

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

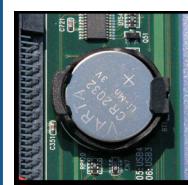
- Small form-factor
- Similar mounting points and power as ATX

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

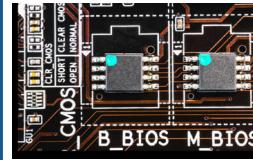
- Not needed for today's flash-based storage
- Maintains older BIOS configurations
- May only be used to maintain date/time
- A bad battery will require a BIOS configuration on every boot
- Can reset the BIOS configuration by removing the battery on older systems

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

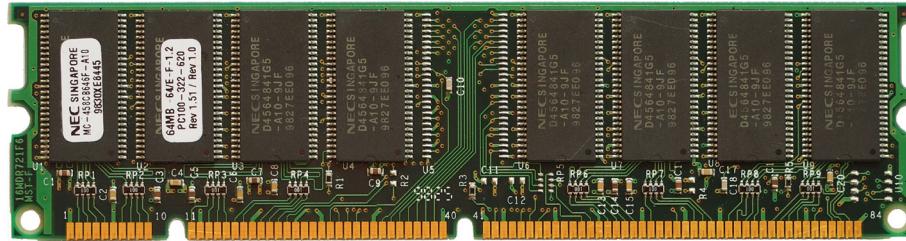
PCIe (PCI Express)

- Serial communication - x1, x2, x4, x8, x16, 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

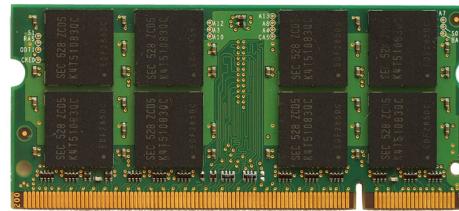
- PCI and PCI Express for laptops
- Adapter cards are internal to the device

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)

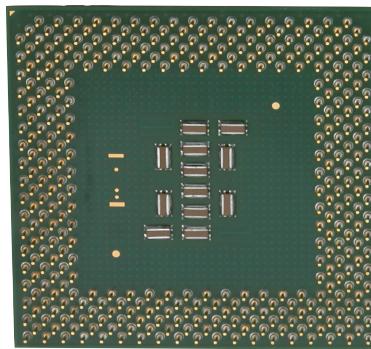
- Used in laptops and mobile devices
- DDR and DDR2 SDRAM - 200 pins
- DDR3 SDRAM - 204 pins



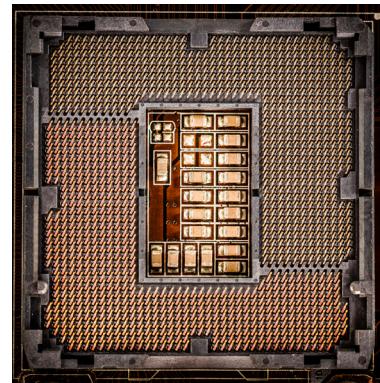
Micro-DIMM (Micro Dual In-line Memory Module)

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

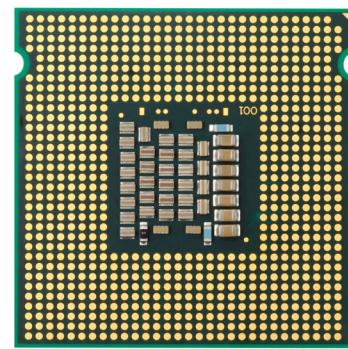
CPU Sockets



Pin Grid Array (PGA)

