

A stylized, yellow and white graphic of a race car, viewed from the front, positioned behind the text.

***THE FULLY
NETWORKED
CAR***

Prof. Burkhard Goeschel

How Cars Communicate with their Environment

- analyze chassis data, e.g. handling, aerobalance, tire temperature
- derive necessary setup changes to improve car behavior, e.g. wing position, brake distribution
- analyze engine data in terms of performance and life time
- derive engine/ECU setup changes, done by the driver, e.g. lambda, ignition
- get objective data for race strategy decisions, e.g. pit stops, fuel quantity
- correlate the driver feedback with objective car data, prove driver requests
- Technology is restricted by rules: Only one way communication since 2003



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Performance of Formula 1 Telemetry Systems



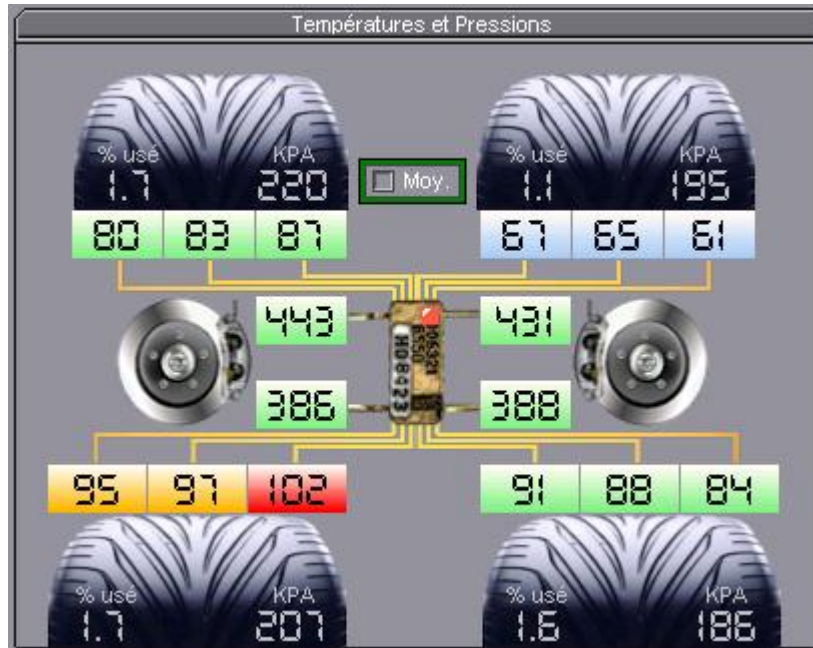
- o Voice and real time telemetry within one unit
- o Up to 400 independent data channels
- o 3-4.5 GHz transfer frequency
- o Transfer rate up to 1 Mbit/s
- o 2 ms maximal time delay to pit and to head office
- o On board data storage for low signal quality regions
- o 600 grams



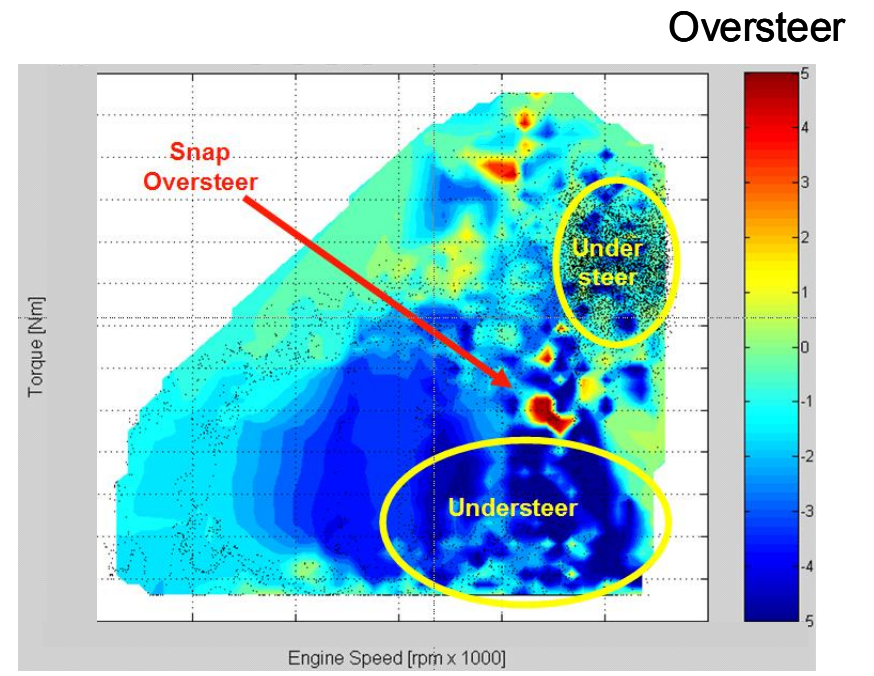
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Examples for Telemetry Data Analysis Results



