A view of the dual-stack world from .jp

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motivation

- it’s time to consider the quality of IPv6 network
  - one of the major hurdles in IPv6 deployment
    - IPv6 network should be better than IPv4 to attract users
  - in reality, IPv6 performance is much worse
    - advanced users play with IPv6 for a while
    - and then, disable IPv6 for performance reasons
    - which might leave yet another unmanaged IPv6 network...
  - possible causes
    - low-quality operations, lack of peering, poor tunneling
- we need to understand the real situation:
  - is IPv6 network so bad?
  - is it caused by a small number of bad ones?
    - if so, we can improve IPv6 network by fixing them
- need to identify specific problems to fix bad ones
  - routing problems, bad tunnels, lack of peering

approach

- identify dual-stack nodes with poor IPv6 performance by
  - comparing IPv4/IPv6 RTTs
  - comparing IPv4/IPv6 paths
  - from several points to thousands of dual-stack nodes
- methods
  - create a list of target dual-stack nodes
    - dual-stack nodes: hosts with both A and AAAA
      - a target list from real traffic
  - run ping{,6} to the targets
  - extract nodes with large v6rtt/v4rtt ratio
  - run traceroute{,6} to the extracted targets
  - visualize results to identify the causes of the problems

preliminary measurements

- results are preliminary
- caveats
  - the same DNS name could point to different hosts
    - load balancing, different hosts for IPv4 and IPv6
  - ping isn’t good to measure RTT
    - slow-forwarding path for ICMP, ICMP is often filtered
  - measurements currently only from jp
    - planning to do the same in US and Europe

- but the results still provide some ideas

AAAA capturing

- AAAA capturing tool (to obtain IPv6 addresses in use)
  - monitor DNS responses by pcap(3), and print name/AAAA pairs apearing in answer, authority, additional sections
  - tested at 3 sites in japan (AS2500) for 2 weeks in Feb 2004
- got 6514 unique IPv6 address/hostname pairs
  - valid(5448):
    - 2001::/16(4276), 2002::/16(134), 3ffe::/16(970), ::ffff/96(67)
  - invalid(1066) link-local, unassigend prefixes
- use 2001::/16 and 3ffe::/16 (5247) for further tests
  - countries by prefixes in RIR info
    - JP(1146) NL(1059) DE(609) US(562) FR(405) UK(183) IT(120) CH(117) CA(112) PL(98) SE(90) FI(69) CZ(65) SK(58) DK(49) AT(43) PT(43) IE(33) EE(33) AU(32) NO(30) TW(29) ZA(29) EU(24) BE(16) KR(15) BR(14) CN(13) ES(13) HU(13) LT(13) LU(12) MY(11) TH(9) YU(8) MX(7) RU(5) HK(4) GR(4) AR(3) TN(2) SG(2) RO(1)

