

# APNIC eLearning: BGP Basics

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# Overview

- What is BGP?
- BGP Features
- Path Vector Routing Protocol
- Peering and Transit
- BGP General Operation
- BGP Terminology
- BGP Attributes
- Inserting Prefixes into BGP

# What is BGP?

- Border Gateway Protocol
- A Routing Protocol used to exchange routing information between different networks
  - Exterior gateway protocol
- Described in RFC4271
  - RFC4276 gives an implementation report on BGP
  - RFC4277 describes operational experiences using BGP

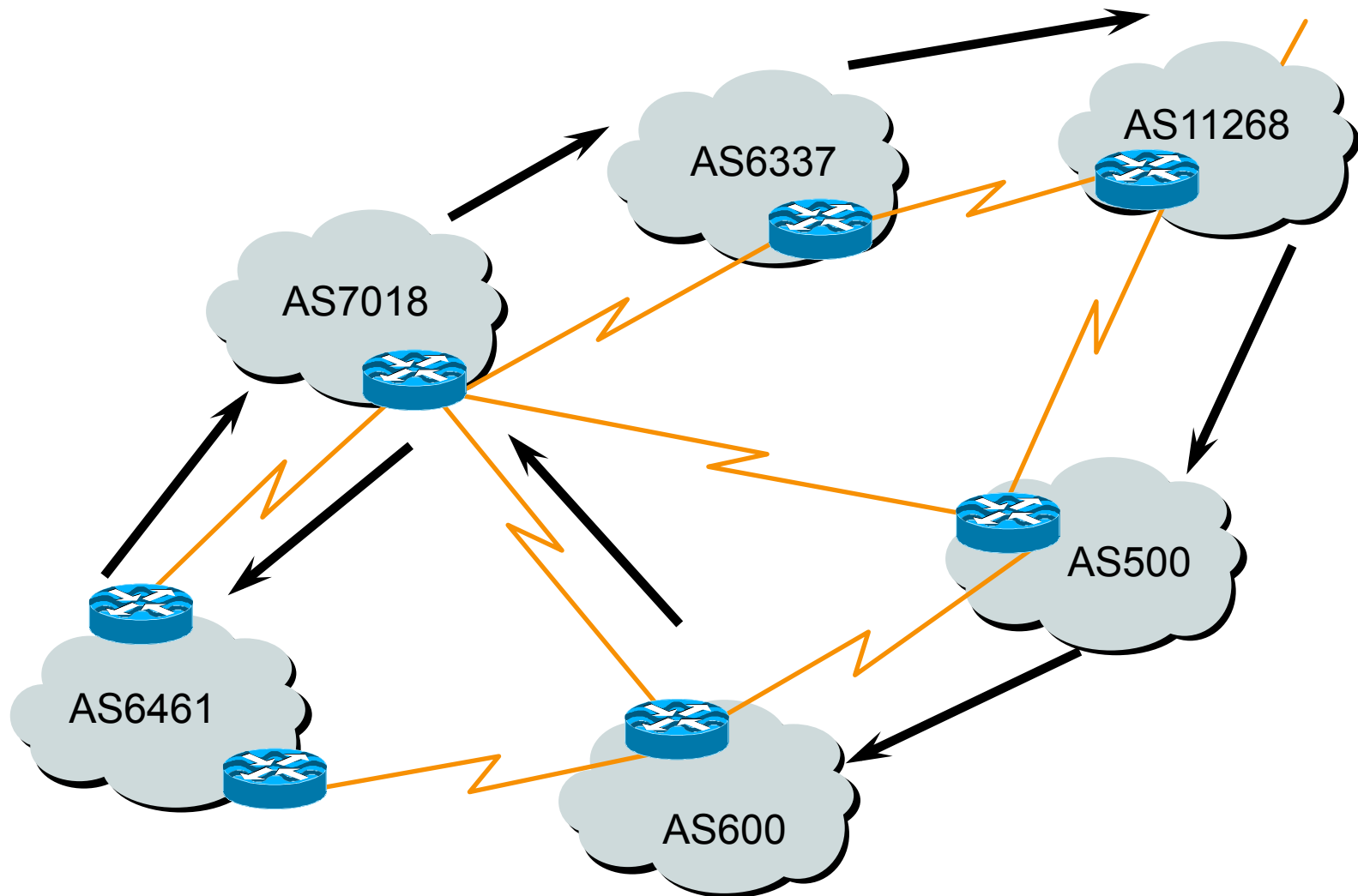
# BGP Features

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

# What is Path Vector Routing Protocol

- A path vector routing protocol is used to span different autonomous systems
- It defines a route as a collection of a number of AS that it passes through from source AS to destination AS
- This list of ASes are called AS path and used to avoid routing loop
- AS path is also used to select path to destination
- RFC 1322
  - “A path vector protocol defines a route as a pairing between a destination and the attributes of the path to that destination.”

