Router and Routing Basics

The **Cisco Certified Network Associate** Curriculum

Distance vector Routing Protocols

CISCO SYSTEMS
NETWORKING ACADEMY

Version 3.0
Cisco Regional Networking Academy

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Objectives

- Describe how routing loops can occur in distance vector routing
- Describe several methods used by distance vector routing protocols to ensure that routing information is accurate
- Configure RIP
- Use the **ip classless** command
- Troubleshoot RIP
- Configure RIP for load balancing
- Configure static routes for RIP
- Verify RIP
- Configure IGRP
- Verify IGRP operation, troubleshoot IGRP

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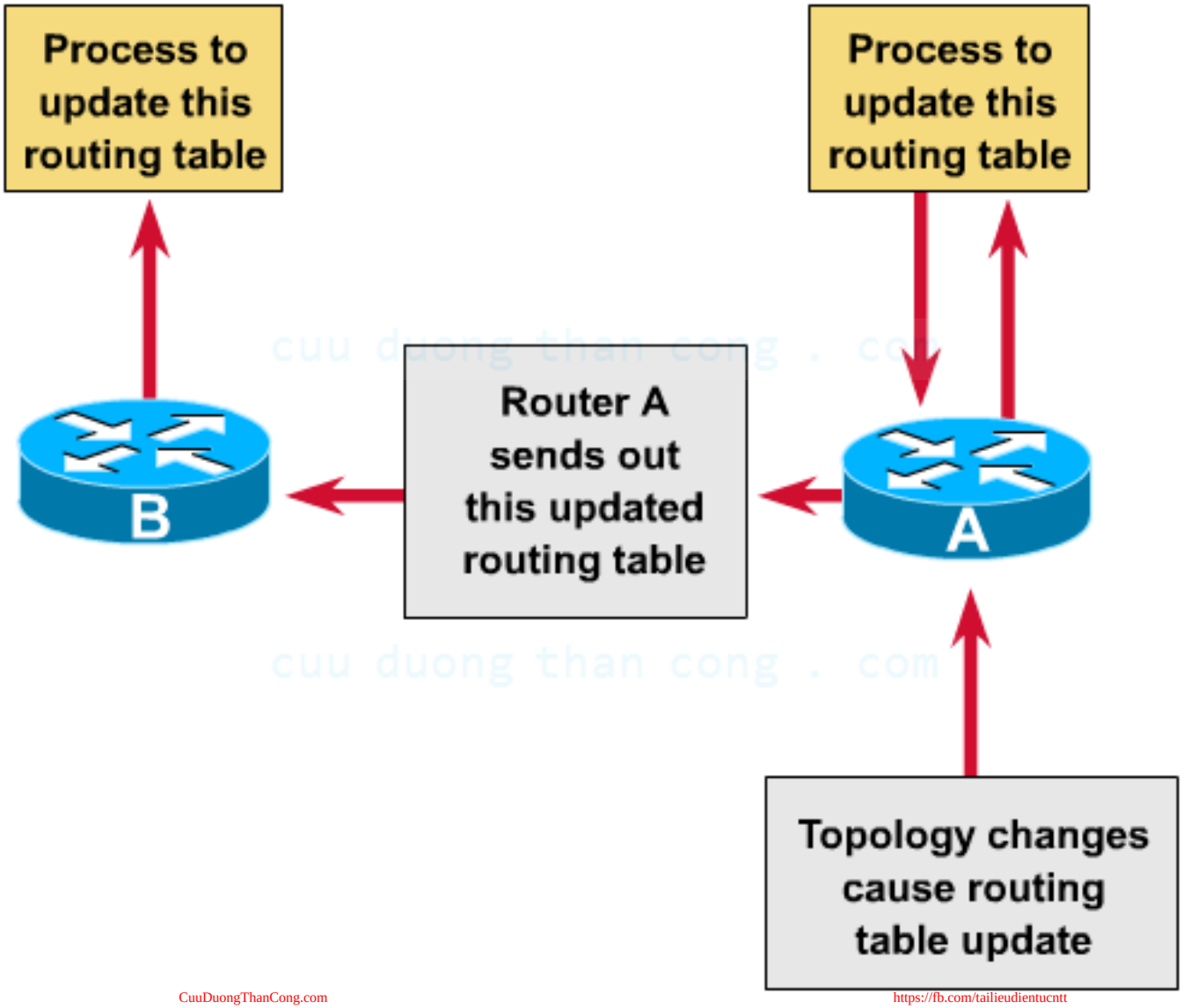
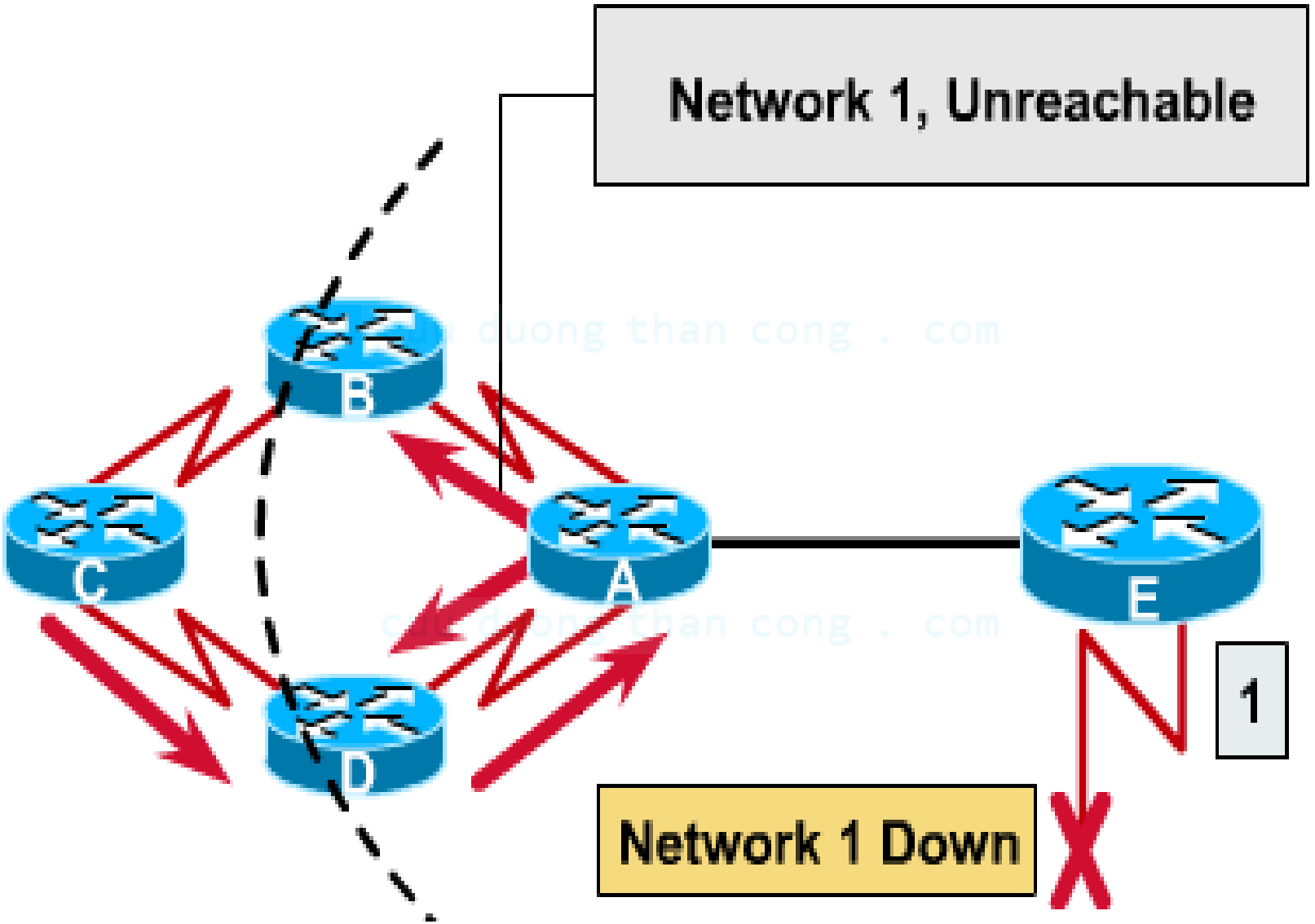
DISTANCE VECTOR ROUTING

