Alcatel·Lucent

Options to Deliver ELAN Services

Marc Lasserre

mlasserre@alcatel-lucent.com

Agenda

Introduction

Network Modeling

E-LINE & E-LAN Service Requirements

PBB vs VPLS

Conclusion

Alcatel·Lucent

Ethernet Transport & Services

- Ethernet is multipoint by nature
  - Native broadcast/multicast
  - Any-to-any connectivity
- Two types of Ethernet Services
  - Point-to-point: ELINE service
    - ng-Sonet/DH (EoS)
    - MPLS PW
  - Multipoint-to-multipoint: ELAN service
    - Focus of this presentation
    - 2 options: PBB & VPLS

Alcatel·Lucent

Options to deliver ELAN Services

- Ethernet has been evolving over time
  - 802.1Q
    - VLANs as virtual broadcast domains
    - 4K instances per end-user domain
  - QinQ
    - Separation of end-user and provider domains
      - C-VLAN: 4K instances per end-user domain
      - S-VLAN: 4K instances per provider domain
  - PBB
    - Interconnect model for QinQ domains
      - B-VLAN: Provider Broadcast Domain
      - I-SID: Service Instance
  - VPLS
    - MPLS based mp2mp (any-to-any) service
    - MPLS TE tunnel
    - PW service instance

Alcatel·Lucent

Ethernet Paradigm

- Simplicity
  - Dynamic Learning
    - Flooding
    - Learning
  - Loop Resolution
    - xSTP
      - Spanning Tree Protocols have been evolving over time
- Automatic Topology Discovery
  - xSTP
  - End-point discovery
- Adequate for LANs

Alcatel·Lucent

Native Ethernet Solutions: Incremental Enhancements towards Carrier Class Ethernet

- Native Ethernet solutions only address some original weaknesses
  - End-user & provider domain separation
  - Enhanced STP for faster convergence & basic TE
- Issues to be addressed: Work in Progress
  - MAC Hiding
    - Learning of end-user MACs at every hop along path from source to destination: PBB
  - Scalable Service Instantiation
    - From VLAN to I-SID: PBB
    - Proper layering (B-VID/I-SID separation)
- Issues not yet addressed
  - CLPS mode:
    - xSTP based loop avoidance mechanism
    - COPS only addressed for p2p (p2mp in future): PBB-TE
  - Inter-domain connectivity (flat ISID addressing space)
  - Extended TE capabilities: Only applicable p2p services (p2mp in future): PBB-TE

