Net Measurement Neutrality:
An Enabler for Watchdog or Partnership?

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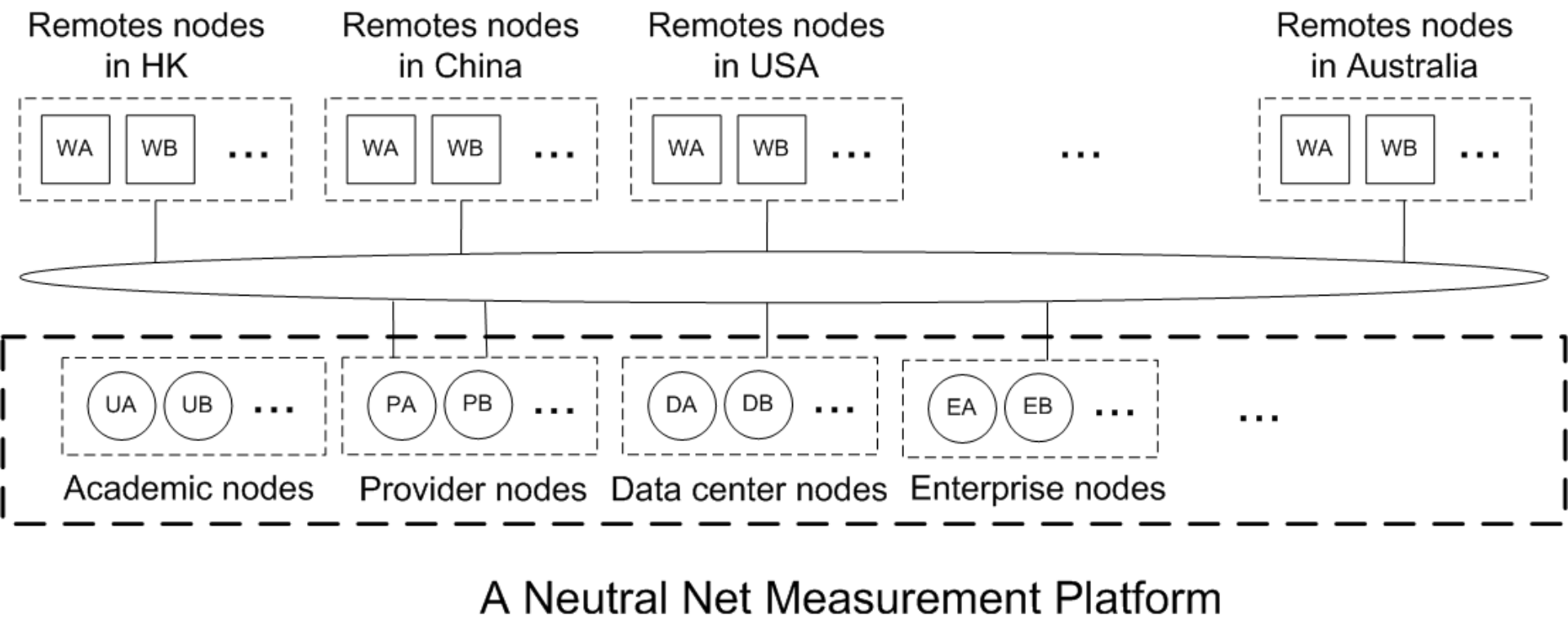
The (old) problem statement

- Information asymmetry between Internet service providers and users
- Providers do not collaborate beyond peering.
- Possible results:
  - Lack of incentives to innovate
  - Competition based on competitive pricing
  - Slow adoption of advanced technology

Possible solutions

- Empower users with the ability to monitor the quality of service afforded to them.
  - E.g., speed tests
- Empower users with the ability to monitor all the providers' quality of service.
  - E.g., NetDiff
- Provide incentives for the providers to collaborate on improving their quality of service.
  - E.g., through a neutral net measurement platform


Remotes nodes in HK
Remotes nodes in China
Remotes nodes in USA
Remotes nodes in Australia
WA
WB
UA
UB
PA
PB
DA
DB
EA
EB
Academic nodes
Provider nodes
Data center nodes
Enterprise nodes
A Neutral Net Measurement Platform

Is WIN-WIN-WIN possible?

- For providers
  - Compare providers' performance
  - Enforce SLAs
  - Troubleshoot network problems
- For users
  - Independent value-for-money comparison
- For authorities
  - Watchdog of telecom markets and services

Incentives for providers to participate

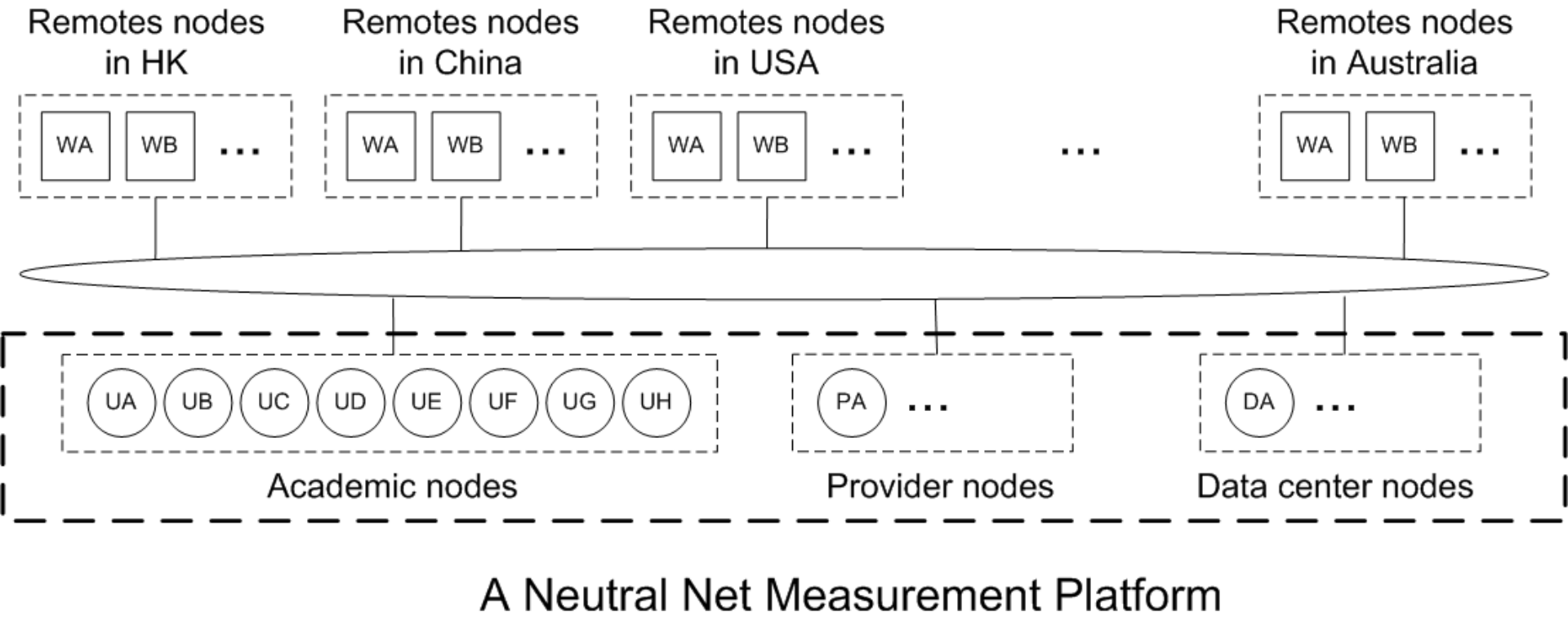
- Access to other providers' performance data which, however, do not reveal the providers' business secrets
- A more accurate and timely diagnosis of network problems
- Benchmark their service quality relative to others' service quality.
- Improve their service quality (and revenue).

