INTEGRATION OF MECHANICAL AND ELECTRONIC ENGINEERING: TRENDS AND CHALLENGES IN EDUCATION, RESEARCH AND TECHNOLOGY TRANSFER

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DII - UNIVERSITY OF PISA

READY FOR THE CHALLENGE?

- High potential industrial ecosystem in vehicular technologies in the Pisa-Livorno area
- High potential research ecosystem in vehicular technologies in the Pisa-Livorno area
- UCAR (University Center for Automotive Research
- MOVET (Motors Vehicles Technologies)
- C3T (Centro Competenza Cybersecurity Toscano)
- CrossLabs @ DII
- Pontech & Polo Tecnologico Navacchio
- Partnership outside region: Calearo, Magneti Marelli
- Polo logistica a Livorno (UNIPISA)

CROSSLAB
Innovation for industry 4.0

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

EDUCATION IN ELECTRONICS/MECHATRONICS @ UNIPISA

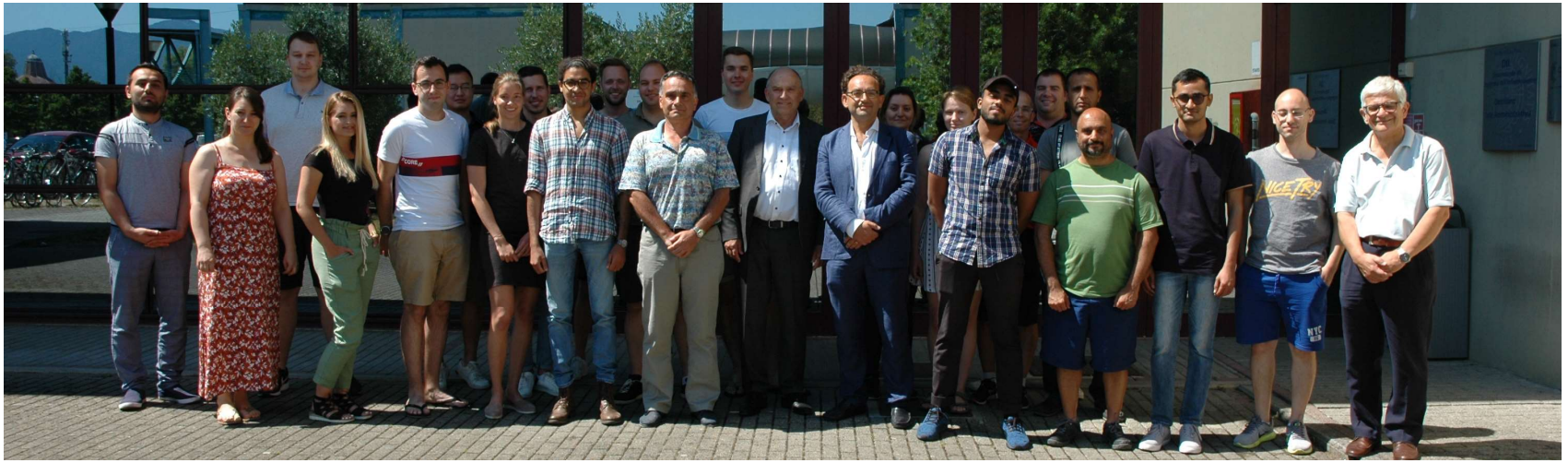
UNIVERSITÀ DI PISA

- 2-year Master Degree in Vehicular Engineering at University of Pisa
- Dedicated courses on vehicle & component electrification, connectivity, smart control, digital-flow for design, production and verification also in 2-year Master Degrees in Electronic Engineering, Automation and Robotic Engineering, Electrical Engineering
- Junior electronic/electrical engineer from the 3-year BSc in Electronic Engineering (test, HW board design, FW/SW design)
- New Master Degrees in Cybersecurity and in Data Engineering and Artificial Intelligence
- PhD program in Information Engineering (30 PhD/year of which 75% funded by industry/EU projects) + PhD program in Smart Industry (Regione Toscana)
- Post-degree 1-year master in Cybsersecurity
- E-Team squadra corse driverless

EDUCATION IN ELECTRONICS/MECHATRONICS @ UNIPISA

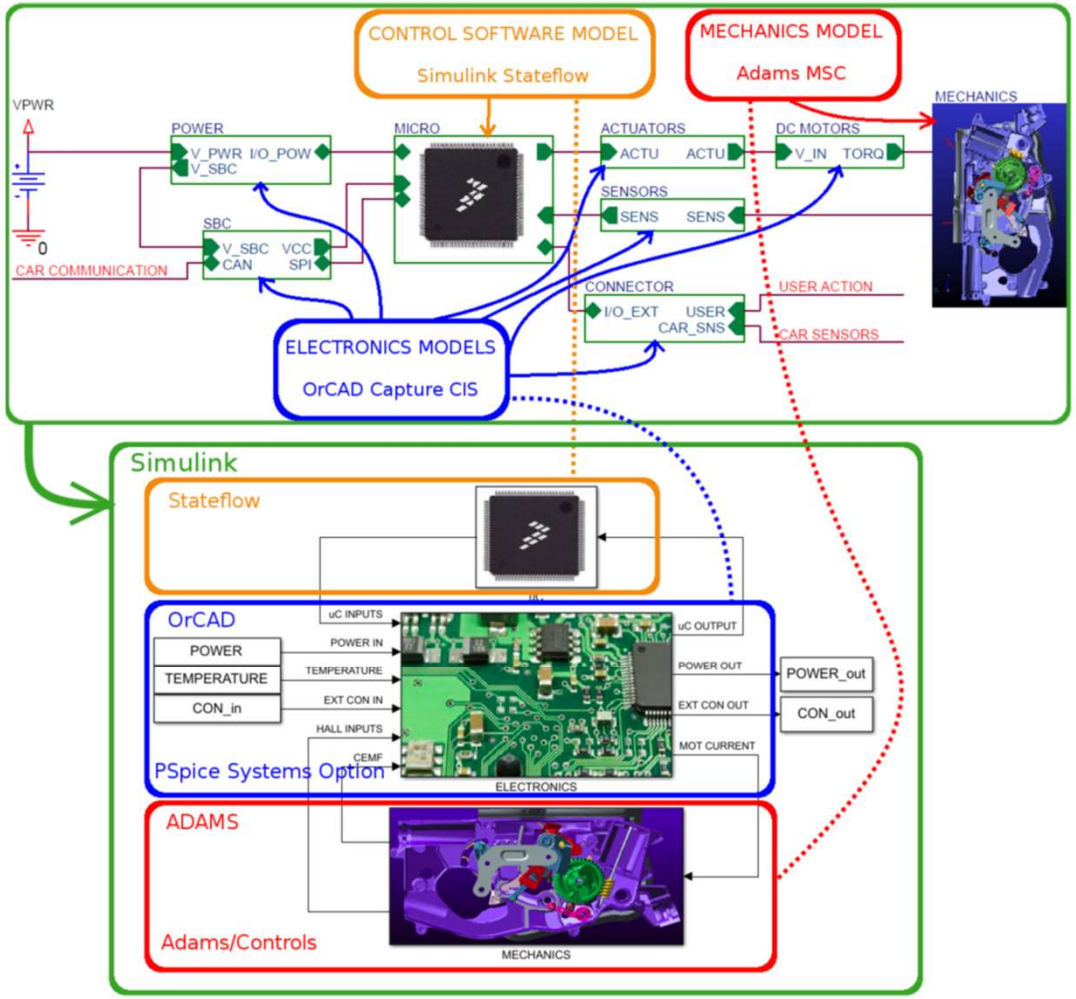
UNIVERSITÀ DI PISA

- Master thesis in industries (now many ongoing in PPC, Magna, Pierburg, Magneti Marelli, Leonardo, INTECS…)
- Dedicated courses for short-intensive education in electronic&ICT field & mechatronics (e.g. Summer school on IoT, dedicated course for industries: already done for Magna, Pierburg, ABB, Leonardo-Finmeccanica)