Source: MOTEC



Source: AVL

Understeer



Changes in the industry require business transformation

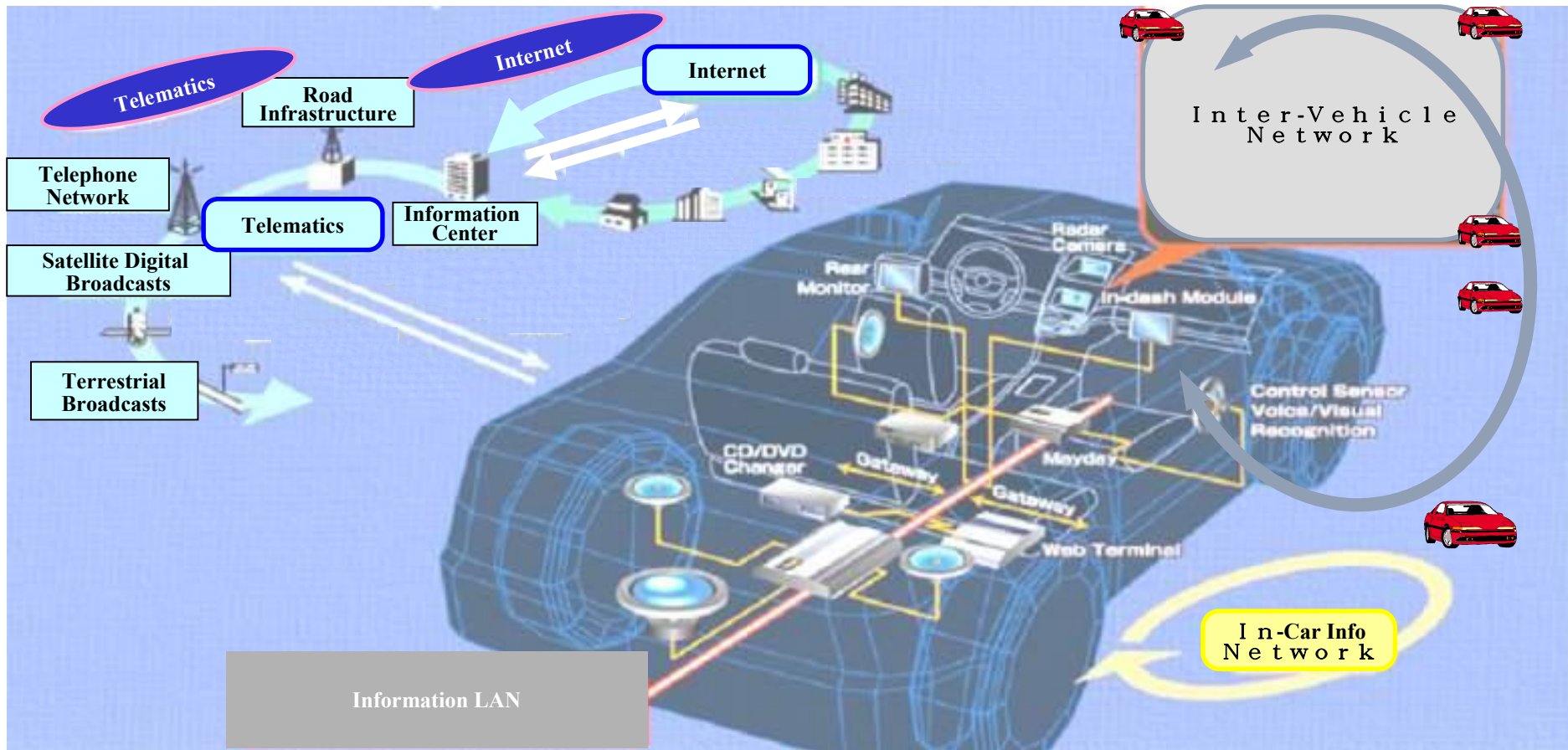


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- Increasing regulations (Emissions, Safety..) will drive vehicle and services complexity
- 90% of future vehicle innovations will be in electronics and software
- Warranty costs are exploding because of increasing electronics and software failures
- OEM/Supplier collaboration transforms from hierarchical to value net model with new entrants from IT and SW Industry
- Ongoing customer relationship from initial vehicle purchase through disposal
- Innovative information-based services and business models enabled by telematics will open up new profit streams



