ARI Registry Services

Digital Archery Geographical Bias

Tuesday, 19 June 2012

AusRegistry International Pty Ltd, trading as ARI Registry Services
ACN 103 729 620
Head Office
Level 8, 10 Queens Road, Melbourne, Victoria, Australia 3004
p +61 3 9866 3710 **f** +61 3 9866 1970

US Office
5267 Warner Avenue, Suite 176, Huntington Beach, California, United States 92649
p +1 714 846 8780 **f** +1 323 443 3573

ariservices.com

This document is provided pursuant to the disclaimer provided on the last page.

Document Contact

Contact the following for details relating to this document:

Company	ARI Registry Services
Address	Level 8, 10 Queens Road, Melbourne 3004 Victoria Australia
Contact Number	+61 3 9866 1970
Email	info@ariservices.com

About ARI Registry Services

In October 2011, AusRegistry International evolved to a new name and brand identity in a move to support the continued expansion of the organisation and position it as a dominant force in the global TLD Registry Services marketplace.

ARI Registry Services is now used as a trading name of the AusRegistry International corporate entity.

Document Purpose

This document examines the effect of an applicant's geographic location on their ability to compete in ICANN's Digital Archery secondary timestamp mechanism. It investigates if the location of the applicant has an appreciable impact on the reliability of their latency to ICANN's Digital Archery system.

Document Scope

This document investigates the effects of an applicant's geographic location on their network latency and the variable nature of that latency. This document does not discuss alternate solutions to Digital Archery.

Intended Audience

ICANN, new gTLD applicants and interested parties.

Table of Contents

Introduction

Following the announcement of the details regarding Digital Archery, ARI Registry Services (ARI) commenced an investigation to determine whether the described method offered an equitable opportunity for all applicants. As applicants originate from regions all over the world, ARI wished to investigate whether an applicant's location would affect their likelihood of achieving a precise Digital Archery shot. In order to examine whether Digital Archery offered applicants an even playing field, ARI ran a series of tests, measuring the network performance between multiple geographically dispersed locations to ICANN's Digital Archery data centre.

Until the announcement, the location and number of Digital Archery systems (targets) was not clear. It is now clear that a single target system will be used, with the accommodation for regional diversity being the round robin distribution method.

While the latency to the Digital Archery target, from a remote site, has been acknowledged, the variability of that latency has received little notice and it is to this that ARI wishes to draw attention. The premise that an applicant can measure their distance from the Digital Archery target and subtract that time from their Digital Archery shot, thus equalising their chances with those in closer networks, is fundamentally flawed.

It is important to note that the practice shots within the TAS which an applicant can take to calibrate their time are simply a crude way of measuring latency and as such suffer from the same variability as the more detailed network measurements within this report do. For the purposes of this investigation, more regular and thorough network measurements were taken than would be possible through the practice shot mechanism. Nevertheless, should one wish to generate practice shots in a similar volume to the tests contained herein, ARI believes that the results would be the same as those within this report.

Digital Archery Calibration

The process for calibrating a Digital Archery shot is logically simple, but becomes complex in practice. The sequence below is a brief summary:

1. An applicant logs into the TAS, creates a test target time.
2. The applicant, measuring against a clock they control, takes their shot and observes the difference.
3. The applicant would then add or subtract as appropriate the difference and use this to adjust their target time for taking the shot.
4. This test would be repeated, until an acceptable level of precision is attained.

While there are some difficulties to reliably executing the button press (the "shot"), this affects all applicants and exists irrespective of locality. Therefore this variable can be considered a fair skill challenge.

However, taking the shot in a consistent manner is not the only variable. The shot is taken by the applicant from a location outside ICANN's Data Centre, this signal must then travel to ICANN and arrive within a predictable time. If for example an applicant was 200ms from ICANN and it took 1ms to generate their shot, they would try to take their shot at 201ms prior to the target time. In this way, the latency itself would be cancelled out. An applicant closer would start earlier and one further away, later. However a change in network latency will undermine this strategy in a manner

to which the applicant is powerless to adapt. Therefore the ability to calibrate and to ultimately achieve the best possible Digital Archery shot, is directly related to the likelihood and size of any network latency changes.

It should be noted that calibration must be conducted several times as close as possible to the actual shot. Calibration or latency tests become irrelevant within minutes, especially the further one is from ICANN's Data Centre.

