

COMPTIA TROUBLESHOOTING METHOD

1. IDENTIFY

Question the user

Observe the symptoms

Find evidence of contributing events or errors

Determine recent changes in hardware or procedure - "Something else new or unexpected"

2. ESTABLISH A THEORY OF PROBABLE CAUSE

using your expertise

conducting research

3. TEST THEORY

4. ESTABLISH PLAN OF ACTION; TAKE STEPS TO IMPLEMENT IT

5. VERIFY FULL SYSTEM FUNCTIONALITY

often the user is the best person to do this

implement preventative measures to prevent problem in future, if possible

6. DOCUMENT EVENT

Findings

Action taken

Outcome

COMPUTER AND DEVICE DISASSEMBLY

1. document and label cable and screw locations

2. organize your parts

3. use the right tools

4. refer to manufacturer resources

MOTHERBOARD SIZES

ATX - advanced technology extended; Intel advanced technology (AT) standard

ITX - information technology extended; VIA standard; for small form factors

ATX 12"x9.6"

XL-ATX 12"x9.6"

MINI-ATX 11.2"x8.2"

MICRO-ATX 9.6" square or smaller

FLEX-ATX 9"x7.5"

MINI-ITX 6.7" square

NANO-ITX 4.7" square

Full-sized desktops

Extended from ATX to allow 4 graphics cards + sometimes additional CPU

derived from micro-ATX

single expansion slot

only supports mini-PCI and laptop RAM slots

CASE SIZES

Full tower

Mid tower

mini-tower

Slimline

Small form Factor

22" height or more; ATX or even XL-ATX; 6-16 drive bays

18"-22" height; 2-6 internal drive bays; up to 4 external bays

12"-18" height; micro-ATX or smaller; 2-3 drive bays; 1-2 ext. bays at most

horizontal; micro-ATX or mini-ITX

mostly mini-ITX

NOTEBOOK FORM FACTORS

LAPTOP

SUBNOTEBOOK

TABLET

2-IN-1

PHABLET

13-17 in. screen size

< 12" screen size

no attached keyboard; usually 7"-10" screen

detachable or foldable keyboard; "convertible"

small tablet or large smart phone; 5"-7" screen

CPU

ALU arithmetic logic unit
CU control unit

CPU CHARACTERISTICS

CORE COUNT

HYPERTHREADING

CPU THROTTLING

CACHE

adds additional registers on a physical core so that it can emulate multiple cores
slows down CPU during idling to conserve power

instruction cache
data cache
unified cache

L1 smallest, highest speed
L2 bigger, slower
L3 slowest, biggest

ALL are
FASTER than
RAM!

BIT ARCHITECTURE

32 vs 64

32 maximum of 4GB RAM
64 - requires 64-bit software to utilize

INTEGRATED GPU

puts graphics processing on CPU
if you add a separate graphics card you may need to use BIOS or a motherboard jumper to disable the iGPU

VIRTUALIZATION NX BIT

changes that allow easier virtualization on a CPU
allows flagging of areas of memory as non-executable
requires compatible OS and "executed disable bit" capability on CPU
usually 1GHz or 5GHz

CLOCK SPEED

SOCKET TYPES

INTEL

B (LGA 1366)	2008
H (1156 LGA)	2009
H2 (1155 LGA)	2011
R (LGA 2011)	2011
H3 (LGA 1150)	2013
H4 (LGA 1151)	2015

AMD

Am3	2009	941 PINS
FM1	2011	905
Am3+	2011	942
FM2	2012	904
FM2+	2014	906
Am4	2016	1331

COOLING STRATEGIES

heat sink
heat pipe
cooling fan
thermal paste
liquid cooler

POWER SUPPLY SELECTION

Select the correct form factor + size
determine needed wattage (PSU wattage calculator)
verify PSU has needed connectors and connector types
determine if you need a single-rail or multi-rail PSU
dual or single voltage (110 + 220, etc.)
select appropriate PSU fan size; go for high
highest efficiency rating

REMOVING POWER SUPPLIES

1. Power down PC
2. unplug power cable
3. unplug all cables from chassis
4. open chassis
5. detach power connectors from MFB
6. remove PSU screws
7. remove PSU with wire cutters

INSTALLING POWER SUPPLIES

1. Seat new PSU
2. secure with screws
3. connect power connectors
 - a. ATX 20/24 pin
 - b. ATX 4-pin
 - c. drive connectors
 - d. PCIe connectors
4. tie off unused wires/connectors
5. close chassis
6. set correct PSU voltage if required
7. reattach external cables to chassis
8. power cord to wall
9. boot + verify

PC POWER ISSUES

PSU is under-powered

PSU is old or poor quality

electrical interference (power surge, lightning strike, etc.)

brown-outs damaged PSU

Overheating of PSU due to insufficient ventilation, a failed fan, accumulated dust + debris

SYMPTOMS

not starting up

powering off after powering on

rebooting unexpectedly with or w/o blue screen of death (BSOD)

intermittent lockups (small brown-outs)

USB devices failing together or underpowered

HDD errors or file system corruption

HDD + CPU fan won't spin together

memory errors

overheating due to fan failure

booting/shutting down takes longer than normal

circuit breaker trips

electric shocks from chassis

sight or smell of smoke from chassis

PSU buzzes or makes unusual sounds

Bios beep codes upon booting

TESTING PSU WITH A MULTIMETER

1. Power down PC, disconnect external devices and open chassis
2. disconnect PSU from motherboard + internal components
3. bridge pins 15 + 16 on 24-pin connector with piece of wire
4. plug in PSU, make sure power switch of PSU is on if necessary
5. turn on multimeter and set it to 10.0V if it doesn't have an auto-range feature
6. Connect negative probe to any ground pin and positive probe to one of the power pins
test each power pin one-at-a-time to look for values outside of specifications
7. if step 6 doesn't find any failures, test the PSU under load
 - a. remove wire bridge between pins 15 + 16
 - b. reattach all connections and devices (internal, any way) after unplugging PSU
 - c. plug back into wall and power up PC
 - d. remove connector from a device and test it (google pin-outs for power + ground pins)
 - e. repeat all devices to find a failure
8. reconnect everything and power on computer and reattach chassis

USING A POWER SUPPLY TESTER

1. Power down computer, disconnect peripherals, open chassis
2. decouple PSU from motherboard and internal devices and components
3. plug ATX 24-pin and ATX 4-pin connectors into power-supply connectors
4. plug PSU back into wall
5. turn on power supply tester
6. if any measured voltages are outside of PSU specs replace it
7. if no faults found, test other power connectors

MOBILE DEVICE POWER ISSUES

Battery is old or damaged

Charger port broken

defective internal circuitry

BATTERY/CHARGER INSPECTION

1. power off
2. unplug from charger
3. remove battery
4. check for battery damage
5. check for clean contact terminals
6. check charging port
7. inspect charger

READ-ONLY MEMORY

BIOS basic input/output system

Startup BIOS - computer or device startup program

System BIOS - instructions to load drivers for basic hardware

CMOS setup - motherboard settings like system date/time, what hard disks are connected, which disk has the OS, port configuration, etc.

