Partial Networking in Electrical Vehicles AMAA 2011, Berlin

Steffen Müller, Bernd Elend

NXP Semiconductors

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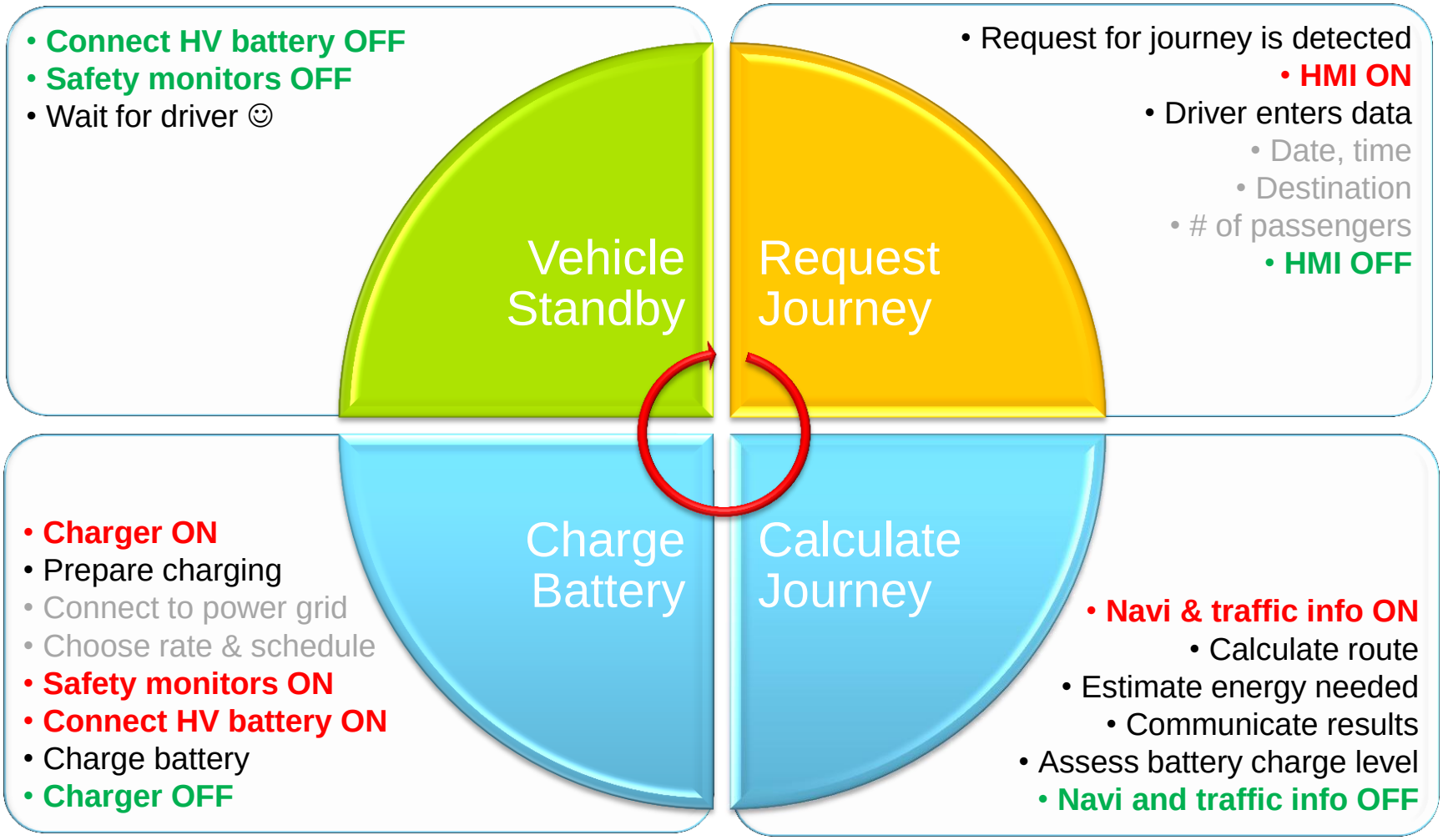
What is important for Electrical Vehicles?

