Smart Automotive Domain Gateways

Khaldoun Albarazi

Market Development Engineer

Automotive Product Division

STMicroelectronics

life.augmented

ST Developers Conference | September 12th, 2019
Santa Clara Convention Center - Mission City Ballroom
Santa Clara, CA

Agenda

- Automotive Industry Transformation
- Technology Drivers
- Architecture Evolution
- Advanced Processing Demand

Agenda

- Automotive Industry Transformation
- Technology Drivers
- Architecture Evolution
- Advanced Processing Demand

Automotive Industry Transformation

From Simple Mechanics to Complex Electronics

Computational Power

Mechanical era

Car Engine

Electronics era

Gasoline / Diesel ECUs

Software in-car networking era

Data Processing
Hybrid Engine

End-to-End User Experience
Environmentally Friendly
Cloud / Data Business Model

Connectivity
& Full Electrification

Poor Drivability
High maintenance costs

Electronic Engine Control
Manual Gearbox

Automatic Gearbox
Driver Assisted

Smooth Electric Engine
No gearbox / No thermal engine
Maintenance free

Mainly Analog &
Power ICs

1st Simple MCU's

16-bit MCU's

32-bit MCU's

Multicore, Virtual Cores, High processing,
Security & Fast connectivity

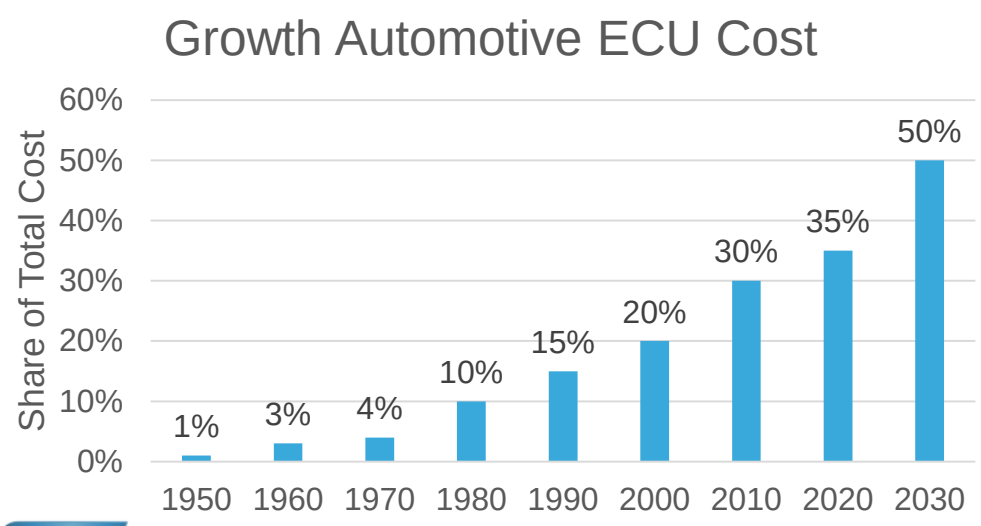
1900 **1970** **1990** **2010** **Today**

life.augmented

Today's Automotive System

Application Segmentation

- 70-90 ECUs on average
- 8-12 communication buses
- Various communication protocols
  - CAN
  - LIN
  - Ethernet
  - Flexray ..



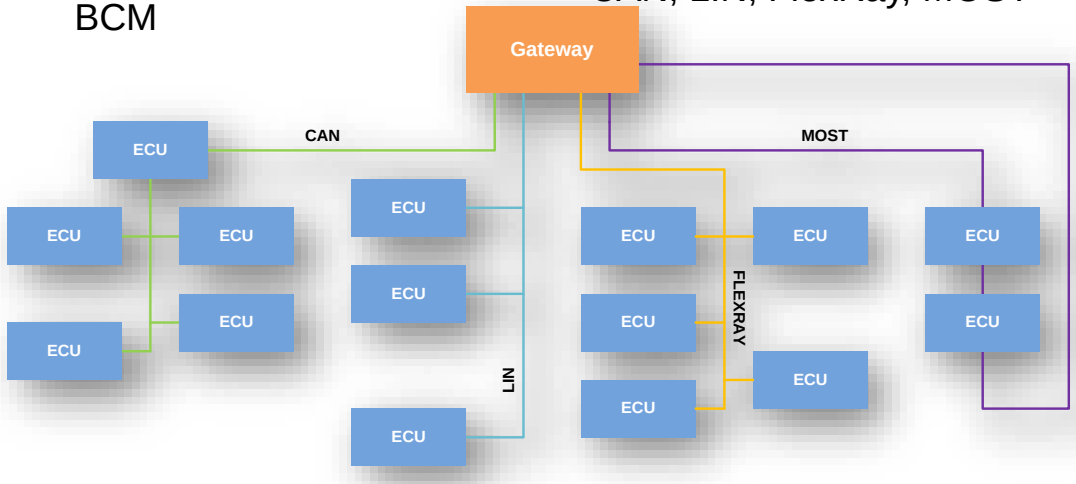
Source: Statista

Previous & Current Architectures

Topology and Key Properties

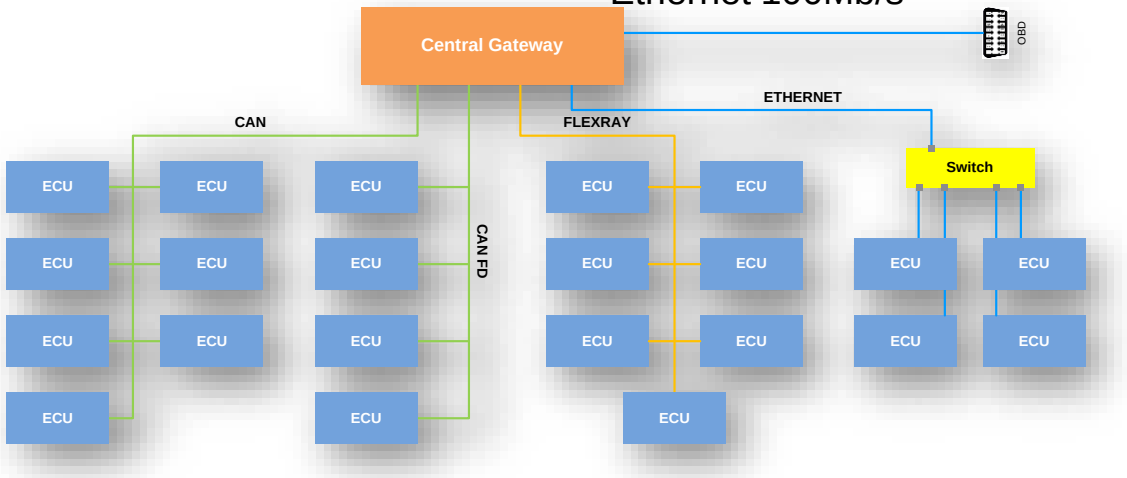
Legacy Network

- Distributed / modular flat architecture
- Dominated by classic CAN
- Low protection level
- Gateway integrated into BCM
- Each ECU serves specific function
- Application-specific buses and many 1-to-1 direct communication links
- CAN, LIN, FlexRay, MOST



