How To

Allied Telesyn

Configure Multiple Spanning Tree Protocol (MSTP)

Introduction

This document provides configuration examples and guidelines for configuring Multiple Spanning Tree Protocol on Allied Telesyn switches. At the time of writing this document, MSTP is available on the Rapier (as a Beta). It will soon be available on the 8948, and 9924.

Overview of MSTP

The Multiple Spanning Tree Protocol (MSTP) addresses the limitations in the existing spanning tree protocols, STP and RSTP, within networks that use multiple VLANs with topologies that employ alternative physical links. MSTP is defined in IEEE 802.1s, Amendment 3: "Multiple Spanning Trees." The protocol builds on, and remains compatible with, the following previous IEEE standards:

- 802.1d, which defines the spanning tree protocol.
- 802.1w, which defines the rapid spanning tree protocol.
- 802.1Q, which defines VLAN operation.
- 802.1D/D4 2003, which defines a draft standard for local and metropolitan area networks.

MSTP supports large networks by grouping bridges into regions that appear as a single bridge to other devices.

Extension of RSTP

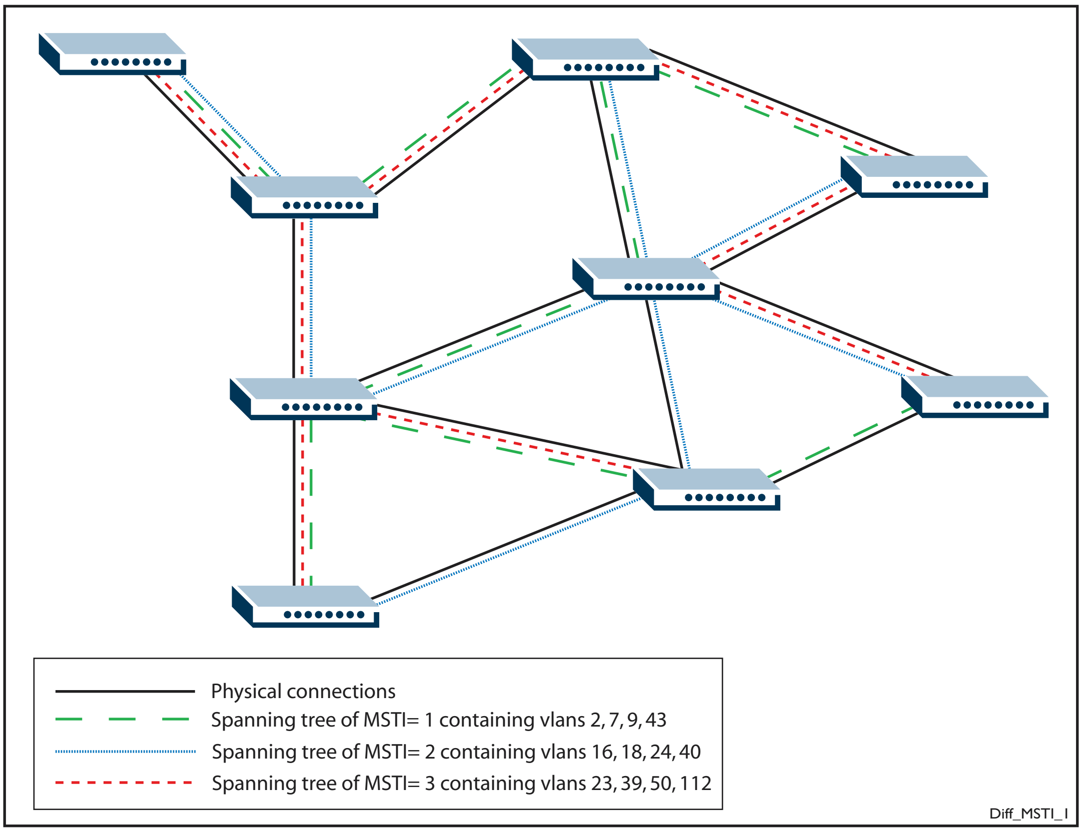
MSTP supports multiple spanning tree instances on any given link within a network. It is an extension to Rapid Spanning Tree Protocol (RSTP) - IEEE standard 802.1w, 2001 Edition, which supports only a single spanning tree instance on any given link within a network. It should be noted that MSTP and RSTP share many common characteristics such as rapid convergence and parameters such as port path costs, and so on. It is assumed that readers of this document are familiar with RSTP.

Multiple spanning tree concepts

Multiple Spanning Tree Instances (MSTI)

MSTP enables the grouping and mapping of VLANs to different spanning tree instances. So, an MST Instance (MSTI) is a particular set of VLANs that are all using the same spanning tree.

Figure 1: DIfferent spanning trees created by different MSTIs on the same physical layout



