PingER: a lightweight active end-to-end network monitoring tool/project

Prepared by Les Cottrell for the

RIPE 46 Meeting, Amsterdam Sept 2003

www.slac.stanford.edu/grp/scs/net/talk03/ripe-sep03.ppt

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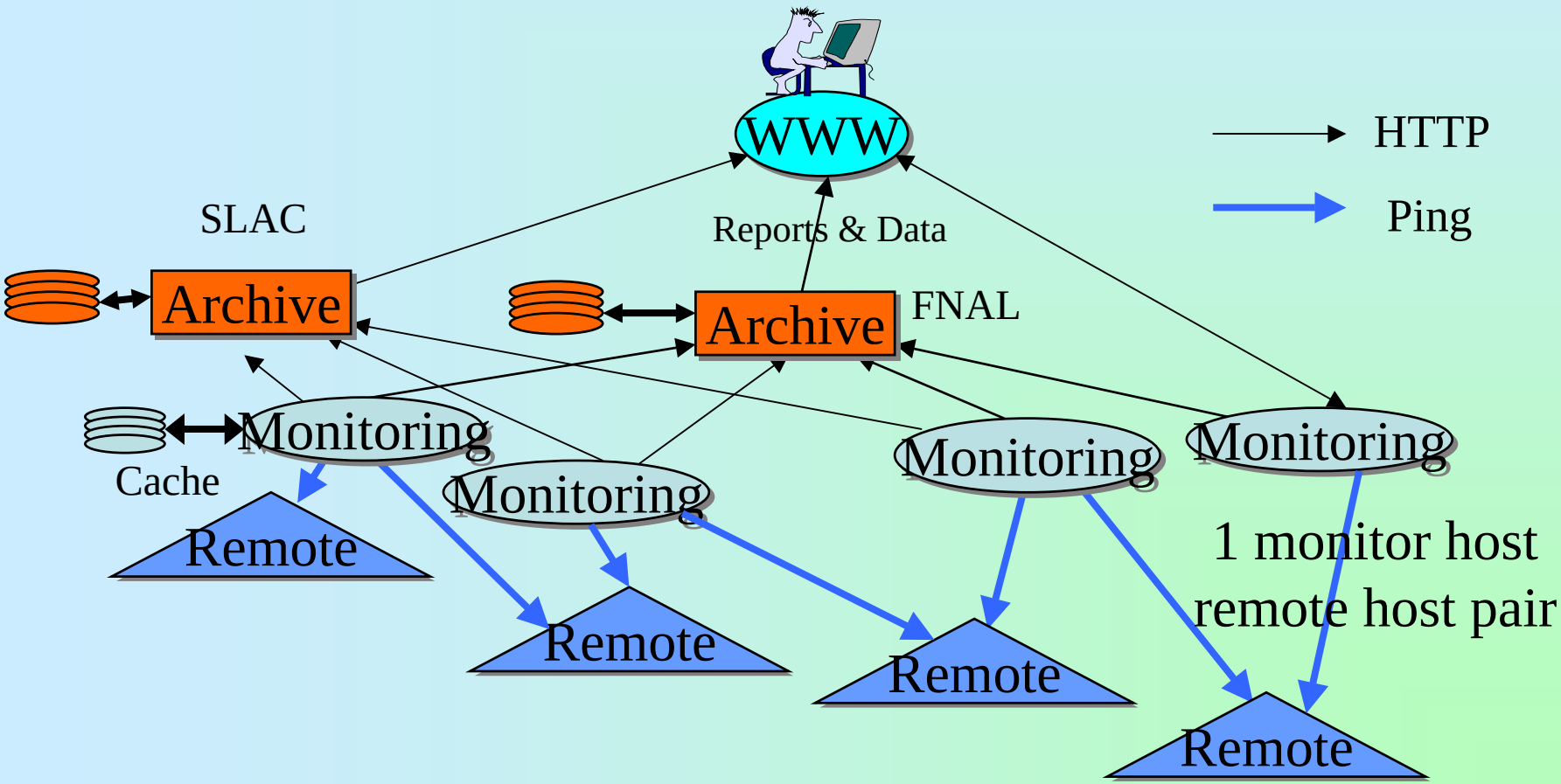
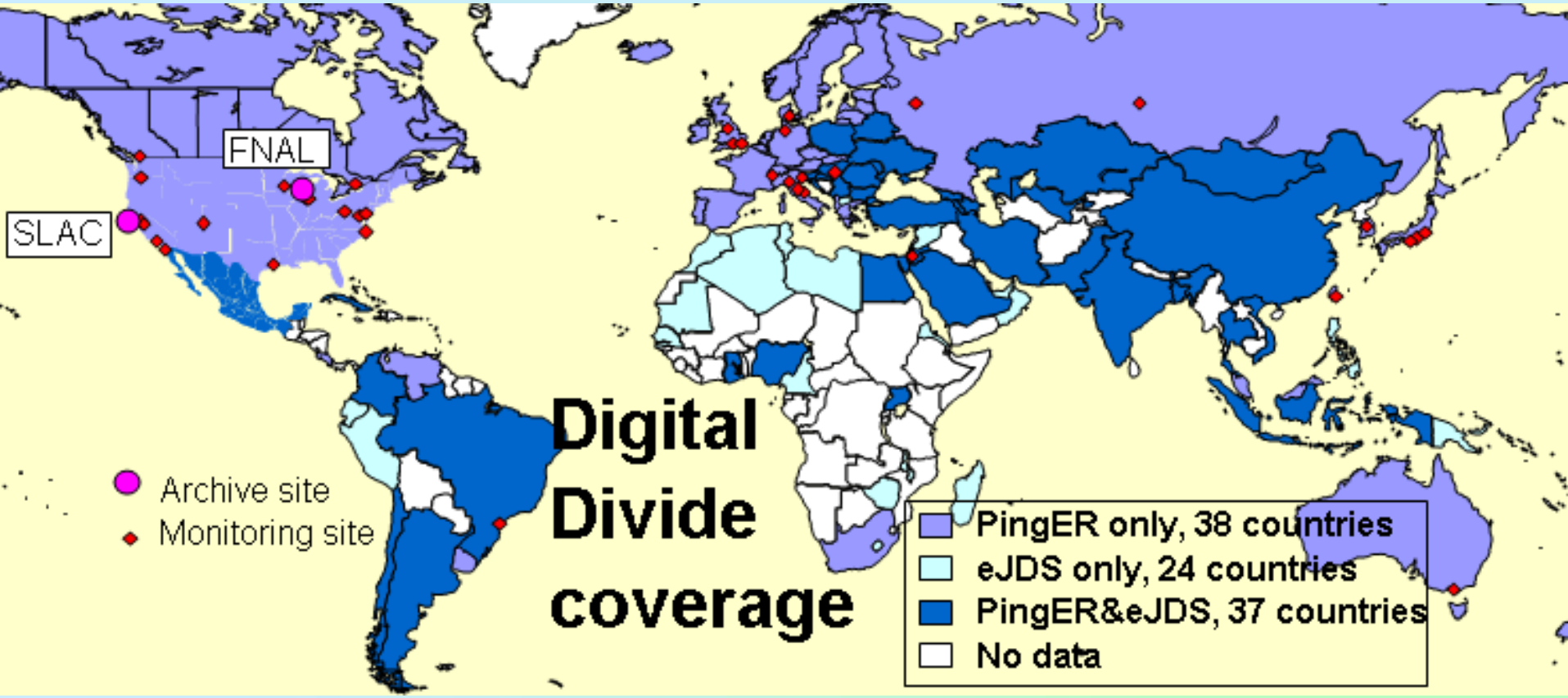
Methodology

