Assignment No 4: WLAN with static IP addressing and DHCP with MAC security and filters Using a Network Simulator (e.g. packet tracer) Configure EIGRP – Explore neighbor-ship Requirements and Conditions, its K Values Metrics Assignment and Calculation, RIPv2 and EIGRP on same network.

Theory:

Following are the protocols which are to be configured in Packet Tracer.

Static Routing: There are two basic methods of building a routing table:

•**Static Routing**

•**Dynamic Routing**

A static routing table is created, maintained, and updated by a network administrator, manually. A static route to every network must be configured on every router for full connectivity. This provides a granular level of control over routing, but quickly becomes impractical on large networks. Routers will not share static routes with each other, thus reducing CPU/RAM overhead and saving bandwidth. However, static routing is not fault-tolerant, as any change to the routing infrastructure (such as a link going down, or a new network added) requires manual intervention. Routers operating in a purely static environment cannot seamlessly choose a better route if a link becomes unavailable. Static routes have an Administrative Distance (AD) of 1, and thus are always preferred over dynamic routes, unless the default A D is changed. A static route with an adjusted AD is called a floating static route , and is covered in greater detail in another guide.

- **Advantages of Static Routing**

  •Minimal CPU/Memory overhead

  •No bandwidth overhead (updates are not shared between routers)

  •Granular control on how traffic is routed

- Disadvantages of Static Routing

  •Infrastructure changes must be manually adjusted

  •No "dynamic" fault tolerance if a link goes down

  •Impractical on large network

Configuration of Static routing:

- **RIPV2 Routing Protocol:**

RIP (Routing Information Protocol)

RIP is a standardized Distance Vector protocol, designed for use on smaller networks. RIP was one of the first true Distance Vector routing protocols, and is supported on a wide variety of systems.

RIP adheres to the following Distance Vector characteristics:

•RIP sends out periodic routing updates (every 30 seconds)

•RIP sends out the full routing table every periodic update

•RIP uses a form of distance as its metric (in this case, hop count)

•RIP uses the Bellman-Ford Distance Vector algorithm to determine the best "path" to a particular destination

Other characteristics of RIP include:

•RIP supports IP and IPX routing.

•RIP utilizes UDP port 520

•RIP routes have an administrative distance of 120

•RIP has a maximum hop count of 15 hops.

Any network that is 16 hops away or more is considered unreachable to RIP, thus the maximum diameter of the network is 15 hops. A metric of 16 hops in RIP is considered a poison route or infinity metric.

If multiple paths exist to a particular destination , RIP will load balance between those paths (by default, up to 4) Only if the metric (hop count) is equal. RIP uses a round-robin system of load-balancing between equal metric routes, which can lead to pinhole congestion.

For example, two paths might exist to a particular destination, one going through a 9600 baud link, the other via a T1. If the metric (hop count) is equal, RIP will load-balance, sending an equal amount of traffic down the 9600 baud link and the T1. This will (obviously) cause the slower link to become congested.

CONFIGURATION:

1. RIP

There is no big difference between RIP version 1 and version 2 when we are applying them in packet tracer. In order to apply RIP version 2 on packet tracer.

Just make sure that the protocol is applied as an additional step and cannot replace the basic steps i.e. we have to assign IP addresses to the router's interfaces and PCs and also change the state of the interfaces from down to UP and then we will go ahead and apply Protocol.

2. EIGRP

EIGRP (Enhanced Interior Gateway Routing Protocol)

EIGRP is a Cisco-proprietary Hybrid routing protocol, incorporating features of both Distance-Vector and Link-State routing protocols.

EIGRP adheres to the following Hybrid characteristics:

•EIGRP uses Diffusing Update Algorithm (DUAL) to determine the best path among all "feasible" paths. DUAL also helps ensure a loop-free routing environment.

•EIGRP will form neighbor relationships with adjacent routers in the same Autonomous System (AS)

•EIGRP traffic is either sent as unicasts, or as multicasts on address 224.0.0.10, depending on the EIGRP packet type.

•Reliable Transport Protocol (RTP) is used to ensure delivery of most EIGRP packets.

•EIGRP routers do not send periodic, full-table routing updates. Updates are sent when a change occurs, and include only the change.

•EIGRP is a classless protocol, and thus supports VLSMs.

Other characteristics of EIGRP include:

•EIGRP supports IP, IPX, and AppleTalk routing.

•EIGRP applies an Administrative Distance of 90 for routes originating within the local Autonomous System.

•EIGRP applies an Administrative Distance of 170 for external routes coming from outside the local Autonomous System

•EIGRP uses Bandwidth and Delay of the Line, by default, to calculate its distance metric. It also supports

three other parameters to calculate its metric: Reliability, Load, and MTU.

•EIGRP has a maximum hop-count of 224, though the default maximum hop-count is set to 100.

