>THIS IS **THE WAY**

B-VLAN Protection 802.1ah Networks

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>THIS IS **NORTEL**

Problem

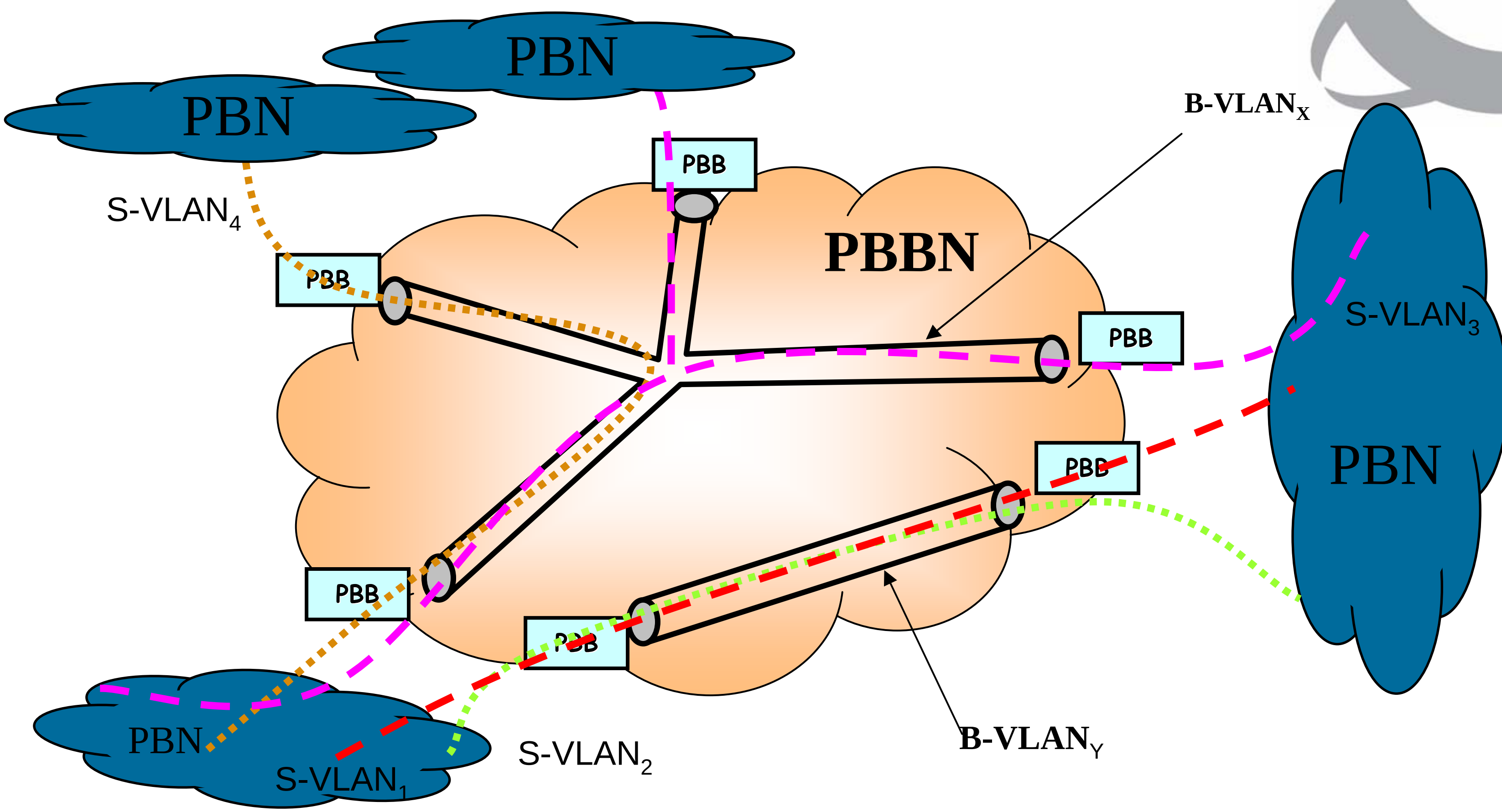
> Many carrier environments require very rapid recovery from network failures to maintain SLAs
  - Sub-50 millisecond restoration is the typical carrier standard
  - Some environments are demanding restoration times as short as 20 milliseconds

> Carriers must be able to constantly monitor there network recovery paths to assure they are functioning

> Carriers must be able to support QoS on recovery paths with known bandwidth and performance characteristics

> Carriers can not afford to protect and monitor each service independently, instead they need to monitor trunks and switch entire bundles of services around failures

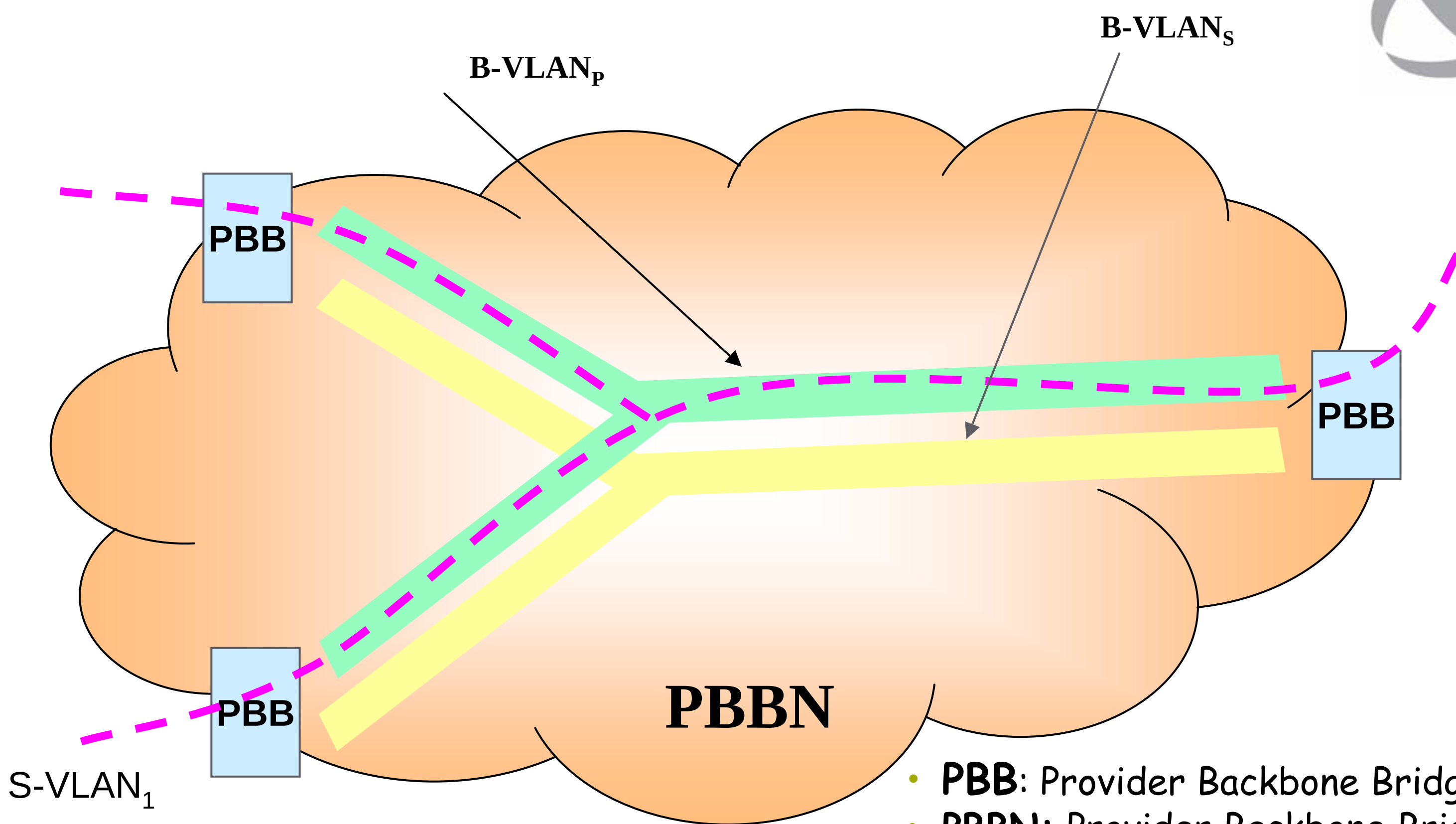
Basic PBBN Network



- **PBB**: Provider Backbone Bridge Edge

- Each B-VLAN carries many S-VLANs
- S-VLANs may be carried on a subset of a B-VLAN (i.e. all P-P S-VLANs could be carried on a single MP B-VLAN providing connection to all end points.

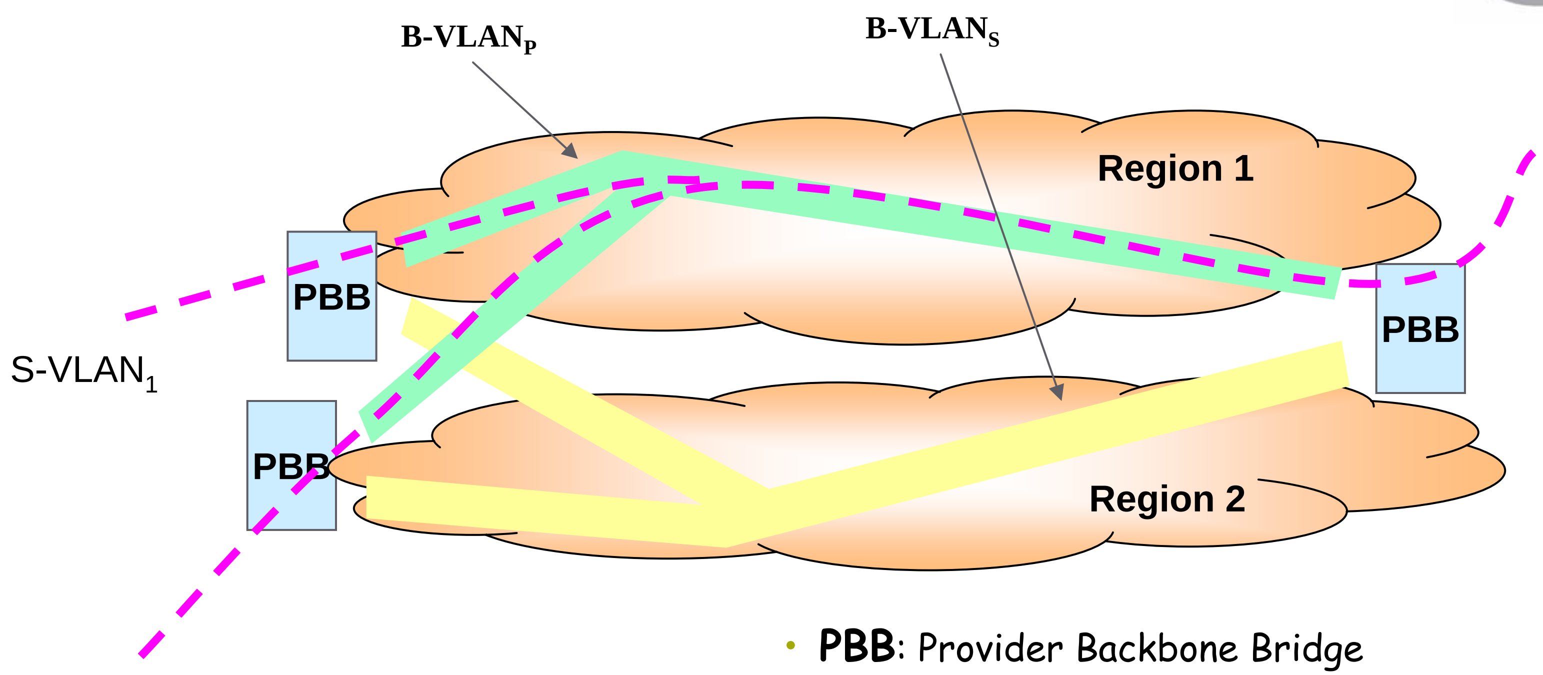
Primary and Secondary B-VLANs



- **PBB**: Provider Backbone Bridge
- **PBBN**: Provider Backbone Bridge Network

- B-VLAN$_P$ is the working B-VLAN while B-VLAN$_S$ is the protection B-VLAN
- The primary and secondary B-VLANs are normal B-VLANs with different B-VIDs
- The PBB B-Shim determines the mapping of S-VLANs into the Primary and Secondary B-VLAN

