

Other Layer-2 Features

Campus Network Design & Operations Workshop



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Other Layer-2 Features

- Link Aggregation
- Rapid Spanning Tree
- Multiple Spanning Tree
- Switch Configuration Advice:
 - Network Management
 - Documentation



Link Aggregation

- Also known as *port bundling*, *link bundling*
- You can use multiple links in parallel as a single, logical link
 - For increased capacity
 - For redundancy (fault tolerance)
- LACP (Link Aggregation Control Protocol) is a standardized method (802.1AX) of negotiating these bundled links between switches
- Proprietary methods exist too (Cisco's PAgP, EtherChannel: Juniper's Aggregated Ethernet, etc)

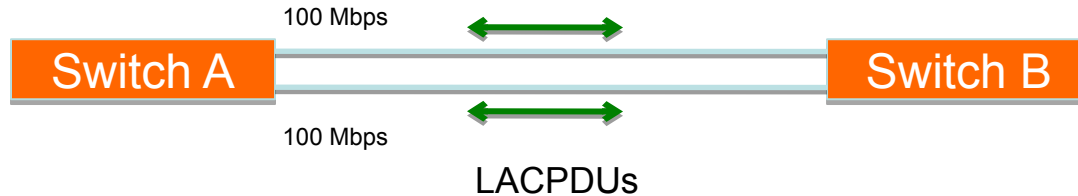


LACP Operation

- Two switches connected via multiple links will send LACPDU packets, identifying themselves and the port capabilities
- They will then automatically build the logical aggregated links, and then pass traffic.
- Switch ports can be configured as active or passive
- Software implementations of LACP exist allowing Linux, BSD servers etc. to combine ports as well. Useful for things like NAS devices.



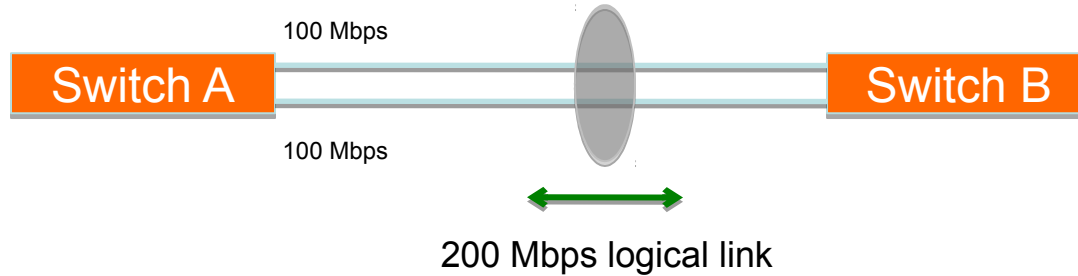
LACP Operation



- Switches A and B are connected to each other using two sets of Fast Ethernet ports
- LACP is enabled and the ports are turned on
- Switches start sending LACPDU's, then negotiate how to set up the aggregation



LACP Operation



- The result is an aggregated 200 Mbps logical link
- The link is also fault tolerant: If one of the member links fail, LACP will automatically take that link off the bundle, and keep sending traffic over the remaining link



Distributing Traffic in Bundled Links

- Bundled links distribute frames using a hashing algorithm, based on:
 - Source and/or Destination MAC address
 - Source and/or Destination IP address
 - Source and/or Destination Port numbers
- This can lead to unbalanced use of the links, depending on the nature of the traffic
- Always choose the load-balancing method that provides the most distribution



Questions?



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Rapid Spanning Tree (802.1w)

- Backwards-compatible with 802.1d
- Convergence is **much** faster
 - Communication between switches is more interactive
- Edge ports don't participate
 - Edge ports transition to forwarding state immediately
 - If BPDUs are received on an edge port, it becomes a non-edge port to prevent loops



Rapid Spanning Tree (802.1w)

- Defines these port roles:
 - Root Port (same as with 802.1d)
 - Alternate Port
 - A port with an alternate path to the root
 - Designated Port (same as with 802.1d)
 - Backup Port
 - A backup/redundant path to a segment where another bridge port already connects.