Distance vector routing updates

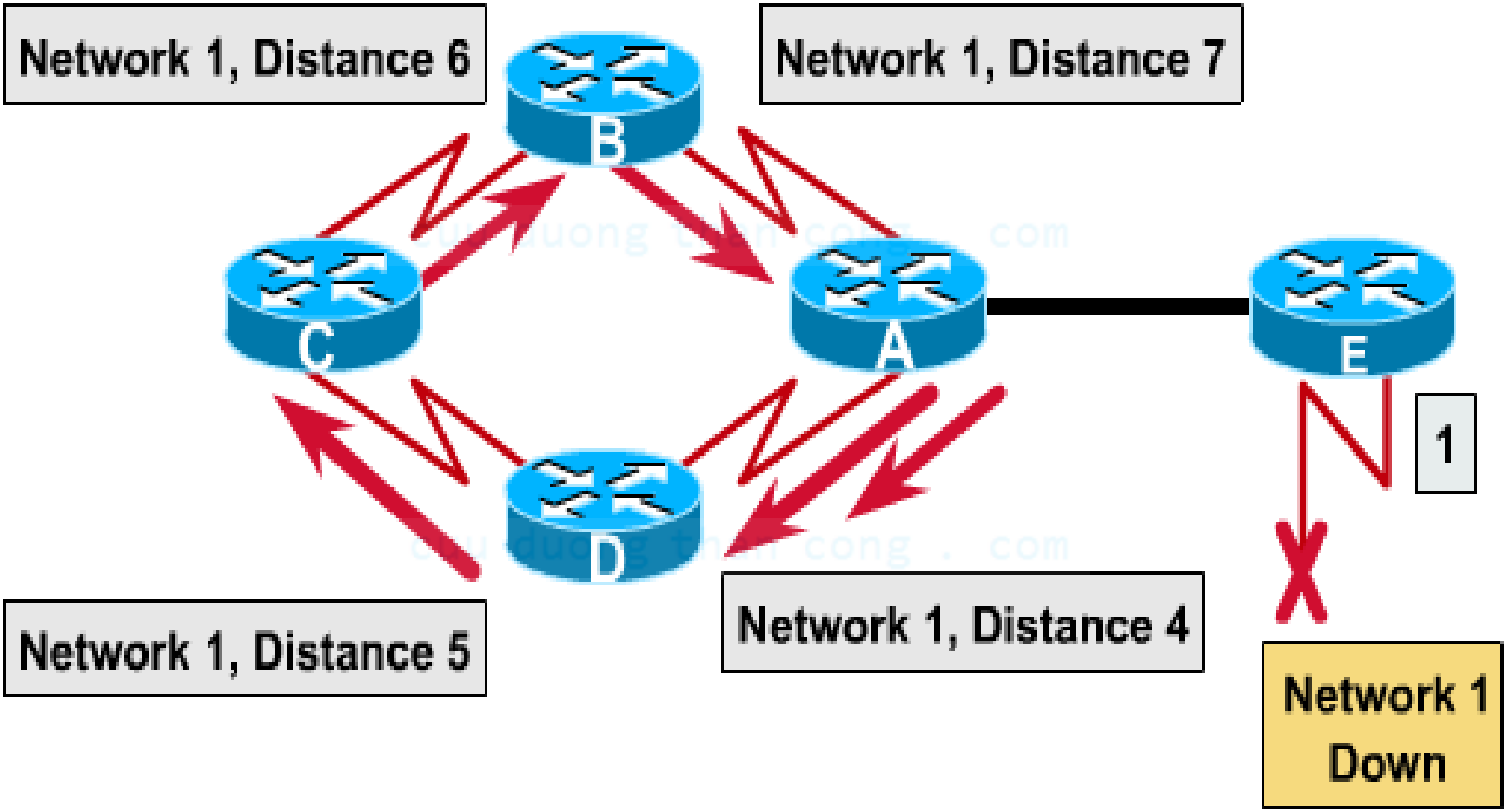


Distance vector routing loop issues



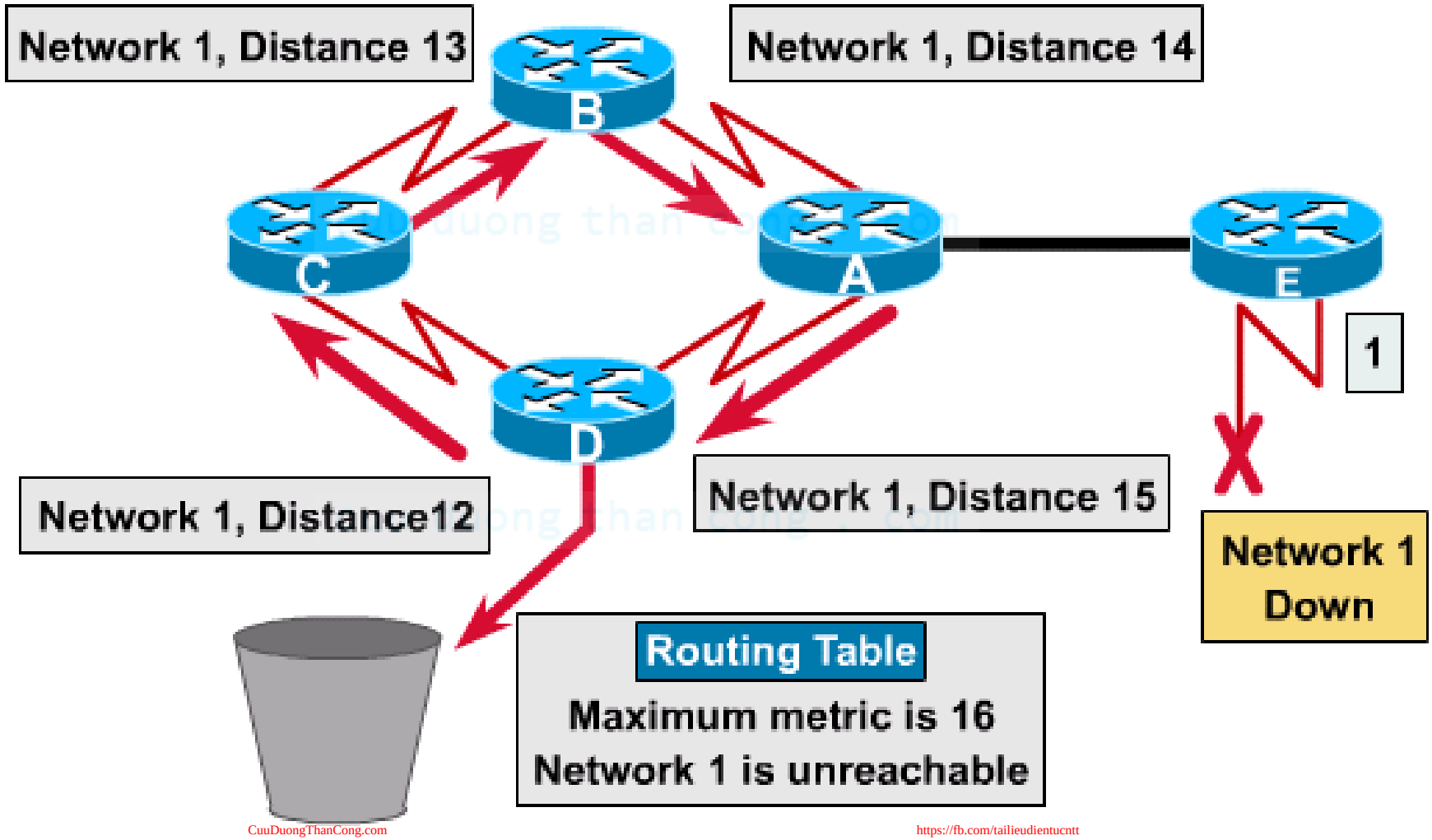
The Problem of Count to infinity

- Routing loops increment the distance vector



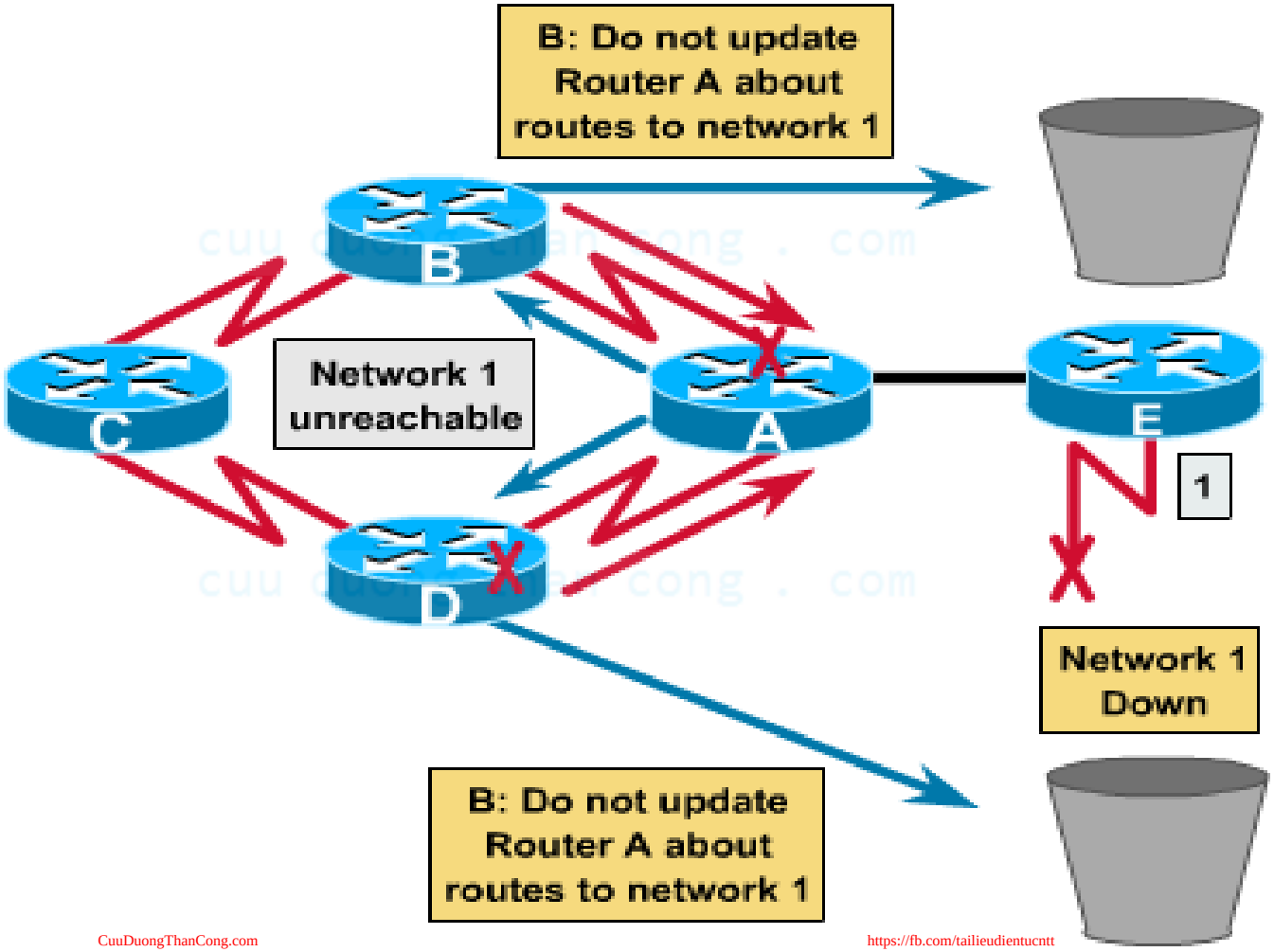
