IPv6 integration in operational networks

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Conference: Where are we with IPv6?
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Motivations for Deploying IPv6
Extending the reach of Internet

IPv4 limitation

Source: http://www.ripe.net
Motivations for Deploying IPv6
Extending the reach of Internet

IPv6 potential

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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

IPv6 non upgradeable router
- Runs IPv4 only, maybe MPLS
- 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
- Will run IPv4 only, maybe MPLS
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;
      }
    }
  }
}
```
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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

```plaintext
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
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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

Attack with Source address = 3ffe:1411:2205::5

uRPF

3ffe:1411:2205::/48 [BGP/170]
> via so-0/0/0/0.0

3ffe:1451:2305::/48

3ffe:1411:2205::/48 [BGP/170]
Real-time DDoS Identification

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 ffeee::10:255:73:2/128;
      - Accounting
        - Destination-class-usage;
    - 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

3ffe:1541:2305::12
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 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
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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 bypass potential non IPv6 capable routers
- IPv6 education and training will be determinant to develop a business strategy
Thank you!

http://www.juniper.net