BGP Common Rules and Regulations

BGP Split Horizon Rule:

- The Split Horizon Rule **applies strictly** in iBGP.
- Routes learned from one iBGP peer **are not advertised** to another iBGP peer.

  - The Split Horizon Rule **does not apply** in the same strict way for eBGP.
  - Routes learned from one eBGP peer **can be advertised** to another eBGP peer. In fact, this is the primary function of eBGP: to exchange routing information between ASes.
  - However, the rule still applies **within the context of a single eBGP session**: routes learned from one eBGP peer are not advertised back to the same eBGP peer

Concept of Update source Loopback:

- When you configure update-source loopback, BGP uses the **loopback interface** IP address as the source for its packets.
- In large networks using iBGP, sessions are often **established using loopback addresses** to ensure reachability and session stability.
- **Condition-** *When creating a BGP adjacency using loopback interfaces, the loopback IP addresses must be reachable via an **IGP (Interior Gateway Protocol),** such as OSPF, EIGRP, IS-IS, or RIP, or through static routes.*
- When BGP attempts to establish a session with a peer using the loopback address, it needs to validate the *peer's address through the routing table.* If the loopback IP is not reachable, the session will not form.

Problems with iBGP Full Mesh:

The number of iBGP neighbors increases quadratically with the number of routers:

- **Formula**: Number of connections=n(n−1)2,
  where n is the number of routers.

- For example:

  - 3 routers require 3 connections.
  - 10 routers require 45 connections.
  - 50 routers require 1225 connections.

The use of **Route Reflectors** and **BGP Confederations** is the industry-standard approach to overcome these challenges.

How Route Reflectors Work

A Route Reflector works by allowing a router (the Route Reflector) to **reflect routes between iBGP peers** that are not directly connected to each other. Here's how the process works:

1. **Route Reflector (RR)**:
   - A router that **reflects BGP routes** to other iBGP routers (known as **clients**).
   - It can also accept routes from its **clients** and propagate them to other routers in the network.
   - The RR helps bypass the need for a full mesh by allowing a router to advertise routes to other routers even if they are not directly connected.
2. **Route Reflector Clients (RR Clients):**
   - These are iBGP routers that peer with the Route Reflector (RR).
   - They do **not need to be connected directly** to other iBGP routers as the RR reflects the routes to them.
   - Each RR client can still learn routes from the other routers in the network through the RR.
3. **Non-Clients**:
   - These routers do not participate in route reflection, but they can receive routes from an RR via the normal iBGP process.

Route Reflection Process

- **Step 1**: When a Route Reflector receives a route from a client, it **reflects the route** to all other clients and non-client routers in the AS.
- **Step 2**: If the RR receives a route from a non-client, it **propagates it to all its clients**.
- **Step 3**: The RR does not reflect routes it receives from other RRs to its own clients to prevent route loops (to avoid circular route reflection).

Concept of Next-Hop in iBGP:

iBGP (Internal BGP): When an iBGP router advertises a route to another iBGP peer:

- The **next-hop IP address** is **not changed**.
- It remains the **same as the original next-hop** received from an eBGP neighbor or another iBGP neighbor.

Concept of Next-Hop in eBGP:

eBGP (External BGP): By default, when an eBGP router advertises a route to an eBGP neighbor, the next-hop IP address is changed to the IP of the router sending the update. This behaviour is due to the assumption that the two eBGP routers are directly connected.

"The **next-hop-self command** can be configured on iBGP peers. This command forces the router to change the next-hop IP address to its own IP when advertising the route to its iBGP neighbors."

Purpose of the eBGP Multi-Hop Command:

The 'ebgp-multihop' command allows an eBGP session to be established over **multiple hops** by increasing the TTL value for BGP packets.

1. **Default Behaviour**: eBGP packets use a TTL of **1**, meaning the router must be directly connected to its neighbor.
2. **When Needed**: When eBGP peers are **more than one hop away**, the TTL value needs to be increased to allow packets to traverse intermediate routers.

