

Networking Fundamentals Study Reviewer

Module 1: Introduction to Networking

Networking Software Functions

- Helps to set up and install computer networks
- Enables users to have access to network resources in a seamless manner
- Allows administrations to add or remove users from the network
- Helps to define locations of data storage and allows users to access that data
- Helps administrators and security system to protect the network from unauthorized access and attacks
- Enables network virtualizations

Web Browser and Plug-Ins

Web browsers acts on behalf of a user by contacting a web server, requesting information, receiving information, displaying the results on a screen.

Plug-ins is to view special, or proprietary, file types that standard web browsers are not able to display like QuickTime, Real Audio, Android Emulator.

Software Defined Networking (SDN)

Is a framework that has three layers:

APPLICATION LAYER – SDN applications reside in the Application Layer. The applications convey their needs for resources and services to the control layer through API (Application Program Interface).

CONTROL LAYER – The Network Control Software, bundled into the Network Operating System, lies in this layer. It provides an abstract view of the underlying network infrastructure. It receives the requirements of the SDN applications and relays them to the network components.

INFRASTRUCTURE LAYER – Also called the Data Plane Layer, this layer contains the actual network components. The network devices reside in this layer that shows their network capabilities through the Control to data-Plane Interface.

Key SDN Concepts

- **Data plane** refers to all the functions and processes that forward packets/frames from one interface to another.

- **Control plane** refers to all the functions and processes that determine which path to use.
- The separation of functions from hardware, such as firewalls or load balancing, is called **Network Functions Virtualization (NFV)**.

10 Best Network Monitoring Tools & Software of 2020

1. Solarwinds Network Performance Monitor
2. PRTG Network Monitor from Paessler
3. ManageEngine OpManager
4. WhatsUp Gold 2017
5. Nagios XI
6. Zabbix
7. Incinga
8. Datadog
9. ConnectWise Automate
10. Logic Monitor

Module 2: Networking Terminology

Internet vs Intranet vs Extranet

- **Internet:** computer network system that connects the computers of the world and normally connecting through WAN and LAN.
- **Intranet:** physically secured computer network system, as it covers a small area and only authorized people can access it.
- **Extranet:** controlled private network that allows access to partners, vendors and suppliers or an authorized set of customers, normally to a subset of the information accessible from an organization's intranet.

Key Networking Terms

- **World Wide Web (WWW):** service that is used on Internet to view and search contents (in the form of web-pages).
- **Voice over Internet Protocol (VoIP):** protocol, which is used for voice transfer over IP network; facilitates users to make phone-calls by using the internet.
- **Firewall:** machine and its software that serves as a special gateway to a network, protecting it from unauthorized access.

- **Really Simple Syndication (RSS):** a technique which is used for the dissemination of information, articles; users normally subscribe to the RSS channel.
- **Web log:** online inventory (normally on a specialized topics) that consists of a series of entries arranged in reverse chronological order.
- **Public Switched Telephone Network (PSTN):** technical expression for public telephone system.
- **Integrated Services Digital Network (ISDN):** set of communication standards that transmits voice, video, data, and other network services simultaneously.
- **Podcast:** digital file that normally contains audio or video record available on the Internet.
- **Broadband:** wide bandwidth data transmission that transports multiple signals and traffic types swiftly.
- **Asymmetric Digital Subscriber Line (ADSL):** a sort of Digital Subscriber Line (DSL) technology that facilitates faster data transmission.
- **Dial-up:** technique in which a phone line is used in order to connect to the Internet through an equipment called a modem.
- **Node:** is a point of intersection/connection within a network; devices that are accessible through the network are all considered nodes.