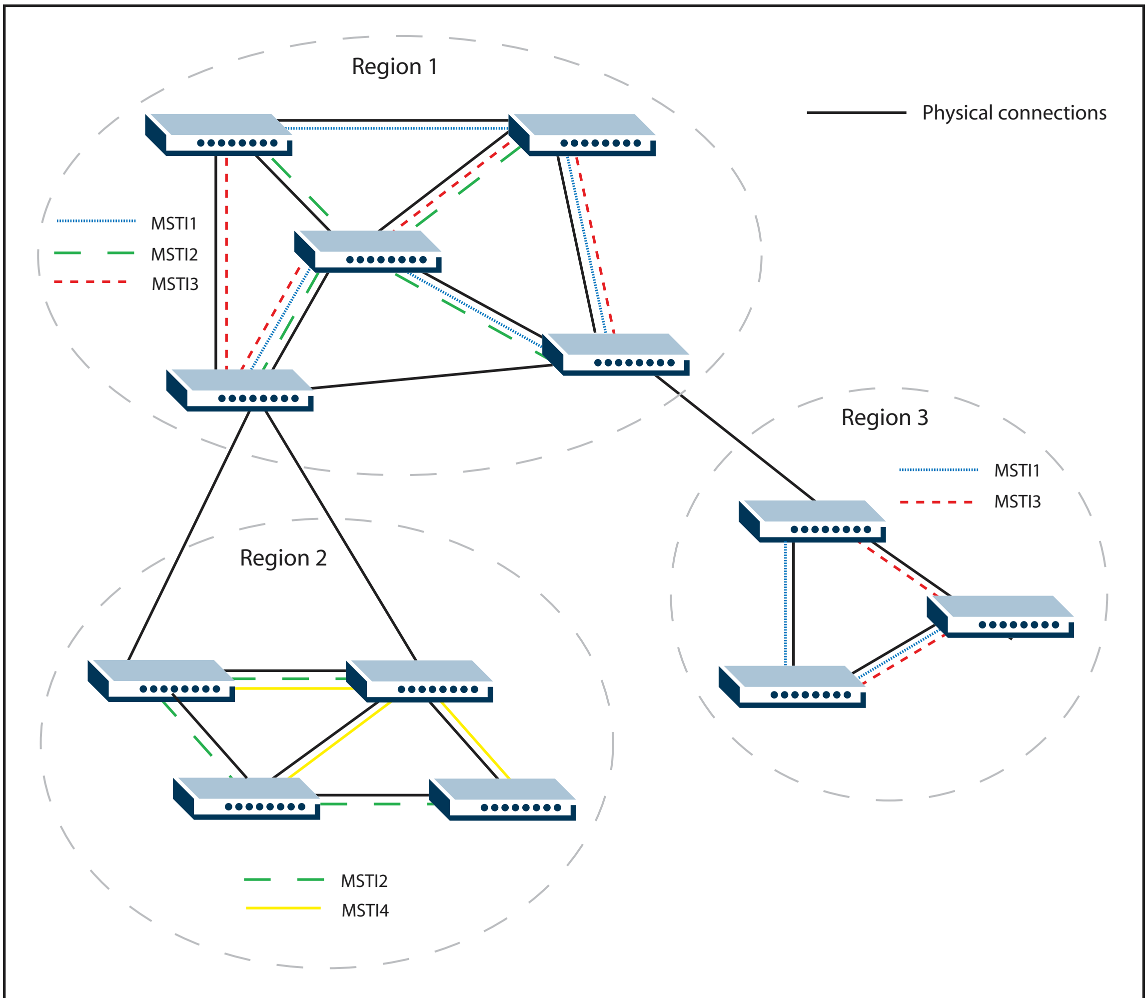
Regions

An MST region is a set of interconnected switches that all have the same values for all following MST configuration identification elements:

- MST configuration name - the name of the MST region
- Revision level - the revision number of configuration
- Configuration Digest - the mapping of which VLANs are mapped to which MST instances

Each of the MST instances created are identified by an MSTI number. This number is locally significant within the MST region. Therefore, an MSTI will not span across MST regions.

Figure 2: MSTIs in different regions

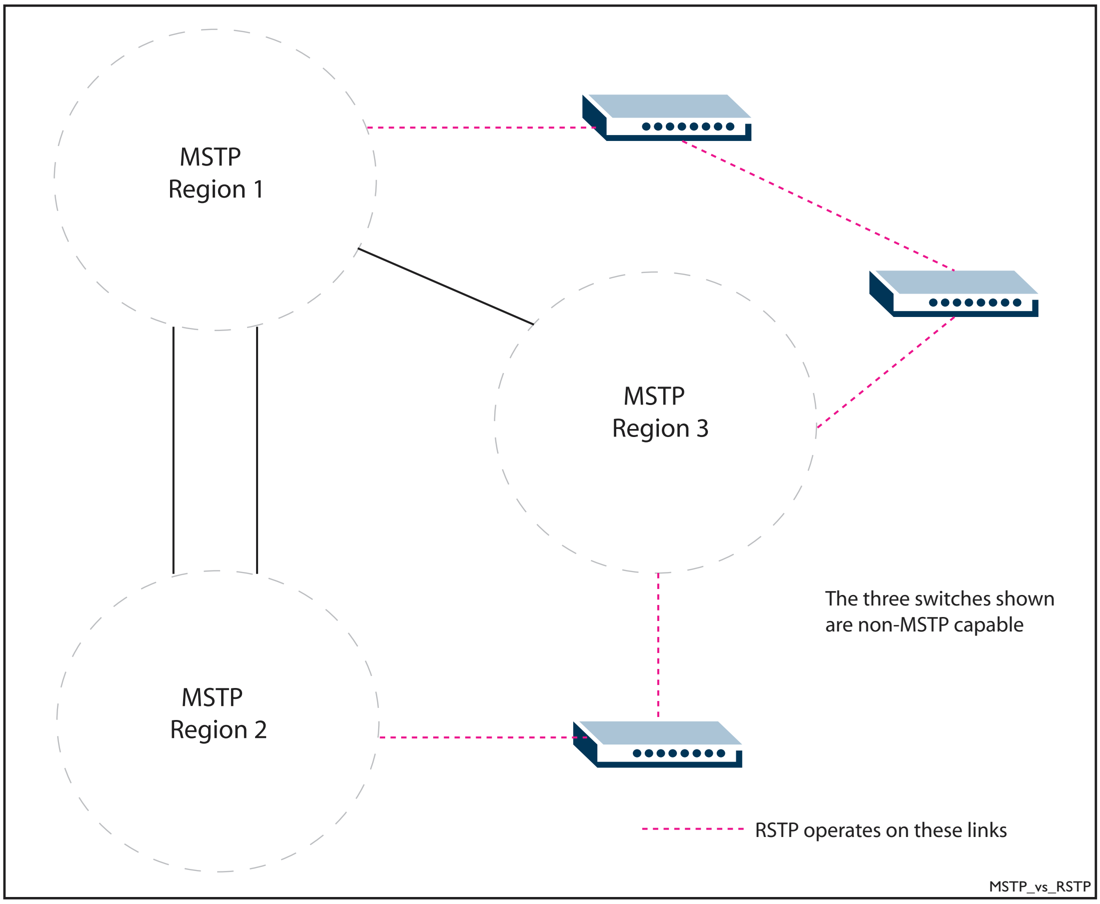


The MSTI1 in Region 1 is unrelated to the MSTI1 in Region 3. Similarly, the MSTI2 in Region 1 is quite unrelated to the MSTI2 in Region 2.

Common and Internal Spanning Tree (CIST)

The CIST is the default spanning tree instance of MSTP, i.e. all VLANs that are not members of particular MSTIs are members of the CIST. Also, an individual MST region can be regarded a single virtual bridge by other MST regions. The spanning tree that runs between regions is the CIST. The CIST is also the spanning tree that runs between MST regions and Single Spanning Tree (SST) entities. So, in Figure 3 on page 4, the STP that is running between the regions, and to the SST bridges, is the CIST.

Figure 3: The CIST operates on links between regions and to SST devices



Advantage of MSTP over RSTP

As mentioned above, MSTP is similar to RSTP, in that it provides loop resolution and rapid convergence. But it also has the significant extra advantage of making it possible to have different forwarding paths for different MST instances. This enables load balancing of network traffic across redundant links. For example, in Figure 3 all the links in the network are being used by at least one of the MSTIs, so there is no link left completely idle (as would be the case if RSTP was being used).

