

# IPv6-mostly Deployment

**VNIX-NOG 2026**

Makito Lay  
Network Analyst / Technical Trainer  
APNIC

# About Me

- **Makito Lay**

- Network Analyst / Technical Trainer @ APNIC
- Volunteering:
  - TWNOG Multi-Stakeholder Group Member
  - KHNOG Executive Committee Member
- Experiences:
  - 18 years in ISP and Telecom industry
  - MikroTik Certified Trainer
  - Ex-programmer
- Certifications: CCIE # 47682, JNCIP-SP, MTCINE...etc.
- Areas of Interest: BGP, MPLS, IPv6, Coding & Databases



# Background

- Dual-stack is the most common IPv6 transition model.
- Dual-stack does not solve IPv4 exhaustion.
- IPv6-only is the real solution, but difficult in practice.
- Limited operator control slows IPv6-only adoption.
- IPv6-only adoption faces a chicken-and-egg problem.
- Segmenting networks by capability does not scale.

# Key Characteristics

- “IPv6-mostly” is an “extension” to Dual-stack, with two additional key elements:
  - DHCPv4 with Option 108 ([RFC 8925](#))
  - RA with PREF64 ([RFC 8781](#)) for NAT64 ([RFC 6146](#))
- Supports a mix of endpoint types on the same network:
  - IPv4-only
  - Dual-stack
  - IPv6-only

# Endpoint Behavior Scenario



IPv6-mostly capable Host

- Configures IPv6 addresses
- Does **not** obtain IPv4 address
  - Requests DHCPv4 Option 108
- Receives PREF64 (NAT64)



Dual-stack Host  
(not IPv6-only capable)

