Exploring IPv6 Extension Header Deployment - Updates 2020

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Our ERG Probes

We did experiments too!

- Physical probes

  - APU boards

  - Ansible configured

  - California, Slough and Aberdeen (hosted by Tim Chown, Bob Hinden and Warren Kumari)

- Other **virtual probes** in Digital Ocean Data Centres

  - *Could YOU also host one?*

Experiments

Hop-by-Hop Options Extension Header (Type 0)

Destination Options Extension Header (Type 60)

	End2End traversal tests	Traceroute-style tests
Protocol	DNS/UDP/IPv6	ICMP/IPv6
Test	Send a DNS query and tests for valid responses	Records ICMP replies from routers along the path
Targets?	IPv6 authoritative NS-es for all domains in the latest Alexa Top 1M list (=~20,000 targets)	

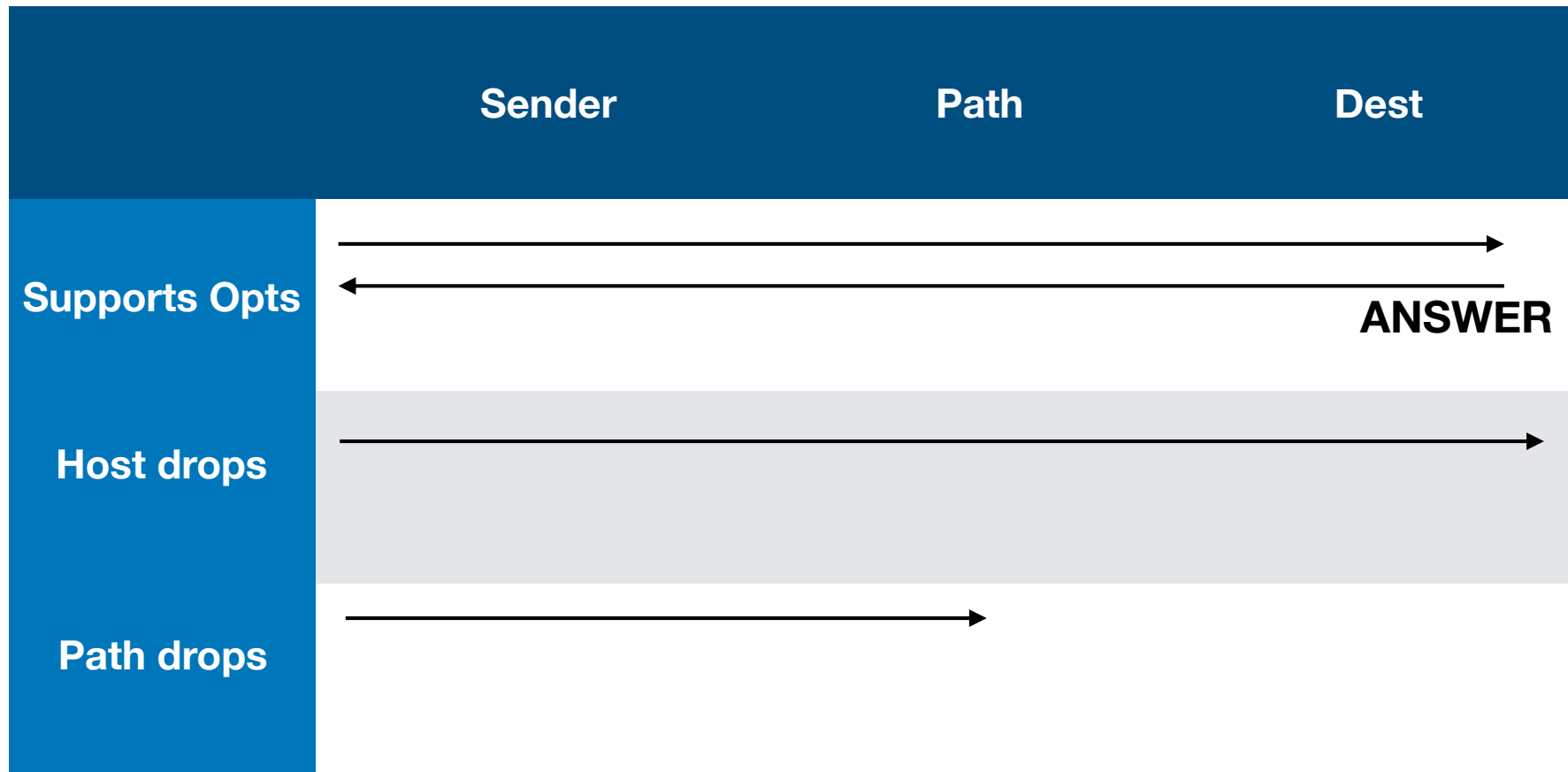# Experiments

Hop-by-Hop Options Extension Header (Type 0)

Destination Options Extension Header (Type 60)

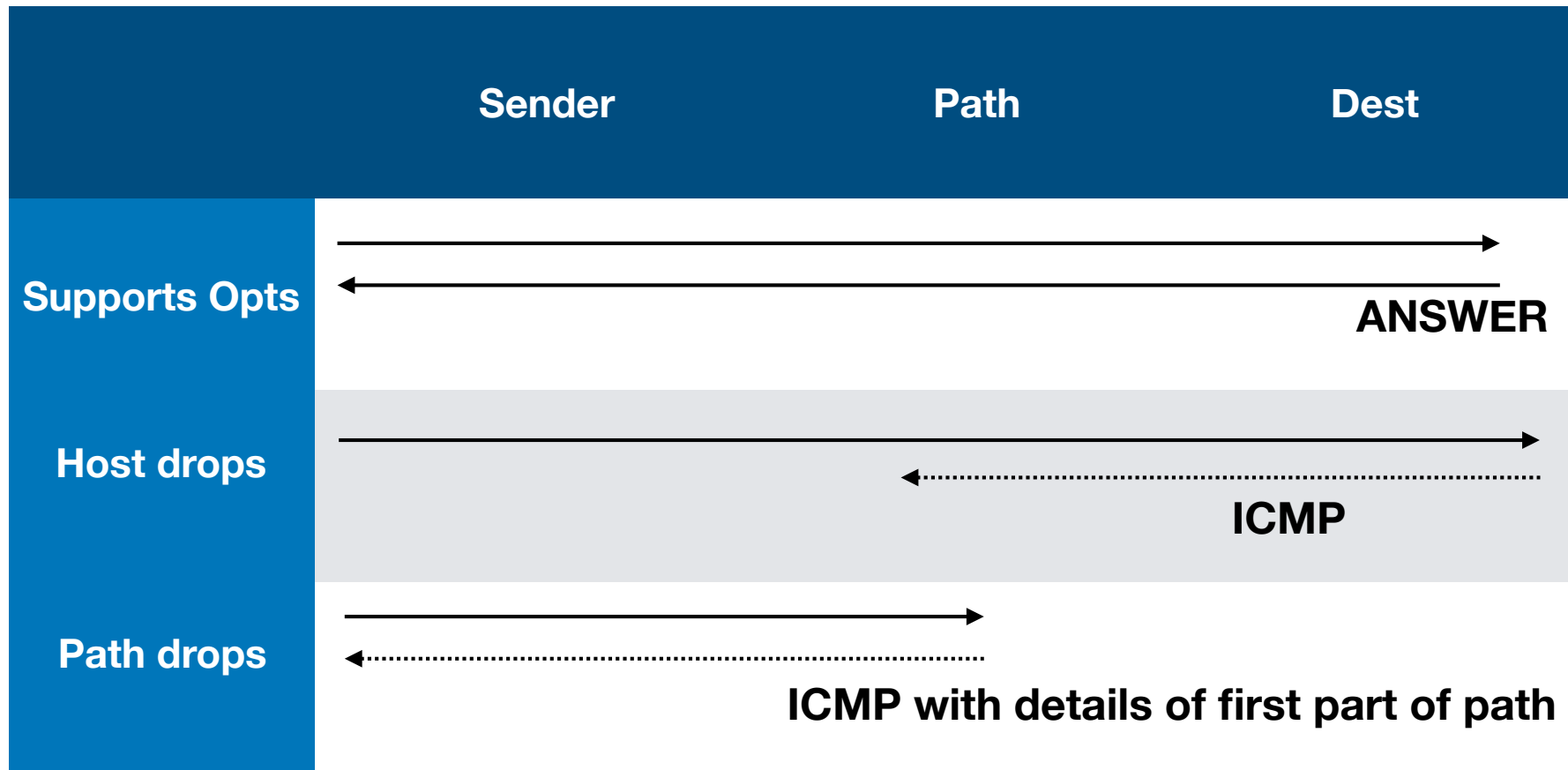|	End2End traversal tests	Traceroute-style tests
Protocol	DNS/UDP/IPv6	ICMP/IPv6
Test	Send a DNS query and tests for valid responses	Records ICMP replies from routers along the path
Targets?	IPv6 authoritative NS-es for all domains in the latest Alexa Top 1M list (=~20,000 targets)	
Additional tests	• Valid PadN • Invalid PadN • Empty/all zeroes • Minimum PMTU (draft-ietf-6man-mtu-option)	

