IPv6 integration in operational networks

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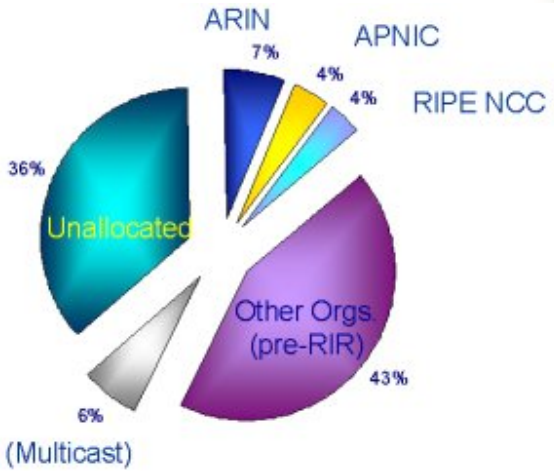
Conference: Where are we with IPv6 ?

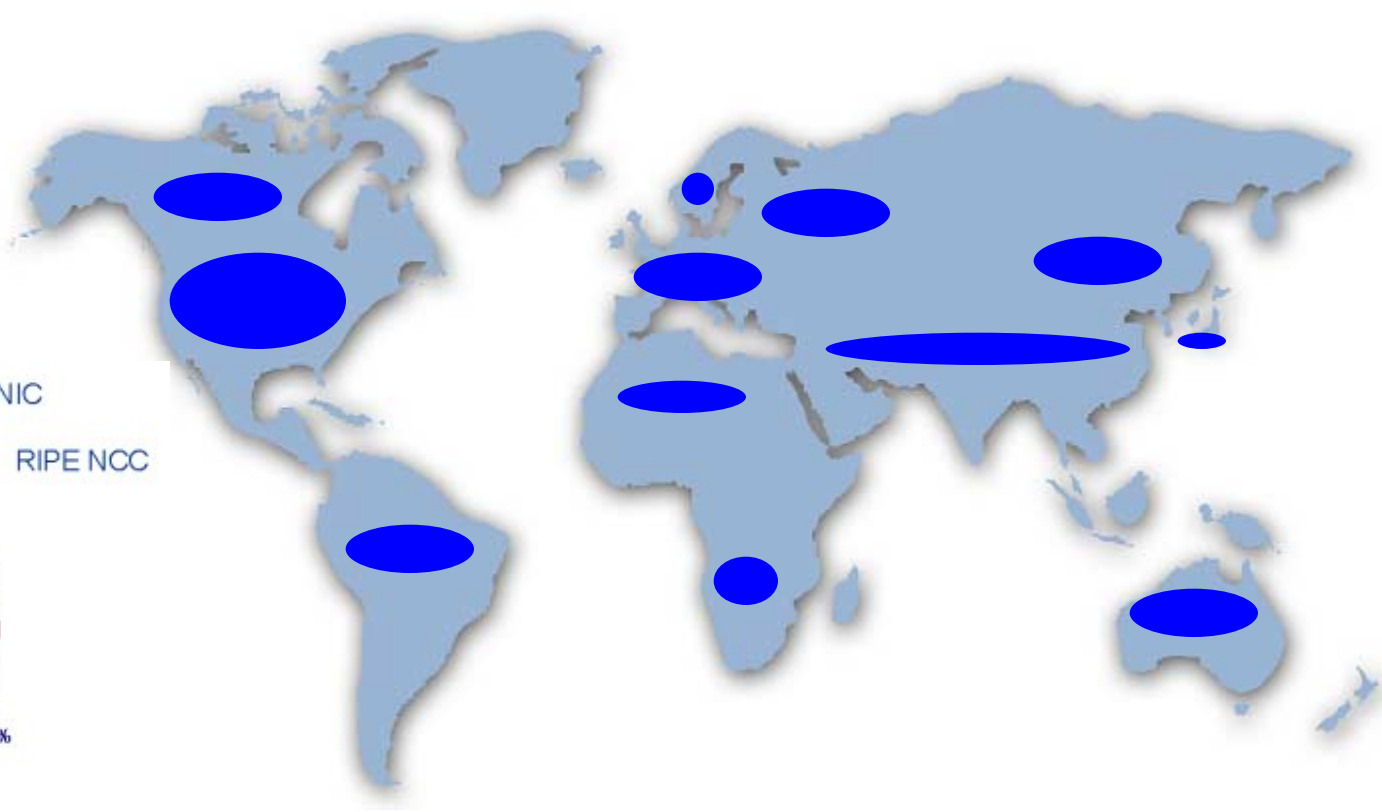
Paris, October 29, 2002

Motivations for Deploying IPv6
Extending the reach of Internet

GEOGRAPHICALLY

IPv4 limitation



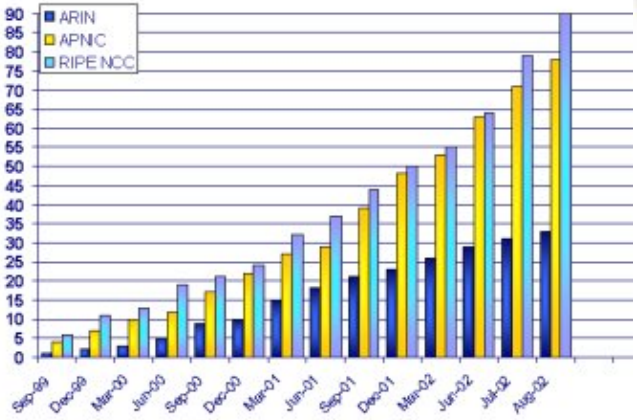


Source: http://www.ripe.net

Motivations for Deploying IPv6
Extending the reach of Internet

GEOGRAPHICALLY

IPv6 potential



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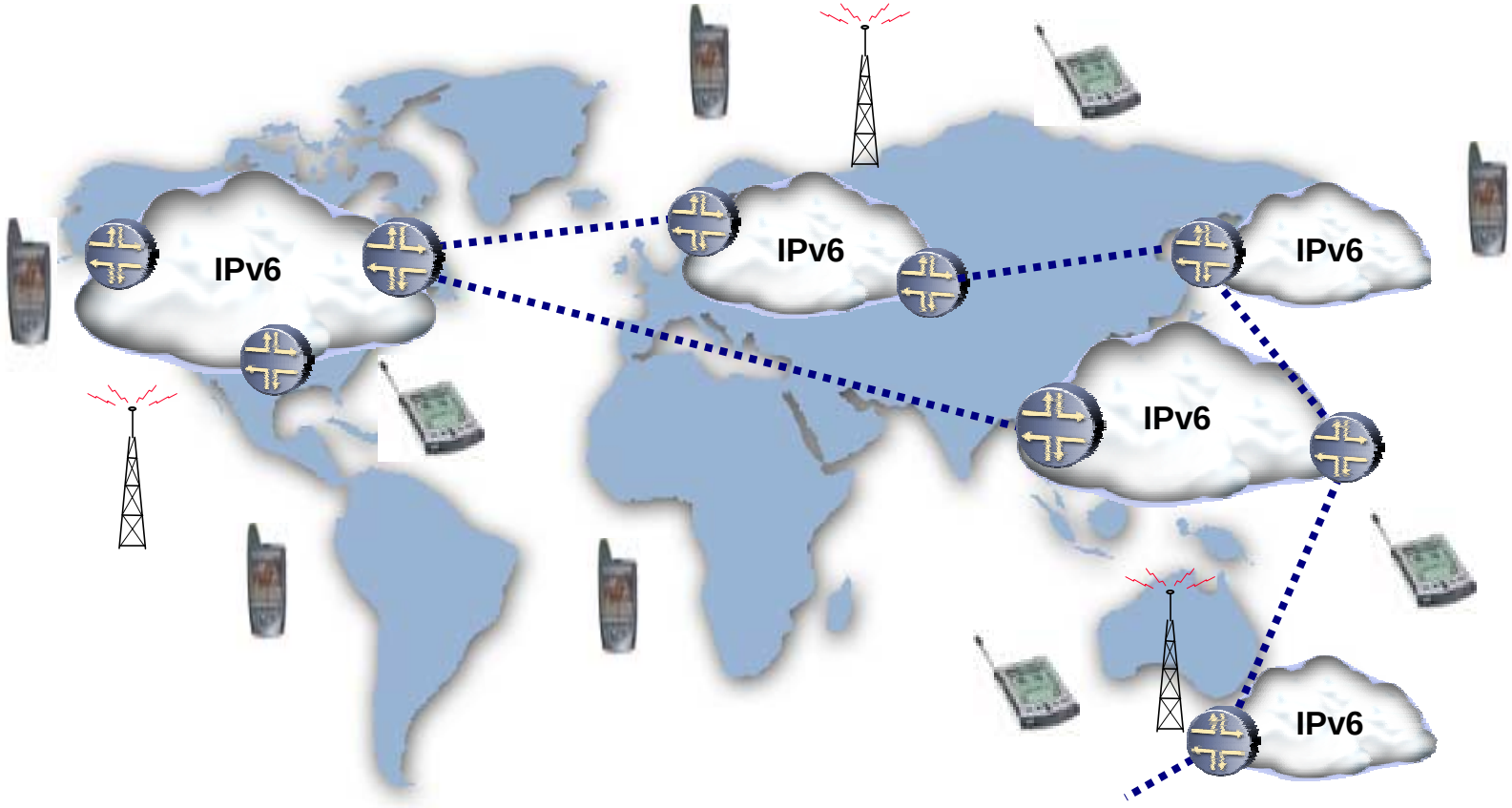
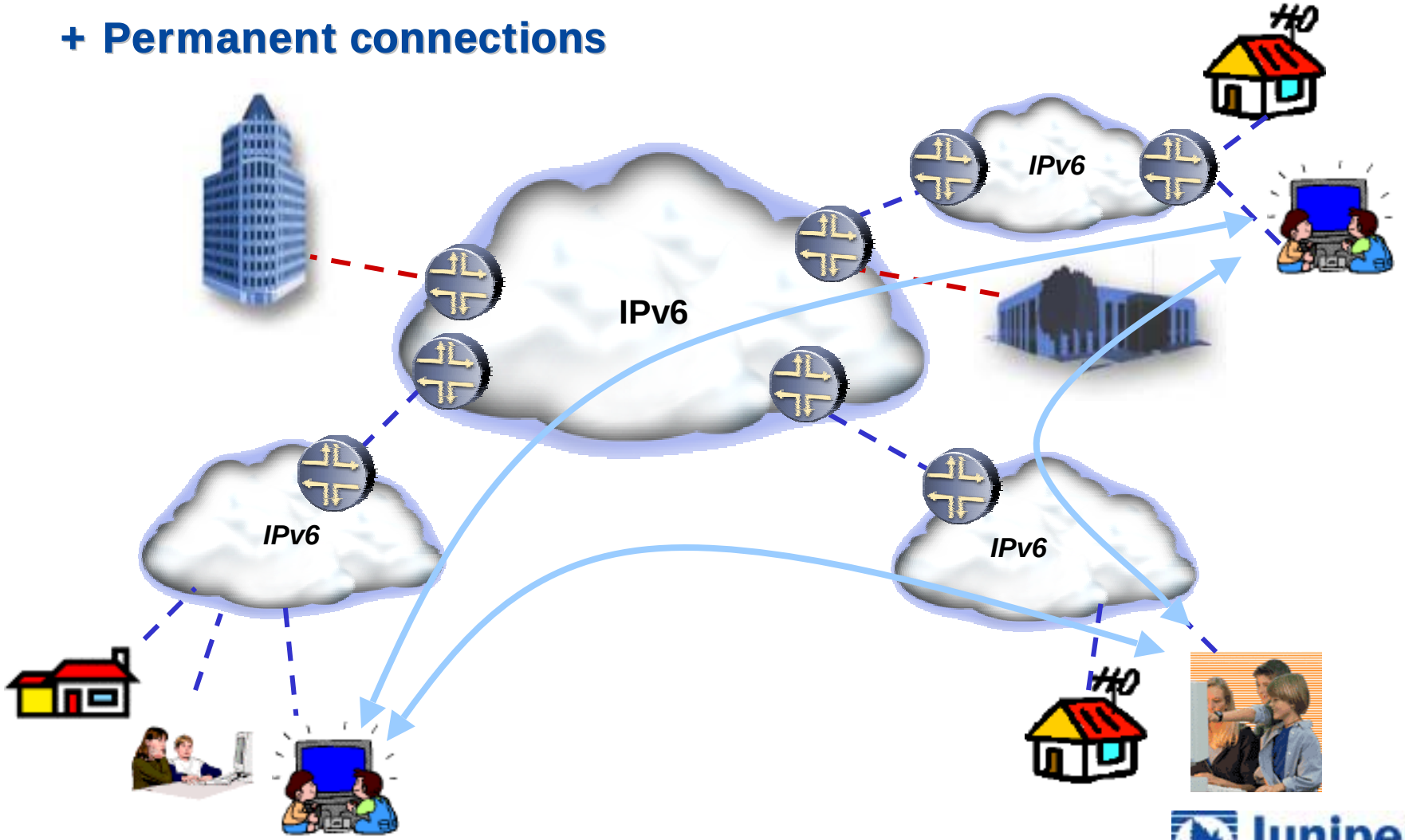
Motivations for Deploying IPv6
Extending the reach of Internet