*** When establishing eBGP Sessions between 2 loopback interfaces on a router, always run **"disable-connected-check"** command, this will by-pass the default behaviour of eBGP and neighborship (eBGP) will form between 2 Loopback interfaces. ***
don't forget to run update-source loopback command also

BGP Attributes

Well known Mandatory- **MUST BE PRESENT** in every BGP update message for it to be valid

1. **AS_PATH**

- **Description**: Lists the sequence of Autonomous Systems (ASes) that a route has traversed.
- **Purpose**: Used to prevent routing loops and to determine the shortest AS path for route selection.
- **Example**: *AS_PATH: 65001 65002 65003 indicates the route traversed through ASes 65001, 65002, and 65003.*

2. **NEXT_HOP**

- **Description**: Specifies the IP address of the next-hop router to reach the destination.
- **Purpose**: Tells the receiving router how to forward packets toward the destination.
- **Example**: NEXT_HOP: 192.0.2.1 indicates that 192.0.2.1 is the next router to forward traffic to.

3. **ORIGIN**

- **Description**: Indicates the origin of the route, i.e., how BGP learned about the route.
- **Values**:
    - IGP (i): Route originated within the same AS using an IGP (e.g., OSPF, RIP).
    - EGP (e): Route originated via an Exterior Gateway Protocol.
    - INCOMPLETE (?): Route was learned through other means (e.g., static route, route redistribution).
- **Purpose**: Helps in route preference and decision-making.
- **Example**: ORIGIN: IGP shows the route is internal to the AS.

Well-Known Discretionary- **NOT MANDATORY** to be included in every BGP update message.

4. **LOCAL_PREF (Local Preference)**

- **Description**: Indicates the degree of preference for a route within the same AS. Higher values are preferred.
- **Purpose**: Used for influencing outbound traffic within an AS.

- **Default Behaviour**: If not explicitly set, the default value is 100.
- **Example**: LOCAL_PREF: 200 indicates this route is preferred over others with a lower LOCAL_PREF.

5. **ATOMIC_AGGREGATE**

- **Description**: Signals that the route information has been aggregated and may not include the full AS path details.
- **Purpose**: Used to indicate that some detailed information about the route (e.g., specific prefixes) has been intentionally omitted during route aggregation.
- **Example**: When present, it informs peers that the route has been summarized.

Optional Transitive - May or may not be recognized by all BGP implementations. Marked as partial if not recognize by BGP routers.

6. **AGGREGATOR**

- **Description**: Identifies the AS and router that performed route aggregation.
- **Fields**:
    - The AS number of the aggregator.
    - The IP address of the router that aggregated the route.
- **Purpose**: Helps in troubleshooting and understanding the origin of aggregated routes.
- **Example**: AGGREGATOR: AS 65001, IP 192.0.2.1.

7. **COMMUNITY**

- **Description**: Used to tag routes with information that can influence routing decisions. Communities are 32-bit values, often represented in the format [AA:NN.]
- **Purpose**: Provides flexibility for route policies, such as controlling advertisement to specific neighbors or modifying attributes like LOCAL_PREF.
- **Common Examples**:
    - no-export (65535:65281): Prevents route advertisement outside the local AS.
    - no-advertise (65535:65282): Prevents route advertisement to any peers.
- **Example**: COMMUNITY: 65001:100

Optional non-transitive - **Are not forwarded to other BGP peers if the receiving router does not recognize them**. These attributes are locally significant to a BGP peer and are not propagated across AS boundaries.

8. **MULTI_EXIT_DISC (MED)**

- **Description**: Used to indicate the preferred path into an AS when multiple entry points are available.
- **Purpose**: Helps in influencing inbound traffic by advertising a preference for one route over another.
- **Behavior**:
  - Lower values are preferred.
  - Only compared when routes are received from the same neighboring AS.
- **Example**: MULTI_EXIT_DISC: 50 indicates this path has a higher preference compared to one with MULTI_EXIT_DISC: 100.

