

MATS CENTRE FOR OPEN & DISTANCE EDUCATION

IT For Managers

Bachelor of Business Administration (BBA) Semester - 3







ODLBBASEC022 IT for Managers

IT FOR MANAGERS

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MODULE INTRODUCTION

Course has five Modules. Under this theme we have covered the following topics:

Module 1 Computer Basics and Classification

Module 2 Operating Systems and Database Basics

Module 3 Data Representation and Conversion

Module 4 Network Technologies and Internet Basics

Module 5 Internet Applications and Security

These themes are dealt with through the introduction of students to the foundational concepts and practices of effective management. The structure of the MODULES includes these skills, along with practical questions and MCQs. The MCQs are designed to help you think about the topic of the particular MODULE.

We suggest that you complete all the activities in the modules, even those that you find relatively easy. This will reinforce your earlier learning.

We hope you enjoy the MODULE.

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MODULE 1 COMPUTER BASICS AND CLASSIFICATION

Structure

Unit 1 Introduction to Computers

Unit 2 Computer Organization and Memory

UNIT 1 INTRODUCTION TO COMPUTERS

An electronic device called a computer is made to operate with data; it takes in information, processes it in accordance with instructions, stores it, and then outputs the intended result. Computers can do a wide range of jobs thanks to this capability, from the most basic ones like calculations to the most intricate ones like simulations.

Computer Hardware Components: The physical component of the computer system is called hardware, and it consists of many fundamental parts. The CPU, RAM, and other required components are all included in the system unit. For instance, input devices (such as a keyboard and mouse) enable users to input data into the system, while output devices (such as a printer and monitor) display processed data. Devices for storage: Solid-state drives (SSDs) and hard drives long-term data storage the non-physical components of a computer, such as the programs and applications that instruct the hardware on how to carry out specific tasks, are referred to as software, as opposed to hardware.

Functions of Computer: Computer serves five basic functions which are essential for their operations. The data can be fed into the systems by others use cases/inputs. In processing, the CPU is powerful enough to run the instructions and process the raw data into useful information. Storage is still when data and instructions are saved in RAM (temporary) for immediate use or hard drives and solid-state drives (permanent) for later access. Through devices like speakers, printers, and monitors, output subsequently sends these processed data back to the user or other systems. Lastly, control is in charge of



managing resources, directing operations, and coordinating those activities throughout the entire computer system.

Types of Computers:

Computers vary in size, power, and application. Common types include:

- **Personal Computers (PCs):** Individual-use general-purpose computers, including desktops and laptops.
- Mainframe Computers: Powerful systems used by large organizations for bulk data processing.
- **Supercomputers:** Extremely fast computers used for complex scientific calculations.
- Embedded Systems: Specialized computers integrated into other devices, like appliances and vehicles.

Applications of Computers: From several walks of life, the evolution of computers has played a significant role in how we learn, work, and entertain ourselves today. In education, they enable online learning, research, and virtual collaboration, improving accessibility and engagement. Healthcare relies heavily on computers to maintain patient records, act as diagnostic aids and facilitate telemedicine. They are used in businesses for effective data organization, communication, and automation, leading to increased productivity and informed decision-making. Plus, the entertainment industry flourishes on digital platforms like gaming, streaming, and creative tools that serve different interests. Computer is everything in modern days; in the material and personal side of human being, if the understanding of its fundamental if knowledge needed in today era of digital machine and modern day lifestyles and inventions.

a) Definition and Evolution of Computers

An electronic device that manipulates data, or information, is called a computer. You have gained knowledge of the most recent information as of the well-known idea of "computer generations" refers to the progressive advancements in computer architecture over time:





Computer Basics and Classification

Figure 1.1: Evolution Of Computer

- Generation (1940s-1950s): These early computers had magnetic drums for memory and vacuum tubes for electronics. They generated a lot of heat, were large, and consumed a lot of power. Every machine has a vernacular of its own. The ENIAC and UNIVAC computers, for instance.
- Generation (1950s-1960s): The replacement of vacuum tubes with transistors in this era allowed computers to be smaller, faster, more reliable and more energy efficient. As computer languages like COBOL and FORTRAN evolved, programming became more widely available.
- Generation (1960s-1970s): This era was characterized by the invention of integrated circuits (ICs), which reduced the size and cost of systems, while increasing performance. Punch cards and printouts gave way to keyboards and monitors, and operating systems enabled multiple applications to run at the same time.
- Fourth Generation (1970s-Present): Thousands of integrated circuits, including microprocessors, were constructed on a single silicon chip. This led to the development of graphical user interfaces (GUIs) and the rise in popularity of personal computers (PCs), which made computers accessible to a large audience.
- Gen (Now and Further): This generation was all about making software and programs that eventually lead to A.I and Machine learning which allowed computers to perform natural language processes, pattern recognition, and decision making processes. Such developments



include quantum computing and advanced parallel processing, which really stretched the limits of computation.

• CHARACTERISTICS AND CAPABILITIES OF COMPUTER SYSTEMS

Computer systems have several defining characteristics that make them indispensable in various fields, from scientific research to business operations. Below is a detailed explanation of these key attributes:

- **Speed:** Instructions to computers are a million billion times faster than human instructions. Computers reduce the time it takes for humans to perform tasks from hours to days to the storage of information to milliseconds. This speed, measured in microseconds (one-millionth of a second) or nanoseconds (one-billionth of a second), enables real-time data processing, instant communication, and rapid computations in various applications, such as financial transactions and artificial intelligence.
- Accuracy: Calculations and data processing done by computers are usually highly accurate. Unlike human beings who can make mistakes due to fatigue or miscalculations, computers strictly follow chronological algorithms and it executes instructions flawlessly. When errors do come up, it is typically due to bad data entry, a software bug or a hardware failure rather than a flaw in the computer's basic processing power. This high level of precision is vital for areas like medical diagnostics, engineering simulations and scientific research.
- Diligence: Computers do not get tired, bored, or distracted, like humans do. They can work continuously without tiring, producing the same results with precision and efficiency. Computers are process isolated and access synchronized, ranging from processing vast data piles to continuing simulations for hours, making them consistent and reliable, giving them edge for 24X7 applications like automated factories, servers management, computations for scientific disciplines.
- Versatility: Computers are very flexible and can perform many different forms of work, such as an easy calculation, machine learning, and artificial intelligence. This flexibility enables them to be used in multiple industries, making them excel in their functions and enhancing the



efficiency and innovation of those sectors altogether. In education, they facilitate online learning platforms and virtual classrooms, allowing for access to knowledge from remote locations. They enable medical imaging and patient data management in healthcare, enhancing diagnostics and record-keeping. Computer-aided design (CAD) and structural analysis have already brought significant advantages to engineering, making design and building processes faster. At the same time, the entertainment industry uses computers for gaming, video editing, and content creation. Computers are universally essential in every sector because they allow quick transitioning from any application with the least amount of modification.

- Storage Capacity: The ability of computers to store and retrieve large amounts of data has widened their application in many areas. While human memory may be limited and fallible, computers can retain structured and unstructured data indefinitely. Advances in storage technologies employed include hard drives, solid-state drives (SSDs), cloud storage systems, etc. This feature provides advantages across various fields, including big data analytics, where massive datasets are processed to derive actionable insights; business management, where companies store records, accounting data, and customer information, and also scientific research, where experimental data, simulations, and computational models must be securely stored for analysis and future use.
- Automation: Computers run without human intervention after programming and perform tasks automatically as per pre-defined instructions. This is seen in various sectors like manufacturing (robot process automation), financial services (automated trading systems), and information technology (scheduled systems update and backup). In addition, automation not only optimizes efficiency but also minimizes human efforts from extremely monotonous or unsafe labor.
- **Reliability**: Computers are very reliable if maintained properly and given correct data input. They provide accurate results over and over and can run for months without failure. Such reliability is crucial in fundamental applications like banking and financing where secure transactions and accurate record maintenance are critical. Computers have been a staple in medicine to provide accuracy in health care analytics and imaging for



precise ordering of services are delivered and prepare clinicians and patients for accurate diagnostics and treatment. Similarly, in aerospace and defense, robust control systems are critical for navigation, security, and mission-critical operations, ensuring safety and efficiency.





• CLASSIFICATION OF COMPUTERS

There are numerous classifications of computers, which can be based on processing data, usage, and size and capacity; each respective classification is used for specific functions in a variety of industries. Computers fall into three categories based on data handling: Analog, digital, or hybrid. Analog computers deal with continuous data, typical in speedometers and thermometers. The dominant type of computer are digital computers, which manipulate abstract symbols while working with discrete quantities, and use binary numbers to integrate vast amounts of complex data, making them essential in modern life across devices such as your personal computer, smartphone, and tablet. These computers can process discrete and continuous data simultaneously by combining features of both analog and digital computing. They are often used in specific applications, such as in medical diagnostics and industrial automation, where precision and versatility are important. Computers can be divided into general-purpose and specialpurpose types based on their purpose. General-use computers like desktops, laptops, and servers are capable of performing almost any task be it word processing, gaming, data analysis, or software development. These computers are highly flexible and used everywhere from homes, businesses and institutions. Special-purpose computers are designed for specific



functions and can only process what they were created to do. These include traffic light controllers, Automated teller machines (ATMs), and embedded systems, used in medical devices, which all work in a very application specific manner with an optimized approach.



Computer Basics and Classification

Figure 1.3: Classification Of Computer

Some other classification could be based on size and capacity, which informs processing power and intended usage. The most powerful class of computers, known as supercomputers, are used for advanced computational requirements like weather forecasts, climate simulations, and other scientific calculations. Mainframe computers are also extremely powerful but slightly less so than supercomputers and are used by large organizations (e.g., banks, government agencies, or multinational corporations) to process billions of transactions and handle massive amounts of data. Minicomputer, also called mid-range computer, computer of intermediate processing capacity that was developed in the mid-20th century to fill the need for lower-cost, smaller systems than those offered by the emerging large mainframe computers, while still allowing enough power for medium-size applications. Microcomputers most often called personal computers are created to be used by one person at a time and consist of desktops, Laptops, and Tablets catering personal or professional needs. They are a generalpurpose tool for technical, engineering, and scientific applications, providing greater computing power than a simple microcomputer.



Another category is servers, which handle network resources, store data, and deliver services to many users. Finally, embedded systems are also specialized computers that are integrated into a range of devices, including home appliances, cars, and medical equipment, to perform specific tasks efficiently. These classifications provide individuals and businesses with critical insights to help them choose computing devices that best suit their way of working.

a) Classification Based on Logic Used by Computers

Computers can be classified based on the type of data they process and the logic they use to handle this data. This classification includes analog, digital, and hybrid computers.

1. Analog Computers: There are two major architectures for computers: digital computers and analog computers. Digital computers work with discrete values while analog computers work with continuously varying data. They have important applications in environments where, for instance, a practical simulation or modeling of the movement of physical processes, such as temperature, speed, electrical current, and so on, is required. Analog computers have a major advantage which is able to solve differential equations in real time. They have traditionally found applications in scientific and engineering domains, notably in aerodynamics simulations, control system analysis, and electrical circuit modeling. Such systems were among the earliest examples of computers, used in missile guidance systems, flight computers, and some of the earliest space missions. Analog computers have been used in engineering to model fluid dynamics, the responses of structures to loads, and the temperature distribution within solids. These work well in applications for computing in continuum cases at high speed, such as areas like hydrodynamics, biomechanics, and electrical power systems analysis. Digital computers soon surpassed their analog cousins in flexibility and precision, but hybrids are still used, and examples of both types exist today. These hybrid computers harness the power of real-time processing with analog computation combined with the precision of digital computing. the field of neuromorphic engineering and artificial intelligence where



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researchers are still trying to build chips that process continuously like the human brain.

2. Digital Computers: As the name suggests, digital computers work with discrete data, typically represented as binary numbers (0s and 1s) that indicate the states of their bits. In contrast, analog computers deal with continuously changeable data, demonstrating physical transition, while digital computers deal with discrete amounts (numerical) by processing data without errors. Central Processing Unit (CPU), Memory, Input/Output devices and Storage are the primary components of a digital computer. The CPU is commonly known for its processing, as it carries out instructions and manages both arithmetic and logical operations. RAM, ROM are called memory units, which store temporary data, whereas hard ejectable or solid-state storage devices are used to store data or information for a long time. Types of Digital Computer: Digital computers are classified into different types according to their functions and uses: Point being, microcomputers, the personal computer (PC) or a laptop that individual users utilize for word processing, web browsing, and gaming are generally more equipped for single-user-multi-tasking applications. Minicomputers are for small businesses and scientific applications; mainframes process vast amounts of data for corporations and financial institutions. Supercomputers, the fastest digital computers, run complex simulations and calculations, such as weather forecasting and scientific research. Smartphones, tablets and embedded systems in everyday digital devices use digital computing principles as well. Servers, which store and organize data in networked computers, are critical to both cloud computing and internet services. Digital computers are still evolving, powered by advances in artificial intelligence, quantum computing, and high-performance computing that continue to impact entire industries and daily life with faster computation capabilities.

3. Hybrid Computers: As the name implies, it is a combination of the both types of computer which is able to handle both continuous as well as discrete pieces of information. This has made them well-suited for high-performance applications requiring real-time data processing and complex computations. Analog systems are excellent when it is time to process data, especially when



this has values that change with time, such as temperature, pressure, or biological signals. On the other hand, digital computers offer accuracy, large storage capacity, and logical processing functions, enabling them to handle complicated mathematical calculations and data analysis. The power of this approach is that most eventual computations are carried out through digital devices, pulling together the contributions from multiple components connected in a hybrid architecture. Hybrid computers are one of the most extensively used components of modern medical application- cardiac monitors and in intensive care units (ICUs). These systems, which rely on analog sensors, constantly measure biological signals such as heart rate, blood pressure and oxygen levels. The information gathered is digitized before it is analyzed by healthcare staff, who are able to detect abnormalities quickly through its real-time nature. Apart from healthcare hybrid computers are employed in industrial automation, military use, and scientific simulations. An example of hybrid computer systems is aircraft and missile guidance systems, where real-time sensor data is obtained and processed for digital computation and adjustment. In the case of weather prediction too, hybrid systems identify the state of atmosphere and forecast future states using a combination of measured data and predictive models. Hybrid computers provide an elegant solution to tasks that require both real-time responsiveness and computational accuracy, combining the rapid resolution capability of analog computers with the precision and storage potential of digital systems.

b) Types of Computers (Supercomputers, Mainframes, Minicomputers, Microcomputers)

Computers are categorized based on their processing power, size, and intended applications. The primary classifications include:

1. Supercomputers: Supercomputers are the most powerful computers in the world designed to perform very complex calculation at very high speed. They are essential for problems that demand enormous computational power, like climate modeling, fluid dynamics, nuclear simulations and astrophysical investigation. These high-performance machines exploit parallelism, performing calculations in parallel with thousands or millions of cores.



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Supercomputers are often used for weather predictions, analyzing huge sets of atmospheric data to help provide more accurate forecasts of storms, temperature changes, and climate trends. Similarly, in fluid dynamics they simulate airflow in aerodynamics, or blood flow in biomedical research. Supercomputers help nuclear scientists model nuclear fusion reactions, and simulate atomic particles and their properties, breakthroughs essential in ensuring a safe nuclear environment, as well as advancing energy research. In theoretical astrophysics, scientists use supercomputers to simulate black hole formation, galaxy evolution, and cosmic radiation. Supercomputers are particularly valuable in engineering, facilitating elaborate simulations for the development of advanced materials, aircraft and infrastructure. They facilitate swift handling and analysis of large amounts of data, expediting breakthroughs in science and improving studies in various fields. Supercomputers will continue to transform computation, solving complex problems such as drug discovery, climate modeling, and fundamental physics, powered by ongoing developments in quantum computing and AI integration.



Figure 1.4: Type Of Computer

2. Mainframe Computers: huge enterprises primarily employ mainframe computers, which are strong and high-performing computer systems, for vital applications involving a lot of data processing, such ERP, census, and processing huge transactions. Because of their excellent security, scalability,



and dependability, these systems are excellent for effectively handling and processing massive amounts of data. The flawless operation of banking, healthcare, payment systems, government, and telecommunications is actually made possible by systems like these, which can handle thousands of users and transactions at once. They are crucial for centralized computing settings that demand always-on service because of their ability to operate at extremely high speeds with virtually no downtime. Additionally, mainframes offer sophisticated security capabilities that safeguard sensitive data, like access limits and encryption. Mainframes, in contrast to typical servers, are designed with redundancy and fault tolerance to prevent system breakdowns and continue to function even during periods of heavy demand. They can make use of virtualization, which makes resource usage more effective by enabling many operating systems to operate concurrently. The latest architectures incorporate modernization in the form of the cloud and AI-enabled analytics, bringing relevance to modern-day mainframes in the digital transformation process. With features such as unmatched processing power, security, and efficiency, mainframe computers are an integral part of enterprise computing for largescale, mission-critical applications.

3. Minicomputers: Used to provide intermediate computing power between mainframes and microcomputers. Although they are smaller, less powerful than mainframes, they are also multi-user, making it suitable for organizations with a need for shared computing resources. Utilized in a variety of business applications, including in house manufacturing processes, research laboratories, and in networks as servers, minicomputers tackle more sophisticated tasks like managing databases, processing transactions, and performing scientific calculations. They offer commercial organizations a low-friction route for utilizing workloads that would exceed personal computers' capabilities, but not the cost and infrastructure of a mainframe. They are efficient for Small to Medium Sized Enterprises who want application processing for multiple tasks as these devices can be used for application of computing, as it allowed for more cost-effective, multi-user systems. The architectural design of a minicomputer was a revelation and like



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mainframes, their dominance has been more or less diminished with the advancement of microprocessor technology and distributed computing, but their impact on server designs is profound. While today most of the functions that minicomputers fell into are now hosted on multi-terabyte data centre servers or in the cloud, the impact of minicomputers has lived on in networked computing and business computing environments.

4. Microcomputers: Often referred to as personal computers or PCs, microcomputers are the most widely utilized type of computer for both personal and business use. They support a broad range of use cases, from document processing and online browsing to multimedia playing and gaming, and are designed for personal use. Because they may be used with a variety of devices, such as desktops, laptops, tablets, and smartphones, microcomputers are flexible and can be tailored to meet the needs and preferences of different users. Because of their cheap and ease of use, they are widely used in homes, workplaces, and institutions. They usually have easy-to-use operating systems, robust processors, and effective storage methods for seamless use of casual, advanced computing resources. These devices have evolved over time, with continuous improvements in the underlying hardware and software leading to the addition of various capabilities - from high-speed connectivity and cloud computing to applications powered by artificial intelligence. Microcomputers have become an integral PART OF all the segments of modern life such as work, communication, entertainment, education. As a result, organizations and individuals are increasingly investing in these powerful devices and even customizing them for specific applications, making microcomputers a key component of modern digital experiences.

UNIT 2 COMPUTER ORGANIZATION AND MEMORY

A computer system is made up of numerous fundamental parts that cooperate to process data and carry out numerous functions quickly. I have previously discussed these components, which are all necessary for the system's general operation and include the input unit, memory unit, output unit, and central processing unit (CPU). For example: webcams, scanners, keyboards, and mice



Hardware that records user data and converts it into a format the system can comprehend. The central processing unit (CPU), sometimes referred to as the computer's "brain," receives the data after it has been received. The CPU is made up of two primary parts that work together to successfully execute instructions: the Arithmetic and Logic Unit (ALU), which handles all arithmetic calculations and logical operations for any task, and the Control Unit (CU), which regulates the system's data flow and arranges for several safety precautions to guarantee inter-unit communication. The memory unit, which both temporarily and permanently stores data and instructions, is crucial to the CPU's overall efficiency. It is separated into primary memory (RAM) and secondary memory (storage devices), such as solid-state drives and hard drives. The former allows for long-term storage, while the latter facilitates rapid access to data that is currently in use and essential to system performance. The user guides the processed input results through the output unit, which produces the digital data in convenient formats and includes devices like speakers, printers, and displays. Through these components, data moves in a predetermined way: input devices receive the data, the CPU processes it with memory's help, and output devices display the results to the user. In this sense, computers can carry out a wide range of tasks, from basic computations to intricate data processing, which makes them indispensable in both daily life and several professional domains.

a) Input, Processing, Storage, and Output Units

Input Unit: One important component of a computer system that gets information and commands from outside sources is the input unit. serve as a go-between for the user and the computer, converting human input into commands that the computer can understand and execute. Input devices such as keyboards, mice, scanners, and microphones are used to record user inputs, which are subsequently sent to the computer for processing. For example, a keyboard allows users to enter commands and text by pressing keys, each of which stands for a different action or letter. Every time a key is pressed, an electronic signal is received by the central processing unit (CPU), which decodes and processes it. Because a mouse records the user's clicks and movements and converts them into digital signals that move the on-screen



s of data Computer such as Computer Basics and Classification

cursor, it also enables users to navigate the visual interface. The kinds of data that a computer can receive are expanded by additional input devices, such as microphones and scanners. Using a scanner, hard copy papers and photos are transformed into digital formats that are simple to keep and work with. At the same time, a microphone listens to audio waves, converts them into digital signals that can be understood by the machine when you give commands or talk to it. The input unit is an integral part of a functioning computing system, which is crucial to maintaining seamless interactions with the human operator. It helps users interact with the computer efficiently by translating physical movements into electronic signals, which is why it is a vital part of any computing hardware.

Processing Unit: The processor (CPU), or the "brain" of the computer, executes computer programs and manage data flow between other devices connected in computer. If someone asks you about your activities so far in this world, you will be able to answer: "IT gives power to computers performs arithmetic calculations, logical operations, and data processing." Hardware interaction comes from devices outside of the CPU, while software interaction is from programs run directly on the computers, like applications and the operating system, to return meaningful output from the execution of an instruction. Most of the modern CPUs are multicore thus having the ability for executing multiple tasks in parallel, thus they work with parallelism. This improves performance for demanding applications like gaming, data analysis, and artificial intelligence, and makes power consumption more efficient for multitasking. Each core acts as its own processing unit, carrying out commands either alone or in tandem with other cores in applications that use multiple threads. The Arithmetic Logic Unit (ALU), which carries out logical and mathematical calculations, and the Control Unit (CU), which controls data flow and instruction processes, are the two most important components of the CPU, according to a popular description. However, they also provide access to the cache via a memory interface, which is much quicker. This is because current CPUs have Cache Memory, which lowers latency because a lot of data and instructions are stored in the CPU's direction. The clock speed, which is measured in



gigahertz (GHz), indicates the number of instructions that a central processing unit (CPU) can handle in a second. A higher Ghz indicates a faster speed. Additionally, technologies like integrated graphics and hyper-threading enhance performance by making better use of core capabilities and reducing the need for external hardware. CPU performance has increased while power consumption has decreased as a result of ongoing developments in semiconductor technology. This is primarily due to new techniques using fewer transistors and more efficient structures.

Storage Unit: Apart from that, computing storage offers a variety of tools for keeping the information and processing instructions needed when needed. Primary storage and secondary storage are its divisions.

Primary Storage: When the CPU is working on data and instructions, primary storage—also referred to as main memory or RAM (Random Access Memory)—is in charge of temporarily storing them. Whereas the CPU retrieves data for processing, RAM provides quick access to your data. RAM loses its contents when the power is switched off because it is volatile. Modern computers employ both static random-access memory (SRAM) and dynamic random-access memory (DRAM) to speed up processing. Currently, the only components of primary storage that significantly contribute to its speed are Vara cache memory and registers.

Secondary Storage: Secondary storage Secondary storage, in contrast to RAM, is non-volatile, meaning that data is stored there even after the computer is shut down. consists of optical media (CD, DVD, Blu-ray discs), flash drives, solid-state drives (SSDs), and hard disk drives (HDDs). Solid-state drives use flash memory to provide quicker read/write speeds than hard drives, which store data on revolving magnetic disks. Due to their increased durability and efficiency, SSDs are slowly replacing HDDs in the computing industry. Additionally, the category covers external storage devices that give users different ways to store and retrieve data, such as cloud storage and USB drives.

Output Unit: Following data processing, a computer must be able to use output devices—which convert digital data into a



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format that can be recognized or perceived-to convey the results to the user or to another system. Typical output devices that provide output through several modalities include speakers, printers, and monitors. For instance, a monitor presents visual information in the form of pixels, allowing users to interact with graphical user interfaces, view documents, or watch videos. You are also up to date on the latest technology releases, including LED and OLED monitors, which offer high-resolution views with bright colors and crisp details. In contrast, printers offer tangible output by creating hard copies of digital documents, images, or reports. There are different categories of printers such as inkjet, laser printers, and 3D printers - each designed for certain fields from office jobs to industrial prototyping. Speakers Output Audio: Speakers and headphones produce audio output, converting digital signals into sound waves, enabling users to listen to music, participate in virtual meetings, or receive auditory feedback from software applications. Surround sound, the art of giving an immersive and realistic audio output, and noise cancellation, the process of reducing the sound pollution are advancements compared to their predecessors. In practical terms, other types of output devices like these special output units, projectors, braille displays for blind users, haptic feedback apparatuses, among others. By providing access to processed data in a human-readable form, output devices allow users to interact with computers in a meaningful way, enabling communication, decision-making, and engagement with the technology. These devices transduce digital processing into human perception: whether through visual display, print output, or sound generation, computation becomes useful across a wide range of domains-to say nothing of business, education, entertainment, and accessibility solutions in its broadest sense. Further, you can also modify your textual output device based on the technology development level if you are scientifically literate.

b) Working of CPU and Communication Paths

The physical part of a computer that handles data processing and instruction execution is called the CPU (Central Processing Unit). It consists of a few key components that cooperate to effectively carry out these tasks. Additionally, it controls how the CPU communicates with memory and input/output through input/output devices. Registers are tiny storage spaces that can hold data and



instructions as they go through the CPU, while the Arithmetic Logic Unit (ALU) is specialized hardware inside the CPU that does arithmetic computations and logical operations. Additionally, cache memory, a tiny, fast memory integrated into the CPU to hold the most frequently used data and instructions, is crucial to lowering the time it takes to retrieve data from main memory to the CPU. cycle of fetch, decode, and execute The fetch-decode-execute cycle, which consists of three commands, is how the CPU operates. The Control Unit retrieves an instruction from the main memory during the fetch step. Step 2: Decode At this point, the instruction is decoded to determine the necessary action. In the execute step, the ALU performs the calculation or data manipulation, and in the store stage, the outcome is written back to a register or memory address. Indefinite repetition of the cycle enables the CPU to complete tasks.

Communication Paths: One important aspect of computing architecture is the communication that takes place both within and between a Central Processing Unit (CPU) and other parts of the computer system, which is made possible by a pest control system. These crucial pathways enable the entire system to make use of the data, addresses, and control signals that are exchanged between the different parts. When combined, the three bus types effectively format and transfer data between the CPU, memory, and I/O devices. One of the most crucial components of this communication system is the data bus, which is in charge of moving actual data from the CPU to the other components of the system. The quantity of data that may be conveyed in a single operation is influenced by the data bus width, which is expressed in bits. For example, a 64bit data bus performs faster because it can carry twice as much input in a single cycle as a 32-bit data bus. Because it enables the CPU to read and write data to and from peripherals, storage devices, and memory via a data bus, memory is an essential component of all CPU architectures. The speed and bandwidth provided by the terrestrial data bus determine a system's overall processing capacity; hence, the faster the data transfer, the more efficient the computing. On the other hand, in response to a request from the CPU, the address bus is in charge of transferring memory addresses that point to certain data or instructions that are kept in memory.



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Address buses merely carry location-related data, whereas data buses are in charge of actually transmitting data. The width of the address bus dictates the size of a system's address space. Because the address bus is unidirectional, addresses are sent from the CPU to memory or I/O devices but not the other way around. For example, a 32-bit address bus could handle 4GB of memory, whereas a 64-bit address bus might handle less than that until the computer's memory is limitless. A system's overall performance can be accelerated and made more responsive by improving how it accesses memory. As the command and coordination hub, the control bus receives return status signals from the CPU and transmits control signals to other parts. They dictate the manner in which various hardware components read, write, or process data. Clock signals, interrupt messages, reading and writing commands, etc. are examples of common control signals. To read data from memory, for example, the CPU uses the control bus to send a read signal to memory, which places the needed data on the data bus. Similarly, a write command instructs memory or an I/O device to save information that the CPU has supplied. The control bus is also crucial for handling system interruptions, which allows external devices to alert the CPU when an urgent action is required. High-priority operations, such as network requests or keyboard inputs, are handled considerably faster and without needless waiting thanks to this procedure. All three of these buses—the data bus, address bus, and control bus-combine to provide an integrated communication system that enables data transfer between computer instances. The CPU wouldn't be able to access memory, connect to peripherals, or carry out commands without these buses. The speed, width, and synchronization of these buses determine other aspects of the system. These may include high-speed bus technologies, like PCIe (Peripheral Component Interconnect Express) and Hyper Transport, for improved data transfer rates and reduced latency. With advancements in technology, bus architectures evolve, allowing for higher bandwidths while minimizing communication bottlenecks. Simply put, these buses are to computing systems what the spinal cord is to human beings, providing communication between the components of the system and ensuring that programs and processes are functioning properly.



• MEMORY TYPES

a) Primary Memory (RAM, ROM)

Primary memory, often known as main memory, is a part of a computer system that houses information and commands that the processor must instantly access. This comprises Read-Only Memory (ROM) and Random Access Memory (RAM). They all have different functions that contribute to the computer's seamless operation.

Random Access Memory (RAM)

A form of volatile memory called RAM (storage random-access memory) is used to temporarily store running applications and data. Because the information stored in RAM is volatile, it is deleted when the machine is turned off. Discrete RAM is significantly slower than registers, but it is extremely fast when compared to secondary storage devices (hard drives, solid-state drives). This allows the CPU to retrieve and manipulate data more quickly, which enhances performance and facilitates multitasking. Static RAM and dynamic RAM are two types of RAM.

1. Static RAM (SRAM): Static Random Access Memory, or SRAM for short, is faster and more dependable than DRAM because it stores every bit of data in a flip-flop circuit. Due to its high cost and power consumption, it is only utilized in the processor's cache memory rather than the system's main memory.

2. Dynamic RAM (DRAM): DRAM stores data in capacitor and need to refresh repeatedly to keep the information. While it is slower than SRAM, it is more cost-effective to produce, making it the most commonly used type of RAM found in personal computers, laptops, and mobile devices. By keeping frequently used data and instructions in RAM, a system speeds up operations compared to accessing the information from slower, secondary storage options. It defines the present time, how well a processor performs while running more than one program at a time. Having more RAM means users can run memory-hungry applications like video editing software, gaming programs, and virtual machines without having to wait for the applications to respond.



Since RAM is volatile, this means that any unsaved work would be lost during a sudden power failure or shutdown of the system.

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Read-Only Memory (ROM)

Regardless of whether the computer is turned on or off, ROM is a sort of memory that permanently stores vital data. Since data in ROM cannot be easily removed or overwritten, unlike RAM, it is a great choice for storing firmware, which includes embedded software, BIOS (the system's power-up instructions), and other crucial data the system needs to operate. ROM can be divided into several categories, including PROM, EPROM, and EEPROM.

1. Programmable Read-Only Memory (PROM): With specific tools, PROM, a form of ROM, can be programmed once it has been manufactured. It is used in situations where once data is coded, it doesn't need to be altered.

2. Erasable Programmable Read-Only Memory (EPROM): Ultraviolet (UV) radiation can be used to erase and reprograms EPROMS. Additionally, it enables you to reprogram the erasing circuit; however, this requires specific UV exposure.

3. Electrically Erasable Programmable Read-Only Memory (EEPROM):

For firmware updates, EEPROM is more convenient because it can be electrically erased and rewritten. It is most frequently seen in embedded systems and BIOS chips, among other contemporary gadgets. When a computer boots up, ROM is crucial. The operating system (OS) is moved from secondary storage into random-access memory (RAM) and the hardware components are initialized by the Basic Input/Output System (BIOS) in read-only memory (ROM) when the machine is powered on. Because ROM is non-volatile memory, it permanently saves boot instructions, giving the system stability and security.

