Heaven's Light is Our Guide

Rajshahi University of Engineering & Technology

Department of

Electrical & Computer Engineering

Lab Report 1

Study of Different Kinds of Topologies and Their Simulations

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1 Introduction

Network topology represents the geometric arrangement of various elements, such as links and nodes, within a computer network [1]. Selecting an appropriate topology is a fundamental step in network design, as it directly dictates the network's overall performance, cost-efficiency, scalability, and fault tolerance. In this sessional lab, we explore a comprehensive range of configurations—specifically Point-to-Point, Bus, Ring, Star, Tree, Mesh, and Hybrid topologies—to understand their operational strengths and limitations in a controlled environment.

1.1 Cisco Packet Tracer

Cisco Packet Tracer [2] is a sophisticated network simulation program developed by Cisco Systems to facilitate the experimentation of complex network behaviors. It provides a rich visual environment where users can design, configure, and troubleshoot virtual hardware, including routers, switches, and workstations. For the purpose of this report, Packet Tracer served as the primary tool to simulate real-time data flow via ICMP packets, allowing for the verification of end-to-end connectivity and path analysis through its "Simulation Mode."

2 Methodology

The methodology of this lab involves the systematic construction and testing of seven distinct network architectures. Each topology is evaluated through a three-step validation process: first, the creation of a physical **Schematic**; second, the execution of **Message Passing** to confirm successful delivery; and third, the analysis of the **Event List**, which captures the precise hop-by-hop journey of data through the network infrastructure.

2.1 Point-to-Point (P2P) Topology

This topology consists of a direct link between two endpoints, ideal for secure communication like leased lines. It offers simplicity, low cost, and guaranteed bandwidth but lacks scalability and redundancy.

The Cisco Packet Tracer simulation shows two workstations connected via Ethernet, with the schematic confirming successful ICMP pings, validating connectivity.

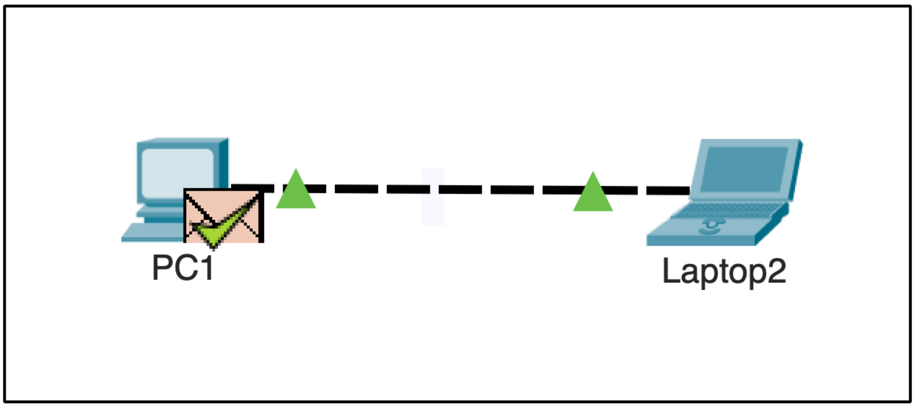
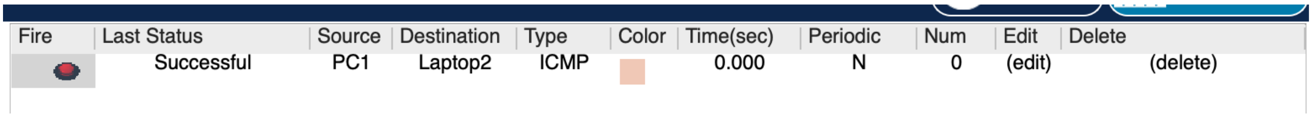


Figure 1: P2P Schema



Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC1	Laptop2	ICMP		0.000	N	0	(edit)	(delete)

Figure 2: P2P Successful Message Passing

2.2 Bus Topology

A Bus topology is one of the simplest network configurations where all nodes—such as computers, printers, and servers—are connected to a single central cable, often called the "backbone." This backbone serves as the shared communication medium; data transmitted by any node travels along the cable and is received by all other nodes, though only the intended recipient processes the packet. While cost-effective and easy to set up for small networks, it is susceptible to network-wide failure if the central cable is damaged [3].

The following figures illustrate the network simulation: Figure 3 shows the physical arrangement and the sequence of events during data transmission, while Figure 5 confirms the successful delivery of the simulated message.