MOBILITY



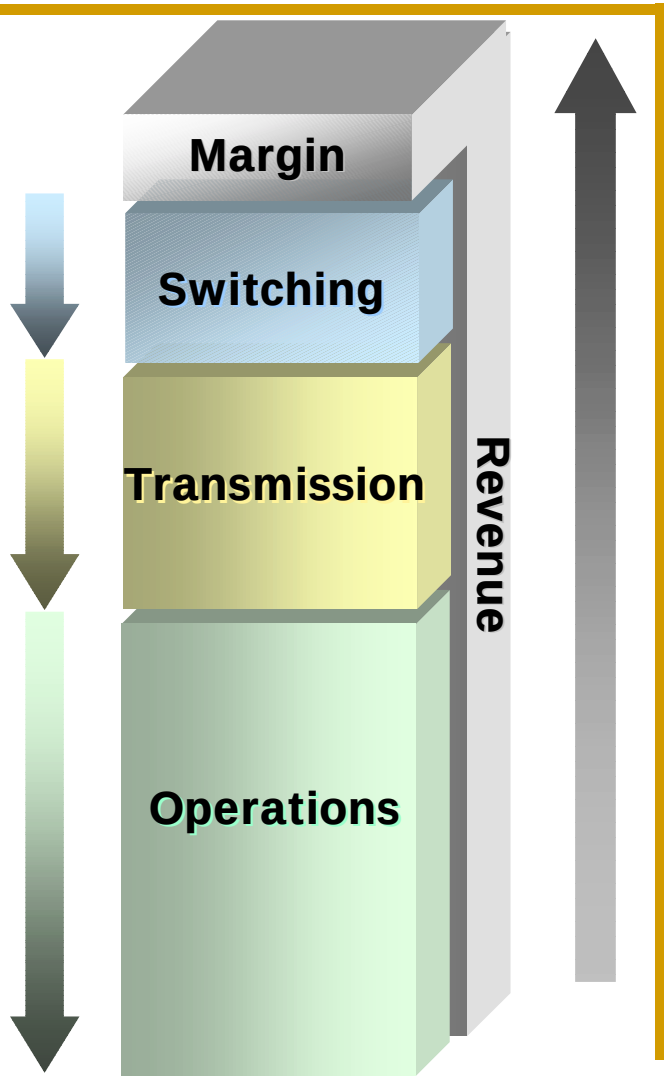
Motivations for Deploying IPv6
Peer-to-peer applications model

+ Permanent connections



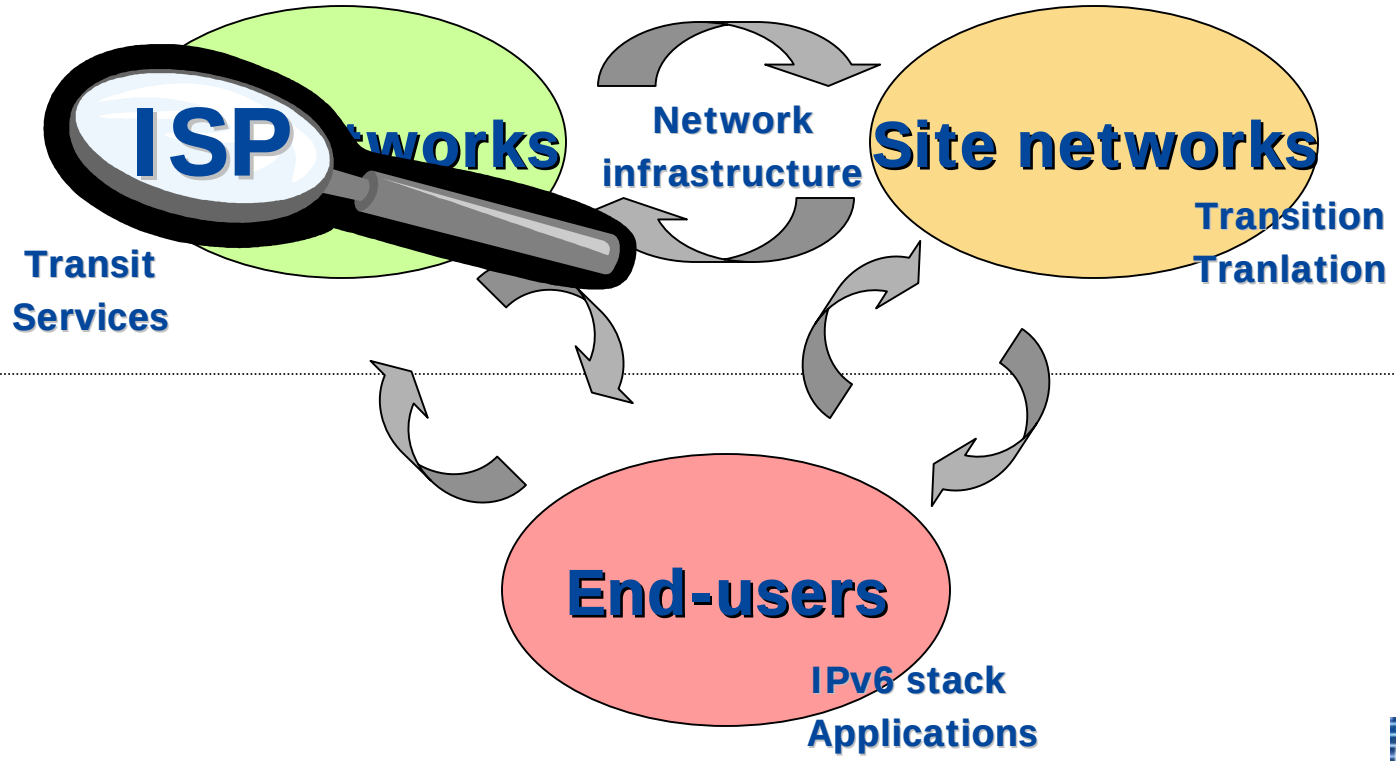
ISP general concerns

- Turn on new service revenues
- Reduce operating costs
- Optimize bandwidth
- Reduce depreciation



How to start?

