

LETS HAVE A BYTE

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2021

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The Life of a Data Byte

This is based on article by Jessie Frazelle with the above title.

He is the cofounder and chief product officer of the Oxide Computer Company.

This appeared in the December 2020 issue of Communications of the ACM.

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Byte

- A byte is the smallest unit of measure in a computer
- A byte is a string of consecutive bits
- A byte can store a single character of text, i.e. number, letter or special character
- The number of bits has been machine dependent and varied over the years
- It is currently considered to be eight bits
- The term Byte was first used in 1956

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Bit (Binary Digit)

- A bit is expressed as a 0 or 1, on or off, yes or no, + or -, etc.
- In Babbage's Analytical Engine(1837) it the position of a gear.
- In Hollerith's cards (1887) it was the presence or absence of a hole
- In computers it is magnetic polarity
- In DRAM it is two levels of electric charge in a capacitor

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Word

- A word is the smallest unit of measure in some (older) computers
- A word is a string of consecutive bits
- A word can store multiple characters of text, i.e. number, letter or special character
- The number of bits has been machine dependent and varied over the years usually in the range of 12 to 36

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1951 – Uniservo Tape Drive

- Primary input output device for Univac I computer
- Metal tape:
 - a $\frac{1}{2}$ -inch-wide thin strip of nickel-plated phosphor bronze (called Vicalloy)
 - 1200 feet long
 - Moved 100 inches per second
- 7200 characters per second

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1952 -- 726 Tape Drive

- Primary input output device for IBM 701 computer
- Tape was
 - oxide-coated
 - non-metallic tape
 - half-inch wide
 - 100 bits per linear inch
 - six channels that ran parallel to the length of the tape
 - seventh channel on the tape served to check the reading and writing of the other six channels by an odd-number redundancy (parity) check
- 7500 characters per second

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1956 – 305 RAMAC

- It weighed over a ton
- Stored 5 million characters
- Six data bits, one parity bit and one space bit for eight bits recorded per character
- Fifty 24-inch-diameter disks
- 1200 RPM
- 12,500 characters per second

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1963 - DECtape

- $\frac{3}{4}$ inch tape
- Laminated between two layers of Mylar
- 4 inch reel
- 6 data tracks, 2 mark tracks, and 2 clock tracks
- 350 bits per inch
- Wrote data in blocks, size depending on which PDP
- 8325 words (12 bit) per second

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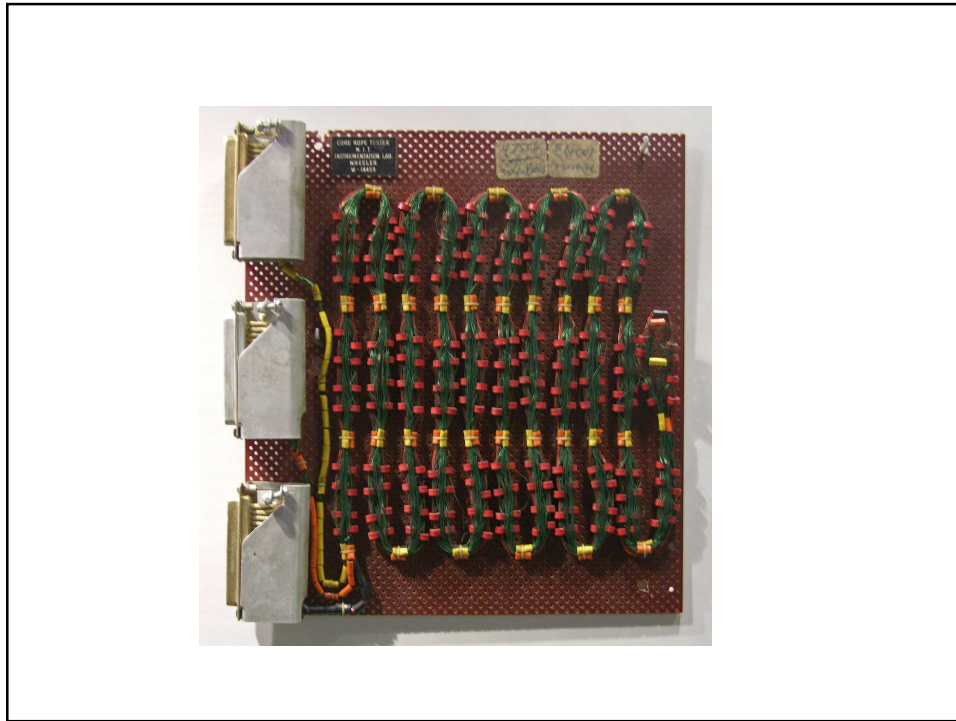


