EPoSS
European Technology Platform on Smart Systems Integration

Strategic Research Agenda (SRA) on Smart Systems Integration

A Brief Overview

7 years into the future

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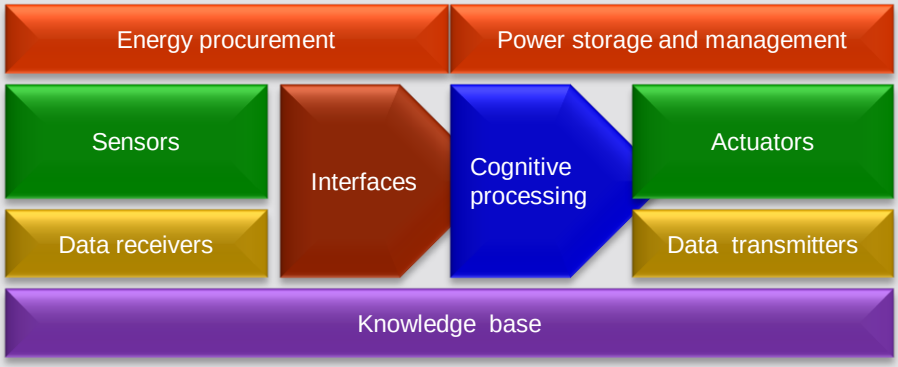
- 2020 is 7 years from now
- 2006 was 7 years ago
- There was no i-Phone (introduced June ’07)
- Nintendo Wii arrived in November ’06
- The future becomes history very quickly

...what is this “Smartness” and where is it taking us?

Anatomy of a Smart System

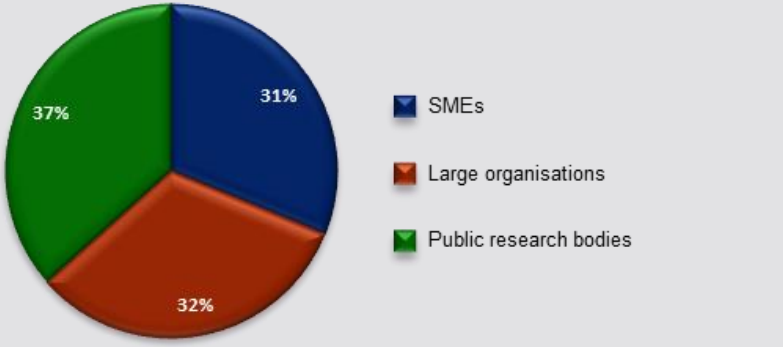


They are truly *interactive systems*

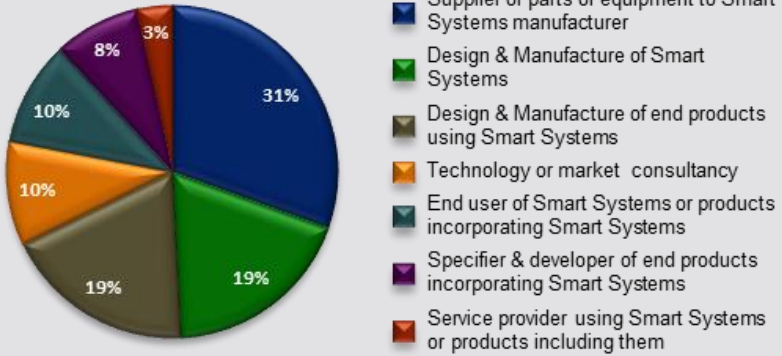
- Smart Systems are autonomous or collaborative systems
- They bring together sensing, actuation, informatics and communications
- They detect / evaluate / predict / respond:
  - to help users or other systems perform a role

