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Central European Institute of Technology

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BRNO UNIVERSITY OF TECHNOLOGY

Pavel Václavek

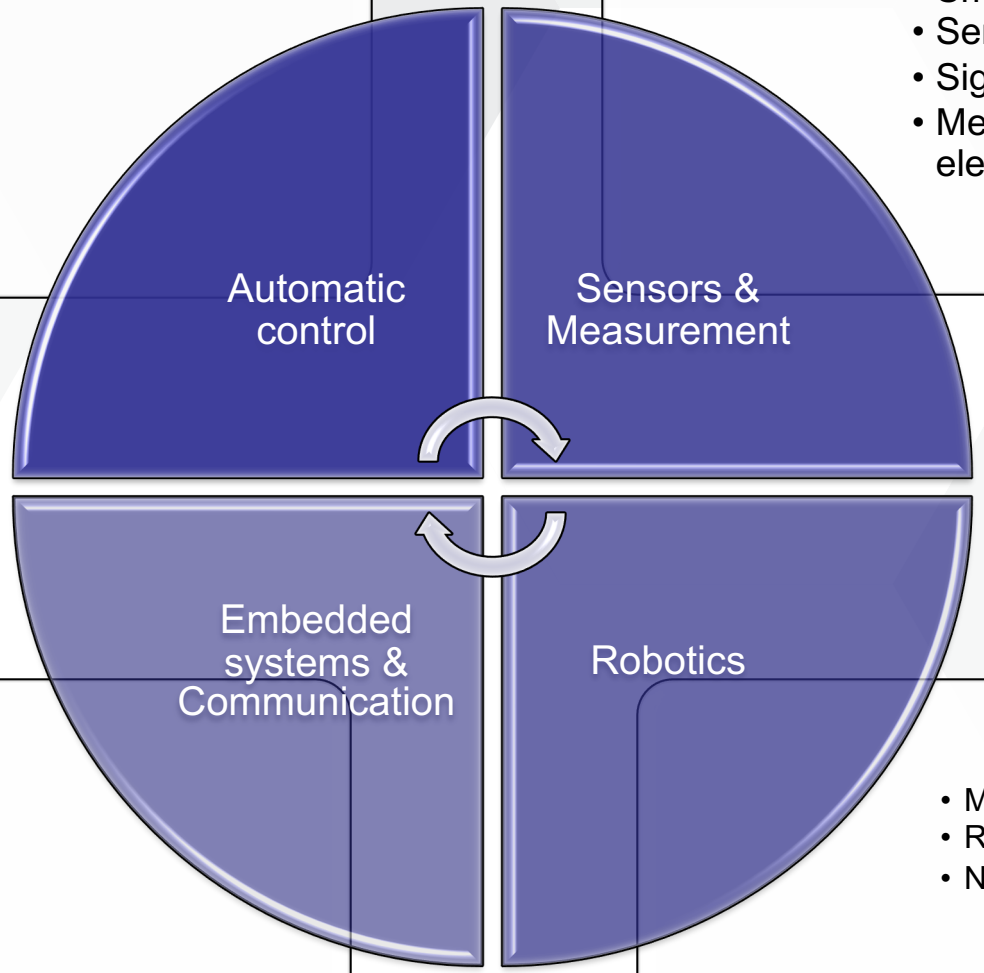
Electromobility and Automated Driving research at CEITEC

Cybernetics in Material Science

50 researchers

- Algorithms
- Industrial processes control
- Drives and Power Systems Control

- Smart sensors
- Sensors design using new materials
- Signal processing
- Measurement of electrical and non-electrical quantities

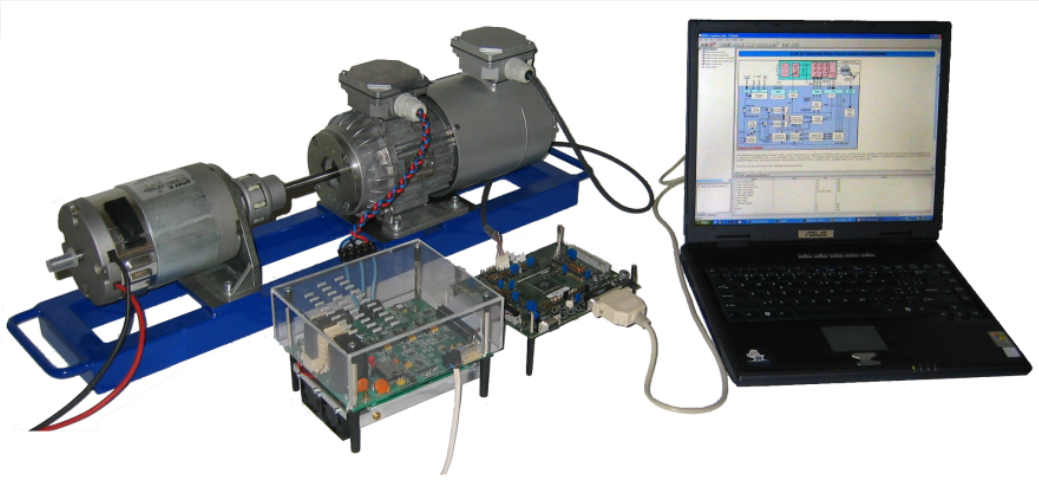


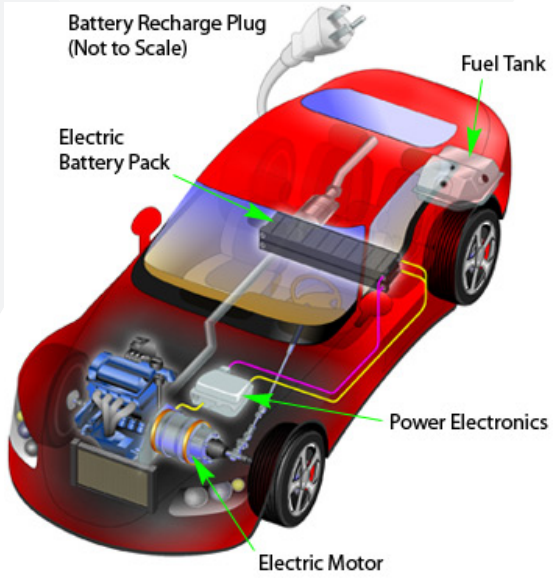
- Wired and Wireless Industrial communication
- High-performance embedded systems
- Computer Vision