Current Network

- Basic functional integration
- Multiple network interfaces
- More function-specific ECUs
- Security becomes crutial
- Introduction of OTA
- Application-specific buses and multiple 1-to-1 direct communication links
- CAN FD, LIN, FlexRay, Ethernet 100Mb/s



life.augmented

Agenda

- Automotive Industry Transformation
- Technology Drivers
- Architecture Evolution
- Advanced Processing Demand

Technology Drivers

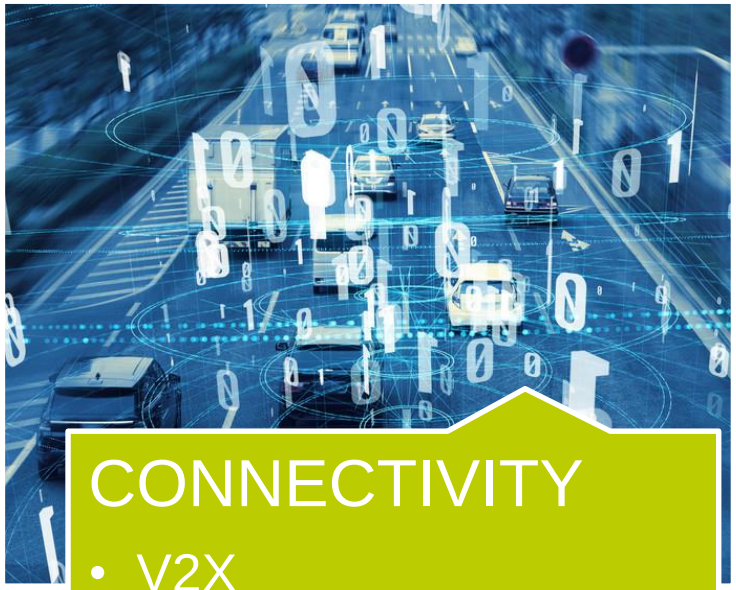
Major Trends

ADAS & AD

- Sensor fusion
- Safety & security
- Artificial intelligence

ELECTRIFICATION

- System integration
- Functional safety
- Cost optimization

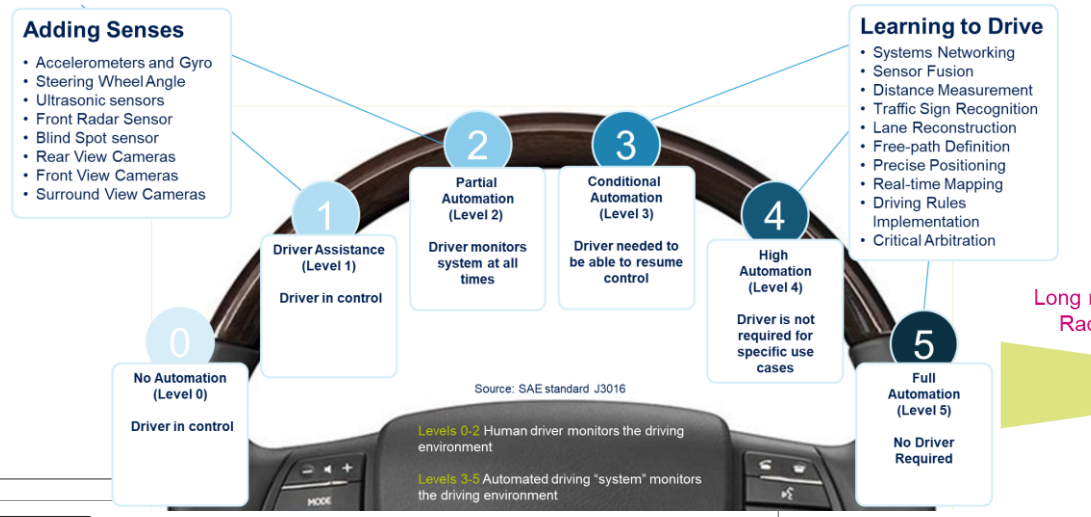


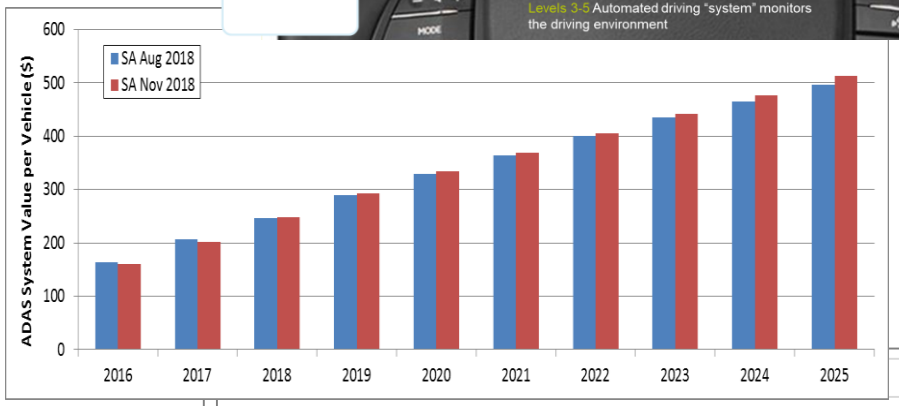
CONNECTIVITY

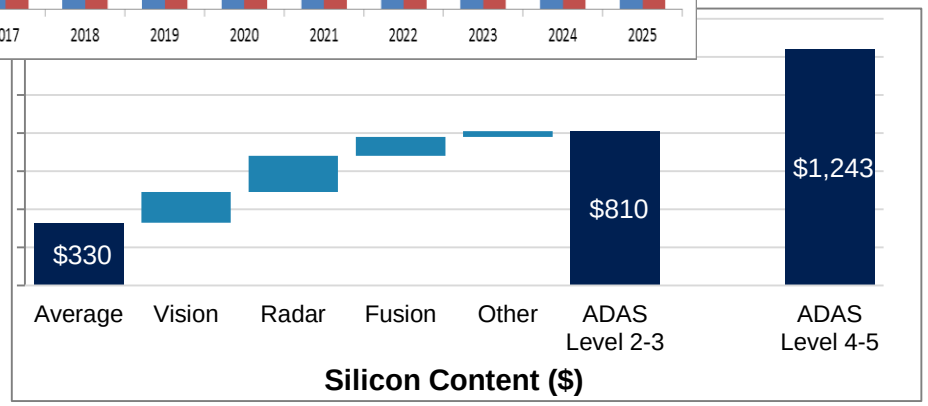
- V2X
- Cloud computing
- Media streaming
- Over-The-Air

