# IPv6 Extension Headers Filtering Measurements with RIPE Atlas

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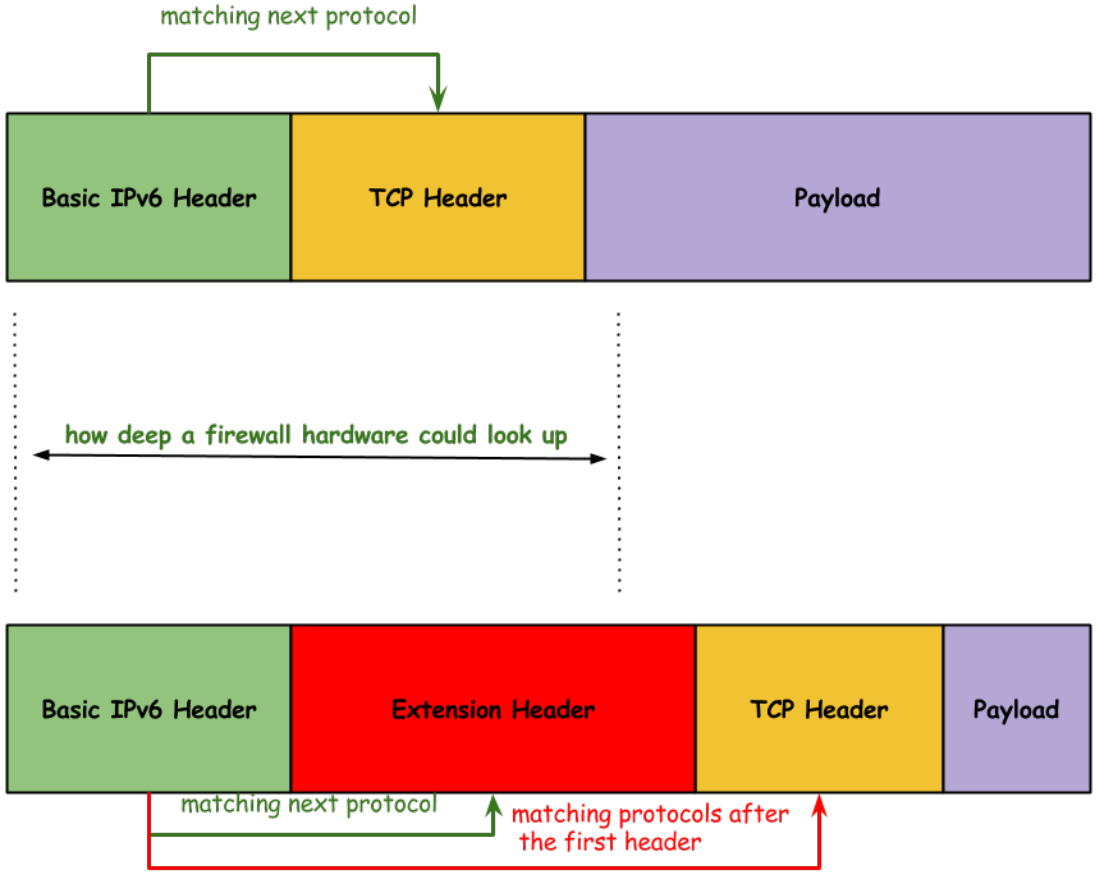
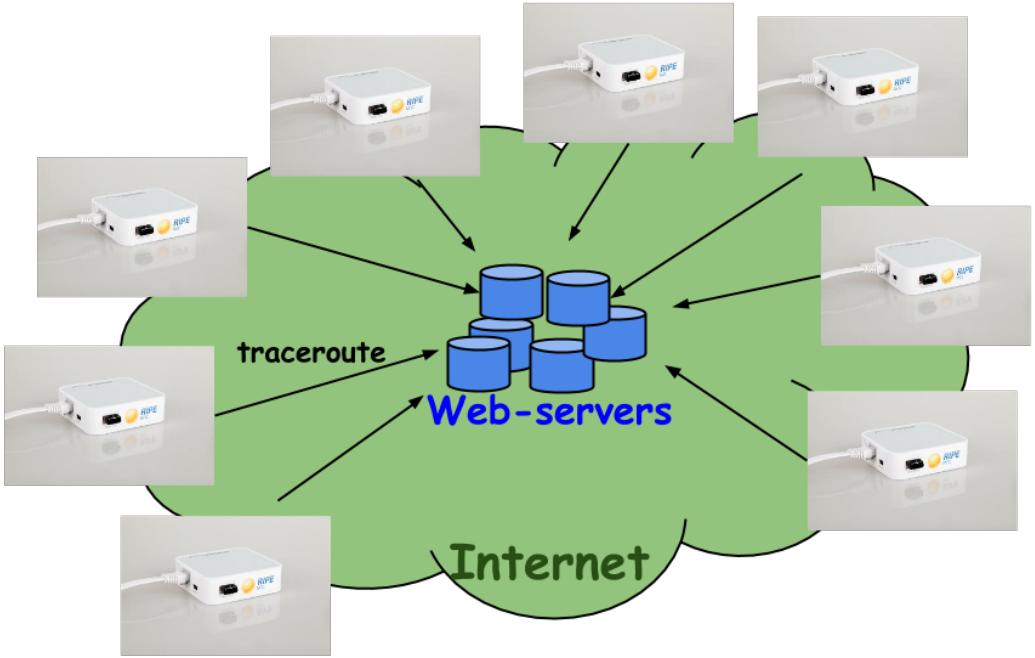
# Motivation

