Lab Report: LAN Design and Simulation for Innovatech Solutions

Group:

- Meer Hadeed
- Rizwan Ahmed
- Muhammad Abdullah Khan

Course: Computer Networks
Instructor: Sir Anwar Ali Sathio

1.0 Objective

The primary objective of this lab was to design, simulate, and verify a functional Local Area Network (LAN) for a two-floor office. This report details the design decisions, network topology, and IP addressing plan.

The simulation's goal was to prove the design's reliability by testing connectivity between all devices, including those on different floors, demonstrating a practical understanding of network components, cabling, and IP protocols.

2.0 Case Study Scenario

The network was designed for "Innovatech Solutions," a company moving into a new two-floor office. The requirements were:

- **Floor 1 (Sales):** 10 workstations and 1 network printer.
- **Floor 2 (Engineering/Admin):** 15 workstations, 1 file server, and 1 network printer.
- **Requirement:** All 28 devices (25 PCs, 2 Printers, 1 Server) must be able to communicate with each other reliably and efficiently.

3.0 Network Topology Design: The Hybrid Star-Bus

A **Hybrid Topology** was chosen for this scenario, combining the strengths of the Star and Bus topologies.

- **Why a Hybrid?**
  - A single, large Bus topology is outdated, insecure, and unreliable (a break in the main cable downs the entire network).
  - A single, giant Star topology (one central switch for both floors) is a major single point of failure and creates a cabling bottleneck between floors.
- **Our Solution: The "Star-Bus-Star" (or Tree Topology):**
  1. **The "Stars":** Each floor is built as its own independent **Star Topology**. A central switch is placed on each floor, and all devices on that floor (PCs, printers) are connected directly to it.
     - **Purpose:** This is highly reliable. If one PC's cable fails, it only affects that one PC. The rest of the floor stays online. It's also easy to manage and troubleshoot.

2. **The "Bus":** A single cable (the "backbone" or "bus") is used to connect Switch-Floor1 to Switch-Floor2.
    - **Purpose:** This is a simple, cost-effective way to link the two "Stars." It creates an "Extended Star" or "Tree" topology, allowing all devices to communicate as if they were on one giant network.

4.0 Simulated Equipment and Purpose

This section explains *why* each network device and cable type was chosen for the simulation.

4.1 Network Devices

Device	Model (in Packet Tracer)	Purpose & Justification
Router	1911	**The "Gateway" and "Brain."** Its job is to connect different networks. In our lab, it has two critical roles: 1. **Default Gateway (192.168.1.1):** It acts as the "door" out of the LAN. When a PC on Floor 1 wants to talk to the Server on Floor 2, it sends the packet to the router, which "routes" it to the correct destination. 2. **DHCP Server:** It automatically gives IP addresses to all the PCs, saving the administrator from manually configuring 25 machines.
Switch	2960 (x2)	**The "Traffic Cop" for a floor.** Its job is to be the central connection point for a Star network.

		Why a Switch (and not a Hub)? A switch is "smart." It learns the unique MAC address of every device plugged into it. When PC-1 pings the printer, the switch sends that packet *only* to the printer's port. This is called a **unicast**, and it's fast and secure. A "dumb" hub would have shouted the packet to *every* port, creating collisions and slowing down the network.
Server	Server-PT	**A "Central Resource."** This device provides services to the network (e.g., file storage, hosting a website). **Why a Static IP?** A server is a *service*. Clients (PCs) must be able to find it reliably. It is given a fixed, permanent "Static IP" (192.168.1.10) so PCs always know its address. A dynamic (changing) IP would be like a library changing its address every day.
Printer	Printer-PT (x2)	**A "Shared Resource."** Like a server, a printer is a service that other devices need to find.

		Why a Static IP? For the same reason as the server. It is given a Static IP (e.g., 192.168.1.50) so that when a user clicks "Print," their PC knows exactly where to send the print job.

