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Agenda

- Automotive Storage Trends
- Special Requirements for Autonomous Vehicles
- Where Automotive Data is Typically Stored
- Special Use Cases
- Networking & Compute Changes and Challenges

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What is Driving Growth in Automotive Storage?
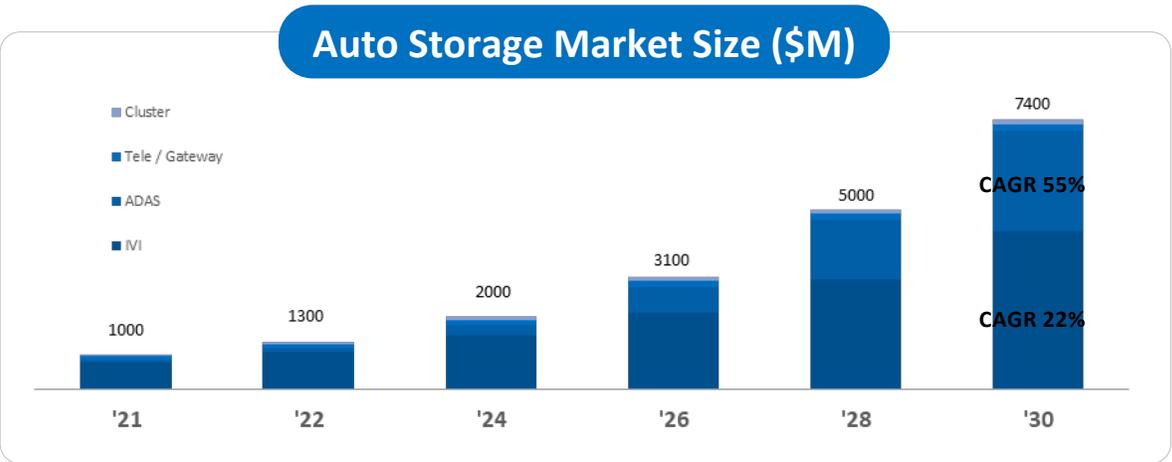
In-Vehicle-Infotainment (IVI)