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1963 -- AGC

- Apollo Guidance Computer
- Rope storage
- One in command module and one in lander
- Made by hand
- 72 KB capacity
- Read only
- Wire through magnetic core was 1 around core was a 0
- It would take a few minutes to weave a 16 bit word into the rope

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1967 – Floppy Disk

- Started in 1967 completed in 1971
- 23FD Floppy Disk Drive System
- Used to load microcode into computers
- 8 inch flexible Mylar disks coated with magnetic material
- 80 kilobytes of read only storage
- 1973 read/write version 33FD

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1973 – 3348 Data Module

- IBM
- 885 KB per second
- 35 and 70 MB capacity
- Removable sealed cartridge
 - Disks
 - Head Arm assemblies

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1977 – 1530 Datasette

- Commodore PET personal computers
- Converted data into sound to be stored
- Cassettes 100KB per 30 minute side
- 70 Bytes/Sec transfer
- Very cost effective

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1978 -- LaserDisk

- AKA Discovision
- Read Only
- 2 single sided 12 inch aluminum disks layered in plastic
- Very expensive
- Led to CDs and DVDs

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1979 – ST506

- Shugart Technology which became Seagate Technology
- $5\frac{1}{4}$ hard drive
- Single platter coated on both sides
- 5MB capacity
- 625 KB per second

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1981 – 3 ½ Floppy

- Developed by Sony for SMC 70
 - Actually 90 x 94 mm
 - Single sided 85.8 mm disk
 - 218.8 KB capacity
 - Double sided in 1982
- Microfloppy Industry Committee
 - consortium of 23 media companies
 - agreed upon a 3 1/2-inch media in 1982
- 1984 Macintosh

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1984 – CD-ROM

- Compact Disk – Read Only Memory
- Phillips and Sony
- 120 mm in diameter 1.2 mm thick
 - 80 mm diameter 'mini' later
- Polycarbonate plastic, with a thin layer of aluminum
- Capacity initially 553 KB later 650 KB
- Data is stored as a series of microscopic indentations (pits and lands)
- Laser light used to read the disc

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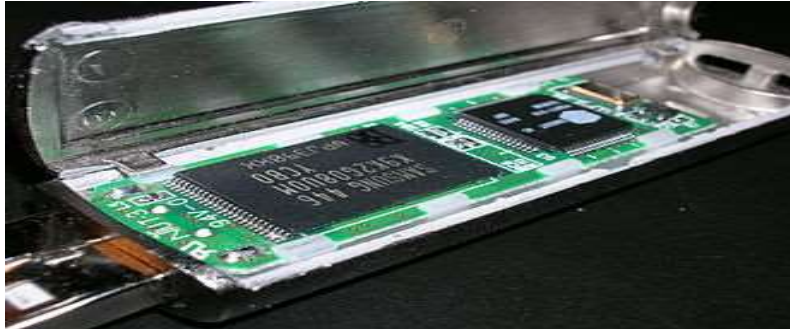


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1984 – Flash Memory

- Toshiba
 - Proposed in 1980
 - Invented in 1984
 - Product in 1987
- Electronically erasable programmable read only memory (EEPROM)
- Transistors which are on or off
- USB flash drives, MP3 players, digital cameras and solid-state drives.