SRA Methodology

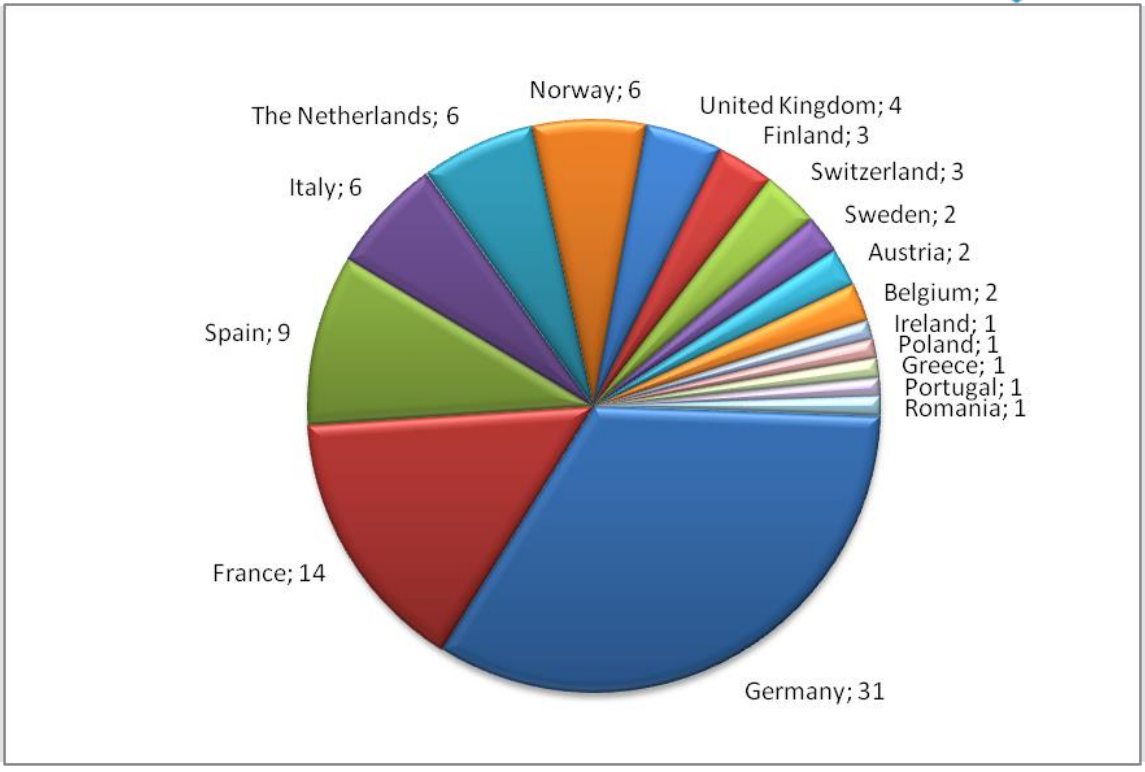
1. The IRISS structured survey of 93 contributors:



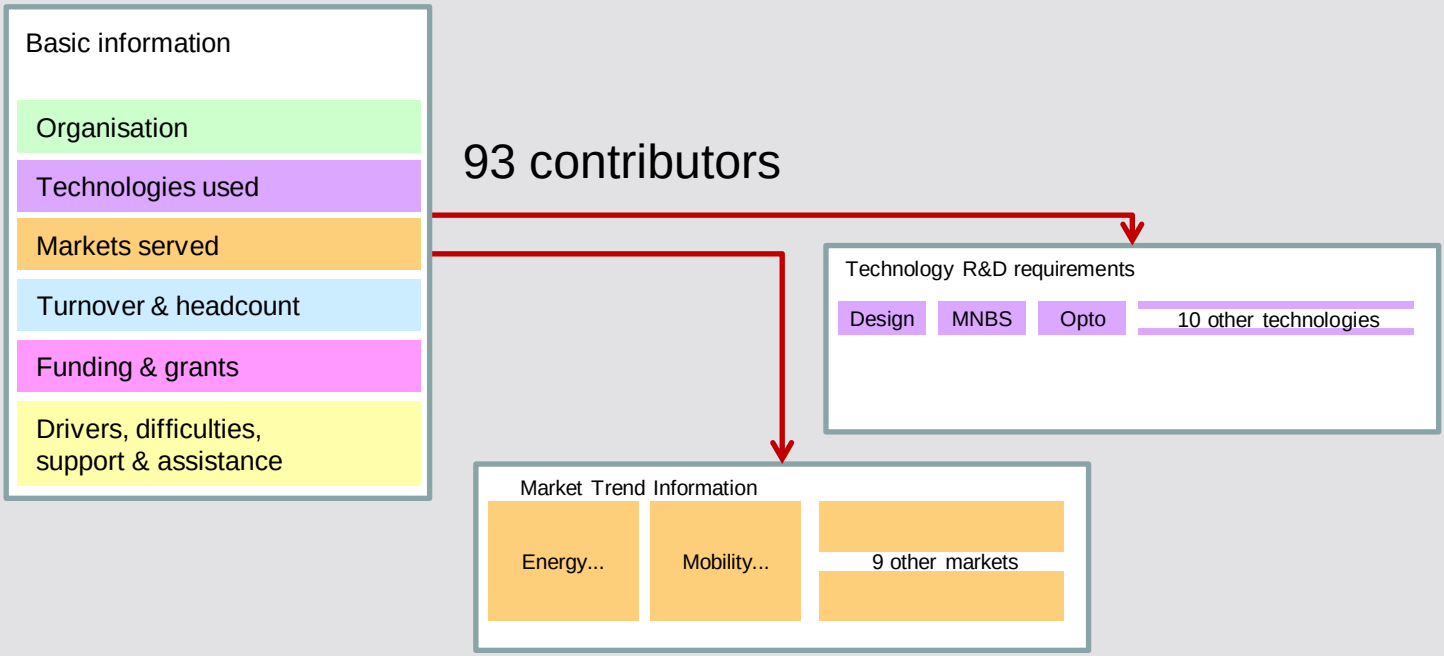
2. Stakeholder workshop for data validation and condensation.
3. Ten structured expert discussion workshops seeded by the data from Step 2.
4. Outcomes from expert workshops prepared by specialist chapter authors.