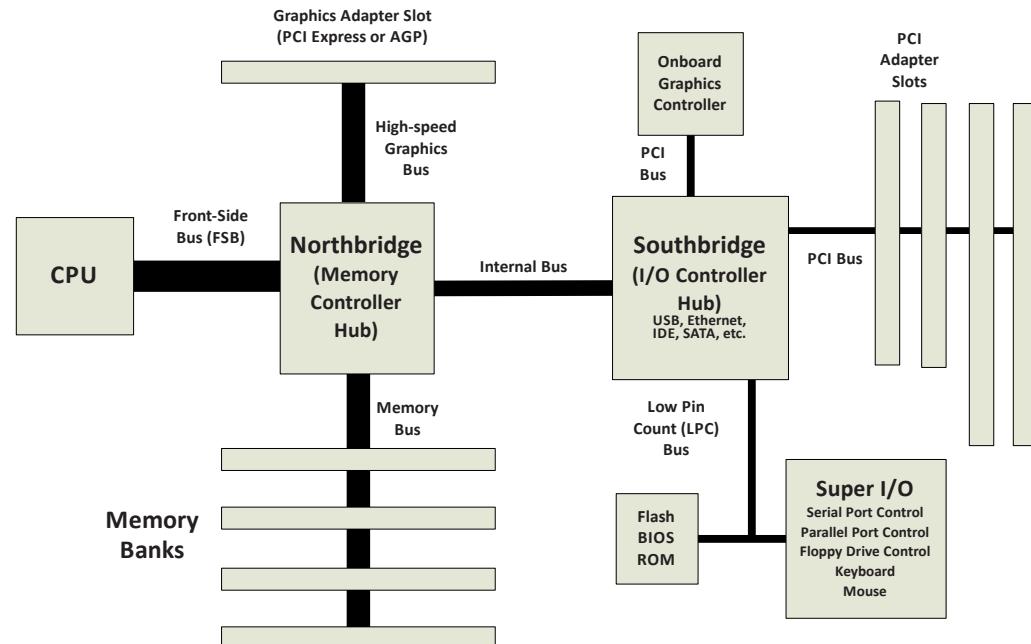


Land Grid Array (LGA)



Zero Insertion Force (ZIF)

Legacy Chipsets



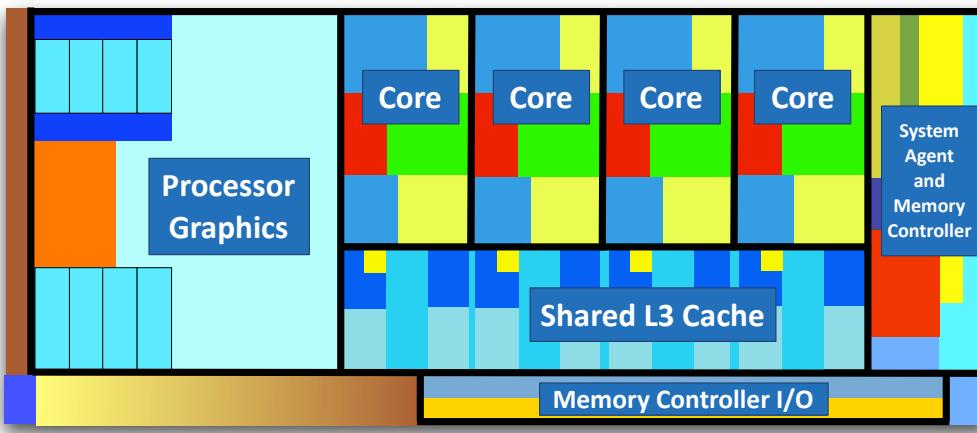
Northbridge

- 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

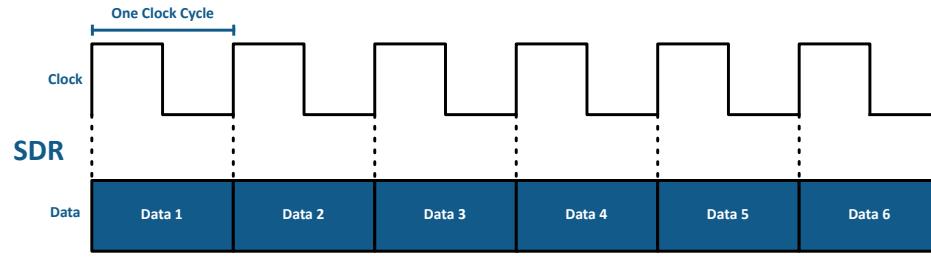
DDR2 (Double Data Rate 2 SDRAM)

- 2x the bus clock multiplier of DDR

DDR3 (Double Data Rate 3 SDRAM)

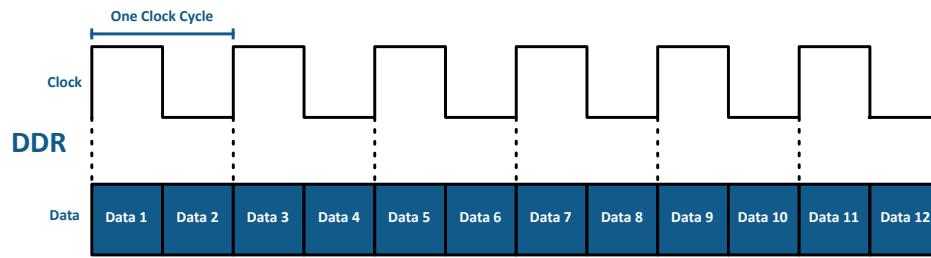
- 4x the bus clock multiplier of DDR

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)



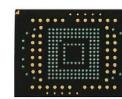
miniSD



microSD



xD-Picture Card

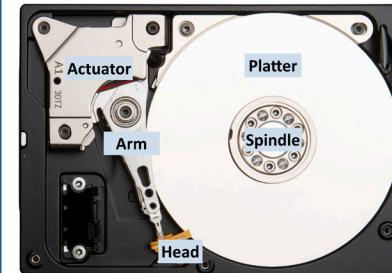


eMMC

Hot swappable formats

- USB, FireWire, SATA, eSATA

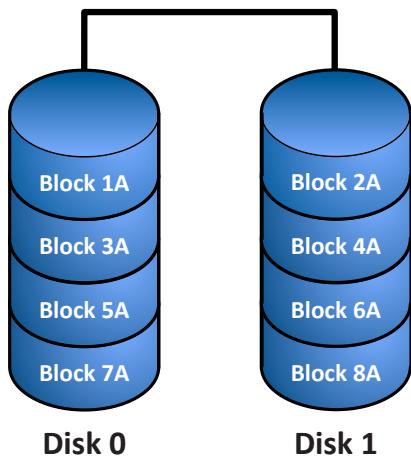
Inside a Hard Disk Drive



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)