Outline

- Our experience
- Case studies
  - User's perspective
    - Compare ISPs' performance
    - SLAs enforcement
  - ISP's perspective
    - Different uplinks selected
    - Inter-network measurement
  - Authority's perspective
    - Major network outages

Our experience with HARNET

- Continuous measurement since Jan 2009
- Probes at eight universities in Hong Kong
  - 8Us share Internet connectivity through HARNET
  - HARNET changed ISP in March 2010
  - Monitor e2e paths to the same set of > 40 targets
- Collaboration with a major data center since 2007
- Collaboration with a major ISP since mid-2010
- Report findings to users and obtain feedback
- Visualize results to users in real time



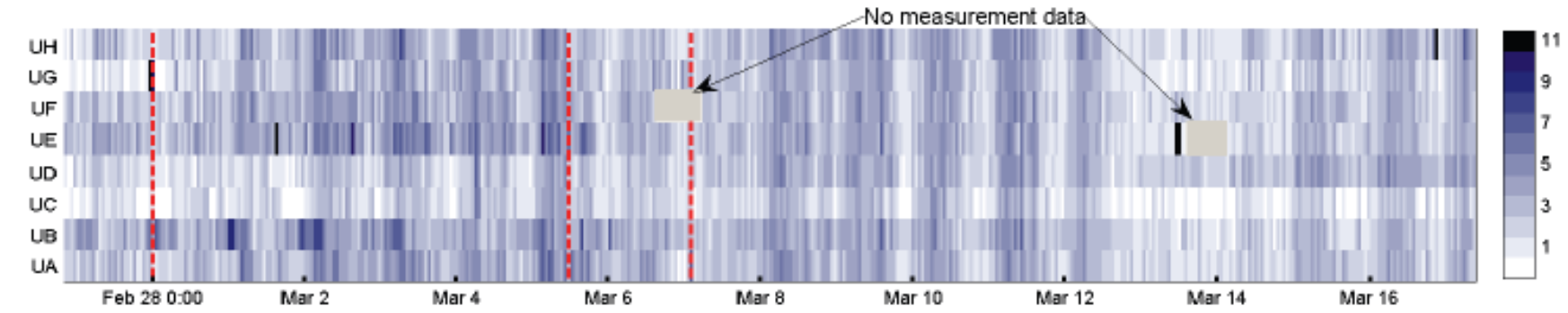
A Neutral Net Measurement Platform

Case study 1
Comparing two ISPs' performance

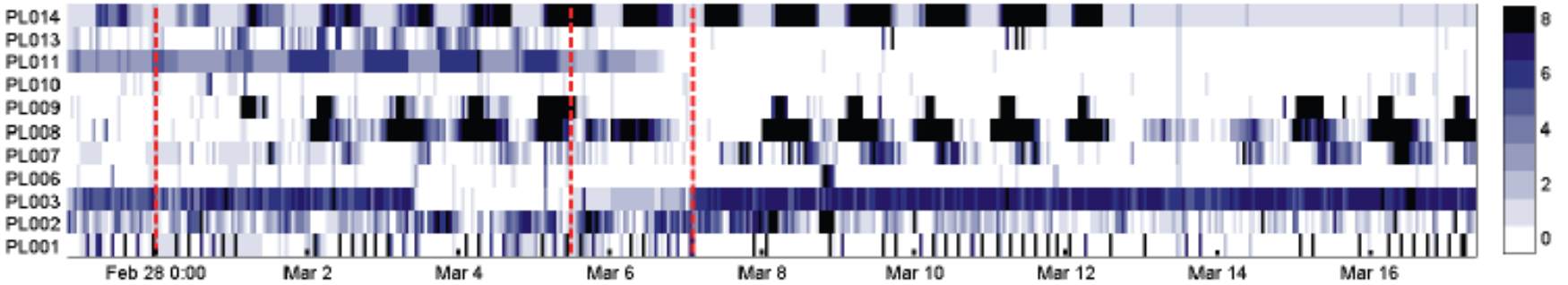
- User select service provider based on price and quality of service
- Service provider transition for HARNET during 24 Feb 2010 14:00 UTC to 7 Mar 2010 2:00 UTC
- ISP1 → A temporary network → ISP2

Case study 1
Comparing two ISPs' performance

Forward-path loss rates



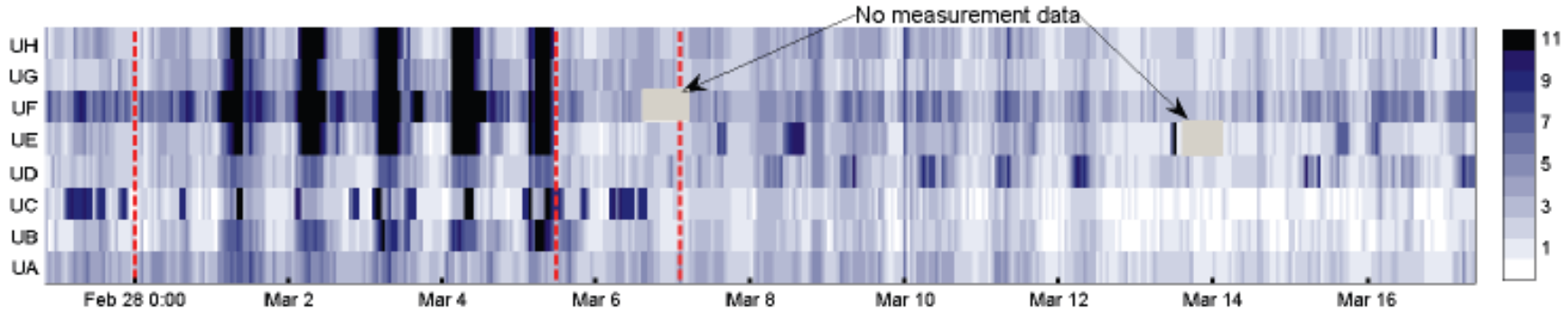
(a) Forward paths (grouped by sources).