- Use ubiquitous ping
- 1 ping to prime caches,
- Each 30 minutes: from Monitoring site to target: by default send10x100Byte pkts then 10x1000Byte pkts
- Record loss & RTT, (+ reorders, duplicates)
- Derive throughput, jitter, unreachability …

Architecture



Countries Monitored



Recent additions

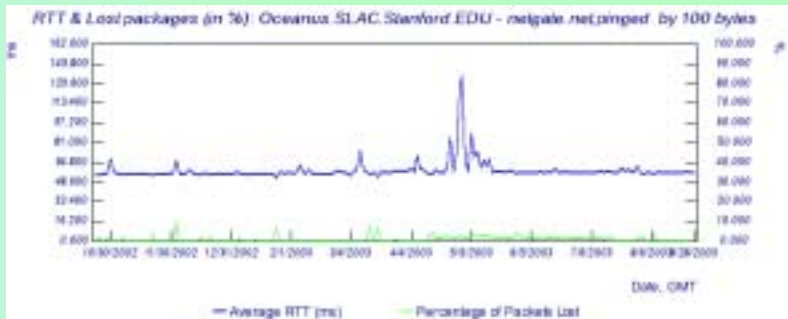
- Added hosts in Macedonia, Serbia/Montenegro, Belarus, Turkey, Armenia, Mexico and Azerbaijan.
- Contacts
  - Working with contacts for Vietnam, the Philippines, Albania, the Silk Road, and Tunisia
  - Looking for contacts in Cuba, Kenya, Algeria and South Africa, & Uganda
  - Working with Iran site to become monitor host
- Increased hosts monitored from CERN to give better European view
  - Now monitoring 60 countries

Visualization

Keep it simple, enable user to do their own by making data available

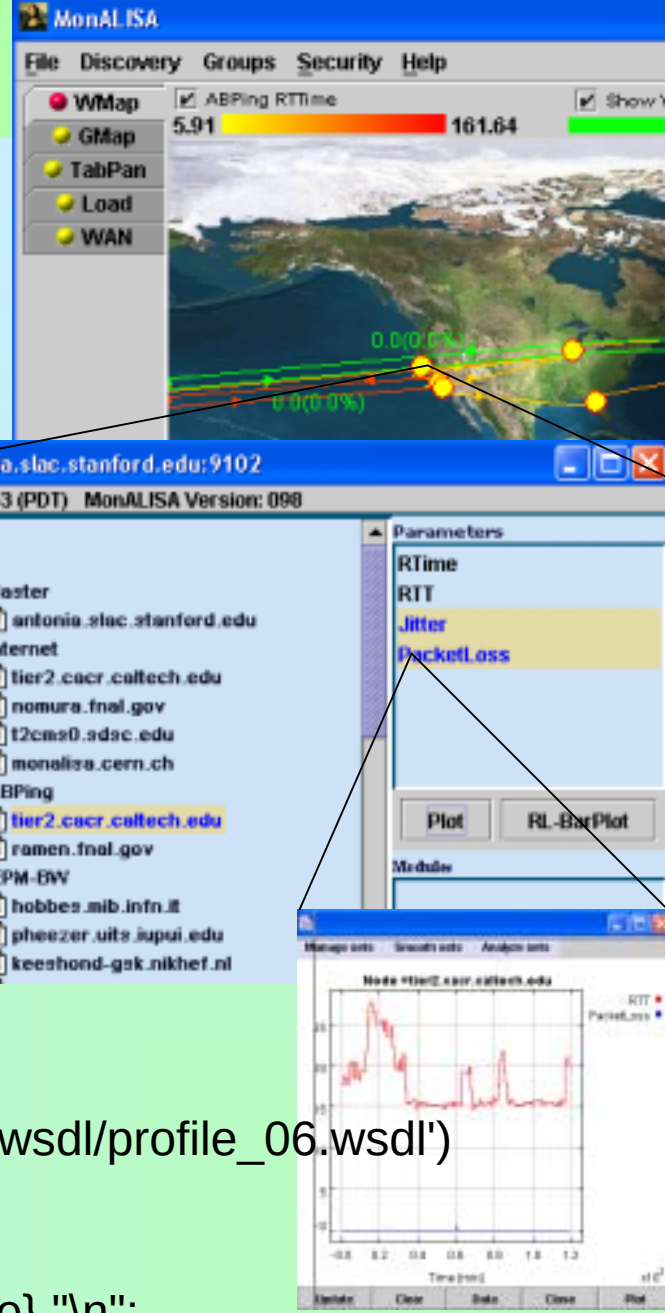
- Tables
  - Time series (www-iepm.slac.stanford.edu/cgi-wrap/pingtable.pl):
    - select metric (loss, RTT etc.), time ticks, packet size, aggregations from/to, etc.
    - Color code numbers, provide sort, drill down to graphs, download data (TSV), statistical summaries
  - Monitoring site vs. Remote sites (www-iepm.slac.stanford.edu/cgi-wrap/table.pl):
    - Select metric, region aggregations
    - Drill down to time series, download data
- Graphs
  - Select source(s)/destination(s), metric, time window, SQL selects, graph type

Monitoring-Site	Remote-Site	Jul2003	Jun2003	May2003
SLAC	LC-HOME-G-SU.NET	0.07	0.06	0.05
SLAC	OS-HOME-MSPNG.NET	0.30	1.07	1.37
SLAC	GB-HOME-G.PBI.NET	0.00	0.00	0.13
SLAC	STANFORD	0.04	0.06	0.06
SLAC	CB-HOME-G-PBI.NET	0.02	0.15	0.13
SLAC	PACBELL-ADSL	0.00	0.01	0.25
SLAC	NETGATE	1.14	1.39	1.73