9. **ORIGINATOR_ID**

- **Description**: Identifies the router ID of the originator of a route in a BGP route reflector environment.
- **Purpose**: Helps in preventing routing loops in route reflector setups.
- **Example**: ORIGINATOR_ID: 192.0.2.1.

10. **CLUSTER_LIST**

- **Description**: Contains the list of route reflector cluster IDs that the route has traversed.
- **Purpose**: Used in route reflector setups to detect and prevent routing loops.
- **Example**: CLUSTER_LIST: 192.0.2.1, 192.0.2.2.

Path Attributes (order wise):

1) **WEIGHT (Cisco-specific attribute)**

- **Description**: A Cisco-proprietary attribute used to influence outbound traffic locally on a single router.
- **Default Value**: 0 (except for locally originated routes, which have a default weight of 32768).

- **Preference**: Higher weight is preferred.
- **Scope**: Local to the router; not propagated to other routers.

---

2. LOCAL_PREF (Local Preference)

- **Description**: Determines the preferred path for outbound traffic within an AS.
- **Default Value**: 100.
- **Preference**: Higher values are preferred.
- **Scope**: Propagated within the local AS.

---

3. AS_PATH

- **Description**: Lists the sequence of ASes a route has traversed.
- **Default Value**: Not explicitly set; varies based on route advertisement.
- **Preference**: Shorter AS_PATH is preferred (fewer AS hops).
- **Scope**: Propagated across AS boundaries.

---

4. ORIGIN

- **Description**: Indicates how BGP learned about the route.
- **Default Value**: IGP for routes injected using network commands.
- **Preference**: IGP < EGP < INCOMPLETE. (i<e<?)
- **Scope**: Propagated across AS boundaries.

---

5. MULTI_EXIT_DISC (MED)

- **Description**: Influences inbound traffic by advertising a preference for one route over others.
- **Default Value**: 0 (if MED is explicitly set, else treated as absent).
- **Preference**: Lower values are preferred.
- **Scope**: Compared only between routes from the same neighboring AS; not propagated across AS boundaries. Mainly used between **eBGP peers**

---

6. eBGP vs. iBGP (Prefer eBGP)

- **Description**: External BGP (eBGP) routes are preferred over internal BGP (iBGP) routes.
- **Default Value**: None (depends on the type of peering).
- **Preference**: eBGP is preferred.

---

7. IGP Metric (Interior Gateway Protocol Metric)

- **Description**: Refers to the cost of the path to the NEXT_HOP as calculated by the IGP.
- **Default Value**: Depends on the IGP metric.
- **Preference**: Lower IGP metric to the NEXT_HOP is preferred.
- **Scope**: Local to the AS.

---

8. Router ID

- **Description**: Used as a tiebreaker when all other attributes are equal.
- **Default Value**: Router ID is chosen based on the highest IP address of any active interface, unless explicitly configured.
- **Preference**: Lower router ID is preferred.

Precise Summary:

- Prefer the highest weight **(Cisco-specific and local to the router).**
- Prefer the highest local preference **(applies within the AS).**
- Prefer the route originated by the local router **(originated using a network or aggregate command**).
- Prefer the path with the shorter AIGP metric **(Accumulated Interior Gateway Protocol, if used).**
- Prefer the shortest AS_PATH **(fewer AS hops).**
- Prefer the best Origin code **(IGP < EGP < INCOMPLETE).**
- Prefer the lowest multi-exit discriminator (MED) **(compared only for routes from the same neighboring AS).**
- Prefer an external path over an internal path **(eBGP > iBGP).**
- Prefer the path through the closest IGP neighbor **(lowest IGP metric to the NEXT_HOP).**
- Prefer the path from the oldest eBGP session **(ensures stability).**
- Prefer the path with the lowest neighbor BGP Router ID (RID) **(used as a tiebreaker).**
- Prefer the path with the minimum cluster list length (avoids route reflector loops).
- Prefer the path with the lowest neighbor IP address **(final tiebreaker).**

Creating Route Maps using Prefix List

Prefix lists are used to match specific routes (IP prefixes).

