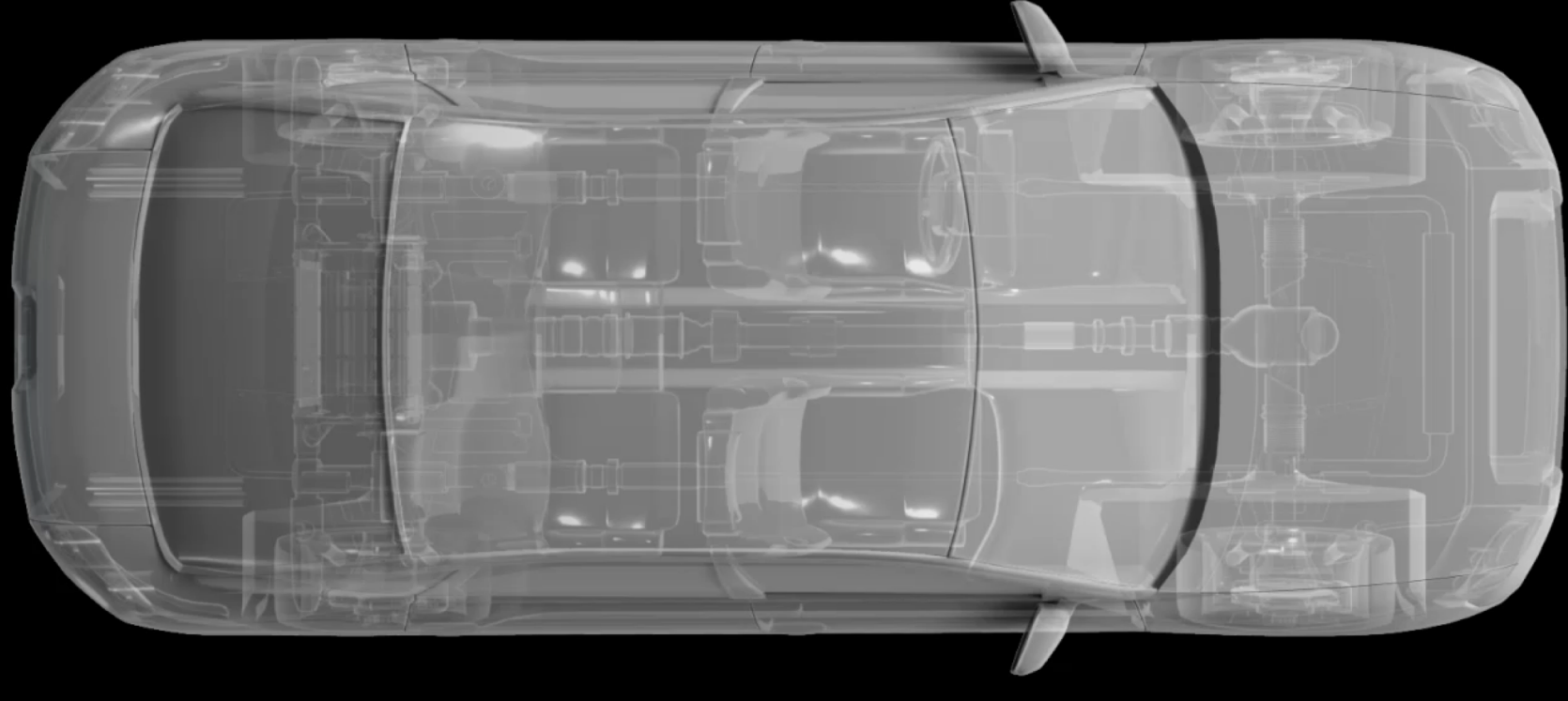
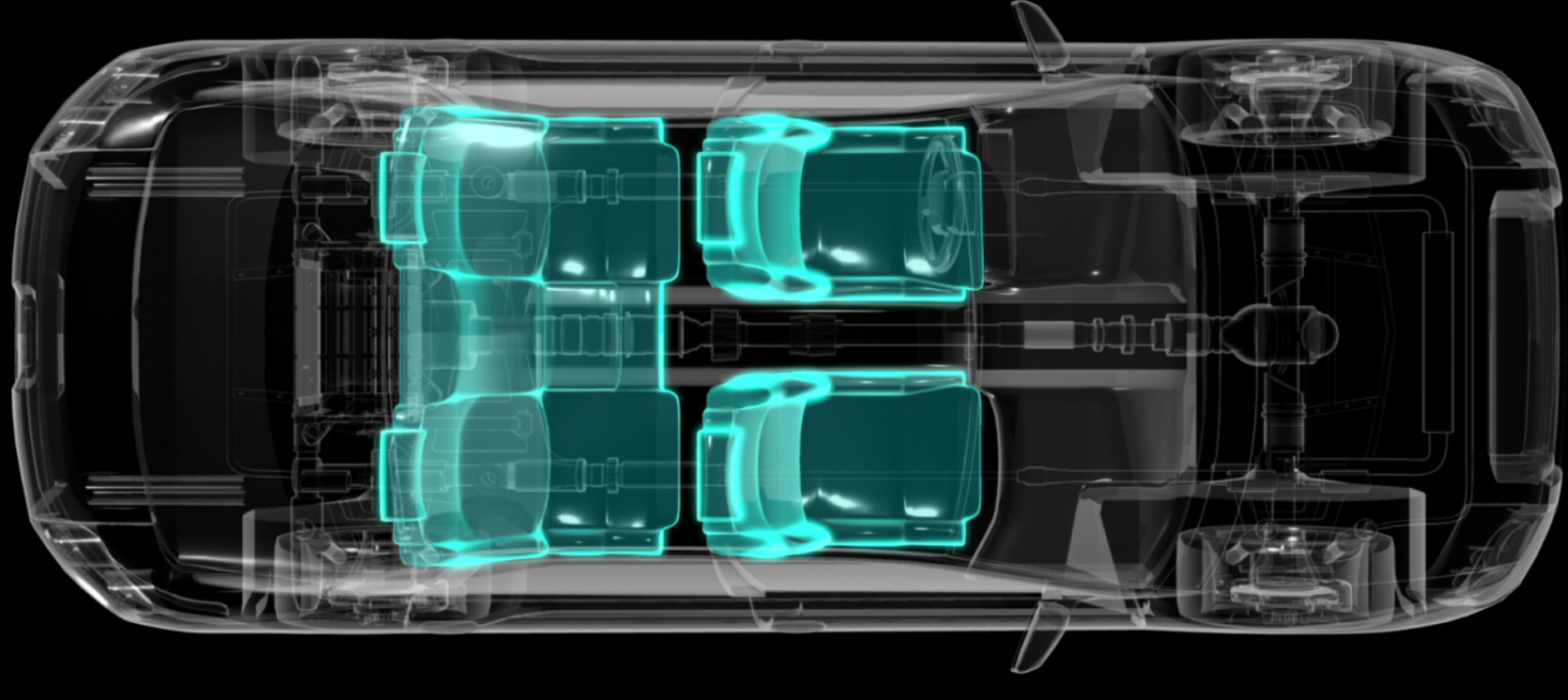
McKinsey&Company

