Pseudowires from 1999 to 2009 , 10 years of evolution and deployments.

Luca Martini

lmartini@cisco.com

Agenda

- "Martini draft" Background and History.
- Deployments: SP Ethernet/ATM services, and Mobile IP R.A.N.
- PW Evolution: VPLS, and MS-PWs.
- PW and MPLS-TP: PW in access networks.

History:

- Year 1998/99:
  - –ATM has failed to deliver the multi-service networks, and is too slow/expensive
  - –Huge bandwidth demand. (or at least we thought so)
- New network from the ground up:
  - –All packet based services must run on one single packet network.
  - –MPLS is an emerging technology with the best management/granularity compromise
  - –Must create new telecom market competition to make network elements and services widely available.

Motivation of "draft-martini"

- Next Generation SP design:
  - –Classical frame/ATM is expensive and does not integrate well.
  - –Multi-service Backbone.
  - –Re-deployment or expand existing Hardware.
- Multiple vendor Implementation = market competition.
- New lower cost services with market acceptance.

Protocol Design Criteria

- "Simple" protocol Implementation.
- Must use existing hardware when possible.
- Leverage MPLS, for multi-service Core network
- Support existing SP protocols, and existing CPE
- Similar operational model to standard SP services.

Result:

- 11 vendors inter-operated when I stopped counting (~2001).
- Draft-martini is LDP based, a modern extensible design.
- Point-to-point links - operationally similar to classical frame-relay/ATM.
- MPLS based Multi-service network.
- Service management granularity/scalability compromise

IETF Influence on draft-martini design
Draft-martini -> rfc4447

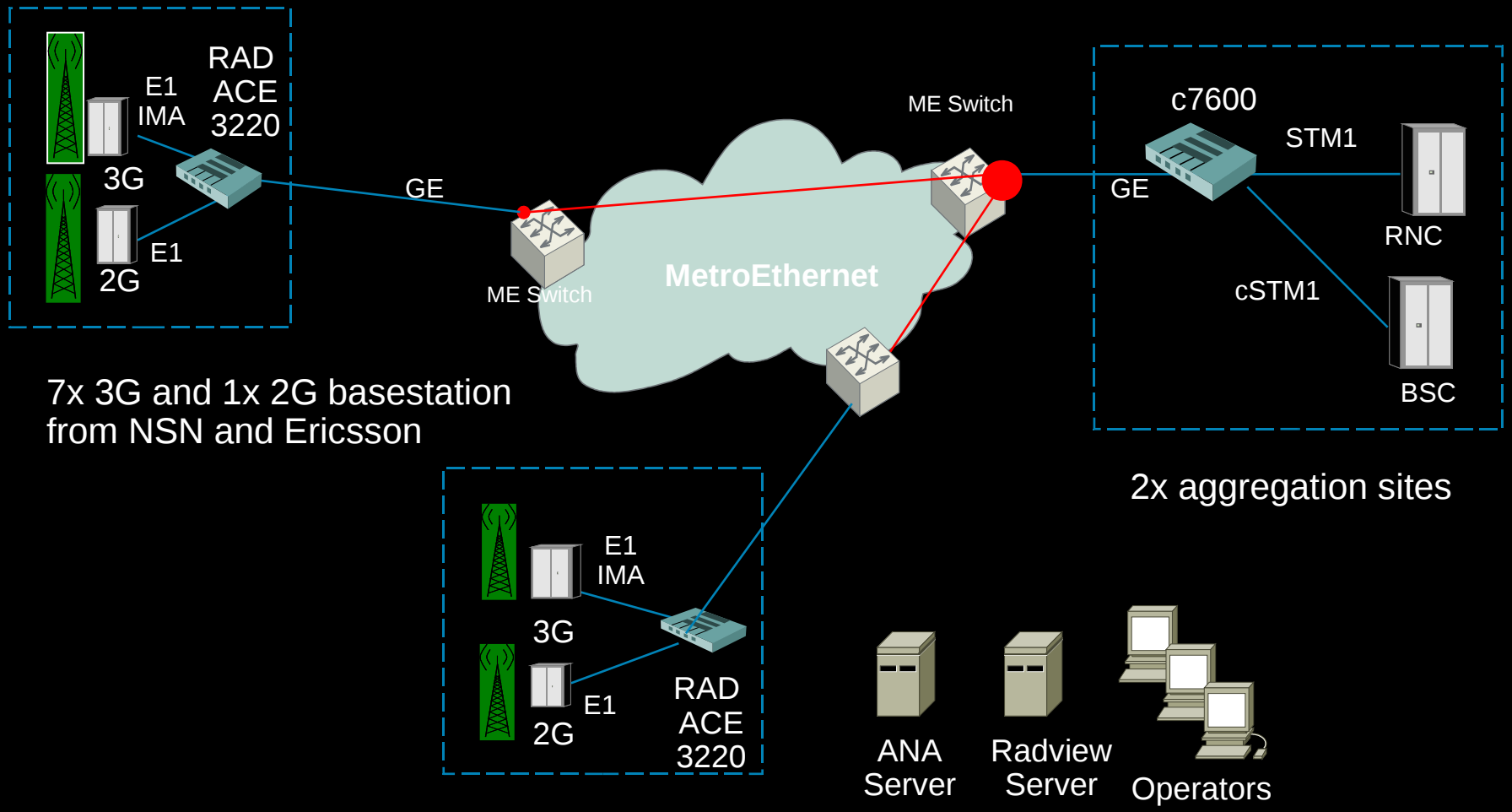
- Reorganized text , countless times !
- Changed Terminology
- PW remain 100% backward compatible to draft-martini
- Added FEC129 (generalized PWid) (0.1% deployment)
- Added PW status. (100% deployment)
- Added Fragmentation. (0% deployment)
- Wildcard Pseudowire Type. (0% deployment)
- Many ATM special optimizations (make ATM over MPLS better then ATM , long live ATM!) (0.1% deployment)
- Added Ethernet FCS retention (0% deployment)
- Etc. etc. .....