- Mobile robotics, telepresence control
- Rescue and Reconnaissance systems
- Navigation and self-localization systems

Automatic Control

- Modern control theory applications – robust and predictive control, control performance assessment, state observers
- Advanced control systems for AC drives control
- Sensorless drives
- Drives modeling and parameters estimation





- "Green" cars powertrain control – multiphase and high-speed machines
- Fail-safe and Fail-operational control
- Drive, electronics and sensors self-diagnostics
- Implementation and verification of control algorithms in embedded systems

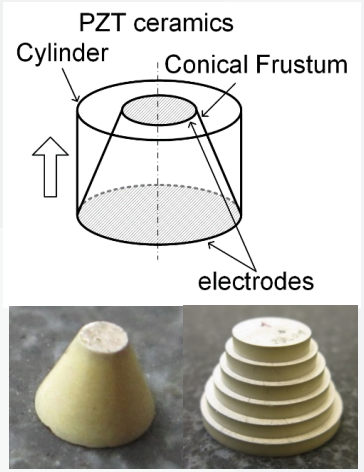
Fail-operational control

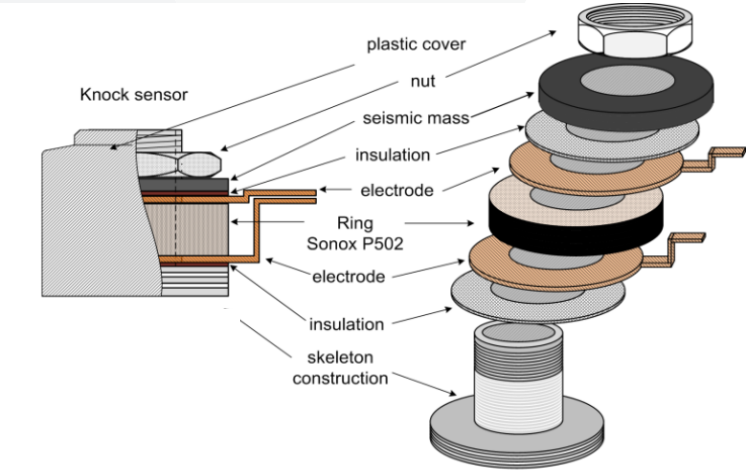
- Research of algorithms for fault detection and control of failing systems
- Fail-safe systems are not sufficient for critical and highly automated systems (aircraft, automated/autonomous cars, automated production systems)

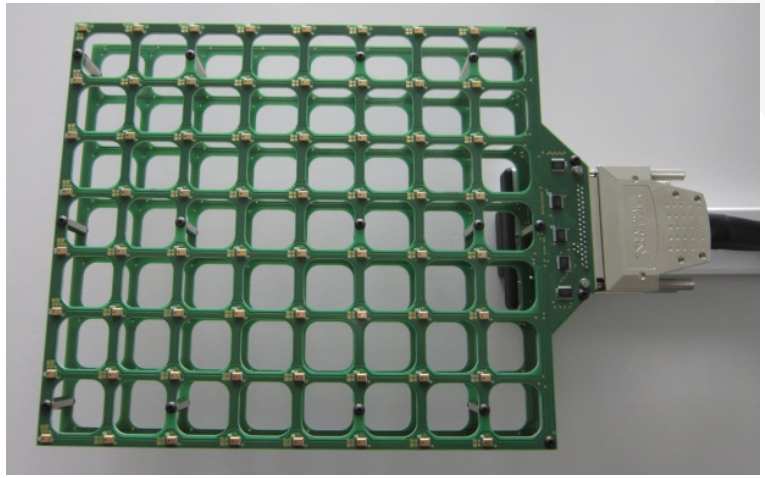
- Experience from complex automotive systems control
- Principles of highly automated automotive systems will be used also in production technologies

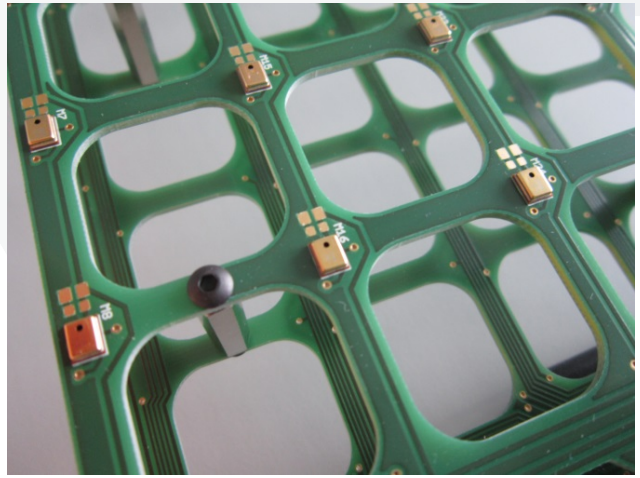
Smart Sensing

- Smart sensing for vibration and acoustic measurement
  - characterization of new materials for piezoelectric accelerometers
  - application of MEMS devices for industrial measurement
  - design of vibration sensors with MEMS devices
  - development of broadband acoustic (ultrasonic) emission sensors
  - implementation of autodiagnostics and autocalibration in smart sensors
  - development of sensor systems for vibration and acoustic measurement

