Packet Path through QinQ and PBB Switched Network
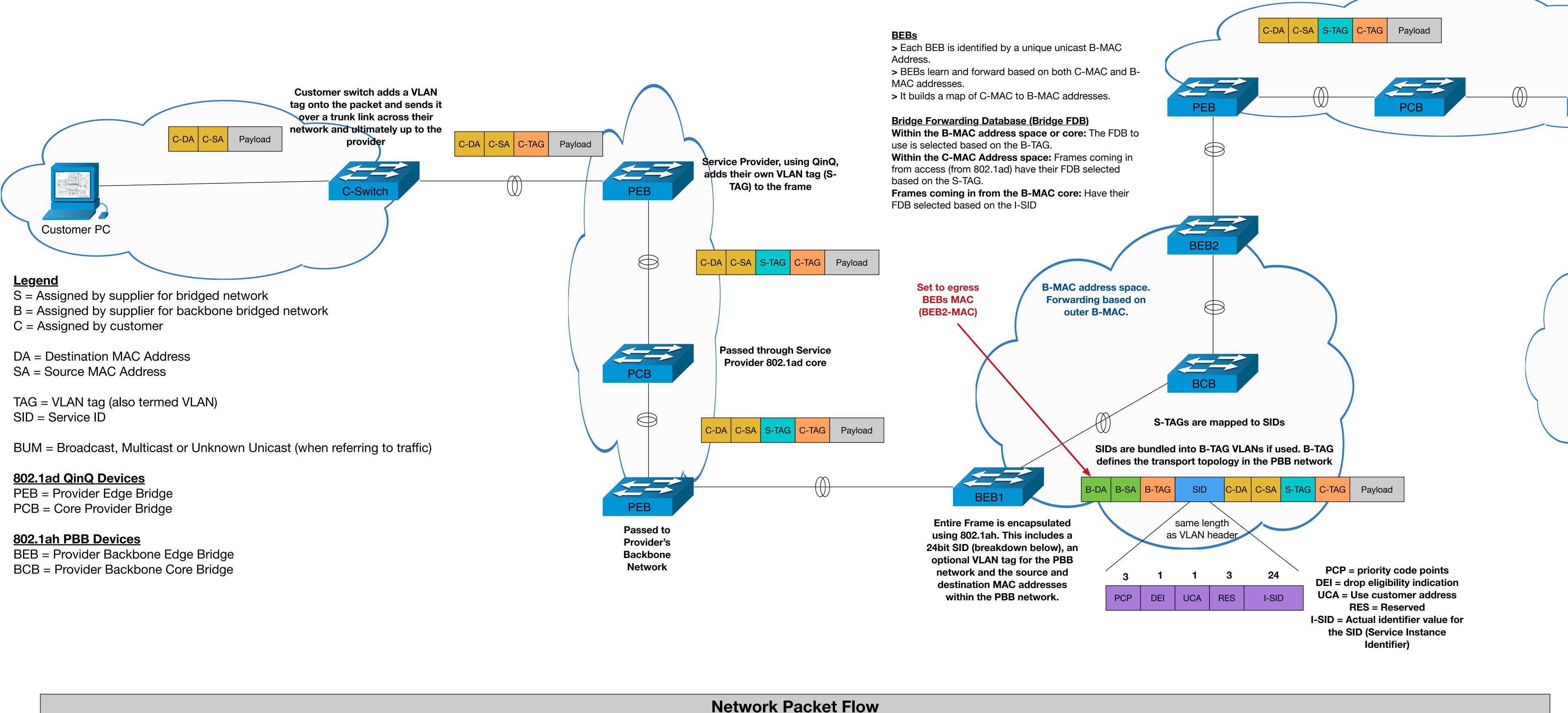
by Steven Crutchley

Customer switch adds a VLAN tag onto the packet and sends it over a trunk link across their network and ultimately up to the provider

C-DA | C-SA | Payload

C-DA | C-SA | C-TAG | Payload

Customer PC

C-Switch

PEB

Service Provider, using QinQ, adds their own VLAN tag (S-TAG) to the frame

C-DA | C-SA | S-TAG | C-TAG | Payload

Passed through Service Provider 802.1ad core

PCB

C-DA | C-SA | S-TAG | C-TAG | Payload

Passed to Provider's Backbone Network

PEB

BEB1

Legend
S = Assigned by supplier for bridged network
B = Assigned by supplier for backbone bridged network
C = Assigned by customer

DA = Destination MAC Address
SA = Source MAC Address

TAG = VLAN tag (also termed VLAN)
SID = Service ID

BUM = Broadcast, Multicast or Unknown Unicast (when referring to traffic)

802.1ad QinQ Devices
PEB = Provider Edge Bridge
PCB = Core Provider Bridge

802.1ah PBB Devices
BEB = Provider Backbone Edge Bridge
BCB = Provider Backbone Core Bridge

BEBs
> Each BEB is identified by a unique unicast B-MAC Address.
> BEBs learn and forward based on both C-MAC and B-MAC addresses.
> It builds a map of C-MAC to B-MAC addresses.

