

Introduction to BGP

ISP/IXP Workshops

Border Gateway Protocol

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- **Routing Protocol used to exchange routing information between networks**
exterior gateway protocol
- **Described in RFC1771**
work in progress to update
www.ietf.org/internet-drafts/draft-ietf-idr-bgp4-23.txt
- **The Autonomous System is BGP's fundamental operating unit**
It is used to uniquely identify networks with common routing policy

BGP

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

Path Vector Protocol

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- 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.

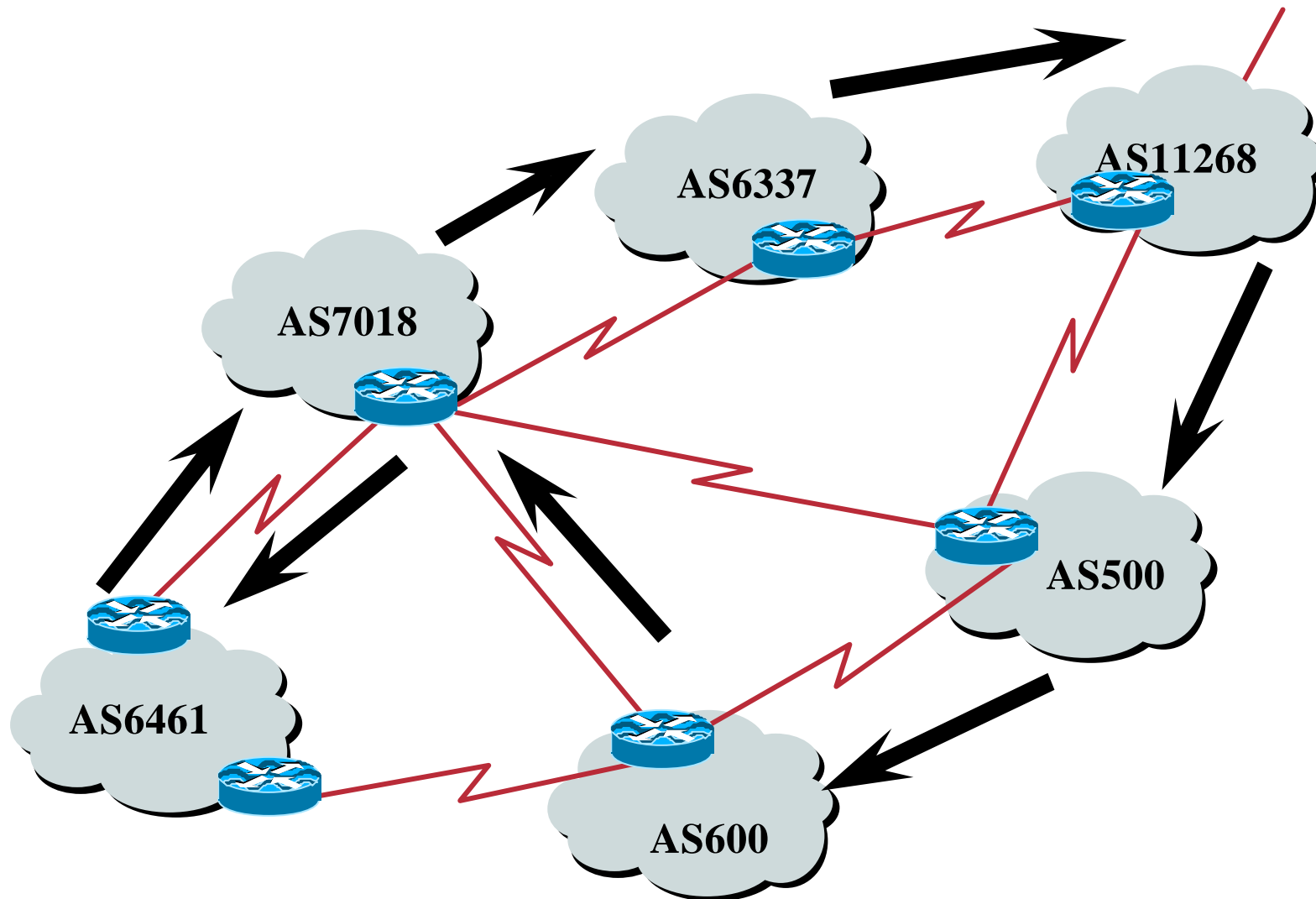


12.6.126.0/24 207.126.96.43 1021 0 6461 7018 6337 11268 i

AS Path

Path Vector Protocol

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Definitions

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- **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 in the routing table

