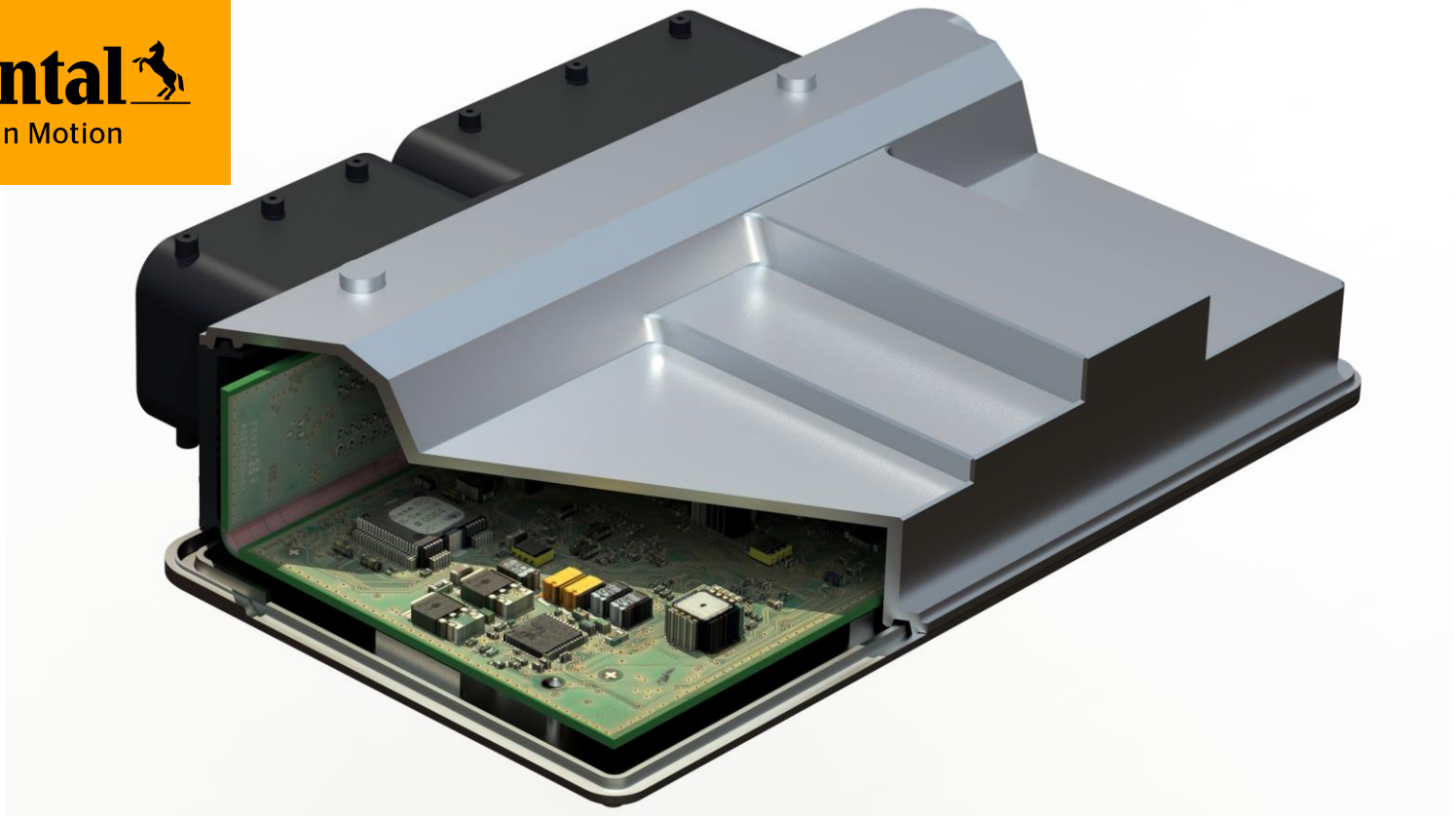
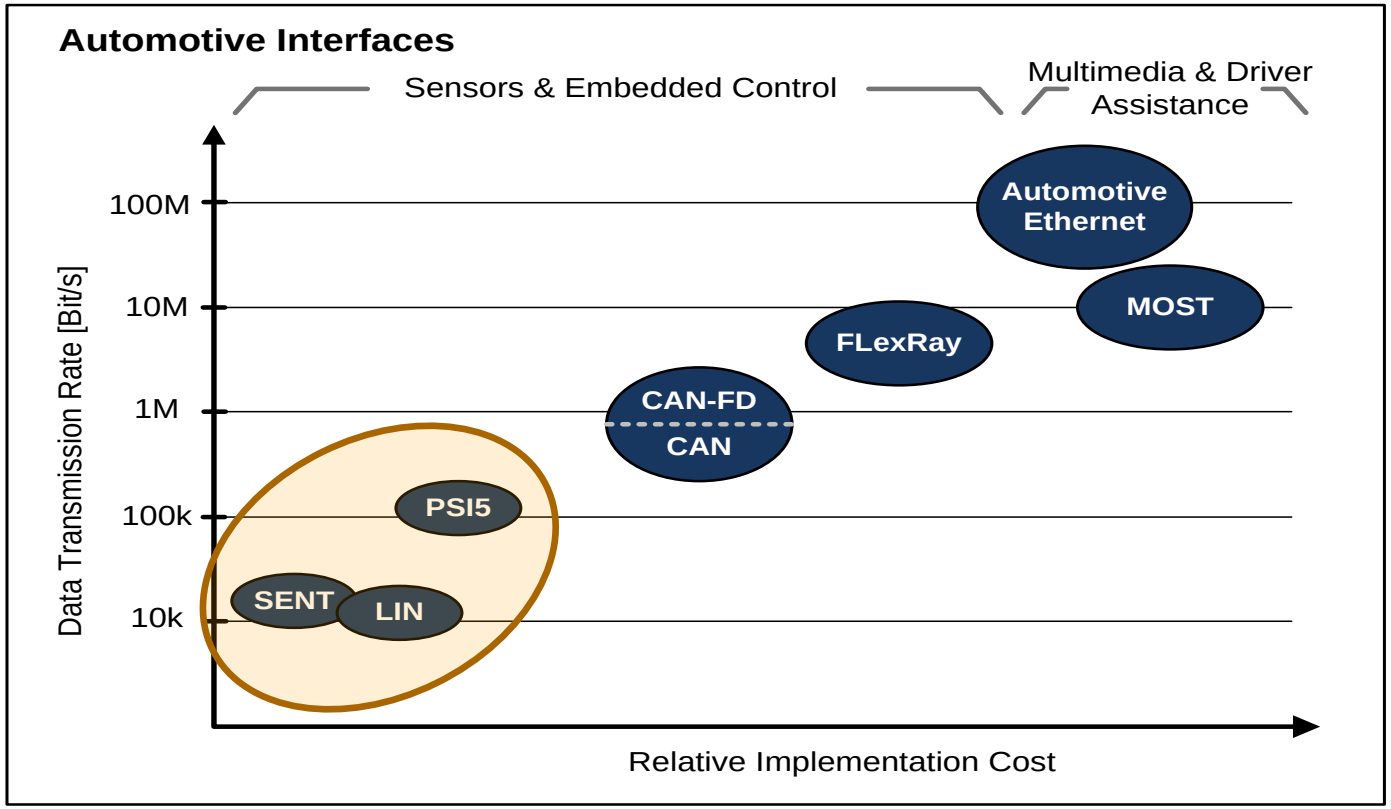
Continental
The Future in Motion