Future Mobility: C2X Communication, I2X Communication


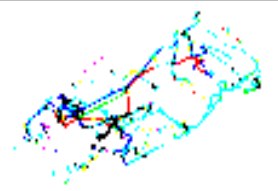






Source: ALPINE

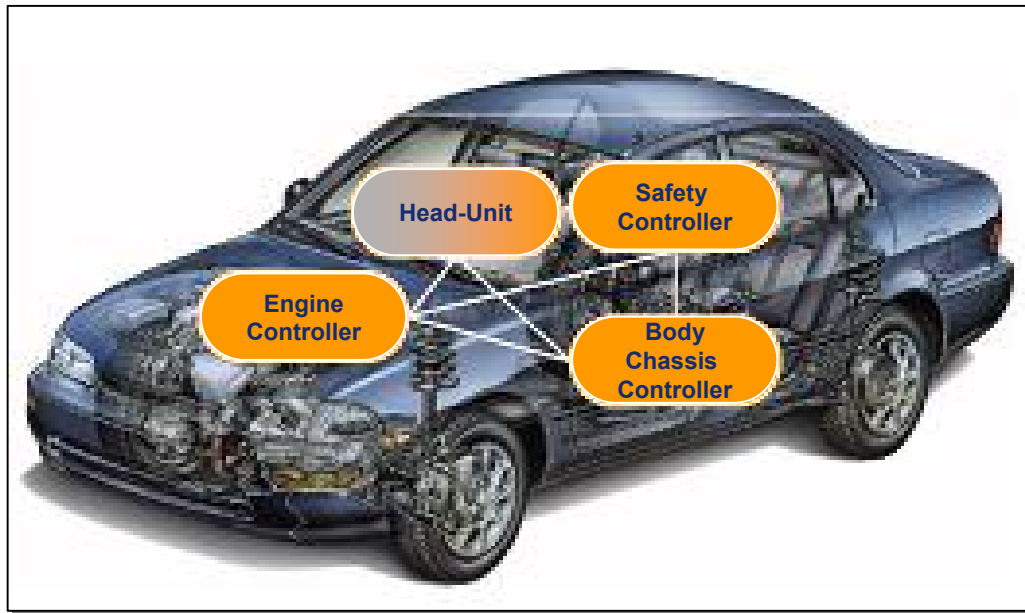
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Increase in Complexity

Wiring Harness per Vehicle:	 50-300m	 2-5km	 < 1-4km
ECUs per Vehicle:	 0-3 Units	 30-70 Units	 < 20-50 Units
Bordnet-Development / New Architectures:	empiric, evolutionary	component oriented, decentral, local and proprietary structures	functions oriented, highly integrated, holistic structures, standards (i.e. AUTOSAR)
	Yesterday	today	tomorrow

