1:1 Protection Switching Overview

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v01

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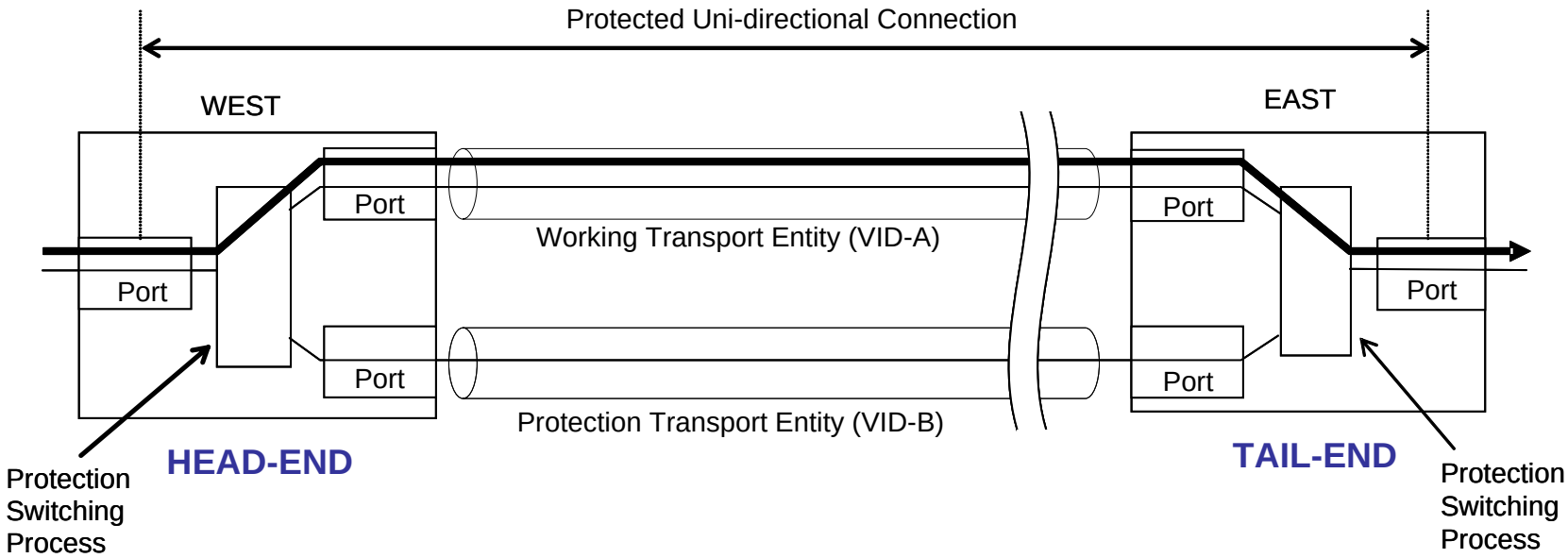
Agenda

- 1:1 Protection Switching Architecture & Terminology
- Introduction To ITU-T G.8031
- Mapping To PBB-TE BEB Model
- Conclusions

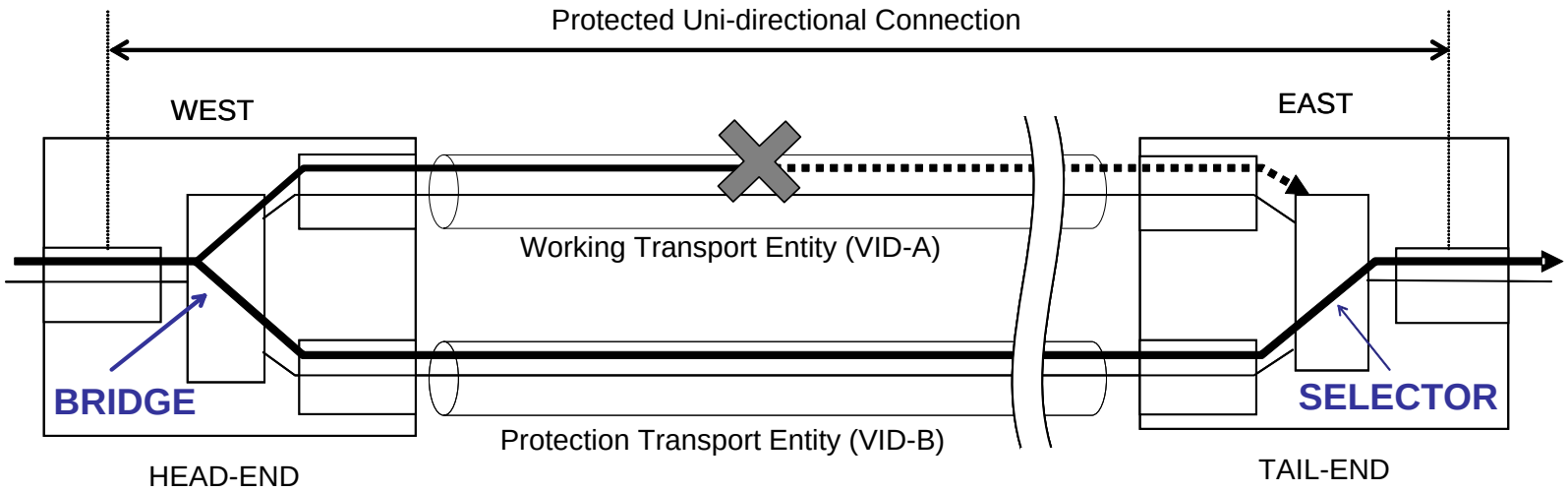
1:1 Protection Architecture & Terms

- 1:1 Protection Architecture
- Head-end, Tail-end
- Bridge, Selector, Switch
- Extra Traffic
- Forward path, Reverse path
- Uni-directional, Bi-directional
- APS Signalling
- 1-, 2-, 3-Phase APS Protocols
- Revertive, Non-revertive
- User-initiated, Automatic

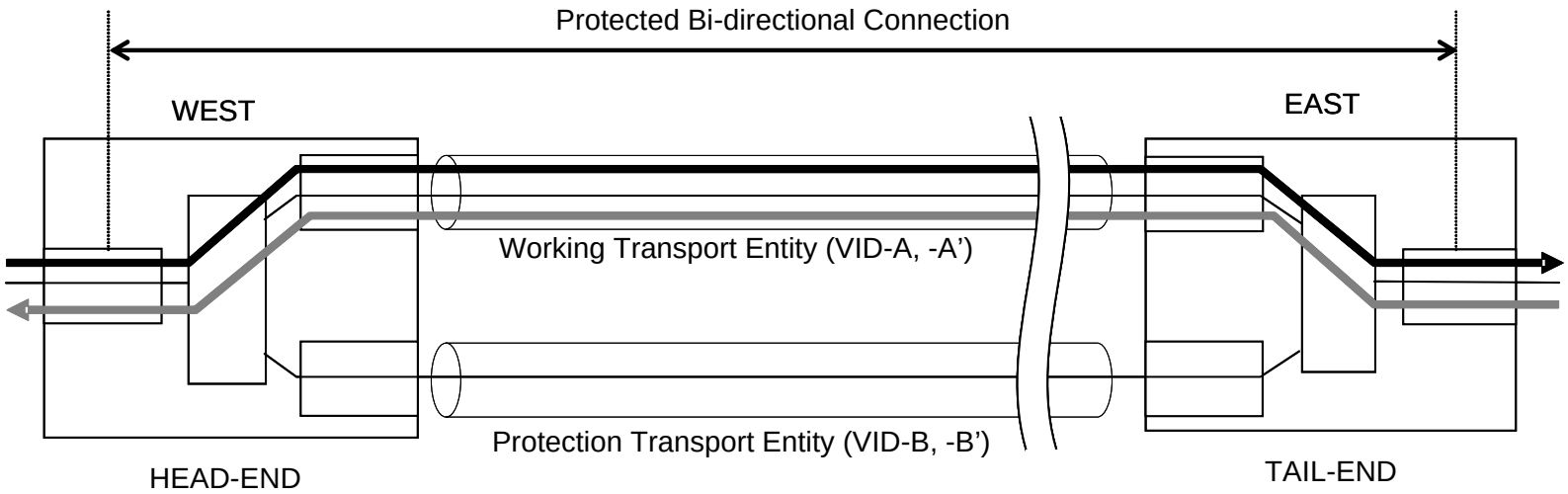
1:1 Protection Architecture



1:1 Protection Architecture (cont'd)