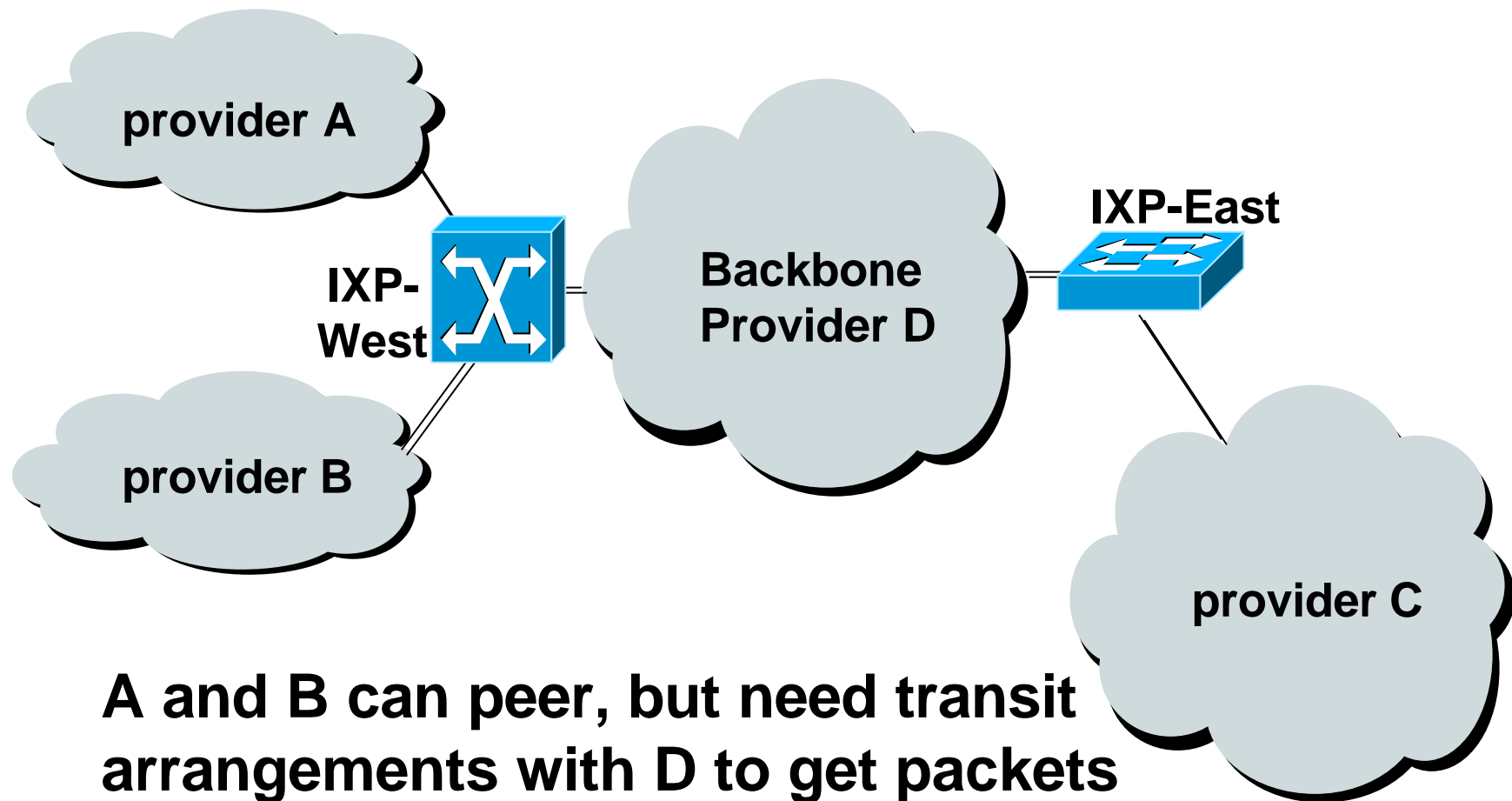
Default Free Zone

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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

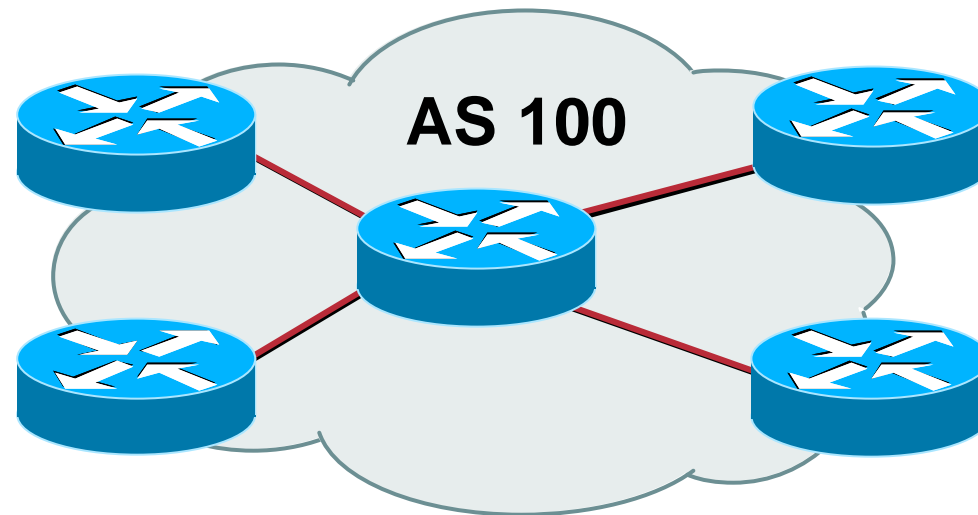
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A and B can peer, but need transit arrangements with D to get packets to/from C

