

A+ Review Guide, starting 12/4/2025

Core 1 Domain Breakdown:

Mobile Devices → 15%
Networking → 20%
Hardware → 25%
Virtualization & Cloud → 11%
Troubleshooting → 29%

Core 2 Breakdown:

Operating Systems → 31%
Security → 25%
Software Troubleshooting → 22%
Procedures → 22%

Part 1:

1.1 → Topics:

- ↳ 1. Hardware/Device Replacement
- 2. Physical Privacy & Security Components

Hardware/Device Replacement

- Note: many laptops will void the warranty if unauthorized persons open it
- Most PC toolkits come with T-8 screwdrivers
 - ↳ these come with a variety of bits
- Battery Replacement in laptop
 - ↳ 1. remove battery storage bay
 - 2. remove old battery from bay
 - 3. place new battery in bay
 - 4. Place bay back in laptop
- warning: if bitlocker encryption is enabled, the laptop will not boot after battery replacement unless bitlocker encryption key is provided

- Keyboard/Key replacement

- ↳ 1. Fully power off and unplug laptop
- ↳ 1. determine necessary screw bits
- 2. unscrew back of laptop and remove base plate
 - ↳ note: some laptops have "interesting" cases with clamps at outer plastic pieces
- 3. after removing plastic covers, unscrew keyboard, look for a clip, will be visible
- 4. carefully remove keyboard and keep hold of the aforementioned clip - old one keyboard
- 5. replace keyboard and connector pieces
- 6. close laptop and reinsert the pieces back in.

RAM Replacement:

- Before starting, look for panel used to access memory modules, if panels are not marked, refer to laptop manual

↳ 1. remove screws and remove panel from laptop, unclip memory modules

2. gently remove old module, and carefully line up new module at a 45° angle, once pins are aligned, gently turn new module and rotate until flat metal clips latch into place

3. Replace memory access panel, and if necessary, enter computer BIOS to ensure new RAM is detected

HDD/SSD replacement:

- Before starting, back up old drive

1. remove screws and remove panel from laptop. Identify and unlock drives to be removed.

2. carefully remove old drive(s), pay attention to unique elements such as a caddy or mounting rails. Attach new drive

3. reverse the process to ensure new drive is secured and laptop is closed.

SSD drives:

- most laptops use SSD drives or hybrid drives

↳ hybrid is just a combination of mechanical and

- advantage of SSDs is higher durability, also faster because no moving parts are involved

- disadvantages: more expensive, don't display warning signs of failure

1.8 in v. 2.5 in

- 2.5 in hard drives operate from 5,400 - 7,200 rpm (2.5 Watts)

- 3.5 in hard drives operate from 7,200 - 10,000 rpm (5 Watts)

HDD → SSD migration

↳ make sure both are installed in laptop, backup original data to new disk

Wireless Cards:

- Both 802.11 and Bluetooth wireless cards can be replaced

Relevant steps:

1. Locate card → could be near RAM, could be located at the edge of the laptop

2. Disconnect the two antennas from the card, pull by the connector ~~pin~~

3. Insert new card at 45° angle, replace screws, connect antenna.

Cellular Cards (also) / Mini PCIe cards

↳ similar steps to replacing the 802.11 or Bluetooth cards

- before replacing any cards, ensure location in the documentation

Physical Privacy and Security Components:

↳ Biometrics: most devices now offer biometric authentication

↳ fingerprint, face ID, etc...

- ↳ more secure than a password or PIN

↳ Near-Field Scanner Features: allows you to measure and map EMC that may be leaking from a system or its cables.

Exam Essentials:

List: steps to install or replace components: keyboards, HDD/SSDs, optical drives, wireless ~~cards~~, mini PCIe's and Webcams

List: steps to configure biometrics.

