Cabrillo College

Cisco Systems

Networking Academy

CCNP – Advanced Routing

Ch. 7 Route Optimization – Part II

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1

Route Optimization Part II

- Passive Interfaces
- Route Filters
  - Distribute Lists
- Policy Routing
  - Route Maps
- Route Redistribution
  - Multiple Routing Protocols
  - Changing Administrative Distances
  - Configuring Redistribution
  - Default Metrics

2

Route Redistribution

- Cisco routers support up to 30 dynamic routing processes.
  - A router can run RIP, OSPF, IGRP, IS-IS, EIGRP, IPX RIP, RTMP (AppleTalk), and other protocols simultaneously.
  - Most of these routing protocols allow an administrator to configure multiple processes of the same routing algorithm; RIP is a notable exception.
    - I.e. Multiple OSPF processes
    - router ospf 10
    - router ospf 15

Multiple Routing Protocols Multiple Routing Processes

RTA#**show running-config**

```
router ospf 24
 network 10.2.0.0 0.0.255.255 area 0
!
router ospf 46
 network 192.168.2.0 0.0.0.255 area 2
!
router igrp 53
 network 172.16.0.0
 network 172.17.0.0
!
router igrp 141
 network 10.0.0.0
 network 192.168.3.0
```

Not recommended! (router ospf 24 / router ospf 46)

Not recommended! (router igrp 53 / router igrp 141)

Route Redistribution

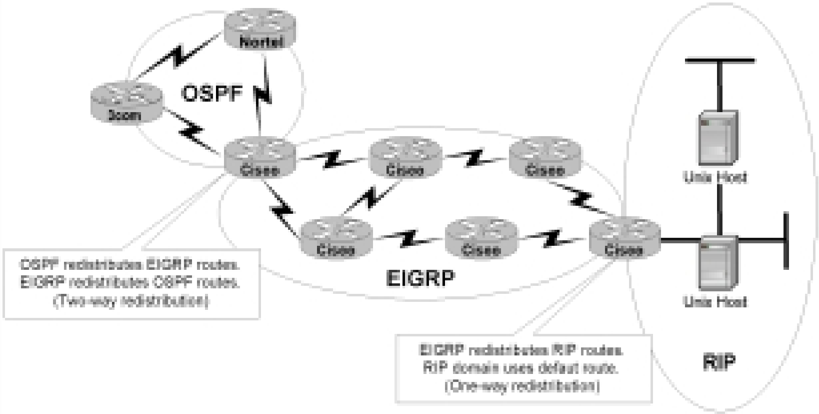
- To support multiple routing protocols within the same internetwork efficiently, routing information must be shared among the different routing protocols.
  - For example, routes learned from a RIP process may need to be imported into an IGRP process.
- The process of exchanging routing information between routing protocols is called **route redistribution**.

5

Route Redistribution

- Route redistribution can be **one-way** (that is, one protocol receives the routes from another) or **two-way** (that is, both protocols receive routes from each other).
- Routers that perform redistribution are called **boundary routers** because they border two or more ASs or routing domains.
- The term **boundary router** is also sometimes used to describe a router running a classful routing protocol (like RIP) that has interfaces in more than one classful network.

6

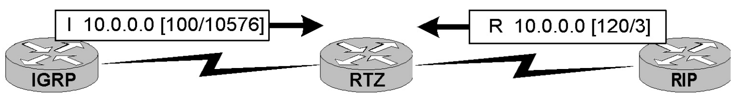


Why configure redistribution?

- You want to run IGRP/EIGRP in one or more areas in a mixed vendor environment
- You want to support legacy UNIX systems that support RIP only, but use a more scalable protocol elsewhere.
- You need a temporary fix during a prolonged upgrade from older protocols and hardware to newer, more scalable solutions.

7

- Because each routing process places substantial demands on the router's memory and CPU resources, only **boundary routers** should run more than one routing process for the same routed protocol, and only when absolutely necessary.
- If a boundary router is running multiple IP routing protocols, then it may be possible that the router will learn about the same network from more than one routing protocol.



8

Route Optimization

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  - Default Metrics

Administrative Distance

- A routing protocol's **administrative distance** rates its trustworthiness as a source of routing information.
  - Administrative distance is an integer from 0 to 255.
  - The lowest administrative distance has the highest trust rating.
  - An administrative distance of **255** means the **routing information source cannot be trusted at all and should be ignored**.
  - An administrative distance of **zero** is **reserved for connected interfaces, and will always be preferred**.

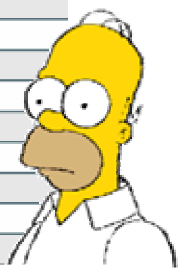
Administrative Distance

- Specifying administrative distance values enables the Cisco IOS software to discriminate between sources of routing information.
- The software always picks the route whose routing protocol has the lowest administrative distance.
- Although we can't easily compare apples with oranges, we can, for example, instruct the router to always choose oranges over apples.

