

Installing, Configuring, and Troubleshooting Storage Devices

CompTIA®

Installing, Configuring, and Troubleshooting Storage Devices

- Install System Memory
- Install and Configure Mass Storage Devices
- Install and Configure Removable Storage
- Configure RAID
- Troubleshoot Storage Devices

System Memory (Slide 1 of 2)



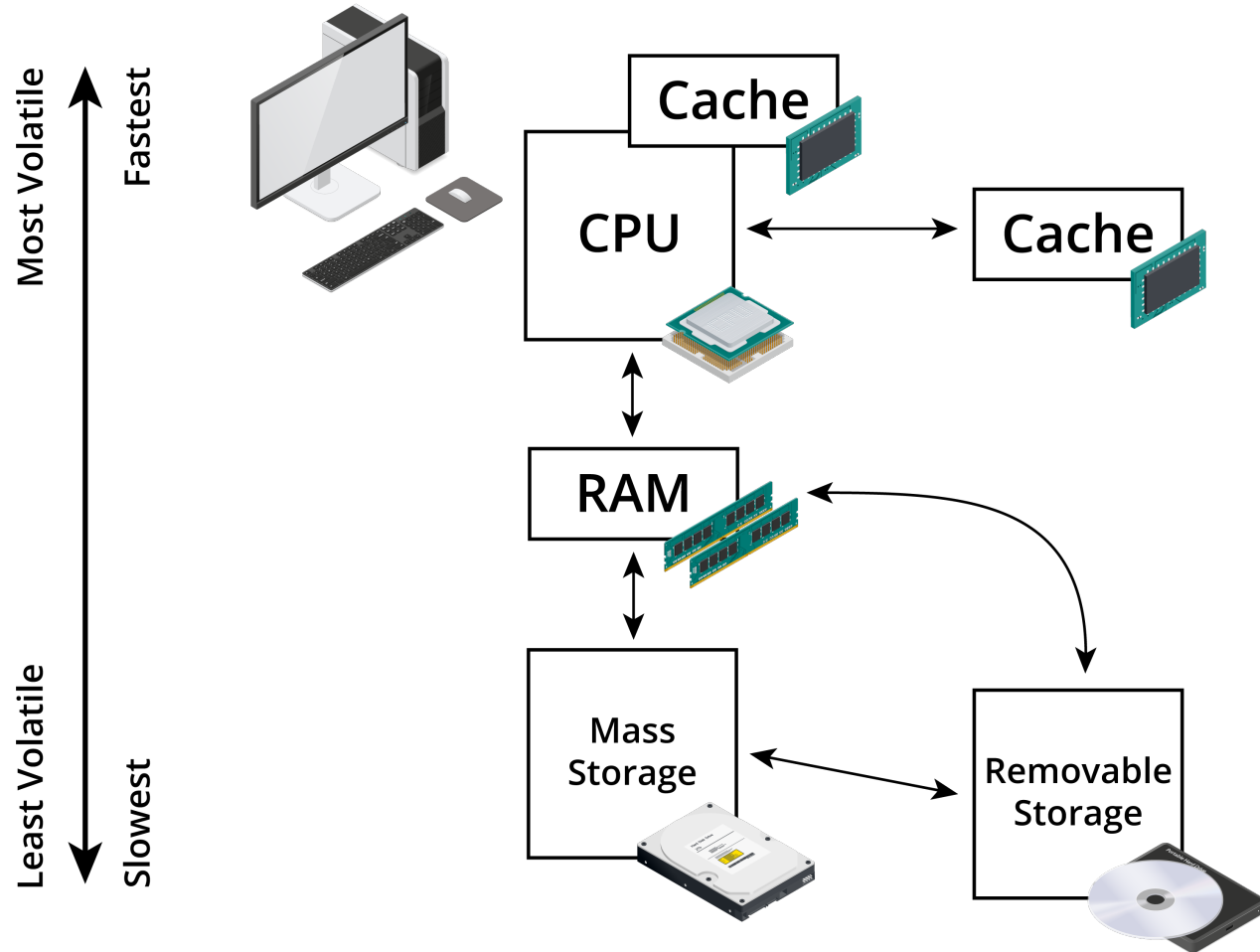
System memory: The main storage area for programs and data when the computer is running. Mostly held in:

RAM: (random access memory) The principal storage space for computer data and program instructions.

Volatile: A type of memory where data cannot be stored without power being supplied.

Virtual memory: An area on the hard disk allocated to contain pages of memory. Usually when the RAM runs out (slower)

System Memory (Slide 2 of 2)



RAM Types



DRAM: A type of volatile memory that stores each bit of data as a charge within a single transistor.

SDRAM: A variant on the DRAM chip designed to run at the speed of the system clock, thus accelerating the periodic refresh cycle times.

- DRAM:
 - Stores each data bit as an electrical charge within a single bit cell.
 - Bit cell composed of a capacitor and a transistor.
 - Charge dissipates, causing memory to lose information.
 - Dynamic memory has to be refreshed to keep the information.
- SDRAM:
 - Older technology.
 - Synchronized to the system clock.

DDR SDRAM



DDR SDRAM: Standard for SDRAM where data is transferred twice per clock cycle.

RAM Type	Memory Clock (MHz)	Bus Clock (MHz)	Data Rate (MT/s)	Transfer Rate (Gbps)
DDR-200/PC-1600	100	100	200	1.6
DDR-26/PC-2100	133	133	266	2.1
DDR-333/PC-2700	167	167	333	2.7
DDR-400/PC-3200	200	200	400	3.2

DDR2/DDR3/DDR4 SDRAM (Slide 1 of 3)

RAM Type	Memory Clock (MHz)	Bus Clock (MHz)	Data Rate (MT/s)	Transfer Rate (Gbps)
DDR2	100 to 266	200 to 533	400 to 1066	3.2 to 8.533
DDR3	100 to 266	400 to 1066	800 to 2133	6.4 to 17.066
DDR4	200 to 400	800 to 1600	1600 to 3200	12.8 to 25.6

DDR2/DDR3/DDR4 SDRAM (Slide 2 of 3)

Examples of DDR Standards:

- DDR2 – 1066/PC28500:
 - Memory works at 266 MHz, bus works at 533 MHz.
 - Double data rate gives 1066 MT/s.
 - Nominal transfer rate of 8.533 GBps.
- DDR3 – 1600/PC321800:
 - Memory works at 200 MHz, bus works at 800 MHz.
 - Double data rate gives 1600 MT/s.
 - Nominal transfer rate of 12.8 GBps.

