MPLS Transport Profile

Igor Giangrossi

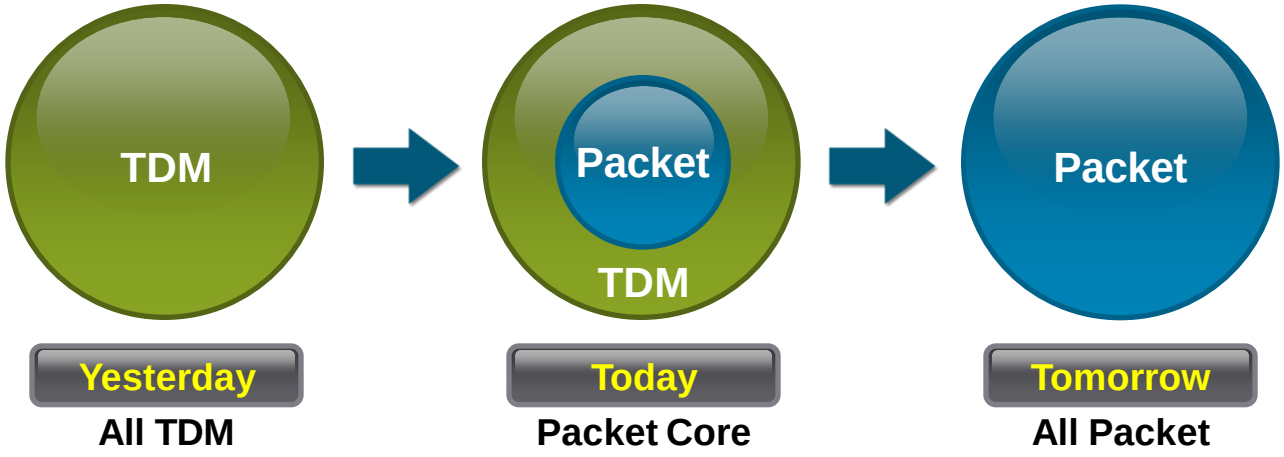
igor.giangrossi@cisco.com

Agenda

- Motivations
- Brief MPLS Review
- MPLS-TP Architecture
- Applicability and Comparison

Market Trends in Infrastructure

- **Growth of Internet and hence IP traffic**
- **Ethernet cost points drop**
  - Effective technology to carry IP
- **Revenue shifts from voice to data**
- **Video accelerates the problem**
  - IP Traffic doubles every year
  - Drives infrastructure migration from TDM to Packet



Transport Networks Characteristics

- Deterministic Behavior
- Strong OAM tools
- Static Provisioning (via NMS, no Control Plane)
- Static back-up paths
- Generally IP seen as “too complex” for transport teams (changing recently, though)

Making MPLS more Transport Friendly

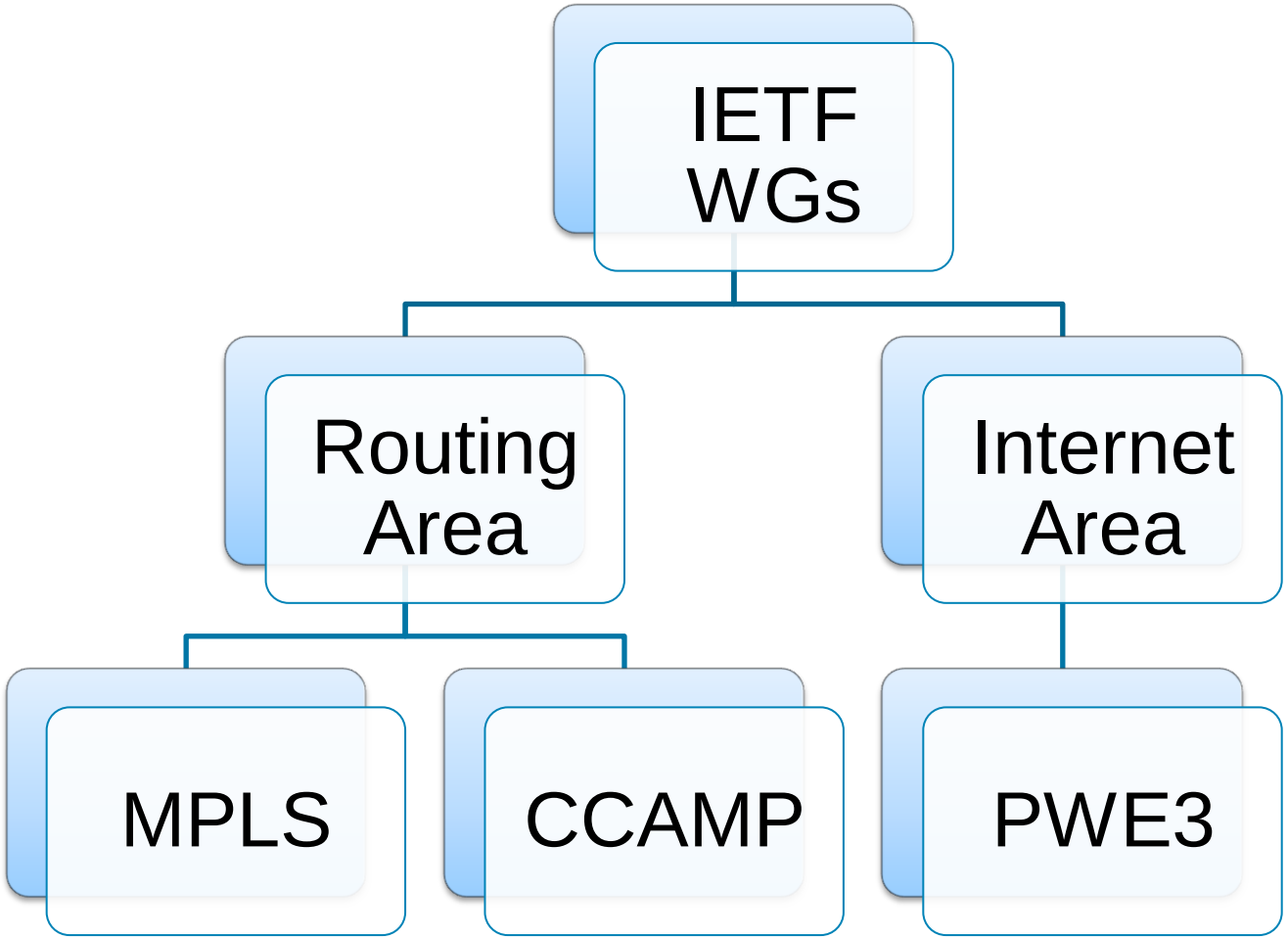
- Static configuration LSPs and PWEs
- LSPs and PWEs management via external NMS
- Nesting of LSPs and PWEs similar to SONET/SDH environments
- OAM and data path are congruency
- Transport protection mechanisms within MPLS architecture
- Transport OAM capabilities at LSP and PWE independent of configuration mechanism