EXAMPLE THESIS IN MECHATRONICS @ MAGNA (DIGITAL FLOW)

Integrated simulation environment for co-design/ verification of mechanic, electronic and control of automotive e-drives: the smart-latch case study.



CROSSLAB @DII-UNIPI

UNIVERSITÀ DI PISA

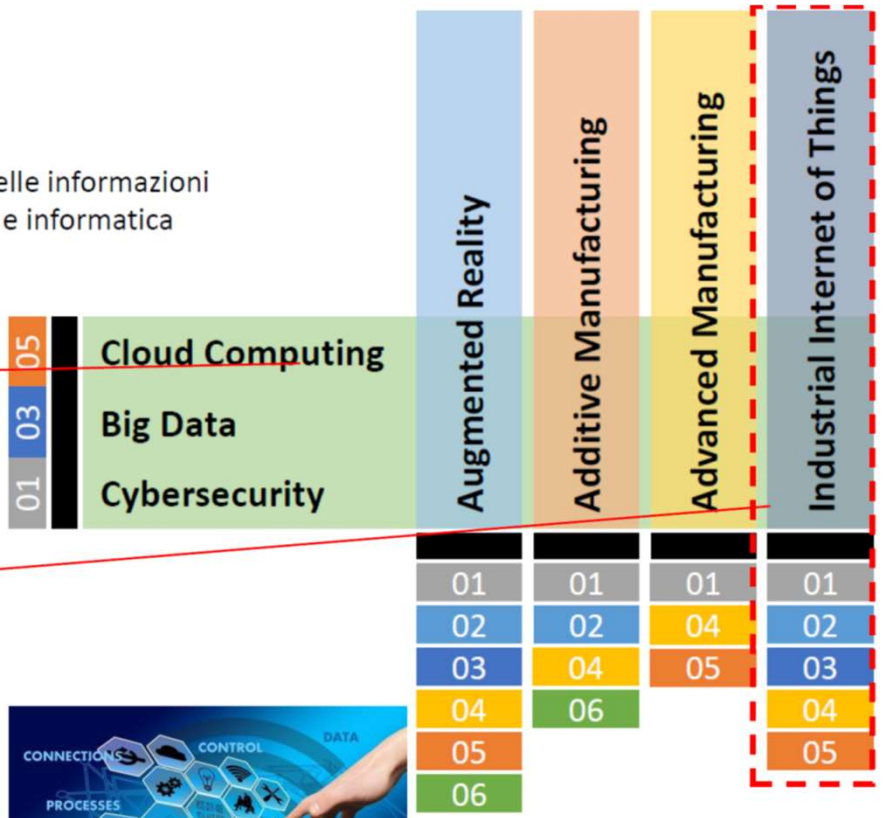
01 ING-INF/01 - Elettronica
02 ING-INF/02 - Campi elettromagnetici
03 ING-INF/03 - Telecomunicazioni
04 ING-INF/04 - Automatica
05 ING-INF/05 - Sistemi di elaborazione delle informazioni
06 ING-INF/06 - Bioingegneria elettronica e informatica

Two Cross-labs for:

- ***Cloud, big data and Cybersecurity***
- ***Industrial IoT***

New physical spaces

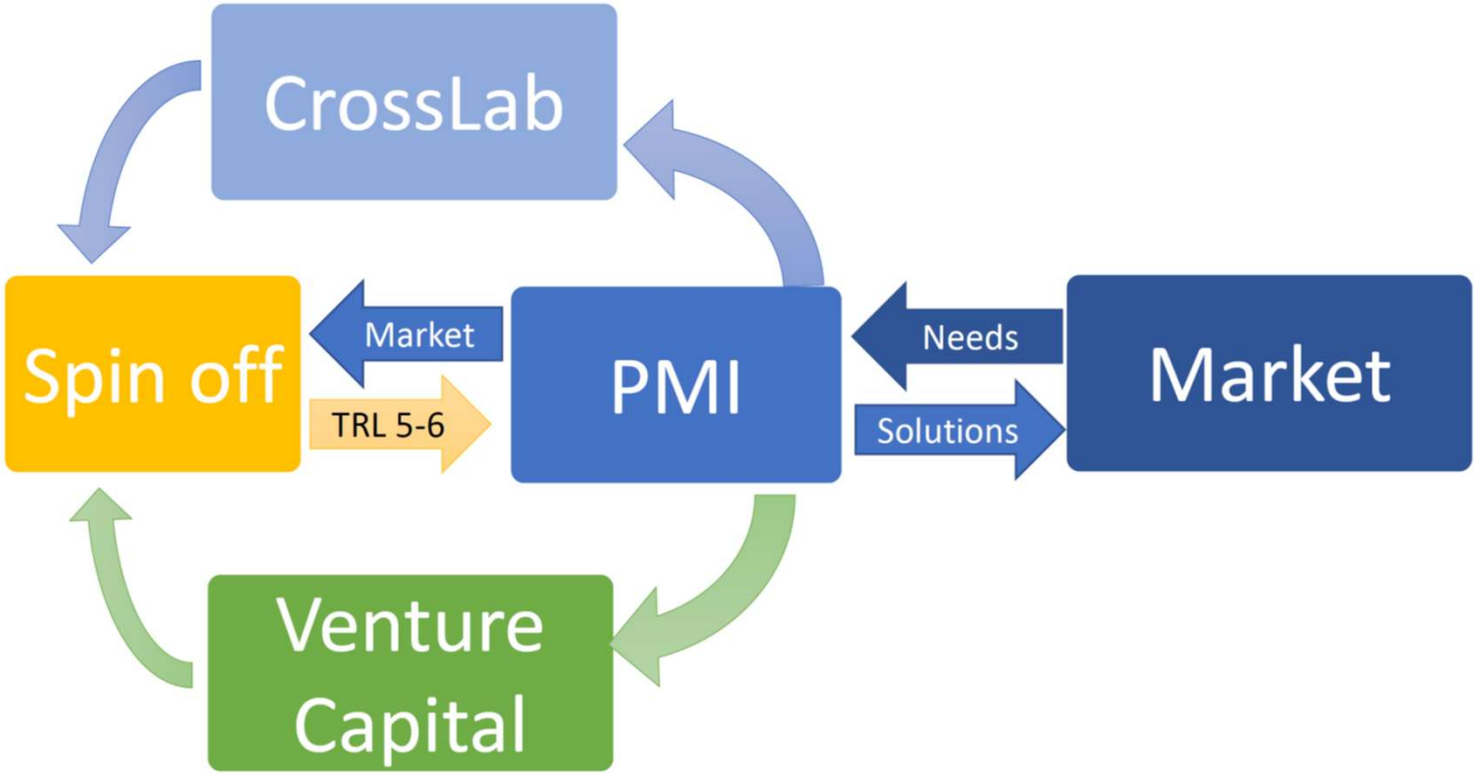
New instrumentation labs (1 ME)



