

IPv6 Extension Headers and Testing Results

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Vision

Multi-year project: IPv6 deployment at enterprises.

- Provide training,
- Analysis of security and application conversion,
- Help enterprises plan their IPv6 deployment.

**India
Internet
Engineering
Society
(IIEsoc) and
Industry
Network
Technology
Council
(INTC)**

A few words about me

- President: Industry Network Technology Council
- Founder & CEO: Inside Products, Inc.
- Advisory Board: India Internet Engineering Society
- RFCs: RFC8250 (Embedded performance and diagnostics for IPv6) and others
- Product developer (OEMed by IBM and others)
- Working with IPv6 for 15 years
- Working with network management, diagnostic, performance issues at large brick-and-mortar enterprises for over 30 years



Collaborators

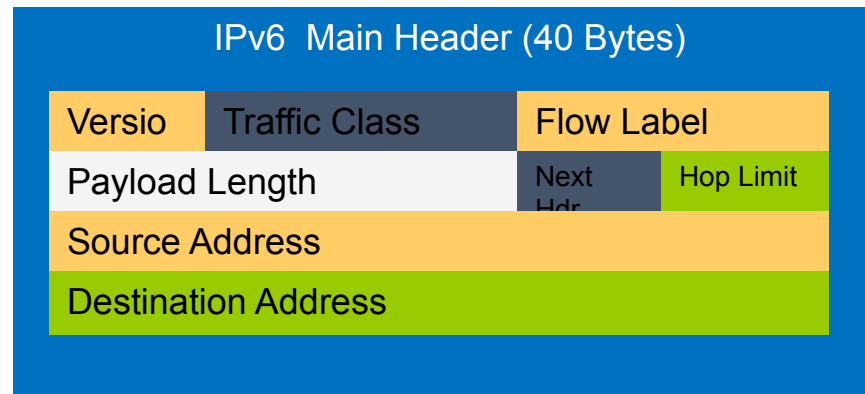
- Dr. Priyanka Sinha was most recently the IoT Analytics lead at Zenatix. She previously worked on Redback Networks' SmartEdge 800, Itaas' interactive TV, and TCS Research's social IoT. She received her BTech in CSE from IIT Guwahati in 2004, her MS in Computer Engineering from Auburn University in 2007, and her PhD in CSE from IIT Kharagpur in 2022. She was a Vodafone fellow at Auburn, where she worked on autoconfiguration in multi-hop mobile adhoc networks.
- Vivek Jain is a PhD student at the University of California, Riverside.

Agenda

- Introduction
 - IPv6 address structure
 - IPv6 extension headers
 - Past EH testing
- Cloud Topologies
- Cloud Testing Results

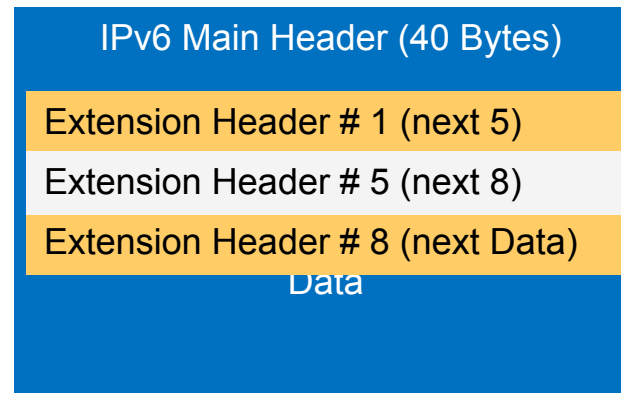
The IPv6 Header

- IPv6 main header:
fixed 40 bytes
- Source and
destination
addresses larger!
- Defined in
RFC8200
(originally
RFC2460)



IPv6 Extension Headers

- New: IPv6 extension headers
- Next Header field chains headers
- Rules:
 - May appear only once
 - Must appear in fixed order
 - Exception: Destination Options



Common IPv6 Extension Headers

Next Header (Hex)	Next Header (Decimal)	Header Name	Description
0	0	Hop-by-Hop Options	For all devices on the path
2B	43	Routing	0 – Source Routing (deprecated) 2 – Mobile IPv6
2C	44	Fragment	Only when packet is fragmented
32	50	Encapsulated Security Payload (ESP)	IPSec encrypted data
33	51	Authentication Header (AH)	IPSec authentication
3C	60	Destination Options	http://www.iana.org/assignments/ipv6-parameters/ipv6-parameters.xml (Mobile IP, etc)

Can IPv6 Extension Headers Be Used on the Internet?

- Controversy for many years
- A number of studies showing that IPv6 extension headers “don’t work”
- Studies (by and large) sent “fake” IPv6 extension headers to Alexa top n sites
- If this is true, IPv6 extensibility is at risk. We DO NOT want, IPv6 + n!

What we did

- Used a small hosting service (not one of the “brand-name” ones)
- Locations throughout the world
 1. PDM-Warsaw
 2. PDM-Toronto
 3. PDM-Seattle
 4. PDM-Mumbai
 5. PDM-Melbourne
 6. PDM-Frankfurt

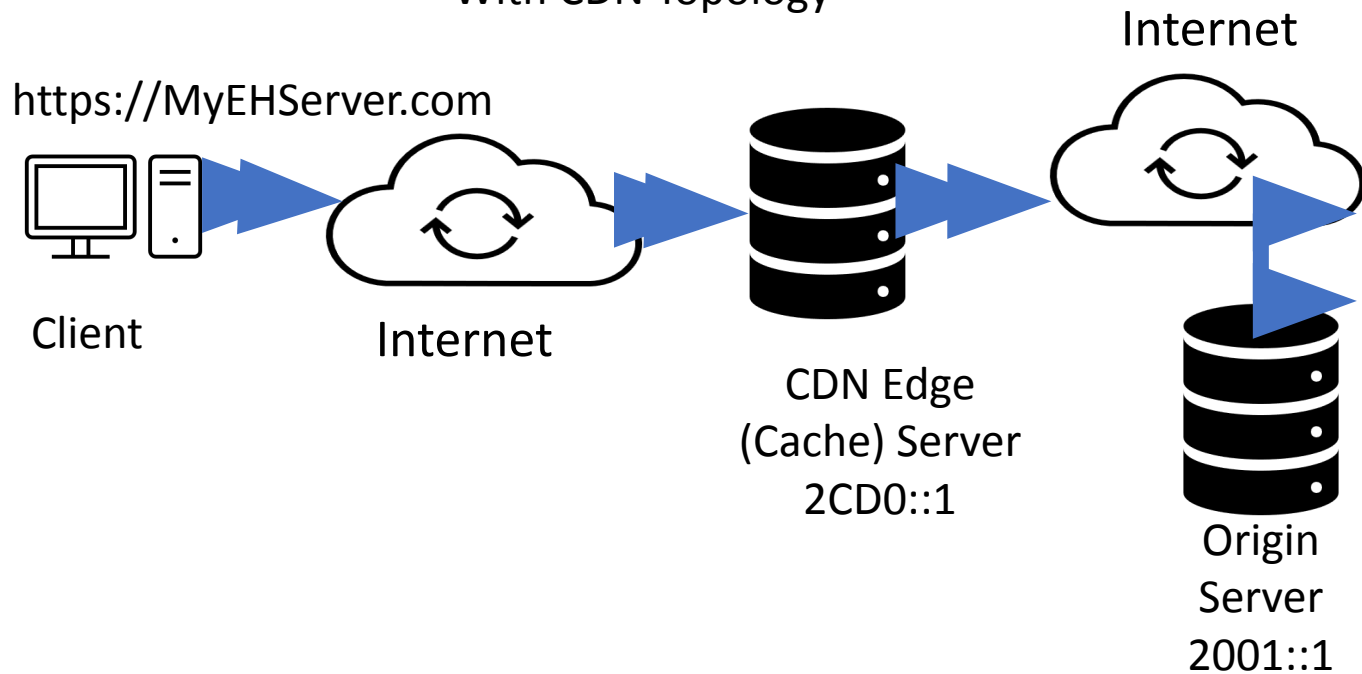
All machines are FreeBSD with a modification to the kernel to send PDM IPv6 Destination option with every packet. (Now changed to Ubuntu using eBPF)

