Webinar

Unlock the future of SDVs: Integrating TI's remote-controlled edge node solutions

Matt Sullivan

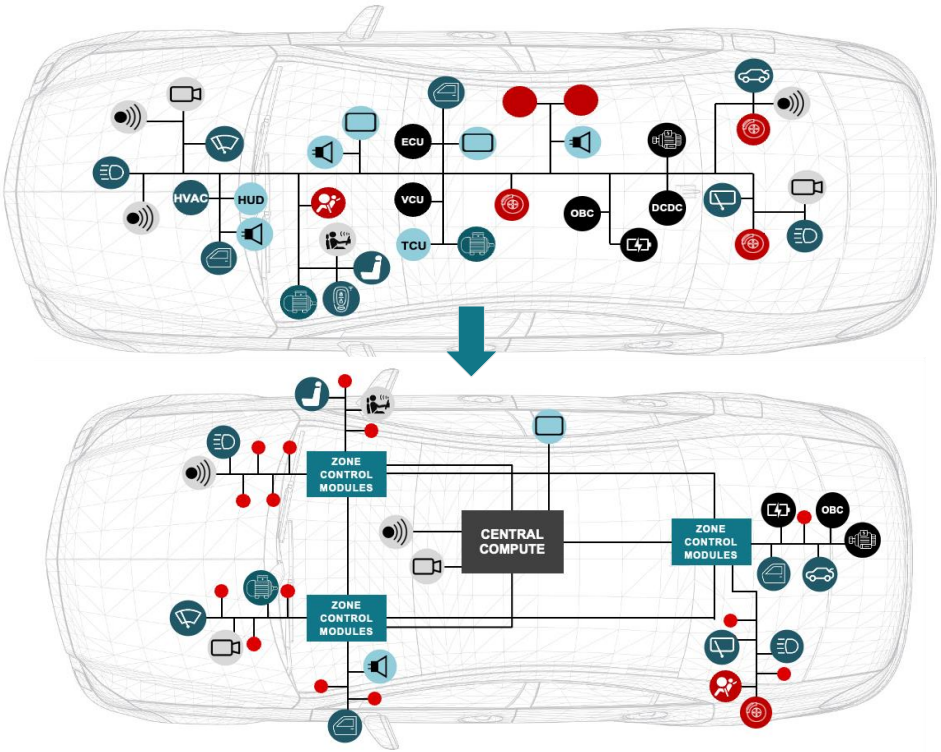
Automotive Systems Engineer

Agenda

- SDV and zone impact on automotive network
- RCE overview
- RCE technology comparison
- End-equipment example: Headlamp

Path to SDVs

Key enabler: Domain to zonal architecture shift & remote-control edge nodes



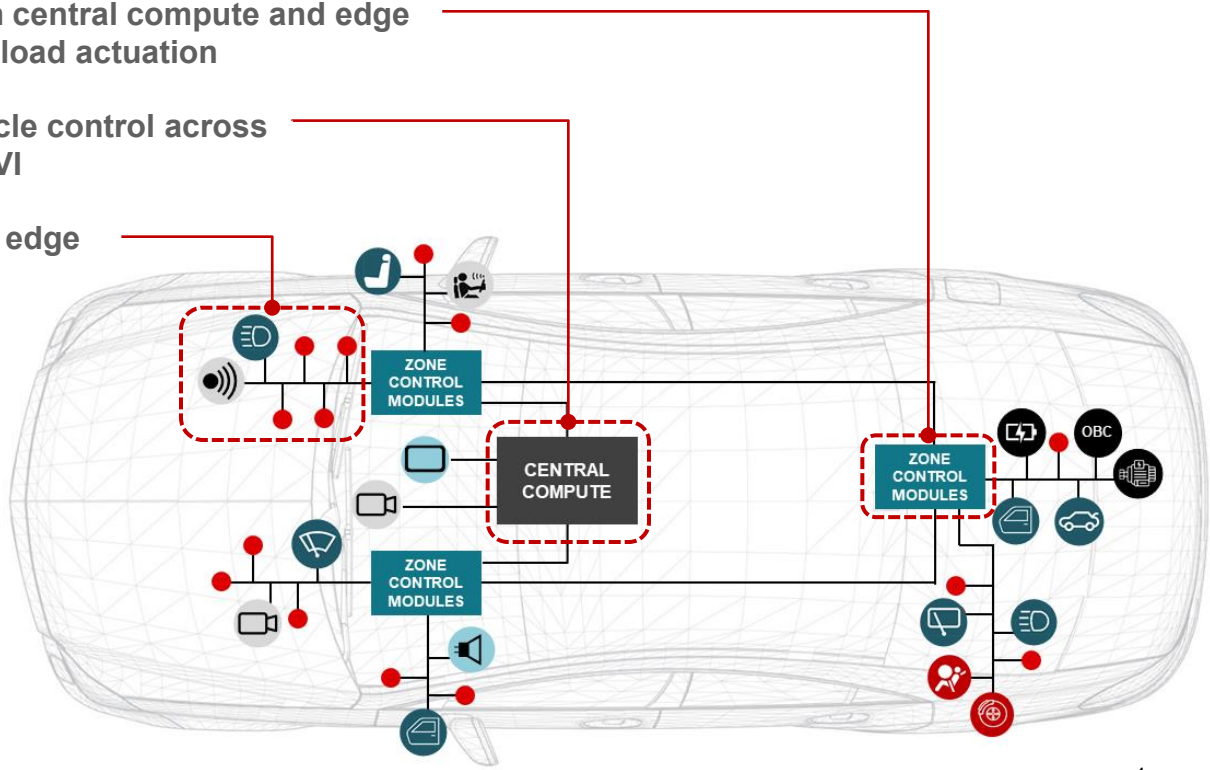
- ECU consolidation from 250+ to ~10.
- Domain-centric ECUs => Cross-functional ECUs
- Central compute = Main command center
- Centralization of software
- Remote-control edge nodes

Zone architecture overview

Zone control module – Gateway between central compute and edge nodes, including power distribution and load actuation

Central compute – Centralization of vehicle control across multiple functions including ADAS and IVI

