Routing Protocols
- IUT –

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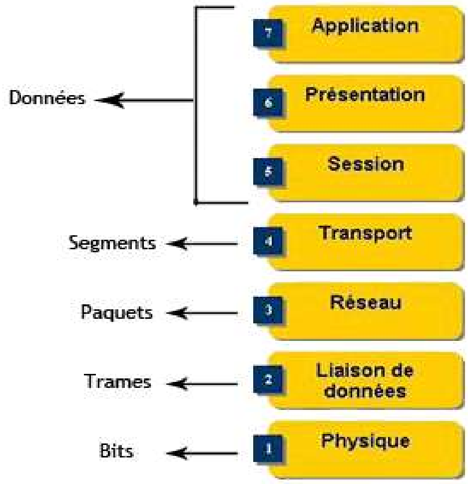
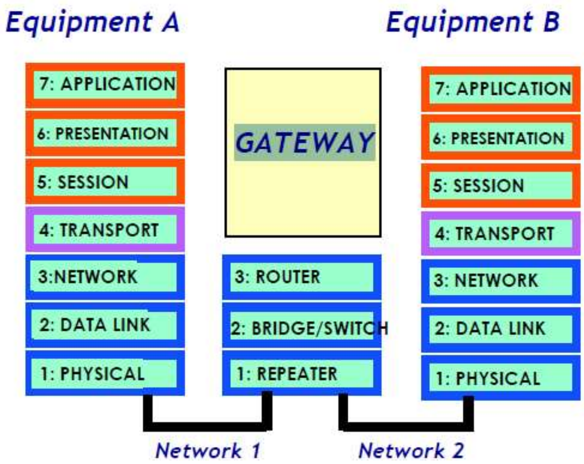
Agenda

- Overview routing
- Routing table vs Forwarding table
- Types of routes: Static vs Dynamic
- Interior Gateway Protocol
- Exterior Gateway Protocol
- Protocol Categories
- IGP's vs EGP's
- OSPF
- BGP
- Annex

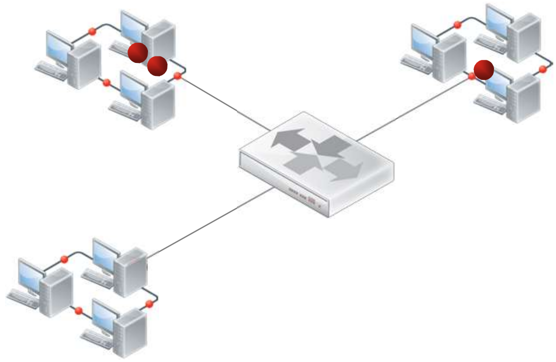
Modele OSI



Router: Layer 3 Device



Routing



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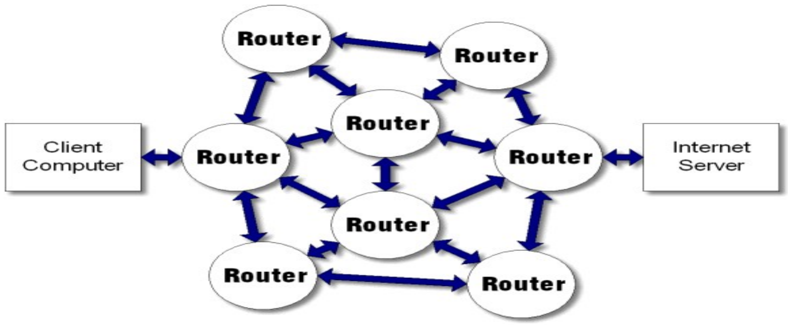
What Is routing

- Routing is the process of moving packets of data between devices on a network from a source to a final destination
  - The destination address is used to determine where the packets must go



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Components of routing

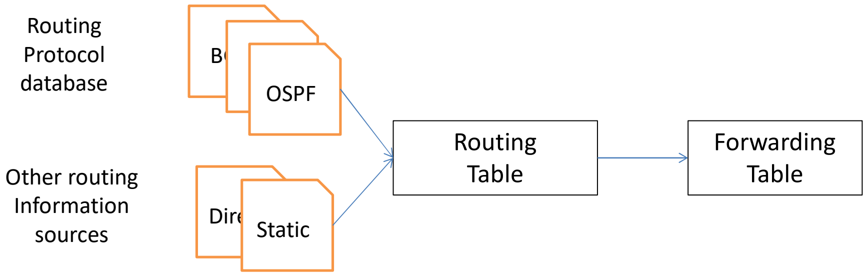
- For device to communicate with another device in remote network, the following requirements exist:
  - End-to-end communications path
  - Routing information on participating Layer 3 device

Overview of routing

- Gateway
  - For any device to communicate with another outside its directly connected subnet, a properly configured gateway is required
  - Router, requires sufficient routing information to determine the proper next hop to sent traffic

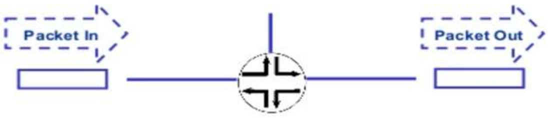
The routing table

- Compiles information learned from routing protocols and other routing information sources
- Selects an active route to each destination
- Populates the forwarding table



Routing Table

- Packet's destination address is for:
  - One of the router's interfaces or a broadcast address
    - Packet is for an internal router process
  - Any other known address
    - Packet must be routed
  - Unknown address
    - Look for default route. If none exists, packet is dropped



Contents of routing table

- Minimum contents of routing table:
  - Destination prefix
  - Next-hop IP address

```
R1#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
       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 not set

     172.31.0.0/16 is variably subnetted, 6 subnets, 2 masks
S       172.31.3.16/28 [1/0] via 172.31.123.3
S       172.31.3.0/28 [1/0] via 172.31.123.3
S       172.31.2.0/24 [1/0] via 172.31.123.2
C       172.31.1.0/24 is directly connected, Loopback1
C       172.31.14.0/24 is directly connected, Serial0/2
C       172.31.123.0/24 is directly connected, FastEthernet1/0
S    192.168.4.0/24 is directly connected, Serial0/2
S    192.168.5.0/24 [1/0] via 172.31.123.2
```


Route selection

- Route selection is based on:
  - Longest, or most specific, match
  - Preferences, for different protocols
  - Routing metrics, for same protocol
- Given multiple routes to a destination, the route must select the best route
- Load balancing may be considered

Route selection: Longest Match

- Most specific address is matched
  - Host route
  - Subnet
  - Summary route, or group of subnets
  - Major network number
  - Supernet, or group of major networks
  - Default address

Route selection: Preference

- Routing protocol processes calculate the active route from all routes in the routing table
- Preference routes are placed in the forwarding table
- The active route is the route with the lowest preference value
  - Preference is value in the range of 0 through 255
  - Preference is used to rank routes received from different protocols, interfaces, or remote systems
- Identifies the believability of a source in determining best route

