

CCNP 3:  
CHAPTER 3



IMPLEMENTING SPANNING TREE

# OVERVIEW

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- Basics of implementing STP
- Election of Root Bridge and Backup
- Enhancing STP
  - RSTP
  - MSTP
- EtherChannels

# BASICS OF IMPLEMENTING STP

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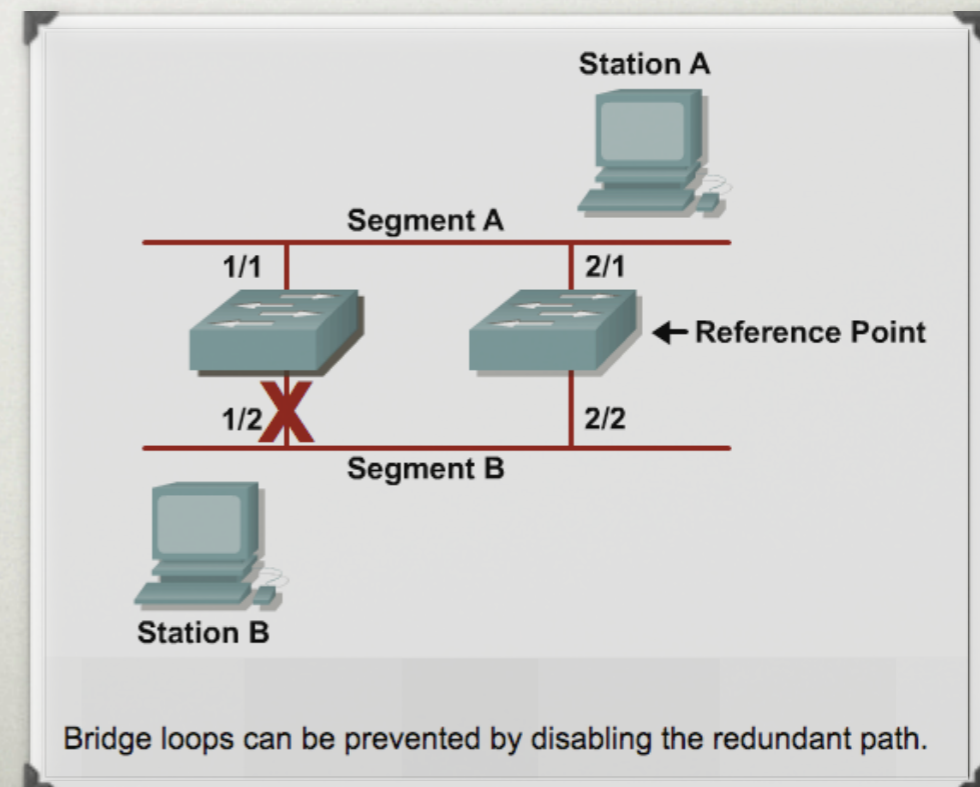
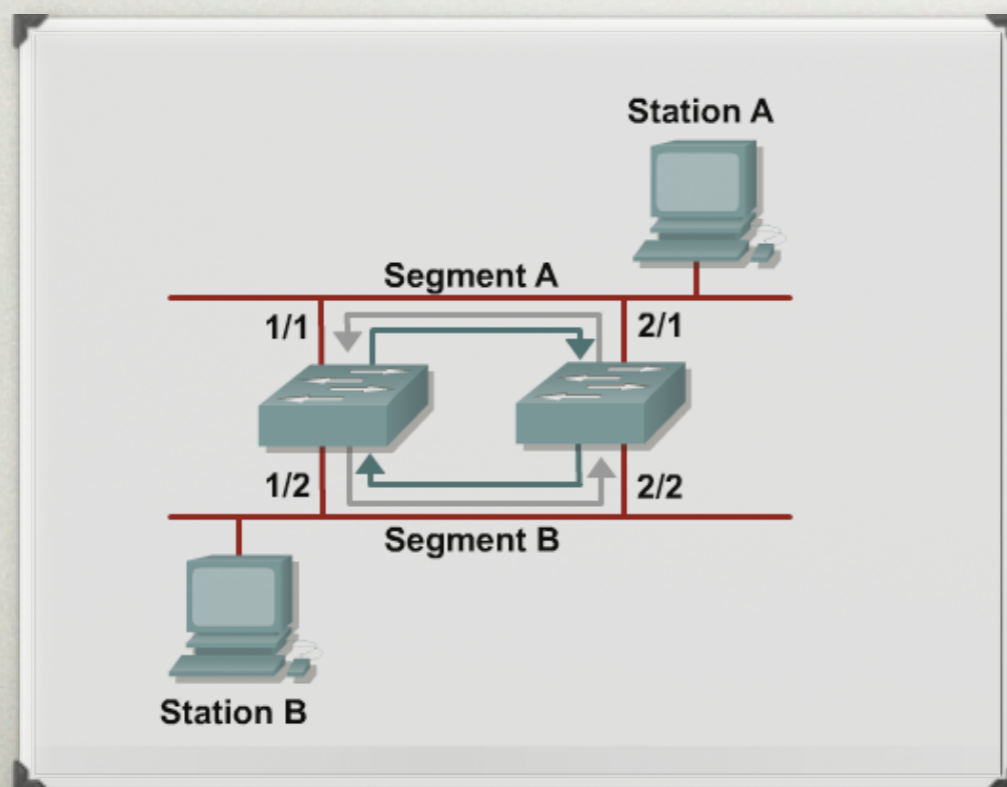
## Describing Transparent Bridges