Draft-martini Oops , If I had known !

- MTU interface Parameter.
  - –Folks clearly want broken networks
  - –Vendors write really crappy driver code
  - –10 years later I still average 1 long call per quarter on this topic!
- Frame-relay Encapsulation Header Bits.

Deployment Examples.

RAN Deployment case study



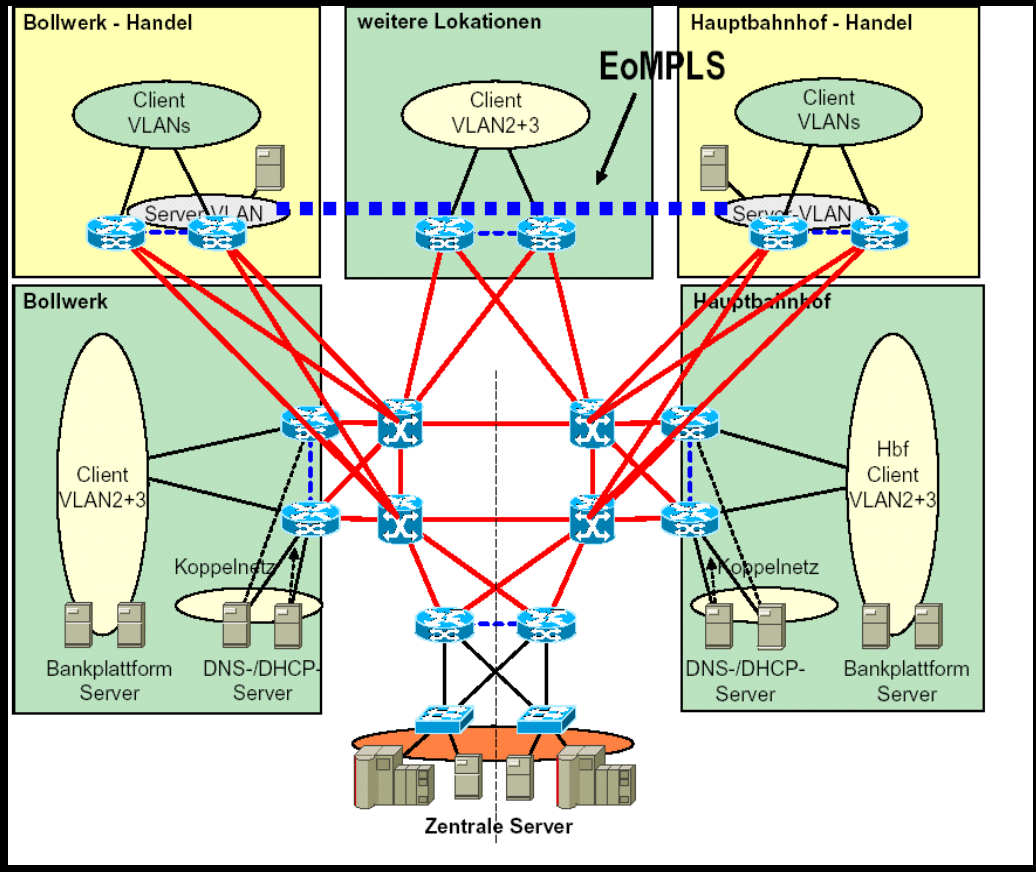
VPLS for Carrier Ethernet networks – Case Study

- Integrated Communications Provider
- Use VPLS with QoS for various access network
- Deployed VPLS using 50 c7600s network
- Hardware
  - C7600s for PEs, c3750ME for CEs,
- Use
  - QoS for service classes
  - RSVP-TE Tunnels
  - vlan rewrite
  - Max mac-address limitation (16 per vlan)
  - H-VPLS, QinQ

