Routing & Servizi IPv6 a valore aggiunto a wire-rate: visione e roadmap

Febbraio ‘03

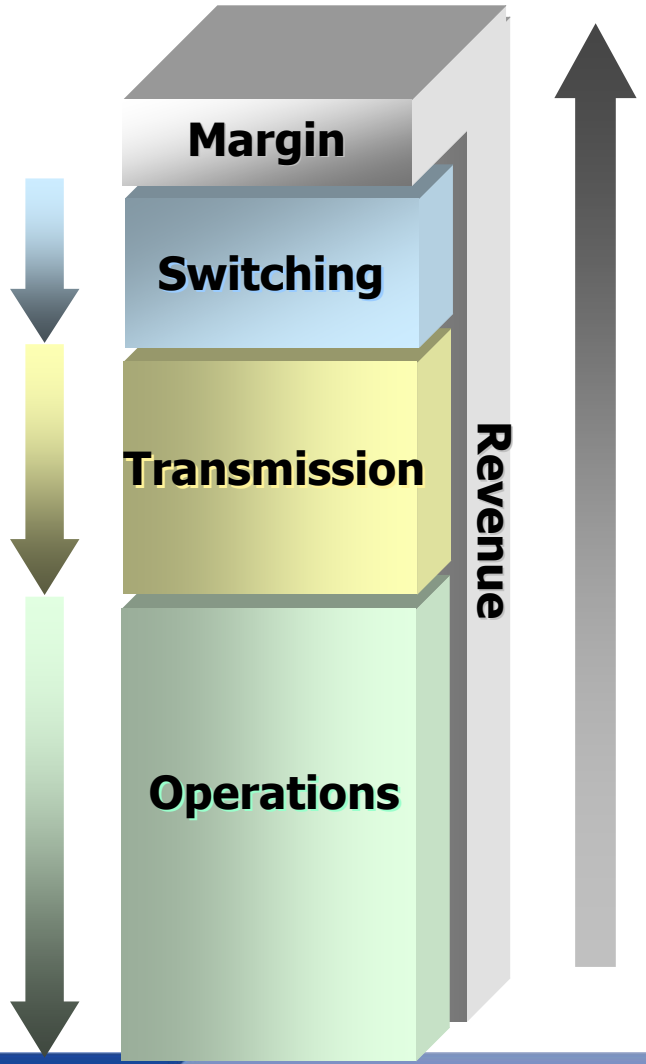
Juniper™ NETWORKS

Agenda

- Introduction
- IPv6 Implementation
- Case Studies
- Summary

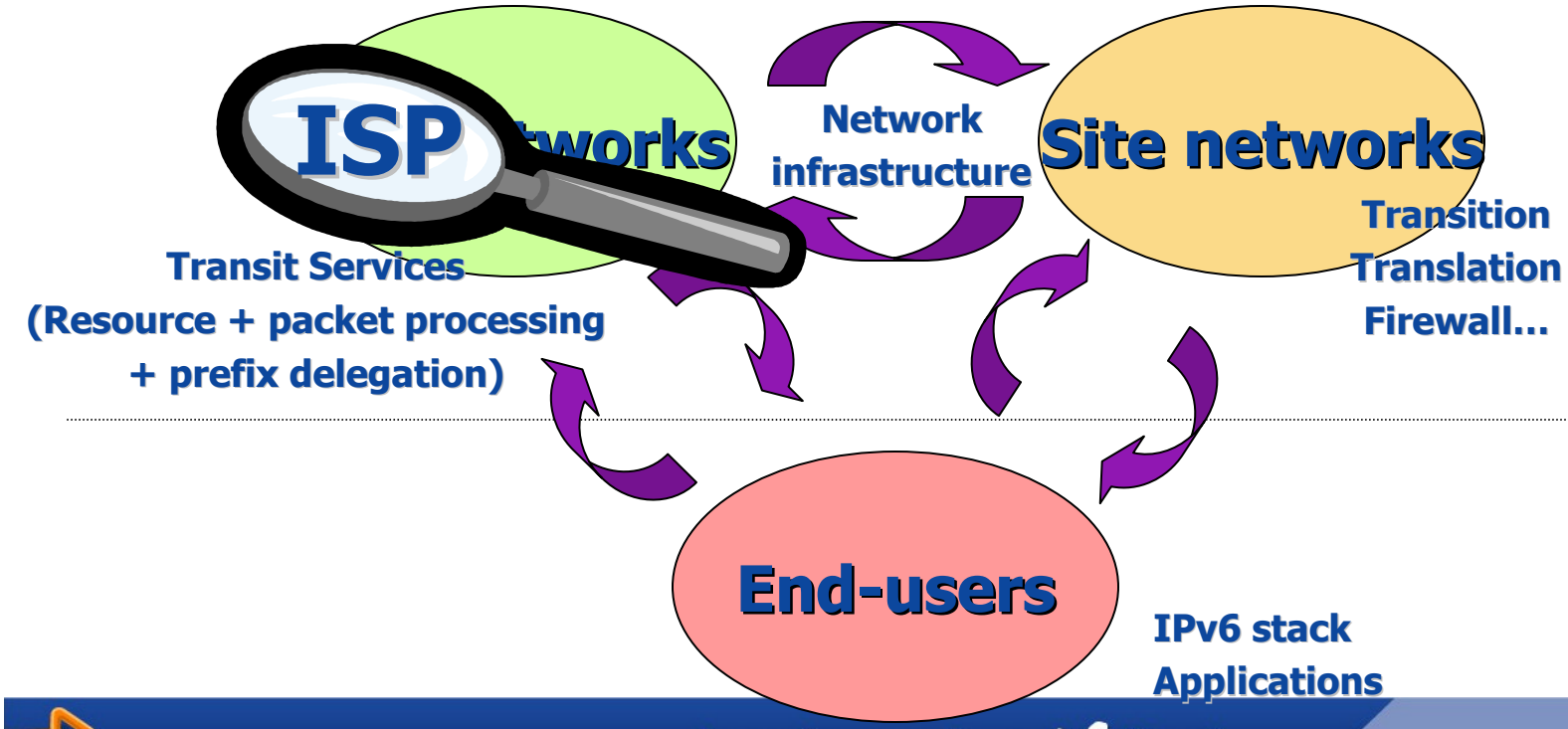
ISP general concerns

- **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) …



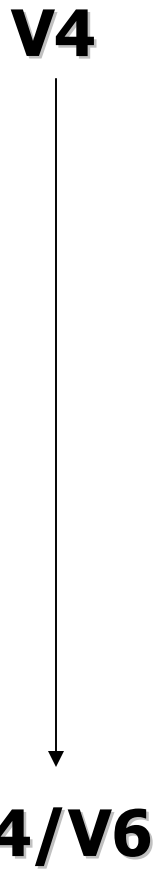
Integrating IPv6 in ISP networks

- **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**

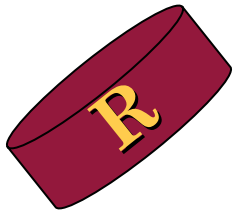
IPv6 integration process

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

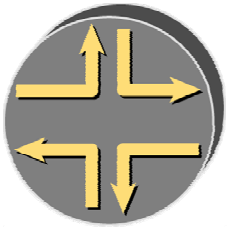


IPv6 routers Taxonomy

IPv6 non upgradeable router



IPv6 upgradeable router



IPv6 qualified router

Will run IPv4 only, maybe MPLS

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

Justification generally linked to short term revenues …

Ready

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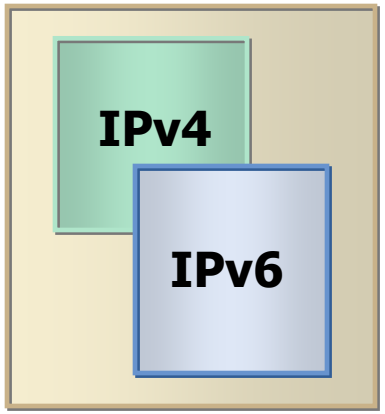
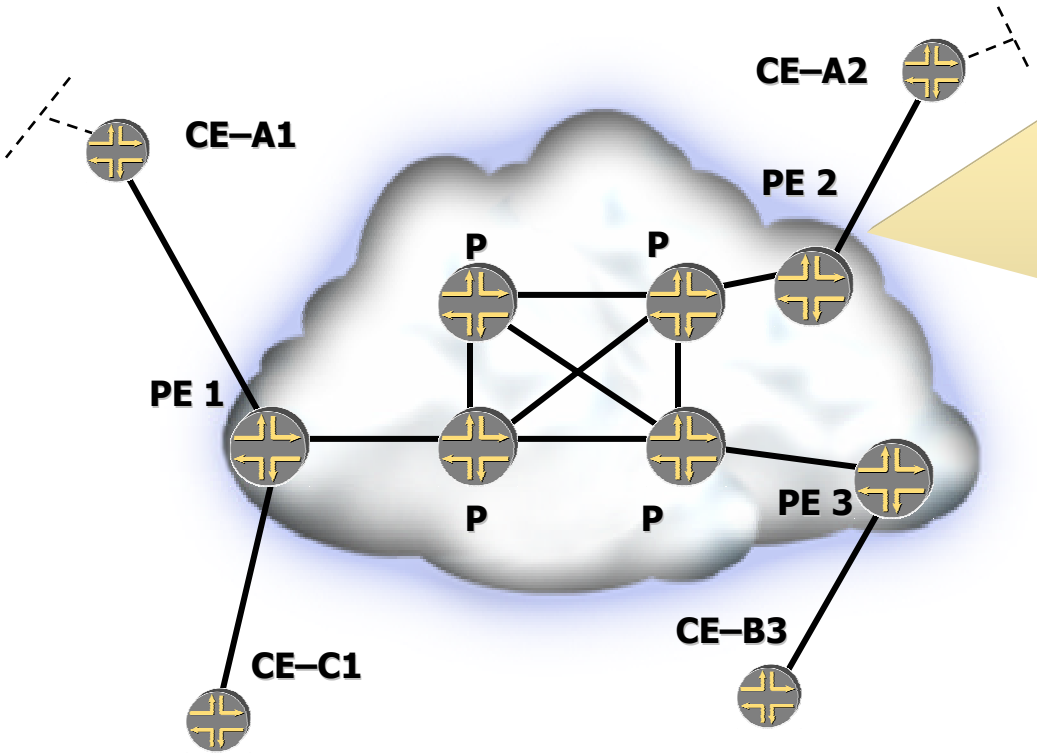
IPv6 Qualified Router
What means really Dual Stack?