Defining a maximum count

- Specific a maximum distance vector metric as infinity.

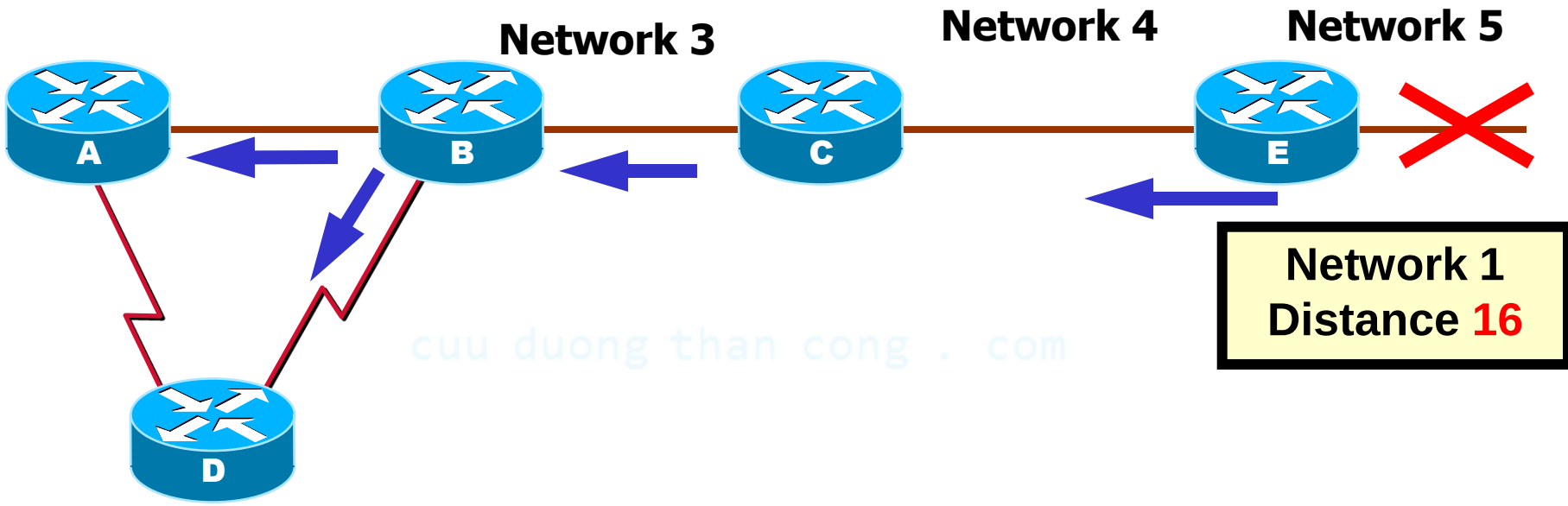


Elimination routing loops through split horizon

- Advertises routes out an interface only if they were not learned from updates entering that interface.