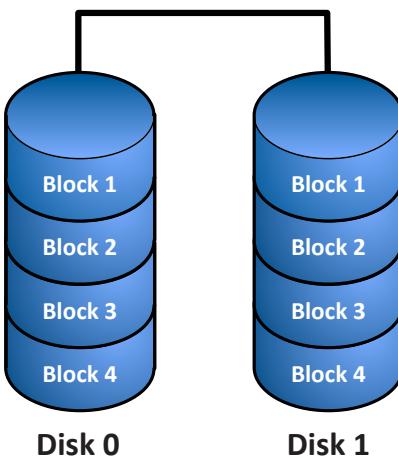
RAID 0 - Striping



Disk 0 Disk 1

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

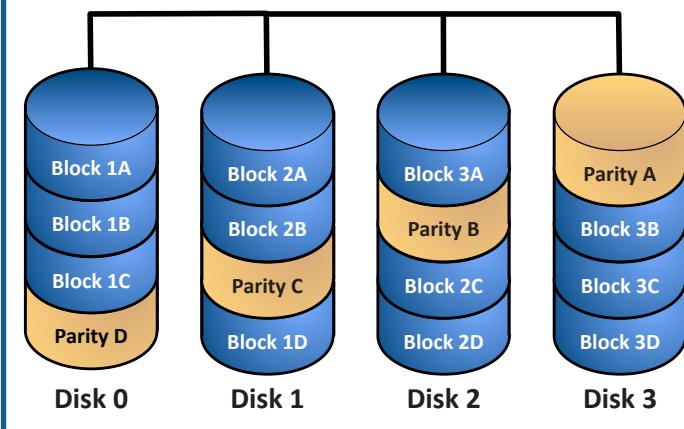
RAID 1 - Mirroring



Disk 0 Disk 1

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

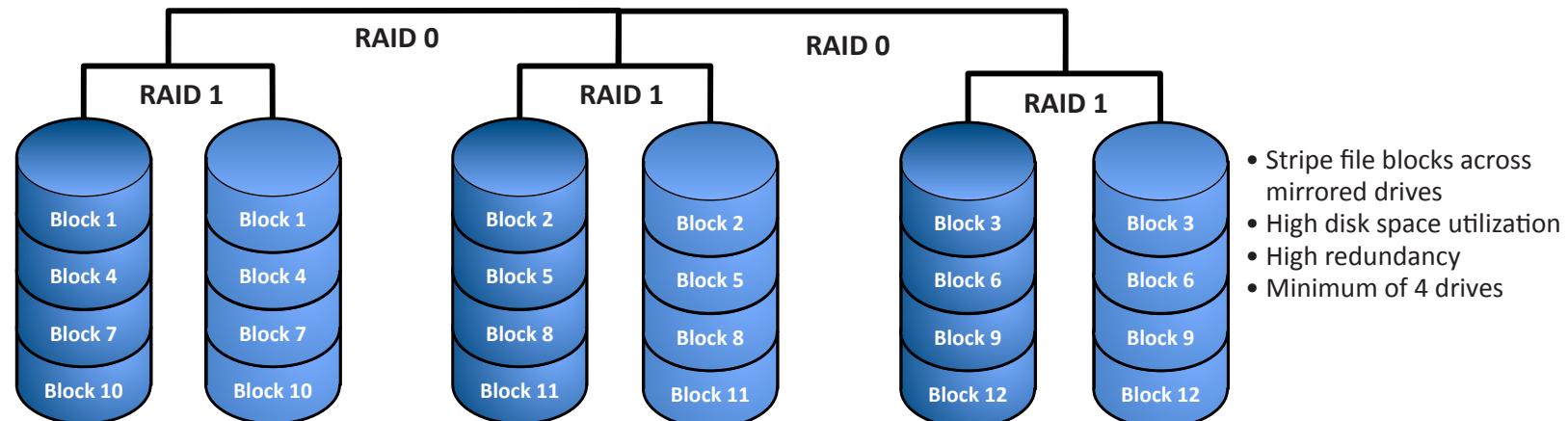
RAID 5 - Striping with Parity



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: 4.8 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

