CompTIA Network+ Exam N10-008

Lesson 7

Configuring and Troubleshooting Routers

Objectives

- Compare and contrast routing concepts
- Compare and contrast dynamic routing concepts
- Install and troubleshoot routers

Lesson 7

Topic 7A

Compare and Contrast Routing Concepts

Routing Tables and Path Selection

- Protocol
  - Source of the route
- Destination
  - Network/host address and prefix
- Interface
  - Outgoing interface
- Gateway/next hop
  - Address of next router along the path

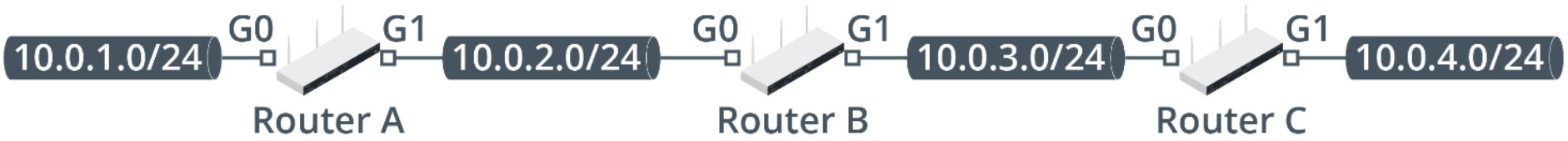
```
vyos@vyos:~$ show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR, f - OpenFabric,
       > - selected route, * - FIB route, q - queued route, r - rejected route

C>* 10.0.0.2/32 is directly connected, lo, 00:06:52
S>* 10.0.1.0/24 [1/0] via 10.0.2.254, eth0, 00:02:26
C>* 10.0.2.0/24 is directly connected, eth0, 00:02:26
C>* 10.0.3.0/24 is directly connected, eth1, 00:06:51
S>* 10.0.4.0/24 [1/0] via 10.0.3.254, eth1, 00:06:49
```

Static and Default Routes

- Categories of routing table entries
  - Directly connected
  - Paths to remote networks
  - Host routes
  - Default route
- Directly connected routes
  - IP network/subnet for each active interface
- Static routes
  - Added manually by administrator
- Default route
  - Static route used if no other match
  - 0.0.0.0/0 or ::/0

Routing Table Example

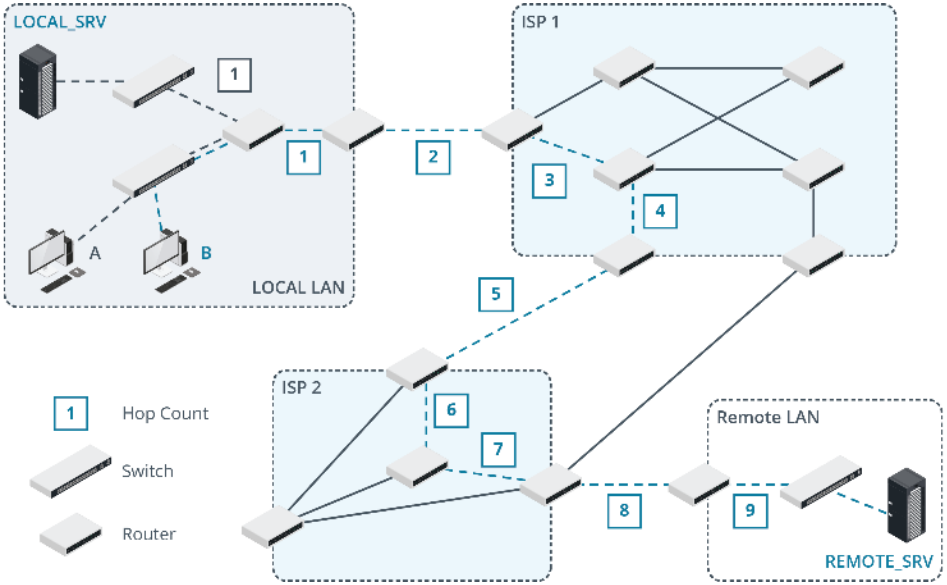
Router B Routing Table		
Network	**Interface**	**Source**
10.0.1.0/24	G0	Static
10.0.2.0/24	G0	Connected
10.0.3.0/24	G1	Connected
10.0.4.0/24	G1	Static



Router A Routing Table		
Network	**Interface**	**Source**
10.0.1.0/24	G0	Connected
10.0.2.0/24	G1	Connected
10.0.3.0/24	G1	Static
10.0.4.0/24	G1	Static

Router C Routing Table		
Network	**Interface**	**Source**
0.0.0.0/0	G0	Static
10.0.3.0/24	G0	Connected
10.0.4.0/24	G1	Connected

Packet Forwarding



- Encapsulation for interface data link protocol
- Hop count
- Time to Live (TTL)

