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All About Routers: Types Of Routers, Routing Table And IP Routing

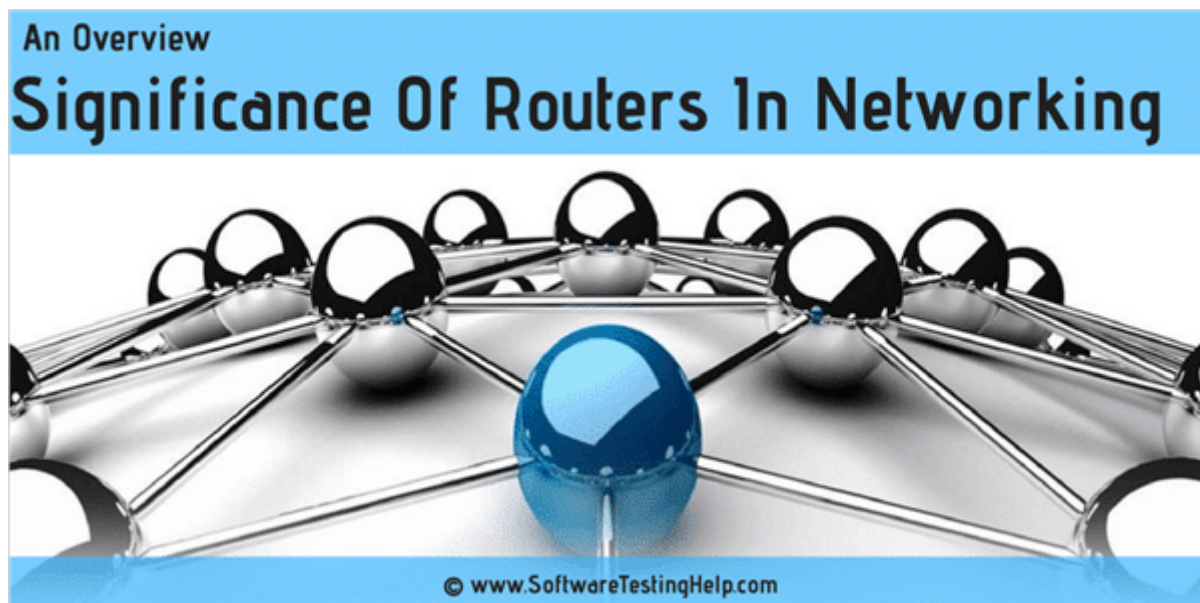
Last Updated: **September 13, 2020**

Role and Significance of Routers in Computer Networking System:

Our previous tutorial in this **Full Networking Training Series** explained us about **Layer 2 and Layer 3 switches** in detail. In this tutorial, we will see about Routers in detail.

Routers are widely used everywhere in our daily life as these connect the various networks all together spread over long distances.

As the name is self-explanatory, routers acquire their nomenclature from the work they perform, means they do routing of data packets from the source end to a destination end by using some routing algorithm in the computer networking systems.



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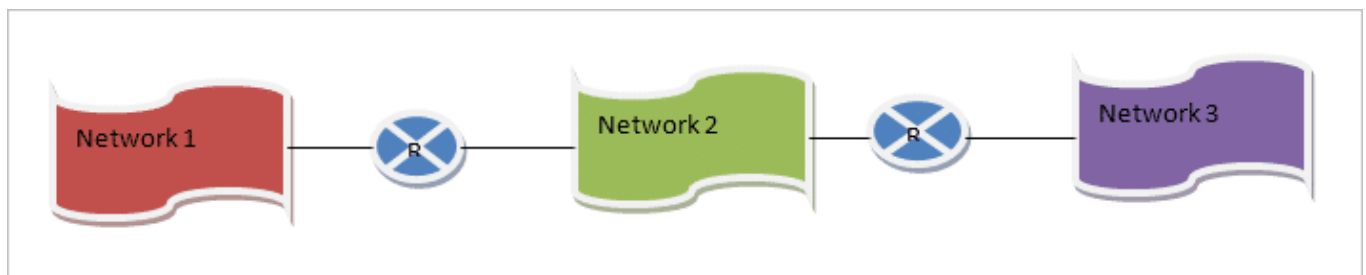
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which were connected through fiber optic cable through high bandwidth STM links or DS3 links.