ACPI - advanced power configuration interface for device power saving features

PnP - plug and play configuration

UEFI unified extensible firmware interface

Better security against bootkit attacks

Quicker startup, including hibernation mode

Supports drives larger than 2.2TB

Supports 64-bit firmware devices, allowing system to access 17.2 billion gigabytes of memory during startup

Uses boot manager instead of boot sector

PXE - preboot execution environment (for network booting)

Stand-alone UEFI apps like OS loaders can be installed and run independently of the system manufacturer

Boot services + runtime services

RANDOM-ACCESS MEMORY

- * SIMM single inline memory module; 32-bit; outdated
- * DIMM dual inline memory module; 64-bit; desktop standard
- * SODIMM small outline DIMM - used in laptops
- RIMM ram-bus memory - outdated

RAM FEATURES

Buffering

Parity

ECC

FB-DIMMs or RDIMMs, mostly used in servers

extra bit for error checking; obsolete; ECC is the new standard

uses algorithms to encode blocks of error checking data;

slightly slower than non-ECC RAM

Clock Speed

Channels

each channel transmits 64-bits at a time

dual channel memory has 128-bit memory bus

triple channel memory has 192-bit memory bus

DDR MEMORY DOUBLE DATA RATE MEMORY

uses both rising and falling ~~edge~~ of the clock signal to transmit data, doubling the rate of that of SDRAM which only uses the rising edge

DDR - 184 PINS

DDR2, DDR3 - 240 PINS

DDR4 - 288 PINS; most energy efficient

DDR-200 100 1600 MB/s DDR3-800 400 6400 MB/s

DDR-266 133 2133

DDR-333 166 2666

DDR-400 200 3200

DDR2-400 200 3200

DDR2-533 266 4266

DDR2-667 333 5333

DDR2-800 400 6400

DDR2-1066 533 8533

DDR3-1066 533 8500

DDR3-1333 666 10666

DDR3-1600 800 12800

DDR4-2133 1066 17631/s

DDR4-2400 1200 19200/s

DDR4-2666 1333 213

DDR4-3200 1700 25.6

INSTALLING RAM

1. power down PC
2. detach power cable and external cords
3. open chassis
4. open memory support arms
5. snap in; use channel architecture of motherboard
6. lock support arms
7. close chassis
8. reattach cords
9. boot + verify

PHYSICAL EXPANSION INTERFACES

USB

universal serial bus

USB-1 12 MB/s

USB-2 480 MB/s 500 mA

USB-3 5 GB/s 900 mA

OTG - on-the-go devices

must have single USB port

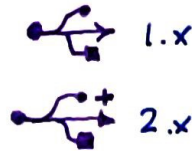
detect whether master or slave

can only charge over their USB port when acting as peripheral

hosts can provide power

oval ports are USB-C, which are usually but not necessarily USB-3

blue = USB 3; white = USB 1; black = USB 2 if other connectors are blue or white



SATA

Serial AT attachment

SATA 1.0 1.5 GB/s; 150 MB/s effective data rate (edr)

SATA 2.0 3 GB/s; 300 MB/s edr

SATA 3.0 6 GB/s; 600 MB/s edr

eSata - an external connector for SATA drives

shielded
up to 2m

RJ-11

telephone line

RJ-45 / ETHERNET

FIREWIRE

Firewire-400; Firewire 800

RS-232

obsolete, low-speed serial connector

PARALLEL

DB-9, DB-25 connectors

PS-2

for mice and keyboards; popular before USB-2

VIDEO EXPANSION INTERFACES

VGA

DVI

HDMI high-definition multimedia interface

DISPLAYPORT can be daisy-chained

AUDIO EXPANSION INTERFACES

Pink - analog mic in

Light blue - analog line in

Light green - analog line out

black - analog line out for rear surround

orange - analog line out for center + subwoofer

optical

gray - rear channel if also black, which is left/right

THUNDERBOLT

thunderbolt 1 20 Gb/s (10 Gb/s x 2 channels)

2 20 Gb/s, single channel

3 40 Gb/s (10 Gb/s x 4 channels)

- bidirectional
- daisy-chain up to 6 devices
- 10 W power to each device (TB3 = 15 W)
- can be used to directly network two Apple Computers
- TB1, TB2 use mini-display port connector
- TB3 uses USB-C connector, can support 4K x 60 Hz displays
- with adaptors can connect DisplayPort, DVI, HDMI, and VGA

WIRELESS PERIPHERAL INTERFACES

BLUETOOTH

2.4 GHz

WPAN - wireless personal area network

piconet

up to 8 devices including

PC or master device

class 1-3

2 most common, 10m range

1 industrial, more range

3 short range (1m) low power

versions 2.x - 5

2.x 2 MB/s

3.0 25 MB/s

4.x 25 MB/s, most common

5 updated for IoT use

NFC

no pairing

only one device needs power

contactless pay (Apple Pay, etc.)

INFRARED

COMMON EXPANSION CARDS

Video functions (Video out/Video capture/TV tuner)
network interface
Peripheral interface (USB/Thunderbolt/Bluetooth)
Storage (SATA, eSATA, IDE, SCSI)
audio/sound

USB DONGLES

USB-TO-ETHERNET
USB-TO-WIFI
USB-TO-BLEETOOTH
USB-TO-CELLULAR MODEM

USB GRAPHICS ADAPTER
USB LEGACY CONNECTOR (serial, parallel, PS2 etc.)
SECURITY DONGLE (authentication, software protection)

INSTALLING EXPANSION CARDS

1. Power down PC
2. Detach all external cords
3. open chassis
4. remove old card if appropriate
 - a. decouple from cables connecting it to MB
 - b. unscrew or uncouple card from back of case
 - c. gently unseat card and remove it
5. find compatible slot for new card
6. remove slot cover from chassis
7. set any necessary physical configuration changes on new card
8. line card's contacts up with slot
9. firmly but gently snap card into place
10. attach any required cables to card
11. secure to back of case with screw or clip
12. close chassis
13. reattach external cables
14. if necessary boot to BIOS/UEFI and disable any existing component that conflicts w/new card
15. Set any necessary BIOS/UEFI settings pertaining to the new card
16. BOOT
17. install drivers if necessary
18. make desired software/os changes (eg. display settings for a new graphics card)

USB CONNECTORS

TYPE A, TYPE B

Standard
mini
micro
TYPE-C

eSATA
LIGHTNING

DISPLAY CABLES AND CONNECTORS

HDMI

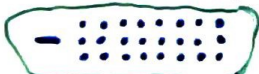
Standard 1080i; 720p "Standard HDMI w/ Ethernet" has dedicated channel for networking
high-speed 1080p; 4K 30Hz; 3D; deep color; available as "high speed HDMI w/ ethernet"
ultra-high-speed 4K, 5K, 8K, 10K @ 120Hz; all versions also carry ethernet
best practice is to stay below 15m cable

CONNECTORS

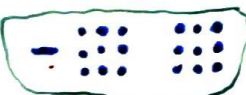
standard HDMI
mini-HDMI
micro-HDMI

DVI

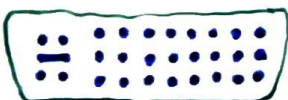
DVI-D dual link



DVI-D SINGLE LINK



DVI-I DUAL LINK



DVI-I SINGLE LINK



DVI-A



DISPLAY PORT

- Full-size
- mini

Version 1.0-1.1 8.64 Gb/s over 4-lane main links
1.2 17.28 Gb/s in HBR2 mode
1.3-1.4 32.4 Gb/s in HBR3 mode

HBR2
"high bit rate 2"

VGA

COMPOSITE

COMPONENT

COAXIAL; BNC COAXIAL

MINI-DIN-4 S-VIDEO

MAGNETIC HARD DRIVES

Platter
spindle
read/write heads
actuator

3.5", 2.5", 1.8" form factors

SSDs non-volatile flash memory configured for use as a hard drive

- eMMC embedded multimedia card - laptops, tablets, phones
- PCIe card
- 2.5" HD form factor
- M.2 } usually onto motherboard - on newer laptops + high-end motherboards
- NVMe }

