



>THIS IS **THE WAY**

## IEEE 802.1ah Update

Paul Bottorff, Editor 802.1ah  
November 15, 2005

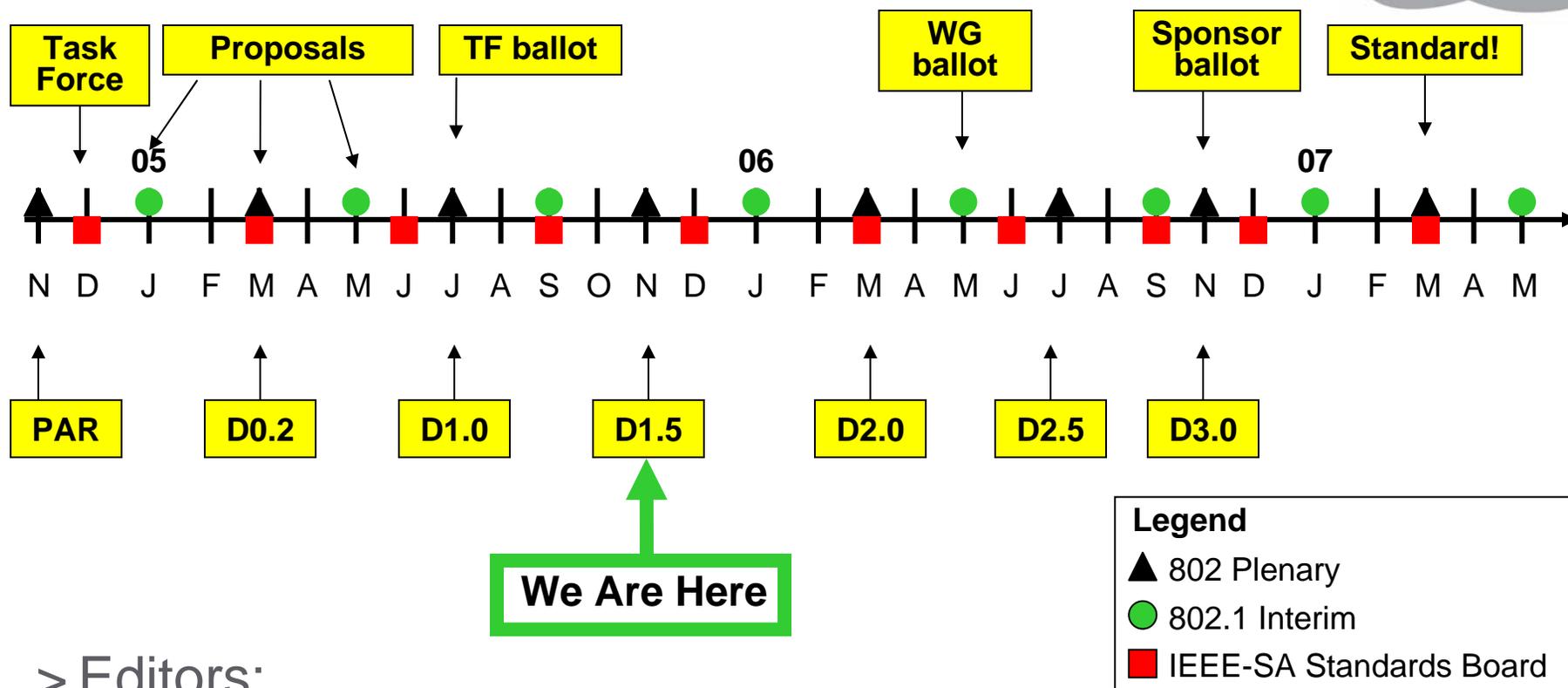
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# Agenda

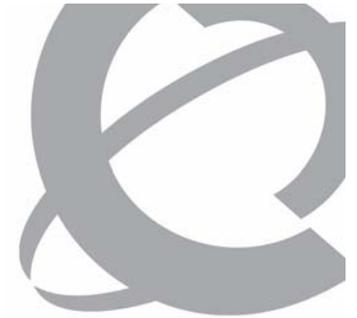
- > Introduction
- > Review
  - Terminology
  - Basic Operation
- > Service interface considerations
- > Reference Model Alternative
  - I-Comp/B-Comp reference model (Draft 1)
  - M-Comp reference model alternative
  - Revised I-Comp/B-Comp reference model
- > Frame Format Alternative
  - Formats types
  - Format identifier field proposal

# P802.1ah - Provider Backbone Bridges – Targeted Timeline



## > Editors:

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# Draft 1.5 Content

- > **Clause 1: Scope**
  - Inserted scope statement
- > **Clause 3/4: Definitions**
  - Removed Service Instance and aligned text for 802.1ad definition
  - Added I Port, B Port, I-B Interface, B-B Interface
- > **Clause 5: Conformance**
  - Added Conformance Statements for I-Comp and B-Comp
  - Defined Conformance for I-PBB and B-PBB
  - Need to decide if we need a statement for IB-PBBs
- > **Clause 6: Support of the MAC Service in VLANs**
  - Added section headings for 802.1ah
- > **Clause 17: Management Protocols**
  - Added header section for 802.1ah MIB and management
- > **Clause 23: Support of the MAC Service by Provider Backbone Bridged Networks**
  - Added updated figures and text alignment
  - Removed multiple links between I-Comp and B-Comp
- > **Clause 24: Principles of Provider Backbone Bridged network operation**
  - Aligned terminology with clause 23
- > **Clause 25: Principles of Provider Backbone Bridge operation**
  - Aligned frame format section with moving the encapsulation/de-encapsulation to I-Comp



# Big Ticket Items Draft 1.5

- > Clause 5:
  - Equipment and port definitions
- > Clause 6:
  - Ethernet and Multiprotocol encapsulation with Ethertype or Subtype
- > Clause 12,17,20:
  - 802.1ah MIB
- > Clause 23:
  - Bundled S-VLAN service description
  - Demarcation at I-TAG or S-TAG interfaces
  - Access protection description for Class I-V (should class IV) be included
  - Service protection considerations
- > Clause 24:
  - Extended network diagrams
  - Extension of PBN spanning trees over PBBN
  - Connection to Other networks
  - Hierarchical and Peer 802.1ah interconnect
  - Extension of CFM for 802.1ah
- > Clause 25:
  - Reference model decision
  - Details of I Component and B Component operation
  - Operation of address correlation data base



# Agenda

> Introduction

> Review

- Terminology
- Basic Operation

> Service interface considerations

> Reference Model Alternative

- I-Comp/B-Comp reference model (Draft 1)
- M-Comp reference model alternative
- Revised I-Comp/B-Comp reference model

> Frame Format Alternative

- Formats types
- Format identifier field proposal



# Agreed Terminology

## > IEEE 802.1ad Terminology

- C-TAG                      Customer VLAN TAG
- C-VLAN                    Customer VLAN
- C-VID                     Customer VLAN ID
- S-TAG                     Service VLAN TAG
- S-VLAN                    Service VLAN
- S-VID                     Service VLAN ID

## > Additional Provider Backbone Bridge Terminology

- I-TAG                      Extended Service TAG
- I-SID                      Extended Service ID
- B-TAG                     Backbone TAG Field
- B-VLAN                    Backbone VLAN (tunnel)
- B-VID                     Backbone VLAN ID (tunnel)
- C-MAC                    Customer MAC Address
- B-MAC                    Backbone MAC Address



## More Terminology

- > CBN            Customer Bridge Network
- > CB             Customer Bridge
- > PBN            Provider Bridge Network
- > PB             Provider Bridge
- > PBBN          Provider Backbone Bridge Network
- > PBB            Provider Backbone Bridge



## **New Terminology**

> I Port

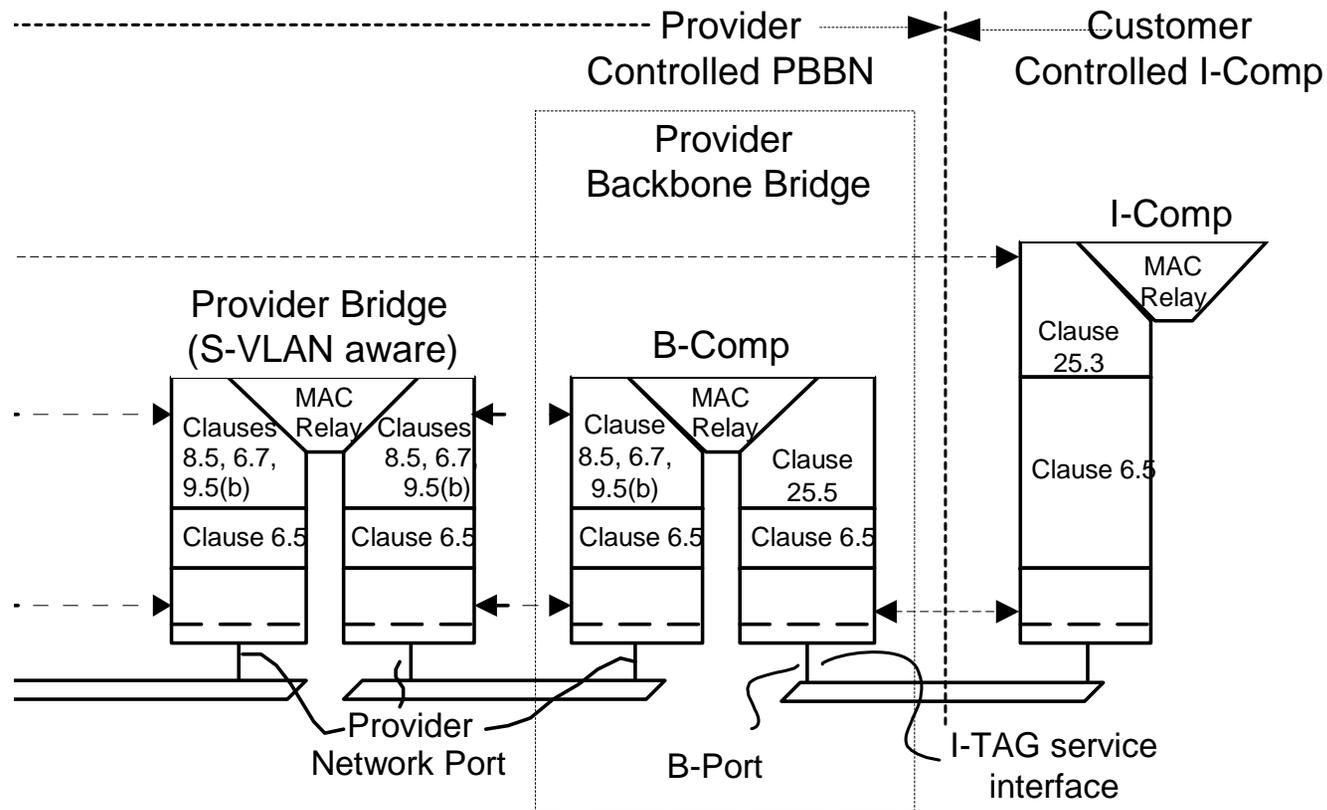
> B Port

> I-B Interface (I-TAG Service Interface)

> B-B Interface (I-TAG Service Interface)

