**STP Concept**

**I. What is Layer 2 loop?** In short, a Layer 2 loop is a situation where network data circulates endlessly due to multiple paths between switches, caused by **redundant connections (kết nối dự phòng).**

**II. STP (Spanning Tree Protocol)**

Spanning Tree Protocol (STP) is a loop-prevention network protocol that allows for redundancy while creating a loop-free Layer 2 topology. IEEE 802.1D is the original IEEE MAC Bridging standard for STP.

**III. Issues with Redundant Switch Links**

- Redundancy Benefits & Risks:

* Path redundancy improves network reliability by preventing single points of failure.
* However, without STP, redundant paths create harmful Layer 2 loops.

- Loop Consequences: Loops cause MAC address table instability, link saturation, and high CPU usage, making the network unusable.

- Layer 2 vs. Layer 3:

* Layer 2 (Ethernet) lacks built-in loop prevention, unlike Layer 3 (IPv4/IPv6), which uses TTL/Hop Limit to stop endless packet forwarding.
* Layer 2 will forward a frame forever if there is a loop.

- STP's Role: Spanning Tree Protocol (STP) was specifically designed to prevent Layer 2 loops in Ethernet networks.

**IV. Layer 2 Loops**

- Loops and Network Collapse: Without STP, Layer 2 loops lead to rapid network failure (within seconds).

- Broadcast Storms:

* Broadcast frames (like ARP requests) endlessly circulate, flooding the network.
* Switches forward these out all ports, creating a loop if multiple paths exist.

- MAC Address Instability:

* Loops cause constant MAC address table updates, leading to instability.
* This instability, along with broadcast storms, causes high CPU usage on switches.

- Impact on Other Traffic:

* Not just broadcasts: unknown unicast frames also loop, resulting in duplicate frames at destinations.
* Unknown unicast frames are flooded out all ports except the ingress port, so they are also subject to looping.

- Overall Effect:

* The combined effect of these issues renders the network unusable.
* **For more information:** [**https://www.youtube.com/watch?v=ZfoURvPekmY**](https://www.youtube.com/watch?v=ZfoURvPekmY)

**V. STP Alogrithms**

1. Root Bridge Election:

* Purpose: To designate a central reference point for the STP topology.
* Process:
  + Switches exchange Bridge Protocol Data Units (BPDUs).
  + Each switch has a Bridge ID (BID), which consists of a Bridge Priority and a MAC address.
  + The switch with the lowest BID becomes the root bridge.
  + Therefore, the lower the bridge priority number, the more likely that switch will become the root bridge.

2. Root Port Selection:

* Purpose: For each non-root bridge, to determine the port with the best path to the root bridge.
* Process:
  + Non-root bridges analyze received BPDUs.
  + They calculate the path cost to the root bridge.
  + The port with the lowest path cost becomes the root port.

3. Designated Port Selection:

* Purpose: For each network segment, to determine the port that will forward traffic toward the root bridge.
* Process:
  + Switches on each segment compare BPDUs.
  + The switch with the lowest path cost to the root bridge for that segment's link, will have its port on that segment, become the designated port.
  + Designated ports forward traffic.

4. Blocking Redundant Ports:

* Purpose: To eliminate loops by disabling redundant paths.
* Process:
  + Ports that are neither root ports nor designated ports are placed in a blocking state.
  + Blocked ports do not forward traffic, preventing loops.
  + Blocked ports will still recive BPDUs.

Key Aspects:

* BPDUs: These are the communication messages that switches use to exchange STP information.
* Path Cost: This is a value that represents the cost of a link, used to determine the best paths.
* Port States: STP defines different port states (blocking, listening, learning, forwarding) to control traffic flow.

In essence, the STP algorithm creates a logical tree structure, with the root bridge at the top, ensuring that there is only one active path between any two switches.