Low-Speed Communication

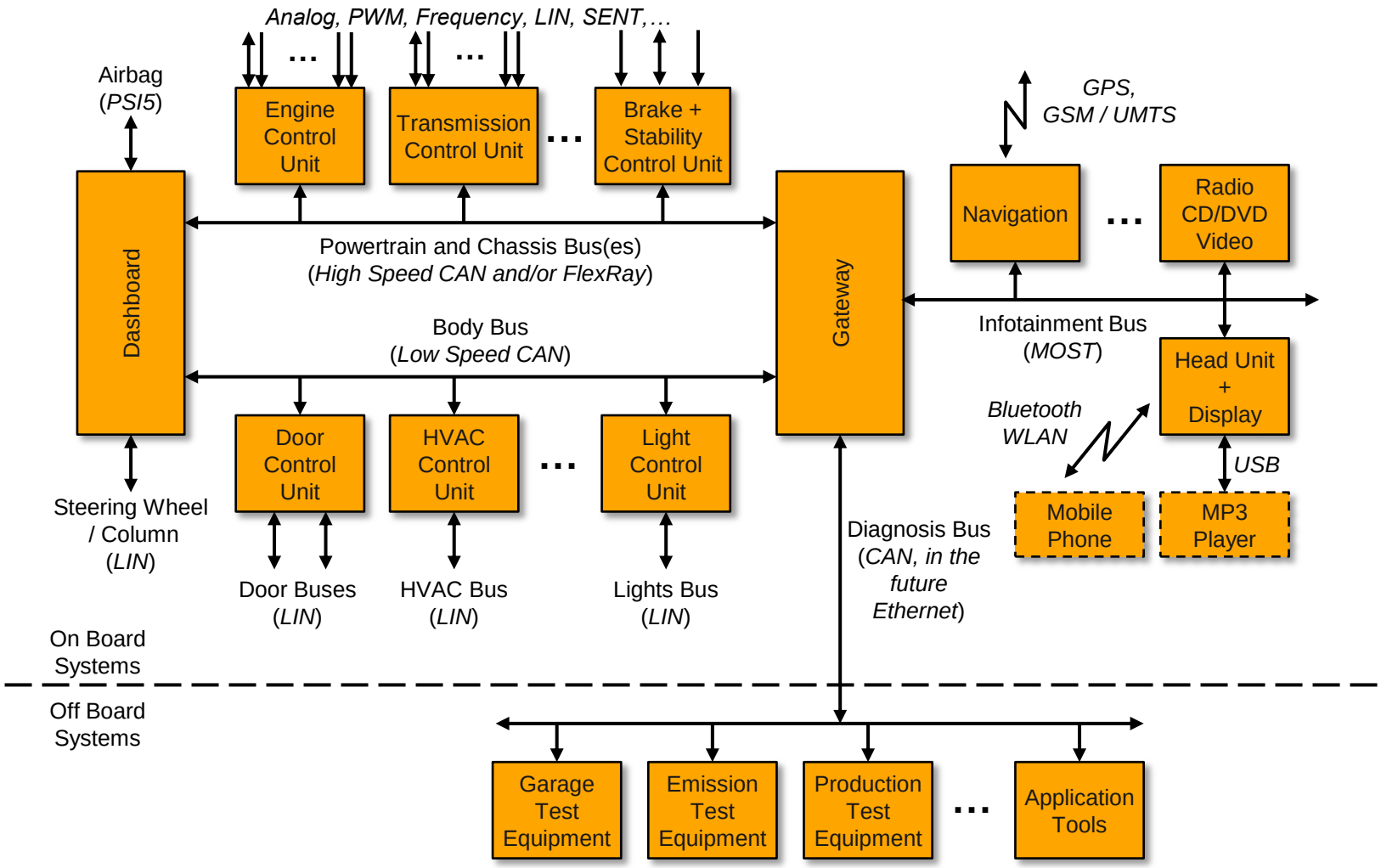
LIN, SENT & PSI5 optimized for the applications