MCKINSEY CENTER FOR FUTURE MOBILITY

A byte future

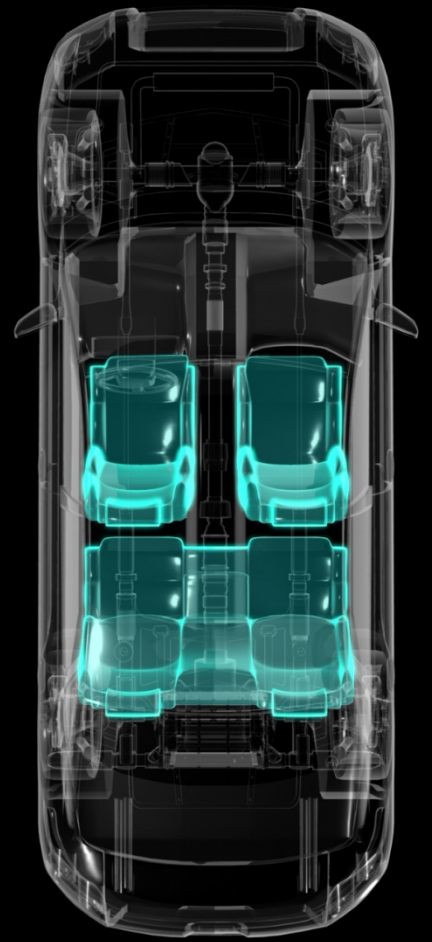
Software-based solutions
are reshaping automotive electronics
and architecture