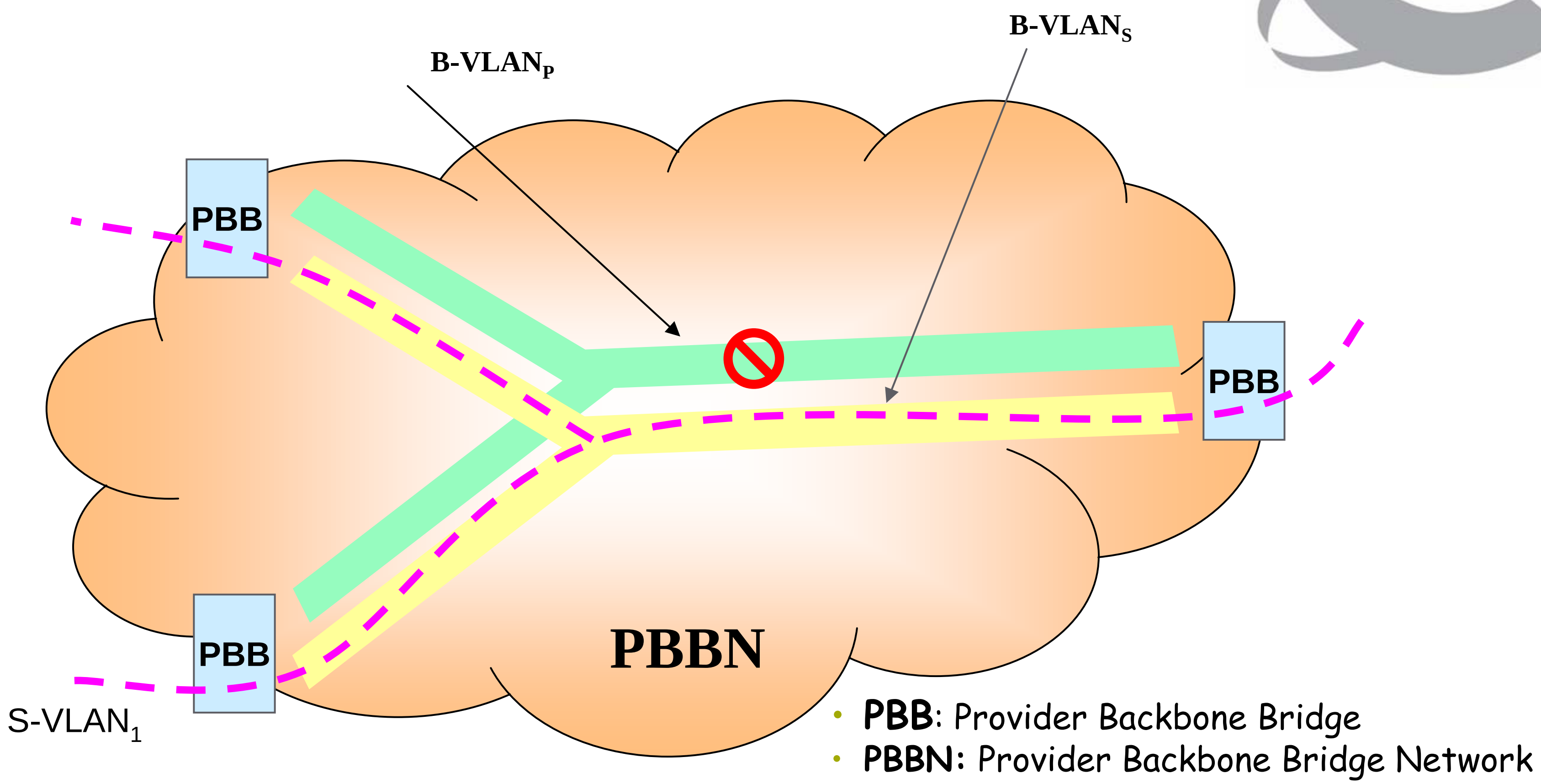
Primary and Secondary in Different MSTP Regions



- **PBB**: Provider Backbone Bridge
- **PBBN**: Provider Backbone Bridge Network

- Both the primary and secondary B-VLANs are completely configured
- The protection B-VLAN is a hot standby which may replace the primary immediately on failure detection
- Protection B-VLANs may be 1:1 and n:1

On A Failure All Services Move B-VLANs



- B-VLAN$_S$ becomes the working B-VLAN while B-VLAN$_P$ is failed
- All services are moved to protection B-VLAN

P802.1ag (CFM) Detects B-VLAN Faults

> CFM CC messages are run constantly on both the working and protection B-VLAN

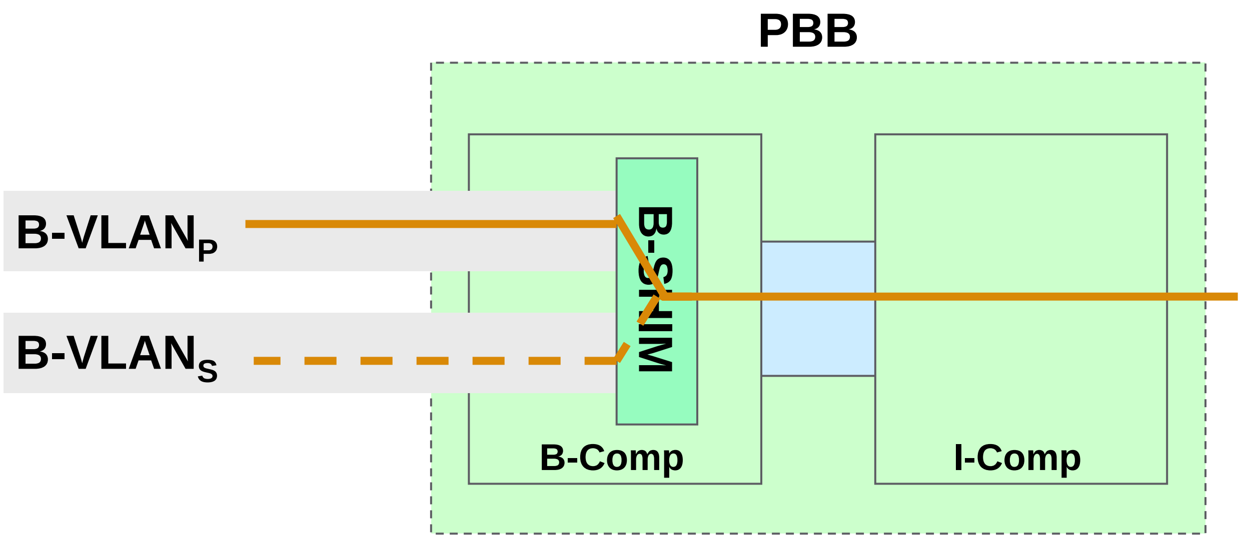
> Failures are detected through CC timeout, AIS detection, or manual intervention

> When a failure is detected the B-Shim moves the services to the protection B-VLAN
  - If the protection B-VLAN is failed the B-Shim protection switching is inhibited.

> Once receivers see traffic on the protection B-VLAN they must discard the old working path traffic to prevent mis-ordering
  - This may result in some loss during the protection switch

> Before the failed B-VLAN is reactivated the NMS must inform all the PBBs involved that the primary is available.
  - Prevents protection switching oscillations

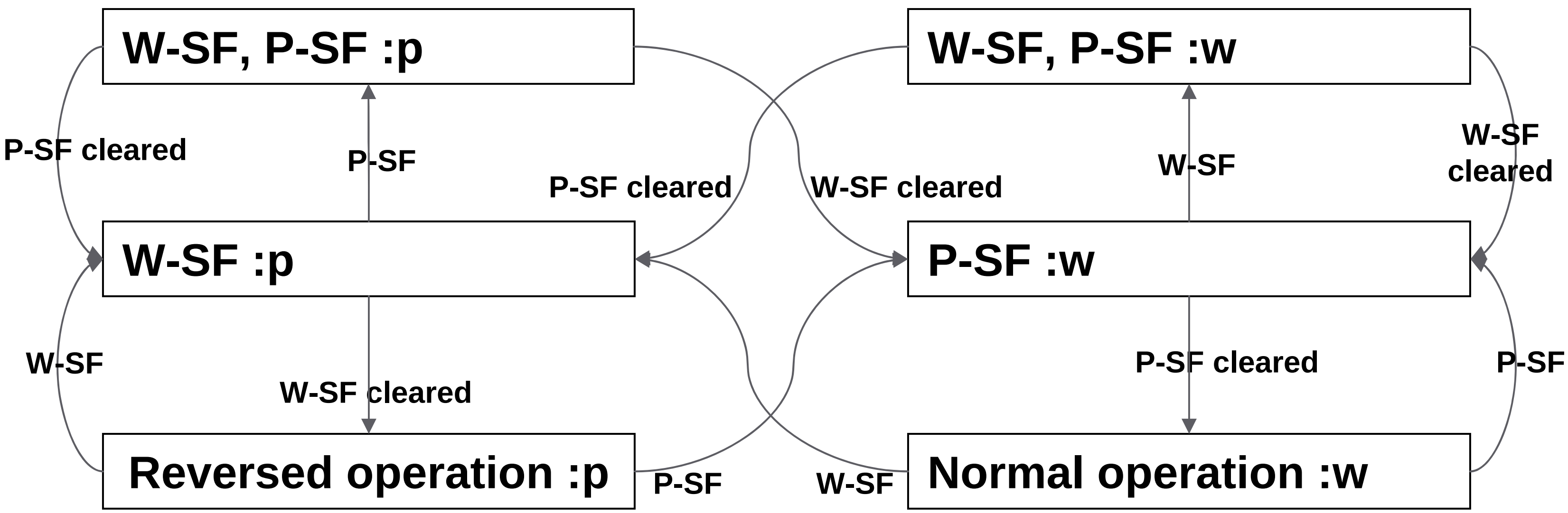
B-Shim Performs Switch



Provisioned B-Shim

I-SID	B-VID$_P$	B-VID$_S$
0x010090	0x0c0	0x0c1
0x070707	0x007	0x008
	⋮	
0x808080	0x0c0	0x0c1