11

Administrative Distance

Route Source	Default Distance
Connected Interface	0
Static Route	1
Enhanced IGRP Summary Route	5
External BGP	20
Internal Enhanced IGRP	90
IGRP	100
OSPF	110
IS-IS	115
RIP	120
EGP	140
External Enhanced IGRP	170
Internal BGP	200
Unknown	255



Good CCNP Routing Exam Knowledge!

12

Administrative Distance

- When using multiple IP routing protocols on a router, the default distances almost always suffice.
- However, some circumstances call for changing the administrative distance values on a router.
- If, for example, a router is running both **IGRP** and **OSPF**, it may receive routes to the same network from both protocols.
- The default administrative distances **favor IGRP** routes over OSPF routes:

IGRP at 100 favored

```
I   10.0.0.0   [100/10576] via 192.168.0.1, Serial0
O   10.0.0.0   [110/192] via 172.17.0.1, Serial1
```

13

Changing Administrative Distance

- But since IGRP doesn’t support CIDR, you may want the router to use the OSPF route instead.
- In this case, you can configure the local router to apply a custom administrative distance to all OSPF routes:

```
RTZ(config)#router ospf 1
RTZ(config-router)#distance 95
```

14

Changing Administrative Distance

- With the **distance 95** command, RTZ compares the IGRP and OSPF routes and comes up with a different result:

```
I  10.0.0.0  [100/10576] via 192.168.0.1, Serial0
O  10.0.0.0  [ 95/192] via 172.17.0.1, Serial1
```

OSPF at 95 now favored

15

Changing Administrative Distance

- You can also apply the **distance** command with optional arguments to make changes to selected routes based on where they originate.
- The expanded syntax of the **distance** command is as follows:

Router(config-router)#**distance** ***weight*** **[*source-ip-address source-mask* (*access-list-number* | *name*)]**

16

Changing Administrative Distance

- Using the optional arguments, we can configure a router to **apply an administrative distance of 105 to all RIP routes received from 10.4.0.2**.
- These values are local to the router, all other routers will apply the administrative distance of 120.

```
Router(config-router)#distance weight [source-ip-
  address source-mask (access-list-number | name)]

RTZ(config)#router rip
RTZ(config-router)#distance 105 10.4.0.2 255.255.255.0
```

17

Changing Administrative Distance

- Or, we can configure a router to apply an administrative distance of 97 to *specific* RIP routes, 192.168.3.0, received from 10.3.0.1.

Source of the route

```
RTZ(config)#router rip
RTZ(config-router)#distance 97 10.3.0.1
  255.255.255.0 2
RTZ(config-router)#exit

RTZ(config)#access-list 2 permit 192.168.3.0
  0.0.0.255
```

The route that will get the administrative distance of 97

18

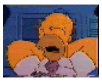
Changing Administrative Distance

The results:

```
RTZ(config)#router rip
RTZ(config-router)#distance 105 10.4.0.2 255.255.255.0
RTZ(config-router)#distance 97 10.3.0.1 255.255.255.0 2
RTZ(config)#access-list 2 permit 192.168.3.0 0.0.0.255

RTZ#show ip route
R    192.168.5.0/24 [105/1] via 10.4.0.2, 00:00:02, Serial1
     10.0.0.0/16 is subnetted, 5 subnets
R       10.2.0.0 [120/1] via 10.3.0.1, 00:00:02, Serial0
C       10.3.0.0 is directly connected, Serial0
R       10.1.0.0 [120/2] via 10.3.0.1, 00:00:02, Serial0
C       10.4.0.0 is directly connected, Serial1
R    192.168.1.0/24 [120/3] via 10.3.0.1, 00:00:02, Serial0
R    192.168.2.0/24 [120/2] via 10.3.0.1, 00:00:02, Serial0
R    192.168.3.0/24 [97/1] via 10.3.0.1, 00:00:02, Serial0
```

19



Route Optimization

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20

Configuring Redistribution

- "The **redistribution** command is available for all IP routing protocols, so the command is considered to be independent of any one protocol."
  - This is misleading, because the **redistribution** command can be used differently depending on the IP routing protocols involved.
- Redistribution can take on various complexities depending upon the from and to routing protocols and the options that can be implemented.
  - This can be a matrix of "what if's," but we will keep the complexity to a minimum, concentrating on the basics.
  - We will examine the redistribute command and some of the other options and tools available.