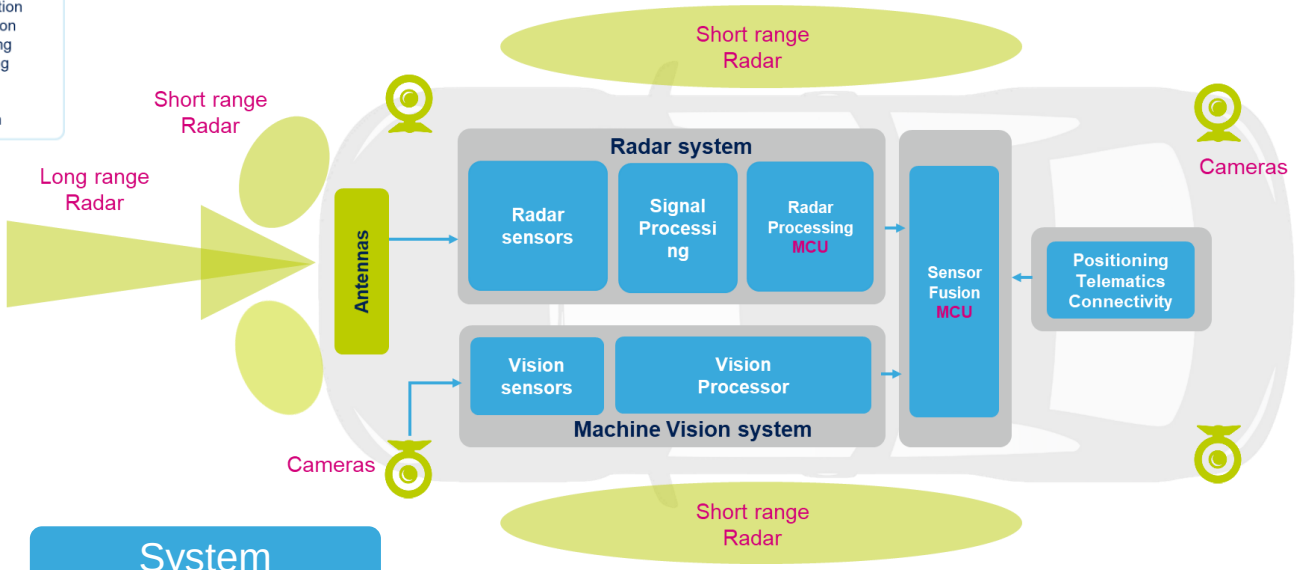
ADAS / AD

System, Trends, and Challenges









System

- **ADAS:** Camera, Radar, and LiDAR coupled with V2X, Telematics, and GNSS
- **AD:** Higher level of autonomy and controllability

Trends

- ADAS value per vehicle will grow from $160 to $512
- Silicon content will grow with automation level

Challenges

- Higher level of integration
- Centralized decision making
- Safety pushed to the next level "Fail-Operational"
- Improved reaction time
- Security becomes a top safety priority

Source: Strategy Analytics

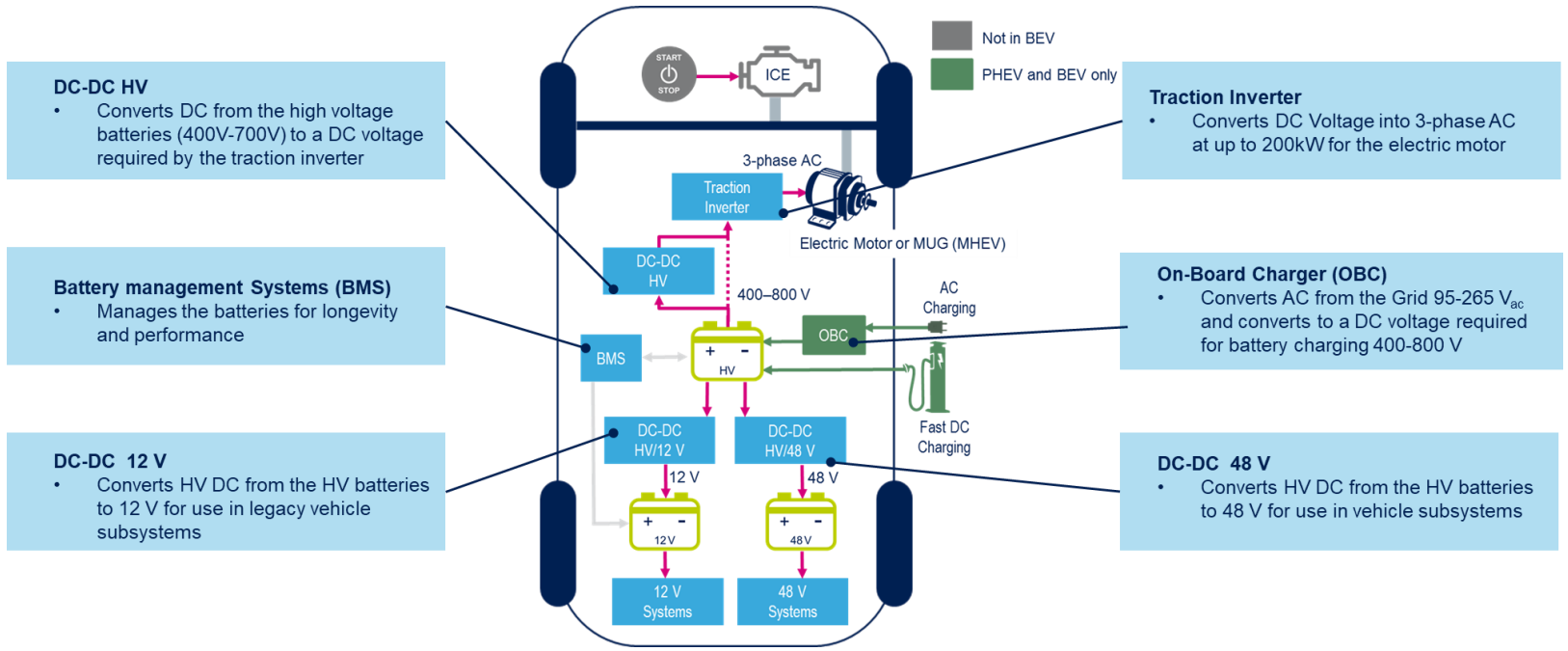
life.augmented

Electrification

System, Trends, and Challenges

System

- **Hybrid Electric Vehicle (HEV):**
  engine plus motor (small motor/battery)
  Plug-in Hybrid Electric Vehicle (PHEV):
  HEV plus charger (medium motor/battery)
  Battery Electric Vehicle (BEV):
  PHEV minus engine (large motor/battery)

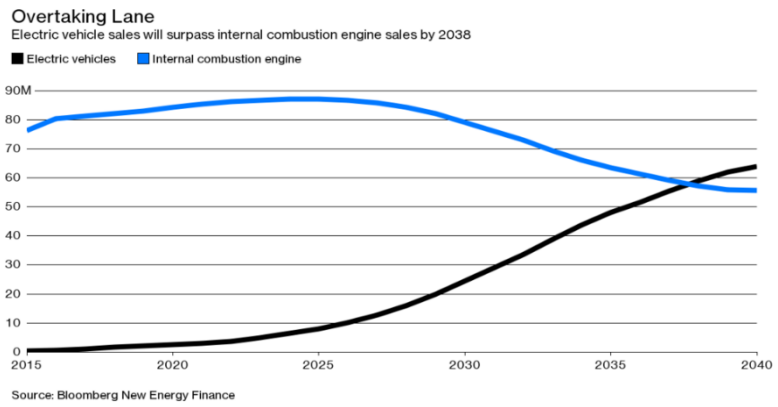


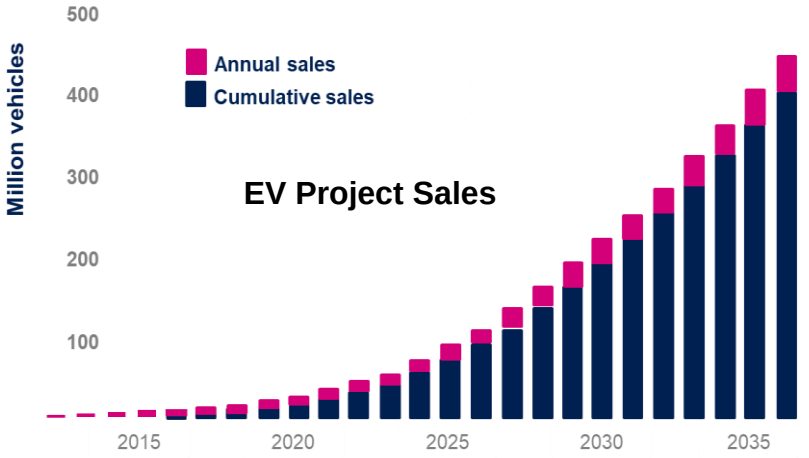
Trends

- EVs will cost same as non-EVs by 2025
  EVs sales will surpass non-EVs by 2038

Challenges

- Functional integration of multiple applications
- Higher safety
- Standardization
- Cost improvement
- Modular power architecture