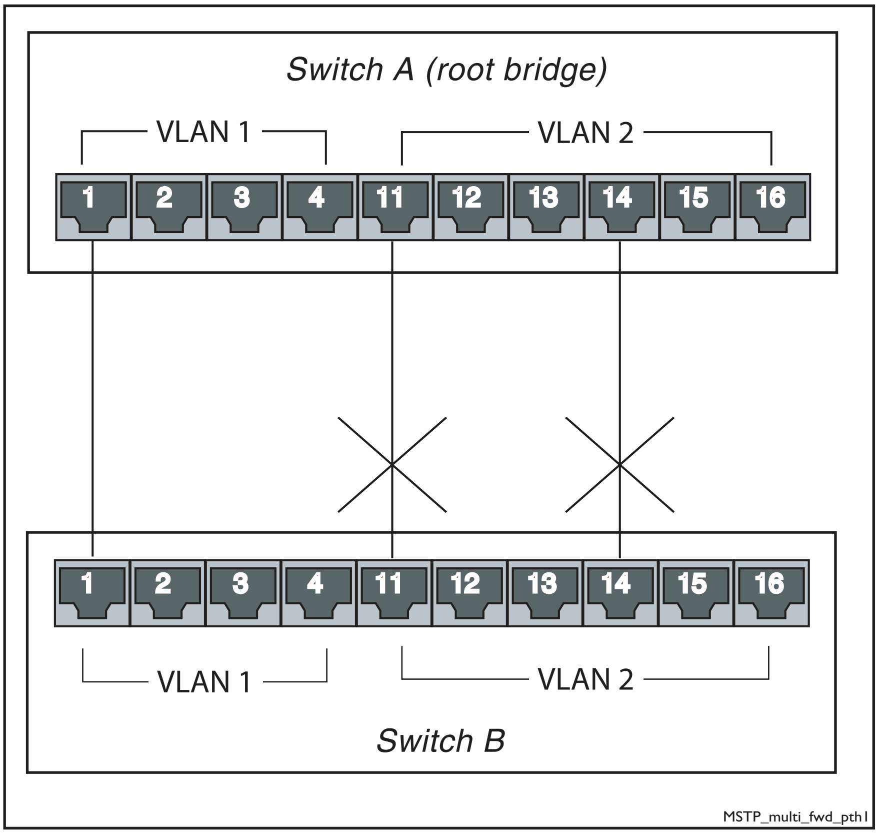
The following sections of this document provide configuration examples on how to configure the new functionalities of MSTP on the switches.

Configuration Examples

Scenario One: MSTP with multiple forwarding paths

Figure 4 depicts a network of two switches with two configured VLANs. If the switches are running STP or RSTP, all the links for VLAN 2 would be blocked. This is because both STP and RSTP support only a single spanning tree for the whole network and block the redundant links.

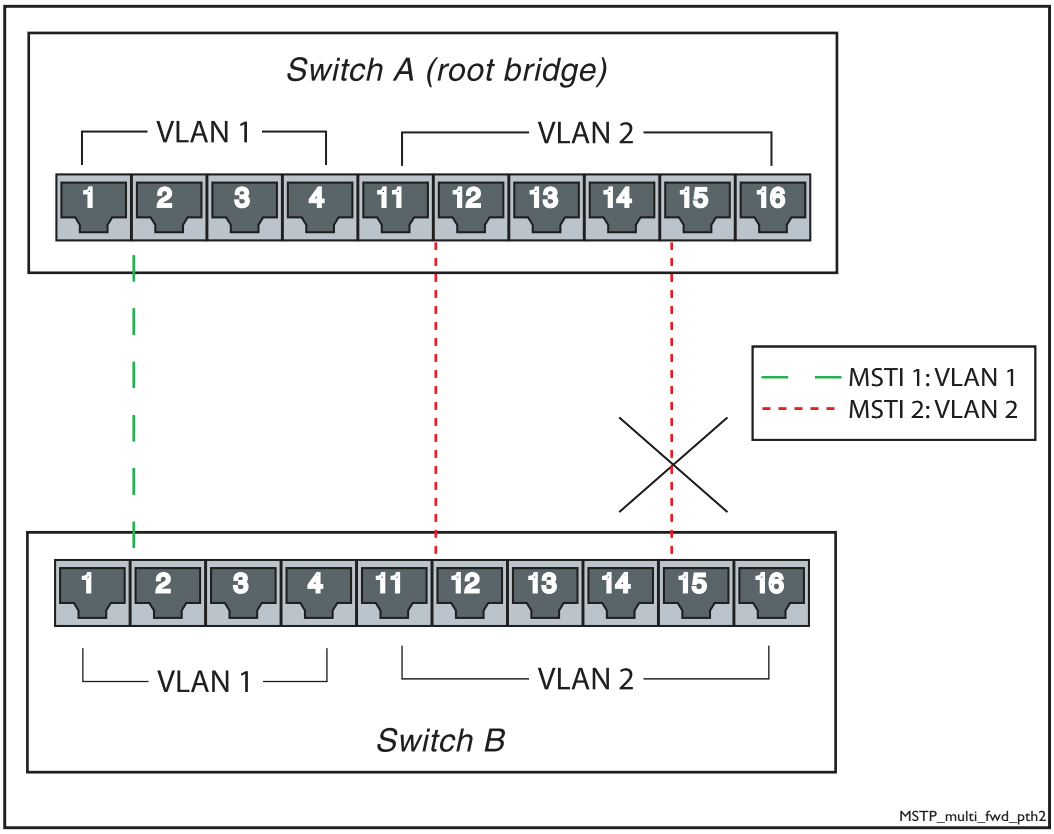
Figure 4: Example of two switches with two configured VLANs



The above situation can be rectified by using MSTP. With MSTP, VLAN 1 and VLAN 2 can be mapped to different MSTIs. Hence, each instance can have a topology independent of other spanning tree instances.

Figure 5 depicts the active topologies for MSTIs 1 and 2. The MSTP configures separate spanning tree for VLANs 1 and 2 and blocks the redundant links for VLAN 2.

Figure 5: Active topologies for MSTI 1 and MSTI 2



A sample configuration of commands for Switch A and Switch B as illustrated in Figure 5 follows.

Switch A Configuration

1. Create VLAN 2

```
create vlan=vlan2 vid=2
```

2. Add ports to VLAN 2

```
add vlan=2 port=11-20
```

3. Set the MSTP configuration identification elements for configuration name and revision level

```
set mstp configname=atr revisionlevel=1
```

The configname parameter is just an arbitrary string that specifies the name you want to assign to the MST region for identification. The revisionlevel parameter specifies the revision of the current MST configuration. The revisionlevel is an arbitrary number that you assign to an MST region. It can be used to keep track of the number of times that MST configuration has been updated for the network. For switches to be in the same MST region, they must be configured with the same name, revision number, and VLANs to MSTI mapping (which is detailed in Step 6).

4. Enable the modification in role selection function for statically configured VLANs to avoid network partitioning

```
set mstp staticvlan=on
```

The parameter relates to the fact that when the MST algorithm calculates the active topology, it doesn't consider the VLAN membership of ports. This could result in a problem if the active topology of an MSTI includes, and depends on, a port that is not a member of the VLANs assigned to the MSTI and this port is selected as a root port. To avoid this issue the modification to the role selection functions is required. This enables the MSTP to choose the port roles within the MSTI(s). For further information on MSTP static VLAN configuration support, please refer to Appendix A of this document.

