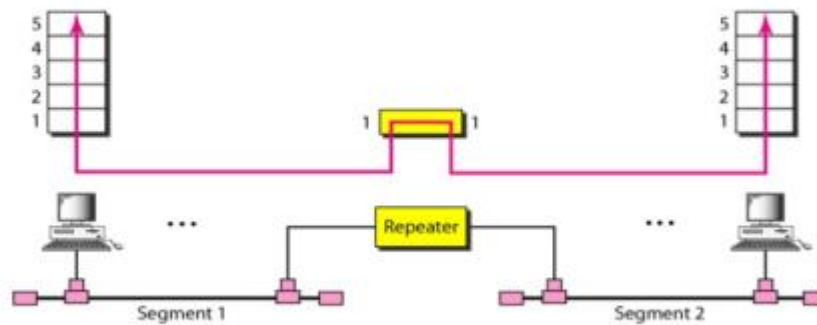**Department of Electronics and Telecommunication Engineering**

Semester	T.E. Semester VI – EXTC Engineering
Subject	Computer Communication Network (CCN)
Laboratory Teacher:	Prof. Beena R Ballal
Laboratory	MS-Teams online

Student Name	Anuj Shah	
Roll Number	18104B0024	
Grade and Subject Teacher's Signature		

Experiment Number	01	
Experiment Title	Networking and internetworking devices	
Aim	Study of networking and internetworking devices in detail	
Resources / Apparatus Required	Hardware: PC	Software: Internet connectivity
Theory:	Repeater, Hubs, Bridges,Routers,Switches,NIC,Modem,Gateways, Firewall **Repeater** - Definition: A repeater connects segments of a LAN. - Operation: A repeater is a device that operates only in the physical layer. Signals that carry information within a network can travel a fixed distance before attenuation endangers the integrity of the data. A repeater receives the signal and, before it becomes too weak or corrupted, regenerates the original bit pattern. The repeater then sends the refreshed signal.	

A repeater connecting two segments of a LAN

Segment 1   Repeater   Segment 2

15.4

US Plug

LAN Port

Reset Button

Power
Wireless
WPS
LAN

WPS Button

Specifications of a repeater:
- General specifications: Power supply
- Transmission specifications: RF data rate, RF frequency range, RF receiver sensitivity, RF transmission power, Transmission range, Number of RF channels, Spreading method, Modulation
- Construction specifications: Casing, Dimensions, Single unit weight
- Environmental conditions: Operating temperature, Storage temperature, Operating

humidity, Altitude

Companies: Advanced RF Technologies, Bird, Cobham Wireless, Comba Telecom, CommScope, Excelwave, Fiplex Communications, Kavveri Telecom, Lianstar, Microlab, Morelink Technology Corporation, Westell Technologies, Communication Components Inc, DeltaNode Wireless Technology, Pivotal Commware, Shyam Telecom Limited, Vialite Communications

References:
- Definition and Operation from "Data Communication and Networking" by Behrouz Forouzan, Chapter 15 (Connecting LANs, Backbone Networks, and Virtual LANs)
- Specifications from "P2P-R datasheet" by Define Instruments: https://www.instrumart.com/assets/Repeater-datasheet.pdf
- Company list from "RF Repeater Manufacturers" by everythingRF: https://www.everythingrf.com/directory/rf-repeaters

