Dell Force10
VLT Technical Guide

Overview, Optimization, and Performance Testing

Document control

Version	Date	Contact details	Action (e.g. creation, review, change)
V1.0	31st May 2012	Alexis Dacquay Network Sales Engineer alexis_dacquay@dell.com	1st release
V1.11	15th June 2012	Alexis Dacquay	Corrections Added failover diagrams Added Test 6 Added Configurations

Disclaimer

1. VLT overview

1.1. Definitions

This document focuses on VLT performance technical details and assumes a minimum knowledge of VLT as provided by the FTOS configuration guide.

VLT is supported on the S4810 in general availability from FTOS 8.3.10.2.

The below picture illustrate the positioning of the different elements that participate in a VLT implementation, the goal is to disambiguate the terms usage.

For example:

- VLT is a trunk (as per its name) attaching remote hosts or switches.
- VLTi is the interconnect link between the VLT peers. For historical reasons that is also called ICL (InterConnect Link) in the command outputs.

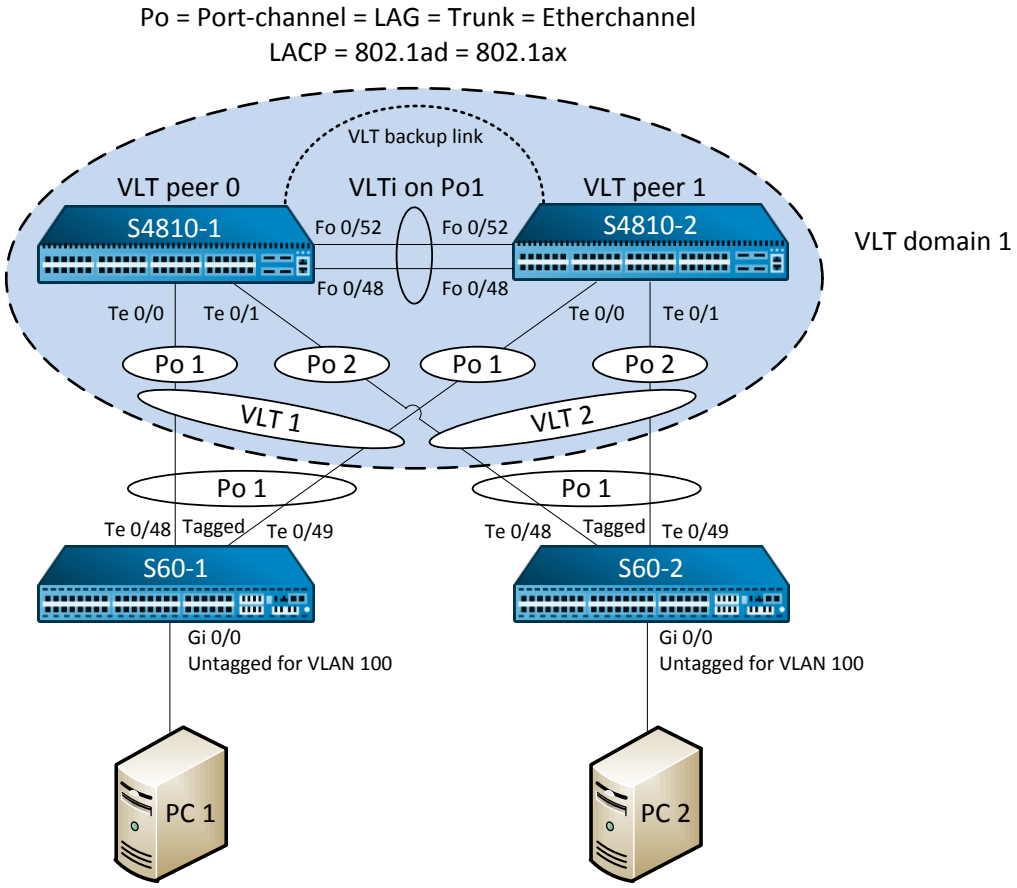


Figure 1 - VLT terms illustrated

Unit management role

The VLT peers have distinct management planes. The only virtualization operates at Layer2 for termination the remote devices' port-channel to a single VLT logical end-point (physically separated).

All the following management tasks and control protocol roles need to be implemented (possibly uniquely) on each individual unit in the VLT domain. The peers hold different roles for all these functions:

- CLI configuration and configuration management
- Spanning-Tree
- LACP
- VRRP
- VLT

The VLT peers exchange and synchronize Layer2-related tables to achieve harmonious Layer2 forwarding among the whole VLT domain, but the mechanism involved is transparent.

1.2. Topologies

Illustrations

The below diagram illustrate the currently supported topology. Devices connected to the VLT domain could be either switches or hosts, as long as they support port-channel (LAG, 802.1ax, etc)

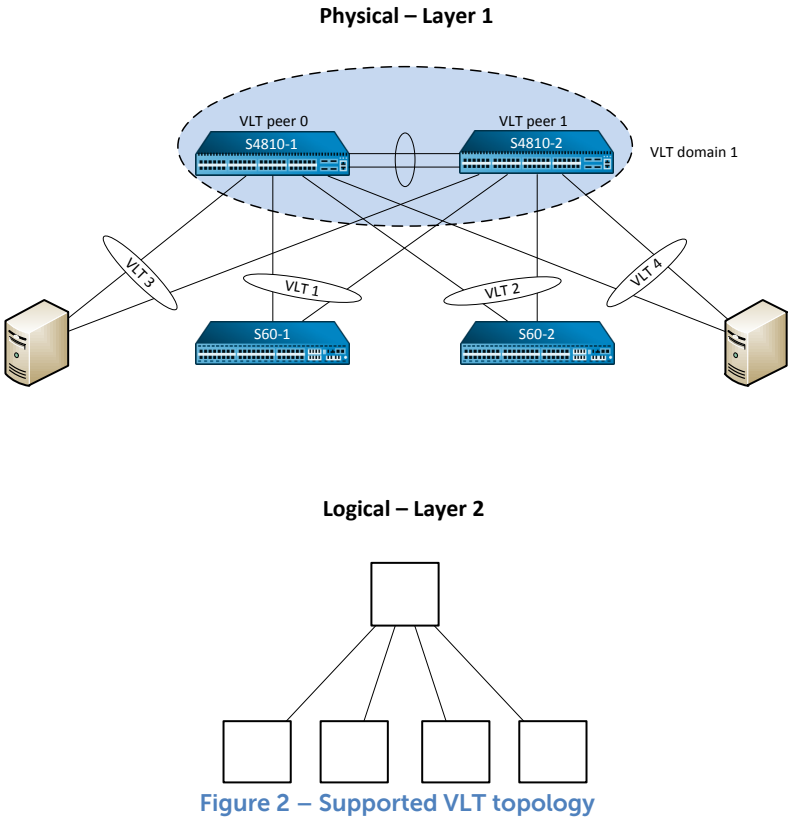


Figure 2 – Supported VLT topology

Design rules

All the following rules apply to the VLT topologies

- 2 unit per domain (as of FTOS 8.3.10.2)
- 8 links per port-channel or fewer.
- Units should run the same FTOS version
- The backup should employ a different link than the VLTi, and preferably a diverse path

Future topologies - not supported yet

This section illustrates several topologies that are not supported yet but would be in the future.