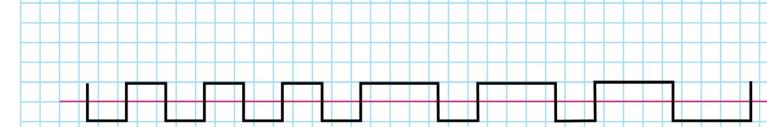
Analog data signal



Analog modulation

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

Digital data signal

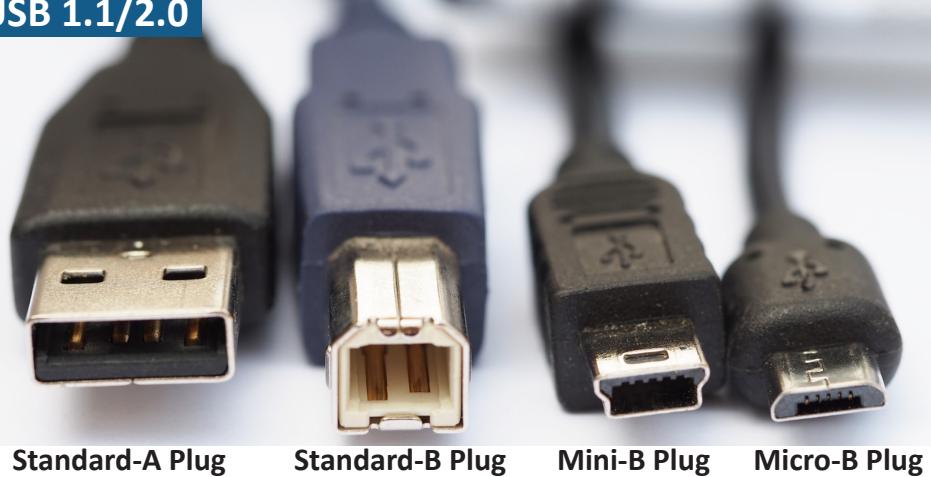


Digital modulation

- 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



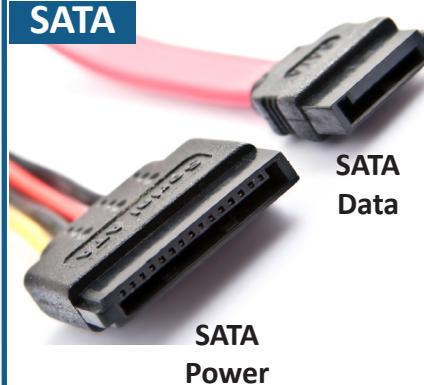
USB
Type A Plug

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

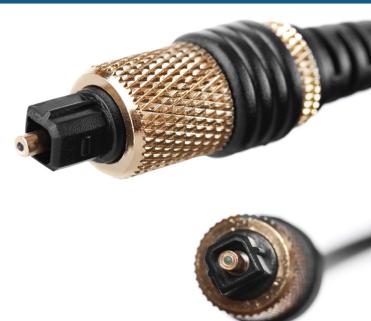
HDMI

Digital Video and Audio

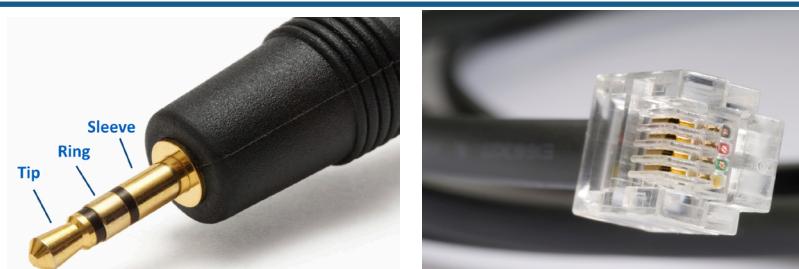


DVI

Analog and Digital Video



TOSLINK (Toshiba Link)
Optical Fiber Audio



Tip
Ring
Sleeve

TRS - Analog Audio

RJ11

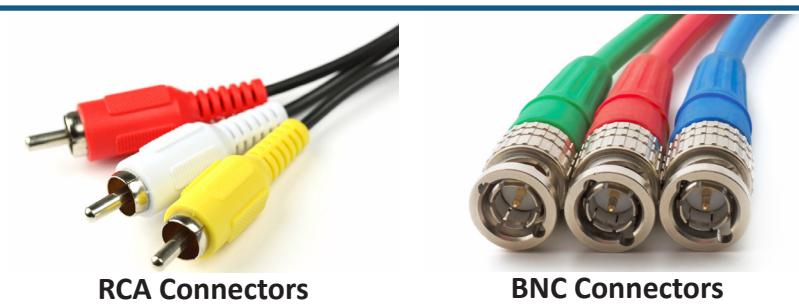


RJ45



DisplayPort

Mini DisplayPort
or Thunderbolt



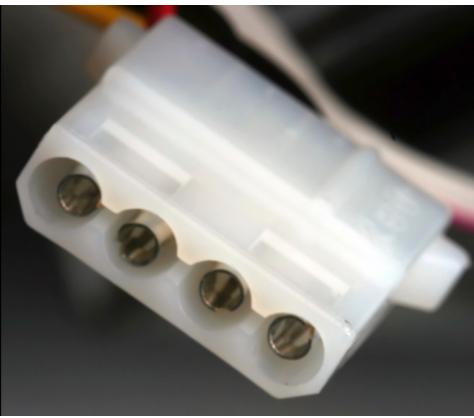
RCA Connectors

BNC Connectors

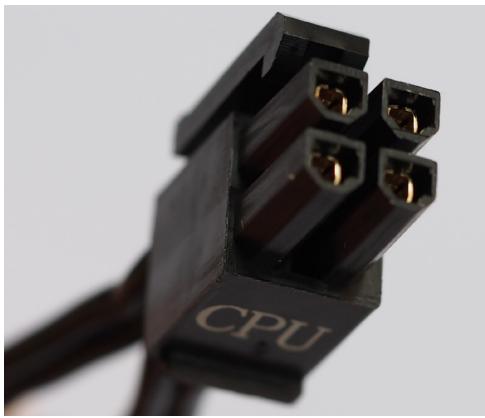
Mini-DIN-4 (S-Video)

Mini-DIN-6 (Keyboard/Mouse)

