IPv6 over IPv4/MPLS Networks: The 6PE approach

Athanassios Liakopoulos
Network Operation & Support Manager (aliako@grnet.gr)
Greek Research & Technology Network (GRNET)

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Presentation outline

- IPv6 support over MPLS networks
- Applicability - Requirements
- Label distribution
- Packet forwarding
- Bibliography

IPv6 support over MPLS networks

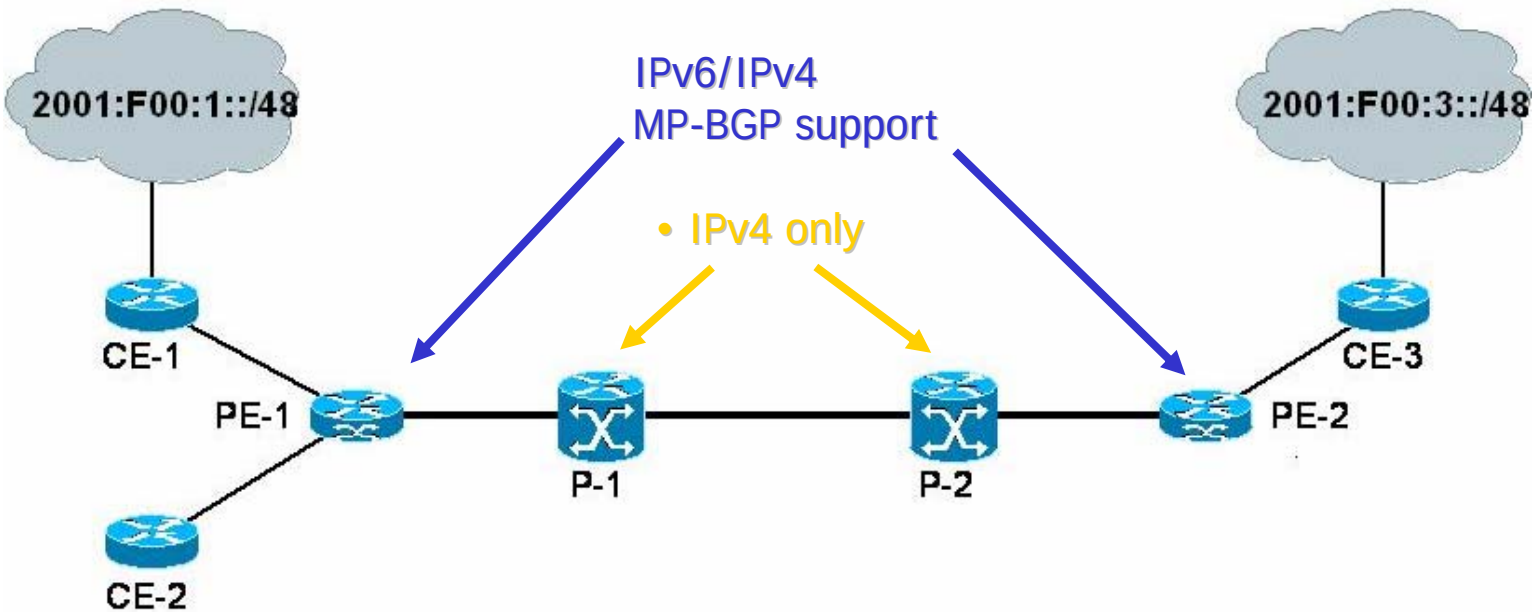
- Native IPv6 over MPLS
  - Requires dual stack core network, a.k.a IPv6 routing and label distribution protocols.
  - IPv6 and IPv4 traffic is treated identically by the core routers.
- IPv6 over Circuit Transport over MPLS
  - MPLS tunnels are terminated at PE routers.
  - L2 frames, e.g. Ethernet frames or ATM cells, are encapsulated into MPLS frames and transported over the network.
  - No changes are needed to P routers.
  - PE routers has to support the appropriate functionality, such as Cisco AtoM or Juniper CCC/TCC, in order to terminate the tunnels. IPv6 support is also a requirement for the PE routers.
  - Scalability problems arise in heavily (L2 tunnel) mesh topologies.
- The *6PE* approach
  - 6PE is similar to MPLS VPNs in terms of technical implementation and complexity.

