provided to researchers at universities, institutions and industry to explore these directions and define the next generation of amazing products.

3. Focus on applications.

Today’s high-tech equipment is composed of a collection of mechanical, optical, bio, electromagnetic and electronic subsystems. The electronic system often has the role of controlling and arranging the communication with the outside world. Signals could come from an antenna system for mobile communication, from a wired interface, such as an USB connector or an optical fiber, or from sensors measuring parameters like temperature, humidity, carbon dioxide, road conditions. These data are converted into digital signals and subsequently processed digitally. After processing, these signals are further transmitted, stored, displayed, transmitted via an optical fiber, or made audible. To ensure that the systems are functioning properly, the total system needs to be efficiently powered.

The processing and storage parts are typically in the realm of digital electronics. The interfaces are built in RF (Radio Frequency), analog and power technologies, often called mixed-signal electronics (i.e. a challenging combination of analog and digital electronics).

3.1 Components and circuits contribute to the Grand Challenges

Our society is facing major challenges like depletion of natural energy sources, the large pressure on the eco system, traffic congestion, the ageing population increasing the healthcare cost, security problems, etc. Europe has coined these challenges: Grand Challenges [2] to emphasize that multiple disciplines on a long timeframe are needed to solve them. The directions coming from these Grand Challenges influence the research roadmap for components and circuits:

**Energy applications** focus on alternative energy sources like solar energy. These must compensate for the shortage in fossil energy and to reduce CO2 emission. The efficiency of solar panels is relatively low and mixed-signal electronics combined with power efficiently transforms solar energy into mains compatible electricity. Energy saving with smart power grids relies on efficient power conversion, accurate monitoring of energy consumption and sending this data to a control centre. RF, sensors, power and mixed-signal electronics are key enablers. The transition from conventional incandescent lamps to energy efficient lamps, like CFL and LED light sources, is enabled by efficient electronics to optimally control the light system.
Electric vehicles are a key to reduce climate problems. The electronic challenge for electrical cars is in the domain of the (electric) power converters with efficient and cheap GaN switches. Almost 30% of our food is disposed. Measuring and logging food parameters like temperature, and humidity of the perishable goods allows predicting more accurately the condition of food. Combining sensors with data processors in a wireless sensor network will make this happen.

**Traffic congestions and logistics** will benefit from advances in RF technology (navigation, communication, entertainment) and the extensive deployment of sensors (engine control, all-around radar, safety, comfort). The design of these functions in a robust and reliable manner is a challenge with consequences down to the fundamentals of device degradation. New advanced traffic management systems use information about throughput of traffic (obtained via wireless networks), position information obtained via GPS systems, road condition information signals via sensors, information about traffic in front of the cars. These systems equipped with advanced electronics, will enable autonomous driving systems.

In society there is a strong demand to be connected to information at any time, at any place, made accessible on various forms of displays. The strong demand on the capacity of communication networks is reflected in the transition to fifth generation communication networks. All electronic devices in the world will be accessible (Internet of Things) when devices become ultra low power (scavenge the energy).

**Healthcare systems** require a lot of mixed-signal electronics to convert sound, RF and mm-wave signals, Magnetic Resonance (MR)- or X-ray signals and their combinations into interpretable and useful information. There is a strong tendency towards fast diagnosis systems for diseases at so-called Point-of-Care places. Next to traditional diagnostics, RF sensors are becoming more important in health and cure applications because their non-ionizing nature creates less tissue damage. Examples are detection in early stage of tumors, monitoring of elderly people at home and replacing labor intensive surveillance in hospitals. The medical RF systems range from disposable tags to complex image capturing and processing systems. Biosensors will enable the determination of diseases in only a few seconds. These radar and biosensors require high-frequency mixed-signal electronics, imaging technologies and micro-fluidics and also advanced packaging and assembly techniques. Also in this field, THz technology can play an important role due to its imaging and spectroscopy features.

