Carrier Ethernet Evolution

Next phase of carrier-class Ethernet services wave

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Agenda

1. Introduction
2. Understanding PBB
3. PBB-VPLS — The next phase
4. Conclusions

1 Introduction

VPLS — The de facto carrier-class Ethernet services standard

Carrier Ethernet = Ethernet + MPLS

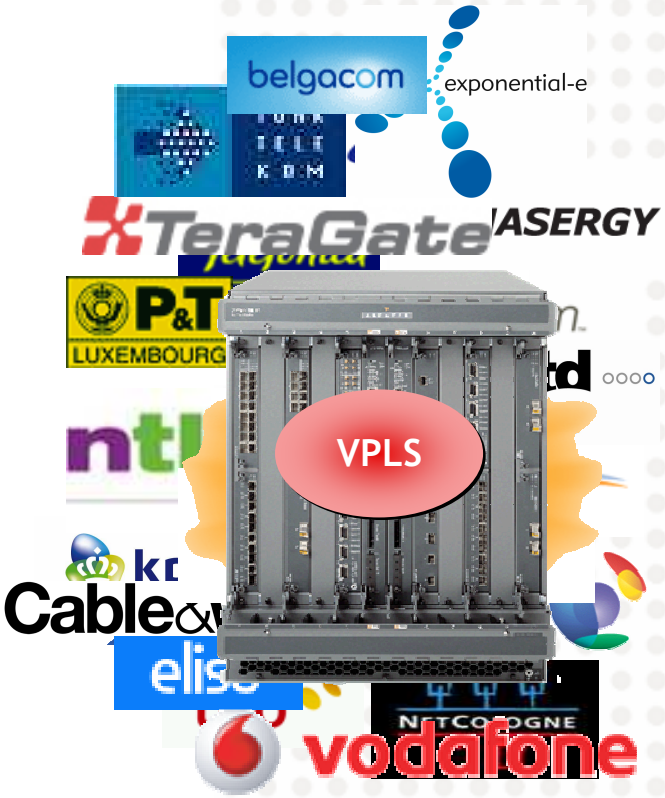
MPLS is the predominant technology used by service providers

- Scalability — millions of users/end points
- Resiliency/Reliability — high availability including rapid restoration (sub-50ms deterministic failover)
- QoS — Traffic Engineering plus QoS, SLA tools
- Service Management — ease of troubleshooting & provisioning, various OA&M

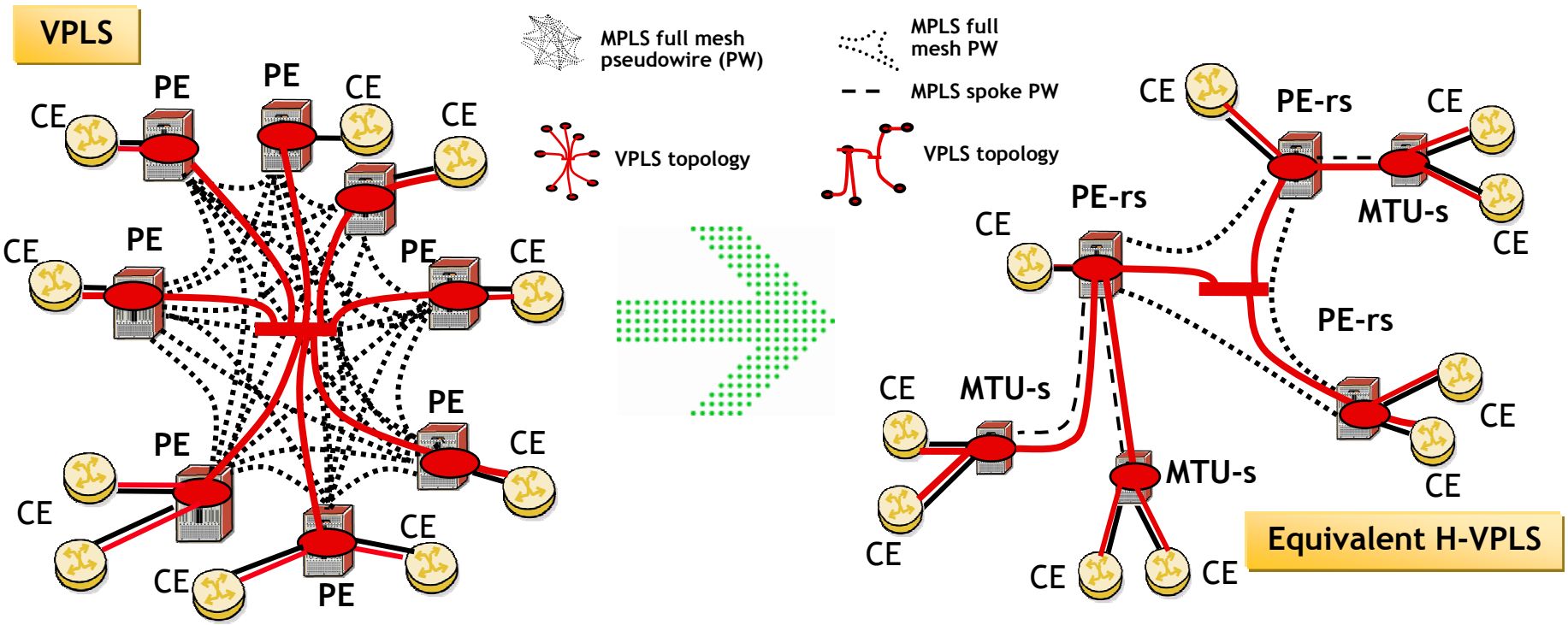
VPLS inherits the MPLS benefits

Alcatel-Lucent LDP derived VPLS leadership

- Industry best VPLS solution, technology innovators
- Deployed in large service provider networks — 1,000s of PEs and 100,000s of VPLS services



H-VPLS — Second phase of carrier-class Ethernet services wave



- Full mesh of peering sessions
- High operating and capital expenditures
- Source-based BUM replication

- Hierarchy, scalability
- Simplified operations, low cost MTU-s
- Optimized BUM replication