Digital Archery Result Times

When discussing latency and variance in latency and their collective impact on a Digital Archery shot, a discussion of expected shot times is pertinent. Based on both ARI's and other parties' efforts into automating Digital Archery shot taking, it is clear that times of 1 millisecond(ms) or less are possible when a shot is taken on a local internal network. That means network latency will comprise the largest component of time when taking a Digital Archery shot. For an applicant in Asia, just .5% of the calibration time, would be a variable component from their own software.

This also indicates the scale of impact a large change in latency would cause to an applicant's chance of achieving a good Digital Archery shot. Variability of 1ms, will have much lower impact than 40ms or several seconds would.

Conclusions

As a result of the testing conducted by ARI Registry Services, it is clear that an applicant's presence outside of North America would place them at a significant disadvantage, both in terms of latency and the variability of that latency. Issues of network congestion and variable network paths are increasingly magnified the further a network is from the Digital Archery target.

The conclusion is simple; the closer an applicant is to the ICANN Data Centre in Virginia, the greater likelihood of repeatable results, allowing a significantly higher chance of calibrating the network latency and thus setting a low Digital Archery time. It is therefore a significant advantage being located as close as possible to ICANN's Digital Archery target or employing an organisation who is.

It is ARI's contention that the frequency and size of network changes seen in networks outside North America mean the greatest influence on an applicant's Digital Archery shot is luck. The further one is from North America, the greater the influence luck has on an applicant's Digital Archery shot. Those applicants without the resources to access systems or representative organisations within North America are to all intents and purposes, playing a lottery, hoping that latency remains consistent between their calibration tests and their actual shot. The applicant's ability to influence this game of chance reduces the further they are from North American networks.

Figure 1, Visual representation of network latency to the ICANN Digital Archery server by geographic region.

Geographic locations outside of North America are shown to be at a disadvantage of between 25ms-260ms (see figure 1). ARI Registry Services' research indicates that the ability of non-North American applicants to accurately predict and thus calibrate and account for this is directly impacted by the distance of that applicant.

Note: The values shown in Figure 1 are determined by Round Trip Totals (RTT). Please see Section "Using RTT" for a further explanation of RTT.

Results

ARI Registry Services recorded the minimum, maximum, average and standard deviation times from each sampling location (see Figure 2).

As discussed in 1.1 Digital Archery Calibration, for the best results and there must be as few network latency changes as possible. When a latency change occurs, the larger the change, the greater the penalty on an applicant's Digital Archery shot.

Results are listed in order of average latency. Regional network infrastructure plays a greater role than simple geographic distance. While network latency does increase with geographical distance, network paths do not travel directly to the USA from all regions. As a result Australia, which has submarine cables travelling more or less directly to land on the US West coast has latency lower than Singapore, whose cables first travel north to land at other countries in the region. This arrangement is entirely practical when one considers the costs and logistics involved in laying such infrastructure throughout the region. Nevertheless, applicants from the East Asian region and those regions passing through that infrastructure will not have access to particularly direct network paths to North America.

Location	Distance from ICANN Data Centre	Minimum	Maximum	Average	Standard Deviation
Virginia, USA	~0kms	2.84	48.52	3.56	0.872
California, USA	3,676kms	74.32	105.05	77.03	1.837
Oregon, USA	3,820kms	72.93	99.11	75.92	1.452
Dublin, Ireland	5,574kms	98.75	378.41	99.39	3.685
Sao Paolo, Brazil	7,520kms	138.02	183.16	143.04	4.933
Tokyo, Japan	11,020kms	166.29	6886.35	181.17	137.072
Sydney, Australia	15,669kms	225	404	232.04	0.878
Melbourne, Australia	16,334kms	247	301	248	0.978
Singapore, Republic of Singapore	15,714kms	246.74	279.85	262.63	7.697

Figure 2, Summary of data at sampled locations. All times are in milliseconds (ms).

Summary

In summary, the further distant an applicant is located from the ICANN Digital Archery server, the less chance that applicant has of posting a low, and therefore competitive, Digital Archery shot. The distance between the minimum and maximum values increases the further one is from the Digital Archery target. Even when one ignores the increase in average latency, variable network measurement values increase markedly when not in North America.