Fragmentation

- IP is unreliable, connectionless delivery mechanism
- Packets might be lost, delivered out of sequence, duplicated, or delayed
- ID, flags, and fragment offset fields record sequence and fragmentation
  - Fragmentation to fit layer 2 frame maximum transmission unit (MTU)
  - MTU path discovery

Review Activity: Routing Concepts

- Routing Tables and Path Selection
- Static and Default Routes
- Routing Table Example
- Packet Forwarding
- Fragmentation

Lab Activity

Assisted Lab: Configure Static Routing

- Lab types
  - Assisted labs guide you step-by-step through tasks
  - Applied labs set goals with limited guidance
- Complete lab
  - Submit all items for grading and check each progress box
  - Select “Grade Lab” from final page
- Save lab
  - Select the hamburger menu and select “Save”
  - Save up to two labs in progress for up to 7 days
- Cancel lab without grading
  - Select the hamburger menu and select “End”

Lesson 7

Topic 7B

Compare and Contrast Dynamic Routing Concepts

Dynamic Routing Protocols

- Build routing information base
- Share information with other routers (learned routes)
- Topology and metrics
  - Distance vector versus link state
  - Metrics assess similar routes for use of least-cost path in IP routing table
  - Algorithm determines nature of metrics
- Convergence
  - All routers agree on network topology

Interior versus Exterior Gateway Protocols

- Interior Gateway Protocol (IGP)
  - Routing within an autonomous system (AS)
- Exterior Gateway Protocol (EGP)
  - Routing between autonomous systems
- Classless versus classful protocols
- IPv6 support

Protocol	Type	Class	Transport
Routing Information Protocol (RIP)	Distance Vector	IGP	UDP (port 520 or 521)
Enhanced Interior Gateway Routing Protocol (EIGRP)	Distance Vector/Hybrid	IGP	Native IP (88)
Open Shortest Path First (OSPF)	Link State	IGP	Native IP (89)
Border Gateway Protocol (BGP)	Path Vector	EGP	TCP (port 179)

Routing Information Protocol (Slide 1 of 2)

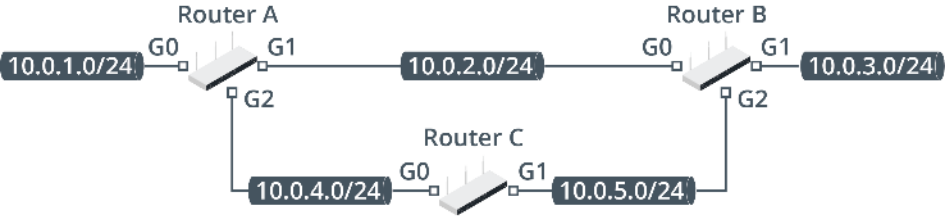
- Distance vector
  - Next hop (vector)
  - Hop count (distance)
- Slow convergence and inefficient updates
- Maximum hop count of 15

Router B Routing Table			
Network	Interface	Metric	Source
10.0.1.0/24	G0	1	RIP
10.0.2.0/24	G0	0	Connected
10.0.3.0/24	G1	0	Connected
10.0.4.0/24	G1	1	RIP

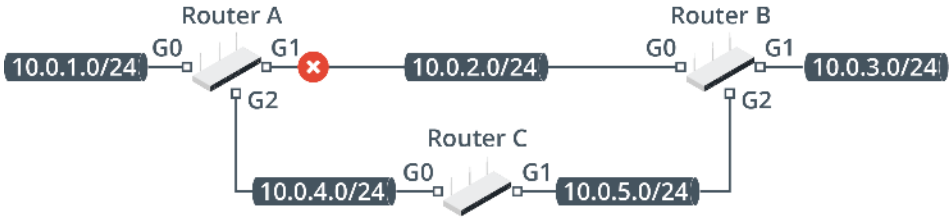
Router A Routing Table			
Network	Interface	Metric	Source
10.0.1.0/24	G0	0	Connected
10.0.2.0/24	G1	0	Connected
10.0.3.0/24	G1	1	RIP
10.0.4.0/24	G1	2	RIP

Router C Routing Table			
Network	Interface	Metric	Source
10.0.1.0/24	G0	2	RIP
10.0.2.0/24	G0	1	RIP
10.0.3.0/24	G0	0	Connected
10.0.4.0/24	G1	0	Connected

Routing Information Protocol (Slide 2 of 2)



Router A Routing Table				
Network	Interface	Metric	Via	Source
10.0.1.0/24	G0	0		Connected
10.0.2.0/24	G1	0		Connected
10.0.2.0/24	G2	2	10.0.4.0	RIP
10.0.3.0/24	G1	1	10.0.2.0	RIP
10.0.3.0/24	G2	2	10.0.4.0	RIP
10.0.4.0/24	G2	0		Connected
10.0.5.0/24	G1	2	10.0.2.0	RIP
10.0.5.0/24	G2	1	10.0.4.0	RIP



