Network + Section 8 - Routing

Routing Fundamentals

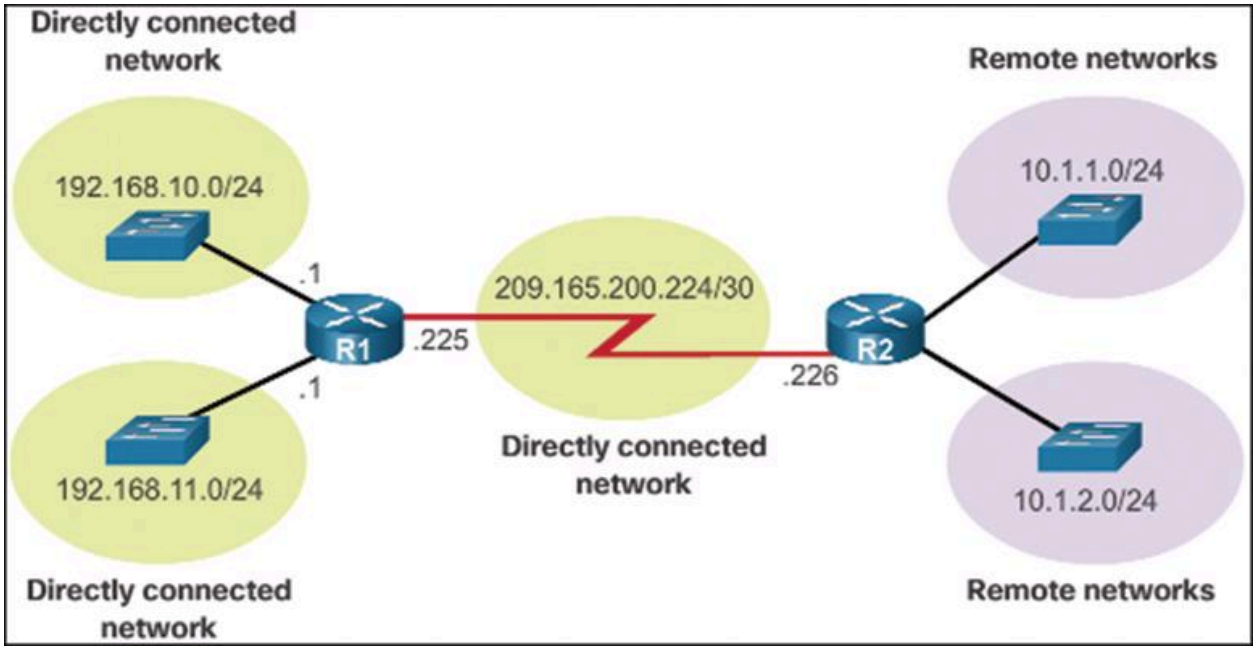
- Router - Forwards traffic between subnets, between an internal and external network, or between two external networks.
    - Each subnet or external network is going to be its own broadcast domain. Routers are used to separate broadcast domains.
    - In the workplace, multilayer switches also perform routing functions.
- In the exam…
    - Switch - Layer 2 Switch
    - Multilayer Switch - Router
- OBJ 1.4 - Given a scenario, configure a subnet and use appropriate IP addressing schemes.
- OBJ 2.2 Compare and contrast routing technologies and bandwidth management concepts.
- OBJ 5.5 Given a scenario, troubleshoot general networking issues.

