Finding and Fixing Persistent Problems with IPV6

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Introduction

RIPE Atlas measurements show IPv6 has roughly 10% loss rate while IPv4 has closer to none. Is IPv6 really bad?

We're evaluating if this difference is a measurement problem or an actual difference in the networking protocols.

Our evaluation uses data from RIPE Atlas measurement vantage points (VPs). We classify Atlas VPs after observing how often they have query failures. VPs see two common problems: *islands*, where no root letter is reachable from a VP, and *peninsulas*, where a VP sees some but not all roots.

DNS operators and RIPE Atlas can use our classification and network analysis to identify good Vantage Points and provide a more accurate view of the network.

Method for Measurement

We analyze queries from **RIPE Atlas Vantage Points** to **DNS Root Servers**, typically every 5 minutes. Queries use DNS (SOA requests) in both IPv4 and IPv6.

Probes Around the World (atlas.ripe.net)

DNS Root Servers

RIPE Atlas
- 10,000+ Vantage Points
- Measure connectivity & latency

DNS Root Servers
- Assign names to IP address
- 13 root servers
- USC operates B root

Classifying VPs

We analyze 24hours of SOA data from 2022-06-29.
We see the following distribution of VPs:
- Queries for ~80% of VPs *always succede*
- ~10% of VPs have occasional query failure
- ~10% of VPs *always fail*

→ we use VPs which always fail to identify root causes based on how many root letters the VP can successfully reach

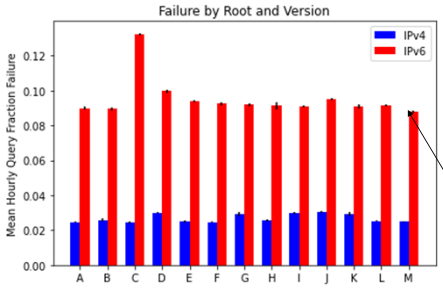
Core Routing Failure: VPs which never succeed for some root servers, but do succeed for others (peninsulas)

Edge Routing Failure: VPs which never succeed for any root server (islands)

Type	Total Probes	Islands	Peninsulas
IPv4	10082	205 (.020)	239 (.024)
IPv6	5173	400 (.078)	396 (.077)

Network Results

Is IPv6 Worse than IPv4? Yes

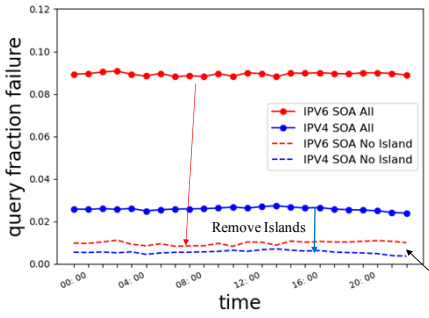


SOA 24 hours (2022-07-23)

=> Yes. Consistent large discrepancy between IPv4 and IPv6 for every root

(small error bars show that results are consistent hourly over 24 hours)

Can Measurement be fixed? Remove Islands.



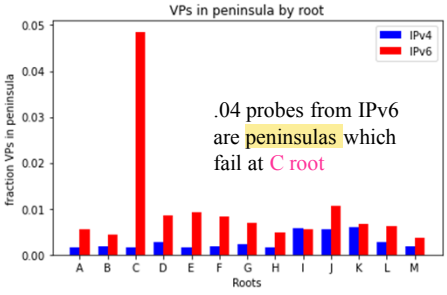
B Root SOA 24 hours (2022-07-23)

Hypothesis: IPv6 problems are due to misconfigured probes. Islands are indicative of misconfiguration, probes which cannot see anywhere.

Fix: Remove these probes.

⇒ IPv6 is much more like IPv4. peninsulas contribute to the remaining diff.

Understanding Peninsulas



Frequency of root in peninsulas over 24 h in IPv6 SOA (2022-07-23)

Problem: C Root stands out. Why?

Answer: C root is run by Cogent. Cogent has a known IPv6 peering dispute with Hurricane Electric.

⇒ Cogent and HE need to negoitate.

Is IPv6 Worse Than IPv4? (Redux)

After removing islands and peninsulas,
~0.01 of queries fail for IPv6 and ~0.005 fail for IPv4 across roots.
⇒ **IPv6 is still *slightly* worse than IPv4** (about ½%)
⇒ Fixing VP problems is necessary to see this result.

Plans

Planned Next Steps: investigate probes with persistent loss and upload relevant data to webpage with automated analysis
- Distinguish between probes which have multiple failures in a row vs. spread out failures using CUSUM statistical test
- Develop heuristic to detect temporary islands/peninsulas

Additional Information:
- Webpage: https://ant.isi.edu/reu/2022
- Background: Guillermo Baltra and John Heidemann. *What Is The Internet? (Considering Partial Connectivity)*. Technical Report N. arXiv:2107.11439v1, USC/ Information Sciences Institute, May, 2021.

Conclusions

Benefits
- RIPE Atlas VP operators can find and fix VPs with problems (misconfiguration/routing issues)
- Root DNS operators can filter measurements to get truer IPv4/IPv6 measurement

Conclusions
- IPv4 and IPv6 are different
- Differences are mostly VP misconfiguration (islands) and, in some cases, partial connectivity (peninsulas)
- RIPE Atlas VP and root operators can fix problems with information
- Until then, we can filter misleading data

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Work performed under REU Site program
supported by NSF grant #2051101

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