Point to Multipoint Traffic Engineering with MPLS

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CHALLENGES…for Video Multicast Distribution

- It has to be there all the time - *availability*
  - In most cases only a few frames or 10s of ms of loss can be tolerated
- You can't send it again - *integrity*
- Timing constraints – *continuity*
  - End to end latency requirements are stringent
- Bandwidth Requirements
  - Compressed few kbit/s-80Mbit/s
  - Uncompressed 270Mbit/s
- Video multicast distribution from a broadcaster's video head-end to receiving sites
- Video multicast distribution from a receiving site to the end users

Typical Network Design To Date

- Video Multicast Backbone Network
  - Analogue connections – coax, radio & fibre
  - Digital SDH/PDH native mappings
  - ATM packet-based PVCs and S-PVCs
- Video Multicast Access Network
  - RF Distribution

Typical Emerging Network Design

- Video Multicast Backbone Network
  - IP/MPLS
  - Motivated by "converged" infrastructure
- Video Multicast Access Network
  - RF Distribution
  - IP/MPLS Access Network
    - Aggregation network may be L2 or MPLS

MPLS Converged Backbone Design

- More traffic on a network is more cost effective
- Solutions exist for migrating ATM and Frame Relay data to MPLS
- If multicast/unicast video can be incorporated as well it will be able to benefit from the cost savings

Backbone Network
Is IP Multicast Sufficient ?

- Network convergence on failure can take up to a few seconds or more
  - NOT sufficient for Real Time Video
- No Traffic Engineering
  - Desirable to guarantee QoS without significant over-subscription
- Lack of Control
  - Desirable to have the flexibility to set up explicitly routed redundant paths
  - Desirable to set up minimum cost paths

Summary Slide

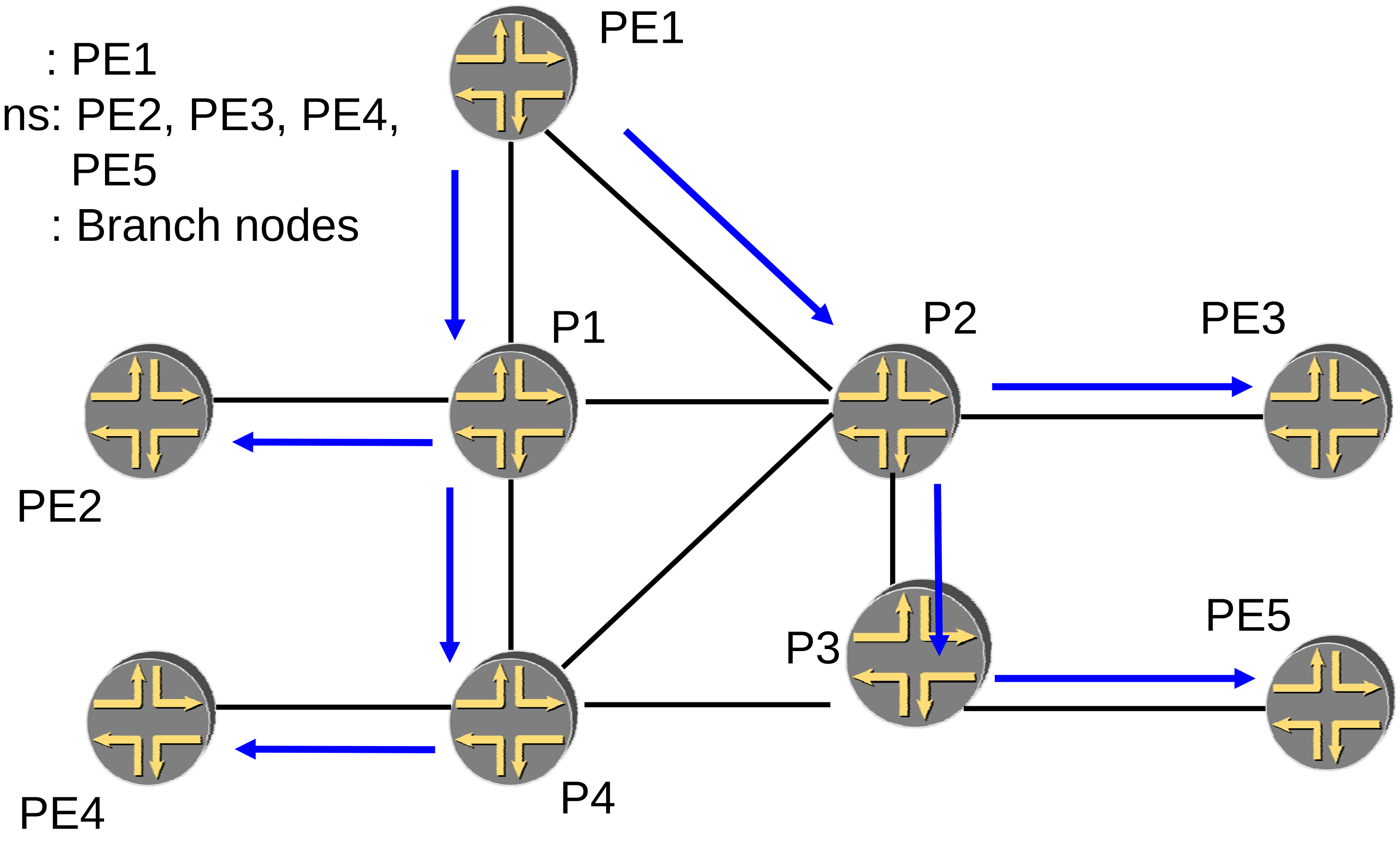
- What is a P2MP TE LSP ?
- RSVP-TE vs PIM
- Solution Terminology
- Solution Mechanisms
- Applications
- Configuration examples
- Conclusion

