

IP Routing 101

Presented by:
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About Me

- Been breaking routers since about 1995
- Been fixing these breaks since about 1996
- Been breaking switches since 1998
- Started fixing those much faster ...

About Us

- First SCCUG Meeting was June 1999 – but it was not a REAL meeting
- Second Meeting was July 1999, and Robert and I were there!
- While Robert and I present a lot ... there is room for more!!!



Terms for the Evening

RIB – Routing Information Base, another term for routing table.

FIB – Forwarding Information Base, built off the RIB, used in packet switching (CEF)

EIGRP – A distance vector protocol, called a hybrid

OSPF – A common link-state protocol.

BGP – External protocol, popular for ISP redundancy and MPLS

Static Route – A manually entered route

Terms for the Evening

Administrative Distance – How believable a routing protocol is to the router – the lower the number the better.

Distance Vector – A type of routing protocol which knows about networks solely based on what neighbors tell them – also called “routing by rumor”.

Link State – A type of routing protocol which receives updates flooded through an area and then builds a “map of the network” with itself in the center.

What is a Route?

- A route is the prefix you are trying to reach – it is destination based!
- If the routes overlap, the most specific one always wins.
- If they are the same length, then Administrative Distance wins.

List of common AD's:

Connected = 0

Static = 1

eBGP = 20

EIGRP = 90/170

OSPF = 110

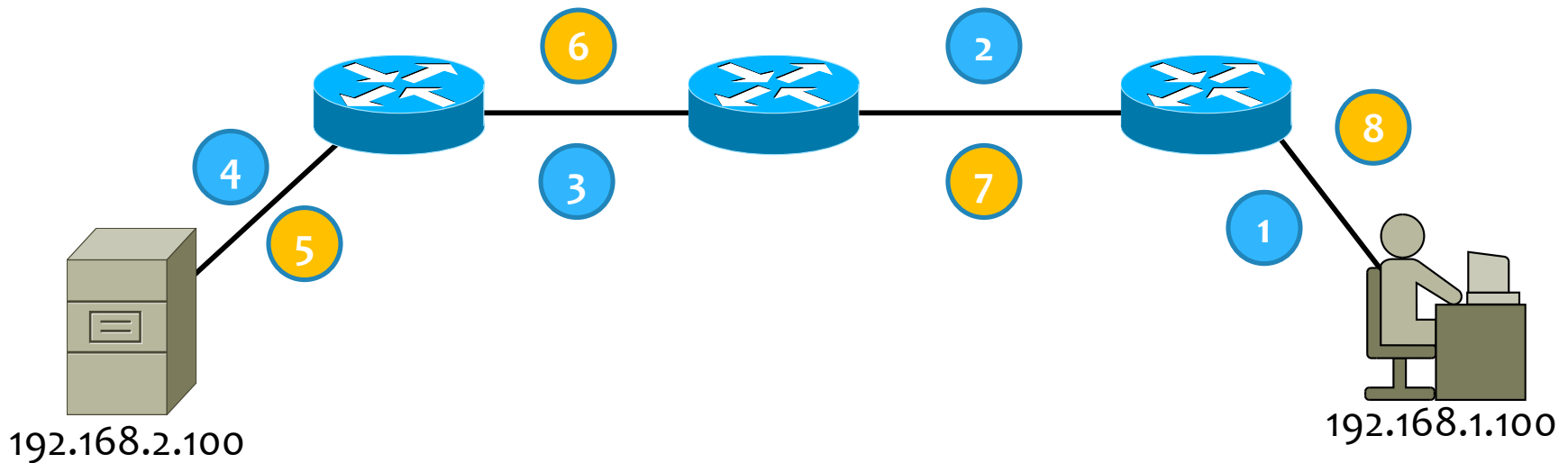
IBGP = 200

Is it a routing issue?

A client calls in and says “Exchange is down” – how do we determine if it is a routing issue?

- What is the client’s IP
- What is the Exchange server’s IP
- What is the path from client to server
- What is the path from server to client

Is it a routing issue?



In routing, we care more about if 192.168.1.0 can get to/from 192.168.2.0 more than can two hosts communicate!

The Greatest Command in History?

R1#sh ip route

Codes: **C** - connected, **S** - static, **R** - RIP, **M** - mobile, **B** - BGP

D - EIGRP, **EX** - EIGRP external, **O** - OSPF, **IA** - OSPF inter area

N1 - OSPF NSSA external type 1, **N2** - OSPF NSSA external type 2

E1 - OSPF external type 1, **E2** - OSPF external type 2

i - IS-IS, **su** - IS-IS summary, **L1** - IS-IS level-1, **L2** - IS-IS level-2

ia - IS-IS inter area, ***** - candidate default, **U** - per-user static route

o - ODR, **P** - periodic downloaded static route

Gateway of last resort is 10.100.60.1 to network 0.0.0.0

D EX 127.201.228.240 [170/4864] via 10.100.60.1, 2w1d, GigabitEthernet0/0

10.0.0.0/8 is variably subnetted, 309 subnets, 6 masks

D 10.100.110.0/25

[90/297252232] via 10.100.60.3, 14:07:08, GigabitEthernet0/0

D 10.100.108.0/25

[90/297252232] via 10.100.60.3, 09:10:03, GigabitEthernet0/0

What Makes a Routing Table?