- Configures IPv6 addresses
- Obtains IPv4 address via DHCPv4



IPv4-only Host

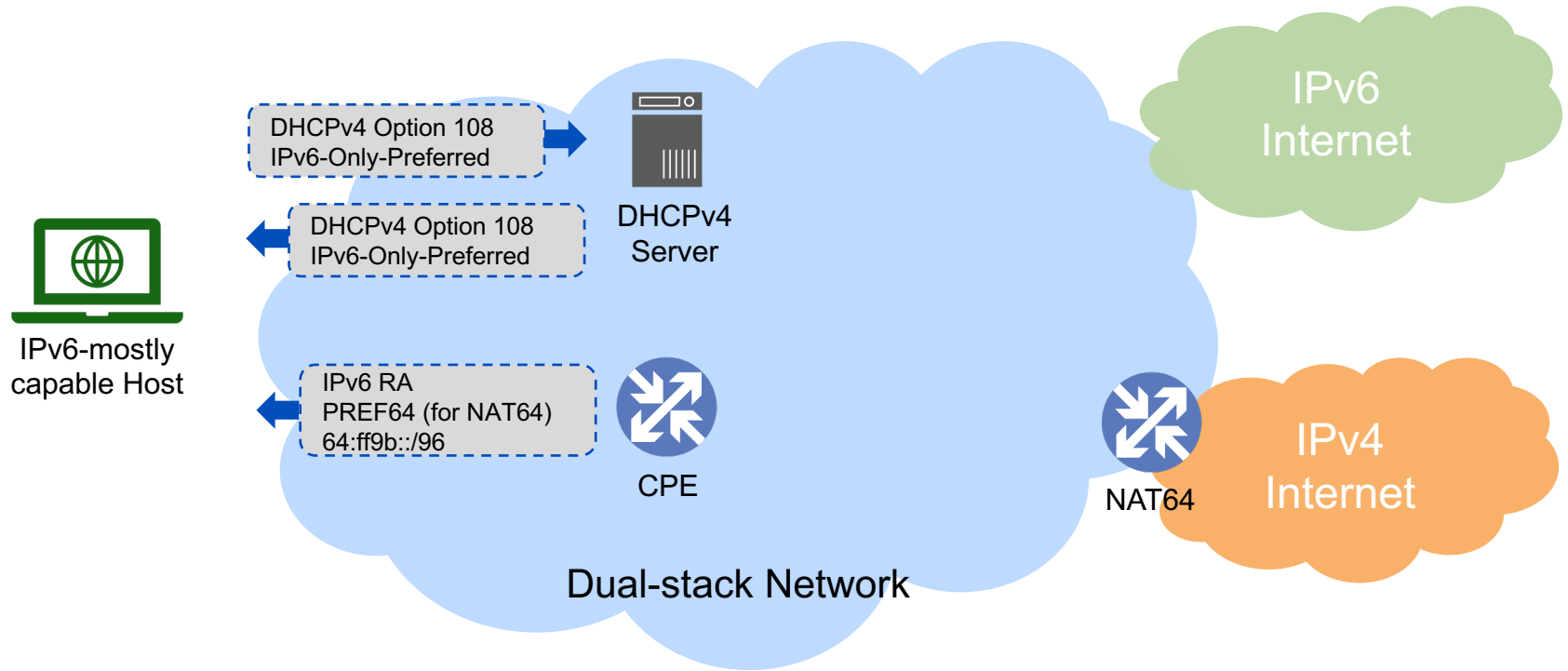
- Obtains IPv4 address via DHCPv4



IPv6-only capable host:

- Operates without native IPv4
- Same user experience as dual-stack

# IPv6-mostly: Network Scenario



# DHCP Message Exchange with Option 108



IPv6-mostly capable Host



DHCP Server

1 DHCPDISCOVER

DHCPOFFER 2

Example configuration on Kea DHCP:

```
"subnet4": [  
  ...  
  "option-data": [  
    {  
      "name": "v6-only-preferred",  
      "data": "86400"  
    },  
    ...  
  ]  
]
```

Using  
86400 as an  
example

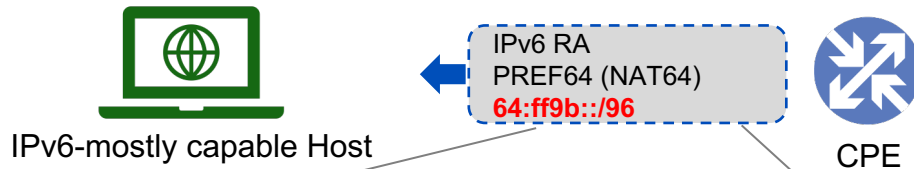
```
> Option: (3) Router  
> Option: (6) Domain Name Server  
> Option: (15) Domain Name  
✓ Option: (108) IPv6-Only Preferred  
  Length: 4  
  IPv6-Only Preferred wait time: 1 day (86400)  
> Option: (255) End
```

Client SHOULD NOT request the IPv4 address offered  
Client starts V6ONLY\_WAIT timer and stops IPv4 DHCP process  
[No DHCPREQUEST for IPv4 address]  
(until network attachment event or timer expiry)

<https://datatracker.ietf.org/doc/html/rfc8925>

<https://directaccess.richardhicks.com/2025/08/25/windows-server-dhcp-and-option-108/>

# RA Message with PREF64



Example configuration on Cisco IOS-XE 17.11 or later

```

ipv6 unicast-routing
interface GigabitEthernet0/0/1
ip address 220.247.144.1 255.255.248.0
ip helper-address 220.247.159.4
ip verify unicast source reachable-via rx
nat64 enable
ipv6 nd ra nat64-prefix 64:ff9b::/96
ipv6 nd ra dns server 2001:df9:1::8
ipv6 verify unicast source reachable-via rx
    
```