B-Shim Protection State Machine



> W-SF state is primary B-VLAN signal fail

> P-SF state is secondary B-VLAN signal fail

> :p state is running on secondary :w state is running on primary

Summary

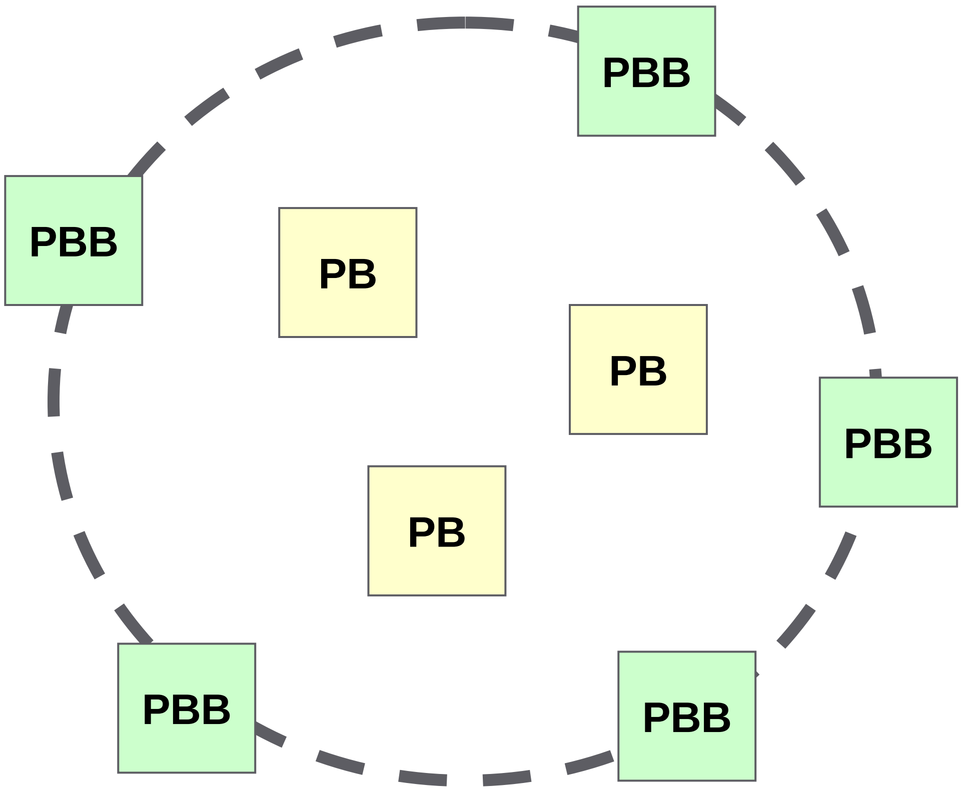
> B-VLAN protection may be implemented at the B-Shim to provide rapid protection switching between a primary and secondary B-VLAN

> Failure detection relies on CFM (802.1ag) to determine failures in B-VLANs

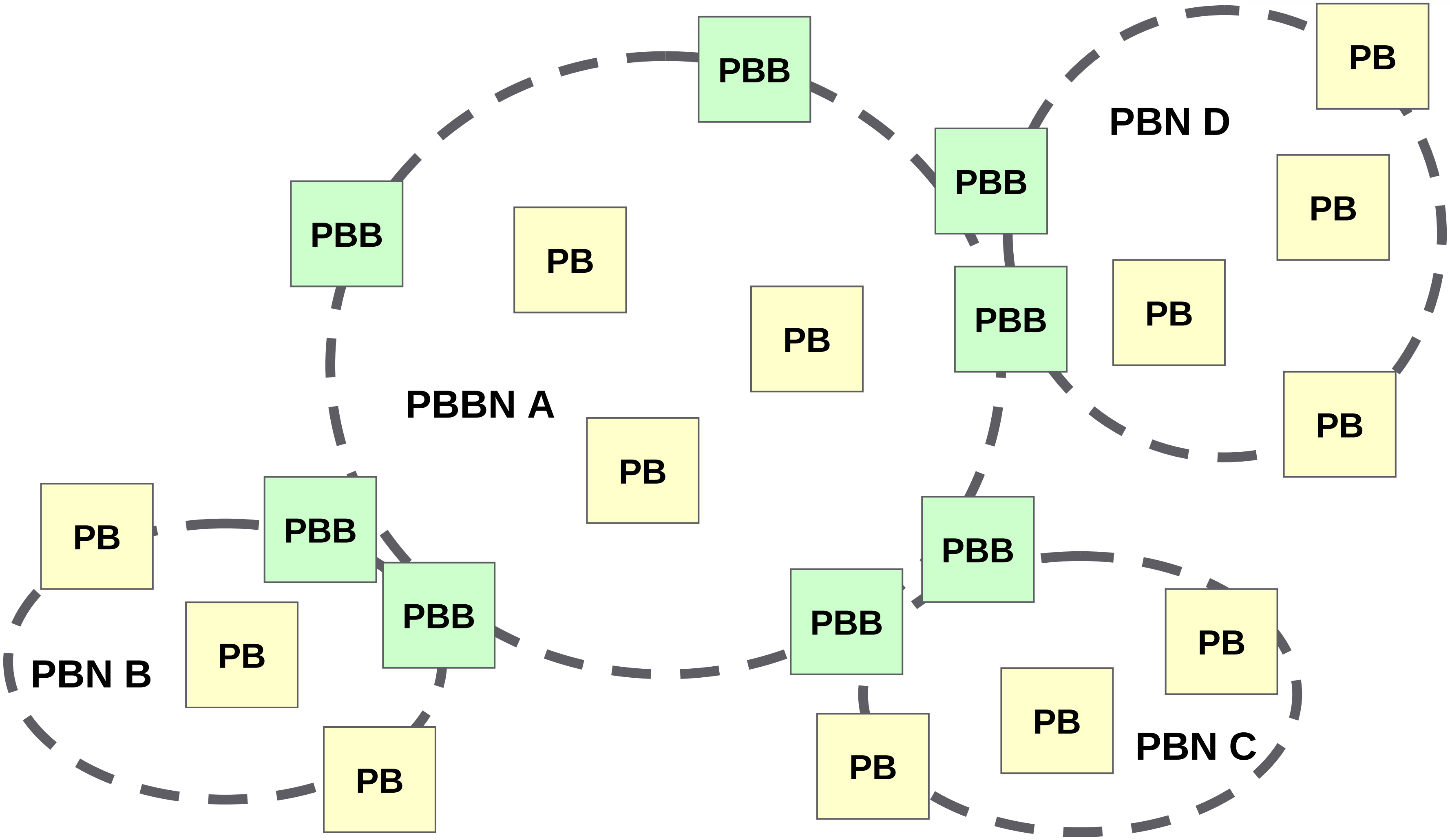
> Switching my be 1:1 or 1:n and revertive or non-revertive