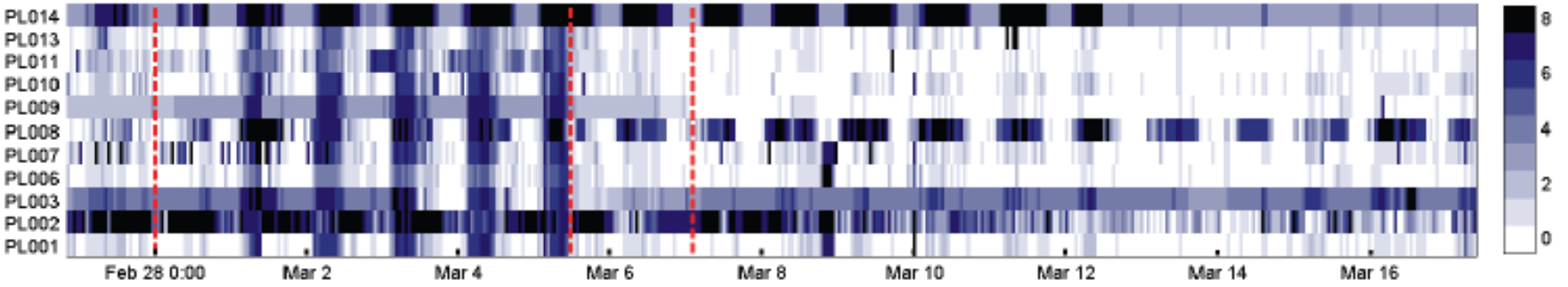
(b) Forward paths (grouped by destinations).

Case study 1
Comparing two ISPs' performance

Reverse-path loss rates



(c) Reverse paths (grouped by sources).



(d) Reverse paths (grouped by destinations).

Case study 1
Comparing two ISPs' performance

- Change of ISP and performance in HARNET
- Two-month periods immediately before and after change-over from ISP1 to ISP2

	ISP1			ISP2		
	RTT	FWL	RVL	RTT	FWL	RVL
China	✘	✔	✘	✔	✘	✔
Japan	✘	✘	O	✔	✔	O
US	✔	✘	✔	✘	✔	✘
Europe	✘	✔	✔	✔	✘	✘
Australia	✔	✔	✔	✘	✘	✘