Country spread of contributors



Survey structure



SRA Content:
Sectors and Sub-Sectors

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Transport & Mobility	Health & Beyond	Manufacturing / Factory automation	Communi-cations & RFID	Energy	Aerospace	Environment
Automotive	Diagnosis & Monitoring	Manufacturing equipment	Optical	Lighting	Avionics & Control systems	Pollution control
Mass transit	Treatment & Surgical	Process control	Wireless	Fossil-fuelled generation	Navigation & Guidance	Built & Ambient environment
Navigation	In Vitro processes	Robotics / Factory automation	Personal & Mobile	Oil & Gas exploration	Health & Usage Monitoring Systems	Weather & Climate
Infrastructure & Signalling	Implants	Prototyping equipment	RFID & Internet of Things	Nuclear	Remote Sensing	Recycling & Reuse
	Telemedicine	Test & Inspection		Renewables		
				Distribution, Storage & Use		

Per Sector:
- Sector-wide discussion & charts

Per Sub-Sector:
- Timeline
- Impact
- SWOT
- Eisenhower-Matrix

SRA Content:
Technologies and Production Processes

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Technologies

Design & Simulation	Large area sensors / actuators
Micro-Nano-Bio-Systems	Multifunctional materials
MEMS, MOEMS, microfluidics	Energy management & scavenging
Semiconductors & More-than-Moore technologies	Opto/organic/bio data processing
Microsensors, Microactuators	Adaptive surfaces
Combinational sensing	Machine cognition & Human Machine Interfaces

Per Topic:
- Topic-wide discussion & charts

Per Technology:
- Timeline
- Impact
- SWOT
- Eisenhower-Matrix

Production Processes

Etching & Lithography	Deposition & Coating
Printing & Nanoprinting	Encapsulation
Micromachining, Forming & Handling	Direct manufacturing & Rapid prototyping
Microjoining & Bonding	Test & Inspection
Moulding & Micromoulding	Repair & Recycling

Per Topic:
- Topic-wide discussion & charts

Per Technology:
- Timeline
- Impact
- SWOT
- Eisenhower-Matrix

SRA Content and its Multiple Roles

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- A clear statement of technology and market categories
- A record of questions, barriers, difficulties and opportunities
- A checklist with *timescales and forecasts* for researchers and strategists in SMEs, Large Companies and RTOs
- A discussion paper to support dialogues with government, funding and regulatory bodies
- *Above all, a reference document upon which to base action*