Future ECU integration potential



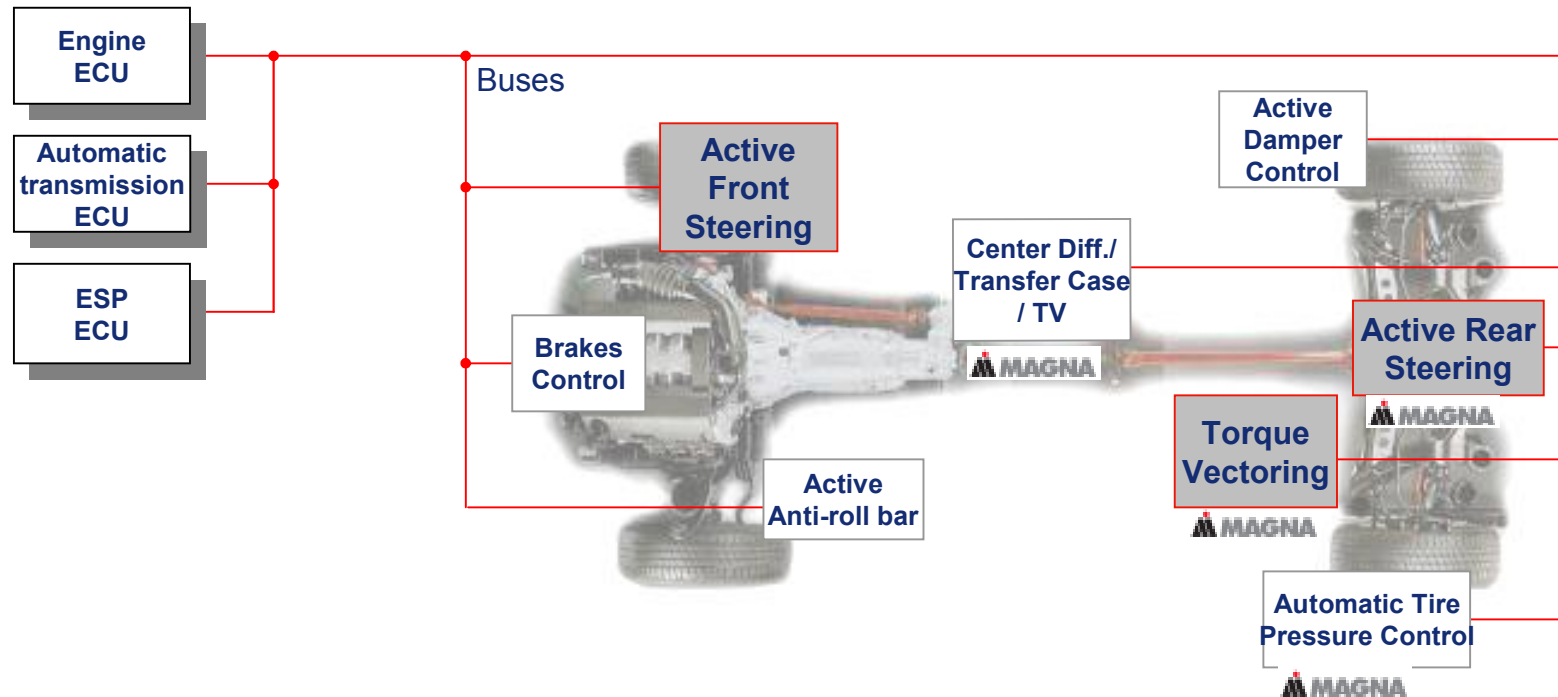
Key Point:
The number of vehicle ECUs could be reduced to a few as 3-5 at some point in the future*.

*Interviews have indicated that the number of ECUs will vary by OEM and by model

Source: Industry Interviews, Roland Berger Analysis

Example Chassis Control Systems: Today

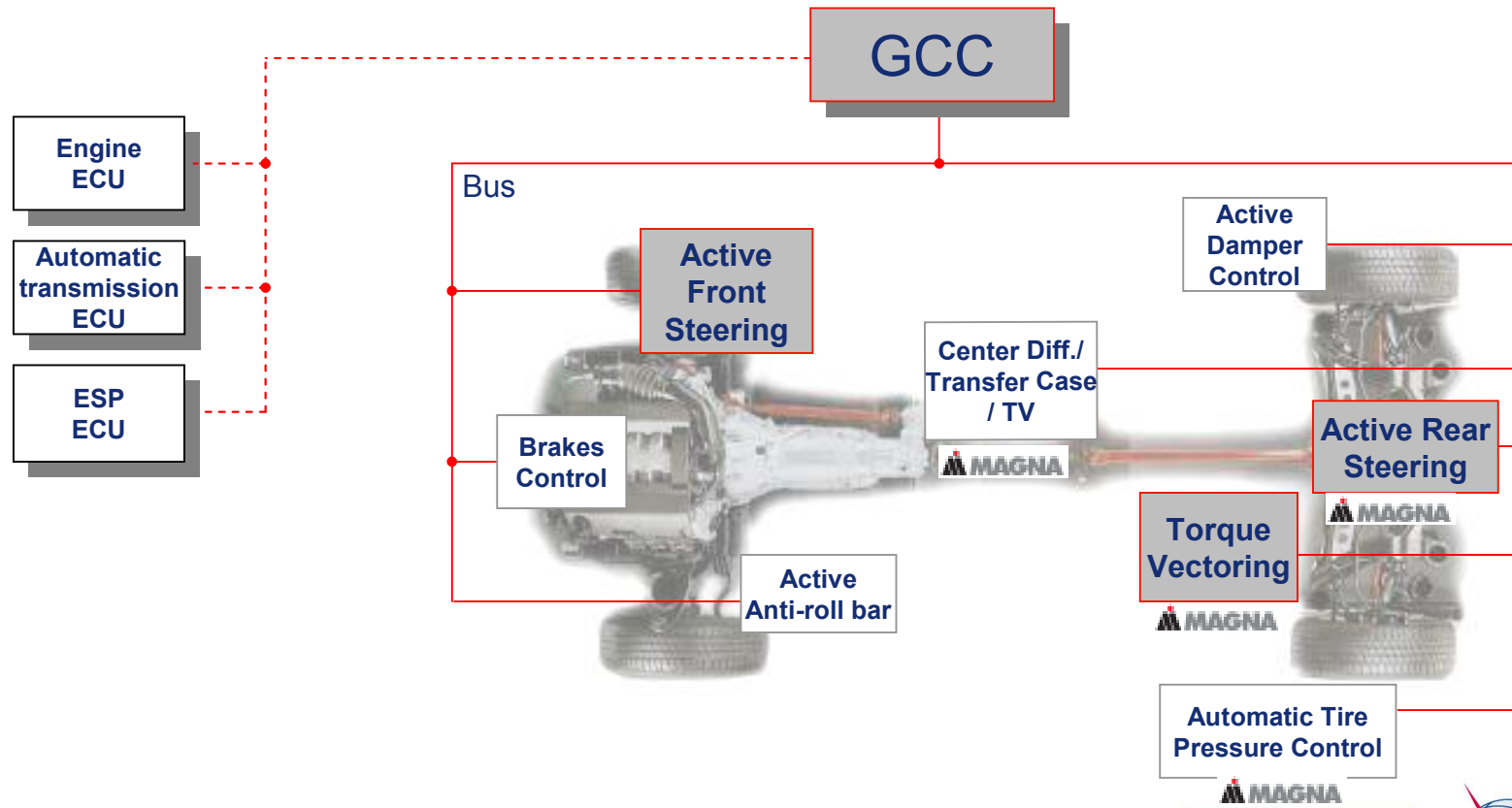
- o Combination of the systems results in high complexity
- o High application effort (different suppliers)
- o Interferences in vehicle dynamics control



