ENCS4130 Computer Networks Laboratory

EXP#5 Dynamic Routing 3 (Path Vector) Border Gateway Protocol (BGP)

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Objectives

- Learn how to configure and verify IP routing with Cisco routers.
- Introducing to exterior gateway protocol and interior gateway protocols.
- Introducing to Autonomous systems.
- Dynamic routing BGP.





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Introduction





Border Gateway Protocol (BGP) Overview

- **Type:** Exterior Gateway Protocol (EGP), unlike IGPs (RIP, OSPF, EIGRP).
- **Purpose:** Routes between Autonomous Systems (AS), not within an AS.
- Routing Method: Path Vector protocol using AS Path and other attributes (not metrics like distance or cost).
- Internet Backbone: The Internet is made up of interconnected AS's using BGP.
- Autonomous System Numbers (ASN):
 - Range: 1 65535.
 - Private ASN Range: 64512 65535.





When to Use BGP

• BGP Not Always Needed:

- IGPs (OSPF, EIGRP) can handle fault tolerance for outbound traffic.
- Single Internet connection doesn't require BGP.

• Use BGP When:

- Multiple connections to external AS's via different providers.
- Multiple connections to external AS's through the same provider but separate routing policies or CO.
- Routing equipment can handle the extra load.

• BGP's Main Benefit:

- Controls incoming traffic to a local AS (not outgoing).
- BGP Configuration Command:
 - Router(config)# router bgp <AS-NUMBER>

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BGP Peers/Neighbours

- BGP Peers: Routers must form neighbour relationships (peers) to exchange routing information.
 - iBGP Peers: Neighbours within the same Autonomous System (AS).
 - eBGP Peers: Neighbours between different Autonomous Systems.
- BGP Administrative Distance (AD):
 - eBGP Routes: AD = 20.
 - iBGP and Local Routes: AD = 200.
- Routing Information Sharing:
 - Full routing table shared initially.
 - Only routing updates are sent after the initial exchange.
- eBGP Peer Configuration:

- Router(config-router)# neighbor <IP-ADDRESS-NEXT-INTERFACE> remote-as <AS-OF-REMOTE-NEIGHBOR> STUDENTS-HUB.com Uploaded By: an only not



BGP Peers/Neighbours (Cont.)

- Example:
 - **iBGP:** Routers 1, 2, 3, and 4 in AS 200.
 - eBGP: Router0 (AS 100) and Router5 (AS 200).





BGP Peer Communication Messages

Message Type	Purpose	Details
OPEN	Initiates session between BGP peers.	Contains: BGP Version, Local AS Number, and BGP Router ID.
KEEPALIVE	Ensures peers are still available.	Sent every 60 seconds (default). Hold-time is 180 seconds (default).
UPDATE	Exchanges routing information between peers.	Used to advertise new routes or withdraw outdated ones.
NOTIFICATION	Signals a fatal error.	Terminates and resets the BGP session.

- Adjust Timers:
 - Router(config)# router bgp <AS-NUMBER>
 - Router(config-router)# timers bgp <KEEP-ALIVE> <HOLD-TIME>

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BGP Finite-State Machine (FSM)

State	Description
ldle	Initial state.
Connect	BGP waits for a TCP connection. Sends OPEN message if successful, otherwise moves to Active.
Active	BGP tries to establish a TCP connection. Sends OPEN message if successful, otherwise retries.
OpenSent	TCP connection established; OPEN message sent, awaiting reply.
OpenConfirm	Waiting for a KEEPALIVE message to confirm the session.
Established	Session fully established. Routes are exchanged via UPDATE messages.

• Troubleshooting Active State:

- Check IP connectivity, neighbour statement, or access-list filtering port 179.





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BGP Finite-State Machine (FSM) Cont.





Procedure



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Topology





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Area 0 / AS 100

Area/AS & BGP Links	Network	Device	Interface	IP	Subnet Mask	Wildcard Mask
Area 0 / AS 100	192.X.0.0/30	Router 0	Se2/0	192.X.0.1	255.255.255.252	0.0.0.3
		Router 1	Se2/0	192.X.0.2	255.255.255.252	0.0.0.3
	192. X.1.0/27	Router 0	Fa0/0	192.X.1.1	255.255.255.224	0.0.0.31
		PC 0	Fa0	192.X.1.2	255.255.255.224	0.0.0.31
	192. X.1.32/27	Router 0	Fa1/0	192.X.1.33	255.255.255.224	0.0.0.31
		PC 1	Fa0	192.X.1.34	255.255.255.224	0.0.0.31
	192. X.1.64/26	Router 1	Fa0/0	192.X.1.65	255.255.255.192	0.0.0.63
		PC 2	Fa0	192.X.1.66	255.255.255.192	0.0.0.63



