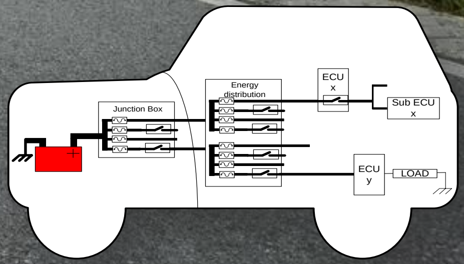
Architecture Trends Body Electronics

Infineon Symposium, Sep. 2010



Li Shi Ming
Body Application Marketing Manager
IFCN, ATV Marketing Team, Shanghai

Agenda

Body Architecture Trends

- Centralized vs. Decentralized Architectures
- Typical System Block Diagrams
- Solutions for Decentralized Electronics
- Power Distribution System

Energy Efficient Networks

- Motivation
- Two Ways to Improve Energy Efficiency of ECUs
- Sample Calculation – How much Energy Can be Saved

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Body Electronics / Body Control Module
Changing the Cost-Benefit Situation

In the Past → **Trends** → **In the Future**

In the Past

Power BOM Device Cost | System benefits

Trends

- ↗ Diagnostic & PWM
- ↗ Flexibility
- ↘ PCB space & Pdiss
- Unified BCM

In the Future

Power BOM Device Cost | System benefits

Limited system functionality

⇓

Focus on Power BOM / Device cost

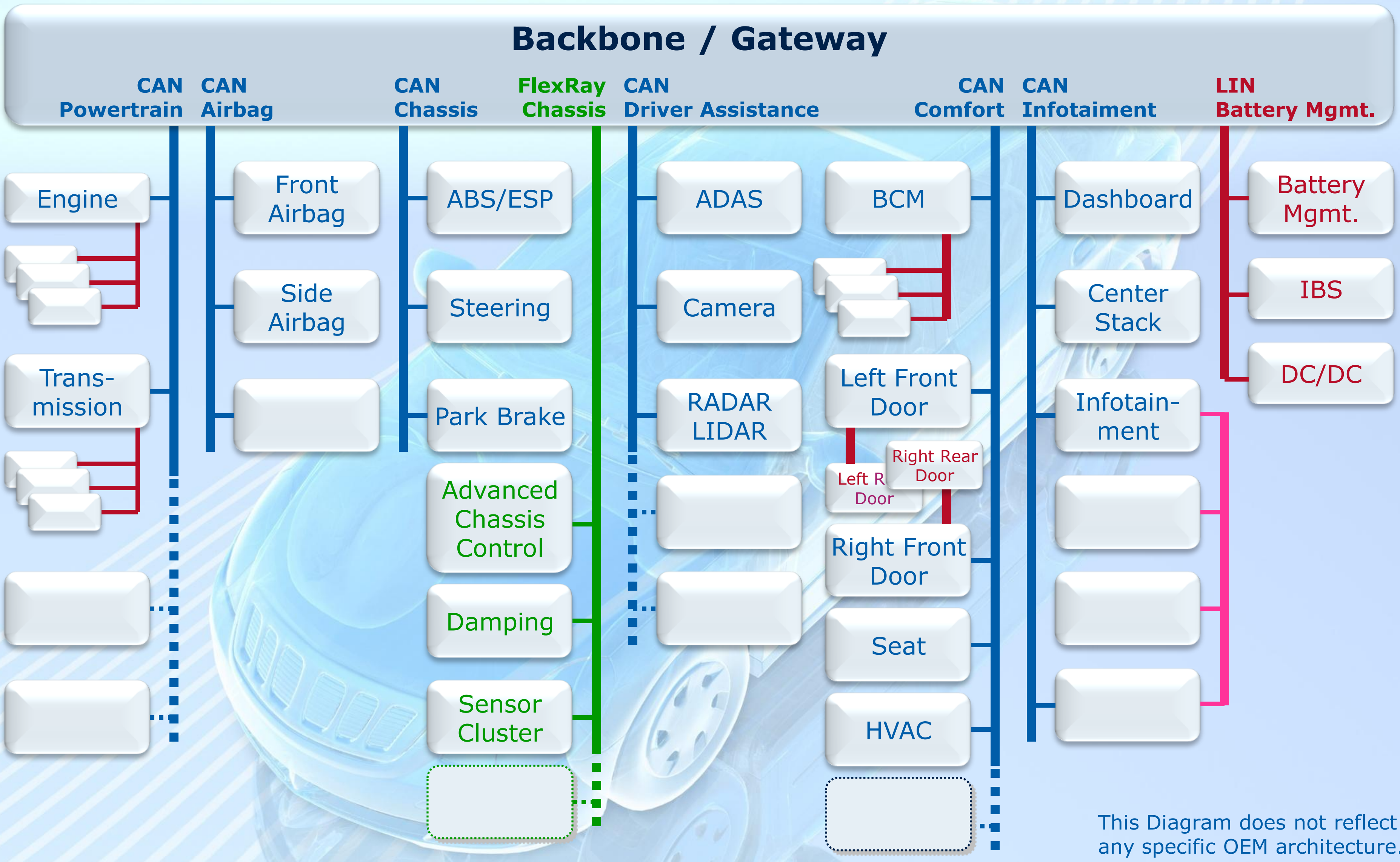
Increased complexity, More features

⇓

Focus on System cost

High Sophisticated System Architecture

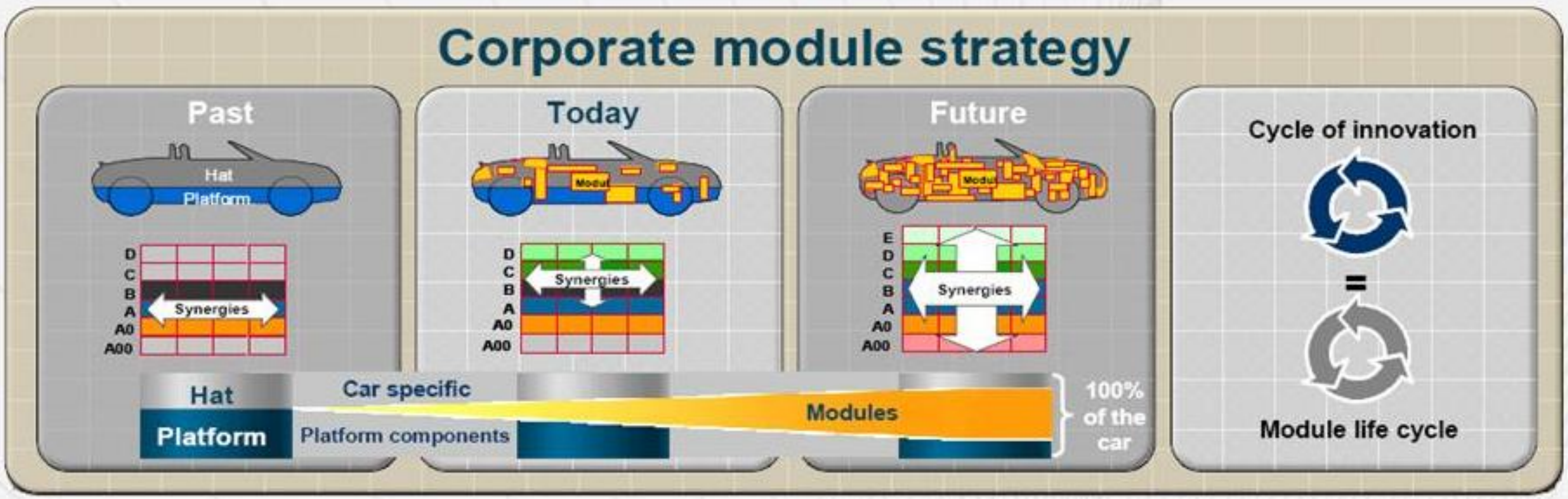
- CAN
- FlexRay
- LIN
- MOST



Platform and Module Strategy
Standardization vs. Individualization

VOLKSWAGEN
AKTIENGESELLSCHAFT

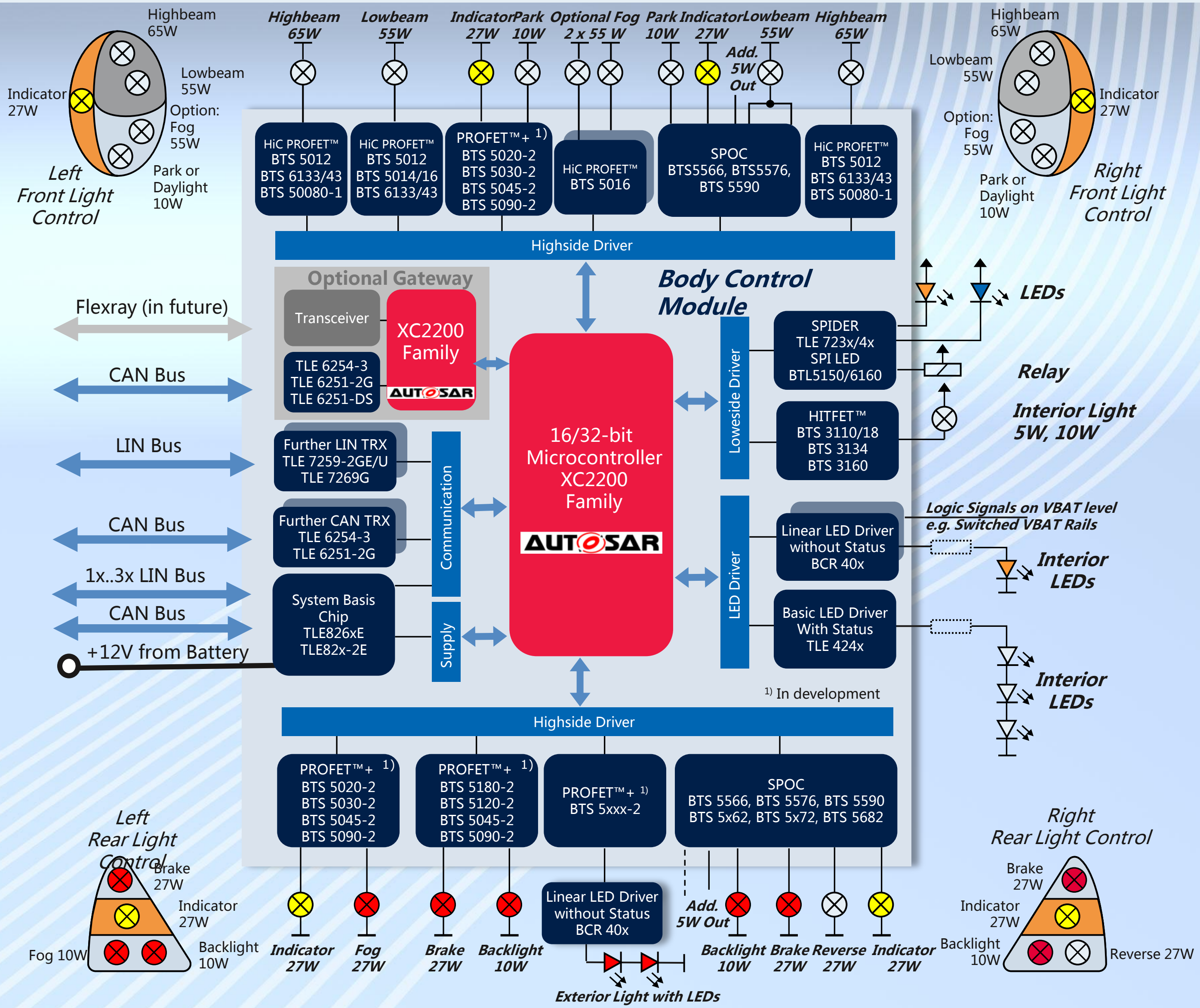
The modular character of components and systems contributes to the success of automotive electronics



- The aim of modularisation is to standardise non-perceivable parts and to individualise perceivable parts
- The multiple utilisation of corporate modules leads to considerable advantages in both cost and quality. At the same time developmental periods become shorter.