- Mobility
  - Predictable cruising range, telematics, energy efficiency, size, and weight
- Lifetime and safety
  - Introduction of new safety-relevant embedded systems
- System complexity
  - New energy source and powertrain concepts result in new network demands
- Robustness
  - Harsh automotive environment, fast transients in power electronics / drive
- Isolation towards human interface
  - High voltages above 60V DC across the vehicle and network

Networking (NW) Trends for EVs

- New NW Boundaries are set (domains)
  - Safety and energy saving are main drivers for new E/E architectures
  - System partitioning based on used voltage levels (domain interfaces)
  - Chassis, body, powertrain become sub-categories
- Longer Duty Time for the NW (“EV never sleeps”)
  - NW is (almost) never completely switched off
  - Alert for critical situations: system or HV battery failures, car collision
  - Anticipated role as “storage” medium in energy grid (while parking)
- Change of NW Management Implementation
  - Functions are distributed between ECUs (e.g. telematics, driver assistance)
  - Conventional cars send status messages via NW on a regular base
  - Move to an “event based” implementation is anticipated to save bandwidth
- NW becomes Part of Energy Management system
  - Some ECUs are always on (BatMon, energy mgmt) and create bus traffic
  - Mechanism needed to switch off/on functions
  - Best option is dynamic re-configuration via control network

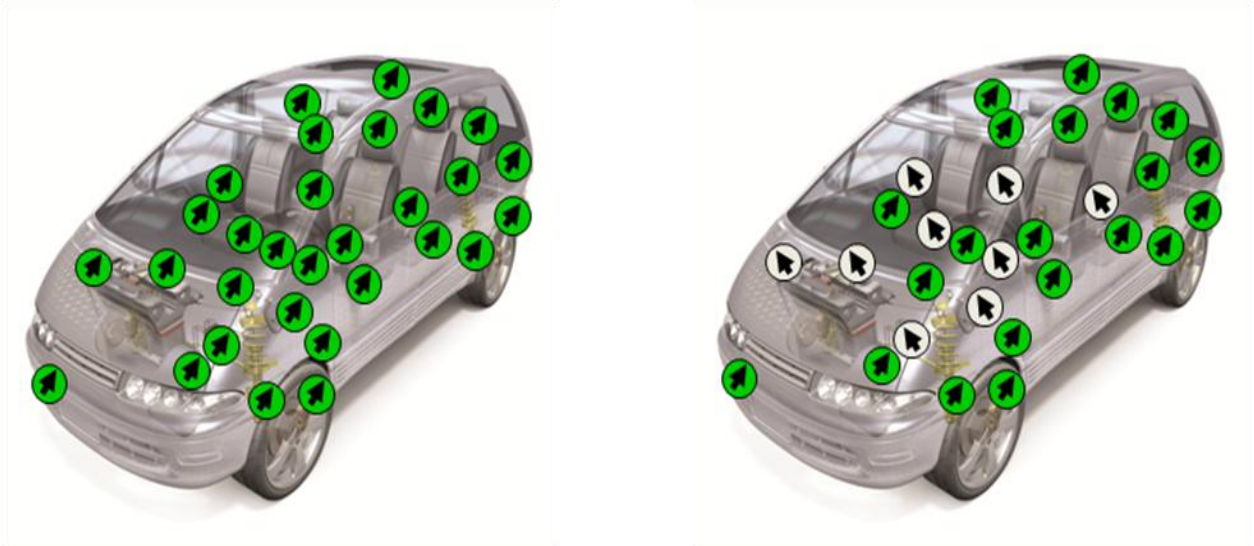
Energy Management – Use Case Example



Paradigm Change in Networking from Conventional Car to EV

- Parts of the control network are (almost) always active
- Safety aspects dominate architecture and network choice (separation of voltage domains is main driver)
- Control network becomes important means of energy management
- While increased energy efficiency in conventional cars is enabling "only" a reduction of CO_2 emissions, it enhances directly the operation range for EVs!