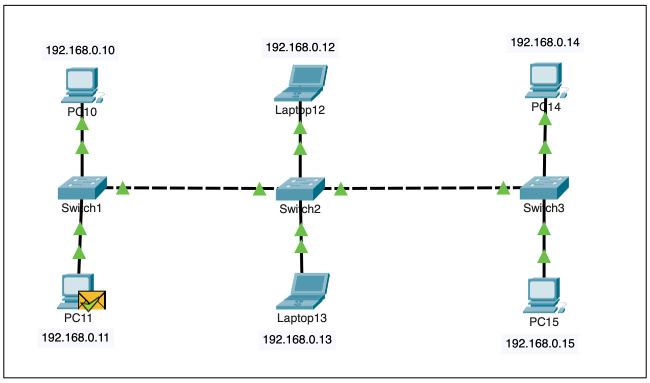
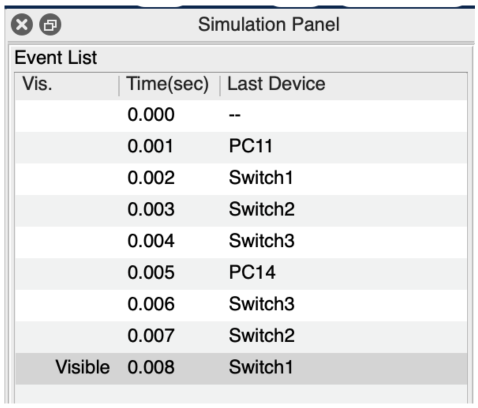


Figure 3: Bus Topology Schematic


Simulation Panel

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.001	PC11
	0.002	Switch1
	0.003	Switch2
	0.004	Switch3
	0.005	PC14
	0.006	Switch3
	0.007	Switch2
Visible	0.008	Switch1

Figure 4: Bus Event List

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC11	PC14	ICMP		0.000	N	0	(edit)	(delete)

Figure 5: Bus Topology: Successful ICMP Message Passing

2.3 Ring Topology

In a Ring topology, each node is connected to exactly two other nodes, forming a continuous circular pathway for signals. Data travels from node to node in one direction (unidirectional) or sometimes two (bidirectional), with each intermediate node acting as a repeater to keep the signal strong. This topology handles high-volume traffic better than a bus network and eliminates the need for a central server to manage connectivity between workstations [3].

The simulation of this topology is documented below. Figure 6 provides a side-by-side view of the circular node arrangement and the chronological event list of the packet's journey. Figure 8 displays the ICMP status table, verifying that the packet successfully traversed the ring to its destination.

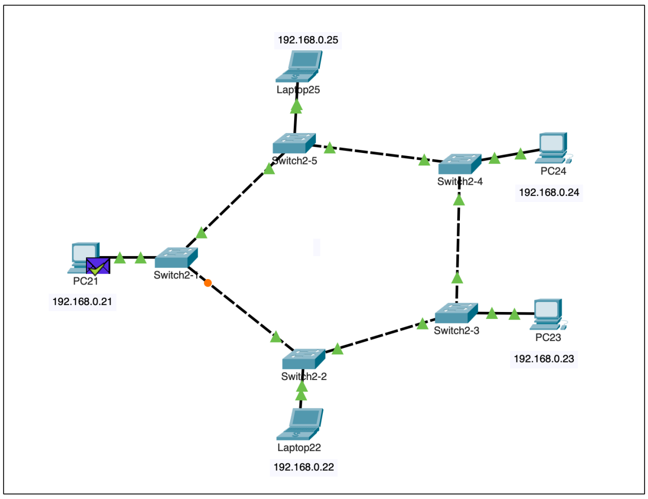


Figure 6: Ring Topology Schematic

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.012	--
	0.013	PC21
	0.014	Switch2-1
	0.015	Switch2-5
	0.016	Switch2-4
	0.017	Switch2-3
	0.018	Switch2-2
	0.019	Laptop22
	0.020	Switch2-2
	0.021	Switch2-3
	0.022	Switch2-4
	0.023	Switch2-5
Visible	0.024	Switch2-1

Figure 7: Ring Event List

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC21	Laptop22	ICMP		0.000	N	0	(edit)	(delete)

Figure 8: Ring Topology: Successful ICMP Message Passing

2.4 Star Topology (with Switch)

The Star topology is the most widely used configuration in modern Ethernet networks. In this setup, every device is connected to a central switch via a dedicated cable. The switch manages the data flow by directing packets only to the target device, which minimizes collisions. If one cable fails, only the node connected to that cable is affected, making the network highly resilient and easy to troubleshoot [3].