Global Chassis Control: Tomorrow

Advantages

- Centralized coordination of the active chassis
- Extended possibilities (driver assistance systems)
- Less application effort and more modularity



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International
Telecommunication
Union

Electrified Powertrain Components („Drive by Wire“ components):

- Servo control/ steering help
- Brakes / Brake assist



Electrical steering



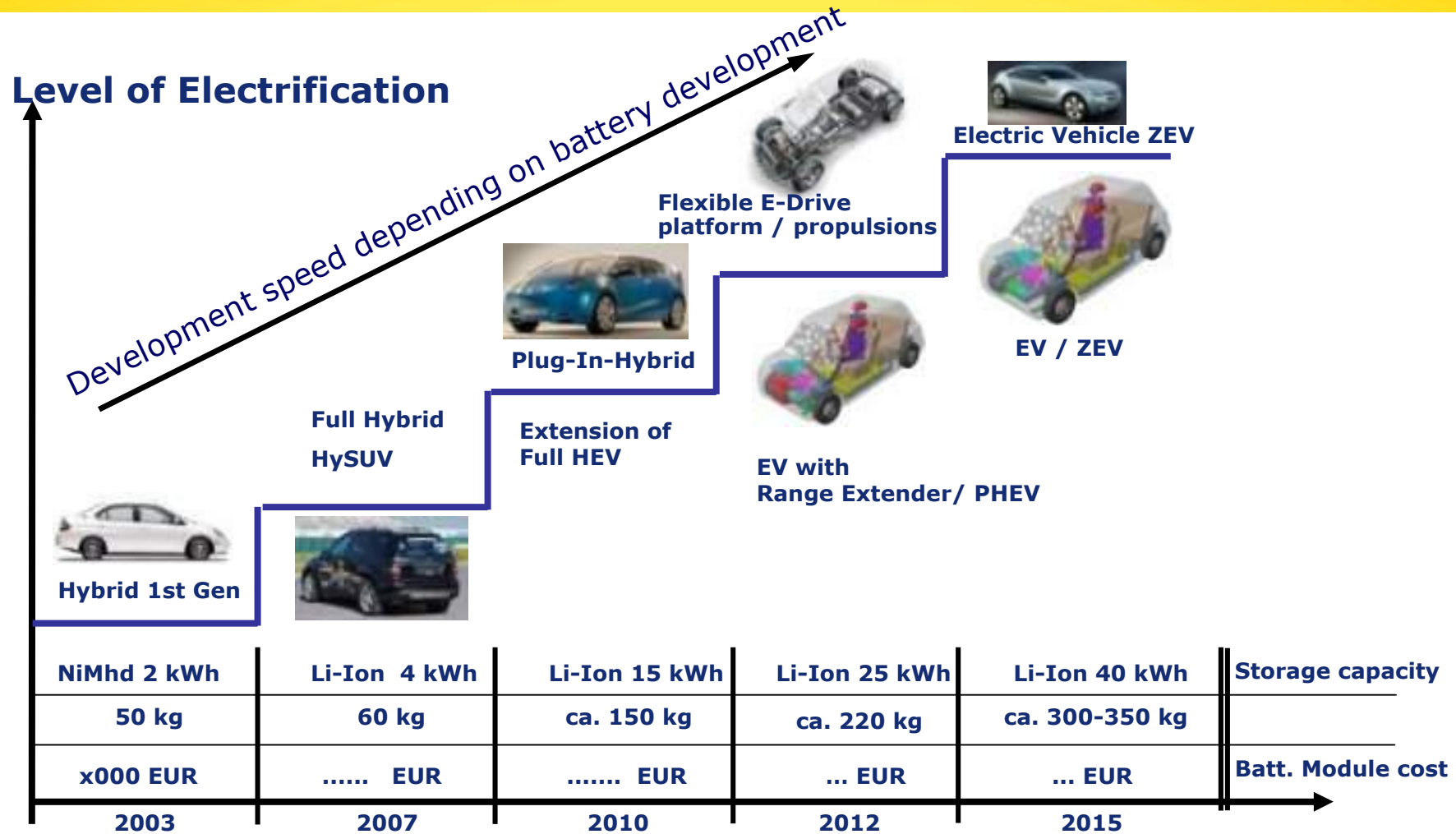
Electrified comfort components :