EoMPLS Case Study
EoMPLS between Campus for Server groups

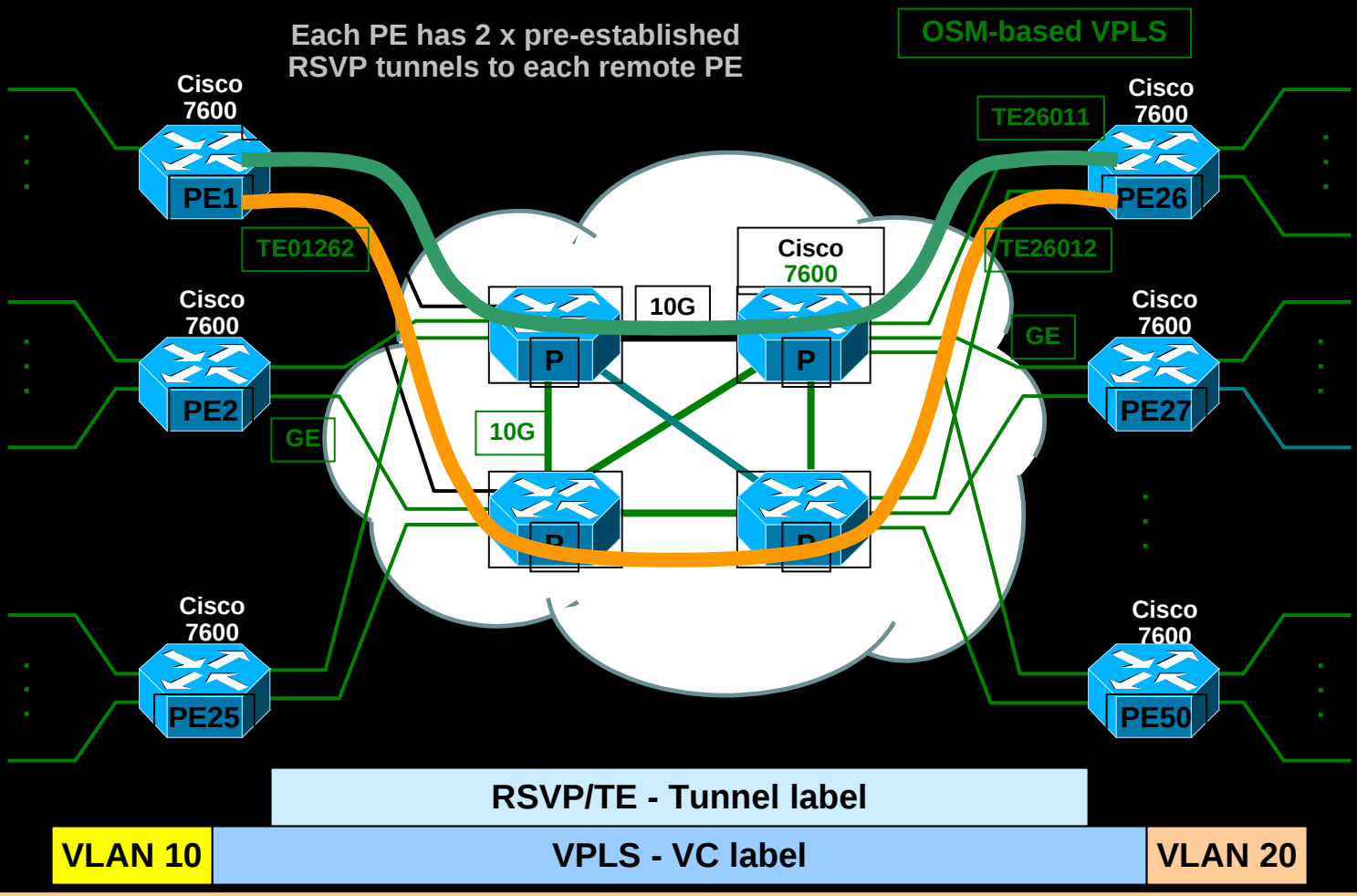
- Segmentation (Migration from Global Routing) and L2 over MPLS with HA and QoS

- **Type of PE-Box: SUP720, C7200**
  - PE-Topology: full meshed
- L2-Tunnel #: 2; L2-STP: Rapid STP
  - Cisco IOS: 12.2SX/12.0S
- PE-CE links: directly connected GE
  - QoS on Core Links
  - iBGP RR for L3VPNs
  - **Type of P-Box: SUP720**
    - P-Topology: P2P (4)
    - Cisco IOS: 12.2SX
    - Core Routing: OSPF
- Type of core links: 10GE (MAN)
  - QoS on Core Links
  - **Type of CE-Box: Cat3550**



VPLS for Carrier Ethernet networks – Case Study

Basic Architecture (PE-P-PE)