1.2 Compare and Contrast the Display Components of Mobile Device

↳ Topics:

1. Types
2. Mobile Display Components
3. WiFi antenna placement
4. Camera/webcam
5. Microphone
6. Touch Screen/digitizer
7. Inverter

Types:

↳ LCDs → Liquid Crystal Displays

↳ Default display types for computers

- Passive v. Active matrix:

↳ Passive: uses a row of transistors across the top and side of the screen

- becoming obsolete because they are less bright

↳ Active: uses a separate transistor for each pixel

- use more power than passive

- variant called "thin-film transistor" or "TFT" uses multiple transistors per pixel

↳ In-Plane Switching (IPS):

↳ Advantages:

- newer, solves issues of poor quality at angles, better color quality

↳ Disadvantages:

- more expensive, slower response time

→ Twisted Nematic (TN):

↳ Advantages:

- best response time, high brightness, low power consumption

↳ Disadvantages:

- poor quality when viewed from angles, some color distortions

QUESTION

Fluorescent v. LED backlighting:

- ↳ Fluorescent is older → similar to passive matrix lighting in layout
- LEDs are more akin to active lighting
- ↳ comparison:

	Fluorescent	LEDs
Size	Higher and broader	Higher, lighter
Cost	cheaper	expensive
Power	high power, high heat	low power, low heat
brightness	lower	higher
LifeSpan	shorter	longer

Vertical Alignment (VA)

- ↳ combines the best elements of IPS and TN displays,
- giving good visibility viewing angles and best color

Organic Light-Emitting Diode (OLED)

- ↳ uses an emitting electroluminescent layer of organic compounds that give off light in response to current.
- known for flexibility, these can be rolled up like a mat and you can see through them

Mobile Display Components:

- ↳ WiFi antenna is often placed in the display on the edge
- to access camera in a button, you will need to remove the front panel and screen from the assembly.
- ↳ Microphone is located either in the bottom of a display or near the WiFi antenna

Exam Essentials:

- ↳ Differentiate types of Displays Available in Laptops
- Describe the function and characteristics of active and passive matrix lighting
- ↳ Identify the function of an inverter
- ↳ Compare DL panel to LCD which can be used by an LCD display

1.3 Given a scenario, set up and configure accessories and parts of mobile devices

↳ Connection Methods:

↳ Universal Serial Bus (USB) → also (USB-C, microUSB, miniUSB)

↳ type A : S found on USB hubs, type B plugs into devices

- cables "cannot exceed 5-ft in length"

- USB-C connects to both hosts and devices

↳ USB 2.0 / 3.0

↳ USB 1.1 runs at 12 Mbps, USB 2.0 runs at 480 Mbps,

USB 3.0 runs up to 5 Gbps

↳ Lightning → Apple's "USB"

↳ Advantages:

- supplies more power

- can be inserted either way

- more physically durable than USB

- can detect and adapt to devices

↳ Serial Interfaces:

- older connector, speeds up to 115,200 bps

Update: the CompTIA A+ exam was updated earlier this year (September 2025), and I have been using outdated tools, so to fix that, I am going to

include a "study priority list" of topics from VTS

of the exam, and my future notes will reflect

that.

12/7/2025

CompTIA A+ Study Priority List:

1. Hardware:

- Modern CPUs (cores v. threads, and virtualization)
- DDR4 v. DDR5 RAM
- NVMe v. SATA SSDs
- USB-C v. Thunderbolt
- Wi-Fi b/g/n
- Modern Peripherals
- UPS and Power Protection
- Laser v. Inkjet Troubleshooting
- Thermal Management and Airflow

2. Networking:

- Ports (80, 443, 22, 25, 3389, 53)
- WiFi Security (WPA2, WPA3)
- SOHO Routers and Access Points
- DNS, DHCP
- Basic Subnet Awareness
- Cable Types (Cat5e, Cat6, Fiber)
- NAT and Firewalls
- Common Network Failures

3. Mobile and Virtualization:

- MDM (Mobile Device Management)
- Email Sync/Corporate Policies
- BYOD Security
- VM Basics
- Cloud Models (SaaS, PaaS, IaaS)

4. Operating Systems:

- Windows 10/11 installation
- Command Line Tools (ipconfig, ping, sfc, chkdsk, netstat)
- Mac OS v. Windows Utilities, Linux Basics (ls, cd, rm, chmod)
- System Recovery Methods
- Registry Awareness
- Task Manager & Event Viewer

5. Security:

- MFA
- Least Privilege
- Zero Trust
- Social Engineering
- Malware Types
- Encryption
- Physical Security
- Authentication Methods
- Mobile Device Security
- Certificates and HTTPS

6. Troubleshooting:

- Best Practice Steps (in-order!!)
- PC won't Boot
- Slow System Diagnosis
- No Internet
- Blue Screen
- Overheating
- Printer Failures
- Mobile Connectivity Issues