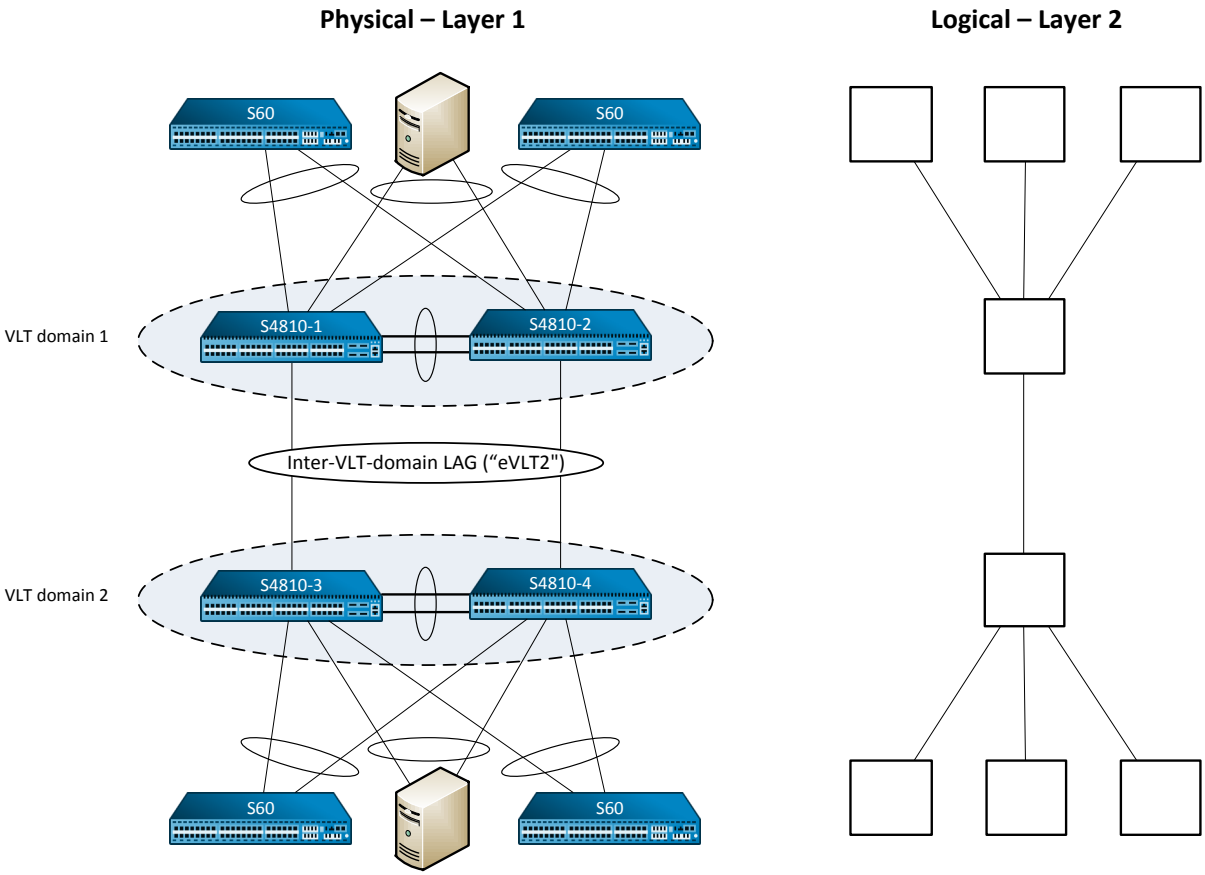


Figure 3 - Future topology: square core, not yet supported (as of 8.3.10.2)

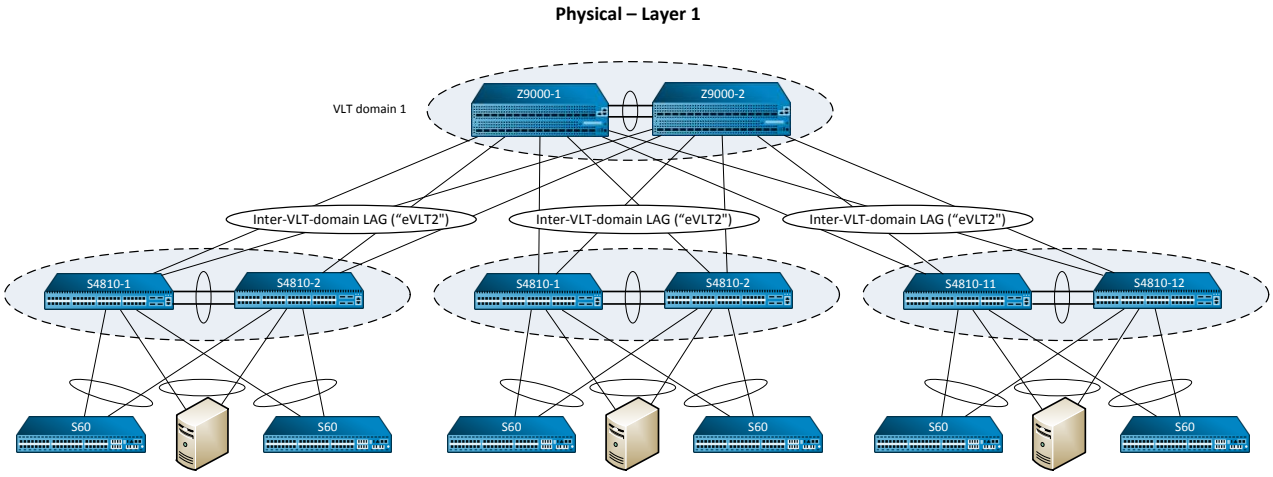


Figure 4 - Future topology: Tree core, not yet supported (as of 8.3.10.2)

Path selection inside the domain

The VLT peers operate local-switching. Even is a VLT peer is not the VRRP master, it will locally forward (Layer2 or Layer3) the packet to its destination without needing to redirect traffic to the VRRP master. In essence, a VLT domain with VRRP is natively active-active.

2. VLT deployment

2.1. Procedure

Satisfying requirements

1 Ensure that all the standalone units have the same FTOS version
- Minimum requirement: 8.3.10.2 (RTS release)

RSTP

2 Enable RSTP (no other STP as of 8.3.10.2)

```
protocol spanning-tree rstp
 no disable
```

Despite VLT offering a loop-free Layer2 topology, it is recommended to use RSTP to prevent configuration and patching mistakes. Removing RSTP does not necessarily benefit performance.

3 RSTP - Configure the bridge priorities for deterministic behaviour

```
bridge-priority <priority>
```

Suggested bridge priorities:
- SW1 root bridge 0
- SW2 secondary root bridge 8192
- Others (if any) 32768 (default)

4 RSTP - Tune the timers to their minimum for faster convergence

```
forward-delay 4            (instead of 15 by default)
max-age 6                  (instead of 20 by default)
hello-time milli-second 50 (instead of 2 by default)
```

For interoperability but negligibly slower convergence, use the following improved timer (instead of "hello-time milli-second 50")

```
hello-time 1               (instead of 2 by default)
```

In very large deployments, all the above aggressive times might need to be increased.

VLT

5 VLT - Configure a VLT domain

```
vlt domain <domain-id>
```

6 VLT - Fix the VLT system parameters to avoid negotiations (for faster convergence)

```
primary-priority <value>   (suggestion: 1 for the primary, 8192 for sec)
system-mac mac-address <value>   (same MAC address on all VLT peers)
unit-id <value>      (suggestion: 0 for the primary, 1 for secondary)
```

Avoid picking some weird MAC addresses like reserved, multicast, etc. It could potentially cause trouble.

7 VLT (optional) - Prepare your port-channel for VLTi configuration (only if you have previous non-default configuration).

To become a VLTi (automatically managed by the system), the port-channel should be in *default mode* (no switchport). For example, to return a Layer2 tagged port-channel to default, you would un-configure the following way:

```
int range vlan <begining – end>
  no untag port <LAG-ID>
int port-channel <LAG-ID>
  no switchport
```

Note: The system will automatically include needed VLANs to be tagged into the VLTi. You *do not* need to manually tag VLANs on the VLTi.

8 VLT - Configure the core VLT peering relationship across the port-channel that will become the VLT interconnect (VLTi)

Note: it is recommended to build the VLTi port-channel statically to minimize negotiations in the VLT domain core.

```
(conf-vlt-domain)# peer-link port-channel <LAG-ID>
```

9 VLT - Configure the VLT backup link (used for health checks)

```
(conf-vlt-domain)# back-up destination <ip-address>
```

The backup link should be a different link than the VLTi and if possible following a diverse path. This could be the management interface IP address.

10 VLT - Configure both VLT peers to agree on making two separate port-channels a single VLT toward a common attached device.

Note: It is recommended that VLTs that are facing hosts/switches should be preferably built by LACP, to benefit from the protocol negotiations. However static port-channels are also supported

```
interface port-channel <id-number>
 vlt-peer-lag port-channel <id-number>
```

The command needs to specify what port-channel ID is used on the VLT peer. It is obviously recommended that both peer locally use the same port-channel ID.

Dampening

11 Configure dampening (or equivalent) on the interfaces of connected hosts/switches (access switches, not VLT peers)

At start-up time, once the physical ports are active a newly started VLT peer takes several seconds to fully negotiate protocols and synchronize (VLT peering, RSTP, VLT backup links, LACP, VLT LAG sync, etc). The attached devices are not aware of that activity and upon activation of a physical interface, the connected device will start forwarding traffic on the restored link, despite the VLT peer unit being still unprepared. It will black-hole traffic.

Dampening on connected devices (access switches) will hold an interface temporarily down after a VLT peer device reload. A reload is detected as a flap: the link goes down and then up. Dampening acts as a cold start delay, ensuring that the VLT peers are upmost ready to forward before the physical interface is activated, avoiding temporary black holes.

Example:

```
int ten 0/0
 dampening 10 100 1000 60
```

Suggested dampening time: 30 seconds to 1 minute
Several forms of the command can achieve the target dampening time, you may tune it.
Too short time can void the benefit of dampening: the goal is to hold the interface down.
Long dampening has no adverse effect on convergence.

