Measuring TCP Connection Establishment Times of Dual-Stacked Web Services

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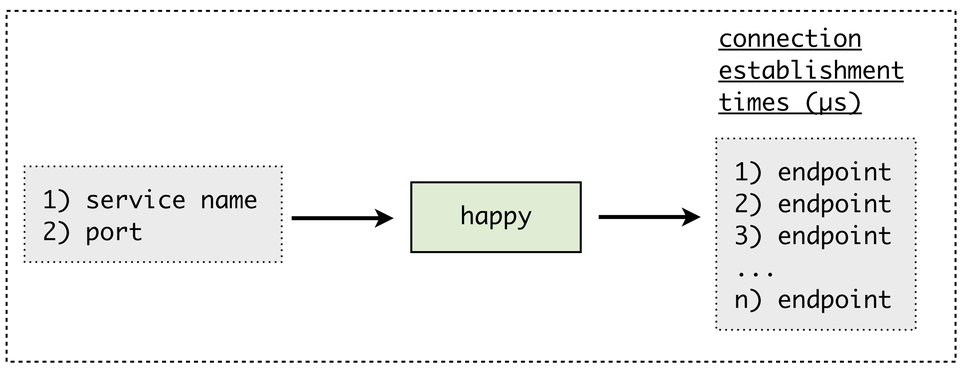
Research Question

The Address Selection Policy [3] makes `getaddrinfo(...)` prefer IPv6 over IPv4. We want to know, how does the preference given to IPv6 impacts the experience of dual-stacked users?

Methodology

We have developed a metric to measure Transmission Control Protocol (TCP) connection establishment times. The `happy` tool is an implementation of our metric as shown below:



The input parameters are a list of a service name and port number and the output is the connection establishment time for each endpoint (measured in microseconds). The features supported by the tool are shown below:

- Uses `getaddrinfo(...)` to resolve service names.
- Uses non-blocking TCP `connect(...)` calls.
- Domain Name System (DNS) resolution time is not accounted.
- Capability to read multiple service names as arguments.
- Capability to read service names list from a file.
- File locking capability.
- Applies a delay between `connect(...)` calls to avoid SYN floods.
- Capability to produce both human-readable and CSV output.
- Cross-compiled for OpenWrt platform. Currently running on SamKnows probes.

The tool has been open-sourced and is available at: http://happy.vaibhavbajpai.com

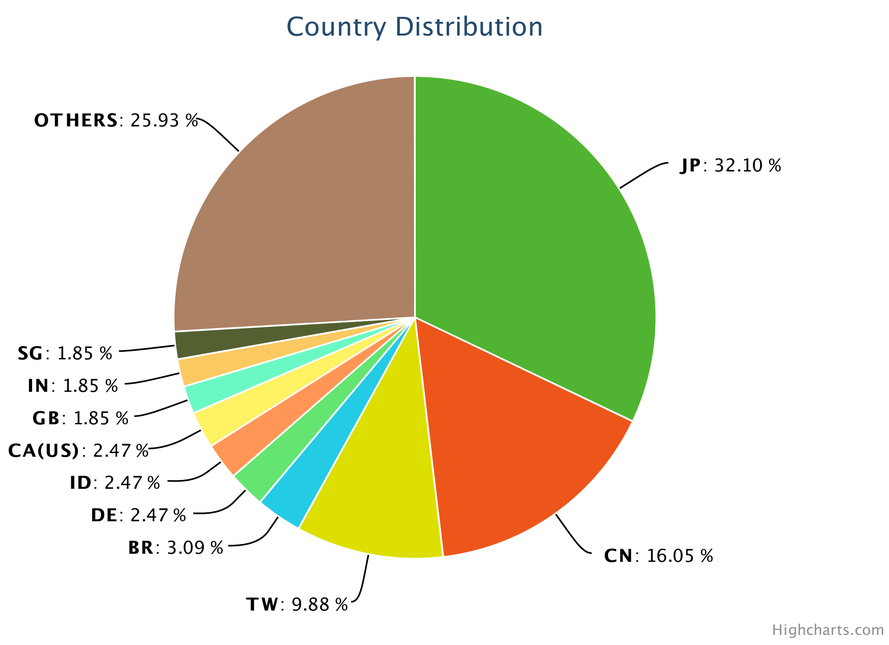
Selection of Web Services

- Hurricane Electric maintains a top 100 dual-stacked service names list. However, it does *not* follow CNAMES: http://bgp.he.net/ipv6-progress-report.cgi
- We use the top Alexa Top Sites 1M service names list to prepare a top 100 dual-stacked service names list. We follow CNAMES and prepend a www to each service name to cross-check a AAAA entry: http://s3.amazonaws.com/alexa-static/top-1m.csv.zip

Whitelisting and Blacklisting

- Google used to perform AAAA prefix whitelisting [2].
- Google has changed its policy. The whitelist has been replaced by a blacklist since the World IPv6 Launch Day in 2012: http://googleipv6.vaibhavbajpai.com

