Study of IPv6 Multicast Deployment in MPLS Networks

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IPv6 Today – Technology and Deployment

Bucharest, August 2, 2006

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Introduction

- **MPLS 6PE (Provider Edge)**

  Widely deployed architecture for forwarding IPv6 unicast packets across an IPv4 / MPLS enabled core infrastructure

- **IPv6 Multicast**

  New types of end-user applications will significantly increase the need for deploying IPv4 and IPv6 multicast solutions

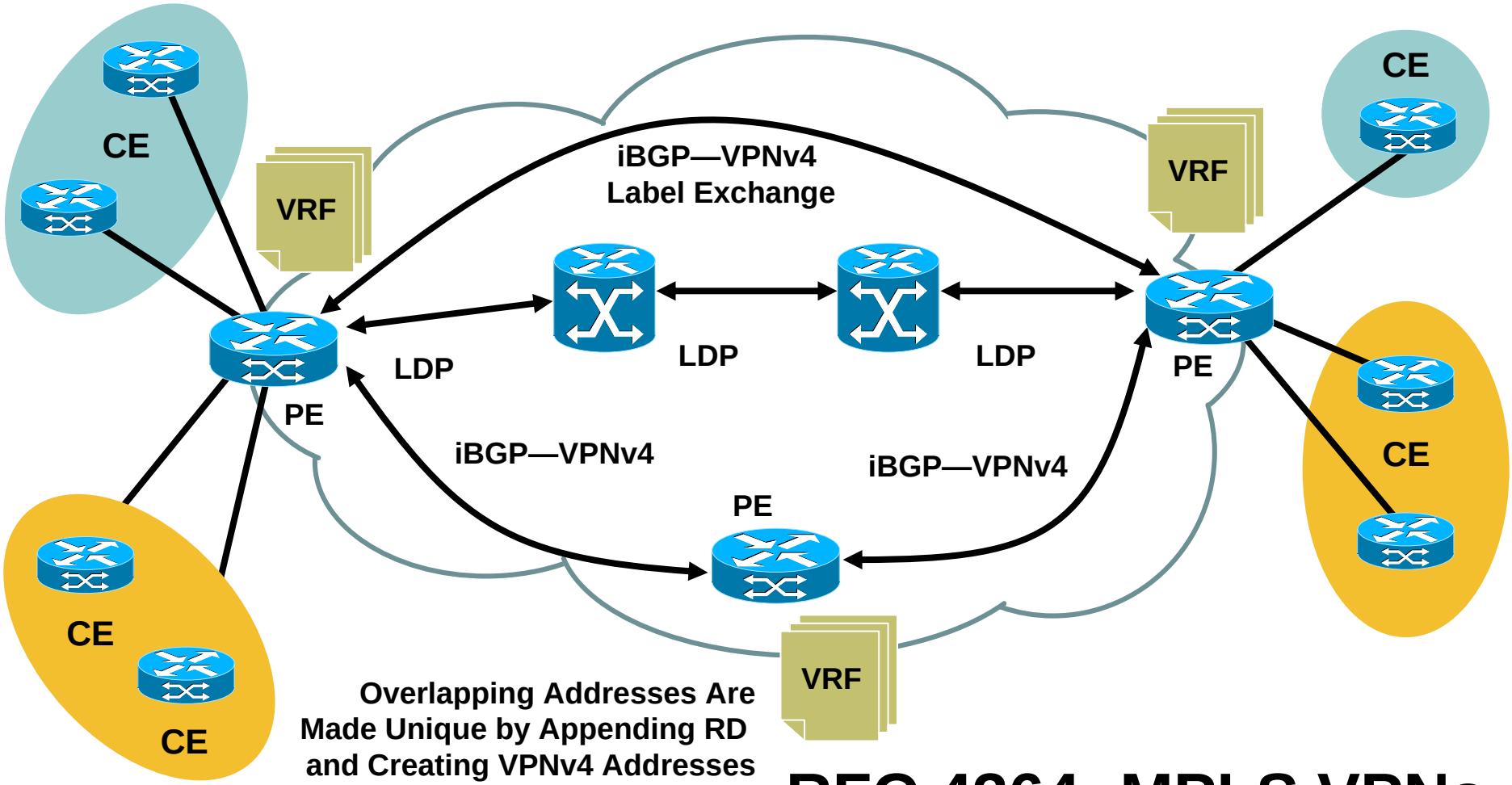
- **2 possible architecture options for deploying IPv6 multicast across an existing IPv4 / MPLS core infrastructure**