Syntax: (First Step)

ip prefix-list **<PREFIX_LIST_NAME>** seq **<SEQ_NUMBER>** {permit | deny} **<NETWORK/MASK_LENGTH>** [ge <GE_VALUE>] [le <LE_VALUE>]

Example: - ip prefix-list MY_PREFIX_LIST seq 10 permit 192.168.1.0/24 le 32

Sequence Number- specifying the order in which entries are evaluated. Lower sequence numbers are evaluated first.

(Second Step)
route-map **<ROUTE_MAP_NAME>** {permit | deny} **<SEQ_NUMBER>**

match ip address prefix-list **<PREFIX_LIST_NAME>**

set **<ATTRIBUTE> <VALUE>**

Prefix List name should be same

Example: - route-map SET_LOCAL_PREF permit 10

match ip address prefix-list MY_PREFIX_LIST

set local-preference 200

(Third Step)
Attach the route map to the BGP configuration using neighbor or network statements.

router bgp **<ASN>**
neighbor **<PEER_IP>** route-map SET_LOCAL_PREF in

Route Map Name must be same

Feature	Default Behaviour in iBGP	Default Behaviour in eBGP
Topology Requirement	Requires **full-mesh** connectivity among all iBGP peers (due to the split-horizon rule).	No full-mesh requirement; peers are typically directly connected.
Split-Horizon Rule	Routes learned from one iBGP peer are **not advertised** to another iBGP peer.	Routes learned from one eBGP peer are advertised to other eBGP and iBGP peers.
Next-Hop Attribute	Retains the **next-hop** attribute of routes as advertised by an eBGP peer.	Automatically changes the next-hop to the router's local interface IP when advertising.
AS-Path Attribute	Does not modify the **AS-Path** attribute.	Adds the local AS number to the **AS-Path** attribute.
Administrative Distance	Default is **200**, making iBGP less preferred than eBGP and IGP routes.	Default is **20**, making eBGP more preferred than iBGP and IGP routes.
Hold Timer	Default is **180 seconds**.	Default is **180 seconds**.
Keepalive Timer	Default is **60 seconds**.	Default is **60 seconds**.
Loop Prevention	Relies on the **split-horizon rule** to prevent routing loops within the same AS.	Uses the **AS-Path** attribute to prevent loops (rejects routes containing the local AS).
Route Advertisement	Does not advertise routes learned from one iBGP peer to another iBGP peer.	Advertises routes learned from iBGP or eBGP peers to other peers.
MED Propagation	Propagates the **MED** attribute only within the same AS (not across AS boundaries).	Propagates the **MED** attribute to external peers (if explicitly configured).
Local Preference	Assigns a **default Local Preference** of **100** to all routes within the AS.	Does not use Local Preference; the attribute is ignored in eBGP path selection.
Weight Attribute	Default weight is **0** for iBGP-learned routes.	Default weight is **32768** for locally originated routes (highest priority).
Path Selection	Prefers paths with the highest **Local Preference** and shortest IGP cost to the next hop.	Prefers paths with the shortest **AS-Path** and lowest IGP cost to the next hop.
Route Redistribution	Requires explicit configuration for redistribution into IGP protocols (e.g., OSPF, EIGRP).	Requires explicit configuration for redistribution into IGP protocols.

Transport Protocol	Uses **TCP port 179** for establishing BGP sessions.	Uses **TCP port 179** for establishing BGP sessions.
BGP Session Establishment	Peers must be manually configured; iBGP does not assume direct connectivity.	Peers are expected to be **directly connected** unless explicitly configured otherwise.
TTL (Time to Live)	Default TTL is **255**, allowing multi-hop BGP sessions without additional configuration.	Default TTL is **1**, requiring directly connected peers unless multi-hop is configured.
Multipath Support	Supports **Multipath** for equal-cost paths if explicitly enabled.	Supports **Multipath** for equal-cost paths if explicitly enabled.
Router ID Selection	Uses the highest IP address of active interfaces or manually configured router-id.	Uses the highest IP address of active interfaces or manually configured router-id.
Route Reflector Support	Requires **Route Reflectors** or Confederations for scalability due to the full-mesh rule.	Route Reflectors are not required as eBGP peers communicate directly.
Policy Enforcement	Relies on manually configured **route-maps**, **prefix lists**, or **filter policies**.	Relies on manually configured **route-maps**, **prefix lists**, or **filter policies**.

