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Understanding STP

Spaning Tree Protocol

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Why Layer-2 loops are dangerous

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Layer-2 Loops

Ethernet frames have no TTL

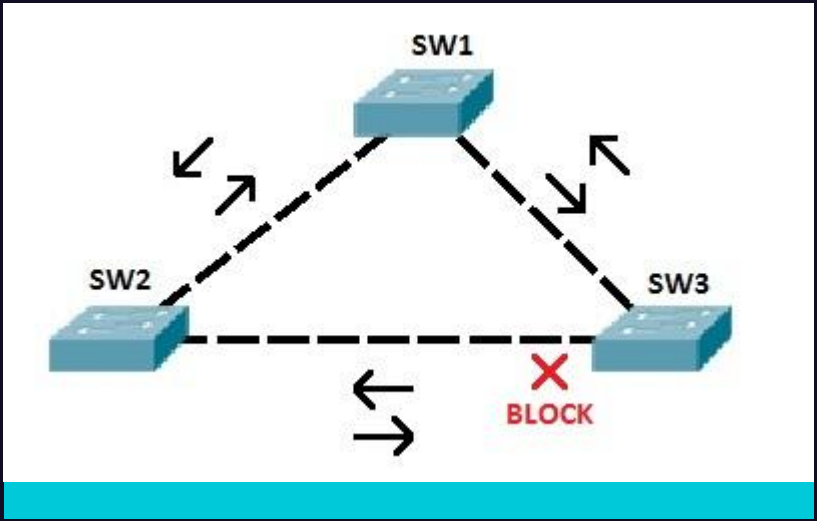
- Ethernet frames lack a Time-to-Live counter, so once injected they continue circulating until a loop is broken, unlike IP packets that eventually expire

Redundant switch links create loops

Loops cause:

- Broadcast storms
- MAC address table instability
- Network outage

STP exists to stop this.



What is STP

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STP

STP stand for Spanning Tree Protocol

- It is a Layer-2 protocol designed to prevent switching loops in Ethernet networks while still allowing physical redundancy.

STP defined by IEEE 802.1D

- How switches (bridges) communicate using.
- Bridge Protocol Data Units (BPDUs).
- How a loop-free logical topology is calculated.
- How switches agree on a single root bridge.
- How ports transition between states to safely converge.

Dynamic Loop Elimination

STP **dynamically** detects multiple paths and:

- Calculates the best path to the root bridge.
- Selects one active path per segment.
- Automatically reacts to topology changes (link failure or recovery).

Logical Blocking (Not Physical)

STP does **not** shut down interfaces.

- Cables stay connected
- Interfaces remain up
- Ports are logically blocked from forwarding traffic

Bridge ID and Priority

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How STP Works

STP performs three steps

Elects a Root Bridge

- All switches send BPDUs to each other.
- The switch with the lowest Bridge ID (BID) becomes the Root Bridge.
- Bridge ID = Priority + MAC Address
- Lower priority wins.
- If priorities match, the lowest MAC address wins.

All decisions are based on BPDUs

Best Path Calculation

- Every non-root switch calculates the shortest path to the Root Bridge.
- This is done using path cost, based on link speed.
- The interface with the lowest total cost to the root becomes the Root Port.
- Only one Root Port per switch is allowed.

This ensures each switch has a single, optimal path toward the root.

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How STP Works

Blocking Redundant Ports

- On each network segment, STP selects one **Designated Port** to forward traffic.
- All other ports that would create loops are placed into a **blocking state**.
- Blocked ports:
  - Do **not** forward frames
  - Still **listen to BPDUs**
  - Can transition to forwarding if the topology changes
- Redundancy is preserved without allowing loops.

Role of BPDUs

- All STP decisions are driven by Bridge Protocol Data Units (BPDUs):
- Root Bridge election
- Path cost calculation
- Port role assignment
- Topology change detection

No BPDUs = no STP logic.

STP Communication

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Root Bridge election

Switches exchange BPDUs

BPDUs carry:

1. Root Bridge ID
2. Sender Bridge ID
3. Path cost

Lowest values always win

Decision Logic: Lowest Wins

- STP uses a strict comparison order:
- Lowest **Root Bridge ID**
- Lowest **Path Cost**
- Lowest **Sender Bridge ID**
- Lowest **Sender Port ID** (tie-breaker)

There is no negotiation or averaging.

Lowest numerical values always win.