Alcatel·Lucent

Overlay Ethernet Solutions

- VPLS
  - COPS attributes
  - Scaleable Service multiplexing
  - MAC Learning within PE nodes only
  - Split-horizon to avoid STP
  - Inter-domain capability
  - MPLS transport for
    - Fast protection (e.g. FRR)
    - TE
- Work in progress
  - PBB (MAC-in-MAC) encapsulation in edge nodes
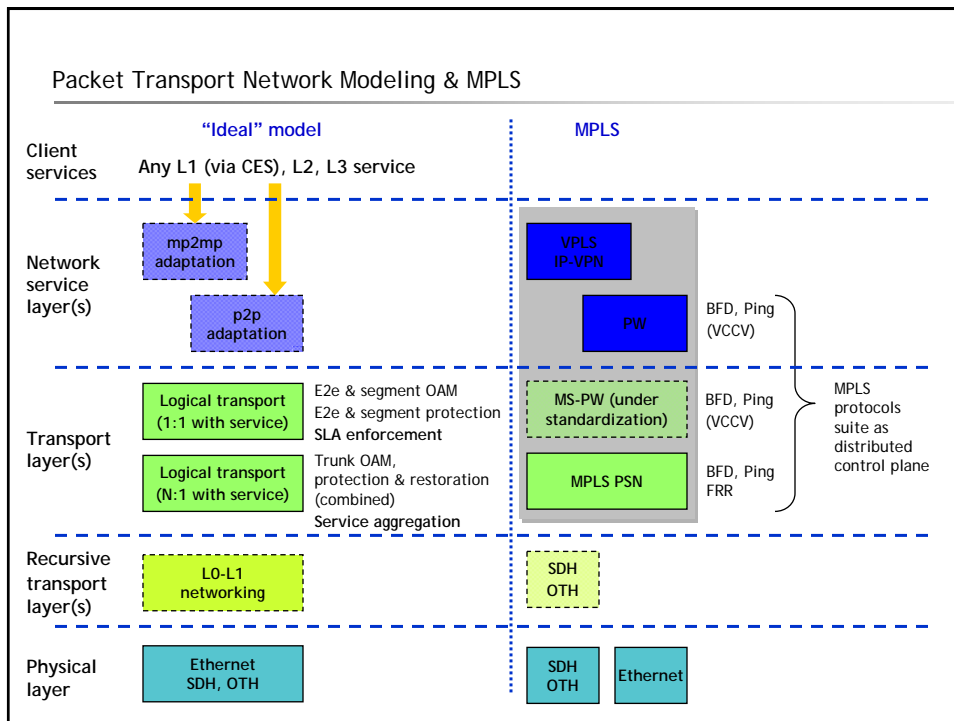   - No end-user MAC learning in PEs
  - VPLS Multicast Optimizations
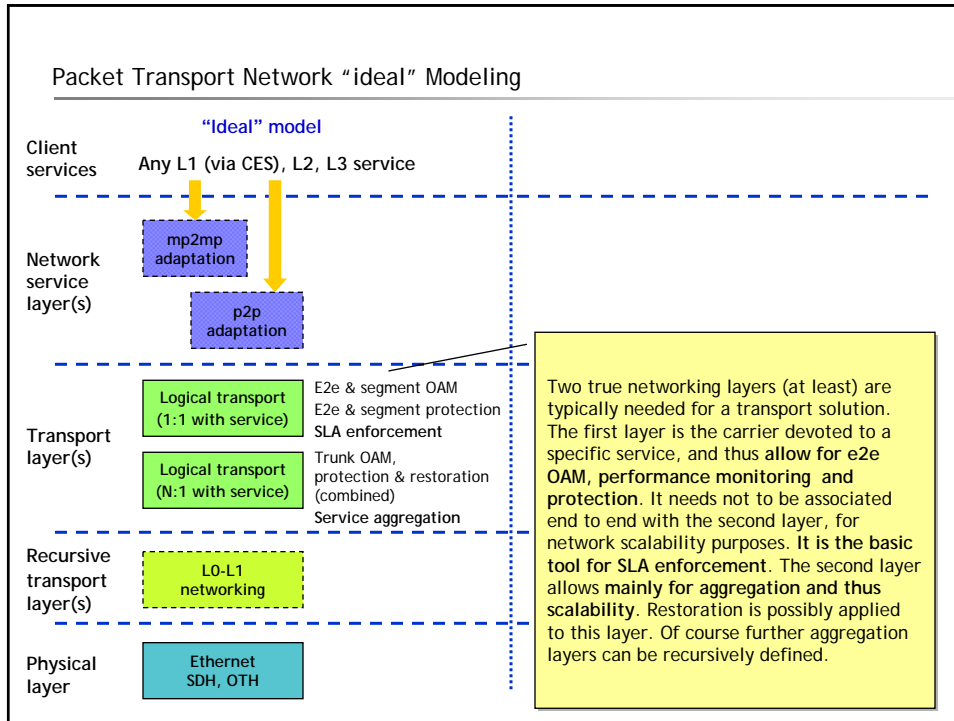 - OAM

