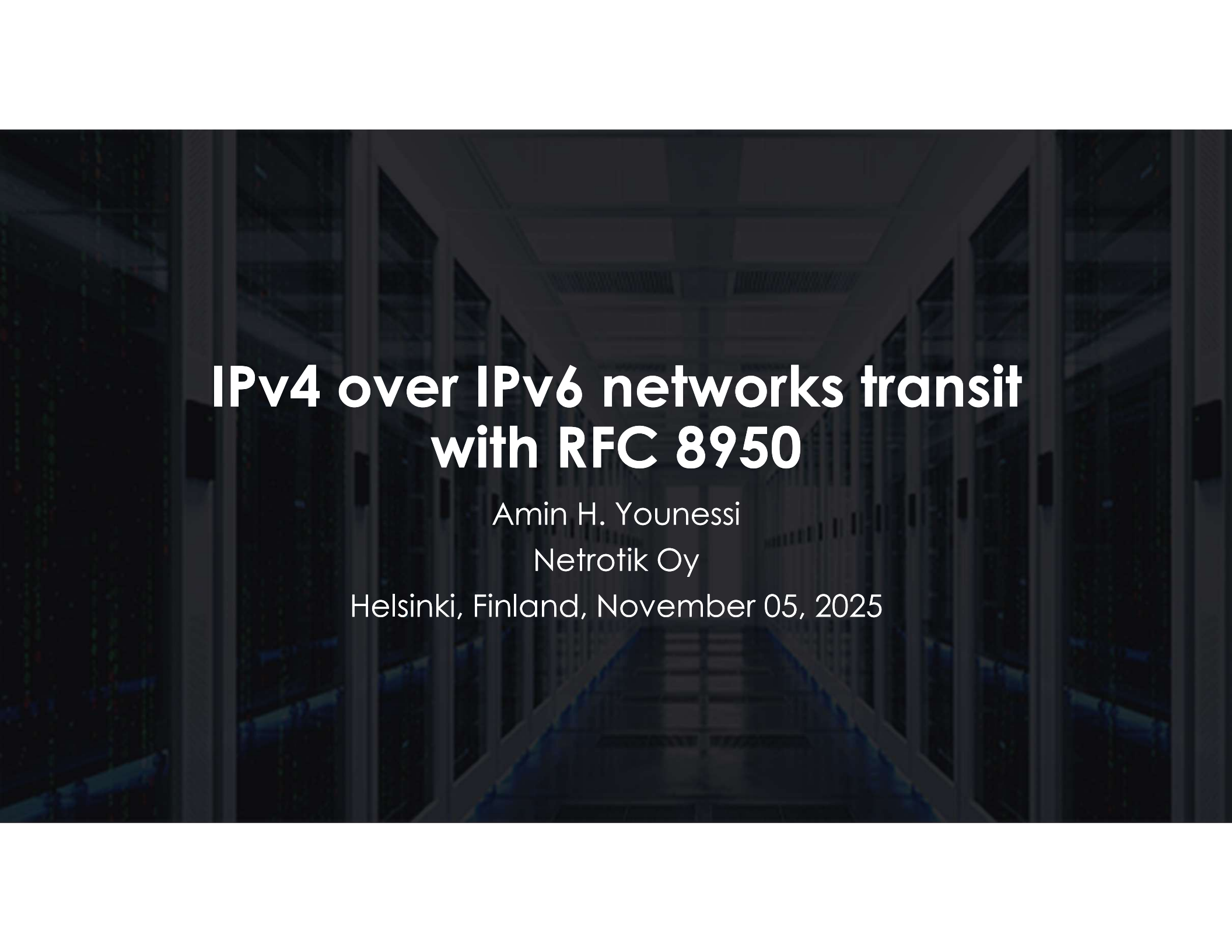




IPv4 over IPv6 networks transit with RFC 8950

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The IPv4 Challenge & a Modern Solution

Enabling IPv4 Services in an IPv6-only World with [RFC 8950](#)

1. The Problem: An IPv4-Constrained World

- IPv4 Address Exhaustion: We've run out of public IPv4 addresses. This is a critical issue for ISPs and enterprises trying to scale and connect new customers.
- The Transition to IPv6 is Essential: IPv6 offers a massive address space, but the world isn't fully IPv6-native yet. Many legacy services, websites, and clients still require IPv4.