Our Goals

- We are doing troubleshooting and trying to isolate and fix problems
- We are **NOT** doing large scale measurements
- We will do that after problems are fixed. Otherwise, moving target.
- Two large providers of Internet services appear to have changed their EH handling already. Conversation with a third (cloud vendor) is in progress. They stand ready to work with us.

Also tested with CDNs

With CDN Topology



Move Server Behind CDN

- Our server has a domain name: MyEHServer
- Our server also has an IPv6 address (also IPv4 probably)
- Let's say: 2001::1 and 201.1.1.1 (MyEHServer resolves to these)
- To move behind a CDN, you have to give the CDN authority to resolve MyEHServer
- Let's give the CDN IPv6 addresses starting with 2CD0::/64 (2CD0::1, 2CD0::2, etc)
- After CDN move, MyEHServer will resolve to some CDN cache server address (2CD0::1 for example)



We will now refer to our server as the “Origin Server”

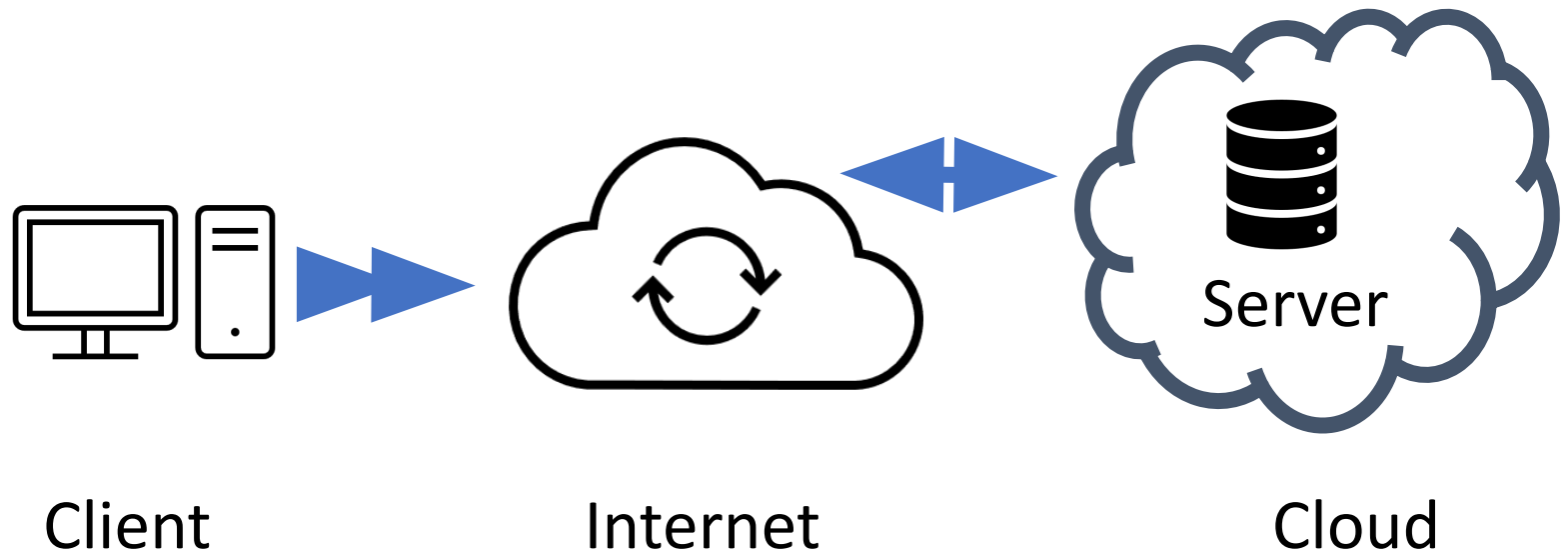
Cloud Topologies

Various configurations:

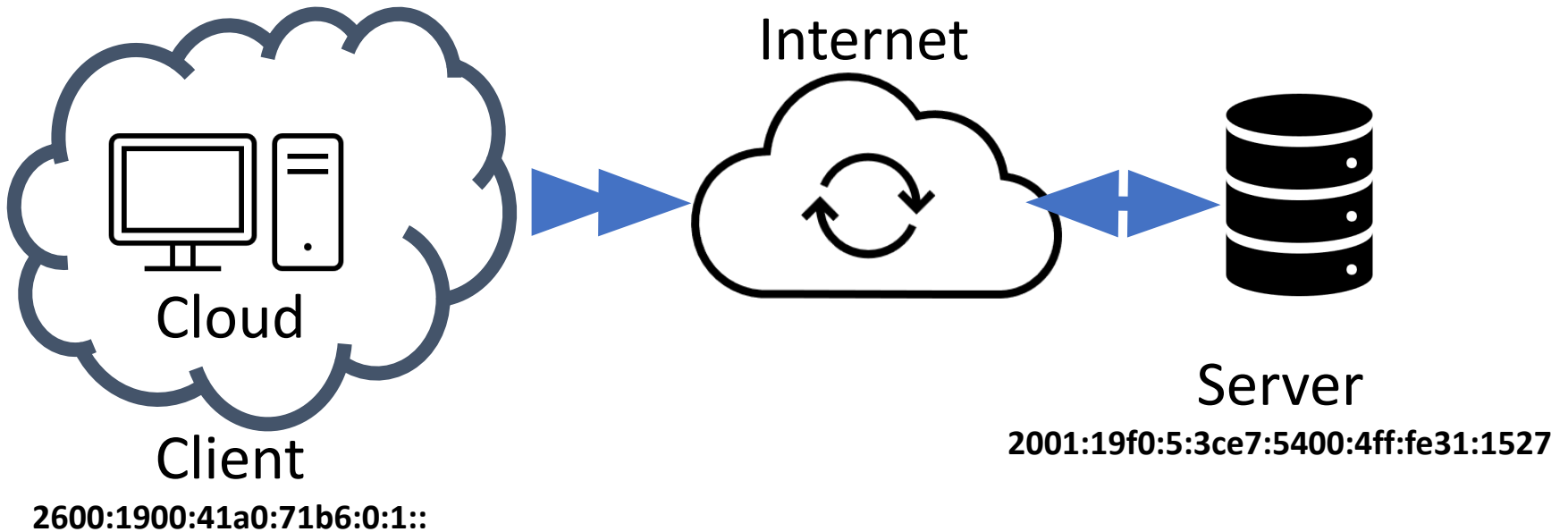
- Outside Cloud to Inside Cloud
 - Standalone to Cloud (OC-S)
 - Cloud to Standalone (S-OC)
 - Data center to Cloud (OC-D)
- Inside Cloud (IC),
 - Cloud #1 – One Datacenter (IC-SD)
 - Cloud #1 – Multiple Datacenters (IC-MD)
- Between Clouds (BC) cloud#1- cloud #2

