MIT’s Dudley Buck creates first semiconductor NVM from ferroelectric crystals.

Bell Labs’ Meir and Anderson create monolithic 256-bit FRAM ferroelectric NVM, the first monolithic memory chip.

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<td>1971</td>
<td>Toshiba's Iizuka, Masuoka and others introduce the first double-layered polysilicon memory cell with Floating Gate electrical erase as Stacked-Gate Avalanche-Injection Type MOS (SAMOS) Memory at the Conference on Solid State Devices and Materials in Tokyo.</td>
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<tr>
<td>1972</td>
<td>Fujio Masuoka goes on to receive the 2013 FMS Lifetime Achievement Award.</td>
</tr>
<tr>
<td>1974</td>
<td>General instrument ships EAROM, the first commercial EEPROM.</td>
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<td>1975</td>
<td>Hitachi files for patent on NAND-type MRAM. Portable digital camera invented at Eastman Kodak Company with digital image storage on a cassette tape.</td>
</tr>
<tr>
<td>1977</td>
<td>Eli Harari (2012 and 2022 FMS Lifetime Achievement Awardee), then of Hughes Microelectronics, files for patent on first practical floating gate EEPROM using thin SiO2 and Fowler-Nordheim tunneling for program and erase.</td>
</tr>
<tr>
<td>1979</td>
<td>Patent granted to TI's Gerald Rogers for mask ROM configured as a NAND array to reduce chip area and cost.</td>
</tr>
<tr>
<td>1979</td>
<td>Hughes Microelectronics introduces first CMOS NOVRAM 256-bit chip (non-volatile SRAM) employing Fowler Nordheim floating gate EEPROM at IEEE ISSCC in San Francisco.</td>
</tr>
<tr>
<td>1979</td>
<td>George Perlegos (2017 FMS Lifetime Achievement Awardee) designs the Intel 2816, which was introduced in 1980 and became the first commercially successful EEPROM.</td>
</tr>
</tbody>
</table>
Hughes Microelectronics introduces the 3108, first CMOS EEPROM 8Kb chip employing Fowler-Nordheim tunneling. Intel introduces the 2816, a 16Kb HMOS EEPROM with a FLOTOX (floating gate tunnel oxide) structure employing Fowler-Nordheim tunneling, at IEEE ISSCC in San Francisco. Fujitsu files for patent on improvements to Hitachi’s 1975 MROM.

British scientist and inventor Kane Kramer designs first digital audio player (IXI) based on magnetic bubble memory chips. SeeQ Technology presents paper at ISSCC in San Francisco introducing its 5213, the first EEPROM with an on-chip charge pump for in-system write and erase, an invention used in all flash memory devices. Ramtron introduces first commercial FRAM NVM.

Intel introduces 2817A 16Kb EEPROM.

First paper describing flash EEPROM (later known as NOR flash) presented by Toshiba’s Fujio Masuoka (2013 FMS Lifetime Achievement Awardee) at IEEE International Electron Devices Meeting (IEDM) in San Francisco. Intel begins flash process development. George Perlegos (2017 FMS Lifetime Achievement Awardee) founds ATMEL (which stands for ‘Advanced Technology for Memory and Logic’).

Exel files for patent on first NOR Flash cell. NEC’s Kitamura files for first MLC (Multi-Level Cell) EEPROM patent (in Japan).

Toshiba’s Fujio Masuoka (2013 FMS Lifetime Achievement Awardee) presents paper on NAND flash memory at IEEE IEDM in Washington, DC; the 35th anniversary of this inventive paper was celebrated at the 2022 FMS.