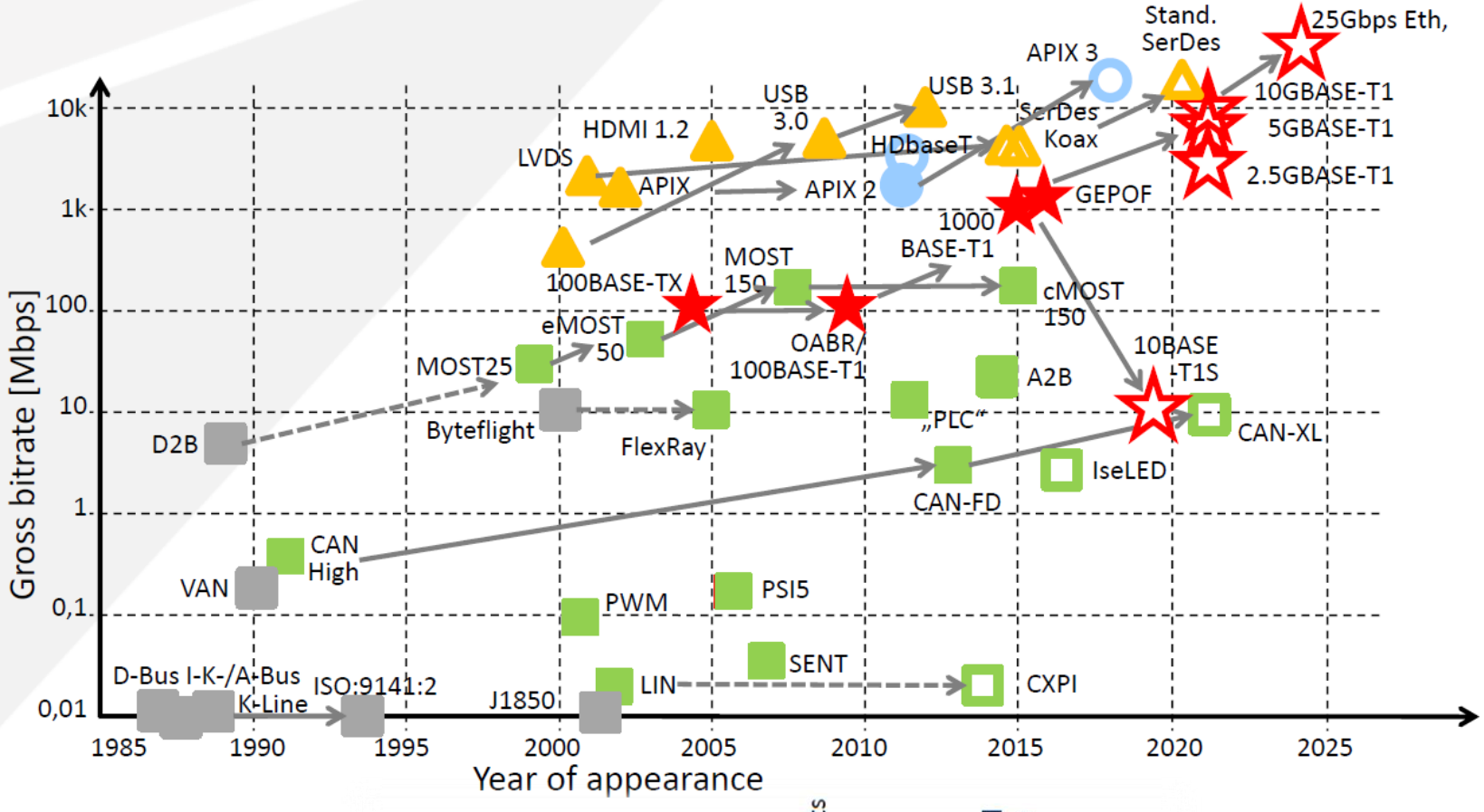


life.augmented

Source: Bloomberg New Energy Finance

Connectivity

Trends and Challenges



Challenges

- Higher bandwidth
- Cybersecurity
- SW and HW Standardization
- Data
- Virtualization
- Low latency
- OTA
- Adaptive Autosar / service oriented

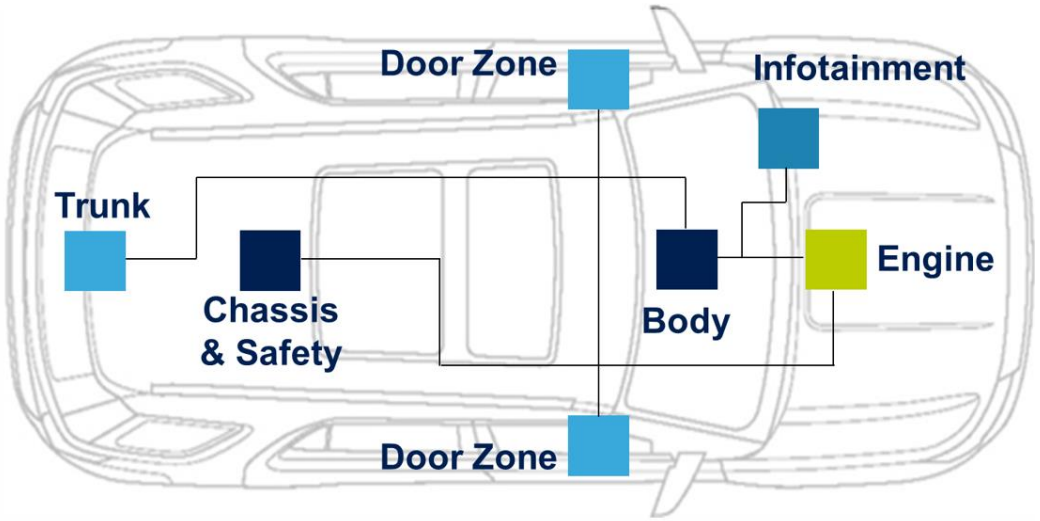
Source: Dr. Kirsten Matheus, BMW AG, Automotive Ethernet Congress 2019