RIB:

- Routing protocols create a routing table
- Connected networks and static networks count in the RIB

FIB:

- The router builds this RIB and then uses it to populate a forwarding table
- Each interface knows how to properly switch the packet
- Solely built by entries from the RIB

EIGRP - Introduction

This is probably the most common dynamic routing protocol you will run into.

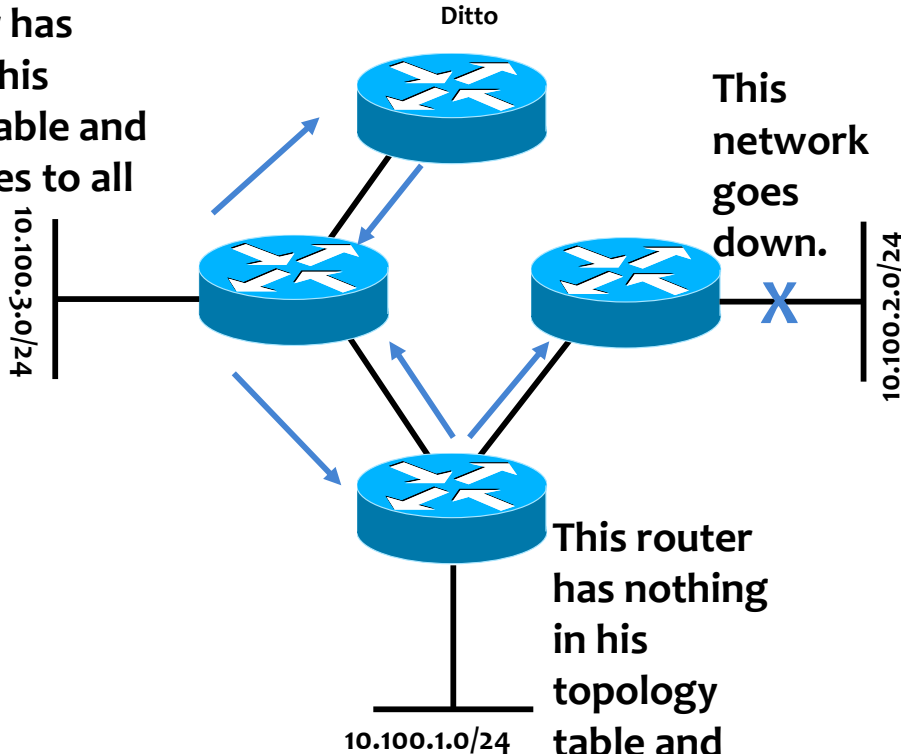
- Distance Vector
- Partial Updates
- Flash Updates
- Topology Table
- Bandwidth/Delay Metric

EIGRP - Introduction

- EIGRP runs under an engine called DUAL. DUAL can be very fast at converging, however, as a network grows, it becomes CRITICAL to design around some of the limitations of DUAL.
- When DUAL needs to converge, it floods an update out of all it's EIGRP interfaces to its neighbors. They in turn flood out their interfaces, etc.
- EIGRP utilizes a topology table, and if a network is “lost” it can look to its own topology table first before sending any queries at all.

EIGRP - Flooding

This router has nothing in his topology table and send queries to all neighbors.



This router has nothing in his topology table and send queries to all neighbors.

This is all fairly inefficient as there IS no other path to the missing network. We could BOUND a query by using techniques like:

- Summarization
- Stub Routing
- a new EIGRP process

EIGRP - Sample

```
router eigrp 100
```

This is the EIGRP
Autonomous System
Number and the router-id.

```
eigrp router-id 172.20.0.6
```

Let's make it
classless!

```
no auto-summary
```

```
eigrp log-neighbor-changes
```

We want to know if a
neighbor goes up/down

```
network 10.1.100.0 0.0.0.255
```

```
network 172.18.100.0 0.0.0.3
```

```
network 172.18.101.1 0.0.0.0
```

Specific Network
Statements

EIGRP – Wrap Up

- EIGRP is about the fastest protocol
- Spend the time to design it upfront in all but the smallest networks.
- Want to learn more?
 - Variance
 - Feasibility (successor, condition, distance)
 - VRF
 - Summarization
 - Authentication

OSPF - Introduction

- OSPF is a link state protocol. It is a very scalable protocol and feature rich. It is most likely the only link-state protocol you will run into.
- It is a fair bit more complex than the default EIGRP design, but it is also more scalable than the default EIGRP design.
- An Autonomous System is a group of routing devices that administratively have common management
- An Area is specific to OSPF and a group of Area's make up an OSPF AS.
- One area is very special, this is Area 0 which is also called the backbone.

OSPF - Introduction

There are a number of special cases for routers and areas in OSPF, they are:

- Area Router
- Backbone Router
- Area Border Router (ABR)
- Autonomous System Boundary Router (ASBR)
- Stub Area
- Totally Stubby Area
- Not so Stubby Area

OSPF - Roles

OSPF – Roles and Responsibilities

ASBR –

This router is bringing in default route from BGP (another AS).