Autonomous System (AS)

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- **Collection of networks with same routing policy**
- **Single routing protocol**
- **Usually under single ownership, trust and administrative control**
- **Identified by a unique number**

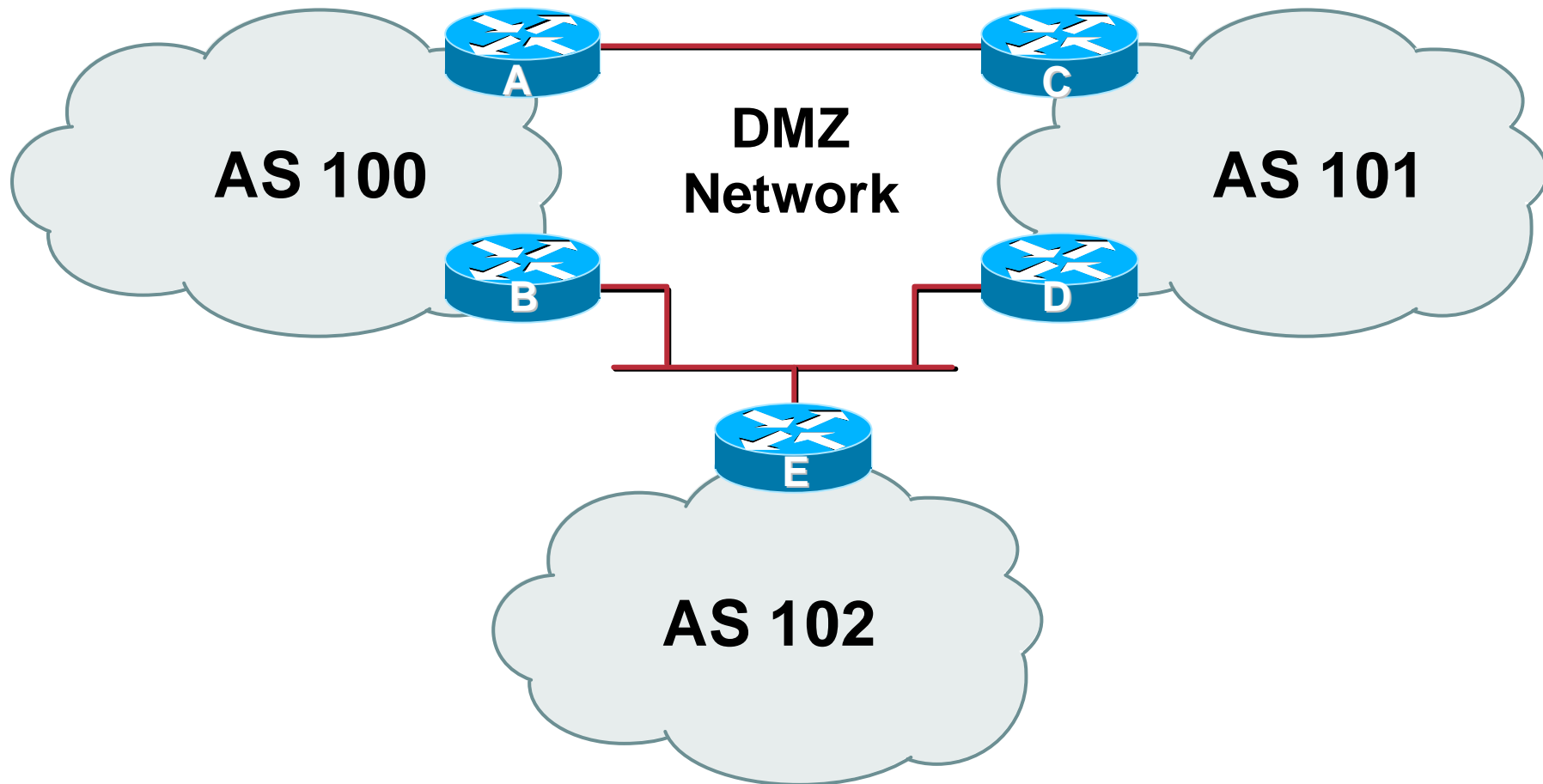
Autonomous System Number (ASN)