By this scenario, the traffic in the form of data, voice or video will flow from both ends dedicatedly between them without the interference of any third unwanted traffic. This process is cost-effective and time-efficient.

Likewise, this router also plays a key role to establish connections between software testers, this we will explore further in the tutorial.

Below is the diagram of a router network where two routers namely R1 and R2 are connecting three different networks.



In this tutorial, we will study the various aspects, features, and applications of Routers.

Types Of Routers

There are basically two types of Routers:

Hardware Routers: These are the hardware with distinctive in-built software competence provided by the manufactures. They use their routing abilities to perform routing. They have some more special features also in addition to basic routing feature.

Cisco 2900 router, ZTE ZXT1200, ZXT600 routers are the example of commonly used hardware routers.

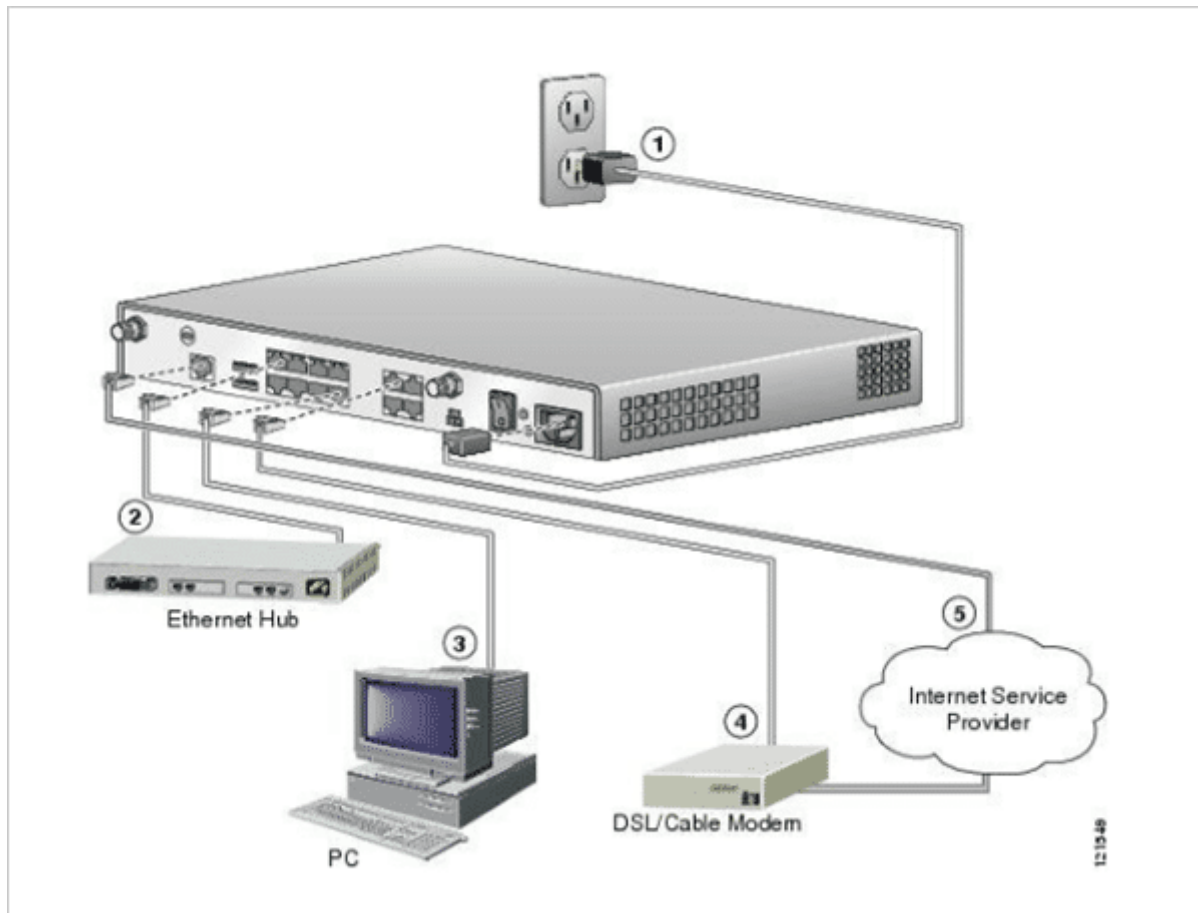
Software Routers: They operate in the same way as the hardware routers do, but they don't have any separate hardware box. It perhaps is a window, Netware or Linux server. These all have the inbuilt routing abilities.