MPLS Transport Profile

- T-MPLS
  - All work has ceased in the ITU-T
  - Transport solution moved to the IETF
- MPLS-TP: a subset of MPLS
  - Fully conformant with IETF MPLS, all extensions applicable to MPLS
  - IETF Based: Started in April 2008
  - 4 Working Group drafts: Requirements and architectures
  - ~20 other drafts
  - Existing IETF work groups – MPLS, PWE3 and CCAMP
  - RFCs now appearing
- MPLS-TP Architecture
  - MPLS Forwarding plane with restrictions
  - PWE3 pseudowire architecture
  - Control Plane: Static or dynamic (G-MPLS)
  - Enhanced OAM functionality
  - OAM Monitors and drives protection switching

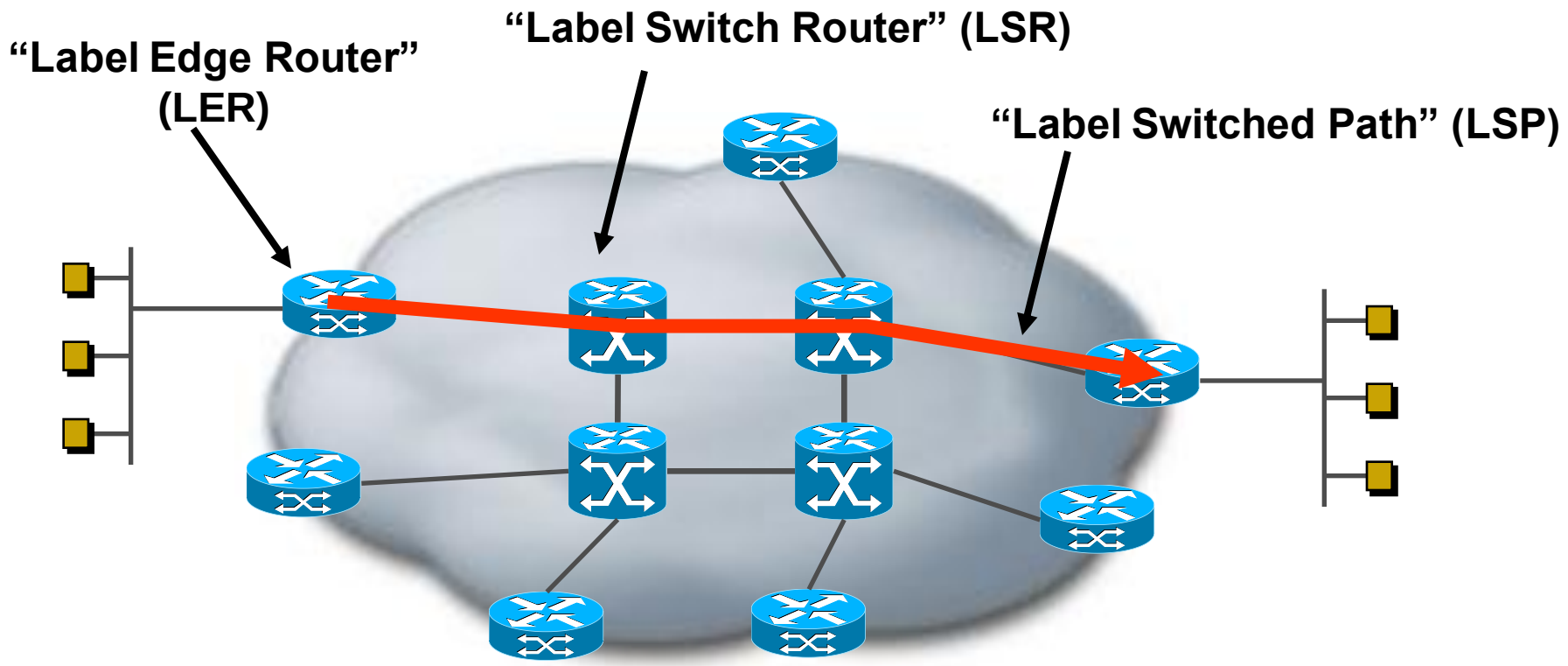
Driven by carrier's wishing to evolve SONET/SDH networks to support packet based services and networks, and the desire to take advantage of flexibility and cost benefits of packet switching technology