Absolute Essentials:

- Ports
- Windows Tools
- WiFi and Routers
- Malware and MFA
- Troubleshooting Flow

12/8/25

Hardware:

↳ Modern CPUs:

- CPU → "Central Processing Unit"
- Cores → Physical Processing Units → more cores = better multitasking
- Threads → Logical Processing Tasks → A virtual execution path
- Hyperthreading / SMT (Simultaneous Multithreading) → Allows a single core to run 2 threads simultaneously
- Virtualization Support (Intel VT-x, AMD-V) → allows vms (Virtual Machines) to run efficiently

- Exam focus:

- Performance Comparisons

- Virtualization Requirements

- Heat and Power Management

↳ DDR4 v. DDR5 Memory:

- DDR = "Double Data Rate" SDRAM

- Differences:

↳ Speed: DDR5 is much faster

- Power Efficiency

- Bandwidth

→ voltage decreases with newer gens.

- Exam Focus

- Matching memory types to system requirements

- Laptop v. Desktop RAM (SO-DIMM v. DIMM)

↳ NVMe v. SATA SSDs

- NVMe = "Non-Volatile Memory Express"

- SATA = "Serial Advanced Technology Attachment"

- NVMe uses PCIe lanes

- SATA is limited to 600 Mbps

- Exam Focus

- Identify by slot type (M.2 or 2.5")

- Speed Troubleshooting

→ match CPU to correct socket

↳ intel LGA v. AMD AM4

CPU must support virtualization

↳ either VT-x or AMD-V

	DDR4	DDR5
Speed	2133-3200 MT/s	4800-7200 MT/s
Voltage	1.2V	~1.1V
Channels	Single	Dual per DIMM
Power Management	Motherboard	PMIC on module
DDR4 cannot be installed on DDR5		
DDR5 performance relies on CPU bandwidth		

USB-C v. Thunderbolt:

↳ USB-C = "Universal Serial Bus Type-C"

- Thunderbolt = Intel standard over USB-C

↳ Data, video, power, and networking

- Supports external GPUs and docks

- Exam Focus:

- Cable capability confusion

- Charging v. Data v. Display

→ WiFi 6 / 6E:

- 802.11ax

- 6E = Opens 6 GHz frequency band

- Lower latency, better multi-device performance

- Exam Focus:

- Speed v. Range Comparisons

- Interference troubleshooting

→ Modern Peripherals:

- Webcams, VR Headsets, Drawing Tablets

- HID = "Human Interface Device"

- Exam Focus:

- Driver Issues

- Device Pairing

→ UPS and Power Protection:

- UPS = Uninterruptible Power Supply

- Surge Protector v. Power Strip v. UPS

- Line-interactive v. online UPS models

- Exam Focus:

- Selecting correct protection for servers

- Safe shutdown processes

→ UPS types:

- Offline/Standby: Limited Protection

- Line-interactive: Good for PCs

- Online/Double Conversion: Best for Servers

→ USB-C is a connector type, not a standard.

- not all USB-C cables support video or fast data

- Thunderbolt 3 or 4 is most common

→ WiFi 6 = 802.11ax (2.4, 5 GHz)

→ WiFi 6E = 802.11ax (6 GHz)

Focus is on drivers, connecting and compatibility

→ "Check device manager for driver updates" is a common answer

UPS → battery backup, protects

against outages

Surge Protector → protects against voltage spikes

Power Strip → no protection

Laser Printers: Never plug into UPS → high power draw

Server: Online UPS

Home Office: Line interactive UPS

→ Laser vs. Inkjet Troubleshooting:

- Laser: toner, drum, fuser
- Inkjet: Liquid ink, clogging, alignment

- Exam Focus:

- Streaks, faded prints, ghosting
- Maintenance kits and calibration

→ Thermal Management and Airflow:

- Heat Sinks, fans, thermal paste, liquid coolers
- Proper Airflow Direction

- Overclocking Risks

- Exam Focus:

- Overheating Symptoms
- Thermal Throttling

cool air in, hot air out

- positive pressure reduces dust

- negative pressure improves airflow, but increases dust

- Dust is #1 cause of overheating

- Old thermal paste → CPU throttling

Laser Printer Components:

- ↳ Toner, Drum, Transfer Roller, Fuser Assembly

Problems:

- ↳ Faded print = low toner
- Ghosting = bad fuser
- Smudging = fuser not heating
- Blank Pages: disconnected toner or drum

Inkjet Printer Issues:

- ↳ Streaks = clogged nozzles
- Incorrect colors = alignment or ink

- Paper jams = bad feed rollers

Laser /

~~Inkjet~~ printers require maintenance kits

Inkjet printers require alignment or calibration.