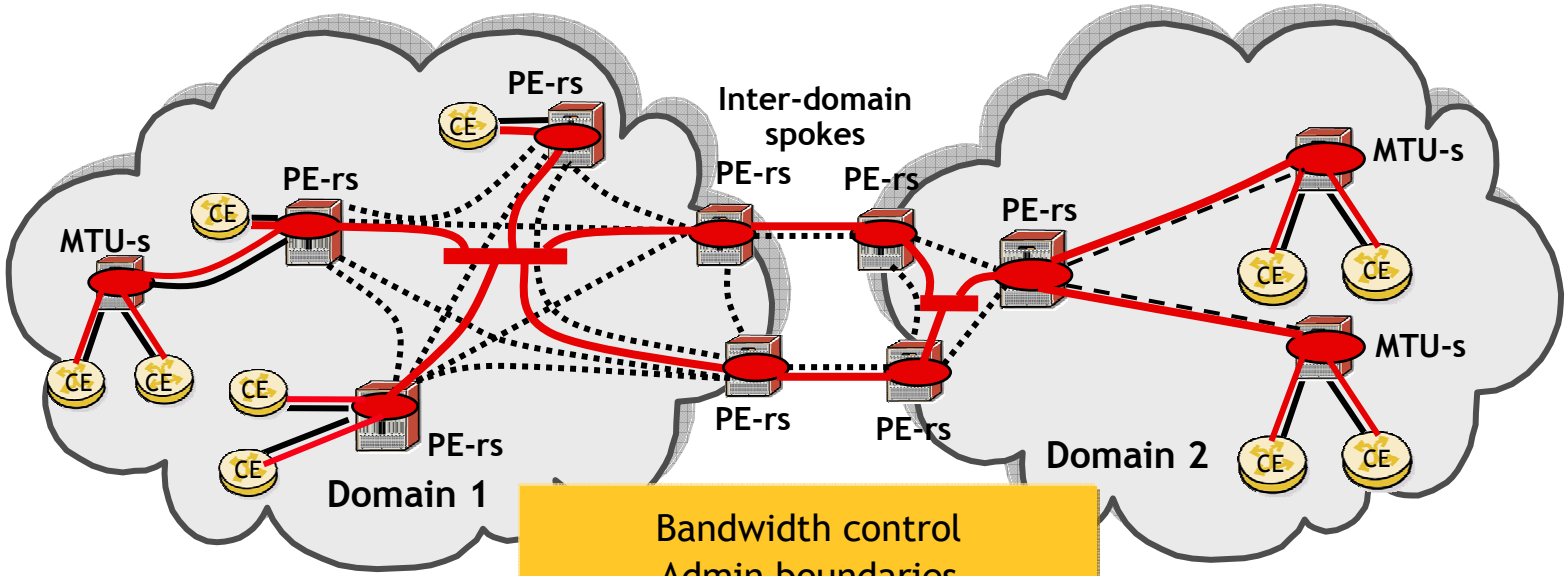
H-VPLS — Advantages over VPLS

Quick service activation

Flexible topologies with replication efficiency

- Metro access rings (chained spokes), hub and spoke

- Simplified service deployment model — one model fits all
  - Covers small, medium and large customers; intra- and inter-domain connectivity



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The next phase: PBB-VPLS

Carrier-class Ethernet services are entering a new phase of deployment

- Metro networks collected by regional networks, connecting to national and international backbones
- VPLS Carrier's Carrier services
- Growth to 1,000s VPLS devices, 10,000s VPLS services

Large-scale networks require H-VPLS, however aggregation hub nodes need customer-awareness:

- 100,000 MAC addresses
- 10,000 VPLS services/pseudowire emulation (PWE)

Customer awareness is recommended to be kept at the edge

- This can be achieved by using PBB capability to hide MACs from core and aggregate services and PWE

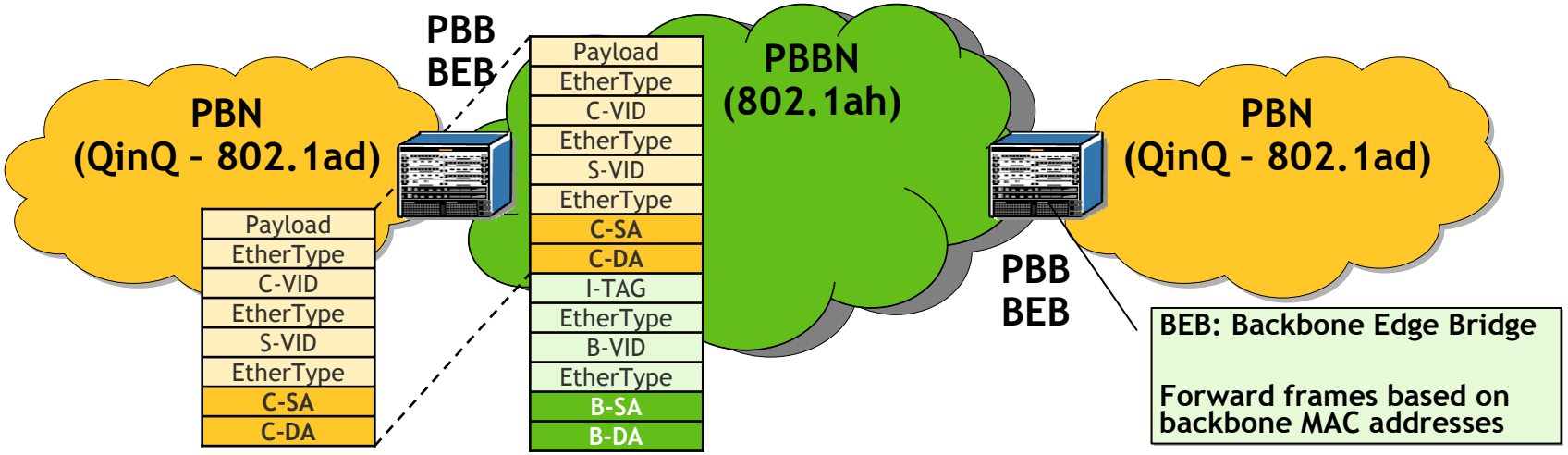
H-VPLS combined with PBB (PBB-VPLS) meets the next phase of requirements