  Both rely on MPLS 6PE to transport IPv6 unicast packets

Agenda

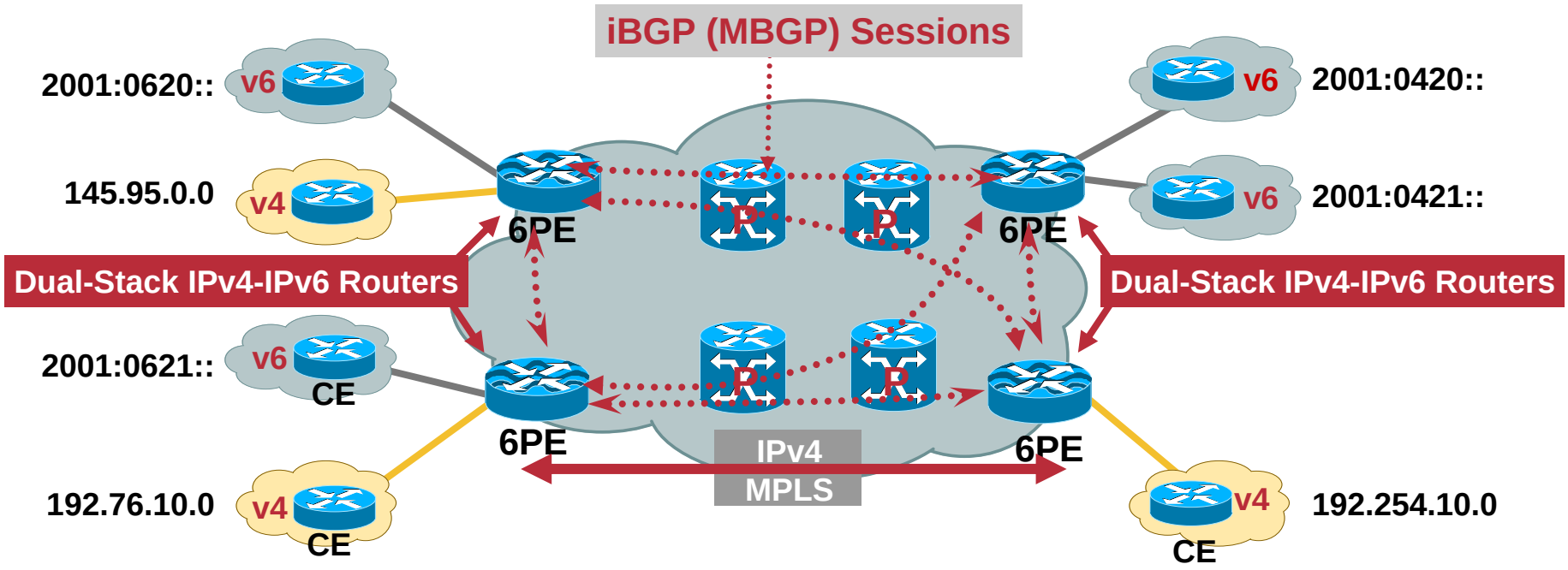
- **Introduction**
  - **MPLS and its applications**
  - **MPLS 6PE for IPv6 unicast**
  - **IPv6 multicast**
  - **2 possible architecture options for deploying IPv6 multicast across an existing IPv4 / MPLS core infrastructure**
- **Solution I – Native IPv6 Multicast Forwarding**
- **Solution II – Layer 2 Encapsulated IPv6 Multicast Forwarding**
- **Conclusions**

Introduction – MPLS and its Applications



RFC 4364: MPLS VPNs

Introduction – MPLS 6PE for IPv6 Unicast



- **IPv4 / MPLS core infrastructure is IPv6-unaware**
- **PEs are updated to support dual-stack / 6PE**
- **IPv6 reachability exchanged among 6PEs via iBGP (MBGP)**
- **IPv6 packets transported from 6PE to 6PE inside MPLS**

Introduction – IPv6 Multicast

Service	IPv4 Multicast	IPv6 Multicast
Addressing Range	32-bit, Class D	128-bit (112-bit Group)
Routing	Protocol Independent, All IGPs and MBGP	Protocol Independent, All IGPs and MBGP with IPv6 Multicast SAFI
Forwarding	PIM-DM, PIM-SM, PIM-SSM, PIM-bidir, PIM-BSR	PIM-SM, PIM-SSM, PIM-bidir, PIM-BSR
Group Management	IGMPv1, v2, v3	MLDv1, v2
Domain Control	Boundary, Border	Scope Identifier
Interdomain Solutions	MSDP across Independent PIM Domains	Single RP within Globally Shared Domains

