S32G3 AND THE ROLE OF THE SOFTWARE-DEFINED VEHICLE COMPUTER

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SECURE CONNECTIONS FOR A SMARTER WORLD

IN THIS SESSION YOU WILL LEARN ABOUT:

- The Central Compute Architecture for Software-defined Vehicles
- Cornerstones of the Vehicle computer:
  1. Vehicle Data Intelligence
  2. Vehicle Communications
  3. Vehicle Security
- S32G3, GoldVIP & partners enabling vehicle computer

CONNECTED VEHICLE ENABLES INNOVATIONS IN AUTONOMY AND ELECTRIFICATION

DevOps, Digital Twins, Machine Learning, Cloud Services, Cloud Storage...

CLOUD

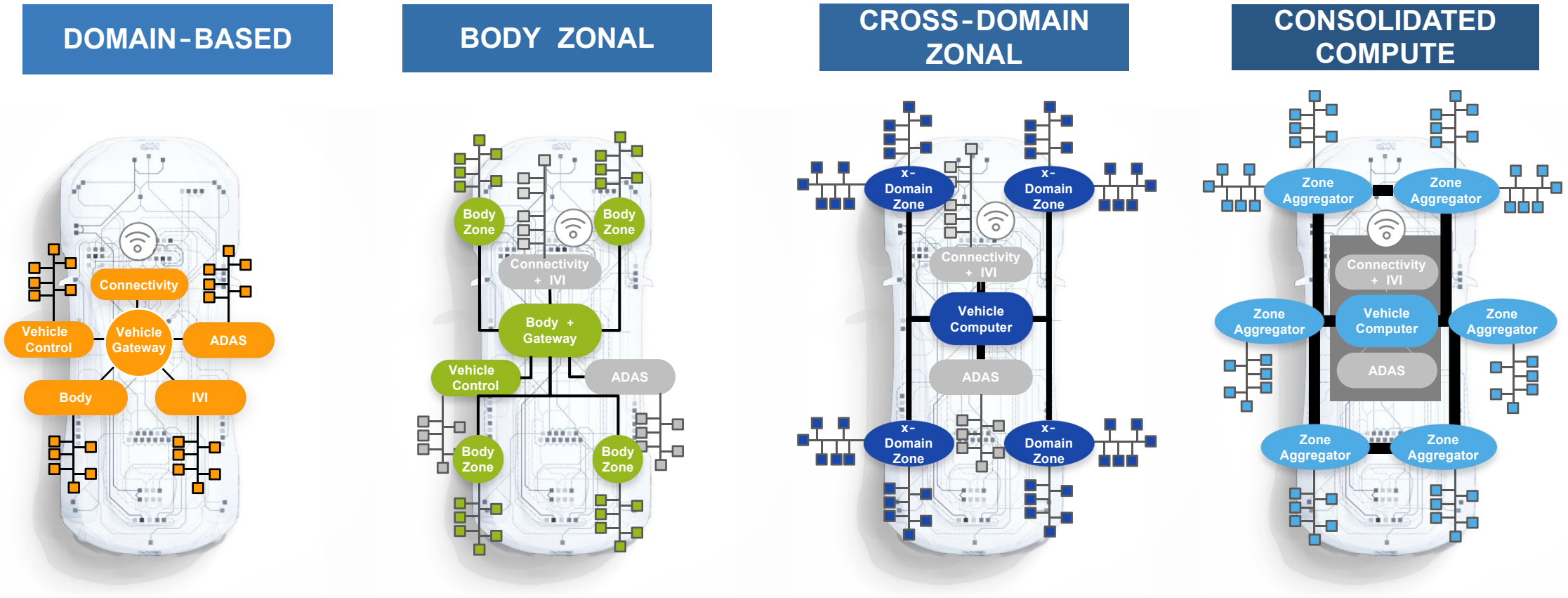
Vehicle Data ↕ Over-the-Air (OTA) Services

Autonomous ↔ Connected ↔ Electric

Vehicle data-driven insights used to drive digital twins, improve algorithms and machine learning models deployed via Over-the-Air (OTA) updates through the life of vehicles

Vehicles get more intelligent over time –
safer, more secure, higher efficiency, improved experiences...

MULTIPLE PATHS TO SOFTWARE-DEFINED VEHICLES
VEHICLE E/E ARCHITECTURES

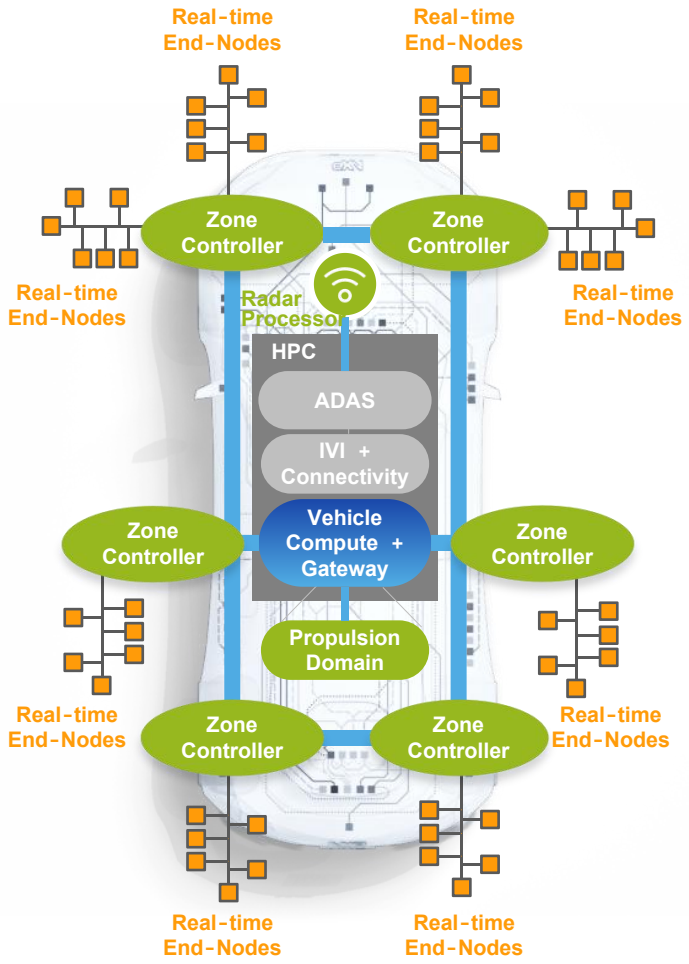


NXP Semiconductors, 2023

NXP solutions support global carmakers' unique architectures and diverse compute requirements.

NXP S32 DIVERSE COMPUTE PLATFORM FOR SOFTWARE-DEFINED VEHICLES

ESSENTIAL BUILDING BLOCKS FOR SAFE VEHICLE COMPUTING, SECURE NETWORKING AND DATA INTELLIGENCE INFRASTRUCTURE



Typical Vehicle Electronic Architecture (VEA)

High-Performance **Compute**
Service-oriented, **Soft** real-time
Low direct I/O control

Scalable & Flexible Diverse Processing Solutions

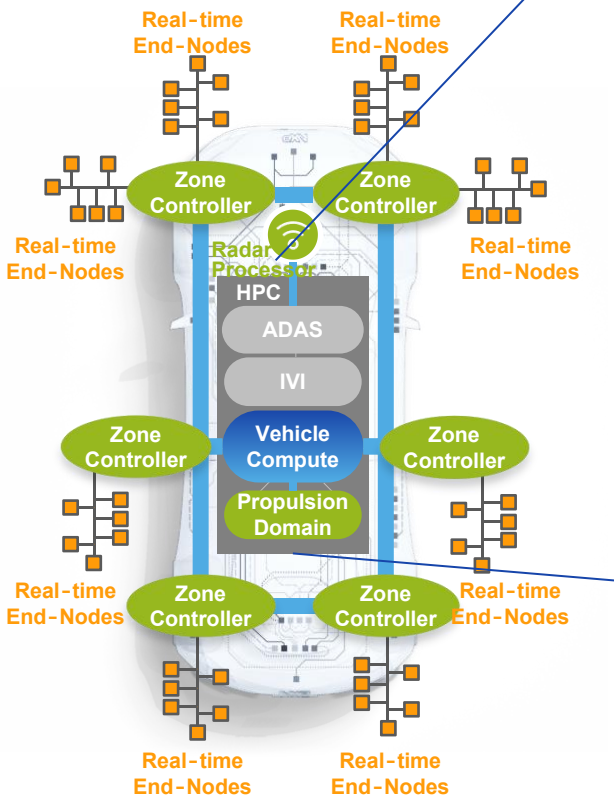
High-Performance **Control**
Signal-oriented, **Hard** real-time
High direct I/O control

Enablement Middleware / SDN / ECU Virtualization SW
ASIL D Safety / Strong Security Engine / Robust Isolation
Arm® Cortex® cores / Accelerators / Common Peripherals

S32G3 (5nm)	Central Vehicle Compute Processors
S32G2	Vehicle Network Processors
S32E	Electrification Real-Time Processors
S32Z	Zonal / Domain Real-Time Processors
S32R	Radar and 4D Imaging Radar Processors
S32K3	Zonal Control / End-Node MCUs

S32 Diverse Compute Platform

CENTRAL COMPUTE REQUIREMENTS



VEHICLE FUNCTIONS

AUTOMATED DRIVING + ADAS	VEHICLE RESOURCE MANAGER	VEHICLE MOTION
IN VEHICLE INFOTAINMENT	VEHICLE STATE CONTROL	VEHICLE ENERGY
USER APPLICATIONS (SDV)	VEHICLE HEALTH	BODY FUNCTIONS

VEHICLE INFRASTRUCTURE

- DATA INTELLIGENCE
- VEHICLE COMMUNICATIONS
- VEHICLE SECURITY

PROCESSING REQUIREMENTS

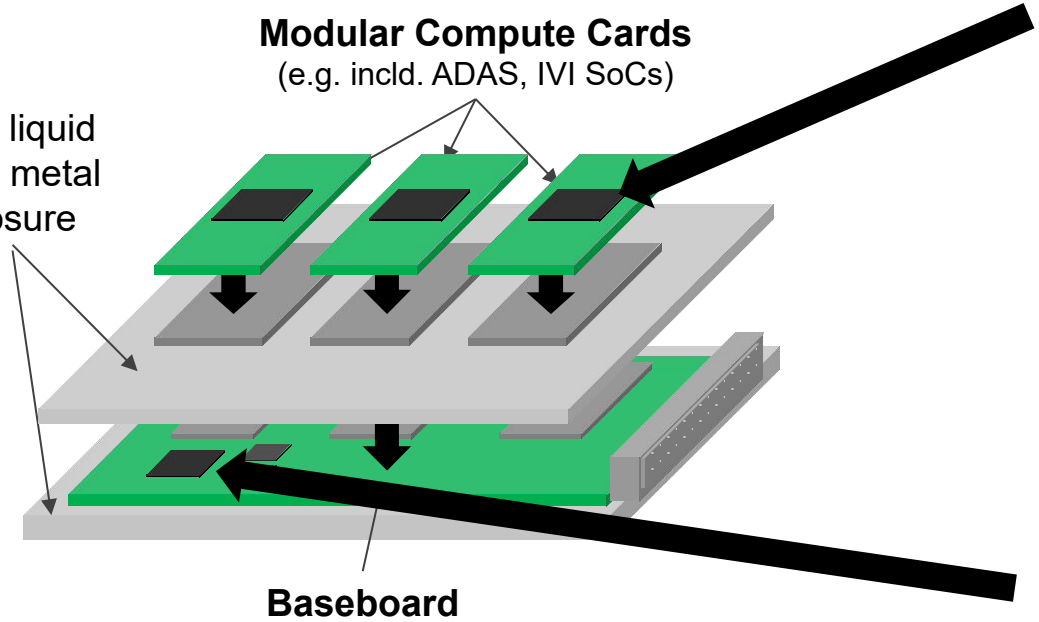
PERFORMANCE COMPUTE	HETEROGENEOUS COMPUTE	REAL-TIME COMPUTE
Upgradable	Fast Wakeup	Deterministic
Interchangeable	HL and RT OS	Real-Time Operating System
High Level Operating System	Isolation	Functional Safety
High Bandwidth Video Processing	Functional Safety	
	Secure Foundation	

The Vehicle Computer must:

- **Boot up fast** and take central responsibility for vehicle infrastructure
- Act the cornerstone for **Vehicle Security**
- Provide a **safety concept** built around robust **isolation** of secure, safe and performance and real-time partitions
- Redundancy for ADAS

MODULAR HPC APPROACH WITH A STABLE VEHICLE COMPUTE FOUNDATION

Central HPC ECU Design



High Performance Processing Modules

NATIVE COMPUTE
Upgradable
Interchangeable
HL OS

Vehicle Apps

Compute SoC

Software Defined Vehicle Computer

HETEROGENEOUS COMPUTE
Fast Wakeup
HL and RT OS
Isolation
Functional Safety
Secure Foundation