Tests - E2E Traversal

Traversal considered successful if we receive a valid DNS reply to our query

	Sender	Path	Dest
Supports Opts	→ → → **ANSWER** ← ←		
Host drops	→ → →		
Path drops	→ →		

Tests - E2E Traversal

Traversal considered successful if we receive a valid DNS reply to our query

	Sender	Path	Dest
Supports Opts			ANSWER
Host drops			ICMP
Path drops		ICMP with details of first part of path	

Results of E2E Server Tests

- Around 50% of DNS servers support IPv6 Destination options, reliably from all sites

- HbH traversal varies greatly depending on the vantage point! Bob's house does not pass them (sorry Comcast!) We did not look at other home access networks.

- A padN option that advertises an invalid length only traverses **0.2% of paths** - we conclude people do check!

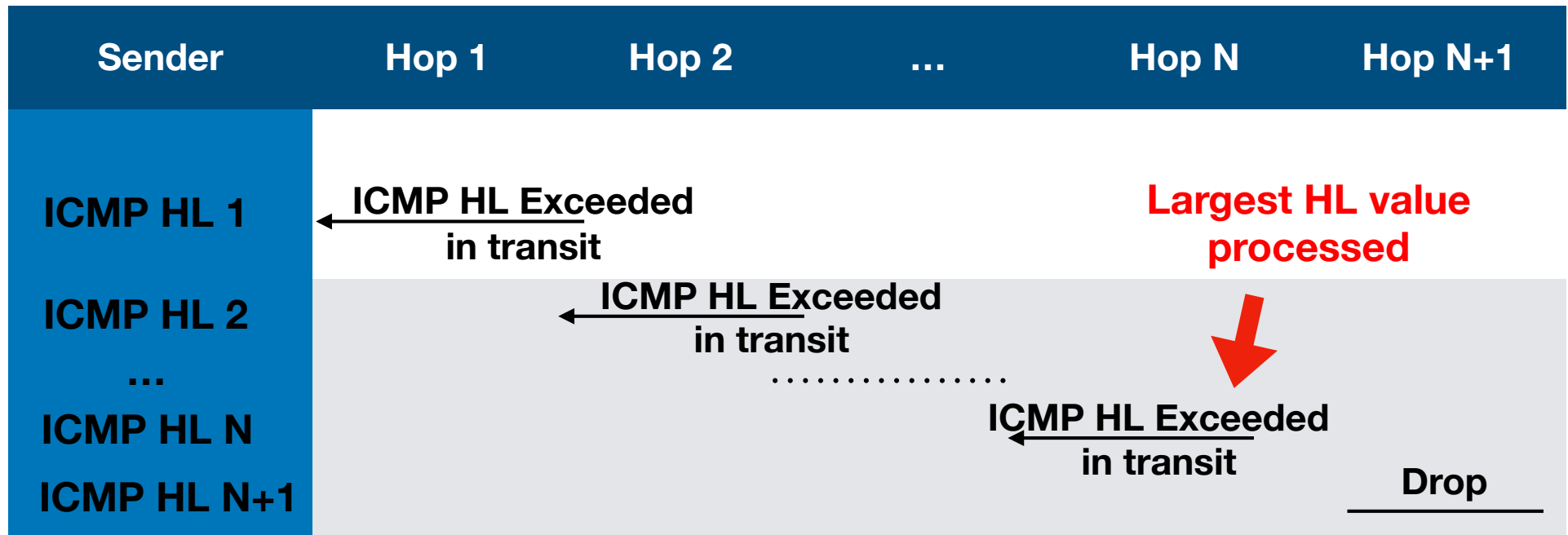- A new/unknown option (Min PMTU) has the same traversal rate as a well-known one (PadN)