Connectivity

Electrification



Autonomous driving

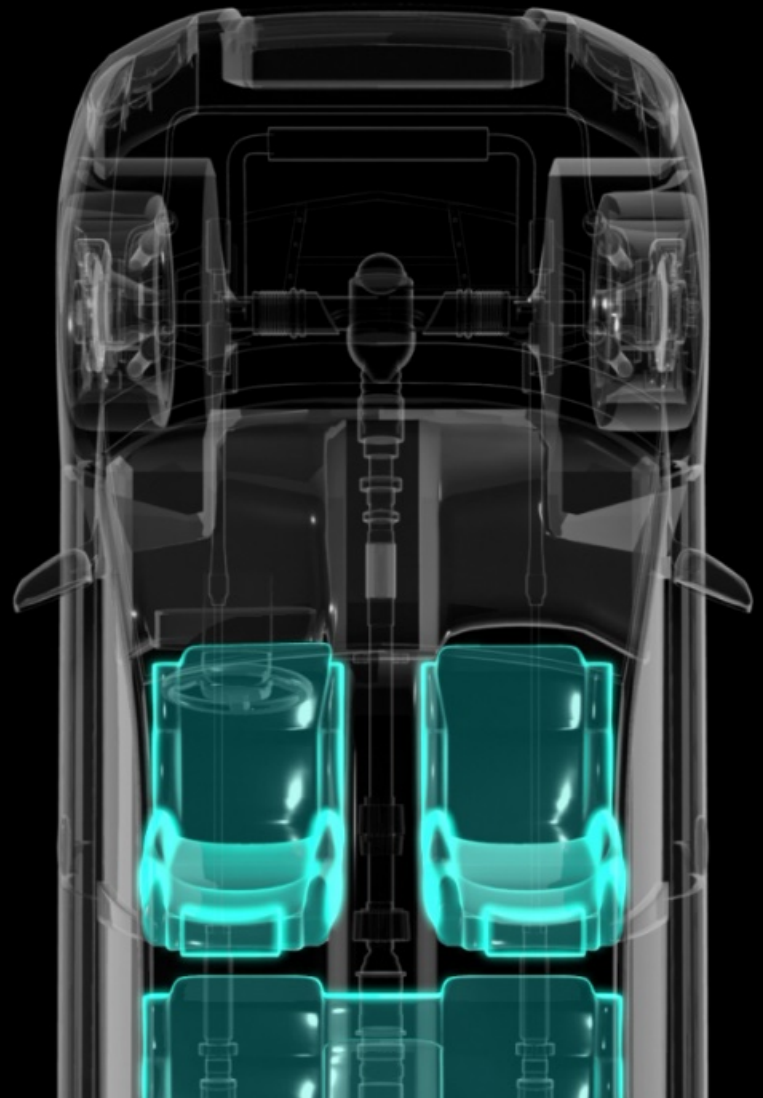
Diverse mobility

Integrated third-party services

Over-the-air updates

Partially cloud-based operation

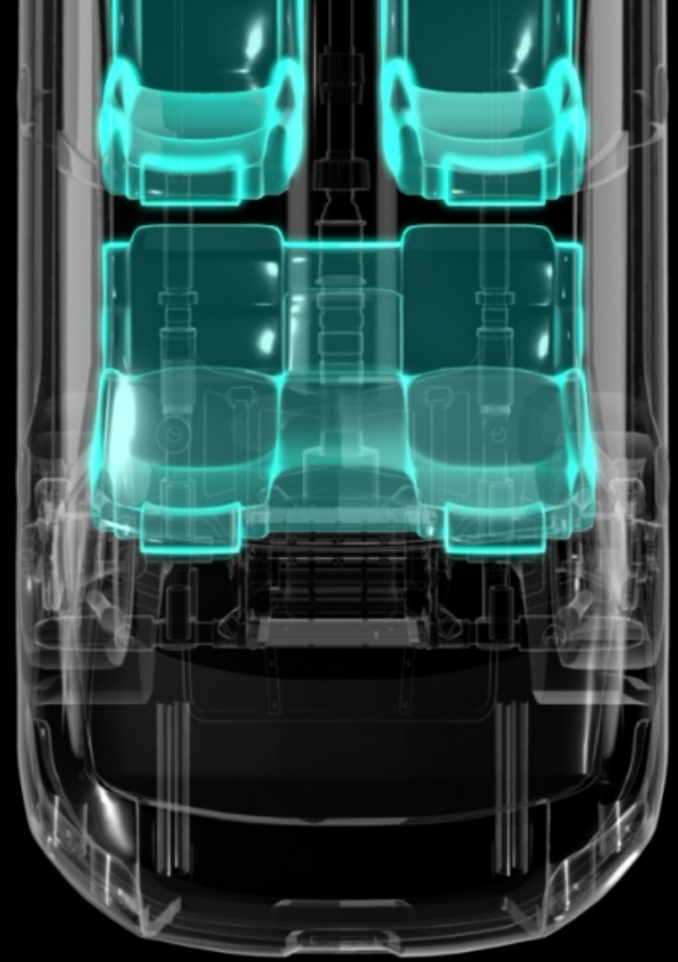
Connectivity

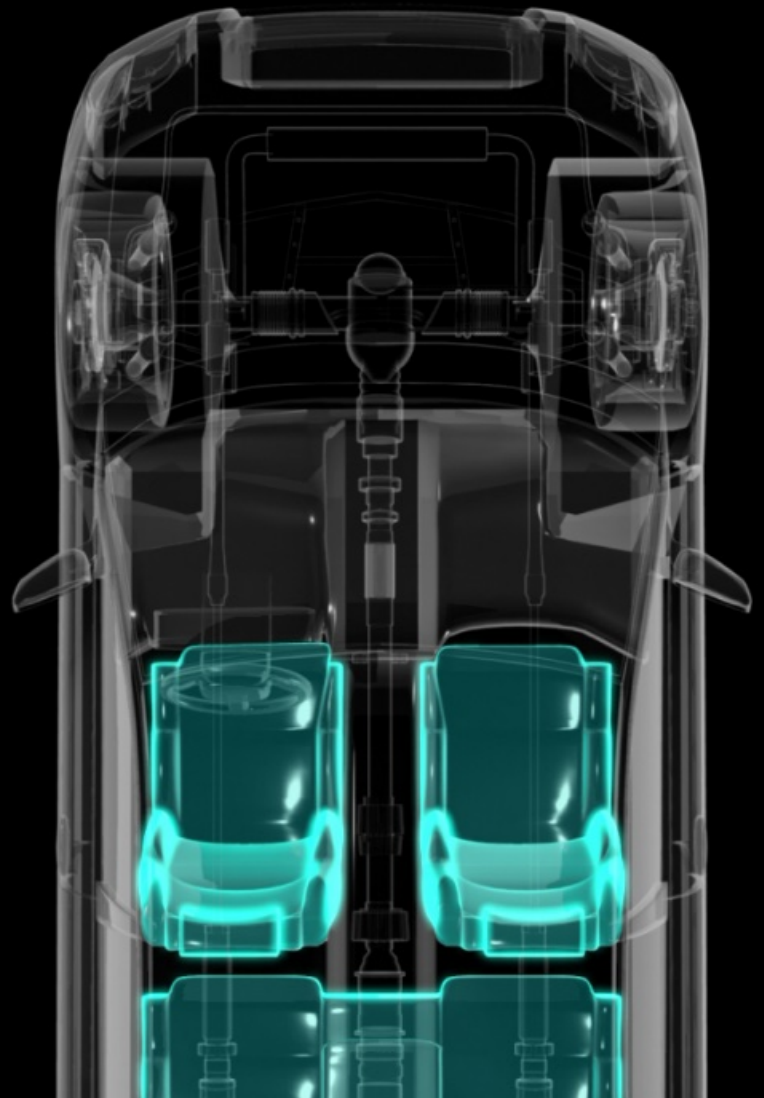


Electrification

New electronics

Advanced algorithms
to reduce energy consumption



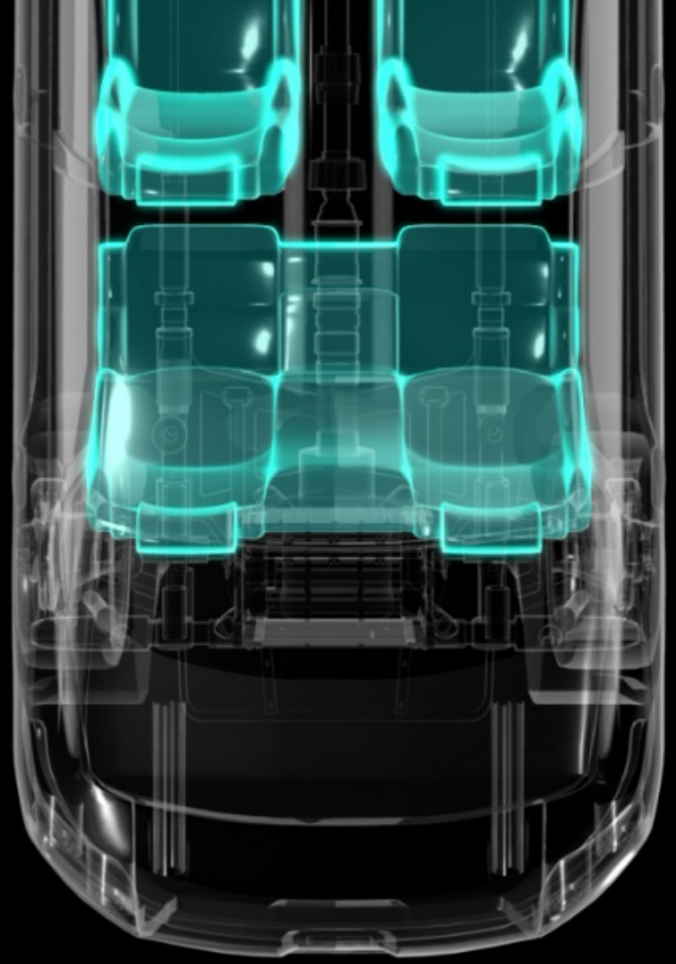


Need for unlimited reliability

Higher demand for computing power and communication

Built-in sensors and actuators

Autonomous driving



Diverse mobility

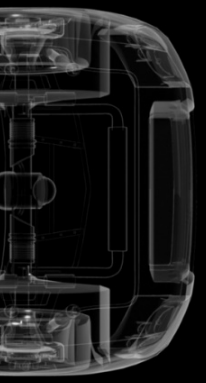
Shared mobility services and robotaxis

Customized driver experience

OEMs enter partnership
to standardize vehicle architecture

New regulations require OEMs
to provide third-party interface

5G Mobile networks are
widely available around the world



Requirements call for redundant
implementation of safety-critical
functions in vehicles

Alibaba announces own
open-source vehicle stack

Regulatory changes facilitate
use of OTA updates

2030

Architecture

Expanded middleware layer to abstract applications from hardware

Limited number of architecture stacks with integrated hardware and software

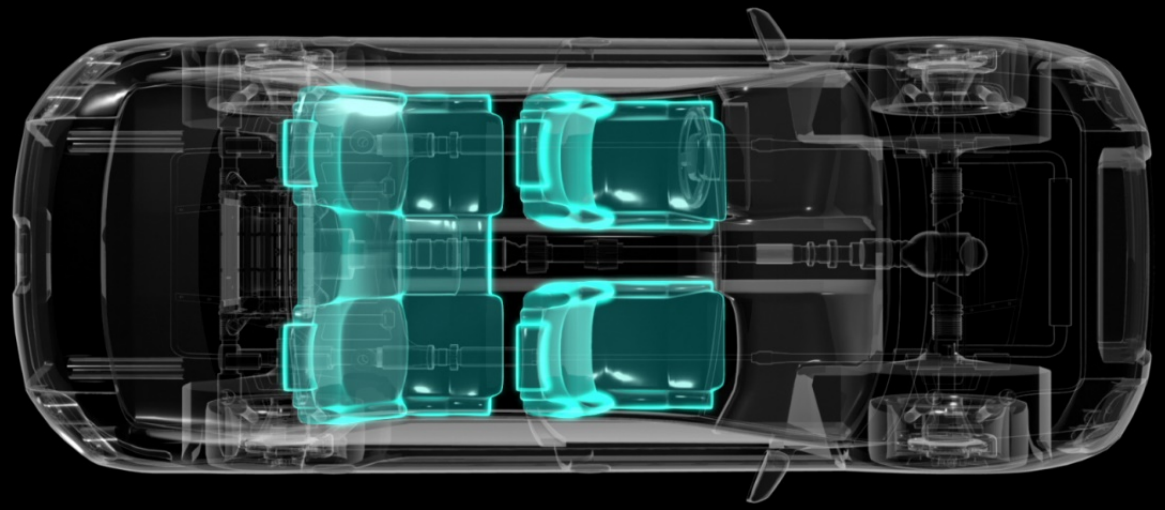
ECU consolidation

Data capabilities

Data connectivity for entertainment and HAD channeled via the OEM; more open interfaces in infotainment