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- An ASN is a 16 bit number
 - 1-64511 are assigned by the RIRs
 - 64512-65534 are for private use and should never appear on the Internet
 - 0 and 65535 are reserved
- 32 bit ASNs are coming soon
 - www.ietf.org/internet-drafts/draft-ietf-idr-as4bytes-07.txt
- ASNs are distributed by the Regional Internet Registries
 - Also available from upstream ISPs who are members of one of the RIRs
 - Current ASN allocations up to 32767 have been made to the RIRs

Demarcation Zone (DMZ)

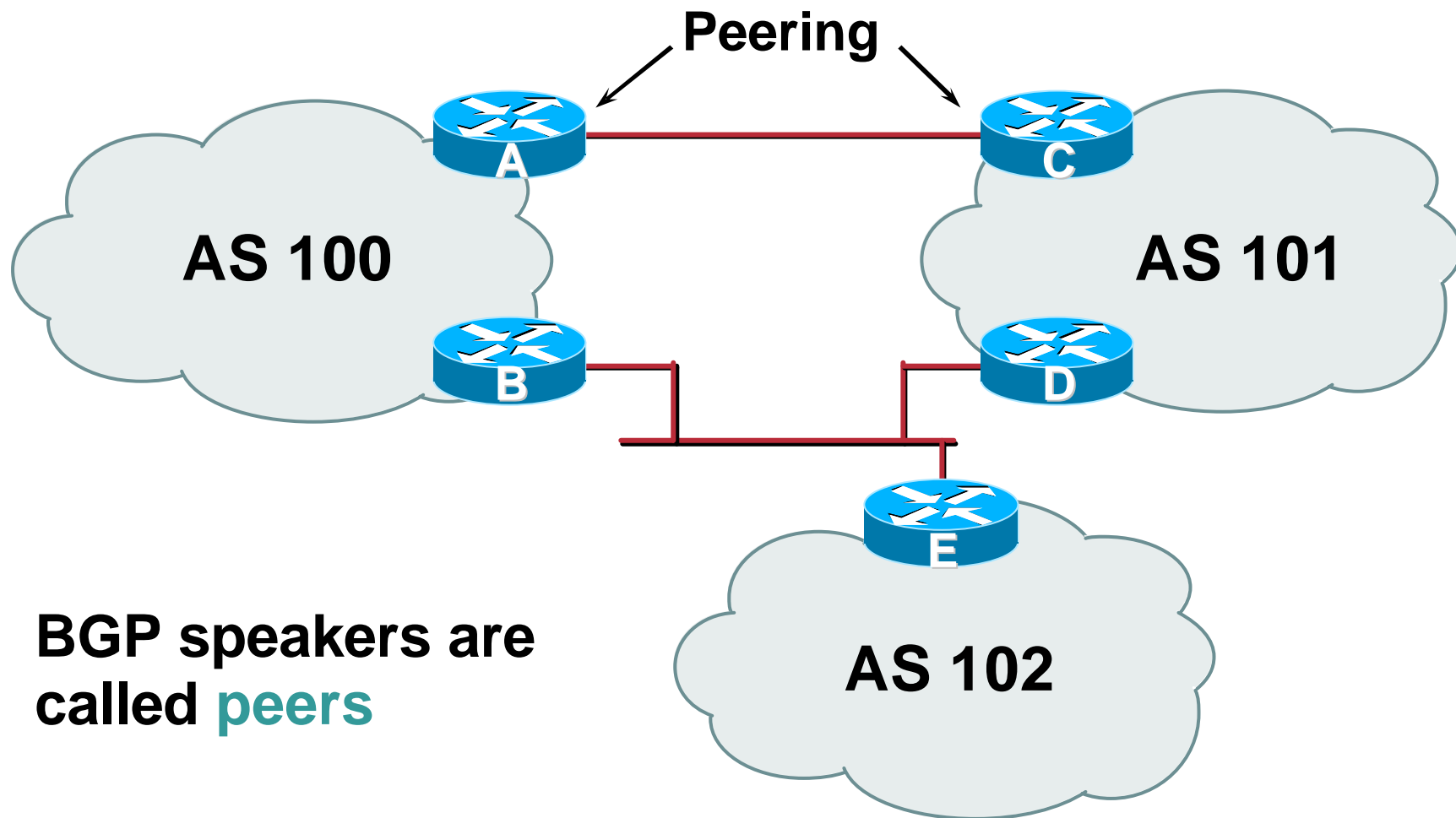
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- **Shared network between ASes**