2 Understanding PBB

Provider Backbone Bridging – IEEE 802.1ah

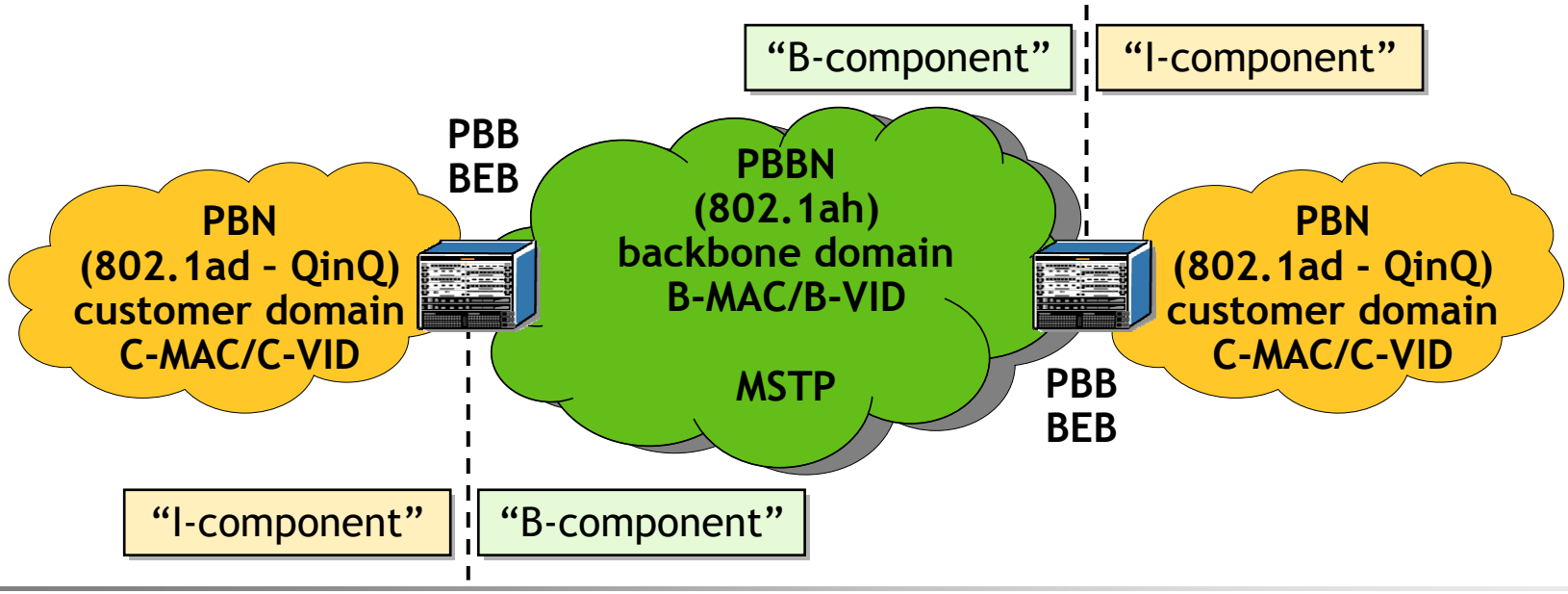
IEEE 802.1ah PBB model

- Designed to interconnect Provider Bridge Networks (PBN - IEEE 802.1ad – QinQ)
- Adds a backbone header to a customer/QinQ Ethernet frame
  - Provider addressing for backbone forwarding (B-MACs: B-DA/B-SA)
  - Backbone VLAN ID defining the backbone broadcast domain
  - New extended tag for service virtualization (I-TAG)
- Provider Backbone Bridge Network (PBBN) is Ethernet based:
  - Connectionless forwarding based on MAC learning and forwarding
  - Loop avoidance based on xSTP
  - VLAN-ID for broadcast containment

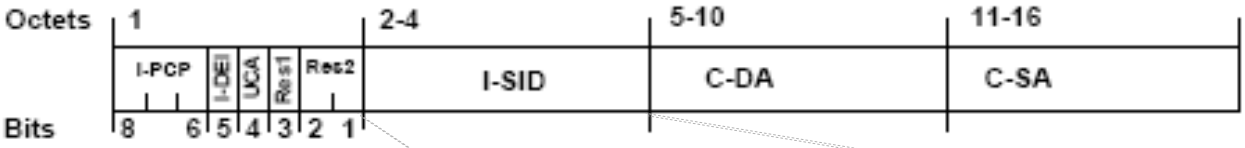


IEEE 802.1ah PBB model (cont.)

- The IEEE model for PBB is organized around a:
  - B-component handling the provider backbone layer
  - I-component (boundary between the customer and backbone MAC domains)
    - concerned with the mapping of customer/provider bridge (QinQ) domain (e.g. C-MACs, C-VLANs) to the provider backbone (e.g. B-MACs, B-VLANs)
- PBB requires the use of P-MSTP as the core control plane (B-domain) for loop avoidance and load balancing.



IEEE 802.1ah PBB "MAC-in-MAC" encapsulation



4B	FCS	
46B - 1500B	Payload	Customer Payload
2B	EtherType (e.g. 0x0800 = IP)	
2B	C-VID	802.1ad Customer Tag (inner)
2B	EtherType (0x8100 = 802.1q)	
2B	S-VID	802.1ad Service Tag (outer)
2B	EtherType (0x8100 = 802.1q)	
6B	C-SA	Customer destination and source MAC address
6B	C-DA	
4B	I-TAG TCI (contains I-SID)	PBB Service Tag
2B	EtherType (0x88e7 = 802.1ah)	
2B	B-VID	PBB Backbone Tag
2B	EtherType (0x8100 = 802.1q)	
6B	B-SA	Backbone destination and source MAC address
6B	B-DA	

I-SID – Backbone Service Instance Identifier

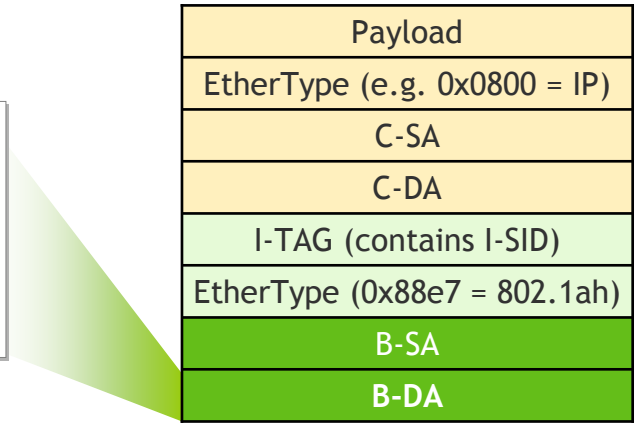
- Identifies the service instance
- Allows up to 16M service instances (24 bits) within a single Provider Backbone Bridged Network (PBBN)
- Used at the destination BEB as a demultiplexer field