Area 1



ABR –

This router is in Areas 0, 1 and 2. Note an ABR is always in Area 0 since all other areas connect to Area 0.



Area 0



Backbone Router –

This router is only in Area 0.



Area 2



Totally Stubby/Stubby –

We could easily make Area 2 either a Stubby Area or a Totally Stubby.

OSPF – Routing Behavior

Due to the creation of areas, you can have:

- Intra-area routes
- Inter-area routes
- External routes

Keep a few rules in mind:

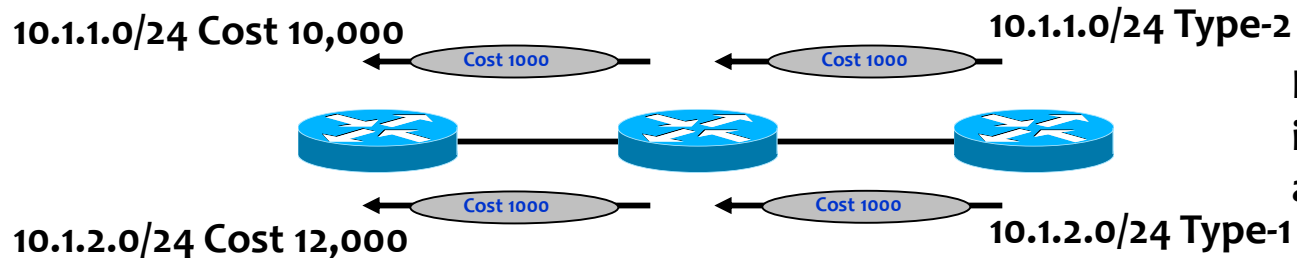
- A route will stay Intra-area as long as possible.
- Within an Area, the protocol is truly link-state, outside the Area, it is distance vector like.
- Summary's are typically sent INTO the backbone.

OSPF – External Routes

There are two types of external routes in OSPF, aptly named Type-1 and Type-2.

Internal routes are always preferred over External ones

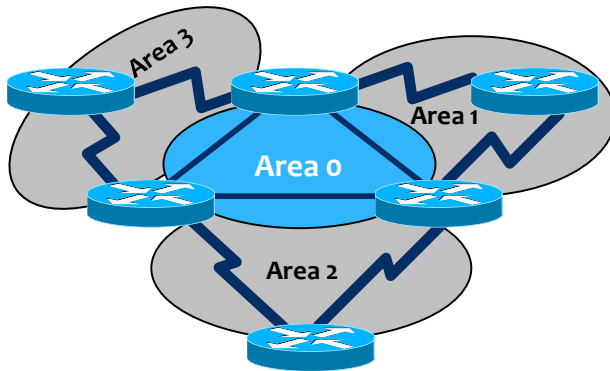
Type-1 are always preferred over Type-2 – which comes in quite handy at times.



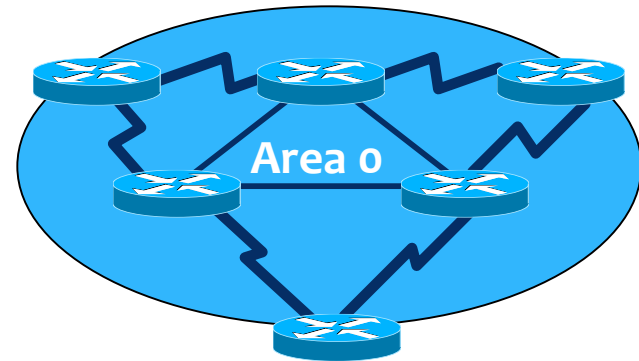
Each of these routes is initially introduced with a cost of 10,000.

OSPF – Area 0

Area 0 must be contiguous, even during breaks. You should not have a situation where the failure of a link leaves you with two Backbones.



Good Area 0 Design



Bad Area 0 Design

OSPF - Sample

```
router ospf 100
```

This is the OSPF Autonomous System Number and the router-id.

```
router-id 172.20.1.1
```

```
network 172.20.1.1 0.0.0.0 area 0.0.0.0
```

```
network 10.1.100.0 0.0.0.255 area 0.0.0.0
```

Add in our network statements. These should be specific.

```
network 10.1.200.0 0.0.0.3 area 1.1.1.1
```

```
area 1.1.1.1 stub
```

Define any Area specific commands such as Stub

OSPF – Wrap Up

- Not as fast, but very scalable and standards based
- Requires design UPFRONT

If you want to know more, at a minimum learn about:

- Virtual Links
- Internal Summarization
- External Summarization
- LSA Types/Flooding behavior
- Authentication

Design Guidelines

- Build so you CAN scale and CAN support advanced features, don't necessarily add them.
- Lock any protocol down with a Router ID that you can, be deterministic on these things when possible.
- I like to use different major networks for data networks (voice, data, servers) and administrative networks (loopbacks, point-to-points, etc.).
- Always dynamically route when you can!

Thank You!