Route selection: Metric

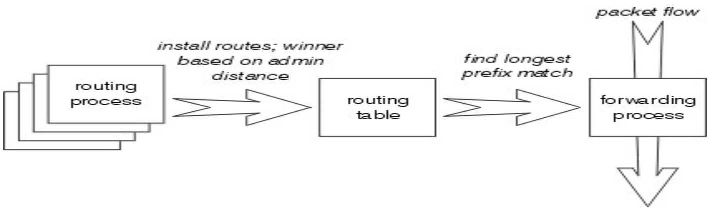
- Routing metrics are generally a measurement of cost or overhead
- Metrics are protocol-specific
  - Used to determine the best route for a single protocol
  - Don’t compare metrics from different routing protocols

Route elements

- Each route in the routing table includes the following elements:
  - IP address/mask
  - Gateway IP address/interface
  - Distance
  - Metric
  - Priority

Forwarding table

- Stores required information for packet forwarding operation; contents include the destination prefixes and the associated outgoing interfaces



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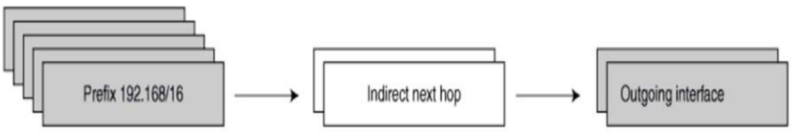
Determining the Next Hop

- Device compares incoming packets against forwarding table entries to determine the appropriate next hop
  - If multiple matches exist, it uses the most specific entry (longest match) to forward packet toward the destination
  - If no matching entry exists, it sends a destination unreachable notification back to the source device



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Types of routes

- Static
  - All packets forwarded to predetermined destinations defined by an administrator
- Dynamic
  - Packets are forwarded to dynamically calculated routes determined by routing protocol

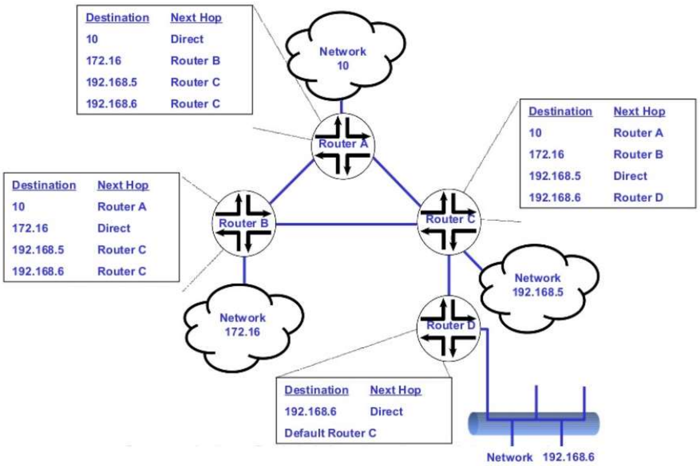
Static Routes

- Manually configured routes added to the route table
- Require a valid next hop
  - Typically the IP address of a directly connected

Static routing

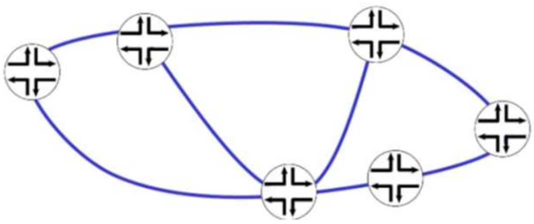
- Benefits
  - Granular control on how traffic is routed
  - Efficiently uses router resources (minimal CPU/Memory overhead)
  - No bandwidth overhead (updates are not shared between routers)
- Drawbacks
  - Does not handle network failures well
  - Infrastructure changes must be manually adjusted
  - Impractical on large network

Static routing example



Dynamic routing

- Method of dynamically learning routing information
- Uses route that a network routing protocol adjusts automatically for topology or traffic changes
- Routing protocols are used between routers to determine path to remote networks and maintain those networks in the routing table



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Dynamic routing

- Benefits:
  - Lower administrative overhead
  - Increased network availability
  - Greater network scalability

- Drawbacks
  - Updates are shared between routers, thus consuming bandwidth
  - Routing protocols put additional load on router CPU/RAM
  - The choice of the “best route” is in the hands ofthe routing protocol, and not the network administrator

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Interior and Exterior Routing Protocols

- Interior Gateway Protocols (IGPs)
  - Operate within a single autonomous system (AS) to exchange network reachability information
- Exterior Gateway Protocols (EGPs)
  - Operate between autonomous system (AS) to exchange network reachability information

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Autonomous System

Autonomous System (AS) Autonomous System (AS) Autonomous System (AS)

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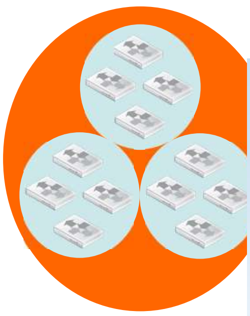
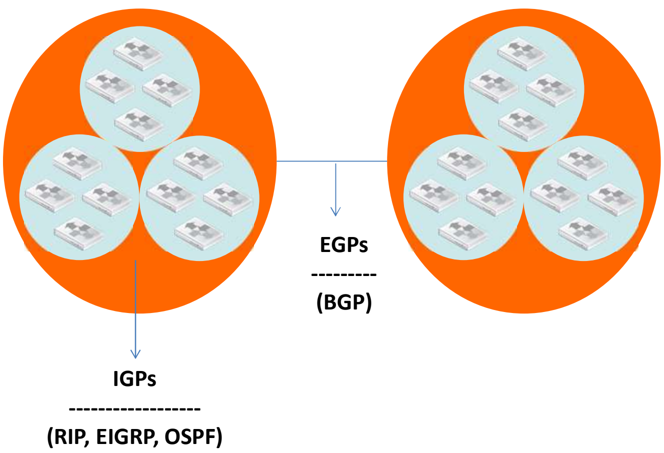
Autonomous System

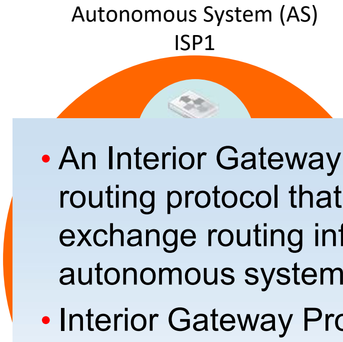


- An autonomous system (AS) is a collection of connected Internet Protocol routing prefixes under the control of one or more network operators
  - Sometimes referred to as a routing domain

Interior and Exterior Routing Protocols



Interior Gateway Protocol (IGP)



- An Interior Gateway Protocol (IGP) is a routing protocol that is used to exchange routing information within an autonomous system
- Interior Gateway Protocols can be divided into two categories
  - Distance-vector routing protocols
  - Link-state routing protocols

Protocols Categories

	Communicate what?	Between whom?
Distance-Vector	Routing tables	Neighbors
Link-State	Interface status	All routers

Distance Vector Protocols

- Distance vector neighbors exchange vectors
  - Metric is typically hop count
  - Vectors reflect both distance and direction
  - Vectors are stored in the routing table
  - Entire table or a portion of table is sent
- The longest network path is limited
- Each router sends a routing table update periodically