Edge nodes – ECUs and actuators at the edge of the in-vehicle network



Networking trends

Higher bandwidth

- Central processing, more throughput

Unified

- Single network till edge & application specific networks

Scalable

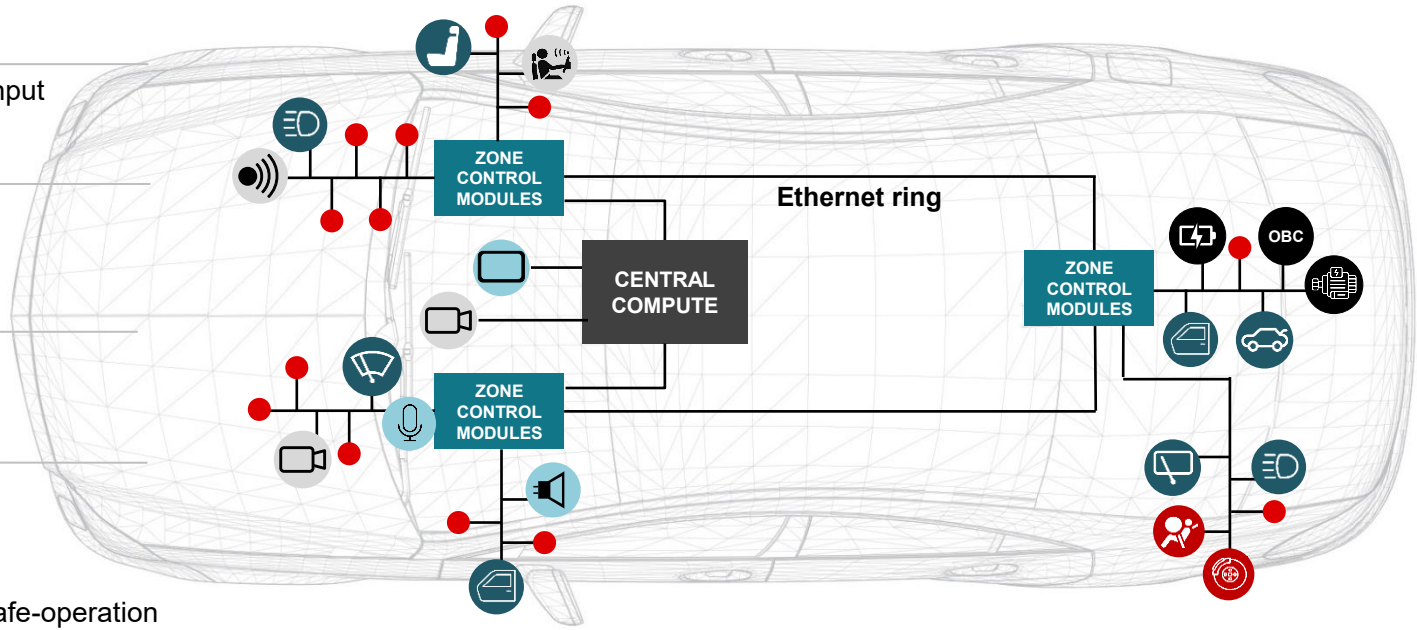
- Easy to scale across platforms

Real-time

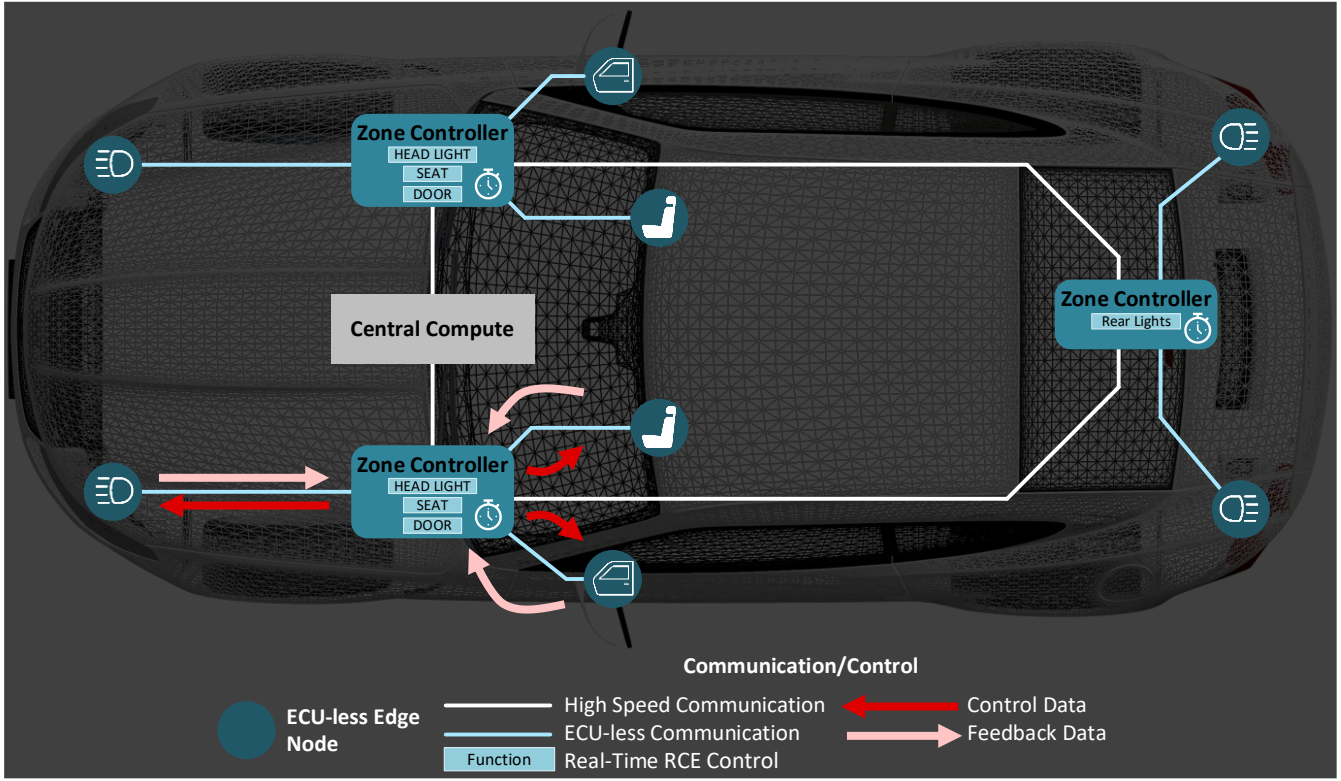
- Time critical, latency specific

Secure

- Authentication, encryption and safe-operation



Remote-control edge introduction

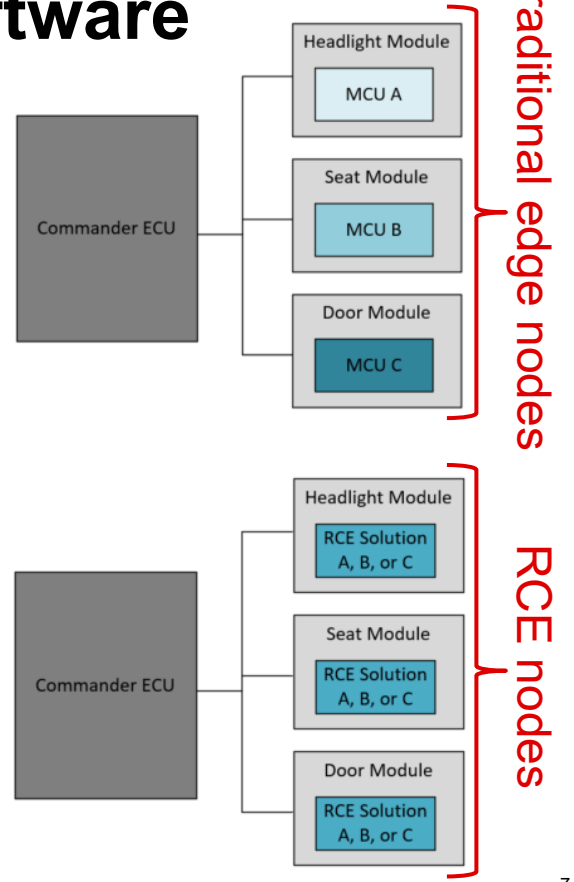


RCE benefits | Centralization of software

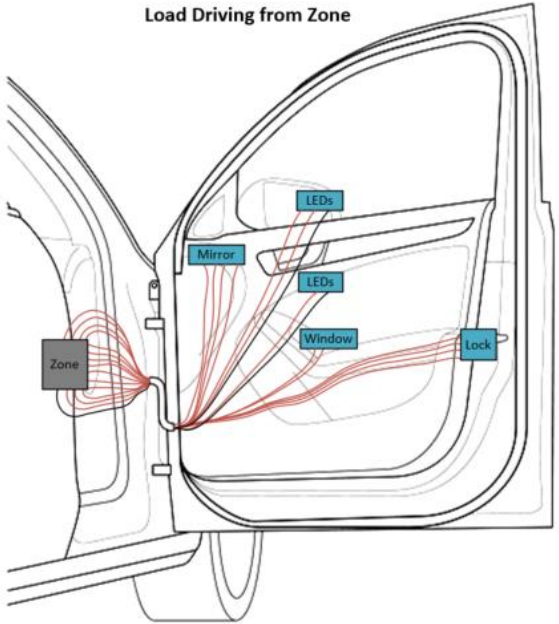
Reduces software development costs
- No MCU in edge node
