Examples of the use of PingER

Table of Contents

Setting expectations

Given that we have measurements from SLAC to most countries in the world, we can translate them to indicate what connectivity is likely to most countries in the world for various types of applications such as email, web, VoIP, holding Skype meetings, data transfer rates, and real-time interactivity such as haptic surgery or gaming etc. This is very valuable for:

workforce globalization

- travellers to meetings
- longer term visitors etc
- collaborators
  - As SLAC has diversified from an HEP site there is an increased number of scientists interested in collaborating with SLAC. This is particularly so for developing regions such as Africa, South Asia, the Middle East, Latin America etc. PingER with its emphasis on the Digital Divide is well positioned to provide relevant performance information
  - In addition, there are scientific centers of interest to SLAC in developing regions. These include telescopes in Chile, the SESAME synchrotron Lab in Jordan and in particular from Africa
    - There is the Square Kilometer Array[1] with cores in Sub-Saharan Africa and Australia costing €1.5 billion, with construction starting 2016, and initial observations 2019. The network traffic requirements are equivalent to ten times the Internet traffic today.
    - Aug 30, 2012: CERN donated 220 computer servers from CERN to the Kwame Nkrumah University of Science and Technology in Ghana[2].
    - Strategic plan for a synchrotron light source in southern Africa[3] championed by SLAC's own Herman Winick
    - Drugs from rain-forest, environment studies, geo-physics
    - Six HEP International Conferences in Madagascar[4]

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    [1] See http://en.wikipedia.org/wiki/Square_Kilometre_Array
    [2] See http://euroafrica-ict.org/2012/08/30/cern-to-deliver-220-computers-servers-to-ghana
    [3] See http://vector.nsbp.org/2012/02/04/synchrotron-science-on-the-move-in-south-africa/
    [4] See http://www.globaleventslist.elsevier.com/events/2014/01/6th-high-energy-physics-international-conference-hep-mad-13/
  - Bear in mind
    More funding and better Internet connectivity access are helping [Africa]. The number of scientific papers produced by Africans has tripled in the past decade, to over 55,400 in 2013 according to Reed Elsevier. That still only accounts for 2.4% of the world's total but is quite a jump. The quality is rising too. From Economist August 9th, 2014.
- collaboration examples
  - Several High Energy Physics (HEP) experiments have introduced the concept of regional computer centers. Typically there a few of these (e.g. BaBar regional computer centers in France, Italy, and the U.K. as well as the main center at SLAC). These centers are expected to perform much of the computing required by the collaboration and so need good connectivity to the experiment in order to get a copy of the data and to be able to share the results. By using PingER to measure the loss and RTT, we are able to provide expectations for the performance for bulk data transfer and other applications.
  - When putting together the Particle Physic Data Grid (PPDG) proposal (a collaboration of 3 universities and 6 Labs), it was very valuable to be able to look at the PingER data and evaluate what the performance between the sites would be like with the existing production links. As a result of this, we put together a website for the PPDG collaboration focussed on the PingER results for the collaborators.

workforce remote workers

- Choosing an ISP for home connectivity, e.g. for telecommuting etc.:

- In 1996, SLAC wanted to recommend an ISDN Internet Service provider (ISP) for people wishing to connect to SLAC from their homes in the San Francisco Bay Area. To evaluate the connectivity that the various ISPs could provide we decided to use PingER to monitor the ISP gateways in areas where we had several potential SLAC users. The results enabled us to select an ISP who had low loss and good RTT. We continued the monitoring after selecting the ISP and used it to request improvements to and identify problems with the ISP. We also used the information to recommend a second ISP and remove our recommendation on the first ISP. Finally, due to inconsistent performance, we removed all recommendations for ISPs and provided our own ISDN service.
- In 1999, SLAC wanted to recommend a DSL ISP for people wishing to connect to SLAC from their home. There were 2 major contenders, one of which was about twice the price of the other. We needed to compare the performances of the 2 ISPs, so we set PingER to monitor nodes on both networks from SLAC. We discovered that the TCP thruput of the more expensive ISP was an order of magnitude better. This was very valuable information that we were able to provide to prospective users to help in making a decision.

Identifying sites to upgrade

From the PingER reports, we identified that some U.S. universities had poor to bad connectivity to ESnet sites. This was impeding some collaborations. In 1997, a working group was formed by the ESnet Steering Committee (ESSC) to review the situation and provide recommendations. We selected the top 20 universities (ranked by DoE funding) which did not have direct ESnet connections and made sure they were all monitored by PingER. After reviewing the results, we identified those (there were 4) with very poor (> 5% packet loss) and poor (> 2.5% loss) connectivity (there were 8) over a period of 4 months. This list was then reviewed to look at the existing plans for improved connectivity (in particular several of the universities were about to join the vBNS). The information was then provided to the ESnet management to evaluate the cost of providing direct ESnet connections for each of the universities. This exercise was repeated a year later, except the threshold was reduced to 1%. This time there were 2 with poor packet loss (> 2.5%) and 8 with acceptable packet loss (>1%).