Intel introduces NOR flash chips.
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<td>1988</td>
<td>SunDisk founded by Eli Harari (2012 and 2022 FMS Lifetime Achievement Award winner) to develop new “System Flash” architecture combining embedded controller, firmware, and flash to emulate disk storage, and files for first MLC (Multi-Level Cell) flash patent. First flash memory sampled by Intel as 1Mb NOR chips. Intel’s Design Team of Richard Pashley, Stefan Lai, Bruce McCormick and Niles Kynett go on to receive 2011 FMS Lifetime Achievement Awards. Intel and Psion design flash-based mobile PC. First flash-based digital camera, Fuji DS-1P, demonstrated. 150mm wafers used.</td>
</tr>
<tr>
<td>1989</td>
<td>SunDisk files for patent on “System Flash” which describes on-chip cell management. M-Systems founded and introduces Flash Disk concept (predecessor to flash SSDs); M-Systems co-founder Dov Moran and Aryeh Mengi go on to receive 2018 FMS Lifetime Achievement Awards. Intel ships 512KB and 1MB NOR flash. Psion flash-based PC introduced. Microsoft introduces Flash File System In joint effort with Intel. DigiPro introduces 8MB NOR Flashdisk at Comdex. Western Digital and SunDisk pioneer NOR-based SSD fully emulating an ATA HDD. Personal Computer Memory Card International Association (PCMCIA) founded. Silicon Storage Technology (SST) founded to produce NOR SuperFlash compatible with a CMOS logic process.</td>
</tr>
<tr>
<td>1991</td>
<td>Kodak ships DCS-100, its first DCS at $15,000. Zenith, Poqet and HP palm-sized notebook computers using flash memory cards shown at Spring Comdex. Intel introduces 1MB “boot block” NOR flash chip with sectors for BIOS applications—first use of internal write state machine to manage flash write algorithm. SunDisk introduces first serial 9Mb NOR Flash chip for SSD applications. PCs begin using flash for BIOS storage. The Joint Photographic Experts Group published the JPEG standard, enabling digital cameras to store compressed photos using media such as flash memory.</td>
</tr>
<tr>
<td>1992</td>
<td>Toshiba ships first mass-produced NAND flash chips (4Mb). Information Storage Devices introduces flash-based voice recorder chip. AMD introduces its first NOR product. Fujitsu introduces its first NOR product. M-Systems introduces TrueFSS, the first flash memory card FTL; this was later adopted by the PCMCIA as its FTL. Intel launches second-generation FFS2. Intel introduces 8Mb NOR flash chips and 4MB-20MB linear flash memory cards. Intel introduces 1Mb “boot block” NOR flash with sectors for BIOS applications—first use of internal write state machine to manage flash write algorithm. SunDisk introduces CompactFlash card. Norris Communications introduces Flashback, the first portable digital voice recorder with flash memory. A 0.5 micron process announced. SunDisk introduces 18Mb Serial NOR flash chip for SSD applications. M-Systems introduces NOR-based DiskOnChip.</td>
</tr>
<tr>
<td>1993</td>
<td>Toshiba ships 16Mb NAND flash chips, which enable portable storage with the first PCMCIA cards. Datellight introduces “Card Trick” flash management software. Apple introduces NOR flash-based Newton PDA. Intel introduces 16Mb and 32Mb NOR flash. Intel and Conner Peripherals introduce jointly-developed 5Mb/10Mb ATA flash disk drive. AMD introduces new flash chip using negative gate erase. SunDisk introduces CompactFlash card. Mitsubishi introduces DiNOR. SunDisk changes name to SanDisk. CompactFlash Association (CFA) founded.</td>
</tr>
<tr>
<td>1994</td>
<td>Flash (NOR and NAND) revenues exceed $1B. Casio introduces the QV-11 digital camera with flash rather than film or floppy. Mitsubishi introduces DiNOR. SunDisk changes name to SanDisk. CompactFlash Association (CFA) founded.</td>
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<tr>
<td>1995</td>
<td>$6,400,000 $25,600,000 $100,000,000 $170,000,000 $295,000,000 $505,000,000 $864,805,000 $1,860,089,000</td>
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</table>
$2.6B in flash memory revenues, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.