21

Redistribute command

```
Router(config-router)# redistribute protocol [process-id]
  {level-1 | level-1-2 | level-2} [metric metric-value]
  [metric-type type-value]  [match {internal | external
  1 | external 2}]  [tag tag-value] [route-map map-tag]
  [weight weight] [subnets]
```

- The **static [ip]** keyword is used to redistribute IP static routes. The optional ip keyword is used when redistributing into the Intermediate System-to-Intermediate System (IS-IS) protocol.
- The **connected** keyword refers to routes that are established automatically by virtue of having enabled IP on an interface. For routing protocols such as Open Shortest Path First (OSPF) and IS-IS, these routes will be redistributed as external to the autonomous system.
- (Optional) **metric** used for the redistributed route. If a value is not specified for this option, and no value is specified using the **default-metric** command, the **default metric value is 0, except for OSPF where the default cost is 20**. Use a value consistent with the destination protocol. (more later)
- (Optional) **metric-type,** for OSPF, the external link type associated with the default route advertised into the OSPF routing domain. It can be one of two values: 1—Type 1 external route, 2—Type 2 external route
- Lets look at the other options, defaults, and command usage guidelines: Redistribute Command

22

Redistributing from Classless to Classful Protocols

- Careful consideration must be given when redistributing routes from a classless routing process domain into a classful domain.
- Remember, a **classful routing protocol** does ***not*** advertise an address mask along with the advertised destination address.
- For every route a classful router receives, one of two situations will apply:
  - The router will have one or more interfaces attached to the same major (classful) network.
  - The router will have ***no*** interfaces attached to the major (classful) network.

23

Redistributing from Classless to Classful Protocols

The router will have one or more interfaces attached to the same major (classful) network.

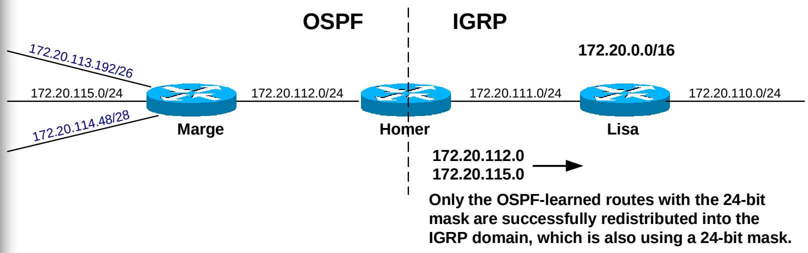
- The router must use its own configured mask for that major network to correctly determine the subnet of a packet's destination address.

The router will have ***no*** interfaces attached to the major (classful) network.

- Only the major network address itself can be included in the advertisement because the router has no way of know which subnet mask to use.

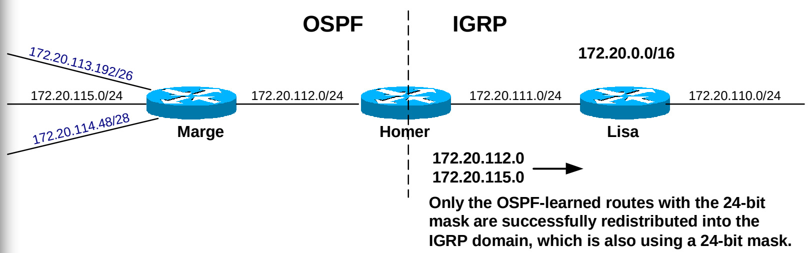
24

Redistributing from Classless to Classful Protocols



- This behavior of only advertising routes between interfaces with matching masks also applies when redistributing from a classless routing protocol into a classful routing protocol.

Redistributing from Classless to Classful Protocols



Routing Tables

- Homer: Has routes to all networks
- Marge: Has routes to all networks
- Lisa: Only knows about the IGRP subnets and the matching 24-bit redistributed subnets, 172.20.112.0 and 172.20.115.0.

We will see how to successfully redistribute from classless to classful in the next section.

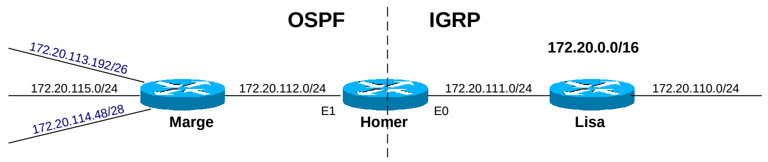
Configuring Redistribution

Redistribution is configured in two steps:

1. In the routing protocol configuration that is to **receive** the redistributed routes, use the **redistribute** command.
2. Specify the metric to be assigned to the redistributed routes. Two methods:
   - Use the **metric** keyword
   - Use the **default-metric** command
     - Note: If both the **metric** and **default-metric** commands are used the **metric** command takes precedence.

The values (parameters) used with these commands are dependent upon the routing protocol being redistributed.