Automotive Interfaces Overview

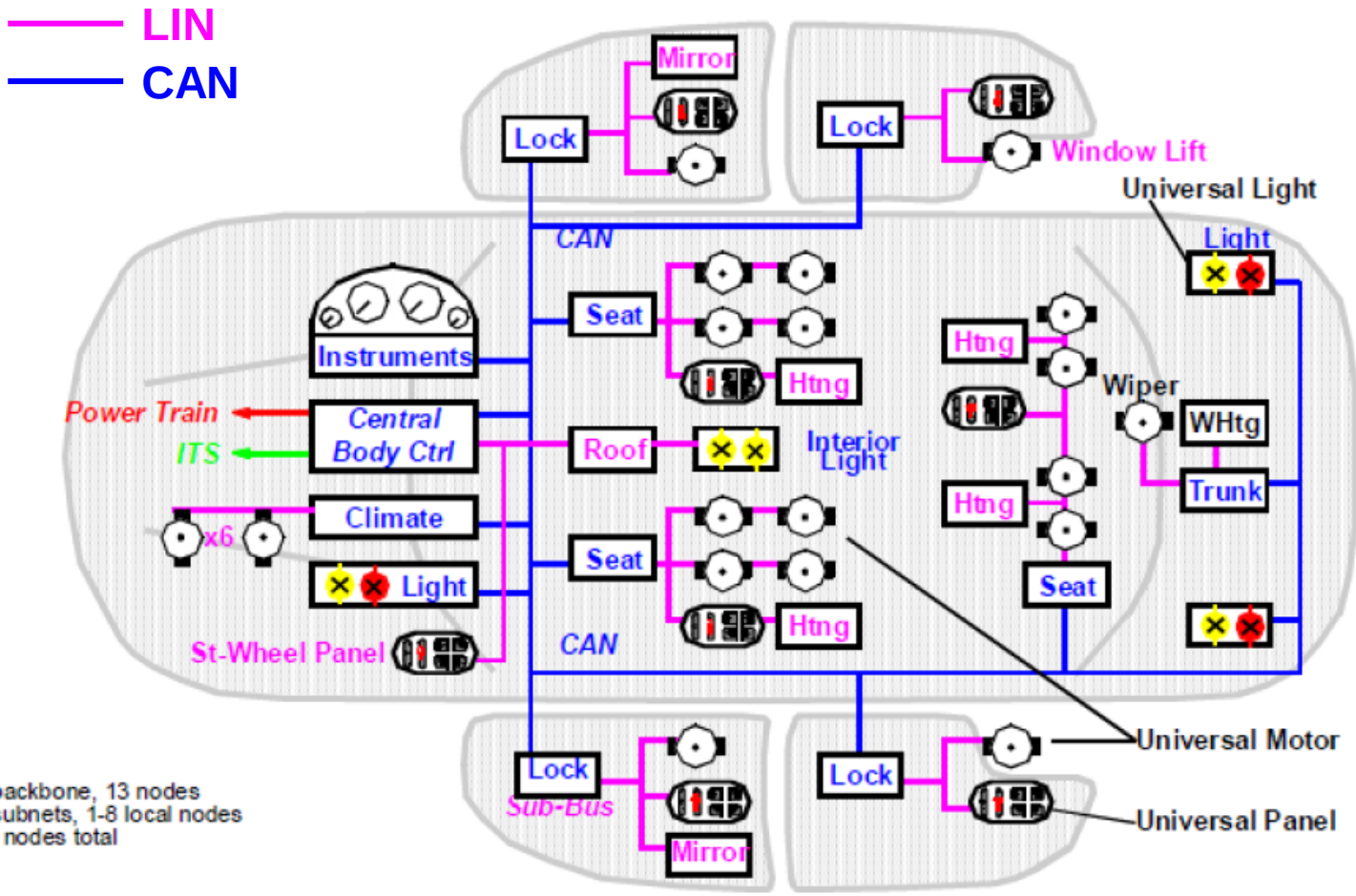


LIN, SENT and PSI5
…why do we need beside CAN?
…why the diversity in this area of application?

Vehicle Bus Architecture



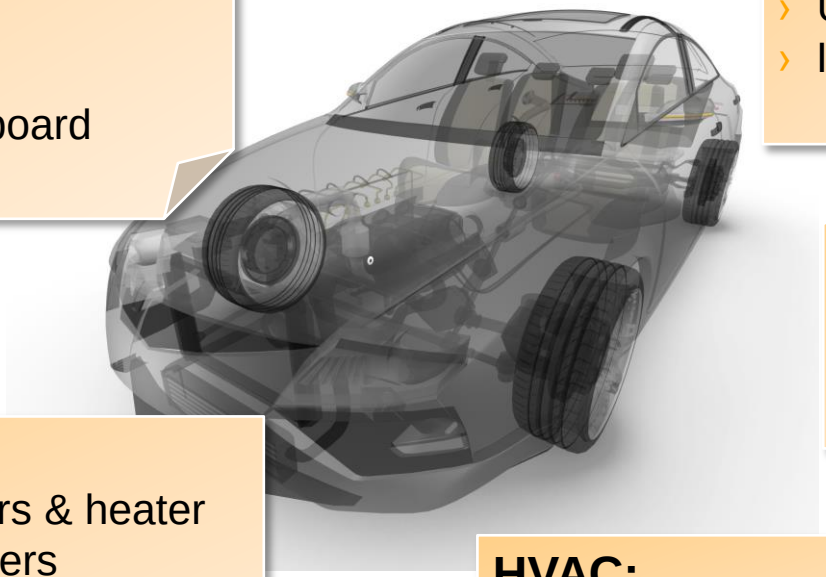
LIN (Local Interconnect Network)
Vehicle Partitioning with CAN



Typical Application of LIN

Steering wheel and column:
(a lot of controls are positioned on the steering wheel and column)
- Cruise control
- Wipers / washer
- Head & turning light
- Infotainment & dashboard

Roof:
(high amount of wiring)
- Rain & light sensor
- Sun roof
- Upper switch panels
- Interior light

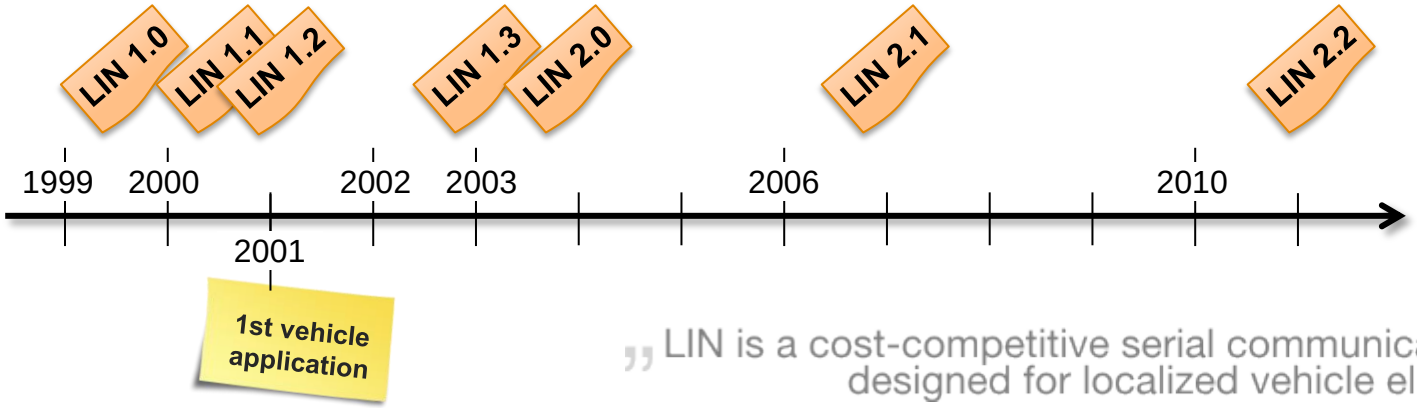


Seat:
- Seat position motors
- Occupancy sensor
- Control panel

Door:
- Mirror switches, motors & heater
- Window controls & lifters
- Seat control switch
- Door lock switches & motor

HVAC:
- Many small motors / flaps
- Control panel

LIN
Concept and History



LOCAL INTERCONNECT NETWORK

„LIN is a cost-competitive serial communication system designed for localized vehicle electrical networks.“