Architecture Options

- **Native IPv6 Multicast Forwarding**
  - **IPv6 Multicast packets forwarded natively**
  - **Requires core to be IPv6 enabled**
  - **IPv6 Unicast forwarding performed though 6PE**
  - **No constraints on the location of multicast sources and receivers**
- **Layer 2 Encapsulated IPv6 Multicast Forwarding**
  - **IPv6 Multicast packets L2 MPLS encapsulated and forwarded across an IPv4 / MPLS enabled core**
  - **Core remains IPv6 agnostic**
  - **IPv6 Unicast forwarding performed though 6PE**
  - **Content distribution application – well-known sources and receivers**

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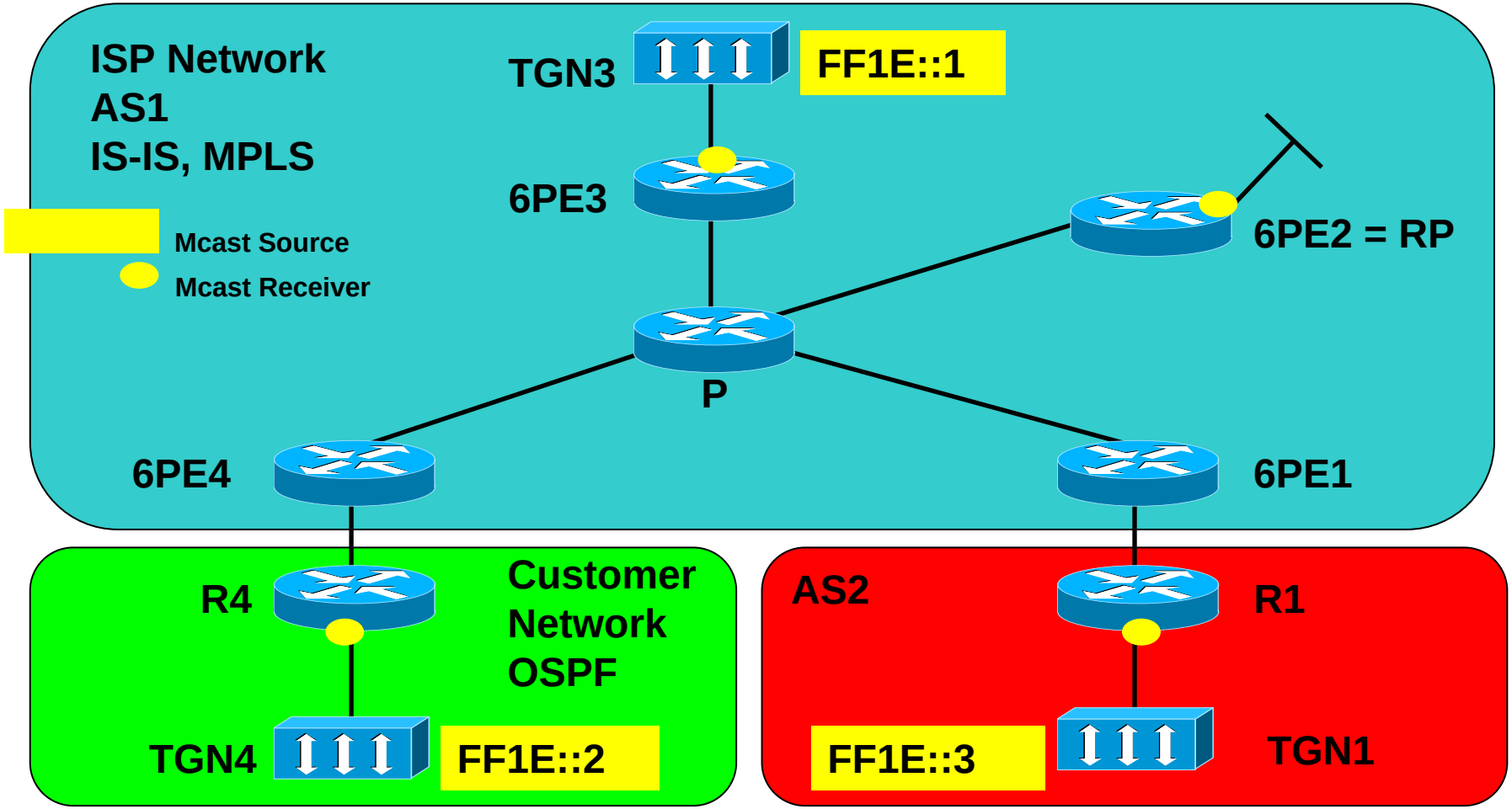
Solution I - Native IPv6 Multicast Forwarding