DRIVE CONNECTIONS

- SATA
- IDE
- SCSI serial attached SCSI (SAS) more expensive, used on servers and SANs
USB-attached SCSI (UAS)
iSCSI - SCSI over ethernet or another network interface
all devices on SCSI chain need a device ID

DIRECT SSD CONNECTIONS - SSD motherboard slot configurations

mSATA - looks like a mini-PCIe slot; older motherboards
SATA M.2
NVMe M.2 - newer
PCIe over AHCI - for systems that don't support NVMe
ordinary PCIe → sometimes not bootable

NTFS NT File System; Microsoft

$2^{32}-1$ maximum clusters
4KB cluster size → 16TB maximum volume size
2048KB max clustersize → 8PB max vol. size

NORMAL USAGE HARD DRIVE PROBLEMS

Bad sectors

R/w errors

S.M.A.R.T. errors self monitoring, analysis + reporting technology

slow performance CHKDSK; convert from FAT/FAT32 to NTFS; disk cleanup utility

INPUT DEVICES

mouse

keyboard

barcode reader

biometric device

camcorder

digital cam

digitizer

signature pad

game pad

joystick

microphone

motion sensor

Scanner

smart card reader

NFC reader

web cam

OUTPUT DEVICES

Display
Printer
Speakers

DUAL I/O DEVICES

KVM
STB set-top box Apple TV; Roku
Smart TV

Touch-Screens Resistive - only one touch point
inexpensive
outdated

CAPACITIVE - most common
Surface-acoustic wave technology - no multi-touch, more expensive

TROUBLESHOOTING A TOUCHSCREEN

Clean it
restart computer
recalibrate touchscreen
device manager
update drivers
check for electromagnetic interference

VIRTUAL REALITY
vs
AUGMENTED REALITY

DISPLAY DEVICE TYPES

LCD liquid crystal display backlight; most common; liquid crystal sandwiched between two polarizing layers
OLED organic light-emitting diode no backlight; higher contrast than LCD; thinner + lighter than LCD
PLASMA uses cells filled with noble gases or phosphors; no backlighting needed
popular in late 1990's - early 2000's, largely replaced by LCD
CRT cathode-ray tube obsolete

LCD MATRIX

Passive - older tech; slower refresh times, lower contrast
active - TFT (thin film transistor) a transistor at each pixel - dominant technology

LCD BACKLIGHTING

Reflective uses a mirror; requires ambient light; used only with passive matrix LCD
Transmissive uses a backlight; not as pretty in strong ambient light
Transflective uses both a backlight and a reflective surface, more expensive

LCD technologies

TN twisted nematic most common + oldest type shortest response time, narrow view angle
IPS in-plane switching best viewing angle; slower response time
VA vertical alignment better contrast + color; wide viewing angles; slowest response time
expensive

OLED DISPLAY DEVICES (LAYERS)

SUBSTRATE structural framework. RGB tinted plastic layers added to produce color
ANODE draws electrons
CATHODE provides electrons

ORGANIC LAYER

- conducting in which electrons move
- emissive produces light
- Best quality of any display thus far
- best contrast (deep-dark blacks)
- 160° viewing angle
- quick response time (refresh rate)

CONS:

- expensive
- blue degrades faster than other colors

DISPLAY PROJECTORS

LCD more accurate colors
sharper images
brighter image per watt

DLP more reliable, less moving parts
smaller, more portable
deeper blacks, more contrast
less pixellation

NETWORK COMPONENTS

NODE — any device on network that actively transmits and receives info
Printer, storage device, computer, switch, router, etc.

HOST — a node that serves as a beginning or end point of communication. a computer is a node; a modem or switch isn't. a router or printer might be considered one, based on context. Must have an address.

MEDIA — the physical path connecting nodes — UTP cable, fiber optic cable, radio transceivers

DATA — the information carried by the media; data is formatted using protocols to insure the nodes know to handle it, and that the destination host can decipher it. Most data is broken up into frames or packets which are reassembled at destination.

NETWORKING

DEVICE — a node that functions as part of the networking structure rather than just a host or resource. Hubs, repeaters, switches, routers, modems, gateways, firewalls can be a general purpose computer running specialized software for networking tasks

PHYSICAL VS. LOGICAL NETWORKS

PHYSICAL NETWORK — the interface cards, network hardware, cables, even radio signals that comprise the network's physical component

LOGICAL NETWORK — the information carried by the physical network and the paths the information follows.

NETWORKING CHALLENGES

Availability — the ability of a network to maintain connectivity as consistently as possible while avoiding outages.

Reliability — network traffic free of communication errors, every packet arrives at destination intact and unaltered, transmission errors are minimized, errors that do occur are detected and corrected.

Serviceability — how easy it is to perform maintenance and upgrades on a network

Performance — the network's ability to rapidly convey traffic

Security — the difficulty level of unauthorized users to access data on the network

Scalability — the network's ability to grow to meet changing demands

Compatibility — the ability of all a network's components to communicate successfully both physically and logically

QoS — **quality of service** overall connection quality as seen by network users includes performance, reliability, and availability

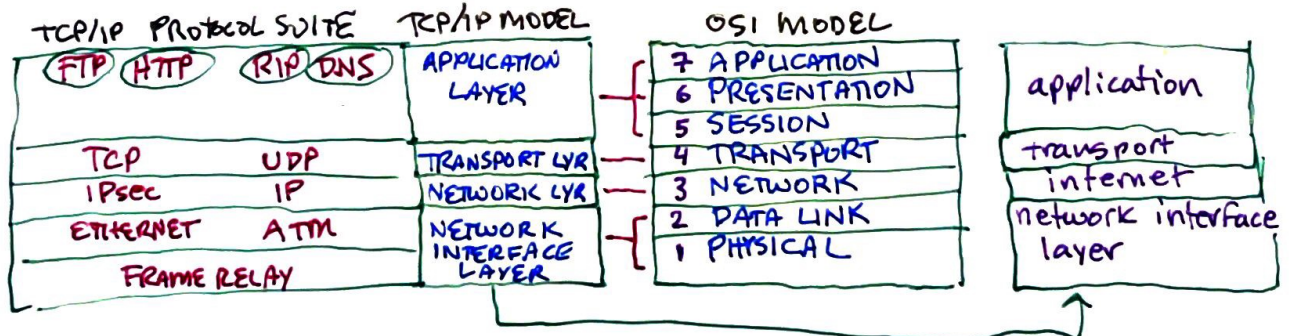
SCOPE

LAN local area network
WAN wide area network
PAN personal area network
CAN campus area network
MAN municipal-area network
SAN storage area network

RESOURCE-SHARING MODELS

Peer-to-Peer
Client-Server

TCP/IP NETWORK REFERENCE MODEL



END-TO-END NETWORK COMMUNICATIONS

End-to-end principle

1. Transitions between layers should be as close to the endpoints as possible
2. Devices between endpoints should be operating on lowest network layer possible

SOPHISTICATION LEVELS

1. Repeaters and hubs
2. bridges and switches
3. Routers and gateways

* MODEMS
* ACCESS POINTS
* WIRELESS DEVICES
* POWER-OVER-ETHERNET DEVICES

* REPEATER

Sometimes called an extender (or range extender if wireless)