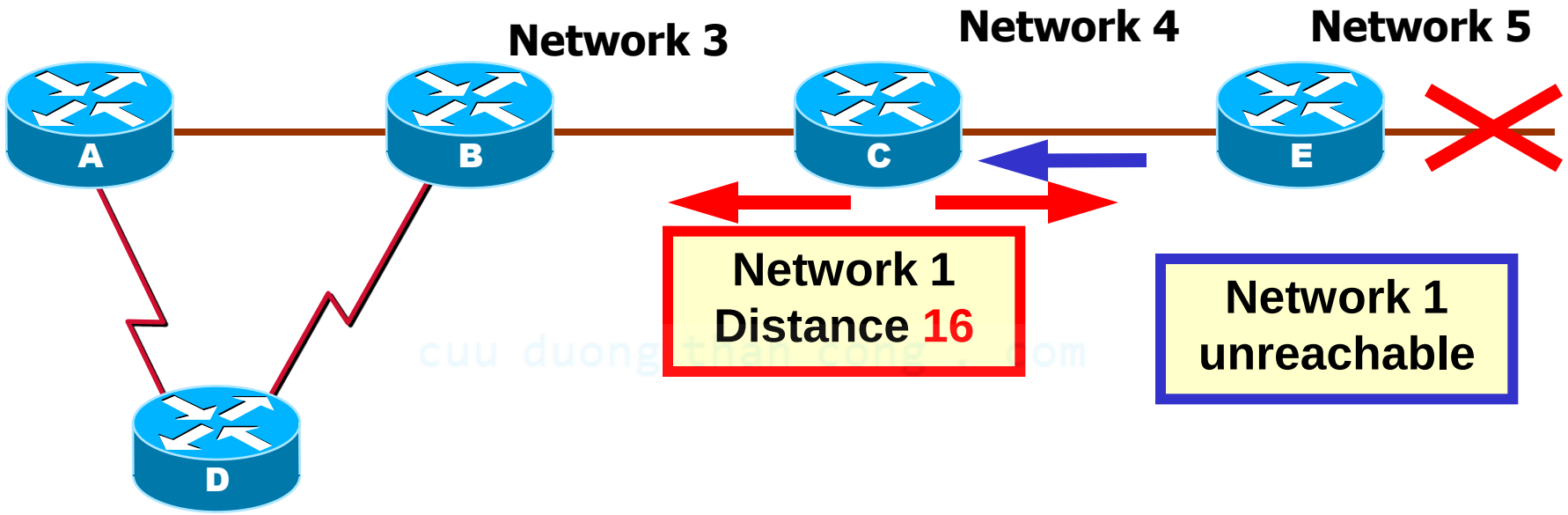


Route poisoning



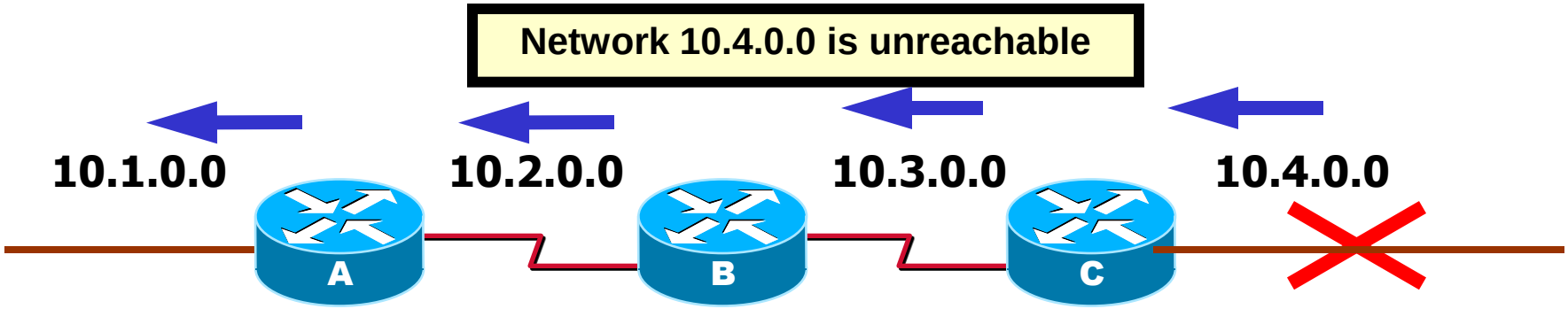
- When Network 5 goes down, Router E initiates route poisoning by making a table entry for Network 5 as 16, or unreachable.
- When route poisoning is used with triggered updates it will speed up convergence time.

Split horizon with poison reverse



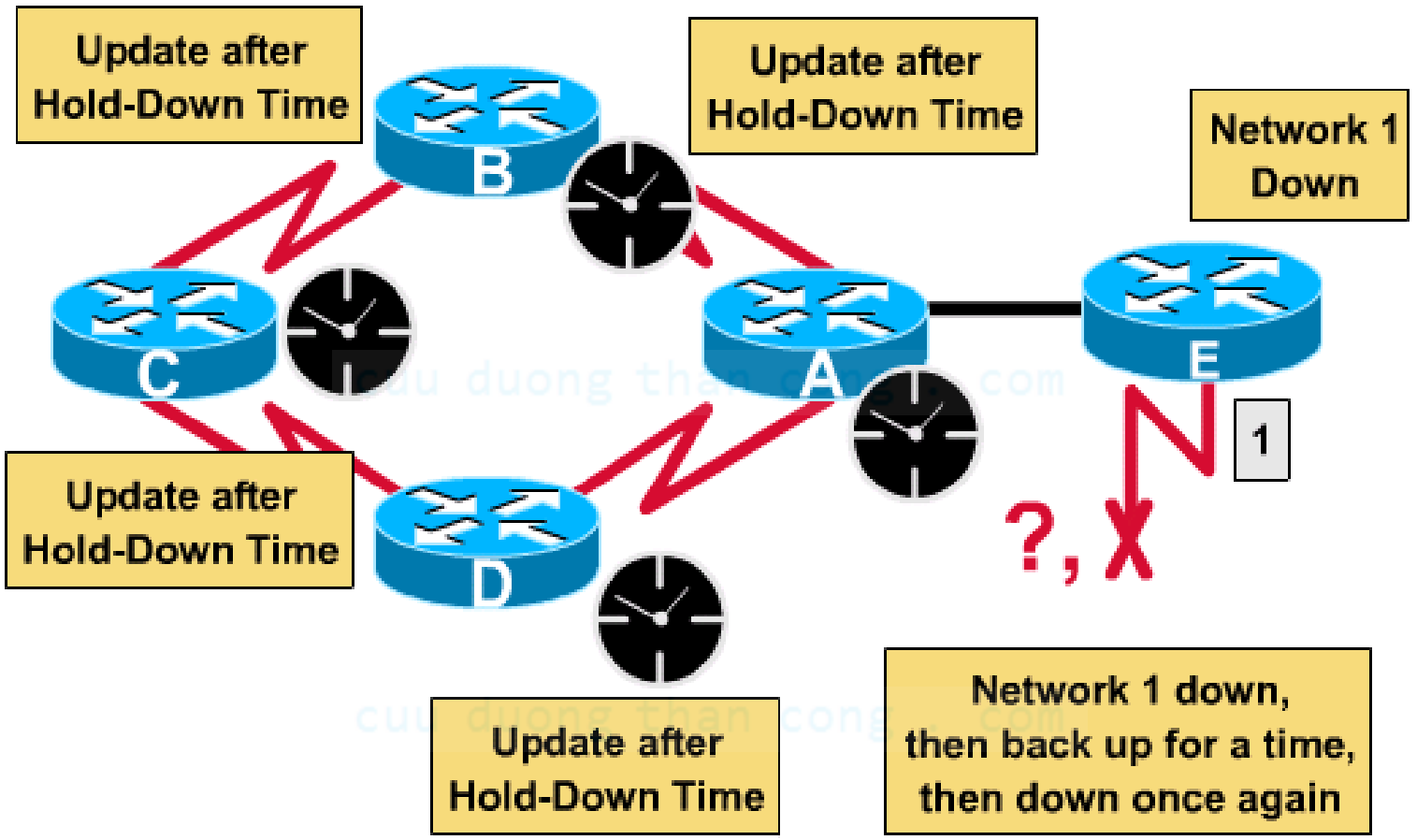
- Route poisoning does not break split horizon rules.
- Split horizon with poison reverse is essentially route poisoning, but specifically placed on links that split horizon would not normally allow routing information to flow across, the failed routes are advertised with infinite metrics.

Avoiding routing loops with triggered updates



- With the triggered update approach, routers send messages as soon as they notify a change in their routing table

Preventing routing loops with holddown timers



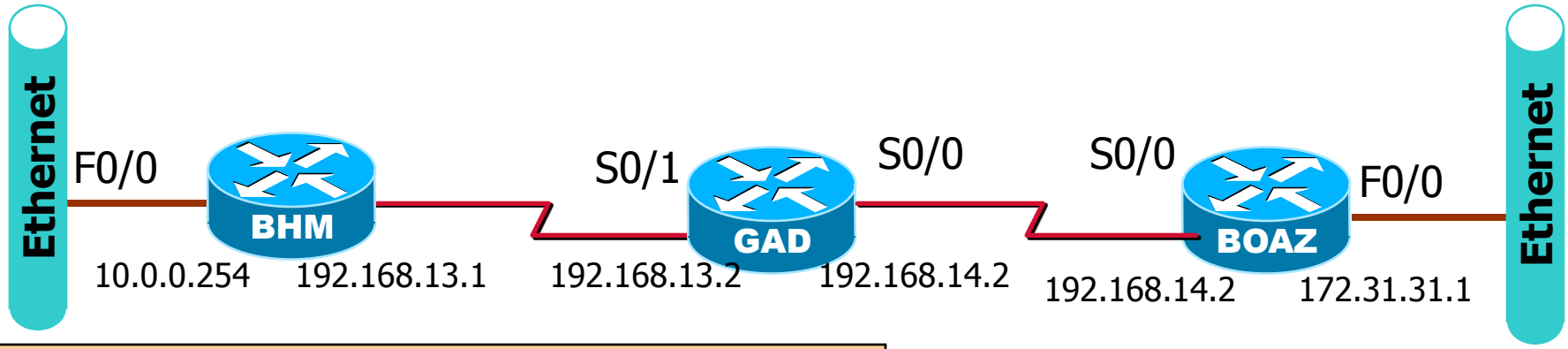
RIP

ROUTING INFORMATION PROTOCOL

RIP routing process

- It is a distance-vector routing protocol. RFC 1058.
- Hop count is used as the metric for path selection.
- If the hop count is greater than 15, the packet will be discarded.
- By default, routing updates are broadcast every 30 seconds.
- RIP has evolved over the years from a Classful Routing Protocol, RIP Version 1 (RIP v1), to a Classless Routing Protocol, RIP Version 2 (RIP v2). RIP v2 enhancements include:
  - Ability to carry additional packet routing information.
  - Authentication mechanism to secure table updates.
  - Supports variable length subnet masking (VLSM).