1997
500 million flash chips shipped. Saehan Information Systems introduces flash-based MPMan MP3 player. SanDisk and Siemens introduce MultiMedia Card (MMC and MMCplus). Sony introduces the Memory Stick. First cell phone ship with flash memory. M-Systems introduces NAND-based DiskOnChip. 200mm wafers begin production. SanDisk begins using 256 Mb MLC flash chips in its CompactFlash (CF) cards. Intel introduces 2-bit/cell 64Mb MLC StratFlash chip. MultiMediaCard (MMC) unveiled by SanDisk and Siemens. SanDisk begins transition from NOR to NAND flash. Atmel introduces DataFlash based on SPI NOR and 8-pin interface, leading to widespread consumer product usage. NOR revenues exceed $2B. 250nm process announced. Saehan Information Systems and licensee Eiger ship first mass-produced MP3 player (IMPMan) with 32MB. Diamond Rio introduces PMP300 MP3 player. MultiMediaCard Association (MMCIA) founded by 14 companies. Apple (Mac) introduced without floppy but with USB, encouraging USB-based external storage. USB Implementers Forum first publishes USB Mass Storage Class spec (finalized in 1999) to standardize USB-based storage. NOR revenues exceed $4B. Over one billion flash chips shipped. Toshiba and SanDisk create flash memory manufacturing joint venture. Micron announces NOR products. Hi-Star Sys-Com begins shipping FlashGate, a USB SmartMedia flash memory card drive. Dow Moran (2018 FMS Lifetime Achievement Co-Awardee) is co-inventor on M-Systems patent filing for USB flash drive. Lexar Media introduces CompactFlash-to-USB JumpSHOT. Panasonic (Matsushita), SanDisk and Toshiba establish SD Association to standardize and promote the Secure Digital memory card. SLC NAND-based SD cards introduced in 8MB to 64MB capacities. NAND revenues exceed $5B. Toshiba and SanDisk announce 1Gb MLC NAND. SanDisk introduces first NAND “System Flash” product. Hitachi introduces AG-NAND. Samsung begins mass production of 512Mb flash memory device. Saffid develops NROM with charge trap flash structure, the basis for Spansion’s MirrorBit. Olympus and Fujifilm introduce X-Picture Card. MMCmobile card introduced by MMC (MultiMediaCard Association). Sony and SanDisk jointly introduce the Memory Stick PRO and half-size Memory Stick PRO Duo cards. M-Systems introduces Mobile DiskOnChip, the first SSD in a chip; this was used in handsets by Nokia, Motorola and Ericsson. AMD introduces MirrorBit using hot electron injection-based charge trap flash. Cypress introduces Programmable System on Chip (PSOC) with first embedded SONOS using quantum mechanical tunneling-based charge trap flash. 130nm process announced.

1998
$2.61B, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.

1999
$4.56B, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.

2000
$10.637B, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.

2001
$7.594B, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.

2002
$7.766B, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.

