Understand STP Loop Guard and UDLD Features

Contents

Introduction

This document describes Spanning Tree Protocol features that are intended to improve the Layer 2 network stability.

Prerequisites

Requirements

This document assumes that the reader is familiar with the basic operation of STP. Refer to Understand and Configure Spanning Tree Protocol (STP) on Catalyst Switches for more information.

Components Used

This document is based on Catalyst switches, however the availability of the features described can depend on the software release used.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Conventions

Refer to Cisco Technical Tips Conventions for more information on document conventions.

Background Information

Spanning Tree Protocol (STP) resolves physically redundant topologies into loop-free, tree-like topologies. The biggest issue with STP is that some hardware failures can cause it to fail. This failure creates forwarding loops (or STP loops). Major network outages are caused by STP loops.

This document describes the loop guard STP feature that is intended to improve the stability of the Layer 2 networks. This document also describes Bridge Protocol Data Unit (BPDU) skew detection. BPDU skew detection is a diagnostic feature that generates syslog messages when BPDUs are not received in time.

Feature Availability

Cisco IOS

- The STP loop guard feature was introduced in Cisco IOS® Software Release 12.1(12c)EW for Catalyst 4500 switches and Cisco IOS Software Release 12.1(11b)EX for Catalyst 6500.

STP Port Roles

Internally, STP assigns to each bridge (or switch) port a role that is based on configuration, topology, relative position of the port in the topology, and other considerations. The port role defines the behavior of the port from the STP point of view. Based on the port role, the port either sends or receives STP BPDUs and forwards or blocks the data traffic. This list provides a brief summary of each STP port role:

- **Designated—**One designated port is elected per link (segment). The designated port is the port closest to the root bridge. This port sends BPDUs on the link (segment) and forwards traffic towards the root bridge. In an STP converged network, each designated port is in the STP forwarding state.
- **Root—**The bridge can have only one root port. The root port is the port that leads to the root bridge. In an STP converged network, the root port is in the STP forwarding state.
- **Alternate—**Alternate ports lead to the root bridge but are not root ports. The alternate ports maintain the STP blocking state.
- **Backup—**This is a special case when two or more ports between the same switches are connected together, directly or through shared media. In this case, one port is designated, and the rest of the ports are blocked. The role for this port is backup.

STP Loop Guard

Feature Description

The STP loop guard feature provides additional protection against Layer 2 forwarding loops (STP loops). An STP loop is created when an STP blocking port in a redundant topology erroneously transitions to the forwarding state. This usually happens because one of the ports of a physically redundant topology (not necessarily the STP blocking port) no longer receives STP BPDUs. In its operation, STP relies on continuous reception or transmission of BPDUs based on the port role. The designated port transmits BPDUs, and the non-designated port receives BPDUs.

When one of the ports in a physically redundant topology no longer receives BPDUs, the STP conceives that the topology is loop free. Eventually, the blocking port from the alternate or backup port becomes designated and moves to a forwarding state. This situation creates a loop.

The loop guard feature makes additional checks. If BPDUs are not received on a non-designated port, and loop guard is enabled, that port is moved into the STP loop-inconsistent blocking state, instead of the listening / learning / forwarding state. Without the loop guard feature, the port assumes the designated port role. The port moves to the STP forwarding state and creates a loop.

When the loop guard blocks an inconsistent port, this message is logged:

- **Cisco IOS**

```
%SPANTREE-2-LOOPGUARD_BLOCK: Loop guard blocking port FastEthernet0/24 on VLAN0050.
```