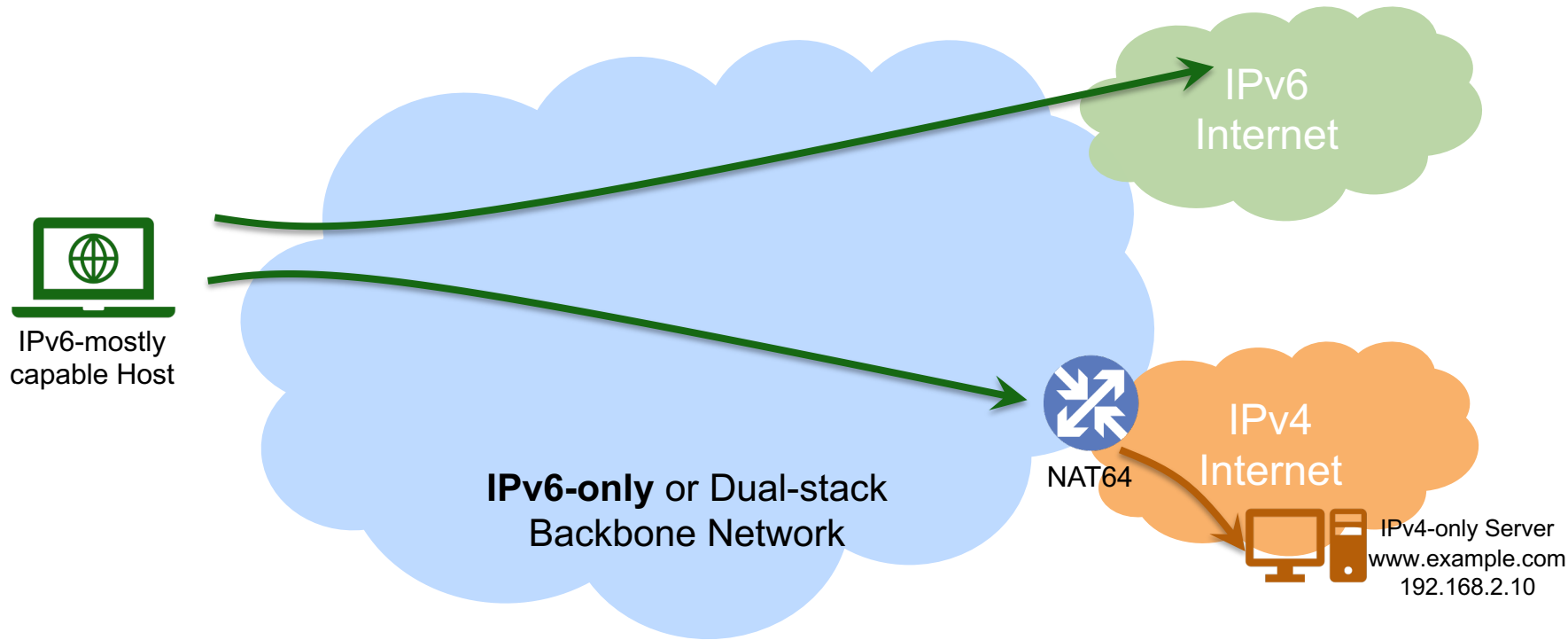
```

-Checksum: 0x3c9b [correct]
-[Checksum Status: Good]
-Cur hop limit: 64
> Flags: 0x40, Other configuration, Prf (Default Router Preference): Medium
-Router lifetime (s): 9000
-Reachable time (ms): 27000
-Retrans timer (ms): 1000
> ICMPv6 Option (Source link-layer address : c[redacted])
> ICMPv6 Option (MTU : 1450)
> ICMPv6 Option (Prefix information : 2[redacted]4::/64)
> ICMPv6 Option (Recursive DNS Server fe80::cc60:23ff:fe56:4e64)
~ ICMPv6 Option (PREF64 Option)
  -Type: PREF64 Option (38)
  -Length: 2 (16 bytes)
  -1111 1111 1111 1... = Scaled Lifetime: 8191
  -.... .... .000 = PLC (Prefix Length Code): 96 bits prefix length (0x0)
  -Prefix: 64:ff9b::
    
```

<https://ipv6.social/@tschaefer/114604564214542435>

<https://www.slideshare.net/slideshow/ipv6-mostly-experience-at-apricot-by-yoshinobu-matsuzaki-iii/279639596#4>