2. The Old Solutions: Complex & Costly

- Dual-Stack: Running both IPv4 and IPv6 on every router and every link. This is operationally complex, doubles the management overhead, and consumes router resources.
- Complex Tunneling & NAT: Solutions like NAT444 or DS-Lite create multiple layers of complexity, introduce latency, and are difficult to troubleshoot.

The IPv4 Challenge & a Modern Solution

3. The Modern Solution: RFC 8950

- A Simple Idea: Use your high-speed, scalable IPv6 core network as the transport for your IPv4 traffic.
- How it Works: BGP is used to advertise IPv4 routes, but the next-hop address is an IPv6 address. This allows IPv4 packets to traverse your IPv6-only core without any complex tunneling.
- Key Benefits:
 - Operational Simplicity: Run a single, clean IPv6-only core. No more dual-stack complexity.
 - Reduced Overhead: Less protocol management, fewer configurations.
 - Scalability: Future-proof your network by moving towards a pure IPv6 environment while still serving IPv4 customers.

The Magic behind RFC8950

1. The Core Concept: MP-BGP in Action

- RFC 8950 isn't a new protocol; it's a new way to use an existing one: **Multiprotocol BGP (MP-BGP)**.
- MP-BGP allows BGP to carry routing information for protocols other than IPv4, such as IPv6 or even VPN routes.
- RFC 8950 specifically defines how to advertise **IPv4** routing information using an **IPv6** next-hop.

The Magic behind RFC8950

2. How it Changes BGP

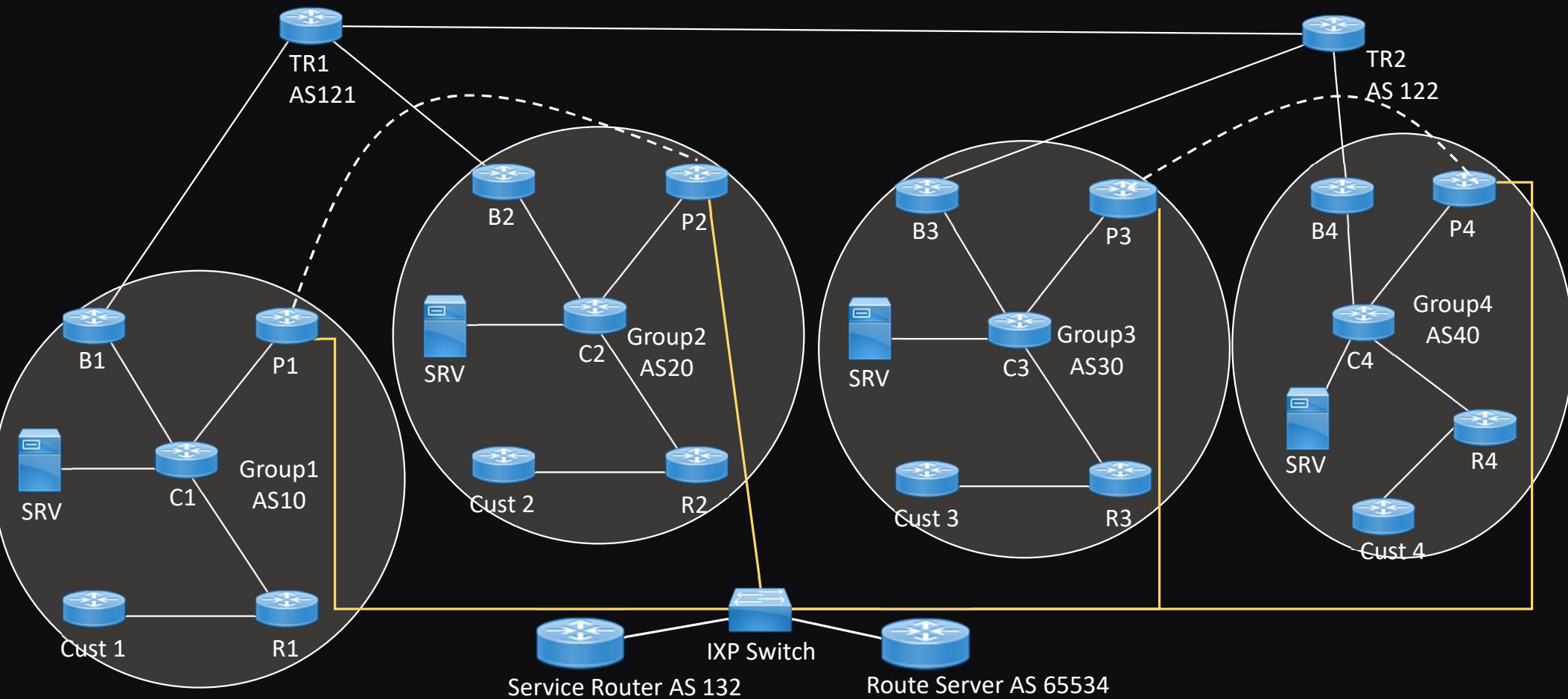
- Standard BGP: When an IPv4 prefix (10.0.0.0/24) is advertised, the BGP next-hop must be an IPv4 address. This requires a full dual-stack network.
- With RFC 8950: The router advertises the same IPv4 prefix, but the next-hop is a **global IPv6 address**. The IPv4 traffic is then encapsulated and transported over the IPv6-only core network.