- Aircondition
- „Infotainment“
- etc



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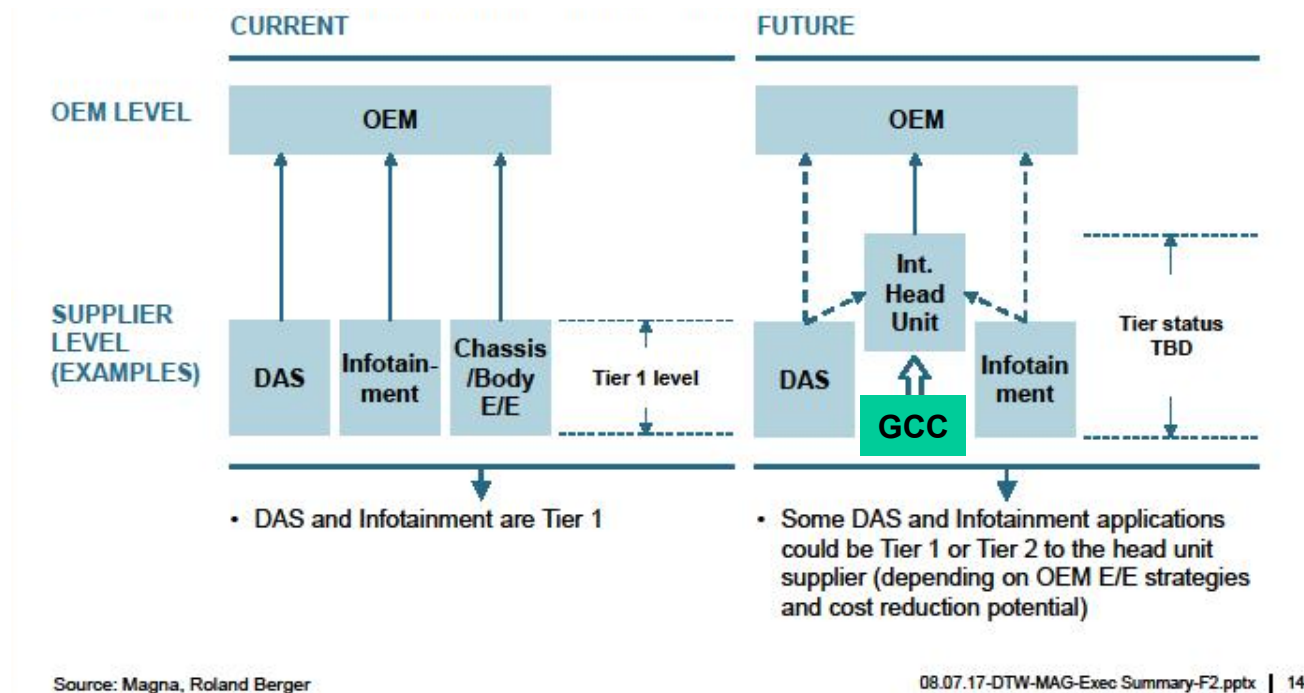
Electrification Roadmap MAGNA