Backup Slides

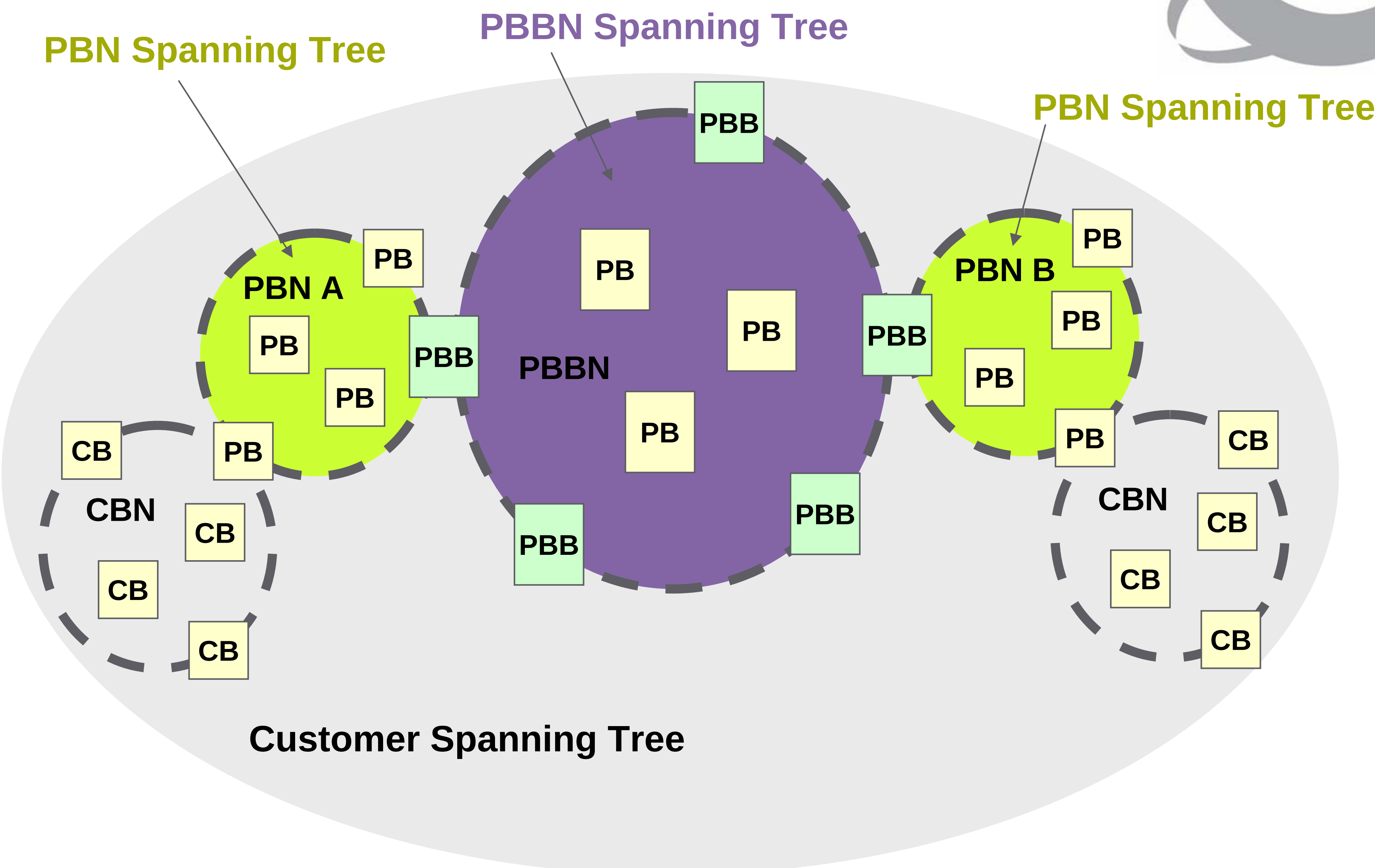
Single 802.1ah Network



Combined 802.1ad and 802.1ah Network



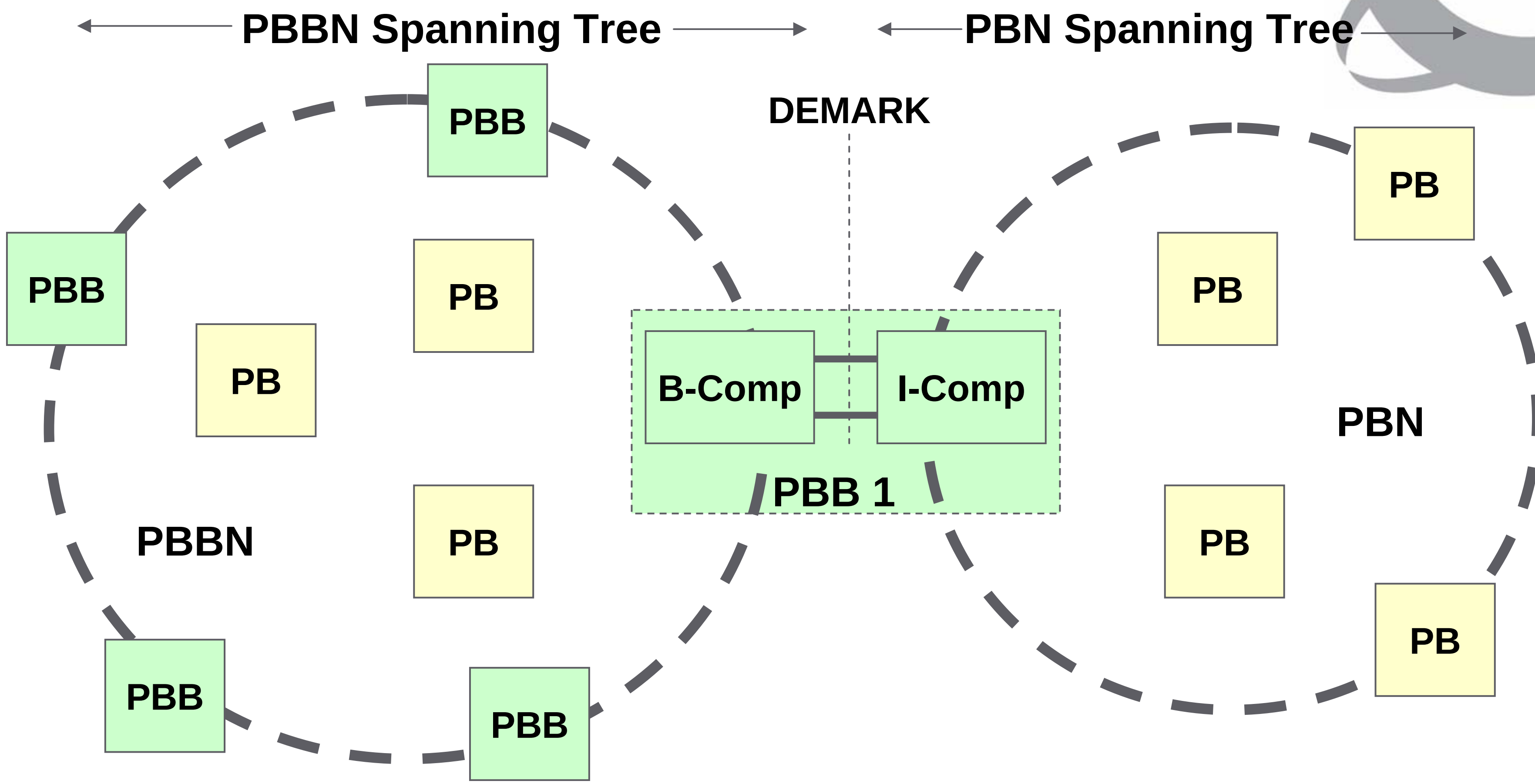
PBN and PBBN Spanning Trees



Topology Assumptions

1. Each PBN and PBBN prevents forwarding loops by running an independent spanning tree
2. Each PBNs connects to other PBNs only through a PBBN
3. Each PBN ensures that no data frames pass through more than one PBB attachment into or out of the PBN.
4. Each PBN ensures that it attaches any given S-VLAN to no more than one PBBN.

