

The 220-901 CompTIA A+ Exam



220-901 Exam Objectives

- 1.0 - Hardware (34%)
- 2.0 - Networking (21%)
- 3.0 - Mobile Devices (17%)
- 4.0 - Hardware and Network Troubleshooting (28%)

- Maximum of 90 questions
- Multiple choice and performance-based questions
- 90 minutes
- Passing score is 675 on a scale of 100-900
- Six to twelve months of hands-on experience recommended

BIOS and UEFI

Basic Input/Output System (System BIOS, ROM BIOS)

- Software (firmware) used to start your computer
- POST - Power-On Self-Test
- BIOS settings are stored in nonvolatile BIOS memory
- Formerly the CMOS (Complimentary Metal-Oxide Semiconductor)
- Usually flash memory these days

Legacy BIOS

- The original / traditional BIOS
- No drivers for modern network, video, and storage devices

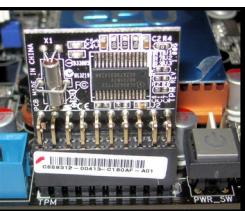


UEFI BIOS

- Unified Extensible Firmware Interface
- Based on Intel's EFI (Extensible Firmware Interface)
- Designed to replace the legacy BIOS
- Boot from large (> 2.2 TB) GUID partition table (GPT) disks

Trusted Platform Module (TPM)

- Adds advanced cryptographic functions
- Used by full disk encryption software
- May be a separate module or integrated into the motherboard



Secure Boot

- Part of the UEFI specification
- Digitally sign known-good software
 - Software won't run without the proper signature
- Support in many different operating systems
 - Windows 8, 8.1, Windows Server 2012 and 2012 R2
 - Linux Fedora, openSUSE, Ubuntu
- Built into the BIOS

Motherboards

ATX (Advanced Technology Extended)

- Standardized by Intel 1995
- Still very popular

microATX

- Small form-factor
- Similar mounting points and power as ATX

Mini-ITX

- An even-smaller form factor
- Similar mounting points as ATX and microATX
- Designed for single-purpose computing, i.e., streaming media

BIOS Configurations

- Use BIOS configuration key during startup
- Configure and enable/disable components
- May include built-in hardware diagnostics
- Always have a backup before making changes



The "CMOS" Battery

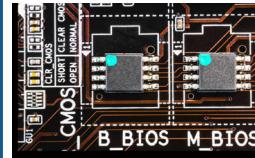
- Not needed for today's flash-based storage
- Maintains older BIOS configurations
- May only be used to maintain date/time
- A bad battery will require a BIOS configuration on every boot
- Can reset the BIOS configuration by removing the battery on older systems

BIOS Passwords

- User Password - Needed to start the computer
- Supervisor Password - Needed to make configuration changes

LoJack for Laptops

- Built into the BIOS
 - Software installed into the OS
 - Reinstalls itself if removed or new storage drive installed
 - "Phone home" function provides location information
 - Theft mode remotely locks the laptop and/or delete files and can force a startup password



Upgrading your BIOS firmware

- Identify current firmware version
- Read the upgrade documentation
- Have a reliable power source

Expansion Slots and Bus Speeds

PCI (Peripheral Component Interconnect)

- Legacy expansion slots - Speeds from 133 MB/s to 533 MB/s

PCI-X (PCI Extended)

- Designed for servers (this is not PCI Express)
- 1,064 MB/s throughput

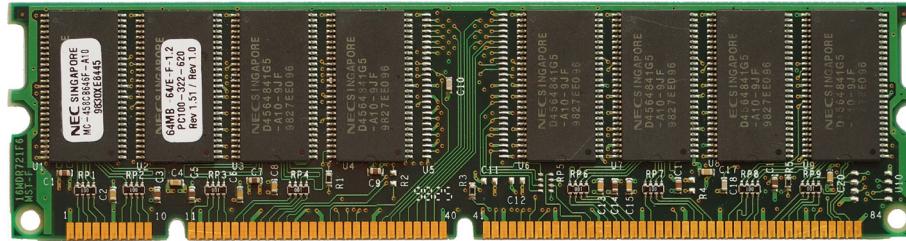
PCIe (PCI Express)

- Serial communication - xl, x2, x4, x8, xl6, x32 lanes
- High performance for devices like high-end graphics adapters
- PCI Express throughput per-lane in each direction
- Speeds from 250 MB/s to 2 GB/s

Mini PCI and PCI Express Mini Card

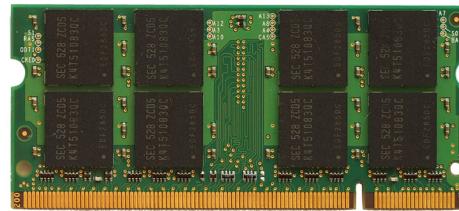
- PCI and PCI Express for laptops
- Adapter cards are internal to the device

Memory Types



DIMM (Dual In-line Memory Module)

- Electrical contacts are different on each side
- SDRAM - 168 pins
- DDR SDRAM - 184 pins
- DDR2 and DDR3 SDRAM - 240 pins



SO-DIMM (Small Outline Dual In-line Memory Module)

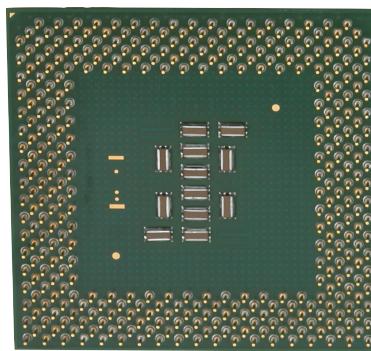
- Used in laptops and mobile devices
- DDR and DDR2 SDRAM - 200 pins
- DDR3 SDRAM - 204 pins



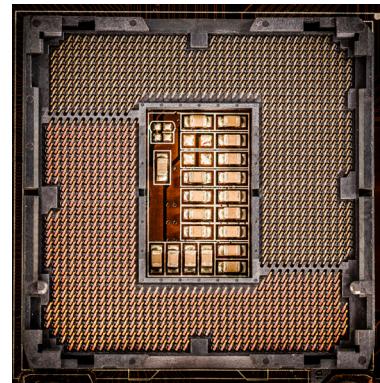
Micro-DIMM (Micro Dual In-line Memory Module)

- Electrical contacts are different on each side
- DDR SDRAM - 172 pins
- DDR2 and DDR3 SDRAM - 214 pins

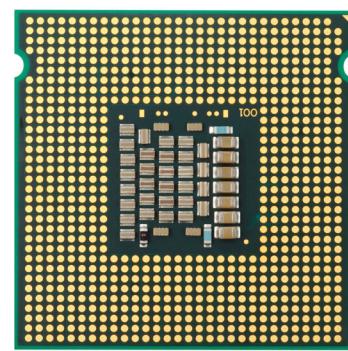
CPU Sockets



Pin Grid Array (PGA)

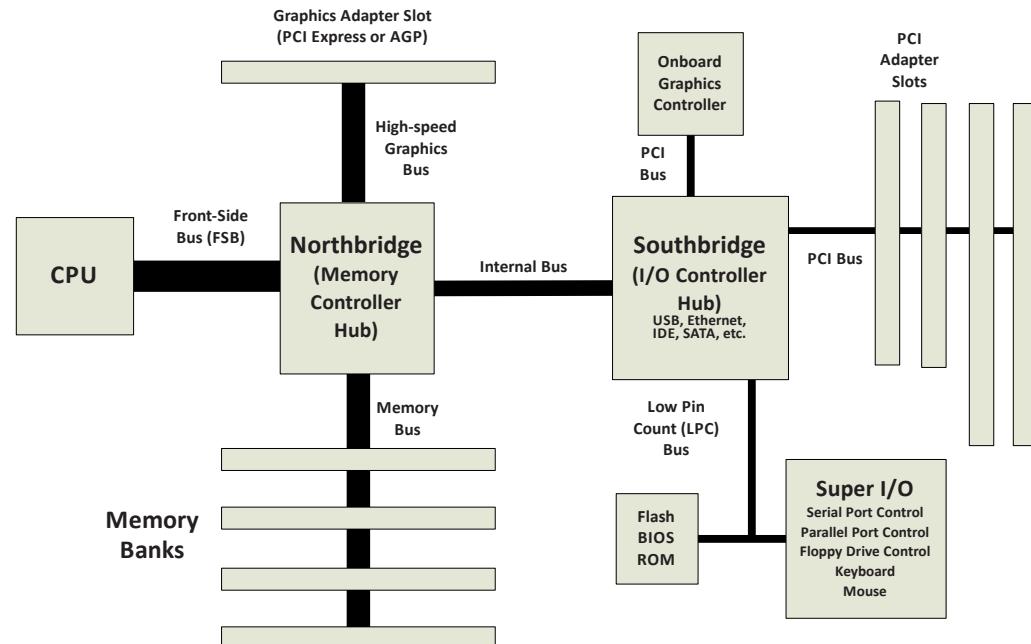


Land Grid Array (LGA)



Zero Insertion Force (ZIF)

Legacy Chipsets



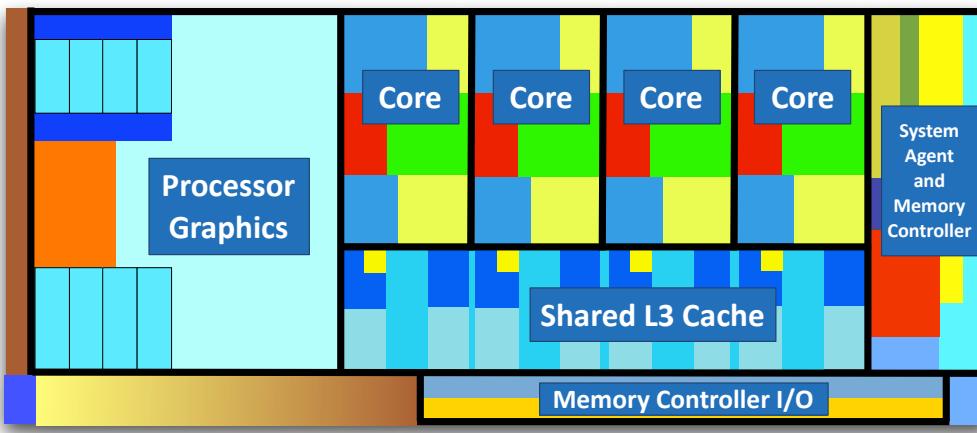
Northbridge

- Manages the connection between the CPU and memory
- May also connect high-end graphics such as PCI Express
- High speed processor

