# Measuring the Effectiveness of Happy Eyeballs

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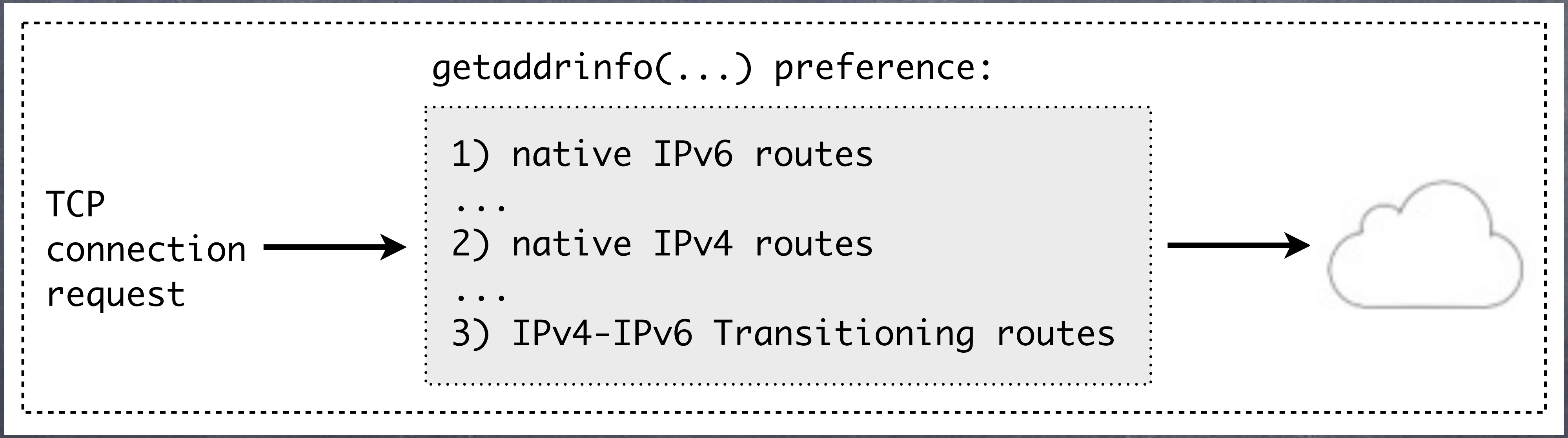
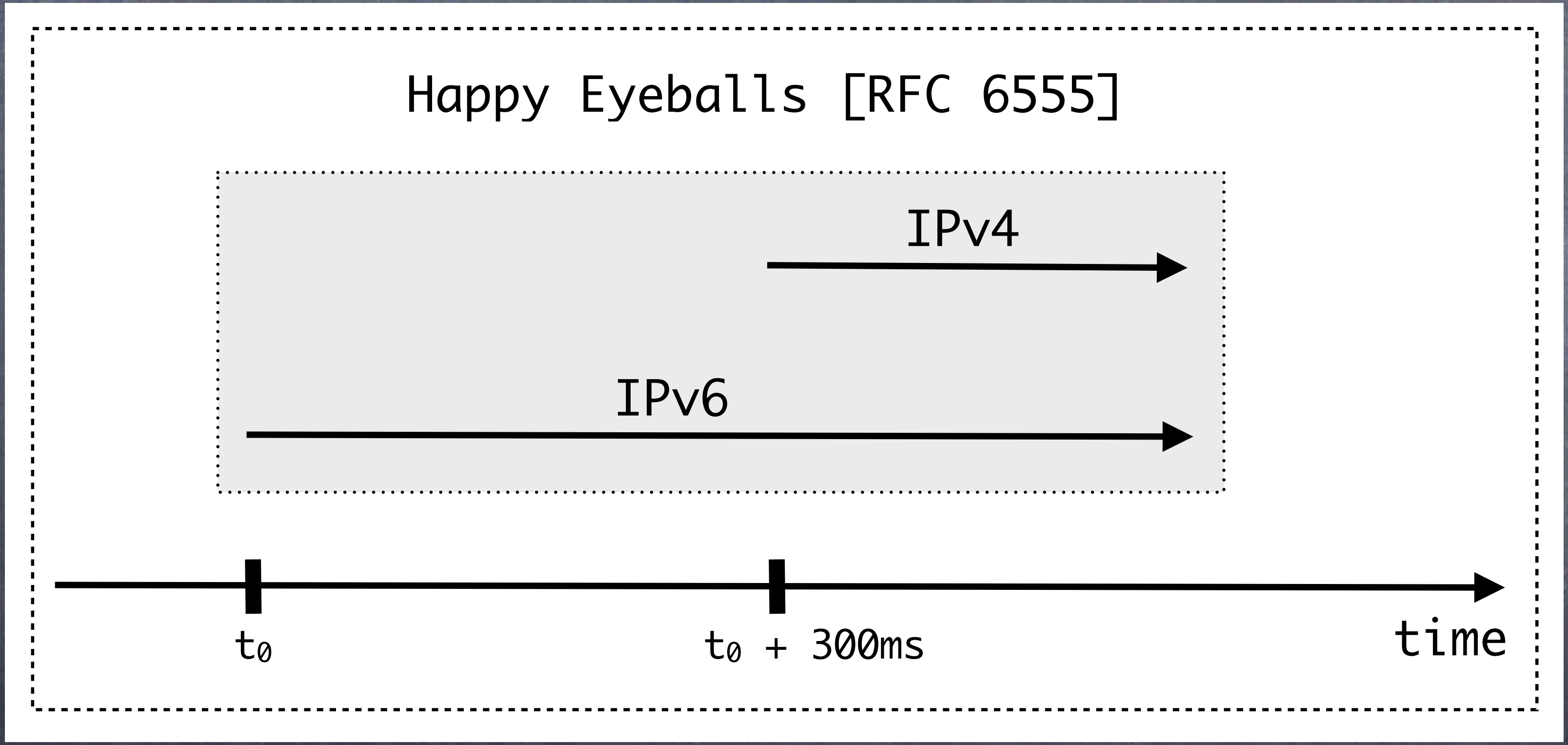
## motivation