Vehicle without and with Partial Networking



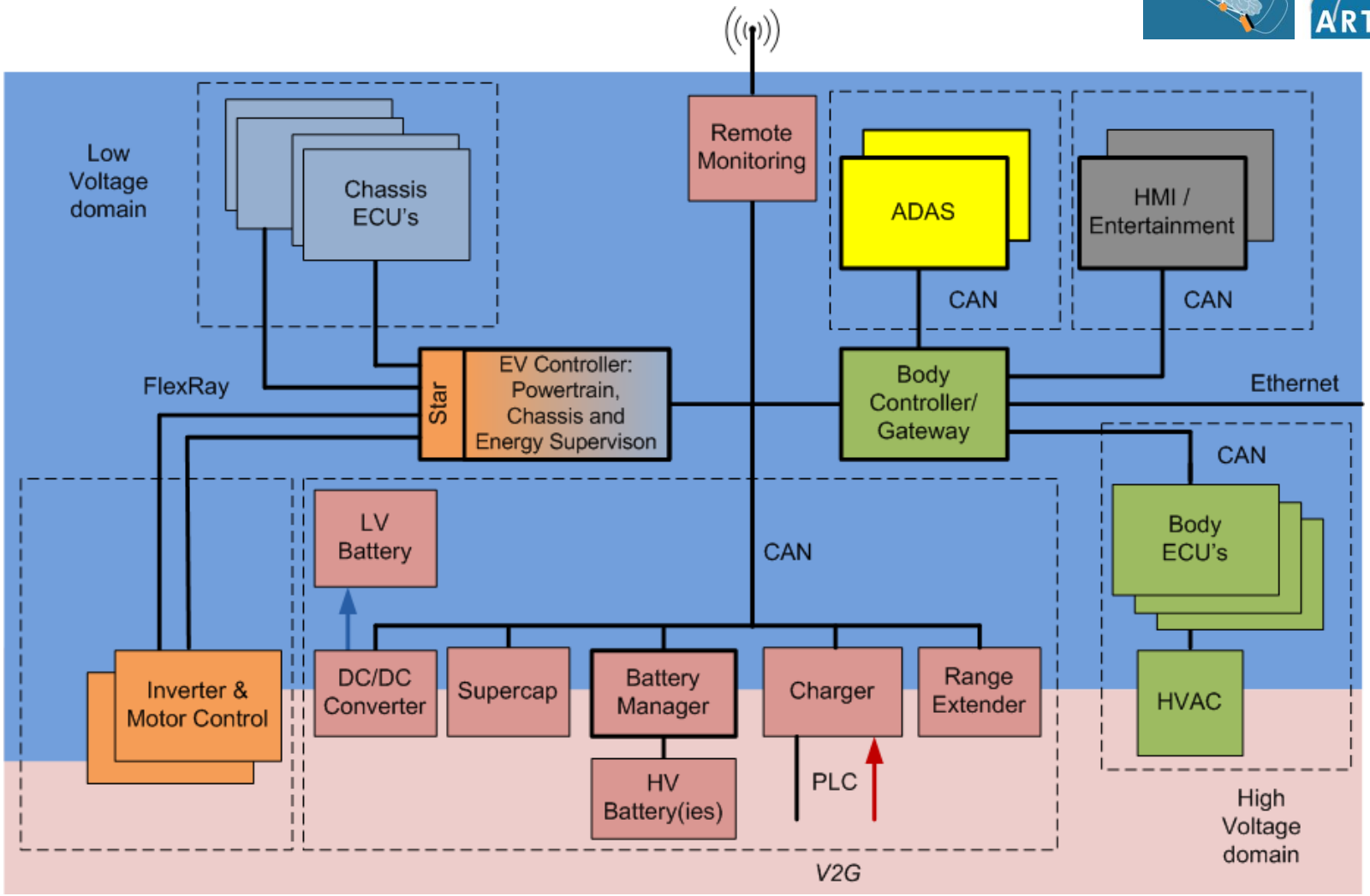
- Left: all modules active during operation – normal ISO11898-5 CAN
- Right: some modules switched off by means of PN

- Examples
  - Trunk lift, seat, window lifter, pre-/auxiliary heating, sunroof

What is Partial Networking (PN) about?