Southbridge

- Relatively slower connections
- USB, Ethernet, SATA, etc.
- BIOS

The Chipset Evolution



Today's integrated CPUs

- More functions are moving into the CPU
- Multiple processor cores
- Memory controller
- Graphics processing unit (GPU)

System Memory

ROM (Read-Only Memory)

- Can't be changed or erased

PROM (Programmable Read-Only Memory)

- Programmable ROM
- Write once

EPROM (Erasable PROM)

- Write / Erase / Write again

EEPROM (Electrically Erasable PROM)

- Flash memory

SRAM (Static RAM)

- Maintains data without constant refreshing
- Very fast, very expensive
- Often used in processor caches

DRAM (Dynamic RAM)

- Requires constant refreshing to maintain data
- Write once

SDRAM (Synchronous Dynamic RAM)

- Synchronous with the common system clock

EEPROM (Electrically Erasable PROM)

- Flash memory

DDR (Double Data Rate SDRAM)

- Twice the data rate of SDRAM

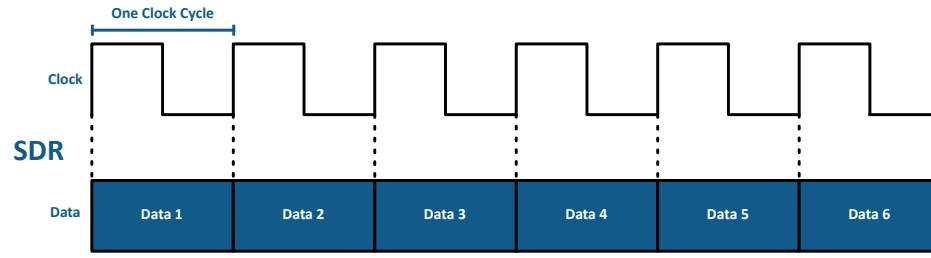
DDR2 (Double Data Rate 2 SDRAM)

- 2x the bus clock multiplier of DDR

DDR3 (Double Data Rate 3 SDRAM)

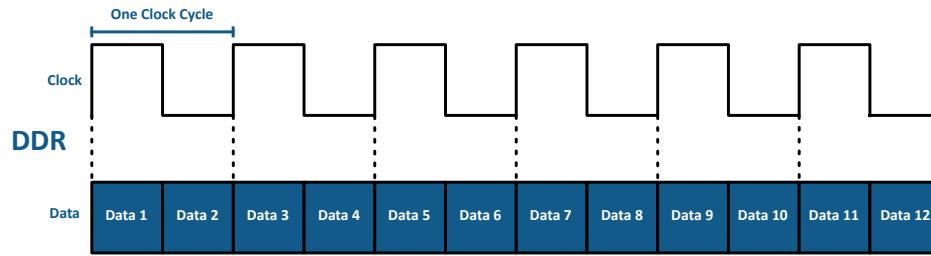
- 4x the bus clock multiplier of DDR

SDR and DDR



DDR Speeds

Memory Clock Speed	I/O Bus Clock Speed	DDR Speed	Transfers per Second	Transfer Rate	Module Name
100 MHz	100 MHz	DDR-200	200 Million	1,600 MB/s	PC1600
133 MHz	133 MHz	DDR-266	266 Million	2,133 MB/s	PC2100
166 MHz	166 MHz	DDR-333	333 Million	2,667 MB/s	PC2700
200 MHz	200 MHz	DDR-400	400 Million	3,200 MB/s	PC3200



DDR2 Speeds

Memory Clock Speed	I/O Bus Clock Speed	DDR Speed	Transfers per Second	Transfer Rate	Module Name
100 MHz	200 MHz	DDR2-400	400 Million	3,200 MB/s	PC2-3200
133 MHz	266 MHz	DDR2-533	533 Million	4,266 MB/s	PC2-4200
166 MHz	333 MHz	DDR2-667	667 Million	5,333 MB/s	PC2-5300
200 MHz	400 MHz	DDR2-800	800 Million	6,400 MB/s	PC2-6400
266 MHz	533 MHz	DDR2-1066	1.066 Billion	8,533 MB/s	PC2-8500

Memory Types

Parity Memory

- Additional parity bit
- Can't correct an error

Error Correcting Code (ECC) Memory

- Detects errors
- Corrects on the fly
- Ideal for servers

Multi-channel Memory

- Installed in pairs or trios for maximum throughput

Registered Memory

- Includes an additional register between the RAM module and the memory controller
- Also called "buffered" memory

Single Sided vs. Double Sided Memory

- Groups of memory on a module that can be independently accessed
- Memory controller moves between the ranks/sides

DDR3 Speeds

Memory Clock Speed	I/O Bus Clock Speed	DDR Speed	Transfers per Second	Transfer Rate	Module Name
100 MHz	400 MHz	DDR3-800	800 Million	6,400 MB/s	PC3-6400
133 MHz	533 MHz	DDR3-1066	1.066 Billion	8,533 MB/s	PC3-8500
167 MHz	667 MHz	DDR3-1333	1.333 Billion	10,667 MB/s	PC3-10600
200 MHz	800 MHz	DDR3-1600	1.600 Billion	12,800 MB/s	PC3-12800
233 MHz	933 MHz	DDR3-1866	1.866 Billion	14,933 MB/s	PC3-14900
267 MHz	1067 MHz	DDR3-2133	2.133 Billion	17,066 MB/s	PC3-17000

Installing Expansion Cards

- Check your motherboard documentation to determine number and type of slots
- Check adapter card documentation for hardware and software requirements
- Use ESD strap, anti-static bag, and other electrostatic discharge precautions
- Confirm driver installation through Windows Device Manager

Storage Formats

- CD - 700 MB capacity
- DVD - 4.7 GB (single layer), 8.5 GB (dual-layer)
- Blu-ray - 25 GB (single layer), 50 GB (dual-layer)
- ROM - Read-only memory - Cannot write to media
- RW - Read-write - Used for backups
- BD-R - Blu-ray Disc Recordable
- BD-RE - Blu-ray Disc Recordable Erasable
- Magnetic Tape - 100 GB to multiple TB / cartridge

Flash Memory



USB Flash Drive



CompactFlash (CF)



Secure Digital (SD)



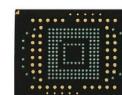
miniSD



microSD



xD-Picture Card

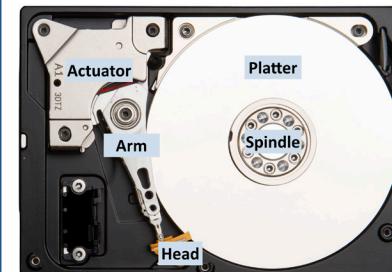


eMMC

Hot swappable formats

- USB, FireWire, SATA, eSATA

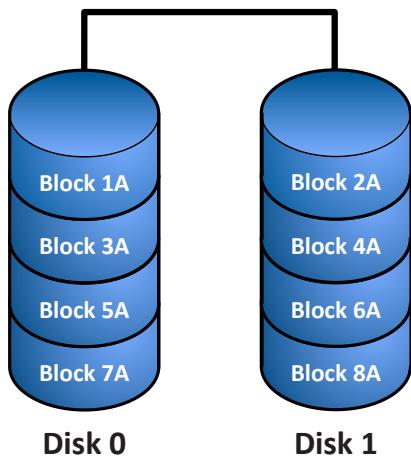
Inside a Hard Disk Drive



Rotational Speed (rpm)	Average Latency
10,000	3 ms
7,200	4.16 ms
5,400	5.55 ms

RAID (Redundant Array of Independent Disks)

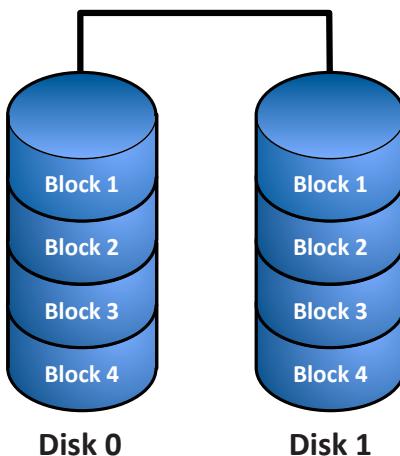
RAID 0 - Striping



Disk 0 Disk 1

- File blocks are split between physical drives
- High performance
- No redundancy
- Minimum of 2 drives

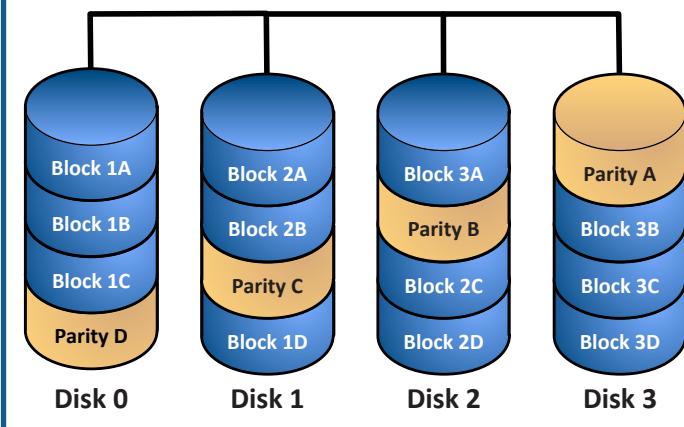
RAID 1 - Mirroring



Disk 0 Disk 1

- File blocks are duplicated between physical drives
- High disk space utilization
- High redundancy
- Minimum of 2 drives