Hub
- Definition: An active hub is a multiport repeater.
- Operation: It is normally used to create connections between stations in a physical star topology. Hubs can also be used to create multiple levels of hierarchy.
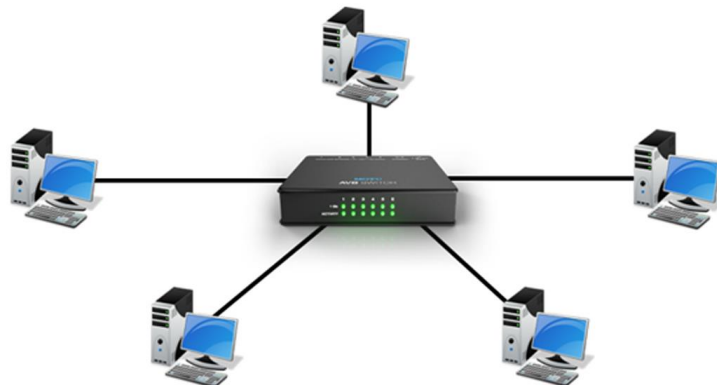
Specifications of a hub:
- General specifications: Subtype, Ports, Status Indicators, Manufacturer
- Power device: Voltage required, Voltage required margin, Nominal voltage, Frequency required, Power consumption operational, Type
- Networking: Cabling type, Subcategory, Subtype, Form factor, Type, Connectivity technology, Compliant standards, Ports quantity
- Miscellaneous: Rack mounting kit
- Power: Max supported quantity
- Interface provided: Gender, Connector quantity, Interface, Quantity, Connector type
- Chassis: Built-in devices
- System requirements: OS required
- Environmental parameters: Min operating temperature, Max operating temperature, Humidity range operating
- Header: Brand, Product line, Model, Localization, Country kits, Packaged quantity, Compatibility
- Dimensions and weight: Width, Depth, Height
- Cable details: Type
- Software: Type
- Expansion bays: Type
- Ports: Type, Quantity
- Expansion slots: Type
- Ports (2nd): Type, Quantity
- Ports (3rd): Type, Quantity
- Slot required: Type
- Service and Support: Type
- Servie and Support details: Type, Servie included, Location, Full contract period
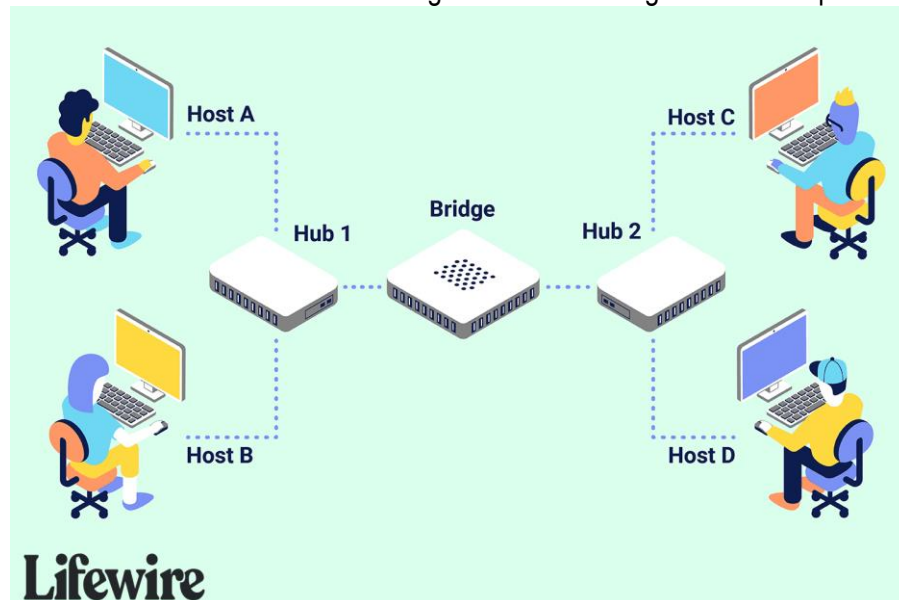- General: Manufacturer

Companies: AOS Technologies, Procentric, Profichip, Contemporary Controls, Rabbit, Circutor, Taiwan Pulse Motion, Hopeland, Black Box, Famur, Vauban Systems

References:

- Definition and Operation from "Data Communication and Networking" by Behrouz Forouzan, Chapter 15 (Connecting LANs, Backbone Networks, and Virtual LANs)
- Specifications from "P2P-R datasheet" by Define Instruments: https://www.instrumart.com/assets/Repeater-datasheet.pdf
- Company list from "RF Repeater Manufacturers" by everythingRF: https://www.everythingrf.com/directory/rf-repeaters
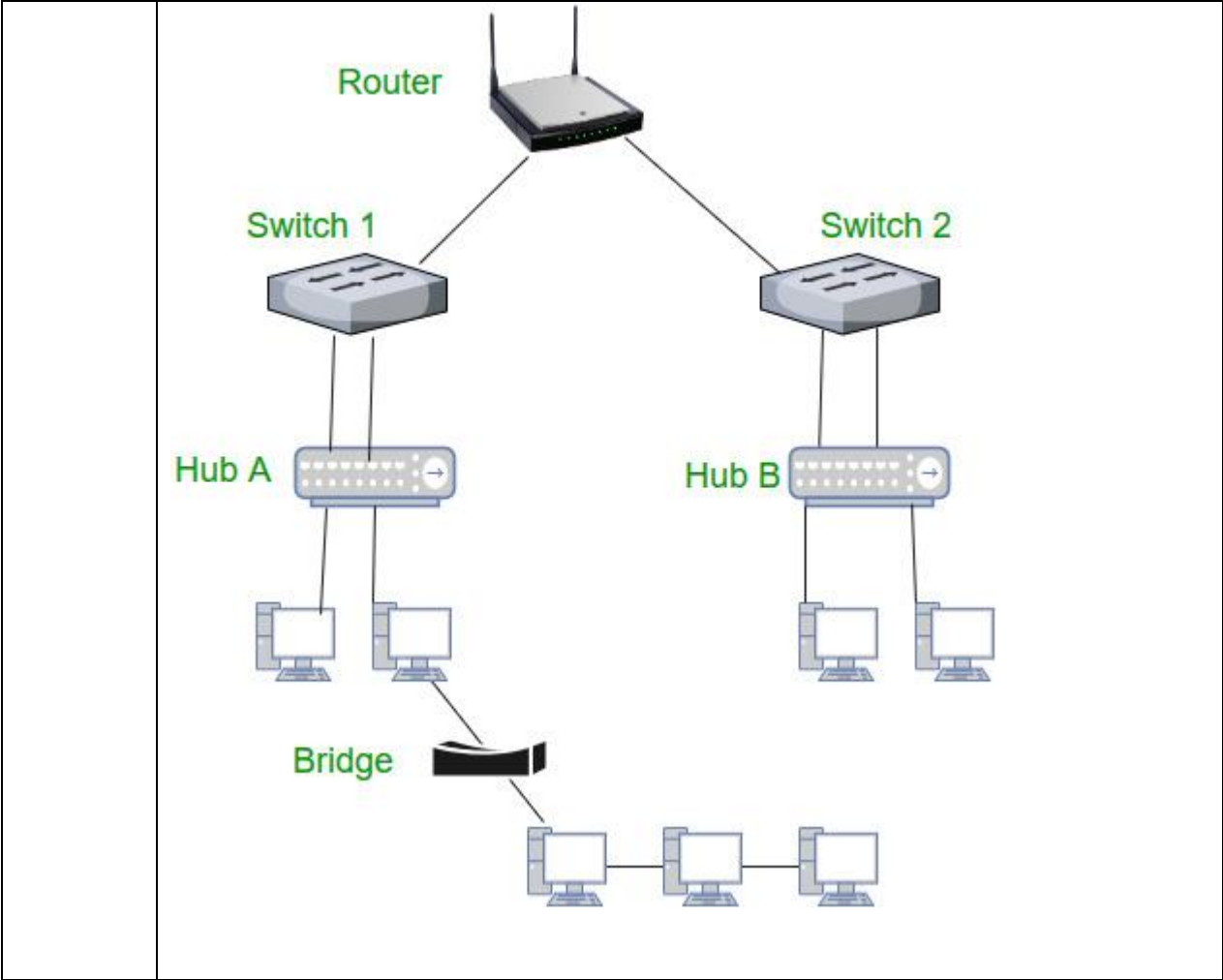
Bridge
- Definition: A bridge is a repeater with the added functionality of filtering content.
- Operation: A bridge operates at data link layer. In addition to filtering content, it is also used for interconnecting two LANs working on the same protocol.

Specifications of bridge:
- General specifications: Enclosure type, Frequency band, Status indicators, Encryption algorithm, Manufacturer
- Expansion/connectivity: Interfaces
- Power device: Type
- Modem: Antenna quantity, Type
- Networking: Form factor, Type, Connectivity technology, Data link protocol, Features, Compliant standards, Wireless protocol, Remote management protocol, Data transfer rate, Spread spectrum method, Line coding format,
- Antenna: Antenna, Antenna quantity, Directivity, Antenna form factor
- Miscellaneous: Encryption algorithm
- Interface provided: Type, Interface, Quantity, Connector type
- Environmental parameters: Min operating temperature, Max operating temperature,

Humidity range operating
- Header: Brand, Product line, Model, Packaged quantity, Compatibility
- Dimensions and Weight: Width, Depth, Height, Weight
- Cable details: Type, Including quantity, Form factor
- Line properties: Line coding format
- Service and support: Type
- Service and support details: Type, Full contract period
- General: Manufacturer

Companies: Black Box, MTL, Microsens, BrainChild

References:
- Definition and operation from "Networking Devices" from GeeksforGeeks
  https://www.geeksforgeeks.org/network-devices-hub-repeater-bridge-switch-router-gateways/
- Specifications from "Linksys WET54G Wireless-G Ethernet bridge specs" by CNET
  https://www.cnet.com/products/linksys-wet54g-wireless-g-ethernet-bridge/specs/
- Companies from Direct Industry
  https://www.directindustry.com/industrial-manufacturer/ethernet-bridge-81097.html

Router
- Definition: A router is a device that finds the best path for the packets based on their IP addresses.
- Operation: Router is mainly a network layer device. It normally connects LANs and WANs together. It has a dynamically updating routing table based on which it can make decisions on routing the data packets. It divides broadcast domains of hosts connected through it.