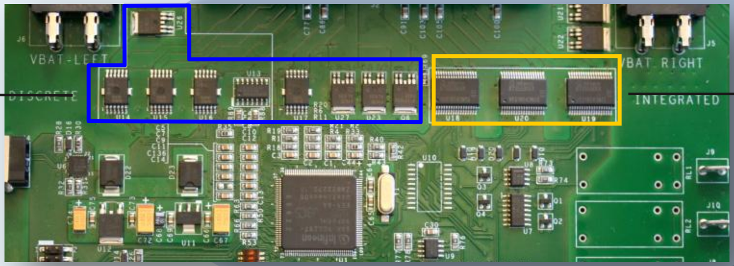
Dr. Axel Heinrich – Volkswagen AG
Electronica automotive conference, Nov. 2008, Munich

Central Body Computer
Example Electronics Architecture



Coexistence of Discrete and Integrated Power Drivers

Discrete implementation



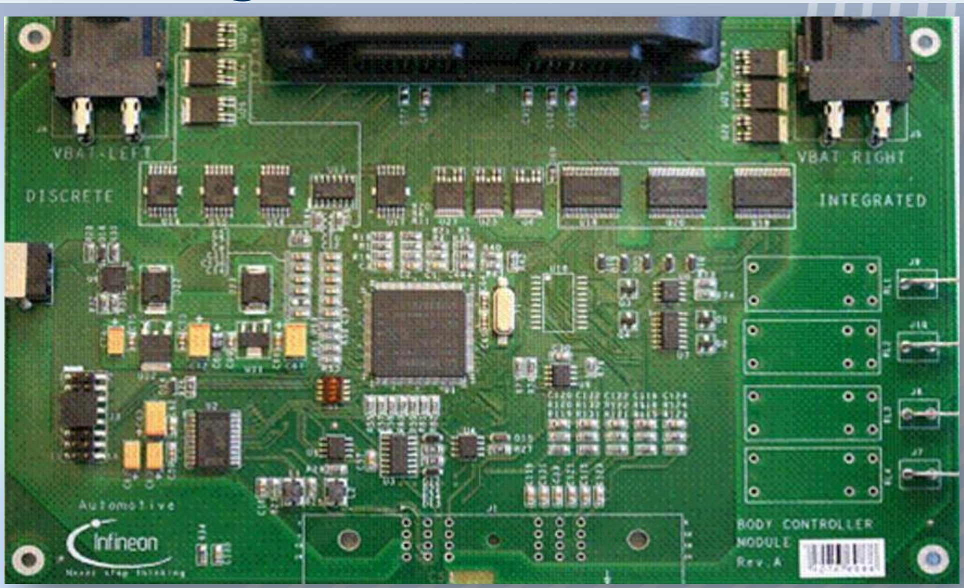
Integrated approach

BCM with **low** complexity

BCM with **high** complexity

Complexity	Market Share	Added Features (SPI, Pdiss, PCB, ...)
High	30% (trend: ↑)	high value
Mid	40% (trend: ↑)	depends
Low	30% (trend: ↓)	hardly relevant

Wide Range of Scalability of Generic BCM Designs



Low end car model

No LED, Bulbs only

Mid range car model

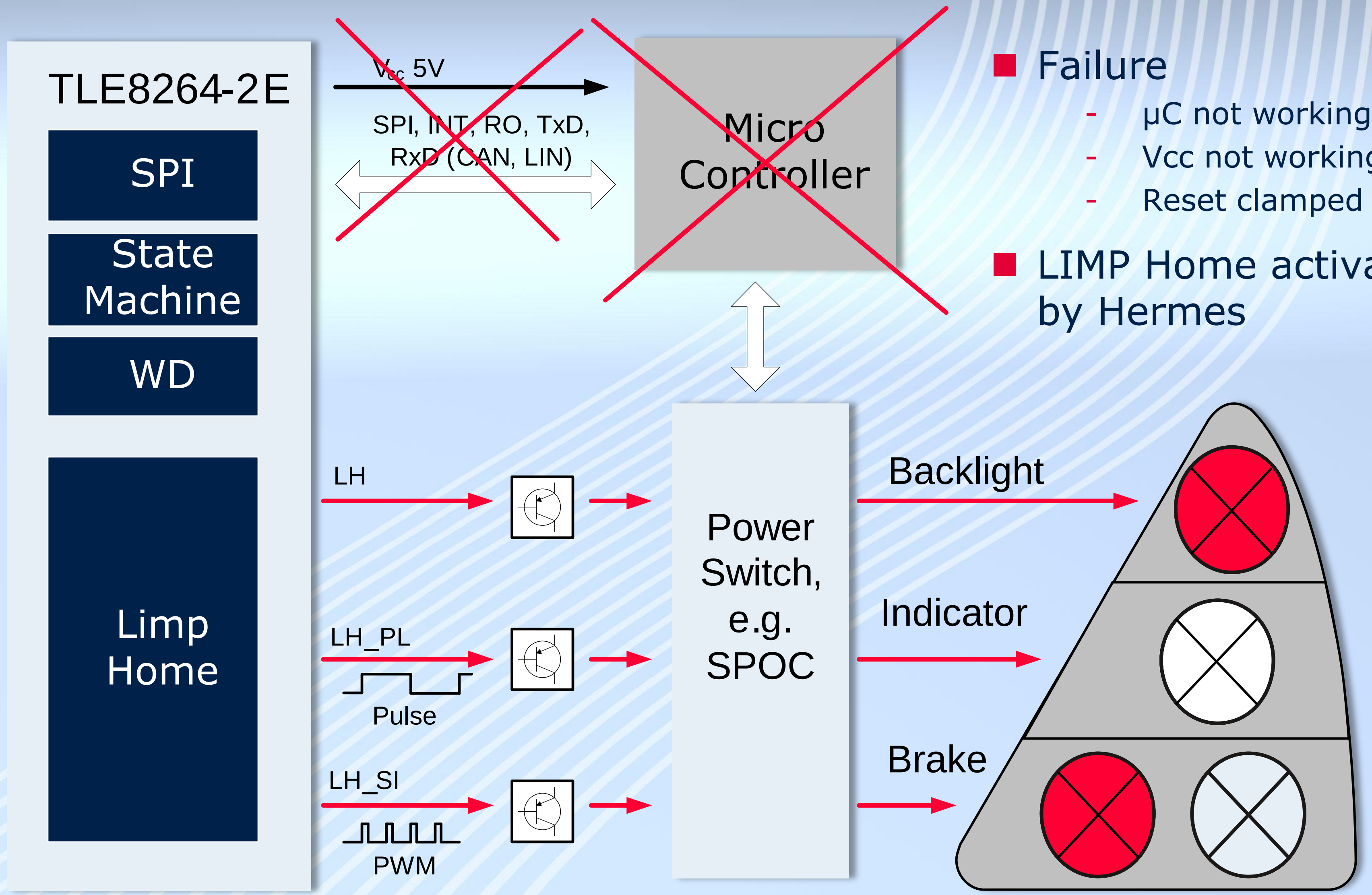
LED as option

High end car model

LED only

One BCM/PCB design but multiple Variants to handle.

"Limp Home" Function
Functional Safety in Lighting Control



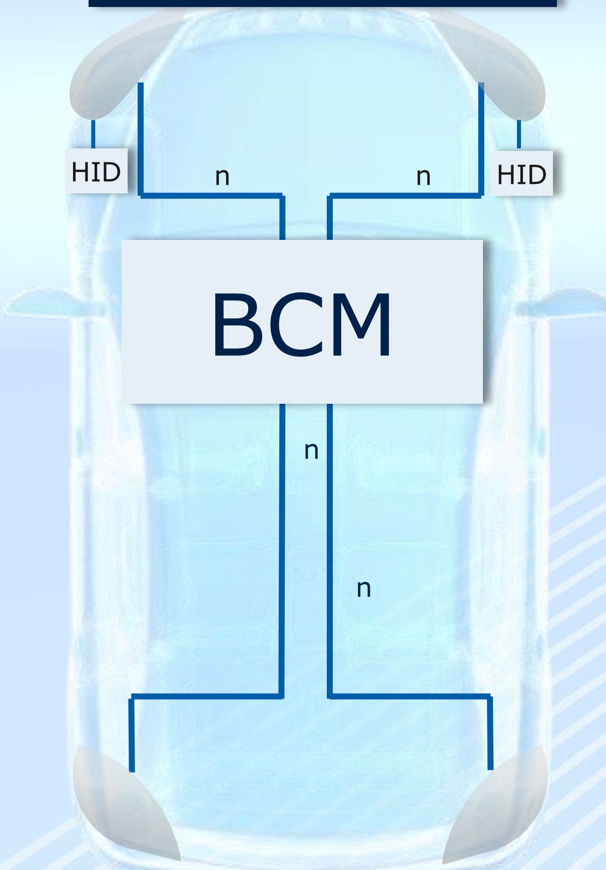
- Failure
  - µC not working
  - Vcc not working
  - Reset clamped
- LIMP Home activated by Hermes

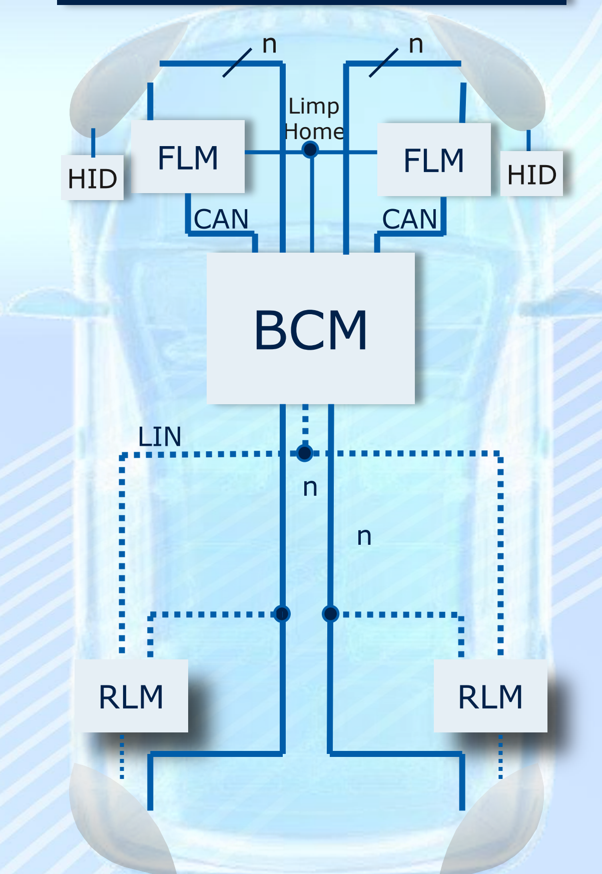
ASIL Compliant Requirements in Body Future Requirement – Arising Soon

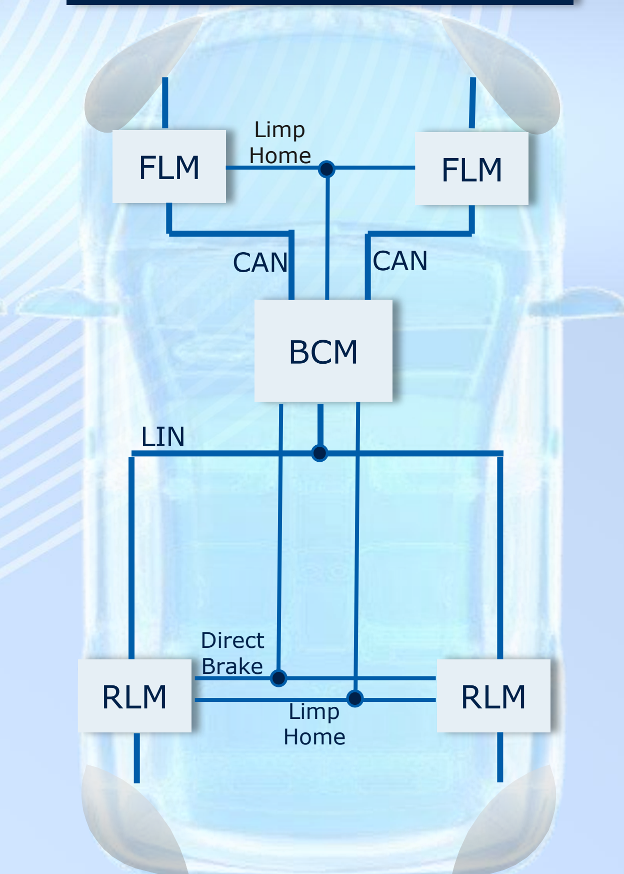
Function	ASIL (ISO 26262)	Failure Reaction Time (us)	Comment
IGN Switch (Body Computer, Ignition key)	B	t.b.d.	Failure Critical Event: Unwanted switching off KL15 during driving
Lighting function: Low beam, Front & Rear Turn signal light	B	t.b.d.	Failure Critical Event: Turn Signal need to be switched off, low beam need to be switched on
Lighting function: High beam, Parking light, Side marker	A	t.b.d.	Requirements not known
Lighting function: Stop light, Tail light	A ?	t.b.d.	Requirements not known
Any motor load (window lift, seat, wiper, HVAC etc.)	??	t.b.d.	No demand of ASIL so far