Although the software routers are generally used as gateways and firewalls in large computer networking systems both types of routers have their own features and significance.

The software routers have limited port for WAN connectivity and other port or card support LAN connectivity, therefore, they can't take the place of hardware routers.



Features of Routers



- Works on the network layer of the OSI reference model and communicate with neighbor devices on the concept of IP addressing and subnetting.
- The main components of routers are central processing unit (CPU), flash memory, non-volatile RAM, RAM, network interface card and console.
- Routers have a different kind of multiple ports like fast-Ethernet port, gigabit, and STM link port. All ports support high-speed network connectivity.
- Depending upon the type of port needed in the network the user can configure them accordingly.
- Routers carry out the data encapsulation and decapsulation process with filter out the unwanted interference.
- Routers have the inbuilt intelligence to route traffic in a big networking system by treating the sub-networks as an intact network. They have the capability to analyze the type of next link and hop connected with it which makes them superior to other layer-3 devices such as switch and bridges.
- Routers always work in master and slave mode thus provides the redundancy. Both routers will have the same configurations at software and hardware level if the master fails then slave will act as Master and perform its entire tasks. Thus saves the complete network failure.



Routers inspect the destination end IP address and next-hop address and according to results will forward the data packet to the destination.

Routing tables are used to find out the next hop addresses and destination addresses.

Default Gateway: A default gateway is nothing but a router itself. It is deployed in the network where an end device host doesn't have next-hop route entry of some explicit destination network and don't able to make out the way to arrive at that network.

Therefore the host devices are configured in such a way so that the data packets which are directed towards remote network will be destined firstly to the default gateway.

Then the default gateway will provide the route towards the destination network to the source end host device.

Routing Table

The routers have the internal memory called as RAM. The all the information a routing table gathers will be stored in RAM of routers. A routing table identifies the path for a packet by learning the IP address and other related information from the table and forwards the packet to the desired destination or network.

The following are the entities contained in a routing table:

1. IP addresses and Subnet mask of the destination host and the network
2. IP addresses of all those routers which are required to reach the destination network.
3. Extrovert interface information

There are three various procedures for populating a routing table:

- Directly connected subnets
- Static routing
- Dynamic routing

Connected Routes: In the ideal mode, all the interfaces of the routers will remain in 'down' state. So the interfaces on which user going to implement any configuration, firstly change the state from 'down' to 'up'. Next step of configuration will be assigning the IP addresses to all interfaces.

Now the router will be smart enough to route the data packets to a destination network via directly connected active interfaces. The subnets are also added in the routing table.

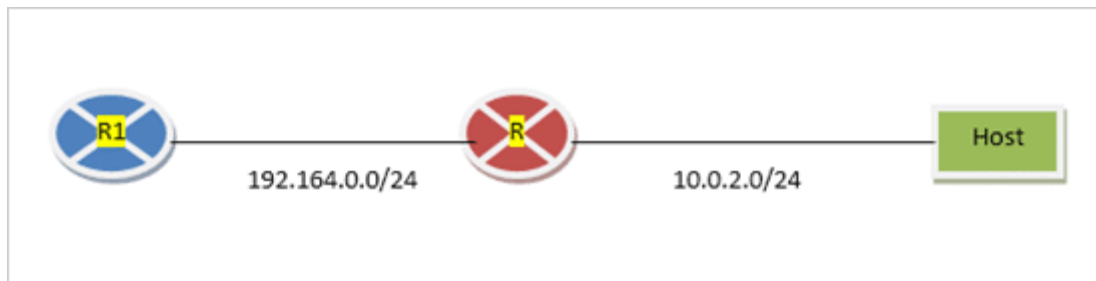
Routing is done manually by running a particular command which is globally used.

The command is as follows:

IP route destination_network _IP subnet_mask_ IP next_hop_IP_address.

It is generally used in tiny networks only as it needs lots of manual configuration and the whole process is very lengthy.

