

IPv6-mostly Network Deployment

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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

IPv6 Mostly: Key Elements

- "IPv6-mostly" is an "extension" to dual-stack, with two additional key elements:
 - **DHCPv4 with Option 108** (RFC 8925)
 - **RA with PREF64** (NAT64 - RFC 6146)

<https://datatracker.ietf.org/doc/draft-palet-v6ops-ipv6-only/09/>
<https://www.rfc-editor.org/rfc/rfc8925.html>
<https://www.rfc-editor.org/rfc/rfc6146.html>

Endpoint Behaviour 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

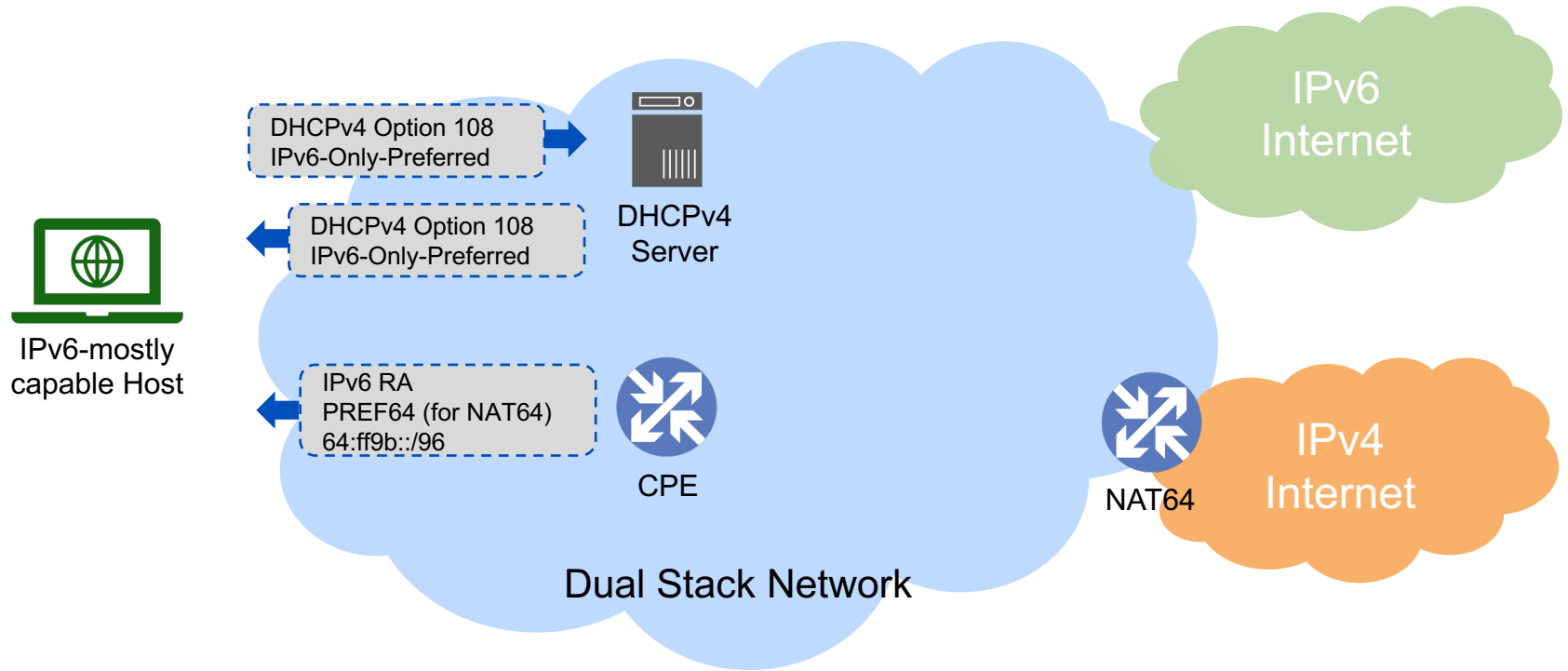
- Obtains IPv4 address via DHCPv4



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

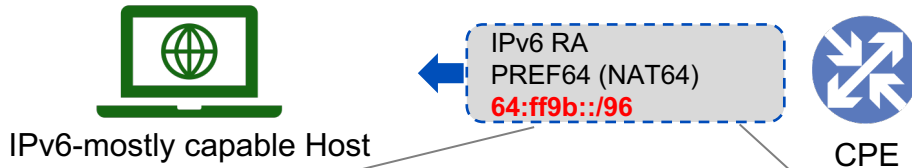
```
> Option: (3) Router
> Option: (6) Domain Name Server
> Option: (15) Domain Name
> Option: (108) IPv6-Only Preferred
  Length: 4
  IPv6-Only Preferred wait time: 1 day (86400)
> Option: (255) End
```