FWL / RVL = Forward / Reverse-path packet loss

Case study 1
Comparing two ISPs' performance

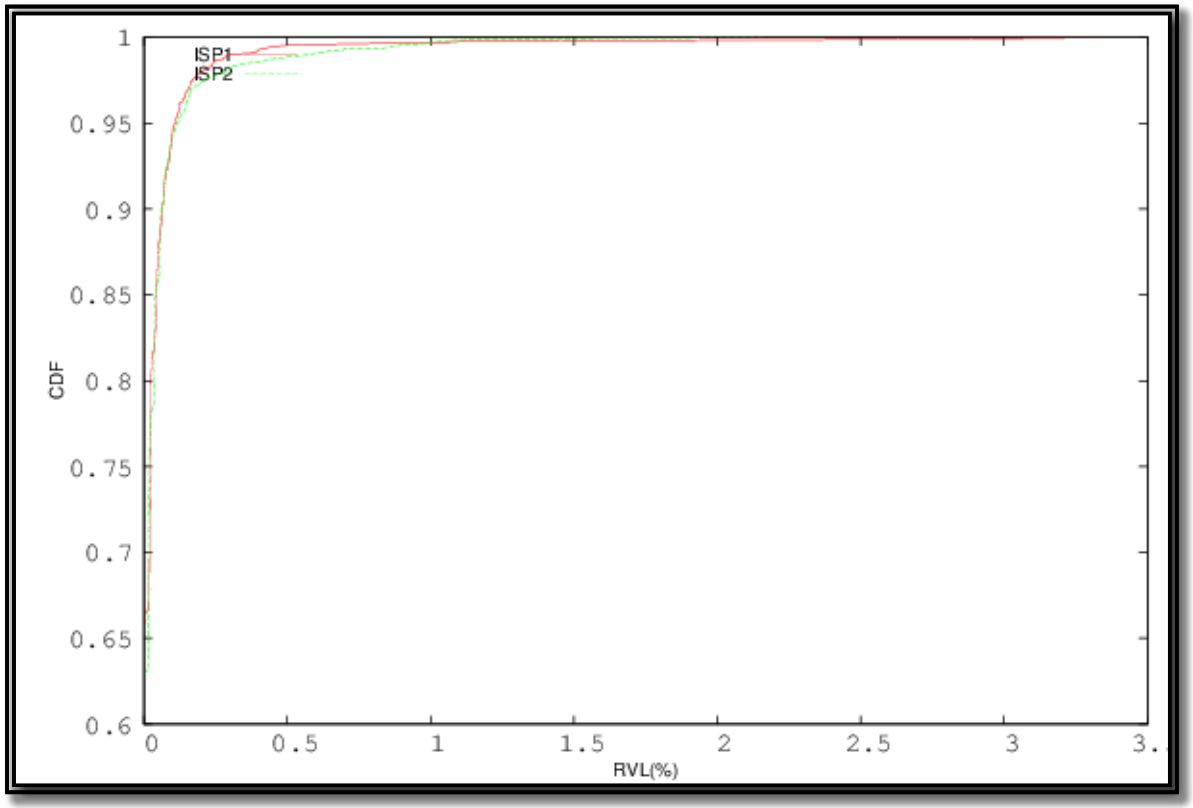
Performance for Japan

RTT: ISP2 > ISP1

FWL: ISP2 > ISP1

RVL: ISP1 > ISP2

ISP2 ✓



Case study 1
Comparing two ISPs' performance

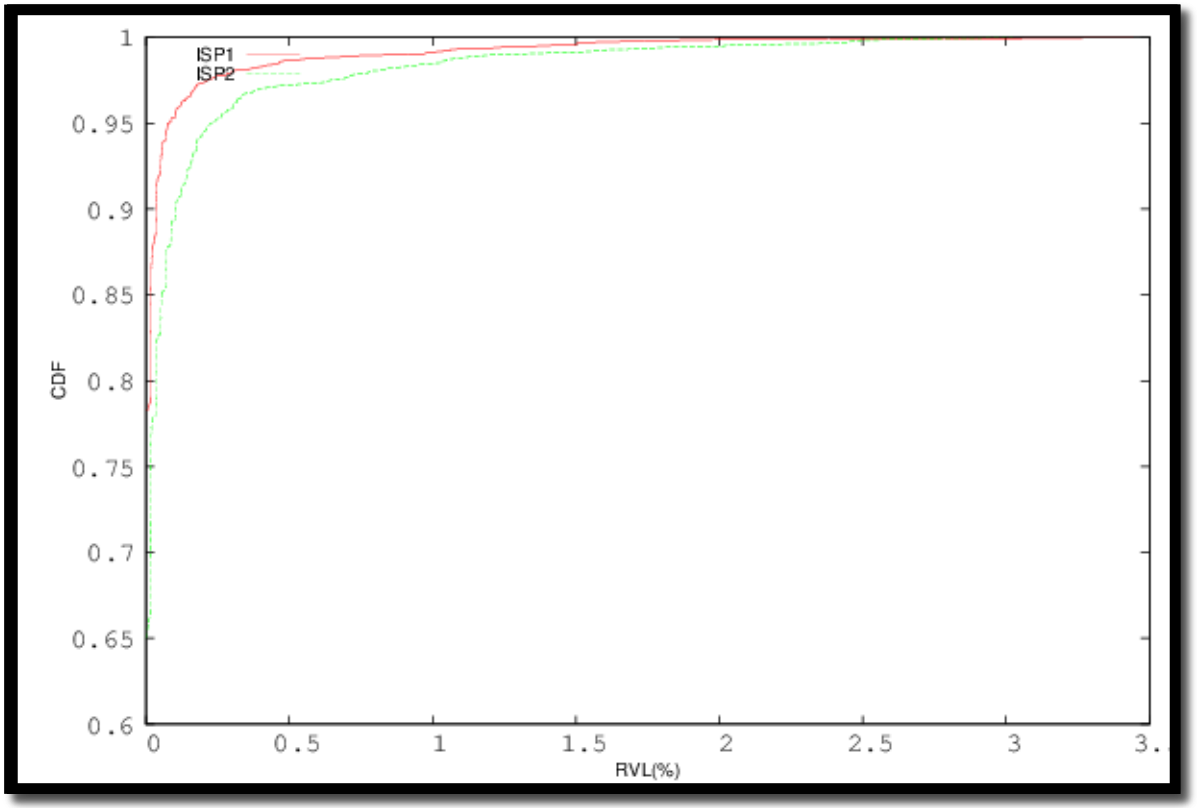
Performance for the States

RTT: ISP1 > ISP2

FWL: ISP2 > ISP1

RVL: ISP1 > ISP2

ISP1 ✓



Case study 1
Comparing two ISPs' performance

Each ISP is good for some (but not all) paths.

Case study 2
SLA measurement

Network performance

- Hong Kong household coverage of 97% via xDSL technology and 67% via Fiber Direct technology.
- 99.99% broadband network availability.
- Service plans for all kinds of needs, including 1.5M, 3M, 6M, 8M, 18M, 30M, 100M and 1000M.

Case study 2
SLA measurement

First "Steady Speed" Guarantee

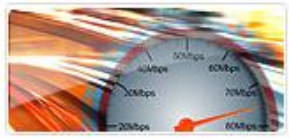