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



IPv6 Addressing

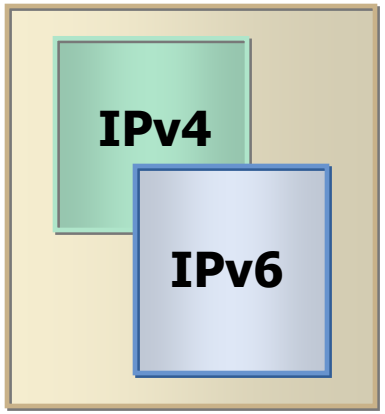
- Dual IP addressing on the same interface
- Neighbor discovery
- ICMPv6




```
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

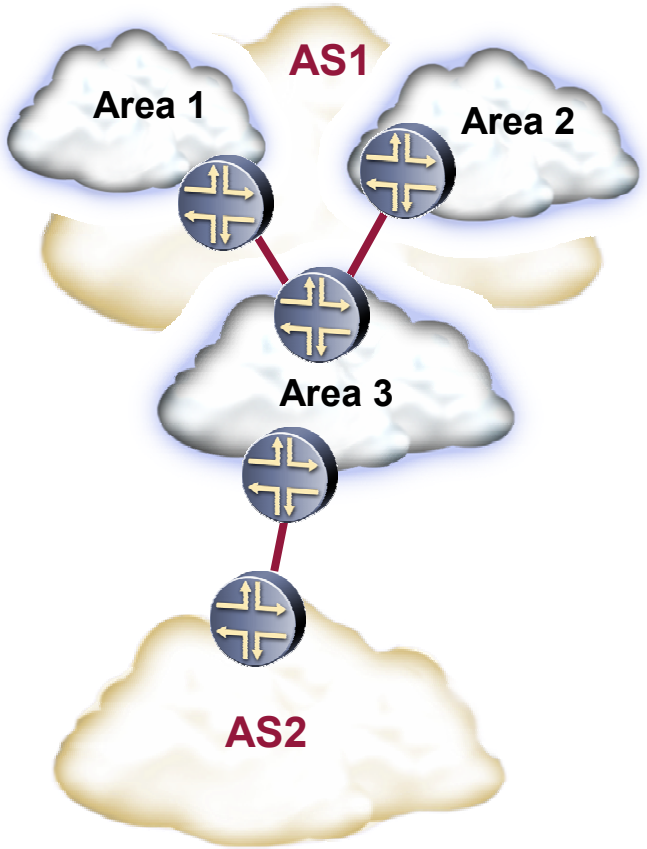


Routing Protocols

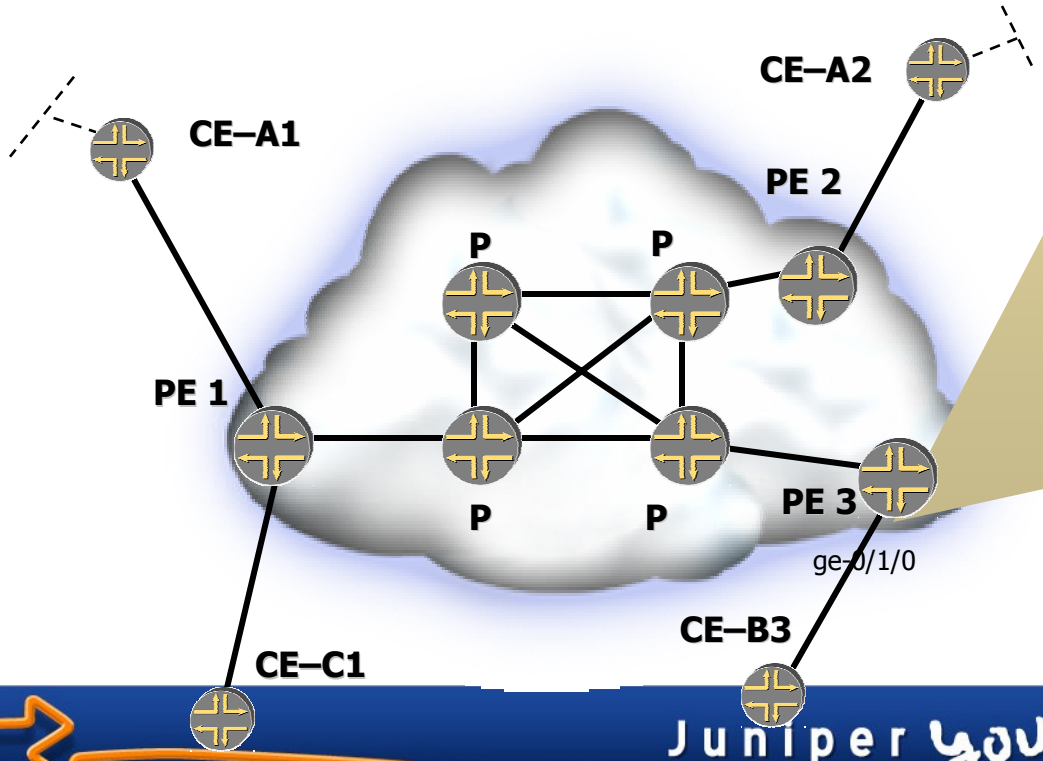
- Static routing
- IGP
  - IPv6 unicast can be routed by RIPng, OSPFv3, or ISIS
  - Current ISIS backbone don't need IGP upgrade
  - Current OSPF backbone need to:
    - Migrate to IS-IS
    - Or add/deploy OSPFv3
- BGP-MP
  - Just add the IPv6 routing in existing M-BGP set-up
  - Can use same design
  - Can be set-up over v4 or v6
    - Just add v6 routing over BGP/v4 sessions (next-hop!)
    - Use BGP over v6 in case of IPv6 deployment in IPv4 tunnels
  - Separating BGP sessions for v4 and v6 may also have some advantages
    - Monitoring, flexibility…

OSPFv3

- Major changes to accommodate:
  - Address size
  - General protocol semantics
- Addressing semantics removed from OSPF packets and LSAs
  - New LSAs for IPv6 addresses & prefixes
  - OSPF runs on per-link, not per-subnet
  - Flooding scope for LSAs generalized
  - Authentication removed
- Benefits
  - Other functions remain the same (e.g. SPF calculation, area support, etc.)
  - Familiarity - widely deployed IGP



External M-BGP example



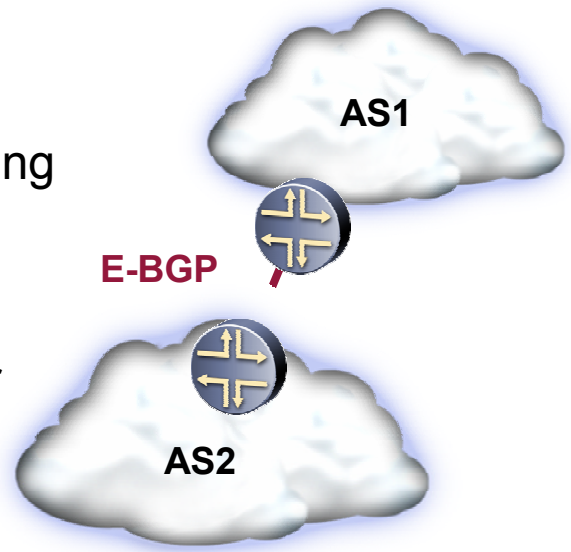

```
interfaces {
 ge-0/1/0 {
  unit 0 {
   family inet {
    address 11.19.1.2/24;
   }
   family inet6 {
    address ::11.19.1.2/126;
   }
  }
 }
}