Networking:

Network types:

- LAN (Local Area Network) → one building or small area (home office)
- WAN (Wide Area Network) → connects multiple LANs across large areas
- PAN (Personal Area Network) → Bluetooth, NFC, tethering
- MAN (Metropolitan Area Network) → rare in exam, city-sized networks
- SAN (Storage Area Network) → high speed storage networks

most commonly tested: LAN, WAN, PAN

Network Topologies:

- Star Topology → most common, each device connects to a central switch
- Mesh Topology → fault tolerant, used in modern WiFi mesh kits
- Bus Topology → legacy, coax networks
- Ring Topology → legacy, token ring (IBM)
- Hybrid - mix of star/bus → modern networks

most tested: star, mesh

Network Hardware Devices:

Routers:

- connect different networks (LAN ↔ WAN)
- performs NAT (Network Address Translation)
- has WAN port and LAN Ethernet ports
- WiFi access point

Switches:

- connects devices inside a LAN
- Managed switches: VLANs, port security, SNMP
- Unmanaged switches: plug and play
- learns MAC addresses to forward frames

Access Points (APs)

- provide WiFi connectivity
- may support multiple SSIDs or guest networks

Modems:

- convert ISP signals (DSL, cable, fiber) into ethernet
- modern ISP gateways combine modem, router, and AP

- M*
- Network Interface Card (NIC)
 - Wired or wireless
 - Supports MAC Addressing and link negotiation

Internet Protocol (IP)

→ IPv4

- 32 bit addressing
- Four octets
- Private Ranges:
 - 10.0.0.0, 10.255.255.255
 - 172.16.0.0, 172.31.255.255
 - 192.168.0.0, 192.168.255.255

- APIPA (Automatic Private IP Addressing)

- 169.254.x.x
- Means DHCP failed

→ IPv6

- 128 bit addressing (2^{128})
- Auto configures using SLAAC
- No NAT needed

Subnetting Basics:

- Identify subnet masks (255.255.255.0)
- Masks define network size
- Recognize CIDR notation (/24, /16)
- Identify Network, Host, and Broadcast

→ Network Address:

- First IP address in a subnet
- ↳ identifies subnet itself
- Determining where packets should be forwarded

→ no device can use this address

↳ the network will break if you try to

$$192.168.1.0/24 = 192.168.1.0$$

→ Host Address:

- IP Addresses assigned to devices

$$192.168.1.0/24 = 192.168.1.1 - 192.168.1.254$$

→ Broadcast Address:

- used to send message to every host on subnet simultaneously

$$192.168.1.0/24 = 192.168.1.0 - 192.168.1.255$$

Zzz

Ports and Protocols:

Port	Protocol	Name	Purpose	Most tested Ports
20/21	FTP	File Transfer Protocol	Legacy file transfer	✓
22	SSH	Secure Shell	Secure remote login	✓
23	Telnet	Remote Terminal	Unencrypted legacy	
25	SMTP	Simple Mail Transfer Protocol	Email sending	
53	DNS	Domain Name System	Resolves names to IP Addresses	✓
67/68	DHCP	Dynamic Host Control Protocol	Assigns IP Addresses	✓
80	HTTP	Hypertext Transfer Protocol	Web browsing	✓
110	POP3	Post Office Protocol 3	Email Retrieval	
143	IMAP	Internet Message Access protocol	Email Syncing	
443	HTTPS	HTTP Secure	Secure web browsing	✓
445	SMB	Server Message Block	Windows File sharing	
3389	RDP	Remote Desktop Protocol	Windows desktop	✓

TCP v. UDP

Networking Cables and Connectors:

↳ Twisted Pair Ethernet:

- Copper

- ↳ Cat 5e - 1 Gbps, up to 100m

- Cat 6 - 1 Gbps at long lengths, 10 Gbps up to 55m

- Cat 6a - 10 Gbps up to 100m → very commonly tested

- Cat 7/8 - shielded, higher speed, less tested

- Connectors

- RJ-45 - Standard Ethernet

- RJ-11 - Phone Line / DSL modem

- Cable types

- UTP = "unshielded twisted pair"

- STP = "shielded twisted pair" → used in high-interference environments

- Termination

- Straight-through = unlike devices (PC → Switch)

- Crossover = like devices (PC → PC)

Fiber Optic

- immune to EMI (Electromagnetic interference)
- long distance, high bandwidth
- uses light instead of electric signals
- two main types
 - ↳ single-mode fiber (SMF) - long distance
 - multi-mode fiber (MMF) - short distance
- connectors:
 - LC, SC, ST, MPO/MPO

Wireless Networking:

Standard	Frequency	Max Speed	Notes	Must tested
802.11a	5 GHz	54 Mbps	Legacy	
802.11b	2.4 GHz	11 Mbps	Legacy	
802.11g	2.4 GHz	54 Mbps	Legacy	
802.11n	2.4/5 GHz	600 Mbps	Introduced MIMO	✓
802.11ac	5 GHz	~1 Gbps+	Very common	✓
802.11ax	2.4/5 GHz	~1-2 Gbps	OFDMA modern standard	✓
WiFi 6E	6 GHz	Highest	Newest consumer tech	

Security:

- WEP (Wired Equivalent Privacy) - Outdated, insecure
- WPA (Wi-Fi Protected Access) - improved, but weak
- WPA2 - AES based, industry standard
- WPA3 - Latest, more secure, but not super common yet

SOHO Network Configuration:

- SSID - network name
- Encryption type (WPA2 or WPA3)
- DHCP (enable/disable)
- MAC filtering (security through restriction)
- Port forwarding (gaming servers/cameras)
- DMZ
- QoS (Quality of Service) - prioritizes traffic

Networking Services:

- DHCP → Dynamic Host Control Protocol
 - ↳ Assigns IP, Gateway, Subnet mask, DNS automatically
- DNS → Domain Name System
 - ↳ translates domain names to IP Addresses
 - if websites work by IP, but not by name DNS is failing
- NAT and PAT
 - |- NAT = Network Address Translation
 - PAT = Port Address Translation (NAT overload)
 - Allows many devices to share one public IP

Tools:

- Crimper - RJ-45 cable making
- Cable tester - identifies correct wiring
- Punch down tool - secures wires into patch panels
- Toner Probe - traces cables in walls
- Loopback Plug - NIC and Port testing
- Wi-Fi Analyzer - Detects Channel Interference

Troubleshooting:

1. Identify problem
 2. Establish a theory
 3. Test the Theory
 4. Create a plan
 5. Implement the fix
 6. Verify functionality
 7. Document findings
- ↳ No Connectivity = check link lights, cable, APIPA
 - Limited Connectivity: IP Conflict, weak signal
 - Intermittent Connectivity: interference, bad cable
 - Slow network: band width saturation, distance issues
 - Firewall / Router: can reach LAN but not internet

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Mobile Devices:

- Smartphones:

- Run Android or iOS
- Touchscreen interface
- Use Cellular, WiFi, Bluetooth, NFC

- Tablets:

- Larger Screens
- Can use WiFi or LTE/5G versions
- Can often support keyboard/pen input

- Laptops:

- Replaceable parts = keyboard, RAM, Battery, Storage (SSD, NVMe), WiFi/Bluetooth card, Display

- Wearables:

- Smartwatches, and fitness trackers
- ↳ Use Bluetooth Low Energy "BLE"

Networking on Mobile Devices:

- Cellular standards

- 3G - Legacy
 - 4G LTE - (Long Term Evolution) - common
 - 5G NR - (New Radio) - fastest
- ↳ only LTE and 5G support simultaneous voice and data

- WiFi

- 802.11 a/b/g/n/ac/ax
- 2.4 GHz (longer range), 5G (faster)
- 6 GHz (WiFi 6E)

- Bluetooth

- Class 1 - 100m
- Class 2 - 10m - most common
- Class 3 - 1m

- Hotspot/Tethering

- USB or Bluetooth tethering
- WiFi hotspot

Mobile OS Features:

- iOS v. Android:

iOS	Android
- Closed Ecosystem	- Open Ecosystem
- Apps from App Store Only	- APK Sideload
- iCloud Integration	- various hardware manufacturers