Hong Kong Broadband is the first ISP in Hong Kong that provides a "Steady Speed" guarantee, ensuring that our FibreHome 200, bb100, bb50 and bb25 broadband plans always provide upload and download speeds* no less than 80% of what we advertised. If we fail to live up to this guarantee, we'll double refund you for each day you experienced slow speeds.

* Measured from user home's wallplate to HKIX2

Take the test and see how your ISP stacks up!

Broadband Speed Test Details

Only a few simple steps to see your download/ upload speeds! (Only Available in Chinese)



FibreHome 200 Speed Test Details

Dedicated FibreHome 200 user's speed test (Only Available in Chinese)

Case study 2
SLA measurement

The System enables broadband service users to measure the performance of their broadband connections as follows:

Download speed refers to the speed for downloading data from the System to the user device.

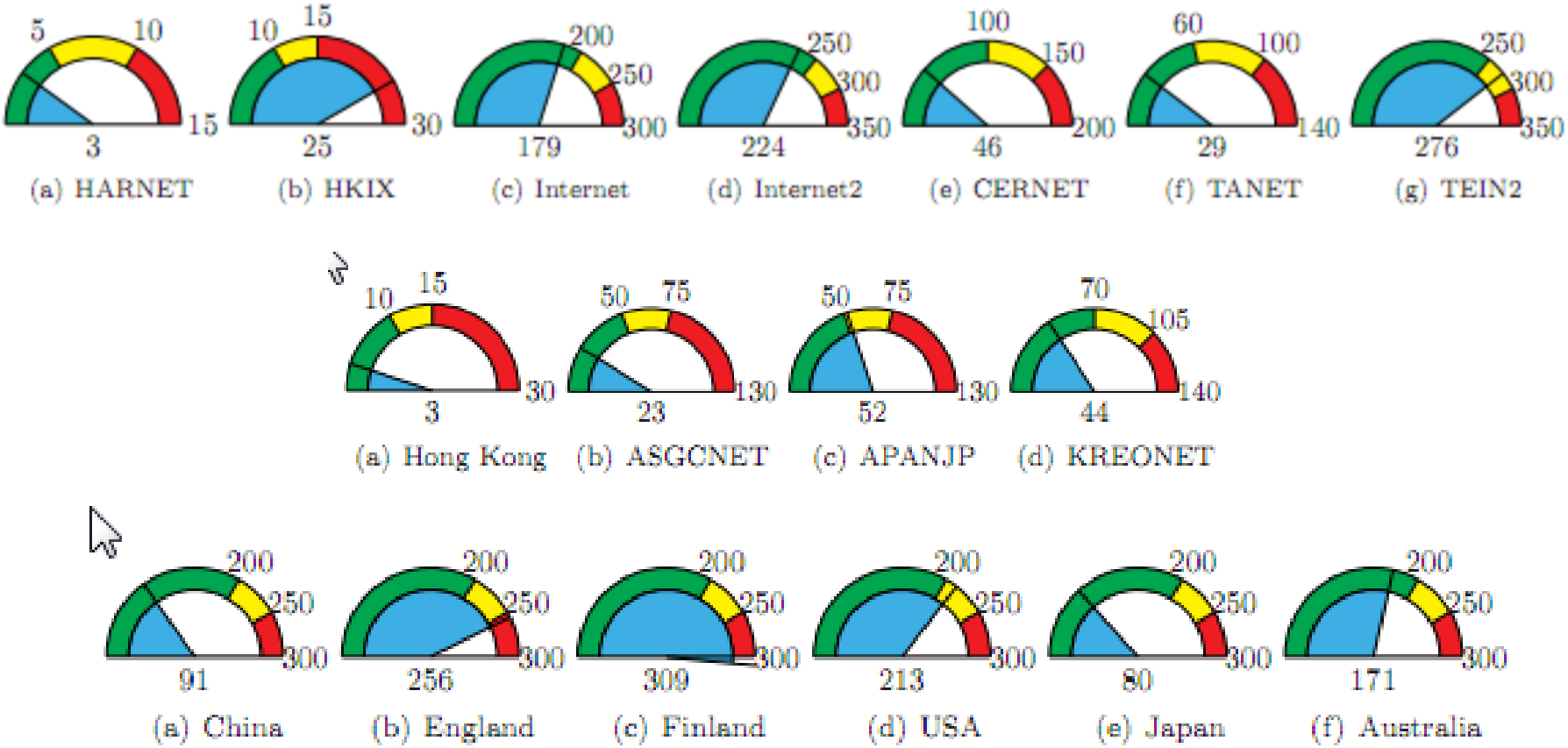
Upload speed refers to the speed for uploading data from the user device to the System.