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
    
```

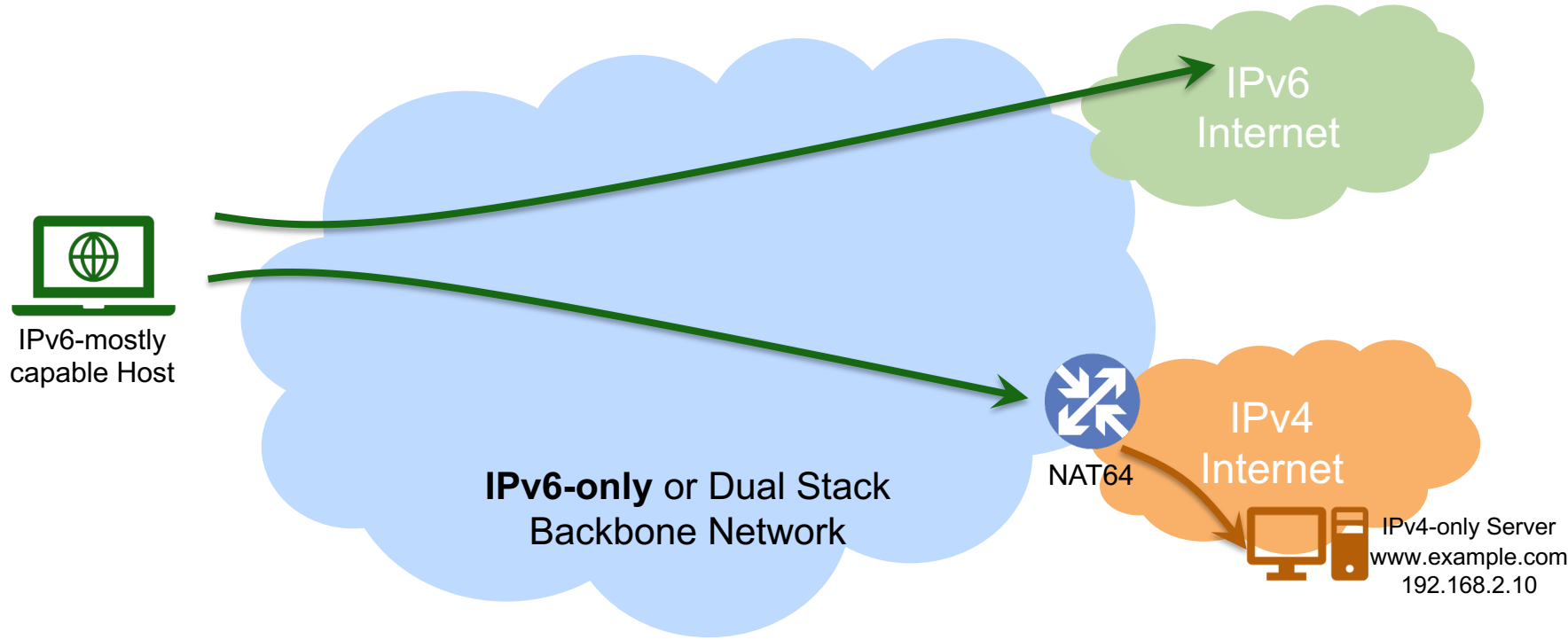
```

-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-ijj/279639596#4>

IPv6-mostly Traffic Flow