SRA Format: Scale

Sector overview & narrative discussion

EU SWOT analyses & Research Priorities

Subsector Roadmaps, Timelines & Prospects

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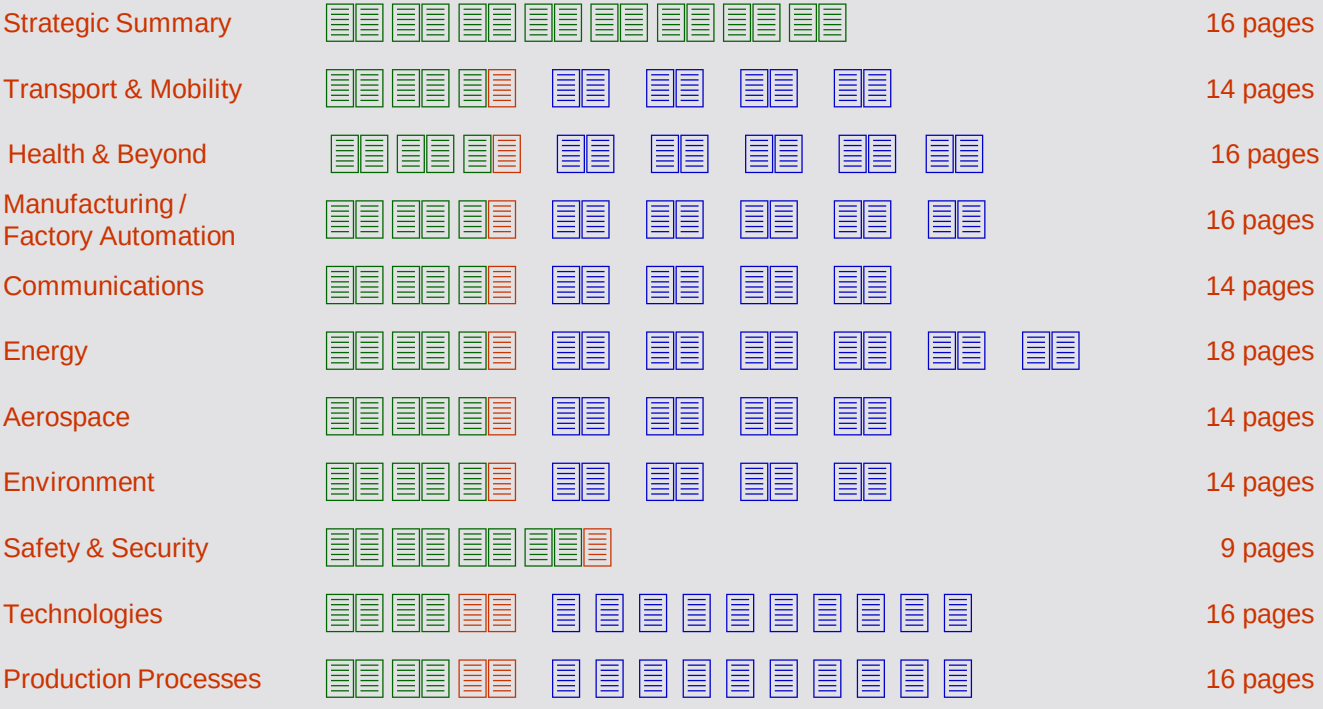

SRA Format: Implementation

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- Designed as a Webpage:

  www.smart-systems-integration.org

- Easy to access
- Easy to distribute
- “Multi-dimensional” visualisation
- Easy to navigate and explore
- Easy to update

Adapting the SRA Presentation

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- In the next section the Transport & Mobility sector and Automotive sub-sector are given as an example
- This may be substituted for another sector and sub-sector with higher relevance to local economy
- Go through description and high-light most relevant entries in SWOT and Eisenhower matrices
- Use as basis for elaborating regional actions

Example of Sector analysis

Overview of *Smart Systems for Transport & Mobility*

Introduction

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- The Transport & Mobility SRA chapter comprises an overview, then details of 4 subsectors
  - Automotive
  - Mass Transit
  - Navigation
  - Infrastructure & Signaling

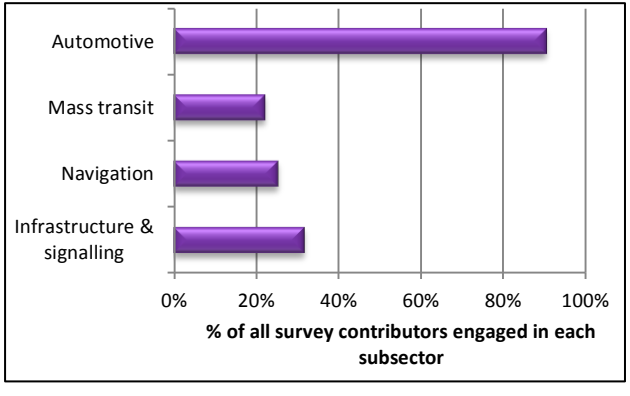
- Today I will show you excerpts from the overview and one of the subsectors: Automotive

Smart Systems for Transport & Mobility

Overview

All forms of transport and their necessary infrastructure are continually demanding increasing levels of safety, efficiency and environmental performance.