- Can Extension Headers be used?
  - Are they filtered/dropped?
- Where?
  - at source or destination network (under client/server control)
  - by transit networks?
- Measurements have been done (mostly for fragment header) - but what is the trend?

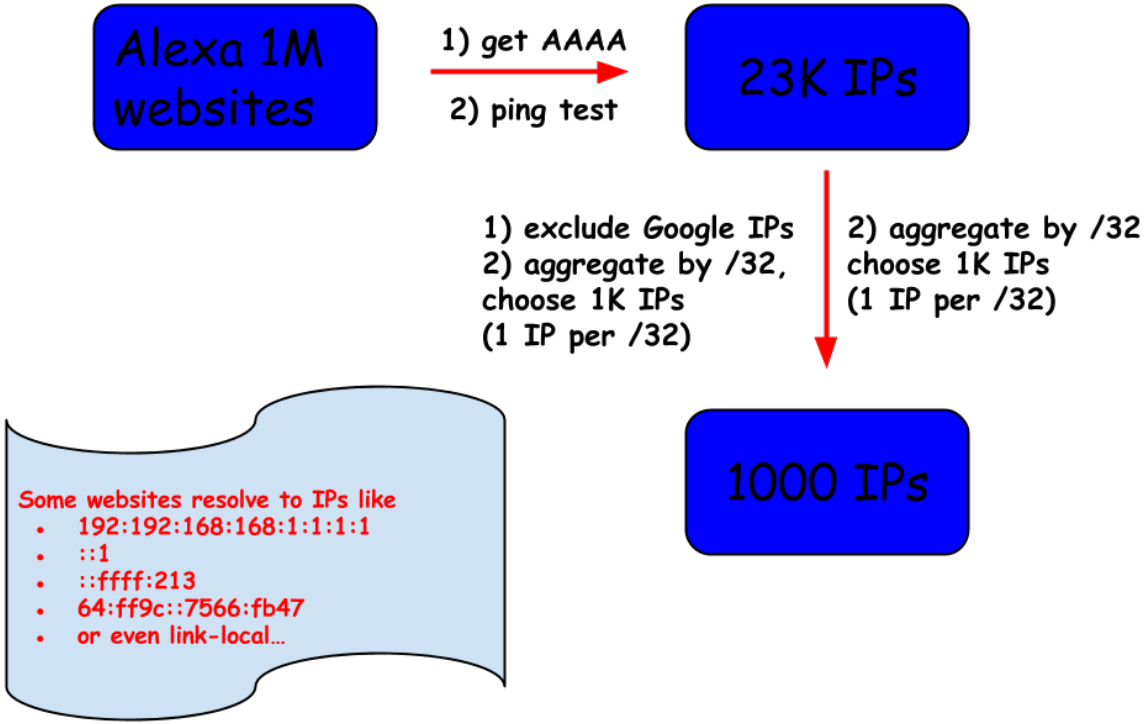
# IPv6 Extension Headers (TCP Example)