What is Bridge ID

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What is Bridge ID

The Bridge ID is a 64-bit value made of two parts:

- **Bridge Priority**
  - Controls how likely a switch is to become Root Bridge
  - Default value: 32768
  - Lower value = higher chance of winning
  - Configurable by the administrator
- **MAC Address**
  - A unique hardware address on the switch
  - Used only as a tie-breaker when priorities match

Bridge ID = Priority + MAC Address

Priority:

- Default: 32768
- Lower is better

STP Priority

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STP Priority

STP Priority is the primary control mechanism used to influence **Root Bridge election**.

Valid Priority Values

- Range: 0 to 61440
- Increments of 4096
  - 0, 4096, 8192, 12288, ..., 61440
- Default priority on most switches: 32768
- You cannot set arbitrary numbers because part of the priority field is reserved for the VLAN ID (Extended System ID).

How Priority Affects Election

- **Lower priority = higher chance of becoming Root Bridge**
- Priority is evaluated **before** MAC address
- MAC address is used **only if priorities are equal**
- This is why relying on defaults is lazy and dangerous MAC-based elections are accidental, not designed.

Root Bridge

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Root Bridge

In Spanning Tree Protocol, there is **only one Root Bridge per VLAN**.

Each VLAN builds its own independent spanning tree, with its own root.

- The Root Bridge has a special role in STP:

- **No Root Port**
  A Root Port is defined as the *best path toward the Root Bridge*.
  Since the Root Bridge *is* the destination, it does not need one.

- **All Ports Are Designated Ports**
  Every active port on the Root Bridge forwards traffic for its segment.
  There is no reason to block ports on the root itself.

The Root Bridge acts as the **logical center** of the Layer-2 topology.

All other switches:

- Calculate their path cost **toward the Root Bridge**
- Choose a single Root Port pointing to it
- Decide which ports must block based on their position relative to the root
- Without the Root Bridge, STP has no anchor and no direction.

STP Port Roles

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STP Port Roles

STP assigns a **role** to every switch port based on its position in the spanning-tree topology.

These roles determine **which ports forward traffic and which must stay silent**.

Root Port (RP)

- The port with the **best path toward the Root Bridge**
- Selected using **lowest total path cost**
- **Only one Root Port per non-root switch**
- Always in a forwarding state (after convergence)
- This is the switch's upstream path toward the root.

Designated Port (DP)

- The port with the **best path away from the Root Bridge**
- **One Designated Port per network segment**
- Responsible for forwarding frames for that segment
- Always in a forwarding state
- If two switches compete on a segment, the one with the better BPDU wins the Designated Port role.

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STP Port Roles

Blocked / Alternate Port

- Exists to **prevent Layer-2 loops**
- Placed in a **blocking state**
- Does **not forward user traffic**
- Still listens to **BPDUs**
- This port is not useless—it is **standby redundancy**.
  If the active path fails, this port can quickly take over.

How STP Decides Port Roles

- Decisions are based on BPDU comparison:
- Lowest Root Bridge ID
- Lowest path cost
- Lowest sender Bridge ID
- Lowest sender Port ID
- Deterministic. Predictable. No guessing.

Path Cost

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Path Cost

Path Cost is the metric STP uses to determine the **best path to the Root Bridge**.

How Path Cost Works

- Each switch port is assigned a **cost** based on its **link speed**
- When BPDUs move toward the Root Bridge, the costs are **added together**
- The path with the **lowest total cost** is selected as the preferred path
- Lower cost always wins.

- STP chooses paths based on cost
- Cost depends on link speed
- Lower total cost = preferred path