5. Create MSTP instances

   ```
   create mstp msti=1
   create mstp msti=2
   ```

6. Map VLANs to MST instances

   ```
   add mstp msti=1 vlan=1
   add mstp msti=2 vlan=2
   ```

7. Set the priority of the switch to become the Root Bridge in the specified MSTI

   ```
   set mstp msti=1 priority=0
   set mstp msti=2 priority=0
   ```

8. Enable the MSTP operation for the switch

   ```
   enable mstp
   ```

Switch B Configuration

1. Create VLAN 2

   ```
   create vlan=vlan2 vid=2
   ```

2. Add ports to VLAN 2

   ```
   add vlan=2 port=11-20
   ```

3. Set the MSTP configuration identification elements for configuration name and revision level

   ```
   set mstp configname=atr revisionlevel=1
   ```

4. Enable the modification in role selection function for statically configured VLANs to avoid network partitioning

   ```
   set mstp staticvlan=on
   ```

5. Create MSTP instances

   ```
   create mstp msti=1
   create mstp msti=2
   ```

6. Map VLANs to MSTP instances

   ```
   add mstp msti=1 vlan=1
   add mstp msti=2 vlan=2
   ```

7. Enable the MSTP operation for the switch

   ```
   enable mstp
   ```

Examining the port states

Let us now look at some of the commands that enable you to examine the operation of MSTP.

Figure 6: Example output showing that port 1 of Switch B is the Root Port for MSTI 1 and is in Forwarding State

```
Manager Switch_B> sh mstp msti=1 po=1
MSTI 1 Port Information
-----------------------------------------------------------------------------
Port Number ........................... 1
  Port Identifier ..................... 128:1
  Port Role ........................... Root Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 0 : 00-00-cd-08-37-f0
  Designated Port ..................... 128:1
-----------------------------------------------------------------------------
```

Figure 7: Example output showing that port 11 of Switch B is the Root Port for MSTI 2 and is in Forwarding State

```
Manager Switch_B> sh mstp msti=2 po=11
MSTI 2 Port Information
-----------------------------------------------------------------------------
Port Number ........................... 11
  Port Identifier ..................... 128:11
  Port Role ........................... Root Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 0 : 00-00-cd-08-37-f0
  Designated Port ..................... 128:11
-----------------------------------------------------------------------------
```

Figure 8: Example output showing that port 14 of Switch B is the Alternate Port for MSTI 2 and is in Discarding State

```
Manager Switch_B> sh mstp msti=2 po=14
MSTI 2 Port Information
-----------------------------------------------------------------------------
Port Number ........................... 14
  Port Identifier ..................... 128:14
  Port Role ........................... Alternate Port
  Port State .......................... Discarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 0 : 00-00-cd-08-37-f0
  Designated Port ..................... 128:14
-----------------------------------------------------------------------------
```

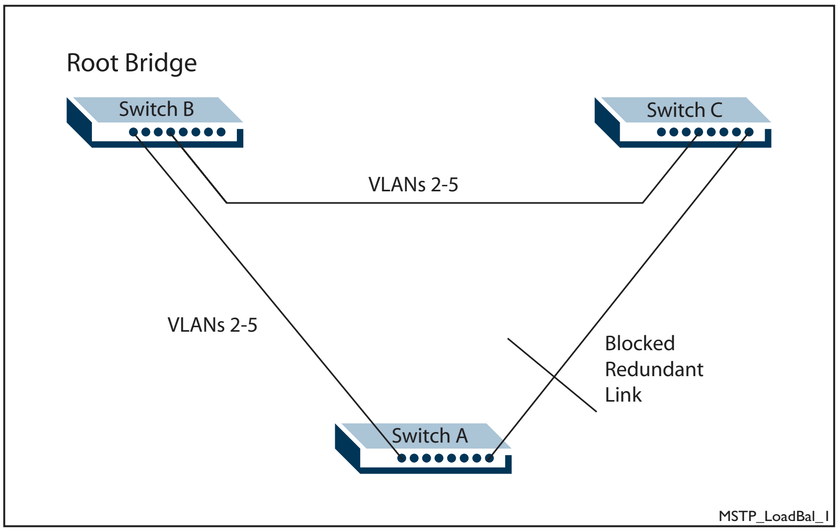
So, the choice of Forwarding and Discarding ports is as shown in Figure 5 on page 7.

Scenario Two: MSTP with load balancing

Figure 9 depicts a network of three switches with VLANs 2, 3, 4 and 5 configured. The switches are interconnected via the links between tagged ports on the switches. If the switches were running STP or RSTP, the link between Switches A and C would be blocked. All the traffic for VLANs 2-5 would flow via the links between Switches B and C and Switches B and A.

The complete blocking of the link A-C is due to the fact that STP and RSTP only support one instance of spanning tree for the whole network and have no regard to the number of VLANs in the network. Therefore, load balancing across redundant links is impossible.

Figure 9: Three switches with VLANs 2, 3, 4, and 5 configured



However, MSTP supports load balancing by mapping different VLANs to different spanning tree instances. As such, different instances can use different active links for the independent topology to route traffic. Therefore, the traffic load can be shared among different network links.

Figures 10 and 11 depict the active topologies enabled by MSTP with two spanning tree instances, MSTI 1 and MSTI 2. MSTI 1 is mapped with VLANs 2 and 3. The topology of MSTI 1 has a blocked redundant link between Switches A and C. MSTI 2 is mapped with VLANs 4 and 5. The topology of MSTI 2 has a blocked redundant link between Switches A and B.