The Magic behind RFC8950

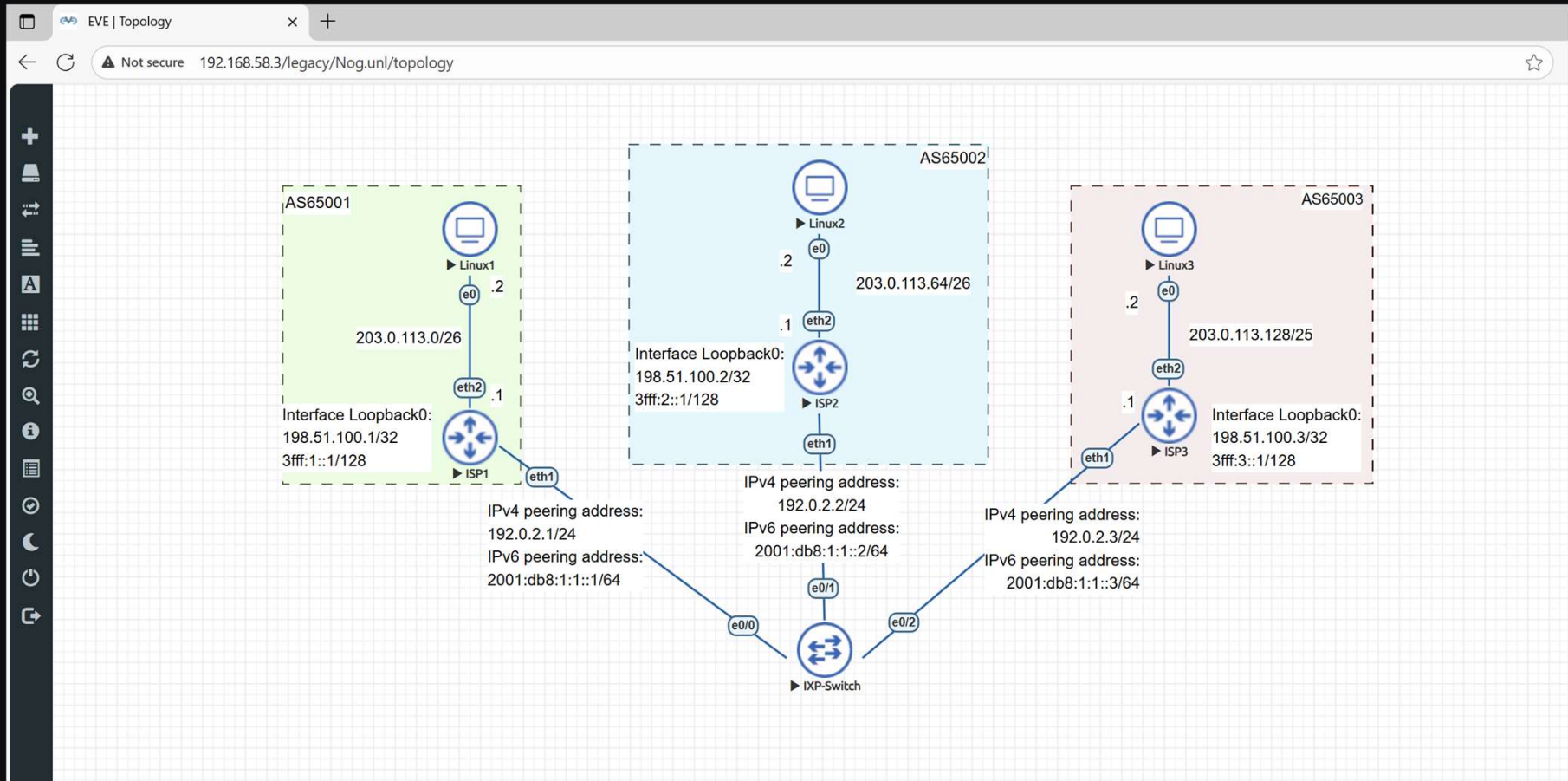
3. The Formal Name

- **RFC 8950:** Advertising IPv4 Network Layer Reachability Information (NLRI) with an IPv6 Next Hop.

The IXP and ISP Lab Topology



Practical Demonstration in EVE-NG



BGP configuration in MikroTik RouterOS 7.20.rc3

```
ISP3
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] > routing bgp export
# 2025-11-02 23:17:07 by RouterOS 7.20rc3

#
/routing bgp instance
add as=65003 disabled=no name=Instance1 router-id=198.51.100.3
/routing bgp connection
add comment=peer-AS65001 disabled=no instance=Instance1 local.address=\
2001:db8:1:1::3 .role=ebgp name=bgp1 output.redistribute=connected \
remote.address=2001:db8:1:1::1/128 .as=65001 routing-table=main
add as=65003 comment=peer-AS65002 disabled=no instance=Instance1 \
local.address=2001:db8:1:1::3 .role=ebgp name=bgp2 output.redistribute=\
connected remote.address=2001:db8:1:1::2/128 .as=65002
[admin@ISP3] >
```

BGP session confirmation