BGP Basics

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BGP speakers are called peers

BGP General Operation

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- **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**

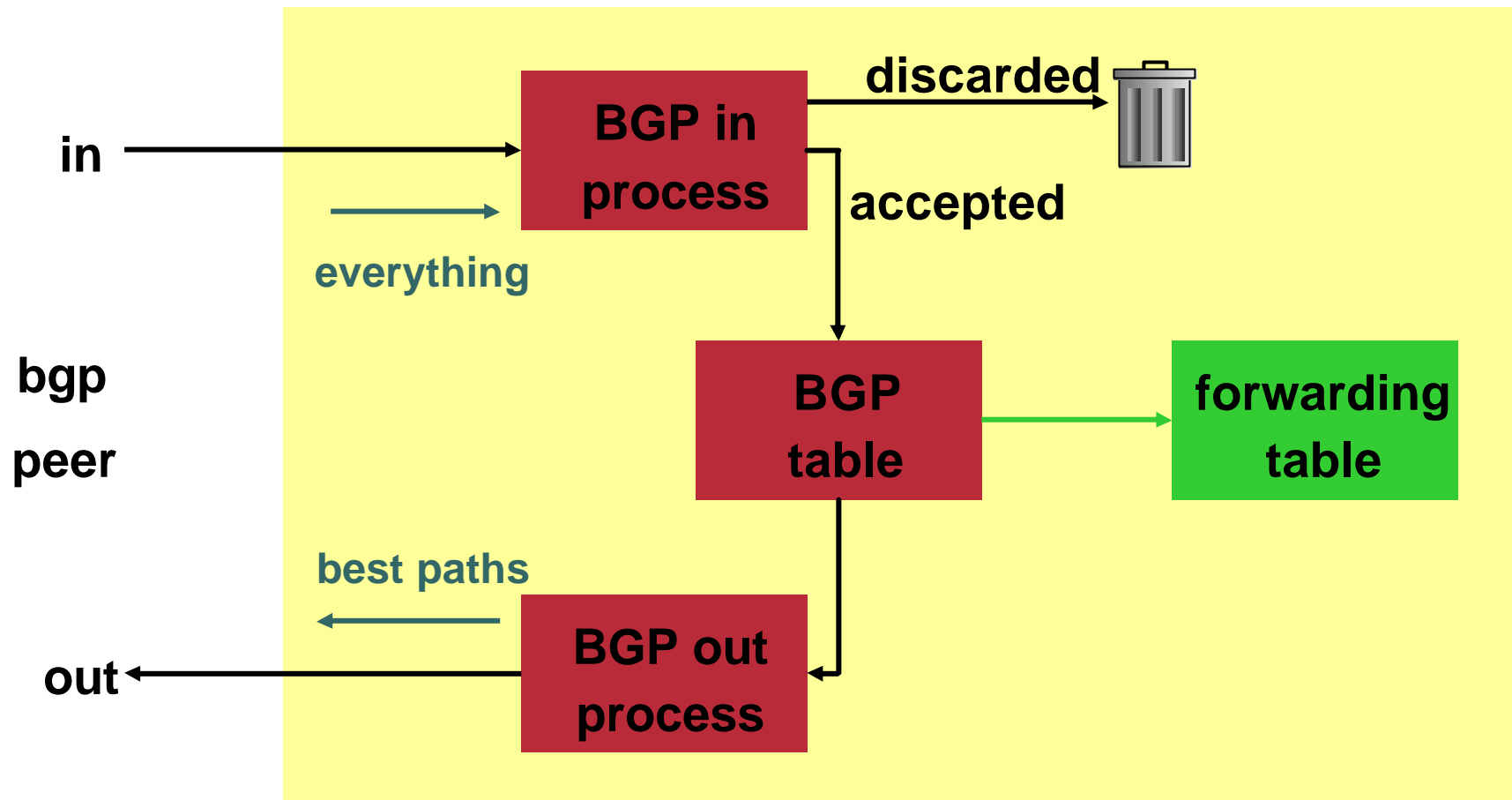
Constructing the Forwarding Table

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- **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