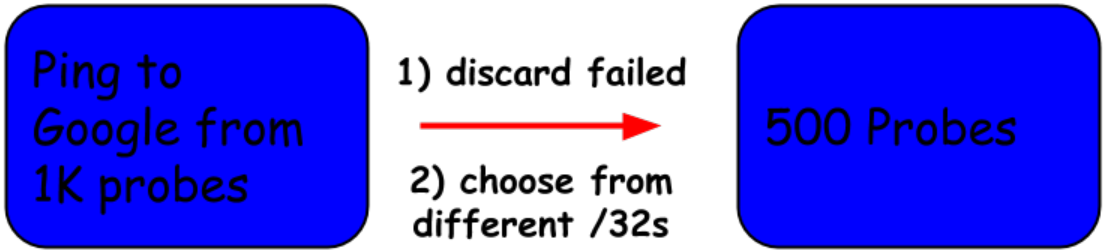
# Testing Topology



# Choosing Targets



# Choosing RIPE Atlas Probes



# Methodology

To each destination from each probe:

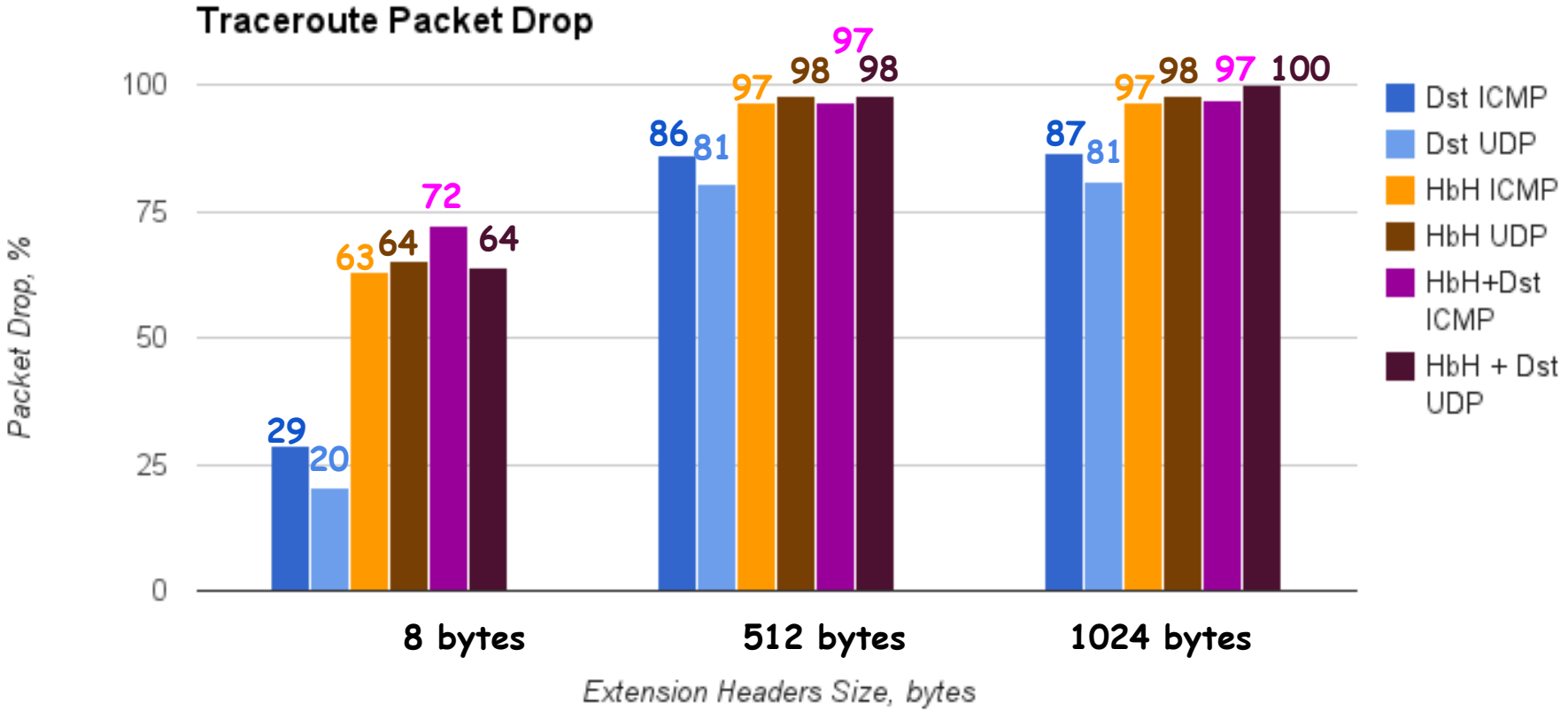
For $PROTOCOL in ("ICMP", "UDP"):