Router A Routing Table				
Network	Interface	Metric	Via	Source
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10.0.2.0/24	G1	0		Connected
10.0.2.0/24	G2	2	10.0.4.0	RIP
10.0.3.0/24	G1	1	10.0.2.0	RIP
10.0.3.0/24	G2	2	10.0.4.0	RIP
10.0.4.0/24	G2	0		Connected
10.0.5.0/24	G1	2	10.0.2.0	RIP
10.0.5.0/24	G2	1	10.0.4.0	RIP

RIP Versions

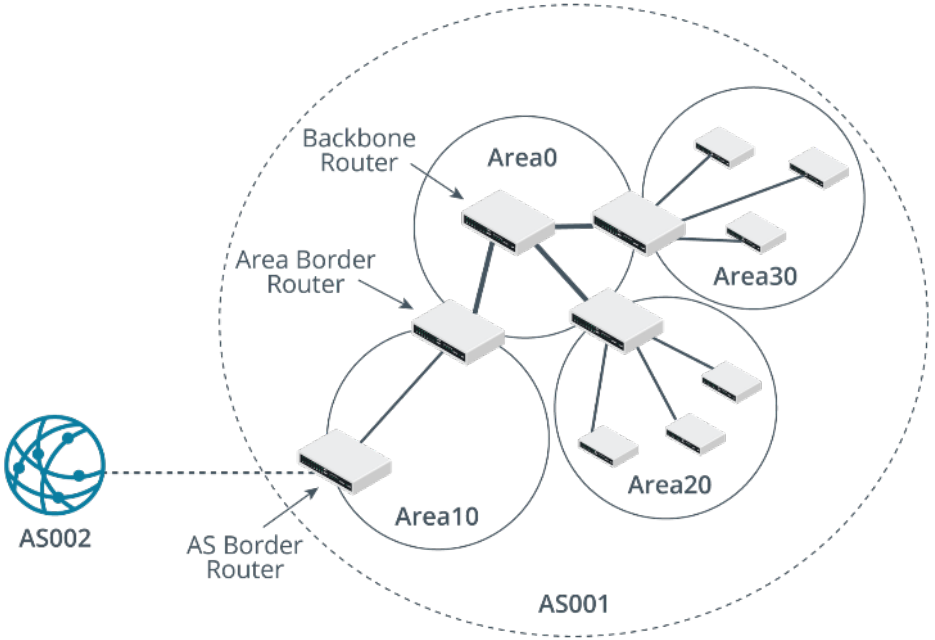
- RIPv1
  - Classful and uses broadcasts over UDP/520
- RIPv2
  - Classless and uses more efficient multicasts
- RIPng
  - IPv6 support over UDP/521

Enhanced Interior Gateway Routing Protocol

- Update to Interior Gateway Protocol to support classless addressing
- Advanced distance vector/hybrid with administrator weighted metric
  - Bandwidth
  - Delay
- Best convergence performance
- Runs over IP directly (protocol number 88) using multicasts

Open Shortest Path First

- Link state interior gateway protocol suited to complex private networks
- Group related networks by area hierarchy
- Supports classless addressing
- Runs over IP directly (protocol number 89) using multicasts



Border Gateway Protocol

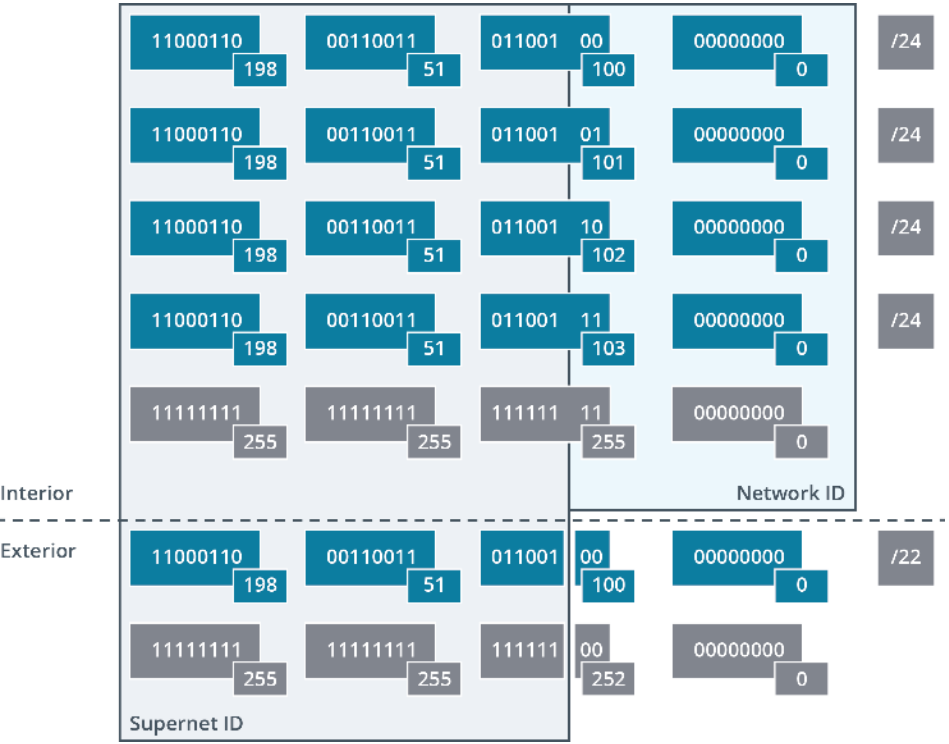
- Classed as hybrid or path vector
- Usually deployed as an Exterior Gateway Protocol
- Supports routing on the Internet
  - Autonomous Systems (ASes) hide internal network complexity from Internet routers
  - Autonomous System Number (ASN)
  - BGP routers exchange AS path data between Autonomous Systems
- Supports classless addressing
- Runs over TCP on port 179