Centralized vs. Decentralized Architecture LED for Exterior Lighting

Centralized Architecture Today	Partially Decentralized Architecture > 2012	Fully Decentralized Architecture >2020





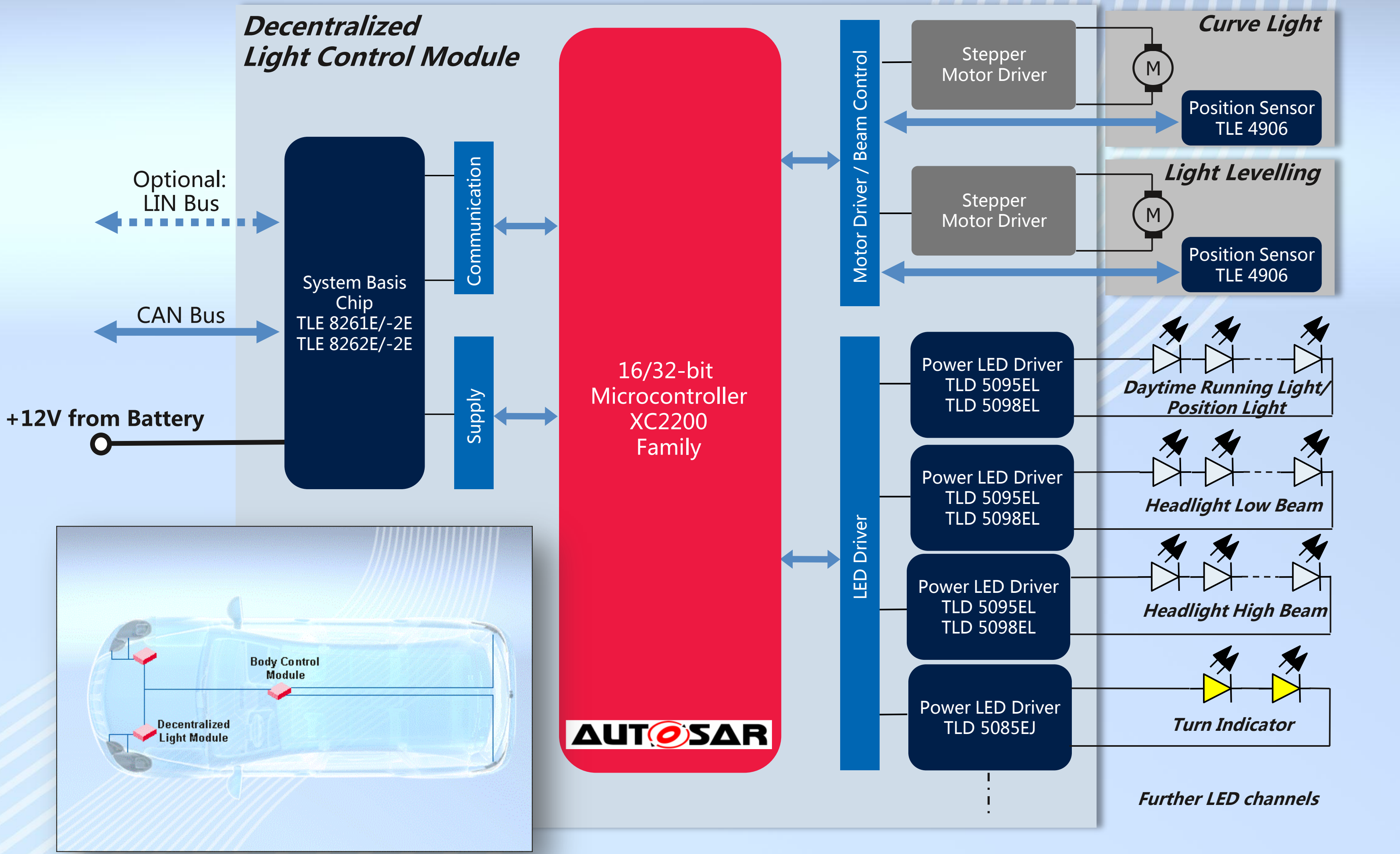


LED as an option
For **Certain** Car Models of One Platform

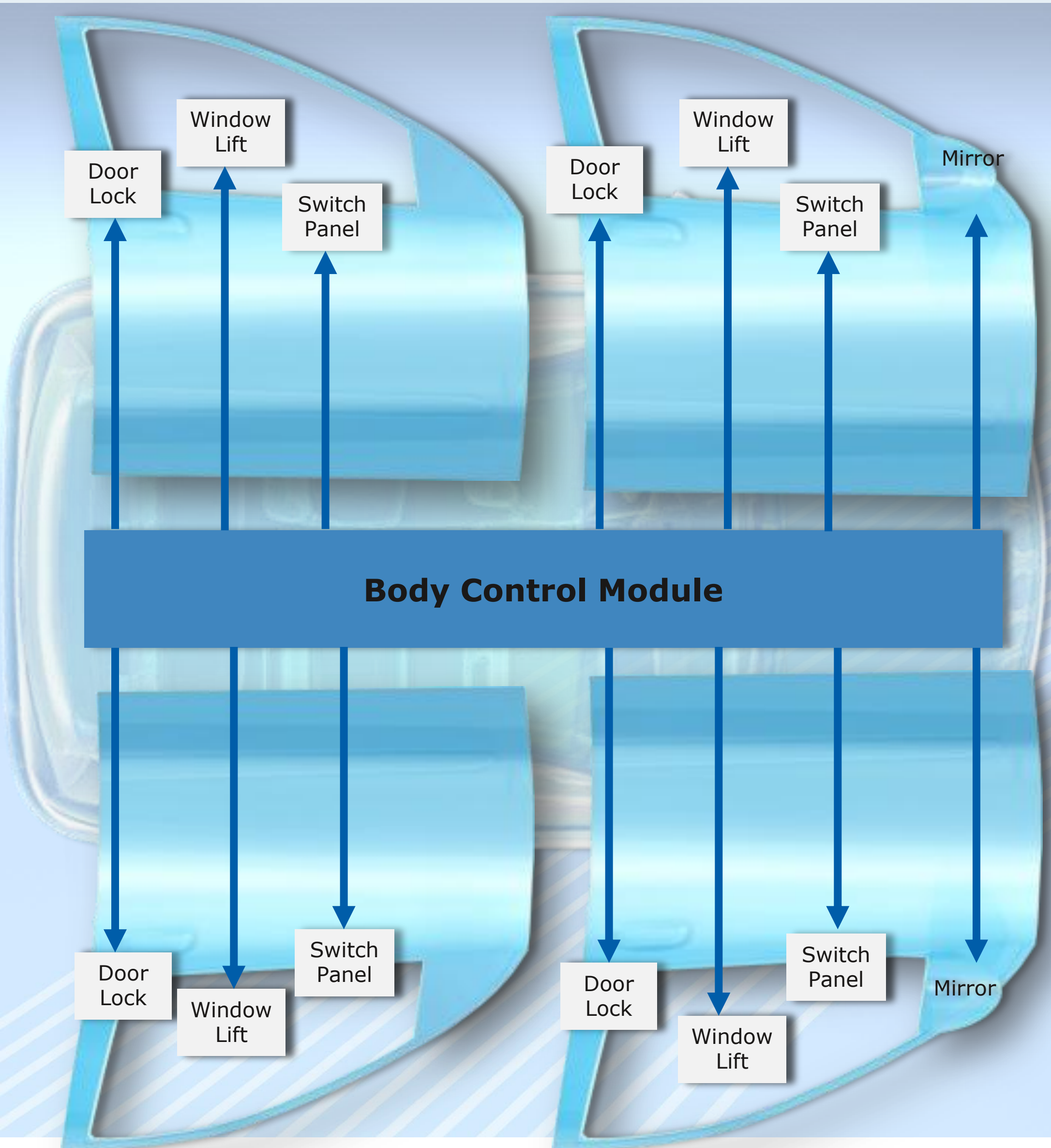
LED-only
For **Certain** Car Models of One Platform

LED-only
For **All** Car Models of One Platform

Generic
Decentralized Front Light Module



Body Architectures BCM/Door Centralized Architecture



Features:
- Single Central BCM Module

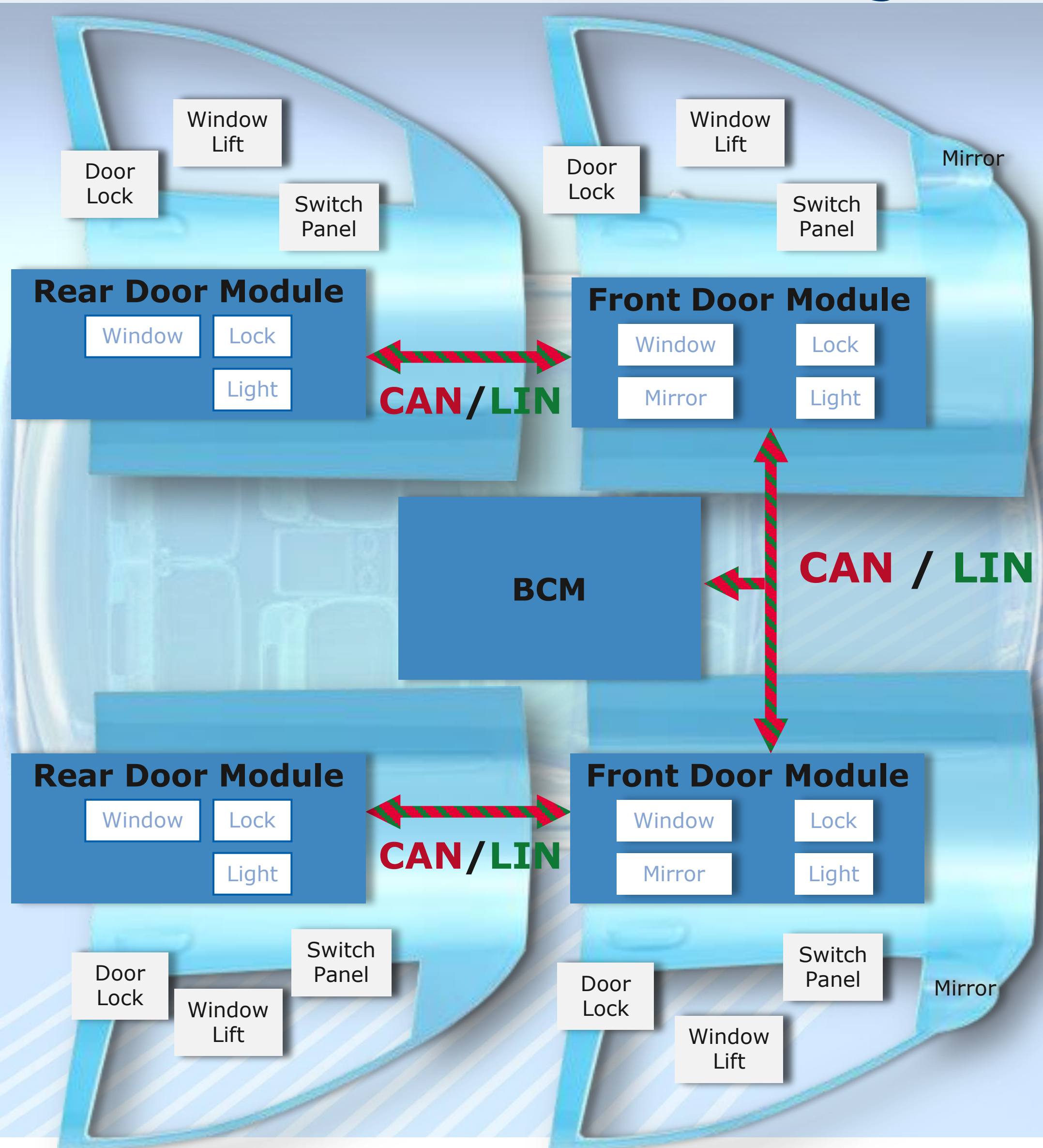
Benefits:
- Fully scalable Functionality