# Path Vector Protocol



# Definitions

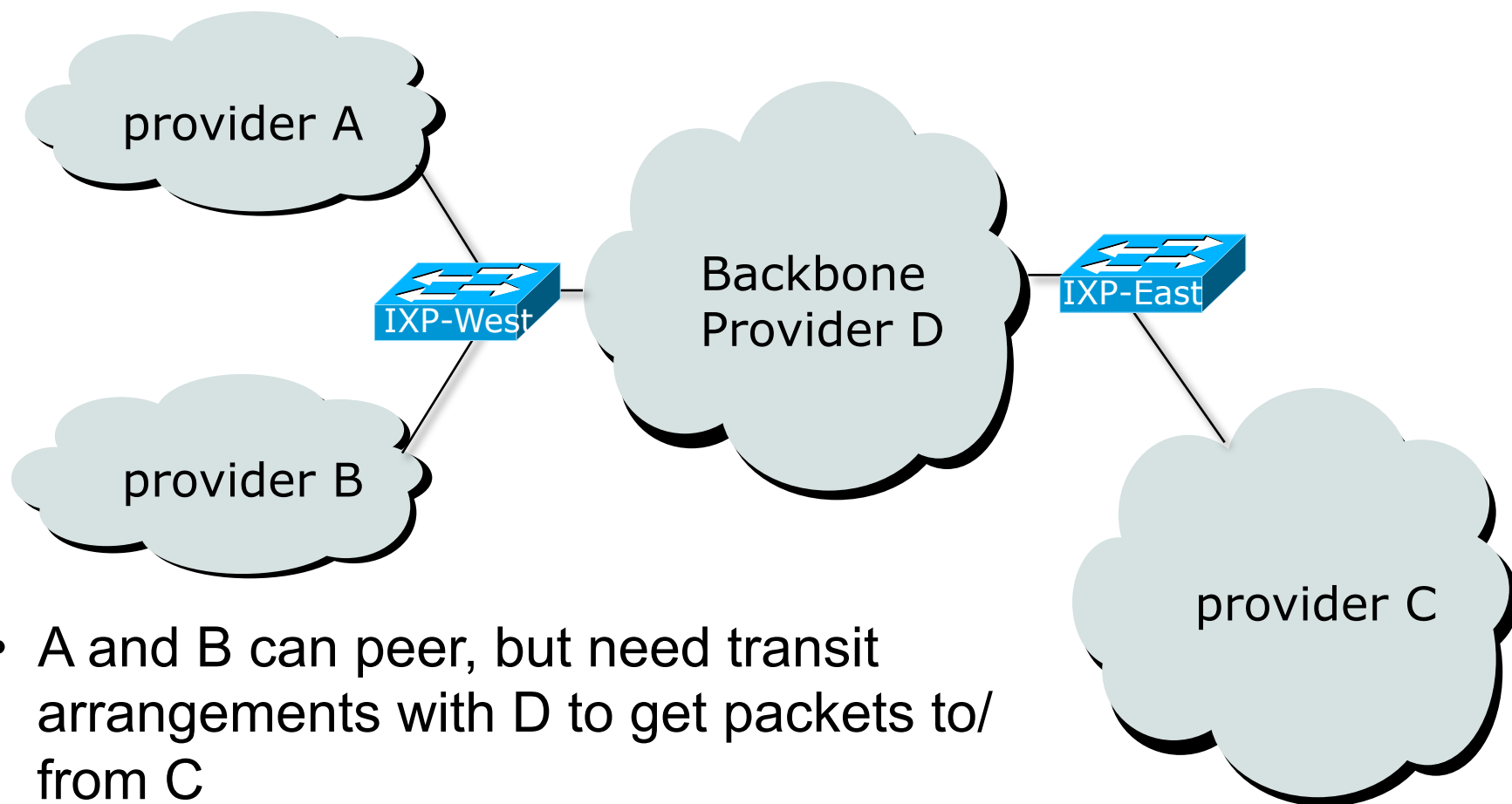
- Transit – carrying traffic across a network, usually for a fee
- Peering – exchanging routing information and traffic
- Default – where to send traffic when there is no explicit match in the routing table

# 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



# What Is An Autonomous System?

- Group of Internet Protocol-based networks with the same routing policy
  - Usually under single ownership, trust or administrative control
- The AS is used both in the exchange of exterior routing information (between neighboring ASes) and as an identifier of the AS itself
- The Autonomous System is the cornerstone of BGP
  - It is used to uniquely identify networks with a common routing policy