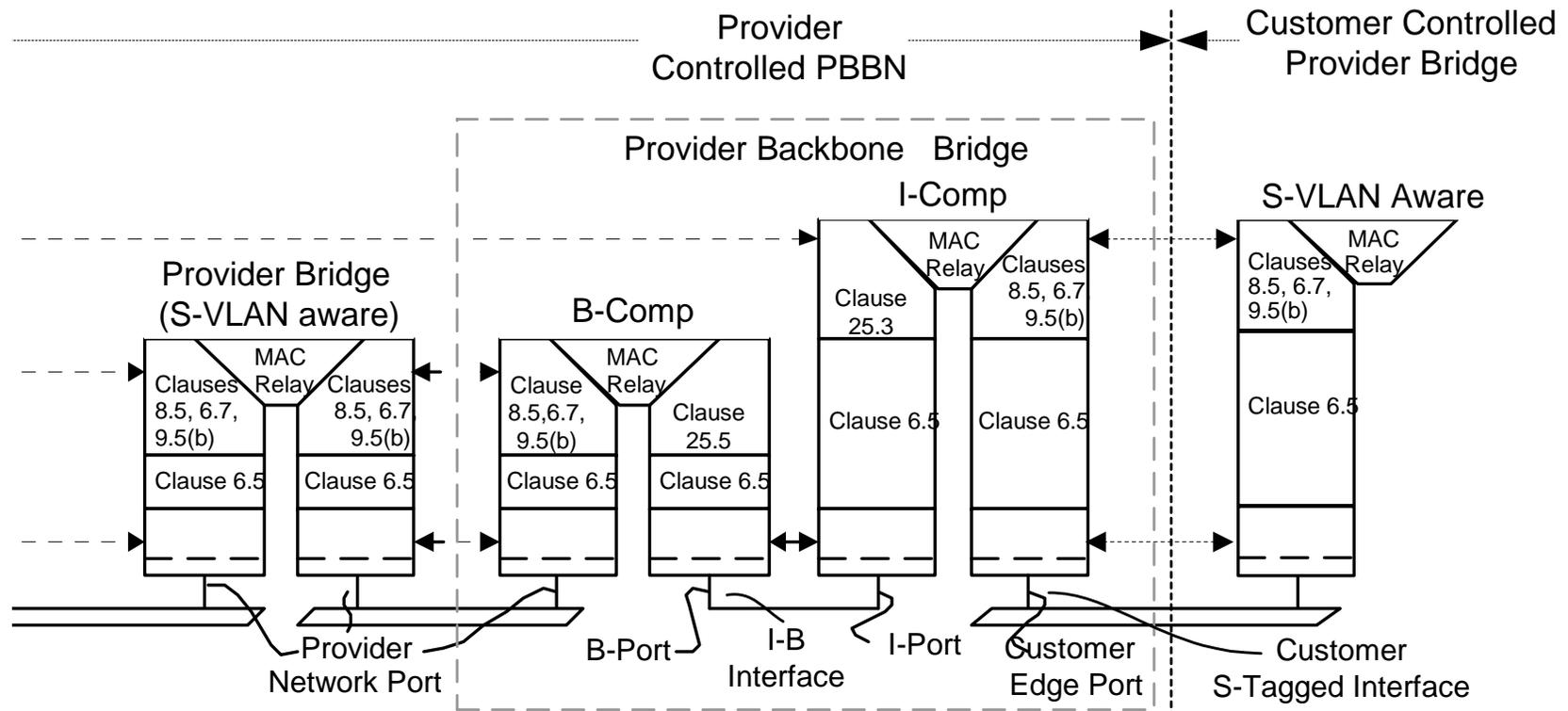


# I-TAG Service Interface – Dual Relay Model



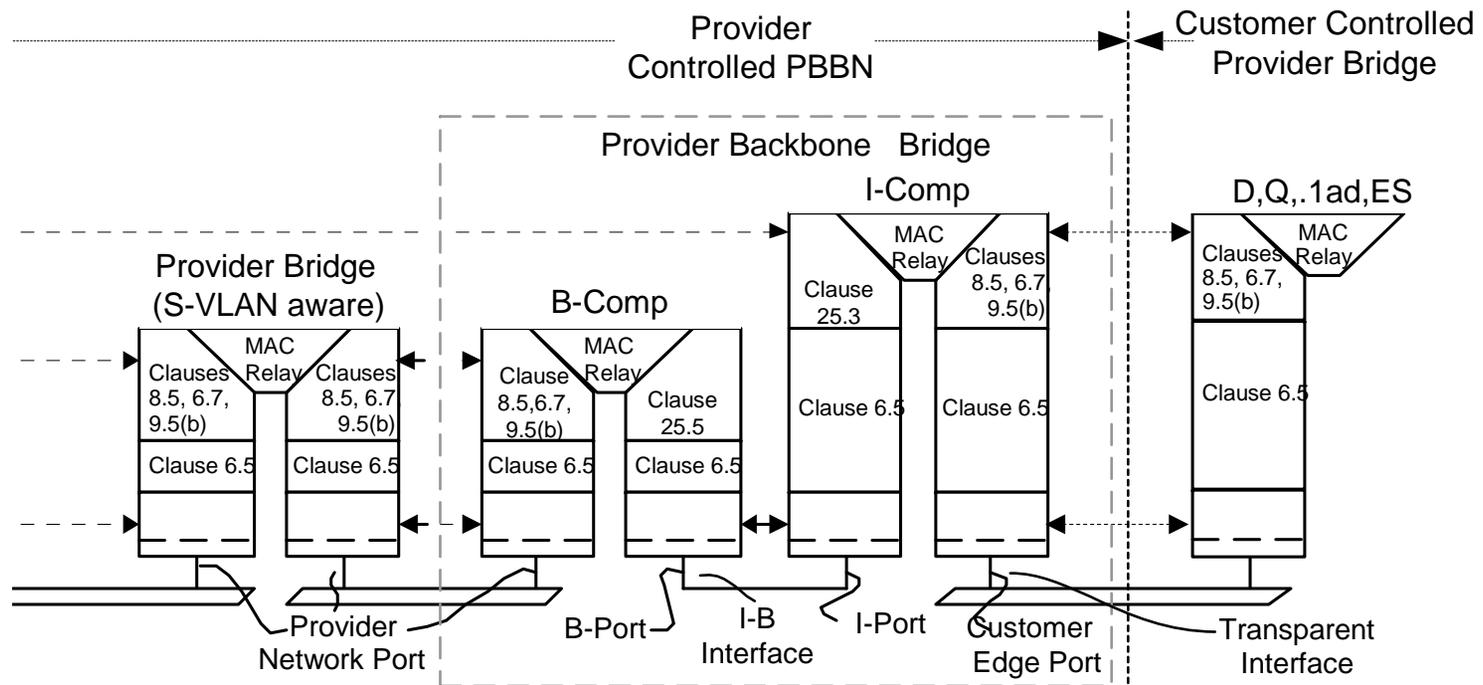


# S-TAG Interface - Dual Relay Model

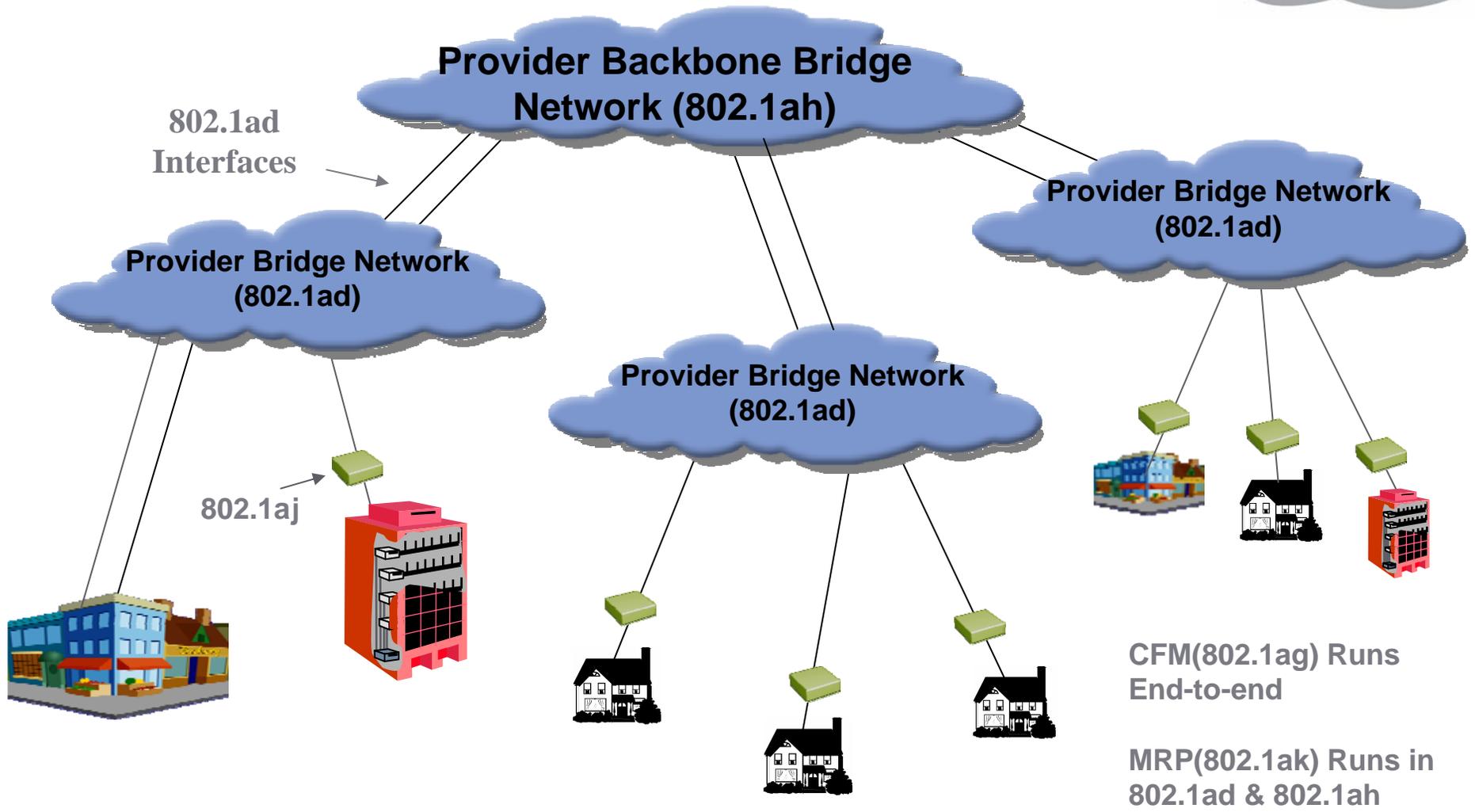




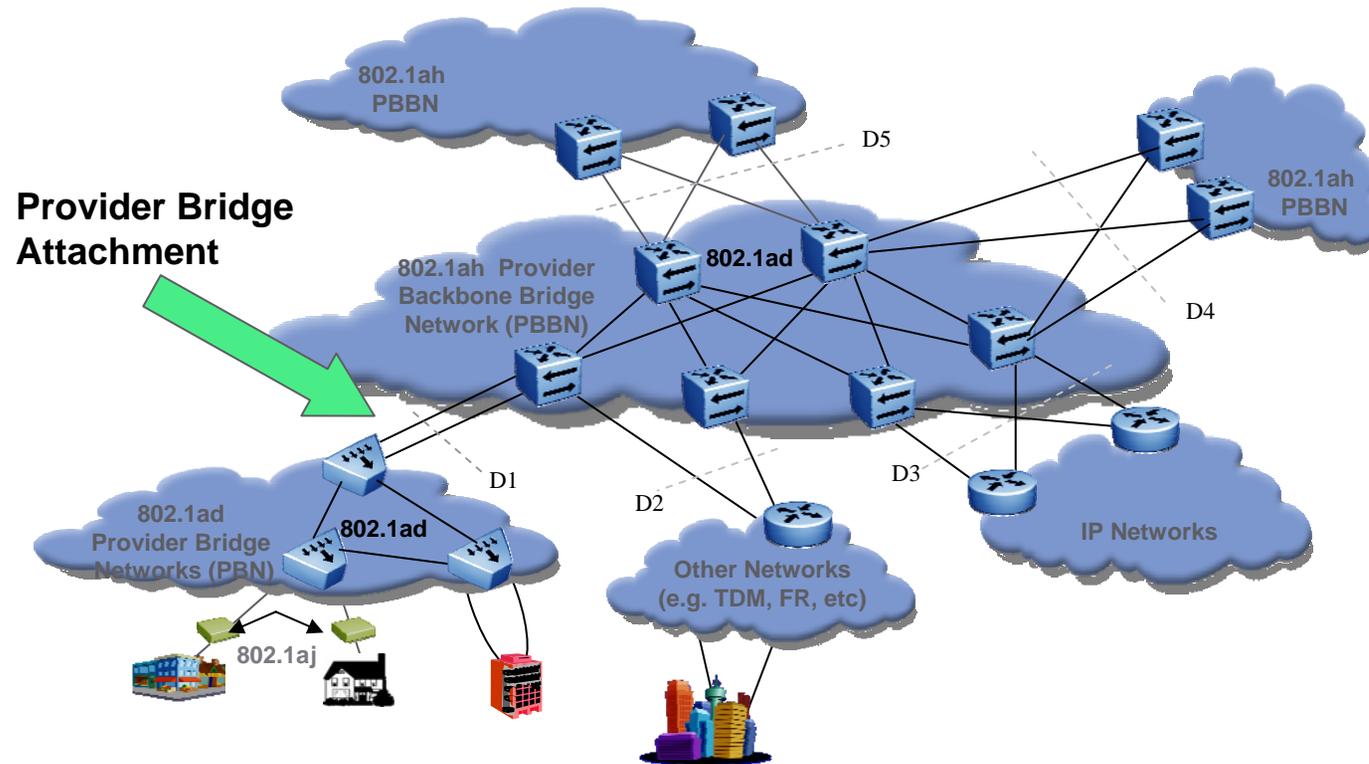
# Transparent Interface – Dual Relay



# IEEE 802.1ah Simple Example



# IEEE 802.1ah More Detailed Example



Example Provider Ethernet

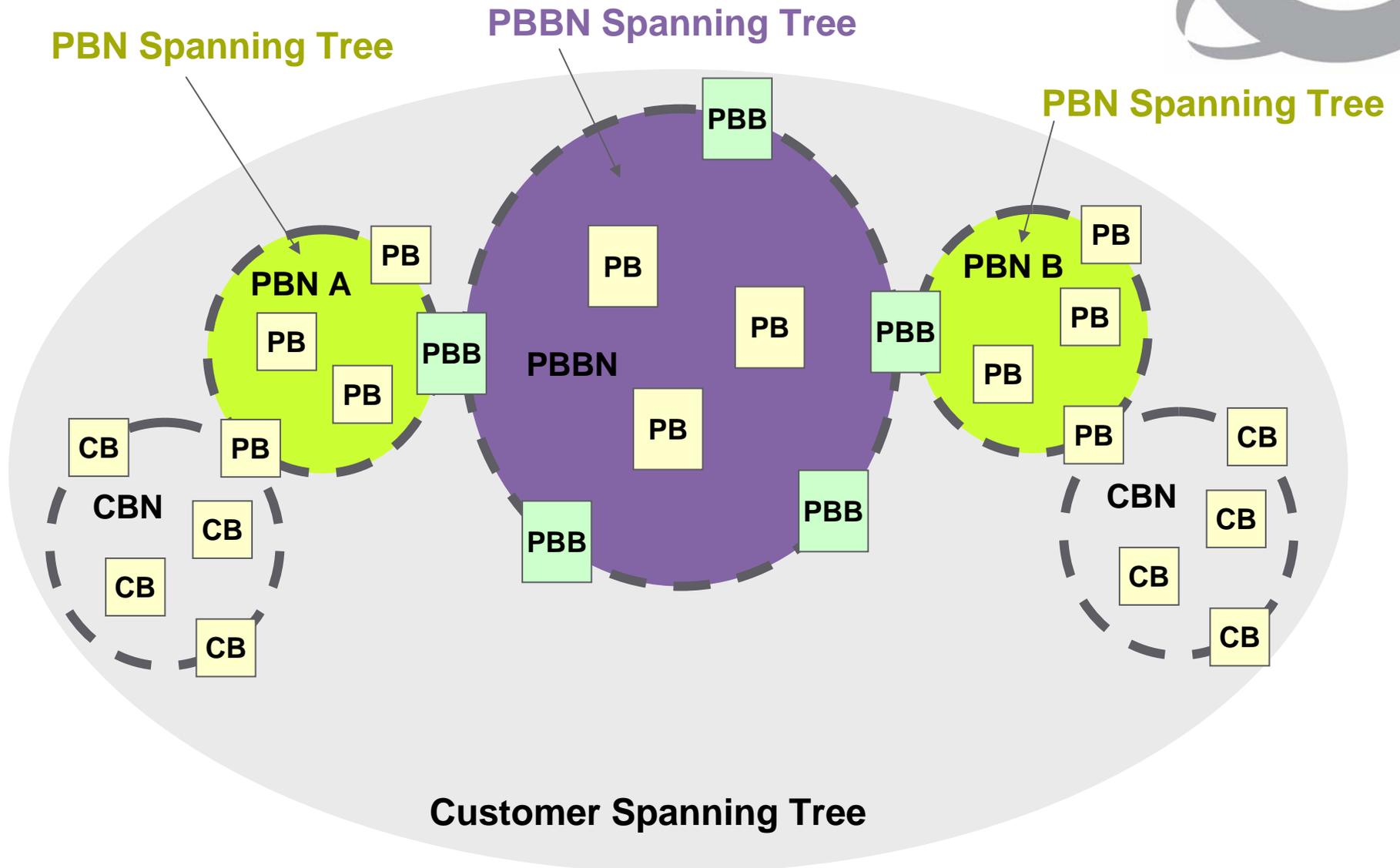
- > In this example 4 client network interfaces at D1, D2, D3, and D5 use the PBBN to connect 802.1ad, IP, “other”, and 802.1ah clients.
- > This example also includes 1 peer network interface at D4 which connects two peer 802.1ah PBBNs.



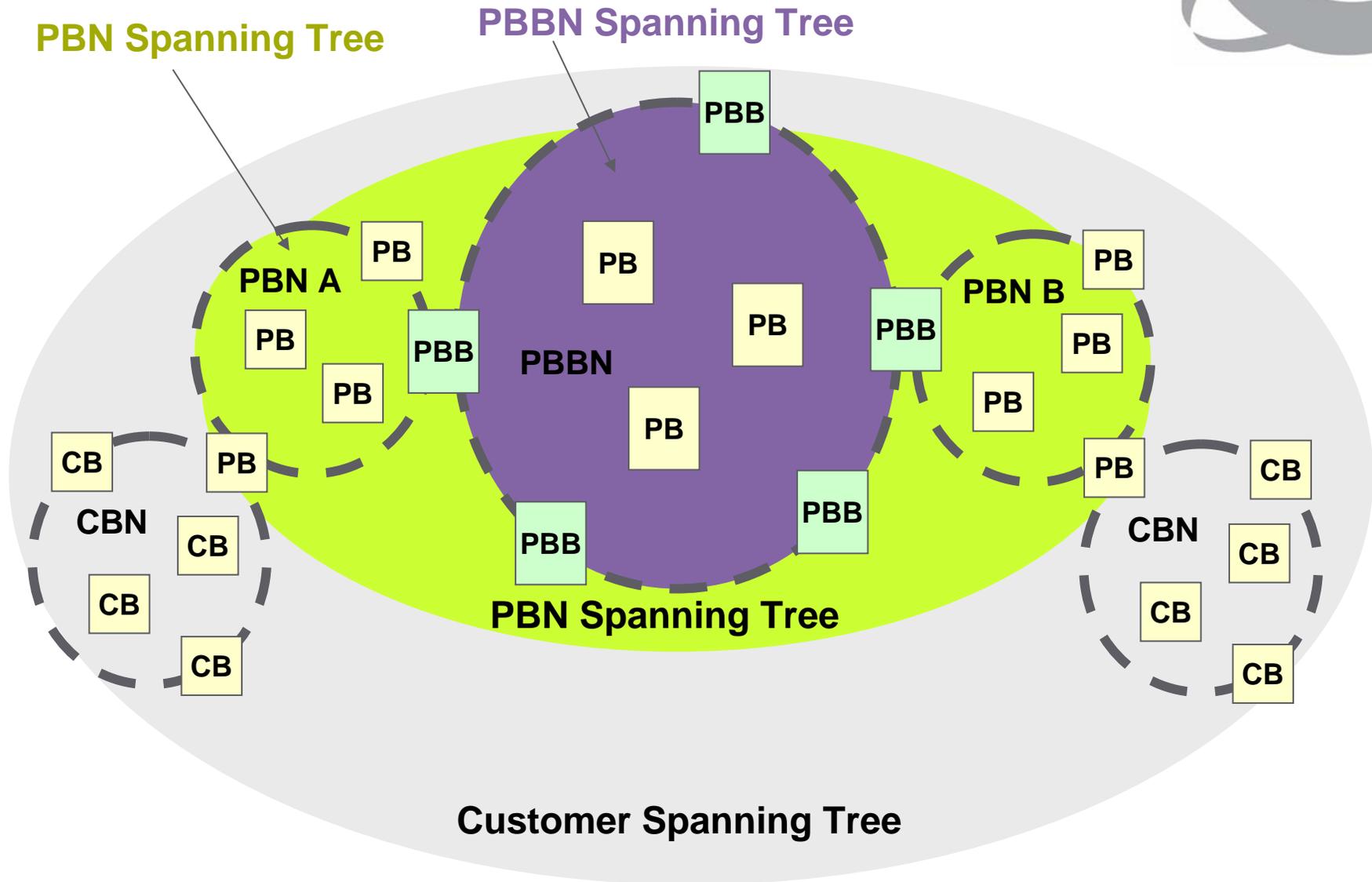
## PBN Attachment (D1)

- > Two possible attachment models
  - D1 could be over an S-TAG interface attaching to an IB PBB
  - D1 could be over an I-TAG interface attaching to a B PBB
    - In this case the I PBB is part of the customer equipment and becomes edge equipment for interfacing to the PBBN
- > Both options hide PBBN addressing
- > Using the I-TAG interface may provide more control over the recovery scenario between I PBB and B PBB

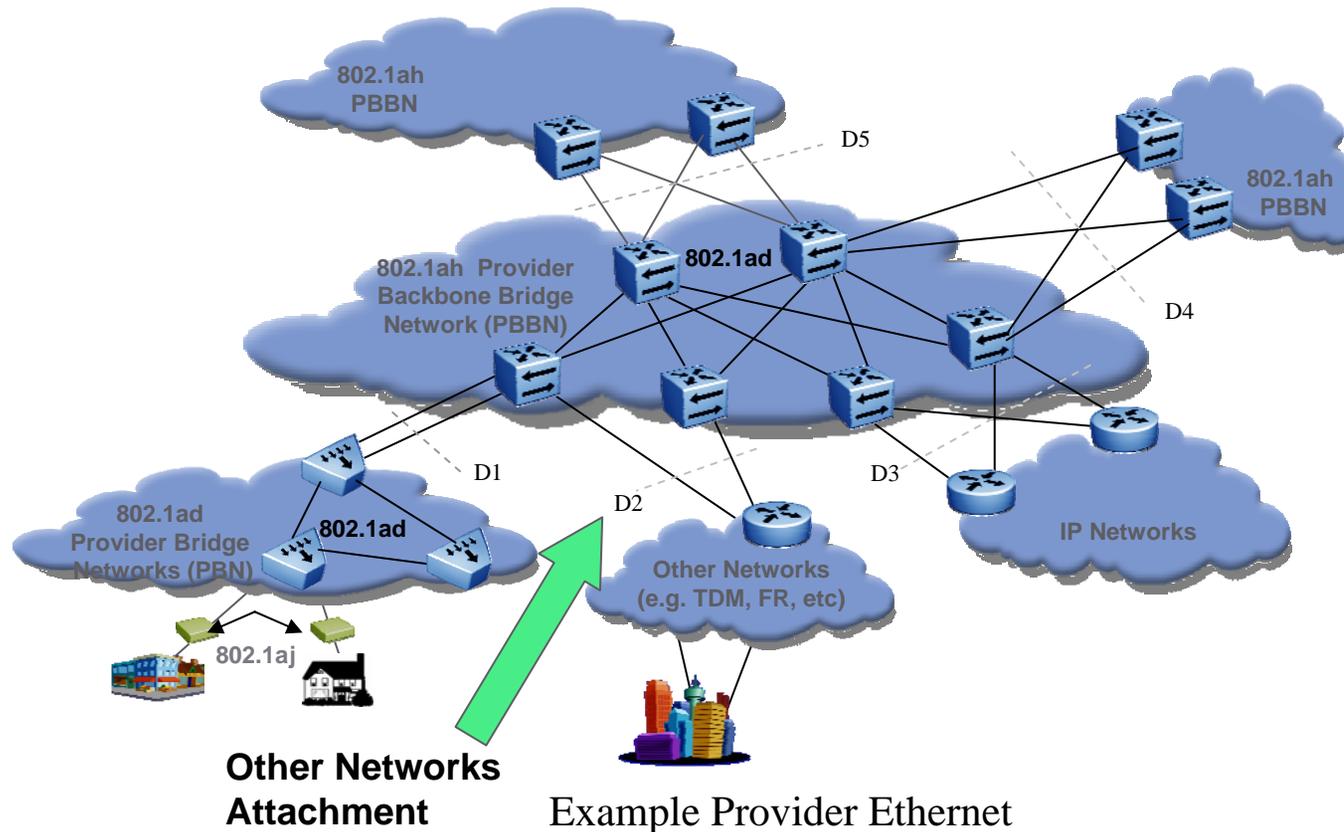
# Discrete 802.1ad and 802.1ah Spanning Trees



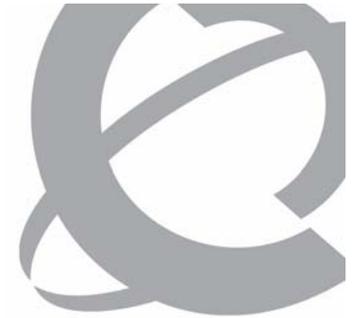
# Extended 802.1ad Spanning Tree



# IEEE 802.1ah More Detailed Example



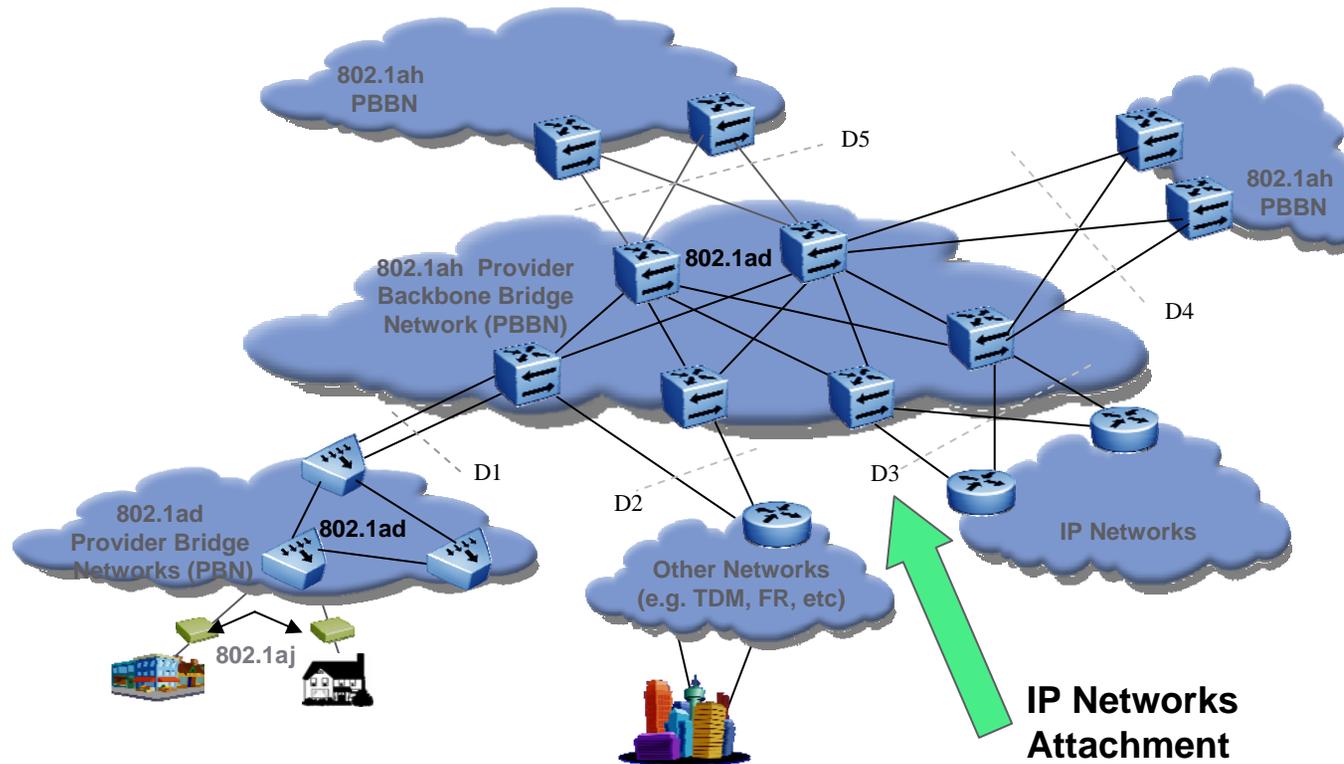
- > In this example 4 client network interfaces at D1, D2, D3, and D5 use the PBBN to connect 802.1ad, IP, “other”, and 802.1ah clients.
- > This example also includes 1 peer network interface at D4 which connects two peer 802.1ah PBBNs.



## Other Network Attachment(D2)

- > Includes attachment to a variety of interworking functions like TDM, FR, MPLS, etc.
- > D2 is over an I-TAG interface therefore no I-Comp is used
  - Pt-Pt networks need larger service instance space than available from S-TAG interface
  - May address entire service space of PBBN
  - Must have resiliency support

# IEEE 802.1ah More Detailed Example



Example Provider Ethernet

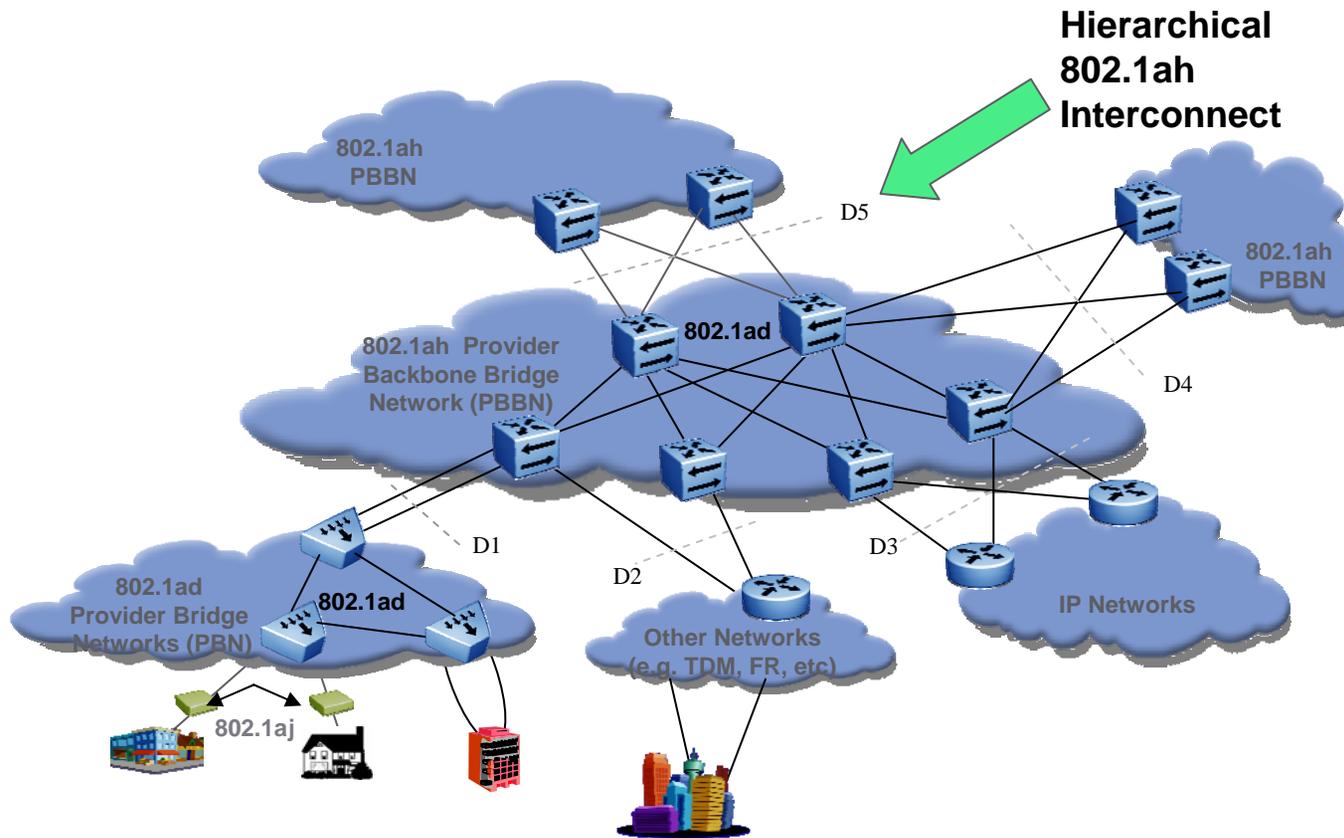
- > In this example 4 client network interfaces at D1, D2, D3, and D5 use the PBBN to connect 802.1ad, IP, “other”, and 802.1ah clients.
- > This example also includes 1 peer network interface at D4 which connects two peer 802.1ah PBBNs.