Cloud Testing: Outside Cloud to Inside Cloud

Standalone to Cloud (OC-S) Topology
Simplest: Client – Internet -- Server



Cloud #1 – Standalone outside Cloud (S-OC)
Cloud Client – Internet – External Server



Packet trace with No Extension Headers

http4goog.v3.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ipv6

No.	Time	Source	Destination	Info
28	4.609591	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	56948 → 80 [SYN] Seq=0 Win=64
32	4.800563	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	80 → 56948 [SYN, ACK] Seq=0 A
33	4.800633	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	56948 → 80 [ACK] Seq=1 Ack=1
35	4.800885	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	GET / HTTP/1.1
39	4.990622	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	80 → 56948 [ACK] Seq=1 Ack=15
40	4.990826	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	80 → 56948 [PSH, ACK] Seq=1 A

> Frame 28: 94 bytes on wire (752 bits), 94 bytes captured (752 bits)

> Ethernet II, Src: 42:01:0a:01:00:03 (42:01:0a:01:00:03), Dst: 42:01:0a:01:00:01 (42:01:0a:01:00:01)

> Internet Protocol Version 6, Src: 2600:1900:41a0:71b6:0:1::, Dst: 2001:19f0:5:3ce7:5400:4ff:fe31:1527

- 0110 = Version: 6
- > 0000 0000 = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
- 0000 0000 0110 0011 1010 = Flow Label: 0x0063a
- Payload Length: 40
- Next Header: TCP (6)
- Hop Limit: 64
- Source Address: 2600:1900:41a0:71b6:0:1::
- Destination Address: 2001:19f0:5:3ce7:5400:4ff:fe31:1527

> Transmission Control Protocol, Src Port: 56948, Dst Port: 80, Seq: 0, Len: 0

No Extension Headers

Cloud is client.
Going to Standalone server outside Cloud. No EH.

WHO-IS
LookUp shows
that this is cloud
provider #1.

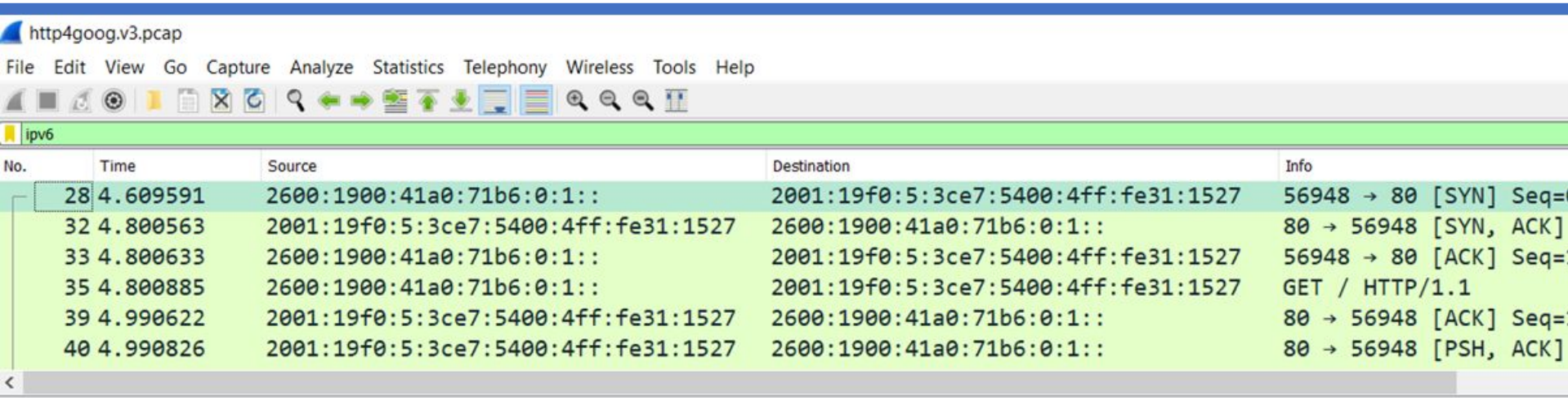


WHOIS-RWS

You searched for: 2600:1900:41a0:71b6:0:1::

Network	
Net Range	2600:1900:: - 2600:190F:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
CIDR	2600:1900::/28
Name	CLOUD
Handle	NET6-2600-1900-1
Parent	NET6-2600 (NET6-2600-1)
Net Type	Direct Allocation
Origin AS	AS
Organization	
Registration Date	2014-05-28
Last Updated	2015-09-21
Comments	** The IP addresses under this netblock are in use by Cloud customers ** Direct all copyright and legal complaints to <a domain"="" href="https://support. .com/legal/oo/report">https://support..com/legal/oo/report

What do we know so far?



The screenshot shows the Wireshark interface with a packet capture named 'http4goog.v3.pcap'. The filter is set to 'ipv6'. The packet list pane shows several packets related to an HTTP connection. Packet 28 is a SYN packet from source 2600:1900:41a0:71b6:0:1:: to destination 2001:19f0:5:3ce7:5400:4ff:fe31:1527. Packet 32 is a SYN, ACK packet from destination to source. Packet 33 is an ACK packet from source to destination. Packet 35 is a GET request for HTTP/1.1. Packet 39 is an ACK packet from destination to source. Packet 40 is a PSH, ACK packet from destination to source.

No.	Time	Source	Destination	Info
28	4.609591	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	56948 → 80 [SYN] Seq=
32	4.800563	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	80 → 56948 [SYN, ACK]
33	4.800633	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	56948 → 80 [ACK] Seq=
35	4.800885	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	GET / HTTP/1.1
39	4.990622	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	80 → 56948 [ACK] Seq=
40	4.990826	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	80 → 56948 [PSH, ACK]

- IP addressing and firewalls set up correctly
- HTTP server set up correctly
- Traffic going back and forth

Bottom Line

- IPv6 to Cloud Provider #1 with no IPv6 extension headers works fine. (PING and HTTP). Client can be inside cloud or outside cloud.

