IPv6 support on MPLS networks: Experiences with 6PE approach

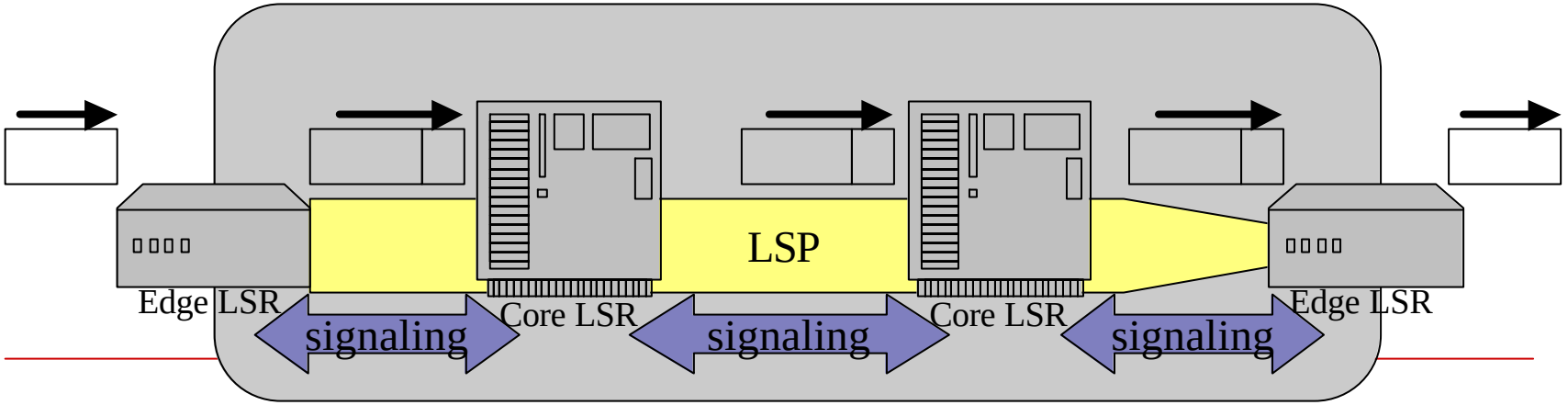
Satoshi UDA <zin@jaist.ac.jp>
School of Information Science,
Japan Advanced Institute of Science and Technology

Agenda

- Technical overview
  - MPLS
  - 6PE approach
- Experiment on operation
  - Interoperability issue
  - Operational issues
- IPv6 native support on MPLS