Token Passing (in a Ring Topology)

- token contains a piece of information which is sent along with data by the source computer
- token regularly passed from one node to another
- a token is like a permission packet which allows a node to release information over the network
- if a node has some information to pass on the network, the node releases the information
- if the node does not have any data to release on the network, then it transfers the token to the next node
- nodes with token are the ones only allowed to send data
- Other nodes have to wait for an empty token to reach them

Connection Types

- **Physical connection:** used to transfer signals between PCs within the local network and to remote devices on the Internet
- **Logical connection:** how the data moves between the devices and uses standards called protocols.
- **Application:** interprets the data and displays the information in an understandable form

Serial Communication Standards

- **RS-232 (Recommended Standard-232):** A TIA/EIA standard for serial transmission, serial port widely used on earlier personal computers prior to USB.
- **TIA/EIA:** Telecommunications Industries Association/Electronic Industries Association; publishes the TIA/EIA Telecommunications Building Wiring Standards.

Frame Relay

- a packet-switching technology offered as a telecommunications service by Telcos and long-distance carriers, used primarily for WAN links.
- used to encapsulate local area network (LAN) traffic such as Ethernet frames for transmission over digital data transmission lines for wide area networks (WANs) and can connect multiple LANs to form a multipoint WAN.

Data Communication Signals

- **Data Communications Equipment (DCE):** an example of DCE is a modem.
- **Data Terminal Equipment (DTE):** common example of this is a computer.
- **Transmitted Data (TD):** one of two separate data signals; generated by the DTE and received by the DCE.
- **Received Data (RD):** second of two separate data signals; generated by the DCE and received by the DTE.
- **Clear to Send (CTS):** used along with RTS to provide handshaking between the DTE and the DCE; after the DCE sees an asserted RTS, it turns CTS ON when it is ready to begin communication.
- **Request to Send (RTS):** when the host system (DTE) is ready to transmit data to the peripheral system (DCE), RTS is turned ON.
- **Data Set Ready (DSR):** this signal is turned on by the DCE to indicate that it is connected to the telecommunications line.
- **Data Carrier Detect (DCD):** this signal is turned ON when the DCE is receiving a signal from a remote DCE, which meets its suitable signal criteria.
- **Data Terminal Ready (DTR):** indicates the readiness of the DTE; this signal is turned ON by the DTE when it is ready to transmit or receive data from the DCE.
- **Ring Indicator (RI):** when asserted, indicates that a ringing signal is being received on the communications channel.

Network Topologies

Definition

Network topology refers to the physical or logical layout of a network; defines the way different nodes are placed and interconnected with each other; describe how the data is transferred between these nodes.

Two (2) Types of Network Topologies

Physical Topology

- emphasizes the physical layout/look of the connected devices and nodes
- the actual layout of the wire or media.
- Cost, scalability, flexibility, bandwidth capacity matters
- Examples: Bus, Star, Ring, Mesh, Hybrid

Logical Topology

- focuses on the pattern of data transfer/travels between network nodes.
- defines how the media is accessed by the hosts for sending data
- Data delivery causing lost packets or congestion.
- Examples: Token Ring, Fiber Distributed Data Interface

Physical Topologies

Bus Topology

- all devices are connected to a main cable
- communication between the devices passes through this main cable

Advantages:

- easy to connect a computer or peripheral
- requires less cable length

Disadvantages:

- entire network shuts down if there is a break in the main cable
- terminators are required at both ends of the backbone cable
- difficult to detect the problem if the entire network shuts down

- not advisable to be used as a stand-alone solution in a large building

Mesh Topology

- each device is connected to another device through a dedicated point-to-point link
- if one link fails, it does not affect the other links.

Types of Mesh Topology:

Full Mesh Topology:

- every computer in the network has a connection to each of the other computers in that network
- number of connections in this network can be calculated using the following formula (n is the number of computers in the network): $n(n-1)/2$

Partially-Connected Mesh Topology:

- at least two of the computers in the network have connections to multiple other computers in that network
- inexpensive way to implement redundancy in a network
- if one of the primary computers or connections in the network fails, the rest of the network continues to operate normally

Advantages:

- manages high amounts of traffic, because multiple devices can transmit data simultaneously
- failure of one device does not cause a break in the network or transmission of data
- adding additional devices does not disrupt data transmission between other devices.

Disadvantages:

- cost to implement is higher than other network topologies, making it a less desirable option
- building and maintaining the topology is difficult and time consuming
- chance of redundant connections is high, which adds to the high costs and potential for reduced efficiency

Star Topology

- each device is connected to another device through a central device (hub)
- there is no direct communication between the devices unlike in mesh topology
- if the central device fails then there will no longer be communication among devices.