Let's add EHs

ipv6.addr == 2600:1900:41a0:71b6:0:1::

No.	Time	Source	Destination	Next Header	Info
227	25.279174	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	46378 → 80 [SYN] Seq=
237	26.301452	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]
241	28.317453	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]
246	32.509455	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]
247	40.701447	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]
418	52.574124	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	41584 → 80 [SYN] Seq=
420	53.597439	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]
421	55.613447	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]
436	59.645440	2600:1900:41a0:71b6:0:1::	2001:19f0:5:3ce7:5400:4ff:fe31:1527	Destination Options for IPv6	[TCP Retransmission]

<

```
> Frame 241: 110 bytes on wire (880 bits), 110 bytes captured (880 bits)
> Ethernet II, Src: 42:01:0a:01:00:03 (42:01:0a:01:00:03), Dst: 42:01:0a:01:00:01 (42:01:0a:01:00:01)
> Internet Protocol Version 6, Src: 2600:1900:41a0:71b6:0:1::, Dst: 2001:19f0:5:3ce7:5400:4ff:fe31:1527
  0110 .... = Version: 6
  > .... 0000 0000 .... .... = Traffic Class: 0x00 (DSCP: CS0, ECN:
  .... 0011 1001 1000 1001 0010 = Flow Label: 0x39892
  Payload Length: 56
  Next Header: Destination Options for IPv6 (60)
  Hop Limit: 64
  Source Address: 2600:1900:41a0:71b6:0:1::
  Destination Address: 2001:19f0:5:3ce7:5400:4ff:fe31:1527
  > Destination Options for IPv6
> Transmission Control Protocol, Src Port: 46378, Dst Port: 80, Seq: 0, Len: 0
```

Cloud is client (:1::).
 Going to Standalone
 server outside Cloud.
 Client has EH (:1527).

What is received at other end?

- Nothing!
- (Only IPv4 packets!)

Let's try the other way

ipv6.addr == 2600:1900:41a0:71b6:0:1::

No.	Time	Source	Destination	Next Header	Info
131	13.562679	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	57280 → 80 [SYN] Seq=0
136	14.574968	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	[TCP Retransmission]
137	16.591208	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	[TCP Retransmission]
140	20.622938	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	[TCP Retransmission]
149	28.818898	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	[TCP Retransmission]
300	53.323457	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	58082 → 80 [SYN] Seq=0
302	54.351027	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	[TCP Retransmission]
303	56.366903	2001:19f0:5:3ce7:5400:4ff:fe31:1527	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	[TCP Retransmission]

> Frame 131: 110 bytes on wire (880 bits), 110 bytes captured (880 bits)
 Ethernet II, Src: 56:00:04:31:15:27 (56:00:04:31:15:27), Dst: fa:19:84:a9:af:ff (fa:19:84:a9:af:ff)
 Internet Protocol Version 6, Src: 2001:19f0:5:3ce7:5400:4ff:fe31:1527, Dst: 2600:1900:41a0:71b6:0:1::

0110 = Version: 6
 > 0000 0000 = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
 0111 0000 0001 1110 1010 = Flow Label: 0x701ea
 Payload Length: 56
 Next Header: Destination Options for IPv6 (60)
 Hop Limit: 64
 Source Address: 2001:19f0:5:3ce7:5400:4ff:fe31:1527
 Destination Address: 2600:1900:41a0:71b6:0:1::

Destination Options for IPv6
 Next Header: TCP (6)
 Length: 1
 [Length: 16 bytes]
 > Performance and Diagnostic Metrics
 > PadN



Cloud is Server (:1::).
 Client is Standalone
 outside Cloud. Client
 has EH (:1527).

What is received at other end?

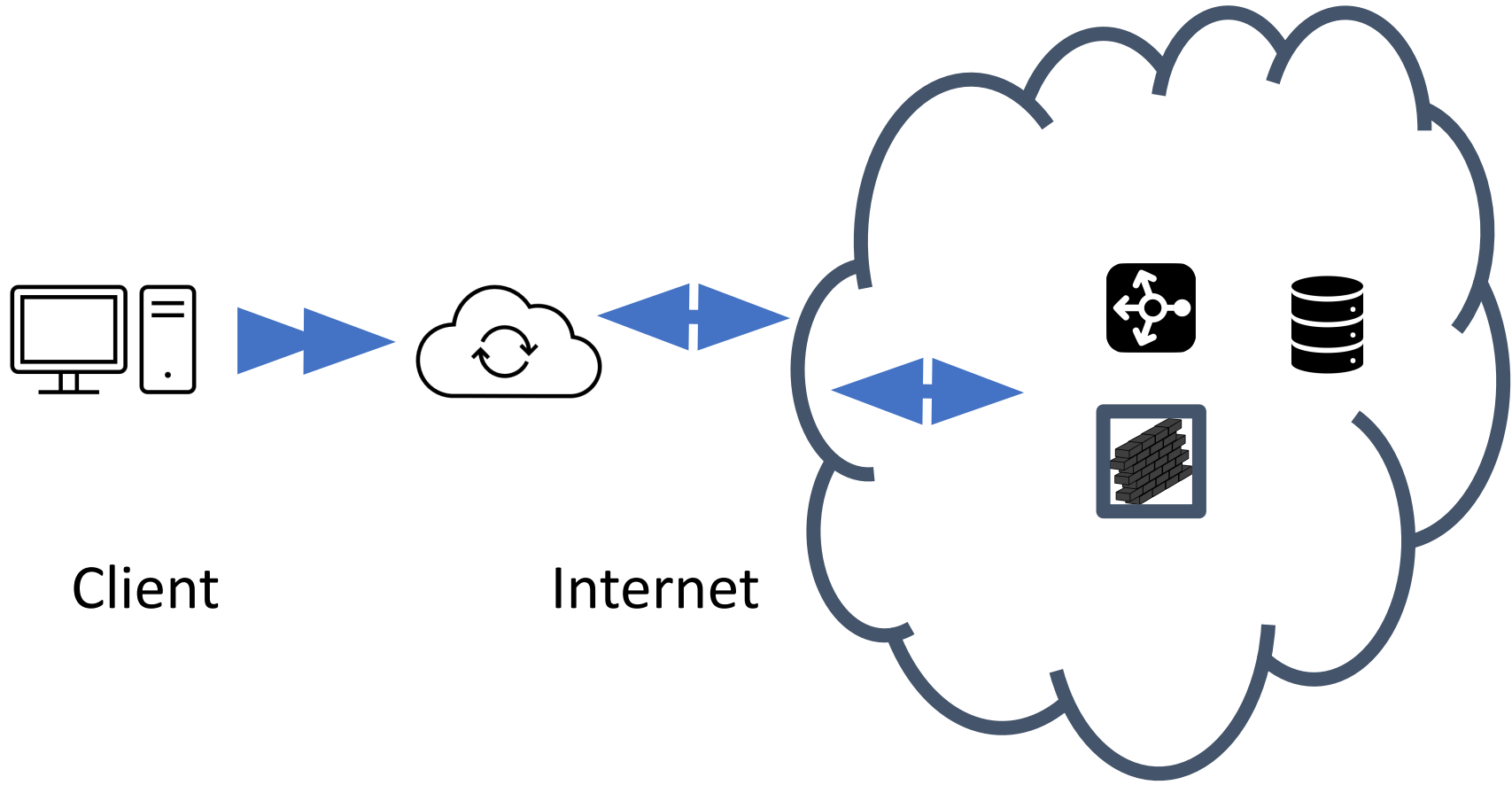
- Nothing!
- (Only IPv4 packets!)