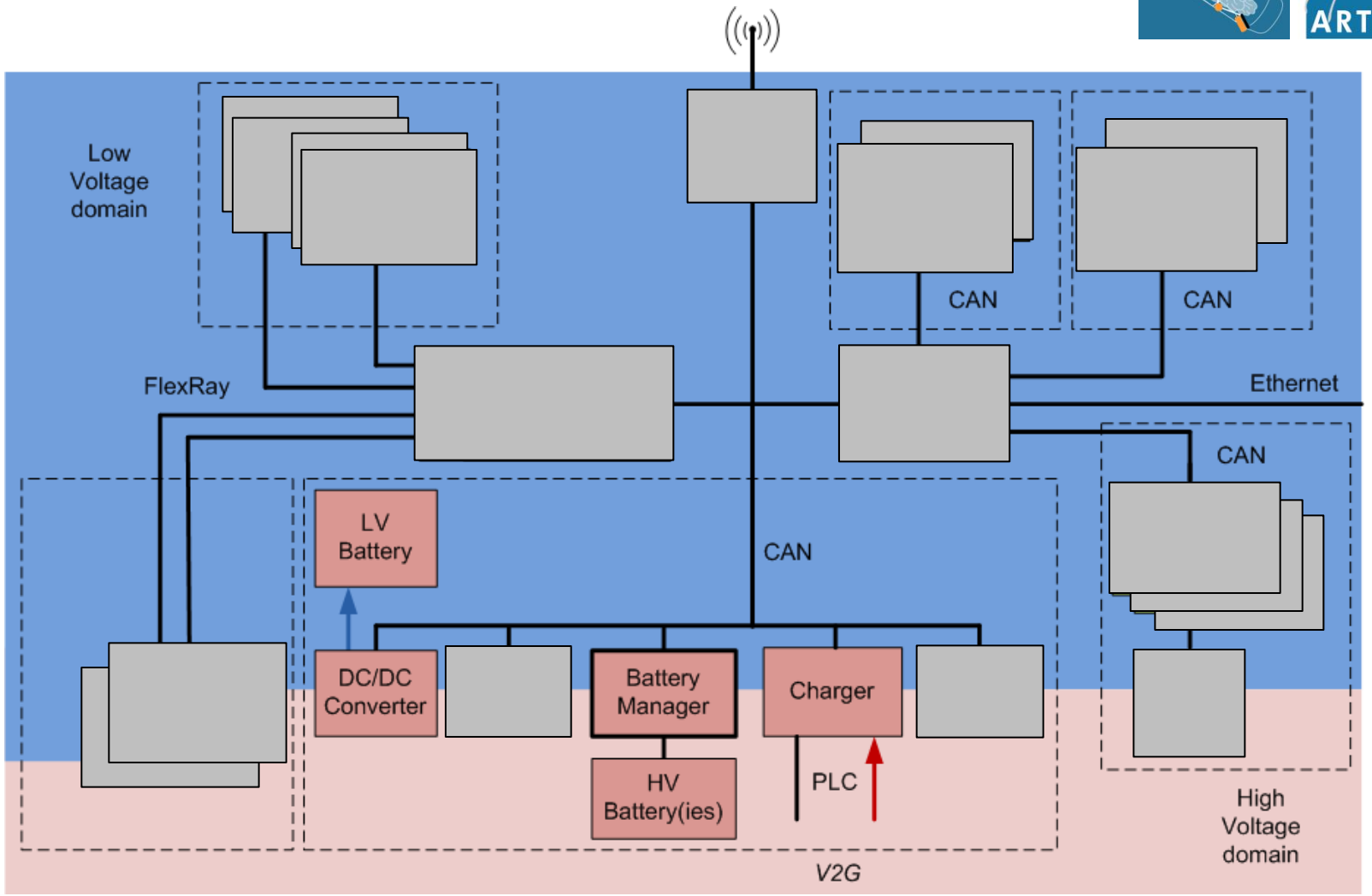
- The ability to operate certain parts of a NW while others remain inactive
- In ISO11898-5 CAN networks, all modules are switched on once at least two modules start to communicate
- PN is realized today by either switching off a module's power supply or via a dedicated wake-up wire
- Those options are hard-wired, and do not offer configuration flexibility
- With the new PN concept, modules wake up by dedicated messages
- Easiness of implementation, robustness, and attached costs are criteria to successfully introduce PN in E/E architectures