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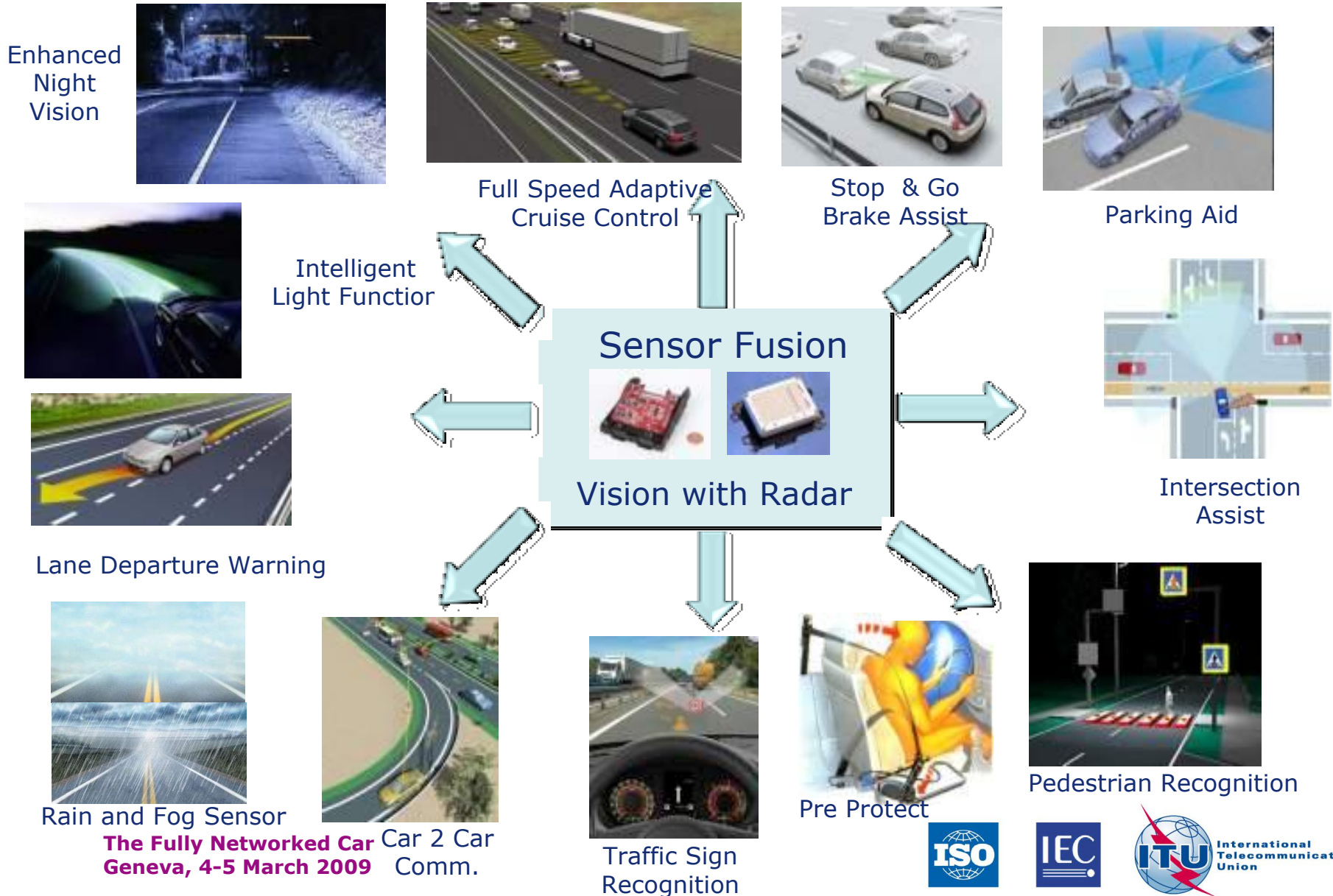