# IPv6-mostly Traffic Flow



# Supported OSes

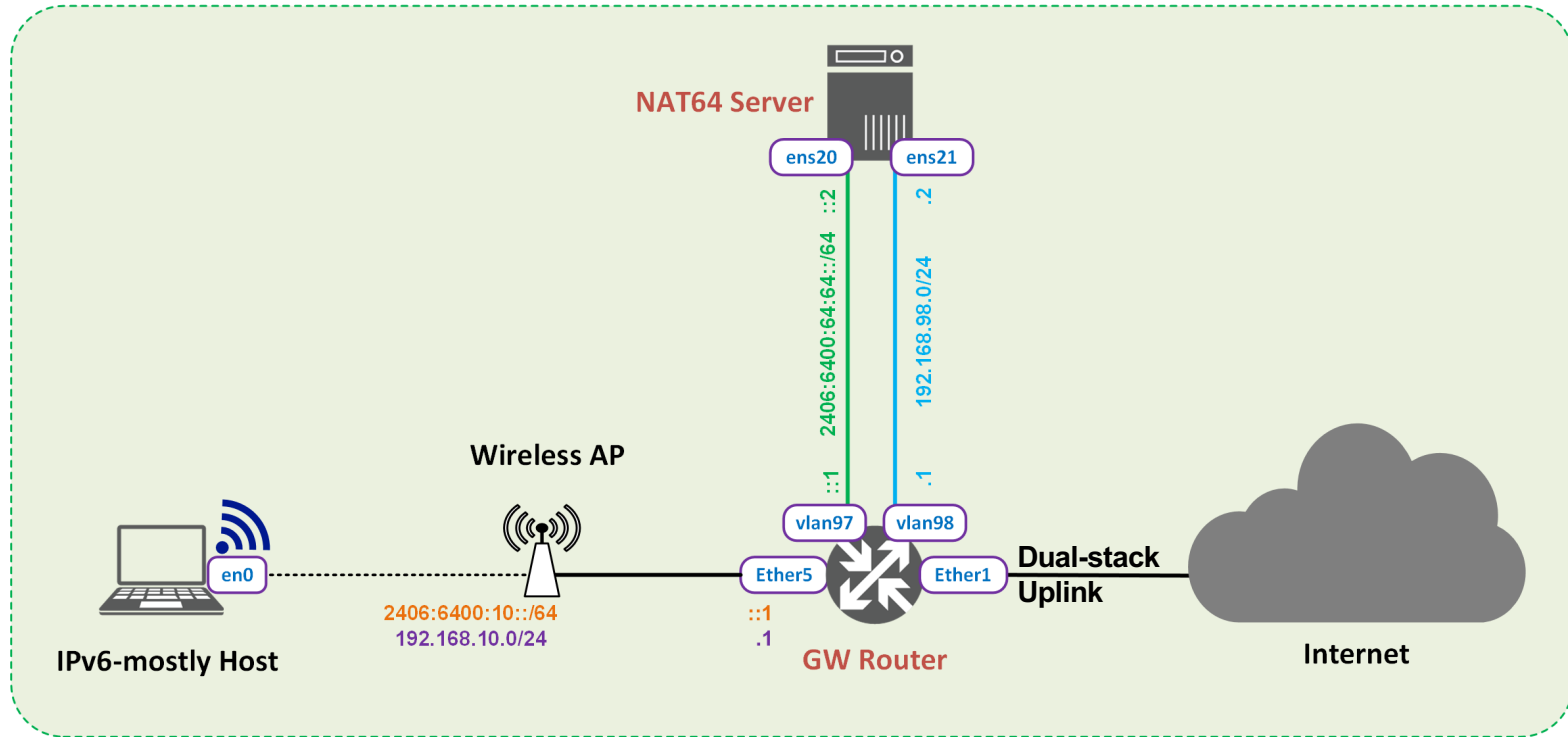
- Current Operating systems with option 108 support
  - **macOS 13.1** or newer
  - **iOS 16.0.3** (and Apple iOS 15.7 running on older devices)
  - **Android 14** (some Android 13 might work too)

# Why IPv6-mostly is Promising?

- IPv6-mostly works perfectly with all user types.
  - IPv6 is preferred
  - IPv4 is still available if host wants it
- Drastically reduced IPv4 consumption.
- Controlled and incremental phase-out of IPv4.
- Path to IPv6-only backbone operations.
- Expected to sunset IPv4 sooner.

# IPv6-mostly Network Setup with MikroTik Router

# Topology



# DHCPv4 Server: Option 108 Configuration

```
# Create DHCPv4 Option 108
# with wait time of 3600 (HEX: 0x00000E10) seconds.
/ip dhcp-server option
    add name=DHCP-OPTION-108 code=108 value=0x00000E10

# Create DHCPv4 Option Set.
/ip dhcp-server option sets
    add name=IPV6-ONLY-PREFERRED options=DHCP-OPTION-108

# Assign DHCPv4 Option Set to DHCPv4 Server.
/ip dhcp-server
    add name=LAN interface=ether5 address-pool=LAN \
        dhcp-option-set=IPV6-ONLY-PREFERRED
```