Comparison Between RAM and ROM

Both RAM and ROM are types of primary memory but have different functions. RAM is a fast, temporary memory that holds data needed for real-time processing, while ROM is slow, permanent, and stores essential system data. While RAM dictates the speed and performance of a device, it is really



ROM that guarantees the core functions are not interrupted with each system restart. As the era advanced, the invention of NVRAM (Non-Volatile RAM) and Flash Memory blurred the distinction between RAM and ROM. For instance, Solid-State Drives are an example for flash memory to provide non-volatile storage with improved access times. Firmware update tools or specialized kits are available to burn information, especially in the form of EEPROMs, but newer BIOS implementations such as UEFI (Unified Extensible Firmware Interface) use EEPROM or flash memory, enabling firmware updates without special equipment. Primary memory also plays an essential role in computing systems. DUAL: Knowing what RAM and ROM mean allows users to choose wisely between hardware upgrade options, and helps them optimize their computer's speed and performance efficiently.

b) Secondary Memory (HDD, SSD, Optical Discs, USBs)

A non-volatile storage medium, secondary memory—also known as external or auxiliary devices—stores data indefinitely, even when the computer is not in use. Since the CPU does not have access to secondary memory like primary memory (RAM), data from secondary memory is moved to primary memory when necessary. This type of memory is used for non-volatile long-term data storage, providing larger capacity at lower perbit cost than primary memory, but with slower access.

Key types of secondary memory include:

- 1. **Hard Disk Drives (HDDs):** These are actually sense on spinning magnetic disks, where read write heads read the data. HDDs come with massive storage sizes for a low price but also come with mechanical parts, making them prone to wear and have slower reading and writing times than solid state drives.
- 2. Solid-State Drives (SSDs): Use flash memory; SSDs have no moving parts, so they have faster data access speeds, higher durability, and lower power consumption. However, they often have a higher cost per gigabyte than HDDs.



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- 3. **Optical Discs:** Examples of this type of storage device are Compact Discs, Digital Versatile Discs, and Blu-ray discs and that use lasers to read and write data. HDDs and SSDs are best for storing information for regular access. Internet is basically a collection of data that is backed up on Optical discs Data can be accessed easily from HDD, the role of Optical discs consists mainly in media distribution and data backup.
- 4. **USB Flash Drives:** are portable storage media using flash technology and using parallel or serial ports. They make data transfer between systems easy and are useful for temporary stores.

c) Cache Memory and Its Importance

Access takes place in processor cache memory, which is a high-performant storage that is only a few millisecond away from CPU and stores frequently accessed data and instructions. Its main function is to minimize the time the CPU needs to access this information, improving overall system performance.

Importance of Cache Memory:

- 1. **Speed Enhancement:** Cache Memory reduces the time it takes for the CPU to reach frequently needed information, with stored data and instructions being transferred to CPU past the main memory.
- Reduced Latency: Cache memory significantly reduces latency by providing frequently used data directly to the CPU without the timeconsuming process of retrieving it from main memory. Lowering latency is critical to performance of computational processes as they operate on the data.
- 3. Efficient Memory Hierarchy: Cache memory is the nearest memory level between the CPU and the main memory and is used as an intelligence to help the CPU to work efficiently.
- 4. **Cost-Effective Performance:** Cache memory is costlier than main memory due to the fact that it is faster, but when used accordingly, it is one of the most effective hardware in computing architectures.



• SOFTWARE OVERVIEW

System Software (Operating Systems, Utilities)

One kind of computer software called system software is made to run hardware and offer a platform on which application software can run. It serves as a conduit between user apps and hardware, facilitating resource management and operation. System Software Operating systems and utility programs are the two primary categories of system software.

Operating Systems (OS): An operating system is a type of system software that controls the resources of a computer, both software and hardware, and offers standard services to applications. Applications can operate effectively and safely thanks to the layer of abstraction it creates between the user and the underlying hardware. When scheduling, we prioritize the activities to run based on FCFS, SJN, and Round Robin. Most operating systems manage process management, which schedules all processes to run while handling multitasking and effectively managing the CPU. Additionally, it manages inter-process communication and process synchronization to provide conflict-free execution. One of an operating system's primary functions is memory management, which involves dynamically allocating RAM (Random Access Memory) while a process is operating. In order to prevent memory fragmentation and enhance performance, it employs strategies like paging and segmentation. Applications that require more memory than the system's installed physical memory can operate thanks to the OS's virtual memory, which adds disk storage to RAM. The operating system also controls the file systems that let you store and access data on your storage devices in a structured way. It uses encryption and permissions to control access and organizes files inside directories. The storage architectures include HFS+, NTFS, FAT32, and ext4. Device management is another crucial function of the operating system; it verifies the interface of peripheral devices like as printers, keyboards, storage drives, etc. using drivers and system functions. The OS makes it easier for the software and hardware to work together, which promotes effective resource allocation and device performance. Users interact with an operating system (OS) through the user interface (UI). A front-end



such windows, menus, and icons for easier interaction, or a command-line interface (CLI), which requires text-based commands. Both interface types are supported by the majority of contemporary operating systems in order to accommodate various user needs and technical specifications. Security and access control, which guarantee system integrity through user authentication, encryption, and firewall configurations, are another crucial function of an operating system. Operating systems manage the application of security policies by restricting unauthorized access to sensitive data and managing user privileges. Examples of operating systems include Linux distributions like Fedora and Ubuntu, which are well-known for being open-source and versatile; mac OS, which is tailored for Apple hardware and is distinguished by high security and seamless performance; and Microsoft Windows, which provides a user-friendly graphical user interface and broad software compatibility. On the other hand, mobile operating systems like iOS and Android, which are made to function in touch-based environments with app stores, are used by smartphones and tablets. The basics haven't changed, even though you can connect the newest OS versions to logic gates. These days, operating systems integrate realtime processing for applications like gaming and industrial automation, virtualization for optimal resource management, and artificial intelligence for automation. Cloud-based operating systems, such as Chrome OS, are more concerned with being online and saved in the cloud, and they affect users' interactions with their computing environment differently. With the development of artificial intelligence, quantum computing, and edge computing, operating systems will continue to change in the future, redefining features to improve efficiency, security, and adaptability. Last but not least, the operating system, which forms the foundation of contemporary computing, is essential to establishing structured communication between the many components of the software and hardware fabric. New computer technologies are brought about by this progress, which enhances system security, user experience, and application performance on these platforms.

can include a graphical user interface (GUI), which displays visual components

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Utility: Utilities are system software that is specialized to analyze, configure, optimize, and maintain the computer, e.g. antivirus software, backup software, etc. They play a critical role in maintaining the overall functioning of users' computer system, optimizing performance, and ensuring stability and security. The utility programs are an essential part of the computer that maintain its health by managing disk space, monitoring the system, enforcing security, and improving performances. Heavily used by companies, they are sometimes integrated with the OS itself but can be downloaded separately depending on requirements. Utility programs include disk management utilities, which are among the lines of these types of programs. Such software includes disk defragmenters that reorganize scattered data to accelerate access and disk cleanup tools that eliminate unnecessary files to recover space and improve performance. File management utilities, which help manage files and directories, are another necessary class of applications. Such shiny new tools include file compression tools (e.g., WinRAR and 7-Zip) to reduce file sizes for storage efficiency, and file recovery programs for restoring lost or deleted data. Just like the road, security utilities also play a role in keeping the computer from hackers, viruses and other risks. Antivirus applications like Windows Defender, Norton, and McAfee detect and remove harmful software, and firewall utilities issue alerts from network traffic to prevent unauthorized data leaking to the outside world. Moreover, sensitive data are protected against copy in the form of encryption software (eg. BitLocker), which transforms sensitive data into unreadable templet to avoid from third-party access. Because system performance utilities concern themselves most with smooth operation and efficiency, These are task manager and system optimization tools such as CCleaner that can be used to remove temporary files, fix registry errors, and optimize startup processes (to speed booting). Another much-used software category includes backup and recovery utilities that assist users in making copies of the most important data, thus eliminating the risk of loss in case of hardware failures or accidental deletions. Some good examples of this would be Windows Backup and Acronis True Image, both of which allow their users to create full system backups and restore them



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at their convenience. Network utilities are also helpful for system management, diagnosing and troubleshooting network-related issues. Connectivity tools like ping and traceroute can help solve network connectivity issues, while bandwidth monitoring utilities simply track internet usage to identify bandwidth slowdowns or unauthorized access. Software update utilities help to keep apps and system components updated with the latest patches and security fixes, which helps decrease vulnerabilities, as well as improves functionality. Virtualization utilities facilitate the creating and managing of a virtual machine enabling users to run multiple operating systems from one hardware platform which is also widely used in testing and development toward different operating systems. Power management utilities are another key component that help optimize energy consumption by adjusting power settings and monitoring battery consumption in laptops and mobile devices as part of system maintenance. These utilities additionally prolonged the lifetime of batteries and improved their energy efficiencies. These accessibility tools adapt the presentation of computer interfaces into forms that are more accessible and usable by users with disabilities, like screen readers and magnifiers. Utility programs are essential for managing and maintaining the computer system and ensuring its efficiency, security, and performance. They are the fundamental tools that equip users to handle and troubleshoot different facets of their computing environment, thereby ensuring an unhindered and optimized user experience.

• APPLICATION SOFTWARE (BUSINESS, SCIENTIFIC, MULTIMEDIA)

Application Software: Refers to application programs for users to conduct (specific) operations. Classifying Applications Based on Their Functions Applications can be generally classified into business, scientific and multimedia software.

Business Application Software: This is a type of software that includes programs designed to help run an organization. These applications are designed for different functions in businesses to make sure that enterprises run smoothly and make data-driven decisions. One of the most important automation in



business applications involves Enterprise Resource Planning (ERP), which brings together all internal core business processes (finance,



human resources, supply chain management, procurement, and production) into a singular system. ERP systems centralize data, automate workflows, and improve operational efficiency while reducing errors and enhancing decisionmaking. An important category of business software is Customer Relationship Management (CRM) software, which helps manage interactions with customers and prospective clients. It helps businesses in monitoring customer interactions, analyzing purchase behavior, and finetuning sales and marketing strategies that enhance customer satisfaction and retention. Also, project management tools are vital to the operative of the company as they help teams in planning, executing, and monitoring projects effectively. With task assignment, progress tracking, collaboration, resource allocation, and deadline management, these solutions keep projects on track and resources in check. Another example of a crucial business application is accounting software, which automates financial transactions, budgeting, payroll management, and tax calculations, ensuring compliance with financial regulations while improving accuracy in financial reporting. Business Intelligence (BI) software allows organizations to process large amounts of data and create reports of market trends, customer behavior, and business performance to make datadriven decisions. SCM software is a very comprehensive approach designed to help people more effectively manage the logistics and distribution of inventory and accelerate the acquisition and movement of materials, which results in reductions in costs and supply chain optimization. Human Resource Management Systems (HRMS) assist businesses with employee records, payroll processing, recruitment, performance evaluation, and benefits administration, streamlining the management of a workforce. Collaboration tools-communication platforms, document-sharing applications, and virtual workspaces that enhance teamwork and boost productivity-are especially valuable in remote and hybrid work environments. Market automation software allows businesses to create, execute and evaluate marketing campaigns, as well as manage leads and measure promotional success. If you perform online selling, then likely eCommerce platforms is used to manage the maximum of transactions in your shop. Customer service tools, such as helpdesk and ticketing systems, enable organizations to manage customer questions and complaints efficiently,



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providing better quality service. Cybersecurity applications are made to protect enterprise information from cyber threats, preserving the krypton of sensitive information. Another widely practised CMS is content type which helps businesses manage the presentation of content in various forms of digital media and online marketing efforts. Business applications powered by artificial intelligence (AI) and machine learning to enable automation, predictive analytics, decision-making, etc. Cloud-based business applications enable companies to scale up and down easily, providing flexibility, accessibility, and allowing employees to access information from anywhere, improving operational efficiency and collaboration. The benefits of business application software give you a leg up on competitors through process optimization, cost burden reduction, enriched customer experience and regulatory compliance. With technology constantly developing, organisations are progressively embedding artificial intelligence, blockchain and the Internet of Things (IoT) into their application software to facilitate greater functionality and innovation. Organizations need to assess their individual needs and choose the right mix of business applications that motives to their strategic objectives and industry demands. Investing in the right business software not only enables businesses to streamline day-to-day operations but also positions them to overcome future challenges and embrace opportunities in an increasingly digital and competitive business landscape.

Scientific Application Software: These are applications tailored to assist researchers, engineers, and scientists with data analysis, complex systems simulations, and real-world phenomenon modeling. So computational efficiency, accuracy and automation are key drivers of most scientific research and these tools provide those. Statistical analysis software is among the most popular categories, allowing researchers to perform complex data analysis, effectively test hypotheses, and develop predictive models. SPSS, SAS, R or Python's NumPy and SciPy libraries allow a scientist to process massive datasets, run regression analyses, apply machine-learning algorithms, and visualize statistical results to transform what appears to be raw data into valuable information. A third one is computer-aided design (CAD), which is commonly used in engineering, architecture, and manufacturing. Examples of



CAD tools are AutoCAD, SolidWorks, and CATIA, which enable users to create accurate technical drawings, three-dimensional models, and structural designs. These applications also provide productivity enhancement through simulations, stress analysis, and finite element modeling to verify that the design is perfect before it is physically implemented. Another critical category of software is simulation software, used extensively in physics, chemistry, meteorology, environmental science, and more. Such programs aid in simulating real-world systems under different conditions, allowing scientists to forecast outcomes and enhance designs. For example, MATLAB and Simulink for engineering simulations, ANSYS for computational fluid dynamics and Gaussian for quantum chemistry simulations. These are the tools that scientists can use for testing theories, for validating experimental results, for optimizing processes in a virtual environment rather than spending money on expensive physical experiments. Also, Geographic Information System (GIS) software like ArcGIS and QGIS is used for spatial analysis, environmental modeling, and mapping. As such, it plays a major role in the visualization and analysis of data related to geography, making it an essential component in everything from the planning of cities to the management of natural disasters to resource allocation more generally. In biology, bioinformatics programs such as BLAST and Bioconductor facilitate the analysis of genetic sequences, the prediction of protein structures, and the simulation of molecular dynamics, expediting breakthroughs in genomics and pharmaceutical development. Open-Source Tools for HPC Simulation: HPC packages such as Open FOAM and LAMMPS that specialize in advanced computational simulations, particularly for fluid dynamics, materials, and astrophysics. In addition, laboratory management software such as LIMS (Laboratory Information Management Systems) assists researchers effectively manage and process experimental data. Parallel to these developments, the evolution of artificial intelligence and machine learning have applied automation and predictive analytics across scientific use cases, delivering realtime data processing and intelligent decision support. Collaborative research with Google Colab, AWS: Google Colab and AWS: Aula traction accelerate big data analysis, deep learning applications In general, scientific application software is a very important area of computing,


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that has changed the way world works by providing useful and reliable tools for data processing, modeling and simulation, enabling scientists to address complex issues, gain better efficiency, and promote efforts in various disciplines.

Multimedia Application Software: provides the tools required in creating, editing, and handling different media types text, graphics, audio, and video for a range of professional and personal applications. Graphic design applications enable users to develop and edit visual content such as digital art, logos, and marketing materials with specialized tools for layering, color correction, and vector-based illustrations. Text editing is also an indispensable function offered by these applications, especially crucial for artists, designers, and marketers who thrive on accuracy and freedom in their creativity. Your time is held such, and you will hold those overlines of both your story points to share content creation-level, and modifying video content uses video editing software. Adobes Premiere Pro, Final Cut Pro, etc. offer timeline editing, special effects, transitions and audio synchronization for pol ye sharing stories. Used heavily in video content production for film, television and the digital marketing space, high-quality video content is vital for user engagement. Just like video editing software like Final Cut Pro and Adobe Premiere, audio editors such as Audacity and Adobe Audition help in recording, editing, and mixing of sound, supporting noise reduction, equalization, multi-track editing, and audio restoration tools. These applications are very important for podcasters, musicians, and audio engineers who want to edit and improve audio recordings. Multimedia software also includes animation and 3D modeling software such as Blender and Autodesk Maya used in game development, animated feature films, and architectural visualization that enables users to produce lifelike models and animations with complex textures and lighting effects. Multimedia applications also encompass presentation software like Microsoft PowerPoint and Prezi, allowing users to generate visually compelling slideshows that incorporate images, videos, and animations to communicate ideas effectively in both business and educational settings. Adobe Dreamweaver and WordPress are examples of web design and development tools that allow users to create websites, enhance them with multimedia



content, and work with written content to create interactive online experiences. Another category of data is digital publishing software, such as Adobe InDesign which allows the creation of professional-quality eBooks, magazines, and brochures, combining text and multimedia elements for both print and digital distribution. Data processing in real world due to its growing trend in multimedia applications is arising up (viz., entertainment, education, marketing, social media, etc.). These applications have made extensive use of AI and machine learning to enhance automation, using functions such as background removal, speech-to-text transcription, or recommendations for intelligent editing to make the creation of multimedia content easier for consumers with varying levels of expertise. Due their versatility and impact, multimedia application software is a valuable asset in several industries and their continued development will ensure this will be the case as digital media consumption is set to remain a major force in the years to come, shaping the future of communication and content.



MODULE 2 OPERATING SYSTEMS AND DATABASE BASICS

Structure

- Unit 3 Operating System (OS) Concepts
- Unit 4 Database and Management Information Systems (MIS)

UNIT 3 OPERATING SYSTEM (OS) CONCEPTS

An Operating System (OS) is a software that creates an interface between the user and computer hardware. This ensures software can communicate with hardware quickly to execute programs in an efficient manner. Without an OS, users would have to interact directly with the hardware components, which would be immensely complex and inefficient. The OS makes this interaction easy by providing an interface through which users can interact with the system in a structured and efficient way. The most part of an operating system is to make things easier, however. It abstracts hardware complexities and retains a simple interface for executing applications. The second important goal is efficiency, which refers to the ability of the system to use its resources for CPU time, memory, storage, and input and output (I/O) devices effectively. It also supports the addition of new functionalities that can be integrated seamlessly without interrupting existing operations, a corner stone in business and adding up to the ability of the OS to evolve over time. The OS has a lot of functions which signals the smooth running of a computer. They include things such as process management, which is where the OS manages the execution of programs, scheduling tasks and managing process creation and termination. It provides a context in which multiple processes can exist without interfering with each other, effectively handling both multitasking and resource management. Another essential role of the OS is memory management, which involves allocating and deallocating memory space to various programs to ensure efficient use of RAM, as well as preventing memory leaks or conflicts. So, file system management is all about how we organize, store, retrieve and



secure data. It is the OS that determines how files are created, accessed, modified and deleted, allowing for proper data management. They can be printers, keyboards, storage devices and are all managed by the OS, written in the lower level programming language, allow the OS to control and manage the communication between hardware devices and the software applications. Moreover, the OS handles security and access management, which includes user authentication and the management of permissions, as well as safeguarding against malware and unauthorized access. An interaction can be enabled naturally by an operating system through various types of user interfaces. The Command-Line Interface (CLI) allows users to enter commands in text format to perform actions, providing fine-grained control. The Graphical User Interface (GUI) offers a graphical-based program for accessing and manipulating data using icons, windows, and menus, which is more intuitive for general users.



Figure 2.1: Operating System (OS) Concepts

a) Definition and Functions of an OS

Definition of an Operating System (OS): An Operating System (OS) is a critical system software that, after being developed, uses as system software that manages all computer hardware and software resources while providing a user interface for the user to interact with the system. It acts as a bridge between users and hardware, managing resource allocation, process execution, and overall system stability. Besides, it manages essential tasks



like memory allocation, file system hierarchies, task scheduling, and hardware control. This facility, which is offered by the OS, allows for multitasking, where several processes can run in parallel without interfering with each other. Besides, it allows securing mechanisms like user authentication, access control, and data protection. There are different types of operating systems like: single user, multi-user, real time, embedded, etc. Common OS are Windows, macOS, Linux and Android. An OS improves system performance and user experience by providing an environment that allows software applications to run efficiently. It is continuously evolving, making it compatible with new technologies, which is the reason it has become a part of modern computing systems.



Figure 2.2: Operating System

Functions of an Operating System: An operating system works in the following ways to ensure smooth functioning of a computer system. Process Management involves the creation, execution, and termination of processes, multitasking, and the CPU border scheduler. Memory Management is responsible for memory space allocation/deallocation, virtual memory management, or efficient use of RAM. File System Management organizes and arranges the files in a systematic manner, controls access to the file system, and helps with operations like reading, writing, and deleting the files. I/O Device Management Controls I/O devices, Data is read from I/O devices and written to I/O devices using drivers, such as buffering and spooling.



Security and Access Control are about preventing illegal access to the protected information with authentication measures, encryption, and firewall mechanisms. User Interface methods of engagement (CLI, GUI) Networking Management Classes allows the computer to communicate with another computer over a network protocol delivering high file transfer efficiency over networks for remote access. Error Detection and Handling: which recognizes and records system errors in order to avoid crashes and implement remedies. Finally, Resource allocation and scheduling aims to optimize the system performance in terms of distributing the CPU, memory, and then storage resources effectively, and then using the scheduling algorithms to enhance the process speed.



Figure 2.3: Function Of Operating System

b) Features and Objectives of an OS

The Operating System (OS) is system software that controls computer hardware and provides various services for computer programs. It serves as a middle layer between the user and the computer hardware.

Features of an Operating System

An OS has many features that help the system work more effectively and we can use it better. The key features include:



1. **Process Management**: Deals with the creation, execution, and termination of processes. Deals with the process scheduling and synchronization.

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- 2. **Memory Management**: Allocates and releases memory space as needed by programs. Utilizes as benefit of virtual memory.
- 3. File System Management: Manages file creation, deletion, reading and writing. Depending on the role you choose, you can manage folders and access rights.
- 4. **Device Management**: It enables Homer communicates with hardware devices (printer, keyboard, storage). Uses drivers and buffers to smooth operations.
- 5. Security and Access Control: permission control is an essential feature of data management system, as it must protect the system resources with authentication and authorization mechanisms. Provides encryption and firewalls to protect against access.
- 6. **Multitasking and Multiprogramming**: It provides multiple applications to run at the same time, utilizing the system efficiently.
- 7. User Interface (UI): A CLI or GUI that allows user interaction.
- 8. Networking Capability: Allows communication between systems and provides networking capabilities: Oversees internet connectivity and remote access.
- 9. Error Handling: Effectively detects and handles system errors to avoid failure.

Objectives of an Operating System

The operating system (OS) refers to the OS that helps a computer to effectively work through management of hardware and provides interface for the user and the applications. Resource management is one of the main goals of the OS; it ensures that crucial resources such as CPU, memory, storage, and I/O devices are assigned and consumed appropriately. This control ensures that they can coexist without stepping on each other's toes and offers a performance boost since the OS can simply avoid handing a process a resource that isn't available



rather than getting them tangled up trying to access something they don't have permission for. This is achieved through scheduling algorithms, memory management techniques, and device management, allowing many processes to run efficiently, minimizing idle time, and avoiding bottlenecks. The other important goal of an OS is user convenience and allows users to operate the system in a simple and easy way. By means of GUIs or CLIs, the OS enables users to perform intricate operations without technical know-how, letting them run commands, start software applications, and organize files with ease. With this user-friendly phenomenon, productivity is also increased, and even nontechnical users can access computing. The OS executes programs; it loads them into memory and executes them.

It controls the scheduling of processes, resolves dependencies between programs, and allocates resources such as memory and CPU time as required, enabling the user to run several applications concurrently and without program conflicts. Another goal of OS is performance but it's efficiency for maximum execution speed with minimum resource usage. OS introduces various techniques like caching, prioritization of processes and improved disk scheduling to aid in improving system responsiveness and reducing processing delays. One of the major functions of an OS is to provide security and protection of data and prevent it from intruders. The OS ensures privacy and system security by employing authentication systems, access control policies, and encryption methods. The OS implements error detection and handling mechanisms, enabling the OS to monitor system activities, identify potential failures, and take corrective actions to prevent data loss or system crashes. Stability and reliability: A cleverly designed OS minimizes crashes and system failures, so users can work without disruption. Fault tolerance methods, system updates, and error recovery techniques contribute in this direction. The OS provides concurrent and parallel processing of tasks and genuine multi-user support, enabling multiple processes and users to run at the same time, thus facilitating modern commutating environments. An operating system is essential to make sure that



the system works smoothly, it increases the efficiency of the resources, security, and user experience. It acts as an intermediary between users and the hardware, helping ensure a stable and secure environment for applications to run and perform operations.

• TYPES OF OPERATING SYSTEMS

a) Batch OS, Multiprogramming OS, Multitasking OS, Real-Time OS, Distributed OS

OS (Operating System) is crucial software that manages a computer's hardware and software resources, as well as providing common services for computer programs. Various types of operating systems have been developed to satisfy the needs of specific computing contexts. Here's a breakdown of a few common varieties:

Batch Operating Systems: These general purpose systems allow similar jobs to be directed together in a very efficient manner without end user involvement while processing. Instead of interacting with the system in real time, users prepare jobs in advance, and they are applied for processing at regular intervals. It works very well for repetitive tasks that need no instant reaction on a signal or need no human to complete. For example, batch processing is commonly used in payroll applications where data regarding logged employee hours, salaries and deductions are accumulated over time and processed all at once at a scheduled time, like the end of the pay cycle. The primary benefit of batch processing is that it automates repetitive tasks, decreasing human involvement and lowering the likelihood of mistakes. Because bulk operations, the system can optimize a lot because to help in bulk, the system can efficiently utilize resources. Additionally, such an approach can be very cost-effective as it allows for the utilization of central resources and reduces the dependence on human effort to be kept in a constant cycle of oversight. Batch processing systems are often employed in environments where workload needs are regular and known, and include examples such as data entry, transaction processing, inventory control, and report generation. The main downside, however, is the absence of immediate results — jobs are processed one after



another as they are submitted, so it takes longer to receive output. Nonetheless, batch processing is still a key approach to process large-scale and repeatable workloads efficiently.

Time-Sharing (Multitasking) Operating Systems: A time-sharing operating system is designed to allow multiple users or tasks to share a computer system simultaneously. These systems give each user or process a fixed time slice, and the computer steps through the tasks at high speed. This gives an impression of concurrent execution while the system actually processes all of it within the issue queue at a time but so quickly that you cannot notice it. Time-sharing is important in situations where multiple applications must be executed at the same time, like in a multi-user operating system or a large server system. Time-sharing is based on the idea that the system gives each task a small, fixed quantum of CPU time in the context of which the system switches context to the next one. The OS manages these switches and allocates system resources fairly to each task. This switching is so rapid that the user perceives the system as if multiple tasks run in parallel. Underneath the surface, the OS itself uses multitasking techniques to juggle all the tasks at once, in a way that the user don't even notice. This approach is highly efficient in cases where few resources (memory, processing power, or storage) are available. The system optimally uses resources without allocating one of them for one dedicated task if there is still utilization of the other hardware by at least another user or task. Alongside increasing productivity, these systems allow users to run several applications concurrently, which is incredibly useful in business, educational, and research environments. Still, effectively managing task switching and resource allocation is crucial to preventing performance degradation and maintaining optimal system functionality.

Distributed Operating Systems: They are OSs that manage a group of independent computers, providing them to the user as one single machine. Internet In systems of this type, a user obtains a unified view of his or her storage system, even though these resources are physically distributed across multiple machines. Distributed OSs can aggregate processing power, memory, and storage through the coordinated operation of multiple



computers, which increases performance and reliability. One of the main benefits of distributed OSs is sharing computational tasks across multiple nodes. This division of workload can be executed at the same time, making it much more effective than mere processing on a single machine. The system can also intelligently distribute the resources according to the workload of each node at present, which can effectively optimize the performance of the whole system. Data structures are explained in distributed osso for fault tolerance to be increased for reliability. Instead, if a machine goes down, the system can remap flows on other machines so that nothing is broken for the user. This distributed structure also gives us redundancy, allowing us to replicate data on additional machines to avoid loss. Also, by employing decentralized management, an OS of this type can manage failures or slowdowns without bringing down the entire system, making them resilient to individual machine failures.

Network Operating Systems: A network operating system (NOS) manages and supports workstations, personal computers, and servers connected to a local area network (LAN) A NOS mainly serves to allow for effective sharing of resources and data over the network. These systems allow for communication and interaction between devices with a common platform for sharing files, printers, and management of other resources. A NOS facilitates access to the distribution of network resources like storage capacity and peripheral devices, making permissions for users connected to the network so they can print documents, access files remotely, or use shared applications. Besides managing physical resources, a NOS also enables network security protocols and user authentication, allowing safeguarding of sensitive data. It protects gateway resources, enforcing access control by administrators and restricting access control to only those people you want. And such security is significant in business and institutional areas, since confidential information needs to be protected. In addition, a NOS usually offers a few utilities for managing a network, such as monitoring network performance, diagnosing problems, and setting up network devices. Network monitoring offers system admins the tools they need to undercut network performance, pinpoint bottlenecks, and solve connectivity issues, contributing to a smooth and



reliable experience for the end-user. In a nutshell, a NOS is all about keeping the LAN(s) up to par with functionality, securo-crud, and performance, all things required & essential in any networked environment.

Real-Time Operating Systems (RTOS): Used in applications requiring precise timing and reliability, such as medical equipment and industrial control systems, RTOS is designed to process data and events within strict time constraints. They can be categorized into

- Hard Real-Time Systems: Timing constraints in these systems are so strict that missing a deadline may result in a system failure.
- **Soft Real-Time Systems**: These are more relaxed in scope; occasional deadline misses are acceptable.

Embedded Operating Systems: The embedded operating system (OSs) is the specialized software that manages hardware resources and provides the ability to execute tasks in embedded systems — computers that live in other devices (PDAs, smartphones, automotive systems, industrial machinery and other specialized hardware) They are different than general-purpose operating systems such as Windows or Linux, as they are designed to run on resourceconstrained environments, providing a high level of efficiency in terms of processing power, memory utilization, and power consumption. These systems have been designed with targeted control functions in mind, which typically emphasize real-time performance, reliability, and minimal resource overhead. Examples include Windows CE and Minix 3. One example is Windows CE which was built by Microsoft to provide a slimline version of Windows suitable for resource constrained devices across a range of hardware platforms and embedded uses. With its powerful API and real-time and flexible options, it can support a variety of embedded devices. In contrast, Minix 3 is a fault tolerant open-source OS. It emphasizes a microkernel architecture which compartments critical functions, enhancing system stability and security. But Minix 3 is perhaps most famous for the fact that it is extremely resource-efficient, all the while remaining a simple, easy-tounderstand code base. These operating systems also exhibit essential characteristics of embedded OSs, including small memory



footprints, real-time capabilities, and ease of integration into hardware. This is why they are perfect for running embedded systems where speed and resource usage is crucial.