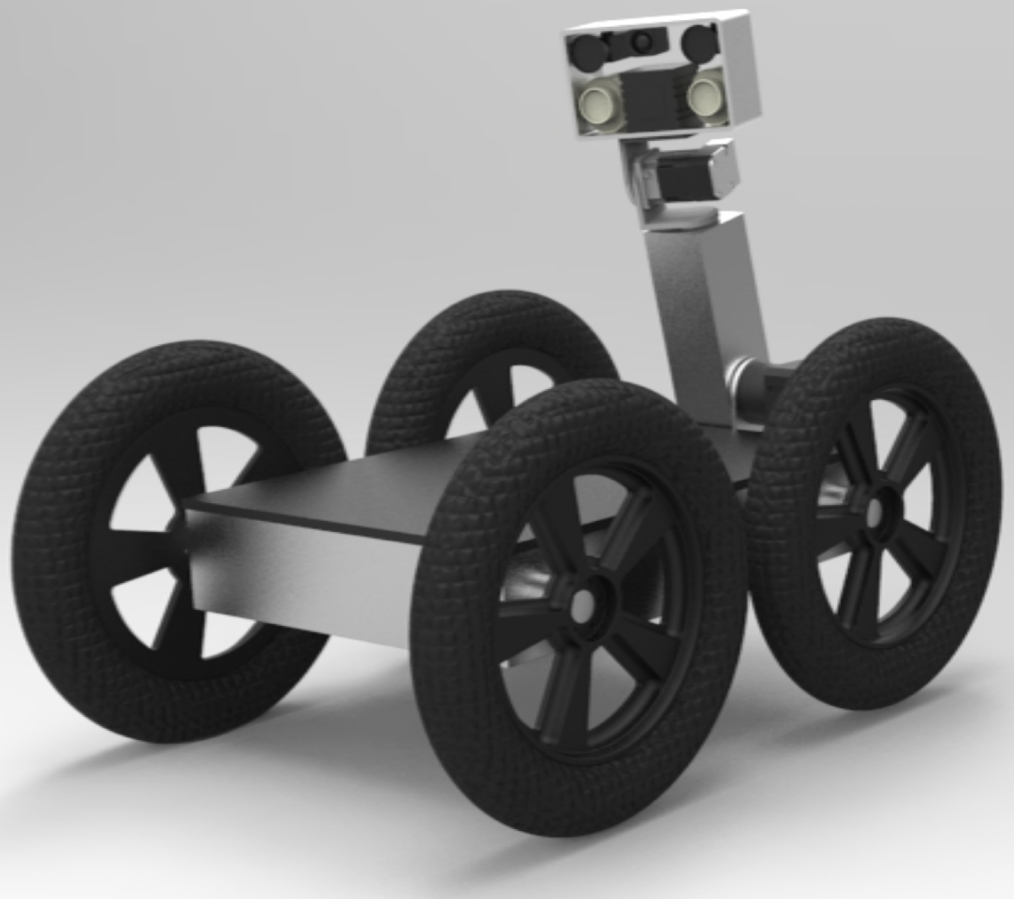








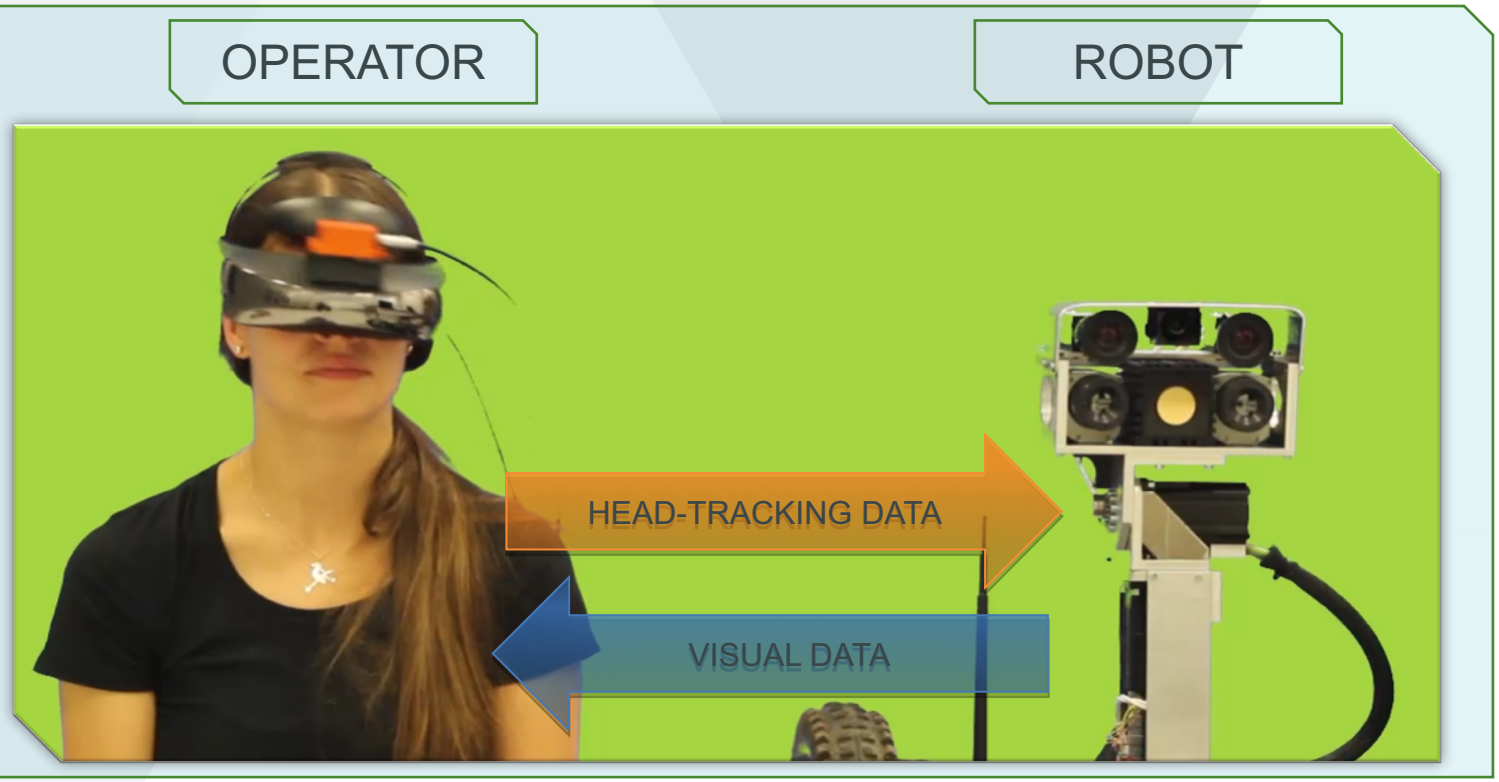
Mobile Robots



- GENERAL RECONNAISSANCE
- CBRNE
- SEARCH FOR VICTIMS/CRIMINALS
- MULTISPECTRAL MAPPING
- ENVIRONMENT MEASUREMENT
- AUTONOMOUS AREA GUARDING