When to Use Distance Vector Routing

- Use in very small networks that have a few, if any, redundant paths and no stringent network performance requirements
- Epitome of the distance-vector routing protocol is Routing Information Protocol (RIP)
- Distance vector Drawbacks:
  - Long convergence time
  - Simplistic metrics

Distance Vector Stability Issues

- Counting to infinity
  - solution:
    - Defining a Maximum
    - Split Horizon
- Routing loops
  - Solution:
    - Route Poisoning and Poison Reverse
    - Hold-Down Timers

Link-state routing protocol

- Link-state routing protocols build and maintain a database of link state information
- Hello message are used to discover neighbors
- Costs are associated with links
- Updates are sent to communicate link state changes
- Information is flooded to all neigbors who create a link state database

The Link-State Database (LSDB)

- The LSDB is like a puzzlethat, when complete, is an accurate picture of the network
- LSDB entries are like a puzzle pieces that can describe:
  - ✓ Routers and their attached links
  - ✓ Links and their attached routers
  - ✓ Routing information from outside the network
  - ✓ Link metrics, often represented as Cost
- Each router maintains its own copy of the LSDB
- Each router stores a copy of every LSDB entry in the network
- Different protocols use different names for LSDB entries

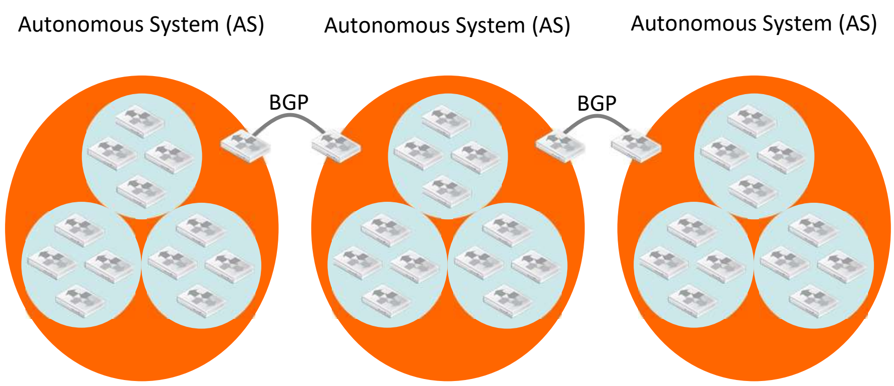
When to Use Link-State Routing

- Use link-state routing with:
  - Any size, well-designed network
  - Any network that requires network scalability
  - Larger, more complicated networks
  - Faster convergence required
- Drawbacks
  - Can flood the network’s transmission facilities, thereby significantly decreasing the network’s capability to transport data
  - Memory and processor intensive

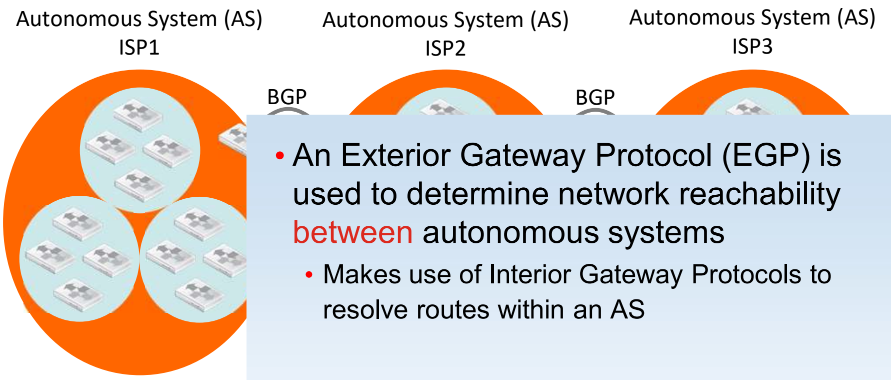
Martian Addresses

- Host or network addresses about which all routing information is ignored
- Commonly sent by improperly configured systems on the network and have destination addresses that are obviously invalid
- In IPv4, these are the default martian addresses:
  - 0.0.0.0/8
  - 127.0.0.0/8
  - 128.0.0.0/8
  - 191.255.0.0./16
  - 192.0.0.0/24
  - 223.255.255.0/24
  - 240.0.0.0/4

Exterior Gateway Protocol



Exterior Gateway Protocol



- An Exterior Gateway Protocol (EGP) is used to determine network reachability between autonomous systems
  - Makes use of Interior Gateway Protocols to resolve routes within an AS

IGP's vs EGP's

- IGP – Internal Gateway Protocol
  - Used to optomize the route a packet takes between points within an Autonomous (AS – Network infrastructure under a unique set of administrative and technical policies)
- EGP – External Gateway Protocol
  - Used to provide for the exchange of routing information between Autonomous Systems
  - Typically designed for doing policy routing, providing control over routes leaving and entering an AS

OSPF

Open Shortest Path first

What Is OSPF

- An interior gateway protocol (IGP) based on the shortest path first (SPF) algorith, also known as the Dijkstra algorithm
- Created to fill the need for high-functionality, standards-based IGP for the TCP/IP protocol family
- Main RFCs:
  - 1587 – OSPF NSSA Option
  - 2328 – OSPF Version 2

What Is Link-State Protocol

- Link = router interface
- State = description of interface and its relationship to neighboring routers
- OSPF routers send link-state advertisements (LSAs) to all other routers within the same hierarchical area
- Routers store information in a link-state, or totpological, database
- Each OSPF router uses the SPF algorithm to calculate the shortest path to each node

What Is SPF?

- Places each router at the root of a tree and calculates the shortest path to each destination based on cumulative cost to reach that destination
- Each router has its own view of the topology, even through all routers build a shortest-path tree using the same link-state database

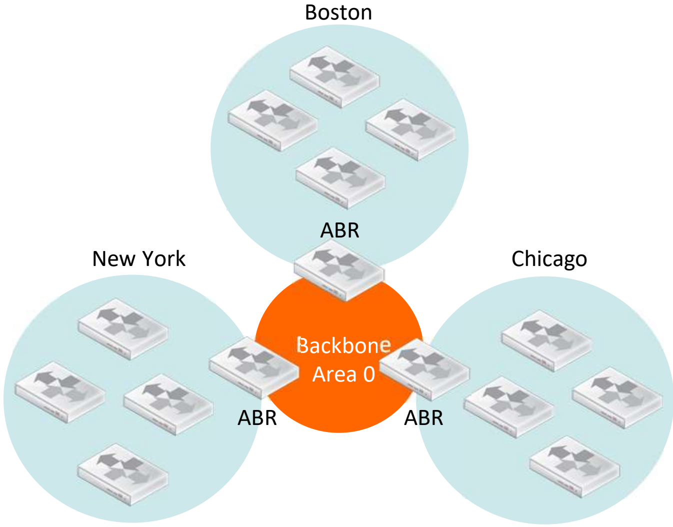
OSPF Routing Hierarchy

- Largest entity is the autonomous system (AS)
- An AS can be divided into areas, groups of contiguous networks, and hosts
  - Routers within a single area have identical link-state databases
  - Area Border Routers (ABRs): routers with interfaces in multiple areas
  - AS boundary Routers (ASBRs): routers that act as gateways to other protocols or another AS