PATH*spider*

Results - E2E Traversal
Feb2020 -> Jul2020

	Aberdeen	Slough	California (Bob)	California (Warren)
Supports HBH Opts	14.9%->13.6%	22.4%->21.8%	0%->0%	36%->42.4%
Supports Destination Opts	52.7%->47.9%	53.7%->49.5%	51.9%->47.1%	52%->46.5%
None Supported	35.1%->41%	26%->34.3%	38.5%->42%	28.2%->26.2%
Both supported	14.6%->13.4%	12.6%->14.1%	0%->0%	26%->24.1%
Total servers	18296->19519	18252->19657	18261 ->19647	18250->19652

Results from testing with a valid PadN option

Results of Path Tests using ICMP

Sender	Hop 1	Hop 2	...	Hop N	Hop N+1
ICMP HL 1	← **ICMP HL Exceeded in transit**			**Largest HL value processed** (red)	
ICMP HL 2		← **ICMP HL Exceeded in transit**			
...			....		
ICMP HL N				← **ICMP HL Exceeded in transit**	
ICMP HL N+1					Drop

- Out of 1.8 M packets examined, none had their PadN option altered

- One hop removed the fields for both Extension Headers entirely

- Largest HL value correctly processed = Maximum hops traversed until discarded or reached destination