What is a P2MP TE LSP ?

- Point to Multipoint Label Switched Path (LSP)
  - Efficient traffic replication in the network
  - Application agnostic
- Set up with TE constraints
  - May involve resource reservations throughout the network
  - Determine path of these P2MP TE LSPs
- RSVP-TE Signaling
  - Enhancements to P2P (GMPLS) RSVP-TE

What is P2MP MPLS TE ?

Source : PE1
Destinations: PE2, PE3, PE4, PE5
P1, P2 : Branch nodes



Why RSVP-TE ?

- What are the choices ?
  - RSVP-TE
  - PIM
- Why is RSVP-TE a better fit ?

RSVP-TE vs PIM

RSVP-TE

- Has resource reservation mechanisms
- Supports explicit routing along paths different from hop-by-hop IP routing
- P2MP LSP is signaled by the root and hence allows flexible P2MP computation algorithms
- Fast reroute and Make before-break capabilities

PIM

- No resource reservation mechanisms
- No equivalent support
- Receiver initiated trees are limited in tree computation flexibility
  - Do not support Minimum cost trees
- No such capabilities. PIM is NOT a TE protocol !

Problem Statement

- The practical problem is to introduce multicast functionality in the MPLS data plane
  - Optimize data plane for high volume multicast
- P2MP TE is performed in the data plane
- Control plane uses P2MP sub-LSPs as building blocks
- Minimize changes to existing P2P RSVP-TE

Problem Statement - Solution Simplicity

- Operational simplicity
  - P2P RSVP-TE is deployed and understood
  - Leverage the existing control plane model
- Protocol simplicity
  - Minimize complex protocol changes
- Implementation simplicity
  - Minimize changes to existing software: Less Bugs !