IEEE 802.1ah PBB flooding – Backbone Group MAC (Group B-MAC)

The Backbone Destination MAC (B-DA) for customer BUM frames is set to a special Backbone Group MAC ("flooding" MAC), derived from the I-SID:

Backbone Service Instance Group Address

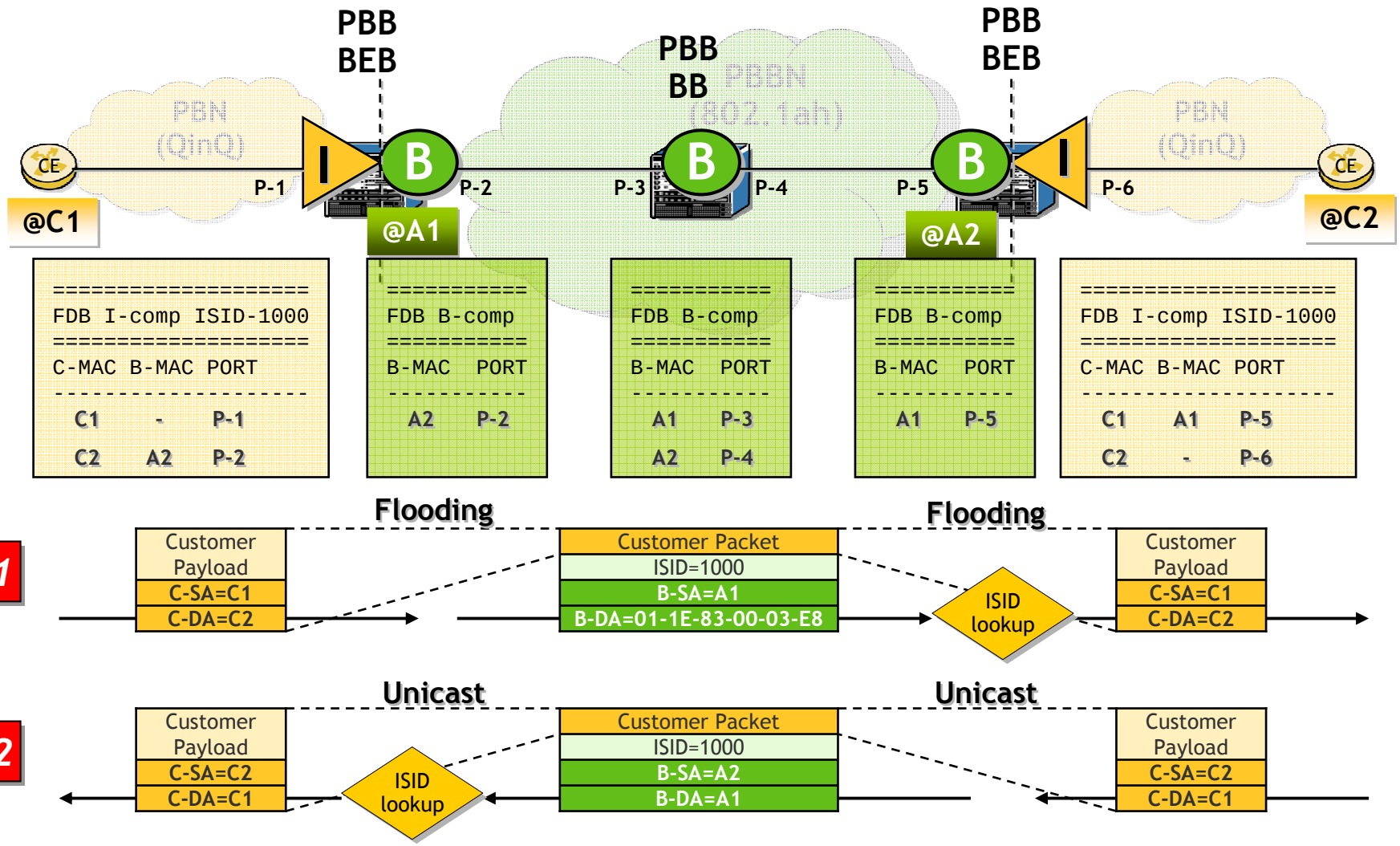
Name	Value
802.1Q Backbone Service Instance Group Address	00-1E-83-nn-nn-nn



Where

- 01-1E-83 is a standard based Group OUI assigned for 802.1ah (multicast bit set)
- nn-nn-nn are the encoding of the 24 bit I-SID

IEEE 802.1ah PBB – Packet walkthrough



Can PBB alone deliver carrier-class Ethernet services?

Within a service provider environment PBB has some shortfalls

- Lacks carrier-class functionality and tools
- Leverages the standard Ethernet connectionless model so
  - No traffic engineering
  - No carrier-grade resiliency
- Relies on Spanning Tree Protocol for resiliency and loop avoidance (P-MSTP)

Predecessor proprietary MAC-in-MAC available since 1999 with very limited deployments in the carrier space

However, PBB brings two unique positive attributes:

- MAC hiding
- Service (I-component) aggregation into B-components

Alcatel-Lucent brings the best of PBB to complement H-VPLS

3 PBB-VPLS — The Next Phase

The Alcatel-Lucent model for PBB

Alcatel-Lucent model for PBB — Draft-balus

- VPLS extensions for PBB being standardized in IETF:

"Virtual Private LAN Service (VPLS) [RFC4762] provides a solution for extending Ethernet LAN services, using MPLS tunnelling capabilities, through a routed MPLS backbone without running (M)STP across the backbone. As a result, VPLS has been deployed on a large scale in service provider networks.

