IPv6 Hitlist: Dusting and Updates

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Dusting an IPv6 Research Foundation - The IPv6 Hitlist

The large and sparsely used IPv6 address space is infeasible to scan.

Gasser et al.[1] established an ongoing IPv6 Hitlist in 2018, that:

- collects address candidates from multiple sources,
- applies different filters,
- and tests addresses for their responsiveness.

We updated the Hitlist service in two steps:

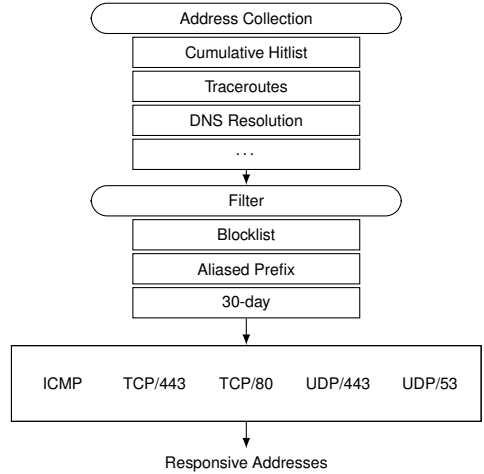
- Zirngibl et al. “Rusty Clusters? Dusting an IPv6 Research Foundation,” Internet Measurement Conference, 2022 [3]
- Steger et al., “Target Acquired? Evaluating Target Generation Algorithms for IPv6,” Network Traffic Measurement and Analysis Conference, 2023 [2]

Research questions:

RQ1 How did the IPv6 Hitlist develop?

RQ2 Should addresses from aliased prefix be strictly excluded?

RQ3 Can we improve the IPv6 Hitlist with new sources?

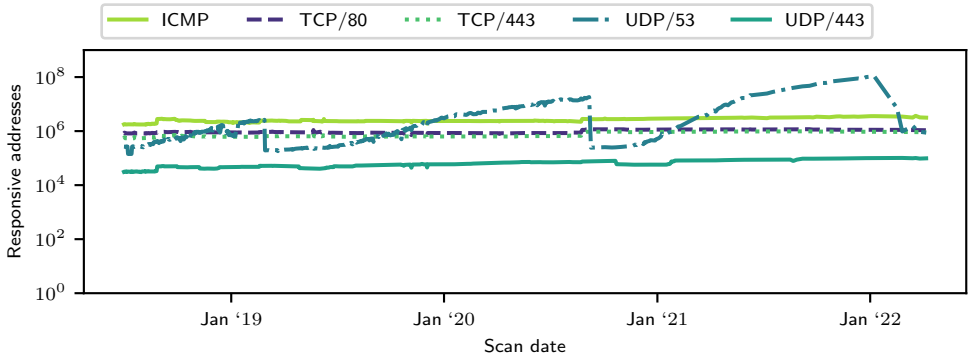


[1] O. Gasser et al. 2018. Clusters in the Expanse: Understanding and Unbiasing IPv6 Hitlists. In Proc. ACM Int. Measurement Conference [1]

How did the IPv6 Hitlist develop? (1/3)

- Input increased from 90 M to 790 M addresses.
- 250 M addresses are within aliased prefixes.
- 405 M addresses are unresponsive for at least 30 d.
- Up to 100 M addresses are responsive to at least one protocol.

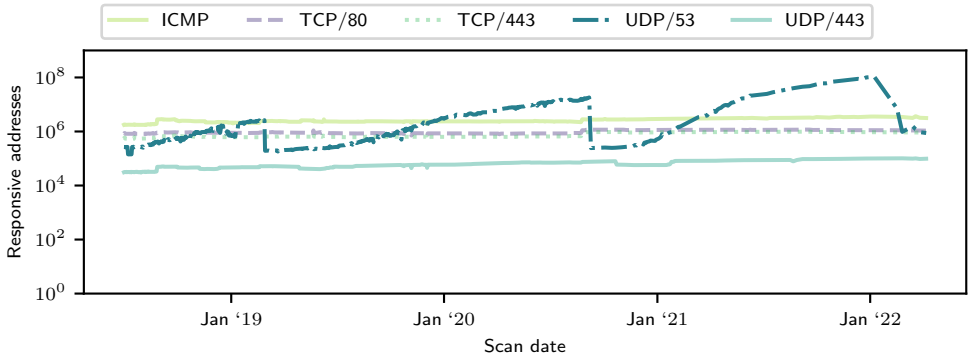
→ However, large spikes in addresses responsive to UDP/53 are visible.



How did the IPv6 Hitlist develop? (2/3)

- ZMapv6 is configured to send DNS queries for `www.google.com`
- Most responses
  - contain invalid addresses (Teredo),
  - are received multiple times,
  - and responsive addresses are mostly related to Chinese autonomous systems (ASes).

→ Prevalence of DNS responses is due to injected DNS responses by Chinese censorship mechanisms.