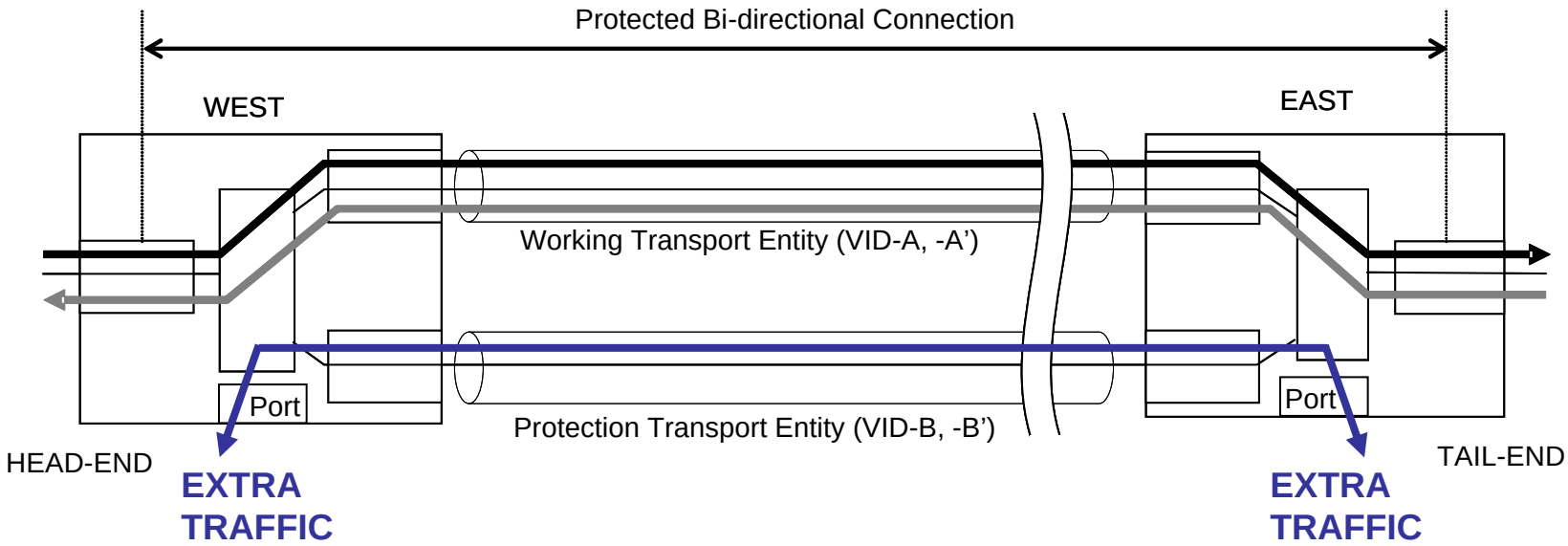


1:1 Bi-Directional Mode



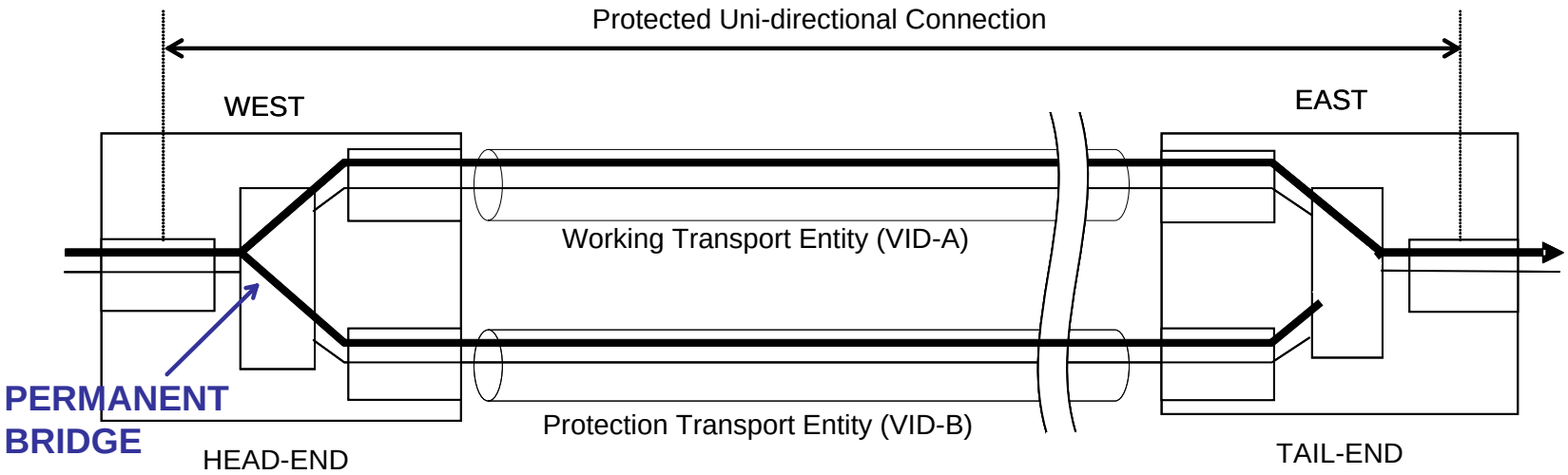
- **Could use a different VID for each direction of W and P entities**

Extra Traffic



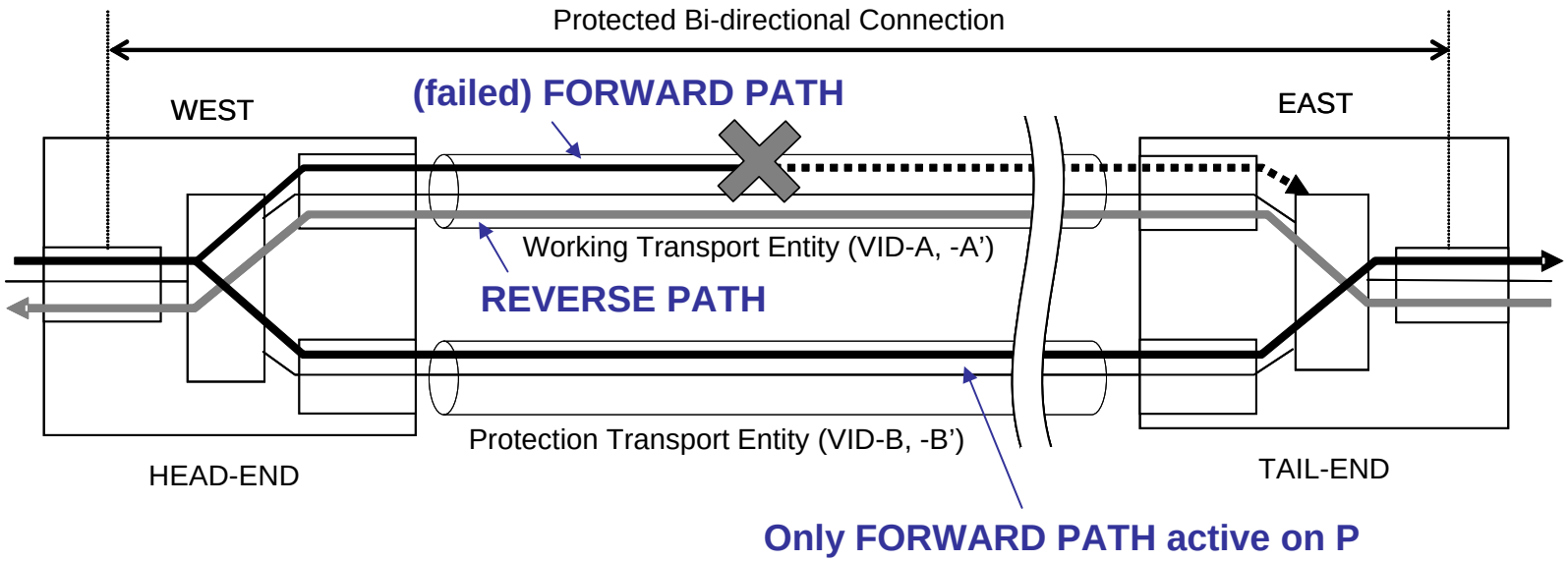
- **Extra Traffic (ET) is possible with a 1:1 protection architecture**

1+1 Protection Switching (for contrast)

