Peeking into the Car of the Future

Luis Basto

Sep 25, 2019

SECURE CONNECTIONS
FOR A SMARTER WORLD

Agenda

Cost of Automotive Electronics
Architecting the Car of the Future
Domain Based Architecture
- Connectivity
- ADAS & Highly Automated Driving
- Powertrain & Vehicle Dynamics
- Body & Comfort
- Infotainment & In-Vehicle Experience

Safety & Security

Some terms use in automotive electronics

- CAN bus – Controller Area Network
- DSRC – Dedicated short range communication (802.11p)
- V2X – V2V, V2I, V2X (vehicle-vehicle, infrastructure)
- ADAS – Advanced Driver Assist System
- ASIL – Automotive Safety Integrity Level
- LIDAR – Light Detection and Ranging
- EPS – electronic power steering
- ESP – electronic stability program
- ISO -26262 Functional Safety Standard

Autonomy

Electrification

Connectivity

Safe and Secure Mobility

More than tripling the semi value per car – today's standard car at $380

Autonomy

+$700	Full Automation	5
+$600	High Automation	4
+$400	Conditional Automation	3
+$100	Partial Automation	2
+$50	Driver Assistance	1
	No Automation	0

Level **3-5**
Automated Driving System
Performs entire dynamic driving task
Monitors environment

Level **0-2**
Human Driver
Performs part of dynamic driving task
Monitors environment

Semi Content per Car increase (TAM) vs Level 0
Source: Strategy Analystics; IHS; Evercore; ABI Research; NXP

Electrification

+$450	Pure Electric Vehicle	E5
+$425	Range Extended Electric Vehicle	E4
+$400	Plug-in Hybrid	E3
+$350	Full Hybrid	E2
+$200	Mild Hybrid	E1
	Combustion Engine	E0

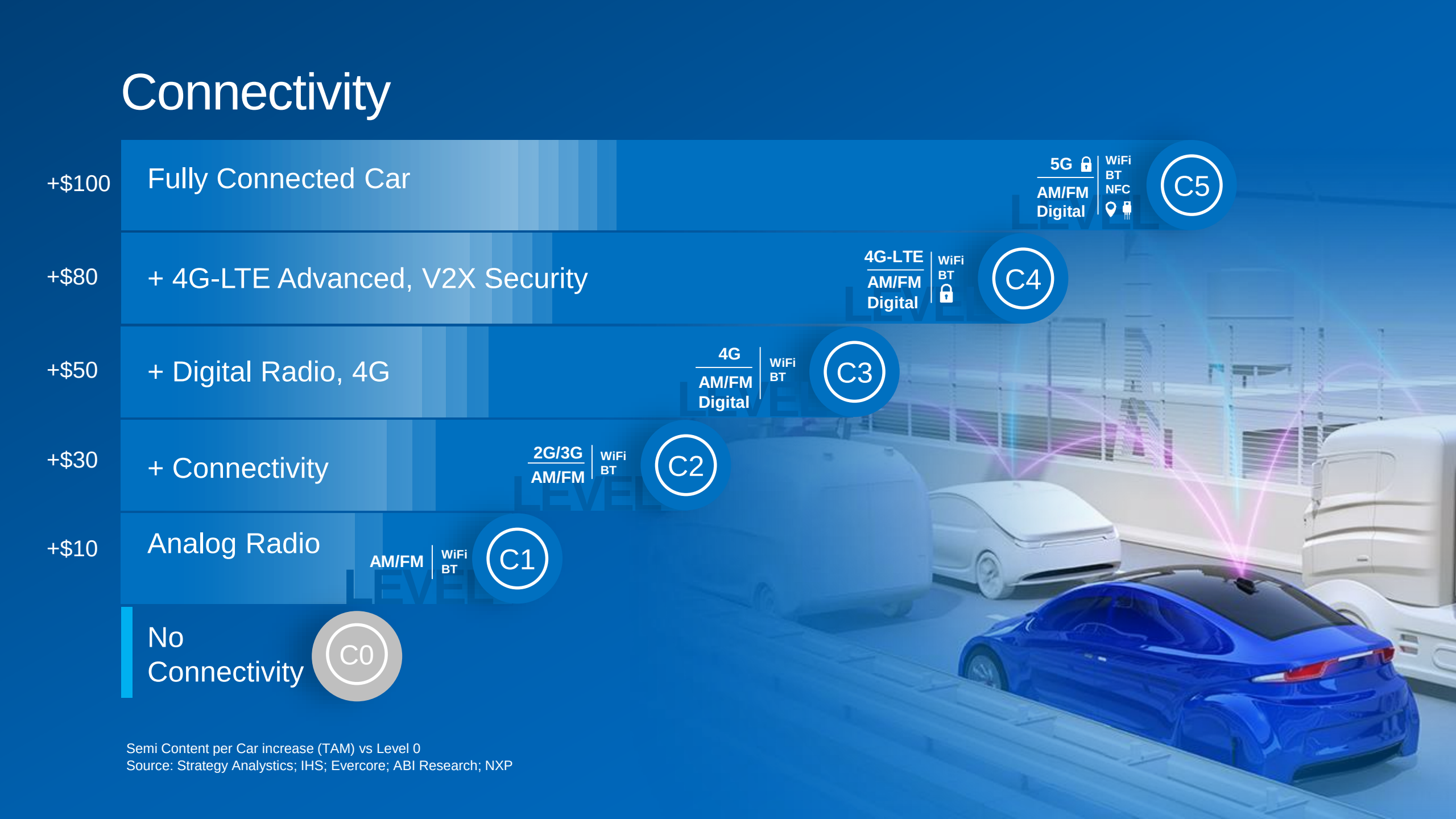
Semi Content per Car increase (TAM) vs Level 0
Source: Strategy Analystics; IHS; Evercore; ABI Research; NXP

Vehicle Electrification: Diversity of Approaches

Electrification Levels	E0	E1	E2	E3	E4	E5
Common Name	Combustion Engine (ICE)	Mild Hybrid (M-HV)	Full Hybrid (F-HV)	Plug-in Hybrid (PHEV)	Range Extended EV	Pure Electric Vehicle
Example	Ford Mustang 	Honda Insight 	Toyota Prius 	FCA Pacifica 	BMW i3 	Nissan Leaf 
Combustion Engine	●●●●	●●●●	●●●	●●●	●●	
Battery System	12V	12V 48V	LV HV	LV HV	LV HV	LV HV
Mains Charging	-	-	-			
Electric Traction	-	 10 – 20kW	 15 – 60kW	 40 – 80kW	 40 – 80kW	 > 80kW

Connectivity

+$100	Fully Connected Car	5G / AM/FM Digital	WiFi BT NFC — C5
+$80	+ 4G-LTE Advanced, V2X Security	4G-LTE / AM/FM Digital	WiFi BT — C4
+$50	+ Digital Radio, 4G	4G / AM/FM Digital	WiFi BT — C3
+$30	+ Connectivity	2G/3G / AM/FM	WiFi BT — C2
+$10	Analog Radio	AM/FM	WiFi BT — C1
	No Connectivity		C0



Semi Content per Car increase (TAM) vs Level 0
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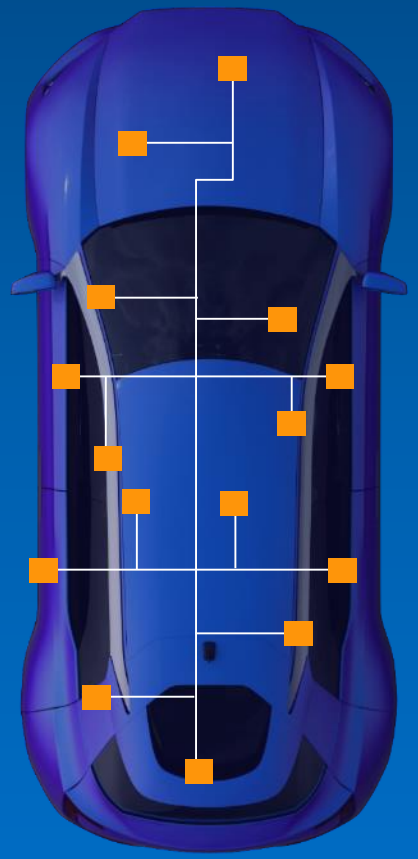
Architecting the Car of The Future