Publish information

- www.slac.stanford.edu/cgi-wrap/pingtable.pl => tabular reports
- Data accessible from MonaLisa
- Implementing web services access prototype
  - Includes: PingER, IEPM-BE, RIPE-tt, I2 E2Epi OWAMP
  - Use GGF/NMWG schema/profile, e.g.
    - path.delay.roundTrip




```
#!/usr/bin/perl
use SOAP::Lite;
my $characteristic = SOAP::Lite
  -> service('http://www-iepm.slac.stanford.edu/tools/soap/wsdl/profile_06.wsdl')
  -> pathDelayOneWay("tt81.ripe.net:tt28.ripe.net");
print $characteristic->{NetworkTestTool}->{toolName},"\n";
print $characteristic->{NetworkPathDelayStatistics}->{value},"\n";
```

PingER Benefits

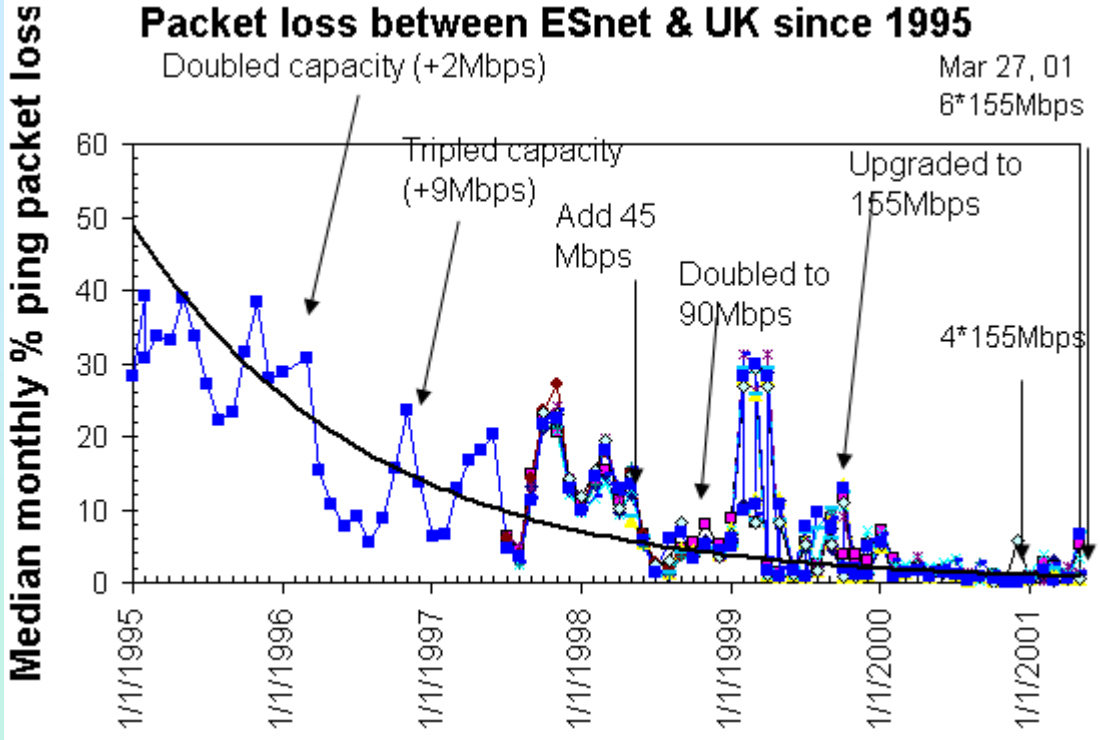
- Aimed at: end-user (net-admin & sophisticated user), planners
- Measures analyzes & reports round-trip times, losses, availability, throughput ...
  - Uses ubiquitous ping, no special host, or software to install/configure at remote sites
  - Low impact on network << 100bits/s, important for many DD sites
  - Covers 75+ countries (99% of Internet connected population)
- Provides **quantitative** historical (> 8yrs) and near real-time information
  - Aggregate by regions, affiliations etc.
  - How bad is performance to various regions, rank countries?
  - Trends: who is catching up, falling behind, is progress being made?
  - Compare vs. economic, development indicators etc.
- Use for trouble shooting setting expectations, identify needed upgrades, choosing a provider, presenting to policy makers, funding bodies

WORLD	Russia	Europe	East Asia	Australasia	North America
Middle East	1.40	0.38	1.27	0.91	1.75
Africa		86.67			6.68
Russia	0.03	1.05	0.81	0.67	0.71
Balkans	1.09	0.77	1.00	0.68	1.16
Europe	1.04	0.34	0.68	0.31	0.36
South Asia					2.57
Baltics	1.10	0.39	0.72	0.43	0.60
Latin America	2.02	0.62	1.17	0.59	1.41
East Asia	1.05	1.43	0.85	1.84	1.39
Australasia	2.18	0.51		0.42	0.92
North America	0.83	0.31	0.68	0.24	0.37
Caucasus					0.78
Central Asia					1.49
.	Russia	Europe	East Asia	Australasia	North America

