Lab Report: Interconnection and Redundancy Design

1. Lab Heading

- **Student ID:** 220041125
- **Course:** CSE-4512
- **Lab Title:** Inter-Lab Connectivity and High Availability Design

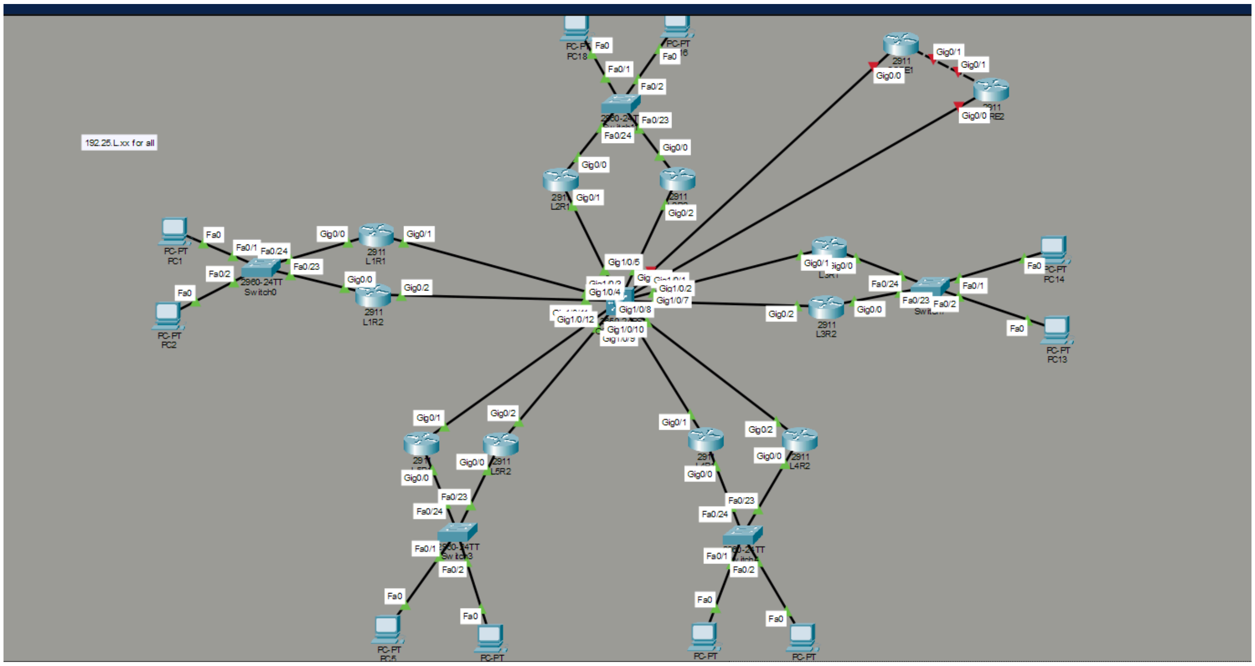
2. The Lab Task(s)

The primary tasks for this lab were derived from the scenario focused on ensuring global connectivity and redundancy in the face of frequent load shedding:

Lab Task Summary

1. **Design and Build the Topology:** Create a network design featuring five distinct computer labs, each with its own network, two PCs, and two routers for redundancy. All labs connect to a central OSPF switch.
2. **Configure IP Addressing:** Assign appropriate IP addresses to all PCs and router interfaces using the 192.25.L.x pattern (where 'L' is derived from the lab no.).
3. **Establish Global Connectivity:** Configure an interconnection method (OSPF) to ensure that any PC in Lab x can successfully reach any PC in Lab y.
4. **Solve the Load Shedding Problem:** Implement a high-availability solution (HSRP) to ensure uninterrupted connectivity and redundancy in the event of a single router failure (simulating a device failing due to frequent load shedding).
5. **Verify Connectivity:** Confirm local and global connectivity using successful ping commands.

3. Screenshot of the Final Network Topology



4. Procedure - Step-by-Step Instructions

The configuration was performed on 5 pairs of redundant routers (L1R1/L1R2 through L5R1/L5R2) and the Central OSPF Switch. The network uses the 192.25.X.0/24 scheme for LANs and 192.25.XY.0/24 for WAN uplinks.

Part A: Central Switch Configuration (Core Routing)

1. Assigned IP addresses to all Gigabit Ethernet interfaces on the Central Switch for the ten router uplinks (GigabitEthernet1/0/3 through 1/0/12).
2. Enabled OSPF on the Central Switch (Router ID: 10.10.10.1).
3. Advertised all connected uplink networks (e.g., 192.25.11.0/24, 192.25.12.0/24... 192.25.52.0/24) into **Area 0** using the appropriate wildcard masks.

Part B: Router Configuration (L1R1 to L5R2)

This procedure was repeated for all 5 labs, using the corresponding 3rd octet (X) for the LAN and the correct 4th octet (Y) for the uplink.

Interface Assignment Summary

Interface	Purpose	Router	Example IP (Lab 3)

GigabitEthernet0/0	LAN (HSRP)	R1/R2	192.25.3.x
GigabitEthernet0/1	WAN Uplink 1	R1	192.25.31.x
GigabitEthernet0/2	WAN Uplink 2	R2	192.25.32.x

Step 1: Interface and OSPF Setup (R1 & R2)

1. Configured IP addresses on GigabitEthernet0/0, GigabitEthernet0/1 (for R1), and GigabitEthernet0/2 (for R2) with /24 masks.
2. Configured OSPF on each router (Router IDs: X.X.X.1 for R1, X.X.X.2 for R2).
3. Advertised the respective WAN uplink network (192.25.XY.0/24) and the LAN network (192.25.X.0/24) into **Area 0**.