Mega Trends Force Vehicle Architecture Transformation

TODAY: FLAT

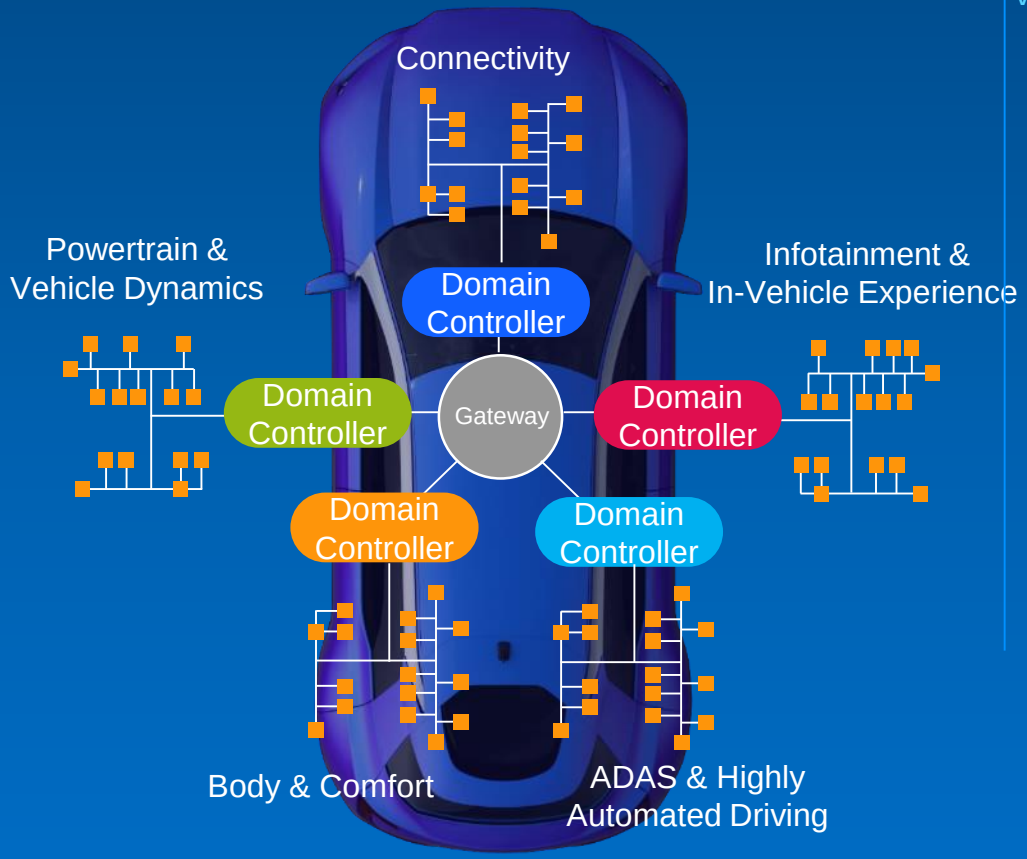


- Low bandwidth, flat network
- One MCU per application

Unfit to future Mobility

Flat to hierarchical

TOMORROW: DOMAINS

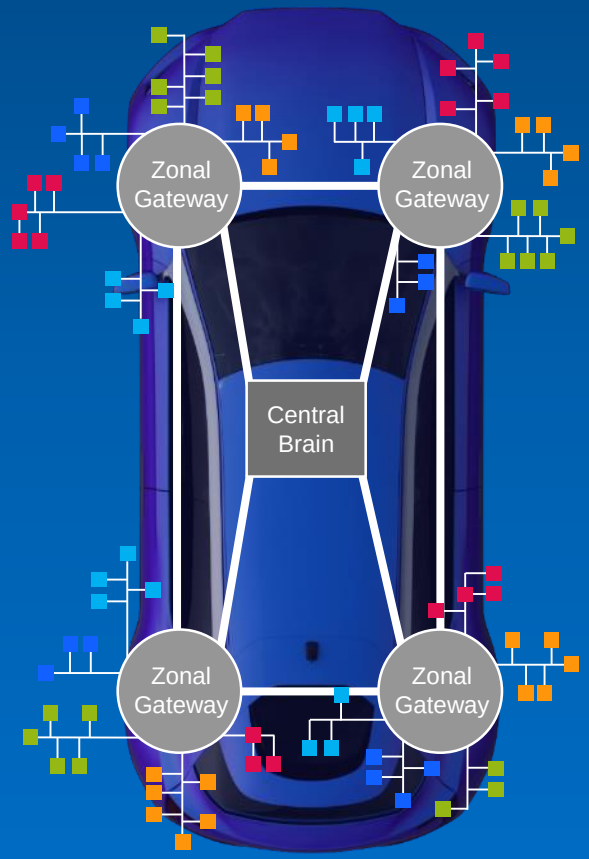


- High bandwidth network
- Gateway key to communication between domains

Step to Autonomous Car

Wires go virtual

AFTER TOMORROW: ZONES



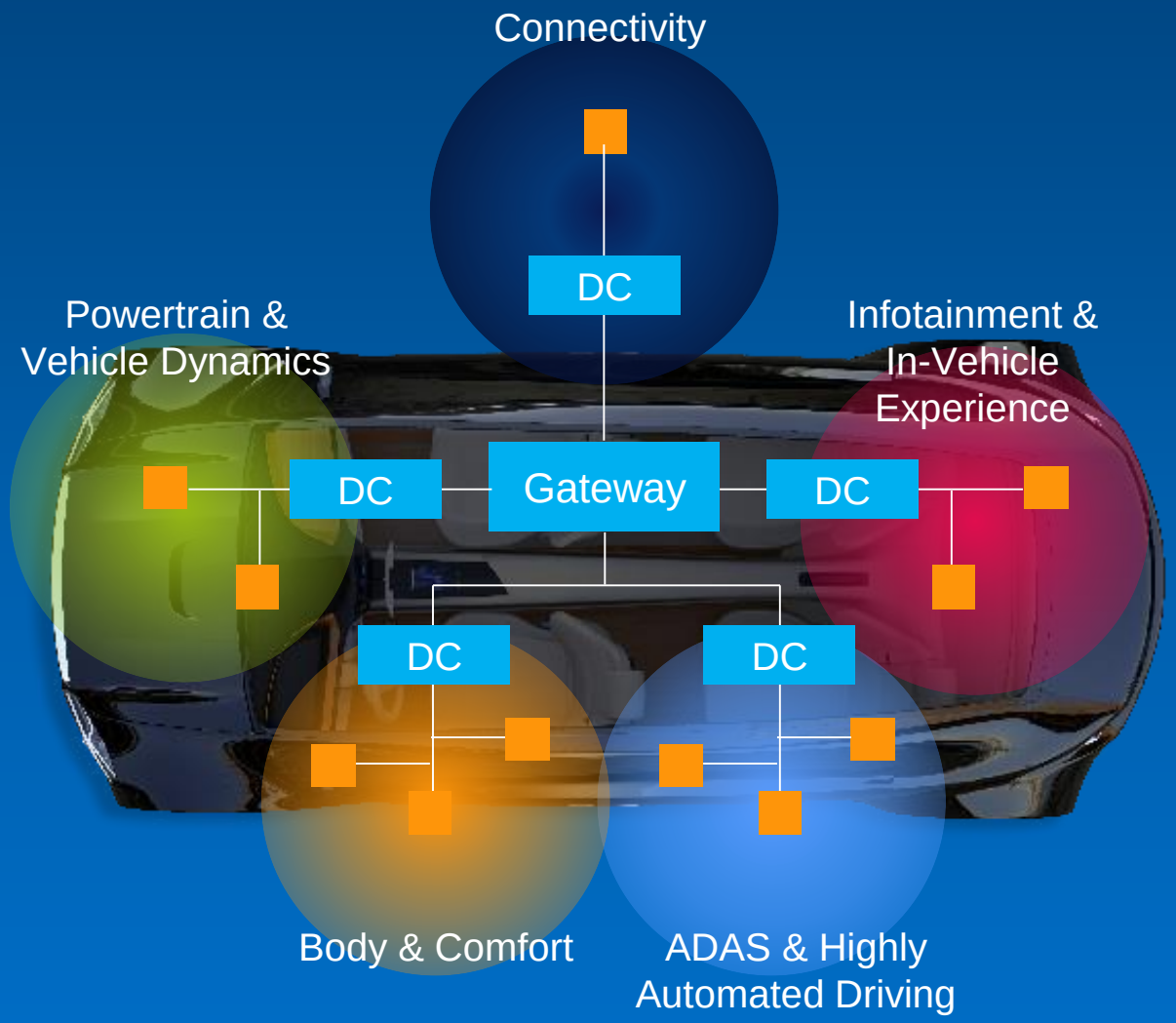
- Domains virtualized by SW – enabling high flexibility
- Easy enable/disable or update functions

Step to User-Defined Car

Domain-based Architecture

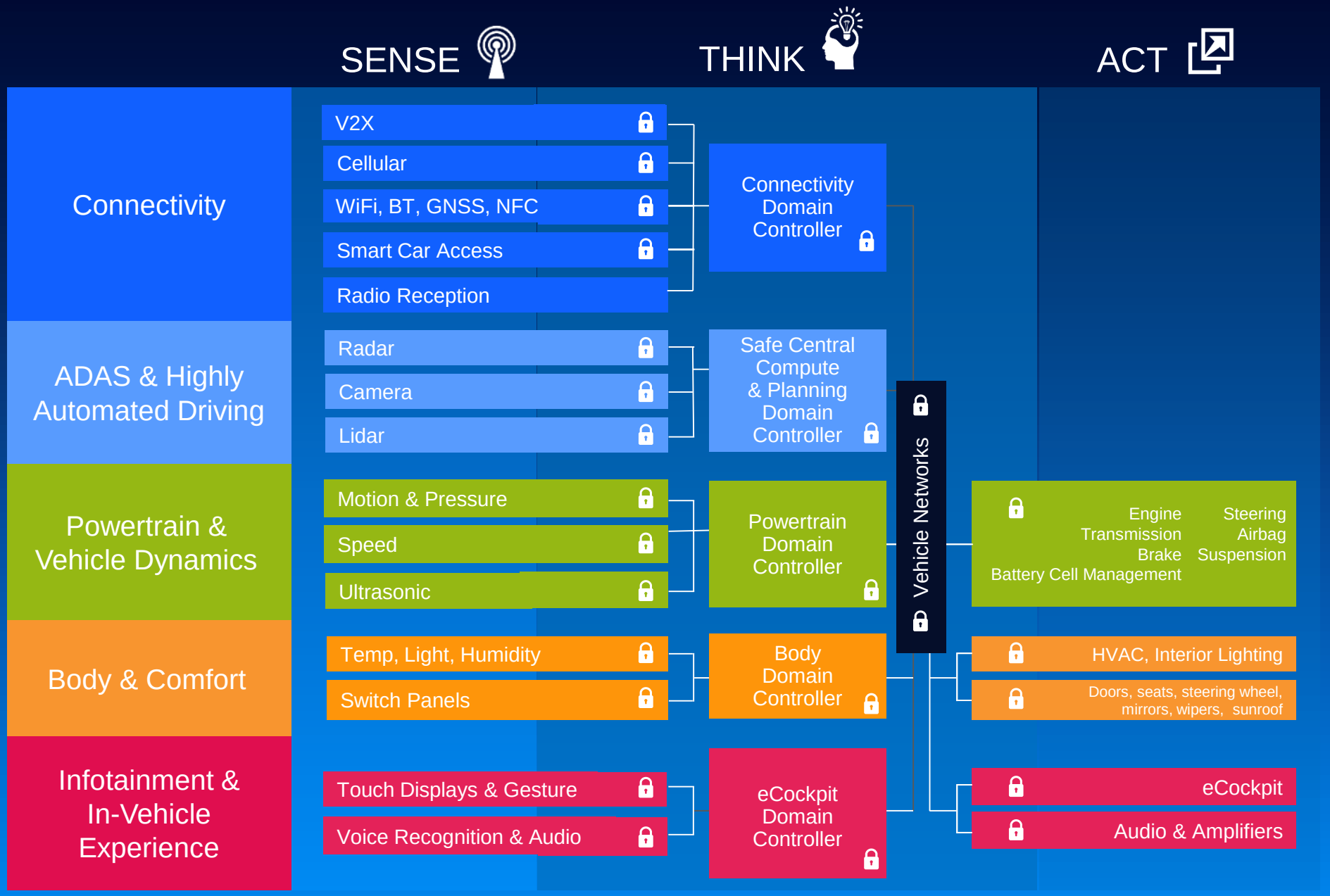
Vehicle Networking

- Connectivity
- ADAS & Highly Automated Driving
- Powertrain & Vehicle Dynamics
- Body & Comfort
- Infotainment & In-Vehicle Experience

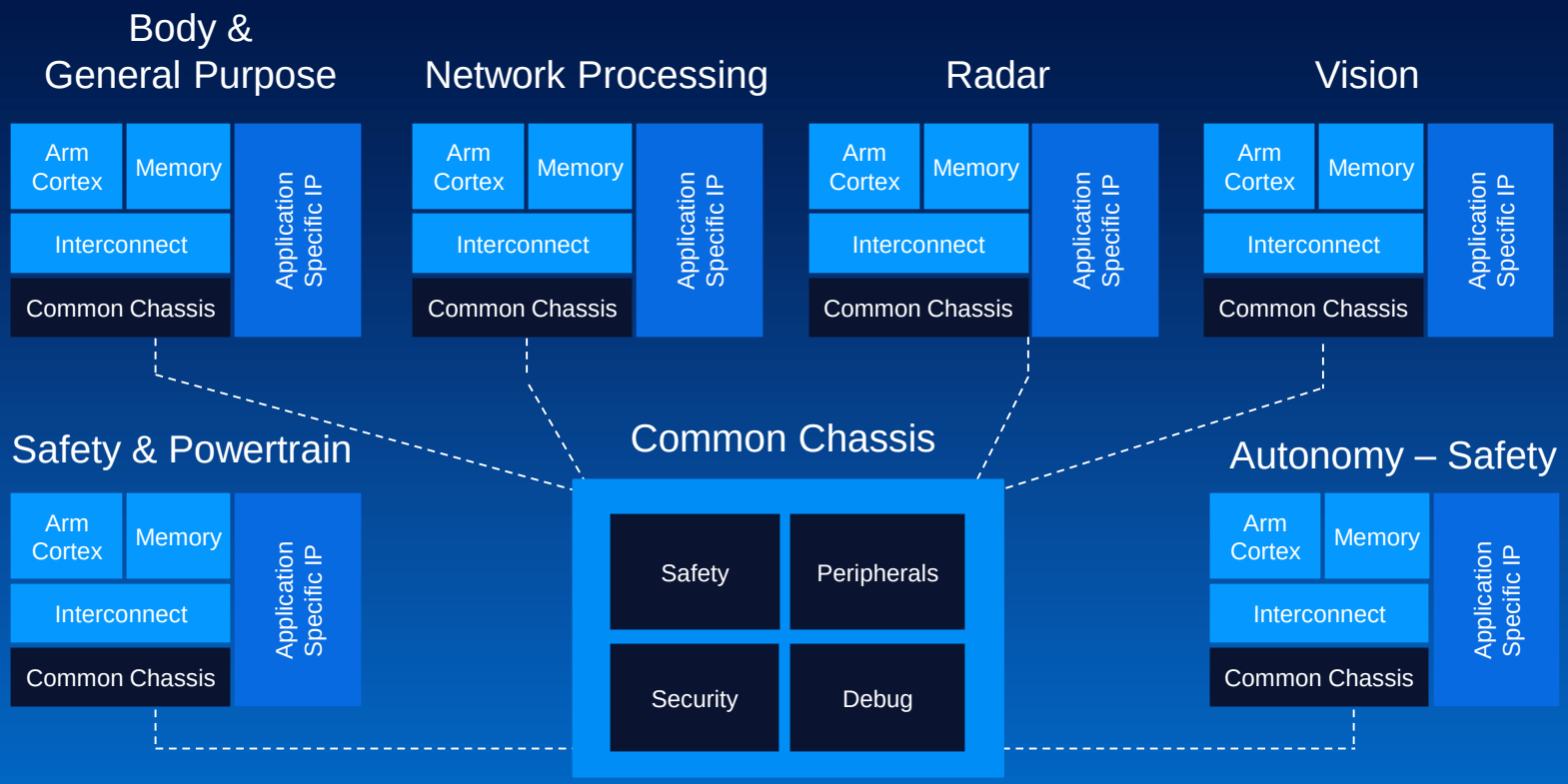


Domain Architecture

- Domain MPUs
- Edge Nodes & Sensors
- High Bandwidth
- Gateway
- Safety & Security



