# COMPTIA TECH+ NOTES

# Contents

# IT CONCEPTS AND TERMINOLOGY

## Understanding Notational Systems

- A notational system is just a method to represent numbers
- Decimal is base 10. Everyday counting system 0-9
- Binary is called Base 2 – uses 2 digits: 1 & 0. 1 = ON 0 = OFF
    - Computers use switches
- Hexadecimal is base 16. 0-9 then letters. A-F. A = 10. B = 11 C = 12 etc.
    - Simplifies binary numbers
- Octal is Base 8. 0-7.
    - Occasionally used in programming languages

## Basics Of Computing

- Four key stages of every action:
    - Input
    - Processing
    - Output
    - Storage

## Comparing Units Of Measure

- A bit is the smallest unit of data in computing. Only have 2 values. 0 or 1
- Byte is 8 bits
- 1 kilobyte = 1024 bytes
- 1 megabyte = 1024 KB
- 1 gigabyte = 1024 MB
- 1 terabyte = 1024 GB
- Throughput is the speed of data transfer:
    - 1 bps = 1 bit per second
    - Kbps = 1000 bits per second
    - Mbps = 1000 bits per second
    - Mbps = 1 million bits per second
    - Gbps = 1 billion bits per second
- Processing speed is measured in Hertz which tells us how many cycles per second the CPU can perform:
    - 1 Megahertz: 1 million cycles per second
    - 1 Gigahertz: 1 billion cycles per second

## Troubleshooting Methodology

- Step 1 – INDENTIFY THE PROBLEM with information gathering
- Step 2 – ESTABLISH THEORY OF PROBABLE CAUSE with information gathered
- Step 3 – TEST THE THEORY to confirm it's the root issue
- Step 4 – ESTABLISH PLAN OF ACTION on how to fix and the impacts
- Step 5 – IMPLEMENT SOLUTION
- Step 6 – VERIFY SOLUTION AND PREVENT FUTURE ISSUES
- Step 7 – DOCUMENT PROCESS

# INFRASTRUCTURE

## Internal Components Of Computers

- Motherboard:
  - Central hub of computer. Main circuit board.
  - Holds CPU, RAM, storage and expansion cards and power connectors
  - Allows expansion such as GPUs
  - Includes ports such as USB HDMI ethernet and many more
- Firmware and BIOS:
  - BIOS stands for Basic Input Output System
  - UEFI stands for Unified Extensible Firmware Interface
  - BIOS/UEFI is the built in software and responsible for booting the system and managing communication between hardware and operating systems
  - Firmware is the software embedded directly into the motherboard
  - When powered on BIOS performs a POST (power on self-test) to check if all essential hardware components are working. If ok, BIOS gives control to operating system (e.g. Windows 11)
- Central processing Unit (CPU)
  - Brain of the computer
  - Executes instructions it receives from OS and programs. Does everything
  - Modern CPUs have multiple cores and threads. A core is a processing unit that can handle its own tasks. A thread is a virtual core allowing the CPU to multitask more efficiently
  - More cores and threads, the better it is at handling tasks
  - Clock speed is the speed of which the CPU processes data. Measured in GHz

- Random access memory (RAM)
    - Systems short term memory
    - Temporarily stores data the CPU needs. Volatile which means its all wiped if the computer is shut down or restarted
    - More capacity, more apps and data can be handled without slowing down
    - Faster RAM means system performance increases
- Cooling Fans
    - Maintains optimal temperature of internal components like CPU, GPU etc.
    - Prevents over heating by circulating air through the computer case
- Power Supply (PSU)
    - Takes AC from wall outlet and converts it to DC
    - Higher end systems require higher wattage
    - PSU has multiple connectors for each component
- Storage Drives
    - HDD – uses spinning magnetic platters to read write data. Low price but slower
    - SSD – no moving parts and use flash memory. Quicker and commonly used
    - Non-Volatile Memory Express (NVMe) – fastest out there. They use PCIe lanes to achieve high data transfer rates. Ideal for gaming, video and editing
- Graphical processing unit GPU
    - Responsible for rendering graphics
    - Integrated GPUs are part of CPU and fine for everyday browsing
    - Dedicated GPUs have their own memory (VRAM) and essential for gaming, 3D rendering etc.
- Network Interface Card (NIC)
    - Allows computer to connect to a network
    - Converts data from computer into signals that are sent over a network cable. Responsible for incoming and outgoing data packets