Commands:

show ip bgp summary
show ip bgp neighbors <neighbor-ip>

show ip bgp neighbors <neighbor-ip> advertised-routes

show ip bgp neighbors <neighbor-ip> received-routes

show ip bgp prefix-list <prefix-list-name>

show ip bgp vpnv4 all ***(for MPLS VPNv4 Routes)***

show bgp vpnv4 unicast all summary **(will show unicast routes)**

show run | section router bgp **(this will show configuration of BGP)**

Default Behaviour of BGP communities

BGP Community	Hex Value	Decimal Value	Leaves AS?	Works Inside AS?	Description
No-Advertise	0xFFFFFF02	65535:65282	No	Yes	Prevents route advertisement to any BGP peer.
No-Export	0xFFFFFF01	65535:65281	No	Yes	Prevents route from being advertised to eBGP peers (stays within the local AS).
No-Export Subconfed	0xFFFFFF03	65535:65283	No	Yes	Prevents route from being advertised outside a BGP confederation sub-AS.
Local-AS	0xFFFFFF04	65535:65284	No	Yes	Prevents route from being advertised outside the local AS and confederation.
Standard BGP Communities	Defined by operator	Defined by operator	☑ Yes (if configured)	☑ Yes (if configured)	Used for tagging and applying routing policies, behavior depends on configuration.

****** Communities are applied using route-maps. *******

Some Question and Answers (FAQ):

Q-1 **"The Weight Attribute"** in BGP is always applied in Customer Environment Router? true or false?

True.

The **Weight attribute** in BGP is a **Cisco-proprietary** attribute used for path selection. It is **local to the router** and is **not advertised to other BGP peers**.

In a **customer environment**, typically:

- The **customer's router** (CPE) receives multiple BGP routes from its **ISP(s)**.
- The **Weight** attribute is used by the **customer's router** to prefer one path over another.
- Since **Weight is not propagated**, it is only relevant to the **local router** where it is configured.

Q-2 Can the **Weight attribute** in BGP work within an (AS), or can it propagate to an external AS?

The Weight attribute in BGP only works inside an AS and does NOT propagate to other ASes.

Weight is strictly a **local attribute** and never leaves the router where it is set. If you need to influence routing inside your AS, use "Local Preference" instead.

Q-3 Does "Weight" attribute affects Inbound Path or Outbound Path? *For example,* you have 2 ISR Customer Edge Routers R1 and R2 connected with ISP-1 and ISP-2 respectively?

✅ **BGP Weight affects the Outbound Path (Egress Traffic) from the local router.**

Example Scenario: Two Customer Edge Routers (R1 & R2) Connected to Different ISPs

Network Setup: ←← --------------------------------------- ***Interview Question***

- R1 (CE Router) → ISP-1 (BGP Peer 1)
- R2 (CE Router) → ISP-2 (BGP Peer 2)
- Both R1 and R2 are in the same AS (Customer AS 65001).
- Both receive the same route (e.g., 8.8.8.0/24) from ISP-1 and ISP-2.

Applying BGP Weight to Control Outbound Traffic

- By default, BGP chooses the best route based on its path selection process.
- If we want R1 to prefer sending traffic via ISP-1, we **configure higher Weight on R1** for routes received from ISP-1.
- If we want R2 to prefer ISP-2, we configure higher Weight on R2 for routes from ISP-2.