Operating Systems and Database Basics

Mobile Operating Systems: Mobile operating systems (OS) are tailored software platforms that are built specifically for mobile devices such as smartphones and tablets. These OSs work to integrate seamlessly to the hardware and the software domain and support for the wireless communication, the mobile applications, and the multimedia formats that are key to the mobile experience. After dealing with Blackberry, Windows, and even Apple, the two most common and used mobile OSs are Android and iOS, tailored to different user needs and requirements. Google created an open-source OS called Android, which offers a high degree of customization options for the user and provides flexibility in device personalization and access to a broad selection of third-party apps. Most of the world uses it because it can connect to numerous devices made by all types of manufacturers. On the contrary, iOS is a proprietary OS made by Apple, which is famous for its shiny finish, seamless user interface, and high-level security features. iOS guarantees a consistent experience across Apple's ecosystem, allowing for seamless integration between devices such as iPhones, iPads, Macs, and beyond. Which operating system is better for your personal needs often depends on the trade-offs users will make in the name of customization and/or consistency, app availability, and interoperability with other devices. Mobile OSs designed to process for Handling the Touch Engine, Support for Mobile Optimized Applications, Resource Management (Efficient processing is done to ensure the Minimal processing power, Memory and battery life is not wasted). Moreover, mobile OSs centrally handles wireless communication like cellular, Wi-Fi, and Bluetooth to allow users to being always online while enhancing the performance of multiple running applications. These unique operating systems increase the functionality of all mobile phones by ensuring smooth, secure and intuitive operations on mobile devices.



a) H

• LAYERS OF A COMPUTER SYSTEM

a) Hardware: The basis of any computing system is hardware which provides the physical framework for the functioning of a computer. These components of hardware serve specific duties which contribute toward any system's capability. At the heart of this arrangement is the central processing unit (CPU) popularly known as the computer's "brain." CPU - Central Processing Unit — The part of a computer that executes instructions and processes data. It handles arithmetic logic, control, and input/output operations; in simpler terms, it decides the speed and efficiency of the system. Focus on Memory (in particular, Random Access Memory, or RAM)Another critical element of hardware RAM is a volatile type of memory, which means that it temporarily stores information and instructions that are currently in use or being processed by the CPU. It will help retrieve this information at a rapid pace, which will aid in ensuring the program continues to run. RAM is yet another hardware component that can greatly affect performance since the more tasks the system can run at once, the less likely it is to lag or crash. RAM is responsible for temporarily storing data that is actively being used by programs, while Storage Devices like Hard Disk Drives (HDDs) and Solid-State Drives (SSDs) store information permanently - including data, applications, and the OS itself. HDDs (hard disk drives) are slower than SSDs (solid-state drive) as the former stores data for reading on mechanical parts, whereas the latter uses unmovable flash memories in which the price increases according to the capacity of the memories (maximum capacity is 8) TB) but it has higher speeds to read and write compared to HDDs, which makes the whole system more responsive. SSDs are more prevalent in modern systems because of their speed, robustness, and reducing price. These include Input Devices, such as keyboards, mice, and touchscreens that allow users to interact with the computer by entering data or giving commands. The interact with the computer and convert the actions into input Output Devices allow the computer to communicate information to you, the user, either on a screen (like a monitor) or on paper (like a printer). Additionally, higher quality and



more clear monitors and printers directly increase the output quality. A Motherboard is the part that connects all of these above hardware parts. It serves as a medium for communication between CPU, memory, storage devices and peripheral devices. There is a place on the motherboard where the CPU will sit, there are RAM slots, and there are interfaces for connecting storage devices and other peripherals. It also contains the chipset that handles data flow and makes sure the various hardware pieces all work in harmony. As a result, these together make the architecture of a computer system, and their proper coordination defines performance, reliability, and other system capabilities. This is not only establishing software processes but also combined with the hardware, and much significant facilitates systems optimized, friendly user interface, and allowing advanced tasks.

b) Operating System (OS): The operating system (OS) is an essential part of a computer system, serving as the intermediary among users, applications, and hardware. Operating system software: It manages the hardware and software resources of the computer and provides the services that applications and other software require. It can make sure every application is running smoothly and working on its own, with its tasks. Resource management is one of the main tasks of the OS. It manages the computer's resources, including the central processing unit (CPU) time, memory, storage, and other resources, and allocates these resources to different processes and applications that are running concurrently. The OS will enforce the limited number of resources that each task allocates to prevent competition or excessive use of resources. For example, the OS employs algorithms to handle how memory is allocated between processes and prevents applications from overwriting or interfering with one another's data. It also comes with a user interface (UI) which interacts with the users and executes tasks. The Graphical User Interface (GUI) is what we refer to as the principles of visual communication; it contains text, graphical elements, and text including icons, windows, and menus, which facilitate the way a user interacts with a computer; the CLI refers to the Command-Line Interface wherein typing is required to communicate with the system and to execute functions. In contrast, CLI-based systems are often chosen for technical work or



pecialized tasks where responsiveness and accessibility are paramount -because they can often perform just as well as their more user-friendly counterparts. Managing files is another important role of an OS. The OS facilitates management, organization, and storing of files, and directories on storage devices such as hard drives, solid-state drives, or cloud storage. It also excesses that files are named, quoted to fitting catalogs, and go usable to clients and applications when they are required. The os manages the permissions and the rights, when to allow an operation and when not to, maintaining the security and privacy. Besides file management, the OS is also responsible for device management. It manages and works the hardware devices such as printers, monitors, scanners, disk drives, and inputs devices (keyboard and mouse etc). Through device drivers, software which serves as an intermediary between the OS and hardware, the OS communicates with hardware to make sure the devices are used correctly and efficiently. An operating system is a type of software that serves as an essential layer for a computer system to work correctly. An OS is a essential software for users that makes it easy to communicate with the computer and allows third-party applications to function. It is thus the brain of modern computing.

c) Application Software: This term is given to the programs that enable users to perform certain tasks or activities on a computer or other devices. Application software is specialized for the end-user, as opposed to system software, which is a software that bridges the gap between user and hardware, covering functions such as device management and system resource management. It is the features of the numerous programs that make everyday activities more productive, creative and fun. Productivity software is one of the most common types of application software. Programs like Microsoft Office, Google WorkSpace, and other similar suites that offer the ability to create documents, form spreadsheets, prepare slideshows and manage databases fall under this category. These applications also enable users to generate documents, analyze data, and communicate effectively in both personal and business settings. Whether you're working on a personal or professional project, and with features like



formatting tools, chart creation, and collaborative editing, productivity and workflows are optimized for both individuals and teams alike. Media players are another common kind of application software. VLC Media Player, Windows Media Player, and similar programs that play audio and video files so you can watch things. Such players support different types of files along with playlists, equalizers, and streaming capabilities. Media players enable users to seamlessly access videos and audio content as needed for entertainment, education, and business use, as well as edit files or convert them. Another type of application software is web browsers. Web browsers are what allow people to access and surf the web, such as Google Chrome, Mozilla Firefox, Safari, and Microsoft Edge. These browsers read HTML, CSS, JavaScript, and other web technologies and process them to show web pages on users' devices and allow them to interact with Internet communications. In addition to the ones mentioned previously, web browsers typically include other built-in features such as tabs, bookmarks, extensions and privacy settings that improve the user experience and enable individuals and organizations to get the most out of the web. Finally, games are a major category of application software that is purely for entertainment purposes. Whether casual mobile games or PC or console experiences, the programs keep users entertained and allow them to take part in interactive and recreational activities. Games can be anything from a simple puzzle or strategy game to a highly complex, narrative-driven experience featuring lifelike graphics and multiplayer elements. They are commonly used for recreation, but also for educational, social, and therapeutic purposes in schools, hospitals, and homes.

UNIT 4 INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS (DBMS)

A DBMS is an important part of a company as it ensures the effective management of data while also maintaining its availability, security, integrity, and reliability. A DBMS serves as an intermediary between the user and the database; thus, it is a software that makes it easier to define, create, maintain, and control access to the data. As businesses, educational institutions, healthcare providers, and others increasingly rely on data, DBMSs have become essential for efficient and effective data management. Data Storage,



Retrieval, and Update \rightarrow One of the major functions of a DBMS is storing, retrieving, and updating data as it provides efficient access to large amounts of data. This much of flexibility is very important for deploying applications from small devices to Very Large systems. DBMSs simplify complicated data administration tasks through organized systems for storing data, including tables or hierarchical models, facilitating speedier data updates and retrieval. Moreover, one of the key functions of any DBMS is the data security. Unauthorized users cannot access or modify sensitive data due to user authentication and role-based access control in DBMSs. This guarantees that only people with the right permissions can use the database in the way that was intended. Stability of content is another major aspect of DBMSs which maintain data integrity. Primary keys, foreign keys, unique constraints, etc: Integrity constraints avoid invalid data or duplicate entries from reaching the database. It preserves the quality and reliability of stored information. In addition, DBMSs offer data backup and recovery tools, protecting data from system failures, hardware errors or human mistakes. So, even if you have to encounter a failure, regular backups and recovery options restore data to its previous state with minimum data loss. Apart from single-user access, DBMS provide support to multi-user access, letting many users access the database at a time and combined data. This is especially useful in a multi-user environment, where multiple users read/write the data simultaneously. In addition, advanced locking mechanisms and transaction management help users interact with the data sequentially, while maintaining data consistency and preventing data corruption. Hierarchical, network, relational, and NoSQL DBMSs are all different types with different uses. However, each has its pros and cons and the use cases depend on the organization and requirements of the data. Relational DBMSs, well known and popular, utilized for structured data in business applications with SQL, and NoSQL DBMSs, best for handling unstructured, or semi-structured data, giving flexibility, and scalability.

a) Definition, Purpose, and Importance of DBMS

Definition: Database Management System (DBMS) is a software package that provides an interface for the user to work with a large amount of data.



It acts as a bridge between users and the underlying database, allowing them to define, create, update, and query data. One of the core functions of a DBMS is to enable data to be stored in a well-structured and organized way, often established by the use of tables, rows, and columns, allowing data to be retrieved easily and efficiently. For example, developing or maintaining information would of necessity require the keyboarding of knowledge about the DBMS. The main function of a DBMS is to store and retrieve data. It keeps data in physical files and also maintains data in an organized manner logically, which helps in keeping data retrieval in an efficient manner. To achieve faster query returns as data grows, the DBMS implements indexing techniques and query optimization strategies. Moreover, to improve performance, the system frequently employs caching, which retains frequently used data in memory for when it is needed.

These transactions can be grouped as a single unit to save time and resources, ensuring that changes are made in one go instead of making multiple changes across different database structures. In critical applications where the data integrity is of utmost importance, e.g. banking systems, these feature is an indispensable aspect. ACID properties (Atomicity, Consistency, Isolation, Durability) are used to deal with transactions — ensuring a series of database operations are completed successfully and that the data remains consistent if any failure occurs. Protection is another big task of a DBMS. It also provides access control mechanisms to determine who is allowed to access the data and the actions they can perform. Sensitive information can only be modified by users and administrators with appropriate permissions, such as users making sure that no unauthorized non-admins are altering sensitive information. Some DBMS also offers encryption capabilities for data-at-rest and in-transit, making it an important tool in ensuring data privacy. In addition, a database management system (DBMS) can also help simplify the process of designing and building the database itself. Using design tools such as those based on Entity-Relationship (ER) diagrams, it becomes possible to specify the relationships of different entities of the system. Data is then entered into the system by the user, and the appropriate schema is generated by dbms-providing the necessary functionality required for data to be efficiently,



securely, and scalable structure within a hardware. This makes it an invaluable tool for businesses, organizations, and developers that require large-scale data storage and management systems, with the ability to ensure data integrity as well as providing query processing abilities, managing transactions, and maintaining security.

Purpose:

The main purposes of a DBMS are:

- 1. **Data Organization:** DBMS organizes data for easy retrieval and manipulation. The nature of the SQL language allows for this through tables, schemas, and interconnecting your different pieces of data.
- 2. **Data Integrity and Accuracy:** DBMS'rules and constraints ensure that data is consistent and accurate. It also helps in ensuring if the data is correct, and if it is valid against the pre-defined standards.
- 3. Efficient Data Access: DBMS is used to get data in an efficient manner as DBMS will process the query in such a manner that users can get a lot of data, that they want to manipulate, easily. DBMS uses indexing, searching algorithms, and optimized query plans to minimize the time taken for data operations.
- 4. **Data Security:** Sensitive data will get secured mechanisms like access control, encryption, and authentication. Requiring that only certain users be able to view certain pieces of data or to carry out certain actions on that data.
- 5. **Data Redundancy Control:** DBMS reduces the redundancy of data, i.e., it does not hold the same data at multiple positions when it is not needed and, thus, increases storage efficiency.
- 6. **Data Independence:** DBMS gives an abstraction of how data is stored and how data can be accessed. This allows for independent database maintenance and scaling without complex impacts on the application layer.



Importance: A Database Management System (DBMS) provides the necessary means to manage data without working out details. Centralized management of data is one key advantage an enterprise DBMS brings. This centralization allows all of your data to live in a single system, reducing the complexity of updating, maintaining, and managing all the data. Your application will still get a performance benefit from using the API abstraction on top of your app, but this is by your design to handle communication with multiple apps so the latest data is being shown (across, potentially, different environments) and the risk of duplicating or conflicting data between roles is reduced. It means the single source of truth of the instance which increases data integrity and operational efficiency. The next key feature of a DBMS is data consistency. Its role is to enforce the predefined rules and constraints that keep the state of the data intact. Relational databases, for example, will use primary and foreign key constraints to enforce the various relationships that exist between tables and to help ensure that data across various parts of the system is consistent and aligned. This minimizes the chances of any anomalies (like storing inconsistent or incomplete data), which is usually the case when data is maintained manually or across many non-integrated systems. Adhering to these rules of consistency is the reason why DBMS keeps data consistent and trustworthy over all applications. Concurrent access to data is critical in today's fast-paced business environments.

A DBMS allows multiple users to access the database concurrently without interference or data corruption. The end goal here is undoubtedly sophisticated data locking and transaction control, which prevents one user from interfering with the actions of another while reading from or writing to data. This enabled the prevention of conflicting updates that could lead to data which is incorrect or not evenly consistent. Uptime DB maintains a clear transaction order and guarantees this order for smooth access for users. DBMS has another important characteristic which is backup and recovery. Data is a currency; its loss can have serious repercussions. Reliable backup and recovery: A DBMS provides features for automatic backup processes and recovery options, so, in case of a hardware or software failure, the data is restored to the last known good state. This reduces the possibilities of data loss making sure, even facing



the unknown capabilities of business continuity. # Improved Collaboration and Data Sharing: With a DBMS, one can access and perform operations on the same data by different users or applications at the same time. It enables users to share and collaborate on data smoothly, improving decision-making and coordination within an organization. And last of all, the support for complex queries is crucial. The versatile nature of a DBMS enables storing, retrieving, and manipulating data efficiently for decision-making processes.

b) Types of Databases and Data Models

Databases are structured arrangements of data usually handled by Database Management Systems (DBMS). Their types are based on their composition and usage. The various types of databases and data models are:

- 1. **Hierarchical Database**: This type of database structures data in a hierarchical manner with parent-child relationships. The child records have only one parent, so the data is read along this hierarchical path. It's good for applications with a clear, one-way relationship, such as organization charts or file systems.
- 2. **Network Database**: Essentially Extensible Seniority Network Database: Like hierarchical databases but makes for more complicated relationships. Here, a child may have many parents, a network. It is a more flexible model than hierarchical model and supports many to many relationships. It's also useful for modeling more complex relationships, like telecommunications networks.
- 3. **Relational Database**: This is the popular and widely used database model. Data is held in tables (relations), columns (attributes), and rows (records). Foreign keys allow different tables to be related to one another, facilitating highly effective database queries and data manipulations via Structured Query Language (SQL). It also makes for excellent business applications, such as managing customers or inventory.
- 4. **Object-Oriented Database**: Data is represented as objects, as in objectoriented programming. Objects encapsulate both data and the



 operations on that data. The model is designed for applications where complex multi-modal data representation is needed, including but not limited to multimedia content, engineering systems, and real-time applications.

Operating Systems and Database Basics

6. NoSQL Database: NoSQL databases are suitable for big data applications, as they can manage large volumes of unstructured data. When it can store data in any format: document, key-value, column-family, or graph. With the rise of NoSQL data stores, they offer flexibility and scalability to work with a variety of data types, and are used commonly in modern web and mobile apps.

MANAGEMENT INFORMATION SYSTEMS (MIS)

The Management Information System (MIS) is an important mechanism that organizations use to collect, process, store, and arrange information to facilitate decision-making, coordination, control, and analysis. MIS can be seen as anyone or any system that creates value in integrating people, processes and technology to enhance operational efficiency, communication and strategic planning for an organization. It utilized as a device that ensure efficient execution of business processes, making precise data available on time to facilitate data-driven decisions. MIS aids organizations in achieving a competitive advantage, sustained organizational success, by ensuring data accuracy, security, and efficiency within the organization's core elements: people, technology, data, processes, and feedback.

a) Definition and Characteristics of MIS

Management information system (MIS) is a planned system designed to provide the information needed to manage organizations efficiently and effectively. MIS makes sure that managers at every level receive correct and up-to-date information that is essential for effective decision-making. The way a company works is hugely dependent on the data available to them. These reports help managers to improve organizational performance by monitoring operations, identifying trends and making decisions. An information system can be manually or automated process and can often



be automated, and includes data input devices, software, data storage, and output systems (information distribution) to end users. MIS deploys an organized system for providing information to the decision-makers at both operational and strategic levels. 3) Improved Coordination and Communication: MIS improves coordination and communication between departments and employees in an organization by streamlining the flow of information. Besides, it supports the organization in adjusting to changing business environments through the systems for data evaluation, predictions, and imagining of results. It assists managers in decoding intricate trends, forecasting future directions, and recognizing areas that require enhancement. Overall, a good MIS helps to meet business goals by increasing efficiency, improving decision making, and aligning the operations of the organization with its strategic objectives. MIS provides necessary insights based on the data which is required for organizations to sustain and be competitive in today's fast-evolving business world, making it a valuable tool thanks for its data integration and real-time potential insights capabilities.

Characteristics of MIS:

A Management Information System (MIS) is a framework that assists management decision-making, planning, and control activity in an organization. The right information: it is the most important building block needed to facilitate managers of all levels with great visibility into the organization's operations and help them to manage effectively. One of the key features of a MIS is its holistic approach. It depicts the organization as a whole system, with all its elements related. This is done so that every department or function is pulling in the same direction towards the organizational goals, and the system acts in concert toward the same objectives. An MIS allows for a more complete view of the organization, enabling better decision making across a wide variety of disciplines. MIS are used primarily by managers and designed with their needs in mind. It is what gives the data and insights needed to track performance, measure outcomes and make decisions, whether at the operational, tactical or strategic level. The katu system is system that would be useful in



organizing and controlling the activity by the organization. An MIS helps to address not only the information needs of managers, but also their requirement for timely information. One of the features of MIS is that it is designed based on requirement. This information is specialized to provide users within the organization with information that is useful. An MIS delivers the information that is relevant as well as useful and caters the need to relevant role only, making it much more efficient. By providing this level of detail, the information allows the users to make more informed decisions, reducing the uncertainty that typically surrounds it. MIS also stands out for its capability to consolidate data from various sources. Such an integrated approach to business performance management ensures that (for every department in the organization) there is a unified set of data for analysis. It is a collection of integrated software applications designed to manage a company's core business processes. Such integration enhances decision-making accuracy and facilitates improved interdepartmental communication and cooperation.

MIS is future-oriented too; it assists businesses to anticipate future trends from past data. The system can then analyze the data to identify patterns and make predictions based on insights gained from previous performance, allowing managers to forecast potential opportunities and challenges they might face down the line. This foresight enables market intel and risk management for proactive planning and strategy that not only prevents potential risks but also enables organizations to identify and successfully utilize new trends. Such insights are leveraged by managers to develop long-term strategies that resonate with organizational objectives. One of the critical components of an MIS is exception drop reporting, which highlights the discrepancies with the set standards or performance norms in this way, managers are able to allocate their attention towards performance deficits for which they need to take remedial actions, thus making the process of reporting more targeted and efficient. The system also aids in task and resource prioritization by highlighting the important exceptions that need to be figured out. MIS allows a broad data flow within the organization, so that communication and coordinating can be carried out efficiently. This standardization of data flow ensures that all users access the same dataset, regardless of department or role,



removing discrepancies and further promoting consistency. This approach standardizes the data, which improves decision-making and can prevent the entire organization from working off of different data sheets. Last but not least is long-term planning supported by an MIS that delivers invaluable insights about both in-house and outside performance. This information assists managers in making a better decision about the future direction of the organization to have a business prepare for contingencies and problems in the future. The MIS helps feed operational and strategic level information, enabling the organization to execute immediate actions and to effectively move the organization forward during prolonged timelines.

b) Components of MIS: Hardware, Software, Database, Network, and People

An MIS framework is being used by organizations to collect, process, store, analyze and communicate information. An MIS mainly has the following components:

1. Hardware: Hardware is the backbone of any computing system, including the physical devices that collect, process, store, and distribute data. At its core, input devices allow users or other machine systems to input data into the machine. These can include devices like keyboards, allowing the input of text; scanners, which convert physical documents to digital formats; and sensors, which collect environmental or physical data, such as temperature, motion, or light. As these devices play a key role in interfacing the real-world data representations with the computer algorithms. After data input, it is given to processing units such as the Central Processing Unit (CPU). Relevant to the computer, the CPU is the "brain," running instructions, executing calculations, as well as, maintaining the data flow. It will handle and extract the input data as per the architecture and the software instructions in this particular system. The data after processing needs to be in a form to be stored and used for present or future references. The role of storing and retrieving data is carried out by storage devices, which include everything from traditional hard drives (HDDs) to solid-state drives (SSDs) and even newer technologies like cloud storage. In general, storage devices enable systems to store large amounts of data so they can be retrieved when needed, whether for



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long-term archival or quick access in real-time applications. After processing and storing data, the system must write the data. You do this using output devices like monitors for visual information, printers for hard copies of digital content, and speakers for sound. These devices enable the users to work with the output of their systems and achieve their goals. These hardware components collectively function to ensure proper data entry, processing, storage, and output, resulting in a seamless computing experience for users.

2. Software: The collection of programs and applications that communicate with hardware, run applications and control the infrastructure is essential to maintaining the operations of individual computers as well as controlling the larger organizational systems. This suite consists of several building blocks, with each individual element performing its own vital function. The crux of this suite are Operating Systems (OS) like Windows, macOS, and Linux, which serve as intermediaries between the raw computer hardware and the person using it. The operating system (OS) is responsible for managing the hardware resources, allowing components like the CPU, memory, and storage devices to communicate and work efficiently without interference. It has a user interface that enables users to communicate with the system using graphical or command-line interfaces. Application Software is software also designed to perform high-level tasks that are essential for personal and business functions outside of the OS. Such software can be "Database Management Systems (DBMS)" to organize a large amount of data, "Enterprise Resource Planning (ERP)" to manage core business processes such as finance, human resources and supply chain management, and "Customer Relationship Management (CRM)" to assist the business in creating a customer interaction process to improve sales strategy related to the business. These applications automate tasks and collect valuable data analytics to help run organizations more efficiently and smoothly. Finally, Utilities These are specialized tools specific to assist in system maintenance, security, and optimization Such as the antivirus application, firewall, disc and performance cleanup tools, etc. Utilities guarantee systems are secure, running optimally, and free of duplicate files or threats. These elements combined make a vital ecosystem that not just



tell the hardware what to do, but also improve the system's functions, assisting users to perform various tasks from simple computing to complex business workings.

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4. Network: This infrastructure includes several key components that work in tandem to facilitate seamless connectivity and data exchange. Communication media: One of the basic components of computer networks is communication media which includes the connection paths used for data transfer. These can be wired think fiber optic and coaxial cables or wireless including Wi-Fi and Bluetooth. Optical fiber, for example, allows for high-speed data transmission over long distances with very little signal degradation, making them suitable for backbone connections in large scale networks. On the contrary, wireless technologies alternatives throughput and flexibility, as they can make devices communicate without physical connections. The second crucial aspect is network devices, responsible for network traffic processing and maintain network connectivity between various parts of the system. Routers (connect multiple networks or segments) route packets of information, to ensure the information we send gets to the right destination. Whereas Switches help route the path of the packet within the individual network, by ensuring the data from an individual packet ends up at the right device based on its MAC address. While Switch are highly used in networks but are less efficient as Hubs as they send data to all devices on the network, while Switches forward data to only the intended devices on the network. These devices provide a crucial function in preserving the network's structure, directing traffic demands, and assuring communication among devices. Protocols a set of rules and standards guide data transmission; allowing different devices of different manufacturers or systems architecture to communicate with each other. For example, one of the most commonly used protocols is TCP/IP completion, which is designed to break data down into packets, send them across the network, and reassemble them on the other end. TCP/IP and similar standards enable very different types of devices to utilize diverse hardware and software, enabling everything to work seamlessly. These three elements how information is shared (communication media), where and on what devices data is sent and received (network devices), and the rules governing its transmission (protocols) integrate to create the foundation of much of modern communication



infrastructure, facilitating the dependable exchange of data and powering everything from local area networks to worldwide internet systems.

5. People: The data component is a crucial part of any Management Information System (MIS). It comprises three key groups: end users, IT professionals and management, each of which has a unique, but critical role in maintaining the appropriateness of the MIS to support its organizational objectives. End users have the individual users who directly interact with the system daily. They are the employees, managers, or even customers that interact with the system to complete tasks, make decisions, and gain access to vital information. This can be quite a tough job as MIS is expected to deliver the exact day to day operational or strategic related information to functions. From processing sales orders and tracking inventory to analyzing scorecards, the end users' interactions with the system make all the difference in usability and overall effectiveness. The input of these early adopters is crucial to refine and adapt the system for specific requirements. MIS Technical Staff This group of professionals is responsible for the technical side of the MIS, e.g. system designers, developers, and support staff. They build out the system infrastructure, which they maintain and troubleshoot to keep it running and provide good quality security. IT experts help guarantee that the framework is dependable, adaptable, and fit for taking care of the developing needs of the association. They collaborate closely with end users to understand their needs and ensure that the system addresses these needs. They also oversee the integration of different technologies and data sources, keeping the MIS flexible though evolving with changes in the organization. Top-level management uses the information generated by MIS to make strategic decisions. The system provides data to executives and managers to inform their planning and resource allocation and performance evaluation. They rely on the system's output to fuel informed decisions, trend analyses, and strategy formulation that is aligned with the organization's objectives. The end users rely on an MIS to deliver accurate and relevant information, management relies on MIS for decision-making tools, and IT integrates and maintains the supporting infrastructure or software.



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c) Role of MIS in Decision-Making, Planning, and Control

Management Information Systems (MIS) play a crucial role in the functioning of organizations, especially in decision-making, planning, and control. MIS facilitates this process by providing managers at all levels with the tools they need to collect, process, and distribute information efficiently, enabling them to make well-informed decisions, formulate tactical plans, and exercise effective control over their operations.

Role of MIS in Decision-Making: A Management Information System (MIS) is essential for effective decision-making as it provides accurate, timely, and relevant data to managers. It organizes and processes information from diverse sources and provides insights that help identify trends, forecast potential outcomes, and assess different options. MIS serves as a central repository for important business data, enabling decision-makers to easily access relevant information and make informed decisions. MIS provides a holistic view of an organization's performance and future prospects by bringing together data from internal operations, customer feedback, market trends, and external economic factors. An important benefit of MIS is finding patterns in big data. Tracking past and current performance metrics helps managers identify upward or downward trends in their business. Managers can identify seasonal trends or growth opportunities in certain geographical areas by looking at data on sales, market share or consumer habits. Not only that, MIS helps in predicting future trends based on past data, which can help organizations in strategic planning and resource allocation. A forecast is an accurate prediction that helps the managers to predict future problems, like supply chain issues or changes in customer demand and plan to overcome it. Another reason why MIS is important is that it gives the opportunity to analyze different choices in the process of decisionmaking. In this ambiguous situation, you have numerous choices to make, maybe whether you should spend money on new technology or how to flatten a division; MIS delivers the data you require to consider how it would affect each option. MIS data, the management information system, is showing one management team consistently underperforming while others are exceeding their targets. [XX Corp] can instead start to allocate extra resources



into the team that's not achieving up to par, create additional training programs for what they are lacking, or redeploy resources from one team to another to better balance that out. Relevant data allows managers to assess each alternative's cost-benefit-risk tradeoff and select the best alternative.

Role of MIS in Planning: An integral part of the planning aspect of management in the organization; MIS helps develop the strategic as well as operational plans. MIS provides timely and accurate data for managers to assess current performance and predict future trends to make decisions. MIS provides detailed information about all aspects of the organization such as sales, finances, and customer behavior, which is one of the most essential areas of support in planning. The insights gained from these analyses are essential in pinpointing the weak areas and are required to make the adjustments possible with future goals and milestones achievable. Additionally, MIS helps the organization for allocating the resources out of human, financial, or technological resources by providing data on resource allocation. It allows managers to maximize their resource allocation, making sure the funds are geared toward the most critical space that would promote the building of the organization in the long term. MIS not only helps with resource allocation but also helps in anticipating issues and barriers that may come in the way of executing plans. Using historical data, industry trends, and external factors, MIS can enable managers to identify risks such as market fluctuations, disruptions in supply chain, or changes in the regulatory environment. This predictive capability enables companies to create contingency plans to address and mitigate these challenges, ensuring that the plans run smoothly. In addition, it assists in interconnecting the strategic goals with organizational objectives and market conditions. MIS allows managers to drive changes in consumer preferences, technological advancement and competitive forces through market analysis and competitor benchmarking for e.g. This helps organizations adjust their strategies as needed so they remain pertinent and competitive in an ever-changing market. One of MIS comes in handy during the planning process, as businesses can use the integrated and analyzed data over multiple sources across the organization. MIS collects data from various operations and



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provides managers with an integrated overview of their operation and assists them in identifying patterns or trends, which will enable them to identify strengths, weaknesses, and opportunities. By taking a 360-degree view of data, we can create plans that work on ground reality, but are closer to the big picture and overall long term purpose for the organization. In conclusion, MIS is a vital component in making sure that planning and implementation are backed by relevant information, enabling better decisions and outcomes for the organization.

Role of MIS in Control: One of the most important tasks in most organizations is to keep track of the operational activities as part of management information systems (MIS) requirement. These systems allow for data to be collected, processed, and analyzed to inform all levels of management making decisions. MIS allows the managers to track key performance indicators and benchmarks against specified standards and provide analysis of deviations. The key here is that you track ops so you can fix what needs fixing to keep the org headed the right direction. MIS system compiles data from various departments and operational activities, resulting in reports that show comprehensive information about the performance in different areas of the organization. These reports help you recognize underperformance areas, be it relation to declining sales, decreased productivity or inefficient resource allocation. MIS can therefore detect such deviations, set off alerts, and enable managers to make quick corrective actions, in turn, reducing the adverse effects on the organization as a whole. In addition, the MIS is crucial for strategic planning support. MIS provides historical data trends, market outlooks, and internal performance data that help managers make decisions about how the organization will function in the future. It allows strategies to be devised which rely on actual measurable insight rather than gut feeling. This makes sure that organizations can effectively align their resources with the overall strategy, so they do not deviate from the path they want to take! Besides planning, MIS is essential to control organizational activities also. Management may use the system to monitor progress toward established goals and standards of performance. Managers must monitor these metrics on a continuing basis to identify any



deviations from control and eliminate them. MIS allows us to do our planning, thus MCS is a knowledge-enabling and process-enabling subsystem that responds to the organization's internal and external environment. MIS provides timely and accurate information and facilitates corrective actions by managers as and when required, which helps to ensure that activities are progressing in accordance with organizational goals and objectives. This ultimately enables operational efficiency, growth and sustainable success.



MODULE 3 DATA REPRESENTATION AND CONVERSION

Structure

Unit 5 Number Systems in Computing

UNIT 5 NUMBER SYSTEMS IN COMPUTING

Due to the nature of binary systems in computing, number systems will eventually make up the fundamentals of how data is represented, processed, and stored in digital systems. These number representation systems are utilized for representing numbers in formats suitable for specific computing tasks ranging from simple arithmetic to intricate algorithms. In computing, the four central number systems are binary, decimal, octal, and hexadecimal.

a) Decimal, Binary, Octal, and Hexadecimal Number Systems

A number system is a way of using symbols and rules to represent numbers. Four basic number systems:

1. Thebinary number system (base 2) The most fundamental and basic numerical system in the computer system, works on the principles of 2 where only two digits are used(0,1) These are known as the binary digits, or bits, and they are the building blocks of digital information based on powers of 2. Since the internal circuitry of computers operates naturally in two states—commonly referred to as "on" (1) and "off" (0)—the binary numbering system is an ideal representation for the state of each element of this circuitry and thus is used by all computers. This dual-state system corresponds to the binary format, with each bit being a 1 or a 0, which signifies the two possible electrical states of the digital circuit. A bit is the smallest unit of data in computing and sets of bits form larger, more complex values. In binary, numerical values are denoted as strings of 0s and 1s, with



each positional weighting constituting a power of 2. For instance, decimal number 14 is written as 1110 in binary. How does this work, to help picture how this works we can convert this binary number 1110 back to decimal as follows: Starting from the rightmost digit the first bit 0 = 20, second bit 1 =21, third bit 1 = 22, and finally the last bit 1 = 23. When we take the sum of these numbers, $1 \times 23 + 1 \times 22 + 1 \times 21 + 0 \times 20$, we will obtain 8 + 4 + 2 + 0, that is equal to 14 (in decimal). Well, the answer lies in the hardware design of computers. For example, transistors are the basic building block of digital circuits, and they work in two states: either allowing electricity to flow or not, which is equivalent to a binary 1 and 0. Having two settled states is a very effective, reliable and durable property against electrical chatter and problems, which makes it so much better for fast data processing. Additionally, computers also perform operations very fast because binary other simple logic operations such as AND, OR, and XOR can be easily implemented in digital circuits. This adoption of binary data representation is quite efficient, in terms of both data storage and manipulation. This is important because computers store data in binary and binary arithmetic is used to enable rapid computation. Furthermore, binary-based systems enable straightforward error detection and correction, enhancing the reliability of computations. The binary system is a fundamental building block of modern computing, offering a simple and efficient means to represent, manipulate and store data.