Basic Configuring RIP




```
BHM(config)#router rip
BHM(config-router)#network 10.0.0.0
BHM(config-router)#network 192.168.13.0
```

Selects RIP as the routing protocol

Specifies a directly connected network
Major netwotk not subbnetwork

```
GAD(config)#router rip
GAD(config-router)#network 192.168.14.0
GAD(config-router)#network 192.168.13.0
```

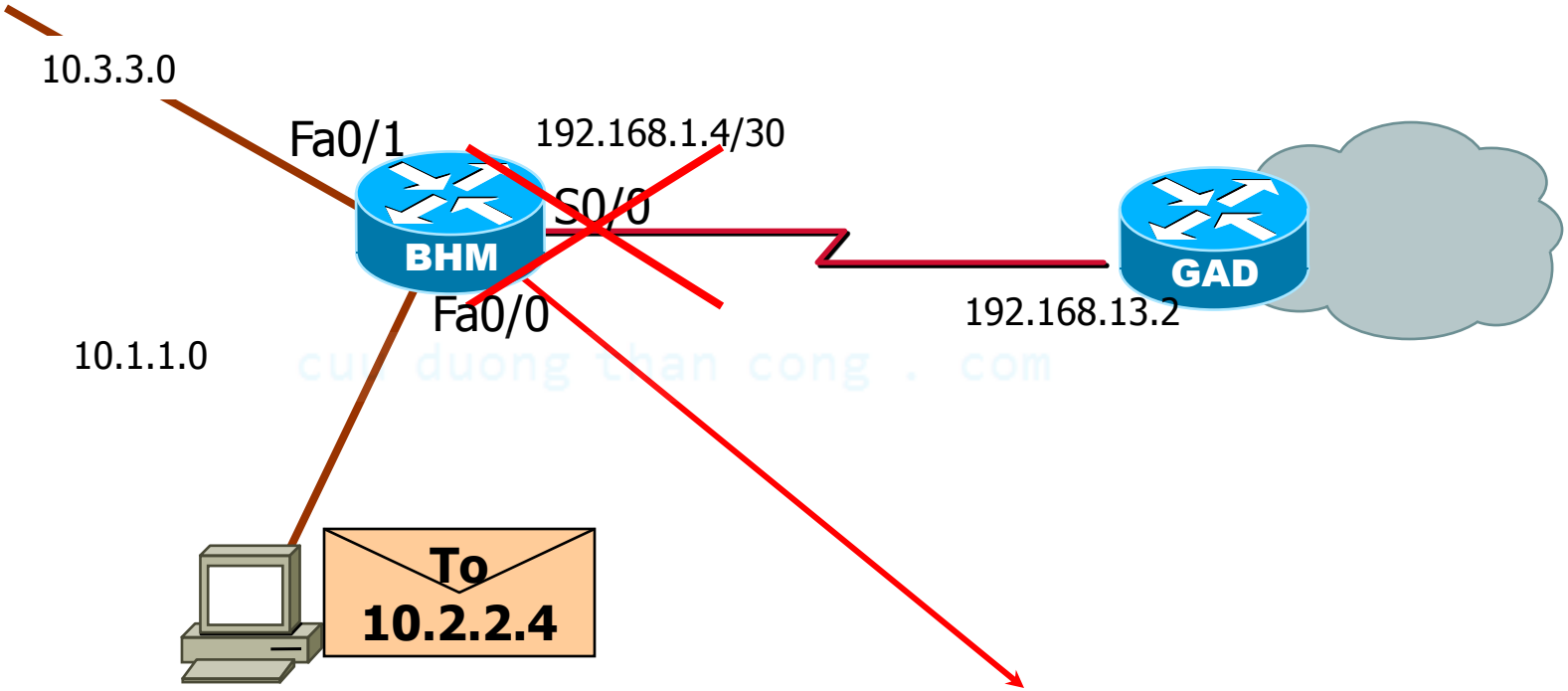
```
BOAZ(config)#router rip
BOAZ(config-router)#network 192.168.14.0
BOAZ(config-router)#network 172.31.0.0
```

```
BHM(config)#interface s0/0
BHM(config-if)#ip rip triggered
```

Configuring RIP: Option tasks

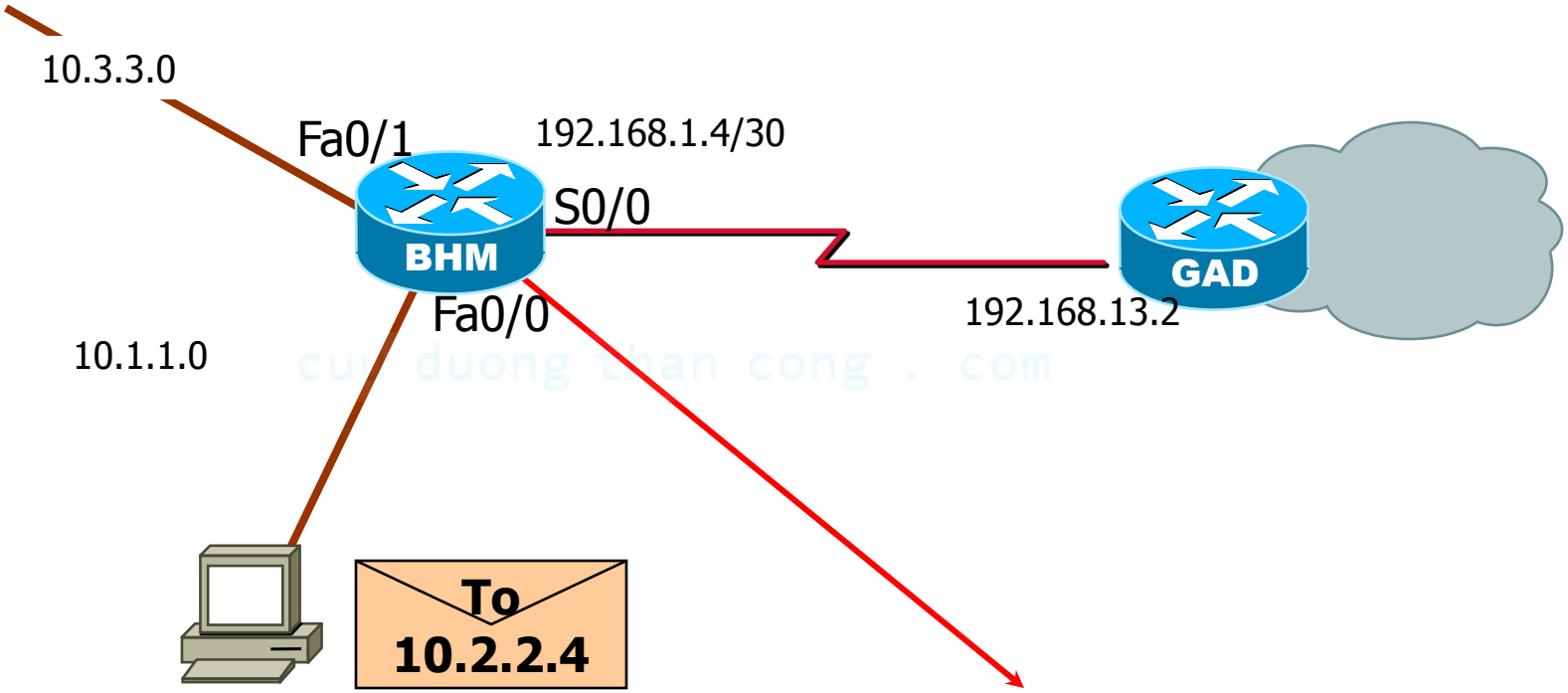
- Applying offsets to routing metrics
- Adjusting timers
- Specifying a RIP version
- Enabling RIP authentication
- Configuring route summarization on an interface
- Verifying IP route summarization
- Disabling automatic route summarization
- Running IGRP and RIP concurrently
- Disabling the validation of source IP addresses
- Enabling or disabling split horizon
- Connecting RIP to a WAN

Without ip classless command



Destination network	Outbound interface
10.3.3.0	Fa0/1
10.1.1.0	Fa0/0
0.0.0.0	S0/0

With ip classless command



Destination network	Outbound interface
10.3.3.0	Fa0/1
10.1.1.0	Fa0/0
0.0.0.0	S0/0

Common RIP configuration issues

- To reduce routing loops and counting to infinity, RIP uses the following techniques:
  - Count-to-infinity
  - Split horizon
  - Poison reverse
  - Holddown counters
  - Triggered updates

Setting holddown timer

To disable split horizon:

Router(config-if)#**no ip split-horizon**

To change the holddown timer:

Router(config-router)#**timers basic** *update invalid holddown flush [sleeptime]*

To change the update internal:

Router(config-router)#**update-timer** *seconds*

Disable the sending of routing updates on specified interfaces:

Router(config-router)#**passive-interface** *interface*

Configure RIP in a non-broadcast network:

Router(config-router)#**neighbor** *ip address*

To configure the router to send and receive packets

Command	Purpose
Router(config-router)#**version** {1 | 2}	Configure the software to send and receive RIP version 1 version 2 packets
Router(config-if)#**ip rip send version 1**	Configure an interface to send RIP version 1 packets
Router(config-if)#**ip rip send version 2**	Configure an interface to send RIP version 2 packets
Router(config-if)#**ip rip send version 1 2**	Configure an interface to send RIP version 1 or 2 packets
Router(config-if)#**ip rip receive version 1**	Configure an interface to receive RIP version 1 packets
Router(config-if)#**ip rip receive version 2**	Configure an interface to receive RIP version 2 packets
Router(config-if)#**ip rip receive version 1 2**	Configure an interface to receive RIP version 1 or 2 packets

Verifying RIP configuration: SHOW IP PROTOCOLS

Command

```
Router> show ip protocol
Routing Protocol is rip
  Sending updates every 30 seconds, next due in 13 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interface is not set
  Incoming update filter list for all interface is not set
  Redistributing: rip
  Routing for Networks:
    183.8.0.0
    144.253.0.0
  Routing Information Sources:
  Gateway                 Distance          Last Update
    183.8.128.12              120           0:00:14
    183.8.64.130              120           0:00:19
    183.8.128.130             120           0:00:03
  Distance: (default is 120)
```

RIP interface

Networks being advertised

Verifying RIP configuration: SHOW IP ROUTE

Command

```
Router> show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2, E-EGP
       i - IS-IS, L1 - IS-IS level 1, L2 - IS-IS level 2
       * - candidate default

Gateway of last resort is not set

     144.253.0.0 is subnetted (mask is 255.255.255.0), 1 subnets
C       144.253.100.0 is directly connected. Ethernet1
R    133.3.0.0
R    153.50.0.0 [120/1] via 183.8.128.12, 00:00:09, Ethernet0
     183.8.0.0 is subnetted (mask is 255.255.255.128), 4 subnets
R       183.8.0.128 [120/1] via 183.8.128.130.00, 00:00:17, Serial0
                    [120/1] via 183.8.64.130, 00:00:17, Serial1
C       183.8.128.0 is directly connected, Ethernet0
C       183.8.64.128 is directly connected, Serial1
C       183.8.128.128 is directly connected, Ethernet0
R    192.3.63.0
```

Networks being advertised

Troubleshooting RIP update issues: DEBUG IP RIP

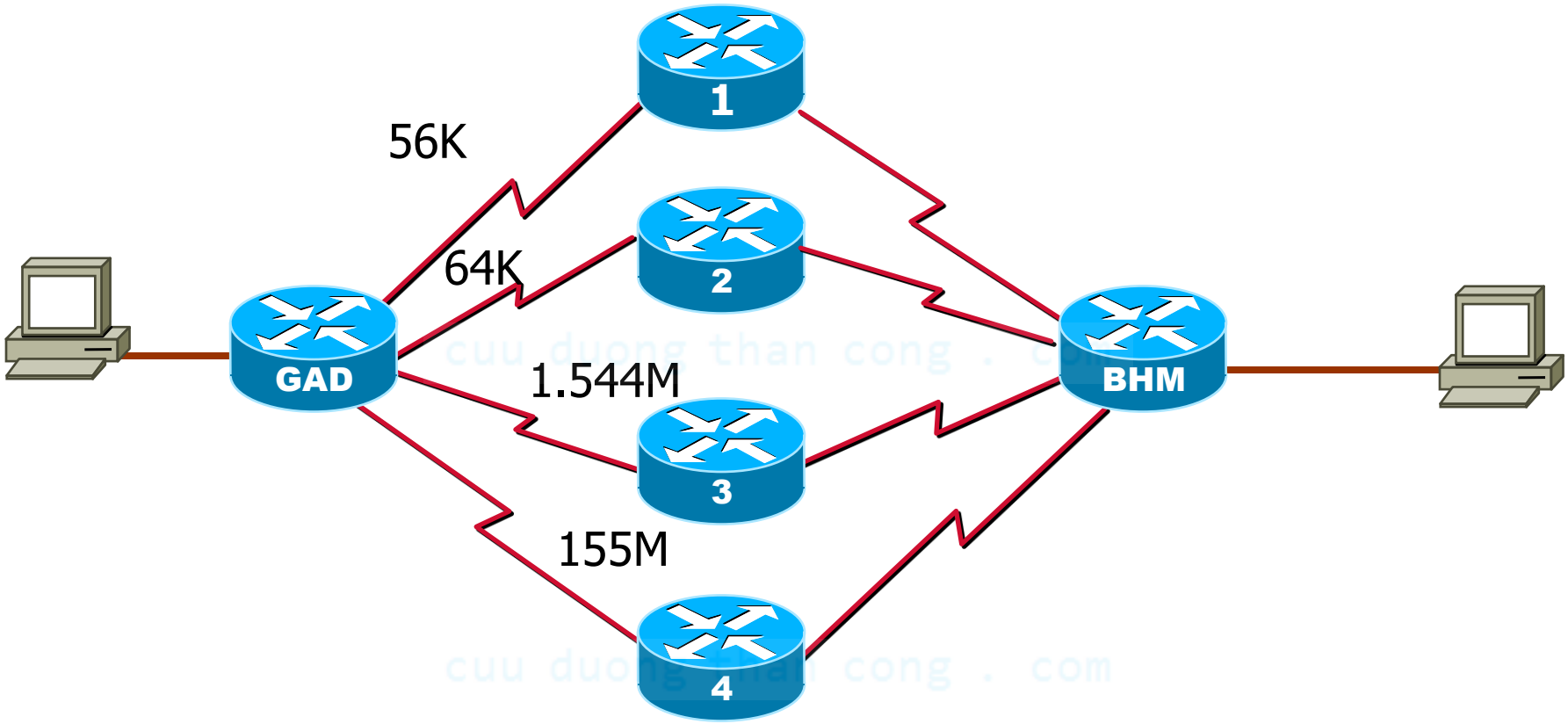
Command

```
Router# debug ip rip
RIP Protocol debugging is on
Router#
RIP: received update from 183.8.128.130 on Serial0
     183.8.0.128 in 1 hops
     183.8.64.128 in 1 hops
     0.0.0.0 in 16 hops (inaccessible)
RIP: received update from 183.8.64.140 on Serial1
     183.8.0.128 in 1 hops
     183.9.128.128 in 1 hops
     0.0.0.0 in 16 hops (inaccessible)
RIP: received update from 183.8.128.130 on Serial0
     183.8.0.128 in 1 hops
     183.8.64.128 in 1 hops
     0.0.0.0 in 16 hops (inaccessible)
RIP: sending update to 255.255.255.255 via Ethernet0 (183.8.128.2)
     subnet 183.8.0.128, metric 2
     subnet 183.8.64.128, metric 1
     subnet 183.8.128.128, metric 1
     default 0.0.0.0, metric 16
     network 144.253.0.0, metric 1
RIP: sending update to 255.255.255.255 via Ethernet1 (144.253.100.202)
     default 0.0.0.0, metric 16
     network 153.50.0.0, metric 2
     network 183.8.0.0, metric 1
```

Troubleshooting RIP update issues: Others command

- show ip rip database
- show ip protocols {summary}
- show ip route
- debug ip rip {events}
- show ip interface brief

Load balancing with RIP



- RIP is capable of load balancing over as many as six equal-cost paths, with four paths being default. RIP performs what is referred to as "round robin" load balancing.
- Router(config-router)#**maximum-paths** [*number*]