## **IP Network Attachment (D3)**

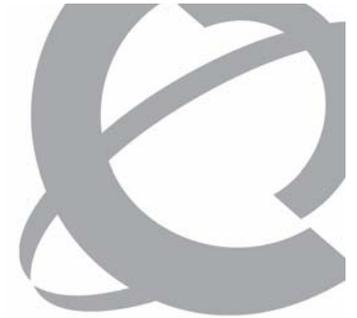
- > Typically an S-TAG service interface
- > Same interface considerations as PBN
- > The backbone may form a demarcation over the S-TAG interface or over an I-TAG interface

# IEEE 802.1ah More Detailed Example

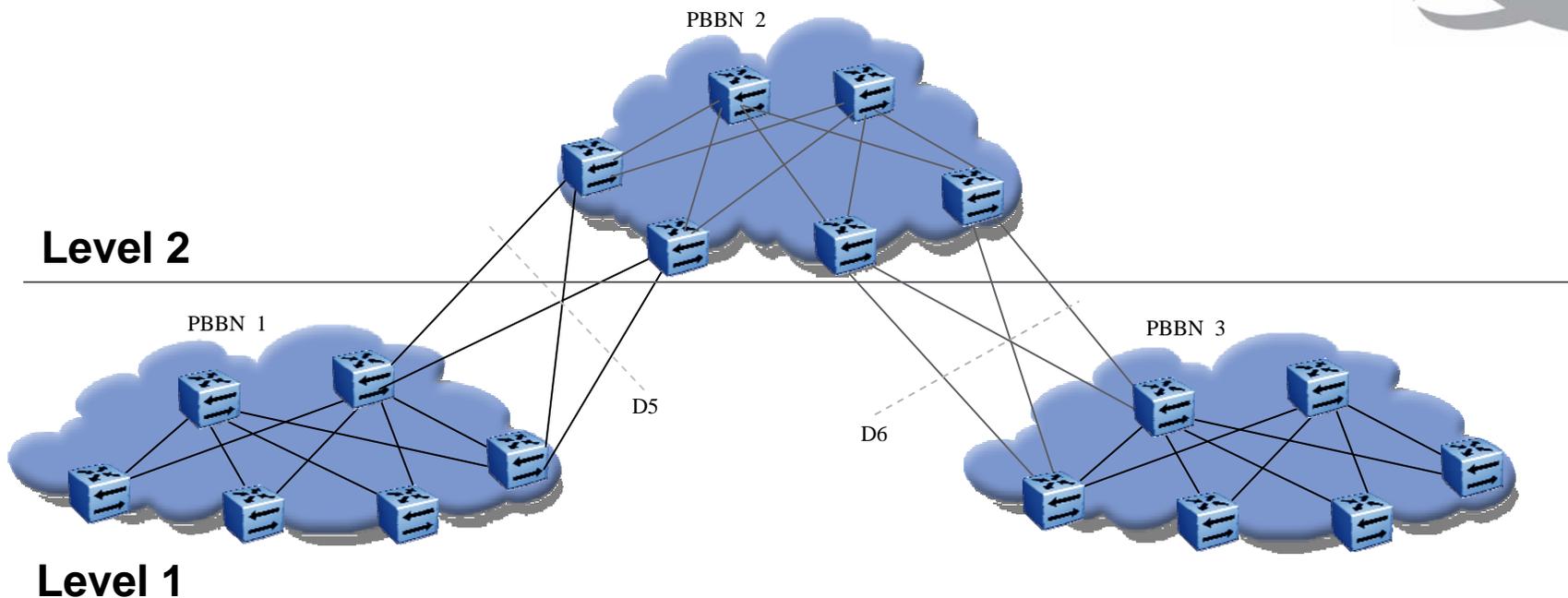


Example Provider Ethernet

- > In this example 4 client network interfaces at D1, D2, D3, and D5 use the PBBN to connect 802.1ad, IP, "other", and 802.1ah clients.
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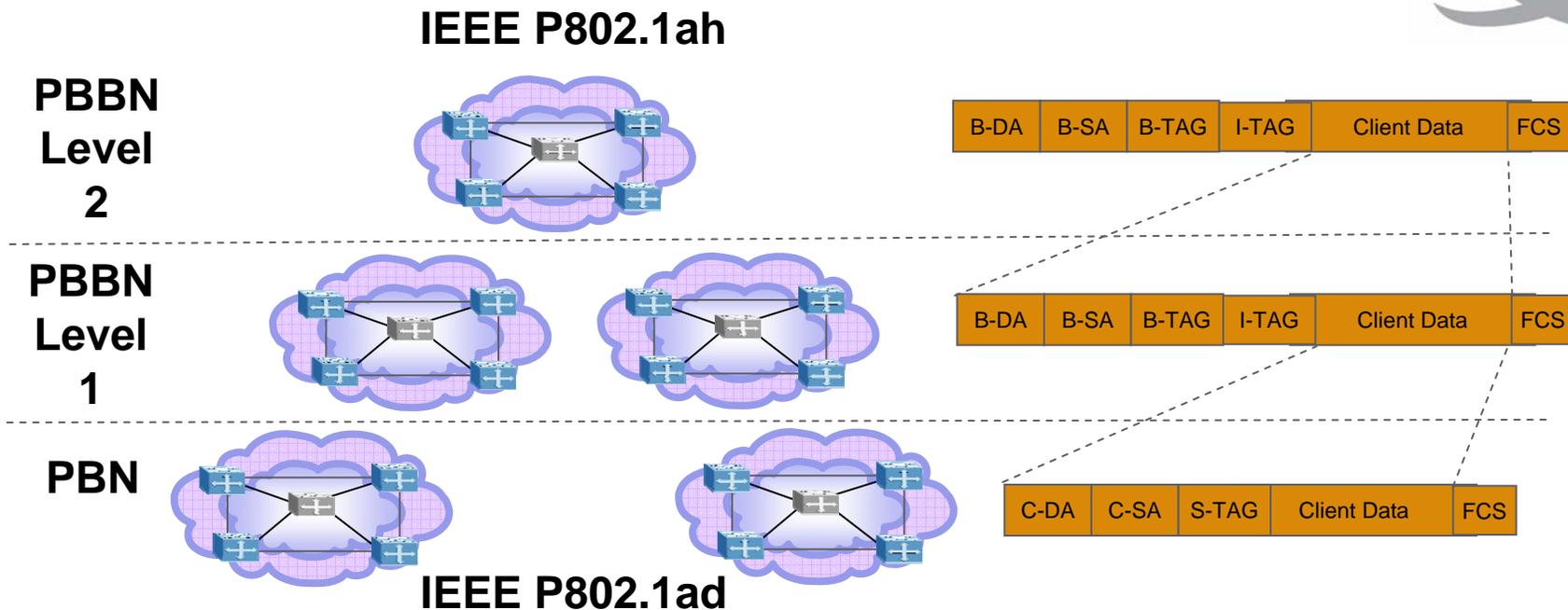
# Hierarchical 802.1ah Interconnect (D5)



- > Example shows multiple level 1 PBBNs interconnected by a level 2 PBBN
- > The L2 PBBN 2 extends the L1 B-VLANs between PBBNs 1 and 3
- > Just works since the backbone core is 802.1ad encoded the B-VIDs will be mapped to L2 I-SID and extended to connected PBBNs

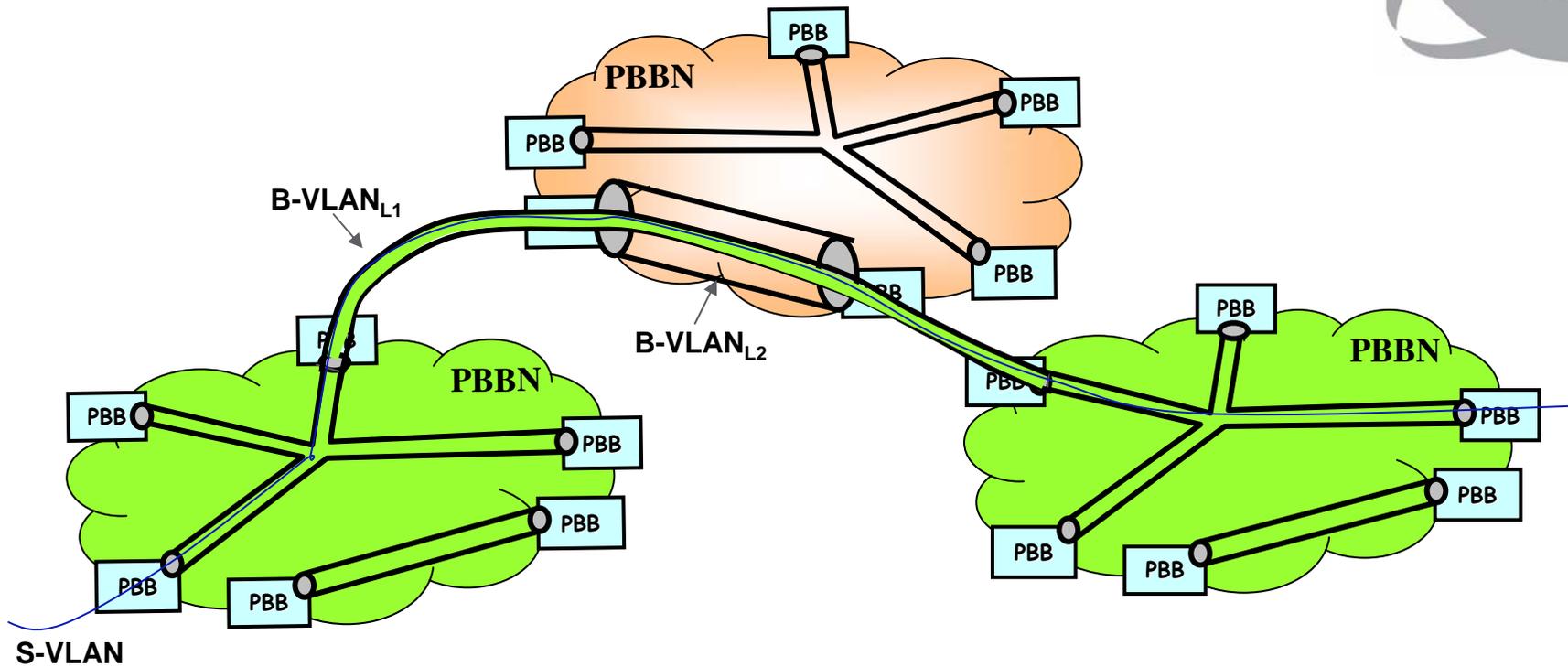


# Hierarchical Interconnect MiMiM...



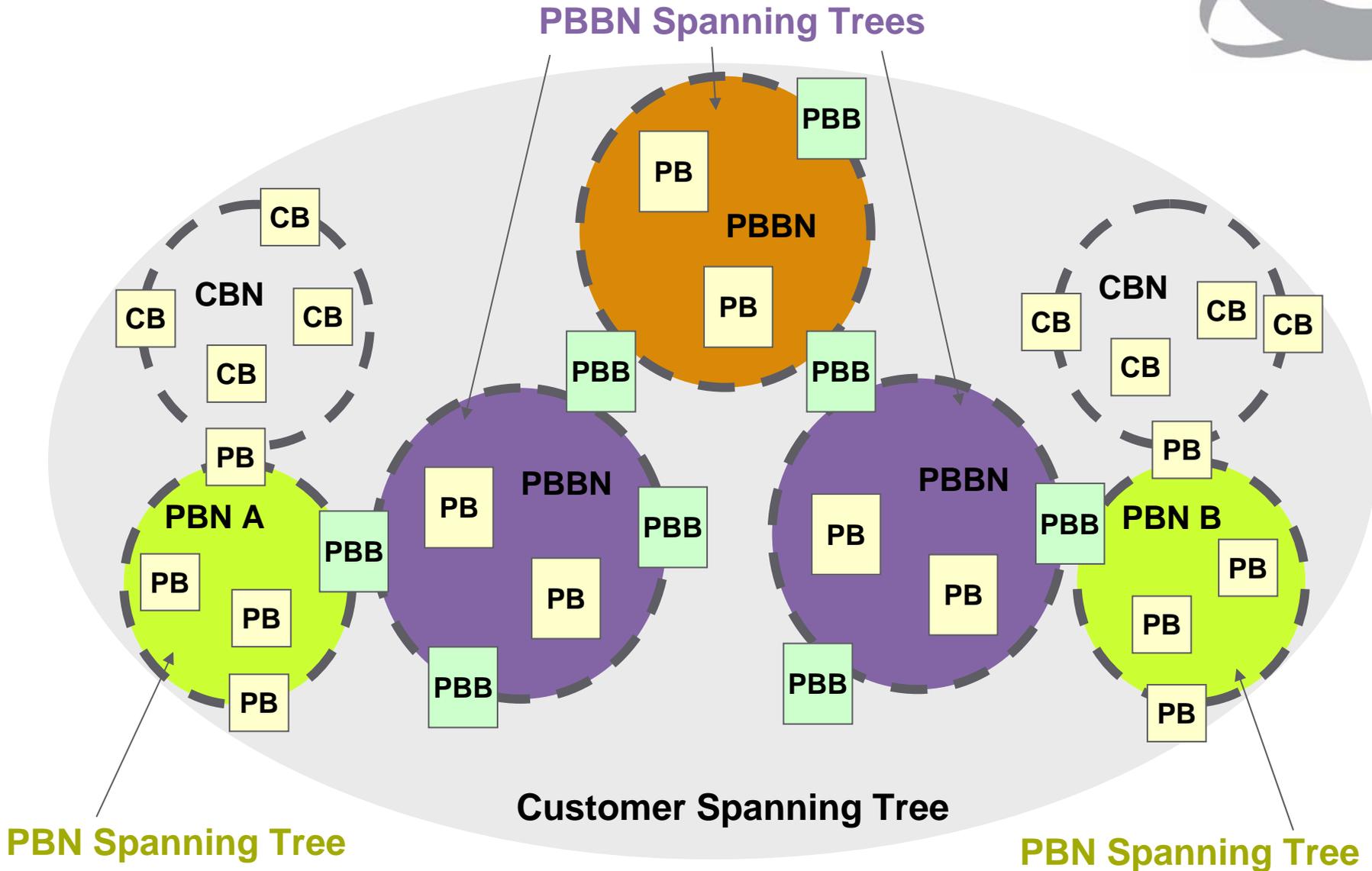
- > Each nesting level summarizes the MAC addresses of the lower level with a MAC address
- > The higher level Provider Backbone Bridges forward on L2 B-MACs which summarize the L1 B-MAC addresses

# Hierarchical Interconnect Logical Connections

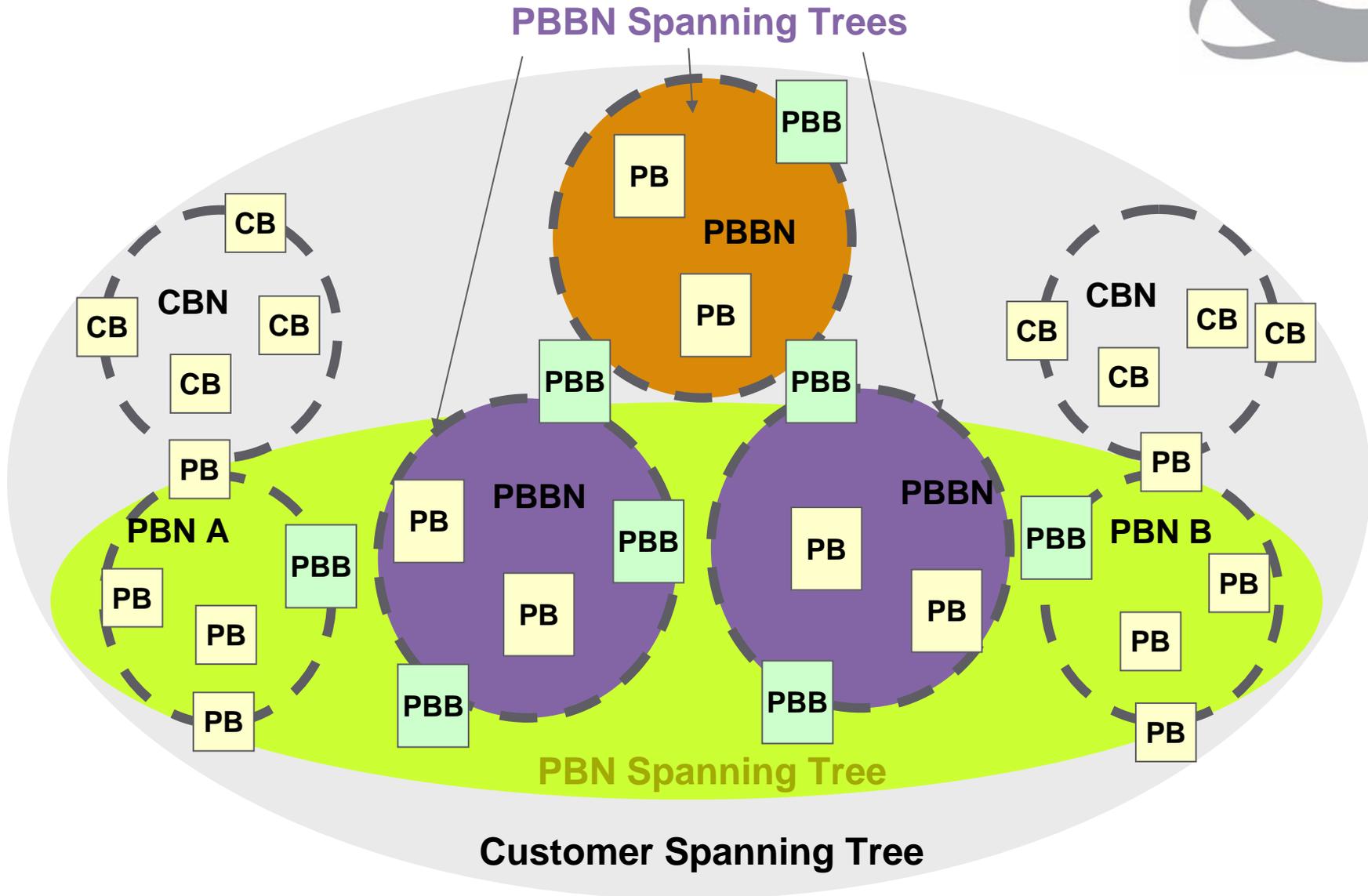


- > C-VLAN is tunneled through  $B\text{-VLAN}_{L1}$
- >  $B\text{-VLAN}_{L1}$  is tunneled through  $B\text{-VLAN}_{L2}$