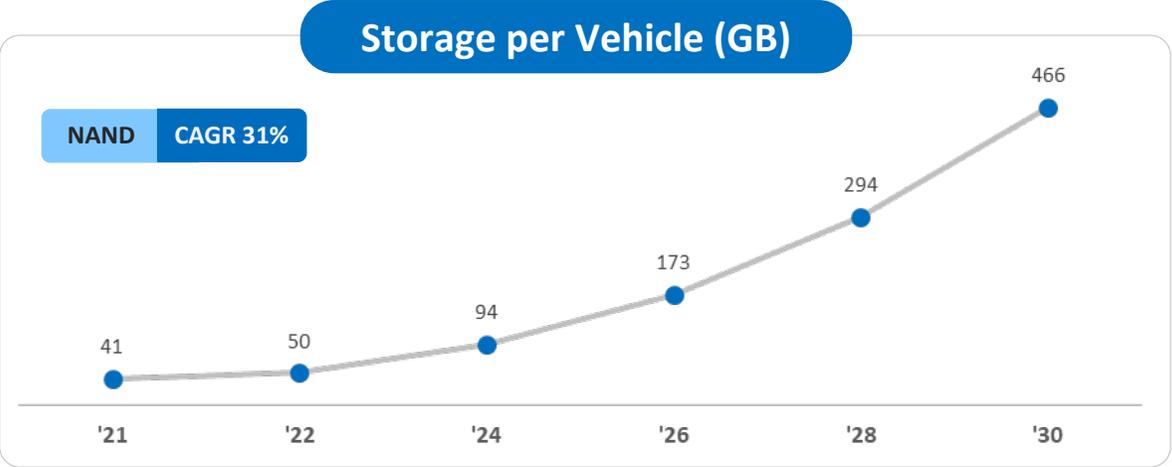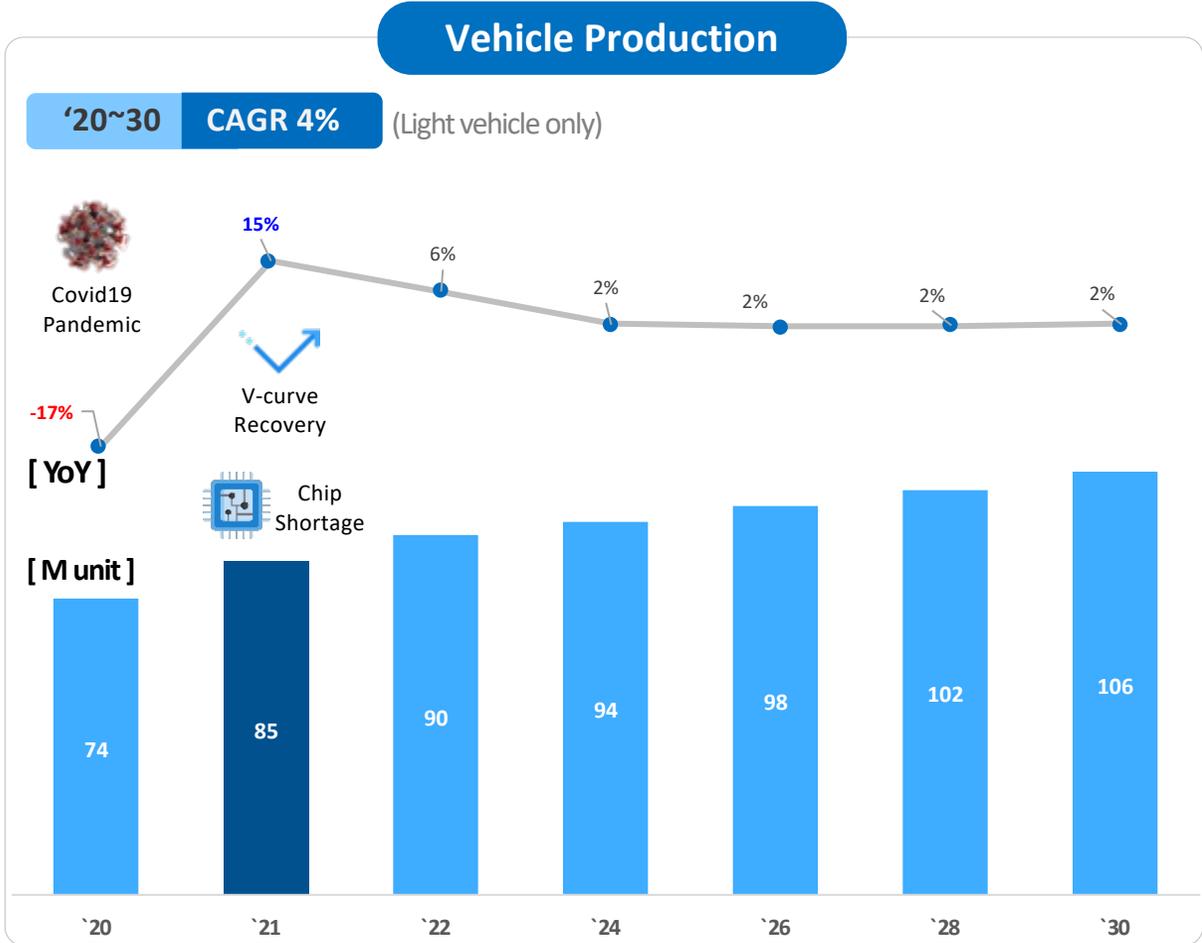Advanced Driver Assistance System (ADAS)/Autonomous Driving

Connected Car

Automotive Storage Market Outlook

Vehicle Production

'20~30 | CAGR 4% (Light vehicle only)