- By profitable services ? Not a short term…
- No D-Day
- Start where it is easy and prepare the coming challenge



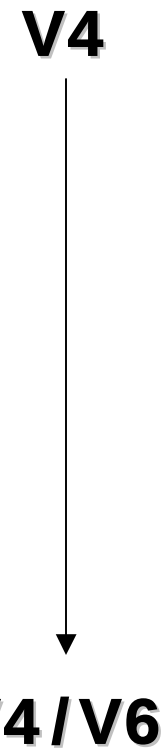
Integrating IPv6 in ISP networks

- But what if IPv6 can be deployed in a seamless way without expensive upgrades and operational costs?

- IPv6 deployment requires preservation of:
  - Reliability
  - Performance
  - Services

IPv6 integration process

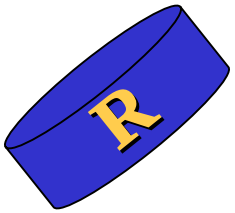
- **Network readiness**
  - **Required upgrade?**
  - **Equipment limitations?**
- **Design**
  - **Based on existing infrastructure**
- **Migration phases**
- **Operational procedures**



IPv6 routers Taxonomy

Will run IPv4 only, maybe MPLS

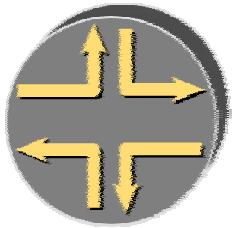
IPv6 non upgradeable router



Issue: how much cost the hardware and software upgrade (CAPEX + OPEX) ???

IPv6 upgradeable router

Justification generally linked to short term revenues …

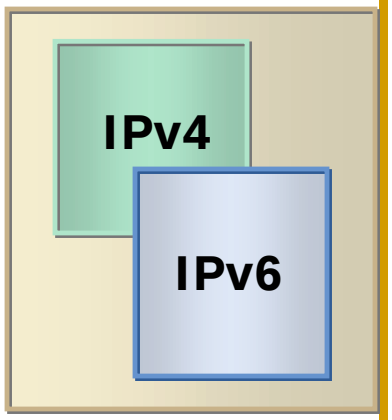


Ready

IPv6 qualified router

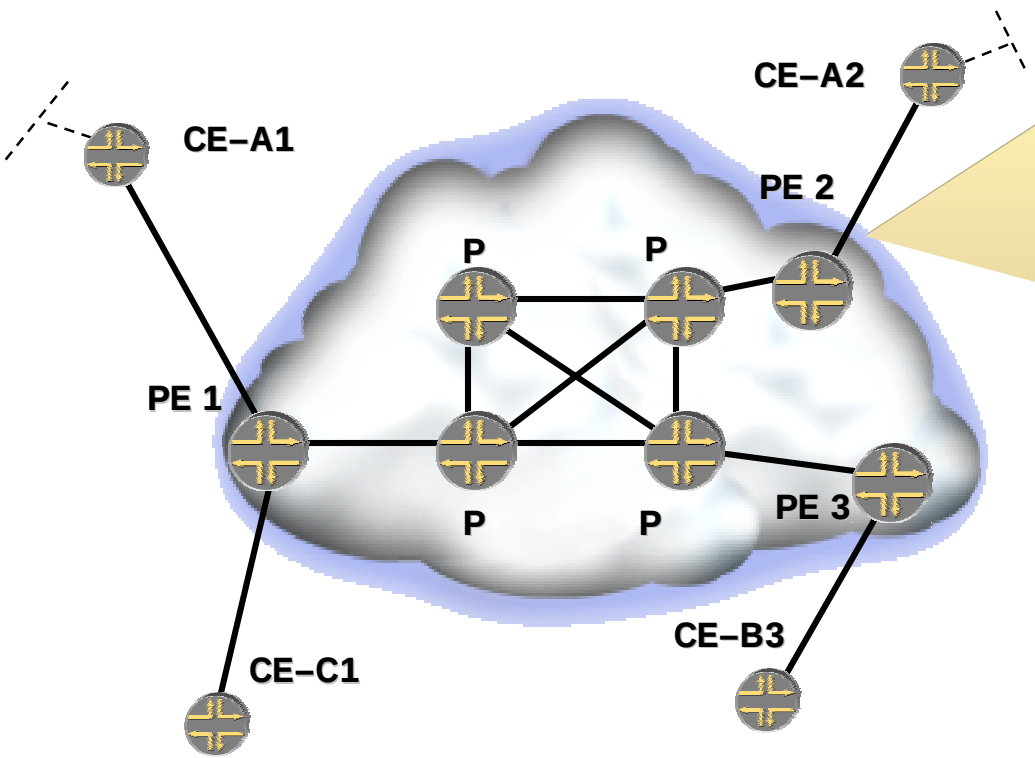
IPv6 Qualified Router for ISPs
What means really Dual Stack?

- **Addressing & Forwarding**
- Routing Protocols
- Service Richness
- Operational Efficiency



IPv6 Addressing

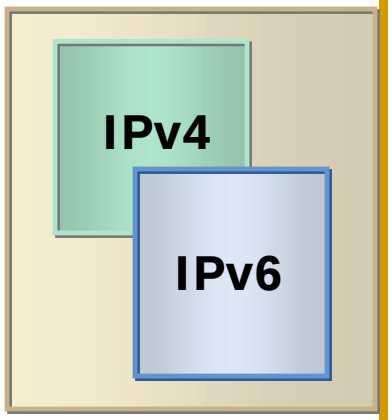
- Dual IP addressing on the same interface
- Neighbor discovery
- ICMPv6




```
interfaces {
 ge-0/1/0 {
  unit 0 {
   family inet {
   address 157.168.0.5/24;
   }
   family inet6 {
   address 8028:20::1/64;
   }
  }
 }
}
```

IPv6 Qualified Router for ISPs
What means really Dual Stack?

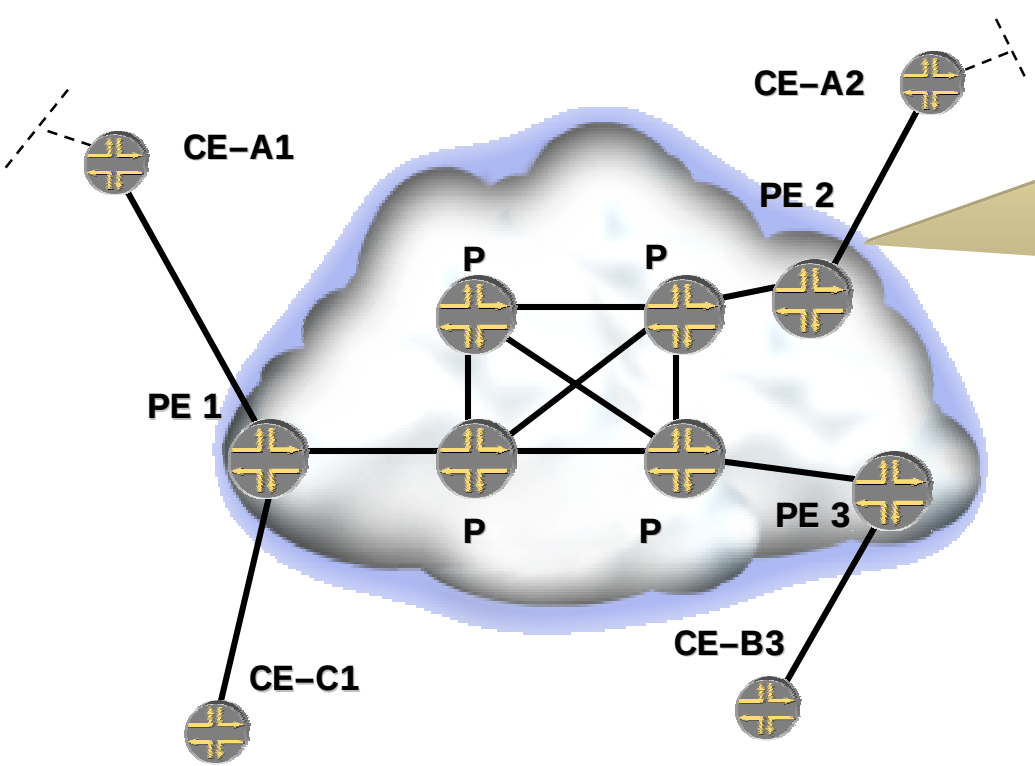
- Addressing & Forwarding
- **Routing Protocols**
- Service Richness
- Operational Efficiency