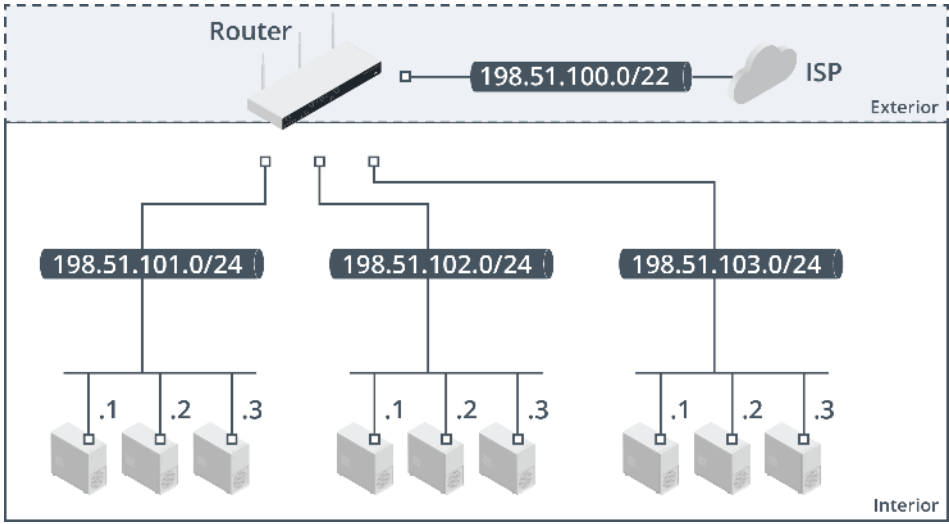
Administrative Distance

Source	AD
Local interface/Directly connected	0
Static route	1
BGP	20
EIGRP	90
OSPF	110
RIP	120
Unknown	255

- Longer prefixes preferred for path selection
- Protocols add one route per destination prefix to global IP routing table
- Routing protocol uses metric to determine least-cost path
- Router uses administrative distance to prefer paths to same destination learned by different protocols