- The basic functionality of a switch is identical to that of the transparent bridge.
- It must not modify the frames that are forwarded.
- It learns addresses by “listening” on a port for the source address of a device.
- It must forward all broadcasts out of all ports, except for the port that initially received the broadcast.
- If a destination address is unknown to the bridge, it forwards the frame out of all ports, except for the port that initially received the frame. This is called unicast flooding.

# BASICS OF IMPLEMENTING STP

## What is a Bridge Loop?

- A bridge loop occurs when there is no Layer 2 mechanism, such as time-to-live, to manage the redundant paths and stop the frame from circulating endlessly.
- Spanning Tree is a protocol that prevents loop formation by detecting redundant links and disabling them until needed.
- The Spanning Tree Algorithm (STA) runs on each switch to activate or block redundant links. The STA chooses a reference point in the network and determines if there are redundant paths to that reference point.



# BASICS OF IMPLEMENTING STP

## STP communication

- 802.1D STP communicates Layer 2 information between adjacent switches by exchanging bridge protocol data unit (BPDU) messages.
- STP sends BPDUs out of every port of the bridge.
- Each switch, except for the root bridge (Of which there's always only one), selects a root port that provides the best path to the root bridge, redundant ports enter a blocking
- The "Type" field for the BPDU message is 0x00, it uses the multicast MAC address of 01-80-C2-00-00-00.

### Anatomy of a BPDU

Bytes	Field
2	Protocol ID
1	Version
1	Message type
1	Flags
8	Root ID
4	Cost of path
8	Bridge ID
2	Port ID
2	Message age
2	Max age
2	Hello time
2	Forward delay

5	Forward delay
5	Hello time
5	Max age

# ELECTION OF ROOT BRIDGE AND BACKUP

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## General Overview

- The STP topology is converged after a root bridge has been selected, and each bridge has selected its root port, designated bridge, and the participating ports.
- Path calculation through the network is based on the root bridge which serves as reference point for the topology.
- One root is elected for each VLAN.
- The root maintains the topology and propagates timers.