Increasing use of cloud to combine in-vehicle data with environmental data

Updatable components that communicate bidirectionally



More intelligent sensors

Significant spike in the number of in-vehicle sensors in the medium term

Sensors

Rise of the automotive Ethernet

Fully redundant power and data networks

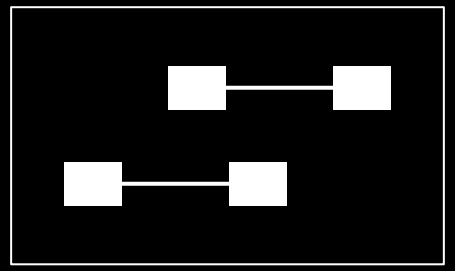
Power and data networks

Evolving E/E architecture

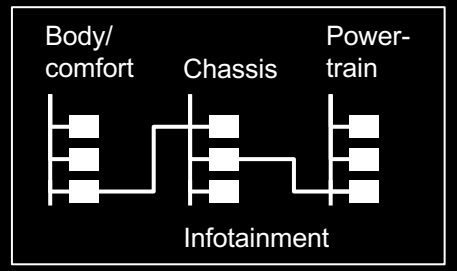
Today

Outlook

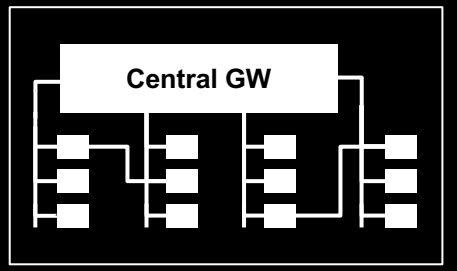
1st generation



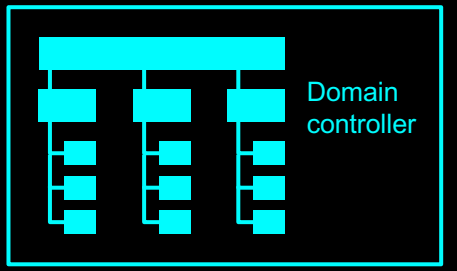
2nd generation



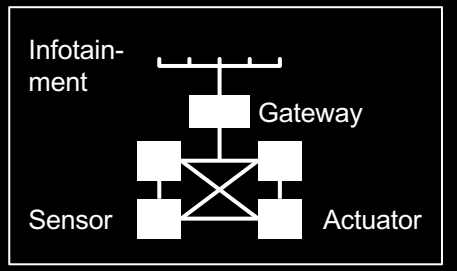
3rd generation



4th generation



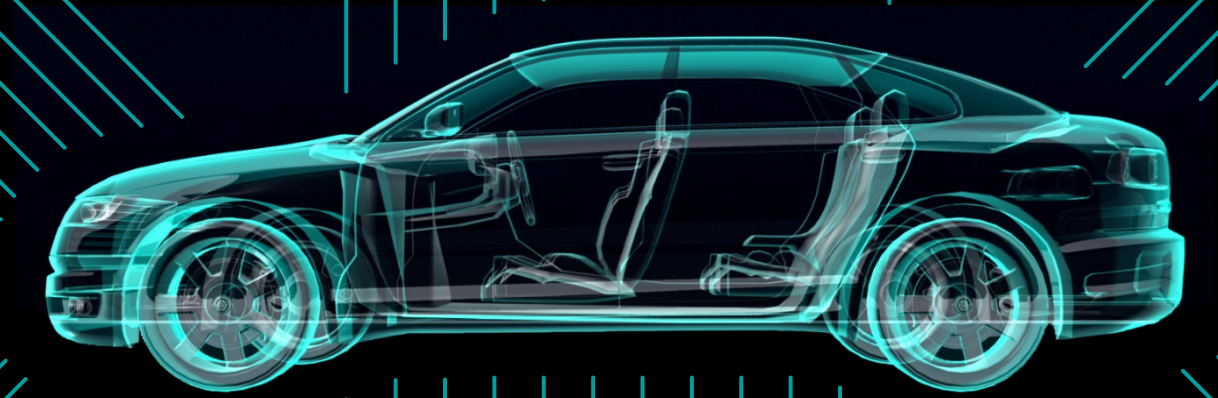
5th generation



Distributed E/E architecture

Domain centralized E/E architecture

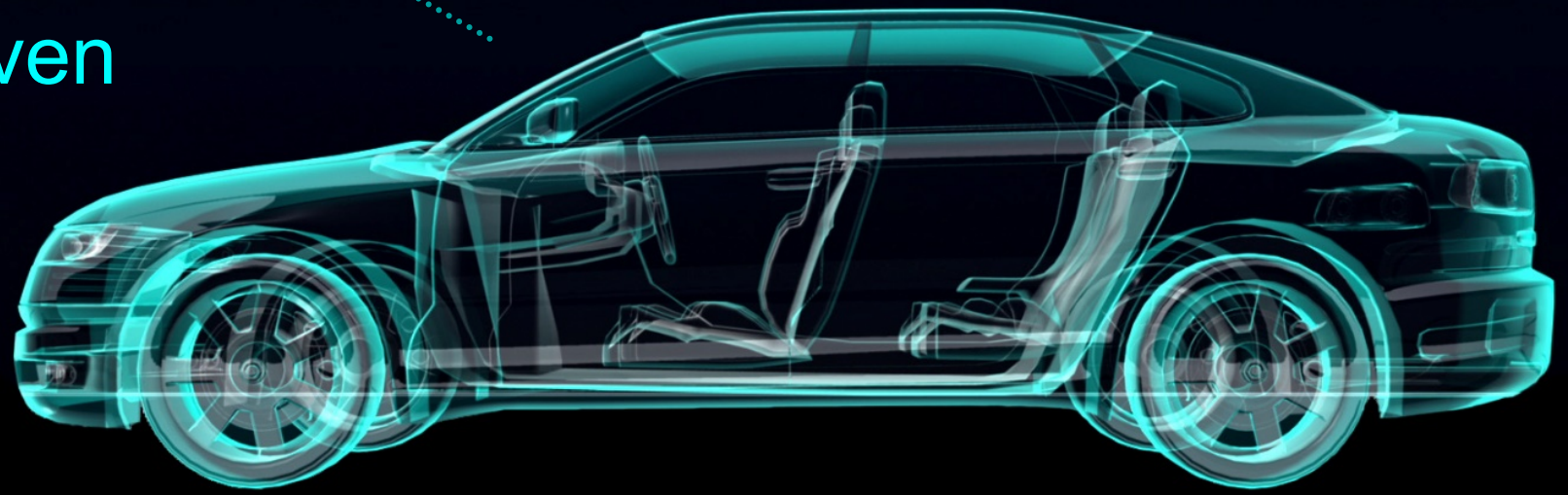
Vehicle centralized E/E architecture


Parental controls
Driver alertness monitoring
Instrument cluster
Accident recorder
Event data recorder
Auto-dimming mirror
Interior lighting
Active cabin noise suppression
Voice/data communica-tion
Cabin environment controls
DSRC
Entertainment system
Head-up display
Battery management
Night vision
Lane correction
Windshield wiper control
Electronic toll collection
Engine control
Digital turn signals
Airbag deployment
Navigation system
Adaptive front lighting
Security system
Adaptive cruise control
Active exhaust noise suppression
Automatic braking
Active suspension
Electric power steering
Hill-hold control
Electronic throttle control
Regenerative braking
Electronic valve timing
Tire pressure monitoring
Idle stop/start
Cylinder deactivation
Active vibration control
Blind spot detection
Active yaw control
Remote keyless entry
Lane departure warning
Trans-mission control
Seat position control
Electronic stability control
OBDII
Parking system
Anti-lock braking

