

Data Communications:

Introduction to Data Communications: In Data Communications, data generally are defined as information that is stored in digital form. Data communications is the process of transferring digital information between two or more points. Information is defined as the knowledge or intelligence. Data communications can be summarized as the transmission, reception, and processing of digital information. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs). The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter. A data communications system has five components:

1. **Message:** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
2. **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
3. **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
4. **Transmission medium:** The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.
5. **Protocol:** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices.

Standards Organizations for Data Communications An association of organizations, governments, manufacturers and users form the standards organizations and are responsible for developing, coordinating and maintaining the standards. The intent is that all data communications equipment manufacturers and users comply with these standards. The primary standards organizations for data communication are:

1. **International Standard Organization (ISO)** ISO is the international organization for standardization on a wide range of subjects. It is comprised mainly of members from the standards committee of various governments throughout the world. It is even responsible for developing models which provides high level of system compatibility, quality enhancement, improved productivity and reduced costs. The ISO is also responsible for endorsing and coordinating the work of the other standards organizations.
2. **International Telecommunications Union-Telecommunication Sector (ITU-T)** ITU-T is one of the four permanent parts of the International Telecommunications Union based in Geneva, Switzerland. It has developed three sets of specifications: the V series for modem interfacing and data transmission over telephone lines, the X series for data transmission over public digital networks, email and directory services; the I and Q series

1 Data C Unit-1 Introduction to Data Communications for Integrated Services Digital Network (ISDN) and its extension Broadband ISDN. ITU-T membership consists of government authorities and representatives from many countries and it is the present standards organization for the United Nations.

3. **Institute of Electrical and Electronics Engineers (IEEE)** IEEE is an international professional organization founded in United States and is comprised of electronics, computer and communications engineers. It is currently the world's largest professional society with over 200,000 members. It develops communication and information processing standards with the underlying goal of advancing theory, creativity, and product quality in any field related to electrical engineering.
4. **American National Standards Institute (ANSI)** ANSI is the official standards agency for the United States and is the U.S voting representative for the ISO. ANSI is a completely

private, non-profit organization comprised of equipment manufacturers and users of data processing equipment and services. ANSI membership is comprised of people from professional societies, industry associations, governmental and regulatory bodies, and consumer goods.

5. Electronics Industry Association (EIA) EIA is a non-profit U.S. trade association that establishes and recommends industrial standards. EIA activities include standards development, increasing public awareness, and lobbying and it is responsible for developing the RS (recommended standard) series of standards for data and communications.

6. Telecommunications Industry Association (TIA) TIA is the leading trade association in the communications and information technology industry. It facilitates business development opportunities through market development, trade promotion, trade shows, and standards development. It represents manufacturers of communications and information technology products and also facilitates the convergence of new communications networks.

7. Internet Architecture Board (IAB) IAB earlier known as Internet Activities Board is a committee created by ARPA (Advanced Research Projects Agency) so as to analyze the activities of ARPANET whose purpose is to accelerate the advancement of technologies useful for U.S military. IAB is a technical advisory group of the Internet Society and its responsibilities are:

- I. Oversees the architecture protocols and procedures used by the Internet.
- II. Manages the processes used to create Internet Standards and also serves as an appeal board for complaints regarding improper execution of standardization process.
- III. Responsible for administration of the various Internet assigned numbers
- IV. Acts as a representative for Internet Society interest in liaison relationships with other organizations.
- V. Acts as a source of advice and guidance to the board of trustees and officers of Internet Society concerning various aspects of internet and its technologies.

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8. Internet Engineering Task Force (IETF) The IETF is a large international community of network designers, operators, vendors and researchers concerned with the evolution of the Internet architecture and smooth operation of the Internet.

9. Internet Research Task Force (IRTF) The IRTF promotes research of importance to the evolution of the future Internet by creating focused, long-term and small research groups working on topics related to Internet protocols, applications, architecture and technology.