Routing Protocols

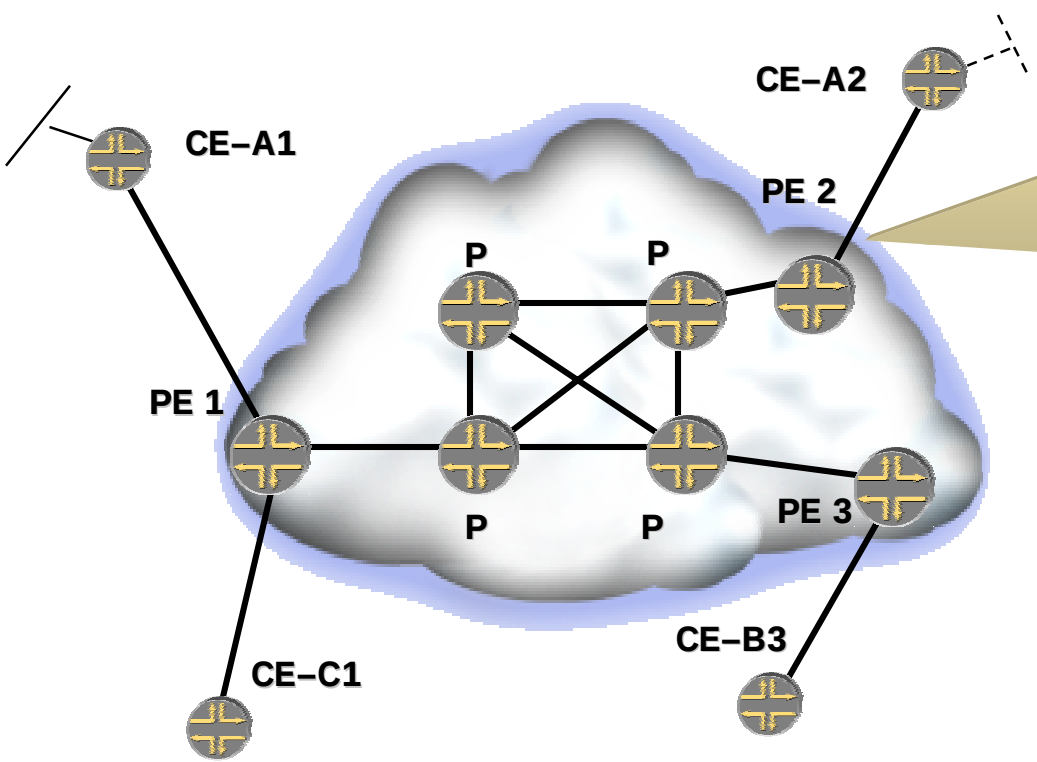
- **Static routing**
  - **May be used with customer sites**
- **IGP**
  - **IPv6 unicast can be routed by RIPng, OSPFv3, or ISIS**
  - **Current ISIS backbone don't need IGP upgrade**
  - **Current OSPF backbone need to:**
    - **Migrate to IS-IS**
    - **Or add/deploy OSPFv3**
- **BGP-MP**
  - **Just add the IPv6 routing in existing M-BGP set-up**
  - **Can use same design**
  - **Can be set-up over v4 or v6**
    - **Just add v6 routing over BGP/v4 sessions**
    - **Use BGP over v6 in case of IPv6 deployment in IPv4 tunnels**

Static Routing example



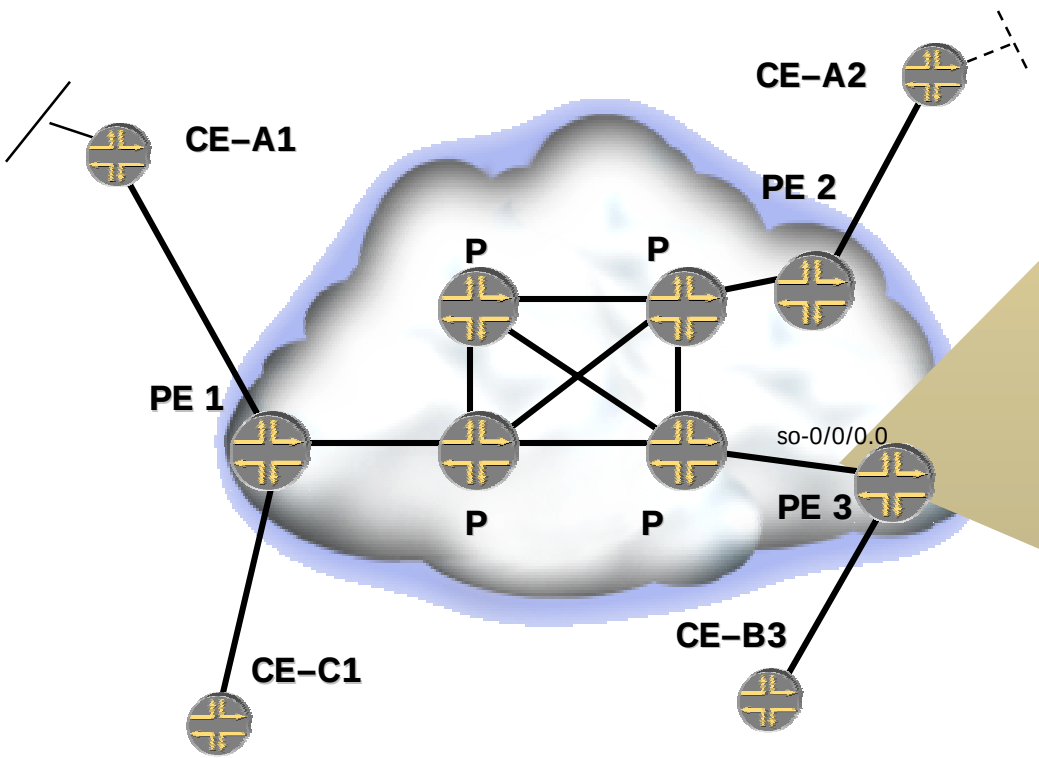

```
routing-options {
    rib inet6.0 {
        static {
          route 8028:10::1/128
                      next-hop 8028:25::2;
        }
    }
}
```

RIPng Routing example



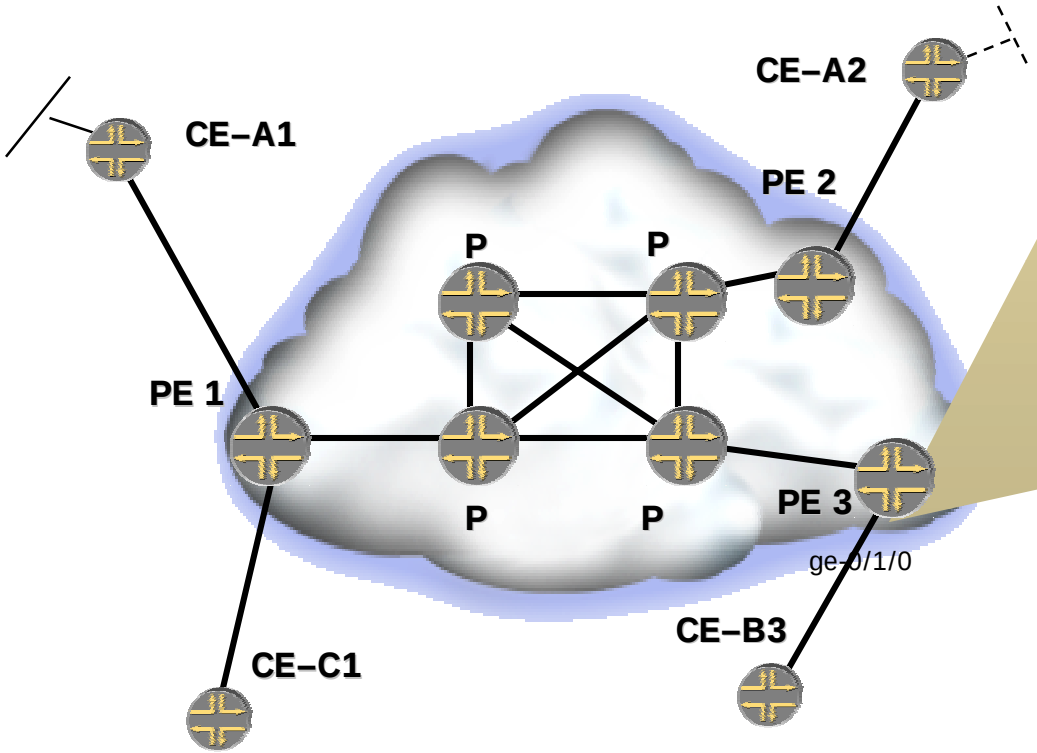

```
protocols {
    ripng {
        group igp {
            neighbor ge-0/1/0.0;
        }
    }
}
```

OSPFv3 example




```
interfaces {
 so-0/0/0 {
  unit 0 {
   family inet {
    address 10.19.6.2/24;
   }
   family inet6 {
    address 9009:6::2/64;
   }
 }
}

lo0 {
 unit 0 {
  family inet {
   address 10.245.71.6/32;
  }
  family inet6 {
   address feee::10:255:71:6/128;
  }
 }
 }
}

protocols {
 ospf3 {
  area 0.0.0.2 {
   interface so-0/0/0.0;
   interface lo0.0 {
    passive;
   }
  }
 }
}
```

External M-BGP example



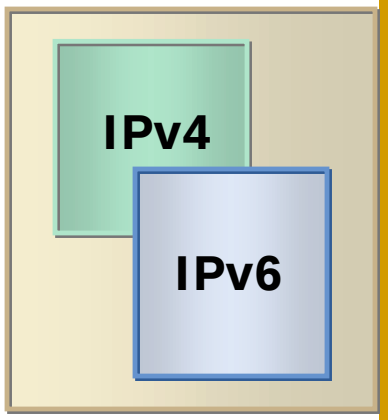

```
interfaces {
 ge-0/1/0 {
  unit 0 {
   family inet {
    address 11.19.1.2/24;
   }
   family inet6 {
    address ::11.19.1.2/126;
   }
  }
 }
}

routing-options {
 autonomous-system 100;
}

protocols {
 bgp {
  group ebgp_both {
   type external;
   local-address 11.19.1.2;
   family inet {
    unicast;
   }
   family inet6 {
    unicast;
   }
   peer-as 1;
   neighbor 11.19.1.1;
  }
 }
}
```

Multicast Routing

- Performance and scaling for IPv6 multicast clearly important
- PIMv2 to support for IPv4 and IPv6
- Multicast Listener Discovery (MLD) protocol to discover the presence of multicast listeners
  - Derived from IGMPv2
  - Uses ICMPv6 message type instead of IGMP message types

IPv6 Qualified Router for ISPs What means really Dual Stack?

