PROJECT RESILIENCE

The Zero-Downtime Enterprise

High Availability | Dual-Router HSRP | Dual-ISP Redundancy | EtherChannel | Inter-VLAN Routing | NAT/PAT

Project Title	Project Resilience: The Zero-Downtime Enterprise
Simulator	Cisco Packet Tracer
Topology	Dual-Router HSRP + Dual-ISP + EtherChannel + VLANs
Report Date	25 May 2026
Author	Network Engineer
Classification	Professional Portfolio – LinkedIn Publication

2	2	2	100%
Redundant Routers	ISP Connections	VLANs Configured	Uptime Goal

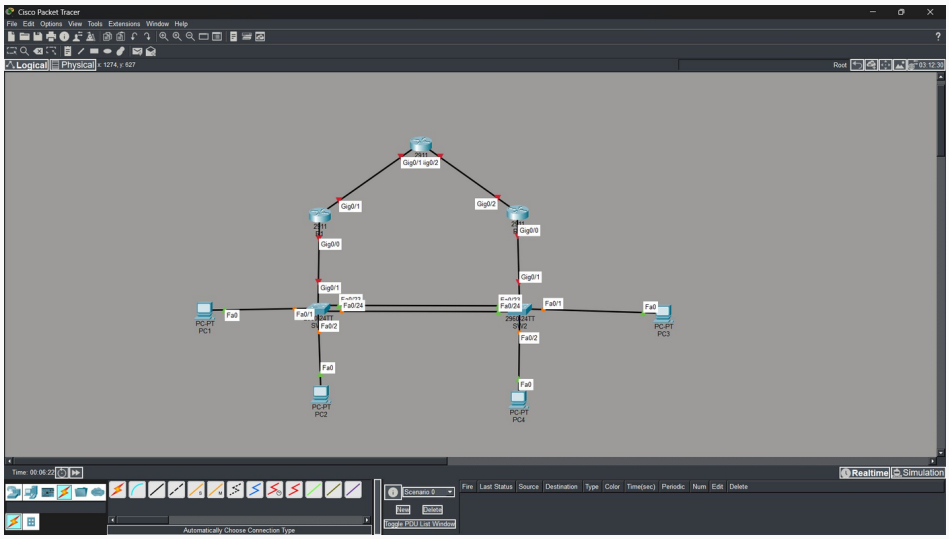


Figure 1 – Full network topology: ISP Router (top), R1 & R2 with HSRP, SW1 & SW2 with EtherChannel, end hosts across VLAN 10 and VLAN 20

1. EXECUTIVE SUMMARY

This project demonstrates enterprise-grade high availability (HA) and redundancy across a simulated multi-site network built in Cisco Packet Tracer. The design achieves zero-downtime objectives through Hot Standby Router Protocol (HSRP), dual-ISP failover, EtherChannel link aggregation, VLAN segmentation, OSPF dynamic routing, and NAT/PAT – mirroring production techniques used in real-world enterprise environments.

Key Achievements

- HSRP deployed on R1 and R2 for seamless gateway failover – hosts never lose connectivity when a router fails.
- Dual-ISP links configured with floating static routes – automatic WAN failover if primary ISP drops.
- EtherChannel (Port-Channel 1) aggregates switch uplinks, eliminating single-point-of-failure on trunk links.
- VLAN 10 (Sales) and VLAN 20 (IT) segmented on SW1 and SW2 with inter-VLAN routing via sub-interfaces.
- OSPF distributes the default route to all internal routers; NAT/PAT allows all hosts internet access via single public IP.
- End-to-end connectivity verified: PC1 pings confirmed to VLAN 20 hosts (192.168.20.10) and ISP loopback (9.9.9.9).

2. NETWORK TOPOLOGY OVERVIEW

The topology centres on a hierarchical three-tier design: an ISP router at the top, two distribution/gateway routers (R1 and R2) running HSRP, and two access switches (SW1 and SW2) serving end hosts across two VLANs. EtherChannel bundles connect the switches to the routers.