2.2. Hints and tips

If the network is not tuned, some failures can lead to outages up to 30 seconds. The proposed heavy tuning reduces that to around 2-3 seconds (inter-VLAN routing) or 200-300 milliseconds (Layer2).

Use RSTP and **tune it**. (timers, port-fast where needed, etc)

Dampen interfaces of connected devices (access switches)

Prefer static LAG between VLT peers and LACP towards hosts/switches.

To become VLTi the port-channel must be in default mode (no switchport, no VLAN assigned).

You do not need to manually tag VLANs on the VLTi. The system does it by itself for any VLAN tagged on VLTs.

3. Verification and troubleshooting

In the current FTOS release (8.3.10.2) there are not VLT debug command, only show commands.

3.1. Overview

Verify:

- VLT parameters on each peer (domain, role, etc)
- Links and sessions status
- If something is down (e.g. "`Not Established`", resolve it)

```
sh vlt brief
 VLT Domain Brief
------------------
 Domain ID:                    1
 Role:                         Primary
 Role Priority:                1
 ICL Link Status:              Up
 HeartBeat Status:             Not Established
 VLT Peer Status:              Up
 Local Unit Id:                0
 Local System MAC address:     00:01:e8:8a:d6:bc
 Remote System MAC address:    00:01:e8:8a:d6:b0
 Configured System MAC address:00:11:22:33:44:55
```

3.2. Statistics

Make sure that:

- the VLTi (ICL) link is passing (receiving and sending) hellos
- There is no mismatch error (config mistakes)

```
sh vlt statistics
 VLT Statistics
----------------
 HeartBeat Messages Sent:       0
 HeartBeat Messages Received:   0
 ICL Hello's Sent:              158
 ICL Hello's Received:          159
 Domain Mismatch Errors:        0
 Version Mismatch Errors:       0
 Config Mismatch Errors:        0
```

In the above "show system" output, the information to quickly look at for the unit roles is:

- Unit Type
- Master priority

3.3. Backup link

To operate, the backup link should pass communication bi-directionally. Check configuration mistakes or networking issues if seeing unidirectional traffic

```
sh vlt backup-link
 VLT Backup Link
-----------------
 Destination:                    10.0.0.1
 Peer HeartBeat status:          Not Established
 HeartBeat Timer Interval:       1
 HeartBeat Timeout:              3
 UDP Port:                       34998
 HeartBeat Messages Sent:        705
 HeartBeat Messages Received:    0
```

3.4. VLANs

The VLTi is automatically configured for tagged VLANs required by the VLTs

```
sh vlan

Codes: * - Default VLAN, G - GVRP VLANs, R - Remote Port Mirroring VLANs, P
- Primary, C - Community, I - Isolated
Q: U - Untagged, T - Tagged
   x - Dot1x untagged, X - Dot1x tagged
   G - GVRP tagged, M - Vlan-stack, H - VSN tagged
   i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT
tagged

    NUM    Status    Description                    Q Ports
*   1      Active                                   U Po12(Fo 0/48,52)
    100    Active                                   T Po1()
                                                    T Po2()
                                                    V Po12(Fo 0/48,52)
    101    Active                                   T Po1()
                                                    T Po2()
                                                    V Po12(Fo 0/48,52)
```

4. Failover Testing

This section review results from different failover scenarios.

4.1. Overview

If the network is not tuned, some failures can lead to outages up to 30 seconds. The proposed heavy tuning reduces that to around 2-3 seconds (inter-VLAN routing) or 200-300 milliseconds (Layer2).

4.2. Generic equipment list for tests

Several tests were run and the following lists the equipment used.

Hardware

- 2 x S4810 as core units
  - FTOS 8.3.10.2
  - Unit 1 – master for all the protocols (RSTP, VLT, VRRP)
  - Unit 2 – backup (in term or protocols, not traffic path)
- 2 x 1G S-Series (dual-homed) as access layer
  - S-60: FTOS 8.3.3.6
  - S-50: FTOS 8.4.2.6
- 2 x hosts connecting to the access switches
  - PC1: Windows 7 32 bits
  - PC2: Windows 7 64 bits

Physical topology (common to all tests)

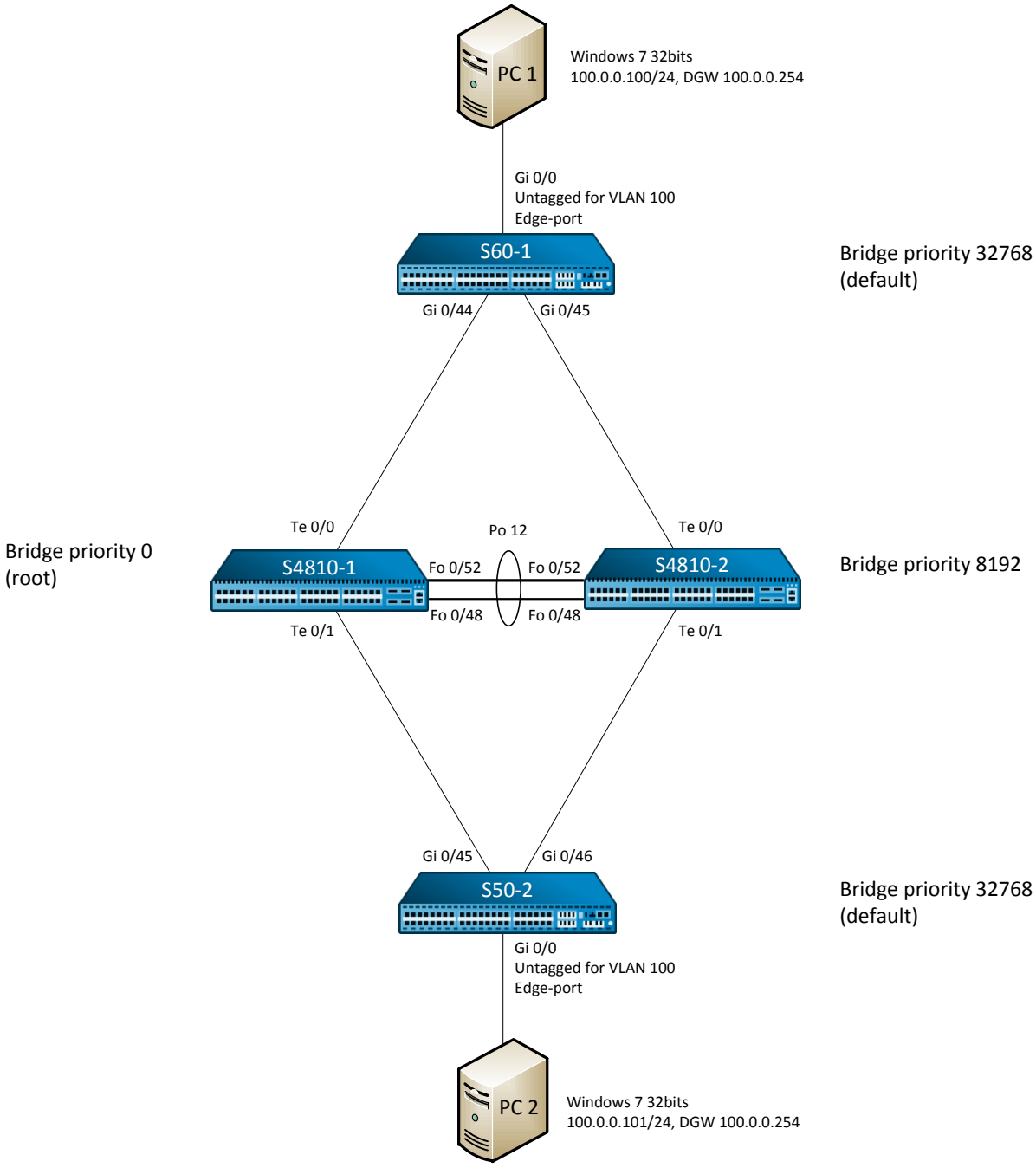


Figure 5 - Physical topology

Software

- FPing v 2.2.2
  - 10 ms interval
  - 10 ms timeout
  - 64B ICMP echo requests

FPing is being used on both hosts to collect bidirectional measurement.

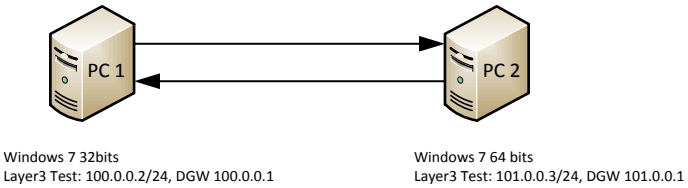


Figure 6 - Host to host test communications

FPing command examples:

```
PC1 (100.0.0.1/24)
fping.exe 101.0.0.2 -s 64 -c -t 10 -w 10 -j -T -L output1.txt

PC2 (101.0.0.2/24)
fping.exe 100.0.0.1 -s 64 -c -t 10 -w 10 -j -T -L output2.txt
```

Methodology

A device outage is caused by power failure, unplugging the power cable.
A link failure is caused by plugging out the LC connector of a patch fibre.