OSPF Backbone

- OSPF backbone (Area 0) distributes routing information between areas
  - Contains all area border routers and backbone routers
  - All traffic between areas goes through the backbone
- Backbone is itself an OSFP area
- If backbone is configured as not contiguous, must configure *virtual links*
  - Between any backbone routers that share a link to a nonbackbone area, or the transit area
  - Function as direct links

Area and ABR



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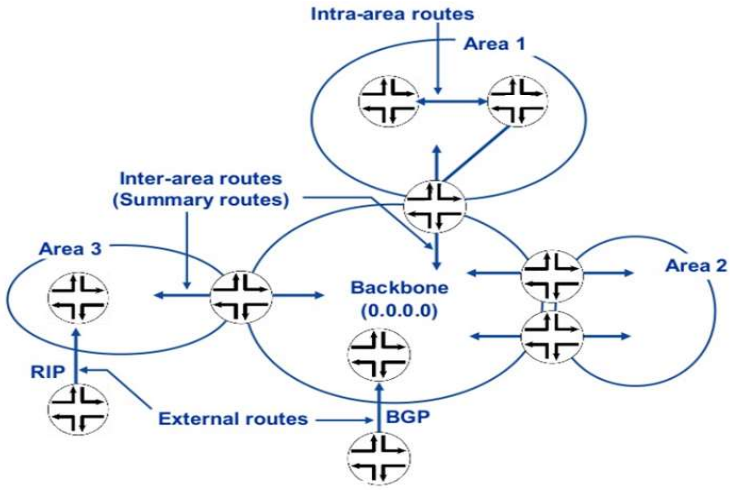
OSPF Area Relationships



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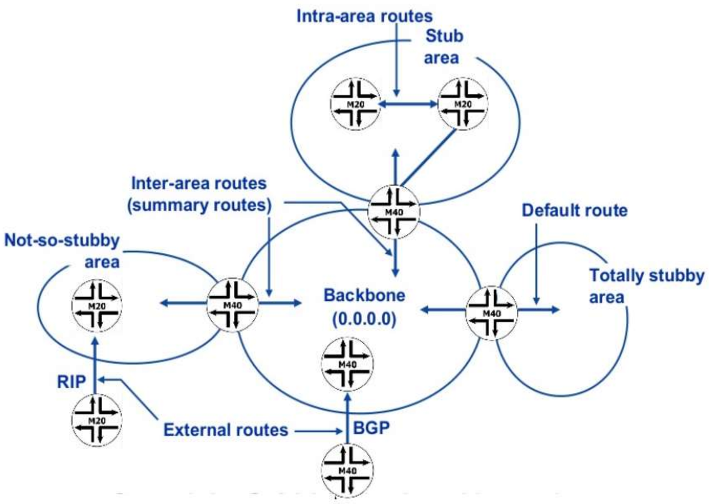
OSPF Stub Areas

- Stub areas
  - Do not carry external routes
  - Virtual links cannot be configured across
  - Cannot contain ASBR
- Totally stubby areas
  - Stub area that only receives the default route from the backbone
- Not-so-stubby areas
  - Allows limited importing of external routes
- Transit areas
  - Used to pass traffic from one adjacent area to the backbone, or to another area if the backbone is more than two hops away from an area

OSPF Area Types



OSPF Neighbors

- Routers that share a common segment within a single area are neighbors
- Neighbors become *adjacent* to exchange LSAS
- The goal: to achieve identical link-state databases

Neighbors Exchange Link-State Info

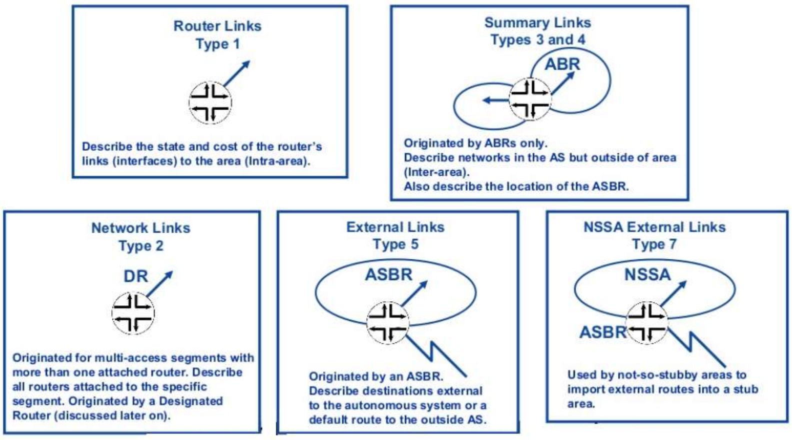
- Neighbors exchange link-state update packets containing LSAs at initialization and when routing information changes
- Link-states exchanged by flooding: Each router that receives a link-state update stores a copy in its link-state database and then propagates the update to other routers
- Once the database is complete, the router calaculates an SPF Tree to all destinations using the Dijkstra algorithm
- OSPF activity determined by the amount of change the less change, the less activity

OSPF Packet Types

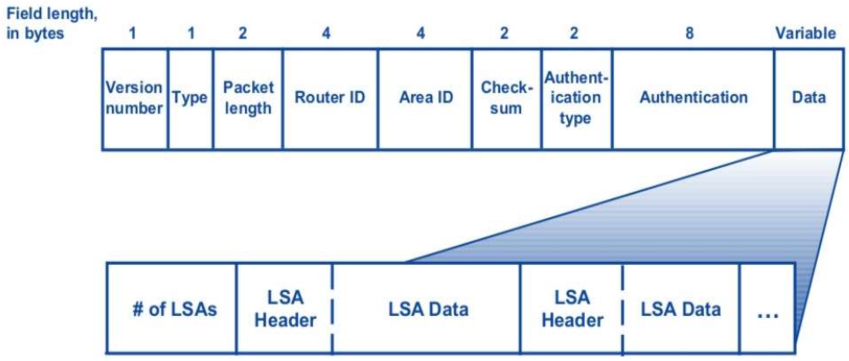
- ***Hello***: Establishes and maintains neighbor relationships
- ***Database Description***: Describes the contents of the link-state database by sending LSA headers. Exchanged when an adjacency is initialized
- ***Link-state Request***: Requests specific LSAs from neighbor routers. Exchanged after a router discovers that parts of its database are missing or out of date.
- ***Link-state Update***: Responds to a link request packet. Also used for the regular dispersal of LSAs to reflect topology changes. Several LSAs can be included within a single link-state update packet
- ***Link-state Acknowledgment***: Acknowledges receipt of link-state update packets. Implements guaranteed flooding

Link-state Advertisements

- Link-state advertisements



Link-state Advertisements



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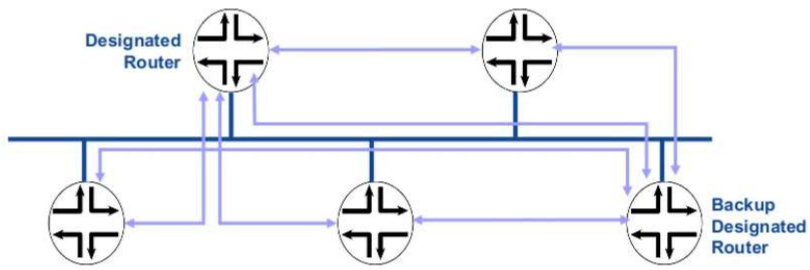
Designated Routed