# GW Router (CPE) : PREF64 Configuration

```
# Enable RA to advertise PREF64 prefix.  
  
/ipv6 nd  
    set [ find default=yes ] \  
        interface=ether5 dns=2406:6400:10::53 \  
        pref64=64:ff9b::/96 ra-preference=high  
  
# Route traffic destined for PREF64 prefix to NAT64 Server.  
  
/ipv6 route  
    add dst-address=64:ff9b::/96 gateway=2406:6400:64:64::2
```

# DHCPv4 Packet: macOS to MikroTik

```
0.0.0.0.68 > 255.255.255.255.67: [udp sum ok] BOOTP/DHCP, Request from
7e:39:ac:e6:a4:38, length 300, xid 0xba3290ad, Flags [none] (0x0000)
Client-Ethernet-Address 7e:39:ac:e6:a4:38
Vendor-rfc1048 Extensions
  Magic Cookie 0x63825363
  DHCP-Message (53), length 1: Discover
  Parameter-Request (55), length 13:
    Subnet-Mask (1), Classless-Static-Route (121), Default-Gateway (3),
    Domain-Name-Server (6)
    Domain-Name (15), Unknown (108), URL (114), Unknown (119)
    Unknown (162), Unknown (252), LDAP (95), Netbios-Name-Server (44)
    Netbios-Node (46)
  MSZ (57), length 2: 1500
  Client-ID (61), length 7: ether 7e:39:ac:e6:a4:38
  Lease-Time (51), length 4: 7776000
  Hostname (12), length 3: "Mac"
  .....
```

# DHCPv4 Packet: MikroTik to macOS

```
192.168.10.1.67 > 192.168.10.57.68: [udp sum ok] BOOTP/DHCP, Reply, length 300,  
xid 0xba3290ad, Flags [none] (0x0000)
```

```
Your-IP 192.168.10.57
```

```
Server-IP 192.168.10.1
```

```
Client-Ethernet-Address 7e:39:ac:e6:a4:38
```

```
Vendor-rfc1048 Extensions
```

```
  Magic Cookie 0x63825363
```

```
  DHCP-Message (53), length 1: Offer
```

```
  Subnet-Mask (1), length 4: 255.255.255.0
```

```
  Default-Gateway (3), length 4: 192.168.10.1
```

```
  Domain-Name-Server (6), length 8: 1.1.1.1, 8.8.8.8
```

```
  Lease-Time (51), length 4: 86400
```

```
  Server-ID (54), length 4: 192.168.10.1
```

```
Unknown (108), length 4: 3600
```

```
  END (255), length 0
```

```
  PAD (0), length 0, occurs 16
```

# Client Status: macOS

```
user@ipv6-mostly-host~> ifconfig en0
```

```
en0: flags=88e3<UP,BROADCAST,SMART,RUNNING,NOARP,SIMPLEX,MULTICAST> mtu 1500
    options=6460<TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 7e:39:ac:e6:a4:38
    inet6 fe80::18a2:33a:154d:1f92%en0 prefixlen 64 secured scopeid 0xe
    inet6 2406:6400:10:0:81f:7e0f:1716:8656 prefixlen 64 autoconf secured
    inet6 2406:6400:10:0:5d3d:ff8c:a0a3:8c5 prefixlen 64 autoconf temporary
inet 192.0.0.2 netmask 0xffffffff broadcast 192.0.0.2
    inet6 2406:6400:10:0:145a:ea31:62c3:9c6 prefixlen 64 clat46
nat64 prefix 64:ff9b:: prefixlen 96
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect
    status: active
```

# Client Status: Windows

Wireless LAN adapter Wi-Fi:

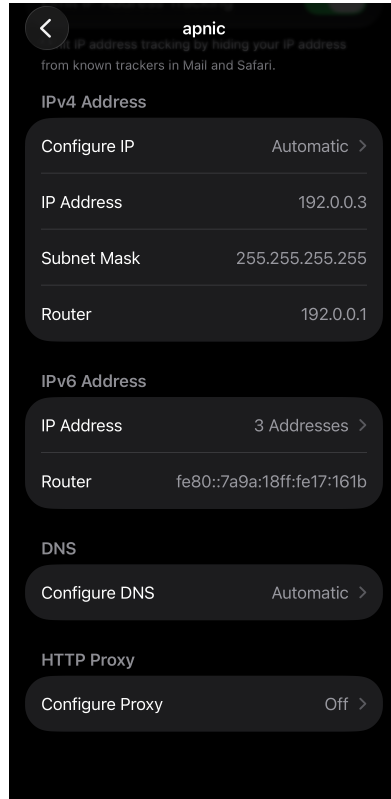
```
Connection-specific DNS Suffix . :  
Description . . . . . : Intel(R) Wi-Fi 6 AX201 160MHz  
Physical Address . . . . . : 88-D8-2E-58-35-D1  
DHCP Enabled . . . . . : Yes  
Autoconfiguration Enabled . . . : Yes  
IPv6 Address . . . . . : 2406:6400:10:0:d83d:e278:7b42:ae13(Preferred)  
Temporary IPv6 Address . . . . : 2406:6400:10:0:30f6:de32:bc0b:c517(Preferred)  
Link-local IPv6 Address . . . . : fe80::26d8:5445:f6fb:77d6%17(Preferred)  
IPv4 Address . . . . . : 192.168.10.92(Preferred)  
Subnet Mask . . . . . : 255.255.255.0  
Lease Obtained . . . . . : Saturday, Aug 27, 2026 2:59:45 PM  
Lease Expires . . . . . : Saturday, Aug 28, 2026 2:59:45 PM  
Default Gateway . . . . . : fe80::7a9a:18ff:fe17:1619%17  
                            192.168.10.1  
DHCP Server . . . . . : 192.168.10.1  
DHCPV6 IAID . . . . . : 126408750  
DHCPv6 Client DUID . . . . . : 00-01-00-01-2A-04-E3-01-6C-24-08-49-91-7B  
DNS Servers . . . . . : 1.1.1.1  
                        8.8.8.8  
                        2001:4860:4860::8888  
                        2606:4700:4700::1111  
NetBIOS over Tcpi . . . . . : Enabled
```

Dual-stack  
Windows  
PC

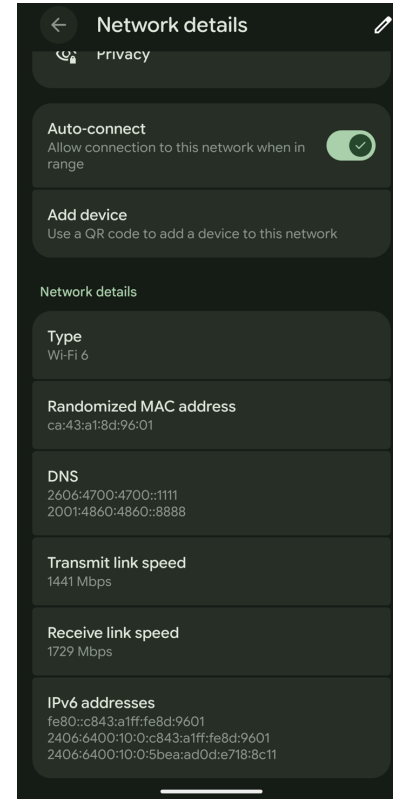
# Client Status: iOS and Android

Locally  
generated  
IPv4 address

iOS



Android



Local IPv4  
address is  
hidden

# Connectivity Test

v6.ipv6test.app

6

ipv6test

Dualstack Page

IPv6-Only Page

IPv4-Only Page



You are using IPv6 to connect to this server!

Your IP Address

2001:dc0:2001:210:7a9a:18ff:fe17:1615

v4.ipv6test.app

4

ipv6test

Dualstack Page

IPv6-Only Page

IPv4-Only Page



You are using IPv4 to connect to this server.