Configuring Redistribution

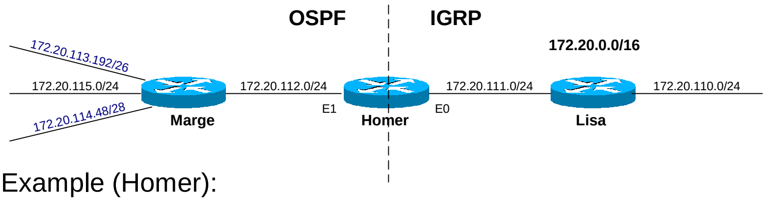


Example (Homer): By the way this will not necessarily fix the previous issue of Lisa not seeing all networks.

```
router igrp 1
  redistribute ospf 1 metric 10000 100 255 1
  passive-interface ethernet 1
  network 172.20.0.0

router ospf 1
 redistribute igrp 1 metric 30 metric-type 1 subnets
 network 172.20.112.2 0.0.0.0 area 0
```

Configuring Redistribution



Example (Homer):

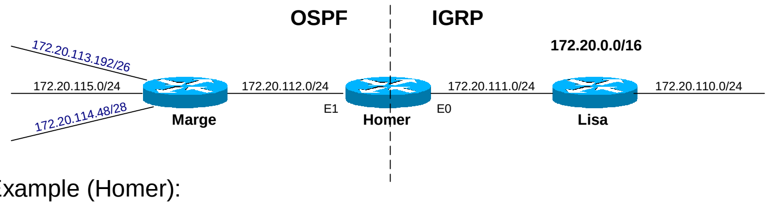
```
router igrp 1
  redistribute ospf 1 metric 10000 100 255 1
  passive-interface ethernet 1
  network 172.20.0.0
```

Bandwidth kbps | **Delay** mircoseconds | **Reliability** n/255 | **Load** n/255

- This configuration redistributes routes discovered by OSPF process 1 into IGRP process 1.
- The **metric** portion assigns IGRP metrics to these routes.
- These values constitute the **seed metric** in our example.
- The *seed metric* is the initial metric value of an imported route.

29

Configuring Redistribution



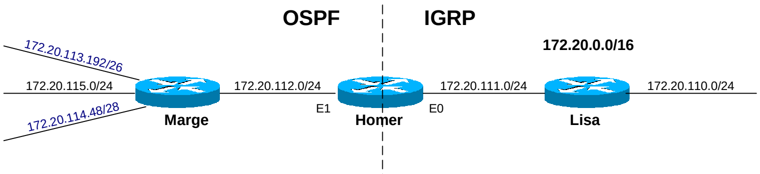
Example (Homer):

```
router ospf 1
 redistribute igrp 1 metric 30 metric-type 1 subnets
 network 172.20.112.2 0.0.0.0 area 0
```

- This configuration redistributes routes discovered by IGRP process 1 into OSPF process 1.
- The **metric** portion assigns an OSPF cost of 30 to each of these routes.
- The redistribution makes Homer an ASBR and the redistributed routes are advertised as external routes, E2.
- The **metric-type 1** portion specifies that the these routes will be advertised as E1 routes, and the internal costs will be added.
- The **subnets** keyword redistributes subnet details. Without it, only the classful address would be redistributed. (more later)

30

Configuring Redistribution

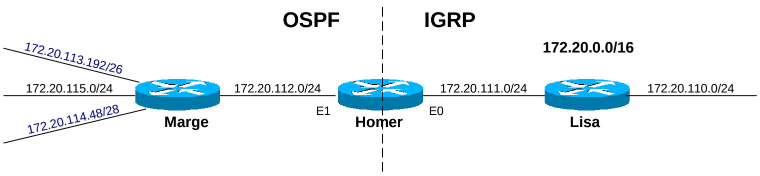


Alternative Method (Homer): Assuming RIP and EIGRP networks also attached

```
router ospf 1
  redistribute igrp 1 metric-type 1 subnets
  redistribute eigrp 1 metric-type 1 subnets
  redistribute rip metric-type 1 subnets
  default-metric 30
  network 172.20.112.2 0.0.0.0 area 0
router igrp 1
  redistribute ospf 1
  redistribute eigrp 2
  redistribute rip metric 50000 500 255 1
  passive-interface ethernet 1
  default-metric 10000 100 255 1
  network 172.20.0.0
```

31

Configuring Redistribution



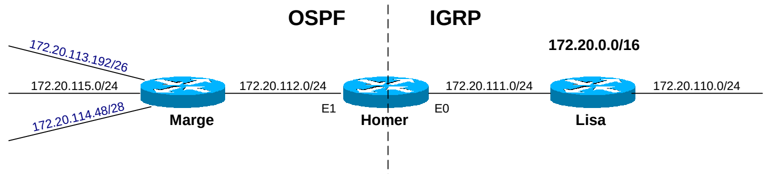
Alternative Method (Homer): Assuming RIP and EIGRP networks also attached

```
router ospf 1
  redistribute igrp 1 metric-type 1 subnets
  redistribute eigrp 1 metric-type 1 subnets
  redistribute rip metric-type 1 subnets
  default-metric 30
  network 172.20.112.2 0.0.0.0 area 0
```

- **default-metric** command is useful when routes are being redistributed from more than one source.
- **default-metric** command is used to assign an OSPF cost of 30 to all IGRP, EIGRP, and RIP learned routes. (**metric** keyword is not used in the redistribute command.)