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;
  }
 }
}
```

E-BGP Peering over IPv6 Link Local Addresses

- E-BGP Peering over IPv6 LLA
  - BGP4+ Peering Using IPv6 Link-local Address
  - draft-kato-bgp-ipv6-link-local-00.txt
  - Allows use of link-local address for direct peering connections instead of using global addresses
- How it works
  - Link local addresses can be auto-generated or manually configured
- Benefits
  - Simpler administration
  - Flexibility
    - NSPIXP6 uses link local address

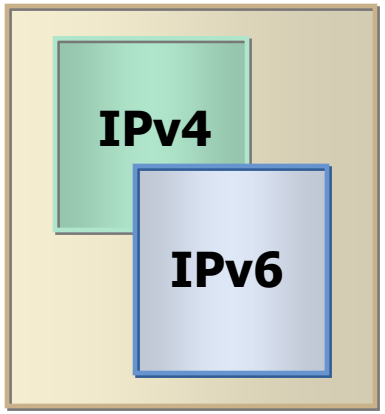


Multicast Routing

- 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

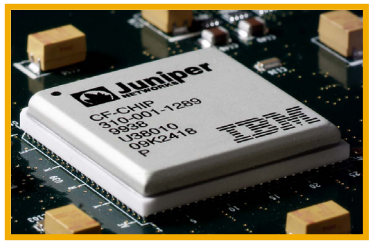


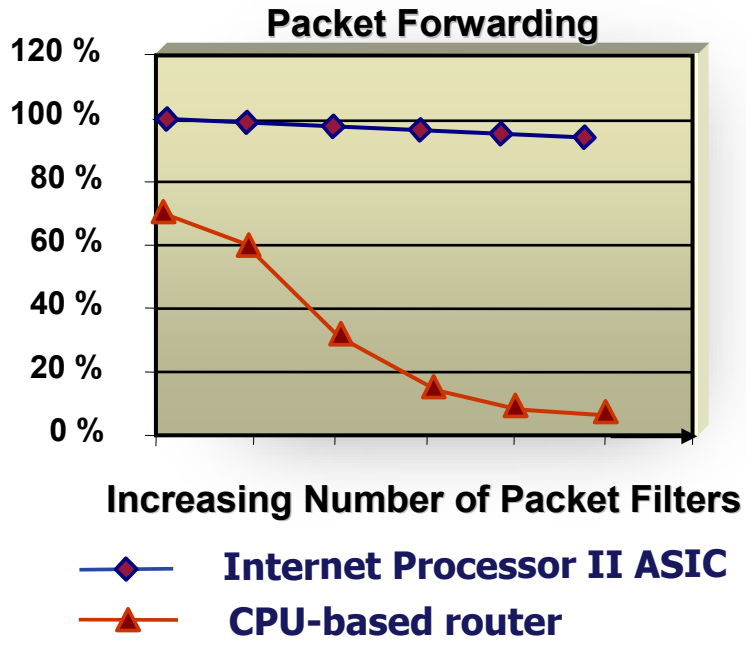
IP Services

- 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

IP2 Services
Filtering & Policing

- Packet filtering
  - DoS attack prevention
  - Comprehensive security
  - E.g. Source Address Filters
- Policing
  - Interface-level rate limiting
  - E.g. Bandwidth - limits bps
  - E.g. Maximum burst size
- Predictable performance with rich IPv6 services





IPv6 Filtering

- IP-II enables significant functionality with applications to network management
  - Security
  - Monitoring
  - Accounting

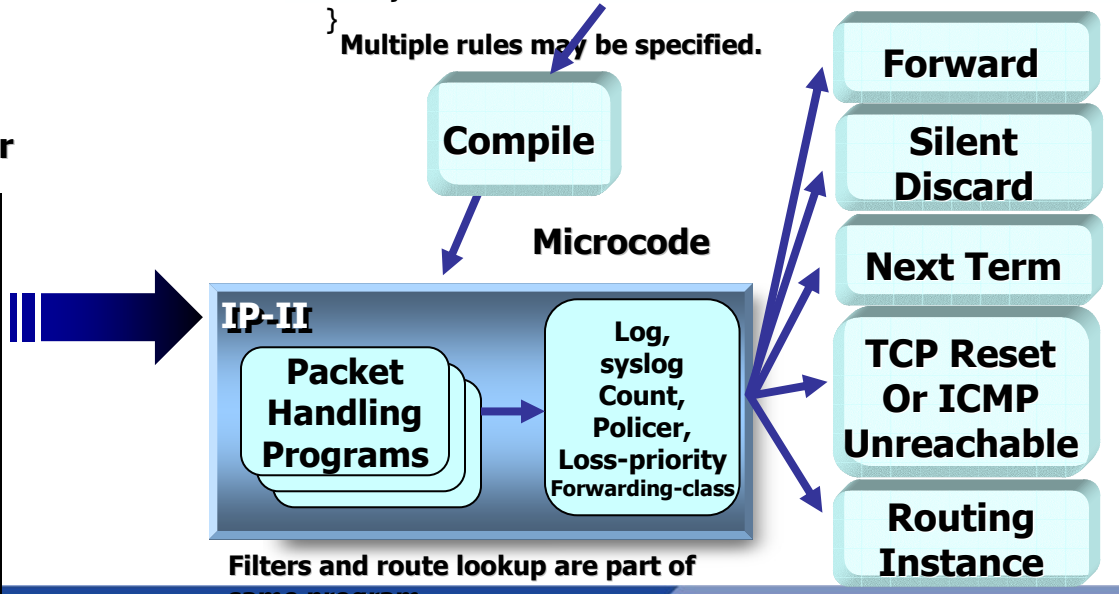
Filter Specification