Your IP Address

203.119.77.128

# DHCPv4 Behavior

| v4 DHCP Server                    |                |         |               |                 |                  |  |
|-----------------------------------|----------------|---------|---------------|-----------------|------------------|--|
| DHCP                              |                |         |               |                 |                  |  |
| Networks                          |                |         |               |                 |                  |  |
| Leases                            |                |         |               |                 |                  |  |
| Options                           |                |         |               |                 |                  |  |
| Option Sets                       |                |         |               |                 |                  |  |
| Option Matcher                    |                |         |               |                 |                  |  |
| Alerts                            |                |         |               |                 |                  |  |
| New Enable Disable Remove Comment |                |         |               |                 |                  |  |
|                                   | Address        | Status  | Expires After | Active Class ID | Active Host Name |  |
| D                                 | 192.168.10.117 | bound   | 23:45:25      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.92  | bound   | 23:49:52      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.74  | bound   | 22:53:04      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.110 | bound   | 22:13:24      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.75  | bound   | 22:12:27      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.71  | bound   | 21:22:26      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.109 | bound   | 22:12:51      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.58  | bound   | 23:55:19      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.69  | bound   | 20:04:57      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.60  | bound   | 23:43:51      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.79  | bound   | 23:50:59      | MSFT 5.0        |                  |  |
| D                                 | 192.168.10.101 | testing | 00:00:37      |                 | iPhone           |  |
| D                                 | 192.168.10.50  | testing | 00:00:38      |                 | iPhone           |  |
| D                                 | 192.168.10.53  | testing | 00:00:47      |                 | iPhone           |  |
| D                                 | 192.168.10.112 | testing | 00:01:32      |                 |                  |  |
| D                                 | 192.168.10.90  | offered | 00:00:08      |                 | iPhone           |  |
| D                                 | 192.168.10.118 | offered | 00:01:42      |                 | iPhone           |  |
| D                                 | 192.168.10.93  | offered | 00:00:04      |                 | iPhone           |  |
| D                                 | 192.168.10.82  | offered | 00:00:34      |                 | iPhone           |  |
| D                                 | 192.168.10.66  | offered | 00:01:21      |                 | iPhone           |  |
| D                                 | 192.168.10.87  | offered | 00:01:52      |                 | iPhone           |  |
| D                                 | 192.168.10.95  | offered | 00:01:42      |                 | iPhone           |  |

# DHCPv4 Behavior

| DHCP Server                                                                                                     |                |         |               |        |        | Status  |
|-----------------------------------------------------------------------------------------------------------------|----------------|---------|---------------|--------|--------|---------|
| <div> <span>New</span> <span>Enable</span> <span>Disable</span> <span>Remove</span> <span>Comment</span> </div> |                |         |               |        |        |         |
|                                                                                                                 | Address        | Status  | Expires After | Active |        |         |
| D                                                                                                               | 192.168.10.117 | bound   | 23:45:25      | MS     | 10.92  | bound   |
| D                                                                                                               | 192.168.10.92  | bound   | 23:49:52      | M      | 10.74  | bound   |
| D                                                                                                               | 192.168.10.74  | bound   | 22:53:04      | M      | 10.110 | bound   |
| D                                                                                                               | 192.168.10.110 | bound   | 22:13:24      | M      | 10.75  | bound   |
| D                                                                                                               | 192.168.10.75  | bound   | 22:12:27      | M      | 10.71  | bound   |
| D                                                                                                               | 192.168.10.71  | bound   | 21:22:26      | M      | 10.109 | bound   |
| D                                                                                                               | 192.168.10.109 | bound   | 22:12:51      | M      | 10.58  | bound   |
| D                                                                                                               | 192.168.10.58  | bound   | 23:55:15      | M      | 10.58  | bound   |
| D                                                                                                               | 192.168.10.69  | bound   | 20:04:57      | M      | 10.69  | bound   |
| D                                                                                                               | 192.168.10.60  | bound   | 23:43:51      | M      | 10.60  | bound   |
| D                                                                                                               | 192.168.10.79  | bound   | 23:50:59      | M      | 10.79  | bound   |
| D                                                                                                               | 192.168.10.101 | testing | 00:00:37      | M      | 10.101 | testing |
| D                                                                                                               | 192.168.10.50  | testing | 00:00:38      | M      | 10.50  | testing |
| D                                                                                                               | 192.168.10.53  | testing | 00:00:47      | M      | 10.53  | testing |
| D                                                                                                               | 192.168.10.112 | testing | 00:01:32      | M      | 10.112 | testing |
| D                                                                                                               | 192.168.10.90  | offered | 00:00:08      | M      | 10.90  | offered |
| D                                                                                                               | 192.168.10.118 | offered | 00:01:42      | M      | 10.118 | offered |
| D                                                                                                               | 192.168.10.93  | offered | 00:00:04      | M      | 10.93  | offered |
| D                                                                                                               | 192.168.10.82  | offered | 00:00:34      | M      | 10.82  | offered |
| D                                                                                                               | 192.168.10.66  | offered | 00:01:21      | M      | 10.66  | offered |
| D                                                                                                               | 192.168.10.87  | offered | 00:01:52      | M      | 10.87  | offered |
| D                                                                                                               | 192.168.10.95  | offered | 00:01:42      | M      | 10.95  | offered |