Auto Processors Tomorrow – NXP's Unique S32 Platform



Reduces SW R&D[1] by 35%

Unified HW with identical SW environment

10x the Performance[2]

Multiple real time OS
ADAS AI accelerators

Safe and Secure

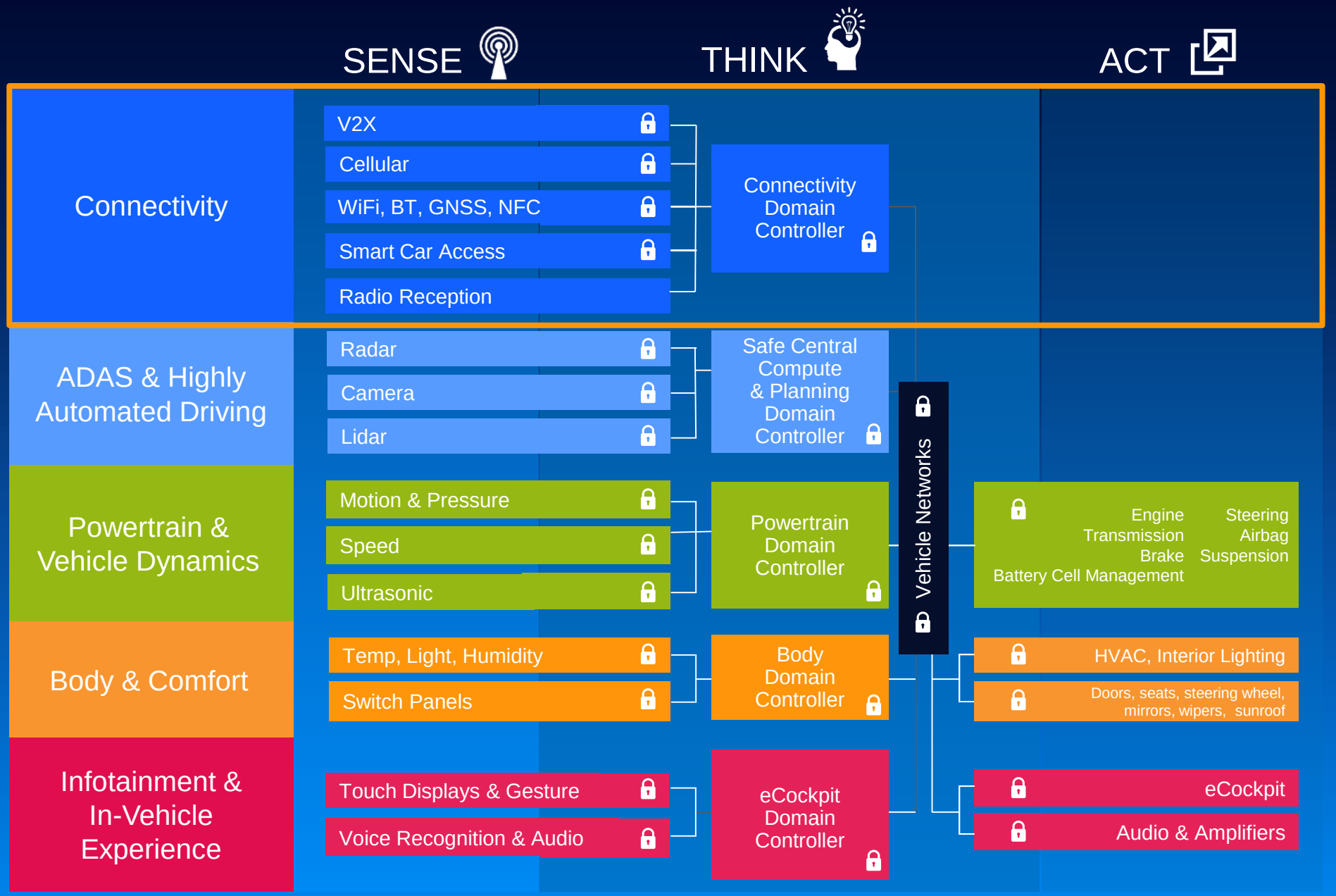
4 independent ASIL D paths
HW security engine
Ready for OTA

The World's First Fully Scalable Safe Auto Compute Platform

Unprecedented Design Win Pipeline ➔ 1.5x of Previous Generations

1. Based on analysis of existing NXP Software code in existing customers' applications
2. Based on publicly available competitor roadmap performance statements versus today's best safe auto platform

Connectivity


SENSE
THINK
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Connectivity
V2X
Cellular
WiFi, BT, GNSS, NFC
Smart Car Access
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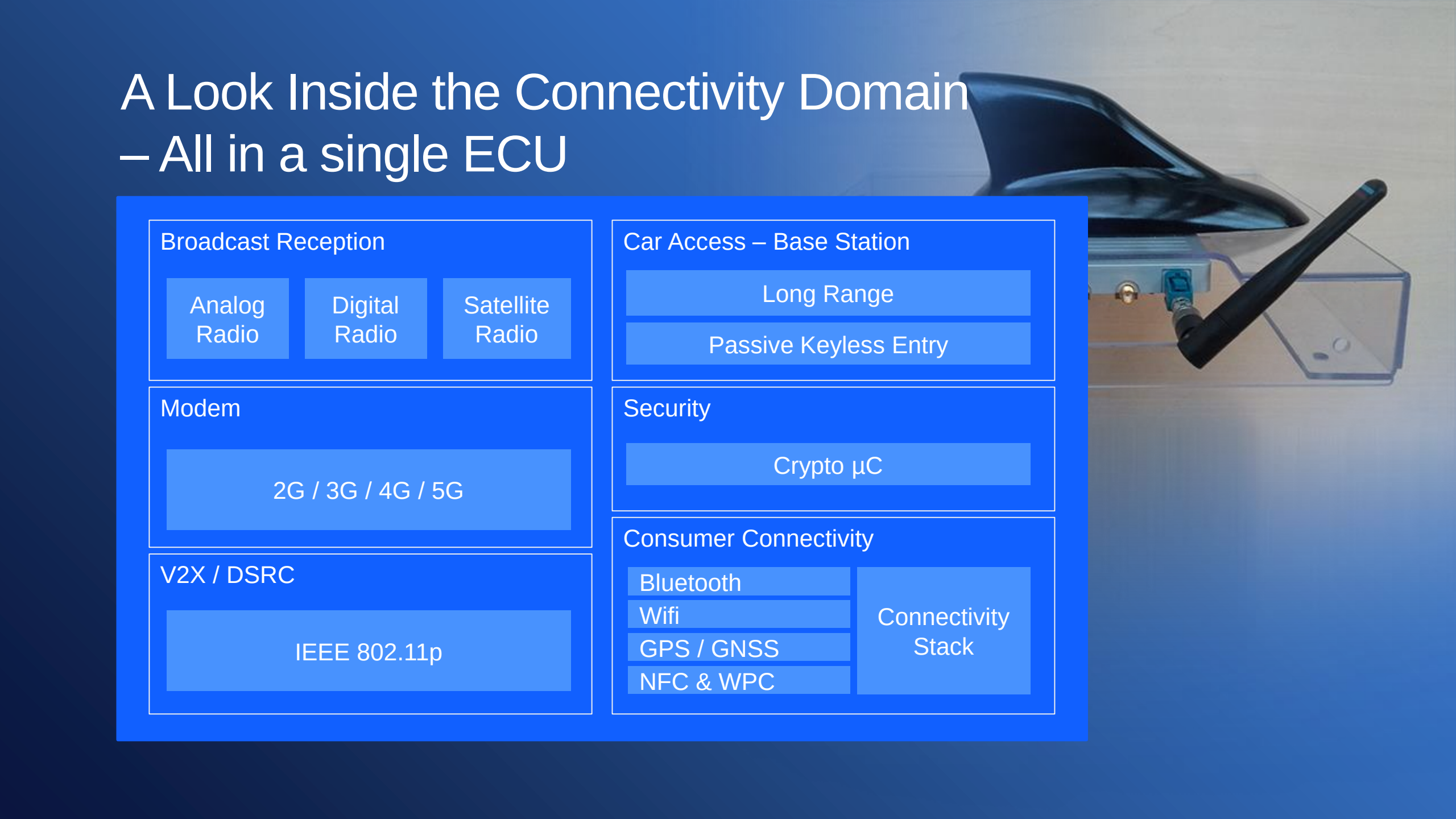
HVAC, Interior Lighting
Doors, seats, steering wheel, mirrors, wipers, sunroof
Infotainment & In-Vehicle Experience
Touch Displays & Gesture
Voice Recognition & Audio
eCockpit Domain Controller
eCockpit
Audio & Amplifiers