Configuration on R1:

```
router bgp 65001
 neighbor x.x.x.x remote-as 100  # ISP-1
 neighbor y.y.y.y remote-as 200  # ISP-2
 !
# Set higher weight for routes received from ISP-1
ip prefix-list PREFER_ISP1 seq 5 permit 0.0.0.0/0 le 32
route-map SET_WEIGHT permit 10
 match ip address prefix-list PREFER_ISP1
 set weight 5000
!
neighbor x.x.x.x route-map SET_WEIGHT in
```

This setting does NOT affect R2 or inbound traffic from ISPs.

Q-4 What exactly is Inbound and Outbound Traffic. Explain

Inbound Traffic = Data coming into your network from the internet.
Outbound Traffic = Data going out from your network to the internet.

Q-5 what is this "in" and "out" when we apply route maps in BGP? what exactly does this? and which attribute requires "in" and "out" parameters in BGP attributes.

- "in" (Inbound): Affects routes received from a BGP neighbor.
- "out" (Outbound): Affects routes sent to a BGP neighbor.

How "in" and "out" Work?

- **Route Map "in" (Inbound)** → Modifies routes received **from** the BGP neighbor **before** they enter the BGP table.
- **Route Map "out" (Outbound)** → Modifies routes **before** they are sent **to** a BGP neighbor.

⇒ Attributes like **Weight & Local Preference** are applied inbound.
⇒ Attributes like **AS Path Prepending & MED** are applied outbound.

(In Real World Enterprise)

BGP Attribute	Applies "in" or "out"?	Common Usage
Weight	in (Inbound)	Affects outbound traffic (local router only)
Local Preference	in (Inbound)	Influences outbound traffic (inside AS)
AS Path Prepending	out (Outbound)	Influences inbound traffic
MED (Multi-Exit Discriminator)	out (Outbound)	Suggests a preferred inbound path to another AS
Prefix Filtering	in / out	Controls which routes are received/sent
Community Tags	in / out	Used for route control with ISPs

Q-6 Can **Local Preference** Attribute in BGP works Inside AS or it can Propagate to Outside AS?

✅ Local Preference (LOCAL_PREF) works inside an AS and is propagated within the AS.
❌ It does NOT propagate outside the AS.

- Used inside an AS to influence outbound traffic.
- Higher Local Preference = More preferred path.
- Propagated to all routers within the AS via iBGP.

Consider the Previous example from Question-3:

- **Customer AS 65001** has two exit points:
  - **R1** (connected to ISP-1)
  - **R2** (connected to ISP-2)
- Both R1 and R2 receive the same route (e.g., 8.8.8.0/24) from their respective ISPs.

Applying Local Preference (Inbound) on R1

To **prefer ISP-1 for outbound traffic**, set a **higher Local Preference** on R1:

Configuration on R1:

```
router bgp 65001
 neighbor 192.168.1.1 remote-as 100   # ISP-1
 neighbor 192.168.2.1 remote-as 200   # ISP-2
 neighbor 192.168.1.1 route-map SET_LOCAL_PREF in
!
route-map SET_LOCAL_PREF permit 10
 set local-preference 300
```

Now what will happen:

- All routers in **AS 65001** will prefer R1 (ISP-1) for **outbound traffic**.
- Local Preference is **shared inside AS 65001** via **iBGP**.
- **ISP-1 and ISP-2 do NOT see Local Preference** because it is not sent over eBGP.

Q-7 How **IGP Metric** helps in BGP Running Environment for choosing best path or Shifting the Internet traffic on different links. Explain

(v.v Important Interview Question)

Role of IGP in a BGP:

- BGP itself **does not know about physical link costs** or internal network topology.
- BGP relies on **IGP (OSPF, EIGRP, IS-IS, etc.)** to **resolve next-hop reachability**.
- If multiple BGP routes exist, the **IGP metric helps decide the best exit point** within the AS

How IGP Metric Affects BGP Path Selection?

When BGP has multiple equal-cost external routes, the router checks:
✅ **IGP Metric to Next-Hop →** The path with the lowest IGP metric to the next-hop BGP router is preferred.