Dynamic partition

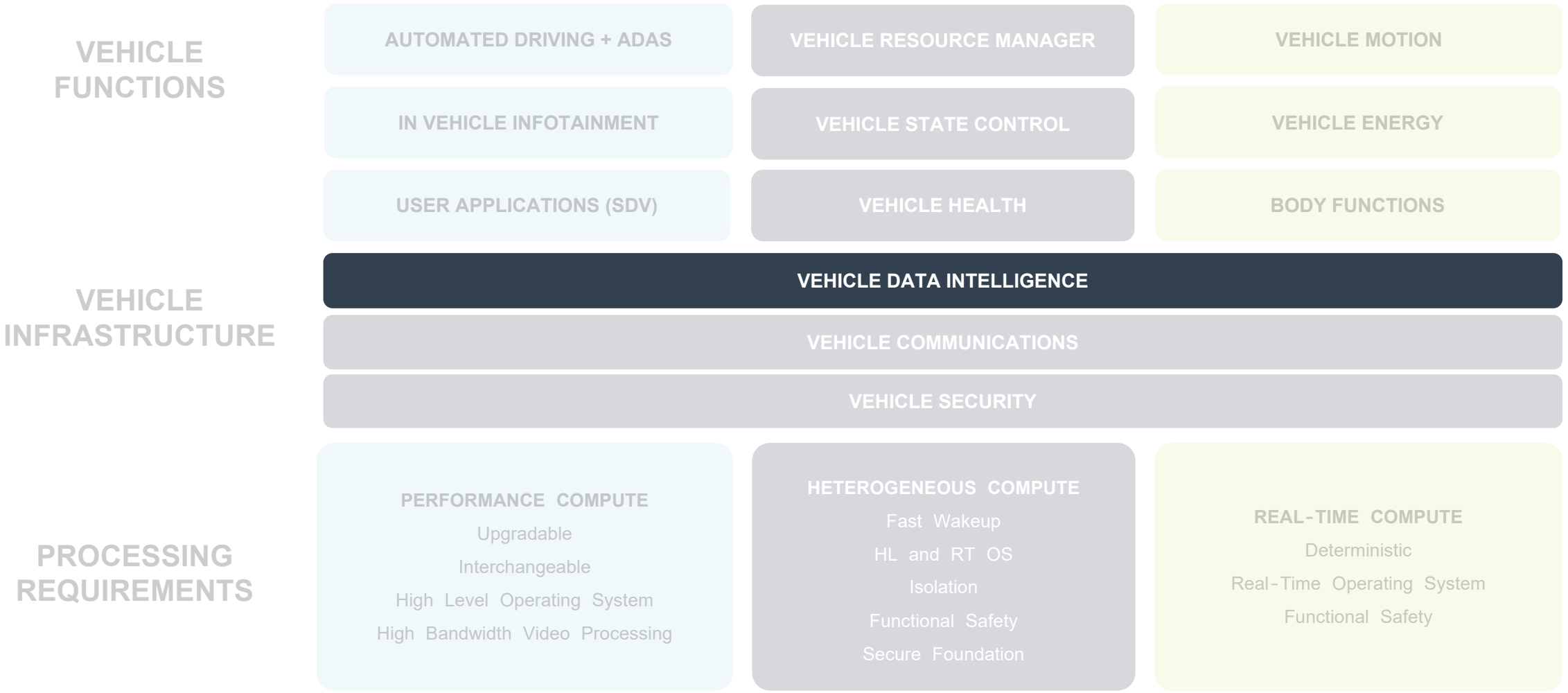
NATIVE REAL-TIME
Deterministic
RT OS
Safe

NXP 5nm

NXP S32G | **NXP S32Z**

NXP Ethernet Switch & PHYs

VEHICLE DATA INTELLIGENCE



HARNESSING THE VALUE OF DATA

Driver characteristics and personalisation

User experience enhancement

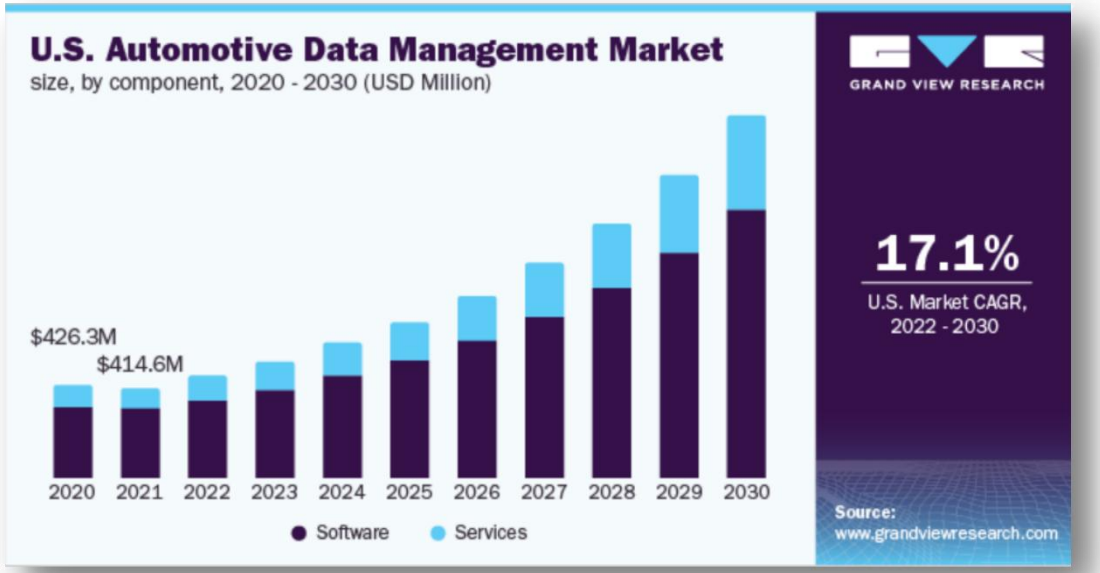
predictive maintenance

Software Audit trail – security analyst, *UN WP/29 regulation 156*

Instrumentation and logging for observability in SDV

In-Field validation of Software update. i.e software and network debug logs

Forensics and support for car maintenance



https://www.grandviewresearch.com/industry-analysis/automotive-data-management-market-report

Usage Based Insurance

SaaS

THE CONNECTED INTELLIGENT VEHICLE DATA LIFECYCLE WITH DIGITAL TWINS AND MACHINE LEARNING

THE CONNECTED VEHICLE

CLOUD CONNECTIVITY

SOFTWARE PLATFORM

SOFTWARE

HARDWARE

HARDWARE PLATFORM

INTELLIGENT EDGE SOFTWARE

INTELLIGENT EDGE

DATA SOURCES
CAMERA
RADAR
LiDAR
GPS
IMU
TIRES, BATTERY…
OTHER SENSORS

TERABYTES OF DATA/VEHICLE/DAY

VEHICLE PROCESSING PLATFORMS

INTELLIGENT DATA FROM VEHICLE

SECURE OVER-THE-AIR (OTA) UPDATE

THE CLOUD

RELEVANT AND WIDE-RANGING DATA

MASSIVELY SCALABLE STORAGE AND COMPUTE

1 INGEST

2 ENRICH, ALALYZE, STORE

3 LEARN & DREAM

4 DEPLOY

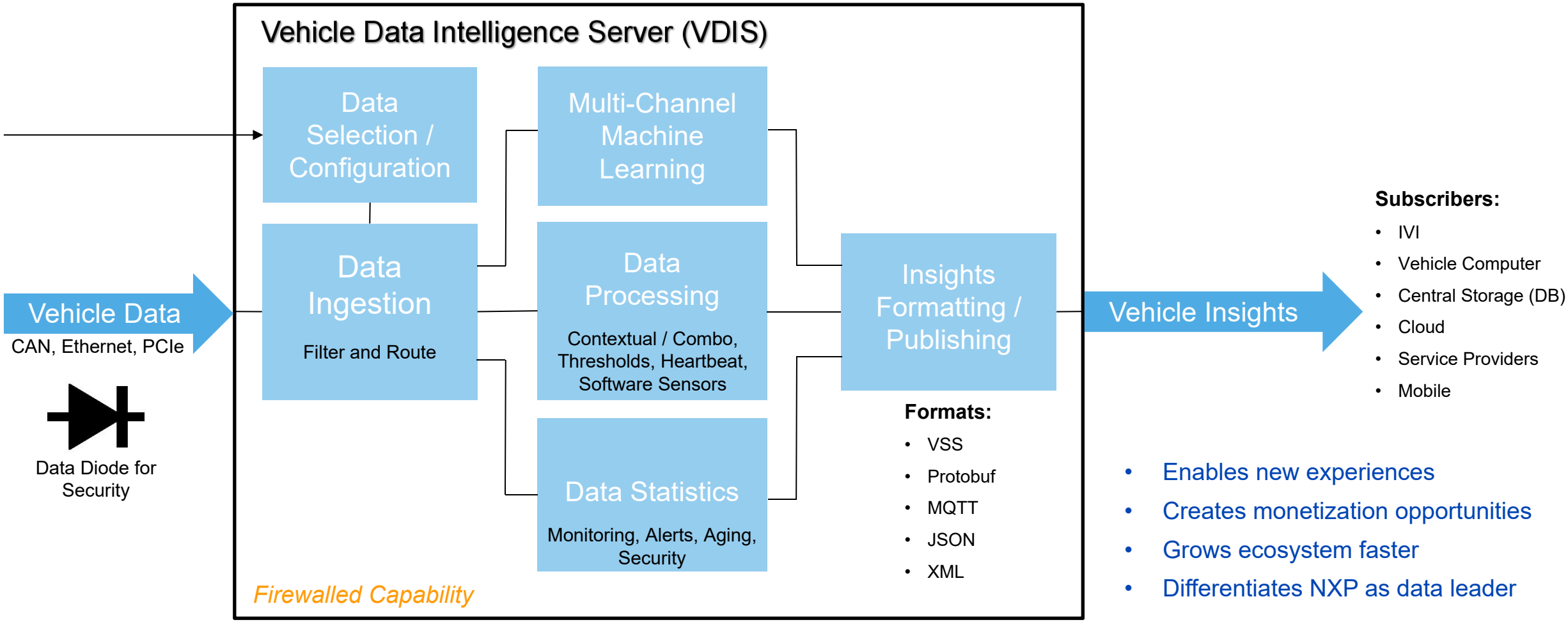
THE CONNECTED VEHICLE DATA LIFECYCLE

DEPLOY SOFTWARE ML MODEL UPDATES TO VEHICLES

CONTINUOUSLY MONITOR DIGITAL TWINS AND UPDATE ML MODELS

VEHICLE DATA INTELLIGENCE SERVER CONCEPT

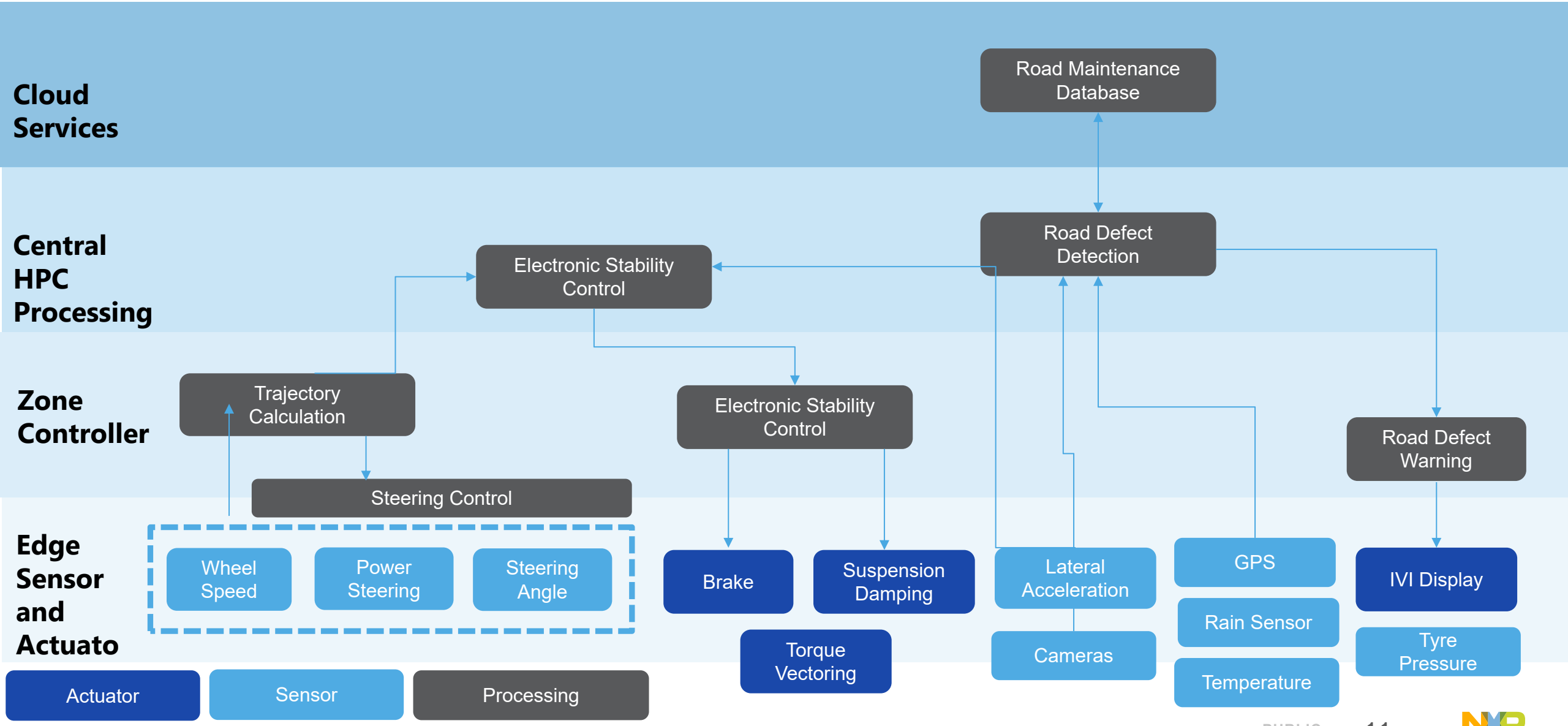
- Provide efficient, in-vehicle data intelligence to drive data-driven innovations (in-vehicle, cloud, mobile)
  - Centralized and standardized way to manage vehicle data securely and privately



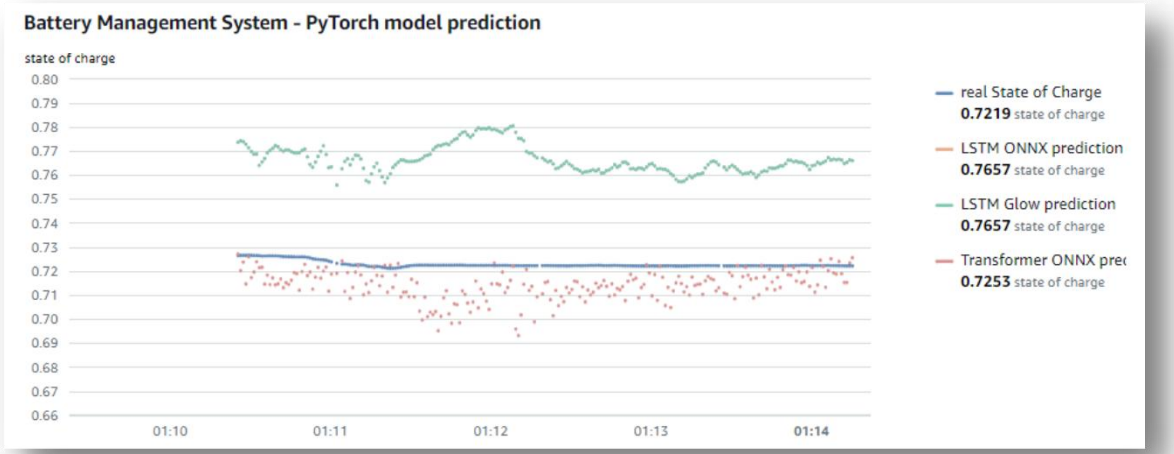
- Enables new experiences
- Creates monetization opportunities
- Grows ecosystem faster
- Differentiates NXP as data leader