Monitoring site vs. Remote sites screen shot

Usage Examples

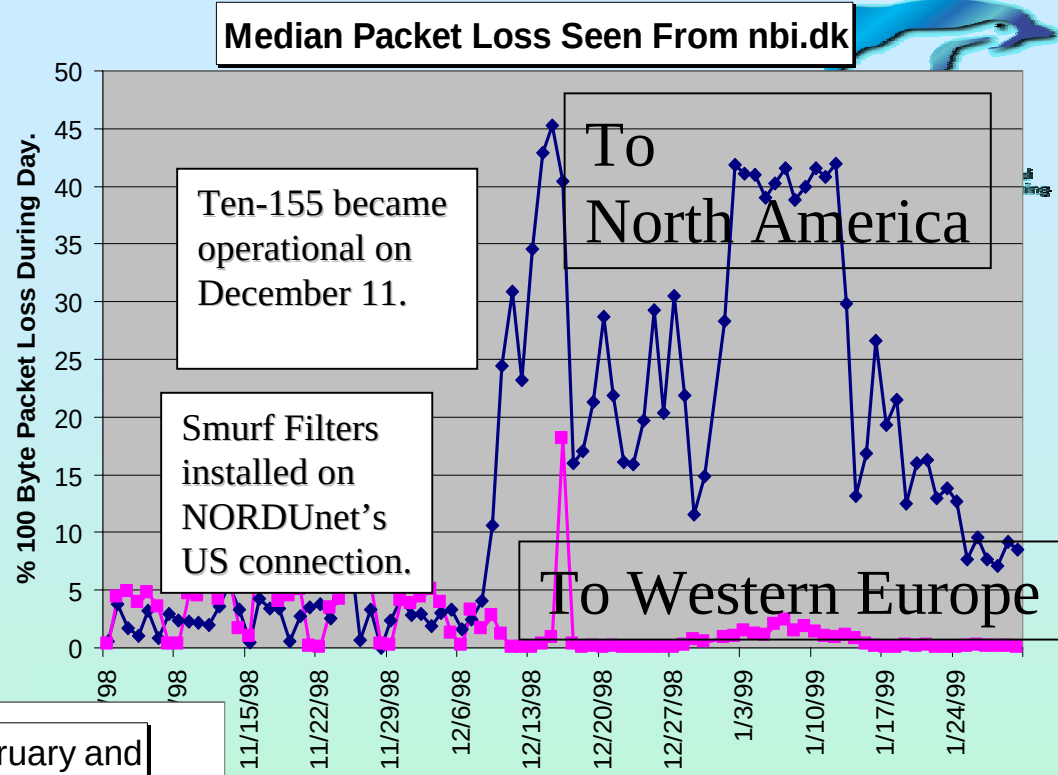
Identify need to upgrade and effects

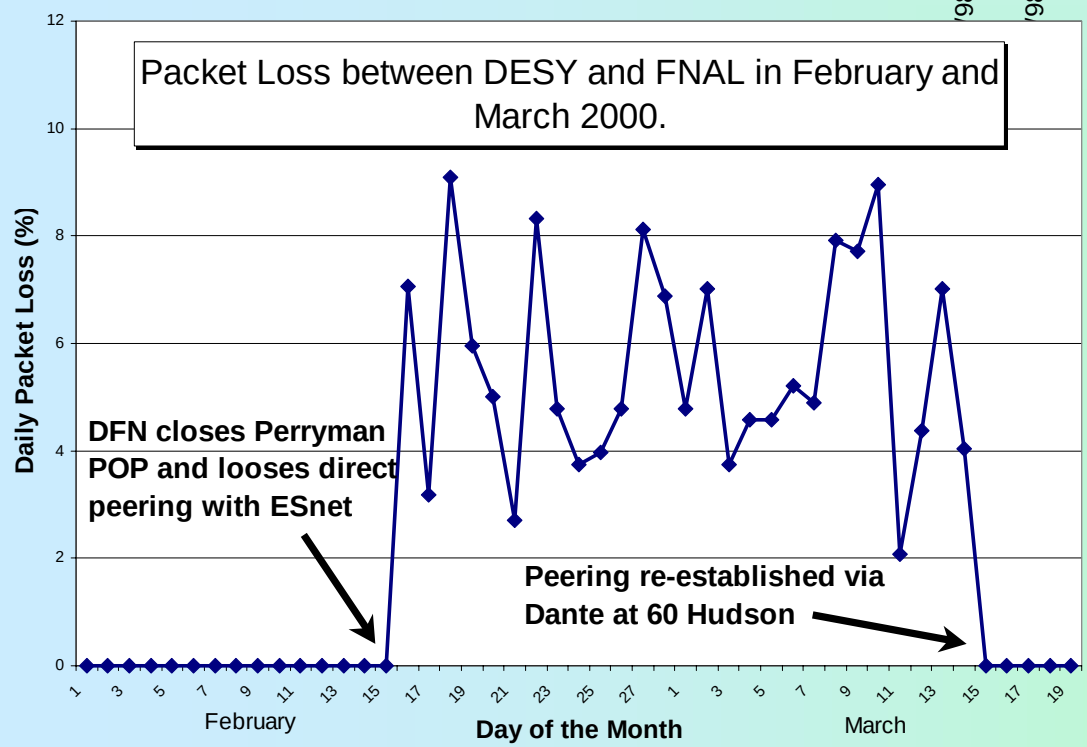


- Selecting ISPs for DSL/Cable services for home users
  - Monitor accessibility of routers etc. from site
  - Long term and changes
- Trouble shooting
  - Identifying problem reported is probably network related
  - Identify when it started and if still happening or fixed
  - Look for patterns:
    - Step functions
    - Periodic behavior, e.g. due to congestion
    - Multiple sites with simultaneous problems, e.g. common problem link/router …
  - Provide quantitative information to ISPs

Usage Examples

Upgrades & ping filtering





Peering problems

Current State – June '03 (throughput)

Jun-03	RU	AU	CA	DK	DE	HU	IT	JP	CH	UK	US	Median
Europe	354.2	146.2	226.9	1064	3608	11589	1491	164.2	11178	4928	359.1	1064
S.E. Europe	305.6	147	218	1027	1760	6444	1183	163.5	1417	1301	320.1	1027
Baltics	365.4	145.2	205.6	2327	1093	935.6	776.7	165.5	728.5	1010	319.6	729
Middle East	215.5	124.3	192.6	401.4	492.8	462.8	590.8	132	453.6	545.9	207.1	401
North America	238.8	234	2446	293.6	347.8	343.5	366.4	241.4	288.7	453.5	16122	343
Russia	66834	124.9	178.5	513.9	569.7	305.7	294	248	282	322.4	246.3	294
Latin America	121.3	130.8	155.3	170.5	167.1	178.3	183.6	132.4	152.2	185.8	215.3	167
Australasia	111.8	9582	87.87			153.6	155			164	231.6	155
East Asia	167.6	127.2	171.7	136	144.8	141.8	142.5	8340	138.7	160.2	217.9	145
South Asia			69.02								137.5	103
Central Asia											85.29	85
Caucasus											69.88	70
Africa							36.29		50.67		72.53	51
Median	238.8	145.2	185.5	457.7	531.2	343.5	330.2	164.8	288.7	453.5	217.9	167.14

- Within region performance better
  - E.g. Ca|US-NA, Hu-SE Eu, Eu-Eu, Jp-E Asia, Au-Au, Ru-Ru
- Africa, Caucasus, Central & S. Asia all bad