Layered Network Architecture

To reduce the design complexity, most of the networks are organized as a series of layers or levels, each one build upon one below it. The basic idea of a layered architecture is to divide the design into small pieces. Each layer adds to the services provided by the lower layers in such a manner that the highest layer is provided a full set of services to manage communications and run the applications. The benefits of the layered models are modularity and clear interfaces, i.e. open architecture and comparability between the different providers' components. A basic principle is to ensure independence of layers by defining services provided by each layer to the next higher layer without defining how the services are to be performed. This permits changes in a layer without affecting other layers. The basic elements of a layered model are services, protocols and interfaces. A service is a set of actions that a layer offers to another (higher) layer. Protocol is a set of rules that a layer uses to exchange information with a peer entity. These rules concern both the contents and the order of the messages used. Between the layers service interfaces are defined. The messages from one layer to another are sent through those interfaces. In a n-layer architecture, layer n on one machine carries on conversation with the layer n on other machine. The rules and conventions used in this conversation are collectively known as the layer-n protocol. Basically, a protocol is an agreement between the communicating parties on how communication is to proceed. Five-layer architecture is shown below;

the entities comprising the corresponding layers on different machines are called peers. In other words, it is the peers that communicate using protocols. In reality, no data is transferred from layer n on one machine to layer n of another machine. Instead, each layer passes data and control information to the layer immediately below it, until the lowest layer is reached. Below layer-1 is the physical layer through which actual communication occurs.

3 Data C Unit-1 Introduction to Data Communications Peer-to-peer communications

Peers With layered architectures, communications between two corresponding layers requires a unit of data called a protocol data unit (PDU). A PDU can be a header added at the beginning of a message or a trailer appended to the end of a message. Data flows downward through the layers in the source system and upwards at the destination address. As data passes from one layer into another, headers and trailers are added and removed from the PDU. This process of adding or removing PDU information is called encapsulation/decapsulation. Between each pair of adjacent layers there is an interface. The interface defines which primitives operations and services the lower layer offers to the upper layer adjacent to it. A set of layers and protocols is known as network architecture. A list of protocols used by a certain system, one protocol per layer, is called protocol stack.

Open Systems Interconnection (OSI) International standard organization (ISO) established a committee in 1977 to develop architecture for computer communication and the OSI model is the result of this effort. In 1984, the Open Systems Interconnection (OSI) reference model was approved as an international standard for communications architecture. The term “open” denotes the ability to connect any two systems which conform to the reference model and associated standards. The OSI model describes how information or data makes its way from application programmes (such as spreadsheets) through a network medium (such as wire) to another application programme located on another network. The OSI reference model divides the problem of moving information between computers over a network medium into SEVEN smaller and more manageable problems. The seven layers are:

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The lower 4 layers (transport, network, data link and physical —Layers 4, 3, 2, and 1) are concerned with the flow of data from end to end through the network. The upper four layers of the OSI model (application, presentation and session—Layers 7, 6 and 5) are orientated more toward services to the applications. Data is Encapsulated with the necessary protocol information as it moves down the layers before network transit.

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As with any layered architecture, overhead information is added to a PDU in the form of headers and trailers. Each layer provides a service to the layer above it in the protocol specification. Each layer communicates with the same layer’s software or hardware on other computers.

Physical Layer {the physical layer is responsible for transmitting individual bits from one node to the next} The physical layer is the lowest layer of the OSI hierarchy and coordinates the functions required to transmit a bit stream over a physical medium. It also defines the procedures and functions that physical devices and interfaces have to perform for transmission occur. The physical layer specifies the type of transmission medium and the transmission mode (simplex, half duplex or full duplex) and the physical, electrical, functional and procedural standards for accessing data communication networks. Transmission media defined by the physical layer include metallic cable, optical fiber cable or wireless radio-wave propagation. The physical layer also includes the carrier system used to propagate the data signals between points in the network. The carrier systems are simply communication systems that carry data through a system using either metallic or optical fiber cables or wireless arrangements such as microwave, satellites and cellular radio systems.

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Data-link Layer {the data link layer is