# ELECTION OF ROOT BRIDGE AND BACKUP

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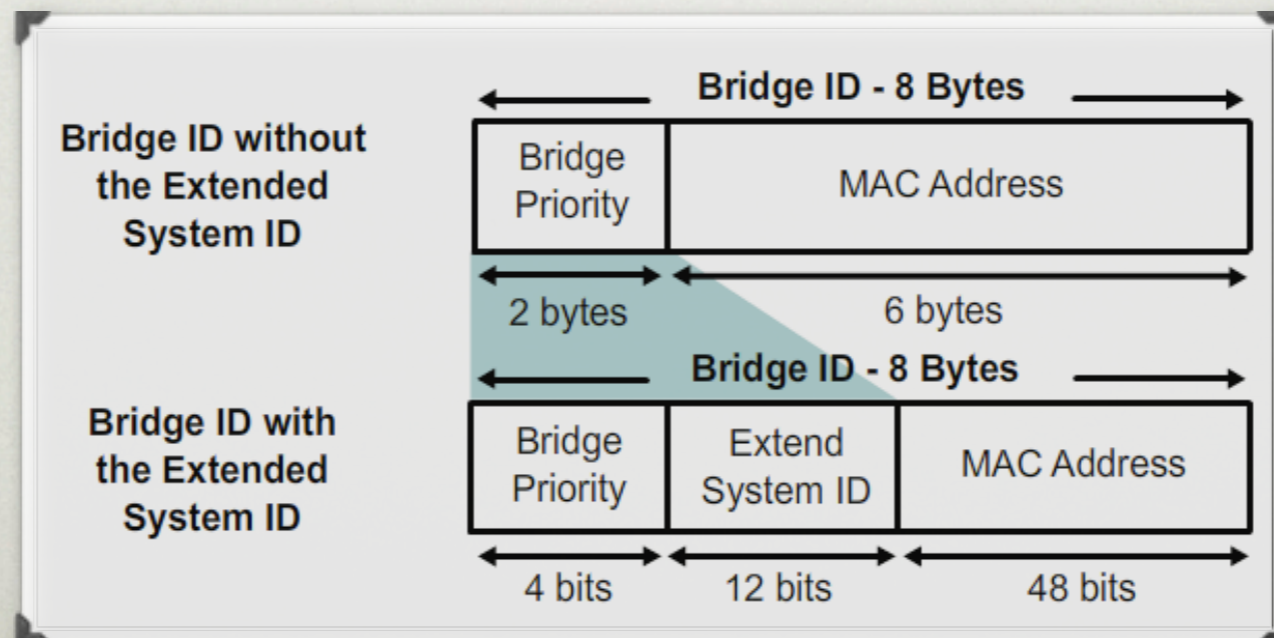
## Selecting the Root Bridge

- The bridge is selected using the bridge ID (BID), which consists of a 2-byte Priority field plus a 6-byte MAC address.
- Lower BID values are preferred.
- The Priority field value helps determine which bridge is going to be the root and can be manually altered.
- When the default Priority field is the same for all bridges, selecting the root bridge is based on the lowest MAC address.
- When a switch first boots and begins sending BPDUs, it has no knowledge of a root ID, so it populates the Root ID field of outbound BPDUs with its own BID.
- Spanning tree operation requires that each switch have a unique BID.

# ELECTION OF ROOT BRIDGE AND BACKUP

## Selecting the Root Bridge - Continued

- Because PVST requires that a separate instance of spanning tree run for each VLAN, the BID field is required to carry VLAN ID (VID) information, which is accomplished by reusing a portion of the Priority field as the extended system ID.





## ELECTION OF ROOT BRIDGE AND BACKUP

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### Port States

- Each Layer 2 port on a switch running STP is running in one of the following 5 states:
  - Blocking (Determined by Max Age Timer)
  - Listening (Determined by Fwd Delay Timer)
  - Learning (Determined by Fwd Delay Timer)
  - Forwarding (Participates in networking)
  - Disabled (Port is administratively down)

# ELECTION OF ROOT BRIDGE AND BACKUP

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## STP Timers

- Hello timer: Determines how often root bridge sends configuration BPDUs. The default is 2 seconds.
- Maximum Age (Max Age): Tells the bridge how long to keep ports in the blocking state before listening. The default is 20 seconds.
- Forward Delay (Fwd Delay): Determines how long to stay in the listening state before going to the learning state, and how long to stay in the learning state before forwarding. The default is 15 seconds.