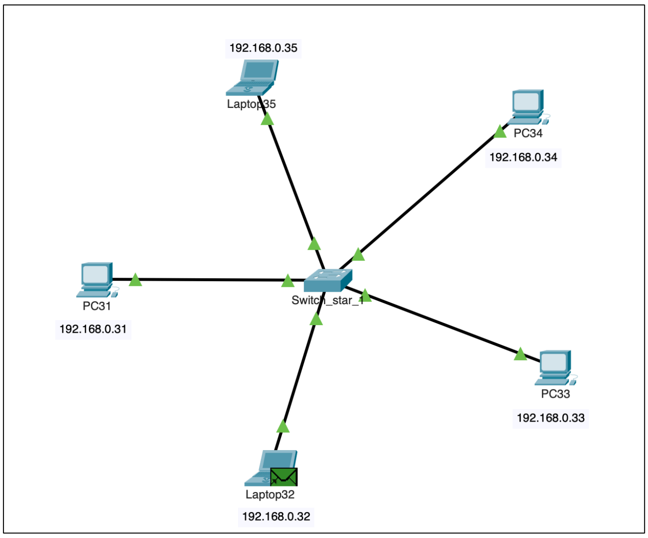
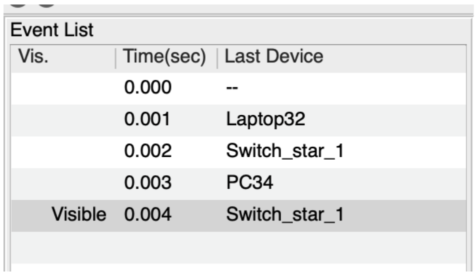


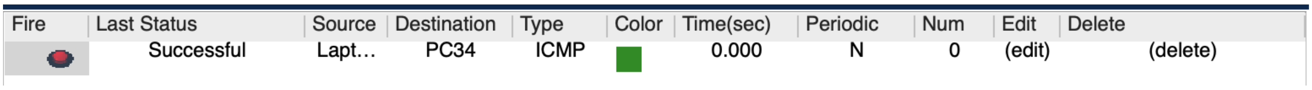
Figure 9: Star (Switch) Schematic



Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.001	Laptop32
	0.002	Switch_star_1
	0.003	PC34
Visible	0.004	Switch_star_1

Figure 10: Star (Switch) Event List



Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	Lapt...	PC34	ICMP		0.000	N	0	(edit)	(delete)

Figure 11: Star (Switch): Successful Message Passing

2.5 Star Topology (with Router)

Using a Router as the central hub of a Star topology adds a layer of intelligence to the network, enabling routing between different IP subnets. While a switch connects devices within the same network, the router handles communication between distinct network segments. This setup is typical for small office or home office (SOHO) environments where a single router provides connectivity for multiple local devices to the internet or other networks [3].

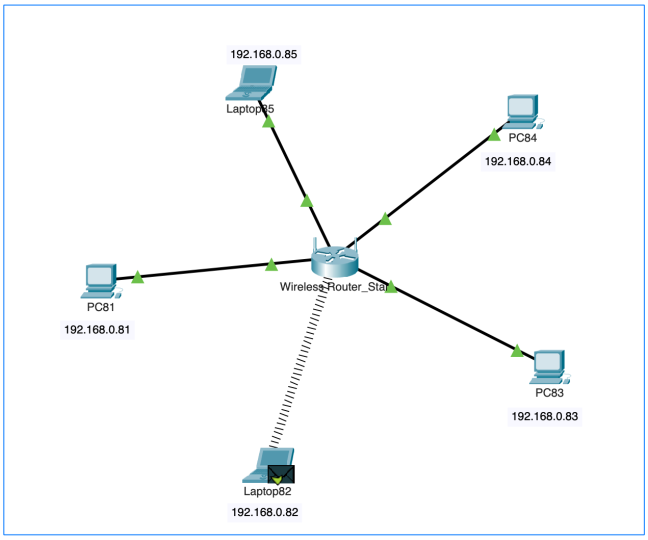
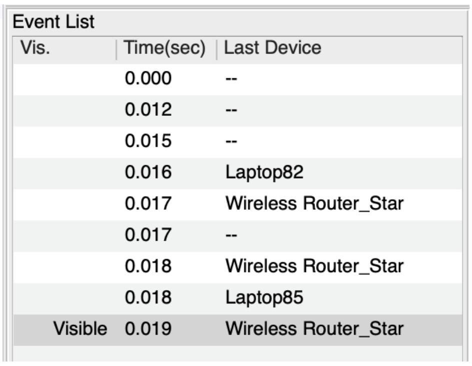