- getaddrinfo(…) behavior:
  - returns list of endpoints in an order that prioritizes IPv6 upgrade path
  - order is dictated by [RFC 6724] and /etc/gai.conf
  - if IPv6 is broken, application is unresponsive in order of seconds



## motivation

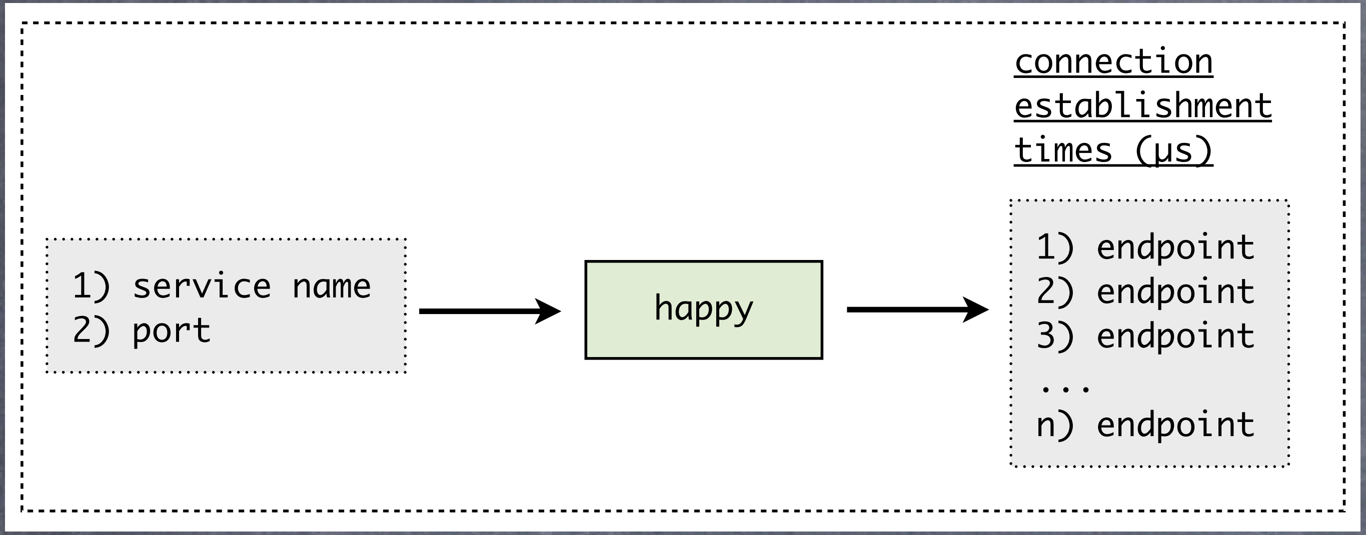
- happy eyeballs algorithm [RFC 6555]:
  - initiate a TCP connect(...) with the first endpoint, give it 300ms
  - switch over with a TCP connect(...) to a different address family otherwise
  - the competition runs fair after 300ms



- does the algorithm help improve the user experience?

