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Advancing safe technologies, improving human lives.

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Dr. Edin Arnautovic
Coordinator R&D Projects

Towards Automated Driving-
Safety-Critical Supercomputer on Wheels

6/15/2018

What Do They Have in Common?

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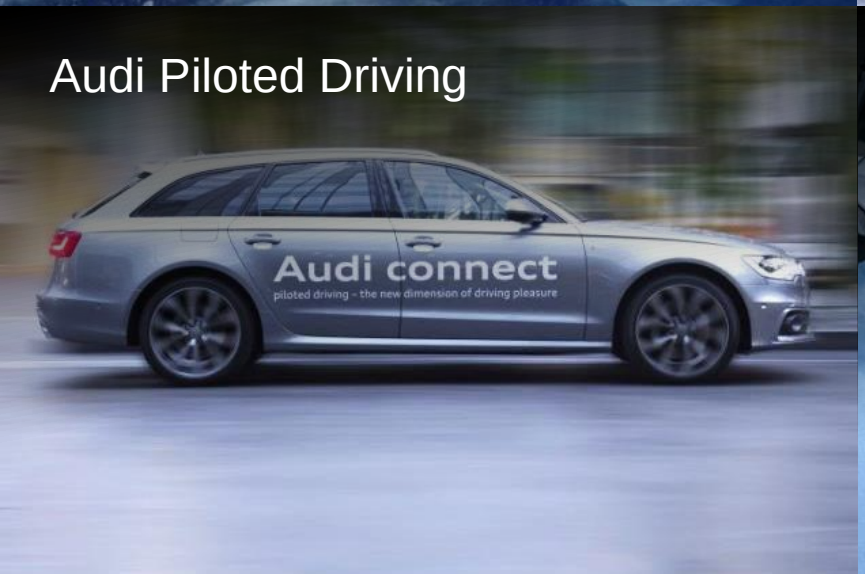
Reliable Networks and Safety Controls from TTTech

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The future of mobility
is automated

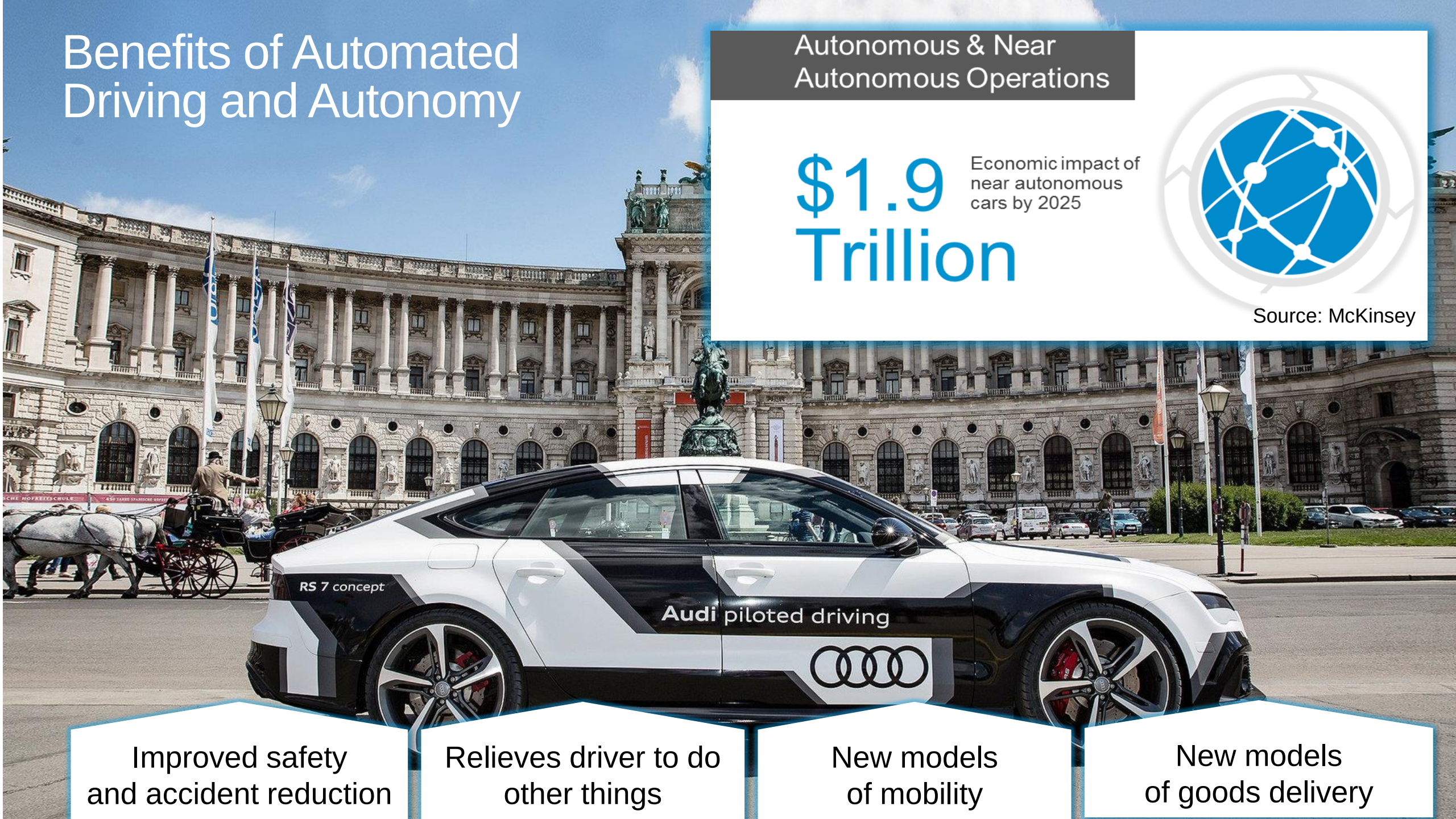
Benefits of Automated Driving and Autonomy