Figure 12: Star (Router) Schematic



Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.012	--
	0.015	--
	0.016	Laptop82
	0.017	Wireless Router_Star
	0.017	--
	0.018	Wireless Router_Star
	0.018	Laptop85
Visible	0.019	Wireless Router_Star

Figure 13: Star (Router) Event List

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	Laptop82	Laptop85	ICMP		0.000	N	0	(edit)	(delete)

Figure 14: Star (Router): Successful Message Passing

2.6 Tree Topology

The Tree topology is a hierarchical structure where central nodes of various star networks are connected to a primary bus or a "root" switch. This creates a tiered architecture, typically consisting of a core layer, distribution layer, and access layer. It is highly scalable, allowing for the easy addition of new branches without disrupting the entire network. However, if the root node or the main backbone fails, the entire branch connected to it loses connectivity [3].

The simulation results are presented below. Figure 15 displays the hierarchical arrangement of switches and the resulting event log as the packet moves through the branches. Figure 17 provides the confirmation of successful ICMP communication between the chosen source and destination nodes.

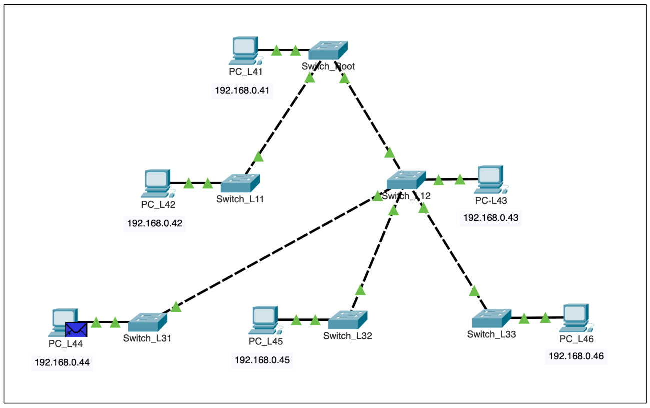


Figure 15: Tree Topology Schematic

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.001	PC_L44
	0.002	Switch_L31
	0.003	Switch_L12
	0.004	Switch_Root
	0.005	PC_L41
	0.006	Switch_Root
	0.007	Switch_L12
Visible	0.008	Switch_L31

Figure 16: Tree Event List

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC_L44	PC_L41	ICMP		0.000	N	0	(edit)	(delete)

Figure 17: Tree Topology: Successful Message Passing

2.7 Mesh Topology

A Mesh topology is a robust network design where nodes are interconnected, providing multiple redundant paths for data transmission. In a full mesh, every node is connected to every other node, while a partial mesh (as simulated here) connects key nodes to ensure that even if a specific link or switch fails, the network can reroute traffic through an alternative path. This topology offers the highest level of fault tolerance and is commonly used in critical backbone infrastructures and wireless mesh networks [3].

The simulation results, based on the interconnected switch fabric, are shown below. Figure 18 demonstrates the complex schematic and the detailed event list showing how packets are handled across multiple switch hops. Figure 20 displays the ICMP success table for the transfers between PC51 to PC53 and Laptop55 to Laptop52.