# metric and implementation

- developed a simple TCP happy eyeballs [RFC 6555] probing tool



  - uses `getaddrinfo(...)` to resolve service names to endpoints
  - uses non-blocking `connect(...)` to connect to all endpoints of a service
  - uses a short-delay between connection attempts to avoid SYN floods
  - the service name resolution time is not accounted in the output
  - can produce either human-readable or machine-readable output
  - file locking capability

```
>> ./happy -q 1 -m www.google.com www.facebook.com
HAPPY.0;1360681039;OK;www.google.com;80;173.194.69.105;8626
HAPPY.0;1360681039;OK;www.google.com;80;2a00:1450:4008:c01::69;8884
HAPPY.0;1360681039;OK;www.facebook.com;80;2a03:2880:10:6f01:face:b00c::8;170855
HAPPY.0;1360681039;OK;www.facebook.com;80;31.13.72.39;26665
```

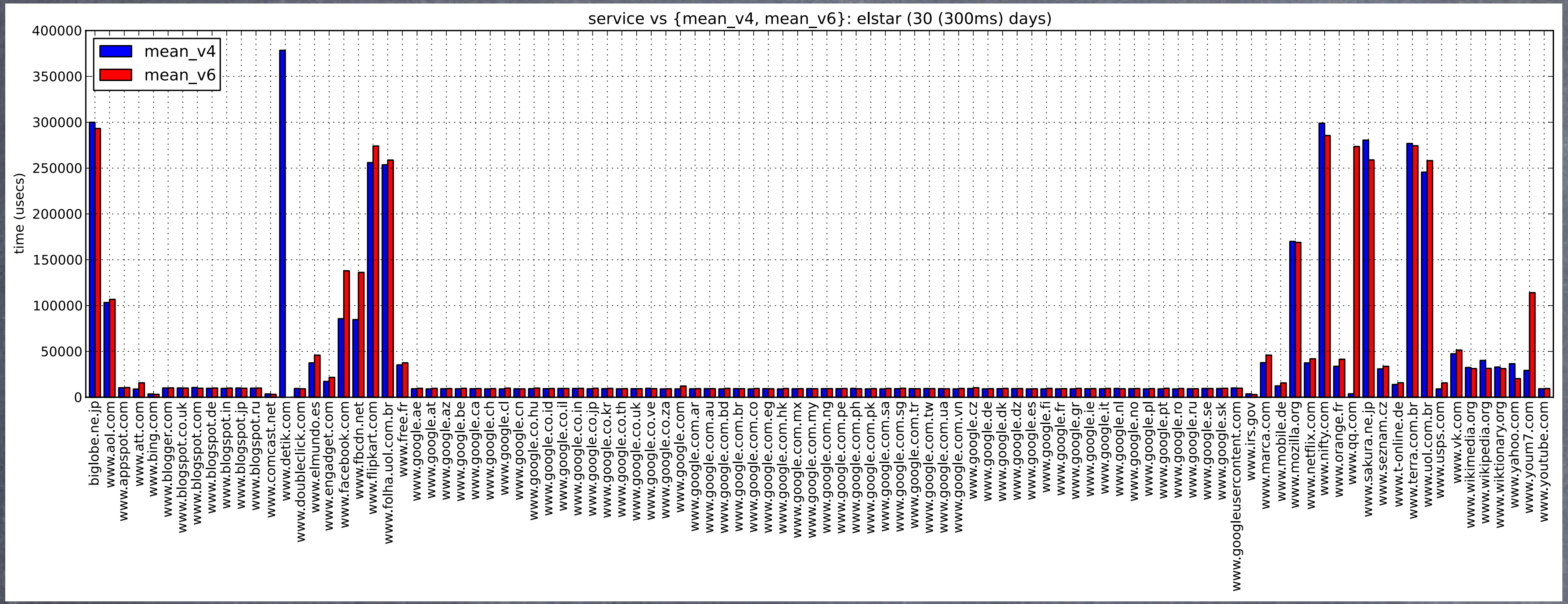
# measurement trials

- dual-stacked web service name list:
  - HE.net maintains a list of top 100 dual-stacked service names
    - they use 1M service names from Alexa Top Sites
    - some domains we expect are missing from the list
    - some services only provide a IPv6 endpoint on prepending a www
    - HE.net does not follow CNAMEs (for e.g. wikipedia.org)
  - amazon has made 1M service name list public
    - we use it and script it ourselves to explicitly follow CNAMEs
- measurement agents:
  - native IPv6, 6in4, Teredo, IPv6 tunnel broker endpoints, native IPv4
  - located at Bremen, Amsterdam, Braunschweig
- measurement cycle length:
  - 1 month