Network latency refers to the round-trip time taken to transmit data from the user device to the System and subsequently for the user device to receive the data from the System .

Packet loss refers to the percentage of packets lost during the sending of the data from the user device to the System.

Jitter refers to the variation in the delay of received packets. At the sending end, packets are sent in a continuous stream with the packets spaced evenly apart. Due to network congestion and other factors, the delay between each packet may vary instead of remaining constant when received.

Case study 2
SLA measurement at HARNET



Case study 2
SLA measurement at HARNET

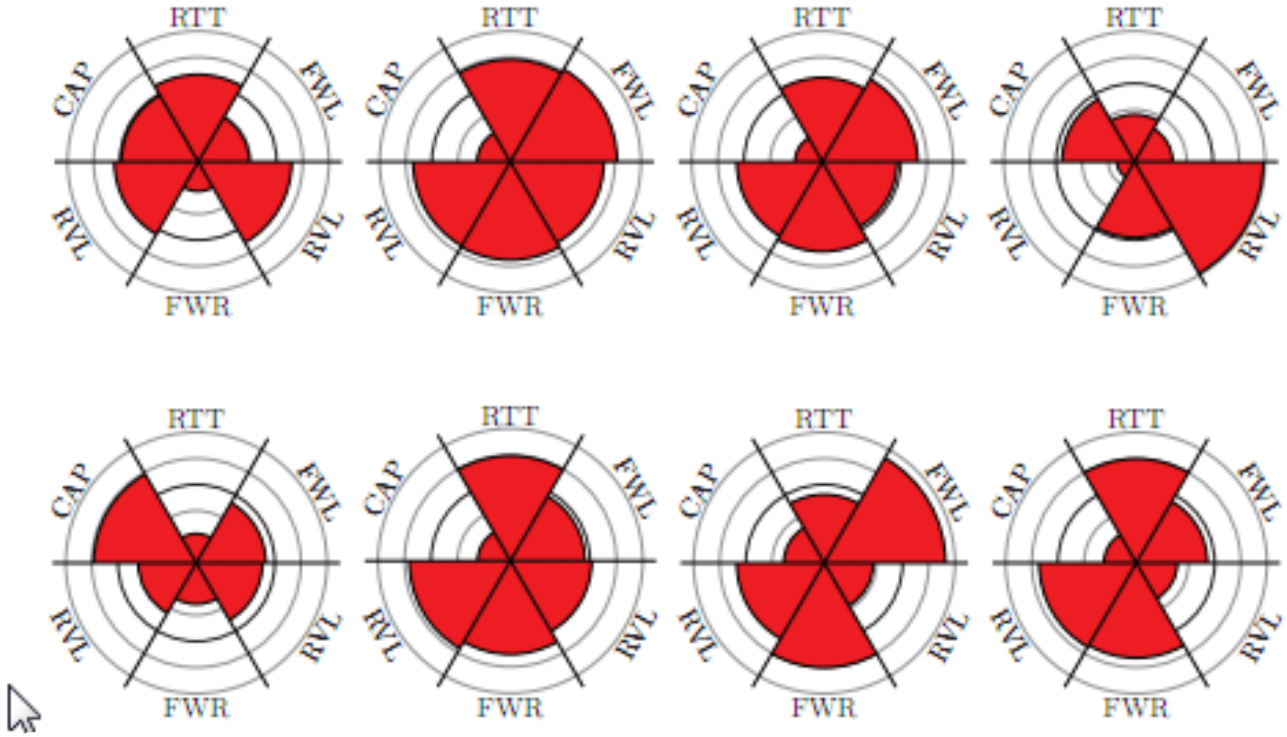


Figure 4: Relative Score For All Institutes - Local

Case study 2
SLA measurement at HARNET

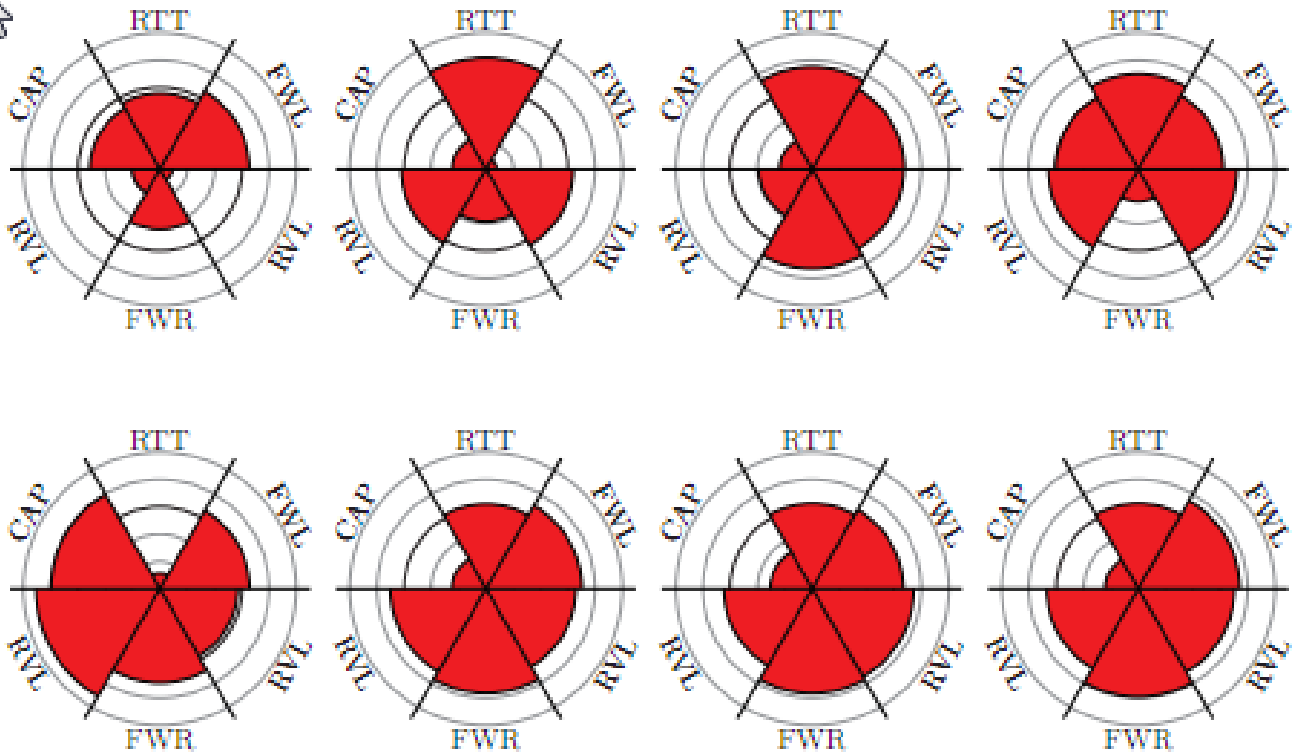


Figure 5: Relative Score For All Institutes - Overseas

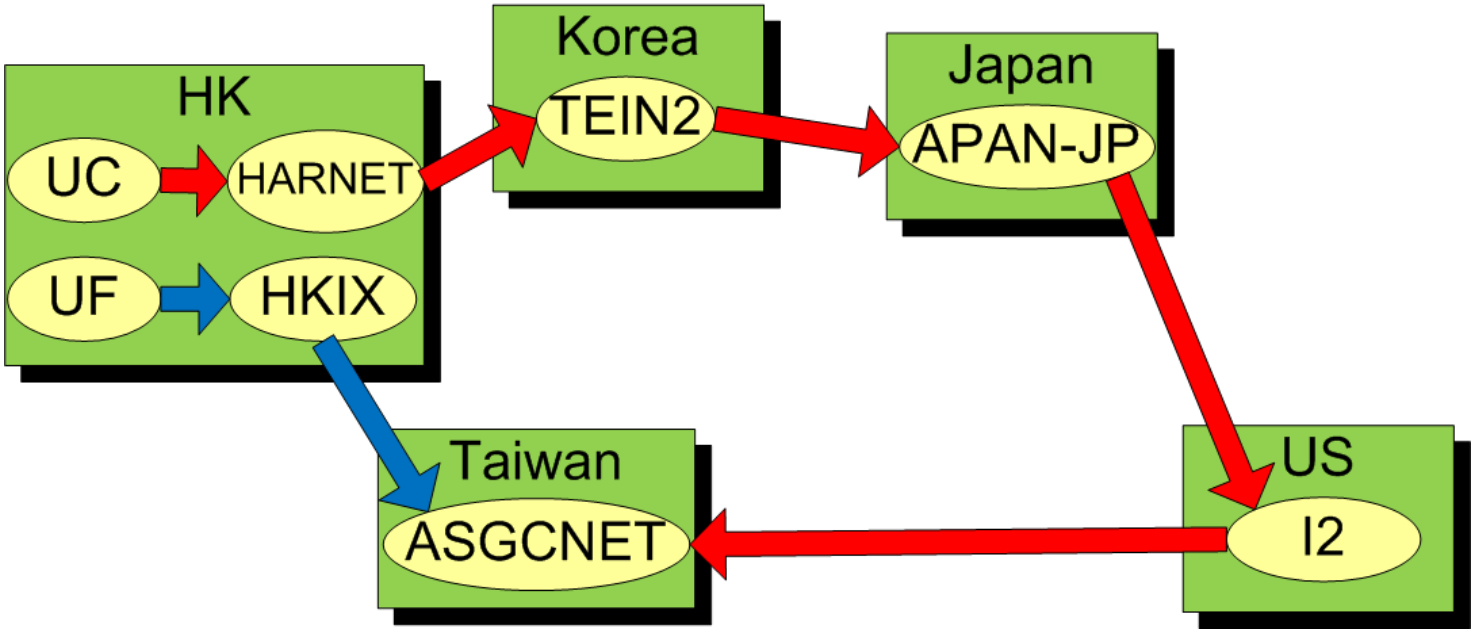
Case study 3
Uplink selection

- Uplink selection based on the cost and quality
- Measuring the quality of the current routes
- Beyond load balancing