Supported OSes

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

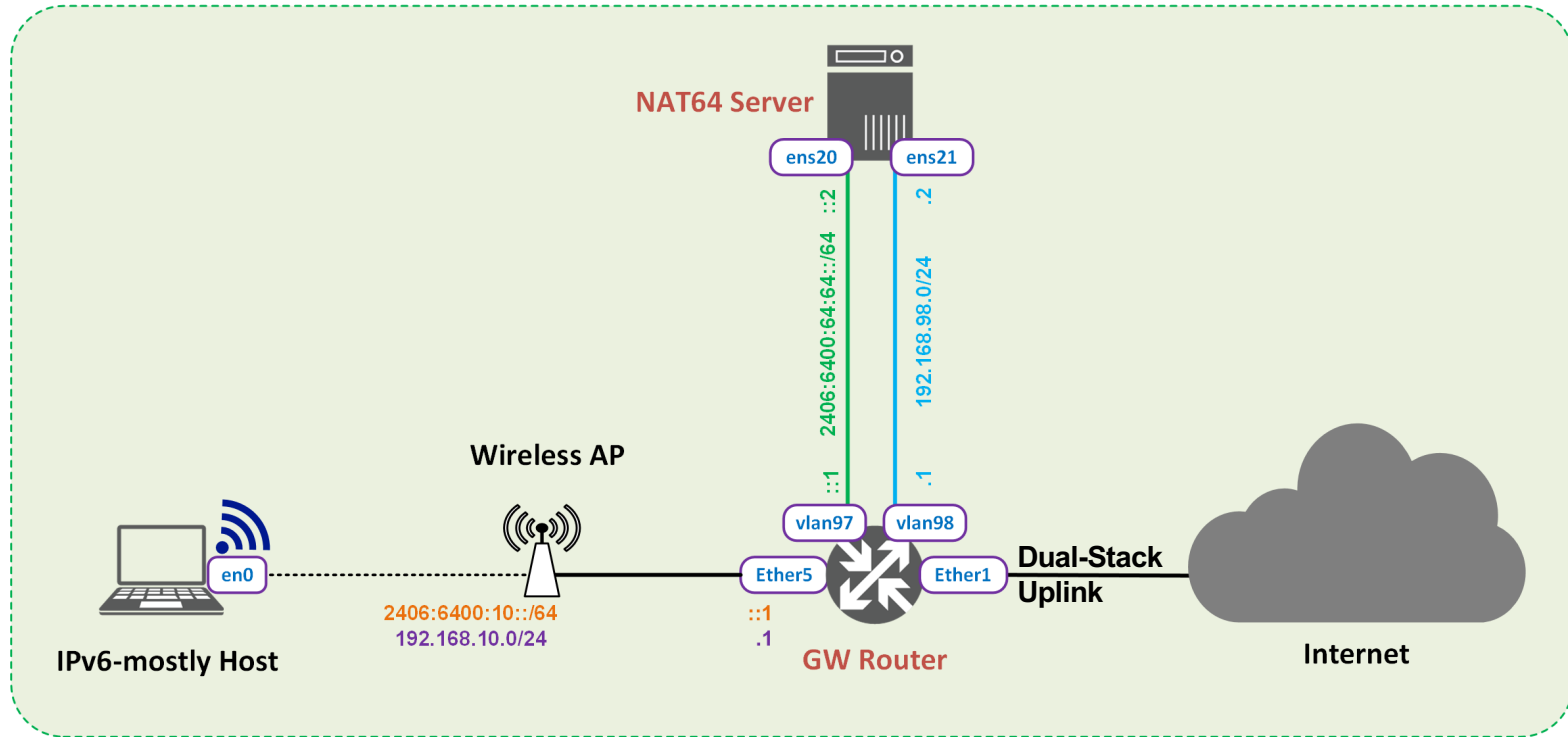
<https://indico.cern.ch/event/1274792/contributions/5444353/attachments/2676554/4642104/IPv6%20mostly.pdf>

