



Lesson 5.7 BGP Additional Paths

This document is a visual and conceptual summary of Lesson 5.7 of the **Understanding and Mastering BGP** course. It explores **BGP Additional Paths**, a feature that allows BGP to advertise more than just a single best path to its peers, thereby overcoming the default behavior of path hiding and improving convergence and path diversity in large-scale networks.

1 Introduction

In this lesson, we introduce **BGP Additional Paths**, a feature designed to enhance how BGP shares routing information with its peers.

Up to now, we have studied the BGP best path algorithm and observed that BGP always selects a **single best path** to a destination. Even when multiple valid paths exist, only one is typically installed and advertised.

This behavior is fundamental to BGP's stability, but it also introduces certain limitations in large and complex topologies.

2 BGP Behavior and Path Hiding

By default:

- BGP selects **one best path**
- Only that best path is placed in the BGP table as the active path
- Only that best path is **advertised to BGP peers**

Even if a router learns multiple routes to the same destination, it will advertise **only one**. This leads to a phenomenon known as **path hiding**.

2.1 What is Path Hiding?

Path hiding occurs when:

- A router knows multiple valid paths internally
- But advertises only the single best path to its neighbors

As a result:

- Downstream routers remain unaware of alternative paths
- Backup paths are only learned **after a failure occurs**
- Convergence becomes slower because the BGP algorithm must rerun to discover a new best path

In very large networks with thousands of routes, this can:

- Increase CPU usage
- Increase convergence time
- Lead to temporary instability or suboptimal routing

2.2 Additional Paths vs Multipath

It is essential to clearly distinguish between **BGP Multipath** and **BGP Additional Paths**.

BGP Multipath

- Installs multiple equal paths in the **local BGP and routing table**
- Enables **ECMP (load balancing)**
- Has **local significance only**
- Still advertises only one best path to peers

BGP Additional Paths

- Advertises **multiple paths** to BGP neighbors
- Provides **path diversity**
- Improves convergence and backup path awareness
- Does NOT automatically imply ECMP

In simple terms:

- **Multipath** = Using multiple paths locally
- **Additional Paths** = Advertising multiple paths to peers

3 Additional Paths

3.1 Additional Paths improves BGP

The Additional Paths feature allows a router to:

- Advertise the best path **and additional alternative paths**

- Pre-populate peers with backup route information
- Avoid waiting for a failure before learning alternate routes

This results in:

- Faster failover
- Reduced reconvergence time
- More optimal routing decisions
 - Instead of path hiding, the network gains **path diversity**.

3.2 iBGP-Only Feature

Additional Paths primarily applies to:

- **iBGP peerings within the same AS**

It does not change how:

- eBGP peers normally receive advertisements

Externally, the AS still behaves like a standard BGP speaker advertising a best path.

3.3 BGP Extension and Path Identifiers

Additional Paths is a BGP extension that introduces:

- A **unique path identifier** per advertised path

This allows routers to:

- Distinguish multiple paths to the same prefix
- Maintain multiple route entries for a single destination

4 Additional Paths Config Workflow

There are three fundamental steps required to deploy Additional Paths:

- **Enable sending and receiving additional paths**
- **Define the path selection algorithm**
- **Control which neighbors receive additional paths**

These steps are typically configured under the BGP address-family context.

4.1 Path Selection Algorithms

When enabling Additional Paths, you must define how many and which paths will be advertised.

Best N

- Advertises the best path plus the next N-1 best paths
- Controlled and scalable
- Common in large enterprise networks

Group-Best

- Advertises the best path **per neighboring AS**
- Useful for multi-homed environments
- Enhances inter-AS path diversity

All

- Advertises **all available paths** with unique next-hop values
- Maximum path visibility
- Higher memory and CPU usage

Choice of algorithm depends on:

- Network size
- Policy requirements
- Hardware capacity

5 Lab Topology Overview

The following is the first lab topology used for this lesson:

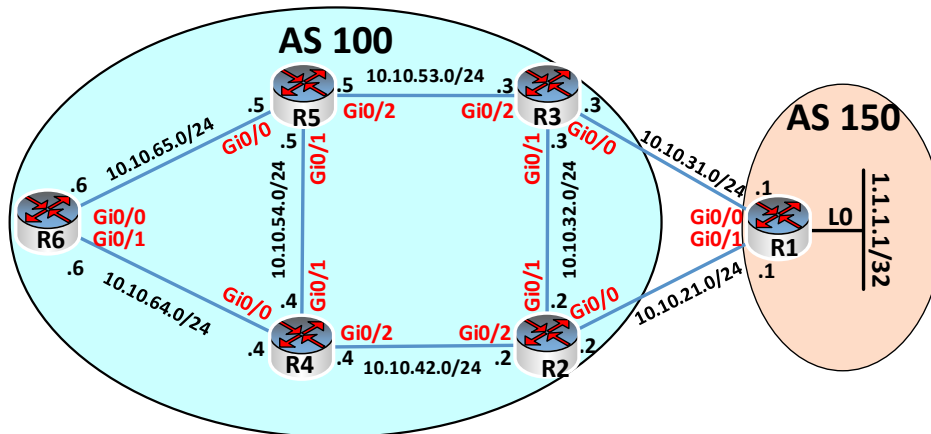


Figure 1: Lab topology for examining the behavior of the BGP Additional Paths feature