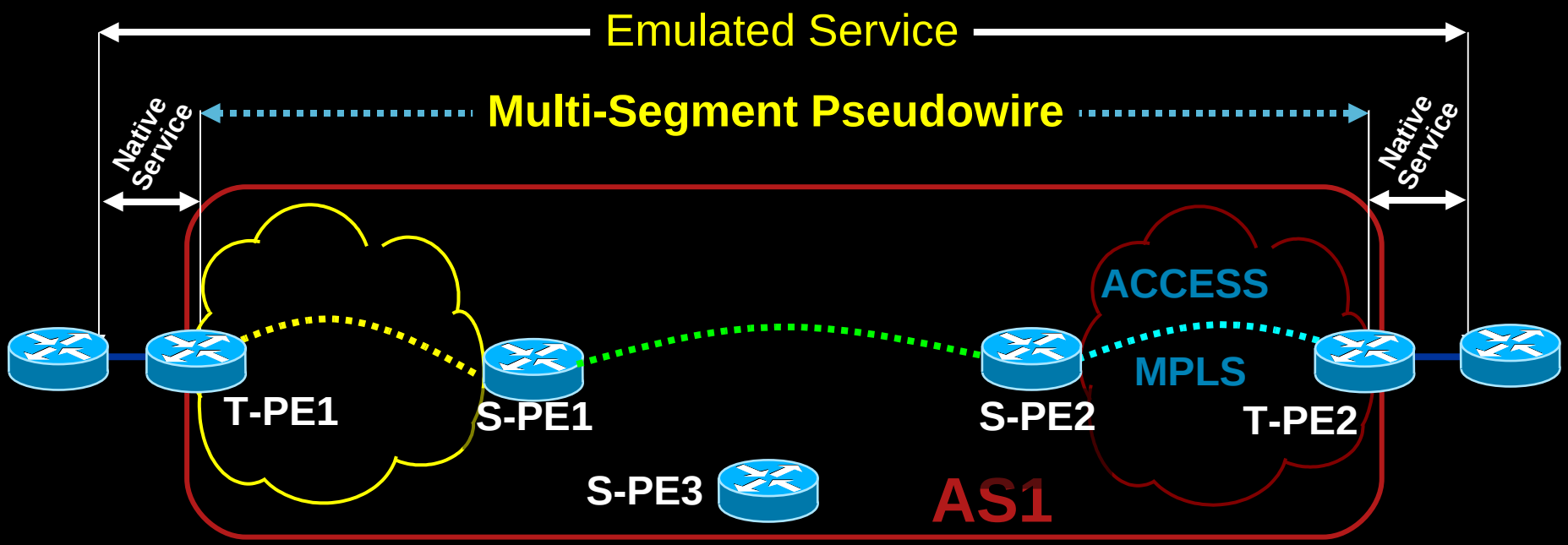


Dual Attached PEs to the core; 2 TE Tunnels to each PE, 50 PEs, 5000 Tunnels
VC are evenly load-shared over 2 pre-established Tunnels
Each TE LSP takes one explicit-route, dynamic path on one TE
When one OSM port/link is down, all VC traffic switches to another established LSP

PW Technology Evolution:

Dynamic Placement of Multi-Segment Pseudowires

Multi-Segment PW Definition



- S-PE – Switching Provider Edge – Can switch control and data planes of preceding and succeeding segments of a MS-PW. S-PE initiates the signaling for MS-PWs.
- T-PE – Terminating Provider Edge – Customer facing PE, hosting the first or last segment of a MS-PW