```
filter Limit-Customer-A {
    policer Lim {
        if-exceeding {
            bandwidth-limit 1m;
            burst-size-limit 100k;
        }
        then discard;
    }
    term 1 {
        from {
            source-address {
                3ffe:1002:6411::/48;
            }
        }
        then {
            policer Lim;
            accept;
        }
    }
}
```

Multiple rules may be specified.

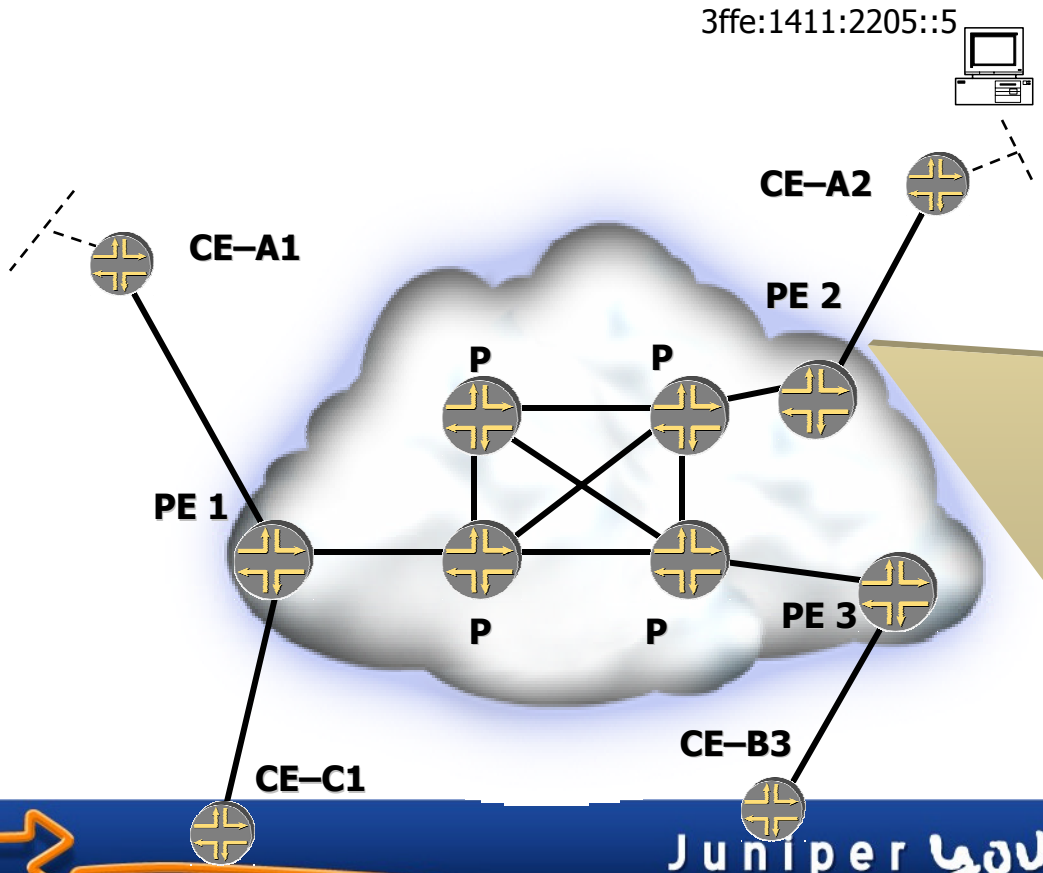
All IPv6 Packets Handled By Router

- IPv6 source address field
- IPv6 destination address field
- TCP/UDP source port field
- TCP/UDP destination port field
- Next header field
- Traffic class field
- Packet length
- ICMP packet type and code
- Source-class
- Destination-class



Filters and route lookup are part of same program

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
- Filter Based Forwarding