## how does IPv6 compare in performance to IPv4?

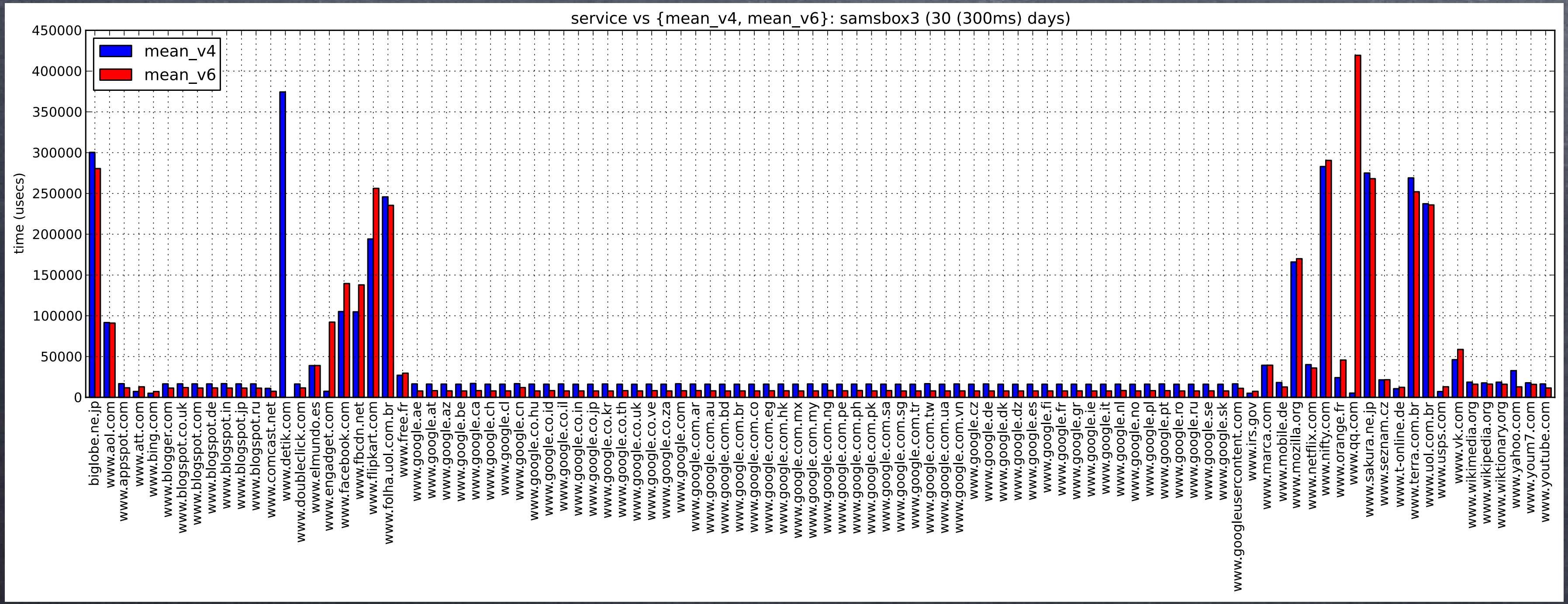
# TCP connection establishment times

## Native IPv6 [Bremen]



- IPv4 connectivity via DFN [AS 680]
- IPv6 connectivity via DFN [AS 680]