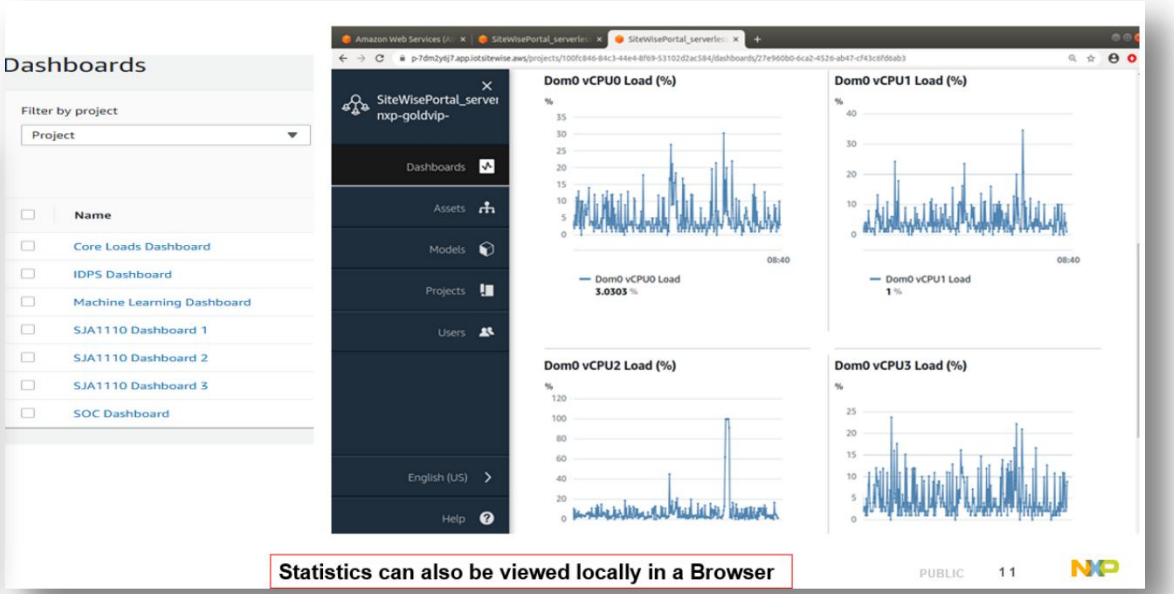
The brain's left hemisphere specializes in processing numerical information works together with other regions of the brain such as the cerebellum for this process.

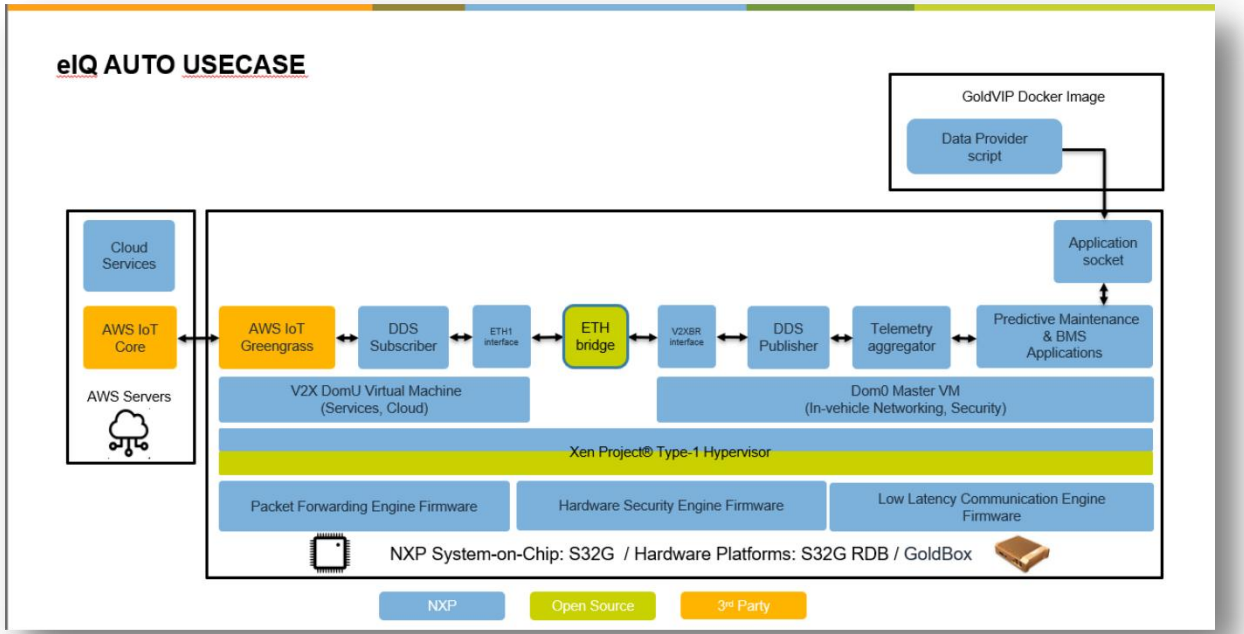
HOW DO WE ENRICH DRIVING FUNCTIONS WITH DATA USING THE VEHICLE COMPUTER?

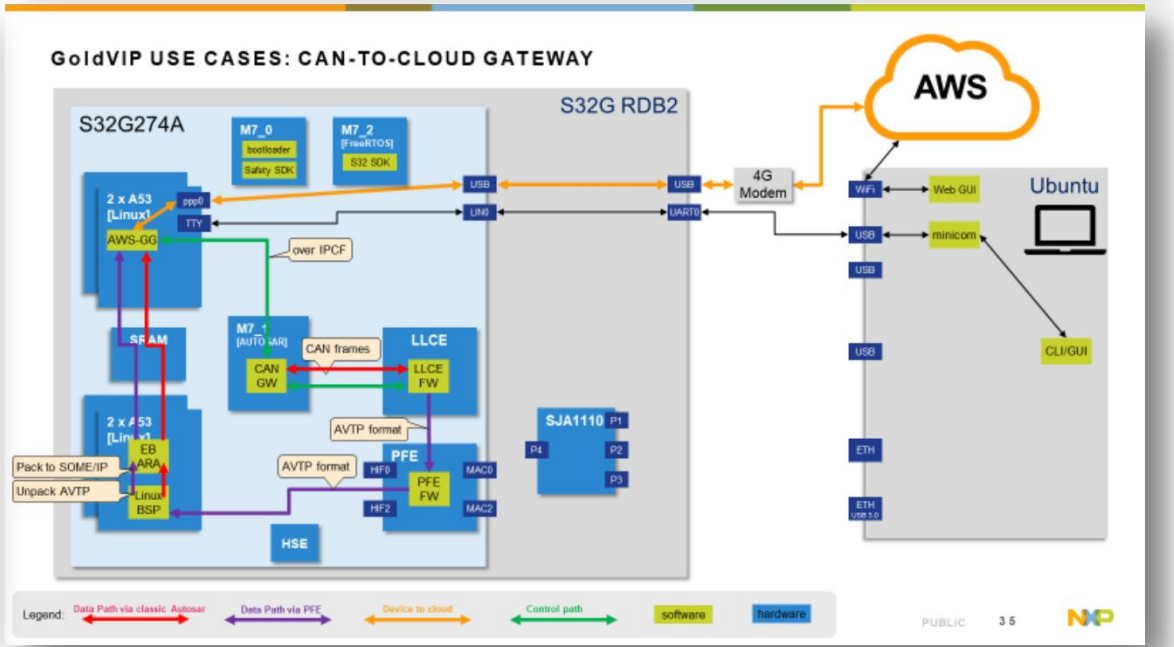


HARNESS THE VALUE OF DATA



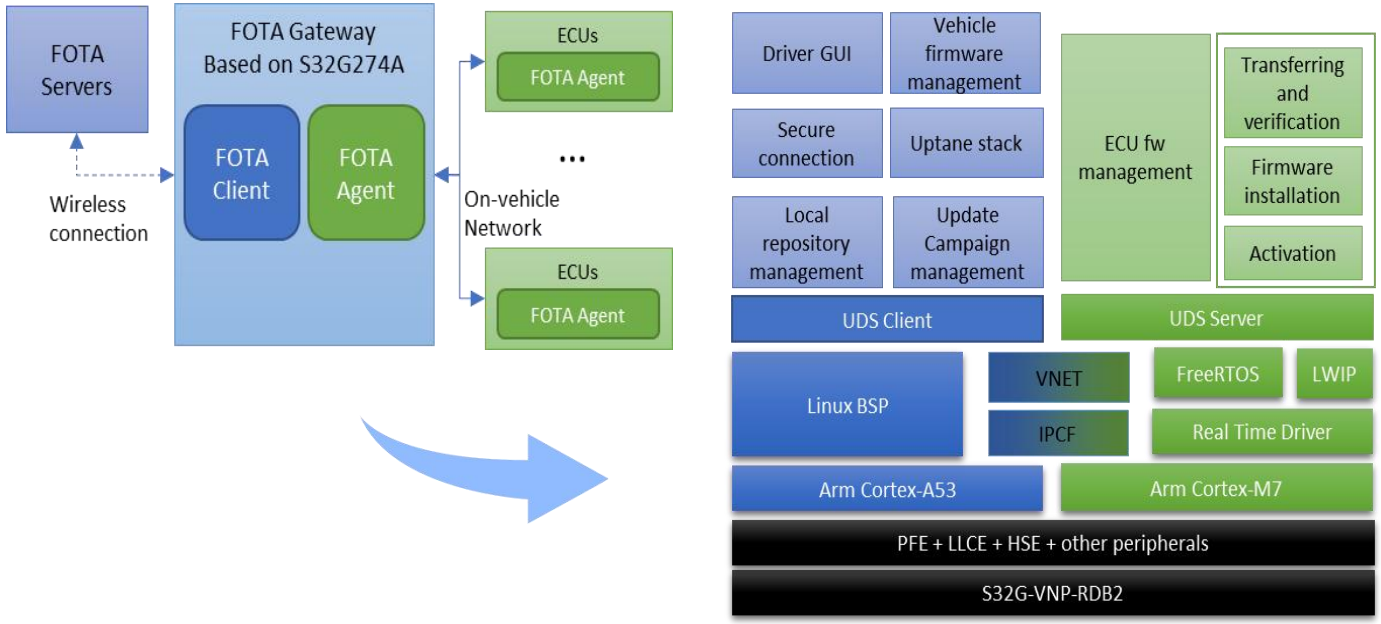






SOFTWARE UPDATE THROUGH OTA

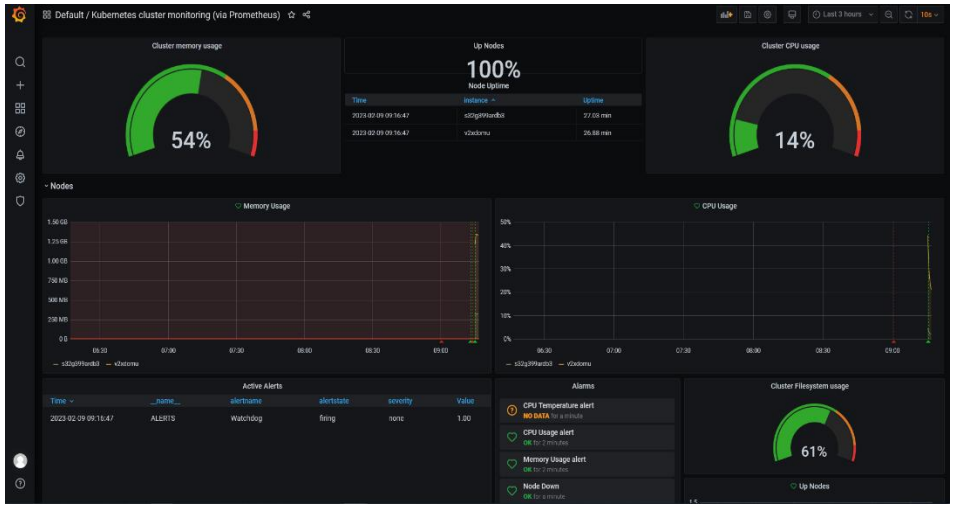
- OTA Servers
  - Operated by OEM
  - Responsible for package management, vehicle management, security related services, policy management, among others.
  - Customized OTA service for vehicles
- OTA Client
  - Runs on the ECU with higher performance
  - Serves as the master point of interface to the OTA Servers for all devices/ECUs in the vehicle
  - Local package management, updating campaign management
  - Security services
- OTA Agent
  - Runs on other ECUs with OTA updating functionality
  - Local security verification
  - A/B update…

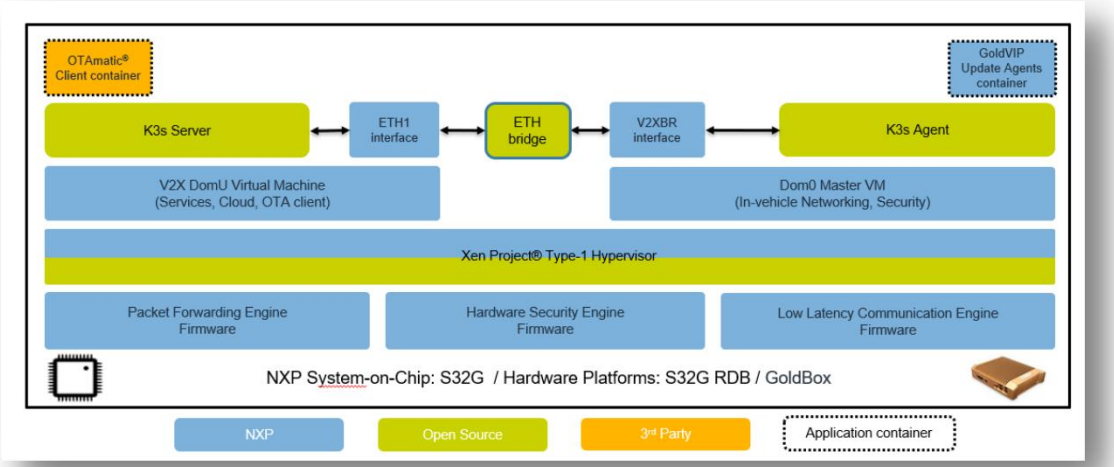


CONTAINER RUNTIME AND ORCHESTRATION

- Containers promise to accelerate innovation enabling cloud-native applications and third-party services to deploy to the vehicle **automatically** using **manifest files** rather than complex binary based software OTA updates.