Methodology

ARI Registry Services used sites situated in diverse locations from an independent compute services provider. Each location ran an automated network measurement tool which captured the round trip time (RTT) from it to ICANN's data centre. A measurement was taken every five minutes with five individual probes being used on each occasion. The median result from the probes was recorded as the RTT.

These tests ran from Friday (8th June) to Tuesday (12th June), encompassing both weekend and weekday conditions.

To this was added the results of tests from ARI's own data centres in Australia. In this case the probes were sent every second. As a result the Australian graphs are significantly more granular.

The graphs for each site also include packet loss, which also increases the further a testing point is from ICANN's data centre. Packet loss will significantly disrupt any Digital Archery effort, causing at least the resending of the lost packet, effectively doubling the latency for that instance.

Using RTT

Round Trip Time (RTT) is the only reliable method for measuring point to point network latency. Delays in latency occurring in either direction are thus averaged amongst the collected data.

Measurements

The following graphs serve to illustrate the variance in latency. ARI Registry Services used SmokePing, a network monitoring tool which, as well as noting the median measurement result of each test instance, also graphs the outlying results as “smoke”. This allows the viewer to easily see the average measurement time, while also indicating the variance in measurements taken.

How do I read the graphs?

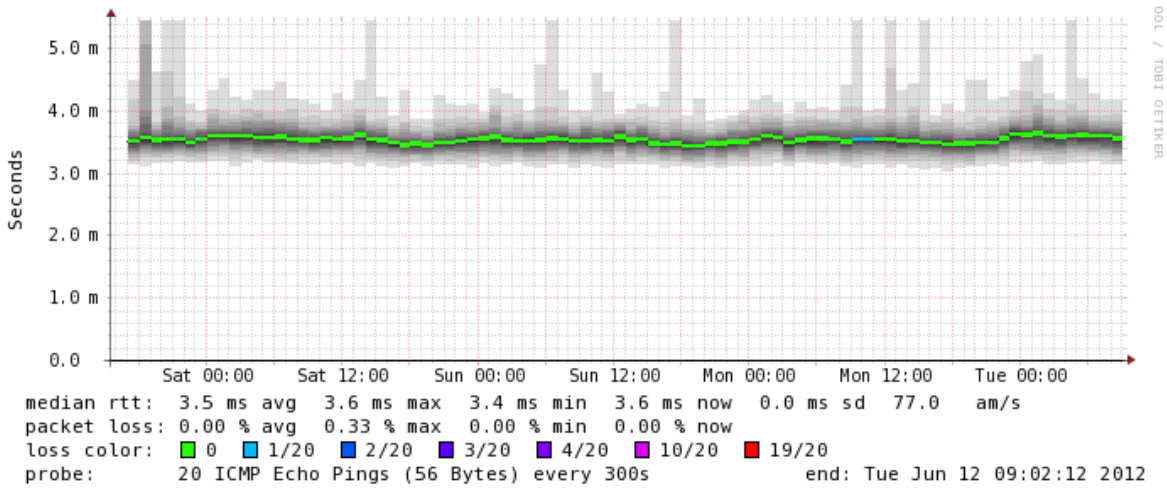
Put simply, less smoke is better. The more narrow and straight the graph, the more reliable the network path will be and thus more predictable to an applicant trying to compete in Digital Archery. With target times of less than a millisecond, standard deviation values should be as low as possible. When increases do occur, ideally they should be as low as possible. With sub millisecond precision the desired result, regular changes of 10ms or more will make networks unsuitable for Digital Archery outcomes that place an applicant in the first batch.

Note: Because graphically representing the measured times can be difficult at a fixed scale, the graphs below will have different scales as appropriate to the range of measurements they display.

Virginia, USA

ICANN’s Digital Archery system is in a data centre located in Reston, Virginia. The graph below illustrates the significant advantage that applicants able to fire their Digital Archery “shot” from close to this location receive. Not only is the latency low, it is far more predictable. All times are in milliseconds.