- One less MCU where software would need to be developed, validated, and managed

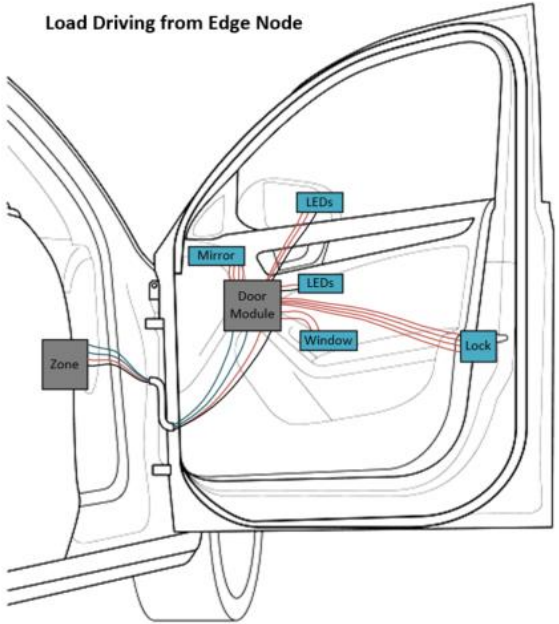
Simplifies OTA updates
- No MCU in edge node means no software updates needed for the edge node

Enables hardware scalability
- Edge node becomes a fully hardware solution
- Hardware can be scaled across end equipments
- Hardware can be multi-sourced



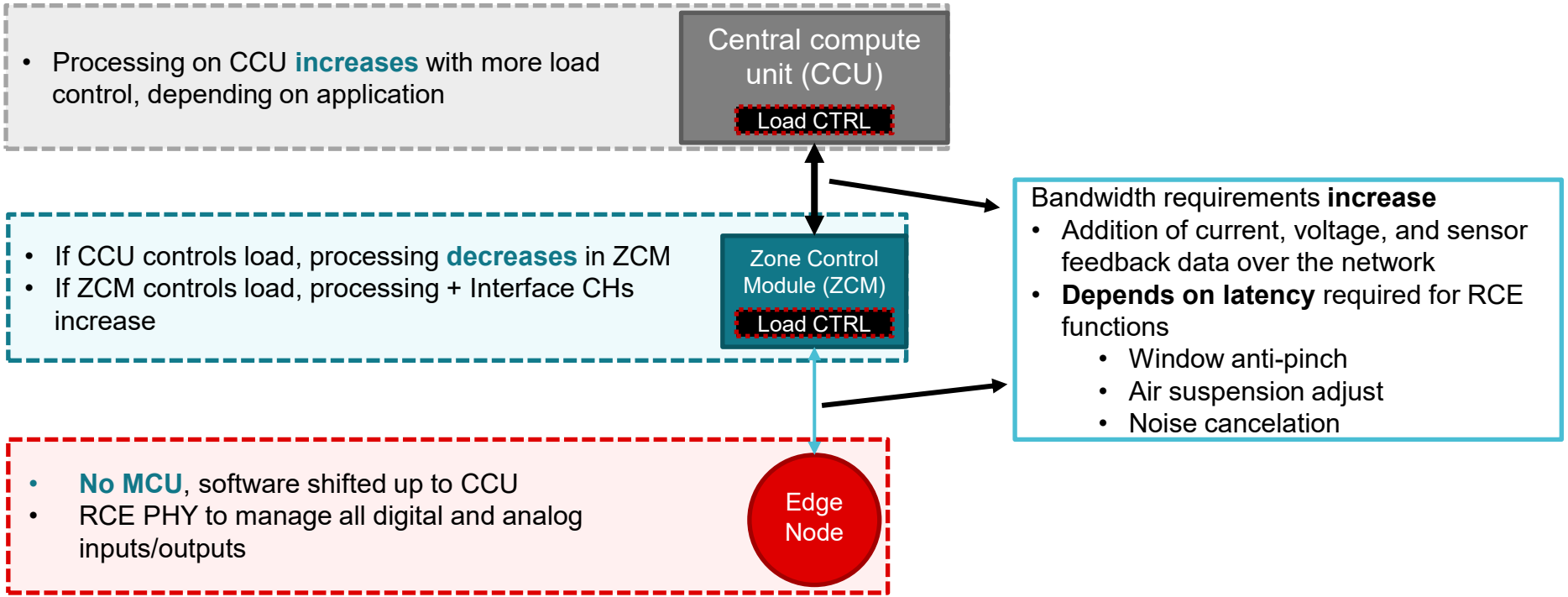
RCE benefits | Minimize load wiring





Solution	Centralized software	Cable reduction	EMC/EMI improvement
Load driving from zone	✓		
Load driving from traditional edge node		✓	✓
Load driving from remote control edge node	✓	✓	✓

