ARTEMIS-IA Brokerage Event

MASRIA/MASP 2016 Chapters

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Introduction to the MASRIA and MASP

It serves as input/recommendation for the 2016 Multi-Annual Strategic Plan (MASP) of the ECSEL Joint Undertaking

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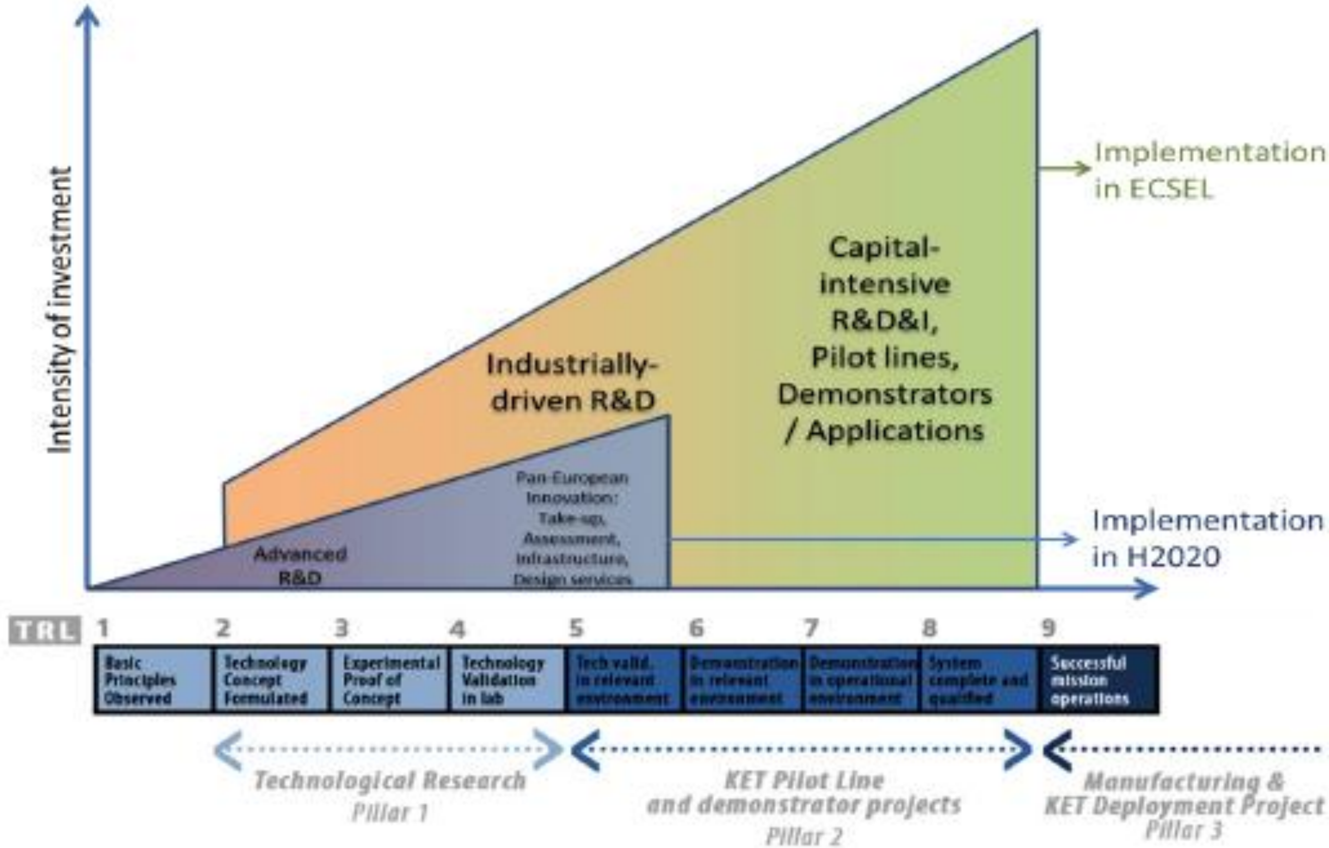
MASRIA 2016 Introduction

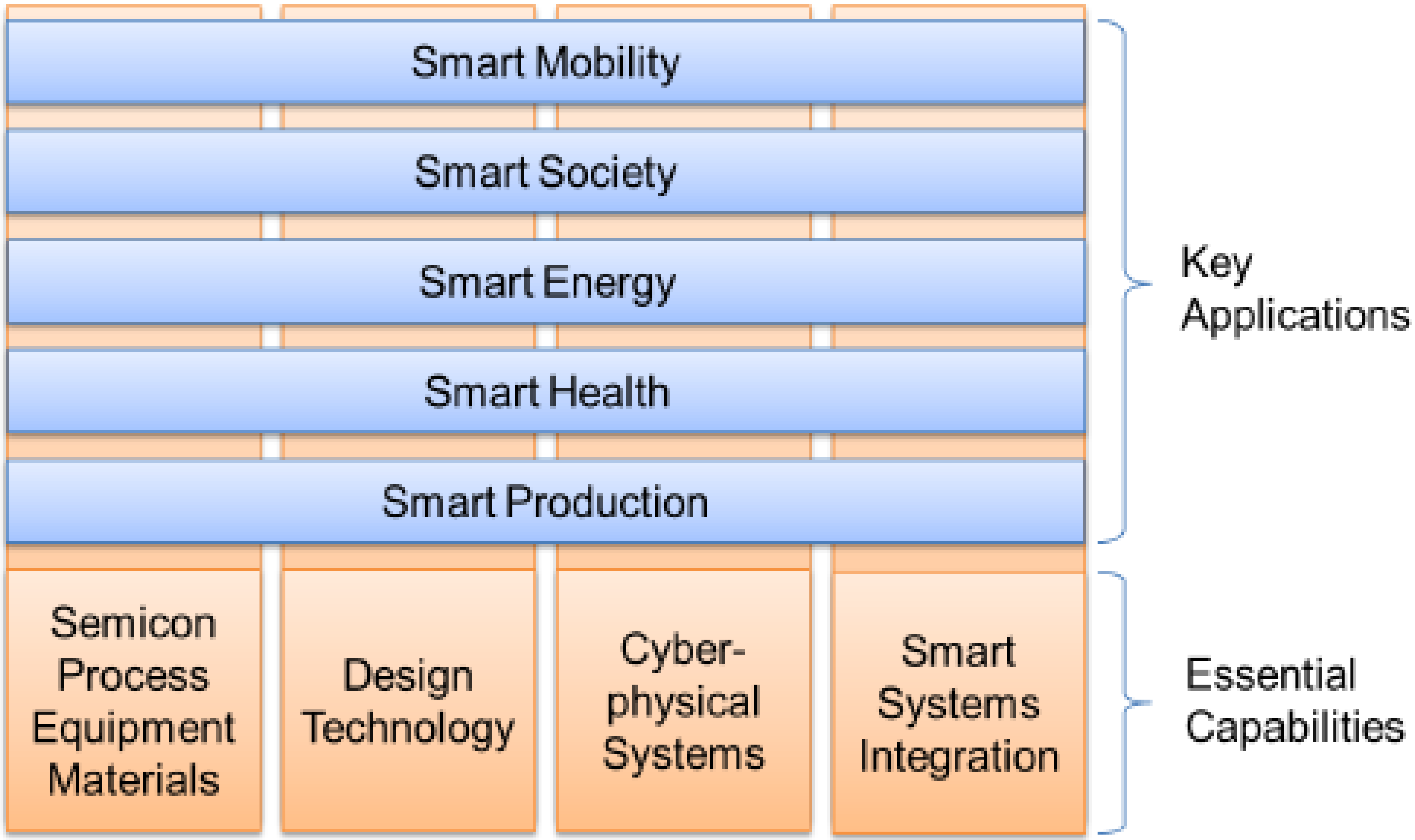


MASRIA’s Vision, Mission, Strategy & Objectives

- **The Vision**: Benefit of the major evolution
- **The Mission** : Remain on the forefront of innovation in the ECS domain.
- **The Strategy**: Build on the European strength
  - Cover the complete ECS value chain
  - address TRL 2-8, with emphasis on higher TRLs.
  - Agility to respond to unexpected markets development, by combining the ‘bottom-up’ and ‘Top-down’ approaches

- **The Objectives**
  - Contribute to the implementation of H2020 in the Leadership in enabling and Industrial technologies
  - Contribute to the development of a strong and competitive ECS industry in the Union
  - Ensure availability of ECS for Key markets
  - Align the strategies with Member States
  - Maintain and grow semiconductor and smart system manufacturing in Europe
  - Secure and strengthen a commanding position in design and system engineering, including embedded technologies
  - Provide access for all the stakeholders to a world-class infrastructure.
  - Build a dynamic ecosystem involving SMEs

The Strategic Thrusts



❑6.1 Smart Mobility

- *6.1.1 Objectives*
- *6.1.2 Strategy*
- *6.1.3 Impact*
- *6.1.4 Cross references*
- *6.1.5 Schedule/Roadmap*

6.1 Smart Mobility

6.1.1 Objectives

To Respond to **crucial societal challenges by** :

- **Reducing CO2 emissions, improving air quality**, and
- **Eliminating congestion** for improved logistics and traffic efficiency using existing infrastructure
- **Advancing towards accident-free and causality-free mobility scenario**, addressing the needs of **vulnerable road users** such as children or an **ageing population**.
- **Maintaining global leadership** while serving the needs of society by the development and deployment of new capabilities of ECS (Electronics, Components and Systems)
- Introducing **new methods and tools for the design, verification & validation and production**
- Providing vehicles, transportation systems and infrastructure with the required **intelligence and flexibility** by extending and **reinforcing the well-established strengths of the European industry**.