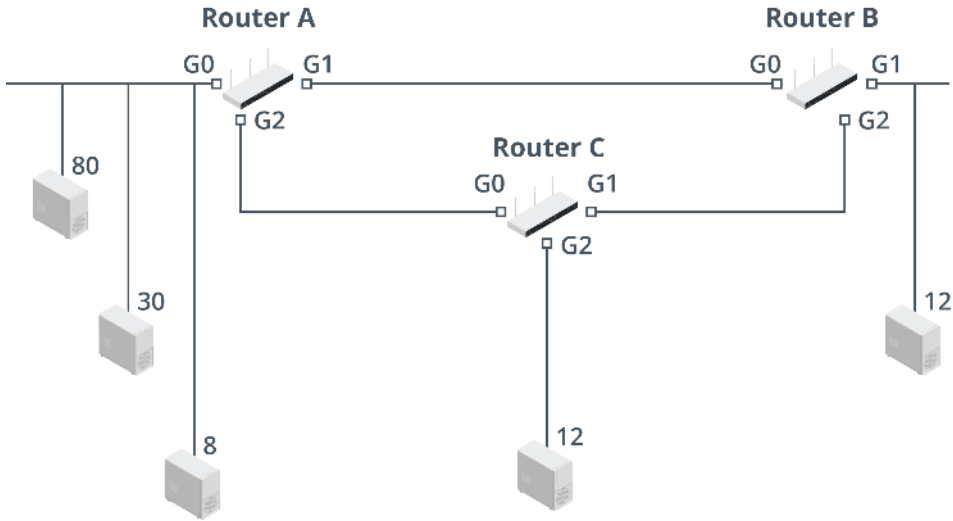
Classless Inter-Domain Routing





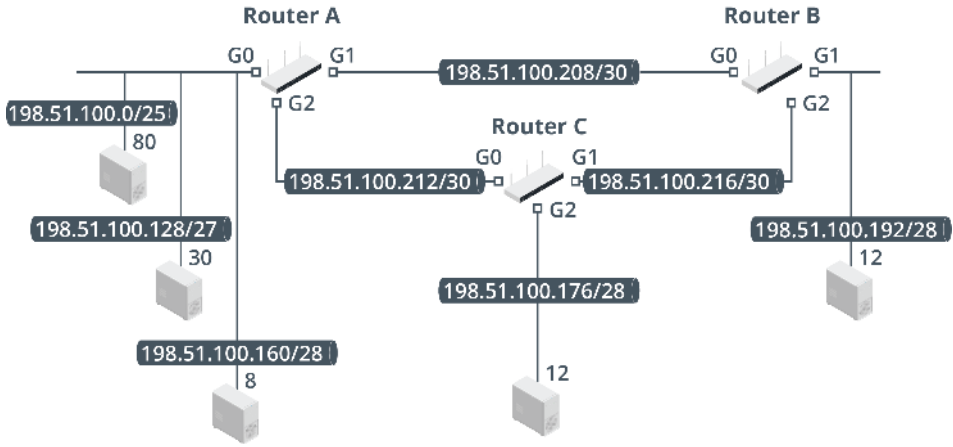
Variable Length Subnet Masks

- Use address space in IPv4 network more efficiently
- Rather than use the same mask for all subnets, use different mask lengths according to host numbers per subnet



VLSM Design

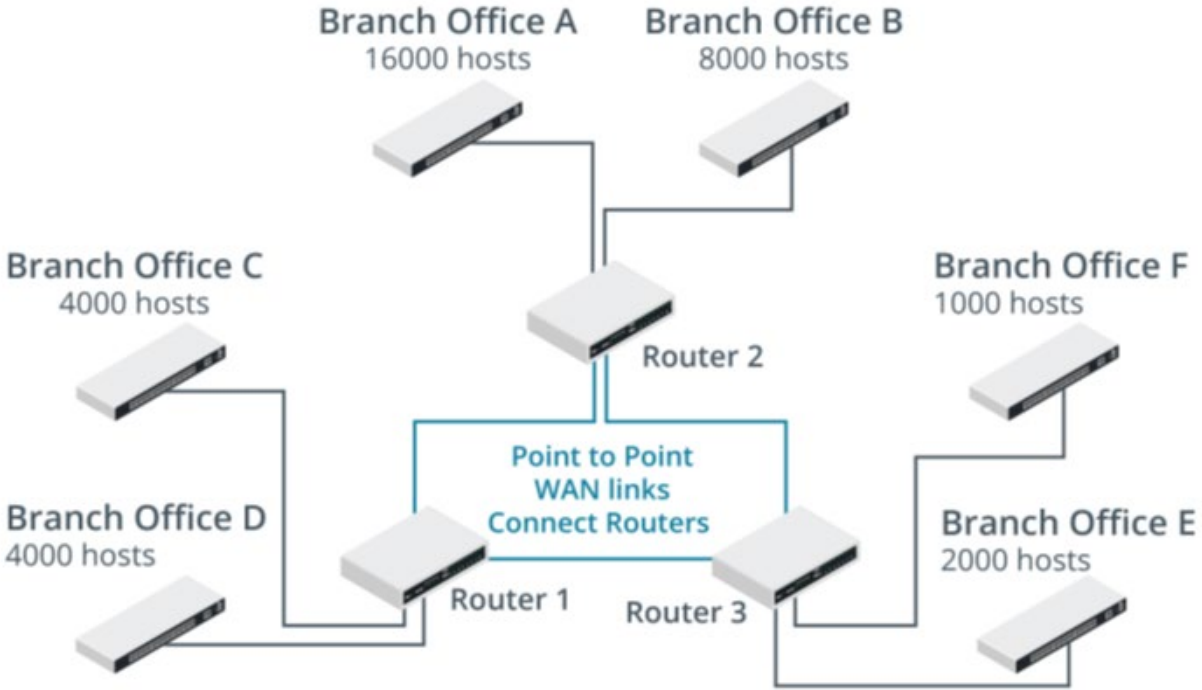
Office/Subnet	Required Number of IP Addresses	Mask Bits	Actual Number of IP Addresses	Prefix
Main Office 1 (Router A)	80	7	126	/25
Main Office 2 (Router A)	30	5	30	/27
Main Office 3 (Router A)	8	4	14	/28
Branch Office (Router B)	12	4	14	/28
Branch Office (Router C)	12	4	14	/28
Router A – Router B	2	2	2	/30
Router A – Router C	2	2	2	/30
Router B – Router C	2	2	2	/30