- We averaged maximum hops traversed from a vantage point across all paths

Number of hops traversed
(max hops, from Aberdeen)
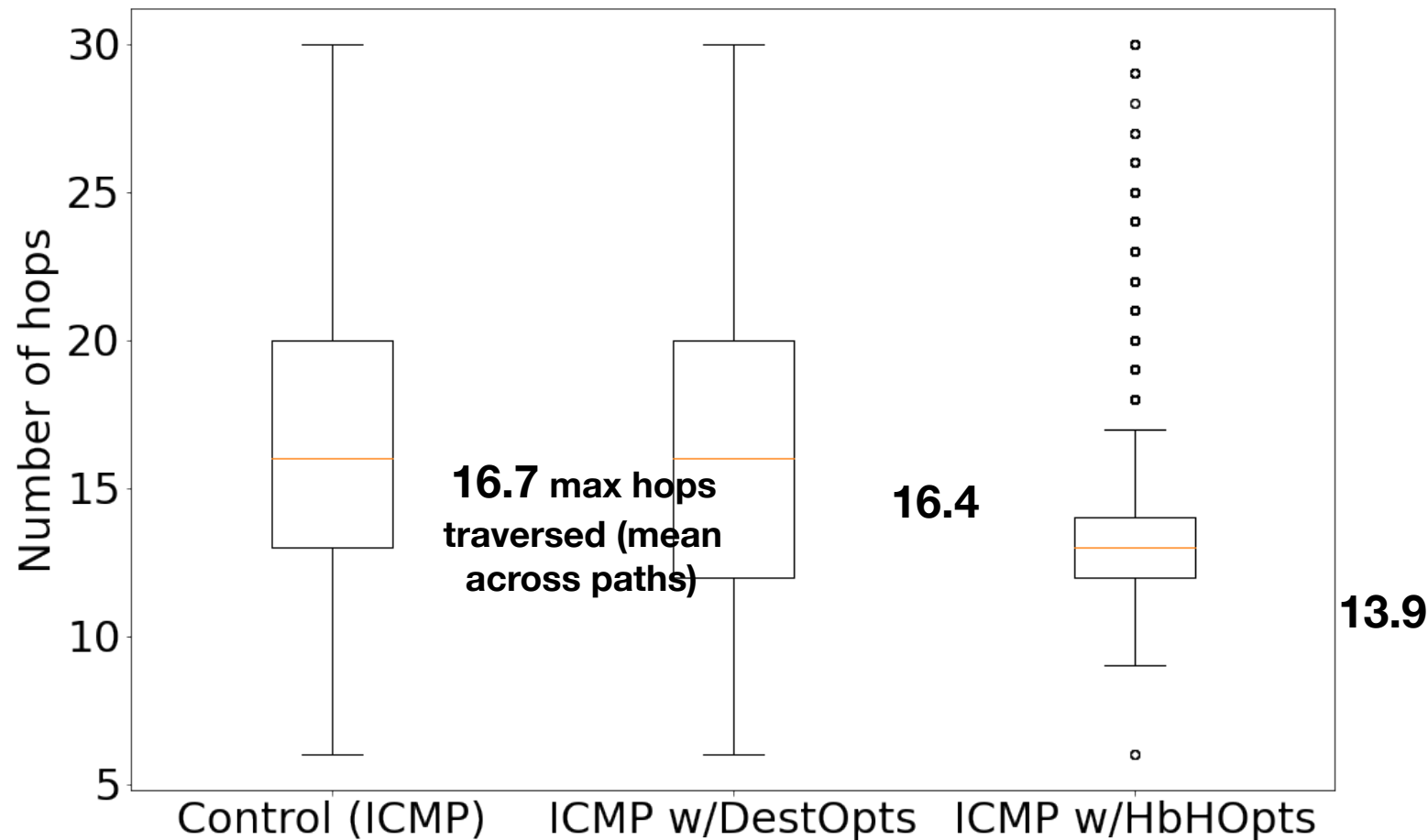
Destination Option packets are probably discarded at server edge (16.7 vs 16.4)

HbH Option packets are dropped 2-3 hops earlier on average (13.9)

Results validated from (almost) all vantage points. Sorry Comcast!

What did we Learn?

- Dest and HbH options travel "far" along a path,

  - We did not test access networks…more measurements needed!!

- In many cases options are forwarded to the destination: the Min PMTU option can be used by the DPLPMTUD algorithm

- In many cases the packet carrying the option is dropped…best to send any option on a probe packet that doesn't impact normal traffic!

  - When dropped, 2% of paths get an ICMPv6 response that quotes EH

  - Mostly, ICMP and v6 Options are silently dropped

    - The default behaviour for many firewalls (pf, ipfw & friends)!

- Nothing to suggest using this option in a DC would break anything

Next Steps for this Draft

We plan to revise the draft with what we learned.

(1) Advise setting option on a probe packet.

(2) Other aspects are the same as any other HbH Option.

(3) No current API in protocol stacks to set/receive this information.

(4) Could this ID target PS?

Virtual Probe Details

- Help us do experiments from the edge!

  - e.g. RIPE Atlas?

- Can you host a virtual probe?

  - Image file for a VM with 2 cores, 4096 MB of RAM and 50 GB disk, format (e.g., qcow2) can be arranged