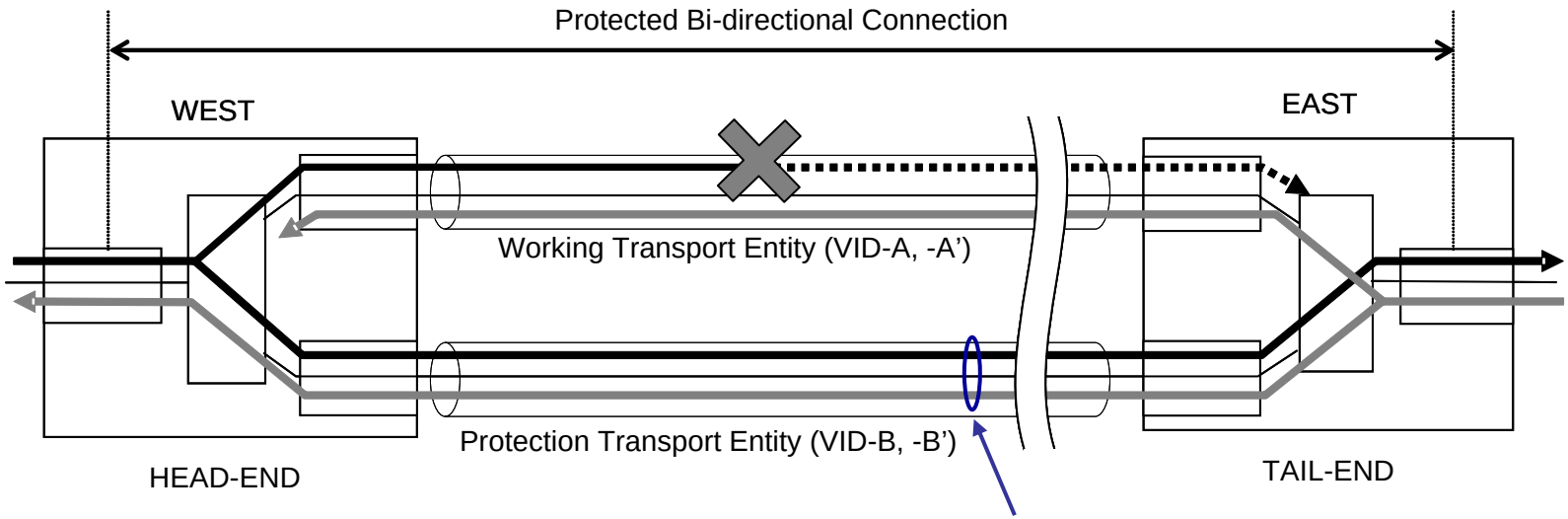


- **Extra Traffic (ET) is precluded by a 1+1 protection architecture**

1:1 Uni-Directional Switch

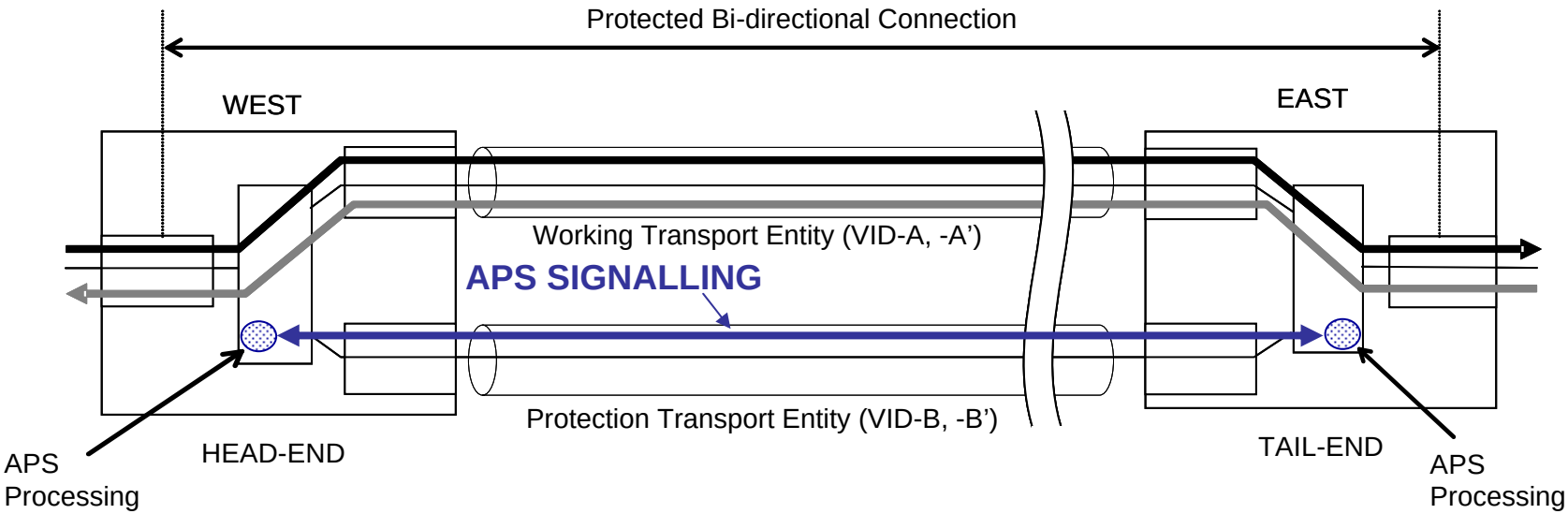


1:1 Bi-Directional Switch



Note: In bi-directional switching, although both ends are performing both the Bridge (head-end) and the Selector (tail-end) functions, typically the term "tail-end" still refers to the end initiating the protection Switch and "head-end" still refers to the other end.

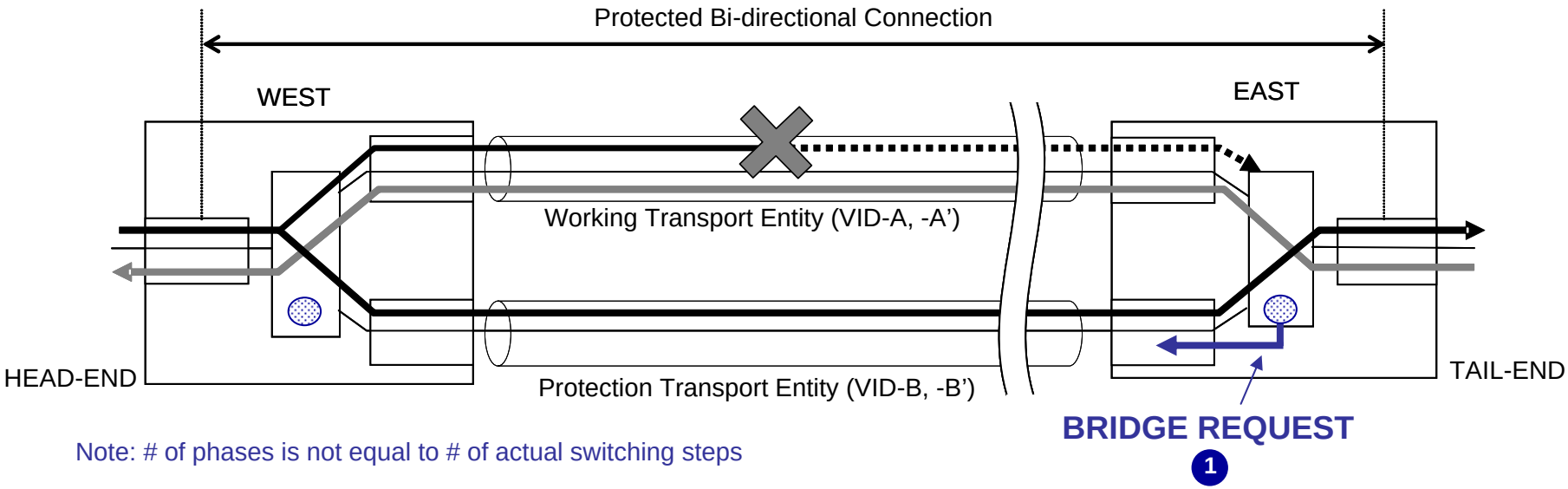
APS Signalling



- **APS signalling is generally required to co-ordinate head-end (Bridge) and tail-end (Selector) actions**