Bad < 200kbits/s < DSL

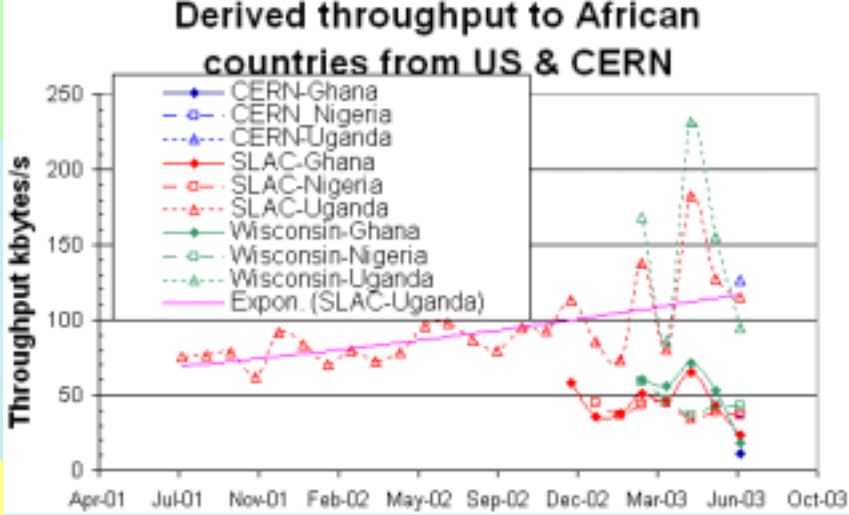
Acceptable > 200, < 1000kbits/s

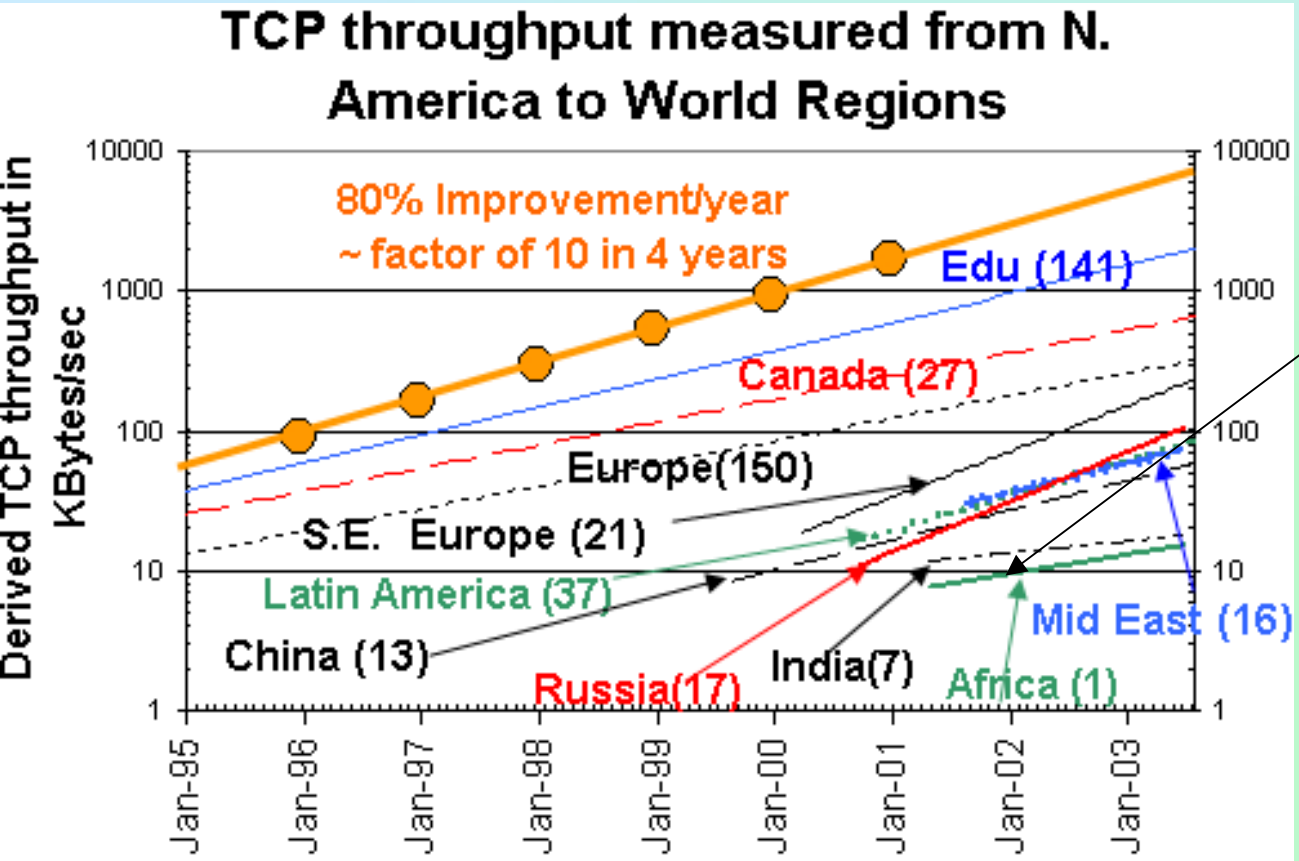
Good > 1000kbits/s

Trends

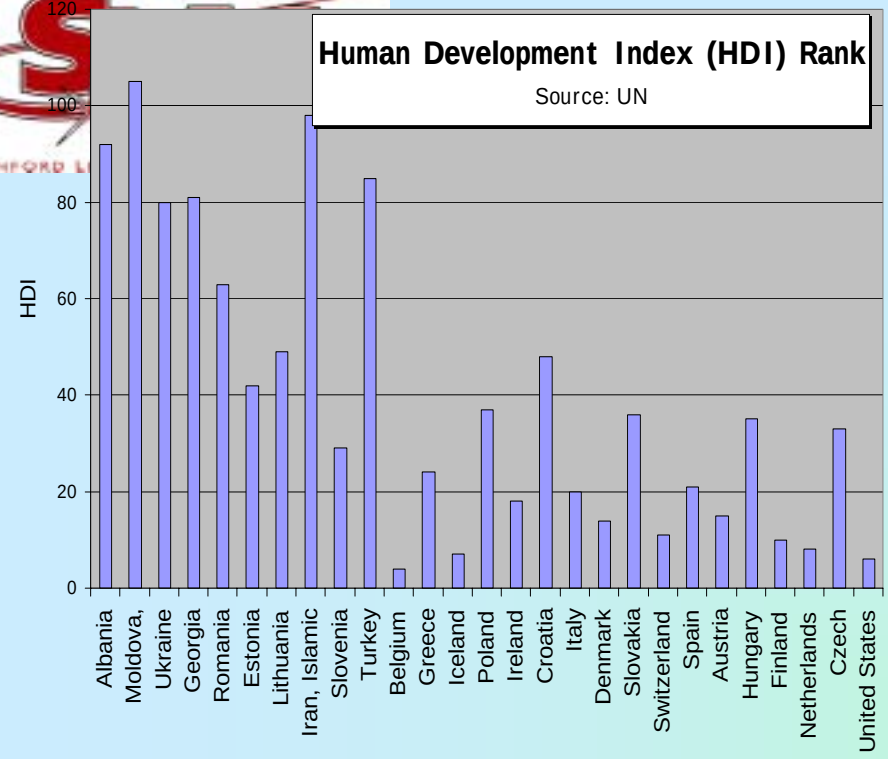
S.E. Europe, Russia: **catching up**
Latin Am., Mid East, China: **keeping up**
India, Africa: **falling behind**