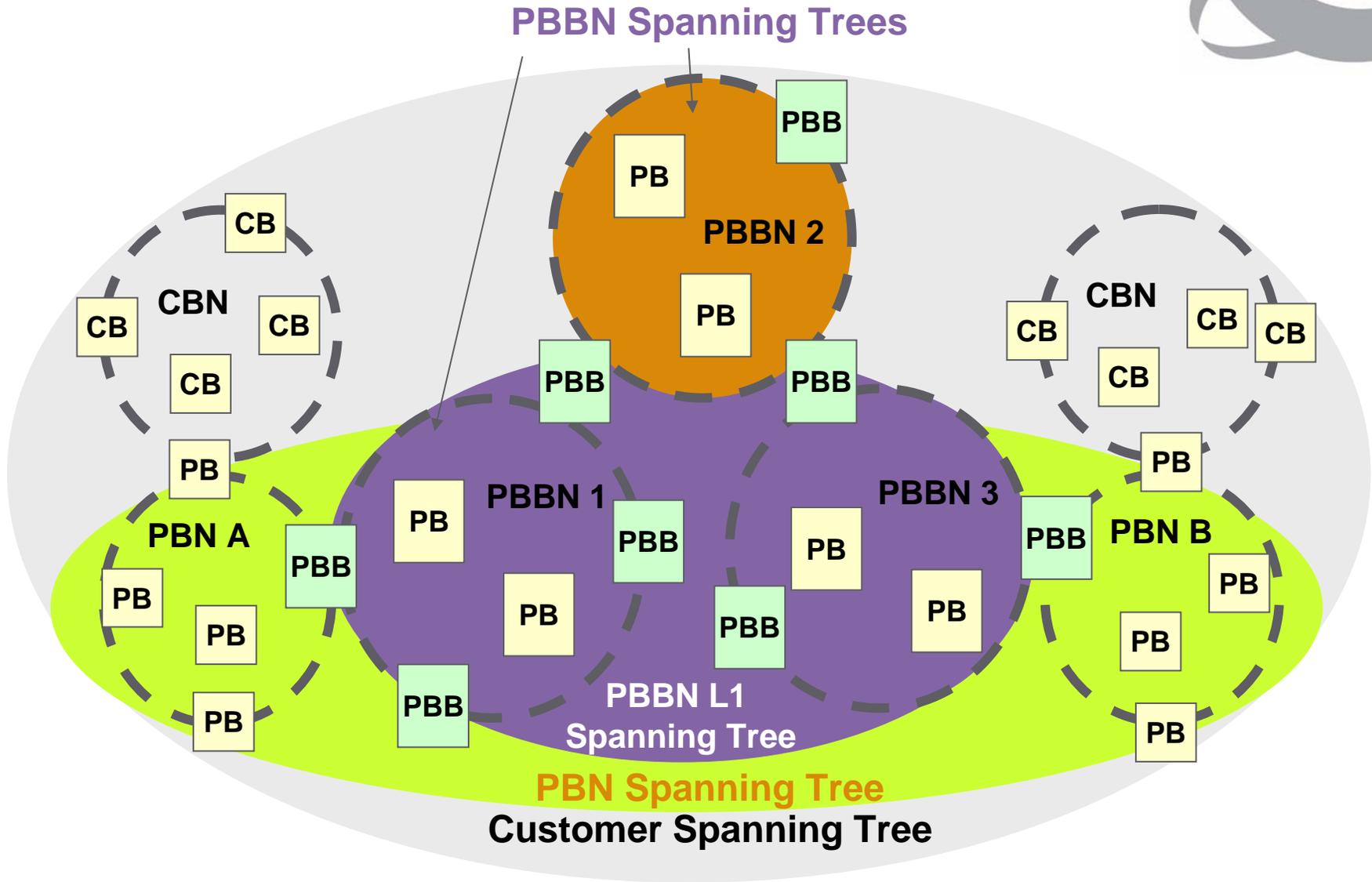
# Discrete PBN & PBBN Spanning Trees



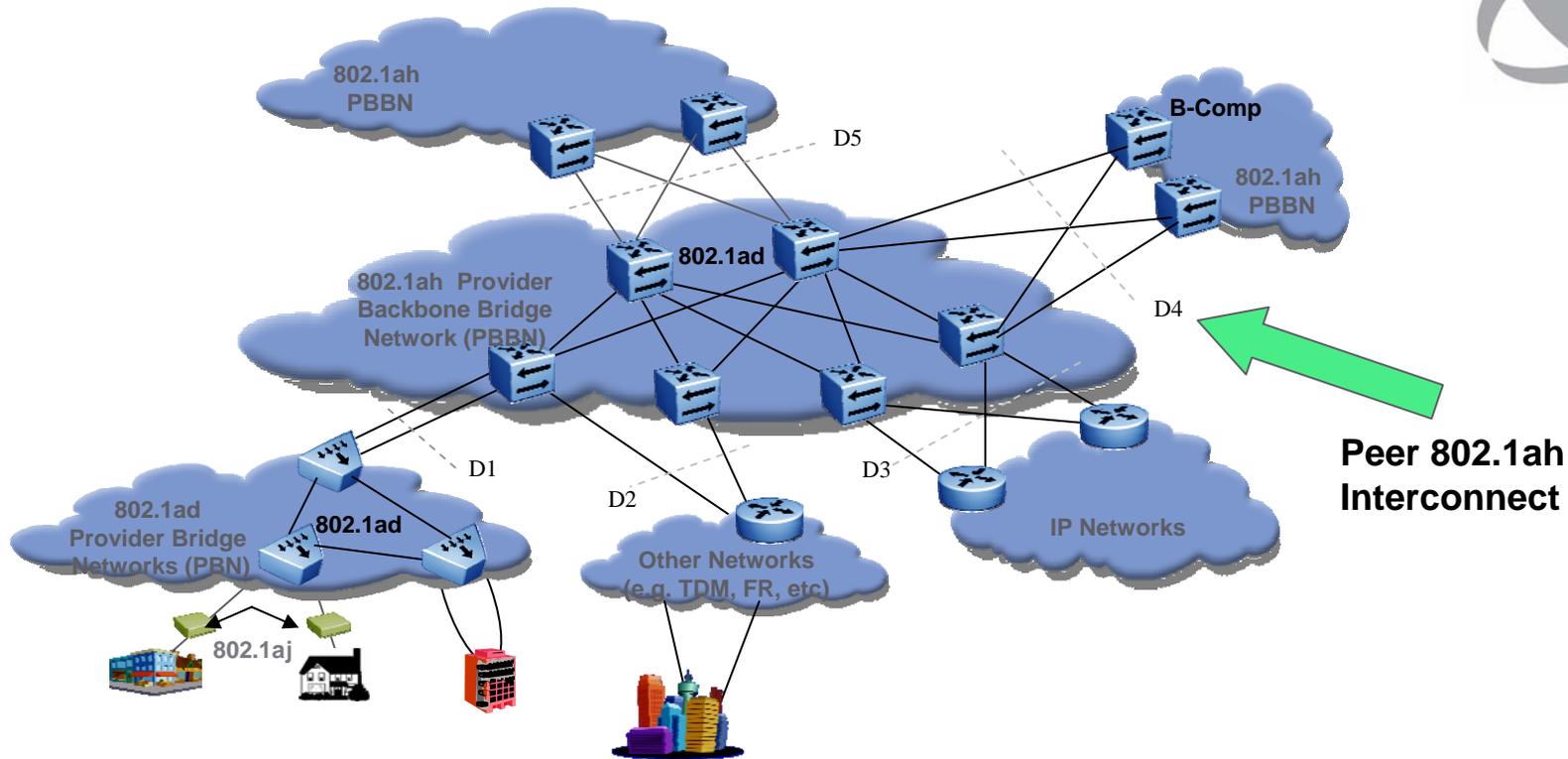
# Merged PBN Spanning Trees



# Merged PBBN L1 Spanning Trees



# IEEE 802.1ah More Detailed Example

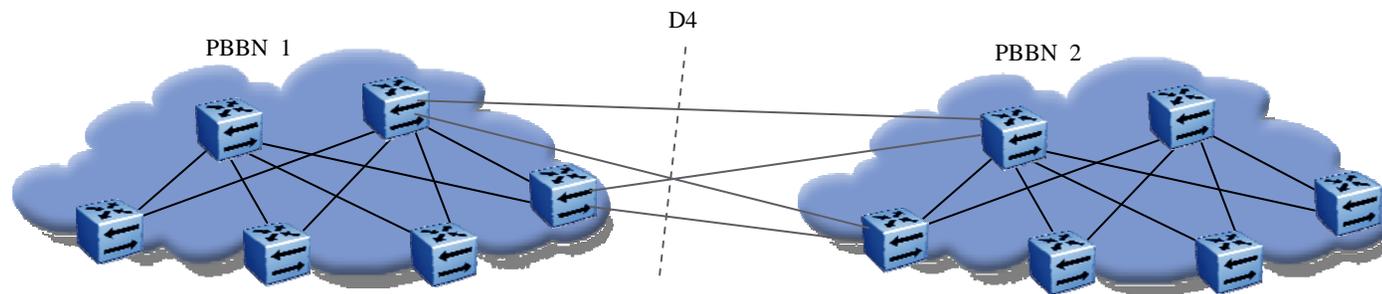


Example Provider Ethernet

- > In this example 4 client network interfaces at D1, D2, D3, and D5 use the PBBN to connect 802.1ad, IP, "other", and 802.1ah clients.
- > This example also includes 1 peer network interface at D4 which connects two peer 802.1ah PBBNs.



## Peer 802.1ah Interconnect (D4)

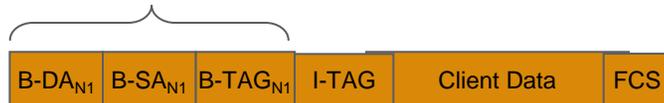


- > Interconnects two 802.1ah PBBN over a demarcation point at the service level.
- > Does not nest another encapsulation level
- > Interconnect exchanges an I-SID over D2
- > Both PBBNs resolve new B-MACs from C-MAC addresses
- > Peer interconnect requires an I-TAG serviced interface

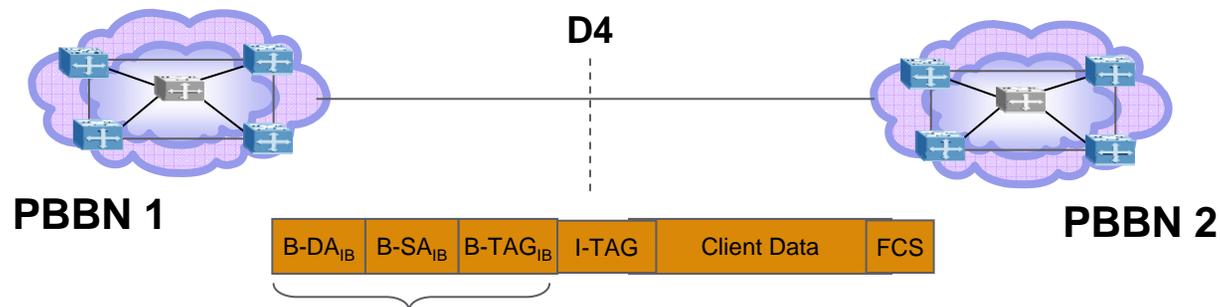


# Peer Interconnect Reframing

## PBBN 1 B-MACs & B-TAG



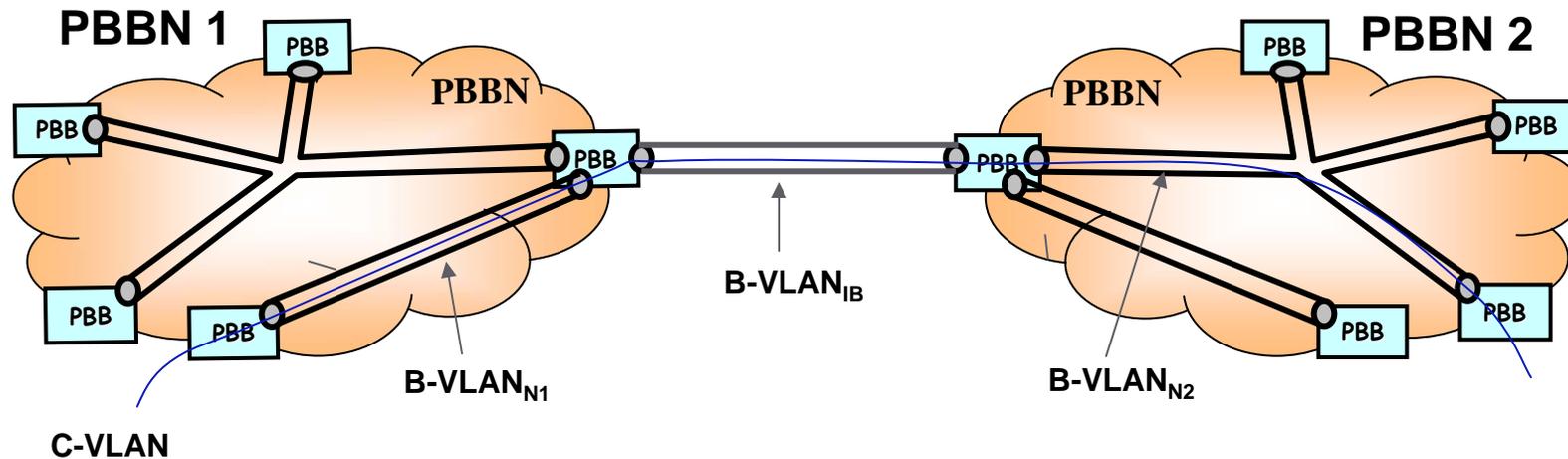
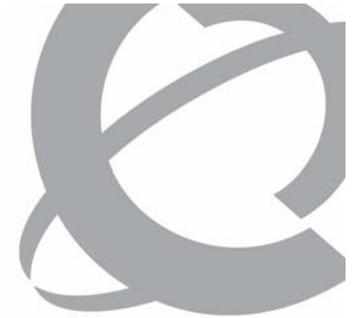
## PBBN 2 B-MACs & B-TAG



## Demarcation B-MACs & B-TAG

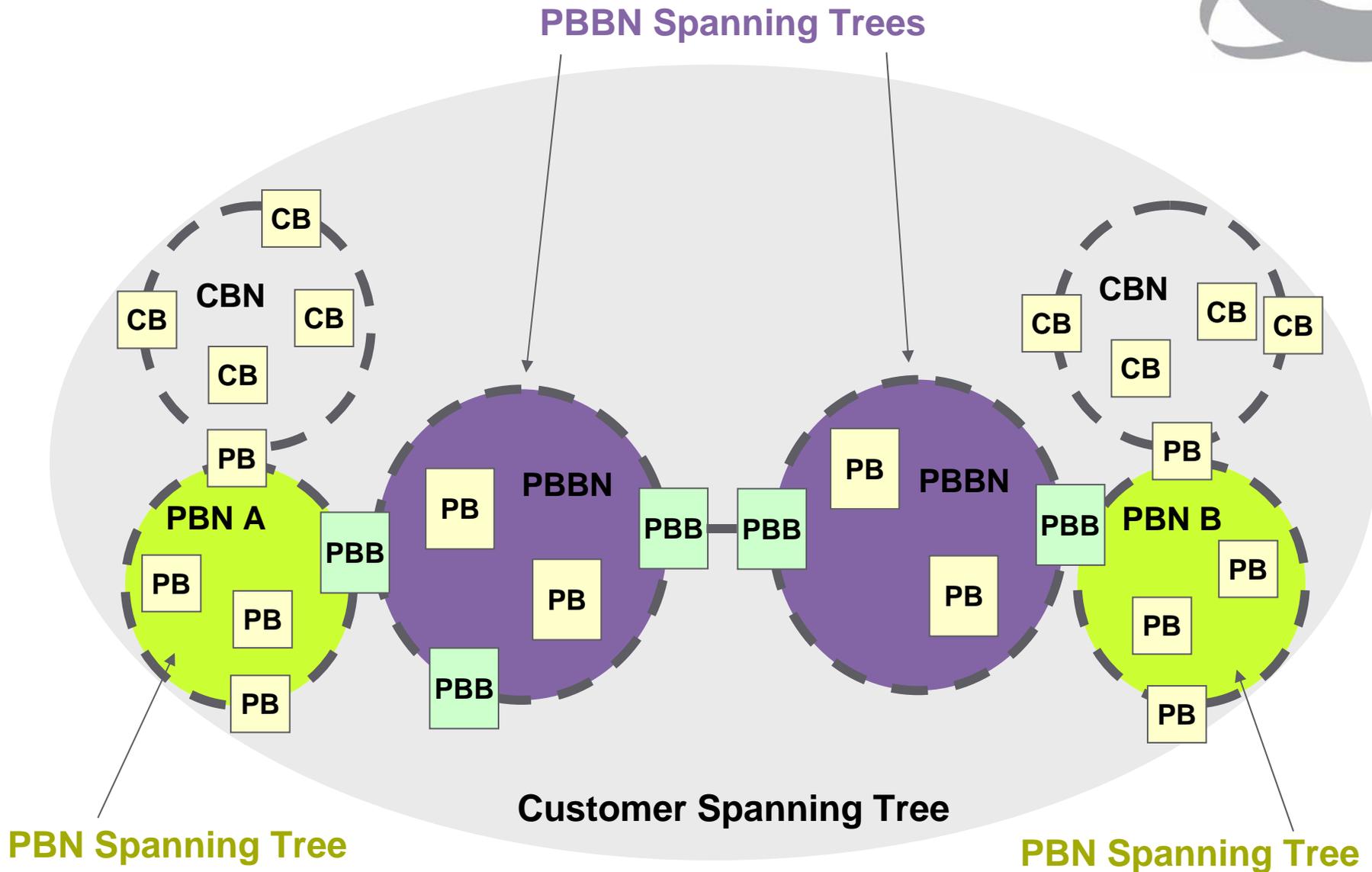
- > Demarcation point between peer networks exchange the I-TAG information while hiding the B-MACs used within the connected networks.
- > Each network must (N1 and N2 in this example) must resolve new B-MACs and B-TAGs based on the I-TAG and C-MAC addresses.

# Peer Interconnect Logical Connections

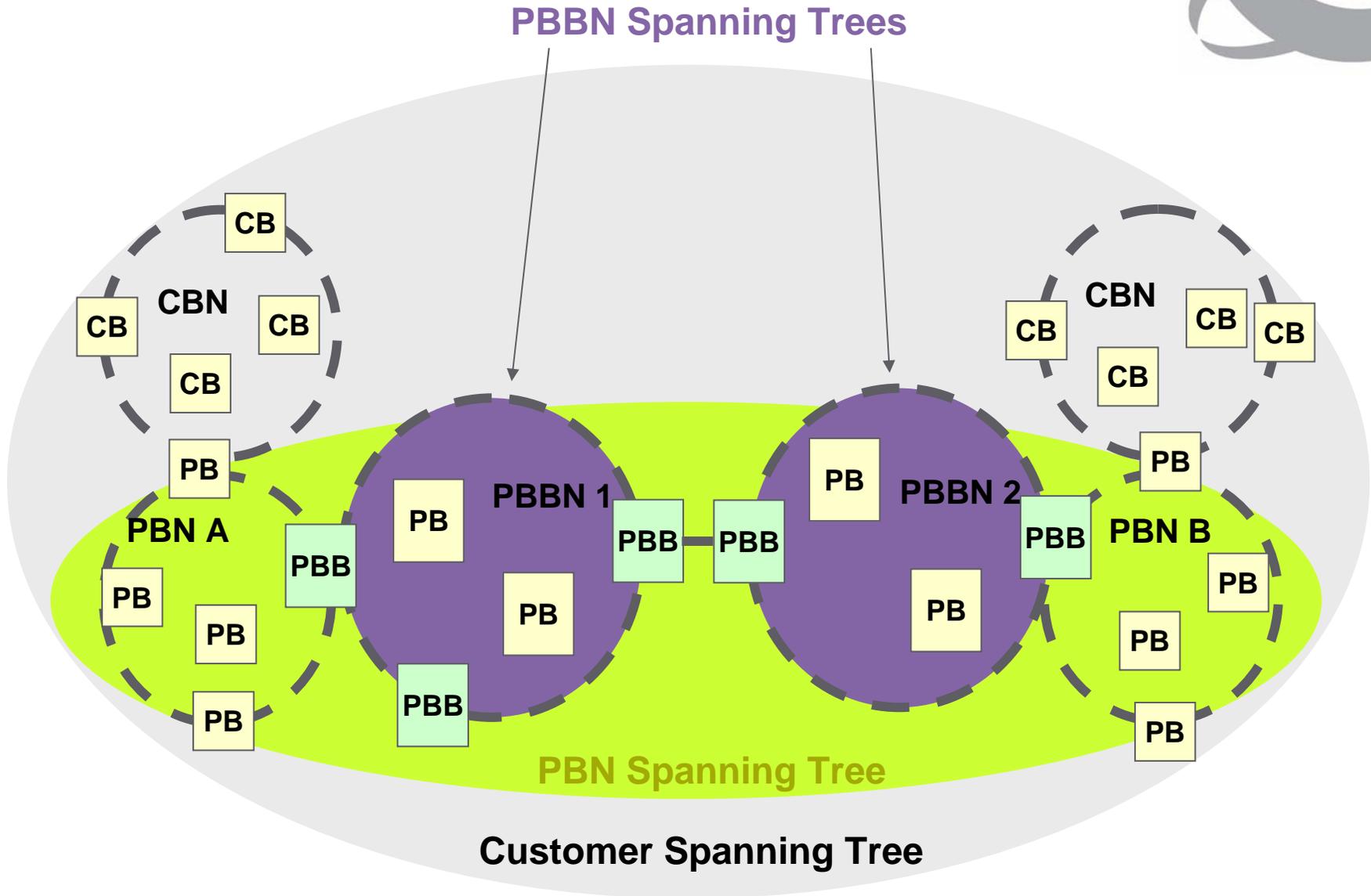


- > C-VLAN is tunneled through B-VLAN<sub>N1</sub>, B-VLAN<sub>IB</sub> and B-VLAN<sub>N2</sub>
- > B-MACs are recalculated over demarcation point between N1 and N2
- > Both N1 and N2 require C-MAC/B-MAC correlation tables