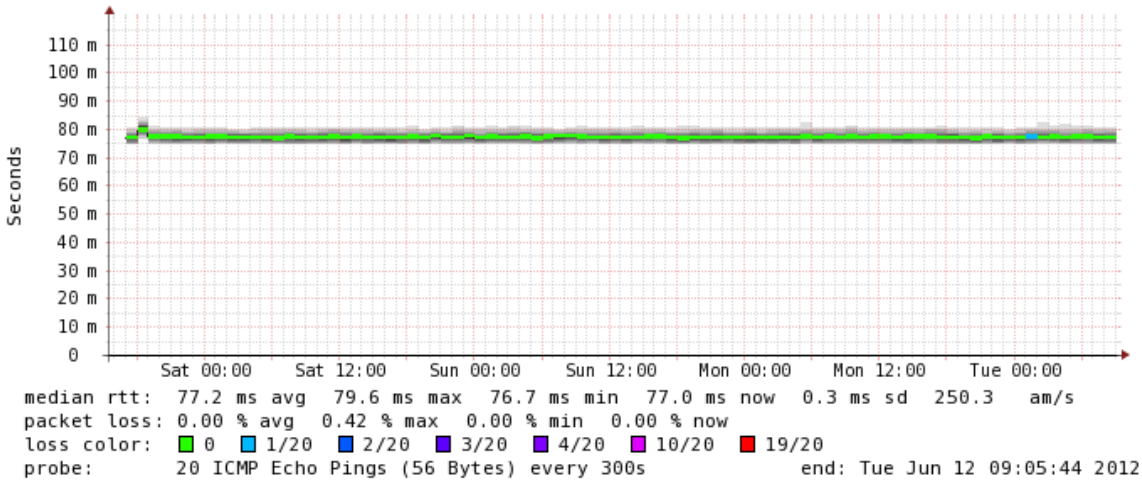
Minimum	Maximum	Average	Standard Deviation
2.84	48.52	3.56	0.872



California, USA

California's average probe latency is higher than the probes from Virginia experienced, but variance in latency remains low, as does packet loss. An applicant in California is still capable of taking a Digital Archery shot with confidence that the network conditions to ICANN's Digital Archery system will not change.

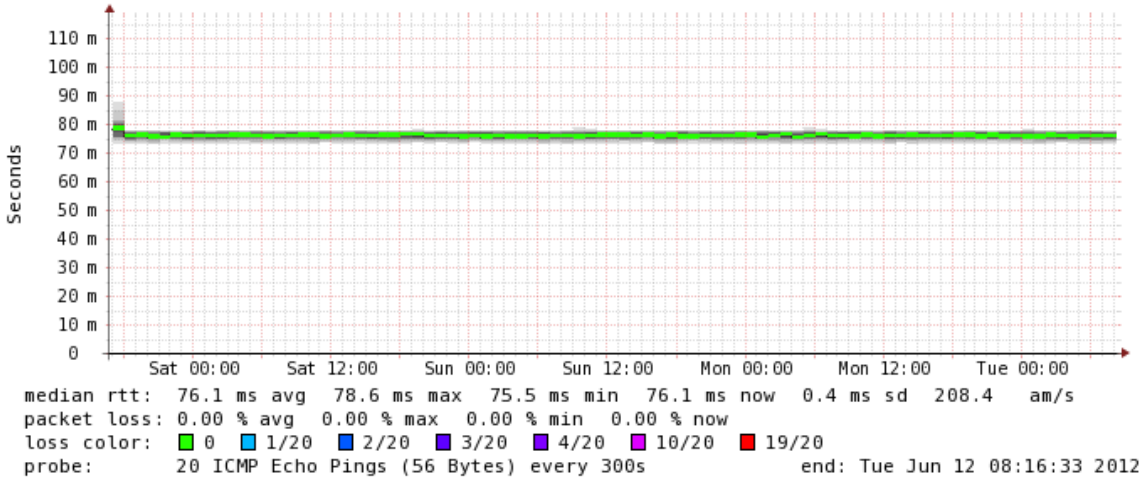
Minimum	Maximum	Average	Standard Deviation
74.32	105.05	77.03	1.837



Oregon, USA

Similar to the samples recorded from California, the Oregon samples show a higher latency than those in Virginia. However, as with California, variance in results remains low.