Source: http://www.lin-subbus.org

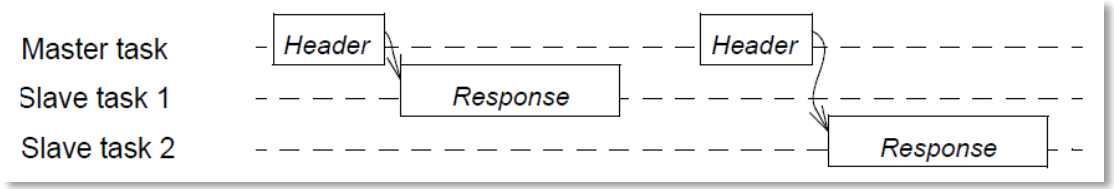
What LIN is

- A slower, easy-to-use and **cheaper alternative** to CAN.
- As **single-wire bus** concept with **single master** and **multiple slaves**
- Designed to link switches/gateways, actuators and sensors into a sub-bus that connects to the main bus (e.g. CAN)
- An **open automotive standard** set by the steering group with the final release of Spec 2.2A
- Is being transcribed to the ISO to be accepted as ISO 17987 Part 1-7 standard

LIN
Overview

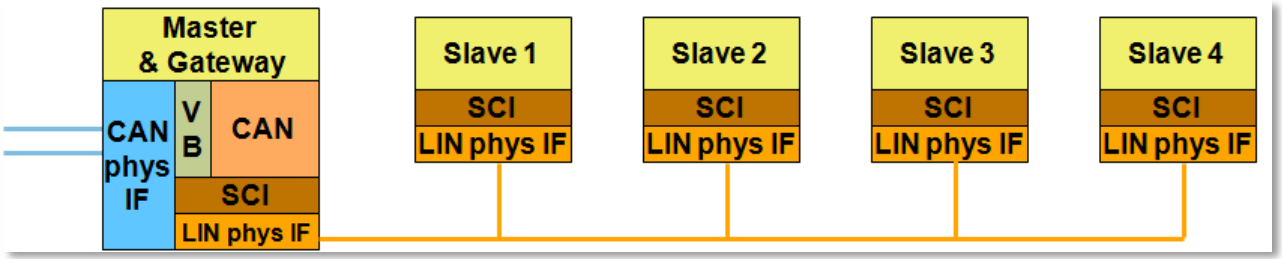
How LIN works

- The signal transmission is based on a UART/SCI interface (1 start, 8 data, 1 stop bit)
- Master has full control over the bus & protocol w/ deterministic scheme
- Self-synchronization with a synch field and a max. clock deviation of 14%
- Voltage signal with absolute thresholds (12 V Vbatt range) for recessive (1) and dominant (0) levels
- Max. transfer band width: 19,2 k bit/s / 52 µs/bit.



How LIN is realized

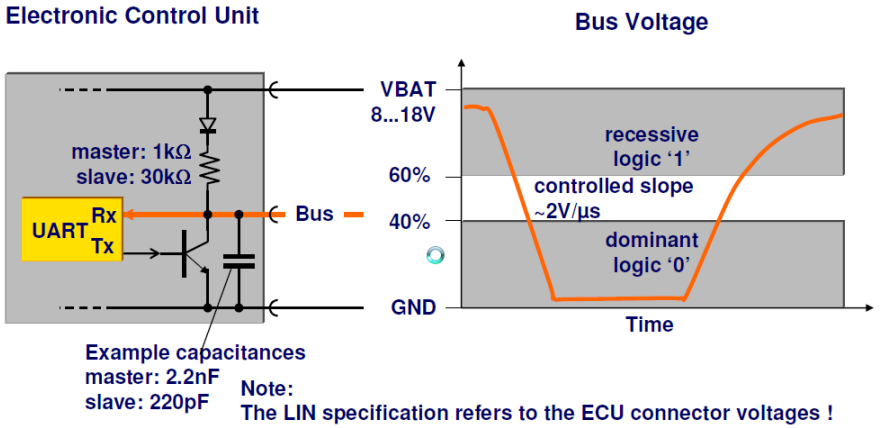
- Single-line bus, with pull-ups in the nodes
- Neither twisted pair nor shielding necessary
- Max. 16 nodes
- Max. 40 m bus length



Why LIN as Cost-Efficient Alternative to CAN?

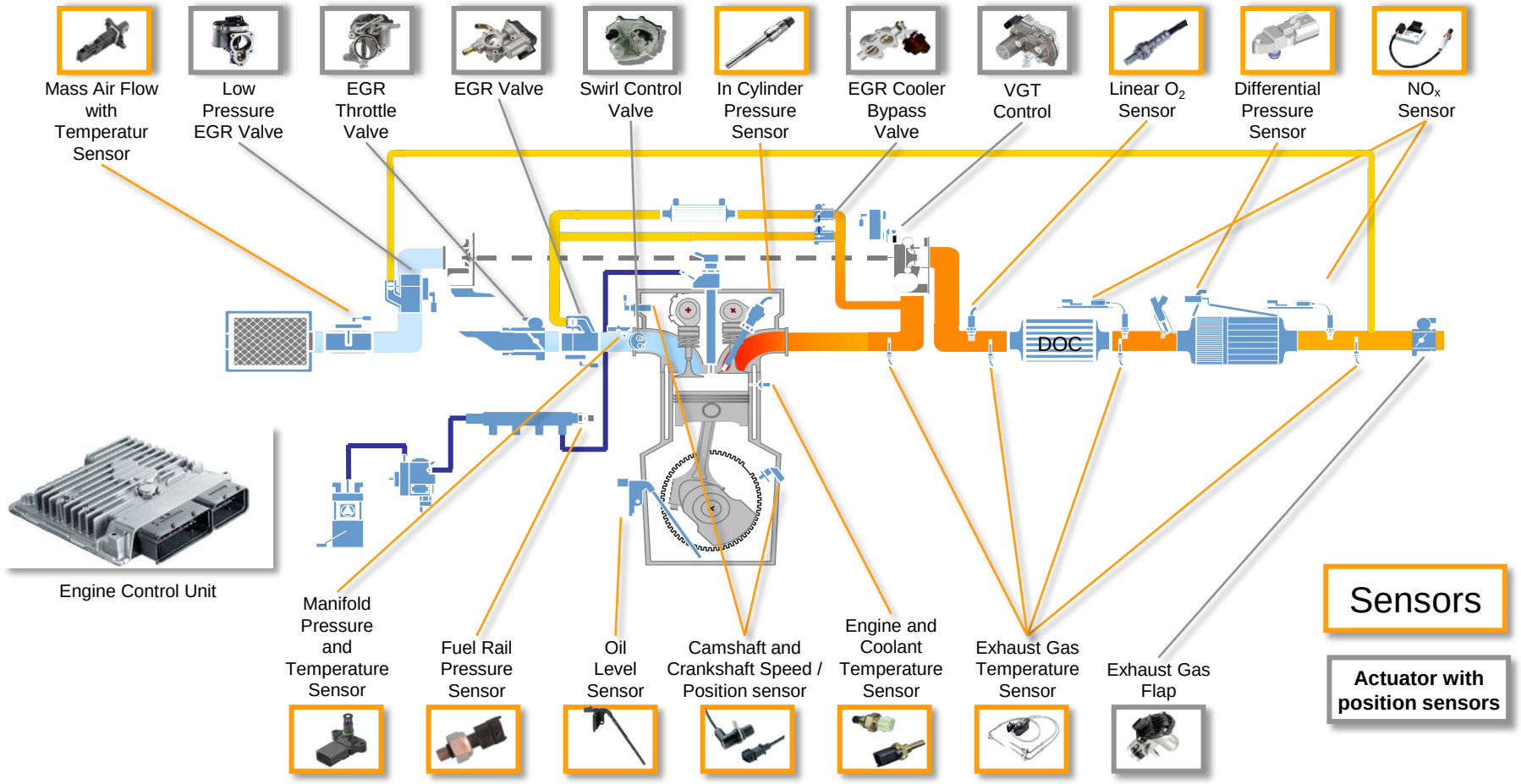
- **Wiring Harness**
  - One pin, one wire, one HW driver etc. only (in opposite to CAN)
  - No twisted pair, no wire shielding