- AS150 originates network **1.1.1.1/32**
- Advertised via eBGP to R2 and R3 (in AS100)
- R2 and R3 then advertise the route via iBGP
- R5 acts as a **Route Reflector**
- RR Clients: R2, R3, R4, and R6
- OSPF is used as the IGP within AS100

This topology is ideal to demonstrate:

- Path hiding with route reflectors
- The benefit of Additional Paths in iBGP environments

6 Behavior Without Additional Paths

Before enabling Additional Paths:

- R2 and R3 both learn the prefix from AS150
- Both advertise it to the Route Reflector (R5)
- R5 installs multiple paths in its BGP table
- BUT reflects only the **single best path** to clients

Observed consequences:

- No load balancing opportunities
- Suboptimal routing decisions
- Hidden alternate paths
- Slower failover if the best path fails

6.1 Limited Load Balancing

If downstream routers:

- Do not learn multiple paths
- Then even with multipath enabled,
- ECMP cannot occur due to lack of path visibility

6.2 Suboptimal Routing

Because only one next-hop is advertised:

- Traffic may follow a longer or less optimal path
- Alternative shorter paths remain unused

6.3 Slower Convergence

If the best path fails:

- BGP must rerun the algorithm
- Discover the next best path
- Re-advertise updates
- Install new routes

This takes significantly more time compared to having backup paths already known.

7 Lab Tasks

- Enable the Feature on the Route Reflector
- Enable Sending Additional Paths to Specific Neighbors
- Select the Path Advertisement Algorithm
- Advertise the Additional Paths
- Enable Receiving Additional Paths on Clients

After this:

- Clients learn multiple paths to the same destination
- Backup paths are pre-installed in the BGP table
- Faster rerouting is achieved upon failure

8 Interaction with Route Reflectors

Additional Paths is especially powerful in **Route Reflector topologies** because:

- RRs normally reflect only the best path
- This causes severe path hiding
- Clients lose visibility of alternative paths

With Additional Paths enabled on the RR:

- Multiple paths are reflected
- Clients gain full path awareness
- Network resilience significantly improves

9 Additional Paths and Multipath

A powerful design approach is to combine:

- **Additional Paths** → for path visibility and fast convergence
- **Multipath** → for ECMP and load sharing

This allows routers to:

- Know multiple paths (control plane)
- Use multiple paths (data plane)

10 Key Operational Considerations

- Additional Paths increases:
 1. Memory usage
 2. CPU processing
 3. BGP update size
- Should be deployed selectively
- Best suited for:
 1. Large enterprise networks
 2. Service provider cores
 3. Route reflector architectures

Improper use in very large networks may impact scalability.

11 Summary Recap

In this lesson, we:

1. Explained how default BGP behavior leads to **path hiding**
2. Introduced **Additional Paths** as a solution for path diversity
3. Distinguished clearly between **Multipath** and **Additional Paths**
4. Explored the configuration process:
 - a. Enabling send/receive
 - b. Selecting path criteria
 - c. Advertising additional paths
5. Examined a Route Reflector topology and observed:
 - a. Hidden paths without the feature
 - b. Improved visibility and convergence after enabling it
6. Learned that Additional Paths enhances convergence, resiliency, and routing optimality in complex iBGP environments

12 Other Resources

12.1 Study Questions

These are some further discussion questions that you can read and consider. I don't give the answers here, but you can use them to test your familiarity with the content. If you have fully understood it, you should be able to feel comfortable explaining the answer to these questions to someone else.

1. What is path hiding in BGP?
2. Why does BGP advertise only one best path by default?
3. How does Additional Paths improve convergence?
4. What is the difference between Multipath and Additional Paths?
5. Why is Additional Paths especially useful in Route Reflector topologies?
6. What are the three selection algorithms for Additional Paths?
7. Does Additional Paths automatically enable load balancing?
8. Why must receiving routers explicitly enable additional-paths receive?

12.2 Notes

12.3 Additional Lab Resources

This lab is provided as a YAML file for use with Cisco CML, with the initial configurations already preconfigured. An additional YAML file containing the final completed state is also included. You can use both files as reference resources to support and enhance your studies.

12.4 External Links

- [RFC 7911](#) – The RFC that defines the advertisement of multiple paths in BGP
- Border Gateway Protocol definition where BGP Multipath is described
- [Cisco documentation](#) on the BGP Additional Paths feature

12.5 telecomTech Resources

- Web: www.telecomtech.io
- YouTube: www.youtube.com/@telecomTech.explained
- Email: Lazarus@telecomtech.io