In section “Smart Mobility” vehicle shall mean cars, airplanes, vessels, trains, off-road vehicles, satellites, drones.

6.1.2 Strategy

- Smart Mobility Strategy is to focus on capabilities in the domains of **sensing**, **communication**, **navigation/positioning**, **computing** and **decision-making**, **control and actuation** based on **ECS** and the necessary development and validation tools and methods.
  - ECS for resource efficient transportation
  - ECS for Partial, conditional, highly and fully automated transportation
  - Integrated and multimodal networks

6.1 Smart Mobility

6.1.3 Impact

- Shape the **convergence of the worlds of digital data and transportation**
- Provide functionally **safe and reliable products** and related efficient processes.
- Strengthen European leadership in electronics and smart embedded computer systems, and supports Europe's role as a frontrunner for innovation and engineering quality in the automotive and other transportation sectors, such as for instance aerospace and railways : <u>those industrial sectors that are most important for employment and economic growth in Europe.</u>
- Take into account the activities of the European Green Vehicles Initiative PPP, JTIs as Clean Sky 2, Fuel Cells and Hydrogen 2, and specific parts of the three pillars of H2020, e.g. Mobility for Growth, Smart Cities and Communities by advances in electronic components and systems for smart mobility.
- Helping to achieve the long-term objectives of the EC's Transportation White Paper.

6.1.4 Cross references

- Synergies with application-oriented transport research programmes such as:
  - H2020-”Mobility for Growth”, H2020-“Automated Road Transport”, H2020-”Green Vehicle”, H2020-ICT-IOT Large scale Pilots (focusing on cloud infrastructure for intermodal and automated transport),
  - JTI Fuel Cells and Hydrogen 2 and Clean Sky 2,
  - H2020-“Space” Work Programme (e.g. in the navigation, communication and remote sensing domains)
- The smart mobility research programme expects research results from horizontal ECSEL capabilities as
  - Semiconductor processes, equipment and material,
  - Design technologies,
  - CPS technologies (as embedded systems design, development methods and tools, integration of real-time simulation with control, safety and security in CPS based smart systems) and
  - Smart system integration.

6.1 Smart Mobility Chapter content

6.1.5 Schedules/Roadmaps

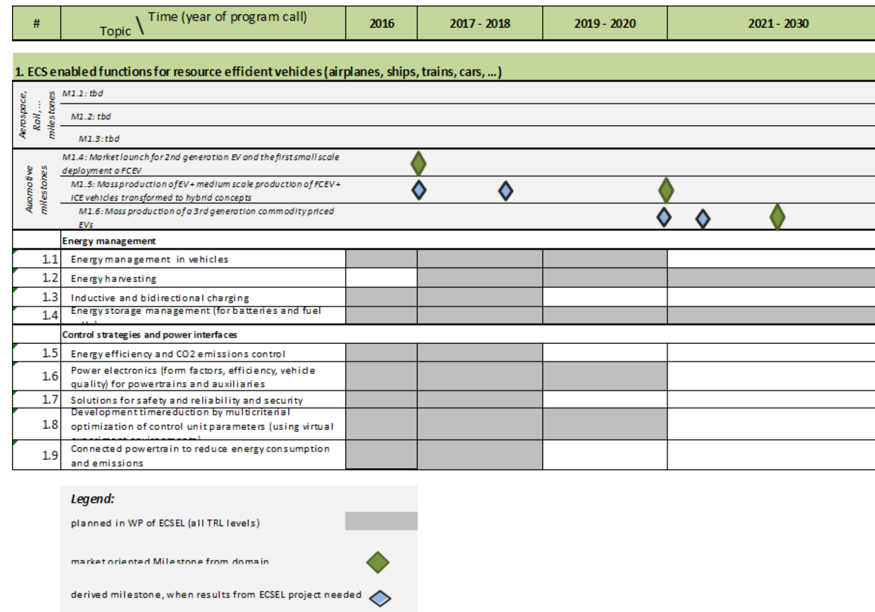
ECS for Resource Efficient Vehicles

Energy management

- Energy management in vehicles
- Energy harvesting
- Inductive and bidirectional charging
- Energy storage management (for batteries and fuel cells)

Control strategies and power interface

- Energy efficiency / CO_2 emissions control
- Power electronics (form factors, efficiency, vehicle quality) for powertrains and auxiliaries
- Solutions for safety and reliability and security
- Development time reduction by multi-criterial optimization of control unit parameters (using virtual experiment environments)
- Connected powertrain to reduce energy consumption and emissions



6.1 Smart Mobility Chapter content

6.1.5 Schedules/Roadmaps

ECS for Highly Automated and Autonomous Transport

- Environment recognition and data distribution within vehicles
  - Sensors
  - Actuators
  - (wireless) Networks in vehicles
- Control strategies
- Communication
  - Cyber Security
- Cloud Backbone
- Testing and dependability
  - Virtual testing
  - Stimuli
  - ...
- Lifecycle
- Development Tools and Methods

#	Topic \ Time (year of program call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
	2. ECS enabled functions for highly automated and autonomous traffic (land, air, water, ...)				
Aerospace, Rail,... milestones	*M1.1: tbd*				
	M1.2: tbd				
	M1.3: tbd				
Automotive milestones	*M2.4: Conditional automated driving in low speed and less complex driving environments, e.g. in parking lots and in traffic jam situations on one-way motorways*				
	M2.5: Conditional automated driving at higher speeds in environments with limited complexity, e.g. highways				
	M2.6: Highly automated driving in most complex traffic situations				
	Environment recognition and data distribution within vehicles (airplanes, ships, trains, cars)				
2.1	Sensing, actuation and data fusion – in- vehicle and with sensors and actuators in the environment				
2.2	Positioning (absolut position and velocity measurement using sensor fusion) and navigation (e.g. as input for V2V communication)				
2.3	Scene and object recognition				
2.4	Traffic scene interpretation; scenario cataorization; catalogue of safety relevant scenarios; scenarion description language				
2.5	Lifetime, reliability, robustness; quality attributes of sensors; aging of sensors; influence of environment to sensor quality; handling of quality attributes of sensors in software; on-board diagnostics for automated transport systems				
2.6	Automative EtherNet based on OABR (open alliance broad reach communication): Higher Data Rate Ethernet for Automotive Objective; Pave the way to 1Gbit/s Ethernet suitable for automotive				
	Control strategies				
2.7	Framework for scene interpretation, environment object handling to separate sensing from control stategies; object standardization; standardization of test procedures				
2.8	Service oriented distributed dynamically reconfigurable HW/SW architecture (e.g. using automotive Ethernet)				
2.9	Mission oriented automated system sw: Mapping and routing, Control strategies & real time data processing; online mission verification				
2.10	Goal oriented collaborative automated system sw: Mapping and routing, Control strategies & real time data processing				
2.11	Value oriented automated system sw: Mapping and routing, Control strategies & real time data processing (cognitive modelling)				
2.12	Human-vehicle interaction				
	Communication				
2.13	Safe and secure communication; build-in data security and privacy				
2.14	Seamless integration and cooperation of multiple communication platforms : C2X, Radar, DAB, 5G, eLicense Plates, NFC, Bluetooth, 802.11p, etc.				
	Cloud backbone				
2.15	Infrastructure supporting autonomous transport				
2.16	Intelligent in-vehicle networking				
2.17	Interacting safety ; testing in complex traffic scenarious				
	Testing and dependability				
2.18	Verification, validation & simulation and decomposition of environment, sensors, tracks, objects etc. to increase resusability and decrease validation effort; teststands for real-time scenario testing with varying combinations of real and simulated components				
2.19	Fail operational concept for unknown envirionments; fail safe and secure operation				
2.20	functional safety and depandability				
2.21	Certification and testing				
2.22	Quality of services in extreme situations				
	Lifecycle				
2.23	Reliable and temper-free blackbox recorder for near incendent data (including dependable communication and near incident scenario evaluation, definition of minimal data set)				
2.24	Learning process for automated vehicles (including necessary online SW update-infrastructure)				
	Developement tools				
2.25	Tools to develop components and systems using Automative EtherNet based on OABR (open alliance broad reach communication): e.g. ADAS sensors, sensors and actuators for automated driving; multimedia components				

6.1 Smart Mobility Chapter content

6.1.5 Schedules/Roadmaps

ECS for Integrated and Multimodal Mobility Networks

<u>Multimodal traffic communication</u>

- Cloud based backbone services
- Intelligent infrastructure and information systems
- Standardisation for intermodal communication

<u>Traffic management</u>

- Traffic density control
- Multimodal traffic tolling
- Trajectory generation

<u>…</u>

<u>Guidance systems</u>

- Predictive online traffic information
- Assistive transport networks
- Intermodal traffic guidance
- ….