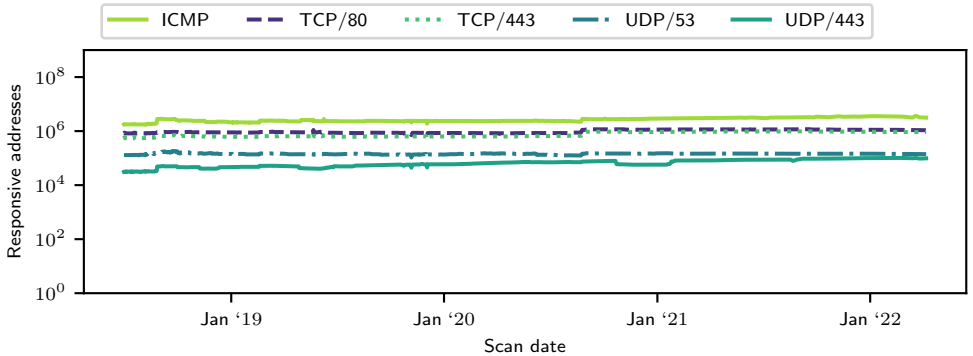
How did the IPv6 Hitlist develop? (3/3)

- We accumulated a blocklist of 134M unresponsive hosts receiving injections.
- We filter injected packets directly after our scans.

→ We cleaned the hitlist and published data.

→ The result is more stable for all protocols.

→ 3.2 M addresses are responsive, covering 15.7 k ASes.



Should addresses from aliased prefix be strictly excluded?

The IPv6 Hitlist treats aliased prefixes as:

- a complete prefix
- with each IPv6 address used as alias
- by a single host.

→ A single such prefix could bias the hitlist and make scans infeasible.

A prefix is labeled as aliased and excluded if

- 16 randomly generated addresses are responsive.

Should addresses from aliased prefix be strictly excluded?

However, many of these are not necessarily aliased but fully responsive:

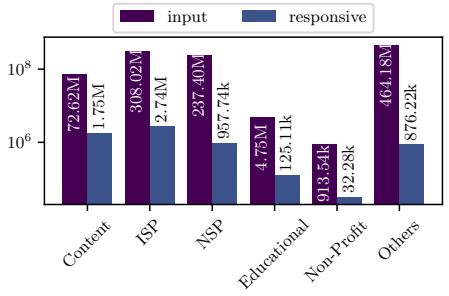
- Aliased prefixes are often announced by CDNs.
  - For Fastly, more than 98 % of announced IPv6 addresses are aliased.
- Many domains resolve to IPv6 addresses in aliased prefixes.
  - For Cloudflare, aliased prefixes host more than 10 M domains.
- Fingerprinting reveals different behavior between hosts within the same aliased prefix.

→ Including addresses from fully responsive prefixes should be considered in research relying on the IPv6 Hitlist.

From which Network Category are Addresses?

- Categorization via PeeringDB.[2]
  - Community-maintained database.
  - Offers categorization on AS-level.
- Category representation in Hitlist is not uniform.
- Most frequent categories are ISP, CDN and NSP.

→ We added the categorization as an ongoing service.



[2] https://www.peeringdb.com/

Can we improve the IPv6 Hitlist with new sources?

While the existing IPv6 Hitlist sources regularly update the input, new sources have not been added.

We evaluated different target generation approaches to extend our hitlist, e.g.,:

- 6Tree
- 6Graph
- 6GAN
- 6VecLM

Method	Addr	Responsive Addr. ↓	Responsive ASes
6Graph	125.8 M	3.8 M	10.7 k
6Tree	37.6 M	2.2 M	11.5 k
6GAN	3.3 M	4.3 k	39
6VecLM	70.3 k	1.0 k	105

→ All sources contribute additional responsive addresses.
→ First run: 5.6 M new responsive IPv6 addresses from 14.6 k ASes.
→ Second run: 13.9 M new responsive addresses from 18.1 k ASes.

Conclusion

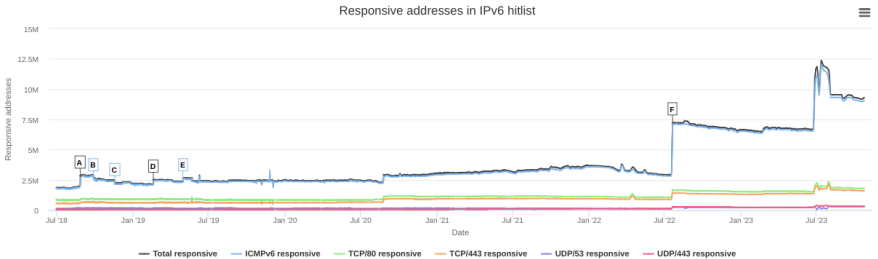
We updated the IPv6 Hitlist service and

- removed the impact of DNS response injection;
- added new sources to the ongoing Hitlist service;
- recommend scanning targets from fully responsive prefixes in the future.

We encourage everybody to share

- new address sources or target generation approaches,
- and new insights or ideas to update the ongoing service with us.

https://ipv6hitlist.github.io/



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[2] L. Steger, L. Kuang, J. Zirngibl, G. Carle, and O. Gasser.
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[3] J. Zirngibl, L. Steger, P. Sattler, O. Gasser, and G. Carle.
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