## Native IPv6 [Braunschweig]

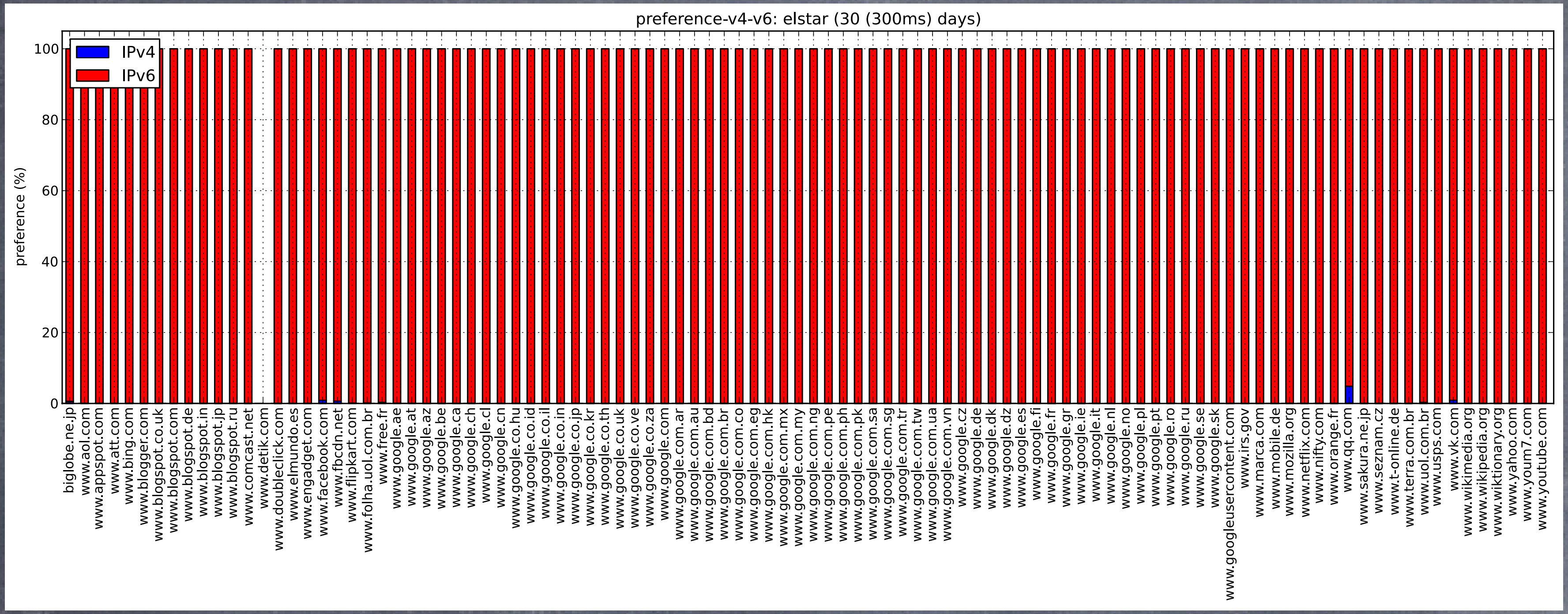


- IPv4 connectivity via Gaertner Datensystems [AS24956]
- IPv6 connectivity via Gaertner Datensystems [AS24956]

## to what extent is IPv6 preferred when connecting to a dual-stacked service?

# IPv6 preference levels

## Native IPv6 [Bremen]



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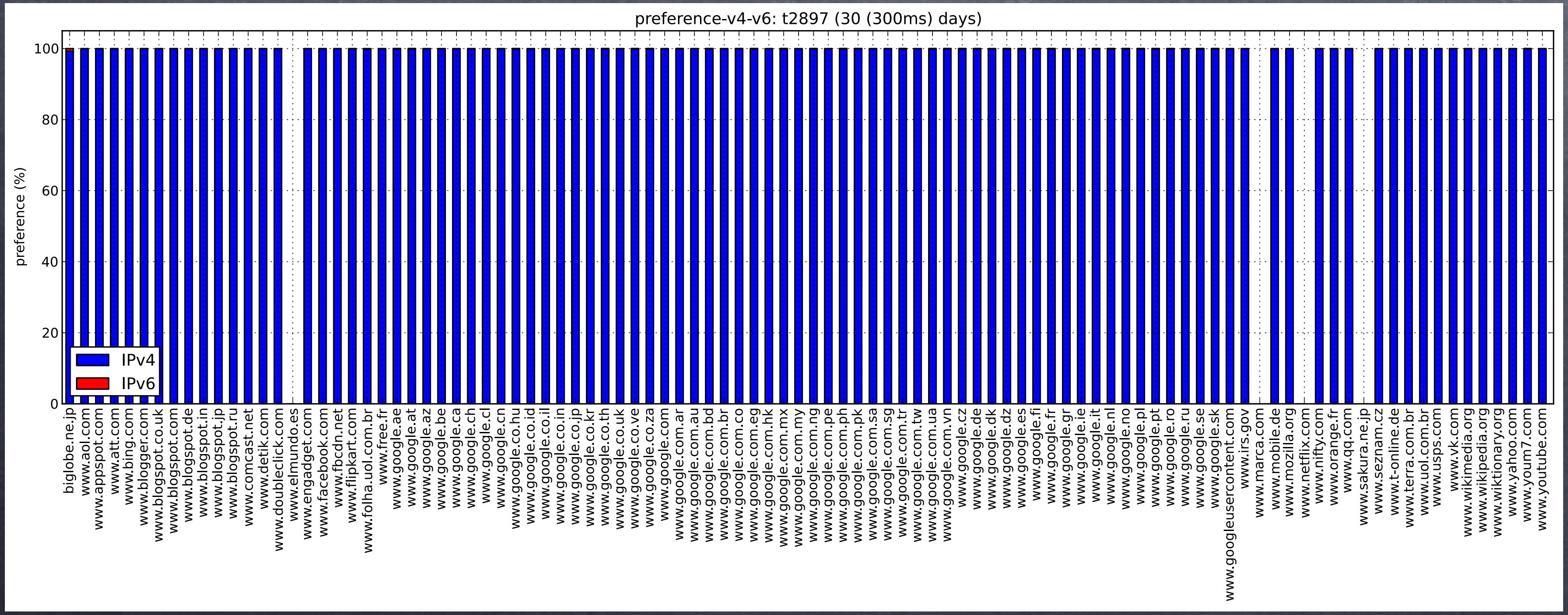
## Teredo IPv6 [Amsterdam]