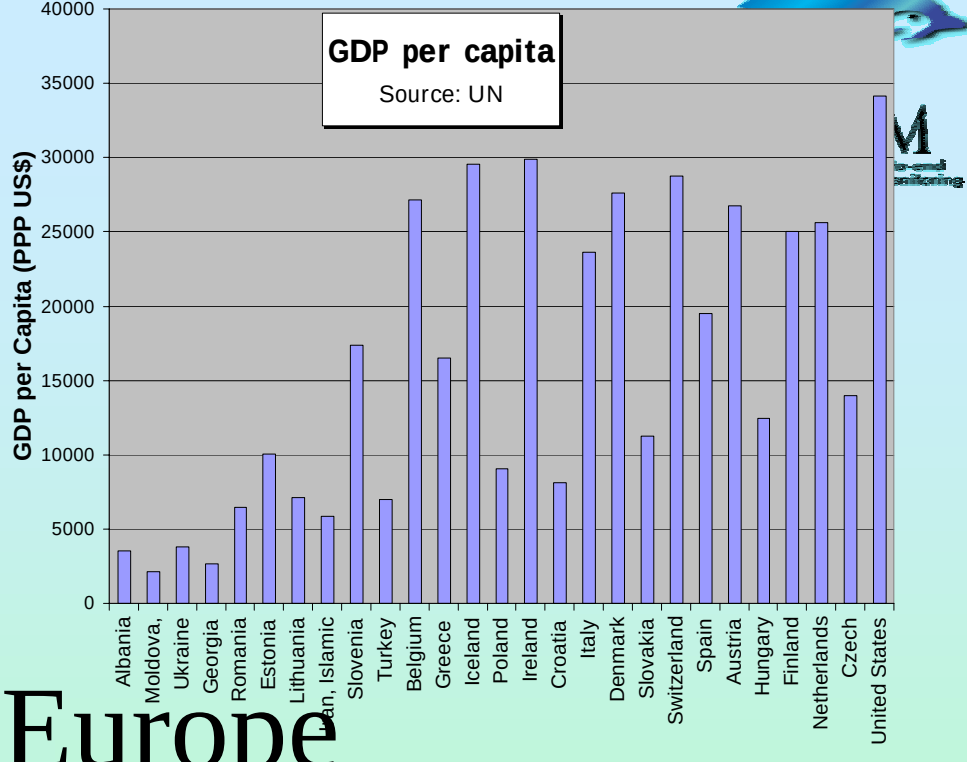
Derived *throughput~MSS/(RTT*sqrt(loss))*



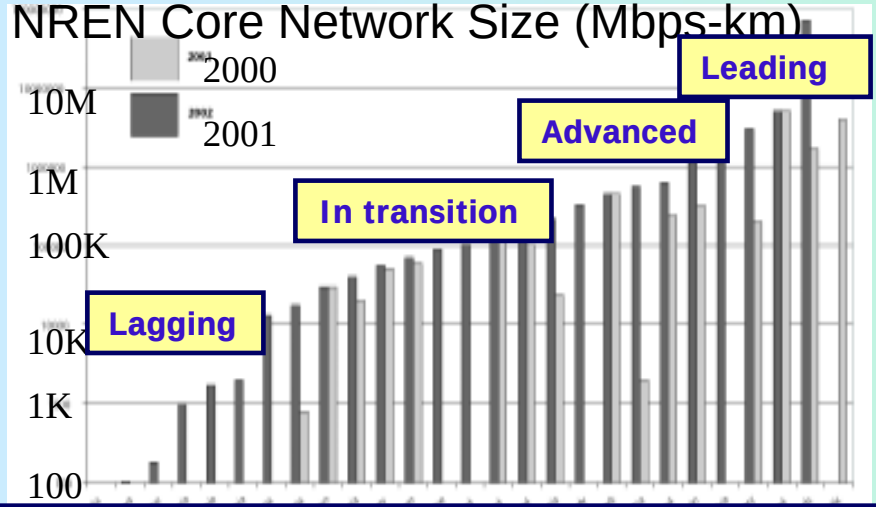


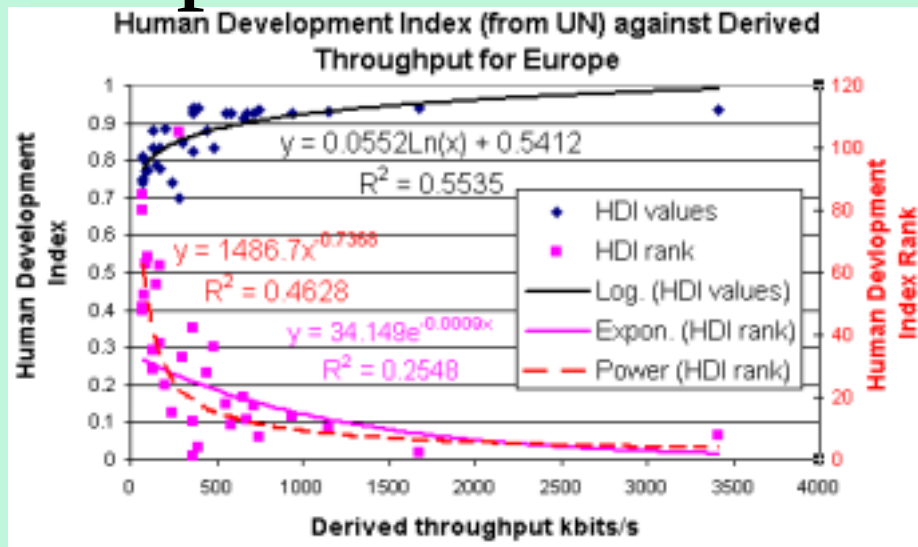
Africa shown for only Uganda seen from SLAC, since adding new countries with very different throughputs distorts result