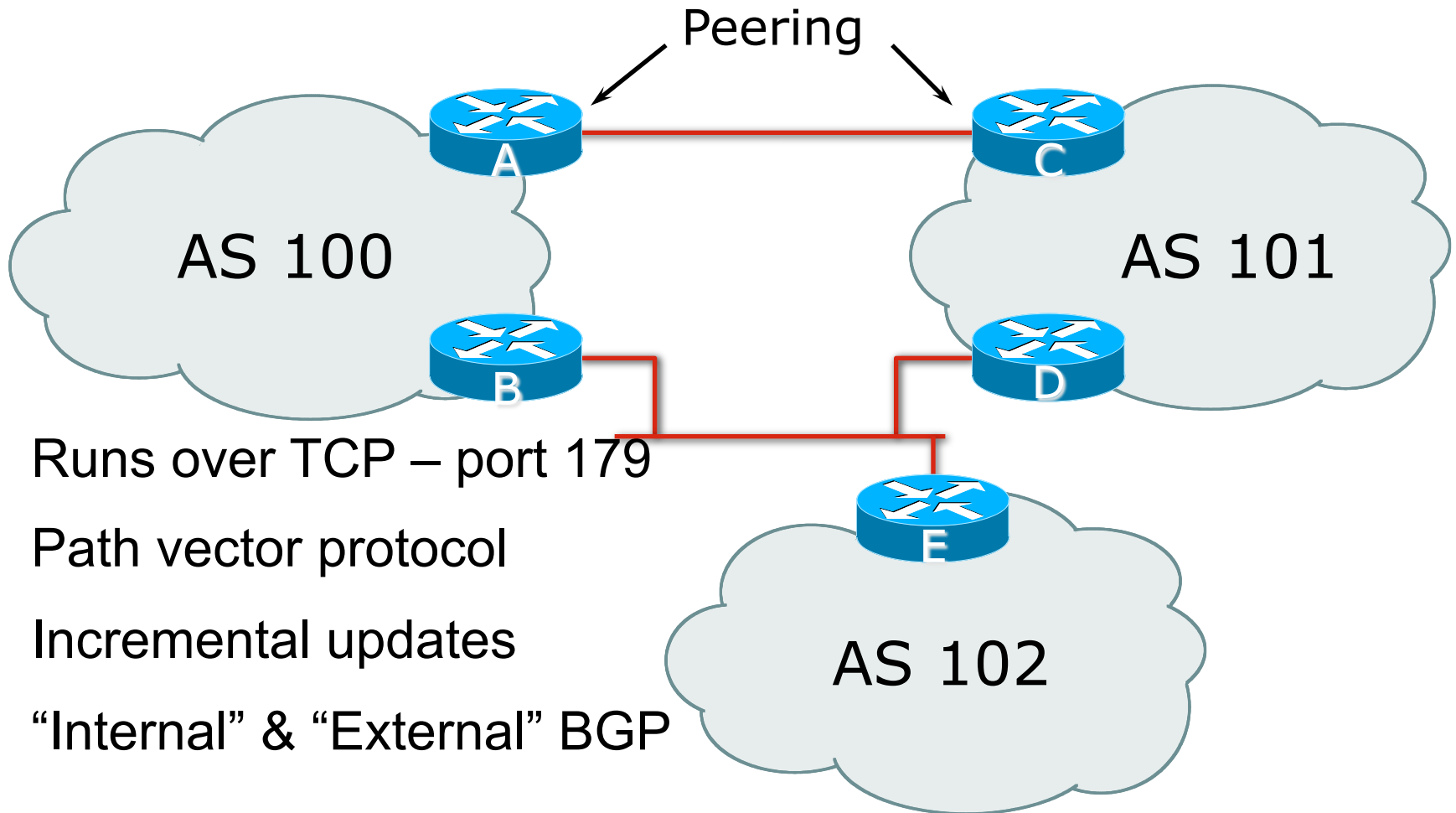
# Autonomous System Number (ASN)

- globally unique identifiers for IP networks
- ASN uniquely identifies each network on the Internet
- allocated to each Autonomous System (AS) for use in BGP routing
- 2-byte only AS number range : 0 – 65535
- 4-byte only AS number range – represented in two ways
  - AS PLAIN: 65,536 - 4,294,967,295
  - AS DOT: 1.0 - 65535.65535

# BGP General Operation

- Learns multiple paths via internal and external BGP speakers
- Picks the best path and installs it in the routing table (RIB)
- Best path is sent to external BGP neighbours
- Policies are applied by influencing the best path selection