Bottom Line

- IPv6 to Cloud Provider #1 with no IPv6 extension headers works fine. (PING and HTTP). Client can be inside cloud or outside cloud.
- IPv6 with Cloud Provider #1 with IPv6 extension headers does not work. Client can be inside cloud or outside cloud.
 - OS supports EHs
 - “Network” does not

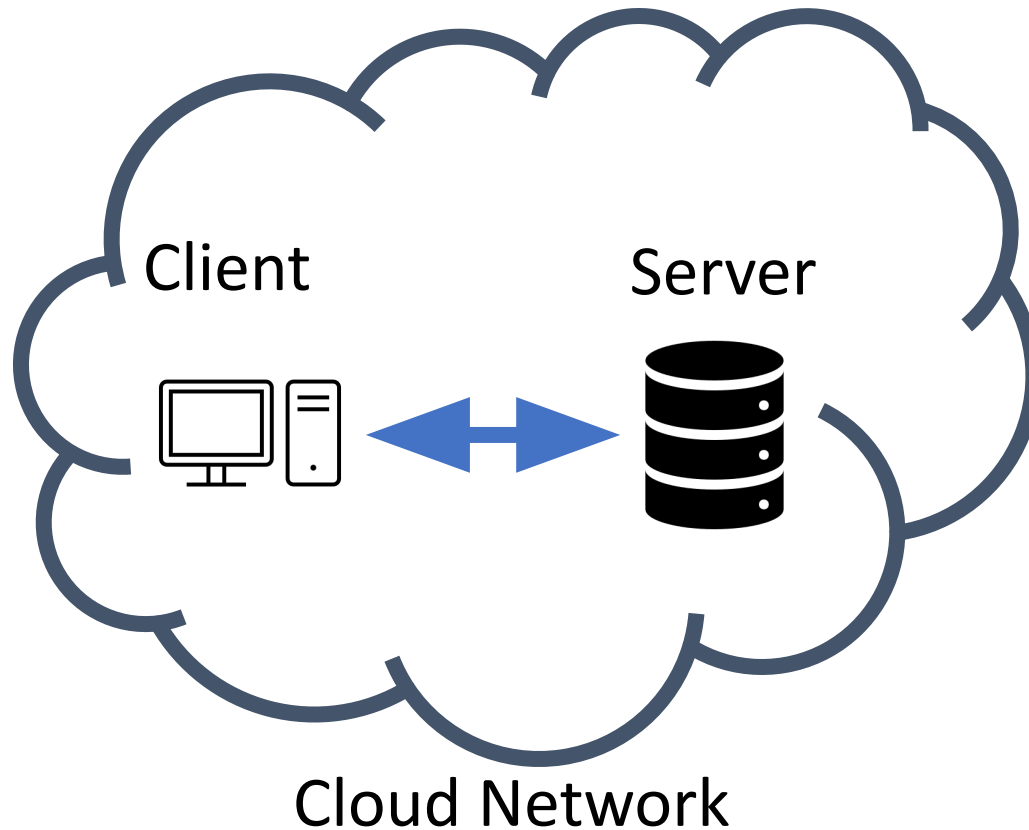
Realistic Topology

Client – Internet -- Cloud Network

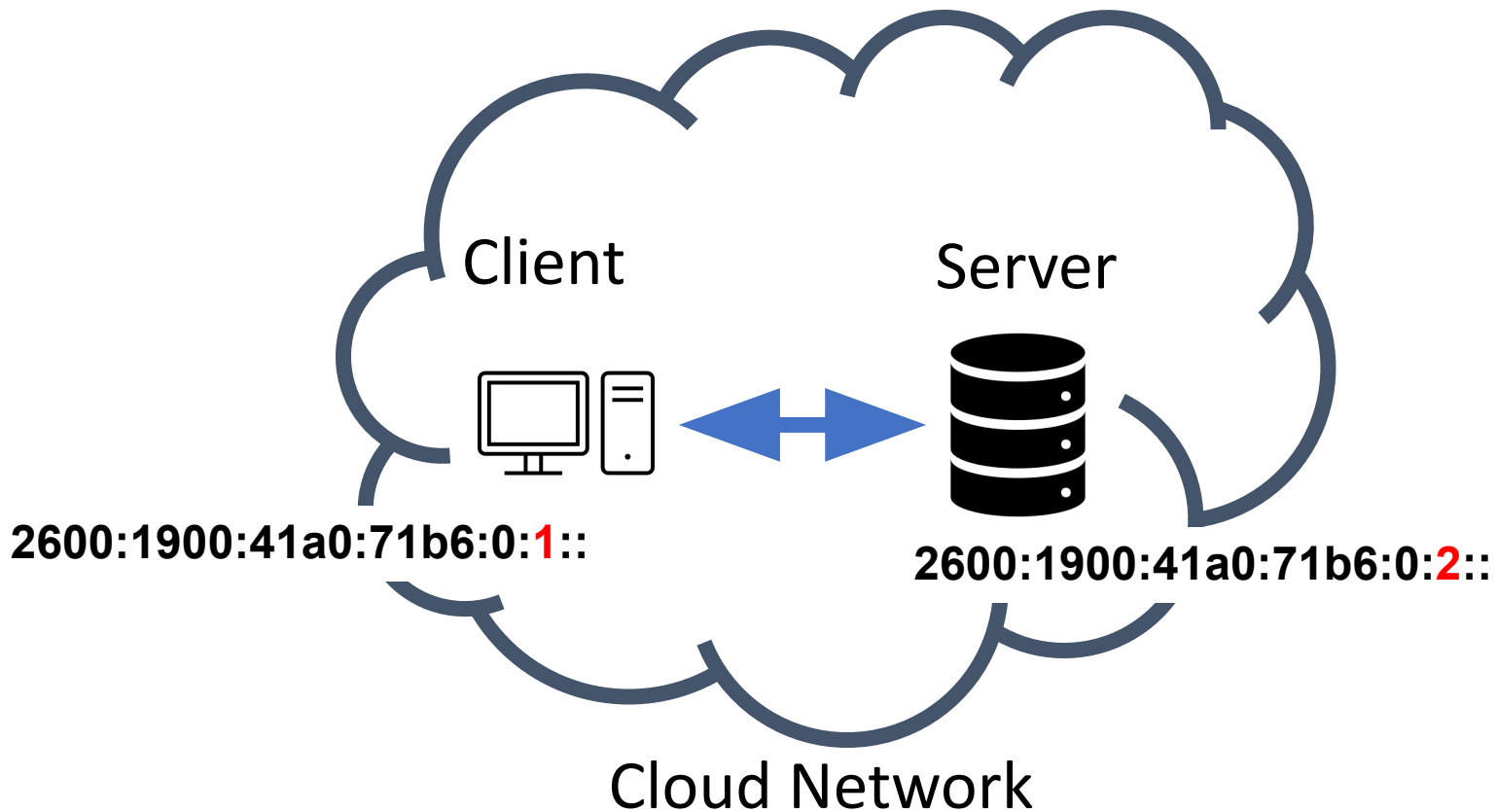


Cloud Testing: Inside Cloud

Inside Cloud (IC)
Cloud #1 – One Datacenter (IC-SD)
Client – Server



Inside Cloud (IC)
Cloud #1 – One Datacenter (IC-SD)
Client – Server



WHO-IS
LookUp shows
that this is cloud
provider #1.