EIGRP, much like OSPF, builds three separate tables

•Neighbor table

– list of all neighboring routers. Neighbors must

belong to the same

Autonomous System

•Topology table

– list of all routes in the Autonomous System

•Routing table

– contains the

Best route for each known network

Essential configuration values

EIGRP Router doesn’t trust anyone blindly. It checks following configuration values to insure that requesting router is eligible to become his neighbor or not.

1. Active Hello packets
2. AS Number
3. K-Values

Active Hello packets

EIGRP uses hello packets to maintain the neighborship between routers. It uses them for neighbor discovery and recovery process. Hello packets are periodically sent from all active interfaces.

By default when we enable EIGRP routing, all interfaces (that meet network command criteria) become participate of it. EIGRP allows us to exclude any interface from it.

EIGRP sends hello packets from all active interfaces in hello interval. Hello interval is a time duration that EIGRP takes between two hello packets. Default hello interval for high bandwidth link is 5 seconds. For low bandwidth links, hello interval is 60 seconds.

- Ethernet, Token Ring, Point to Point serial links, HDLC leased lines are the examples of high bandwidth link.
- Multipoint circuits, Multipoint ATM, Multipoint Frame Relay, ISDN and BRIs are the example of low bandwidth links.

An EIGRP router must receive hello packets continuously from its neighbors. If it does not receive hello packets from any neighbor in hold down time, it will mark that neighbor as dead.

Hold time is the time duration that an EIGRP router waits before marking a router dead without receiving a hello packet from it. Typically hold down time is three times of hello interval. So for high bandwidth link it would be 15 seconds and 180 seconds for slow bandwidth link. We can adjust hold down time with ip hold-time eigrp command.

EIGRP uses multicast and unicast for hello packets delivery. It uses 224.0.0.10 IP address for multicast. Since hello packets do not have any important routing information, they need not be acknowledged.

Basically Hello packets perform two essential functions of EIGRP.

- Find another EIGRP router in network and help in building neighborship.
- Once neighborship is built, check continuously whether neighbor is alive or not.

Adjacency

Neighborship is referred as adjacency in EIGRP. So when you see New Adjacency in log, take it for new neighborship. It indicates that a new neighbor is found and neighborship with it has been established.

AS Number

An AS is a group of networks running under a single administrative control. This could be our company or a branch of company. Just like Subnetting AS is also used to break a large network in smaller networks.

AS creates a boundary for routing protocol which allow us to control how far routing information should be propagated. Beside this we can also filter the routing information before sharing it with other AS systems. These features enhance security and scalability of overall network.

Basically AS concept was developed for large networks. Routing protocols which were developed for small networks such as RIP do not understand the concept of AS systems.

There are two types of routing protocols IGP and EGP.

- **IGP** (Interior Gateway Protocol) is a routing protocol that runs in a single AS such as RIP, IGRP, EIGRP, OSPF and IS-IS.
- **EGP** (Exterior Gateway Protocol) is a routing protocol that performs routing between different AS systems. Nowadays only BGP (Border Gateway Protocol) is an active EGP protocol.

To keep distinguish between different autonomous systems, AS numbers are used. An AS number start from 1 and goes up to 65535. Same as IP addresses, AS numbers are divided in two types; Private and public.

- **Public AS Numbers**: - We only need to use public numbers if we connect our AS with Internet backbone through the BGP routes. IANA (Numbers Authority) controls the public AS numbers.
- **Private AS Numbers**: - Private AS numbers are used to break our internal network into the smaller networks.

EIGRP routers that belong to different ASs don’t become neighbors therefore they don’t share any routing information.

So our second condition that needs to be fulfilled in order to become EIGRP neighbor is the same AS number. Two routers will become neighbors only when they see same AS number in each other's hello packets.

K Values

EIGRP may use five metric components to select the best route for routing table. These are Bandwidth, Load, Delay, Reliability and MTU. By default EIGRP uses only two components; Bandwidth and delay. With K-Values we can control which components should be used in route metric calculation. For five metric components we have five K values.

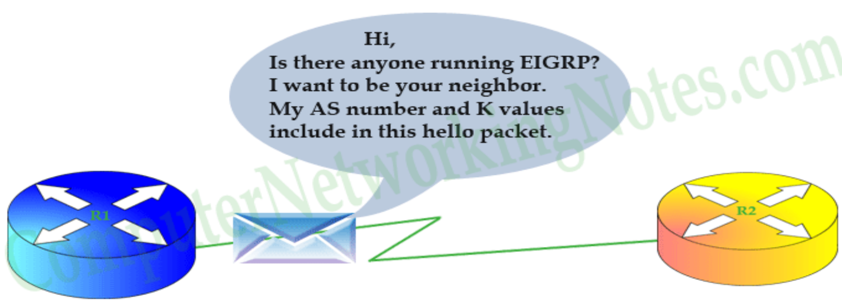
K Values	Metric components
K1	Bandwidth
K2	Load
K3	Delay
K4	Reliability
K5	MTU

Two routers must use same K Values in order to become the EIGPR neighbor. For example if one router is using three K- Values (K1, K2 and K3) while second router is using default K values (K1 and K3) then these two routers will never become neighbor.