An Example is as follows:



Router 1 is physically connected with router 2 on the Fast Ethernet interface. Router 2 is also directly connected to subnet 10.0.2.0/24. As the subnet is not physically connected with Router 1, therefore it doesn't make out the way to route packet to the destination subnet.

Now we need to configure it manually which is as follows:

- Go to command prompt of Router 1.
- Enter show IP route, the routing table has the below type of configuration.

Router# show IP route

C 192.164.0.0/24 is directly connected, FastEthernet0/0, C stands for connected.

- Now we use static route command for configuration so that Router 1 can be able to arrive at Subnet 10.0.0.0/24.

Router# conf t

Router (config) # ip route 10.0.0.0 255.255.255.0 192.164.0.2

Router (config) # exit



S 10.0.0.0 [1/0] via 192.164.0.2

C 192.164.0.0/24 is directly connected , FastEthernet0/0

S stands for static.

Note: The command prompt of the router has much other information also but I have explained here only that command and information which is relevant to the topic.

Dynamic Routing: This type of routing works with at least one type of routing protocol is facilitated with it. A routing protocol is practiced by routers so that they can share the routing information among them. By this process, each of the routers in the network can learn that information and will deploy it in building up their own routing tables.

Routing protocol works in such a way so that if a link goes down on which it was routing data, it dynamically change their path for routing packet which in turn makes them fault-resistant.

Dynamic routing also doesn't need any manual configuration which saves the time and administration load.

We only need to define the routes and their corresponding subnets which router will be using and the rest is taken care by routing protocols.

Administrative Distance

Greater than one routing protocol can be practiced by the network, and the routers can gather route information about the network from various sources. Routers main task is to search for the best path. Administrative distance number is practiced by routers to discover which path is best suitable to route the traffic. The protocol indicating lower number administrative distance is best suitable to use.

Metric

Consider that router find out two distinctive paths to arrive at the destination host of the same network from the same protocol, then it has to take the decision to choose the best path to route traffic and storing in the routing table.

Metric is a measurement parameter which is deployed to fix the best suitable path. Again lower will be the number of metric better will be the path.

Types of Routing Protocols

There are two kinds of routing protocols:

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Both above types of routing protocols are interior routing protocols (IGP) which denotes that they used to trade routing data inside one self-governing network system. While Border gateway protocol (BGP) is a type of exterior routing protocol (EGP) which denotes that it is used to trade routing data between two dissimilar network systems on the internet.

Distance vector Protocol

RIP (Routing Information protocol): RIP is a kind of Distance vector protocol. As per the name, distance vector routing protocol employ distance to obtain the best-suited path to reach the remote network. The distance is basically the count of routers exist in-between while approaching remote network. RIP has two versions but version 2 is most popularly used everywhere.

Version 2 has the ability to present subnet masks and practices multicast to send routing updates. Hop count is practiced as a metric and it has the administrative count of 120.

RIP version 2 launch the routing tables in every interval of 30 seconds thus lots of bandwidth is utilized in this process. It utilizes the multicast address 224.0.0.9 to launch routing information.

EIGRP (Enhanced interior gateway routing protocol): It is a progressive type of distance vector protocol.

The various types of routing aspects it backs are:

- Classless routing and VLSM
- Load balancing
- Incremental updates
- Route summarization

The routers which use EIGRP as a routing protocol practices the multicast address 224.0.0.10. EIGRP routers maintain three kinds of routing tables which has all the necessary information.

The administrative distance of EIGRP is 90 and it determines the metric by using bandwidth and delay.

Link State Protocol

The objective of link state protocol is also similar to that of distance vector protocol, to locate a best-suited path to a destination but deploy distinctive techniques to perform it.



state protocol should have the similar network topology statistics.

These are difficult to configure and require much memory storage and CPU memory than distance vector protocol.

This works faster than that of distance vector protocols. They also maintain the routing table of three types and **perform the shortest path first algorithm** to find out the best path.

OSPF is a kind of link state protocol.