Router

Switch 1

Switch 2

Hub A

Hub B

Bridge

Specifications of router:
- System specifications: Wireless standard, Wireless speed, Wireless security, Wireless features, Routing, Firewall, Application control, System management, Operation mode
- Hardware specifications: WAN, LAN, Antenna, LED indicators, Buttons, Power, Power consumption
- Physical specifications: Item dimensions, Item weight, Packaging dimensions, Packaging weight
- Environmental specifications: Operating environment, Storage environment
- Certifications: Safety, EMC
- Package contents: Wireless router, Power adapter, Ethernet cable, Quick start guide

Companies: Amped Wireless, Apple, ASRock, Asus, AVM, Belkin, Buffalo, D-Link, Draytek, Edimax, EnGenius, HooToo, JCG, Linksys, Medialink, MicroTik, Netgear, Netis, Securifi, Sitecom, SMC, Synology, Tenda, Totolink, TP-Link, Trendnet, Ubiquiti, Zyxel

References
- Definition and operation from "Networking Devices" from GeeksforGeeks
  https://www.geeksforgeeks.org/network-devices-hub-repeater-bridge-switch-router-gateways/
- Specifications from "AC1200 Dual-Band Wireless Router" by Zyxel Networks
  https://www.zyxel.com/in/en/products_services/AC1200-Dual-Band-Wireless-Router-NBG6604/specifications
- Companies from "Router Brands" by RouterChart
  https://routerchart.com/brands

Switch

- Definition: A switch is a multiport bridge with a buffer in it
- Operation: A switch is a data-link layer device. It can perform error checking before forwarding data, which makes it very efficient. In other words, a switch divides collision domain of hosts, but broadcast domain remains the same.
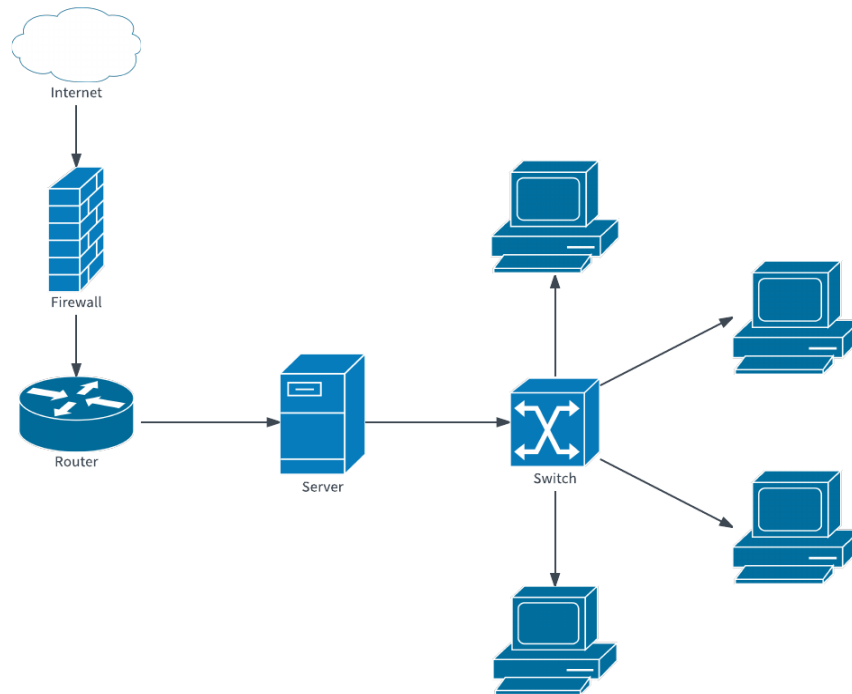
Specifications of switch:
- Base model
- Interfaces
- MAC address table size
- Flash memory
- VLAN ID's

- Forwarding rate
- Authentication method
- Advanced defense mechanisms
- Routing protocol
- Mean time between failure
- Acoustic noise
- Indicators: Per-port status LEDs
- Physical specifications: Rack size, Height, Width, Depth, Weight
- Power consumption: Maximum, Power supplies
- Environmental specifications: Operating temperature, Storage temperature, Humidity
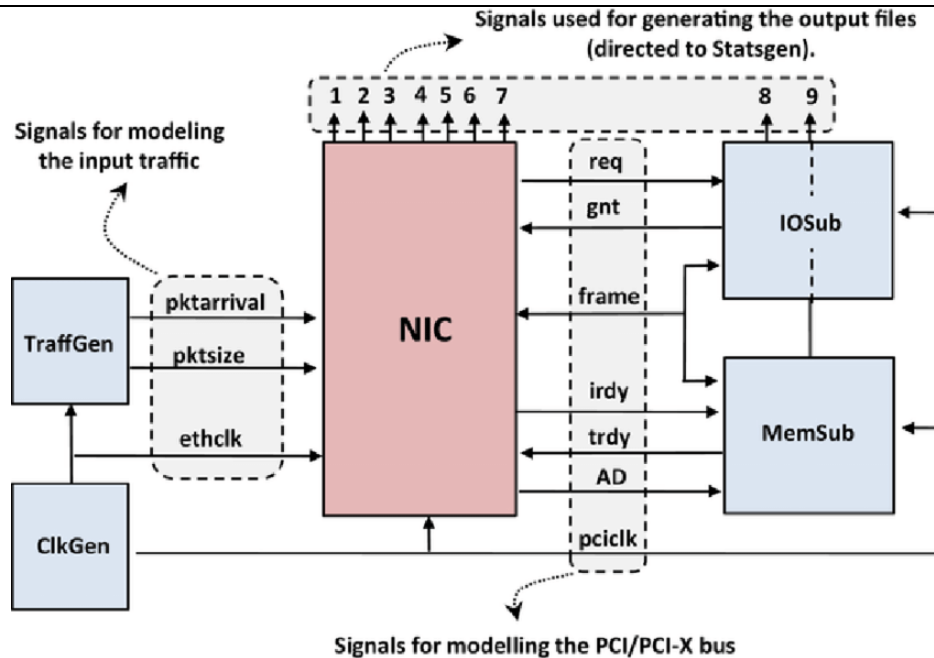- Warranty
- Security accreditations