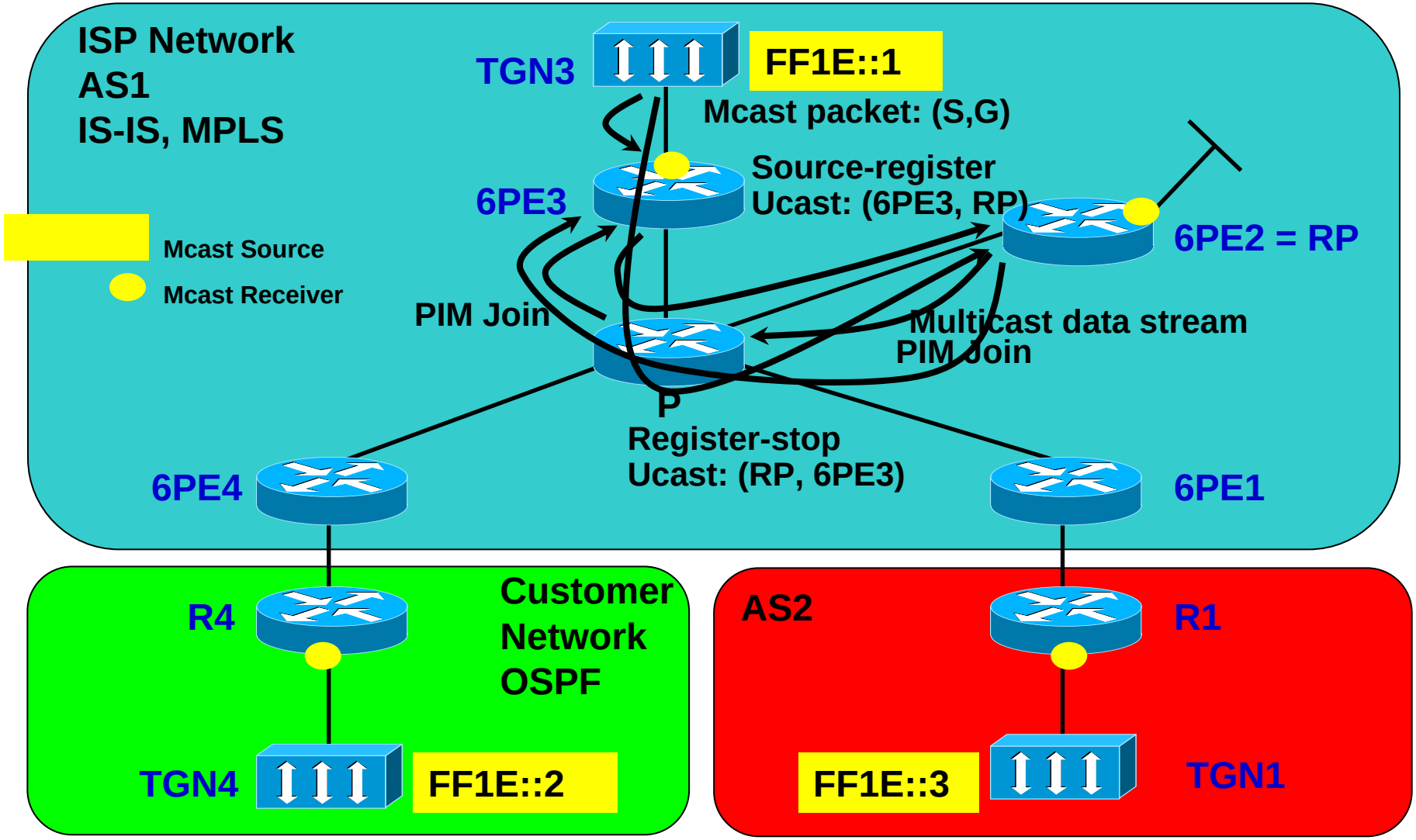


- **Reference network topology**

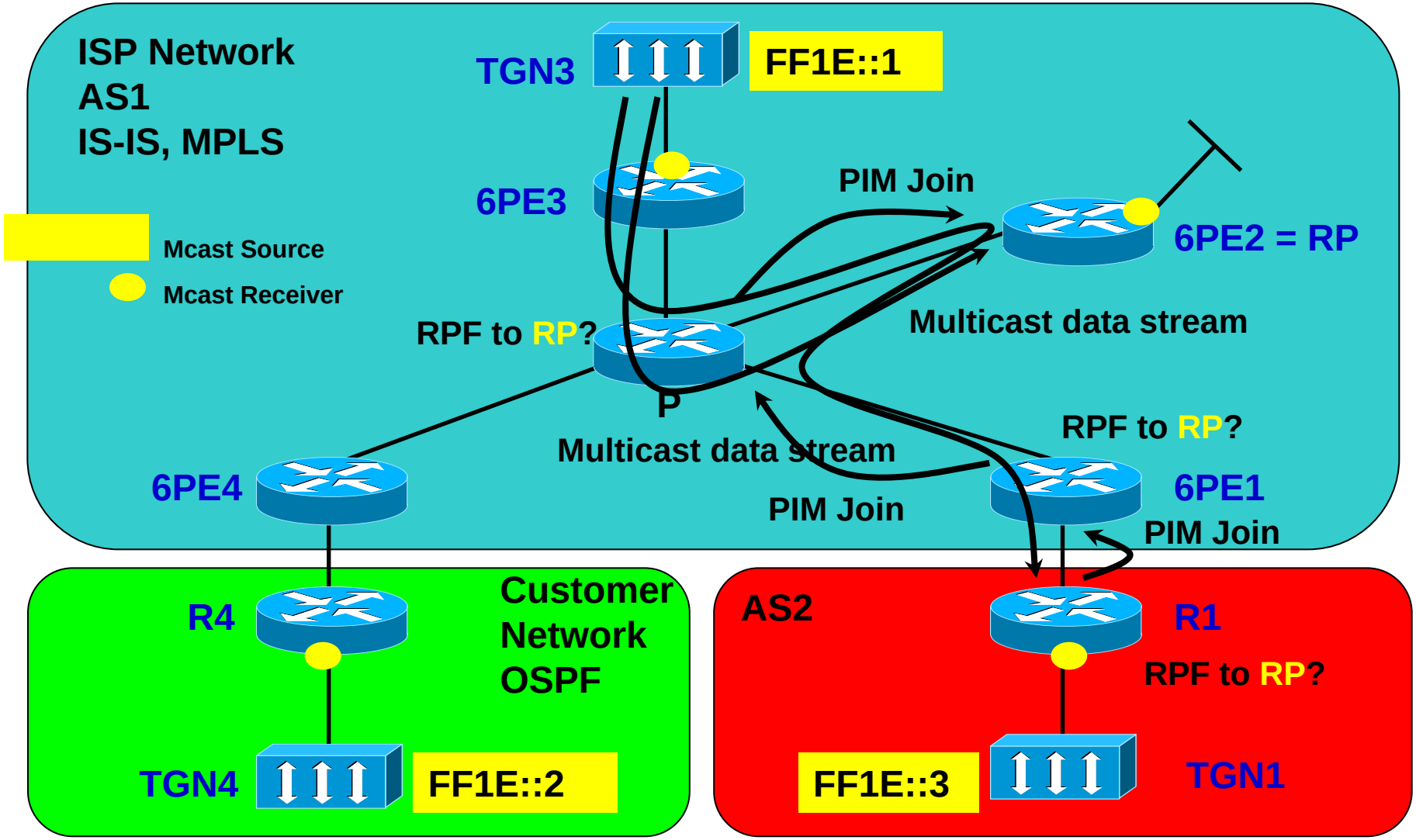
Solution I - Native IPv6 Multicast Forwarding

- **IPv6 Multicast packets forwarded natively**
- **Requires core to be IPv6 enabled**
- **IPv6 Unicast forwarding performed though 6PE**
- **No constraints on the location of multicast sources and receivers**
  - **Within ISP backbone, customer network, external AS**
- **IPv6 multicast control plane operation requires distribution of IPv6 unicast routing in backbone**
  - **PIM Register, PIM Register-Stop messages**
  - **PIM Join / Prune messages**
  - **Reverse Path Forwarding (RPF) check**