Drawbacks:
- Heavy wiring effort or cars with high functionality

Coverage:
- Low End Cars
- Only few electronic functions

Low-end Markets Trend to be replaced

Body Architectures BCM/Door
BCM + Door Modules Using CAN/LIN



Features:
- Full Featured Door Modules
- CAN or LIN connection to BCM and between Front &Rear Door

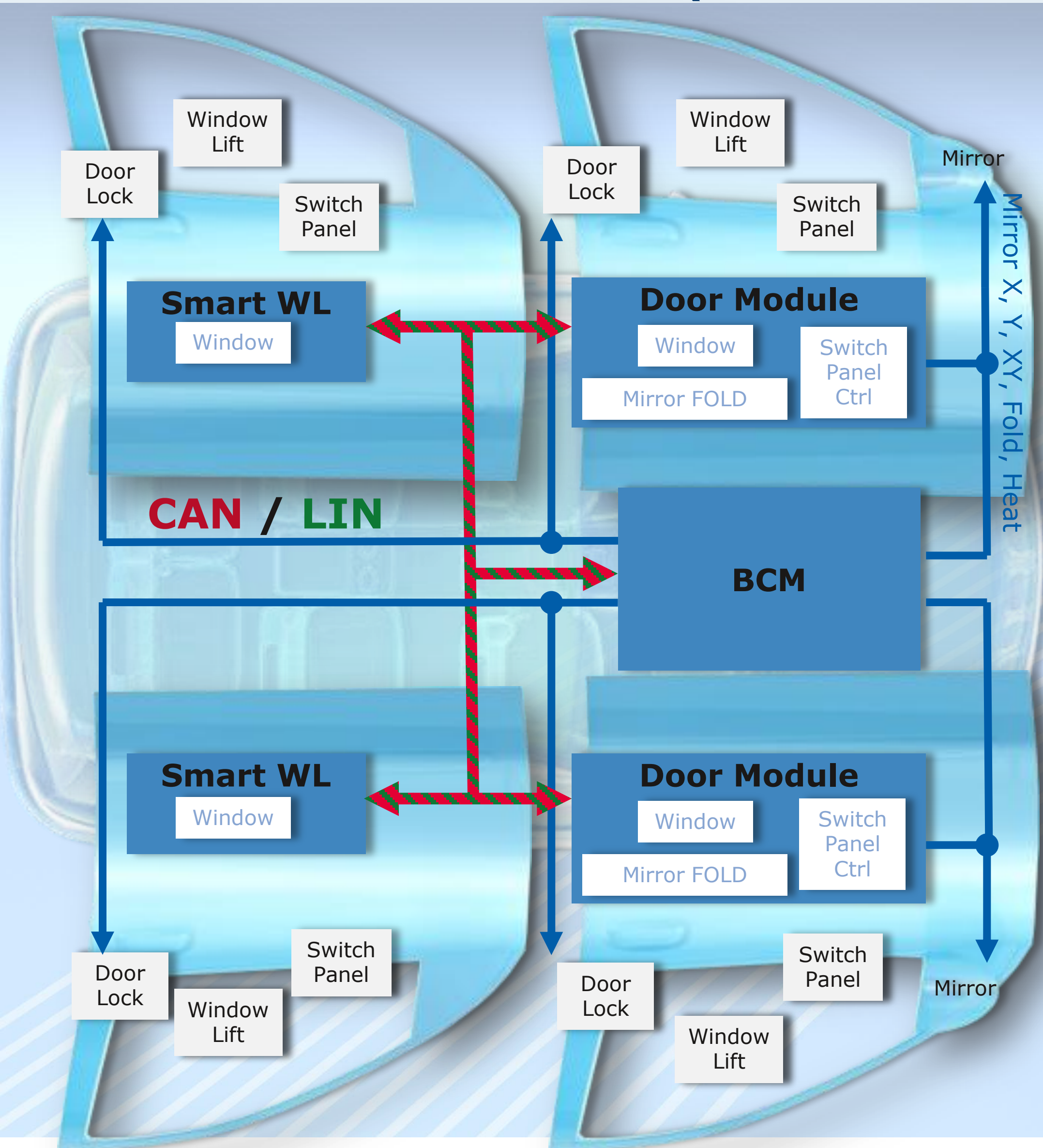
Benefits:
- Low wiring harness effort
- Full functional network
- Automatic Door Functions

Drawbacks:
- Expensive
- High end Solution / Low Scalability

Coverage:
- Premium Brands

Fewest Wiring Harness

Body Architectures BCM/Door
Mixed Architecture (DCM + Central Lock)



Features:
- Door Modules without Door Lock
- CAN or LIN connection to BCM and between Front & Rear Door
- Smart Window Lift in Rear Door

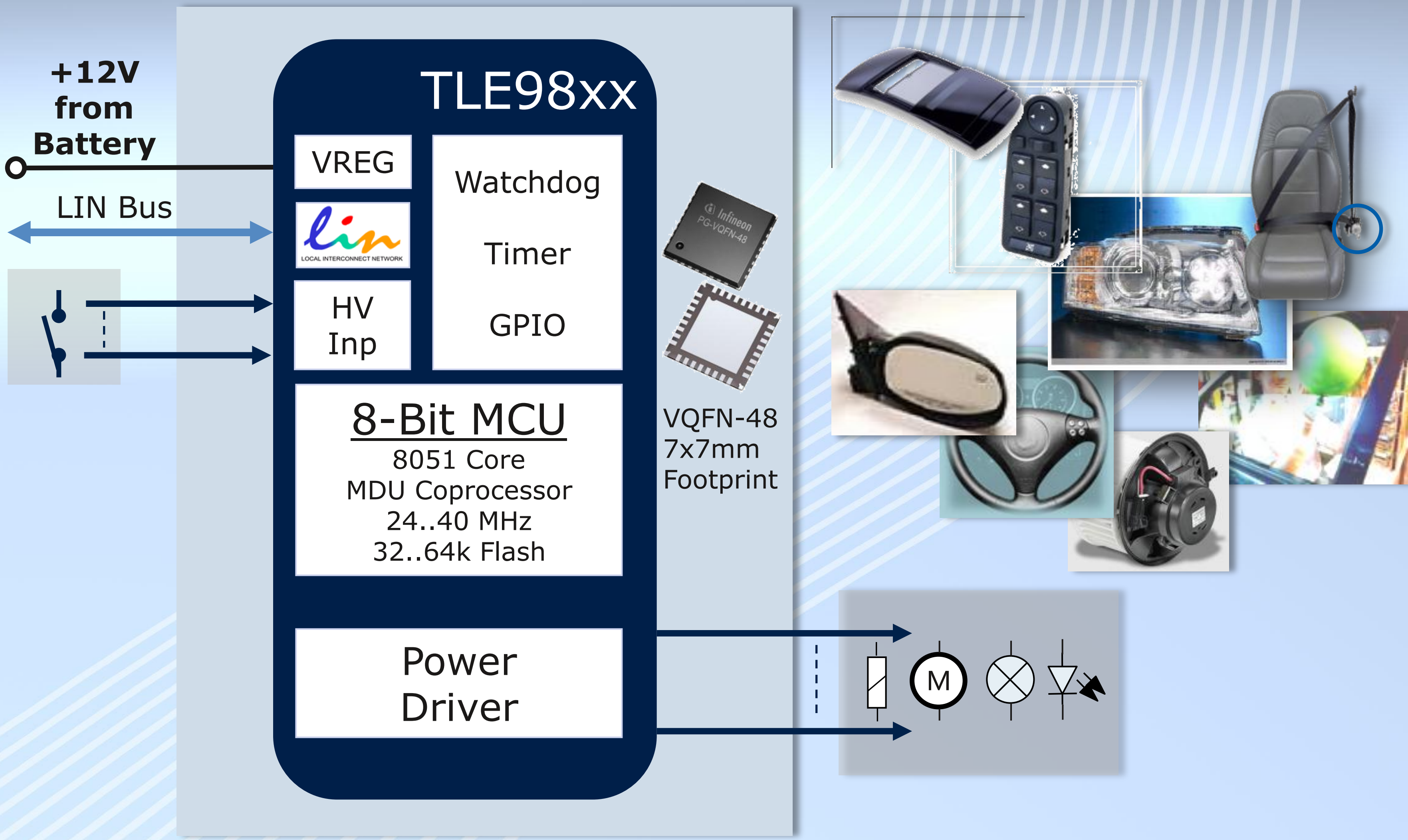
Benefits:
- Kind of mixed architecture
- Partially scalable

Drawbacks:
- Low scalability @ Front Doors

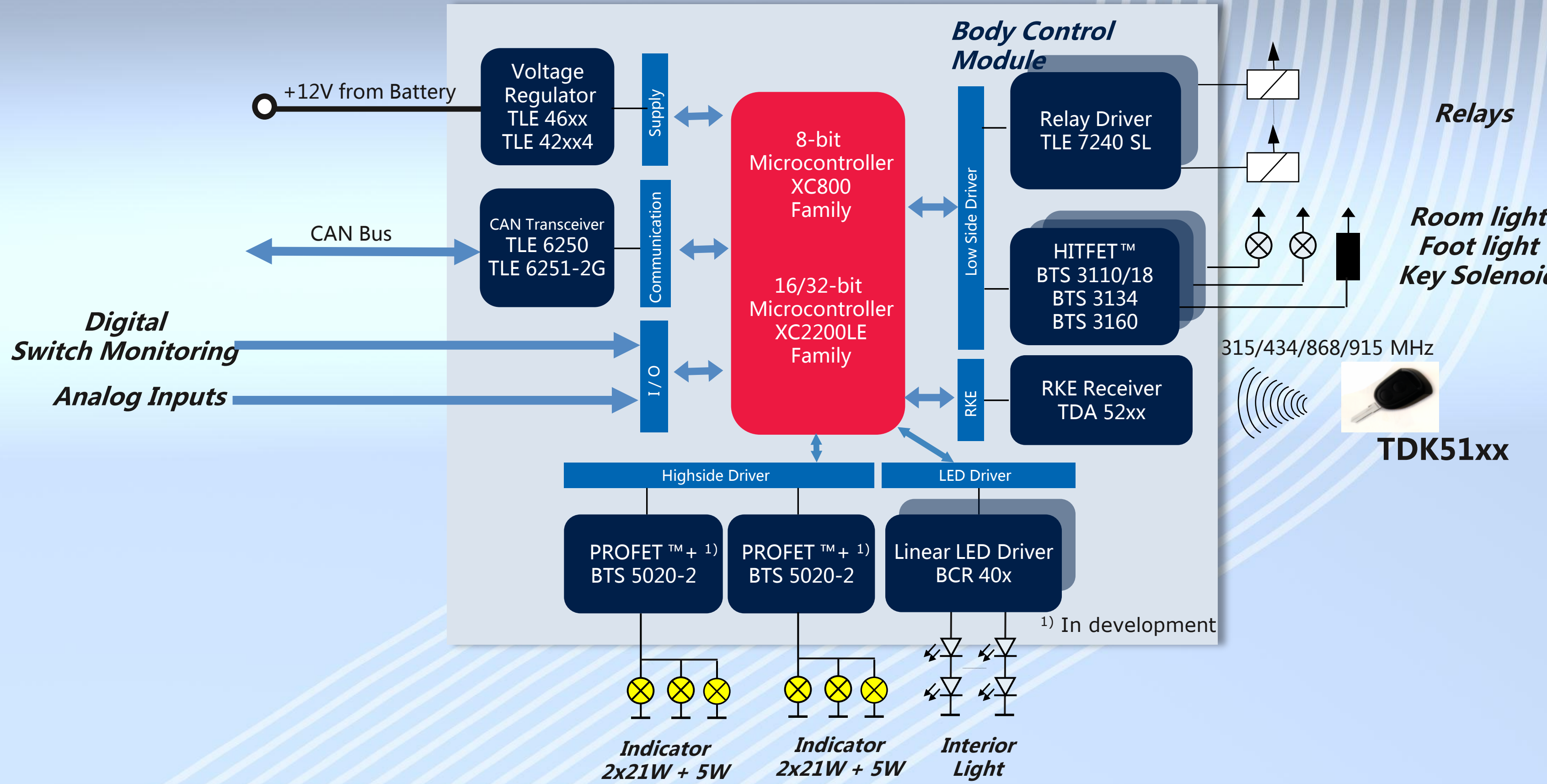
Coverage:
- Mid Class and Premium Class Vehicles