```
ISP3
[admin@ISP3] >
[admin@ISP3] > routing bgp session print
Flags: E - established
0 E name="bgp1-1" instance=Instance1
  remote.address=2001:db8:1:1::1 .as=65001 .id=198.51.100.1
  .capabilities=mp,rr,enhe,gr,as4 .afi=ip,ipv6 .messages=6 .bytes=398
  .eor=""
  local.address=2001:db8:1:1::3 .as=65003 .id=198.51.100.3
  .cluster-id=198.51.100.3 .capabilities=mp,rr,gr,as4 .afi=ip,ipv6
  .messages=6 .bytes=398 .eor=""
  output.procid=21
  input.procid=21 ebgp
  hold-time=3m keepalive-time=1m uptime=25s980ms
  last-started=2025-11-02 23:25:09 last-stopped=2025-11-02 23:25:03
  prefix-count=3

1 E name="bgp2-1" instance=Instance1
  remote.address=2001:db8:1:1::2 .as=65002 .id=198.51.100.2
  .capabilities=mp,rr,enhe,gr,as4 .afi=ip,ipv6 .messages=5 .bytes=318
  .eor=""
  local.address=2001:db8:1:1::3 .as=65003 .id=198.51.100.3
  .cluster-id=198.51.100.3 .capabilities=mp,rr,gr,as4 .afi=ip,ipv6
  .messages=6 .bytes=398 .eor=""
  output.procid=20
  input.procid=20 ebgp
```