Autonomous & Near Autonomous Operations

$1.9 Trillion

Economic impact of near autonomous cars by 2025

Source: McKinsey



- Improved safety and accident reduction
- Relieves driver to do other things
- New models of mobility
- New models of goods delivery

SAE Automated Driving Levels

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SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

Full Automation

0	1	2	3	4	5
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**High Automation**	**Full Automation**
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Automated Driving 2005: DARPA Grand Challenge

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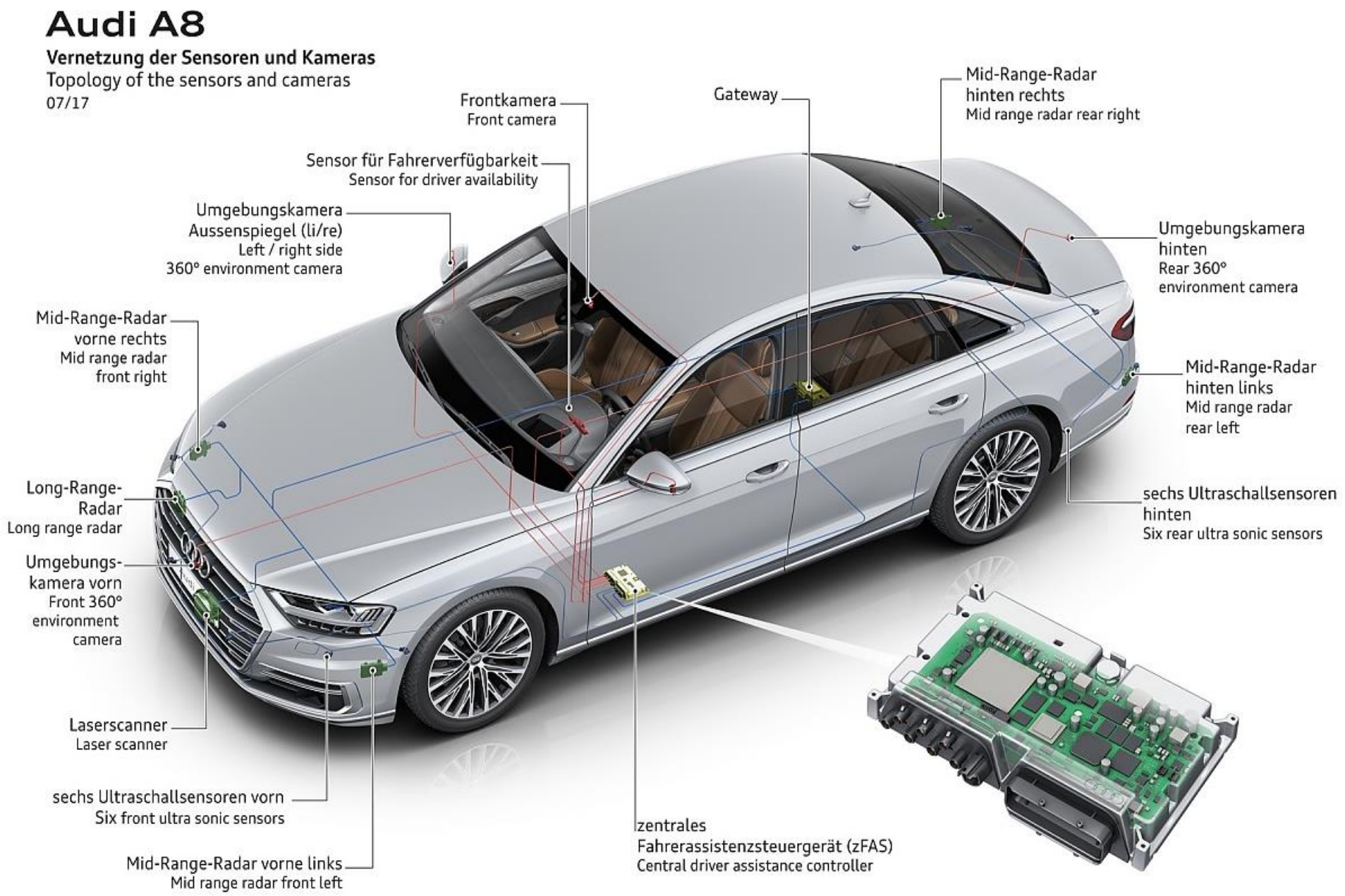
- 4 Pentium III for 360° RADAR interface, Long range LIDAR interface, etc