Review Activity: Dynamic Routing Concepts

- Interior versus Exterior Gateway Protocols
- Routing Information Protocol
- RIP Versions
- Enhanced Interior Gateway Routing Protocol
- Open Shortest Path First
- Border Gateway Protocol
- Administrative Distance
- Classless Inter-Domain Routing
- Variable Length Subnet Masks and VLSM Design

Review Activity: Design VLSM Subnets



Lab Activity

Assisted Lab: Configure Dynamic Routing

- Lab types
  - Assisted labs guide you step-by-step through tasks
  - Applied labs set goals with limited guidance
- Complete lab
  - Submit all items for grading and check each progress box
  - Select “Grade Lab” from final page
- Save lab
  - Select the hamburger menu and select “Save”
  - Save up to two labs in progress for up to 7 days
- Cancel lab without grading
  - Select the hamburger menu and select “End”

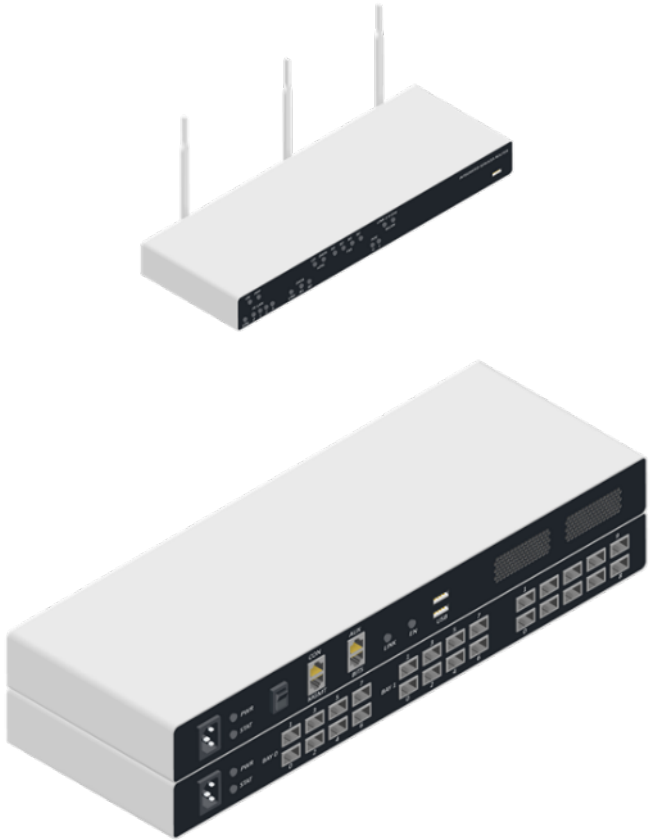
Lesson 7

Topic 7C

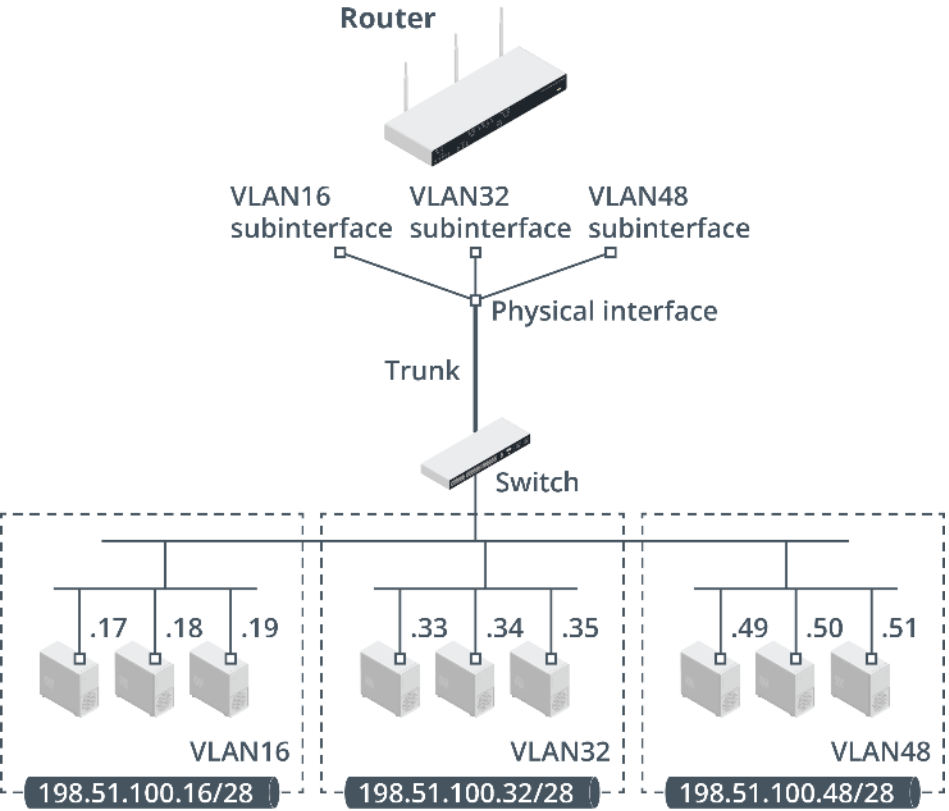
Install and Troubleshoot Routers

Edge Routers

- Placement
  - Hosts in same IP network/subnet must not be separated by a router
  - Hosts in different IP networks/subnets must be separated by router
- Edge routers on network perimeter
  - Customer edge (CE) to provider edge (PE)
  - L1/L2 type (metro-optical, leased line, DSL, cable)
- SOHO-class routers versus enterprise routers