Europe



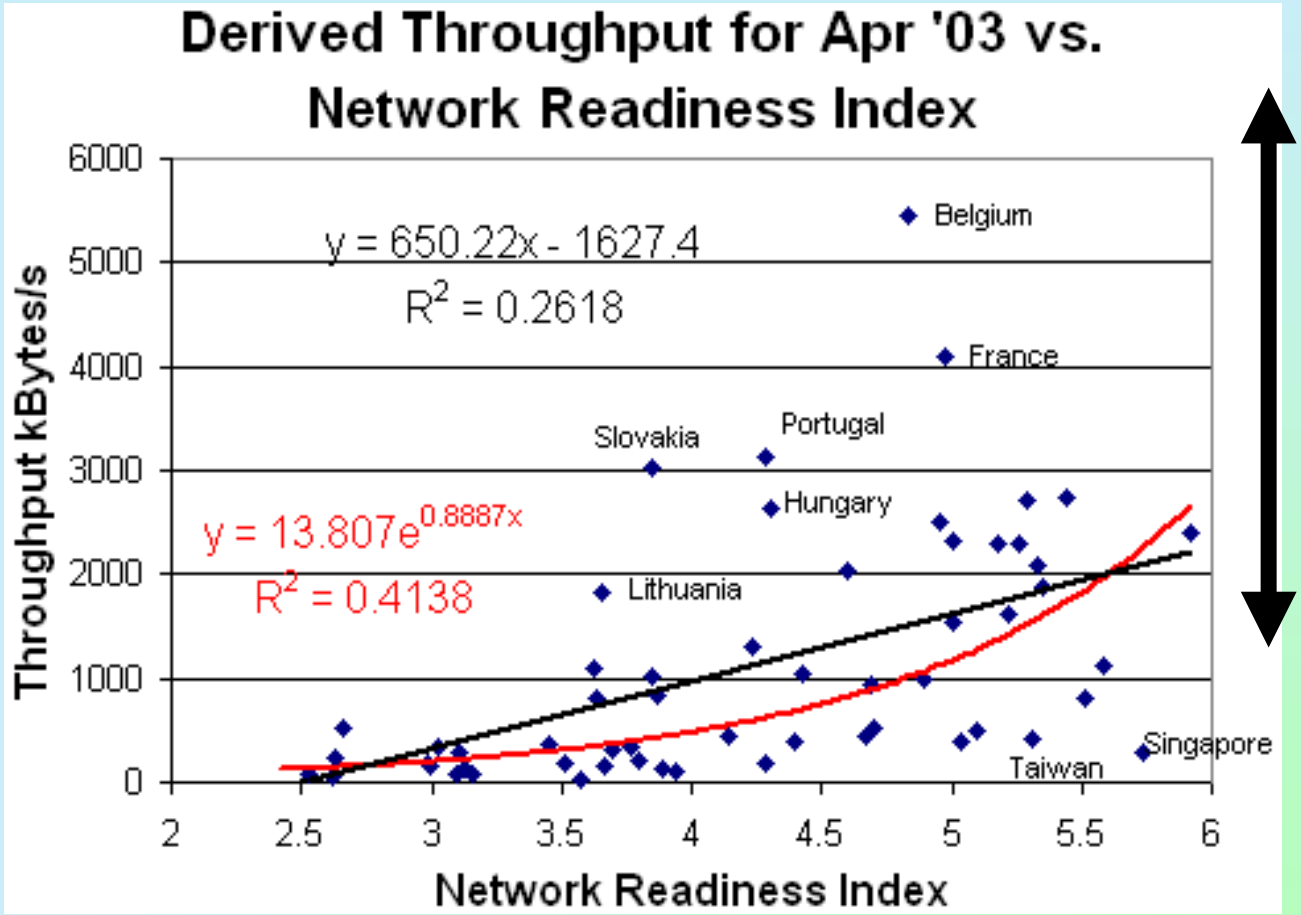


Source: From slide prepared by Harvey Newman, presented by David Williams ICFA/SCIC talk on Serenate report. Data from the TERENA Compendium

Derived throughput~MSS/(RTT*sqrt(loss))

Network Readiness Index

- NRI from Center for International Development, Harvard U. http://www.cid.harvard.edu/cr/pdf/gitrr2002_ch02.pdf



- Using derived *throughput ~ MSS / (RTT * sqrt(loss))*
  - Fit to exponential is better

Challenges

- Effort:
  - Negligible for remote hosts
  - Monitoring host: < 1 day to install and configure, occasional updates to remote host tables and problem response
  - Archive host: 20% FTE, code stable, could do with upgrade, contact monitoring sites whose data is inaccessible, find new contacts & explain etc.
  - Analysis: your decision, usually for long term details download & use Excel
  - Trouble-shooting:
    - usually re-active, user reports, then look at PingER data
    - have played with automating alerts, data will/is available via web services
- Ping blocking
  - Complete block easy to ID, then contact site to try and by-pass, can be frustrating for 3rd world
  - Partial blocks trickier, compare with synack
- Derived throughputs poor for well connected sites (<0.1% loss)
- Funding
  - "Unfortunately, network management research has historically been very under-funded, because it is difficult to get funding bodies to recognize this as legitimate networking research." Sally Floyd, *IAB Concerns & Recommendations Regarding Internet Research & Evolution.*
  - http://www.ietf.org/internet-drafts/draft-iab-research-funding-00.txt

Collaborations & Funding

- 35+ monitoring sites in 15 countries
  - Plan to add ICTP Trieste if funded
  - Other projects used toolkit, e.g. PPCNG, XIWT
- SLAC with help from FNAL, PPCNG and monitor sites
  - New support at SLAC: Warren Matthews, main PingER tech support, leaving SLAC
- Digital Divide collaboration (MOU) with ICTP/eJDS, Trieste
  - They are looking for a EU grant for eJDS and PingER
- Need funding for coming year:
  - Working with DoE, NSF, Pew Charitable Foundation …
  - Tasks:
    - (0.5 FTE) ongoing maintain data collection, explain needs, reopen connections, open firewall blocks, find replacement hosts, make limited special analyses, prepare & make presentations, respond to questions
    - (+ 0.5 FTE) extend the code for new environment (more countries, more data collections), fix known non-critical bugs, improve visualization, automate reports generated by hand today, find new country site contacts, add route histories and visualization, automate alarms, update web site for better navigation, add more DD monitoring sites/countries, improve code portability
- Also looking for small grants for helpers in developing countries
- ICFA: show importance to policy makers, funding agencies, identify sympathetic contacts at agencies, get support
- Ported to IPv6

Summary

- Valuable light-weight tool for end-to-end performance
- Good for trouble-shooting, planning, setting expectations
- Performance from U.S. is improving all over
- Performance to developed countries are orders of magnitude better than to developing countries
- Poorer regions 5-10 years behind
- Poorest regions Africa, Caucasus, Central & S. Asia
- Some regions are:
  - catching up (SE Europe, Russia),
  - keeping up (Latin America, Mid East, China),
  - falling further behind (e.g. India, Africa)

More Information

- PingER:
  - www-iepm.slac.stanford.edu/pinger/
- MonaLisa
  - monalisa.cacr.caltech.edu/
- GGF/NMWG
  - www-didc.lbl.gov/NMWG/
- ICFA/SCIC Network Monitoring report, Jan03
  - www.slac.stanford.edu/xorg/icfa/icfa-net-paper-dec02
- Monitoring the Digital Divide, CHEP03 paper
  - arxiv.org/ftp/physics/papers/0305/0305016.pdf
- Human Development Index
  - www.undp.org/hdr2003/pdf/hdr03_backmatter_2.pdf
- Network Readiness Index
  - www.weforum.org/site/homepublic.nsf/Content/Initiatives+subhome