Augmented Reality & Visual Telepresence

OPERATOR SHOULD FEEL TO BE IN THE ROBOT'S PLACE



- remote control, inspection
- mission planning

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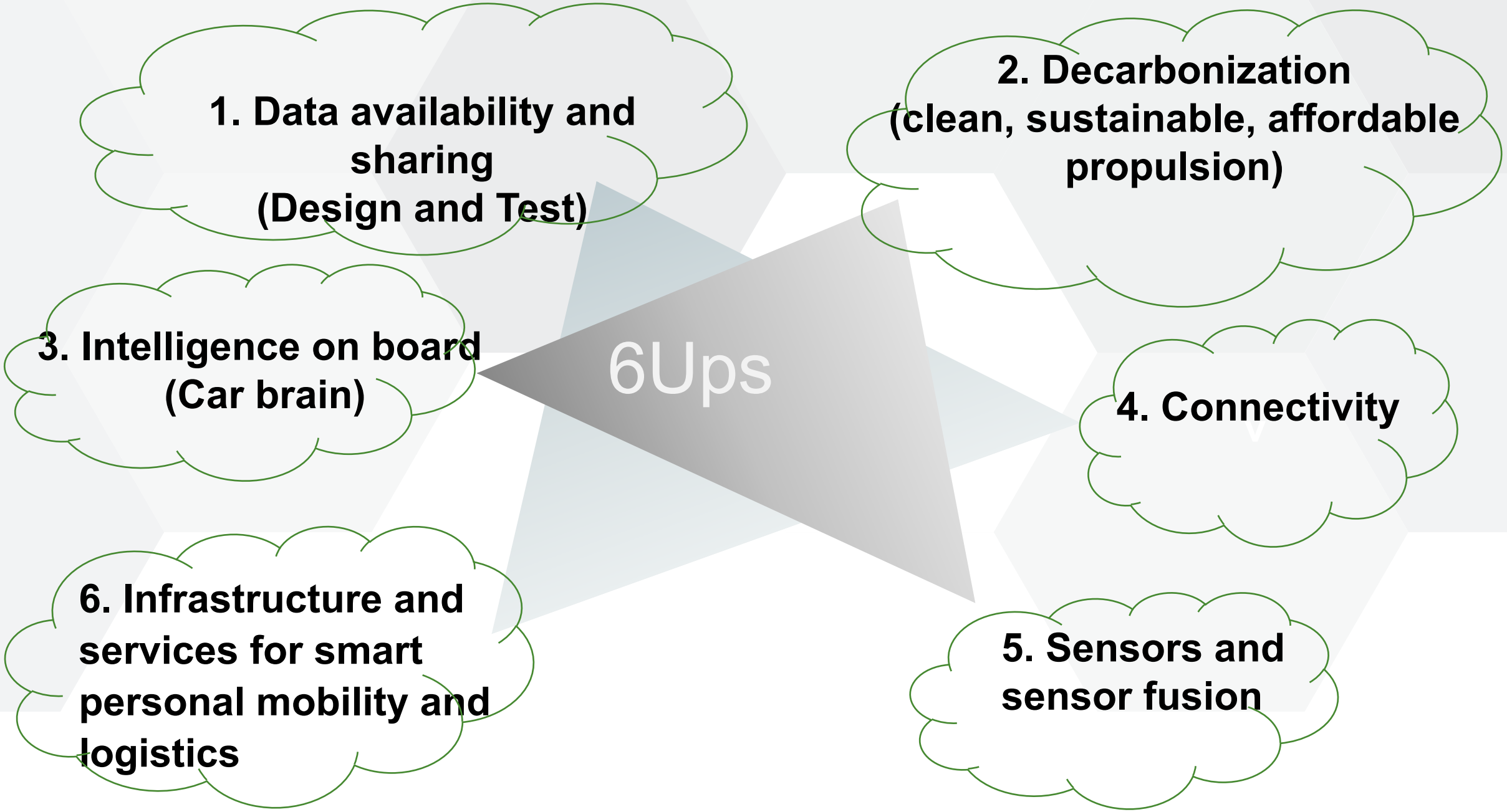
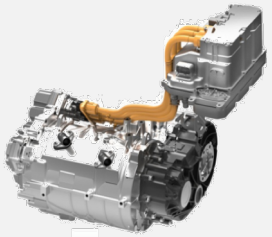
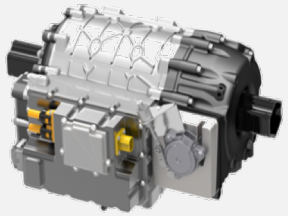


6 Urgent priorities (6Ups) to focus the lighthouse Mobility.E clearly

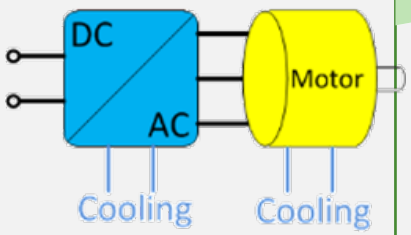
First generation el. Powertrains

No integration or built-on





E3Car



2008

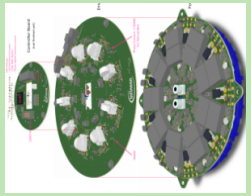
Nanoelectronic Component Integration
Electro-Mechanical Integration
Electronic System Integration

Functional Integration

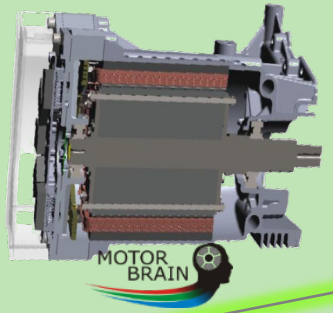
Motorbrain

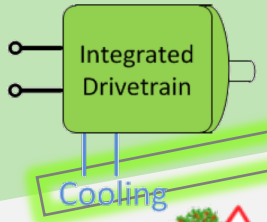
Axial integration

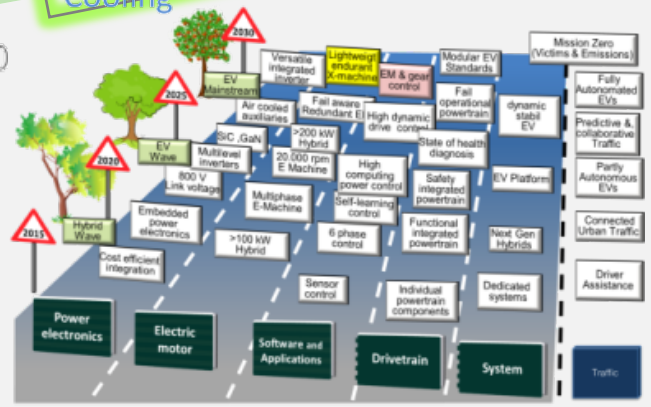
60 kW pk

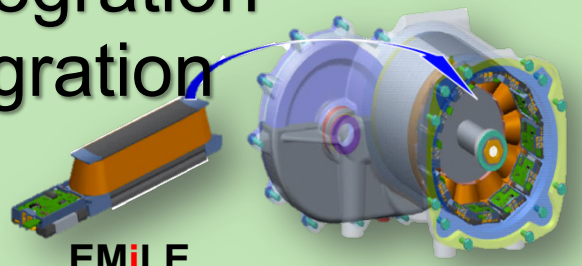


Easy integration
- Lower currents
- Smaller modules
- Better EMI
- Faster switching
- Higher efficiency
- Better scalability