- SNMPv3 improves router authentication

Source Address Verification

- uRPF can be configured per-interface/sub-interface
- Supports both IPv4 and IPv6
- Packet/Byte counters for traffic failing the uRPF check
- Additional filtering available for traffic failing check:
  - police/reject
  - Can syslog the rejected traffic for later analysis
- Two modes available:
  - Active-paths:
    - uRPF only considers the best path toward a particular destination
  - Feasible-paths:
    - uRPF considers all the feasible paths. This is used where routing is asymmetrical.

QoS

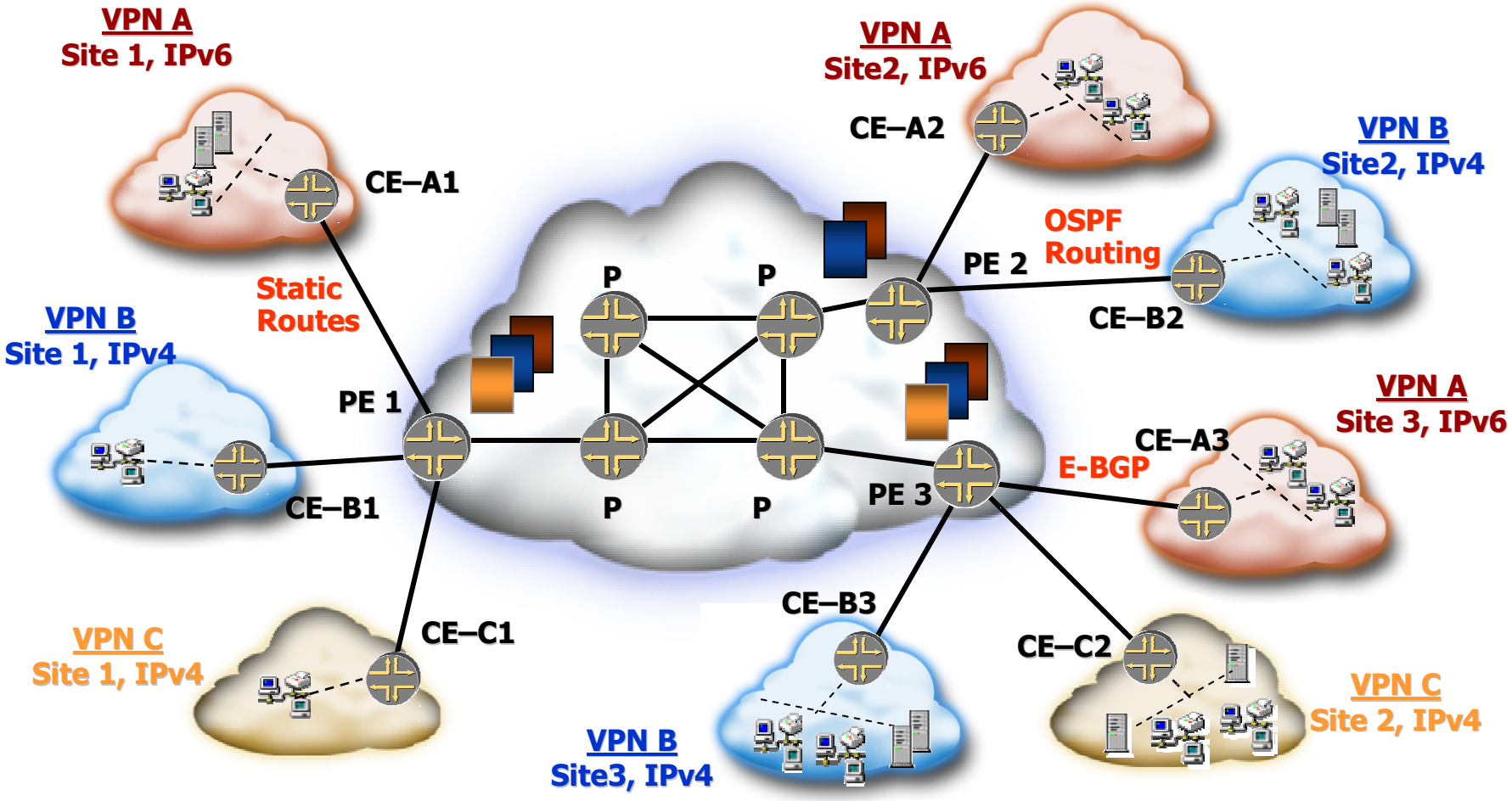
- IPv6 header includes traffic class and flow label
  - Traffic class function = DSCP
  - Largely undefined flow label identifies a traffic flow that needing special handling, I.e. voice, video, etc.
- IPv6 routers must be able to use traffic class and flow label without incurring performance cost