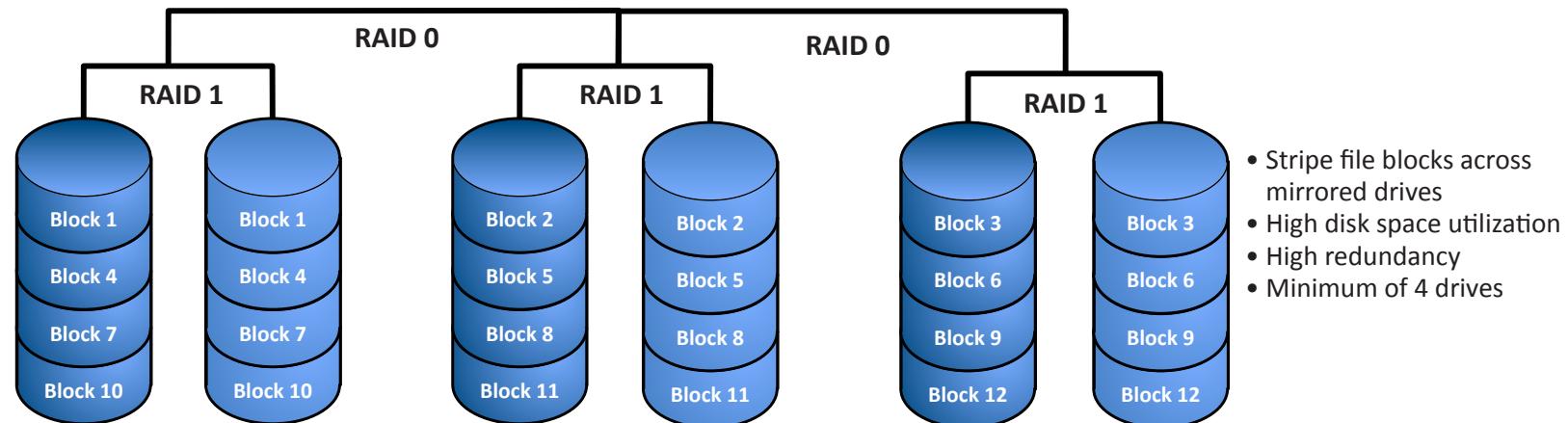
RAID 5 - Striping with Parity



Disk 0 Disk 1 Disk 2 Disk 3

- File blocks are striped along with a parity block
- Efficient use of disk space
- High redundancy
- Minimum of 3 drives

RAID 1+0 - A Stripe of Mirrors



- Stripe file blocks across mirrored drives
- High disk space utilization
- High redundancy
- Minimum of 4 drives

Intel Sockets

Socket	Type	Pins	Release Date	Supported CPUs	Supported RAM
Socket T	LGA	775	2004	Pentium 4, Core 2	DDR2 and DDR3
Socket B	LGA	1366	2008	Core i7 (Nehalem)	DDR3 triple-channel
Socket H / H1	LGA	1156	2009	Core i3/5/7 (Nehalem)	DDR3 dual-channel
Socket H2	LGA	1155	2011	Sandy/Ivy Bridge	DDR3 dual-channel
Socket H3	LGA	1150	2013	Haswell, Broadwell	DDR3 dual-channel
Socket R	LGA	2011	2011	Sandy Bridge-E/EP, Ivy Bridge-E/EP, Haswell-E/EP	DDR3/DDR4 quad-channel

AMD Sockets

Socket	Type	Pins	Release Date	Supported CPUs	Supported RAM
AM3	PGA	941	2009	Athlon II / Phenom II	DDR2/DDR3 dual-channel
AM3+	PGA	942	2011	Athlon II / Phenom II	DDR3 dual-channel
FM1	PGA	905	2011	AMD 10h	DDR3 dual-channel
FM2	PGA	904	2012	Piledriver	DDR3 dual-channel
FM2+	PGA	906	2014	Steamroller	DDR3 dual-channel

Interface Speeds and Distances

USB - Maximum of 127 ports

USB 1.1

- Low speed: 1.5 megabits per second, 3 meters
- Full speed: 12 megabits per second, 5 meters

USB 2.0

- 480 megabits per second, 5 meters

USB 3.0

- SuperSpeed: 5 gigabits per second, 3 meters

Thunderbolt

- Thunderbolt v1: 10 Gbit/s per channel, 20 Gbit/s total throughput
- Thunderbolt v2: 20 Gbit/s aggregated channels
- Thunderbolt v3: 40 Gbit/s
- Max 3 meters (copper), 60 meters (optical)

FireWire 400 (Alpha mode) - IEEE 1394a

- 100, 200, or 400 Mbit/s half-duplex
- 4.5 meters (15 feet), 72 meters max

FireWire 800 (Beta mode) - IEEE 1394b

- 800 Mbit/s full-duplex
- Optical connections - 100 meters max

IrDA (Infrared Data Association)

- 4 Mbit/s speed
- Line of sight, 1 meter

VGA (Video Graphics Array)

- 10 meters

DVI (Digital Visual Interface)

- Max distance isn't part of the standard
- 15 feet at 1920 x 1200 resolution

SATA

- Revision 1.0 - 1.5 Gbit/s, 1 meter
- Revision 2.0 - 3.0 Gbit/s, 1 meter
- Revision 3.0 - 6.0 Gbit/s, 1 meter

eSATA

- Matches the associated SATA revision
- 2 meters

Bluetooth Speeds and Distances

Radio Class	Maximum Power (mW)	Typical Range in meters
1	100	100
2	2.5	10
3	1	1

Bluetooth Version	Data Rate
1.2	1 Mbit/s
2.0 + EDR	3 Mbit/s
3.0 + HS	24 Mbit/s
4.0	24 Mbit/s

802.11 Network Speeds and Distances

	Frequency	Maximum theoretical throughput (per stream)	Maximum allowable streams	Maximum theoretical throughput (total)	Approximate outdoor range
802.11a	5 GHz	54 Mbit/s	1	54 Mbit/s	120 meters
802.11b	2.4 GHz	11 Mbit/s	1	11 Mbit/s	140 meters
802.11g	2.4 GHz	54 Mbit/s	1	54 Mbit/s	140 meters
802.11n	5 GHz and/or 2.4 GHz	150 Mbit/s	4	600 Mbit/s	250 meters
802.11ac	5 GHz	866.7 Mbit/s	8	6,934 Mbit/s	250 meters

Connection Characteristics

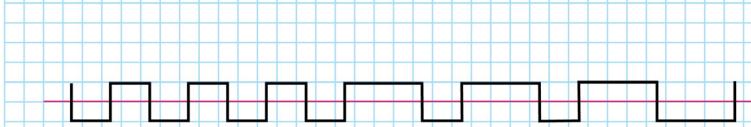
Analog data signal



Analog modulation

- Send an analog signal over an analog channel
- AM and FM audio over radio frequencies

Digital data signal

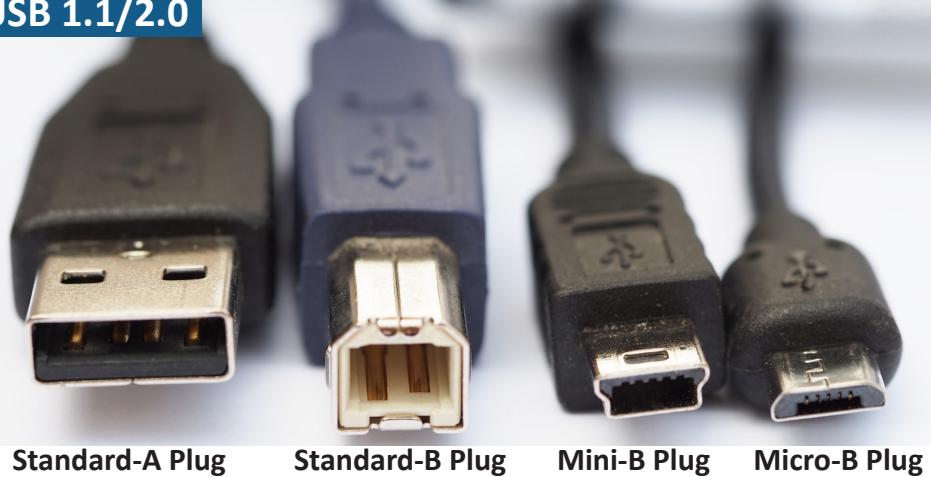


Digital modulation

- Send a digital bitstream over an analog channel
- Send digital audio signal over satellite radio frequencies

Connectors

USB 1.1/2.0



Standard-A Plug

Standard-B Plug

Mini-B Plug

Micro-B Plug

USB 3.0



USB 3.0
Standard-B
Plug

USB 3.0
Standard-A
Plug

USB 3.0
Micro-B
Plug

FireWire



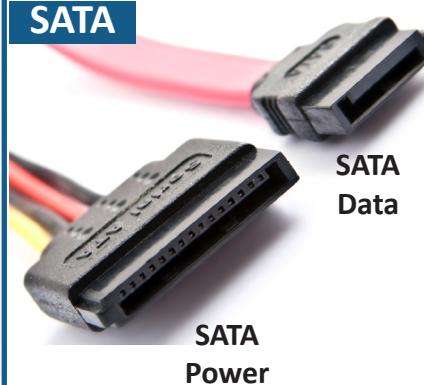
USB
Type A Plug

6-pin Alpha
(powered)

