

Root Controlled Bridging: A Scalable Control Protocol for Shortest Path Bridging

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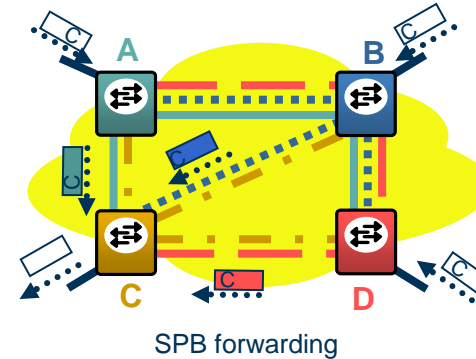
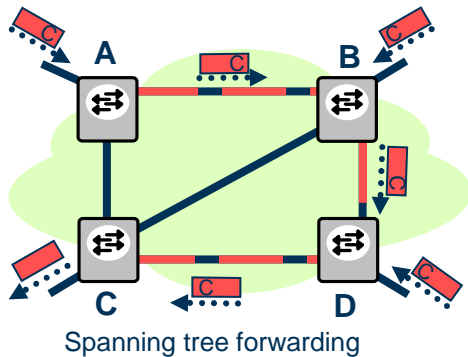
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Outline

- IEEE 802.1aq Shortest Path Bridging (SPB) basics
- Root Controlled Bridging (RCB)
- Performance Analysis
 - Convergence time
 - Control traffic load
- Summary