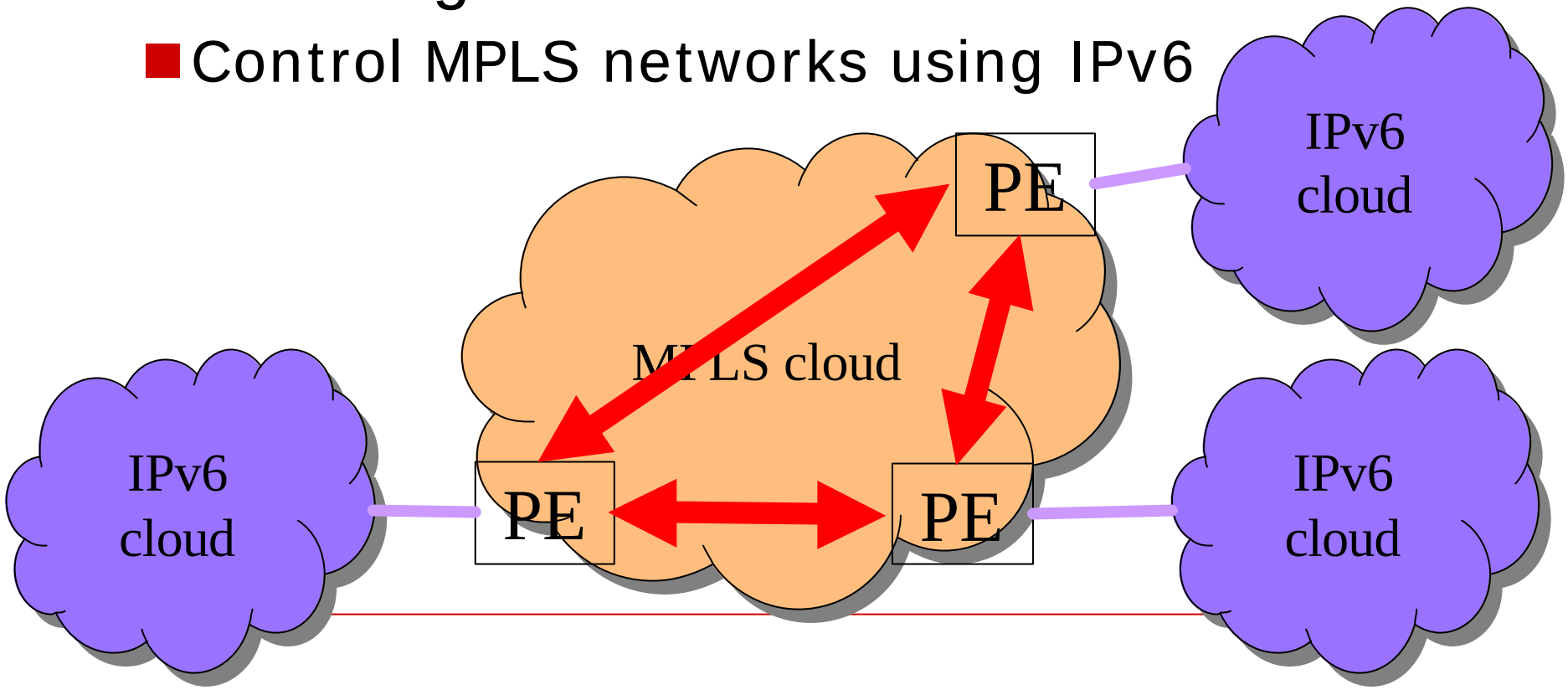
MPLS
(Multiprotocol Label Switching)

- Internet friendly label switching technology (Standardized as RFC3031)
- Feature:
  - Separating “control” and “forwarding”
  - Network control using IP (routing, managements and label distribution)
  - Supports any datalink medias