4-pin Alpha
(unpowered)

9-pin Beta
(powered)

SATA



SATA
Data

SATA
Power

eSATA

SATA
Data



VGA

15-pin DB15 Analog Video

HDMI

miniHDMI

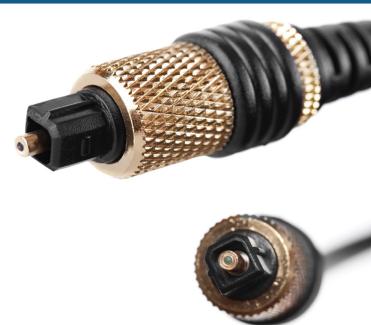
HDMI

Digital Video and Audio

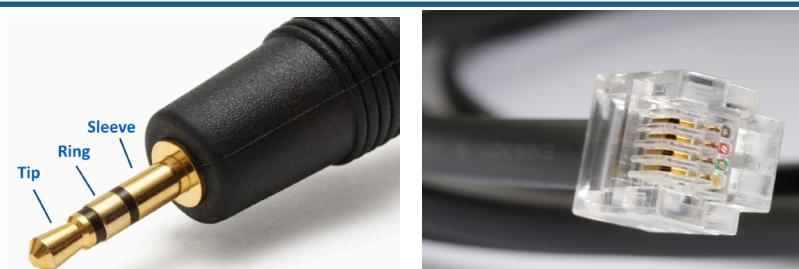


DVI

Analog and Digital Video



TOSLINK (Toshiba Link)
Optical Fiber Audio



Tip
Ring
Sleeve

TRS - Analog Audio

RJ11

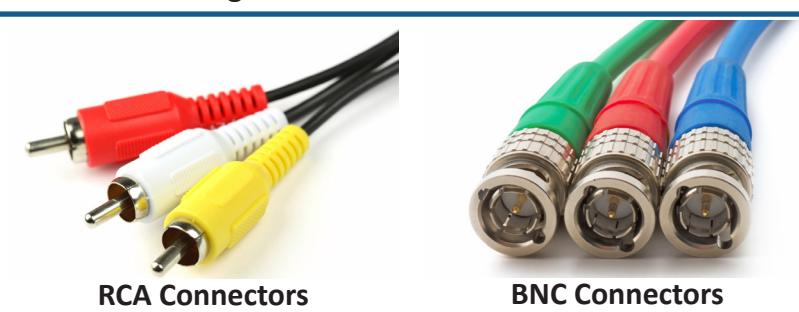


RJ45



DisplayPort

Mini DisplayPort
or Thunderbolt



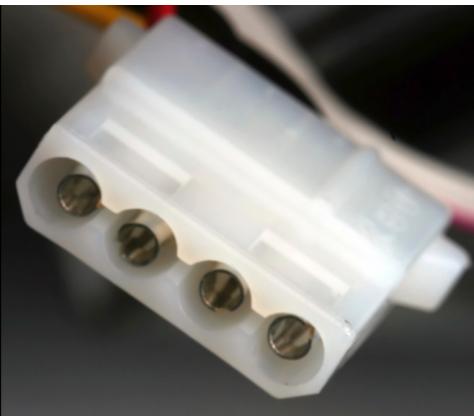
RCA Connectors

BNC Connectors

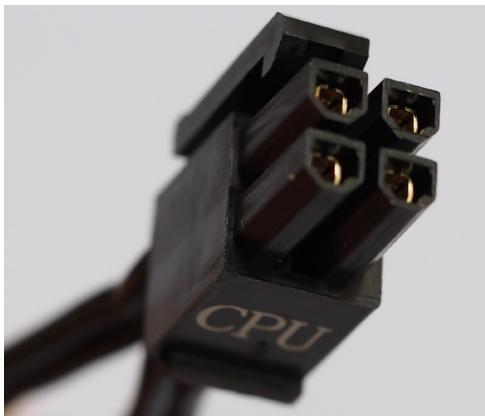
Mini-DIN-4 (S-Video)

Mini-DIN-6 (Keyboard/Mouse)

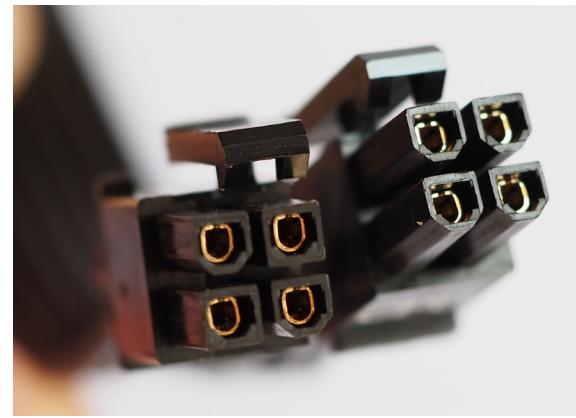
Power connectors



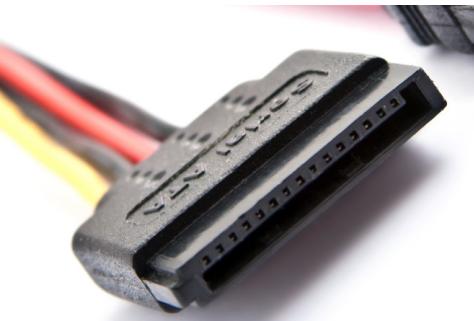
Molex connector



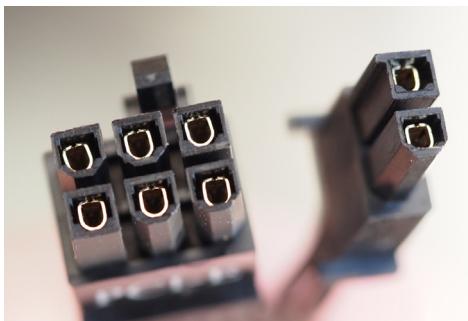
4-pin ATX +12 V



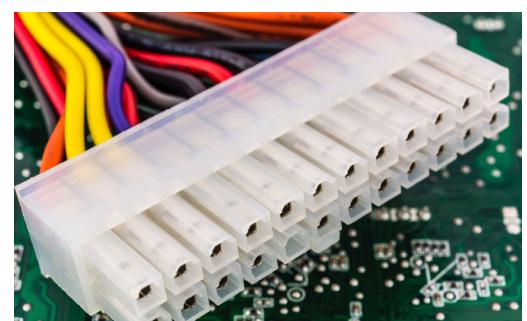
8-pin EPS +12 V power



SATA power - 15 pins



PCIe 6-pin and 8-pin power



24-pin motherboard power

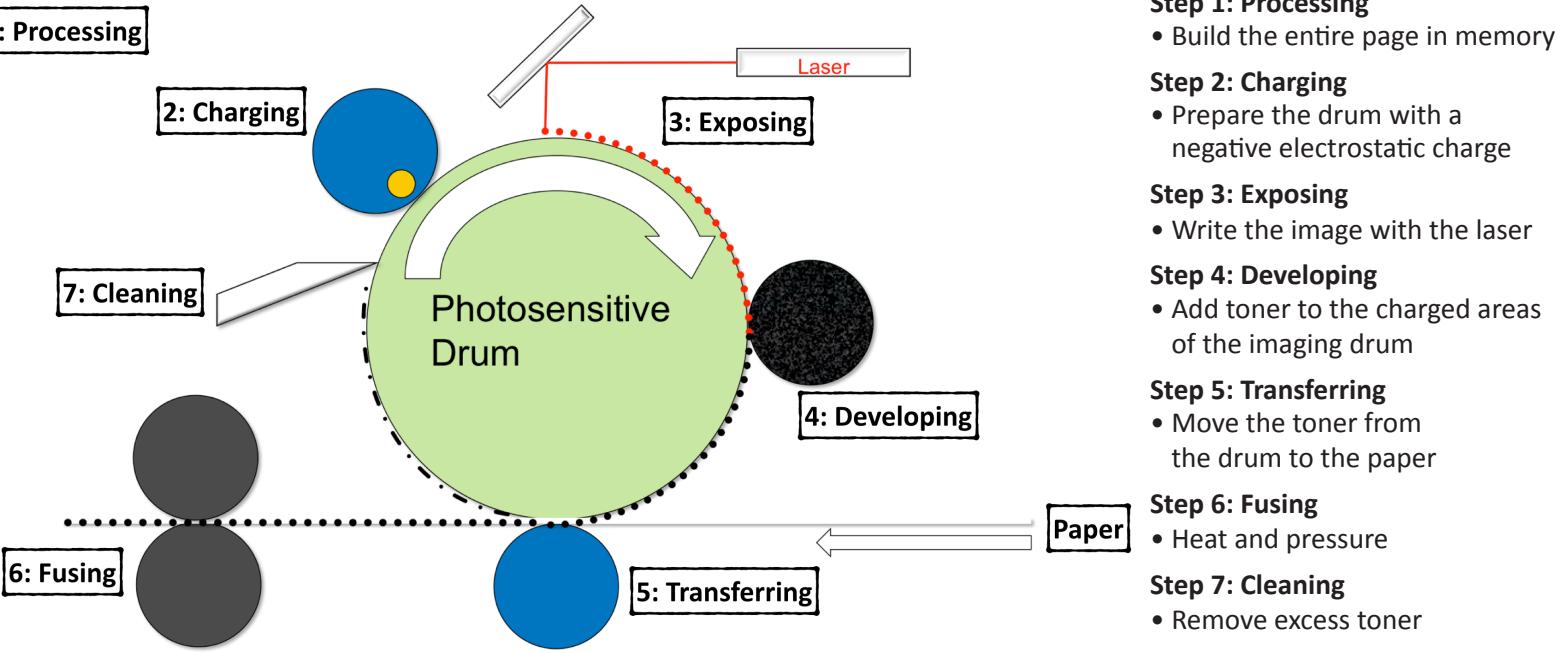
Custom Workstation Configurations

Workstation	Processor	Video	RAM	Storage	Audio	Notes
Graphics/CAD/CAM	✓	✓	✓			Maximum RAM
Audio/Video Editing		✓		✓		Fast storage, dual monitor
Virtualization Workstation	✓		✓			Maximum CPU and RAM
Gaming	✓	✓			✓	High-end cooling
Home Theater		✓			✓	HDMI, surround sound, TV tuner
Thick Client						Recommended Windows requirements
Thin Client						Basic applications

