Lab Assignment 7: Routing Protocols Simulation

Name: Kushal Kesharwani
Roll No: 2301MC57

---

1. Introduction

This lab assignment aimed to simulate and analyze the functioning of four major routing protocols — **RIP, OSPF, BGP, and IS-IS**. The simulation explored how each protocol determines optimal paths, how routing tables converge, and the distinct operational mechanisms that set them apart. This report summarizes the simulated results, routing table outcomes, and key insights into each protocol's characteristics.

---

2. Network Topology Diagrams

RIP & OSPF Topology

A four-node network was used with routers **A, B, C, and D**.

- **RIP Topology:** All direct links were assigned equal cost (1). Connections include: A-B, A-C, B-C, B-D, and C-D.
- **OSPF Topology:** The same network structure was used but with varying link costs:
  - A-B (1), A-C (5), B-C (2), B-D (1), C-D (4).

BGP Topology

The BGP network consisted of four Autonomous Systems (**AS1, AS2, AS3, AS4**):

- AS1 connected to AS2 and AS3.
- AS2 connected to AS1 and AS3.
- AS3 connected to AS1, AS2, and AS4.
- AS4 originated the advertised network.

IS-IS Topology

A 4-router setup (**R1, R2, R3, R4**) with defined link costs:

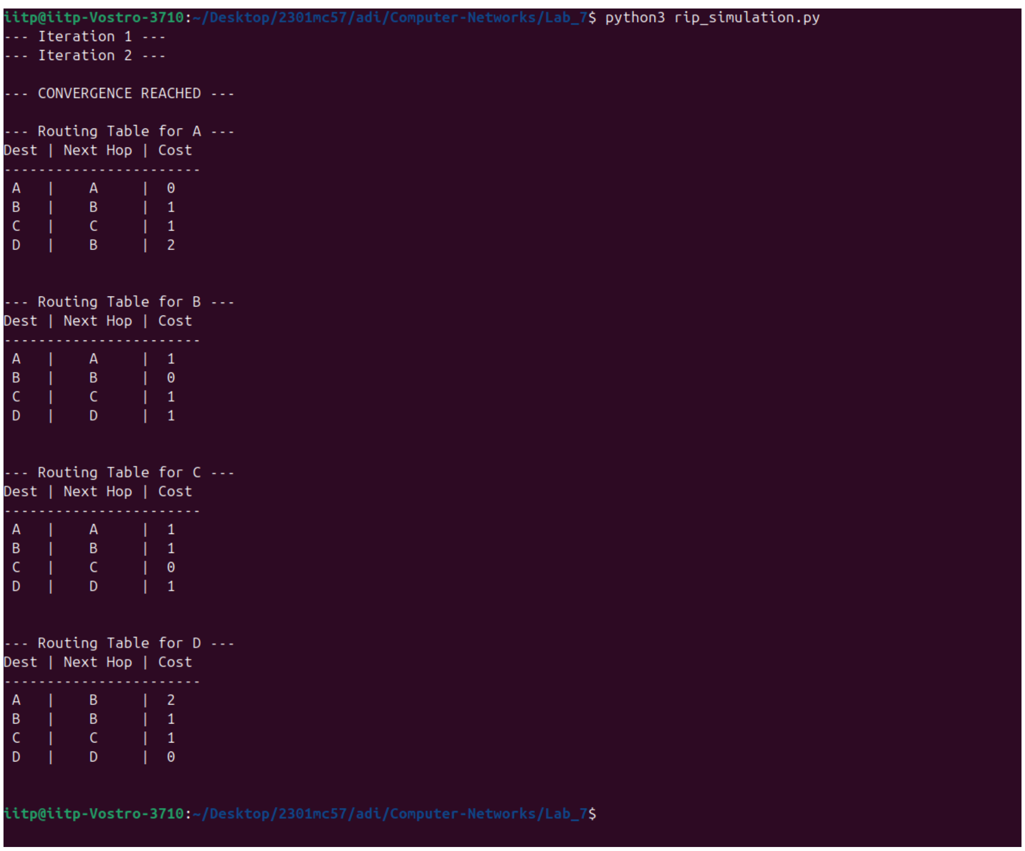
- R1–R2 (10), R1–R3 (5), R2–R4 (2), and R3–R4 (1).