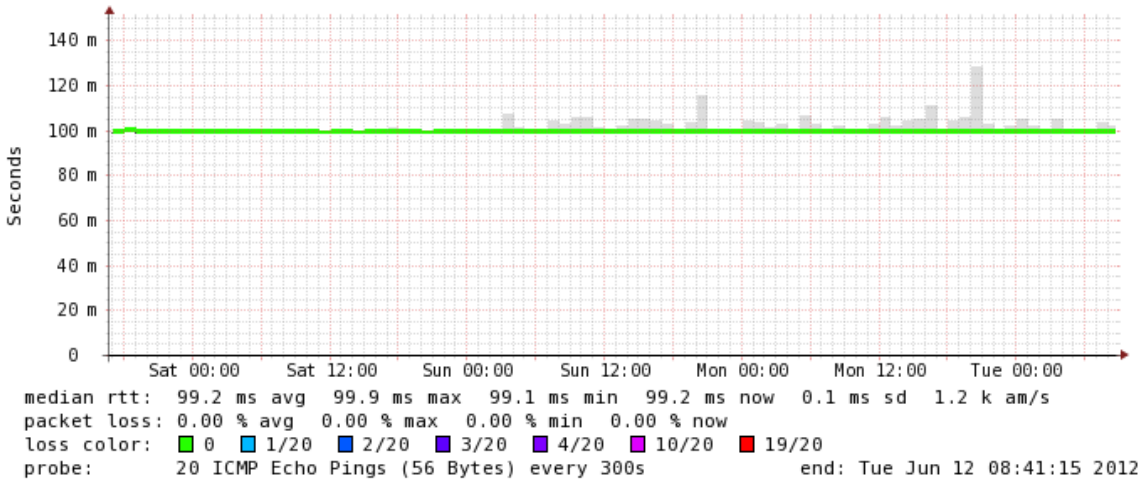
Minimum	Maximum	Average	Standard Deviation
72.93	99.11	75.92	1.452



Dublin, Ireland

Ireland recorded the lowest average result amongst the non-North American sites. A combination of direct submarine links to the US East Coast and geographic proximity mean a generally fast and reliable network path to ICANN's Digital Archery system. Nevertheless, unlike the North American sites, the smoke on the graph represents variance which would significantly impact an applicant's Digital Archery shot. The summary of measurements also indicates results that might be adverse to a Digital Archery shot.

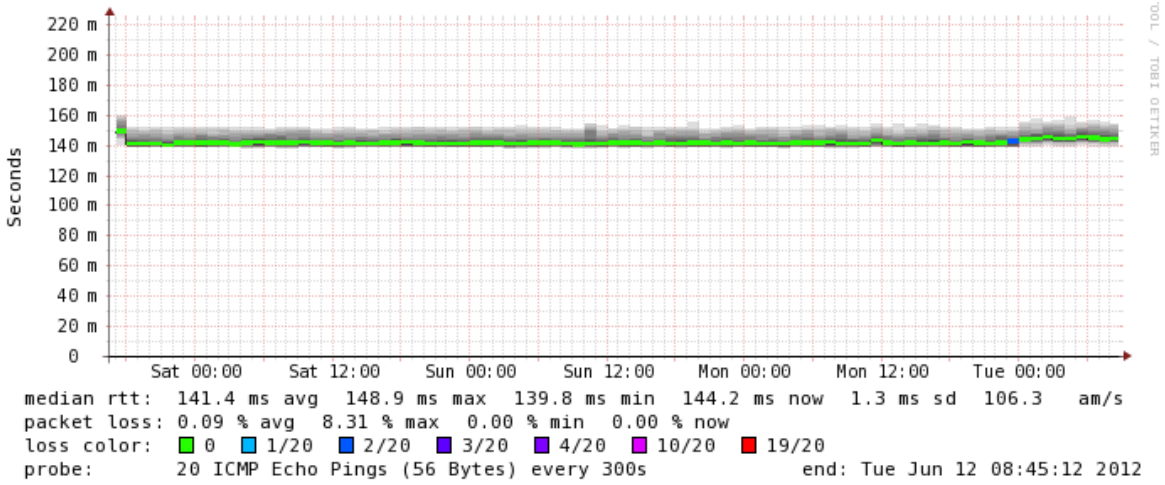
Minimum	Maximum	Average	Standard Deviation
98.75	378.41	99.39	3.685



Sao Paulo, Brazil

Sao Paulo received a higher average measurement result than Dublin, Ireland and the variance was also higher more often. The level of variance seen in the graph and indicated in the summary figures represents a network that could regularly compromise a Digital Archery shot.

