Shortest Path Bridging and Time Sensitive Networks

How can SPB assist real-time networks?

Rev. 1

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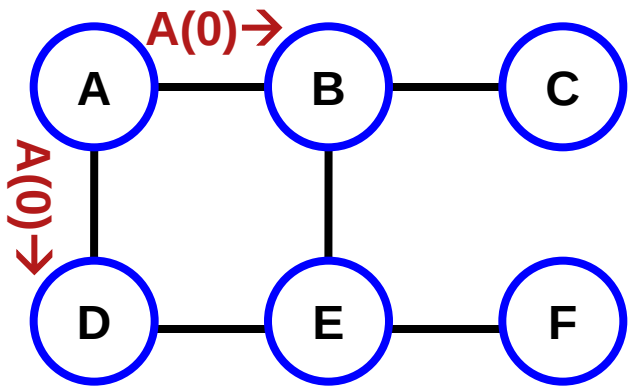
http://www.ieee802.org/1/files/public/docs2012/new-avb-nfinn-spb-tsn-0112-v01.pdf

Spanning Tree Protocol and Shortest Path Bridging basics

Global information delivered locally, versus local information delivered globally

Spanning Tree



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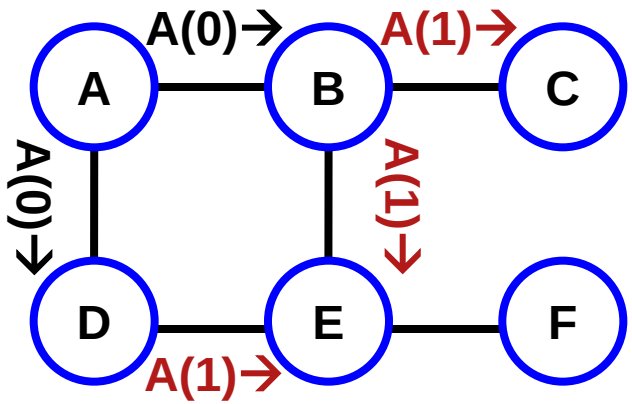
- **A** advertises "**I am** the root."

Spanning Tree



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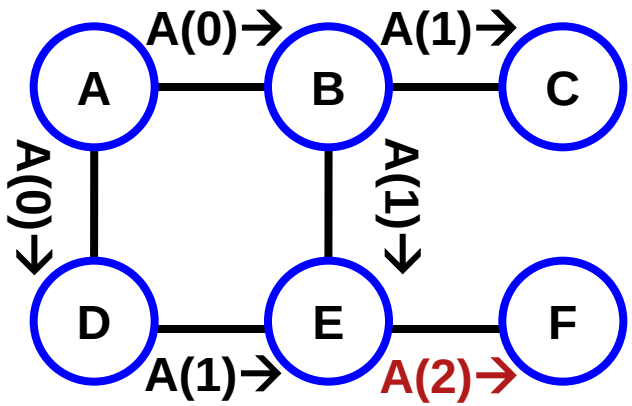

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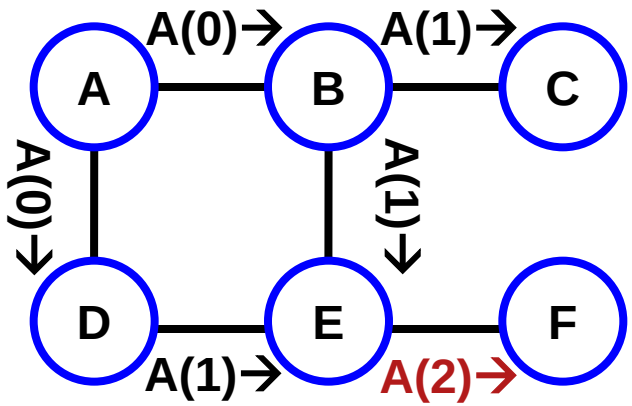

