

Internet Measurements Infrastructure at kenet

*A presentation AFPIF 2016
Dar es Salaam, Tanzania*

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KENET*

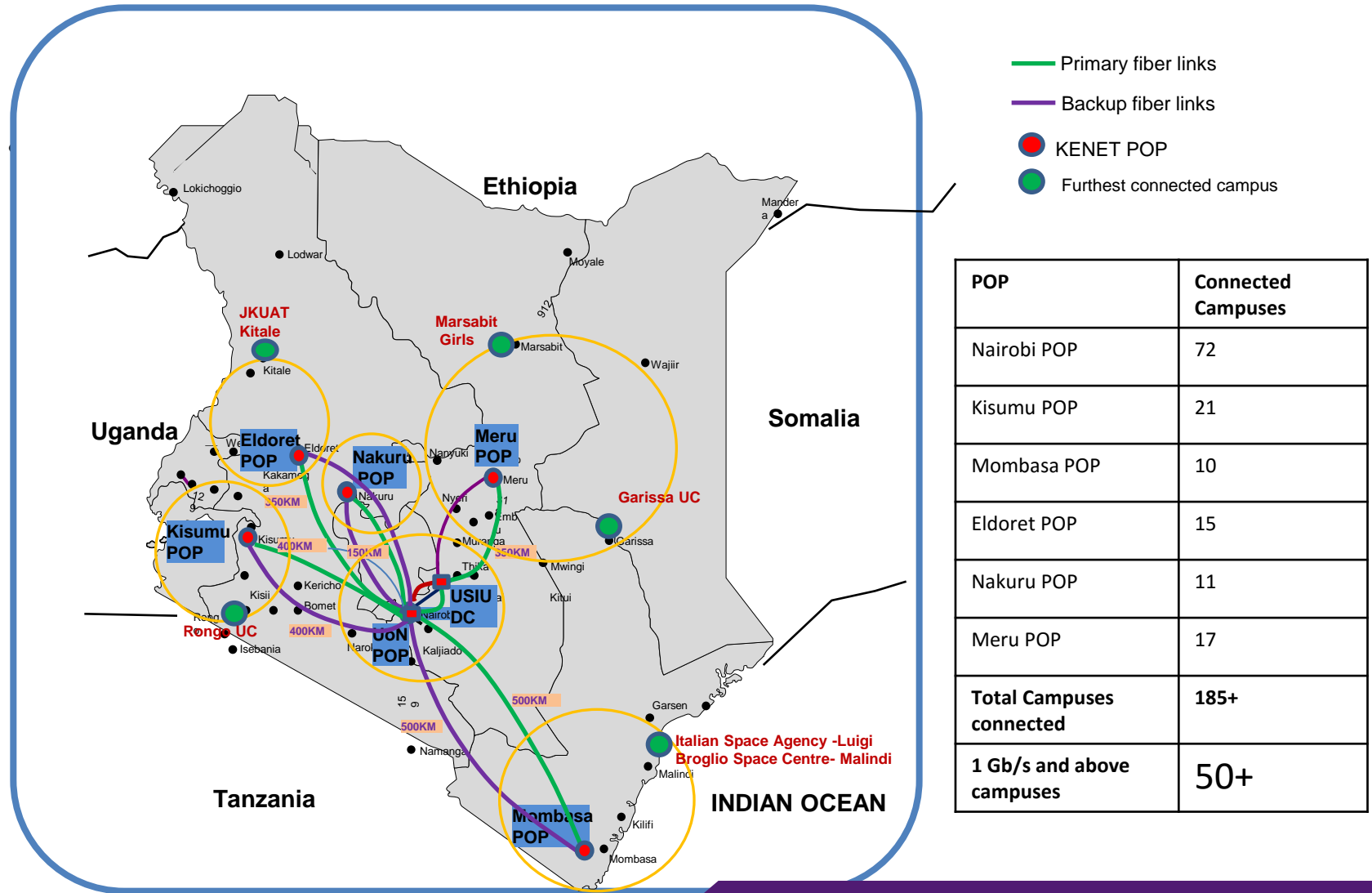
Agenda

- KENET as the National Academic Network of Kenya
- The KENET Internet Measurements Agenda
- Internet Measurements Infrastructure and tools @ kenet
- KENET experience and usage of Internet measurement tools and infrastructure for network operations
- Emerging Internet research community in Africa