Alcatel·Lucent
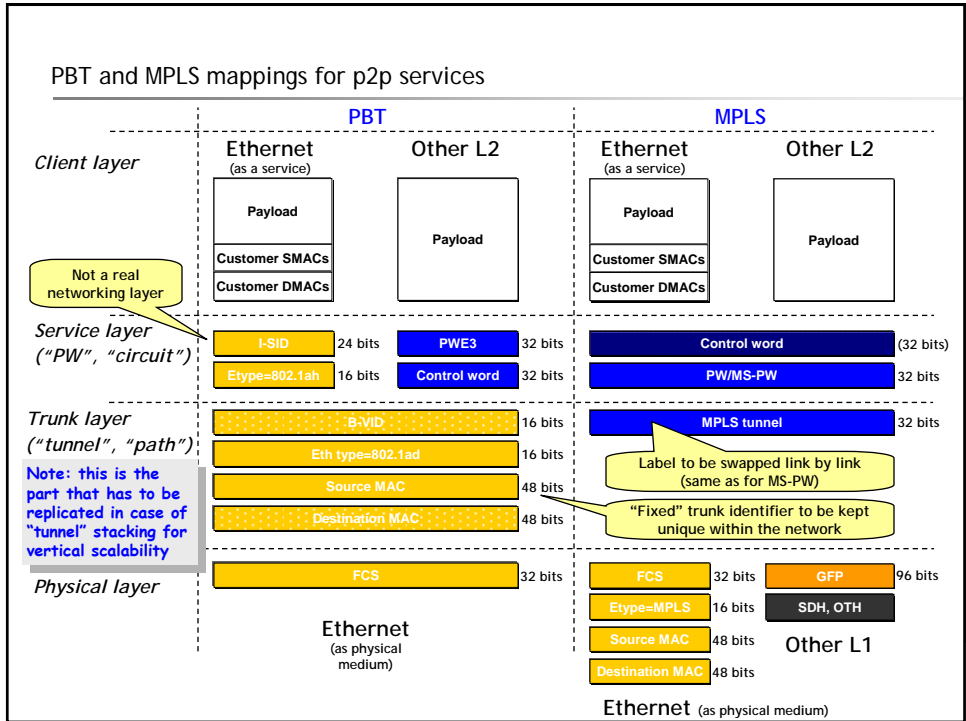

Agenda

Introduction

Network Modeling

E-LINE & E-LAN Service Requirements

PBB vs VPLS

Conclusion

Alcatel·Lucent

Packet Transport Network "ideal" Modeling

"Ideal" model

Layer	
Client services	Any L1 (via CES), L2, L3 service

Network service layer(s)
- mp2mp adaptation
- p2p adaptation

Transport layer(s)
- Logical transport (1:1 with service) — E2e & segment OAM / E2e & segment protection / SLA enforcement
- Logical transport (N:1 with service) — Trunk OAM, protection & restoration (combined) / Service aggregation

Recursive transport layer(s)
- L0-L1 networking

Physical layer
- Ethernet SDH, OTH

> Two true networking layers (at least) are typically needed for a transport solution. The first layer is the carrier devoted to a specific service, and thus **allow for e2e OAM, performance monitoring and protection**. It needs not to be associated end to end with the second layer, for network scalability purposes. **It is the basic tool for SLA enforcement**. The second layer allows **mainly for aggregation and thus scalability**. Restoration is possibly applied to this layer. Of course further aggregation layers can be recursively defined.

Packet Transport Network Modeling & MPLS

"Ideal" model   **MPLS**

Layer	
Client services	Any L1 (via CES), L2, L3 service

Network service layer(s)
- mp2mp adaptation
- p2p adaptation
- VPLS IP-VPN
- PW — BFD, Ping (VCCV)

Transport layer(s)
- Logical transport (1:1 with service) — E2e & segment OAM / E2e & segment protection / SLA enforcement
- Logical transport (N:1 with service) — Trunk OAM, protection & restoration (combined) / Service aggregation
- MS-PW (under standardization) — BFD, Ping (VCCV)
- MPLS PSN — BFD, Ping FRR