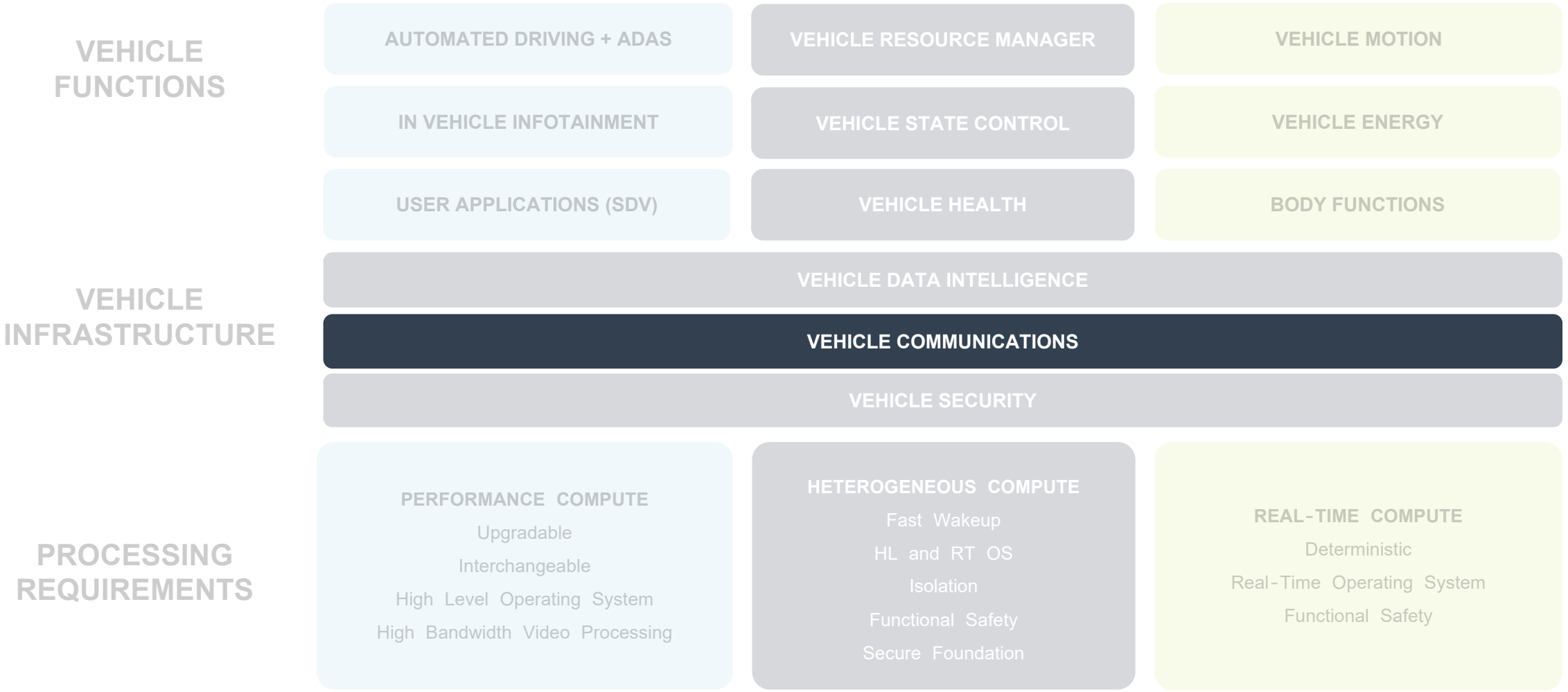
- However, strict principles should be applied to Cloud-Native Technology:
  I. The Vehicle Computer must manage **the secure access permissions** for containerised services to SOA Data
  II. The Vehicle Computer must manage a strict partition within which the containers may run without violating **Vehicle Safety Concept**
  III. Services should ideally not affect Vehicle Type approval **Certification Criteria**
  IV. VC Containers may require **FAST start-up** and **deterministic** execution



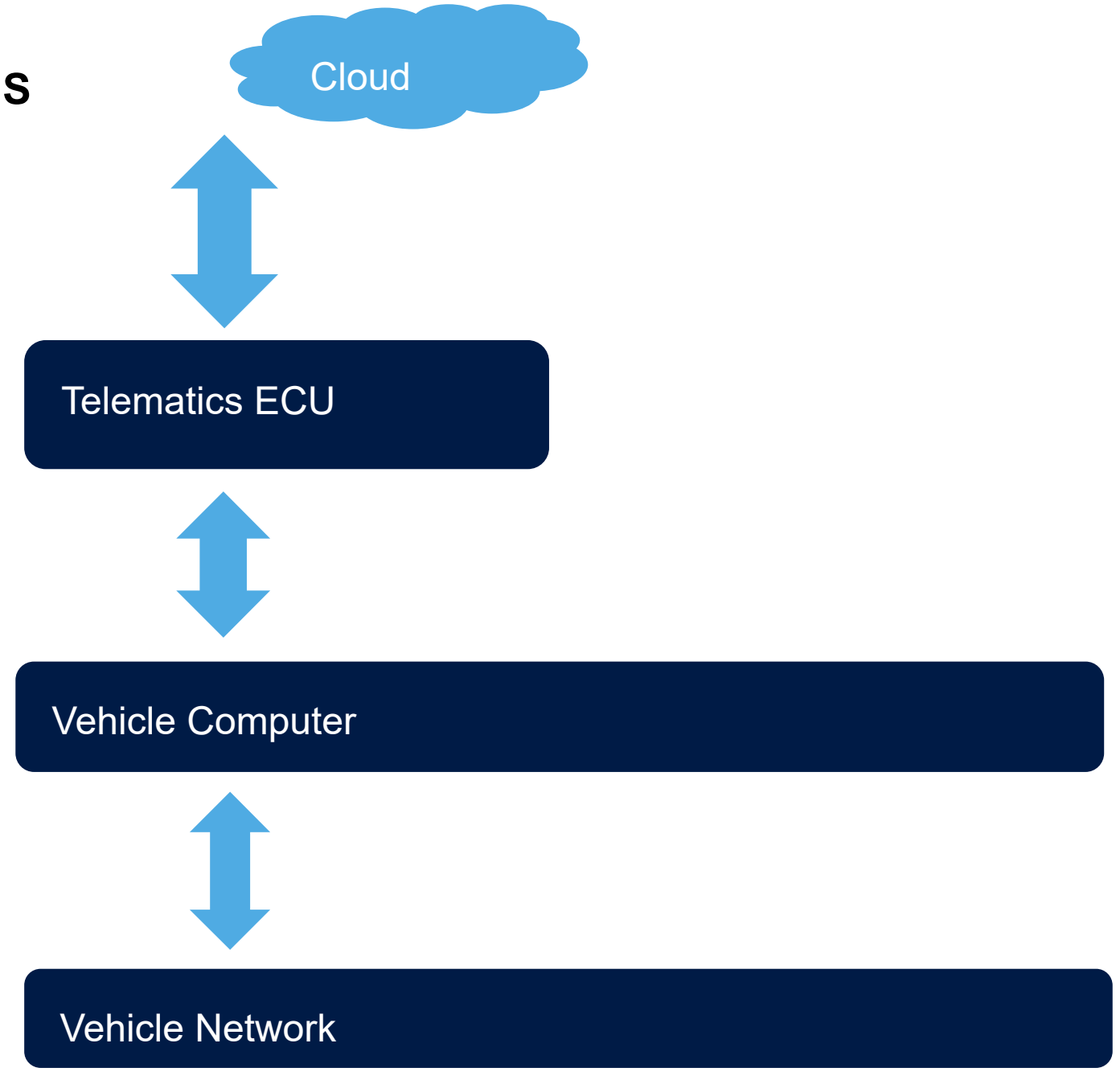


NXP considers new SW partners to enable commercial, automotive certified container frameworks for future

VEHICLE DATA INTELLIGENCE



VEHICLE COMPUTER COMMUNICATIONS



External communications Protocols

Secure communications to cloud with TLS, MQTT, HTTP

Internal communications Protocols

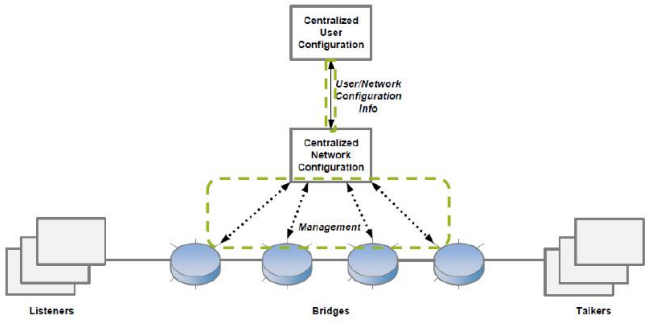
- SOMEIP;
- Diagnostics;
- CAN-over-Ethernet;
- Audio Video
- Network Management
- PCIe

EMERGING COMMUNICATIONS REQUIREMENTS FOR SOFTWARE DEFINED VEHICLE

Communications Security

Stateful and Automated Network **Configuration** Management (SDN)

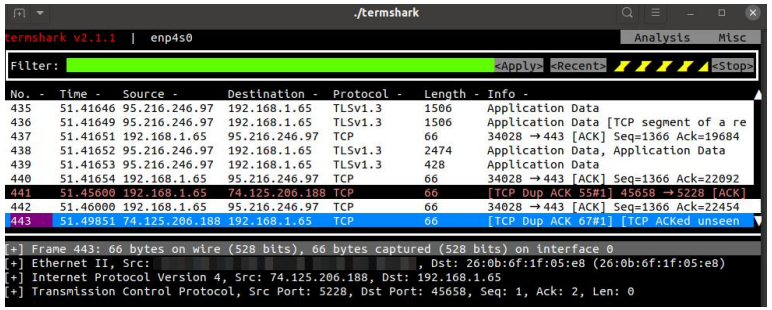
- SDN facilitates dynamic network configuration
- SDN facilitates abstracted network configuration using standardized models
- The Vehicle Computer must act as the Central Network Controllers



IEEE 802.1Qcc-2018 - Fully centralized model for TSN Configuration

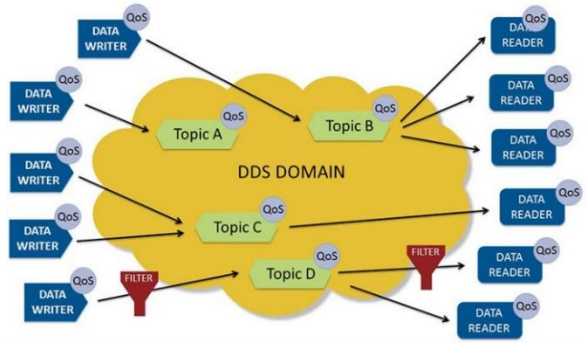
Network **Instrumentation** and status for Debug

- Networks must be monitored and instrumented for Security
- As part of the development and validation of OTA deployments to Zonal Architectures