APS = Automatic Protection Switching

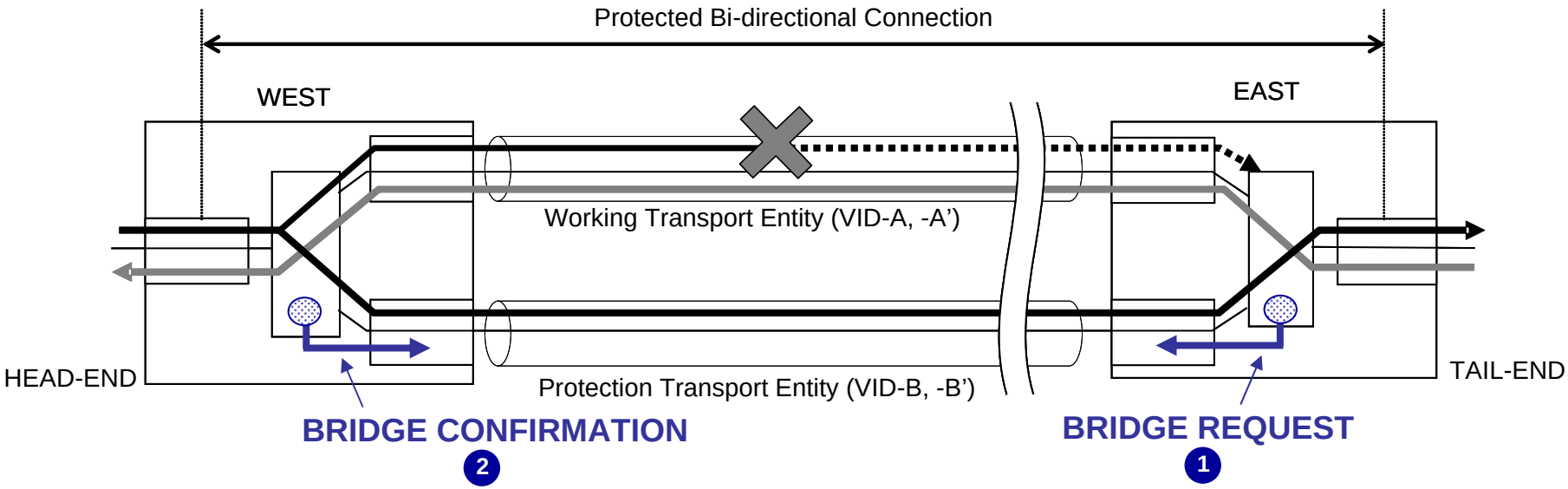
1-Phase APS Protocol



Note: # of phases is not equal to # of actual switching steps

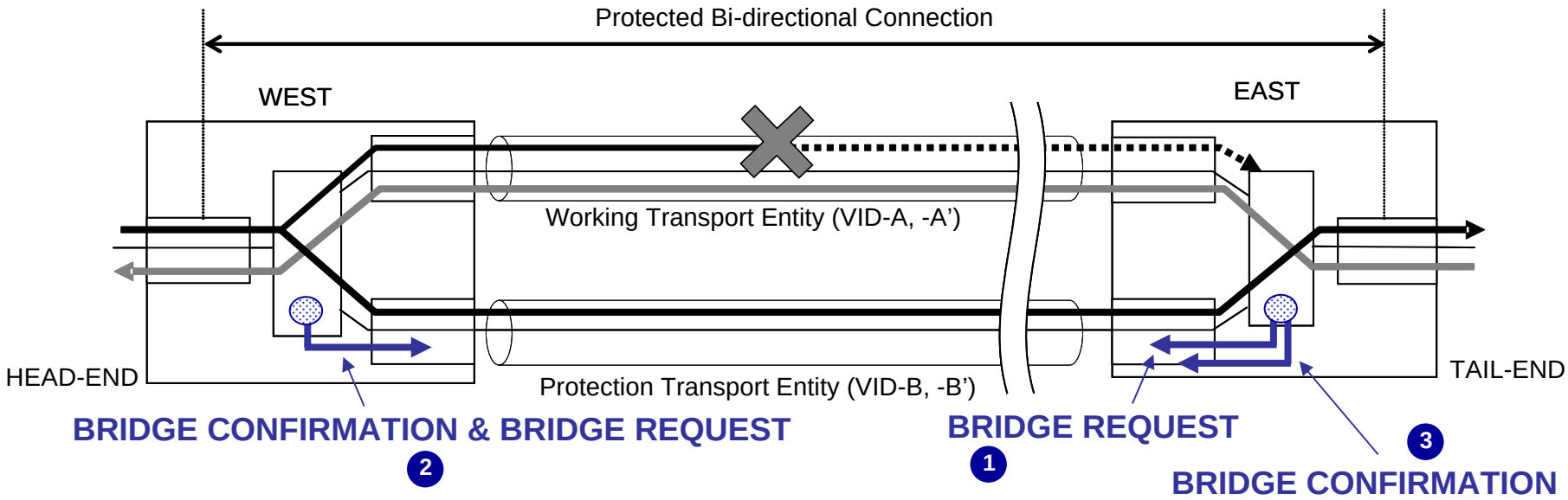
- **Tail-end signals Bridge Request to head-end & immediately operates its Selector ("blind switch")**
- **Head-end operates its Bridge upon reception of Bridge Request**
- **OK for switching on failure**
- **Not ideal for operator initiated switching as traffic is lost until head-end Bridge activated**
- **Can also be used for bi-directional mode (tail-end Bridges when Selector activated, head-end operates its Selector when it Bridges)**

2-Phase APS Protocol



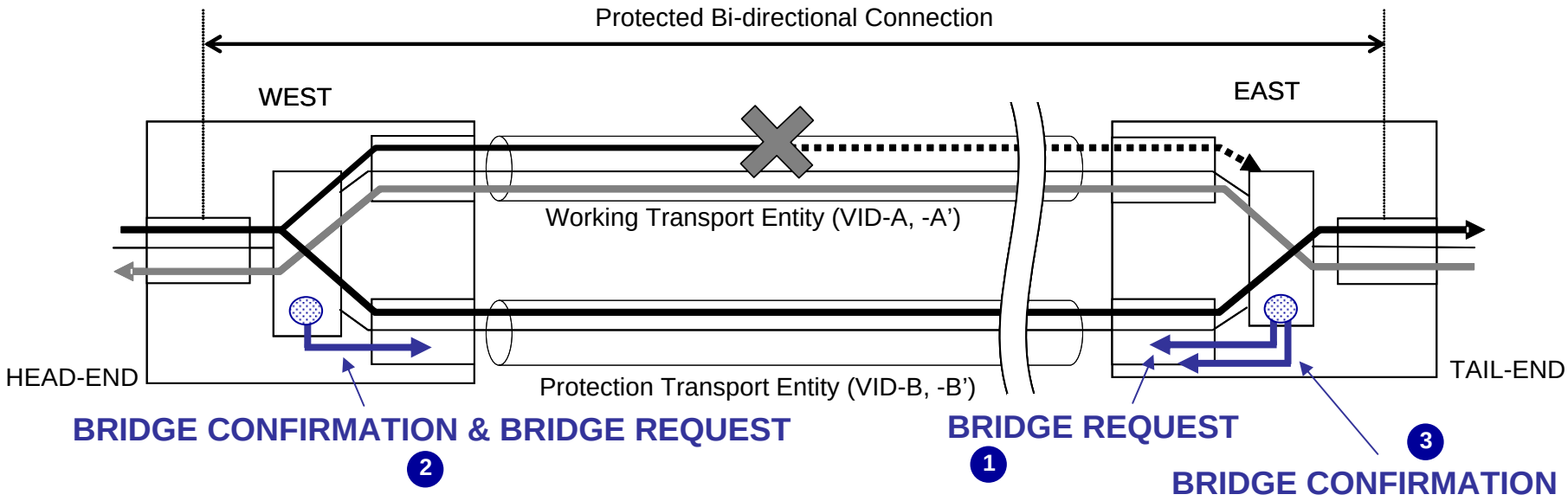
- **Tail-end signals Bridge Request to head-end & waits for confirmation**
- **Head-end operates its Bridge upon reception of Bridge Request & sends Bridge Confirmation**
- **Tail-end operates its Selector upon reception of Bridge Confirmation**
- **Better for operator initiated switching as any traffic loss is minimized (just path length deltas)**
- **Can also be used for bi-directional mode (tail-end Bridges when sending Bridge request, head-end operates its Selector when it Bridges)**

3-Phase APS Protocol



- **Tail-end signals Bridge Request to head-end & waits for confirmation**
- **Head-end operates its Bridge upon reception of Bridge Request & sends Bridge Confirmation & Bridge Request back to tail-end**
- **Tail-end operates its Selector upon reception of Bridge Confirmation & Bridges in response to Bridge Request & sends Bridge Confirmation back to head-end**
- **Head-end operates its Selector upon reception of Bridge Confirmation from tail-end**

3-Phase APS Protocol (cont'd)



- **Better for multi-working-channel systems (i.e., 1:N where N>1) when bi-directional mode and ET usage are common**
- **The initial tail-end Bridge from the bi-directional 2-phase protocol could take down ET unnecessarily if the head-end for that working channel is unable to "honour" the Bridge Request due to a "hidden" higher priority local request, such as Protection Group Freeze**

Switching Modes

- **Revertive**
  - **Traffic returned to Working entity after original fault repaired and a wait-to-restore timer has expired**
  - **Often used with 1:1 architecture, to allow ET**
  - **When the Working entity is optimal path**
  - **Operational preference, known normal location of traffic**
- **Non-Revertive**
  - **Traffic remains on Protection entity after original fault repaired**
  - **Often used with 1+1 architecture**
  - **Avoids potential packet loss due to a revertive switch when both paths equivalent**

Switch Initiation

- User Initiated
  - Lockout of Protection
  - Force Switch
  - Manual Switch*
  - Exercisor
- Automatic
  - Signal Fail*
  - Signal Degrade
  - Scheduled Exercisor

*A useful test of a protection switching design is how it responds to a uni-directional Manual Switch request (when there is no failure to trigger APS) or a uni-directional Signal Fail (when head-end requires signalled notification of failure)

Agenda

- 1:1 Protection Switching Architecture & Terminology
- **Introduction To ITU-T G.8031**
- Mapping To PBB-TE BEB Model
- Conclusions

Introduction To ITU-T G.8031

- General
- Applicability To PBB-TE
- 1:1 Protection Switching with MEPs & MIPs
- MEP Details
- APS PDU Structure

G.8031 General Info

- **“Ethernet Protection Switching”**
- **Created by Question 9 within Study Group 15 (9/15) of ITU-T**
- **Published June 2006 (publicly available)**
- **Amendment 1 under final approval (in-bound liaison this meeting)**
- **An ongoing activity within 9/15 addressing issues on Living List**
- **It defines:**