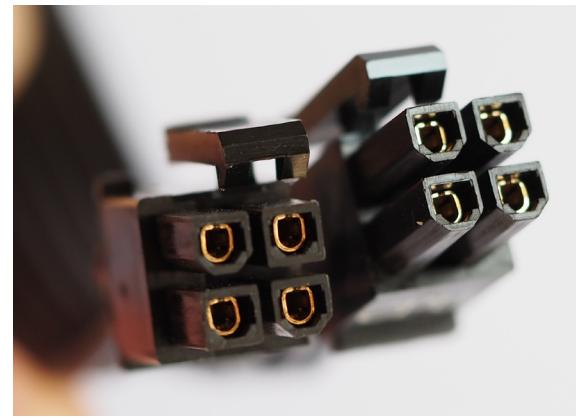
Power connectors



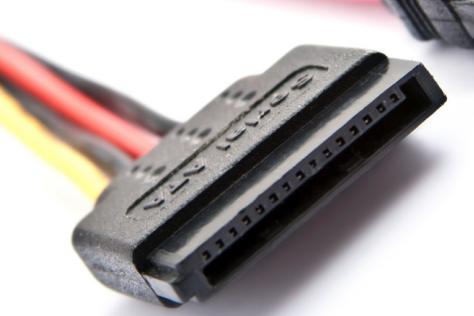
Molex connector



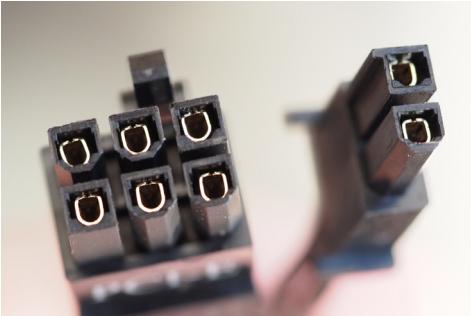
4-pin ATX +12 V



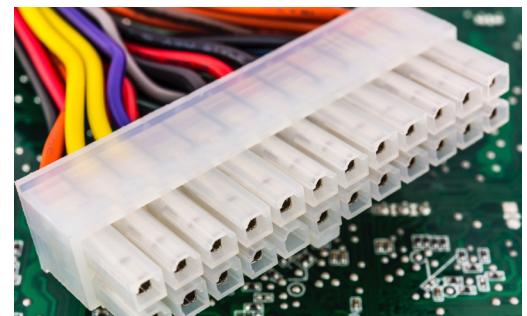
8-pin EPS +12 V power



SATA power - 15 pins



PCIe 6-pin and 8-pin power



24-pin motherboard power

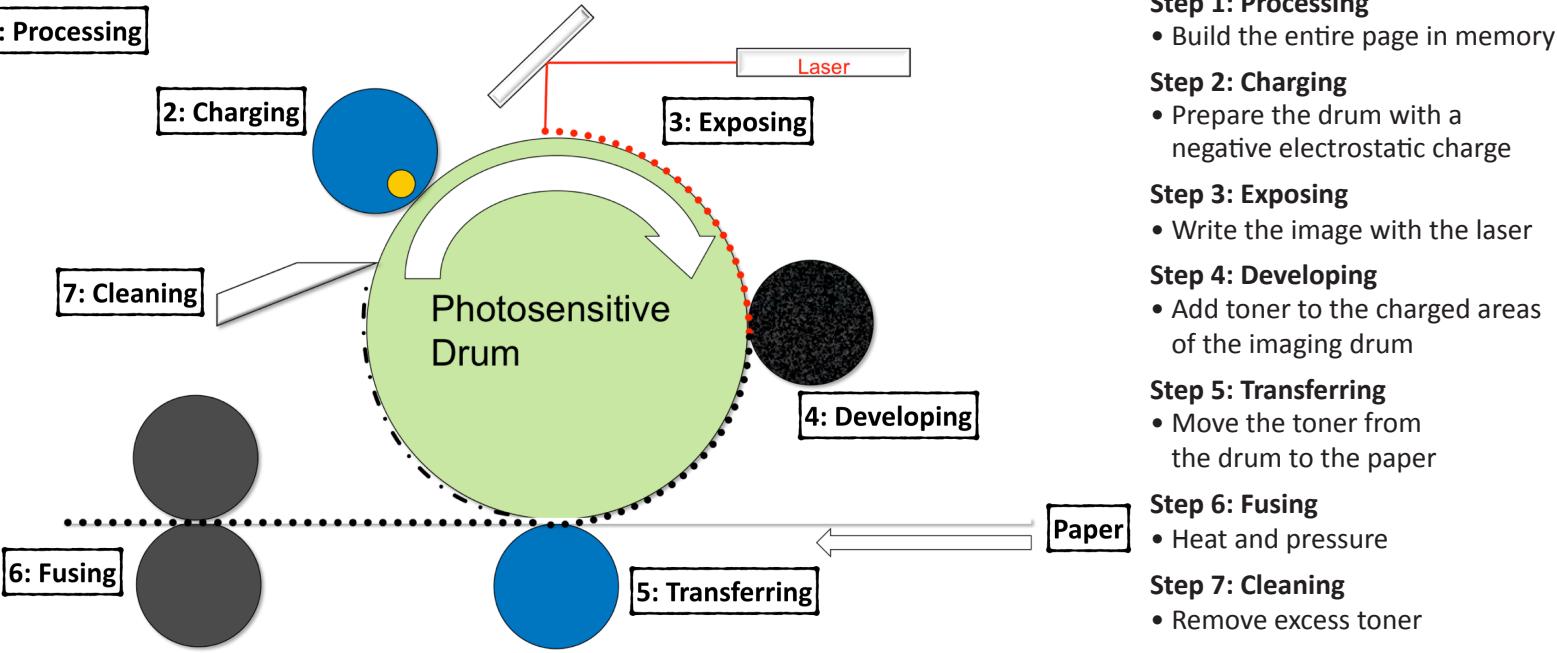
Custom Workstation Configurations

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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• Applies heat to special paper+ Very inexpensive+ Almost silent- Requires a specially coated paper- Sensitive to light and heat- Image degrades rapidly	Impact Printer <ul style="list-style-type: none">• Printer head strikes a ribbon and the paper+ Low cost per page+ Good for multiple copies- Very noisy- Poor graphics