- One designated router (DR) and one backup designated router (BDR) per multi-access segment
- Minimizes amount of information exchange on the segment



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External Routes

- ASBRs discover external routes
  - Static routes
  - Exterior gateway protocol, such as BGP, for example
- External Type 1
  - Cost = external cost + internal cost
  - Preferred over Type 2
- External Type 2
  - Cost = external cost

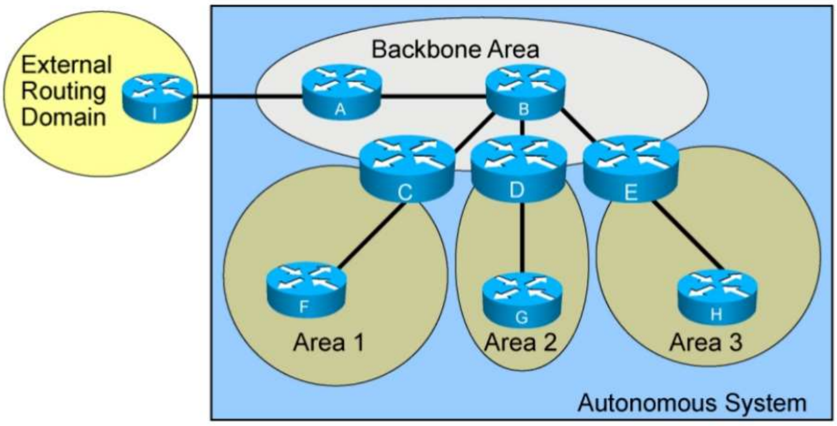
When to Use OSPF

- Faster convergence than distance vector
- Supports much larger networks
- Less susceptible to bad routing information

OSPF Design Tips

- Number of routers per area
  - Depends on many factors
- Number of neighbors
  - Fewer neighbors = better performance
  - Link state Database grows proportionately to the number of links in an area
- Number of areas per ABR
  - Fewer areas = better performance
- Full mesh vs. Partial mesh
  - Partial works better

OSPF Hierarchy Example



- Minimizes routing table entries
- Localizes the impact of a topology change within an area

BGP

Border Gateway Protocol

What Is BGP

- BGP is an inter-domain routing protocol that communicates prefix reachability
- BGP is a path vector protocol
  - Similar to distance vector
- BGP views the Internet as a collection of autonomous systems
- Stability is very important to the Internet and BGP
- BGP routers exchange routing information between peers
- Defined in RFC 1771

BGP Fundamentals

- Routes consist of destination prefixes with as AS path and BGP specific attributes
- Each BGP updates contains one path advertisement and attributes
  - Many destinations can share the same path
- BGP compares the AS path and attributes to choose the best path
- Unfeasible routes can be advertised
  - Unreachable routes are withdrawn

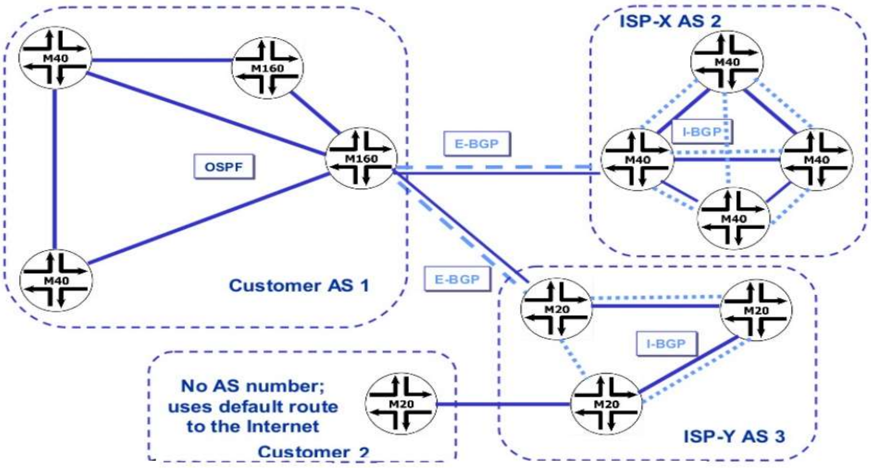
BGP Connections

- BGP updates are incremental
  - No regular refreshes
  - Except at session establishement, when volume of routing can be high
- BGP runs over TCP connections
  - TCP port 179
  - TCP Services
    - Fragmentation, Acknowledgments, Checksums, Sequencing, and Flow Control
  - No automatic neighbor discovery

BGP peering

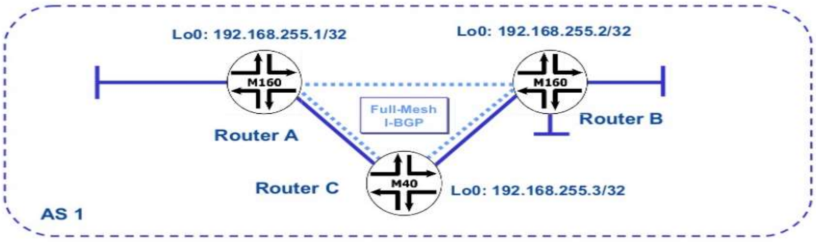
- BGP sessions are established between peers
  - BGP Speakers
- Two types of peering sessions
  - E-BGP (External) peers with differents AS's
  - I-BGP (internal) peers within the AS
- Still requires interior gateway protocols (IGPs)
  - IGP connects BGP speackers within the AS
  - IGP advertises internal routes

E-BGP and I-BGP

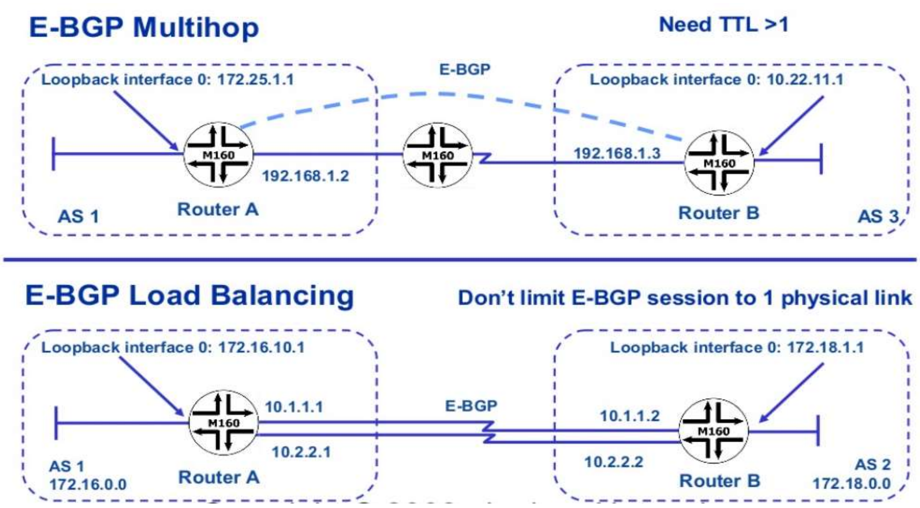


I-BGP Loopback Interfaces

- I-BGP peering is often done using loopback interfaces
  - Loopback interfaces are more stable
  - Not tied to a single physical path
- The AS needs an IGP so that I-BGP speakers can reach each other's loopback address