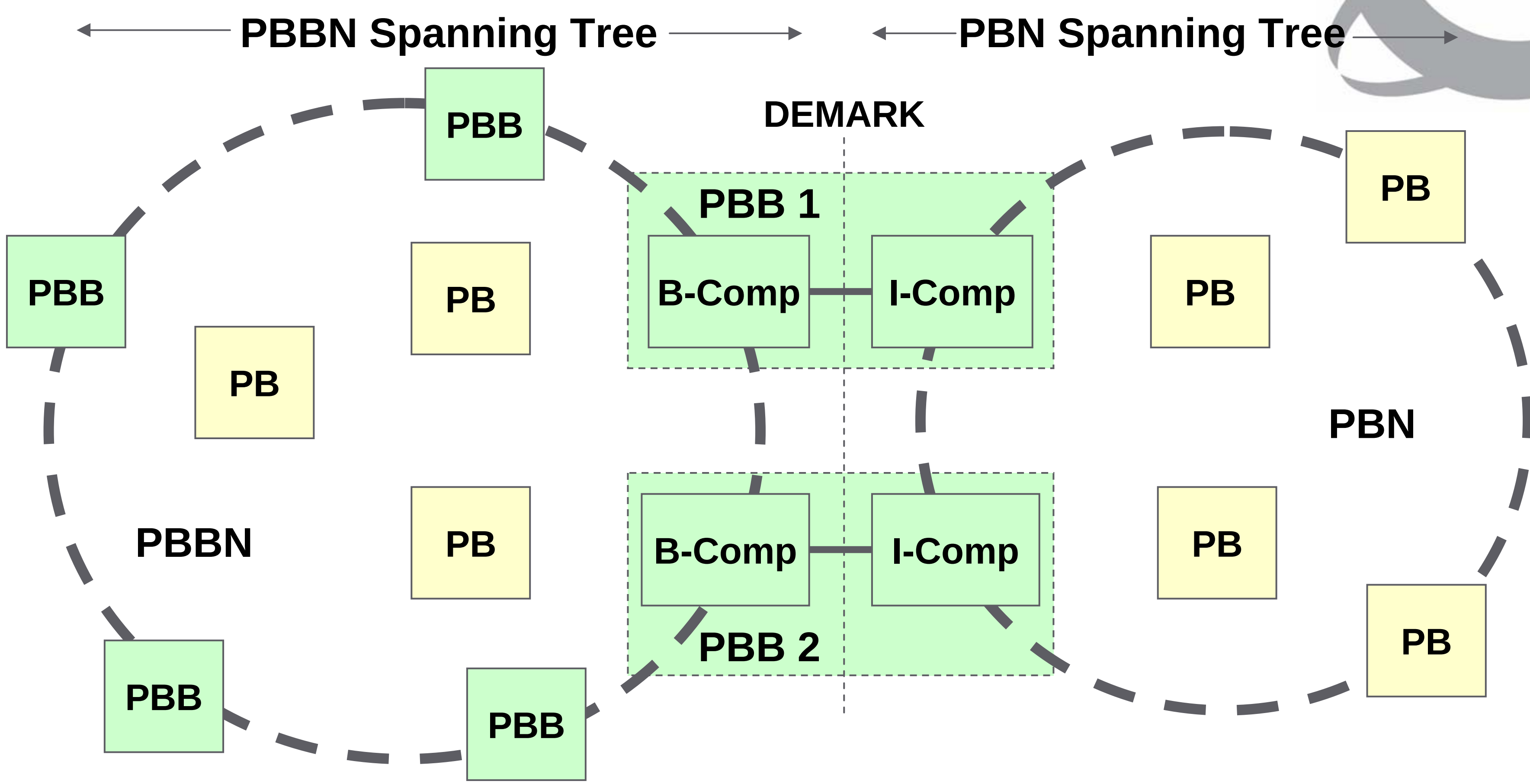
PBB Redundant Interconnect: Class 1



> PBB B-Components participate in the PBBN topology

> PBB I-Components participate in the PBN topology

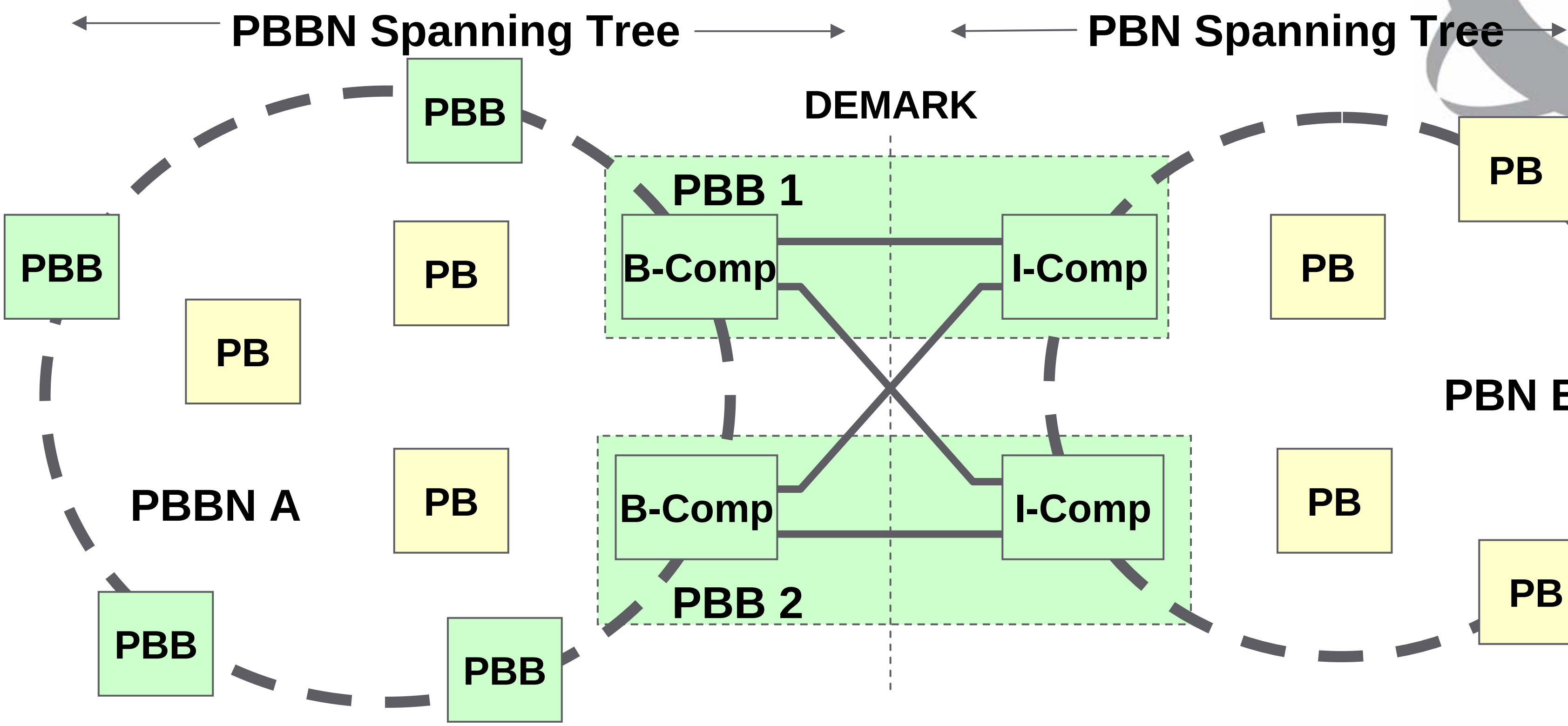
PBB Redundant Interconnect: Class 2



> Redundant PBBs allow recovery from both node and link failures

> Multiple links may be used between B-Comp and I-Comp

PBB Redundant Interconnect: Class 3



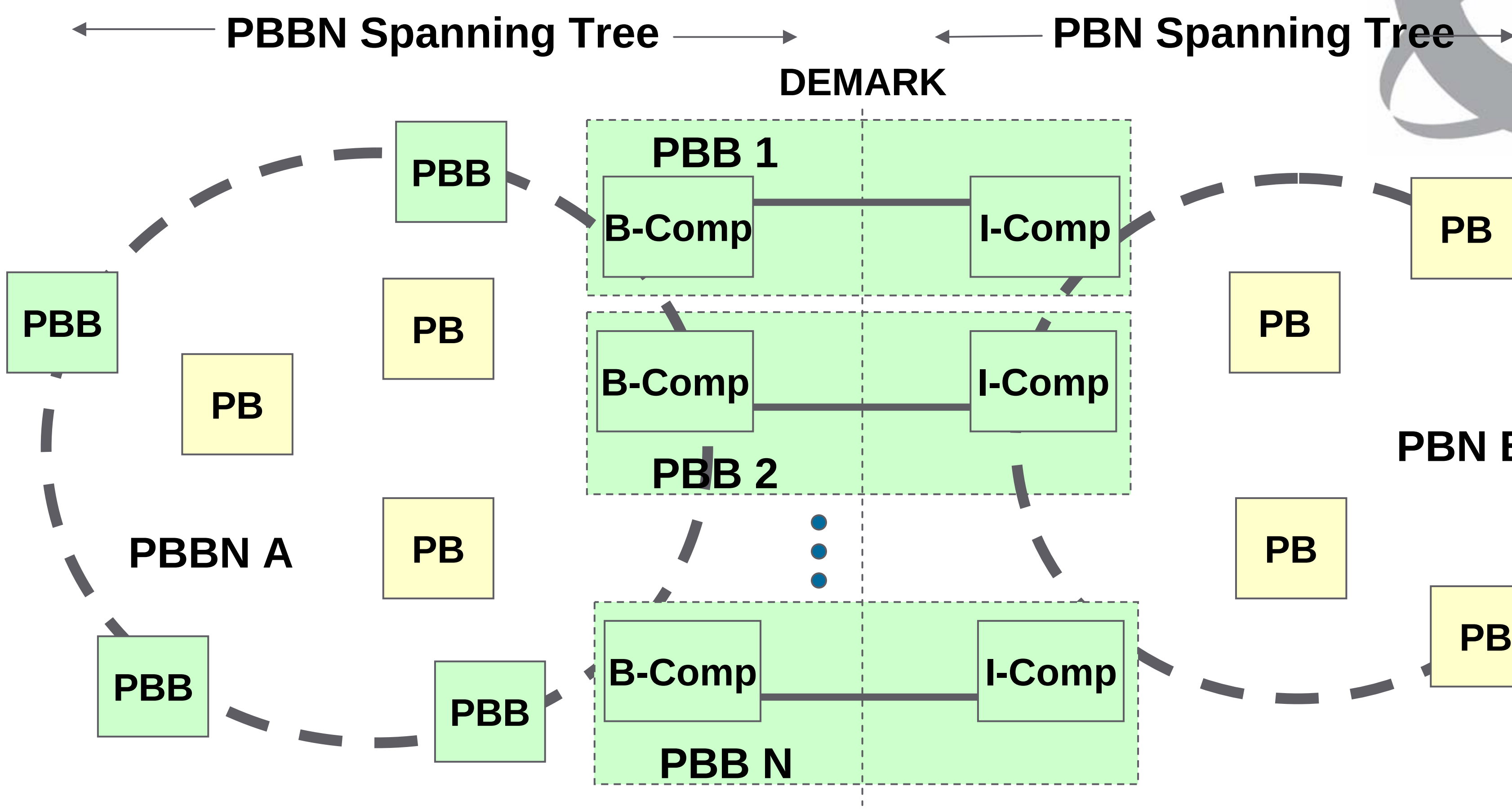
> Cross connection of PBB1 & PBB2 allows alternate paths through B-Comp or I-Comp

> Advantage is faults in PBBN or PBN may be isolated from affecting the state of the network on the other side of the redundant interconnect

> Disadvantage is the requirement for additional links between PBB1 and PBB2

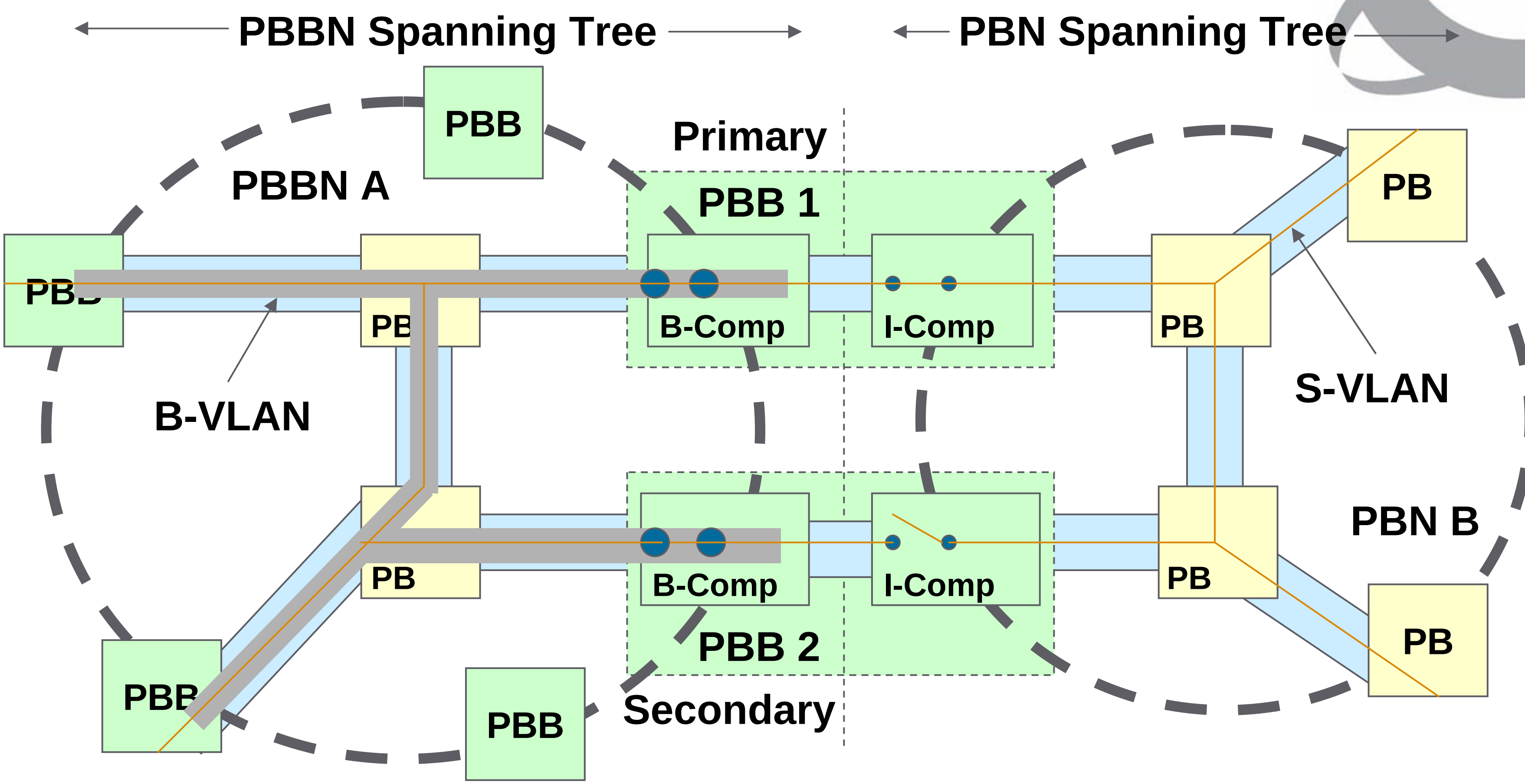
> Must implement option 1 as a subset since failure of a complete PBB will still require state changes within the network on the other side of the interconnect

Generalized Class 2



- Both class 2 & 3 may have N redundant PBBs
- Class 2 is a building block for class 3
- This presentation will focus on class 2