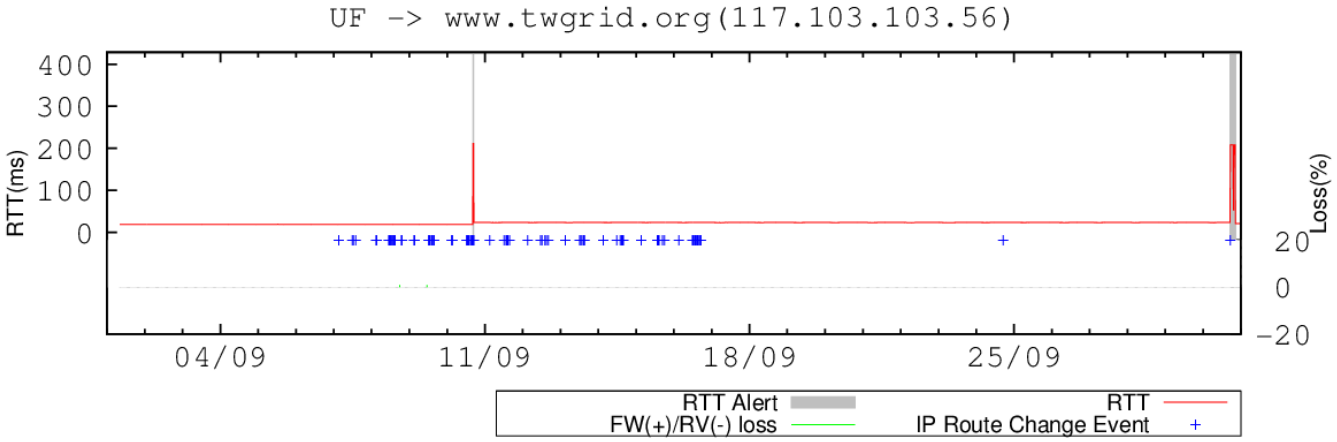
From Peplink

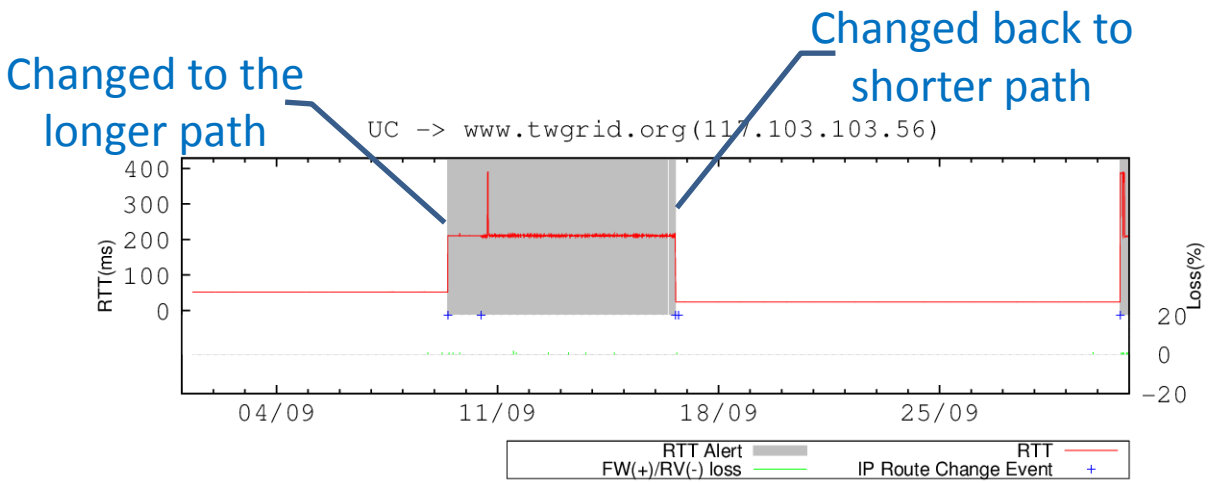
Case study 3
Uplink selection

- One of the links give poor performance
- Collaboration helps make the best selection.



Case study 3
Uplink selection



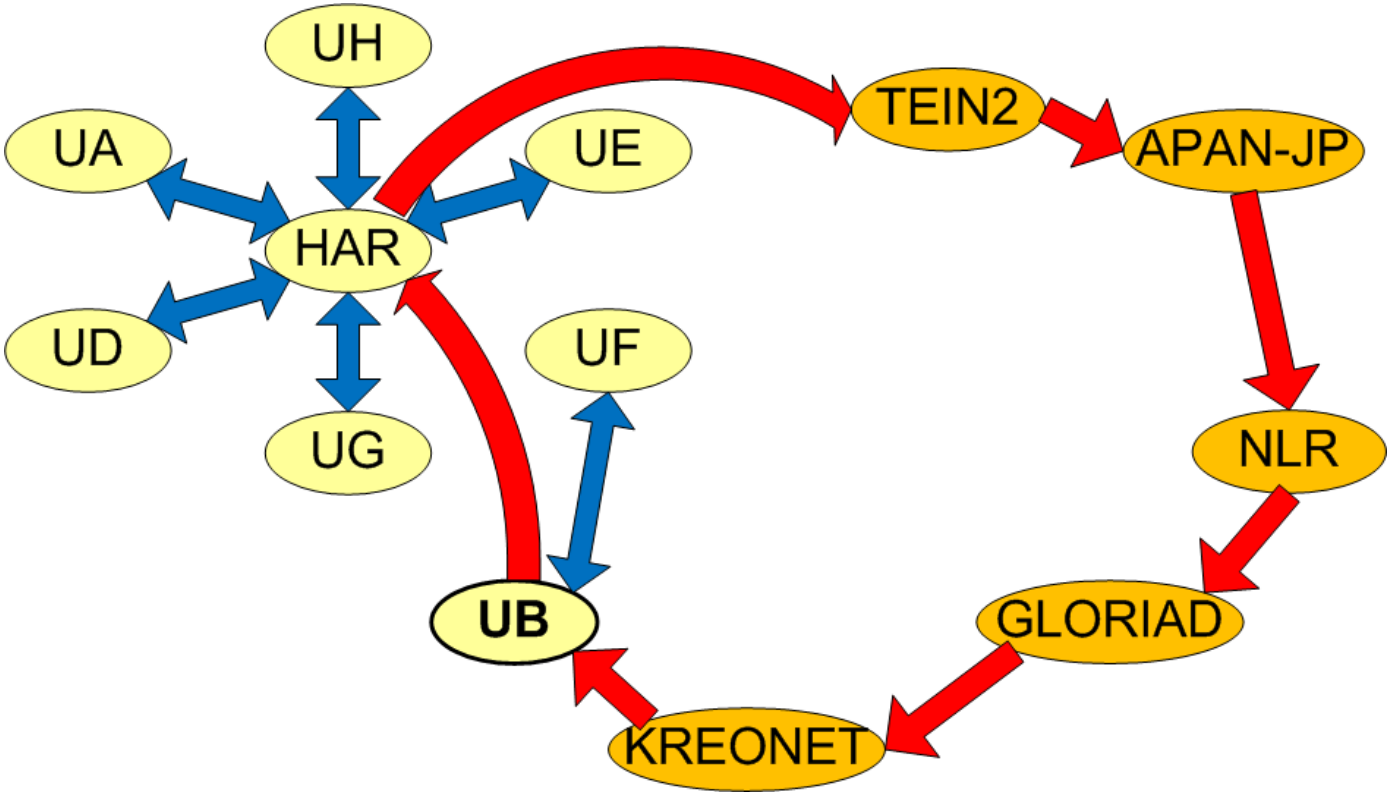


Case study 4
Inter-network measurement

- Active measurement reveals
  - Forward-path traceroute
  - Quality of e2e paths from a single source
- Unanswered questions:
  - Reverse path?
  - Problems inside or outside our network?

Case study 4
Inter-network measurement

- Co-operative two-way measurement
- Reveal both forward and reverse paths.

