Measuring the Effectiveness of Happy Eyeballs

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***Abstract*—The IETF has developed solutions that promote a healthy IPv4 and IPv6 co-existence. The happy eyeballs algorithm for instance, provides recommendations to application developers to help prevent bad user experience in situations where IPv6 connectivity is broken. We study the effectiveness of the happy eyeballs algorithm.**

I. Motivation

The function `getaddrinfo(...)` resolves a service name to a list of endpoints in an order that prioritizes an IPv6-upgrade path [1]. The order can dramatically reduce the application's responsiveness when IPv6 connectivity is broken. The degraded user experience can be subverted by implementing the happy eyeballs algorithm [2]. The algorithm recommends that a host, after resolving the service name, tries a TCP `connect(...)` to the first endpoint. However, instead of waiting for a timeout, it waits for 300ms, after which it must initiate another TCP `connect(...)` to an endpoint with a different address family and start a competition to pick the one that completes first.

II. Metric

We have defined a metric that uses the TCP connection establishment times as a parameter to measure the algorithm' effectiveness. The methodology also helps examine the impact of tunneling mechanisms employed by early adopters. The input parameter of the metric is a (IP address, port number) tuple and the output is the connection establishment time, typically measured in microseconds.

III. Implementation

We have developed `happy`, a simple TCP happy eyeballs probing tool that conforms to the definition of our metric. It uses non-blocking `connect(...)` calls to concurrently establish connections to all endpoints of a service and measures the elapsed time. The tool enforces a small delay between concurrent `connect(...)` calls to avoid bursty TCP SYN traffic. The initially performed service name resolution is not accounted in the connection establishment elapsed time.

IV. Measurment Trials

We use Alexa' top 1M service names[1] as input to prepare a top 100 dual-stacked service names list. We run `happy` on our internal test-bed of multiple measurement agents with different flavors of connectivity ranging from native IPv4, native IPv6, IPv6 tunnel broker endpoints, teredo and tunnelled IPv4.

[1] http://s3.amazonaws.com/alexa-static/top-1m.csv.zip

V. Data Analysis Insights

The initial results show higher connection times and variations over IPv6 as shown in Fig. 1. It appears that an application never uses IPv6 using Teredo except when IPv4 connectivity is broken. We noticed, that a 300ms advantage leaves a dual-stacked host only 1% chance to prefer a IPv4 route even though it may be significantly faster than IPv6. We also measured the margin by which happy eyeballs is inhibiting the fastest available route by comparing the slowness of a happy eyeballed winner to that of the loser.

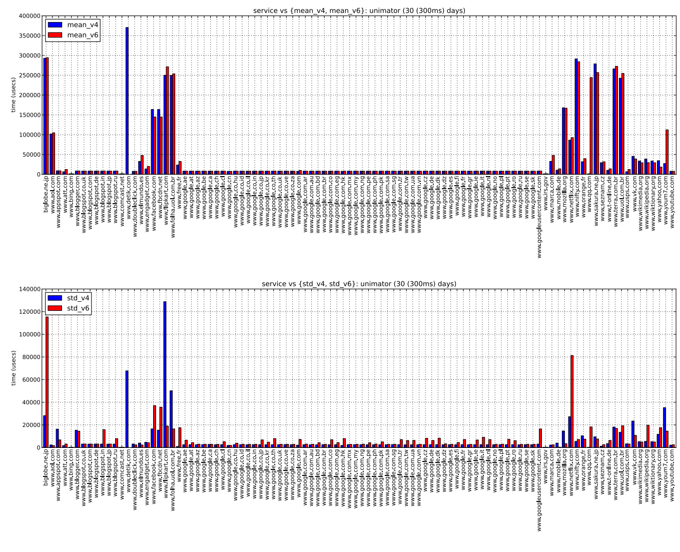

Fig. 1. Mean time and its standard deviations to establish TCP connections to a list of web services. The measurement agent is a server located at the University of Braunschweig. It has native IPv4 and IPv6 connectivity via the German Research Network [AS680]

VI. Conclusion

We have performed a preliminary study on evaluating the effectivness of happy eyeballs. We noticed several cases where the algorithm does not select the best route and instead hampers the user experience. We want to run this test on a large-scale measurement platform to develop a more comprehensive picture to help improve the algorithm.

References

[1] D. Thaler, R. Draves, A. Matsumoto, and T. Chown, "Default Address Selection for Internet Protocol Version 6 (IPv6)," RFC 6724 (Proposed Standard), Internet Engineering Task Force, Sep. 2012. [Online]. Available: http://www.ietf.org/rfc/rfc6724.txt

[2] D. Wing and A. Yourtchenko, "Happy Eyeballs: Success with Dual-Stack Hosts," RFC 6555 (Proposed Standard), Internet Engineering Task Force, Apr. 2012. [Online]. Available: http://www.ietf.org/rfc/rfc6555.txt