This draft discusses extensions to the VPLS model required to incorporate desirable PBB components while maintaining the Service Provider fit of the initial model.."

draft-balus-l2vpn-vpls-802.1ah-02.txt - Work in Progress

- Co-authored by Alcatel-Lucent, KPN, France Telecom, British Telecom, Verizon and Extreme Networks
- Defines the PBB-VPLS model using standard components

The Alcatel-Lucent SR/ESS PBB implementation and objectives

Combine the best of both PBB and H-VPLS

- MPLS backbone (no need for MSTP), PWE3 for ePipe, multi-service
- PBB used for VPLS:
  - MAC hiding in an H-VPLS environment
  - Service aggregation in M:1 model
- PBB used for ePipe (optional):
  - Uniform provisioning model as VPLS
  - Service aggregation in M:1 model
- Enables Carrier of Carrier VPLS

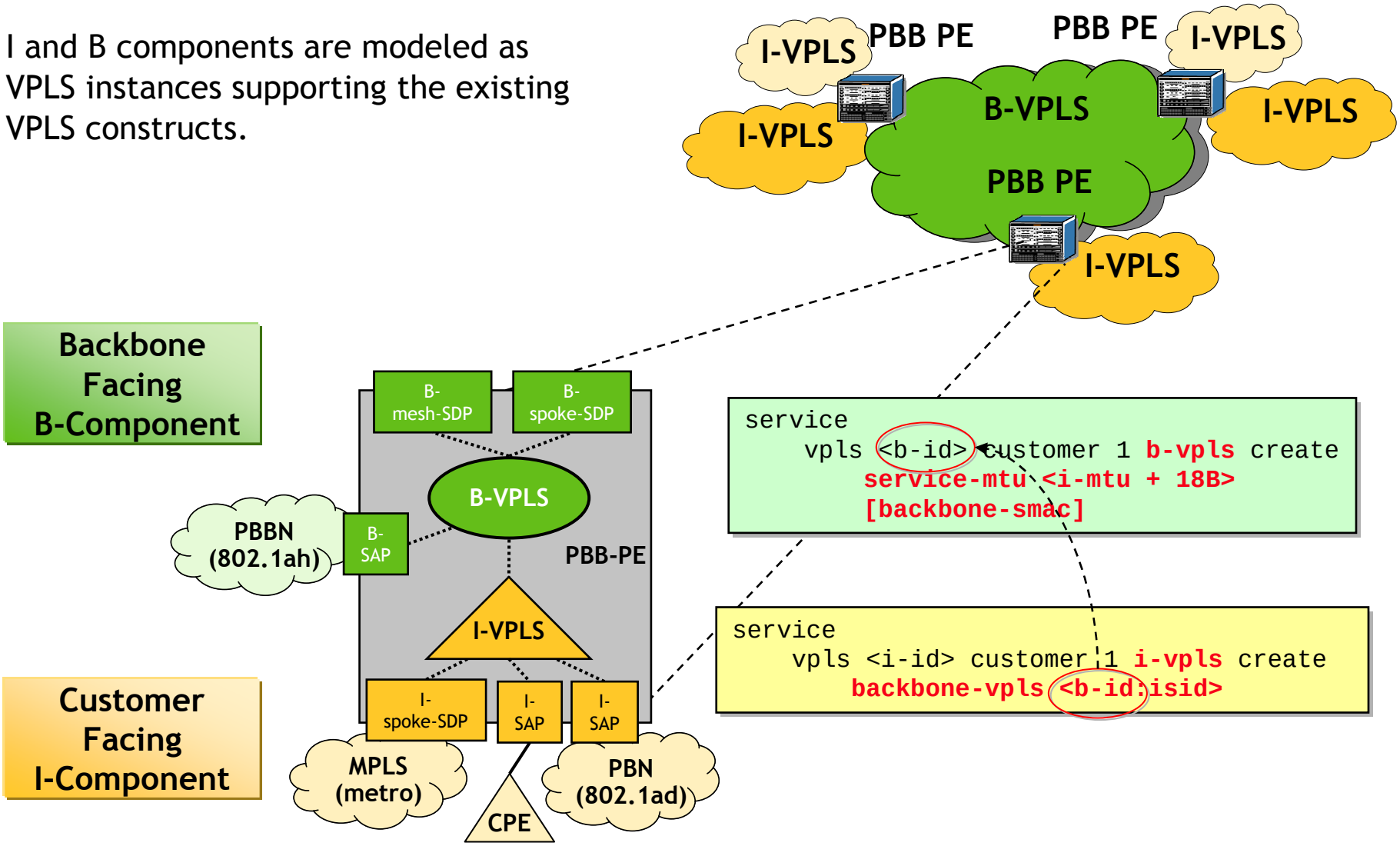
Supports native PBBN [IEEE802.1ah] for interoperability

- P-MSTP in backbone for loop avoidance
- Seamless introduction of MPLS tunneling when required