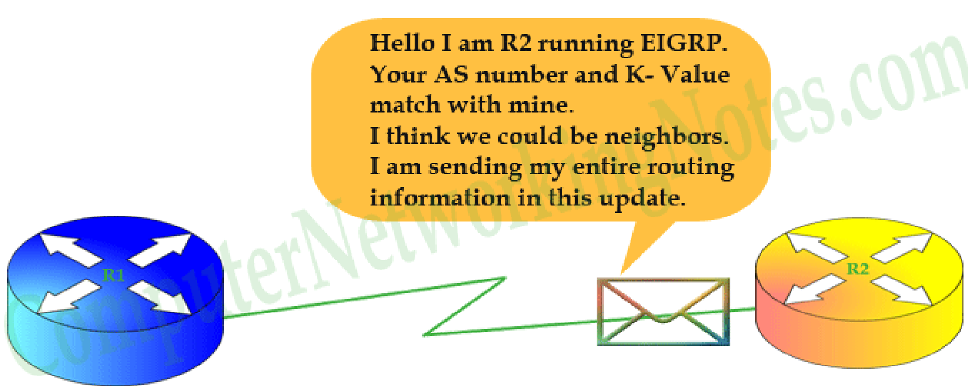
In order to become EIGRP neighbor two routers must use same K values.

EIGRP Neighbor Discovery process

Step 1:- First router R1 sends a hello packet from all active interfaces. This packet contains essential configuration values which are required to be a neighbor.



Step 2:- Receiving router R2 will compare these values with its own configuration values. If both necessary values match (AS number and K-values), it will reply with a routing update. This update includes all routes information from its routing table excluding one route. The route which it learned from the same interface that bring hello packet to it. This mechanism is known as split horizon. It states that if a router receives an update for route on any interface, it will not propagate same route information back to the sender router on same port. Split horizon is used to avoid routing loops.

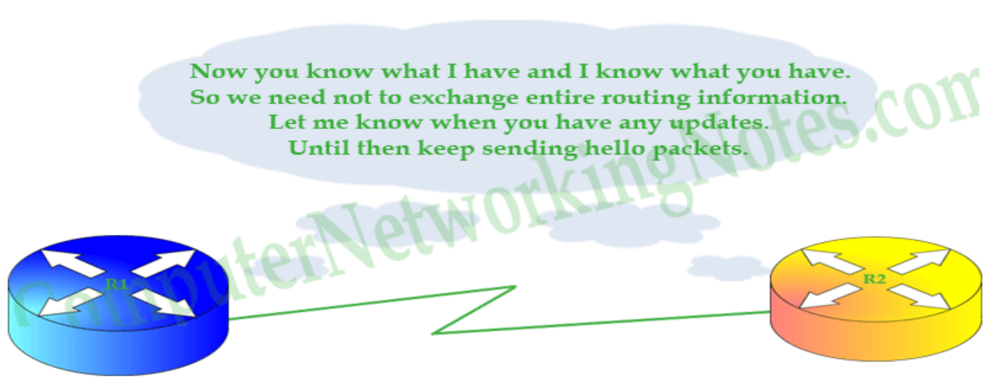


Step 3:- First router will receive R2's routing update and sends an acknowledgement message back to R2.

Step 4:- R1 will sync its EIGRP topology table with routing information that it received in routing update. It will also send a routing update containing all route information from its routing topology to R2.

Step 5:- R2 will respond with an acknowledgement message. It will also sync its EIGRP topology table with routing information that it received in routing update.

At this point, the two routers have becomes neighbor. Now they will maintain this neighborship with ongoing hello packets. If they see any change in network, they will update each other with partial updates.



Partial update contains information only about the recent change.

Configure EIGRP routing protocol

Enabling EIGRP is a two steps process:-

1. Enable EIGRP routing protocol from global configuration mode.
2. Tell EIGRP which interfaces we want to include.

For these steps following commands are used respectively.

Router(config)# router eigrp autonomous_system_#

Router(config-router)# network IP_network_# [subnet_mask]

Router(config)# router eigrp autonomous_system_#

This command will enable EIGRP routing protocol in router. We can use any ASN (Autonomous System Number) from 1 to 65,535. In order to become EIGRP neighbors this number must be same on all participates.