KENET – The Broadband Academic Network of Kenya

- **Aggregates Demand for Connectivity, Internet bandwidth and Cloud Services of member institutions**
 - Increasing buyers power of the higher education sector and reducing costs
 - KENET operates expensive data centers for member institutions to provide community cloud services
- **Aggregates Internet traffic from Higher Education and research institutions**
 - KENET generates up to 4,500 Mb/s of Google traffic per day
 - Up to 9,000 Mb/s of traffic generated by connected campuses
 - Peering with Global content distributors like Google and Akamai in Kenya
- **Develops High-end ICT talent – technical + project management**
 - Capacity building for KENET and member institutions
 - **KENET Critical-mass of high-end ICT and engineering talent for R & E community**
- **Builds and operates advanced research infrastructures for the R &E community of Kenya** in different areas
 - Africa Science Gateway and federated services (KENET CA, iDP, EDUROAM)
 - Special Interest Groups (SIGs) in Educational technology and Engineering Education constituted in FY 2014-2015
 - SIGs in Medicine, Agriculture and ICT shall be constituted in FY 2015-2016
 - *KENET focus is support for STEM education and research!*

KENET Operates a Broadband Network for Members (broadband = 1 Gb/s and above)



KENET Internet Measurements

Research Agenda

- Provide Kenyan Internet users and regulator with tools for measuring quality of broadband Internet (MLAB)
- Support Internet engineering and policy research by graduate students and faculty
- Providing end-to-end measurement infrastructure and ability to isolate faults on multi-domain networks
- Providing global Internet community with tools to measure quality of Internet in Kenya

Does It Matter?

- **Real Time Applications**
 - Sensitive to packet loss, jitter and latency
 - Telemedicine not tolerant to packet loss
 - Video and voice conferencing not tolerant to packet loss
 - Results in loss of communication
- **Large Research Data Transfers**
 - Large data transfer requires large TCP window scaling and buffers
 - TCP design limits window scaling
 - Based on end-to-end delay
 - Based on end-to-end packet loss
- **Bandwidth Subscription**
 - Periodic verification of bandwidth subscription capacity
 - Bandwidth testing to support specific application requirements
- **End-To-End Reachability**
 - Realtime verification of end-to-end reachability of networks and resources

Internet Measurement Infrastructure and Tools @KENET

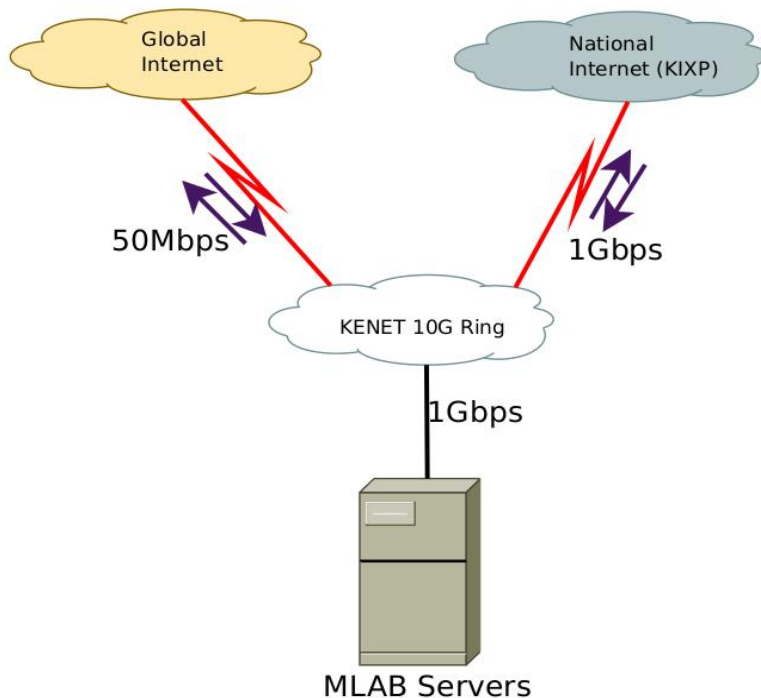
- **Measurement Lab**
 - End User Connectivity Tests
 - End users can perform tests using a web browser
 - Uses NDT and NPAD tools
 - Deployed in Feb 2013
 - Consist of one node of three (3) servers
- **RIPE Atlas Probes**
 - Global Internet Reachability/Availability
 - Sends active measurement traffic from thousands of vantage points across the Internet and records the responses
 - Deployed in 2013
 - Consists of three (3) distributed probes at KENET
- **perfSONAR**
 - Automated backbone network tests (Packet Loss, Throughput, Latency)
 - Uses OWAMP (delay, packet loss) and BWCTL (throughput tests)
 - Deployed in 2015
 - Consists of seven (7) distributed measurement nodes at KENET

