

# TI *Live!* INDIA AUTOMOTIVE SEMINAR

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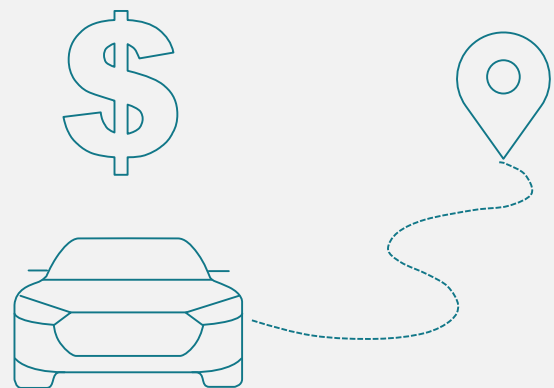
MAKING EVs MORE AFFORDABLE WITH  
POWERTRAIN INTEGRATION

# Cost and driving range are still hurdles for EV adoption

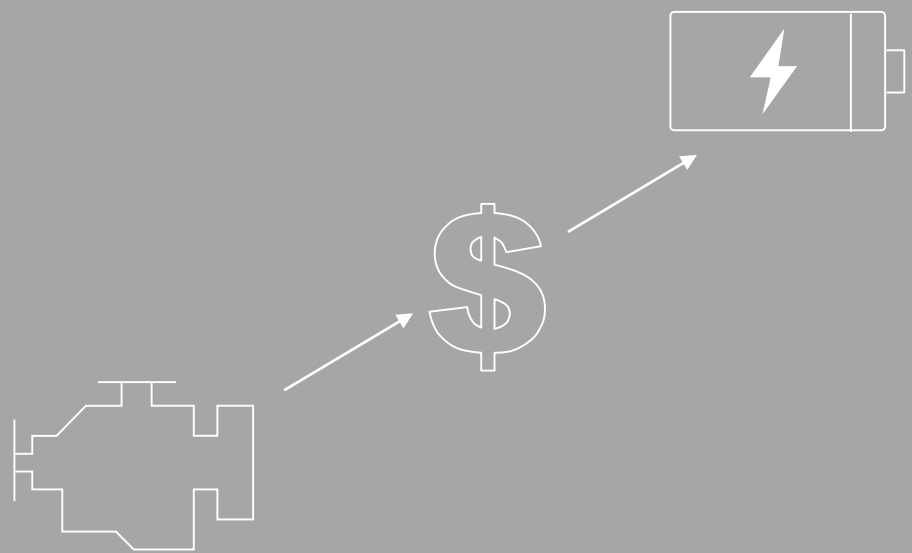
The number of consumers who would consider purchasing an EV varies.



EV purchase price and driving range are the biggest hurdles to wider consumer adoption.