RCE system considerations



RCE system considerations

Latency
- Limited local real time control
- Added latency transmitting information to and from commander ECU

Functional safety
- Added latency poses additional concerns for FuSa
- Loss of communication poses a bigger threat since there is limited local real time control

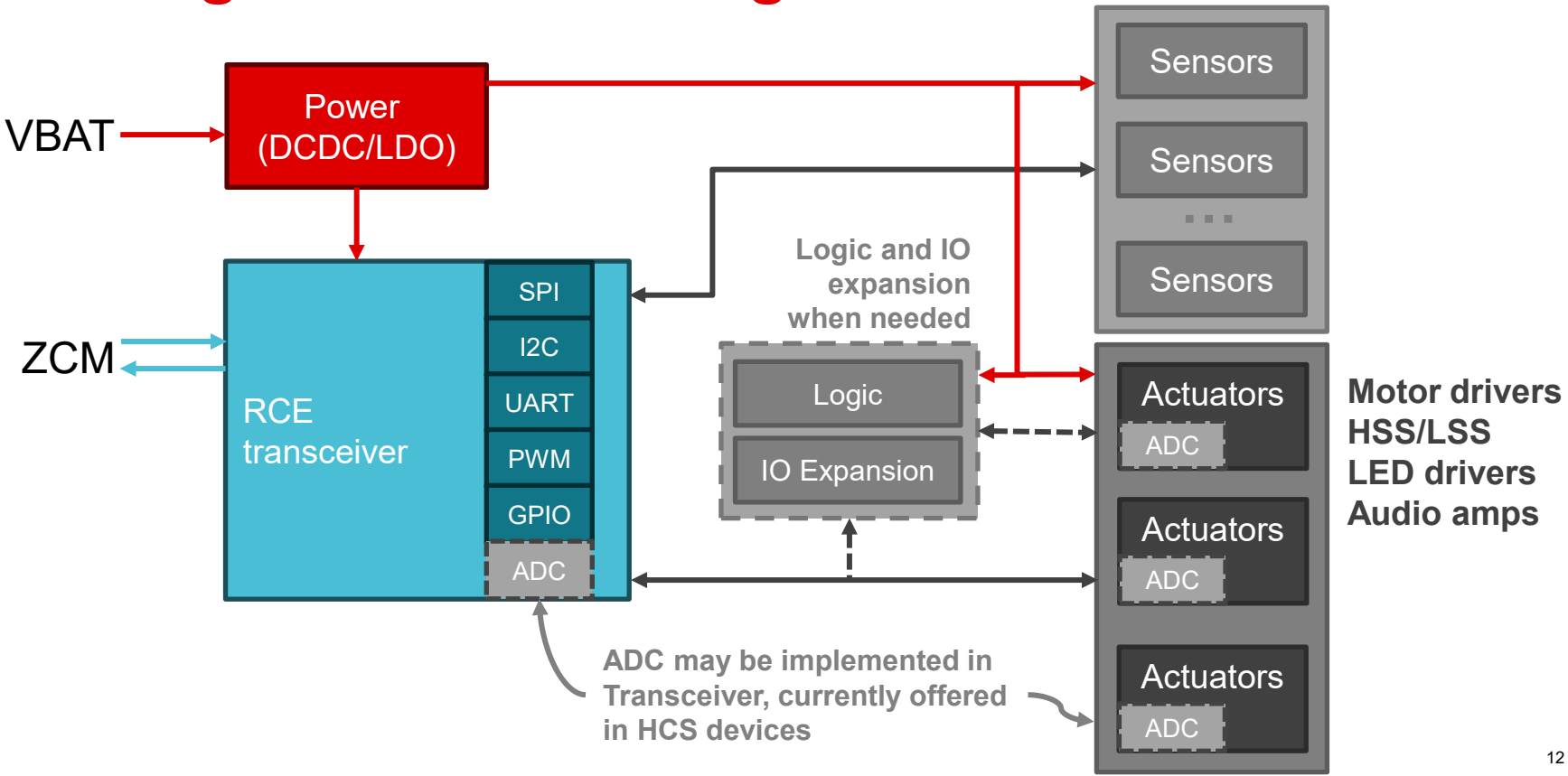
Cybersecurity
- More difficult to implement cybersecurity without a local MCU

Cost
- RCE devices may be more expensive than a low level MCU
- While hardware may be more expensive, software will likely be less expensive

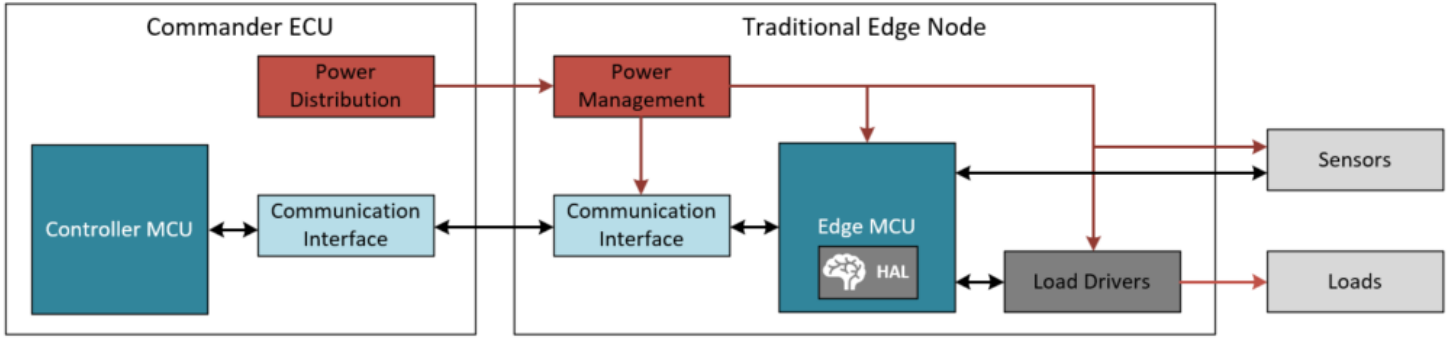
RCE applications

Application	Why RCE?
Headlights	Easy to implement since only a single low-level protocol is needed (UART and/or SPI)
Ambient lighting	
BMS	
Radar	Have many nodes throughout the vehicle, providing a good opportunity for hardware scalability
Ultrasonic sensing	
Car access	
Seat modules	Easier to implement since load drivers are integrating more diagnostic features
Door modules	