7x50 PBB-VPLS model

7750 ✓
7450 ✓
7710 ✓

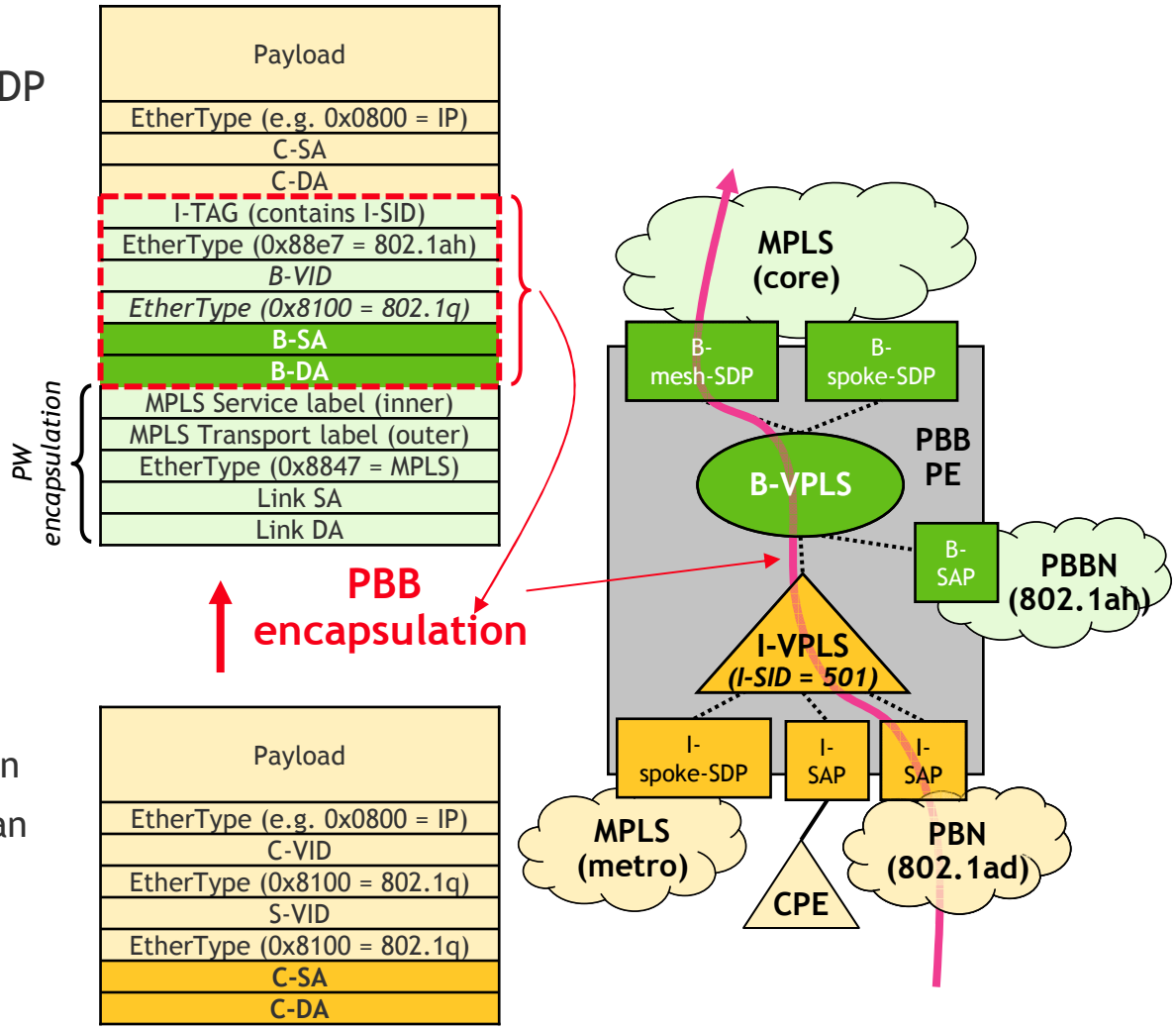
I and B components are modeled as VPLS instances supporting the existing VPLS constructs.



7x50 PBB-VPLS model: Ingress walkthrough

A frame ingressing an I-VPLS SAP/SDP and egressing a B-VPLS SAP/SDP is PBB encapsulated:

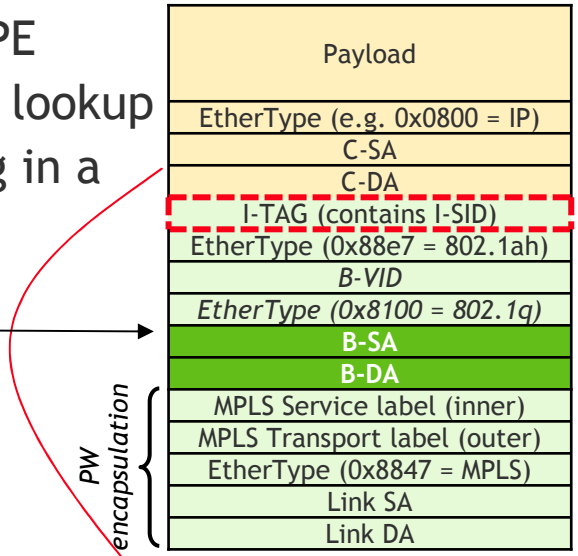
- Insert **B-MACs**:
  - B-SA = PBB-PE base MAC
  - B-DA = learned base MAC of remote PBB-PE (ucast) or group B-MAC (BUM)
- Insert **I-TAG**:
  - I-SID = I-VPLS backbone service identifier
- Insert **B-VID**:
  - SAP: According port encapsulation
  - SDP: Only in case of vc-type = vlan

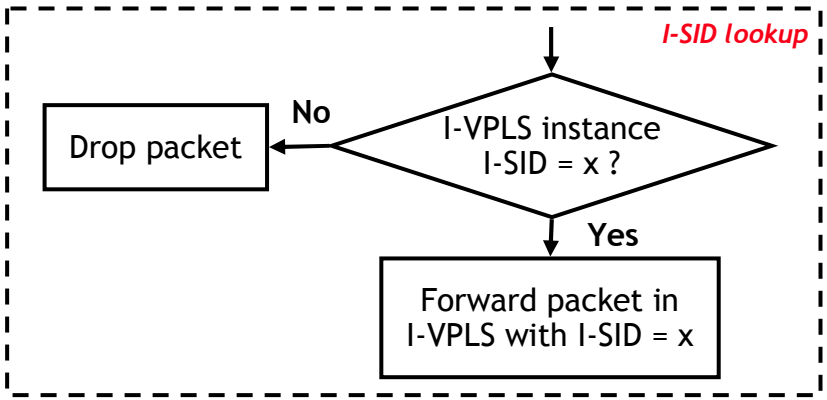


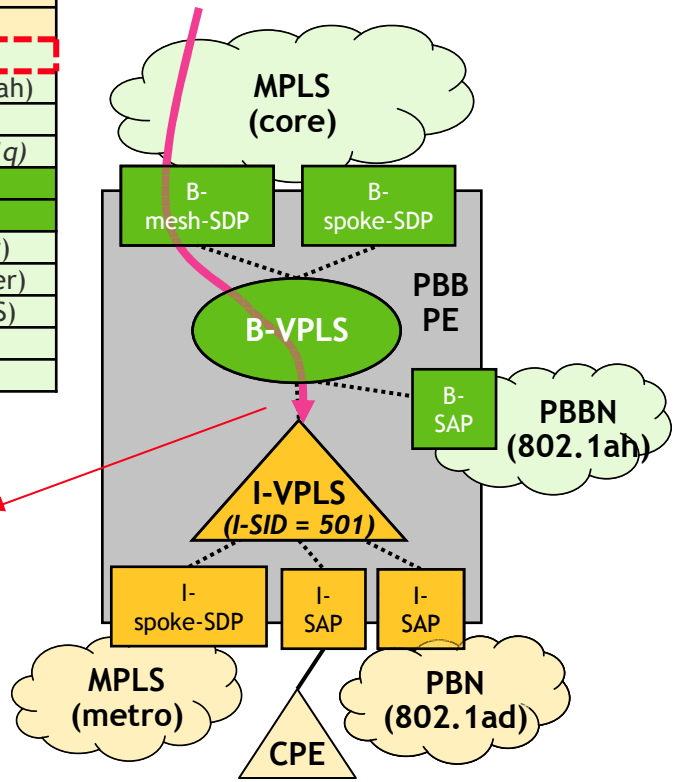
7x50 PBB-VPLS model: Egress walkthrough

On a frame ingressing a PBB-PE in a B-VPLS SAP/SDP, an I-SID lookup is done to check if forwarding in a local I-VPLS is required:

- If the B-DA is
  - A group MAC address
  - A local backbone MAC





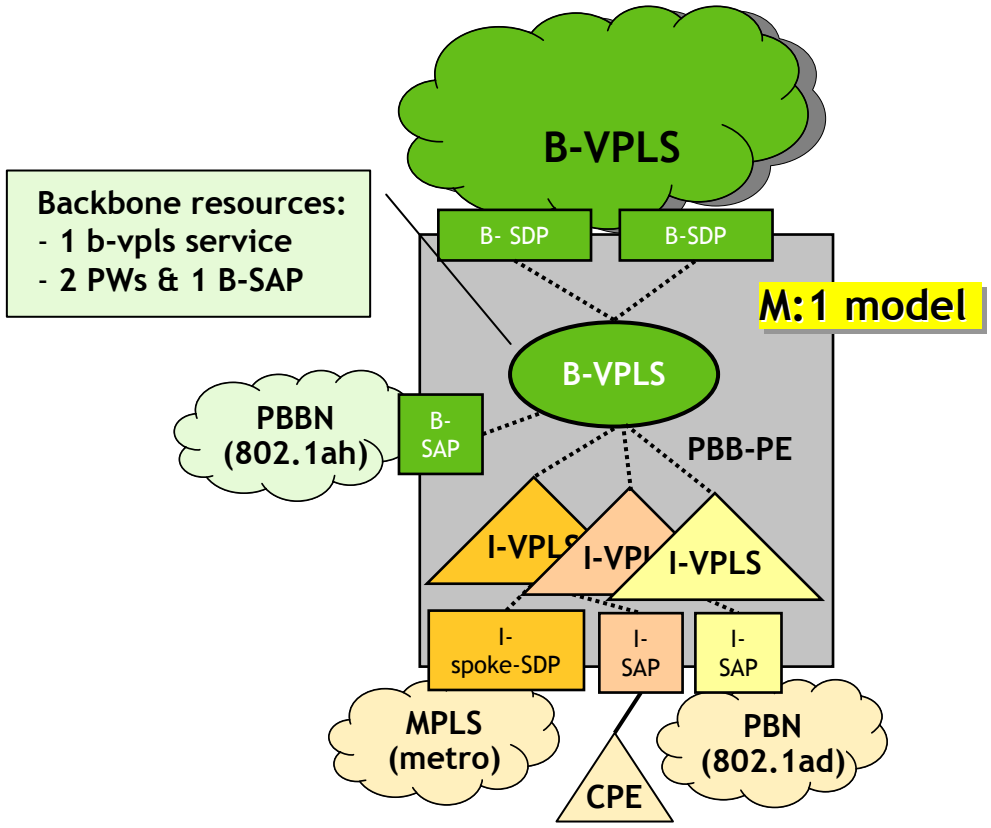


The M:1 model provides service and PW aggregation

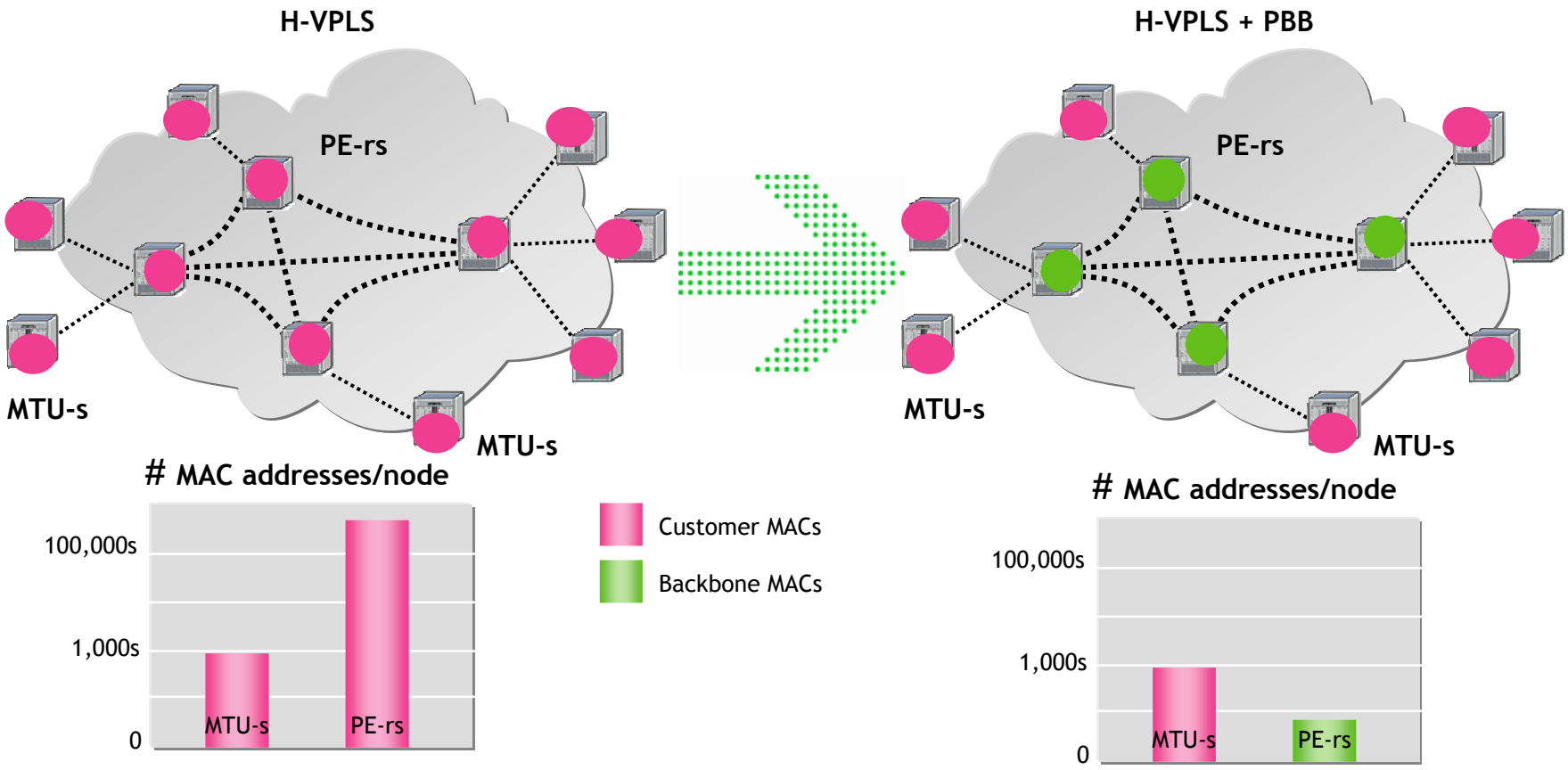
Flexible choice of mapping I-to-B components (1:1 or M:1)