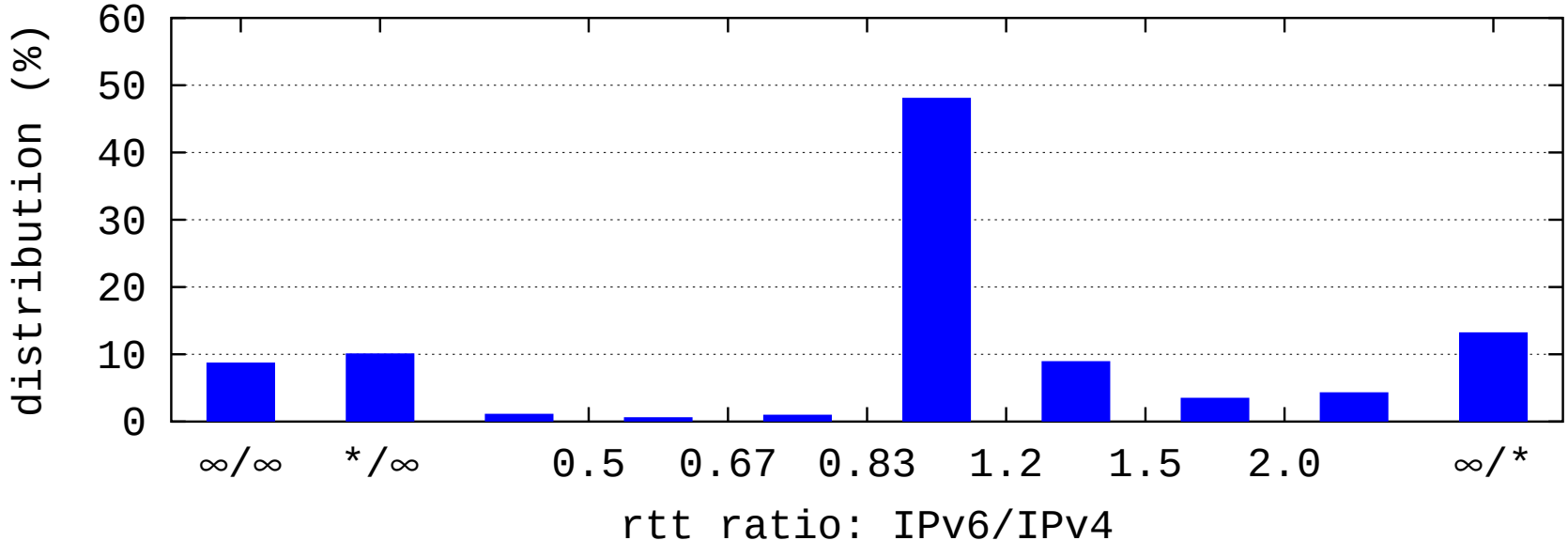
target list creation

- extract dual-stack nodes (with both A and AAAA) by DNS lookup
  - 2001::/16 and 3ffe::/16 (5247)
  - A+AAAA(3434) A only(68) AAAA only(1635) nodata(109) err(1)
- filter ones with bad A: 127.0.0.1(4) RFC1918(19)
- got 3411 dual-stack nodes
  - JP(1033) NL(451) US(409) DE(395) FR(204) UK(128) IT(84) CA(81) SE(68) CH(61) SK(40) PL(37) FI(35) IE(32) AU(28) NO(27) AT(26) DK(25) CZ(25) PT(22) EE(20) TW(18) KR(15) EU(14) CN(12) LT(11) BR(10) BE(10) HU(10) MY(9) TH(8) ZA(8) LU(8) YU(7) ES(6) HK(4) MX(4) RU(4) GR(2) TN(2) SG(2) AR(2) RO(1)
  - CA(81) includes 77 in freenet6 (3ffe:0b/24)
- RTT measurement by ping from a single site in WIDE(AS2500)