# Discrete PBN & PBBN Spanning Trees



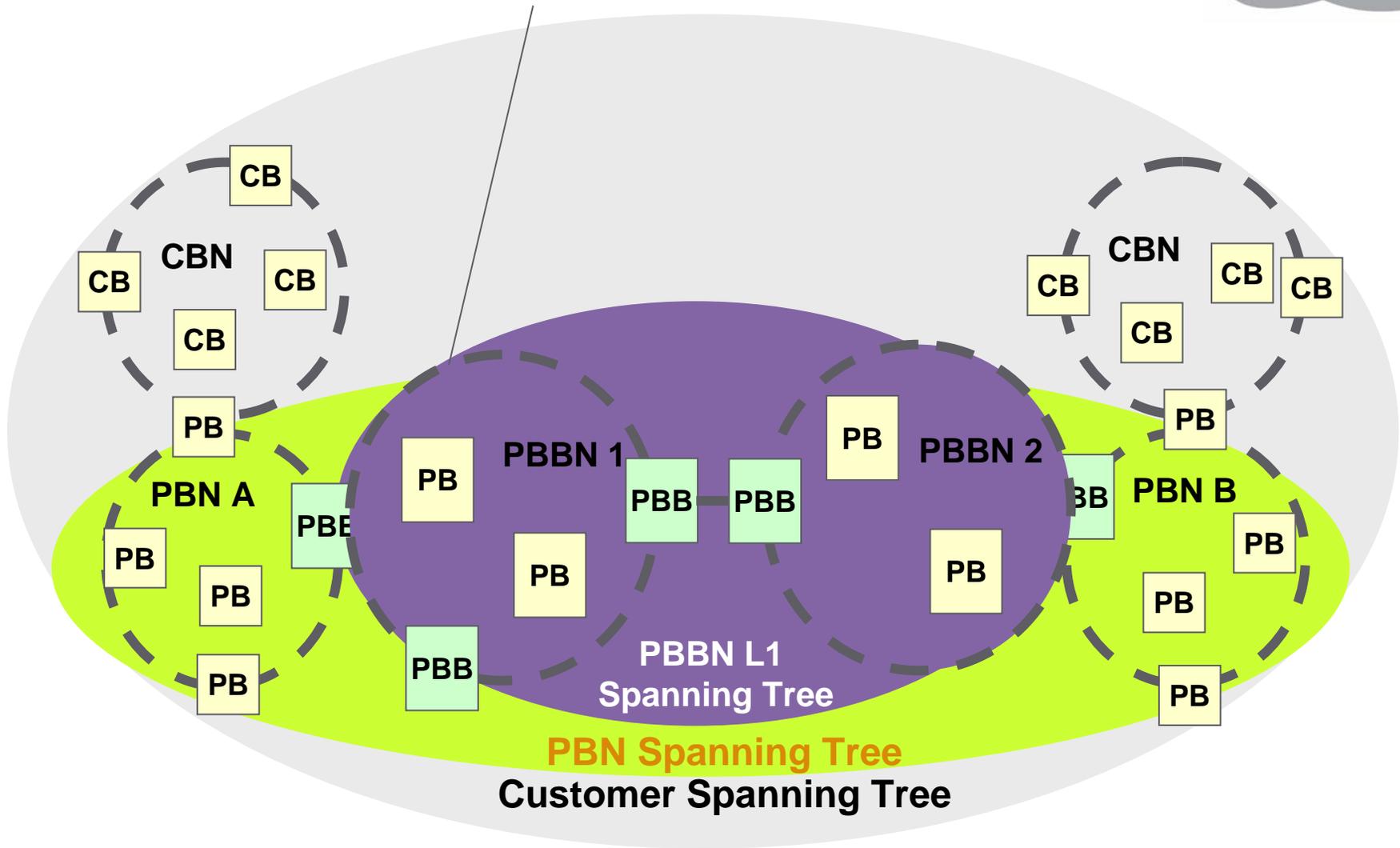
# Merged PBN Spanning Trees



# Merged PBBN Spanning Trees

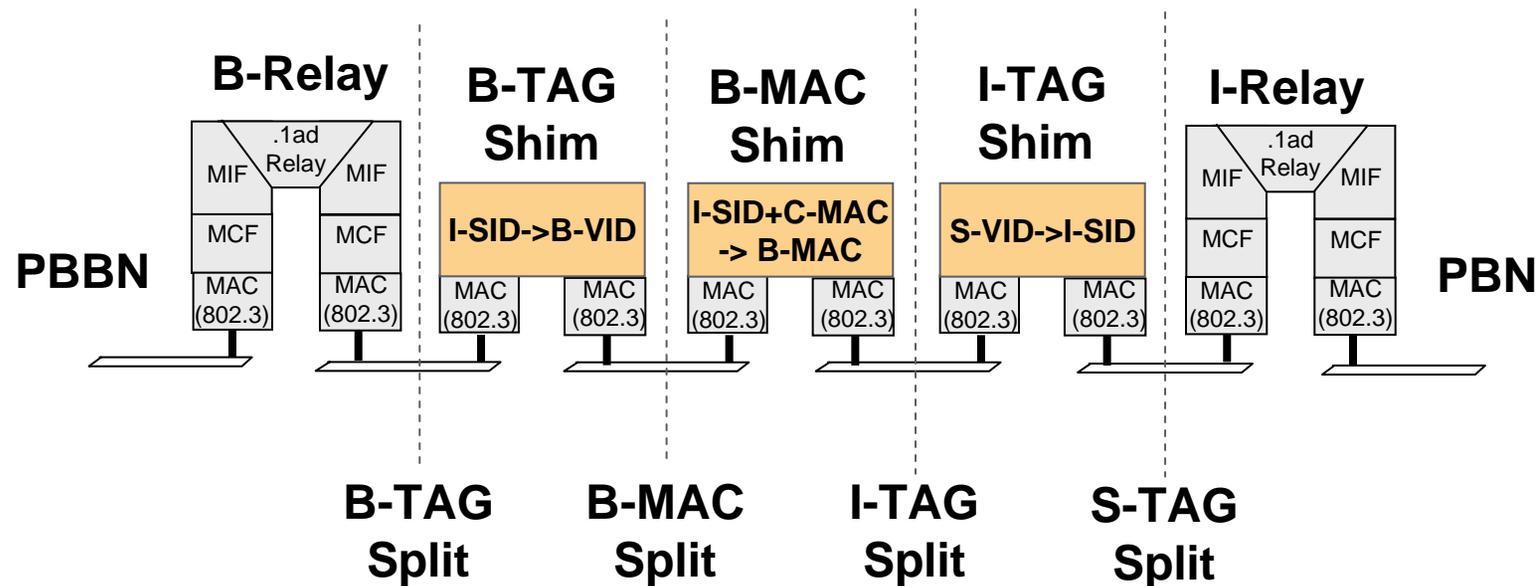


PBBN Spanning Trees

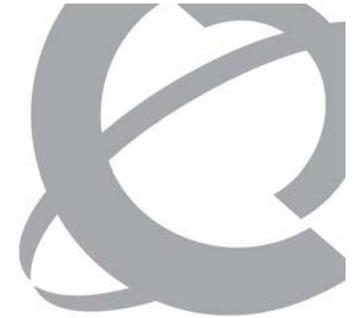




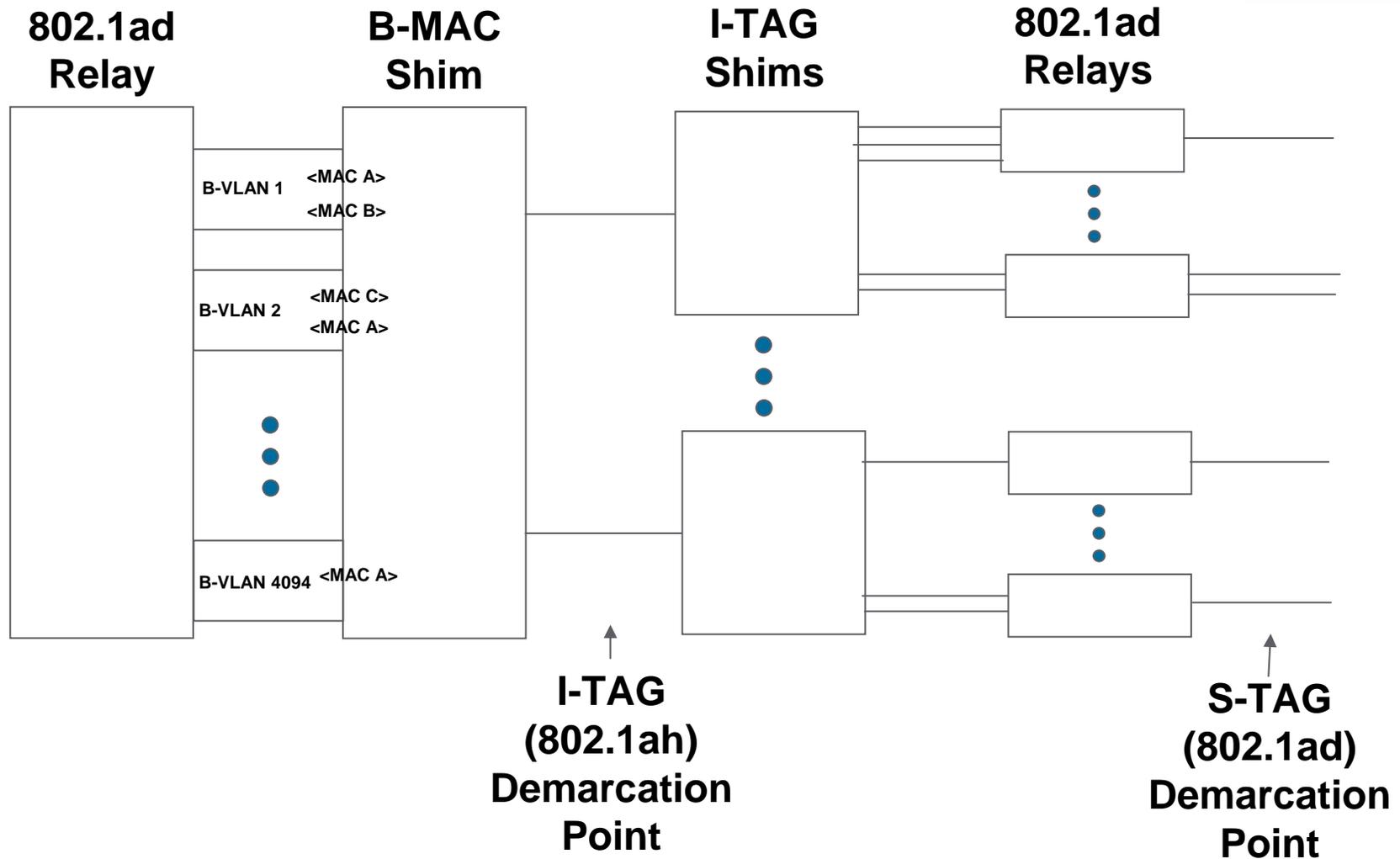
# IEEE P802.1ah Function Breakdown

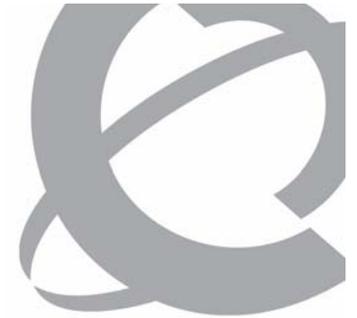


- > The two models in current draft provide a B-MAC and an I-TAG split
- > B-TAG Shim is only required for B-TAG split

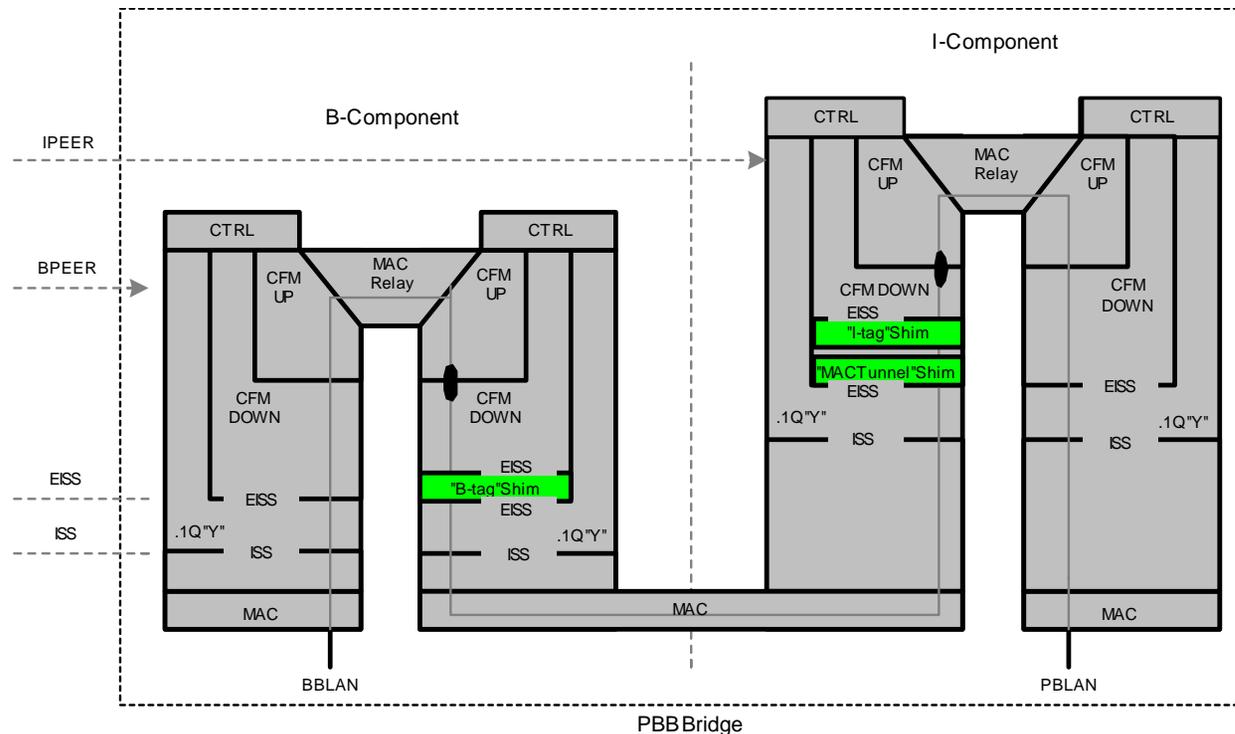


# Top View of Shims





# B-TAG Split

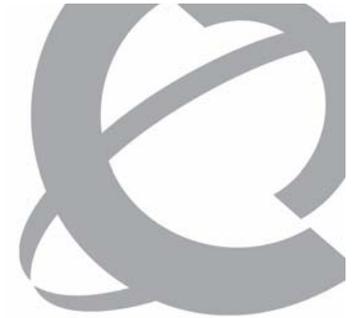


- > Results in an architecture similar to 802.1ad .
- > The B-TAG Shim can be a standard tagging function and the B-component becomes a standard 802.1ad bridge.
- > In this split 4094 I-B interfaces are used each representing a B-VID
- > The I-Component relay is used to direct frames to the correct I-B interface

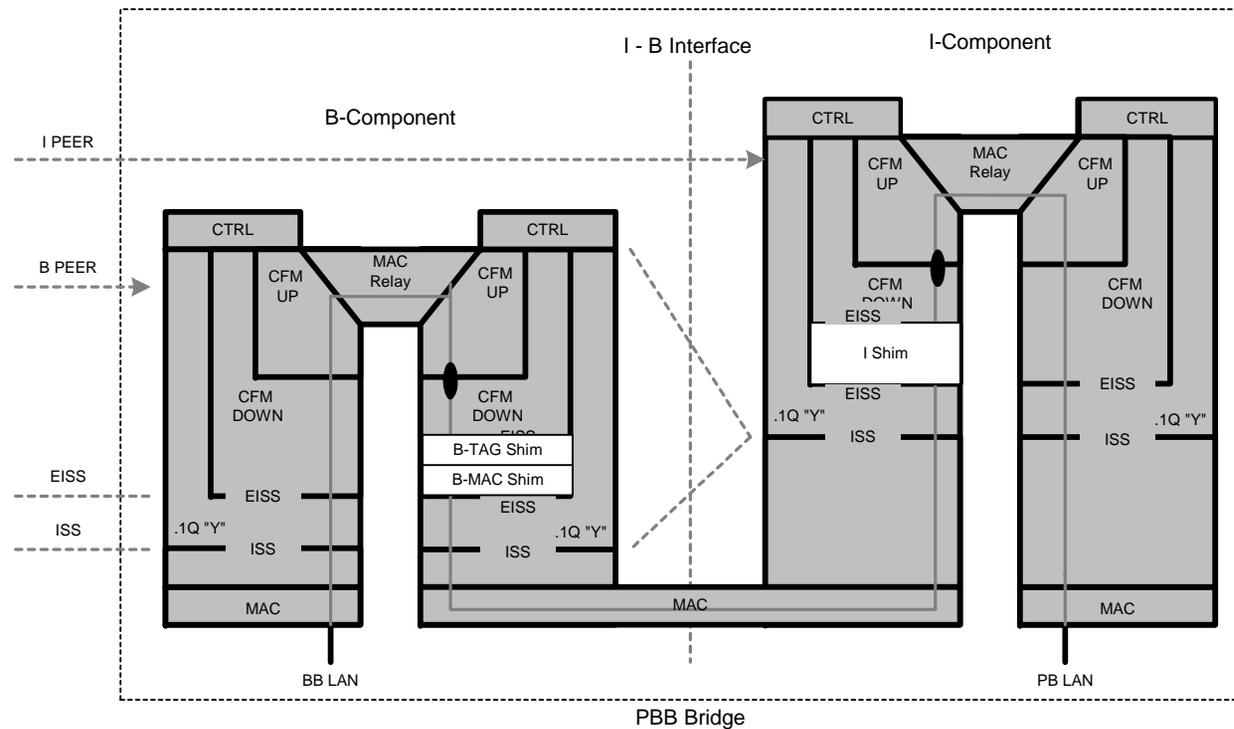


## **B-TAG Split Utility**

- > With an I-B interface for each B-VID any physical implementation will be constrained to a backplane or a virtual backplane within a rack.
- > The architecture is therefore not able to express a practical demarcation point which can be used to connect between a transport and a service organization.
- > When we consider the operation of a protected interface this split will not have any utility in representing the state machines on each side of the demarcation point used to split the interface.



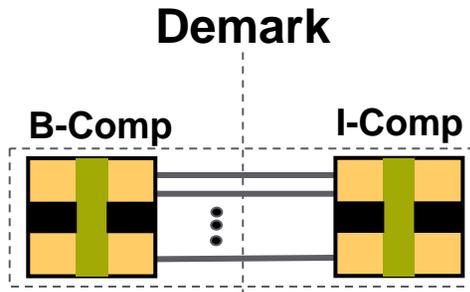
# I-TAG Split



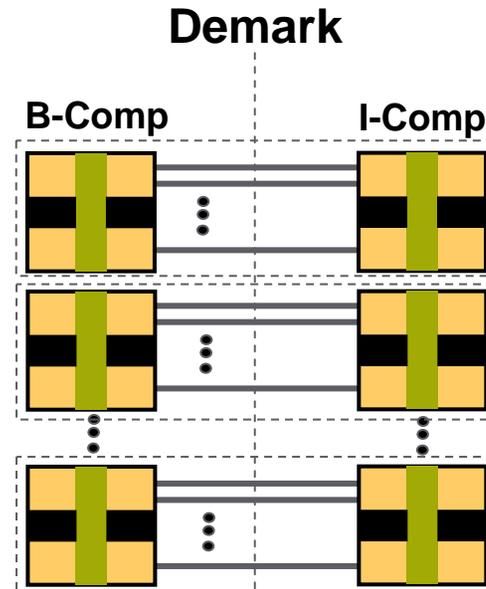
- > Very different model from B-TAG split
- > The I-B interface in the I-TAG split is a single link or a set for links used for redundant interconnect.
- > The I-B interface multiplexes all services over the single (or redundant) physical link. The shims are then responsible for creation of SAPs representing the multiplexed B-VLANs and services.



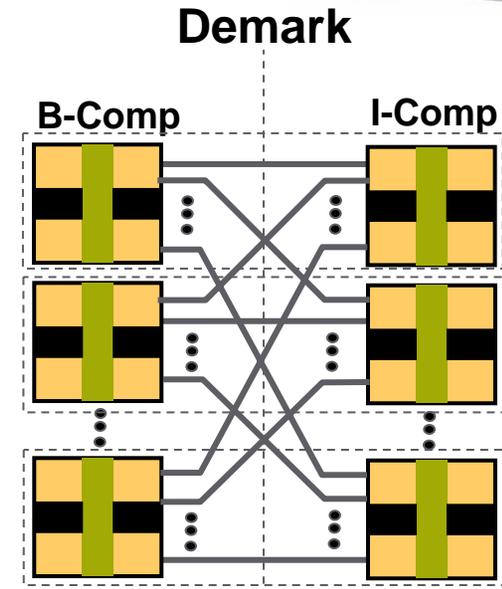
# I-TAG Split Interfaces



- > Class 1:
- > Redundant Links and Non-redundant Switch



- > Class 2:
- > Redundant Links and Redundant Switches



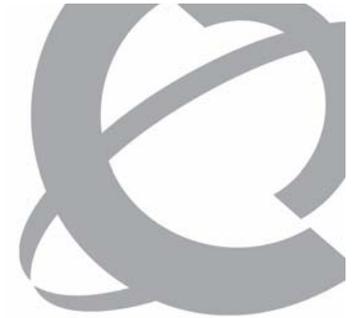
- > Class 3:
- > Redundant Links and Mesh Connected Redundant Switches



# Demarcation Point Qualities

## > Information hiding

- The majority of the topology information for the connected networks is hidden at the demarcation point.
- B-MAC addresses for remote locations on the PBBN should be hidden over the demarcation points.
- B-VIDs and I-SIDs for the PBBN must be able to be hidden.
- Topology information which affects the connected networks must be limited to the extent that recovery actions on each side of the demarcation are controllable.
- The protection architecture must minimize the state changes within the connected networks.
- Connection fault management over the demarcation point uses levels to hide topology information.