32

Configuring Redistribution



Alternative Method (Homer): Assuming RIP and EIGRP networks also attached

```
router igrp 1
 redistribute ospf 1
 redistribute eigrp 2
 redistribute rip metric 50000 500 255 1
 passive-interface ethernet 1
 default-metric 10000 100 255 1
 network 172.20.0.0
```

- **default-metric** command is used where the **metric** command is not being applied in the **redistribute** command.
- **metric** keyword takes precedence over the **default-metric** command

33

Configuring Redistribution

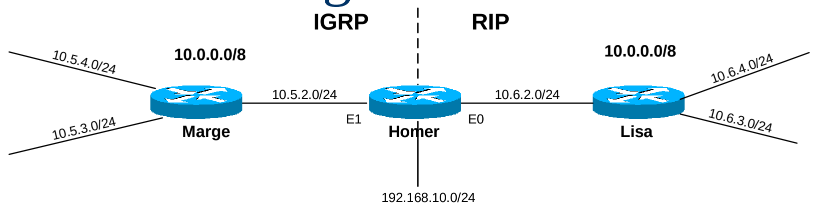
```
Router(config-router)# redistribute protocol
  [process-id] {level-1 | level-1-2 | level-2}
  [metric metric-value] [metric-type type-value]
  [match {internal | external 1 | external 2}]
  [tag tag-value] [route-map map-tag] [weight
  weight] [subnets]
```

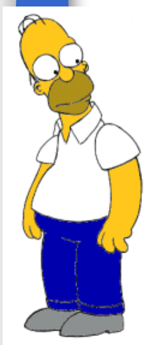
(Optional) **metric** used for the redistributed route.

- If a value is not specified for the **metric** option, and no value is specified using the **default-metric** command, the **default metric value is 0, except for OSPF where the default cost is 20**.
- 0 is only understood by IS-IS and not by RIP, IGRP and EIGRP.
- RIP, IGRP and EIGRP must have the appropriate metrics assigned to any redistributed routes, or redistribution will not work.
- Use a value consistent with the destination protocol.

34

Redistributing IGRP and RIP





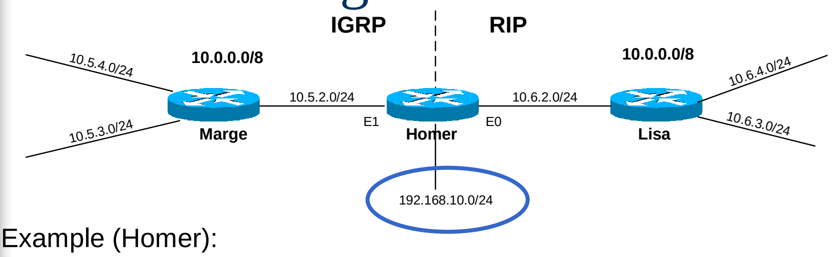
Example (Homer):

```
router rip
  redistribute igrp 1 metric 5
  passive-interface ethernet 1
  network 10.0.0.0

router igrp 1
  redistribute rip
  default-metric 1000 100 255 1
  passive-interface ethernet 0
  network 10.0.0.0
```

35

Redistributing IGRP and RIP

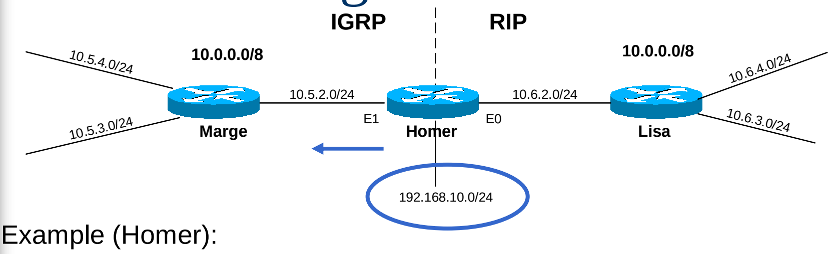


Example (Homer):

- Notice Homer is also connected to a stub network, **192.168.10.0/24**.
- We want this stub network to be advertised into the **IGRP** domain, but ***not*** the **RIP** domain.
- One way to do this is to add the appropriate **network** statement under IGRP, however this will create unnecessary IGRP broadcasts on the stub network (okay, so you can add a passive-interface).
- Another way to achieve the same result is to add the **redistribute connected** command, only to the IGRP domain.