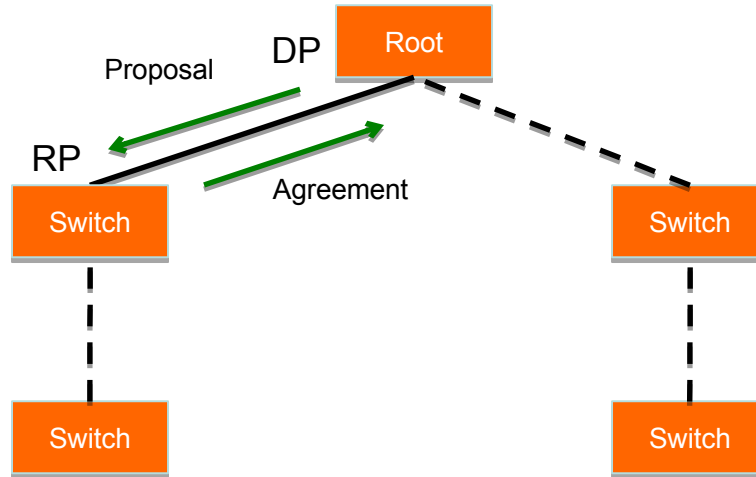


Rapid Spanning Tree (802.1w)

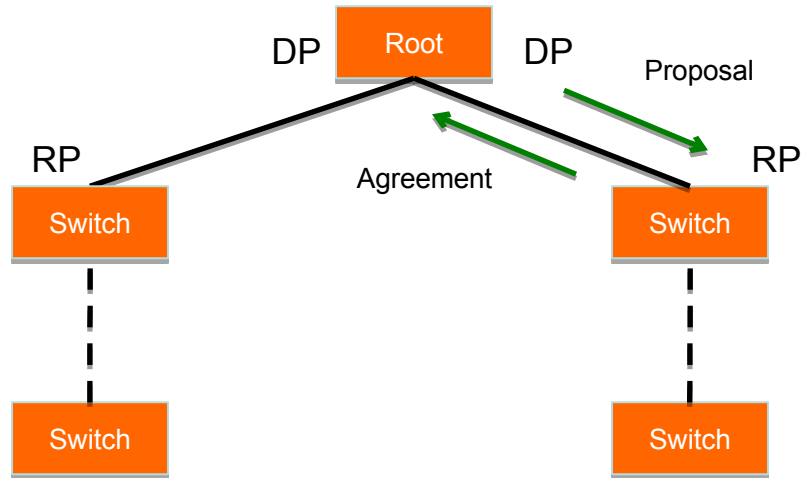
- Synchronization process uses a handshake method
 - After a root is elected, the topology is built in cascade, where each switch proposes to be the designated bridge for each point-to-point link
 - While this happens, all the downstream switch links are blocking



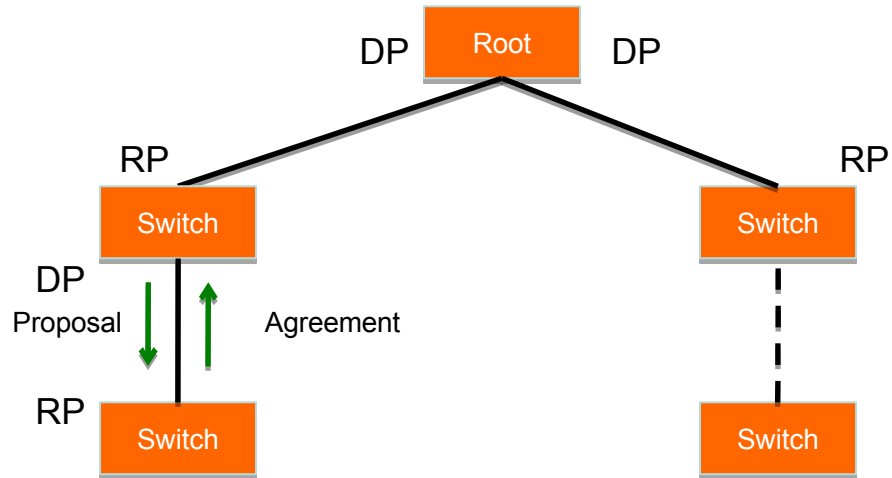
Rapid Spanning Tree (802.1w)