DDR2/DDR3/DDR4 SDRAM (Slide 3 of 3)

Examples of DDR Standards (continued):

- DDR4 – 1600/PC4-12800:
 - Memory works at 200 MHz, bus works at 800 MHz.
 - Double data rate gives 1600 MT/s.
 - Nominal transfer rate of 12.8 GBps.
 - Lower voltage, so less power consumption than DDR3.
- DDR4 – 2400/PC4-19200:
 - Memory works at 300 MHz, bus works at 1200 MHz.
 - Double data rate gives 2400 MT/s.
 - Nominal transfer rate of 19.2 GBps.
 - Faster than any DDR3.

Memory Modules (Slide 1 of 3)



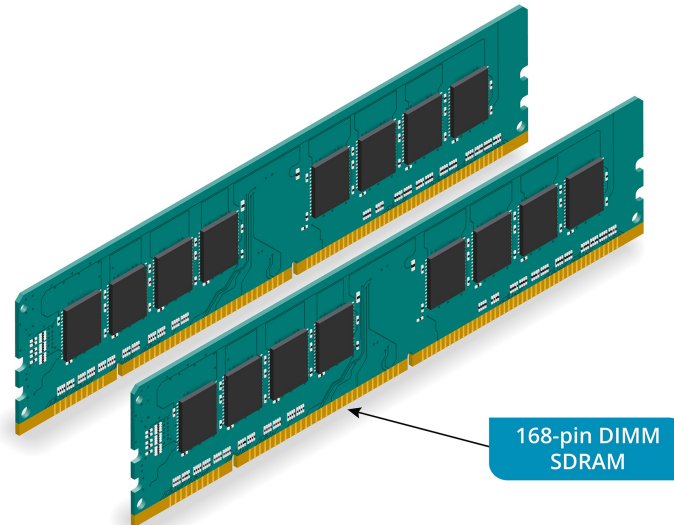
Memory module: A printed circuit board that holds a group of memory chips that act as a single unit.

DIMM: (dual inline memory module) Standard packaging for system memory. There are different pin configurations for different RAM types.

- Located in slots on motherboard.
- Removable and replaceable.
- Defined by their design and by the number and type of chips contained.

Memory Modules (Slide 2 of 3)

RAM Type	Pins	Voltage
DDR	184	2.5 to 2.6 V
DDR2	240	1.8 to 1.9 V
DDR3	240	1.35 to 1.5 V
DDR4	288	1.2 V

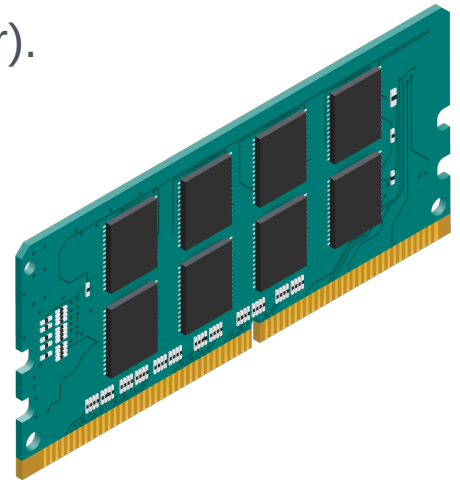


Memory Modules (Slide 3 of 3)



SODIMM: Memory that is half the size of DIMMs, is available in 32- or 64-bit data paths, and is commonly found in laptops and iMac systems.

- Laptop RAM.
- DDR and DDR2 have the same number of pins, but the key position is different.
- Typically fits into slots that pop up at a 45° angle to allow the chips to be inserted or removed (the lever).
- Pins:
 - DDR 200 pin packages.
 - DDR2 200 pin packages.
 - DDR3 204 pin packages.
 - DDR4 260 pin packages.



Dual-Channel Memory (Slide 1 of 2)