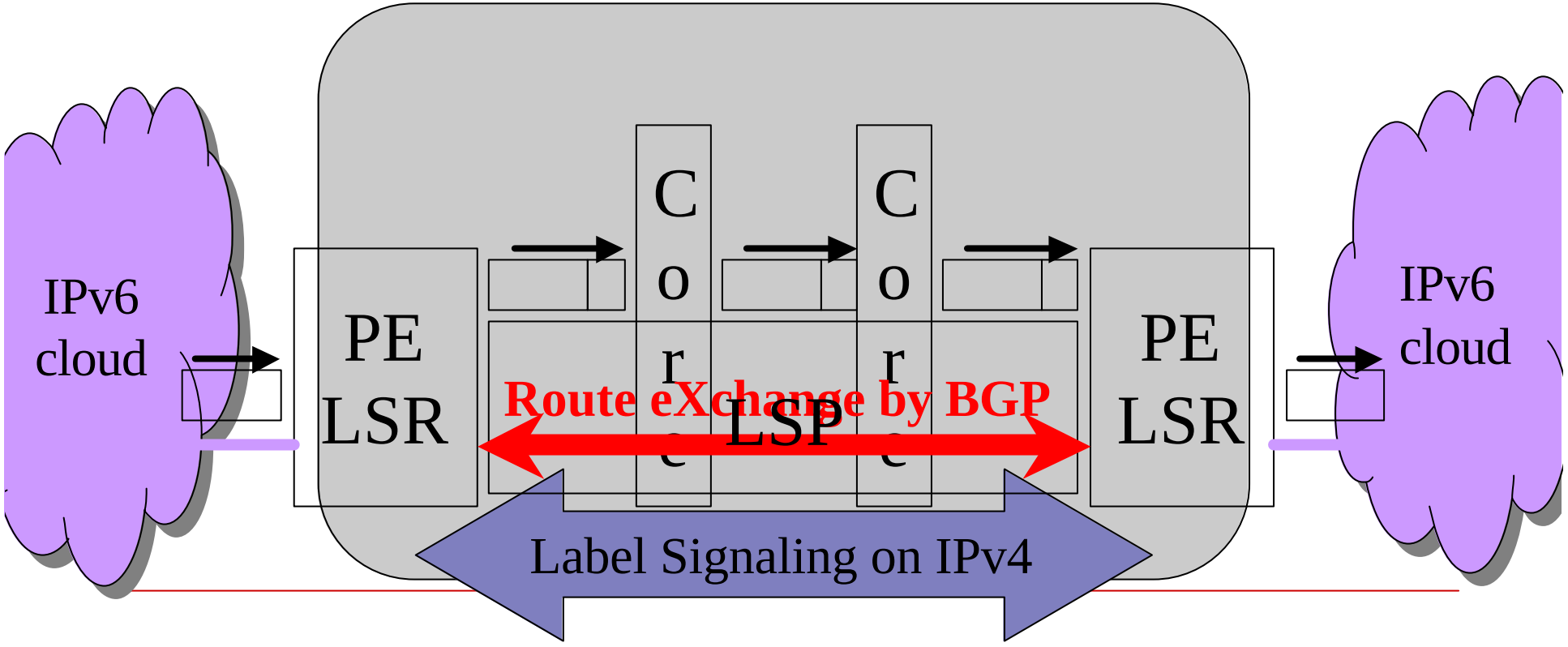
IPv6 on MPLS network

- First step:
  - IPv6 packets transit MPLS network
- Ultimate goal:
  - Control MPLS networks using IPv6



6PE model

- IPv6 packets transit between PE LSRs, only by extending PE LSRs

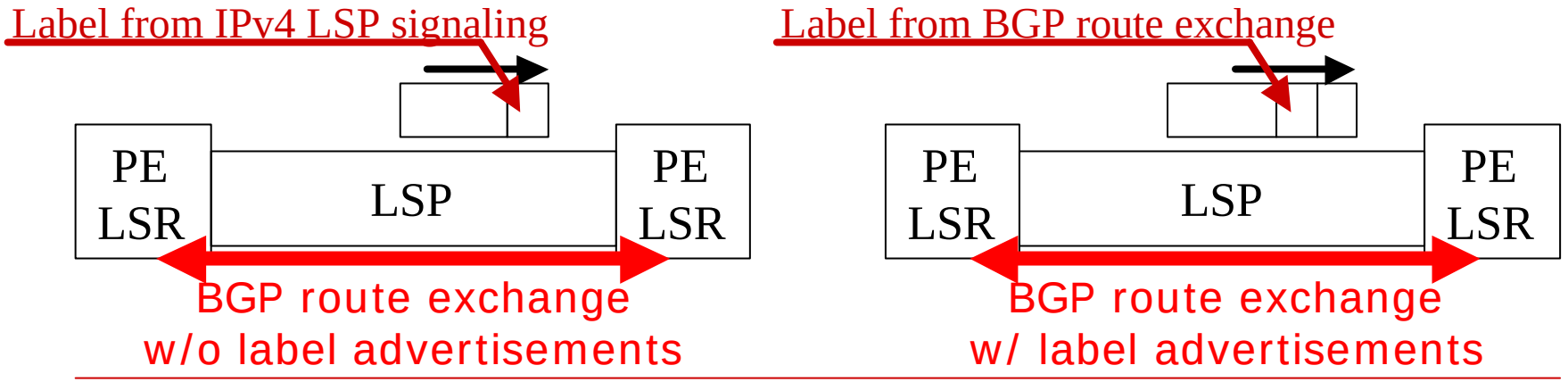


6PE model (2)

- Exchanging IPv6 routing information using BGP
  - BGP NEXT_HOP attribute for each route:
    - Use IPv4-mapped IPv6 address of the advertising router
  - Advertising label information (optional)
    - Using VPN SAFI (128) -- RFC 2547bis
    - Using Label SAFI (4) -- RFC 3107