IETF Working Groups



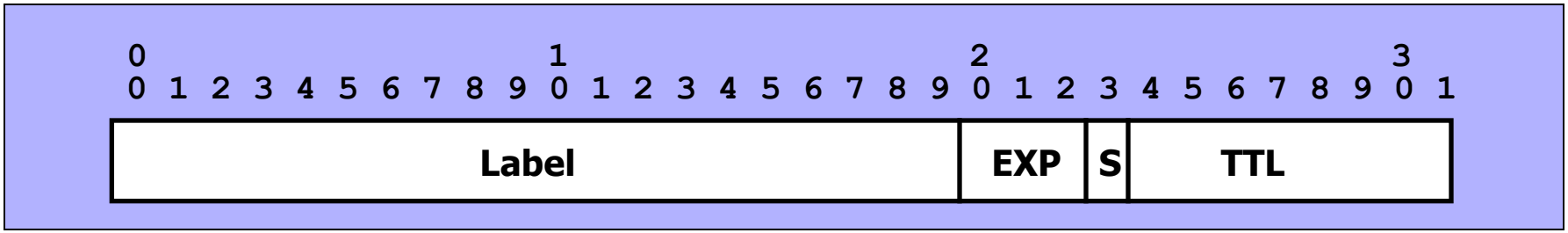
Brief MPLS Review

MPLS Concepts: Terminology



- LSP defines the path through LSRs from ingress to egress LER
  - A collection of label pushes, swaps and Pops
  - Can be defined in many different ways : statically, dynamically through LDP, BGP, RSVP

MPLS Concepts: Labels

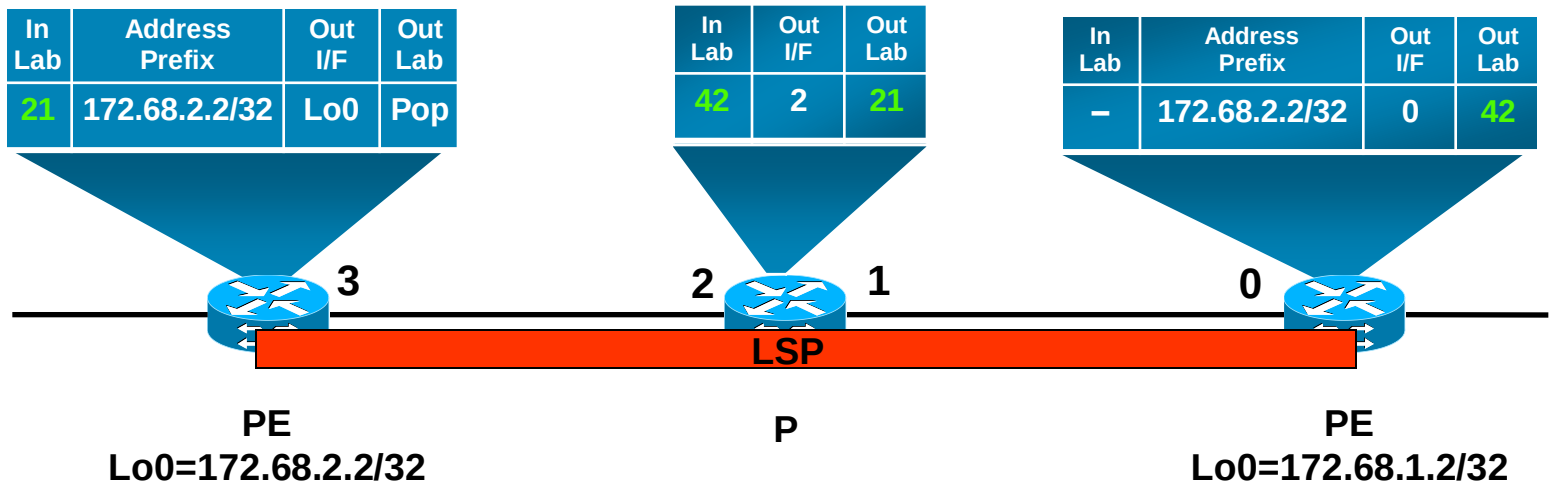


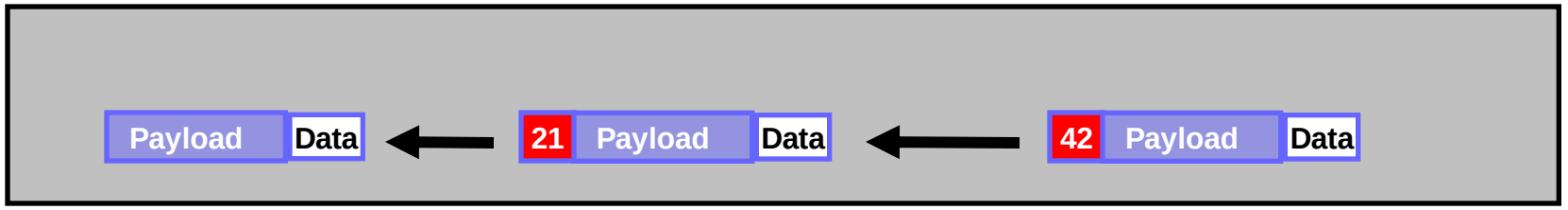
Label = 20 bits
EXP = Experimental bits, 3 bits
S = Bottom of Stack, 1 bit
TTL = Time to Live, 8 bits

- Generic: can be used over Ethernet, 802.3, PPP links, Frame Relay, ATM PVCs, etc.
- Uses new Ethertypes / PPP PIDs / SNAP values etc.:

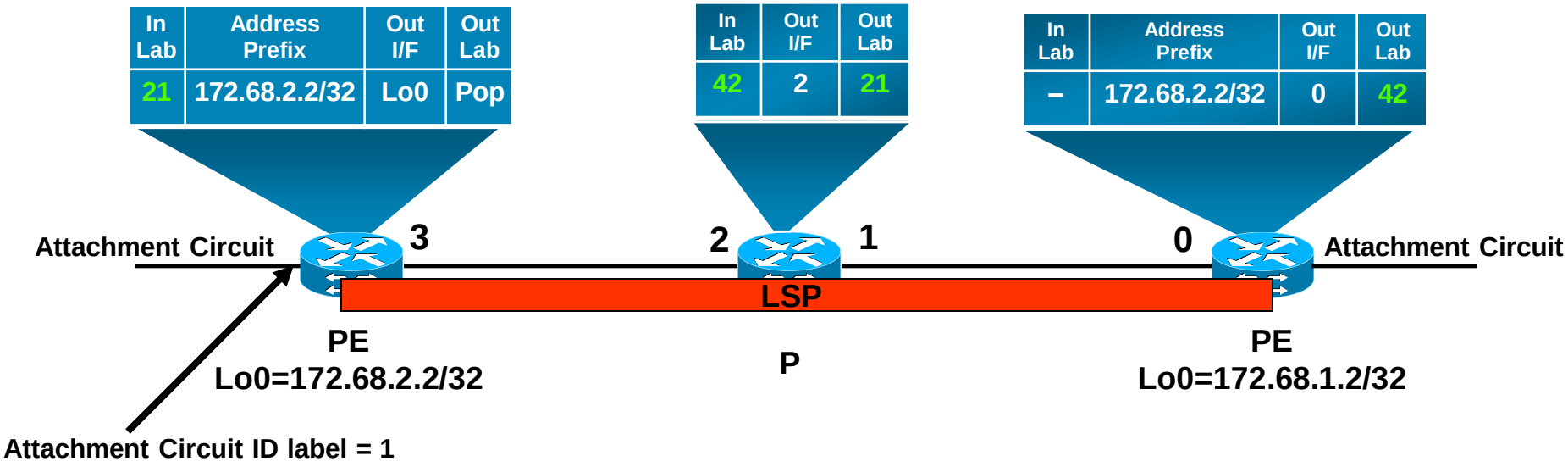
  Different Ethertypes for unicast and multicast
- 4 octets (per label)