Walkthrough
Example topology

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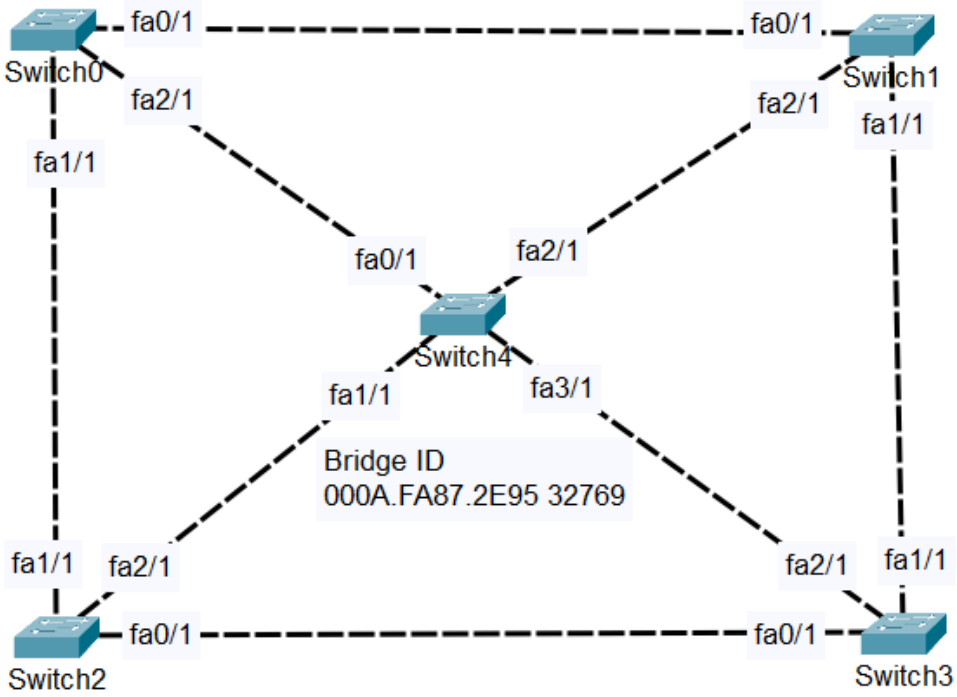

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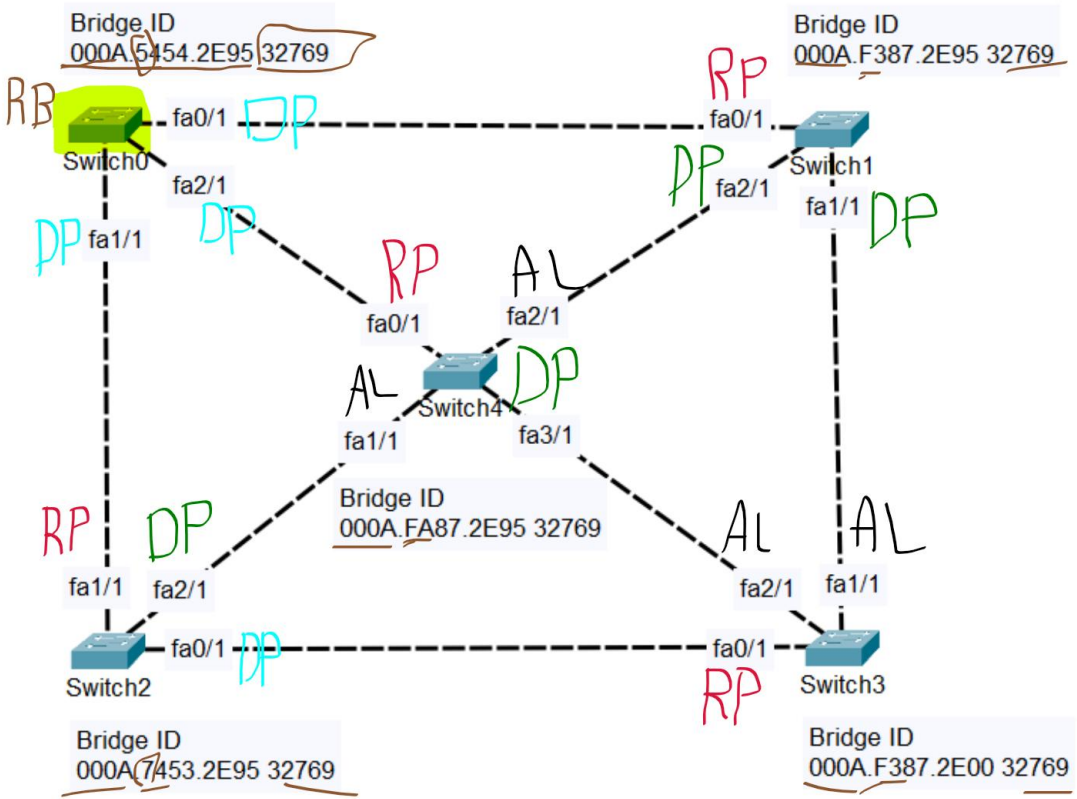

THANKS!

For watching
Wishing you the best

Do you have any questions?
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