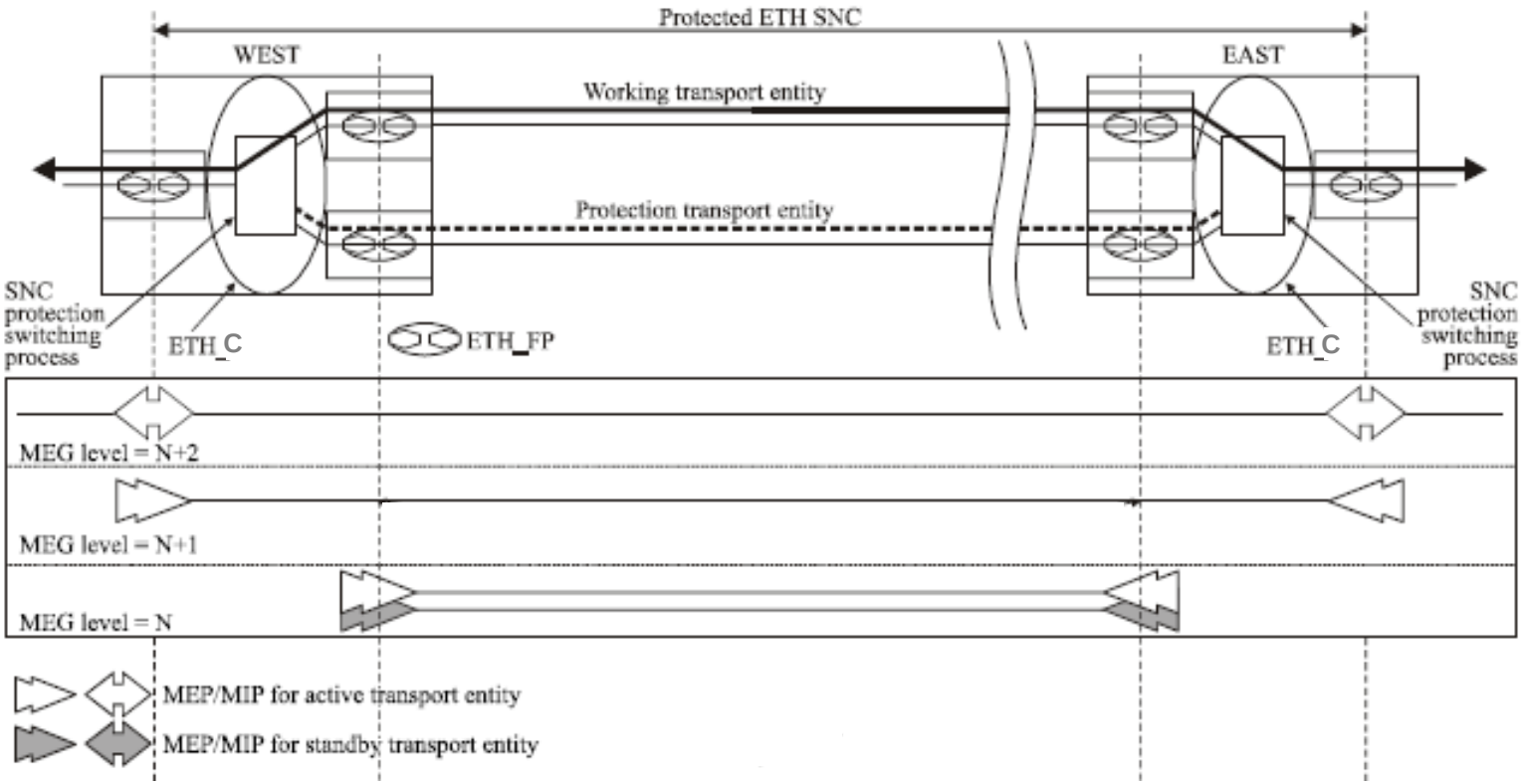
  “The APS protocol and linear protection switching mechanisms (1+1, 1:1) for point-to-point VLAN-based ETH layer subnetwork connections with sublayer monitoring for Ethernet transport networks”
- **It leverages:**
  - **CFM OAMPDU Type and structure**
  - **CCMs for fault initiated switching**
  - **Y.1731 (from Q5/SG13) for the APS OAMPDU Opcode (39) and structure**

G.8031 Applicability To PBB-TE

- Can use the 1:1 protection definition with 1-phase APS protocol
- Apply it to point-to-point PBB-TE B-VLANs
  - One B-VID for the Working entity (same B-VID value as the source traffic)
  - A different B-VID for the Protection entity
- The ITU-T "ETH layer subnetwork connection" can be between the B-VLAN creation points on CBPs in B-BEBs (a B-VLAN "trail")
- The ITU-T "sublayer monitoring" can be CFM CCMs (as extended by P802.1Qay) between MEPs at the Working/Protection B-VLAN creation points on CBPs

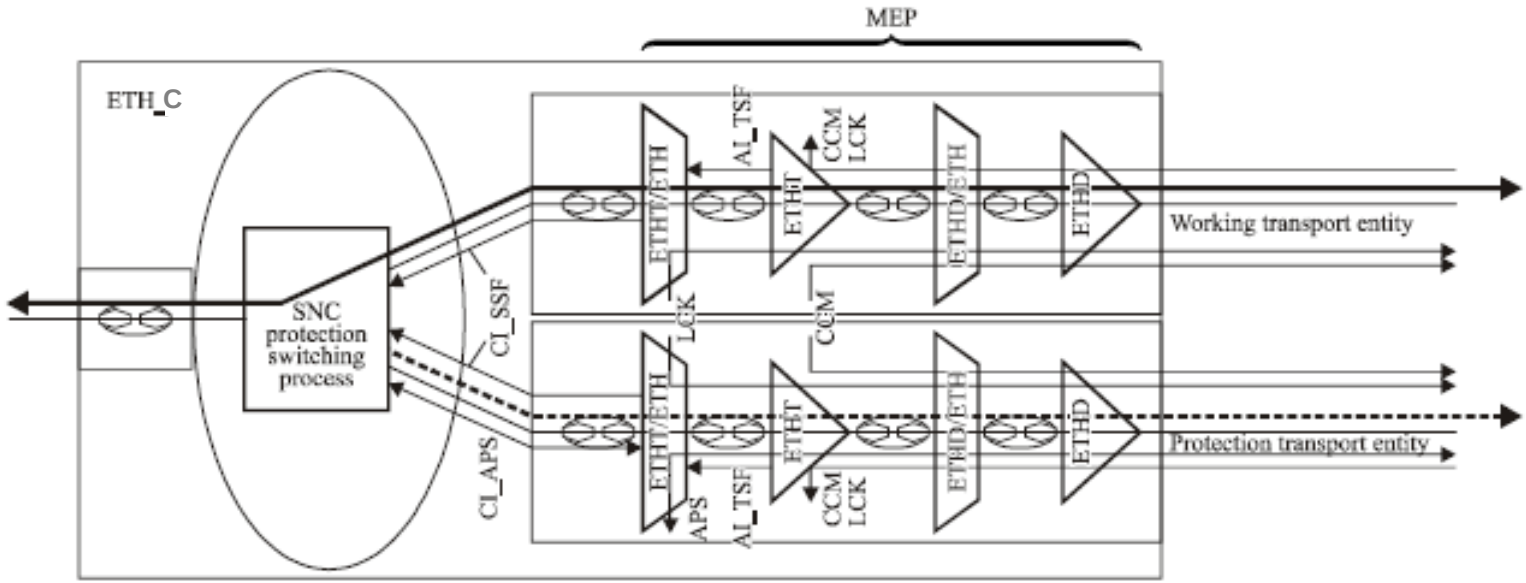
We should explore how to leverage G.8031 for P802.1Qay clause 26.10