-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

VPNs

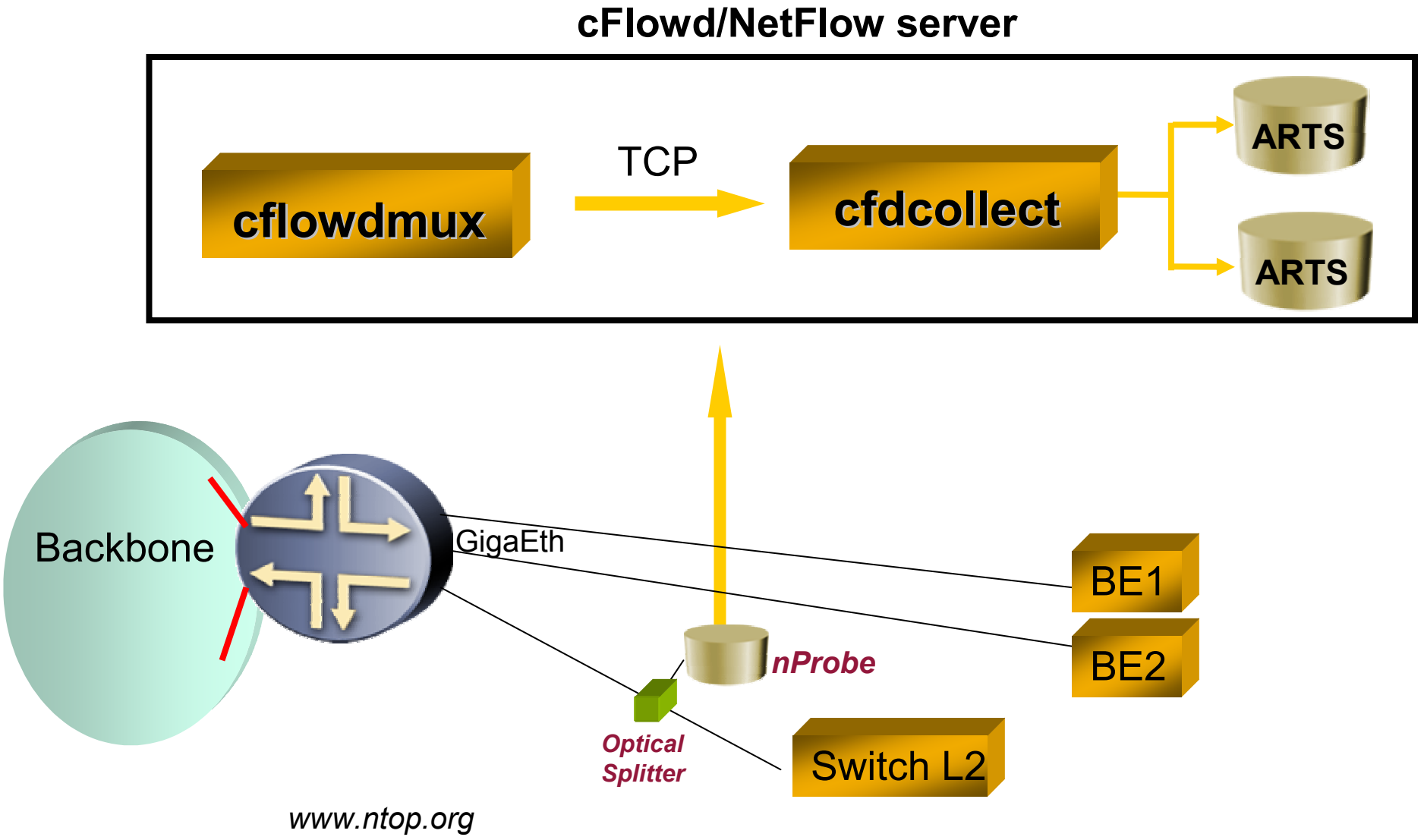
- VPNs are a valuable service
- Provider managed IPv4 VPN models have been successful
- Established VPN technologies used for IPv4 must be carried over to IPv6
- Services offered as part of a VPN, I.e. QoS, will still be required for IPv6
- VPN management must be able to support IPv4 and IPv6 traffic

L3 VPN over MPLS (a la 2547bis)

draft-ietf-ppvpn-bgp-ipv6-vpn



NetFlow v9



www.ntop.org

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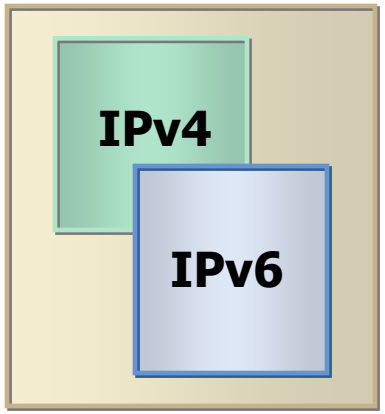


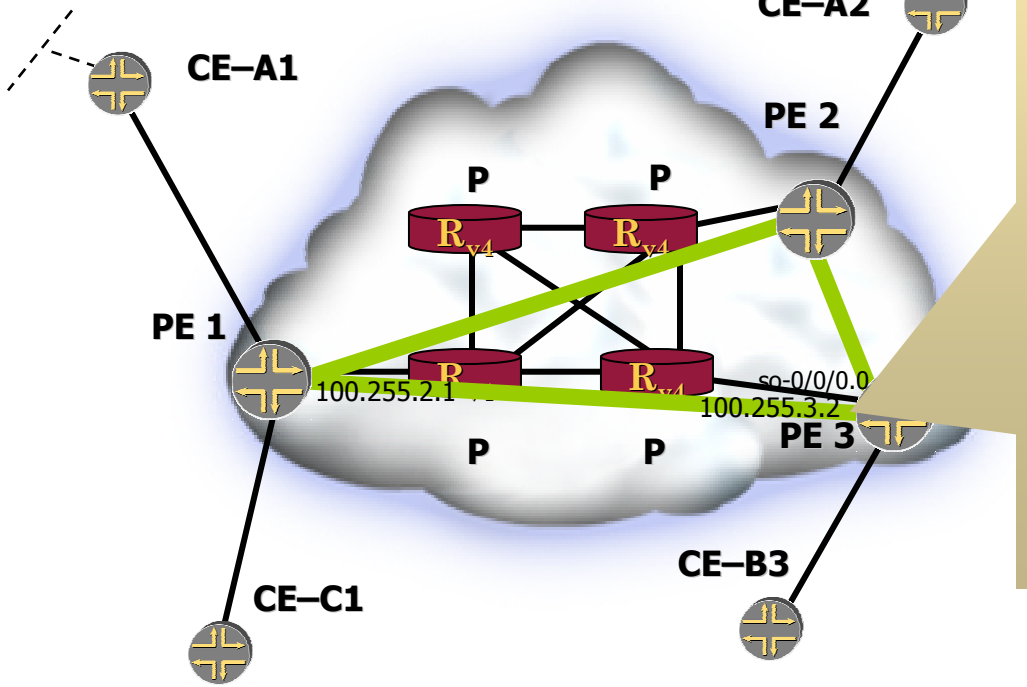
Network Management

- 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…

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

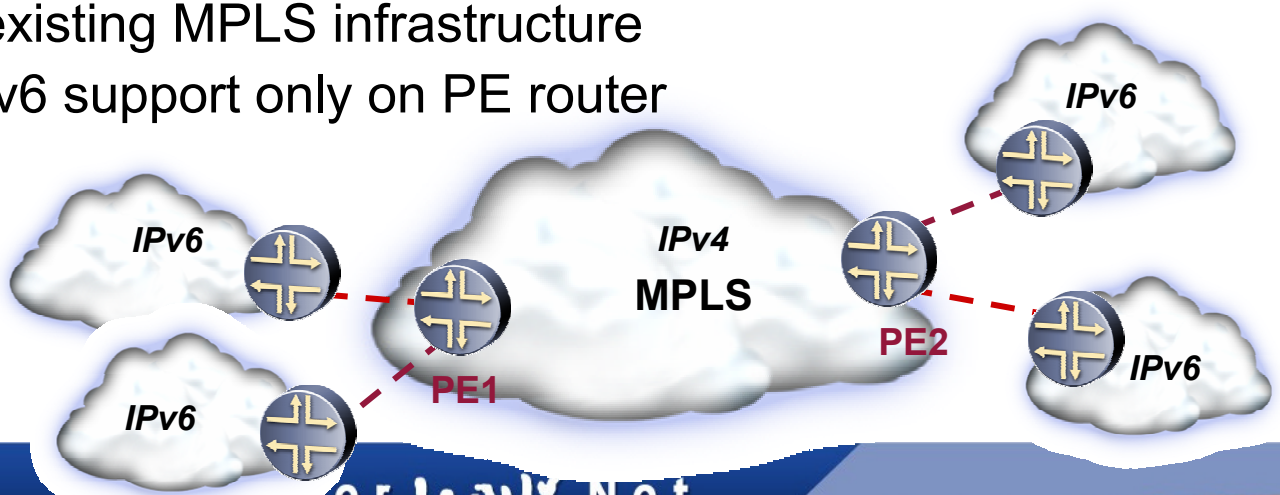
IPv6 in IPv4 tunnels