PN Use Case ‘Charging‘



All ECUs are in operation

PN Use Case ‘Charging‘

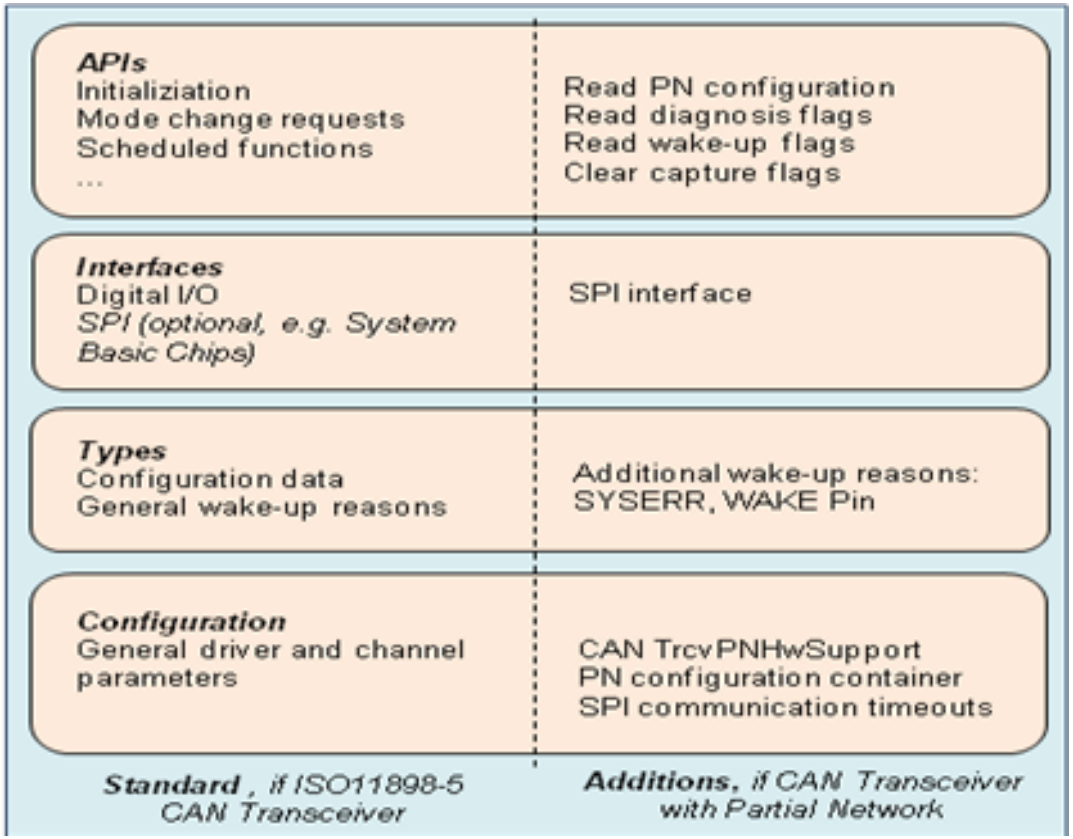


Only some ECUs are in operation

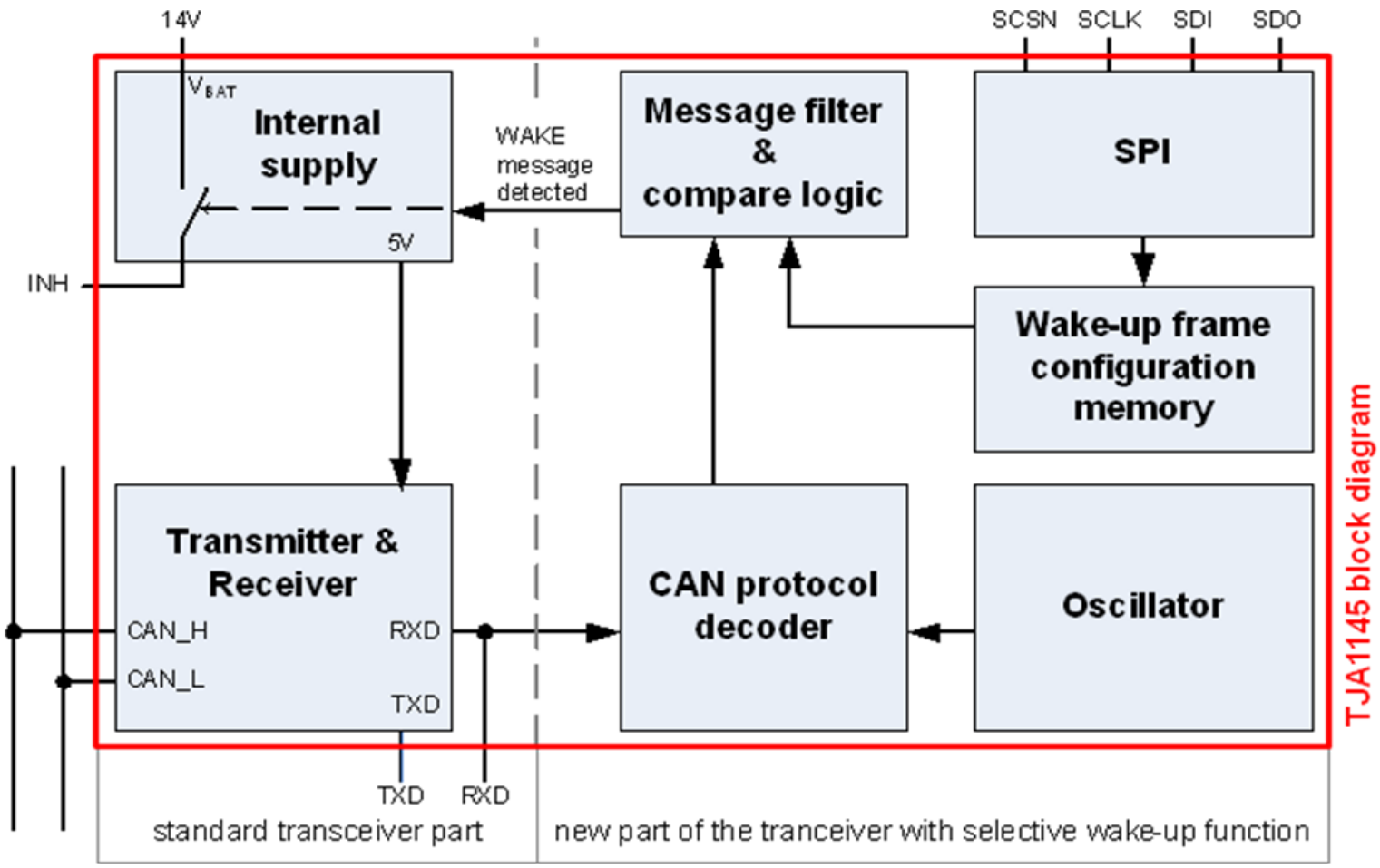
Hardware Standardization in SWITCH

- German car makers initiated the SWITCH (Selective Wake-able and Interoperable Transceiver in CAN High-speed) group
- Other OEMs and semi vendors like NXP joined this interest group
- SWITCH developed between July and December 2010 a draft for the extension of ISO11898 introducing a new wake-up mechanism
- In short, a valid wake-up message is detected when
  - the received ID matches to a predefined ID
  - the received data length code matches to the predefined data length code
  - the received data field matches to a predefined data field content