Solution Mechanisms

- Building blocks
  - P2MP Tunnel
  - P2MP LSP
  - P2P sub-LSP
- Path Messages
- Resv Messages
- Fast-reroute
- Make-before-break

Solution Mechanism: P2MP Tunnel

- May comprise multiple P2MP LSP Tunnels
- Identified by the P2MP SESSION Object which includes
  - P2MP ID: Logical 32 bit identifier of the P2MP tunnel
  - Tunnel ID: 16 bit identifier
  - Extended Tunnel ID: IPv4/IPv6 Address Source Address or left unspecified

Solution Mechanism: P2MP LSP Tunnel

- A specific instance of a P2MP Tunnel
- May comprise multiple P2P sub-LSPs
- Identified by the P2MP Tunnel SESSION and P2MP SENDER_TEMPLATE object combination
- P2MP SENDER_TEMPLATE
  - Identifies the sender (ingress)
  - Includes
    - Source IPv4/IPv6 address
    - LSP ID

Solution Mechanism: P2MP Sub-LSP

- LSP from the ingress LSR to a particular egress LSR
- A P2MP LSP Tunnel comprises multiple P2MP sub-LSPs
- A P2MP sub-LSP is represented by
  - P2P sub-LSP object
  - ERO or sub ERO

Solution Mechanism: P2P Sub-LSP

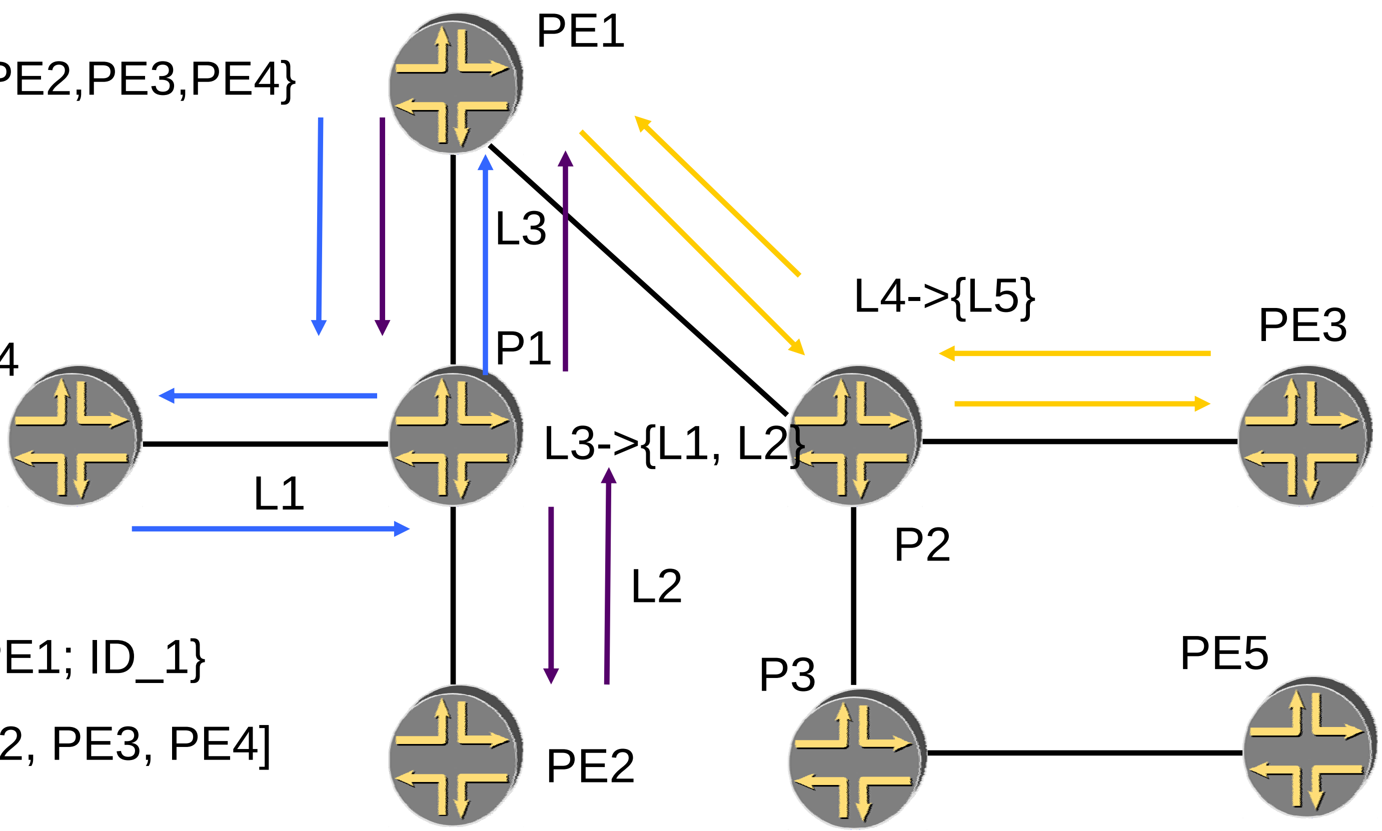
- P2P sub-LSP object
  - Identifies a P2P Sub-LSP
  - Egress LSR Destination address
  - P2P sub-LSP identifier (sub-LSP ID)
- Sub-Explicit route
  - Represents the explicit route from ingress LSR to the egress LSR
  - May be compressed