Possible Future Positioning of DAS and Infotainment Functions

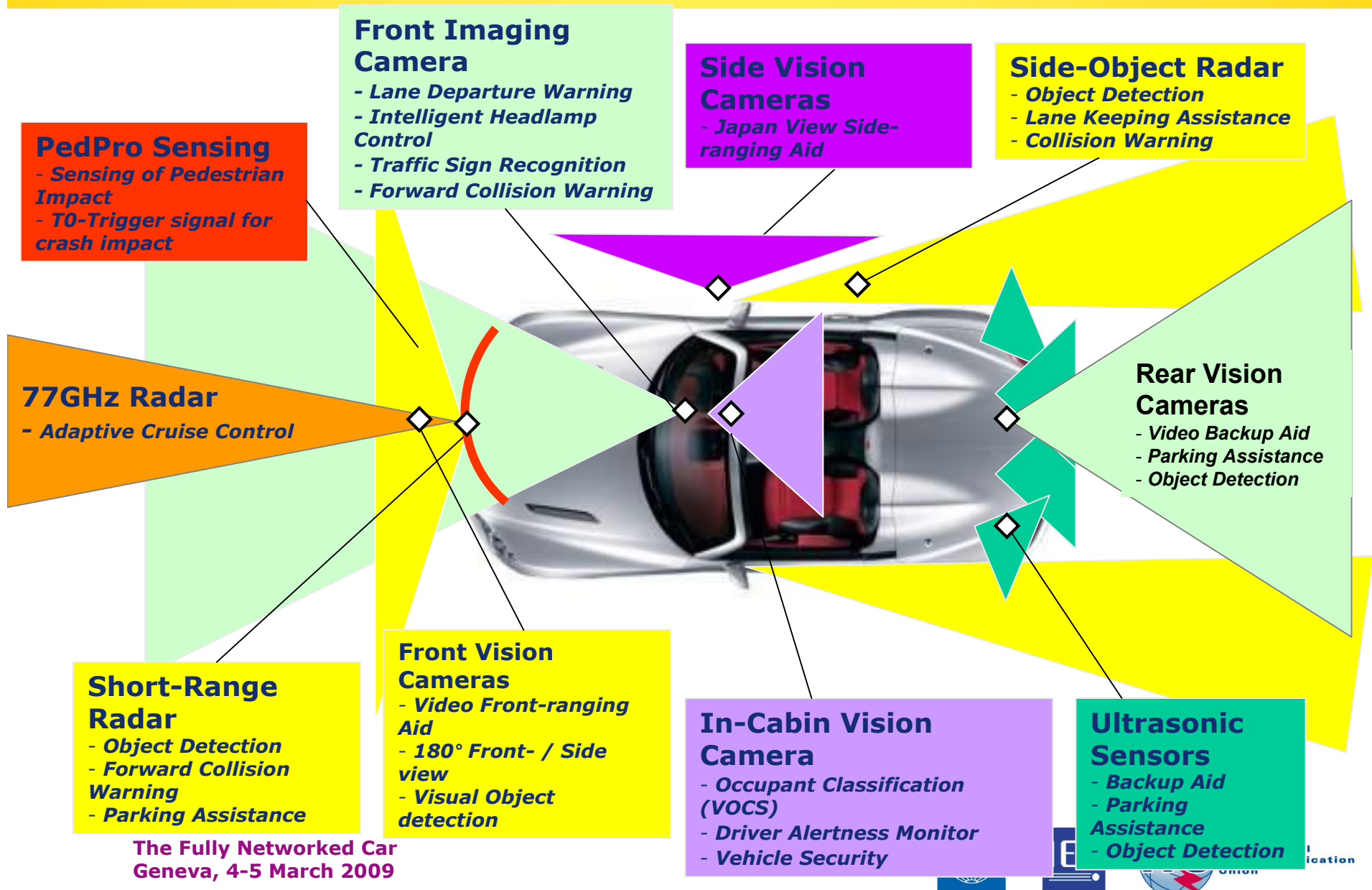


- o Future Head-Units will contain more functions than today, such as
 1. Advanced Driver Assistance Systems (ADAS)
 2. Integrated Chassis Controls (GCC)

Fusion of Vision with Radar Sensor Supports Additional Safety Features



Active and passive driver assistance systems



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Governmental Regulations

Need for more Safety

Electrification of

- Entire Powertrain
 1. Battery,
 2. DC/DS,
 3. DC/AC
 4. Electric Motors
- Aggregates: Braking, Steering, Damping..

Sensorics

- X2X Communication
- Driver Assistance Systems
- Traffic Control Systems
-
- COMPLEXITY: Int/Ext Data
- Data Analysis/Data Redundancy
- Actuators

New Board Net Architectures