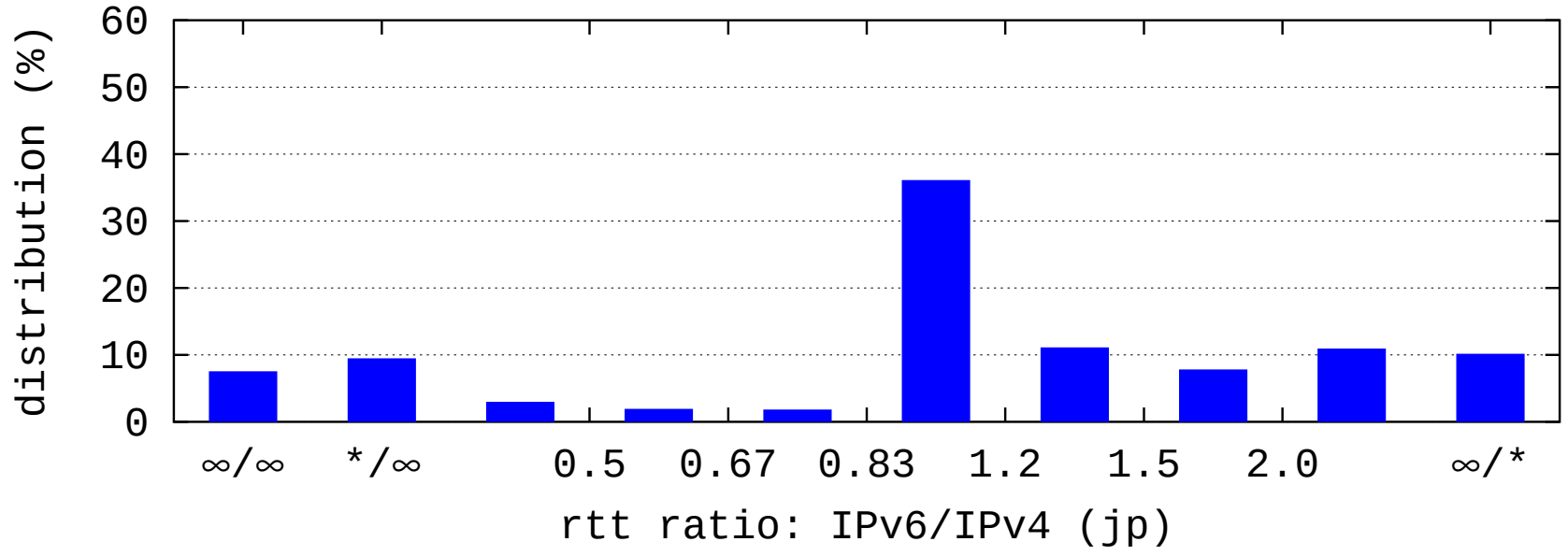
ping results

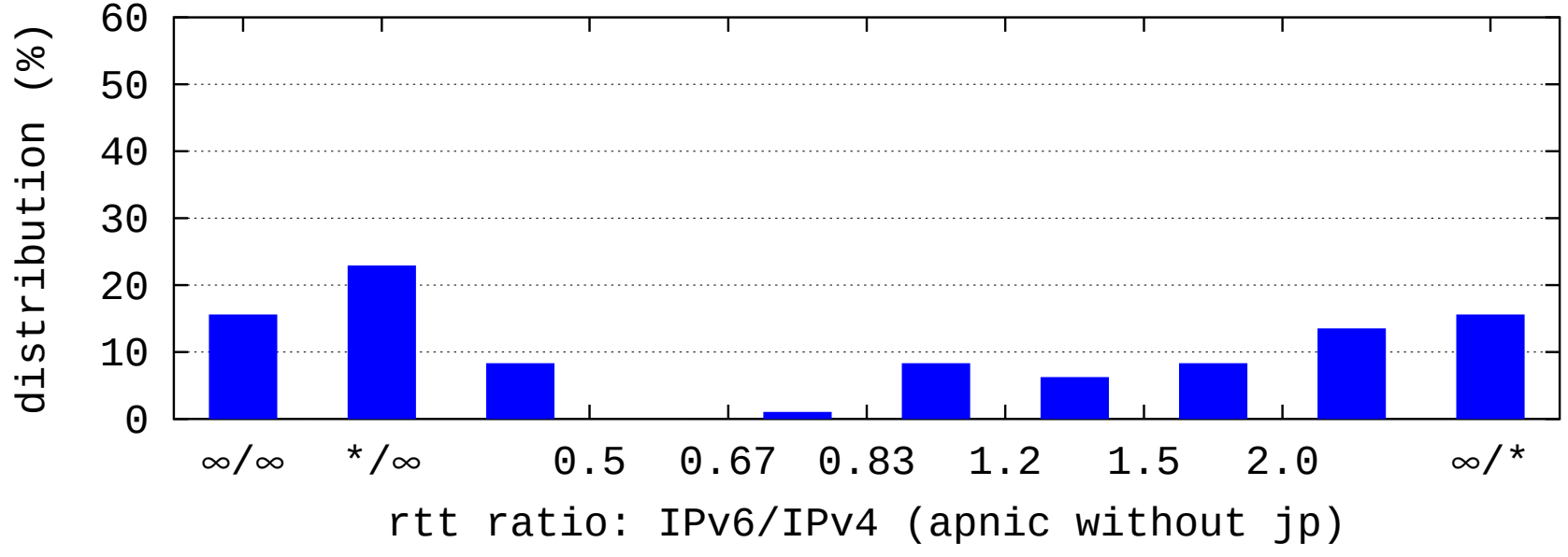
- 48% have similar RTT (+-20%) for IPv4 and IPv6
- result suggests connectivity is a bigger issue than RTT
  - 9% are not reachable by both IPv4 and IPv6
  - 10% are not reachable by IPv4 (or ICMP filterd) but ok for IPv6
  - 13% are not reachable by IPv6 but ok for IPv4

- distibution of IPv6/IPv4 rtt ratio (3411 nodes)