# ELECTION OF ROOT BRIDGE AND BACKUP

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## Configuring PVST

- If no priority has been configured, every switch will have the same default priority of 32768. Assuming all other switches are at default priority, the **spanning-tree vlan *"vlan-id"* root primary** command sets a value of 24576.
- Assuming all other switches are at default priority, the **spanning-tree vlan *"vlan-id"* root secondary** command sets a value of 28672.
- By default STP is enabled and need no configuration.

### CAUTION:

Spanning tree commands take effect immediately, so network traffic is disrupted while the reconfiguration occurs.

# ENHANCING STP

## STP Enhancements

- Spanning Tree enhancements focus on faster network convergence.

PortFast	Skips learning and listening, going straight to forwarding.	(Config-if)Spanning-tree portfast
UplinkFast	The switch identifies backupports on upstream fail, going straight to backup.	(Config)Spanning-tree uplinkfast Uplink fast is set globally, the switch creates uplinkgroups for faster convergence.
BackboneFast	Like uplinkfast but used to detect indirect failures. RootLinkQueries are sent out on all ports to determine the new root route.	(Config)Spanning-tree backbonefast Backbonefast is set globally and need to be set on all switches in the network.

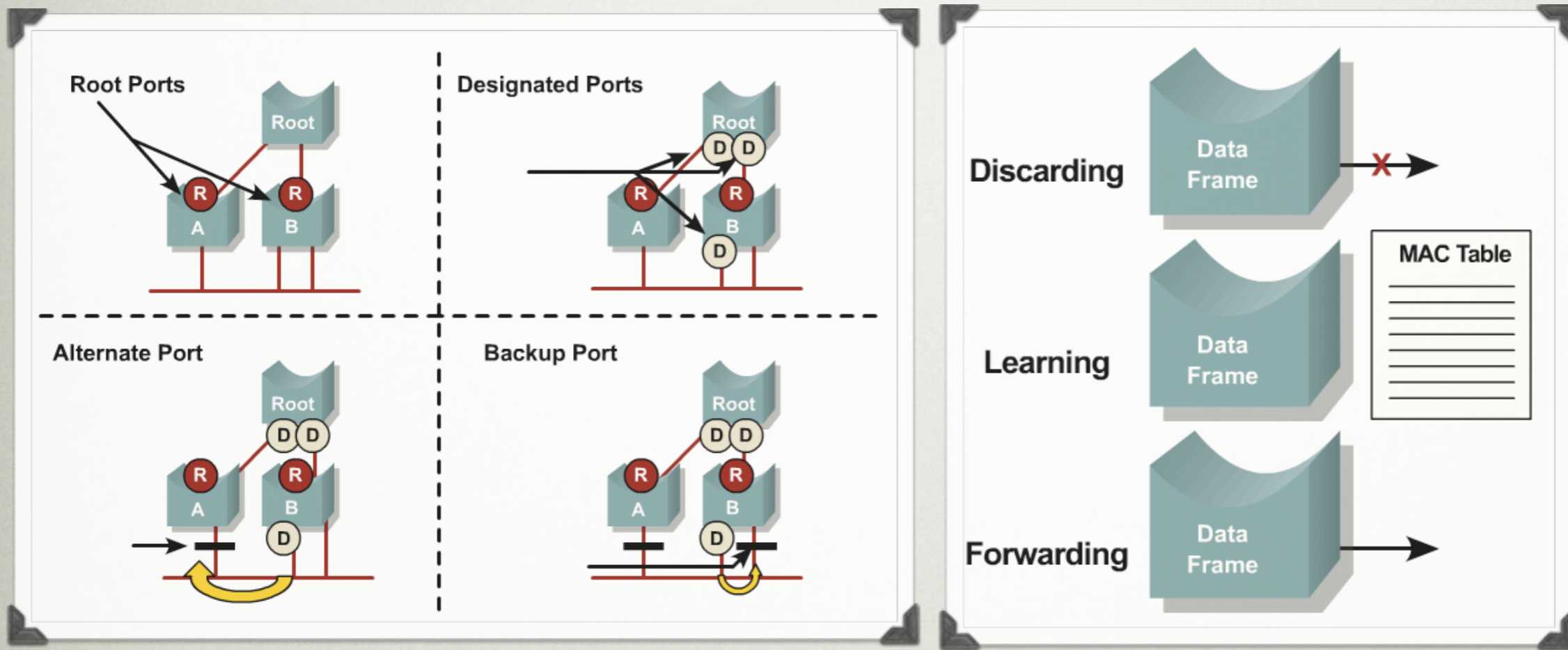
# ENHANCING STP -RSTP

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- RSTP works much like STP, the main differences are:
  - RSTP is proactive and doesn't just "forget" blocked ports
  - RSTP cuts downtime during convergence by up to 50 seconds
  - RSTP is... Well.. Rapid...