Step 2: HSRP Implementation (R1 & R2 - on Gig0/0)

The Hot Standby Router Protocol (HSRP) was implemented to solve the load shedding problem, creating a redundant gateway (**192.25.X.254**) for the PCs.

Track Object Creation (Required to fix a syntax error):

1. Created a unique tracking object for each router's uplink interface (GigabitEthernet0/1 or GigabitEthernet0/2): track XX interface GigabitEthernet0/Y line-protocol.

HSRP Configuration (Applied to GigabitEthernet0/0):
2. Set the Virtual IP (VIP): standby 1 ip 192.25.X.254.
3. Set R1 as the primary Active router: standby 1 priority 110 and standby 1 preempt.
4. Set R2 as the Standby router: standby 1 priority 100 and standby 1 preempt.
5. Crucial step: Linked HSRP to the tracking object to ensure failover when the WAN uplink fails: standby 1 track XX decrement 15.

Part C: PC Configuration

1. Assigned unique static IP addresses (192.25.X.10/24) to all 10 PCs.
2. Set the **Default Gateway** on all PCs to the HSRP Virtual IP (VIP) for their respective lab: **192.25.X.254**.

5. Observations & Results

The successful completion of the lab is verified by confirming OSPF adjacency and global connectivity (ping).

OSPF Adjacency Verification

- **Command:** Switch#show ip ospf neighbor
- **Result:** All 10 router neighbors (R1s and R2s from 5 labs) showed a **FULL** state, confirming successful routing table exchange.

```
show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           1   FULL/BDR        00:00:38    192.25.11.1     GigabitEthernet1/0/3
1.1.1.2           1   FULL/BDR        00:00:32    192.25.12.1     GigabitEthernet1/0/4
2.2.2.1           1   FULL/BDR        00:00:30    192.25.21.1     GigabitEthernet1/0/5
2.2.2.2           1   FULL/BDR        00:00:38    192.25.22.1     GigabitEthernet1/0/6
3.3.3.1           1   FULL/BDR        00:00:34    192.25.31.1     GigabitEthernet1/0/7
3.3.3.2           1   FULL/BDR        00:00:38    192.25.32.1     GigabitEthernet1/0/8
4.4.4.1           1   FULL/BDR        00:00:34    192.25.41.1     GigabitEthernet1/0/9
4.4.4.2           1   FULL/BDR        00:00:30    192.25.42.1     GigabitEthernet1/0/10
5.5.5.1           1   FULL/BDR        00:00:34    192.25.51.1     GigabitEthernet1/0/11
5.5.5.2           1   FULL/BDR        00:00:34    192.25.52.1     GigabitEthernet1/0/12
Switch#
```

[**OSPF neighbors]**

HSRP Status Verification

- **Command:** Router#show standby brief (Run on any R1 router, e.g., L3R1)
- **Result:** Confirmed L3R1 was in the **Active** state and L3R2 was in the **Standby** state, verifying the redundancy setup.

Global Connectivity Verification

- **Command:** Ping from a PC in Lab x to a PC in Lab y (e.g., Ping PC in Lab 5 from a PC in Lab 2).
- **Result:** Successful communication (ping) between all pairs of PCs across all five labs, confirming OSPF routes are correct.

Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
Successful	PC6	L1R2	ICMP		0.000	N	2	(e...	(delete)
Successful	PC5	L1R2	ICMP		0.000	N	3	(e...	(delete)
Successful	PC5	PC1	ICMP		0.000	N	4	(e...	(delete)
Successful	PC5	PC2	ICMP		0.000	N	5	(e...	(delete)

[**Screenshot of some successful Ping command**]

6. Challenges Faced During the Lab

Throughout the implementation, two primary conceptual and practical challenges were encountered:

Challenge 1: Implementing HSRP Tracking Syntax

The most significant practical difficulty was encountered when implementing the **HSRP tracking mechanism** designed to solve the "load shedding problem." Initially, the direct syntax for combining tracking and decrementing priority was rejected by the router. This required self-learning and troubleshooting to identify the correct two-step process:

1. Creating a separate **Track Object** (track XX interface GigabitEthernet0/Y line-protocol).
2. Then, referencing that object in the HSRP command: standby 1 track XX decrement 15.

This correction ensured the redundancy solution correctly monitored the OSPF uplink and triggered a failover, thus achieving the goal of the lab task.

Challenge 2: Conceptual Understanding and Application of OSPF

The entire core routing design relied on the OSPF protocol, which was a self-learned concept for this lab. Understanding the roles of the Router ID, Wildcard Masks, and ensuring all networks were properly advertised into **Area 0** was a steep learning curve. The initial difficulty in getting the R2 routers (e.g., L3R2, L4R2) to appear in the Central Switch's neighbor table confirmed that the OSPF network statements needed precise validation and cleanup to ensure successful neighbor adjacency and route propagation. This process required significant time to fully master and correctly apply the OSPF configuration across all ten routers and the central switch.