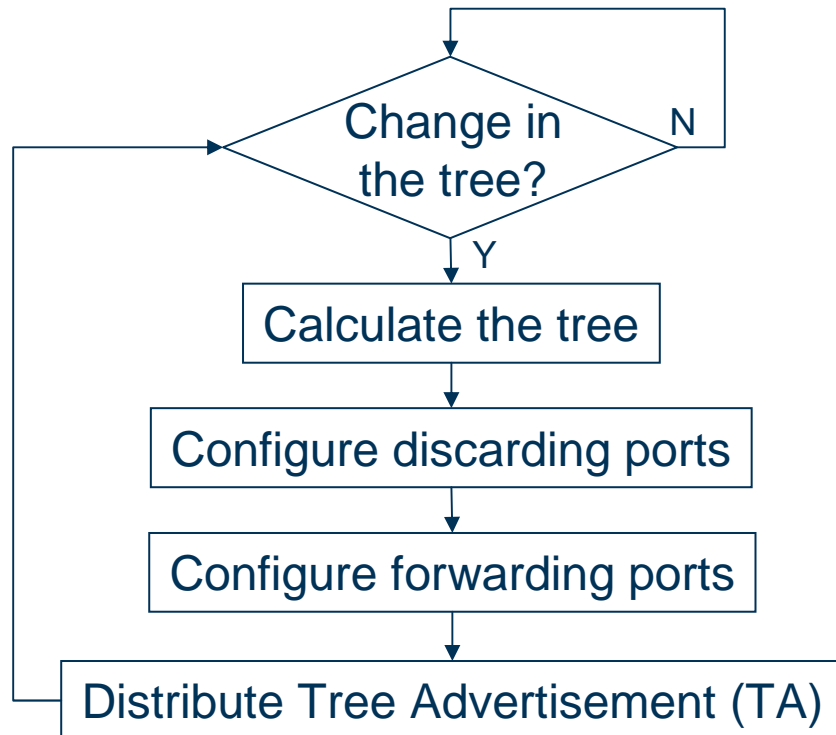
Shortest Path Bridging basics



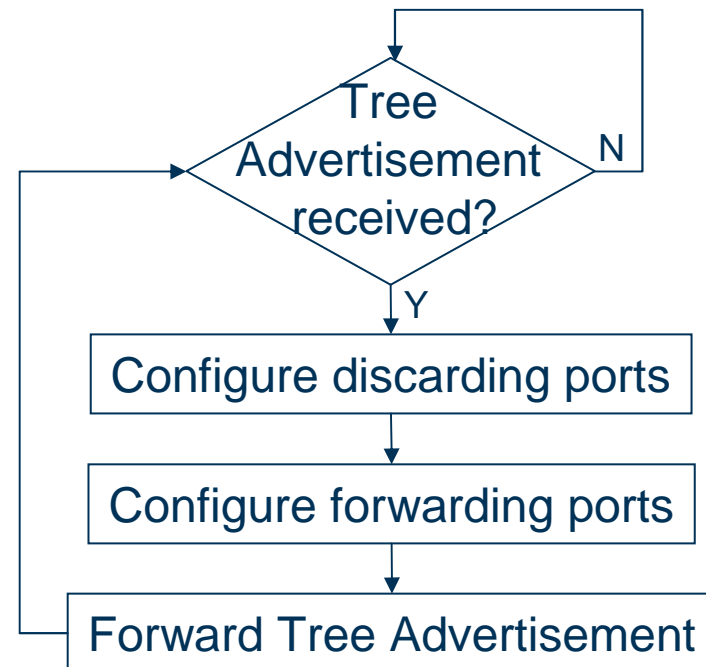
- IEEE 802.1aq Shortest Path Bridging
 - Each bridge only sends frames on its own Shortest Path Tree (SPT)
 - Frames are sent on the shortest path
 - Automatic SPT management: No additional configuration required
- IS-IS routing protocol establishes SPTs
 - MSTP convergence problems are eliminated
 - In-built auto-discovery
 - Topology
 - Addresses (Address learning is in control plane)

Root Controlled Bridging Extension to IS-IS

Root Bridge

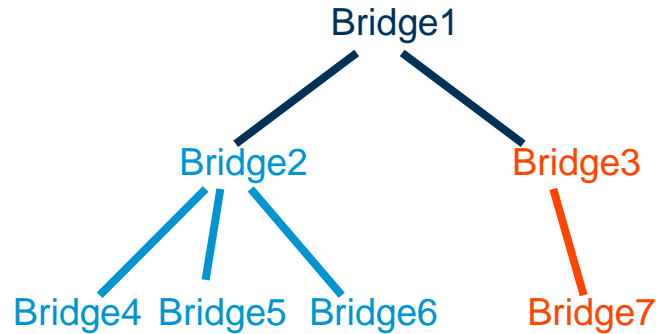


Non-Root Bridge



Tree Advertisement (TA)

Compressed tree description



Tree description for Bridge1:

Tree Advertisement TLV
Tree ID
Bridge1{Bridge2{Bridge4}{Bridge5}{Bridge6}}{Bridge3{Bridge7}}

Tree description for Bridge2:

Tree Advertisement TLV
Tree ID
Bridge2{Bridge4}{Bridge5}{Bridge6}

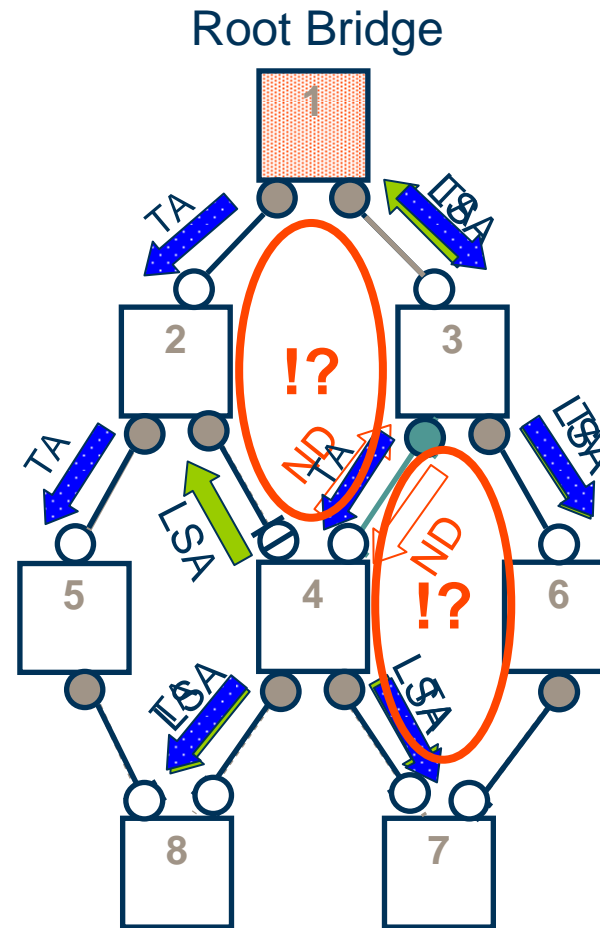
Tree description for Bridge3:

Tree Advertisement TLV
Tree ID
Bridge3{Bridge7}

- Compressed tree description
- Similar to preorder listing
- Appropriate subtree is only forwarded
- TA becomes simpler when forwarded towards the leaves

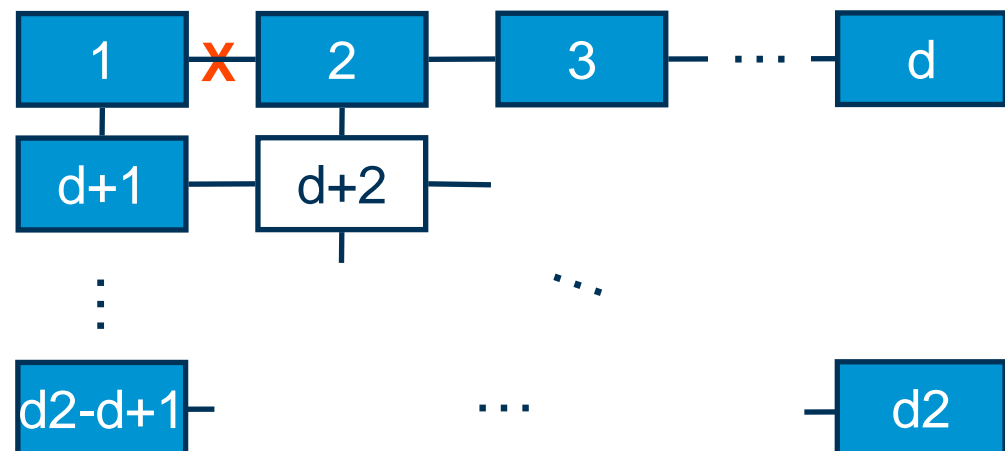
Root Controlled Bridging Properties

- Link-state fashion
 - Collection of neighbor information
 - Advertisement of neighborhood
- Bridges have identical map of physical topology
- Centralized configuration by Root Bridge
 - Tree calculation: Any TE method could be applied!
 - Root Bridge controls the configuration of its tree
- Controlled topology transients
 - Accidental loops are prevented