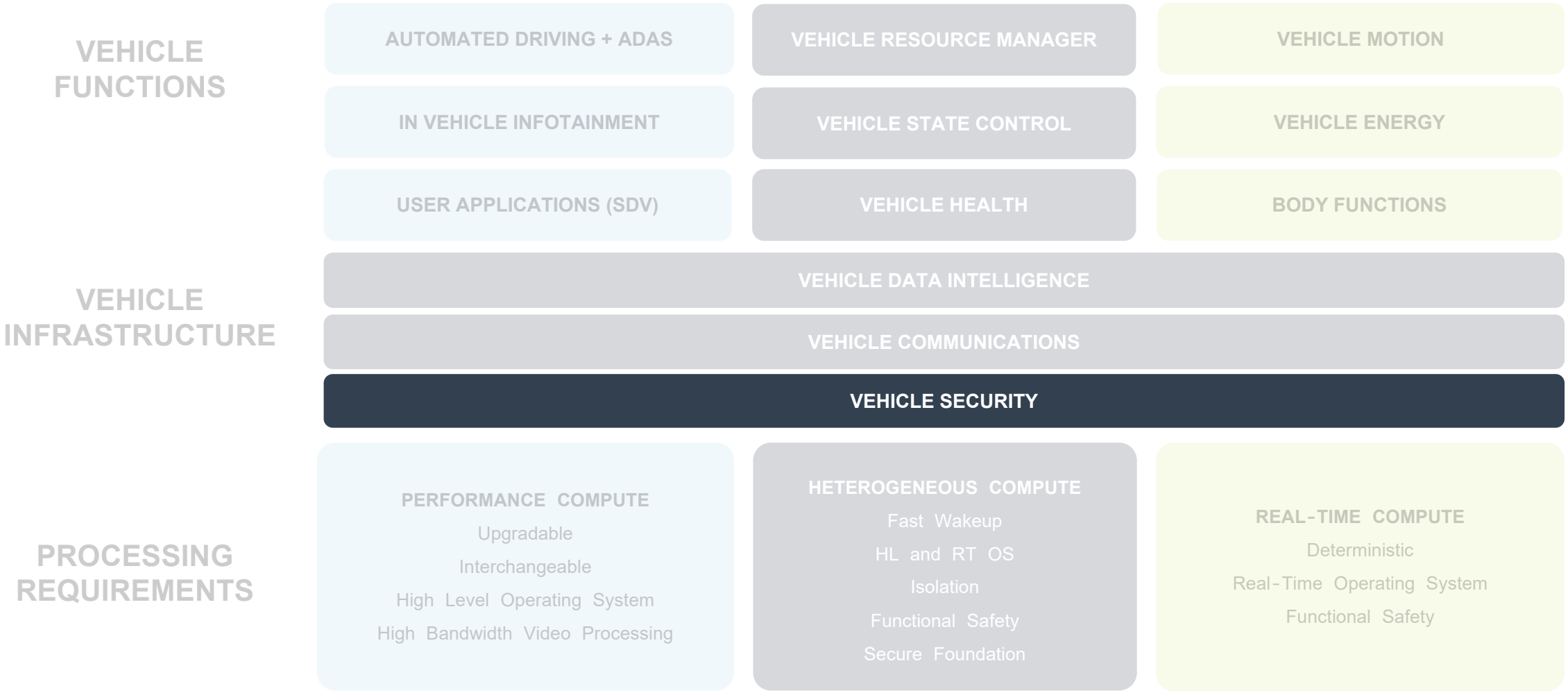


SOA Middleware Access Control

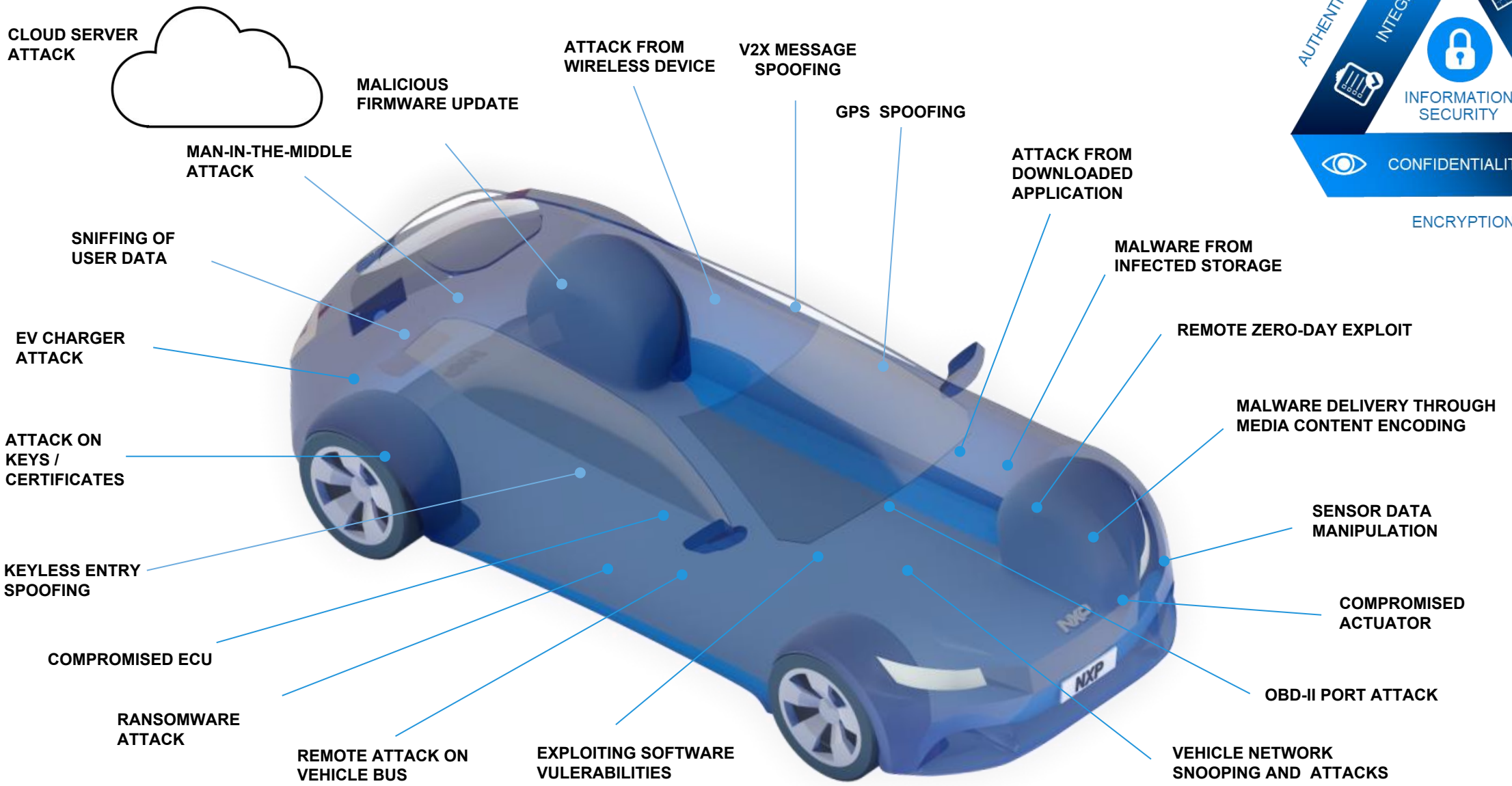
- Service layer allows applications to easily access data
- Decouples applications from the communication route
- Vehicle Computer must implement SOA access control and management



VEHICLE DATA INTELLIGENCE



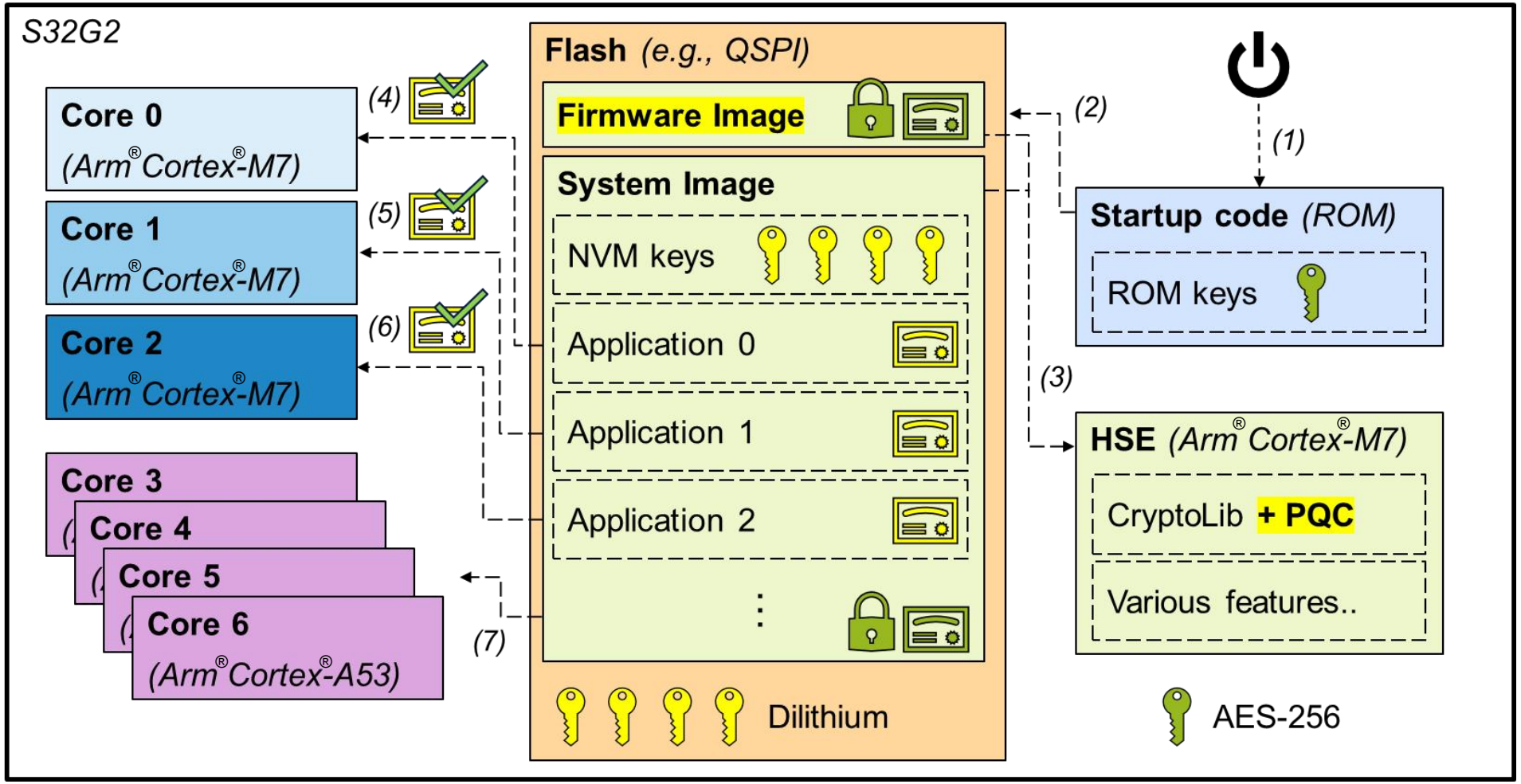
SOFTWARE-DEFINED VEHICLE SECURITY RISKS



HOLISTIC APPROACH – SOLUTIONS AND ORGANIZATION

	PREVENT ACCESS	**DETECT** ATTACKS	**REDUCE** IMPACT	**FIX** VULNERABILITIES
SECURE INTERFACES	M2M Authentication & Firewalling	Secure Ranging (UWB)		
SECURE FUNCTIONAL ISOLATION	Firewalling, VLAN, …	Network Intrusion Detection Systems (NIDS)	Separated Functional Environments	Secure Updates
SECURE NETWORKS	Secure Messaging		Message Filtering & Rate Limitation	
SECURE PROCESSING	Code / Data Authentication (@ start-up)	Code / Data Authentication (@ run-time)	Resource Control (virtualization)	
SECURE ENGINEERING	SDLC incl. Security Reviews & Testing, …	Threat Monitoring, Intelligence Sharing, …	Incident Management / Response	
	Security-Aware Organization, Policies, Governance			

S32G2 HSE SECURE BOOT OVERVIEW WITH PQC SUPPORT



PQC Changes

KEY TAKEAWAYS

Quantum Computers are evolving quickly and will cause disruption

- Problems that take thousands of years today may be solved in seconds
- Today's cryptography for security can be rendered useless
- We need to prepare now for a Post-Quantum Cryptography era

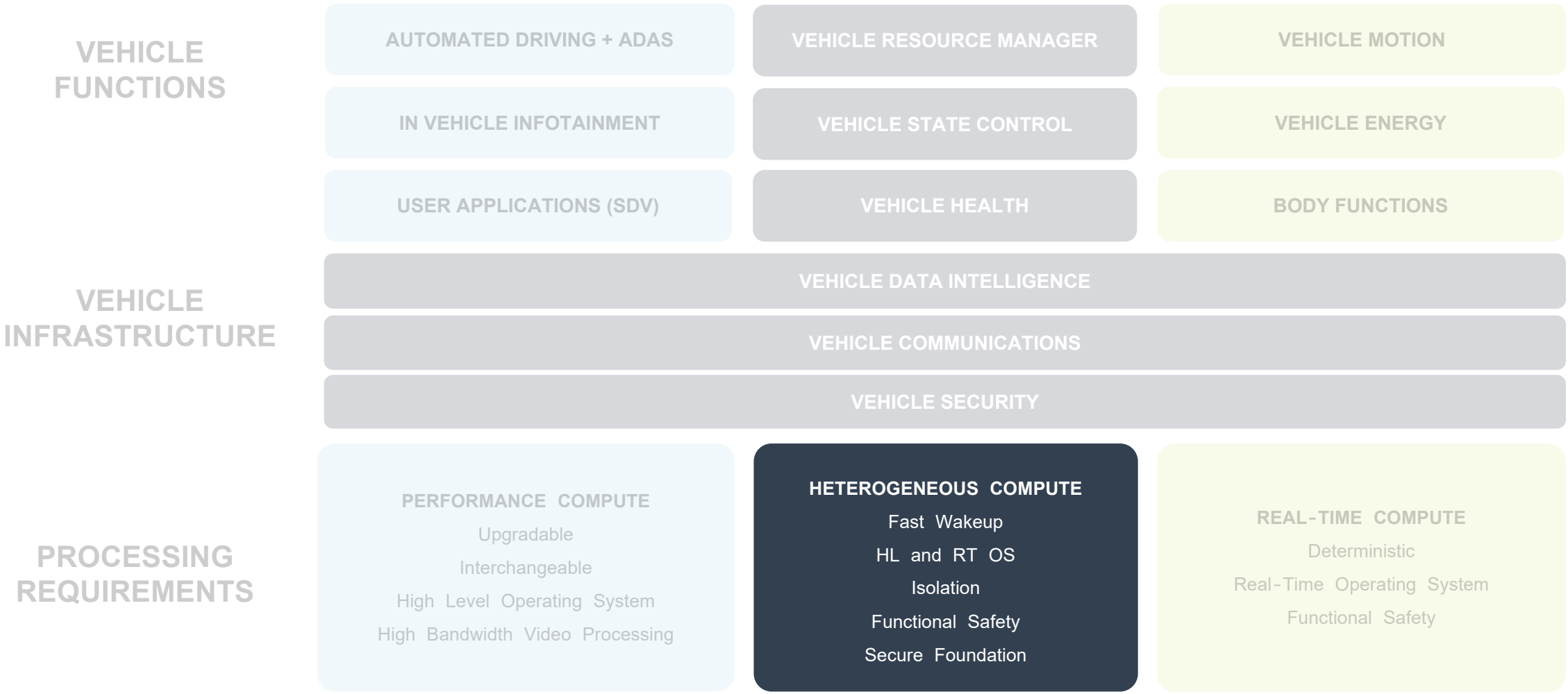
The automotive industry is moving to Software-Defined Vehicles

- Always-connected SDVs will be targets of cybersecurity threats
- Strong vehicle/cloud security is required to protect SDVs for 15+ years
- We need to start planning to secure SDVs that operate in a PQC era