- 7 Pentium Ms PCs for Short range LIDAR interface, Path planning & tracking, Drive-by-wire interface, etc.

Automated Driving 2017: zFAS - Advanced Driver Assistance System



TTTech - zFAS: Advanced Driver Assistance System Platform for Audi

Car Electronics Architecture - Today's Critical Limitations (1)

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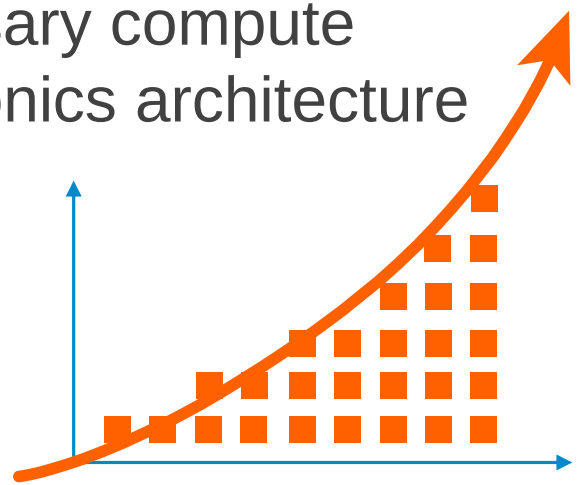
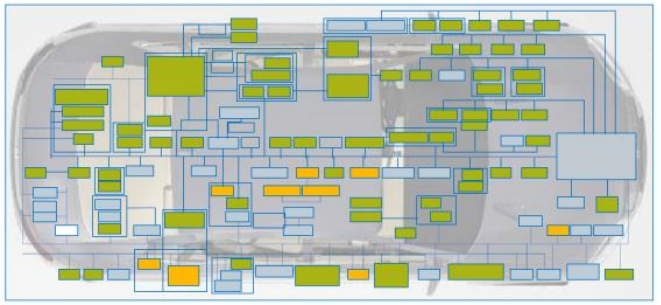
- Rapid growth of software functionality and the necessary compute performance cannot be addressed with current electronics architecture and ECUs
  - autonomous driving
  - connectivity
  - Infotainment
  - electrification & hybrids
  - new mobility
- Too many ECU's with too little processing power and memory