Covid19 Pandemic

15%

6%

2% 2% 2% 2%

-17%

V-curve Recovery

[YoY]

Chip Shortage

[M unit]

`20	`21	`22	`24	`26	`28	`30
74	85	90	94	98	102	106

Storage per Vehicle (GB)

NAND | CAGR 31%

'21	'22	'24	'26	'28	'30
41	50	94	173	294	466

Auto Storage Market Size ($M)

- Cluster
- Tele / Gateway
- ADAS
- IVI

'21	'22	'24	'26	'28	'30
1000	1300	2000	3100	5000	7400

CAGR 55%

CAGR 22%

* Source : SEC & IHS

※ Note: All the information is subject to change without notice.

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Storage Trends

UFS

eMMC

SSD

'20 '22 '24 '26 '28 '30
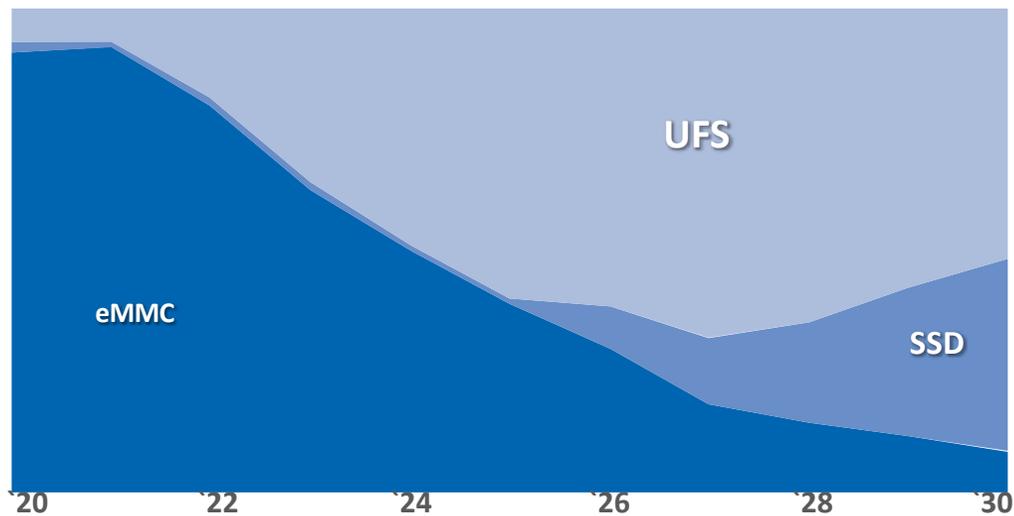
* Source: SEC

Density & Interface by Application

IO BW (bps)