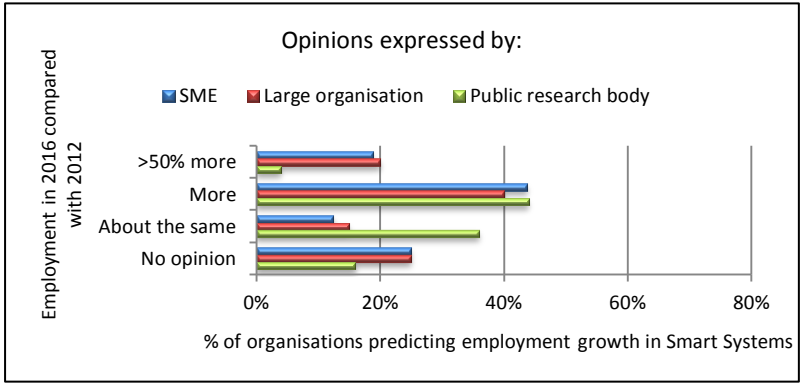
Smart Systems, with their in-built knowledge base, offer reduced operator distraction and error, and optimisation of vehicle control, navigation and logistics potentially across multiple modes of transportation.



Profile

63 Smart Systems providers representing the Transport & Mobility supply chain from research through to market servers were predominantly engaged in the automotive sector (illustrated left).

Instruments such as the EU Green Car Initiative have attracted the attention of Smart Systems providers and users. This activity needs to migrate to other aspects of transportation.



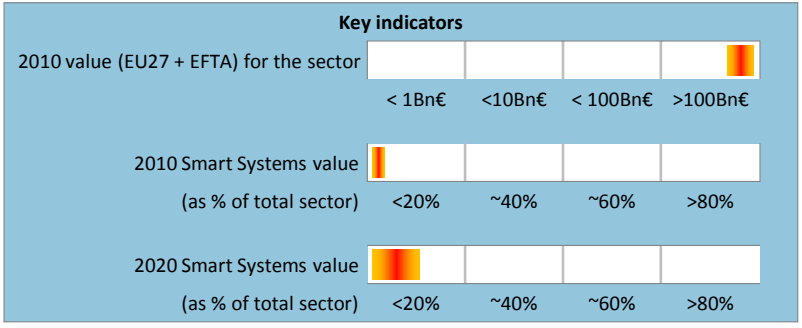
Growth prospects: Organisations

Of the 63 Smart Systems providers surveyed, the great majority forecast employment growth, with a significant proportion of companies predicting headcount increasing by more than 50% by 2016 (illustrated left). There were no predictions of reductions in headcount

A similar picture emerged for growth in financial terms.

Growth prospects: Whole sector

The Transport sector in EU27 is immense in value (>640 Bn€). The sector represents ~ 22% of worldwide production and R&D investments are ~5% of turnover (>26 Bn€). Currently Smart Systems account for possibly ~1% of this, but could rise to ~10% (>60 Bn€) by 2020 by greater adoption of sensor networks in the automotive subsector, smart devices for navigation, and seamless multimode transportation.



The indicators above are shaded to reflect uncertainty

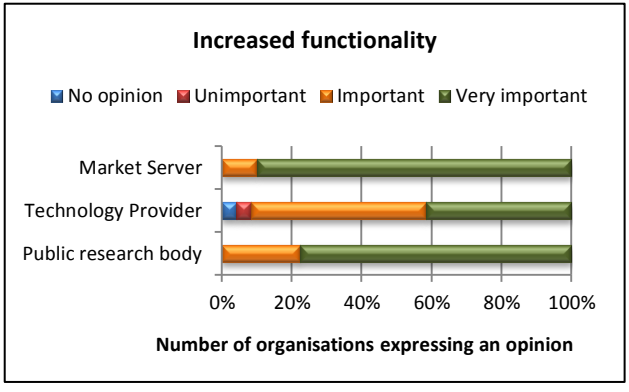
Drivers and barriers

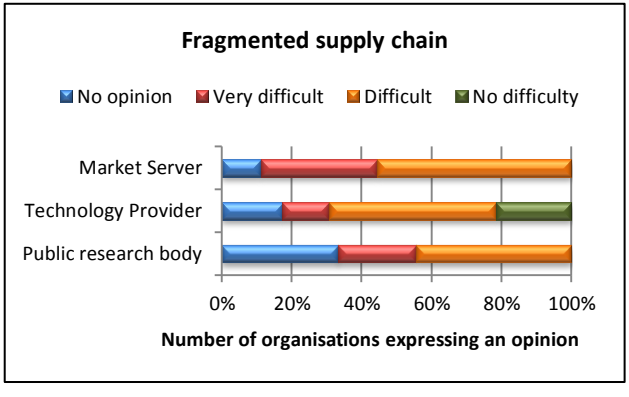
The survey of 63 Smart Systems providers to the Transport & Mobility sector rated "Increased Functionality" as the most important driver compared to, in descending order, Reduced Cost, Increased Reliability, New Markets, Global Competitiveness, Simplicity in Use, and legislative drives to compel the use of new devices or techniques.