Understanding Printers

Laser Printer • Uses heat and pressure to melt toner pellets onto the page + Very high quality + Fast printing speeds - Many moving parts - Requires memory in the printer - Requires high voltages	Inkjet Printer • Prints with very fine drops of ink +Inexpensive technology + High quality +Relatively quiet - Ink is expensive and proprietary - Eventually fades - Print head clogs easily	Thermal Printer • Applies heat to special paper +Very inexpensive +Almost silent - Requires a specially coated paper - Sensitive to light and heat - Image degrades rapidly	Impact Printer • Printer head strikes a ribbon and the paper +Low cost per page +Good for multiple copies - Very noisy - Poor graphics
Print to File • Print to the driver, but save it as a file • File will be in a output format specific to that printer • Must copy the file to the printer: <code>copy filename LPT1:</code>	Print to PDF • One-way print from app to PDF • Requires specialized software to create and view a PDF • PDF viewers built into many Internet browsers • Many third party tools available	Print to XPS • Microsoft XML Paper Specification • Similar use case to Adobe PDF • Print to XPS, view in any operating system	Print to image • Print to a graphics image • Not integrated into the OS • Some third-party image print drivers are available

The Laser Printing Process



Step 1: Processing

- Build the entire page in memory

Step 2: Charging

- Prepare the drum with a negative electrostatic charge

Step 3: Exposing

- Write the image with the laser

Step 4: Developing

- Add toner to the charged areas of the imaging drum

Step 5: Transferring

- Move the toner from the drum to the paper

Step 6: Fusing

- Heat and pressure

Step 7: Cleaning

- Remove excess toner

Laser Printer Maintenance

Toner Cartridge Replacement

- Replace cartridge when output is faded
- Keep in the bag to protect OPC from light
- Power down printer before replacement
- Remove packing strips from the new cartridge

Laser Printer Maintenance Kit

- Periodic maintenance based on page count
- Replacement feed rollers, transfer rollers, pickup rollers and fuser unit
- Power down during maintenance
- Reset the page counter when done

Impact Printer Maintenance

Printer Ribbon Replacement

- Self-contained cartridge
- Replace when output is faded
- Modular design, replace in a few minutes

Print Head Replacement

- Gets very hot during use
- Another modular part, look for release bar
- Consider replacing both head and ribbon simultaneously for best effect

Thermal Printer Maintenance

Thermal Paper Replacement

- Relatively inexpensive
- Must use the correct size
- Replace spool and feed through the printer

Cleaning the Heating Element

- Use an isopropyl alcohol (IPA) cleaning pen
- Follow printer manufacturer recommendations
- Usually a small area
- Cleaning cards can be used for the paper path

Inkjet Printer Maintenance

Cleaning print heads

- Output may have streaks or sections of missing color
- Cleaning process can be started manually
- Some print heads/cartridges can be removed and cleaned manually

Replacing the Inkjet Cartridge

- Usually separate colors
- Takes seconds to replace

Inkjet printer calibration

- Align nozzles to the paper
- Printer includes a calibration option

Study Tips

Exam Preparation

- Download the exam objectives, and use them as a master checklist
- Use as many training materials as possible. Books, videos, and Q&A guides can all provide a different perspective of the same information.
- It's useful to have some hands-on, especially with network troubleshooting commands.

Taking the Exam

- Use your time wisely. You've got 90 minutes to get through everything.
 - Choose your exam location carefully. Some sites are better than others.
 - Get there early. Don't stress the journey.
 - Manage your time wisely. You've got 90 minutes to get through everything.
 - Wrong answers aren't counted against you. Don't leave any blanks!
 - Mark difficult questions and come back later.
- You can answer the questions in any order.

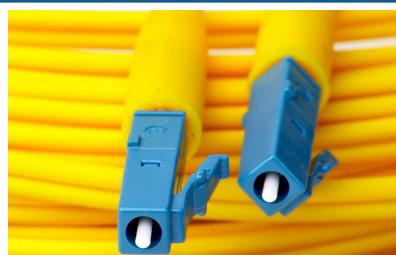
Network Connectors



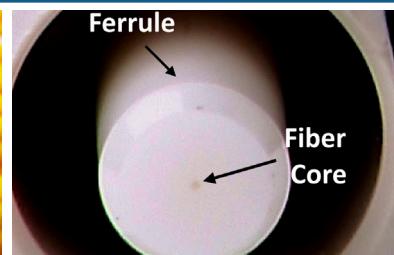
ST Connectors - Straight Tip



SC Connectors



LC Connectors



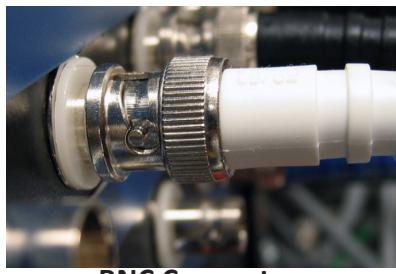
Fiber connector



RJ11 Connector



RJ45 Connector



BNC Connectors



F Connector

TIA/EIA Standards

TIA/EIA 568A	
1	White and Green
2	Green
3	White and Orange
4	Blue
5	White and Blue
6	Orange
7	White and Brown
8	Brown

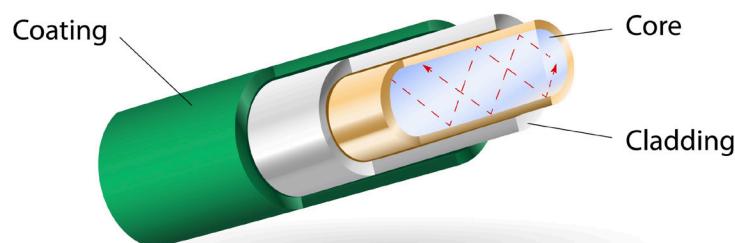


TIA/EIA 568B	
1	White and Orange
2	Orange
3	White and Green
4	Blue
5	White and Blue
6	Green
7	White and Brown
8	Brown

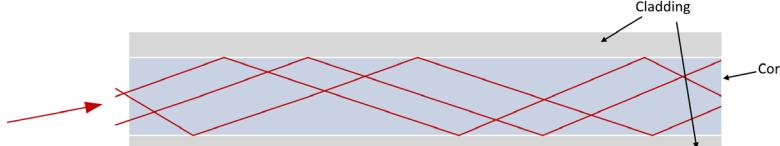
Cable Categories

Cable Category	Ethernet Standard	Maximum Distance
Category 3	10BASE-T	100 meters
Category 5	100BASE-TX, 1000BASE-T	100 meters
Category 5e (enhanced)	100BASE-TX 1000BASE-T	100 meters
Category 6	10GBASE-T	37 to 55 meters
Category 6A (augmented)	10GBASE-T	100 meters
Category 7* (shielded)	10GBASE-T	100 meters

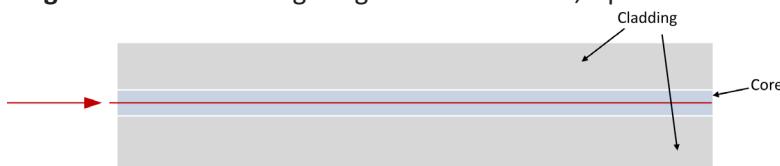
Fiber Optics



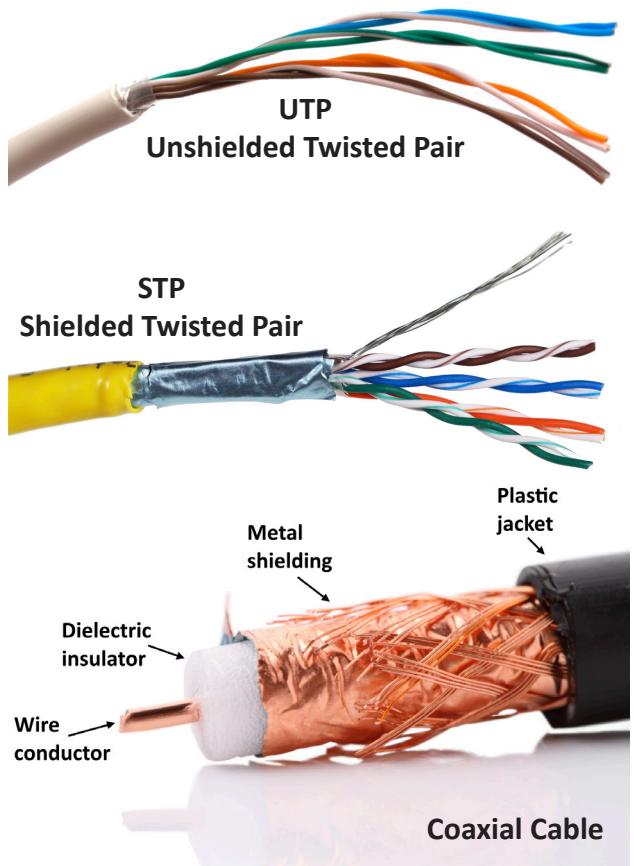
Multimode Fiber - Short-range communication, Up to 2 km