Bridge Forwarding Database (Bridge FDB)
Within the B-MAC address space or core: The FDB to use is selected based on the B-TAG.
Within the C-MAC Address space: Frames coming in from access (from 802.1ad) have their FDB selected based on the S-TAG.
Frames coming in from the B-MAC core: Have their FDB selected based on the I-SID.

Set to egress BEBs MAC (BEB2-MAC)

B-MAC address space. Forwarding based on outer B-MAC.

PEB — **PCB** — **PEB**

C-DA | C-SA | S-TAG | C-TAG | Payload

BEB2

BCB

S-TAGs are mapped to SIDs

SIDs are bundled into B-TAG VLANs if used. B-TAG defines the transport topology in the PBB network

B-DA | B-SA | B-TAG | SID | C-DA | C-SA | S-TAG | C-TAG | Payload

same length as VLAN header

Entire Frame is encapsulated using 802.1ah. This includes a 24bit SID (breakdown below), an optional VLAN tag for the PBB network and the source and destination MAC addresses within the PBB network.

3	1	1	3	24
PCP	DEI	UCA	RES	I-SID

PCP = priority code points
DEI = drop eligibility indication
UCA = Use customer address
RES = Reserved
I-SID = Actual identifier value for the SID (Service Instance Identifier)

C-DA | C-SA | S-TAG | C-TAG | Payload

C-Switch

C-DA | C-SA | Payload

Customer PC

C-DA | C-SA | C-TAG | Payload

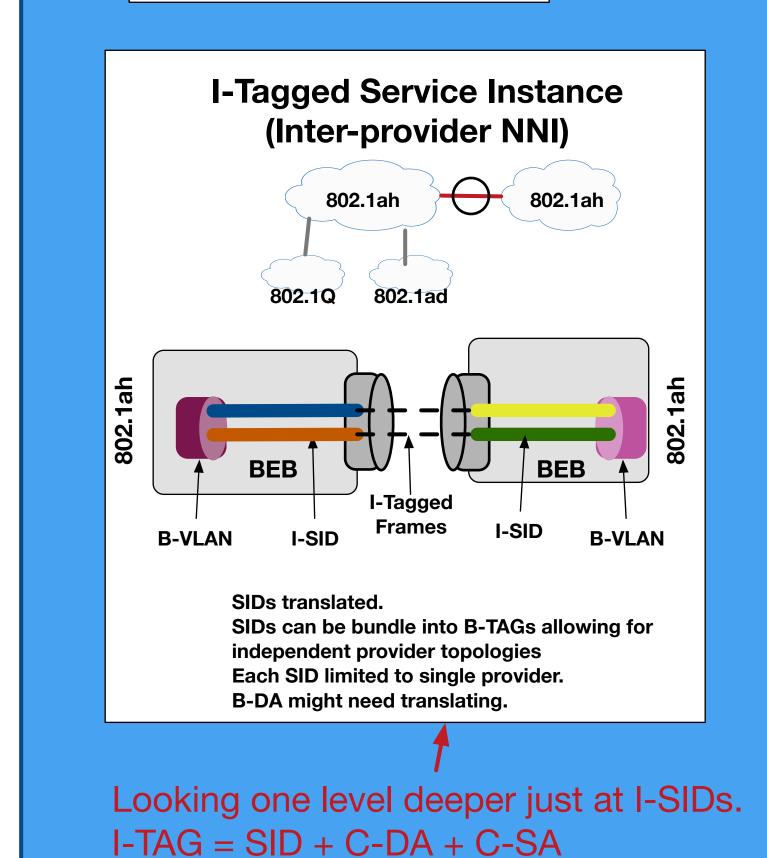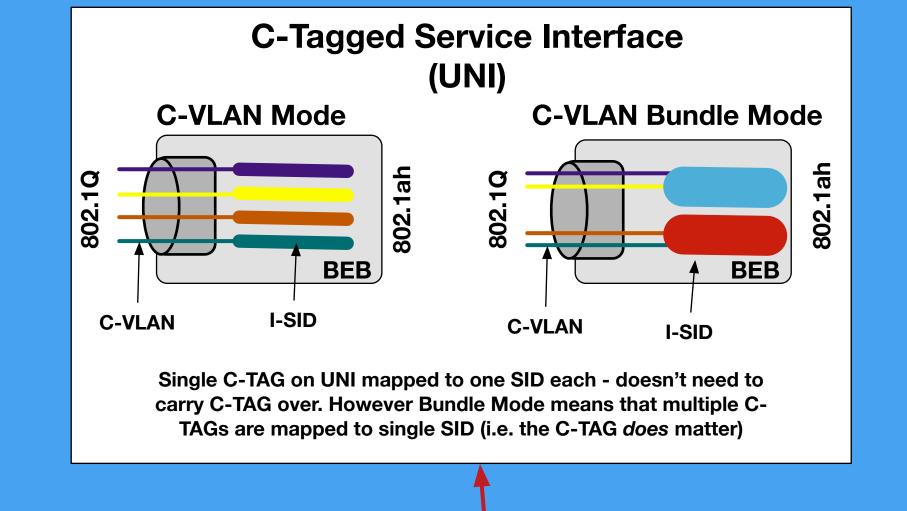**Each I-SID will have a multicast group for BUM traffic, so think how this will affect things if many customers map to one I-SID (See BUM Network Packet Flow diagrams below)**