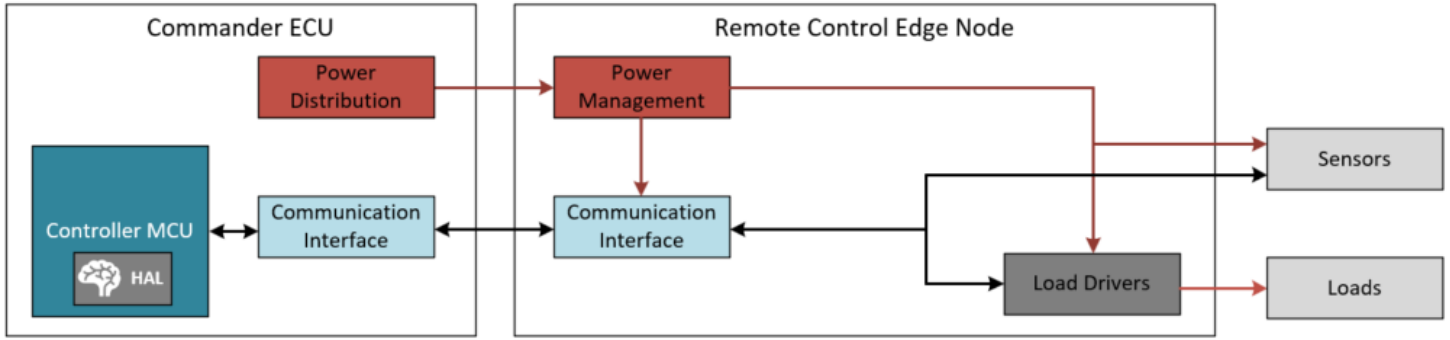
RCE edge node block diagram



Traditional vs remote-control edge block diagram

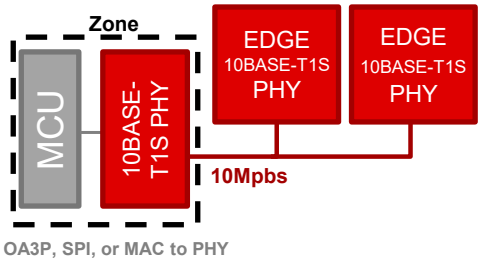


Hardware Abstraction Layer (HAL) is moved upstream



TI's RCE investments

10BASE-T1S

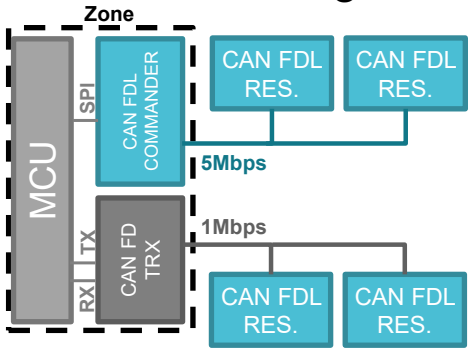


Supports bus/multi-drop topology
- Round-robin bus access

10Mbps
- Any 10BASE-T1S PHY upstream
- Dedicated RCE PHY in edge

IEEE1722b transport protocol

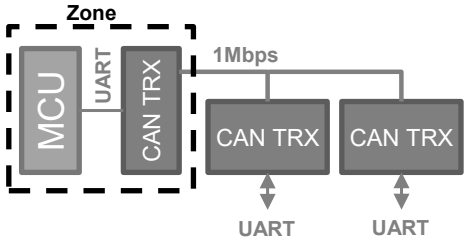
CAN FD Light



Supports bus/multi-drop topology
- Commander-responder bus access

1Mbps to 5Mbps
- 1Mbps with standard CAN FD trx
- 5Mbps requires commander

UART over CAN



Supports bus/multi-drop topology
- Commander-responder bus access
- UART over CAN