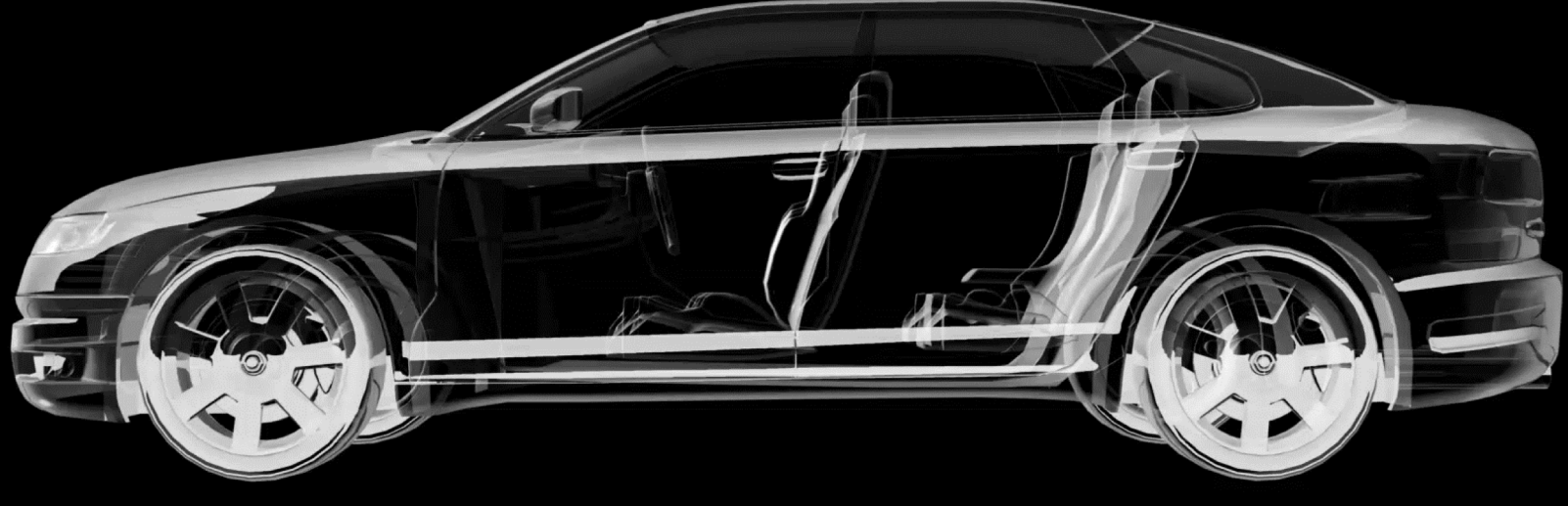
Time-driven

Time- and event-driven

Cloud-based (off-board stack)



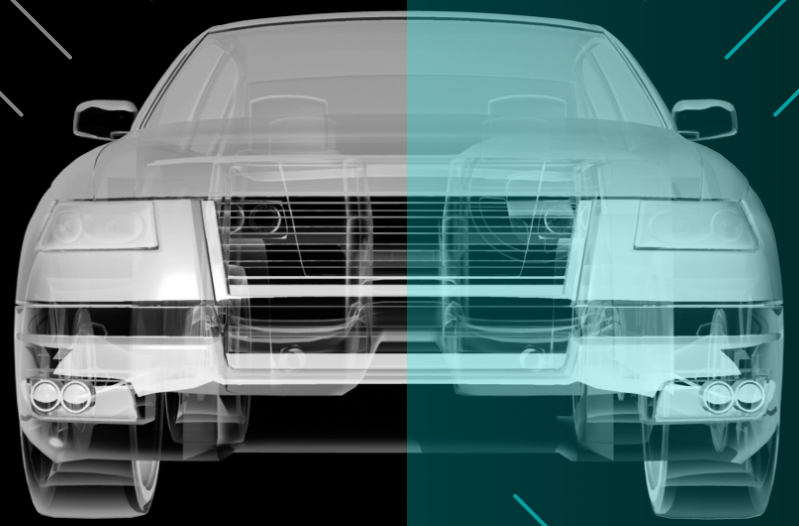
Event-driven



L3 automation

sensors

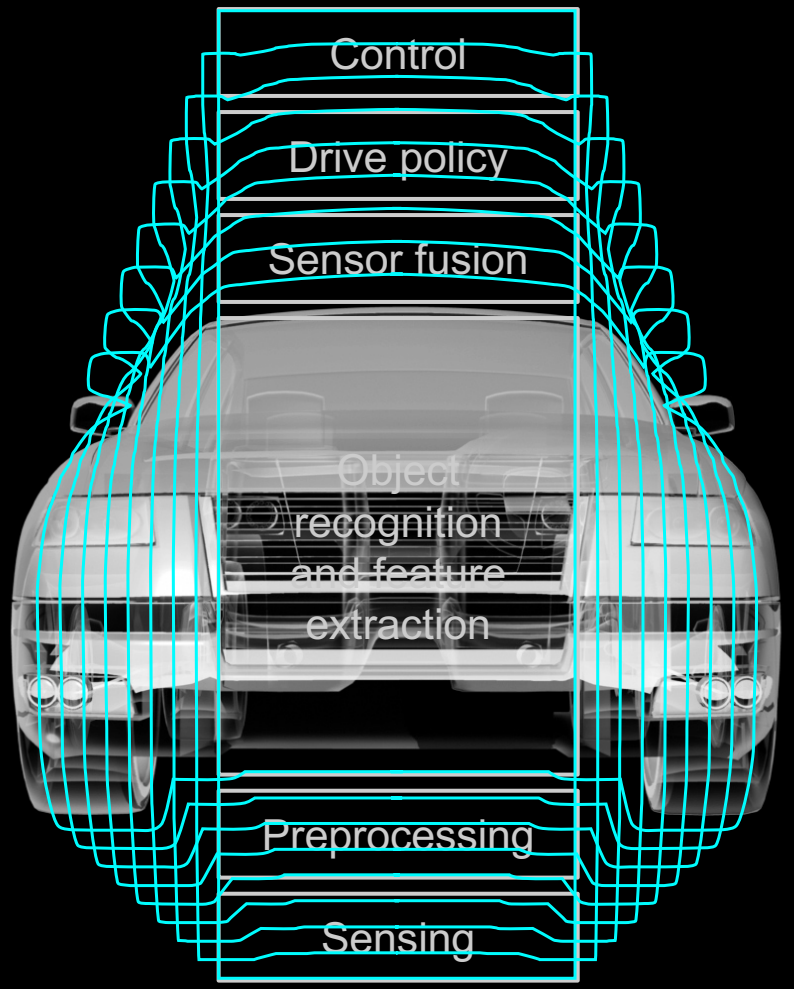
- Radar
- GNNS
- Cameras
- LiDAR
- Ultrasound