A Look Inside the Connectivity Domain – All in a single ECU



Broadcast Reception

- Analog Radio
- Digital Radio
- Satellite Radio

Modem

- 2G / 3G / 4G / 5G

V2X / DSRC

- IEEE 802.11p

Car Access – Base Station

- Long Range
- Passive Keyless Entry

Security

- Crypto µC

Consumer Connectivity

- Bluetooth
- Wifi
- GPS / GNSS
- NFC & WPC

Connectivity Stack

Secure **V2X** Sensors

Seeing around Corners

Sees objects up to 1km, around corners

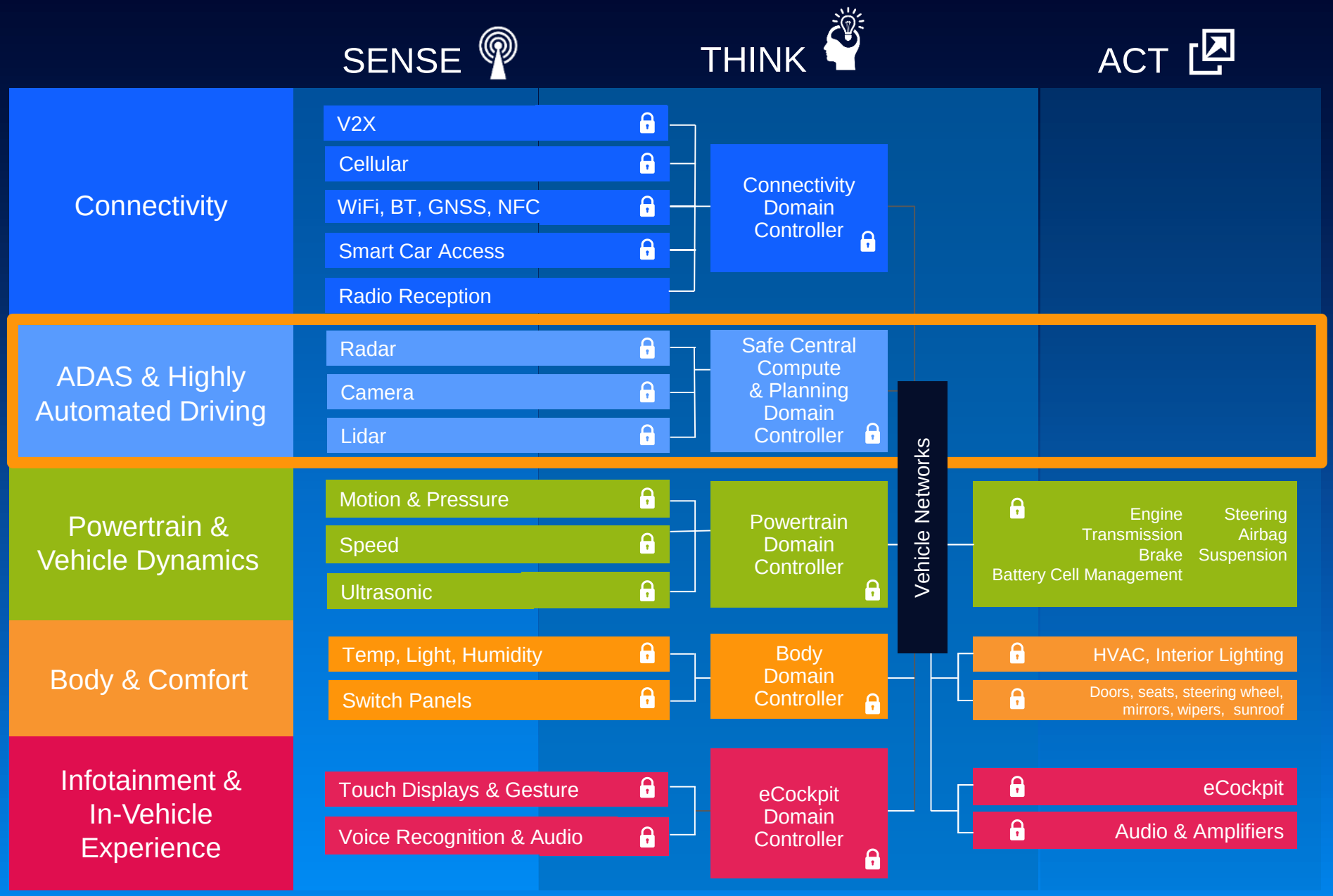
Proven IEEE 802.11p standards

Highest security

Scalable architecture

NXP RoadLINK
In volume production
1st to market with secure 1-chip modem

ADAS & Highly Automated Driving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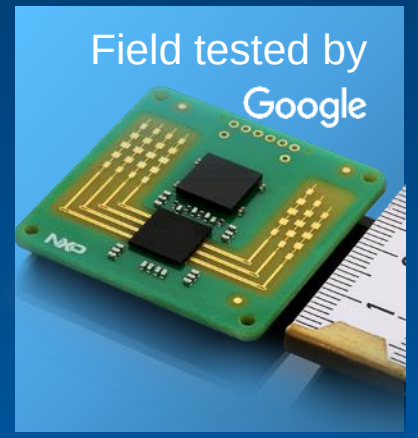
Radar

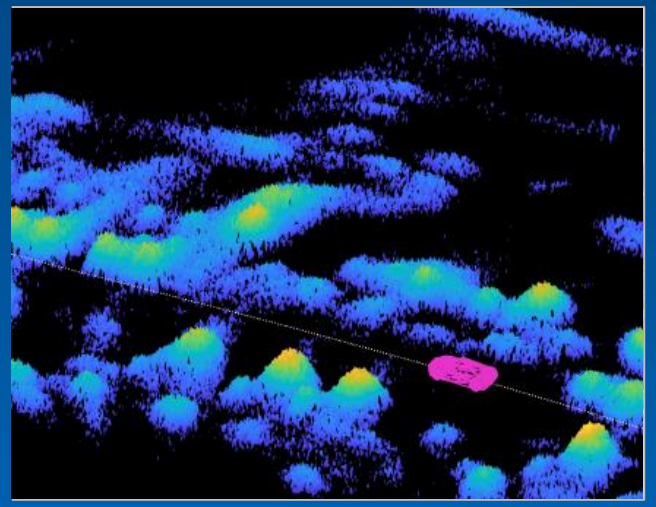
Evolves to 360° view with high-performance integration



Enabling A/D Perception & Sensing Requirements in Radar

Detection & Tracking

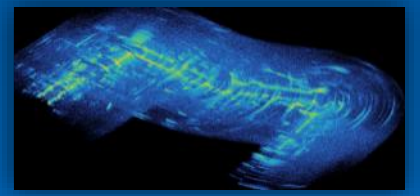
Resolve cluttered, hidden objects & track directionality



Mapping

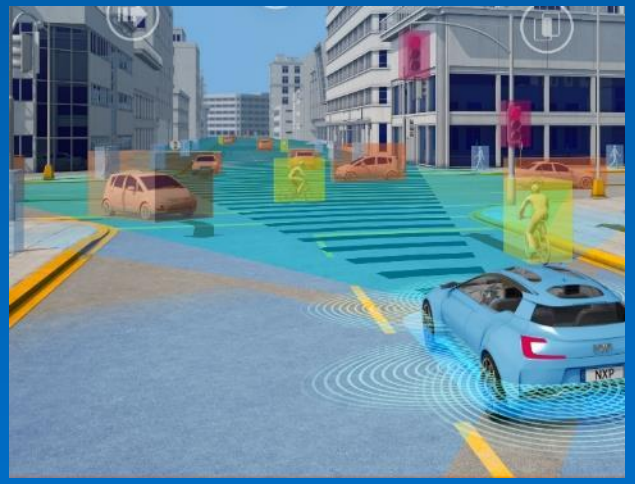
Static and Dynamic Object & Free Space detection (L4 functions)

3D Shapes (images) with classification (Deep Learning)



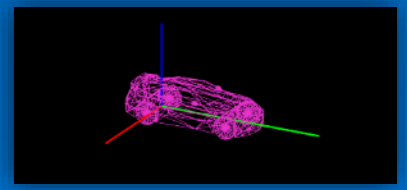
Classification & Segmentation

Pedestrians, Cars, Trucks, Motorcycles



Localization

Ego motion and pin-point position via map correlation or SLAM



SOP 2021

for L3-4 vehicles

High-performance **Vision** Sensors

Improve Safety on the Road

Front View

Surround View

Driver Monitor

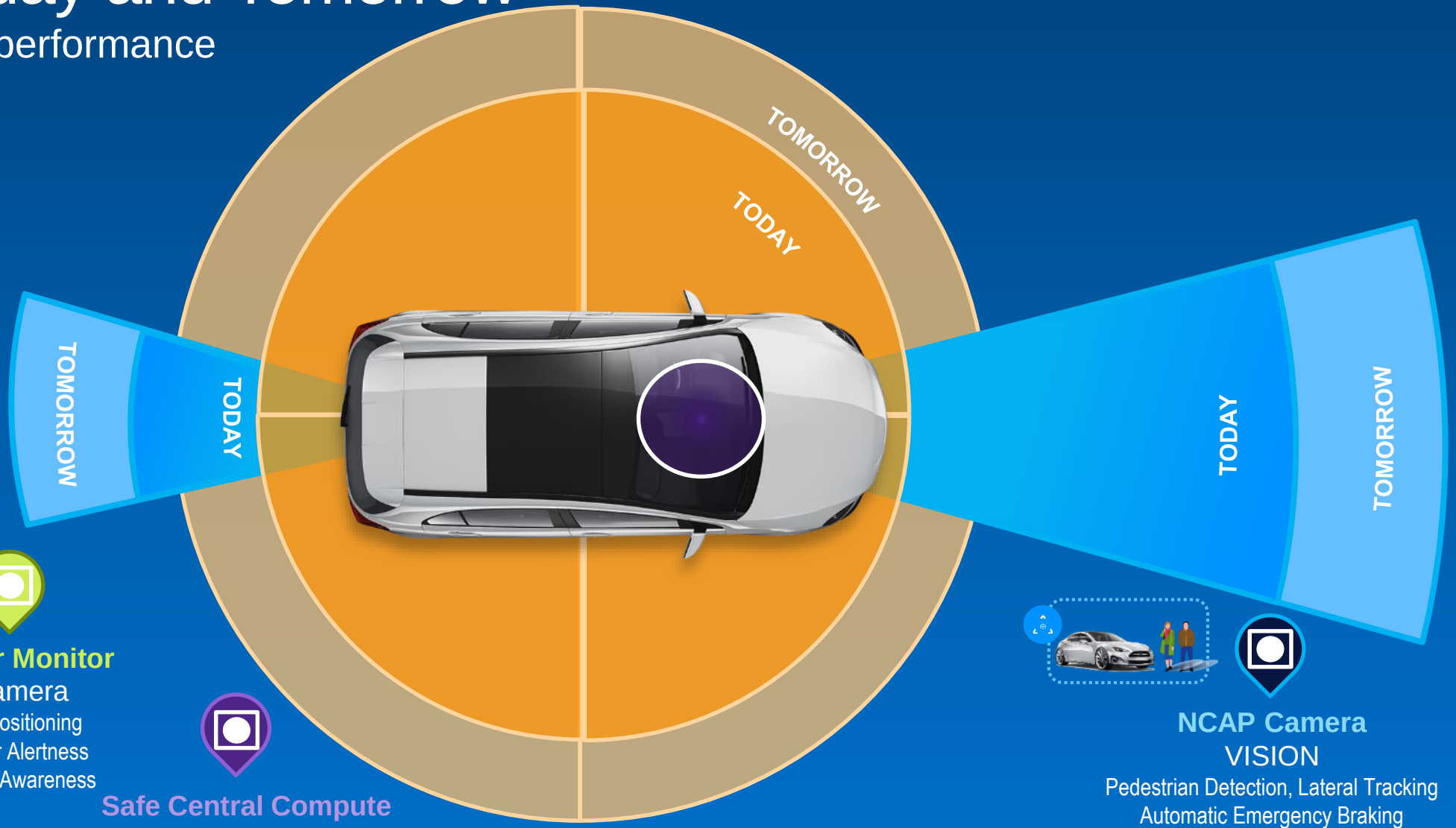
Perception

NXP S32V

Supports demand for
open, safe, scalable solutions, and AI

Vision Today and Tomorrow

Market leading performance



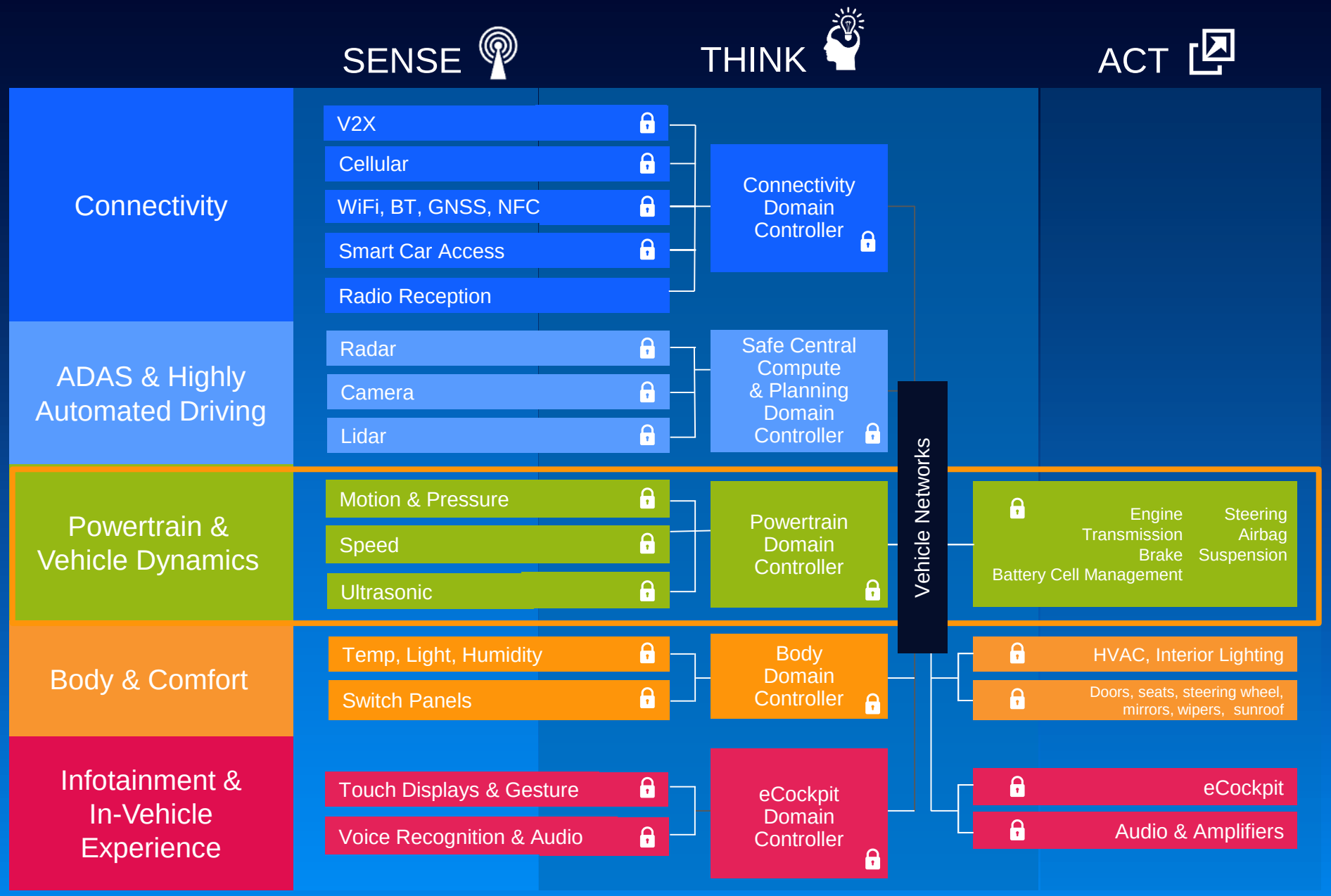
Surround View
VISION
3D Segmentation
Highway Autopilot Assist
Park Assist
Pedestrian Detection