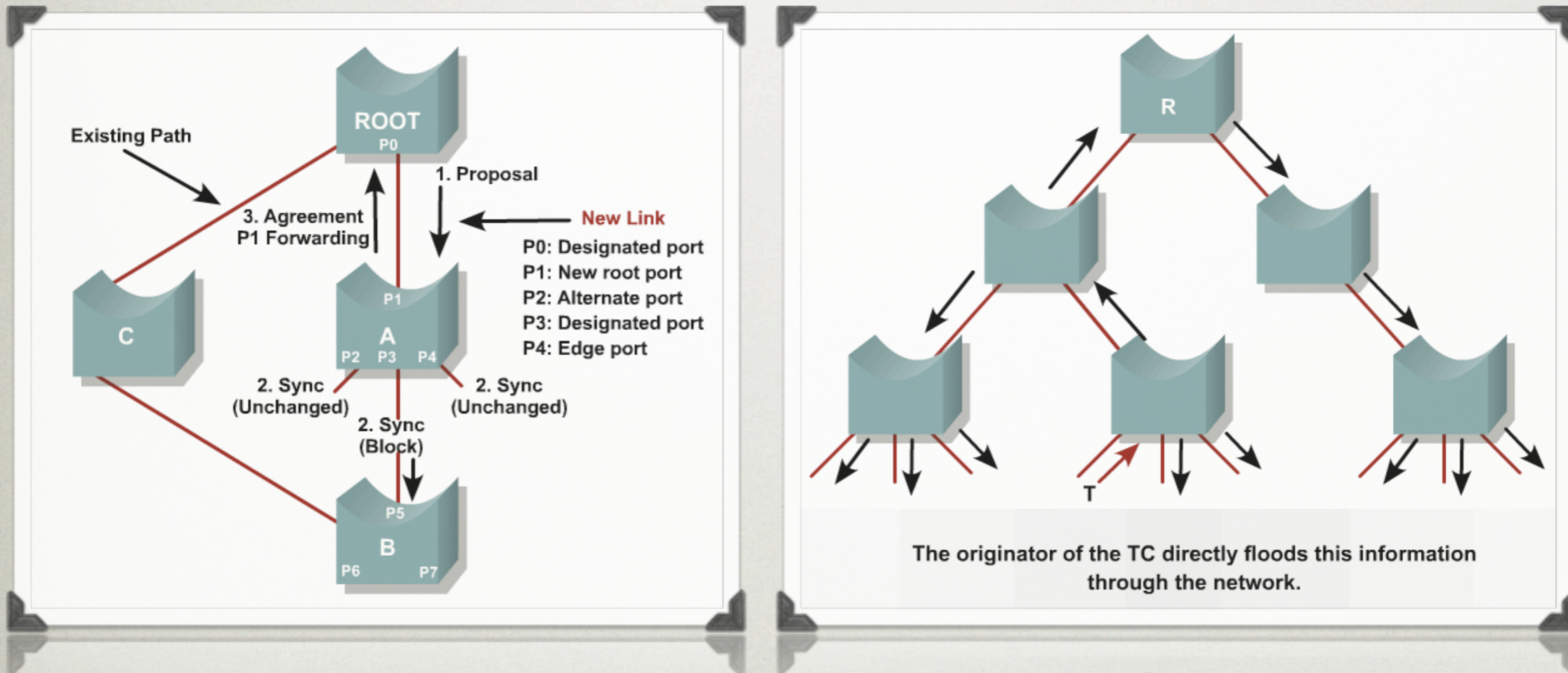
# ENHANCING STP - RSTP

- Port States and Roles



# ENHANCING STP - RSTP

- How it works



through the network.  
The originator of the TC directly floods this information

# ENHANCING STP -RSTP

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- Configuring RSTP

## Configuring

- `spanning-tree mode rapid-pvst`

## Verifying

- `show spanning-tree vlan 101`

## Debugging

- `debug spanning-tree`



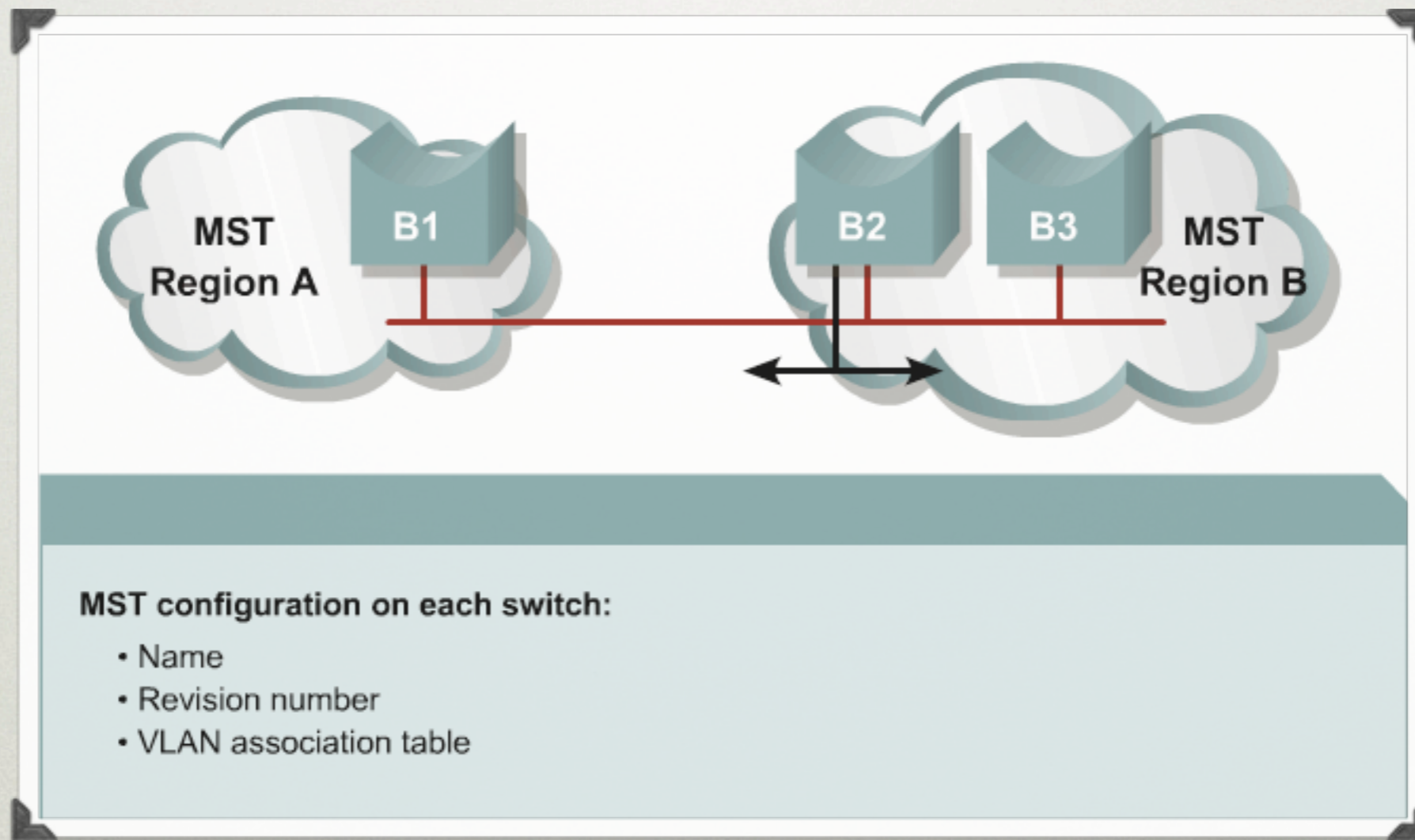
# ENHANCING STP -MSTP

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- MSTP differs from other spanning tree implementations in that it combines some, but not necessarily all, VLANs into logical spanning tree instances.

# ENHANCING STP -MSTP

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# ENHANCING STP -MSTP

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- Configuring MSTP

```
Switch(config)#spanning-tree mst configuration
```

- Enters MST configuration submode

```
Switch(config-mst)#name name
```

- Sets the MST region name

```
Switch(config-mst)#revision rev_num
```

- Sets the MST configuration revision number

```
Switch(config-mst)#instance inst vlan range
```