## Types Of Storage

- Hard Disk Drive – HDD
    - Pros – cheap and large amount of storage
    - Cons – slow and moving parts = wear out
    - Faster the HDD spins, the faster data can be accessed. Measured in RPM
    - Most use SATA (serial advanced technology attachment) – a standard to connect storage devices to the motherboard

    - Transfer speeds up to 600 Mbps
- Solid State Drives – SSD
    - No moving parts makes them quicker, quieter and more durable
    - Use flash memory to store data – much quicker than spinning platters
    - Pros – blazing fast and more durable compared to HDDs
    - Cons – more expensive than HDDs
    - M2 SSDs are tiny and plug directly into motherboard and are even faster than SATA SSDs. M2 > SATA
    - NVMe drivers are even faster. These drives use PCIe bus to communicate directly to the CPU meaning up to 6x quicker than SSDs
        - Pros – crazy fast. Perfect for data intensive tasks
        - Cons – more expensive than SATA SSDs
- Random Access Memory (RAM)
    - Your systems quick access memory
    - Temporary and when no longer needed its flushed or returned to permanent storage media
    - Types of RAM:
        - DDR 3 – older standard. Speeds up to 2133 mega transfers per second
        - DDR 4 – currently most common. Speeds up to 4800 mega transfers per second
        - DDR 5 – newest one on the market. Capable of over 6400 mega transfers per second
- Network Storage
    - Pros - Great for file sharing, backups and media streaming
    - Cons – not as fast as local storage
- Cloud Storage
    - Pros – access files from anywhere + automatic backups
    - Cons – limited by internet speed and pricey

## Peripheral Devices And Installation

- Monitors – main visual output
    - LCD monitors are most common providing good balance between price and quality
    - LED monitors are more energy efficient compared to LCD and provide brighter colours and better contrast
    - OLED monitors are premium with better colour accuracy and contrast often used in creative industries
    - Connect via display port (HDMI, Type-C) offer high resolution and refresh rates

    - VGA and DVI are older and lower refresh rates and resolution
- USB 3.1 and Type C offer high transfer speeds than older USB 2.0
- Power Protection (UPS)
    - Critical in defending devices from sudden power outages and surges
    - Provides battery backup and surge protection
    - Steps in to provide just enough power to protect device from sudden power problems to be able to save work before system shuts down
- Drivers
    - Act as the bridge between operating system and the hardware ensuring communication between the two
    - External peripherals will not work without them
    - Most are plug and play meaning once plugged into the device the drivers are automatically installed, and the device can be used immediately
    - Some require manual installation such as gaming peripherals and multi-functional printers

## Virtualization And Cloud Technologies

- Virtualization is the technology that allows you to create virtual versions of physical hardware such as servers, storage media or even networks
- Allows multiple OS to run on one physical hardware component
- Hypervisors:
    - Software which sits between physical hardware and the VM
    - Manages the VMs allocating resources like CPU and storage
    - Type 1:
        - Run directly on hardware and include solutions like VMware ESXi
    - Type 2:
        - Run on top of existing OS such as Oracle VirtualBox
    - Virtual machines:
        - Individual OS like windows or Linux running on virtualized hardware. All run independently but share resources with each other
- Cloud computing refers to the delivery of computing resources such as servers and databases over the internet
- Instead of owning and maintaining physical hardware you can rent resources from providers like Amazon (AWS) Microsoft (Azure) or Google Cloud
- Key features:
    - On demand resources: allows users to access resources when needed. Pay for what you use
    - Public cloud: resources provided by 3rd party providers and shared across multiple users. Examples include AWS and Azure

    - Private cloud: resources are dedicated to a single organization. Either hosted internally or by a third party provider
    - Hybrid Cloud: combines public and private elements allowing data to move between the 2 if needed. Provided in different models:
        - Infrastructure as a service (IaaS): provides virtualised resources
        - Platform as a service (PaaS): delivers a platform for developers to build application without worrying about underlying infrastructure
        - Software as a Service (SaaS): delivers software applications over internet removing need for installing things
- Key differences between virtualization and cloud computing:
    - Virtualization: you control and own the physical hardware, but you create virtual environments on top of it. You manage both physical server and the VMs running on it
    - Cloud computing: the physical infrastructure is managed by 3rd party. You don't own or manage hardware. Only manage the virtual resources you rented