# BGP Basics



- Runs over TCP – port 179
- Path vector protocol
- Incremental updates
- “Internal” & “External” BGP

# BGP Terminology

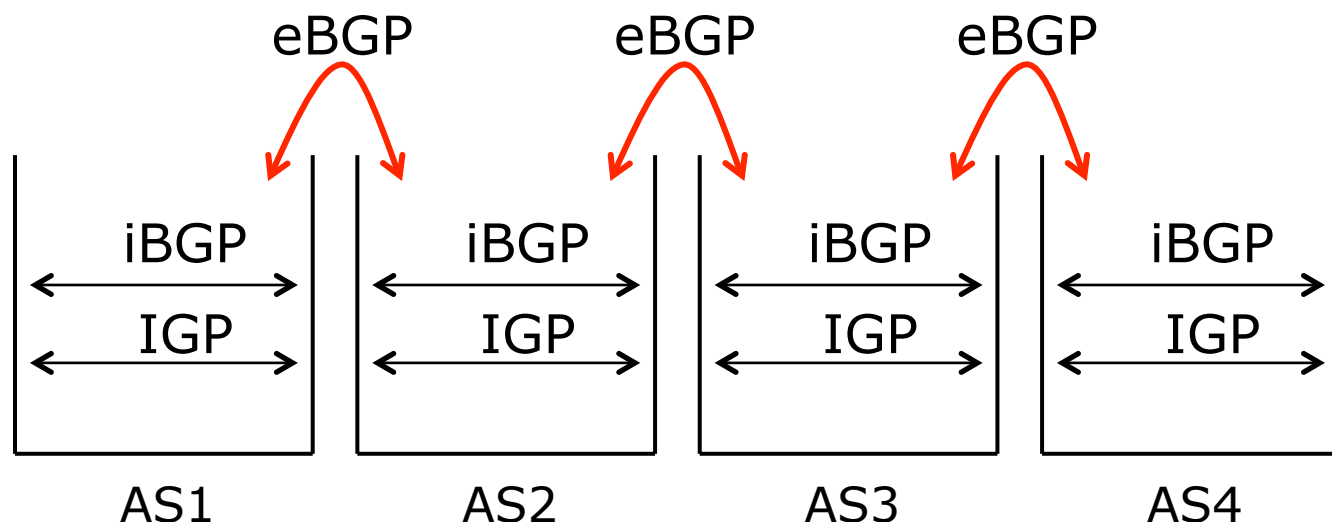
- Neighbor
  - Any two routers that have formed a TCP connection to exchange BGP routing information are called peers or neighbors
- iBGP
  - iBGP refers to the BGP neighbor relationship within the same AS.
  - The neighbors do not have to be directly connected.
- eBGP
  - When BGP neighbor relationship are formed between two peers belongs to different AS are called eBGP.
  - EBGP neighbors by default need to be directly connected.

# BGP Attributes

- Well-known attributes – must be supported by every BGP implementation
- Mandatory attributes – must be included with every route entry. If one attribute is missing, it will result in an error message
  - Ex: ORIGIN, AS\_PATH, NEXT\_HOP, LOCAL\_PREF
- Discretionary attributes – every BGP router must recognize, but they don't have to be present with every route entry
  - Ex. ATOMIC\_AGGREGATE
- Optional attributes – not necessarily supported by all BGP implementations. It can be either transitive or non-transitive.
  - AGGREGATOR, COMMUNITY, MULTI\_EXIT\_DISC