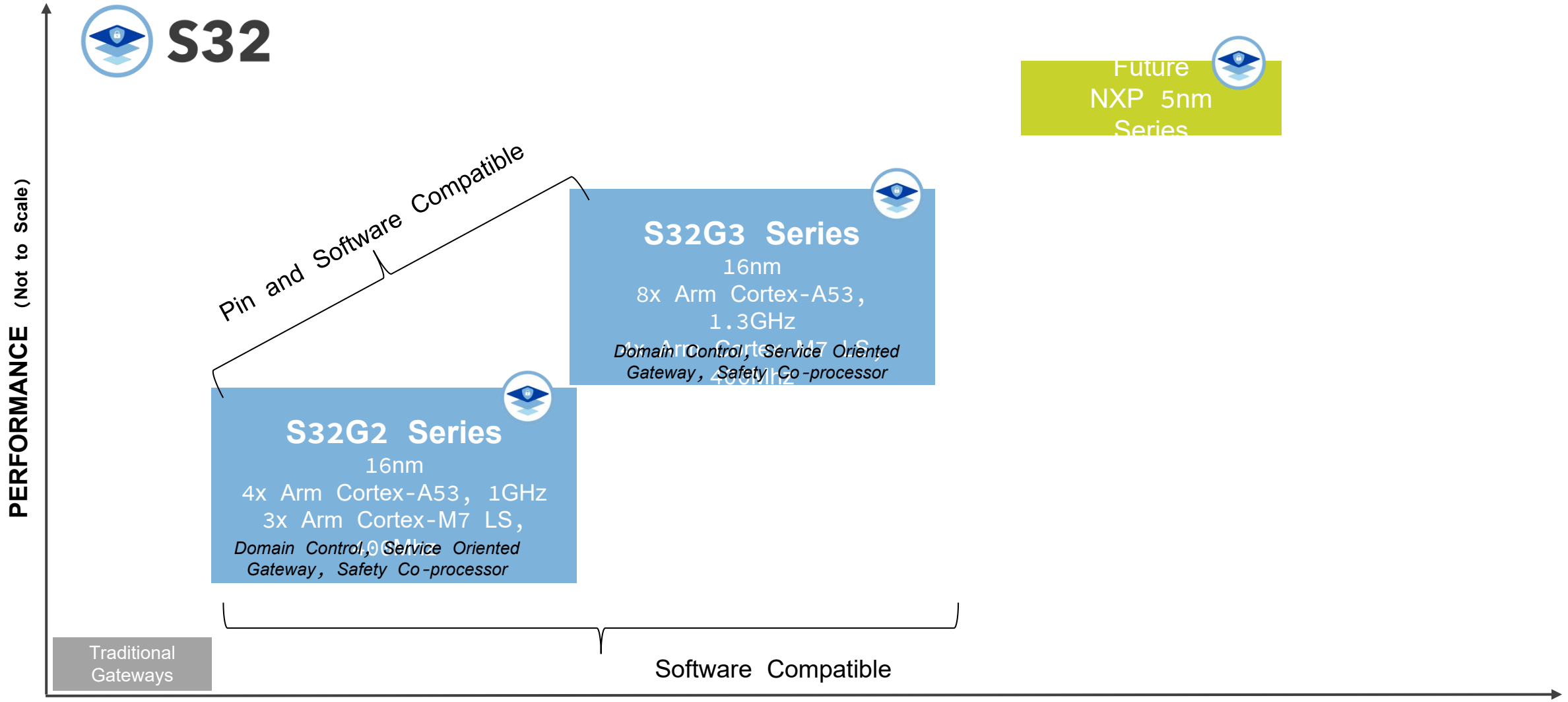
NXP is a leader in industry PQC and SDV efforts to address needs

- NXP has authored CRYSTALS-Kyber algorithm that has been selected as the foundation for future post-quantum cryptography (PQC) standards
- NXP has shown how S32G automotive processors with hardware security can support PQC for secure boot today
- NXP is collaborating with partners to show end-to-end solutions for PQC-secure over-the-air (OTA) updates and signing services

VEHICLE DATA INTELLIGENCE

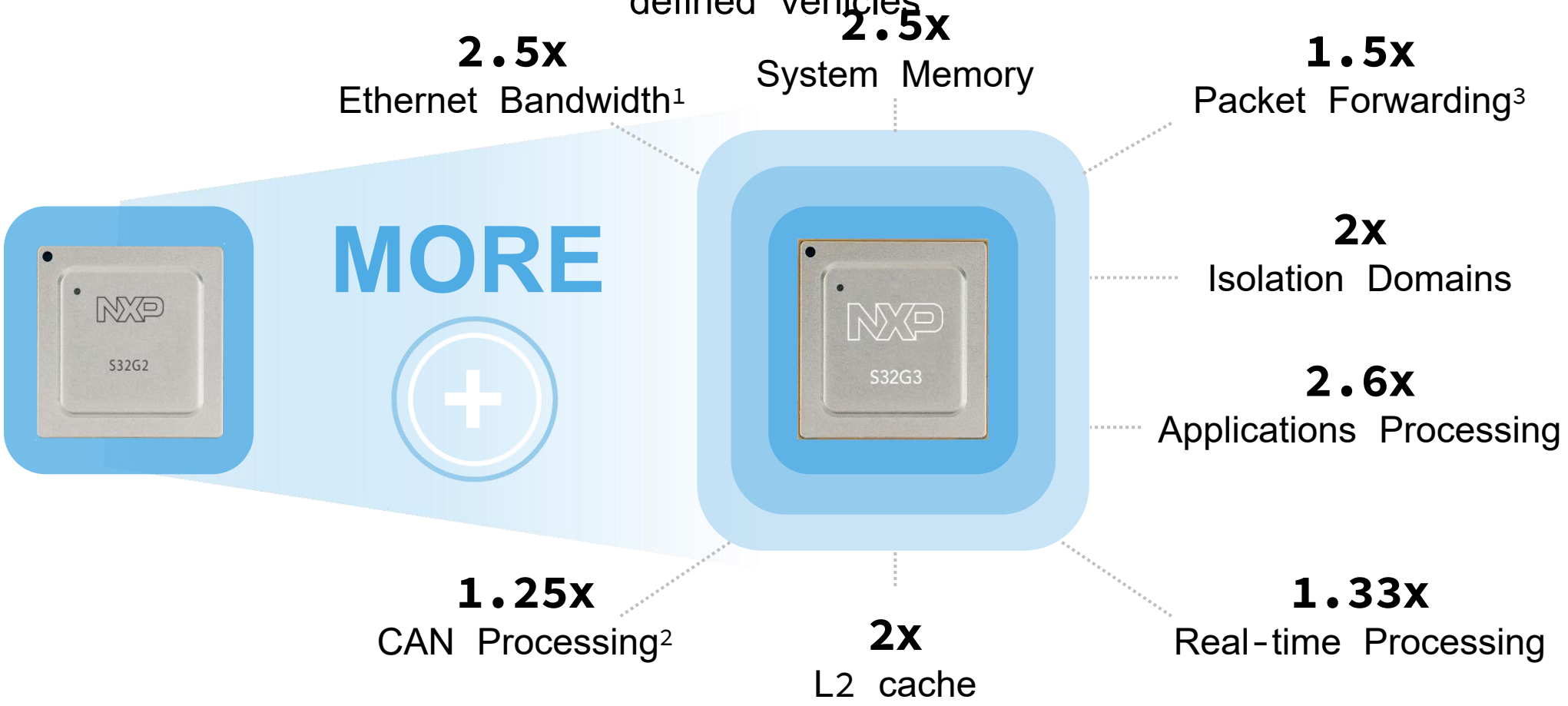


NXP VEHICLE NETWORK PROCESSOR ROADMAP



DO “MORE” WITH S32G*

The S32G3 family maintains software and package-pinout compatibility with S32G2, while offering **more capabilities** to address key needs of software-defined vehicles



* NXP S32G399A -vs- S32G274A
[1] On two Gigabit Ethernet ports
[2] 1.25x improvement for 16 CAN interfaces
[3] 1.5x improvement for 64-byte packets

www.nxp.com/S32G3

S32G FAMILY LINEUP

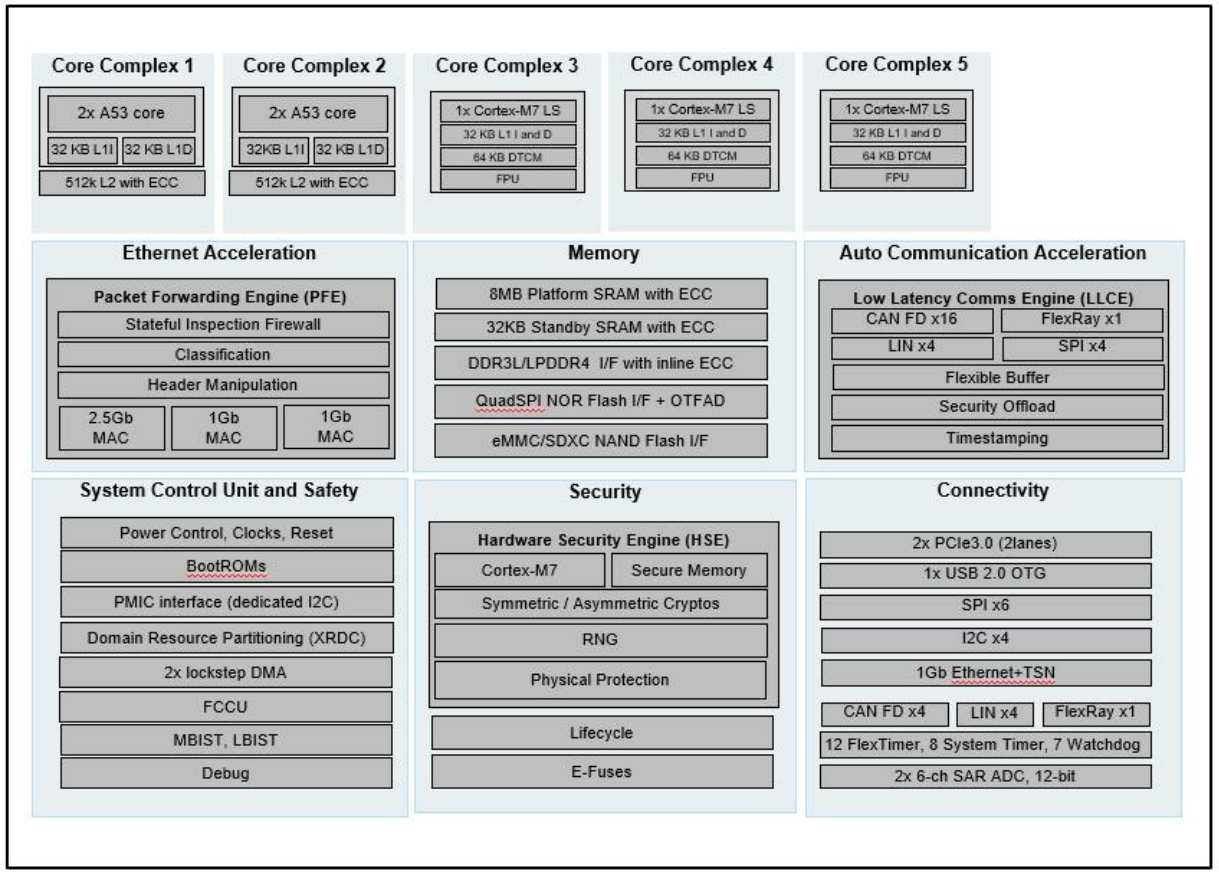
- Performance Scale
  - MCU → MPU
  - 3.9 kDMIPS to 36.2 kDMIPS
  - ASIL D MPU
- HW Compatibility
  - Same SoC package and pinout
  - PMIC scalability option
  - Same peripherals and accelerators
- SW Compatibility
  - Application code compatible
  - Same BSP
  - Same boot flow
  - Same security

Feature	S32G234M	S32G233A	S32G254A	S32G274A	S32G378A	S32G379A	S32G398A	S32G399A
Package	525 FC-PBGA, 19x19mm 0.8pitch							
Arm CPU Cluster 1	-	1x Cortex-A53 @ 1 GHz		2x Cortex-A53 @ 1 GHz	2x Cortex-A53 @ 1.3 GHz		4x Cortex-A53 @ 1.3 GHz	
Arm CPU Cluster 2	-	1x Cortex-A53 @ 1 GHz		2x Cortex-A53 @ 1 GHz	2x Cortex-A53 @ 1.3 GHz		4x Cortex-A53 @ 1.3 GHz	
Applications DMIPS	-	4600-5990		9200-11980	12000-15500		24000-31100	
Arm RT CPU	3x Cortex M7, 400 MHz	1x Cortex M7, 400 MHz	3x Cortex M7, 400 MHz	3x Cortex M7, 400 MHz	3x Cortex M7, 400 MHz	4x Cortex M7, 400 MHz	3x Cortex M7, 400 MHz	4x Cortex M7, 400 MHz
Real-time DMIPS	3900	1300	3900		3900	5200	3900	5200
DDR	-	LPDDR4 / DDR3L 32bit (Up to 4GB)						
System SRAM	8MB	6MB	8MB		15MB	20MB	15MB	20MB
NVM-IF	Octal DDR NOR, eMMC/SDXC NAND							
AI/ML		Arm Cortex Neon: 16 GFLOPS		Arm Cortex Neon: 32 GFLOPS	Arm Cortex Neon: 41.6 GFLOPS		Arm Cortex Neon: 83.2 GFLOPS	
PCIe	1x PCIe3.0 (2lanes)	2x PCIe3.0 (2lanes)						
Ethernet Acceleration	**Packet Forwarding Engine (PFE)** 2 Gbps @ 64B forwarding 3 ext ports				**Packet Forwarding Engine (PFE2)** 3 Gbps @ 64B forwarding 3 ext ports			
Accelerated Ethernet Ports (PFE)	2x 1G/100M 1x 2.5G/1G/100M				3x 2.5G/1G/100M			
Automotive Network Acceleration	**Low Latency Communication Engine (LLCE)** CAN FD x16 / LIN x4 / FR x1				**Low Latency Communication Engine (LLCE2)** CAN FD x16 / LIN x4 / FR x1			
Non-Accelerated IF CAN FD / LIN / FR Gb ETH / USB2.0 SPI / I2C	4 / 3 / 1 1 / 0 6 / 5	4 / 3 / 1 1 / 1 6 / 5						
Timer	12 FlexTimer, 7 System Timer, 7 Watchdog Timer				12 FlexTimer, 13 System Timer, 12 Watchdog Timer			
ADC	2x 6-ch SAR ADC, 12-bit							
Temp Range	-40 to 105°C (Tj=125°C)							