Mixture of Door Module and Smart Window Lift

Decentralized Body Electronics
LIN Slave System IC

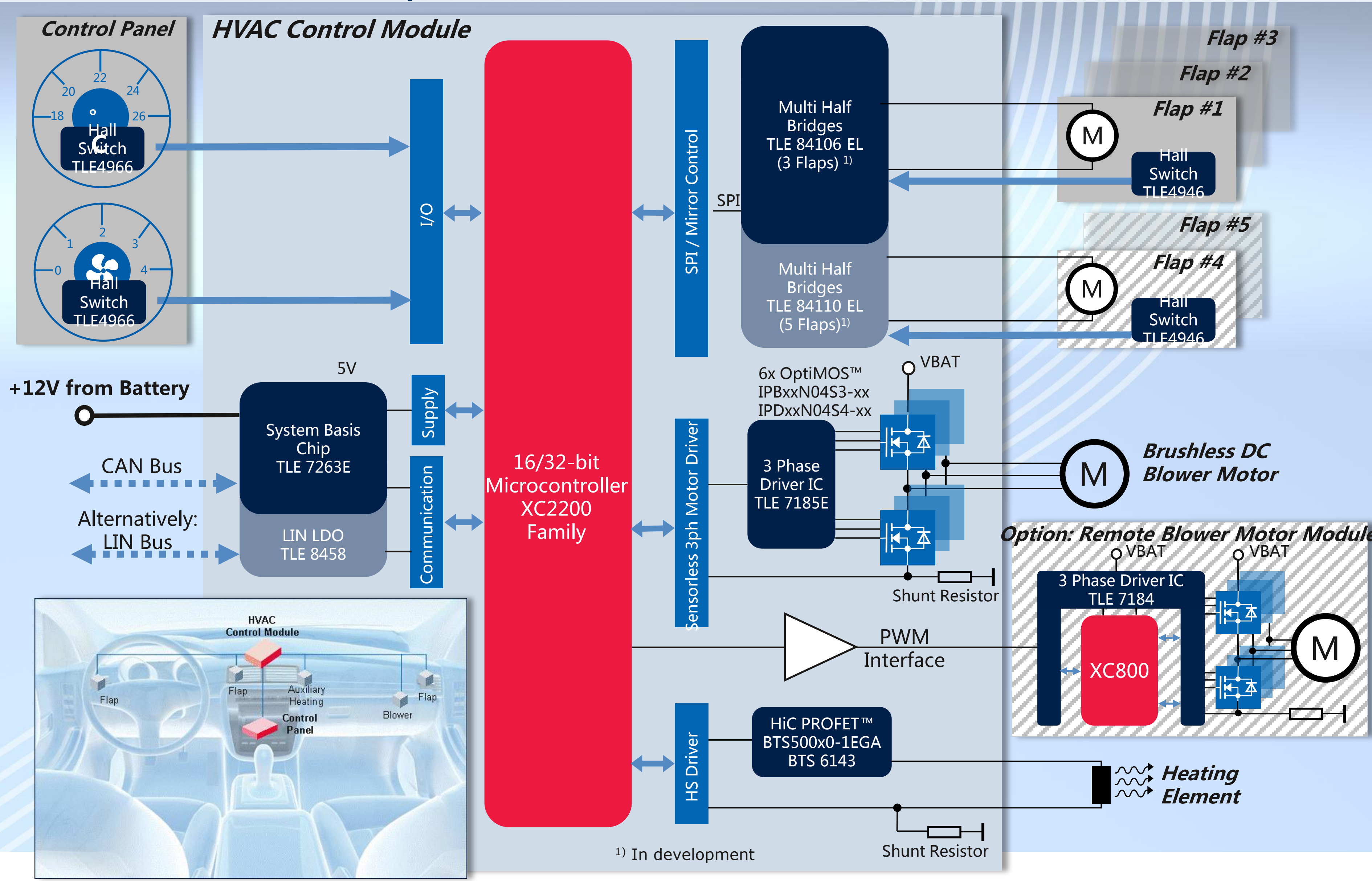


Small Body Control Module Emerging Markets

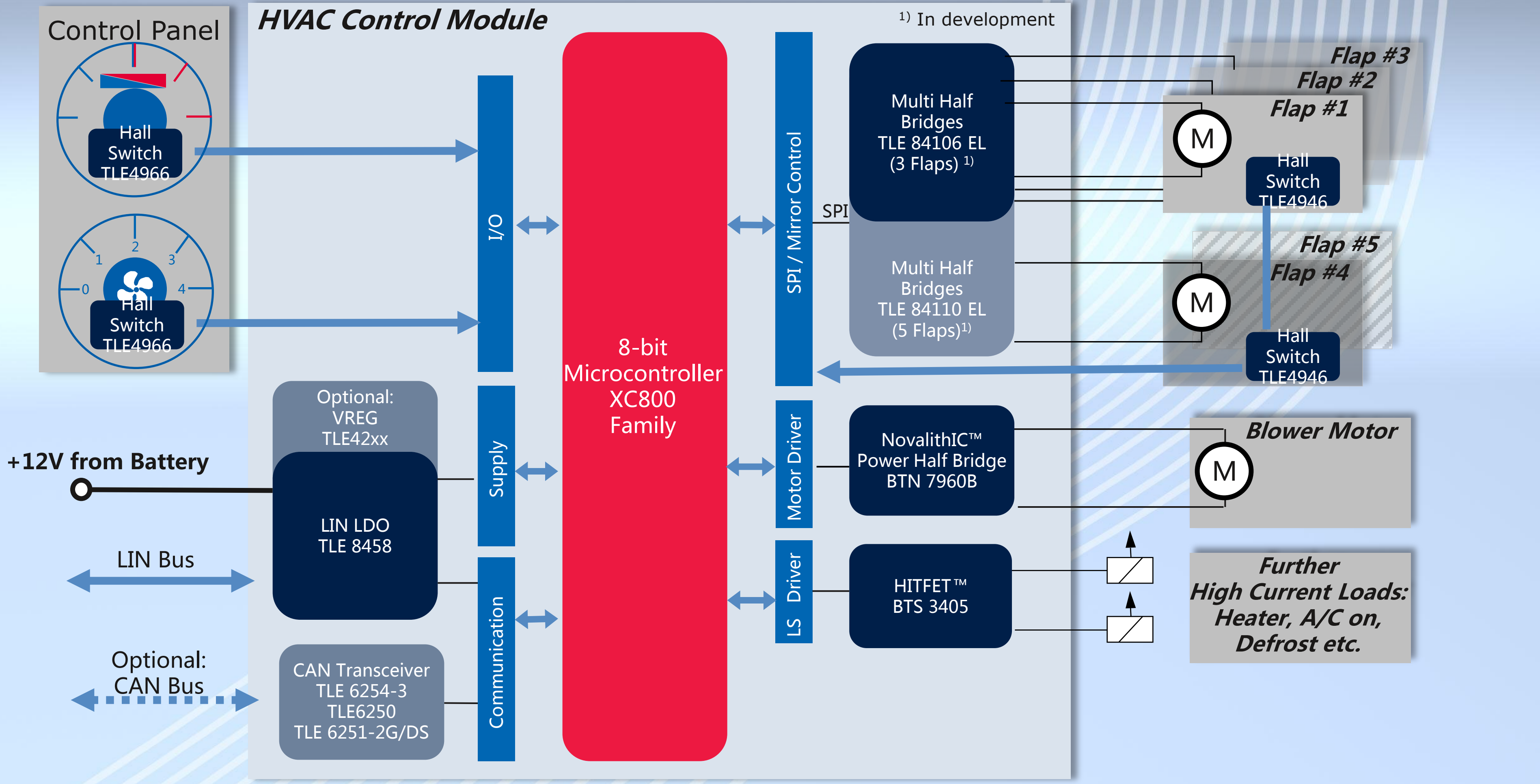


- Single CAN connects to Powertrain Electronics
- Reduced Number of High Side Switch Loads (e.g. Indicators, Brake)
- Many High Current Loads still driven by relays
- Optional RKE functionality, interior LED, etc.

HVAC Control Module
Full Automatic Operation

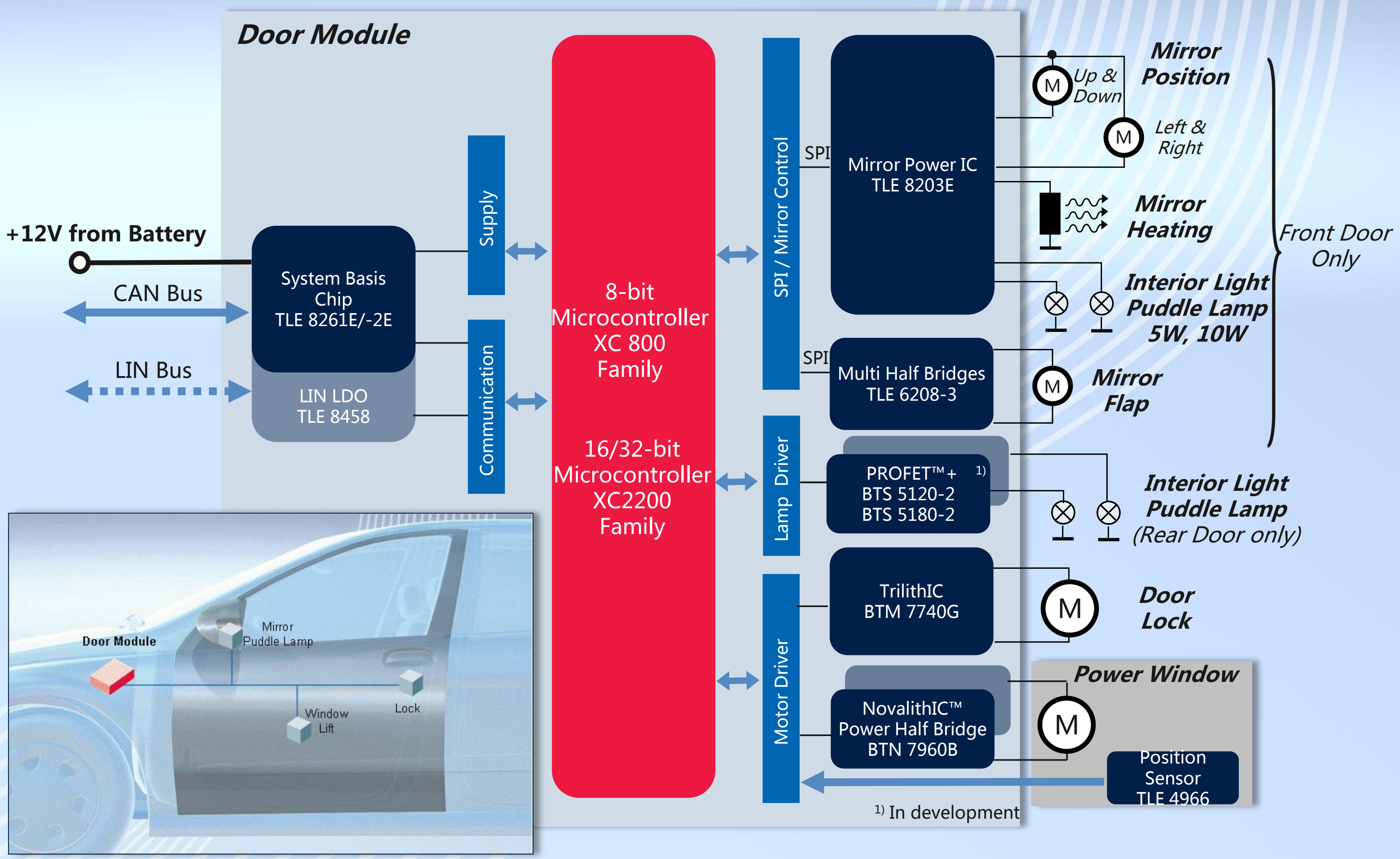


HVAC Control Module
Low to Mid End / Manual + Semi-Automatic



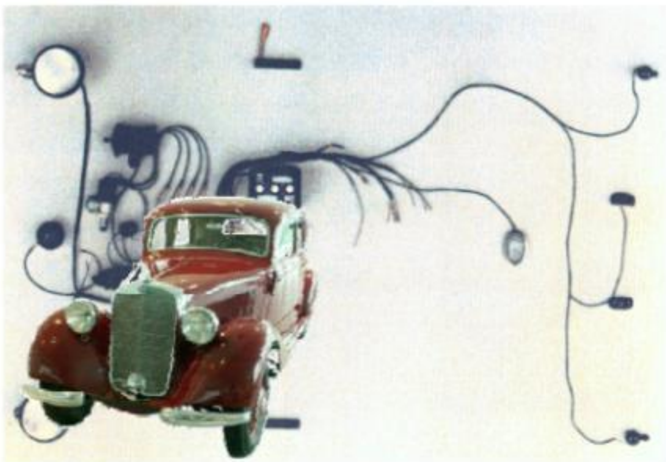
- Same Loads as in High-End Systems / Same Devices Appocable
- Low Cost Microcontroller