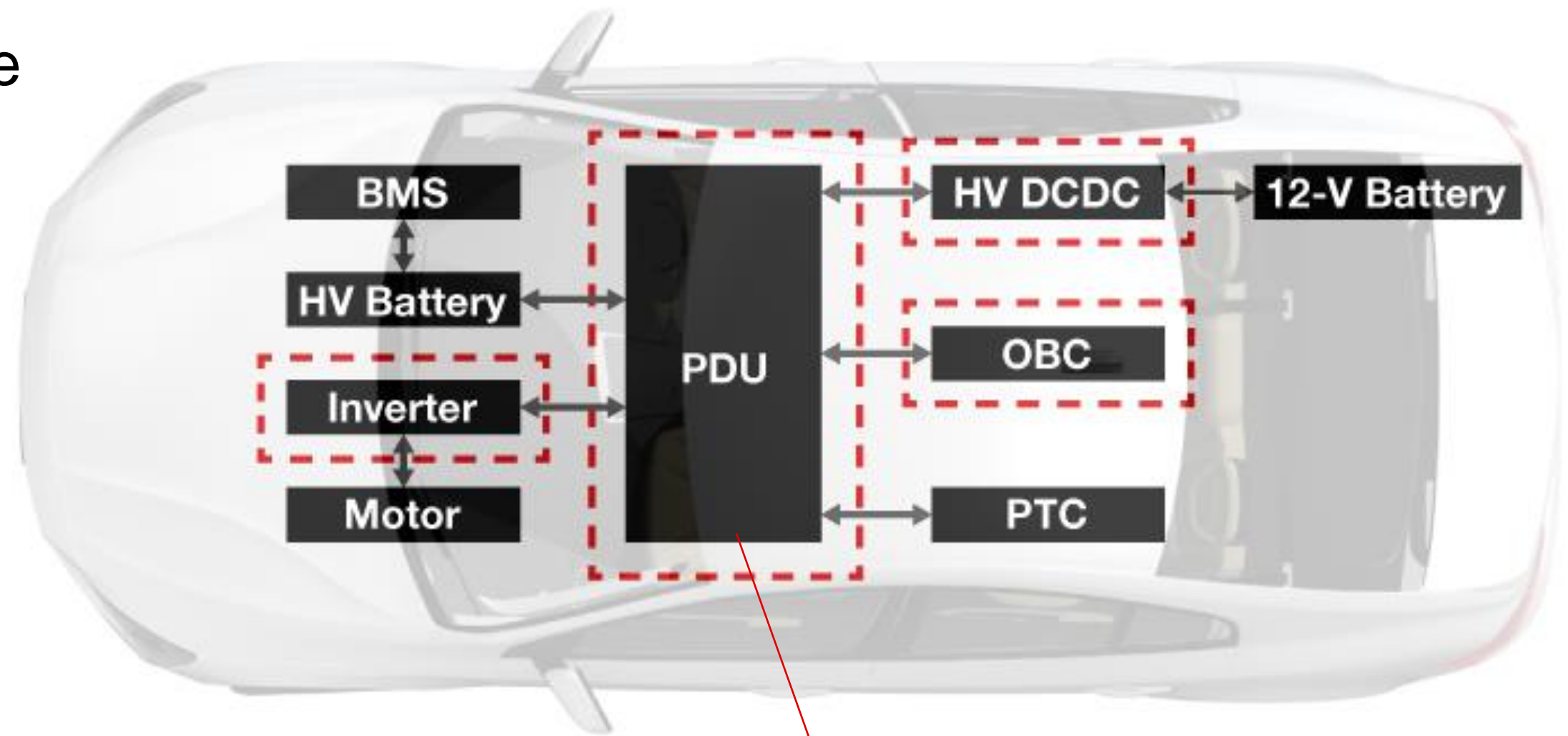


There's a cost gap of about \$12,000 between internal combustion-engine vehicles and electric vehicles today.



# Integrating a powertrain system

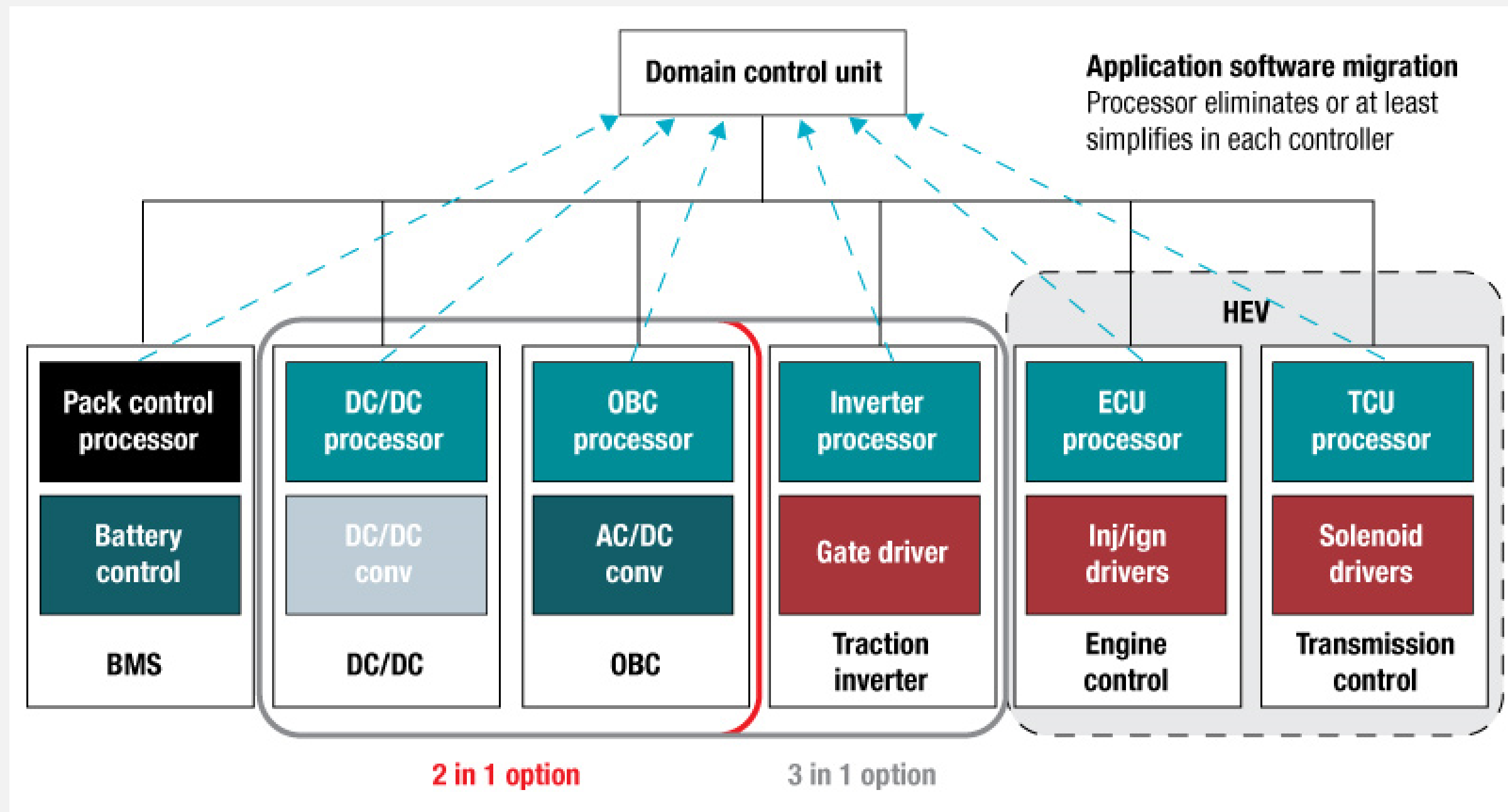
- An integrated powertrain architecture includes:
  - Inverter
  - Power distribution unit (PDU)
  - High-voltage DC/DC
  - On-board charger
  - Battery management system (BMS)
- The integration can be mechanical, control or powertrain level.