Driver Monitor
Camera
3D Positioning
Driver Alertness
Driver Awareness

Safe Central Compute
Camera / RADAR
Safe Decision Making

NCAP Camera
VISION
Pedestrian Detection, Lateral Tracking
Automatic Emergency Braking
Collision Avoidance
Rear View

Powertrain & Vehicle Dynamics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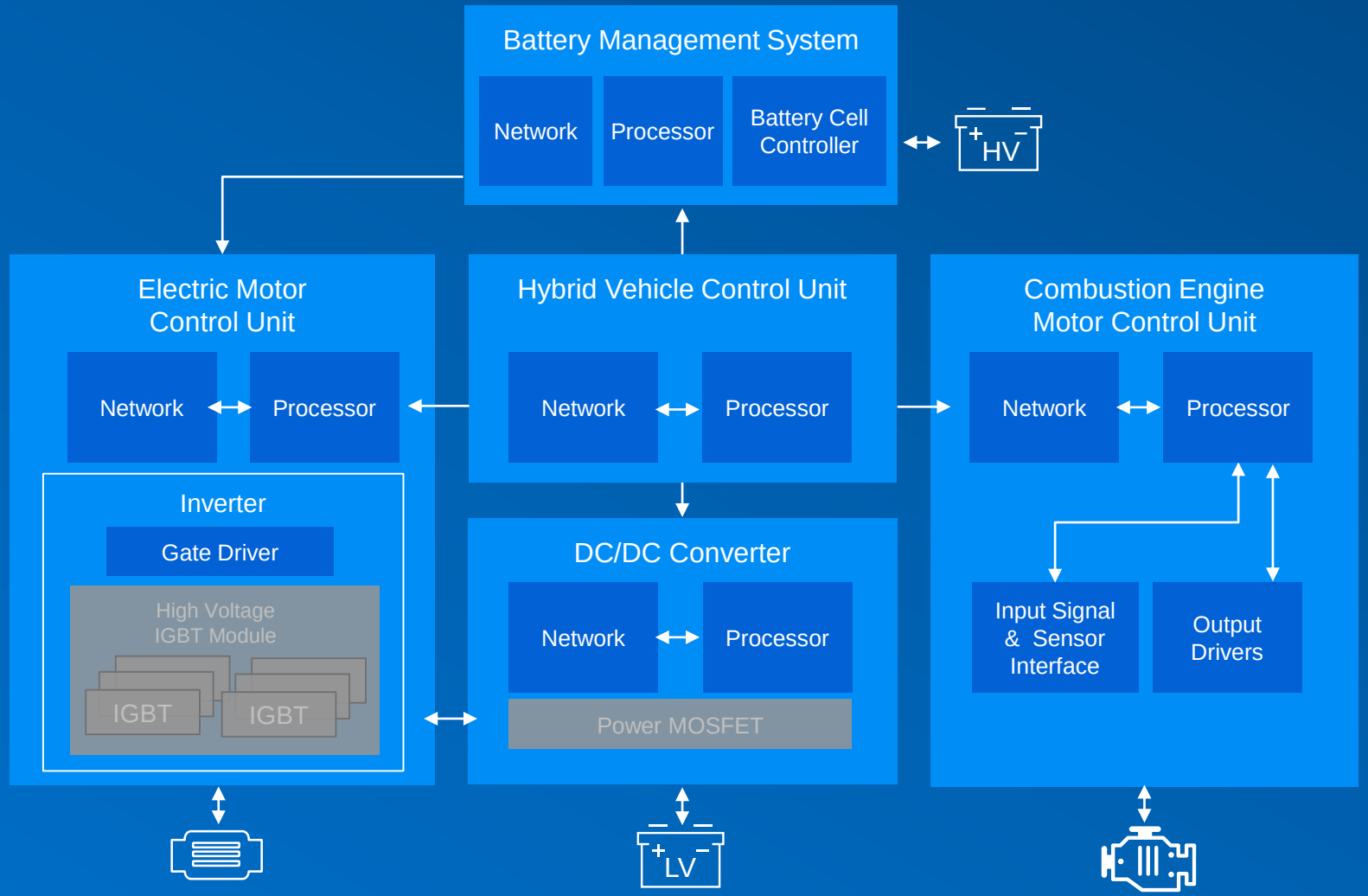
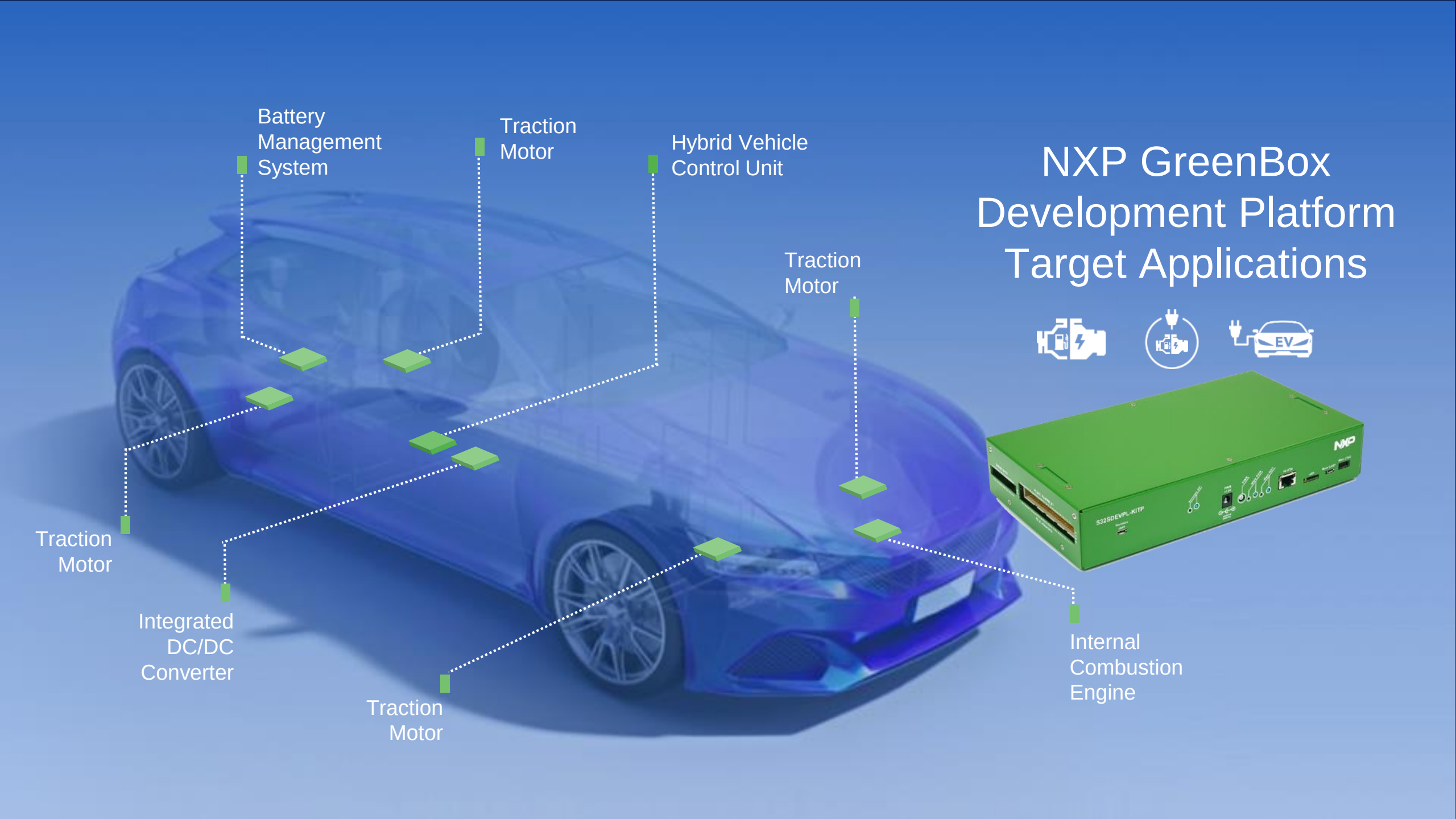
NXP Provides Leading Powertrain Control Solutions

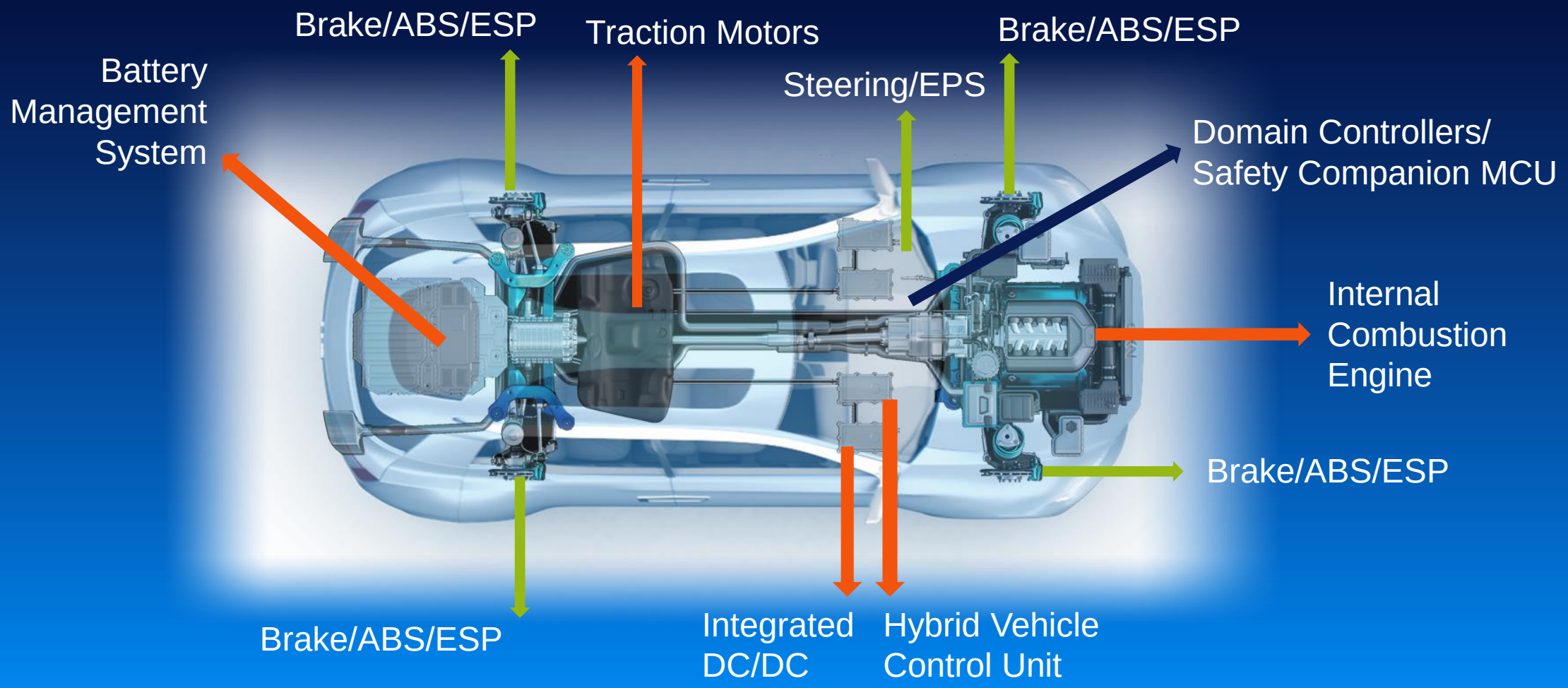
System optimized, scalable, secure and safe