Single-mode Fiber - Long-range communication, Up to 100 km



Copper Cable Categories



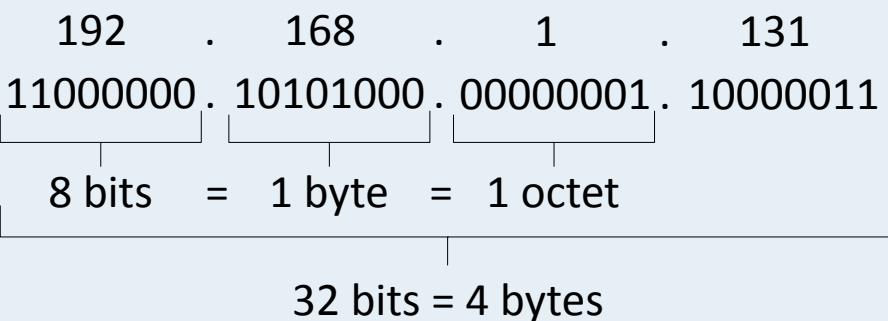
RFC 1918 Private Addresses

IP address range	Number of addresses	Classful description	Largest CIDR block (subnet mask)	Host ID size
10.0.0.0 – 10.255.255.255	16,777,216	single class A	10.0.0.0/8 (255.0.0.0)	24 bits
172.16.0.0 – 172.31.255.255	1,048,576	16 contiguous class Bs	172.16.0.0/12 (255.240.0.0)	20 bits
192.168.0.0 – 192.168.255.255	65,536	256 contiguous class Cs	192.168.0.0/16 (255.255.0.0)	16 bits

IP subnets

Binary	Decimal	CIDR
11111111.00000000.00000000.00000000	255.0.0.0	/8
11111111.11111111.00000000.00000000	255.255.0.0	/16
11111111.11111111.11111111.00000000	255.255.255.0	/24

IPv4 Addressing



APIPA (Automatic Private IP Addressing)

- Automatically assigned addresses
- 169.254.1.0 through 169.254.254.255

IPv6 Link Local Addresses

- Required on every IPv6-enabled interface
- fe80::/10 with only one subnet allocated (all zeros)
- The last 64 bits are created with a modified EUI-64

IPv6 Addressing

fe80::5d18:652:cfd:8f52	fe80:0000:0000:0000:5d18:0652:cfd:8f52		
fe80 : 0000 : 0000 : 0000 : 0000 : 5d18 : 0652 : cfd : 8f52	11000000 . 10101000 . 00000001 . 10000011		
111111010000000:0000000000000000:0000000000000000:0000000000000000:0101110100011000:0000011001010010:11001111111101:1000111101010010	8 bits = 1 byte = 1 octet		
16 bits = 2 bytes = 2 octets			128 bits = 16 bytes

Common Network Protocols

Protocol	Port	Name	Description
DHCP	udp/67-68	Dynamic Host Configuration Protocol	Automate the IP address configuration process
DNS	udp/53	Domain Name System	Convert domain names to IP addresses
LDAP	tcp/389, udp, 389	Lightweight Directory Access Protocol	Directory service protocol
SNMP	udp/161	Simple Network Management Protocol	Gather metrics and manage network devices
SMB	tcp/445	Server Message Block	Windows file transfers and printer sharing
SSH	tcp/22	Secure Shell	Encrypted remote console login
AFP	tcp/548	Apple Filing Protocol	Mac OS file transfers
SLP	tcp/427, udp/427	Service Location Protocol	Find Mac OS services by name

Common Network Ports

Protocol	Port	Name	Description
FTP	tcp/20, tcp21	File Transfer Protocol	Sends and receives files between systems
SSH	tcp/22	Secure Shell	Encrypted console access
Telnet	tcp/23	Telecommunication Network	Insecure console access
SMTP	tcp/25	Simple Mail Transfer Protocol	Transfer email between mail servers
DNS	udp/53, tcp/53	Domain Name System	Convert domain names to IP addresses
HTTP	tcp/80	Hypertext Transfer Protocol	Web server communication
POP3	tcp/110	Post Office Protocol version 3	Receive email into a email client
IMAP4	tcp/143	Internet Message Access Protocol v4	A newer email client protocol
HTTPS	tcp/443	Hypertext Transfer Protocol Secure	Web server communication with encryption
RDP	tcp/3389	Remote Desktop Protocol	Graphical display of remote devices
NetBIOS	udp/137	NetBIOS name service	Register, remove, and find Windows services by name
NetBIOS	udp/138	NetBIOS datagram service	Windows connectionless data transfer
NetBIOS	tcp/139	NetBIOS session service	Windows connection-oriented data transfer
SLP	tcp/427, udp/427	Service Location Protocol	Find Mac OS services by name
SMB	tcp/445	Server Message Block	Windows file transfers and printer sharing
AFP	tcp/548	Apple Filing Protocol	Mac OS file transfers

Wireless Encryption Standards

WEP

- 64-bit or 128-bit key size
- Cryptographic vulnerabilities found in 2001
- WEP can no longer be used

WPA

- Short-term workaround after WEP
- Used RC4 cipher as a TKIP (Temporal Key Integrity Protocol)
- TKIP has its own vulnerabilities

WPA2

- Replaced TKIP with CCMP (Counter Mode with Cipher Block Chaining Message Authentication Code Protocol)
- Replaced RC4 with AES (Advanced Encryption Standard)
- WPA2 is the latest and most secure wireless encryption method

Network Types

LAN

- Local Area Network
- A building or group of buildings

WAN

- Wide Area Network
- Spanning the globe (or the neighborhood)

PAN

- Personal Area Network
- Bluetooth, WiFi
- Automobile, mobile phone, health telemetry

MAN

- Metropolitan Area Network
- Contained in a regional area

Configuring a SOHO Wireless Router

Wireless channels and encryption

- Configure for the highest encryption possible
- Choose WPA2-AES over WPA or WEP

NAT

- SOHO devices do this automatically
- Source NAT, also called PAT

Port Forwarding

- 24x7 access to a service hosted internally
- External IP/port number maps to an internal IP/port
- Also called Destination NAT or Static NAT

Port Triggering

- Similar to a port forward, but not static
- Internal client communicates externally on a particular port
- Reverse port forward is dynamically created
- Only one person can trigger at a time

IP Addressing

- DHCP (automatic) IP addressing vs. manual IP addressing
- IP addresses are easy to see in an unencrypted wireless network

Firewall and DMZ ports

- Every SOHO router is also a firewall
- DMZ ports can be configured to allow unrestricted access

Managing QoS (Quality of Service)

- Change the priority of your traffic
- Prioritize applications, ports, or MAC addresses

Firmware updates

- Can have dramatic change on wireless performance
- May improve compatibility with chipsets from other devices

UPnP (Universal Plug and Play)

- Automatically configure and find other network devices
- Applications on the network can open inbound ports using UPnP
- Best practice would be to disable UPnP

Internet Connection Types

Cable Modem

- DOCSIS (Data Over Cable Service Interface Specification)
- 4 Mbit/s through 250 Mbit/s
- Data, Voice



DSL

- ADSL (Asymmetric Digital Subscriber Line)
 - 24 Mbit/s downstream / 3.3 Mbit/s upstream
- VDSL (Very-high-bit-rate DSL)
 - 3 Mbit/s through 100 Mbit/s

Dialup

- Network with voice telephone lines
- 56 kbit/s modems, compression up to 320 kbit/s
- Legacy systems, network utility



Fiber

- Fiber optics to the home
- Converged services - Voice, Video, Data
- Enhanced features



Satellite networking

- Non-terrestrial communication
- 15 Mbit/s down, 2 Mbit/s up
- High latency
- High frequencies - 2 GHz



ISDN - Integrated Services Digital Network

- BRI – Basic Rate Interface (2B+D)
 - Two 64 kbit/s bearer (B) channels
 - One 16 kbit/s signaling (D) channel
- PRI – Primary Rate Interface
 - T1 – 23B + D, E1 – 30B + D + alarm channel



Cellular networks

- Mobile devices - "Cell" phones
- Tethering - Turn your phone into a wireless router
- Mobile hotspot - Standalone networking devices



Line-of-sight services

- Visual path between antennas - high frequencies
- Common in metropolitan areas
- WiMAX networking - Worldwide Interoperability for Microwave Access



Network Devices

Hub

- Multi-port repeater
- Traffic going into one port is repeated to every other port



Switch

- Bridging done in hardware
- Forwards traffic based on data link address



Router

- Routes traffic between IP subnets
- Forwards traffic based on network address
- Routers inside of switches sometimes called "layer 3 switches"



Wireless access point (WAP)

- Bridges from wired network to wireless
- Makes forwarding decisions based on MAC address



Modem

- Modulator/Demodulator
- Converts analog sounds to digital signals



Firewall

- Filters traffic by IP, port number, or application



Patch panels

- Punch-down blocks and RJ-45 connectors
- Runs from desks are made once
- Patch panel to switch can be easily changed



Copper line drivers and extenders

- Extend the range of copper wire
- Used with serial links, copper Ethernet
- Powered device, regenerates the signal



PLC (Power Line Communication)

- May be marketed as Ethernet over Power (EOP)
- 500 megabits per second



PoE (Power over Ethernet)

- One wire for both network and electricity
- Built-in power - Endspans
- In-line power injector - Midspans

Networking Tools

Crimper

- "Pinches the connector onto the wire
- The final step of a cable installation



Cable stripper

- Quickly remove the insulation from the copper
- Speeds the cable installation process



Multimeter

- Measures voltage, current, resistance
- Check AC/DC voltage, cable continuity



Tone generator and probe

- Find a specific wire
- 2 pieces; tone generator and inductive probe



Cable tester

- Measure the quality of a cable installation
- Crosstalk, signal loss, etc.



Loopback plug

- Used for diagnostics and troubleshooting
- Is a received signal is the same as the sent signal?