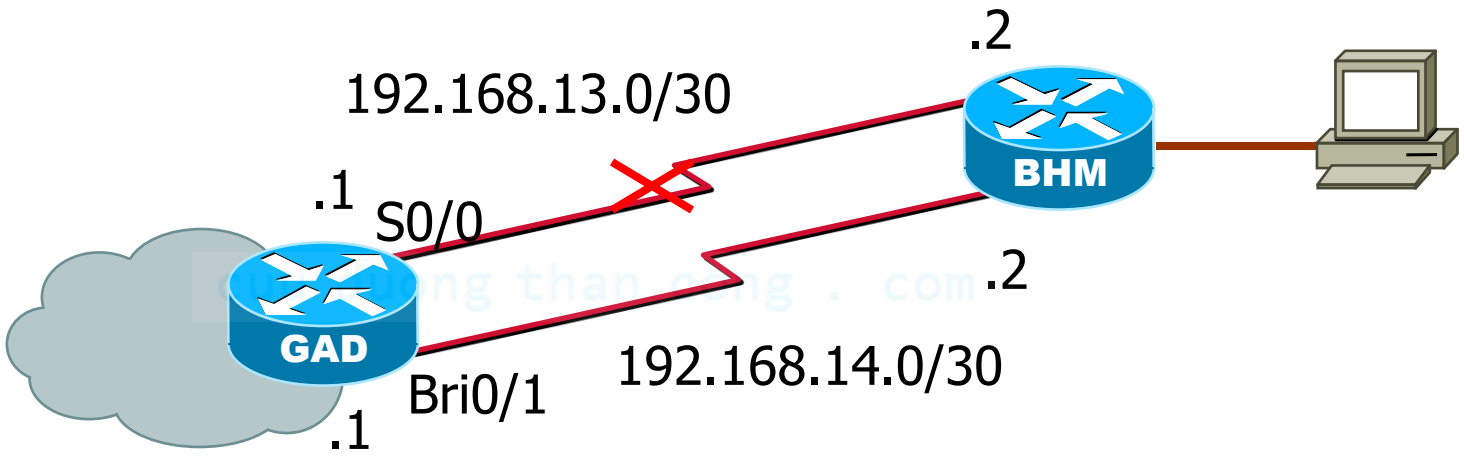
Load balancing with RIP

```
RouterC#show ip route 192.168.2.0
Routing entry for 192.168.2.0/24
  Known via "rip", distance 120, metric 1
  Redistributing via rip
  Last update from 192.168.4.2 on FastEthernet0/0,
00:00:18 ago
  Routing Descriptor Blocks:
  192.168.4.1, from 192.168.4.1, 00:02:45 ago, via
FastEthernet0/0
  Route metric is 1, traffic share count is 1
  * 192.168.4.2, from 192.168.4.2, 00:00:18 ago,
via FastEthernet0/0
  Route metric is 1, traffic share count is 1
```

Integrating static routes with RIP

- Static routes are user-defined routes.
- They are also useful for specifying a "gateway of last resort", commonly referred to as a default route.
  - A router running RIP can receive a default route via an update from another router running RIP.
  - Another option is for the router to generate the default route itself.
- RIP will advertise a static route throughout the internetwork.
  - If static route is assigned to an interface that is defined in the RIP process, via a **network** command.
  - Other, via a **redistribute static** command is specified in the RIP process.

RIP with floating route



- The floating static route was configured by defining an AD on the static route (130) greater than the default AD of RIP (120).

IGRP

INTERIOR GATEWAY ROUTING PROTOCOL

Characteristics

- Cisco's Distance-vector routing protocol.
- Routing updates at 90 second intervals, advertising networks for a particular AS.
- The versatility to automatically handle indefinite, complex topologies
- The flexibility needed to segment with different bandwidth and delay characteristics
- Scalability for functioning in very large networks.
- Use a composite metric of bandwidth, delay, load and reliability.

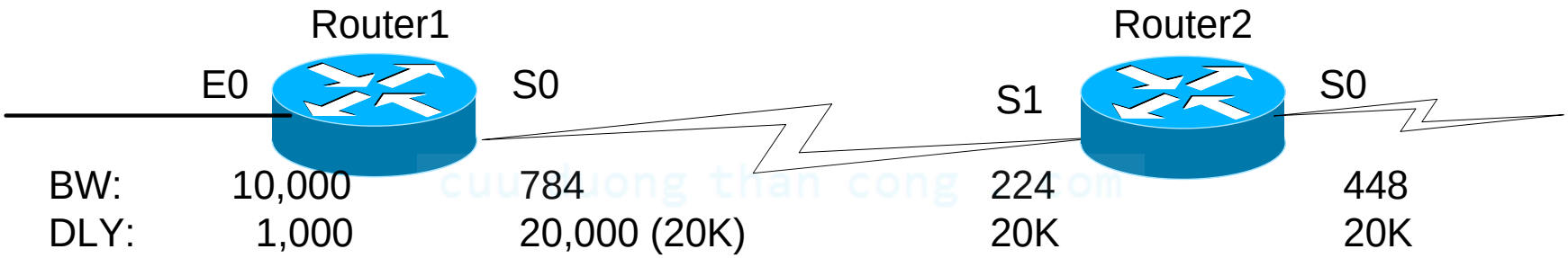
IGRP Metric

$$\text{Metric} = k_1 \times BW + \frac{k_2 \times BW}{256 - Load} + k_3 \times Delay$$

$$\text{If } k_5 \neq 0 \text{ then: } \text{Metric} = \text{Metric} \times \frac{k_5}{Rel + k_4}$$

- Default: $k_1 = 1$, $k_2 = 0$, $k_3 = 1$, $k_4 = 0$, $k_5 = 0$.
- Delay is the sum of all the delays of all outgoing interfaces divided by 10.
  - Delay = [Delay / 10ms].
- BW is the lowest bandwidth of all outgoing interfaces divided by 10,000,000.
  - BW = [10.000.000 / bandwidth in Kbps].

Example: IGRP Metric



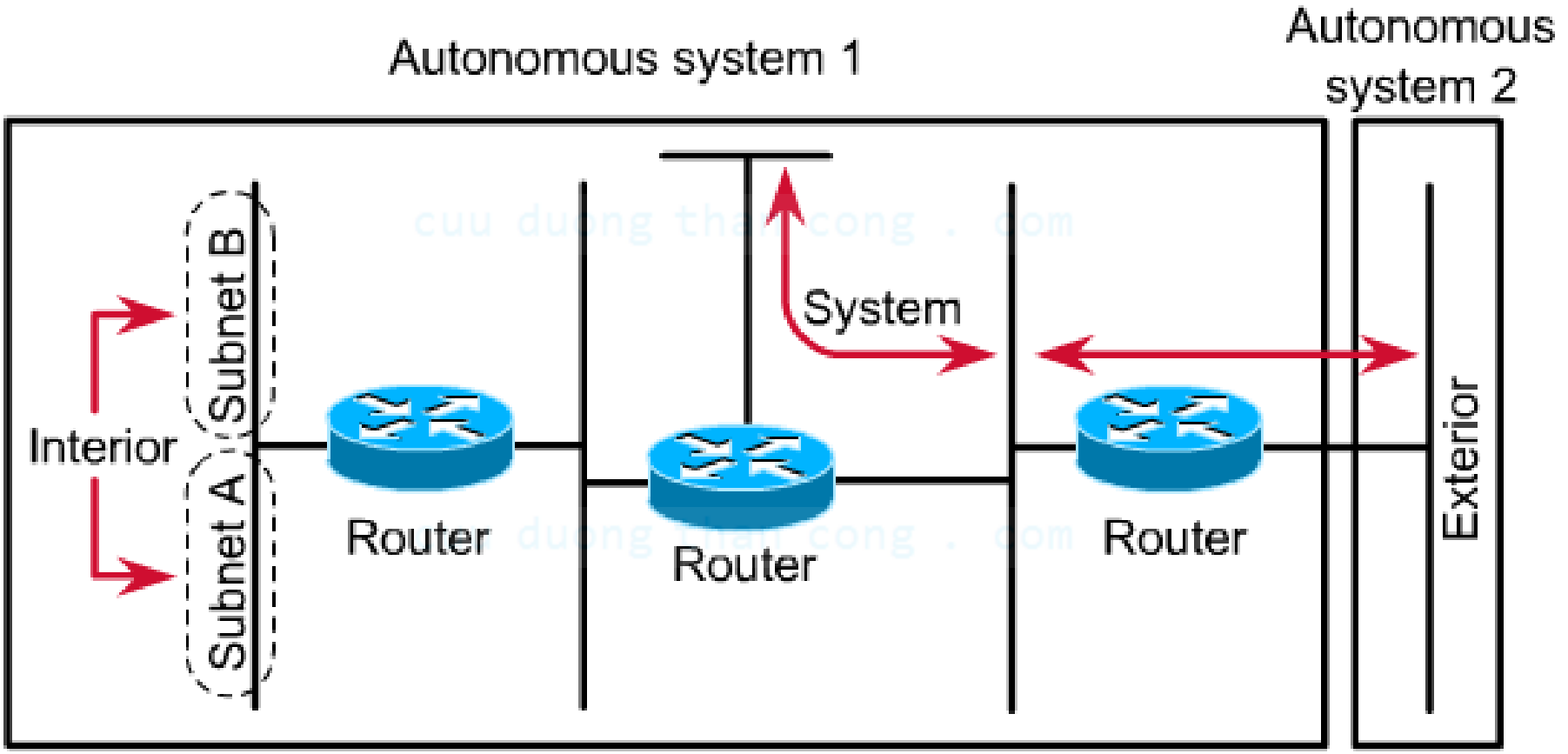
Show ip route “Router2-S0”