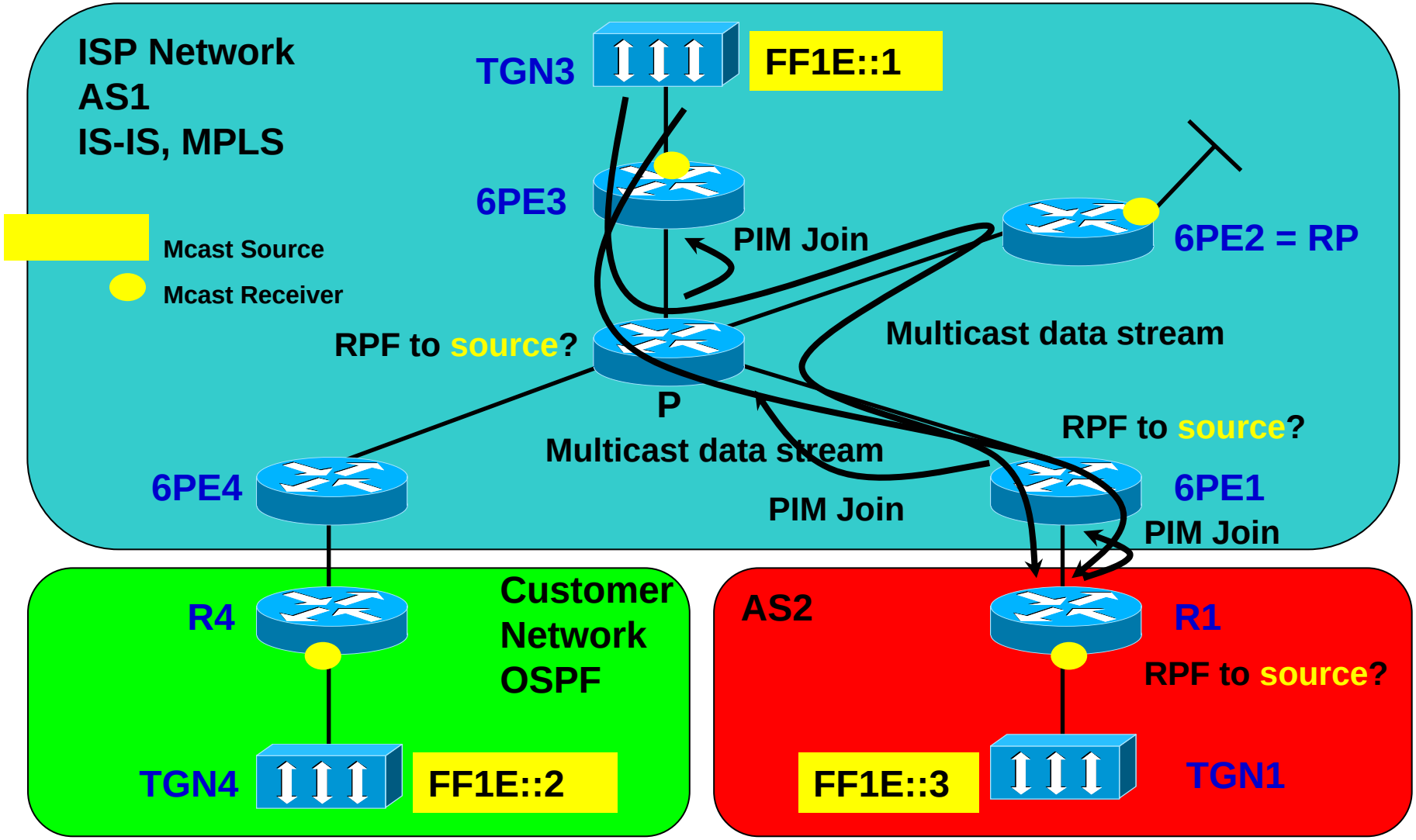
Native IPv6 Multicast Forwarding – Source Registering



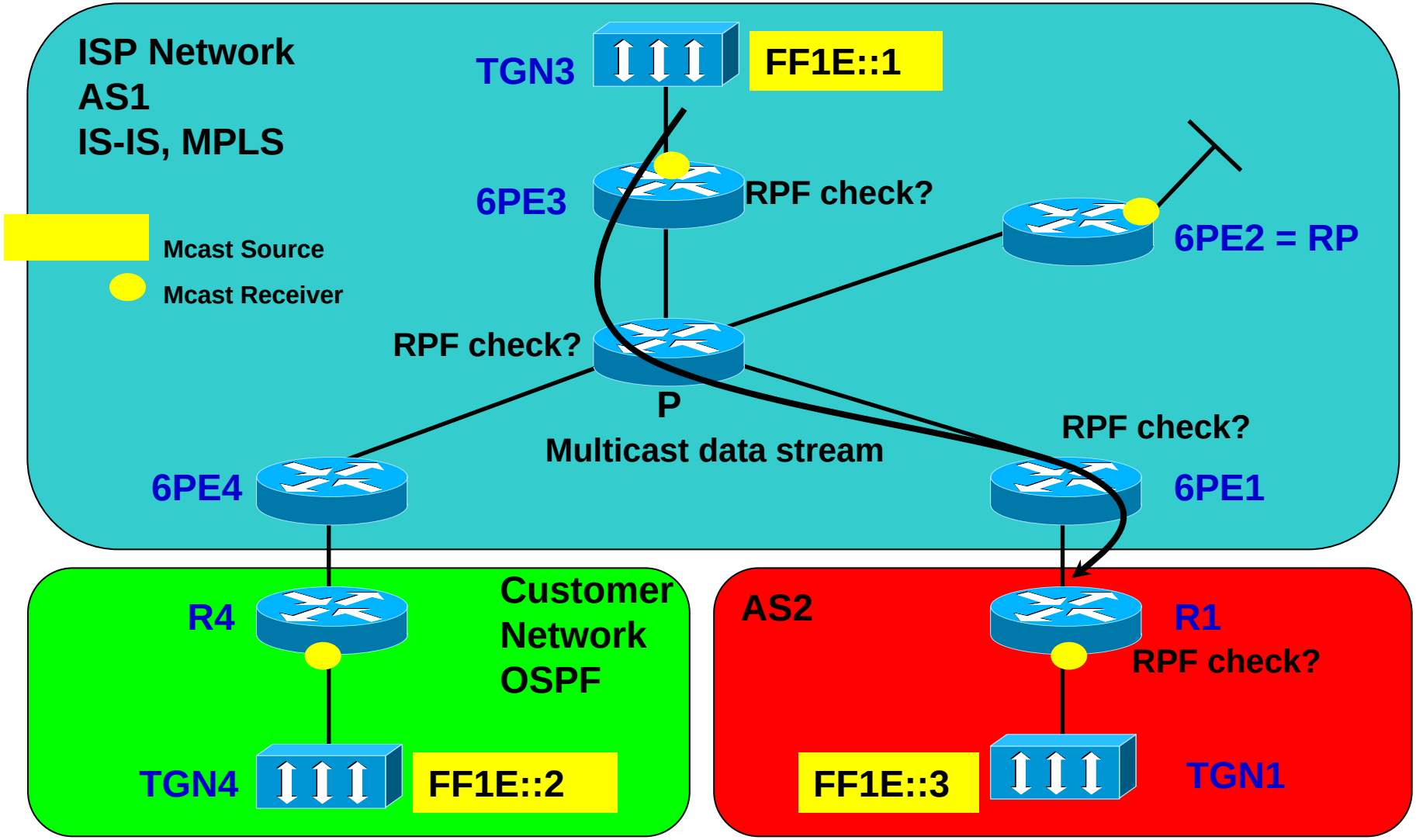
Native IPv6 Multicast Forwarding – PIM (*,G) Join / Prune