1:1 Protection With MEPs & MIPs



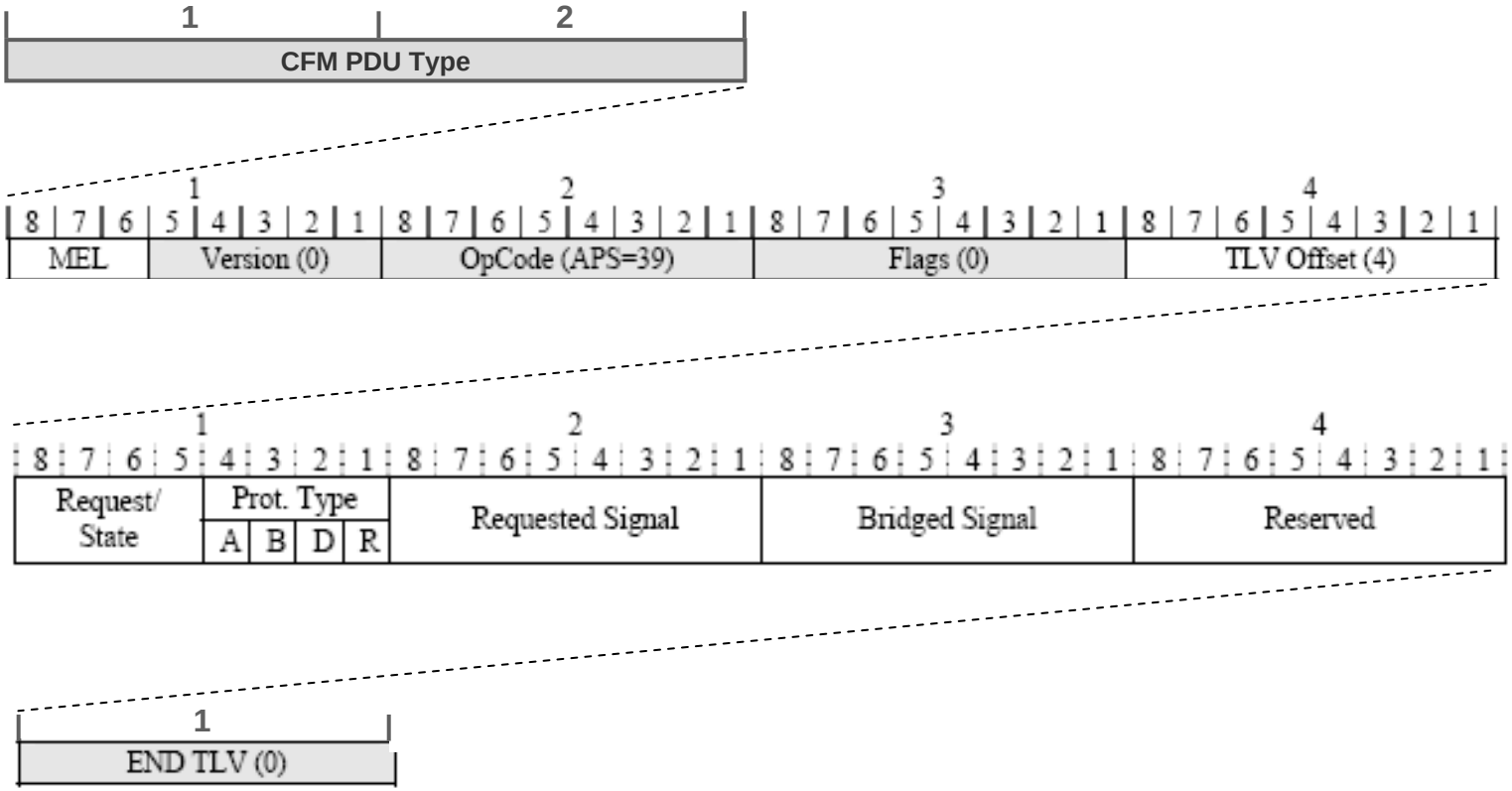
From Figure III.3 / G.8031

MEP Details



From Figure 10-3 / G.8031

APS PDU Structure



From Figures 11-1, 11-2 / G.8031

APS PDU Structure (cont'd)

Request/State		1111	Lockout of Protection (LO)	Priority
		1110	Signal Fail for Protection (SF-P)	highest
		1101	Forced Switch (FS)	
		1011	Signal Fail for Working (SF)	
		1001	Signal Degrade (SD) (Note 1)	
		0111	Manual Switch (MS)	
		0101	Wait to Restore (WTR)	
		0100	Exercise (EXER)	
		0010	Reverse Request (RR) (Note 2)	
		0001	Do Not Revert (DNR)	
		0000	No Request (NR)	lowest
		Others	Reserved for future international standardization	
Protection Type	A	0	No APS Channel	
		1	APS Channel	
	B	0	1+1 (Permanent Bridge)	
		1	1:1 (no Permanent Bridge)	
	D	0	Unidirectional switching	
		1	Bidirectional switching	
	R	0	Non-revertive operation	
		1	Revertive operation	

Requested Signal	0	Null Signal
	1	Normal Traffic Signal
	2-255	(Reserved for future use)
Bridged Signal	0	Null Signal
	1	Normal Traffic Signal
	2-255	(Reserved for future use)
NOTE 1 – SD is for further study. NOTE 2 – RR is reserved for future standardization by ITU-T.		

From Table 11-1 / G.8031

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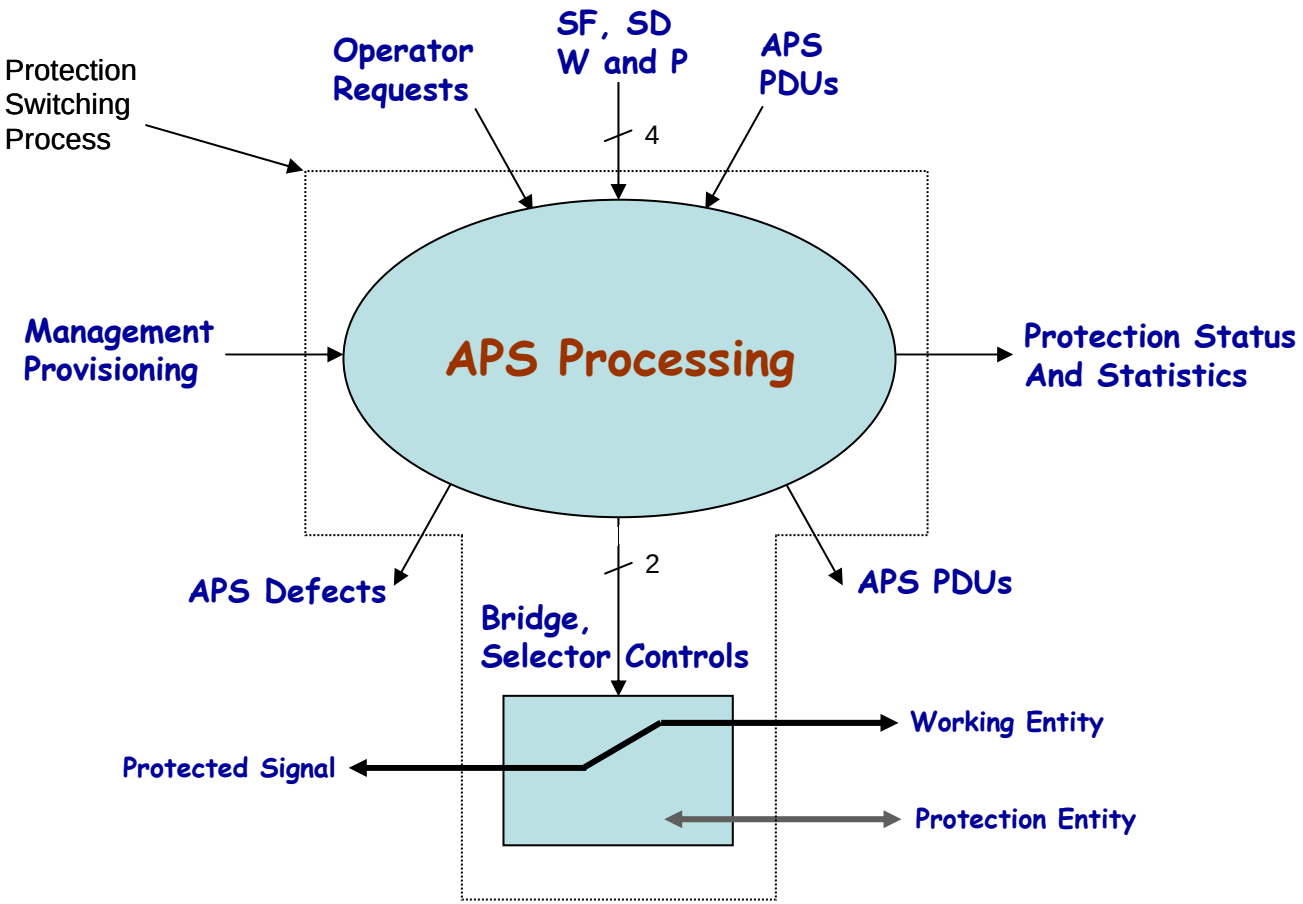
- 1:1 Protection Switching Architecture & Terminology
- Introduction To ITU-T G.8031
- **Mapping To PBB-TE BEB Model**
- Conclusions