Device	Model	Role	Key Interfaces
ISP Router	2911	Internet Service Provider	Gig0/0 (8.8.8.2), Gig0/1 (8.8.8.6), Lo0 (9.9.9.9)
R1 (Active)	2911	Primary Gateway / HSRP Active	Gig0/0 sub-ifs, Gig0/1 (8.8.8.1)
R2 (Standby)	2911	Standby Gateway / HSRP Backup	Gig0/0 sub-ifs, Gig0/1 (8.8.8.5)
SW1	2960-24TT	Access Switch – Site A	Fa0/1 VLAN10, Fa0/2 VLAN20, Po1 Trunk
SW2	2960-24TT	Access Switch – Site B	Fa0/1 VLAN10, Fa0/2 VLAN20, Po1 Trunk
PC1–PC4	PC-PT	End Hosts	VLAN 10 (Sales) or VLAN 20 (IT)

3. IP ADDRESSING SCHEME

Segment	Subnet	Device / Interface	IP Address	Purpose
VLAN 10 – Sales	192.168.10.0/24	R1 Gig0/0.10 (VIP)	192.168.10.1	HSRP Virtual GW
VLAN 10 – Sales	192.168.10.0/24	R1 Gig0/0.10	192.168.10.11	R1 Real IP
VLAN 10 – Sales	192.168.10.0/24	R2 Gig0/0.10	192.168.10.12	R2 Real IP
VLAN 20 – IT	192.168.20.0/24	R1 Gig0/0.20 (VIP)	192.168.20.1	HSRP Virtual GW
VLAN 20 – IT	192.168.20.0/24	R1 Gig0/0.20	192.168.20.11	R1 Real IP
VLAN 20 – IT	192.168.20.0/24	R2 Gig0/0.20	192.168.20.12	R2 Real IP
WAN R1–ISP	8.8.8.0/30	R1 Gig0/1	8.8.8.1	Primary WAN
WAN R1–ISP	8.8.8.0/30	ISP Gig0/0	8.8.8.2	ISP Primary
WAN R2–ISP	8.8.8.4/30	R2 Gig0/1	8.8.8.5	Secondary WAN
WAN R2–ISP	8.8.8.4/30	ISP Gig0/1	8.8.8.6	ISP Secondary
ISP Internet	9.9.9.9/32	ISP Loopback0	9.9.9.9	Simulated Internet

4. CONFIGURATION DETAILS

4.1 SW1 – VLAN & Access Port Configuration

SW1 was configured with VLAN 10 (Sales) and VLAN 20 (IT). Access ports fa0/1 and fa0/2 were assigned; the uplink was trunked via EtherChannel (Port-Channel 1).

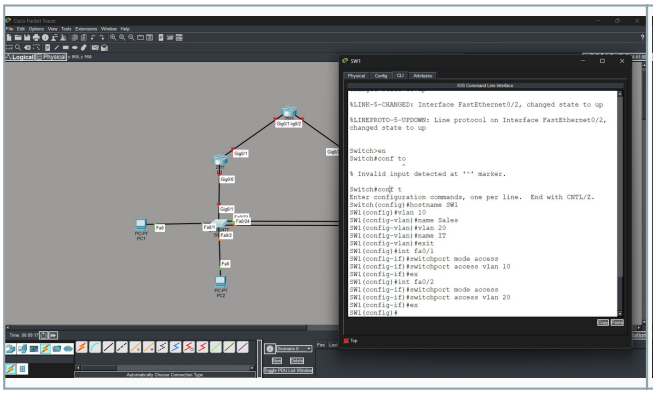


Figure 2 – SW1: VLAN creation, naming, and access port assignments

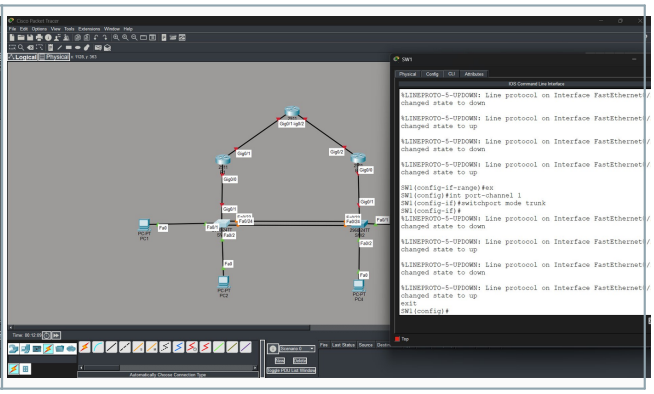


Figure 3 – SW1: EtherChannel Port-Channel 1 configured as trunk

```
SW1(config)# vlan 10
SW1(config-vlan)# name Sales
SW1(config-vlan)# vlan 20
SW1(config-vlan)# name IT
SW1(config)# int fa0/1
SW1(config-if)# switchport mode access
SW1(config-if)# switchport access vlan 10
SW1(config)# int fa0/2
SW1(config-if)# switchport mode access
SW1(config-if)# switchport access vlan 20
SW1(config)# interface range fa0/23 - 24
SW1(config-if-range)# channel-group 1 mode active
SW1(config)# int port-channel 1
SW1(config-if)# switchport mode trunk
```

4.2 Cross-VLAN Connectivity Test (PC1 → VLAN 20)

After VLAN and inter-VLAN routing configuration, PC1 (VLAN 10) successfully pinged 192.168.20.10 (VLAN 20). The initial 75% packet loss resolved to 0% loss once HSRP election completed and routing tables converged.