Figure 10: Topology of MSTI 1

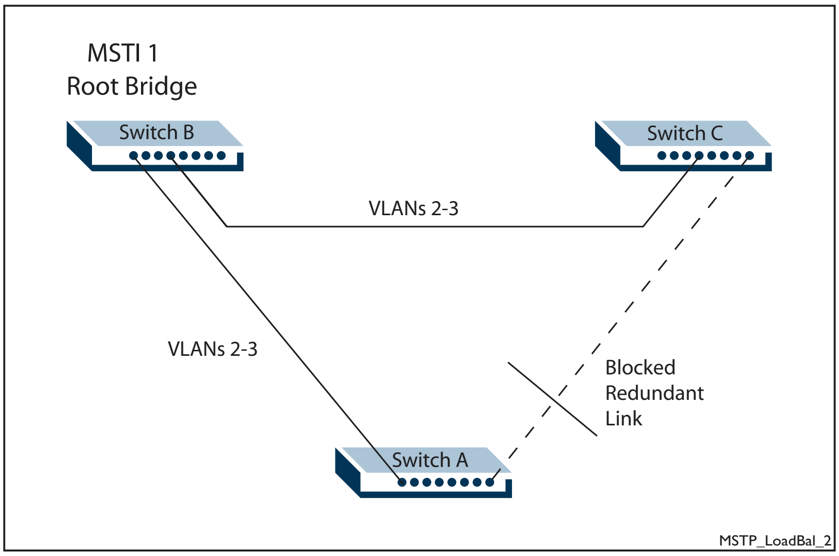
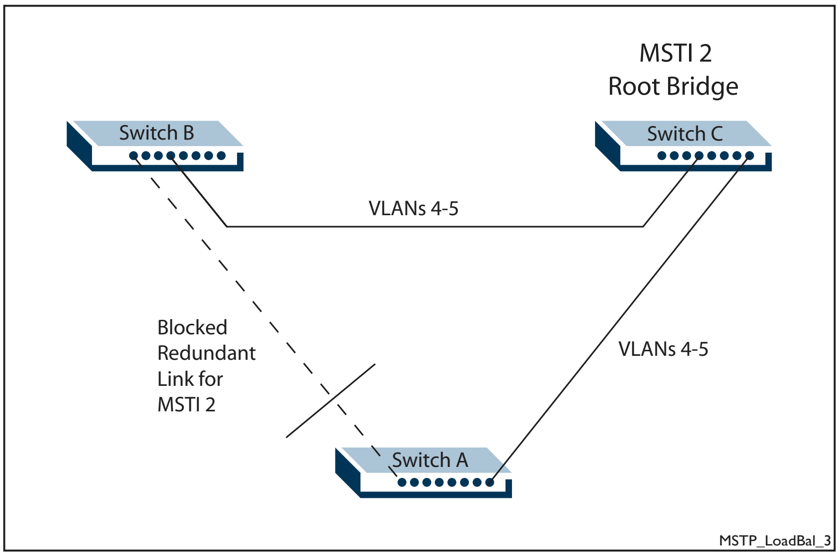


Figure 11: Topology of MSTI 2



A sample configuration of commands for Switch A, B and C as illustrated in Figures 10 and 11 follows.

Switch A Configuration

1. Set the system name

```
set sys name=Switch_A
```

2. Create VLANs 2-5

```
create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5
```

3. Add ports to VLANs

```
add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21,23 frame=tagged
add vlan=3 port=21,23 frame=tagged
add vlan=4 port=21,23 frame=tagged
add vlan=5 port=21,23 frame=tagged
```

4. Set the MSTP configuration identification elements for configuration name and revision level

```
set mstp configname=atr revisionlevel=1
```

5. Create MSTP instances

```
create mstp msti=1
create mstp msti=2
```

6. Map VLANs to MSTP instances

```
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
```

7. Set the priority of the switch to become the Root Bridge in the CIST

```
set mstp cist priority=0
```

8. Enable the MSTP operation for the switch

```
enable mstp
```

Switch B Configuration

1. Set the system name

```
set sys name=Switch_B
```

2. Create VLANs 2-5

```
create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5
```

3. Add the ports to VLANs

```
add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21,24 frame=tagged
add vlan=3 port=21,24 frame=tagged
add vlan=4 port=21,24 frame=tagged
add vlan=5 port=21,24 frame=tagged
```

4. Set the MSTP configuration identification elements for configuration name and revision level

```
set mstp configname=atr revisionlevel=1
```

5. Create MSTP instances

```
create mstp msti=1
create mstp msti=2
```

6. Map VLANs to MSTP instances

```
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
```

7. Set the priority of the switch to become the Root Bridge for MSTI 1

```
set mstp msti=1 priority=0
```

8. Enable the MSTP operation for the switch

```
enable mstp
```

Switch C Configuration

1. Set the system name

```
set sys name=Switch_C
```

2. Create VLANs 2-5

```
create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5
```

3. Add ports to VLANs

```
add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=23,24 frame=tagged
add vlan=3 port=23,24 frame=tagged
add vlan=4 port=23,24 frame=tagged
add vlan=5 port=23,24 frame=tagged
```

4. Set the MSTP configuration identification elements for configuration name and revision level

```
set mstp configname=atr revisionlevel=1
```

5. Create MSTP instances

```
create mstp msti=1
create mstp msti=2
```

Associate VLANs to MSTP instances

```
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
```

6. Set the priority of the switch to become the Root Bridge for MSTI 2

```
set mstp msti=2 priority=0
```

7. Enable the MSTP operation for the switch

```
enable mstp
```

Examining the port states on Switch A

Figure 12: Example output showing that port 21 is the Root Port and in Forwarding State, and port 23 is the Alternate Port and in Discarding State for MSTI 1

```
Manager Switch_A> sh mstp msti=1 po=21
MSTI 1 Port Information
----------------------------------------------------------------------------
Port Number ........................... 21
  Port Identifier ..................... 128:21
  Port Role ........................... Root Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 0 : 00-00-cd-08-37-f0
  Designated Port ..................... 128:21
----------------------------------------------------------------------------
Manager Switch_A> sh mstp msti=1 po=23
MSTI 1 Port Information
----------------------------------------------------------------------------
Port Number ........................... 23
 Port Identifier .....................  128:23
 Port Role ...........................  Alternate Port
 Port State ..........................  Discarding
 Switch Port State ...................  Enabled
 Link Status .........................  Up
 Port Path Cost ......................  200000
 Designated Bridge ...................  32768 : 00-00-cd-05-f4-c0
 Designated Port .....................  128:23
----------------------------------------------------------------------------
```

Figure 13: Example output showing that port 21 is the Alternate Port and in Discarding State, and port 23 is the Root Port and in Forwarding State for MSTI 2