Companies: Cisco Meraki MS, Cisco Ethernet Switches, HPE Aruba Ethernet Switches, D-Link Ethernet Switches, MikroTik Routers and Switches, Juniper EX Series Ethernet Switches, Dell PowerConnect Switches, Adtran NetVanta Routers and Switches, Extreme Ethernet Switches, Lantronix XPress-Pro SW, Arista 7000 series, NETGEAR Ethernet Switches, Huawei Ethernet Switches, NVIDIA Mellanox Switches, NoviFlow NoviSwitch, Ericsson-LG Ethernet Switches, IBM BladeCenter Ethernet Switches, Broadcom Ethernet Switches, Apresia Ethernet Switch, Alcatel-Lucent OmniSwitch, H3C Ethernet Switches, Linksys Ethernet Switches, TTTech Ethernet Switches, QCT QuantaMesh Ethernet Switches, Lenovo Flex System Ethernet Switches, IEI iSwitch, NEC QX-S1000 Series Switches, Cisco Industrial Ethernet Switches, CenturyLink Ethernet Services, FortiSwitch Secure Access Switches, MikroTik CRS Series
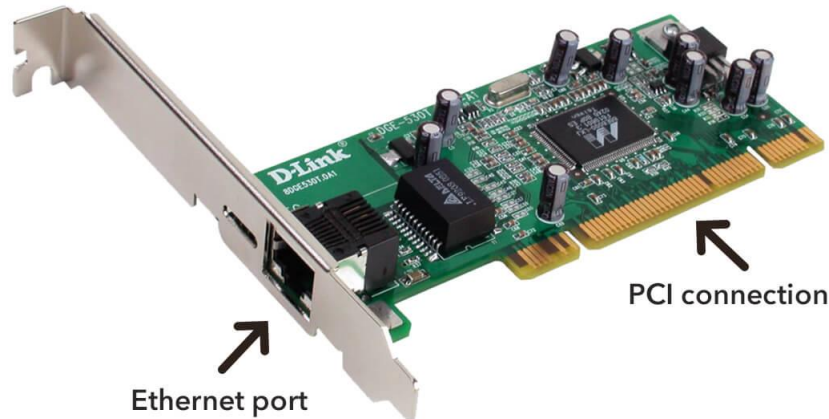
References:
- Definition and operation from "Networking Devices" from GeeksforGeeks
  https://www.geeksforgeeks.org/network-devices-hub-repeater-bridge-switch-router-gateways/
- Specifications from "Cisco SG300 10 Port Fiber Switch" by Emcon
  https://www.zyxel.com/in/en/products_services/AC1200-Dual-Band-Wireless-Router-NBG6604/specifications
- Companies from "Ethernet Switches" by TrustRadius
  https://www.trustradius.com/ethernet-switches

NIC
- Definition: A NIC (network interface controller) is a computer hardware component that connects a computer to a computer network.
- Operation: The network controller implements the electronic circuitry required to communicate using a specific physical layer and data link layer standard such as Ethernet or Wi-Fi. This provides a base for a full network protocol stack, allowing communication among computers on the same local area network (LAN) and large-scale network communications through routable protocols, such as Internet Protocol (IP).

Signals used for generating the output files
(directed to Statsgen).