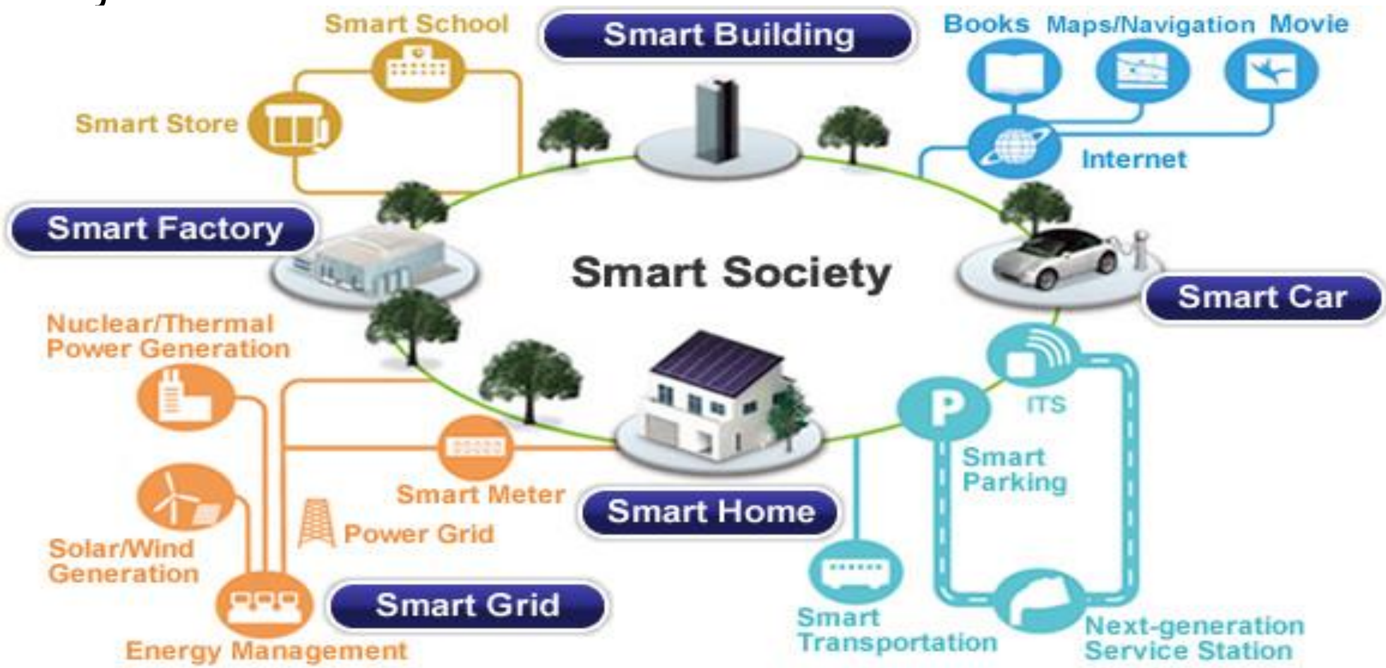
#	Topic \ Time (year of program call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
3. ECS enabled functions for integrated and multimodal mobility networks					
	Communication				
3.1	Cloudbased beackbone services for multimodal mobility coordination				
3.2	Intelligent infrastructure and information systems for integrated and multimodal mobility (multiple environments as for example multiple countries, cities, ...)				
3.3	Standardization of intermodal communication				
	Traffic management				
3.4	Traffic density control and (re)routing and cooperative decision making				
3.5	Multi modal, multi country traffic tolling and payment				
3.6	Trajectory generation and validation using HPC				
3.7	User interface to multi modal and integrated transport systems (including gamification algorithms)				
3.8	Online status/location monitoring and trajectory re-routing				
3.9	Intermodal cross country travel information				
3.10	Access and parking management				
3.11	Fleet management				
3.12	Rail energy use and storage management				
3.13	Aerospace SW platform for 100% operational availability and reliability, full situational awareness, human centered operation, seamless connectivity with the in-flight and ground environment				
3.14	Cost efficient, flexible reconfigurable, dependable and safely operating satellite systems for Smart Environment developments				
	Guidance systems				
3.15	Predictive online traffic information (using social media and historic information from big data)				
3.16	Assistive transport networks systems (e.g. for the elderly living)				
3.17	Intermodal traffic guidance with personalized user interfaces and personalized way of interaction for people with special interestes (e.g. elderly people, handicapped people)				

❑ 6.2 Smart society

- *6.2.1 Objectives*
- *6.2.2 Strategy*
- *6.2.3 Impact*
- *6.2.4 Cross references*
- *6.2.5 Schedule/Roadmap*

6.2 Smart Society

6.2.1 Objectives



- ❑ Holistic Integration of technologies and services to serve people living in a more and more urban environment.
  - ➢ Big Data , M2M , IoT , Mobile devices.....
  - ➢ Information exchange , mobile computing , payment , ticketing ......
  - ➢ Security , privacy , identity , authentication ...

6.2.2 *Strategy*

- Strategy : Leverage on European Strengths with **focus on safety & security** for **connected & trustable components over internet and other networks** through
  - Selection of Market opportunities
  - Understanding what creates Trust and impact on security
  - Living labs & Public procurement
  - Solutions driven by Market or usage brought by end users
  - Low TRL projects only to cover missing items (Added Authentication techno)
  - High TRL projects is the priority in the context of smart society with development of new architecture and high level building blocks but also adaptation of existing solution .

6.2.3 Impact

- Impact :
  European independence on critical assets , European leadership on IoT , European assets protection and competitiveness of European Industry .
  - European independence for security enabling components & systems
  - European leadership for smart and connected Things (IoT)
  - European Assets protection
  - Reduction of time to market of European innovations
  - Open up new market opportunities for European industry

6.2.4 Cross references

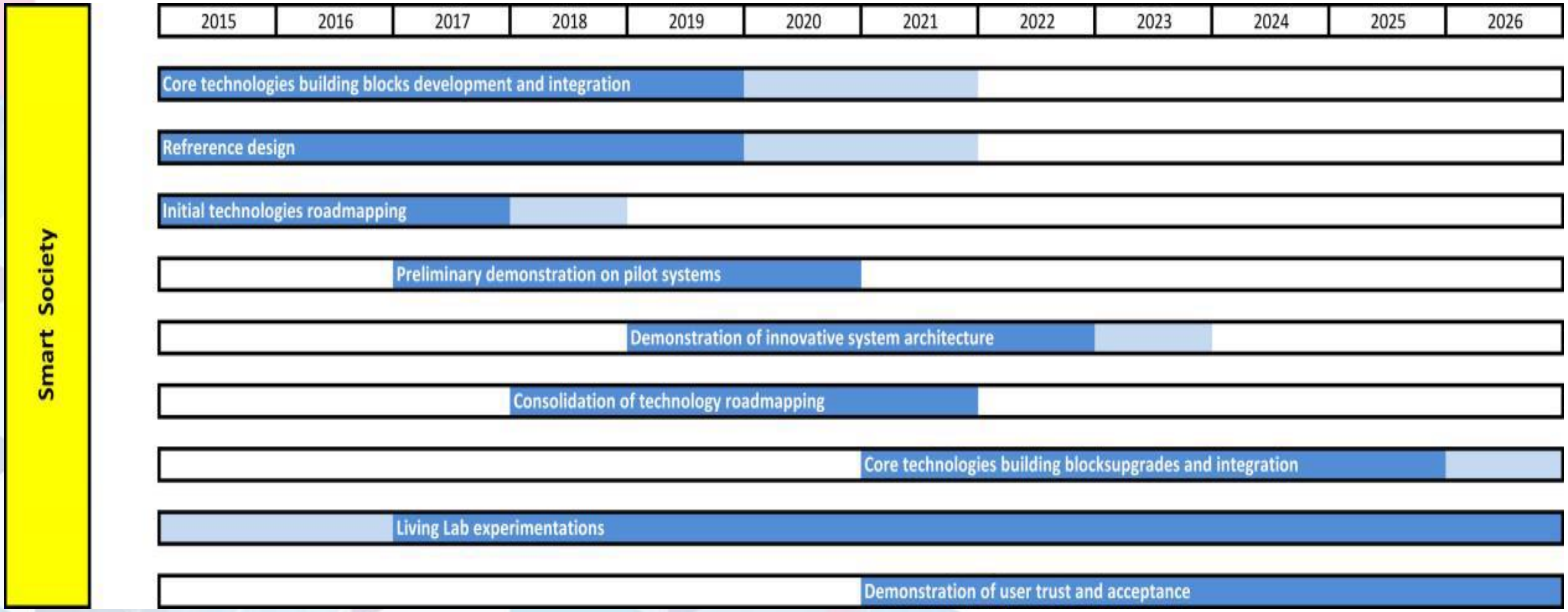
- Core technologies needed for smart societies to be developed in the context of Cyber physical systems 7.3 and Smart system integration domains 7.4
- System design tools from Technologies & Design domain 7.2 will be required for the security and safety aspects of the specification of system architectures
- Technical Blocks developed for smart society should feed other domains in ECSEL context :
  - Smart Health
  - Smart Mobility
  - Smart Production
  - …….

6.2 Smart Society

6.2.5 Schedules/Roadmaps

- **Short term**: availability of core technology building blocks and reference designs, preliminary demonstrations of pilot systems, and initial technology road mapping for next steps based on market priorities
- **Midterm**: demonstration of innovative system architectures based on these building blocks and **reference designs**. Consolidation of technology road mapping.
- **Long term**: co-developed concepts for trusted smart society services, strategies for creating trusted solutions, demonstration of user trust and acceptance. Evidence of the actual support to implementation of innovative digital services for a smart society.

A limited number of living labs experimentations, spanning the whole duration of the program, fed by technology innovations, contribute to their integration, and support the demonstrations.



❑6.3 Smart energy

- *6.3.1 Objectives*
- *6.3.2 Strategy*
- *6.3.3 Impact*
- *6.3.4 Cross references*
- *6.3.5 Schedule/Roadmap*

6.3.1 Objectives

- Significant **reduction of primary energy consumption** along with the reduced carbon dioxide emissions is the key objective of the Smart Energy chapter.
- Electronic components and systems **(ECS) are key enablers** for higher efficiencies and intelligent use of energy along the whole energy value chain, from generation to distribution and consumption.
- Enhancing **efficiency in the generation**, **reducing energy consumption** and carbon footprint are the driving forces for the research in nano/micro-electronics, embedded and integrated systems in order to secure in all energy applications the balance between sustainability, cost efficiency and security of supply.