**Security/privacy** is becoming a fast expanding application area. Very high frequency radio signals (THz frequencies) are a very good alternative to X-ray detection systems, because very high frequency signals are not harmful for body tissues. However also enhanced security near the living quarters becomes affordable with low-power sensors, electronics and communication. Security systems will guarantee the privacy of people. Passports, transportation tickets, and banking cards contain increasing amounts of crypto systems and mixed-signal electronics. The RF interfaces need to run at very low energy levels. Sensors and image capturing systems for buildings, bridges, dikes etc. should give early warning signals when intervention is needed to avoid big disasters.

The effectiveness of security enforcement depends heavily on the availability, quality and processing of information. This **“information dominance”** is the most critical success factor for future Defense and Security operations. High performance radars, fully functional integrated sensor suites and the capability to transform sensor data into user required information are crucial. New requirements define future generations as detailed in roadmaps at European level [7]. Particularly networks of sensors rely on
dedicated active phased-array technology, including custom RF, mixed-signal and digital electronics. Future challenges include a high degree of integration, reconfigurability and array systems. Solving performance issues around range and robustness will continue to be vital.

Avionics and space systems represent an application domain for compact active RF arrays. Earth observation for environmental purpose, airspace security and aircraft landing aids are of large economic benefit to Dutch society. The design of electronics for space satellite instruments demands integration of analog, mixed-signal and digital functions on single ASICs, with unique requirements on radiation hardness and EMC characteristics.

Many professional applications with relatively low volume and high margins are often innovation pioneers for large-scale low-cost consumer applications. The research in health, security, astronomy and avionics, etc. is an essential stepping stone for creating an affordable cost level to start transferring technology into consumer equipment.

The above mentioned topics make clear that applications come with their own demands on components and circuits, be it very high accuracy, very low power, very high frequencies, or special process or packaging options. The continuous drive to push the envelope of what is technically possible allows efficiently implementation of functions. This trend must and will be continued.

4. Priorities and programs for 2012 to 2017

The program ambitions lead to one overall and 5 sub-TKIs1 that can be identified within the Roadmap Components and Circuits. In addition TKI’s that cover multiple HTSM roadmaps, including the Components en Circuits roadmap, are being formed. Those TKI’s are summarized in the financial tables.

Sub TKI-1 Dealing with performance, variability, reliability and degradation in advanced technologies. Every new process node or derivative requires adapting the circuits to the changing set of boundary conditions. With lower power supply, increased variability, and higher performance targets at lower energy consumption, often radical concept changes are needed. Due to the reducing margins in technology, reliability issues and (slow) degradation, achieving a good performance over the entire lifetime is not trivial. Physics insight, new models and CAD tools and new circuit topologies and sub system solutions (reconfigurable, low-power signal processors) are needed in communication domains, sensor interfaces and energy converters.

Sub TKI-1 partners: Dialog, NXP, Recore, Salland, Synopsys, TNO, 3TU.

Sub-TKI-2 Components and circuits for wireless networks. Communication systems connect the world. This application field will remain for decades one of the dominant system drivers for components and circuits. Starting from relatively low-performance low-energy sensor communication up to high-performance radar systems many novel applications and implementations are expected.

1 The definition of TKI is still under development. Our current understanding of a TKI (Topconsortium voor Kennis en Innovatie) is a co-operation between various partners from Knowledge Institutes and Companies to execute part of the innovation contract. The level of involvement of the partners will depend on the final definition of a TKI and IP rules.
With cheaper components in smart packages, Ultra Low Power Sensor Networks (LAN, PAN, BAN) will enable the monitoring of large and complex infrastructures "Internet of Things". An optimum integration in the network is required. The ultimate goal is to strive for net-zero power devices, where nodes in a network scavenge their energy from the environment (e.g. Guardian Angels project).