The most obstructive difficulty reported was "Fragmented supply chain", responses indicating also that some 30% of public research bodies had no opinion about supply chain matters.

Accordingly, action should be considered to:

- *Encourage researchers to gain better understanding of the Smart Systems supply chain to achieve a better match between research approaches and manufacturing capability*





The sector and its subsectors

There is a sort of “red wire" which links Mobility and the other aspects of transportation, including Mass transit, Navigation and Infrastructure & Signalling. In fact they share some global trends such as:

- *Improved connectivity (e.g. IoT)*
- *System availability and exceptional quality levels*
- *Eco-sustainability and progressive shift towards “electrification”*

With particular respect to the “electrification, as it is very often confused with EV technology only, it is worthy to notice that it will be pervasive through the massive introduction of e-actuators and x-by-wire technology on a very wide range of applications. In fact, in the coming years several millions of vehicles, ranging from 2 wheels up to busses, trucks and agricultural machines, will feature a wide range of e-systems which will be “smart” by nature.

“Young man, that’s the thing: you have it. Keep at it. Electric cars must keep near to power stations. The storage battery is too heavy. Steam cars don’t do either for they have to keep a boiler and a fire. Your car is self contained – carries its own power plant – no fire, no boiler, no smoke and no steam”.

Thomas A. Edison to Henry Ford, Aug. 1896

e-car, e-bike, e-dozer, e-tractor, e-bus, e-truck, e-copter, e-car, e-bike, e-dozer, e-tractor, e-bus, e-truck, e-copter, e-car, e-bike, e-dozer, e-tractor, e-bus, e-truck, e-copter, e-car, e-bike, e-dozer, e-tractor, e-bus, e-truck, e-copter, e-car, e-bike, e-dozer, e-tractor, e-bus, e-truck, e-copter, e-car, e-bike, e-dozer

Example Subsector: Automotive

Automotive

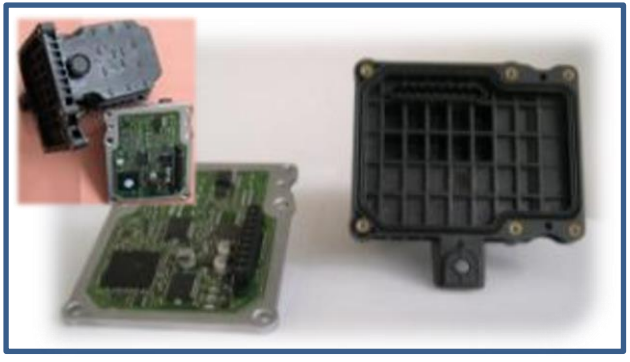
Overview

Smart systems affect every aspect of the automotive sector. A great number of sensors, actuators and processors are already in place in today's cars, so there is a ready opportunity to install "smartness".

The long term vision of autonomous vehicles rests with building a reliable set of images to describe precisely both the internal and external "state-of-functions". A huge amount of information must be processed in real time in order to provide a coherent picture. At the same time the vehicle will be integrated into the Transport & Mobility infrastructure and thus will interact into a much larger eco-system.

Opportunities for Smart Systems

- Much intelligence is integrated already, in all vehicles, but is particularly at the heart of the EV
- Optimise driver decision making and navigation.
- Health and Usage monitoring
- Real-time sensor fusion and virtual sensor creation
- Smart "shells" the design and implementation of an intelligent environment for occupants



Courtesy of Magneti Marelli – Selespeed (Robotized gear-box Control Unit

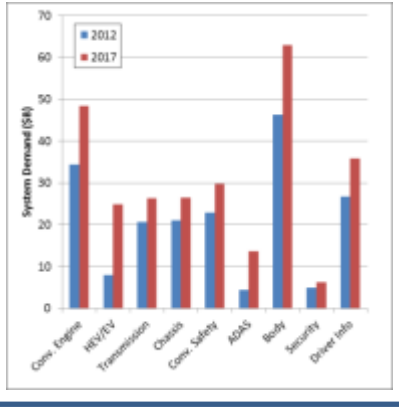
Hurdles to be overcome

- Re-inventing architectures – simplifying, localising in actuators, distributing. Trade-off from local to remote.
- Real time processing performance and a multi-core platform
- Affordable solutions for safety relevant applications
- Consumer Electronics and Cyberspace interact with Automotive