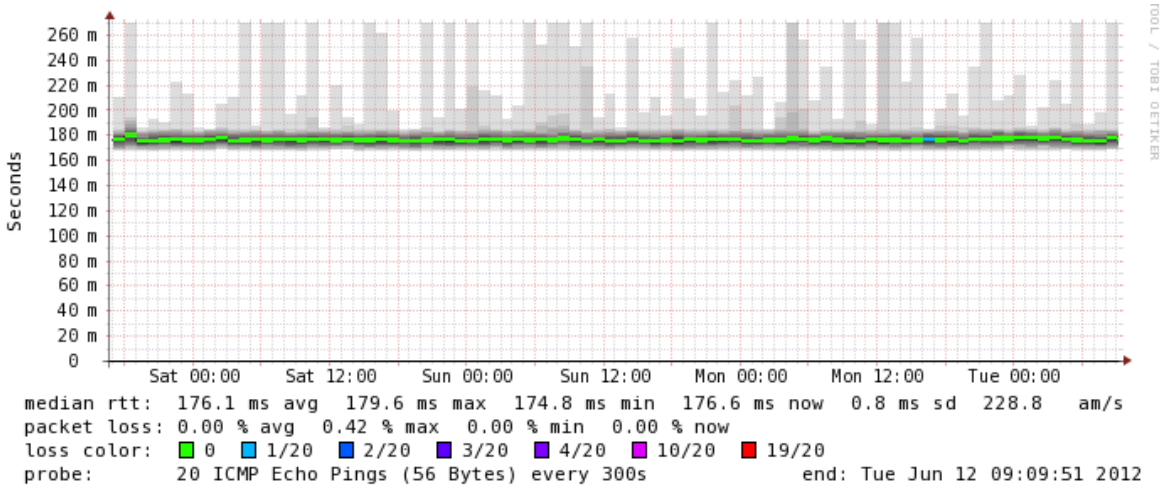
Minimum	Maximum	Average	Standard Deviation
138.02	183.16	143.04	4.933



Tokyo, Japan

Samples from Tokyo show a large amount of smoke indicating significant variance throughout the sampling in addition to the maximum recorded value (6886.35ms). ARI initially thought this result was due to a compromised probe or test site, however careful review of the raw response data confirmed that the network latency experienced by the Tokyo probe regularly exceeded 1 sec (1000 ms). This level of instability is likely to disrupt any attempts for Japanese applicants to secure a successful Digital Archery shot.

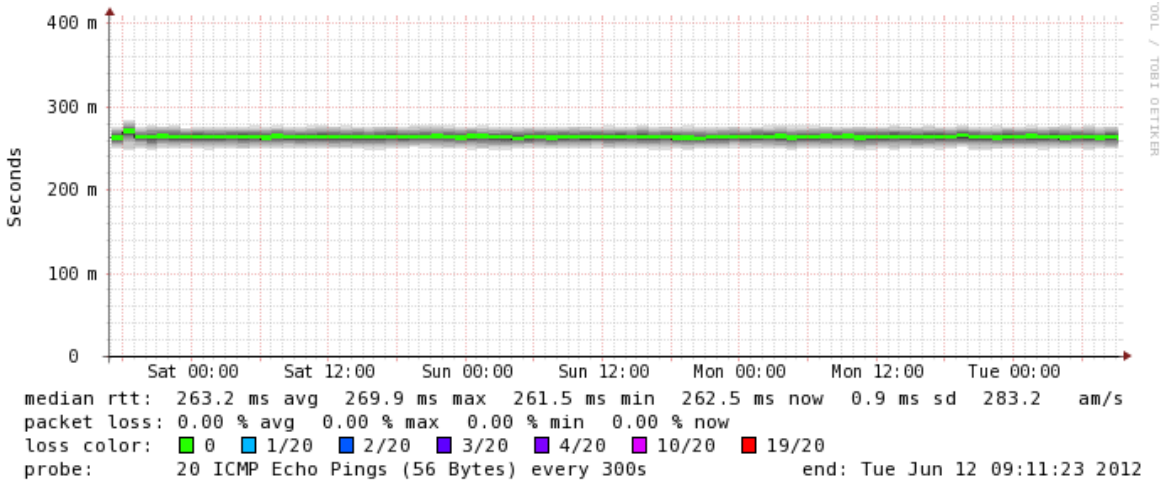
Minimum	Maximum	Average	Standard Deviation
166.29	6886.35	181.17	137.072



Singapore, Republic of Singapore

Singapore's graph is notable for a much lower variance relative to its distance and neighbouring test location (Japan), than one might expect. Singapore benefits from its status as a hub for regional internet access, allowing it to enjoy far more paths to North America than would otherwise be the case. In Singapore's case the presence of 14 submarine cables landing within their border ensures uncongested paths, resulting in a much lower variance in latency. Despite this, they still received the highest average probe result and the standard deviation indicates a network which would nevertheless be unsuitable for sub-millisecond target times.