36

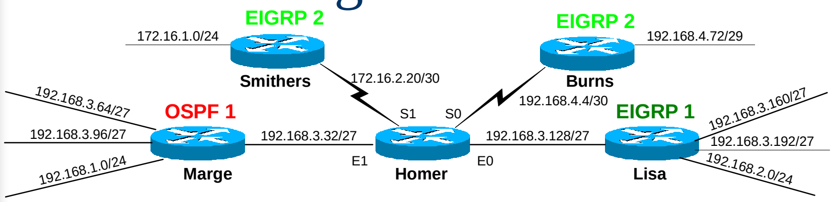
Redistributing IGRP and RIP



Example (Homer):

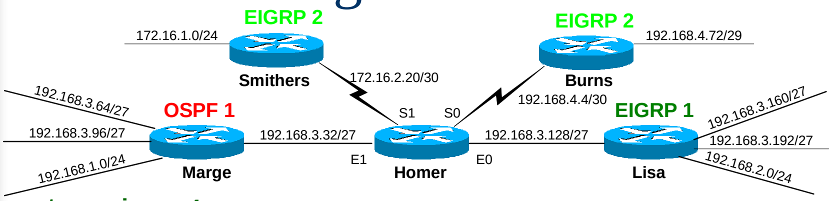
```
router igrp 1
  redistribute rip
  redistribute connected
  default-metric 1000 100 255 1
  passive-interface ethernet 0
  network 10.0.0.0
```


Redistributing EIGRP and OSPF




```
router eigrp 1
  redistribute ospf 1 metric 1000 100 1 255
  redistribute eigrp 2
  passive-interface ethernet 0
  network 192.168.3.0
router eigrp 2
  redistribute ospf 1 metric 1000 100 1 255
  redistribute eigrp 1
  network 192.168.4.0
  network 172.16.0.0
router ospf 1
  redistribute eigrp 1 metric 50
  redistribute eigrp 2 metric 100
  network 192.168.3.33 0.0.0.0 area 0
```

Redistributing EIGRP and OSPF

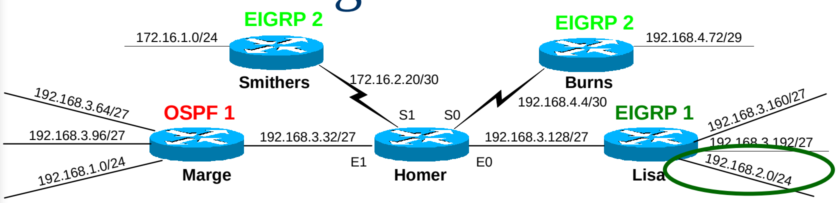



```
router eigrp 1
  redistribute ospf 1 metric 1000 100 1 255
  redistribute eigrp 2
  passive-interface ethernet 0
  network 192.168.3.0
router eigrp 2
  redistribute ospf 1 metric 1000 100 1 255
  redistribute eigrp 1
  network 192.168.4.0
  network 172.16.0.0
```

- **Notice there are no metrics configured for redistribution between EIGRP processes.**
- **The processes use the same metrics, so the metrics are tracked accurately across the redistribution boundary.**
- **Redistributed routes are tagged as EIGRP external routes (D EX).**

39

Redistributing EIGRP and OSPF



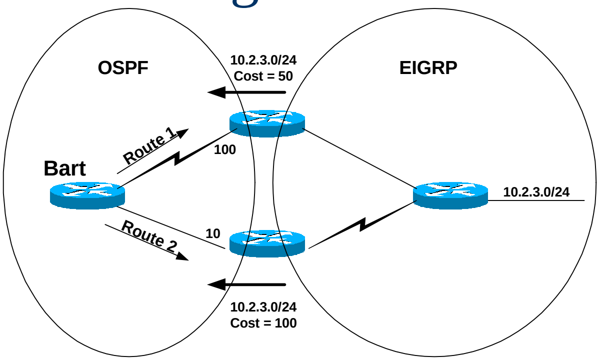

```
router ospf 1
  redistribute eigrp 1 metric 50 subnets
  redistribute eigrp 2 metric 100 subnets
  network 192.168.3.33 0.0.0.0 area 0
```

- There is a problem with redistributing EIGRP routes into OSPF.
- The only non-OSPF routes in Marge's routing table is the E2 route, **192.168.2.0/24**
- Why? Only major network addresses that are not directly connected to the redistributing router, Homer, will be redistributed into OSPF.
- Solution? Include the keyword **subnets.**

Remember, **redistributed connected** only redistributes directly connected networks**.**

40

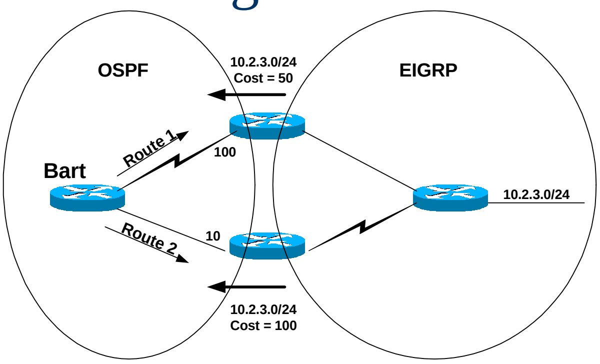
Redistributing OSPF: E1 vs E2



- By default, external routes are redistributed into OSPF as type 2 routes (**E2**).
- **E2** routes include only the external cost of the route.
- As a result, Bart will **choose the preferred route of route 1** with a cost of 50, over route 2 with a cost of 100.
- In this scenario, this is not the ideal route.