- **Keep it simple and tailored to the application!**
  - No need for quartz nor ceramic resonator in the slaves due to low clock accuracy requirement for slaves (up to 14% clock frequency accuracy)
  - Only low calculation power in nodes needed, because of slow transmissions and simple checksum calculations
  - No additional need for voltage regulator due to battery voltage reference
  - Slow speed (EMC, timings,…)
  - Max. 16 nodes



Sensors and System for Engine Controls

Example Diesel Engine and Aftertreatment configuration for EU6-c / 2017



Sensor Interface Analog vs. Digital

Benefits of digital serial interfaces

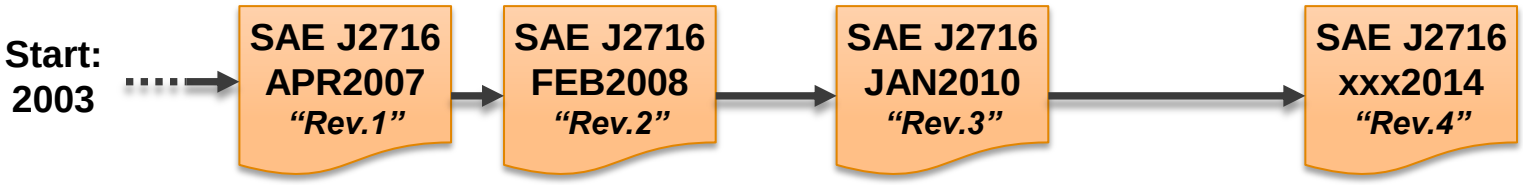
- **Higher signal resolution and accuracy**
  - Sensor-specific scaleable resolution
  - No losses due to multiple A/D and D/A conversions
  - No losses due to signal line issues and disturbances (e.g. contact resistance)
- **Transmission of additional / multiple data within one channel**
  - Multiple sensor signal information
  - Sensor status and diagnosis data
  - Additional sensor-specific information
    (e.g. sensor signal characteristic, manufacturer, part #...)
- **Advanced diagnosis capabilities through the sensor (localization)**

Main disadvantage of digital serial interfaces

- **Discontinuous sensor signal transmission**

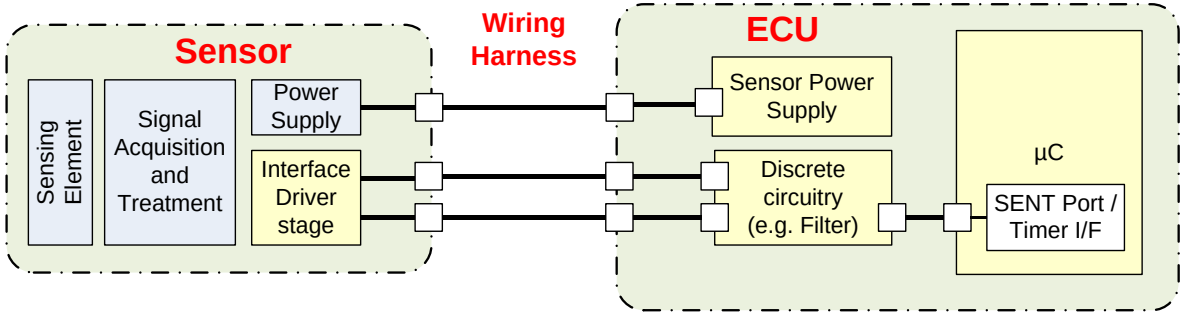
SENT (Single Edge Nibble Transmission)

Development / Release timeline of SAE Standard J2716 - SENT



What SENT is

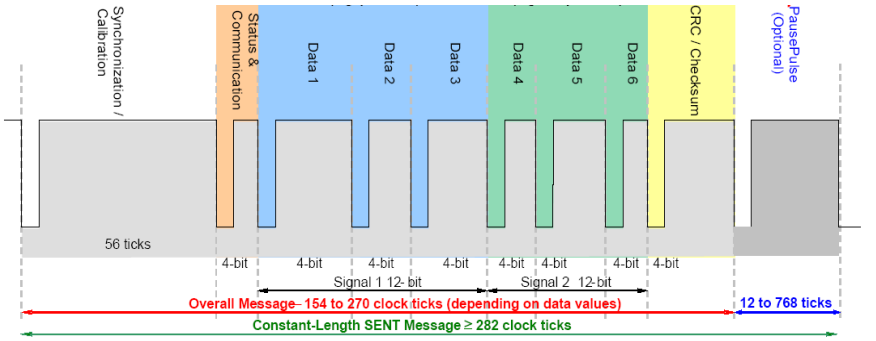
- A simpler **low-cost alternative** to CAN or LIN.
- **Unidirectional, digital, P2P** communication interface from sensor to controller (ECU)
- For applications where **high resolution** and **reliable** sensor data are required as a replacement for analog-ratiometric and PWM-coded transmission