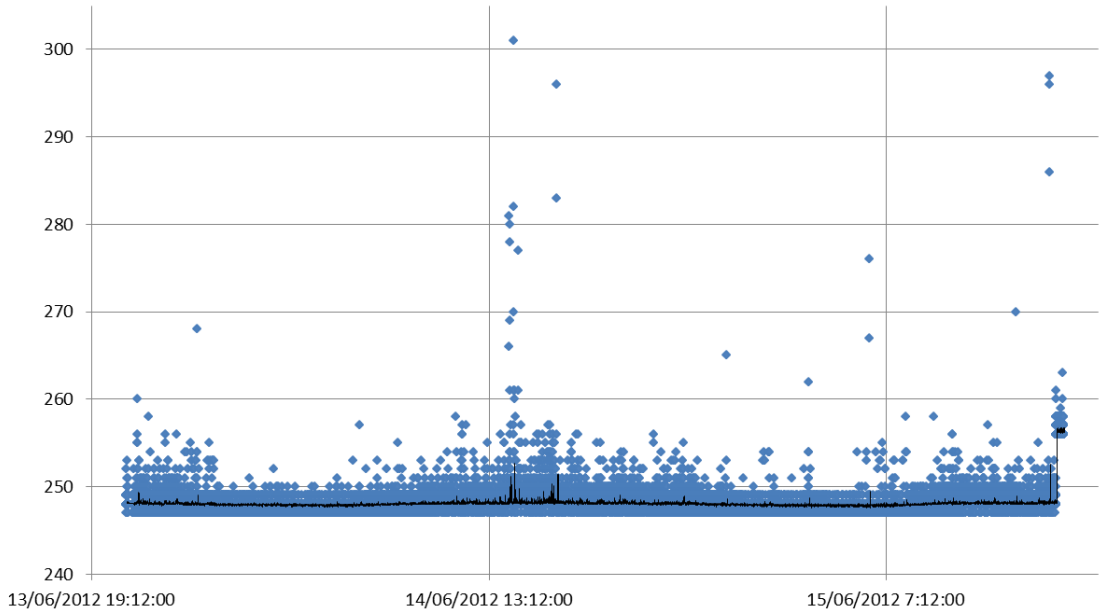
Minimum	Maximum	Average	Standard Deviation
246.74	279.85	262.63	7.697



Melbourne, Australia

ARI's Melbourne Data Centre boasts significant network capacity and available routes to the US West Coast. The performance of the measurements from ARI's network shows considerable advantages over its regional neighbours, in both latency and variability of latency. The data for both Australian based probes is considerably more granular and shows that network access despite distance from the US, performance is generally reliable. While this is laudable from a regular network operations point of view, the variances remain both regular and of a size large enough to entirely undermine the most precise of Digital Archery shots. Thus even a well-connected organisation within Australia would face uncertainties too great to risk. The black line in the graph indicates a moving five minute average.