WHOIS-RWS

You searched for: 2600:1900:41a0:71b6:0:1::



This is the :1:: address

Network	
Net Range	2600:1900:: - 2600:190F:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
CIDR	2600:1900::/28
Name	[REDACTED]-CLOUD
Handle	NET6-2600-1900-1
Parent	NET6-2600 (NET6-2600-1)
Net Type	Direct Allocation
Origin AS	AS1 [REDACTED]
Organization	[REDACTED]
Registration Date	2014-05-28
Last Updated	2015-09-21
Comments	** The IP addresses under this netblock are in use by [REDACTED] Cloud customers ** Direct all copy[REDACTED] legal complaints to https://support.[REDACTED].com/legal/oo/report



WHO-IS
LookUp shows
that this is cloud
provider #1.

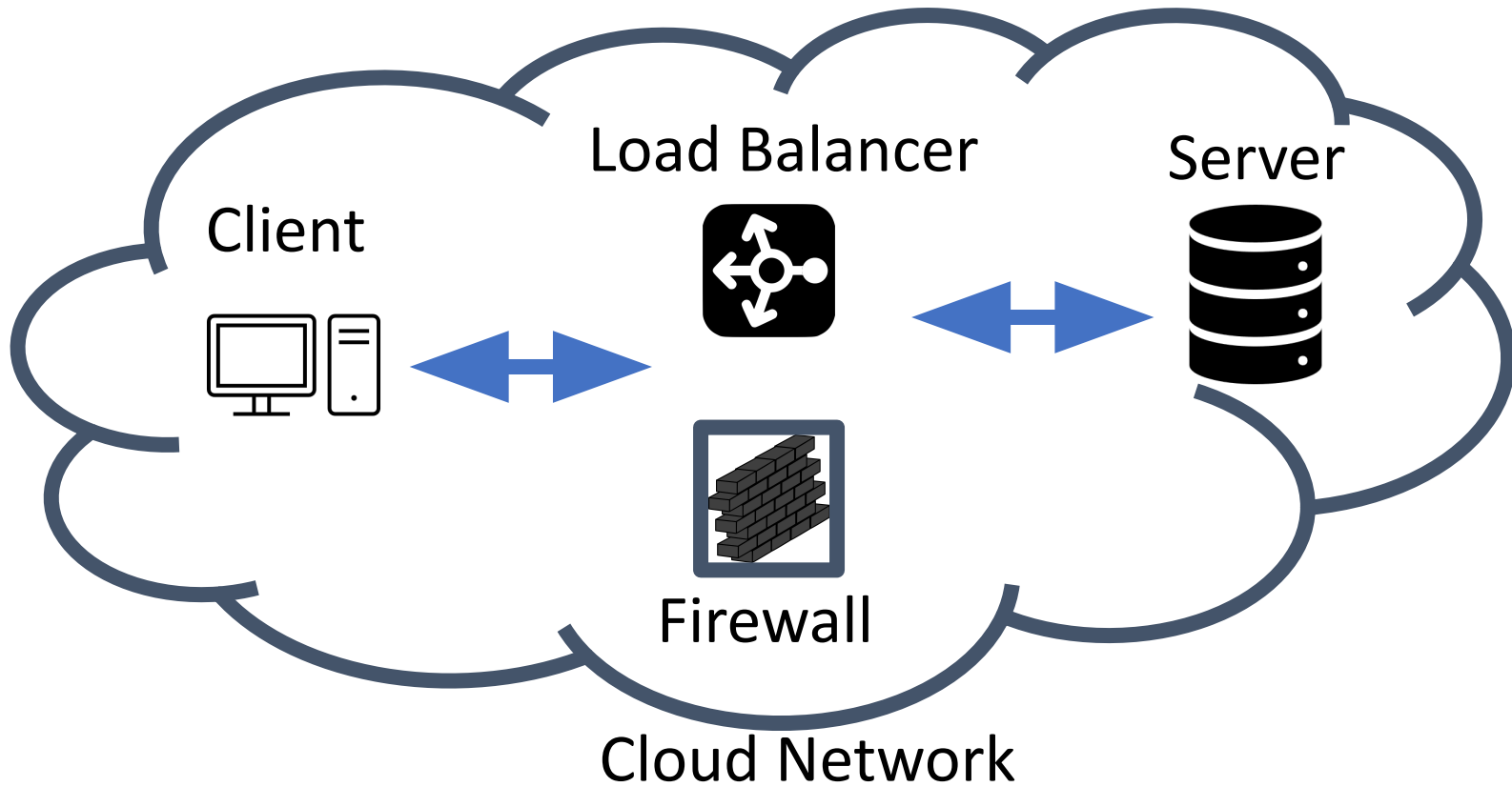


WHOIS-RWS

You searched for: 2600:1900:41a0:71b6:0:2:: ← **This is the :2:: address**

Network	
Net Range	2600:1900:: - 2600:190F:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
CIDR	2600:1900::/28
Name	[REDACTED] CLOUD
Handle	NET6-2600-1900-1
Parent	NET6-2600 (NET6-2600-1)
Net Type	Direct Allocation
Origin AS	AS [REDACTED]
Organization	[REDACTED]
Registration Date	2014-05-28
Last Updated	2015-09-21
Comments	** The IP addresses under this netblock are in use by [REDACTED] Cloud customers ** Direct all copyright and legal complaints to https://support.[REDACTED].com/legal/go/report

Inside Cloud (IC)
Cloud #1 – One Datacenter (IC-SD)
Realistic: Client – Load Balancer, Firewall, etc – Server



ping3g1v2.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ipv6

No.	Time	Source	Destination	Next Header	Info
50	7.037920	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	Echo (ping) request id=0x000a,
53	7.038952	2600:1900:41a0:71b6:0:2::	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	Echo (ping) reply id=0x000a, s
56	8.039165	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	Echo (ping) request id=0x000a,
57	8.039452	2600:1900:41a0:71b6:0:2::	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	Echo (ping) reply id=0x000a, s
62	9.057504	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	Echo (ping) request id=0x000a,

<

> Frame 3: 102 bytes on wire (816 bits), 102 bytes captured (816 bits)

> Ethernet II, Src: 42:01:0a:01:00:03 (42:01:0a:01:00:03), Dst: 42:01:0a:01:00:01 (42:01:0a:01:00:01)