# BGP/IGP model used in ISP networks

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

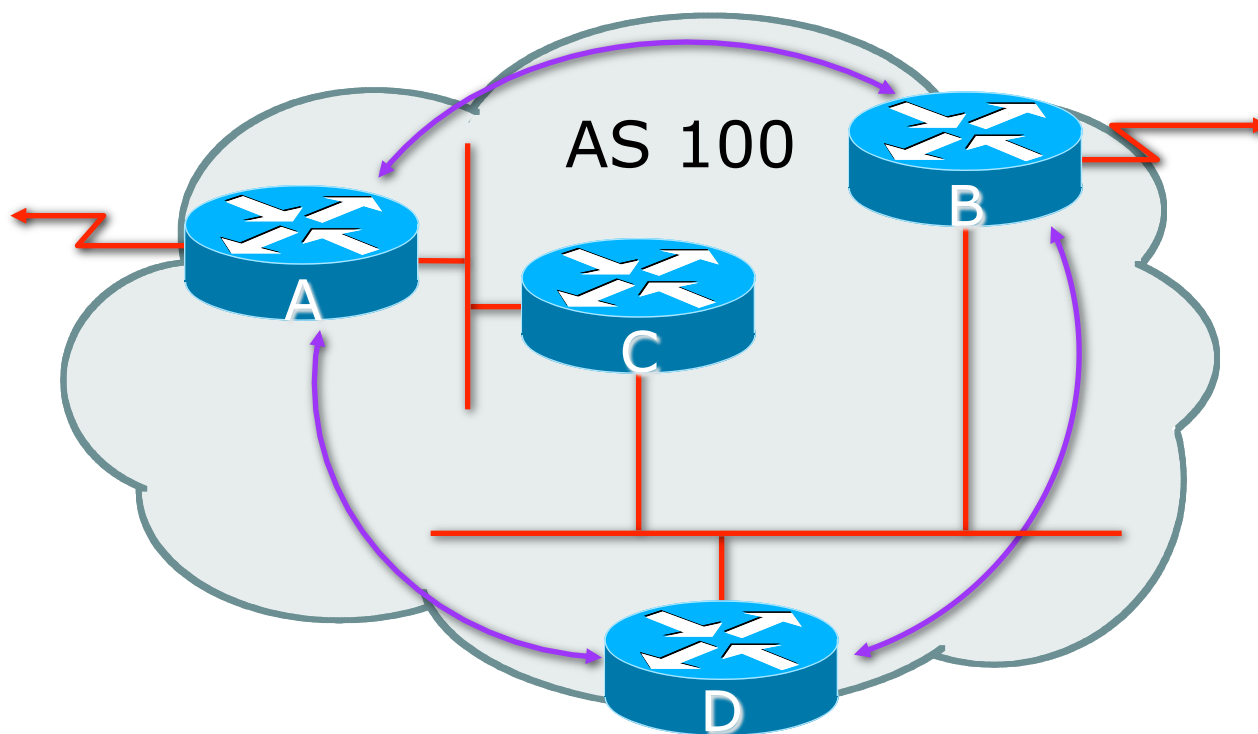




# Internal BGP (iBGP)

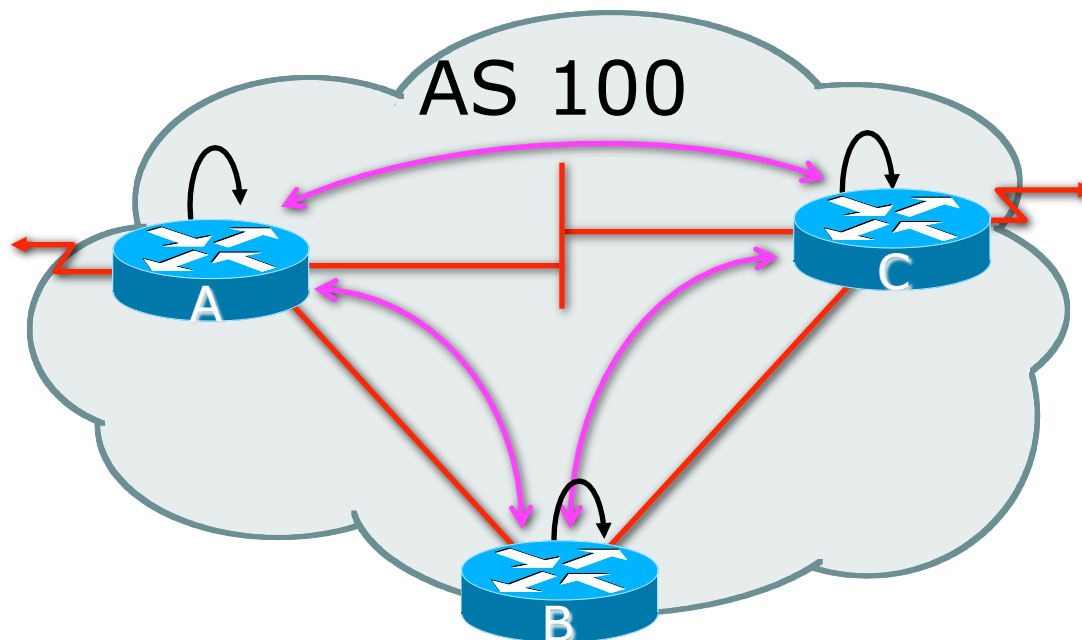
- BGP peer within the same AS
- Not required to be directly connected
  - IGP takes care of inter-BGP speaker connectivity
- iBGP speakers must be fully meshed:
  - They originate connected networks
  - They pass on prefixes learned from outside the ASN
  - They do not pass on prefixes learned from other iBGP speakers