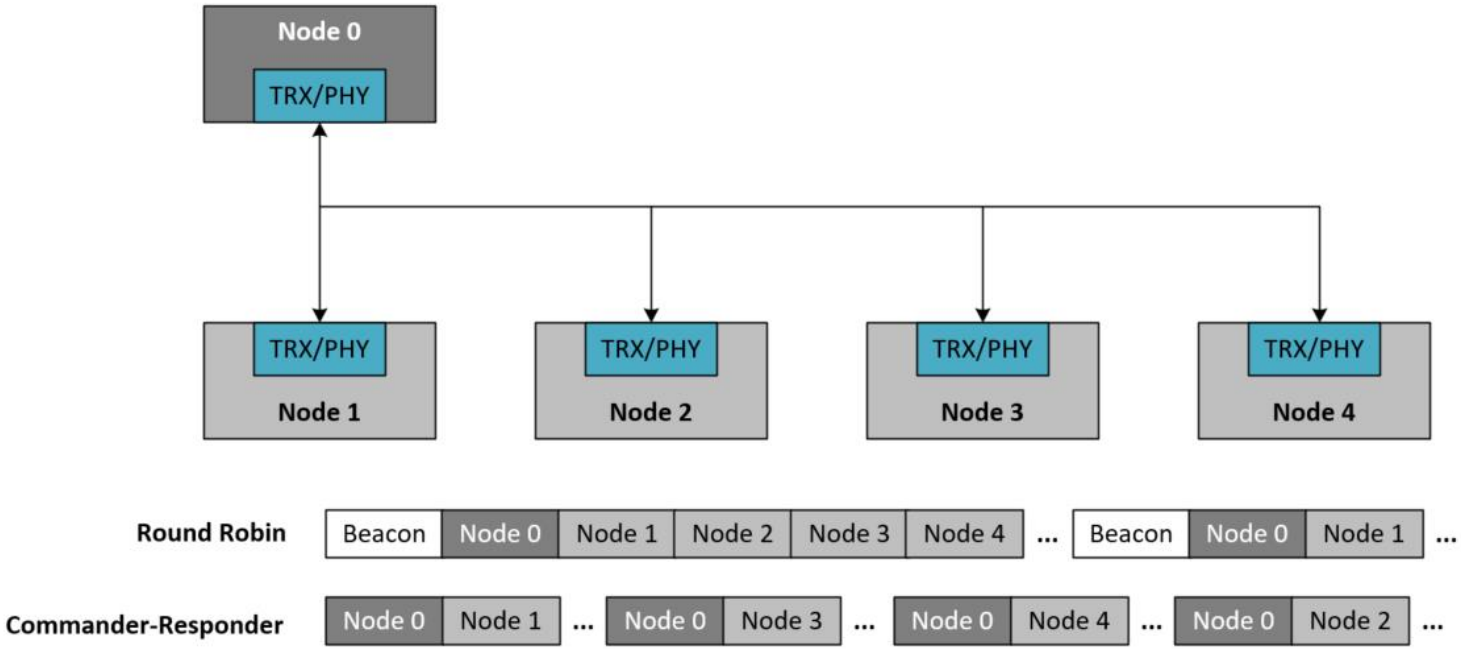
2Mbps

Targeted for lighting network

RCE protocol options

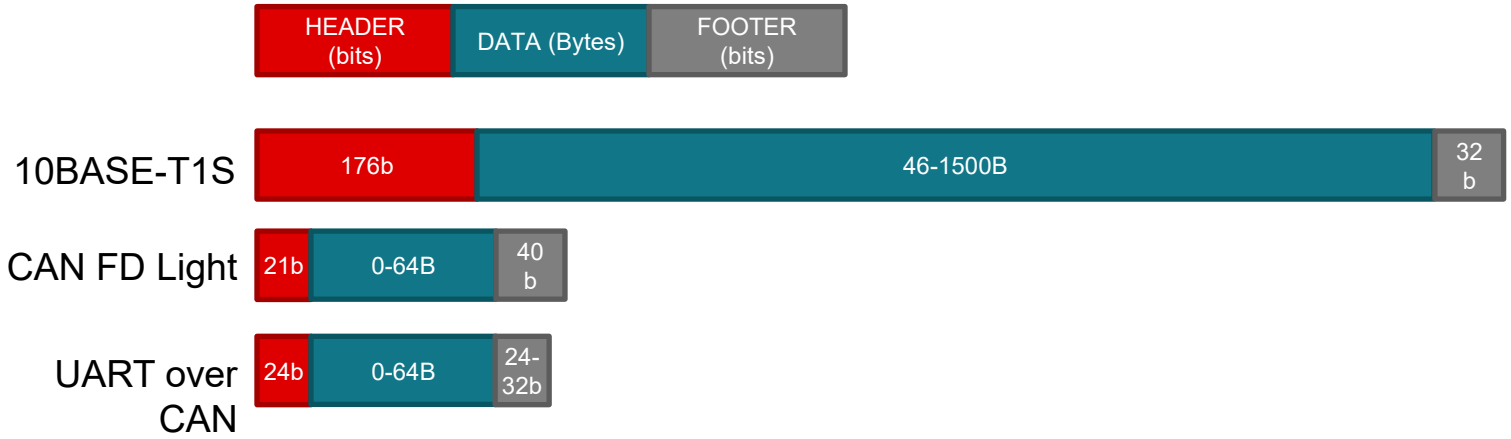
	10BASE-T1S	CAN FD Light	UART over CAN
Protocol	Ethernet	CAN	UART
Standard	IEEE 802.3cg	Protocol is standard – ISO11898-1:2024 Frame format is not standard	No standard
Speed	10Mbps	1-5Mbps	0.1-1Mbps
Payload	46-1500 Bytes	1-64 Bytes	1-64 Bytes
Multi-drop	Yes	Yes	Yes
Max # nodes on bus	16	64	64
Topology	Round Robin	Commander-Responder	Commander-Responder
Cybersecurity	MACSec	None	None
Time Sensitive Networking?	Yes	No	No
Edge hardware	10BASE-T1S RCP PHY	CAN FD Light Responder	CAN Transceiver
Peripherals	CMC, Crystal, ESD Diodes Recommended	ESD Diodes Recommended	ESD Diodes Recommended
PoDL?	Yes for point to point 5W @12V, 50W @48V	No	No

Topology comparison



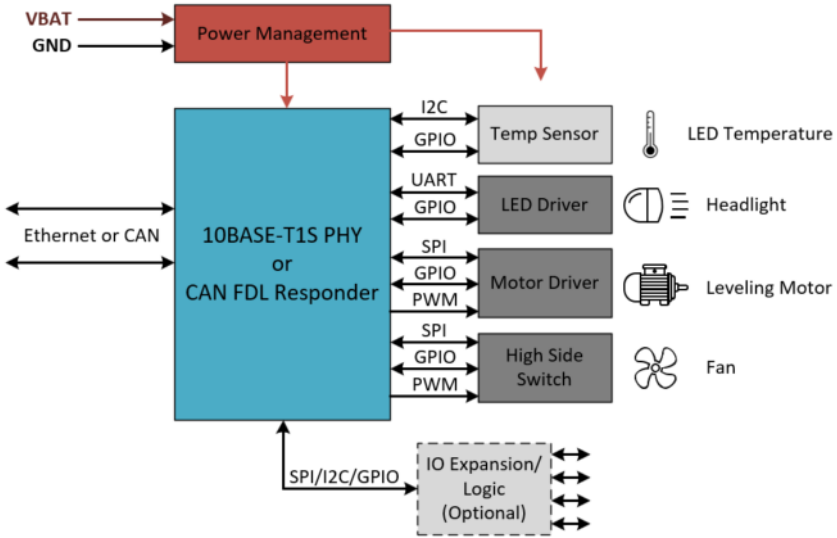
10BASE-T1S + CAN FD light data rate/payload

Protocol	Data rate	Max payload
10BASE-T1S	10Mbps	1500 Bytes
CAN FD Light	1-5Mbps	64 Bytes
UART over CAN	0.1-1Mbps	64 Bytes