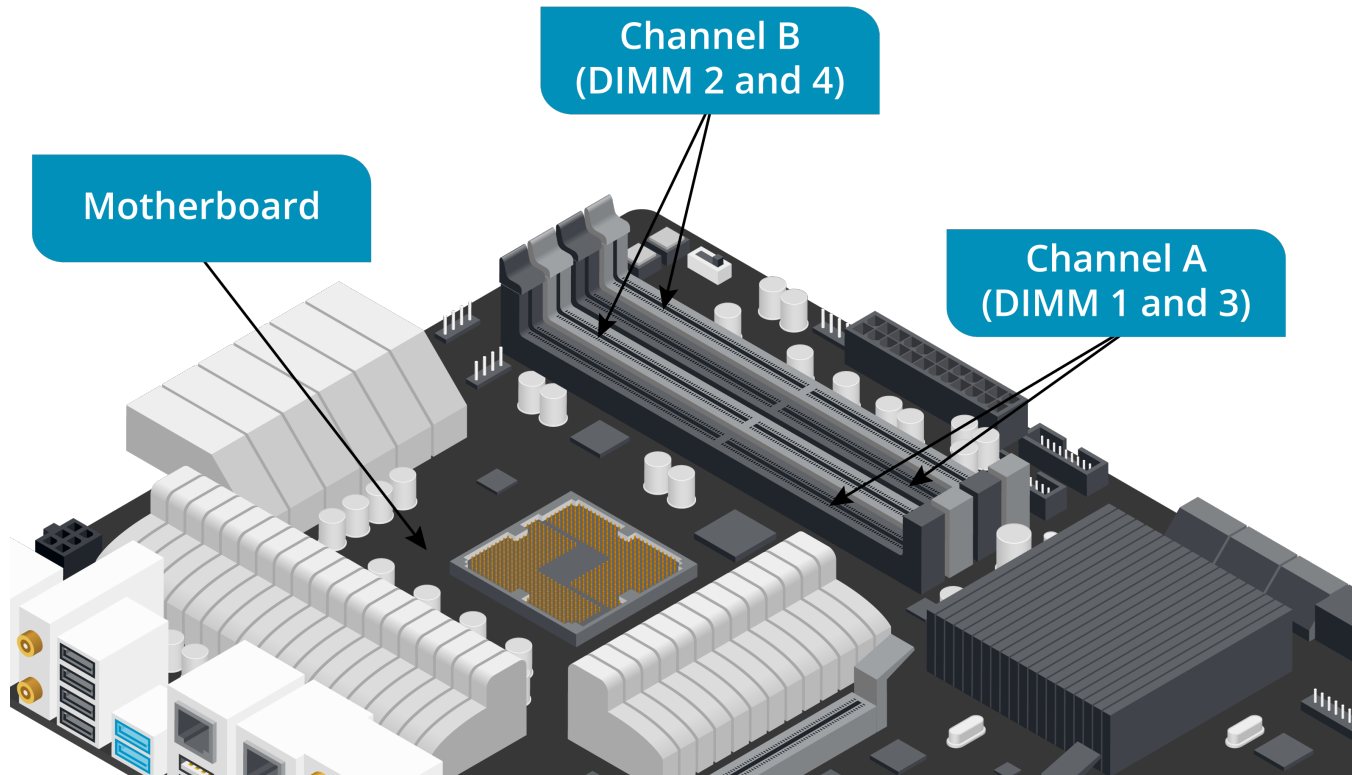


Single-channel memory: Memory with one 64-bit bus between the CPU and RAM.

Dual-channel memory: Memory controller with two pathways to the CPU, enabling 128 bits of data transferred per transaction.

- Effectively two pathways through the bus to the CPU.
- 128 bits of data can be transferred per transaction.
- Installed memory modules should be identical in terms of:
 - Speed
 - Capacity
 - Chip number
 - Density
 - Location
- Refer to documentation for which slots to insert memory into.

Dual-Channel Memory (Slide 2 of 2)



Parity and ECC RAM



Parity checking: An error-checking method where each byte of data in memory is accompanied by a ninth bit used to check for corrupted data.

Nonparity: System memory that does not perform error checking.

ECC memory: RAM with built-in error correction security.

- Parity checking:
 - Uses 8 bits for memory and 1 bit to check parity.
 - Old technology rarely if ever used now.
- Most desktops now use non-parity memory.
- Systems that require a high level of reliability use ECC memory.
 - ECC memory has an extra chip and a 72-bit data bus.
 - Motherboard must support the use of ECC memory modules.
 - Cannot mix ECC and non-ECC modules.

Memory Installation and Upgrade

- If the motherboard supports an upgrade (to the RAM type) but the system is not configured to use it, enable a dual-channel configuration to increase speed.
- Increasing the bus speed requires purchasing a new motherboard and memory modules (and possibly CPU).

Memory Compatibility Issues (Slide 1 of 2)

- The DIMM format must match the motherboard.
- Different capacity modules can be installed.
 - Most vendors recommend installing the largest module in the lowest numbered slot.
- Modules from different vendors can be mixed.
 - This may cause problems with multi-channel configurations.
- For best performance, the modules should be the same speed as the motherboard.
 - Different speeds can be mixed.
 - The system will only operate at the best speed supported by all installed.

Memory Compatibility Issues (Slide 2 of 2)

- For best performance and reliability, configure multi-channel systems with identical memory modules for each channel.
- ECC memory cannot be mixed with non-parity memory and must be supported by the motherboard.
- Registered (buffered, less electrical use, more RAM modules possible) memory cannot be mixed with unbuffered modules and must be supported by the motherboard.

Activity



Discussing System Memory Installation (Section 3 flashcards)

Activity



Upgrading Memory

Section 3 Lab, 30Bird 4.2.1&2, Video

<https://www.youtube.com/watch?v=VA-eGltpsw>

Storage Devices



Mass storage devices: Non-volatile storage devices that are able to hold data when the system is powered off.

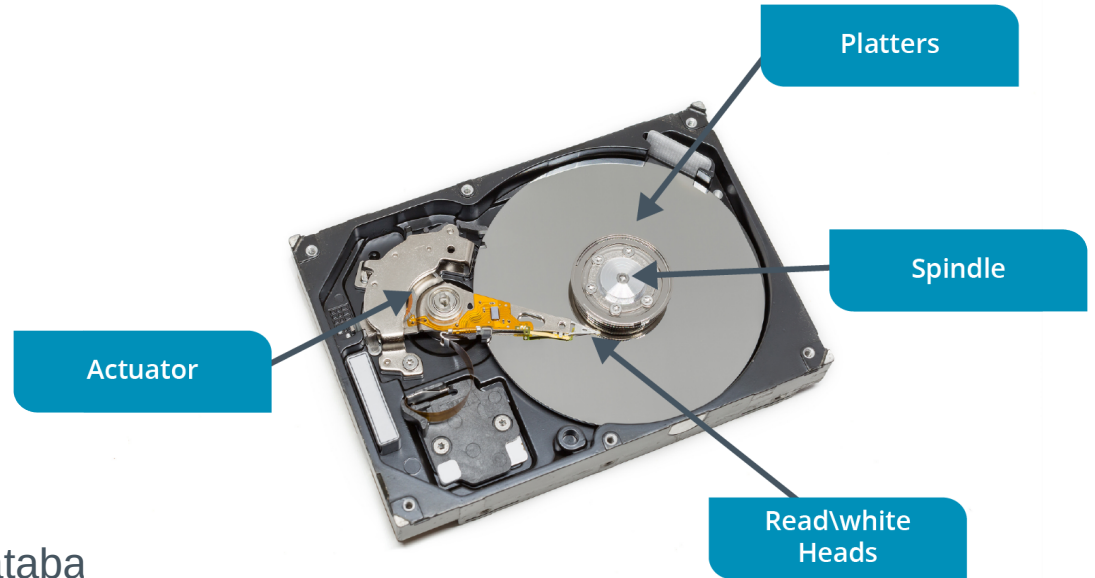
- Hold data when system is powered off.
- Can be internal or removable.
- To store data, it uses one of these methods:
 - Magnetic
 - Optical
 - Solid state

Hard Disk Drives (Slide 1 of 2)



HDD: (hard disk drive) A device that provides persistent mass storage for a PC.

- Primary persistent storage method.
- On workstations, typically stores:
 - OS files.
 - Application program files.
 - Drivers.
 - User data.
- On servers, typically stores:
 - OS files.
 - Individual user files.
 - Shared information sources such as databa



Hard Disk Drives (Slide 2 of 2)



Tracks: Data written as concentric rings on a disk drive.

Cylinders: The aggregate of all tracks that reside in the same location on every disk surface.