- control measurement ($PROTOCOL traceroute)
- 9 $PROTOCOL traceroute tests:
  - Hop-by-Hop Options:
    - 8 bytes, 512 bytes, 1024 bytes
  - Destination Options
    - 8 bytes, 512 bytes, 1024 bytes
  - Hop-by-Hop + Destination Options
    - 8 bytes + 8 bytes
    - 128 bytes + 128 bytes
    - 512 bytes + 512 bytes

# Processing the Results

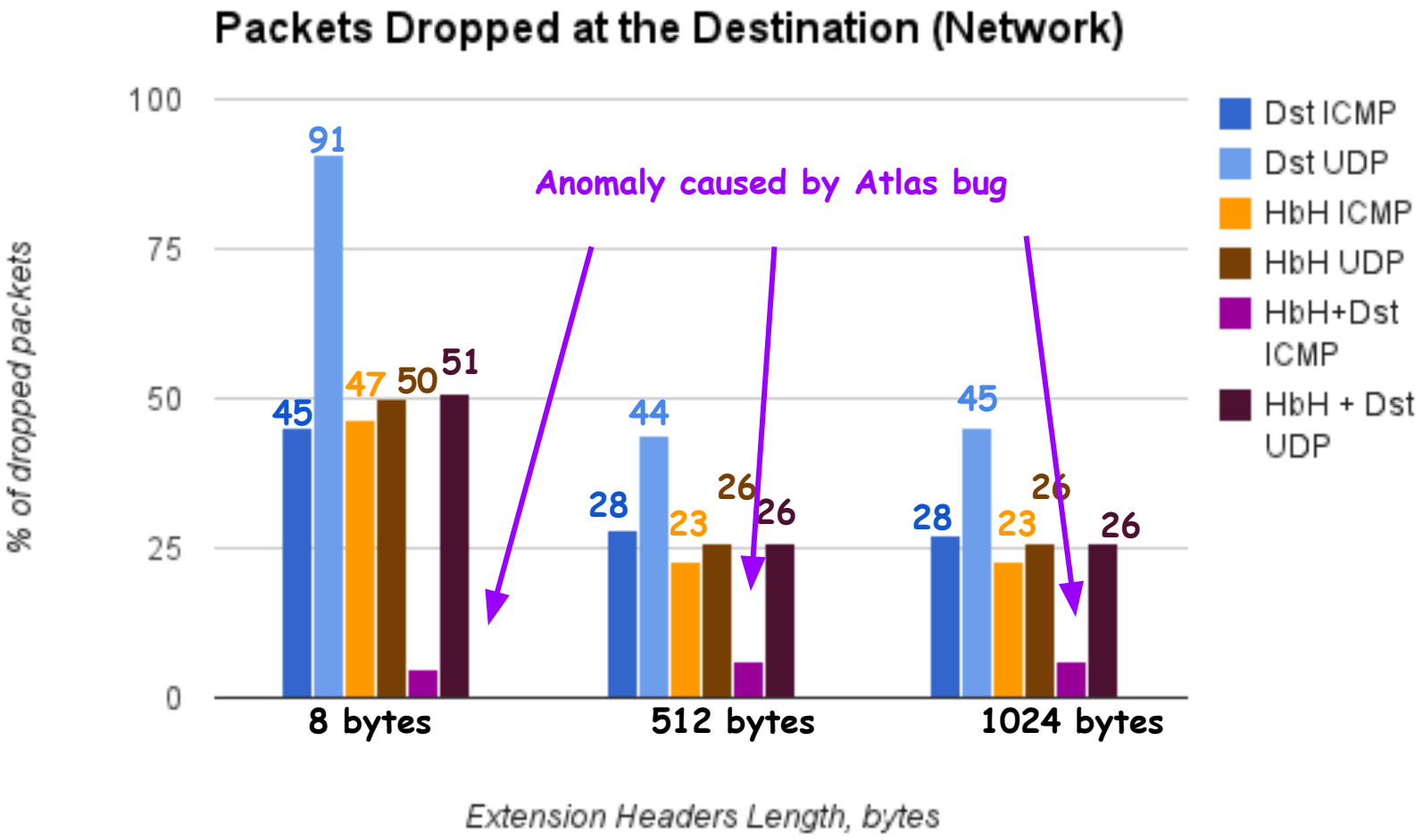
For each (probe; destination) test:

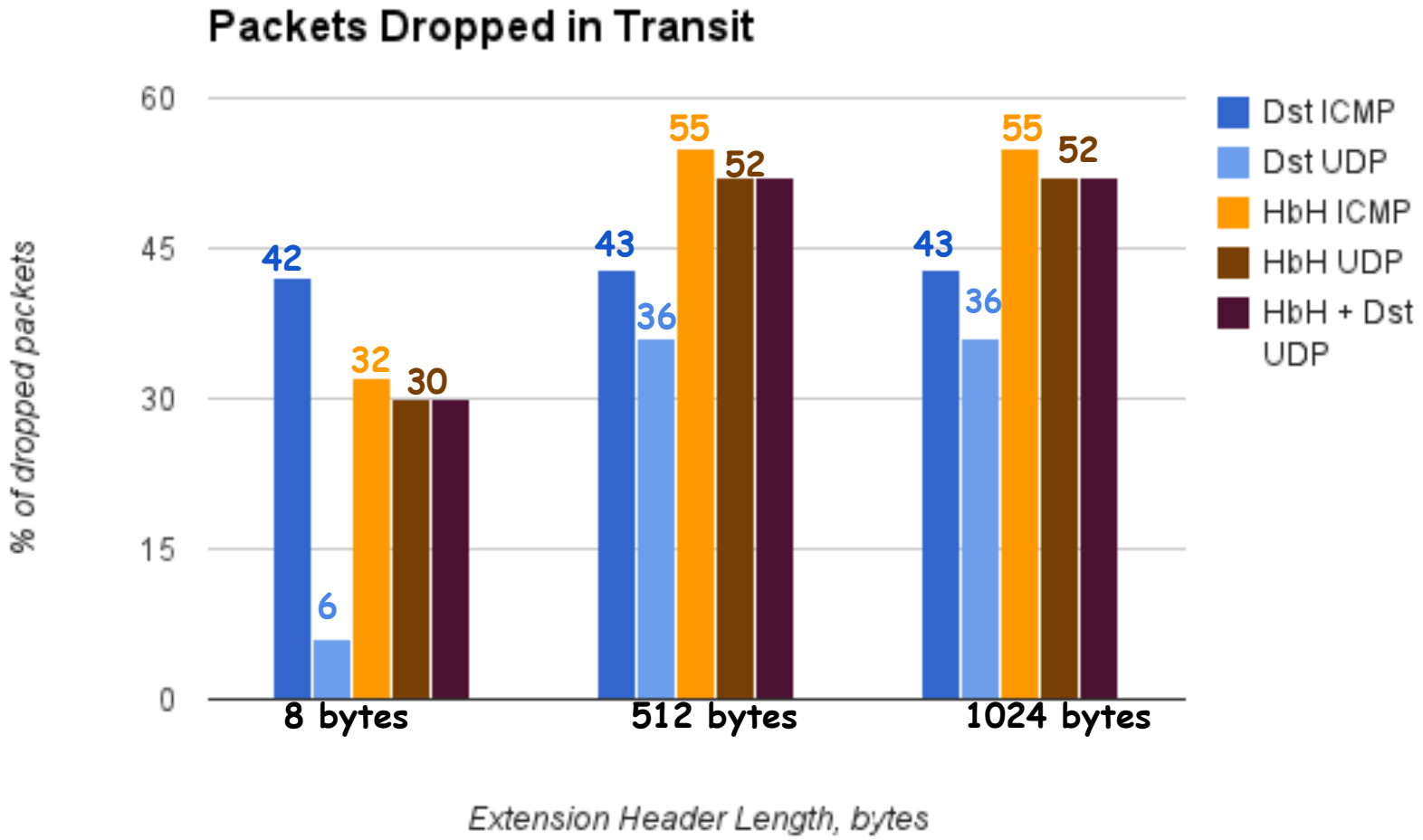
- **discard** the test if the control test failed
- **discard** the test if **not all 10 sub-tests** were run on the probe (you don't necessarily get all probes you requested)