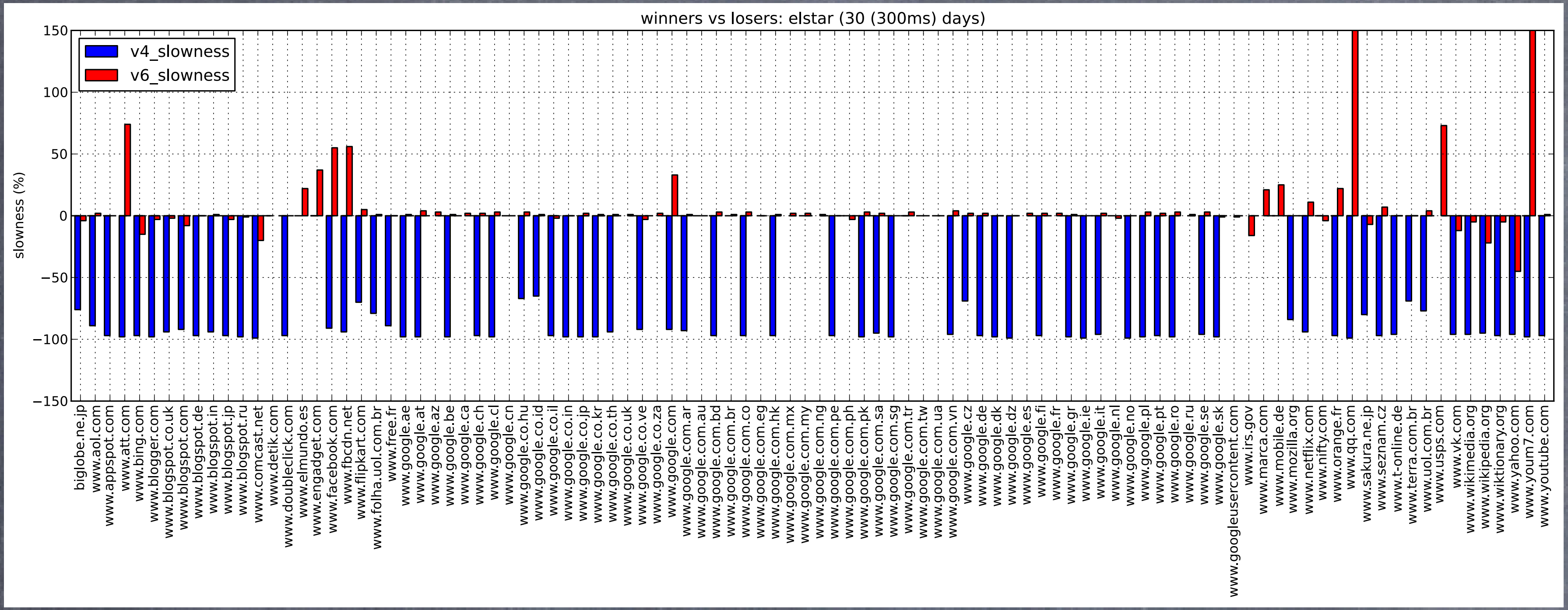


- IPv4 connectivity via LambdaNet Communications
- IPv6 connectivity via Teredo

how <u>slow</u> is a happy eyeballed winner to that of a loser?