- HDD up to 8 TB.
- Data is stored on metal or glass platters coated with magnetic substance.
- Each platter has:
 - Top and bottom read/write heads.
 - Heads that float above platters.
- Form factors include 3.5” and 2.5”.
 - Height varies: 15 mm , 9.5 mm, 7 mm, and 5 mm.

HDD Performance Factors (Slide 1 of 2)



Access time: Speed at which memory or a disk drive can be addressed and utilized.

Internal transfer rate: Measure of how fast read/write operations are performed on the disk platters.

External transfer rate: Measure of how fast data can be transferred to the CPU across the bus.

Early-life Failure Rate: A method of calculating how quickly a device will fail through accelerated testing.

HDD Performance Factors (Slide 2 of 2)



MBTF: (mean time between failures) The rating on a device or component that predicts the expected time between failures.

Life expectancy: The length of time for which a device can be expected to remain reliable.

S.M.A.R.T. (Self Monitoring Analysis Reporting Tech) : Technology designed to alert the user to possible hard disk failures before the disk becomes unusable.

Storage Adapters and Cables



HBA: (host bus adapter) A component that allows storage devices to exchange data with a computer system by using a particular interface.

Drive controller: The circuitry in the disk unit that allows it to put data on the bus, which the HBA shuttles to the CPU or RAM.

- Connection point for internal mass storage devices.
- Interface between drive, HBA, rest of the system is a type of bus.
 - Old technology included PATA and SCSI.
 - Most systems now use SATA.

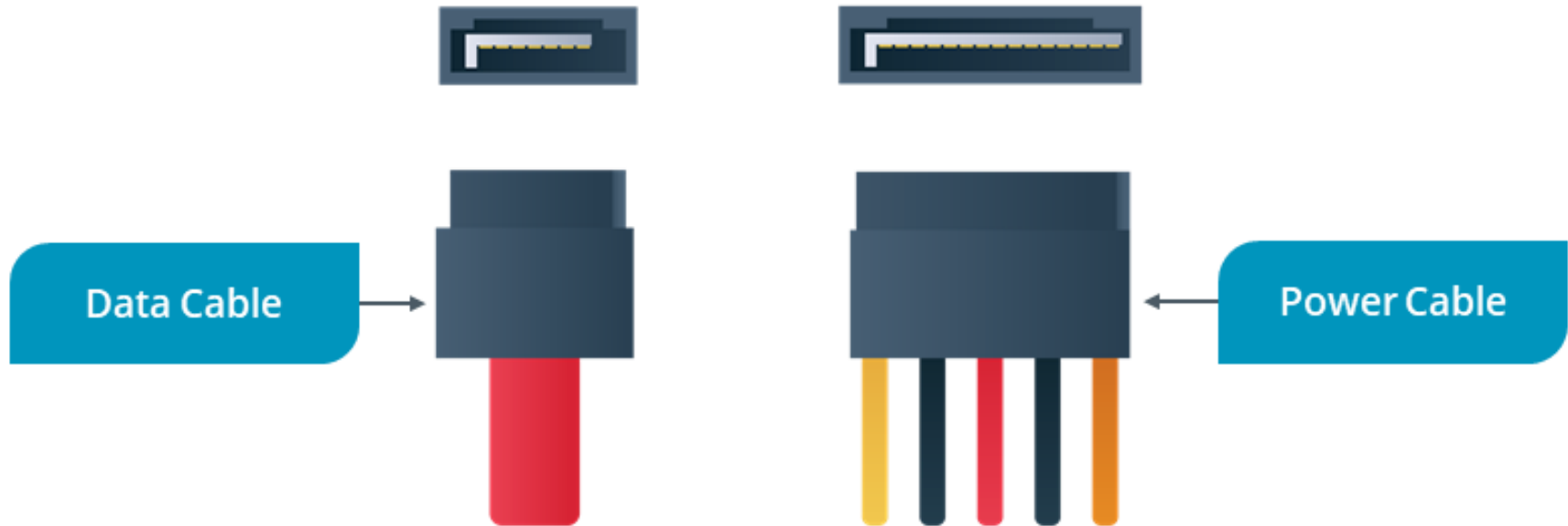
SATA (Slide 1 of 3)



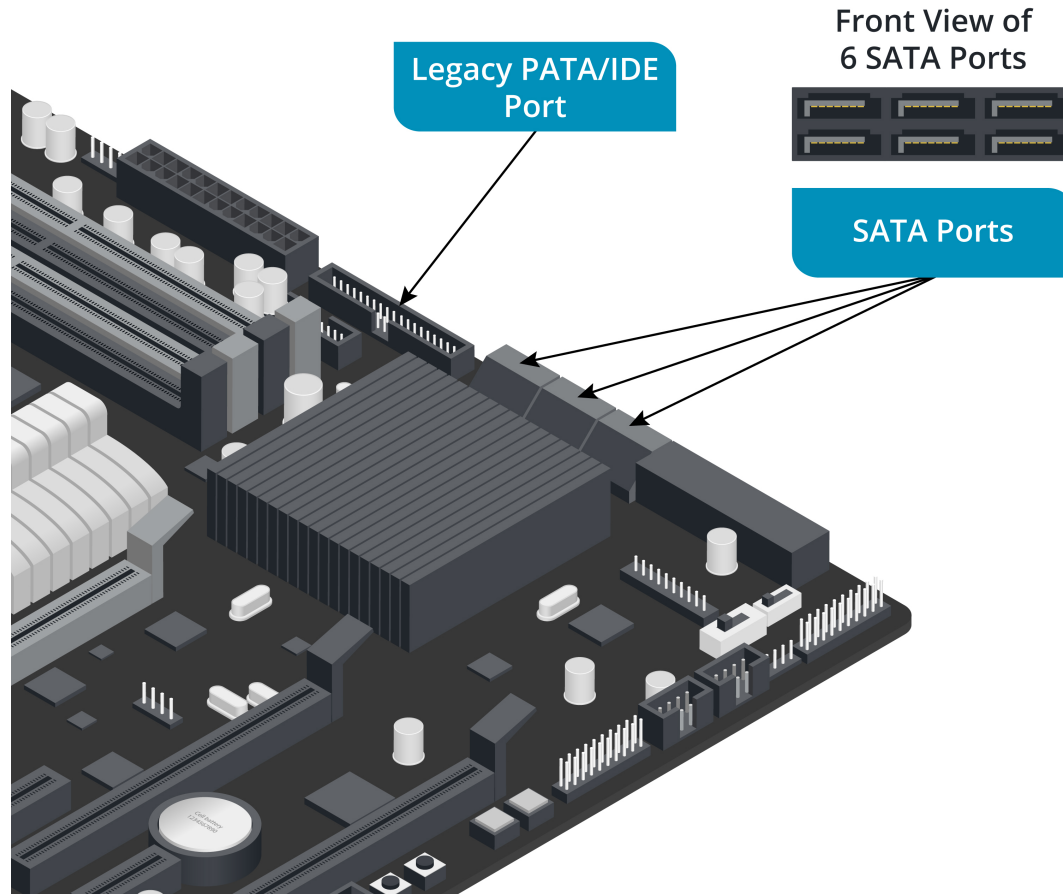
SATA: A widely used hard disk interface using a 7-pin data connector and a 15-pin power connector.