Contains relay, circuit breaker, fuse, etc. and handles the power flow between different EE

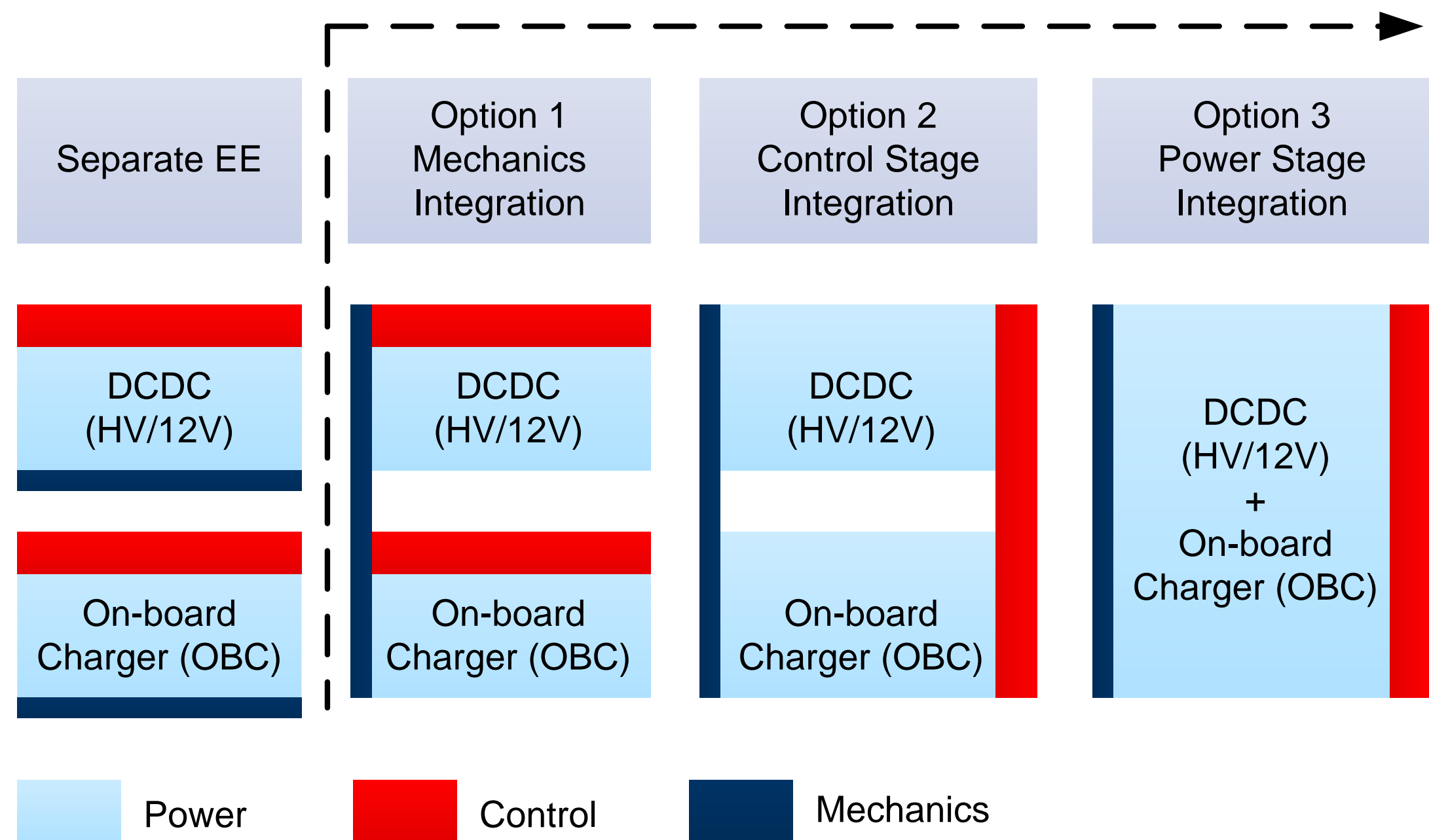
# EV powertrain integration – at any level