MPLS protocols suite as distributed control plane

Recursive transport layer(s)
- L0-L1 networking
- SDH OTH

Physical layer
- Ethernet SDH, OTH
- SDH OTH
- Ethernet

Packet Transport Network Modeling & PBB

	"Ideal" model	PBB
Client services	Any L1 (via CES), L2, L3 service	

Network service layer(s)
- mp2mp adaptation
- p2p adaptation
- I-SID — CCM, LB, LTR (802.1ag)

Transport layer(s)
- Logical transport (1:1 with service) — E2e & segment OAM, E2e & segment protection, SLA enforcement
- Logical transport (N:1 with service) — Trunk OAM, protection & restoration (combined), Service aggregation
- B-VID/B_DA PSN — CCM, LB, LTR (802.1ag)

Recursive transport layer(s)
- L0-L1 networking
- SDH OTH

Physical layer
- Ethernet SDH, OTH
- SDH OTH
- Ethernet

PBT and MPLS mappings for p2p services

	PBT		MPLS	
	Ethernet (as a service)	**Other L2**	**Ethernet** (as a service)	**Other L2**
Client layer	Payload / Customer SMACs / Customer DMACs	Payload	Payload / Customer SMACs / Customer DMACs	Payload

Not a real networking layer

| *Service layer* ("PW", "circuit") | I-SID 24 bits / Etype=802.1ah 16 bits | PWE3 32 bits / Control word 32 bits | Control word (32 bits) / PW/MS-PW 32 bits | |
| *Trunk layer* ("tunnel", "path") | B-VID 16 bits / Eth type=802.1ad 16 bits / Source MAC 48 bits / Destination MAC 48 bits | | MPLS tunnel 32 bits | |

Note: this is the part that has to be replicated in case of "tunnel" stacking for vertical scalability

Label to be swapped link by link (same as for MS-PW)

"Fixed" trunk identifier to be kept unique within the network

| *Physical layer* | FCS 32 bits | | FCS 32 bits / Etype=MPLS 16 bits / Source MAC 48 bits / Destination MAC 48 bits | GFP 96 bits / SDH, OTH |

Ethernet (as physical medium)

Other L1

Ethernet (as physical medium)

PBB and MPLS mappings for e2e services

	PBB	VPLS
	PBB	**VPLS**

Client layer

PBB	VPLS
Payload	**Payload**
Customer SMACs	**Customer SMACs**
Customer DMACs	**Customer DMACs**

> Not a networking layer

Demultiplexing layer

PBB	bits	VPLS	bits
I-SID	24 bits	Control word	(32 bits)
Etype=802.1ah	16 bits	PW/MS-PW	32 bits

Mp2mp transport layer

PBB	bits	VPLS	bits
B-VID	16 bits	MPLS tunnel	32 bits
Eth type=802.1ad	16 bits		
Source MAC	48 bits		
Destination MAC	48 bits		

> Full mesh of p2p LSPs

Physical layer

PBB	bits
FCS	32 bits

VPLS	bits		bits
FCS	32 bits	GFP	96 bits
Etype=MPLS	16 bits	SDH, OTH	
Source MAC	48 bits		
Destination MAC	48 bits	Other L1	

Ethernet as physical medium)

Agenda

Introduction

Network Modeling

E-LINE & E-LAN Service Requirements

PBB vs VPLS

Conclusion

Alcatel·Lucent

Which xLINE Model – PBB/PBB-TE or MPLS?
Customer feedback to date

- SP Requirements for p2p L2 services (xLINE)
  - Connection Oriented Packet Switching (COPS)
  - Multi-service support with CoS, TE capabilities
  - One backbone model for all L2 & L3 services
- PBB Model (CLPS)
  - BVID based, mp2mp paradigm
    - Difficult to engineer p2p service aggregate
  - No Multi-service support
    - Ethernet only
- PBB-TE (COPS)
  - ELINE service only
  - PWE3 for other p2p services
- MPLS PWE3 Model (COPS)
  - Any p2p services: Ethernet, TDM, FR, ATM, PPP etc…