- Transfers data in serial format.
- Cables can be up to 1 m and are thin and flexible.
- Cables terminate with 7-pin connectors.
- Each host adapter port supports a single device.
- Drives are hot swappable.
- SATA speeds:
 - Original SATA: up to 1.5 Gbps.
 - SATA 2: up to 3 Gbps.
 - SATA 3: up to 6 Gbps.

SATA (Slide 2 of 3)



SATA (Slide 3 of 3)

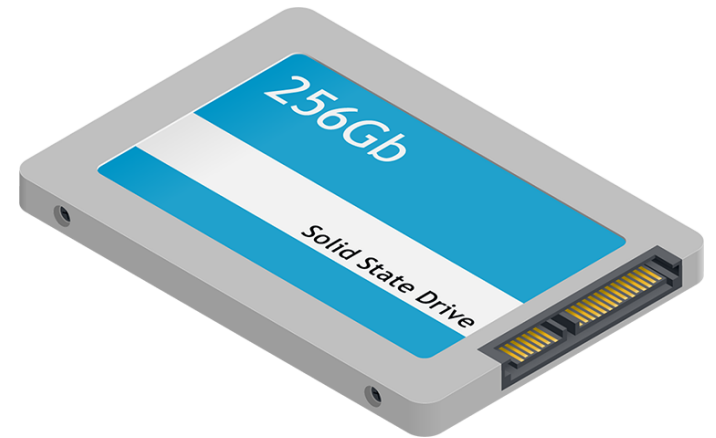


Solid State Drives



SSD: (solid state drive) A personal computer storage device that stores data in non-volatile special memory instead of on disks or tape.

- Advantages:
 - No moving parts.
 - Quieter and more power efficient than HDD.
 - Less prone to failure due to shock.
 - Better read times:
 - Seek time is faster.
 - File fragmentation is eliminated.
 - Less likely to lose data due to power failures.
- Disadvantage:
 - High cost.



SSD Interfaces and Form Factors (Slide 1 of 2)



AHCI: (Advanced Host Controller Interface) A logical interface used by SATA drives to communicate with the bus.

NVMHCI: (Non-Volatile Memory Host Controller Interface Specification) A logical interface used by PCIe-based SSD drives to communicate with the bus.

NVMe: (NVM Express) An interface for connecting flash memory devices, such as SSDs, directly to a PCI Express bus.

Lanes: In PCIe, two wire pairs (four wires in total) using low voltage differential signaling, with one pair used to transmit and the other pair to receive (bi-directional).

SSD Interfaces and Form Factors (Slide 2 of 2)

- Often used for the OS and applications.
 - HDD used for user data files.
- Some SSDs are connected using SATA interface.
 - 6 Gbps capacity can be a bottleneck over AHCI logical interface.
- SSDs often communicate directly to the PCIe bus using NVMe.
- PCIe-based SSD:
 - Can be implemented as regular PCIe adapter card or AiC.
 - Uses the M.2 adapter interface.
- M.2 adapters:
 - Are not hot-swappable or hot-pluggable.
 - Are smaller than a PCIe adapter.
 - Supply the power over the bus.
 - Can use up to 4 PCIe lanes.

SDD Performance Factors (Slide 1 of 2)

- SDD usually outperforms HDD.
 - Serving large files, HDD usually performs better.
- Compare different types of data transfer:
 - Read performance.
 - Write performance.
 - Sequential access.
 - Random access.
 - Transferring lots of small files.
 - Data throughput.
 - Latency.
 - IOPS.

SDD Performance Factors (Slide 2 of 2)



Wear leveling: Routines used by flash drives to prevent any single storage location from being overused and to optimize the life of the device.

- Flash chips are susceptible to degradation.
- Use wear leveling:
 - Prevents any single location from being overused.
- Wear leveling helps optimize life of the drive.

Hybrid Drives



Hybrid drive: A drive that contains an SSD portion, which functions as a large cache, containing frequently accessed data; and a magnetic disk portion, which is spun up only when non-cached data is accessed.

Host-hinted mode: A SATA standard (version 3.2) that defines a set of commands to allow the host computer to specify how the cache should be used.

- SATA 3.2 standard allows host to specify how to use the cache.
- Drive firmware can run self-optimizing routines.
- User does not have direct control over which files are stored in cache.

Dual-Drive Configurations

- Install separate SSD and HDD devices.
- System chipset and storage drivers make caching decisions.
 - Often uses Intel SRT.
 - User does not have control over use of the SSD cache.

Legacy Storage Technologies (Slide 1 of 8)



PATA: Older drive technology that supported two devices per channel: master and slave. Also referred to as IDE or EIDE.