## Why a Dual Relay Model?

- > Model needs to provide a means for describing a Demarcation Point(DP) between the PBN and PBBN.
  - The model must allow an implementation where the DP is located on a link between the connected networks
  - The link having the DP must be able to be realized as a protected or unprotected link
  - It must be possible to protect the nodes on both sides of the DP
  - At the DP the topology of the connected networks must be hidden
  - Packets exchanged over the DP may not directly cause topology changes in the attached networks
- > The model needs an I-TAG interface which can be implemented on a real link
  - It must be possible to support a DP on this link with full protection
- > The model needs to support other network than PBN
  - Routers must be able to directly attach to the backbone
  - Interworking Functions(IWF) to networks such as TDM must be able to directly attach to the backbone

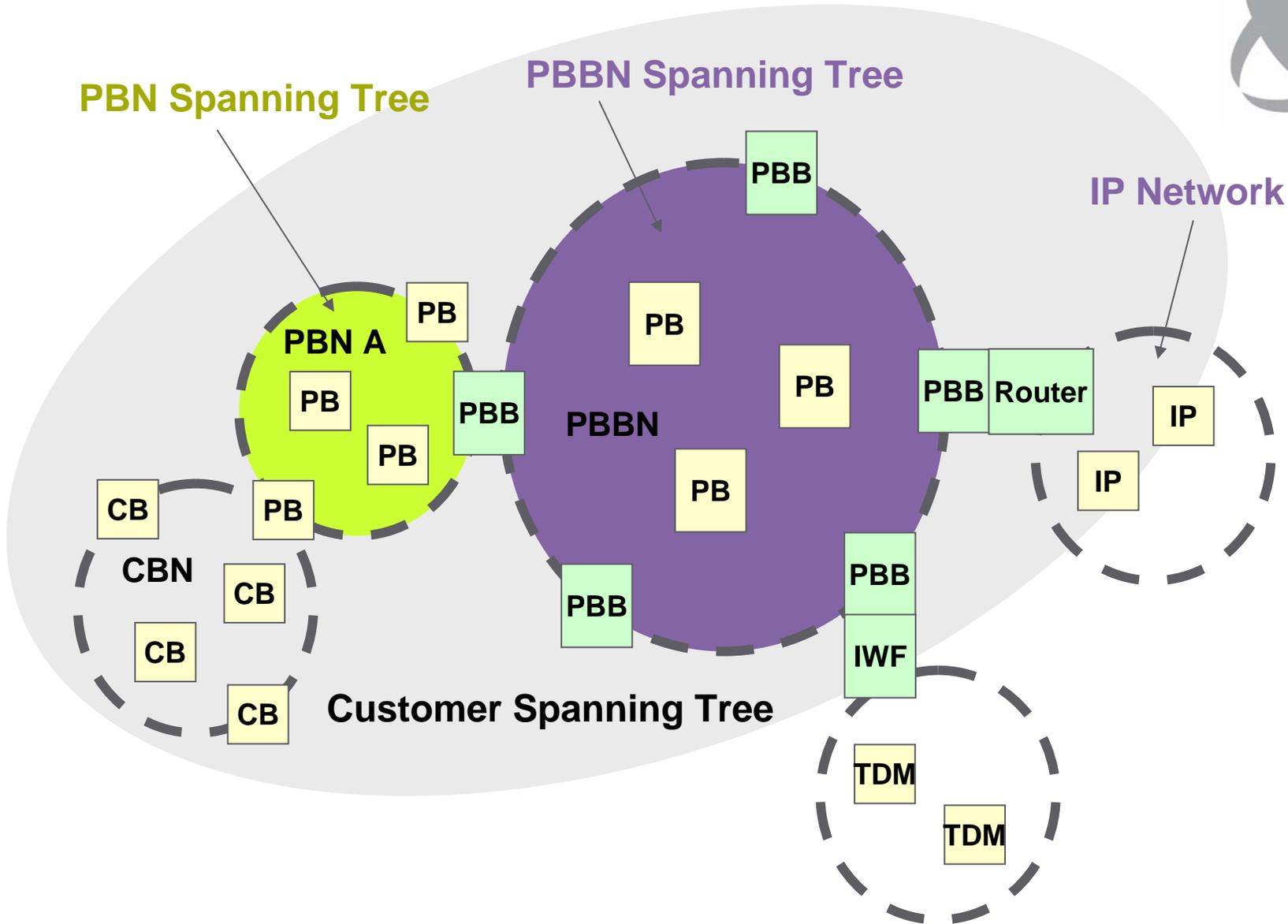


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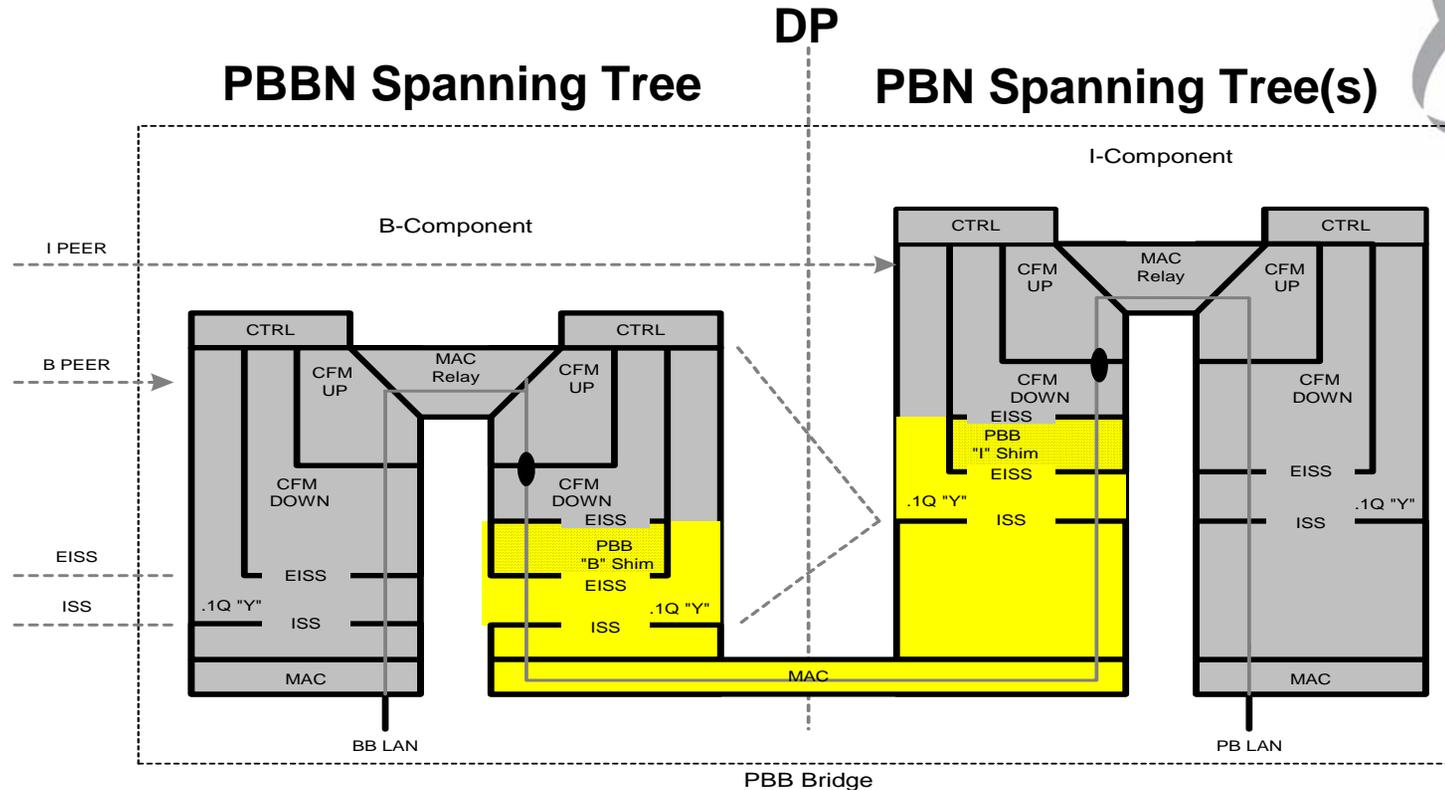
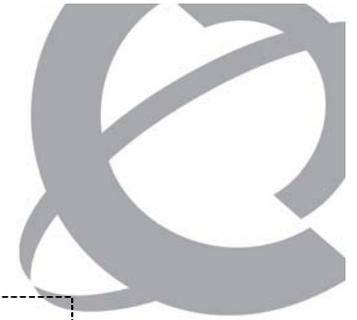
# Backup Slides

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# 802.1ah to Other Network

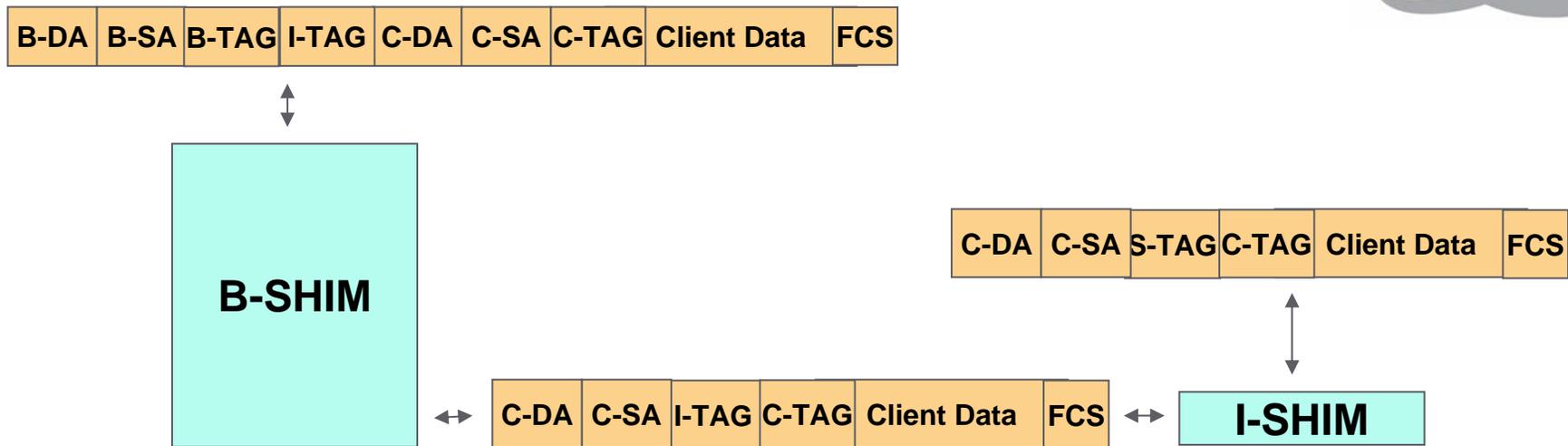


# Shims May Split Functions Anywhere



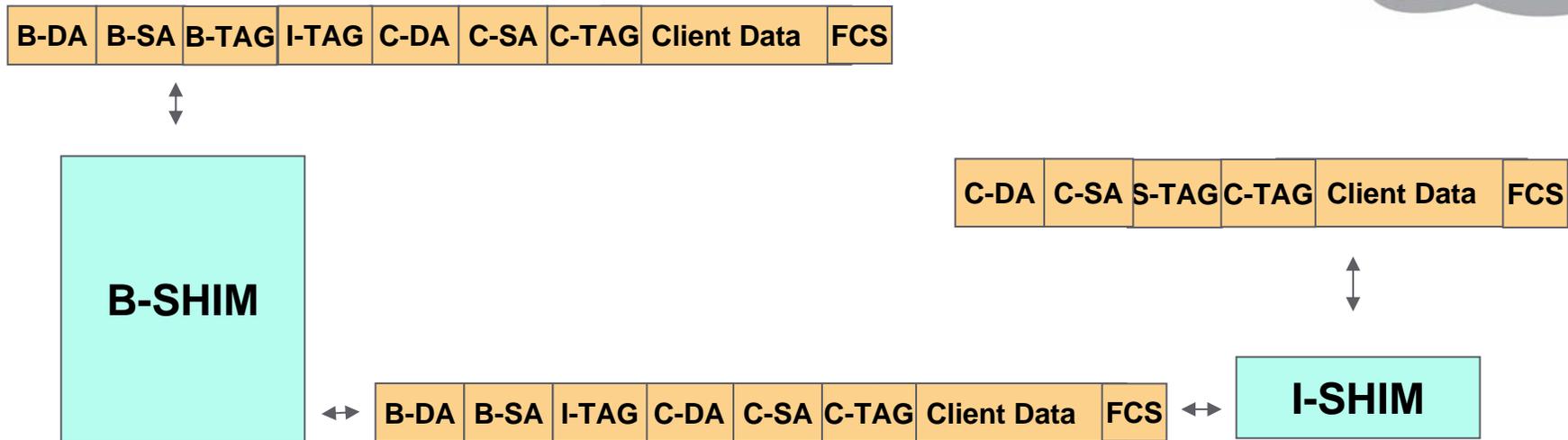
- > Entire yellow region may be considered a single shim with functions divided to either side of the interconnect
- > The B-Comp is part of the PBBN spanning tree while the I-Comp is part of the PBN spanning tree. The DP is on a physical or virtual wire. If it is physical it must be realizable as a single unprotected wire.
- > The DP point must provide the I-TAG interface

# Current Reference Model: Alternative 1



- > I to B Shim format “naked I-TAG” in I-Format
  - Minimum frame information between I-Shim and B-Shim
  - B-Shim transform is irregular since I-TAG is moved in frame
  - B-Shim upside down since frame grows moving upward
- > I to B Shims are 1-1
- > I-Shim function is very thin while B-Shim does most of work

# Alternative 2



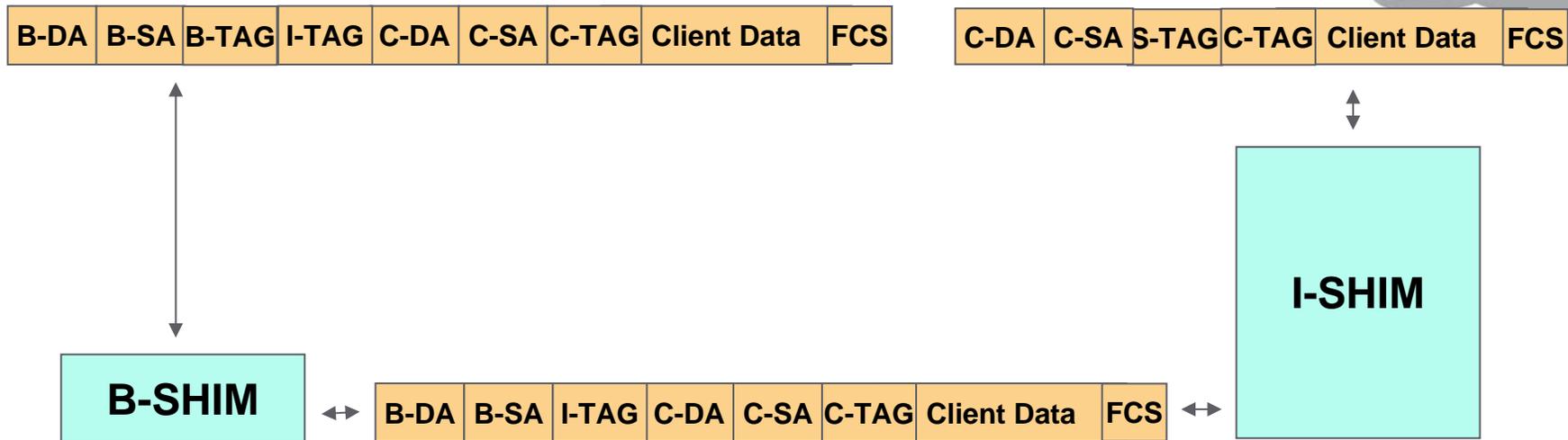
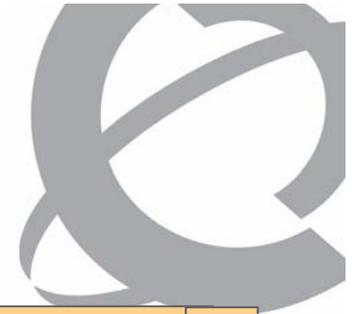
> I to B Shim format “naked I-TAG” in B-Format

- B-DA is dummy field
- B-Shim transform is regular
- B-Shim right side up

> I to B Shims are 1-1

> I-Shim function is thin while B-Shim does most of work

# Alternative 3



> I to B Shim format “naked I-TAG” in B-Format

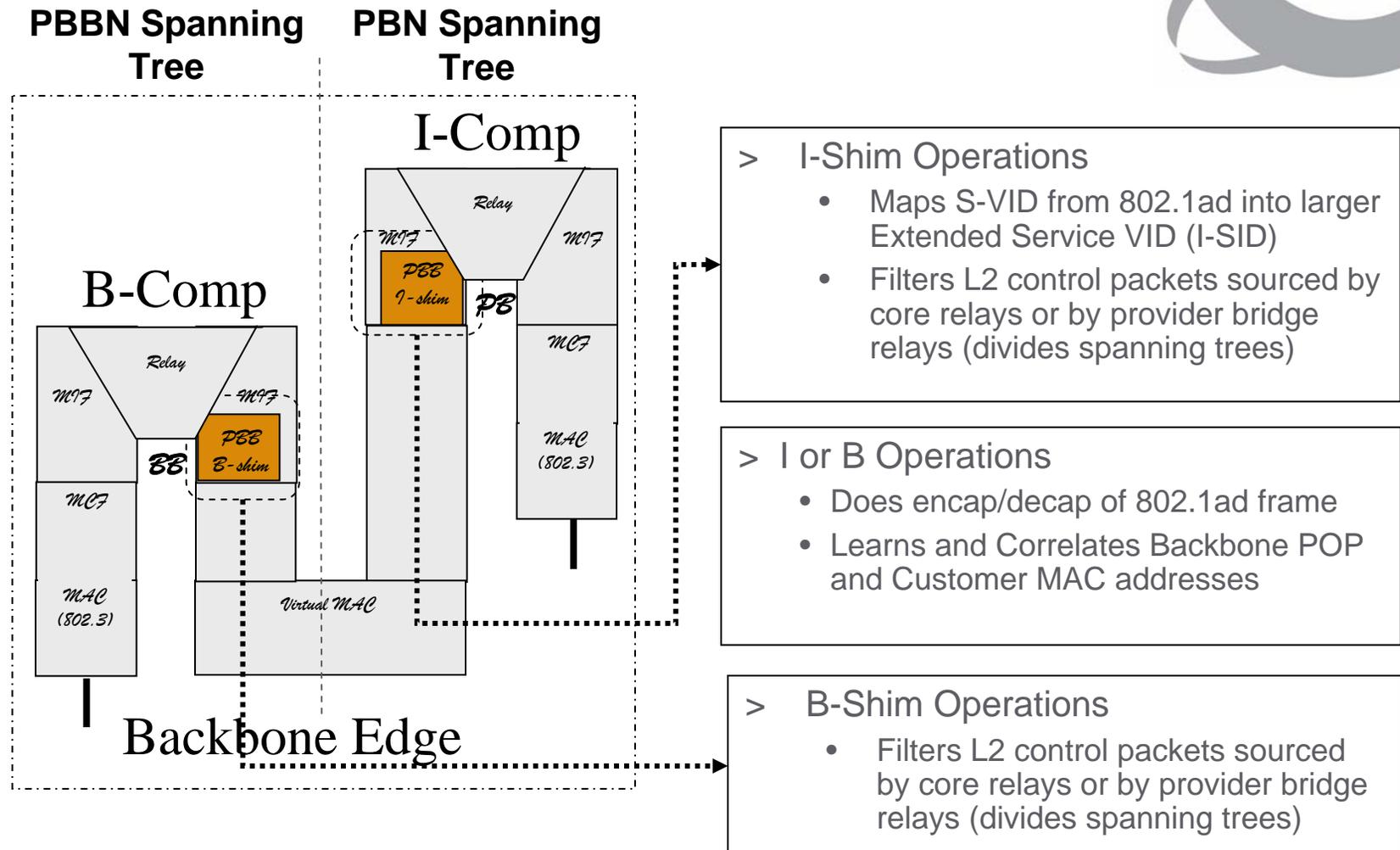
- B-DA functions handled by I-Shim
- B-Shim transform is regular
- B-Shim right side up

> I to B Shims are 1-1

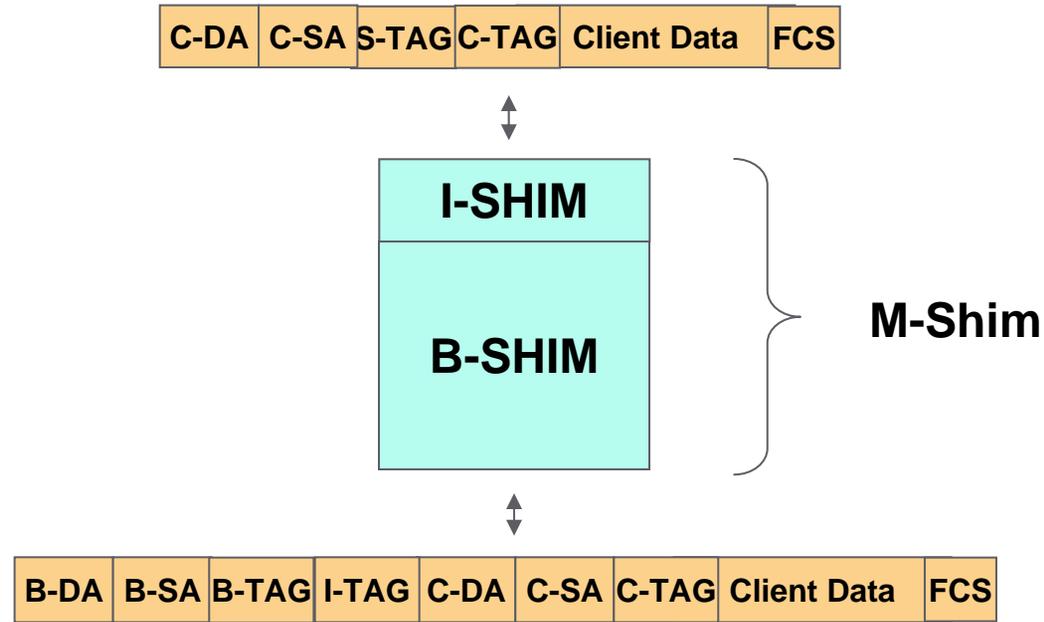
> I-Shim function is thick while B-Shim only handles B-TAG