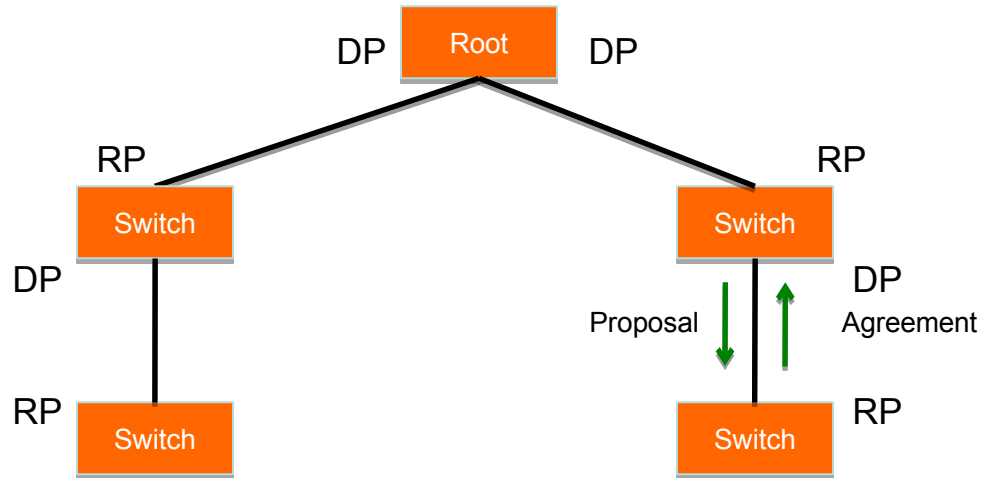
Rapid Spanning Tree (802.1w)



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Rapid Spanning Tree (802.1w)



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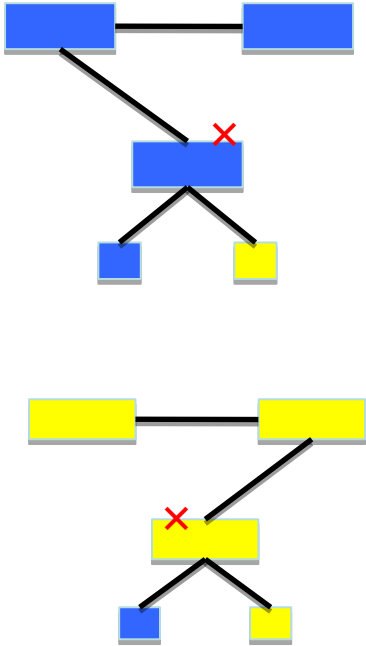
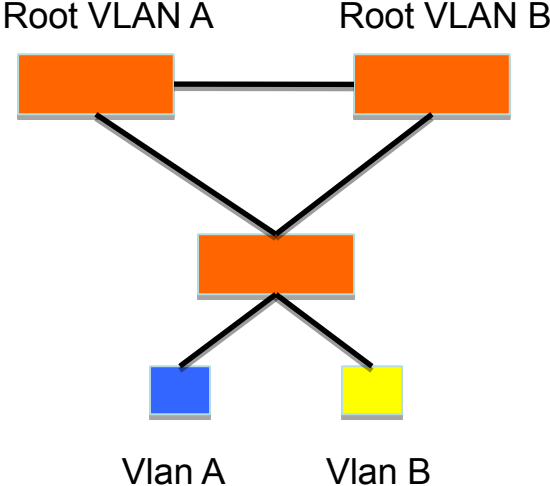


Multiple Spanning Tree (802.1s)

- Backwards-compatible with 802.1d
- Compatible with RSTP
- Allows separate spanning trees per VLAN group
 - Different topologies allow for load balancing between links
 - One or more VLANs are assigned (mapped) to an “instance” of MST (MSTI)
 - A particular VLAN can be mapped to only one MSTI



Multiple Spanning Tree (802.1s)



Multiple Spanning Tree (802.1s)

- MST Instances
 - Groups of VLANs are mapped to particular Spanning Tree instances
 - These instances will represent the alternative topologies, or forwarding paths
 - You specify a root and alternate root for each instance



Multiple Spanning Tree (802.1s)