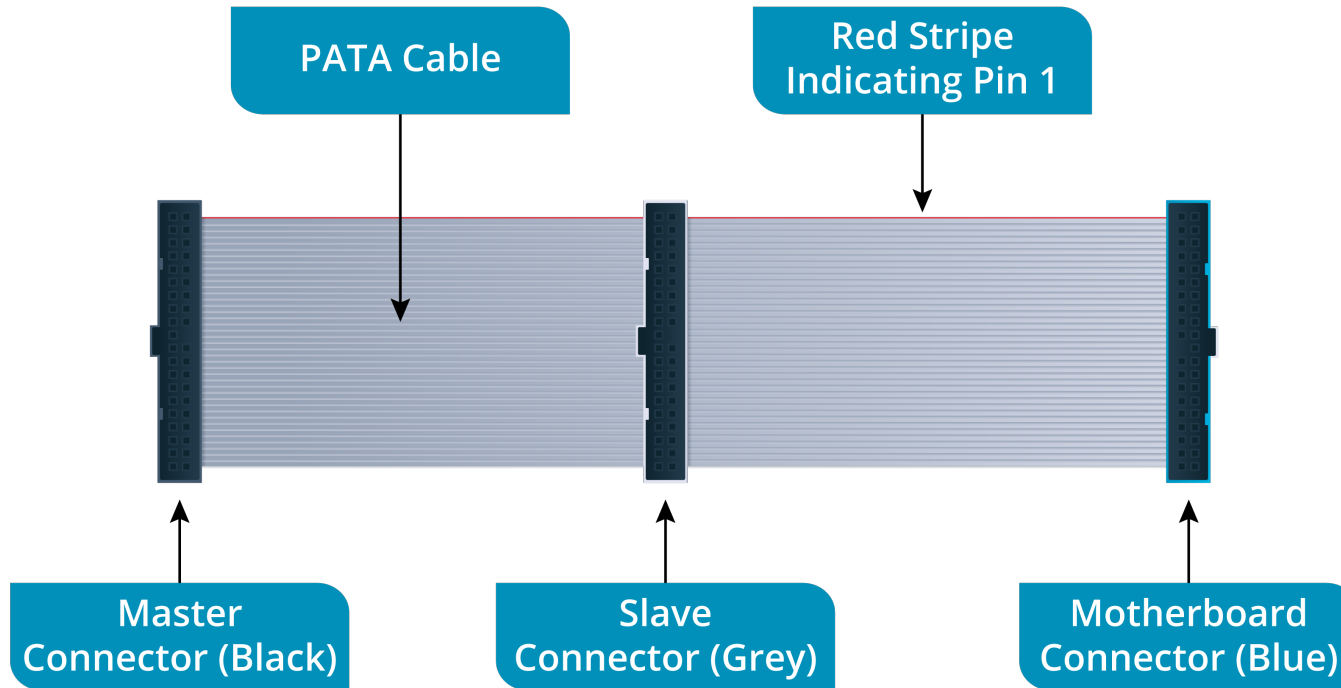
Channels: Paths between PATA drives and motherboard, called IDE1 and IDE2 or primary (PRI IDE) and secondary (SEC IDE).

- Uses parallel data transfers, with 6 bits transferred per clock tick.
- Motherboards supporting PATA include 1 or 2 host adapters (“channels”).
 - IDE1 or PRI IDE and IDE2 or SEC IDE
- Each PATA channel supports 2 devices.
 - 01 and 1.
 - Master and slave.

Legacy Storage Technologies (Slide 2 of 8)

- PATA drives use 40-pin port and 80-wire shielded cables.
 - Required for UDMA4 or better transfer modes.
- PATA cable can be up to 18” long and has 3 connectors.
 - One for motherboard.
 - One for each device (master and slave).
- Most cables are Cable Select.
 - Drives are identified as master or slave based on position of the connector.
- Pin 1 on cable must be oriented to pin 1 on the connector.
 - Identified on cable with a red stripe.
 - Keyed to prevent improper insertion.

Legacy Storage Technologies (Slide 3 of 8)



Legacy Storage Technologies (Slide 4 of 8)

Interface Standard	DMA Mode	Max Transfer Rate (MBps)	Special Features
ATA/ATAPI-4	UDMA 2 (Ultra ATA/33)	33	Ultra DMA, 80-conductor cable, and cyclic redundancy checking
ATA/ATAPI-5	UDMA 4 (Ultra ATA/66)	66	
ATA/ATAPI-6	UDMA 5 (Ultra ATA/100)	100	48-bit LBA expansion, and disk noise reduction
ATA/ATAPI-7	UDMA 6 (Ultra ATA/133)	133	Multimedia streaming

Legacy Storage Technologies (Slide 5 of 8)



SCSI: (Small Computer Systems Interface) An older personal computer connection standard that provides high-performance data transfer between the SCSI device and the other components of the computer.

- One SCSI HBA can control multiple devices.
 - Attach with internal ribbon or external SCSI cables.
- SCSI command language allows HBA to identify:
 - Which devices are connected.
 - How they are accessed.
- Typically used to connect storage devices.
 - Older devices such as scanners could also be connected through SCSI.
- SCSI port is denoted with the symbol



Legacy Storage Technologies (Slide 6 of 8)

Interface Protocol	Standard	Bandwidth (MBps)	Bus Width (bits)	Max. Cable Length (meters)
SCSI-1	SCSI-1	5	8	<ul style="list-style-type: none">• SE: 6• LVD: NA• HVD: 25
Fast SCSI	SCSI-2	10	8	<ul style="list-style-type: none">• SE: 3• LVD: NA• HVD: 25
Fast-Wide SCSI	SCSI-2	20	16	<ul style="list-style-type: none">• SE: 3• LVD: NA• HVD: 25
Ultra SCSI	SCSI-3	20	8	<ul style="list-style-type: none">• SE: 1.5• LVD: NA• HVD: 25
Ultra Wide SCSI	SCSI-3	40	16	<ul style="list-style-type: none">• SE: NA• LVD: NA• HVD: 25

Legacy Storage Technologies (Slide 7 of 8)

Interface Protocol	Standard	Bandwidth (MBps)	Bus Width (bits)	Max. Cable Length (meters)
Ultra2 SCSI	SCSI-3	40	8	<ul style="list-style-type: none">• SE: NA• LVD: 12• HVD: 25
Ultra2 Wide SCSI	SCSI-3	80	16	<ul style="list-style-type: none">• SE: NA• LVD: 12• HVD: 25
Ultra3 SCSI (Ultra160 SCSI)	SCSI-3	160	16	<ul style="list-style-type: none">• SE: 1.5• LVD: NA• HVD: 25
Ultra 320 SCSI	SCSI-3	320	16	<ul style="list-style-type: none">• SE: NA• LVD: 12• HVD: NA

Legacy Storage Technologies (Slide 8 of 8)

Term	Description
SCSI Host adapter	<ul style="list-style-type: none">• Must be installed and recognized for devices to be detected.• May require third-party driver to be installed.
Bus width	<ul style="list-style-type: none">• Originally supported 8 devices.• Wide SCSI supports up to 16 devices.• HBA is counted as a device.
Signaling	<ul style="list-style-type: none">• Most buses and devices use LVD.• SE devices can be added to an LVD bus.• HVD is incompatible with LVD and SE devices.
Termination	<ul style="list-style-type: none">• Bus must be terminated at both ends.• Termination can be enabled on the device by a switch or by connecting a terminator pack to the device or HBA.
ID	<ul style="list-style-type: none">• Each device is allocated a unique ID from 0 to 7 (to 15 for Wide SCSI).• Can be automatically allocated or set using jumpers or click-wheel on the device.• Priority goes 7 to 0, then 15 to 8.