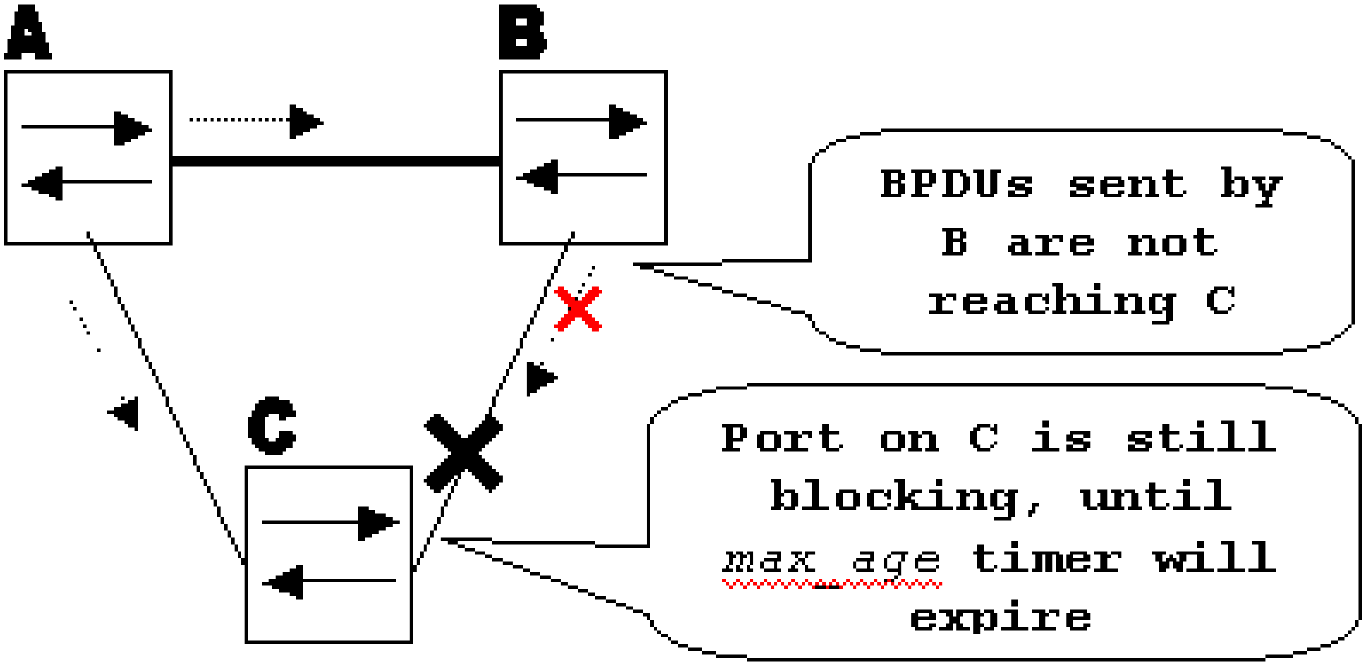
Once the BPDU is received on a port in a loop-inconsistent STP state, the port transitions into another STP state. To the received BPDU, this means that the recovery is automatic, and intervention is not necessary. After recovery, this message is logged:

- **Cisco IOS**

```
%SPANTREE-2-LOOPGUARD_UNBLOCK: Loop guard unblocking port FastEthernet0/24 on VLAN0050.
```

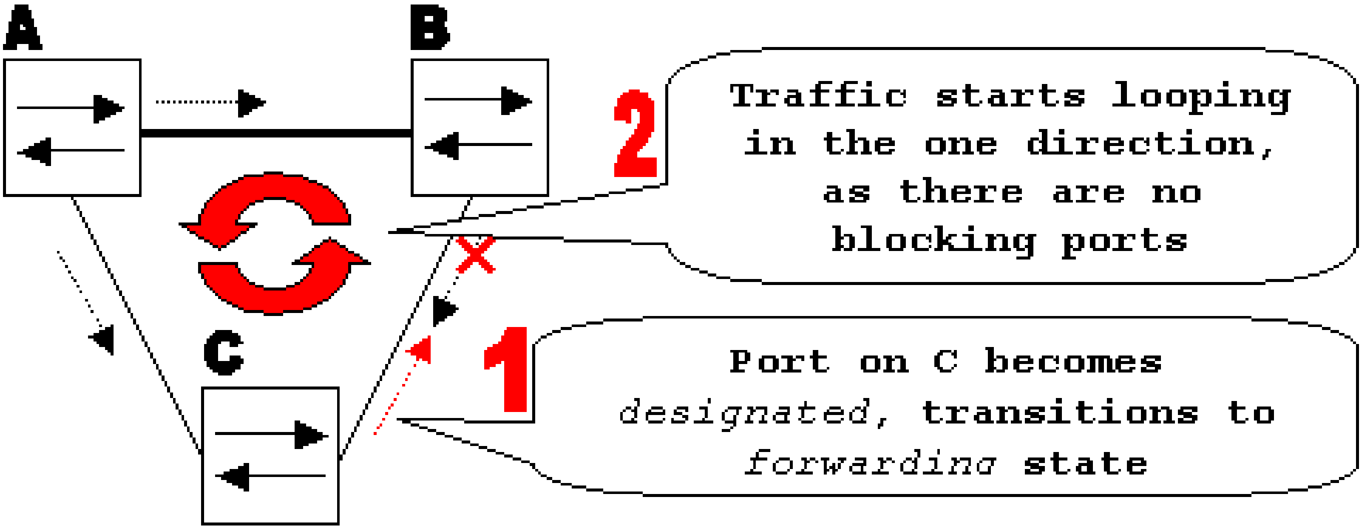
Consider this example to illustrate this behavior:

Switch A is the root switch. Switch C does not receive BPDUs from switch B due to unidirectional link failure on the link between switch B and switch C.


A
B
C
BPDUs sent by B are not reaching C
Port on C is still blocking, until max_age timer will expire

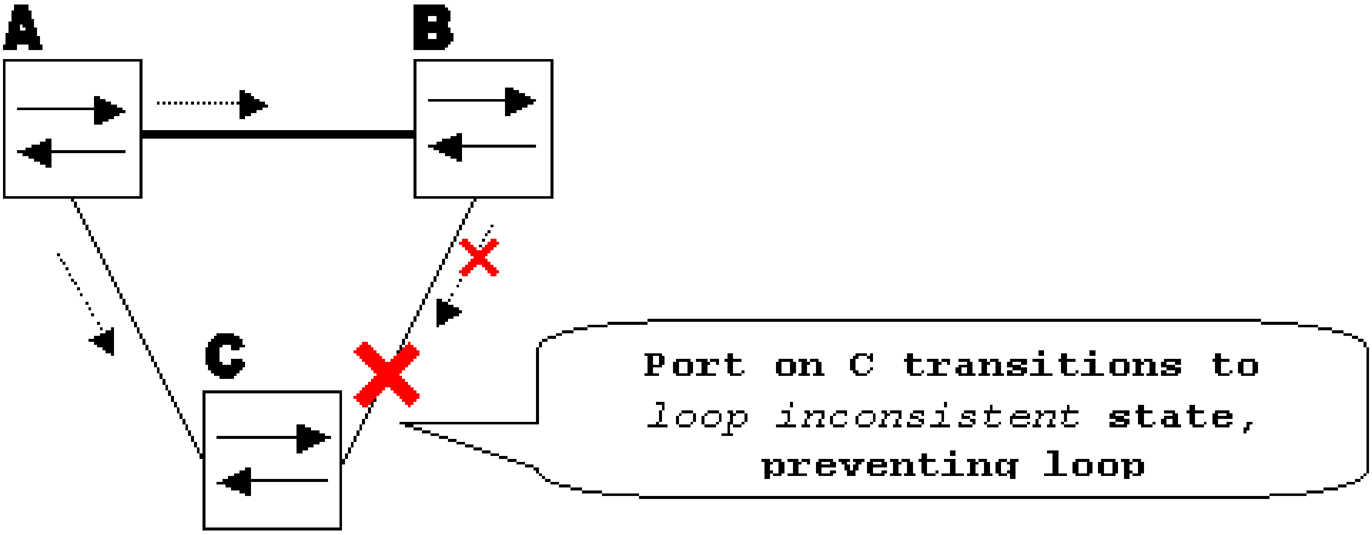
Unidirectional Link Failure

Without loop guard, the STP blocking port on switch C transitions to the STP listening state when the max_age timer expires, and then it transitions to the forwarding state in two times the forward_delay time. This situation creates a loop.