* HUB

Passive hub - splits signal in multiple directions

active hub - a repeater with more ports

* BRIDGE

LAYER 2

similar to a repeater but stores packets until appropriate nodes are clear, avoiding packet collisions

newer bridges also filter packets and only let packets cross if they are addressed to a host on the other side of the bridge, reducing network traffic

- LEARNING BRIDGES dynamically update the mac tables they use to filter packets

* TRANSLATING BRIDGE

a bridge that can connect two network segments that use different settings or standards

* SWITCH

LAYER 2

a bridge with four or more ports

completely eliminates collisions

- unmanaged - works out of box at least for simple networks
- managed - requires user configuration
- multi-layer - examines frame payloads to understand them on the network or even application layers. complex, expensive, requires user expertise

* ROUTER

LAYER 3

works like a bridge or switch but forwards IP packets not destined for internal network to WAN or Internet through default gateway

* VLAN

virtual LAN - devices put on VLANs can use same physical network but remain isolated in their own logical one

* NIC

network interface controller, connects a host to the network

- ethernet • WI-FI most common types

NETWORK SECURITY APPLIANCES

FIREWALLS

INTRUSION DETECTION AND PREVENTION SYSTEMS

VPN ENDPOINTS

UNIFIED THREAT MANAGEMENT

* UTM FIREWALL

combines firewall, IDS/IPS, content filtering, NAT, OLP, VPN, etc.

* FIREWALL

software- or hardware-based

* INTRUSION DETECTION AND PREVENTION

IDS - passive, alert admins but take no direct action to filter network

IPS - active, can block suspicious traffic, disconnect users, etc.

Can be appliances (network-based) or apps (host-based)

* VPN ENDPOINT

runs on host, router, or a specialized appliance called a VPN Concentrator

components:

1. VPN gateway
2. Secure transport protocol (IPsec, SSL/TLS)

WIRED INTERNET ACCESS

DIAL-UP	< 56 Kbps	analog phone line
ISDN	64-128 Kbps	digital phone line
DSL	128 Kbps - 100 Mbps	analog phone line
BROADBAND CABLE	384 Kbps - 400 Mbps	cable television lines / coaxial
FIBER-OPTIC	up to 1 Gbps	optical cables

Demarcation point - the device or terminus that separates the portion of the network owned by the consumer or client, with the portion owned and controlled by the ISP

- DIAL-UP outdated but still used and sometimes the only option in rural areas
- ISDN integrated services for digital network. uses terminal adapter; no modem needed
 - BRI - basic rate interface - 144 kbps max
 - PRI - primary rate interface - 1.544 Mbps in US, 2.048 Mbps in Europe
- DSL digital subscriber line
 - SDSL - symmetric - same bitrate up as down - better for hosting
 - ADSL - asymmetric - higher bitrate in one direction than the other
- CABLE BROADBAND
 - DOCSIS - data over cable service interface specification
 - 10-100 Mbps down
 - 1-20 Mbps up
- FIBER-OPTIC
 - FTTN - fiber to the neighborhood
 - FTTC - fiber to the curb
 - FTTP - fiber to the premises
 - FTTH - fiber to the home
 - FTTB - fiber to the building

WIRELESS INTERNET ACCESS

CELLULAR
TERRESTRIAL
SATELLITE

TROUBLESHOOTING TOOLS

wireless locator
punch-down tool

WAN TROUBLESHOOTING RESOURCES

Speed test site
www.speedtest.net; www.speakasy.net
TCP/IP test site
network-tools.com; ping.eu
Public DNS server
8.8.8.8; 8.8.4.4
LOOKING GLASS SITE
www.bgplookingglass.com
www.bgp4.as/looking-glasses

INTERNET CONNECTIVITY TROUBLESHOOTING

interface errors - configuration problems w/ host or router
DNS errors
Router errors
interference - check wireless signals
Policy-based - fair-access throttling, ISP malware blocking, etc.

ELECTRICAL INTERFERENCE

EMI - electromagnetic interference

Attenuation

Twisted-pair cables reduce EMI
Ethernet cable uses four twisted pairs:

GREEN
BLUE
ORANGE
BROWN

G, G/
B, B/
O, O/
Br, Br/

WIRING STANDARDS

1 2 3 4 5 6 7 8
G G O O B B Br Br

T-568A

1 2 3 4 5 6 7 8
O O G G B B Br Br

T-568B

ETHERNET CATEGORIES

CAT 1	CLASS A	100 KHZ
CAT 2	CLASS B	1 MHZ
CAT 3	CLASS C	16 MHZ
CAT 4		20 MHZ
CAT 5	CLASS D	100 MHZ
CAT 5e	CLASS D	100 MHZ
CAT 6	CLASS E	250 MHZ
CAT 6A	CLASS EA	500 MHZ
CAT 7	CLASS F	600 MHZ
CAT 7A	CLASS FA	1 GHZ

for old telephone networks / not used in data
older nets like ARCnet, token ring
early ethernet, phone networks
early ethernet, some token rings, was never common
ethernet, Gigabit ethernet, telephone video; superseded by cat 5e
like cat 5 but higher testing standards
stronger xtalk spec than 5e; short distance 10Gbit ethernet
full-distance 10Gbit ethernet. shielded
like cat 6a but screened + shielded
possibly suitable for 40Gbit ethernet, an emerging standard

TWISTED-PAIR ETHERNET

10BASE-T	Cat-3 or higher
100BASE-TX	Cat-5 or higher
1000BASE-T	Cat-5 or higher
10GBASE-T	Cat-6A; can work on Cat-6 for short distances

CONNECTORS

RJ-11 phone
RJ-45 ethernet

TERMINATION TOOLS

SNIPS
WIRE STRIPPER
CRIMPER
PUNCH-DOWN TOOL

TERMINATING TWISTED-PAIR CABLES

1. review precise needs, verify you have right components + tools
2. Cut cable to length with snips
3. add cable boot if appropriate and slide it down away from end
4. strip 1.5" of wire with wire stripper or snips
5. spread out and untwist 0.5" of wire pairs + straighten ends
6. line up wires in T-568A or T-568B order
7. slide wires into modular plug
8. insert plug into matching die on crimper, clamp down until "click"

CABLE TESTING TOOLS

MULTIMETER resistance, current, voltage; can test if a rack is grounded
TONER PROBE connectivity; can trace a wire and ID it along its entire length
CABLE TESTER conductivity, resistance, breaks, shorts, sometimes length + noise levels etc.
TIME DOMAIN REFLECTOMETER sophisticated cable tester, attempts to find breaks, shorts, flaws in a cable and estimate their locations
CABLE CERTIFIER performs advanced tests to certify that it meets appropriate performance standards

LOOPBACK PLUG connects transmit + receive pins on a cable, allowing for diagnostic testing

make sure multimeter is configured - cable unplugged; device OFF - RESISTANCE
set to appropriate test type - AC or DC sensitivity range
ZERO METER by touching probes together if testing for resistance
touch leads to each side of circuit. negative value prob. means leads are backwards

COAXIAL CABLES

RG STANDARDS

RG-59	.64 mm	6.1 mm
RG-6	1 mm	6.96 mm
RG-11	1.43 mm	10.5 mm
RG-8	2.17 mm	10.3 mm
RG-58	0.81 mm	5.0 mm

baseband and old cable TV. obsolete
newer cable (digital), satellite, cable modem. Higher-grade RG-59
like RG-6 but used underground/over large distances
10BASE "thicknet" - obsolete
10BASE-2 "thinnet" - also obsolete

CONNECTORS (COAX)