CROSSLAB
Innovation for industry 4.0

FROM CROSSLAB TO ENTERPRISES (13 SPIN-OFFS AT DII)

UNIVERSITÀ DI PISA



TECHNOLOGY TRANSFER

UNIVERSITÀ DI PISA

- Master or Training Courses

Es. training for Magna, ABB-PowerOne, Pierburg, ….Summer Schools

- Dottorato di Ricerca «Industriali», Assegni di Ricerca, RTD

Es. funding from Ri.Co., Kayser, STM, AMS, Gaisler, Sensichip, PPC, Calearo,.

- **Direct contracts «conto terzi»,** es. Leonardo, Intel, AMS, STM, Renesas, Magna, ABB, Ri.Co, Thales, Intel, INTECS, IDS, ISE,…

- **Common EU/ESA projects** Leonardo, Magna, STM, AMS, Valeo, IDS, INTECS, Thales, TAS, IDS,..

- **Common Regional Projects** es. SIMPLE, AMDS, IREAD4.0, AirCardio, Corsair,

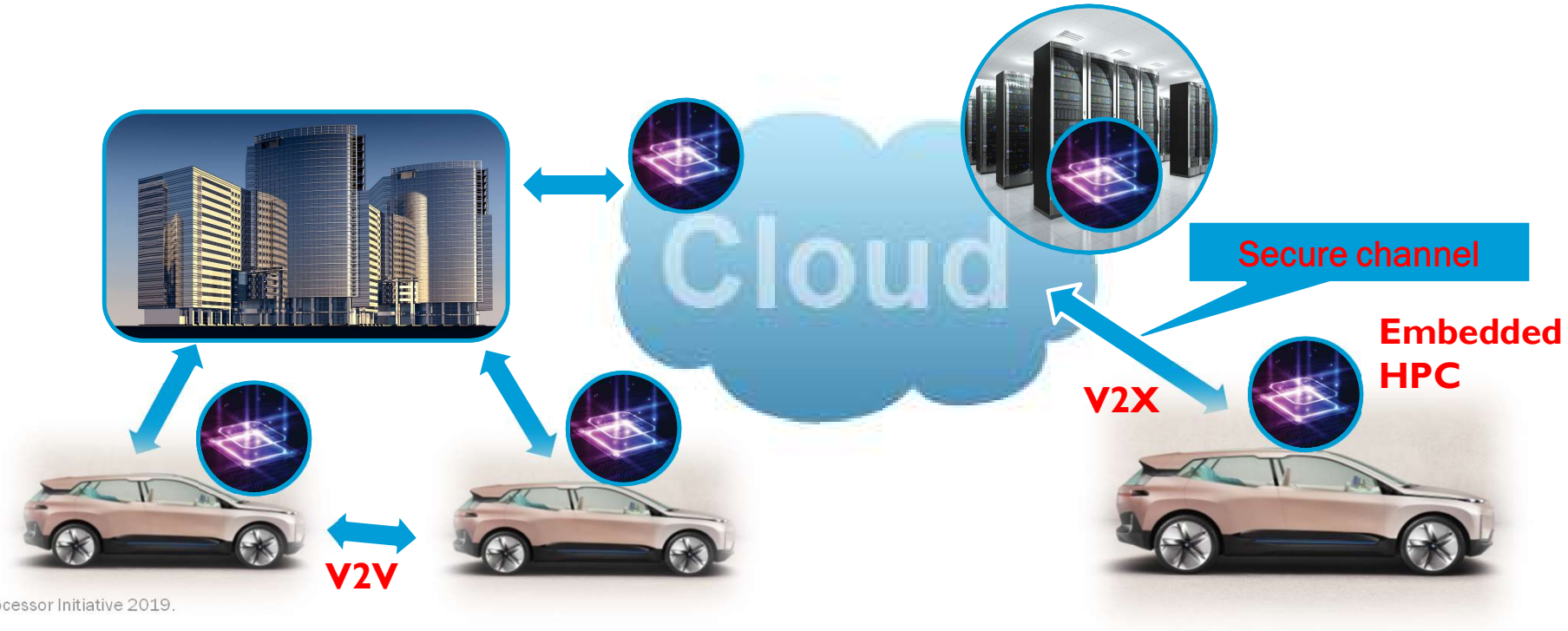
JOINT LABS @ DII (Enterprises physically hosted at UNIPI)
STMicroelectronics, CNIT, Calearo Antenne, Bejing LMV Institute
3-year agreement signed with Magneti Marelli (discussion for a physical site at Villa Letizia-Livorno)
on-going discussions with NVIDIA

RESEARCH

Enabling **TE**chnologies for sm**A**rt vehicles and **M**obility (EPI 120 M€ project in 5 years)

Research on new *technologies, sensors, analog&smart-Power, mechatronics,*

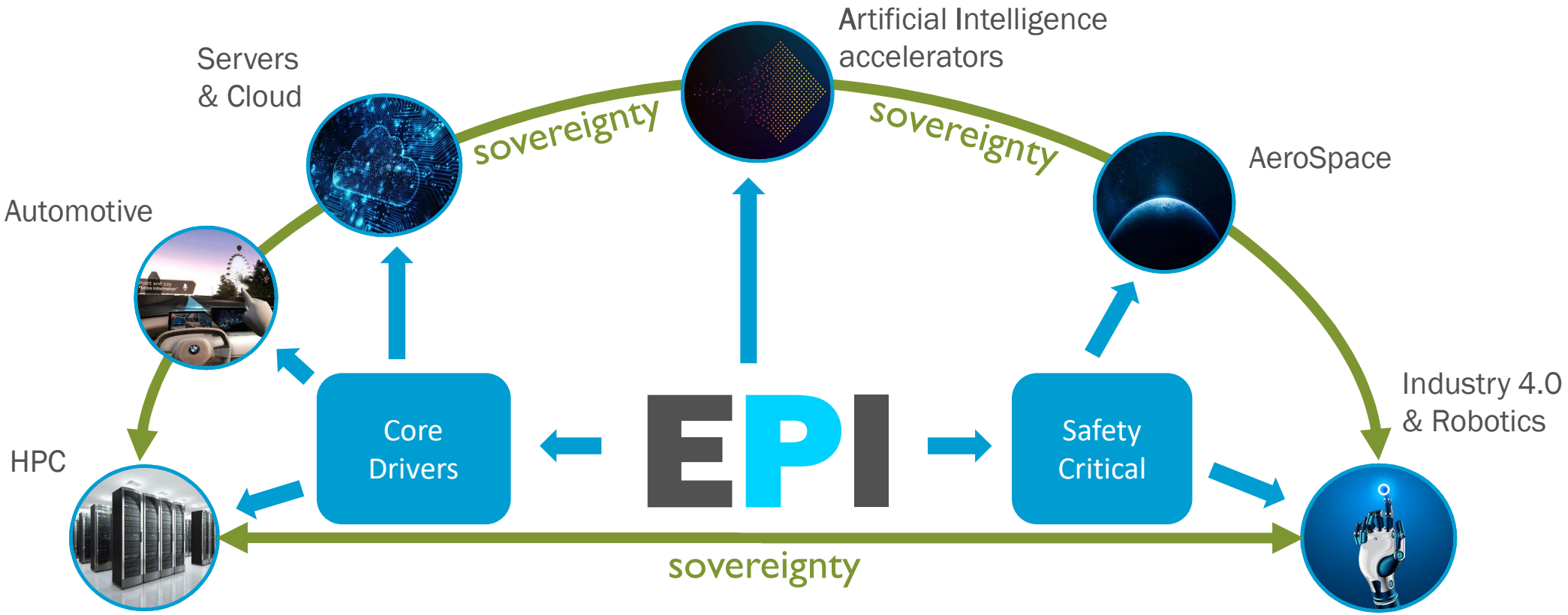
embedded systems for control/navigation, cybersecurity, AI (ML/DNN) accelerators