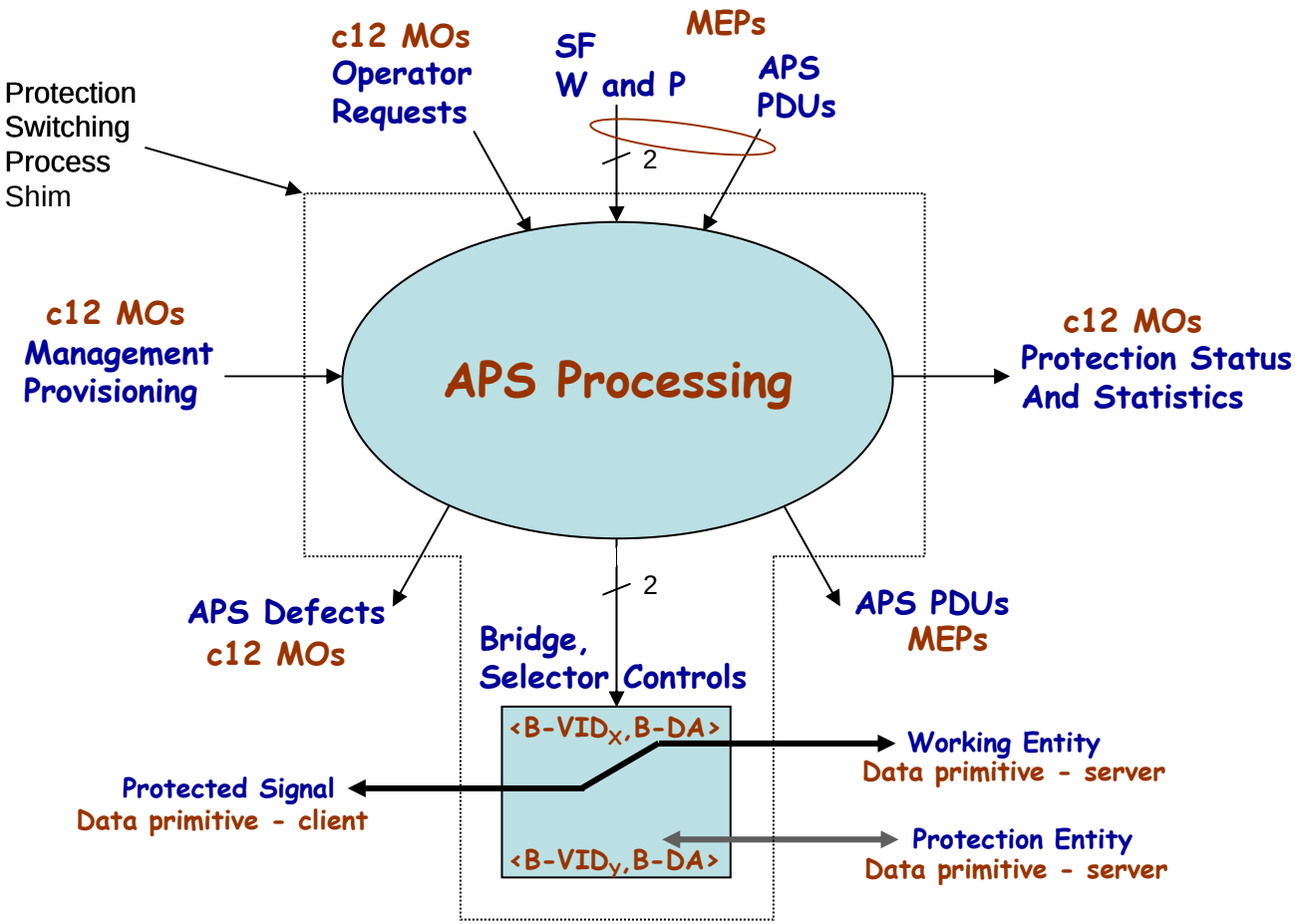
Mapping To PBB-TE BEB Model

- Generic APS Model and I/O
- PBB BEB Model
- Possible PBB-TE BEB Model

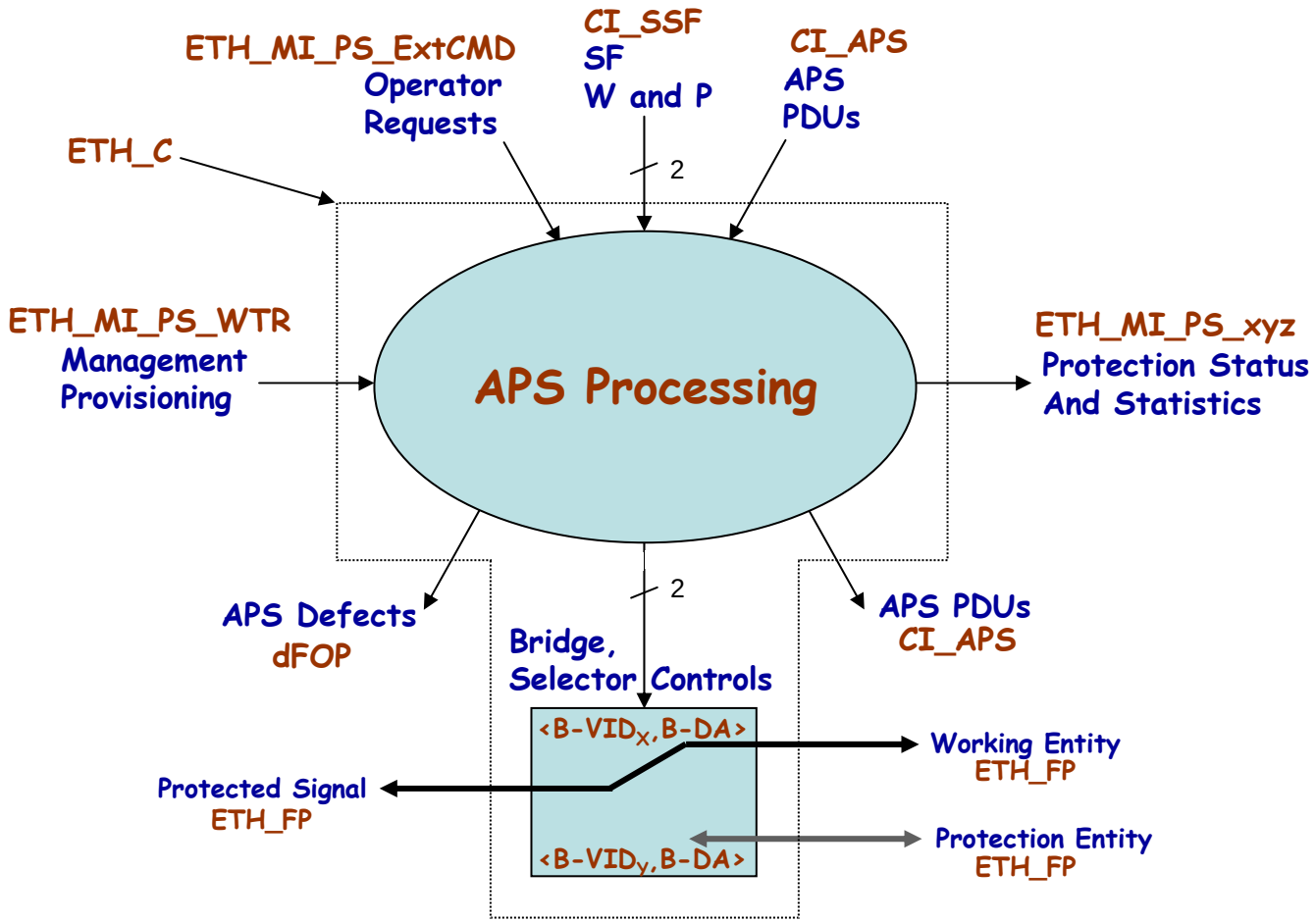
Generic APS Model and I/O



APS Model and I/O: 802.1 Perspective

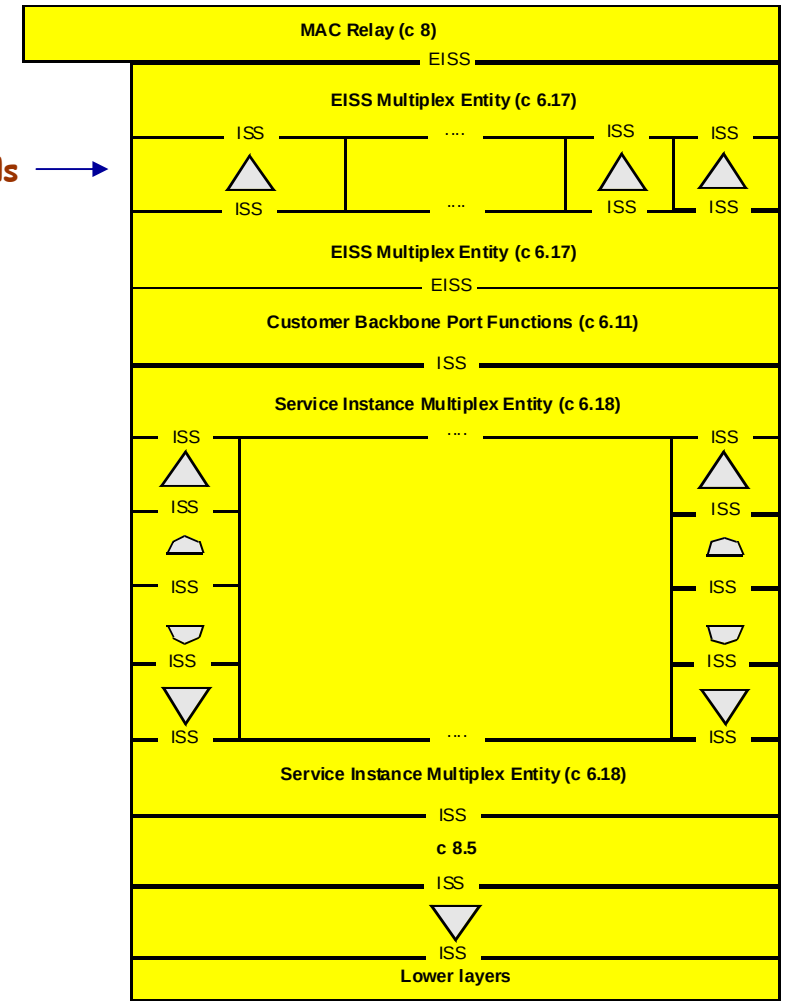


APS Model and I/O: G.8031 View



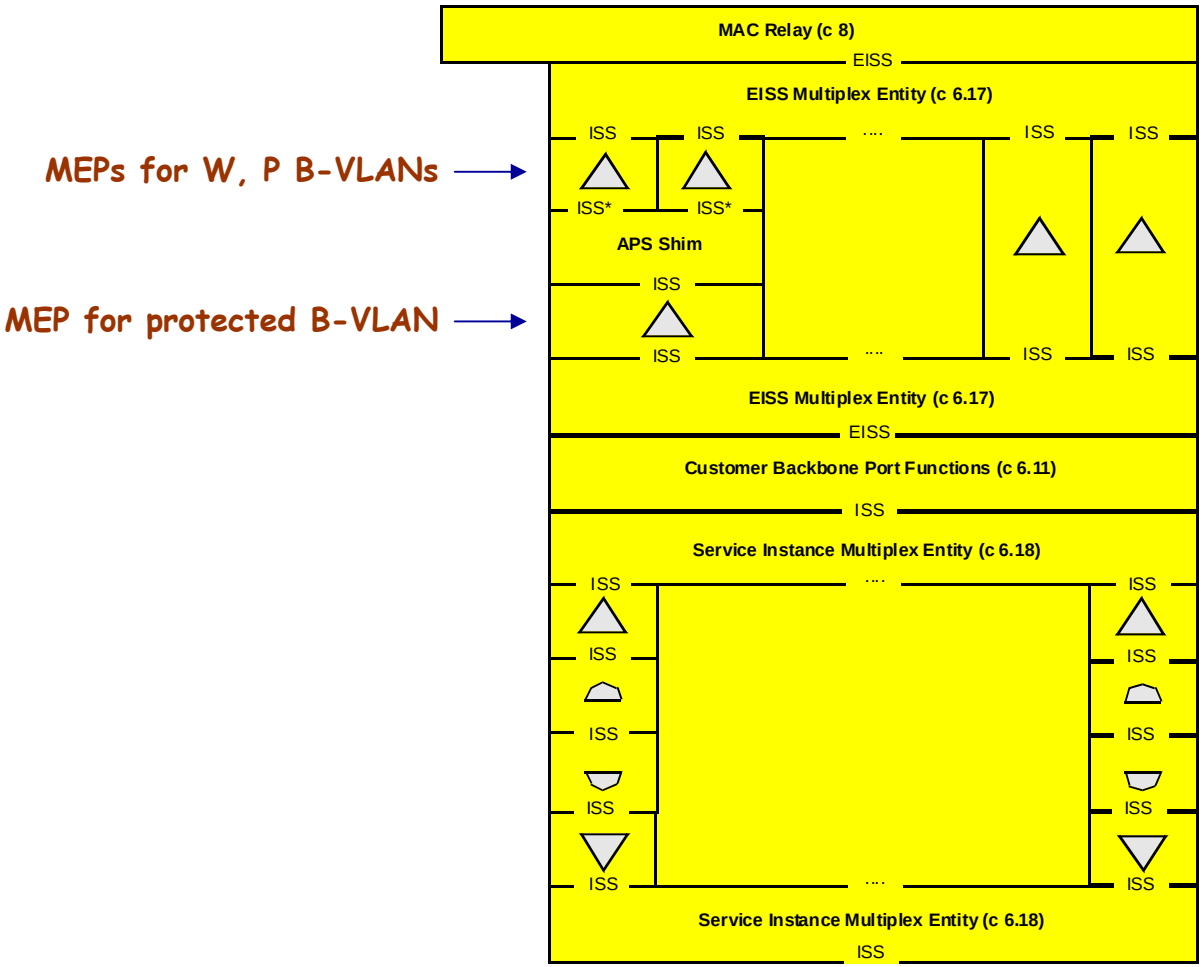
PBB BEB Model: CBP

MEPs for B-VLANs →

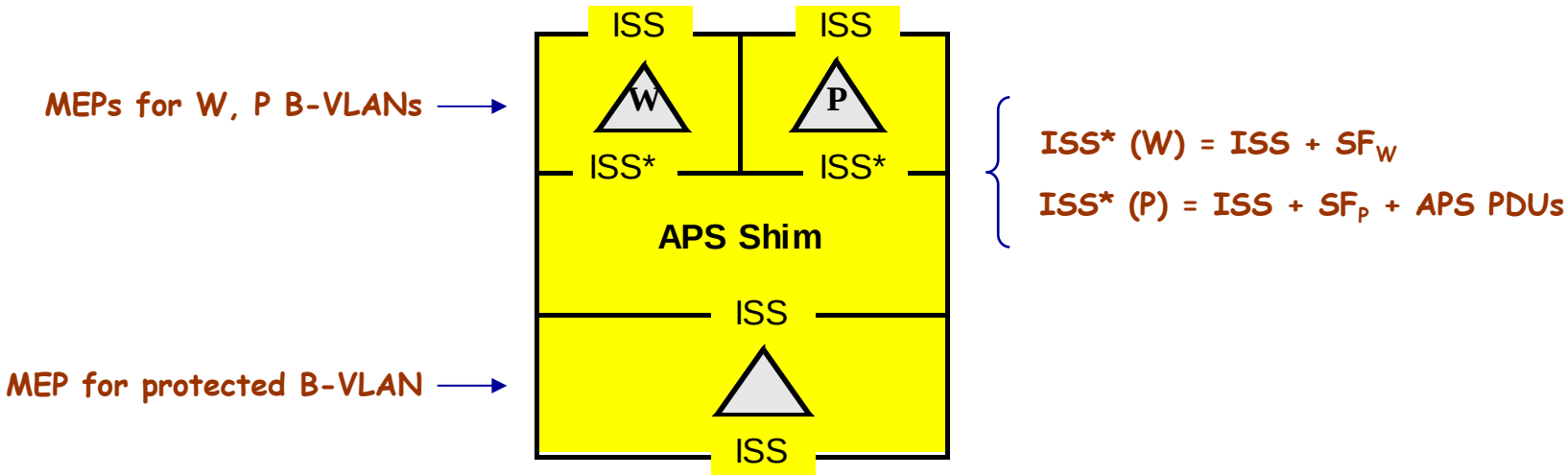


From Figure 26-2
P802.1ah/D3.6

Possible PBB-TE BEB Model: CBP



Possible PBB-TE BEB Model (cont'd)



Cross-check With
Slide 29 I/O

Agenda

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- **Conclusions**

Technical Challenges

- **None**
- **Linear APS protocol is very “well known”**
  - **1960s – 1980s: proprietary variants used in microwave systems and first asynchronous fiber optics networks**
  - **Late 1980s: refined and standardized for SONET** (GR-253-CORE)
  - **Late 1990s: re-applied to ATM VC, VP, VPG protection** (I.630)
  - **Mid 2000s: re-applied to point-to-point Ethernet** (G.8031)