BNC bayonet Neill-Concelman

F standard cable TV and cable modem threaded connector

TERMINATING COAXIAL CABLES

- make sure you have the right tools. Some F connectors are attached with compression tools, and others with crimpers.
- 1. after cutting the cable to length, slide the cable stripper onto its end.
- 2. Clamp the stripper on and spin it around the cable until you feel no resistance
- 3. pull off both cut segments
 - a. the first cut near the end should remove everything but the inner core
 - b. the second cut removes only the outer jacket to expose the shield
- 4. fold back the braid to expose the dielectric
 - a. if using a BNC connector slide the crimp ferrule on first
- 5. Push the connector onto the cable end
- 6. using the crimper or compression tool, clamp the connector or ferrule into place

COAXIAL CONNECTION TROUBLESHOOTING

- less risk of crosstalk or wiring errors
- more easily damaged by tight bends or kinks in wire
- no linear scale of quality, so easier to use bad cable or terminate it w/ wrong connector
- must be terminated with a special resistor when testing to avoid signal reflection
- used more often outdoors so more subject to environmental degradation

OPTICAL CABLE (OPTICAL FIBERS)

CORE transparent fiber that carries the signal

CLADDING transparent optical shield that keeps signal trapped in core

BUFFER strengthens and protects fiber

STRENGTH MEMBERS usually aramid (kevlar), provides tensile strength to reduce stress on fiber

OUTER JACKET usually color-coded to give techs info on type of fiber inside

FIBER TYPES

level of shielding, based on use of cable

plenum-grade: don't burn or produce smoke that's toxic

multi-fiber cables: separate channels, duplex operation, etc.

SMF single-mode fiber

single mode; supports longer cable

MMF multi-mode fiber

multiple modes; shorter cable; cheaper

OPTICAL FIBER CONNECTORS

ST	straight tip	bayonet	one of the first; replaced by small form factor connectors
FC	ferrule connector	screw	early singlemode, replaced by SC and LC
SC	standard connector	push/pull	square; often clipped together for duplex SC-DC
LC	Lucent connector	snap	SFF connector; like SC but smaller
MT-RJ	mechanical transfer registered jack	snap	duplex SFF connector; looks like small RJ-45

SFF



BINARY NUMBERING

VALUE	C8	V >= C8?	DIGIT	REMAINDER
212	128	Y	1	84
84	64	Y	1	20
20	32	N	0	20
20	16	Y	1	4
4	8	N	0	4
4	4	Y	1	0
0	2	N	0	0
0	1	N	0	0

$$212 = 11010100$$

IANA
internet
assigned
numbers
authority

IPV4 ADDRESSES @ 4 billion possible addresses 32 bits long

NETWORK ID + HOST ID

SUBNET MASK: A STRING OF 1'S FOLLOWED BY A STRING OF ZEROS
THAT DEFINES THE LENGTHS OF THE NETWORK AND HOST ID'S

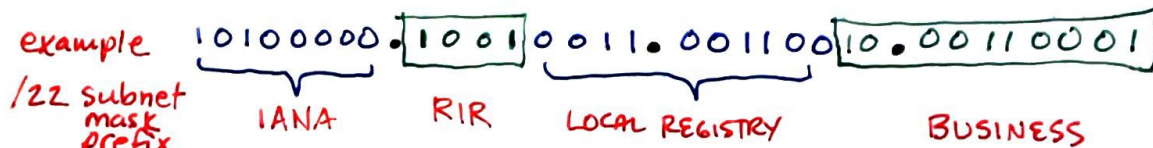
CLASSFUL + CLASSLESS ADDRESSING

Before subnet masks the first bits of the first octet specified net and host ID's

CLASS	FIRST OCTET	FIRST BITS	# SUBNETS	# HOSTS	SUBNET MASK	MASK PREFIX
A	0-127	0	128	16,777,216	255.0.0.0	/8
B	128-191	10	16,384	65,536	255.255.0.0	/16
C	192-223	110	2,097,152	256	255.255.255.0	/24
D	224-239	1110	*	*	*	*
E	240-254	1111	*	*	*	*

CLASSLESS INTERDOMAIN ROUTING (CIDR)

Subnets of any size could be specified



SPECIAL IPV4 ADDRESSES

0.0.0.0 non-routable; current net, default route, error message, etc
255.255.255.255 broadcast address that addresses entire subnet at once
any packet addressed to here is forwarded throughout local broadcast domain

127.0.0.0 loopback address; points right back to local host
127.0.0.1 usually points to local system

Private network ranges - used on internal networks, not routable on internet

10.0.0.0/8 10.0.0.0 - 10.255.255.255 single class A network
172.16.0.0/16 172.16.0.0 - 172.31.255.255 16 contiguous class B networks
192.168.0.0/16 192.168.0.0 - 192.168.255.255 256 contiguous class C networks

169.254.0.0/16 link-local or APIPA - automatic private IP addressing
used for automatic IP address assignments when a host
doesn't have one and can't get one from a server

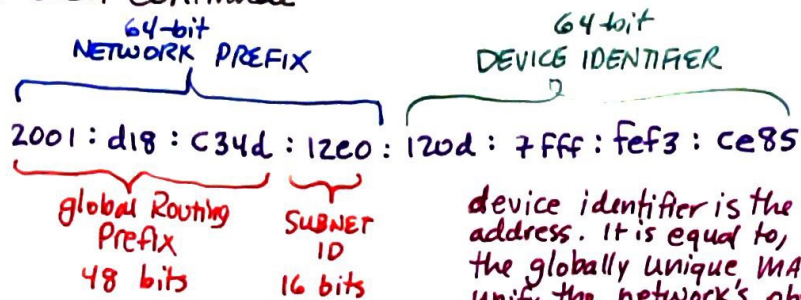
IPV6 3.4×10^{38} possible addresses; 32 hexadecimal digits in 8 groups of 4

fe80:0000:0000:0000:c249:3765:00c0:9b22

can be written as: fe80::c249:3765:c0:9b22

two colons can represent multiple consecutive groups of zero once in an IPv6 address

IPv6 ADDRESSES, Continued



device identifier is the device's EUI-64 hardware address. It is equal to, or can be derived from, the globally unique MAE address. This helps unify the network's physical and logical addressing

IPv6 ADDRESS SCOPES

- unicast addresses → one host
- multicast addresses → a defined group of hosts
- anycast addresses → a multicast that only goes to the nearest host on the list

Scope distance an address is relevant across a wider network
can easily be determined from the IPv6 address' network ID

- * **LOOPBACK** ::1/128 equivalent to 127.0.0.1 in IPv4
- * **LINK-LOCAL** fe80:: usable on local segment but not routable
link-local net uses fe80::/10
individual addresses on it use fe80::/64
- * **UNIQUE LOCAL** fd00::/8 private, routable internally but not on Internet
fc00::/8 allocated but not currently in use
- * **GLOBAL** 2000::/3 all global or public unicast addresses begin with the bits 001 and the first group is in the range 2000-3fff
IANA assigns them to RIR's

multicast addresses always begin with FF, followed by a 4-bit flag field, then a four-bit **Scope** field. scope can range from loopback to global

ADDRESS RESOLUTION

- ARP address resolution protocol IPv4
- NDP neighbor discovery protocol IPv6

DOMAIN NAME SYSTEM

servlets . web . mycorp . com
host subdomain domain TLD

top-level domain — .com, .org, .edu etc.

domain — particular organization

subdomain — optional level used for categories of a domain organization

host — the name of the specific host on the domain, or an alias of it

DNS RESOLUTION

ADDRESS ASSIGNMENT

- STATIC — by host itself
- DYNAMIC — by a host server on the local net. usually DHCP
- STATELESS ADDRESS CONFIGURATION — on IPv4 its done using APIPA and verified using ARP
on IPv6 its the link-local address and verified with NDP

DHCP dynamic host configuration protocol

contains a pool of available addresses called a scope

can be assigned dynamically or by reservation

can also assign DHCP options: default gateway, DNS addresses, DNS domain/suffix, time server, etc.