The M:1 model provides service and PW aggregation

- All the I-services share the same set of backbone ports (H-VPLS PWs on the core)
- Aggregation “Hub” PE-rs (N-PE) nodes are relieved from customer-service awareness
- Customer demultiplexer is based on I-SID (identifies the I-VPLS instance)

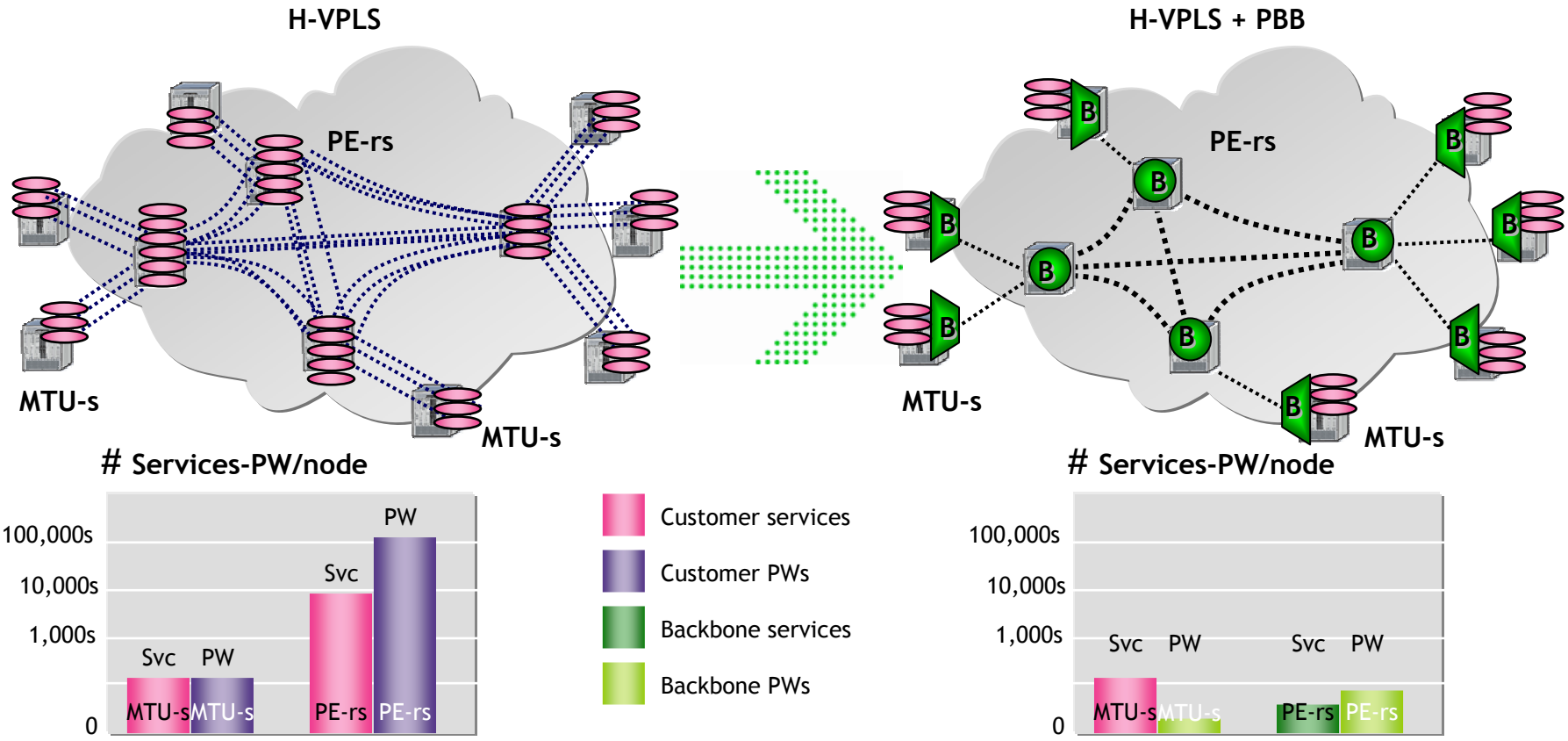


PBB-VPLS benefits — MAC scaling and customer-addressing awareness



- "Hub" PE-rs get visibility of 100,000 MACs
- High customer-addressing awareness
- MAC tables reduced: 1 B-MAC per node
- No customer-addressing awareness

PBB-VPLS benefits — Service/PW scaling and customer-service awareness



- "Hub" PE-rs aggregates 1,000s services and PWs
- High customer-service awareness
- Services and PWs dramatically reduced
- No customer-service awareness

4 Conclusions

Conclusions

Alcatel-Lucent leads the carrier-class Ethernet market

- Largest VPLS (H-VPLS) networks: Proven operational and engineering (development and design) expertise capabilities
- Extends a well-established VPLS offering with PBB-VPLS, ready for the next phase of carrier Ethernet services wave

Complete PBB-VPLS implementation combining:

- MPLS strength and H-VPLS benefits
- PBB's ability to relieve the core from customer awareness
- Service delivery across operational boundaries using the PBB-VPLS M:1 model
- The highest reliability and flexibility to suit any topology and preference

Industry-leading VPLS now extended by a first-to-market PBB-VPLS implementation

THANKS

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