41

Redistributing OSPF: E1 vs E2



- To redistribute routes into OSPF as **E1**, the keyword **metric-type 1** is added to the redistribution commands in the boundary routers.
- **Bart will now choose route 2**, with a cost of 110 (100+10) over route 1, with a cost of 150 (50 + 100).

42

Redistribution between EIGRP and IGRP

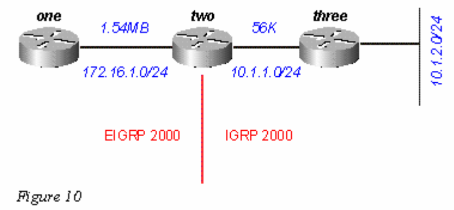


Figure 10

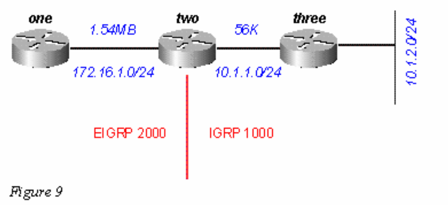


Figure 9

Same AS numbers

Router Two

```
router eigrp 2000
 network 172.16.1.0
!
router igrp 2000
 network 10.0.0.0
```

(automatic redistribution)

Different AS numbers

Router Two

```
router eigrp 2000
 redistribute igrp 1000
 network 172.16.1.0
!
router igrp 1000
 redistribute eigrp 2000
 network 10.0.0.0
```

43

Redistribution between EIGRP and IGRP

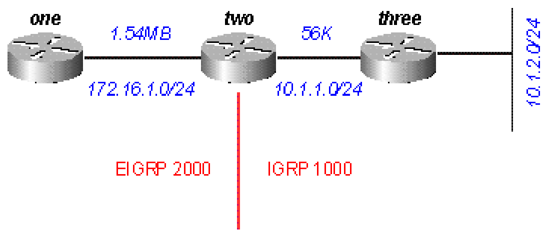


Figure 9

Router TWO

```
router eigrp 2000
  redistribute igrp 1000
  network 172.16.1.0
!
router igrp 1000
   redistribute eigrp 2000
   network 10.0.0.0
```

- IGRP metrics are preserved when routes are redistributed into EIGRP with a different autonomous system, but they are scaled by multiplying the IGRP metric by the constant 256.
- There is one caveat to redistribution between IGRP and EIGRP that should be noted.
  - If the network is directly connected to the router doing the redistribution, it advertises the route with a metric of 1.

44

Redistribution between EIGRP and IGRP

- There are several other caveats which are not important here, but if you are interested or have a need, they can be examined at:
- http://www.cisco.com/warp/public/103/eigrp4.html

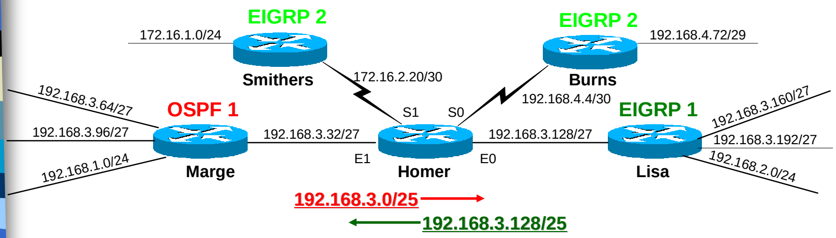
45

Redistribution and Summarization

- This is going beyond the scope of the material or the exam, but here is a quick example of redistribution and summarization.
- This example does not do this topic justice, as there are several issues, including the routing table outputs, that are not discussed.
- Let’s take a quick look anyways…

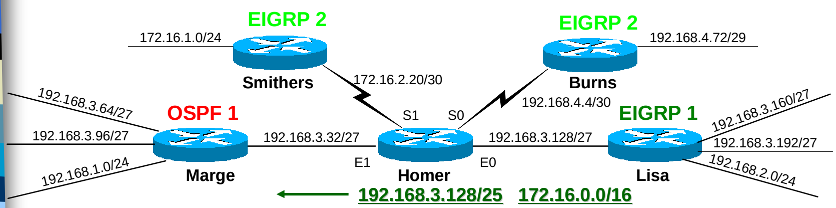
46

Redistribution and Route Summarization



- EIGRP, OSPF and IS-IS have the capability to summarize redistributed routes.
- Summarization is most useful if the IP subnet addresses have been planned for summarization.
- For example, the **192.168.3.0** subnets within the OSPF domain all fall under the summary address **192.168.3.0/25**.
- The subnets of the same major address within the EIGRP 1 domain, **192.168.3.0** all fall under the summary address **192.168.3.128/25**.
- If subnet **192.168.3.0/27** were to be connected to **Lisa**, that single destination would have to be advertised separately from the summary address, because it falls under the OSPF summarization.