- MST Region
 - Switches are members of a region if they have the same set of attributes:
 - MST configuration name
 - MST configuration revision
 - Instance-to-VLAN mapping
 - A digest of these attributes is sent inside the BPDUs for fast comparison by the switches
 - One region is usually sufficient



Multiple Spanning Tree (802.1s)

- CST = Common Spanning Tree
 - Defined in 802.1q standard (which also defines VLAN tagging)
 - In order to interoperate with other versions of Spanning Tree, MST needs a common tree that contains all the islands, including other MST regions
 - One spanning-tree instance for the entire bridged network regardless of the number of VLANs or regions

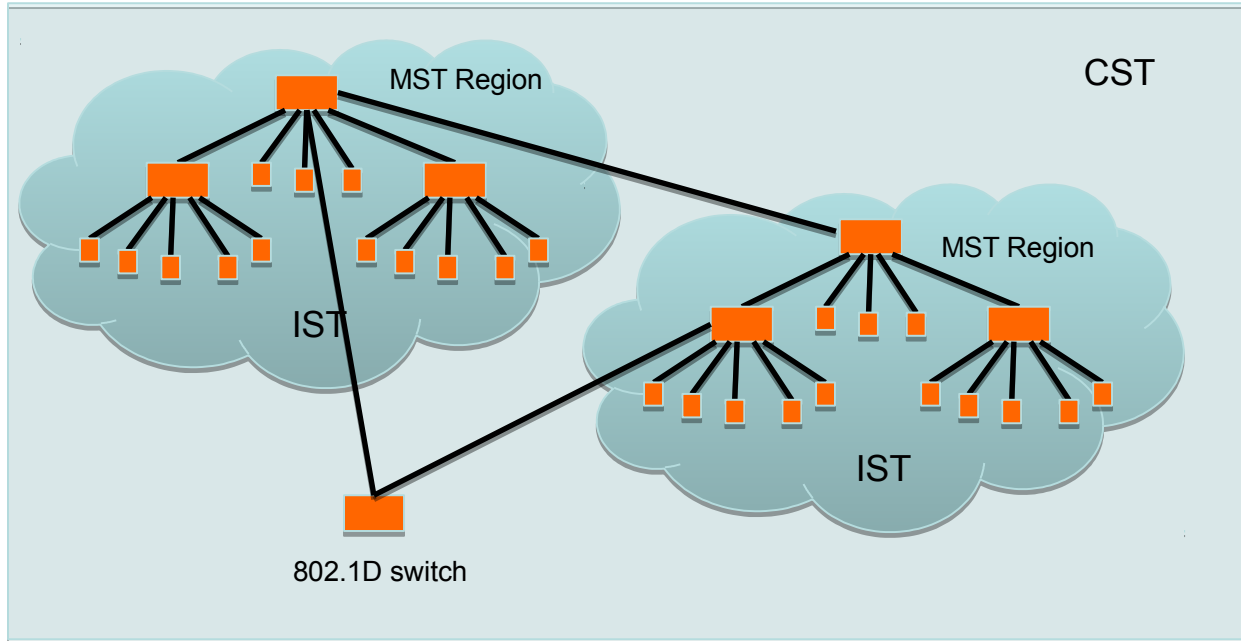


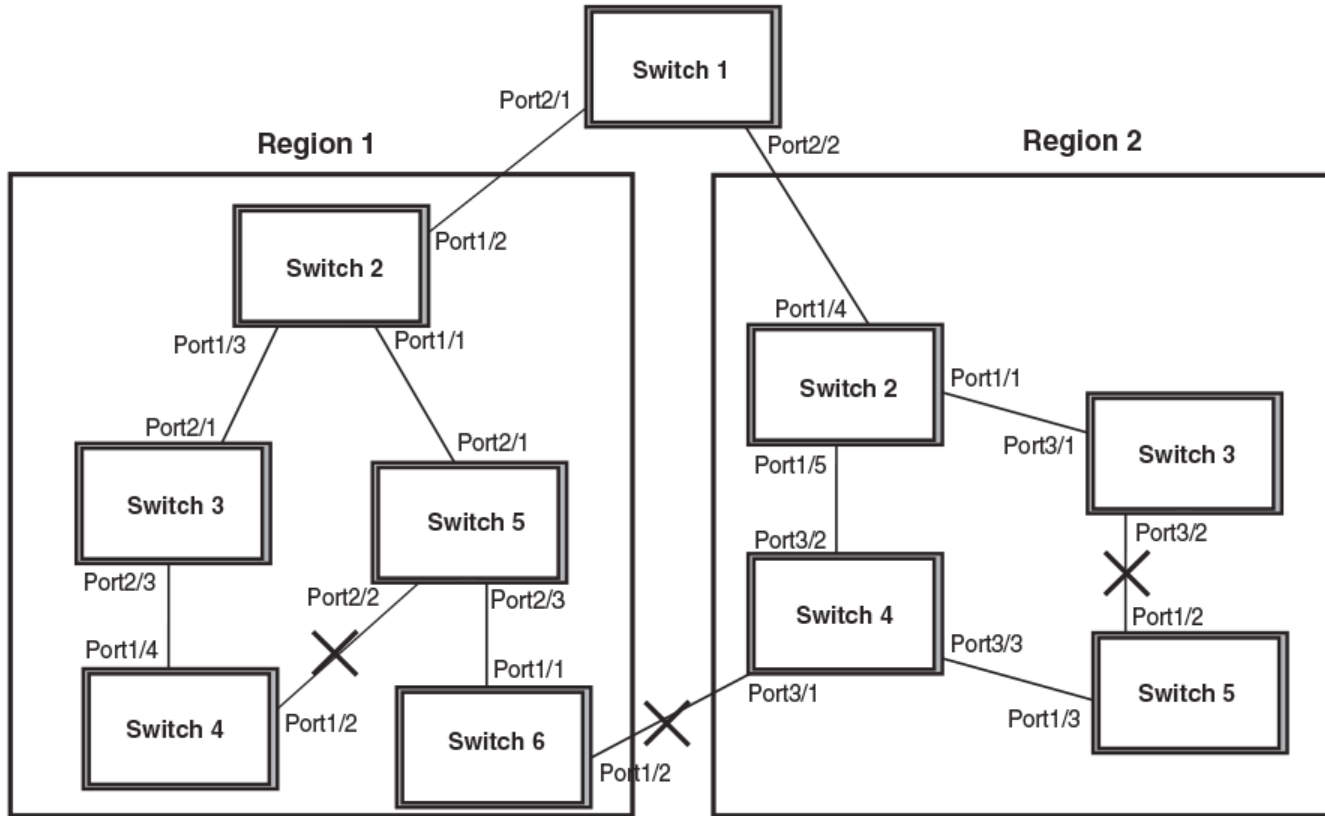
Multiple Spanning Tree (802.1s)

- IST = Internal Spanning Tree
 - Internal to the Region, that is
 - Within each MST region, the MSTP maintains multiple spanning-tree instances
 - Instance 0 is a special instance known as IST, which “extends” CST inside the MST region
 - MSTI instance 0 is always present if the switch is running MSTP
 - Presents the entire region as a single virtual bridge to the CST outside



Multiple Spanning Tree (802.1s)





Source: brocade.com L2 Switch configuration guide



Multiple Spanning Tree (802.1s)

- Design Guidelines
 - Determine relevant forwarding paths, and distribute your VLANs equally into instances matching these topologies
 - Assign different root and alternate root switches to each instance
 - Make sure all switches match region attributes
 - Do not assign VLANs to instance 0, as this is used by the IST



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Network Management

- Enable SNMP traps and/or syslog
 - Collect and process in centralized log server
 - Spanning Tree Changes
 - Duplex mismatches
 - Wiring problems
- Monitor configurations
 - Use RANCID or Oxidized to report any changes in the switch configuration



Network Management

- Collect forwarding tables with SNMP
 - Allows you to find a MAC address in your network quickly
 - You can use simple text files + grep, or a web tool with DB backend
- Enable LLDP (or CDP or similar)
 - Shows how switches are connected to each other and to other network devices



Documentation

- Document where your switches are located
 - Name switch after building name
 - E.g. building1-sw1
 - Keep files with physical location
 - Floor, closet number, etc.
- Document your edge port connections
 - Room number, jack number, server name



Questions?

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