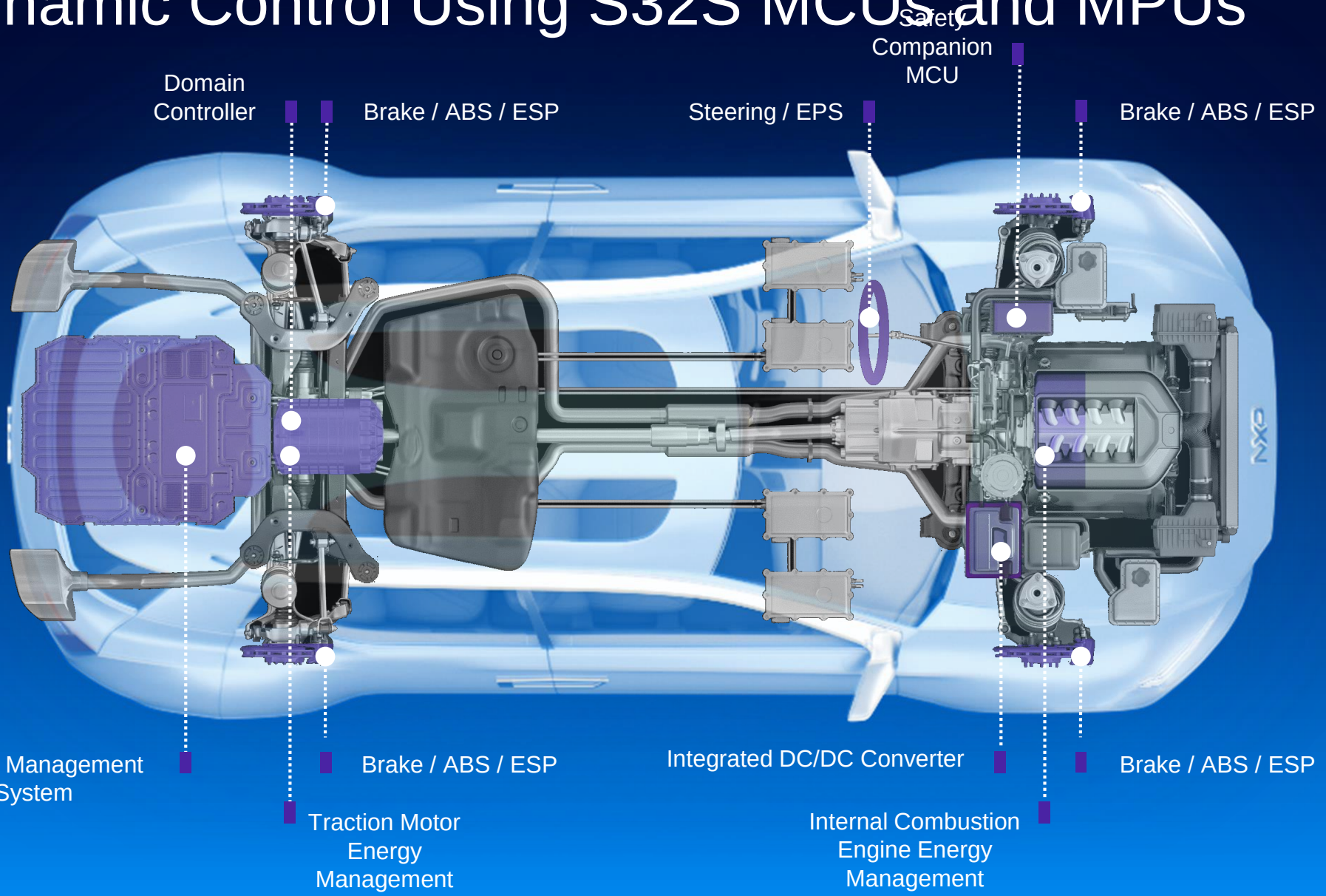
NXP GreenBox Development Platform Target Applications



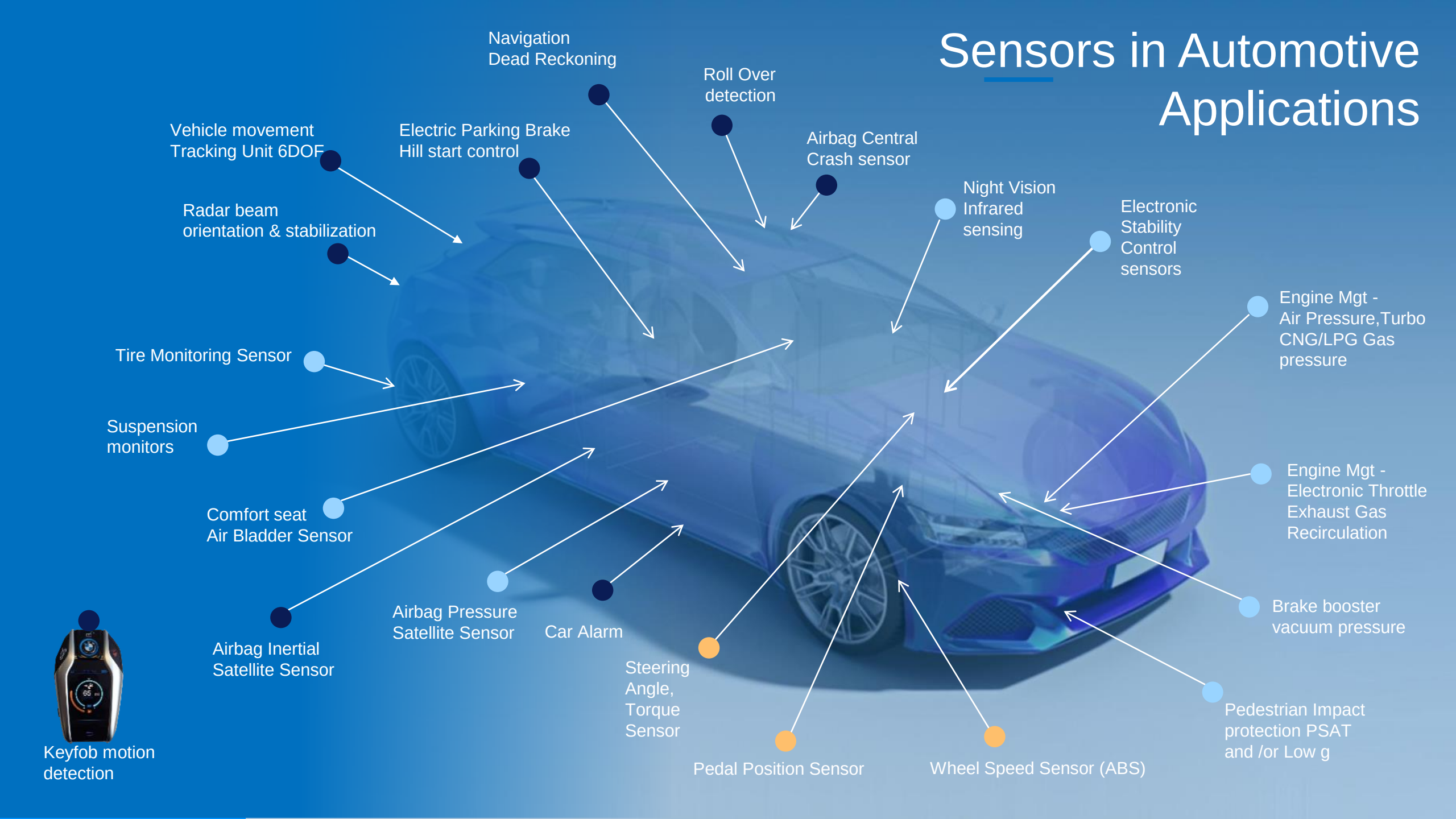
Vehicle Dynamics “Start, Stop and Steer”



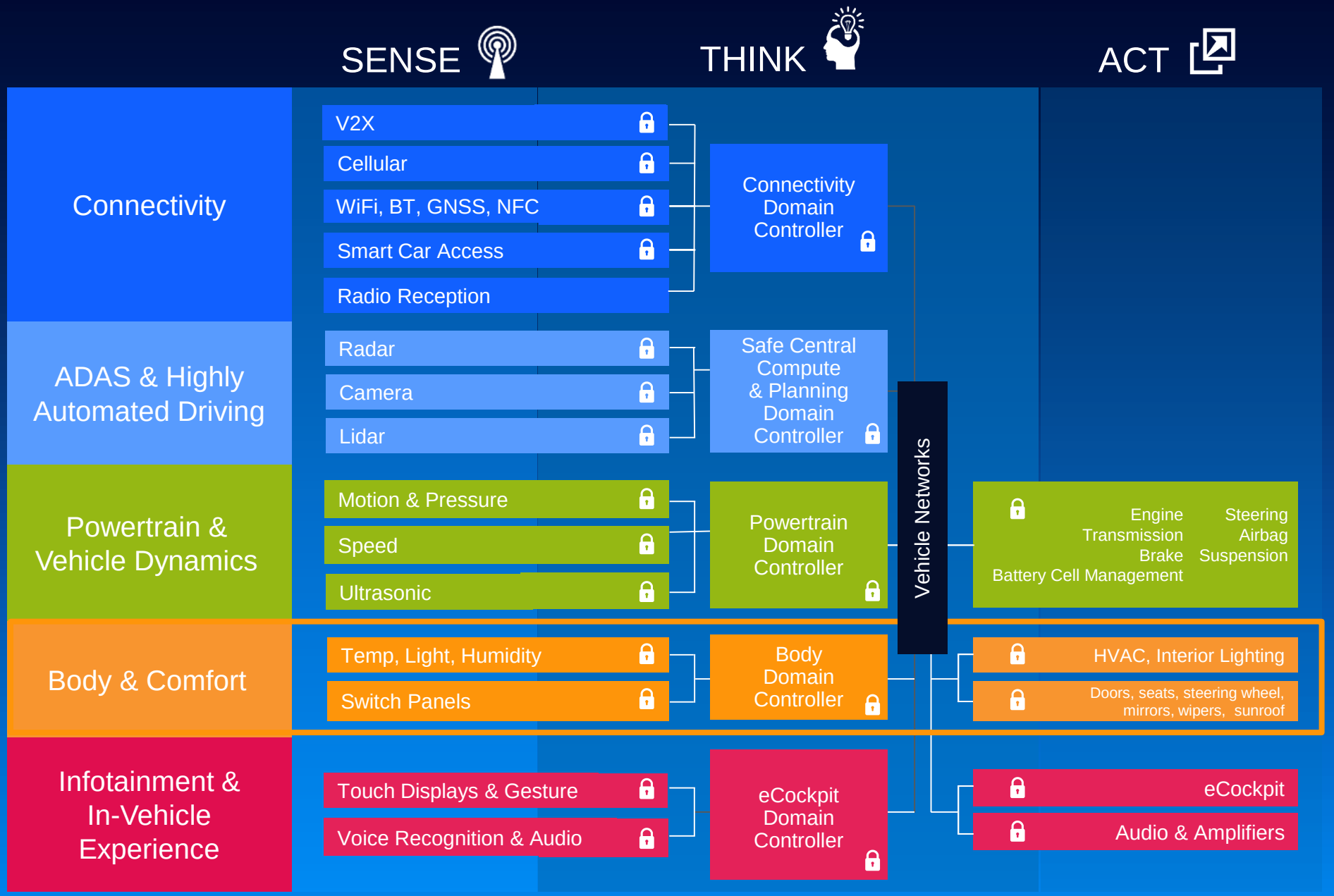
Safe Dynamic Control Using S32S MCUs and MPUs