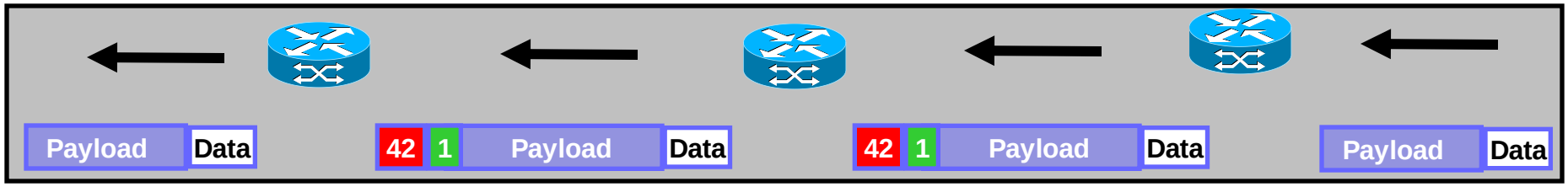
LSP example





Pseudowire Example



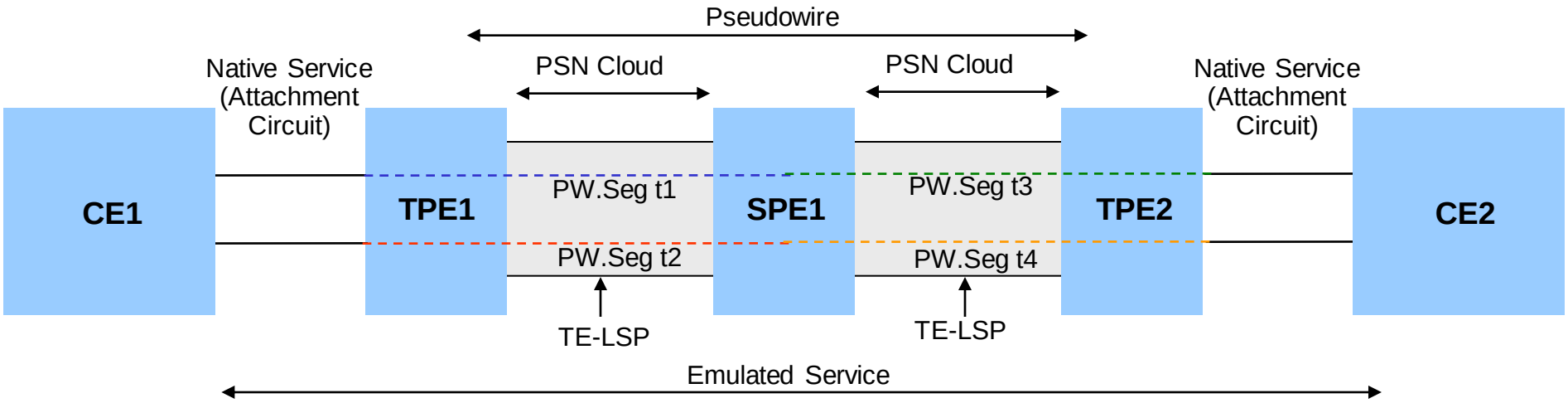


MPLS-TP Architecture

MPLS-TP – Requirements

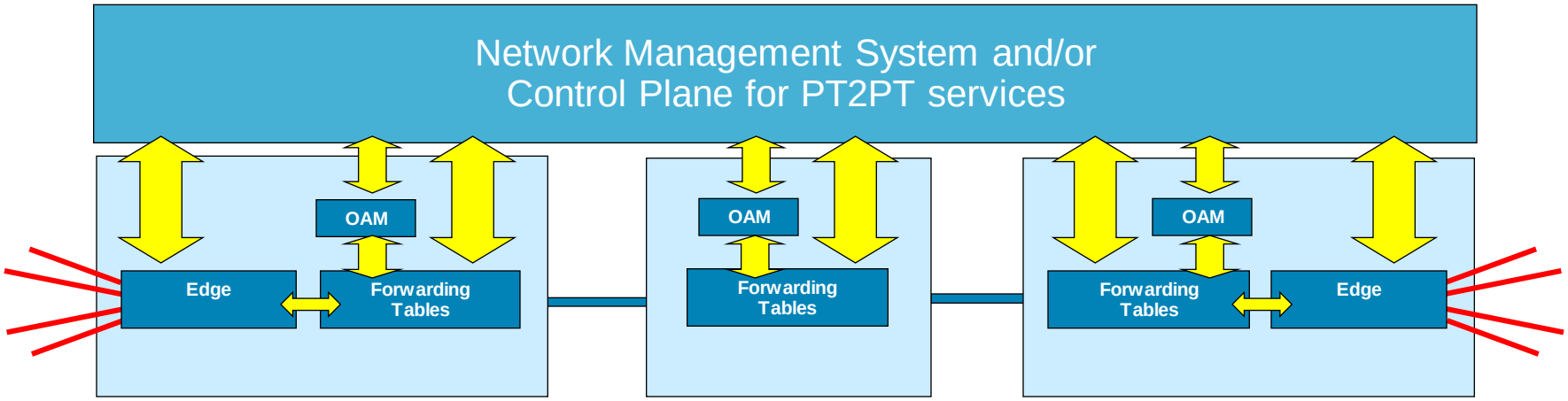
- MUST NOT modify MPLS forwarding architecture
- MUST be based on existing pseudo-wire and LSP construct
- MUST interoperate or interwork with existing MPLS and pseudo-wire control and forwarding plane
- Point to point LSPs MAY be unidirectional or bi-directional. It MUST be possible to construct a congruent Bi-directional LSPs. Point to multipoint LSPs are unidirectional
- MPLS-TP LSPs do not merge with other LSPs at an MPLS-TP LSR.
- MUST be possible to forward packets based solely on switching the MPLS or PW label
- MUST be possible to establish and maintain LSPs and/or pseudo-wires both in the absence or presence of a dynamic control plane
- When using static provisioning there MUST be no dependency on dynamic routing or signalling
- OAM, protection and forwarding MUST be able to operate without IP forwarding
- MUST be possible to monitor LSPs and pseudo-wires through the use of OAM in the absence of control plane or routing function. In this case information gained from OAM is used to initiate path recovery at either PW or LSP layers

MPLS-TP Architecture



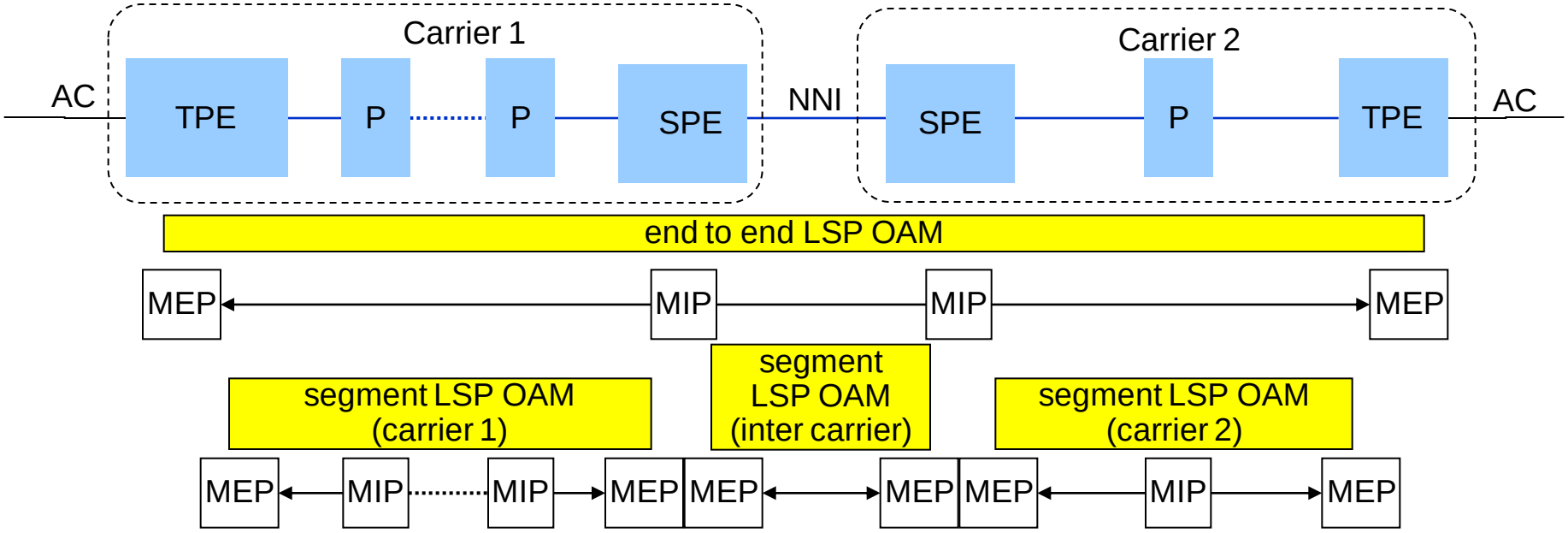
- No reliance on IP in the forwarding process
- MPLS : RFC3031, RFC3032, RFC3270
  Simplified profile : No ECMP, No PHP, No LSP merge etc
- Pseudowires : RFC3985
- Multi-segment pseudo-wires : draft-ietf-pwe3-ms-pw-arch-05
- Comprehensive set of OAM and protection-switching capabilities : SONET/SDH equivalent
- A Network Management system with or without support of a control plane
- Defines a mechanism to differentiate specific packets (OAM,APS etc) for user packets
- Primary MPLS-TP construct are LSP and Pseudo-wires