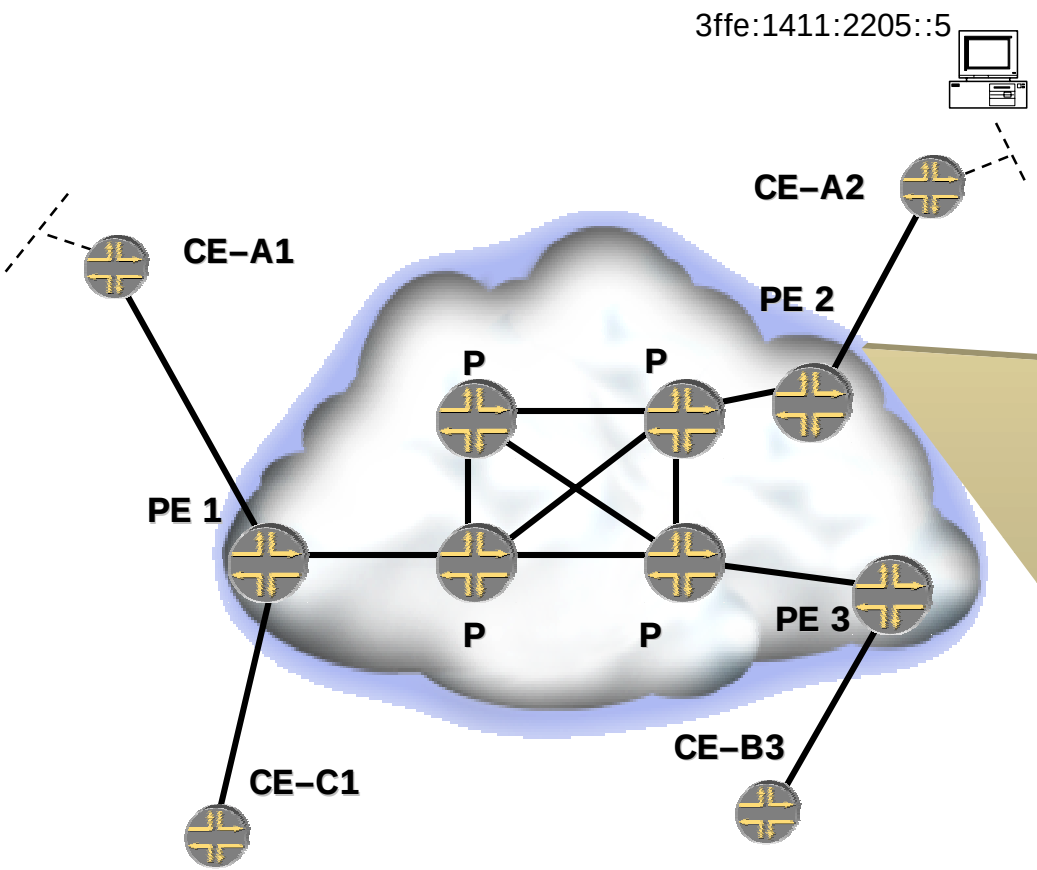
- Addressing & Forwarding
- Routing Protocols
- **Service Richness**
- Operational Efficiency



IP Services

- Routers must be able to perform intelligent IPv6 packet handling
  - Filtering – Selective forwarding and discarding
  - Monitoring - Sampling, counting, logging, etc.
  - QoS - Policing, shaping, queuing, profiling, etc.
  - Forwarding – Directing packets based on any header information
- All classification and packet handling must be done in hardware to truly minimize performance impact
- IP services and performance must not be mutually exclusive

Flexible bandwidth

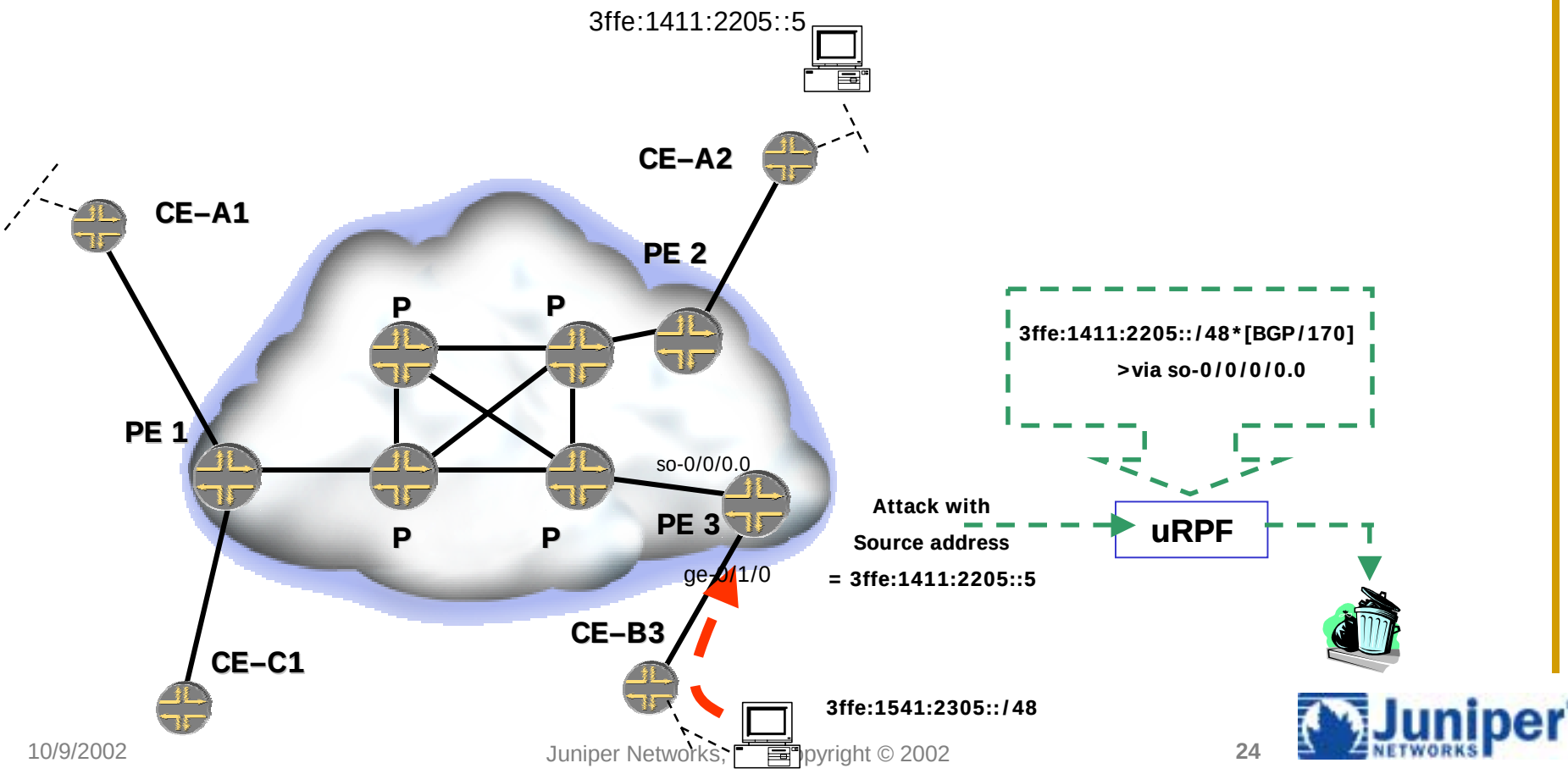



```
firewall {
 family inet6 {
  filter LimitCE-A2{
   policer LimCE-A2 {
    if-exceeding {
     bandwidth-limit 1m;
     burst-size-limit 100k;
    }
   then discard;
   }
   term 1 {
    from {
     source-address {
      3ffe:1411:2205::/48;
     }
    }
    then {
     policer LimCE-A2;
     accept;
    }
   }
  }
 }
}
```