EMiLE

Full tooth integration

80 kW pk

Silverstream

OSEM-EV

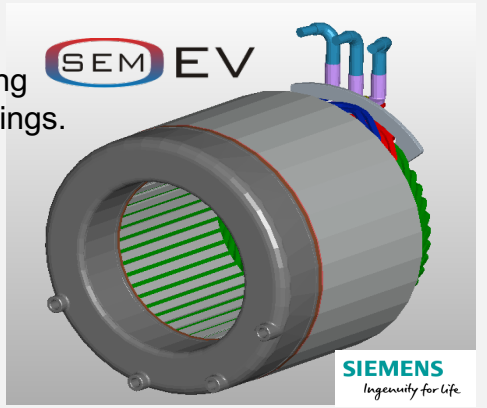
Direct coil cooling distributed windings. Hairpins

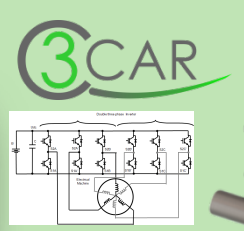
125 kW

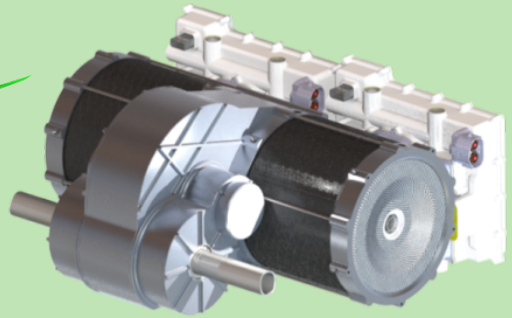
eDAS

Oil injection on end-windings

125 kW



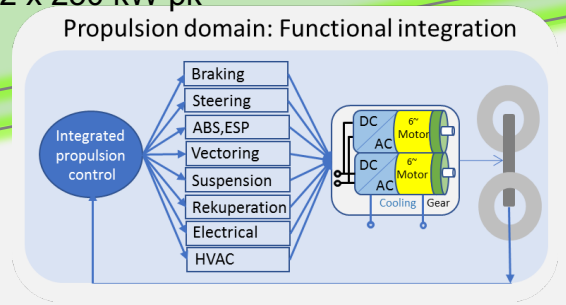




3Ccar

Gearbox, Inverter, Machine integration, very high speed, fail-operational

2 x 250 kW pk



Thermal-Electrical Integration

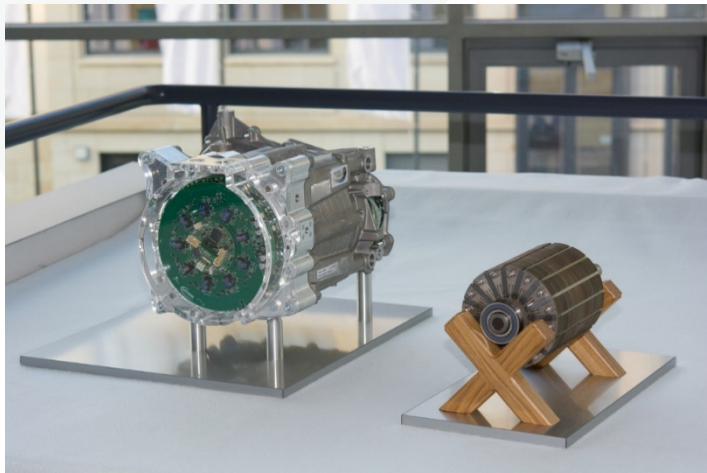
2018

FP7 ENIAC MotorBrain

Nanoelectronics for Electric Vehicle Intelligent Failsafe Power Train

- EU FP7 ENIAC initiative project, 2011-2014 - 30 partners from Austria, Czech Republic, Germany, Spain, Italy, Netherlands, Romania, Sweden, United Kingdom – Infineon, Siemens, ZF Friedrichshafen, Fraunhofer, TU Dresden, NXP, ST Microelectronics, Fiat,…
- Development of a new powertrain for electrical car, CEITEC involved in the drive control system design and implementation
- RG involved in electrical drive advanced fault tolerant control, energy efficient control, drive and electronics diagnostics
- Prototype presented at the Hannover Messe ”MobiliTec” in 2014

MOTOR BRAIN



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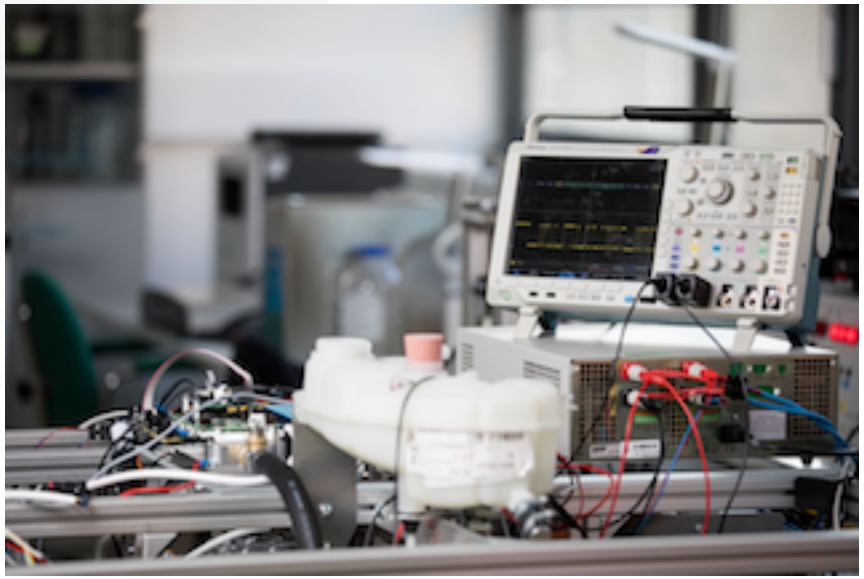
H2020 ECSEL 3Ccar