Alcatel·Lucent

Which ELAN Model - PBB or MPLS?
Customer feedback to date

- SP Requirements for E-LAN Service
  - Mostly sparse connectivity – i.e. 10-20 sites on 5 PEs distributed across the network
  - One backbone model for all L2 Services
- PBB Model (CLPS)
  - Efficient handling of replication for dense multicast distribution
  - Requires Service Awareness in core devices
    - For efficient broadcast containment & replication
- MPLS/VPLS Model (COPS)
  - TE, Sparse connectivity, inter-domain
  - Efficient replication for sparse multicast distribution (p2mp, snooping, rings)
  - L2 VPNs, especially Point-to-point xLINE, better served by COPS backbone

COPS mode favored by most operators for L2 Services

Alcatel·Lucent

Agenda

Introduction

Network Modeling

E-LINE & E-LAN Service Requirements

PBB vs VPLS

Conclusion

Alcatel·Lucent

Provider Backbone Bridging (PBB) Overview

Ethernet Technology being standardized in IEEE 802.1ah Task Group

- Designed to interconnect Provider Bridge Networks (PBN - IEEE 802.1ad)

- Adds a Backbone Header to a Customer/QinQ Ethernet Frame

  - Provider Addressing for Backbone Forwarding
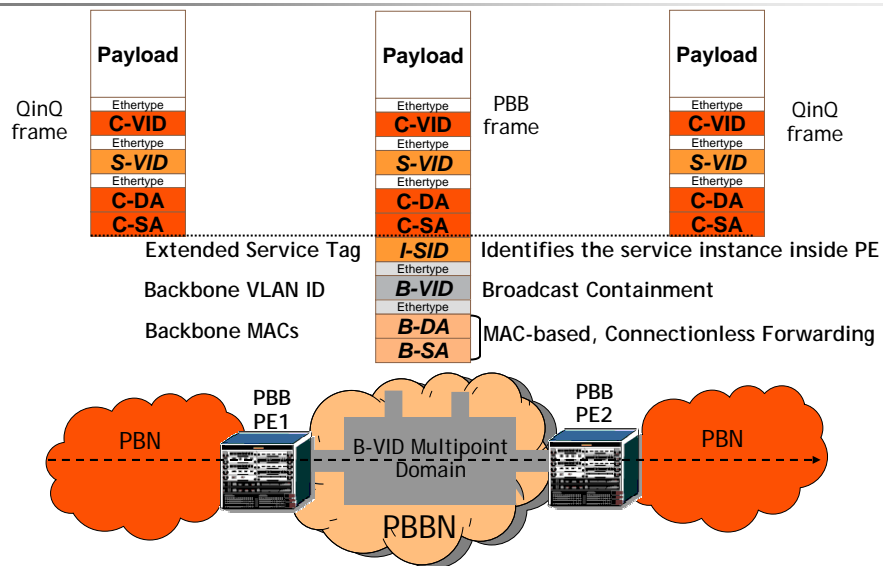
  - New extended tag for Service Virtualization
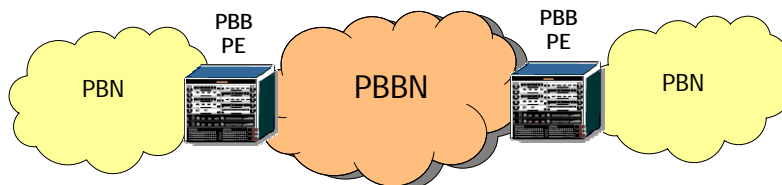
PBBN is Ethernet based: Connectionless Forwarding based on MAC Learning & Forwarding, Loop Avoidance based on STP, VLAN ID for Broadcast Containment

Alcatel·Lucent

PBB Packet Walkthrough

Payload		Payload		Payload	
QinQ frame	Ethertype **C-VID** Ethertype **S-VID** Ethertype **C-DA** **C-SA**	PBB frame	Ethertype **C-VID** Ethertype **S-VID** Ethertype **C-DA** **C-SA**	QinQ frame	Ethertype **C-VID** Ethertype **S-VID** Ethertype **C-DA** **C-SA**