Measurement Lab

- **What Is It?**
 - Open, distributed platform for researchers to deploy measurement tools
 - Open data for regulators, consumer bodies, researchers
- **Measurement Tools**
 - NDT (Network Diagnostic Tool) – Speed & Diagnostics
 - NPAD (Network Path & Applications Diagnostics)
 - Identifies performance problems on the end-to-end path
 - Neubot – Gathers data for network neutrality
 - ShaperProbe – Identifies traffic shaping in the path
 - Glasnost – Identifies application-specific traffic shaping, Deep packet inspection on the path

MLab Setup at KENET

Measurement Lab



- Broadband Connectivity

requirements

- At least 1Gbps KIXP Connection (national Internet)
- Reserve Minimum of 50Mb/s International Capacity
- Three (3) Physical Servers
- IPv4/IPv6 Support
- KENET Usage?
 - Leased line commissioning

tests

MLab Deployment Map – Kenya, South Africa and Nigeria, Ghana

MLAB

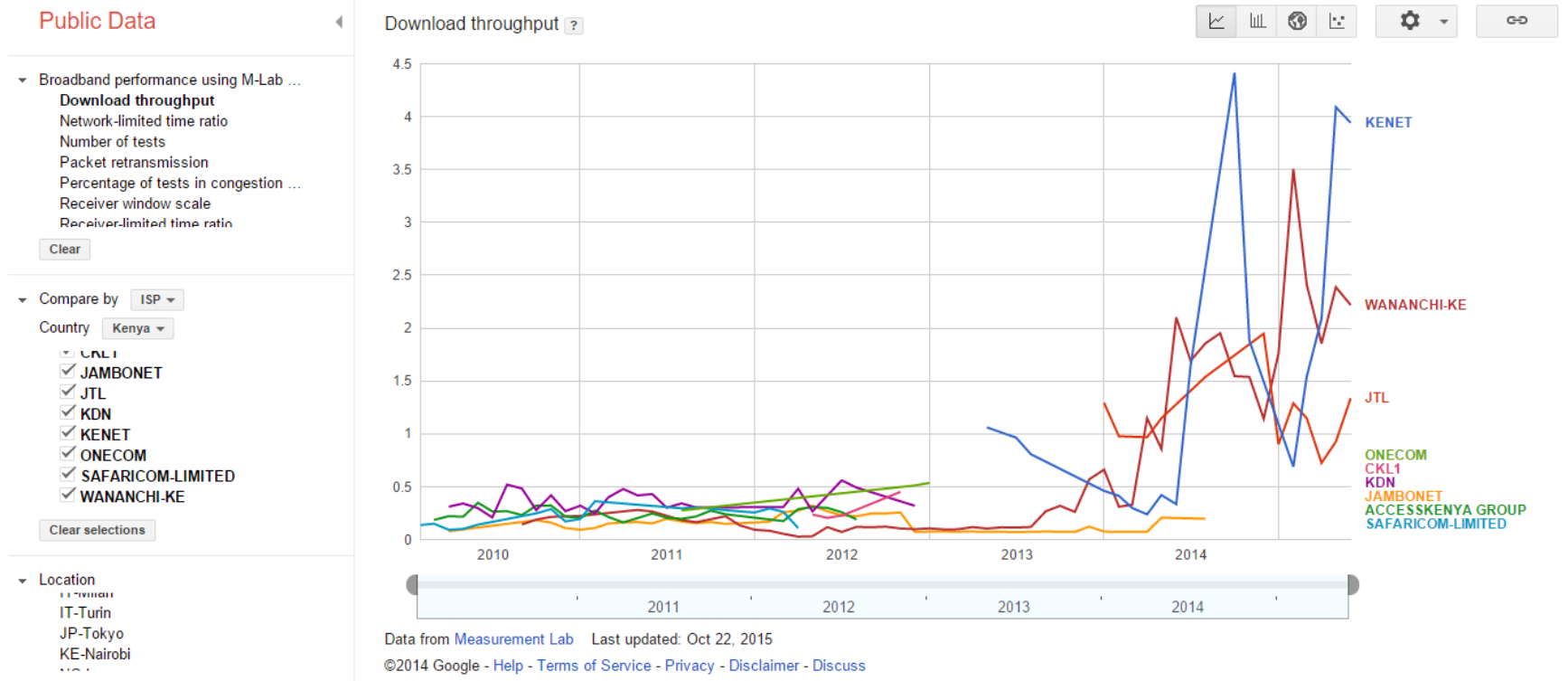
[Map IPv6](#)[Map IPv4](#)[Sliver Tools](#)[Sites](#)[Privacy policy](#)[Design document](#)[M-Lab](#)[About M-Lab](#)[Contact](#)[FAQ](#)

er status

M-lab tests – who is testing?