Sensors in Automotive Applications



Body & Comfort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MagniV – Applications

SENSE **Sensor Interface** | **Motor Control** ACT

Alarm sensors
Ultrasonic sensors
Rain / light sensor
Particle sensor
NOx sensor
Urea sensor

Airmass sensor
Air quality sensor

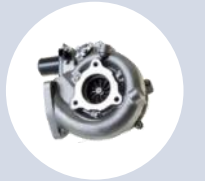
Passenger occupancy detection

Steering wheel sensors
(touch / hands off)

Convertible or sliding roof
Door closing
Seat, headrest control
Mirror adjustment
Steering wheel adjustment
Steering column lock
Starter / alternator
Water pump engine cooling
Engine cooling fan
Headlight cleaning,
levelling

Oil pump
ABS pump
Parking break
Window lifter
Seatbelt system
Tailgate closing

Throttle valve
HVAC water pump



Infotainment & In-Vehicle Experience

Infotainment & In-vehicle Experience

- Cockpit
- Multimedia
- Media Source
- Radio
- Audio

Connected Infotainment:
Key Differentiator & Sales Driver for OEMs

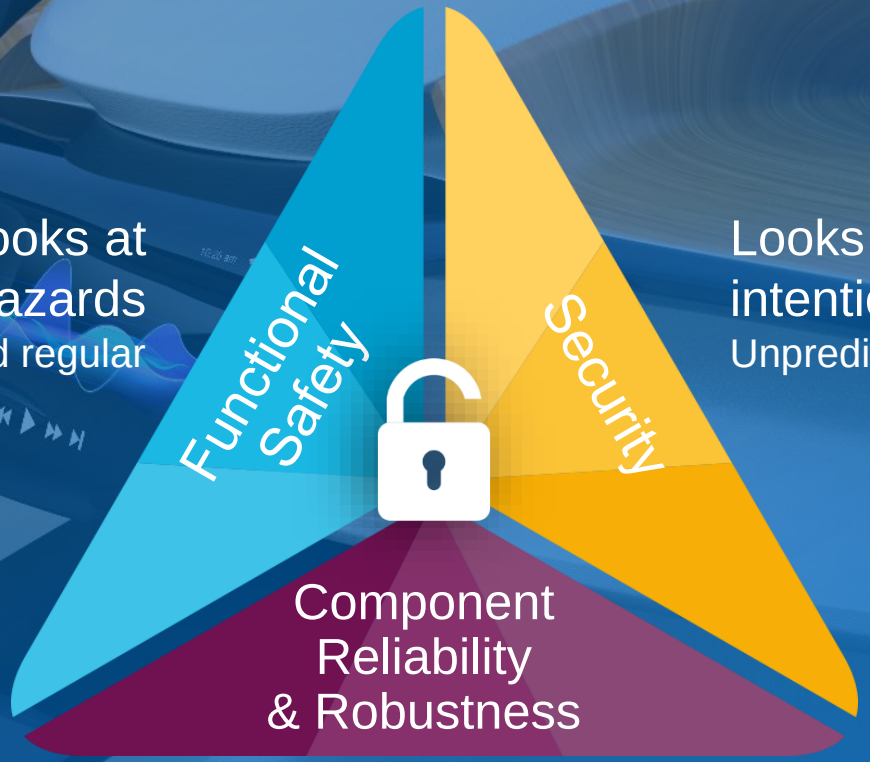
Cockpit	Full digital eCockpit
Multimedia	Multiple high resolution displays
Media Source	Smartphone content, apps & services
Radio	Digital radio & regional standards
Audio	Noise cancellation, engine sound …

Safety & Security

System Development Unlocks NXP's Value Propositions

Functional Safety and Security

Looks at
unintentional hazards
Predictable and regular



Looks at
intentional hazards
Unpredictable and irregular

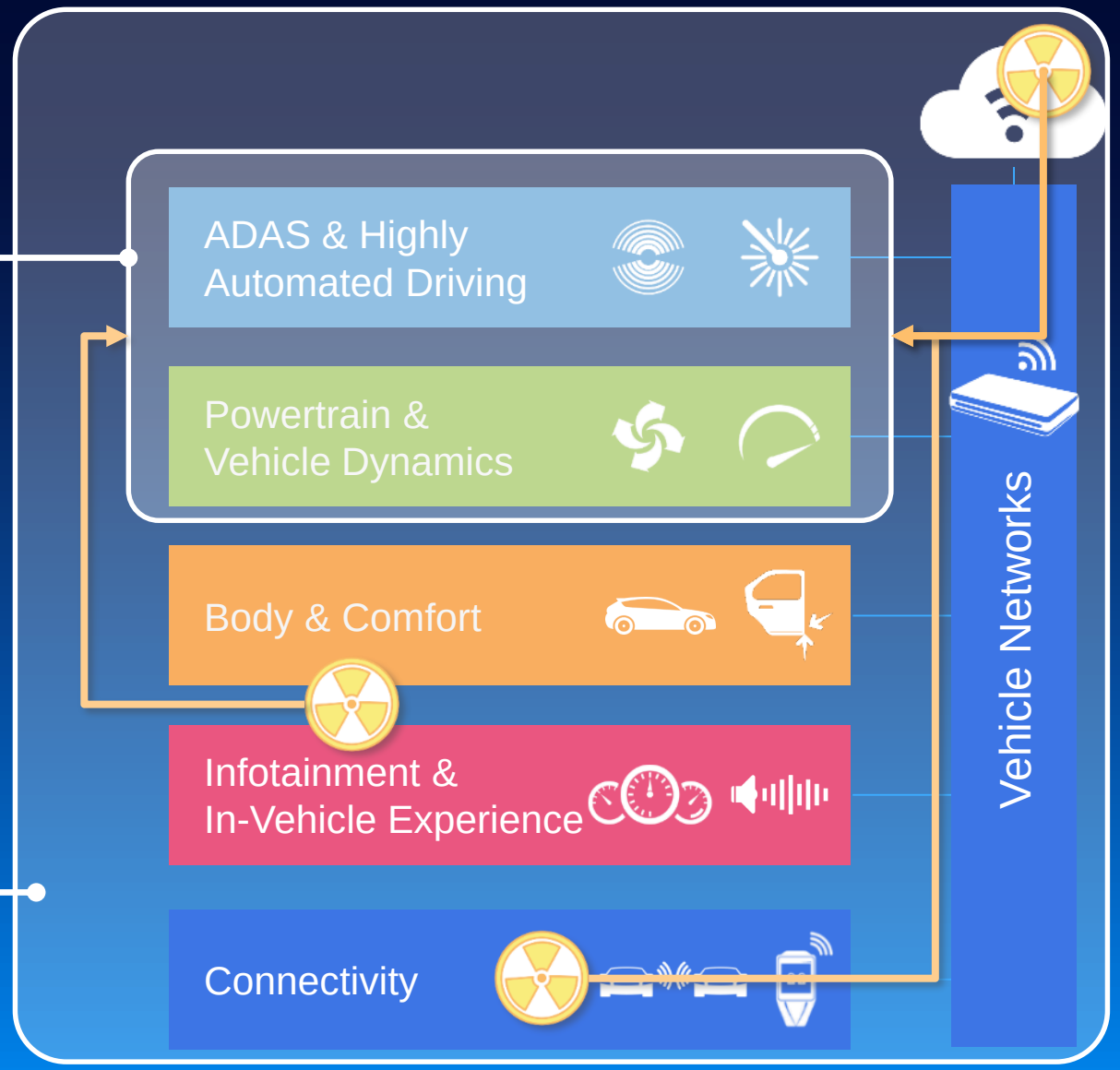
Maximum quality of components is mandatory for high-value system

Safety & Security Go Together

#1 Objective: no functional hazards
on mission-critical ECUs

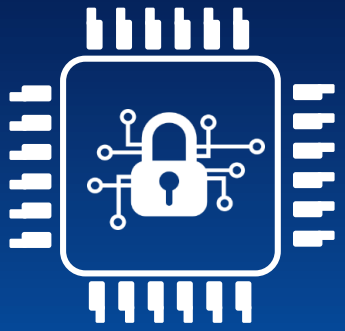
Only possible, if:
System availability ensured
Information received / processed trustworthy

Cyber-security is a prerequisite for
availability and trust in the system



Functional Safety & Security – System-Level Concerns

IC-LEVEL SAFETY & SECURITY SOLUTIONS



- Resource isolation
- On-die monitoring
- Integrity & authenticity checks

+

SAFE & SECURE DOMAIN ARCHITECTURES

- Domain isolation
- Firewalls
- Network intrusion detection

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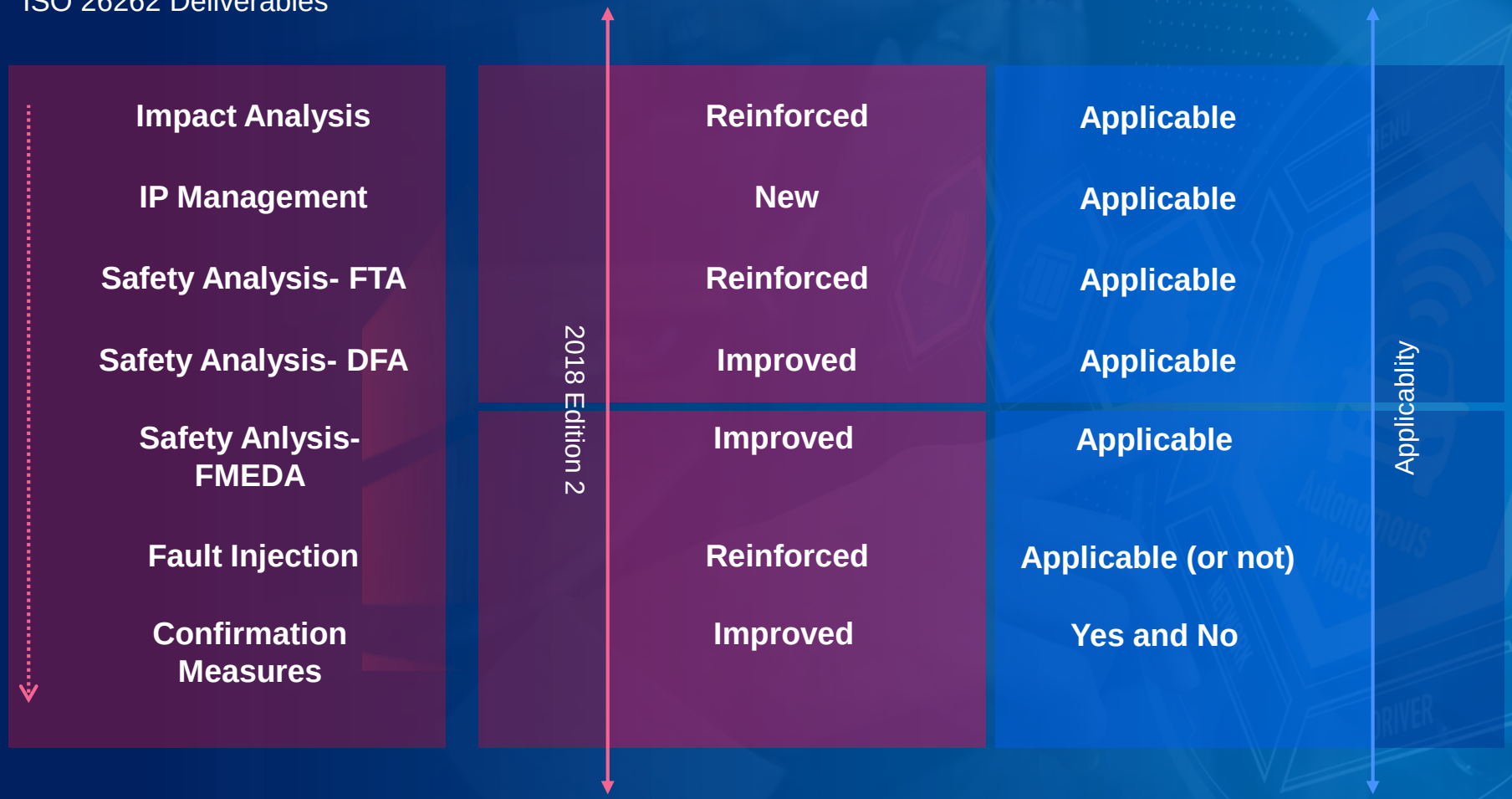
SAFE AND SECURE MOBILITY