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

```
[admin@mikrotik] > /ip dhcp-server option
[admin@mikrotik] /ip/dhcp-server/option > add code=108 name=ipv6-
only-preferred value=0x00000E10

[admin@mikrotik] > /ip dhcp-server option sets
[admin@mikrotik] /ip/dhcp-server/option/sets > add name=ipv6-only-
preferred options=ipv6-only-preferred

[admin@mikrotik] > /ip dhcp-server
[admin@mikrotik] /ip/dhcp-server > add address-pool=dhcp_pool10
dhcp-option-set=ipv6-only-preferred interface=ether5 name=dhcp-
server
```

GW Router (CPE) : PREF64 Configuration

```
[admin@mikrotik] > /ipv6 nd
[admin@mikrotik] /ipv6/nd > set [ find default=yes ]
dns=2406:6400:10::53 interface=ether5 pref64=64:ff9b::/96 ra-
preference=high

[admin@mikrotik] > /ipv6 route
[admin@mikrotik] /ipv6/route > add disabled=no 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:

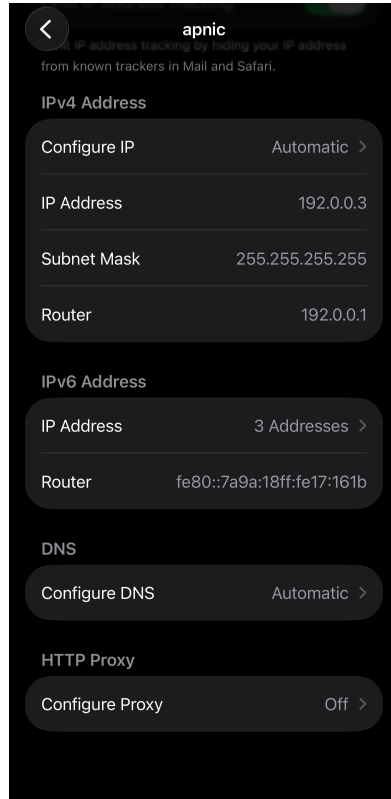
```