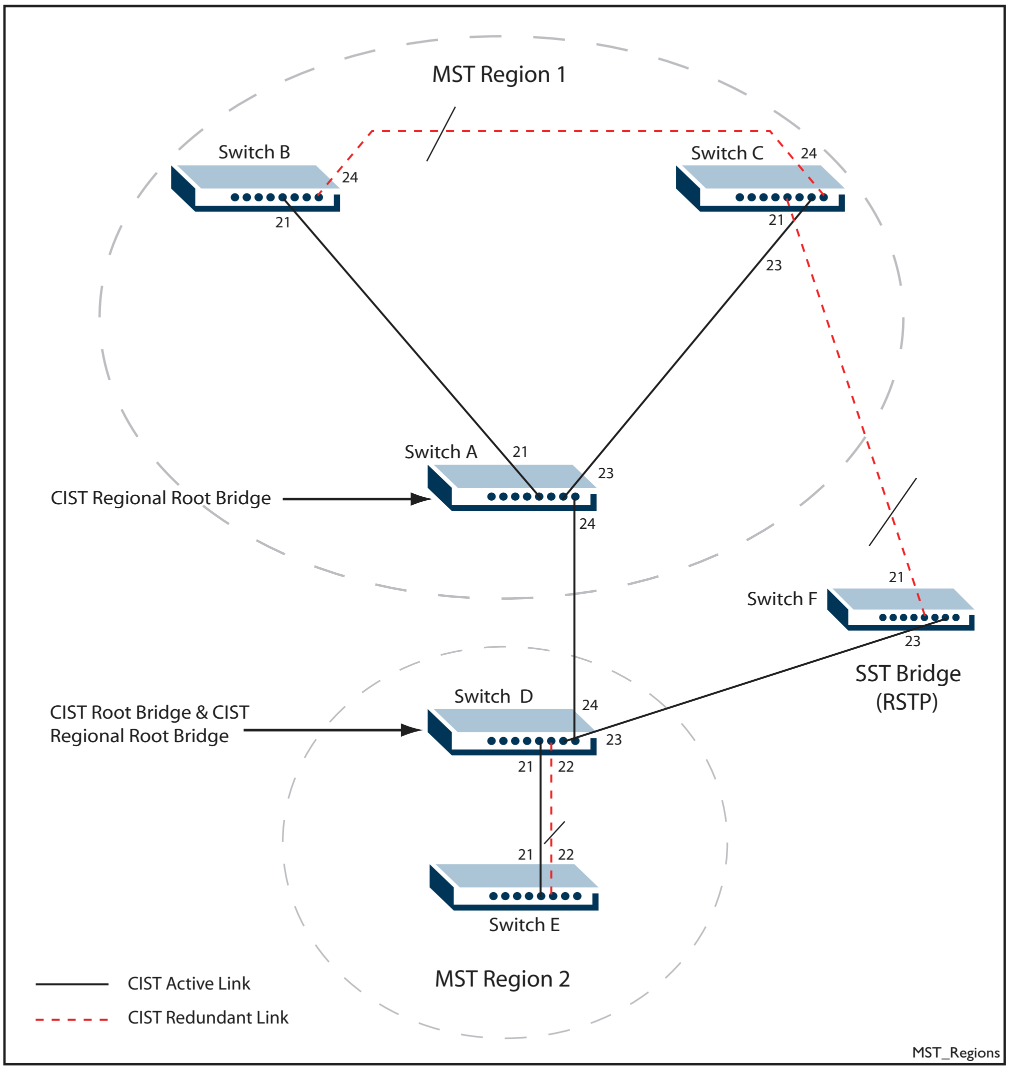
```
Manager Switch_A> sh mstp msti=2 po=21MSTI 2
Port Information
----------------------------------------------------------------------------
Port Number ........................... 21
Port Identifier .....................   128:21
  Port Role ........................... Alternate Port
  Port State .......................... Discarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 32768 : 00-00-cd-08-37-f0
  Designated Port ..................... 128:21
----------------------------------------------------------------------------
Manager Switch_A> sh mstp msti=2 po=23MSTI 2
Port Information
----------------------------------------------------------------------------
Port Number ........................... 23
  Port Identifier ..................... 128:23
  Port Role ........................... Root Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 0 : 00-00-cd-05-f4-c0
  Designated Port ..................... 128:23
----------------------------------------------------------------------------
```

So, it is evident that on Switch A the port that is forwarding in MSTI 1 is blocking in MSTI 2, and vice versa.

Scenario Three: MSTP connection with MST Regions and SST Bridge

MSTP uses the CIST instance to achieve the functionality of loop resolution and link redundancy to connect multiple MST regions and SST bridges. As specified in the IEEE standard, MSTP is designed to be compatible and interoperable with STP and RSTP. Each MST region will appear as a single virtual bridge from the point of view of other MST regions and SST bridges.

Figure 14: Example of a network with two MST regions and a switch running 802.1w RSTP



When configuring multiple MST regions for MSTP, users should take note that MSTIs are locally significant within an MST region. MSTIs will not span from one region to another region. For example, although there is an MSTI=1 and MSTI=2 on switches A, B, C and also an MSTI=1 and MSTI=2 on switches D, E; there is no relationship at all between these MSTIs.

It should also be noted that switches running RSTP are able to process MSTP BPDUs as if they are RSTP BPDUs. Therefore, in the scenario in Figure 14, Switch D (MSTP switch) will use MSTP BPDUs and the Switch F (RSTP switch) will use RSTP BPDUs for spanning tree communication. However, if Switch F runs 802.1D STP and Switch D receives STP BPDUs on the link connecting Switch F, Switch D will only send STP BPDUs to communicate with Switch F.

A sample configuration of commands for Switches A-F as illustrated in Figure 14 follows.

Switch A Configuration

```
set sys name=Switch_A

create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5

add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20
add vlan=2 port=21,23,24 frame=tagged
add vlan=3 port=21,23,24 frame=tagged
add vlan=4 port=21,23,24 frame=tagged
add vlan=5 port=21,23,24 frame=tagged

set mstp configname=atr revisionlevel=1
create mstp msti=1
create mstp msti=2
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
set mstp cist priority=4096
enable mstp
```

Switch B Configuration

```
set sys name=Switch_B

create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5

add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21,24 frame=tagged
add vlan=3 port=21,24 frame=tagged
add vlan=4 port=21,24 frame=tagged
add vlan=5 port=21,24 frame=tagged

set mstp configname=atr revisionlevel=1
create mstp msti=1
create mstp msti=2
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
set mstp msti=1 priority=0
enable mstp
```

Switch C Configuration

```
set sys name=Switch_C

create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5

add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21-24 frame=tagged
add vlan=3 port=21-24 frame=tagged
add vlan=4 port=21-24 frame=tagged
add vlan=5 port=21-24 frame=tagged

set mstp configname=atr revisionlevel=1
create mstp msti=1
create mstp msti=2
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
set mstp msti=2 priority=0
enable mstp
```

Switch D Configuration

```
set sys name=Switch_D

create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5

add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21-24 frame=tagged
add vlan=3 port=21-24 frame=tagged
add vlan=4 port=21-24 frame=tagged
add vlan=5 port=21-24 frame=tagged

set mstp configname=test revisionlevel=2
create mstp msti=1
create mstp msti=2
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
set mstp msti=1 priority=0
set mstp msti=2 port=22 pathcost=120
set mstp cist priority=0
enable mstp
```

Switch E Configuration

```
set sys name=Switch_E

create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5

add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21,22 frame=tagged
add vlan=3 port=21,22 frame=tagged
add vlan=4 port=21,22 frame=tagged
add vlan=5 port=21,22 frame=tagged

set mstp configname=test revisionlevel=2
create mstp msti=1
create mstp msti=2
add mstp msti=1 vlan=2
add mstp msti=1 vlan=3
add mstp msti=2 vlan=4
add mstp msti=2 vlan=5
set mstp msti=2 priority=0
enable mstp
```

Switch F Configuration

```
set sys name=Switch_F

create vlan=vlan2 vid=2
create vlan=vlan3 vid=3
create vlan=vlan4 vid=4
create vlan=vlan5 vid=5

add vlan=2 port=1-5
add vlan=3 port=6-10
add vlan=4 port=11-15
add vlan=5 port=16-20

add vlan=2 port=21,23 frame=tagged
add vlan=3 port=21,23 frame=tagged
add vlan=4 port=21,23 frame=tagged
add vlan=5 port=21,23 frame=tagged

enable stp=default
set stp=default mode=rapid
```

Examining the states of the ports and MSTIs

The output in Figure 15 is from Switch A and shows that Switch A is the CIST Regional Root Bridge for Region 1. It also shows that Switch A has an External Root Path Cost of 200000 and an Internal Root Path Cost of 0.