TROUBLESHOOTING TCP/IP SETTINGS

- DHCP enabled but assigned address is 169.254.x.x /16 range (APIPA)
 - client can't contact DHCP server
- client's IP address or subnet mask doesn't match Subnet it's connected to
 - no network connectivity
- common with hosts with static IP addresses that are physically moved
- two hosts have duplicate IP addresses
 - failed connectivity
- unpredictable network behavior
- improper default gateway
 - host can't connect outside its local subnet
- host has multiple network interfaces
 - allowed, but makes configuration more difficult and complex
- improper DNS settings
 - host cannot resolve Domain names, but IP addresses still work

TRANSPORT LAYER PROTOCOLS

- * TCP transmission control protocol
 - connection-oriented - establishes a dedicated channel between hosts; two-way communication
 - Reliable - failed segments are resent by sender host
 - Error correction checksums; bad checksum segments are resent
 - Flow control data flow regulated to keep slower hosts from being overloaded by faster ones
 - Sequencing makes sure packets are reassembled in correct order even if received out of order
- * UDP user datagram protocol
 - unreliable
 - connectionless
 - fast
 - lightweight
 - * Performs well with streaming and other non-critical realtime apps such as online multiplayer games
 - * often used for DNS/DHCP when simply sending another request is quicker than establishing a TCP channel connection
 - * Apps that do their own sequencing and error correction and don't need the overhead of TCP

PORT RANGES

SYSTEM PORTS	1-1023	most standard apps
USER PORTS	1024-49151	any user/creator of a valid server app can apply for one
PRIVATE PORTS	49152-65535	private and often temporary, often automatically assigned; ephemeral

HTTP	80		SLP	427	service location protocol
HTTPS	443		LDAP	389, 636	secure lightweight directory access prot.
FTP	20 data, 21 control		RDP	3389	remote desktop protocol
TELNET	23		NETBIOS	137-139	
SSH	22	secure shell	SNMP	161, 162	simple network mgmt protocol
SMTP	25		SYSLOG	514	
POP3	110		DNS	53	
IMAP	143		DHCP	67, 68	
SMB	445	server message block			
NFS	2049, 111				
AFP	548, 427	apple filing protocol			

SERVER APPLICATIONS

authentication server controls access to the network or other resources
DHCP Server provides dynamic IP and related configuration settings to client systems
DNS Server provides domain lookups
Endpoint Management Server manages security policies for end user systems like PC's + mobile devices
File Server centralized network file storage + sharing
Mail Server receives, stores, delivers email
Print Server central network access to a printer
Proxy Server relays communication between LAN hosts and internet hosts
SYSLOG Server gathers syslog data from hosts on net and compiles them in one place
WEB server distributes web pages

REMOTE ACCESS PROTOCOLS

Telnet Command line terminal interface with a remote system Port 23 TCP
SSH Secure alternative to Telnet + file transfers. TCP port 22
RDP remote desktop protocol. Windows proprietary. GUI. TCP port 3389
VNC virtual network computing; open-standard; graphical; screen sharing TCP 5900+N; N=display
HTTP web-based interfaces
SNMP simple network management protocol UDP ports 161, 162

AUTHENTICATION SYSTEMS

RADIUS remote authentication dial-in user service dial-up access to private LANs; other networks
TACACS+ terminal access controller access-control system plus proprietary CISCO Protocol
similar to RADIUS, but proprietary and more resource-intensive
KERBEROS allows client to access multiple network resources via a single sign-in. used by a number of network systems including Windows domain networks
802.1X an IEEE standard used to authenticate connections to an ethernet switch or wireless access point (WAP). Protocol used by Wi-Fi hotspots acting in Enterprise mode
802.1X servers commonly used RADIUS servers for back-end authentication
LDAP lightweight directory access protocol manages distributed directory information services across a network. Novell's eDirectory and Microsoft Active Directory.
more suited to trusted LANs because it's got limited security features

RESOURCE SHARING PROTOCOLS

FTP TCP ports 20, 21 for control
SMB allows folders and drives to be shared over the network and accessed like local folders and drives ports 137-139, 445. Developed by Microsoft for Windows
NFS network file systems like SMB but used by LINUX and other UNIX derivatives
AFP Apple Filing Protocol Apple's version of SMB
NETBIOS a session-layer API rather than strictly a protocol. Used widely on older Windows peer-to-peer networks and allowed for resource and printer sharing, as well as computer identification. Numerous security vulnerabilities limit its utility to trusted LANs

EMAIL PROTOCOLS

25 SMTP simple mail transfer protocol sending emails to servers and transfer from server to server
110 POP post office protocol sending and receiving + storing
IMAP internet message access protocol receiving
MAPI messaging application programming interface - used by Microsoft Exchange

SMTP, POP, IMAP are by default not secure but can be used with the same SSL or TLS protocols used by HTTP

WIRELESS BANDWIDTH



2.4 GHz

- in the US, channels 1-11 are available for use without special licensing
- Spread-spectrum breaks the transmission into a large number of subchannels on nearby frequencies, increasing data rate and mitigating interference. The disadvantage is that each channel overlaps onto adjacent channels. To avoid this, different WiFi hotspots can be set a few channels apart. Commonly, using channels 1, 6, 11 minimizes crosstalk

MIMO Multiple input, multiple output Uses multiple antennae to simultaneously receive and transmit data.

thin APs access points that use centralized administration and shared network configuration by means of a WLC or wireless LAN controller, for complex or large WLANs

Central cloud based network controller a WLC based in the cloud

WMN wireless mesh network

LOCAL WIRELESS TECHNOLOGIES

RF Radio frequency. Generic term usually used by proprietary technologies with unreliable security

RFID RF identification. Uses passive tags. inventory tracking, ID badges, pet ID's, etc.

BLUETOOTH wireless PAN apps, piconets. mice, speakers, etc.

NFC nearfield communication. range 20 cm, 484 Kbps rate. Contact payment systems etc.

- Reader/writer mode - reads data from an NFC tag

- P2P mode - transfer between two NFC enabled active devices

- card emulation mode - device emulates an NFC tag or smart card

ANT+ GARMIN proprietary. Range 30m. Fitness trackers, watches, medical devices

Z-WAVE Silicon Labs proprietary. 800-900 MHz 15m band. Home automation. 40Kbps, 10-100m

ZIGBEE IEEE 802.15.4 PAN Standard. Competitive with Z-wave.