SSD PCIe Gen4 / NVMe v1.4

16G

UFS 3.1

12G

A.D Lv4 & Blackbox

8G

UFS 2.1

Infotainment + Dash-board

6G

SSD PCIe Gen3 / NVME v1.3

eMMC5.1

ADAS

400M

Telematics Gateway

8G 16G 32G 64G 128G 256G 512G 1T Density
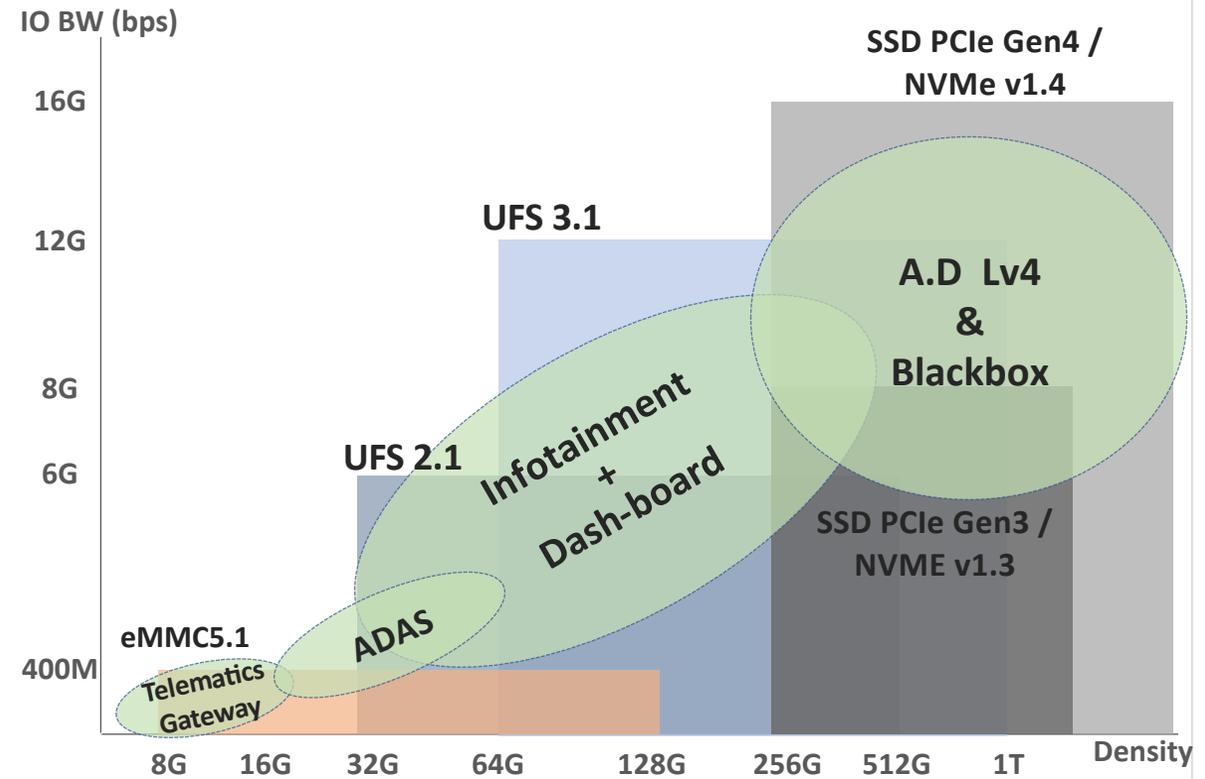
eMMC – Embedded Multi-Media Card
UFS – Universal Flash Storage

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Storage In the Car – Vehicle Operations

- In-vehicle Infotainment

- Modern Vehicles run on Software and Data
  - Engine/motor operations
  - User interfaces, Assisted/autonomous driving
  - Navigation, location tracking, remote diagnostics,

- OTA Communications
  - Software updates
  - Tracking/telemetry for vehicle maker and/or owner

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"Black Box" Storage In the Car

- **Record parameters right before or during incidents**
  - Speed, accelerator/brake use, steering inputs
  - G-forces, airbag deployment,
  - External video, radar, lidar inputs
- **Determine cause/fault for accidents**
  - Accident report, investigation, insurance/liability
  - Help design safer cars/software for future
- **Must be immutable and durable**
  - Record large burst of data in real-time
  - Survive impact, fire, tampering attempts

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Collecting Data From the Cars

- **Manufacturers Store Telemetry**
  - Customer behavior, marketing/sales
  - Predictive maintenance
  - Improving current software, future products
- **Employer Data Collection for the job**
  - Dashcams, safety video (bus/taxi/truck cam)
  - Driver evaluations and training
  - OTA or periodic connected uploads
- **Must be sharable, long-term storage**
  - May be object-oriented, replicated, on-prem or cloud
  - Survive impact, fire, tampering attempts

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Vehicle Design Storage

- Vehicle design is increasingly complex
- More Storage for design/testing
  - Mechanical design
  - Software/chip design
  - Virtual testing/simulations
  - Regulatory/compliance
  - Assisted/autonomous driving training/design/testing

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Special Storage Requirements for Autonomous Vehicles