# PBB I & B Shim Alternatives 1-3



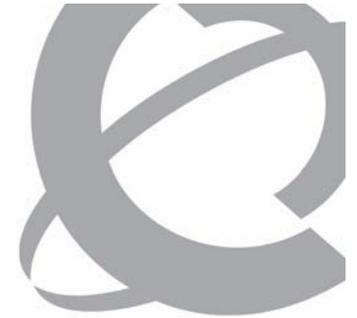
# Alternative 4



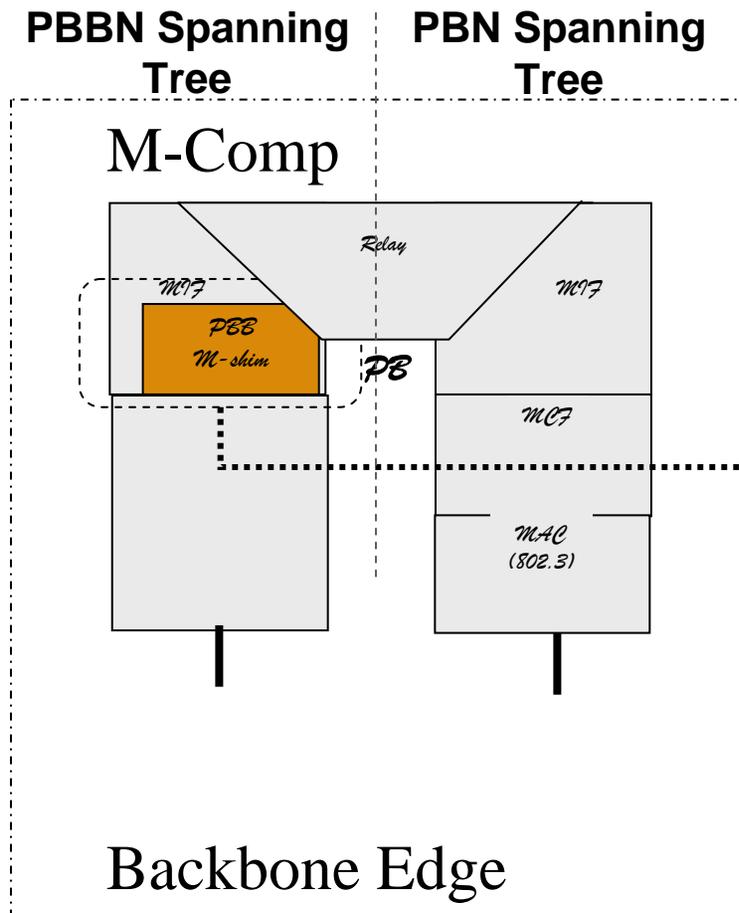
> I and B Shim combined into an M-Shim

- All functions contained in single shim
- Model becomes a single relay model
- Functions are right side up
- Spanning tree splits in the middle of the relay

> No middle level interface exposed by architecture



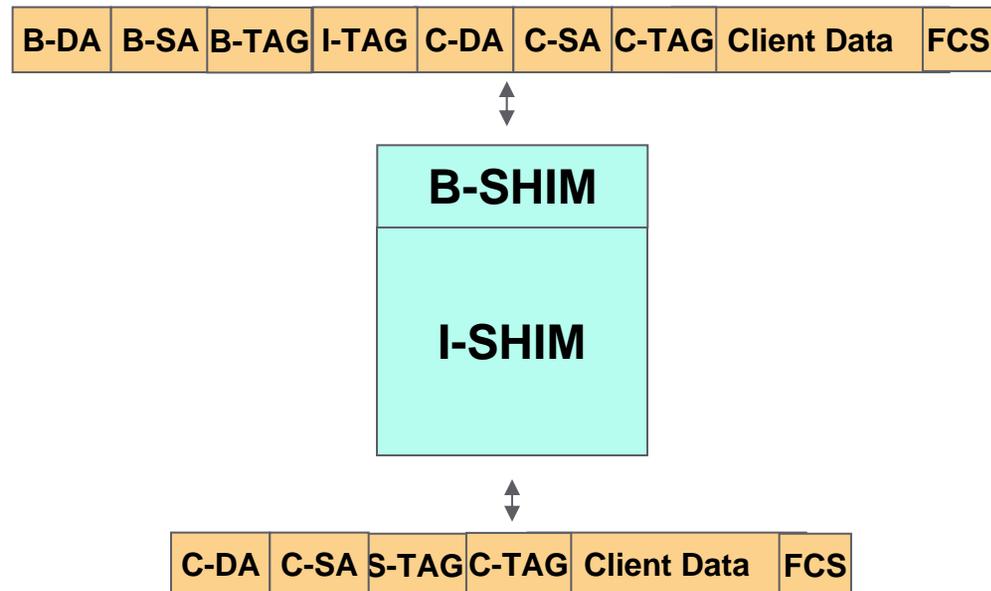
# PBB I & B Shim Alternatives 4



## > M-Shim Operations

- Maps S-VID from 802.1ad into larger Extended Service VID (I-SID)
- Filters L2 control packets sourced by core relays or by provider bridge relays (divides spanning trees)
- Does encap/decap of 802.1ad frame
- Learns and Correlates Backbone POP and Customer MAC addresses
- Filters L2 control packets sourced by core relays or by provider bridge relays (divides spanning trees)

# Alternative 5



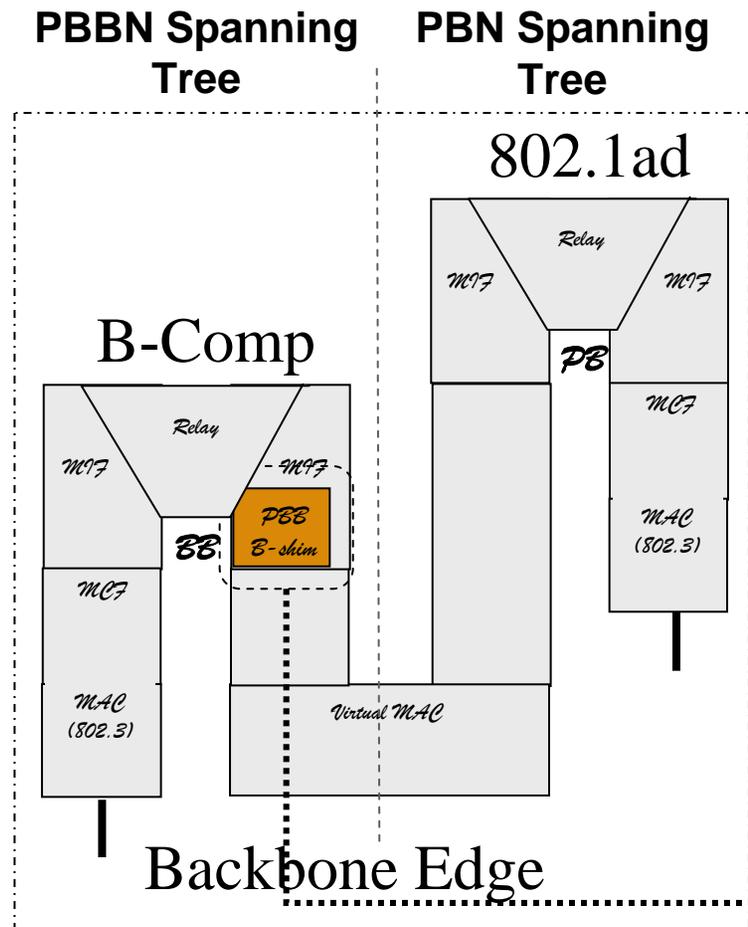
> I and B Shim combined into an M-Shim

- All functions contained in single shim
- Model becomes a single relay model
- Functions are right side up
- Spanning tree splits on link

> No middle level interface exposed by architecture

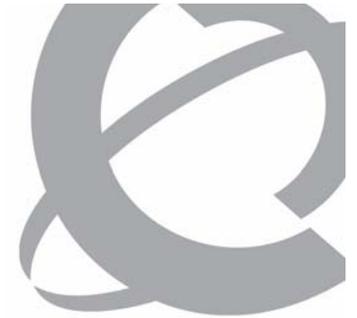


# PBB I & B Shim Alternatives 5

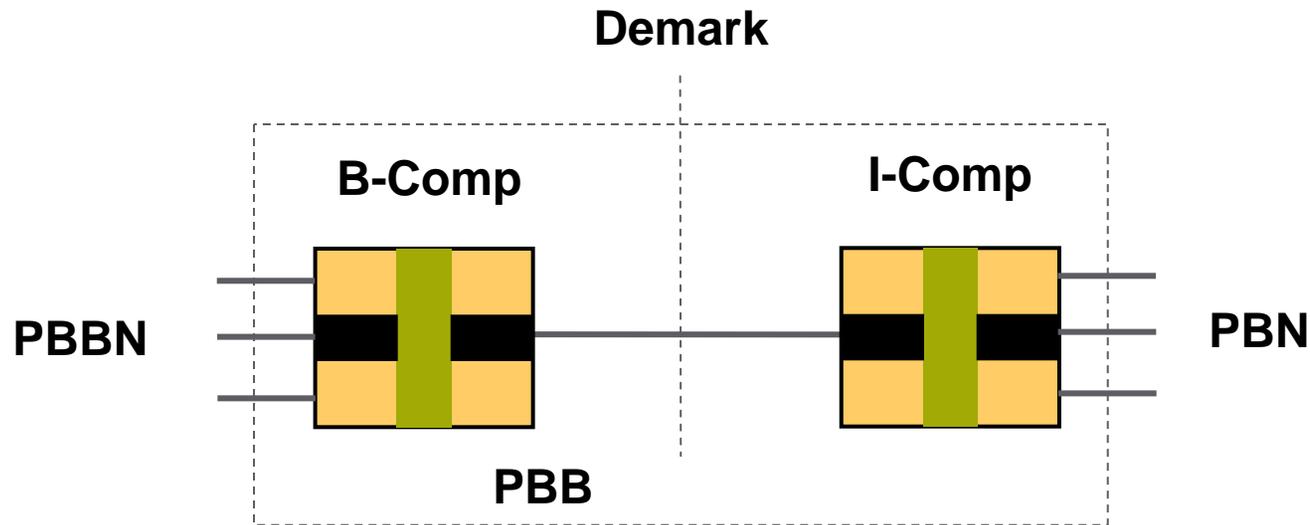


## > I & B -Shim Operations

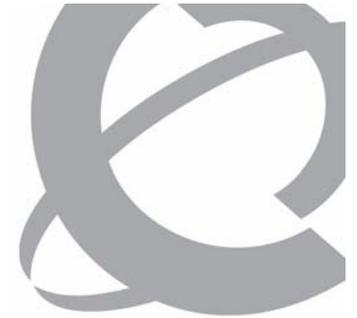
- Maps S-VID from 802.1ad into larger Extended Service VID (I-SID)
- Filters L2 control packets sourced by core relays or by provider bridge relays (divides spanning trees)
- Does encap/decap of 802.1ad frame
- Learns and Correlates Backbone POP and Customer MAC addresses
- Filters L2 control packets sourced by core relays or by provider bridge relays (divides spanning trees)



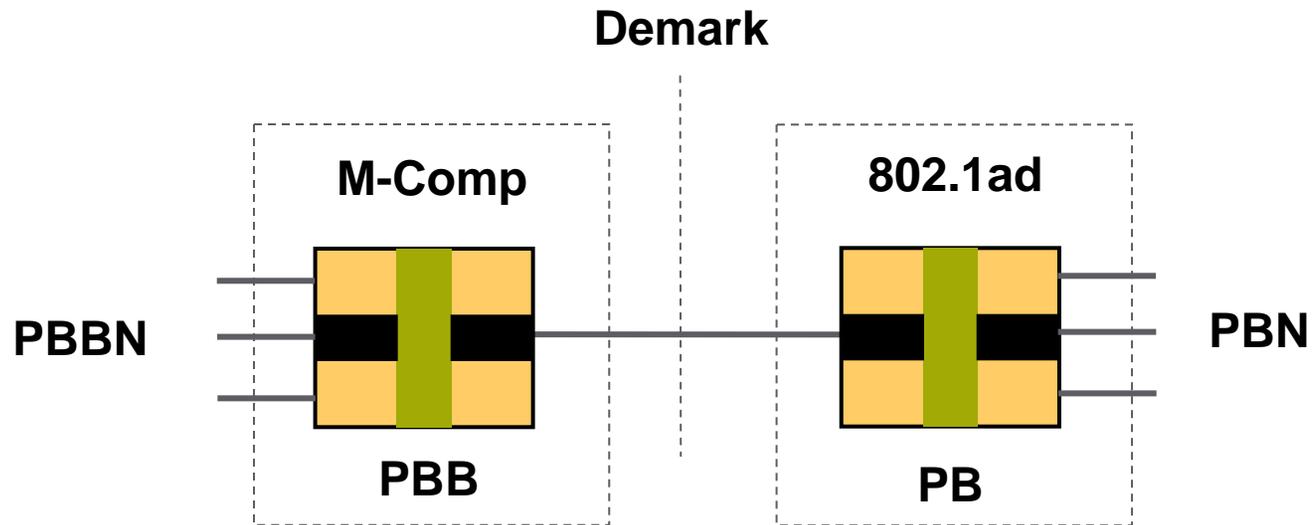
## Alternatives 1-3: PBN to PBBN Demark



- > I-Shim and B-Shim 1-1 connected
- > Single I-B Shim pair forms interconnect of PBN and PBBN
- > Spanning trees split between B-Comp to I-Comp
- > Implementation may be a single box or two boxes



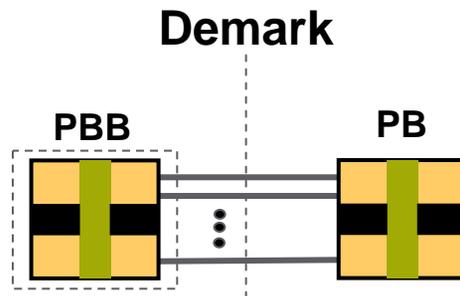
## Alternatives 4: PBN to PBBN Demark



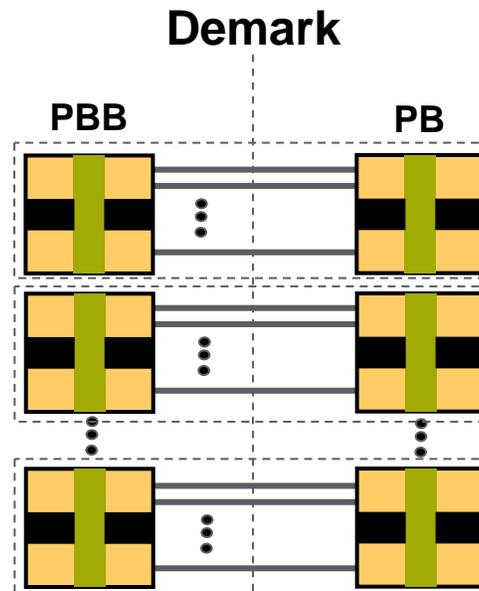
- > Interconnect of PBN and PBBN is between a PBB and a PB
- > Spanning trees split between in middle of M relay



## Redundant Interconnects: Alternative 4



- > Class 1:
- > Redundant Links and Non-redundant Switch



- > Class 2:
- > Redundant Links and Redundant Switches

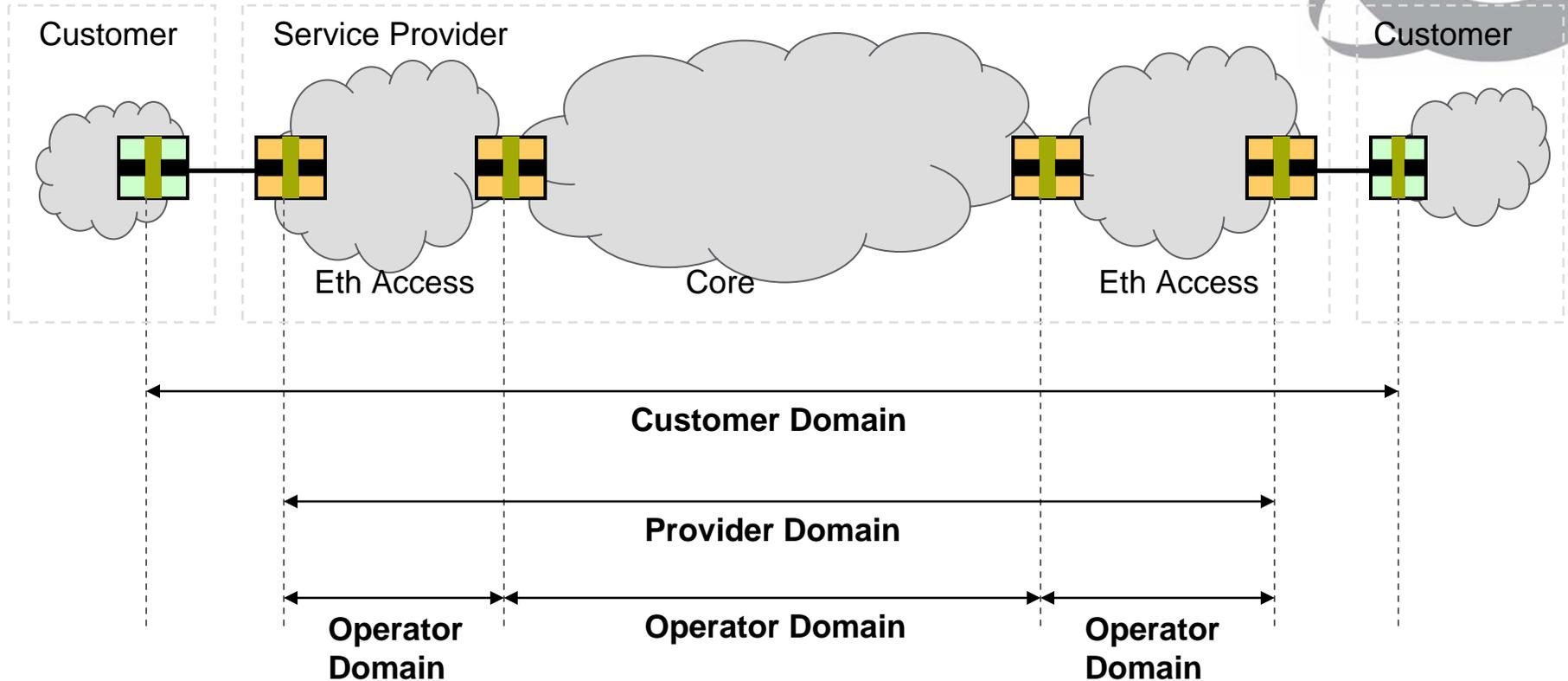
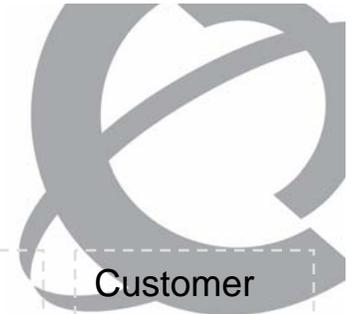
- > Class 3:
- > Probably outside model