Routing Tables

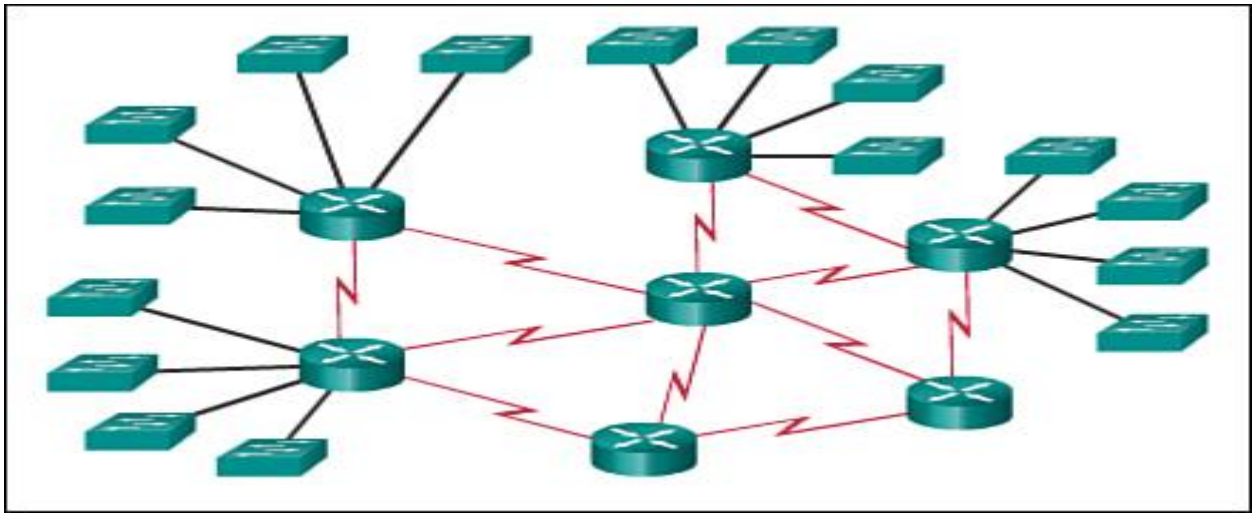
- Routing Table - Helps determine which route entry is the best first for the network. Decides where packets need to go inside and outside our network.
    - Layer 3 information and will do a layer three to a layer 2 map.
    - Router will use an ARP cache to map an IP address to a given MAC address.
    - Each forwarding decision will be dependent on its routing table.
    - A router entry with the longest prefix is the most specific network.
    - 10.1.1.0/24 is more specific than 10.0.0.0/8

Destination Network	Next Router	Port	Route Cost
125.0.0.0	**137.3.14.2**	**1**	**12**
161.5.0.0	**137.3.6.6**	**1**	**4**
134.7.0.0	**134.17.3.12**	**2**	**10**

- Directly Connected Route - Learned by physical connection between routers.
- Static Route - Manually configured by an Administrator.
    - Default Static Route (0.0.0.0/0) “If you don’t know where to go, just go here”
- Dynamic Route - Learned by exchanging information between routers. Automatic process.
    - When you connect to the internet you connect to your ISP and they know that they are now your default route. Anything you need to get to not in your internal environment will be sent to the ISP and on to the next router.
- Directly Connected Route



- Dynamic Routing protocols can have more than one route for an existing network.
    - How does the router know which is the best route?
        - The route will be negotiated by the number of hops required to get to the next network, number of link bandwidth that's available (how fast it is) and many other factors.



- There are two ways to prevent a routing loop.
    - Split Horizon - Prevents a route learned on one interface from being advertised back out of that same interface.
    - Poison Reverse - Causes a route received on one interface to be advertised back out of that same interface with a metric considered to be infinite.