- Use a single powertrain domain controller, power stage and mechanical enclosure or design a distributed power architecture.
- Integrate powertrain systems, including:
  - Inverter
  - Power distribution unit (PDU)
  - High-voltage DC/DC
  - On-board charger
  - BMS
- Integrate at the mechanical, control or powertrain level.



# Integration of on-board charger, DCDC, traction inverter

# Powertrain integration (OBC+HV DCDC)



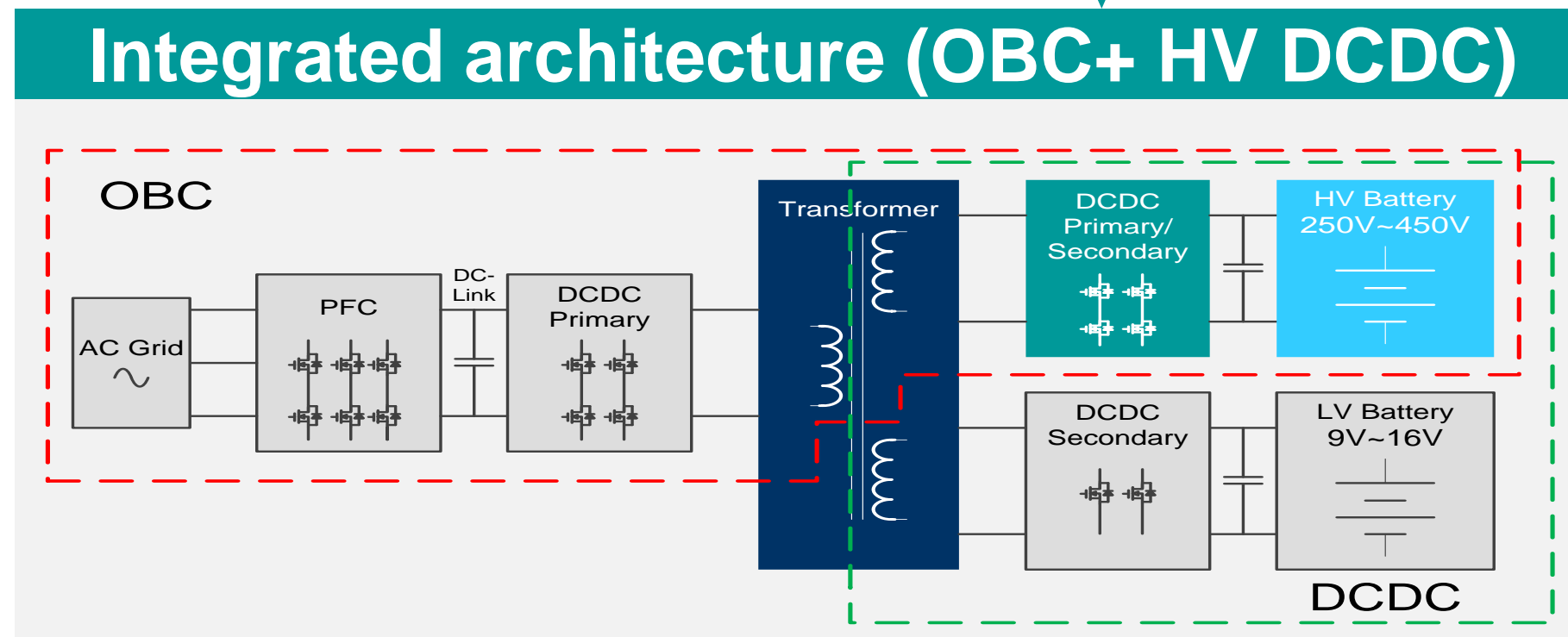
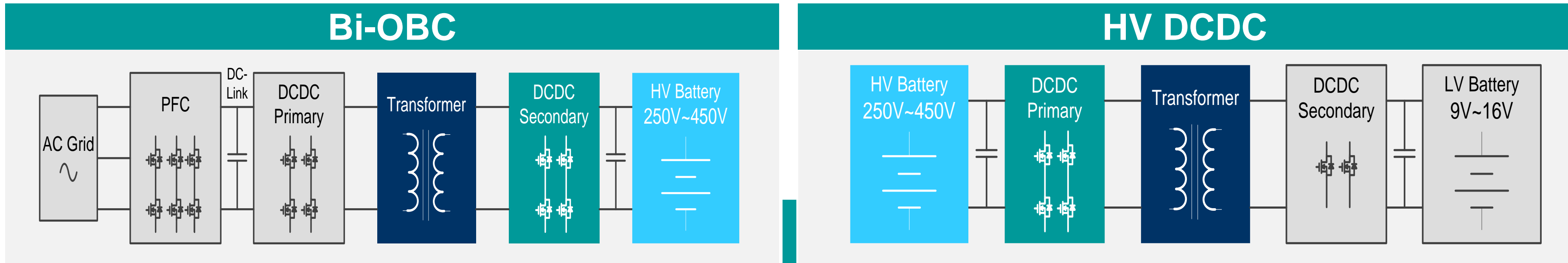
## Powertrain integration