2003
$11.739B, 163.063% growth in 10 years. Toshiba introduces SmartMedia Memory Card (also called Solid State Floppy Disk Card). Samsung starts shipping NAND flash. Kodak DC-25 is first DSC with CompactFlash card. Datalight introduces “FlashFX” flash management software supporting NOR and NAND in a single driver. SanDisk introduces world’s first MLC (2 bits/cell) flash chip (80 Mb) in a CompactFlash (CF) card. Palm introduces flash memory-based PDA. 0.35 micron process announced. Lexar Media spins off from Cirrus Logic. USB Association (USBA) founded.
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<td>2004</td>
<td>SanDisk and Motorola introduce TransFlash card, now the microSD card</td>
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<td>2005</td>
<td>Flash revenues exceed $20B. Over three billion flash chips ship</td>
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<td>2006</td>
<td>NVMHCI 1.0 Spec released by Intel, SanDisk introduces ABL to enable high speed MLC, TLC, and X4 QLC NAND, 34nm process announced by Intel and Micron. SanDisk introduces first 512GB MLC SATA-based SSD.</td>
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<td>2007</td>
<td>Toshiba introduces first SATA-based MLC SSD. Apple introduces the iPhone. Fusion-io announces 640GB iDrive MLC NAND-based PCIe X4 SSD. Micron, Samsung and Sun Microsystems announce high-endurance flash memory. Violin Memory introduces first flash-based storage appliance. Samsung announces 150GB 2.5&quot; MLC SSD with SATA II interface. Several companies announce MLC flash SSDs with up to 256GB storage. Micron introduces first serial NAND flash. Apple sells one million flash-based iPhones in 3 days. Sub-$200 netbook computers introduced with flash memory storage. Microsoft introduces flash-based Zune Player. Seagate announces Hybrid Storage Alliance. Seagate introduces first hybrid SSD, the Momentus PSD.</td>
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<td>2008</td>
<td>Flash revenues exceed $22B, almost 9 times 1997 revenues. NVM HCI revenues exceed $54.3B. Non-Volatile Memory Host Controller Interface (NVMHCI) Working Group formed, with Intel’s Amber Huffman as Chair. Toshiba introduces eMMC NAND. IMFT begins shipping 50nm NAND flash. Toshiba introduces first SATA-based MLC SSD. Apple introduces the iPhone. Fusion-io announces 640GB iDrive MLC NAND-based PCIe X4 SSD. Micron, Samsung and Sun Microsystems announce high-endurance flash memory. Violin Memory introduces first flash-based storage appliance. Samsung announces 150GB 2.5&quot; MLC SSD with SATA II interface. Several companies announce MLC flash SSDs with up to 256GB storage. Micron introduces first serial NAND flash. Apple sells one million flash-based iPhones in 3 days. Sub-$200 netbook computers introduced with flash memory storage. Microsoft introduces flash-based Zune Player. Seagate announces Hybrid Storage Alliance. Seagate introduces first hybrid SSD, the Momentus PSD.</td>
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<td>2009</td>
<td>NVMHCI renamed “NVM Express” (aka NVMe) and NVM Express Work Group established, NVM Express Rev. 1.0 published. JEDEC publishes first Universal Flash Storage (UFS) spec. SIA publishes two Solid State Storage Performance specs: Enterprise and Client. JEDEC publishes Serial Flash Discoverable Parameters (SFDI) spec. Facebook launches the Open Compute Project (OCP) to enable broad industry collaboration of open source software and scalable energy-efficient data center hardware. Facebook launches the Open Compute Project (OCP) to enable broad industry collaboration of open source software and scalable energy-efficient data center hardware. Intel’s 1988 NOR Flash Memory Design Team of Richard Paoli, Stefan Lai, Bruce McCormick and Niles Kynett receive first FMS Lifetime Achievement Awards.</td>
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<td>2010</td>
<td>Toshiba introduces 128GB SSD card based on 16-chip stack. Intel, Micron introduce 25nm TLC and MLC NAND. Numonyx acquired by Micron. Micron, Numonyx introduce first self-managed hybrid HDD, Momentus XT, with 4GB NAND flash and 500GB HDD storage. Seagate announces second generation Momentus XT hybrid HDD with 8GB NAND flash and 750GB HDD storage. Apple acquires signal-processing controller IP firm Anobit. Fusion-io introduces virtualization-aware flash caching software company IO Turbine. NVMe renamed “NVM Express” (aka NVMe) and NVM Express Work Group established, NVM Express Rev. 1.0 published. JEDEC publishes first Universal Flash Storage (UFS) spec. SIA publishes two Solid State Storage Performance specs: Enterprise and Client. JEDEC publishes Serial Flash Discoverable Parameters (SFDI) spec. Facebook launches the Open Compute Project (OCP) to enable broad industry collaboration of open source software and scalable energy-efficient data center hardware. Facebook launches the Open Compute Project (OCP) to enable broad industry collaboration of open source software and scalable energy-efficient data center hardware. Intel’s 1988 NOR Flash Memory Design Team of Richard Paoli, Stefan Lai, Bruce McCormick and Niles Kynett receive first FMS Lifetime Achievement Awards.</td>
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<td>2011</td>
<td>LSI acquires SandForce. SanDisk acquires Phlant. IMFT introduces 20nm NAND flash. Intel announces Smart Response Technology (SRT) SSD caching (UFS) spec. Seagate announces second generation Momentus XT hybrid HDD with 8GB NAND flash and 750GB HDD storage. Apple acquires signal-processing controller IP firm Anobit. Fusion-io introduces virtualization-aware flash caching software company IO Turbine. NVMe renamed “NVM Express” (aka NVMe) and NVM Express Work Group established, NVM Express Rev. 1.0 published. JEDEC publishes first Universal Flash Storage (UFS) spec. SIA publishes two Solid State Storage Performance specs: Enterprise and Client. JEDEC publishes Serial Flash Discoverable Parameters (SFDI) spec. Facebook launches the Open Compute Project (OCP) to enable broad industry collaboration of open source software and scalable energy-efficient data center hardware. Facebook launches the Open Compute Project (OCP) to enable broad industry collaboration of open source software and scalable energy-efficient data center hardware. Intel’s 1988 NOR Flash Memory Design Team of Richard Paoli, Stefan Lai, Bruce McCormick and Niles Kynett receive first FMS Lifetime Achievement Awards.</td>
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SanDisk and Toshiba announce 19nm process in 128Gb chips at IEEE ISSCC in San Francisco.