# Internal BGP Peering (iBGP)



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

# Peering between Loopback Interfaces

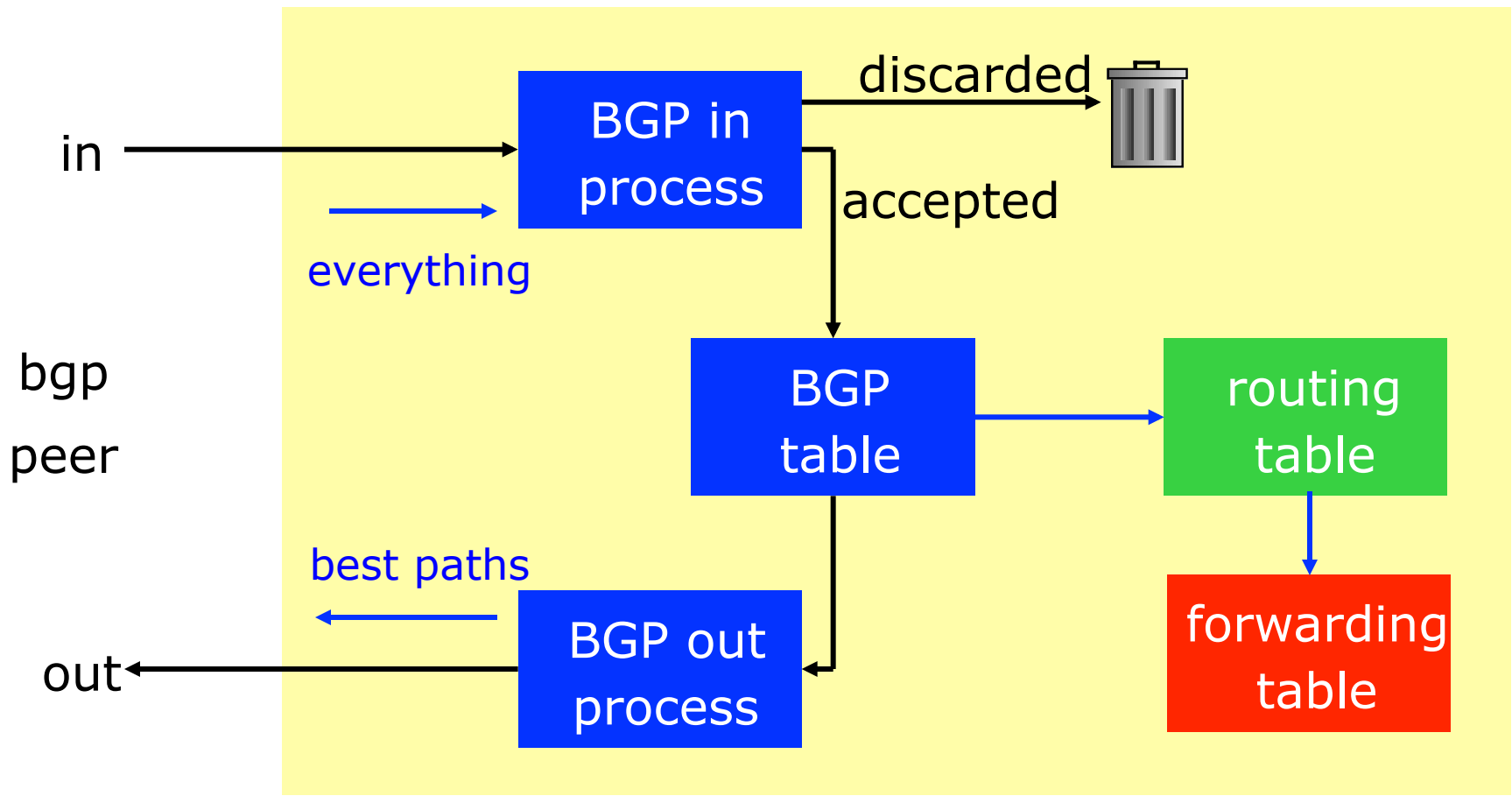


- Peer with loop-back interface
  - Loop-back interface does not go down – ever!
- Do not want iBGP session to depend on state of a single interface or the physical topology