## Common Internet Service Types

- Fiber Optic Internet
    - One of the fastest and reliable internet connections available
    - Uses fibre optic cables to transmit data as pulses of light. Offers high bandwidth and low latency
    - Offers speeds up to 1 Gbps and even more
    - More resistant to interference and degradation
- Cable Internet
    - Most widely used in urban areas
    - Uses coaxial cables already laid for cable TV making it readily available in many areas
    - Can offer speeds up to 1 Gbps but often limited to 500 Mbps depending on the plan
    - Operates on shared network meaning speeds depends on the amount the network is being used
- Digital subscriber line
    - Uses pre-existing telephone lines to transmit internet data making it widely available
    - Common in rural areas
    - Slower compared to fibre and cable
    - Speeds between 5 Mbps to 50 Mbps

- Satellite Internet
    - Often used in remote or rural areas where no other internet services are available
    - Available pretty much everywhere
    - Speeds range from 10 Mbps to 50 Mbps
    - High latency however (delays) due to distance
- Fixed wireless internet
    - Internet delivered wirelessly from a base station to a receiver installed at your location
    - Commonly used in rural areas where physical cales aren't feasible
    - Requires clear line of sight – no obstructions

# NETWORKING FUNDAMENTALS

## Core Principles of Computer Networking

- A network is a collection of devices that are connected to one another enabling them to communicate and share resources. They can be established physically through wired connections like ethernet or through Wi-Fi and Bluetooth
- Communication is governed by protocols. One of the most common is TCP/IP which stands for transmission control protocol / internet protocol. The most common protocol
- Types of Networks:
    - Local area networks (LANs)
        - Connects devices within a small geographical area such as an office or school. Often used for sharing files and printers
    - Wired LANs
        - Use ethernet cables
    - Wireless LANs (WLANs)
        - Use Wi-Fi connections to connect devices
    - Wide Area Networks (WANs)
        - Spans large geographical areas and connects multiple LANs
        - Often used by businesses to connect  multiple office locations
    - Metropolitan Area Networks (MANs)
        - Larger than a LAN but smaller than a WAN
        - Usually covers a city or metropolitan area
    - Personal Area Networks (PANs)

        - Used for connecting devices near an individual such as Bluetooth connections between headphones and a phone
- What does a network do?
    - Share resources like files, printers and storage
    - Enable communications through Teams, Zoom and Slack
    - Provide access to internet to all users
- Network protocols:
    - TCP/IP
        - Fundamental protocol that governs most internet and network traffic. Breaks down data into packets, sends them across the network and reassembles them at the other end
    - HTTP/HTTPS
        - Used for web browsing and ensure reliable communication between browser and websites
    - FTP (File Transfer Protocol)
        - Used to transfer files between computers on a network and uploading/downloading files from a server
- Network Ports:
    - Critical in understanding how devices communicate across a network
    - Act as doorways through which data flows helping services and apps connect easily
    - Think of it as a virtual door that allows specific types of data to enter and leave a device
    - Each port is assigned a number corresponding to a specific service or protocol. For example:
        - Port 80 for HTTP
        - Port 443 for HTTPS
    - Port numbers range from 0 to 65,535
    - Numbers are standardized by Internet Assigned Numbers Authority (IANA)
    - The 2 primary protocols that use ports are TCP and UDP (user datagram)
    - Port Ranges:
        - 0-1023 are reserved for commonly used protocols such as:
            - Port 80 for HTTP
            - Port 443 for HTTPS
            - Port 25 for SMTP (sending email0
            - Port 53 for DNS
            - Port 21 for FTP (file transfer)
        - 1024-49,151 for registered ports. These ports are registered for use by specific applications or services such as:
            - Port 3306 for MySQL database communication

        - Port 3306 for remote desktop protocol (RDP)
        - Port 1433 for Microsoft SQL server
    - 49,152-65,535 are not assigned any specific services and are typically used dynamically by applications when trying to establish a temporary connection. AKA ephemeral ports
  - Why are ports important:
    - Managing network traffic
    - Security (firewalls)
    - Troubleshooting