Door Module
Full Door Functionality



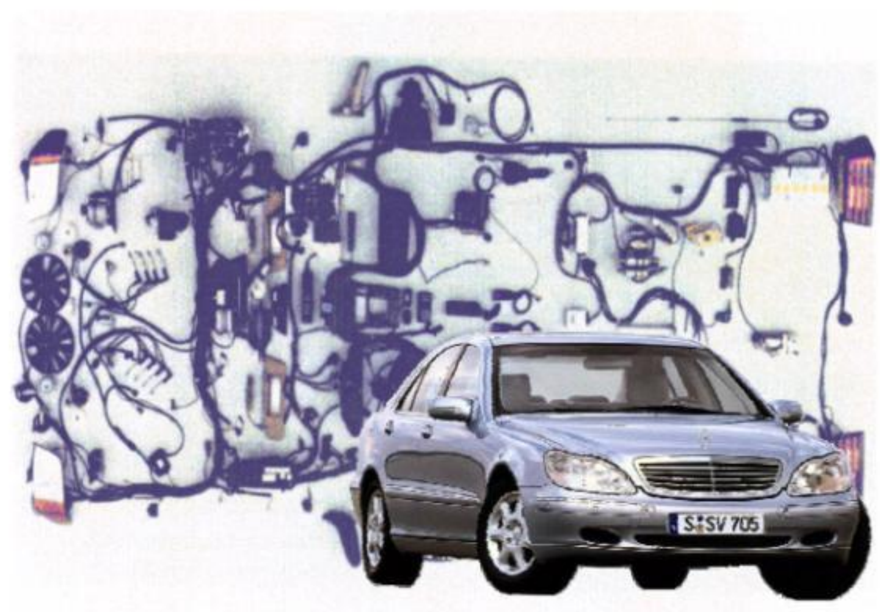
Main Wire harness of Power Distribution is getting more volume/ weight and complex

We have seen these comparisons



Harness 1949
ca. 40 wires
ca. 60 connectors

Harness 1999
ca. 3 km cables
ca. 39 kg weight
ca. 1900 wires
ca. 3800 contacts



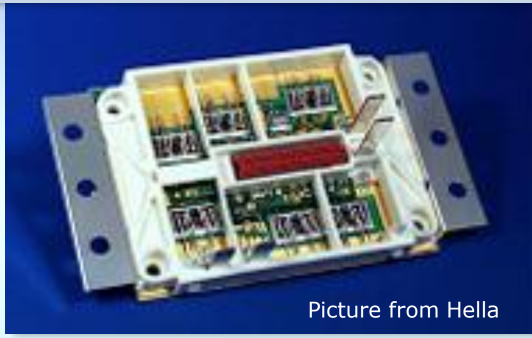
Dr. Wulf Bramesfeld
Freudenberg NOK Mechatronics GmbH & Co. KG
Electronica automotive conference, Munich 2008

Contribution of Smart Power Semiconductors 1990s Automotive Lighting Module Evolution

Body Control Module Evolution @ BMW

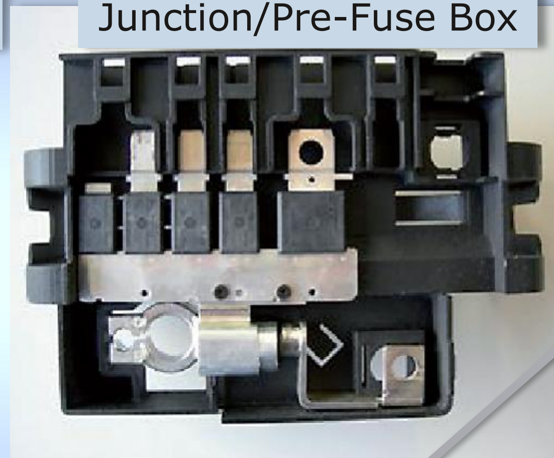
Vehicle Power Distribution Architecture Split into Various Applications

Smart Integrated Pre-fuse Box



Picture from Hella

Junction/Pre-Fuse Box



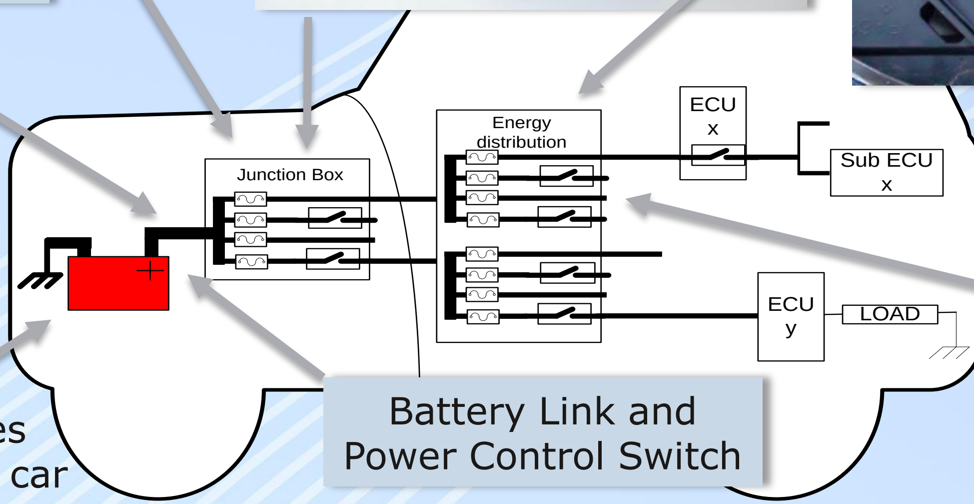
Picture from Lear

Power Distribution Center, Relay and Fuse Box

Picture made in Sixt rental Suzuki SX4

Battery Disconnect

Picture from Auto Kabel



Single Load Relay

Picture from Tyco

One or two Batteries in front or rear of the car

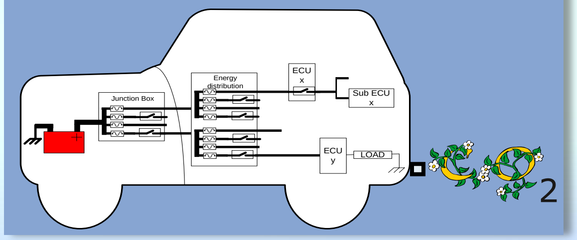
Battery Link and Power Control Switch

Power Distribution architectures are the same in conventional, hybrid or electric vehicles 12 V Power Net part

SMART Power Distribution - Enabling Technology for Energy efficiency, Reliability and functionality

SMART Power Distribution is the enabler for

Energy Efficiency



Material weight
- * device
- * module
- * wire harness

Energy Consumption
- * Power dissipation
- * Driving current
- * idle mode

Reliability

Stop – Start
(> 500 k cycles)

On-board diagnostic
(Short circuit detection)

Reaction time

(switch off speed)

Robustness

(vibration, shock)

Secure disconnect

Functionality

Maintenance Cycles
(Including Reset Ability)

Module volume
(Space enabler)

Module flexibility
(Location)

Module handling
(Waterproof)

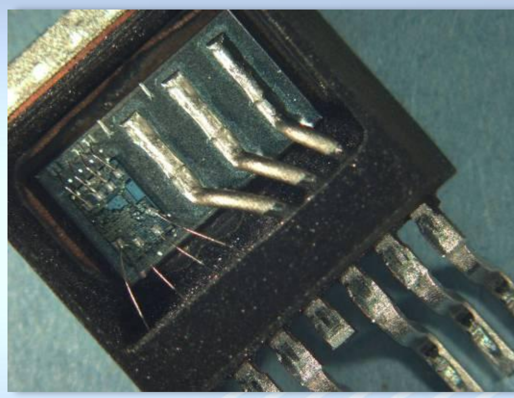
Scalability/ Modularity

Cost down on system level under lifetime consideration

Relay + Fuse Replacement by Power PROFET™
Relay Replacement by Infineon® Connect FET

Lead Type (1.5 mΩ)
Engineering
Samples available

switch



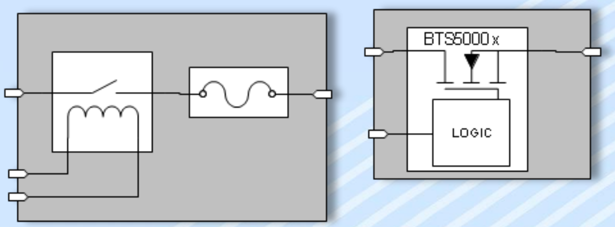
Chip-On-Chip Technology

Lead Type (1.0 mΩ)
Engineering
Samples available

connect

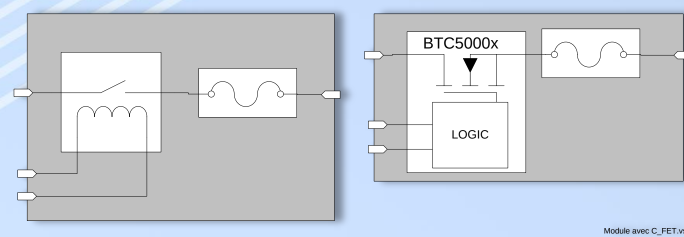
Power PROFET™

Replacement **relay + fuse**



Infineon® Connect FET

Replacement of the **relay only**



Master: BTS 50015-1TAA SOP Dec 2010

Master: BTC 50010-1TAA SOP Apr 2011

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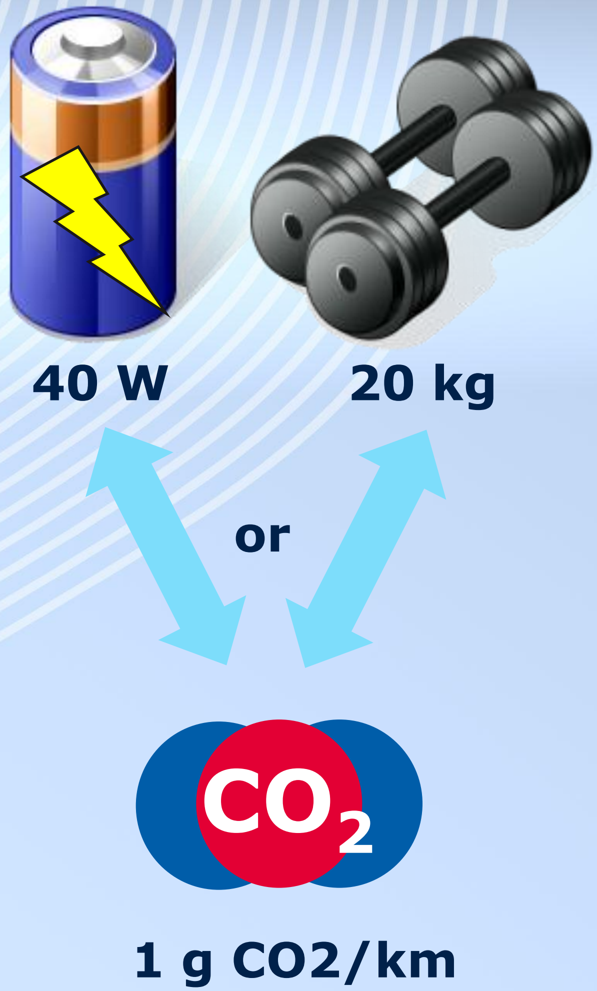
- Sample Calculation – How much Energy Can be Saved