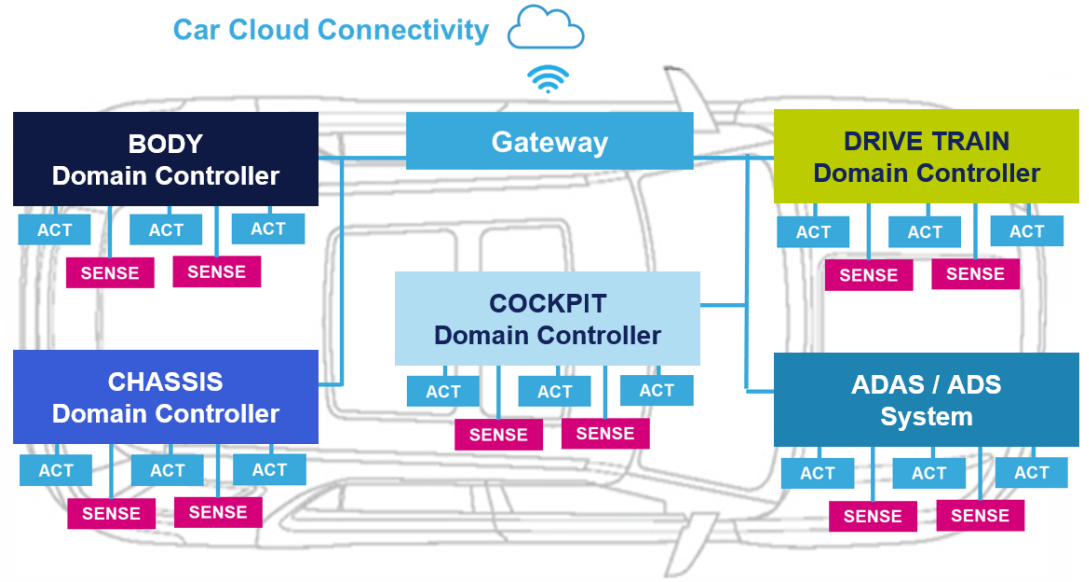
Agenda

- Automotive Industry Transformation
- Technology Drivers
- Architecture Evolution
- Advanced Processing Demand

Architecture Evolution

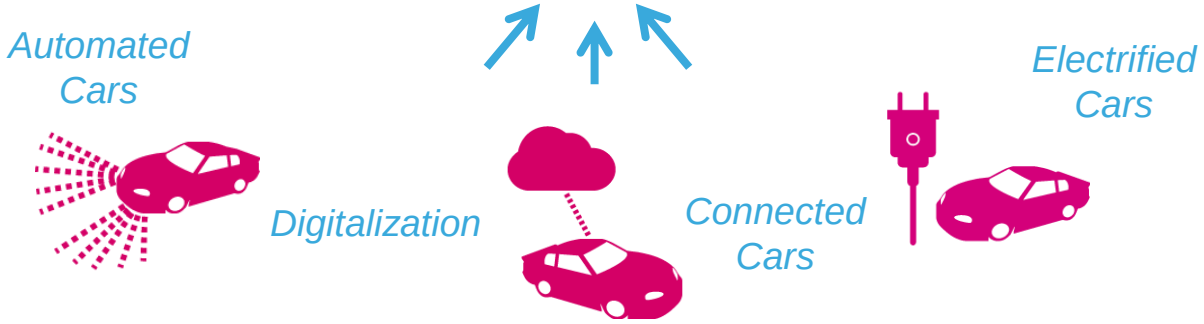
Functional Consolidation





- Introduction of Gateways between traditional ECUs of associated domain and backbone
- Protocol translation between signal-based and service oriented domains with inner and cross domain communications
- Centralization and integration of related SW functionalities