The External Root Path Cost is the path cost to the region (Region 2) containing the CIST Root Bridge from this region (Region 1). The value of 200000 represents a default path cost for 100 Mbps link speed.

The Internal Root Path Cost is the path cost to the CIST Regional Root Bridge from this switch. As Switch A is the CIST Regional Root Bridge, the value of Internal Root Path Cost is 0.

Figure 15: Example output of SH MSTP CIST

```
Manager Switch_A> sh mstp cistCommon Internal Spanning Tree
------------------------------------------------------------------------
Bridge Identifier ........................ 4096 : 00-00-cd-11-b1-ca
Bridge Role .............................. Regional Root Bridge
VLAN Members ............................. 1,6-4094
CIST Root Bridge ......................... 0 : 00-00-cd-08-77-20
CIST Regional Root Bridge ................ 4096 : 00-00-cd-11-b1-ca
Designated Bridge ........................ 0 : 00-00-cd-08-77-20
Root Port ................................ 24
Designated Port .......................... 128:24
External Root Path Cost .................. 200000
Internal Root Path Cost .................. 0
```

Figure 16: Example output showing that Switch D is the CIST Regional Root Bridge for Region 2 and CIST Root Bridge for the whole network

```
Manager Switch_D> sh mstp cist
Common Internal Spanning Tree
----------------------------------------------------------------------------
Bridge Identifier ........................ 0 : 00-00-cd-08-77-20
Bridge Role .............................. Root Bridge
VLAN Members ............................. 1,6-4094
CIST Root Bridge ......................... 0 : 00-00-cd-08-77-20
CIST Regional Root Bridge ................ 0 : 00-00-cd-08-77-20
Designated Bridge ........................ 0 : 00-00-cd-08-77-20
Root Port ................................ N/A
Designated Port .......................... N/A
External Root Path Cost .................. 0
Internal Root Path Cost .................. 0
```

Figure 17 shows that Port 24 on Switch A is the CIST Root Port for Region 1 and a Boundary Port. A Boundary port is a bridge port connecting an MST region to another MST region or to a single spanning tree bridge.

Figure 17: Example output of SH MSTP CIST PO=24

```
Manager Switch_A> sh mstp cist po=24
CIST Port Information
----------------------------------------------------------------------------
Port Number .......................... 24
  Port Identifier ..................... 128:24
  Port Role ........................... Root Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  External Port Path Cost ............. 200000
  Designated Bridge ................... 0 : 00-00-cd-08-77-20
  Designated Port ..................... 128:24
  Edge Port ........................... No
  Point to Point Link ................. Yes (Auto)
  Boundary Port ....................... Yes
----------------------------------------------------------------------------
```

Figure 18 shows that Port 24 and Port 23 on Switch D are the CIST Designated ports for Region 1 and the RSTP Bridge respectively. Port 24 and Port 23 are also Boundary ports.

Figure 18: Example output of SH MSTP CIST PO=24

```
Manager Switch_D> sh mstp cist po=24
CIST Port Information
----------------------------------------------------------------------------
Port Number ........................... 24
  Port Identifier ..................... 128:24
  Port Role ........................... Designated Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  External Port Path Cost ............. 200000
  Designated Bridge ................... 0 : 00-00-cd-08-77-20
  Designated Port ..................... 128:24
  Edge Port ........................... No
  Point to Point Link ................. Yes (Auto)
  Boundary Port ....................... Yes
----------------------------------------------------------------------------
Manager Switch_D> sh mstp cist po=23
CIST Port Information
----------------------------------------------------------------------------
Port Number ........................... 23
  Port Identifier ..................... 128:23
  Port Role ........................... Designated Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  External Port Path Cost ............. 200000
  Designated Bridge ................... 0 : 00-00-cd-08-77-20
  Designated Port ..................... 128:23
  Edge Port ........................... No
  Point to Point Link ................. Yes (Auto)
  Boundary Port ....................... Yes
----------------------------------------------------------------------------
```

Figure 19 shows that Port 24 on Switch A is the Master Port for all the MSTIs in Region 1. A master Port is a bridge port that is the CIST Root Port for the CIST Region and provides connectivity from the Region towards the CIST Root Bridge that lies outside the Region.

Figure 19: Example output of SH MSTP MSTI=1 PO=24

```
Manager Switch_A> sh mstp msti=1 po=24
MSTI 1 Port Information
----------------------------------------------------------------------------
Port Number ........................... 24
  Port Identifier ..................... 128:24
  Port Role ........................... Master Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 32768 : 00-00-cd-11-b1-ca
  Designated Port ..................... 128:24
---------------------------------------------------------------------------
Manager Switch_A> sh mstp msti=2 po=24
MSTI 2 Port Information
---------------------------------------------------------------------------
Port Number ........................... 24
  Port Identifier ..................... 128:24
  Port Role ........................... Master Port
  Port State .......................... Forwarding
  Switch Port State ................... Enabled
  Link Status ......................... Up
  Port Path Cost ...................... 200000
  Designated Bridge ................... 32768 : 00-00-cd-11-b1-ca
  Designated Port ..................... 128:24
---------------------------------------------------------------------------
```

Configuration guidelines for MSTP

- Switches must have the same MST configuration identification elements (MST configuration name, revision level number and VLAN to MSTI mapping) to be in the same MST region.
- Common and Internal Spanning Tree (CIST) is the default spanning tree instance for MSTP. This means that all VLANs that are not explicitly configured into another MSTI are members of the CIST.
- The software supports a single instance of the MSTP Algorithm consisting of the CIST and up to 64 MSTIs.
- A VLAN can only be mapped to one MSTI or to the CIST. One VLAN mapped to multiple spanning trees is not allowed. All the VLANs are mapped to the CIST by default. Once a VLAN is mapped to a specified MSTI, it is removed from the CIST.
- An MSTI is locally significant within an MST region. An MSTI cannot span across multiple MST regions. The CIST is the spanning tree instance for connecting different MST regions and single spanning tree entities, such as RSTP and STP switches.
- MSTP is compatible with RSTP and STP. An MST region appears as a virtual bridge connecting to single spanning tree entities.

- To avoid unnecessary STP processing, a port that attaches to a LAN that is known to have no other bridges/switches attached can be configured as an edge port with the command:

```
set mstp cist port=port-list edge port=yes
```

Static VLAN Configuration Support

The model used in the design of MSTP is that of a virtual bridged LAN where the VLAN membership of ports on the various bridges is auto-configured through the use of Generic VLAN Registration Protocol (GVRP). In this model every port on a bridge is assigned a role by each spanning tree configured on the bridge (the CIST and multiple MSTIs). Each VLAN is either explicitly or implicitly assigned to one spanning tree (the CIST or one of the MSTIs). However, this does not specify which ports are associated with each VLAN, it simply specifies which spanning tree the packets associated with that VLAN may follow. The spanning tree determines the active topology, then GVRP configures VLANs over the active ports in that topology, as they are required. It is only at this point that ports are directly associated with a particular VLAN.