- End-users – students, faculty, researchers
 - MobiPerf is an Android app
 - Testing from the browser
 - Low level of end-user awareness
- Bit-torrent applications installed by end-users
e.g., Vuze bittorrent clients
- How can we increase the number of tests?

MLab Throughput Data - Kenya



MLab Top Testers - Kenya

Public Data

- Broadband performance using M-Lab ...
 - Download throughput
 - Network-limited time ratio
 - Number of tests**
 - Packet retransmission
 - Percentage of tests in congestion ...
 - Receiver window scale
 - Receiver.limited time ratio

Clear

Compare by **ISP**

Country **Kenya**

- CKL1
- JAMBONET
- JTL
- KDN
- KENET
- ONECOM
- SAFARICOM-LIMITED
- WANANCHI-KE

Clear selections

Location

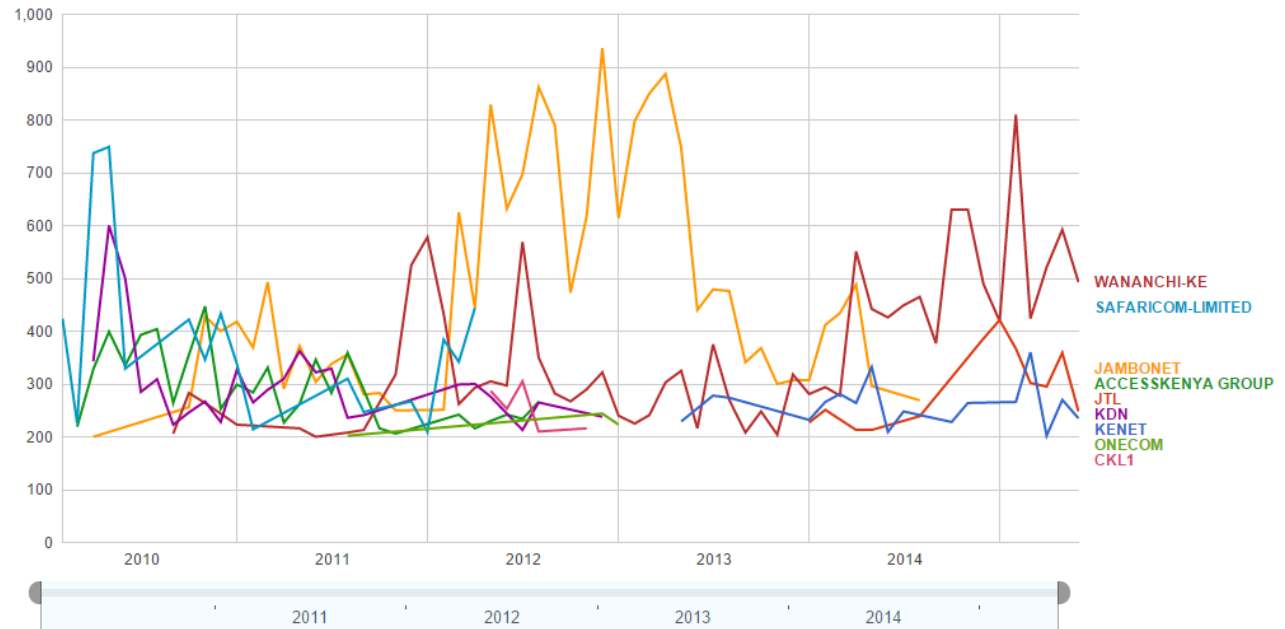
- IT-Turin
- JP-Tokyo
- KE-Nairobi

Number of tests ?