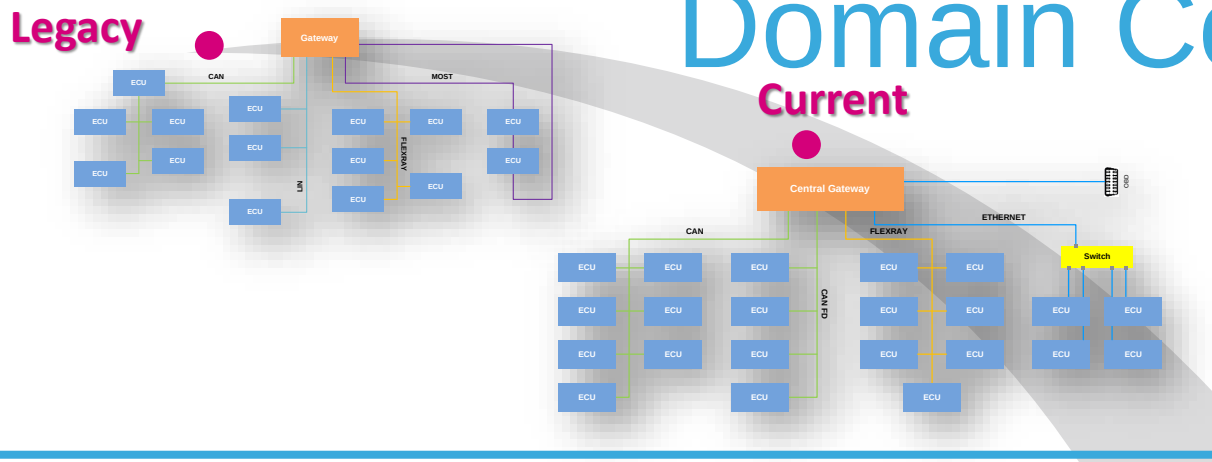
New Car Digital Architecture



life.augmented

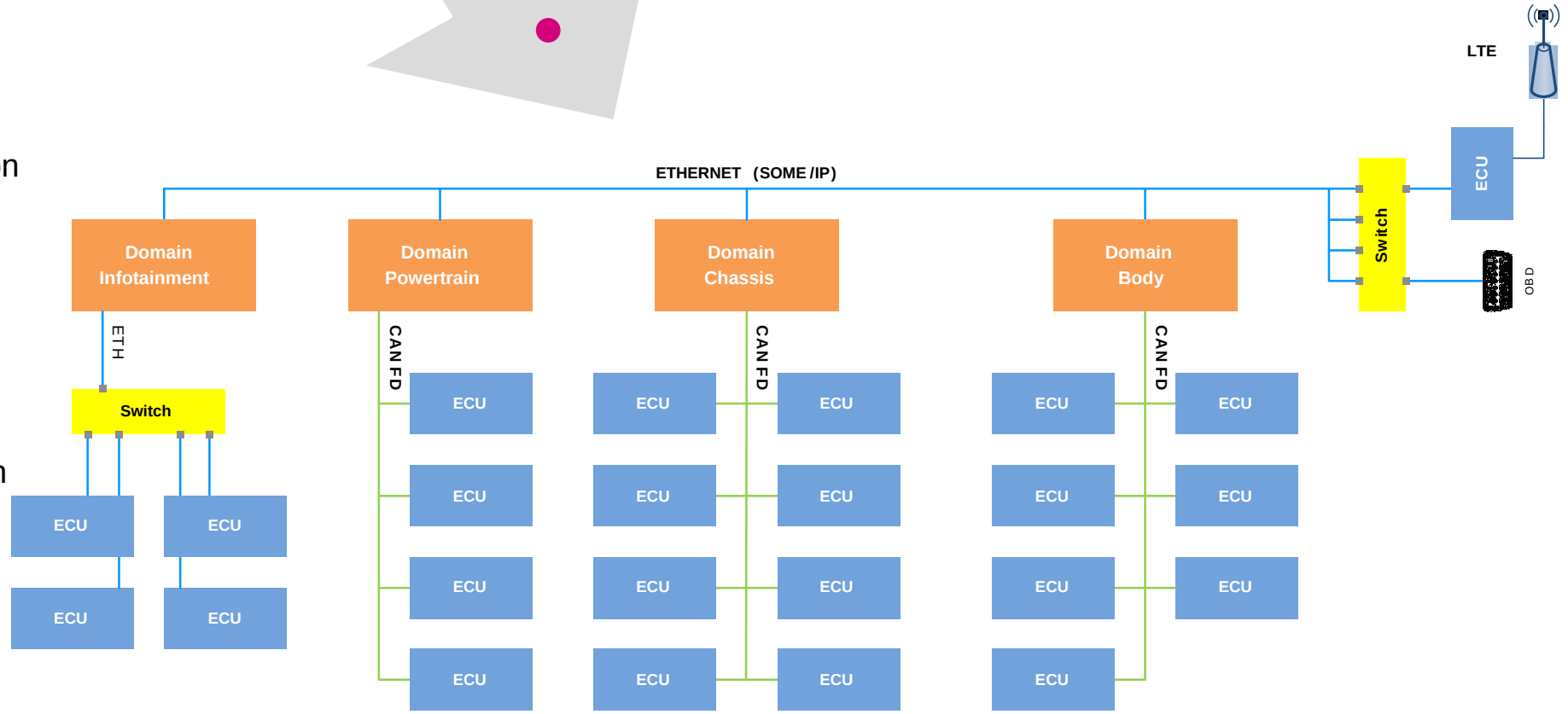
Domain Controller Architecture

Topology and Key Properties



Upcoming Network

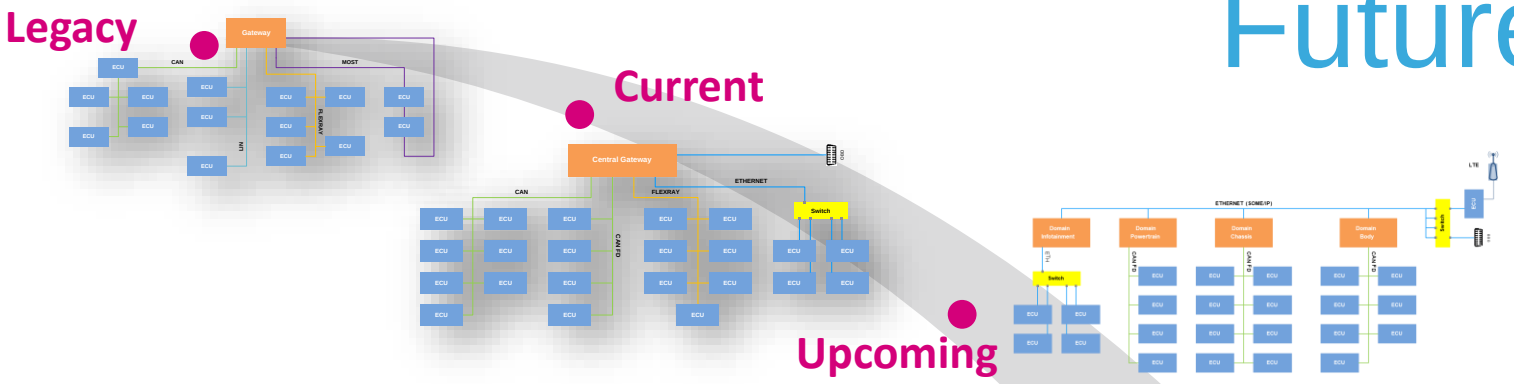
- Centralization and domain fusion with functional consolidation
- Hierarchical architecture
- High computing platforms with smart actuators/sensors
- Many-to-1 communication with Ethernet backbone
- CAN FD, Ethernet 1-10Gb/s
- Increased security and Intrusion Detection Systems
- OTA everywhere
- Service oriented approach