BGP next-hop validation check

```
ISP3
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] >
[admin@ISP3] > ip route print
Flags: D - DYNAMIC; A - ACTIVE; c - CONNECT, b - BGP
Columns: DST-ADDRESS, GATEWAY, ROUTING-TABLE, DISTANCE
  DST-ADDRESS    GATEWAY      ROUTING-TABLE  DISTANCE
DAc 192.0.2.0/24 ether1        main           0
D b 192.0.2.0/24 2001:db8:1:1::2 main           20
D b 192.0.2.0/24 2001:db8:1:1::1 main           20
D b 198.51.100.1/32 2001:db8:1:1::1 main           20
DAb 198.51.100.1/32 2001:db8:1:1::1 main           20
DAb 198.51.100.2/32 2001:db8:1:1::2 main           20
D b 198.51.100.2/32 2001:db8:1:1::2 main           20
DAc 198.51.100.3/32 Loopback0     main           0
D b 203.0.113.0/26 2001:db8:1:1::1 main           20
DAb 203.0.113.0/26 2001:db8:1:1::1 main           20
DAb 203.0.113.64/26 2001:db8:1:1::2 main           20
D b 203.0.113.64/26 2001:db8:1:1::2 main           20
DAc 203.0.113.128/25 ether2        main           0
[admin@ISP3] >
```

Customer's connection result

```
QEMU (Linux1)
user@user: ~
File Edit View Search Terminal Help
user@user:~$ ifconfig
ens3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 203.0.113.2 netmask 255.255.255.192 broadcast 203.0.113.6
    inet6 fe80::4366:2eaf:eb71:d862 prefixlen 64 scopeid 0x20<link>
    ether 00:50:00:00:05:00 txqueuelen 1000 (Ethernet)
    RX packets 64 bytes 13080 (13.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 99 bytes 12073 (12.0 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 1379 bytes 108784 (108.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 1379 bytes 108784 (108.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

user@user:~$
```

```
QEMU (Linux3)
user@user: ~
File Edit View Search Terminal Help
user@user:~$ ping 203.0.113.2
PING 203.0.113.2 (203.0.113.2) 56(84) bytes of data.
64 bytes from 203.0.113.2: icmp_seq=1 ttl=62 time=5.83 ms
64 bytes from 203.0.113.2: icmp_seq=2 ttl=62 time=6.09 ms
64 bytes from 203.0.113.2: icmp_seq=3 ttl=62 time=6.07 ms
64 bytes from 203.0.113.2: icmp_seq=4 ttl=62 time=5.62 ms
64 bytes from 203.0.113.2: icmp_seq=5 ttl=62 time=9.07 ms
64 bytes from 203.0.113.2: icmp_seq=6 ttl=62 time=7.14 ms
64 bytes from 203.0.113.2: icmp_seq=7 ttl=62 time=6.28 ms
64 bytes from 203.0.113.2: icmp_seq=8 ttl=62 time=7.05 ms
64 bytes from 203.0.113.2: icmp_seq=9 ttl=62 time=4.38 ms
64 bytes from 203.0.113.2: icmp_seq=10 ttl=62 time=6.07 ms
^C
--- 203.0.113.2 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9018ms
rtt min/avg/max/mdev = 4.383/6.360/9.066/1.157 ms
user@user:~$
```

Conclusion: Why this Matters

- **Scalability:** Reduces dependence on IPv4 address space for the core network.
- **Operational Simplicity:** A single IPv6-only underlay network is easier to manage than a dual-stack one.
- **Future-Proofing:** Prepares the network for an IPv6-dominant future without sacrificing existing IPv4 services.