6.3.2 Strategy

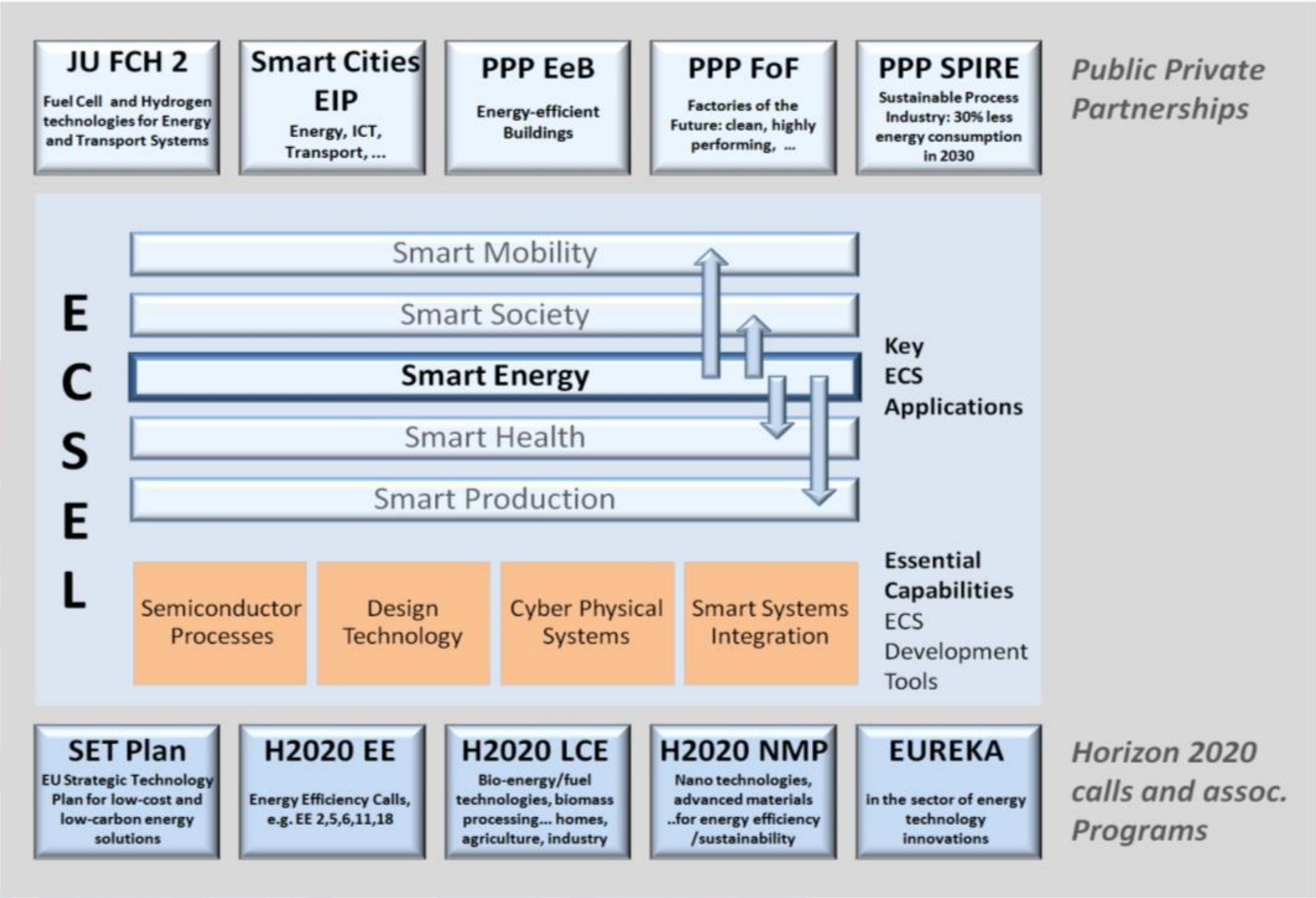
Three main domains will be in the focus of upcoming research for ECS:

- 1) Sustainable **power generation and energy conversion**
- 2) Reduction of **energy consumption**
- 3) Efficient community **energy management**

6.3.3 Impact

- to support the EU target for 2020 of **saving 20%** of its primary energy consumption compared to projections
- **reduction and recovery of losses** by significant values
- **decreased size of the systems** by miniaturization and integration,
- **increased functionality, reliability** and lifetime (incl. sensors & actuators, ECS HW/SW, ...),
- **increased market share** by introducing (or adopting) disruptive technologies
- **the game change to renewable energy** sources and decentralized networks involving energy storage to stabilize the power grid preferably on medium and low voltage levels as well as to manage the intermittence of renewable power generation, offering new opportunities to consumers.
- “plug and play integration” of ECS into **self-organized grids** and multi-modal systems
- **safety and security** issues in self-organized grids and multi-modal systems

6.3.4 Cross-References



6.3.5 Schedules/Roadmap

ECSEL MASRIA 2016 **SMART ENERGY Road Map**

1	**ECS for Sustainable Power Generation and Energy Conversion**	**2016**	**2017 - 2018**	**2019 - 2020**	**2021 - 2030**
1.1	**Highly efficient and reliable** ECS for all kind of electrical energy generation – de-centralized to large power plants, cross link to processes and materials				
1.2	Smart and micro **converter reference architecture** with integrated control				
1.3	**Highly integrated power electronics**, actuators for safe and reliable DC and AC grids				
1.4	**Converter on a chip** or integrated modules				
2	**ECS for Reduction of Energy Consumption**	**2016**	**2017 - 2018**	**2019 - 2020**	**2021 - 2030**
2.1	**Implementation** of smart electronics **in smart grid nodes** including system integration with communication interfaces				
2.2	ECS for controlled power/drive trains and illumination				
2.3	**Smart electronic components** for (MV/LV)DC power supply implemented in e.g. buildings, factories, infrastructure and vehicles/planes)				
2.4	**Distributed DC network**				
2.5	Smart electronic components for MV/DC grid integration of **storage** and renewable				
2.6	**Fully connected ECS** for e.g. illumination and city energy use				
3	**ECS for Efficient Community Energy Management**	**2016**	**2017 - 2018**	**2019 - 2020**	**2021 - 2030**
3.1	**monitoring** of energy infrastructure and cross domain services (e.g. maintenance, planning and IoT services)				
3.2	Decreased integration costs in **self-organizing grids**				
3.3	Smart systems enabling optimized heat / cold and el. power supply				
3.4	ECS support for standalone grids and self-organization incl. Scavenging				
3.5	Smart systems enabling optimized **power to fuel and coupling of transport and el. Power sector**				

❑6.4 Smart Health

- *6.4.1 Objectives*
- *6.4.2 Strategy*
- *6.4.3 Impact*
- *6.4.4 Cross references*
- *6.4.5 Schedules/Roadmaps*

6.4.1 Objectives

- **Objective 1**: Transform from now to 2025 healthcare from state of the art to standardized care in order that existing medical devices and medical supplies become more and more applicable outside the hospitals.

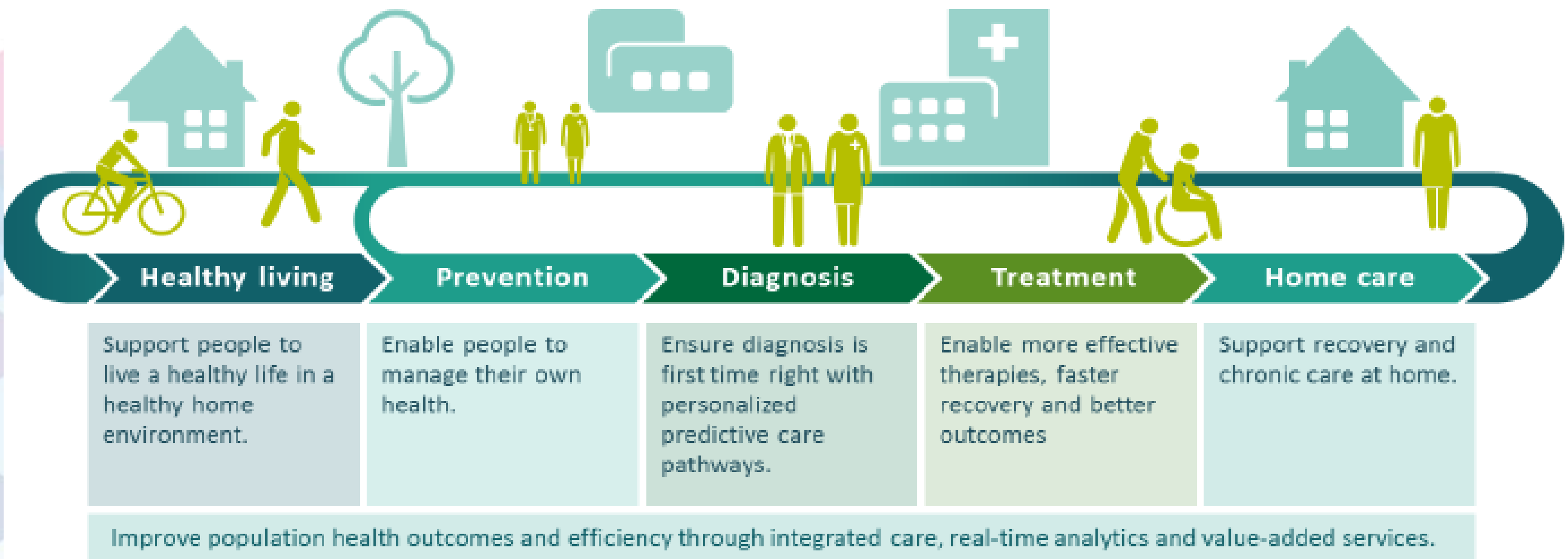
- **Objective 2**: Creation of an open Digital Health Platform ecosystem, enabling cost effective development and validation of healthcare appliances and applications. The platform is open for new appliances and applications by providing API's (Application Programming Interfaces), while taking safety, security and privacy into account.