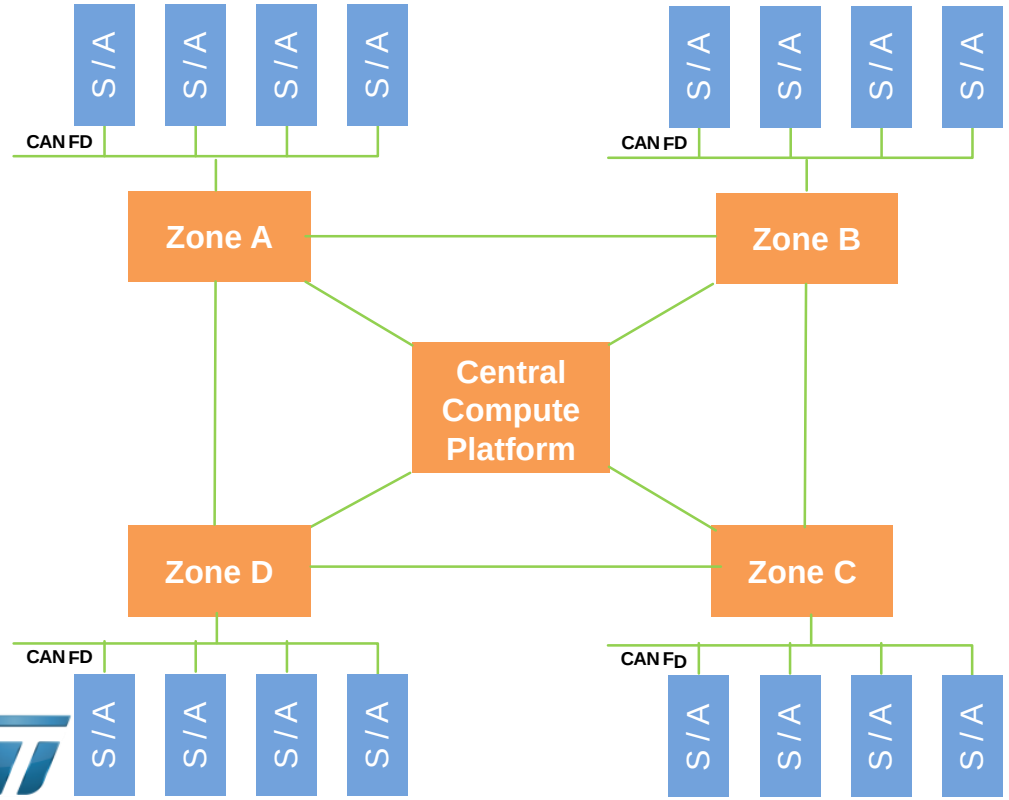


life.augmented

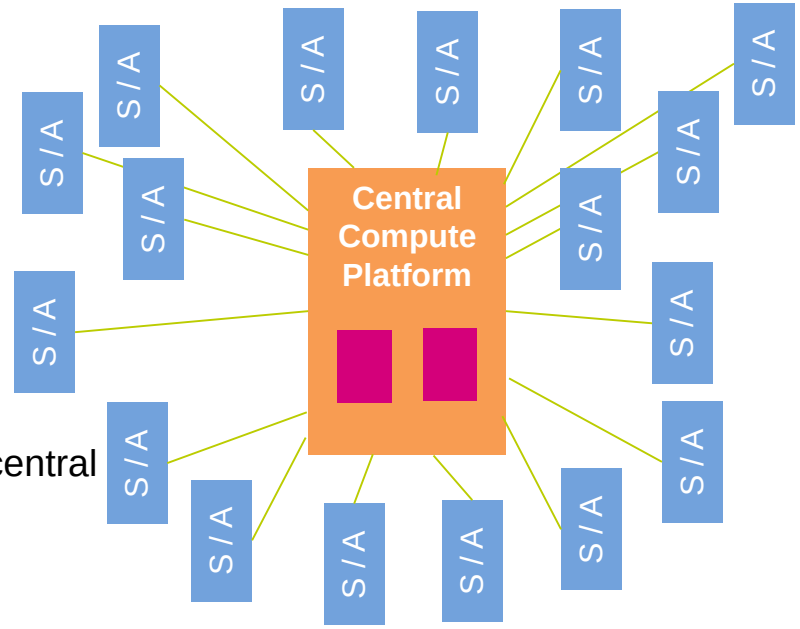
Future Architectures

Topology and Key Properties





Future Networks



- High-level of centralization
- Domain independent with central super computing platform
- Physical distribution and software-driven
- All-to-some communication
- Ethernet up to 50Gb/s

life.augmented

Agenda

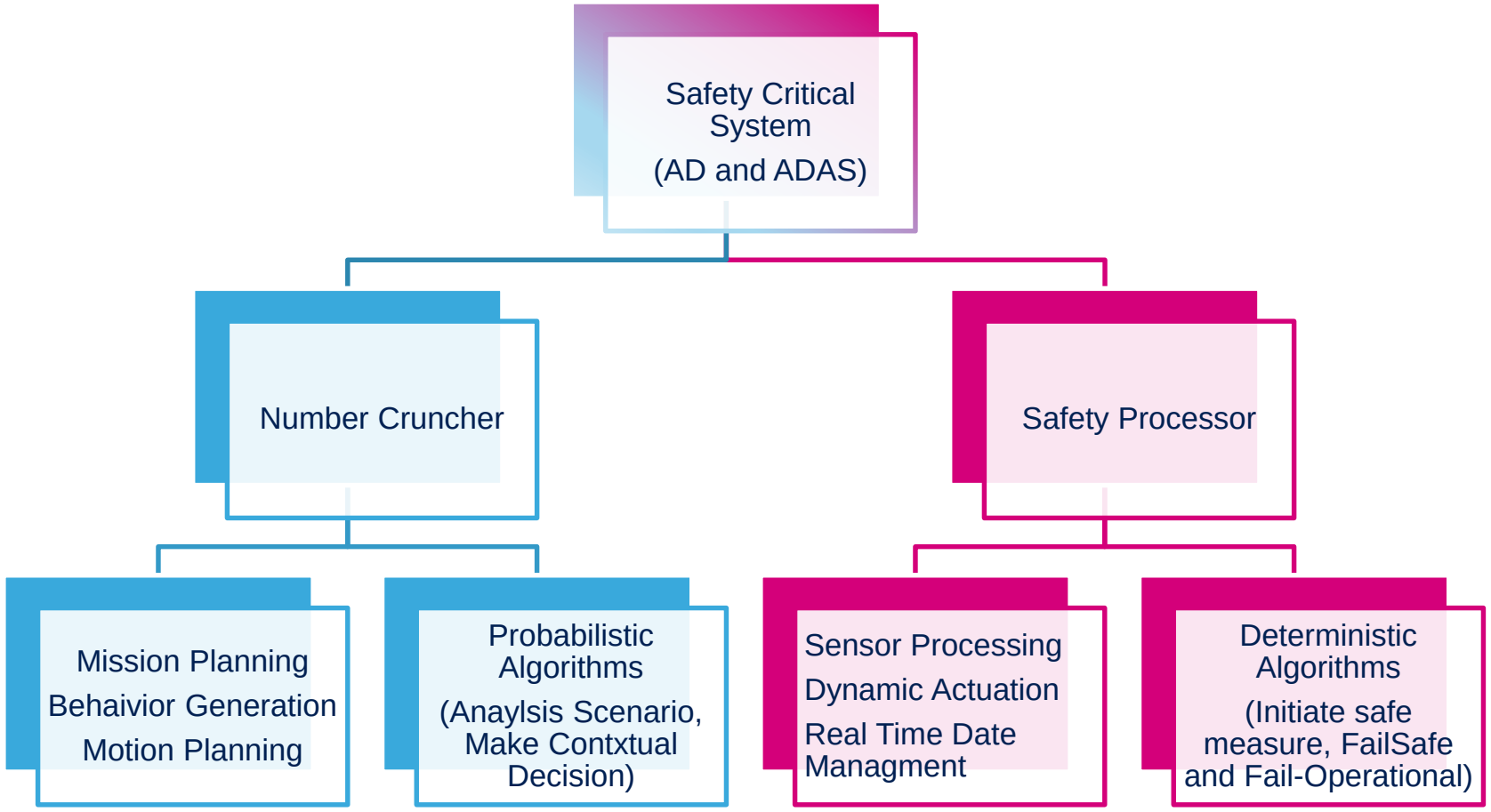
- Automotive Industry Transformation
- Technology Drivers
- Architecture Evolution
- Advanced Processing Demand