Advantages:

- easy to install and wire
- no disruptions to the network when connecting or removing devices
- easy to detect faults and to remove parts.

Disadvantages:

- requires more cable length than a bus topology.
- if the hub, switch, or concentrator fails, nodes attached are disabled.
- more expensive than bus topologies because of the cost of the hubs, switch, or concentrator.

Ring Topology

- each device is directly connected to two other devices on its sides, this continues until a ring is formed among all the devices
- communication between the devices gets passed through this ring until the intended recipient is reached
- failure of one device can fail the entire network if the signal cannot be forwarded.

Types of Ring Topology Based on Data Flow:**Unidirectional Ring Topology:**

- handles data traffic in either clockwise or counterclockwise direction
- this data network, can also be called as a half-duplex network
- easy to maintain compared to the bidirectional ring topology.
- Ex: SONET network, SDH network etc.

Bi-directional ring topology:

- handles data traffic in both the direction and can be a full-duplex network
- data traffic flows in both clockwise and counter clockwise directions
- this is realized by having two rings that run in opposite directions
- a node selects the ring to transmit to another node based on the shortest distance between the source and the destination.

Advantages:

- reduced chances of data collision as each node release a data packet after receiving the token

- token passing makes ring topology perform better than bus topology under heavy traffic
- no need of a server to control connectivity among the nodes
- equal access to resources

Disadvantages:

- in Unidirectional Ring: data packet must pass through all the nodes.
- single point of failure, that means if a node goes down entire network goes down.

Hybrid Topology

- a combination of two or more topologies
- used if only one type of topology is not enough for the user requirements
- result of joining two or more existing networks with different topologies

Types of Hybrid Network Topologies:

1. Star-Wired Ring Network Topology:

- set of star topologies are connected by a ring topology as the adjoining topology
- joining each star topology to the ring topology is a wired connection

2. Star-Wired Bus Network Topology:

- made up of a set of star topologies interconnected by a central bus topology
- joining each star topology to the bus topology is a wired connection

3. Hierarchical Network Topology:

- structured in different levels as a hierarchical tree
- also called as tree topology
- connection of the lower levels like level 2 to higher levels like level 1 is done through wired connection
- first level, level 0, contains the parent (root) node
- nodes at the last level are called leaf nodes

Logical Topologies

Broadcast

- Each host sends its data to all other hosts on the network medium.

- First-come, first-serve.
- Eg: Ethernet

Token Ring

- physically wired as star topology but the communication signal is passed sequentially from one device to another in the manner of a ring topology until it returns to the source
- uses tokens to ensure that only one device is used at a time thus preventing collision of signals.

Fiber Distributed Data Interface (FDDI)

- using fiber cable, this is a high-bandwidth dual token-passing ring which serves as the network backbone within a ring or star topology
- consists of a primary and a secondary ring which can act as the backup in case the primary ring fails.

Considerations in selecting a Topology

- **Length of cable needed:** bus topology uses shorter lengths of cable.
- **Money:** bus topology may be the least expensive way to install a network; you do not have to purchase switch, hub, concentrators
- **Future growth:** star topology, expanding a network is easily done by adding another concentrator.
- **Cable type:** most common cable in schools is unshielded twisted pair, which is most often used with star topologies.

Types of Networks

Personal Area Network (PAN)

- Thomas Zimmerman was the first research scientist to bring out the idea
- is used for connecting the computer devices for personal use.
- is a network arranged within an individual person, typically within a range of 10 meters.

Two (2) types of Personal Area Network:

- **Wired Personal Area Network:** created by using the USB.
- **Wireless Personal Area Network:** developed by simply using wireless technologies such as WiFi or Bluetooth (low range network)

Examples:

- **Body Area Network:** is a network that moves with a person. Example: mobile network moves with a person.
- **Offline Network:** created inside the home, so it is also known as a home network.
- **Small Home Office:** used to connect a variety of devices to the internet and to a corporate network using a VPN

Local Area Network (LAN)

- is a group of computers connected to each other in a small area such as a building or an office.
- is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.
- it is less costly as it is built with inexpensive hardware such as hubs, network adapters, and ethernet cables.
- data is transferred at an extremely faster rate in Local Area Network.
- provides higher security.