Energy Efficiency and CO_2 Emission Impact of Electric Power and Weight

100 W (elektr.)	⇔	**0.1 ℓ/100km**
50 kg	⇔	**0.1 ℓ/100km**

1 ℓ/100km Gasoline	⇔	**23.6 g CO2/km**
1 ℓ/100km Diesel	⇔	**26.5 g CO2/km**

1 g CO2/km	⇔	**40 W (elektr.)**
1 g CO2/km	⇔	**20 kg**

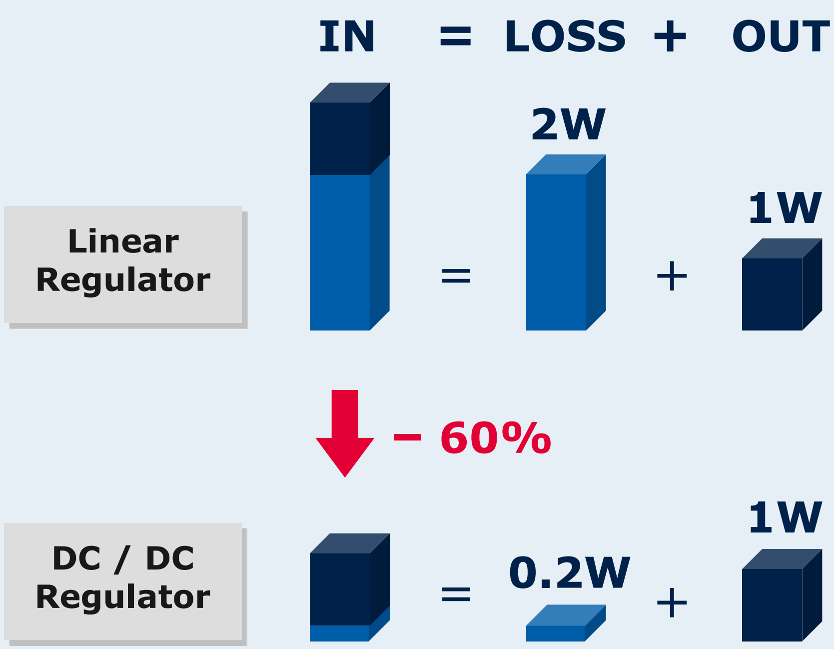


Source: VDI Conference „Elektronik im Kraftfahrzeug", Baden-Baden 2007

Semiconductors Contribute to Energy Efficiency in Nearly Every ECU

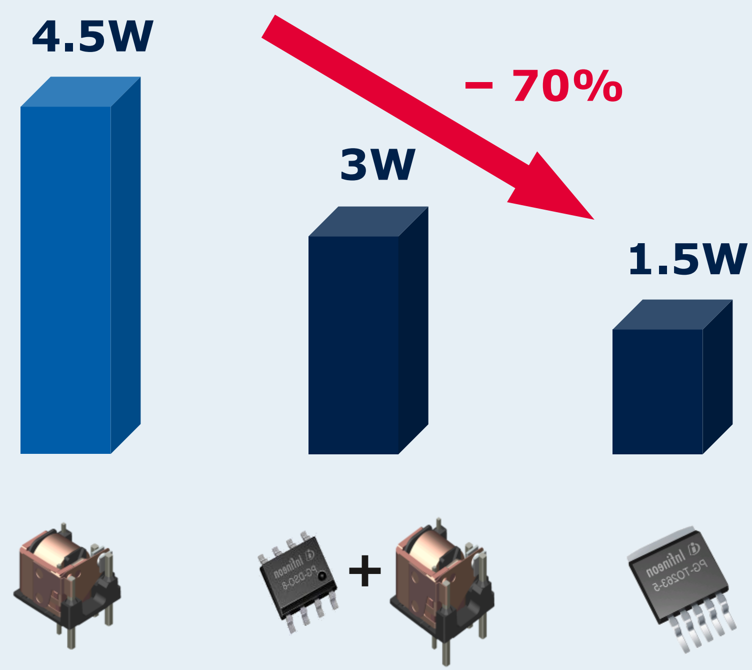
Voltage Supply Efficiency

Example: 5V, 200mA
60% less input power



Power Switching Efficiency

Example: 14V, 20A
70% less switching losses



Motivation

Source: http://images.google.de

IGN off – Car in Sleep Mode

- Target: Sleep mode current <100 µA per ECU
- No Bus traffic, Wakeup events possible
  - Remote Keyless Entry
  - Inquiry of Switch Panels

Total Car Current Consumption:

~ 5..20 mA

Source:Infineon AG

IGN on – Car runs

- Target Parameter Performance / Functionality
- Current Consumption – Not Yet a Constraint
- Permanent Network Traffic

Total Car Current Consumption:

~ > 10 Amps
(without any loads)

How To Enhance Vehicle Efficiency when Car Drives

Partial Node Deactivation	Complete Deactivation of unused ECU‘s
Scalable Functionality	Dynamical Adaptation of ECU Performance

Energy Efficient Networks
Different Ways to Save Energy

Partial Node Deactivation

Affected Products
- Standalone CAN Transceiver
- System Basis Chip

Challenge
- Standardization of Wakeup CAN message

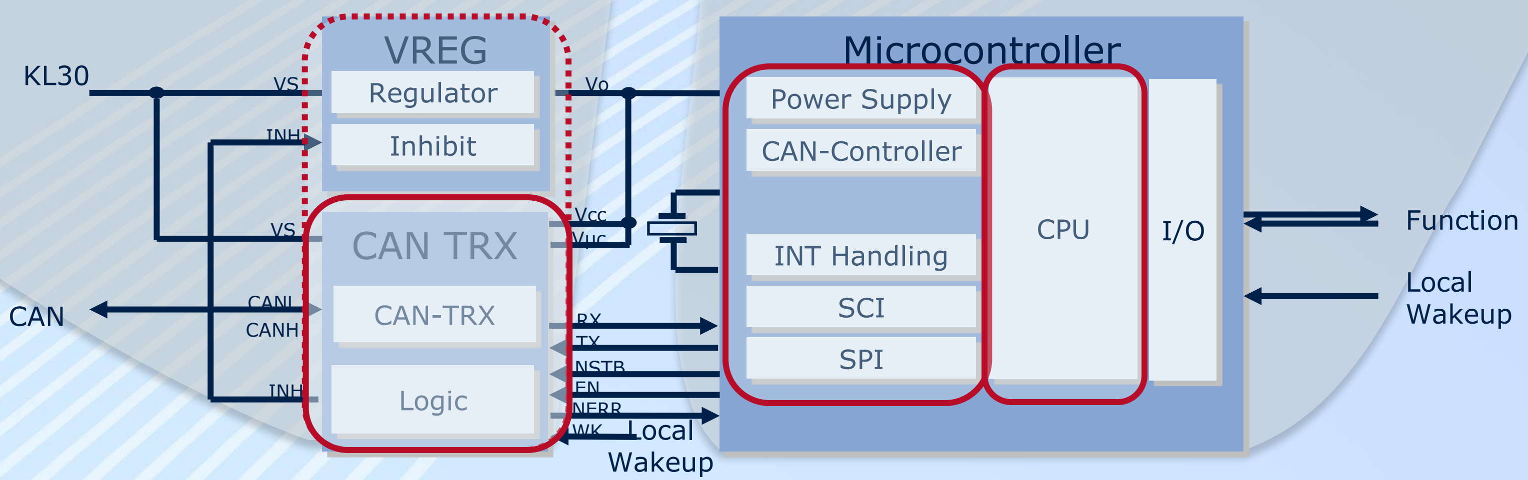
Market
- Mid-/high end vehicles, world-wide