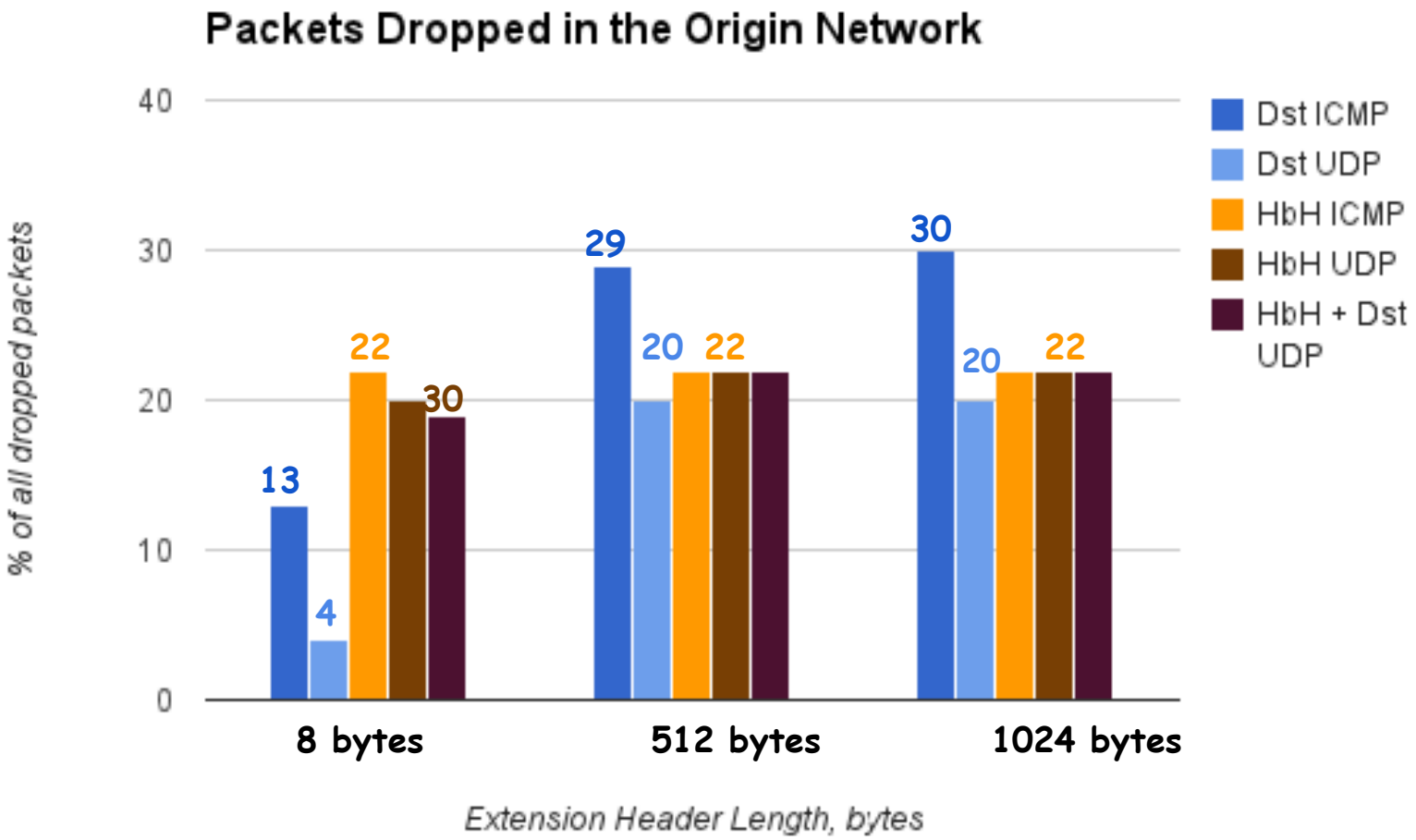

Traceroute Packet Drop
Packet Drop, %
100
75
50
25
0
29
20
63
64
72
64
86
81
97
98
97
98
87
81
97
98
97
100
8 bytes
512 bytes
1024 bytes
Extension Headers Size, bytes
Dst ICMP
Dst UDP
HbH ICMP
HbH UDP
HbH+Dst ICMP
HbH + Dst UDP

# Where Are Packets Dropped?

- Finding origin AS for each traceroute hops
- Ignoring invalid IPs/link-local/ULAs/etc
- Comparing 'AS_PATH' for control test and the measurement;
    - If AS_PATH for failed test has length 0 or 1:
        - packet could not leave the origin network
    - If last AS in AS_PATH for failed test is destination AS or PHP AS from the control test:
        - packet was dropped in the destination network or on its edge


Packets Dropped at the Destination (Network)
100
75
50
25
0
% of dropped packets
Anomaly caused by Atlas bug
45
91
47
50
51
28
44
23
26
26
28
45
23
26
26
8 bytes
512 bytes
1024 bytes
Extension Headers Length, bytes
Dst ICMP
Dst UDP
HbH ICMP
HbH UDP
HbH+Dst ICMP
HbH + Dst UDP


Packets Dropped in Transit
60
45
30
15
0
% of dropped packets
42
6
32
30
43
36
55
52
43
36
55
52
8 bytes
512 bytes
1024 bytes
Extension Header Length, bytes
Dst ICMP
Dst UDP
HbH ICMP
HbH UDP
HbH + Dst UDP


Packets Dropped in the Origin Network
40
30
20
10
0
% of all dropped packets
13
4
22
30
29
20
22
30
20
22
8 bytes
512 bytes
1024 bytes
Extension Header Length, bytes
Dst ICMP
Dst UDP
HbH ICMP
HbH UDP
HbH + Dst UDP

# ~~Speculations~~ Conclusions

- Packets with EHs ARE DROPPED ;(
- Short EHs have lower drop rate
  - most chips could not look deeper than first 64-128-256 bytes?
- For long EHs the next protocol does not matter
  - ACLs could not match it
- UDP packets with 8-bytes DO have the best chances to reach the destination
  - 80% success
  - ~50% of filtering - at the destination

# Roadmap

- Fragment Header from servers to clients
- More details analysis of where packets are dropped
  - how many dropped by the host?
- Test TCP
- Re-run ICMP HbH+DO measurememnt

Repeat the measurement in 1 year

...any other ideas?