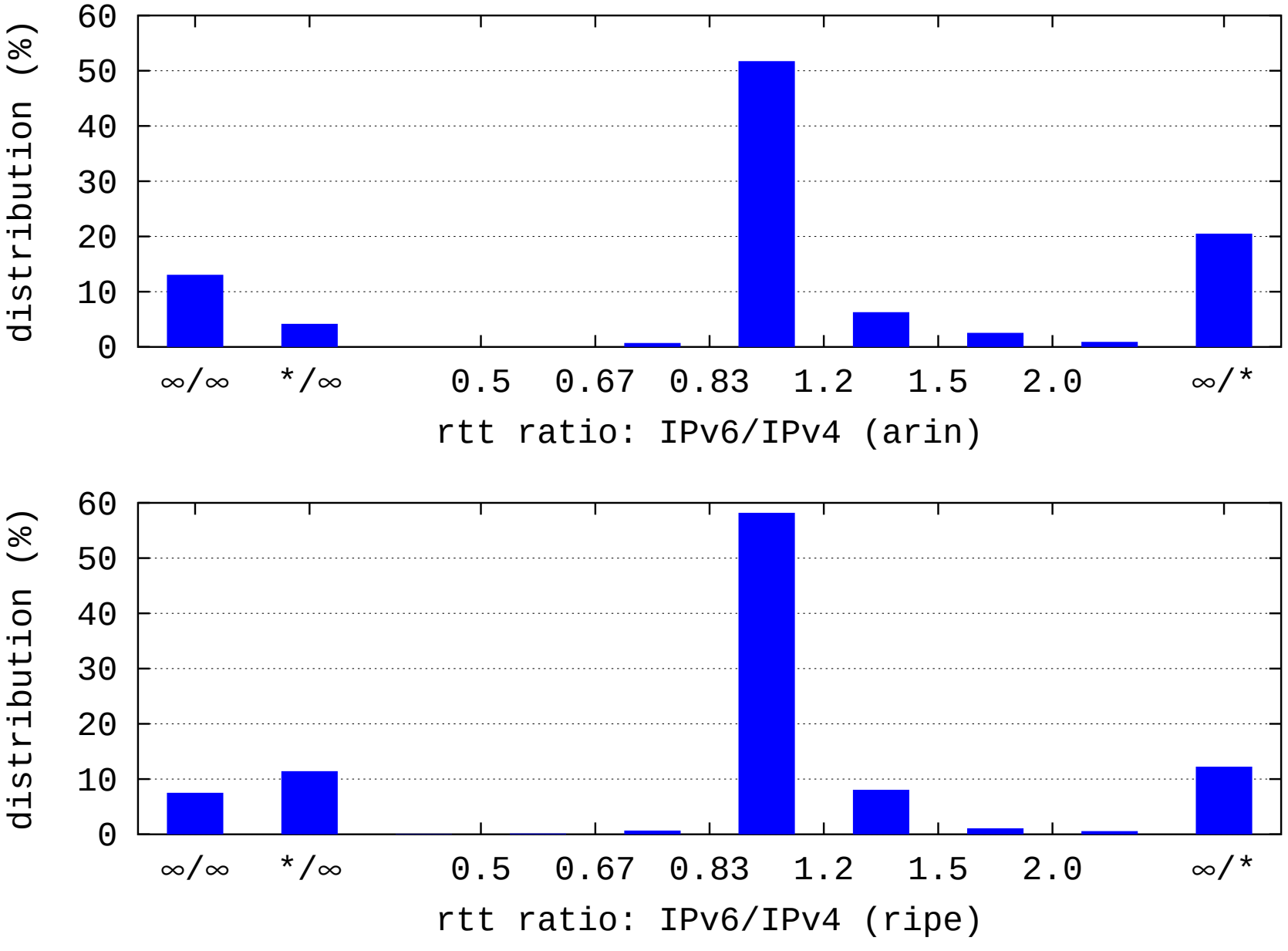


jp (1033 nodes) and other APNIC (96 nodes)

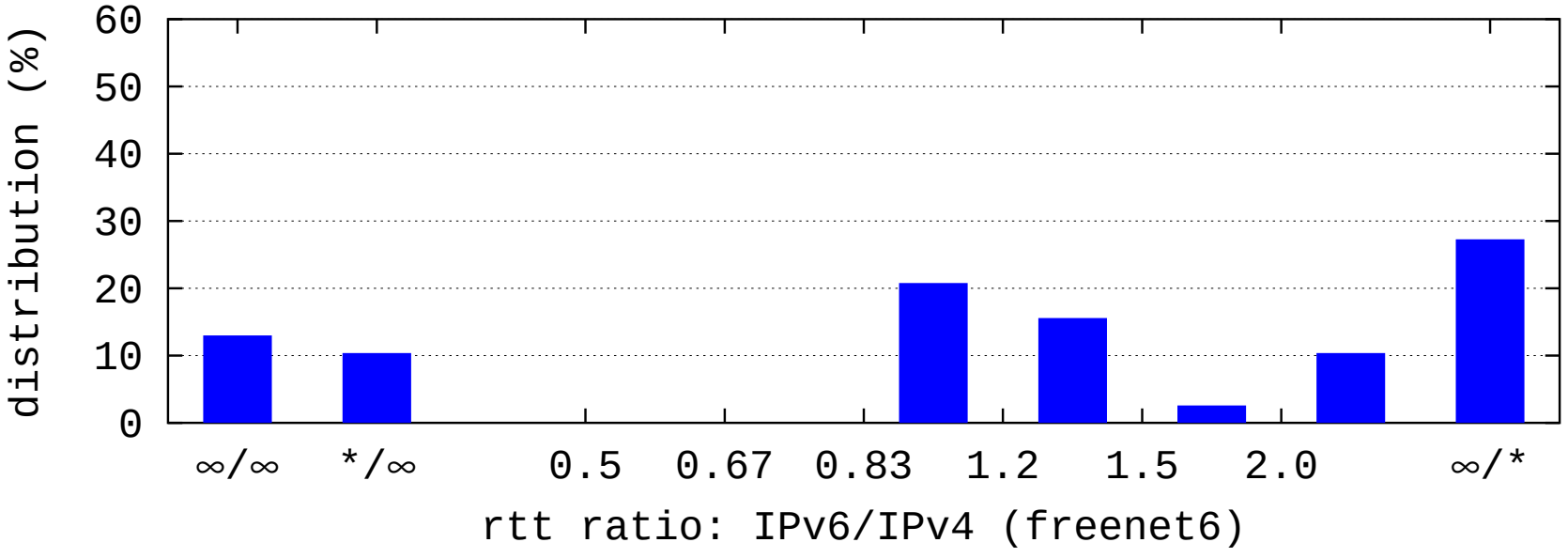




ARIN (506 nodes) and RIPE (1739 nodes)