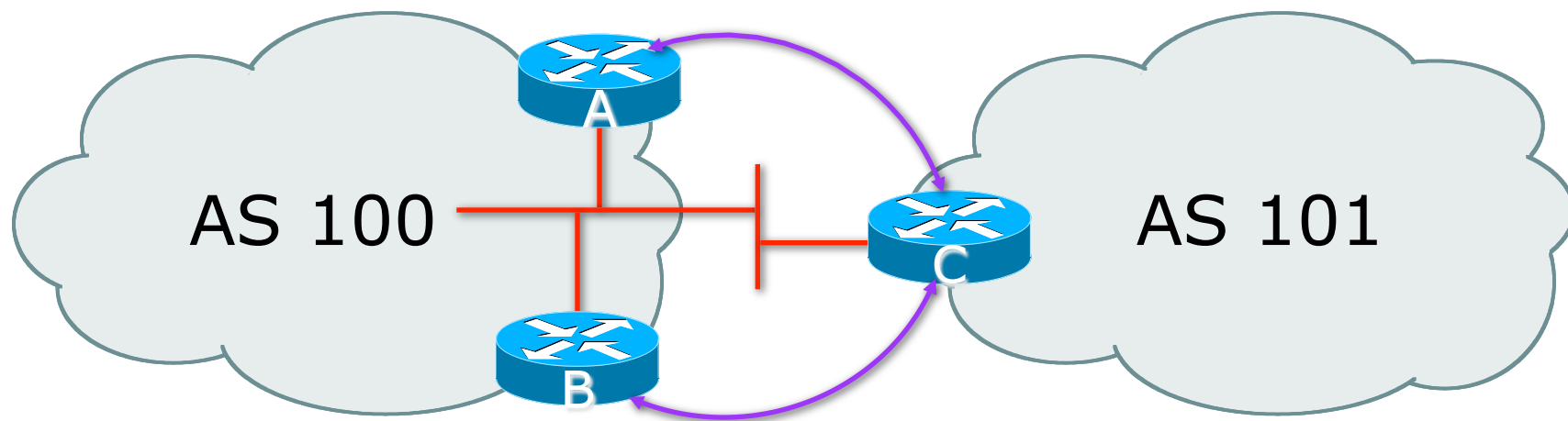
# Constructing the Forwarding Table

- 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 path stored in Routing Table (RIB)
- Best paths in the RIB are installed in forwarding table (FIB) 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
- Never run an IGP between eBGP peers

# Configuring BGP in Cisco IOS

- This command enables BGP in Cisco IOS:

```
router bgp 100
```

- For ASNs > 65535, the AS number can be entered in either plain notation, or in dot notation:

```
router bgp 131076
```

or

```
router bgp 2.4
```

- IOS will display ASNs in plain notation by default
  - Dot notation is optional:

```
router bgp 2.4
```

```
bgp asnotation dot
```

# Configuring External BGP

Router A in AS100

```
interface ethernet 5/0
  ip address 102.102.10.2 255.255.255.240
!
router bgp 100
  network 100.100.8.0 mask 255.255.252.0
  neighbor 102.102.10.1 remote-as 101
  neighbor 102.102.10.1 prefix-list RouterC in
  neighbor 102.102.10.1 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

Router C in AS101

```
interface ethernet 1/0/0
  ip address 102.102.10.1 255.255.255.240
!
router bgp 101
  network 100.100.8.0 mask 255.255.252.0
  neighbor 102.102.10.2 remote-as 100
  neighbor 102.102.10.2 prefix-list RouterA in
  neighbor 102.102.10.2 prefix-list RouterA out
!
```

ip address on  
ethernet interface

Local ASN

Remote ASN

ip address of Router  
A ethernet interface

Inbound and  
outbound filters

# Configuring Internal BGP

Router A in AS100

```
interface loopback 0
 ip address 105.3.7.1 255.255.255.255
!
router bgp 100
 network 100.100.1.0
 neighbor 105.3.7.2 remote-as 100
 neighbor 105.3.7.2 update-source loopback0
 neighbor 105.3.7.3 remote-as 100
 neighbor 105.3.7.3 update-source loopback0
!
```

ip address on  
loopback interface

Local ASN

Local ASN

ip address of Router  
B loopback interface

# Configuring Internal BGP

Router B in AS100

```
interface loopback 0
 ip address 105.3.7.2 255.255.255.255
!
router bgp 100
 network 100.100.1.0
 neighbor 105.3.7.1 remote-as 100
 neighbor 105.3.7.1 update-source loopback0
 neighbor 105.3.7.3 remote-as 100
 neighbor 105.3.7.3 update-source loopback0
!
```

ip address on  
loopback interface

Local ASN

Local ASN

ip address of Router  
A loopback interface

# Inserting prefixes into BGP – network command

- Configuration Example
  - router bgp 100
  - network 102.10.32.0 mask 255.255.254.0
  - ip route 102.10.32.0 255.255.254.0 serial0
- A matching route must exist in the routing table before the network is announced
- Forces origin to be “IGP”

# Configuring Aggregation – Network Command

- Configuration Example
  - router bgp 100
  - network 102.10.0.0 mask 255.255.0.0
  - ip route 102.10.0.0 255.255.0.0 null0 250
- A matching route must exist in the routing table before the network is announced
- Easiest and best way of generating an aggregate

# Summary

## BGP neighbour status