- **Objective 3**: Mobile healthcare systems based on micro-/nano-electronics, to increase sustainability and efficiency of health systems and support the improvement of quality of life for patients, in particular of elderly people with chronic disease. Patients should be more self-empowered to manage their disease by their own.

- **Objective 4**: Medical equipment and devices are evolving fast, especially in the changeover from open surgery to closed (minimal invasive) surgery.
- Innovation in imaging (e.g: functional imaging, higher resolutions), multi-model imaging (e.g. HIFU) and image guided intervention will open up complete new treatments, workflows and markets.

6.4.2 Strategy

- Enhance health continuum and standardized care complementing medical equipment with wearable / implanted, multi parameter sensor systems, and related algorithms covering the whole health spectrum between healthy living and home care



6.4.3 Impact

Impact for Patients:

- Shorter hospital stay , Safer and more secure access to healthcare information
- Better personalized prevention, diagnoses and treatment
- Improved quality of life , Reduced risk to further complications that could result from hospital treatment

Impact for Healthcare professionals:

- Improving decision support , Providing safer and more secure access to healthcare information
- Unlocking totally new clinical applications
- Enabling better training programmes leading to more well trained professionals

Impact on European industry:

- Maintaining and extending leadership positions of European Industry
- Creating new market opportunities in the Digital world for European large industry and SME's
- Opening up a new world of cloud based collaborative care
- Increasing efficiency of health prevention, diagnoses and treatment

Impact on European society:

- Creating of a European ecosystem around digital healthcare
- Contributing to the reduction of growth of healthcare cost
- Improving quality of life and productivity of labour force

Impact on Health Care Payers (insurance companies, national authorities)

- Reducing cost
- Introducing a more lean approach to health care provision
- Appropriate budget is not wasted and value for money is prioritized

6.4.4 Cross-References

Application chapters:

1) **Smart Mobility**: e.g. mobile health status monitoring

2**) Smart Society**: the next-generation digital lifestyle to guarantee prevention and privacy. Smart healthcare is part of the smart environment.

3) **Smart Production**: certification of medical equipment implies careful manufacturing using affordable and flexible production tools such as 3D printing,….

Technology chapters:

1) **Process technologies**: for integrated smart systems, advanced sensors, advanced materials and novel process technologies; 3D printing and packaging for low to medium volume medical device.

2) **Design technologies**: integrated tool chain to supports all stages of system design. Access to design tools that are adapted to low to medium volume industrial needs.

3) **Cyber-Physical Systems**: most medical equipment will be wirelessly 'connected' and will measure multiple physical parameters, secure, adaptive CPS platform architectures, standardization and semantic interoperability

4**) Smart Systems Integration**: For multidisciplinary system integration - e.g. from lab-on-chip and point-of-care diagnostics to complex diagnostic, interventional/therapeutic systems. Unobtrusive, mobile health-status monitoring and smart-treatment systems also require multidisciplinary integration and packaging.

5) **Autonomous, low-power techniques** for both wearable and implantable smart devices, including energy harvesting and wireless power transfer for autonomous implants or wearables

6.4 Smart Health

6.4.5 Schedules/Roadmaps

1. HEALTHY LIVING					
1.1	Life style, diet support and physical exercice promotion based on artificial Intelligence AI, natural language processing				
1.2	Connected trackers powered by energy scavengers or having more than one year autonomy				
1.3	Inexpensive sensor systems that can detect changes in health status without bothering the user				
1.4	Aggregating sensor systems or trackers data from different vendors to the cloud or to a secured hub				
1.5	Interoperable secured electronic records from sensor systems				
1.6	Artificial Intelligence AI, natural language processing, machine learning, cognitive computing for communicating with a person				
2. Prevention					
2.1	Autonomous sensor system that could detect diseases 10 -14 days before the usual assessment by a health care provider or the adult self-reported illness. Devices powered by energy scavengers or having more than one year autonomy without the need to actively use or wear a device				
2.2	Linking sensor system to cloud a patient hub				
2.3	Inexpensive autonomous sensor system for genomic and biomarkers of vital signs				
2.4	Artificial Intelligence AI, natural language processing for prevention capable of communicating with a patient or a healthcare provider for prevention				
3. DIAGNOSIS					
3.1	Inexpensive autonomous sensor systems for referenced biomarkers vital signs used in emergency situations				
3.2	Artificial Intelligence AI, natural language processing for emergency situations capable of communicating with a patient or a physician				
3.3	Aggregating sensor systemsdata from different vendors to the cloud or to a secured hub				
3.4	New multi model imaging equipment , new minimal invasive devices for improving diagnostis				
4. TREATMENT					
4.1	Quality metrics monitoring and technology assessment, reducing duplicative tests and procedure, reducing errors and readmissions				
4.2	Atomatic delivery of the therapy with minimal or no patient involvment				
4.3	Aggregating data from therapy delivery systems from different vendors to the cloud or to a secured hub				
4.4	Artificial Intelligence AI, natural language processing for prevention capable of communicating with a patient for providing a therapy				
4.5	New multi model imaging equipment , new minimal invasive devices for improving treatments				
5. HOME CARE					
5.1	Systems having artificial Intelligence, natural language processing capable of communicating and interacting with patient for providing a therapy at home				

❑6.5 Smart Production

- *6.5.1 Objectives*
- *6.5.2 Strategy*
- *6.5.3 Impact*
- *6.5.4 Cross references*
- *6.5.5 Schedules/Roadmaps*

6.5.1 *Objectives*

- The key objective of ‘Smart Production’ is the **automation and digitalization of the European industrial production** by means of advanced electronic components and systems (ECS) covering the entire product lifecycle from product design, manufacturing, product in-use till recycling. This would even apply to production sectors in which automation is yet hardly present.
- In the ECSEL-focus of “Smart Production” :
  - the European manufacturer improving their production efficiency along the entire value chain
  - the industrial equipment supplier and tool vendors providing innovative automation solutions, process control and logistic management systems.

6.5.2 *Strategy*

"Smart Sustainable and Integrated Production" R&I will focus on **enhancing the capabilities for automation and smart production through novel technologies, tools and methodologies**:

- Procedures, methods and tools for planning and operating collaborative automation environments, as well as support for the transformation from legacy to future system
- System integration of smart device capabilities: sensing, communication, knowledge management, decision-making, control, actuation, resulting in smart maintenance and smart production execution
- Improved production system integration along three production axes: life cycle, value chain enterprise
- Autonomous optimization of life cycles, value chain integration & enterprise efficiency and flexibility
- Enabling of collaborative automation environments comprising both human and technology while maintaining security and functional safety under real-time conditions
- Enabling large systems featuring distributed big data to useful information transformation in collaborative environments.
- Tools, methodologies and technologies
- New digital manufacturing methods, equipment and tools powered by sensing, tracing, data acquisition, data processing and analytics and cloud
- Large flagship program with integrated R&D&I projects supporting product life cycle optimisation, value chain integration and manufacturing efficiency and flexibility – application independent and across domains

6.5.3 *Impact*

- Comprehensive ECS-and ICT-based solutions for Smart Production to maintain the European industry on complete digitalization of production fit for the global market.
- Large integrated R&D&I projects will enable strong standardisation and early adoption of new and efficient automation and production technologies in Europe.
- The cooperation along value and life cycle chains in large R&D&I efforts will support collaborative automation technology supporting strong integration within the complex network of stakeholders necessary for efficient and sustainable production.
- New disruptive production methods, technologies and services are enabled by novel electronics systems and their embedded software; these are exemplarily additive and subtractive manufacturing technologies for metal and plastics that are seamless integrated in the production chain and that are empowered by new design tools and the digital world.
- Production line availability, flexibility and controllability/traceability will be improved through increased automation and disruptive production technologies. Thus supporting European production to increase well above average and become globally more competitive.
- Large R&D&I activities like flagship programs could foster the building of new cross domain ecosystems especially with high SME-involvement.

6.5.4 Cross-References

- advancement in system design technologies, architectures and tools (design, engineering, test verification, deployment and operation),
- Integrating new CPS and smart system technologies like easy to integrate sensor systems, wireless high-speed communication ability, labelling technologies like RFID, standardized interface technologies and production data analytics.
- Critical success factors will be robustness to industrial production environments, interoperability, validation and standardisation, and last but not least security.
- Strategies, technology and methods used and under development for highly automated semiconductor manufacturing addressed in Essential Technologies Chapter 7.1: ‘Semiconductor Manufacturing, Technology, Equipment and Materials’, are directly connected with the challenges and opportunities addressed in this chapter.

6.5.5 Schedules/Roadmaps

- **Short-term** innovations expected relate to design technologies enabling the **introduction and migration of smart CPS** into production automation and new production technologies.
- **Mid-term** innovations are **industrially proven** production automation systems with integrated smart CPS. This includes maintenance thanks to real time large data collection.
- **Long-term** innovations are **collaborative automation** systems enabling radically increased OEE, production being an agile part of society regarding energy efficiency, sustainability and flexible production

❑7.1 Semiconductors manufacturing, technology , equipment and materials

- *7.1.1 Objectives*
- *7.1.2 Strategy*
- *7.1.3 Impact*
- *7.1.4 Cross references*
- *7.1.5 Schedules/Roadmaps*

7.1 Semiconductors manufacturing, technology , equipment and materials

7.1.1 Objectives

- Availability of **in-Europe manufacturing** is essential to supply Europe's electronic systems manufacturers with critical components.
- The **European manufacturing position must be reinforced** through leadership in processing know-how for all advanced technologies: advanced and beyond **CMOS** (More Moore, MM), **heterogeneous integration** (More than Moore, MtM) and **System in Package** (SiP).
- The complete European value chain in process technology, materials, equipment and manufacturing capability must be supported to **realize next generations of devices meeting the needs** expressed by the application roadmaps of Part A.
- **Pilot lines in MM, MtM and SiP** and supporting test beds are needed to accelerate the uptake of KETs and enable manufacturing. These Pilots should cover all essential aspects for short time-to-market (cost-efficiency, standards, test, etc.), including equipment development and manufacturing science.
- **Competitiveness of European semiconductor manufacturing must be increased through manufacturing science**. The well-concerted combination of activities will increase the attractiveness for private investment and talent with the goal to **keep skilled jobs in Europe and meeting the specific needs of European industry**.