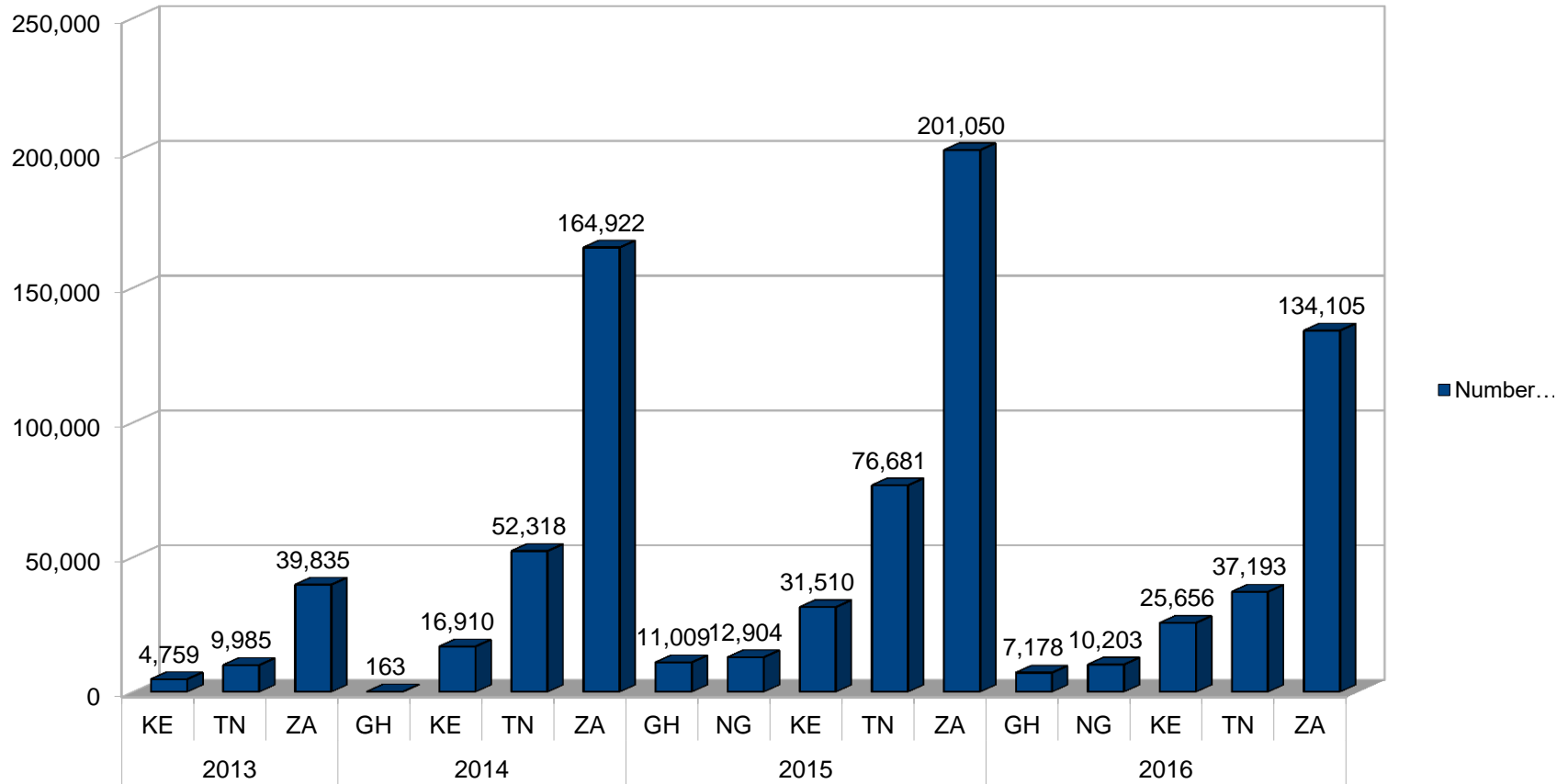



Data from [Measurement Lab](#) Last updated: Oct 22, 2015

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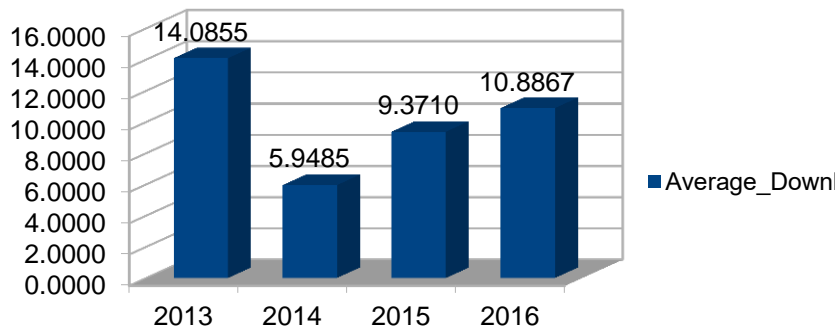
Growth in Intra-Africa tests