Internal Routers



- Implement subnets and internal borders/areas
- Subinterfaces
  - Split single physical connection to per-VLAN subinterfaces
- Layer 3 switches
  - Hardware optimized to forward between VLANs

Router Configuration

- Management interface
  - Console port
  - Loopback interface
- Configure router interfaces
  - IP configuration
  - L2 configuration
- Configure static routes and routing protocols
- show route

```
vyos@vyos:~$ conf
[edit]
vyos@vyos# set protocols rip interface eth0
[edit]
vyos@vyos# set protocols rip interface eth1
[edit]
vyos@vyos# set protocols rip redistribute connected
[edit]
vyos@vyos# commit && save && exit
Saving configuration to '/config/config.boot'...
Done
exit
vyos@vyos:~$ show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

     Network            Next Hop         Metric From            Tag Time
R(n) 10.0.0.1/32        10.0.2.254            2 10.0.2.254        0 02:57
C(r) 10.0.0.2/32        0.0.0.0               1 self              0
R(n) 10.0.1.0/24        10.0.2.254            2 10.0.2.254        0 02:57
C(i) 10.0.2.0/24        0.0.0.0               1 self              0
C(i) 10.0.3.0/24        0.0.0.0               1 self              0
```

route

```
PS C:\Windows\system32> route print
===========================================================================
Interface List
  9...00 15 5d 00 65 31 ......Microsoft Hyper-V Network Adapter
  1...........................Software Loopback Interface 1
===========================================================================

IPv4 Route Table
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0      10.1.24.254      10.1.24.101     15
       10.1.24.0    255.255.255.0         On-link       10.1.24.101    271
     10.1.24.101  255.255.255.255         On-link       10.1.24.101    271
     10.1.24.255  255.255.255.255         On-link       10.1.24.101    271
       127.0.0.0        255.0.0.0         On-link         127.0.0.1    331
       127.0.0.1  255.255.255.255         On-link         127.0.0.1    331
  127.255.255.255  255.255.255.255         On-link         127.0.0.1    331
       224.0.0.0        240.0.0.0         On-link         127.0.0.1    331
       224.0.0.0        240.0.0.0         On-link       10.1.24.101    271
  255.255.255.255  255.255.255.255         On-link         127.0.0.1    331
  255.255.255.255  255.255.255.255         On-link       10.1.24.101    271
===========================================================================
Persistent Routes:
  None

IPv6 Route Table
===========================================================================
Active Routes:
 If Metric Network Destination      Gateway
  9     31 ::/0                     fe80::215:5dff:fe00:6510
  1    331 ::1/128                  On-link
  9     31 fdf0:2413:6d1c:30::/64   On-link
  9    271 fdf0:2413:6d1c:30:997b:634e:5b90:7e/128
                                    On-link
```

- Troubleshoot Windows and Linux hosts
- Verify default gateway
- Add static route

tracert and traceroute

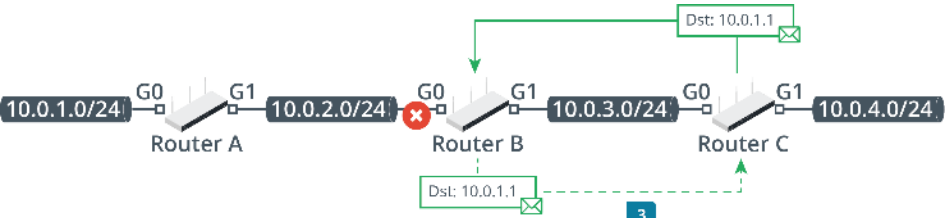
- traceroute
  - UDP probes to identify each hop in a path
  - Increments TTL with each iteration
  - Outputs number of hops, the IP address of the ingress interface of the router or host, and time taken in milliseconds (ms)
- tracert
  - Windows
  - Uses ICMP

```
PS C:\Windows\system32> tracert 203.0.113.33

Tracing route to 203.0.113.33 over a maximum of 30 hops

  1    <1 ms    <1 ms    <1 ms  10.1.24.254
  2    <1 ms    <1 ms    <1 ms  10.1.128.253
  3     1 ms     *        1 ms  198.51.100.30
  4     1 ms     1 ms     1 ms  198.51.100.253
  5     2 ms     2 ms     1 ms  203.0.113.33

Trace complete.
```

Missing Route Issues

- Use ping and traceroute/tracert to identify where network path fails
- Check routing table
  - Missing static route
  - Dynamic protocol failure
- Device configuration review

Routing Loop Issues



Interface G0 on Router B goes down, so it removes routes that use that interface from its routing table.