Solution Mechanism: Path message

- One P2MP Tunnel LSP can be signaled using multiple Path message
- Each such Path message can signal multiple P2P sub-LSPs
- Limiting cases
  - A separate Path message for each P2P sub-LSP
  - A single Path message for all P2P sub-LSPs

Multiple Path Messages: Example

P2MP Tunnel: ID_1 {PE2,PE3,PE4}



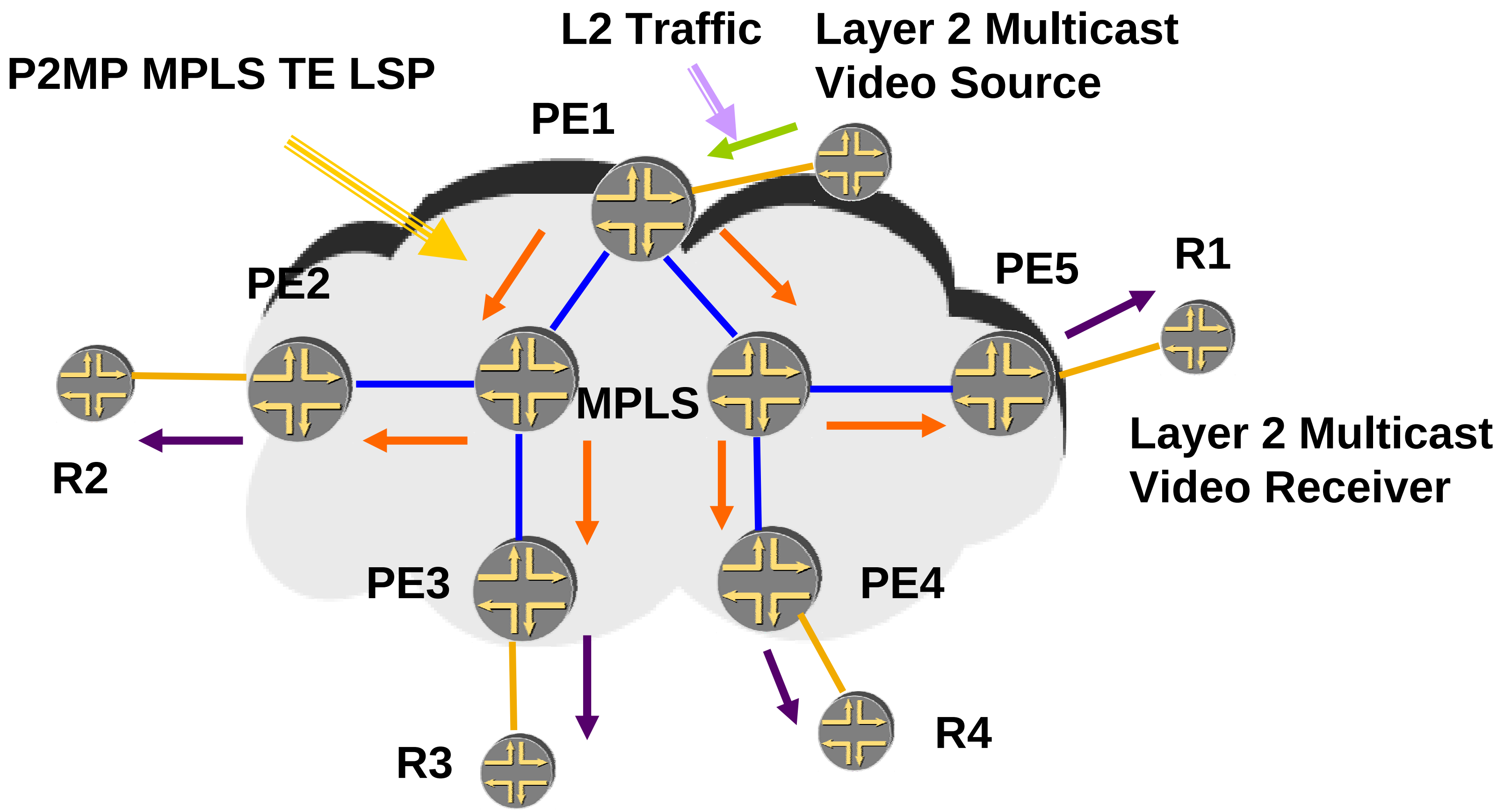
P2MP LSP Tunnel: {PE1; ID_1}

P2P sub-LSP list: [PE2, PE3, PE4]

Applications

- Layer 2 Multicast over P2MP MPLS TE
- IP Multicast over P2MP MPLS TE
- Multicast VPNs (MVPNs) over P2MP MPLS TE
- VPLS Multicast over P2MP MPLS TE