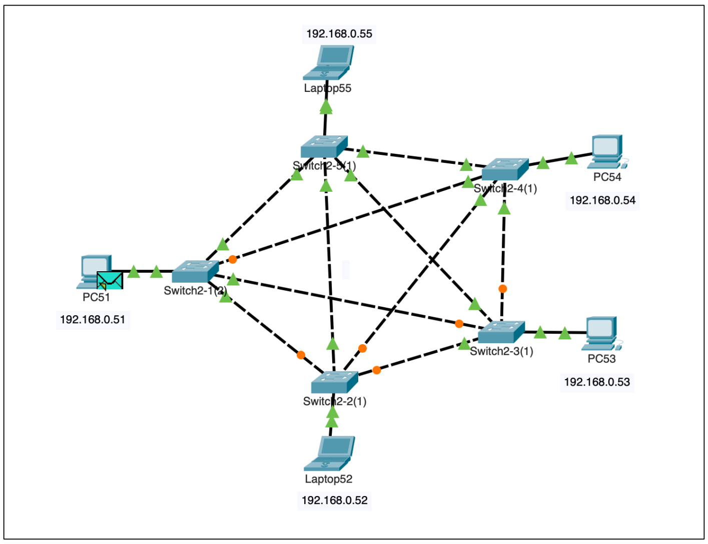


Figure 18: Mesh Topology Schematic

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.000	--
	0.006	--
	0.007	Laptop55
	0.008	Switch2-5(1)
	0.008	--
	0.009	PC51
	0.009	Switch2-2(1)
	0.010	Switch2-1(2)
	0.010	Laptop52
	0.011	Switch2-5(1)
	0.011	Switch2-2(1)
	0.012	Switch2-3(1)
	0.012	Switch2-5(1)
	0.013	PC53
	0.014	Switch2-3(1)
	0.015	Switch2-5(1)
Visible	0.016	Switch2-1(2)

Figure 19: Mesh Event List

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC51	PC53	ICMP		0.000	N	0	(edit)	(delete)
	Successful	Laptop55	Laptop52	ICMP		0.000	N	1	(edit)	(delete)

Figure 20: Mesh Topology: Successful Message Passing

2.8 Hybrid Topology (Star-Ring)

A Hybrid topology is an integration of two or more different topologies. In this specific simulation, a Star topology and a Ring topology are interconnected. This approach allows a network to leverage the centralized management of a Star network for one department while using the efficient, high-traffic handling of a Ring network for another. Hybrid networks are highly flexible and are typically found in large corporate environments where different floors or buildings use different local configurations but must remain part of a single cohesive network [3].

The following figures illustrate the combination of these two architectures. Figure 21 shows the schematic where a central switch (Star) links into a circular node arrangement (Ring), alongside the simulation's event list. Figure 23 verifies that packets successfully traverse between these two distinct structural segments.

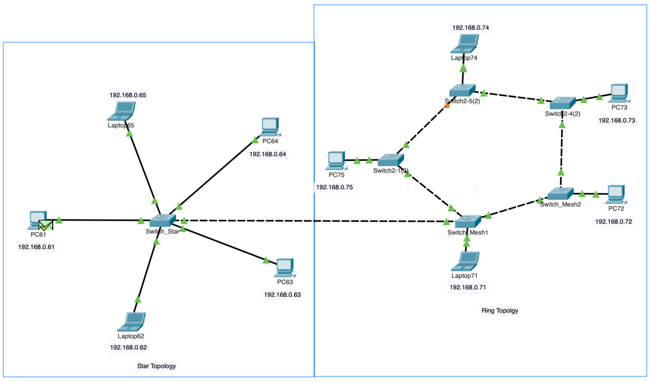


Figure 21: Hybrid (Star-Ring) Schematic

Event List

Vis.	Time(sec)	Last Device
	0.000	--
	0.001	PC61
	0.002	Switch_Star
	0.003	Switch_Mesh1
	0.004	Switch_Mesh2
	0.005	Switch2-4(2)
	0.006	PC73
	0.007	Switch2-4(2)
	0.008	Switch_Mesh2
	0.009	Switch_Mesh1
Visible	0.010	Switch_Star

Figure 22: Hybrid Event List

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC61	PC73	ICMP		0.000	N	0	(edit)	(delete)

Figure 23: Hybrid Topology: Successful Message Passing

3 Discussion

The simulations conducted in this lab highlight the trade-offs inherent in network design. While simpler topologies like Bus and Star are cost-effective and straightforward to implement, they are vulnerable to single points of failure—either the backbone cable or the central hub. In contrast, the Mesh and Tree topologies demonstrated superior scalability and reliability, with the Mesh setup offering the highest fault tolerance due to its redundant paths.

4 Conclusion

Through this sessional lab, we successfully simulated and analyzed seven diverse network topologies. By observing packet propagation across different mediums and examining how central devices like switches and routers manage traffic, we gained a practical understanding of network architecture. The use of Cisco Packet Tracer provided a realistic and iterative environment to bridge the gap between theoretical networking concepts and practical implementation.

References

[1] W. Stallings, "Local and metropolitan area networks," *Prentice Hall*, 2013, detailed analysis of Bus, Ring, and Star configurations.

[2] *Cisco Packet Tracer: Simulation-Based Learning Tool*, Cisco Networking Academy, 2024. [Online]. Available: https://www.netacad.com/courses/packet-tracer

[3] A. S. Tanenbaum, N. Feamster, and D. J. Wetherall, *Computer Networks*, 6th ed. Pearson, 2021, general overview of network topologies and the OSI model.