Looking at S-TAG Service Interfaces (below) as an example - this depends on how customers are mapped to S-TAGs or SIDs. It could be one customer per S-TAG in the 802.1ad realm. If the provider doesn't want to separate them in the core you could use S-TAG Port Mode. Or give them each their own setup and use S-TAG Mode. Or some customers could use multiple S-TAGs (in which case you might what S-TAG Bundle Mode). Or maybe each customer *does* only have one S-TAG each and you want to give a fixed number of internal topologies rather than one each (also Bundle Mode), similar to mapping VLANs to MSTP instances…

Service Instances
(In these diagrams the term TAG has been replaced with VLAN)

Port-Based Service Interface (UNI)
you only care about the PORT. Not the tagging.

802.1ah — 802.1ad
802.1Q | 802.1ad

Port Mode
802.1Q ... BEB ... 802.1ah
C-VLAN — I-SID

C-TAGs, Untagged and Priority tagged frames all map to one SID.

S-Tagged Service Interface (UNI)

802.1ah — 802.1ah
802.1Q | 802.1ad

Port Mode
802.1ad ... BEB ... 802.1ah
S-VLAN — I-SID
All S-TAGs map to one SID

S-VLAN Mode
802.1ad ... BEB ... 802.1ah
S-VLAN — I-SID
Each S-TAG maps to own SID

S-VLAN Bundle Mode
802.1ad ... BEB ... 802.1ah
S-VLAN — I-SID
Some S-TAGs map to some SIDs

I-Tagged Service Instance (Inter-provider NNI)
802.1ah — 802.1ah
802.1Q | 802.1ad

B-VLAN ... BEB ... I-Tagged Frames ... BEB ... B-VLAN
B-VLAN | I-SID ... I-SID | B-VLAN

SIDs translated.
SIDs can be bundle into B-TAGs allowing for independent provider topologies
Each SID limited to single provider.
B-DA might need translating.

Looking one level deeper just at I-SIDs.
I-TAG = SID + C-DA + C-SA

C-Tagged Service Interface (UNI)

C-VLAN Mode
802.1Q ... BEB ... 802.1ah
C-VLAN — I-SID

C-VLAN Bundle Mode
802.1Q ... BEB ... 802.1ah
C-VLAN — I-SID

Single C-TAG on UNI mapped to one SID each - doesn't need to carry C-TAG over. However Bundle Mode means that multiple C-TAGs are mapped to single SID (i.e. the C-TAG does matter)

In this instance there *is no* 802.1ad network. Comes straight from customer VLANs. If it is a one to one mapping you don't need to worry about the VLAN tag but if multiple VLANs map to one SID (either because it is multiple customers or one customer wants different treatment for multiple VLANs) you do need to carry the VLANs.

Network Packet Flow

Known Unicast

C2 — C3
B1 BEB — B4 BEB
C1 — C4
802.1ad ... 802.1ah ... 802.1ad
B2 Ingress BEB
B3 Egress BEB

C4 | C1 | C-VLAN
C-DA C-SA

C4 | C1 | S-VLAN | C-VLAN

B3 | B2 | I-SID | C4 | C1 | S-VLAN | C-VLAN
B-DA B-SA   C-DA C-SA

Ingress BEB encapsulates frame with PBB header:
B-MAC DA is set to egress BEB's MAC address (learnt via reverse traffic)
B-MAC SA is set to ingress BEB's MAC address
I-SID is determined based on S-VLAN & B-VLAN determined based on I-SID
Egress BEB Strips off PBB encapsulation

BUM

C2 — C3
B1 BEB — B4 BEB
C1 — C4
802.1ad ... 802.1ah ... 802.1ad
B2 Ingress BEB
B3 Egress BEB

C4 | C1 | C-VLAN
C-DA C-SA

C4 | C1 | S-VLAN | C-VLAN

G3 | B2 | I-SID | C4 | C1 | S-VLAN | C-VLAN
B-DA B-SA   C-DA C-SA

C4 | C1 | S-VLAN | C-VLAN

00-1E-83	I-SID

Backbone Service Instance Group Address OUI

Ingress BEB encapsulates frame with PBB header:
B-MAC DA is set to **B-MAC multicast group address**
B-MAC SA is set to ingress BEB's MAC address
I-SID is determined based on S-VLAN & B-VLAN determined based on I-SID
One or multiple egress BEBs listen in to the group address