Routing Protocols

- There are two different types of dynamic routing protocols
    - Internal

        - Interior Gateway Protocol (IGP) - Operates within an autonomous
    - External
        - Exterior Gateway protocol (EGP) - Operates between autonomous systems.
- Router Advertisement Method - This is a characteristic of every routing protocol.
    - Distance Vector - Sends full copy of routing table to its directly-connected neighbors at regular intervals.
        - Bad thing about this is that it will have slow convergence time.
            - Convergence - Time it takes for routers to update their routing tables in response to a topology change.
            - Once all routers on the network have the same information it is a converged network. There is a way to speed up the convergence time.
                - Hold-down Timer - Prevents updates for a specific period of time and speeds up convergence.
            - Hop Count - Number of routers from the source router through which data must pass to reach the designation network.
    - Link States - Requires all routers to know about the paths that all other routers can reach in the network.
        - This info is flooded in the link state domain using the **OSPF** protocol.
        - **IS-IS** is another link state protocol to ensure routers have synchronized information inside their routing tables. With that information they can make the best routing decision.
        - Faster convergence time and uses cost or other factors as a metric.
    - Hybrid
- Routing Information Protocol (RIP) - A distance vector protocol that uses hop count (maximum hops of 15; 16 is infinite). Interior routing protocol. Maximum amount of hops is 15.
    - Updates every 30 secs, becomes hard to maintain convergence.
    - Easy to configure
    - Runs over UDP
- Open Shortest Path First (OSPF) - A link state protocol that uses cost. Interior gateway protocol, does not use distance vector it uses link state, it's concerned with cost so more efficient.
- Intermediate System to Intermediate System (IS-IS) - A link state protocol that also uses cost and functions like OSPF protocol, but not as widely popular. Interior gateway protocol.
- Enhanced Interior Gateway Routing Protocol (EIGRP) - Hybrid of distance vector and link state protocols that uses bandwidth and delay. Hybrid protocol, uses link-state and distance vectors to calculate hops. Upgrade to OSPF, developed by Cisco.
    - Proprietary Cisco protocol that is popular in Cisco-only networks.
- Border Gateway Protocol (BGP) - A path vector that uses the number of autonomous system hops instead of router hops. Exterior gateway protocol. This uses a path vector and is more concerned about the systems it needs to run through.
    - Backbone of the Internet
    - Widespread utilization
    - Slow convergence
- Route Believability - If a route has a lower administrative distance (AD), the route is more believable.

Routing Information Source	**Administrative Distance**

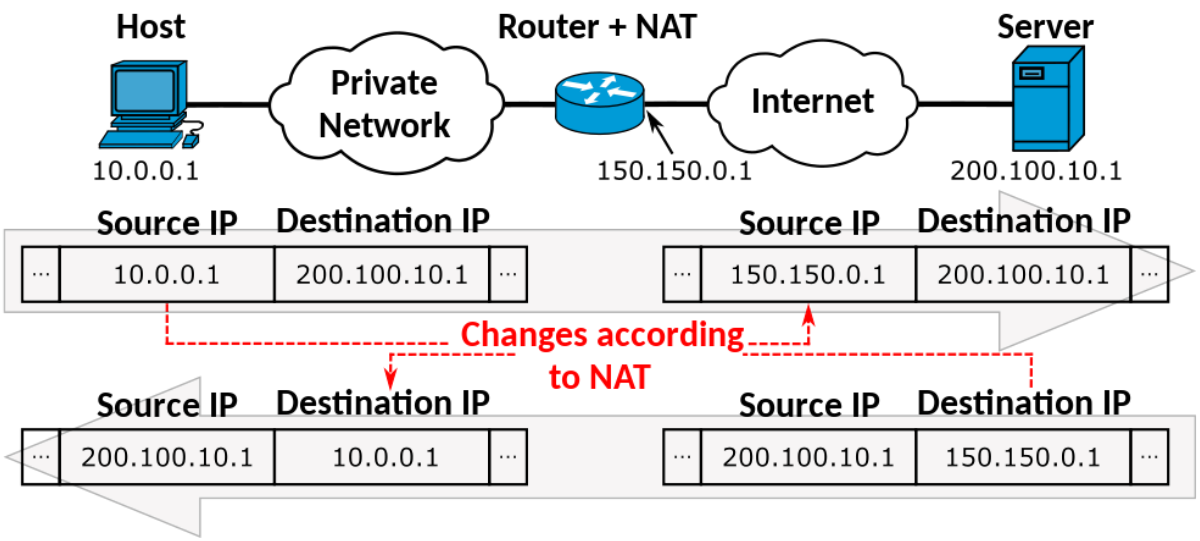
Directly connected network	0
Statically connected network	1
EIGRP	90
OSPF	110
RIP	120
External EIGRP	170
Unknown or Unbelievable	255 (unreachable)

- If there is a lower Administrative Distance then it will seem more believable.
- There are metrics taken into account when measuring these routes, there is going to be a routing protocol that will be able to choose the path it's going on. This is based on metrics like…
    - Hop Count
    - Believability
    - Reliability
    - Bandwidth
    - Delay
    - Cost
    - Other
        - Lower metrics are preferred over higher metrics. Least amount of delay, lowest hop count, lower bandwidth..

