

"Our memories define our past and enable the accumulation of capability that drives our technological civilization. The major business of our age is to pass accumulated experiences, beliefs, and observations to future generations. Data storage is how we will pass on this legacy. The future is storage-centric, stored data is the heart of a modern network."

Digital storage demand is extremely elastic, it cannot be saturated and is bounded only by budget and management capacity. Furthermore digital storage attracts application, similar to the way gravity attracts massive bodies.

Tom Coughlin, Coughlin Associates





KIOXIA Celebrates 35th Anniversary of Invention of NAND Flash Memory



## **CELEBRATING 35 YEARS OF NAND FLASH**

Flash transformed technology...





This year marks the 35<sup>th</sup> anniversary of the company's invention of NAND flash memory, the disruptive technology that's farreaching impact has fundamentally changed how we live, work and play. Flash enables a new way of life...



What do the MP3 players of the 1990s and today's smartphones have in common? Neither would exist were it not for NAND flash memory, an innovation whose influence has reverberated throughout the decades. KIOXIA America, Inc. today announced that it has reached a new milestone – 2022 marks the 35th anniversary of the company's invention of NAND flash memory.

Back in 1987, it would have been hard to imagine all of the ways that this then brand-new technology would impact the world. NAND flash memory has ushered in entire new technological eras, and obsoleted technologies and products that had been in use for years - changing our lives in countless ways. Since starting at zero 35 years ago, the NAND flash market has grown to \$70B1. In terms of die density, flash memory has grown from 4Mb to 1.33Tb – a 333,000x increase2. To put this exponential growth in perspective, in the 1990s, the largest available density flash memory available could hold 1/8 of a photo. Flash forward to today, where the largest available die density is a whopping 1.33Tb – and capable of storing 39,000 photos.

Some of the first applications that flash made possible all those years ago, including digital cameras,

barcode scanners and Personal Digital Assistants (PDAs), have evolved along with the technology, to the point where they are almost unrecognizable today. Additionally, new applications have been born, many of which would simply not exist were it not for the advances being made to KIOXIA's invention. Think smartphones, tablets and notebooks, automotive infotainment systems, gaming, wearables and so much more.

"Flash memory is a game-changer that continues to stand the test of time," said <u>Scott Nelson</u>, senior vice president and chief marketing officer for KIOXIA America, Inc. "Imagine what's to come – will the vision of smart cities be realized? Will truly autonomous cars take us from place to place? Whatever the future



holds, KIOXIA will continue to lead the way forward, investing in and evolving the technology that makes storage densities higher and costs lower. The sky is the limit for flash memory, and the next wave of

applications that will further enrich our lives is just around the corner. In some ways, we're just getting started."

KIOXIA's commemoration of the 35th anniversary of the invention of NAND flash will continue throughout 2022. KIOXIA has also created a dedicated 35th anniversary website, where a series of videos that explore what life would be like without flash memory can be viewed, and industry insights, predictions and opinions related to the importance of flash memory will be shared. For more information and to stay up to date on 35th anniversary activities, please visit www.kioxia.com and follow the company on Twitter and LinkedIn.

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Look How Far We've Come					
Market Growth: From the market size for flash memo	90s to today, the ry continues to grow	In the 90s	vs	Today	
<b>4</b> 0 <b>5</b>	Price Per Gigabyte	\$10,000 per GB		~\$0.20 per GB	
	Die Density	4Mb		1.33Tb	
	Music Storage	<b>1/16</b> of a song could be stored on a 4Mb NAND die		20,000 songs on a 1.33Tb NAND die	
	Photo Storage	1/8 of a photo could be stored on a 4Mb NAND die		<b>39,000</b> photos on a 1.33Tb NAND die	

# 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 <u>53GM/month by 2027</u>. Assisted and self-driving vehicles generate <u>terabytes of data daily</u>.

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

<u>NAND memory</u> 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.



Market research and strategy consulting firm Yole Développement (Yole) projects the market for NAND in automotive to grow to <u>\$3.6 billion in 2025</u>, 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.