responsible for transmitting frames from one node to the next} The data link layer transforms the physical layer, a raw transmission facility, to a reliable link and is responsible for node-to-node delivery. It makes the physical layer appear error free to the upper layer (network layer). The data link layer packages data from the physical layer into groups called blocks, frames or packets. If frames are to be distributed to different systems on the network, the data link layer adds a header to the frame to define the physical address of the sender (source address) and/or receiver (destination address) of the frame. The data-link layer provides flow-control, access-control, and error-control. Network Layer {is responsible for the delivery of individual packets from the source host to the destination host} The network layer provides details that enable data to be routed between devices in an environment using multiple networks, subnetworks or both. This is responsible for addressing messages and data so they are sent to the correct destination, and for translating logical addresses and names (like a machine name FLAME) into physical addresses. This layer is also responsible for finding a path through the network to the destination computer. The network layer provides the upper layers of the hierarchy with independence from the data transmission and switching technologies used to interconnect systems. Networking components that operate at the network layer include routers and their software. 7 Data C Unit-1 Introduction to Data Communications Transport Layer {is responsible for delivery of a message from one process to another} The transport layer controls and ensures the end-to-end integrity of the data message propagated through the network between two devices, providing the reliable, transparent transfer of data between two endpoints. Transport layer responsibilities include message routing, segmenting, error recovery and two types of basic services to an upper-layer protocol: connection oriented and connectionless. The transport layer is the highest layer in the OSI hierarchy in terms of communications and may provide data tracking, connection flow control, sequencing of data, error checking, and application addressing and identification. Session Layer {responsible for dialog control and synchronization} Session layer, some times called the dialog controller provides mechanism for controlling the dialogue between the two end systems. It defines how to start, control and end conversations (called sessions) between applications. Session layer protocols provide the logical connection entities at the application layer. These applications include file transfer protocols and sending email. Session responsibilities include network log-on and log-off procedures and user authentication. Session layer characteristics include virtual connections between applications, entities, synchronization of data flow for recovery purposes, creation of dialogue units and activity units, connection parameter negotiation, and partitioning services into functional groups. 8 Data C Unit-1 Introduction to Data Communications Presentation Layer {responsible for translation, compression, and encryption} The presentation layer provides independence to the application processes by addressing any code or syntax conversion necessary to present the data to the network in a common communications format. It specifies how end-user applications should format the data. The presentation layer translated between different data formats and protocols. Presentation functions include data file formatting, encoding, encryption and decryption of data messages, dialogue procedures, data compression algorithms, synchronization, interruption, and termination. Application Layer {responsible for providing services to the user} The application layer is the highest layer in the hierarchy and is analogous to the general manager of the network by providing access to the OSI environment. The applications layer provides distributed information services and controls the sequence of activities within and application and also the sequence of events between the computer application and the user

of another application. The application layer communicates directly with the user's application program. User application processes require application layer service elements to access the networking environment. The service elements are of two types: CASEs (common application service elements) satisfying particular needs of application processes like association control, concurrence and recovery. The second type is SASE (specific application service elements) which include TCP/IP stack, FTP, SNMP, Telnet and SMTP.

9 Data C Unit-1 Introduction to Data Communications Data Communication Circuits

The underlying purpose of a digital communications circuit is to provide a transmission path between locations and to transfer digital information from one station (node, where computers or other digital equipment are located) to another using electronic circuits. Data communications circuits utilize electronic communications equipment and facilities to interconnect digital computer equipment. Communication facilities are physical means of interconnecting stations and are provided to data communications users through public telephone networks (PTN), public data networks (PDN), and a multitude of private data communications systems. The following figure shows a simple two-station data communications circuit. The main components are:

- Source: - This device generates the data to be transmitted; examples are mainframe computer, personal computer, workstation etc. The source equipment provides a means for humans to enter data into system.
- Transmitter: - A transmitter transforms and encodes the information in such a way as to produce electromagnetic signals that can be transmitted across some sort of transmission system. For example, a modem takes a digital bit stream from an attached device such as a personal computer and transforms that bit stream into an analog signal that can be handled by the telephone network.
- Transmission medium: - The transmission medium carries the encoded signals from the transmitter to the receiver. Different types of transmission media include free-space radio transmission (i.e. all forms of wireless transmission) and physical facilities such as metallic and optical fiber cables.
- Receiver: - The receiver accepts the signal from the transmission medium and converts it into a form that can be handled by the destination device. For example, a modem will
- Destination: - Takes the incoming data from the receiver and can be any kind of digital equipment like the source.

10 Data C Unit-1 Introduction to Data Communications Serial and Parallel Data Transmission

There are two methods of transmitting digital data namely parallel and serial transmissions. In parallel data transmission, all bits of the binary data are transmitted simultaneously. For example, to transmit an 8-bit binary number in parallel from one unit to another, eight transmission lines are required. Each bit requires its own separate data path. All bits of a word are transmitted at the same time. This method of transmission can move a significant amount of data in a given period of time. Its disadvantage is the large number of interconnecting cables between the two units. For large binary words, cabling becomes complex and expensive. This is particularly true if the distance between the two units is great. Long multiwire cables are not only expensive, but also require special interfacing to minimize noise and distortion problems. Serial data transmission is the process of transmitting binary words a bit at a time. Since the bits time-share the transmission medium, only one interconnecting lead is required