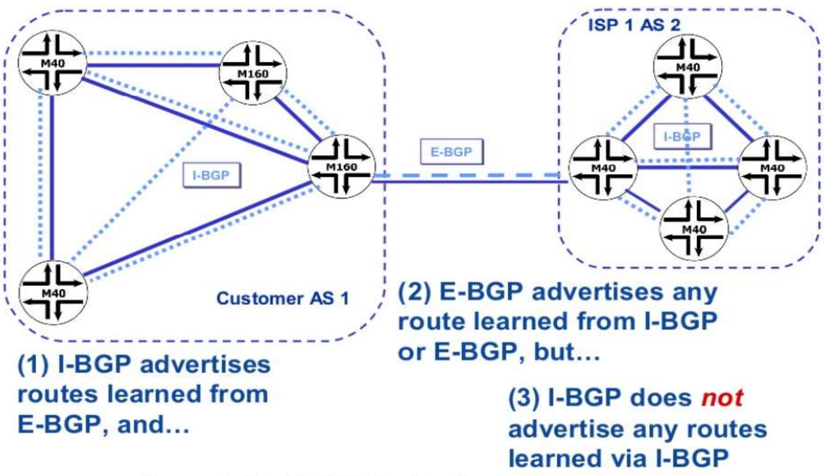
E-BGP Multihop and Load Balancing



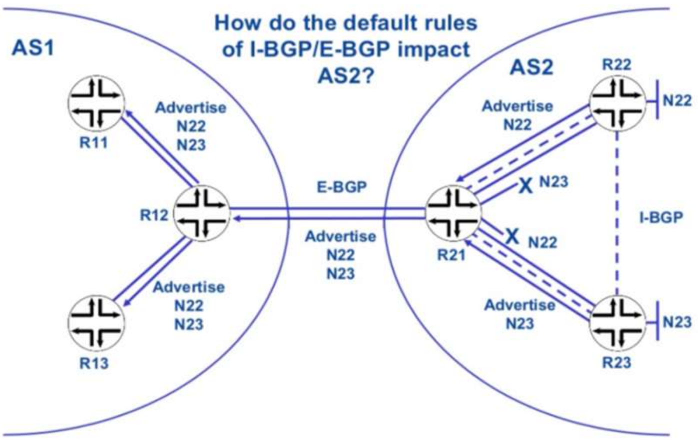
BGP route Advertisement

- Advertise only the active BGP routes to peers
  - BGP next-hop must be reachable
- Never forward I-BGP routes to I-BGP peers
  - Prevents loops
- Withdraw routes if active BGP routes become unreachable

Default BGP Advertisement Rules



The Need for a full I-BGP Mesh

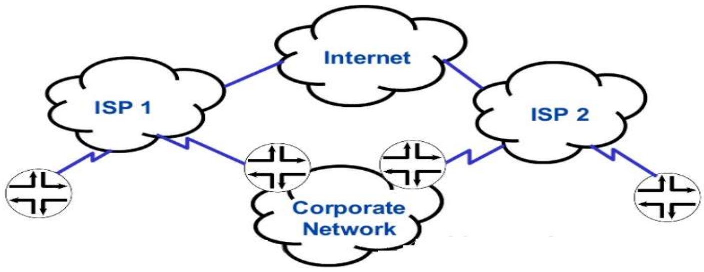


BGP Message Types

- Four BGP message types
  - Open
  - Update
  - Keepalive
  - Notification
- Messages use a common header

When to Use BGP

- Enterprise network that is multihomed to two or more ISPs
  - To support full or partial routes
- To participate as an Internet Backbone Provider



Annex

OSPF

OSPF: Junos Juniper

Configuring OSPF

- Minimal configuration example

```
protocols {
   ospf {
       area 0.0.0.0 {
           interface interface-name;
           interface interface-name;
      }
   }
```


Usefull Commands

- ***show ospf neighbor*** – displays state of neighbors/adjacencies

```
  Address        Intf          State     ID                Pri  Dead
172.16.30.254    fe-0/0/0.0    Full      10.250.240.8      128   30
  area 0.0.0.5, opt 0x2, DR 172.16.30.254, BDR 172.16.30.253
  Up 00:10:50, adjacent 00:10:50

172.16.30.253    fe-0/0/0.0     Full     10.250.240.35     128   30
  area 0.0.0.5, opt 0x2, DR 172.16.30.254, BDR 172.16.30.253
  Up 00:10:50, adjacent 00:10:52

172.16.30.252    fe-0/0/0.0     2Way     10.250.240.32      64   38
  area 0.0.0.5, opt 0x2, DR 172.16.30.254, BDR 172.16.30.253
  Up 00:08:10
```

- ***show ospf interface*** – displays state of interfaces

```
Interface        State    Area          DR ID          BDR ID       Nbrs
fe-0/0/0.0       DR       0.0.0.0       192.168.12.1   192.168.8.1    1
fe-0/0/1.0       DR       0.0.0.0       192.168.12.1   0.0.0.0        0
```

Useful Commands

- ***show ospf database*** – displays all learned OSPF LSAs

```
 OSPF link state database, area 0.0.0.0
Type     ID              Adv Rtr          Seq         Age   Cksum  Len
Router  *10.250.240.8    10.250.240.8     0x800001fc  2388  0x3684  36
Router   10.250.240.17   10.250.240.17    0x80000217  1835  0x444c  36
Router   10.250.240.32   10.250.240.32    0x80000232  1876  0x0158  36
Router   10.250.240.35   10.250.240.35    0x80000291  1100  0x4aa5  36
Network  192.168.254.230 10.250.240.8     0x800001cc   117  0xab67  40
Summary  10.1.2.0        10.250.240.17    0x80000216  1535  0x1729  28
Summary  10.1.3.34       10.250.240.8     0x8000013a  2217  0x842f  28

OSPF link state database, area 1.0.0.0
 Type    ID              Adv Rtr          Seq         Age   Cksum  Len
Router   10.250.240.9    10.250.240.9     0x80000267  116   0x1bb3 36
[additional information]
```


OSPF: Cisco

Configuring Single-Area OSPF

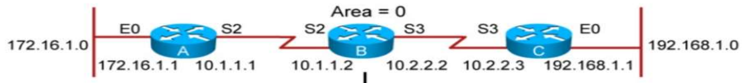
- Defines OSPF as the IP routing protocol

  RouterX (config)# ***router ospf*** ***<process-id>***

- Assigns networks to a specific OSPF area

  RouterX (config router)#

network address wildcard-mask area ***<area-id>***




```
router ospf 100
network 10.1.1.2 0.0.0.0 area 0
network 10.2.2.2 0.0.0.0 area 0
```