## Recommendations

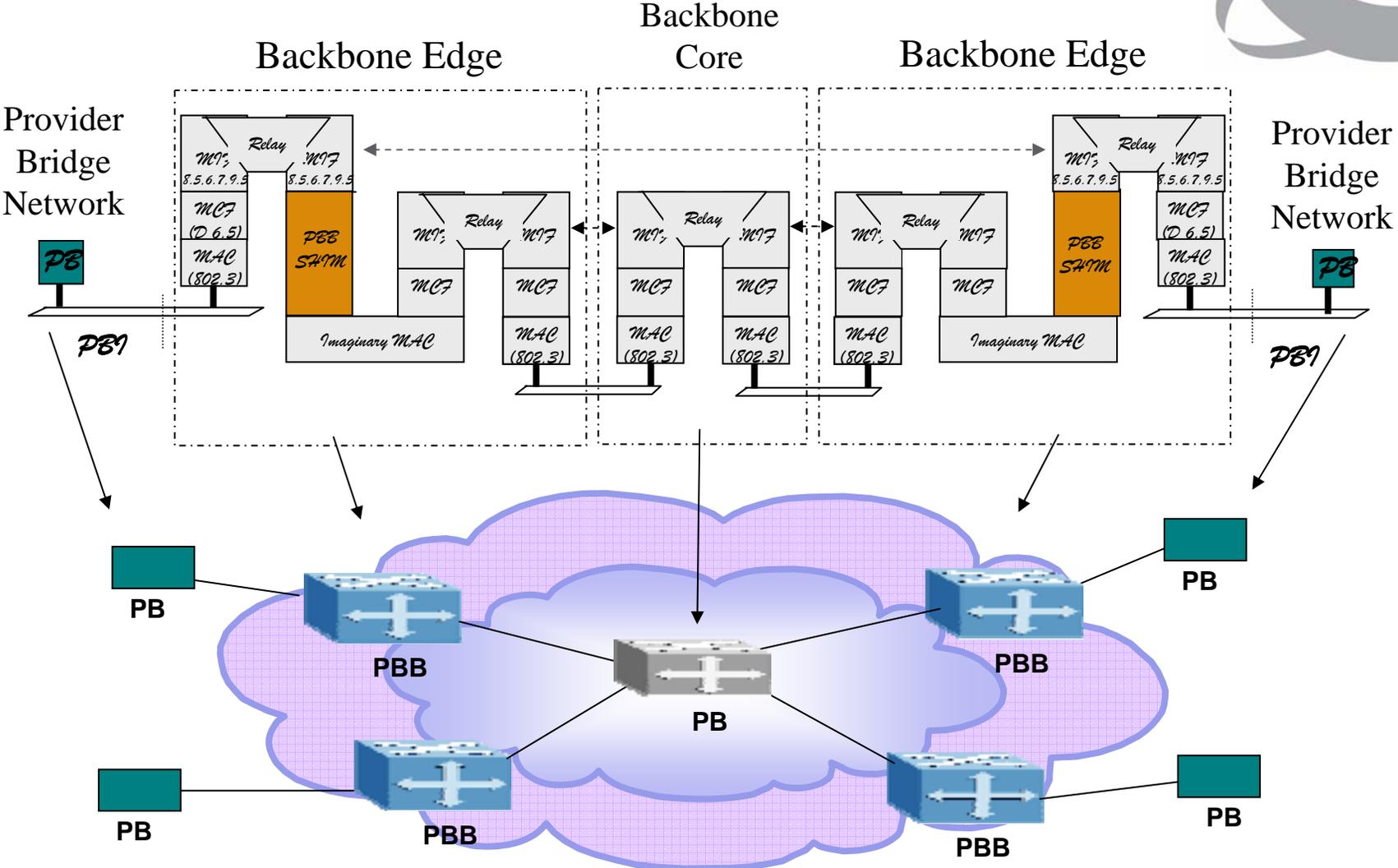
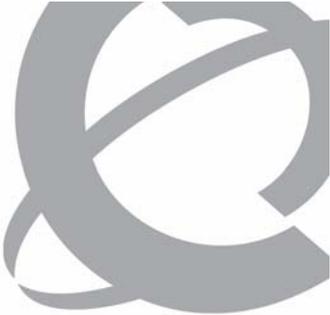
- > Any of the reference models can work
- > The dual relays create internal frame format
- > Alternative 2 dual relay will provide regular frame transformations and right-side up operation
- > Alternative 4 is probably the simplest

# Multiple Domain Management

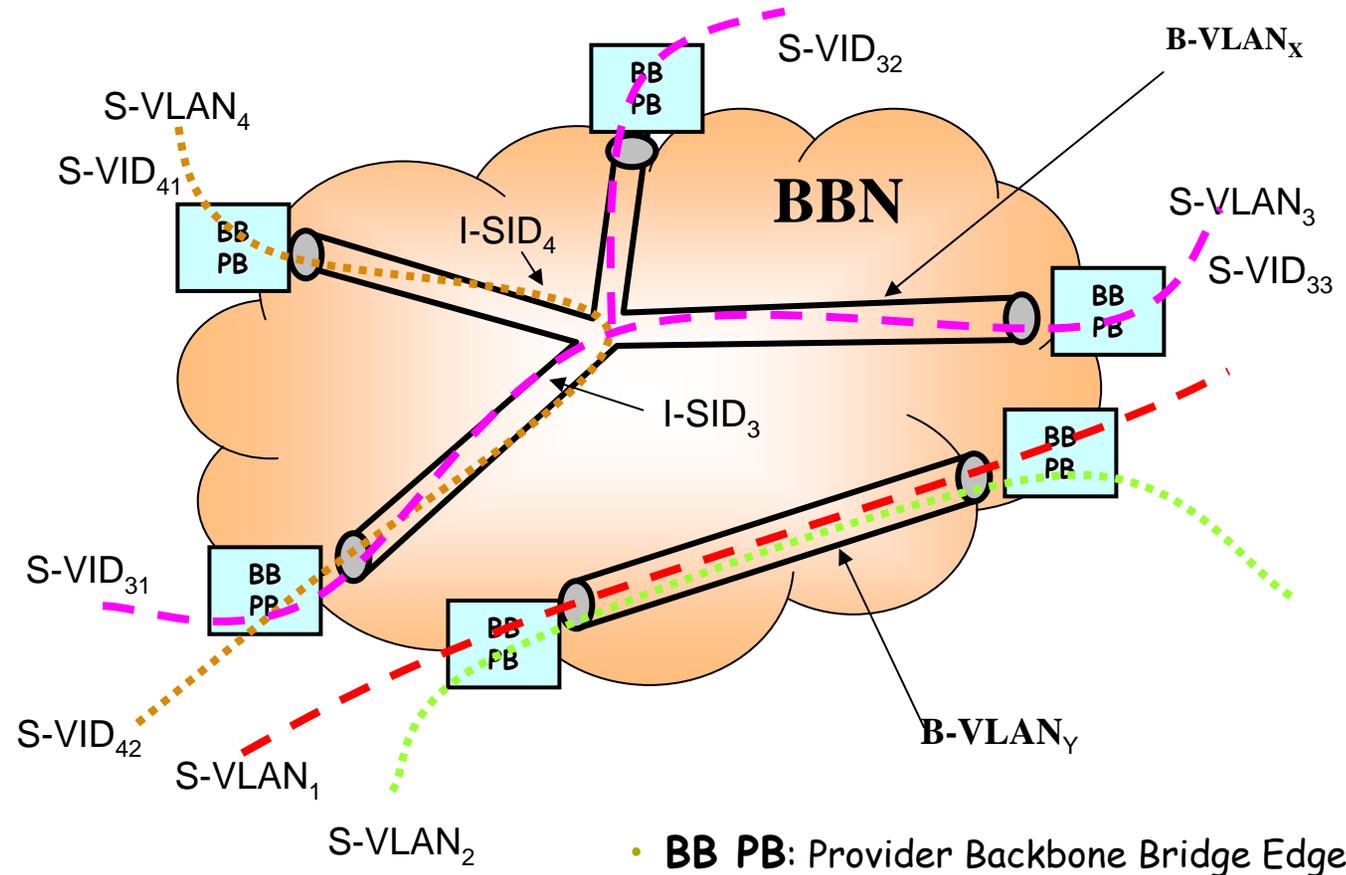
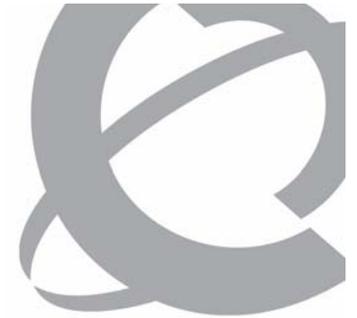


- > Ongoing work at IEEE 802.1ag, ITU SG13 Y.17ethoam, MEF
- > IEEE P802.1ag Service OAM flows at multiple levels.
- > Ethernet Service OAM allows multiple autonomous networks.

# PBB Peer Model

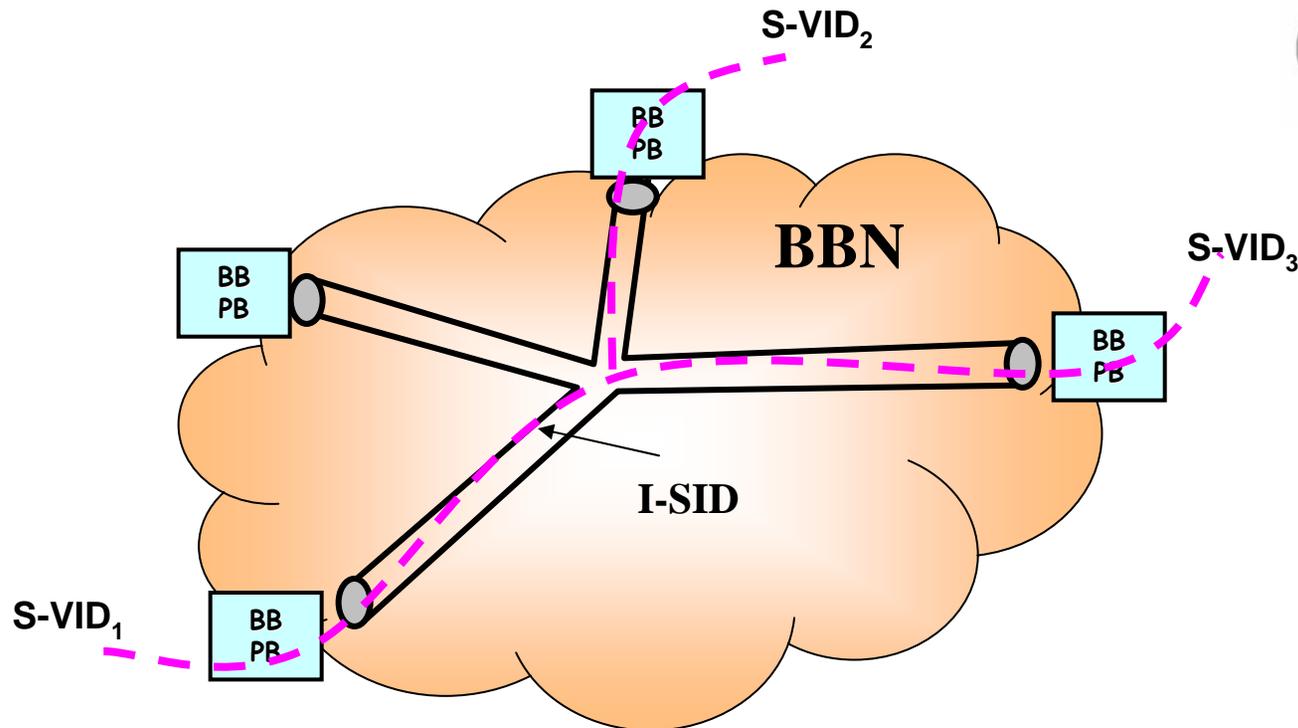
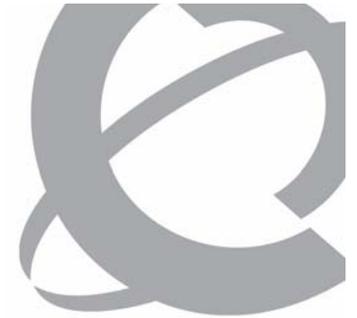


# Extended Service VLAN IDs In Backbone



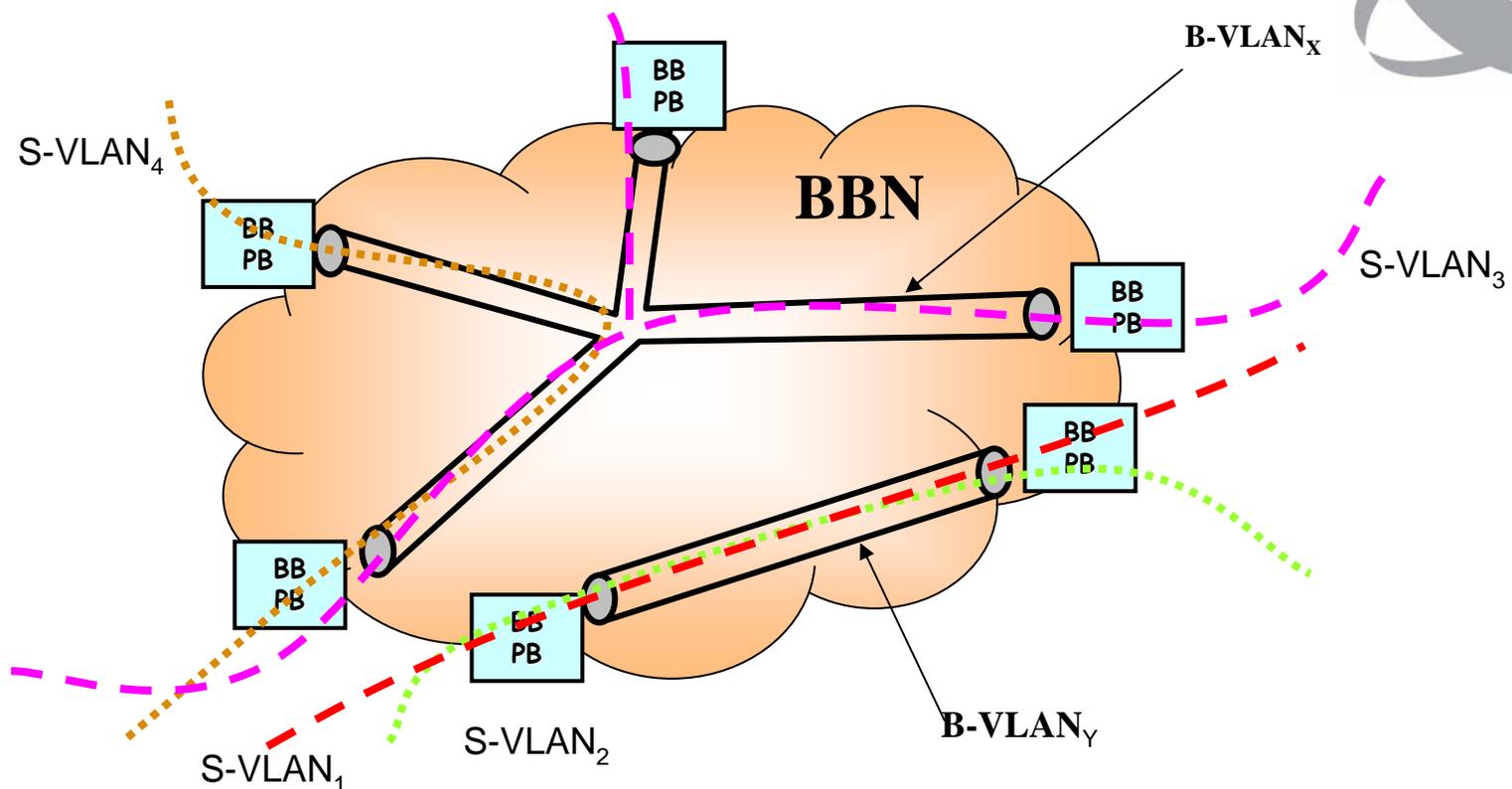
- An I-SID uniquely identifies a S-VLAN within the Backbone
- The MAP Shim translates between S-VID and I-SID
- The I-SID to(from) S-VID mapping is provisioned when a new service instance is created

# Single I-SID per S-VLAN



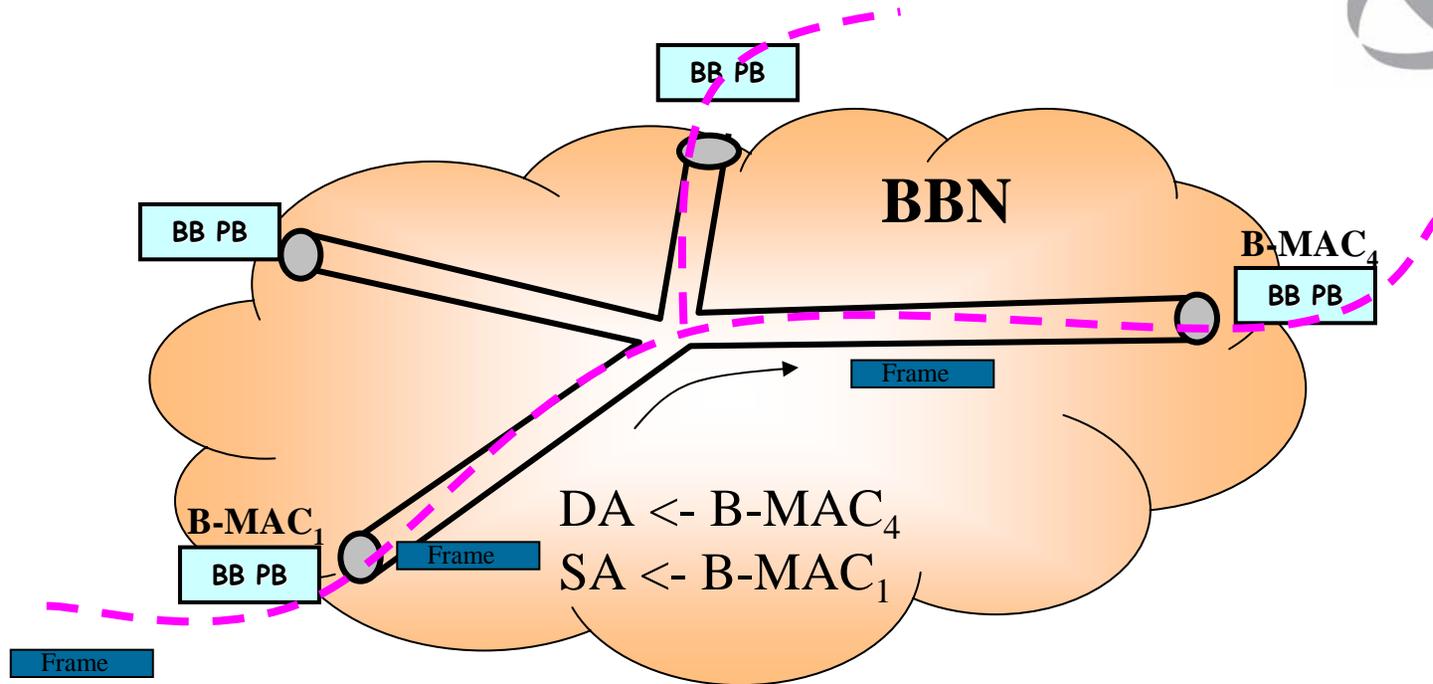
- > Regardless of the I-SID address size the map tables only have 4096 entries since only one I-SID exists per S-VLAN and only 4096 S-VLANs exist per Provider Bridge.
- > A different S-VID in each PBN maps to the I-SID

# Site Connectivity B-VLAN ID

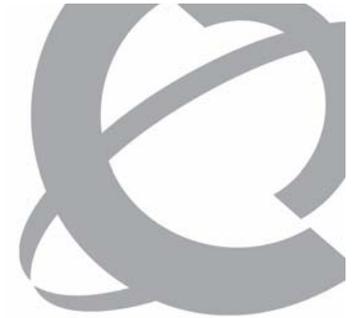


- > B-VLANs are addressed like regular VLANs with a 12 bit B-VID
- > B-VID and I-SID need to be separate ID spaces to allow many S-VLANs to be carried in a single B-VLAN

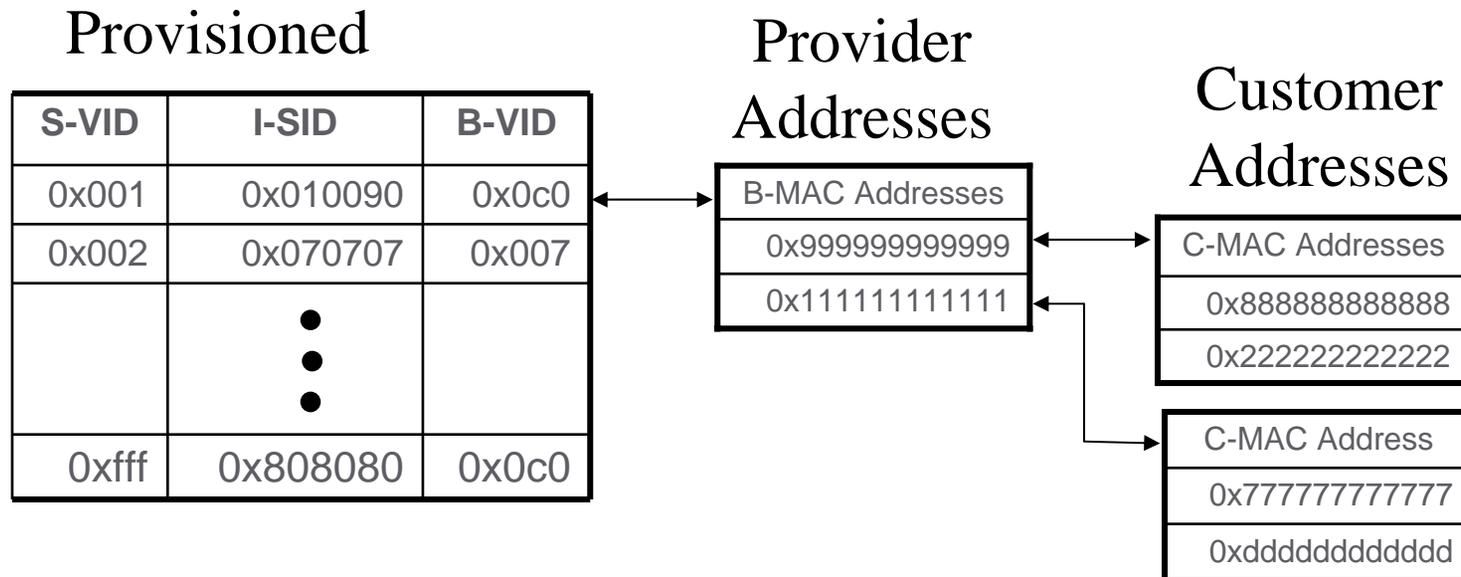
# Backbone POP MAC Address



- > B-MAC Addresses identify the Edge Provider Backbone Bridges (BB PB)
- > B-MAC Addresses are learned by other Edge Backbone Edge Bridges
- > The backbone edge MAC address determines which edge on the B-VLAN will receive the frame.
- > Frames may be flooded by sending with broadcast or multicasts DA B-MACs to the B-VLAN.
- > Map shims filter based on the I-SID removing any misaddressed frames



# MAP Shim Correlation Table



- > In the beginning the MAP Shim is provisioned with the correlation between the S-VID, I-SID, and B-VID
- > During operation the MAP Shim learns both B-MAC addresses and C-MAC addresses
- > The MAP Shim keeps track of which C-MAC addresses are behind which B-MAC
- > The correlation data is used to encapsulate frames from the PBNs