Native IPv6 Multicast Forwarding – PIM (S,G) Join / Prune



Native IPv6 Multicast Forwarding – RPF Check



Native IPv6 Multicast Forwarding – IGP and BGP Routing Design

		IGP	BGP unicast SAFI=1/4	BGP multicast SAFI=2
ISP RP address	PIM Register, PIM J/P, RPF check	X		
External RP address	PIM Register, PIM J/P, RPF check		X Not required on P router	X
ISP first-hop router address	PIM Register-Stop	X		
Customer first-hop router address	PIM Register-Stop		X Not required on P router	
External first-hop router address	PIM Register-Stop		X Not required on P router	
ISP / Customer / External multicast source	PIM J/P, RPF check			X

Native IPv6 Multicast Forwarding – Conclusion

- **IPv6 multicast forwarding can be added relatively easy to an existing IPv6 6PE architecture**
- **Requires core to be IPv6 enabled**
- **IPv6 IGP only needs to carry a very limited number of prefixes**
- **Core "P" routers do not require BGP IPv6 unicast (SAFI=1/4) . Only BGP IPv6 multicast (SAFI=2) operation is required because PIM Register / Register-Stop messages are MPLS 6PE forwarded**
- **Capability of infrastructure to perform hardware assisted IPv6 multicast packet forwarding needs to be taken into consideration**