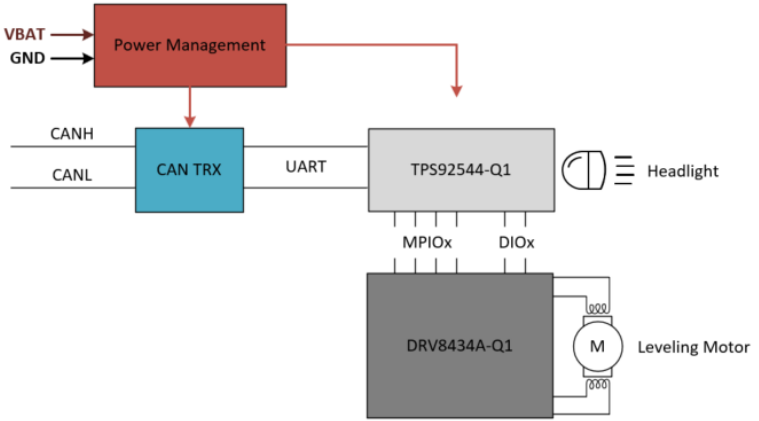


Headlight example

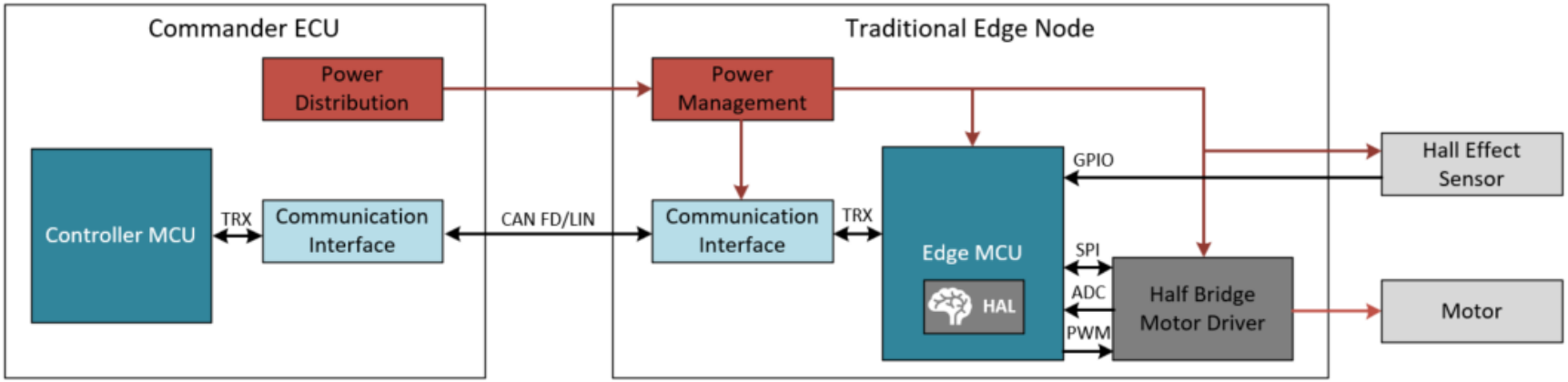
10BASE-T1S or CAN FD Light



UART over CAN

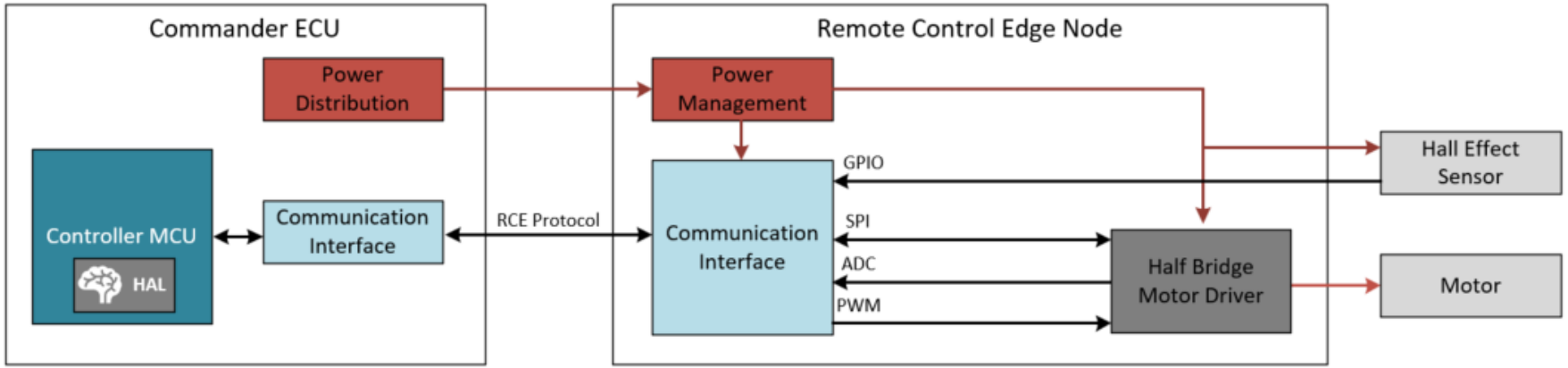


Traditional edge window anti-pinch example



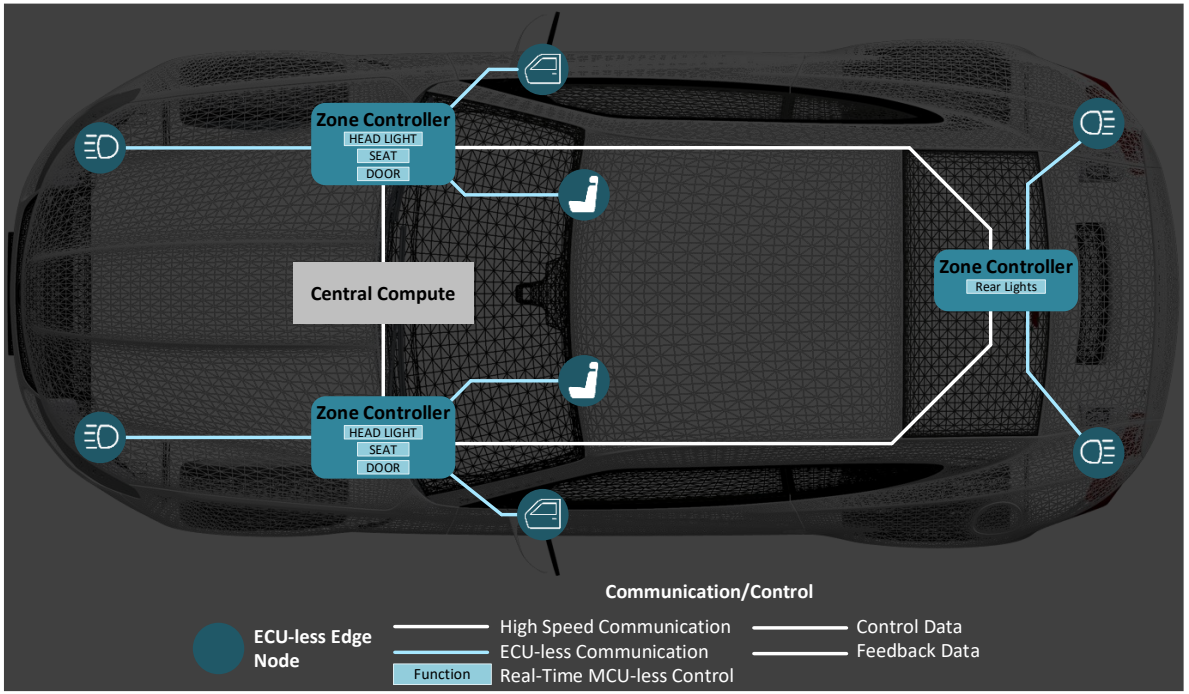
1. Controller MCU tells edge MCU to roll window up
2. Edge MCU generates SPI and PWM to control motor driver to move the window up
3. Edge MCU reads current sense from motor driver and hall effect sensor to detect pinch
4. If a pinch is detected, edge MCU generates SPI and PWM to reverse motor