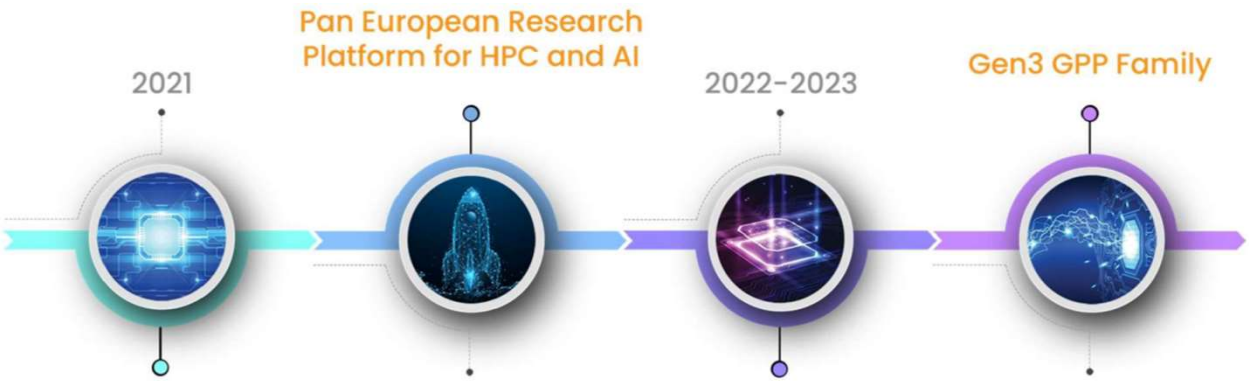
EPI PARTNERS

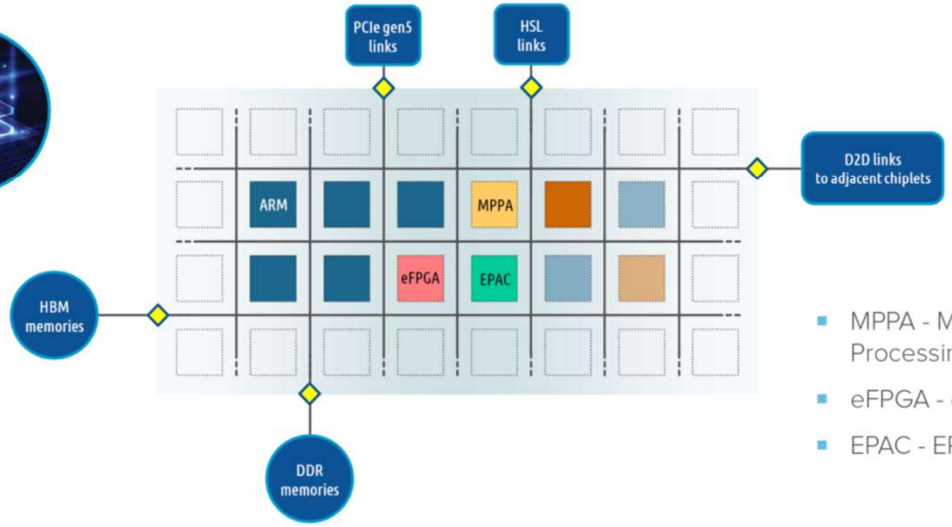
ACES VEHICLES & MOBILITY

Autonomous **C**onnected **E**lectrified **S**hared



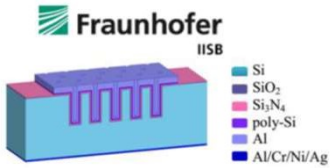
ROADMAP & ARCHITECTURE

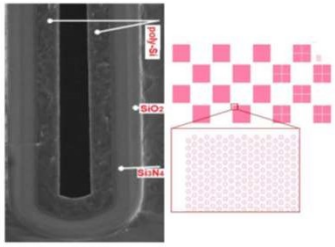


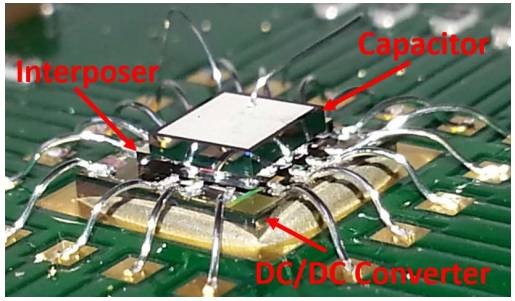


- MPPA - Multi-Purpose Processing Array
- eFPGA - embedded FPGA
- EPAC - EPI Accelerator

Sensors & Mechatronics



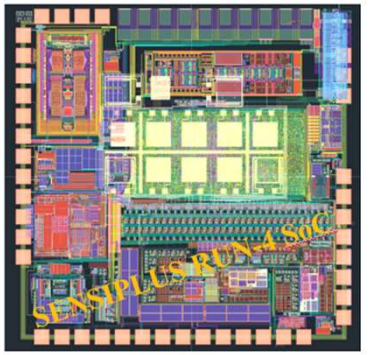




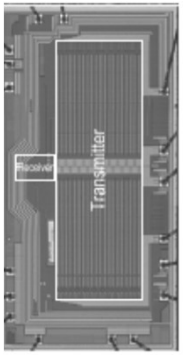
Sensor platform

Temperature, radiation, humidity, pollutant gases

+ communication

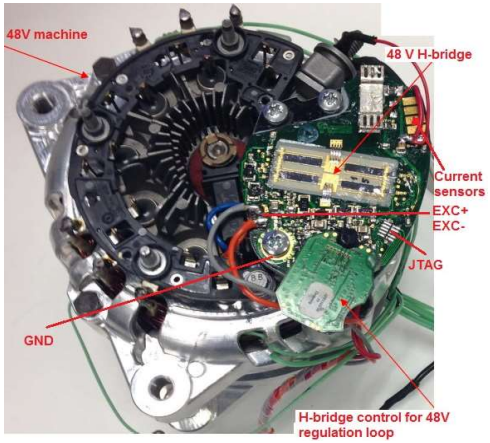


Driver



	min	max
Battery	-0.3 V	+58 V
Bus DC Voltage	-58 V	+58 V
Junction Temp. (TJ)	-40°C	+150°C
ESD (HBM)	-4 kV	+4 kV
Latchup immunity	-100 mA	100 mA