# winner slowness to loser

## Native IPv6 [Bremen]



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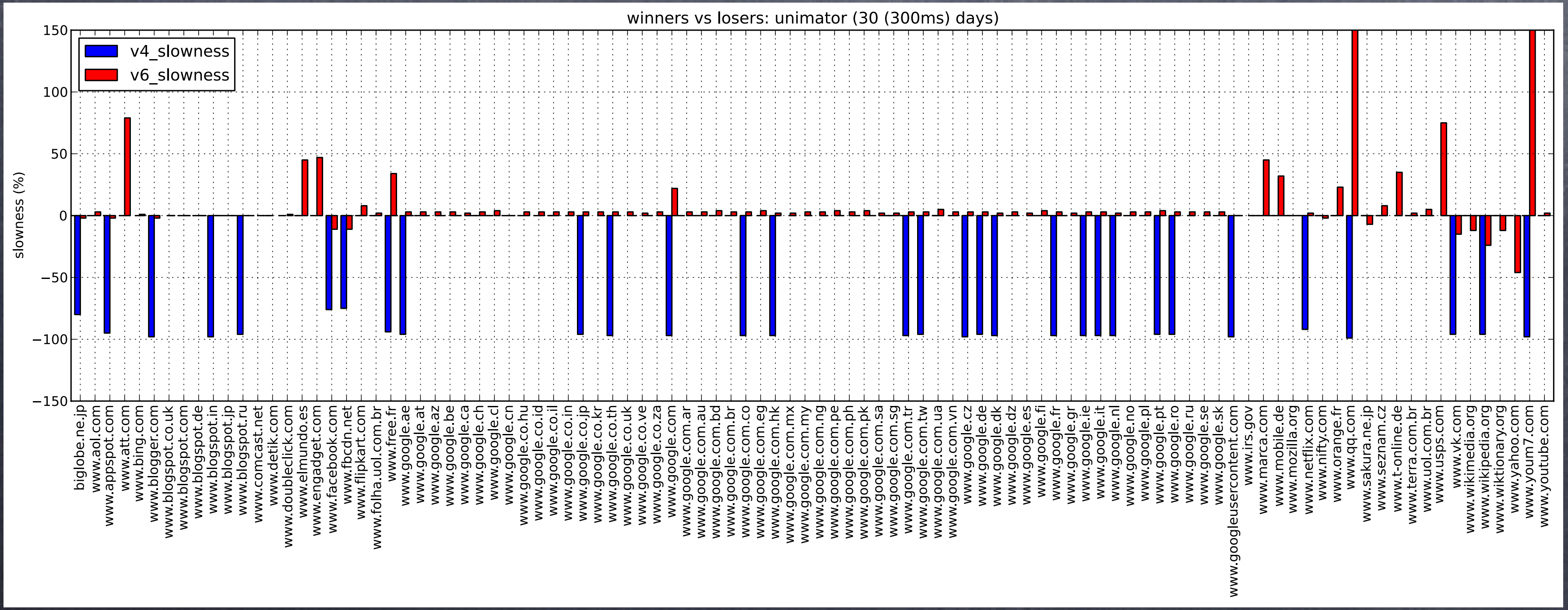
## Native IPv6 [Braunschweig]



- IPv4 connectivity via DFN [AS 680]
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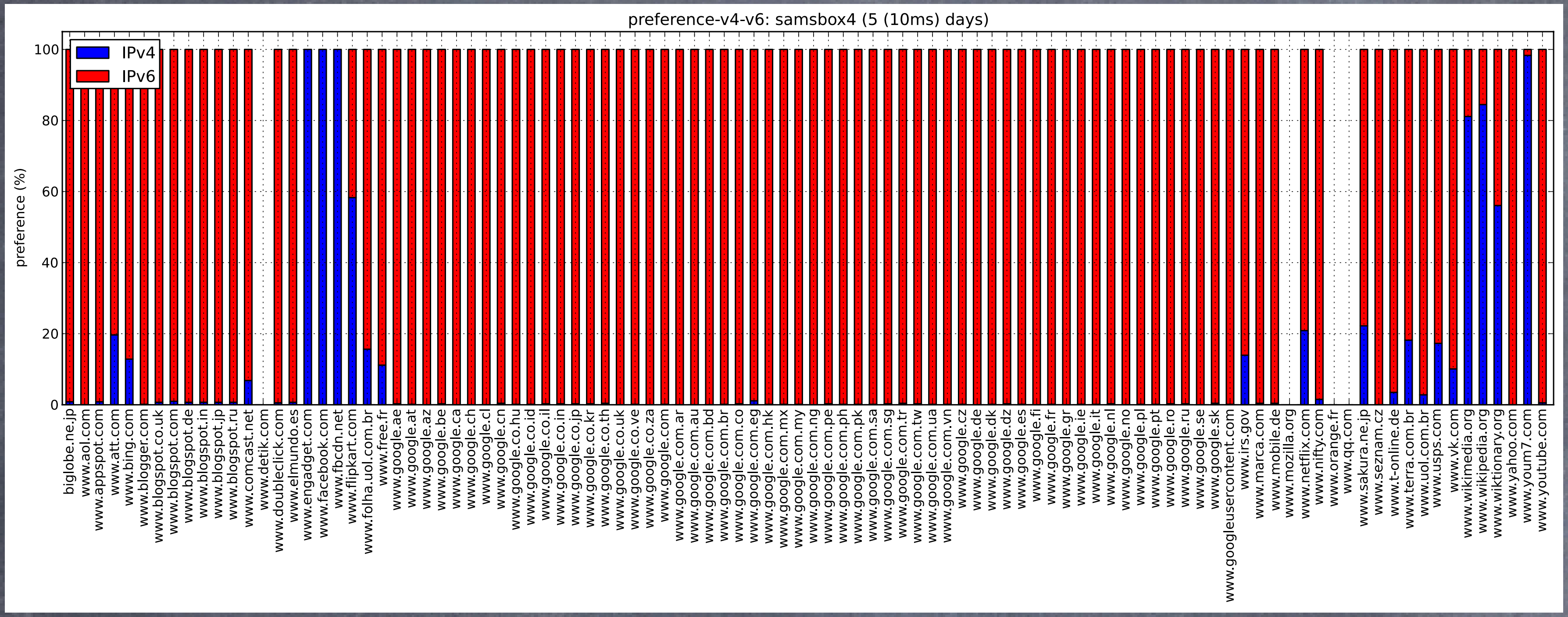
what are repercussions of reducing the IPv6 advantage from <u>300ms to 10ms</u>