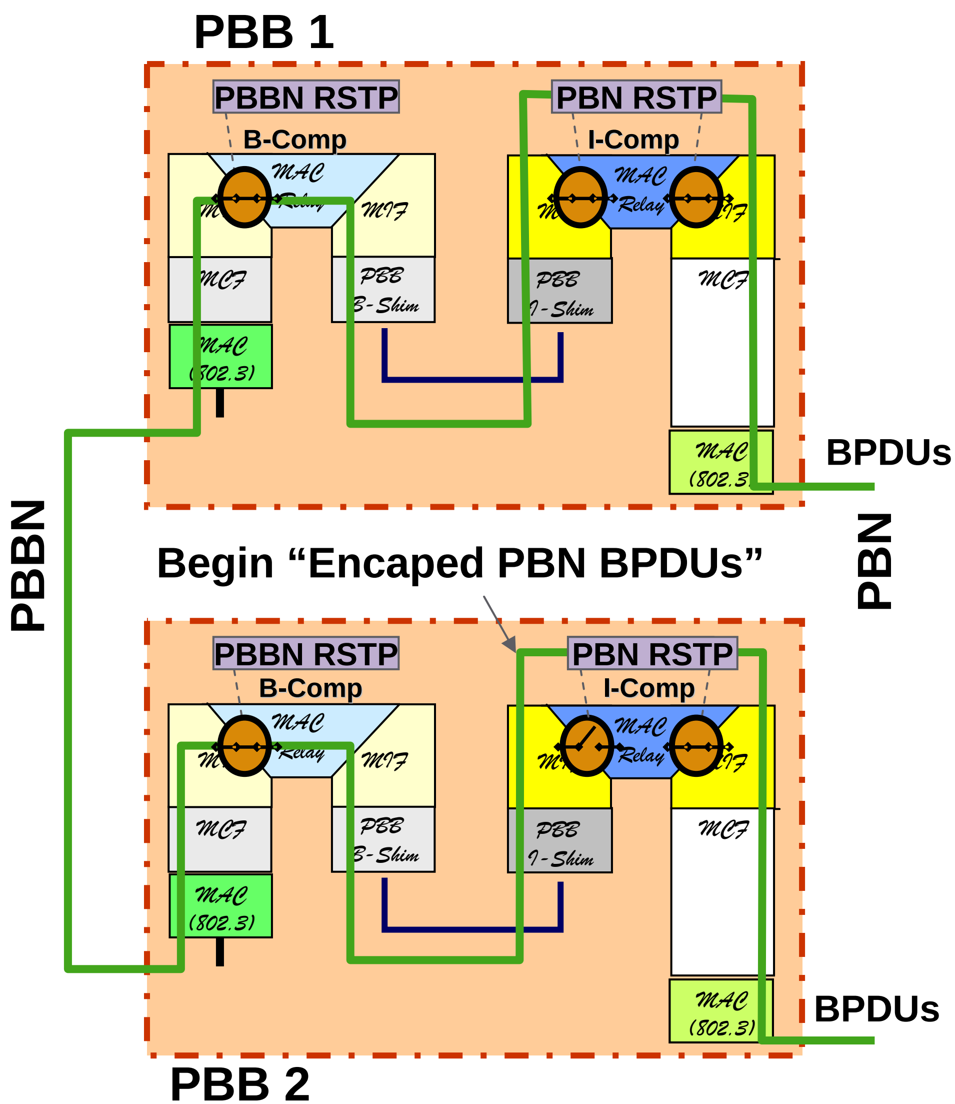
PBB Redundant Interconnect Blocking



> PBBN forwarding may be blocked at the B-Comp

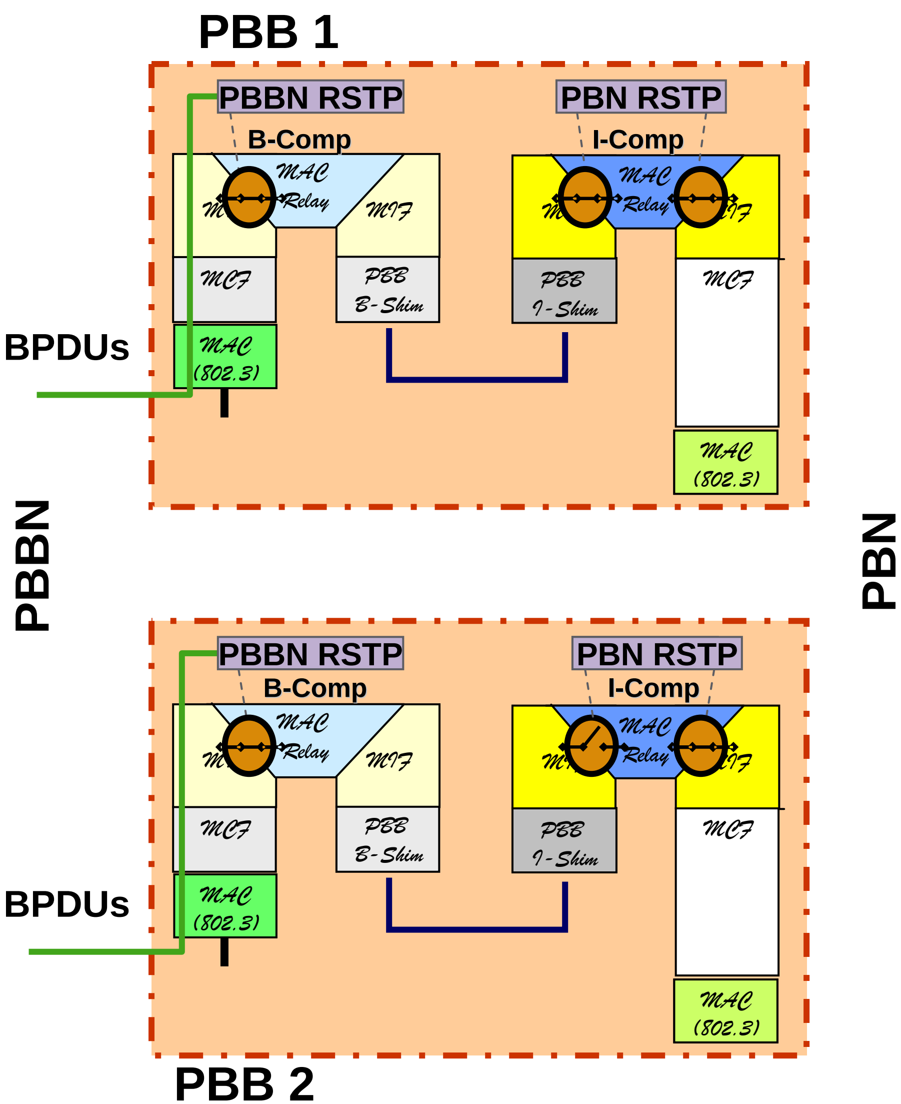
> PBN forwarding may be blocked at the I-Comp

Spanning Tree Handling: Option 1



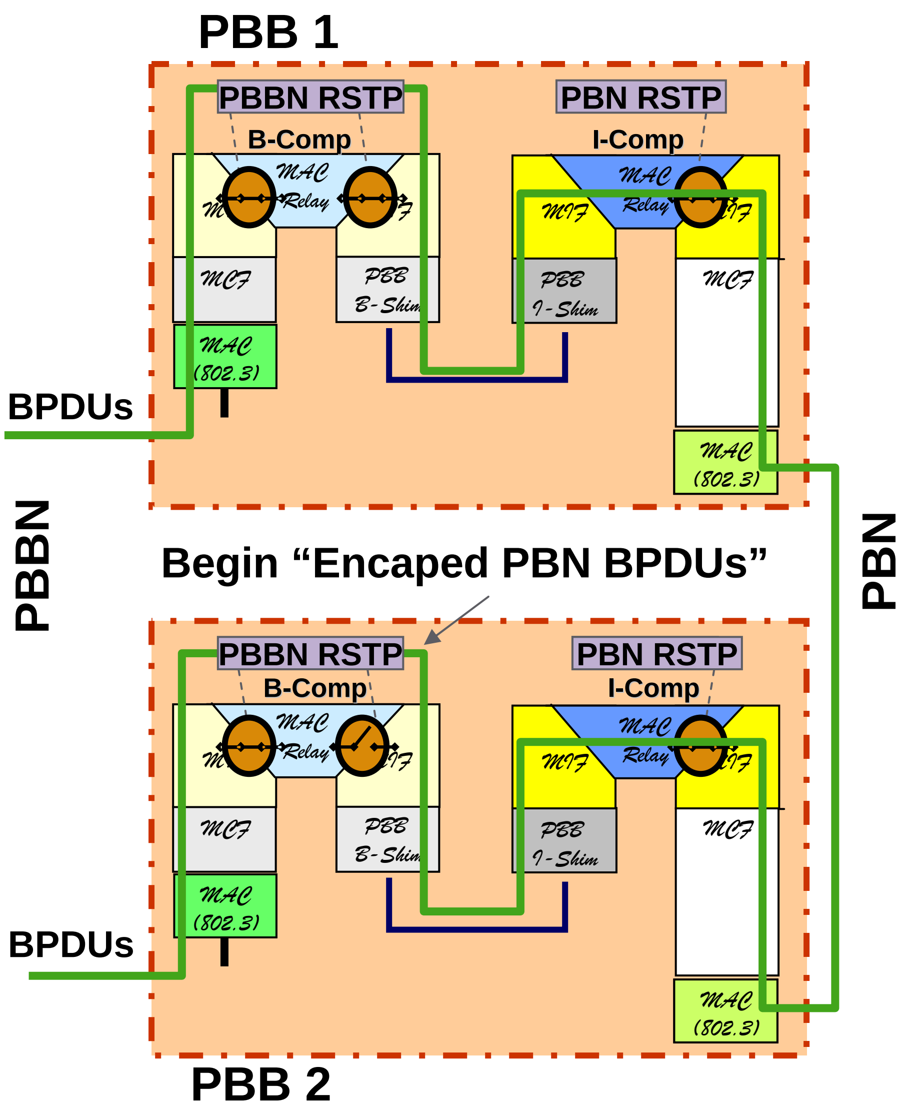
1. All PBN S-VLANs are provisioned through the I-Component of both PBB 1 and PBB 2
2. I-Components of PBBs participate in PBN RSTP protocol
3. B-Components of PBBs DO NOT participate in PBN RSTP protocol
4. PBN BPDUs from inward I-Comp port are forwarded between PBB 1 and PBB 2 I-Comps via a "Encapsuled PBN BPDUs"
5. The encapsuled PBN BPDUs are is passed over the PBBN
6. Each PBN has a dedicated BPDU S-VLAN which only connect the PBBs attaching to the PBN
7. PBN RSTP resolves loops within PBN network elements

Spanning Tree Handling: Option 1



7. B-Component elements of PBB participate in PBBN xSTP protocol
8. PBB B-VLAN is routed by PBBN RSTP to the B-Component of PBB 1 and PBB 2 respectively
9. PBBN RSTP control frames not forwarded to corresponding PBB I-Component (i.e., blocked by B-shim)
10. PBBN RSTP resolves loop within PBBN network elements treating the B-Shim as an end station port