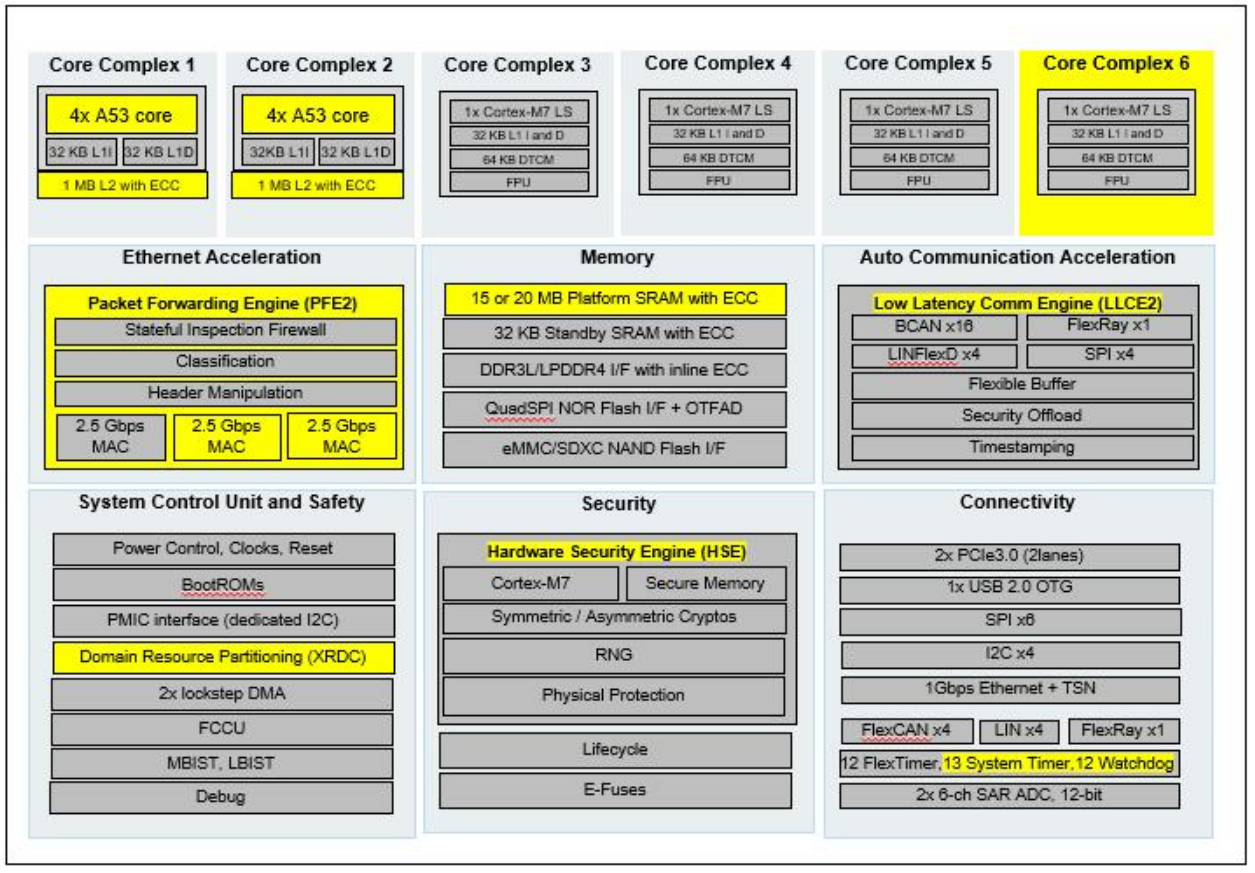
S32G3 Enhancements over S32G2

S32G2 VS S32G3 SUPERSET DEVICES' FEATURE DIFFERENCES

S32G274A Superset Device



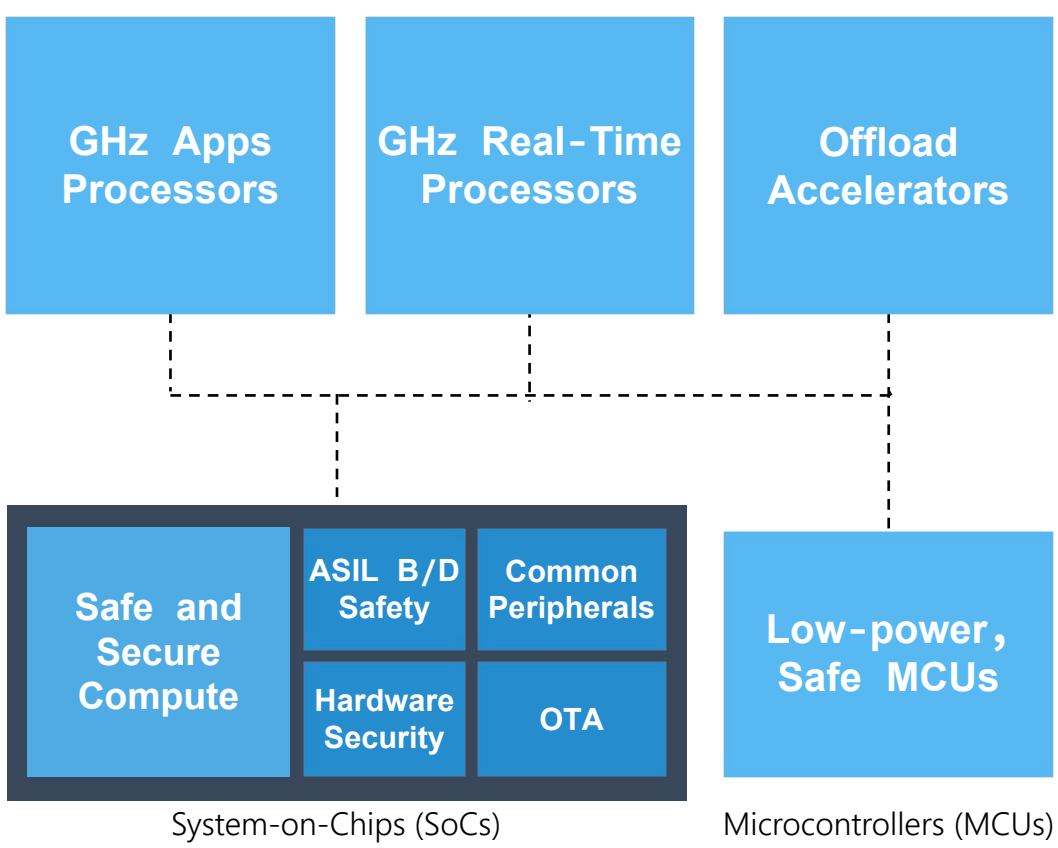
S32G399A Superset Device



S32G3 Enhancements over S32G2

NXP S32 VEHICLE COMPUTE PLATFORM

SCALABLE, CONSISTENT ARCHITECTURE FROM CENTRAL COMPUTE TO ZONES



COMMON FOUNDATIONAL SOFTWARE FOR REUSE AND EFFICIENCY

S32K | S32R | S32Z | S32E | S32G | S32N

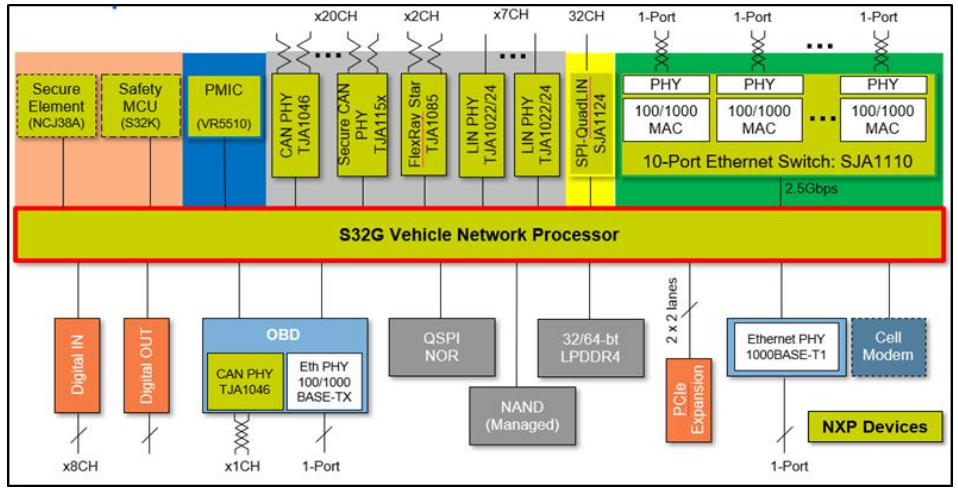
- Virtual Silicon Models
- Vehicle Integration Platforms (VIPs)
- Inter-Platform Communications and Middleware
- Trusted Security Firmware
- S32 Safety Software Framework
- eIQ® Machine Learning Runtime
- Real-Time Drivers and OS Support
- Accelerators' Firmware and APIs
- Automotive-Grade

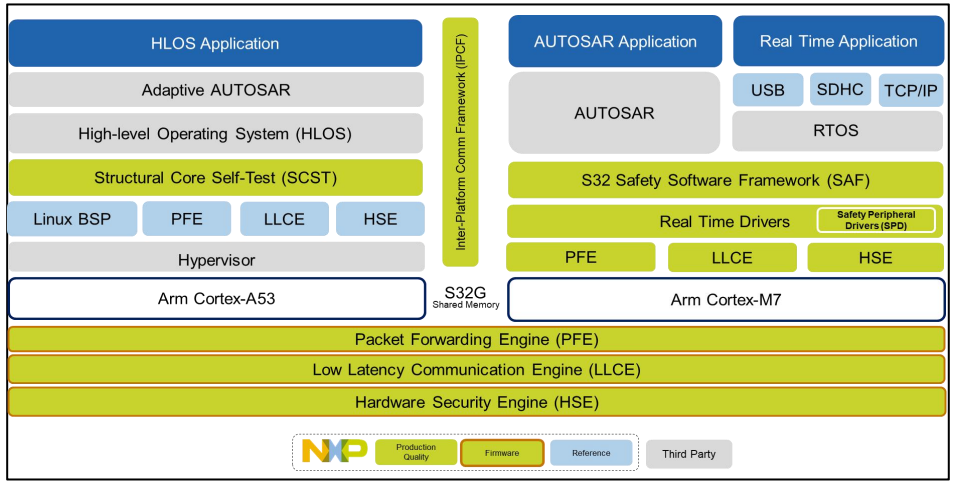
NXP offers scalable, diverse vehicle compute with a common software foundation.

- NXP offers the **GoldVIP** software platform and the **RDB2 / GoldBox** hardware to accelerate S32G evaluation and development
- GoldVIP pre-integrates software for evaluation and rapid connected vehicle application development
- S32G silicon and the RDB2 and GoldBox hardware platforms are available from NXP distributors
- GoldVIP is available on NXP.com