- Mobile Device Management (MDM):

- Central management of corporate devices
- ↳ Remote wipe
- Device encryption
- Screen lock policies
- App whitelisting / blacklisting
- Geofencing (location-based restrictions)

- Email Configuration:

- Microsoft Exchange / Microsoft 365
- Corporate Email
- Uses ActiveSync, supports calendar
- ↳ pushed automatically
- IMAP (Internet message access protocol)
- Syncs email on all devices
- Port 143 (unsecure), 993 (secure)
- POP3 (Post Office Protocol 3)
- Downloads and Deletes from Server
- Port 110 (unsecure), port 995 (secure)

- Mobile Synchronization

- The following data can be synced:
- Contacts - Apps
- Calendars - Music
- Email - Media
- Photos - Documents
- Videos - Cloud Syncing
- Device to Desktop through USB

- Mobile Security:

- Screen Locks:

- PIN, Password, Pattern, Fingerprint, Face ID

- Device Protection:

- Full device encryption

- Remote tracking (Find My...)

- Remote Wipe

- Biometric Authentication

- App Permissions

- Mobile Threats

- Malware (spyware, trojans, adware)

- Unauthorized App Stores (Android)

- Phishing SMS = "Smishing"

- Bluetooth Attacks (Bluejacking)

- Mobile Accessories:

- Headsets

- Docking Stations

- Speakers

- USB-C Adapters

- Smart Watch

- Lightning Cables

- VR/AR Headsets

- MicroSD Cards (Android)

- Troubleshooting Mobile Devices

- ↳ Problem: Battery Draining Quickly:

- ↳ causes: Background Apps, High Brightness

- Bad Battery, Rogue App

- Problem: No Display / Dead Screen:

- ↳ fixes: Hard Reset, Check Battery, Replace

- Display Panel

- Problem: Overheating:

- ↳ causes: Apps using CPU, High environment temp

- Charging while using

- Problem: No wireless connectivity:

- ↳ fixes: Toggle Airplane Mode, reconnect wifi,

- restart router, reset network settings

Virtualization:

- Hypervisors

- Type 1: (Bare Metal)

↳ These run directly on the hardware

- Microsoft Hyper-V

- VMware ESXi

- Xen Server

- Type 2: (Hosted)

↳ These run inside a host OS

- Oracle VirtualBox

- VMware Workstation

- Parallels (Mac OS)

→ At focuses mostly on Type 2

- Virtual Machine (VM) requirements:

- Hardware Requirements:

- CPU must have Intel VT-x or AMD-V

↳ must be enabled in BIOS/UEFI

- High RAM, at least 16 GB

- Sufficient Storage, as VMs can

→ get quite large

- 64-bit CPU and OS

- Hardware support for virtualization-based security

- Common VM Settings:

- vCPUs - virtual cores assigned to VM

- Virtual Drive - .vdi, .vmdk, .vhdx files

- Virtual Switches / NICs - simulate network adapters

- Bridged Network - VM gets its own IP on LAN

- NAT mode - VM shares host IP

- Host-only mode - VM can only talk to host

- Snapshots: → saved state of a VM

- Used for: testing malware, software changes
or config rollback

- not good for long-term backups

-Cloud Computing Concepts:

- IaaS - Infrastructure as a Service
 - ↳ Rent virtual hardware (servers, networks)
 - Ex. AWS EC2, Azure VMs, Google Compute
- PaaS - Platform as a Service
 - ↳ Rent hardware and a development platform
 - Ex. Heroku, Azure App Service
- SaaS - Software as a Service
 - ↳ Use Cloud Hosted Apps
 - Ex. Gmail, Office 365, Sales Force

-Cloud Characteristics:

- Rapid Elasticity - Scale resources automatically
- Measured Service - Pay only for what you use
- On-demand self-service - no human deployment required
- Resource Pooling - Shared computing resources
- Broad Network Access - Available Anywhere

- Virtualization Troubleshooting

- Common Issues:
 - VM won't start - virtualization disabled → fix BIOS
 - VM is slow - allocate more CPU cores, and RAM
 - No Network - incorrect virtual NIC mode
 - VM won't run 64-bit OS - host virtualization off
 - Host Overclocking - over-allocated CPU/RAM