```
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)

- IETF Draft as defined in draft-ietf-ngtrans-bgp-tunnel-04.txt
  - Connecting IPv6 Islands across IPv4 Clouds with BGP
  - Also known as “6PE”
- PEs run Dual Stack MP-BGP over IPv4
  - PE and CE exchanges IPv6 routes
  - MPLS LDP/RSVP LSPs are set up using IPv4
- Benefits
  - Leverages existing MPLS infrastructure
  - Requires IPv6 support only on PE router



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Juniper Networks IPv6 deployment in R&E and ISP Networks

References PR
IPv6 mentioned in all last PRs … does it mean something ???

Internet2 Gigapops: http://www.juniper.net/news/pressreleases/2002/pr-021111.html

GEANT IPv6 Test Program: http://www.juniper.net/news/pressreleases/2001/pr-011128.html

ESNET / 6TAP at PAIX: http://www.juniper.net/news/pressreleases/2001/pr-011128.html

France Telecom / VTHD: http://www.juniper.net/news/pressreleases/2001/pr-011128.html

CSC / FUNET: http://www.juniper.net/news/pressreleases/2002/pr-020507.html

Internet2 / Abilene: http://archives.internet2.edu/guest/archives/I2-NEWS/log200204/msg00003.html

Canarie / CA*net 4: http://www.juniper.net/news/pressreleases/2002/pr-020710.html

ESNET: http://www.juniper.net/news/pressreleases/2002/pr-020828.html

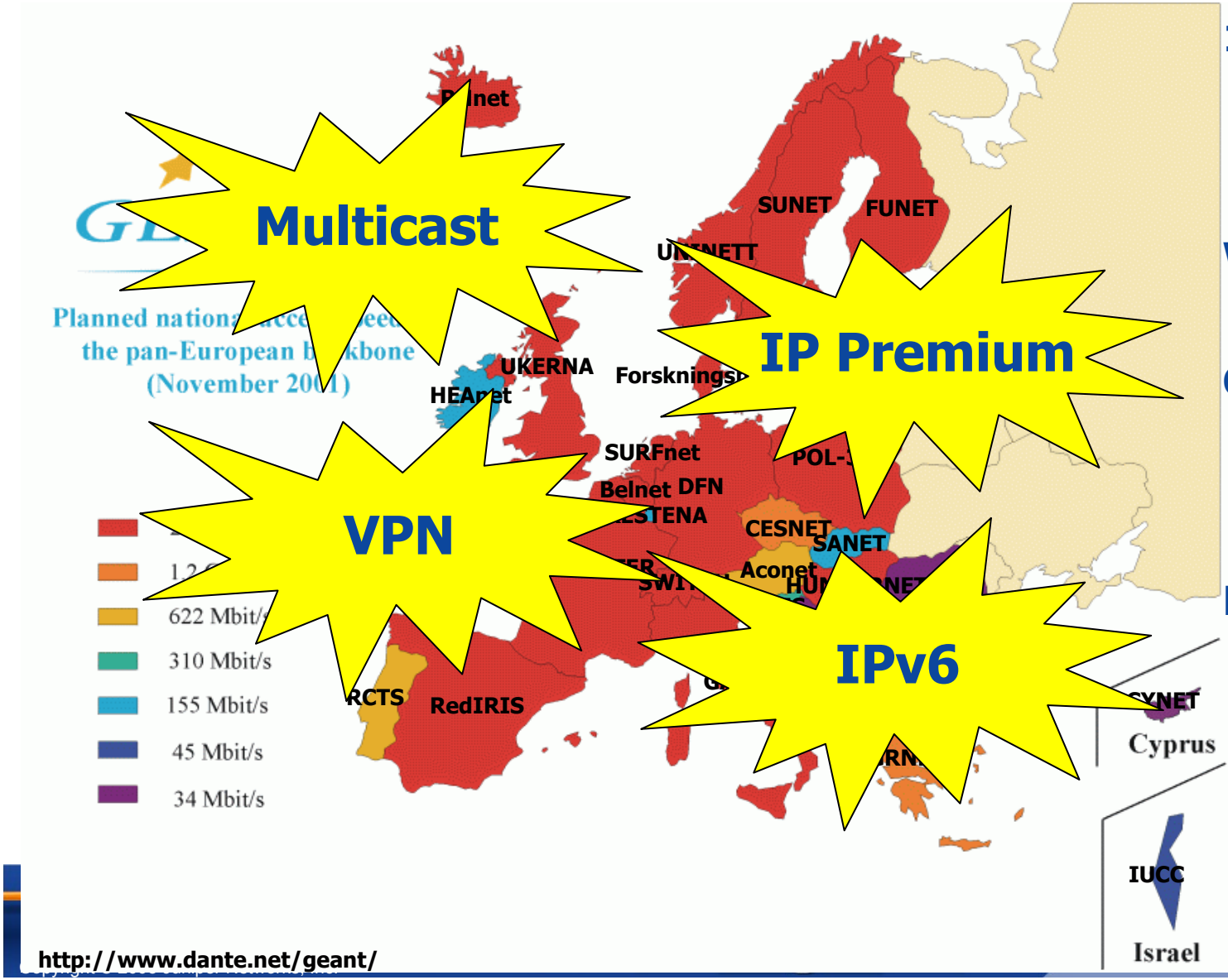
ARNES, DANTE, and REDiris:
http://www.juniper.net/news/pressreleases/2002/pr-021003.html
http://archives.internet2.edu:8080/guest/archives/I2-NEWS/log200210/msg00005.html

Japan Gigabit Network: http://www.juniper.net/news/pressreleases/2002/pr-021112.html

Chunghwa Telecom HiNet: http://www.juniper.net/news/pressreleases/2003/pr-030114.html

NTT Communications: http://www.juniper.net/company/presscenter/pr/2003/pr-030218a.html