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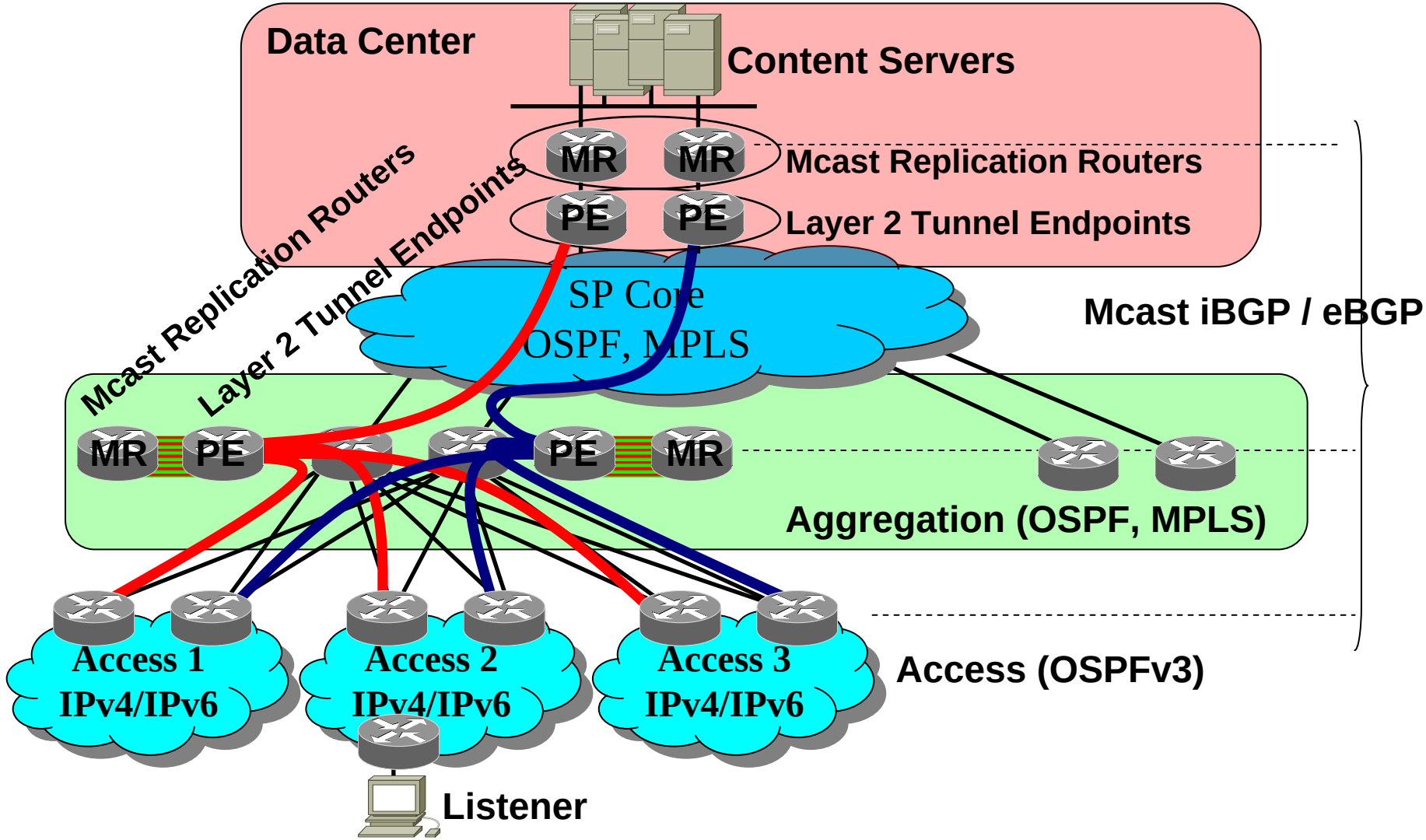
Solution II – Layer 2 Encapsulated IPv6 Multicast Forwarding



Solution II – Layer 2 Encapsulated IPv6 Multicast Forwarding

- **IPv6 Multicast packets L2 MPLS encapsulated and forwarded across an IPv4 / MPLS enabled core**
- **Core remains IPv6 agnostic**
- **IPv6 Unicast forwarding performed though 6PE**
- **Content distribution application – sources located in SP data centers, receivers located at the access layer**

  Well-known SPT with root in data center and leafs in access layer. Allows pre-configuration

  Multicast routing - PIM-SSM

  Receiver management - MLDv2 (setop box) or MLDv1 (*,G) report mapping to predefined sources

Layer 2 Encapsulated IPv6 Multicast Forwarding – Routing Design

- **Simple IPv6 multicast forwarding paradigm – SPT built with help of several L2 tunnels**
- **PIM SSM – no need for an RP**
- **Leads to a simplified IPv6 routing design**

  Dedicated set of IPv6 prefixes identifying sources and tunnel links – used for RPF calculation. Distinct from prefixes used for IPv6 unicast service

  IPv6 multicast iBGP / eBGP (SAFI=2) across L2 tunnels – required for PIM J/P and RPF calculation

  IGP (OSPFv3) in access layer (dual-stack)

		Across L2 Tunnels BGP SAFI=2	Access Layer IGP
Multicast source address	PIM J/P, RPF check	X	X

Layer 2 Encapsulated IPv6 Multicast Forwarding – Routing Design - Conclusion

- An IPv6 multicast infrastructure can be deployed across an MPLS network in order to support a content distribution service
- Core “P” routers not required to become IPv6 aware
- Well-known sources and receivers allows setup of a L2 tunnel based SPT for IPv6 traffic across the MPLS core
- Only multicast source prefixes require advertisement in BGP IPv6 multicast (SAFI=2) across L2 tunnels and in the local IGP at the access layer

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Overall Conclusion

- **Multiple solutions exist to add an IPv6 multicast forwarding capability to an existing, 6PE based, IPv6 unicast service – 2 solutions have been discussed**
- **Native IPv6 multicast forwarding**
  - **MPLS core needs to be IPv6 enabled**
  - **Distribution of IPv6 routing information in core is required**
  - **Flexible location of sources and receivers**
- **L2 encapsulated IPv6 multicast forwarding**
  - **MPLS core remains IPv6 agnostic**
  - **Content distribution service with well-known sources and receivers**
  - **Requires limited distribution of IPv6 routing information**

Q and A