Co-operative networks and cognitive radios use the available bandwidth and are carrier-frequency adaptive. Especially in the lower frequency bands (< 5 GHz) traffic congestion can be avoided. On circuit and component level this requires broad band radio circuits. The traditional radio paradigm, from antenna, architecture and circuit design must be reinvented.

More and more high-frequency electronics is needed for the ever increasing data throughput on an ubiquitous wireless infrastructure. 60GHz wireless systems have been developed, car radar electronics will be centered around 77 GHz, and TeraHertz frequencies will be used. The THz frequency band has unique properties as spectroscopy of materials, imaging capabilities and an extremely high bandwidth for future communication systems. These unprecedented high frequency and high bandwidth systems are an enormous challenge for electronics and require new insights in working principles of new electronic devices working far beyond today’s frequency limits. Applications range from astrophysical research to security. Sensors developed in the THz domain for professional applications (e.g. space) will penetrate in other application areas (security, health).

Active digitized arrays will steadily replace single receivers and transmitters. Individual users will receive their information through tailored, user-centered beams. For receive systems, digitization will be performed at element-level, to allow a much higher information-extraction. For transmit systems, digitization will be performed at element- or sub-array level, to enable reconfigurable multi-function systems.

Sub TKI-2 partners: ASTRON, Boschman, Bruco, CTIT, CTWe, Dalsa, Dialog, DlMES, Holst Centre, MESA+, NXP, Salland, SRON, ST-Ericsson, TDK-EPCOS, Thales, TNO, 3TU

Sub TKI-3 Smart energy applications[8].
All energy management is embedded in a system approach. Combining power-optimized switching circuits and GaN driver devices with electronics controls will result in optimum performance for the end user, e.g. electrical vehicles, energy efficient buildings, and Smart Grids. The energy dissipated in driver stages leads high temperature peaks (>300°C). The harsh environment where these circuits operate, requires improved reliability, packaging and increased lifetime. Efficient, small and reliable power converters are crucial.

The changeover from gasoline cars to E-cars will fuel smart energy management and conversion, where large quantities of power stages with integrated circuits will be used. But also new i-gadgets demand for better energy management. Wireless sensor nodes, in-body electronics require new forms of wireless energy transfer.

Sub TKI-3 partners: Bruco, Eindhoven Energy Institute, EIT KIC InnoEnergy, Heliox, Holst Centre, NXP, Systematic, TNO, 3TU.

Sub TKI-4 More-than-Moore technologies for large-area low-cost electronics.
Low-cost, high throughput technologies able to build transistors and sensors on large flexible foils are leaving the early research stage to enter the development of innovative products. Applications range: from displays and touch screens to cheap RFIDs augmented with sensors.

Based on the same large-area low-cost approach there is a strong development of light emitting devices (OLED) and solar cells (OPV). The applications of OLEDs include light emitting surfaces with very high efficiency and allowing revolutionary applications. New power electronic devices can further improve
the quality, life time and light temperature of LED and CF lamps.
Sub TKI-4 partners: Avantes, Bruco, Holst Centre-TNO, NXP, Philips, 3TU

Sub TKI-5 Components and Circuits for scientific instruments
Advanced components and circuits allow building instruments that enable break-throughs in many scientific areas. The Netherlands has a strong position in several of these domains (material analysis, medical, robotics, microscopy, lithography, detectors for particle physics and space exploration). Although of limited components-and-circuits industrial significance these developments can act as vehicles to explore extreme operating conditions and are of significant value for industrial and scientific instruments.
Sub TKI-5 partners: ASTRON, Bruco, Nikhef, Panalytical, SRON, Systematic

5. Investments
The final definition of TKI will determine the actual size of the contributions to the TKI part and/or the non-TKI part of the roadmap. In this table, most of the in-kind contributions of companies are considered as contributions to the TKI "Components and Circuits".