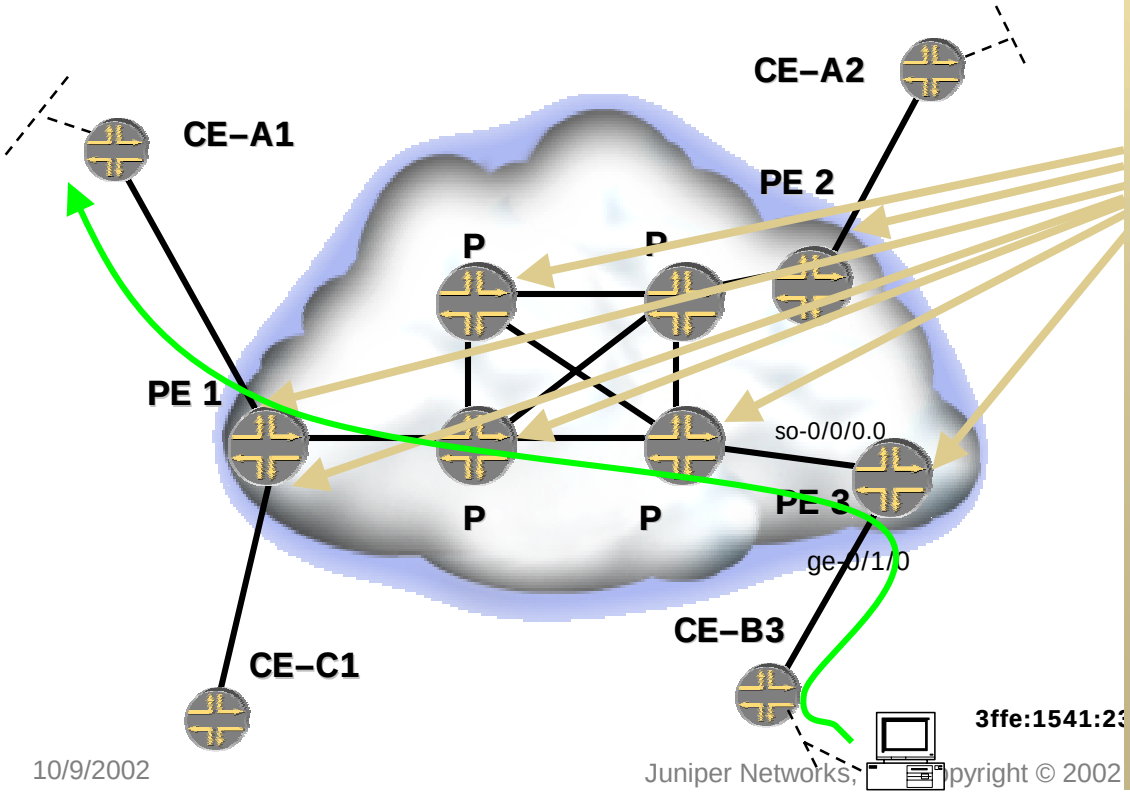
Security

- Security on routers is more important than ever
  - for customer and infrastructure protection
- On-going DoS work in IPv4 to be extended to IPv6
- Hardware-based packet handling, filtering optimize key security actions
- SNMPv3 improves router authentication

Source Address Verification

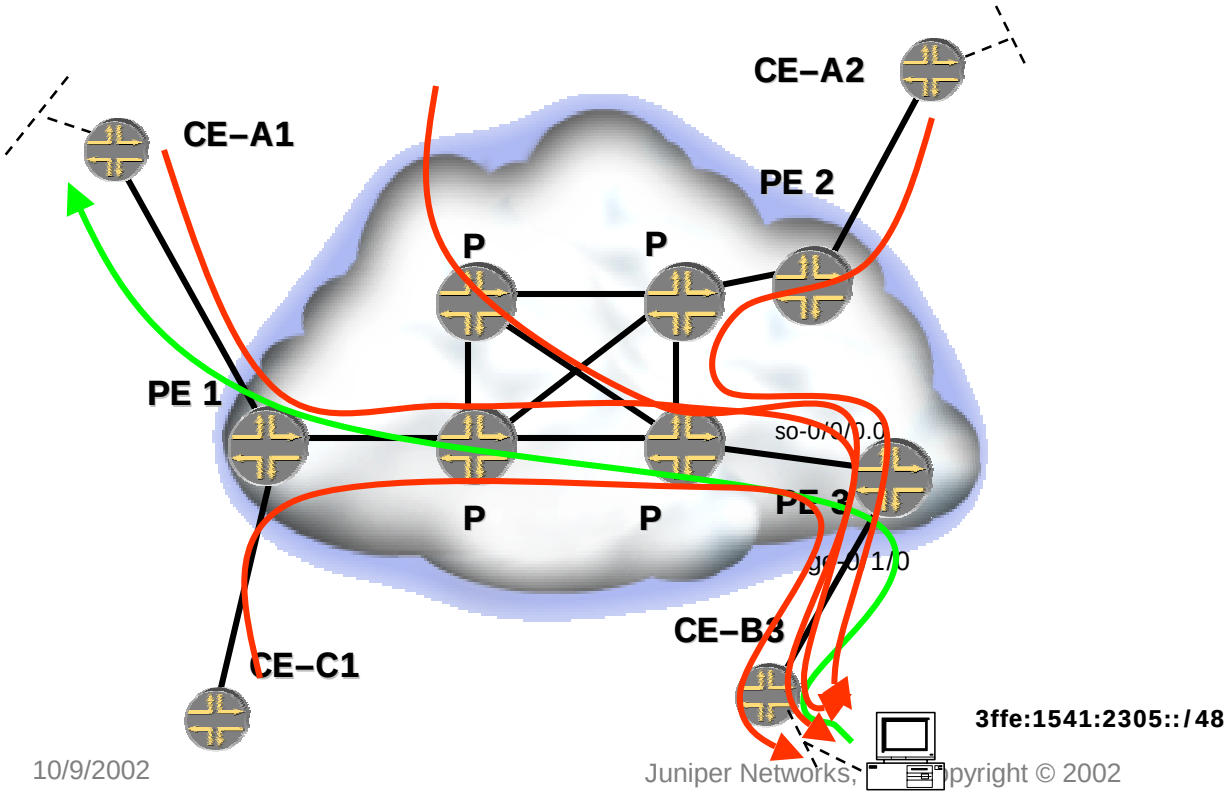


Real-time DDoS Id

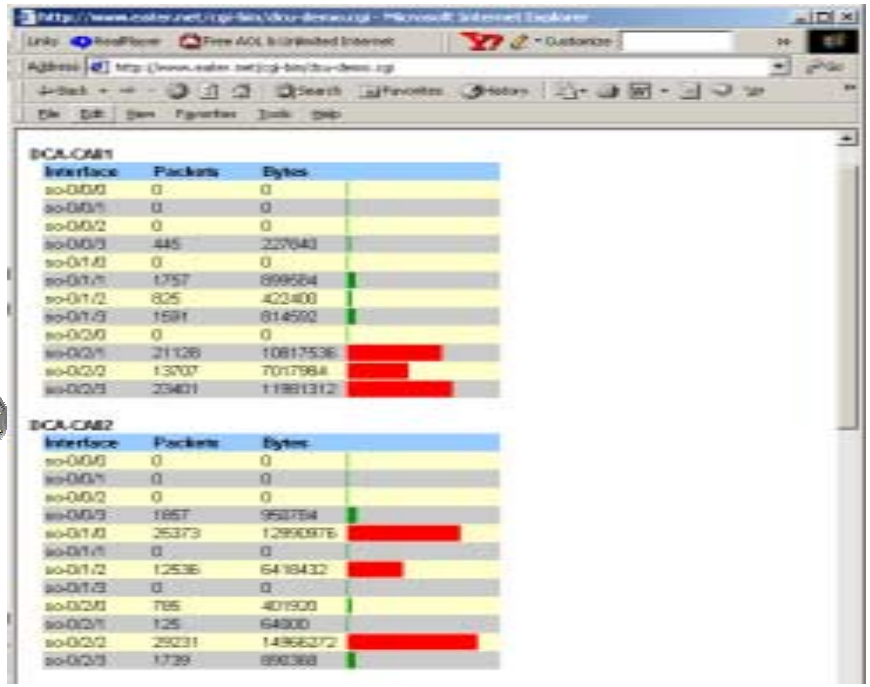


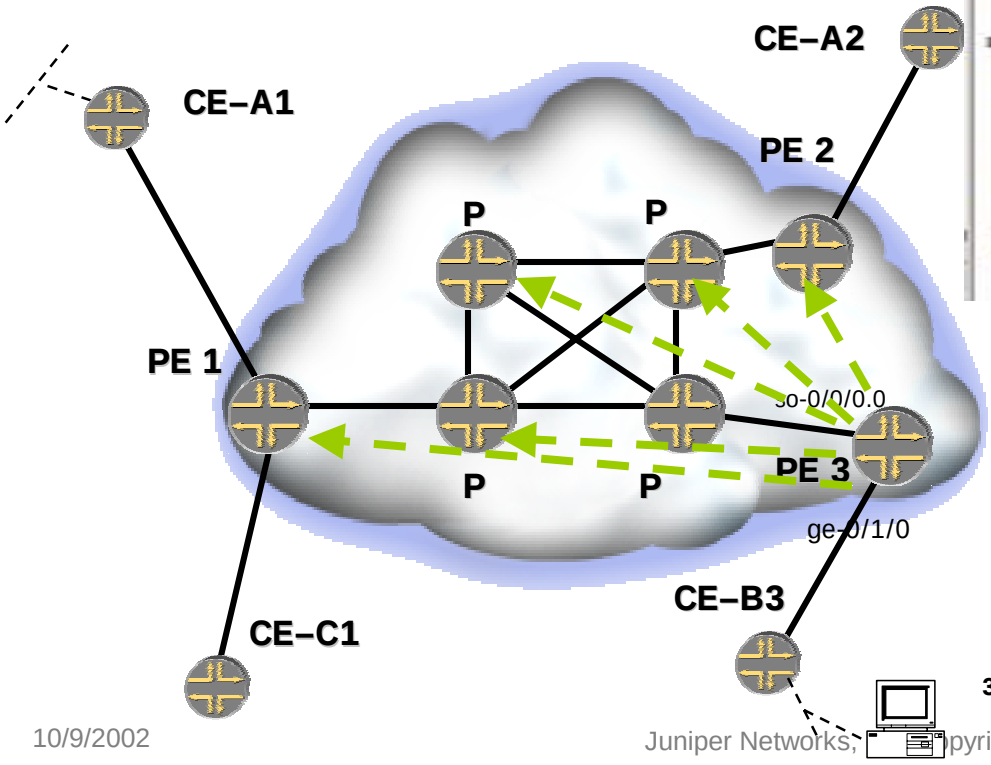

```
policy-options {
 community victim members 100:100;
 policy-statement set-dest-class
  term 1 {
   from {
    protocol bgp;
    community victim;
   }
   then {
    destination-class dcu-victim;
    accept;
   }
  }
 }
}

interfaces {
 so-2/0/1 {
  unit 0 {
   family inet6 {
    address feee::10:255:73:2/128;
    accounting {
     destination-class-usage;
    }
   }
  }
 }
}

routing-options{
 forwarding-table{
  export set-dest-class;
 }
}
```