The outage time is measured in term of packet lost (e.g. 10 packets) and multiplied by the interval between each packet (10ms each packet). 10 lost packets mean 100ms of lost transmission.

The outage time recorded is the total amount in the course of a test run, but outages can in reality be intermittent, so the total duration of the convergence can be longer than the time of lost transmission.

For example:

- Beginning of outage (first packet loss): T0 up to T+10s
- Transmission recovered from T+10s up to T+20
- New losses: T+20s to T+30
- Final recovery (stable): T+30s and thereafter
- In the above example, there had 20 seconds of outage, but the convergence took 30 seconds.

4.3. Test 1 – No VLT, "ultra-"RSTP, L2 only, Unit failure

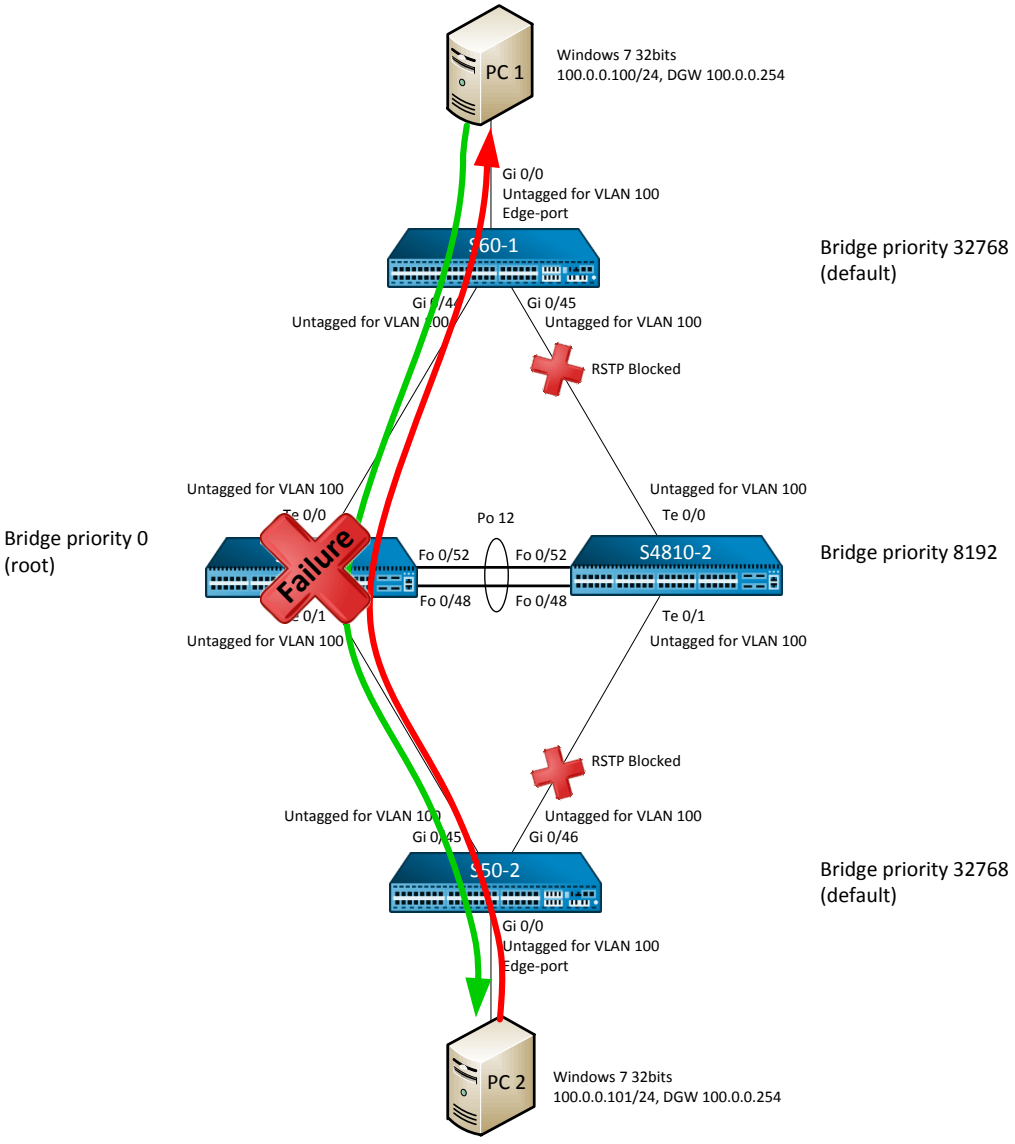
Overview

Note: the "ultra" denomination has nothing official.

Device failure is **S4810-1**
RSTP ultra-optimized to non-standard RSTP values (50ms hellos)
The traffic path is verified in order to select which device to fail
RSTP re-convergence after the topology change.
No inter-VLAN routing (single Layer 2 domain)

RSTP parameters: forward-delay 4, hello-time 50 ms, max-age 6

Topology diagram



Results

Run (Repetition)	Outage at failure (ms)		Outage at recovery (ms)	
	PC1	PC2	PC1	PC2
1	170	180	110	60
2	950	1030	10	30
3	230	250	230	300
4	280	310	100	140
5	330	370	390	460
6	250	280	220	240
7	120	130	100	90
8	230	260	80	80
9	280	320	140	150
10	290	340	210	240
Average	**313**	**347**	**159**	**179**

Table 1 - Test 1 results

4.4. Test 2 – No VLT, RSTP, L2 only, Device failure

Overview

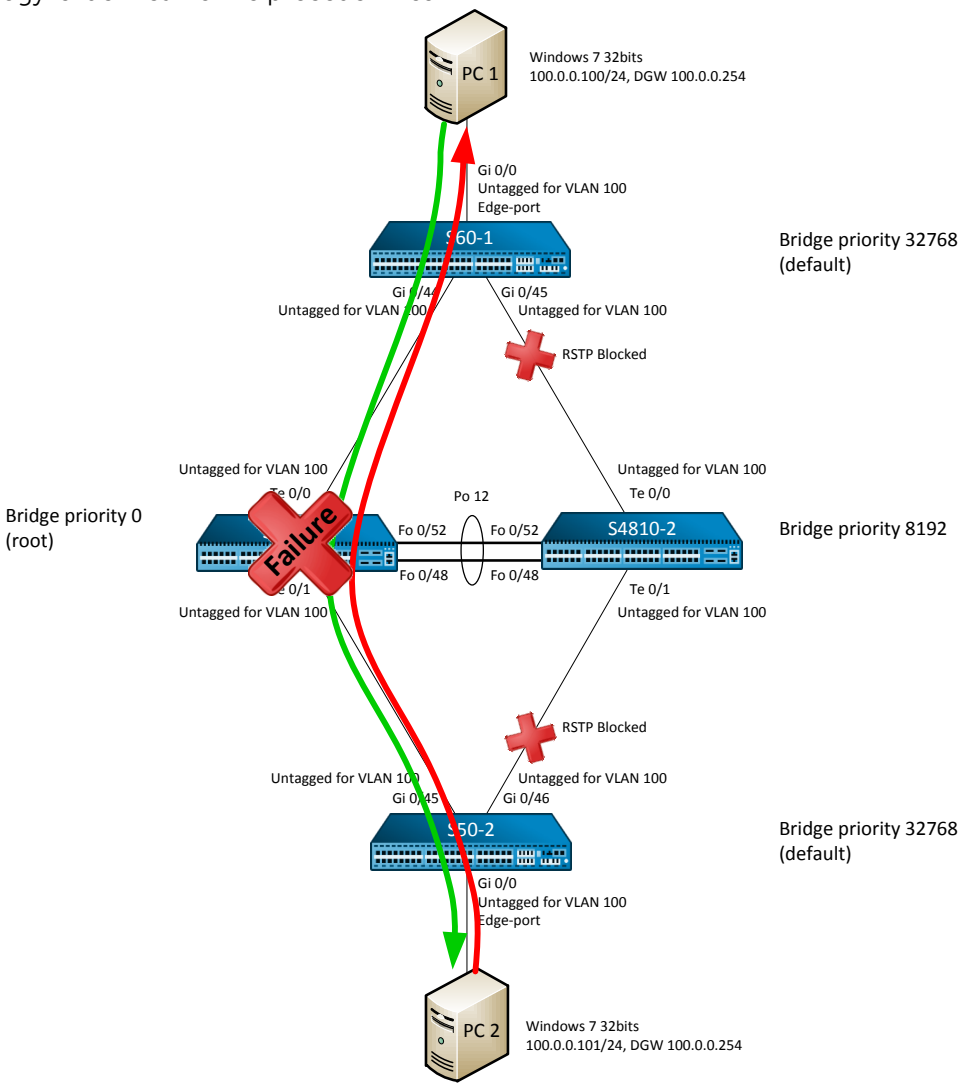
Difference with previous test: RSTP is tune to standard (1 s hello timer instead of 50 ms)