L4 automation

sensors

- Radar
- GNNS
- Cameras
- LiDAR
- Ultrasound
- Infrared camera


Control
Drive policy
Sensor fusion
Object recognition and feature extraction
Preprocessing
Sensing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Drive policy
Sensor fusion
Object recognition and feature extraction
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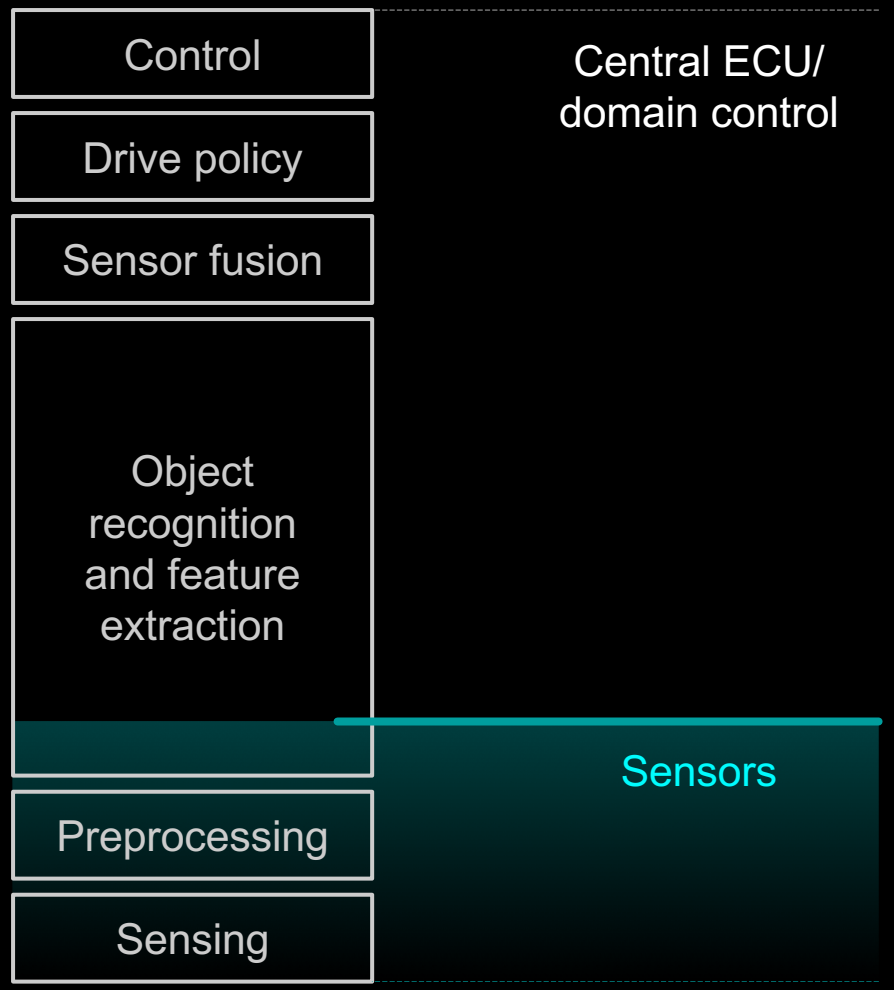
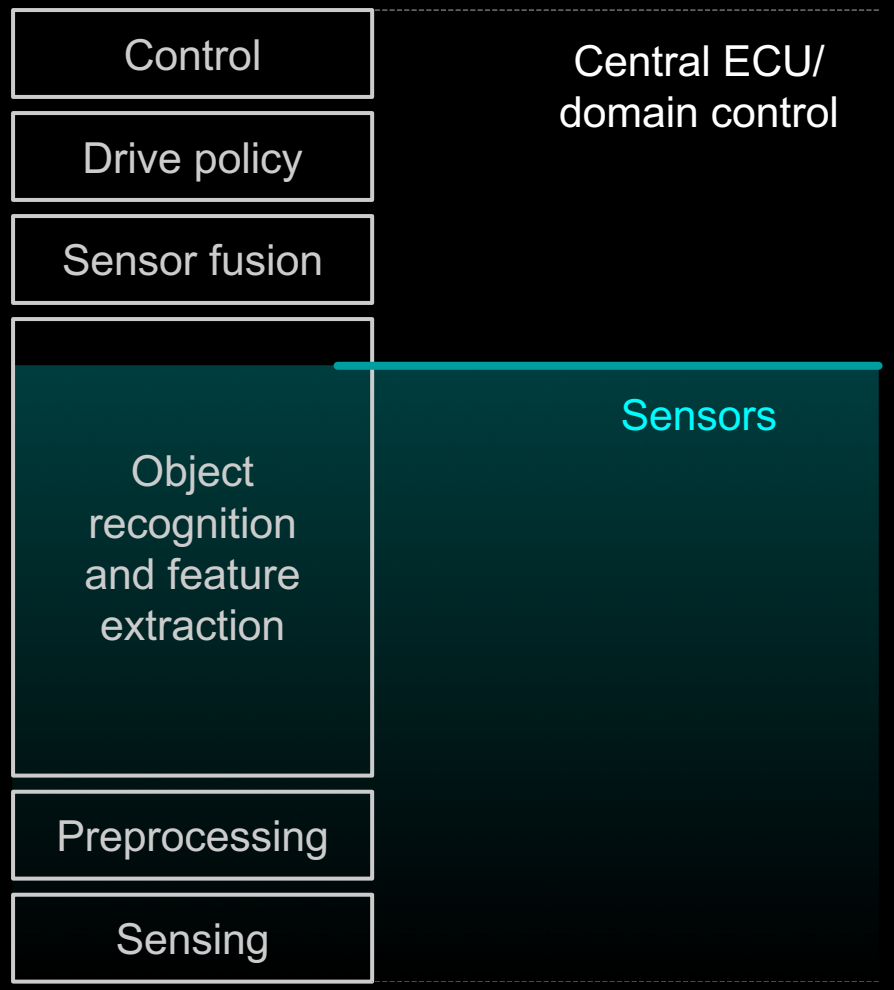
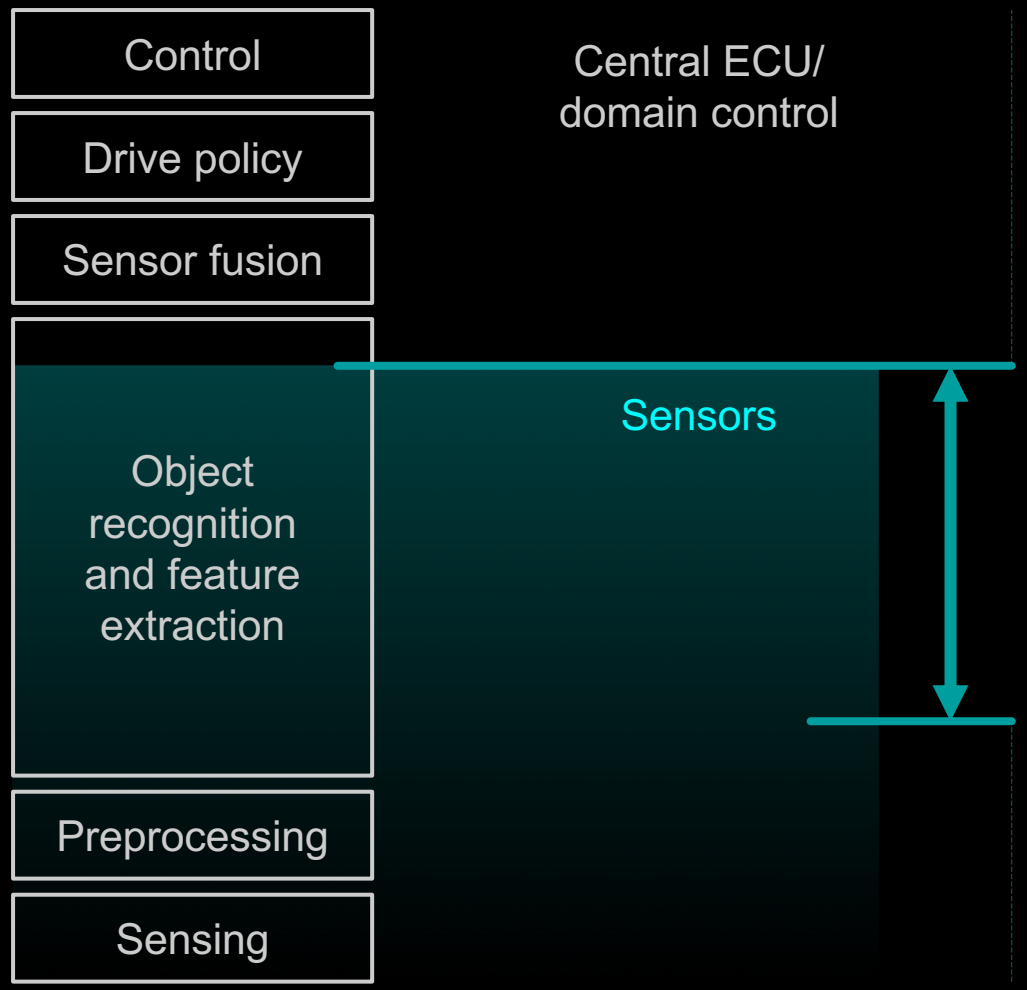
Sensing