Real-time DDoS Identification



Real-time DDoS Identification





BGP update
3ffe:1541:2305::12/128
Community 100:100

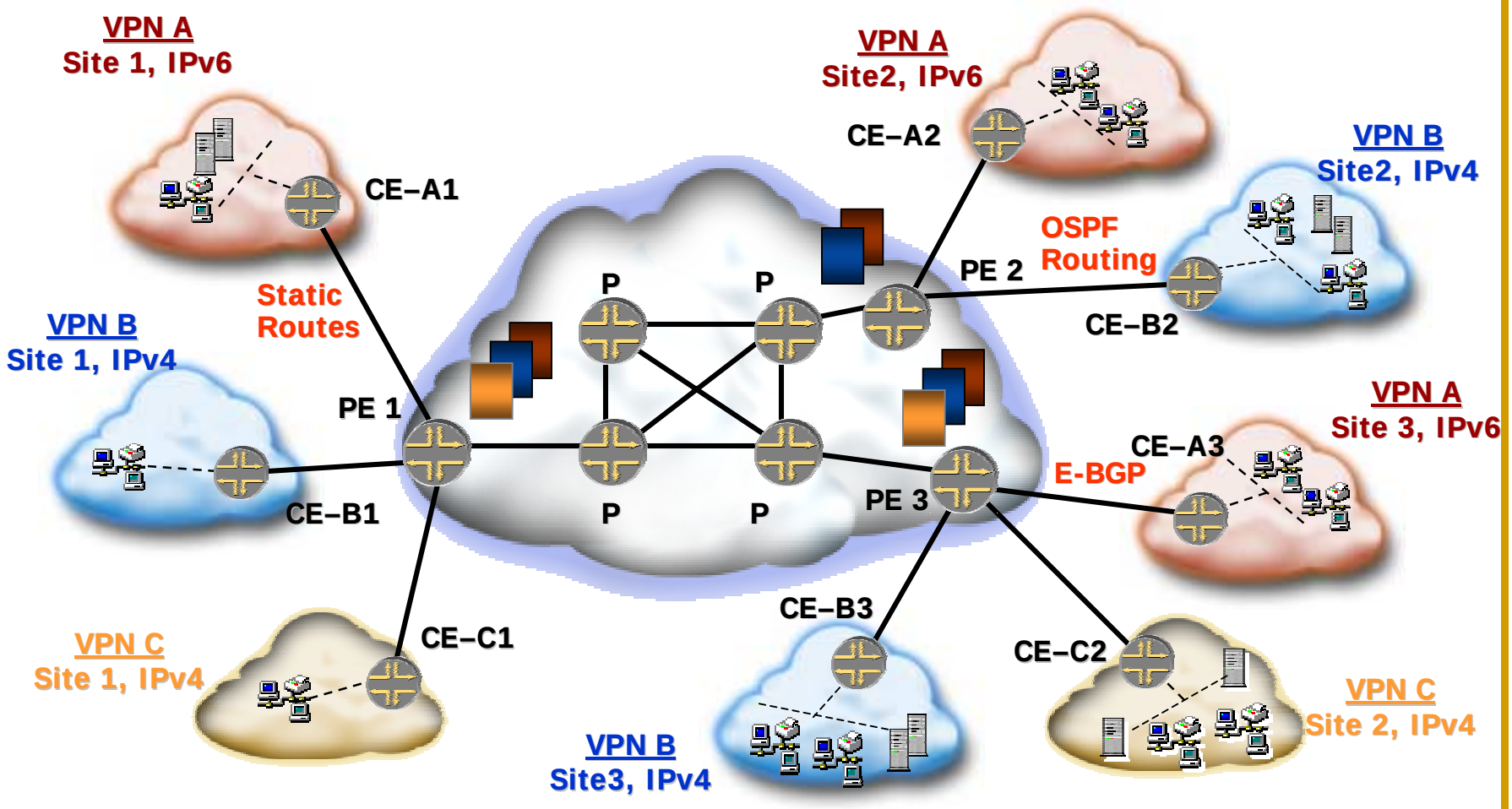
QoS

- IPv6 header includes traffic class and flow label
  - Traffic class function = DSCP
  - Largely undefined flow label identifies a traffic flow that needing special handling, I.e. voice, video, etc.
- IPv6 routers must be able to use traffic class and flow label without incurring performance cost

VPNs

- VPNs are a valuable service
- Provider managed IPv4 VPN models have been succesful
- Established VPN technologies used for IPv4 must be carried over to IPv6
- Services offered as part of a VPN, I.e. QoS, will still be required for IPv6
- VPN management must be able to support IPv4 and IPv6 traffic

L3 VPN over MPLS



IPv6 Qualified Router for ISPs What means really Dual Stack?

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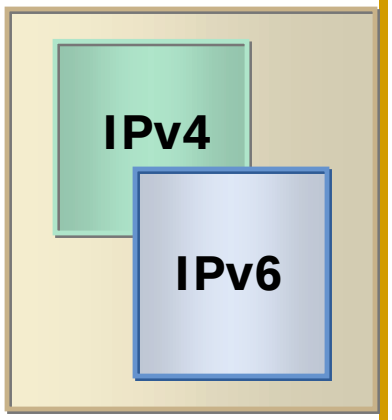
- **Operational Efficiency**



Network Management

- IPv6 Management must be integrated in existing management systems
- SNMP over v6 with IPv6 MIBs
- Intuitive CLI
- IPv6 Accounting
- APIs (e.g. XML) for OSS integration
  - Reduce latency between new vendor feature/service and OSS integration
  - Operational efficiency hinges on OSS integration
- Router operations over IPv6
  - telnet, ssh, ftp, ping, traceroute…

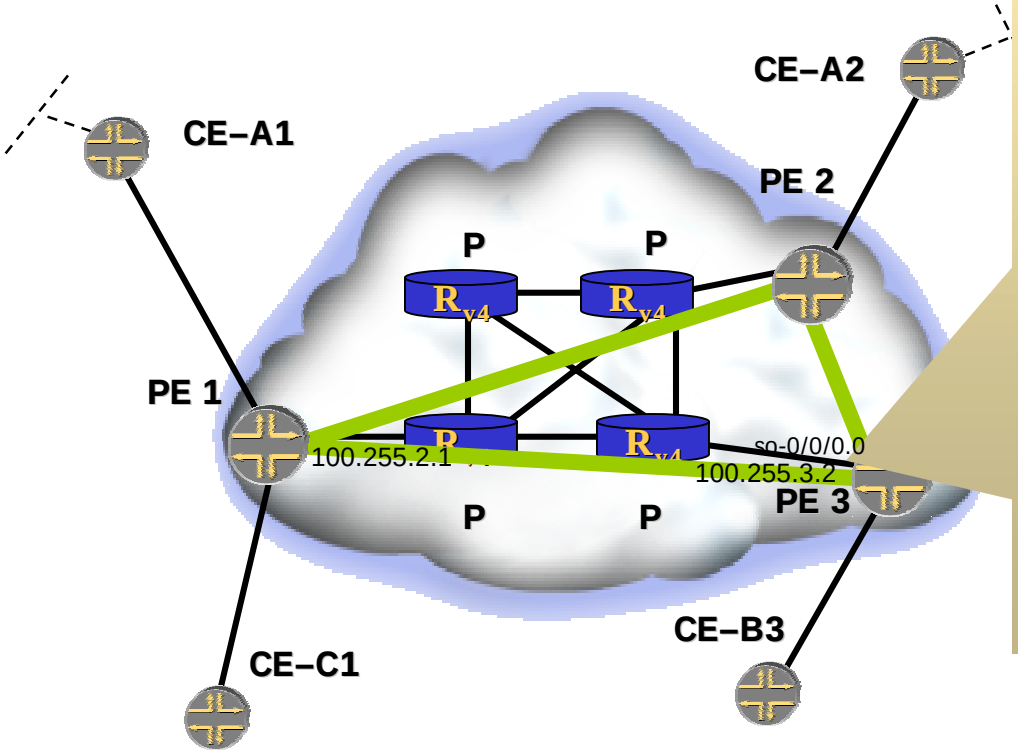
Robustness and Reliability

- Common support of features, services on every interface across all platforms
- Same approach for hardware-based packet handling as IPv4
  - Performance is critical
  - Maintaining SLA agreement for IPv4 while operating IPv6
- Separation of routing and control planes
- Graceful restart mechanisms
  - BGP, OSPF, IS-IS, RSVP, LDP…
- Linear software releases continuity to ensure common support and evolution