OSPF (open shortest path first):

- It is a classless routing protocol and backs VLSM, incremental updates, manual route summarization and equal cost load balancing.
- **Only interface cost is used as a metric parameter in OSPF. The administrative distance number is set to 110. Multicast IP deployed for routing updates are 224.0.0.5 and 224.0.0.6.**
- The link between neighboring routers using OSPF protocol is firstly set up before sharing the routing updates. As it is a link state protocol so routers don't float the entire routing table but only share the statistics regarding network topology.
- Then each router performs SFP algorithm to determine the superlative path and includes it to the routing table. By using this process the possibility of routing loop error is least.
- **OSPF routers send the hello packets on multicast IP 224.0.0.5 to set up the link with neighbors. Then when the link is established then it starts floating routing updates to neighbors.**
- **An OSPF router sends hello packets in every 10 seconds on the network. If it doesn't receive the return hello packet from a neighbor in 40 seconds then it will proclaim that neighbor as down.** Routers to become neighbors should have some fields as common as subnet ID, area id, hello and dead interval timers, authentication, and MTU.
- **OSPF has the process of each message authentication. This is used to avoid routers to transmit false routing information. The false information can lead to denial of service attack.**
- There are two methods of authentication, MD5, and clear text authentication. MD5 is most commonly used. It supports manual summarization process of routes while floating in routing tables.

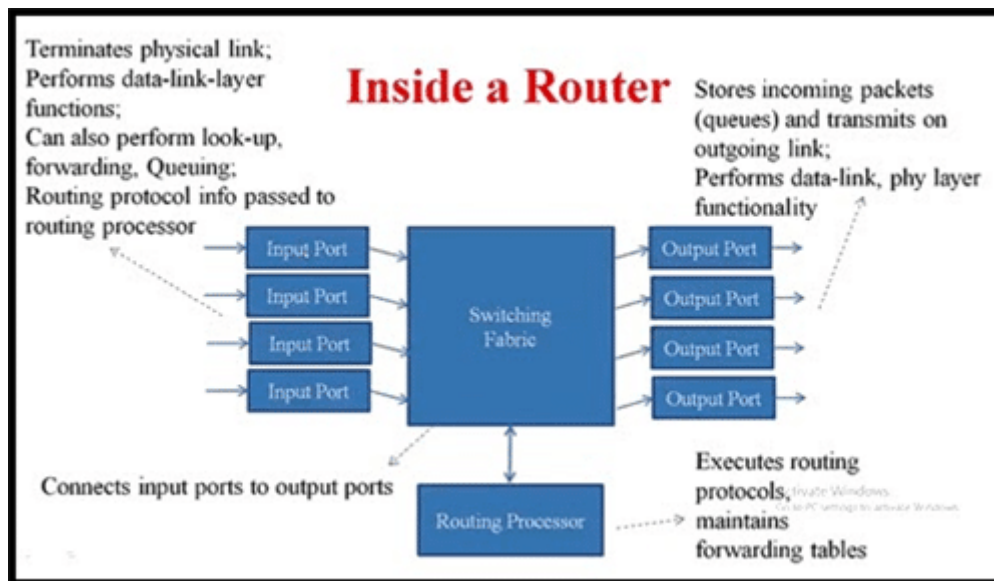
BGP (Border Gateway Protocol):

So far we have discussed the interior routing protocols which are used for small networks. But **for large-scale networks, BGP is used as it has the capability to handle traffic over the internet for big networks.**

governing systems (autonomous systems).

- With the help of this joint venture, industries and network service providers such as mobile operators can provide the BGP- commanded routes and because of this, the systems get the amplified internet speed and efficiency with superior redundancy.
- It constructs the routing assessment on the basis of network policies, set of rules configured and routing paths and also participate in taking main core routing conclusions.
- BGP makes its neighbors by manual configuration among routers to build up a TCP session on port 179. A BGP presenter sends 19-byte messages in every 60 seconds to its neighbors to establish the connection.
- Route-map mechanism handles the flow of routes in BGP. It is nothing but a set of rules. Every rule explains, for routes equivalent specified criteria, what decision to be implemented. The decision is of the discard the route or to do modifications of few attributes of the route before finally storing it in the routing table.
- BGP path selection criteria are different from others. It first finds out the path attributes for loop-free, synchronized routes to reach the destination in the following manner.

Working Of Router



- In the hardware part of the router, the physical connections are made through input ports; it also keeps the copy of the forwarding table. Switching fabric is a kind of IC (integrated circuit) which tells the router on which of the output port it should forward the packet.
- Routing processor saves the routing table within it and implements the several routing protocols to be used in forwarding packets.
- The output port transmits the data packets back to its place.

