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Protocol Racing

Is it really an advancement?

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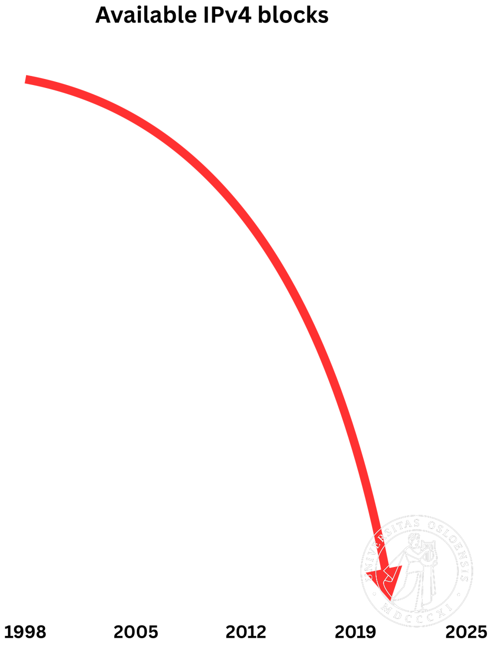


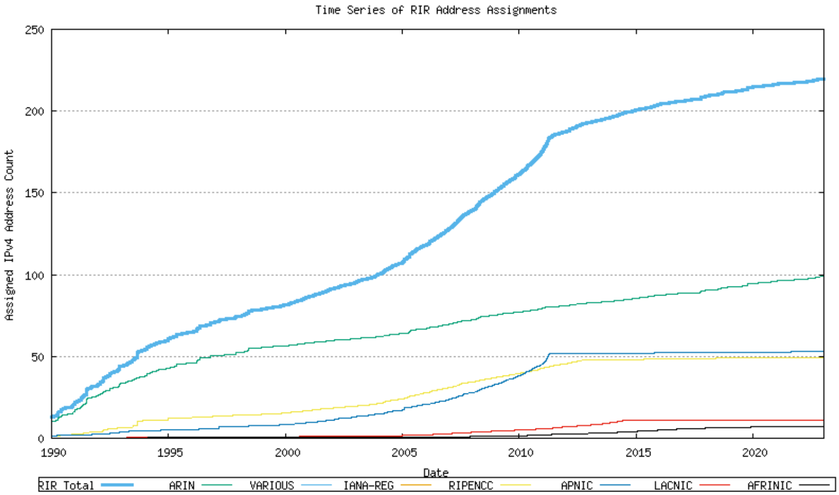
Agenda

1. A bit of history
2. The issue with Dual-Stacking
3. The solution
4. Wrap-up

IPv4

- **RFC 791** – *Internet Protocol*
- Written for DARPA in 1981 (before the IETF existed)
- Designed to interconnect different packet-switched networks (ARPANET, SATNET, university nets)
- Created under the assumption that every device would have its own globally unique, routable address
- 32-bit address space — $2^{32} = 4\ 294\ 967\ 296$ possible addresses
- Sounds like a lot. . . until you remember that there are 8 billion people alive

The problem with IPv4



Source: (*IPv4 Address Report* 2025)

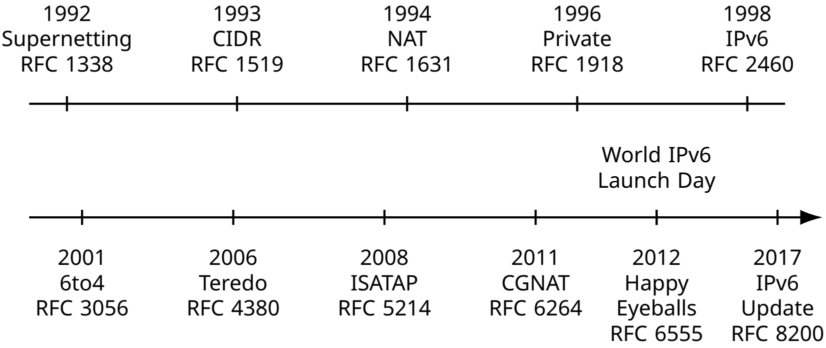
RFC 1338 — Supernetting: an Address Assignment and Aggregation Strategy

It does not attempt to solve the third problem, which is of a more long-term nature, but instead endeavors to ease enough of the short to mid-term difficulties to allow the Internet to continue to function efficiently while progress is made on a longer- term solution.