Total Tests Intra Africa

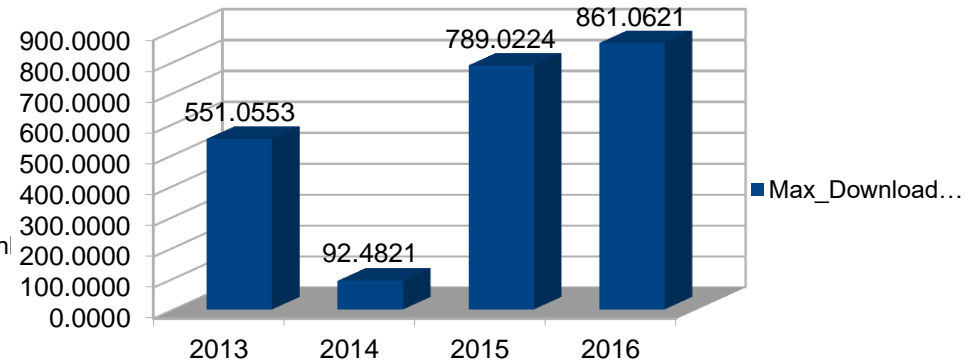


Download speed 2013-2016

Average Download Throughput - Kenya

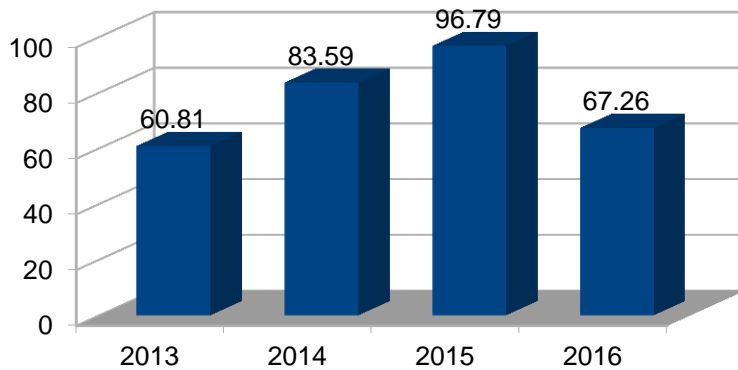


Max Download Throughput - Kenya

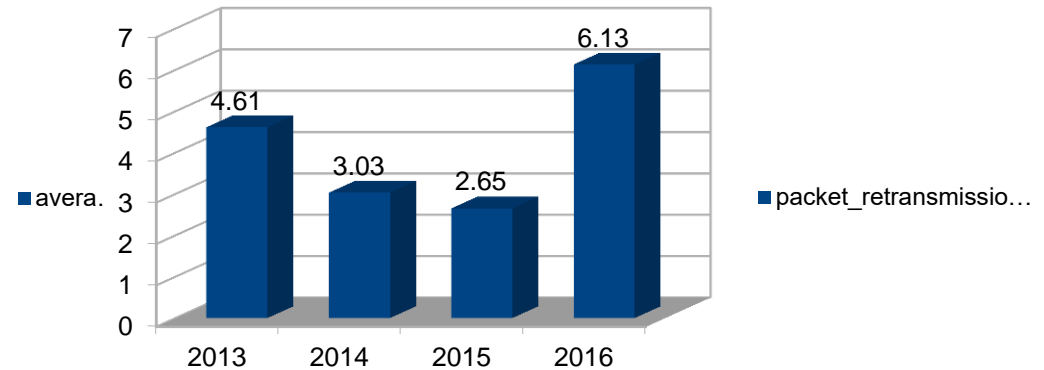


Average RTT and % Retransmissions – 2013 - 2016

Kenya Average RTT



Kenya % Retransmission



How does KENET use M-lab?

- Commissioning and monitoring the quality of managed leased lines
 - Leased lines from campuses to KENET data center
 - Throughput, latency, packet loss – very simple tools
- Measuring the residual Internet bandwidth of end-users
 - From a desktop, from smartphone with MobiPerf or even

Mlab for research

- The internet measurement data is open data and can be used by researchers
 - What are the average download speeds
 - Which ISPs are providing best Internet services
- Crowd sourced Internet measurements data is FREE unlike data from other speedtest applications
- KENET is promoting M-lab usage for Internet measurements research in Kenya and Africa
 - But uptake is low due to lack of awareness

