Assisted and Self-Driving Vehicles are Mobile Datacenters

5-20TB of Data Will Be Consumed Per Day Per Vehicle

The evolution of cars to assisted and self-driving creates the need for cars to serve as mobile data centers with the computing power to process data in real-time. Managing this data effectively and quickly creates new challenges for the enterprise storage industry.

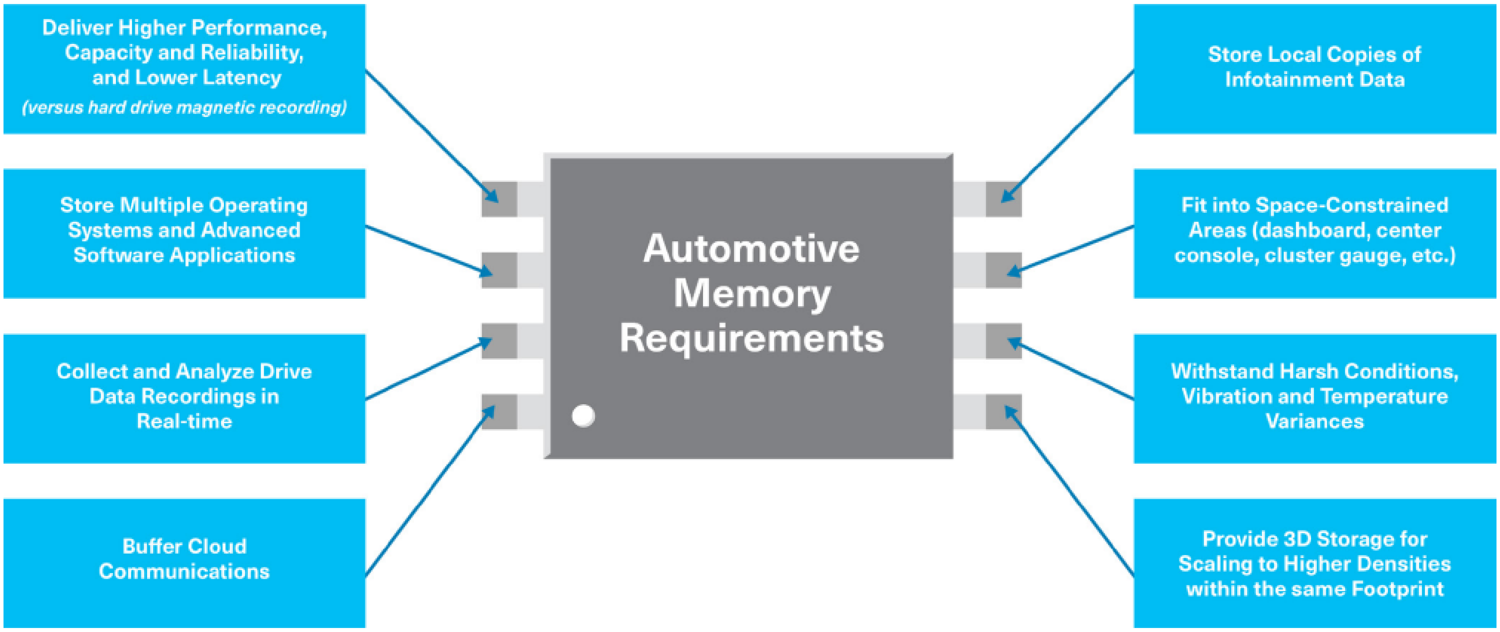
> "For decades, most of the electronics on a car were encased in electronic control units, segmented by function such as braking and infotainment. As more safety features were added and centralized, they were organized by distinct software stacks and automotive OSes based on different domains communicating with each other through a centralized gateway, which is what most new vehicles use today.
>
> But as more autonomy is added into vehicles, the latency of a centralized gateway is proving unworkable. Tighter interdependence, scalability, and flexibility are all required, which a zonal architecture allows, and OEMs are at varying stages of adopting this approach. Strikingly, the automotive zonal architectures look a lot like scaled-down HPC data centers."

One of the challenges of taking data centers on the road is addressing changes in temperature and that impact on data storage integrity. To put the challenge in perspective, consider the fact that, globally, the average useage per smart phone is 11.4GB. Average traffic useage per smartphone in the North America is expected to reach 53GM/month by 2027. Assisted and self-driving vehicles generate terabytes of data daily.

Consumers moving from landlines to cellphones, and carrying computers in their pockets, is not directly analogous to moving from manual to automous cars. People trade cellphones every few years and store far less data. And while consumers appreciate and desire quick data analytics in a phone, the difference in real-time analytics for vehicles may be life-saving. The expectation is that a vehicle will be functional well beyond a few years.