SENT
Overview

How SENT works

- The sensor signal is transmitted as a **series of pulses** with data measured as **falling-to-falling edge times**.
- Physical layer: **3-wire, 0...5 V voltage signal**
- Transfer band width: ~25 kBit/s (net data rate), **2 x 12 bit data per message ≤ 1 ms**



How SENT is realized

- The implementation assumes that the sensor is a **smart sensor** containing a microprocessor or dedicated logic device (ASIC) to create the signal.
- Implementation:
  Sensor: Sensor signal evaluation and coding-ASIC w/ push-pull driving stage
  Receiver (ECU): Pulse length evaluation and decoding w/ **timer + SW** or **SENT interface controller**

Future of Digital Interface for Powertrain (PT) Applications
Assessment of Different Sensor Interface Solution

Powertrain Requirements		CAN	LIN	SENT			PSI5 V1.3
				Standard Jan2010	Concepts w/ SPC	Concepts current interface	
Pin count reduction for EMS		++	+	-	o	o	+
Sensor signal performance		++	o	+	-	+	++
Robustness		+	o	o	-	+	+
Tuning protection		++	o	-	o	-	+
Variant management and logistic effort		++	+	+	+	+	++
Component self-diagnostic		++	o	o	o	o	+
EMV performance (cost independent)		+	o	o	-	+	+
Cost	ECU	--	o	+	+	-	--
	wiring harness	+	++	--	-	-	++
	sensor	--	+	+	+	o	o
Sensor signal operational availability		-	o	+	+	+	o
Data rate	Sensor to ECU	++	-	o	o	o	+
	ECU to sensor	++	o	--	o	--	+

PSI5 V2.0 June 2011

Top 4 requirements

Main improvements necessary

PSI5 (Peripheral Sensor Interface 5)

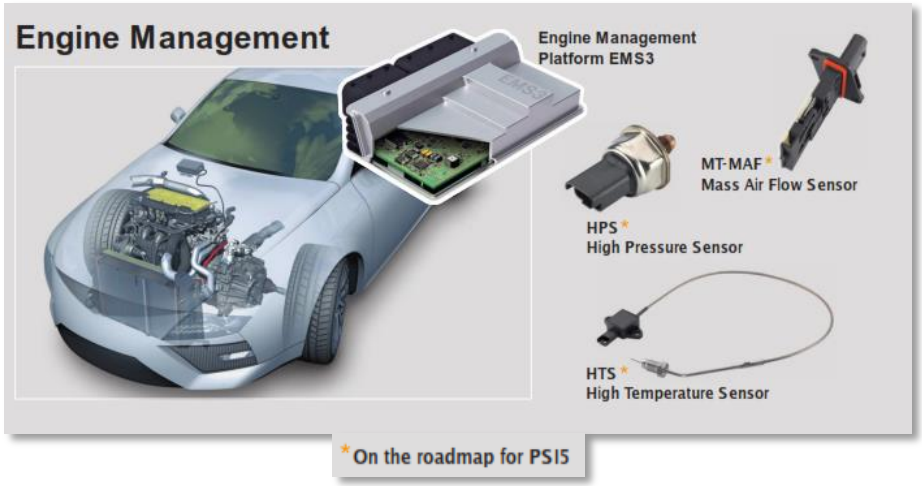
PSI5 at a glance

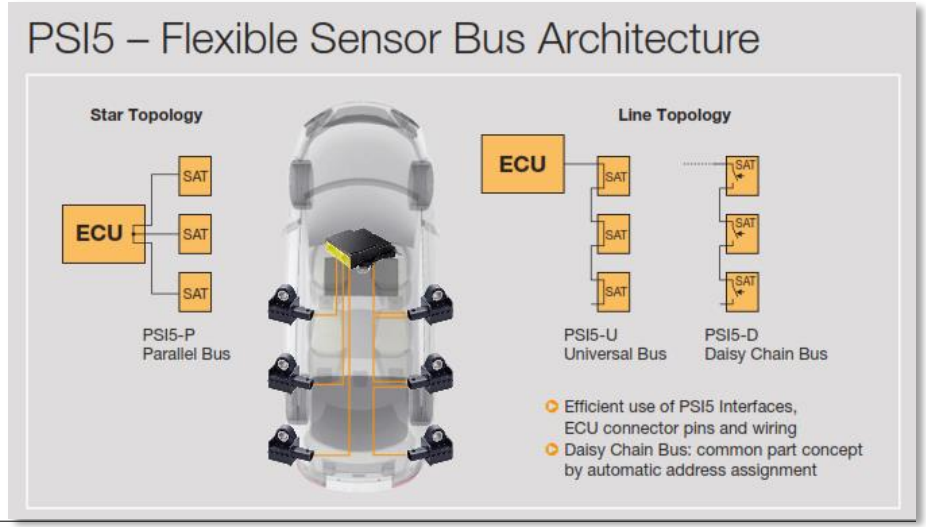
- World-wide **open standard** for sensor interface
- A robust and **well-established** standard for interfacing of peripheral **airbag** sensor
- Supported by the main OEMs, VDA, component and system supplier **proven** already **million times** in the field

PSI5 evolution

- Merged from proprietary airbag protocols in 2007 to V1.2
- Version **V1.3** (2008) latest version with only **focus on airbag**
- Since **V2.0** (June 2011) the **application focus** and supported features were extended towards **powertrain** and **chassis** needs