Dynamic Placement of Multi-Segment PW (= PW Routing) Procedures

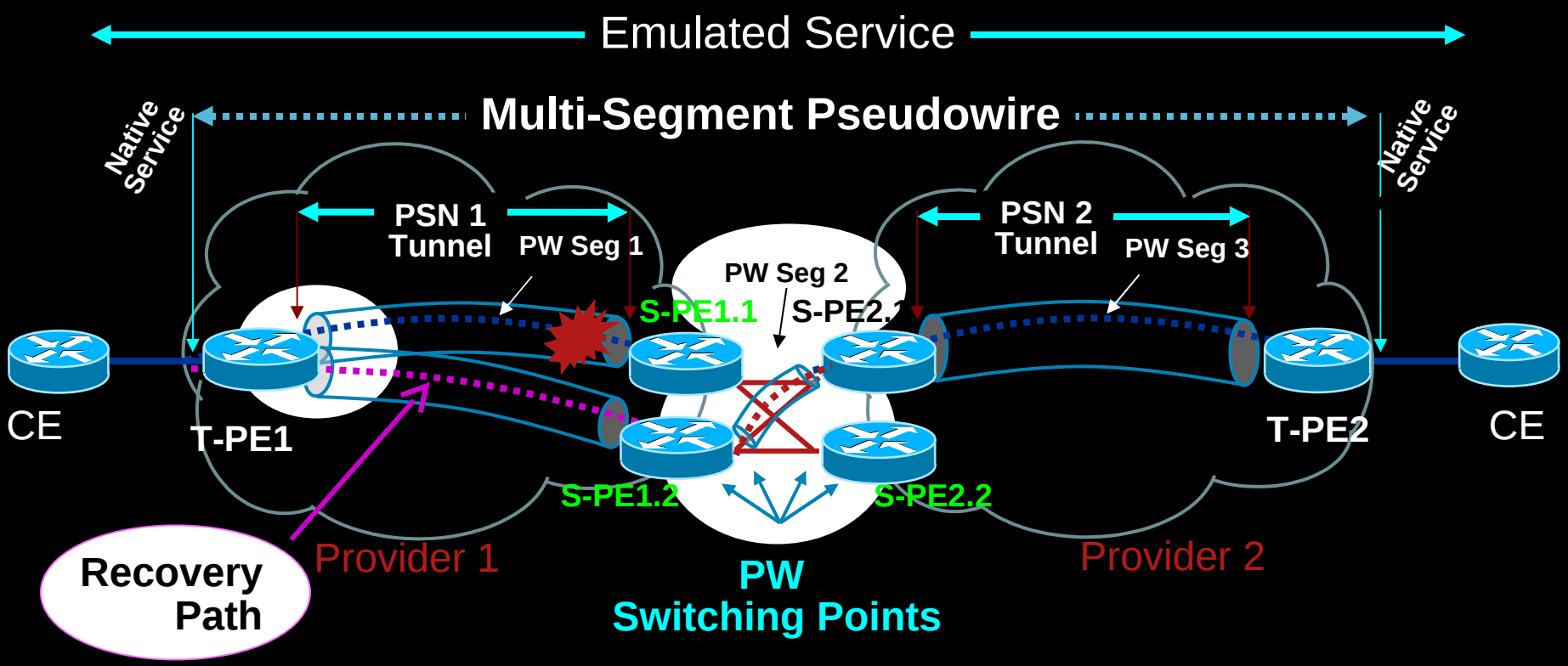
- For DP MS-PW, need global addresses assigned to individual PW Attachment Circuits and all S-PEs composing MS-PW for reachability and manageability of the PW.
- Each AC gets assigned GLOBAL-ID + Prefix+ ACID = AII Type 2.
- This TAII is used by S-PEs to determine the next SS-PW destination for LDP Signaling.

- PW Next Hop Selection from PW Routing Table

0 31	32 63	64 95
Global ID	Prefix	AC ID

- During the signaling phase, the content of the TAII type 2 field from the FEC129 TLV is compared against routes from the PW Routing table. The longest match is NH to be signaled