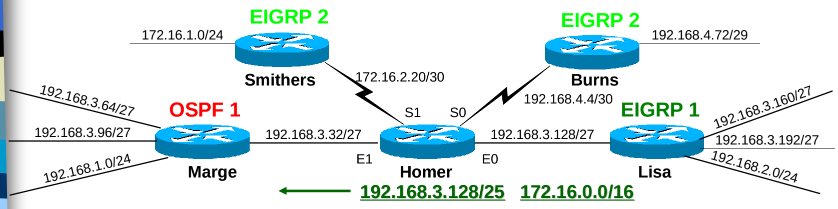
Redistribution and Route Summarization



- The command **summary-address** specifies a summary address and mask to an OSPF process.
- This command is used only on ASBRs – summarization at ABRs is accomplished with the **area range** command.

```
router ospf 1
 summary-address 192.168.3.128 255.255.255.128
 summary-address 172.16.0.0  255.255.0.0
 redistribute eigrp 1 metric 50 subnets
 redistribute eigrp 2 metric 100 subnets
 network 192.168.3.33 0.0.0.0 area 0
```

Redistribution and Route Summarization

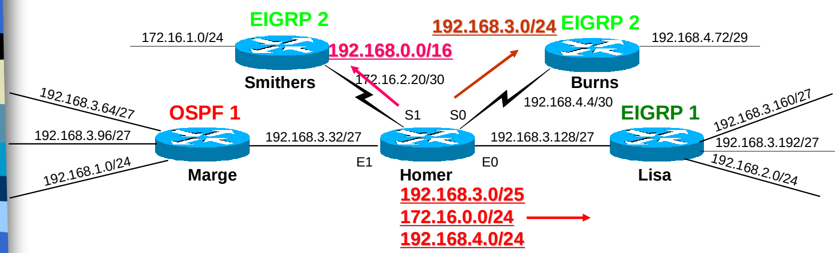


- Marge's routing table will include both of these E2 summary routes with a cost of 50 for the EIGRP 1 route of 192.168.3.128/25 and a cost of 100 for the EIGRP 100 route of 172.16.0.0/16.

```
router ospf 1
  summary-address 192.168.3.128 255.255.255.128
  summary-address 172.16.0.0   255.255.0.0
  redistribute eigrp 1 metric 50 subnets
  redistribute eigrp 2 metric 100 subnets
  network 192.168.3.33 0.0.0.0 area 0
```

49

Redistribution and Route Summarization

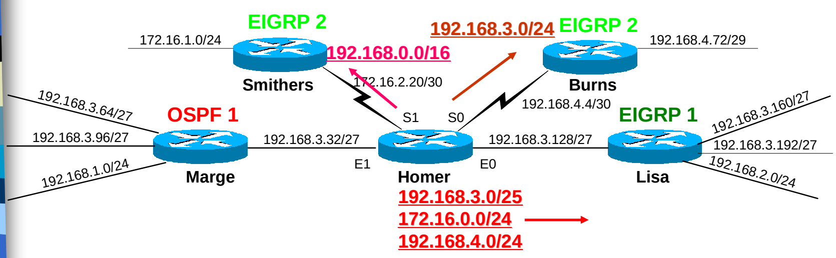


- Summarization for **EIGRP** is interface specific.

```
interface ethernet 0
 ip add 192.168.3.129 255.255.255.224
 ip summary-address eigrp 1 192.168.3.0 255.255.255.128
 ip summary-address eigrp 1 172.16.0.0 255.255.0.0
 ip summary-address eigrp 1 192.168.4.0 255.255.255.0
interface serial 0
 ip add 192.168.4.5 255.255.255.252
 ip summary-address eigrp 2 192.168.3.0 255.255.255.0
interface serial 1
 ip add 172.16.2.21 255.255.255.252
 ip summary-address eigrp 2 192.168.0.0 255.255.0.0
```

50

Redistribution and Route Summarization



- Take a look at which routes are being summarized and why.
- Notice that the 192.160.0.0/16 network can be summarized to Smithers as Smithers has only 172.16.0.0 connected networks.
- Smithers still gets the 192.168.4.0/24 automatically summarized route from within its EIGRP 2 routing domain.
- Burns has 192.168.3.0/24 summarized, as it has 192.168.4.0 subnets and learns about 172.16.0.0 routes via EIGRP.
- Routes learned from a different EIGRP process gets tagged as “external” (EX), but summarized routes from another EIGRP process are not.
- For complete routing tables and a detailed discussion, including some very interesting surprises, refer to *Routing TCP/IP Vol. I by Jeff Doyle*.

That’s it!

- Special thanks to Homer Simpson, Teaching Assistant and CCDP (Crispy Cream Donut Professional)