7.1.2 Strategy

- **Promote the involvement of all actors in the value chain** of process technology, materials and equipment, with application specific partners or cross-links to application specific projects.
- **Complement Pilot Line projects (higher TRL) for the validation of new technologies and equipment** with manufacturing science (typically lower TRL), mastering cost competitive semiconductor manufacturing in Europe including packaging and assembly
- **More Moore manufacturing** will especially require innovative solutions to control the variability and reproducibility of leading-edge processes. A **Productivity Aware Design (PAD)** approach will focus on predictive maintenance, virtual metrology, factory simulation and scheduling, wafer handling automation and automated decision management.
- In addition attention should be given to **Control System Architecture**: **predictive yield modelling**, holistic risk and decision mastering (integrate control methods and tools and knowledge systems).
- **Well-focused projects in the TRL 2 to 4 are needed** as technology push enabling new applications. Extended projects will aim at Pilot lines with emphasis on TRL 4 to 8 delivering industry-compatible flexible and differentiating platforms for strategic demonstrations and for pushing manufacturing uptake.

7.1.3 Impact

- The European semiconductor ecosystem employs approximately 250,000 people directly and is at the core of innovation and competitiveness in all major sectors of the economy.
- ECSEL will help **doubling the economic value of the semiconductor production** in Europe by 2020-2025 23.
- The overall value chain of equipment, materials, system integration, applications and services employs over 2,500,000 people in Europe. By launching new process and equipment technologies based on innovative materials, designs and concepts into pilot-lines, **ECSEL projects will facilitate a strongly growing market share**, increase employment and investments for innovative equipment, materials and for manufacturing of semiconductor devices and systems through European leadership positions in MM, MtM and SiP.
- **Ensuring the continuation of competitive manufacturing in Europe supported by a high level of excellence in manufacturing science** and efficiency will enforce strong global industrial positions (security, automotive, aircraft manufacturing, power generation and medical/healthcare) and significantly contribute to safeguard our strategic independence in critical domains and secure tens of thousands of jobs directly or indirectly linked to the semiconductor manufacturing.

7.1.4 Cross-References

- Europe needs leadership throughout the value chain from process, materials and equipment to production of devices, systems and solutions and deployment of services to leverage Europe's strong differentiation potential and to drive its competitiveness.
- Semiconductor manufacturing and technology is strongly linked with the other Essential Technologies.
- Furthermore it is key to Europe’s strong global positions in all application domains (e.g. security, automotive, aircraft manufacturing, power generation and medical/healthcare industries).
- Therefore the key milestones and deliverables of projects on semiconductor manufacturing and technology will take into account the progress in the other key enabling technologies (B).
- The timely set-up of the pilot lines and platforms will enable the downstream projects in Key Applications for ‘Smart everything’, and should deliver timely and competitive solutions for the manufacturing of the chips and components required for these applications.
- This will allow the European industry to take the lead in various challenging multidisciplinary application domains.

❑7.2 Design Technologies

- *7.2.1 Objectives*
- *7.2.2 Strategy*
- *7.2.3 Impact*
- *7.2.4 Cross references*
- *7.2.5 Schedules/Roadmaps*

7.1.1 Objectives

- Effective design methods, tools and technologies are the way in which ideas and requirements are transformed into innovative, producible, and testable products, at whatever level in the value chain.
- They aim at increasing productivity, reducing development costs and time-to-market, in order to reach the level of targeted requirements such as quality, performance, cost and energy efficiency, safety, security, and reliability.

7.1.2 *Strategy*

1) **Technologies for Model-Based and Virtual Engineering**: aims at enabling the design of **complex smart systems** at **high abstraction**, providing tools, models and environments for verification and validation for the HW and SW architectures.
2) **Managing complexity, safety and security**: aims at developing **solutions** for managing the design of complex smart systems, starting **from specifications** and insuring **consistency along all the design chain**, including **HW and SW**, functional and non-functional property verification, validation and test.
3) **Managing diversity:** aims at the development of design technologies to enable the design of complex smart systems incorporating **heterogeneous devices** and functions, including **verification and validation for heterogeneous systems** towards functional and non-functional properties.
4) **Increasing yield, robustness and reliability**: aims at enabling the design of large systems that communicate with each other and involve multiple owners **optimizing the characteristics of yield, reliability and robustness of the final products .**

These challenges are considered as high priority for the presently required increase of **design efficiency, design ability and the respective competitiveness improvement**. It is therefore recommended that a balance in the activities on low- and high TRL activities should be sought.

7.1.3 Impact

- development of systems and products (incl. services) which are several times more powerful – and, from a design perspective, thus several times more complex – than the current ones and needed to solve existing societal problems without increasing development costs.
- On system level, increase of complexity handling by 100%, design effort reduction by 20%, reduced cost and cycle time of product/system design of up to 50%, while improving design and development efficiency as well as validation speed will lead to improved product and service quality.
- On a larger scale, systems are evolving from single-owner designs to larger systems or even systems-of-systems, which communicate with each other, using internet or similar media, produced by multiple companies. Effective design methods and technologies will cope with this paradigm shift and will allow for larger market share, higher competitiveness of European industry in all application sectors addressed by the MASRIA and contributing to increase employment in Europe.

7.1.4 Cross-References

Challenges	Technologies	Applications: Smart Mobility	Smart Societies	Smart Energy	Smart Health	Smart Production	Semiconductor Process, Equipment & Materials	Cyber Physical Systems	Systems Integration
Technologies for Model-Based and Virtual Engineering	Modelling of devices and components						X		X
	Virtual Platforms and Simulation of ECS	X	X	X	X	X		X	X
	Model based design of ECS	X	X	X	X	X		X	X
	Extendable and evolvable Systems	X	X	X	X	X		X	X
	Human Aspects	X	X	(X)	X	X		(X)	X
Managing complexity, safety and security	Verification and validation methodology and tools for complex, safe and secure ECS. (V&V of ECS)	X	X	X	X	X		X	X
	(Incremental) Certification	X		X	(X)	(X)		X	X
	Monitoring and Diagnosis	X	X	X	X	X	(X)	X	X
	Runtime Support								
Managing diversity	Multi-objective Optimization	X	X	X	X	X	X	X	X
	Multi-dimensional specification and modelling	X	X	X	X	X	X	X	X
	Eco-System for PMT for the cost efficient design, analysis and test of safe and secure ECS	X	(X)	X	X	X	(X)	X	X
	Connection of Digital and Physical World	X	X	X	X	X	X	X	X
Increasing yield, robustness and reliability	Integrating Analog and Digital Designs and Design Methods	X	X	X	X	X	X	X	X
	ultra-low power design		X	X	X	X	X	X	X
	Efficient methodologies for reliability and robustness in highly complex systems including modelling, test and analysis, considering variability and degradation effects	X	X	X	X	X	X	X	X

7.2 Design Technologies

7.1.5 Schedules/Roadmaps

1. Technologies for Model-Based and "Virtual Engineering"

#	Topic \ Time (year of prog. call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
1. Technologies for Model-Based and Virtual Engineering					
1.1	**Modelling of devices and components**	Appropriate models of devices, components, modules and subsystems, covering several operational conditions.		Further topics should be filled in by device/component modelling expert	
1.2	**Virtual Platforms and Simulation of ECS**	Feature and model based system simulation for easier integration.	Virtual engineering of ECS and its subsystems and components on HW and SW level.		Model-based engineering test methodologies for complex systems in rapidly changing environments.
		Virtual platform in the loop: Enabling the efficient combination of model-based design and virtual platform based verification.		Virtual prototyping of complex systems involving the interconnection of up to thousands of components.	Virtual prototyping of complex systems involving the interconnection of up to thousands of components , with debug capabilities.
		Efficient virtual platforms (simulation of the embedded target platform on a simulation host faster than the target platform) for early software integration and testing. (simulation speed in virtual prototyping)		Reuse: Component based design for components and subsystems	Reuse: Component based design for complete products, product line designs, SW blocks, digital, analog IP, subsystem, and standards for the efficient integration in order to improve productivity of platform integrator.
		Virtual prototype providing view of SMP and cache-coherent architectures HW & SW jointly	Virtual prototype support for debug of SW/HW co-design for SMP and cache-coherent archtiectures		Virtual prototype support for automation of SW/HW codesign for SMP and cache-coherent architectures
1.3	**Model based design of ECS**	Interoperability standards (development Tools, Reference Technology Platform); re-use of legacy knowledge	Tools and methods for assuring back-traceability.		Seamless model based design and development processes, including for safety critical systems with constraint-driven design methodology
		Efficient Methods and Tools for modelling and simulation based on interoperability standards (including Reference Technology Platform and knowledge re-use)	Seamless modelling of functional blocks / units		Provide complete interoperable tool-chains for Model-Based Design.
1.4	**Extendable and evolvable Systems**	Basic structures and elements for extendable systems	Monitoring of open systems	Design methods and tools to meet requirements to real-time, high availability and safety of open systems including monitoring techniques	
		Update and evolution strategies, including self learning and adaptation.	Update and evolution strategies for open systems, including self learning and adaptation		Life cycle management for innovative (esp. ECS based) products.