## Network Addresses and Network Identifiers

- A network address is used to uniquely identify devices such as computers, routers and servers on a network. 2 main types of address:
  - IP address
  - MAC address
- IP address:
  - Numeric label assigned to each device connected to a network
  - Tells network where device is located so data can be routed correctly
  - Most common is IPv4 written as four numbers separated by a dot
    - Each number ranges from 0-255
    - First part of the IP is the network portion; identifies the network
    - Last bits are the host portion. Identifies the device on the network
  - IPv6 uses one 128 bit addresses instead of IPv4 32 bit addresses
    - Allows for almost unlimited number of unique IP addresses
    - Allows for more devices to be uniquely identified
    - Improved security and better support for mobile networks
- Public vs Private IP addresses
  - Public IPs are assigned to devices connected to the internet. Unique across the whole web and are assigned by Internet service providers
  - Private Ips are used within LANs. They are used to identify devices inside the local network
- Subnetting
  - The process of dividing a larger network into smaller subnetworks or subnets
  - Subnet mask
    - A special kind of address used to define which portion of the IP refers to the network and the host
- MAC Address
  - Every device has a MAC address and is uniquely assigned by the manufacturer

    - Typically, 48 bits written in hexadecimal format separated by colons or hyphens
    - The first 24 bits (3 bytes) is the manufacturer and the last 24 is the unique identifier
    - Are used within local networks to deliver data to the correct device

## Network Models and Types

- The OSI Model is a 7 layer framework used to standardize the functions of a telecommunication or computing system. Each layer is responsible for a specific aspect of network communication:
    - 1. Physical Layer – deals with physical connections such as cables
    - 2. Data Link Layer – responsible for node-to-node data transfer
    - 3. Network Layer – manages routing and forwarding of packets like Ips
    - 4. Transport Layer – provides reliable data transfer, error checking and flow control for TCP and UDP
    - 5. Session Layer – manages sessions or connections between devices
    - 6. Presentation Layer – ensures data is in a readable format
    - 7. Application Layer – closest to end user. Manages high-level services like file transfer and web browsing
- The TCP/IP Model:
    - Network Interface Layer – combines OSI physical and data link layers handling hardware and direct node communication
    - Internet Layer – corresponds to the OSI Network layer managing Ips
    - Transport Layer – handles data integrity and reliability
    - Application Layer – manages protocols such as HTTP, SMTP and FTP

## Networking Devices and Connectors

- Router
    - Responsible for directing traffic between different networks
    - Routes data packets based on destination IP

- Switches
    - Used within a LAN to connect multiple devices such as computers, printers and servers to a network
    - Use MAC addresses to direct data packets to correct device
- Access Points
    - A wireless access point extends coverage of a wired network
    - Act as a bridge between wired network and wireless devices allowing them to connect without physical connections

- Modems
    - Connects your network to the internet
- Ethernet Cables:
    - Cat5e
        - Supports speeds up to 1 Gbps typically used in home networks
    - Cat6
        - Supports speeds up to 10 Gbps. Commonly used in businesses
    - Cat6a and Cat7
        - Higher speeds and better shielding. Ideal for data centres
    - RJ-45 connectors
        - Ethernet cables, standardized for networking
- Fiber optic cables
    - Use light to transmit data. Used in high speed and long distance connections
    - Greater bandwidth and lower latency
        - Subscriber connector
            - Common in enterprise networks. Uses push pull mechanism
        - Lucent connector
            - Smaller and often used in data centres

# OPERATING SYSTEMS

## What is an operating system?

- Software that serves as the interface between the user and the hardware of the device
- Manages everything from executing apps to controlling hardware resources

- Key functions of an OS:
    - Resource management – OS allocates memory, processor time and storage to different tasks and applications
    - User interface – either through command line or graphical
    - Security and access control – manages user permissions and authorizations

    - Application management – the OS loads, runs and manages software applications ensuring they run smoothly and don't interfere with each other
- Basics of the OS;
    - Kernel – core part of the OS. Responsible for managing hardware and enabling communication between hardware and software
    - Process management – ensures multiple apps and services run simultaneously without conflict
    - File system management – allows user and apps to read and write files efficiently

## Drivers, Applications, Tasks and System Services

- Drivers are small software programs that allow the OS to interact with hardware
- In Windows, this manages in Device Manager
- If a device isn't working properly, you made need to update the driver
- Operating systems provide tools to install and uninstall apps
- The OS can manage system resources and prioritize applications#