# DHCPv4 Behavior

| v4 DHCP Server                                                 |                |         |               |                 |                  |  |
|----------------------------------------------------------------|----------------|---------|---------------|-----------------|------------------|--|
| DHCP Networks Leases Options Option Sets Option Matcher Alerts |                |         |               |                 |                  |  |
| New Enable Disable Remove Comment                              |                |         |               |                 |                  |  |
|                                                                | Address        | Status  | Expires After | Active Class ID | Active Host Name |  |
| D                                                              | 192.168.10.117 | bound   | 23:45:25      | MSFT 5.0        |                  |  |
| D                                                              | 192.168.10.92  | bound   | 23:49:52      | MSFT 5.0        |                  |  |
| D                                                              | 192.168.10.74  | bound   | 22:53:04      | MSFT 5.0        |                  |  |
| D                                                              | 192.168.10.110 | bound   | 22:13:24      | MSFT 5.0        |                  |  |
| D                                                              | 192.168.10.75  | bound   | 22:12:27      | MSFT 5.0        | bound            |  |
| D                                                              | 192.168.10.71  | bound   | 21:22:26      | MSFT 5.0        | bound            |  |
| D                                                              | 192.168.10.109 | bound   | 22:12:51      | MSFT 5.0        | bound            |  |
| D                                                              | 192.168.10.58  | bound   | 23:55:19      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.69  | bound   | 20:04:57      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.60  | bound   | 23:43:51      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.79  | bound   | 23:50:59      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.101 | testing | 00:00:37      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.50  | testing | 00:00:38      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.53  | testing | 00:00:47      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.112 | testing | 00:01:32      | MSFT 5.0        | testing          |  |
| D                                                              | 192.168.10.90  | offered | 00:00:08      | MSFT 5.0        | offered          |  |
| D                                                              | 192.168.10.118 | offered | 00:01:42      | MSFT 5.0        | offered          |  |
| D                                                              | 192.168.10.93  | offered | 00:00:04      | MSFT 5.0        | offered          |  |
| D                                                              | 192.168.10.82  | offered | 00:00:34      | MSFT 5.0        | offered          |  |
| D                                                              | 192.168.10.66  | offered | 00:01:21      | MSFT 5.0        | offered          |  |
| D                                                              | 192.168.10.87  | offered | 00:01:52      | MSFT 5.0        | offered          |  |
| D                                                              | 192.168.10.95  | offered | 00:01:42      | MSFT 5.0        | offered          |  |

# Deployment Considerations

# Host OS Readiness

- **macOS, iOS, and Android:**
  - Fully capable of IPv6-mostly
- **Windows:**
  - Dual-stack or IPv6-only (Not yet IPv6-mostly capable)
- **Linux:**
  - Dual-stack or IPv6-only by default, but possible to make IPv6-mostly capable
    - Enable “clatd” and configure “dhclient” to ignore IPv4 address

# Network Functions

- **DHCP Option 108:**
  - Open source: KEA, coredhcp
  - MikroTik works – Expects 4-byte Option value in DHCP
- **PREF64 in RA:**
  - Popular vendors introduced in limited models / recent OSES
  - MikroTik works – RouterOS 7.8 onwards
  - Alternative open source: radvd
- **NAT64:**
  - Implemented in some routers
  - MikroTik does not do natively, but possible with containers inside
  - Alternative open source: Jool, TAYGA

# Network Functions

- **Uplink / ISP Peering:**
  - Dual-stack uplink towards Internet is expected
- **Backbone:**
  - Better to be Dual-stack (very few users might still use IPv4)

# PPPoE Clients

- Many ISPs use PPPoE for client connectivity.
  - PPPoE does not understand DHCP Option 108
    - Hence, IPv6-only-preferred will not work
- Alternatives for PPPoE clients:
  - NAT64 + DNS64 (IPv6-only)
  - 464XLAT (end device support needed)
- New IPCP/LCP Option for PPPoE may be defined in the future.

# Thank you for your attention!

## Contact Me

❑ E-mail: [makito.lay@apnic.net](mailto:makito.lay@apnic.net)

❑ LinkedIn: <https://www.linkedin.com/in/ogawamakito>