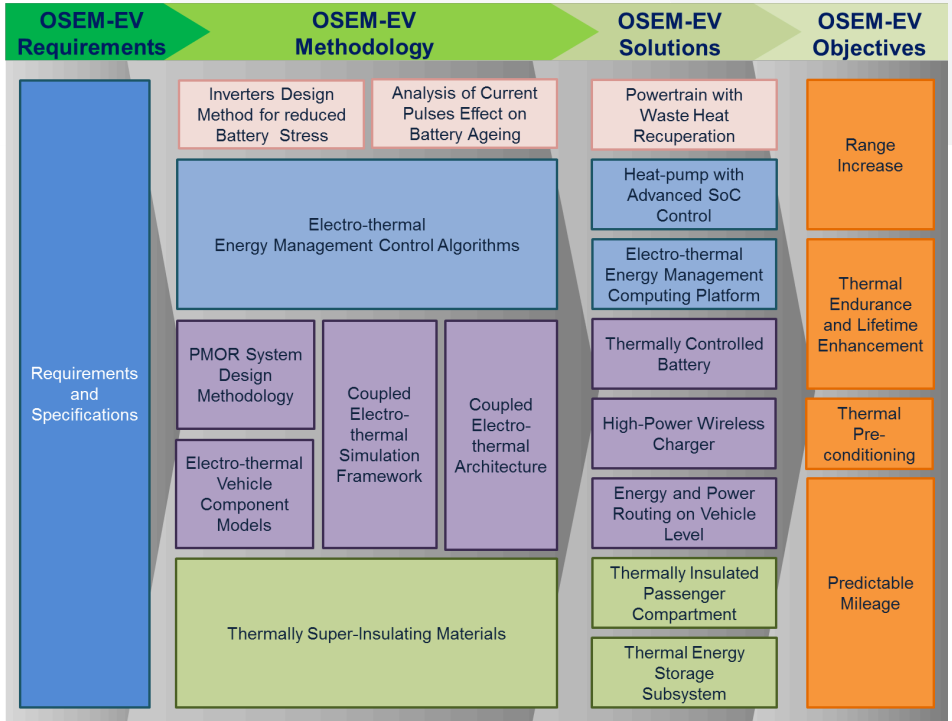
Integrated Components for Complexity Control in affordable electrified cars

- large EU H2020 JTI ECSEL project (2015 – 2018) – 50 partners, over 50 mil. EUR (Infineon, Daimler, Fraunhofer, Siemens, OTH-AW, TU Dresden, AVL, AIT, ITRI Taiwan,….)
- CEITEC responsible for development of control algorithms for powertrain and smart servos, electrified car energy management

H2020 OSEM-EV
Optimised and Systematic Energy Management in Electric Vehicles

- large EU H2020 project (2015 – 2018) – 12 partners, over 8 mil. EUR (Infineon, Daimler, Fraunhofer, Siemens, TU Dresden, AVL, Valeo….)
- development of new electro-thermal system architectures
- CEITEC responsible for development of control algorithms for energy flow management, heat-pump systems and powertrain