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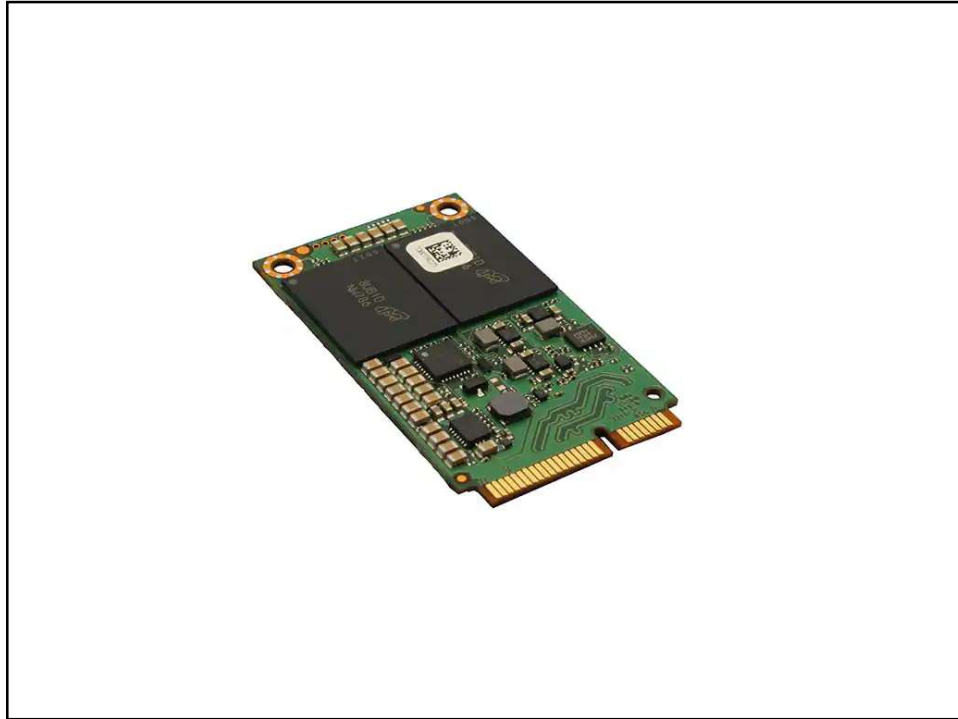
A disassembled USB flash drive. The chip on the left is flash memory. The controller is on the right.

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1991 -- SSD

- Solid State Drive, or Disk, or Device
- Uses Flash storage
- Does not spin therefore not a disk
- Behaves and performs like a fast disk
- Uses disk hardware and software interface (SATSA)
 - Advanced Technology bus on PC (AT)
 - AT Attachment (ATA)
 - Serial ATA (SATA)
- 20 MB capacity cost \$1000
- Storage cost per gigabit higher than a disk

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1994 –Zip Drive

- IOMEGA
- Same size as 3½ in floppy but more capacity
- 100 MB, then 250 MB, finally 750 MB
- 1.4 MB per second

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1999 -- Microdrive

- IBM and later Hitachi
- 1 inch diameter hard drive
- 170 and 340 MB capacity
 - 2000 612 MB and 1 GB
 - 2003 2GB and 4 GB
 - 2006 6GB
 - 2015 Obsolete
- 33 MB per second

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2000 – USB Flash Drive

- M-Systems, an Israeli company
- Universal Serial Bus 1996
- USB 1, USB 2, USB 3, USB4
- 1.5 Mbits per second, now up to 40 Gbits per second with USB4
- 8 MB capacity, now up to 1 TB