Guidelines for Installing Mass Storage Devices

- Does the computer have existing internal storage devices?
- Does the device need additional drivers installed?
- Does the computer have an available power supply cable to supply power to the device?
- Does the computer have an available drive bay for the storage device?
- Do you have the necessary data cables to connect the storage device to the controller?
- Does the placement of the device interrupt the air flow of the case?

Activity



Discussing Mass Storage Device Installation and Configuration

Activity



Installing Storage Devices (30bird 5.1.1, 6.1.2)

<https://www.youtube.com/watch?v=f2kcJH8ASN8>

<https://www.youtube.com/watch?v=WAQZAU0NILE>

Removable Storage



Removable storage: A storage device that can be removed from the computer, or the removable media that can be inserted in a drive, to store portable data.

- Refers to either:
 - Storage devices that can be removed.
 - Storage media that can be removed.
- Can be attached or inserted in different computers to move or copy files.
- Can be used to create a backup.

Optical Media (Slide 1 of 9)



CD: (compact disc) An optical storage technology that can hold 700 MB of data or 80 minutes of audio data.

DVD: (digital versatile disc) An optical storage technology that can hold 4.7 GB per layer.

- CD has 700 MB capacity.
 - Capable of delivering most software applications.
- DVD has about 17 GB capacity.
 - Often used for:
 - Software installs.
 - Games.
 - Multimedia.

Optical Media (Slide 2 of 9)



Pits: In optical storage media, recessed areas on the disk.

Lands: In optical storage media, raised areas on the disk.

CD-R: Compact disks containing a layer with photosensitive dye in which a laser transforms the dye to mimic the pits and lands of a premastered CD.

Burning: In optical disks, the process of using a special laser used to transform the dye to mimic the pits and lands of a premastered CD.

CD-RW: Compact disks containing a heat sensitive compound whose properties can be changed between crystalline and amorphous by a special laser.

Optical Media (Slide 3 of 9)

- CDs (continued):
 - Composed of aluminum foil encased in protective plastic.
 - Standard CD is 120 mm diameter.
 - 1.2 mm thick.
 - Foil layer contains pits and lands arranged in a spiral.
 - Changes between pits and lands used to encode data bits.
 - CD-R contains photosensitive dye.
 - Laser transforms the dye to mimic pits and lands of premastered CDs.
 - A type of WORM (Write Once Read Many) media.
 - After an area has been written to, it cannot be overwritten.
 - If space is available, a new session can be started on the disc.
 - CD-RW
 - Uses a heat sensitive compound to change properties between crystalline and amorphous by a laser.
 - CDs and DVDs have a tendency to degrade and become unusable.

Optical Media (Slide 4 of 9)

- DVDs:
 - Higher density than CDs.
 - Thinner than CDs.
 - Can be dual-layer and/or double-sided.
 - Double-sided discs have to be turned over to access the other side.
 - Higher transfer rate than CDs.
 - Multiples of 1.32 MBps.
 - Fastest models are 24x read and write speeds.
 - DVD-R/DVD-RW versus DVD+R/DVD+RW versus DVD±R discs.
 - Most drives can read all formats.
 - Most drives write in either + or – format.
 - DVD±R supports dual layer and double-sided media.
 - DVD±RW supports double-sided media only.
 - DVD-RAM is not widely supported, but is optimized for multiple write operations.
 - Well suited to data storage.

Optical Media (Slide 5 of 9)



BD: (Blu-ray disc) Latest generation of optical drive technology, with disc capacity of 25 GB per layer. Transfer rates are measured in multiples of 36 MBps.

- Used for High Definition (HD) video recording and playback.
- HD requires more bandwidth and storage space.
 - 1920 x 1080 compared to 720x480 (NTSC) or 720x576 (PAL).
 - Better quality digital surround sound audio.
- Shorter wavelength laser than DVD uses, so has higher density.
 - DVD uses 650 nm red laser.
 - Blu-ray uses 405 nm blue laser.
- Base speed is 4.5 MBps with maximum theoretical rate of 72 MBps (16x).
 - 2x is the minimum required for movie playback.

Optical Media (Slide 6 of 9)

- Blue-ray Discs (continued):
 - Capacity:
 - Standard BD: 25 GB per layer.
 - Mini-discs (8cm): 7.8 GB per layer.
 - Dual-layer discs: 50 GB.
 - BD-XL specification requires compatible drives for reading and writing.
 - Triple-layer discs: 100 GB.
 - Quad-layer discs: 128 GB (not currently recordable).

CD Standard	CD Type
Red book	Audio CDs (16-bit sampled at 44.1 Hz).
Yellow book	Data CDs with error correction (Mode 1) or without (Mode 2). Mode 2 makes more space available but is only suitable for use where small errors can be tolerated.
Orange book	Defines the unused CD-MO and the more popular CD-R and CD-RW.

Optical Media (Slide 7 of 9)

DVD Standard	Capacity (GB)	Description
DVD-5	4.7	Single layer, single-sided.
DVD-9	8.5	Dual layer, single-sided.
DVD-10	9.4	Single layer, double-sided.
DVD-18	17.1	Dual layer, double-sided.
DVD-Video	Up to 17.1	<ul style="list-style-type: none">• Commercially produced DVDs using mpeg encoding and chapters for navigation.• Can be single or dual layer and single or double-sided.
DVD-Audio	8.5	<ul style="list-style-type: none">• Format for high quality audio.• Superior sampling rates and 5.1 surround sound, for instance.