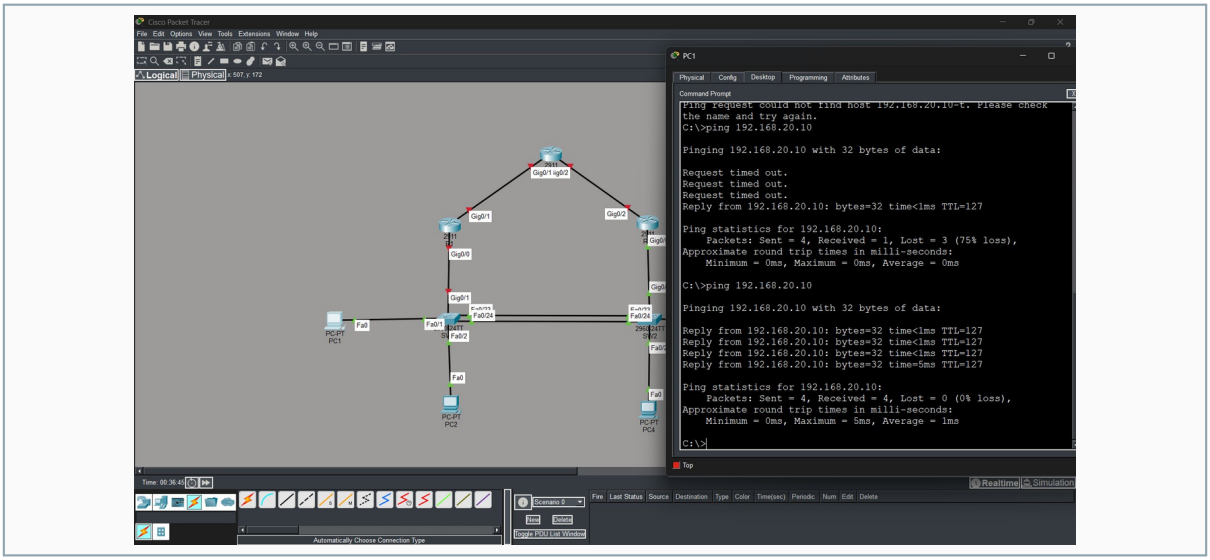
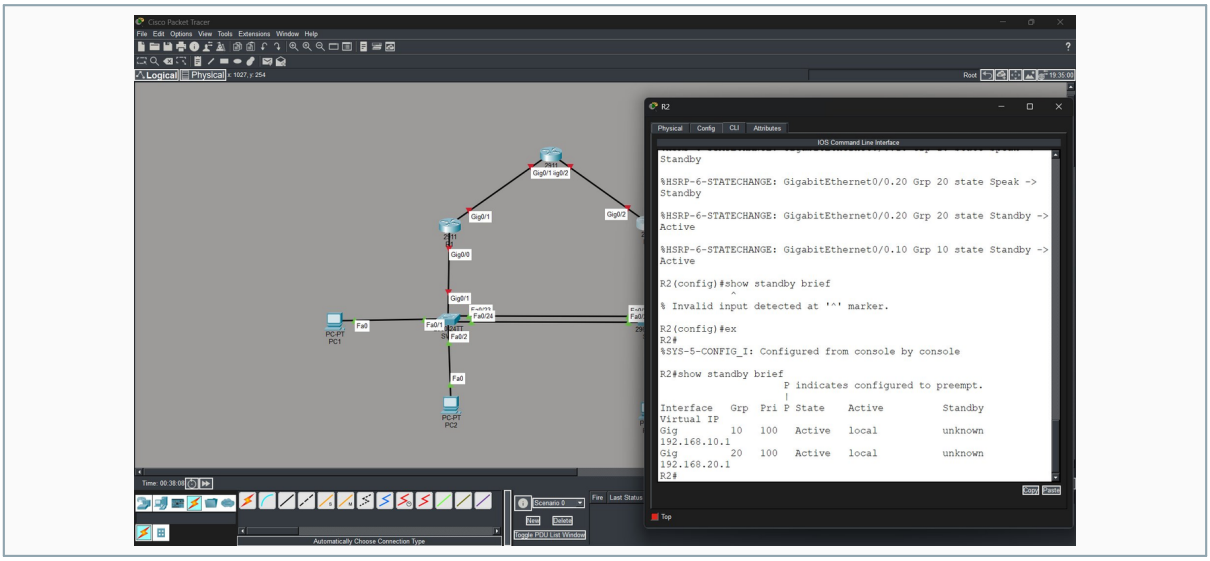