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:f100:6:123:d83d:e278:7b42:ae13(Preferred)
Temporary IPv6 Address. . . . . : 2406:f100:6:123:30f6:de32:bc0b:c517(Preferred)
Link-local IPv6 Address . . . . : fe80::26d8:5445:f6fb:77d6%17(Preferred)
IPv4 Address. . . . . : 10.123.135.221(Preferred)
Subnet Mask . . . . . : 255.255.252.0
Lease Obtained. . . . . : Saturday, May 9, 2026 2:59:45 PM
Lease Expires . . . . . : Saturday, May 9, 2026 3:29:45 PM
Default Gateway . . . . . : fe80::7a9a:18ff:fe17:1619%17
                             10.123.132.1
DHCP Server . . . . . : 10.123.132.1
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 Tcpip. . . . . : Enabled
  
```

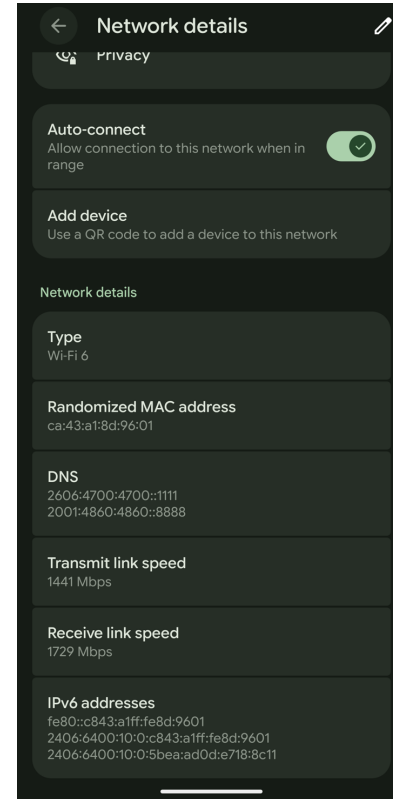
Client Status: iOS and Android

Locally
generated
IPv4 address

iOS



Android



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

MikroTik DHCPv4 Behaviour

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	Df	7S		
D	192.168.10.92	bound	23:49:52	MSFT 5.0	Tr			
D	192.168.10.74	bound	22:53:04	MSFT 5.0	LA	3TO		
D	192.168.10.110	bound	22:13:24	MSFT 5.0	Df	188		
D	192.168.10.75	bound	22:12:27	MSFT 5.0	DL			
D	192.168.10.71	bound	21:22:26	MSFT 5.0	Df	36		
D	192.168.10.109	bound	22:12:51	MSFT 5.0	Kil			
D	192.168.10.58	bound	23:55:19	MSFT 5.0	BT			
D	192.168.10.69	bound	20:04:57	MSFT 5.0	EC			
D	192.168.10.60	bound	23:43:51	MSFT 5.0	BT			
D	192.168.10.79	bound	23:50:59	MSFT 5.0	Df	EA		
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			

MikroTik DHCPv4 Behaviour

v4 DHCP Server					Status
DHCP Networks Leases Options Option Sets					
New	Enable	Disable	Remove	Comment	
Address	Status	Expires After	Active Time	Client ID	
192.168.10.117	bound	23:45:25	MS		
192.168.10.92	bound	23:49:52	M		
192.168.10.74	bound	22:53:04	2		
192.168.10.110	bound	22:13:24			
192.168.10.75	bound	22:12:27			
192.168.10.71	bound	21:22:26			
192.168.10.109	bound	22:12:51			
192.168.10.58	bound	23:55:19			
192.168.10.69	bound	20:04:57			
192.168.10.60	bound	23:43:51			
192.168.10.79	bound	23:50:59			
192.168.10.101	testing	00:00:37			
192.168.10.50	testing	00:00:38			
192.168.10.53	testing	00:00:47			
192.168.10.112	testing	00:01:32			
192.168.10.90	offered	00:00:08			
192.168.10.118	offered	00:01:42			
192.168.10.93	offered	00:00:04			
192.168.10.82	offered	00:00:34			
192.168.10.66	offered	00:01:21		iPhone	
192.168.10.87	offered	00:01:52		iPhone	
192.168.10.95	offered	00:01:42		iPhone	

MikroTik DHCPv4 Behaviour

	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	Df	7S		
D	192.168.10.92	bound	23:49:52	MSFT 5.0	Tr			
D	192.168.10.74	bound	22:53:04	MSFT 5.0	LA	3TO		
D	192.168.10.110	bound	22:13:24	MSFT 5.0	Df	188		
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	68.10.101				
D	192.168.10.50	testing	00:00:38	68.10.50				
D	192.168.10.53	testing	00:00:47	68.10.53				
D	192.168.10.112	testing	00:01:32	68.10.112				
D	192.168.10.90	offered	00:00:08	68.10.90				
D	192.168.10.118	offered	00:01:42	68.10.118				
D	192.168.10.93	offered	00:00:04	68.10.93				
D	192.168.10.82	offered	00:00:34	68.10.82				
D	192.168.10.66	offered	00:01:21	68.10.66				
D	192.168.10.87	offered	00:01:52	68.10.87				
D	192.168.10.95	offered	00:01:42	68.10.95				

Deployment Considerations

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

Deployment Considerations – Network Functions

- DHCP Option 108
 - Opensource – 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 opensource - radvd
- NAT64
 - Implemented in some routers
 - MikroTik doesn't do natively – but possible with containers inside
 - Alternative opensource – Jool, Tayga

Deployment Considerations – Network Functions

- Uplink / ISP Peering
 - Both IPv6 and IPv4 must work towards Internet
- Backbone
 - Better to be Dual-stack (very few users might still use IPv4)

Deployment Considerations – PPPoE Clients

- Many ISPs use PPPoE for client connectivity
 - PPPoE doesn't understand DHCP Option 108
 - Hence, ipv6-only-preferred won't work
- Alternatives for PPPoE Clients
 - NAT64 + DNS64 (IPv6-only)
 - 464XLAT (end device support needed)
- A future RFC might define a new IPCP/LCP Option for PPPoE



Questions