Interoperability Issue
single label vs. double label

- Single Label:
  - No label advertising by BGP
  - IPv6 packets in MPLS network have single label
- Double Label:
  - Advertising label by BGP
    (using RFC2547bis or RFC3107)
  - IPv6 packers in MPLS network have double label

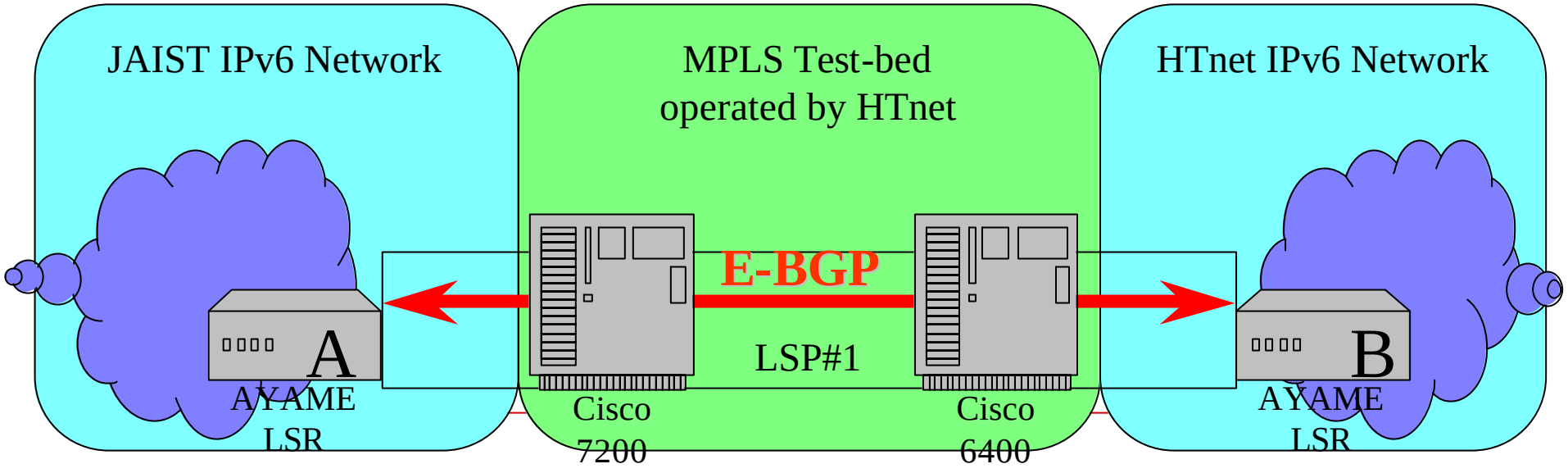


Interoperability Issue single label vs. double label (2)

- Single Label Advantage:
  - Simple
  - Easy to implement
- Double Label Advantages:
  - Edge LSR can distinguish IPv4 or IPv6 only checking a label on each packet
  - BGP route information explicitly indicate “Tunneling over IPv4/LSP tunnel” case
  - Edge LSR may forward packets in label switch method (depends on implementation)
- Mainstream:
  - Double Labels
  - Can decide label advertising method by BGP capability negotiation (RFC2547bis or 3107)

Experiment on operation

- Purposes:
  - Verify feasibility of the 6PE technique
  - Verify stableness of our implementation
- The experimental network:
  - Use MPLS core network based on MPLS-IX model
  - Commodity IPv6 traffic transits this network



Experiment on operation (2)