Optical Media (Slide 8 of 9)

- Consumer DVDs feature DRM and region coding.
- DVD region codes include:
 - Region 0: No coding (playback is not restricted).
 - Region 1: Canada and the US.
 - Region 2: Europe, the Middle East, Japan, South Africa, and Egypt.
 - Region 3: SE Asia.
 - Region 4: South America, Australia, and New Zealand.
 - Region 5: Russia, parts of Africa, and parts of Asia.
 - Region 6: China.
- Blu-ray Disc region codes include:
 - Region A: America, Japan, and SE Asia.
 - Region B: EMEA, Africa, Australia, and New Zealand.
 - Region C: Russia and Central Asia (including China).

Optical Media (Slide 9 of 9)



Optical Drives (Slide 1 of 2)

- CD drives, DVD drives, and Blu-ray drives.
- Larger than HDDs.
 - 5.25 inch drive bay and SATA connectors for internal installation.
 - USB, eSATA, or Thunderbolt connection and external power for external installations.
- Rated by data transfer speed.
 - 150 KBps originally to over 7 MBps.
- Most have read and write capabilities.
 - Record/Rewrite/Read speed.
 - BURN-proof technology.



Optical Drives (Slide 2 of 2)



CD drive: An optical drive consisting of a spindle motor to spin the disc, a laser and lens to read the disc, and a tracking system to move the laser and lens assembly.

DVD drive: An optical drive similar to a CD drive, but with a different encoding method and a shorter wavelength laser. Typically can read and burn CD and DVD media.

Blu-ray drive: An optical drive for reading, and if so equipped, writing to Blu-ray disc media. Most drives can also read CD and DVD discs.

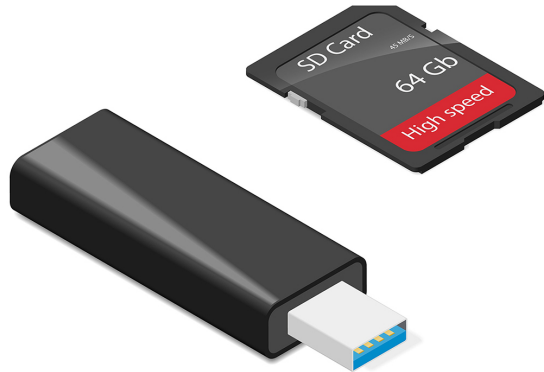
Flash Memory Devices (Slide 1 of 3)



Solid state storage: Any type of persistent digital storage technology that does not use mechanical parts.

Flash memory: Similar to a ROM chip in that it retains information even when power is removed, but it adds flexibility in that it can be reprogrammed with new contents quickly.

Memory card: Flash drives typically used for digital cameras and smartphones; typically small and flat.



Flash Memory Devices (Slide 2 of 3)

- Non-volatile EEPROM or NAND flash.
- Small and light compared to other types of storage.
- Storage capacity typically ranges from 512 MB to 256 GB.
 - Larger drives are available, but are very expensive.
- Packaging of flash memory varies:
 - USB thumb or pen drive.
 - Memory cards.

Flash Memory Devices (Slide 3 of 3)

Type of Memory Card	Description
Secure Digital (SD)	<p>Maximum capacity</p> <ul style="list-style-type: none">• Original SD cards up to 2 GB.• SDHC is up to 32 GB.• SDXC is up to 2 TB. <p>Speed</p> <ul style="list-style-type: none">• Original specification is up to 25 MBps.• UHS allows up to 108 MBps.• UHS-II is rated at up to 312 MBps.
Mini-SD	Smaller version of SD cards, with the same capacity and speed designations.
Micro-SD	Smallest version of SD cards, using the same capacity and speed designations.
Compact Flash (CF)	<ul style="list-style-type: none">• Supports up to 512 GB, but no cards were created larger than 256 GB.• Speed is multiples of 150 Kbps (the same rating as CDs).• Fastest devices work at 1066x read speeds (160 MBps).
xD	Format for Olympus cameras that has been discontinued.

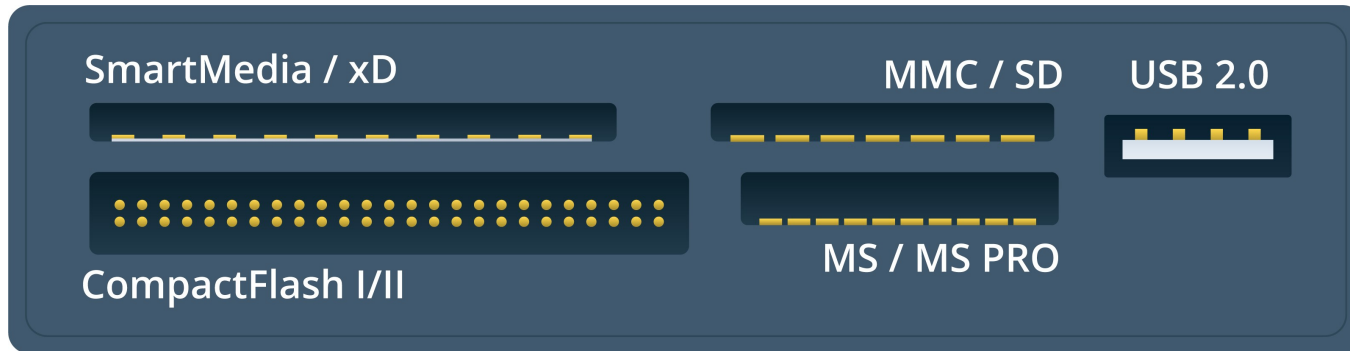
Memory Card Readers (Slide 1 of 2)



Memory card readers: A device containing one or more slots to accommodate reading (and writing) memory cards.

- Can be an internal component with slots on the face, accessed externally.
 - Supports most common memory card formats.
 - Usually designed to fit in 3.5” or 5.25” drive bay.
- Connects to a USB hub.
 - Motherboards typically have at least one spare 9-pin USB header.
 - Might connect to an expansion card.
 - Might use a USB converter cable from the internal reader to an external USB port.
- Also available as an external device that connects to an external USB port.

Memory Card Readers (Slide 2 of 2)



External Storage Drives



Drive enclosure: An external case that holds one or more disks and typically connects to the computer through USB or Thunderbolt ports.

- Enclosure for external drives usually has USB or Thunderbolt ports.
- eSATA can also be used to attach external drives to an eSATA external port.
 - Power is not supplied over the cable.
- Some enclosures support Ethernet connections.
 - Referred to as Network Attached Storage (NAS).
 - Enclosure might hold multiple disks configured as RAID.



Activity



Discussing Removable Storage Device Installation and Configuration