Centralized processing



Distributed processing



Extent of shift to sensor-based processing depends on:

Price of data transmission

Price of computing power

Advances in sensor technology

Degree of vehicle automation

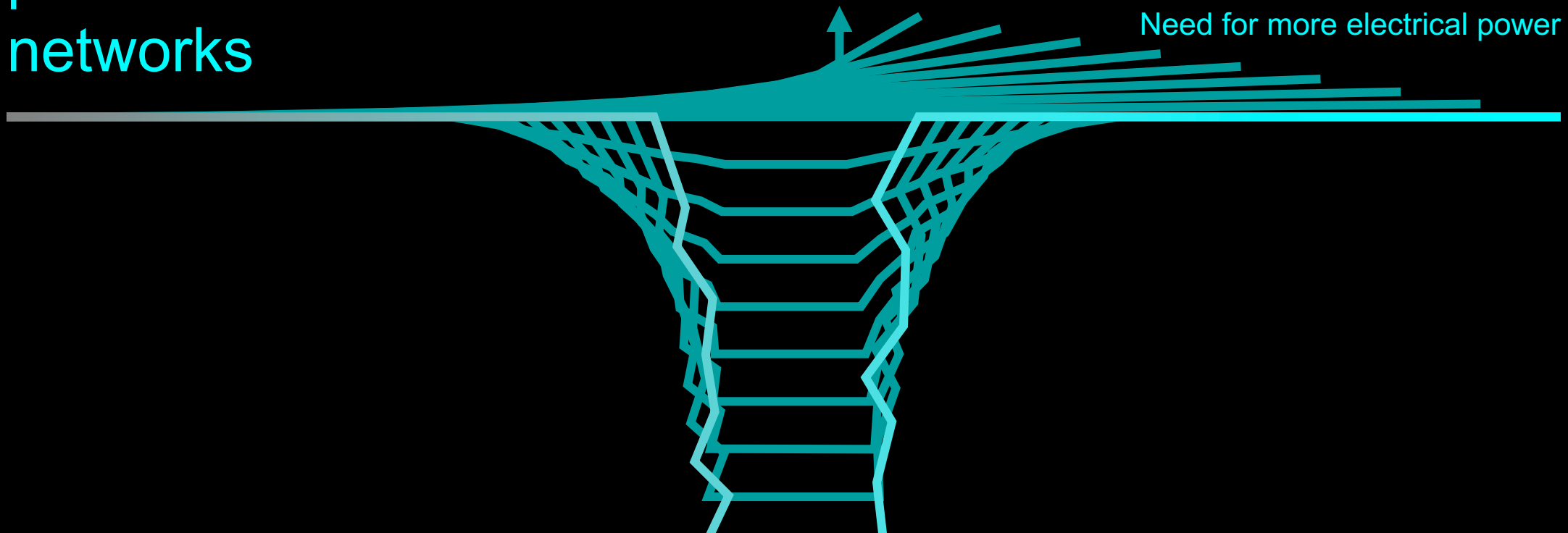
Challenges

Stringent safety requirements for HAD (e.g., redundancy)