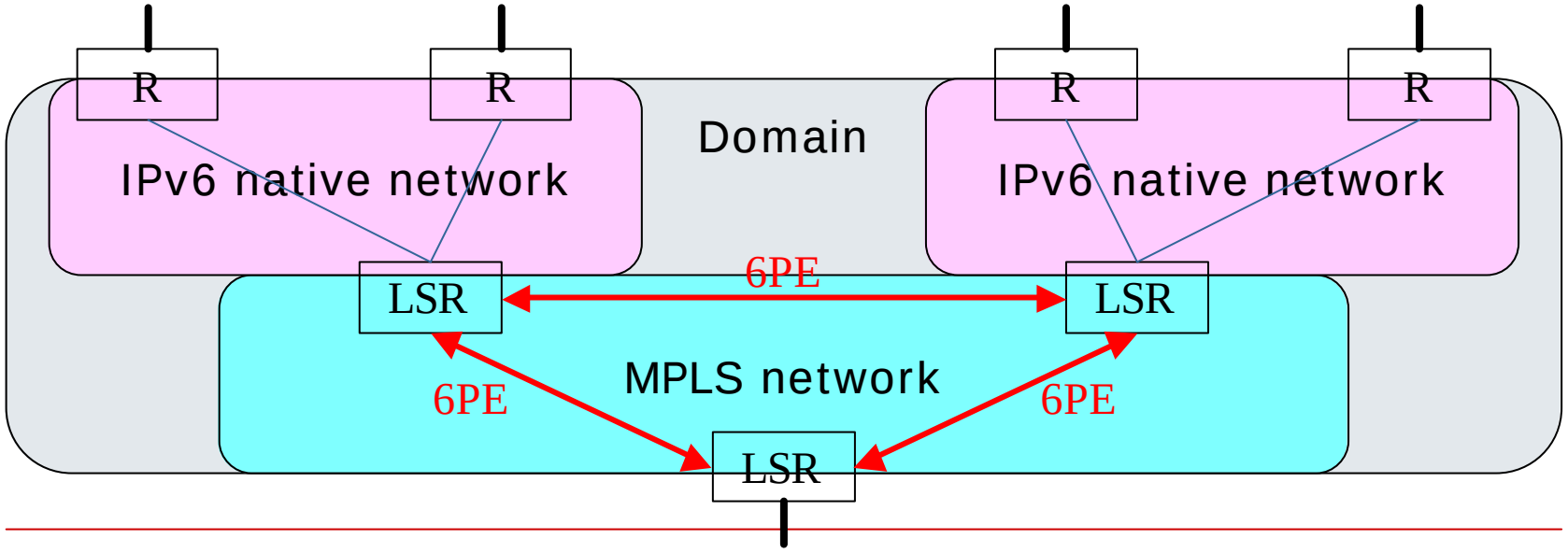
- Feasibility of 6PE technique:
  - IPv6 route information is exchanged between AYAME routers on each side
  - Our IPv6 traffic transit through this experimental MPLS network
- Stableness of AYAME 6PE:
  - Our AYAME LSRs are perfectly running on commodity traffic over half a year

Operational Issues: Issue (1)

- Issue about data path and control path:
  - Control path is not always same as data path on 6PE model network
  - If LSP (i.e. data path) has been broken but route information exchanging is working:
    - This lead to routing loop or black hole
      - In this situation, route information exchanging should be going to shutdown as soon as possible
  - On the MPLS-IX model:
    - The session for route information exchange is certain established on the LSP using eBGP (TTL=1)