Applications

According to some in depth analysis (“Smart Connectivity: Connected Automotive Systems” B. Bihr, President Bosch Engineering GmbH, June 2012) there will be about 7 Bn connected people and about 1 Bn licensed connected vehicles worldwide by 2015. Moreover, due to the capability of HEV/EV to manage electrical energy on-board, it will become natural to consider the vehicle as a user/producer of electrical energy. As a result the vehicle will interact in the Internet of Things (IoT) and Internet of Energy (IoE). Hence, there will be important opportunities for Smart Systems both in consolidated (e.g. pwt, chassis, body,..) and new domains:

- *Smart cluster for driver assistance*
- *Safety*
- *Optimise range, performance, comfort*
- *Smart e-actuators*



Source: Strategy Analytics Data Jan 2013

Introduction of three classes of Smart Systems

The three classes below do not necessarily succeed each other in time: the nomenclature “generation” indicates increasing levels of “smartness” and autonomy.

1st generation Smart Systems include sensing and/or actuation as well as signal processing to enable actions.

Currently there is wide application of algorithms in automotive emissions, fuel injection and combustion. Further applications are appearing continuously

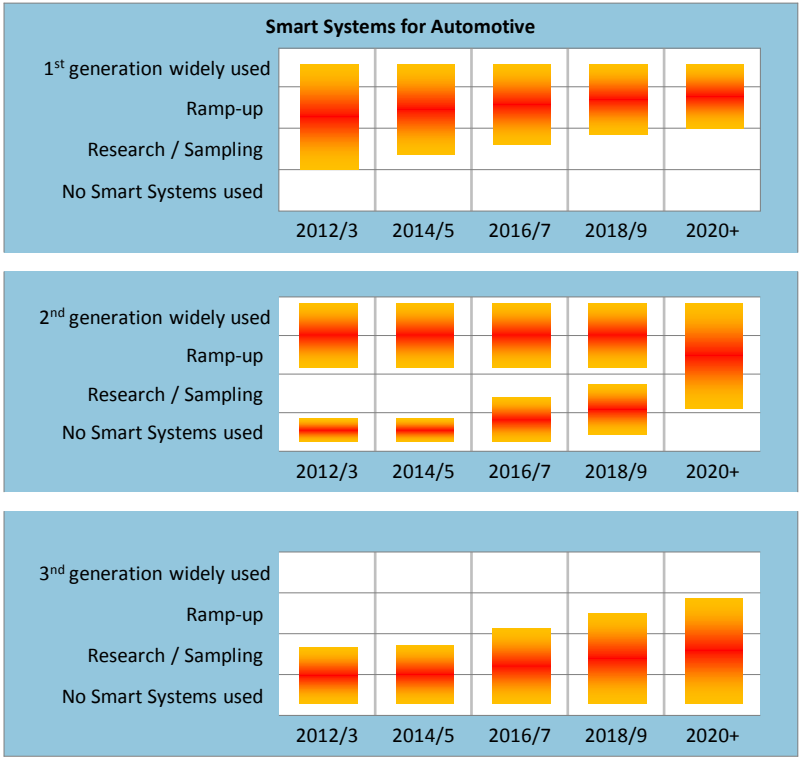
2nd generation Smart Systems become predictive and self-learning.

Huge production volumes bring spreads in the aging of key components. Systems must learn, and react for clean combustion and acceptable performance

3rd generation Smart Systems simulate human perception/cognition.

Co-operative rather than self-organised systems are expected.