Integration of non IPv6 capable routers

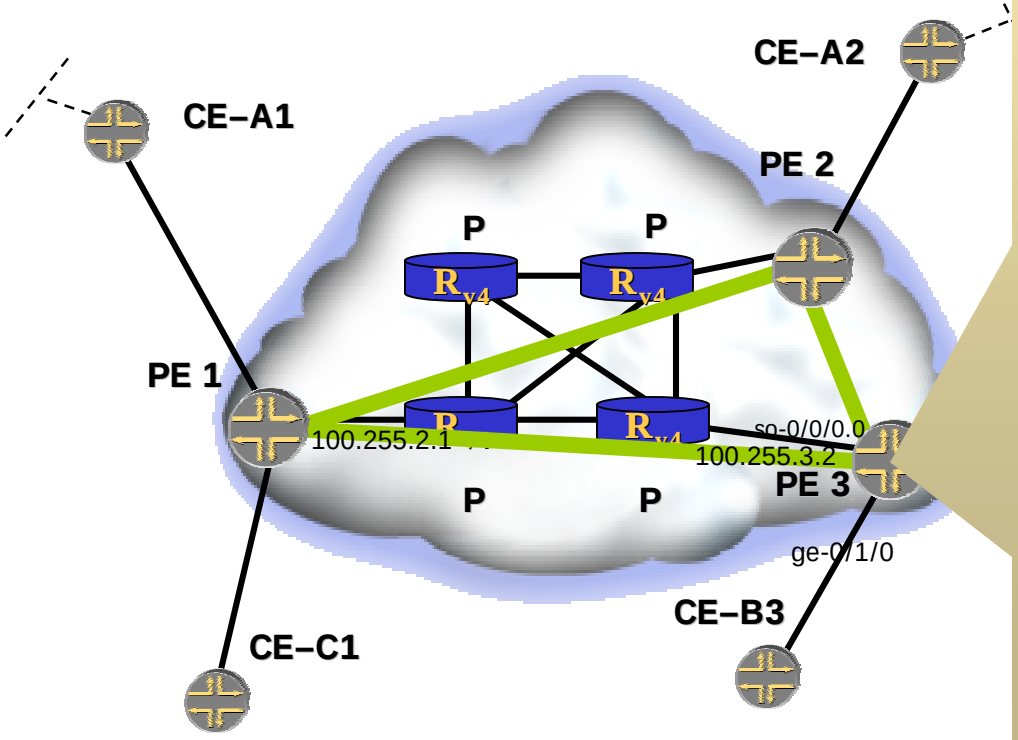
- IPv6 in IPv4 tunnels
  - GRE or IP-IP Tunnels
  - Only possible:
    - with performance (hardware tunneling)
    - at small scale for manageability
- Connecting IPv6 Islands with IPv4 MPLS
  - Requires MPLS capable routers in the core

IPv6 in IPv4 tunnels



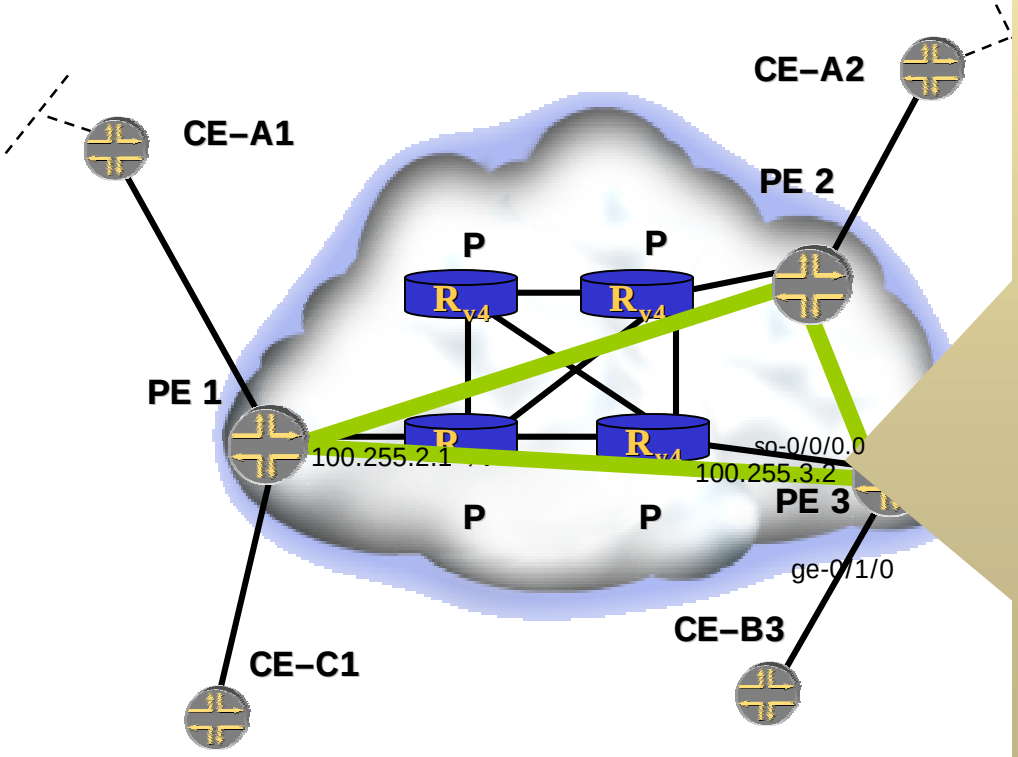

```
interfaces {
 so-0/0/0 {
  unit 0 {
   family inet {
    address 100.255.3.2/24;
   }
  }
 }
 gr-1/0/0 {
  unit 0 {
   tunnel {
    source 100.255.3.2;
    destination 100.255.2.1;
   }
   family inet6 {
    address 9009:6::2/64;
   }
  }
 }
}
```

Connecting IPv6 Islands with IPv4 MPLS (1)



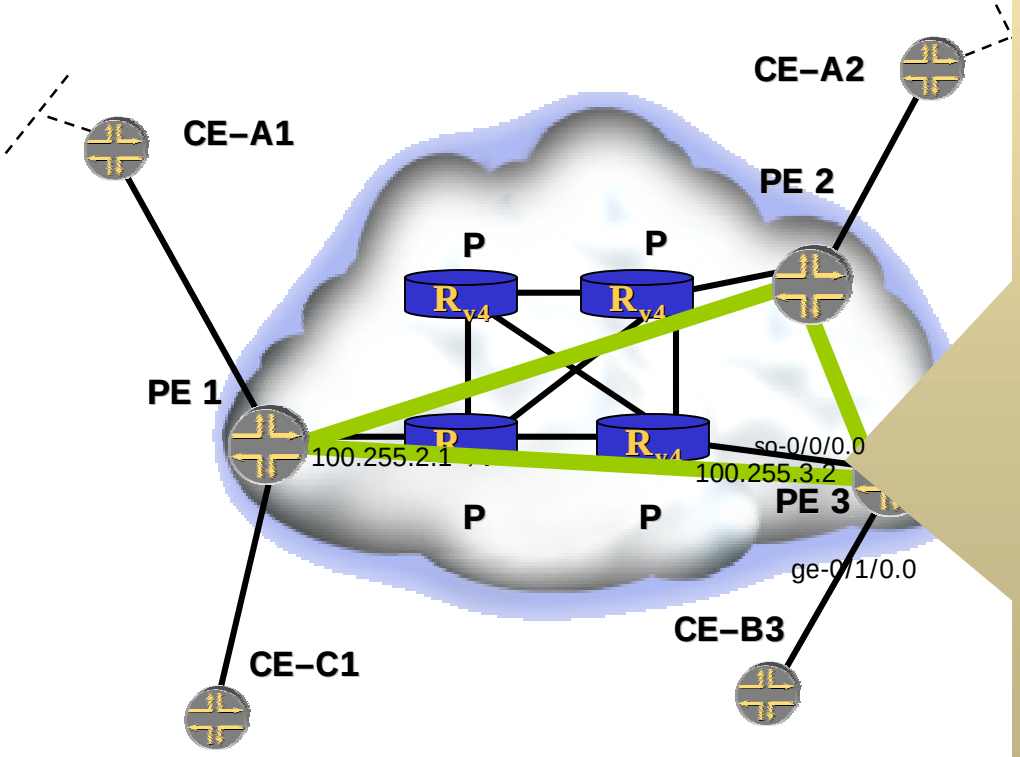

```
interfaces {
 so-0/0/0 {
  unit 0 {
   family inet {
    address 100.255.3.2/24;
   }
   family inet6;
   family mpls;
  }
 }
 ge-0/1/0
  unit 0 {
   family inet6 {
    address 8002::1/126;
   }
  }
 }
 lo0 {
  unit 0 {
   family inet {
    address 10.245.71.6/32;
   }
   family mpls;
  }
 }
}
routing-options {
 autonomous-system 100;
}
```

Connecting IPv6 Islands with IPv4 MPLS (2)




```
protocols {
 rsvp {
  interface so-0/0/0.0;
 }
 mpls {
  ipv6-tunneling;
  label-switched-path to_PE1 {
   to 10.245.72.6;
  }
  interface so-0/0/0.0;
 }
 bgp {
  group to_PE1 {
   type internal;
   local-address 10.245.71.6;
   family inet6 {
    labeled-unicast {
     explicit-null;
    }
   }
   export red-export;
   neighbor 10.245.72.6;
  }
 }
 ospf {
  traffic-engineering;
  area 0.0.0.0 {
   interface so-0/0/0.0;
   interface lo0.0 {
    passive;
   }
  }
 }
```

Connecting IPv6 Islands with IPv4 MPLS (3)




```
# protocols (next)

 ripng {
  group to_CE-B3 {
   export red-import;
   neighbor ge-0/1/0.0;
  }
 }
}

policy-options {
 policy-statement red-export {
  term 1 {
   from protocol ripng;
   then accept;
  }
  term 2 {
   then reject;
  }
 }
 policy-statement red-import {
  from protocol bgp;
  then accept;
 }
}
```

Conclusion

- The transition from IPv4 to IPv6 will be gradual
- ISPs can integrate IPv6 at a reasonable cost by leveraging existing investment for a seamless integration
  - Production-caliber IPv6
  - Internet-scale
  - Fully-featured IPv6
  - Genuinely-deployable IPv6
- IPv6 qualified routers must support solutions to by-pass potential non IPv6 capable routers
- IPv6 education and training will be determinant to develop a business strategy

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Thank you!

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