Layer 2 Multicast over P2MP TE LSP

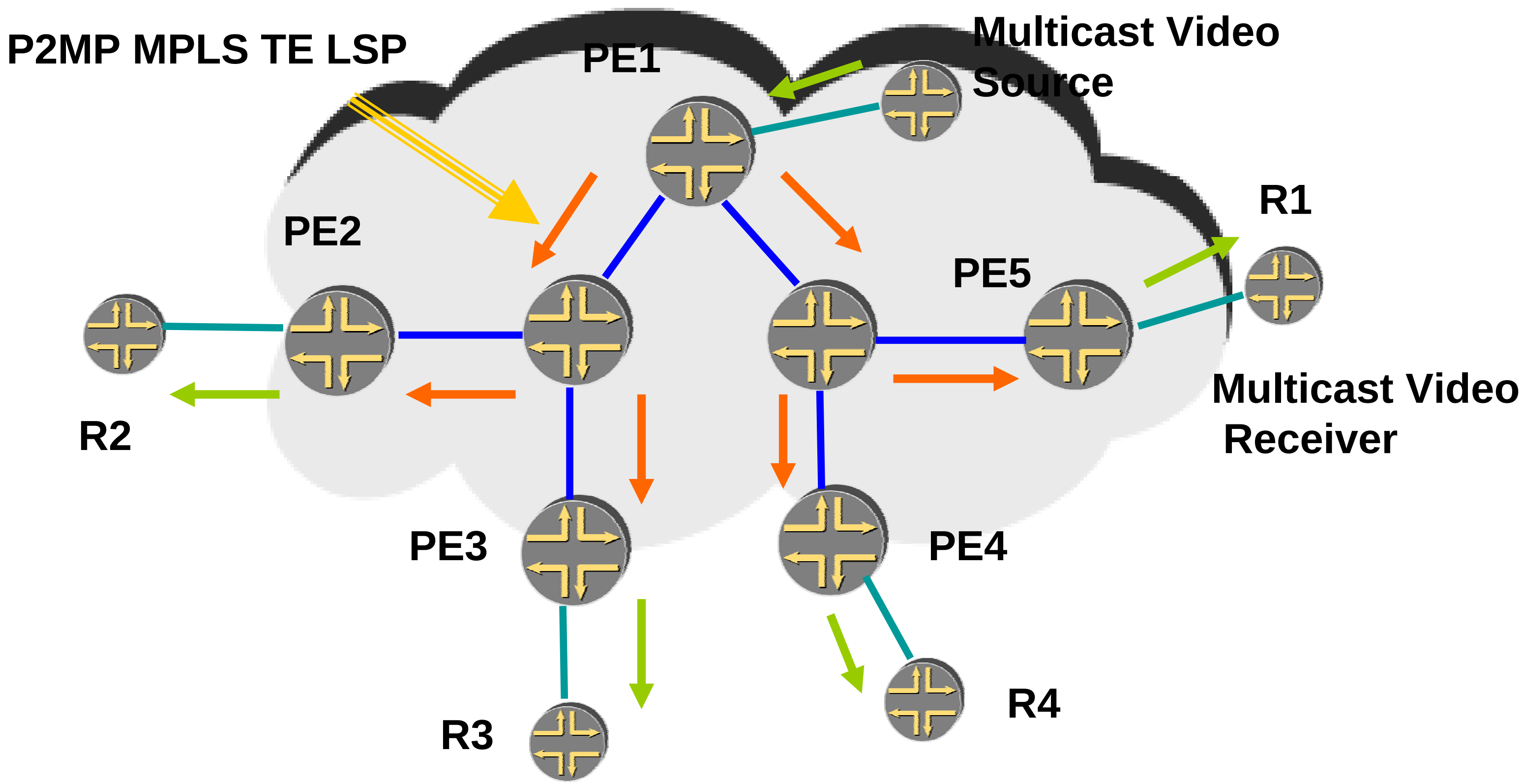


Layer 2 Multicast over P2MP TE LSP

- Goal is to retain all the functionality available to layer 2 services as they migrate to IP/MPLS
  - P2MP functionality is offered by ATM networks
  - P2MP TE is a missing piece in the layer 2 service migration to IP/MPLS
- A Layer 2 interface can be cross-connected to a P2MP LSP
- TE requirement
  - QoS guarantees: strict SLAs for broadband video traffic
  - Protection: Fast reroute