	Autonomous Vehicles	Smartphones	Key storage attributes
Temperature	-40°C to 125°C	0 to 70°C	Data retention and integrity
Lifetime	+10 years	3 years	Wear leveling
Storage capacity	1-5 TB	256 GB	Efficient allocation and management tools
Data processing	Local + Edge	Cloud	Parallel operations
Performance	Safety-critical + UX	User Experience	Fragmentation

NAND memory is appropriate for addressing these automotive data storage needs because it is dense, erases memory blocks quickly, resulting in faster write times, and significantly lower price.



Sample of NAND flash storage uses within assisted and self-driving vehicles

Market research and strategy consulting firm Yole Développement (Yole) projects the market for NAND in automotive to grow to $3.6 billion in 2025, nearly quadrupling from $0.9 billion in 2020.

From NAND Keeps Pace with ADAS Data-Storage Requirements:

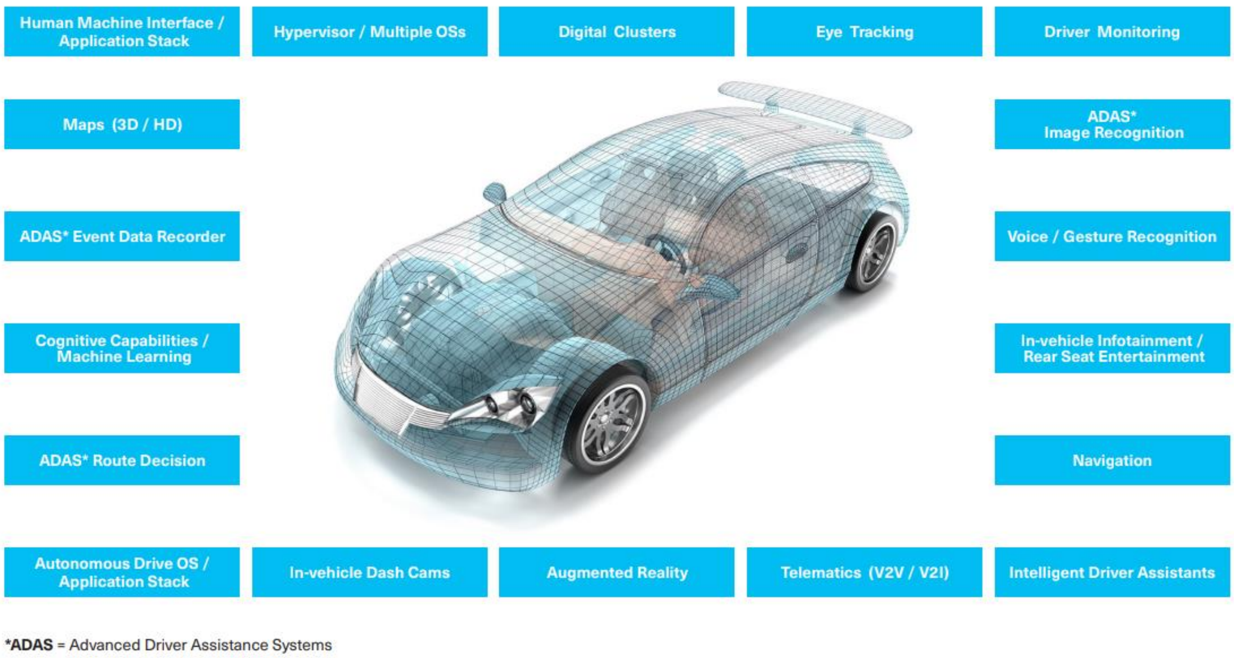
> "As we move from level 1 and 2 autonomy toward level-5 full autonomy, it's estimated there will be between 3 and 10 GB of new data generated every second. Even a car with level-2 autonomous capabilities generates up to 1 GB of data/second.
>
> Since you can't transmit everything to the network or the cloud (and you don't want to for latency reasons), massive storage is needed. This will result in a possible fourfold increase in non-volatile memory (NVM) content, increasing from 16 GB to 128 GB to 64 GB to 1.0 TB, depending on the level of autonomy."

KIOXIA outlines five best practices to using managed NAND for these automotive applications, in light of the temperature needs, flash memory wear-out, and the WAF effect (the ratio of data written to the NAND from the data written by the host).

1. Evaluate the WAF – Collect workload traces and analyse them to evaluate WAFs for system optimization and slower NAND wear.
2. Create Larger Chunk Sizes – Perform less frequent small block write operations to reduce unused dead space. NAND performs better with sequential write operations in big chucks.

Each page should be filled with data as much as feasible. Implement a RAM buffer to aggreage small data chucks before writing it to NAND.

3. Use pSLC Mode – Store a single bit per cell to improve write endurance.
4. Develop a Refresh Implementation – The refresh process checks the blocks to be refreshed and blocks of data considered to be “at risk” and moves them to extend data retention.
5. Monitor the Health Register – Monitor the e-MMC and UFS specification health registers on a regular basis to keep track of NAND real-time usage.



NAND flash storage delivers a number of capabilities within an automotive environment.

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G2M Communications, 2022