Applicability of 6PE approach

- *6PE* is typically deployed by ISPs that have MPLS core network and (possible) supports MPLS VPN (or other) services.
- IPv6 services are requested by a small number of customers.
  - If the IPv6 customers are limited, a L2 tunnelled solution may be preferable.
  - If the IPv6 customers are require most of the access routers to become 6PE, ISP may consider to upgrade to whole network.
- The ISP wants to avoid either to fully upgrade the core network or to deploy IPv6-over-IPv4 tunnels.

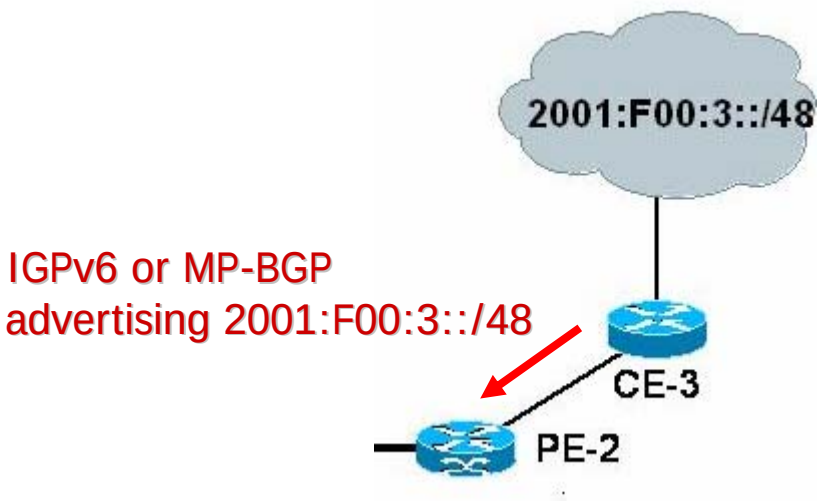
Requirements

- The ISP has to upgrade the Provider Edge (PE) routers to support IPv6 and MP-BGP.
- Core (P) routers do not need any change in terms of configuration or software.



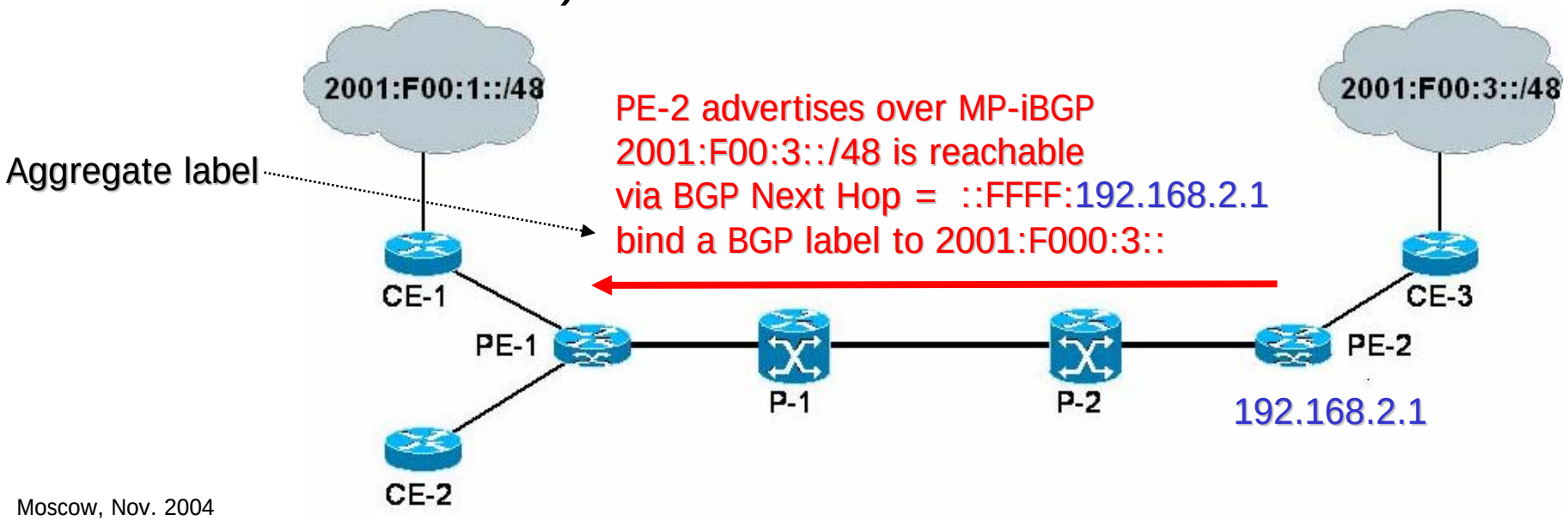
Label distribution (#1)

- Customer Edge (CE) router and 6PE router are connected with (one or more) logical or physical native IPv6 interfaces.
- Any common routing protocol (e.g. OSPF, eBGP) between CE and 6PE allows the distribution of IPv6 reachability information. Static or default routes may also be used.