Print to File <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• Microsoft XML Paper Specification• Similar use case to Adobe PDF• Print to XPS, view in any operating system	Print to image <ul style="list-style-type: none">• 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

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.

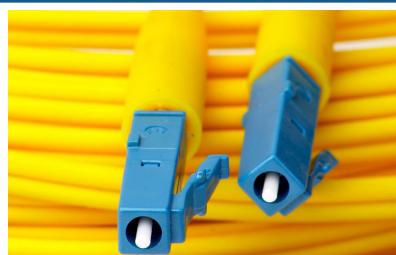
Network Connectors



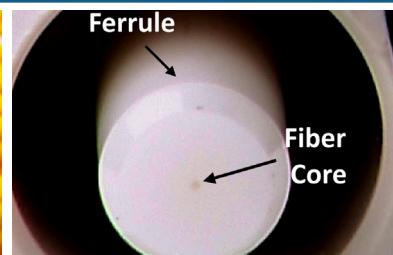
ST Connectors - Straight Tip



SC Connectors



LC Connectors



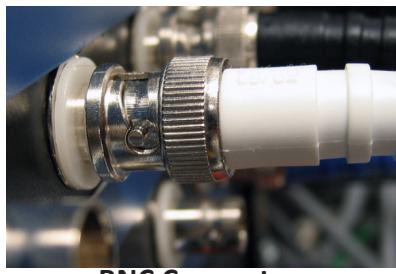
Fiber connector



RJ11 Connector



RJ45 Connector



BNC Connectors



F Connector

TIA/EIA Standards

TIA/EIA 568A

1	Green	White and Green
2	Green	Green
3	Orange	White and Orange
4	Blue	Blue
5	Blue	White and Blue
6	Orange	Orange
7	Brown	White and Brown
8	Brown	Brown



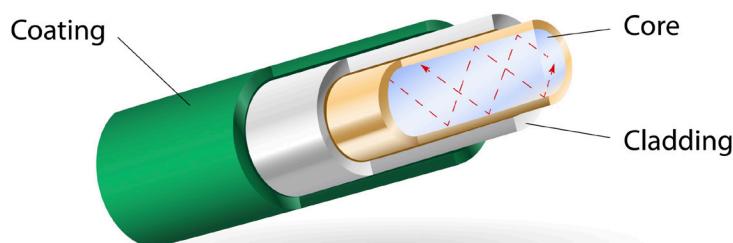
TIA/EIA 568B

1	Orange	White and Orange
2	Orange	Orange
3	Green	White and Green
4	Blue	Blue
5	Blue	White and Blue
6	Green	Green
7	Brown	White and Brown
8	Brown	Brown