Sensors for Mechatronics



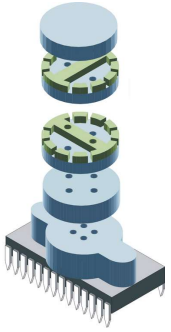
Low-cost Sensors & Converters

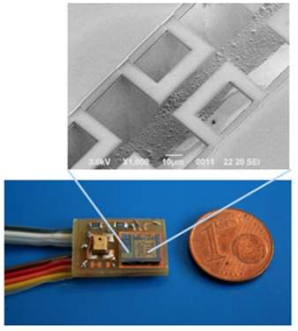
Reliable and low cost tags and sensors for WSNs

MEMS Smart sensors

Acoustic, thermal, flow sensors

In partnership with STM, CNR





Automotive Electronics

RF Circuits
(mmW Radar, 802.11pV2X & 5G C-V2X, GNSS)

Sensor signal processing
(Image, Radar, Lidar, IMU,..& fusion)

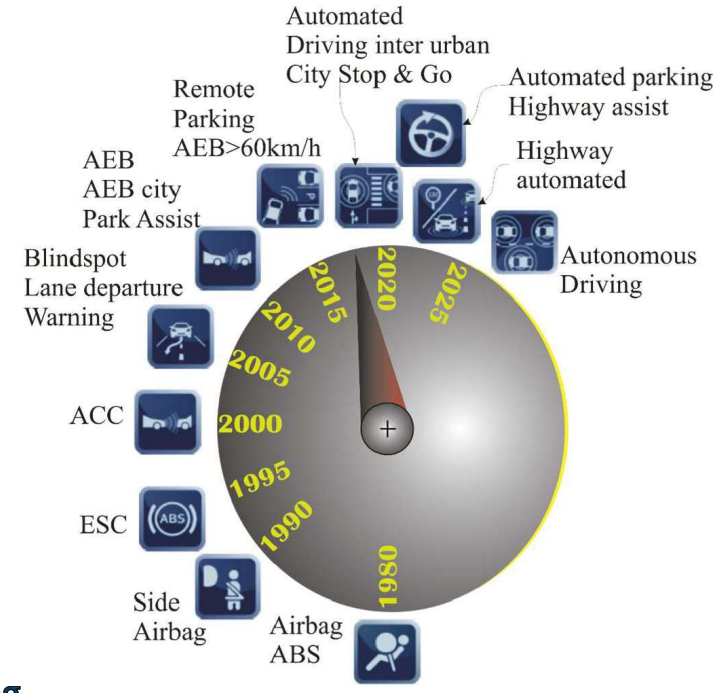
Power Electronics
(DC/DC converters, inverters, BMS
12V→48V→ 300V)

Low-power Analog & Mixed-signal ICs

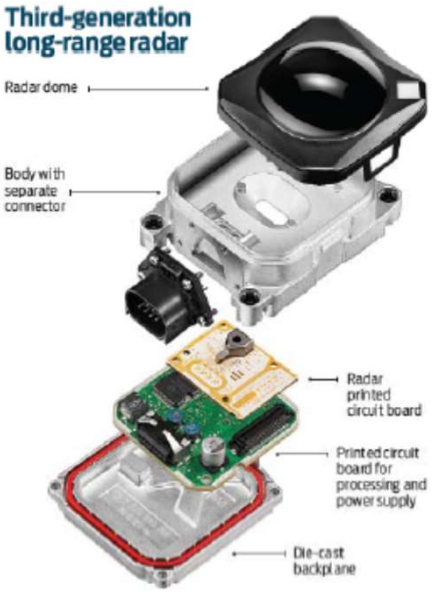
Sensors (device & technologies-MEMS/MOEMS)

MCU & memories (multi-core, deep-learning, high SIL in harsh environments)

Predictive-diagnostic
(thermal, EMI/EMC, electrical, ageing, vibrations,..) for functional safety



Machine Perception



Front camera:
- Active lane assist
- ACC stop&go
- Speed limit display
- Pre sense / front / plus
- Adaptive light

Ultrasonic sensors at side:
- Park assist

Rear camera:
- Parking system plus with reversing camera
- Park assist with reversing camera

Ultrasonic sensors at rear:
- Parking system
- Park assist

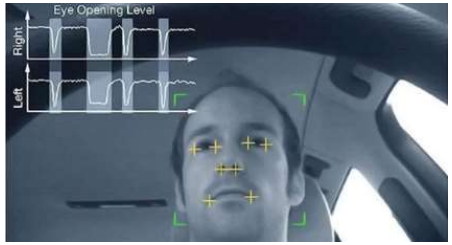
Ultrasonic sensors at front:
- ACC stop&go
- Parking system
- Park assist

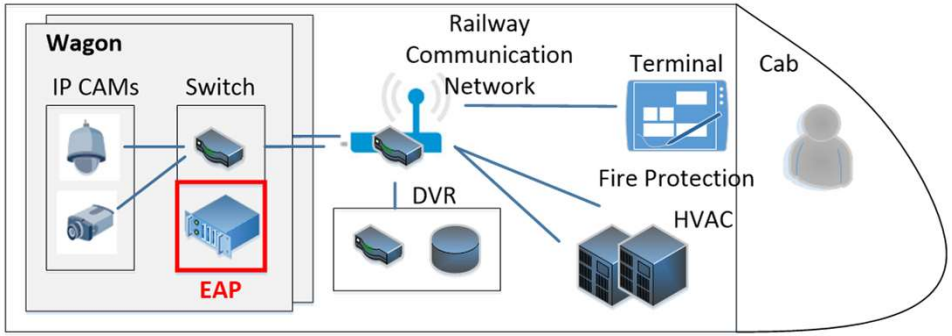
Infrared camera:
- Night vision assistant with highlighting of detected pedestrians

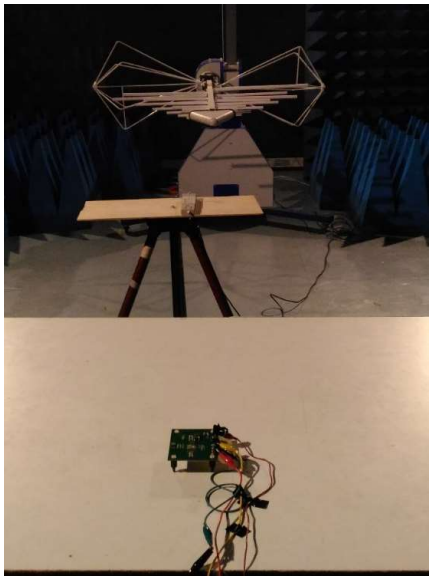
Rear radar sensors:
- Side assist
- Pre sense rear / plus