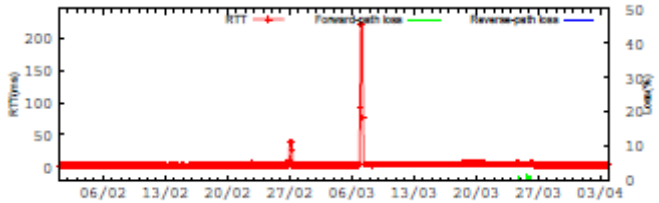


Case study 4
Inter-network measurement

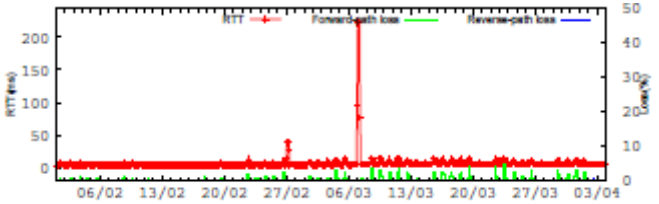
- Significant asymmetric path for UB
  - Much longer incoming paths
  - Occurred during the ISP switchover
- UB prober observed dramatic increase in delays to other Us, but no change the in forward paths
  - Long reverse paths

Case study 4
Inter-network measurement

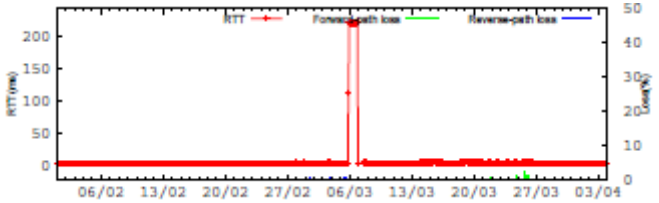
(a) Affected paths



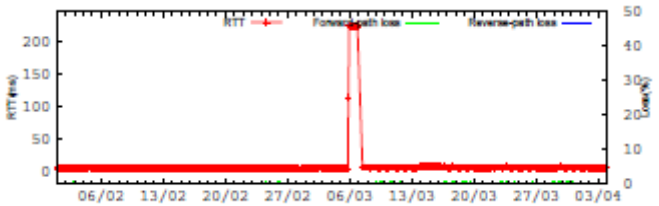
UH -> UB



UB -> UH

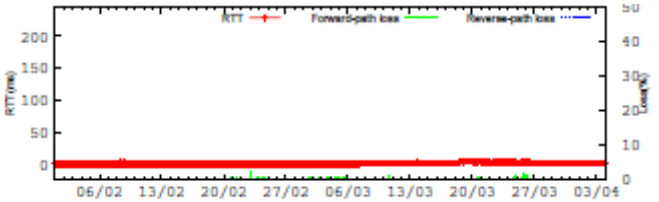


UD -> UB

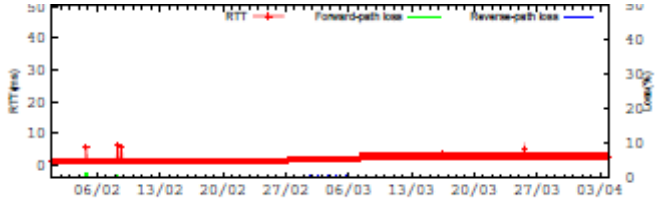


UB -> UD

(b) Unaffected paths



UF -> UB



UB -> UF

Case study 5
Major network outages

- Network outages cause huge financial loss.
- Damage of natural disasters are monitored by Authorities:
  - e.g. typhoon, earthquake, Internet service …
- Passively relying on ISP to report incidents leads to slower responses.
- Collaborative active monitoring helps discover the root cause and bypass the fault.

Case study 5
Major network outages

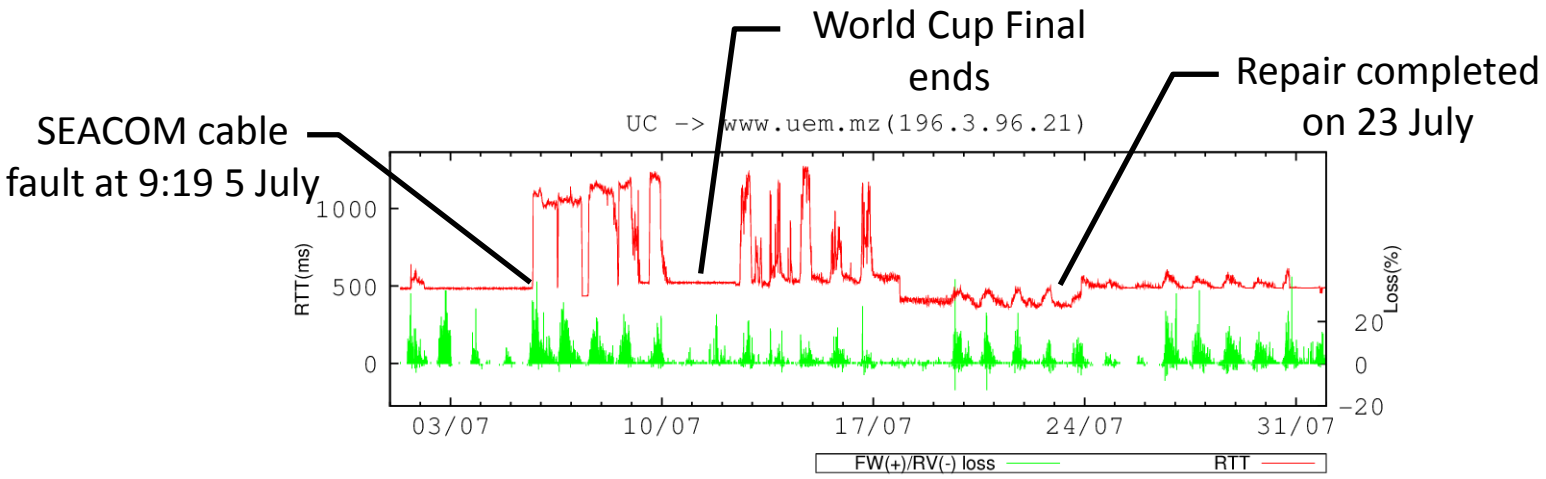
- Submarine optical fiber cables serving most intercontinental traffic
- Outage of major cables → Reduction in the international bandwidth
- Latest major event happened to Africa during World Cup 2010
  - One out of the two cables serving South Africa was down.

Case study 5
Major network outage

- A SEACOM cable fault occurred at 9:19 on 5 July 2010.
- Significant traffic re-routed to SAT-3
  - Bandwidth reserved for TV broadcasting
  - Congestion, packet loss (> 20%), high latency (1sec)
- Many companies and home users in South Africa lost International connectivity.

Case study 5
Major network outage

- Collaborative monitoring immediately raises alerts based on network quality measurement.



To conclude …

- A neutral net measurement platform provides trustworthy information.
  - Benefit users
    - Get the best combination of cost and service quality.
    - Ensure that ISPs maintain their service standards.
  - Co-operative network monitoring helps ISPs
    - Make better business / routing decision.
    - Troubleshoot problem.
  - Necessary for authorities
    - Quick response to incidents

Net Measurement Neutrality

A Watchdog: promote a fair market and ensure reliable service

Your Partner: encourage innovation and improve service quality