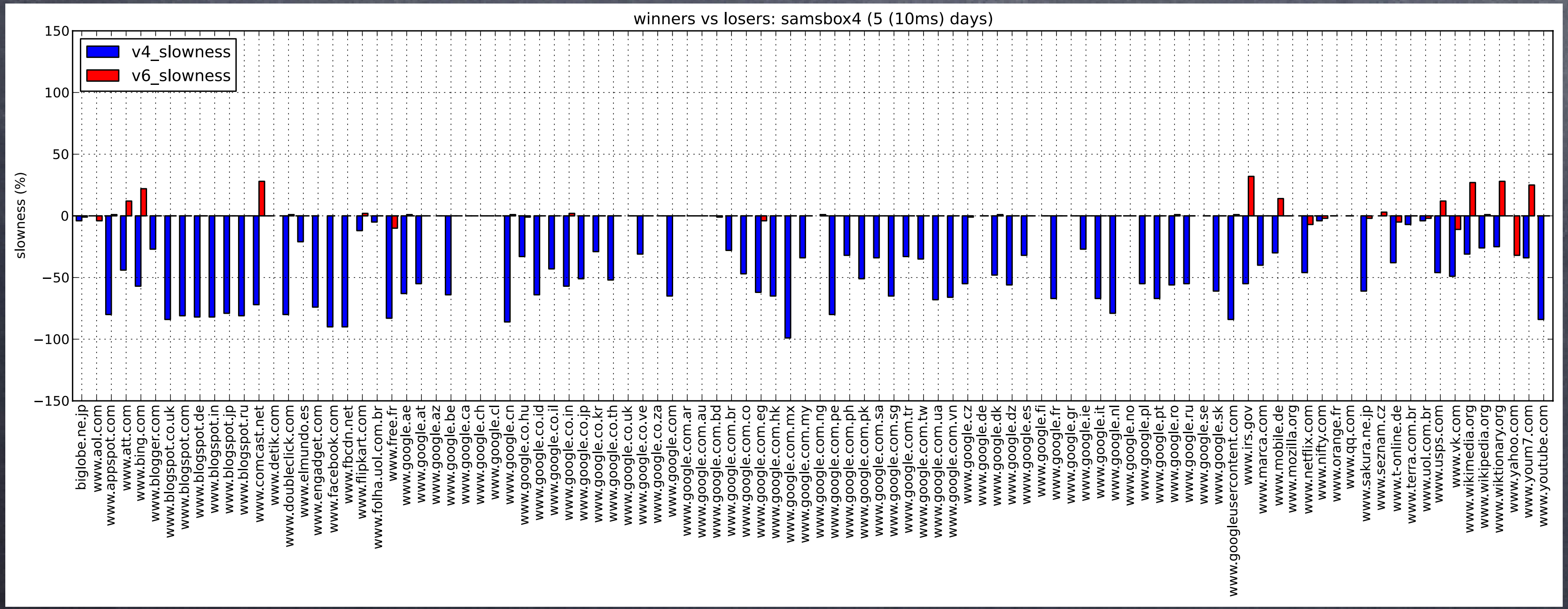
# happy eyeballs advantage: 10ms

Native IPv6 [Bremen]



- IPv4 connectivity via Deutsche Telekom AG [AS3320]
- IPv6 connectivity via Deutsche Telekom AG [AS3320]

Native IPv6 [Bremen]



- IPv4 connectivity via Deutsche Telekom AG [AS3320]
- IPv6 connectivity via Deutsche Telekom AG [AS3320]

# conclusion

- higher connection times and variations over IPv6
- will never use Teredo IPv6 unless IPv4 connectivity is broken
- 300ms advantage leaves 1% chance to prefer IPv4 (even though faster)
- IPv6 happy eyeballed winner is rarely faster than IPv4 route
- 10ms advantage helps remove outliers where IPv6 connectivity is bad

- request:
  - happy must be run from a wider standpoint to get a more comprehensive picture
  - looking for hosts with native IPv6 connectivity to host our happy test.
  - send me your shipment address*, and we ship you a SamKnows probe.

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