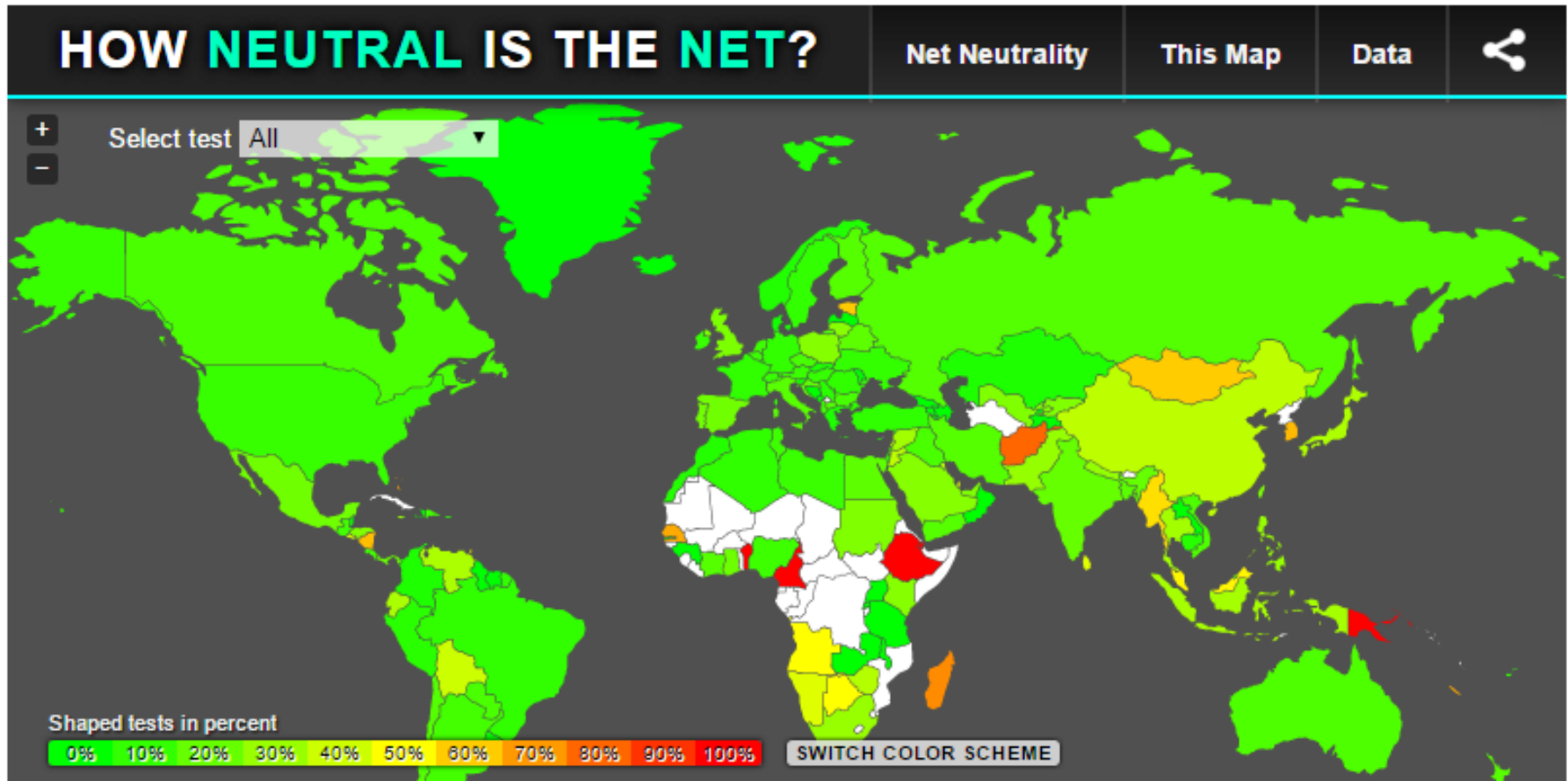
MLab Chart – Global Test Data

Query complete in 316.933 s. 1000000 points plotted.