NXP FOCUSED ON BROAD DESIGN ENABLEMENT FOR S32G CUSTOMERS

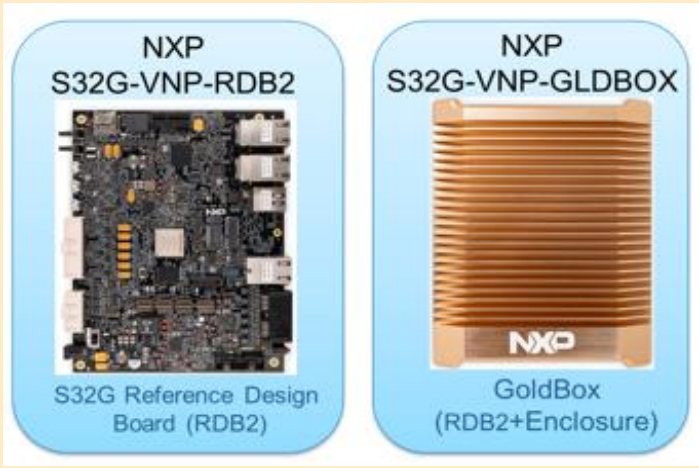
NXP S32G2 System Solution

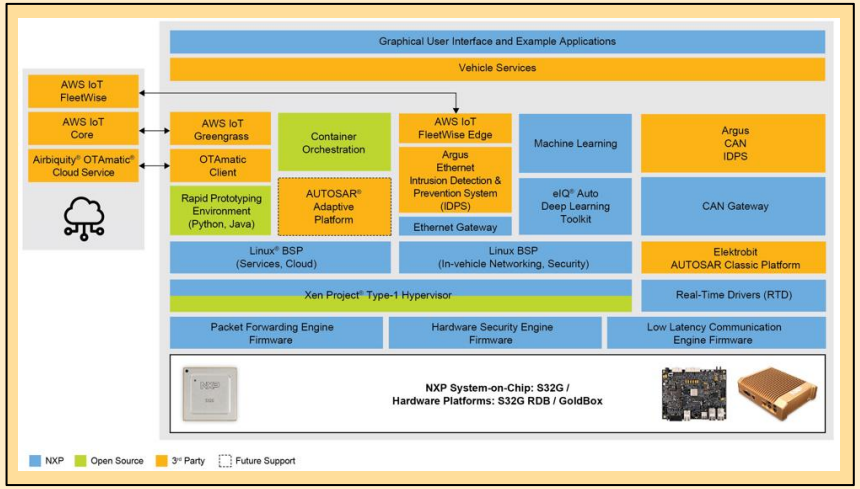




S32G Software Enablement Stack

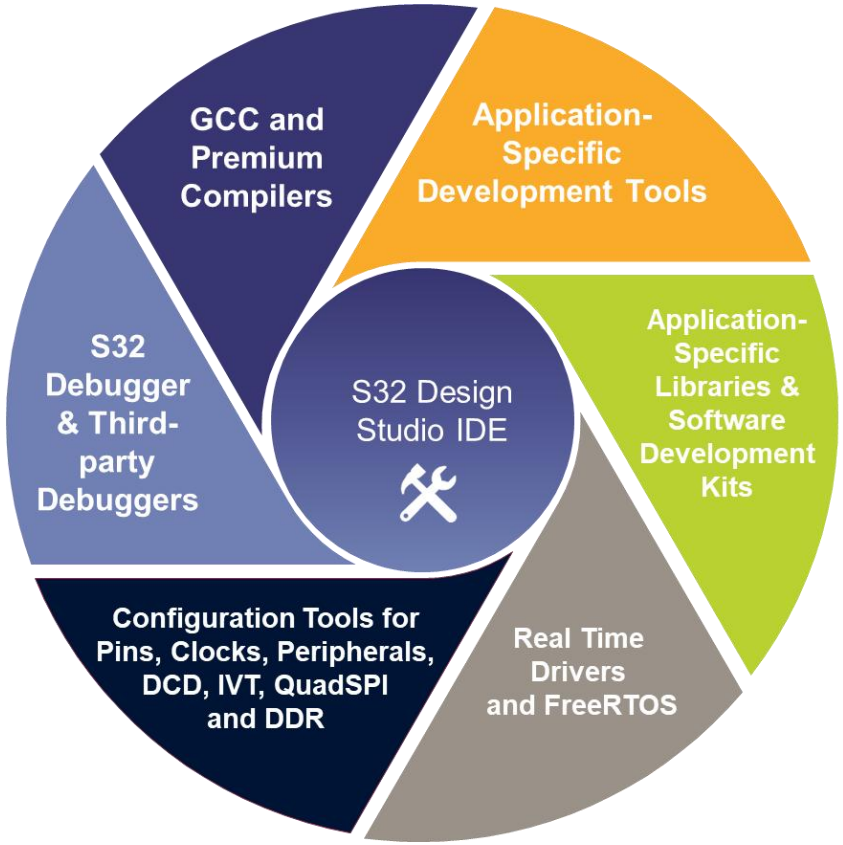
NXP S32G Hardware Platforms



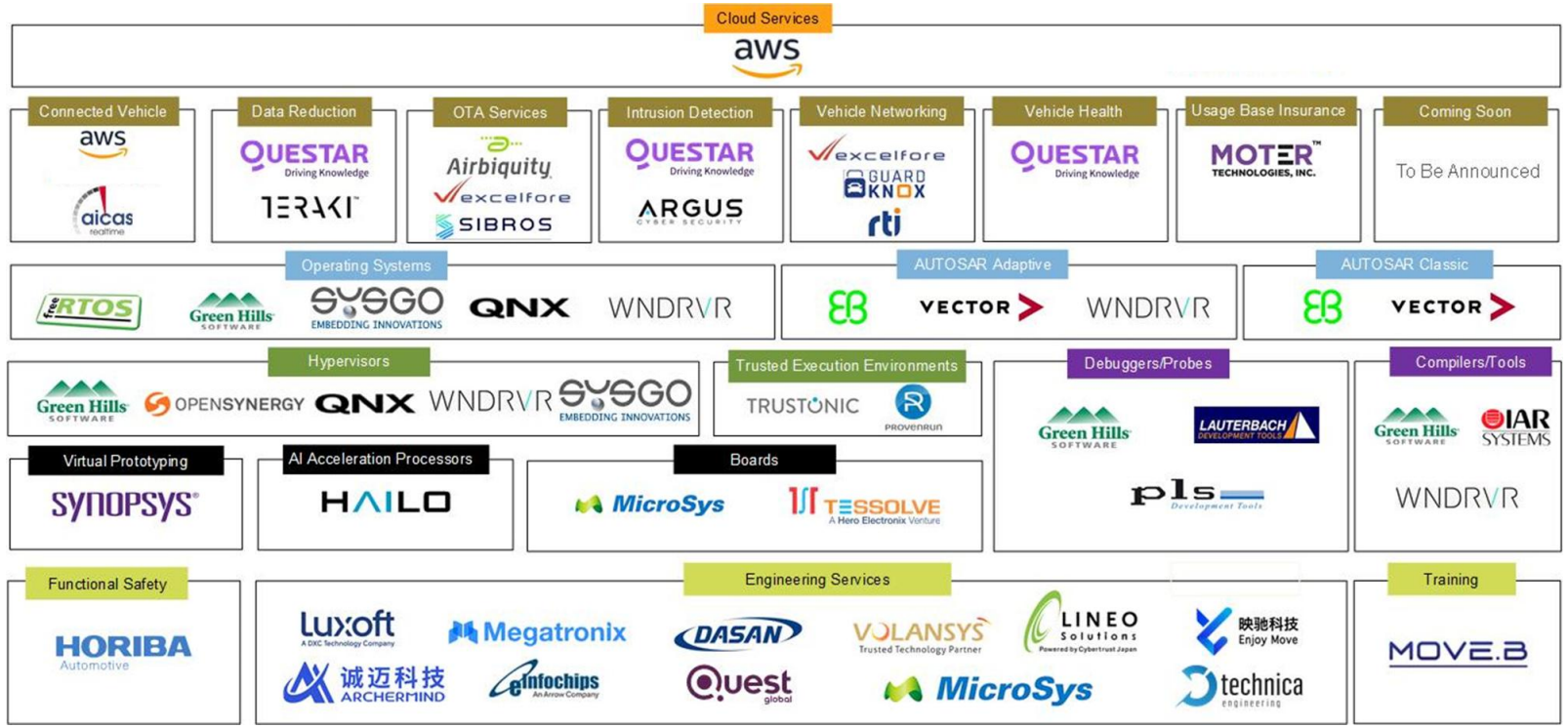


S32G Vehicle Integration Platform (GoldVIP)

S32G ENABLEMENT SUPPORT:
BY NXP SOFTWARE TOOLS AND STRONG ECOSYSTEM OF PARTNERS



NXP Software Tools



NXP S32G Ecosystem Partners*

*As of October 2022. Check with your NXP sales representative for future updates.

NXP SYSTEM SOFTWARE OFFERING

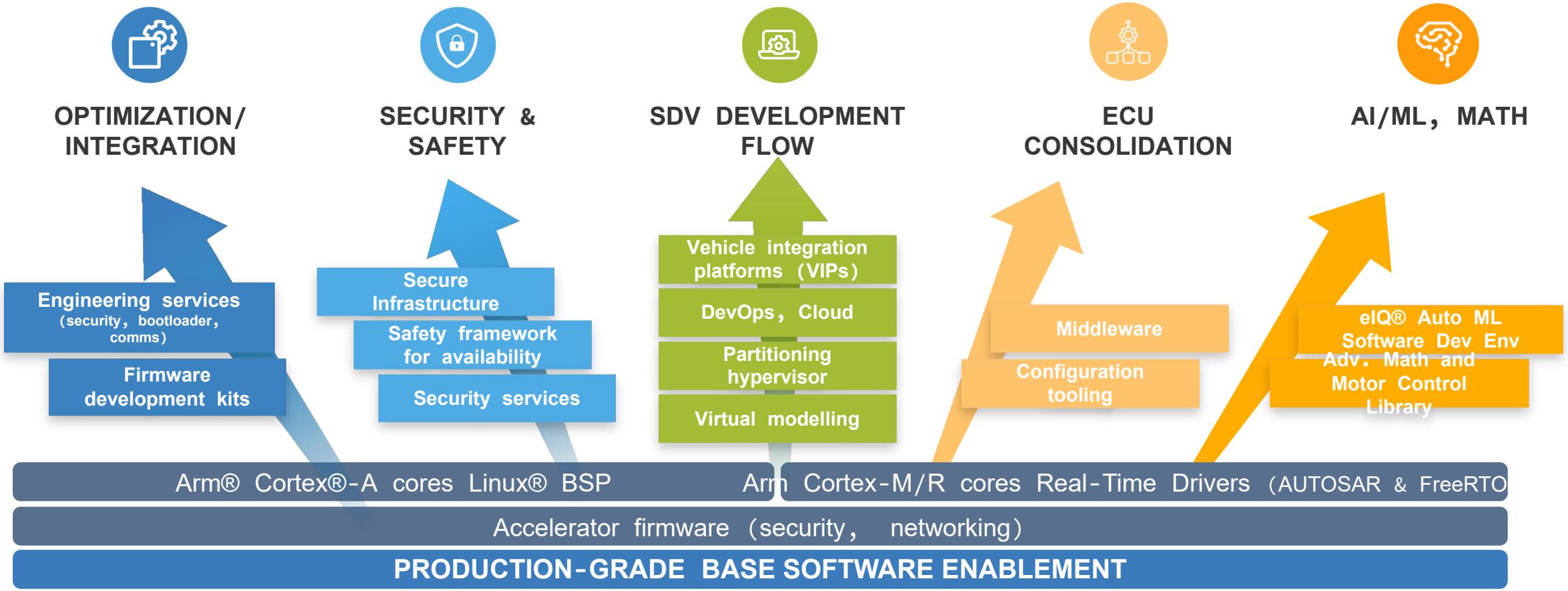
Accelerated customer development

Optimization for customer's specific use case

System expertise to support OEM use cases

Maximized performance from silicon

Strengthen ecosystem through increased NXP added-value



NXP IS HYPERFOCUSED ON ACCELERATING SDV DEVELOPMENT

Scalable hardware and software platform

Differentiation starts with a unified hardware and software platform that's designed to scale, from functions to fleets

Digital twin enablement

Prototype and test before silicon is available using NXP's virtual development environment

Over-the-air updates over the vehicle lifetime

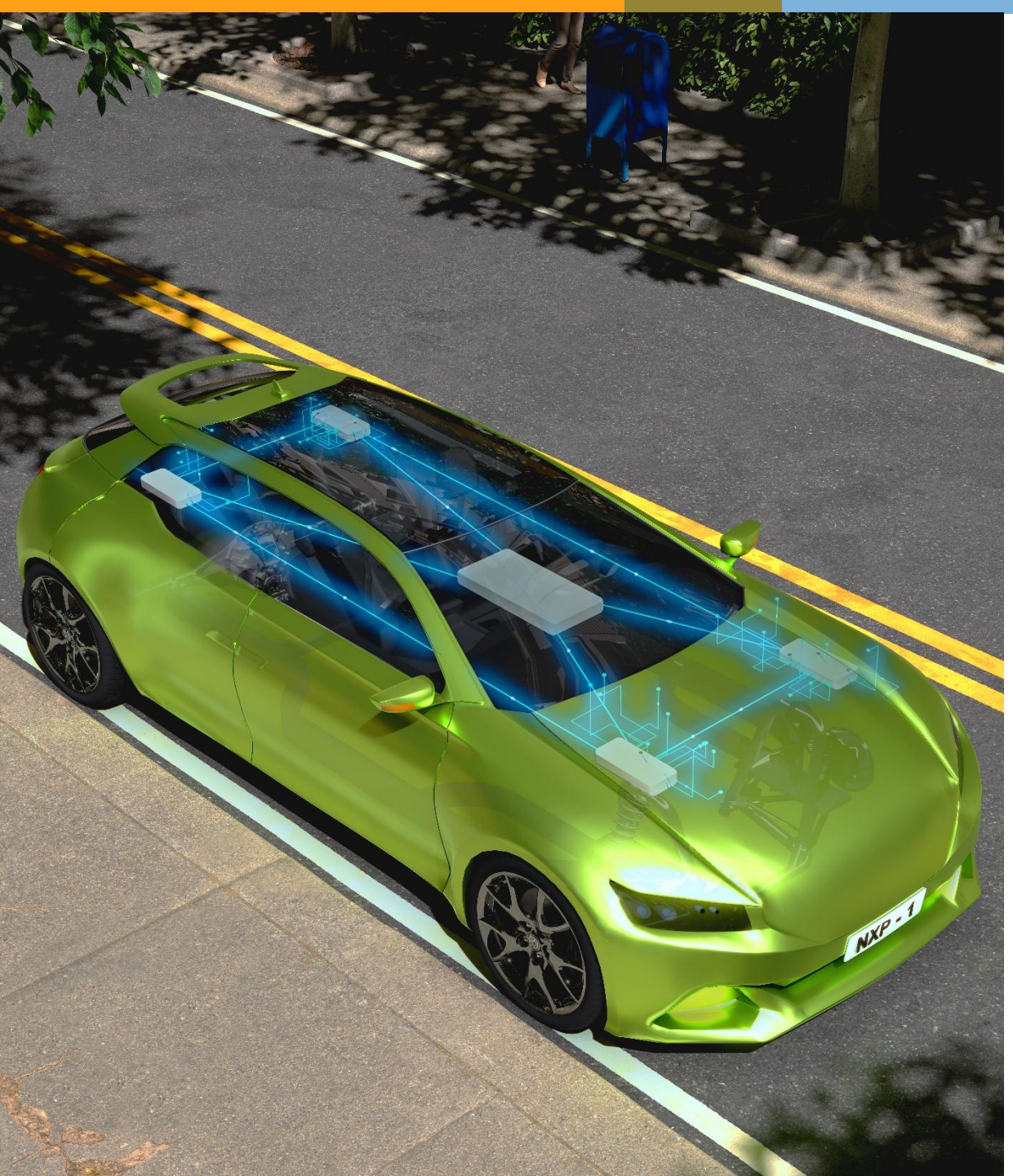
Roll out new updated software features across ECUs to extend the value of vehicle architecture

Software services and system expertise

Accelerate vehicle development with customized support, development and training by NXP engineers and software experts

Extensive ecosystem

Broad automotive partner network across engineering services, applications, and enablement



KEY TAKEAWAYS

- Vehicles are evolving rapidly to be software-defined, data-driven, cloud-connected and service-oriented
  - Major implications to OEMs and ecosystem
- OEMs are designing SDVs with different types of E/E architectures that decouple software from hardware
- NXP's S32 vehicle compute platform offers a wide range of solutions to meet diverse needs for central vehicle compute, domain, zonal and end node needs
- NXP invested in new silicon technologies and offers system solutions to enable the global SDV designs
  - Extending to a virtual development environment and software products to accelerate SDV development
- Global OEMs are launching new vehicles leveraging NXP solutions as they evolve to full SDVs

SECURE CONNECTIONS
FOR A SMARTER WORLD

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