Crash sensors:
- Front protection adaptivity
- Side protection
- Rear impact protection

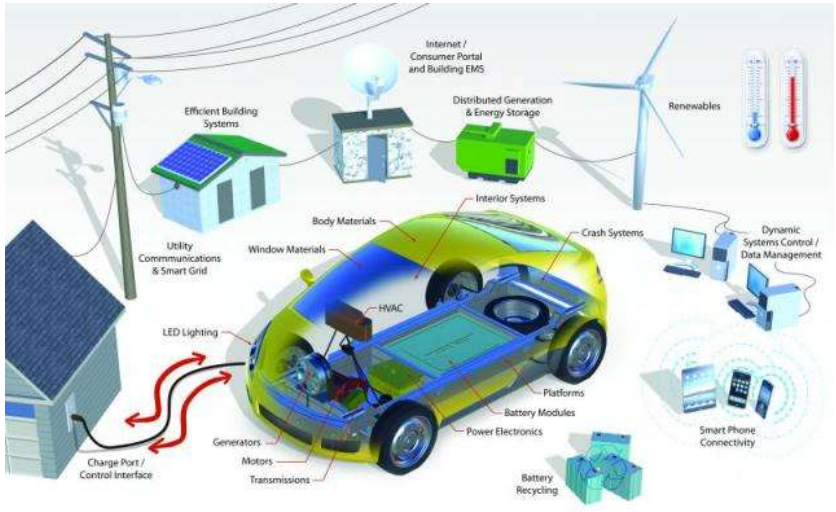
Front radar sensors:
- ACC stop&go
- Pre sense / front / plus

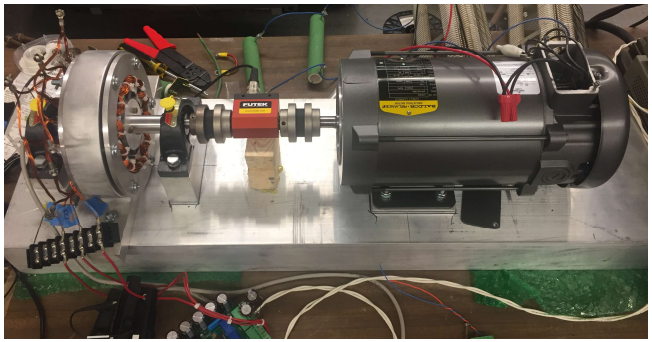


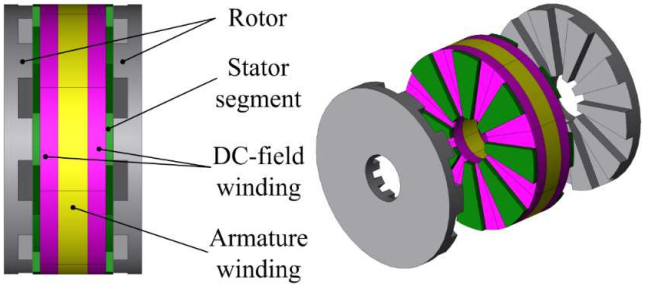




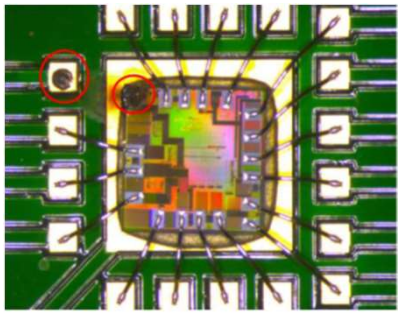
Power & Control Electronics

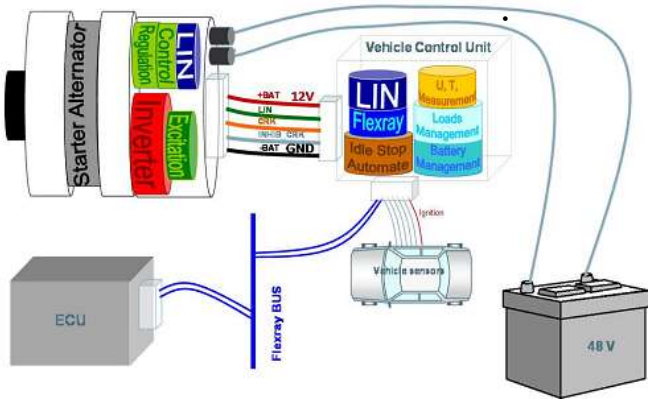


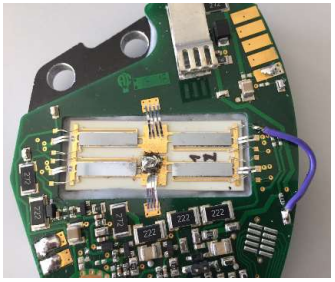




Massachusetts Institute of Technology







Cybersecurity


WIRED Hackers Remotely

BUSINESS CULTURE DESIGN

ANDY GREENBERG SECURITY 07.21.15 06:00 AM

HACKERS REMOTELY KILL A JEEP ON THE HIGHWAY—WITH ME IN IT

Exposure to cyber attacks:

- Vehicle hack
- Data tampering
- Denial of Service

Hardware for security

CMOS-based Physical UnclonableFunction

for secure authentication

Secure Communication in WSNs/IoT/CPS

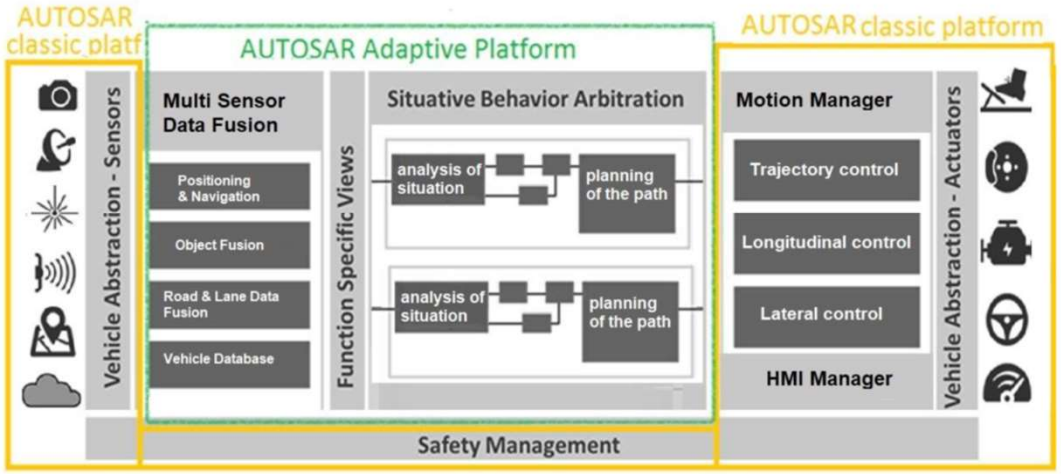
Applied cryptography
Key management
Denial-of-Service
Selective jamming