Advanced Processing Demand

Computing and Safety Requirements

Super Computing → MPU

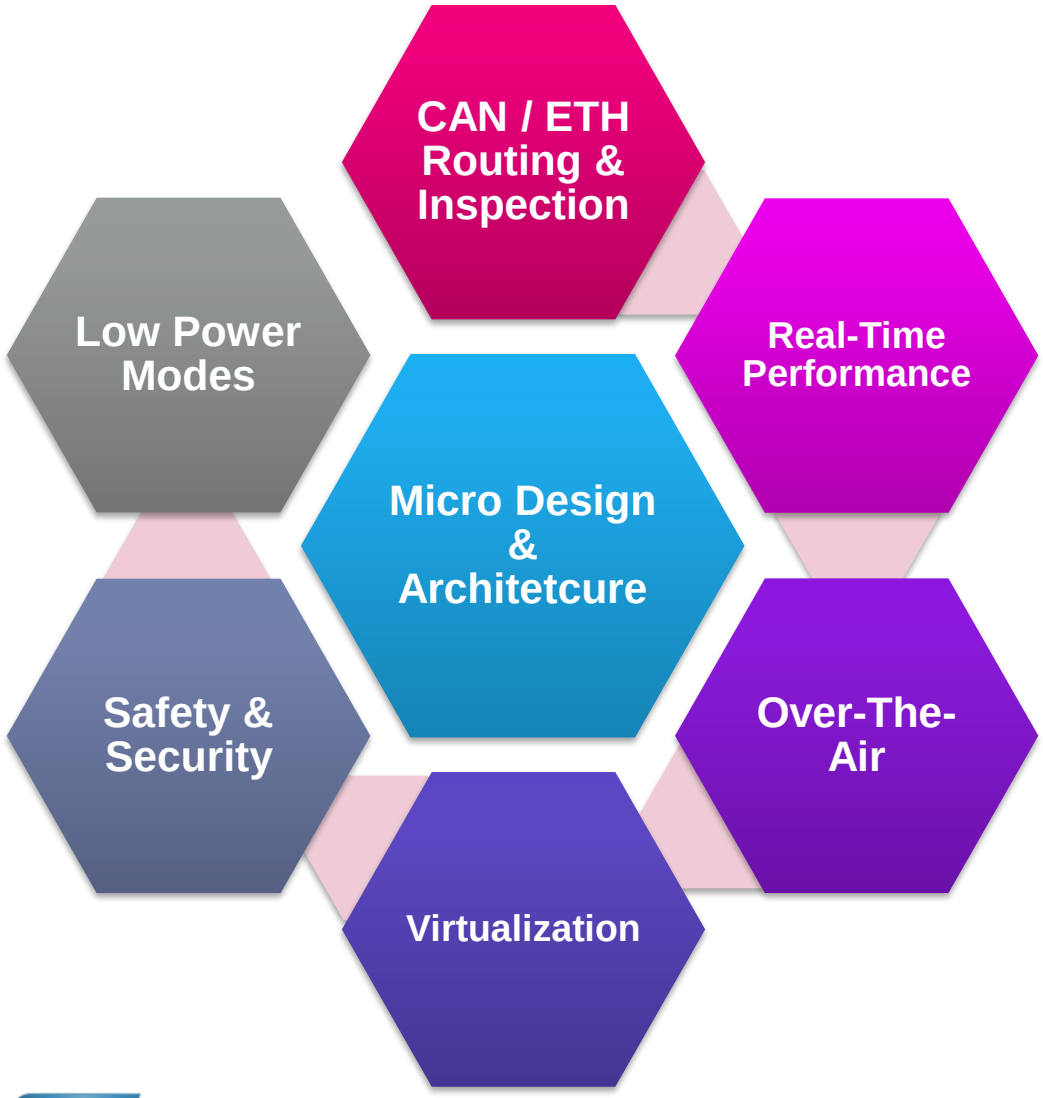
Safe Computing → MCU



life.augmented

Impact on MCU Design

Key Influncers



CAN / ETH Routing & Inspection

- Routing performance
- Packet inspection
- Software overload
- New protocols

Real Time Behavior

- Start-up / power-down
- Reaction time
- Accelerators

Over The-Air

- Hardware support
- Rollback functionality
- External Memory interfaces
- Secure boot

Virtualization

- HW hypervisor
- Real-time, determistic behvior

Safety & Security

- ASIL-D support
- HW self-test
- HSM subsytsem
- Memory protection
- Communication secuirty

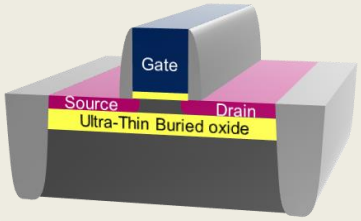
Low Power Modes

- Standby/Stop operations
- Smart wakeup unit

STELLAR MCU Family

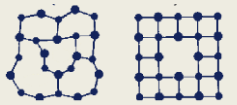
Unique Solution in 28nm eNVM Technology Paradigm

CMOS
28nm FD-SOI



Embedded NVM
Phase Change Memory

PCM



Stellar

Unprecedented
Safe & Secure
Real-time
Performance

1st Automotive MCU
w. real-time Virtualization
ie. Multi Update-able
Applications Platform
(turn-key for DCUs)

STELLAR Real-Time
HW Virtualization Architecture built on

most powerful real-time CPU + only real-time CPU w. HW virtualization

ARM Cortex

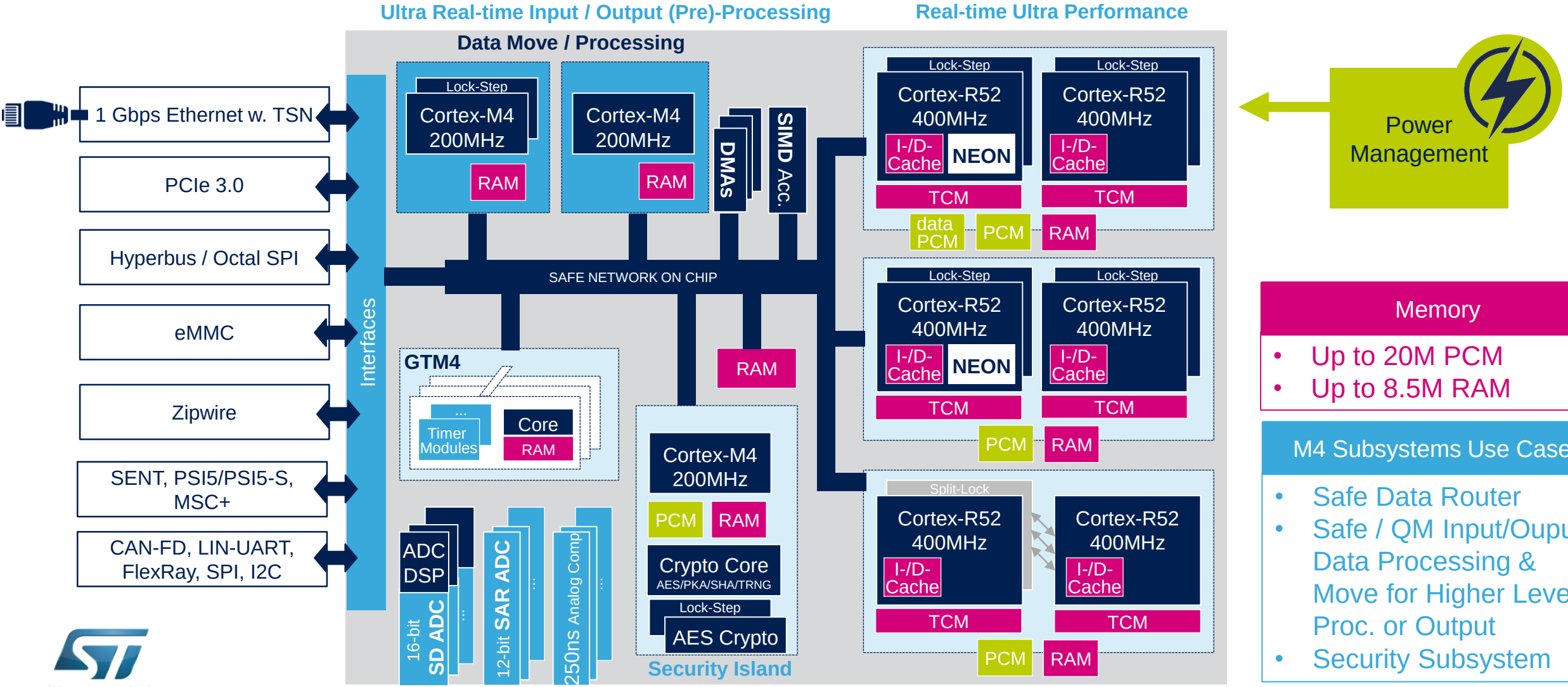
arm CORTEX®-R52

ARM real-time CPU

life.augmented

STELLAR MCU Family

Processing Architecture - Heterogeneous Multiprocessor



Memory

- Up to 20M PCM
- Up to 8.5M RAM

M4 Subsystems Use Cases

- Safe Data Router
- Safe / QM Input/Ouput Data Processing & Move for Higher Level Proc. or Output
- Security Subsystem

life.augmented

Thank You!

Contact

Khaldoun Albarazi
Market Development Engineer
Automotive Product Division
STMicroelectronics
Khaldoun.Albarazi@st.com

life.augmented