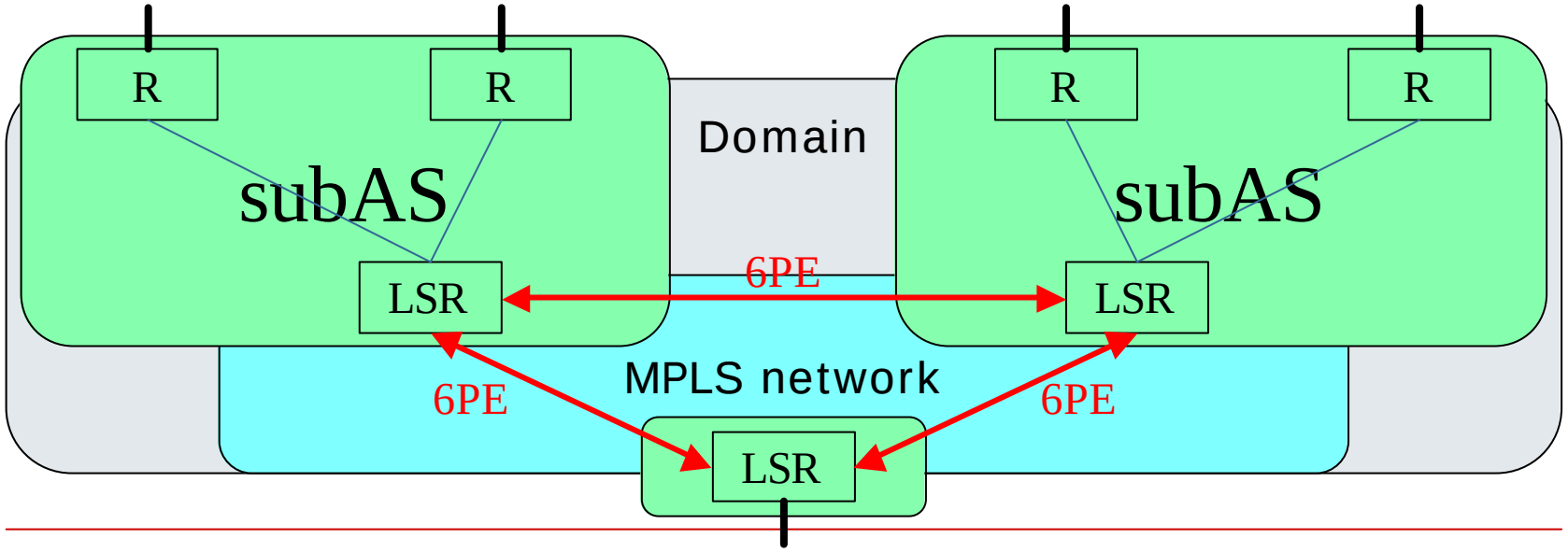
Operational Issues: Issue (2)

- If MPLS is used as a part of an domain...
  - Is there some BGP routers not directory connected to MPLS network?
    - Non 6PE capable router receive 6PE route information!? (using iBGP full-mesh session)



Operational Issues: Solution (1)

- Separating the domain into sub-ASs adopting the method of “AS Confederations”
- The connections across a MPLS network are handle as sub-AS exterior connections.



Operational Issues: Solution (2)

- Considerations
  - Solved:
    - Route exchanging in case of LSP has been broken
    - BGP routers not directly connected to MPLS network
  - Need more consideration:
    - Can the topology of a domain neatly separate into sub-ASs?
  - Weak:
    - Routing in the domain may be going complex
    - BGP may not be suitable for delicate route adjustment such as a intra-domain routing

IPv6 Native support

- IPv4 is going to become HISTORICAL!?
  - Mainstream is surely shifting to IPv6
- Supporting IPv6 on MPLS networks:
  - IPv6 packets can transit MPLS network using 6PE approach
  - But…
  - MPLS signaling is still based on IPv4
  - How long must we keep IPv4 only for MPLS?
- Requirements for migrating MPLS related protocols into IPv6:
  - Network management systems
  - L3 routing (IGP/EGP) systems
  - Label distribution (MPLS signaling) systems

IPv6 native support: Migration status

- Network management and L3 routing systems
  - Basic systems are practically present
  - Supported systems are on the increase as IPv6 deployment process
- Label distribution systems
  - Hardly ever motion
  - No implementation
  - There are specifications for IPv6 addresses in existing label distribution protocols
    - E.g. TLV definitions for IPv6 address
  - Does not match current practice of IPv6 routing
    - E.g. How to handle link local address?

➢ We should adopt label distribution protocols to handle IPv6 as soon as possible with deep consideration

Conclusion

- 6PE model realizes the IPv6 support on MPLS network
  - We implemented 6PE support in AYAME
    - Our implementation is working fine carrying commodity traffic
  - From the experiences, we identified issues
    - We show interoperable and operational issues, and possible solution.
- 6PE approach is useful technology during IPv4 to IPv6 transition period
- And for the near future, we recognize that native IPv6 support is very important

Thanks

Our implementation is available at:

AYAME Project's web page

http://www.ayame.org/