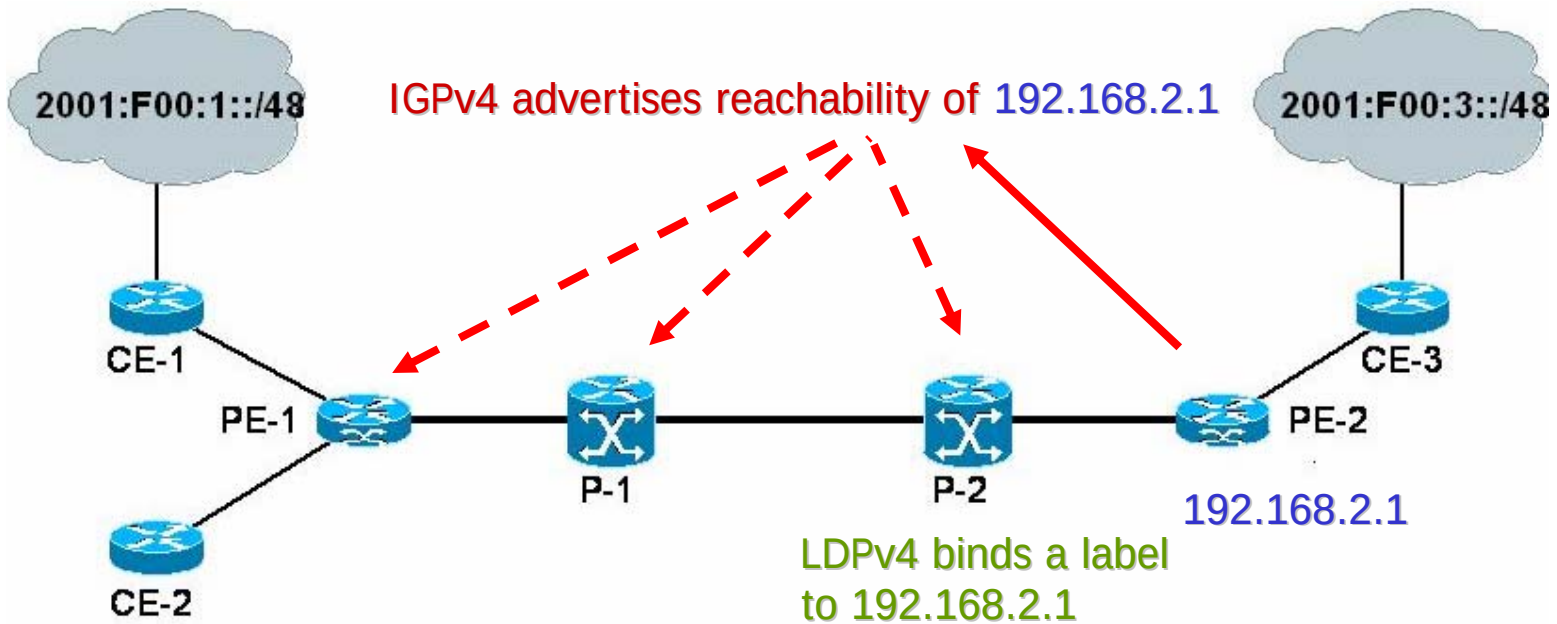
Label distribution (#2)

- Customer IPv6 prefixes are exchanged among the 6PE routers over MP-BGP session running over IPv4. 6PE routers convey their IPv4 address as the BGP Next-Hop for the IPv6 prefixes. (Note that BGP Next Hop field is the IPv4-mapped IPv6 address of the 6PE router.)