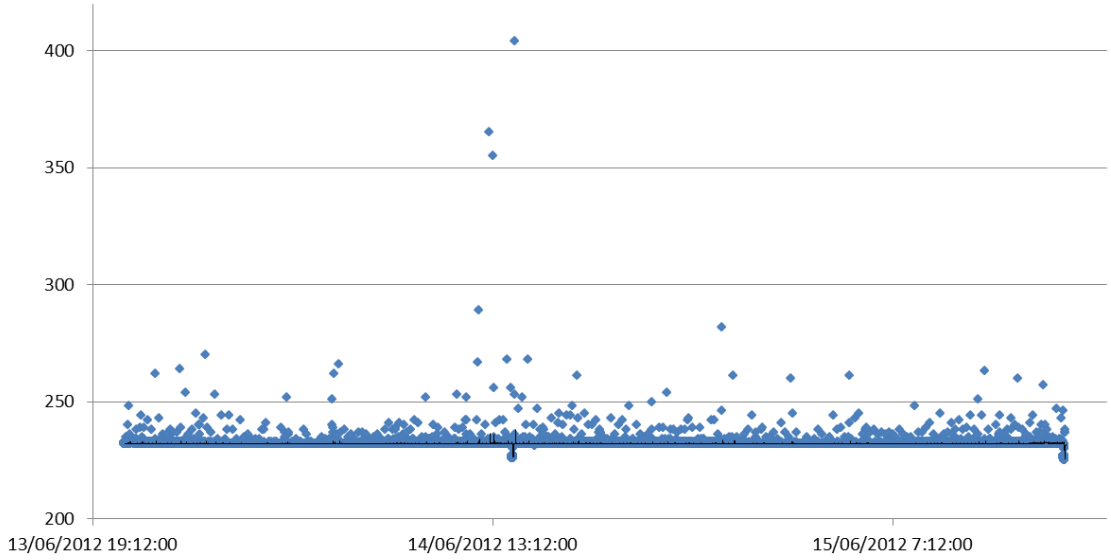
Minimum	Maximum	Average	Standard Deviation
247	301	248	0.978



Sydney, Australia

ARI's Sydney Data Centre is located significantly closer to the submarine cable landing points of the network links from Australia to the US West Coast, than the Melbourne Data Centre. As a result average latency is observably lower and standard deviation is also slightly lower. Nevertheless network latency variance is at a level that would make Digital Archery shot taking an exercise in luck rather than good planning or skill. The outlying results are significantly higher than North American probe sites, meaning the penalty for bad luck is much higher. The black line in the graph indicates a moving five minute average.

Minimum	Maximum	Average	Standard Deviation
225	404	232.42	4.710



Definition of AusRegistry

AusRegistry means any or all of the AusRegistry Group of companies, their related entities and their respective officers, employees, contractors or sub-contractors.

Disclaimer

This document has been produced by AusRegistry and is only for the information of the particular person to whom it is provided (the Recipient). This document is subject to copyright and may contain privileged and/or confidential information. As such, this document (or any part of it) may not be reproduced, distributed or published without the prior written consent of AusRegistry.

This document has been prepared and presented in good faith based on AusRegistry's own information and sources which are believed to be reliable. AusRegistry assumes no responsibility for the accuracy, reliability or completeness of the information contained in this document (except to the extent that liability under statute cannot be excluded).

To the extent that AusRegistry may be liable, liability is limited at AusRegistry's option to replacing, repairing or supplying equivalent goods or paying the cost of replacing, repairing or acquiring equivalent, or, in the case of services, re-supplying or paying the cost of having such re-supplied.

Confidentiality Notice

This document contains commercially sensitive information and information that is confidential to AusRegistry. This document is intended solely for the named recipient, and its authorised employees, and legal, financial and accounting representatives (collectively, Authorised Recipients).

The recipients of this document must keep confidential all of the information disclosed in this document, and may only use the information for the purpose specified by AusRegistry for its use. Under no circumstance may this document (or any part of this document) be disclosed, copied or reproduced to any person, other than the Authorised Recipients, without the prior written consent of AusRegistry.

Trademarks Notice

The names, trademarks, service marks, logos, and icons of AusRegistry appearing in this document may not be used in any manner by recipients of this document without the express prior written consent of AusRegistry. All rights conferred under law are reserved.

All other trademarks contained within this document remain the property of their respective owners, and are used only to directly describe the products being provided by them or on their behalf. Their use in no way indicates any relationship between AusRegistry and the owners of those other trademarks.

Pricing Notice

Any information or pricing provided in this document is subject to change without notice. Whilst AusRegistry has compiled this document in good faith, based on what it believes is accurate and up-to-date information, it is possible that the pricing or other information contained in this document may require amendment due to changing market or other circumstances (including product discontinuation, manufacturer price changes, errors, or insufficient or inaccurate information having been provided by the recipient of this document or others, and other external circumstances). Additional charges may also apply for work that is out of scope.

The pricing in this document is based on AusRegistry standard terms and conditions and is valid for a period of thirty (30) days from the date of this document.


DRIVING INNOVATION AND THE
EXPANSION OF THE INTERNET.