1. **Code**
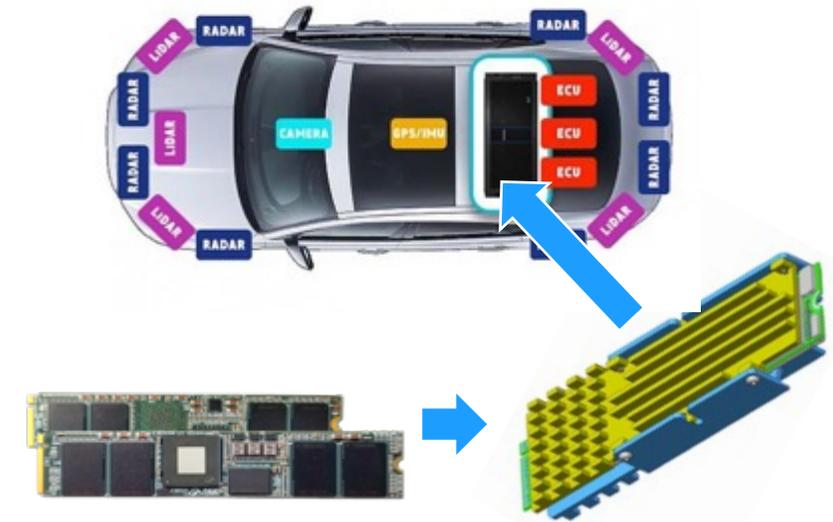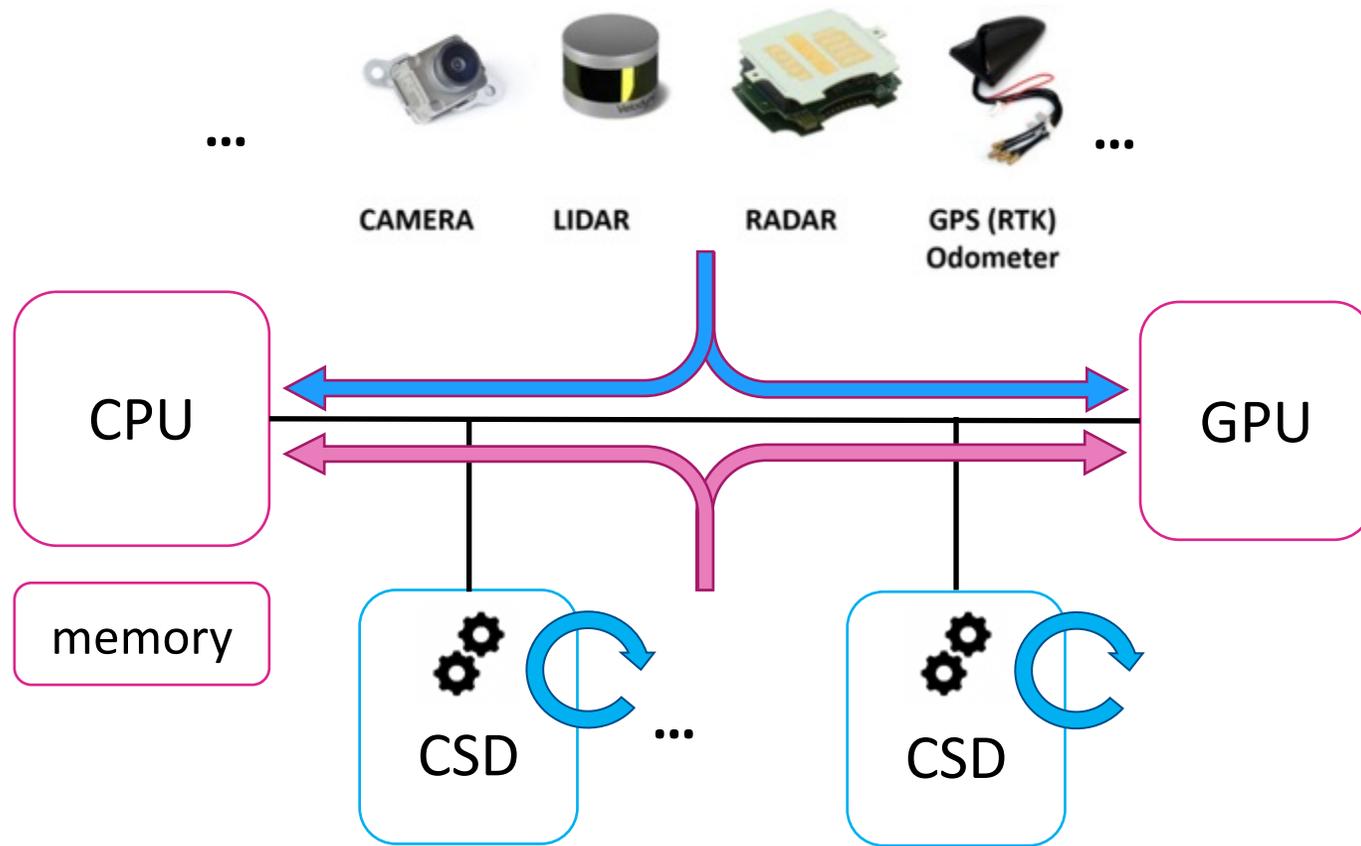   1. Storage for inference; high-definition maps
      1. OTA