Signals for modeling
the input traffic

Signals for modelling the PCI/PCI-X bus

Gigabit Ethernet NIC
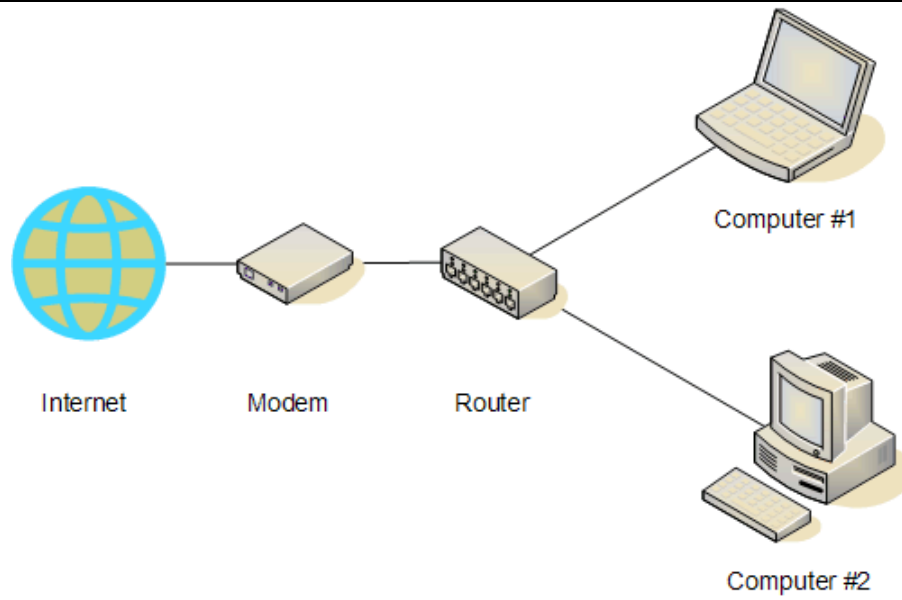
PCI connection

Ethernet port

TechTerms.com

Specifications of NIC:
- General specifications: Form factor, Interface type, Manufacturer
- Power device: Type
- Networking: Ports, Cabling type, Interface (bus) type, Type, Connectivity technology, Data link protocol, Features, Compliant standards, Ports quantity, Data transfer rate, Status indicators
- Miscellaneous: Compliant standards
- Interface provided: Gender, Connector quantity, Type, Interface, Quantity, Connector type
- System requirements: OS required
- Environmental parameters: Min operating temperature, Max operating temperature,

Humidity range operating
- Header: Brand, Product line, Model, Packaged quantity, Compatibility
- Dimensions and weight: Depth, Height, Weight
- Cable details: Type
- Software: Type
- Slot required: Type, Form factor, Total quantity
- Service and support: Type
- Service and support details: Type, Service included, Location, Full contract period
- General: Manufacturer

Companies: Allied Telesis, Broadcom, Buffalo Technology, Cavium, Chelsio, Cisco, D-Link, Intel, Marvell, Mellanox, Oracle Corporation, Realtek, TRENDnet, ZyXEL

Reference:
- Definition and operations from "Network interface controller" on Wikipedia
  https://en.wikipedia.org/wiki/Network_interface_controller
- Specifications from "NetGear FA310TX 10/100 PCI Network Interface Card Specs" on CNET
  https://www.cnet.com/products/netgear-fa310tx-10-100-pci-network-interface-card/
- Companies from "List of networking hardware vendors" on Wikipedia
  https://en.wikipedia.org/wiki/List_of_networking_hardware_vendors#Network_interface_card

Modem
- Definition: A modem- a portmanteau of "modulator-demodulator"- is a hardware device that converts data from a digital format, intended for communication directly between devices with specialized wiring, into one suitable for a transmission medium such as telephone lines or radio.
- Operation: A modem modulates one or more carrier wave signals to encode digital information for transmission, and demodulates signals to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded reliably to reproduce the original digital data.

Specifications of a modem:
- Interfaces: DSL connection, LAN connection
- Modem router specifications: ADSL standards, Internet sharing, Protocols supported, Wired networking standards, DHCP server, IP sharing method, VPN support, Management, Security
- Radio specifications: Wireless standard, Radio technology, Security, Network standards, Media access protocol, Frequency band, Antenna type, Output power, Modulation type, RF channels, Data rate supported, 802.11g
- Wireless specifications: Wireless networking standard, Radio technology, Data rates supported, 802.11g, Frequency band, Antenna type, Output power, Modulation type, RF channels, Wireless clients, Operating range, Encryption/Security
- LED indicators: LEDs

- Power specification: Power supply, Output
- Environmental specifications: Temperature/Humidity, Operating, Storage
- Regulatory: FCC, CE, A-Tick
- Warranty: Manufacturer's lifetime warranty
- Technical support: Free tech support
- Package contents

Companies: D-Link, Netgear, Motorola, 3Com, TP-Link, Zoom Telephonics, Belkin, Huawei, ZyXEL, Beetel, USRobotics, AOPEN, Edimax Technology, Actiontec Electronics, Rosewill, Agere, Airties, Conexant, Cognizant, JCG, Multitech, Synaptics, Netopia