2. Thedecimal number system (base 10) The standard number system that humans use is the decimal system, which is based on the ten digits that go from 0 to 9. Most individuals find this system to be intuitive as it corresponds to the number of fingers we have in our hands making it a natural approach to adding numbers together, subtracting, etc. In daily life, we use the decimal system for things such as computing expenses or measuring distances, as it is the common measuring system for most human activities. But computers work differently and use the binary number system that consists of two digits: 0 and 1. This binary system forms the basis for computer processing, as it represents the two states of an electrical circuit on (1) and off (0). Volts or amps can easily represent these two


states, and binary is a very compact and reliable way for computers to operate on such data. Although decimal and binary systems are polar opposites, computers convert decimal numbers to binary for internal representation. It is a straightforward procedure for this conversion: You divide a decimal number by 2, keep note of the remainder, and repeat this dividing process with the quotient until the quotient is 0. Mixed number division with same base to get remainders which are read back to forward. To illustrate, for the decimal value 13 we divide 2 to yield a quotient of 6 and a remainder of 1. Next, we divide two by six, which gives us three with zero remainder. If we keep repeating this process we will obtain the binary number 1101. Computers convert decimal to binary for processing, but understanding this relationship becomes crucial when it comes to manipulating and analyzing data. For example, whenever we interact with digital systems (like inputting digits into a calculator or engaging with a computer program), the system will first translate the input digits into either binary or hexadecimal before carrying out any computations. The computer translates these binary outputs back into decimal form and shows us the results. This conversion goes both ways and happens automatically and instantaneously, which means we can work with binary numbers without ever having to deal with them directly. To conclude, humans and computers interact with the world around them using the decimal system, but as the latter communicates in binary, the ability to transfer information back and forth between these two representations is critical to any data processing, storage, and calculations we perform using modern technology.

3. Theoctal number system (base 8) is an easy and compact way to represent mostly used binary numbers, to give numbers a more compact shape. Octal is base-8, meaning it only has eight digits: 0, 1, 2, 3, 4, 5, 6, and 7, unlike decimal, which is base-10. Three bits represent one octal digit. It gives a shorthand format of long binary integers which are more human-readable and useful for interpreting binary data and making binary manipulation second to those who are working with low-level operations or managing memory in computer systems. The direct relationship between octal and binary is simple: each three-digit binary group corresponds to exactly one octal digit. This makes it easy to translate between binary and octal — rather than needing



strings of binary digits, a programmer or system administrator can display the same information with fewer symbols. $1110 = 001 \ 110 \rightarrow 16$ (octal) This is beneficial because fewer digits are required to represent the same value; when working with large binary numbers, this reduces the possibility of error." Historically, octal was still widespread in early computing systems, especially in digital electronics and computer hardware, as it was easier for humans to work with than binary. Octal was used as a convenient shorthand in representing machine code or memory addresses, as was the case with early computer systems, minicomputers, and some mainframes. Because three binary digits (bits) fit perfectly into one octal digit, octal made processing data at a low level easier. But in contrast to the octal (base-8) format which is also more compact than binary (base-2), hexadecimal (base-16) quickly gained prominence as computer architecture advanced and more powerful implementations went beyond that of single-byte processors, further facilitating the compact representation of large numbers because each digit in hex is representative of the four digits in binary. That being said, octal is of primary importance in selected fields (like Unix file permissions), in which it is an especially handy method of quickly discussing the read, write, and execute permissions assigned to files.

4. Thehexadecimal number system (base 16) also known as base 16) is a commonly used representation in computing due to its utility in compactly representing the binary values that computers manage. While the decimal system has ten symbols (0-9), the hexadecimal system has sixteen, using 0-9 and A-F. The each symbol in this decimal system A, B, C, D, E, and F is equal to the decimal value 10, 11, 12, 13, 14, and 15 respectively. The larger set of digits enables more compact representation of the same range of values compared to binary, where every bit (0 or 1) represents a power of 2. Hexadecimal is a number system that uses 16 symbols to represent values, and one of its major benefits is that a single digit in a hexadecimal number maps to exactly four bits (binary digits). One such application is in the realm of computing, where binary numbers are the basic language of processors and memory storage, but their long strings of digits can be cumbersome to read and manipulate as is. Hexadecimal about it more



Representation

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compactness and ability to convert makes it a popular choice, for example, in program addresses in memory and debugging. Each digit in hex corresponds to four digits in the binary system, which makes hex a minimal, easily-readable representation of binary values, suitable in particular for dealing with large amounts of data or for even debugging software in machine language. Memory addresses, for instance, are sometimes presented in hexadecimal to enhance readability and maintainability. Other things that are often expressed in hexadecimal include the representation of colors (with red, green, and blue values in hexadecimal). The ability to convert from and to various number systems (binary, decimal, octal, hexadecimal, etc.) is a necessity for both programmers and people in the field of computer science. In hexadecimal, when converting binary you would group the binary digits into groups of four, because each group of four binary digits maps to one hexadecimal digit. Likewise, binary can be translated to octal by organizing bits into triplets. This helps in the smooth transfer, manipulation, and storage of data from platform/vendor to vendor and system to system, thereby improving communication and efficiency. Understanding this conversion and its significance in the context of computers is crucial for improved programming and debugging as they need to visualize and work the underlying transformation as a part of a number system.

| Numbering System | | | | |
|------------------|------|---------------------------------|--|--|
| System | Base | Digits | | |
| Binary | 2 | 0, 1 | | |
| Octal | 8 | 0,1,2,3,4,5,6,7 | | |
| Decimal | 10 | 0,1,2,3,4,5,6,7,8,9 | | |
| Hexadecimal | 16 | 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F | | |

| Figure | 3.1: | Numb | ering | System |
|--------|------|------|-------|--------|
|--------|------|------|-------|--------|

• NUMBER SYSTEM CONVERSIONS

a) Conversion from Any Number System to Decimal

In converting numbers, we also learned how to convert numbers from other numeral systems into the decimal (base-10) system.



So, here is how you can do the required conversion for the various bases:

1. Binary to Decimal Conversion:

Here are some key ideas associated with binary numbers, along with many explanations thereof, since binary numbers are one of the basic elements of the computer: Binary numbers are the way computers listen and will process data. In binary, each digit stands for the power of two, with the rightmost digit corresponding to 2° (the ones place). If you examine each digit from right to left, the place value of the digits increases with powers of two. It is also helpful to understand how to convert a binary number to decimal, the number system that we are using in our daily lives. For example, to understand this process of conversion, consider the number in binary as 1011. All digits in this binary number represent the exponent of 2 starting from the rightmost part. Now, allow me to break this down step by step. The least significant bit (LSB) is the rightmost digit: this is a 1. This is in the 2° this is 1. So, the contribution of this digit is $1 \times 2^{\circ} = 1$. The next digit to the left is a 1. Digit is in 2¹ place, hence 2. Hence, its contribution would be 1 $\times 2^{1} = 2$. Now, we look at the next digit 0, which is in the 2^{2} place. In this case, the digit is 0, so this place contributes $0 \times 2^2 = 0$. And finally, the leftmost digit (most significant bit, MSB) is 1. This digit is at the 2³ place, or 8, So its contribution is $1 \times 2^3 = 8$. Well, to calculate the decimal form of the binary number 1011, we add up the contributions from each one of the digits: 8 + 0 + 2 + 1. This gives a total of 11. Thus, the binary number 1011 corresponds to the decimal number 11. This technique for changing binary into decimal works because of the place worth system using in binary. If we take the first line, we can see that we have a 1 in the 2^0 position (1) and 1 in the 2¹ position (2), which gives us a total of $1 * 2^{1} + 1 * 2^{0} = 3$. In the same way, the binary number 1101 can be converted. This conversion is an essential part of many operations in computing, including but not limited to how information is stored in RAM and how numbers are represented in the Arithmetic Logic Unit (ALU). Data from different digits represent computer calculations, but binary numbers actually get to the point Knowing how every number makes up a power of 2, and the processes for this conversion, we can convert binary to decimal



numbers easily. This process is essential for the operation of digital systems and is at the core of our daily interactions with technology.

Data Representation and Conversion

2. Octal to Decimal: The octal numeral system or base-8 number system employs digits 0 to 7 to represent values. The positional weight of an octal numeral is assigned based on powers of 8, beginning from the rightmost numeral, which represents the 8° place and increases to the left with 8 as the base. Hence, this is a compact way of representing numbers in binary. The method for converting octal to decimal is simply the positional value rule. Take for example the octal value (157)₈. The decimal equivalent can be calculated by taking each digit and multiplying it to the power of 8 of its position. The rightmost digit (7) is in the 8° place, meaning it contributes 7 * 8° = 7 * 1 = 7. The following digit (5) is in the 8¹ place, so it is multiplied by 8¹, or 8. In the leftmost digit (1) is in the 8² place, so we multiply that by 8², or 64. So, to convert (157)₈ to decimal, the calculation will be:

$$(1 \times 82) + (5 \times 81) + (7 \times 80) = (1 \times 64) + (5 \times 8) + (7 \times 1)$$

This simplifies to:

64+40+7=111

Hence octal number (157)⁸ is equal to decimal number (111)¹⁰.

This conversion method can be used for any octal number. To calculate, each digit is multiplied by the corresponding power of 8, and the final result is obtained by summing the products. Octal is also widely used in computing and digital electronics due to its close proximity to binary code. For example, three bits can be represented by one octal digit (it's easier to write integer octal numbers in hardware). Octal is a positional numeral system which means that the value of each digit depends on both the digit itself and the position of the digit in the number. This property holds for any numeral system – such as base (base-10), and base (base-16). The position of each digit has its value based on how many multiples of it's respective base it has, but this won't matter when converting numbers. So decimalization of octal numbers is quite easy after you know what the place value of each digit means.



b) Conversion of Decimal to Binary, Octal, and Hexadecimal

In converting from a decimal (base-10) number to another number system such as binary (base-2), octal (base-8), or hexadecimal (base-16), we employ the division-by-base technique.

1. Decimal to Binary Conversion (Base-2): How to convert decimal number 25 to binary. In this method we divide the number repeatedly by 2 and note down the remainders. So we have 25 divided by 2 gives us 12 remainder 1. Then $12 \div 2$ is 6, remainder 0. Continuing, 6 divided by 2 yields a quotient of 3 with no remainder; Now, 3 divided by 2 gives a quotient of 1 and a remainder of 1. And 1 divided by 2 gives the quotient 0 and leaves a remainder of 1. As the quotient is now zero, we end the process. When we read the remainders from 'bottom" to 'top," we have 11001 == 2510. It is this way because we have a direct representation that guarantees correctness: at each step, it is revealed if a specific power of 2 was needed for the final number. Binary representation is a basic yet fundamental concept that is essential in the field of computing and digital systems, as computers work through two states, represented by 0s and 1s. In many fields, such as computer programming, networking, and electronics, understanding binary conversions is important. Following the same steps, this method can also be applied to a larger number with decimal and any integer can be expressed in binary. In addition, since logic circuits use binary numbers, each bit responds to a particular state in computation. Knowing how to convert between decimal and binary is an important skill for anyone dealing with digital systems, data encoding, and low-level programming. This principle simplifies the process of working inside machine-level instructions and optimizes the computational process.

2. Decimal to Octal Conversion (Base-8): The octal number system is a base-8 number system that uses 8 digits/ordinates (0-7). Decimal Numbers to Octal Numbers | Decimal to Octal Conversion Measuring and Recording the Remainders: Step 2 Keep dividing the quotient by 8 until the quotient = 0. The octal equivalent is read up the page, i.e., in the reverse order of the calculation. For instance, when converting 25



Data Representation and Conversion

(decimal) to octal we divide 25 with 8 and get a quotient, which is 3 and a remainder which is 1. Next, $3 \div 8$, which gives a quotient of 0 and a remainder of 3. Now reading the remainders from bottom to top the octal is 31. This method works for all decimal numbers, making conversions easy. As each octal digit corresponds perfectly to three binary digits, octal is often employed in digital electronics and computer system design. As a result, octal became a way of storing data in a relatively compact manner than binary and relatively efficient for machine-level operations. The insight gained here into converting decimal to octal solidifies an understanding of number bases and their use in computers.

3. Decimal to Hexadecimal Conversion (Base-16): This is after dividing 25 by 16, to find the quotient of 1 and the remainder of 9. Next, you take that quotient (1) and divide it by 16, which gives a quotient of zero and a remainder of 1: At this point, since the quotient has turned into, we say that the conversion process has reached an end. Reading the remainders in reverse order gives 19 (hex) as the hexadecimal equivalent. This process succeeds because hexadecimal is a base-16 number system, where each digit signifies multiples of 16. The same process works for larger decimal numbers, producing multidigit hexadecimal numbers. 25 in decimal to hexadecimal like this: take $255 \div$ 16, which gives a quotient of 15 (hexadecimal F) and a remainder of 15 (also hexadecimal F), so 255 in decimal is FF in hexadecimal. Hexadecimal representation is a popular method in computing and digital electronics as it allows us to express binary numbers in a more concise format. Since four binary digits (bits) represent each hexadecimal digit, it is efficient for representing large binaries values, like memory addresses and color codes in web design.

• APPLICATIONS OF NUMBER SYSTEMS

But those numbers represent a number system, and number systems are a framework for mathematics itself: a way to represent numbers for solving problems in math or science or business or whatever. These systems can be divided into following categories: The most used number system is a decimal system or base 10 where we use digits from 0 to 9. That's how this system is non-intuitive and a part of a concrete routine that facilitates the expression of



quantities in an intuitive and dogged way. Yet, when it comes to computing and digital electronics, the binary system, or base 2, is crucial. Binary is a numeral system that uses just two symbols 0 and 1 which correspond directly to the two states of a transistor, on or off, in electronic circuits. The ease of distinction makes binary an excellent system for computers, with data and instructions encoded as strings of binary digits, called bits. Other related systems, octal or base 8 and hexadecimal or base 16, are also directly tied to binary, providing shorter human-readable representations. Octal groups binary digits in sets of three whereas hexadecimal groups them in segments of four, which allows for a denser representation of large binary numbers. Hex numbers, which use digits from 0 to 9 and letters A to F, are especially helpful in programming and debugging, allowing programmers to manipulate binary data without needing to deal with long strings of ones and zeros. In the real world, number systems have an important representation in cryptography, which depends on number theory. For example, encryption algorithms like RSA rely on number-theoretic properties, such as the difficulty to factor a large composite number. As an example, the public and private keys in RSA are based on two large prime numbers, and the encryption relies on the difficulty of finding these prime factors. Just like that, number systems play an essential role in error detection and correction algorithms that ensure the fidelity of data as it is transmitted and stored. Modular arithmetic and number systems are used in techniques like parity checks, checksums, and cyclic redundancy checks (CRC) to detect and correct errors that occur when data is transmitted through communication networks or stored in devices. Even in music theory, there are some number systems, most notably modular arithmetic, used to analyze musical scales and intervals. For example, the chromatic scale. (consists of 12 semitones) and arithmetic modulo 12, so 12 is effectively treated as 0 in this context represents the relationship between notes, scales, and chords. When used in the context of music, second to the recurrence relations based on number systems reveal themselves in that a musician can insightfully describe different compositions mathematically by emphasizing the symmetries and structures of a musical composition. Finally, number systems are present in physics and engineering, where they



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and

are crucial for performing calculations in quantum mechanics, signal processing, and control systems. For example, in quantum mechanics, complex numbers (real and imaginary numbers, combined) are used to describe wave functions that represent a particle's state. Fourier transform uses complex numbers in Modulor form to analyze the signals. The ability to transform one number system into another underlies many important applications, be it in the design of digital circuits, the encryption of sensitive information, the creation of music, or the analysis of physical phenomena; number systems are fundamental tools through which we can understand, model, and solve problems across a wide swath of disciplines. They have practical use in both scientific and literary arenas, exemplifying their fundamental role in modern mathematics, physics, engineering, and even creative expression.



Figure 3.2: Applications of Number Systems

a) Practical Uses in Computing (Memory Addressing, IP Addressing, Color Representation, etc.)

Because of this, decimal is not often used for general computing numbers; instead, binary, octal, and hexadecimal numerical representations are commonly used. They have numerous applications in fields such as programming, encryption, data compression and digital signal processing. These systems enable faster calculations, consume less memory, and deliver higher accuracy of calculations and data transfer.

1. Memory Addressing: All memory is referred to by a unique address; this is a fundamental concept used by computer hardware to access memory. These unique identifiers are referred to as memory addresses, and they are the abstract representation of where data is stored in the system's memory.



Memory addressing is used by the processor to locate and access data in memory. This is accomplished through both direct or indirect (indexed) addressing, giving applications the opportunity to choose between fast, low overhead solutions but limited addressing, or further hierarchies with larger overhead. In a regular addressing mode, all memory bytes each are assigned with its own address, which allows access to the specific byte the processor needs without confusion. This means that every single device having an IP address can be expressed in numerical format, and while there are five types of addressing in total, hexadecimal (base-16) is the one that is most commonly used, to bring those numbers as close together as possible and to easily translate the numbers in and out of the binary format. Binary (base-2) is the native language of computers-they use a string of 1s and 0s to refer to every address but it can be long and unwieldy to read, especially with large memory spaces found in modern 32-bit or 64-bit processors. As each hexadecimal digit represents four bits in binary (also known as a nibble), hexadecimal notation can provide a more compact representation of memory addresses. This has made it much easier for programmers and system administrators to read and understand memory addresses that can be enormous in modern systems. (For example, a 32-bit processor can address up to 232 distinct memory locations, or addresses, from 0x0 to 0xF in hexadecimal.) So every four hex digits representing 16 bits or two bytes gets us 32-bit locations in memory with this hexadecimal address. You can edit this form and control it like the other form, which is very handy for many data or a large address space since it will make it easier to represent the data in the memory in hexadecimal format. This makes for addresses that are much more compact and readable than binary equivalents in practice. Such is the case that the binary address 101 is written in hexadecimal format as the shorter, more manageable 0xABCDE123.

An even further improvement is hexadecimal notation, where it is easier for the developers to translate the physical memory address and the abstract data in the memory — making tasks such as debugging and memory management easier and more efficient for the programmers. This is also why hexadecimal is typically the notation for memory addresses in many



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development environments such as low-level programming and hardware design. Hexadecimal notation is not only useful for simplifying address representation, but also helps with memory alignment and management. A positive aspect of a RAM-based system is that the number of bits required to describe memory locations can be impacted, particularly in systems where very few addresses are available, such as in embedded equipment. For instance, in the case of 32-bit accumulators, 2³² (or 4,294,967,296) unique memory locations are theoretically addressable with a single instruction, but the actual available memory will depend on the configuration of the system, any operating system constraints, and additional hardware components. A 64-bit processor builds on this idea by expanding upon the amount of memory available for addressable storage, with over 18 quintillion (2⁶⁴) distinct addresses, increasing the memory space of today's computers. While address width is increasing, hexadecimal is still an efficient representation for addresses, no matter their width. Moreover, memory addressing is important in memory management techniques like paging and segmentation, which help to keep track of the available memory. These methods give the operating system the ability to manage memory allocation in blocks of a uniform size or segments, helping to streamline organization and improve the speed of data access. In this way, by employing diverse memory addressing schemes, hexadecimal notation, and optimized memory management strategies, contemporary computing machines can handle extensive data sets, facilitating the foundation for intricate processes demanded within modern computational landscapes. Thank you for reading.

2. IP Addressing: Internet Protocol (IP) addresses are unique identifiers used in computer networking that are associated with a device on a network. 2 Types of IP Addresses IP addresses have two main versions, which are currently used, they are IPv4 and IPv6. IPv4 addresses, the most common types of addresses, are written in decimal dot notation, which is a series of four decimal numbers separated by periods: for example, 192.168.1.1. These sets are also called octets, and each one represents 8 bits of the total 32-bit address, meaning over 4 billion unique addresses are possible. Although this may have appeared adequate during the early days of networking, the explosive expansion of



connected devices — from smartphones to Internet of Things (IoT) devices — has resulted in the depletion of available IPv4 addresses. With the constant growth of internet-connected devices to create a unique IP, it soon became apparent we would run out of addresses and thus, IPv6, which was built to alleviate the challenges. IPv6 utilizes a 128-bit addressing scheme, which allows for an exponentially larger number of potential addresses up to about 340 undecillion (3.4×10^{38}) addresses available, which dwarfs the address space of IPv4. IPv6 addresses are denoted in hexadecimal as a 128-bit address divided into eight 16-bit blocks. Colons separate each group, and the groups are recorded using hexadecimal notation, which is a system for using digits 0–9 and letters A-F to represent values. This representation is more compact and easier for humans to read than binary, which would mean directly writing out the complete 128-bit address as a long string of 1s and 0s an IPv6 address might look something like 2001:0db8:85a3:0000:0000:8a2e:0370:7334, although leading zeros in each 16-bit block can be omitted for compactness so the address can be expressed as 2001:db8:85a3::8a2e:370:7334. This shorter length ensures that IPv6 uses less memory and is thus easier to manage without compromising on the gigantic address space required for all the connected devices today. In contrast to IPv4, which has struggled with address exhaustion, IPv6 was created to provide an effectively infinite pool of IP addresses, making it the forward-looking solution for the growing digital landscape. Nevertheless, with the benefits of IPv6, transition from IPv4 to IPv6 has being slow, as many existing networks and devices still uses IPv4 addresses. Be it dual-stack networking, tunneling, or translation mechanisms these technologies work in tandem for IPv4/IPv6 interoperability. These enable call data disabling yet transformable devices write to the internet, and make certain that the planet internet foundation may be gradually changed into IPv6 but still service IPv4 triggered. Other than being at a much larger scale than its predecessor, one is better security and other network management features. Finally, security was never a primary focus of IPv4, but IPv6 has built-in security features (whereas in IPv4, these security features were only optional), as well as a simplified structure in terms of the number of hops



which needs to be made through a network when data is being transmitted, reducing the complexity of the network.

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Moreover, IPv6 supports Stateless Address Autoconfiguration (SLAAC), which makes it simpler to set up a network because devices can automatically create their own IP address without requiring manual configuration or a dedicated DHCP server. Thus, these improvements to IPv6 were critical considering how expanding the Internet is, and given the growing number of devices connected around the world, IPv6 is not only a remedy to address shortage, but also a boost for more efficient, secure, and scalable networks. To sum up, while IPv4 was sufficient in the first years of the internet, IoT has created a perfect storm of demand that IPv6 introduced in the late 1990s was specifically designed to meet; at a high level, IPv6 supports an almost limitless number of IP addresses, allows for better routing, offers more security features by default, and provides a more optimal growth trajectory to cover the growing number of devices that will be used. Despite the requiring steps, the move from IPv4 to IPv6 for last address space is essential to internet's ongoing development, allowing it to adapt to the requirements of a much more connected community.

3. Color Representation:

Hexadecimal Color Values in HTML: Hexadecimal codes are used to represent colors in the realm of digital graphics and web design, an essential facet of modern computing and digital media. A hexadecimal color code is a six-digit code of numbers and letters, where each pair of digits represents one of the three primary colors of light: red, green, and blue (RGB). Hexadecimal color codes are based on the base-16 numbering system and are used by computer systems to represent the values of red, green, and blue color components in a format that is easy for computers to read and process. Hexadecimal color code: A hex color code consists of six digits that are separated into three pairs of two. In hexadecimal notation, each pair of digits can vary from 00 to FF, which means that each color component has a decimal range from 0 to 255. This gives a total of 16777216 (256 x 256 x 256) unique colors, a range that covers the whole visible spectrum plus some beyond that range and available to designers and developers an almost infinite color palette to work with. This



hexadecimal way is rather handy as it gives a less long form as well as a more readable form for the shade values. Longer strings of digits are needed in the binary system to express the same values as hexadecimal code, since each digit in a hexadecimal code can represent a 4-bit value. For instance, the color code #FF0000 represents pure red, with the first pair (FF) representing the maximum value of red (255 in decimal value) and the subsequent two (00) representing 0 for green and blue, respectively. Pure green is #00FF00, and pure blue is rendered as #0000FF, similarly.

Hexadecimal notation (a.k.a. X11 notation, used in most web, HTML, and CSS work, where a precise color designation is required). In web design, for example, designers can use these codes to specify the exact color for things like backgrounds, text, buttons and borders. Also note that, in addition to the standard six-digit hexadecimal representation, color zcode shorthand notation (e.g., #F00 as opposed to Full #FF0000) is also supported (also dot and whitespace padded examples accepted). Hexadecimal color codes have been widely adopted in web design and allow for consistent replication of colors across various devices and browsers. In addition, hexadecimal color codes are commonly used alongside CSS (Cascading Style Sheets) to specify visual styles in a web page's design. Hexadecimal color codes are just one piece of the puzzle, and CSS as a whole enables web developers to create beautiful and functional websites that can incorporate things like fonts, margins, padding, borders, and so much more. Overall, the use of hexadecimal codes in digital graphics serves as a reminder of the role that numerical systems, such as hexadecimal and binary, play in modern-day computing. These systems serve as the foundation for the representation of data types, providing a uniform framework that guarantees smooth interactions and optimal performance between diverse hardware and software platforms. Binary is the base language of computers and it utilizes only two symbols (0 and 1) to represent data, however, hexadecimal serves as a more compact means of encoding values when imposed on binary values needs to be applied or operated on binary. Being able to transform between the two is critical for



data manipulation, be it recreating images encoded in pixels, converting to/from hex color codes or, for that matter, any sort of mathematical operation needed internally by a piece of software. Consequently, hexadecimal color codes are not only a convenient means of representing colors internationally in the digital world, but also serve as an example of the general methods of data representation and manipulation that define our contemporary technological landscape. Numerical systems, such as hexadecimal and binary, play a crucial role in data encoding, providing efficient means of representation that align with binary logic implemented in several microprocessor architectures.

Data Representation and Conversion



MODULE 4 NETWORK TECHNOLOGIES AND INTERNET BASICS

Structure

Unit 6 Introduction to Network Technologies

Unit 6 INTRODUCTION TO NETWORK TECHNOLOGIES

A technical support function necessary for any communication, whether data, text, images, or videos. They refer to the suite of tools, protocols, and infrastructure that enable devices to communicate and share resources, regardless of their geographic location. With the emergence of various systems for connecting devices, it becomes important to understand the building blocks of network technologies to provide insight into how data is transmitted across networks from local networks to expansive global systems such as the internet. Network (one of the fundamental aspects of network technologies) LAN (Local Area Network) these networks link devices over a small geographic area, like a home, office, or large building. Local Area Networks (LANs) are used to share resources and allow devices to communicate with each other. In a broader context, Wide Area Networks (WANs) extend the reach of multiple LANs across great distances, covering entire cities, states, countries, or even continents. An example of WAN is the internet itself which is the worldwide network that connects billions of devices worldwide. Addressing such concerns are the network devices, which allow data to pass through such networks. Central to networking, routers send data packets between networks, ensuring data transmission to the correct location. Switches, conversely, optimize data traffic within a LAN environment, allowing devices to communicate directly without burdening the whole network. For example, hubs are used to connect several devices with basic operators to connect them to closed networks, and modem devices play a key role in converting signals for Internet access. It uses a set of protocols that govern how devices communicate with each



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other and how data is transmitted. Most communication on the internet is based on the Transmission Control Protocol/Internet Protocol (TCP/IP) suite which provides reliable data transfer and routing. Another set of services includes protocols such as Hypertext Transfer Protocol (HTTP), which are used to transfer web pages, and File Transfer Protocol (FTP), which transfers files around from network to network. Network topologies and transmission media further define how networks are structured and the processes by which data are transmitted. Home » Data Structures » Topology Explained: The Complete Guide to Net Topology Outlined in this section is a full overview of different types of topology, including the pros and cons of each type of topology: Topology matters when it comes to understanding how devices connect: The same category can be found at the data links layer when we progress the data further towards the network layers, as seen in Star Topology, and it can also be seen in the redundancy of mesh topology. Transmission media is the medium through which data is sent from one node to another, e.g., over copper cables, fiber optics, and wireless. Last but not least, network security is a top priority. These include firewalls, encryption, and Virtual Private Networks (VPNs), which help defend sensitive data and guarantee secure communication by protecting your networks from unauthorized use and cyber threats. So, you have a whole system consisting of these three components that provide power across the globe on the connected internet.



Figure 4.1: Network Technology



a) Importance of Networking in Computing

Why networking so important in computing Networking through allows devices systems and users to communicate with each other data sharing. Here are five of the most critical reasons that make networking important in computing:

1. Resource Sharing

Networking and the power of resource sharing. Networking allows multiple computers and different devices to share hardware, software, and data resources, reducing the need to purchase duplicate hardware, software, and networked devices, thereby lowering the cost for users, businesses, and organizations. Of course a networked environment permits many computers to share a single printer or storage device and does not require each workstation to have a printer or hard drive dedicated solely to it. Furthermore, this sharing process not only lessens hardware costs, but consolidates resources for maintenance and management, since centralization makes it simpler to accomplish updates, troubleshoot issues, and monitor security. Additionally, the sharing of resources is also highly efficient as it optimizes the use of networked devices, leading to greater levels of productivity. It allows free access to centralized servers for storing and retrieving documents based on the need and enables users to eliminate the redundancy of maintaining separate files on individual machines which is a common function in a typical office. It guarantees synchronization and consistency of data over the network while eliminating data loss and version conflicts. One of the stark advantages of sharing resources is internet access, another vital resource shared within a network. Organizations can share a single internet connection between many devices, streamlining connectivity and enabling them to save costs. This is especially critical in environments where internet is integral to business operations, including research and development, communication, and access to cloud-based applications. Because of this, their usages can be seen in terms of cloud computing, where millions of computations are performed over several machines on

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single network. This not only enables high-performance computing to be feasible for more users, but also increases scale, as users can use other resources as needed. Networking goes beyond the sharing of tangible resources such as printers and storage to include sharing software applications and services. Licensing software can be expensive and constitutes a considerable cost for organizations; however, if a single instance of software or single license is shared through the network between multiple users simultaneously, the organization can cut down on the number of licenses purchased without breaking the licensing agreement. Notice that networked systems not only allow sharing of data and databases but also provide a basis for collaborative operations/activities in real time. For instance, in a collaborative workplace, employees can share a common database of customer data, sales records, or project data, enabling them to work simultaneously on the same data set while making data-driven decisions based on the most current information available. Resource sharing plays an important part also in terms of enhancing efficiency and availability. As long as users have the correct permissions and credentials, they can access shared resources from anywhere at any time in networked environments. However, this is particularly relevant for remote workers and mobile devices that connect to resources and services hosted within the network, allowing for flexible work arrangements and eliminating geographical constraints. Resource sharing encourages sustainability from the perspective of network economics. This will reduce the need for repetitive hardware and infrastructure, thus fostering a decrease in electronic waste and helping to reduce the overall environmental footprint of the use of technologies. By managing resources more efficiently, centralized systems also consume less energy and thus contribute to environmental conservation as well. Network Sharing Security is one of the most important aspects to consider while sharing network resources. Without proper access controls, encryption, and monitoring mechanisms in place, shared resources may become vulnerable to unauthorized access, misuse, or data breaches, jeopardizing the security and confidentiality of critical information. Additionally, resource-sharing protocols, and policies should still be implemented to guarantee the integrity and trustworthiness of the shared assets. In summary, networking resource sharing helps save costs, increases



efficiency, scales easily, improves accessibility, and is sustainable. Making use of networks ensures that resources are used to their fullest potential, that everyone's a little more coordinated and most importantly, that the tech world is a little bit more connected as well. Nonetheless, the ongoing efforts to secure and control access are vital to preserving the advantages of sharing resources in any networked setting.