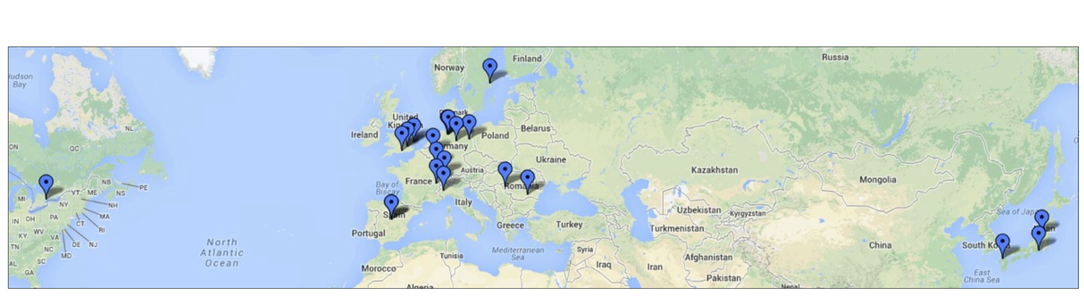
A country-based distribution of prefixes blacklisted by Google over IPv6 is shown below:



[1]RIPE66, May 2013: https://ripe66.ripe.net/archives/video/1208
[2]IETF 87, July 2013: http://www.ietf.org/proceedings/87/slides/slides-87-v6ops-8.pdf

Trial Deployments

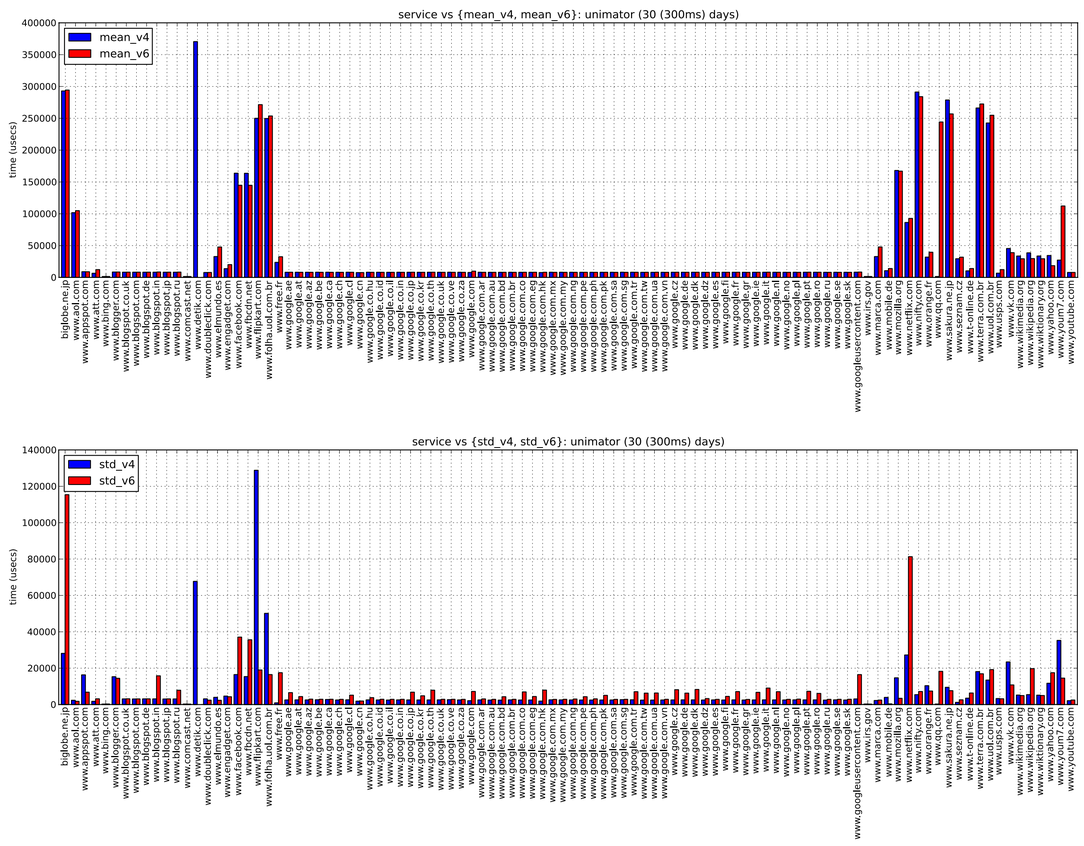
A number of volunteers were gathered to host measurement agents by presenting the work at recent RIPE[1] and IETF[2] meetings. The measurement test is currently running from SamKnows probes deployed at locations shown below:



None of the measurement agents of our trial are behind blacklisted resolvers and therefore can receive Google services over IPv6..

Preliminary Results

The plots below show the mean time and its standard deviation to establish TCP connections to a list of web services. The measurement agent is a server located at the University of Braunschweig. It has native IPv4 and IPv6 connectivity via the German Research Network [AS680]. The plots represent data collected from April 5, 2013 to May 5, 2013.



As can be seen, several services show similar performances, while higher variances are observed over IPv6 compared to IPv4.

Conclusion

- We have defined a metric to compare how TCP connection establishment times to a number of popular web services differ over IPv4 and IPv6. The metric can also be used to examine the impact of tunneling mechanisms employed by early adopters when reaching a dual-stacked service.
- Preliminary results show higher connection establishment variations over IPv6

References

[1] Vaibhav Bajpai and Jürgen Schönwälder. Measuring TCP Connection Establishment Times of Dual-Stacked Web Services. In *9th International Conference on Network and Service Management*, October 2013.

[2] J. Livingood. Considerations for Transitioning Content to IPv6. RFC 6589 (Informational), April 2012.

[3] D. Thaler, R. Draves, A. Matsumoto, and T. Chown. Default Address Selection for Internet Protocol Version 6 (IPv6). RFC 6724 (Proposed Standard), September 2012.

Acknowledgements

This work was supported by the European Community's Seventh Framework Programme (FP7/2007-2013) Grant No. 317647 (Leone).