Verifying the OSPF configuration

- Verifies that OSPF is configured

  RouterX# ***show ip protocol***

- Displays all the routes learned by the router

  RouterX# ***show ip route***

```
RouterX# show ip route

Codes: I - IGRP derived, R - RIP derived, O - OSPF derived,
C - connected, S - static, E - EGP derived, B - BGP derived,
E2 - OSPF external type 2 route, N1 - OSPF NSSA external type 1 route,
N2 - OSPF NSSA external type 2 route

Gateway of last resort is 10.119.254.240 to network 10.140.0.0

O 10.110.0.0 [110/5] via 10.119.254.6, 0:01:00, Ethernet2
O IA 10.67.10.0 [110/10] via 10.119.254.244, 0:02:22, Ethernet2
O 10.68.132.0 [110/5] via 10.119.254.6, 0:00:59, Ethernet2
O 10.130.0.0 [110/5] via 10.119.254.6, 0:00:59, Ethernet2
O E2 10.128.0.0 [170/10] via 10.119.254.244, 0:02:22, Ethernet2
```

Verifying the OSPF configuration

- Displays the OSPF router ID, timers, and statistics

RouterX# ***show ip ospf***

```
RouterX# show ip ospf
 Routing Process "ospf 50" with ID 10.64.0.2
<output omitted>

 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area BACKBONE(0)
    Area BACKBONE(0)
        Area has no authentication
        SPF algorithm last executed 00:01:25.028 ago
        SPF algorithm executed 7 times
<output omitted>
```


Verifying the OSPF configuration

- Displays all area ID and adjacency information

RouterX# ***show ip ospf interface***

```
RouterX# show ip ospf interface ethernet 0

Ethernet 0 is up, line protocol is up
Internet Address 192.168.254.202, Mask 255.255.255.0, Area 0.0.0.0
AS 201, Router ID 192.168.99.1, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State OTHER, Priority 1
Designated Router id 192.168.254.10, Interface address 192.168.254.10
Backup Designated router id 192.168.254.28, Interface addr 192.168.254.28
Timer intervals configured, Hello 10, Dead 60, Wait 40, Retransmit 5
Hello due in 0:00:05
Neighbor Count is 8, Adjacent neighbor count is 2
  Adjacent with neighbor 192.168.254.28 (Backup Designated Router)
  Adjacent with neighbor 192.168.254.10 (Designated Router)
```

Verifying the OSPF configuration

- Displays the ospf neighbor information on a per-interface basics

RouterX# ***show ip ospf neighbor***

```
RouterX# show ip ospf neighbor

ID              Pri  State          Dead Time  Address         Interface
10.199.199.137  1    FULL/DR        0:00:31    192.168.80.37   FastEthernet0/0
172.16.48.1     1    FULL/DROTHER   0:00:33    172.16.48.1     FastEthernet0/1
172.16.48.200   1    FULL/DROTHER   0:00:33    172.16.48.200   FastEthernet0/1
10.199.199.137  5    FULL/DR        0:00:33    172.16.48.189   FastEthernet0/1
```

RouterX# ***show ip ospf neighbor*** ***<neighbor IP>***

```
RouterX# show ip ospf neighbor 10.199.199.137
Neighbor 10.199.199.137, interface address 192.168.80.37
In the area 0.0.0.0 via interface Ethernet0
Neighbor priority is 1, State is FULL
Options 2
Dead timer due in 0:00:32
Link State retransmission due in 0:00:04
Neighbor 10.199.199.137, interface address 172.16.48.189
In the area 0.0.0.0 via interface Fddi0
Neighbor priority is 5, State is FULL
Options 2
Dead timer due in 0:00:32
Link State retransmission due in 0:00:03
```


BGP

BGP: Junos (Juniper)

Basic BGP Configuration

```
routing-options {
        autonomous-system 64;
}
protocols {
        bgp {
                group external-peer1 {
                        type external;
                        peer-as 1234;
                        neighbor 10.0.0.1;
                }
                group internal-peers {
                        type internal;
                        local-address 192.168.1.1;
                        neighbor 10.0.5.1;
                        neighbor 10.0.6.1;
                }
        }
}
```

Basic Policy Configuration

- First, define the policy:

```
policy-statement redistribute-static-routes {
   from protocol static;
   then accept;
}
```

- Then apply the policy under BGP:

```
protocols {
   bgp {
    export redistribute-static-routes;
   }
}
```


Usefull Commands

- **Show bgp neighbor**

```
user@host> show bgp neighbor
Peer: 10.1.1.2+179 AS 29        Local: 10.1.1.1+1048 AS 29
  Type: Internal  State: Established     Flags: <>
  Last State: OpenConfirm        Last Event: RecvKeepAlive
  Last Error: None
  Options: <Preference HoldTime>
        Holdtime: 90     Preference: 170
  Number of flaps: 1
  Error: "Cease" Sent: 1 Recv: 0
  Peer ID: 10.1.1.2      Local ID: 0.0.0.0        Active Holdtime: 90
  NLRI advertised by peer: unicast
  NLRI for this session: unicast
  Group Bit: 0  Send state: in sync
  Table inet.0
    Active Prefixes: 0
    Received Prefixes: 0
    Suppressed due to damping: 0
  Table inet.2
    Active Prefixes: 0
    Received Prefixes: 0
    Suppressed due to damping: 0
  Last traffic (seconds):        Received 25      Sent 21 Checked 21
  Input messages:          Total 4143       Updates 0       Octets 78717
  Output messages:         Total 4156       Updates 10      Octets 79303
```

Usefull Commands

- **Show bgp summary**
  - View basic information about all BGP neighbors

```
Groups: 12      Peers: 26      Unestablished peers: 2

Peer           AS   InPkt   OutPkt  OutQ   Flaps Last Up/Dn   State|#Act/Recv/Da…
172.17.0.2     45   1225    55263   50511    0    18:22:14    47769/50591/0
192.168.1.1    33   911     0       0        0    18:22:27    Active
192.168.1.97   23   10458   2201    41043    0    18:22:03    0/0/0
192.168.1.100  432  10458   163     17643    0    17:01:18    Active
```


Usefull Commands

- **Show route receive-protocol bgp <addr>**
  - Look at routes received by a peer before policy is applied

```
user@host> show route receive-protocol bgp 11.1.1.1
inet.0: 6 destinations, 6 routes (5 active, 0 holddown, 1 hidden)
Prefix                  Nexthop     MED        Lclpref  AS path
10.0.0.0/8              192.168.1.1            100      I
172.16.0.0/12           172.19.1.1             100      I
```

- **Show route advertising-protocol bgp <addr>**
  - Look at routes advertised to specific peer

```
user@host> show route advertising-protocol bgp 10.1.1.2
inet.0: 10 destinations, 10 routes (8 active, 0 holddown, 2 hidden)
Prefix              Nexthop      MED            Lclpref  AS path
10.0.0.0/8          Self                    100          I
172.16.0.0/12       Self                    100          I
```