7.1.5 *Schedules/Roadmaps*

2. Managing Complexity, Safety , and Security

#	Topic \ Time (year of prog. call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
2. Managing complexity, safety and security					
2.1	**Verification and validation methodology and tools for complex, safe and secure ECS (V&V of ECS)**	Modelling enabling extended verification and validation (including coverage) of heterogeneous systems, starting from specification and higher abstraction levels	Extended verification coverage: functional, non-functional; use cases, virtual prototyping, links between HW and SW design, automatic test design and reduction, ECS supported system integration and validation.		V&V methods and tools for Life-Cycle and in-service phase: Adaptation/Upgrades/ Evolvability/Maintainability
		SW development tools and debug environment for verification and validation of the HW and SW ECS architectures and their applications		Extended verification methods: (functional, non-functional, …) supporting quality metrics	Specific compliance standards; considering non-functional requirements with respect to their impact on functionality
		Extended verification and validation, including coverage for heterogeneous systems towards functional and non-functional properties; use cases - virtual prototyping and its link to test.		Faster simulators to handle complex circuits and large number of influencing parameters (especially non-functional properties like power, temperature, and degradation) as well as methods to handle non-uniform distributions.	Handling mixed criticality as it shows up in automotive where safety critical and entertainment components interact (e.g. display);
2.2	**(Incremental) Certification**	Enable modeling of safety and security requirements in early design steps to get certification approval and enable incremental certification.		Design methods and tools for safety and security	Design for compliance for safety and/or security critical applications (e.g. ISO 26262, EAL6+);
		Safety and Security Co-Engineering (Modelling, Dependencies, Analysis)	Consistent design and tool chain for automated transfer of system level design into functional blocks and given HW/SW blocks with inclusion of design checking.		Certified models transformation engines and rules
		Concept of certified design flows	Complete design tool-chains and methods supporting long term archiving needs and standards		Support for long term archiving needs, standards, and back traceability management
2.3	**Monitoring and Diagnosis**	Monitoring, prediction and diagnosis methods and tools	Normalization for testability and diagnosis efficiency metrics.		Monitoring, prediction and diagnosis in real-time
2.4	**Runtime System Support**	Support for OS virtualization methods and tools			

7.1.5 *Schedules/Roadmaps*

3. Managing Diversity

3. Managing diversity					
3.1	**Multi-objective Optimization**	Constraint-driven, easy integration of SW, analog/RF, power devices, sensors, actuators and MEMS at system and component levels multi-dimensional optimisations		Cross-Domain Analysis, V&V, Simulation, Testing Methods (incl. Standards for...)	Manage various constraints (electrical, thermal, mechanical, etc.) over the whole design flow
		Full integration of SW-development process, analog/RF, power devices and sensors/ MEMS in system design flows.		Consistent and complete co-design of IC, SiP, PCB, subsystems, incl. mechatronics and their interfaces.	Cross domains optimization, cross engineering domains across supply chain
		New design technologies to reflect multidimensional optimisation and coupled performances.	3D-Design: improvements to manage systems implemented along the supply chain	Methods and tools to exploit the benefits provided by emerging HW technologies and devices, as well as new SW design tools and methods, including e.g. those incorporating the notion of time in the code.	
3.2	**Multi-dimensional specification and modelling**	Enable specifications for the affected class of systems including the handling of engineering requirements, mission profiles, use cases, architectural design, executable specifications to be consistent with all design domains, including HW and SW design, applications, functional property verification on HW and SW, validation and test.		Capture of specifications and use cases covering not only the functionality of the system, but also its performance, timing, and non-functional properties such as power, temperature, robustness, environmental conditions	Seamless design flow defining standards and models for multi technologies and reuse.
3.3	**Eco-System for processes, methods and tools for the cost efficient design, analysis and test of safe and secure ECS based on Standards, including the whole value chain**	Create Eco-Systems for the design of safety critical complex and/or distributed systems (ECS)	Design Eco-System based on standards: common methodology for functional and non-functional properties for system integration and validation; open for all partners		Design Eco-Systems based on standards extended to heterogeneous components and reliability, yield and robustness.
3.4	**Connection of Digital and Physical World**	Integration of environment modelling and simulation into the HW and SW design flow.	Integrated multi-physical - logical simulation: Simulation of (digital) functional and physical effects, extending classical simulations to multi-physics simulations		Connection of virtual prototyping and physical world (including complex environment models) in complex validation environments

7.1.5 Schedules/Roadmaps

4. Increasing Yield, Robustness and Reliability

4. Increasing yield, robustness and reliability					
4.1	**Integrating analog and digital designs and design methods**	Metric method for testability and diagnosis efficiency in particular for AMS verification, validation and test		Harmonsation of analog and digital design and verification tools and methods to come to a common design and verification environment.	Easy re-use of analog IP in system context; efficient machine to integrate analog and digital design flows
4.2	**Ultra-low power design**	Ultra-low-power: novel design flows for hardware design and efficient software for low-power autarkic systems.	Ultra-low-power: novel design flows for hardware design and efficient software for low-power autarkic systems with energy scavenging	Ultra-low-power: novel design flows for hardware design and efficient software for low-power autarkic systems with energy scavenging capabilities or extremely long battery power lifetime (including the design process covering power supply)	
4.3	**Efficient methodologies for reliability and robustness in highly complex systems including modelling, test and analysis, considering variability and degradation effects**	Improved handling of special critical aspects like ESD, EOS, latch-up, EMC, electro-migration, thermal and mechanical stress at SoC and system levels;	Improved handling of special critical aspects like ESD, EOS, latch-up, EMC, electro-migration, thermal and mechanical stress at SoC and system levels along the value chain		Automated tools for testability metrics in particular for measuring yield loss and test escape
		Efficient management of the design for test (DFT), design for yield (DFY), design for reliability (DfR), and design for variability (DFV), from IP/subsystems up to full SoC.		Consistent analysis, modelling, and descriptions/formats for reliability at all levels of abstraction.	Design and development of error robust circuits and systems;
		Appropriate models of subsystems, covering several operational conditions.	Consistent methodologies and new approaches for reliability and robustness for each component: hardware (HW), OS, and application software (SW), but also in conjunction to each other.		Avoidance, recognition and handling of errors at physical, logical, block, SW, and application levels
		HW/SW sign-off for reliability and robustness at block and system levels. Target is to achieve this for HW/SW at the same time.		Models with variability, reliability and robustness information including degradation effects.	Automated tools for testability and diagnosis efficiency metrics in particular for measuring yield loss and test escape.
		Design for yield (DFY) and litho friendly design (LfD);	Real time monitoring of lifetime behaviour and implementation of control mechanisms	Reliability, yield, and robustness fully integrated in Design Eco-Systems including appropriate interoperable design tool chains in order to enable reduced design cycles even with increasing complexity.	

❑7.3 Cyber-Physical Systems

- *7.3.1 Objectives*
- *7.3.2 Strategy*
- *7.3.3 Impact*
- *7.3.4 Cross references*
- *7.3.5 Schedules/Roadmaps*

7.3.1 Objectives

- Cyber-Physical Systems definition

  Cyber-Physical Systems (CPS) are Electronic Systems, Components and Software that are tightly interacting with Physical Systems: their embedded intelligence provides capabilities to monitor, analyse and control physical components and processes in various applications. Their ability to connect, through all kinds of networks (including the Internet, wired, wireless communications), allows them to collaborate, to coordinate and optimize high-level functionalities. They offer exponentially growing opportunities for many application sectors and businesses.

- The objectives
  - Overcome Fragmentation in both Research and Innovation
  - Exploit the growing potential of the **'Internet Economy'**[1] and **'Always Connected society'** as CPS are the 'Things' of the Internet'
  - Master the complexity while reducing the cost
  - Provide dependable solution: high level of trust, confidence and privacy.
  - Provide support for Standardisation, but also for education and training.

7.3.2 *Strategy*

- Cross domain sharing of technologies and of research
- Virtual Vertical Integration
  - Emergence of vertical ecosystems, platform developments, standards , complementarity of actors and solutions, scalability, and interoperability
- A programme Approach with emphasis on development of interoperable platforms
  - Focused projects : RIA and IA
  - Flagship projects encompassing user's concerns

- Strategy implementation : three strategic axis
  - Architectures, principles and models for dependable CPS
  - Autonomous, adaptive and cooperative CPS
  - Distributed Computing Platforms (including HW, SW and Communication) to address major challenges (energy, efficiency, dependability, edge-computing, HPC, SoS,..)

7.3.3 Impact

- Drive innovation to cope with the ‘new digital transformation’ of Europe leading to Virtual Verticalisation of European Industry.

  - **Increased and efficient connectivity and ubiquity** of CPS as the neural system if society.
  - **Increased efficiency of use of resources** (energy, materials, manufacturing time)
  - **Mastering complexity** while reducing the cost, the power consumption, and increase the performance, reliability and security to greater market opportunities
  - **Create knowledge through development of new designs**, V&V&T for various application domains in multiple time-scales
  - **Enable continuous evolution and innovation** and facilitate smooth transition an **integration with legacy systems**.

7.3.4 Cross-References

- Societal Challenges are the key drivers for innovation in CPS, particularly for ECSEL thrusts described in Part A chapters.

  In ECSEL contexts :
  - Smart Mobility,
  - Smart Societies (security features developed in this chapter)
  - Smart Energy,
  - Smart Health,
  - Smart Production.