Identifying Last Mile Problems

From a detailed Case Study on NIIT Pakistan, we were able to identify that the problem with connectivity to universities in Pakistan was not due to the performance of the Pakistani National Research and Education Network (NREN) supplied by PERN but rather due to the poor last mile connections to the university sites. These were dramatically congested. This was reported to the head of the Higher Education Commission (HEC) Atta ur Rahman and led to the upgrading of the links to universities.

Deciding where to site a software development effort

The BaBar experiment at SLAC needed to locate a software code porting activity at one of the collaborator sites with expertise in a particular Unix platform. We used PingER to evaluate the performance between SLAC and the various potential university collaborator sites to see which one had appropriate connectivity and performance. This information was a major selection factor in the final choice.

Setting expectations for VoIP

Several years ago, various national Labs (CERN in Geneva, DESY in Hamburg, FNAL in Chicago IL, LBNL in Berkeley CA, and SLAC in Menlo Park CA) set up a pilot Voice over IP (VoIP) project to evaluate the utility and performance of this technology. By comparing the results from PingER with various ITU recommendations for loss, RTT and jitter, together with the perceptions of voice quality from the pilot, we are able to determine how well VoIP might work between various pairs of sites.

Choosing routes

SLAC has two connections to the Internet. One is via ESnet, the other via Stanford University. The performance of both these connections is excellent, however, the way the 2 network peer with other ISPs can differ dramatically. By reviewing the performance and routes from Stanford and from SLAC to sites of interest to SLAC we can see whether sending packets via Stanford or via ESnet (SLAC's default routing is via ESnet) should provide better performance for SLAC.

In one example of this we compared the performance between SLAC/ESnet or Stanford and Colorado State (see *Routing via Campus*), discovered it was much better (factor of 2 less RTT) via Stanford, and then worked with the ESnet NOC to change ESnet's routing to Colorado State to make a big improvement.

In another case, we compared the performance between SLAC/ESnet or Stanford and PacBell's Internet. In the former case, the traffic went via the STARTAP in Chicago and sustained RTT's of around 130 msec. In the latter case, it went via Palo Alto and sustained an RTT of about 30 msec.

Evaluating the Impact of:

Major Cable Cuts

When the major cables through the Mediterranean were cut in January and December 2008 the PingER data was used to evaluate which countries were affected, by how much and for how long. See the Effects of Fibre Outage through the Mediterranean and Effects of Mediterranean Fibre Cuts December 2008.

Tsunamis

The earthquake and tsunamis in Japan caused cable cuts (see Japanese Earthquake March 11th, 2011) which resulted in interruptions in connectivity and increased round-trip times caused by re-routing of traffic to avoid fibre optic cables severed off the West costs of Japan

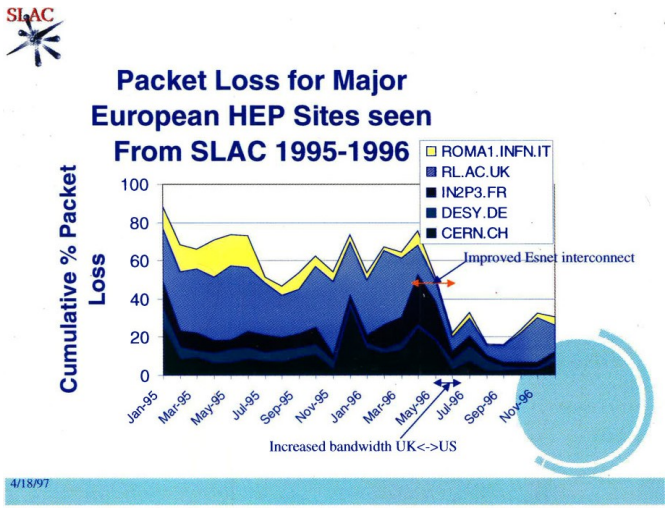
Earthquakes

Earthquakes in Chile (see Chilean Earthquake Feb 27th, 2010) caused loss of connectivity, increased jitter and round-trip times.

Social Upheaval

For example for the Arab Spring (see The Arab Spring 2011 and Internet Instability seen by PingER, Egypt shuts down their Internet) the main impact was the loss of connectivity due to government shut-downs of Internet access.