LAN Characteristics:

- Operate within a limited geographic area
- Allow many users to access high-bandwidth media
- Provide full-time connectivity to local services
- Connect physically adjacent devices

Some common LAN technologies: Ethernet, Token Ring, FDDI

LAN Technology Specifications

Name	IEEE Standard	Data Rate	Media Type	Maximum Distance
Ethernet	802.3	10 Mbps	10Base-T	100 meters
Fast Ethernet/100Base-T	802.3u	100 Mbps	100Base-TX, 100Base-FX	100 meters, 2000 meters
Gigabit Ethernet/GigE	802.3z	1000 Mbps	1000Base-T, 1000Base-SX, 1000Base-LX	100 meters, 275/550 meters, 550/5000 meters
10 Gigabit Ethernet	IEEE 802.3ae	10 Gbps	10GBase-SR, 10GBase-LX4, 10GBase-LR/ER, 10GBase-SW/LW/EW	300 meters, 300m MMF/10km SMF, 10km/40km, 300m/10km/40km

Wireless Local Area Network (WLAN)

- Working like a LAN, WLANs make use of wireless network technology, such as WiFi.
- Normally seen in the same types of applications as LANs, these types of networks don't require physical cables to connect to the network.

Wireless Protocols

Specification	Data Rate	Modulation Scheme	Security
802.11	1 or 2 Mbps in the 2.4 GHz band	FHSS, DSSS	WEP and WPA
802.11a	54 Mbps in the 5 GHz band	OFDM	WEP and WPA
802.11b/High Rate/Wi-Fi	11 Mbps (with a fallback to 5.5, 2, and 1 Mbps) in the 2.4 GHz band	DSSS with CCK	WEP and WPA
802.11g/Wi-Fi	54 Mbps in the 2.4 GHz band	OFDM when above 20Mbps, DSSS with CCK when below 20Mbps	WEP and WPA

Campus Area Network (CAN)

- larger than LANs, but smaller than metropolitan area networks
- types of networks are typically seen in universities, large or small businesses.
- can be extended in buildings that are fairly close to each other so users can share resources.

Metropolitan Area Network (MAN)

- a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.
- in MAN, various LANs are connected to each other through a telephone exchange line.
- most widely used protocols in MAN are RS-232, Frame Relay, ISDN, OC-3, ADSL, etc.
- has a higher range than Local Area Network(LAN).
- network that spans a metropolitan area such as a city or suburban area.
- consists of two or more LANs in a common geographic area.

Uses of Metropolitan Area Network:

- MAN is used in communication between the banks in a city.
- It can be used in an Airline Reservation.

- It can also be used for communication in the military.

Wide Area Network (WAN)

- a network that extends over a large geographical area such as states or countries.
- is quite a bigger network than the LAN.
- is not limited to a single location, but it spans a large geographical area through telephone lines, fiber optic cables or satellite links.
- The internet is the biggest WAN in the world.
- is widely used in the field of business, government, and education.
- operate over a large geographically separated areas
- provide full-time remote resources connected to local services

Some common WAN technologies: Analog modems, Integrated Services Digital Network (ISDN), Digital Subscriber Line (DSL), Frame Relay, Asynchronous Transfer Mode (ATM), T (US) and E (Europe) carrier series: T1, E1, T3, E3, Synchronous Optical Network (SONET)

Examples of Wide Area Network:

- **Mobile Broadband:** A 4G network is widely used across a region or country.
- **Last mile:** A telecom company is used to provide the internet services to the customers in hundreds of cities by connecting their home with fiber.
- **Private network:** A bank provides a private network that connects the remote offices.