Reference:
- Definition and operation from "Modem" on Wikipedia:
  https://en.wikipedia.org/wiki/Modem
- Specifications from "ADSL Modem with Wireless-G Router" on Belkin
  https://www.dell.com/downloads/emea/services/uk/en/belkin_f5d7632_en.pdf
- Companies from "The Best Modem Manufacturers" on Ranker
  https://www.ranker.com/list/the-best-modem-manufacturers/computer-hardware

Gateway
- Definition: A gateway is a passage to connect two networks together that may work upon different networking models.
- Operation: Gateways basically work as the messenger agents that take data from one system, interpret it, and transfer it to another system. Gateways are also called protocol converters, and can operate at any network layer.
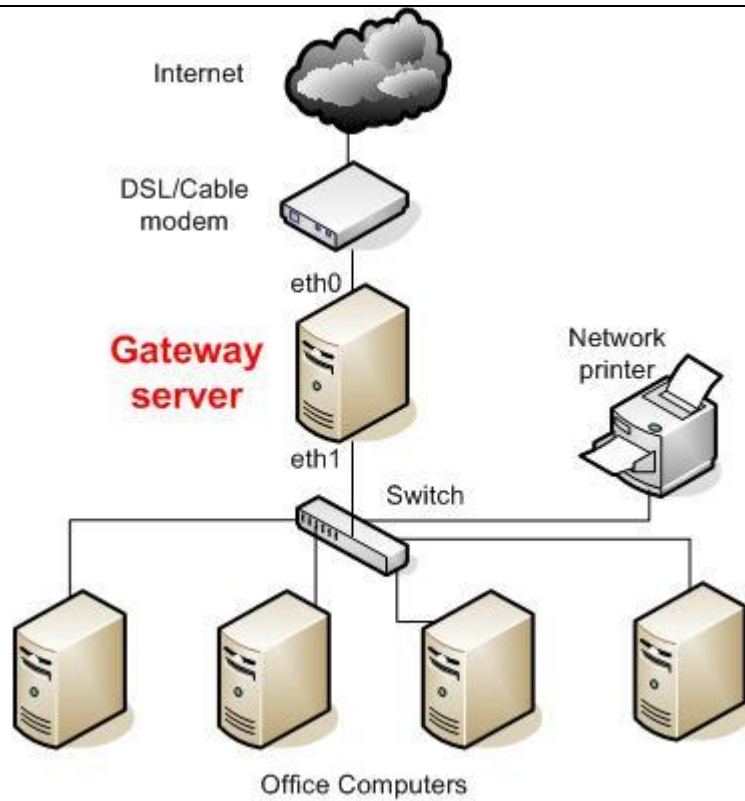
Specifications of a gateway:
- Dimensions (H x W x D)
- Chassis weight
- Average power consumption
- Altitude
- Relative humidity
- Temperature
- Maximal thermal output
- Noise level

Companies: Winmate, Odot, Wlink, Schildknecht, DellEMC, IoT Gateway

Reference:

- Definition and operation from "Networking Devices" from GeeksforGeeks
  https://www.geeksforgeeks.org/network-devices-hub-repeater-bridge-switch-router-gateways/
- Specifications from "SRX210 Services Gateway Specifications" by Juniper
  https://www.juniper.net/documentation/en_US/release-independent/junos/topics/concept/chassis-srx210-description.html
- Companies from Direct Industry
  https://www.directindustry.com/industrial-manufacturer/mobile-network-gateway-99908.html