Punchdown tool

- Forces wires into a wiring block
- Trims the wires and breaks the insulation



WiFi analyzer

- Purpose-built hardware or mobile device add-on
- Identify errors and interference

Laptop Expansion Options



ExpressCard

- Two form factors - 34 mm and 54 mm wide
- 54 mm slot also accepts 34 mm cards
- Can be added and removed while the OS is running

SO-DIMM

- RAM upgrade
- Must power down to install

Flash memory

- USB connected
- Use as additional storage

Thunderbolt and Mini DisplayPort

- It's the same connector
- Mini DisplayPort is video and audio
- Thunderbolt adds data

Interface Adapters

- USB to RJ-45 Ethernet
- USB to Wifi
- USB to Bluetooth
- USB optical drive



Laptop Displays

LCD (Liquid Crystal Display)

- Lightweight, low power consumption
- Requires a separate backlight (fluorescent, LED)

TN (Twisted Nematic) LCD

- + Fast response times (gaming!)
- + Low power draw
- Poor viewing angles - color shifts

IPS (In Plane Switching) LCD

- + Excellent color representation
- + No tailing when touched (mobile devices)
- More expensive to produce than TN

CCFL - Cold Cathode Fluorescent Lamp

- Higher voltage and power needed
- No longer a common backlight

LED-backlit LCD display

- Backlight is LEDs instead of fluorescent
- The latest laptops are LED-backlit

OLED Displays (Organic Light Emitting Diode)

- Thinner and lighter - no glass needed
- The organic compound provides the light
- Used for smaller mobile devices due to cost

Laptop Features

Special Keyboard Function Keys

- Can control external displays and audio

Display Options

- Use the Fn key as a toggle
- Toggle between LCD / external monitor
- May also have a physical / magnetic switch

Wireless Control

- Physical switch to enable/disable wireless

Volume Settings

- Fn key or standalone key

Screen Brightness

- Controls the backlight strength
- Helps to conserve battery life

Keyboard Backlight

- Set intensity, duration, or disable

Touch Pad

- Enable to help avoid inadvertent mouse clicks and movements

Screen Orientation

- Useful on rotating tablet / laptops
- Fn key, hotkey, or another method

Media Options

- Control audio / video from your keyboard
- Play, stop, rewind, fast forward

GPS

- Enable or disable the GPS radio
- May also be associated with airplane mode or other wireless settings

Docking Stations and Port Replicators

- Similar functionality
- Port replicator extends existing laptop interfaces
- Docking station adds additional features, options to include desktop adapter cards

Physical laptop locks

- Keep your laptop from walking away
- Connect to a solid object

Rotating / removable screens

- Combine a laptop keyboard with a tablet screen
- May include a stylus for input

Mobile Devices



Tablets

- Single-screen touch computers
- Designed for touch input,
- Application and media support



Smart phones

- Mobile communication
- Media viewer and mobile applications



Wearable technology

- Smart watches, fitness monitors
- Glasses and headsets



Phablets

- Phones and tablets
- ~5.5 inches to 7 inches diagonal size



e-Readers

- Specialized device
- Electronic paper
- WiFi and cellular network access



Smart camera

- Traditional digital cameras
- Powerful operating systems
- Smart features (touch screen, wireless networking, social media integration, etc.)



GPS

- In-car (and non-car) navigation
- Requires a view of the sky
- Periodic updates required

Mobile Device Connections



NFC (Near Field Communication)

- Send small amounts of data wirelessly over a limited area
- Short range with encryption support



Proprietary mobile interfaces

- Early mobile technology
- Every manufacturer was different



Micro-USB and mini-USB

- EU standardized on Micro-USB
- Older devices may use Mini-USB

Lightning

- Apple proprietary
- 8-pin digital signals



Bluetooth

- High speed communication over short distances
- PAN (Personal Area Network)
- Connects our mobile devices



IR (Infrared)

- Included on many smartphones, tablets, and smartwatches
- Control your entertainment center



Hotspot / tethering

- Turn your phone into a WiFi hotspot
- Dependent on phone type and provider
- May require additional charges and data costs

Mobile Device Accessories



Headsets

- Hands-free audio
- Wired - Connects to TRRS connector
- Wireless - Uses Bluetooth



Speakers

- Mobile audio
- Battery powered
- Bluetooth wireless connection



Game pads

- Gaming console feel
- Connects wirelessly with Bluetooth



Docking stations

- No wires to connect, charge and sync
- Places the phone upright



Extra battery packs / battery chargers

- Swappable battery pack
- External USB chargers



Protective covers

- Screen protector
- Device protector



Credit card readers

- Phone or tablet becomes a point of sale terminal
- Uses the Internet link for approvals



Memory / microSD

- Increase storage capacity of smartphone or tablet
- MicroSD small form factor cards

Troubleshooting Hardware Problems

Unexpected shutdowns

- Check all fans and heat sinks
- Check Device Manager for failing hardware symptoms
- Eliminate what's working

Lockups

- Check for activity lights, update drivers and software patches
- Consider reverting to a restore point
- Hardware diagnostics may be helpful

POST (Power On Self Test)

- Tests system components before starting the OS
- Failures are noted with beeps and/or codes
- Every manufacturer uses different codes

Blank screen on boot

- Bad video, BIOS configuration issue, listen for the beeps

Booting to an incorrect device

- Set boot order in BIOS configuration
- Confirm that the boot device has a valid OS

Continuous reboots

- How far does the boot process get?
- Try safe mode or OS recovery options

Power and reboots

- No power - check the power supply
- Unexpected shutdown - run hardware diagnostics
- Only fans spin - check power supply output

Overheating

- Heat generated from CPUs, video adapters, memory
- Check cooling fans and heat sinks
- Verify temperatures with monitoring software

Loud noises

- Loose components can rattle
- Hard drive scraping noises and clicking
- Check fans for obstructions
- Blown capacitor

Intermittent device failure

- Check and reseat, may be bad hardware

Status light indicators

- Seen often on network devices
- Power, link, speed, activity

Smoke and burning smell

- Electrical problems (Always disconnect power!)
- Locate and replace bad components

Crash screens

- Windows Stop Error (Blue Screen of Death)
- Contains important information

The spinning ball of death

- The Mac OS X Spinning Wait Cursor
- Application bug, bad hardware, slow paging to disk

Hardware Troubleshooting Tools



Multimeter

- Check AC, DC voltages, continuity, and more
- Can answer many electrical questions



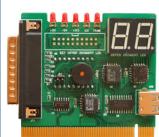
Power supply tester

- Check the power supply power output
- LCD panel can show voltages
- Easier and faster than a multimeter



Loopback plugs

- Usually don't need them until there's a problem
- Need separate plugs for different media



POST card with USB power

- Detailed diagnostics during POST
- Connects to PCI/PCI Express/ Parallel
- Powered through USB

Troubleshooting Hard Drives

Troubleshooting disk failures

- Get a backup as soon as possible
- Check for loose or damaged cables
- Check for overheating - Especially if problems occur after startup
- Check power supply, especially if new devices were added
- Run hard drive diagnostics from the drive manufacturer

Troubleshooting boot failures

- Check your cables
- Check boot sequence in BIOS
 - Check for removable disks (especially USB)
 - Check for disabled storage interfaces
- For new installation, check the hardware configuration
- Try the drive in a different computer

RAID failures

- Missing or faulty RAID controller
- Each RAID is different
- Don't start pulling drives until you check the console!

Crash screens

- Windows Stop Error, Apple spinning wait cursor
- May indicate a storage device issue
- Diagnostics needed for drive and motherboard

S.M.A.R.T. Errors

- Self-Monitoring, Analysis, and Reporting Technology
- Avoid hardware failure, look for the warning signs
- Schedule periodic disk checks

RAID	Disks Required	Failure Condition
RAID 0	2 or more	A single drive failure breaks the array with data loss
RAID 1	2 or more	Array will work as long as one drive is operational
RAID 5	3 or more	Need all drives operational but one
RAID 10	4 or more	Can lose all but one from each set of mirrors

Hard Drive Troubleshooting Tools



Screwdriver

- Flat, crosspoint, torx, non-magnetized
- Never open the drive!



External disk enclosure

- Move from internal to external on separate PC
- USB connected
- May not be bootable, but files are available



CHKDSK

- `CHKDSK /f` - Fixes errors on the disk
- `CHKDSK /r` - Locate and recover from bad sectors



FORMAT

- Adds a file system to a partition
- This also removes all file entries



File recovery software

- Recover deleted files, lost files
- Recover from disk, USB flash, memory card



Defragmentation tool

- Moves file fragments so they are contiguous

Troubleshooting the Boot Process

Boot loaders

- Bootstrap loader in the BIOS
- Second-stage boot loader - Winload, GRUB, LILO

Fixing the Master Boot Record

- Boot from the installation media
- Start the Windows Command Prompt
- `BOOTREC /fixmbr`
 - Fix the Master Boot Record on a physical drive

Fixing the Volume Boot Record

- Boot from the installation media
- Start the Windows Command Prompt
- `BOOTREC /fixboot`
 - Writes a new boot sector

DISKPART

- Replaces the Pre-Windows-XP FDISK command
- Add, remove, list volumes/partitions

Troubleshooting Video and Display Issues

No video image

- Check physical connection
- Confirm input selection on monitor
- Check brightness
- Swap the monitor with a known-good
- Start Windows in VGA mode (F8)

Image quality problems

- Flickering, colors missing, blur
- Check for bent interface connector pins
- Match Windows video refresh rate and resolution settings to the monitor specifications
- Disable hardware acceleration
- Set resolution higher to correct oversized images

Pixel problems

- Stuck pixels (constantly bright)
- Dead pixels (always black)

Video artifacts

- Unusual graphics
 - Check adapter
- Image persistency
 - Turn off display
- Motion trails
 - Disable advanced video features