RCE window anti-pinch example



1. Controller MCU generates SPI packet and PWM generation control and sends it over RCE protocol
2. The communication interface at the edge bridges the SPI command and generates PWM to control motor driver to move the window up
3. Communication interface samples current sense from motor driver and hall effect sensor reading and stores in memory for the commander to request or may be able to send it to the commander autonomously, so that the controller MCU can determine if there is a pinch
4. If a pinch is detected, the controller MCU generates SPI packet and PWM generation control and sends it over the RCE protocol
5. The communication interface at the edge bridges the SPI command and generates PWM control to reverse the motor

Conclusion



RCE benefits:

- Reduces software development costs
- Simplifies OTA updates
- Enables hardware scalability

TI RCE protocols:

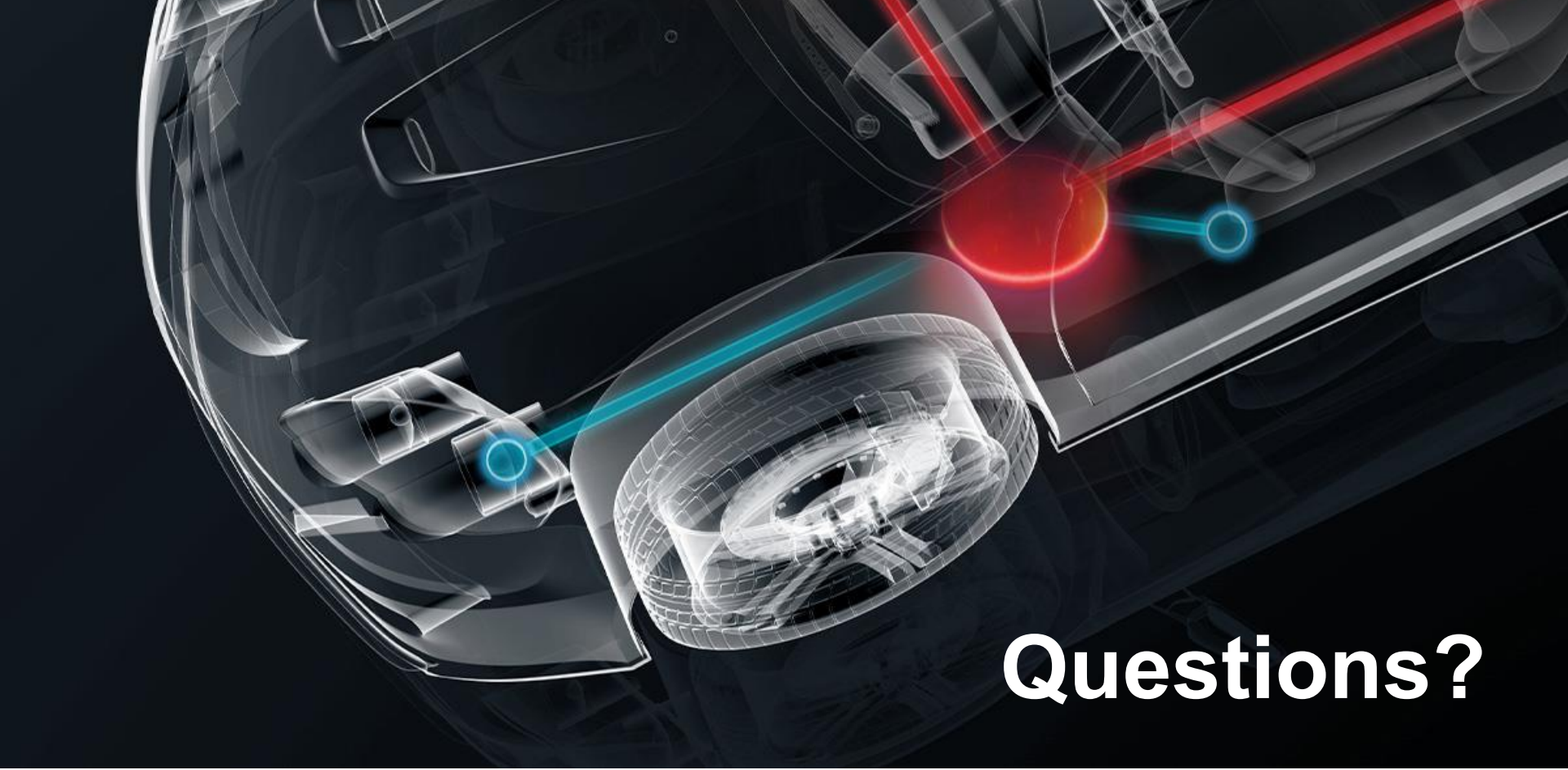
- 10BASE-T1S
- CAN FD Light
- UART over CAN

TI RCE solutions:

- Ethernet
- CAN
- LED drivers
- Motor drivers

Getting started with TI's remote controlled-edge node technology

Content type	Content title	Link to content
Technology page	Software-defined vehicles	https://www.ti.com/applications/automotive/software-defined-vehicle/overview.html
Video	Remote-controlled edge nodes: redefining the future of software-defined vehicles	https://www.ti.com/video/6385538890112
White paper	Inside Tomorrow's SDVs: Integrating Remote-Controlled Edge Nodes	https://www.ti.com/lit/wp/spry351/spry351.pdf


Questions?

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale, TI’s General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Last updated 10/2025