UltraBots ship with Smart Response Technology (SRT) SSD cache.

Macronix and Winbond enter NAND business.

Seagate introduces 5SHD, a Hybrid Hard Drive (HHD) pairing flash with an HDD.

Elpida introduces ReRAM. Micron and Intel introduce 20nm 128Gb NAND chip using Hi-k planar cell.

SK hynix formed upon SK Telecom’s acquisition of controlling interest in Hynix Semiconductor.

MOSAD samples 33GB8 Hi-NAND.

Adesto acquires ATMEL’s Serial NOR business.

DensBits Technologies introduces Memory Modern.

Proximal Data introduces AutoCache.

SanDisk acquires FlashSoft.

EMC acquires Xterion.

OCC acquires Sanrad.

Samsung acquires NViLEO.

Intel acquires Neuvex and introduces CacheWorks.

LSI introduces Nifty flash with MegaRAID CacheCard caching software.

Integrated Device Technology (IDT) introduces first 16Gb SSD controller chip.

Micron introduces 2.5" PCIe enterprise SSD.

IBM acquires Texas Memory Systems.

Cypress Semiconductor introduces Memory Systems.

Micron introduces 2.5" 128Gb 3D NAND.

Toshiba introduces first NVMe SSD. LSI introduces Nytro flash.

Intel acquires Nevex and wins FMS Award.

Samsung announces 12-layer 3D V-NAND at AMD and demo it in a 1TB SSD.

11 companies participate in first NVMe P Nvmefest.

Diablo Technologies announces Memory Channel Storage tech. SMART Storage Systems incorporates Diablo Tech designs into UltraDIMM.

SNIA NVMe SSD SIG formed; many NVMe products introduced.

Western Digital and SanDisk introduce SSD using 3D CML with a Hard Disk Drive. Toshiba introduces line of SSDs.

EsperVision Technologies announces shipments of ST-DRAM.

Micron and others sample 16nm flash memory.

SanDisk releases CFast 2.0 professional video card memory.

M.2 PCIe interface formalized.

Western Digital acquires Sicel, Vincent, Velod. SanDisk acquires SMART Memory.

NVMe introduces software to extend flash endurance.

Micron introduces Elpida.

Intel introduces Intel Cache Acceleration Software.

First UFS devices sampled by Toshiba at BG1.

Panasonic ships first commercial embedded ReRAM in an MLC.

Adesto ships Marqit CBRAM: first commercial stand-alone ReRAM.

SNIA publishes NVMe Programming Model v1.0.

Fuji Masazuka, formerly of Toshiba, receives FMS Lifetime Achievement Award.

SanDisk and Toshiba introduce 3D NAND production facilities.

SanDisk starts mass-producing the first 3D flash SSDS based on its second generation 32-layer Vertical NAND (V-NAND) using TLC.

SanDisk introduces 4TB Enterprise SSD.

Intel ships first NVMe SSD.

SanDisk introduces 128GB microSD card, a 200Gbps increase in capacity on device’s 10th anniversary.

IBM announces eFlash DIMMs using SanDisk UltraDIMM’s implementation of Diablo Memory-Channel Storage technology.

SpanION introduces HyperFlash NOR with 333 MB/s HyperBus.

Toshiba acquires OCZ.

EsperVision introduces and ramps production of ST-DRAM.

Adesto ships one-milithm CBRAM.

SK hynix acquires Violin Memory’s PCIe SSD business.

Seagate acquires LSI/Avioagio storage business.

SanDisk acquires Fusion-Io.

HGST acquires Skyera.

Samsung acquires Proximal Data.