Routing Protocol	Type	Interior/Exterior
Routing Information Protocol (RIP)	Distance Vector	Interior
Open Shortest Path First (OSPF)	Link State	Interior
Enhanced Interior Gateway Routing Protocol (EIGRP)	Advanced distance vector	Interior
Intermediate System-to-Intermediate System (IS-IS)	Link State	Interior
Border Gateway Protocol (BGP)	Path Vector	Exterior
A network can simultaneously support more than once routing protocol through route redistribution. This allows a router to participate in OSPF in one interface and EIGRP on another interface. The router can then translate from one protocol for redistribution as the other protocol.		

Address Translation

- Network Address Translation (NAT) - Used to conserve the limited supply of IPv4 addresses.
    - Translates private IP addresses to public IP addresses for routing over public networks.
    - There are 3 different types of address translation
        - DNAT
        - SNAT
        - PAT
- Dynamic NAT (DNAT) - Automatically assigns an IP address from a pool and gives a one-to-one translation.
- Static NAT (SNAT) - Manually assigns an IP address and gives a one-to-one translation.
    - These IP addresses need to be manually set.
    - Used as a security feature.
- Port Address Translation (PAT) - Sharing of one public IP by multiple private IP addresses which gives a many-to-one translation. Most common one used today.
    - Convenient in taking small networks like a small home office or small business and being able to connect them through one IP, out to the internet.
        - There are specific names for the NAT IP address, these will be on the exam.
            - Inside local - Private IP address referencing an inside device.
            - Inside global - PublicIP address referencing an inside device.
            - Outside global - Private IP address referencing an outside device.
            - Outside local - Public IP address referencing an outside device.
                - Everytime you see **global** think of **public**, everytime you see **local** think **private**.



- When at home PAT is being used because there is only one IP address being used on the router.

Multicast Routing

- Multicast Routing - Multicast sender sends traffic to a Class D IP address, known as a multicast group.
    - There are two way to do multicast routing
        - IGMP
        - PIM

- Internet Group Management Protocol (IGMP) - Lets routers know which interfaces have multicast receivers and allows clients to join a multicast group.
    - There are three variants of IGMP

IGMPv1	**Client requests joining the group and is asked every 60 seconds if it wants to remain in the group.**
IGMPv2	**Client can send a leave message to exit multicast group.**
IGMPv3	**Client can request multicast only from specific server and allows source-specific multicast (SSM) and multiple video streams to a single multicast stream.**

- Protocol Independent Multicast (PIM) - Routes multicast traffic between routers and forms a multicast distribution tree.
    - There are two different modes in PIM
        - Dense Mode (PIM-DM) - Uses periodic flood and prune behavior to form optimal distribution tree.
            - Can cause a negative impact on your network that's why it's not used in modern networks.
        - Sparse Mode (PIM-SM) - Uses a shared distribution tree and creates an optimal distribution tree through shortest path tree (SPT) switchover.
- (I will have to revisit this, there is steps to the process in the diagram I am viewing that I will write down, hopefully I can find a suitable diagram for PIM-DM)
    - PIM - DM: Flooding - Uses source distribution tree (SDT) to form an optimal path between source router and last-hop router. Before the optimal path is formed, the entire network is initially flooded and consumes unnecessary bandwidth.
    - PIM-DM: Pruning If a router receives multicast traffic in the initial flood and the traffic is not needed then the router sends a prune message asking to be removed from the source distribution tree.
    - PIM-DM: After Pruning - After sending prune messages, the resulting source distribution tree has an optimal path between source router and last-hop router. Food and prune repeat every three minutes, which can cause excessive performance impact on the network.
    - This happens every three minutes trying to find a more optimal route. This can cause a performance issue with your network because it's flooding the network.
- (I will have to revisit this, there is steps to the process in the diagram I am viewing that I will write down, hopefully I can find a suitable diagram for PIM-SM)
    - An optimal path between the source and last-hop routers is not initially created. Instead a multicast source sends traffic directly to a rendezvous point (RP). All last-hop routers send join messages to the RP.
    - Originally provides a suboptimal distribution tree, but when the first multicast packet is received by the last-hop router, then the optimal distribution tree is created based on the unicast routing table. Unneeded branches are pruned during shortest path tree (SPT) switchover.
    - Uses less resources up front and eventually gets to the optimal distribution that we're looking for.