2. Data Exchange and Communication

You could say that networking is the backbone of communication in the modern era, as it allows different devices to communicate over various platforms and at different locations. More fundamentally, a network consists of connected devices which exchange messages according to standard protocols. From the computers and smartphones you use to printers and IoT devices, these devices all rely on their networks to operate optimally. Sending emails, streaming videos, or transferring files over long distances is possible thanks to the strength and scalability of networking systems. Connecting devices over local area networks (LANs) (such as computers in a home or within a business) or across wide area networks (WANs) (such as across entire countries, or between continents) to enable the data to flow is the role of networking. The emergence of the internet reshaped networking, creating a universality for data exchange. The most conspicuous example of a WAN is the internet, connecting billions of systems globally for purposes ranging from social networking to e-commerce. Networking involves various protocols, including TCP/IP, that define how data is sent over networks in a reliable, efficient, and secure manner. Once a system attains the capability to pack data into packets, it can build multiple protocols to deal with errors and route the packets to ensure that they reach the right destinations, adjusting the route on the way as the connection may be blocked by congestion in the network or a downstream failure. Being able to send a packet to its destination using any number of different paths, retry in the event of errors, and similar, is how we get the ability to use different links that are being constructed and such are working at the margins of being useful or functional. In addition, networking has extended well beyond a computing system. Another instructing technology



that readily comes to mind the explosion of Internet of Things (IoT) devices that have introduced a whole new era of networking where your refrigerator, your thermostat and even your car all talk to and share information autonomously. This adds convenience, productivity, and automation in our life as everything is now connected to each other. Moreover, as cloud computing becomes more widespread, networking enables the storage and processing of data to take place far away from the local machine. Desktop computers are becoming less effective due to their dependency on physical storage devices, therefore it allows people to open or play elements from around the world. This transformation democratized access to powerful computational apparatuses, allowing businesses of all sizes to scale as needed. However, security is a major challenge in networking. With there being more and more connected devices on the internet, there are increased opportunities for cyber threats and data breaches. Given the widespread use of the internet and networks for data transfer, protecting the integrity of data transmission and providing privacy are becoming more and more critical, resulting in advanced encryption techniques and firewalls. VPNs and SSL protocols are used to protect sensitive data and keep information from being used as it moves through networks. The proliferation of 5G networks will also enhance connectivity further, enabling faster speeds, lower latency, and more robust connections. Then there is the connectivity aspect; whether that is the opportunity for new applications on top of the 5G stack, such as augmented reality, direct remote surgeries, autonomous vehicles and so forth. As a networking professional, it is important to have a diverse skill set that can adapt to the ever-changing landscape of technology. Networking is a critical part of modern life, from the simplest task, such as checking an email, to the most complex, such as operating a smart factory. It allows companies to function properly, governments to deliver services, and people to communicate with each other. Networking will be including in the major shift of technology in the world and matters a lot as networking will provide the resources of networking in our life. Data and innovation will continue to reshape networking as you know them, and with the increasing significance of artificial intelligence and machine learning, the future of networking will embrace the innovation of these technologies to schedule and protect traffic efficiently



while anticipating failures before they happen. Since 22nd September 2021, UPH offers a new program on IT namely the International IT Networking Program, which is a Comprehensive of Networking course. It allows to communicate data, provides internet access, permits authenticated communication, and will keep developing concerning the new innovative advancements, continuing to determine the manners in which we connect with each other, business, and innovation all through the world.

3. Collaboration

Networking is a basic aspect of ensuring collaboration, enabling people, teams, and organizations to work with each other effortlessly as needed, with little or no geographic boundaries. Networking enables multiple platforms for collaborative work by providing the infrastructure for communication and data exchange. Cloud computing is an essential element in contemporary workplaces, providing access to shared (cloud) resources and storage where different users can work on the same documents and applications at the same time. By having all participants work together, it also promotes a top-down approach of everyone having access to the same files, minimizing redundancy and mistakes. In addition, the flexibility of operating from anywhere, on any device, thanks to cloud computing greatly enhances productivity and streamlines workflows. Networking also enables communication tools, including video conferencing, which are critical for virtual teams but are less well-known than cloud-based platforms. These make virtual meetings possible by eliminating the need for physical presence, thereby connecting team members across locations. No matter how innovative your shared format is, you still have video conferencing platforms with screen sharing, breakout rooms and real-time collaboration on digital whiteboards to work with teams, carry out dynamics and make decisions on the run even when you are a world apart. This face-to-face engagement emulates in-person meetings, allowing collaboration to take place in real time and facilitating better brainstorming and problem solving. Instant messaging platforms help to improve collaboration through quick, informal communication between team members to share updates, ask questions, and resolve issues in real



time. This responsiveness minimizes lag time in communication, and allows for agile decision-making and rapid progress on projects. Project management tools, for example, rely on networking to connect with these communication platforms, forming a seamless ecosystem where tasks, deadlines, and project milestones can be monitored and adjusted in real-time. These tools create a single space for members to view progress, assign work, and even discuss those individual components of a project, keeping the entire team aligned. These tools, when integrated within a networked environment, create transparency, accountability, and coordination. Apart from that, networking can facilitate the use of collaborative software, specifically in the cases of document editing, design work, and the end result of coding, where multiple users are able to work on one document at the same time, adding ideas and edits step by step in real time, improving the development process and creating innovation. Another key area networking helps with is the security, to keep our collaboration safe and efficient. Sensitive information and the privacy of collaborative work is preserved through secure communication protocols, encryption, and access controls. As we become more reliant on digital platforms for collaboration, strong security features protect data from unauthorized access and mitigate the risk of cyber threats that could potentially disrupt the collaboration process. Networking is a compelling tool in expanding teamwork, as it provides vital communication pathways as well as post file flow and immediate co-working facilities. Networking allows cloud computing, video-conferencing, instant messaging, and work groups, which ultimately leads to more efficient, flexible, and innovative teamwork. It not only makes information seamless to share, but makes that collaborative process secure, smooth and effective regardless of distance.

4. Remote Access

One of the greatest advantages that networking has brought to the world of IT is that businesses can now function remotely, with access to their systems and information. This connection leads to greater productivity because employees are exposed to working in almost any situation, be it at home, a coffee shop, or whilst travelling. So, the business no longer needs to function on traditional office timings, or location-specific working, enabling flexibility that meets the



needs of the modern workforce. The main advantage of networking is that employees can access files, applications and databases hosted on central servers. These resources are accessible securely through virtual private networks (VPNs) or cloud-based services, protecting data while allowing users to continue working seamlessly. This setup allows for employees to pull documents, work on common platforms, and carry on projects without needing to be present in the office, which is ideal for companies that work across time zones or geographical areas. Moreover, it helps in collaborating in real-time. Whether through video conferencing tools, instant messaging apps, or cloud-based collaboration platforms, teams can communicate and share information efficiently no matter where members are physically located. Being connected means making workflow easier, faster decisionmaking and innovation as teams can immediately troubleshoot, brainstorm and implement without worrying of distance or time zone. Also networking reduces redundancy and improves productivity because it centralizes the data and applications. Instead of employees working on unrelated and completely isolated systems, everyone can work off of a centralized server or cloud infrastructure, making sure everyone is up to date on the same information. This prevents duplication, reduces risks of error, and allows employees not to waste time searching for files or updating versions. Brought to you by Diseconomy Data Decoders Event The higher efficiency through aggregation also does wonders for organizational costs. Companies can optimize office space as the need to physically be present in a space diminishes because work can be done remotely. This leads to the ability of companies to organize better human resource management by providing telecommuting options, making them hire talents from a wider field without consideration of the area. Networking can also automate processes, from payroll to inventory to customer service. Cloud-based systems and computer systems, with the help of ERP software, are designed to estimate what was previously manually entered into a system and free up time and resources, whilst reducing human error. Furthermore, the networking aspect enables increased work-life balance, which can improve employee satisfaction and retention. It provides workers the ability to handle their schedules better, with keeping a balance between personal responsibilities and work duties.



This arrangement has shown that it boosts motivation and job satisfaction, resulting in increased performance and lower turnover rates. When we talk about security, Remote access has always been labelled at risk; however, today networking technologies come with strong encryption methods, multi-factor authentication, and continuous monitoring that protect users from data breaches and ensure unauthorized access to sensitive data is eliminated. By implementing strong cybersecurity measures along with regular updates and training for employees, businesses can cut down the risks involved in remote access and protect data privacy. On the other hand, companies should also be ready to tackle the problems which remote work presents, including ensuring appropriate communication flows, establishing clear expectations, and providing assistance for workers who may encounter technological problems. To overcome these challenges, you need strong leadership, the best fitness training, and the right combination of tools and platforms that promote seamless workflows free from interruptions. The agility that comes with networking isn't only relevant for the ability to work from anywhere; it's about how quickly a business can respond to shifts in the market or other unexpected setbacks. From navigating an economic contraction to managing a natural disaster or the global health emergency brought on by the COVID-19 pandemic, businesses with robust networking capabilities are more adaptive and able to adjust their operations and remain viable with minimal downtime. In summary, networking creates many benefits which greatly improve productivity, flexibility, and efficiency within the modern workforce. It makes information accessible from anywhere, enables collaboration, centralizes information, automates processes thus helping businesses stay agile and competitive in the constantly evolving global economy.

5. Scalability

As the demands of modern technology, businesses, and users continue to expand, a good network design is invaluable to satisfy these expectations. Organizations and societies are more reliant to digital solutions and therefore networks are required to scale easily; using more devices, users and traffic should not need a full upgrade in existing network architecture. Scalability refers to the capability of the network to efficiently provide services to



increase our devices and services or applications above one. It offers this flexibility so smoothly that any network can be expanded as per the need of organization without going through any complex configuration or performance degradation. Designing networks with scale requires flexibility. That includes the modular designs that enable quick addition of new components, be it extra servers, storage, or communication paths. Cloudbased architectures, for instance, have seamless scalability; adding additional virtual components (servers, storage capacity, etc) is possible without altering the entire framing of the network. In a similar vein, software-defined networking (SDN) allows for the centralized management of network traffic and simplifies resource provisioning in response to changing demand. This adaptability allows network administrators to modify bandwidth, security configurations, and routing protocols without substantial impact on the underlying framework of the network, maintaining the balance of growth without complexity or instability. One of the key properties of scalable networks is the efficient distribution of the traffic along the available resource. Scalability: The system should be able to accommodate the addition of more and more devices or users connecting to the network, with appropriate management of data flow to avoid bottlenecks or overloads at any one point. One example is load balancing, like how traffic is distributed evenly over multiple servers or routers. This allows the network to support more devices or traffic without degrading performance or causing network failures. Additionally, an appropriately architected network allows users to scale system performance without concerns of the systems slowing over time. This enables, for example, the resource consumption based on priority (or need), meaning that if you have a critical application or service, you can ensure that it gets the resources it needs, even if it is under heavy load. Translate your data into better decisions and actionable insights in real time. It is especially critical in high-performance and low-latency environments, such as in healthcare, finance, or industrial control systems. Quality of Service (QoS) protocols, for example, are a type of adaptive technology that helps prioritize traffic and maintains the desired performance levels by allocating higher priority to critical data streams compared to less timesensitive flows. Finally, scalable



networks must allow for the adoption of new technologies and innovations without requiring significant changes to the underlying infrastructure. New devices, applications, or protocols should be able to plug into the existing network without diminishing its performance. This necessitates a common set of network protocols, so for instance introducing new technologies does not need custom configurations. Furthermore, they have to adapt to changing security needs as new attacks will be developed all the time. The latter allows advanced security features, like encryption and firewalls to be implemented without compromising performance.

6. Centralized Data Management

Networking facilitates centralized data management by connecting multiple users to the same shared resources like databases and servers, allowing them to access and interact with the data at once in a coordinated manner. This describes a central model of data storage and management where a centralized system or server stores the data in a networked environment for remote access by different users or client-driven devices. This gives us better organization, consistency, and control over critical data. In the context of business or enterprise, for example, a centralized database may be shared across departments or associated teams that can all work from the same, most current data. Thereby, removing the chances of data repetition, inconsistency, or version inconsistencies that may happen when data is stored locally on numerous devices. Centralized data management also increases backup and recovery operations efficiency. As it stores all data in one place, it is easier to set up periodic backups, which lowers the potential for data loss caused by hardware malfunction, human mistake, or a cyberattack. Organizations can reliably restore their data to a consistent time after any disruption when a backup strategy is in place. Centralized data also makes it easier to implement security protocols. Rather than protecting data scattered across disparate devices, network admins can concentrate on the central computer on which sensitive information resides. It allows one to easily enforce security rules (firewalls, encryption, access controls, etc.) The data must also be managed by users that have an optimum understanding of the operations of a specific domain. Centralized data management also supports the ability to apply



disaster recovery plans. In case of disaster, centralization of all data in a secure and accessible place helps in recovery with less time leading to less downtime of business operations. Further, it facilitates the optimization of resources, like computing power and storage, that can be dynamically allocated as required by the network and users. A further benefit offered by centralized data management is a simplification of software updates and maintenance. If software has to be updated or system updates are needed, then network admins can deploy them to the central system so that all users are using the latest versions and security patch. It ensures that all parts of the organization are updated all the time, preventing the potential risks of any outdated software. Centralization introduces a common platform for database to cooperate on planning, sharing, and altering documents and applications. They allow users to concurrently access and edit information, and updates will be shown in real-time, which can enhance collaboration and enable better decision-making. This becomes especially vital in sectors that deal with time-sensitive information like finance, health, and logistics. The data will be synchronized across all branches during operation, and centralized management can provide real-time control over the information flow. Centralized data storage and retrieval allows organizations to streamline their processes and mitigate risks, ensuring that essential information is always accessible, reliable, and secure.

7. Security

Centralization of security at the network level increases the security of systems and helps to secure and protect systems correctly much more efficiently than doing it on single systems. Implementing firewalls, which are critical to networking, is one of the major advantages of networking. Firewalls monitor both incoming and outgoing traffic, filtering data based on established security rules. This ensures that traffic flows according to established rules and protects the environment within the local network. This minimizes the risks of potential vulnerabilities resulting from individual systems that are either unprotected or misconfigured. Networking is also useful for encryption, another key security approach. Also, it isn't always possible to encrypt sensitive information that is sent



over a network, allowing such information to be intercepted. This means that even if there are unauthorized access to network traffic, they cannot understand the data without the proper key to decrypt it. The centralized encryption management in a network streamlines the process of updating encryption protocols and keys, granting all exchanged data within the network continued protection without the need to physically engage all different systems to easily update encryption settings. In addition, networking allows correct access control to be implemented, controlling who can access specific resources within a network. Organizations can enforce stringent access policies by using centralized user authentication systems like LDAP (Lightweight Directory Access Protocol) or Active Directory. For instance, you can limit access to sensitive data to authorized users, while denying access to others depending on their role or department or clearance level. Centralized access management allows security rules to be enforced from a single location, making it easier to update user permissions, deny access to dispossessed user and review user activity on a network-wide basis. By eliminating access control on each different system, access control is more manageable, even if its environment may be more diverse. One of the other most notable benefits of networking is that it enables to deploy security patches and updates in a centralized manner. Patch management in a networked setting allows for security patches to be distributed and applied to all systems over the network, ensuring that vulnerable systems are patched according to international policies. As all systems receive centralized updates simultaneously, the risk of one system being exposed to cyber threats while others are patched is diminished, effectively closing the window of vulnerability. By contrast, continuous updates on a per device level open the door to human error or lack of attention leaving certain devices vulnerable to exploitable security compromise. One of the many important features of networked systems is that they allow for the use of intrusion detection and prevention systems (IDPS) to monitor all traffic in real-time for any suspicious activity and respond automatically to potential threats. These systems can be controlled from a single point to identify and protect against cyberattacks like denial-of-service (Dos)...or malware infections. They can also correlate events from different systems in order to detect events that are localized to individual systems and



may not present at first — because it is happening outside of their local view. Centralized monitoring for network security not only helps detect intrusions, but also makes it possible at a faster pace to respond against potential threats, as security personnel are able to react instantly to alerts can be managed from a single console. In addition, networking allows organizations to easily implement and enforce security policies. That is, policies that specify how to treat data; who can access certain resources; how systems should be protected, can be applied consistently throughout the network. Using networking, administrators can deploy and enforce policies that can be applied across all connected systems, providing consistent protection from threats such as malware, phishing, and unauthorized access. In contained, isolated environments, it becomes difficult to achieve this level of standardization, where each environment may need unique configurations and more security aspects. Furthermore, networking also streamlines security audits and compliance checks. Because we can collect and centralize data and logs from all connected systems, administrators are able to more quickly review security events, track incidents, and maintain compliance with industry regulations. It significantly reduces administrative weight, ensuring that the audit is tight and reliable. Therefore, networking improves security through centralized control on firewalls, encryption, access control, updates, intrusion detection, and policy enforcement. Centralization makes it easier to manage security measures, ensuring consistency across the network and a more proactive and coordinated approach to protecting sensitive data and preventing unauthorized access. Individual systems, on the other hand, face challenges in implementing security policy, handling updates, and responding to threats.

8. Cost Efficiency

In the wake of organizations daily struggling to optimize operational costs, one of the proven ideas that helps organizations achieve this is executing sharing of resources – whether servers, storage, or internet connectivity. In a traditional setup, this translates to assigning dedicated resources to each device in an organization i.e., servers or a sterilized space for storage. For



companies that grew or had locations in multiple areas this approach, however, was expensive and ineffective. Transitioning to a network-based infrastructure, where resources are shared rather than silos built, organizations can drive efficiencies, eliminate duplicative costs, and foster a more economic model. Centralized management is one of the key advantages of shared resources. This eliminates the need for each device or workstation to have its own IT (dedicated server, data storage unit, etc.), and allows for resources to be pooled in a central location. This allows IT staff to control a single network from one place to reduce the complexity and expense of managing a distributed IT environment. This centralization saves on the cost of personnel as well as the avoidance of underutilizing resources. For example, a shared server can support multiple applications and requests, when one or the other requests are not more helpful, use better resource allocation, fewer downtimes, and fewer inefficiencies over multiple servers or storage systems. In addition, shared resources enable companies to scale their operations more efficiently. The growing needs of a business can be well-served by simply adding more storage space, additional processing power, or larger internet bandwidth to the alreadyshared infrastructure, rather than requiring each department or team to invest in independent infrastructure. This approach allows to drive growth without a constant investment into new hardware alongside a reduction in capex. The scalability also enables businesses to respond rapidly to evolving market conditions by being able to scale up or down IT needs depending on workload requirements, also freeing them from being provisions of a fixed amount of resources.

The economic advantages of resource sharing include lower energy use. That requires electricity in significant amounts because each application, or function, or device runs on its own, dedicated server. Organizations can pool resources on shared servers or employ cloud infrastructure, allowing for much more efficient energy usage. For instance, the design of modern data centers focuses on maximizing energy efficiency by utilizing advanced cooling systems and power management technologies, which have decreased the overall energy footprint significantly. Utilizing network-based power and the



IoT in centralized systems allows companies to reduce energy consumption at a lower cost and build a green industry. Not only does the shared usage reduce capital and operational costs, but it also improves the productivity as well. Sharing Resources: Employees and departments can easily access resources like internet connectivity, server capacity and storage, which can also lead to more efficient management of resources across the network. This makes it easier for teams to collaborate, act more quickly and ensures a streamlined flow of information. Shared resources eliminate the problem of waiting for access to dedicated machines or systems, which can delay operations. Instead, resources can be dynamically deployed as required to enhance the speed and efficiency of workflows. This is another one of the main benefits of sharing resources better security. In a centralized network, a single point handles security protocols rather than attempting to secure several disjointed devices or systems. Centralized networks enable organizations to deploy consistent security policies, monitor activity across all devices, and protect all resources from cyber threats. This helps minimize the risk of data breaches or security incidents, as the organization has greater control over its systems, and can patch vulnerabilities more quickly and consistently across all devices. Thirdly, shared resources make it more straightforward to collaborate with external partners or stakeholders. Such as, cloud-based storage or shared servers allow employees to access files and applications from any location with internet access, making it easier to work remotely or collaborate with teams in different geographical areas. It enables communication and sharing of resources, leading to greater overall productivity and savings on travel and office space. This provides a strong mechanism for organizations to decrease their operational costs by using the same resources servers, storage, internet connectivity, etc. This helps businesses run more efficiently and effectively by centralizing management, improving scalability, optimizing energy consumption, enhancing productivity, strengthening security, and enabling better collaboration. Moving toward shared resources is a genius, cost-saving way to do business in the modern world, allowing businesses to remain nimble in a marketplace that is always evolving.



9. Fault Tolerance and Redundancy

One of the main techniques to achieve fault tolerance is redundancy connections. Using multiple physical or logical routes between devices allows networks to redirect traffic if a primary connection goes down. For example, when a router or switch goes down, the redundant path ensures that data is still routed, preventing a single point of failure from affecting the entire network. Notably, this redundancy is not limited to connections; it also includes important infrastructure components like power supplies and storage systems, preventing a failure in one to translate to failures in other components, keeping the entire system up and operational. Backup systems are yet another key component of fault tolerance. These systems are designed to kick in whenever primary systems crash, ensuring that services continue to run smoothly with minimal disruption to users. This is commonly implemented with data centers that regularly create backups of critical data and store them in different locations. Backup systems can provide that in case of a hardware failure or a data breach, allowing essential information to be rapidly restored and ensuring that it will not take long until operations can be resumed without major loss. Additionally, backup power systems like uninterruptible power supplies (UPS) and generators enable the continuation of service during electrical outages, contributing to the resilience of the network against disruptions. Another critical component of such fault tolerance is failover protocols that allow automatic escrow to backup systems or pathways in response to a failure detection. These protocols also need to be invoked to constantly monitor the health of network components and provide an instantaneous response when it fails. Failover protocols, for example, can automatically reroute tasks to a secondary server in the event of a server failure, which results in little to no disruption to the user's experience. Furthermore, combinations of end-to-end encryption with load balancing are also prevalent among these protocols, as it helps to maintain proper traffic flow and avoid a single point of failure as a potential attack vector. Training weights and biases adapt into highly resilient network infrastructure, most responsive to a diverse types of failure through a combination of these mechanisms. To increase fault tolerance, modern



networks rely on SDN (software-defined network) and NFV (network function virtualization). Some of these technologies enable dynamic configuration and management of network resources to mitigate failures quickly and cost-effectively, minimizing human intervention. SDN achieves this by abstracting the network's control plane and enabling the automated rerouting of traffic, whereas NFV allows the virtualization of network functions and facilitates the rapid deployment of backup services and resources in real time. Modern networks, when they incorporate fault-tolerant designs, can survive and dynamically react to failures in the components preserving high availability and minimizing downtime, which allows for an uninterrupted supply of services. Network faults are increasingly being designed to be handled gracefully using redundant connections, backup systems, failover protocols and other mechanisms so that they have little to no impact on users or business operations. And as SDN and NFV are progressively incorporated, greenhouse fault tolerance enhances the entire system, enabling a dynamic and robust architecture. Such mechanisms are central today where across-the-board network failures can radically affect performance and customer satisfaction.

10. Integration with the Internet of Things (IoT)

Networking forms the backbone of IoT, as it is the integral component that allows these everyday objects to connect to the web and interconnect with other devices, thus enabling the formation of interlinked systems that enables a smarter life. For instance, in a smart home setup, various IoT devices like thermostats, lighting systems, security cameras, and appliances are interconnected and linked to the internet, enabling users to control and monitor them from a distance. It provides ease, energy saving and added security. This connection can be enabled using networking technologies that includes Wi-Fi, Bluetooth, Zigbee, Lora WAN and cellular networks. These technologies provide the communication pathways that allow devices to exchange information, streamlining real-time analytics and automating processes. 2. Networking Devices as the Enabler of Seamless Communication: As the IoT ecosystem expands, it is increasingly relying on robust networking solutions that facilitate seamless device interaction, data



transmission, and integration. In most smart cities, much of the IoT networks control urban infrastructure, including traffic lights, waste management, water distribution, and air quality monitoring as a primary application. Citywide sensors gather aggregated and real-time data that pass through the network to various centralized platforms to analyze the data to assist city planners and administrators in decision making in order to optimize and improve utilization of resources and public services. Likewise, in industrial automation, IoTequipped sensors and machines interact through networks, monitoring production processes, tracking inventory, predicting maintenance timing, and increasing safety. All of this results in improved operational efficiency, less downtime, and enhanced decision-making. Yet with the rise of IoT networks, comes substantial hurdles. Thus, the management of IoT networks needs careful planning with many devices, various technologies along with high bandwidth, low latency, and security. And for example, with more devices coming online and needing to connect, routing data effectively and ensuring that your network doesn't become congested is key. Also, the security of IoT is an important area, if vulnerable, it could allow for data breach or unauthorized control of devices. Thus, Encryption, confidant protocols, and strong authentication mechanism are part of IoT network architecture. With these, 5G networks can solve some of the existing problems, delivering high capacity, high speed and low latency connectivity to cater the vast volume of connected devices that IoT solutions require. Also, edge computing is being brought forward as a means to process data closer to the sensor that generates it, which leads to lowering the network strain while providing a faster reaction time. This makes it more efficient and scalable inside the IoT networks. As IoT evolves, it will depend more and more on advanced networking technologies to enable its expanding ecosystem. Whether it's building smart homes, smart grid, smart factories, smart cities, and smart industries, at the center of the IoT revolution is networking, which is bringing together physical and digital worlds like never possible before.



• TYPES OF NETWORKS

a) Local Area Network (LAN)

A Local Area Network (LAN) is a network of connected devices, usually within a limited geographical scope, such as a home, business or a building. This enables users and devices to interact with one another, share resources, as well as access centralized data or services. As data centers become tangible LANs, regardless of whether your system consists of just a few resources or thousands of them, LANs are integrated into your system. A LAN may be as small as a few personal computers in a single room or as large as several hundred devices spread across several floors of a building. A LAN is primarily used to enable communication and data sharing among devices in a small geographic region. It operates as a high-speed link between transferred data and shared services. This enables file, printer, and internet sharing amongst device users. In an office, for example, employees can share access to documents stored on a centralized server or print to a shared network printer. Session Overload (House not Capitalized) In residential setups, the same router can connect multiple devices to the internet, allowing all members of the family to use the internet at the same time. Local Area Network (LAN) Protocols LAN usually function on Ethernet or Wi-Fi protocols. Ethernet is a wired connection method. Ethernet networks are generally more secure and resistant to interference than wireless networks. While traditional Ethernet uses physical cables to connect devices to a network, Wi-Fi is a type of wireless technology that enables devices to connect to the network without the need for physical connections. Wireless LANs are widely used in situations where mobility is desired, such as cafe and airports, in addition to home environments. Centralized Resources One of the significant benefits of a LAN is centralized resources. If it is a LAN then, we may need a file server or a database pro server to store our sensitive files and applications and access from multiple devices. Centralization helps simplify management and maintenance, allowing for software updates, backups, and security measures to be applied to the central server, which guarantees that all devices in the


normal network are up-to-date and secure. LANs also allow some costly hardware to be shared amongst users. With a network connected devices like your printer, you can connect a single printer to the network and share it among the users, eliminating the need for everyone to have their own printer for each device. Switches, hubs, routers and cables are used to implement LANs. One of them, a switch, is a central device used to connect many devices in a network. Because computer network protocol receives data packets from a device and sends them to the correct device. Routers connect a LAN to external networks like the internet and allow communication between different LANs. Chub is a less common network component, but is a common component of LAN. They act as major points of connection for devices but lack the intelligence of switches to route data in the most efficient manner possible. However, devices are connected to physicall media — for example, twisted-pair cables (Ethernet cables) — to connect physically to the network. In WLANs, access points (APs) are used to allow devices to connect to the network wirelessly.

Local Area Network (LAN) has more advantages than the data sharing. For instance, multiple employees in an office can work on the same project simultaneously on a LAN, share resources, and communicate through instant messaging or email. They have strong security features like encryption and firewall protection that can help secure confidential information from unauthorized access. As administrators in a business environment, they can use those used policies to define what aspects of the network you can access and where you can go when browsing. LANs offer security features that make them the preferred option for organizations and institutions that need to secure their data and control their systems. However, even though they are advantageous, LANs do face some challenges. In some cases, network congestion in a LAN may affect its performance, particularly in a crowded location with numerous devices. This can result in a decrease in provisional full network control that can significantly depress the effectivity of a broadband connection. The physical aspects of a LAN, including cable length and quality, can also affect performance. Wireless Local Area Networks (LANs) can suffer from interference, limited range and security vulnerabilities. If no strong security



protocols like WPA2 are applied, hacking and unauthorized access become much easier to do on wireless networks. The VLAN (virtual LAN) has gained a lot of traction in recent years. OSI Layer 2 Protocols: VLANs (Virtual Local Area Networks) It can be beneficial to divide a network into sections, improve security and optimize data transfer. For instance, an organization may create a VLAN for the finance department, where all sensitive financial data will be isolated from other departments (see virtual area network). They also help limit unnecessary broadcast traffic, improving the efficiency of the network. The rise of LANs had also paved the way for more sophisticated networking technologies such as the metropolitan area (MAN) and wide-area networks (WAN). Local Area Networks (LAN) connect to an area while two others, MAN and WAN connects to wider region and these sometimes connect multiple LANs. While these developments may enhance communication, LANs still form a core part of the networking ecosystem, offering crucial networking capabilities in home, collegial, and corporate settings. Local Area Network (LAN) It is an important part of modern computing that allows devices within a limited geographical area to communicate with one another, share resources and access centralized data. Typically, LANs use Ethernet or Wi-Fi for high-speed, reliable connectivity and resource sharing and collaboration. Despite the challenges posed by congestion, interference, and security, LANs continue to play a critical role in network infrastructure, providing a cost-effective, secure, and efficient way of managing and sharing data within an organization. From student administrations to quick exchanges and secure connectivity from automation of technical task to centralized management systems helping in the organization from systematic scheduling to protocol dependent guidance.





Figure 4.2: Local Area Network

b) Wide Area Network (WAN)

Wide Area Network (WAN): WANs are telecommunications networks that extend over a large geographical area they can connect cities, countries or even continents. It is the basic infrastructure on which we extended it with various LANs and other networks on long range communication, by combining/interconnecting them. Wide Area Networks (WANs) are at the heart of global communication, enabling a multitude of services, including internet connectivity, email, video conferencing, and cloud computing applications. While local area networks usually provide connectivity for a limited number of people within a specific area (such as an office, home, or campus), WANs enable connections being made over much greater distances. WAN architecture enables WAN to process data from one place to another using various technologies of transmission such as leased lines, microwave, satellite link, and fiber optics. The WANs can now function at high speed with reliable communication even in remote, difficult to access locations due to these technologies. Generally in practice, WANs are working under the control of one or more telecommunications service providers, and the service providers makes available on the market WAN communication over leased lines or through internet. Redundant Paths — A major feature of WAN is that they offer redundant paths, so that if one fails, the data can still go through another path. Some characteristics of WANs are scale, complexity, and use different technologies to transmit data. A WAN's backbone is one of its key elements,



consisting of a series of high-capacity transmission lines that connect different regional networks. Backbones are usually constructed from fiberoptic cables or other high-speed connections that can accommodate the vast quantities of data that traverse the web. Also, WANs utilize various networking devices like routers, switches, and bridges to manage the flow of data traffic efficiently between various locations. For instance, routers decide the best path on which to send packets of data considering network congestion and transmission speed so that the information can reach its destination at the first opportunity. The WAN must use multiple protocols and technologies to facilitate communication, manage the complexities and meet the communication requirements. Some of the most common protocols on WAN's are Transmission Control Protocol/Internet Protocol (TCP/IP) which is responsible for the transmission of data packets between the internet and other networks. TCP/IP is a fundamental protocol for the functionality of the internet, as it establishes the format of data packets and guarantees their reliable delivery. Also, WANs use technologies such as Multiprotocol Label Switching (MPLS), Frame Relay, and Virtual Private Networks (VPNs) for regulating the traffic and maintaining data confidentiality and optimizing the performance of the network. For example, Multiprotocol Label Switching (MPLS) is one such technique that enhances the speed and efficiency of data transmission by using predetermined paths that your data can take rather than making routing decisions on the spot.