Simon Sze, formerly of Bell Labs, receives FMS Lifetime Achievement Award.

All major vendors ship 3D NAND products. XMC breaks ground on first China-owned NAND flash fab.

Micron introduces 768Gb 3D NAND.

Western Digital acquires SanDisk.

EverSpin announces 256Mb MRAM chips.

IBM adopts TLC to PCM.

SanDisk ships 48-layer 3D NAND.

NVMe-Of (NVMe Express over Fabric) Rev. 1.0 published.

NVMe-of-products demonstrated by at least 12 vendors.

Toshiba introduces Through-Silicon Via (TSV) in 16-deck stack NAND.

Intel and Micron announce 256Gb 3D NAND.

SanDisk introduces first NVMe on 2 m SSDs.

SanDisk introduces 200Gb microSDIC UHS-1 card.

Cypress introduces 4MB serial FRAM.

Intel and Micron announce 3D XPoint Memory.

Intel announces 3D XPoint-based “Optane” DIMMs and SSDs.

Micron introduces device with CMSO at 3D NAND Array (CUA).

SanDisk introduces 200GB microSD card.

Mellanox and partners demonstrated pre-standard NvMe over Fabrics (NvMe-o-f).

Pure Storage has IPO.

JEDEC publishes first DDR4 NVMID-N Persistent Memory Module spec.

LightNVM and Open-Channel SSD support added to Linux kernel.

Bob Norman, formerly of SanDisk and Micron, receives FMS Lifetime Achievement Award.

All major vendors ship or sample 96-Layer NAND. SK hynix, Samsung and Micron sample 128-layer NAND.

All leading foundries produce embedded MRAM (eMRAM).

Ligthsits Labs ships first commercial NVMe/ TCP software-defined disaggregated storage.

YMTM samples 32-layer ‘‘Stacking’’ NAND.

Intel ships Optane (3D XPoint) DC Persistent Memory DIMM.

China’s ‘‘Big Fund’’ Phase 2 targets over $300B for semiconductor investments.

NVMe/TCP Transport Binding spec ratified by NVMe WG.

SNIA forms Computational Storage Technical Work Group (TWG).

Gyrfalcon Technology ships AI accelerator incorporating first use of TSMC’s eMRAM.

SNIA publishes Performance specs for Solid State Storage and for Real World Storage Workloads.

Amber Huffman of Intel receives first FMS SuperWomen in Flash Leadership Award.

Microchip acquires Microsemi.

Dov Moran and Ayeh Meng, M-Systems co-founders, receive FMS Lifetime Achievement Awards.

All major vendors ship or sample 96-Layer NAND. SK hynix, Samsung and Micron assume 128-layer NAND.

All leading foundries produce embedded MRAM (eMRAM).

Toshiba introduces first PCIe 4.0 x4 NVMe SSD and motherboard solution.

Calline Sanchez of IBM receives FMS SuperWomen in Flash Leadership Award.

Sanjay Mehrotra of Micron, and formerly of Intel, SEEG and ATML, receives FMS Lifetime Achievement Award.
2020

$51,152,080,000

Flash Memory Summit’s 15th conference (held as a virtual online-only event).

WDC ships 112-layer BiCS 3D NAND at 512 Gbit TLC part.

HIOXIA ships first Automotive UFS at 512GB density.

Lightbits Labs ships first clustered, redundant scale-out NVMe/TCP software solution.

Infineon acquires Cypress Semiconductor.

HIOXIA acquires LITE-ON Technology.

NVMe ZNS Command Set Spec V1.0 published.

NVMe Computational Storage Task Group formed.

Open Compute Project (OCP) publishes V1.0 specs: NVMe Cloud SSD and NVMe Datacenter SSD.

JEDEC publishes first DDR4 NVDIMM-P Persistent Memory Module spec.

JEDEC publishes DDR5 SDRAM standard and Universal Flash Storage (UFS) Card Extension 3.0 standard.

SNIA publishes specs for Native NVMe-of and Cloud Data Management Interface (CDMI).

HIOXIA ships first PCIe 4.0 x4 Enterprise NVMe SSD.

Dialog Semiconductor acquires Adesto Technologies.