2. **Data (logging)**
   1. Performance - Sustained Write
      1. Resolution of sensor suite
      2. Amount of compression
   2. Endurance
      1. TBW/DWPD
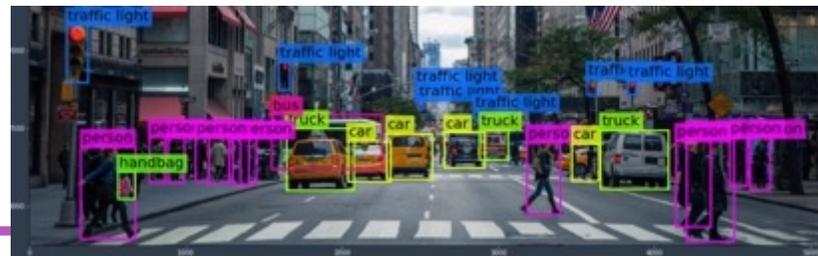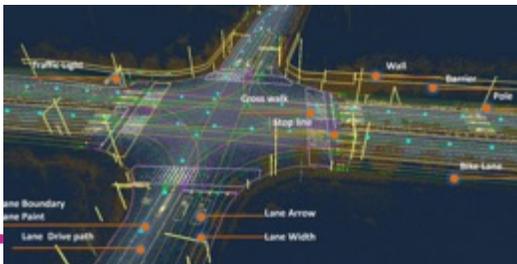   3. Life-time vehicle operation

1. **Qual**
   1. AEC-Q100
   2. ISO26262 - Functional Safety

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Computational Storage in Vehicles

CAMERA LIDAR RADAR GPS (RTK) Odometer

CPU

memory

GPU

CSD ... CSD

Use Cases:
- HD Map Updates
- Object Recognition & Tracking
- Distributed AI/ML Model Training
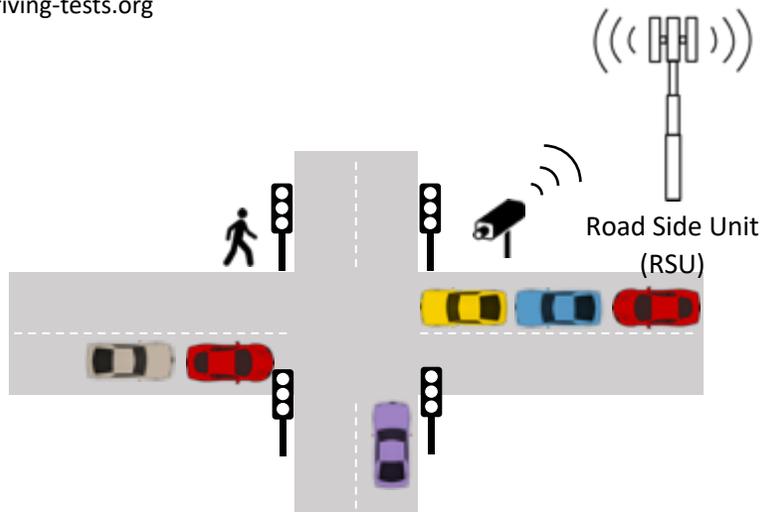
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Special Use Case – Intelligent Traffic Management