(The third problem being IPv4 exhaustion)

Source: (Fuller **andothers** 1992)

Timeline of stopgap measures



Timeline of measures from Supernetting to IPv6 'v2'

IPv6

- **RFC 2460** – *Internet Protocol, Version 6*
- Finished in 1998 later updated in 2017
- Designed to fix the issues of IPv4
- Increases the address space from 32-bit to 128-bit
- 340 282 366 920 938 463 463 374 607 431 768 211 456 addresses
- Allows for some cool things like NAT64

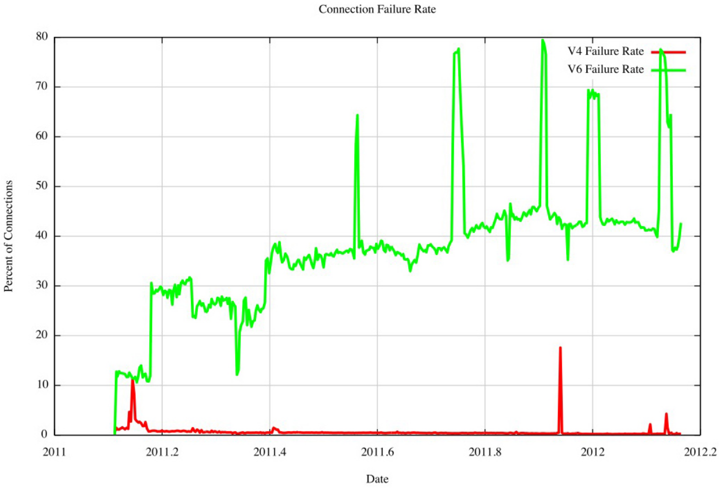
Dual-stack

RFC 1933 — Transition Mechanisms for IPv6 Hosts and Routers

The most straightforward way for IPv6 nodes to remain compatible with IPv4-only nodes is by providing a complete IPv4 implementation. IPv6 nodes that provide a complete IPv4 implementation in addition to their IPv6 implementation are called "IPv6/IPv4 nodes." IPv6/IPv4 nodes have the ability to send and receive both IPv4 and IPv6 packets. They can directly interoperate with IPv4 nodes using IPv4 packets, and also directly interoperate with IPv6 nodes using IPv6 packets.

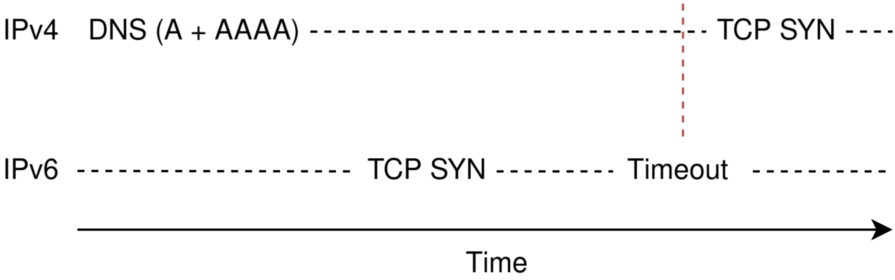
Source: (Nordmark **and** Gilligan 1996)

IPv6 and IPv4 failure rate



Source: (*ISP Column - November 2015* 2025)

Dual-Stacking with IPv6 failure



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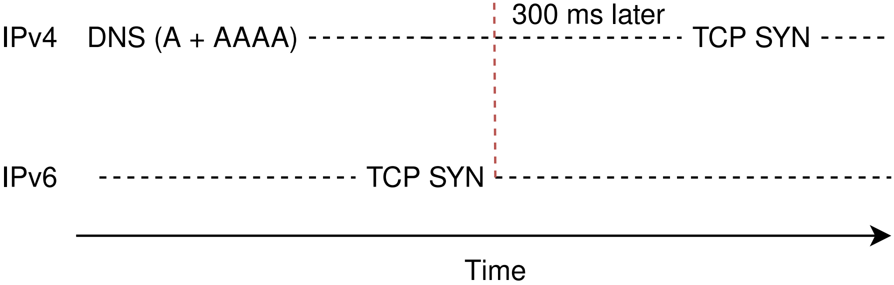
Happy Eyeballs

- **RFC 6555** – *Happy Eyeballs: Success with Dual-Stack Hosts*
- "Races" IPv4 and IPv6 in order to solve blocking behavior
- Applicable to connection oriented transport protocols
- Tries to define a set of standard practices around AAAA DNS records
- No multi-record AAAA responses within the same namespace
- No AAAA specific namespaces e.g. *ipv6.example.com*

Dual-stacking with Happy Eyeballs



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Questions?

References I

- Fuller, V., T. Li, J. Yu **and** K. Varadhan (**june** 1992). *Supernetting: An Address Assignment and Aggregation Strategy*. techreport RFC1338. RFC Editor, RFC1338. DOI: 10.17487/rfc1338. (**urlseen** 16/10/2025).
- *IPv4 Address Report* (2025). https://ipv4.potaroo.net/. (**urlseen** 16/10/2025).
- *ISP Column - November 2015* (2025). https://www.potaroo.net/ispcol/2015-11/v6perf.html. (**urlseen** 17/10/2025).
- Nordmark, Erik **and** Robert E. Gilligan (**april** 1996). *Transition Mechanisms for IPv6 Hosts and Routers*. Request for Comments RFC 1933. Internet Engineering Task Force. DOI: 10.17487/RFC1933. (**urlseen** 17/10/2025).

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