WANs often transport sensitive information over great distances and through public or shared infrastructure, so security is critical. Thus, WANs normally implement strong security solutions to prevent unauthorized access, data breaches, and cyberattacks. This could involve implementing encryption protocols, setting up firewalls, or establishing intrusion detection systems, all of which contribute to maintaining data integrity and confidentiality. VPNs are also prevalent in WANs, helping secure remote office-to-headquarters communications via encrypted tunnels while routing over public networks. WAN performance is characterized by several parameters, such as bandwidth, latency, and network congestion. The



bandwidth is the virtual bandwidth channel through which the network does send the data, we usually measure it in bits per second (bps). In other words, the greater the bandwidth, the more rapidly data can be transferred, making it especially necessary for applications like video conferencing, file sharing, and cloud computing. Cross-pollinate them with latency-that's a delay that refers to the time it takes for data to go from point A to point B, which is affected by everything like distance between endpoints, frame time, and load on the network. Reducing latency is critical for real-time applications, such as voice over IP (VoIP) or online gaming. Network congestion happens when too many data packets try to use the same bandwidth, and all this sharing can slow down speed and degrade performance. WAN administrators can adjust configurations to reduce congestion and ensure optimal performance, but they must always monitor network traffic. The evolution of software-defined WANs (SD-WANs) is one of the most important advancements in WAN technology. Software controls and optimizes the network — the ability for organizations to build more agile, scalable and economical networks. Organizations can benefit from SD-WANs by abstracting the network hardware, which enables centralized control, making it easier to monitor and manage traffic, configure security policies, and deploy new services. Because the SD-WAN makes dynamic real-time routing decisions based on nuanced network conditions, data will travel along the most efficient path for cost and performance. As corporate resources have become more accessible via the cloud, and the demand for remote access has risen, WAN technologies have evolved to accommodate these trends. Applications that use cloud-based services such as storage, computing, and collaboration tools rely on reliable and high-speed connections between data centers, remote offices, and end users. Consequently WANs are evolving to have a closer coupling with cloud architectures, with businesses now availing themselves of private and public cloud services as part of their WAN improvements. Wide Area Network Configuration: A WAN (Wide Area Network) is a type of connectivity that connects multiple local areas over a distance of at least 1-mile bandwidth. On further consideration, WANs, implemented with advanced technologies such as MPLS, VPNs and SD-WAN, provide scalability, performance and security to handle the needs of modern enterprises in today's data-centric landscape. Despite the difficulties associated



with managing complex networks over long distances, WANs have become crucial to maintaining seamless connectivity in a rapidly evolving global economy.

c) Intranet and Extranet

With the rise of the digital age, it is now more than ever that businesses and organizations depend on efficient and secure communication networks to operate internally and externally. Two networks which are significant in this context are the Intranet and Extranet. They are often confused with one another, but serve different purposes and provide different benefits to organizations and stakeholders. In this article, we will discuss both terms, their features, and how they differ from each other and their usefulness in different scenarios.

Intranet: An Intranet is mostly an internal, private outline of the whole organization in which networking is done internally, as it can be accessed by its members. Unlike the public internet, an intranet is not available to all internet users, but is instead restricted to an organization its members, employees, contractors or other stakeholders-to protect sensitive information or resources. An intranet is a self-contained network that mirrors the structure of the internet, leveraging protocols (like TCP/IP (Transmission Control Protocol/Internet Protocol)) for communication, but resides in a secure environment behind security protocols, such as firewalls or encryption. So, an intranet is one of the essential tools required by modern organizations in any work environment as it acts as a single centralized hub for information, resources, and collaboration between the employees. Internal Communication: A core element of an intranet It enables various types of communication within the organization, such as email, instant messaging, and discussion boards. Using these tools, employees can remain connected to others, no matter where they are, to allow workflows to continue as smoothly as possible and to help prevent potential slowdowns. The icebreaking tools enable employees to interact, upload documents and participate in discussions in a secured environment. The use of a custom-built solution allows for a single system to distribute information thus reducing the noise from external communication channels



and increasing the speed with which information is shared throughout the organization. Intranets, besides communication, act as information and file sharing platforms. Intranet systems store and arrange these documents on shared drives or centralized database that employees can quickly access and share important documents, templates and resources. Centralizing this data means that all employees are working off of the same version of documents that matter, preventing confusion and unnecessary duplication of work. Employees can easily access the information they need to do their job, be it company-wide policy documents, project files, administrative resources, etc. In addition, the implementation of version control allows users to access the most recent file versions, significantly reducing the chance of working with old data. Every intranet needs security as a base requirement. Because intranets are employed to traffic sensitive organizational information, they are secured by an extensive suite of security features. Firewalls, encryption, and secure authentication protocols prevent unauthorized access to the system and its contents. This means employees will have to log in through secure credentials, and access to certain areas of the intranet may be role- or department-based. At this level of security, the organization's intellectual property, financial data, and employee records are protected from unauthorized external access and malicious actors.

Things such as various collaboration tools found in modern intranets help improve teamwork and productivity across the organization as well. New tools like wikis, blogs, project management software, and social networking platforms offer organizations new opportunities for collaboration, knowledge sharing, and staying up to date on developments within the organization. For organizations with geographically dispersed teams, these tools are particularly important in enabling real-time collaboration across locations. All of these integrated tools help employees to update documents, monitor project progress, and communicate with profound precision, leading to smoother workflows and fasttracked decision-making processes. Most importantly, access is another critical functionality of an intranet. This enables organizations to control who can see what resources depending on their role or department. So, for instance, financial data might only be available to the finance team, while human



resources policies might only be available to HR staff. Access control is a vital component of data security as it limits who has access to specific information within an organization. For instances, it boasts several advantages including communication and sharing of data. Intranets can bolster productivity significantly by improving internal communications, enhancing collaboration and providing secure access to resources. Enables employees to access information whenever it is required, work together better on projects, and remain aligned with the organizational objectives. Additionally, intranets cut down on paper-based resources so companies save money not having to print everything out and communication becomes more efficient. Intranet also helps in improving knowledge management within the organization. The intranet itself also usually has knowledge repositories where employees can upload and download important pieces of information like best practices, training materials, and procedural guides. This is of particular value to organizations looking to retain intellectual capital for its use by their trained workers, who need it to achieve success. Intranets can track this data centrally, enabling a consistently high level of domain expertise in the organization, even as employees leave and new ones join.

Extranet: Another type of private network is an extranet that extends the traditional capabilities of an organization intranet to external stakeholders such as business partners, suppliers, contractors, and customers. It enables sharing and interaction with anyone outside your organization, while protecting the confidentiality and integrity of internal data through security boundaries. An extranet is a private network that connects a business with its external partners, facilitates the exchange of information, streamlines business processes and strengthens relationships. The primary aspect of an extranet that enables external access to specific data, applications, or services hosted on an organization's network. For example, a company may provide its suppliers access to its inventory management system, so they can view stock levels, place orders and track shipment statuses. Well, this encourages more seamless collaboration between the company along with its suppliers because everybody involved can get in real-time data which



can minimize delays led to in the organization process and improve optimize in the system side of the supply chain. For example, a company might provide clients with access to product catalogs or order tracking systems, allowing them view account information and place orders without continuous to communication with service representatives. Organizations employ rigorous security protocols to guarantee that only authorized individuals have access to the extranet. These mechanisms include password protection, digital certificates, and Virtual Private Networks (VPNs), which provide security by ensuring that only legitimate external users are able to access sensitive resources. Extranets use these security measures to keep sensitive data safe from unauthorized personnel, while still permitting the intended external users to work together. Furthermore, many extranets are set up to provide varying levels of access based on the user's specific role or relationship with the organization. A supplier might have access to inventory data while a customer might only allow access to product information or order tracking.

A key function of an extranet is its ability to facilitate collaboration and communication between an organization and their outside partners. Examples of switches would be shared document repositories, messaging systems, and project management software, which help users collaborate efficiently on joint ventures or partnerships. This proves vital for long-term partnership-based organizations or organizations with an intricate supply chain. Extranets can help minimize the need for in-person meetings and time-consuming email exchanges, allowing faster decision-making and increased productivity. They hold shared content, another important factor of extranets. Extranets can be used by organizations to share key information with their external users, including pricing updates, product specifications, contracts and marketing materials. This helps businesses to provide up-to-date and accurate information to their external stakeholders, thereby improving customer satisfaction and helping organizations to become a more competitive player in the market. By allowing suppliers access to the most current product designs or specifications, an organization can achieve alignment between its supply chain and its current production enhancing that's responsiveness and their performance. Another major advantage of extranets is the customization

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feature. Extranets allow organizations to customize the access for each external user. With tailored access to relevant resources, organizations can make sure that every external party only has visibility on the resources they require for their specific role. So a contractor might need access to construction plans and schedules, whereas a supplier might need access to just procurement information. By providing customization, it helps to control sensitive data and gives the ability to access the required information to the external users. Key benefits of using extranet in the organization include: enhanced collaboration, improved customer service and satisfaction, seamless business process automation, cost-effective processes, and improved data management. An extranet also facilitates collaboration and creates a platform to streamline processes and minimize delays by granting external entities secure access to select resources that will help improve communication with partners, suppliers, and customers. Extranets play a vital role in providing organizations with customizable access according to their needs and the effective and efficient sharing of content between the organization and partners.

• NETWORK TOPOLOGIES AND ARCHITECTURE

a) Bus, Star, Ring, Mesh, Hybrid Topologies

Network topology owns all of the nodes, links and devices inside a computer network — both the logical and physical arrangement. It allows devices to communicate with each other, determine how data traverses the network, and connect the components. Network topology is critical for ensuring a scalable, efficient, secure, and fault-tolerant network. Network Topologies and their Pros and Cons (and suited Networks) Different types of network topologies come with their advantages and disadvantages, making them suitable for different network sizes and requirements.

Types of Network Topologies:

• **Bus Topology** Bus Topology is the simplest and cheapest topology The bus topology. Bus Topology In wire bus topology, all connected devices are connected to a common single central cable bus or backbone. When one device transmits data, that signal is propagated across the bus and



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• is accessible to all devices, though only the intended target processes it. The number of connections is reduced in this topology, making it easy to install and requiring less cabling, hence cost-efficient for small network. But with more devices, it can become congested, and data collisions can occur, causing the network to be inefficient. And if in addition the central cable fails, then the entire network can go down, which makes it less fault-tolerant.

- Star Topology Overcome the drawbacks of Bus topology by connecting each device to a central hub or switch. The primary device is in the middle to route the data flow discretionally. Star topology is beneficial for troubleshooting. If a device fails or a cable goes out, the problem can usually be narrowed down to that particular device or cable. Moreover, data collisions are avoided as each device is connected separately to the hub. The big downside is that this central hub is a single point of failure. If the hub or switch fails, the whole network is impacted. Nevertheless, star topology remains the most common LAN topology because of its simplicity and reliability in the majority of business settings.
- **Ring Topology** devices are arranged in a loop, with each device connected to two other devices. Data in this configuration is always one way around the ring; it turns a corner and heads towards its destination. Data transfer speeds can be good in a ring topology, as the data passes in one direction around the network and does not run the risk of getting congested, as it can on bus networks. However, the topology is highly sensitive to disruptions since if any Device/ connection fails it can break the ring that can disrupt the whole network. In this type of network, some ring networks utilize a dual ring or backup path to achieve redundancy and fault tolerance.
 - Mesh Topology his redundancy provides multiple routes for data to take, improving fault tolerance and network



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reliability. The data can travel through other roads if one route has a problem. Suitable for data centers and large enterprise networks that require always available environment, it is highly scalable and faulttolerant. Its complexity and cost, however, are major drawbacks. Due to the need for multiple connections between devices, the latter can become pretty costly, and managing the network is not always easy, especially with the number of devices increases.

- Tree Topology, Tree topology, also known as hierarchical topology, is a combination of star topology and bus topology. So it has a tree of devices where it has one root node that branches out into other nodes. Network Topology: Tree So, tree topology is a highly scalable and efficient topology, which can be adapted to work for large organizations, needs a very large number of devices to support the network. Similar to star topology, this supports easy isolation of problems to a particular branch. That strength, though, can be a weakness: HDFS relies on the root node. Widespread failures can be caused across the network if the root node fails.
- Hybrid Topology is a combination of any two or more topologies. By using this method, network designers can take advantage of the strengths but not the shortcomings of various topologies. A hybrid may also use a star topology for connecting devices on a LAN and bus topology to connect multiple star networks. Since they combine multiple topologies together, they can offer a customized approach to topologies based on the needs of a large and complex network. However, they can be harder and more costly to design, implement, and maintain than simpler topologies.

b) Network Protocols and Models

Network Protocols and Models IT Essentials Updated These set of protocols allow information to be communicated, transmitted, and interpreted accurately and without conflict despite differences between the devices from which it is exchanged. The models are the set of abstractions that guide the design of these protocols as well as their specifications. Here's a breakdown.



Network Protocols: Network protocols are essential for defining the rules and conventions that govern communication between devices within a network. These protocols govern how data is exchanged between systems, facilitating interactions and services. An example of a basic protocol built on top of IP is the Transmission Control Protocol (TCP), a connection-oriented protocol that provides reliable data transmission between devices. It divides the data into packets, sends it to the destination, and ensures that these packets arrive in the right sequence and without corruption It ensures that all packets sent are successfully received, even with issues such as packet loss, using methods such as acknowledgments and retransmissions. Together with TCP, the Internet Protocol (IP) performs the important work of giving each device an address, then sending data packets from one network to another. It's the postal system of the internet, making sure that everything sent from one device is routed properly to its eventual destination; the foundation for packet forwarding. Data travels where it should when IP addresses identify devices on the network. A major protocol is the Hypertext Transfer Protocol (HTTP), which describes how things are shared from their web resources over the Internet. HTTP manages the interaction between clients, which can be web browsers, and servers, detailing how requests for web-pages and other resources is done and how responses are delivered.

Its a critical component in delivering the rich media content we consume every day. Likewise, the Simple Mail Transfer Protocol (SMTP) handles the transfer of e-mails between the e-mail servers and provides the correct delivery of the emails from one host to another. SMTP is the communication standard for sending messages, especially across the internet. The File Transfer Protocol (FTP) is another important protocol that facilitates the transfer of files between computers on a network. File Transfer Protocol (FTP)FTP allows users to transfer files back and forth to the remote server with easy-to-use command line and graphical interfaces. FTP can transfer binary as well as ASCII files, and can be operated in passive mode, making it hugely versatile for file-sharing needs.



Finally, the DNS is the phone book for the internet, translating humanreadable domain names (like " to machine-readable IP addresses. This translation is crucial factor because, although humans name websites for identification, computers use numeric IP addresses to find servers hosting those websites. The Domain Name System (DNS) plays the vital role of translating human-readable domain names into machine-readable IP addresses, so that when users enter a domain name in a browser, the corresponding IP address is resolved, enabling users to visit websites without memorizing confusing numerical sequences. These are the core protocols for modern communication systems, guaranteeing that data is transferred correctly, effectively, and safely across different networks. They are the backbone of global communication, supporting anything from email exchanges to web browsing and file transfers.

Network Models: OSI (Open Systems Interconnection) and TCP/IP models are the 2 most basic network models. It is a seven-layer framework used to understand how different network protocols interact with each other, and defines which protocols operate at which layers between the application and physical layers. The OSI model consists of seven layers: They are Physical, Data Link, Network, Transport, Session, Presentation, and Application. The RAW bits are sent over the Physical layer through Copper wires, Optical fibers, or Wireless signals. With the second layer being the Data Link Layer, which ensures node-to-node data transfer is error free using techniques such as frame synchronization & error detection. This layer is responsible for handling data transmissions between two or more networks, and uses Internet Protocol (IP) for addressing and routing. The Transport Layer provides reliable end-to-end communication using protocols such as TCP (Transmission Control Protocol), which guarantees data integrity, and UDP (User Datagram Protocol), which emphasizes speed over reliability. This layer is responsible for managing and controlling the connections between computers (or sessions). The only responsibility of the Presentation Layer is to translate, encrypt, compress and format the data, such that it is readable to the Application layer. At last, the Application



Layer sits nearest the user and handles things like HTTP (Hypertext Transfer Protocol), FTP (File Transfer Protocol), and SMTP (Simple Mail Transfer Protocol) those are the things that you are using to connect to the networked services. Alternatively, the TCP/IP model (Internet Protocol Suite) is a more simplified and practical model and is the foundation of the internet. There are four layers in the TCP/IP model: Link Layer, Internet Layer, Transport Layer, and Application Layer. Link Layer: This layer combines OSI's Physical and Data Link Layers, focusing on the hardware and protocols that establish the network's physical connections and dictate how data flows from one point to another. It corresponds to the OSI's Network Layer, which is concerned with routing and addressing; protocols within this layer (such as IP) are its core components. TCP/IP as an OSI model Transport Layer The Transport Layer in TCP/IP model or OSI model is same it secures the reliable, error-free communication with the help of TCP, UDP, and other protocols. At the top, the Application Layer in the TCP/IP model integrates OSI's Session, Presentation and Application Layers. It provides the level of communication necessary between end-user applications which forms the interface for services such as web browsing email and file sharing. Though they differ in complexity, both models use the same high-level, abstract idea to promote reliable, efficient and uniform communication between multifarious network systems; the OSI model provides a higher granularity of understanding of the various functions and roles of each layer of communication protocol, whereas TCP/IP is a more streamlined approach reflecting the practical reality of actual networks, particularly the internet.

• ITES AND CALL CENTERS

a) Information Technology Enabled Services (ITES)

ITES or Information Technology Enabled Services are used across industries for using information technology devices and tools for the enhancement of your business services. ITES is the use of technology that is Internet-based, computerbased or software-based to provide a product, services and solutions for businesses and clientele worldwide which helps to increase efficiency. ITES includes a wide variety of services, such as help desks and call centers for customer support, back-office operations such as data processing and payroll



management, financial services such as banking and insurance, healthcare services such as medical billing and telemedicine healthcare, IT support such as network management and server maintenance, and consulting services offering IT solutions and business analytics. This is where these services come in, as they are critical in ensuring that businesses run smoothly by outsourcing non-core but vital activities to specialized service providers. Two of the more prominent components of ITES is Business Process Outsourcing (BPO), where the person guides the user through a transaction or Business Process (BP), and Knowledge Process Outsourcing (KPO), where the person interacts with the user on behalf of a business entity or guides the user through a Knowledge Process (KP). This form of outsourcing enables businesses to save on operational costs and leverage a pool of skilled workers trained in customer service, technical support, data entry, and other specialized fields. Outsourcing has made it possible for a lot of ITES companies to avail these services at a price that will be affordable, thereby boosting productivity, while also enabling organizations to outsource their non-core functions to experts in those areas to focus on core strengths. Integration of Technology is a core focal point in the ITES. Service providers can deliver scalable infrastructure and flexible service models adapted to the various needs of companies. Also AI being used in ITES helped in automating world to a great extent while saving a lot if time in customer support, data analysis, etc. Overall, AI-powered tools are able to perform routine tasks, thus allowing human workers to devote time to solving more complex problems. Data Analytics Effective communication with clients is enabled by various tools such as email, VoIP, and collaboration platforms that enable seamless connectivity and ensure smooth and timely communication between clients and services. In particular, for countries that excel in providing ITES, the economic benefits of these services are highly significant. Countries such as India turned the outsourcing ITES into their fields, which are providing values to their GDP and employability. Over the past couple of decades, the evolution of ITES has enabled many organizations across the globe to save costs, enhance services quality, and access global resources without incurring the overhead of building hundreds of in-house employees in non-core processes.



Additionally, ITES allows firms to provide service round-the-clock because of differing time zones and additional 24/7 support by external service providers. Basically ITES is changing, the way business practices are run as they have the potential to optimize processes, reduce overheads and keep pace with dynamic changes of the business world. This way, organizations free themselves from the imperatives of legacy systems while admirably addressing the benefits of modern technologies, operational efficiency, and reducing costs through outsourcing of IT functions. A Blessing in Disguise The widespread IT ES is the boon for today's world.

b) GIS and Its Applications in ITES

In the past years, Geographic Information Systems (GIS) have become one of the pillars of several sectors including Information Technology Enabled Services (ITES) GIS stands for Geographic Information System, a computerbased set of tools used for collecting, storing, analyzing and displaying spatial or geographic data. It integrates data, software, and hardware to analyze the relationships among physical places, enabling organizations to gain insights that facilitate informed decision making. GIS has a strong impact on the ITES domain as companies rely on ITES to manage the data and the use of ITES will increase customer service, better logistics, and resource allocation etc. Locationbased services is an important area in which GIS is employed in ITES. For example, dynamic mapping of GIS data can help businesses to visualize and map out the location of customers, track delivery routes, optimize the area of services, and even predict future market opportunities based on demographic trends. In the ITES sector, GIS is also used in supply chain management. Geographic data can help businesses find the best transportation routes, manage inventory, and optimize distribution of resources, resulting in lower operational costs and better delivery of service. Besides, GIS is being used in customer relationship management (CRM) systems to target customers more accurately. Companies are able to study market patterns, recognize customer clusters, and adjust their services accordingly. It is also used for disaster recovery and business continuity planning. GIS offers ITES firms a holistic view of analysis that includes risk areas, infrastructure, and the probable effects of natural or humanmade disasters. Moreover, GIS also



provides insights for higher quality planning in real estate and site selection since companies can decide geographical expansion by tracing out transportation routes, population density and infrastructure. GIS in ITES Furthermore, GIS's integration capabilities with other technologies like GPS and remote sensing enhance its influence on ITES operations. GIS plays an important role in enabling decision-making capabilities with real-time data, which is crucial for industries like telecommunications, healthcare, and ecommerce. Additionally, in urban planning and development, GIS analyzes land usage patterns, zoning regulations, and environmental constraints, which are all critical to service expansion and urban infrastructure development. In achieve, GIS provide ITES companies great benefits, It helps in optimized process, increases productivity, better user experience. GIS is used in location intelligence, resource management, and business analysis, making it an essential tool in the evolving ITES landscape. GIS is likely to become integral to ITES strategies and operations, allowing businesses to analyze geographyrelated data and make more informed decisions based on the location and demographics of their customers.

• INTERNET BASICS

a) History of the Internet

The Internet as we know it today goes back to the 1960s, during the Cold War, when the U.S. Department of Defense funded a communication network called ARPANET. ARPANET (Advanced Research Projects Agency Network) was intended to connect various research institutions so that information could still be shared in the event of nuclear war. The first successful connection between ARPANET nodes occurred in 1969 between the UCLA and Stanford, thus establishing the framework that would become the Internet. By the 1970s, the idea of packet-switching, a way of breaking up data into smaller units, called packets, and sending them along different paths, was conceived by Paul Baran and Donald Davies. This breakthrough made building a decentralized network much more feasible. During the 1980s, TCP/IP (Transmission Control Protocol/Internet Protocol) was developed a set of communication protocols that became a standard for network connection. This set the stage for the explosive expansion of



interlinked networks across the globe. The Internet as a global entity took off in 1983, when TCP/IP was adopted by ARPANET. Within this time frame, a technology called Domain Name System (DNS) came into play, allowing users to input user-friendly domain names that were more memorable (rather than numeric IP addresses). Then arose commercial and educational networks, slowly introducing themselves to one another and creating the web's greater architecture. The decade of the 1990s proved critical in opening the Internet to the masses. By 1991, Tim Berners-Lee at CERN had released the World Wide Web (WWW), which fundamentally changed how information was accessed online. Hypertext was initially used by the World Wide Web to connect documents while also displaying multimedia formatting. The early Web was overwhelmingly text-rich, but as graphical browsers such as Mosaic appeared (in 1993), so the Internet started to become more accessible, less intimidating and more aesthetically pleasing. Thus, the explosive proliferation of websites and online services. Major Internet companies like Yahoo, Amazon, and eBay emerged in the 90s with the molding of e-commerce and online services. The Internet exploded onto the scene and the commercial era of the Internet began with Internet Service Providers (ISPs) providing dial-up services to households, connecting millions of users to the Web. And it did work, initially with slow connection speeds and a limited number of users, slowly according higher bandwidths when broadband and ADSL appeared in the beginning of the 21st century; The millennium was a time for the popular internet with the exposure of high-speed Internet in the 2000s and the birth of social media like Facebook, YouTube, and Twitter. These networks offered a new way for people to connect, engage, and share content with others online. Furthermore the advent of smartphones and mobile Internet credit of late 2000s made the Internet adolescent omnipresent, making people join from most of the appositely everywhere. Cloud computing, big data, and the Internet of Things (IoT) that started in the late 2010s and beyond began to connect even more devices to the Internet starting from smartphones all the way to home appliances. The transfer of control over the Internet to the smaller "fewer" biased military, government and corporate power-broker axes countries has ushered in a new era not of revolution from above but of a revolution from below that impacts the ground out and around, as technologies like 5G,



artificial intelligence, and blockchain began to reshape the function of Internet use, moving people from across continents where streams of selfservice knowledge and service information began to influence their lives. Whereas previous generations of the Internet were shaped primarily by technological progress (i.e. machine learning, artificial intelligence), this generation is being shaped by an increasing number of humans coming online, and more importantly, by the restrictions on what the Internet can do and who can use it. There have been some huge changes since the Internet started out as a military project, but among other things, it has globally changed the world education, business, entertainment, and culture have never been the same. It is the backbone of the digital age, driving unprecedented levels of innovation, collaboration, and global connectivity.

b) Indian Internet History

This paragraph should cover that India start of internet back in early 1990s with the Indian government's initiative to introduce the internet as part of the country's broader efforts toward technological development and modernization. India started its liberalization in 1991 and the web opened in 1995. Internet services in India were brought out for the first time by the Indian government owned company VSNL (Videsh Sanchar Nigam Limited) which provided internet access throughout the major cities like Delhi, Mumbai, and Bangalore. The early internet was restricted to a handful of users, including universities, research centers, and government institutions. But the internet really took off in the late 1990s as telecom services became more liberalized and private service providers entered the market. Then, companies like MTNL (Mahan agar Telephone Nigam Limited) and some private players like Sify, Airtel and Reliance, helped reach more people to the internet. In the 1990s and early 2000s, internet in India was primarily slow, dial-up, and costly, allowing access to a select pool of users. Notwithstanding these limitations, internet usage started increasing thanks to growing email, web browsing, and online forums. The early 2000s, especially after broadband services made an appearance in 2004, changed the game, heralding a more concerted internet revolution. The internet quickly transitioned to be a medium of business.



communication and entertainment, and it was during this time that India became a global outsourcing powerhouse. By 2005, there were about 25 million internet users in India, and the number continued rising steadily during the decade. The introduction of cheaper mobile handsets and the rollout of 3G and later 4G networks revolutionized the Indian internet scenario in the 2010s. The landscape changed significantly with the 2016 introduction of Reliance Jio in the market at prices so low that internet usage became affordable and absorbed by thousands of Indians across small towns and big cities. Such was the aggressive data pricing that Jio adopted that the consumption of data skyrocketed in India, leading to it being one of the largest internet user bases in the world in no time. As of 2020, India has more than 700 million internet subscribers, and this figure is on the increase every day as telecom networks are rolled out by companies and the internet infrastructure improves. Facebook and other social media platform with Twitter, Instagram, and also the Indian app TikTok and Share Chat started this journey, connecting end users in different parts of the world and adding to the Digital transformation of India. The internet revolution also paved the way for e-commerce platforms such as Flipkart, Snapdeal and Amazon India, where consumers could shop online and businesses could connect with customers in even the remote parts of the country. But the internet revolution in India has also not been smooth sailing. Pitfalls such as the digital divide and slow internet speeds in rural areas, and fears surrounding data privacy and cyber security pose major obstacles known6 As Indians grapple with the reality of an increasingly digital world and the government's vision of a "Digital India" — a push to bring government services and digital literacy to every citizen millions of Indians do not yet have access to the internet or reliable internet services. Additionally, there are a number of good and bad aspects that have arisen from internet use. The internet has opened up a treasure trove of information/knowledge as well as business opportunities, on the other hand it has brought about changes that have been troublesome in terms of the misinformation that prevails, online harassment, cybercrimes etc. To tackle these issues, the Indian government has enacted multiple laws and policies, including the Information Technology Act and Digital India Program. The story of India's journey on the internet is one of speed; a tale of acceleration on user adoption, technology innovation, and of



course, connectivity. The internet is likely to transform the nation with an ever-expanding digital infrastructure, contributing work, education, health-care and governance even as India grows.

c) Internet Protocols (TCP/IP)

Known as TCP/IP (Transmission Control Protocol/Internet Protocol), the Internet Protocol Suite is a basic set of communication protocols that allows the movement of data between computers and other devices. This means it is fundamentally a two-layer model with the four layers we might be more familiar with: application, transport, internet and link. These layers interact to provide reliable transmission of data from one device to another, independent of the underlying network technology. The IP (Internet Protocol) is the network layer that handles the addressing and routing of packets of information between devices on the network. Using unique identifiers called IP addresses, IP identifies devices and routes data from the source to its destination. There are two versions of IP currently in use: IPv4 and IPv6 the most common version is IPv4, which employs a 32-bit address space, versus 128 bits for IPv6 a near-endless sequence of numeric addresses to encompass the many, many more devices coming to the internet. Also found in the transport layer, the Transmission Control Protocol (TCP) breaks a large message in small packets to send the message and then assembles it on the other side. It links the sender and receiver, ensures packets are delivered, and provides error correction and detection to ensure that the data arrived correctly. TCP is also responsible for congestion control to prevent flooding the network. User Datagram Protocol (UDP) is another important transport protocol used for applications transmitting data packets quickly (like during video streaming, or in online gaming) as it does not establish a formal connection before sending the data. UDP is a connectionless protocol that does not have the same delivery/sorting guarantees as TCP, which can make it faster, but less reliable. A range of protocols exist at the application layer to facilitate specific services. For instance, Hypertext Transfer Protocol (HTTP) organizes the transfer of web pages, whereas File Transfer Protocol (FTP) allows individual files to be transferred from one device to another. Emails are sent using a protocol



known as Simple Mail Transfer Protocol (SMTP) and the Domain Name System (DNS) translates human-readable domain names to an IP address. Each of these application protocols depends on the TCP/IP stack layer underneath it for the accurate communication devices. The link layer is the physical layer and is responsible for the actual transmission of data over the network medium (e.g., Ethernet, Wi-Fi, etc.). This layer covers the protocols that run on the hardware level, concerned with how information is sent over local networks and interfaces. These layers work synergistically to enable devices to exchange information throughout local and international digital landscapes. Even based on these very simple and widely implemented techniques, TCP/IP turned out to be simple yet very powerful, and with the continuous improvement of the internet, it has achieved an unprecedented global scalability, fault tolerance and robustness that have become the numerous protocols (such as UDP, Sockets, etc.) behind the countless devices all over the world nowadays. Its versatility enables the incorporation of various technologies, which makes it essential for contemporary communication. Although this model may have been built some time ago, it continues to be refined, with newer protocols like IPv6 and additions such as security enhancements to satisfy the needs of a more connected world. Therefore, TCP/IP is regularly updated for new features and optimizations to conform to the developing internet and stay as the focal point of all the systems, providing a dependable structure for exchanging data reliably over the internet.

d) URL, IP Address, and Domain Name System (DNS)

Knowing how Uri, Ipv4, and DNS together run the internet. These are highly interconnected elements that make browsing possible, allowing users to navigate the Web and communicate with different servers and services across the globe. They do so by mapping user-friendly addresses to machine-readable information, facilitating the smooth movement of data over this universal network.



IT for

URL (Uniform Resource Locator) Mangers

A Uniform Resource Locator (URL) is a web address that points to specific resources on the internet. It points to a web resource by describing its location and a means of retrieving it. An URL has a number of components, all of which have their own distinct meanings. A URL can be split into four parts: the scheme, the domain name, the path, and optional query parameters.

- 1. Scheme: The protocol for accessing the resource, for example, http, https, ftp, etc. Most websites will have https, meaning a secure connection.
- 2. Domain Name: The domain name section of the URL indicates the unique address of any server or website on the internet. Avatax is generally also the brand or the identity of the website. com or example. org.
- 3. Path: The path comes after the domain name and indicates a particular location within the website, such as example. com/about or google. com/images. It allows the server to know precisely which resource is requested.
- 4. Query Parameters: These are optional and provide additional information to the server to modify the resource, and are often used in search engines or forms. For example, google. com/search? q=technology.

URLs should be human-readable, designed to be easier to recall. These HTTP hyperlinks make it easy to discover resources on the internet, and have become an essential tool in navigating the amount of data available in the web world.

IP Address (Internet Protocol Address)

Basically, every device connected to a network has a unique identifier called an IP address. Without this address, devices cannot find when



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connecting over the Internet or any other network. The two types of IP addresses commonly used are IPv4 and IPv6.

- IPv4: The original and more common version, IPv4 uses a 32-bit address format, usually expressed as four decimal numbers separated by periods (for example, 192.168.1.1). Instead, the entire address space of IPv4 is 4.3 billion unique addresses, which became a limitation for managing the evergrowing expanse of the internet.
- IPv6: To provide a much larger address space, IPv6 was developed with a 128-bit address format, which can support an enormous number of unique addresses (over 340 undecillion). IPv6 addresses are expressed in hexadecimal and are separated by colons, e.g., a2001:0db8:85a3:0000:0000:8a2e:0370:7334.

An IP address has two primary functions: identification of the host or network interface, and location addressing. This enables devices to direct data packets to where they need to go.