Firewall
- Definition: A firewall is a network security device that monitors incoming and outgoing network traffic and decides whether to allow or block specific traffic based on a defined set of security rules.
- Operation: You can implement a firewall in either hardware or software form, or a combination of both. Firewalls prevent unauthorized internet users from accessing private networks connected to the internet, especially intranets. All messages entering or leaving the intranet (the local network to which you are connected) must pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.
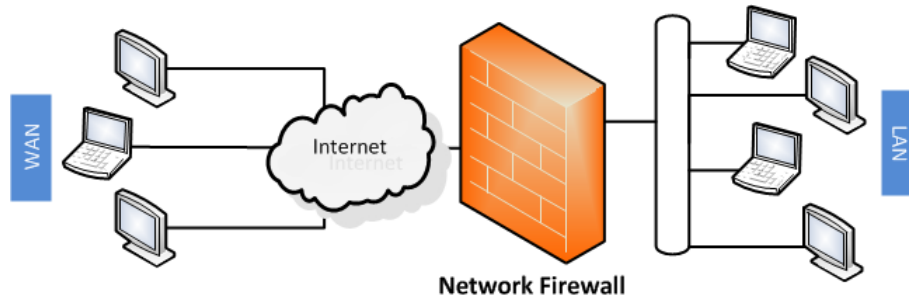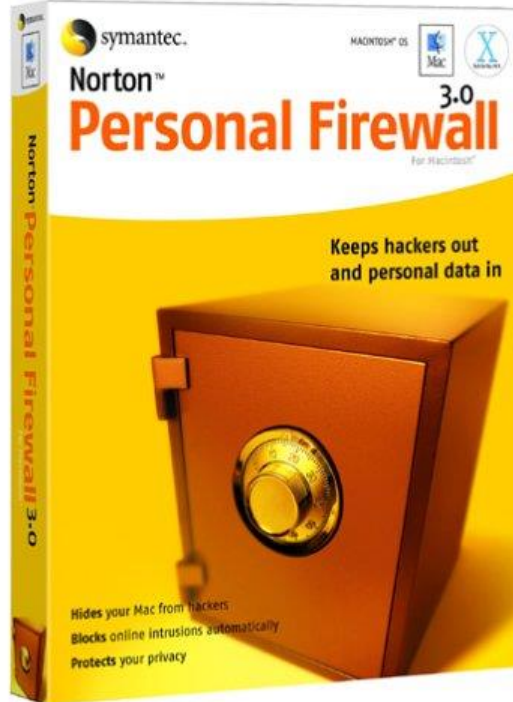

Network Firewall

Companies: Check Point, FortiGate, Palo Alto Networks, WatchGuard, Seqrite Firewall, Cisco Asa Firepower, Cisco PIX, Mcafee Firewall, Juniper SSG, Juniper SRX, Sonicwall, Barracuda Firewall, Cyberoam, D-Link, Endian Firewall, Opendium Iceni, IPCop, pfSense, IPFire, Untangle, Zeroshell, SmoothWall, WinGate, Calyptix Security, Halon Security, Vantronix, Sophos

References:
- Definition from "What Is a Firewall?" from Cisco
  https://www.cisco.com/c/en_in/products/security/firewalls/what-is-a-firewall.html
- Companies from "List of Firewall appliances Company in India" in Wroffy Technologies
  https://www.wroffy.com/list-of-firewall-appliances-company-in-india/

Note that each device should have definition and operation, Two figures(One conceptual and one actual),Specifications and companies, References from where data is taken

Conclusion :	Through research, we now have a general sense of the various networking devices available on the market. Using their definitions and operations, we now know what are their uses.
Post Lab Questions:	1. Draw the diagram showing the position of each device on OSI model 2. What is the need for Networking devices 3. Compare Gateway and Router **Answer 1**
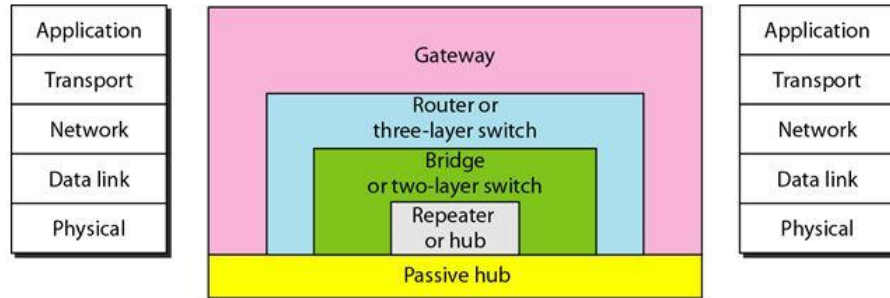
Source: "Data Communication and Networking" by Behrouz Forouzan, Chapter 15 (Connecting LANs, Backbone Networks, and Virtual LANs)

Answer 2

Network devices, or networking hardware, are physical devices that are required for communication and interaction between hardware on a computer network.

Having a solid understanding of the types of network devices available can help you design and built a network that is secure and serves your organization well.

Source: "Network Devices Explained" by Jeff Melnick
https://blog.netwrix.com/2019/01/08/network-devices-explained/

Answer 3

Network Equipment	Router	Gateway
Primary Function	To ensure that data packets are switched to the right addresses.	To connect two networks of different protocols as a translator.
Feature Support	DHCP server, NAT, static routing, wireless networking, IPv6 address, Mac address	Protocol conversion like VoIP to PSTN, network access control etc.
Dynamic Routing	Supported	Not supported
Hosted on	Dedicated appliance (router hardware)	Dedicated/virtual appliance or physical server
Related terms	Internet router, WIFI router	Proxy server, gateway router, voice gateway
OSI layer	Works on Layer 3 and 4	Works up to Layer 5
Working principle	Installing routing information for various networks and routing traffic based on destination address	differentiating what is inside network and what is outside network