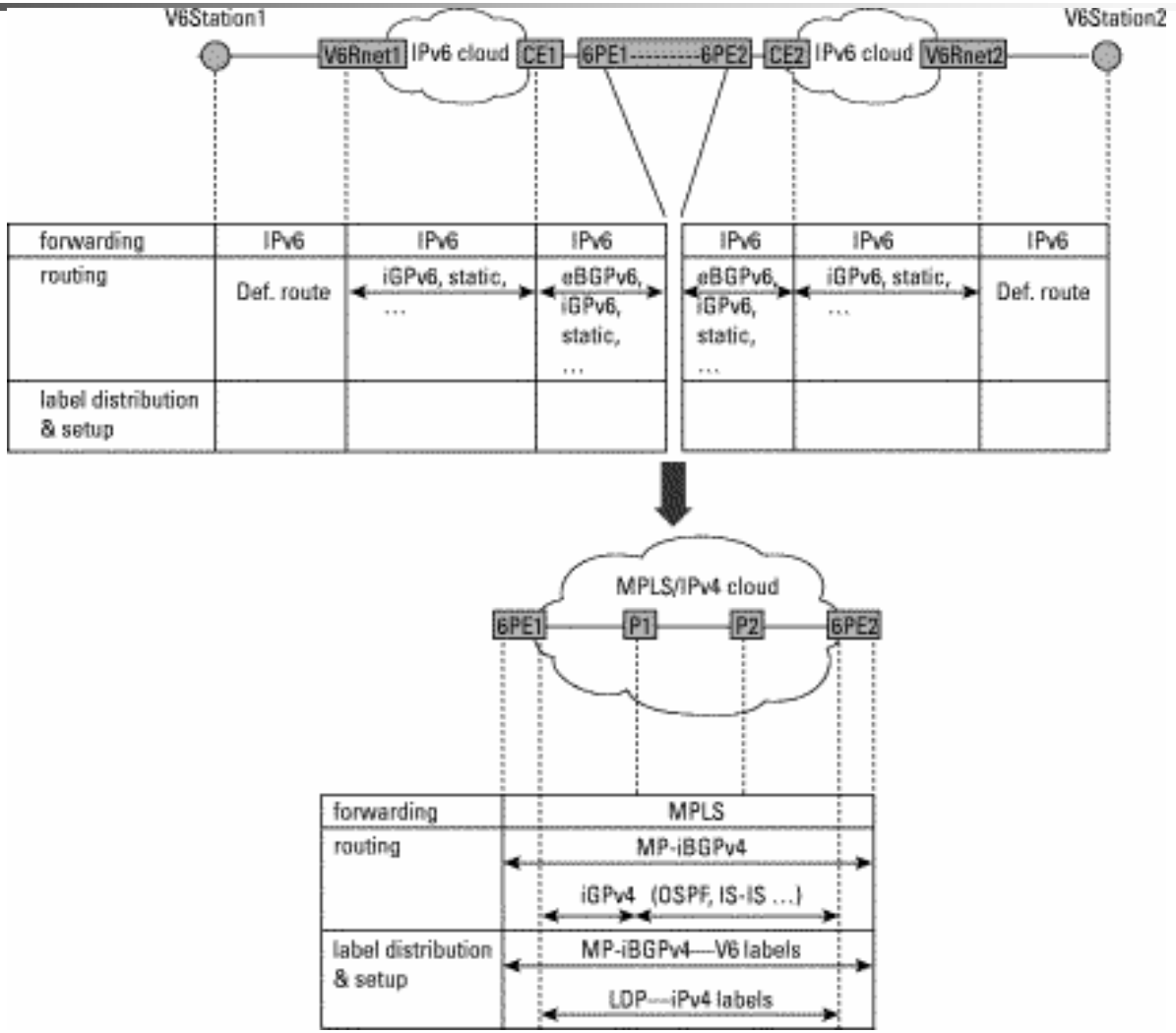


Label distribution (#3)

- 6PE routers insert their IPv4 address into the IGP routing table of the IPv4/MPLS core network. Therefore, each router in the MPLS domain will eventually assigns a label corresponding to the route for each 6PE router.