Device failure is **S4810-1**
RSTP optimized to standard RSTP values (1s hellos).
The traffic path is verified in order to select which device to fail
RSTP re-convergence after the topology change.
No inter-VLAN routing (single Layer 2 domain)

RSTP parameters: forward-delay 4, hello-time 1, max-age 6

Topology diagram

The topology is identical to the precedent test



Results

Run (Repetition)	Outage at failure (ms)		Outage at recovery (ms)	
	PC1	PC2	PC1	PC2
1	110	110	900	990
2	230	240	1160	1210
3	350	380	1230	1350
4	120	130	1120	1210
5	250	270	1860	2000
6	110	140	1030	1130
7	140	250	1180	1250
8	230	130	890	960
9	110	130	1310	1420
10	90	100	1640	1770
Average	**174**	**188**	**1232**	**1329**

Table 2 - Test 2 results

4.5. Test 3 – VLT, L2 only, Dampening, Device failure

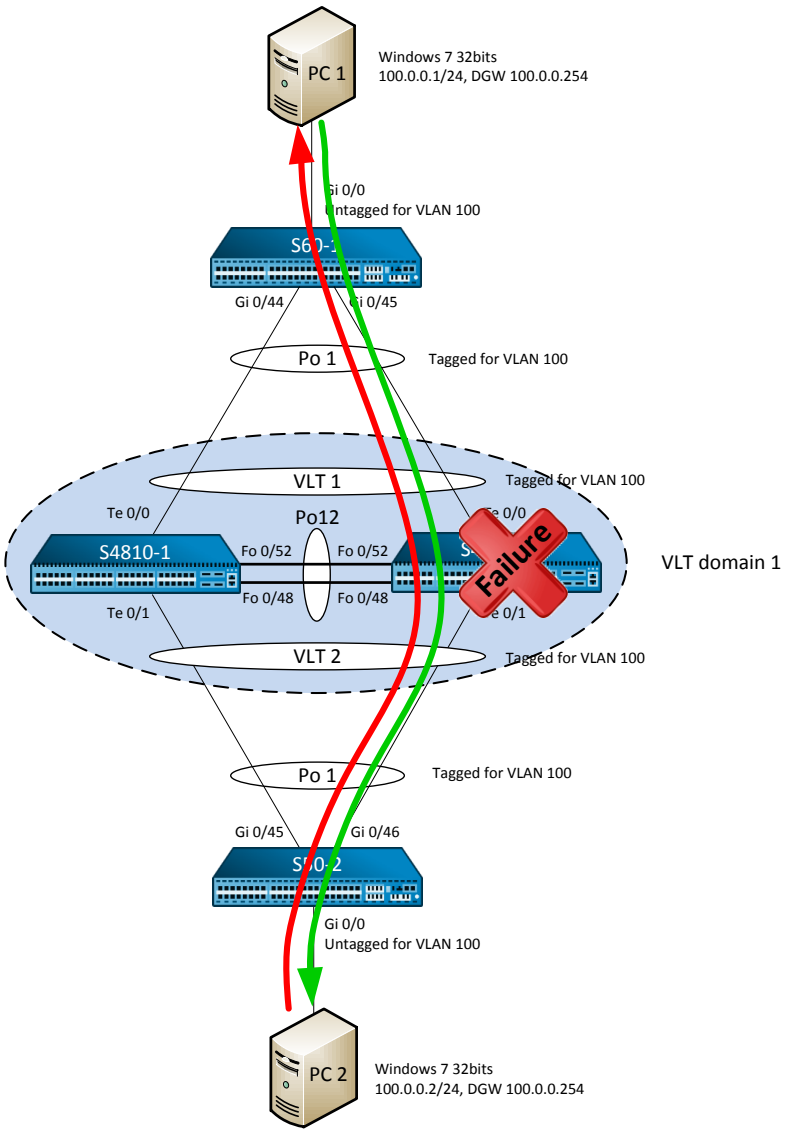
Overview

Difference with previous test: VLT enabled with interface dampening on the access switches

Device failure is **S4810-2**
RSTP optimized to standard RSTP values (1s hellos)
The traffic path is verified in order to select which device to fail
RSTP, LACP and VLT re-convergence after the topology change.
No inter-VLAN routing (single Layer 2 domain)

RSTP parameters: forward-delay 4, hello-time 1, max-age 6
Dampening parameters: dampening 10 100 1000 60

Topology diagram



Results

Run (Repetition)	Outage at failure (ms)		Outage at recovery (ms)	
	PC1	PC2	PC1	PC2
1	240	260	100	110
2	80	80	90	90
3	210	220	60	60
4	110	120	70	50
5	340	360	60	80
6	350	380	270	300
7	140	150	170	180
8	100	120	190	190
9	100	110	40	40
10	140	150	200	190
Average	**181**	**195**	**125**	**129**

Table 3 - Test 3 results

4.6. Test 4 – VLT, L2 only, Dampening, Link failure

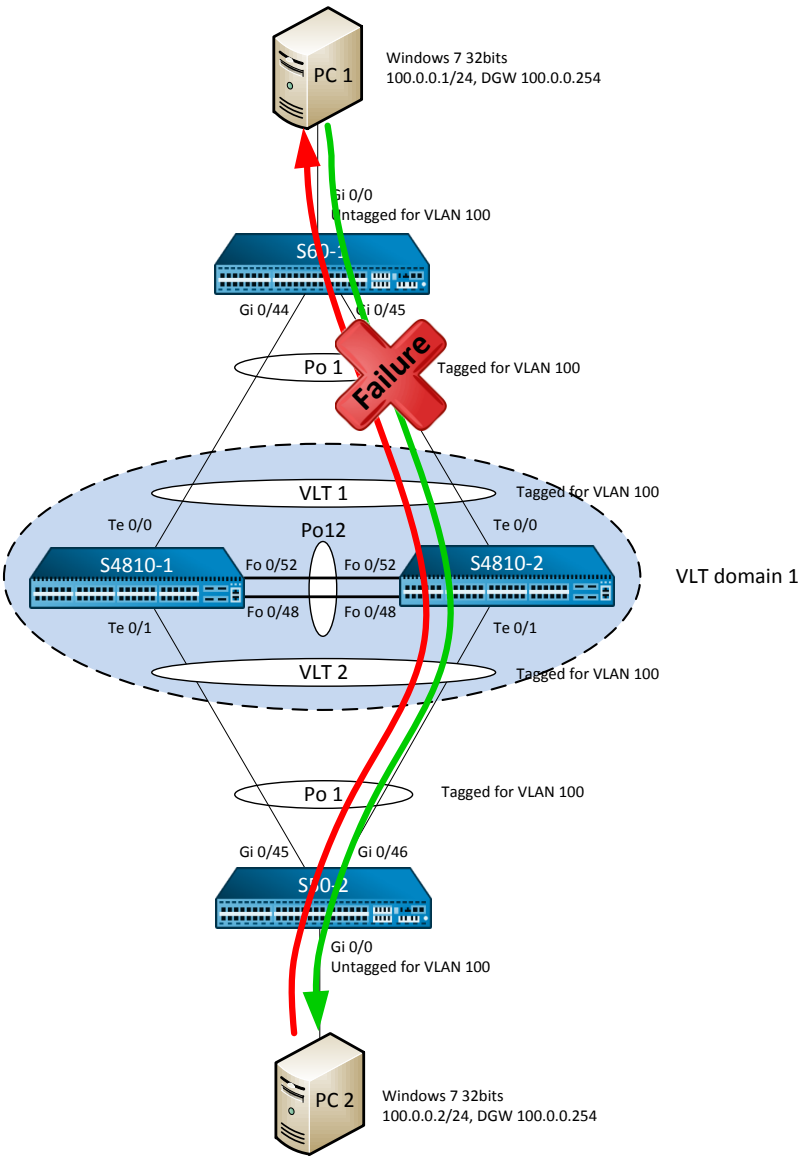
Overview

Difference with previous test: Link failure instead of unit failure

Link failure is S4810-2 Te0/0 to S60-1 Gi0/45, on the S60 side
The traffic path is verified in order to select which device to fail

RSTP parameters: forward-delay 4, hello-time 1, max-age 6
Dampening parameters: dampening 10 100 1000 60

Topology diagram



Results

Run (Repetition)	Outage at failure (ms)		Outage at recovery (ms)	
	PC1	PC2	PC1	PC2
1	270	270	170	200
2	270	270	30	50
3	200	230	10	30
4	240	310	10	40
5	180	200	30	30
6	280	290	50	20
7	240	260	200	210
8	190	210	60	70
9	250	250	50	70
10	200	220	70	10
Average	**232**	**251**	**68**	**73**