∨ Internet Protocol Version 6, Src: 2600:1900:41a0:71b6:0:1::, Dst: 2404:6800:4005:802::200a

- 0110 = Version: 6
- > 0000 0000 = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
- 1001 0010 1010 0001 1111 = Flow Label: 0x92a1f
- Payload Length: 48
- Next Header: Destination Options for IPv6 (60)
- Hop Limit: 64
- Source Address: 2600:1900:41a0:71b6:0:1::
- Destination Address: 2404:6800:4005:802::200a
- ∨ Destination Options for IPv6
 - Next Header: TCP (6)
 - Length: 1
 - [Length: 16 bytes]
 - > Performance and Diagnostic Metrics
 - > PadN

> Transmission Control Protocol, Src Port: 49510, Dst Port: 443, Seq: 1, Ack: 1, Len: 0

**Ping from
Inside Cloud
with EH works
fine.**

ping3g1v2.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ipv6

No.	Time	Source	Destination	Next Header	Info
148	21.280398	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	60474 → 80 [SYN] Seq=0 Win=64
152	21.280670	2600:1900:41a0:71b6:0:2::	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	80 → 60474 [SYN, ACK] Seq=0 A
153	21.280705	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	60474 → 80 [ACK] Seq=1 Ack=1
154	21.280769	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	GET / HTTP/1.1
156	21.280921	2600:1900:41a0:71b6:0:2::	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	80 → 60474 [ACK] Seq=1 Ack=14
158	21.281494	2600:1900:41a0:71b6:0:2::	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	80 → 60474 [PSH, ACK] Seq=1 A
159	21.281494	2600:1900:41a0:71b6:0:2::	2600:1900:41a0:71b6:0:1::	Destination Options for IPv6	HTTP/1.1 200 OK (text/html)
160	21.281545	2600:1900:41a0:71b6:0:1::	2600:1900:41a0:71b6:0:2::	Destination Options for IPv6	60474 → 80 [ACK] Seq=143 Ack=

> Frame 159: 4144 bytes on wire (33152 bits), 4144 bytes captured (33152 bits)

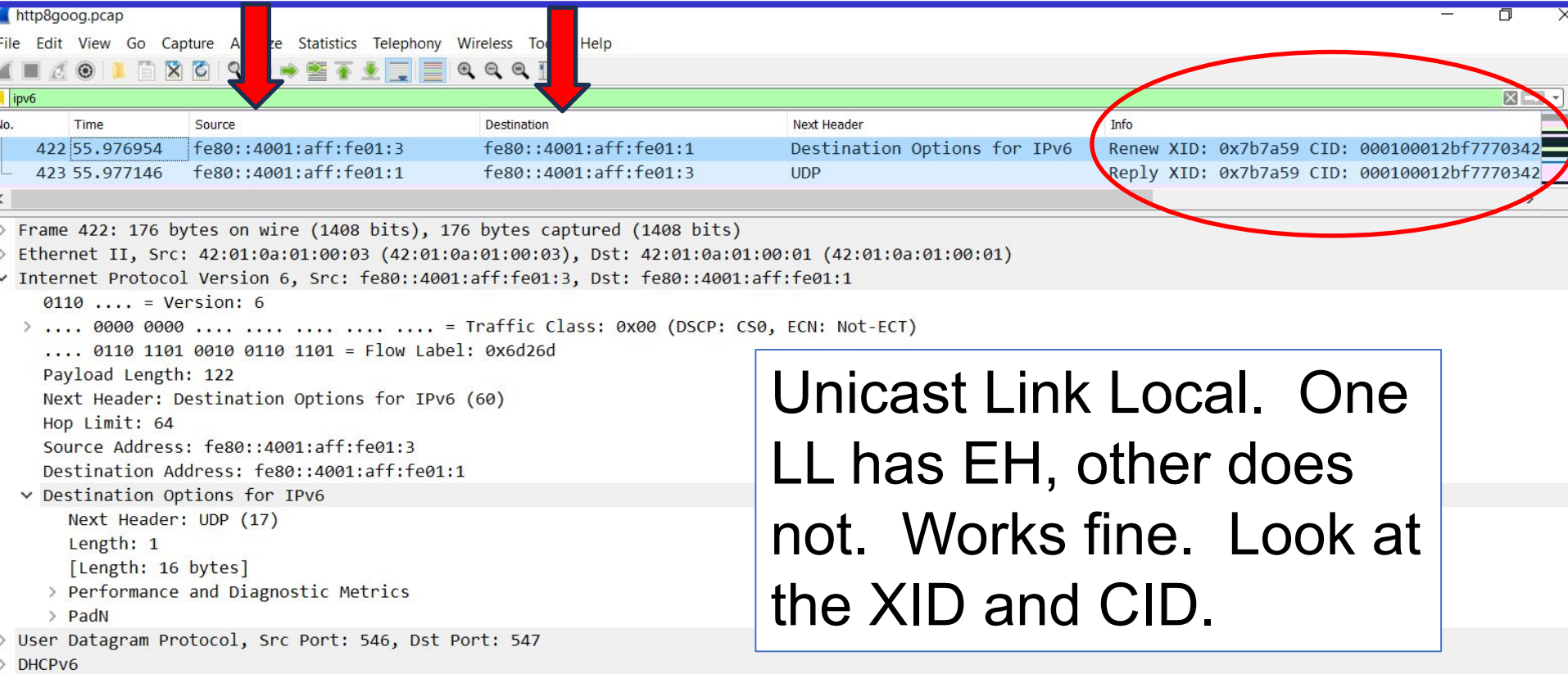
> Ethernet II, Src: 42:01:0a:01:00:01 (42:01:0a:01:00:01), Dst: 42:01:0a:01:00:03 (42:01:0a:01:00:03)

▼ Internet Protocol Version 6, Src: 2600:1900:41a0:71b6:0:2::, Dst: 2600:1900:41a0:71b6:0:1::

- 0110 = Version: 6
- > 0000 0000 = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
- 0111 0101 1101 1010 0110 = Flow Label: 0x75da6
- Payload Length: 4090
- Next Header: Destination Options for IPv6 (60)
- Hop Limit: 64
- Source Address: 2600:1900:41a0:71b6:0:2::
- Destination Address: 2600:1900:41a0:71b6:0:1::
- ▼ Destination Options for IPv6
 - Next Header: TCP (6)
 - Length: 1
 - [Length: 16 bytes]
 - > Performance and Diagnostic Metrics

As does HTTP.