Scalable Functionality

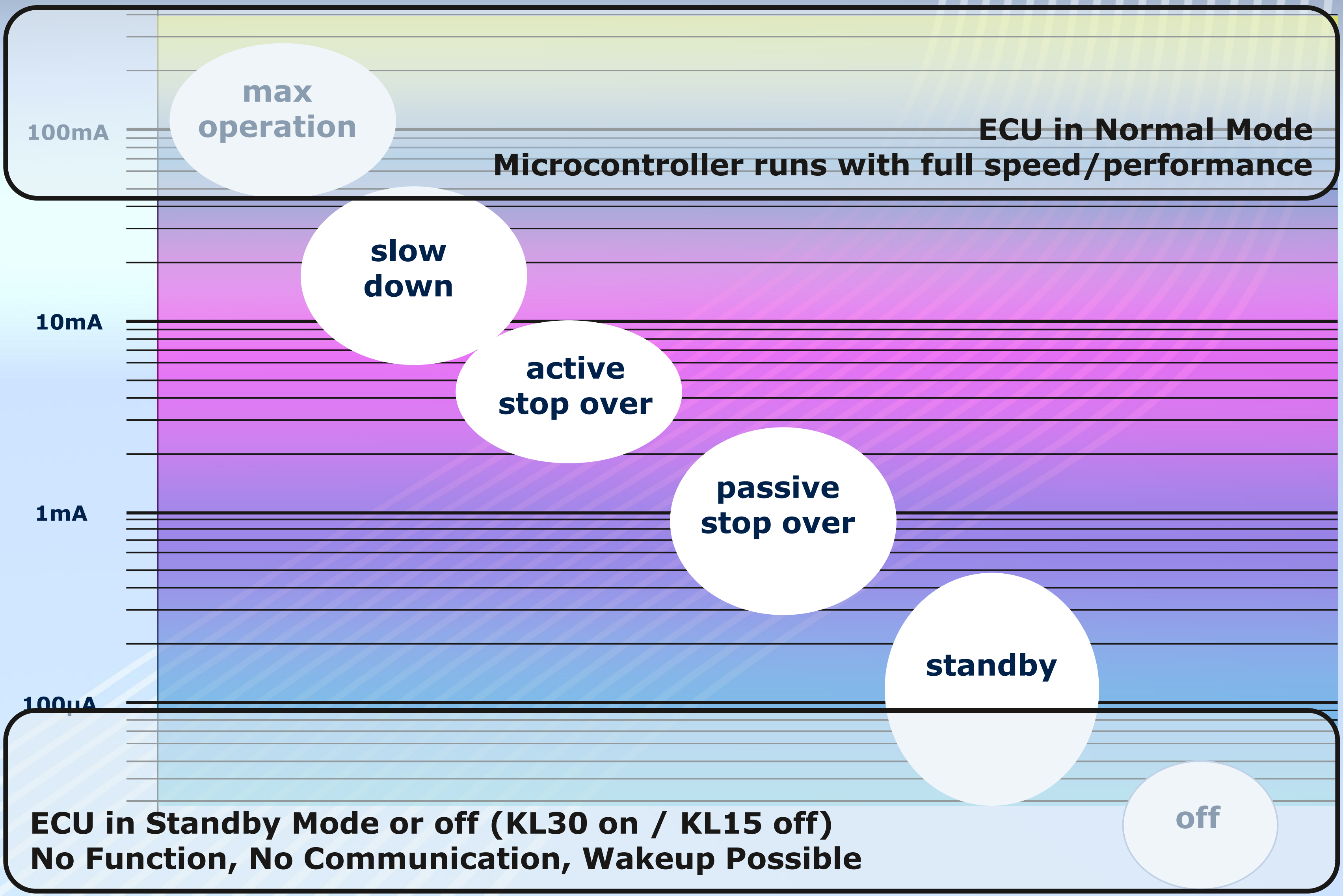
Affected Products
- Microcontroller

Challenge
- Implementation across µC families

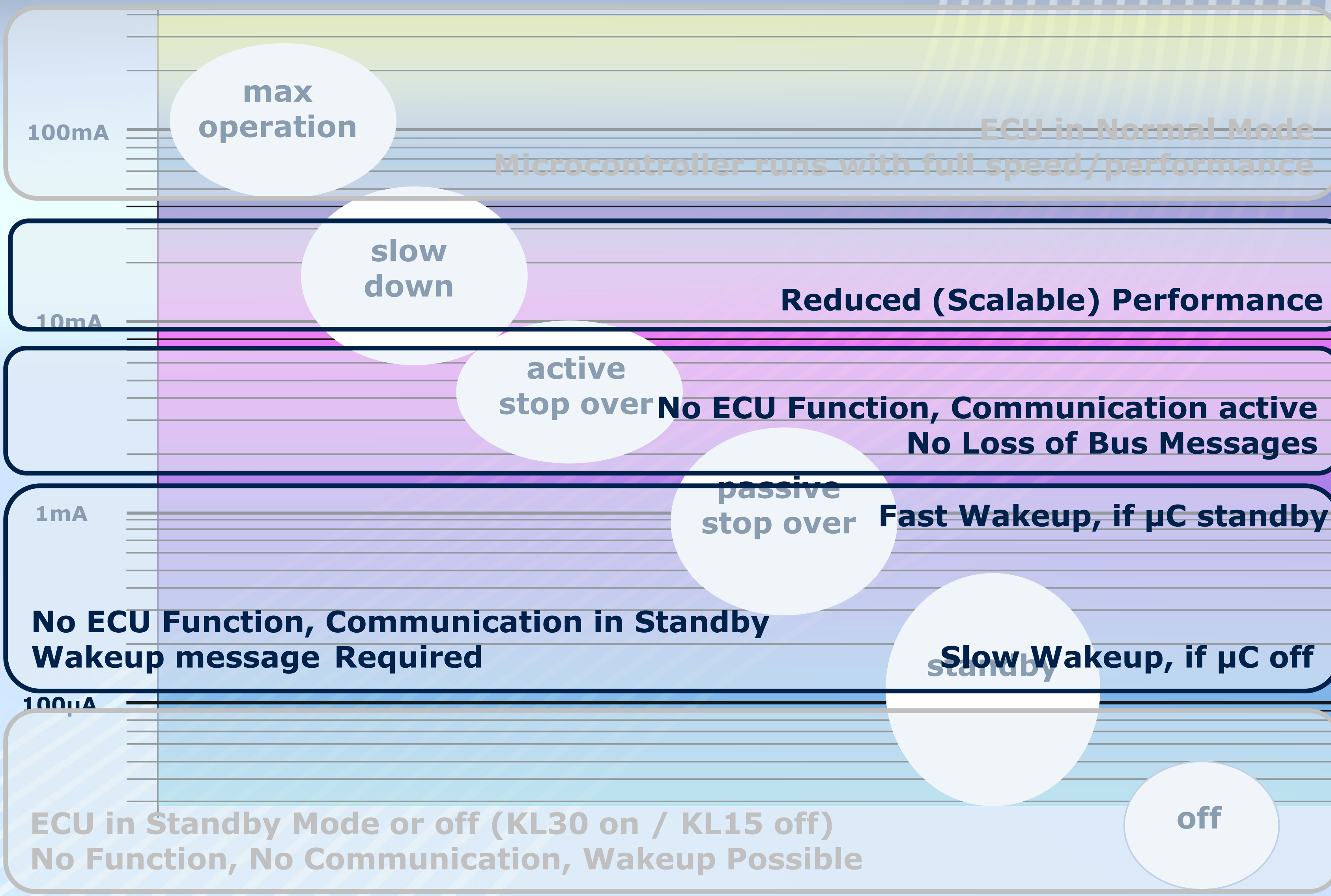
Market
- Mid-/high end vehicles, world-wide



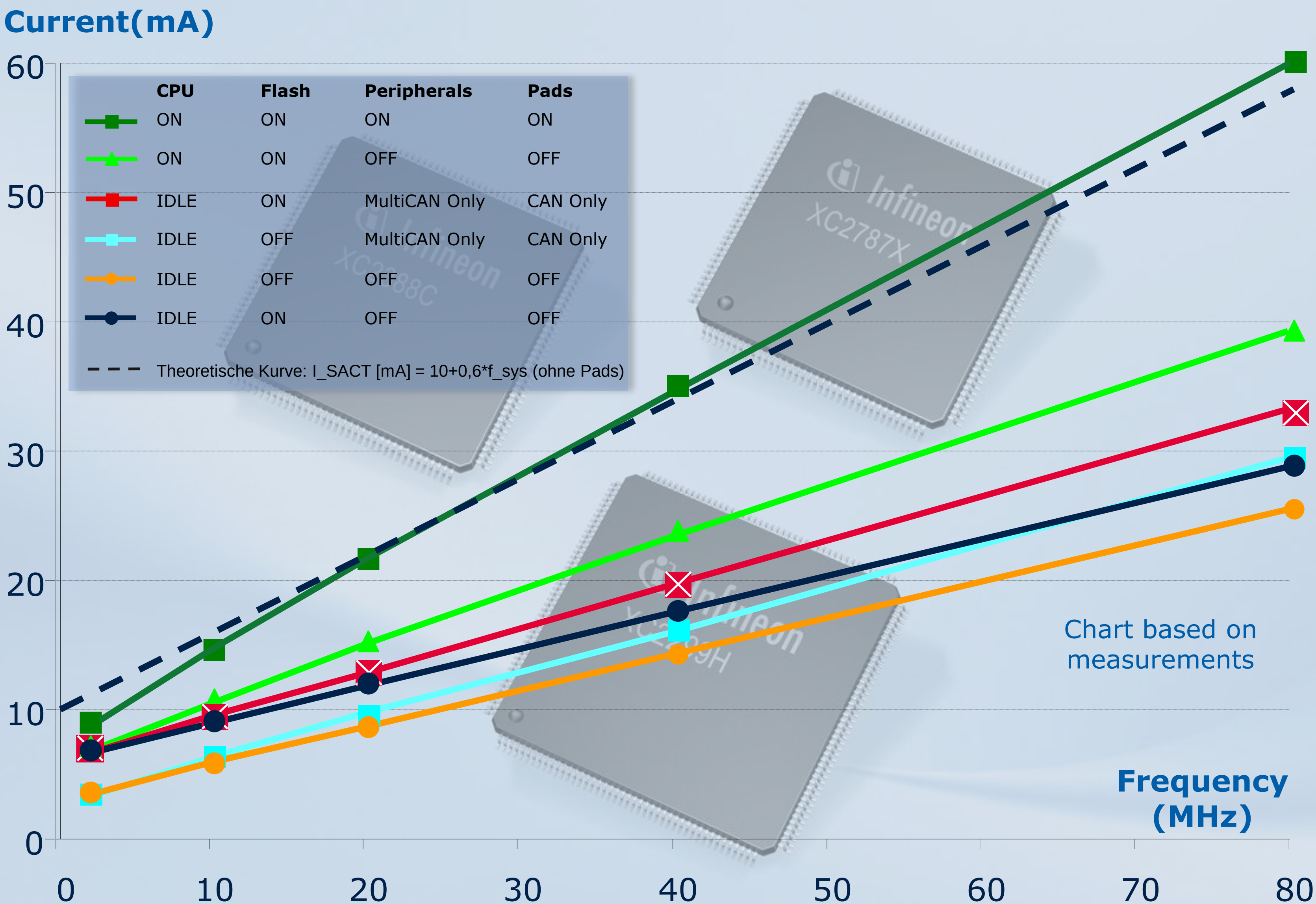
Current ECU Operating Modes
No Energy Efficiency while Car is Driving



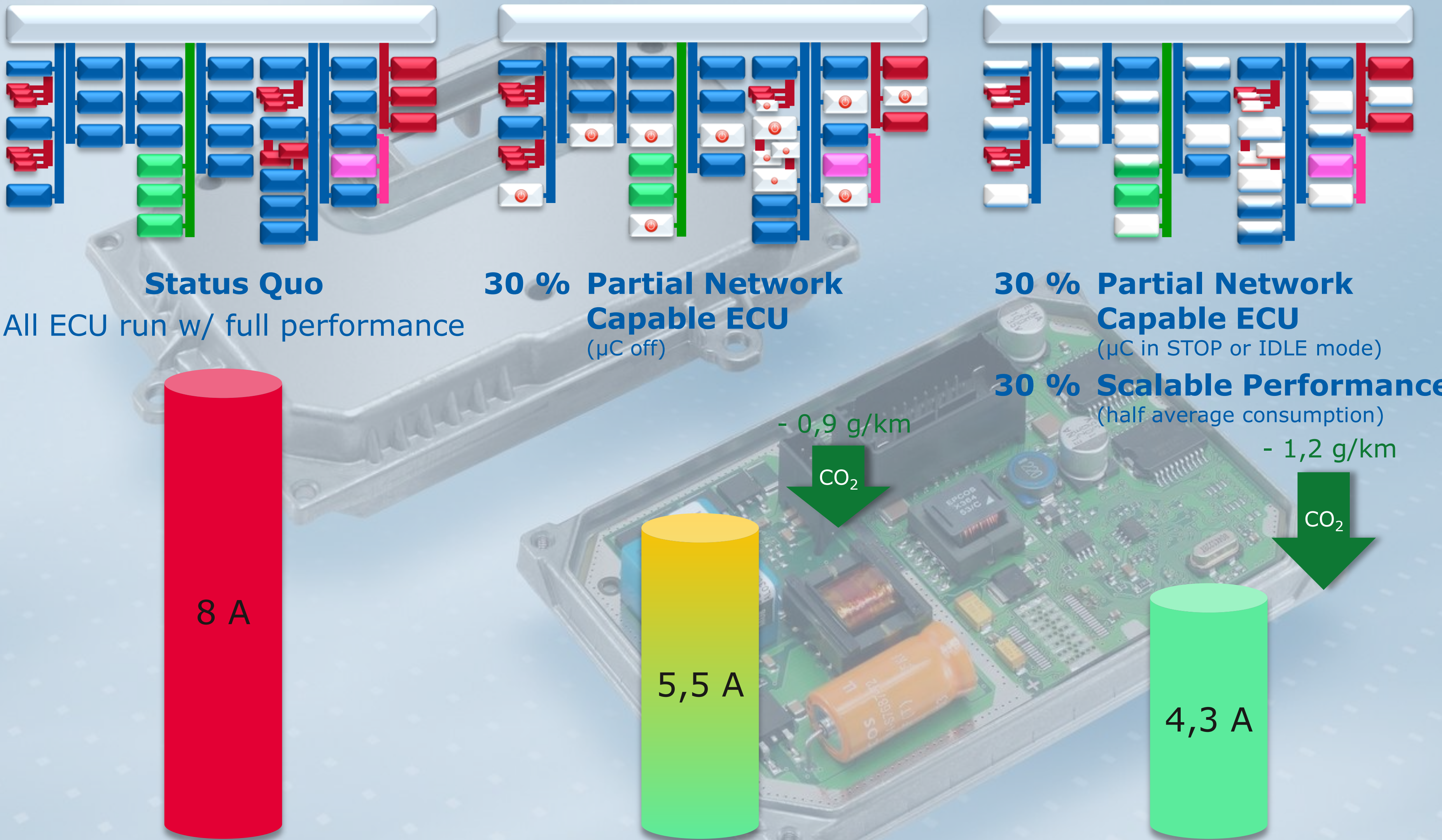
New Operating Modes
Reducing Energy Consumption



Scalable Current Consumption Example: XC228xM Family



Example Calculation / Use Case Analysis Total Current Consumption



Assumptions: Network with 40 ECUs. Average Current Consumption per ECU 200mA. ECUs with scalable performance save 50 % (half average current consumption). Partial Network Mode: Capable ECUs remain 95% of run time in partial network mode with a current consumption of 1mA (µC off) resp. 10mA (µC in STOP or IDLE).