Network upgrades



Quantifying the Impact of Changes

In July 2009, the Seacom submarine fibre cable went line, connecting East Africa at higher speeds and dramatically reduced Round Trip Times (RTT) to the Internet. Using the PingER data we were able to identify the effects via a Case Study.

Quantifying the Digital Divide

PingER has been used in many studies to quantify the discrepancy in Internet performance for developed countries/regions and developing countries regions, see for example: January 2009 Report of the ICFA-SCIC Monitoring Working Group

Correlations with Economic Indicators

There are corelations with several economic indicators.

Comprehensive Nuclear-Test-Ban Treaty Organization

The CTBTO based in Vienna--- is engaged in monitoring the world for signs of nuclear explosions. The collected data and processed results are made available to authorized recipients in CTBTO Member States as well as a number of tsunami warning organizations. Many of the recipients, so-called National Data Centres, receive the data over a secure Internet connection. For this reason, they are interested in evaluations of the quality and available bandwidths for Internet connections in the African countries, as well as in Asia and other parts of the world that are on the low-end side of the so-called Digital Divide. They looked with interest at the data we publish in the PingER pages. More.

HotMail

Identifying the optimal location to provide a HotMail service. Knowing the performance between PingER hosts in similar locations as the client and the various HotMail servers, one can optimize which server to access from the client.

Internet History

With measurements going back to 1997, PingER data provides a very valuable history of Internet performance.

Used as Illustratiions

- Bridging the Digital Divide South Africa needs cheap, fast, and reliable bandwidth to fulfill its aspirations . not just in big science, but to reach its development goals as well. Phil Charles demonstrates the relationship between astronomy and the Internet and argues that the time has come for bold action.
- Internet Communications Using SIP, Delivering VoIP and Multimedia Services with Session Initiation Protocol, by Henry Sinnreich and Alan B. Johnson, Published by Wiley Publishing, Fig 18.3 2nd Edition.
- Email from Mike Jensen, 12/17/2011, *I'm writing a chapter for a book commissioned by the w3 foundation on internet access and I wanted to use one of your pinger project graphics*
- Symmetrry Magazine, Volume 5, Issue 4, September 2008.

- Email from Yohei Kuga at KEIO University, 5/14/2011 *I'm Yohei Kuga at KEIO University from Japan. Now I'm writing a book that topic is Internet architecture and current status written in Japanese. And in this book, I hope to introduce PingER activities with 'PingER metrics intensity map'. Could I use PingER metrics intensity map image in the book? (image URL: http://www-iepm.slac.stanford.edu/pinger/intensity-maps/pinger-metrics-intensity-map.html) We think Image size is one-half page (about size is 10cm x 8cm) with image source and references.*
- Email from Katherine Blundell, Oct 15, 2009, *I have come across an interesting plot attributed to you on page 1 of the attached article, showing growth in bandwidth to various countries, particularly developing ones. Is there an updated version of this plot you might be willing to let me have? This is partly for my own interest, and partly because I will be speaking tomorrow at the annual Microsoft Research e-Science workshop on a project of mine (www.GlobalJetWatch.net) involving deploying telescopes various countries separated in longitude. While the project is research-driven, there is an important educational/outreach component with a web-learning site to help encourage children in developing countries to learn - and love - science, but could potentially be hindered by lack of bandwidth to these countries. I was tentatively wondering about very briefly making this point at this particular workshop, but obviously, I would only do this if you were happy for me to, and I would of course fully attribute the plot to you.*
- Email from Katie Yurkewicz *I am currently creating a Web site companion for Science Grid This Week, and I would like your permission to include the PingER plot I used in Science Grid This Week in the new site's image bank. The site will be called the Science Grid Network, and will host Science Grid This Week and include science grid-related images, links, and presentations. The image bank will be part of the existing interactions.org image bank (http://www.interactions.org/imagebank/) and subject to that bank's permission policy. I will include your name and email address as a contact for the image unless you request otherwise. The image I intend to archive is shown here: http://www.interactions.org/sgtw/2005/0622/pinger_more.html Please let me know if I have permission to archive the image. If you have another PingER image that you'd rather I use, or any other images, links or introductory grid-related presentations that you would like to include on the site, please send them along!*
- Email from robert_mitchell@computerworld.com 12/21/2005 *Computerworld would like to publish the pie charts on page 7 of your January 2005 IDFA SCIC Network Monitoring Report and source them to the ICFA at Stanford. This would be for an infographic concerning Internet reliability and would be part of a larger feature I am writing on the Internet and telecommunications services. Can you let me know before the holidays if you have any objections or if there are issues you would like to discuss, such as proper sourcing?*