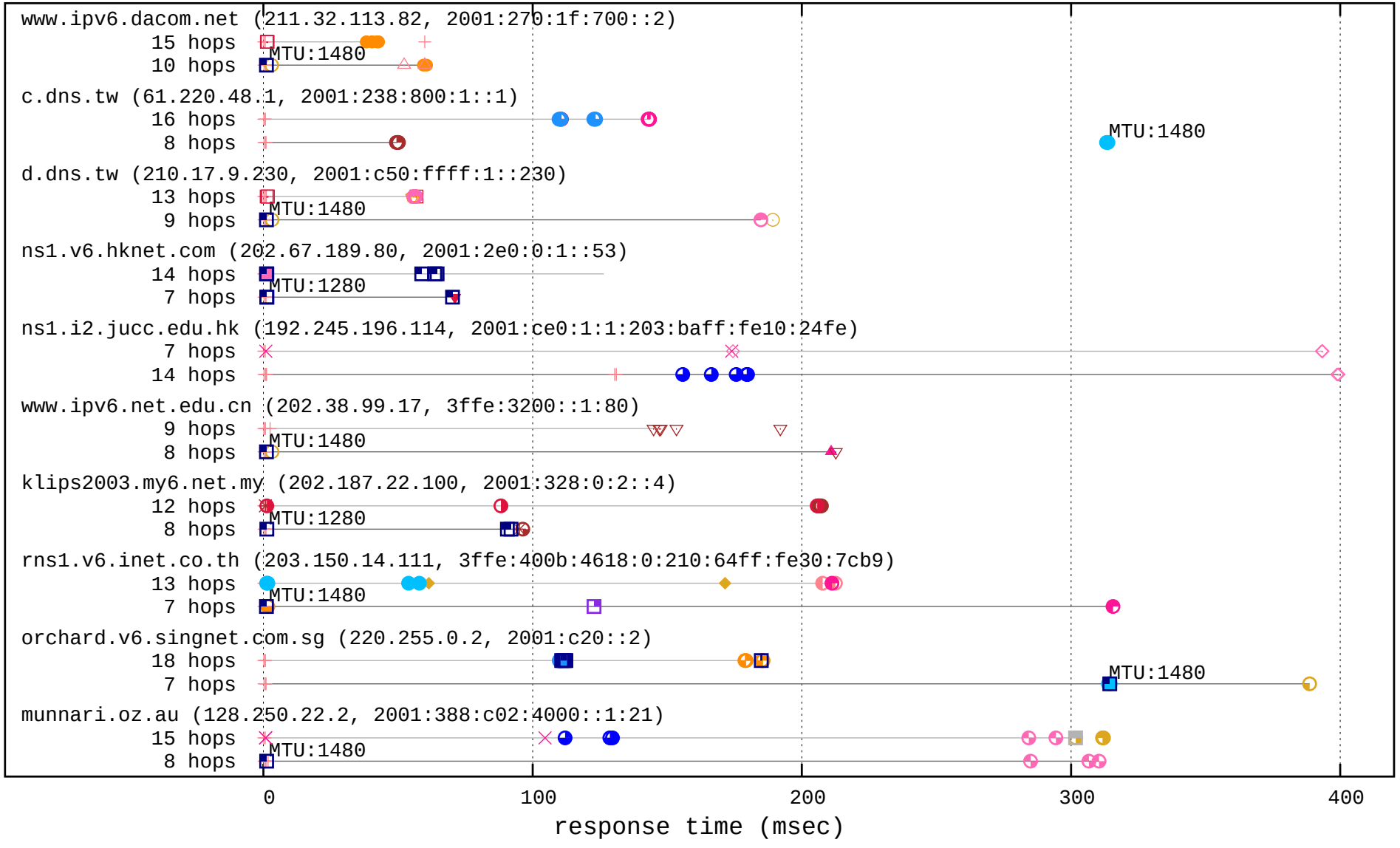
3ffe:0b/24 for freenet6 (77 nodes)