- Option 1 can be divided into two steps: **first step** is to share the mechanical housing but independent cooling system, **second step** is to share both the housing and cooling system.
- Currently the market is moving from option 2 to option 3. Obviously, option 3 has the best cost advantage.



# Integration block diagram

## OBC + high-voltage DCDC



Approaches:

- Magnetic integration
- Power switches sharing
- Control unit sharing (one MCU control PFC stage, one MCU control DCDC stage of OBC & HV DCDC)

# Integrated powertrain overview

## Design Benefits

- The system cost can be reduced by reducing the total number of components
- Improved power density
- Volume & weight can be reduced which will help extend the mileage
- The integrated parts will be much easier for the car OEM to assemble in the vehicle

## Design Challenges

- Magnetic integration need to be designed carefully to achieve good performance
- The control algorithm will be more complex than independent components
- High efficient cooling system should be designed to dissipate all the heat with small volume

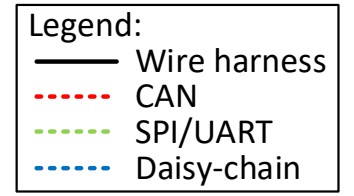
## Design Approach

- Different magnetic components can be integrated into one component
- Power switches of similar rated voltage can be shared
- Different control circuit can also be integrated into one control unit
- Water cooling system and mechanical housing can be shared