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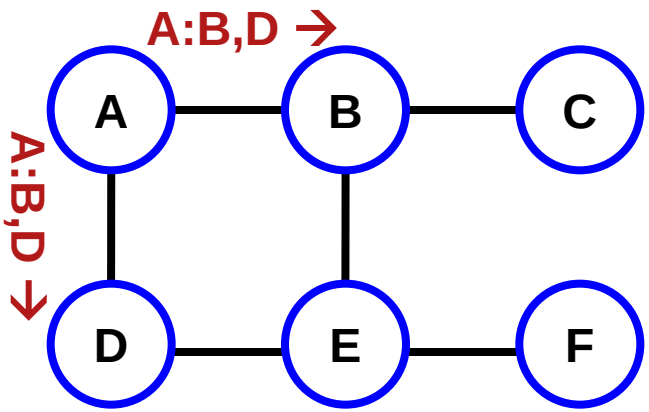
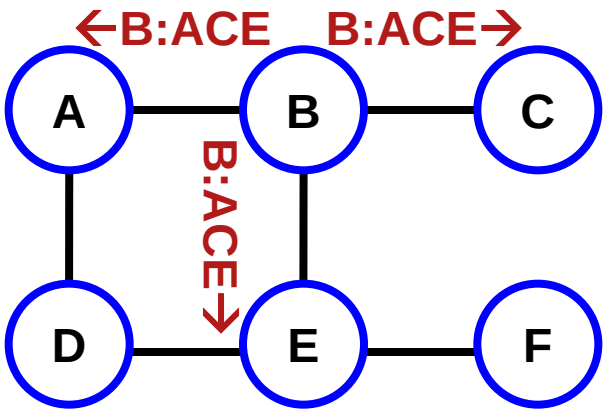
- **A** advertises “I am the root.”
- **B** and **D** advertise “I am one hop from the root.”
- **E** advertises “I am two hops from the root.”
- **F knows nothing of the path** to **A**; only the distance.

Shortest Path Bridging



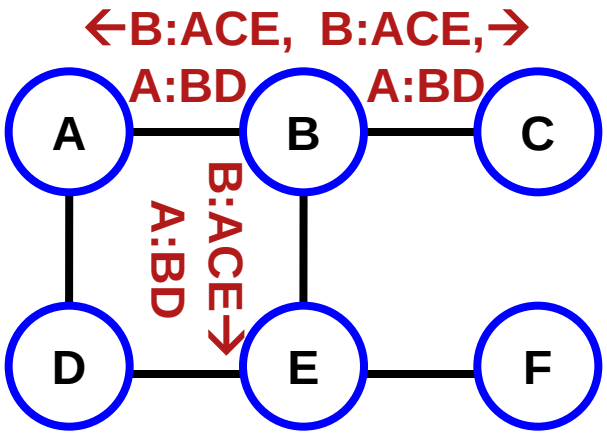
- **A** advertises, “I am **A**. I connect to **B** and **D**.”

Shortest Path Bridging



- **A** advertises, “I am **A**. I connect to **B** and **D**.”
- **B** advertises, “I am **B**. I connect to **A**, **C** and **E**.”

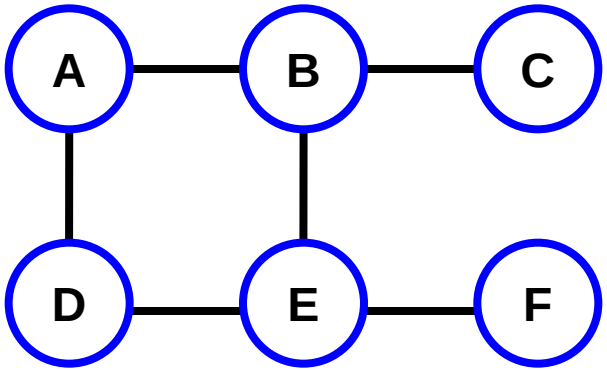
Shortest Path Bridging



- Furthermore, as soon as B hears A's advertisement, it relays A's information to its neighbors.
- That is, **B** says, "I am **B**. I connect to **A**, **C**, and **E**. **A** says that it connects to **B** and **D**."