## File and Disk Management

- A filesystem organizes data into files and directories and keeps track of where those files are stored. Can also manage permissions
- Different types of file systems:
    - NTFS (New Technology File System)
        - Used by Windows
        - Supports large sizes, encryption and access control
    - FAT32 (File Allocation Table)
        - Legacy supported by Windows, macOS and Linux
        - Up to 4GB file size and 8TB disk partitions
    - exFAT
        - more modern filesystem that supports larger files and compatible with both Windows and macOS
        - commonly used in external drives and flash drives
    - APFS (Apple File System)
        - Used by macOS for efficient data handling and encryption
    - ext4
        - common filesystem used by Linux distributions
        - known for stability and performance

## Backup and Recovery

- Full backup:

    - Involves copying all data on a system or device to another storage location
    - Pros – simple and complete with all data backed up at once
    - Cons – time consuming and requires storage space
- Incremental Backup:
    - Saves only the changes made since the last backup (full or incremental)
    - Pros – faster and space-efficient
    - Cons – restoration may take longer
- Differential Backup:
    - Saves all changes made since the last full backup
    - Pros – quicker than full backups but more comprehensive than incremental backups
    - Cons – uses more storage than incremental backups, but less than full backups

# SOFTWARE AND APPLICATIONS

## Common Software Applications

- Software is a collection of instructions, or code, that tells a computer how to perform specific tasks
- Software runs on the hardware and makes the computer functional
- Various types:
    - System Software
        - Includes OS and utilities that manage hardware
    - Application Software
        - Includes programs designed for specific tasks such as browsers and mail clients

# WEB BROWSING, CONFIGURATION & SECURITY

## Secure Web Browsing

- Different types of malware:
    - Viruses
        - Attach themselves to legitimate programs or files and spread when the files are shared or opened
    - Spyware

        - Collects information from your computer like browsing habits and passwords
    - Ransomware
        - Locks your files or system and demands payment to restore access
    - Adware
        - Generates unwanted ads on your device and can slow it down
    - Trojan Horses
        - Disguise themselves as legitimate software. Once installed they create backdoors allowing root access to the system

# DATA AND DATABASE FUNDAMENTALS

## Database Concepts and Structures

- Relational databases (SQL)
    - Store data in tables with rows and columns with structure and rigor
    - Organises data into relationships using keys
    - Tables are linked together by primary keys and foreign keys to connect related data across tables
- Non-Relational Databases (NoSQL)
    - Don't use predefined tables. Instead, they offer flexible data models making them ideal for unstructured data like documents and social media feeds
- Key-Value Databases
    - Stores data as pairs of keys and values
    - For example, retrieving the price of an item using its product ID

## Working with Relational Databases

- What exactly does a schema do?
    - Defines tables and columns
    - Enforces data types
    - Establishes relationships
- Primary keys
    - A unique identifier for each record in a table. Ensures no two records are identical which maintains data integrity. Often a ID number
- Foreign keys
    - A field in one table that refers to the primary key in another table
    - Create relationships between tables allowing links

    - Example in an order you assign a table number or customer ID

### Database Operations and Access

- CRUD:
    - Create
    - Read
    - Update
    - Delete
- Local databases:
    - Hosted on a server or machine within your organization
    - Pros – faster access and more security and control
    - Cons – requires physical resources. Remote access can be tricky
- Cloud databases:
    - Hosted on remote server managed by a provider
    - Pros – accessible anywhere. Scalable. Maintenance provided
    - Cons – internet connectivity required. Higer risk to data security

## SECURITY: KEEPING THINGS SAFE

### Encryption and Data Protection

- Symmetric encryption:
    - The same key is used for both encryption and decryption
    - Means sender and receiver must have the same key
    - Fast and efficient
    - Often used in file encryption
- Asymmetric encryption
    - 2 different keys – public key and private key
    - Commonly used for secure communications. Sending emails and establishing SSL/TLS connections in web browsers

## IMPACT AND USE OF AI

- Two types of AI:
    - Narrow AI
        - Designed for specific tasks
        - Doesn’t possess general intelligence
    - General AI
        - Aims to mimic human intelligence
        - Still largely theoretical and not yet realized