---

3. Simulation Results and Observations

Part 1: RIP (Routing Information Protocol)

Observations:
The RIP simulation achieved convergence after **two iterations**, demonstrating its **distance-vector** nature. Each router periodically exchanged routing tables with its neighbors, updating hop counts until stability was reached.
For instance, **Router A** determined the path to **Router D** as **A → B → D**, with a total cost of **2 hops**.
Although RIP's simplicity is advantageous, its **slow convergence** due to periodic updates is a known limitation.



```
iitp@iitp-Vostro-3710:~/Desktop/2301mc57/adi/Computer-Networks/Lab_7$ python3 rip_simulation.py
--- Iteration 1 ---
--- Iteration 2 ---

--- CONVERGENCE REACHED ---

--- Routing Table for A ---
Dest | Next Hop | Cost
----------------------
 A   |    A     |  0
 B   |    B     |  1
 C   |    C     |  1
 D   |    B     |  2


--- Routing Table for B ---
Dest | Next Hop | Cost
----------------------
 A   |    A     |  1
 B   |    B     |  0
 C   |    C     |  1
 D   |    D     |  1


--- Routing Table for C ---
Dest | Next Hop | Cost
----------------------
 A   |    A     |  1
 B   |    B     |  1
 C   |    C     |  0
 D   |    D     |  1


--- Routing Table for D ---
Dest | Next Hop | Cost
----------------------
 A   |    B     |  2
 B   |    B     |  1
 C   |    C     |  1
 D   |    D     |  0


iitp@iitp-Vostro-3710:~/Desktop/2301mc57/adi/Computer-Networks/Lab_7$
```

Part 2: OSPF (Open Shortest Path First)

Observations:

In OSPF, each router applied **Dijkstra's algorithm** to compute shortest paths based on link costs rather than hop counts.

Example: **Router A's** shortest route to **Router C** was found through **B** (A → B → C) with a total cost of **3 (1+2)**, outperforming the direct A–C link of cost 5.

This highlights OSPF's **efficiency and accuracy** in selecting cost-optimized routes compared to RIP.

```
iitp@iitp-Vostro-3710:~/Desktop/2301mc57/adi/Computer-Networks/Lab_7$ python3 ospf_simulation.py
--- OSPF Routing Table for A ---
Dest | Next Hop | Cost
----------------------
 A   |    A     |  0
 B   |    B     |  1
 C   |    B     |  3
 D   |    B     |  2


--- OSPF Routing Table for B ---
Dest | Next Hop | Cost
----------------------
 A   |    A     |  1
 B   |    B     |  0
 C   |    C     |  2
 D   |    D     |  1


--- OSPF Routing Table for C ---
Dest | Next Hop | Cost
----------------------
 A   |    B     |  3
 B   |    B     |  2
 C   |    C     |  0
 D   |    B     |  3


--- OSPF Routing Table for D ---
Dest | Next Hop | Cost
----------------------
 A   |    B     |  2
 B   |    B     |  1
 C   |    B     |  3
 D   |    D     |  0
```

Part 3: BGP (Border Gateway Protocol)

Observations:

BGP operates as a **path-vector protocol**, using the **AS-path** attribute to determine routes between Autonomous Systems.

In the simulation, **AS4** originated the network, and **AS3** learned the path **AS3** → **AS4**.

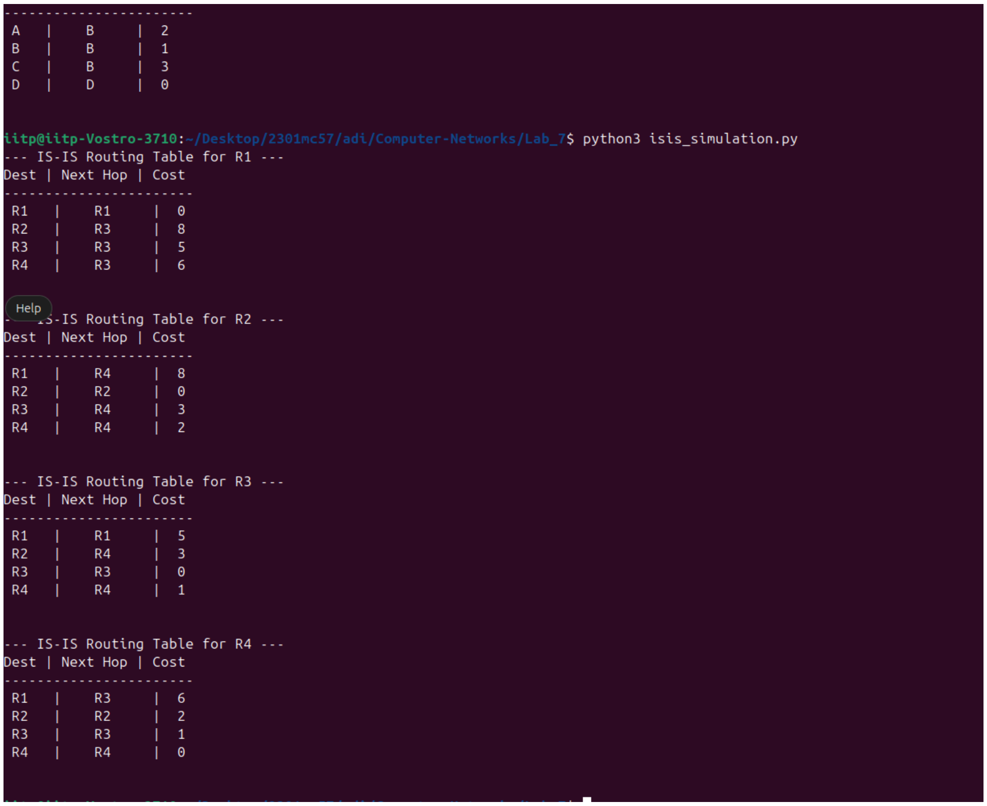
Subsequently, **AS1** and **AS2** discovered their routes as **AS1** → **AS3** → **AS4** and **AS2** → **AS3**