Shortest Path Bridging

A:BD
B:ACE
C:B
D:AE
E:BDF
F:E



- Eventually, every switch in the network has the state of every other switch, and advertises all of that information to its neighbors.
- (Of course, there are tricks so that a huge volume of information is not constantly retransmitted.)

The difference: 1

- **Spanning Tree** uses **global information** (the distance across the network from a node to the root) **distributed locally** to the node's immediate neighbors.
- **Shortest Path Bridging** uses **local information** (a list of a nodes' immediate neighbors) **distributed globally** to every node in the network.

The difference: 2

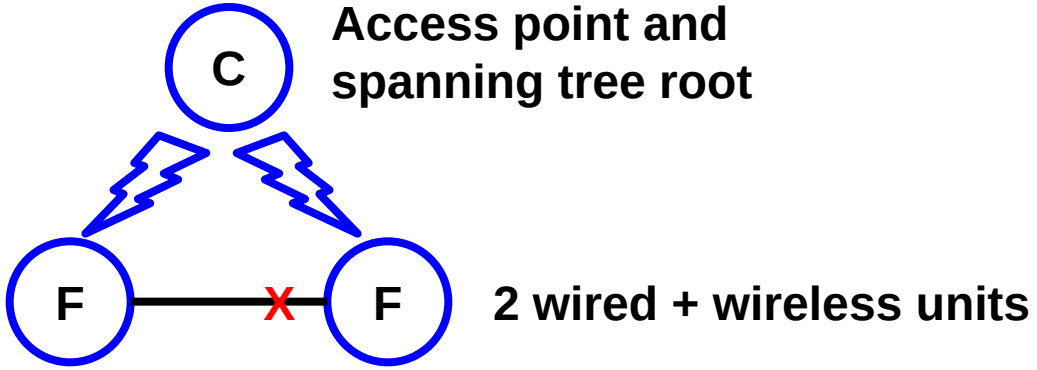
- For most topology changes in a mesh network, **Spanning Tree** converges very rapidly, because it has local access to global information. But in the **worst case**, that information is invalid, and **spanning tree takes a very long time** to converge.
- The time required by **Shortest Path Bridging** to converge after a topology change is usually not as fast as for spanning tree, because there is essential global information that is not transferred in each control packet. But the worst case is not much worse than the best case, and the **worst case for SPB is far faster than** the worst case for **Spanning Tree**.

The difference: 3

- From the information provided by **Spanning Tree**, a node in the network has **no knowledge of the topology of the network**, because that information is summarized into a distance to the root by each of its neighbors.
- From the information provided by **Shortest Path Bridging** **every node knows the topology of the whole network**, subject of course to propagation delays.

The difference: 4

- **Spanning Tree** is a **simpler** protocol and has smaller computational and memory requirements. But, it can route traffic along **inefficient paths**.
- **Shortest Path Bridging** is **more complex** and requires more memory and CPU cycles. But, it routes all traffic along the **shortest path**.



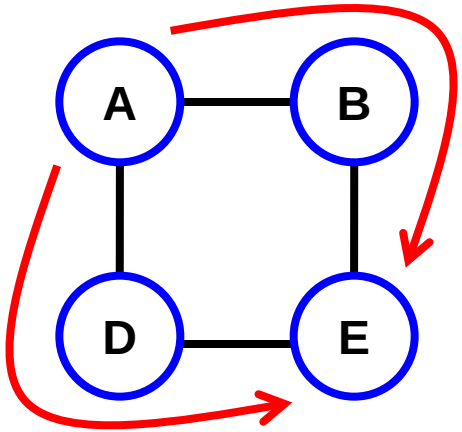
Spanning Tree blocks 10Gb/s link.
SPB uses the link.