Domain Name System (DNS)

The Domain Name System (DNS) can be thought of as the "phonebook" of the internet. It converts human-understandable domain names (like example. Can you assist (when someone visits example. Instead, DNS is a distributed system; a hierarchy of servers coordinate the translation process. DNS steps up when a user enters a URL in any browser, by translating the domain name to the associated IP address. This process generally consists of the following stages:

- 1. **DNS Query:** The browser makes a request (DNS query) to a DNS resolver (usually provided by the user's Internet Service Provider (ISP)). If the resolver does not already know the IP address (it's not in its cache), it sends the request to other DNS servers.
- Recursive Resolution: The resolver queries a root DNS server that refers the query to a top-level domain (TLD) server (such as. com, org, net). The TLD server then



3. resolves to an authoritative DNS server in charge of the actual domain name.

4. Authoritative DNS Server: holds the actual mapping of domain names to IP addresses. When the server returns the IP address, the resolver passes it back to the user's browser so that the connection can then be made.

The DNS system is a fundamental component of the internet's architecture, allowing the use of easily remembered domain names instead of hard-to-remember numerical IP addresses. It is also highly scalable and decentralized, providing widespread redundancy and reliability. This would make navigating the web far more difficult without DNS, as each user would need to memorize the numeric addresses of every webpage they wish to visit. These are the interconnected elements one needs to power the internet functionality, i.e., the URL, IP address, and DNS. By providing a human-readable URL, users can access resources, while the IP address communicates between devices. The DNS acts as an intermediary, facilitating the link between human-friendly names and machine-readable addresses, making the internet run smoothly. These systems all work together to deliver the fast, accessible and efficient web experience that users depend upon every day.



MODULE 5 INTERNET APPLICATIONS AND SECURITY

Structure

Unit 7 World Wide Web (WWW)

Unit 8 Internet Applications

UNIT 7 WORLD WIDE WEB (WWW)

The World Wide Web (WWW), commonly known as the Web, is a system of interlinked hypertext documents and multimedia content accessed via the Internet. It enables users to access, share, and engage with a wealth of information in web pages connected by hyperlinks. The Web, devised by Tim Berners-Lee in 1989 while he was at the particle-physics laboratory CERN, was meant to be a platform for researchers to exchange information seamlessly. Since its public launch in 1993, it has transformed from static, informational pages (known as Web 1.0), to interactive platforms (Web 2.0), and is growing into a decentralized and more secure Web 3.0. With technologies such as HTTP, HTML, and URLs, the Web continues to transform communication, commerce, and consumption of media worldwide.

a) Browsing and Information Retrieval

Accomplished through searching content, browsing is defined by the action of exploration one built on curiosity or general interest, and often characterized by a nonlinear process. Information retrieval, in contrast, leverages defined queries to find relevant data from a set a database or a search engine, looking for precise, goal-oriented results.

Information Retrieval (IR): Information Retrieval (IR)_TERM is a key process for finding or discerning relevant information from a substantial corpus of data or text⁶ collections in answer to a specific user input. This field underpins systems like search engines, which have become ingrained in the modern practice of



information access. Fundamentally, IR is about locating documents or specific data that satisfy user informational needs with relevant and applicable query results. The main purpose of an IR system is to manage massive information collections be it databases, digital libraries, or even the internet and return the most relevant results in response to a user's search query. Information Retrieval is a user-centered process, wherein the user usually conveys their request to the system as keywords, phrase, or natural language statement. The IR system uses these queries to cull a massive repository of documents and retrieve and rank those that are most likely to satisfy the user's information need. It uses attributes of the query being searched on and the kind of documents present in the repository to ascertain how relevant a document is. Several algorithms calculate this relevance based on factors like the presence of query tokens in the document, the linking structure in the document and its position in the document itself and its linking in the whole repository. Indexing is one of the most commonly used techniques used by IR systems. In indexing, the document repository is structured so it is indexed in a better way for the retrieval of relevant documents. This is like an index for a book on a larger scale in practice: specific keywords and phrases are mapped to particular positions in a collection of documents. An index is generally constructed with algorithms that divide documents into smaller, searchable components called words or tokens, and create a mapping between those words and the documents where they're included. This allows the system to quickly find documents that contain certain words, making the retrieval process faster and more accurate. After processing the search query, the system ranks the documents according to their positive relevance to the search words. Relevance ranking is generally calculated using intricate algorithms that take into account elements such as term frequency (how many times a search term can be found in a document), inverse document frequency (considering how ubiquitous or uncommon a search term is through all documents) and, occasionally, more sophisticated approaches such as natural language processing that helps understand the context of a search query. For instance, Google and other search engines employ highly engineered ranking algorithms, such as PageRank, which take into account the use of keywords



Internet application and Security

but also the document's authority based on the number of incoming links or the reputation of the author. Query expansion and refinement techniques are also an important aspect of IR systems. Query expansion is a technique to enhance the retrieval of related documents by automatically enriching the initial query with similar words or synonyms. This can be beneficial when the original prompt is overly specific, or when the system must consider variations in language. Query refinement: based on the results returned initially, users can further refine their terms to home in on more specific or more relevant documents; The development of vector space models, probabilistic IR, and more advanced techniques like machine learning and artificial intelligence have enhanced IR systems even further, as today, IR systems are not simply about matching keywords. These technologies can learn from past queries and previously observed user actions to improve the relevance of documents for future queries.

One example of this is personalized search results, where the search results are customized based on a user's previous behavior, preferences, and context. The evolution of IR is increasingly marked by a shift towards personalized and contextually aware search experiences, with systems that can, increasingly, go beyond word matching to capture the rich tapestry of user intent and preference. The objective should always ultimately be to organize a user experience around retrieving information six degrees of separation away from the individual most in need. It is a challenge that is met with efficient algorithms, sophisticated relevance ranking, and the need to continuously balance the evolving needs of users. With the amount of digital content growing at an exponential rate, the role of IR in assisting people and organizations in finding and accessing relevant information is increasingly critical. With further advances in technology, IR systems will become even more intuitive, accurate, and capable of delivering the specific information users are looking for.





Figure 5.1: Information Retrival

Browsing: Browsing and information retrieval (IR) are two different processes of interacting with information; they serve different purposes, engage users differently and lead to different results. It is critical to understand the intricacies of the difference between browsing and searching when designing any information systems, user interfaces, or digital environments that may need to service a broad range of user needs. Because the IR process is goal-oriented, it aims to find some information that investors will need to satisfy their specific needs. It begins with the user acknowledging a knowledge gap or asking a question. In this scenario, the user constructs a specific request that is submitted to an information retrieval system (such as a search engine, library catalog, or database) to meet the gap. It relies on algorithms to scour an immense quantity of data, scanning, filtering and ranking documents based on how relevant they are to the query. The result is a list that includes the documents, articles, or web pages most likely to address the user's informational need. IR is heavily structured and users are expected to be specific within their search terms to yield relevant results from the system. Users literally refine their search by changing keywords or modifying their queries to get more perfect results



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and find an exact match or a full answer. Oppositely, browsing is more free form, exploratory approach that doesn't depend on target query or a need for instant information. Doing so passively, this exploration component allows users to stumble upon topics or pieces of information that they might find relevant, without a set goal in sight. Browsing is similar to browsing through bookshelves in a library, thumbing through pages, or surfing on websites to find your way to content. It's not a way to get a specific answer to a question; it's a way to find other interests; it's a way to get a rough idea of what something is. While browsing, users may unexpectedly find something that will serendipitously alter their perception. Someone who is exploring a digital encyclopedia, say, might end up at an unplanned-for rabbit hole on an interesting topic. Likewise, digital platforms such as social media or news websites, facilitate browsing by providing a continuous feed of items for users to scroll through and see new items based on their previous interactions or interests. One of the primary differences between browsing vs. IR is their intended use case and user experience.

Information retrieval is optimized to satisfy a specific information need of a user by returning targeted results. It demands active engagement by the user, who has to devise and fine-tune queries to yield the most precise and pertinent information. Browsing, by contrast, is driven by curiosity and discovery. The end-user shouldn't have a pre-set question or goal but rather, to explore resources and more passive, organically. This means browsing is less formalized and can encompass a much wider scope of information, some of which may not even touch on the user's original interest or question. Furthermore, the results from each activity are completely different. In information retrieval (IR), this system returns to the user a list of documents ordered according to their relevance to the user's query. The exact order of this list is determined by algorithms that take into account variables like how often the keywords appear in each document (should you see this site, and think of it as more or less relevant than another one) and how effective users have found each document to be in the past. The user can then narrow down further based on this ranking and find a document that meets their need reasonably well. Using a browser, however, may not give clear results. Rather, it enables users



to discover how to pieces of information that may not have been specifically needed but may prove to love popular or relevant. The result of browsing a description of an experience, not the answer to a question. This knowledge is critical in order to create systems of information and interfaces for such entities. IR systems have to be optimized so that the search based on queries is fast and accurate, whereas browsing systems have to provide an environment that fosters exploration and discovery of unexpected content. As an example, if the app has a query, a digital library or search engine type of app should have a system for users and fast as well as an effective and effective search experience, on the other hand, a news website or streaming services should make the users' initial browsing on the app easy with recommending new content according to the past activities, tastes and so on. The main difference between browsing and information retrieval is in their nature & purpose: IR is goal-oriented and requires specific queries to fetch relevant information whereas browsing is an exploration activity inspired by curiosity and exploration. Both are important ways of interacting with information, and knowing how to differentiate one from the other is important for systems creators designing user-friendly systems or interfaces to meet different user needs.

b) Concept of Websites and Web Standards

1 Concept of Websites

A website is a group of related web pages that can be found on the internet through a web browser. Yes, a website is a collection of webpages hosted on web servers and they can have text, images, videos and interactive elements. Deeply embedded in the internet, websites have become vital tools for communication, business, education, entertainment, and more, and thus indispensable in the modern digital age. Websites can be used for various purposes: information, communication, e-commerce, entertainment, and social networking. Websites are used by businesses to promote their online presence, showcase information about products and services, and enable transactions via e-commerce streams. From the business point of view, most entities that are looking to expand their reach, communication, and customer service depend on their websites, as websites can help



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organizations deliver messages worldwide without any geographical limitations. Educational Institutions: Websites are used by educational institutions to provide online courses, learning materials access, and remote education through electronic and interactive media. Prime Minister websites are used by breaking news agencies, who can use websites to accompany updates as they happen in real-time, especially during major events when users can see what's going on from other sides of the world. Social networking sites have become an essential part of how humans interact. Generally, a website consists of a home page that acts as the main entry and several other subpages that contain detailed information for various subjects. Websites are classified as static or dynamic. There are two types of websites: static and dynamic Static websites are static pages that do not change/get updated frequently Dynamic websites create content based on user interaction or database input. Broadly speaking, CMS (Content Management System) such as WordPress, Joomla and Drupal enable creating and maintaining websites without extensive programming background. Depending on their function, websites can be categorized as a personal blog, company website, news portal, auction or e-commerce website, forum, and government website. That evolution was driven by advances in web development technologies: HTML, CSS, JavaScript and various backend programming languages — PHP, Python, Node and others — so that websites began to be able to deliver customized content and experiences. Modern websites have become even more functional with artificial intelligence, chatbots and data analytics technologies contributing to the mix, offering users personalized experiences and automated customer support. Web design is essential for the usability and accessibility of a website. Make sure your website is well designed with visually appealing and user experience-friendly and looks good on desktops, tablets, and smartphones. Responsive web design makes sure that a website resize according to the changing screen sizes, providing the users a flawless experience in various devices. Search Engine Optimization (SEO) is also a vital part of web development, allowing websites to appear higher in search engine results, leading to more visibility and visitors. In today's digital era, website security is a critical aspect with constant threats of hacking, data leakage, breaches, and malware attacks. These features may include Secure Sockets Layer (SSL)



encryption, advanced authentication protocols, and frequent security updates to protect websites from potential threats. E-commerce websites face a revolution in the retail market, where online shopping, digital payments, and global trade have completely transformed the retail world. By this point, web technologies were powering vast online marketplaces, but it took a while to reach this stage because people had to be convinced, for some reason, that they wanted to buy things online (and, actually, who wouldn't want to buy things online!?), so companies like Amazon/eBay/Alibaba - using the brand new more - hyped web technologies - built their global empires. With the advent of mobile applications and further progressive web apps (PWAs), websites are able to reach out deeply into the operating system, granting quicker and more efficient access to content. Websites became also an essential for businesses for advertisement and marketing through online adds, email marketing campaigns and exploitation of social media. As cloud computing gains popularity, a lot of websites are hosted on cloud servers, offering better scalability, performance and reliability. With each generation, technologies will enhance websites, such as by integrating more with virtual reality (VR) and augmented reality (AR), as well as adding blockchain technology, taking their capabilities and influence to higher level. No matter if you are using them for business, education, entertainment or to express yourself, without websites, daily life in the digital age would not be possible, as they are becoming incredibly integrated into daily life and the way people access information, communicate, and do business.

Types of Websites:

- Static Websites: Provide static content and do not change dynamically (e.g., company brochures).
- **Dynamic Websites:** Content is generated in real-time based on user interaction or database queries (e.g., social media platforms, e-commerce sites)
- E-commerce websites: Websites that facilitate online transactions and sales of goods (e.g., Amazon, eBay).



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- Blogs and personal websites: For personal expression, education, or • business promotion. and Security
- Social Media Websites: Enable users to generate content and interact (e.g., Facebook, Twitter).

2. Web Standards

Web standards are a set of standards and technologies that are created by international organizations (usually the World Wide Web Consortium (W3C) and the Internet Engineering Task Force (IETF)) that are being used to make web pages and web applications work consistently on different web browsers and devices on the Web. They are important for the Web to be uniform and accessible for the user, independent of the software or hardware used to access online content. Web Standards comprises a range of tools in HTML, CSS, and JavaScript; guidelines for accessibility; connectivity specifications; etc. that permet a more user friendly, more accessible, integrated web. Making the web accessible is one of the main goals of the Web Standards. Web accessibility Web Accessibility means that all users whether he or she is disabled they should have equal access to the information available on the web. The WCAG (Web Content Accessibility Guidelines) are developed by the W3C and provide some principles that assist developers in building websites that are navigable and usable by people with visual, auditory, with motor and cognitive impairments. These standards encourage attributes like the inclusion of alternative text on images, keyboard navigation, compatibility with screen readers, and contrast changes to support those with different needs. Following such a standard allows websites to be both inclusive and widely accessible, thus improving the overall usability of the web. Another important point that Web Standards advocates is Usability. Usability on a website refers to how efficiently someone can get information, and how they can do what they need to do. Emerging standards like HTML5 and CSS3 have ushered in new elements and attributes that enhance the user experience, such as semantic tags that provide better structure to a web page, responsive design techniques that allow content to be adapted to different screen sizes, and animation



features that make web interactions more exciting. Standardization of JavaScript through ECMAScript specification brought multiple matured JavaScript frameworks that helped developers to develop highly interactive and dynamic web applications which work seamlessly across different browsers. These standards help web designers create interfaces that are intuitive and user-friendly, providing efficient navigation and functionality to all users. Web Standards is also built upon a fundamental premise of interoperability—that web technologies should work together, regardless of environment. During the primitive age of web development, it was a common task for developers to deal with website behavior differences across browsers. Browser webs can be made more standardized to remedy above issues by defining a common set of rules followed by all browsers.

For example, Hypertext Markup Language (HTML) defines an overall structure for web pages and Cascading Style Sheets (CSS) determine how those web pages are presented. JavaScript facilitates interactivity, and protocols like HTTP and HTTPS manage how data is transferred across the web. These standards ensure that users have a seamless experience with web content regardless of their choice of browser, device, or operating system. Web Standards also help improve security and performance in addition to accessibility, usability, and interoperability. Using secure coding practices, standardized encryption protocols and data privacy guidelines ensures that web applications can protect users against cyber attacks such as phishing, malware, and data breaches. HTTPS and similar standards are recommended and enforced by the Internet Engineering Task Force (IETF) that allows both users and websites to develop secure communication by encrypting data transfers. Just like them, in arise modern standards favor the optimization performance of the web through lazy loading, caching strategies, and management of resources before making it in order for the websites to load faster and perform to a high standard even in conditions of high traffic. Web Standards evolve as technology and trends grow. Constantly, as new devices, browsing or general technologies, and user expectations are matched together (to cause, by hkaps with all the homeowner pages), standardization bodies try to find out this occurrence


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with the information you have and guidelines. The evolution of web technologies can be demonstrated by the introduction of Progressive Web Applications (PWAs) and Web Assembly (WASM), enabling faster, more reliable, and richer experiences. Such a tentpole goal reinforces the need for Web Standards, which is what will help ensure a high-quality web for everyone. Web Standards are essential for the modern internet, providing guidelines for constructing websites and applications that are accessible, user-friendly, interoperable, secure, and efficient. In doing so, they help create a more inclusive, efficient, and consistent digital experience based on accepted norms and best practices. As new technologies are developed, Web Standards will continue to drive innovation without compromising the web's consistency and usability for users worldwide.

Key Web Standards:

- HTML (Hyper Text Markup Language): Defines the structure of the web pages.
- 2. CSS (Cascading Style Sheets): Manipulates the appearance and formatting of web pages.
- 3. JavaScript: Enables interactivity and dynamic functionality on web pages.
- HTTP / HTTPS (Hyper Text Transfer Protocol) protocols used to transfer data between web browsers and servers.
- W3C: World Wide Web Consortium (W3C; www.w3.org) develops and maintains web standards for consistency.
- 6. WCAG (Web Content Accessibility Guidelines): Makes sure that sites are usable by disabled people.
- 7. **Responsive Design Principles:** Use adaptive design principles to ensure websites perform well across different screen sizes and devices.

• INTERNET APPLICATIONS

Internet applications: — software programs that use the internet to provide users with specific functional capabilities. Therefore, these applications run on a client-server model, where the user (client) communicates with a server, in



order to request and obtain data or services. This communication occurs over ordinary internet protocols, allowing diverse offerings for web-based services and applications.

a) File Upload and Download

Uploading and downloading are basic computing processes that allow data to be moved between a local device (like a PC, laptop, tablet or smartphone) and a remote computer system, often over a network like the internet. Downloading is the term used for the process of obtaining data from a remote system (server or another device) to a local device (computer, smartphone or tablet). You are able to have the access for different kind of file with this process through the internet or private network that includes documents, images, videos, software, other digital content. Downloading happens whenever a user visits a website, plays an online video, saves a file from an email attachment and much more. This allows for an easy access to various resources, such as web applications and allows the users to download and use files offline if required. Downloading is an essential activity for numerous sectors, such as entertainment, education, corporate, and software development; it enables users and enterprises to efficiently acquire vital assets. A commonly encountered scenario of downloading is saving a photo from the web onto a mobile phone or laptop. Typically, when a user clicks on a download link, the browser or application sends a request to the server which transfers the file to the local device. The download is completed based on multiple variables such as file size, bandwidth of the internet connectivity, and time taken by the server to respond to the request. For example highresolution videos or larger software applications take more time to download than text file or low-resolution images. Newer Internet connections - like broadband, fiber-optic, and mobile networks — have raised download speeds considerably, allowing users to access significant amounts of data quickly and efficiently. In addition, online services often include the ability to pause and continue downloads, which is useful in situations where bandwidth may be restricted or the connection is inconsistent. Download is a basic capability in many industries but is particularly common in software distribution and multimedia streaming.



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Downloading of applications, updates and security patches of applications is done by software companies in the form of files for latest features/enhancements. Operating systems like Windows, macOS, and Linux issue regular updates which the user is required to download in order to improve security and performance. Gaming platforms such As Steam, PlayStation Network, and Xbox Live let users download digital copies of video games instead of having to buy physical discs, making gaming more accessible. Transmitting multimedia streams also often works through a temporarily downloaded form — buffering — in which small data chunks are downloaded in real time in order to allow smooth and uninterrupted playback (just like on Netflix, Spotify, or YouTube).

Storage Space: One of the most important parameters while considering a download. Devices need enough storage available to download files, so they might fail if they don't have enough space, or users need to erase an existing file to free some space. Cloud storage services for business, like Google Drive, Dropbox, or OneDrive, offer to upload files from your local device onto a remote server. This method has the benefit of saving storage space, while also allowing the files to be accessed from many devices, aiding accessibility and convenience. Moreover, Content files are compressed and stored in an efficient format if possible, reducing their size and making transmission faster and storage costs smaller. Most ISPs offer faster downloads than the ability to upload content. This asymmetry is founded upon average user behavior, since most internet users download exponentially more data than they effectively upload. The download bandwidth is always more than the upload bandwidth because a lot of tasks, such as streaming movies, browsing websites and downloading applications, require greater download bandwidth, while uploading tasks, such as sending emails or serving file downloads need far lower bandwidth. However, for certain applications, e.g. video conferencing, cloud backups, and online gaming, upload speeds become important. More specialized users, like content creators and remote workers, are likely to need high upload speeds too — to transfer large files from one device to another, while streaming live content and so on. Although downloading has its benefits, there is also potential dangers to it, such as possible security threats and



malware infections. Cybercriminals often conceal malicious software as legitimate downloads, luring users into installing harmful programs. Users should download files from reputable websites, check the authenticity of a file, and use trusted antivirus software to reduce these risks. Furthermore, organizations employ network security tools like firewalls and secure gateways to track and control downloading activities within corporate environments. downloading is one of the basic fascinations of all the greatest tools you are using from long time. Be it documents, software or multimedia content, downloading is a fundamental aspect of everyday Internet usage. Thanks to improvements in network connection speed, cloud storage capabilities, and security protocols, downloading now is quicker, safer, and more efficient than before. Yet, users should stay alert for security risks and control their storage to maximize their downloading experience. With continued innovations, downloading will remain an integral part of digital communication, powering diverse applications in personal, professional, and industrial sectors.

Upload: Uploading is still a process that allows you to move data from a device to a network, enabling many online activities. Downloading means receiving data from a remote system to a local device, while uploading means transferring data from a local device to a remote system. These two processes are also vital for sharing content, backing up data, and retrieving information on the web. By conducting download and upload, users can maximize their use of the internet, the information bank, and transfer data more effectively. Upload: a user takes a file, like a document, image, video, etc., from their computer and sends it to a server in the internet. This behavior is widely used in things like posting pictures on social media, uploading assignments on educational portals or storing files in cloud facilities like Google Drive and Dropbox. When a file is uploaded, it travels from the user's device to a remote server, which stores the file and makes it available to others, depending on the privacy settings. Uploading speed is largely dependent on your Net connection speed, Your server size, Network speed and Etc. Uploading Unlike downloading, where data from a server is



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retrieved, uploading requires storage space on the server side to ensure the server can receive the uploaded data. The upload speed: one of the main features of upload is the speed with which, the data gets transferred. If this post were in a different format (analog radio, for example, vs digital video or an text post). Internet service providers (ISPs) get more bandwidth download than upload because most users are content consumers, not share-ers. For example, streaming movies, loading web pages and downloading software updates all require large amounts of data to be transmitted from remote servers to users' devices. On the other hand, upload activities like sending emails (with attachments) or posting videos require smaller data transfers. To address this disparity between demand and limited resource availability, ISPs also tend to offer their customers asymmetric internet speeds, where download speeds are much higher than upload speeds. This can lead to delays when uploading large files, especially with high-speed data transfer use cases like live streaming, video conferencing, and online gaming. Upload is an essential feature employed by modern digitized communication and storage solutions, despite its drawbacks. Another example of where uploading becomes significant is cloud computing, where user data is stored and can be accessed from multiple devices. Creative professionals like photographers, videographers, and graphic designers often upload large media files to be shared and distributed on the web. Likewise, businesses utilize filesharing services to upload and manage critical documents safely. Uploading data also facilitates real-time communication with apps like Zoom and Microsoft Teams, where users upload audio and video streams to connect.

Downloading, on the other hand, is the process of receiving the data from the remote server to the local device. This covers actions like downloading images from web pages, downloading apps, and streaming services like Netflix and YouTube. In contrast to uploading (where the user begins the transfer), downloading is typically initiated when a user requests data stored on a remote server. Download speed and efficiency vary based on several factors, including the user's internet connection, server responsiveness, and network congestion. If downloading is a more popular use than uploading, then ISPs balance that by



allocating more bandwidth to downloads. Uploading and downloading are crucial for online interactions, enabling users to efficiently share, access, and store data. Students and professionals, for instance, often upload documents to cloud-based services, only to download them when they are needed. Social media sites support an active bi-directional exchange of data, where users upload content to share and download media to view. Similarly online backups facilitate data security as they keep uploading files continuously to cloud storage which allows users for recovering lost information when required. Furthermore, as more internet infrastructure is developed (including fiber-optic and 5G technology), upload and download speeds will increase, latency will decrease, and data transfer becomes more efficient. Knowledge of the upload versus download is helpful for end-users to know how to utilize their network. People working from home, attending video meetings, and uploading photos and videos need upload speeds that will enable them to do their work without annoying delays in the system. When sharing a significant file, content creators and businesses leveraging cloudbased services must best estimate the balance of storage constraints and data transfer speeds to use. Also, consumers who stream premium content often need to keep in mind the bottlenecks and data caps set by the ISPs. They are two complementary processes that allow for the transfer of data over the internet. Downloading is all about retrieving and consuming content, whereas uploading enables content creation, sharing, and storage. Depending on network bandwidth, storage and ISP policies, these processes can be efficient. The ability to upload and download data quickly is already proven useful, and as technology advances so will the speed and reliability of connections give us new and improved experiences and capabilities.

b) HTML Introduction (HTML Documents/Files)

HTML stands for Hypertext Markup Language which is the basic language of web development and it is the standard for creating and designing documents on WWW (World Wide Web). It organizes web content through a foundational framework of elements and tags, specifying how text, images, multimedia, and interactive elements are arranged and displayed. HTML is a standard markup language that creates the skeleton of web



pages, allowing developers to structure documents into headings, paragraphs, lists, links, tables, and forms. Its hypertext functionality — where people click on a word and jump to a new page via a hyperlink — was one of its defining features, and what made moving around parts of the web so easy. Make sure that you notice that HTML is not a programming language but a markup language, it means that it is not logic-based and it is not used to execute actions. But it works hand-in-hand with Cascading Style Sheets (CSS) and JavaScript, making the design and function of web pages better. This text includes more elaborate text that gives various aspects of CSS, which is used for styling components, attributes and justify the layouts of components with a more engaging and responsive layout of web pages. While JavaScript introduces interactivity, allowing for content to change dynamically, animations, and real-time data manipulation. With HTML developing over the years, HTML5 has made some new additions of its own such as, , , , thereby improving semantic clarity and multimedia integration. HTML5 provides better accessibility and support for modern web technologies such as offline storage and geolocation. Web APIs are essential for creating web applications, such as Progressive Web Apps (PWAs) and mobile-friendly designs. HTML control is still an essential skill for web development due to its relative simplicity and pervasive usage as a web content composition language. Using HTML in conjunction with CSS and JavaScript enables developers to create dynamic, interactive, and engaging web pages which improve user experience and functionality on multiple platforms.

HTML Documents/Files

An HTML (Hypertext Markup Language) document is essentially a simple text file that includes a structured collection of HTML elements that dictate the contents, layout, and organization of a web page. These documents are the very backbone of web development, enabling web browsers, including Google Chrome, Mozilla Firefox, Microsoft Edge, and Safari, to interpret and render them into visually organized web pages. HTML files typically have a. html or. file extension and can be created and modified using any text editor Notepad, Visual Studio Code, Sublime text. The basic function of an HTML document is structuring information on the web, making this content understandable and



accessible for users. For each HTML document we will kick-off it with a declaration, which tells the browser what version of HTML we're using. Next, we have the element which contains the root of the document. Between the element, there are two parts, the and the. The section defines the metainformation about the web page, such as its title (defined by the tag), links to stylesheets (), scripts (), and metadata that allows search engines and web crawlers to understand the content of the page. Whereas the houses all the things users see and interact with, including headers, paragraphs, images, links, lists, tables, and multimedia elements. The elements of an HTML document are made up of words/characters surrounded by angle brackets, and most (e.g., for a paragraph, through for headings) have an opening and closing tag. Some elements, such as for images and for line breaks, are selfclosing. With HTML, you can create hyperlinks with the tag, allowing users to navigate between different web pages, by clicking on text or images. An ordered () or unordered () lists can be used for sorting, and, (table rows), and (table data) can be used for a table. Forms also play an equally important role in HTML as they are used within a web page to collect user input using text boxes, radio buttons, and, check boxes, and submit buttons, all defined in the tag. HTML5 also brought in some new semantic elements like, , , , and , all of which help improve readability of web pages as well as accessibility to web pages by conveying a more clearly defined structure. However, it contains semantic elements that help with search engine optimization (SEO) and logically structure content for developers. HTML documents are read by web browsers, and the tags are interpreted by built-in default rules; these can also be overridden with external or inline styles with CSS to determine things like color, typography, spacing, and layout. JavaScript is commonly used together with HTML and CSS to create dynamic and interactive web pages. HTML, CSS, and JavaScript are the three fundamental technologies used to create the basic structure, design, and behavior of modern web applications. HTML documents can contain embedded media elements ({{}}, {{}}, and {{}}) that allow richer user experiences. In addition, HTML has support for accessibility features, like the addition of alt attributes for images and aria attributes for improved interactions with



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assistive technologies. An HTML document has a tree-like structure, where elements can be nested inside of one another in a clear and structured document hierarchy. All of the content in your website is underpinned by the rules of syntax and structure defined by HTML which is why it is so important that all web developers understand HTML. HTML forms the foundation for building web pages and is used by developers to create static content, and can be extended with the help of CSS and JavaScript for building dynamic and responsive websites. This makes the fact that all browsers can interpret and display these documents without any problems an important characteristic of web browsers. So for that reason, HTML is still an integral and core technology for the World Wide Web, and it provides the basic structure for the construction of websites and web applications.

a) Search Engines and Their Functionality

Search Engine is a software system that is designed to search for piece of information on the world wide web. They deploy meticulous algorithms to index, assess, and deliver search results in a streamlined manner. Popular search engines are Google, Bing, Yahoo, Baidu and DuckDuckGo.

1. Crawling: Search engines depend on automated programs called web crawlers, spiders, or bots, to methodically crawl the web to index content and keep their database updated. These crawlers serve as the foundation of search engine functionality, silently roaming the WWW in search of websites, tracking changes, or updating their databases. It all starts with a crawler that visits a web page, scanning its content and capturing important information such as text, images, metadata, and links. These crawlers perform one of their primary functions: link-following, the process of accessing web pages to traverse through hyperlinks attached to a site. The interconnected structure of links between web pages enables search engines to map the extensive online landscape effectively. For example, a crawler visits various websites and strives to find any content that is new, updated, or has changes, which is useful when users perform a search query, as they will receive the most relevant and updated results. However, without this ongoing process, search engines would not be able to deliver accurate and up-to-date information, resulting in outdated or irrelevant search results. But website owners are able to control the



way crawlers treat their websites using a distinctive file called robots. txt. The Robots file is stored in the root directory of a website and is used to tell search engine crawlers what pages to crawl and which to avoid. It acts like a dialogue between a website's owner and robots, assisting in managing internet traffic and preventing sensitive data from getting indexed. For example, the website owner could use a robot. txt to ensure crawlers do not index their private directories, duplicate content, as well as unimportant pages on their site, like login pages or temporary files. Most search engines respect these directives, but certain malicious bots can disregard them, highlighting the necessity of added security measures such as authentication and firewall protection. Crawlers also respect meta tags like "noindex" or "nofollow" that help them determine whether or not to crawl specific pages. A noindex tag tells a search engine not to include a specific page in its index so that it will not show up in search results. On the other hand, the "nofollow" tag tells the crawler not to follow the links on a given page, thus helping to preserve link equity and prevent the proliferation of low quality or spammy links. How often your site gets crawled will depend on various factors, including update frequency, domain authority, and internal linking structure. Dynamic and well-authority sites like regularly updating news or popular blogs are crawled more than static or low-traffic sites. Search engines use complex algorithms and ranking factors to determine which pages should be crawled first, indexing the most relevant and valuable content on the web in a timely manner. In addition excessive crawling can put a load on a website's server resources, leading to potential performance issues. To minimize this, webmasters can employ crawl-delay parameters in their robots. txt file that specifies how often crawlers should visit their website, minimizing the possibility of server overload. While these are good steps, crawling in and of itself does not mean that you will rank well on a DOC search engine. After a page is crawled, its content is analyzed, categorized, and stored in a massive search engine database through a process called indexing. The search engine then uses ranking algorithms with different criteria like relevance, keyword usage, page authority, and user experience to decide how a page should be ranked in the search results. So, while web crawlers are a key aspect of content discovery,



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search engine optimization (SEO) is what gets your content in front of more people. They play a crucial role in the functioning of search engines, ensuring that users can access the most relevant and up-to-date information available on the web. The systematic process of browsing by them ensures that the search engine serves accurate and live content to the users, while ensuring mechanisms such as robots. Meta tags and txt files give website owners control over the appearance of their site on search engines and if they want content to be prioritized over others. Understanding web crawlers and optimizing websites accordingly can help businesses and content creators improve the visibility and accessibility of their online presence.