- Maps the VLANs to an MST instance

```
Switch(config-mst)#spanning-tree mst instance_number root  
primary|secondary
```

- Establishes primary and secondary roots for MST instance



# ETHERCHANNELS

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- To configure EtherChannels you need to both
  - Make ports ready for EtherChannels
  - Configure the Port Channel

# ETHERCHANNELS

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- Configuring a Port Channel

## Configure PAgP

- `interface port-channel {channel-group-number}`
- `channel-protocol pagp`
- `channel-group 1 mode {mode}`

## Verify

- `show interfaces fastethernet 0/1 etherchannel`
- `show etherchannel 1 port-channel`
- `show etherchannel 1 summary`

- `show etherchannel 1 summary`
- `show etherchannel 1 port-channel`
- `show interfaces fastethernet 0/1 etherchannel`

# ETHERCHANNELS

- Configuring ports for EtherChannel

```
Switch(config)#interface range interface slot/port - port
```

- Specifies the interfaces to configure in the bundle

```
Switch(config-if-range)#channel-protocol {pagp | lacp}
```

- Specifies the channel protocol—either pagp or lacp

```
Switch(config-if-range)#channel-group number mode {active | on | auto | desirable | passive}
```

- Creates the port-channel interface and places the interfaces as members

```
Switch(config)#interface port-channel port-channel-number
```

- Creates a port-channel interface

```
Switch(config-if)#no switchport  
Switch(config-if)#ip address address mask
```

- Specifies L3 and assigns an IP address and subnet mask to the EtherChannel

```
Switch(config)#interface interface slot/port
```

- Specifies an interface to configure

```
Switch(config-if)#no switchport  
Switch(config-if)#channel-group number mode {auto | desirable | on}
```

- Configures the interface as L3 and specifies the port channel and the PAgP mode

# ETHERCHANNELS

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- EtherChannels can be Layer 3
- Use the command “No Switchport” in the Interface Portchannel Configuration Mode
- Assign an IP address like you would a Layer 3 port



# ETHERCHANNELS

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- Port-channel load-balance

Load balancing is applied globally for all EtherChannel bundles in the switch. To configure EtherChannel load balancing, use the `port-channel load-balance` command. Load balancing can be based on the following variables:

`src-mac`: Source MAC address

`dst-mac`: Destination MAC address

`src-dst-mac`: Source and destination MAC addresses

`src-ip`: Source IP address

`dst-ip`: Destination IP address

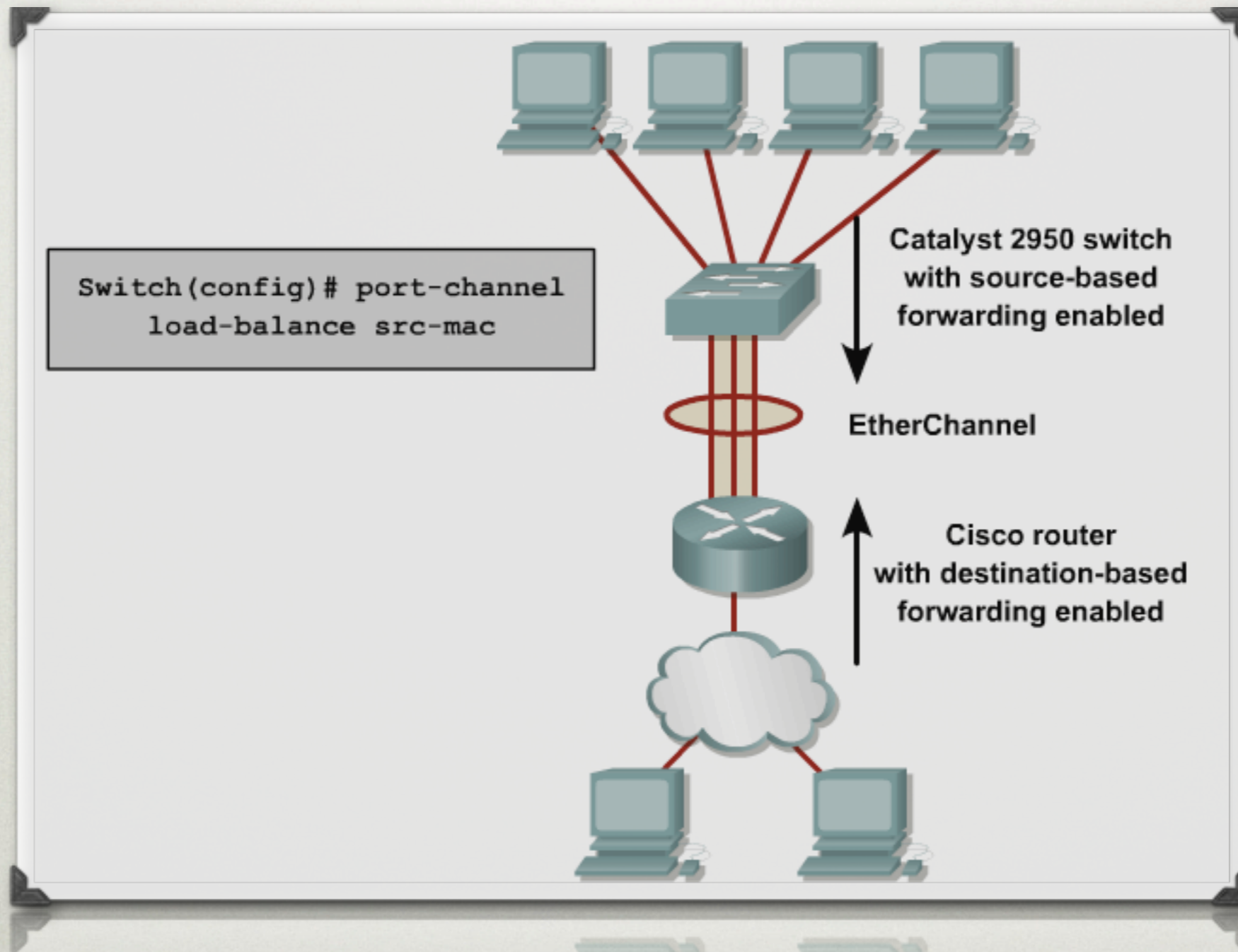
`src-dst-ip`: Source and destination IP addresses (default)

`src-port`: Source TCP/User Datagram Protocol (UDP) port

`dst-port`: Destination TCP/UDP port

`src-dst-port`: Source and destination TCP/UDP ports

# ETHERCHANNELS



# ETHERCHANNELS

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- This example shows an example of how to configure and verify EtherChannel load balancing.
- Switch(config)# port-channel load-balance src-dst-ip
- Switch(config)# exit
- Switch# show etherchannel load-balance