- **More of an editorial effort…**

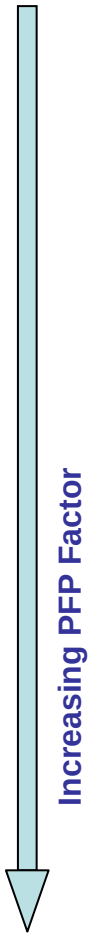
P802.1Qay c26.10 Editorial Options

a) Simply cross-reference 1:1 portion of G.8031
   - There are language / modeling differences
   - Need clause 12 managed objects
   - Need a clause 17 MIB module

b) Cross-reference 1:1 portion of G.8031 and provide a BEB model, c12 MOs, c17 MIB
   - G.8031 will continue to evolve via amendments

c) Copy and paste 1:1 portion of a specific G.8031 issue and amendment and provide a BEB model, c12 MOs, c17 MIB

d) Some other variant



PFP = Pain For Panos

REFERENCES

Documents

- G.8031 – Ethernet Protection Switching
- G.8031 Amendment 1
- Y.1731 – OAM Functions and Mechanisms For Ethernet Based Networks
- P802.1ag/D8.1
- "ITU-T G.8010 Ethernet Bridging Architecture", Maarten Vissers, ITU-IEEE Carrier Class Ethernet Workshop, May 31 - June 1, 2007 http://www.itu.int/ITU-T/worksem/cce/programme.html (session 3)

ITU-T G-series documents available from: http://www.itu.int/rec/T-REC-G/e

ITU-T Y-series documents available from: http://www.itu.int/rec/T-REC-Y/e