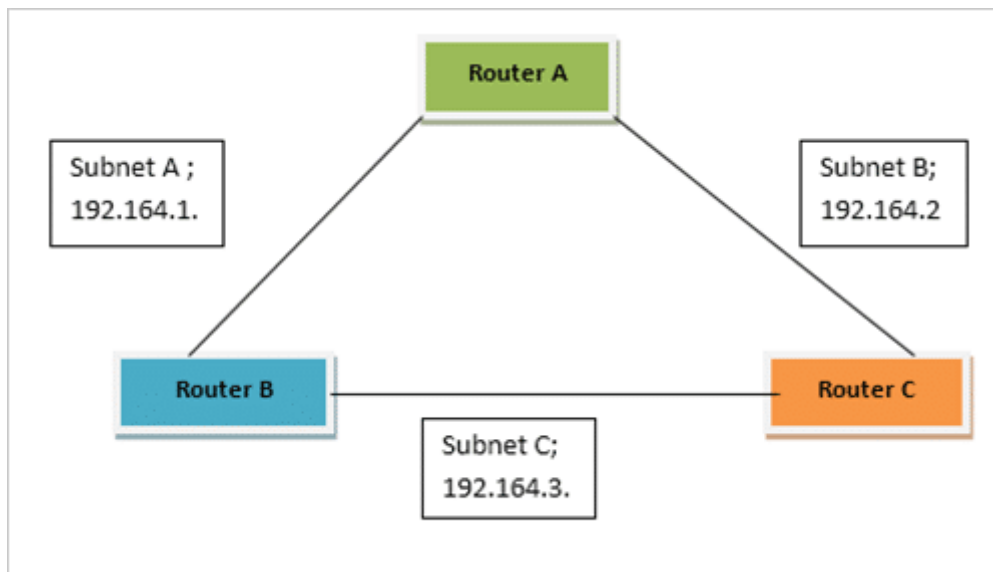
The working is divided into two different planes,



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control plane is a logic which fabricates a forwarding information base (FIB) to be utilized by forwarding plane and also it has the information regarding the physical interface the routers to be connected.

- **Forwarding Plane:** based on the information it gathers from the control plane based on records in routing tables it forwards the data packet to correct remote network host. It also takes care of correct inward and outward physical connections.
- **Forwarding:** As we know that the main purpose of routers is to connect big networks such as WAN networks. As it works on layer-3 so it takes the forwarding decision on the basis of the destination IP address and subnet mask stored in a packet directed for the remote network.



- As per the figure, Router A can reach out the Router C via two paths, one is directly through Subnet B and another is through Router B using Subnet A and Subnet C respectively. In this way, the network has become redundant.
- When a packet arrives at router it first lookouts in the routing table to find the best-suited path to reach the destination and once it gets the IP address of next hop it encapsulates the data packet. To find out the best path routing protocol is used.
- The route is learned by gathering information from the header associated with each of data packet arrives at each node. The header contains the IP address information of the next hop of the destination network.
- To reach a destination, several paths are mentioned in the routing table; by using a mentioned algorithm it uses the best suitable path to forward data.
- It also checks that the interface on which packet is ready to be forward is accessible or not. Once it collects all the necessary information then it sends the packet according to the route decided.
- The router **also supervises the congestion** when packets reach any hope of the network at a pace greater than the router is able to process. The procedures used are a tail drop, random early detection (RED) and weighted random early detection (WRED).

- The idea behind these is router drops the data packet when the size of the queue is full.