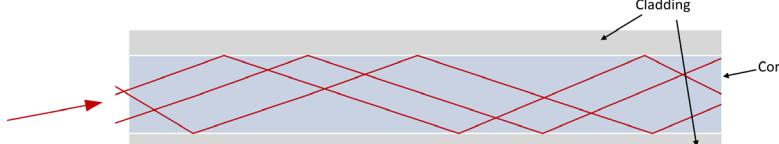
Cable Categories

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

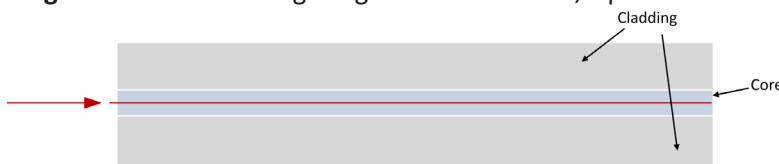
Fiber Optics



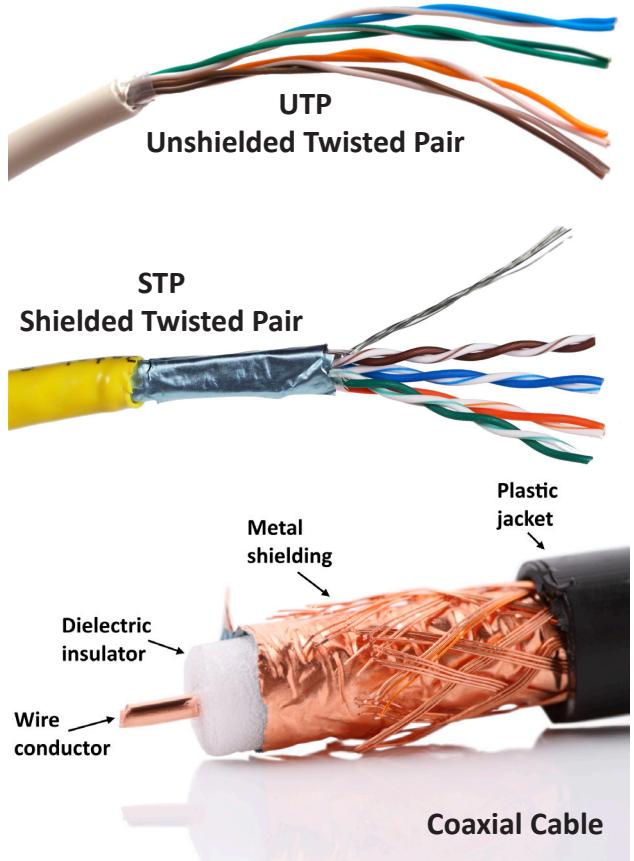
Multimode Fiber - Short-range communication, Up to 2 km



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



Copper Cable Categories



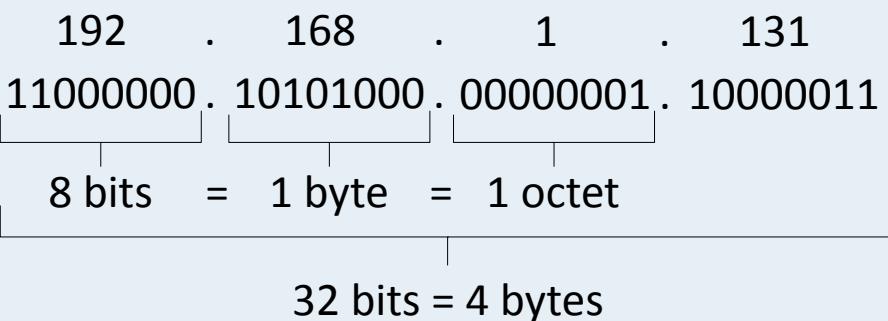
RFC 1918 Private Addresses

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 : 5d18 : 0652 : cfd : 8f52
fe80 : 0000 : 0000 : 0000 : 5d18 : 0652 : cfd : 8f52	fe80:0000:0000:0000:5d18:0652:cfd:8f52	fe80 : 0000 : 0000 : 0000 : 5d18 : 0652 : cfd : 8f52
1111111010000000:0000000000000000:0000000000000000:0000000000000000:0101110100011000:0000011001010010:11001111111101:1000111101010010	1111111010000000:0000000000000000:0000000000000000:0000000000000000:0101110100011000:0000011001010010:11001111111101:1000111101010010	1111111010000000:0000000000000000:0000000000000000:0000000000000000:0101110100011000:0000011001010010:11001111111101:1000111101010010
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