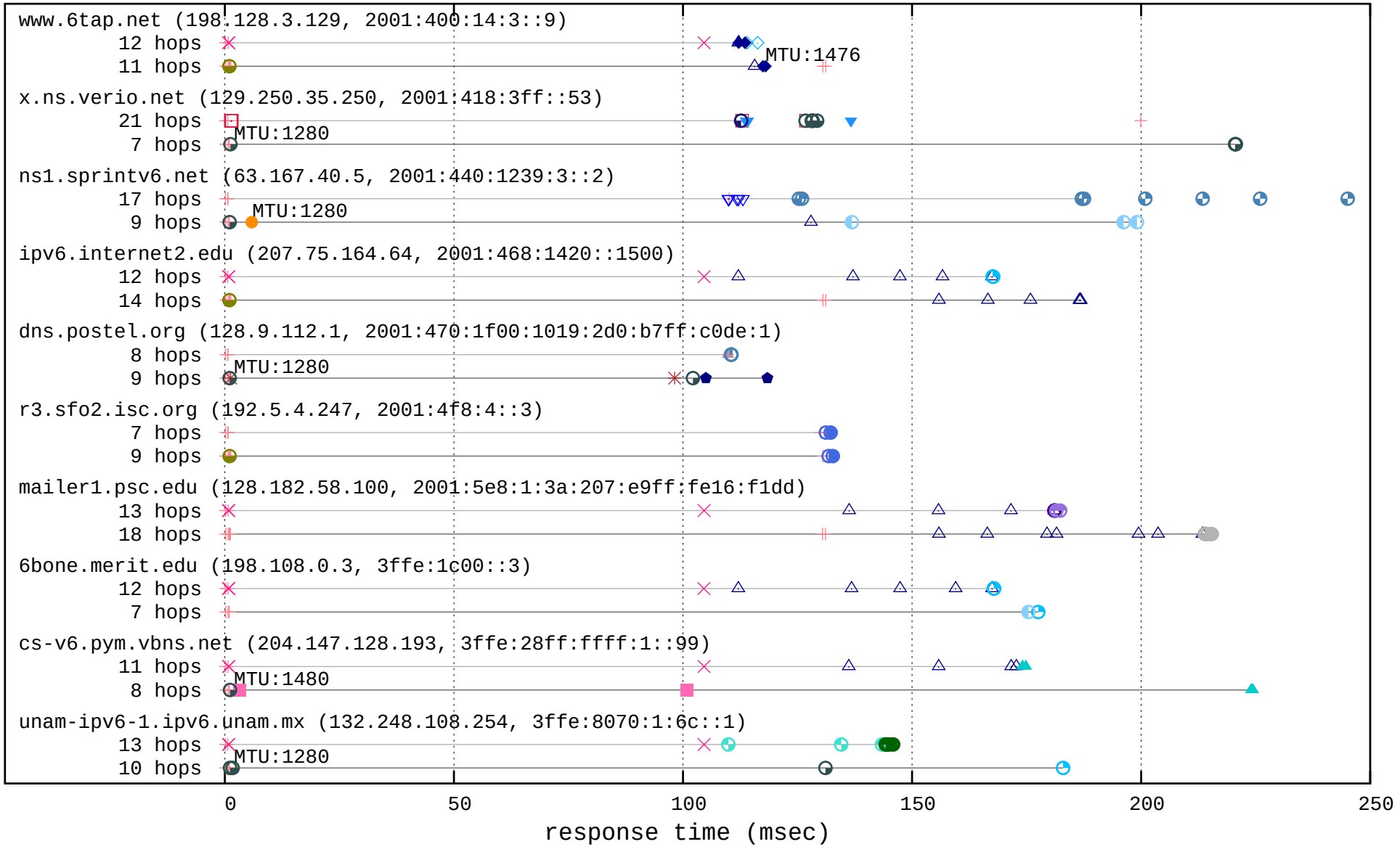
traceroute results

- data collection: scamper tool by Waikato/CAIDA/WIDE
  - traceroute optimized for a large list
  - IPv4 and IPv6 supported
  - Path MTU discovery for IPv6
- visualization
  - plot IPv4 path and IPv6 path, side by side
  - mark hops colored by AS number
    - APNIC:red, ARIN:blue, RIPE:green
  - mark MTU to identify tunnels