Table 4 - Test 4 results

4.7. Test 5 – VLT, L3 (inter-VLAN), Dampening, Unit failure

Overview

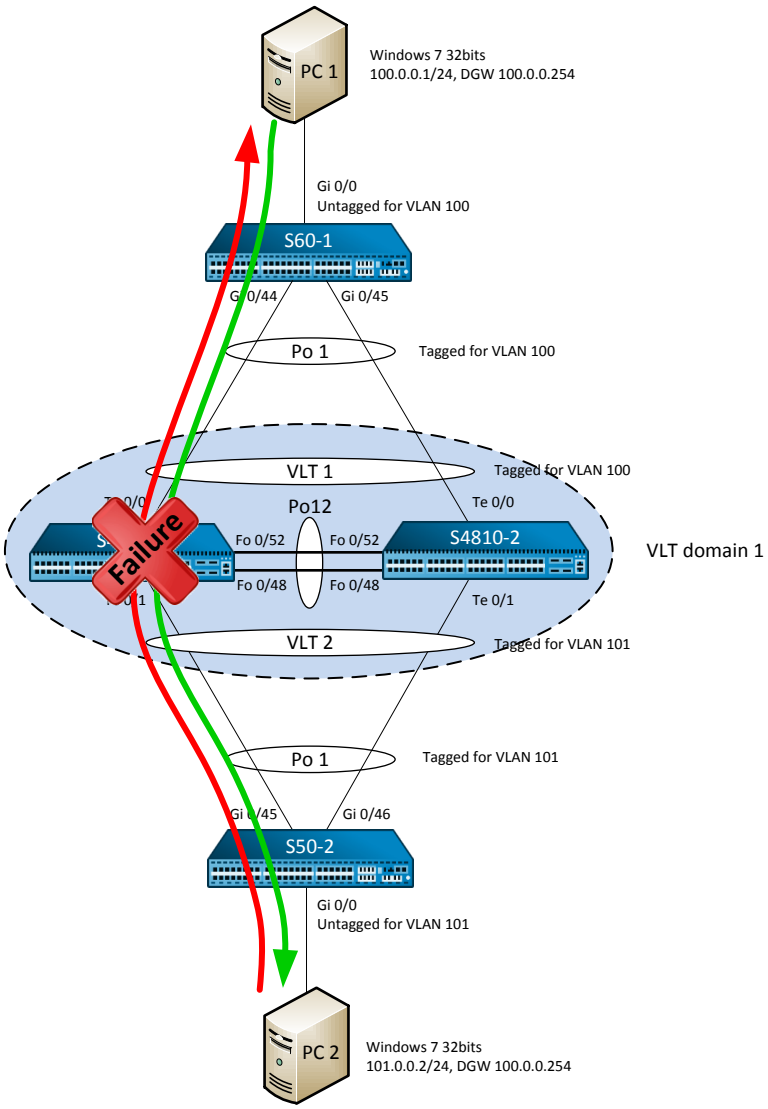
Difference with previous test: inter-VLAN routing instead of intra-VLAN traffic

Device failure is **S4810-1**
Inter-VLAN routing between VLAN 100 and 101

RSTP parameters: forward-delay 4, hello-time 1, max-age 6
Dampening parameters: dampening 10 100 1000 60

Topology diagram

Similar to test 4, but PC2 IP addressing changed in order to accomplish inter-VLAN routing. Also, due to hashing change, traffic now flows via S4810-1.



Results

Run (Repetition)	Outage at failure (ms)		Outage at recovery (ms)	
	PC1	PC2	PC1	PC2
1	230	250	940	1020
2	100	110	1880	1880
3	230	250	1990	2050
4	190	210	1830	1910
5	270	280	1710	2650
6	160	160	1260	1420
7	110	120	1580	1600
8	160	220	2110	2140
9	100	110	1730	1800
10	70	80	1520	1650
Average	**184**	**197**	**1598**	**1790**

Table 5 - Test 5 results

4.8. Test 6 – VLT, L3 (inter-VLAN), Dampening, Link failure

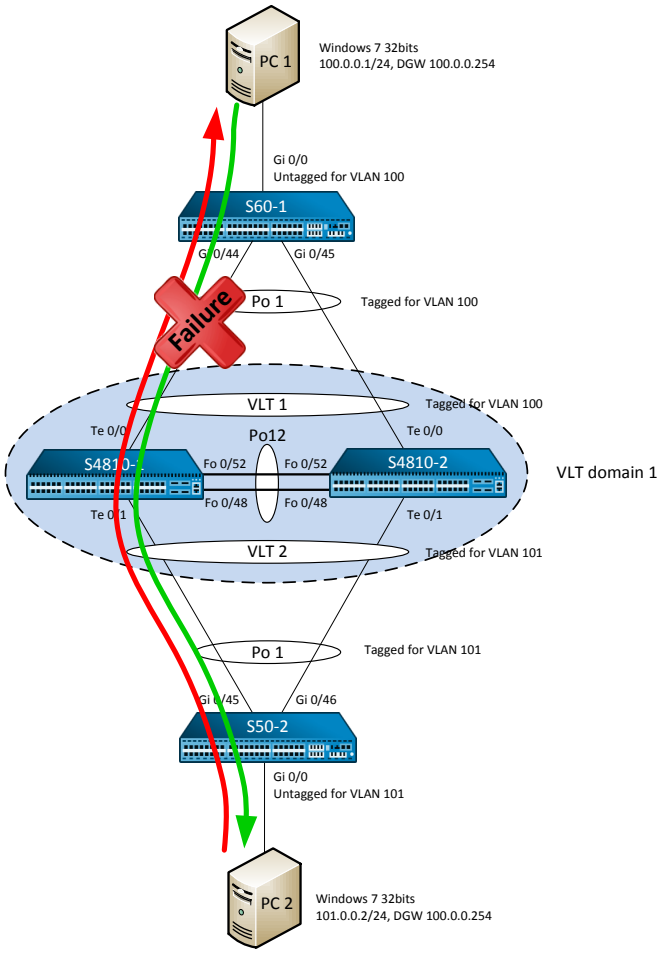
Overview

Difference with previous test: Link failure instead of unit failure.

Link failure is S4810-1 Te0/0 to S60-1 Gi0/44, on the S60 side

RSTP parameters: forward-delay 4, hello-time 1, max-age 6
Dampening parameters: dampening 10 100 1000 60

Topology diagram



Results

Run (Repetition)	Outage at failure (ms)		Outage at recovery (ms)	
	PC1	PC2	PC1	PC2
1				
2	1100	1150	1020	1100
3	590	680	950	1000
4	250	280	960	1020
5	1080	1140	960	1040
6	1080	1110	1070	1110
7	1170	1260	1030	1010
8	1100	1140	1010	1020
9	1100	1160	1010	1070
10	1110	1130	990	1050
Average	**953**	**1130**	**1000**	**1046**