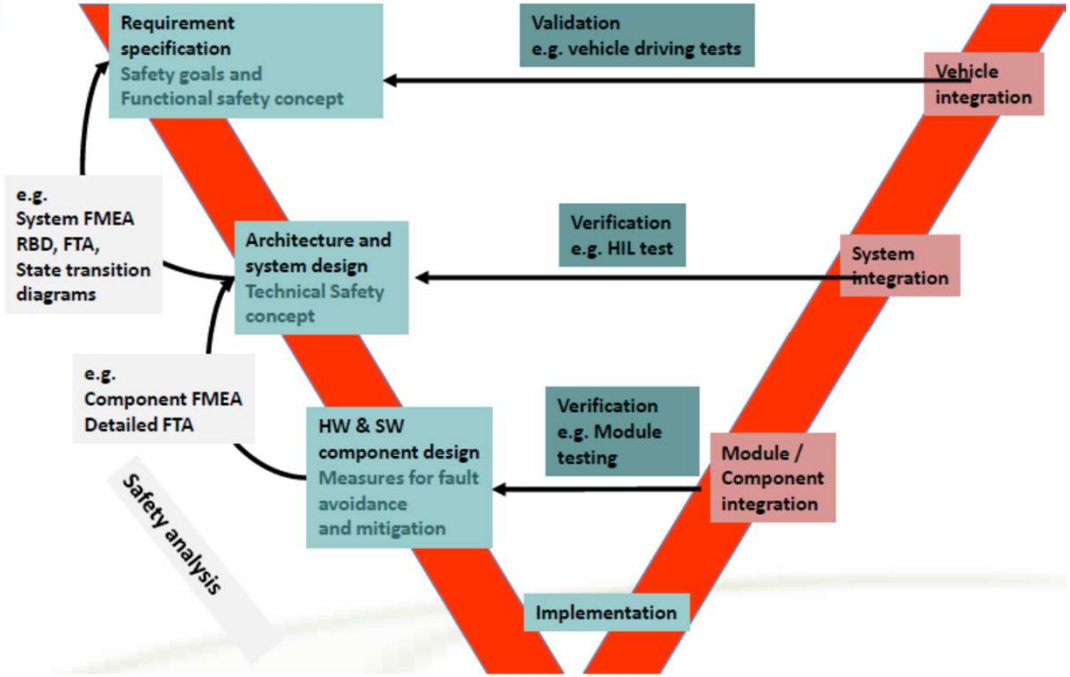
Automotive Cybersecurity

Abstract modeling
Architecture patterns
Methods and tools for analysis and synthesis
Secure information flow

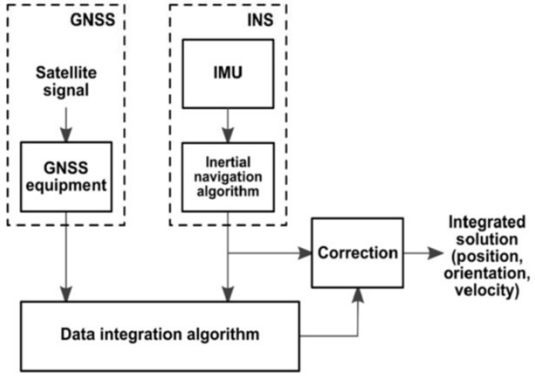
Functional Safety & Verification

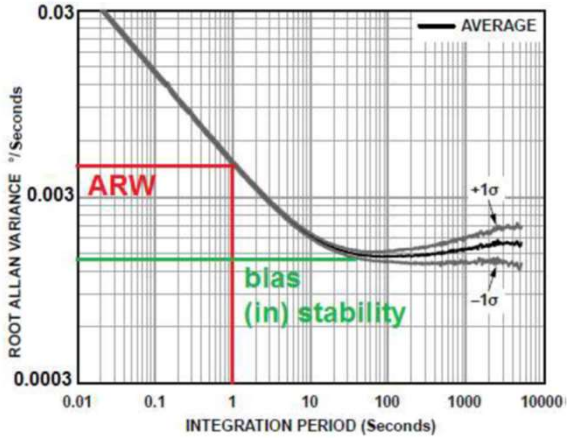
ASIL - D	> 99% faults detected < 10 FIT	EPS, braking, airbag safing, etc...
ASIL - C	> 97% faults detected < 100 FIT	HEV/EV bat…ry mng. powert…
ASIL - B	> 90% faults detected < 100 FIT	ADAS
ASIL - A	(> 60% faults detected)	

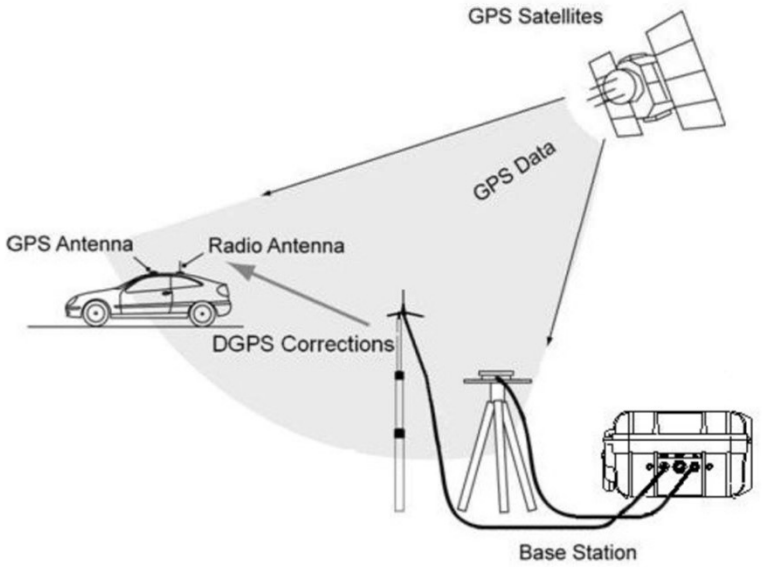


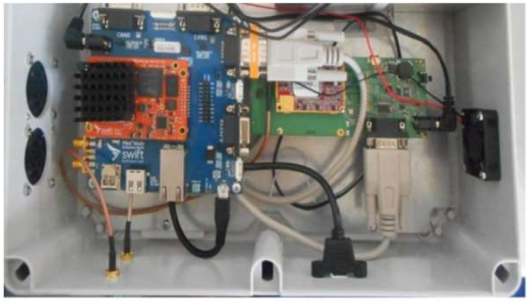


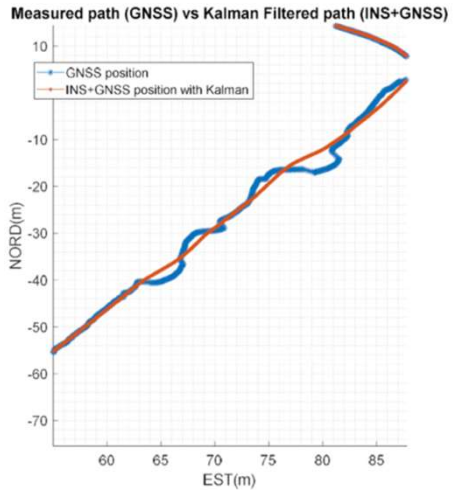
Positioning/Navigation











Printed & Wearable Electronics

GRAPHENE FLAGSHIP

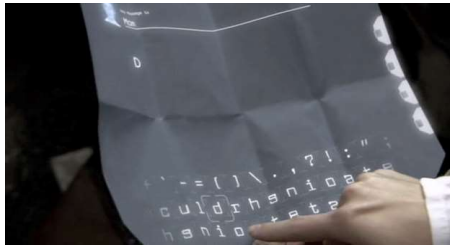
Printed Circuits

- Electronics circuits printed on flexible substrates
  - Paper
- Through two-dimensional materials
  - graphene