\*ADAS = Advanced Driver Assistance Systems

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



#### Polls Results from <u>Advanced NVMe<sup>™</sup> SSDs</u> –<u>Changing the Game</u> with Sponsors <u>Western Digital</u>, <u>Intel</u>, <u>NGD Systems</u>, and <u>KIOXIA</u>

What is are the greatest concerns your organization has for the adoption of flash storage, both in servers and in storage systems? (check all that apply):

Cost (as measured in \$/TB):	52%
Cost/TB deflation:	24%
Capacity:	17%
Reliability:	39%
Impacts on Application Performance:	22%
Storage Management:	26%
Avoiding Vendor Lock-In:	33%
Difficulties Migrating from Hard Disk Drives:	9%
Other:	7%

Who will you primarily look to for guidance when considering adoption of a new flash form factor (choose one):

Server Vendors:	13%
Storage Systems Vendors:	30%
My System Integrator (SI) or reseller:	4%
End-User Focused Analysts (Gartner, IDC, Forrester, etc.):	9%
My peers in the industry:	11%
SSD Vendors:	32%
Other:	2%

What would be your biggest concerns when considering SSDs with "extended capabilities" (choose all that apply):

Development environment maturity:	38%
Lack of support from application vendors:	25%
Application porting/adapting:	33%
Vendor lock-in:	50%
Lack of interoperability across devices:	48%
Lack of a clear potential ROI:	23%
Other:	40%



#### **KIOXIA Webinar Series**

Tuesday, February 8, <u>KIOXIA</u> provided an analysis of "4 Ways Multi-Protocol Can Maximize Flash Value." The webinar video is available to view <u>here</u> and the slidedeck is available <u>here</u>. KIOXIA industry expert, Earle Philhower explains how flash memory revolutionized the data center by being backwards compatible with legacy hard drive protocols. However, in certain applications that backwards compatibility limits how valuable flash memory can be. In order to improve TCO and maximize performance and storage utilization, multiple unique and incompatible flash storage protocols have been developed. Unfortunately, managing all these different drive types at cloud scale can be a challenge.

This was the third in a four part webinar series to dive deeper into learning how an open-source, software-defined approach to flash protocols can deliver better economics, increased deployment flexibility and simpler supply management.

Each webinar stands alone and collectively provides an overview of the innovation, direction, and leadership <u>KIOXIA</u> provides in this enterprise storage space.

November 17, KIOXIA presented the second webinar in their four-part webinar series, <u>"The Next Flash Revolution at Scale: Open Source Software + Software-Enabled Technology.</u>" The video is available to <u>view</u> and a copy of the slidedeck is available <u>here</u>. KIOXIA webinar Part 1, <u>"Why Flash Memory At Scale Should be Software-Defined</u>" is available to view <u>here</u> along a copy of the slidedeck <u>here</u>.

# 4 Ways Multi-Protocol Can Maximize Flash Value

Earle F. Philhower, III KIOXIA America, Inc.

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### Upcoming Conferences

February 14-15	Gartner Security & Risk Management Summit, Dubai
February 17-18	Deep Learning Hybrid Summit, San Fran & Virtual
February 28- March 3	MWC Barcelona
March 2-3	Big Data & Al World, London
March 2-3	<u>Cloud Expo Europe</u> , London
March 2-3	Cloud & Cyber Security Expo, London
March 11-12	SXSW 2022, Austin
March 14-16	Gartner Identity & Access Management, Vegas
March 14-17	Gartner Data & Analytics Summit, Orlando
March 23-24	Paubox SECURE 2022, Vegas
March 28-31	Data Center World, Austin
April 19-21	ODSC East, Boston
April 23-27	<u>NAB</u> , Vegas
April 26-28	Smart NICs Summit, San Jose
May 4-5	World Summit AI Americas, Montreal
May 9-11	Gartner Data & Analytics Summit, London
May 10-13	Black Hat Asia, Singapore
May 11-12	Al & Big Data Expo, Santa Clara
May 11-12	Cyber Security & Cloud Congress, Santa Clara
May 18-19	Gartner Digital Workplace Summit, London
June 6-9	RSA Conference, San Francisco & Virtual
June 7-10	Women in Tech Global Conference 2022, TBA & Virtual

June 12-16	<u>Cisco Live</u> , Vegas
June 14-16	Digital Enterprise Show, Malaga
June 15	Cloud Security Summit, Virtual
June 21-22	Gartner Security & Risk Management Summit, Sydney
June 21-22	Gartner Digital Workplace Summit, San Diego
June 29- July1	Mobile World Congress, Shanghai
July 19-20	Cyber Solutions Summit & Expo, Virtual
August 2-4	Flash Memory Summit, Santa Clara
August 6-11	Black Hat USA, Vegas
August 11-14	DEF CON 30, Vegas
September 13-14	CISO Forum, Virtual
September 19-20	Industry of Things World, Berlin
September 28-29	IoT World, Santa Clara
October 5-6	Evolve, Vegas
October 24-27	ICS Cybersecurity Conference, Hybrid/Virtual
November 16	San Diego Cybersecurity Conference, Hybrid
November 16	Threat Hunting Summit, Virtual
November 18-19	Data Strategy & Insights (Forrester Research), Virtual
December 1-2	Al & Big Data Expo Global, London
December 6	Security Operations Summit, Virtual





Effective Marketing & Communications with Quantifiable Results