```
Router>sh ip bgp sum
```

```
BGP router identifier 10.0.15.246, local AS number 10
BGP table version is 16, main routing table version 16
7 network entries using 819 bytes of memory
14 path entries using 728 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 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 1795 total bytes of memory
BGP activity 7/0 prefixes, 14/0 paths, scan interval 60 secs
```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/
PfxRcd									
10.0.15.241	4	10	9	8	16	0	0	00:04:47	2
10.0.15.242	4	10	6	5	16	0	0	00:01:43	2
10.0.15.243	4	10	9	8	16	0	0	00:04:49	2
...									

BGP Version

Updates sent  
and received

Updates waiting

# Summary

## BGP Table

```
Route6>sh ip bgp
```

```
BGP table version is 30, local router ID is 10.0.15.246
```

```
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
*>i10.0.0.0/26	10.0.15.241	0	100	0	i
*>i10.0.0.64/26	10.0.15.242	0	100	0	i
*>i10.0.0.128/26	10.0.15.243	0	100	0	i
*>i10.0.0.192/26	10.0.15.244	0	100	0	i
*>i10.0.1.0/26	10.0.15.245	0	100	0	i
*> 10.0.1.64/26	0.0.0.0	0		32768	i
*>i10.0.1.128/26	10.0.15.247	0	100	0	i
*>i10.0.1.192/26	10.0.15.248	0	100	0	i
...					

# Questions

- Please remember to fill out the feedback form
  - `<survey-link>`
- Slide handouts will be available after completing the survey





# APNIC Helpdesk Chat

The screenshot displays the APNIC website's Helpdesk page. At the top left is the APNIC logo. The navigation menu includes Home, Services, Community, Events, Publications, and About us. The main content area features a 'Services' sidebar with a list of services: Registration services, Informing the community, Routing Registry, Resource certification, Training & education, Policy development, Helpdesk (selected), and Using VoIP. Below this is a list of links: Apply for resources, Become a Member, Make a payment, Manage Internet resources, and Helpdesk. The central 'Helpdesk' section provides contact information for Monday-Friday, 09:00 to 21:00 (UTC +10). It lists contact methods: Email (helpdesk@apnic.net), Phone (+61 7 3858 3188), VoIP (helpdesk@voip.apnic.net), and Fax (+61 7 3858 3199). A 'Multi-language phone support' section lists languages: Bahasa Indonesia, Bengali, Cantonese, English, Filipino (Tagalog), Hindi, and Mandarin. A 'Click here to chat' button is also present. On the right, a 'Request Live! Support' chat window is open, showing the URL livehelp.apnic.net/request.php?l=apnhlive&x=1&deptid=1&pa... and a form with fields for Name, Email, and a question, along with a 'Chat' button. Below the chat window are links for 'A-Z Glossary' and 'Contact APNIC'. A 'Helpdesk queries' section lists: APNIC's Member Services, Status of requests, Membership enquiries, Billing issues, and Database enquiries. An 'Existing members' section notes to use MyAPNIC for resources. A 'Public holidays' section and 'APNIC offices and Helpdesk' section are partially visible at the bottom.

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## Services

Services APNIC provides

- > Registration services
- > Informing the community
- > Routing Registry
- > Resource certification
- > Training & education
- > Policy development
- ▼ Helpdesk
  - Using VoIP

- ▶ Apply for resources
- ▶ Become a Member
- ▶ Make a payment
- ▶ Manage Internet resources
- ▶ Helpdesk

## Helpdesk

Monday - Friday  
09:00 to 21:00 (UTC +10)

**Email**  
helpdesk@apnic.net

**Phone**  
+61 7 3858 3188

**VoIP**  
helpdesk@voip.apnic.net

**Fax**  
+ 61 7 3858 3199

**Multi-language phone support**  
Bahasa Indonesia, Bengali, Cantonese, English, Filipino (Tagalog), Hindi, and Mandarin.

**APNIC Live Chat Online**  
Click here to chat

Request Live! Support  
livehelp.apnic.net/request.php?l=apnhlive&x=1&deptid=1&pa...

## APNIC Helpdesk Chat

Welcome to our Live Chat.

Name:

Email:

What is your question?

Chat

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- ▶ A-Z Glossary
- ▶ Contact APNIC

## Helpdesk queries

**APNIC's Member Services**  
Helpdesk can assist you receive faster responses for:

- Status of requests
- Membership enquiries
- Billing issues
- Database enquiries

**Existing members**  
Please use MyAPNIC to apply for resources.

## Public holidays

**APNIC offices and Helpdesk**

# Thank you!

End of Session

**APNIC**