MPLS-TP Control Plane and Network Management



- Management System
  - FCAPs capabilities
- Control Plane
  - Signalling, routing, path calculation, automated OAM and recovery
  - **Not mandatory in an MPLS-TP environment, everything could be done via the NMS and OAM**
- MPLS-TP Control Plane
  - Pseudowire control for pseudowires → LDP for pseudowire signalling
  - G-MPLS for MPLS-TP LSPs → RSVP-TE for LSP signalling
  - Automated set-up of OAM functionality and recovery actions
- OAM
  - Monitoring and driving switches between primary and backup paths for path segments

MPLS-TP architecture – OAM

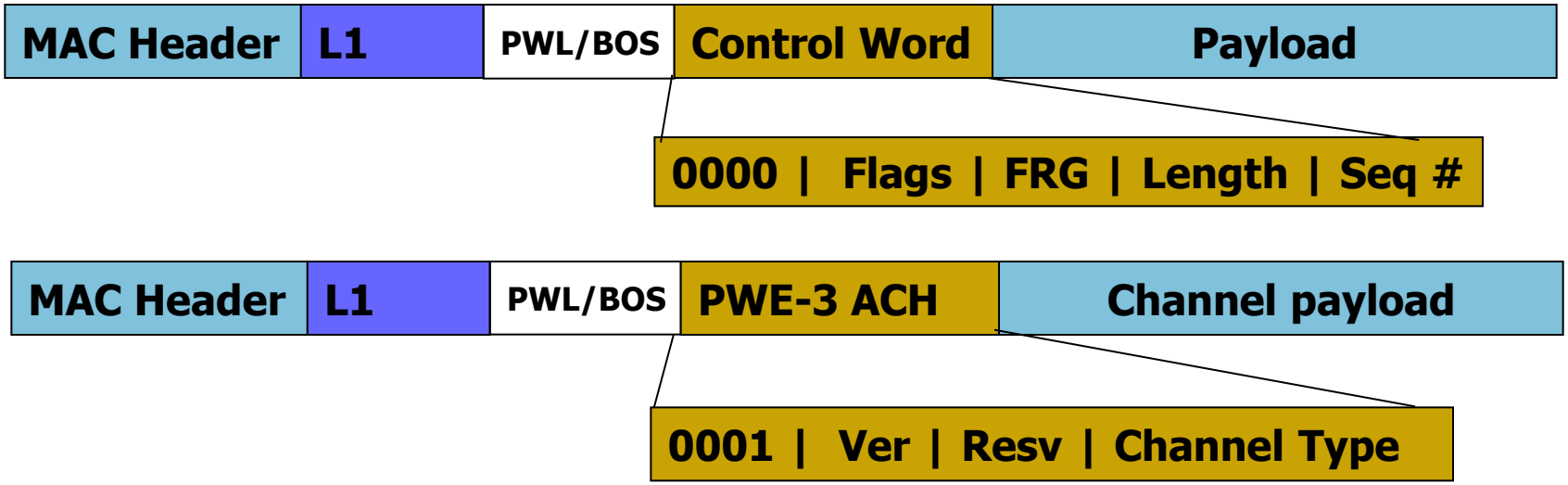


- Based on Maintenance Entities
  - Maintenance End Points (MEPs) and Maintenance Intermediate Points (MIPs)
  - Multiple levels
- Maintenance Entities
  - Association of two MEPs
  - Zero or more intermediate MIPs
  - MEPs source and sink OAM flow
  - MIPs can only sink or respond to an OAM flow

MPLS-TP architecture – OAM Constructs

- Common mechanism for carrying OAM and out-of-band management information
  - Regardless of MPLS construct
  - Travels same path as the data
- Major components
  - Generic Associated Channel (G-ACH) based on RFC4385
  - Generic Alert Label (GAL) defined by MPLS-TP architecture team
- G-ACH is the generalised container
  - Capable of carry : OAM, APS, DCC, MCC traffic
  - Works across PWs, LSP and MPLS Sections
  - Existing IP/MPLS OAM functions can be used (LSP-Ping, BFD and VCCV)
- OAM classes
  - Continuity Checks
  - Connectivity Verification
  - Performance Monitoring : packet loss measurement and delay
  - Alarm suppression
  - Remote integrity

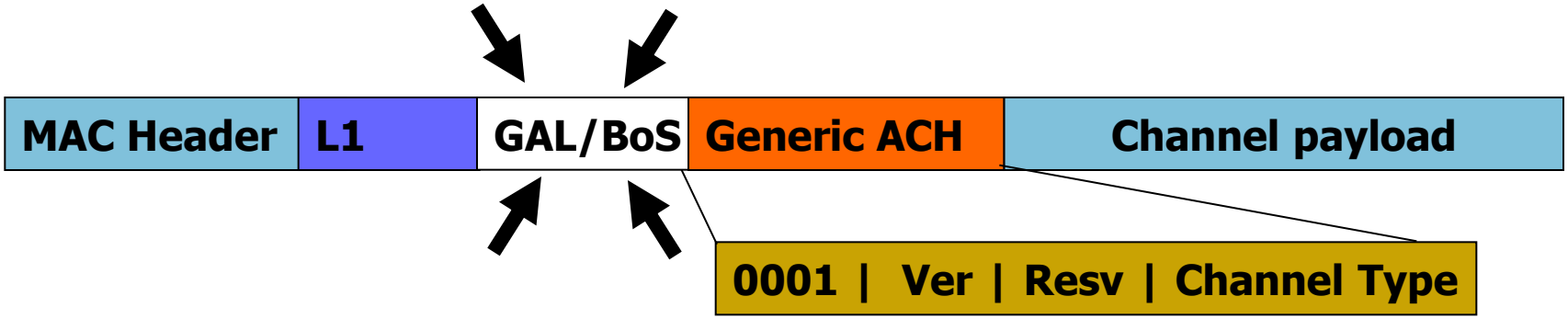
RFC 4385: PWE-3 Control Word and PW-Associated Channel