PSI5
Typical Application

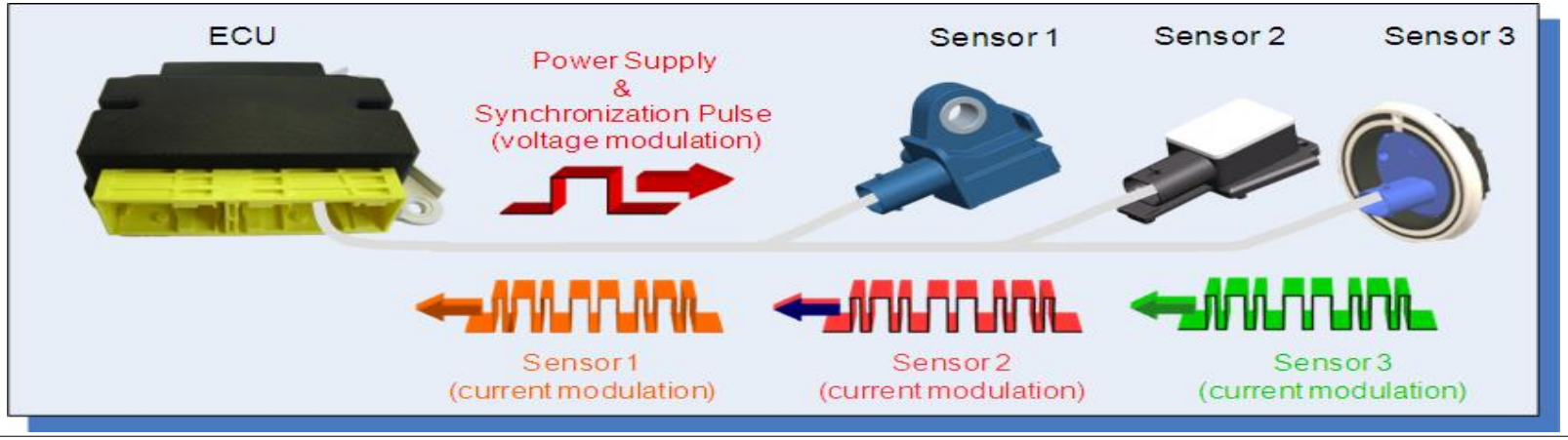




PSI5
How the Interface Works

2-wire, current modulated, digital, serial sensor interface

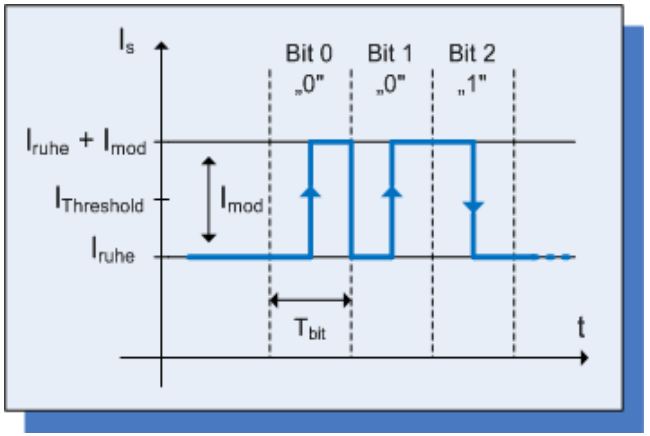
- Power supply from the ECU to the sensors (**true 2 wire interface**)
- **Current modulation:**
  Transmission of **sensor data to the ECU** in defined timeslots
- **Voltage modulation**
  (1) **Synchronization pulse** from the ECU (bus master)
  (2) **Bidirectional ECU2Sensor** communication with the synchronization pulse

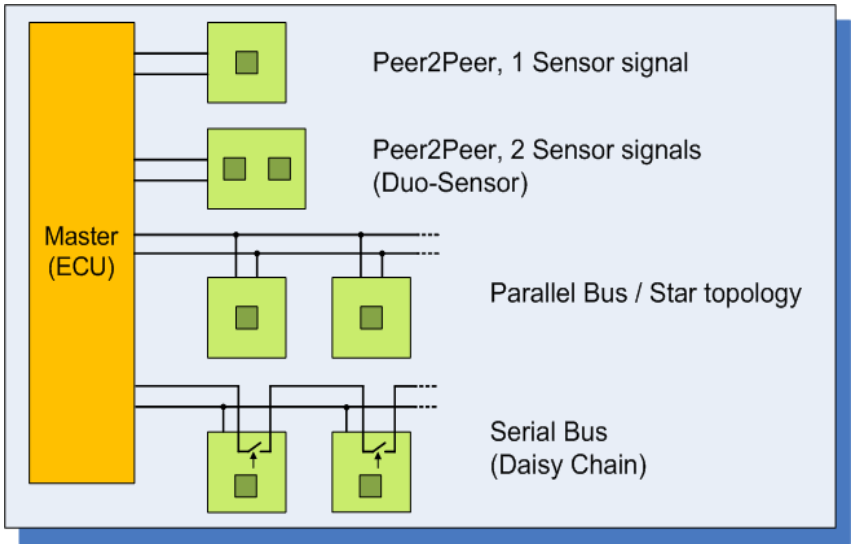


PSI5
Basic Functionality

Sensor data communication with Manchester-Coding

- High data rate with 125 kbit/s (optional 189 kbit/s)
- Flexible payload range (10 … 28 bit) with parity or 3 bit CRC





Different bus topologies possible

- Asynchronous Peer2Peer unidirectional transmission
- Synchronized master-slave bus communication
  - Parallel bus
  - Daisy-Chain

New Field of Applications for PSI5
Status Quo – Engine Management Systems

Driver

- **System complexity** with increasing count and functionality on sensors
- Pin count of **ECU connector**
- For the intended sensor applications the **existing interfaces** are either too
  - **limited** (SENT, LIN) or
  - too **complex** and **expensive** (CAN)

Hurdles

- **Sensor bus systems** are **not widely used** and if than only for complex aftertreatment sensor solutions (e.g. NOx)
- The **analog ratiometric** sensor interface is **widely spread** and comes with low cost