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eBGP & iBGP

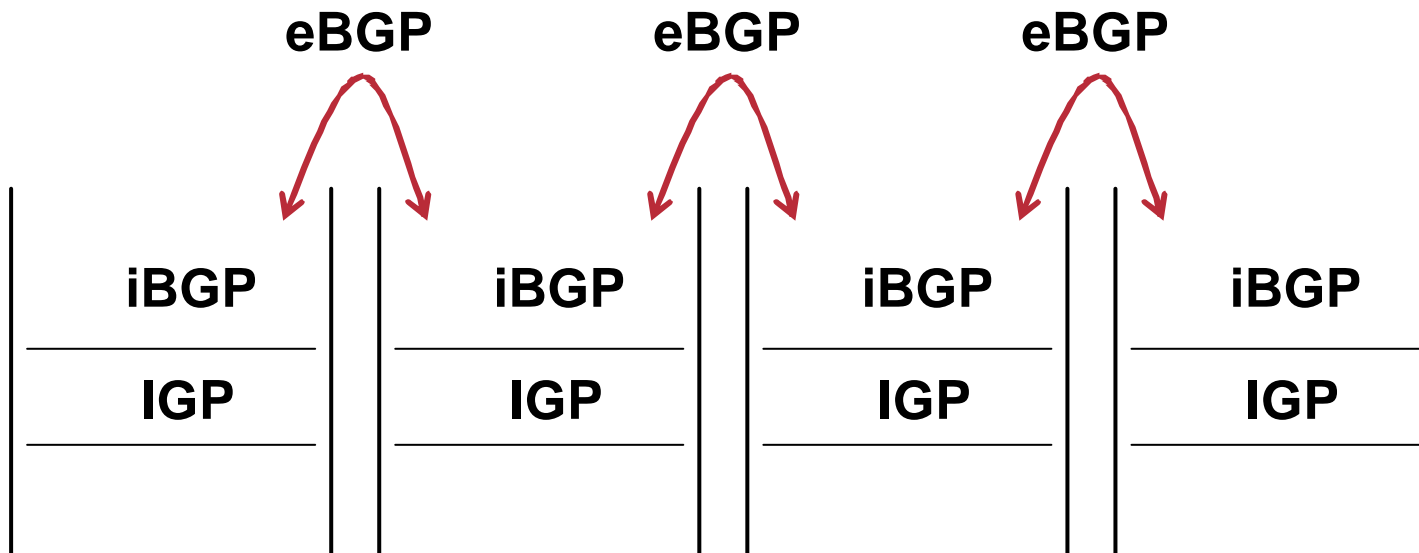
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- **BGP used internally (iBGP) and externally (eBGP)**
- **iBGP used to carry**
 - some/all Internet prefixes across ISP backbone**
 - ISP's customer prefixes**
- **eBGP used to**
 - exchange prefixes with other ASes**
 - implement routing policy**

BGP/IGP model used in ISP networks

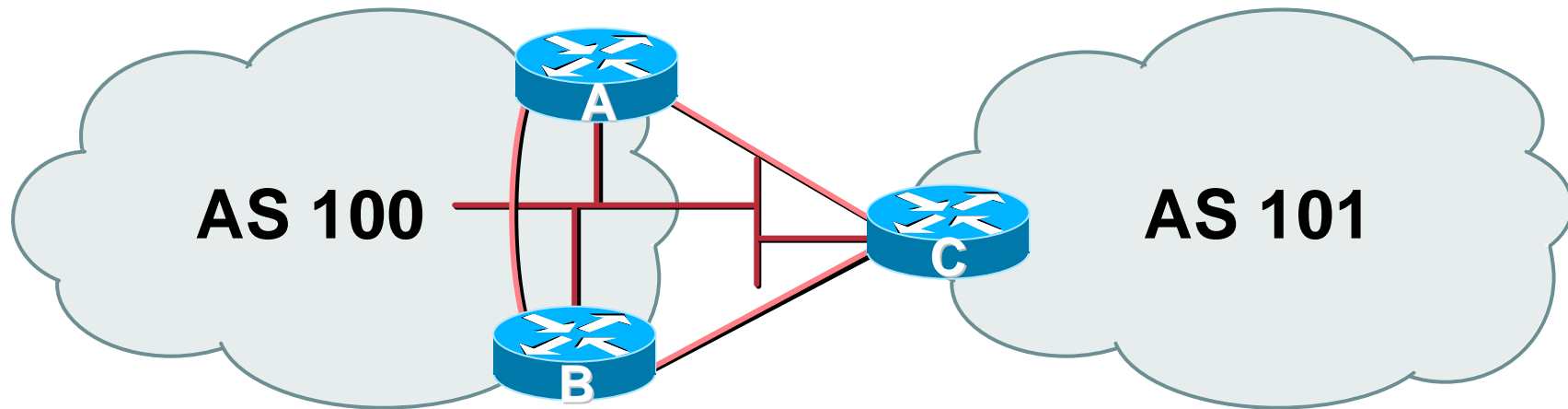
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- **Model representation**



External BGP Peering (eBGP)

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- **Between BGP speakers in different AS**
- **Should be directly connected**
- **Never** run an IGP between eBGP peers