A
B
C
2
Traffic starts looping in the one direction, as there are no blocking ports
1
Port on C becomes *designated*, transitions to *forwarding* state

Loop is Created

With loop guard enabled, the blocking port on switch C transitions into STP loop-inconsistent state when the max_age timer expires. A port in STP loop-inconsistent state does not pass user traffic, so a loop is not created. (The loop-inconsistent state is effectively equal to blocking state.)


A
B
C
Port on C transitions to *loop inconsistent* state, preventing loop

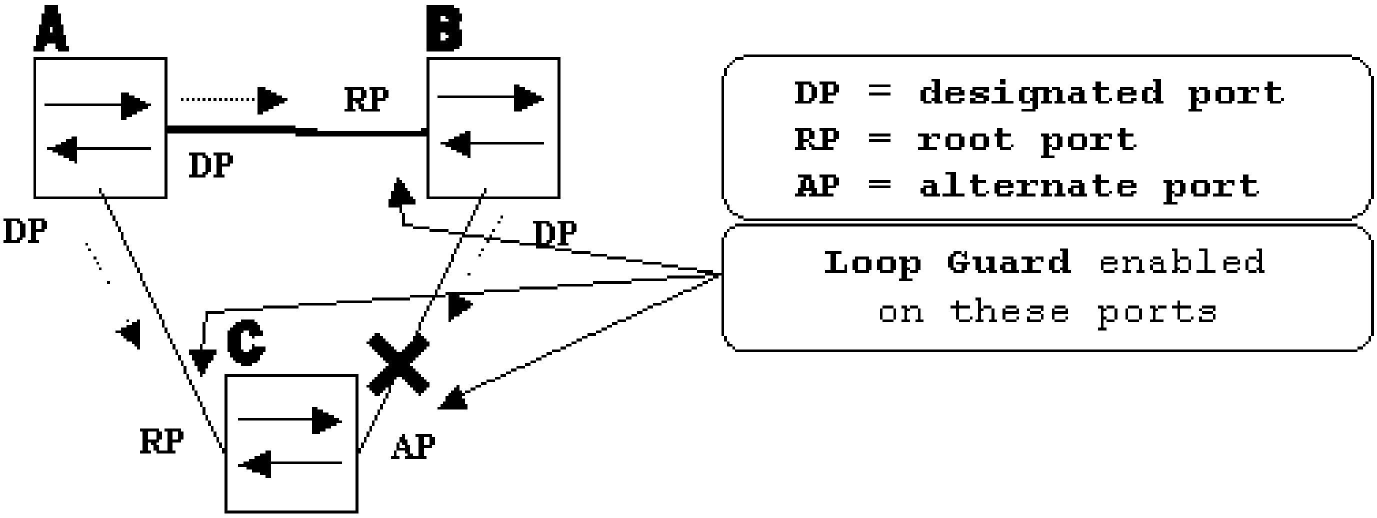
Loop Guard Enabled prevents Loop

Configuration Considerations

The loop guard feature is enabled on a per-port basis. However, as long as it blocks the port on the STP level, loop guard blocks inconsistent ports on a per-VLAN basis (because of per-VLAN STP). That is, if BPDUs are not received on the trunk port for only one particular VLAN, only that VLAN is blocked (moved to loop-inconsistent STP state). For the same reason, if enabled on an EtherChannel interface, the entire channel is blocked for a particular VLAN, not just one link (because EtherChannel is regarded as one logical port from the STP point of view).

On which ports is the loop guard be enabled? The most obvious answer is on the blocking ports. However, this is not totally correct. Loop guard must be enabled on the non-designated ports (more precisely, on root and alternate ports) for all possible combinations of active topologies. As long as the loop guard is not a per-VLAN feature, the same (trunk) port can be designated for one VLAN and non-designated for the other. The possible failover scenarios must also be considered.

Example



Ports with Loop Guard Enabled

By default, loop guard is disabled. This command is used to enable loop guard:

- **Cisco IOS**

```
<#root>

spanning-tree guard loop

Router(config)#

interface gigabitEthernet 1/1

Router(config-if)#

spanning-tree guard loop
```

Effectively, loop guard can be enabled on all point-to-point links. The point-to-point link is detected by the duplex status of the link. If duplex is full, the link is considered point-to-point. It is still possible to configure, or override, global settings on a per-port basis.