Finding Alternate Paths

Enabling multiple simultaneous delivery using SPB

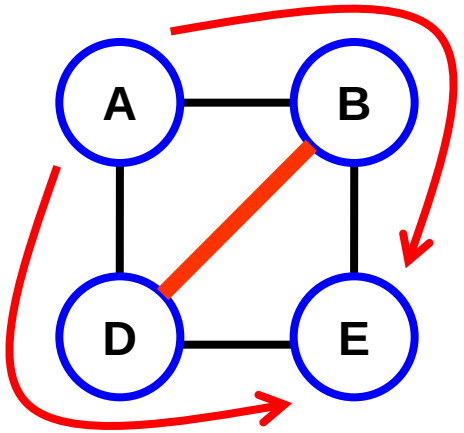
Multiple paths

- When human lives are at stake, it may be unacceptable for some data flows to wait even for SPB to reconverge after a link or node failure.
- For these flows, the more-or-less simultaneous delivery of a data stream along multiple separate paths can provide the greatest possible reliability.



Multiple paths

- Both Spanning Tree and Shortest Path Bridging **support** the **simultaneous delivery** of data along different paths, using separate VLANs for the different paths.
- However, **both algorithms** can **interrupt** the flow along **all paths** during a topology event, even if that event **does not lie** directly along any of the paths, in order to ensure absolutely against forwarding loops.



The addition of a new link can cause both flows to be interrupted briefly.

Multiple paths

- In 802.1Q-2011, both the Spanning Tree Protocol and Shortest Path Bridging can be configured to operate on disjoint subsets of the VLANs, leaving the other **VLANs controlled by neither protocol**.
- Thus, it would be possible, by some as yet unspecified means, to use one or more VLANs **not** under the control of either the STP or SPB to create multiple paths between particular nodes in a network.

  No topology event could cause STP or SPB to **disturb** the paths due to loop prevention.

  Misconfiguration of those paths could, however, **create a forwarding loop**, precisely because the paths are operating outside the algorithms' loop prevention control.

Finding multiple paths

Certainly, it would be possible to modify SRP to explore a network and find alternate paths. **On the other hand:**

- As experience with 802.5 Token Ring shows, O(*n*!) exploration algorithms are grossly inefficient.
- Having multiple Talkers repeat this exploration makes the situation even worse.
- There is a better, more properly structured, means for accomplishing the same goal.

Finding multiple paths

- If one is running Shortest Path Bridging for the Reserved Bandwidth and Best Effort traffic, one already has a complete map of the network.
- Using that map, it is relatively easy for a Talker to discover appropriate multiple paths.
- Once a path is identified, it is a trivial matter to construct a protocol that distributes that path choice to the other nodes in the network, or better yet, to **use IS-IS to distribute the choice**.
- Once the path is constructed, then if desired, SPB can be used to make a bandwidth reservation along the path, because SPB is not tied to the underlying topology protocol. (But see the next slide.)

Fast SRP

- There is no need to run a separate (very chatty) SRP after the topology has converged.
- A node could include all Talker advertisements, Listener registrations, and port configurations in its IS-IS advertisements.
- With every **edge** registration known to every switch, every switch can compute the paths, compute what flows can and cannot be accommodated, and configure its ports accordingly.
- When a topology change occurs, none of the above information need be redistributed by means of a protocol; recomputation is sufficient to reconfigure all of the switches.

Is Shortest Path Bridging “The Answer”?

Doing it all with SPB

We could …

- Use SPB to create an active topology for the VLAN(s) that carry all traffic that is not subject to multiple simultaneous delivery.
- Use the network map obtained from SPB to create alternate paths for multiple simultaneous delivery.
- Use SPB to distribute the SRP registrations, the alternate path choices, and the SRP registrations for alternate paths.
- Recompute the information that is now passed with SRP after a topology event without any SRP PDU exchanges.

The question

- **Are the advantages of SPB worth the added complexity?**