Configuring External BGP

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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
!
```

ip address on
ethernet interface

Local ASN

Remote ASN

ip address of Router C
ethernet interface

Inbound and
outbound filters

Configuring External BGP

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Router C in AS101

```
interface ethernet 1/0/0
 ip address 222.222.10.1 255.255.255.240
!
router bgp 101
 network 220.220.8.0 mask 255.255.252.0
 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
!
```

ip address on
ethernet interface

Local ASN

Remote ASN

ip address of Router A
ethernet interface

Inbound and
outbound filters

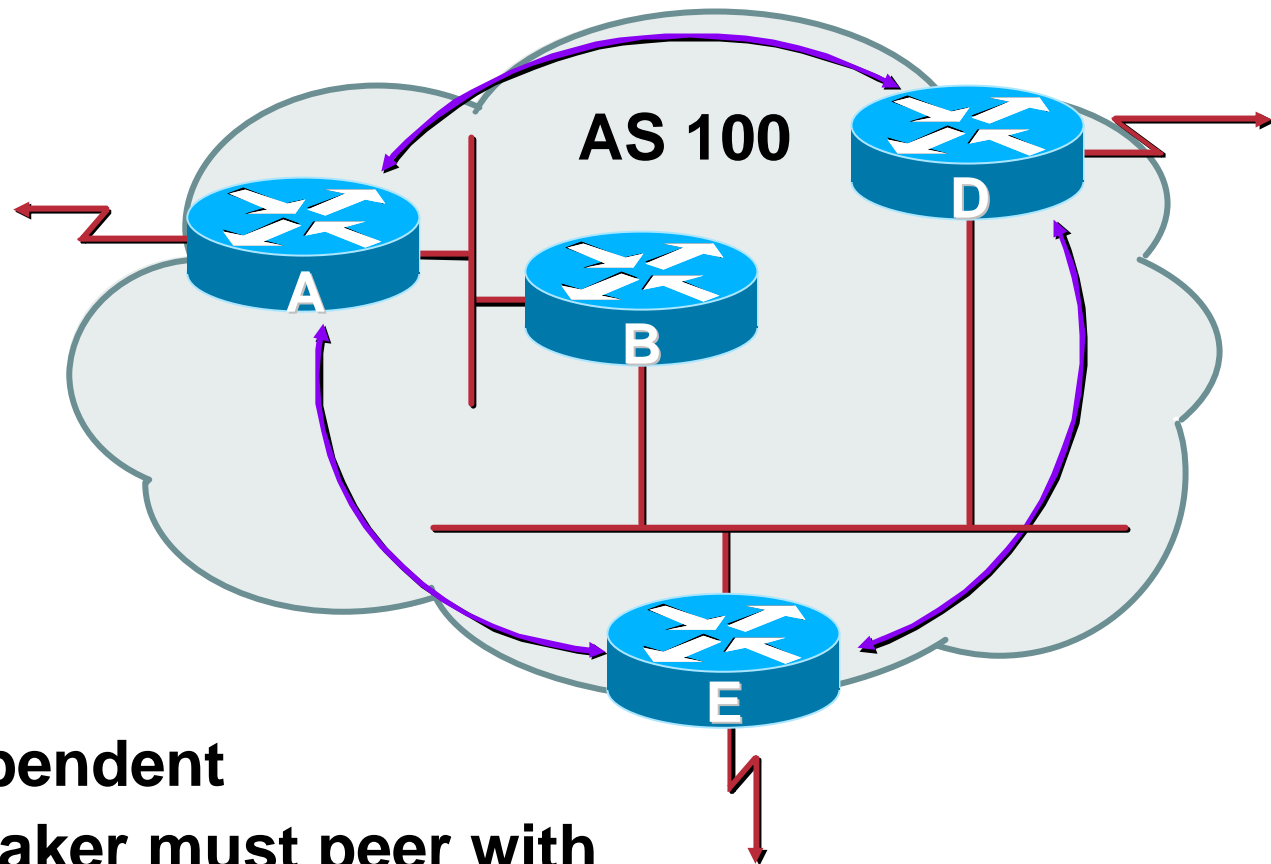
Internal BGP (iBGP)

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- **BGP peer within the same AS**
- **Not required to be directly connected**
IGP takes care of inter-BGP speaker connectivity
- **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)

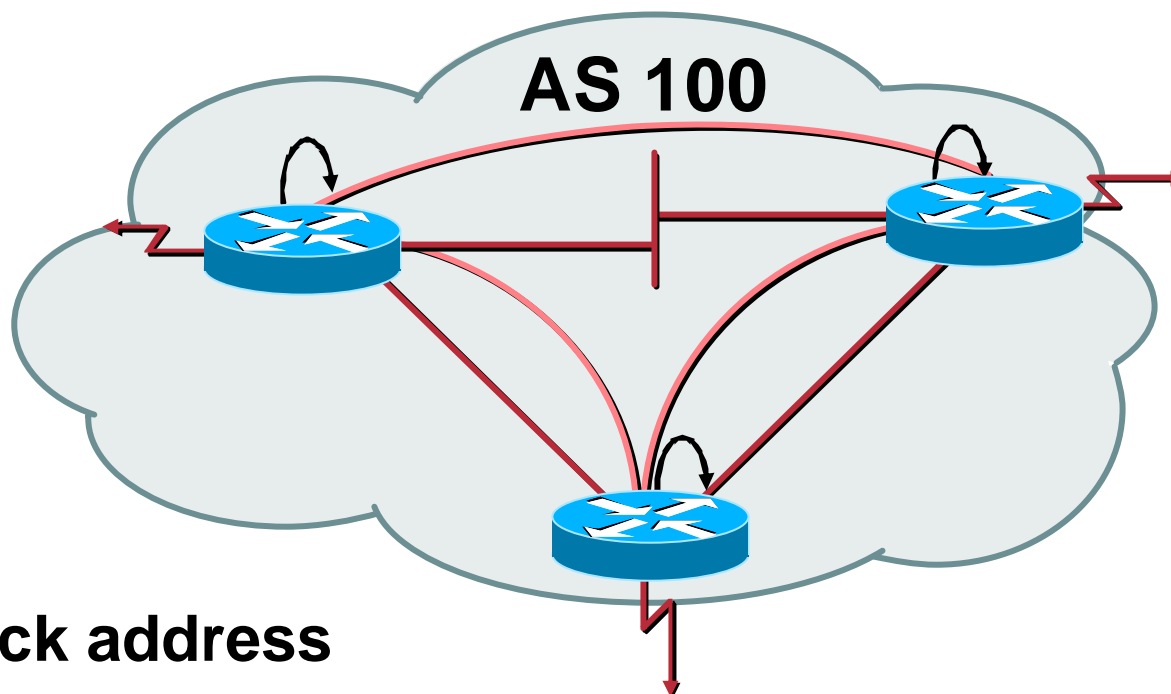
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- **Topology independent**
- **Each iBGP speaker must peer with every other iBGP speaker in the AS**

Peering to Loop-back Address

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

Configuring Internal BGP

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Router A in AS100