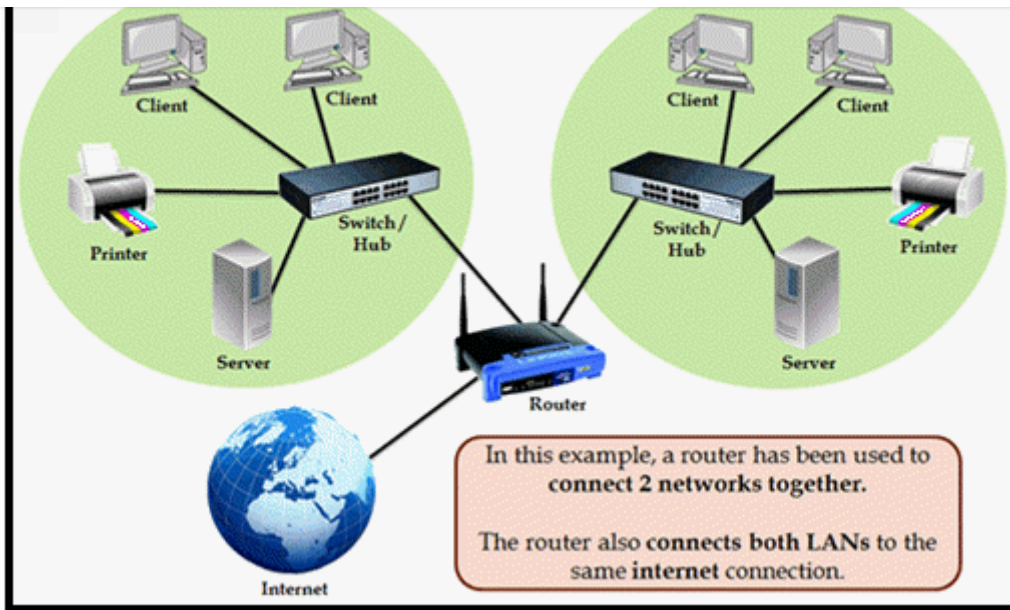
first or at what number when several queues exist. This is implemented by QoS (quality of service) parameter.

- Performing policy-based routing is also a function of Routers. This is done by bypassing all the rules and routes defined in the routing table and making a new set of rules, to forward data packet on an immediate basis or on priority. This is done on the requirement basis.
- By performing the various tasks within the router the CPU utilization is very high. So some of its functions are performed by Application specific integrated circuits (ASIC).
- The Ethernet and STM ports are used to connect the fiber optic cable or another transmission media for physical connectivity.
- ADSL port is used to connect the router to ISP by using CAT5 or CAT6 cables respectively.

Applications Of Routers

- Routers are the building blocks of Telecom service providers. They are used for connecting core hardware equipment such as MGW, BSC, SGSN, IN and other servers to remote location network. Thus work as a backbone of Mobile operations.
- Routers are used in deploying the operation and maintenance center of an organization which can be called as NOC center. All the far end equipment is connected with central location over optic cable via routers which also provides redundancy by operating in main link and protection link topology.
- Support fast rate of data transmission as uses high bandwidth STM links for connectivity thus used for both wired and wireless communication.
- Software testers also use routers for WAN communications. Suppose the manager of a software organization is situated in Delhi and its executive is situated at various other locations like Bangalore and Chennai. Then the executives can share their software tools and other applications with their manager via routers by connecting their PC's to the router using WAN architecture.
- Modern-day routers have the feature of USB ports inbuilt within the hardware. They have internal memory with enough storage capacity. External storage devices can be used in combination with routers for data storing and sharing.
- Routers have the feature of access restriction. The administrator configures the router in such a way that only a few clients or person can access the overall router data while others can access only those data which is defined to them to look up.
- Apart from this routers can be configured in such a way that only one person has the rights i.e. the owner or administrator to perform modify, add or delete function in software part while others can have only the view rights. This makes it highly secure and can be used in military operations and finance companies where data confidentiality is a prime concern.
- In wireless networks, with the help of configuring VPN in routers, it can be used in the client-server model by which can share internet, hardware resources, video, data and voice being far apart. An example is shown in below figure.





- Routers are widely used by the internet service provider to send data from source to destination in the form of e-mail, as a web page, voice, image or video file. The data can be sent everywhere in the world providing that the destination should have an IP address.

Conclusion

In this tutorial, we have studied in deep about the various features, types, working, and application of routers. We have also seen the working and features of several kinds of routing protocols used by routers to find out the best path for routing data packets to the destination network from the source network.

By analyzing all the various aspects of routers we have realized the fact that routers play a very important role in modern day communication systems. It is widely used almost everywhere from small home networks to WAN networks.

With the use of routers, the communication over long distance whether it is in the form of data, voice, video or image becomes more reliable, fast, secure and cost-effective.

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