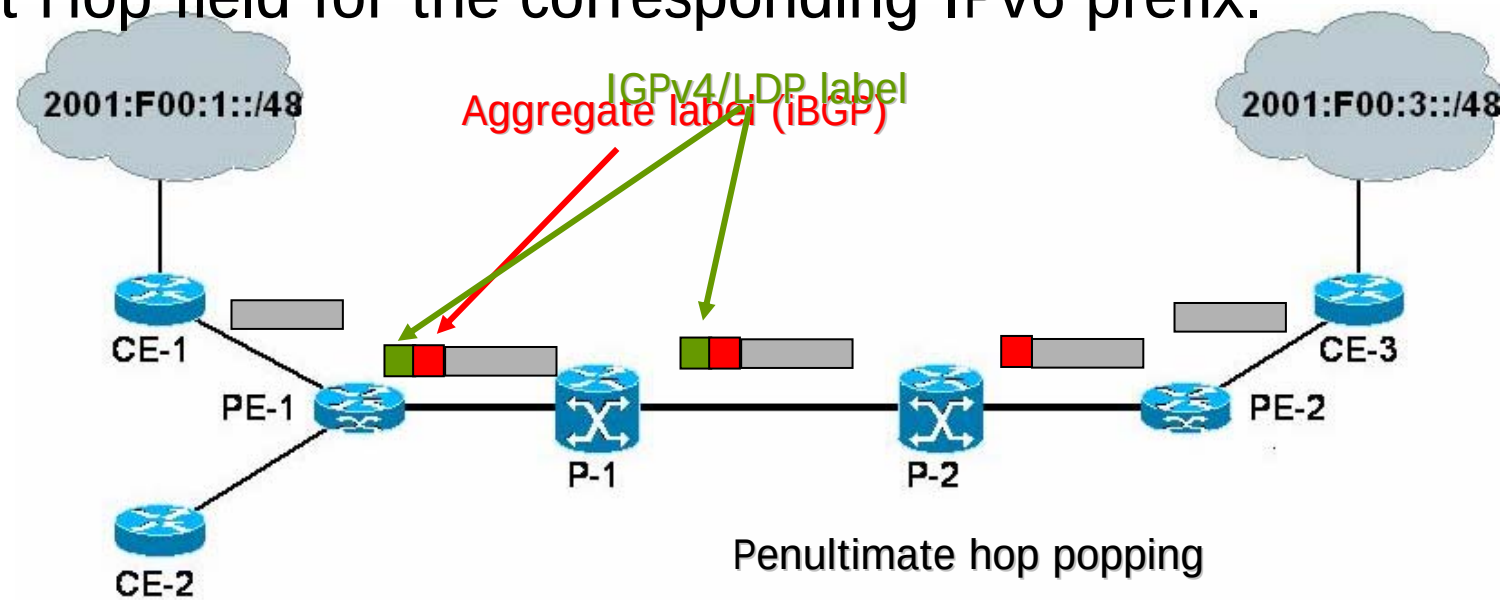


Routing interactions



Packet forwarding (#1)

- The CE sends a IPv6 packet to PE-1
- The ingress 6PE router tunnels the IPv6 data over an LSP towards a the Egress 6PE router identified by the IPv4 address that derives from the IPv4-mapped IPv6 address of the BGP Next Hop field for the corresponding IPv6 prefix.



Packet forwarding (#2)

- 6PE encapsulation involves two labels. The inner label (“aggregated IPv6 label”) is bounded to each advertised destination IPv6 prefix. The outer label is associated with the egress 6PE IPv4 address. Note that the inner label is not actually required for the operation but it helps to keep the MPLS core unaffected. In particular, without the inner label the “penultimate hop” P router would have to be able to forward a plain IPv6 packet to the egress 6PE router.

Conclusions

- PE routers has to be dual stack and to support MP-BGP. P routers does not need any modification.
- Provide native IPv6 services to customers without changing the IPv4 MPLS core network. This means minimal operational cost and risk.
- 6PE scenario is similar to packet forwarding in MPLS VPNs (RFC2547bis). IPv6 CEs have only one routing peer and do not need any change whenever remote IPv6 CEs are connected or removed (scalability).
- 6PE technology fits very well into the general MPLS philosophy. However, 6PE does not justify the deployment if MPLS core network. Therefore, 6PE should be deployed in in cases where MPLS core is available.

Bibliography

- J. DeClercq, D. Ooms, S. Prevost, F. Le Faucheur, "*Connecting IPv6 Islands over IPv4 MPLS using IPv6 Provider Edge Routers (6PE)*", IETF Internet Draft, Work in Progress.
- *"D2.2.3: Updated IPv4 to IPv6 transition Cookbook for organisational/ISP (NREN) and backbone networks"*, http://www.6net.org.