```
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
!
```

ip address on
loopback interface

Local ASN

Local ASN

ip address of Router B
loopback interface

Configuring Internal BGP

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Router B in AS100

```
interface loopback 0
  ip address 215.10.7.2 255.255.255.255
!
router bgp 100
  network 220.220.1.0
  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
!
```

ip address on
loopback interface

Local ASN

Local ASN

ip address of Router A
loopback interface

Inserting prefixes into BGP

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

Inserting prefixes into BGP – redistribute static

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- **Configuration Example:**

```
router bgp 100
```

```
    redistribute static
```

```
    ip route 222.10.32.0 255.255.254.0 serial0
```

- **Static route must exist before redistribute command will work**
- **Forces origin to be “incomplete”**
- **Care required!**

Inserting prefixes into BGP – redistribute static

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- 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

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- **Configuration Example**

```
router bgp 100
```

```
network 222.10.32.0 mask 255.255.254.0
```

```
ip route 222.10.32.0 255.255.254.0 serial0
```

- **A matching route must exist in the routing table before the network is announced**
- **Forces origin to be “IGP”**

Configuring Aggregation

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

Configuring Aggregation

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- **Configuration Example:**

```
router bgp 100
```

```
redistribute static
```

```
ip route 222.10.0.0 255.255.0.0 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!

Configuring Aggregation – Network Command

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- **Configuration Example**

```
router bgp 100
```

```
network 222.10.0.0 mask 255.255.0.0
```

```
ip route 222.10.0.0 255.255.0.0 null0 250
```

- **A matching route must exist in the routing table before the network is announced**
- **Easiest and best way of generating an aggregate**

Configuring Aggregation – aggregate-address command

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- **Configuration Example**

```
router bgp 100
  network 222.10.32.0 mask 255.255.252.0
  aggregate-address 222.10.0.0 255.255.0.0 [ 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

Historical Defaults – Auto Summarisation

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- **Disable historical default 1**
- **Automatically summarises subprefixes to the classful network when redistributing to BGP from another routing protocol**

Example:

61.10.8.0/22 ® 61.0.0.0/8

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

```
router bgp 100
```

```
no auto-summary
```

Historical Defaults – Synchronisation

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- **Disable historical default 2**
- **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 100  
no synchronization
```

Summary

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

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