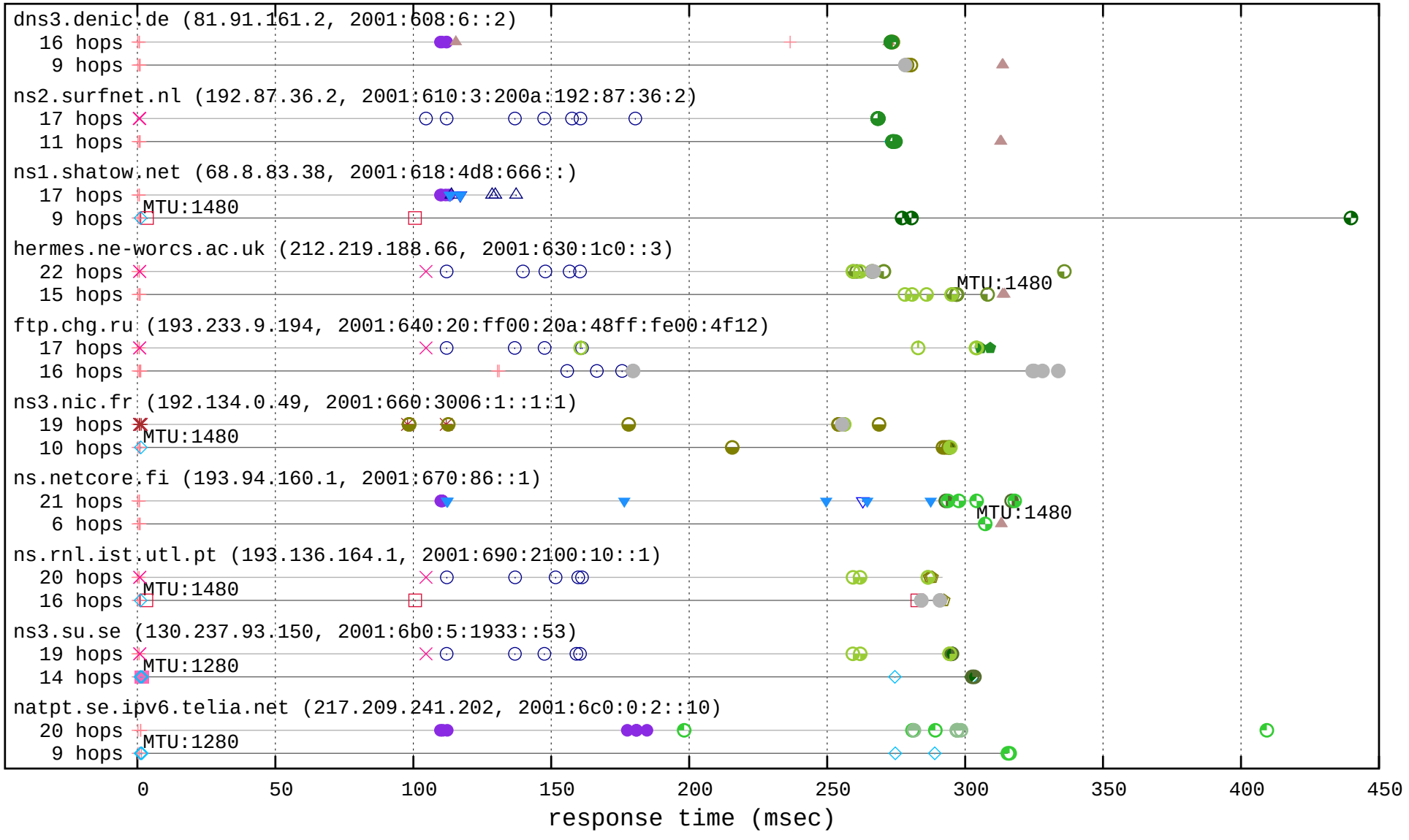
APNIC targets



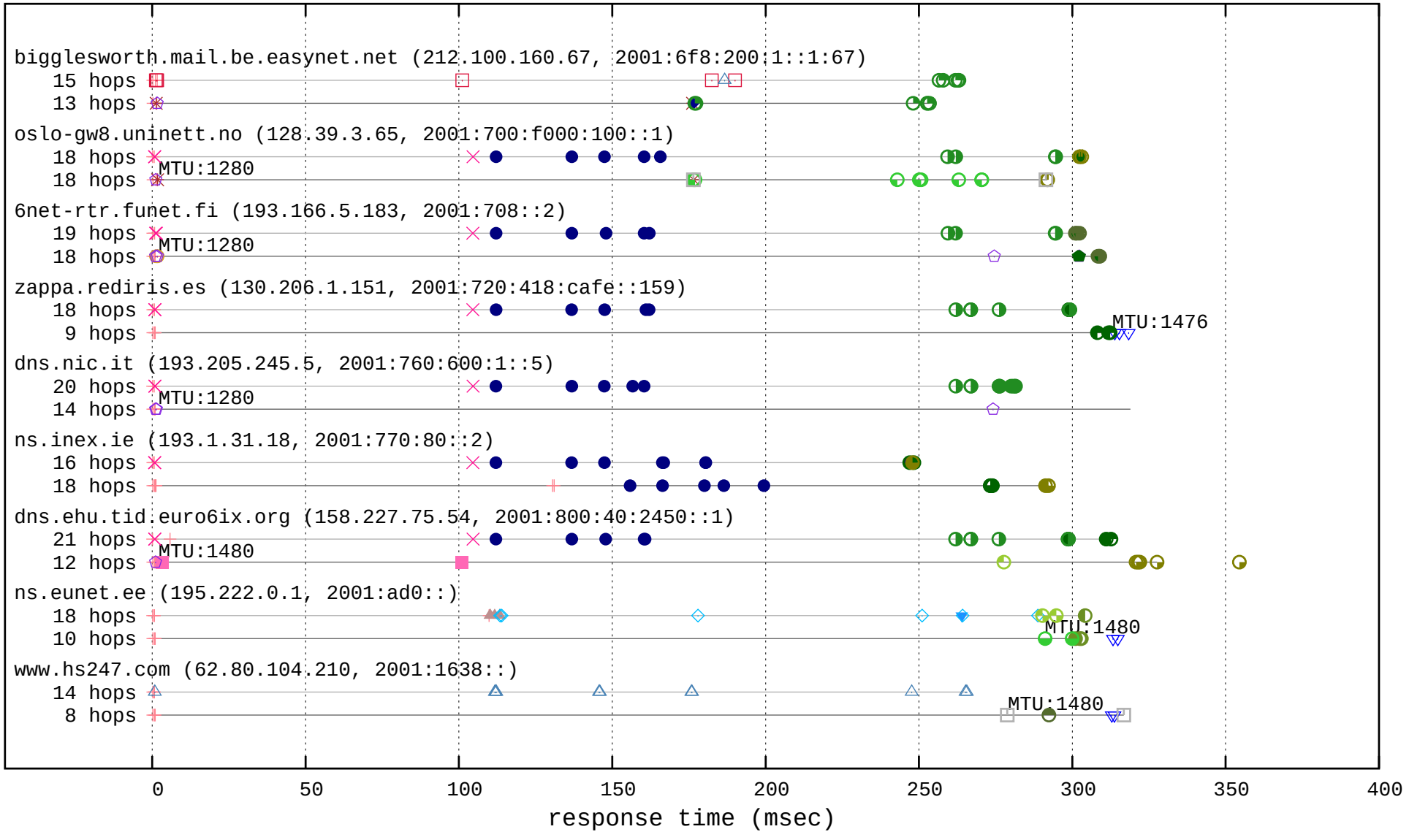
ARIN targets



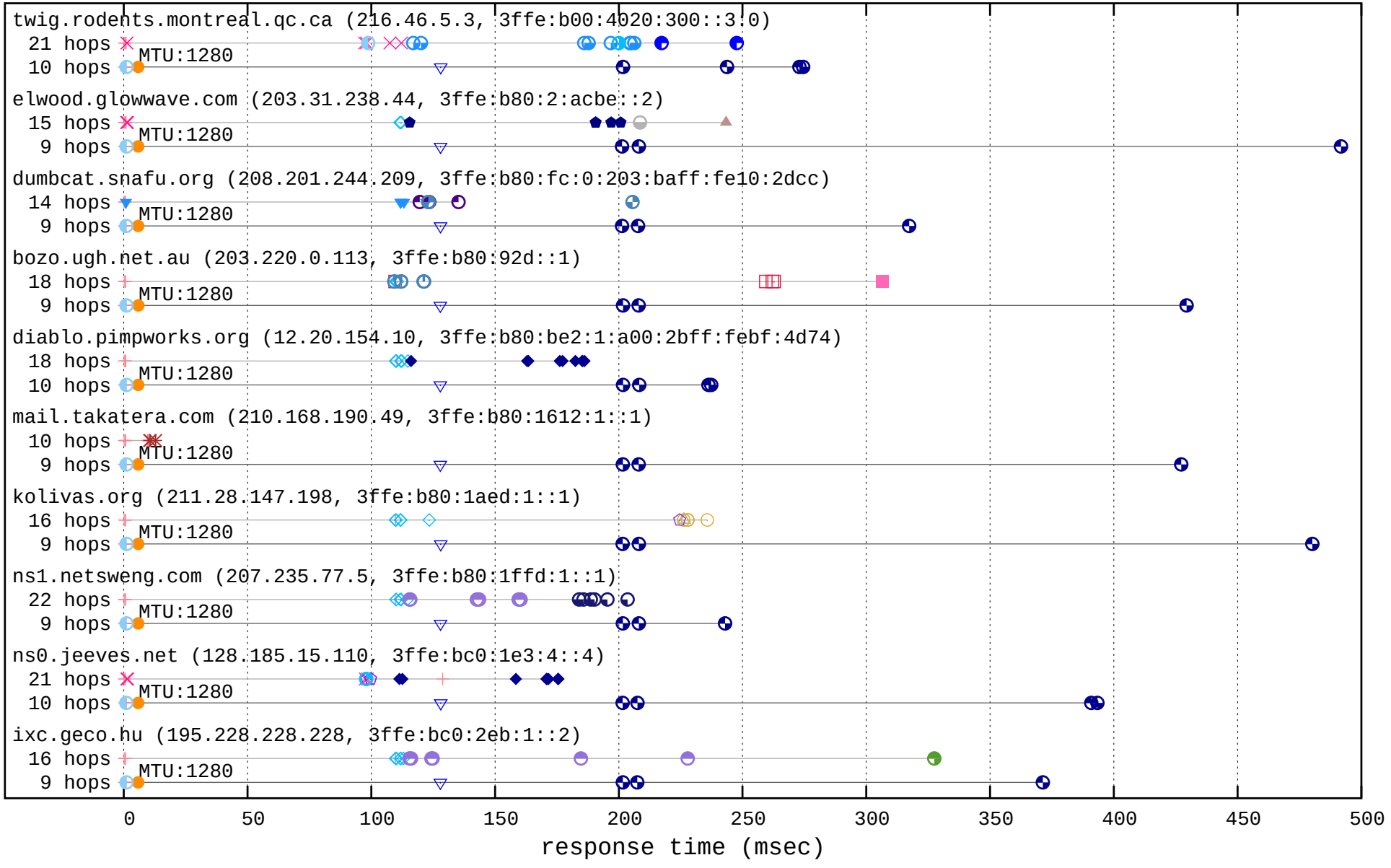
RIPE targets (1/2)



RIPE targets (2/2)



freenet6 targets



next step

- a better target list
  - AAAA capturing in US/Europe, at commercial ISP
- more measurement points for ping and traceroute
- improve tools
  - scamper: beta release in summer is planned
  - many (ugly) perl scripts
- improve visualization
  - difficult to plot many sites in a single graph

comments and suggestions are welcome!