Table 6 - Test 5 results

5. Annexes

5.1. Configurations

5.1.1. S4810-1

```
! Version 8.3.10.2
!
boot system stack-unit 0 primary system: B:
boot system stack-unit 0 secondary system: A:
boot system stack-unit 0 default system: B:
boot system gateway 0.0.0.0
!
redundancy auto-synchronize full
!
hardware watchdog
!
hostname S4810-1
!
enable password 7 b125455cf679b208e79b910e85789edf
!
!
bsd-username force10 secret 7 $1$T0duaorE$wE19jk5ypeohACiLFqDsS0
username force10 password 7 387a7f2df5969da4
!
protocol spanning-tree rstp
 no disable
 hello-time 1
 max-age 6
 forward-delay 4
 bridge-priority 0
!
stack-unit 0 provision S4810
!
interface TenGigabitEthernet 0/0
 description To SW1
 no ip address
!
 port-channel-protocol LACP
  port-channel 1 mode active
 no shutdown
!
interface TenGigabitEthernet 0/1
 description To SW2
 no ip address
!
 port-channel-protocol LACP
  port-channel 2 mode active
 no shutdown
!
interface TenGigabitEthernet 0/2
 no ip address
 shutdown
!
```

```
interface TenGigabitEthernet 0/3
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/4
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/5
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/6
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/7
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/8
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/9
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/10
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/11
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/12
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/13
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/14
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/15
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/16
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/17
 no ip address
 shutdown
```

```
!
interface TenGigabitEthernet 0/18
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/19
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/20
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/21
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/22
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/23
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/24
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/25
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/26
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/27
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/28
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/29
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/30
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/31
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/32
 no ip address
```

```
 shutdown
!
interface TenGigabitEthernet 0/33
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/34
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/35
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/36
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/37
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/38
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/39
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/40
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/41
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/42
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/43
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/44
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/45
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/46
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/47
```

```
 description To VLT peer - backup link
 ip address 10.0.0.1/24
 no shutdown
!
interface fortyGigE 0/48
 description To VLT peer - VLTi
 no ip address
!
 port-channel-protocol LACP
  port-channel 12 mode active
 no shutdown
!
interface fortyGigE 0/52
 description To VLT peer - VLTi
 no ip address
!
 port-channel-protocol LACP
  port-channel 12 mode active
 no shutdown
!
interface fortyGigE 0/56
 no ip address
 shutdown
!
interface fortyGigE 0/60
 no ip address
 shutdown
!
interface ManagementEthernet 0/0
 ip address 1.1.1.1/24
 no shutdown
!
interface ManagementEthernet 1/0
 no shutdown
!
interface ManagementEthernet 2/0
 no shutdown
!
interface ManagementEthernet 3/0
 no shutdown
!
interface ManagementEthernet 4/0
 no shutdown
!
interface ManagementEthernet 5/0
 no shutdown
!
interface ManagementEthernet 6/0
 no shutdown
!
interface ManagementEthernet 7/0
 no shutdown
!
interface ManagementEthernet 8/0
 no shutdown
!
interface ManagementEthernet 9/0
 no shutdown
!
```

```
interface ManagementEthernet 10/0
 no shutdown
!
interface ManagementEthernet 11/0
 no shutdown
!
interface Port-channel 1
 description To SW1
 no ip address
 switchport
 rate-interval 10
 vlt-peer-lag port-channel 1
 no shutdown
!
interface Port-channel 2
 description To SW2
 no ip address
 switchport
 rate-interval 10
 vlt-peer-lag port-channel 2
 no shutdown
!
interface Port-channel 12
 description To VLT peer - VLTi
 no ip address
 no shutdown
!
interface Vlan 1
!untagged Port-channel 12
!
interface Vlan 100
 ip address 100.0.0.252/24
 tagged Port-channel 1-2
!
 vrrp-group 1
  no preempt
  priority 120
  virtual-address 100.0.0.254
 no shutdown
!
interface Vlan 101
 ip address 101.0.0.252/24
 tagged Port-channel 1-2
!
 vrrp-group 1
  no preempt
  priority 120
  virtual-address 101.0.0.254
 no shutdown
!
ip ssh server enable
!
protocol lldp
 advertise management-tlv system-description system-name
 no disable
!
line console 0
 exec-timeout 0 0
 logging synchronous level 2 limit 20
```

```
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
line vty 5
line vty 6
line vty 7
line vty 8
line vty 9
asf-mode stack-unit all
!
vlt domain 1
 peer-link port-channel 12
 back-up destination 10.0.0.2
 primary-priority 1
 system-mac mac-address 00:11:22:33:44:55
 unit-id 0
!
end
```

5.1.2. S4810-2

```
! Version 8.3.10.1
!
boot system stack-unit 0 primary system: A:
boot system stack-unit 0 secondary system: B:
boot system stack-unit 0 default tftp://192.168.1.2/FTOS-S4810.bin
boot system gateway 0.0.0.0
!
redundancy auto-synchronize full
!
hardware watchdog
!
hostname S4810-2
!
enable password 7 b125455cf679b208e79b910e85789edf
!
!
bsd-username force10 secret 7 $1$T0duaorE$wE19jk5ypeohACiLFqDsS0
username force10 password 7 387a7f2df5969da4
!
protocol spanning-tree rstp
 no disable
 hello-time 1
 max-age 6
 forward-delay 4
 bridge-priority 8192
!
stack-unit 0 provision S4810
!
interface TenGigabitEthernet 0/0
 description To SW1
 no ip address
!
 port-channel-protocol LACP
  port-channel 1 mode active
 no shutdown
!
interface TenGigabitEthernet 0/1
 description To SW1
 no ip address
!
 port-channel-protocol LACP
  port-channel 2 mode active
 no shutdown
!
interface TenGigabitEthernet 0/2
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/3
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/4
 no ip address
 shutdown
```

```
!
interface TenGigabitEthernet 0/5
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/6
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/7
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/8
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/9
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/10
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/11
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/12
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/13
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/14
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/15
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/16
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/17
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/18
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/19
 no ip address
```

```
 shutdown
!
interface TenGigabitEthernet 0/20
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/21
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/22
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/23
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/24
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/25
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/26
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/27
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/28
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/29
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/30
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/31
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/32
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/33
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/34
```

```
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/35
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/36
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/37
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/38
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/39
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/40
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/41
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/42
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/43
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/44
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/45
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/46
 no ip address
 shutdown
!
interface TenGigabitEthernet 0/47
 description To VLT peer - Backup
 ip address 10.0.0.2/24
 no shutdown
!
interface fortyGigE 0/48
 description To VLT peer - VLTi
 no ip address
```

```
!
 port-channel-protocol LACP
  port-channel 12 mode active
 no shutdown
!
interface fortyGigE 0/52
 description To VLT peer - VLTi
 no ip address
!
 port-channel-protocol LACP
  port-channel 12 mode active
 no shutdown
!
interface fortyGigE 0/56
 no ip address
 shutdown
!
interface fortyGigE 0/60
 no ip address
 shutdown
!
interface ManagementEthernet 0/0
 no ip address
 no shutdown
!
interface ManagementEthernet 1/0
 no shutdown
!
interface ManagementEthernet 2/0
 no shutdown
!
interface ManagementEthernet 3/0
 no shutdown
!
interface ManagementEthernet 4/0
 no shutdown
!
interface ManagementEthernet 5/0
 no shutdown
!
interface ManagementEthernet 6/0
 no shutdown
!
interface ManagementEthernet 7/0
 no shutdown
!
interface ManagementEthernet 8/0
 no shutdown
!
interface ManagementEthernet 9/0
 no shutdown
!
interface ManagementEthernet 10/0
 no shutdown
!
interface ManagementEthernet 11/0
 no shutdown
!
interface Port-channel 1
```

```
 description To SW1
 no ip address
 switchport
 rate-interval 10
 vlt-peer-lag port-channel 1
 no shutdown
!
interface Port-channel 2
 description To SW2
 no ip address
 switchport
 rate-interval 10
 vlt-peer-lag port-channel 2
 no shutdown
!
interface Port-channel 12
 description To VLT peer - VLTi
 no ip address
 no shutdown
!
interface Vlan 1
!untagged Port-channel 12
!
interface Vlan 100
 ip address 100.0.0.253/24
 tagged Port-channel 1-2
!
 vrrp-group 1
  no preempt
  priority 110
  virtual-address 100.0.0.254
 no shutdown
!
interface Vlan 101
 ip address 101.0.0.253/24
 tagged Port-channel 1-2
!
 vrrp-group 1
  no preempt
  priority 110
  virtual-address 101.0.0.254
 no shutdown
!
ip ssh server enable
!
protocol lldp
 advertise management-tlv system-description system-name
 no disable
!
line console 0
 exec-timeout 0 0
 logging synchronous level 2 limit 20
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
line vty 5
line vty 6
```

```
line vty 7
line vty 8
line vty 9
asf-mode stack-unit 0
asf-mode stack-unit all
!
vlt domain 1
 peer-link port-channel 12
 back-up destination 10.0.0.1
 primary-priority 8192
 system-mac mac-address 00:11:22:33:44:55
 unit-id 1
!
end
```