4.2 Network Cabling

Cable Type	Packet Tracer Icon	Purpose & Justification
Copper Straight-Through	Solid Black Line	**Connects "Different" Devices.** This cable is used to connect devices that use *opposite* pins for transmitting (TX) and receiving (RX) data. **Our Lab Uses:** • PC -> Switch • Server -> Switch • Printer -> Switch • **Router -> Switch** (This is the most important one!)
Copper Crossover	Dotted Black Line	**Connects "Same" Devices.** This cable is used to connect devices that use the *same* pins for TX/RX. The cable "crosses over" the wires internally so that one device's TX pin connects to the other's RX pin.

		Our Lab Uses: • **Switch -> Switch** (To create the "bus" backbone between Floor 1 and Floor 2).

5.0 IP Addressing Plan

A Class C network, 192.168.1.0 with a /24 (255.255.255.0) subnet mask, was used.

Device / Group	**IP Range / Address**	**Assignment Method**	**Justification**
Router (Gateway)	192.168.1.1	**Static**	Must be a fixed, known address for all devices to use as their Gateway.
Server (Floor 2)	192.168.1.10	**Static**	A critical resource that must be reliably findable.
Printer (Floor 1)	192.168.1.50	**Static**	A shared resource that must be reliably findable.
Printer (Floor 2)	192.168.1.51	**Static**	A shared resource that must be reliably findable.
PCs (All)	192.168.1.x	**Dynamic (DHCP)**	These are "client" devices. Assigning IPs automatically with DHCP is efficient and prevents human error (like two PCs having the same

			IP).
DHCP Exclusions	192.168.1.1, 192.168.1.10, 192.168.1.50, 192.168.1.51	N/A	We configured the DHCP server (on the router) to *never* give out these static IPs, to prevent an IP conflict.

6.0 Configuration & Implementation (Summary)

1. **Physical Layout:** All devices were placed in Packet Tracer as per the hybrid topology.
2. **Cabling:** Devices were connected using the correct Straight-Through and Crossover cables as detailed in section 4.2.
3. **Static IPs:** The Server and Printers were configured manually.
   - **Server:** Desktop > IP Configuration
   - **Printers:** Config > Settings (Gateway) and Config > FastEthernet0 (IP Address)
4. **Router Configuration (CLI):**
   - The router's GigabitEthernet0/0 interface (connected to Switch-Floor1) was activated.

     ```
     enable
     configure terminal
     interface GigabitEthernet0/0
     ip address 192.168.1.1 255.255.255.0
     no shutdown
     ```

   - The DHCP service was configured on the router to serve the PCs.

     ```
     ! Create the pool
     ip dhcp pool INNOVATECH_LAN

     ! Define the network and gateway
     network 192.168.1.0 255.255.255.0
     default-router 192.168.1.1

     ! Exclude static IPs to prevent conflicts
     ip dhcp excluded-address 192.168.1.10
     ip dhcp excluded-address 192.168.1.50
     ip dhcp excluded-address 192.168.1.51
     ```

5. **PC Configuration:** All PCs were set to Desktop > IP Configuration > DHCP.

7.0 Verification and Test Results

After the network converged (all link lights turned green), a series of ping tests were conducted from the Command Prompt of various devices.

Test	Action (from PC-Floor1)	Destination	Result	Purpose
1	ping 192.168.1.1	Router (Gateway)	**SUCCESS**	Verifies PC can reach the router.
2	ping 192.168.1.50	Printer (Floor 1)	**SUCCESS**	Verifies intra-floor connectivity (local "Star").
3	ping 192.168.1.10	Server (Floor 2)	**SUCCESS**	**Verifies inter-floor connectivity** (proves the "Bus" backbone works).
4	ping 192.168.1.51	Printer (Floor 2)	**SUCCESS**	**Verifies inter-floor connectivity.**

Note: The first ping in Test 3 and 4 showed a Request timed out. This is normal and expected behavior. It is not a failure. This packet was an ARP (Address Resolution Protocol) request, which the PC must send first to discover the server's MAC address.

8.0 Conclusion

The simulation was a complete success. The chosen hybrid star-bus topology was proven to be a reliable and efficient design for the Innovatech case study. All devices were able to communicate with each other, regardless of their physical floor, by using the central router as a gateway.

This lab demonstrated the specific roles of network devices (routers, switches) and the clear rules for network cabling (Straight-Through vs. Crossover). The IP addressing plan successfully and efficiently provided addresses to all 28 network devices.

Lab Demo