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



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



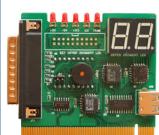
Power supply tester

- 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

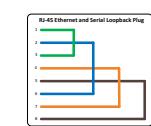
- Windows will identify a duplicate
- Two identical IP addresses will conflict
- Reboot or reset the network adapter

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

Printer Troubleshooting Tools



Laser printer maintenance kit

- Replacement feed rollers, new fuser unit, etc.
- Based on the printer's page counter
- Reset the page counter when kit is installed



Toner vacuum

- Specialized vacuum - low static, filtered for toner
- Use damp cloth on the outside
- Wipe dust away on the inside
- Don't use a traditional vacuum cleaner



Compressed air

- "Canned air"
- Fluorocarbon gas compressed into a liquid
- Not a great choice for cleaning printers
- Consider using a chemical-free air compressor



Printer spooler

- Manages printing in the background
- Runs as a Windows service
- May need to restart after a crash

Common Printing Problems



Windows Printer Test Page

Congratulations!

If you can read this information, you have correctly installed your Adobe PDF Converter on DAEDALUS.

The information below describes your printer driver and port settings.

Submitted Time: 12:13:27 PM 10/5/2008
 Computer name: DAEDALUS
 Printer name: Adobe PDF
 Printer model: Adobe PDF Converter
 Color support: Yes
 Port name(s): Documents*.pdf
 Data format: RAW
 Share name:
 Location:
 Comment:
 Driver name: PSCRIPT5.DLL
 Data file: APPDF8.PPD
 Config file: PS5UI.DLL
 Help file: PSCRIPT.HLP
 Driver version: 6.00
 Environment: Windows NT x86

Additional files used by this driver:
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADUIGP.DLL (8, 1, 0, 0)
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADREGP.DLL (8, 1, 0, 0)
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADGELP.INI
 C:\Windows\system32\spool\DRIVERS\W32X86\3\PSCRIPT.NTF
 C:\Windows\system32\spool\DRIVERS\W32X86\3\PS_SCHM.GDL

This is the end of the printer test page.

Normal Windows Printer Test Page



Windows Printer Test Page

Congratulations!

If you can read this information, you have correctly installed your Adobe PDF Converter on DAEDALUS.

The information below describes your printer driver and port settings.

Submitted Time: 12:13:27 PM 10/5/2008
 Computer name: DAEDALUS
 Printer name: Adobe PDF
 Printer model: Adobe PDF Converter
 Color support: Yes
 Port name(s): Documents*.pdf
 Data format: RAW
 Share name:
 Location:
 Comment:
 Driver name: PSCRIPT5.DLL
 Data file: APPDF8.PPD
 Config file: PS5UI.DLL
 Help file: PSCRIPT.HLP
 Driver version: 6.00
 Environment: Windows NT x86

Additional files used by this driver:
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADUIGP.DLL (8, 1, 0, 0)
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADREGP.DLL (8, 1, 0, 0)
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADGELP.INI
 C:\Windows\system32\spool\DRIVERS\W32X86\3\PSCRIPT.NTF
 C:\Windows\system32\spool\DRIVERS\W32X86\3\PS_SCHM.GDL

This is the end of the printer test page.

Windows Printer Test Page from a laser printer with a scratched photosensitive drum



Windows Printer Test Page

Congratulations!

If you can read this information, you have correctly installed your Adobe PDF Converter on DAEDALUS.

The information below describes your printer driver and port settings.

Submitted Time: 12:13:27 PM 10/5/2008
 Computer name: DAEDALUS
 Printer name: Adobe PDF
 Printer model: Adobe PDF Converter
 Color support: Yes
 Port name(s): Documents*.pdf
 Data format: RAW
 Share name:
 Location:
 Comment:
 Driver name: PSCRIPT5.DLL
 Data file: APPDF8.PPD
 Config file: PS5UI.DLL
 Help file: PSCRIPT.HLP
 Driver version: 6.00
 Environment: Windows NT x86

Additional files used by this driver:
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADUIGP.DLL (8, 1, 0, 0)
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADREGP.DLL (8, 1, 0, 0)
 C:\Windows\system32\spool\DRIVERS\W32X86\3\ADGELP.INI
 C:\Windows\system32\spool\DRIVERS\W32X86\3\PSCRIPT.NTF
 C:\Windows\system32\spool\DRIVERS\W32X86\3\PS_SCHM.GDL
 Driver name: PSCRIPT5.DLL

This is the end of the printer test page.

A "ghosting" Windows Printer Test Page from a laser printer with a faulty cleaning subsystem

A series of heavily distorted and illegible text patterns are displayed across the page, characteristic of a "ghosting" or "double exposure" effect seen in laser printer output when the cleaning subsystem is faulty. The text is mostly illegible but appears to be a repetition of the standard printer test page content.

Printer Test Page printed with the incorrect page description language or incorrect driver