- Defines the PW Control Word, also defines the “PW Associated Channel”
- Pseudowire endpoints identify the ACH by 1st nibble (0001) in Control Word
- One of the mechanisms used by VCCV to transmit OAM packets over a PW
- Channel Type allows different payloads to be carried –defined by channel type
- Multiple channels can be carried between two points
- MPLS-TP proposal : Generic Associated Channel (G-ACH)

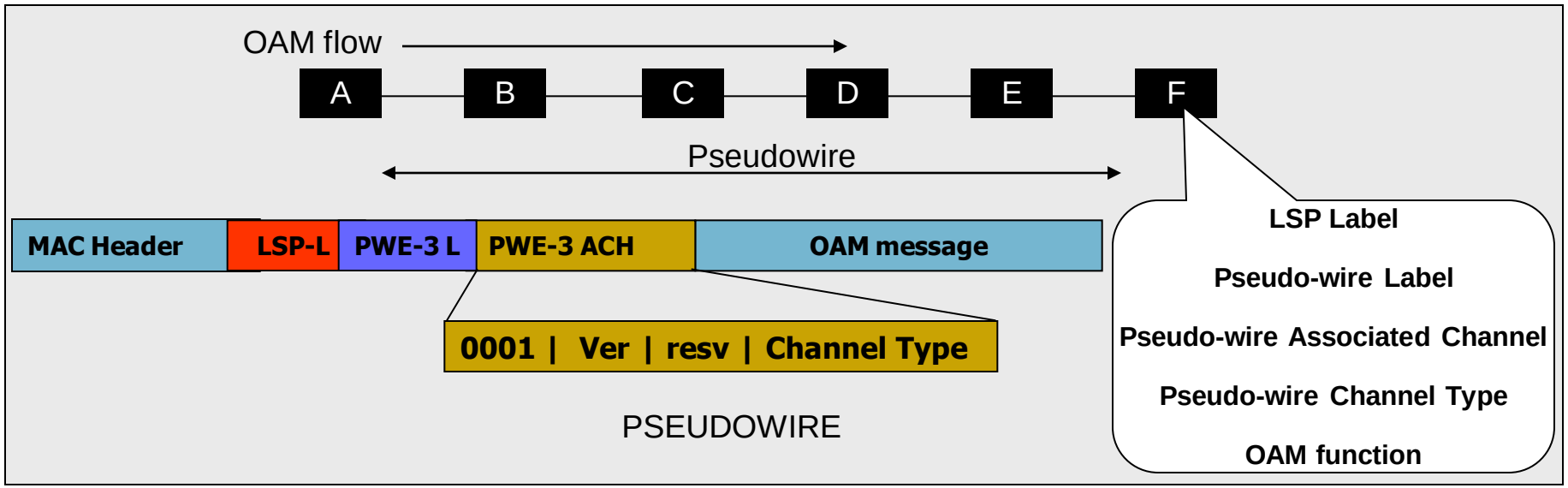
  Utilise it as a common FCAPs mechanism OAM, MCC, APS etc etc across LSPs and PWs

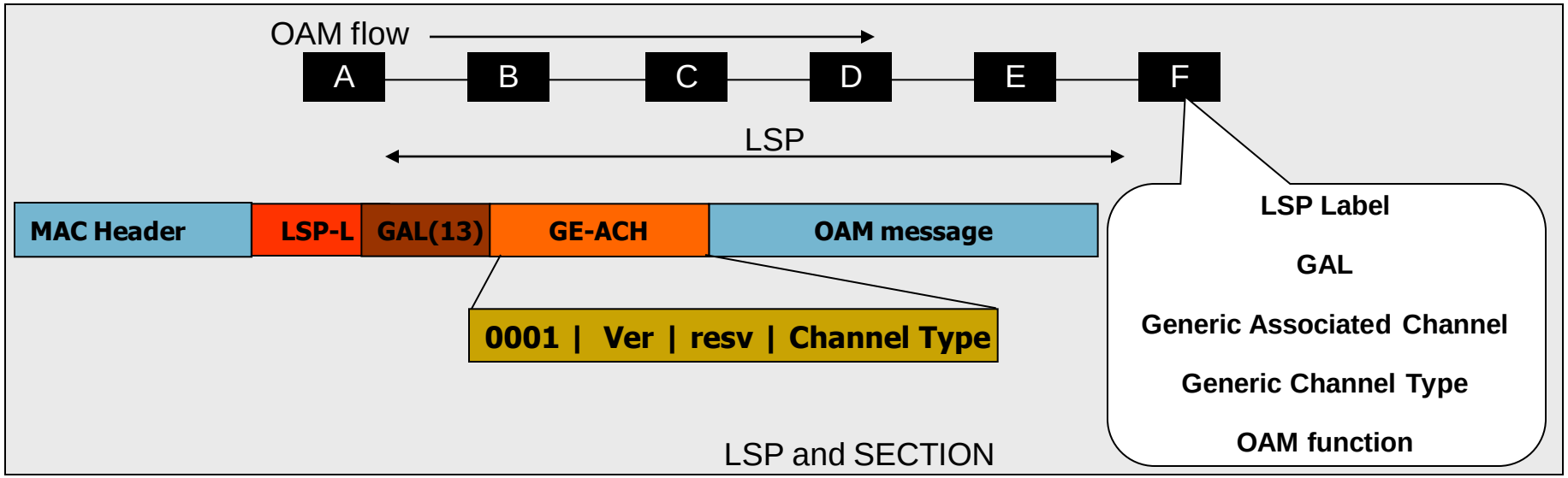
Generic Alert Label



- MPLS-TP OAM packets needs to follow the same path as the data flows
- LSPs have no mechanism to differentiate user packets from OAM packets
- Generic Alert Label (GAL) provides this function
  - New reserved label - Label 13
  - In MPLS-TP GAL allways appears at the Bottom of Stack
- If a GAL is found anywhere in the label stack it indicates the payload begins with G-ACH
- Normal MPLS operations apply
  - MPLS devices only examine the top label in normal operations
  - MPLS devices inspect the label stack when TTL expires
- GAL will be found :
  - If it's the popped label
  - If the TTL expires