- CPS chapter is tightly connected to the “Design technologies” chapter as tools for modeling, simulation….etc.. are essential for mastering the development of complex Cyber Physical Systems.

- CPS also leverages the essential capabilities:
  - Semiconductor Process, Equipment and Materials,
  - System Integration.

7.3.5 Schedules/Roadmaps

1	**Architectures principles and Models for safe and Secure CPS**	**Short Term**	**Medium Term**	**longer Term**
1.1	**Virtual Verticality** Standardization activities: Interoperability, scalability, variability management, each system being a brick for a larger system			
1.2	System of Systems Methodology Global simulation environment, design space exploration, verification methods			
1.3	Reference Architectures (HW, SW, Communication) Multi domain reference architecture			
1.4	Dependability by design and enabling certification Mixed criticality- dependability of open systems			
1.5	Answering to the fundamental challenges in CPS design			
1.6	Social acceptability of CPS			
2	**Autonomous, adaptive and cooperative CPS**	**Short Term**	**Medium Term**	**Longer Term**
2.1	Safe and Robust environmental perception of environment Dealing with complexity – integrating new approaches			
2.2	Evolving, continuously adapting systems through learning and adaptive behaviour of application platform			
2.3	Optimal control using autonomous CPS Efficient use of resources for Self-x capabilities			
2.4	Reliable and trustable decision making and planning Dynamically evolving SoS			
2.5	Cooperation With humans, enhancing Human-in-the loop - Data analytics			
2.6	Advanced methods for V&V&Q&C Of autonomous, adaptive and cooperative systems			
3	**Computing Platforms**	**Short Term**	**Medium Term**	**Longer Term**
3.1	Energy efficiency By all possible means			
3.2	Ensuring Quality of the Service (QoS) In real time context			
3.3	Decreasing global cost			
3.4	Edge Computing computing capabilities shared/exist outside the physical device and in the 'Cloud'			

❑7.4 Smart Systems Integration

- *7.3.1 Objectives*
- *7.3.2 Strategy*
- *7.3.3 Impact*
- *7.3.4 Cross references*
- *7.3.5 Schedules/Roadmaps*

7.4.1 *Objectives*

- Consolidate and extend the world leadership of European Smart Systems companies.
- Provide, by Smart Systems, the necessary functionalities in order to maintain and to improve competitiveness of European industry in the application domains of ECSEL.

7.4.2 Strategy

- Funding instruments shall focus …
- … on Smart Systems, including the necessary key components and their development.
- … on the integration of the Smart Systems in their environment.

- Types of projects envisaged:
  - R&D projects of TRL between 2 and 5
  - Large scale innovation projects of TRL between 4 and 8
  - Pilot lines and flagship projects to provide SSI solutions up to industrial usage.

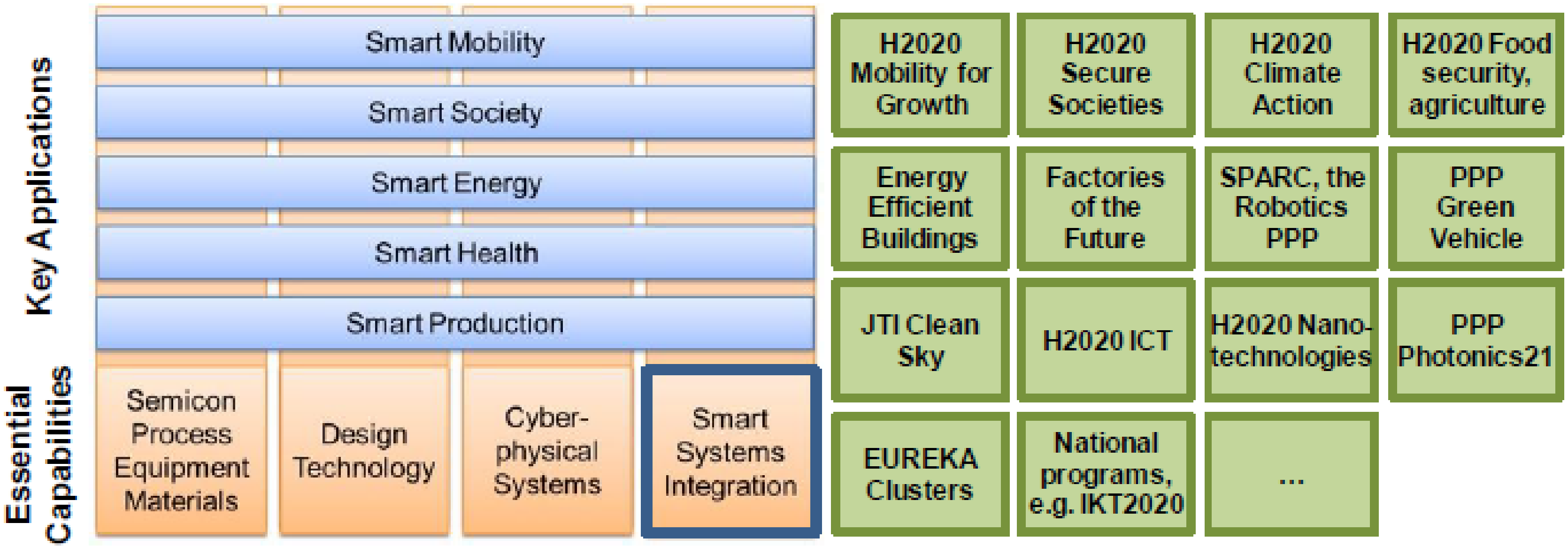
7.4.3 Impact

- Smart Systems Integration … … further strengthens European leadership
- … increases global market share of European companies
- … enables higher levels of integration
- … decreases size and costs of products
- … accelerates time to market

- Some EU facts (2012): 6,000 companies in the EU on Smart Systems
- approx. 827,600 employees
- 8% of the employees (66,200 people) in R&D
- R&D budget of 9.6 B€ per year

7.4.4 *Cross-References*

- The field of SSI draws upon key enabling technologies (KET) and integrates knowledge from a variety of disciplines.



7.4.5 Schedules/Roadmaps

#	Topic \ Time (year of program call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
1. Building blocks of Smart Systems (sensors, actuators, controls and interfaces)					
SSI generation milestones	*M1.1: Short-term activities on smart systems*				
	M1.2: Mid-term activities on smart systems				
	M1.3: Long-term activities on smart systems				
1.1	MEMS and other physical, chemical and biological sensors and systems				
1.2	Effective and efficient mechanical, piezoelectric, electrostatic, electromagnetic, inductive, pneumatic, thermal, optical, chemical, biological and other actuators				
1.3	Modular and highly integrated schemes of power control and actuation				
1.4	Electrical, thermal, mechanical and biological energy management				
1.5	Energy generation and scavenging				
1.6	Digital light, photonics and micro-optics				
1.7	Power electronic inverters/converters and components for high-density energy storage				
1.8	Suitable and tailored structural, electronic, magnetic, piezoelectric, active, fluidic, biocompatible and other materials (for harsh environments)				
1.9	Wide band gap materials for power conversion as well as electro-active polymers and metal organic				
1.10	Building blocks for advanced security functions, e.g. physical unclonable functions				
1.11	Technologies for mechanical, electrical, optical, chemical, and biological interfacing and transmitters and receivers for the transfer of energy and data				

7.4.5 Schedules/Roadmaps

#	Topic \ Time (year of program call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
2. Safe, secure and efficient transfer of information and power					
2.1	Technologies for intelligent wired and wireless interconnection				
2.2	Body area networks				
2.3	Fast, compact, energy efficient, fail-safe and secure wireless communication systems for energy and data and technologies therefor				
2.4	Standardisation of machine to machine interfaces – both data and physical				
2.5	Strategies and technologies for the smart management of electric energy				
2.6	Technologies for energy generation, harvesting and storage				
2.7	Technologies for energy transfer such as wireless charging and seamless power supply				
2.8	Advanced solutions for thermal management				
2.9	Powerful computational and mathematical methods for signal processing, data analysis, data fusion, data storage and data communication				
2.10	Hardware based data fusion methods				
2.11	Dynamic, adaptive and cognitive data processing and methods for cognitive cooperation				
2.12	Dynamic integration of systems or nomadic devices in swarms				
2.13	Research on interfacing, networking and cooperation to enable distributed applications				
2.14	Technologies for mechanical, electrical, optical, chemical, and biological interfacing				
2.15	Advanced intuitive man-machine interfaces and technologies therefor				
2.16	Secure data interfaces for the integration into the Internet of Things				
2.17	Safe and secure HW/SW platforms including privacy and security management				

7.4.5 *Schedules/Roadmaps*

#	Topic \ Time (year of program call)	2016	2017 - 2018	2019 - 2020	2021 - 2030
3. Integration methods enabling smart functionality, automation and reliable operation in harsh and complex environments					
3.1	Multi-physics and multi-scale modelling and simulation methods for components, systems, data and communication channels				
3.2	Certification standards as well as design rules and testing and inspection methods				
3.3	Innovative manufacturing processes for top-down as well as bottom-up fabrication				
3.4	Methods and materials (metals, ceramics, polymers etc.) for system-level interconnection				
3.5	Methods for the physical system integration in-package, on-chip, on-surface, inside printed-circuits, on-tag, in-fabric, or on-PCB for systems				
3.6	Advanced (additive) manufacturing equipment and new integration methods on unusual substrates such as, for example, garments, construction materials or building structures				
3.7	Technologies for smart adaptation, self-testing, self-learning and self-healing at system level				

In Conclusion …..

The MASRIA opens a wide range of opportunities to inspire and generate a world class projects

Thank you for your attention