WI-FI NETWORKS

Infrastructure centrally managed from a central WAP which is usually wired to the Internet or a LAN

Ad-hoc/P2P devices connect to each other. Inefficient - usually one device ends up being configured as a WAP

WMN a sophisticated P2P that allows for greater efficiency + options

TECHNOLOGIES

2.4 GHz ISM (Industrial, Scientific, Medical) most widely used

5 GHz ISM most common newer tech. shorter range, less interference, 23 channels instead of 14 with 2.4 GHz

60 GHz mm wave - very high data rate, don't typically penetrate walls

UHF/VHF traditional television frequencies are being repurposed. Use of white space insulates from standard television. Tech and regulations being sorted out

EARLY WI-FI STANDARDS

802.11a 54 Mbps over 5 GHz
802.11b 11 Mbps over 2.4 GHz

ENCRYPTION STANDARDS

WEP Wired Equivalent Privacy
WPA WiFi Protected Access; TKI
WPA2

temporal
key
integrity

CURRENT WI-FI STANDARDS

802.11g 54 Mbps over 2.4 GHz. Backward-compatible w. 802.11b
802.11n 600 Mbps over 2.4 GHz or 5 GHz if all four spatial streams are used
MIMO, channel bonding
802.11ac 6.93 Gbps in 5 GHz band using OFDM over all eight spatial streams
VHT, more MIMO antennae, beamforming

WIFI ENCRYPTION STANDARDS

- WEP wired equivalent privacy. **Compromised**; no longer part of the Wi-Fi standard. Uses RC4 encryption.
- WPA Wi-Fi protected access. Uses TKIP (temporal key integrity protocol). has vulnerabilities. Draft 802.11i standard.
- WPA2 Final 802.11i standard. Uses AES (advanced encryption standard) as well as TKIP. Current standard, no known vulnerabilities.

WPA OPTIONS

- WPA-Personal aka pre-shared key (PSK) Uses passphrase of 8-63 ASCII characters manually distributed to each user. For small networks w. few users.
- WPA-ENTERPRISE aka 802.1x mode. Connecting clients are only allowed to communicate with an external authorization server, usually RADIUS, with a user name and password. User never sees actual WPA authentication key. Once authenticated, full access to WLAN is granted.
- WPS Wi-Fi Protected Set-up. Has major security flaw.

TROUBLESHOOTING WIRELESS CONNECTIONS

Weak signals cause interference + attenuation. Move client or WAP if possible.

- thicker walls, brick, stone, metal; even coated or tinted glass
- 5GHz signals attenuate more rapidly than 2.4GHz
- interference sources can include other WiFi networks, other wireless technologies, microwave ovens, electrical motors, etc.
- interference from other wireless networks can be minimized by making sure they're on different channels
- antenna orientation can matter

LOW PERFORMANCE can be caused by network congestion or conflicting standards

- wireless networks are prone to congestion from too many clients
- devices using older Wi-Fi standards can effectively slow the entire network
- wireless repeaters/extenders half the bandwidth of the network

NETWORK SECURITY SETTINGS can interfere with the connection, esp. if changed on the WAP

- when the network isn't reachable, it might not be broadcasting its SSID. Configure the network to connect even without an SSID broadcast.
- if an existing network stops connecting, verify its settings haven't changed. Security changes often require reconnecting.
- Public networks might require additional sign-in even if unencrypted.
- Windows might autoconfigure a wireless network as public. If so keep it set for additional security.

ENSURE CONNECTION TO RIGHT WAP and not one with a similar name

IS WAP TURNED ON?

IS WIRELESS CONNECTION ENABLED?

- mobile devices can sometimes disable wireless connections to save power, or in airplane mode
- sometimes wireless adaptors can be inadvertently enabled or disabled by a button or keyboard keystroke combination.
- bluetooth and WiFi might be controlled together on a device.
- some wireless adaptors have trouble reconnecting after hibernation or sleep and need to be manually disabled and reenabled, or the device restarted.

CONFIGURING WAN SETTINGS

ROUTER ITSELF IS A NETWORK NODE REQUIRING VALID TCP/IP CONFIGURATION SETTINGS

- most routers auto-configure using DHCP but can be configured statically
- some connections use tunnelling VPN protocols and require PPPoE, PPTP, L2TP authentication
- some routers require custom host, domain, and MTU settings

SOME ROUTERS CAN BE CONFIGURED IN GATEWAY MODE

- choose gateway mode when connected directly to LAN, router mode when connected to other routers
- some routers have bridge mode, turning routing off
- some routers can use DDNS (dynamic DNS) to update DNS servers

NETWORK ADDRESS TRANSLATION

- One-to-one** every internal host that connects to the internet has its own public IP address. Not common in SOHO routers
- one-to-many** multiple internal hosts share a public IP address. used port address translation (PAT) to differentiate between different hosts on a subnet/LAN

SNAT source network address translation changes source address of outgoing packets
DNAT destination network address translation aka Port Forwarding changes destination address of incoming packets. Best for local servers receiving connections from outside clients.

TROUBLESHOOTING NETWORK CONNECTION STATUS

- Make sure the physical connection is secure, connected and plugged in
- Verify adapter is enabled on computer
- if enabled, try disabling and reenabling it
- Ensure correct drivers and device bindings are installed
- Verify local network requirements; adapter settings may need adjustment in case of MAC filtering, custom ethernet settings, etc.
- if connection requires authentication, verify credentials + security settings
- if computer has multiple network interfaces, make sure the OS is using the right one. disable the others if necessary.
- intermittent drops and slow speeds:
 - Substandard wiring
 - improper duplexing setting
 - LAN congestion
 - LAN misconfiguration
- look for apps that might be hogging network bandwidth

TROUBLESHOOTING NETWORK SETTINGS

- Improper IP address settings
 - IP addresses on a subnet must be unique
 - APIPA or link-local addresses do not transfer across routers
 - if using DHCP, try releasing and renewing the host's lease
 - if not using DHCP check and confirm valid static IP settings, including default gateway, subnet mask, network prefix, etc.
- Ability to connect by IP address but not domain name suggests DNS errors
 - Clear DNS cache
 - if using DHCP, ensure automatic DNS server configuration is right
 - try a public DNS such as 8.8.8.8 or 8.8.4.4
- IPv4 and IPv6 are configured separately
 - A limited connection to local resources but not internet resources:
 - Verify IP address, Gateway, and DNS settings are correct
 - Verify proxy server is correctly configured at server and client points if appropriate
 - if multiple hosts are experiencing the same issues, check for router, modem and WAN problems
- Selective app connection problems - firewall, proxy settings
- inability to access local resources even with network connectivity
 - make sure network location is designated private and network discovery is enabled
 - Ensure target resource is powered on and connected to network
 - if Active Directory domain, verify domain membership
 - on WLAN, make sure you're not connected to a guest subnet or isolated subnet
 - Verify host has right credentials to access the resource.
- inability to send or receive emails
 - Check server name, port, encryption and authentication settings on client app for POP3, IMAP, SMTP, etc.
 - Check SMTP authentication settings
 - if acct. has webmail access verify that it's working
- network troubleshooter
- Network Reset

VIRTUAL MACHINES

HOST the hardware

VIRTUAL MACHINE the software that acts as a virtual OS

HYPERVISOR software that runs virtual machines

- Bare-metal - runs directly on host
- hosted - runs on an OS running on the host

VIRTUAL NETWORKING

virtual NIC

hypervisors also need to be virtual switches and possibly routers and NATs

BENEFITS OF VIRTUALIZATION

- VMs with different OS's can share a host without conflicts
- maintenance on a VM doesn't have to affect different VM's on the same host
- easier to back up, restore or move to a different host
- easier to upgrade host hardware without affecting VM's
- can be used as security sandboxes, limiting the potential danger of untrusted code
- Reduced capital and operating costs
- minimized or eliminated down time
- increased IT productivity, efficiency, agility, and responsiveness
- faster provisioning of applications and resources
- greater business continuity and disaster recovery
- simplified data center management

virtual desktop environments / thin clients (VDE)

virtual desktop infrastructure (VDI)

VIRTUALIZATION REQUIREMENTS

HYPERVISOR

CPU

MEMORY

STORAGE

NETWORK

SECURITY

CLOUD SERVICES

on-demand self service

broad network access

Resource pooling

Rapid elasticity

Measured Service

SAAS CATEGORIES

Desktop productivity
Database
Storage Dropbox etc.
Email

CLOUD SERVICE MODELS

SAAS

Software as a Service

PAAS

Platform as a Service

IAAS

Infrastructure as a Service

NAAS

Network as a Service

IDAAS

ID as a Service

CAAS

Communication as a Service

accounting, antivirus, Google office Suite, etc.