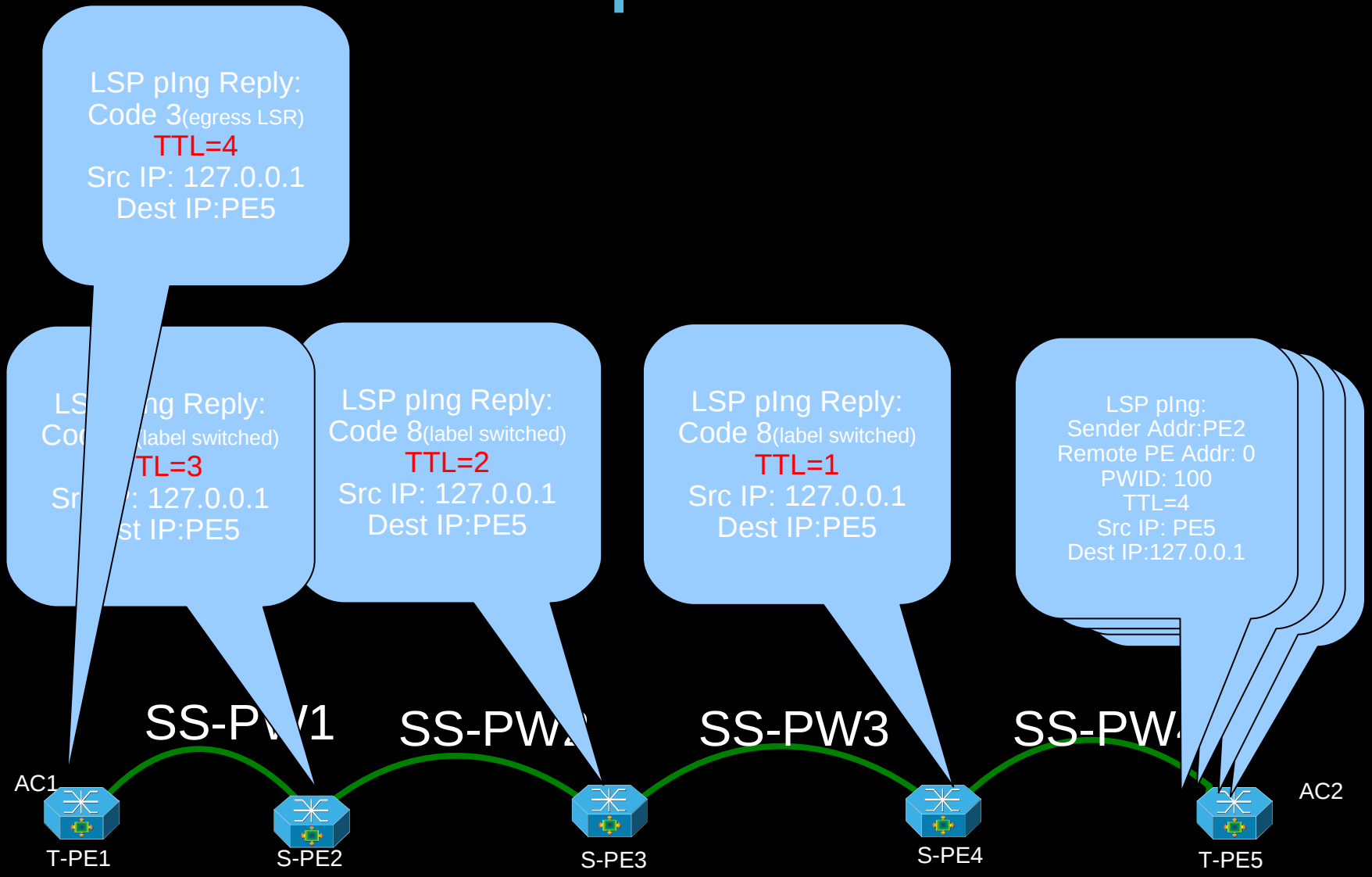
Dynamic Placement of MS-PWs – 4 S-PEs connecting two PSNs with Redundancy



- Recovery Case :
  Routing failure recovered via backup route

Recovery
= MPLS LSP Tunnel

VCCV Trace Example



PW Technology Evolution:
MPLS-TP

MPLS-TP and PWs

- MPLS TP is static provisioned MPLS LSPs with some extra OAM.
- PWs are the only current “Client” application of MPLS-TP
- NO change to PWs, We had static configuration already defined in rfc4447
- Applications:
  - –Lower cost Ethernet Access
  - –SONET Replacement in access/aggregation.

How IT works in 1 slide !

- Basic MPLS LSP with static label configuration at every Router Hop.
- Today: Redundancy by pre-configured backup path, and AIS/RDI failure indication.
- Also BFD monitoring or LSPs, or Segments
- LFU (Label For You , = 13) for segment in-band monitoring.
- Otherwise it's a normal MPLS LSP.....

Thank you !