Juniper your Net

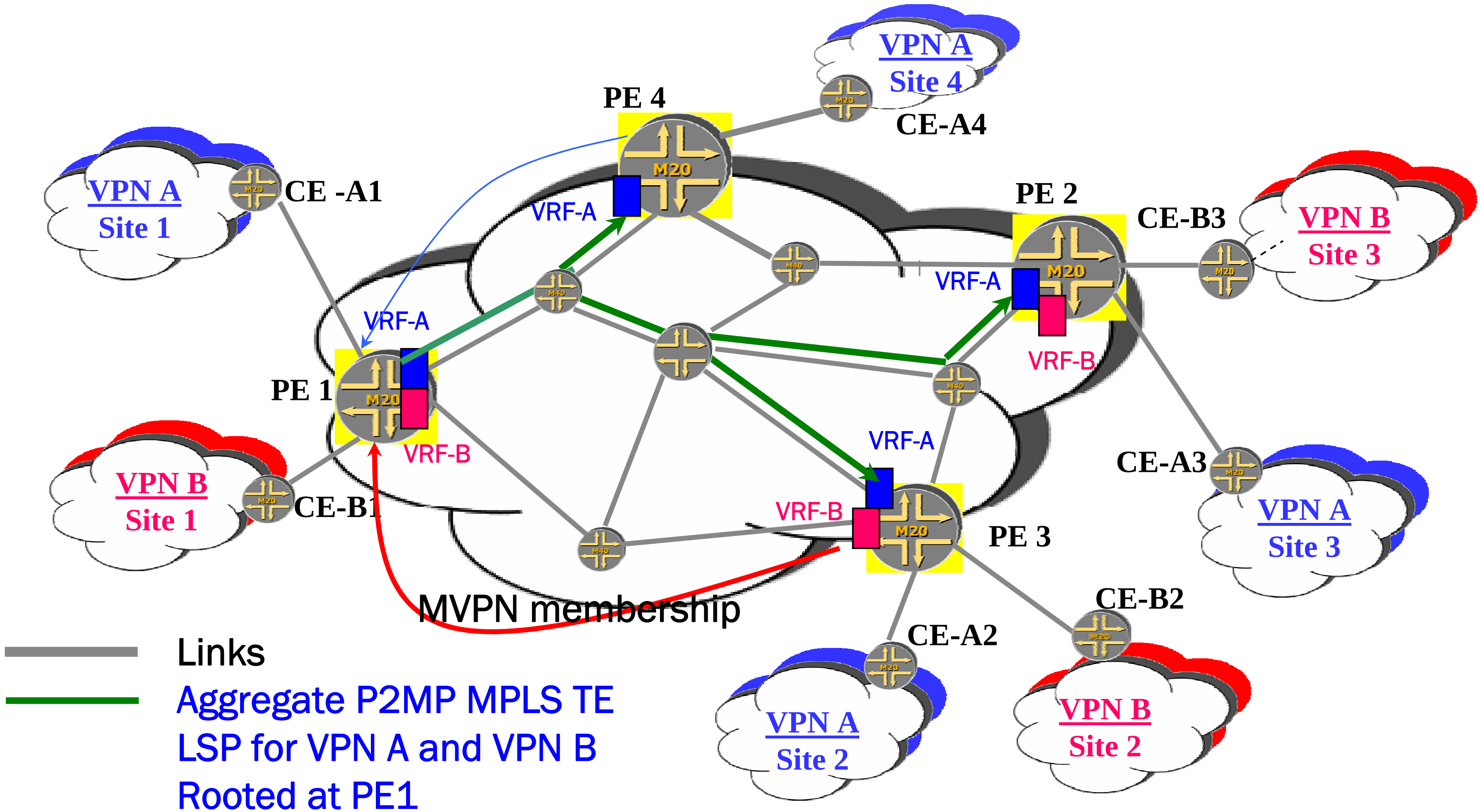
IP Multicast Over P2MP MPLS TE LSP



IP Multicast Over P2MP MPLS TE LSP

- TE for broadband video multicast traffic
  - QoS for content distribution
  - Protection: Fast Reroute
- Multicast (PIM-SM) free core
  - Keeping multicast routes out of the core
- Eliminates the need to use BGP in the core to distribute unicast routes used by multicast RPF
  - Particularly useful if the core is BGP free for unicast routing (e.g. by running RSVP-TE)