Issue this command in order to enable loop guard globally:

- **Cisco IOS**

```
<#root>

Router(config)#

spanning-tree loopguard default
```

Issue this command in order to disable loop guard:

- **Cisco IOS**

```
<#root>

Router(config-if)#

no spanning-tree guard loop
```

Issue this command in order to globally disable loop guard:

- **Cisco IOS**

```
<#root>

Router(config)#

no spanning-tree loopguard default
```

Issue this command in order to verify loop guard status:

- **Cisco IOS**

```
<#root>

show spanning-tree


Router#

show spanning-tree summary

Switch is in pvst mode
Root bridge for: none
EtherChannel misconfig guard is enabled
Extended system ID           is disabled
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Pathcost method used         is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
Total                         0         0        0          0          0
```

Loop Guard versus UDLD

Loop guard and Unidirectional Link Detection (UDLD) functionality overlap, partly in the sense that both protect against STP failures caused by unidirectional links. However, these two features differ in functionality and how they approach the problem. This table describes loop guard and UDLD functionality:

Functionality	Loop Guard	UDLD
Configuration	Per-port	Per-port
Action granularity	Per-VLAN	Per-port
Auto-recover	Yes	Yes, with err-disable timeout feature
Protection against STP failures caused by unidirectional links	Yes, when enabled on all root and alternate ports in redundant topology	Yes, when enabled on all links in redundant topology
Protection against STP failures caused by problems in the software (designated switch does not send BPDU)	Yes	No
Protection against incorrect wiring.	No	Yes

Based on the various design considerations, you can choose either UDLD or the loop guard feature. In regard to STP, the most noticeable difference between the two features is the absence of protection in UDLD against STP failures caused by problems in software. As a result, the designated switch does not send BPDUs. However, this type of failure is (by an order of magnitude) rarer than failures caused by unidirectional links. In return, UDLD can be more flexible in the case of unidirectional links on EtherChannel. In this case, UDLD disables only failed links, and the channel can remain functional with the links that remain. In such a failure, the loop guard puts it into loop-inconsistent state in order to block the whole channel.

Additionally, loop guard does not work on shared links or in situations where the link has been unidirectional since the link-up. In the last case, the port never receives BPDU and becomes designated. Because this behavior could be normal, this particular case is not covered by loop guard. UDLD provides protection against such a scenario.

As described, the highest level of protection is provided when you enable UDLD and loop guard.

Interoperability of Loop Guard with Other STP Features

Root Guard

The root guard is mutually exclusive with the loop guard. The root guard is used on designated ports, and it does not allow the port to become non-designated. The loop guard works on non-designated ports and does not allow the port to become designated through the expiration of max_age. The root guard cannot be enabled on the same port as the loop guard. When the loop guard is configured on the port, it disables the root guard configured on the same port.

Uplink Fast and Backbone Fast

Both uplink fast and backbone fast are transparent to the loop guard. When max_age is skipped by backbone fast at the time of reconvergence, it does not trigger the loop guard. For more information on uplink fast and backbone fast, refer to these documents:

- Understanding and Configuring the Cisco Uplink Fast Feature
- Understand and Configure Backbone Fast on Catalyst Switches

PortFast and BPDU Guard and Dynamic VLAN

Loop guard cannot be enabled for ports on which portfast is enabled. Since BPDU guard works on portfast-enabled ports, some restrictions apply to BPDU guard. Loop guard cannot be enabled on dynamic VLAN ports since these ports have portfast enabled.

Shared Links

Loop guard must not be enabled on shared links. If you enable loop guard on shared links, traffic from hosts connected to shared segments can be blocked.

Multiple Spanning Tree (MST)

Loop guard functions correctly in the MST environment.

Related Information

- **Enhance Spanning Tree Protocol (STP) with Root Guard**
- **Configure the UDLD Protocol Feature**
- **Using PortFast and Other Commands to Fix Workstation Startup Connectivity Delays**
- **Cisco Technical Support & Downloads**