2. Indexing: After a web crawler finds a page, the search engine processes the page's content to understand its purpose and relevance. This is called indexing, which is the process created where search engines analyze the page's textual content, images, multimedia elements, metadata, and structure. The content of the page is analyzed to find its main topics, keywords and phrases, which in turn informs how that page is ranked for specific search terms. Search engines apply powerful natural language processing (NLP) methods to understand what words mean in context, so that the page is classified accurately. In addition, metadata (title tags, meta descriptions, header tags) can describe the content of a page, which can help classify the information. The on-page structure such as internal links, headings, and schema markup enables search engines to understand the hierarchy of a webpage and its relationship with other pages. Aside from text, search engines also analyze non-textual content like images and videos by looking at their alt attributes, captions, and surrounding text to understand their relevance. The data collected is then indexed — which means it is compiled into a huge database, which allows for quick access to relevant web pages when users run searches. Indexing plays a critical role in the speed and accuracy of search engine results, as it allows fast scanning of stored data with no need to examine each page in real time. Indexing also means removing duplicate content, filtering low-quality or spam pages, updating the records whenever some pages get changed/removed, etc. Indexing algorithms of search engines constantly evolve to improve relevance, considering numerous signals ranging from page freshness, user engagement



netrics, to backlink profiles for identifying the authority and credibility of ndexed content. Moreover, structured data help search engines understand the content like event information, recipe, and product details, allowing the search engines to return rich search results, like snippets, knowledge panels, and featured answers. This process should be efficient, as the performance of the search engine relies on it, as the most relevant and qualitative results should be shown to the user. In order for search engines to have an up-todate and comprehensive index, they send crawlers at regular intervals rediscovering pages to capture new content and to update ranking changes. Crawling and processing, with subsequent indexing, allows search engines to keep up with the changing nature of the web and always provides the most relevant content to users when they search with queries. As a result, website owners and SEO professionals alike need to ensure that their websites and content are indexable by establishing a clear site structure, employing appropriate metadata, using proper headings, rich snippets, and schema markup for their content, and providing high-quality, original content that demonstrates relevance to the searcher's intent. Inadequate indexing optimization can lead to low visibility in search results, as search engines may have difficulty properly understanding or categorizing the material. Elements such as page load speed, mobile-friendliness, and secure connections (HTTPS) directly affect how well a page is indexed and its ranking on search engines, as all of which are key factors in search engine's ranking algorithms now place user experience paramount. Unlike traditional search engines, modern search engines employ machine learning and artificial intelligence to build indexing strategies that enable them to not only understand user questions but also provide contextually relevant answers. Semantic search — powered by techniques such as entity recognition and topic modeling — enables search engines to move beyond exact keyword matching to understand the intent behind a search query. At the end of the day indexing is the heart of the search engine, it takes the unorganized web data and turns it into an organized database, so that a user can get an instant search result in a very short span of time.



3. Ranking: A search engine will index a web page, which means it will store the necessary information about it to retrieve it in the future when the user searches for it. When someone types in a search query, the search engine checks its index—a huge database of web pages that have been crawled and stored in its database-to find pages that match the search terms These algorithms are a complex way for assessing many different things that determine the rank of a page in terms of quality and relevance. In total, there are more than 200 factors that can influence ranking, including keyword frequency, quantity and quality of inbound links, user engagement metrics, content freshness, and page structure. Keyword frequency: Refers to how frequently the searched terms occur in a page's content, title, and metadata. Sadly, overusing keywords - keyword stuffing, as it's called — is a quick path to a penalty, instead of a higher ranking. Backlinks, or inbound links, are also integral to ranking. Search engines consider quality links from authoritative domains as an endorsement of a page's trustworthiness and authority. The general rule is that more backlinks from authoritative sites will help with ranking. Furthermore, user engagement signals, which includes clickthrough rates (CTR), dwell time and bounce rates gives an idea to the search engines on how users are interacting with a page. High CTRs plus dwell time suggest a page is valuable to users and low bounce rate indicates irrelevant content or low-quality content. Search engines continually update their ranking algorithms by teaching users as the algorithm effort to provide the most accurate and valuable information in the fastest way. Such tweaks help fight back against remaining manipulative tactics, such as keyword stuffing, link schemes, and cloaking, in which a website displays different content to users than it does to search engines in order to deceive rankings. Search engines keep up with the evolution of technology and user behaviors by incorporating new features like voice search, AI-powered answer boxes, and personalized results. Due to the advent of digital assistants such as Google Assistant and Siri, voice search became popular and caused search engines to focus on natural language processing (NLP) and difference searches. Powered by intelligence, the AI answer boxes, called featured snippets, pick out the



essential content from web pages and present a short answer in the search engine results page (SERP) itself, benefiting the users and minimizing the clicks to display information. Personalization represents another key evolution as search engines tailor their results to a user's location, search history, and preferences, providing information that is more relevant. This customization may result in two different users getting different results for the same query. Due to the rise of mobile browsing, search engines have also implemented mobile-first indexing, giving priority to mobile-compatible websites in their rankings. Machine learning also plays a pivotal role in improving search engine performance by fine-tuning large ranking models based on their training data and user interactions. One example of this would be Google's Rank Brain, which is an AI-powered element that helps processes complex queries and enhance result accuracy over time. Technical factors like page speed, security (HTTPS), structured data, and core web vitals also influence how search engines rank content. Rapidly loading pages with secured connections and well-organized data enhance the user experience and presence in the search results. At the end of the day, search engines have one purpose: to provide users a means of accessing the most relevant and useful information as quickly and effectively as possible. Grasping these core concepts, webmasters, advertisers, and content authors can fine-tune their online visibility to better reflect search engine standards, showing improved visibility and engagement.

UNIT 8 E-COMMERCE AND M-COMMERCE

E-commerce: The buying and selling of goods and services over the internet using varying technologies-commerce: Similar to E-commerce but with special difference that it involves conducting transactions through mobile devices.

E-commerce: Electronic commerce, or e-commerce, is the purchasing and trading of merchandise and services through the internet by using electronic devices, such as desktop computers, laptops, tablets and smartphones. It has revolutionized business operations and allows consumers to obtain products and services easily from anywhere, at any time. E-commerce includes more



than just e-retailing; it also includes online auctions, banking, and payment industry. With online retail, or e-tailing, businesses can sell products directly to customers from dedicated online retailers, or through online marketplaces like Amazon, eBay, and Alibaba. These applications present a wide range of products, usually along with description, pictures, customer reviews, and price listings. E-commerce websites are designed for user experience — they allow users to browse product categories, compare their offerings, and make informed purchasing decisions. Widely used in e-commerce platforms, advanced search techniques. Buyers can limit their selections by search engines and filtering options (both such as price point, manufacturer, customer ratings, araciality). This search functionality is likely driven by advanced algorithms that improve the user experience and provide personalized recommendations and relevant search results. Other e-commerce websites also use artificial intelligence and machine learning to examine user interests and shopping behavior, enabling businesses to determine customers who may be receptive to targeted promotions and advertisements. E-commerce platforms not only allow for search but also offer multiple payment methods that enable convenient and safe transactions. Payment methods vary widely and can range from credit and debit cards, digital wallets (such as PayPal and Google Pay), to cryptocurrency. Payment wallets with security-based technology for secure money transfer for online shopping Most e-commerce utilize web browsers on personal computers/laptops and now m-commerce is a quickly developing phenomenon as virtually every mobile device has internet access and also most mobile applications also have internet access. To offer customers an uninterrupted shopping experience, many companies have created mobile-friendly sites or dedicated apps. Mobile apps also have additional features like push notifications, real-time tracking, and exclusive discounts to keep users engaged. E-commerce convenience has even reached banking services, as people can now do online transactions, transfer funds, pay bills, and apply for a loan easily, all without going to a physical bank. Emerging as one of the key elements of e-commerce, offline banking services are driving the digital revolution. Online auctions are another significant area in e-commerce, enabling buyers to bid on products and services in real time. Online marketplaces such as eBay enable sellers to auction items for sale, where

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buyers can place offers competitively until the auction period is completed. This model allows for an alternate means of selling products for people and businesses, and opens up pricing dynamics based on demand, which is often more favorable. They also combine a variety of customer support features such as live chat, chatbots, and email assistance to ensure customers receive assistance with their concerns and inquiries quickly. As technology progresses into the future, e-commerce advances by providing virtual try-ons via augmented reality (AR), voice-assisted purchasing, and automated inventory logistics to companies. With the growth of e-commerce, this trend is here to stay, altering international commerce as we know it to give both consumers and companies access to a broader collection of goods and services, making global transactions ever more convenient.

M-Commerce: M-commerce (mobile commerce) is the fastest growing subset of e-commerce, allowing users to make transactions using mobile devices like smartphones and tablets. With unparalleled convenience and immediacy, this means of commercial activity is restructuring how everyone shops, banks, and does business. With portable mobile devices and technology growing in popularity M- commerce is becoming huge within the digital economy. This platform represents a game-changing development for both businesses and consumers, as it enables processes to happen in real-time while also offering personalized experiences and transactions. M-Commerce is more accessible than its traditional counterpart since it doesn't require a desktop or a laptop, enabling users to transact at any time from anywhere. Integration of location-based services (LBS) is one of the biggest benefits of M-commerce that provides users personalized and context-aware experiences. Using GPS and other geolocation technologies, they can serve targeted promotions, localized deals, and navigation assistance. For example, businesses have the option to send notifications to users about offers when they get within a certain distance to a store so that it can boost impulse purchases. Likewise, ride-hailing apps, including Uber and Lyft, depend on users' locations in order to match them up with the closest drivers around them, enhancing their convenience goals. By combining real-time location data with marketing tools, M-commerce becomes a highly



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useful and focused solution that can be used by businesses to reach out and engage with their consumers. Push notifications are another crucial aspect of Mcommerce, providing a powerful communication channel between businesses and consumers. Such notifications can inform users about flash sales, special deals or abandoned carts, and urge them to act swiftly. Push notifications pop up on a user's screen immediately — a significant advantage over conventional emails or text messages, which can get lost in a pile of notifications. These alerts help companies improve customer retention and conversions by delivering timely, relevant updates. Push notifications provide the opportunity to implement personalized marketing strategies that involve a focus on user behavior, preference, and past interactions. Additionally, mobile-specific functionalities like QR codes and Near Field Communication (NFC) streamline mobile transactions even further. QR codes — short for Quick Response codes — enable users to receive product details, complete purchases, or use discounts by scanning a code with their smartphone camera. No need for inputting details by hand, transforming the shopping experience. Whereas with NFC, services like Apple Pay, Google Pay, and Samsung Pay allow you to be capable of make safe, contactless payments. Users could make an purchase quickly with contactless payment simply wave the mobile devices with near-field communication, after that no cash and card needed to complete the transaction. This has found wide acceptance, especially in retail, public transport, and hospitality industries, because of its speed and security. Mobile commerce is particularly important in areas like mobile banking and financial services, enabling customers to handle finances, send money, and pay bills straight from their mobile devices. Mobile banking apps enable users to pay bills, check balance, and track their investments, which allows them to have more control over their finances. In addition to traditional online banking, digital wallets and peer-to-peer payment apps, including PayPal, Venmo, and Google Pay have streamlined the process, allowing users to send money without relying on banks. These innovations have increased financial inclusion in many parts of the world, particularly in regions where access to physical bank branches is limited.





Figure 5.2: M -Commerce

a) Overview and Benefits of Online Transactions

Overview: Online transaction means a transaction of sale/purchase of goods /services, which is taken place with the help of internet. They allow people and companies to use digital systems for buying and selling currency, product, or service without needing to be in the same location. Wide adoption of online transactions in different industries and sectors has never been easier due to the rapid advancement of internet technologies, secure payment gateways and encryption techniques. E-commerce purchases, which refers to the buying and selling of goods and services through online platforms, are one of the most popular forms of online transactions. The rise of online shopping has significantly shaped our spending habits, enabling us to purchase goods and services without the inconvenience of visiting a physical store. They provide seamless shopping experience to the users by integrating multiple payment options ranging from credit and debit cards to net banking, and digital wallets among others. E-commerce has transformed the landscape of retail, diminishing the need for physical stores and providing consumers with more options at various price points. Online banking is another important part of the online transaction process, allowing customers to conduct financial transactions



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from anywhere. These online banking services allow customers to access account balance information; make transfers; pay bills; and apply for loans without setting foot in a physical branch. This has also resulted in online banking becoming the preferred medium for millions of users across the globe. With built-in fraud detection and prevention methods to mitigate risks, banks have implemented secure security measures like two-factor authentication (2FA), biometric verification, and encryption for users. With the increasing utilization of smartphones and mobile applications, mobile wallet payments have become extremely popular. Mobile wallets like PayPal, Google Pay, Apple Pay, Paytm, etc., enable users to save card information and make purchases in mere taps. These wallets also offer contactless payments, allowing users to make in-store purchases using QR codes or near-field communication (NFC) technology. Mobile wallets are already the preferred payment method for online and inperson purchases due to their ease, speed, and convenience. Another integral part of online transactions is digital fund transfers, enabling individuals and businesses to send money electronically. This practice involves transferring funds quickly and securely, so systems like Real-Time Gross Settlement (RTGS), National Electronic Funds Transfer (NEFT) and Immediate Payment Service (IMPS) are all used to enable secure transfers between bank accounts. This made peer-to-peer payments easier than ever: In some countries, such as India, Unified Payments Interface (UPI) has gained traction in recent years, allowing users to send or receive payments instantly through one mobile app. Payment gateways and encryption technologies are crucial for securing online transactions. Payment gateways serve as the middlemen between buyers and sellers, encoding sensitive information like credit card numbers to ensure they are not accessed by unwanted parties. Secure Sockets Layer (SSL) and its successor, Transport Layer Security (TLS), technology helps maintain the confidentiality of all transactional data (and protects the data during any cyber-attack). Moreover, the influence of AI and ML has been a revolution in fraud detection systems helping them to monitor and find suspicious transactions and prevent risks.





Figure 5.3: Online Transaction

Benefits of Online Transactions

The rise of digital technology has revolutionized the payment and financial process for both consumers and businesses through online transactions. Here are the major advantages explained:

- 1. Convenience: Consumers can pay, send money, or shop from anywhere, at any time with online transactions. It does not require the same steps as regular banking or shopping methods where you need to go to the shops or the bank. This availability streamlines the process of conducting financial transactions, making it easier for those with busy lives or for people in remote areas to perform financial transactions without stress.
- 2. Speed and Efficiency: Digital transactions are also processed in realtime, so waiting is drastically reduced compared to if we pay by cash or waiting for cheques to clear. This expediency is advantageous for businesses, as they can ensure immediate settlement of payments, hence can receive payments as soon as possible, while for consumers it allows instant purchases without waiting time.
- 3. Security and Fraud Protection: Online transactions are more secure with secure payment gateways, encryption protocols, and two-factor authentication (2FA) due to their advancements in cybersecurity. Such



measures protect sensitive financial user information while defending them against fraud, unauthorized access, and cyber threats.

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- 4. Cost Savings: Digital currency allows businesses and consumers to save on costs related to cash handling, transportation, and in-person bank visits. They also cut costs associated with paper-based transactions such as cheques and receipts, making the economy more effective in the process.
- **5.** Record Keeping and Transparency: Digital transaction methods automatically create records, making it easier for users to monitor their financial transactions. Users can keep track of their spending, and companies can fire off full income statements. This transparency minimizes errors, increases accountability, and creates a systematic approach to managing finances.
- 6. Wide Accessibility: Online transactions are useful for people especially in remote or rural areas who are not able to reach traditional banking infrastructure. However, the advent of mobile banking, UPI, and digital wallets has made it possible for users to manage their finances from their smartphones and via the internet, making financial inclusion possible in urban and rural landscapes.
- 7. Contactless and Hygienic: the COVID pandemic made clear that the less we touch, the better. Online transactions help decrease the possibility of encountering cash or going to busy places such as banks and shops, thus reducing the risk of disease transmission. QR codes and NFC based payments are also available as methods of contactless payments for health and safety purposes.
- 8. Multiple Payment Options: customers with multiple payment options from credit/debit cards to net banking, UPI, mobile wallets to even cryptocurrencies. This flexibility means that users can settle their bills using the payment method they are most comfortable with.
- 9. Global Reach: Online transactions allow businesses to trade on a global scale. Businesses can now sell products and services all over the world, without having to limit their reach to one location. It leads to economic growth as companies can access a more extensive customer base at a global level and enter new market segments.



10. Integration with E-Commerce and Subscription Services: Online transactions integrated effortlessly with e-commerce systems, subscriptions, and digital marketplaces. User experience: Automated billing, one-click payments, and recurring transactions smooths the user experience. The integration helps businesses maintain a steady stream of income while minimizing the need for invoicing.

b) Online Marketing and Digital Business Models

Online Marketing

Online marketing is also called digital marketing, and it includes different ways to connect your products, services, or brands with your target audiences through internet-based and online channels. These strategies and techniques collectively make up what we call 'Digital Marketing'. Search Engine Optimization (SEO) The cornerstone of online marketing, SEO focuses on optimizing website ranking in search results using keyword strategies, content quality, and technical aspects. And where SEO is more of an organic approach to entering Assure Search Engine Results Pages (SERPs), Search Engine Marketing (SEM) covers paid marketing, such as Google Ads, to provide businesses with placement at the top of SERPs. Another important aspect is Social Media Marketing (SMM), which uses platforms such as Facebook, Instagram, LinkedIn, and Twitter to develop brand awareness and increase audience engagement through organic posts and paid ads. Content Marketing is also important in engaging customers through aesthetic and useful blogs, videos, infographics, etc., and helping them in learning, entertaining, and retaining customers. Importance Of Digital Marketing in Business for Email Marketing Email Marketing is a great method to get in contact with consumers directly. Another popular online marketing method is through your Affiliate Marketing which is where businesses find people who sell their products with them taking payment as a commission for any leads they bring in for the companies. Like Super Bowl Ads PI, Influencer Marketing is rising, with partnering with influential consumers or personalities having significant followers to promote



products. This includes Pay-Per-Click (PPC) Advertising, whereby businesses can run paid ads and pay for each click (typically on Google Ads and Facebook Ads). As mobile devices continue to gain popularity, Mobile Marketing becomes an integral component of any marketing strategy, exploiting different channels such as mobile applications, SMS marketing, and push notifications to keep potential users informed. Furthermore, Analytics and Conversion Optimization are also essential aspects of measuring marketing success, as analytics tools such as Google Analytics help businesses monitor website traffic, user behavior, and campaign performance to improve their strategies. Through and by means of that all of these different on-line marketing strategies together with electronic fall ring ad snap help organizations to multiply increases on their return on digital presence, client attention and return on funding.



Figure 5.4: Online Marketing Business Model

Digital Business Models

A digital business model is a blueprint for how an organization uses digital technologies to create, deliver, and capture value in the digital world. This describes how businesses make money; they do so digitally, using media power to attract customers and retain a profit. Several digital business models have evolved to fill various market needs and consumer behaviors. The e-commerce model, in which businesses sell products or services online via platforms such as Amazon, Shopify, or direct-to-consumer (D2C) websites, is one of the most recognizable models. This model removes geographical



constraints and expands the market for businesses worldwide. Possible Answer: One widely used model is the subscription model, where users are charged periodically for uninterrupted access to goods or services. Streaming services, such as Netflix and Spotify, as well as SaaS (Software as a Service) companies, utilize this model to maintain an ongoing throughput of revenue, whilst incentivizing customer loyalty. Digital companies rely on the freemium model as a business strategy; users enjoy free access to basic services, but they pay a premium for enhanced features. They want enough people to sign up, and then they can convert x% into paying customers. The on-demand approach, where companies like Uber, Airbnb, and food delivery apps dominate, allows for immediate service, focusing on convenience and instant availability. One more prominent model is the marketplace model, which involves businesses bringing together buyers and sellers on one platform, earning money through commissions or listing fees. Both Amazon Marketplace and eBay thrive on this model, taking advantage of high transaction throughput. In the same vein, the advertising-based model is just that: you get free content, and they make their money by stuffing ads down your throat. Businesses such as Google, Facebook, and YouTube all operate on this principle, crafting their make a fortune here via targeted advertising. This model includes gathering user data, analyzing it and selling out the results or targeted ads. This model is also what tech giants such as Google and social media platforms use to provide users with a better experience, all while harvesting valuable consumer data. Crowdsourcing: an innovative model where businesses crowd source either information or funding from users. Kickstarter and other platforms allow entrepreneurs to get capital from users, just as Wikipedia is based on crowdsourced knowledge. Aggregator Model Multiple service providers are offered under one brand (Zomato, Expedia, etc) allowing users to seamlessly compare and side-by-side book. Finally, the hybrid model consists of multiple revenue streams that work together. An example of this is Amazon they run an e-commerce site, a subscription service (Amazon Prime), and a cloud computing project (AWS). Every digital business model has its benefits, and organizations tend to adopt

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combination of such models to optimize value proposition, align with market trends, and maximize revenue.



Figure 5.5: Digital Business Model

INTERNET SECURITY AND ONLINE SAFETY

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The types of attacks also vary widely, including the basics, like spam MyDoom.net phishing emails, to more sophisticated threats like advanced persistent threats and impactful ransomware.

Internet Security: Internet security is the measures and protocols that are put in place to protect activities and transactions carried out on the internet. It covers everything from blocking malware from accessing devices to preventing phishing attacks to keep users safe from hacking and unauthorized access to sensitive data. With the rapid-added of digital technology, the use of cybercriminals has also increased and are trying to pay more attention to remain security implementation to preserve integrity, confidentiality, and availability of data in internet. Browser security is one of the most important elements of internet security, encompassing protection against malicious websites, tracking mechanisms, and vulnerabilities on the web. Modern web browsers include built-in security features like HTTPS encryption, private browsing modes, and protection from malicious scripts. Yet users also have to take steps to safeguard themselves, from regularly updating their browsers to installing security plugins and being careful not to be magnetically attracted to any suspicious links or popups that can appear. Phishing attacks also continue to pose a serious threat to users, as attackers may use fraudulent emails or



websites to lure users into providing sensitive data. As a counter-measure, organizations and individuals must implement multi-factor authentication (MFA) and systems that filter e-mail based on phishing criteria. Network Security: This is another important aspect of internet security, which helps safeguard the infrastructure used to connect devices to the internet. These involve using firewalls, intrusion detection systems (IDS) and virtual private networks (VPNs) to block unauthorized access and data theft. They also use encryption protocols like Secure Sockets Layer (SSL) and Transport Layer Security (TLS) to encrypt data transmitted over networks. Wireless security also matters, as unsecured Wi-Fi networks can also be leveraged by hackers to intercept data and launch cyberattacks. Using strong passwords, disabling any network features not needed and using WPA3 encryption if available on any wireless networks are further steps that can help secure your home. Another pillar of internet security is personal data protection. Vulnerabilities are most often exploited by cybercriminals to steal user personal and financial information for the purposes of identity theft and fraud. To help avoid this kind of risk, people should use strong passwords that are different for each online account and turn on security features like biometric authentication. Encryption for data at rest and in transit protects sensitive data from being compromised. Social media platforms also provide privacy policies that they should configure with care to limit data exposure. That being said, this post is meant to provide some basic guidelines on keeping the Internet as secure as possible given the fact that it never ceases to change so we must adapt along with it. Most of the protection against cyber threats lies in the hands of the users themselves, by practicing the best practices in browser security, network security, and personal data protection.

Online Safety: Defined as the process of being safe online or while using the internet, sometimes referred to as internet safety or cyber safety. With digital interaction now a large component of everyday life, people must keep the risks attached to online activities in mind. Cyber threats like phishing, identity theft, cyberbullying, and malware attacks have on the rise, and therefore, it has become critical to implement protective measures



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scams, whether via a dodgy email, phishing fake websites or malicious software. Digital hygiene is one of the most important aspects of internet safety. This means using advanced passwords, two-factor authentication and regular updates to software and security patches. If no, and if your device is wellsecured, there is a strong possibility no one else would have access. Moreover, people must be careful to share personal details over the internet particularly on social networks. Cybercriminals commonly use information pulled from private social media profiles to help them create highly personalized attacks, including social engineering scams. Reducing personal data released publicly, changing privacy settings, and considering who they interact with online can help to reduce potential threats. Another important aspect of online safety is knowing and staying away from malicious websites. Fraudulent sites often duplicate legitimate platforms in order to steal login credentials or spread harmful software. Handle Sensitive Information with Care Before providing sensitive information on a website, users verify that the ultimate destination is the correct domain, they can look up the URL to see other spellings, and do not click on links from untrustworthy sites. As with downloading files from untrusted sources, malware infections are more common and can lead to problems about system integrity or data breaches. Use well known antivirus and firewalls to add another level of security against cyber-attacks. Furthermore, education and awareness contribute significantly to improving online safety. To equip individuals with vital know-how navigate the internet in a safe manner, schools, workplaces, and governments actively promote digital literacy programs. Tips like these, how to spot potential threats, red flags in online communications, where to report suspicious activities all work toward making the online community safer for all. Children and teen, in particular, need special care to develop safe net habits, such as not talking to strangers online and not becoming a part of cyberbullying for that matter, or addressing improper content. At the end of the day, safety online is a collective endeavor that requires a vigilant eye, educated choices, and the right security tools. Taking these measures does not mean you will eliminate your risk of falling victim to a cyber attack; rather, by implementing best practices,

to secure sensitive data. Basic to online safety is acknowledging these risks and

knowing how cyber criminals take advantage of weaknesses in the form of



familiarizing yourself with the latest threats, and making use of technological defenses, you can noticeably reduce your enterprise's vulnerability and create a safer digital network for yourself and your clients.

a) Importance of Internet Security

Internet security is the process of protecting your online accounts, devices, and network from cyber threats in today's digital age, which is essential to safeguarding personal, financial, and sensitive data. As we do most of our daily lives on online platforms, such as communication, banking, shopping, and business activities, the cybersecurity risk is also increasing enormously. Hackers and cybercriminals never cease to create new and sophisticated ways to break into networks, software or to take advantage of user behavior. As a result, robust internet security is important for safeguarding individuals, organizations, and governments against data breaches, identity theft, financial fraud, and other cyber dangers. Protecting personal data — One of the key reasons that internet security matters is because of personal data protection. When a user accesses an online service, he or she provides information about their names, addresses, phone number, and banking details. In such hands, this data can be used to perpetrate identity theft, financial fraud, or even blackmail. Phishing, malware attacks and social engineering are sneak attacks used by cybercriminals to lure people into sharing sensitive information. Users can strengthen their own security through the use of strong passwords, enabling multi-factor authentication, and avoiding suspicious links. Internet security is essential for enterprises and organizations for maintaining business sustainability and customer trust. The Companies hold billions of confidential data like customer and consumer records, trade secrets, and financial transactions. The consequences of a breach can include financial loss, reputational damage, and even legal penalties. Cyber-attacks such as ransomware, distributed denial-of-service (DDoS) attacks, and data leaks are on the rise, disrupting business operations and posing a serious threat to their continuity. To protect their digital treasures, organizations should implement strong security measures (firewalls, encryption, and ongoing security audits, for example). Protecting citizens, critical infrastructure and classified



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information, government and national security agencies also prioritize internet security. The protection of sensitive personal and business data, the protection against cyber warfare and state-sponsored attacks that threaten national defense and infrastructure are among these threats — as powered grids are hacked, defense systems and public databases breached. Combatting cyber threats on a national and global level requires effective cybersecurity policies, investment in threat intelligence, and international cooperation. Apart from the tech aspect, educating people on cybersecurity best practices is equally crucial. Human error is responsible for many cyber security vulnerabilities, including clicking on malicious links and having weak passwords. Training people how to behave online safely, how to spot scams, and when to update software is a big part of reducing the risk of cyber threats. Internet security is essential for the protection of data such as corporate data, personal information, and government information from cyber threats. As cybercriminals develop many tactics, both people and companies should stay aware and use solid protection systems to maintain a safe and secured electronic environment.

b) Measures for Secure Online Practices (Antivirus, Firewalls, Encryption)

In the modern age of technology, it is vital to maintain safety practices in the online world. Important actions include antivirus software, firewalls, and encryption:

Antivirus Software: Antivirus software is designed to detect, prevent, and remove malware (ie viruses, worms, trojans, etc.) They constantly scan your system for known threats, and look for odd behavior that might suggest new, undetected malware. Whenever new threats are discovered, software vendors should update their tools to better detect them, and it's critical to keep this up. Built-in solutions like Windows Security do offer a wealth of protective features, but third-party antivirus software can include extra tools like VPNs, parental controls and password managers.

Firewalls: Firewalls are the First Line of defense between your device (or a network) and potential threats from an external source. Firewalls are systems that control the incoming and outgoing network traffic based on the security



rules. Firewalls are hardware, software, or both. A good firewall will block bad traffic from entering the system as well as unauthorized data from leaving.

Encryption: Encryption is a process in which readable data format is transformed into coded format that cannot be read by unauthorized users. This mechanism guarantees that the data is kept private and secured, even if it is captured. This is critical—it is particularly important to keep sensitive information such as personal data, financial information, and intellectual property encrypted. This will often be used in secure messaging, online banking, and e-commerce platforms. Implementing robust encryption protocols protects data in transit and at rest, ensuring that only those possessing the correct decryption key can access sensitive data.

MCQ

- 1. What is the primary function of the World Wide Web (WWW)?
 - a) Sending emails
 - b) Browsing and retrieving information
 - c) Running operating systems
 - d) Managing local network connections
- 2. Which of the following best defines a website?
 - a) A single web page with no links
 - b) A collection of interconnected web pages under a common domain
 - c) A digital book available online
 - d) A computer program for managing files

3. What is the process of transferring files from a local computer to a web server called?

- a) Downloading
- b) Streaming
- c) Uploading
- d) Browsing

4. HTML is primarily used for:

a) Writing and structuring web pages



- b) Encrypting sensitive data
- c) Managing email services
- d) Developing mobile applications

5. Search engines help users by:

- a) Blocking advertisements on websites
- b) Providing access to the dark web
- c) Indexing and retrieving relevant web pages based on queries
- d) Running antivirus scans on downloaded files

6. Which of the following is an advantage of e-commerce?

- a) Limited access to customers
- b) High operational costs
- c) Convenience and wider market reach
- d) No need for an online presence

7. M-Commerce refers to:

- a) Online shopping through desktop computers
- b) Conducting business transactions via mobile devices
- c) Marketing through TV advertisements
- d) Selling products only in physical stores

8. Why is internet security important?

- a) To increase internet speed
- b) To prevent unauthorized access and cyber threats
- c) To make websites load faster
- d) To avoid using passwords

9. Which of the following is NOT an internet security measure?

- a) Using strong passwords
- b) Installing antivirus software
- c) Avoiding software updates
- d) Enabling firewalls

10. Encryption is used to:

- a) Make web pages load faster
- b) Secure data by converting it into an unreadable format



c) Block internet access

d) Remove viruses from a system

Long answer type Question

- 1. Explain the concept of the World Wide Web (WWW). How does it facilitate browsing and information retrieval? Provide examples of its applications in daily life.
- 2. Discuss the importance of web standards in website development. How do web standards ensure accessibility, security, and interoperability?
- 3. Describe the process of uploading and downloading files on the internet. What are the key differences between the two, and how do they impact data sharing?
- Explain the structure and significance of HTML in web development. How do HTML documents contribute to website creation? Provide examples of basic HTML elements.
- 5. What are search engines, and how do they function? Discuss the role of indexing, crawling, and ranking in search engine optimization (SEO).
- 6. Discuss the benefits and challenges of e-commerce and m-commerce. How have online transactions transformed global business models?
- 7. Explain the role of online marketing in digital business models. How do businesses use SEO, social media, and digital advertisements to enhance their online presence?
- 8. Why is internet security crucial in today's digital world? Discuss the common threats users face while browsing the internet.
- 9. Explain the various security measures, such as antivirus software, firewalls, and encryption, that help in ensuring safe online practices. How do these tools protect users from cyber threats?
- 10. Discuss the ethical and legal aspects of internet security. How do data protection laws and cybersecurity regulations impact individuals and businesses?

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