Pan-European Research Networking



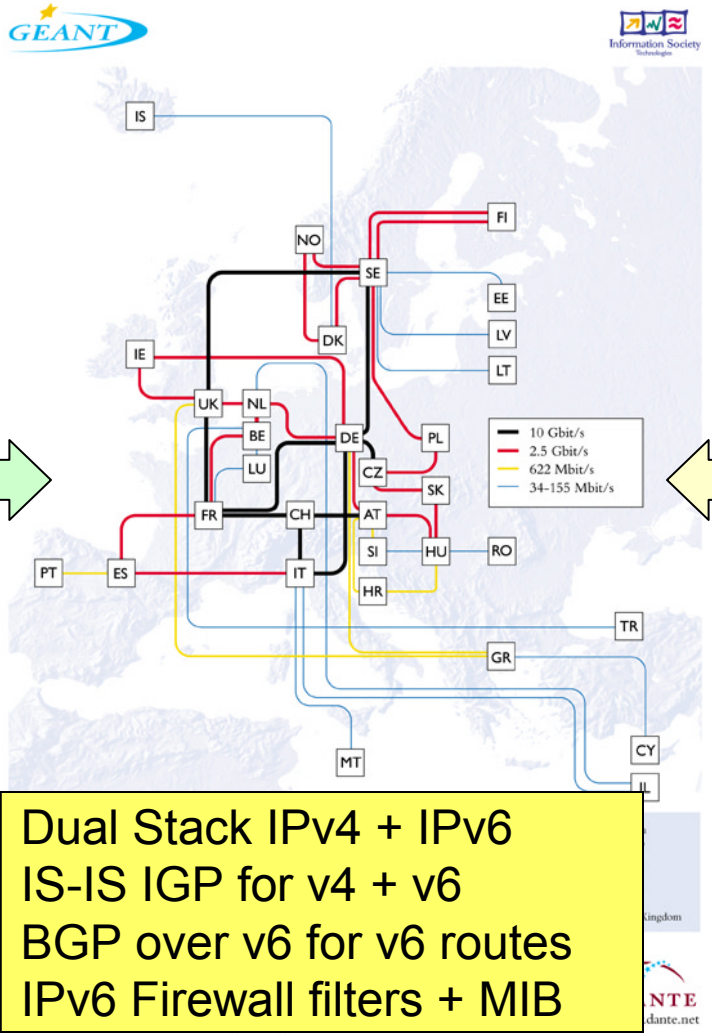
- 10 Gb/s backbone with Juniper M160s
- WDM optical technology
- Connecting 32 European countries and 28 NRENs
- European connectivity to over 3000 R&E institutions

http://www.dante.net/geant/

GEANT IPv6 Service

Native IPv6 Connections

REDIRIS (ES)
Renater (FR)
Surfnet (NL)
GARR (IT)
HEANET (IE)
PSCN (PL)
EENET (EE)
Roedunet (RO)
Abilene (US)



Dual Stack IPv4 + IPv6
IS-IS IGP for v4 + v6
BGP over v6 for v6 routes
IPv6 Firewall filters + MIB

Tunneled IPv6 Connections

IUCC (IL)
Litnet (LT)
Janet (UK)
Switch (CH)
Aconet (AT)
Telia

Other Interoperability Tests

- IPv6 Core Router Test Report by BII Group
  - Basic IPv6 protocols(ICMPv6…), RIPng, BGP4+, OSPFv3, Performances (OC-48)
  - Juniper Networks, Fujitsu, Hitachi, NEC
  - http://downloads.lightreading.com/2003/02/28758_IPv6_v1-4.pdf
- Case Studies

IPv6 Commercial Services

- NTT

offering IPv6 both within their network and transit to the IPv6 exchanges like AMS, 6TAP, NSPIXP-6, NY6IX etc.

- Powered COM

IPv6 Native and IPv6 over IPv6 Tunnel Service.

- KDDI

IPv6 over IPv4 Tunnel Service.

-Japan Telecom

IPv6 over IPv4 Tunnel Service.

-Nifty

IPv6 over IPv4 Tunnel Service.

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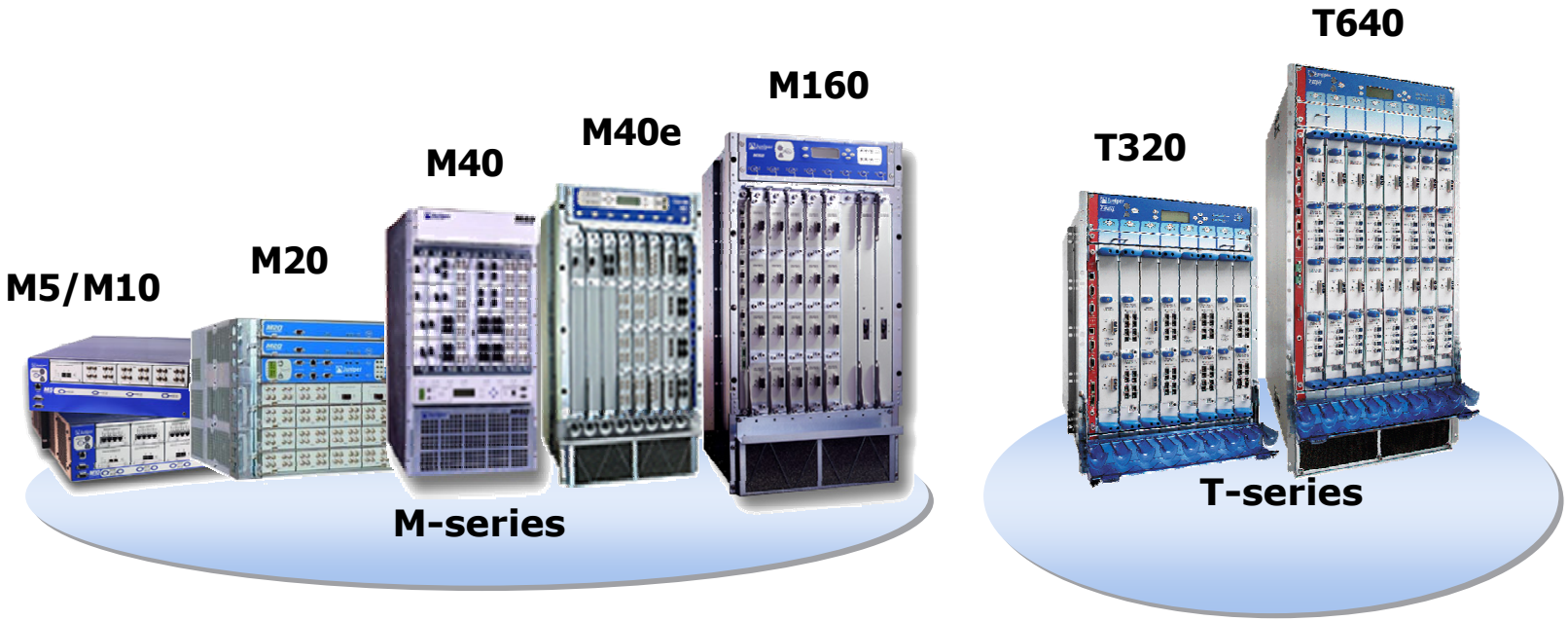
IPv6 Implementation



IPv6 Support Across All Platforms, All Interfaces. Same JUNOS.

IPv6 Available Features

- Available on all M-series and T-series platforms

Addressing & Forwarding

- Forwarding in hardware
- Addressing
  - Link, site, global
  - Stateless autoconfiguration
- Neighbor discovery
- IPv6 Packet Filtering
- EUI 64 Autogeneration
- Unicast RPF
- FBF and CBF for IPv6
- Destination/Source Class Usage

Routing Protocols

- IS-IS
- OSPFv3
- MP-BGP over v4/v6
- RIPng
- Static
- IPv6 VPN (RFC2547bis)
- PIM v2
- MLD

Operations & Transition

- Common support
- ICMPv6
- SNMP over v6 + MIBs
- IP applications
  - Ping, telnet, ssh, ftp…
- Transition
  - Configured tunnels
  - Dual stack
  - Transport IPv6 in MPLS

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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