Example Scenario

Network Setup:

- AS 65001 (Customer AS) has two exit points:
  - R1 → ISP-1 (BGP Peer 100)
  - R2 → ISP-2 (BGP Peer 200)
- R3 (Core Router) receives two identical BGP routes (8.8.8.0/24) from R1 and R2.
- OSPF runs inside AS 65001 to distribute reachability information.
- IGP Metrics:
  - R3 → R1 = OSPF Cost 10
  - R3 → R2 = OSPF Cost 20

🔹 BGP Path Selection:

- Since R3 → R1 has a lower IGP metric (10) than R3 → R2 (20), BGP will prefer sending outbound traffic via R1 → ISP-1.

IGP metrics can be adjusted dynamically to shift BGP traffic between different links.

Traffic Shifting Example: **Manual Change**

- If we want to shift traffic from ISP-1 to ISP-2, we increase **R3 → R1 OSPF Cost** (e.g., from 10 to 30).
- Now, R3 sees R2 as the better path (Cost 20) and switches outbound traffic to ISP-2.

Q-8 When Does a BGP Router Use the IGP Metric to Change Paths?

BGP **does not directly use IGP metrics** unless certain conditions are met.

The decision to use the IGP metric in BGP path selection depends on:

- **BGP Next-Hop Reachability** (Mandatory)
- **BGP Best Path Selection Process** (Step #9) *[Prefer the path through the closest IGP neighbor]*
- **Manual Configuration by an Admin (Optional for Traffic Engineering)**

BGP Next-Hop Reachability (Mandatory Condition) **[Very Important Concept]**

- **Before selecting a path, BGP first checks if the next-hop IP address is reachable**.
- BGP itself does **not perform dynamic link cost calculations**; it relies on ***IGP (OSPF, EIGRP, IS-IS) or static routes*** *to determine reachability.*
- If a BGP next-hop is **not reachable via IGP**, that BGP route is ignored.

✅ **Example:**

- A router receives two BGP paths:
    - **Path A → Next-hop: 10.2.2.2**
    - **Path B → Next-hop: 10.3.3.3**
- **The router checks IGP (OSPF/EIGRP) to see which next-hop has the lowest cost.**
- **If one next-hop becomes unreachable, the route is dropped automatically.**

Q-9 Explain AS-Path Prepend? what does this do? and why is it important in real world scenario?

AS-Path Prepending is a BGP technique used to **manipulate inbound traffic** by **artificially increasing the AS path length** of a route.

👉 **The longer the AS path,** the less preferred it is by other networks.
👉 This means you can **influence which ISP receives inbound traffic** to your network.

Working:

Assume your AS number is **65001**, and your network is advertising **8.8.8.0/24** to two ISPs:

- **ISP-1** (AS 100)
- **ISP-2** (AS 200)

Without prepending, both ISPs will receive:

8.8.8.0/24 via AS 65001

Example with AS-Path Prepending
To make **ISP-2 less preferred**, you prepend your AS multiple times before advertising:

- ISP-1: AS 65001
- ISP-2: AS 65001 65001 65001

Now, external networks see the paths as:

- Path via **ISP-1** → AS 65001 (Shorter, preferred)
- Path via **ISP-2** → AS 65001 65001 65001 (Longer, less preferred)

Since BGP **prefers the shortest AS path**, most inbound traffic will enter via **ISP-1**.

Configure AS-Path Prepending:

Example: AS-Path Prepending on ISP-2

Assume:

- Router R1 (AS 65001) is connected to two ISPs:
  - ISP-1 (AS 100) → Preferred path
  - ISP-2 (AS 200) → Less preferred path (Prepending applied)

```
router bgp 65001
 neighbor 192.168.1.1 remote-as 100    # ISP-1 (No Prepend)
 neighbor 192.168.2.1 remote-as 200    # ISP-2 (Apply Prepend)

 neighbor 192.168.2.1 route-map PREPEND_AS_PATH out

route-map PREPEND_AS_PATH permit 10
 set as-path prepend 65001 65001 65001
```

Effect:

- ISP-1 sees AS 65001 → Preferred
- ISP-2 sees AS 65001 65001 65001 → Less preferred

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