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Area 0 / AS 200

Area/AS & BGP Links	Network	Device	Interface	IP	Subnet Mask	Wildcard Mask
Area 0 / AS 200	192.X.0.8/30	Router 2	Se3/0	192.X.0.9	255.255.255.252	0.0.0.3
		Router 3	Se2/0	192.X.0.10	255.255.255.252	0.0.0.3
	192.X.1.128/26	Router 2	Fa0/0	192.X.1.129	255.255.255.192	0.0.0.63
		PC 3	Fa0	192.X.1.130	255.255.255.192	0.0.0.63
		PC 4	Fa0	192.X.1.131	255.255.255.192	0.0.0.63
	192.X.1.192/26	Router 3	Fa0/0	192.X.1.193	255.255.255.192	0.0.0.63
		PC 5	Fa0	192.X.1.194	255.255.255.192	0.0.0.63

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BGP Links

Area/AS & BGP Links	Network	Device	Interface	IP	Subnet Mask	Wildcard Mask
BGP Links	192.X.0.4/30	Router 1	Se3/0	192.X.0.5	255.255.255.252	0.0.0.3
		Router 2	Se2/0	192.X.0.6	255.255.255.252	0.0.0.3



Steps of Configurations

- **1.** Configuring OSPF Routing
 - Router(config)# router ospf <PROCESS-ID>
 - Router(config-router)# network <ID-ADDRESS> <WILDCARD-MASK> area <AREA-ID>

2. Configuring BGP Routing

- Router (config)# router bgp <AS-NUMBER>
- Router(config-router)# neighbor <IP-ADDRESS-NEXT-INTERFACE> remote as <AS-OF-REMOTE-NEIGHBOR>







Steps of Configurations (Cont.)

- **3.** Define the BGP Over the OSPF
 - Router(config)# router ospf <PROCESS-ID>
 - Router(config-router)# redistribute bgp <AS-NUMBER> subnets

4. Define the OSPF Over the BGP

- Router(config)# router bgp <AS-NUMBER>
- Router(config-router)# redistribute ospf <PROCESS-ID>







Steps of Configurations (Cont.)

- **5.** Configuring BGP Timers
 - Router(config)# router bgp <AS-NUMBER>
 - Router(config-router)# timers bgp <keepalive-interval> <hold-time>

6. Viewing BGP Neighbors

- Router# show ip bgp
- Router# show ip bgp summary
- Router# show ip route





Verifying the Routing Tables

🖗 Router1 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 N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2 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, ia - IS-IS inter area * - candidate default, U - per-user static route, o - ODR P - periodic downloaded static route Gateway of last resort is not set 192.168.0.0/30 is subnetted, 3 subnets 192.168.0.0 is directly connected, Serial2/0 С С 192.168.0.4 is directly connected, Serial3/0 в 192.168.0.8 [20/20] via 192.168.0.6, 00:00:00 192.168.1.0/24 is variably subnetted, 5 subnets, 2 masks 192.168.1.0/27 [110/65] via 192.168.0.1, 00:00:13, Serial2/0 0 192.168.1.32/27 [110/65] via 192.168.0.1, 00:00:13, Serial2/0 0 С 192.168.1.64/26 is directly connected, FastEthernet0/0 в 192.168.1.128/26 [20/20] via 192.168.0.6, 00:00:00 в 192.168.1.192/26 [20/65] via 192.168.0.6, 00:00:00

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Verifying the Routing Tables (Cont.)

	Router0	_	
	Kouter#		
	Router#		
	Router#		
	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		
	N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2		
	E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP		
	i - IS-IS, Ll - 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 not set		
	192.168.0.0/30 is subnetted, 2 subnets		
	C 192.168.0.0 is directly connected, Serial2/0		
	O E2 192.168.0.8 [110/20] via 192.168.0.2, 00:00:19, Serial2/0		
	192.168.1.0/24 is variably subnetted, 5 subnets, 2 masks		
	C 192.168.1.0/27 is directly connected, FastEthernet0/0		
	C 192.168.1.32/27 is directly connected, FastEthernet1/0		
	0 192.168.1.64/26 [110/65] via 192.168.0.2, 00:00:19, Serial2/0		
	O E2 192.168.1.128/26 [110/20] via 192.168.0.2, 00:00:19, Serial2/0		a ,
	O E2 192.168.1.192/26 [110/20] via 192.168.0.2, 00:00:09, Serial2/0		
	Router#		
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Saving Configurations

• Don't forget to save the configurations on your router.

→ Router# write
→ Router# copy run start





Video explaining the experiment

https://www.youtube.com/watch?v=vldkMhMrl8M&ab_channel=TariqOdeh





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References

• Manual for ENCS4130 Computer Networks Laboratory.