Printed Devices

- 2D smart labels, sensors
- smart biomedical devices
- …

Rigid
Produced in series - Not customizable
Designed by somebody else than the user



Flexible, foldable
Fully customized
Designed and fabricated by the user
Cheaper
Low environmental impact

Industrial Wireless Communications

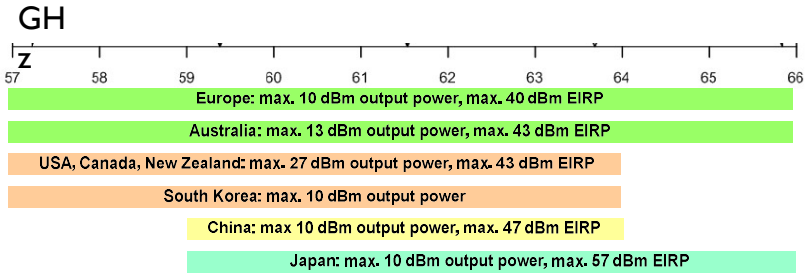
ISM free spectrum can boost the performance of industrial wireless networks

Time-slotted channel hopping & frequency-diversity can provide support for a large number of high bit rate channels (i.e., several Mb/s per channel).

This allows a robust networking of high data-rate industrial sensors, such as hi-res cameras, radars or laser scanners.

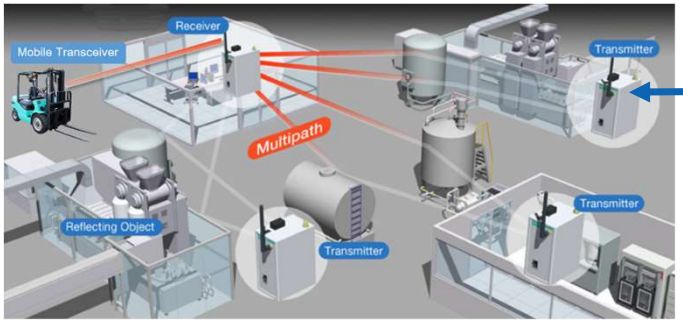
Worldwide free mmW ***Industrial***, Scintific and Medical bands and power limits

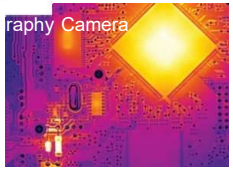
LoRa Alliance™
Wide Area Networks for IoT



Areas of investigation

mmW propagation in industrial environments
Link-layer communication protocols
Networking protocols
Analysis and performance evaluation
HW implementation

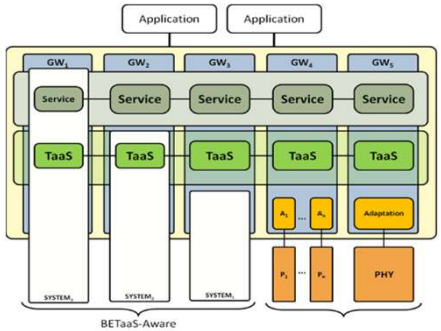




Internet of Things

Software platforms to support **interoperability** in IoT/M2M systems

Fog/Edge Computing paradigm to reduce network latency, improve data security, and enable autonomous control at the system edge



Recent EU Project

Building the Environment for Things as a Service

Expertise on standard and open platforms for IoT/M2M

Augmented Reality

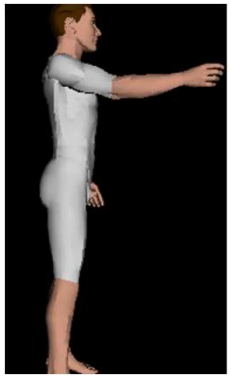
Augmented Reality on wearable head-mounted display

To support manufacturing processes and for security

For computer-assisted surgery

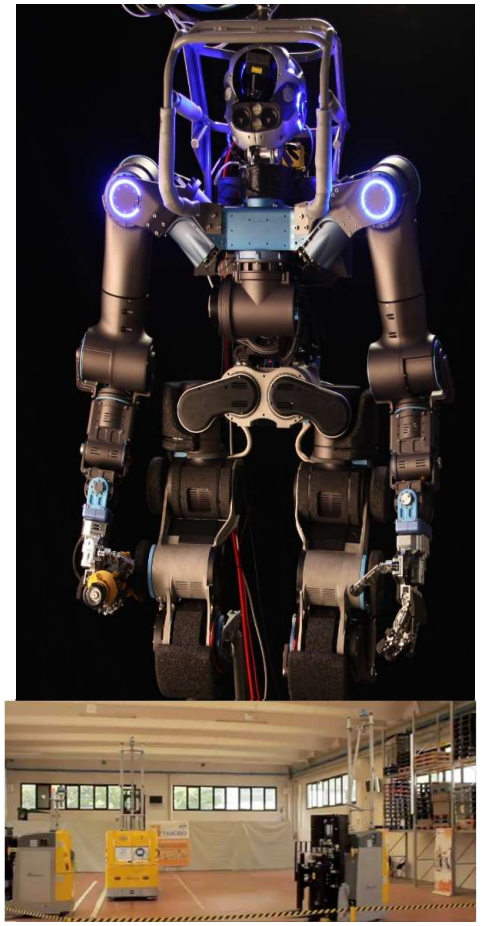
Haptic Interfaces

Virtual reality



Drones, UAV & AGV

- Autonomous Mobile Agents
  - Robots, UAV, Marine Robots
  - Distributed, Scalable and Secure Coordination
- COBOTs
- Soft Robotics
- Smart Human-Machine Interfaces



Big Data & Cloud

Big Data Mining

Learning algorithms for fault detection, business intelligence, customer satisfaction

Frequent pattern analysis for customer analysis, event detection, fraud detection, web mining

Multi-objective evolutionary algorithms for industrial multi-objective optimization problems

Condition-based Maintenance

Fault Prediction

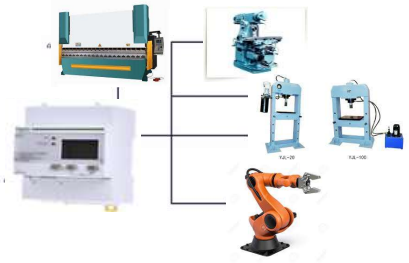
Diagnosis of the causes of efficiency loss in photovoltaic energy systems

Profiling

Recommender systems

Electronic Recruitment

Energy Management: low-cost system to monitor the use of electrical energy



THANKS FOR YOUR ATTENTION

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