Extended Service Tag — *I-SID* — Identifies the service instance inside PE

Backbone VLAN ID — *B-VID* — Broadcast Containment

Backbone MACs — *B-DA* *B-SA* — MAC-based, Connectionless Forwarding

PBN — PBB PE1 — B-VID Multipoint Domain — PBB PE2 — PBN

PBBN

Alcatel·Lucent

PBB Limitations

- Scalability issues

  - Flat addressing space
    - Inter-domain challenges (e.g. I-SID translation at domain boundary)
    - No summarization/aggregation possible
  - 4K transport domains only (B-VIDs)
  - I-SID to B-VID mapping
    - 1:1 (4K provider domains only)
    - N:1 -> Congruency problems

- Convergence issues

  - xSTP usage
  - Flushing of C-MAC to B-MAC mappings
   - STP Protocol extensions?
    - Default timeout -> Black holing

All these issues have already been resolved with MPLS/VPLS

Alcatel·Lucent

Slide 1

Customer Use Case: *HVPLS*

- **MPLS used throughout the Metro and WAN**
  - **Routing, Signaling and Forwarding**
  - **PW for ELINE & Pt2Pt Multi-Service**
  - **HVPLS for ELAN Services**
- **VPLS hides C-MACs from backbone devices**
- **HVPLS introduced to optimize replication**
 - **Core PEs became service aware**

Metro Region

HVPLS

WAN

Core VPLS

HVPLS   Metro   HVPLS
         Regions
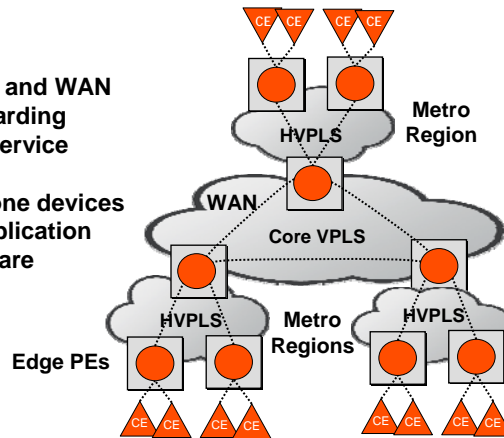
Edge PEs

Can we maintain HVPLS, MPLS Benefits & eliminate C-MAC Awareness from the Core PEs?

FutureNet 2007

Alcatel·Lucent

Slide 2

Customer Use Case: *HVPLS with PBB Encapsulation*

- **Add PBB Encapsulation to HVPLS in the Edge PEs**
  - **C-MAC to B-MAC mapping**
- **Maintain MPLS Tunneling in backbone devices**
  - **Routing, Signaling and Forwarding**
- **Maintain MPLS Service Encap, Addressing**
  - **PW for ELINE and Multi-Service**
  - **HVPLS (PW) for ELAN Services**
- **No BVID or ISID provisioning is required**

Metro Region

HVPLS

WAN

Core VPLS

HVPLS   Metro   HVPLS
         Regions
         Edge PEs
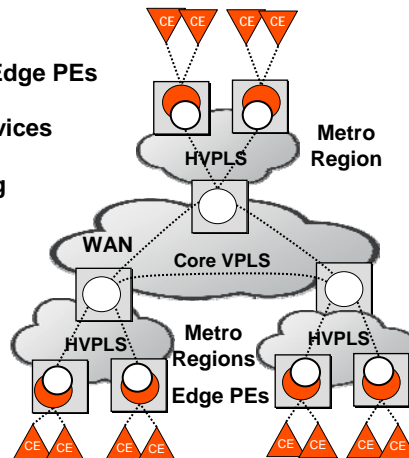
Core PEs operate only on B-MACs (Provider Addressing)
PW encapsulation used for both ELINE and ELAN Services