OS provided, only software development required

Virtual systems from machines to entire networks

monitoring, QoS, etc.

Apple Pay, Google Login, etc.

Voice over IP, instant messaging, etc.

CLOUD DEPLOYMENT

Public

available to general public

Private

accessible only to a single organization

Community

shared between multiple organizations

Hybrid

some combination of public, private and community services

CLOUD CONCERNS

- Needs a lot of bandwidth
- often requires special configuration or plugins to use
- Security risks
 - needs secure communication
 - accounts can be hacked or stolen
 - beware saved credentials on shared devices
 - gives sensitive data to third parties to manage
- lock-in effect often difficult to change cloud providers

MOBILE DEVICES

LAPTOP clam shell type form factor w. 11"-17" monitor
SMARTPHONE 3.5"-6.5" screen
TABLET 7"-10" screen
PHABLET very large screen smart phone
2-in-ONE laptop w. a removable or foldable keyboard that can be converted to a tablet

SPECIALIZED MOBILE DEVICES

SMART WATCH
FITNESS TRACKER
SMART GLASSES
VR HEADSET
FEATURE PHONE Smart phone light
E-READER
SMART CAMERA internet-connected camera
GPS

MOBILE DEVICE OPERATING SYSTEMS

ANDROID - OPEN-SOURCE; Google
iOS - APPLE
CHROME OS by Google; for tablets, cheap laptops
WINDOWS PHONE - UTTER SHIT

MOBILE DEVICE ACCESSORIES

Memory card
Docking Station
Port replicator a cheaper docking station with fewer features, usually USB
eGPU external GPU for adding graphics power to devices
Keyboard
Card Reader
Headset headphones with microphone
Replacement battery
Power bank portable battery that extends life of devices
12v charger Car Charger
Wireless charger
Cable lock
Case/cover

IIOT DEVICES

Security systems (Ring)
Smart home systems
Inventory management systems
Wearable devices (Fitbit)
Connected cars
Medical devices
Infrastructure/Industrial devices

MOBILE OS FEATURES

APP SOURCE Google play, Apple App Store, Windows store
Screen orientation
Screen Calibration - for older touchscreens
GPS; Geotracking
WiFi calling
Launcher / GUI
Virtual assistant Google Assistant, Siri, Cortana
Emergency Notification weather emergencies, AMBER alerts, local and national emergencies
Mobile Payment Service Google pay, Apple Pay, Samsung Pay

MOBILE DEVICE CONNECTIONS

USB Connections

Laptops, usually type-A, type C
Tablets, often type B micro, type C
Mobile accessories - usually type B mini, type B micro, or type C

APPLE MOBILE DEVICES

newer: 9-pin lightning connector
older: 30-pin docking connector

EMBEDDED SYSTEMS

network appliances routers, switches, firewall appliances, WAPs, etc.
network-enabled devices network printers, NAS devices, kiosks, POS systems
IoT smart bulbs, home automation, etc.
Vehicles GPS, engine controls, self-driving, etc.

MOBILE NETWORKING

IMEI unique ID for a phone. International Mobile Equipment Identification
IMSI unique ID for SIM card. International Mobile Subscriber Identification

MOBILE OS AND APP ISSUES

- | | |
|----------------------|---|
| APPLICATION ERRORS | check app logs. failure to launch can be a compatibility problem. |
| SLOW PERFORMANCE | Device overheating, lack of storage, too many apps running |
| NO POWER | unplugged or defective adapter; wet charging port; battery damage or wear |
| BATTERY NOT CHARGING | |
| SHORT BATTERY LIFE | brightness settings too high; too many apps or services; battery wear or defects |
| SWOLLEN BATTERY | battery wear → gas buildup. Can cause fire or explosion |
| OVERHEATING | improper ventilation, excessive processor use, too many apps and services running |
| FROZEN SYSTEM | Lack of sufficient storage; too many running apps; low battery |
| SYSTEM LOCKOUT | Security response to failed login attempts |
-
- | | |
|--|--|
| • NO DISPLAY | connection to external display, power failure, display damage |
| • DIM DISPLAY | brightness settings; auto-brightness settings |
| • FLICKERING DISPLAY | improper driver or display settings; if when moving device, hardware problem |
| • CANNOT BROADCAST TO EXTERNAL MONITOR | MIS-configured broadcast settings on device or monitor; mismatched screen resolution |
| • STUCK KEYS/BUTTONS | Dirt or moisture in keyboard; wear from use |
| • TOUCHSCREEN RESPONSE | touchscreen broken, dirty, wet or miscalibrated |
| • DRIPPING POINTER | touchscreen driver interacting with mouse use; hand brushing laptop touch pad |
| • GHOST CLICKS | while typing |
| • NO SOUND | sound/volume muted; misconfigured settings; failed speaker hardware |
| • INTERMITTENT WIRELESS | items/structures blocking cell tower or WAP |
| • NO WIRELESS | wireless networking turned off; failure in NIC or antenna |
| • NO BLUETOOTH | disabled; devices out of range, powered off or unpaired |
| • UNABLE TO DECRYPT EMAIL | incorrect email security config.; mismatched encryption settings; no S/MIME support |

LASER PRINTERS

- LASER
- MIRROR
- LIGHT
- CORONA WIRE/CONDITIONING ROLLER
- RUBBER CLEANING BLADE
- HOPPER
- PHOTSENSITIVE DRUM
- DEVELOPING ROLLER
- TONER CARTRIDGE
- SECONDARY CORONA WIRE/TRANSFER ROLLER
- FUSING ROLLERS

LASER PRINTING PROCESS

- | | |
|--------------|--|
| CLEANING | excess toner scraped off drum into the hopper; heat roller (lubed) |
| CHARGING | primary corona wire negatively charges drum, removing residual charges |
| EXPOSING | laser projects image on drum, creating charge differential |
| DEVELOPING | charged toner on developing roller creates negative image on drum |
| TRANSFERRING | Drum deposits toner on paper that has been positively charged by secondary corona wire |
| FUSING | heat rollers cure toner onto paper |

INKJET PRINTERS

- CONTROL CIRCUITRY
- INK CARTRIDGES
- PRINT HEAD STEPPER MOTOR
- STABILIZER BAR
- PAPER ADVANCE ROLLERS
- PRINT FEED STEPPER MOTOR
- PRINT HEAD ASSEMBLY
- BELT
- RIBBON CABLE

INK JET PRINTING PROCESS

- | | |
|---------------------------|---|
| THERMAL TECHNOLOGY | heating elements create ink bubbles that burst onto the paper |
| PIEZO-ELECTRIC TECHNOLOGY | EPSON-proprietary. a piezo crystal behind the ink expands and forces a drop onto the paper. |

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|-----------------|--------------------------|
| NORMAL QUALITY/ | 300 x 300, 320 x 320 DPI |
| HIGH QUALITY | 600 x 600 or 720 x 720 |
| PHOTO QUALITY | 1200 x 1200 and up |