Metric = BandWidth + Delay
= 10,000,000/448 + (20,000+20,000)/10
= 26321

Show ip route “Router1-E0”

Metric = BandWidth + Delay
= 10,000,000/224 + (20.000 + 1000)/10
= 46742

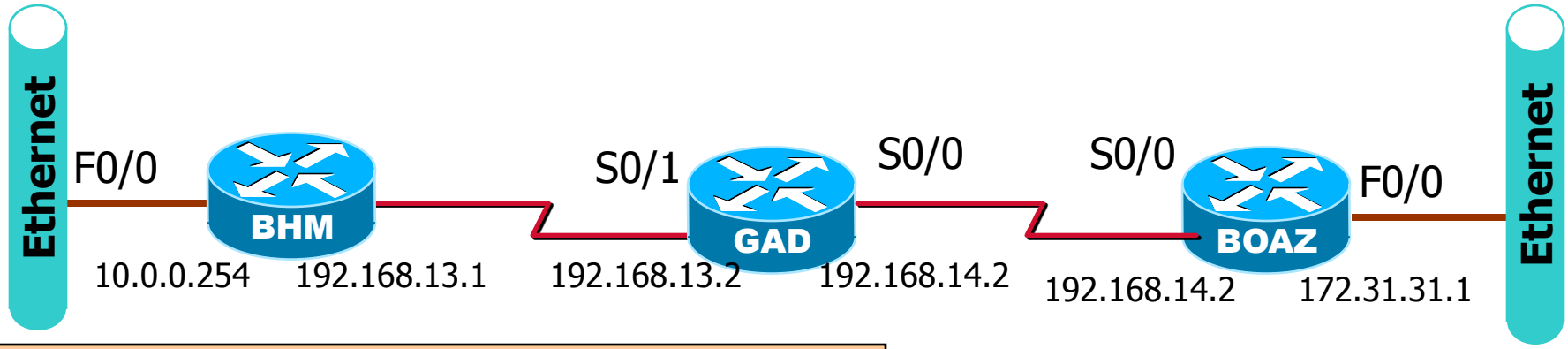
Interior, System and Exterior route



IGRP stability features

- IGRP has a number of features that are designed to enhance its stability, such as:
  - Holddowns
  - Split horizons
  - Poison reverse updates
- IGRP also maintains a number of timers and variables containing time intervals. These include an update timer, an invalid timer, a holddown timer, and a flush timer.

Configuring IGRP and migrating RIP to IGRP




```
BHM(config)#router igrp 101
BHM(config-router)#network 10.0.0.0
BHM(config-router)#network 192.168.13.0
```

Selects igrp as the routing protocol
101 is Autonomous System number is one that identifies the IGRP process.

```
GAD(config)#router igrp 101
GAD(config-router)#network 192.168.14.0
GAD(config-router)#network 192.168.13.0
```

Specifies a directly connected network
Major netwotk not subbnetwork

```
BOAZ(config)#router igrp 101
BOAZ(config-router)#network 192.168.14.0
BOAZ(config-router)#network 172.31.0.0
```

```
BHM(config)# no router igrp 101
```

Verifying IGRP configuration: SHOW IP INTERFACES

Command

```
Router> show ip interfaces
Ethernet0 is up, line protocol is up
  Internet address is 183.8.128.2, subnet mask is 255.255.255.128
  Broadcast address is 255.255.255.255
  Address determined by non-volatile memory
  MTU is 1500 bytes
  Helper address is not set
  Directed broadcast forwarding is enabled
  Outgoing access list is not set
  Inbound access list is not set
  Proxy ARP is enabled
  Security level is default
  Split horizon is enabled
  ICMP redirects are always sent
  ICMP unreachables are always sent
  ICMP mask replies are never sent
  IP fast switching enabled
  IP fast switching on the same interface is disabled
  IP SSE switching is disabled
  Router Discovery is disabled
  IP output packet accounting is disabled
  IP access violation accounting is disabled
  TCP/IP header compression is disabled
  Probe proxy name replies are disabled
  -- More --
```

Verifying IGRP configuration: SHOW IP PROTOCOLS

Command

```
Router> show ip protocol
Routing Protocol is igrp 300
  Sending updates every 90 seconds, next due in 55 seconds
  Invalid after 270 seconds, hold down 280, flushed after 360
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  IGRP maximum hopcount 100
  IGRP maximum metric variance 1
  Redistributing igrp 300
  Routing for Networks:
    183.8.0.0
    144.253.0.0
  Routing Information Sources
    Gateway                 Distance          Last Update
    144.253.100.1           100                0:00:52
    183.8.128.12            100                0:00:43
    183.8.64.130            100                0:01:02
  Distance: (default is 100)
-- More --
```

Verifying IGRP configuration: SHOW RUN

```
RouterA#show running-config | begin igrp
 router igrp 101
 network 192.168.1.0
 network 192.168.2.0
!
no ip classless
no ip http server
!
line con 0
 transport input none
line aux 0
line vty 0 4
 password cisco
 login
!
!
no scheduler allocate
```

Verifying IGRP configuration: SHOW RUN

```
RouterA#show running-config interface fa0/0
Building configuration...

Current configuration:
!
interface FastEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 no ip directed-broadcast
end
```

Verifying IGRP configuration: SHOW IP ROUTE

Command

```
Router> show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2, E-EGP
       i - IS-IS, L1 - IS-IS level 1, L2 - IS-IS level 2
       * - candidate default

Gateway of last resort is not set

    144.253.0.0 is subnetted (mask is 255.255.255.0). 1 subnets
C   144.253.100.0 is directly connected, Ethernet1
I   133.3.0.0 [100/1200] via 144.253.100.200, 00:00:57, Ethernet1
I   153.50.0.0 [100/1200] via 183.8.128.12, 00:00:05, Ethernet0
    183.8.0.0 is subnetted (mask is 255.255.255.128), 4 subnets
I   183.8.0.128 [100/180671] via 183.8.64.130, 00:00:27, Serial1
    [100/180671] via 183.8.128.130, 00:00:27, Serial0
C   183.8.128.0 is directly connected, Ethernet0
C   183.8.64.128 is directly connected, Serial1
C   183.8.128.128 is directly connected, Serial0
I   172.16.0.0 [100/1200] via 144.253.100.1, 00:00:55, Ethernet1
I   192.3.63.0 [100/1300] via 144.253.100.200, 00:00:58, Ethernet1
```

Troubleshooting IGRP

```
RouterA#debug ip igrp events
IGRP event debugging is on

00:21:38: IGRP: sending update to 255.255.255.255
via FastEthernet0/0 (192.168.1.1)
00:21:38: IGRP: Update contains 0 interior, 2
system, and 0 exterior routes.
00:21:38: IGRP: Total routes in update: 2
00:21:38: IGRP: sending update to 255.255.255.255
via Serial0/0 (192.168.2.1)
00:21:38: IGRP: Update contains 0 interior, 1
system, and 0 exterior routes.
00:21:38: IGRP: Total routes in update: 1
```

Troubleshooting IGRP

```
RouterA#debug ip igrp transactions
IGRP protocol debugging is on

00:22:17: IGRP: received update from 192.168.2.2
on Serial0/0
00:22:17:    network 192.168.3.0, metric 80135
(neighbor 110)
00:23:07: IGRP: sending update to 255.255.255.255
via FastEthernet0/0 (192.168.1.1)
00:23:07:    network 192.168.2.0, metric=80125
00:23:07:    network 192.168.3.0, metric=80135
00:23:07: IGRP: sending update to 255.255.255.255
via Serial0/0 (192.168.2.1)
00:23:07:    network 192.168.1.0, metric=110
```

Summary

- *Routing table updates occur periodically, when yhe topology in a distance vector protocol network changes.*
- *RIP is a distance vector routing protocol.*
- *RIP has evolved over the years from classful routing protocol, RIP Version 1 (RIP v1), to a classless routing protocol, RIP Version 2 (RIP v2).*
- *IGRP is a distance vector routing protocol developed by Cisco.*

Q&A

Enjoy the Course