Let's look at Link Local in Cloud



http8goog.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

No.	Time	Source	Destination	Next Header	Info
422	55.976954	fe80::4001:aff:fe01:3	fe80::4001:aff:fe01:1	Destination Options for IPv6	Renew XID: 0x7b7a59 CID: 000100012bf7770342
423	55.977146	fe80::4001:aff:fe01:1	fe80::4001:aff:fe01:3	UDP	Reply XID: 0x7b7a59 CID: 000100012bf7770342

> Frame 422: 176 bytes on wire (1408 bits), 176 bytes captured (1408 bits)

> Ethernet II, Src: 42:01:0a:01:00:03 (42:01:0a:01:00:03), Dst: 42:01:0a:01:00:01 (42:01:0a:01:00:01)

> Internet Protocol Version 6, Src: fe80::4001:aff:fe01:3, Dst: fe80::4001:aff:fe01:1

- 0110 = Version: 6
- > 0000 0000 = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
- 0110 1101 0010 0110 1101 = Flow Label: 0x6d26d
- Payload Length: 122
- Next Header: Destination Options for IPv6 (60)
- Hop Limit: 64
- Source Address: fe80::4001:aff:fe01:3
- Destination Address: fe80::4001:aff:fe01:1
- > Destination Options for IPv6
 - Next Header: UDP (17)
 - Length: 1
 - [Length: 16 bytes]
 - > Performance and Diagnostic Metrics
 - > PadN
- > User Datagram Protocol, Src Port: 546, Dst Port: 547
- > DHCPv6

Unicast Link Local. One LL has EH, other does not. Works fine. Look at the XID and CID.

From the other side Link Local

http8goog.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

No.	Time	Source	Destination	Next Header	Info
422	55.976954	fe80::4001:aff:fe01:3	fe80::4001:aff:fe01:1	Destination Options for IPv6	Renew XID: 0x7b7a59 CID: 000100012bf7770342
423	55.977146	fe80::4001:aff:fe01:1	fe80::4001:aff:fe01:3	UDP	Reply XID: 0x7b7a59 CID: 000100012bf7770342

Frame 423: 162 bytes on wire (1296 bits), 162 bytes captured (1296 bits)

Ethernet II, Src: 42:01:0a:01:00:01 (42:01:0a:01:00:01), Dst: 42:01:0a:01:00:03 (42:01:0a:01:00:03)

Internet Protocol Version 6, Src: fe80::4001:aff:fe01:1, Dst: fe80::4001:aff:fe01:3

- 0110 = Version: 6
- > 0000 0000 = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
- 0000 0000 0000 0000 = Flow Label: 0x00000
- Payload Length: 108
- Next Header: UDP (17)
- Hop Limit: 1
- Source Address: fe80::4001:aff:fe01:1
- Destination Address: fe80::4001:aff:fe01:3

User Datagram Protocol, Src Port: 547, Dst Port: 546

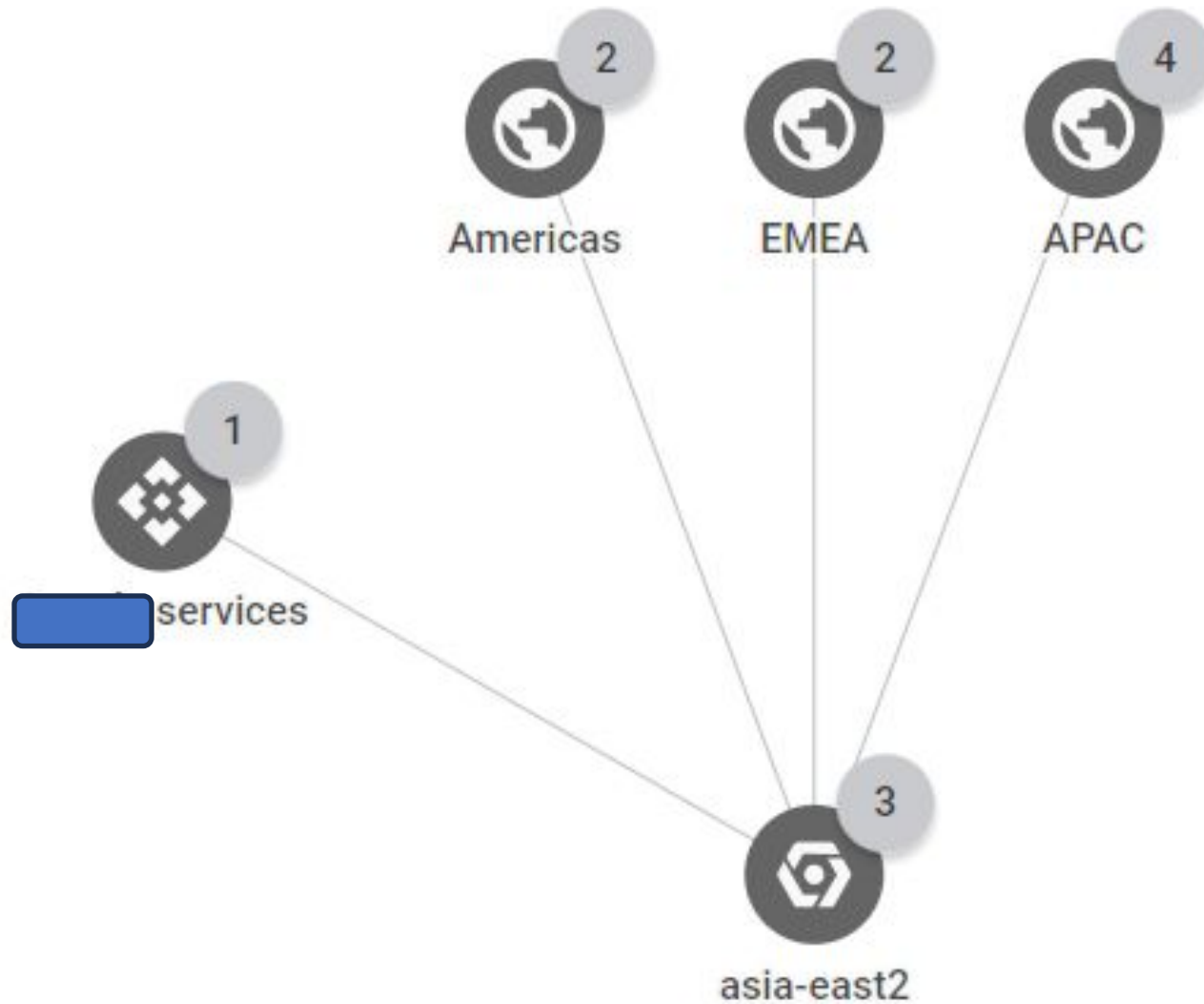
DHCPv6

Response comes back fine.

Bottom Line

- IPv6 to Cloud Provider #1 with no IPv6 extension headers works fine. (PING and HTTP). Client can be inside cloud or outside cloud.
- IPv6 with Cloud Provider #1 with IPv6 extension headers does not work. Client can be inside cloud or outside cloud.
 - OS supports EHs
- “Network” does not
- Inside Cloud: IPv6 with Cloud Provider #1 with IPv6 extension headers works
 - OS supports
 - Internal “Network” appears to be not a factor
 - Link Local as well as Global Unicast works

Cloud #1 – Multiple Datacenters (IC-MD)



Next Steps ...

- Test with:
 - More cloud providers
 - Routers
 - ISPs
 - Load balancers
 - OSs
- Need to test ALL extension headers!
- This will be a multi-year process!

Questions?

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