# Battery management system

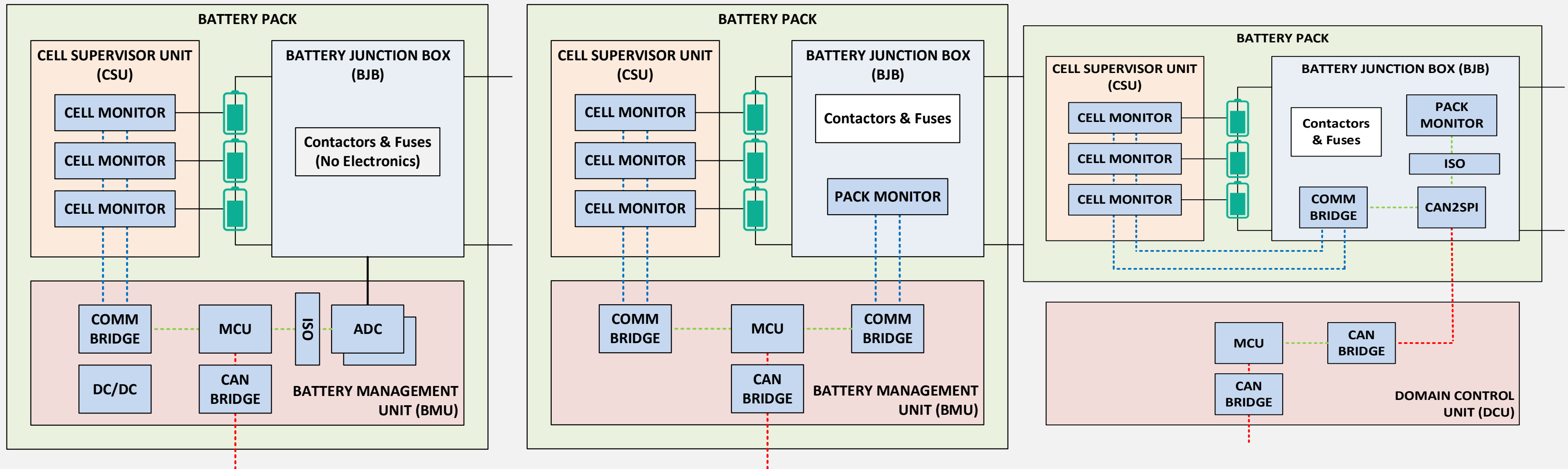
# BMS Evolution



## Traditional BMS

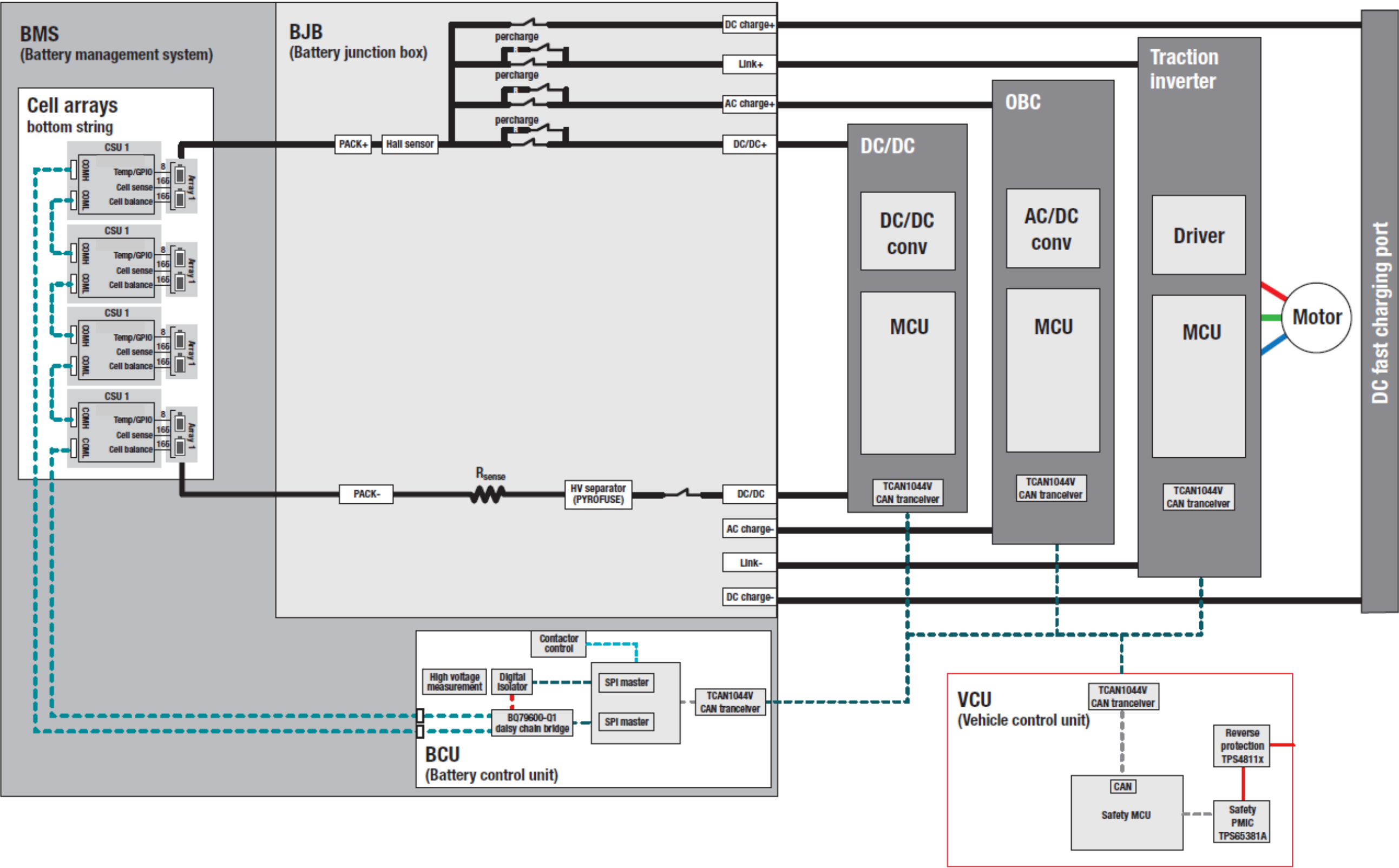
## Intelligent BJB

## Domain Control

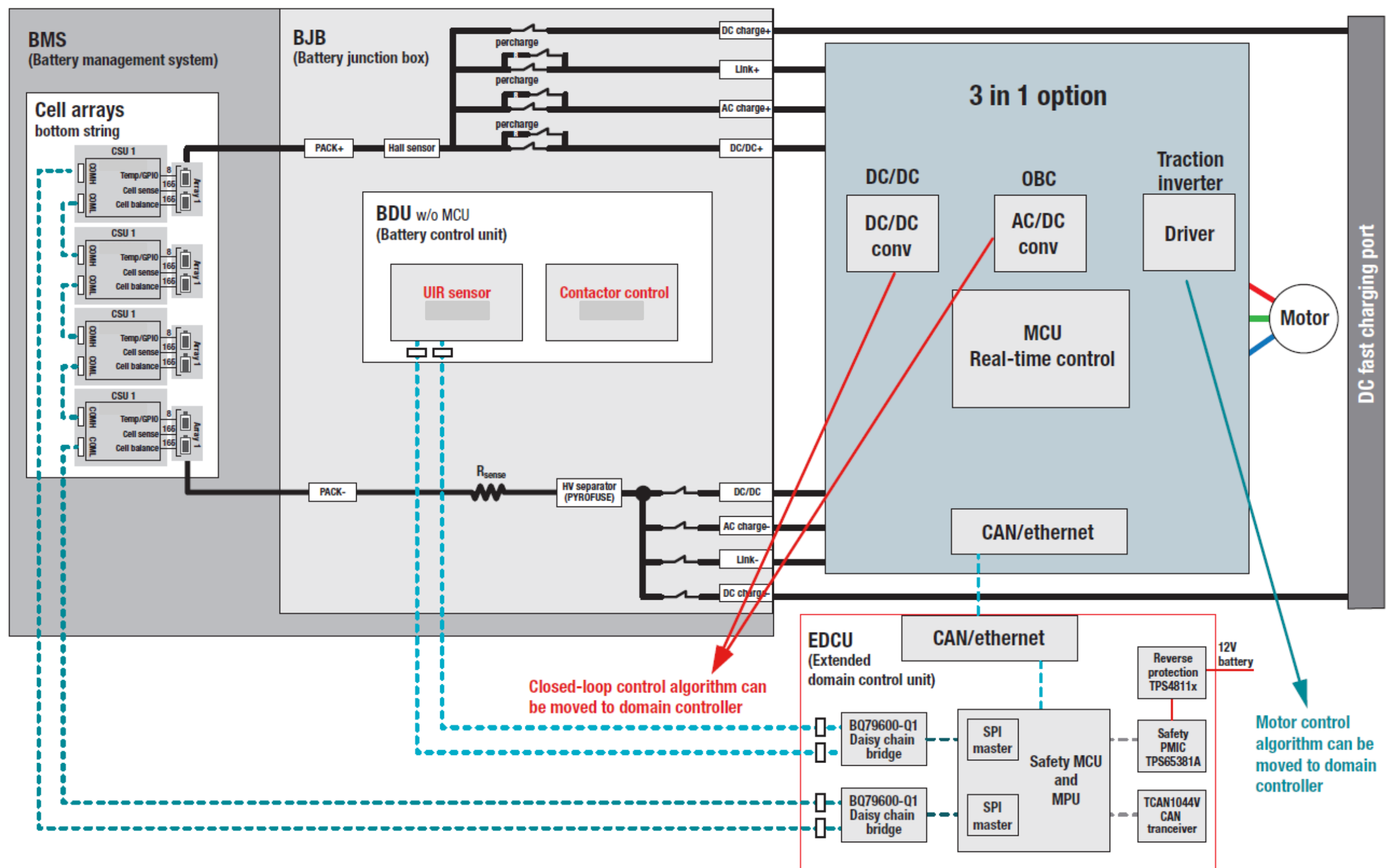