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* University: betreft ook vergelijkbare onderzoekscentra, zoals AMOLF en SRON
* Further funding: regiobijdragen, overheidsTaken (bv defensie), SBIR, IMEC, etc.
* In the line TNO+/TKI, the number in the column 'further funding' includes 2 MEUR MEC contribution to Holst
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* State/or: nationale subsidies, TTI bijdragen, RDA+, etc. (niet WBSC en RDA)
* University: betreft ook vergelijkbare onderzoekscentra, zoals AMOLF en SRON
* Further funding: regiobijdragen, overheidsbijdragen (bv defensie), SBIR, IMEC, etc.
* In the line TNO+/TKI, the number in the column ‘further funding’ includes 2 MEURO IMEC contribution to Helst

Cash

In-kind
### Totaal 2015 - Circuits & Components

<table>
<thead>
<tr>
<th>Finance ? Execution</th>
<th>Comp</th>
<th>State /TNO+</th>
<th>State /NWO</th>
<th>State /other</th>
<th>Univ</th>
<th>EC</th>
<th>Further funding</th>
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<td>11.2</td>
<td>10.4</td>
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</tr>
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</table>

*State /other: nationale subsidies, TTI bijdragen, RDA+, etc. (niet WBSO en RDA)
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**Date&Time: 20111222 - 16h00**

The companies, universities, and institutes active in the domain of Components and Circuits have a long history of participating in public-private R&D programs. In the late 80's companies were already active in Esprit and Jessi programs. Today they are co-operating in Catrene, ITEA, ENIAC, Artemis and FP 7 programs. The programs are instrumental in bringing different parties together to develop pre-competitive technologies or allowing parties in the value-chain to work on new product concepts. The current position of European companies in Components and Circuits is for a substantial part due to their involvement in these co-operative programs. In the 90's the three semiconductor companies jointly developed the advanced CMOS technologies. Well-known application examples that originated from this co-operation are mobile communication (GSM is a result of such European effort), car navigation, e-security etc. We are absolutely convinced that, the Dutch companies should remain involved in the European programs to share costs, develop new concepts with partners in the value chain, and to develop pre-competitive technologies. The Netherlands should continue their leading role in the successor programs of ENIAC and Artemis, should continue driving Eureka programs and should step up their involvement in Horizon 2020. The opportunities are manifold, given the focus of Horizon 2020 on grand challenges and given the fact that micro and nanotechnology has been selected as one of the Key Enabling Technologies in Europe. In 2012 and 2013, additional opportunities will be provided by the JTIs ENIAC and Artemis for exploring the concept of KET pilot lines, an EC-supported initiative to stimulate industrialization by extending the scope of R&D projects into higher degrees of technology readiness.

Also in the Netherlands the Component and Circuits parties have a strong tradition of intense co-operation. The 3TU’s, the institutes like TNO, Holst Centre, ESI, Astron, DIMES, MESA+, and the industrial partners have various ways of interaction via STW programs, direct funding of MSc and PhD programs, industrial involvement in the institutes, partnerships in subsidized programs, and last but certainly not least the many informal interactions between the key-players.

7. Other innovation instruments (such as IPC, Innovation Funds, SBIR, valorization grants)

The Components and Circuits parties have high expectations about the target of the Dutch authorities to use 2.5% of their procurement budget for Innovation. Given the broad application scope of our program we are convinced that we can play a major role in solving many problems in the Netherlands ranging from traffic management, smart energy systems, security systems, observation systems based on sensor systems, efficient radio astronomic systems, avionic systems, etc. There are discussions on going with amongst others Rijkswaterstaat to further explore opportunities.

The SME companies will get more engaged in the Innovation fund programs by the usage of valorization grants, that can be applied for via the universities.

8. References

[6] see also HTSM roadmap on Nanotechnology.
Strategic Research Agenda's of IAP-01 and IAP-02 of the European Defence Agency (EDA), at programmatic level (such as the roadmap STARS and the roadmap radar systems) and the HTSM Security Roadmap: appendix Active Sensors.

[8] see HTSM roadmap for energy.