Advantages of Wide Area Network:

- **Geographical area:** A Wide Area Network provides a large geographical area.
- **Centralized data:** In case of WAN, data is centralized.
- **Access updated files:** Software companies work on the live server.
- **Exchange messages:** In a WAN, messages are transmitted fast.
- **Sharing of software and resources:** In WAN, software and other resources like a hard drive or RAM can be shared.
- **Global business:** Business can be done over the internet globally.
- **High bandwidth:** Leased lines gives a high bandwidth for companies.

Disadvantages of Wide Area Network:

- **Security issue:** A WAN has more security issues as compared to LAN and MAN.

- **Needs Firewall & antivirus software:** The data is transferred on the internet which can be changed or decoded by the hackers.
- **High Setup cost:** An installation cost of the WAN network is high.
- **Troubleshooting problems:** It covers a large area so fixing the problem is difficult.

Storage Area Network (SAN)

- Dedicated high-speed network that connects shared pools of storage devices to several servers, these types of networks don't rely on a LAN or WAN.
- They move storage resources away from the network and place them into their own high-performance network.
- can be accessed in the same fashion as a drive attached to a server.

System-Area Network (also known as SAN)

- used to explain a relatively local network that is designed to provide high-speed connection in server-to-server applications (cluster environments), storage area networks and processor-to-processor applications.
- The computers connected on a SAN operate as a single system at very high speeds.

Passive Optical Local Area Network (POLAN)

- As an alternative to traditional switch-based Ethernet LANs, POLAN technology can be integrated into structured cabling.
- A point-to-multipoint LAN architecture, POLAN uses optical splitters to split an optical signal from one strand of singlemode optical fiber into multiple signals.

Enterprise Private Network (EPN)

- built and owned by businesses that want to securely connect its various locations to share computer resources.

Virtual Private Network (VPN)

- extending a private network across the Internet
- lets its users send and receive data as if their devices were connected to the private network – even if they're not
- through a virtual point-to-point connection, users can access a private network remotely
- A VPN is a private network that is constructed within a public network infrastructure such as the global Internet

- VPN is the most cost-effective method of establishing secured connection

VPN Types:

- Access VPNs
- Intranet VPNs
- Extranet VPNs

Network Architectures

Network architecture is defined as the physical and logical design of the software, hardware, protocols, and media of the transmission of data; how computers are organized and how tasks are allocated to the computer.

Two (2) Types of Network Architectures

Client/Server Network

- is a network model designed for the end users called clients, to access the resources from a central computer known as server
- a server performs all the major operations such as security and network management.
- A server is responsible for managing all the resources such as files, directories, printer, etc.
- All the clients communicate with each other through a server.

Advantages:

- contains a centralized system, therefore back up of the data can be done easily.
- has a dedicated server that improves the performance of the whole system.
- Security is better as a single server administers the shared resources.
- It also increases the speed of the sharing resources.

Disadvantages:

- expensive as it requires a server with large memory.
- A server has a Network Operating System(NOS) to provide the resources to the clients, but the cost of NOS is very high.
- It requires a dedicated network administrator to manage all the resources.

Peer-To-Peer Network

- is a network in which all the computers are linked together with equal privilege and responsibilities for processing the data.
- is useful for small environments, usually up to 10 computers.
- has no dedicated server.
- special permissions are assigned to each computer for sharing the resources, but this can lead to a problem if the computer with the resource is down.

Advantages:

- it costs less as it does not have a dedicated server
- if one computer stops working, other computers will not stop working
- it is easy to set up and maintain.

Disadvantages:

- it does not contain a centralized system
- it is more difficult to back up the data as the data is stored in different locations
- it has a security issue as the devices manage themselves.

Module Summary

- A computer network is comprised of connectivity devices and components.
- To share data and resources between two or more computers is known as networking.
- Basic networking hardware includes switch, router, and access points.
- Networking software are used to setup, maintain, and manage networks.
- There are different types of computer network by size such as LAN, MAN, WAN.
- There are also different topologies of networks categorized into physical and logical.
- Physical topologies include bus, mesh, star, ring, and hybrid
- Logical topologies are Broadcast, Token Ring, and FDDI
- Network architectures are client/server and peer-to-peer