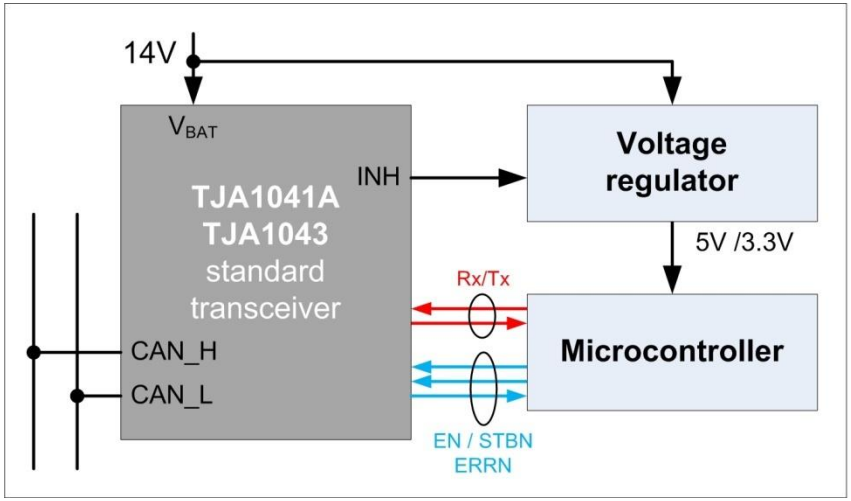
NW Management, Low-level Driver in AUTOSAR

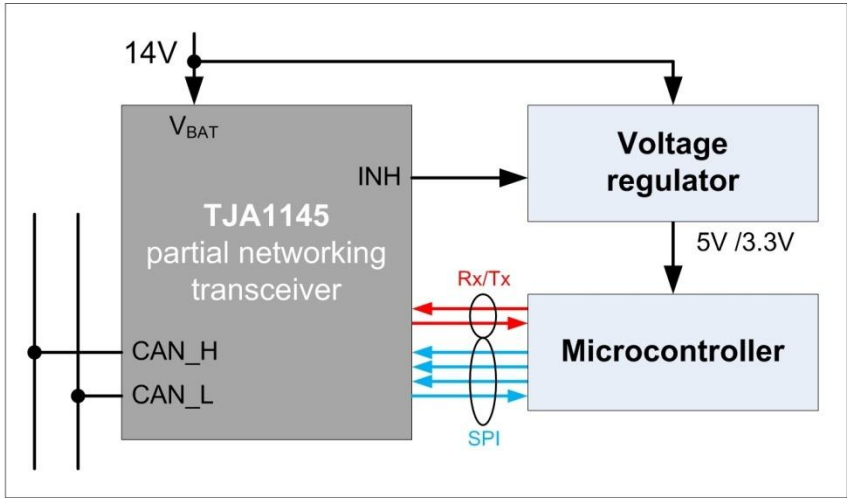


Partial Networking Transceiver Architecture



Architectural Changes on Module Level





Partial Networking at One Glance

- PN does not require a new network or module HW architecture
- Will be standardized in ISO11898 as well as in AUTOSAR
- Offers new functions used in conventional cars to increase comfort but also to comply with new governmental rules for energy saving
- Provides excellent benefit to EVs for the implementation of a robust energy management system resulting ultimately in an increased cruising range

Relevance of Partial Networking for EVs

- Mobility
  - Experts expect steep improvements in the power density of batteries
  - Needless to say that each “saved” Watt contributes to higher cruising range
  - PN excellently contributes to an efficient usage of energy in an EV
- System Complexity and Lifetime
  - Changes in the hardware are limited to the transceiver
  - Anticipated that µC, voltage regulators, capacitors, etc. are not affected
  - First indication from car makers is to triple lifetime testing for transceivers
- Safety and Lifetime
  - EV stands for the introduction of safety-relevant embedded systems
  - Safety sub-system needs to follow extended product lifetime tests
  - Again, PN is limited hardware wise to a change in the transceiver
- Robustness
  - SWITCH group has defined dedicated PN EMC requirements
  - Experts see in EVs increasing challenge for EMC due to high voltage drive
  - ISO7637 impulse immunity becomes new challenges for semi suppliers

Summary

- EV enable new dimension of efficient driving
- With this comes the need for enhanced energy management
- Paradigm change PN: conventional car → comfort, EV → energy mgmt
- PN is excellent means for energy mgmt; parts of EV are always active
- PN contributes to all operation modes of EVs: drive, charge, and park
- Lifetime aspects in EVs are important due to embedded safety systems
- Hardware change needed to introduce PN is limited to the transceiver
- Multiple disciplines are involved in PN; standards driven for HW & SW
- Robustness will be key differentiator between PN transceivers due to embedded CAN engine and on-chip oscillator