Use Case 1: Adaptive Traffic Control
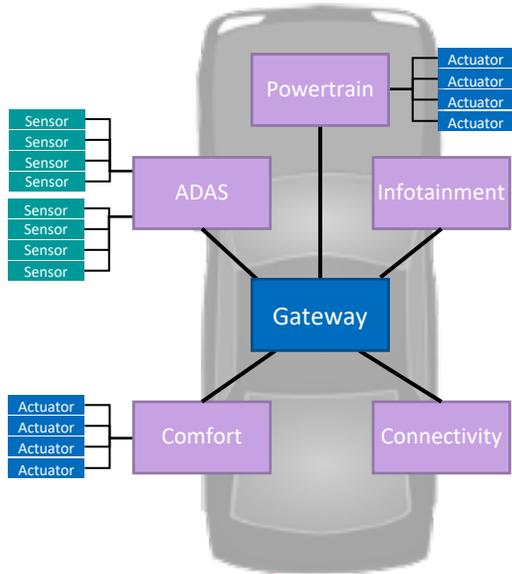

Driving-tests.org

Use Case 2: Sensor Extension

The Dallas Morning News

Road Side Unit (RSU)

RSU

RSU

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Vehicle Networking and Compute Challenges

Today
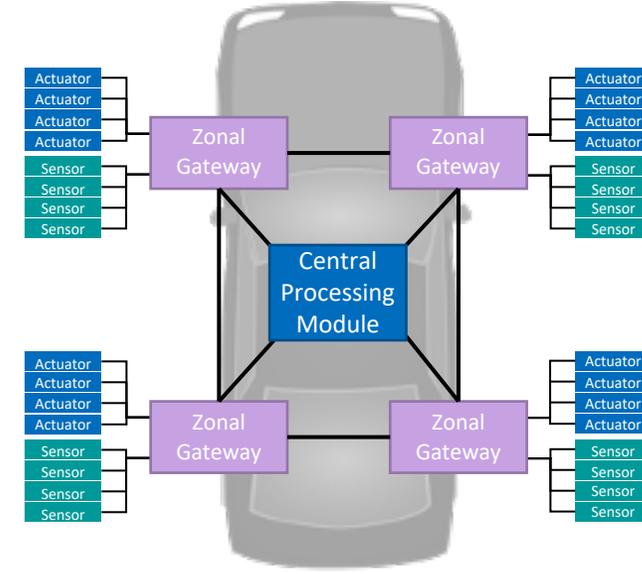

Next Generation : Centralized

Domain Architecture

- Vehicle functions separated into specific functions or domains – ADAS, IVI, etc.
- Central gateway connects to the different domains enabling data communication among the ECUs
- Each domain contains separate storage – eMMC, UFS or PCIe3

Consolidation of domains into Centralized compute platform

- Zonal Architecture: Partitioning/Local Pre-processing/Prioritizing
- SW defined architecture: Variation of chip integration & Data traffic/flow
- Central CPU, Virtualization/Hypervisor, Network
- High speed busses (PCIe5, 10Gb Ethernet, MIPI)
- Storage: High Density/Bandwidth requirement

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Summary

- Automotive storage growing 31% annually

- Driven by In-vehicle Infotainment (IVI) and advanced driver-assistance systems (ADAS) and autonomous driving systems

- Data collected during vehicle operation driving growth off-vehicle storage

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