BGP: Cisco

BGP configuration

RouterX# ***router bgp autonomous-system***

- This command enters router configuration mode only; subcommands must be entered to activate BGP.
- Only one instance of BGP can be configured on the router at a single time
- The autonomous system number identifies the autonomous system to which the router belongs
- The autonomous system number in this command is compared to the autonomous system numbers listed in neighbor statements to determine if the neighbor is an internal or external neighbor

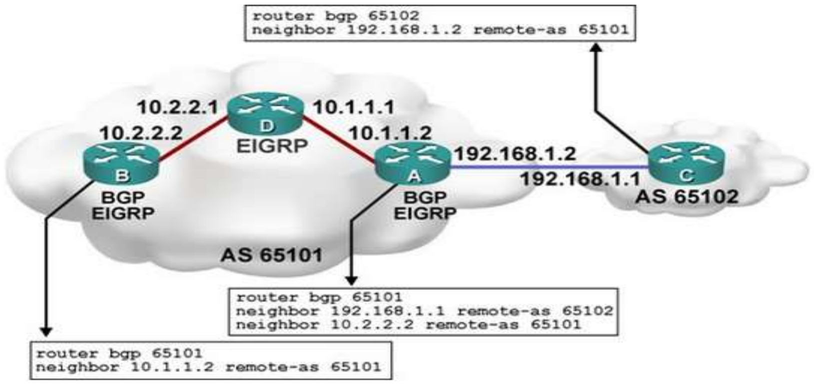
BGP configuration

RouterX (config-router)#

neighbor {ip-address | peer-group-name} remote-as autonomous-system

- The ***neighbo***r command activates a BGP session with this neighbor.
- The IP address that is specified is the destination address of BGP packets going to this neighbor.
- This router must have an IP path to reach this neighbor before it can set up a BGP relationship
- The r***emote-as*** option shows what AS this neighbor is in. This AS number is used to determine if the neighbor is internal or extarnal.
- This command is used for both external and internal neighbors.

Example: BGP neighbor command



BGP neighbor shutdown command

RouterX (config-router)#

neighbor {ip-address | peer-group-name} shutdown

- Administratively brings down a BGP neighbor
- Used for maintenance and policy changes to prevent route flapping

RouterX (config-router)#

no neighbor {ip-address | peer-group-name} shutdown

- Re-enables a BGP neighbor that has been administratively shut down.

BGP neighbor update-source command

RouterX (config-router)#

neighbor {ip-address | peer-group-name} update-source {interface}

- This command allows the BGP process to use the IP address of a specified interface as the source IP address of all BGP updates to that neighbor.
- A loopback interface is usually used, because it will be available as long as the router is operational.
- The ***neighbor update-source*** command is normally used only with IBGP neighbors.
- The address of an EBGP neighbor must be directly connected by default; the loopback of an EBGP neighbors is not directly connected.

BGP neighbor ebgp-multihop command

RouterX (config-router)#

neighbor {ip-address | peer-group-name} ebgp-multihop {ttl}

- This command increases the default of one hop for EBGP peers
- It allows routes to the EBGP loopback address (which will have a hop count greater than 1)

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BGP neighbor next-hop-self command

RouterX (config-router)#

neighbor {ip-address | peer-group-name} next-hop-self

- Forces all updates for this neighbor to be advertised with this router as next hop.
- The IP address used for the ***next-hop-self*** option will the same as the source as the source IP address of the EBGP packet.

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BGP states

When establishing a BGP session, BGP goes through the following states:

- ***Idle***: Router is searching routing table to see whether a route exists to reach the neighbor.
- ***Connect***: Router found a route to the neighbor and has completed the three-way TCP handshake.
- ***Open sent***: opren message sent, with the parameters for the BGP session
- ***Open confirm***: Router received agreement on the parameters for establishing session.
  - Alternatively, router goes into ***active*** state if no response to open message.
- E***stablished***: Peering is established; routing begins

Usefull command

- **show ip bgp neighbors**

```
RouterA#sh ip bgp neighbors
BGP neighbor is 172.31.1.3,  remote AS 64998, external link
  BGP version 4, remote router ID 172.31.2.3
  BGP state = Established , up for 00:19:10
  Last read 00:00:10, last write 00:00:10, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  7          7
    Notifications:          0          0
    Updates:               13         38
<output omitted>
```

Usefull command

- **show ip bgp summary**

```
RouterA# show ip bgp summary
BGP router identifier 10.1.1.1, local AS number 65001
BGP table version is 124, main routing table version 124
9 network entries using 1053 bytes of memory
22 path entries using 1144 bytes of memory
12/5 BGP path/bestpath attribute entries using 1488 bytes of memory
6 BGP AS-PATH entries using 144 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3829 total bytes of memory
BGP activity 58/49 prefixes, 72/50 paths, scan interval 60 secs

Neighbor      V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd

10.1.0.2      4 65001      11      11      124    0    0 00:02:28        8
172.31.1.3    4 64998      21      18      124    0    0 00:01:13        6
172.31.11.4   4 64999      11      10      124    0    0 00:01:11        6
```


Usefull command

- **show ip bgp**
  - Displays networks from lowest to highest

```
RouterA# show ip bgp
BGP table version is 14, local router ID is 172.31.11.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network          Next Hop            Metric LocPrf Weight Path
*> 10.1.0.0/24      0.0.0.0                  0         32768 i
* i                 10.1.0.2                 0    100      0 i
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*>i10.1.2.0/24      10.1.0.2                 0    100      0 i
*> 10.97.97.0/24    172.31.1.3                             0 64998 64997 i
*                   172.31.11.4                            0 64999 64997 i
* i                 172.31.11.4              0    100      0 64999 64997 i
*> 10.254.0.0/24    172.31.1.3               0             0 64998 i
*                   172.31.11.4                            0 64999 64998 i
* i                 172.31.1.3               0    100      0 64998 i
r> 172.31.1.0/24    172.31.1.3               0             0 64998 i
r                   172.31.11.4                            0 64999 64998 i
r i                 172.31.1.3               0    100      0 64998 i
*> 172.31.2.0/24    172.31.1.3               0             0 64998 i
<output omitted>
```

Soft Reset Outbound

RouterX# *clear ip bgp {*|neighbor-address} [soft out]*

- **Routes learned from this neighbor are not lost.**
- **This router resends all BGP information to the neighbor without resetting the connection.**
- **The connection remains established.**
- **This option is highly recommended when you are changing outbound policy**
- **The *soft out* option does not help if you are changing inbound policy.**

Inbound Soft Reset

RouterX (config-router)#

Neighbor [ip-address] soft-reconfiguration inbound

- **This router stores all updates from this neighbor in case the inbound policy is changed.**
- **The command is memory-intensive.**

RouterX# *clear ip bgp {*|neighbor-address} soft in*

- **Uses the stored information to generate new inbound updates**

Route Refresh: Dynamic Inbound Soft Reset

RouterX# ***clear ip bgp {*|neighbor-address} [soft in | in]***

- **Routes advertised to this neighbor are not withdrawn.**
- **Does not store update information locally.**
- **The connection remains established.**
- **Introduced in Cisco IOS software release 12.0(2) and 12.0(6)T.**