Car Electronics Architecture - Today's Critical Limitations (2)

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- Innovation cycle for features too slow
- SW/HW upgrades for existing car models difficult to impossible
  - monetization of upgrades
- Too little SW synergies between ECUs
- Scaling for different feature take rates too costly
- Too little technology synergies with consumer / mobile industry

Requirements for Next Generation Car Electronics Architecture (1)

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Limitations

- Rapid growth of software functionality cannot be addressed with current electronics architecture and ECUs
  - autonomous driving
  - connectivity
  - Infotainment
  - electrification & hybrids
  - new mobility
- Too many ECU's with too little processing power and memory

Requirements

- Scalable, high-performance compute architecture
- drastically reduced ECU count
- real-time, safety and security functions run side-by-side
- high availability and fault-tolerance
- dynamic software re-load and upgrade

Requirements for Next Generation Car Electronics Architecture (2)

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Limitations

- Innovation cycle for features too slow
- SW/HW upgrades for existing car models difficult to impossible
  - monetization of upgrades
- Too little SW synergies between ECUs
- Scaling for different feature take rates too costly
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Requirements

- Compute- and network level virtualization
- Re-use of cloud and mobile technologies (software and hardware)
- Unified, feature-rich and dynamic software platform for faster development

Virtualization

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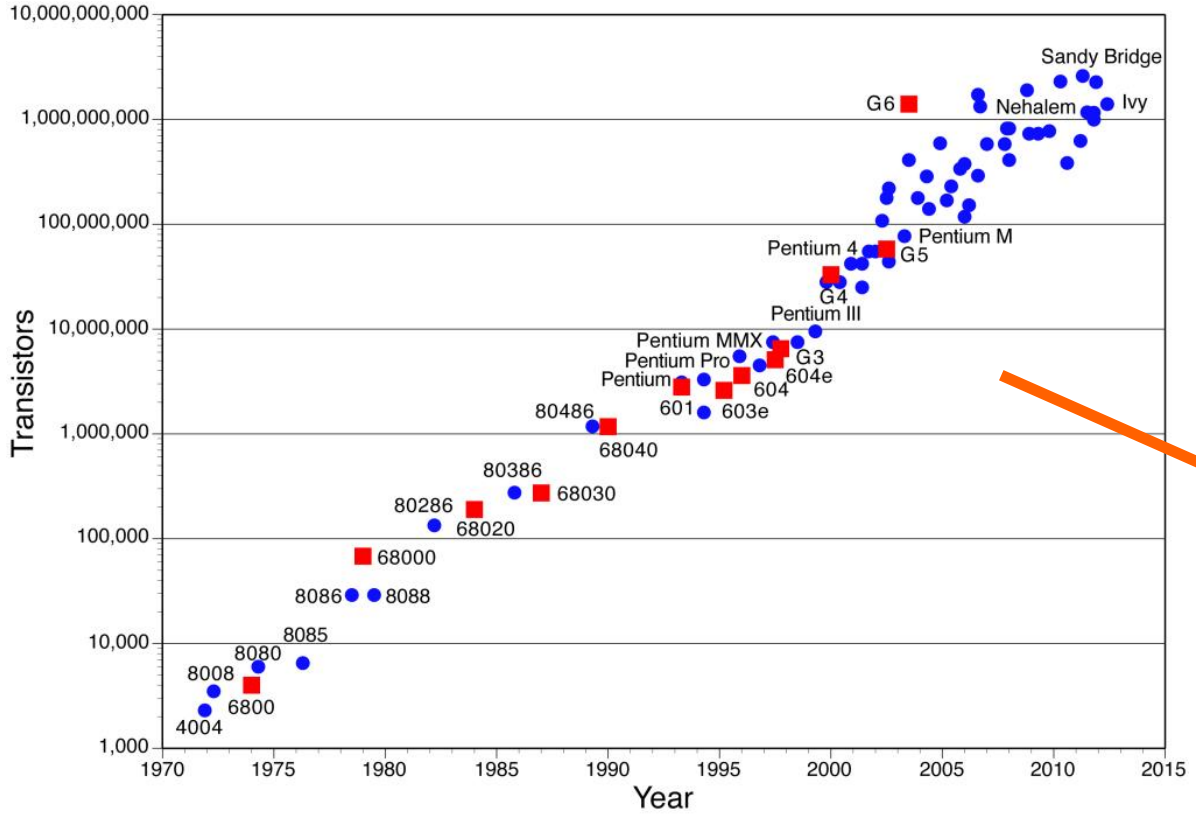
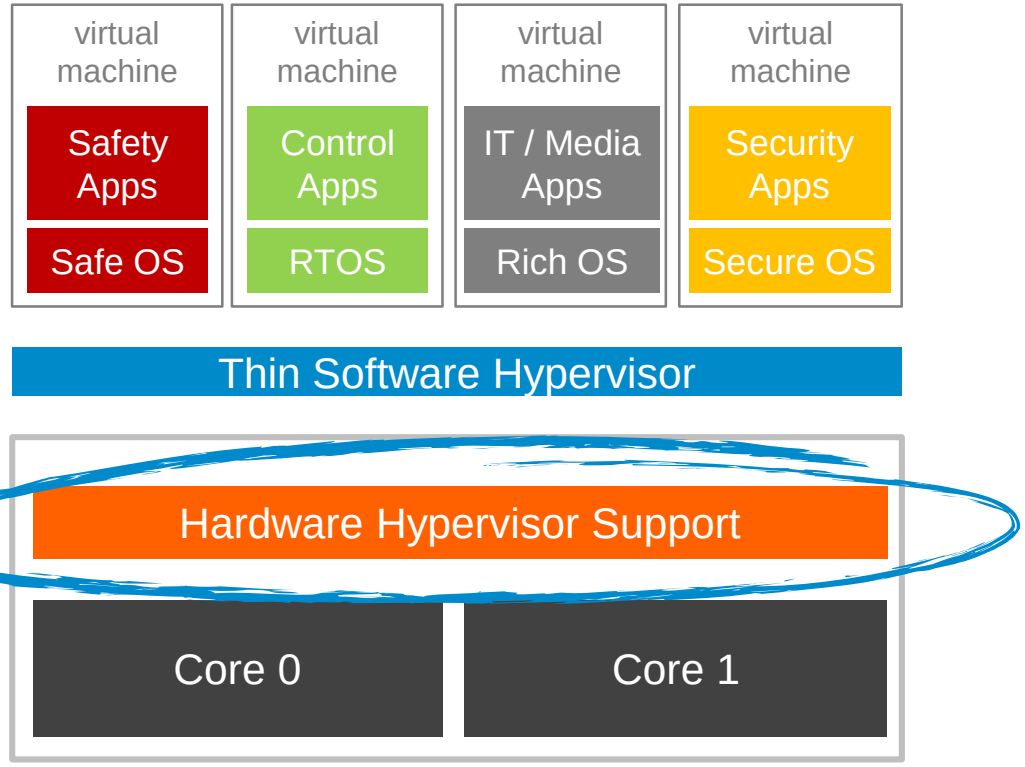
Moore's Law Alive and Well
Heterogeneous Multi-Core



Hardware Supported Virtualization at Chip Level Possible



Automotive Systems Need To Become Fail-Operational

Driver takes over control

Driver needs some time to be prepared for take-over

- System is no longer fail-safe
- Fail-operational behavior for at least a limited time is required

or System needs to reach safe state

Stop car 0 km/h

Lane change to the side and stopping

Reaching a safe state is a limited function that can be automated

Driverless Cars:

90 Percent Done,

90 Percent Left To Go

Sacha Arnoud, director of engineering at Waymo (Google)

Audi RS 7 piloted driving concept @ Hockenheim Ring

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