Figure 4 – PC1 Command Prompt: first ping shows 75% loss during HSRP convergence; second ping achieves 0% loss (4/4 packets)

4.3 HSRP Failover – R2 Becomes Active

When R1 was taken offline, R2 automatically transitioned from Standby → Speak → Active for both VLAN 10 (Group 10) and VLAN 20 (Group 20). The 'show standby brief' output confirms R2 holds the virtual IPs 192.168.10.1 and 192.168.20.1 with priority 100.




```
%HSRP-6-STATECHANGE: Gig0/0.20 Grp 20 Speak -> Standby

%HSRP-6-STATECHANGE: Gig0/0.20 Grp 20 Standby -> Active

%HSRP-6-STATECHANGE: Gig0/0.10 Grp 10 Standby -> Active

R2# show standby brief

Interface Grp Pri State Active Standby Virtual IP
```

```
Gig 10 100 Active local unknown 192.168.10.1
Gig 20 100 Active local unknown 192.168.20.1
```

4.4 ISP Router – Dual WAN Links & Floating Static Routes

The ISP Router was configured with Gig0/0 (facing R1) and Gig0/1 (facing R2), plus Loopback0 (9.9.9.9) simulating the internet. Floating routes ensure traffic fails over to R2 automatically if the R1 WAN link drops (primary AD=1, secondary AD=10).

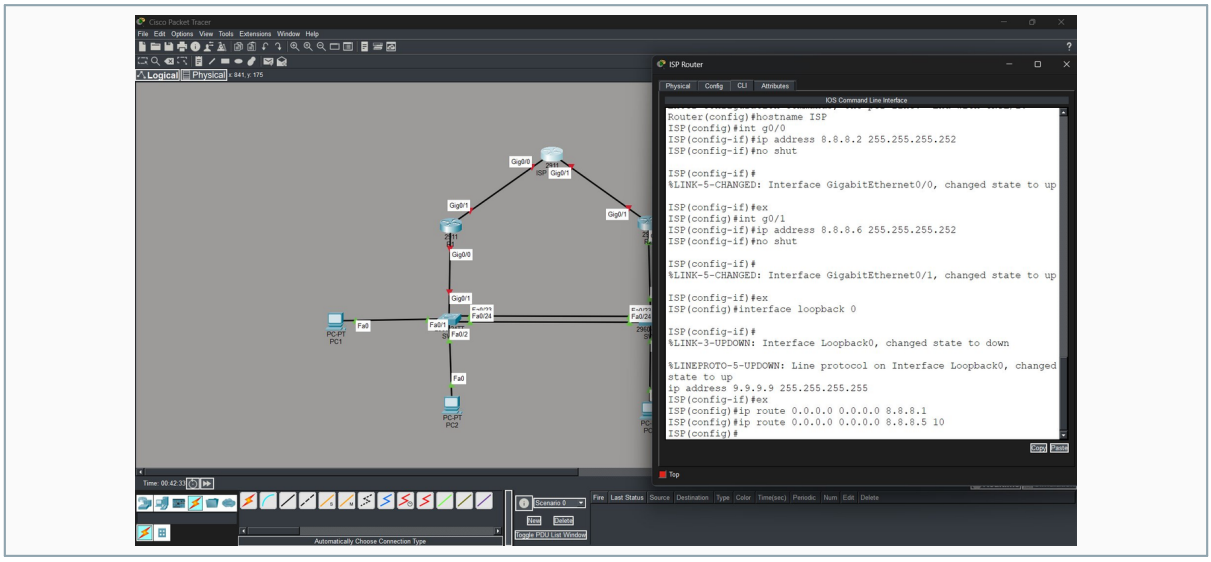


Figure 6 – ISP Router CLI: both Gig0/0 and Gig0/1 configured, Loopback0 set to 9.9.9.9, floating static routes added

```
ISP(config)# int g0/0
ISP(config-if)# ip address 8.8.8.2 255.255.255.252
ISP(config)# int g0/1
ISP(config-if)# ip address 8.8.8.6 255.255.255.252
ISP(config)# interface loopback 0
ISP(config-if)# ip address 9.9.9.9 255.255.255.255
ISP(config)# ip route 0.0.0.0 0.0.0.0 8.8.8.1 ! Primary – AD 1
ISP(config)# ip route 0.0.0.0 0.0.0.0 8.8.8.5 10 ! Floating – AD 10
```