Router(config-router)# network IP_network_# [subnet_mask]

This command allows us to specify the local interfaces which we want to include in EIGRP. Basically we define a range of addresses and router search for these addresses in local interfaces. If match found EIGRP will be enabled on that interface. Once enabled, EIGRP will starts advertising about the connected subnets with that interface.

We have two options while defining the range of addresses with network command

1. Without wildcard mask
2. With wildcard

Without wildcard

Choosing this option allows us to configure the classful network. This option is very straightforward. All we need to do is, type the network ID with network command. For example network 172.168.0.0 command will enable EIGRP on all interfaces which belong to network 172.168.0.0.

What if I type network number instead of network ID?

Well in this situation EIGRP will automatically convert it back to network ID in which this network number is resides. For example 172.168.1.1 will be converted back in 172.168.0.0.

This creates another query. Why it will be converted in 172.168.0.0 instead of 172.168.1.0?

Answer of this question is hidden in classful configuration. In classful configuration EIGRP will match network addresses with in default boundary.

We have four networks 172.168.1.0/24, 172.168.2.0/24, 172.168.3.0/24 and 172.168.4.0/24 Subnetted from single class B network 172.168.0.0/16. Classful configuration does not understand the concept of Subnetting. In classful configuration all these networks belong to a single network. Classful configuration works only with in default boundary of mask. Default boundary of this address is 16 bits. So it will match only first 16 bits (172.168.x.y) of network address.

If we want excludes serial interfaces from EIGRP, we need to configure network command with more specific information.

With wildcard

In this option we provide wildcard mask along with network ID. Wildcard mask allows us to match exact networks. With wildcard we are no longer limited with default boundaries. We can match Subnetted networks as well as default networks.

For example we were tasked to exclude serial interfaces in above configuration. We can use a wildcard mask of 0.0.0.255 to match the subnet mask of /24.

Router(config-router)# network 172.168.1.0 0.0.0.255

Router(config-router)# network 172.168.2.0 0.0.0.255

Above commands will ask router to match /24 bits of address instead of default /16 bits. Now router will look for 172.168.1.x and 172.168.2.x network. Our serial interfaces have 172.168.3.0/24 and 172.168.4.0/24 networks which do not fall in these search criteria.

If you are unfamiliar with wildcard mask, I suggest you to read our tutorials on ACL where we explained wildcard mask in detail with examples.

Until you learn wildcard mask, use subnet mask in the place of wildcard mask. Following commands are also valid and do the same job by matching /24 bits of address.

Router(config-router)# network 172.168.1.0 255.255.255.0

Router(config-router)# network 172.168.2.0 255.255.255.0

Subnet mask is a substitute, not a replacement of wildcard mask. When we use Subnet mask, router converts them in wildcard mask before searching for associated interfaces. We can look in running configuration to know what exactly being used by router.

RIPv2 Routing Information Protocol

Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#

From global configuration mode we can enter in interface mode. From there we can configure the interface. Following commands will assign IP address on FastEthernet0/0.

Router(config)#interface fastEthernet 0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#

interface *fastEthernet 0/0* command is used to enter in interface mode.

ip address *10.0.0.1 255.0.0.0* command will assign IP address to interface.

no shutdown command will bring the interface up.

exit command is used to return in global configuration mode.

Serial interface needs two additional parameters **clock rate** and **bandwidth**. Every serial cable has two ends DTE and DCE. These parameters are always configured at DCE end.

We can use **show controllers interface** command from privilege mode to check the cable's end.

Router#show controllers serial 0/0/0

Interface Serial0/0/0
Hardware is PowerQUICC MPC860
DCE V.35, clock rate 2000000
[Output omitted]

Fourth line of output confirms that DCE end of serial cable is attached. If you see DTE here instead of DCE skip these parameters.

Now we have necessary information let's assign IP address to serial interface.

Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface serial 0/0/0
Router(config-if)#ip address 192.168.1.249 255.255.255.252
Router(config-if)#clock rate 64000
Router(config-if)#bandwidth 64
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface serial 0/0/1
Router(config-if)#ip address 192.168.1.254 255.255.255.252
Router(config-if)#clock rate 64000
Router(config-if)#bandwidth 64
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#

Configure RIP routing protocol
Configuration of RIP protocol is much easier than you think. It requires only two steps to configure the RIP routing.
- Enable RIP routing protocol from global configuration mode.
- Tell RIP routing protocol which networks you want to advertise.

Let's configure it in Router0
Router0
Router0(config)#router rip
Router0(config-router)# network 10.0.0.0
Router0(config-router)# network 192.168.1.252
Router0(config-router)# network 192.168.1.248
router rip command tell router to enable the RIP routing protocol.
network command allows us to specify the networks which we want to advertise. We only need to specify the networks which are directly connected with the router.

Conclusion: We have successfully configured RIP & EIGRP Protocol on routers.