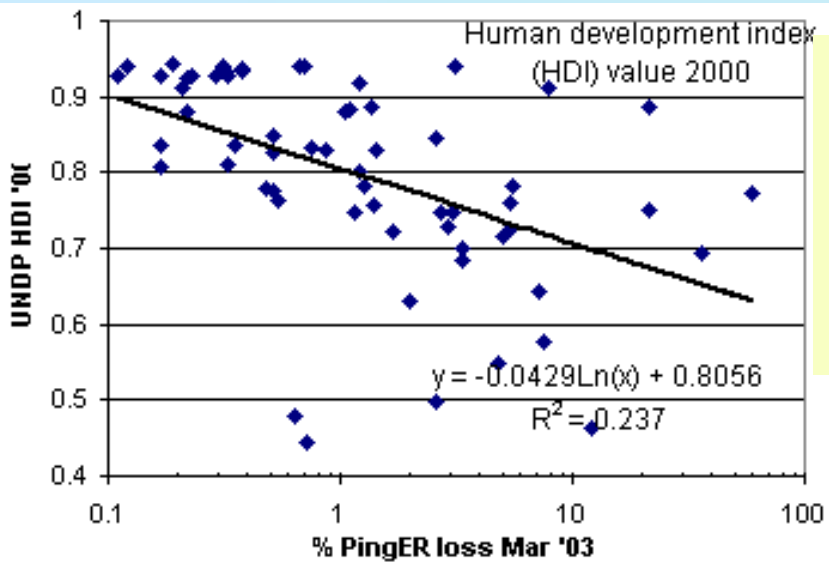
Countries Monitored

Used to monitor
Only 1 host

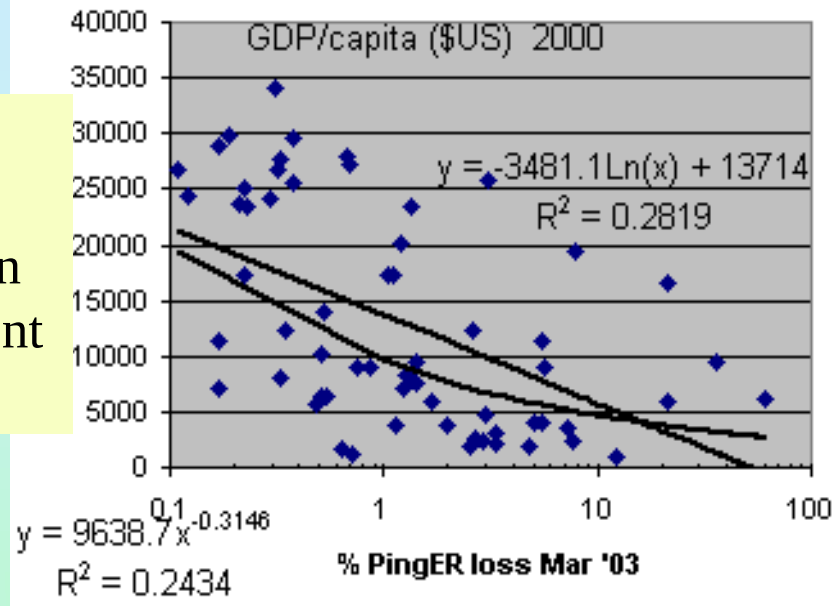
Need > 1 host to reduce anomalies

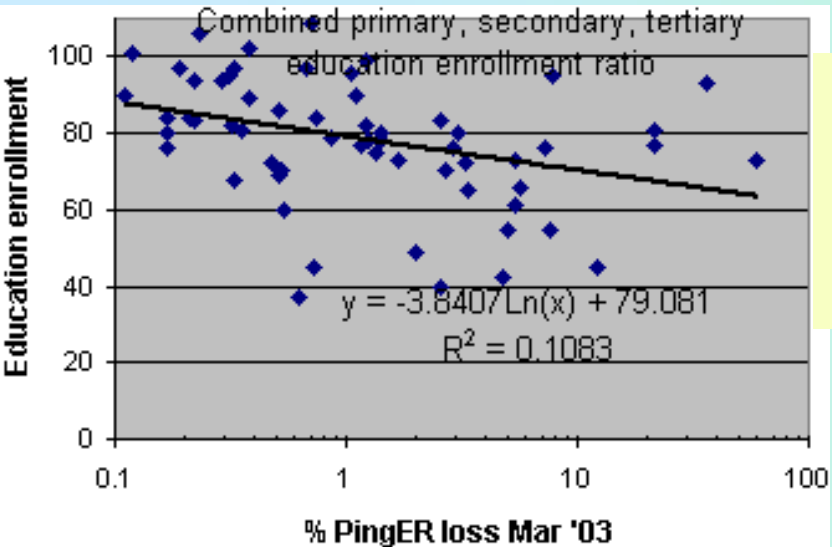
	Hosts	Country	Hosts	Country	Hosts	Country	
	6	Estonia	1	Latvia	1	Slovakia	
	2	Finland	1	Lithuania	1	Slovenia	
	4	France	11	Macedonia	2	S Africa	
	2	Georgia	1	Malaysia	3	Spain	6
Azerbaijan	2	Germany	13	Mexico	5	Sweden	4
Bangladesh	1	Ghana	1	Moldova	2	Switzerland	8
Belarus	2	Greece	1	Mongolia	1	Taiwan	1
Belgium	3	Guatemala	2	Netherlands	12	Thailand	1
Brazil	21	Hungary	5	New-Zealand	4	Turkey	2
Bulgaria	1	Iceland	3	Nigeria	1	Uganda	1
Canada	11	India	10	Norway	2	Ukraine	2
Chile	4	Indonesia	3	Pakistan	1	UK	36
China	6	Iran	4	Peru	1	US	208
Colombia	4	Ireland	2	Poland	4	Uruguay	3
Costa-Rica	1	Israel	5	Portugal	2	Uzbekistan	2
Croatia	5	Italy	13	Romania	1	Venezuela	2
Cuba	2	Japan	11	Russia	12	Vietnam	0
Czech-Rep	3	Jordan	1	Saudi Arabia	1	Albania	0
Denmark	1	Kazakhstan	2	Serbia & Montenegro	2	Philippines	0
Egypt	1	Korea	2	Singapore	1		

Loss Comparisons with Development (UNDP)



Weak correlation with Human Development or GDP





Even weaker with education & literacy