DNA Data Storage Alliance launched.

Barbara Murphy of WeaO receives FMS SuperWomen in Flash Leadership Award.

John R. Szidon, formerly of WesternDigital, receives FMS Lifetime Achievement Award.

Nor reverses exceed $3.6B, primarily for SPI NOR.

HIOXIA and WDC announce 162-layer 3D NAND.

SK hynix ships mass production of 176-layer “4D” NAND.

Samsung announces the first DRAM-based memory running on CXL, based on DRAM.

JEDEC publishes XFM (Crossbar Flash Memory) Embedded and Removable Memory Device standard.

SK hynix completes first phase of Intel NAND and SSD business acquisition, to be branded as Solidigm.

NVIDIA launches GPU Direct Storage (GDS), providing a direct NVMe-to-GPU data path.

HIOXIA and Samsung announce PCIe 5.0 x4 Enterprise NVMe SSDs.

Renesas acquires Dialog Semiconductor.

NVMe 2.0 standard released as a set of 9 specs: base, 3 cmd sets, 4 transports, and Management I/F.

Winbond dual-buffer NAND with SPI interface gets wide adoption for automotive code storage, including for Advanced Driver Assistance Systems (ADAS) and Over-the-Air (OTA) updates.

SNE publishes Transport Layer Security (TLS) spec V2.0.

Samsung introduces SmartSSD computational storage drive (CSD).

35th anniversary of NAND Flash celebrated at FMS.

PCI-SIG releases PCIe 6.0 spec.

Universal Chiplet Interconnect Express (UCIe) V1.0 spec published to standardize die-to-die interconnects.

JEDEC publishes HBM3 update to High Bandwidth Memory (HBM) DRAM standard.

Micron ships 176-layer QLC 3D NAND.

Lightbits Labs ships first clustered NVMe/TCP software-defined public cloud storage solution.

Solidigm demonstrates prototype Penta-Level Cell (PLC) SSD.

CXL Consortium and JEDEC sign MOU to advance DRAM and Persistent Memory.

NVMe Boot Specification published.

JEDEC publishes UFS 4.0 standard and Automotive SSD standard.

DNA Data Storage Alliance joins SNA as a Technology Affiliate.

SNA publishes Computational Storage Architecture and Programming Model V1.0.

Yan Li of Western Digital receives FMS Leadership Award.

Atwood (formerly of Intel, Numonyx, and Micron) receives FMS Lifetime Achievement Awards.

SK hynix ships 238-layer TLC “4D” NAND using peripheral under cells (PUC) layout.

Micron ships 232-layer TLC 3D NAND with 6-plane architecture.

HIOXIA and Western Digital ship 218-layer TLC and QLC 3D NAND using 4-plane CMOS directly Bonded to Array (CBA) technology.

Solidigm ships first product: the PS4320 enterprise SSD with 192-layer QLC NAND.

Lightelligence announces Photoswave to enable CXL data storage connectivity over optics.

NVMe-of Boot Open Source Reference Code available.

JEDEC publishes CMAF specification for CXL-attached Memory Modules.

SCSI Trade Association (STA) becomes SNIA.

SCSI Trade Association Forum (STA Forum).

SNA publishes Smart Data Accelerator Interface V1.0.

SNA Swordfish V1.2.4a becomes an ISO Standard.

NEO Semiconductor launches 3D X-DRAM, the first 3D NAND-like DRAM.

Amy Fowler of Pure Storage receives FMS SuperWomen in Flash Leadership Award.

Amber Huffman of Google (Cloud) and formerly of Intel, receives FMS Lifetime Achievement Award.

2021

$58,817,659,000

Achievement Award.

receives FMS Lifetime Achievement Award.

Westinghouse, formerly of John R. Szedon, Leadership Award.

SuperWomen in Flash receives FMS Lifetime Achievement Award.

WekaIO receives FMS Lifetime Achievement Award.

Barbara Murphy of Alliance launched.

DNA Data Storage Technologies.

Adesto acquires Dialog Semiconductor SSD.

KIOXIA ships first 4.0 x4 Enterprise NVMe SSD.

SNIA publishes specs: base, 3 cmd sets, 4 transports, and Management I/F.

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