In this model then, the choice of which ports belong to which VLAN is effectively governed by the active topology that MSTP chooses.

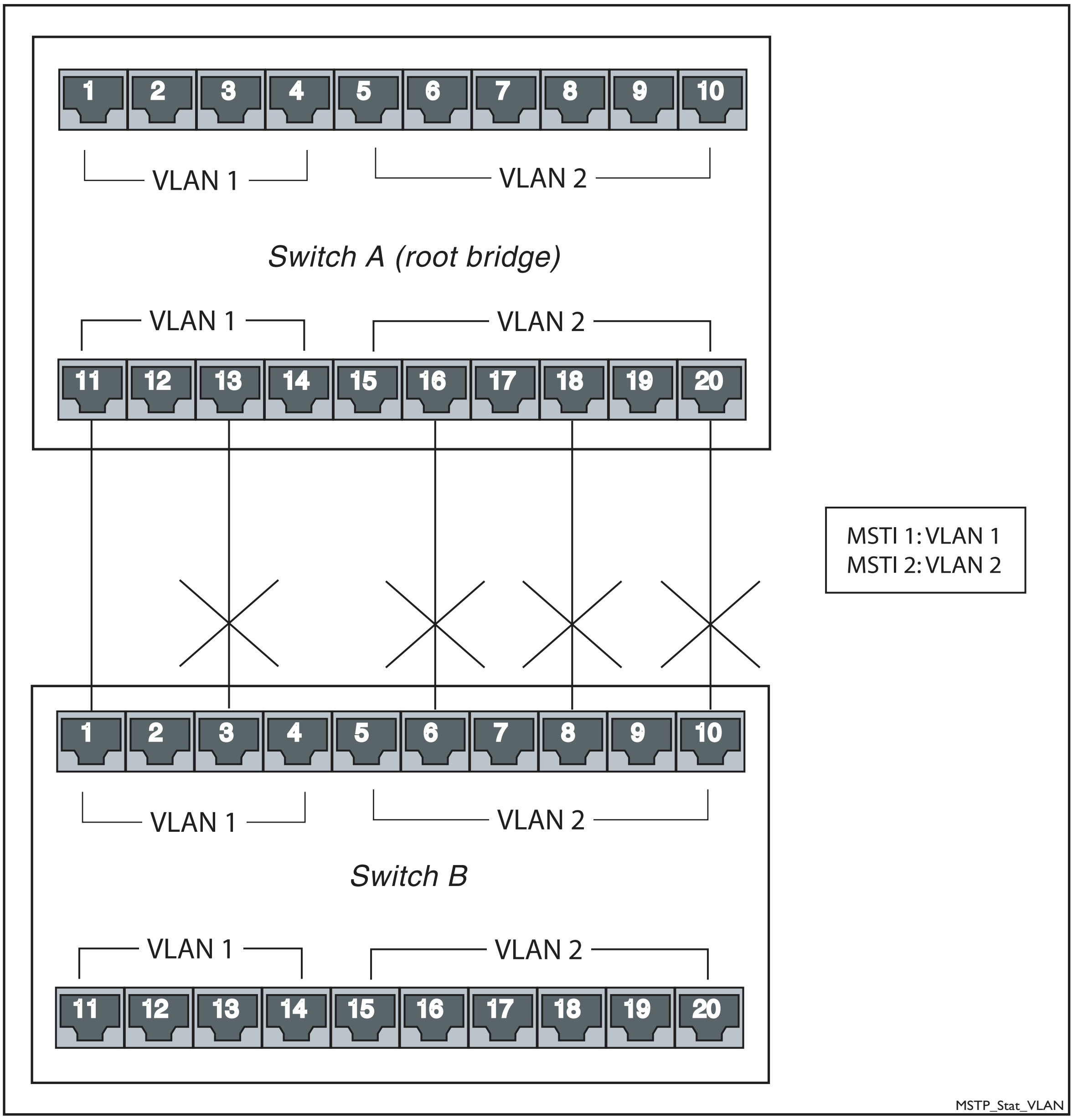
Currently, the common usage scenario for STP on ATI switches, is the model where switch ports are statically configured to belong to one or more VLANs. The VLANs are then assigned to a spanning tree instance, which determines an active topology based only on the ports in the VLANs statically assigned to that instance.

So, the static assignment of ports to VLANs (the typical usage of ATI switches) does not match well to the dynamic port assignment model that underlies the design of MSTP. Let us now see what problem this can cause.

Because MSTP is designed to control all ports on a bridge, not just a subset of ports, for each spanning tree instance, it does not work well with the manual VLAN configuration model. In the form of the algorithm specified in the IEEE standard, MSTP does not consider the VLAN membership of ports when calculating the active topology, so it would be possible for the active topology to include and depend on ports that are not members of the VLANs assigned to the spanning tree instance. Choosing such a port as the root port for an MSTI would partition the VLANs associated with that MSTI. Although the MSTP active topology permits the forwarding of packets associated with those VLANs by the root port, in practice the Ingress Rule Checking (IEEE 802.1Q, 2003, clause 8.6.1) and Egress Rule Checking (IEEE 802.1Q, 2003, clause 8.6.4) will block them.

To understand this problem, let's consider an example. Figure 20 shows an example of a network with statically configured VLANs, where partitioning would occur. The switch ports are configured to be members of the VLANs shown. Both switches have default bridge priority values for MSTI 1 and MSTI 2, with Switch A having the best bridge ID for both instances. All ports are the same speed and have default values for priority and pathcost, so in this case selection of roles is based on sending port number. For both MSTIs port 1 on Switch B receives the best information from Switch A via port 6. As a result both instances choose port 1 as the root port. Ports 2 - 5 are selected as alternate ports for both instances and are set to discarding.

Figure 20: Statically configured VLANs with partitioning



This topology is good for MSTI 1 because it provides a path between the switches via ports that are members of VLAN 1. However, this topology is not good for MSTI 2. Although there are physical links between the two switches via ports which are members of VLAN 2, those ports are excluded from the active topology. Port 1 is in the forwarding state but the ingress and egress rule checking will prevent packets associated with VLAN 2 from using this link. VLAN 2 has been partitioned.

A solution to this problem is to modify the operation of the MSTP functions that choose the port roles within the CIST and the MSTIs. The functions need to be modified to take account of which VLANs each port has been statically assigned to. With these modifications, MSTI 2 would choose port 3 as the root port, resulting in connectivity between the two portions of VLAN 2.

The modifications to the role selection functions may be enabled or disabled by the user using the SET MSTP STATICVLANS={YES|NO|ON|OFF|TRUE|FALSE} command, and should be used to achieve the highest level of VLAN connectivity when using statically configured VLANs. If VLANs are configured dynamically via GVRP, these modifications should be disabled.

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