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USB

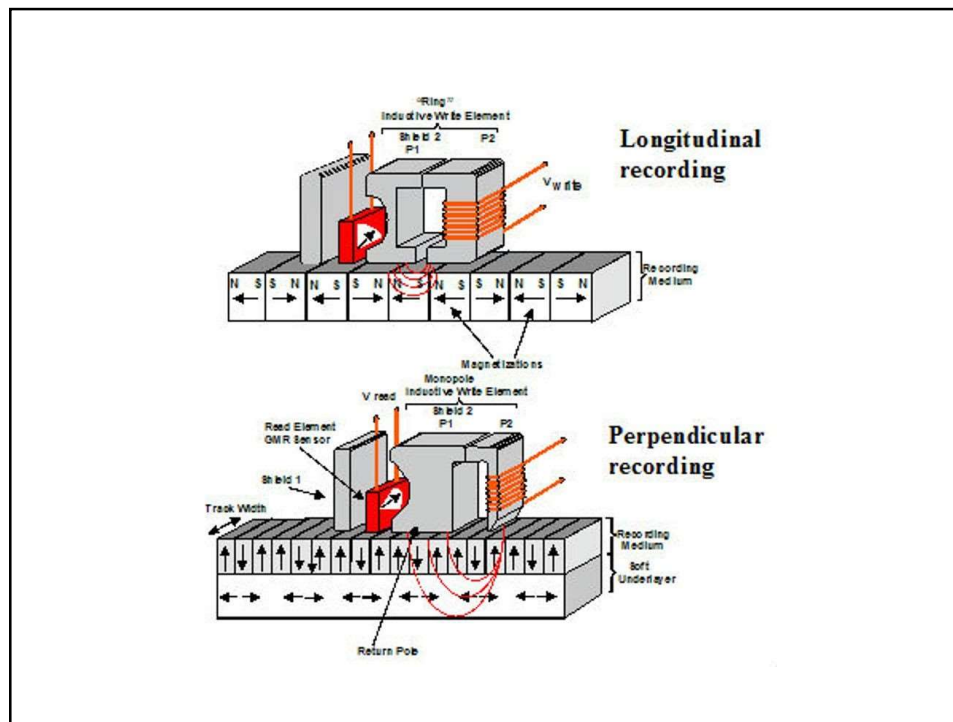


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2005 --PMR

- Perpendicular Magnetic Recording
 - Think of a bit as a bar magnet
 - Previously the bar was horizontal
- Areal density above 100 GB per square inch

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2007 – Deskstar 7K1000

- Hitachi Global Storage Technologies
- First Terabyte Disk
- Five 3½ inch 2000 GB each
- 3.0 Gbits per second

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2009 -- NVMe

- Nonvolatile Memory express
- Communications interface and driver
- Faster interface allowing SSDs to perform better

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2021 Graphene

- *Graphene* -- A single layer of atoms arranged in a two-dimensional honeycomb lattice.
- Ultra-High-Density Hard Drive
- 10 terabyte per square inch
- Graphene properties include corrosion protection, low friction, wear resistance, hardness, lubricant compatibility, and surface smoothness.

University of Cambridge Graphene Centre

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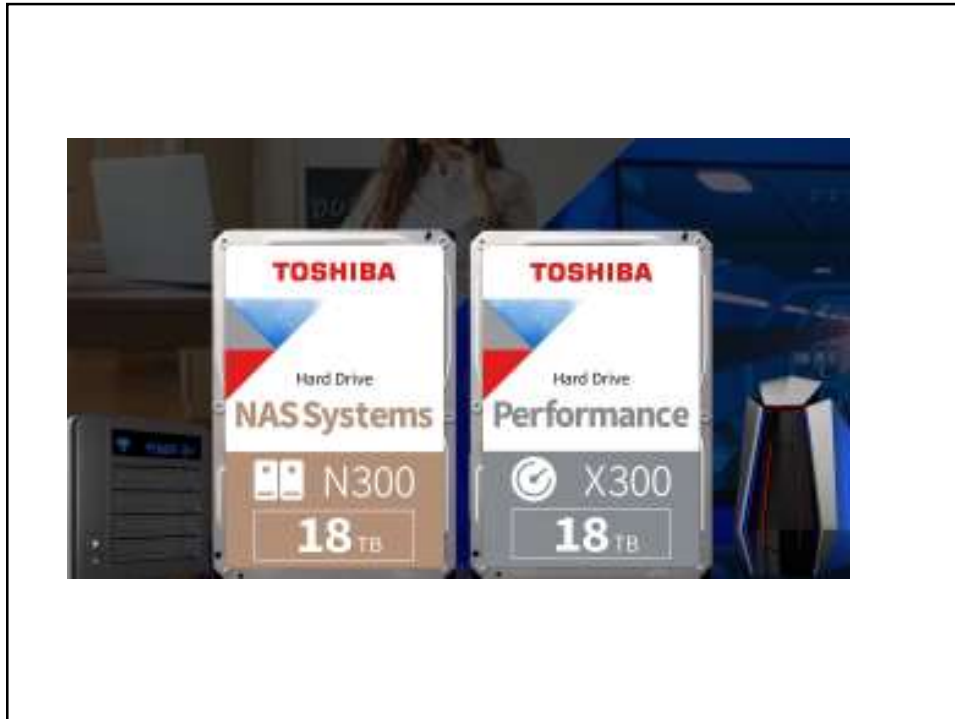


