



## Border Gateway Protocol

- Routing Protocol used to exchange routing information between networks exterior gateway protocol
- RFC1771
  - work in progress to update draft-ietf-idr-bgp4-10.txt
- Currently Version 4
- Runs over TCP

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## BGP

- Path Vector Protocol
- Incremental Updates
- Many options for policy enforcement
- Classless Inter Domain Routing (CIDR)
- Widely used for Internet backbone
- Autonomous systems

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## Path Vector Protocol

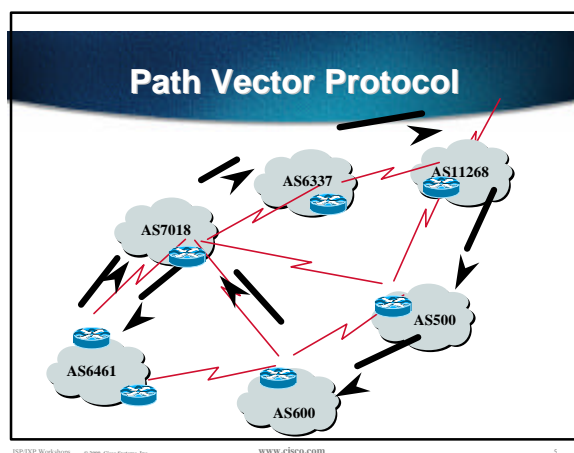
- BGP is classified as a **path vector** routing protocol (see RFC 1322)

A path vector protocol defines a route as a pairing between a destination and the attributes of the path to that destination.

12.6.126.0/24 207.126.96.43 1021 0 6461 7018 6337 11268 1

AS Path

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## Definitions

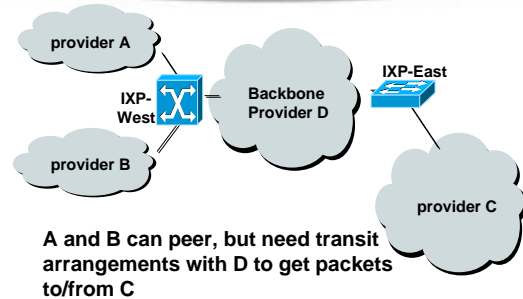
- **Transit** - carrying traffic across a network, usually for a fee
- **Peering** - exchanging routing information and traffic
- **Default** - where to send traffic when there is no explicit match is in the routing table

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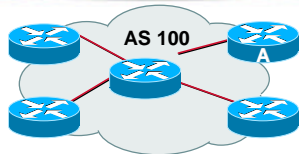
## Default Free Zone

The default free zone is made up of Internet routers which have explicit routing information about the rest of the Internet, and therefore do not need to use a default route.

## Peering and Transit example

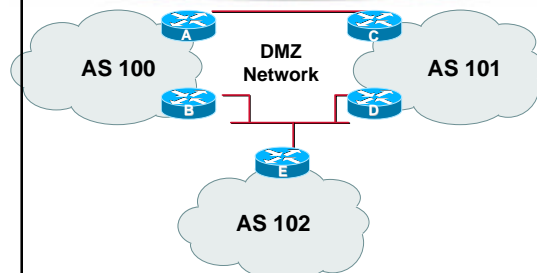


## Autonomous System (AS)



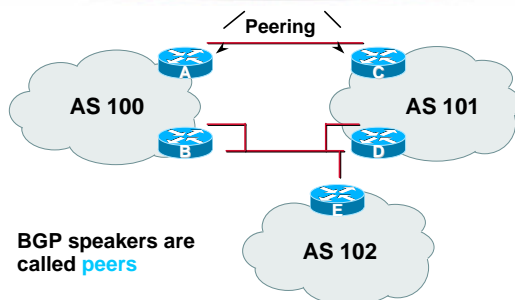
- Collection of networks with same routing policy
- Single routing protocol
- Usually under single ownership, trust and administrative control

## Demarcation Zone (DMZ)



- Shared network between ASes

## BGP Basics



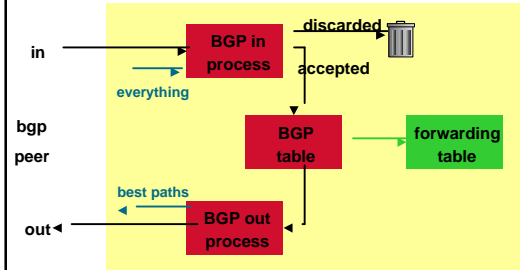
## BGP General Operation

- Learns multiple paths via internal and external BGP speakers
- Picks the best path and installs in the forwarding table
- Policies applied by influencing the best path selection

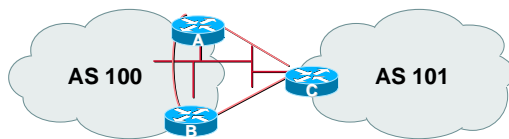
## Constructing the Forwarding Table

- **BGP “in” process**  
receives path information from peers  
results of BGP path selection placed in the BGP table  
“best path” flagged
- **BGP “out” process**  
announces “best path” information to peers
- **Best paths installed in forwarding table if:**  
prefix and prefix length are unique  
lowest “protocol distance”

## Constructing the Forwarding Table



## External BGP Peering (eBGP)



- Between BGP speakers in different AS
- Should be directly connected
- Do not run an IGP between eBGP peers

## Configuring External BGP

**Router A in AS100**

```

interface ethernet 5/0
ip address 222.222.10.2 255.255.255.240
router bgp 100
network 220.220.8.0 mask 255.255.252.0
neighbor 222.222.10.1 remote-as 101
neighbor 222.222.10.1 prefix-list RouterC in
neighbor 222.222.10.1 prefix-list RouterC out
    
```