Evolutionary (self-reconfiguring and healing) hardware is already under development



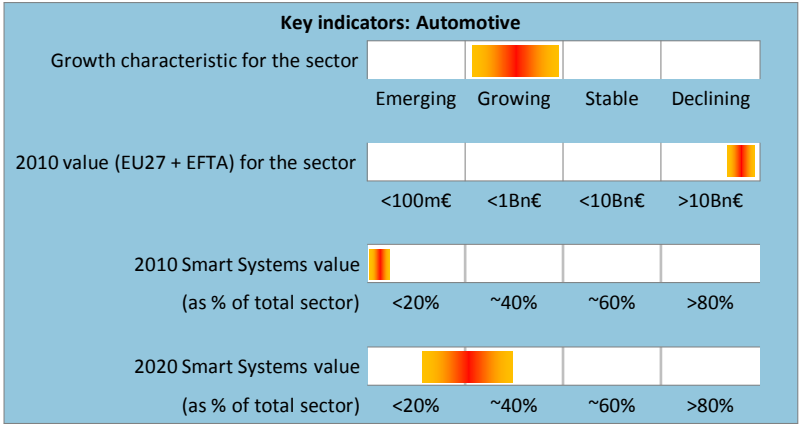
Subsector forecast

Electronic systems are already 40% of the value of a car and will represent up to 75% in Hybrid and Fully Electric Vehicles.

In 2012, the global market for automotive electronics systems was worth $189 billion, a rise of 11.2% over 2010, despite challenging economic conditions in many parts of the globe.

The value of the world-wide market for automotive electronic controllers (ECUs) stood at $51.1B in 2011. This market is expected to continue to grow, due to high-value of vehicles (inc. hybrids), with demand now expected to increase to $263 billion by 2016.

Advanced Driver Assistance Systems and HEV/EV are the major growth drivers, especially in established production areas.



The indicators above are shaded to reflect uncertainty

Sensors are inextricably linked to Smart Systems. The total automotive sensor market in 2011 was $15.4 billion, where Europe remains the largest automotive sensor market, with an expected value of $6.3 billion in 2019.

Subsectors as a whole

- The previous slides showed only Automotive. Similar sets have been developed for:
  - Mass Transit
  - Navigation
  - Infrastructure & Signaling
- The final two slides invite discussion regarding the EU position in Smart Systems and suggested Research Priorities across all these subsectors

Smart Systems for Transport & Mobility: EU Position

Sub-sector	Strengths	Weaknesses	Opportunities	Threats
Sector as a whole	• EU global players have the necessary muscle to develop Smart Systems and to establish their acceptance and appeal			• "Cyber attack" of Smart vehicles and transportation systems
Automotive	• Innovative small companies and >6000 sensor producers • Well established supply chains	• Incremental development based upon improving previous models can hold back revolutionary Smart Systems	• Electrification brings new spaces for Smart Systems • CO_2 reduction is a further driver, with Smart Systems promising higher efficiency and cleaner operation	• Declining numbers of engineering graduates with the breadth to innovate in new fields – as older "experience" may not be relevant to Smart Systems
Mass Transit	• Huge installed infrastructure with "Smart" ticketing and some driverless systems already accepted by the travelling public	• The timescales of long-term infrastructure investment can fail to recognise and intercept with future technologies such as Smart Systems	• Resilient multimodal seamless Passenger - centric and goods-centric. travel. • Retro-fit new technology into existing infrastructures	• Regions of the world having a "clean sheet" for mass transit could develop Smart Systems free from "legacy" constraints
Navigation	• Good GSM and other infrastructure	• Basic display and Human Machine Interfaces are produced outside the EU	• Smart Systems to automatically gathering and update geopositioning information	
Infrastructure & Signalling	• An already well regulated transport system to build upon	• Legacy systems • Legal issues regarding liability	• Use Smart Systems to optimise existing infrastructure at relatively low cost – more capacity on existing routes	• Reliability issues not fully explored regarding autonomous Smart systems

Smart Systems for Transport & Mobility: EU Research priorities

Sub-sector	Priority actions	Longer term actions
Sector as a whole	• Unified semantics for sensor systems around the Transport & Mobility sector and the wider Internet of Things	• Cyber security
Automotive	• Standardisation for integrating the Smart vehicle into a developing infrastructure • How to prove that Smart Systems are "Automotive Grade"	
Mass Transit	• Identify the key points at which Smart Systems could provide significant benefits in existing and future Mass Transit systems, and quantify those benefits	• Establish a mechanism for long-term infrastructure developments to intercept with rapidly developing Smart Systems technologies
Navigation	• Secure linking of personal nomadic systems to vehicle systems, mass transit systems	
Infrastructure & Signalling	• Is there enough "Dumb Copper" installed to support upgrades in technology?	• The integration or upgrading of older vehicles

EPoSS Strategic Research Agenda

End of Excerpt

Consult the full SRA on
www.smart-systems-integration.org