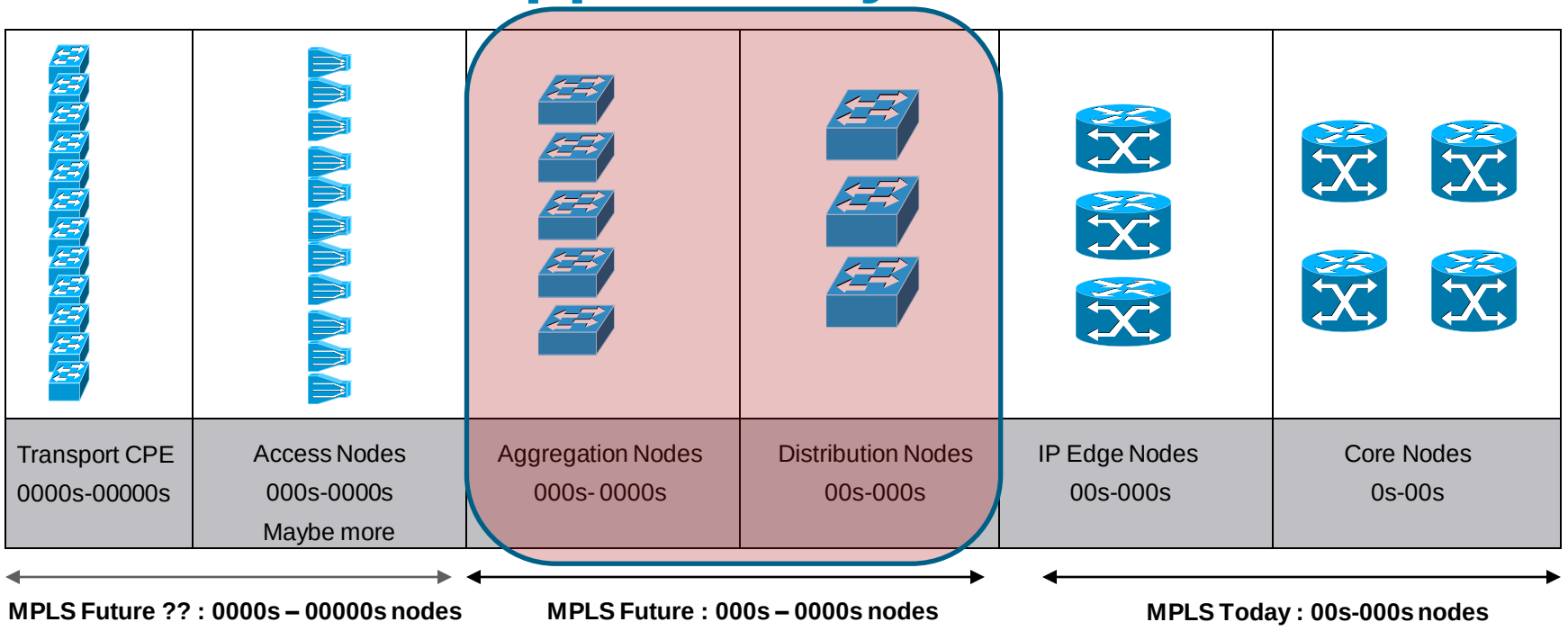
Associated Channel Processing (A-CH)





MPLS-TP Applicability vs Other Technologies

MPLS-TP Applicability



Decreasing Functionality / Less Trust / Simpler Service Mix

More potential paths / Increasing benefit of dynamic path selection

MPLS-TP primary use will be for Access and Aggregation Networks (i.e. Carrier Ethernet)

MPLS-TP vs Other Technologies

- IP/MPLS and MPLS-TP: complementary and interoperable
- T-MPLS: replaced by MPLS-TP
- PBB-TE (PBT): low industry acceptance
- OTN
  - Different technology paradigms
  - Could be complementary
  - Do we really need another TDM layer in the network?

Technology Comparison

	Characteristic	SONET SDH	Optical OTN (ROADMs)	Electrical OTN	PBB-TE	MPLS-TP	IP/MPLS
Ethernet	Eline (10GE)						
	Eline (sub 10GE)						
	E-Tree						
	E-LAN						
Legacy	F/R						
	ATM						
	TDM						
IP	L3VPN						
	L3 Unicast						
	L3 Multicast						
	Content						
General	Traffic Engineering						
	50ms restoration						
	Multiplexing Technology	Time Division	Wave Division	Time Division	Statistical	Statistical	Statistical
	UNI processing	Limited	None	None	Typically rich	Typically rich	Typically rich
	Granularity	VC-4	Lambda	ODU	Variable	Variable	Variable
	Technology Maturity						

Additional Resources

- MPLS-TP Wiki on IETF:

  http://wiki.tools.ietf.org/misc/mpls-tp/

- MPLS-TP Overview (mpls WG):

  http://www.ietf.org/MPLS-TP_overview-22.pdf

- RFCs:

  RFC 5317: JWT Report on MPLS Architectural Considerations for a Transport Profile

  RFC 5462: EXP field renamed to Traffic Class field

  RFC 5586: MPLS Generic Associated Channel

  RFC 5654: MPLS-TP Requirements

- Several drafts available (see wiki for complete list)