**Router C in AS101**

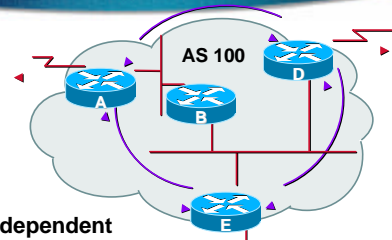
```

interface ethernet 1/0/0
ip address 222.222.10.1 255.255.255.240
router bgp 101
network 220.220.16.0 mask 255.255.240.0
neighbor 222.222.10.2 remote-as 100
neighbor 222.222.10.2 prefix-list RouterA in
neighbor 222.222.10.2 prefix-list RouterA out
    
```

## Internal BGP (iBGP)

- BGP peer within the same AS
- Not required to be directly connected
- iBGP speakers need to be fully meshed  
they originate connected networks  
they do not pass on prefixes learned from other iBGP speakers

## Internal BGP Peering (iBGP)

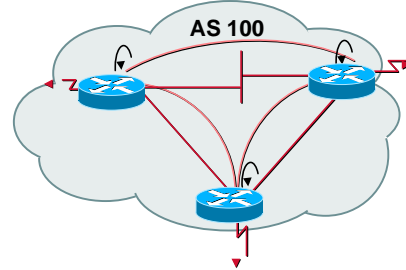


- Topology independent
- Each iBGP speaker must peer with every other iBGP speaker in the AS

## Stable iBGP Peering

- Peer with loop-back address
- iBGP session is not dependent on state of a single interface
- iBGP session is not dependent on physical topology
- Loop-back interface does not go down - ever!

## Peering to Loop-Back Address



## Configuring Internal BGP

```

Router A
interface loopback 0
ip address 215.10.7.1 255.255.255.255
router bgp 100
 network 220.220.1.0
 neighbor 215.10.7.2 remote-as 100
 neighbor 215.10.7.2 update-source loopback0
 neighbor 215.10.7.3 remote-as 100
 neighbor 215.10.7.3 update-source loopback0

Router B
interface loopback 0
ip address 215.10.7.2 255.255.255.255
router bgp 100
 network 220.220.5.0
 neighbor 215.10.7.1 remote-as 100
 neighbor 215.10.7.1 update-source loopback0
 neighbor 215.10.7.3 remote-as 100
 neighbor 215.10.7.3 update-source loopback0
    
```

## Inserting prefixes into BGP

- Two ways to insert prefixes into BGP
  - redistribute static
  - network command

## Inserting prefixes into BGP - redistribute static

- Configuration Example:
 

```

router bgp 109
 redistribute static
 ip route 198.10.4.0 255.255.254.0 serial0
            
```
- Static route must exist before redistribute command will work
- Forces origin to be "incomplete"
- Care required!

## Inserting prefixes into BGP - redistribute static

- Care required with **redistribute**!
  - redistribute <routing-protocol> means everything in the <routing-protocol> will be transferred into the current routing protocol
  - Will not scale if uncontrolled
  - Best avoided if at all possible
  - redistribute normally used with "route-maps" and under tight administrative control

## Inserting prefixes into BGP - network command

- **Configuration Example**  

```
router bgp 109
  network 198.10.4.0 mask 255.255.254.0
  ip route 198.10.0.0 255.255.254.0 serial0
```
- A matching route must exist in the routing table before the network is announced
- Forces origin to be "IGP"

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25

## Configuring Aggregation

- Three ways to configure route aggregation  
 redistribute static  
 aggregate-address  
 network command

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26

## Configuring Aggregation

- **Configuration Example:**  

```
router bgp 109
  redistribute static
  ip route 198.10.0.0 255.255.0.0 null0 250
```
- static route to "null0" is called a pull up route  
 packets only sent here if there is no more specific match in the routing table  
 distance of 250 ensures this is last resort static

care required - see previously!

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27

## Configuration Aggregation - Network Command

- **Configuration Example**  

```
router bgp 109
  network 198.10.0.0 mask 255.255.0.0
  ip route 198.10.0.0 255.255.0.0 null0 250
```
- A matching route must exist in the routing table before the network is announced
- Easiest and best way of generating an aggregate

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28

## Configuring Aggregation - aggregate-address command

- **Configuration Example**  

```
router bgp 109
  network 198.10.4.0 mask 255.255.252.0
  aggregate-address 198.10.0.0 255.255.0.0 [ summary-only ]
```
- Requires more specific prefix in routing table before aggregate is announced
- {summary-only} keyword  
 optional keyword which ensures that only the summary is announced if a more specific prefix exists in the routing table

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29

## Auto Summarisation

- Automatically summarises subprefixes to the classful network.

Example:

61.10.8.0/22 --> 61.0.0.0/8

- **Must** be turned off for any Internet connected site using BGP.

```
router bgp 109
  no auto-summary
```

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30

## Synchronisation

- In Cisco IOS, BGP does not advertise a route before all routers in the AS have learned it via an IGP
  - Disable synchronisation if:
    - AS doesn't pass traffic from one AS to another, or
    - All transit routers in AS run BGP, or
    - iBGP is used across backbone
- ```
router bgp 109
no synchronization
```

## Summary

- BGP4 - distance vector protocol
- iBGP versus eBGP
- stable iBGP - peer with loopbacks
- announcing prefixes & aggregates
- no synchronization & no auto-summary