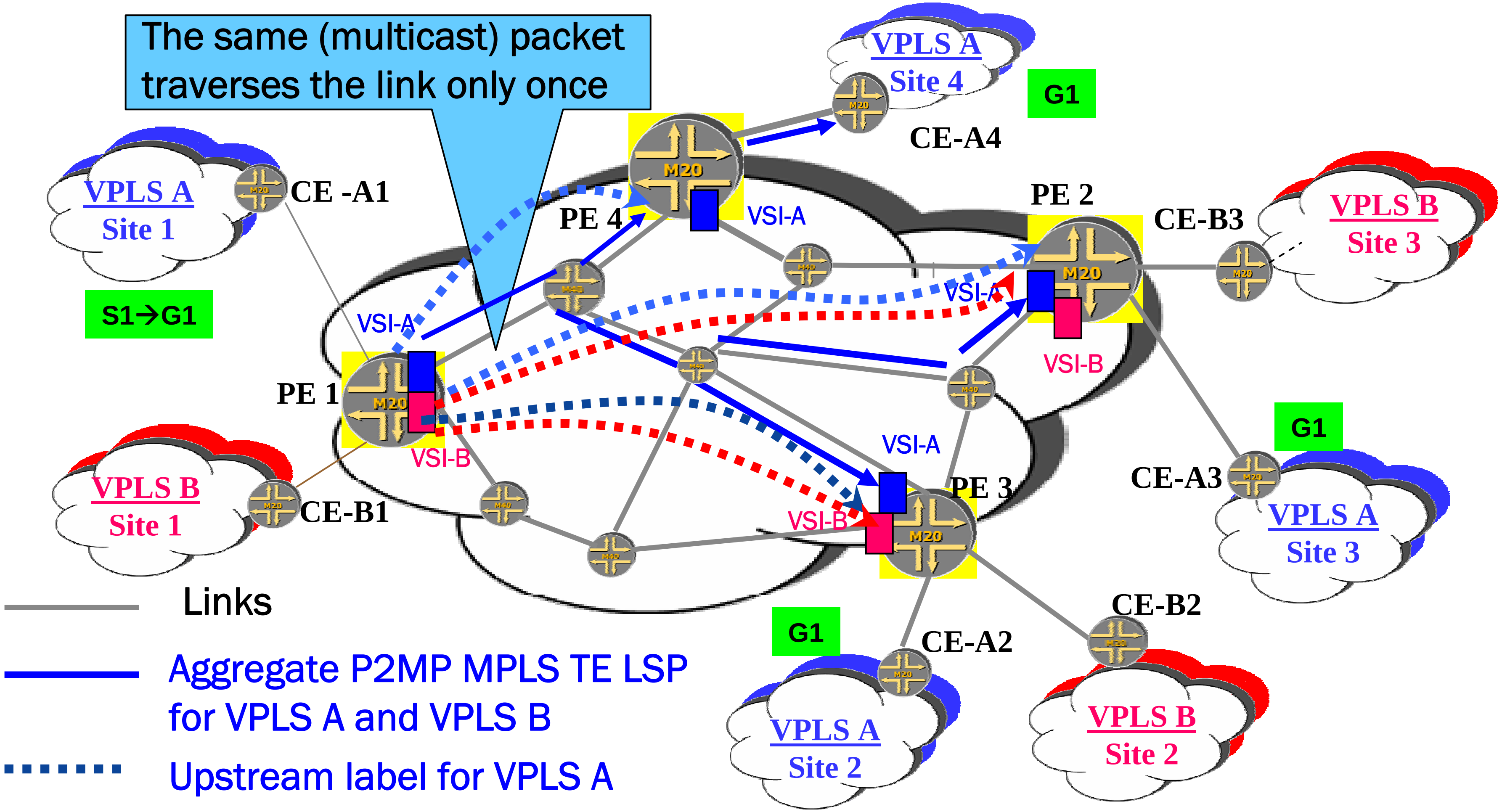
MVPNs over P2MP MPLS TE LSP



2547 Multicast Over P2MP MPLS TE Advantages

- Core can be PIM-SM free
- Core can be BGP free
- A P2MP LSP can be used per VPN
  - Similar to the per VPN Multicast Domain (MD) Group in the existing PIM-SM based solution
- MD Group provisioning overhead is alleviated
- Possible to have multiple P2MP LSPs per VPN
  - A separate LSP for a high b/w stream
- TE benefits

VPLS Multicast over P2MP MPLS TE LSP



Links

Aggregate P2MP MPLS TE LSP for VPLS A and VPLS B

Upstream label for VPLS A

Upstream label for VPLS B

Coupling traffic into a p2mp LSP

- Three cases supported today:
  - CCC
  - IP unicast (statically routed)
  - IP multicast (statically routed)

Conclusion - MPLS Multicast Deployments/Status/Future

- A large Broadcast TV over P2MP MPLS TE deployment in British Telecom
- Other large broadcaster/MSO/ISP pilots and deployments networks
- Ongoing work in the areas of resiliency, scalability, P2MP MPLS TE, IP multicast integration, MVPN and VPLS integration
- Proposed solution should be applicable to GMPLS (e.g. SONET/SDH carrying video stream)
- MPLS Multicast TE is real !!

Thank You!