1

Router B Routing Table

Network	Interface	Metric	Source
10.0.1.0/24	G0	1	RIP
10.0.1.0/24	G1	3	RIP
10.0.2.0/24	G0	0	Connected
10.0.2.0/24	G1	2	RIP
10.0.3.0/24	G1	0	Connected
10.0.4.0/24	G1	1	RIP

Router C Routing Table

Network	Interface	Metric	Source
10.0.1.0/24	G0	2	RIP
10.0.2.0/24	G0	1	RIP
10.0.3.0/24	G0	0	Connected
10.0.4.0/24	G1	0	Connected

2

Router C provides an update to Router B with routes to the missing networks.

3

When Router C tries to send a packet to 10.0.1.0/24 via G0, Router B routes the packet back as according to its routing table, Router C is the next hop interface for 10.0.1.0/24. A loop forms.

4

This loop would be prevented by split horizon. Router C learned the routes to 10.0.1.0/24 and 10.0.2.0/24 from Router B and so should not advertise them back.

- Incorrect path information causes packet to circulate until TTL is exhausted
- Use traceroute to diagnose

Asymmetrical Routing Issues

- Return path different to forward path
- Issues
  - Inconsistent latency
  - Security appliances dropping return packets
- Analyze traceroute output and investigate routing tables

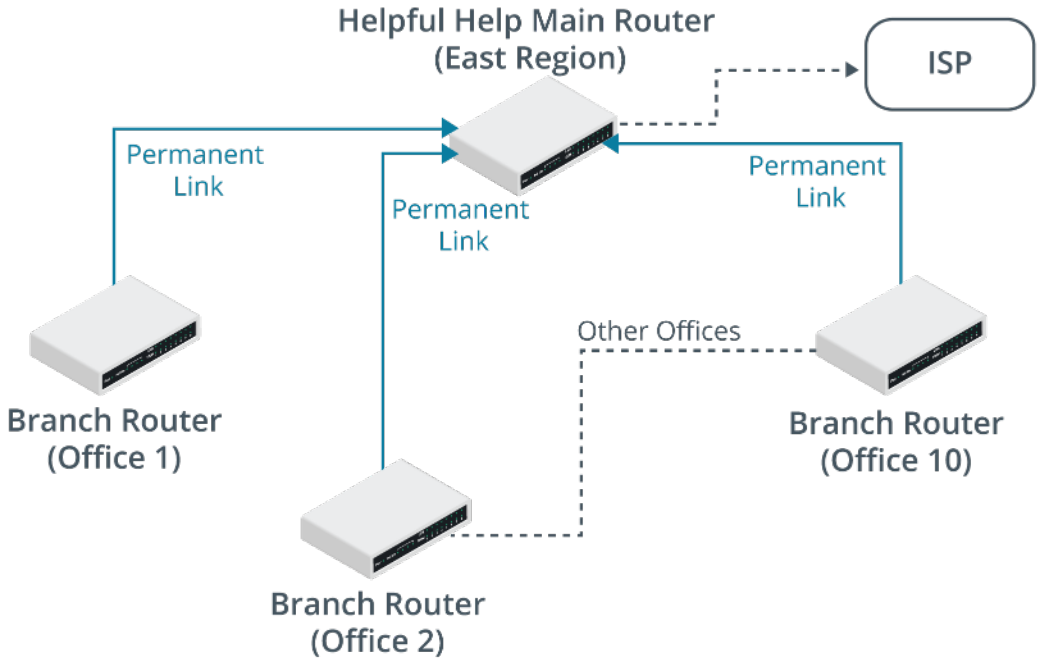
Low Optical Link Budget Issues

- Consider PHY/data link layer issues when routing across WANs
- Poor connectivity across fiber link
- Loss budget expresses amount of loss from attenuation, connectors, and splices measured in dB
- Loss budget must be less than power budget (transceiver transmit power and receive sensitivity)

Review Activity: Router Installation and Troubleshooting

- Edge Routers
- Internal Routers
- Router Configuration
- route
- tracert and traceroute
- Missing Route Issues
- Routing Loop Issues
- Asymmetrical Routing Issues
- Low Optical Link Budget Issues

Review Activity: Design a Branch Office Internetwork



Lab Activity

Applied Lab: Troubleshoot IP Networks (Parts A and B)

- Lab types
  - Assisted labs guide you step-by-step through tasks
  - Applied labs set goals with limited guidance
- Complete lab
  - Submit all items for grading and check each progress box
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Summary