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FC-MAMR

- Flux-control Microwave-Assisted Magnetic Recording
- 9 platters with 2 TB capacity each
- 281 MB/sec (predicted) transfer rate
- Toshiba N300 and X300

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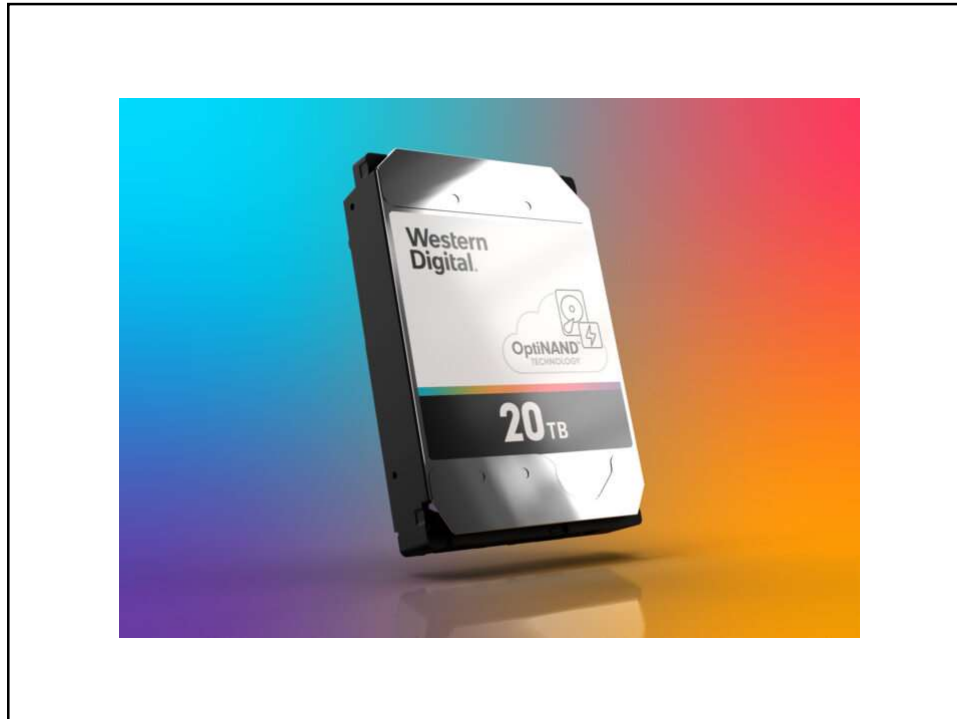
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2021 OptiNAND™

- Optimized NAND
 - Not And logical gate
 - produces an output which is false only if all its inputs are true
- Energy-assisted perpendicular magnetic recording technology platters (ePMR)
- 20 TB HDD in a 3 ½ inch slot!

™ Western Digital

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DNA-Based Storage

- A start-up from Boston named Catalog
- Catalog has raised \$60 million
- DNA writer named Shannon, which is capable of tackling thousands of chemical reactions each second
- At full capacity, Shannon can write data at speeds of 10 megabytes per second
- It doesn't appear that the tech will be commercially available anytime soon

Technology Oct 03, 2021

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The End

I'll step out for a byte!