# System integration of powertrain

# Traditional powertrain architecture

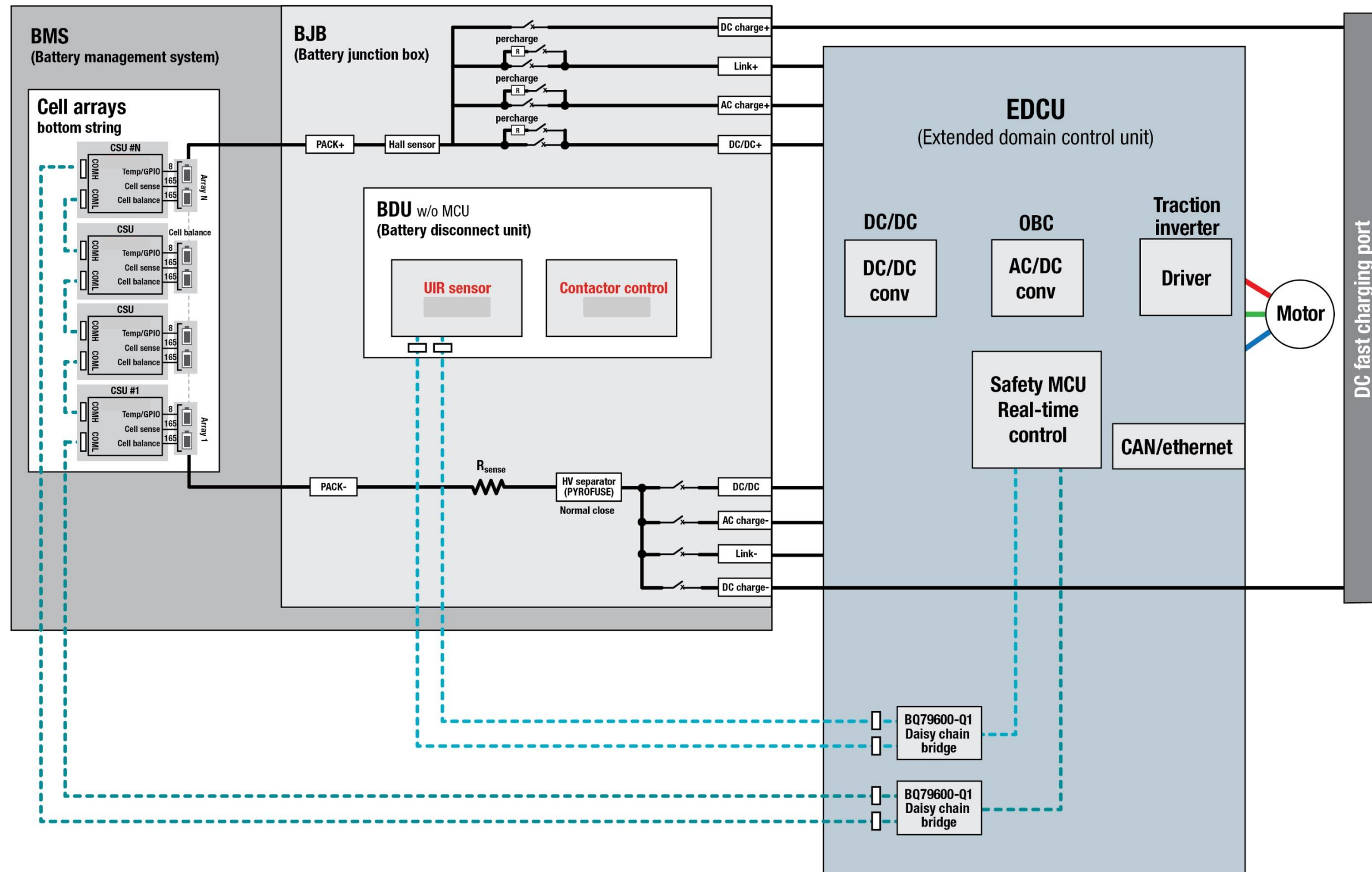


# Powertrain domain control



# Powertrain domain control

If DC/DC and OBC closed-loop control algorithm can't be moved out







**Boost EV adoption by making them more affordable.**

Integrate powertrain systems at all levels.  
Reduce cost, simplify design, streamline functional safety and improve reliability.  
Extend driving range with system efficiency.





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