Diagnostics and self-protection mechanisms

Need for more electrical power

Existing power and data networks

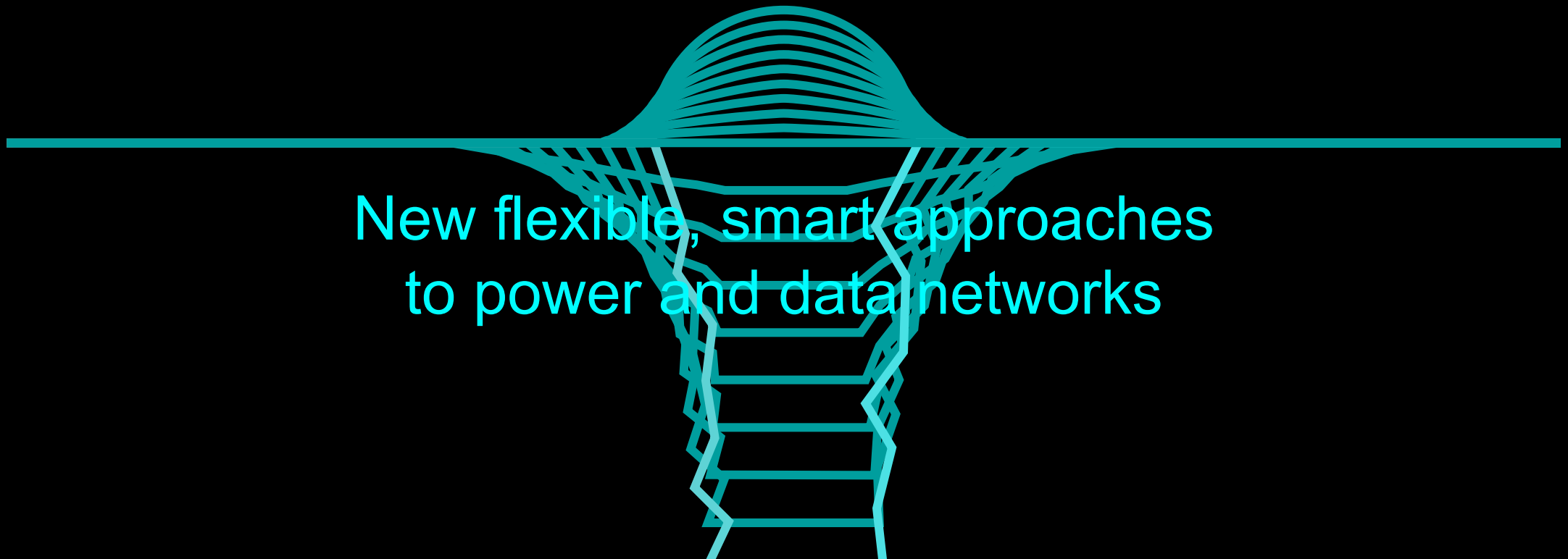


Ring topology

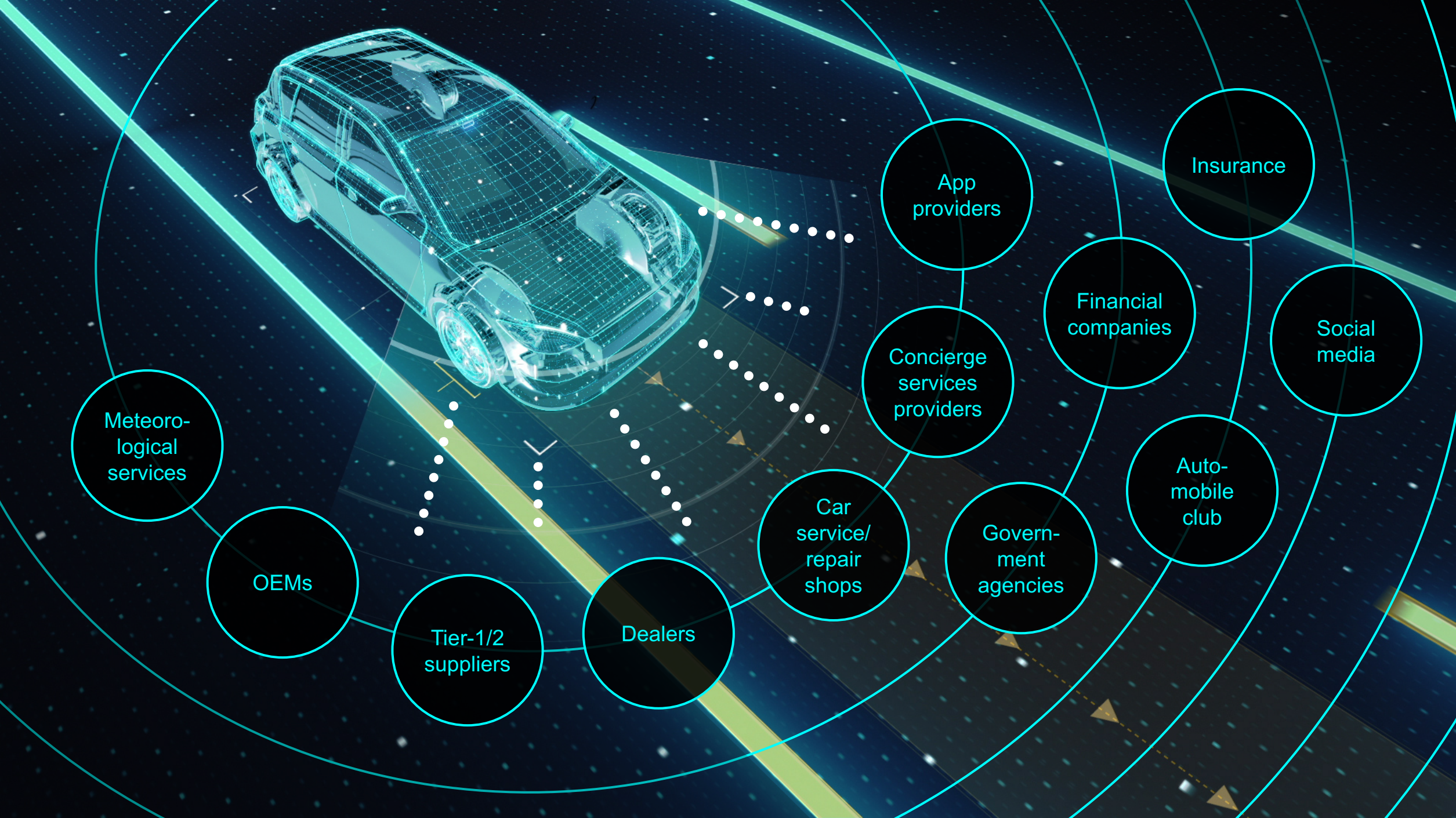
Modular power distribution units

Switched Ethernet

Ethernet AVB and TSN



New flexible, smart approaches to power and data networks


App providers
Insurance
Financial companies
Social media
Concierge services providers
Meteoro-logical services
Auto-mobile club
Car service/ repair shops
Govern-ment agencies
OEMs
Tier-1/2 suppliers
Dealers

- OEMs
- Tier-1/car electronics system suppliers
- Semiconductor suppliers
- Computing and connectivity players
- Software giants and tech players

Capture market opportunities resulting from the increasing need for smart sensors, complexity increase of ECU consolidation and the demand for Software solutions

— **co-developing solutions**
closely with automotive OEMs, tier-1 and tier-2 suppliers

building up

— **dedicated software capabilities**
to complement hardware products

But remember

Speed is crucial

But remember

Speed is crucial

But remember

Speed is crucial

1

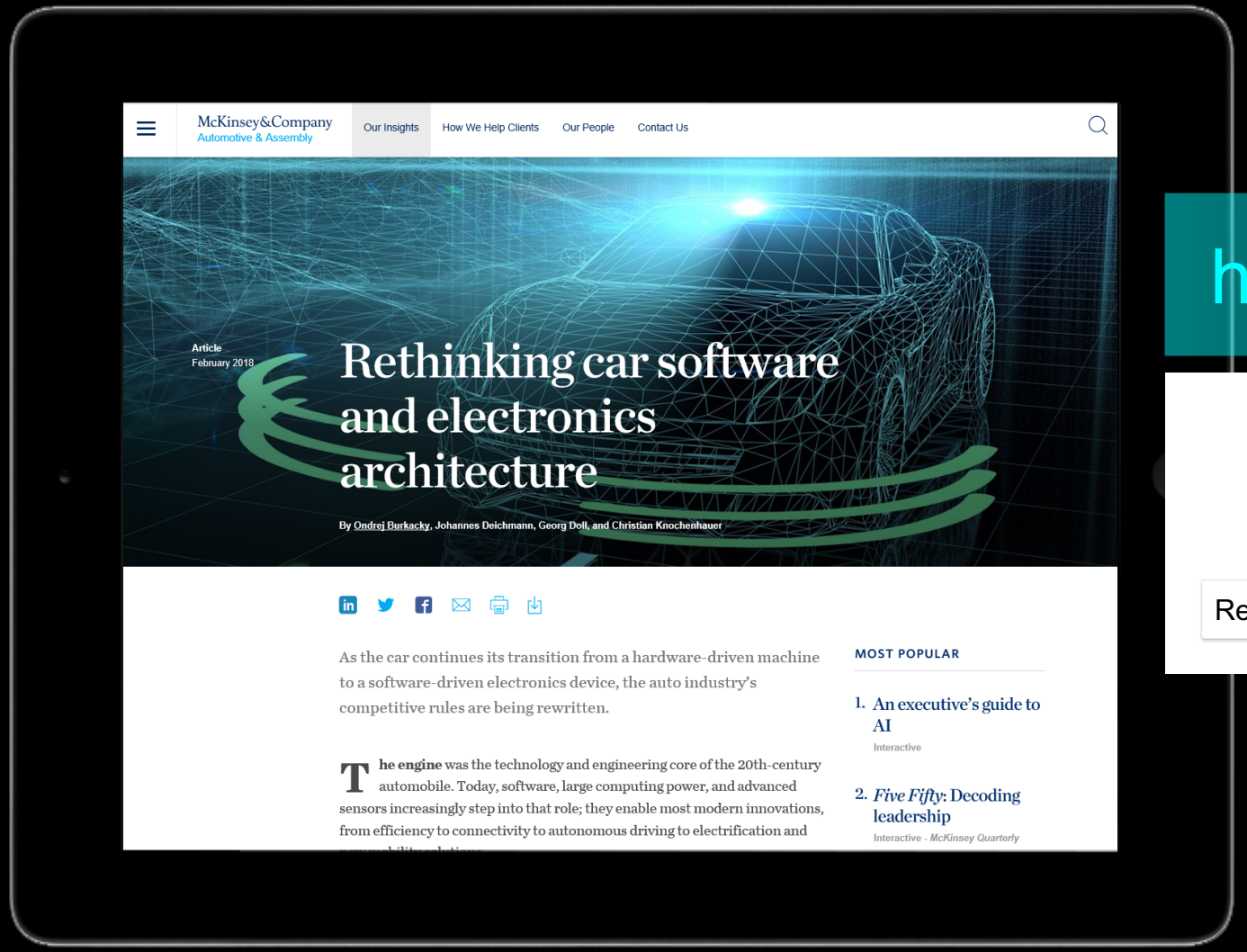
Partnerships along the value chain are useful to get access and to gain a deeper understanding of the automotive industry

2

Solutions should be standardized across platforms onboard and offboard.

3

The transition to Centralized Control Units CCUs offers potential for differentiation at higher stack levels



https://bit.ly/2HgJ0QK

Google

Rethinking car software and electronics architecture