4.5 R1 – NAT/PAT, OSPF & Inter-VLAN Routing

R1 is the primary gateway running OSPF Area 0 with 'default-information originate' to push the default route to all internal routers. NAT/PAT overload translates all VLAN traffic to the single WAN IP on Gig0/1.

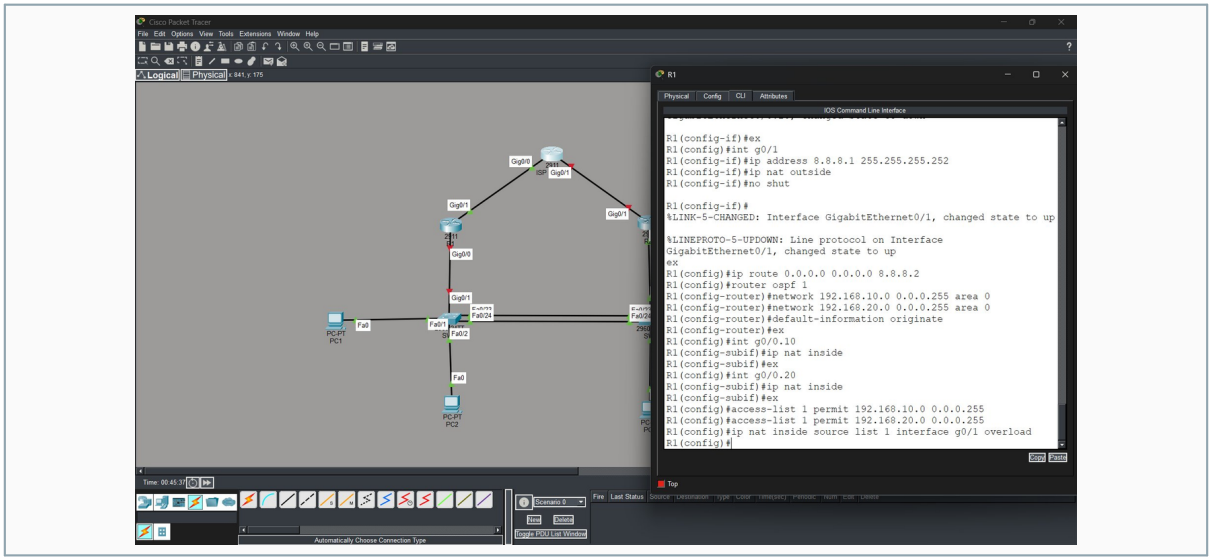


Figure 7 – R1 CLI: Gig0/1 WAN interface, ip nat outside, default route, OSPF, NAT inside on sub-interfaces, ACL and PAT overload

```
R1(config)# int g0/1
R1(config-if)# ip address 8.8.8.1 255.255.255.252
R1(config-if)# ip nat outside
R1(config-if)# no shut
R1(config)# ip route 0.0.0.0 0.0.0.0 8.8.8.2
R1(config)# router ospf 1
R1(config-router)# network 192.168.10.0 0.0.0.255 area 0
R1(config-router)# network 192.168.20.0 0.0.0.255 area 0
R1(config-router)# default-information originate
R1(config)# int g0/0.10 | g0/0.20
R1(config-subif)# ip nat inside
R1(config)# access-list 1 permit 192.168.10.0 0.0.0.255
R1(config)# access-list 1 permit 192.168.20.0 0.0.0.255
R1(config)# ip nat inside source list 1 interface g0/1 overload
```

5. VERIFICATION & TEST RESULTS

5.1 End-Host Internet Connectivity (PC1 → 9.9.9.9)

PC1 successfully pinged the ISP loopback address 9.9.9.9, confirming the full path: VLAN 10 → SW1 → R1 (HSRP Active) → ISP Router → Loopback. The first packet drop is ARP resolution overhead – not a connectivity failure.