FutureNet 2007

Alcatel·Lucent

11

Agenda

Introduction

Network Modeling

E-LINE & E-LAN Service Requirements

PBB vs VPLS

Conclusion

Alcatel·Lucent
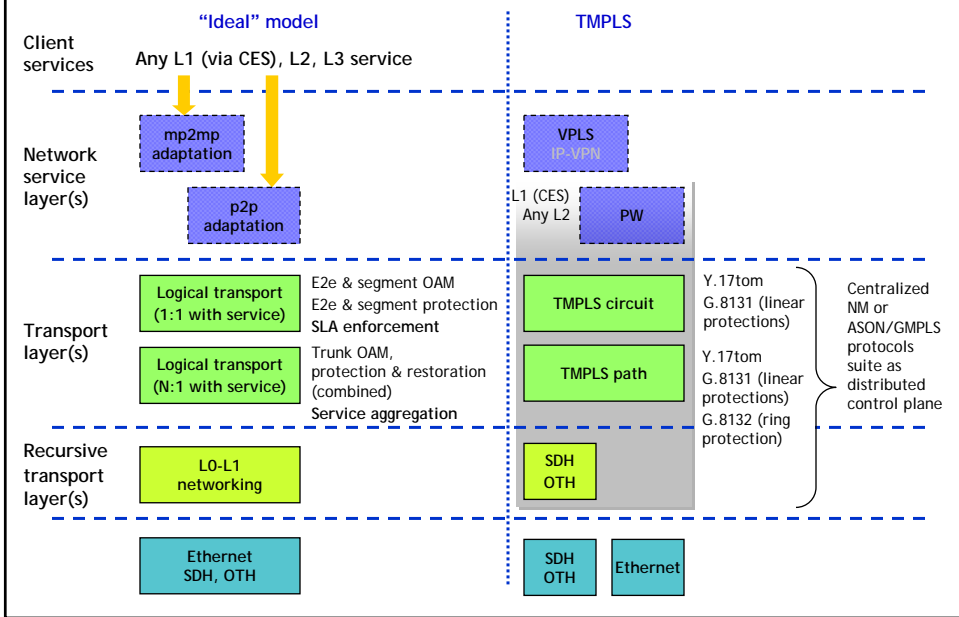

Conclusion

- VPLS/MPLS vs PBB for E-LAN services
  - Unified transport architecture for p2p and mp2mp services & for L1, L2, L3 services
    – MPLS transport & PW label demultiplexing
    – Proven & deployed protocol architecture
  - Scalable transport & service multiplexing
    – TE for p2p and mp2mp
    – Differentiated QoS per service endpoint
    – Fast convergence
      – No Spanning Tree
    – Optimized MAC flushing
    – Layered addressing space for inter-provider support
  - Connection oriented
- PBT only addresses E-LINE services
  - MPLS PWs needed for multi-service

Main value of PBB is its MAC-in-MAC capability and HVPLS will make use of it for MAC hiding.

Alcatel·Lucent

Q & A

Alcatel·Lucent

Packet Transport Network Modeling & TMPLS

	"Ideal" model		TMPLS
Client services	Any L1 (via CES), L2, L3 service		

	"Ideal" model		TMPLS	
Network service layer(s)	mp2mp adaptation		VPLS IP-VPN	
	p2p adaptation		L1 (CES) Any L2 — PW	
Transport layer(s)	Logical transport (1:1 with service)	E2e & segment OAM E2e & segment protection SLA enforcement	TMPLS circuit	Y.17tom G.8131 (linear protections)
	Logical transport (N:1 with service)	Trunk OAM, protection & restoration (combined) Service aggregation	TMPLS path	Y.17tom G.8131 (linear protections) G.8132 (ring protection)
Recursive transport layer(s)	L0-L1 networking		SDH OTH	
	Ethernet SDH, OTH		SDH OTH Ethernet	

Centralized NM or ASON/GMPLS protocols suite as distributed control plane

13

Packet Transport Network Modeling: MPLS-TMPLS synergies