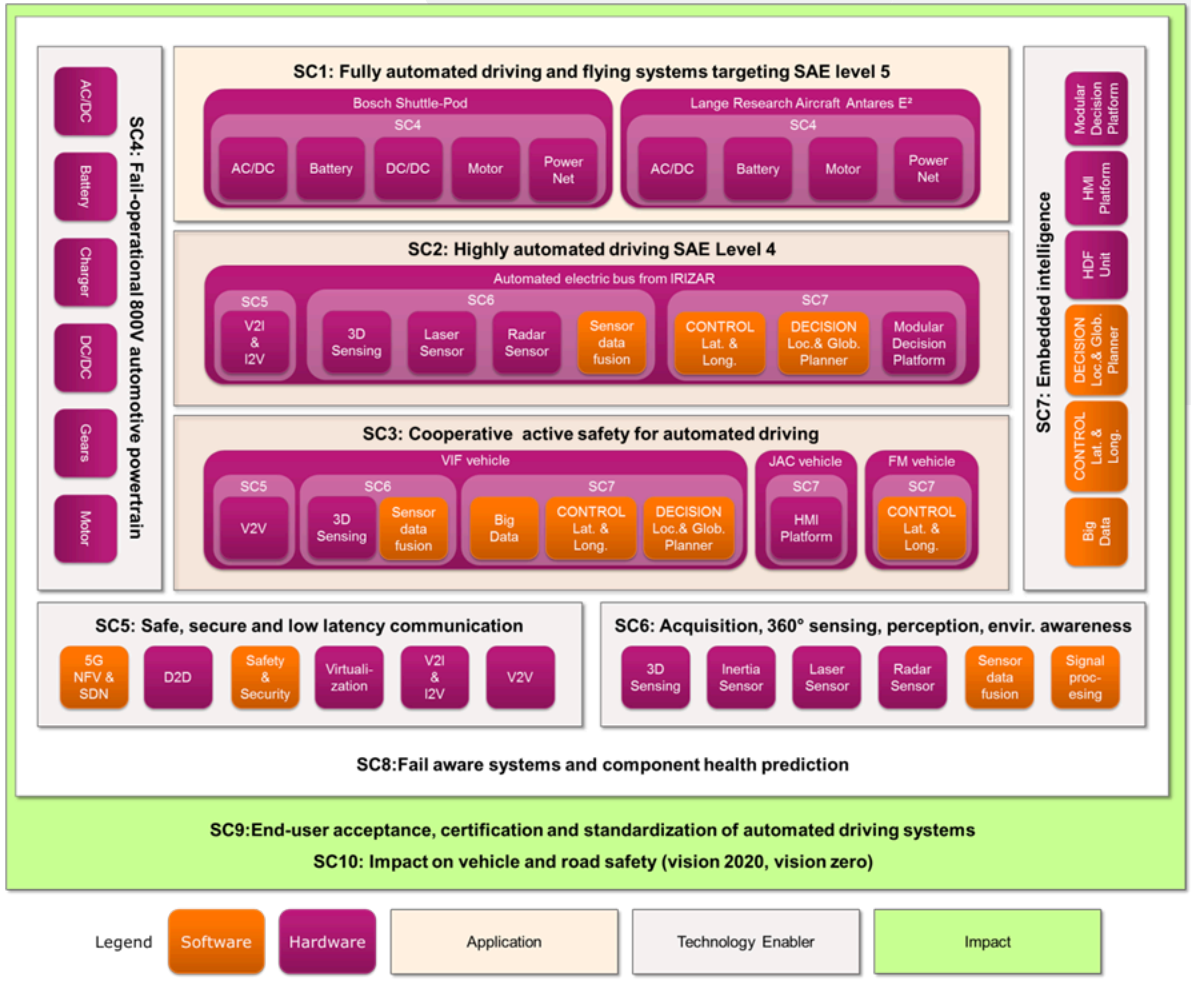


H2020 ECSEL AutoDrive

Advancing fail-aware, fail-safe, and fail-operational electronic components, systems, and architectures for fully automated driving to make future mobility safer, affordable, and end-user acceptable

- project aimed at highly and fully automated vehicles, covering sensing, perception, communication, decision/control and actuation subsystems.
- key industrial partners – Infineon Technologies, Daimler, BOSCH, ZF Friedrichshafen (60 leading companies and institutes from Europe + ITRI Taiwan)
- selected by EU to be cornerstone of Mobility 4.0 light-house initiative
  - clustering of EU automated driving research projects, standardization and commercial activities

AutoDrive



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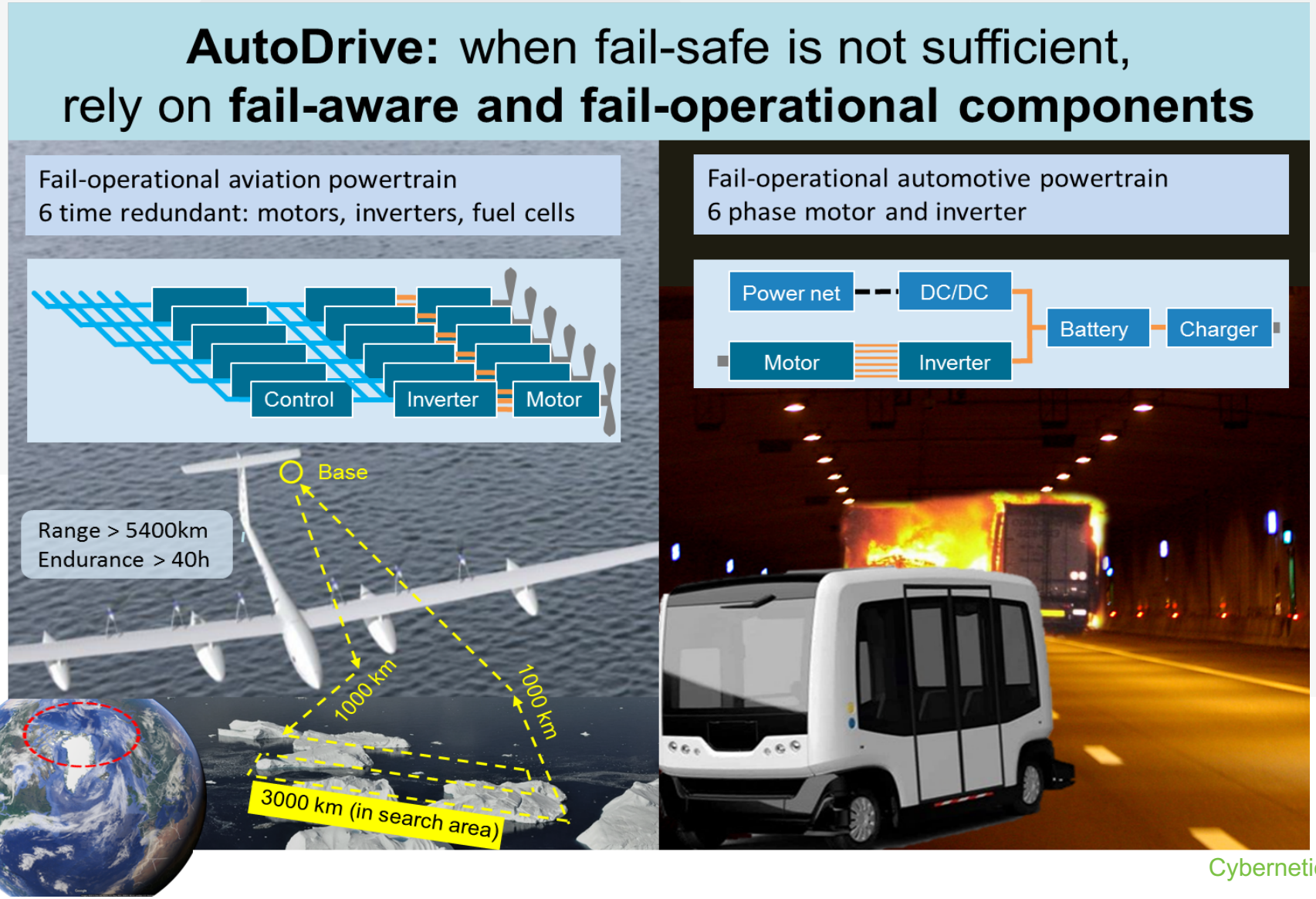
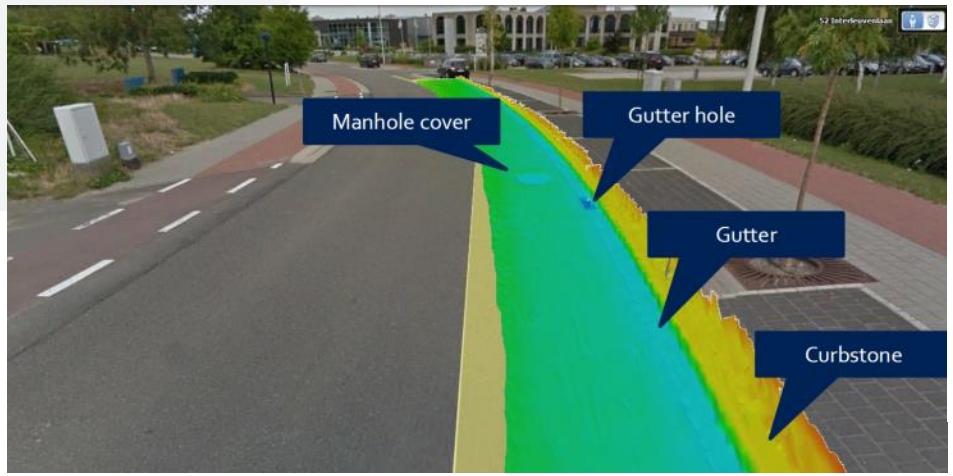
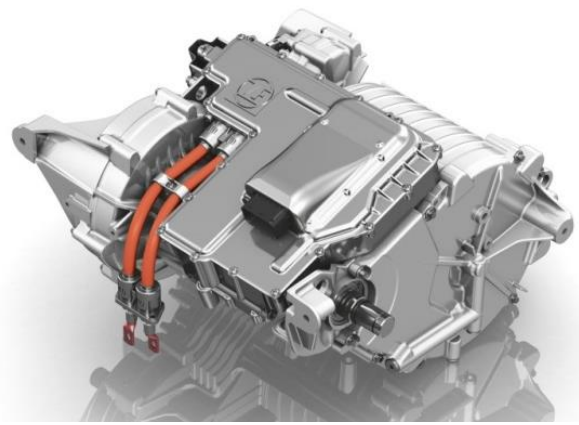
AutoDrive – design of technologies to be safe