Spanning Tree Handling: Option 2



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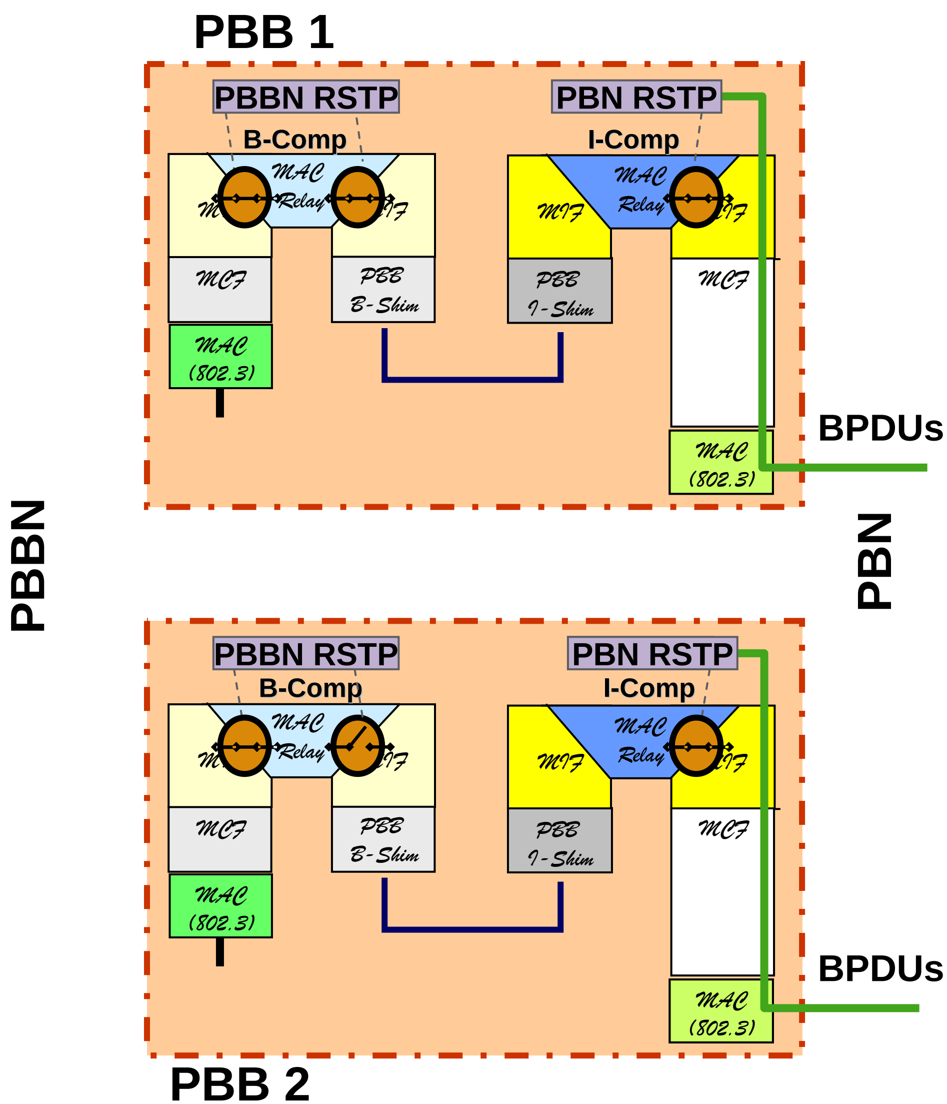

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10. PBN RSTP resolves loops within PBN network elements treating the I-Shim as an end station port

Encapsuled BPDUs

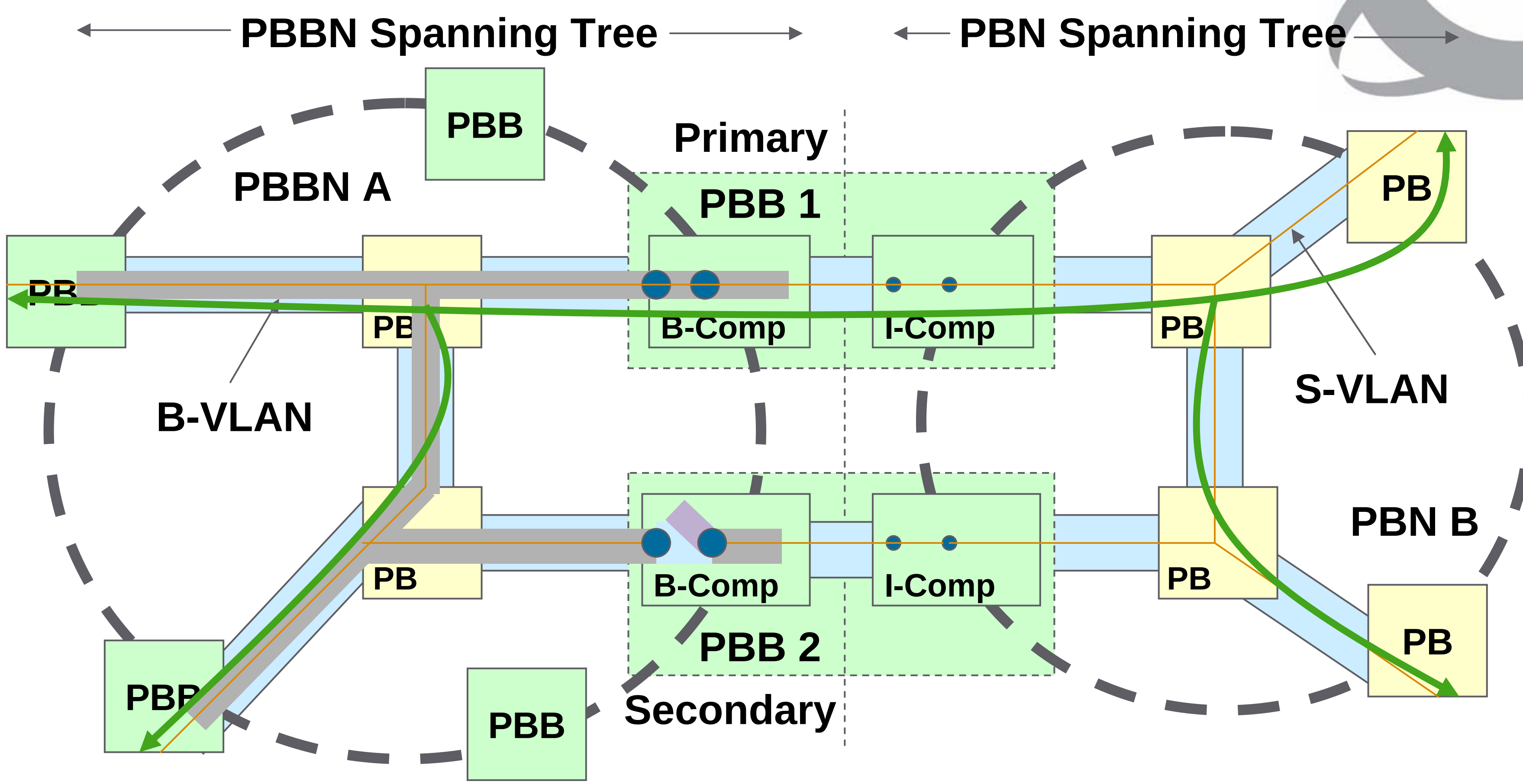
> Encapsuled BPDUs use a well known multicast which is NOT in the reserved address for bridges.

> The Encapsuled BPDU should include some management information designating the global name of the PBBN and PBN connected by the PBBs

> When sending Encapsuled BPDUs to the PBN the BPDUs either need to have a private S-VLAN between the PBBs or should be filtered at the edge of the PBN.

> When sending Encapsuled BPDUs to the PBBN the BDPUs needs to have a private S-VLAN between the PBBs or needs information which allows the PBBs to filter frames for their group.

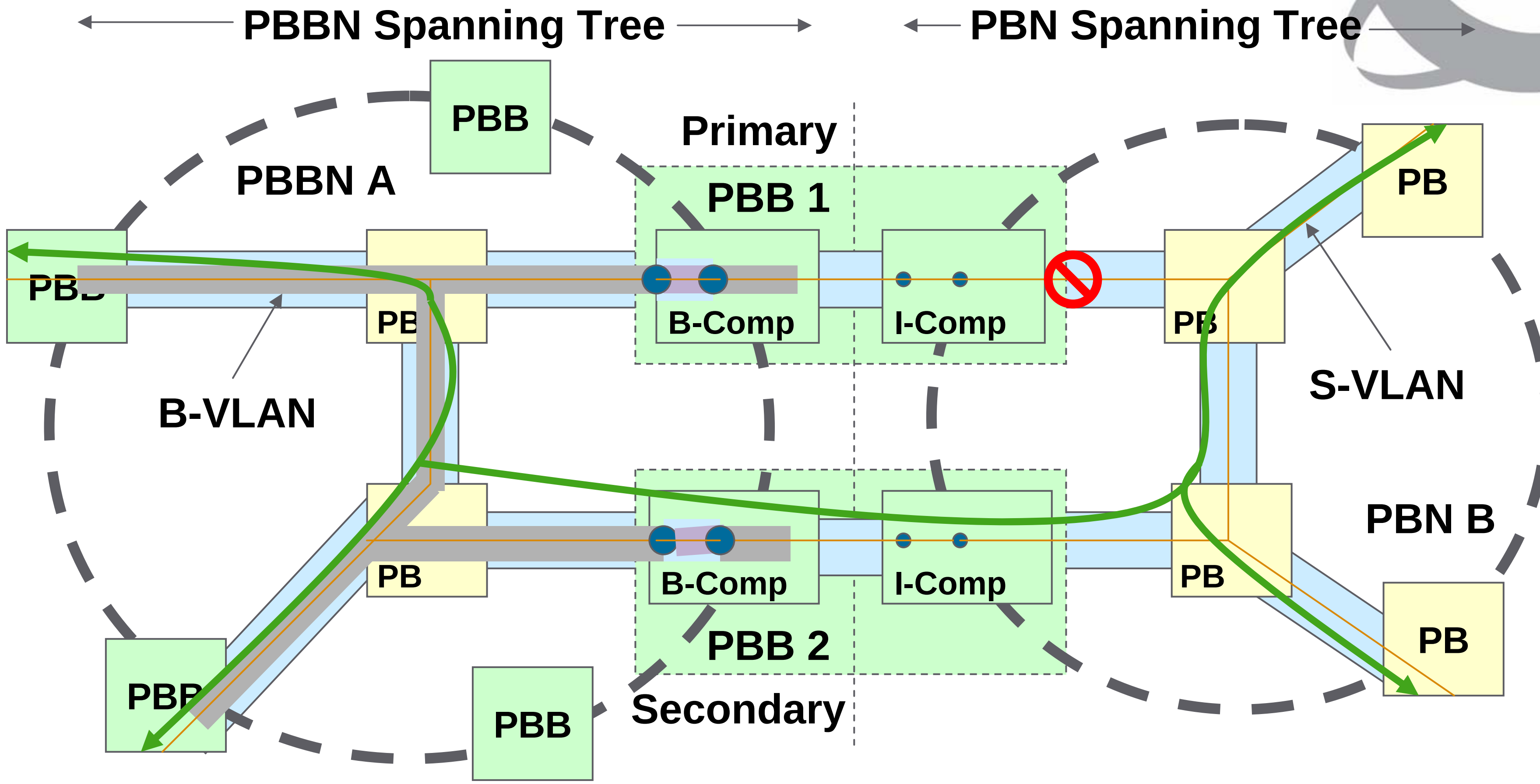
PBB Interconnect: Normal



> PBB 1 B-Comp has been selected as the designated bridge for the PBBN loop through PBN forwarding mode

> The PBBN loop is set to very high cost to prevent spanning tree forwarding through PBBN loop