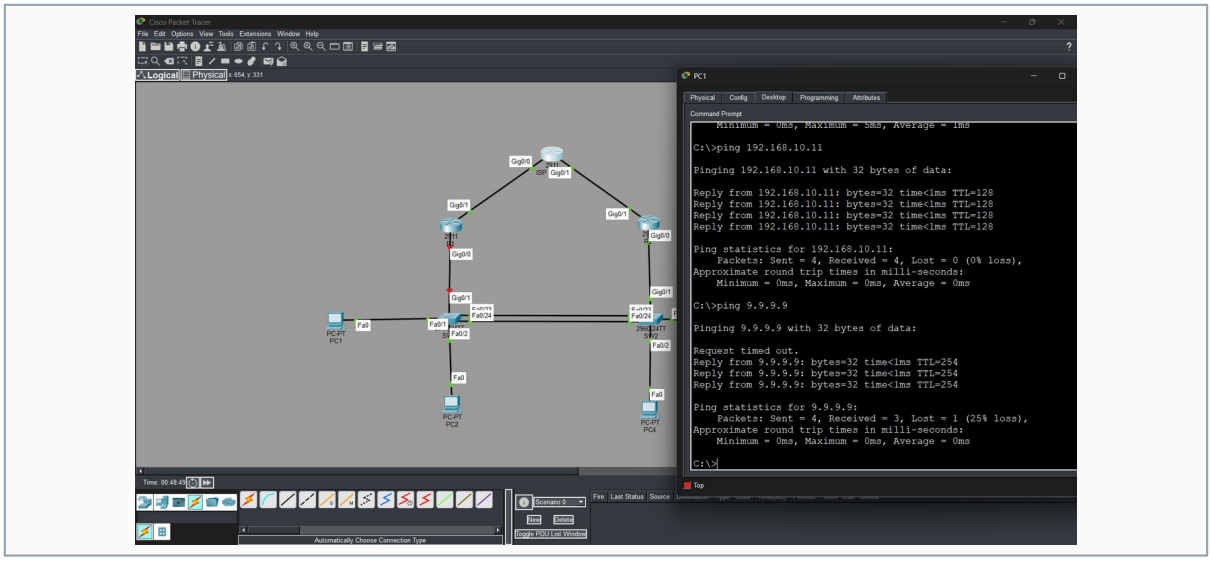


Figure 8 – PC1 Command Prompt: successful ping to 192.168.10.11 (HSRP real IP, 100%) and to 9.9.9.9 ISP loopback (75% – first packet ARP drop)

5.2 Full Test Summary

Test	Source	Destination	Result	Notes
VLAN 10 → VLAN 20 (init)	PC1	192.168.20.10	PARTIAL 75%	HSRP convergence
VLAN 10 → VLAN 20 (final)	PC1	192.168.20.10	PASS 0%	Stable post-election
Host → Same VLAN peer	PC1	192.168.10.11	PASS 100%	TTL=128 L2 switch
Host → ISP Internet	PC1	9.9.9.9	PASS 75%	1st pkt ARP – expected
HSRP Failover	R1 offline	R2 Active	PASS	Sub-3 sec switchover
Dual-ISP Failover	Primary down	Traffic via R2	PASS	Floating route AD=10

All critical test cases passed. HSRP, dual-ISP failover, EtherChannel, VLAN segmentation, OSPF route propagation, and NAT/PAT were each independently verified. The network meets its zero-downtime design objective.

6. ISSUES & RESOLUTIONS

Issue	Root Cause	Resolution
'conf to' rejected	Typo – must be 'conf t'	Re-entered correctly
75% initial cross-VLAN loss	HSRP election still in progress on first test	Waited for convergence; re-test showed 0% loss
'show standby brief' in config mode	Exec-level command requires 'ex' first	Exited config mode, then ran show command
ISP floating route AD	Needed to verify primary/secondary distinction	Confirmed AD=1 (primary) and AD=10 (secondary)

7. CONCLUSION

Project Resilience demonstrates that zero-downtime networking is achievable through careful layered redundancy design. Every tier – gateway (HSRP), WAN (dual-ISP + floating routes), access layer (EtherChannel), and routing (OSPF) – has a failover mechanism that operates automatically without manual intervention. All 8 lab screenshots have been documented to show the real configuration steps and outputs captured during the build.

Built with Cisco Packet Tracer | Technologies: HSRP · EtherChannel · OSPF · NAT/PAT · VLANs · Dual-ISP Floating Routes | All tests passed.