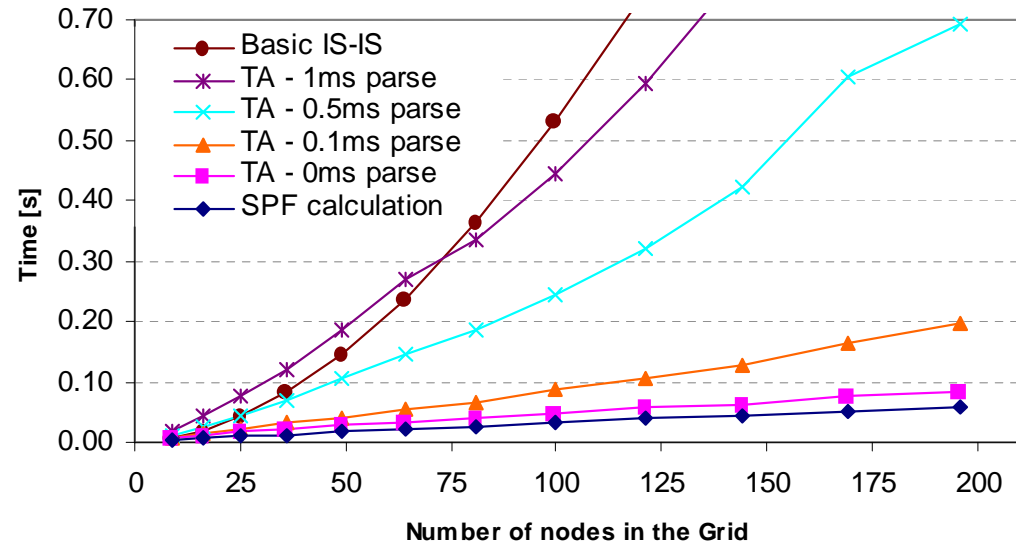
Performance analysis method

- Simulation
 - IS-IS implemented on bridge architecture (Basic IS-IS)
 - Root Controlled Bridging extensions are implemented
- Grid topology
 - Dimension: $d = 3, 4, 5 \dots 14$
 - $d \times d$ bridges (9, 16, 25...196)
 - Only **Edge Bridges** calculate Shortest Path Trees
- Transient
 - Link-down event between bridges 1 and 2
 - End: last change in any SPT



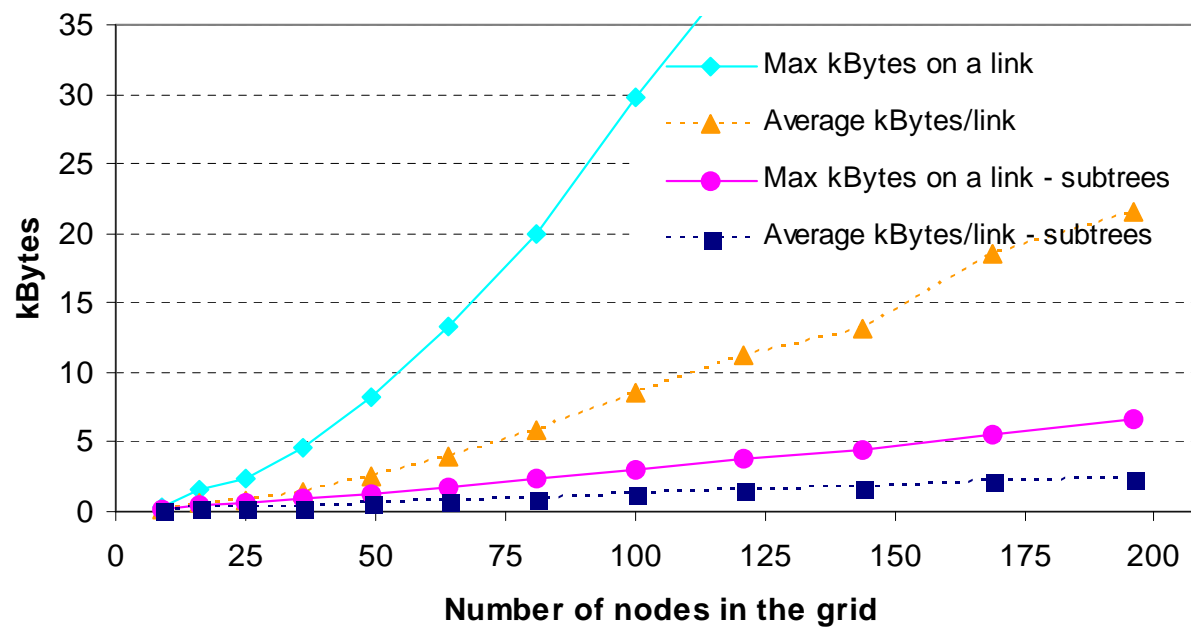
Control protocol convergence

- Computational complexity
 - Dijkstra: $O(n \log n)$
 - Basic IS-IS for SPB: $O(n^2 \log n)$
 - Root Controlled Bridging: $O(n \log n)$
- Convergence time
 - Root Controlled Bridging:
TA propagation is determined by message parsing time: 0-1ms



Control Traffic Load

- Worst-case is examined:
 - All trees are sent after a topology change
 - If the changed trees are only sent: 20% reduction
- Traffic load generated by RCB after a topology change



Summary

- Root Controlled Bridging:
Novel link-state control protocol for Shortest Path Bridging
- Provides loop free operation
- Reduces computational complexity
- Faster convergence than the Basic IS-IS approach
- Traffic load is negligible compared to link capacity

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