AutoDrive – CEITEC contribution

- Fail-safe systems are not sufficient, automated driving will rely on fail-aware and fail-operational systems.
- Making links between automotive and airspace industry to make driving as safe as flying.
- CEITEC is key partner in AutoDrive project for
  - Control, monitoring and diagnostics of fail-operational powertrains (automotive / aviation electrical powertrains)
  - 3D surround sensing – 3D map building algorithms, navigation data fusion, SLAM techniques, moving obstacles detection





H2020 1000kmPLUS

Scalable European Powertrain Technology Platform for Cost-Efficient Electric Vehicles to Connect Europe

- Design of affordable FEV able to travel long distance trips at time comparable with ICE vehicle
- Key partners – Infineon Technologies, Daimler, Valeo-Siemens, IONITY, Fraunhofer
- New technologies
  - Highly efficient powertrain (inverted based on SiC power modules)
  - Battery management and high-speed charging (350 kW)
  - Routing, charging management
- Technologies will be demonstrated in Mercedes-Benz EQ

H2020 ECSEL NewControl

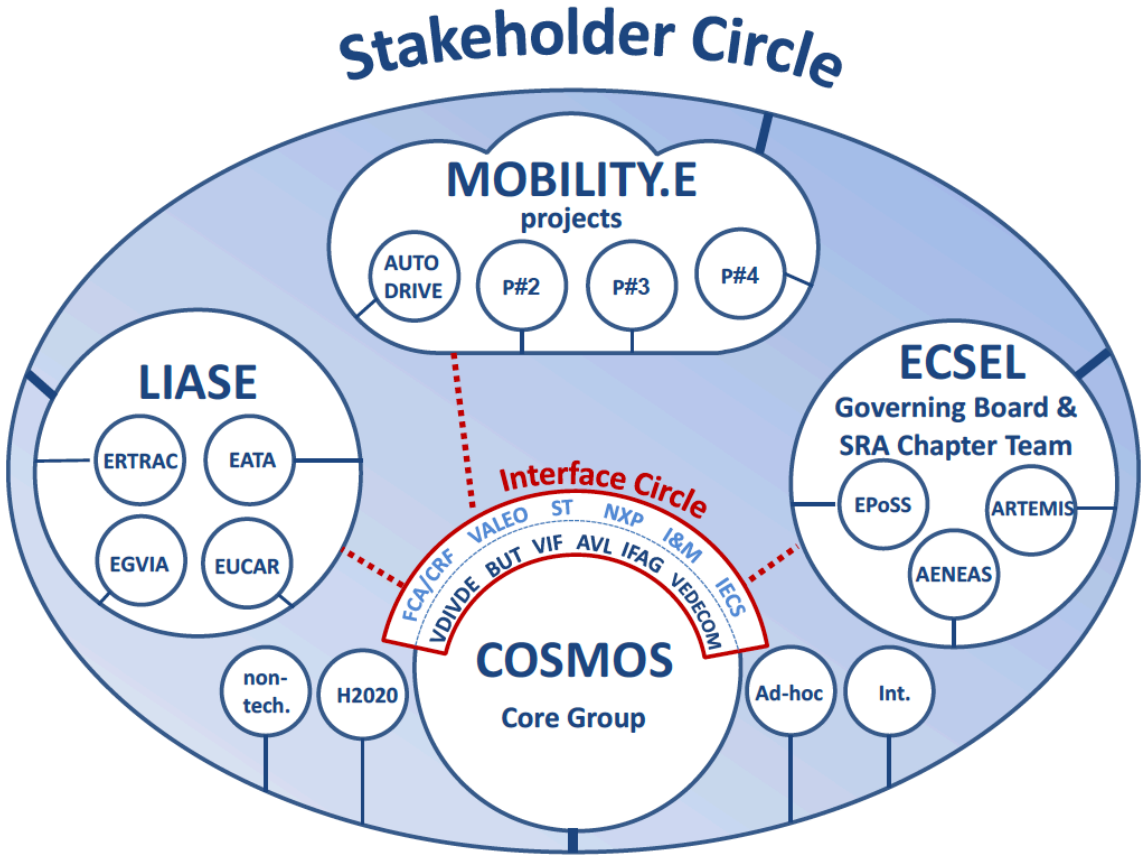
Integrated, Fail-Operational, Cognitive Perception, Planning and Control Systems for Highly Automated Vehicles

- Project just starting
- CEITEC responsible for
  - Powertrain control – predictive and adaptive control, faults mitigation
  - Powertrain diagnostics
  - Perception system and sensors – LIDARs, gyros, signals processing, scene interpretation

H2020 ECSEL COSMOS

COherent Support for MObility.E Strategy

- Support for EU light-house iniciative Mobility.E
- Research strategy development
- Projects clustering and synergies
- Key partners VDI/VDE-IT, Infineon, AVL



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