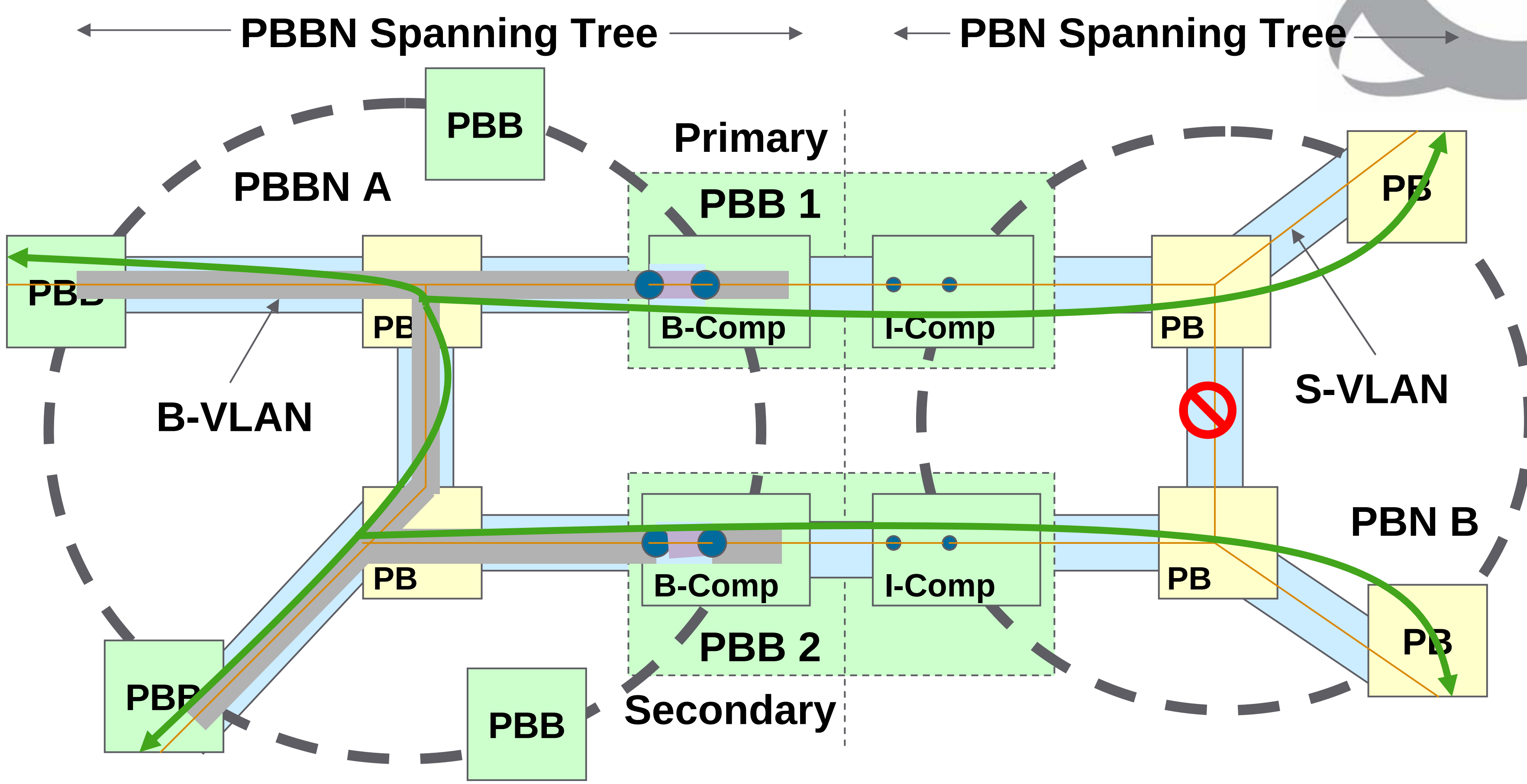
PBB Interconnect: Simple Fault



> PBB 1 B-Comp looses connectivity to PBB 2 through PBN

> PBB 2 Stops seeing the connection to PBB 1 and therefore becomes the designated bridge for the PBN loop

PBB: Segmentation Fault

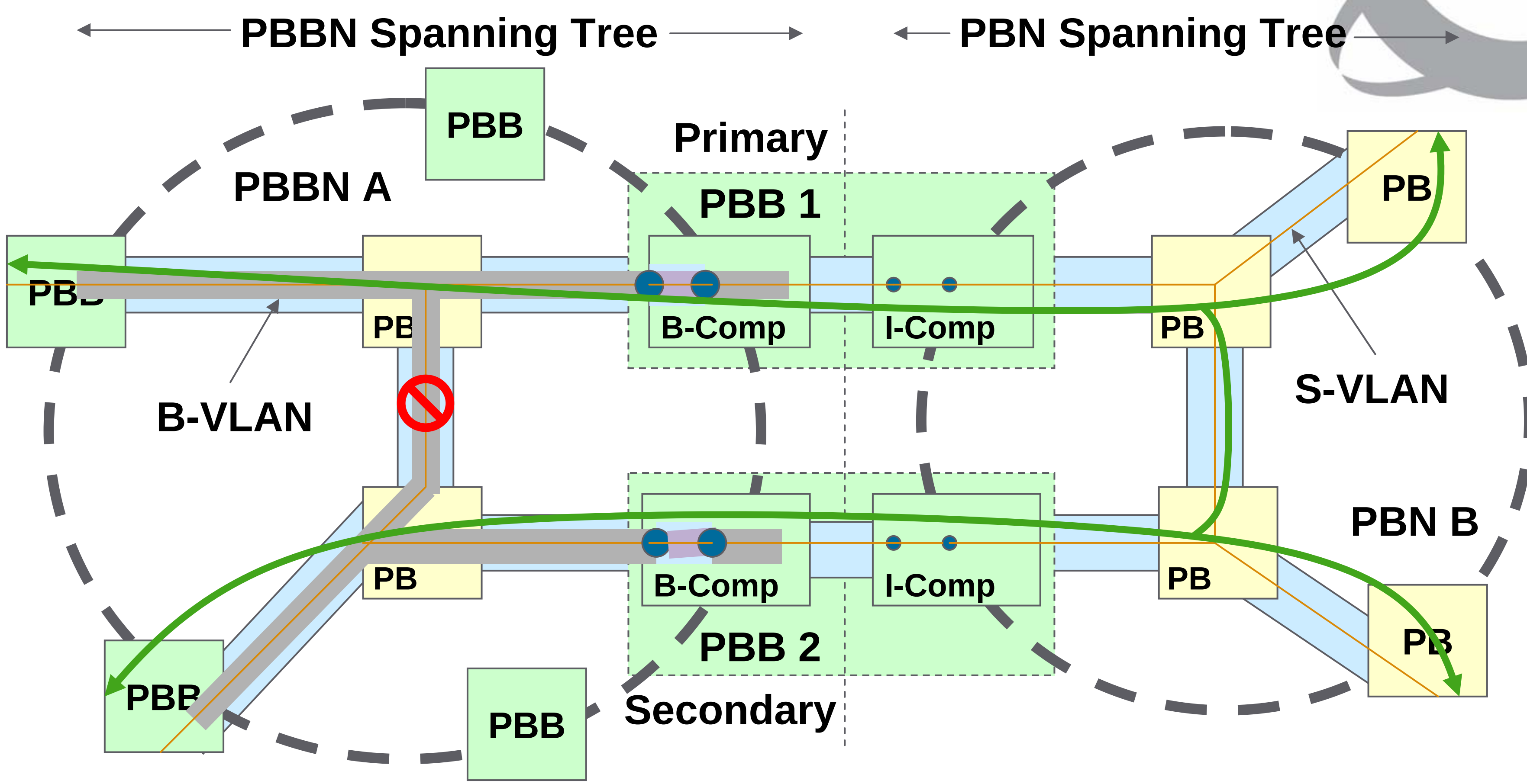


> PBB 1 B-Comp looses connectivity to PBB 2 through PBN

> PBB 2 looses connection to PBB 1 and therefore designates a port facing the PBN loop

> PBN is segment and is reconnected through PBBN

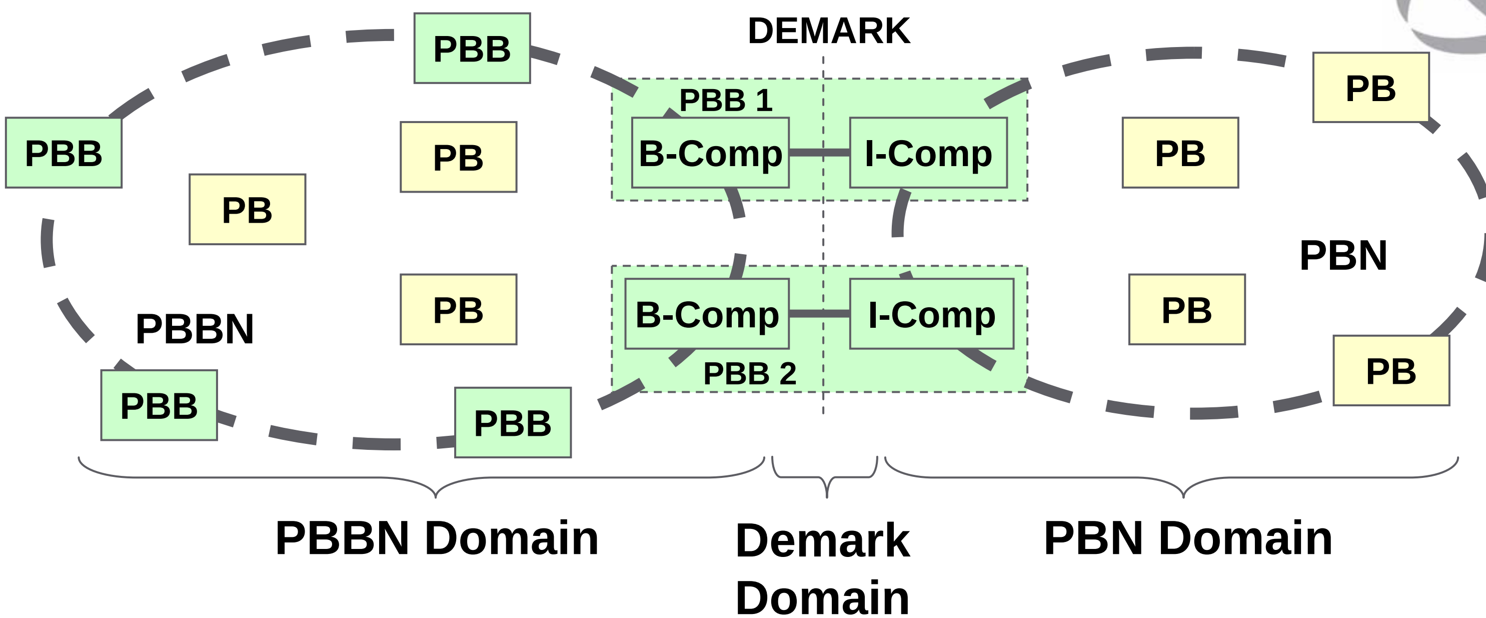
PBB: Segmentation Fault 2



> PBB 1 B-Comp looses connectivity to PBB 2 through PBBN

> PBB 2 goes to fowarding frames destine for PBB1 over PBN which is the only remaining path

802.1ag Based Fault Detection



- Maintenance Domains operating over default VLAN cover call switches in PBBN and PBN
- Add PBB TLV to CC messages to allow discovery of all PBBs and the networks they connect
- Propagate connectivity data by CC
- Propagate error data by AIS

Recommendations

> Add mechanism for redundant interconnect to 802.1ah draft

> Method added should be for Class 2 redundant interconnect

> The spanning tree extension method should be specified

> Future work should inspect 802.1ag protection switching methods