→ **AS4** respectively.
This experiment clearly demonstrated BGP's **policy-driven decision-making**, emphasizing path and policy attributes over basic link costs — making it suitable for **inter-AS routing** on a global scale.

```
iitp@iitp-Vostro-3710:~/Desktop/2301mc57/adi/Computer-Networks/Lab_7$ python3 bgp_simulation.
--- BGP CONVERGENCE REACHED ---

--- BGP Table for AS1 ---
Dest: Network_X | Path: AS1 -> AS3 -> AS4


--- BGP Table for AS2 ---
Dest: Network_X | Path: AS2 -> AS3 -> AS4


--- BGP Table for AS3 ---
Dest: Network_X | Path: AS3 -> AS4


--- BGP Table for AS4 ---
Dest: Network_X | Path: AS4


iitp@iitp-Vostro-3710:~/Desktop/2301mc57/adi/Computer-Networks/Lab_7$
```

Part 4: IS-IS (Intermediate System to Intermediate System)

Observations:
IS-IS, another **link-state protocol**, functions similarly to OSPF, employing **Dijkstra's algorithm** for optimal path calculation.
For example, **Router R1's** best path to **R2** was determined as **R1** → **R3** → **R4** → **R2** with a total cost of **8 (5+1+2)**, outperforming the direct but costlier **R1–R2** link (10).
This confirms IS-IS's **efficiency** in finding low-cost routes through comprehensive link-state analysis.



```
----------------------
A   |    B     | 2
B   |    B     | 1
C   |    B     | 3
D   |    D     | 0

iitp@iitp-Vostro-3710:~/Desktop/2301mc57/adi/Computer-Networks/Lab_7$ python3 isis_simulation.py
--- IS-IS Routing Table for R1 ---
Dest | Next Hop | Cost
----------------------
 R1   |    R1     | 0
 R2   |    R3     | 8
 R3   |    R3     | 5
 R4   |    R3     | 6

 Help S-IS Routing Table for R2 ---
Dest | Next Hop | Cost
----------------------
 R1   |    R4     | 8
 R2   |    R2     | 0
 R3   |    R4     | 3
 R4   |    R4     | 2

--- IS-IS Routing Table for R3 ---
Dest | Next Hop | Cost
----------------------
 R1   |    R1     | 5
 R2   |    R4     | 3
 R3   |    R3     | 0
 R4   |    R4     | 1

--- IS-IS Routing Table for R4 ---
Dest | Next Hop | Cost
----------------------
 R1   |    R3     | 6
 R2   |    R2     | 2
 R3   |    R3     | 1
 R4   |    R4     | 0
```

---

4. Comparison and Conclusion

This simulation effectively demonstrated the working principles and unique features of four key routing protocols:

- **RIP:** A simple **distance-vector** protocol using hop count as its metric. It's easy to implement but suffers from **slow convergence**.

- **OSPF & IS-IS:** Both are **link-state protocols** that compute optimal paths using **Dijkstra's algorithm**, ensuring **fast convergence** and **accurate route selection** within an AS.

- **BGP:** A **path-vector protocol** ideal for **inter-AS routing**, prioritizing AS-path length and **policy-based decisions** rather than link costs.

Overall, the simulation reinforced why **link-state protocols (OSPF and IS-IS)** are preferred for internal routing due to their speed and precision, while **BGP** remains the backbone protocol for **external, internet-scale routing**.