- Fail operational
- Resilient against cyber attacks

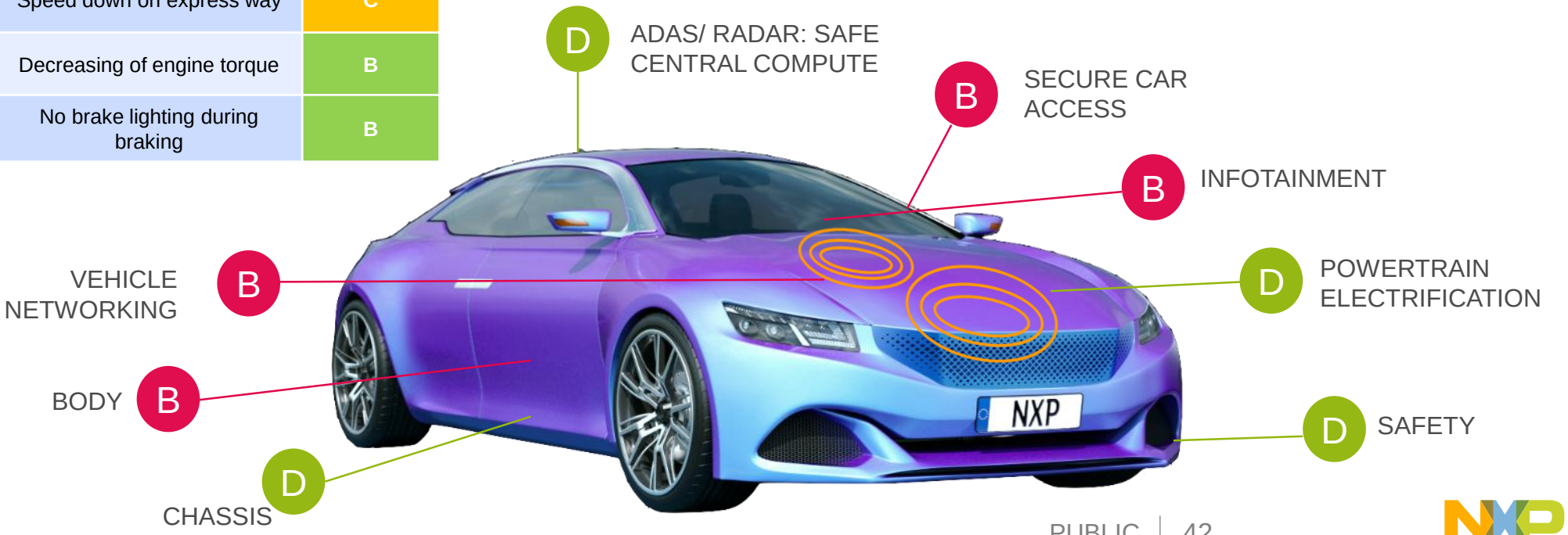
ISO 26262 : 2018 Part 11 – What's New and Already Applicable

ISO 26262 Deliverables



ASIL Level Examples For Different Solutions

Domain	Application	Hazardous Event (example)	ASIL
Active safety	Central Fusion	Inadvertent hard braking during driving	D
Passive Safety	AIRBAG	Inadvertent deployment during driving	D
Chassis	EPS	Self steer during driving	D
	Stability control	One wheel lock during driving	D
	ABS	One wheel lock during hard braking	C
HEV/EV	Motor control	Sudden Torque Up/Down	C
Power Train	Transmission	Speed down on express way	C
	Engine control	Decreasing of engine torque	B
Body	Brake Lamp	No brake lighting during braking	B



Examples Of a System Dreaded Event and ASIL Levels

ADAS Sensor

Phantom detection

ASIL B

Battery Management

Fire

ASIL C

Power Steering

Auto steering, lock, loss

ASIL D

NXP's Safe Assure Program

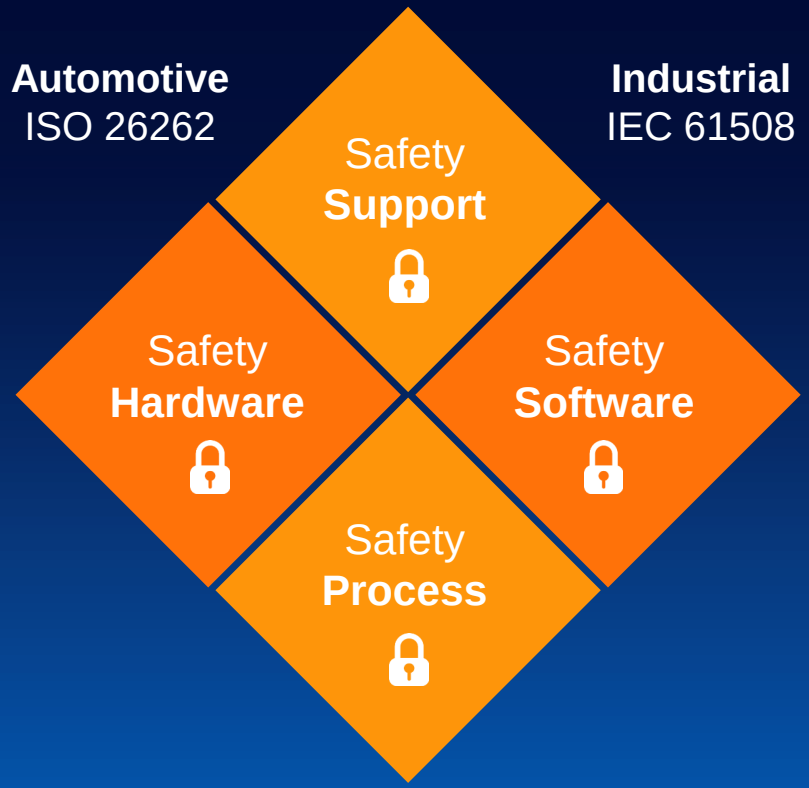
Simplify Customer Experience
ISO26262 system compliance process

Optimize Customer R&D Efficiency
Reduces time and complexity required to develop ISO26262 safety systems

Reduce Risk of Harm
Supports the most stringent Automotive Safety Integrity Levels (ASILs)

Safety Starts with Quality
Zero defect methodology from design to manufacturing to help ensure our products meet the stringent demands of safety applications

Functional Safety Standards



NXP Quality Foundation

SAFE ASSURE by NXP

Proven History in Driving Security

Mid 1990s
- Censorship
- Immobilizers

Early 2000s
- Enhanced Censorship
- Remote Keyless Entry

Mid 2000s
- High Assurance Boot & Fault Detection Sensors
- Passive Keyless Entry

Late 2000s
- Crypto Services Engine (SHE), Active Shields
- Keyless Entry RF Transceivers

2010s +
- Hardware Security Module (HSM)
- Secure Elements (SE)
- Gateway, CAN security
- NFC-based Smart Access

#1 eGovernment

#1 Bank Cards

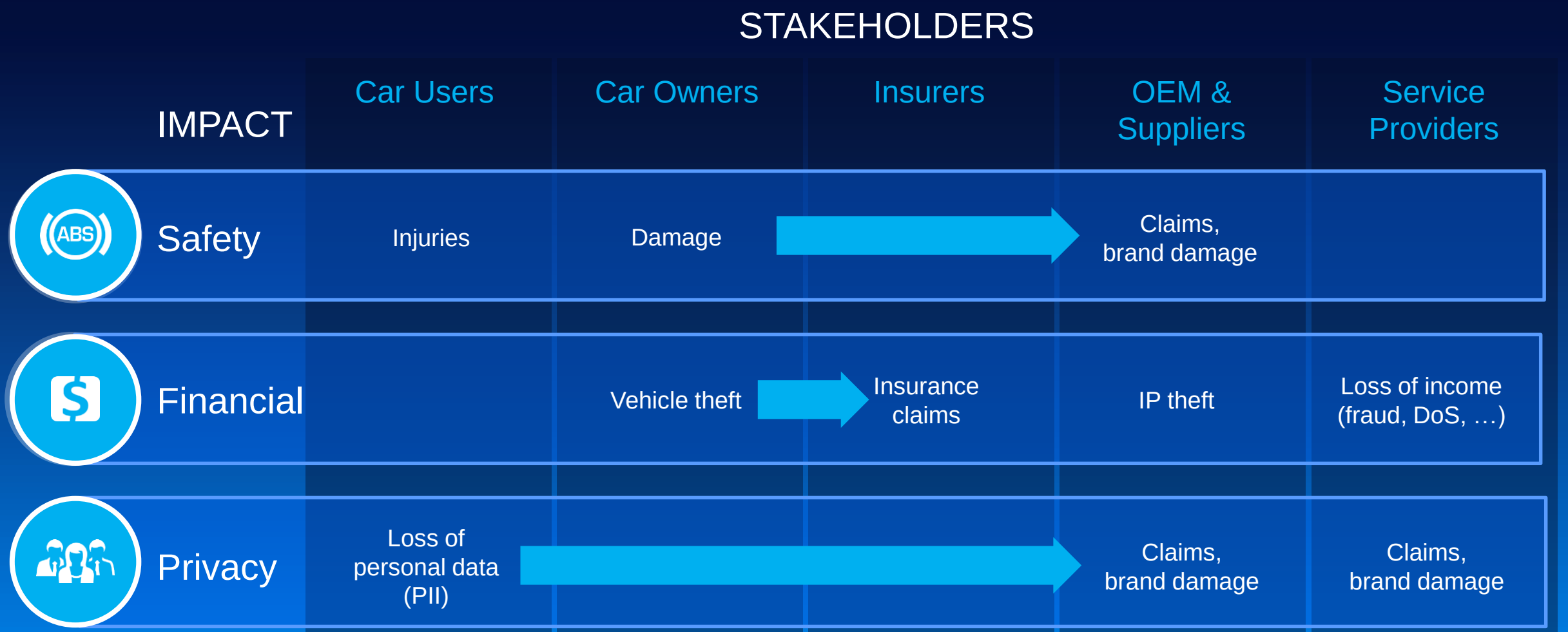
#1 Smart Mobility (MIFARE) Cards

#1 Tags & Authentication

#1 Readers

#1 Mobile

What is at Risk and who is Affected?



NXP's Automotive Security Solutions

Automotive ICs with... …on-chip security subsystems

- Infotainment & In-Vehicle Experience
- Connectivity
- ADAS & Highly Automated Driving
- Vehicle Networking
- Powertrain & Vehicle Dynamics
- Body & Comfort

i.MX8

- Security Controller (SECO)
  - High performance
  - Media content protection

Layerscape

- Security Engine (SEC)

S32x & MPC57xx

- HSE (HSM)
  - High performance
  - Versatile feature set
- CSE
  - Ease-of-use
  - Cost-optimized

Security companions

- Secure Element (SE)
  - Tamper-resistant secure system ideal for M2M authentication (e.g. V2X)

Function-specific secure ICs

- Secure CAN Transceiver (TJA115x)
  - For enhanced IDS & IPS
- Secure Ethernet Switch (SJA1110)
  - Network frame analysis (L2/L3/L4)
- Secure Car Access ICs
  - For advanced RKE / PKE solutions
- V2X DSRC Baseband (SAF5x00)
  - Ultra-fast ECDSA verifications

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SECURE CONNECTIONS
FOR A SMARTER WORLD

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