5.1.3. S60-1

```
! Version 8.3.3.7
!
boot system stack-unit 0 primary system: A:
boot system stack-unit 0 secondary system: B:
boot system stack-unit 0 default tftp://10.0.0.1/FTOS-SC-8.3.3.7.bin
boot system gateway 192.168.128.1
!
redundancy auto-synchronize full
!
hardware watchdog
!
hostname S60-1
!
protocol spanning-tree rstp
 no disable
 hello-time 1
 max-age 6
 forward-delay 4
!
stack-unit 0 provision S60
!
interface GigabitEthernet 0/0
 no ip address
 switchport
 spanning-tree rstp edge-port
 no shutdown
!
interface GigabitEthernet 0/1
 no ip address
 rate-interval 30
 shutdown
!
interface GigabitEthernet 0/2
 no ip address
 shutdown
!
interface GigabitEthernet 0/3
 no ip address
 shutdown
!
interface GigabitEthernet 0/4
 no ip address
 shutdown
!
interface GigabitEthernet 0/5
 no ip address
 shutdown
!
interface GigabitEthernet 0/6
 no ip address
 shutdown
!
interface GigabitEthernet 0/7
 no ip address
```

```
 shutdown
!
interface GigabitEthernet 0/8
 no ip address
 shutdown
!
interface GigabitEthernet 0/9
 no ip address
 shutdown
!
interface GigabitEthernet 0/10
 no ip address
 shutdown
!
interface GigabitEthernet 0/11
 no ip address
 shutdown
!
interface GigabitEthernet 0/12
 no ip address
 shutdown
!
interface GigabitEthernet 0/13
 no ip address
 shutdown
!
interface GigabitEthernet 0/14
 no ip address
 shutdown
!
interface GigabitEthernet 0/15
 no ip address
 shutdown
!
interface GigabitEthernet 0/16
 no ip address
 shutdown
!
interface GigabitEthernet 0/17
 no ip address
 shutdown
!
interface GigabitEthernet 0/18
 no ip address
 shutdown
!
interface GigabitEthernet 0/19
 no ip address
 shutdown
!
interface GigabitEthernet 0/20
 no ip address
 shutdown
!
interface GigabitEthernet 0/21
 no ip address
 shutdown
!
interface GigabitEthernet 0/22
```

```
 no ip address
 shutdown
!
interface GigabitEthernet 0/23
 no ip address
 shutdown
!
interface GigabitEthernet 0/24
 no ip address
 shutdown
!
interface GigabitEthernet 0/25
 no ip address
 shutdown
!
interface GigabitEthernet 0/26
 no ip address
 shutdown
!
interface GigabitEthernet 0/27
 no ip address
 shutdown
!
interface GigabitEthernet 0/28
 no ip address
 shutdown
!
interface GigabitEthernet 0/29
 no ip address
 shutdown
!
interface GigabitEthernet 0/30
 no ip address
 shutdown
!
interface GigabitEthernet 0/31
 no ip address
 shutdown
!
interface GigabitEthernet 0/32
 no ip address
 shutdown
!
interface GigabitEthernet 0/33
 no ip address
 shutdown
!
interface GigabitEthernet 0/34
 no ip address
 shutdown
!
interface GigabitEthernet 0/35
 no ip address
 shutdown
!
interface GigabitEthernet 0/36
 no ip address
 shutdown
!
```

```
interface GigabitEthernet 0/37
 no ip address
 shutdown
!
interface GigabitEthernet 0/38
 no ip address
 shutdown
!
interface GigabitEthernet 0/39
 no ip address
 shutdown
!
interface GigabitEthernet 0/40
 no ip address
 shutdown
!
interface GigabitEthernet 0/41
 no ip address
 shutdown
!
interface GigabitEthernet 0/42
 no ip address
 shutdown
!
interface GigabitEthernet 0/43
 no ip address
 shutdown
!
interface GigabitEthernet 0/44
 no ip address
!
 port-channel-protocol LACP
  port-channel 1 mode active
 dampening 10 100 1000 60
 no shutdown
!
interface GigabitEthernet 0/45
 no ip address
!
 port-channel-protocol LACP
  port-channel 1 mode active
 dampening 10 100 1000 60
 no shutdown
!
interface GigabitEthernet 0/46
 no ip address
 shutdown
!
interface GigabitEthernet 0/47
 no ip address
 shutdown
!
interface ManagementEthernet 0/0
 ip address 10.0.0.1/24
 no shutdown
!
interface ManagementEthernet 1/0
 no shutdown
!
```

```
interface ManagementEthernet 2/0
 no shutdown
!
interface ManagementEthernet 3/0
 no shutdown
!
interface ManagementEthernet 4/0
 no shutdown
!
interface ManagementEthernet 5/0
 no shutdown
!
interface ManagementEthernet 6/0
 no shutdown
!
interface ManagementEthernet 7/0
 no shutdown
!
interface ManagementEthernet 8/0
 no shutdown
!
interface ManagementEthernet 9/0
 no shutdown
!
interface ManagementEthernet 10/0
 no shutdown
!
interface ManagementEthernet 11/0
 no shutdown
!
interface Port-channel 1
 no ip address
 switchport
 rate-interval 30
 no shutdown
!
interface Vlan 1
!
interface Vlan 100
 no ip address
 tagged Port-channel 1
 untagged GigabitEthernet 0/0
 shutdown
!
protocol lldp
 advertise management-tlv system-description system-name
 no disable
!
line console 0
 exec-timeout 0 0
 logging synchronous level 2 limit 20
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
line vty 5
line vty 6
line vty 7
```

```
line vty 8
line vty 9
!
end
```

5.1.4. S50-2

```
! Version 8.4.2.6
!
redundancy auto-synchronize full
!
hardware watchdog
!
hostname SW2
!
protocol spanning-tree rstp
 no disable
 hello-time 1
 max-age 6
 forward-delay 4
!
stack-unit 0 provision S50N
!
interface GigabitEthernet 0/1
 no ip address
 switchport
 spanning-tree rstp edge-port
 no shutdown
!
interface GigabitEthernet 0/2
 no ip address
 shutdown
!
interface GigabitEthernet 0/3
 no ip address
 shutdown
!
interface GigabitEthernet 0/4
 no ip address
 shutdown
!
interface GigabitEthernet 0/5
 no ip address
 shutdown
!
interface GigabitEthernet 0/6
 no ip address
 shutdown
!
interface GigabitEthernet 0/7
 no ip address
 shutdown
!
interface GigabitEthernet 0/8
 no ip address
 shutdown
!
interface GigabitEthernet 0/9
 no ip address
 shutdown
!
```

```
interface GigabitEthernet 0/10
 no ip address
 shutdown
!
interface GigabitEthernet 0/11
 no ip address
 shutdown
!
interface GigabitEthernet 0/12
 no ip address
 shutdown
!
interface GigabitEthernet 0/13
 no ip address
 shutdown
!
interface GigabitEthernet 0/14
 no ip address
 shutdown
!
interface GigabitEthernet 0/15
 no ip address
 shutdown
!
interface GigabitEthernet 0/16
 no ip address
 shutdown
!
interface GigabitEthernet 0/17
 no ip address
 shutdown
!
interface GigabitEthernet 0/18
 no ip address
 shutdown
!
interface GigabitEthernet 0/19
 no ip address
 shutdown
!
interface GigabitEthernet 0/20
 no ip address
 shutdown
!
interface GigabitEthernet 0/21
 no ip address
 shutdown
!
interface GigabitEthernet 0/22
 no ip address
 shutdown
!
interface GigabitEthernet 0/23
 no ip address
 shutdown
!
interface GigabitEthernet 0/24
 no ip address
 shutdown
```

```
!
interface GigabitEthernet 0/25
 no ip address
 shutdown
!
interface GigabitEthernet 0/26
 no ip address
 shutdown
!
interface GigabitEthernet 0/27
 no ip address
 shutdown
!
interface GigabitEthernet 0/28
 no ip address
 shutdown
!
interface GigabitEthernet 0/29
 no ip address
 shutdown
!
interface GigabitEthernet 0/30
 no ip address
 shutdown
!
interface GigabitEthernet 0/31
 no ip address
 shutdown
!
interface GigabitEthernet 0/32
 no ip address
 shutdown
!
interface GigabitEthernet 0/33
 no ip address
 shutdown
!
interface GigabitEthernet 0/34
 no ip address
 shutdown
!
interface GigabitEthernet 0/35
 no ip address
 shutdown
!
interface GigabitEthernet 0/36
 no ip address
 shutdown
!
interface GigabitEthernet 0/37
 no ip address
 shutdown
!
interface GigabitEthernet 0/38
 no ip address
 shutdown
!
interface GigabitEthernet 0/39
 no ip address
```

```
 shutdown
!
interface GigabitEthernet 0/40
 no ip address
 shutdown
!
interface GigabitEthernet 0/41
 no ip address
 shutdown
!
interface GigabitEthernet 0/42
 no ip address
 shutdown
!
interface GigabitEthernet 0/43
 no ip address
 shutdown
!
interface GigabitEthernet 0/44
 no ip address
 shutdown
!
interface GigabitEthernet 0/45
 no ip address
!
 port-channel-protocol LACP
  port-channel 1 mode active
 dampening 10 100 1000 60
 no shutdown
!
interface GigabitEthernet 0/46
 no ip address
!
 port-channel-protocol LACP
  port-channel 1 mode active
 dampening 10 100 1000 60
 no shutdown
!
interface GigabitEthernet 0/47
 no ip address
 shutdown
!
interface GigabitEthernet 0/48
 no ip address
 shutdown
!
interface Port-channel 1
 no ip address
 switchport
 rate-interval 30
 no shutdown
!
interface Vlan 1
!
interface Vlan 100
 no ip address
 tagged Port-channel 1
 shutdown
!
```

```
interface Vlan 101
 no ip address
 tagged Port-channel 1
 untagged GigabitEthernet 0/1
 shutdown
!
protocol lldp
 advertise management-tlv system-description system-name
 no disable
!
line console 0
 exec-timeout 0 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
line vty 5
line vty 6
line vty 7
line vty 8
line vty 9
!
end
```