BSOD and overheating

- Update video drivers
- Monitor the PC's internal temperature

Troubleshooting Networks

No network connectivity

- Check for link light
- Ping loopback (127.0.0.1)
- Ping local IP address
- Ping default gateway
- Ping devices on router's other side

Automatic Private IP Addressing (APIPA)

- A link-local address
- IETF has allocated 169.254.1.0 through 169.254.254.255
- Automatically assigned

Limited or no connectivity

- Windows alert in the system tray
 - "Limited or No connectivity", "No Internet Access"
- Check the local IP address
- If DHCP address is obtained, perform the ping tests

Intermittent connectivity

- Check the system tray for broken LAN icons or messages
- May be a problem with the switch or wireless access point

IP conflicts

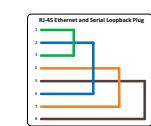
- Windows will identify a duplicate
- Two identical IP addresses will conflict
- Reboot or reset the network adapter

Network Troubleshooting Tools



Cable tester

- Relatively simple continuity test
- Can identify missing pins or crossed wires
- Not usually used for frequency testing



Loopback plug

- Useful for testing physical ports
- Serial / RS-232 (9 pin or 25 pin)
- Network connections - Ethernet, T1, fiber



Punch-down tool

- "Punch" a wire into a wiring block
- Trims the wires during the punch



Toner probe

- Follow the tone to trace a cable
- Tone generator puts an analog sound on the wire
- Inductive probe has a speaker

Slow transfer speeds

- Router or infrastructure congestion
- Speed and duplex incompatibility
- Hardware issue with the adapter
- Malware infection

Low RF wireless signal

- Interference - Something else is using our frequency
- Signal strength - Check the signal and antenna locations
- Incorrect channel - Usually automatic, try tuning manually
- Bounce and latency - Multipath interference; flat surfaces
- Incorrect access point placement - Locate close to the users

Wireless interference

- Predictable
 - Fluorescent lights, microwave ovens, etc.
- Unpredictable
 - Multi-tenant building
- Measurements
 - Signal strength, Performance Monitor

SSID not found

- Too far away
 - Local networks are "louder"
- Wireless router has disabled SSID advertisements

Wire stripper

- Quickly remove insulation around the copper
- Automates the process
- Avoids inadvertent cuts and nicks



Cable crimper

- "Pinch" the connector onto a wire
- Connect the modular connector to the cable
- Metal prongs are pushed through the insulation



Wireless locator

- Software or hardware analyzers
- Identify all wireless networks
- View configuration, channel, frequency settings

Network Troubleshooting at the Command Line

ping - Test reachability

- `ping <ip address>` - Test reachability to a TCP/IP address
- `ping -t <ip address>` - Ping until stopped with Ctrl-c
- `ping -a <ip address>` - Resolve address to a hostname
- `ping -n <count> <ip address>` - Send a # of echo requests
- `ping -f <ip address>` - Send with Don't Fragment flag set

ipconfig – Windows TCP/IP configuration

- `ipconfig /all` - Show all TCP/IP details
- `ipconfig /release` - Release the DHCP lease
- `ipconfig /renew` - Renew the DHCP lease
- `ipconfig /flushdns` - Flush the DNS resolver cache

ifconfig - Linux/Unix TCP/IP configuration

- `ifconfig <interface>` - Show TCP/IP details

tracert (Windows) or traceroute (Linux/Unix)

- Determine the route a packet takes to a destination
- Takes advantage of ICMP Time to Live Exceeded error message
- Not all devices will reply with ICMP Time Exceeded messages

netstat - Network statistics

- `netstat -a` - Show active connections
- `netstat -b` - Show binaries
- `netstat -n` - Do not resolve names

Troubleshooting Laptops

LCD issues

- Dim video may be caused by a bad backlight
- Video may be barely visible without the backlight
- May need to replace the LCD inverter or display

Blurry video

- LCD displays have an optimal native resolution
- Check the manual to determine the correct resolution

Flickering video

- Laptop LCDs are always opening and closing
- Connector issue, bad video cable or hardware

Input issues

- Sticky keys require a cleaning - be careful, keycaps are delicate!
- Inadvertent mousepad touches cause cursor to jump around
 - Updated drivers may help
- Laptops Num lock changes the keyboard from letters to numbers

Troubleshooting Mobile Devices

Touchscreen completely black or not responding to input

- Apple iOS restart
 - Press power button, slide to power off, press power button
 - Hold down power button and Home button for 10 seconds
- Android device restart
 - Remove battery, put back in, power on
 - Hold down power and volume down until restart
 - Some phones have different key combinations
 - Some phone do not have a key-based reset

Apps not loading or slow app performance

- Restart the phone - Hold power button, power off
- Stop the app and restart
 - iPhone: Double-tap home button, slide app up
 - Android: Settings/Apps, select app, Force stop
- Update the app - Get the latest version

nbtstat - Query NetBIOS over TCP/IP information

- `nbtstat -n` - List local NetBIOS names
- `nbtstat -A <ip address>` - List remote NetBIOS names
- `nbtstat -a <device name>` - List remote NetBIOS names

net - Windows network commands

- `NET USE` - Map a network share to a drive letter
 - `net use h: \\<servername>\<sharename>`
- `NET STOP` - Stop a service
 - `net stop spooler`
- `NET START` - Start a service
 - `net start spooler`
- `NET VIEW` - View network resources
 - `net view \\<servername>`

netdom - Manage Active Directory database

- Join a computer to the domain, add a domain account, etc.
- Reset domain password
- `netdom resetpwd /s:<server> /ud:<domain>\User /pd:*`

nslookup - Lookup information from DNS servers

- Canonical names, IP addresses, cache timers, etc.
- Find an ip address - `nslookup www.professormesser.com`
- Find a name - `nslookup 8.8.8.8`

Wireless antenna problems

- A laptop has multiple antennas; WiFi main, WiFi aux, Bluetooth
- Antenna wires wrap around the top of the LCD to get up high
- It's easy to accidentally disconnect the wires during maintenance

Battery not charging

- Battery may be too old to maintain a charge
- The charging hardware could be faulty
- Check the battery voltage with a multimeter

No laptop power

- Check the external power adapter with a multimeter
- Try a master laptop reset, i.e., hold power button for 10 seconds

External monitor issues

- Usually toggled with the secondary Fn keys
- Toggles between LCD / external monitor / both
- Use an external monitor to bypass the LCD

Unable to decrypt email

- Each user has a private key
- Install individual private keys on every mobile device
- Use a Mobile Device Manager (MDM)

Short battery life

- Bad reception
- Disable unnecessary features - 802.11 wireless, Bluetooth, GPS
- Check application battery usage
- Replace aging battery

Overheating

- Check app usage - Some apps can use a lot of CPU
- Avoid direct sunlight

Frozen system

- Soft and/or hard reset
- Ongoing problems may require a factory reset

Troubleshooting Mobile Devices (continued)

No sound from speakers

- Check volume settings - both app and phone settings
- Bad software / delete and reload
- Try headphones

Sound starts but then stops

- Dueling apps
 - Keep app in foreground

No speaker sound from any app

- Load latest software
- Factory reset

GPS not functioning

- Check settings to enable GPS
 - iOS: Settings / Privacy / Location Services
 - Android: Settings / Location
- Configure location mode

Swollen battery

- Buildup of gas - do NOT open the container
- Faulty battery - stop using immediately
 - Dispose of properly
- Device can be damaged - better than having a fire

Device Disassembly Best Practices

Device disassembly

- Many different pieces, intricately engineered
- Taking it apart is easy, getting it back together...
- Easy to break something - very delicate parts

Document and label

- Identify cable locations - many different cables
- Document screw locations - many screws in many locations

Organize parts

- Laptops disassemble in sections
- Take pictures, and use a big workspace
- Use containers to separate the sections

Manufacturer resources

- Often provide step-by-step repair guides
- Online written guides
- YouTube videos

Use appropriate hand tools

- Sometimes a single screwdriver
- Sometimes specialized tools
- Get a good tweezer
- Magnification will be needed
- Get a big anti-static cloth



Troubleshooting Printer Problems

On-printer test page

- This checks the printer operation without any OS or application
- May be a power-on process or menu option
- If the printer's test page doesn't work, the printer is the problem

Windows printer test page

- Print a test page from the Windows printer properties
- A bad Windows printer test page may be related to a driver, cable, interface, or connection

Streaks and blurs

- Inkjet - Clean the print heads
- Laser - Check for scratches on the photosensitive drum

Faded prints

- Low toner and low ink
- Poor quality toner or ink

Ghost images

- The laser printer optical drum may not be cleaning properly
- Print shows ghost or "shadow" from previous drum rotation

Color prints in wrong color

- Low ink in one cartridge
- Other colors should print normally

Laser printer smudging

- The toner isn't fusing to the paper
- The fuser unit may not be heating
- May require replacing the fuser unit

Paper jam

- Tray problem or bad pickup rollers may not feed paper properly
- Creased paper may cause problems in the paper path
- Check the paper weight with printer manufacturer specifications

Printer network issues

- No connectivity - Check for power and cabling
- Wireless printers may require additional configuration
- Check Windows printer security tab for rights and permissions

Garbled output

- Bad printer driver (PCL vs. PostScript)
- The application may be sending bad data
- Confirm the printer health with an on-printer test page

Operating System issues

- Printer driver installation issues may be related to OS permissions
 - Make sure the correct driver is installing (32 bit vs. 64 bit)
- Queue may not be moving, print jobs "stuck" in the queue
 - The print spooler may have crashed or not working
 - Restart the spooler from the Windows Services

Error messages

- Visible on the printer display console
- Low memory problems are related to laser printer RAM
 - Complex images and graphics consume more memory

No output

- Run a test print
- Check the connectivity
- Print from a different program