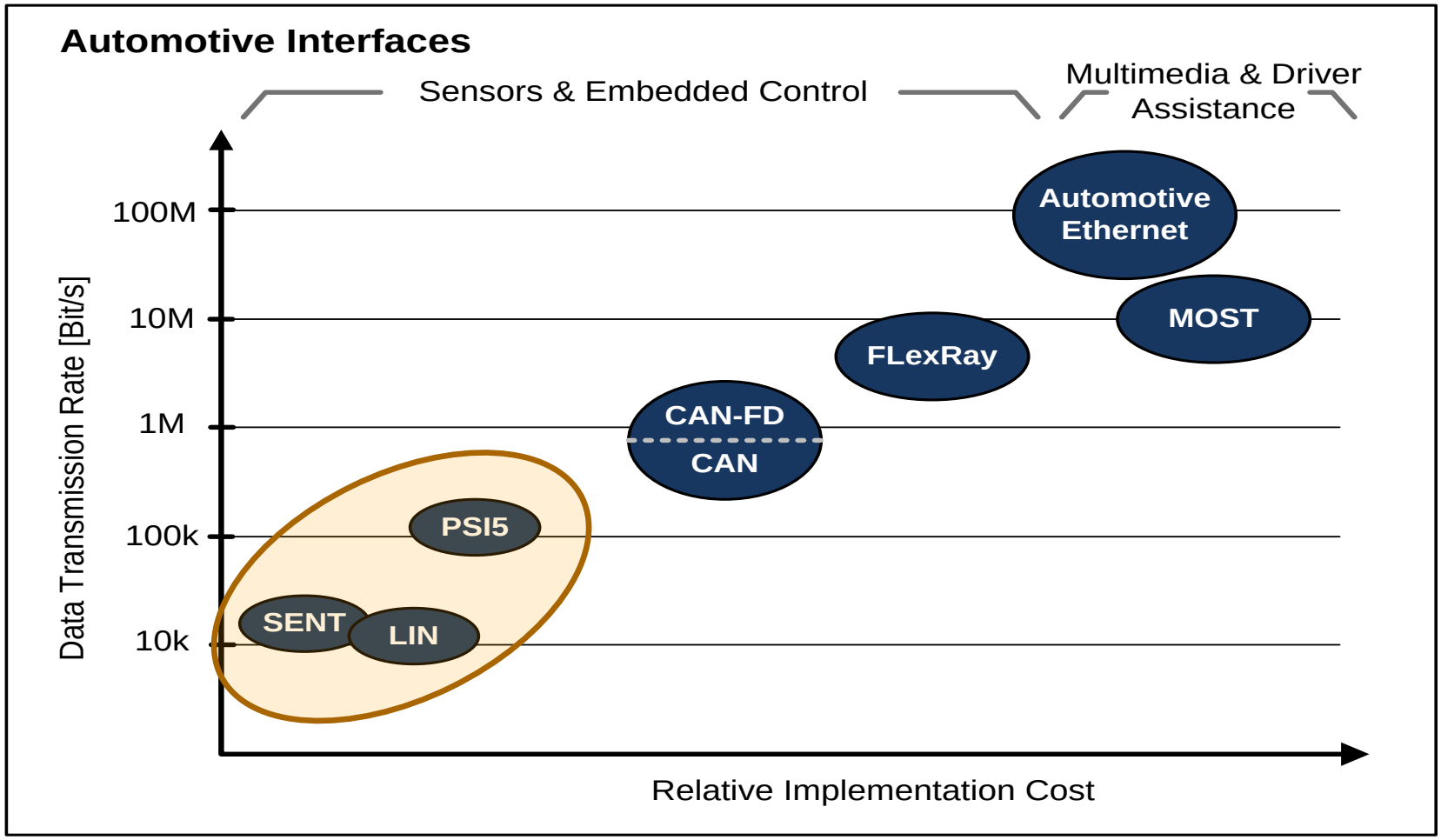
Boundary conditions

- Esp. with stop-start systems a fast **system initialization** is mandatory
- **Battery-supply** voltage drops during engine cranking
- The ECU provides internally a stabilized **power supply** of ~ 6 V

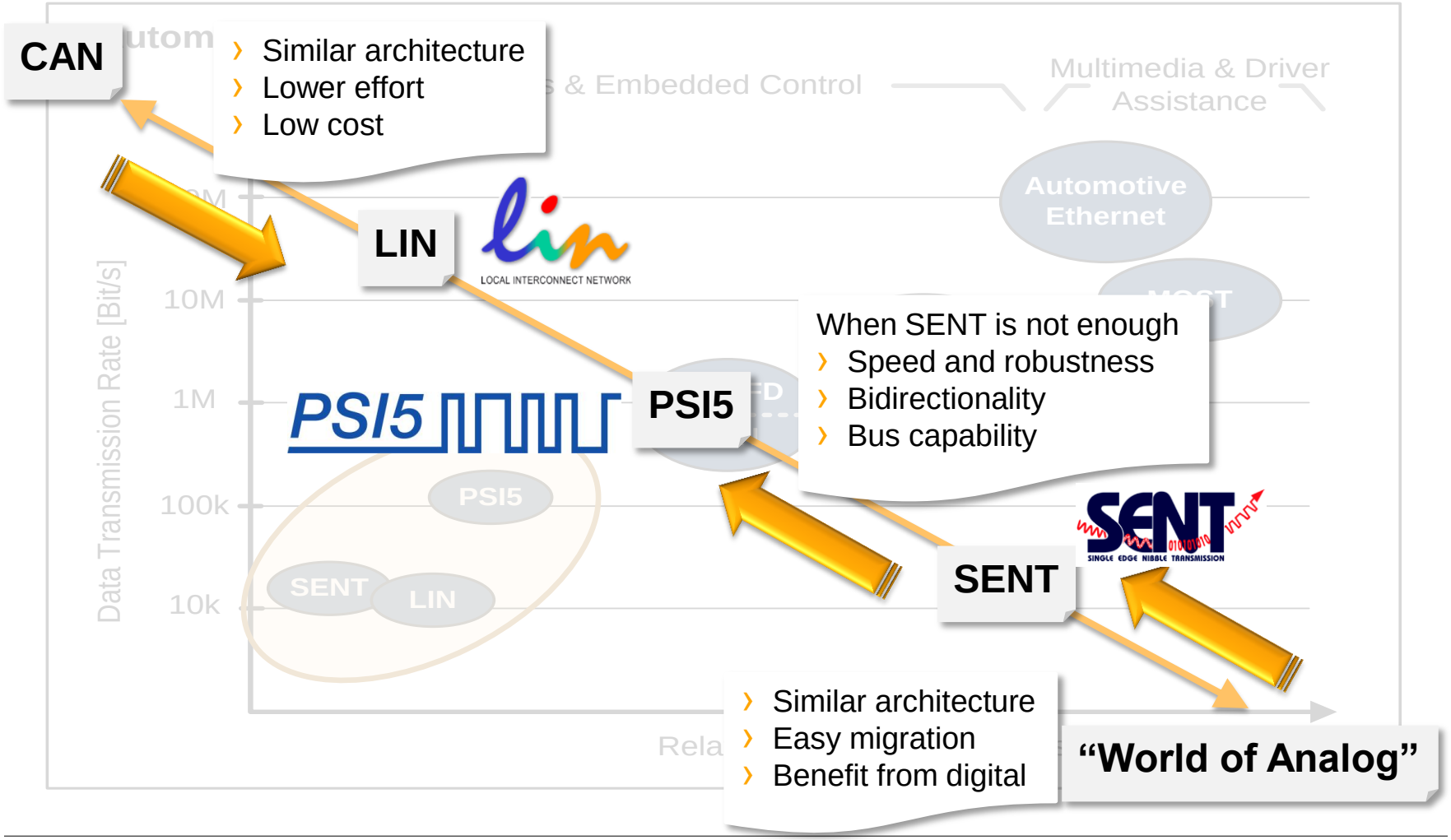
Sensor application

- Exhaust gas sensors
- Position sensors
- Pressure sensors
- Mass air flow sensors
- Temperature sensors

Optimized Solution for Low-Speed Application Needs



Optimized Solution for Low-Speed Application Needs



Thank you for your attention!

Any Questions?

Jürgen Bock

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