Run query

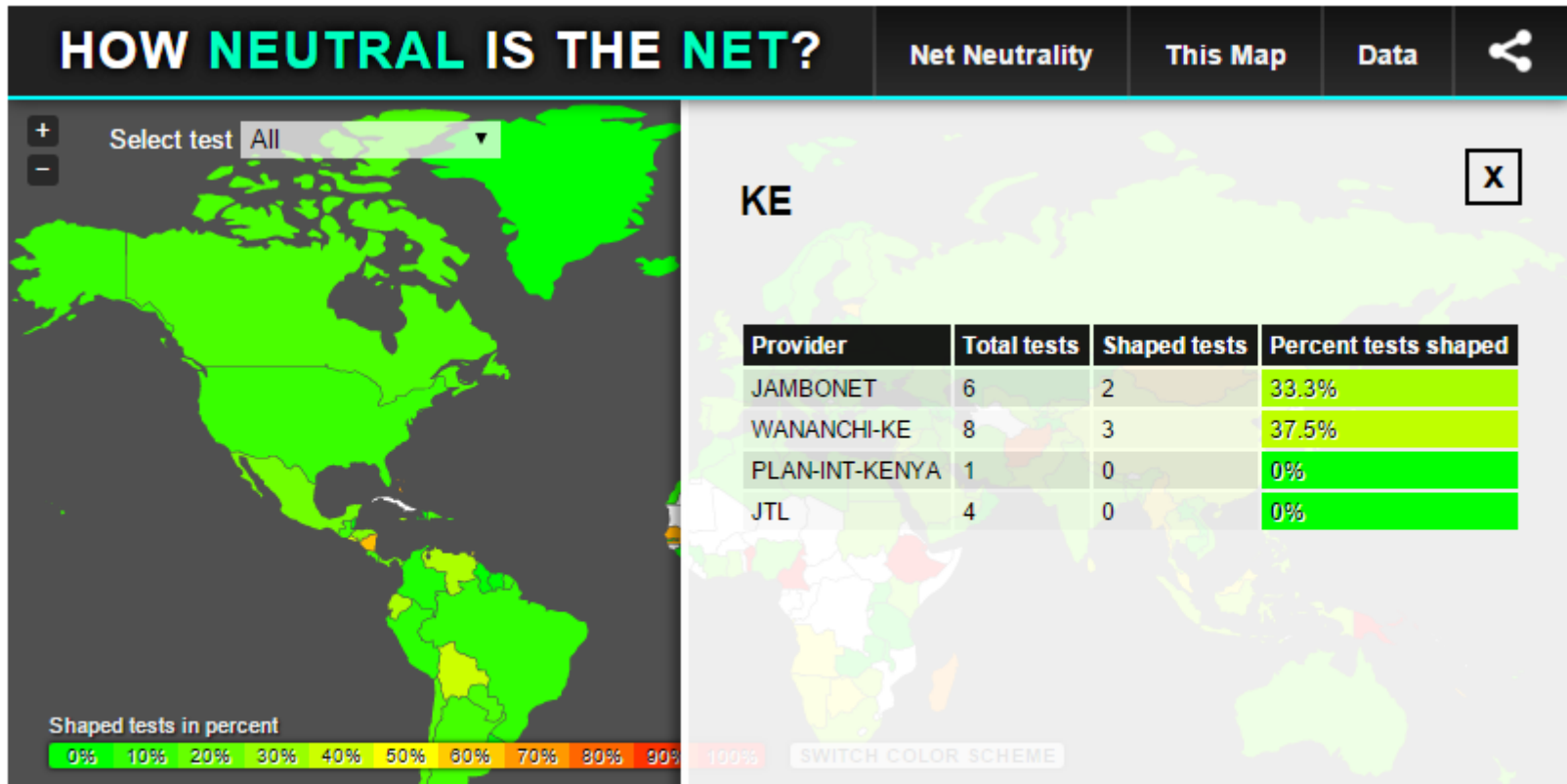


MLab Chart – Net Neutrality Data



- Red (100% Traffic Shaping) – Provider analyzing deep into customer traffic and prioritizing/shaping
- Deep Green (0% Traffic Shaping) – Provider passing traffic without analyzing
- Yellow (50% Traffic Shaping) – Provider analyzing 50% of traffic
- White – No Test Data

MLab Chart – Net Neutrality Kenya



- JTL not analyzing (shaping) customer traffic
- Jambonet & Wananchi analyzing (shaping) ~35% of customer traffic

Atlas Probes

- **What Is It?**
 - A global network of probes that measure Internet connectivity and reachability, providing an unprecedented understanding of the state of the Internet in real time End users can perform tests using a web browser
 - RIPE Atlas probes are small, USB-powered hardware devices that hosts attach to an Ethernet port on their router via a network (UTP) cable.
 - They conduct different measurements and relay this data to the RIPE NCC, where it is aggregated with data from the rest of the RIPE Atlas network.
 - The probes use a very small amount of bandwidth and cannot determine any information about the content passing to or from their host computers.
 - Probes conduct the following types of measurements: ping, traceroute, DNS and SSLcert.

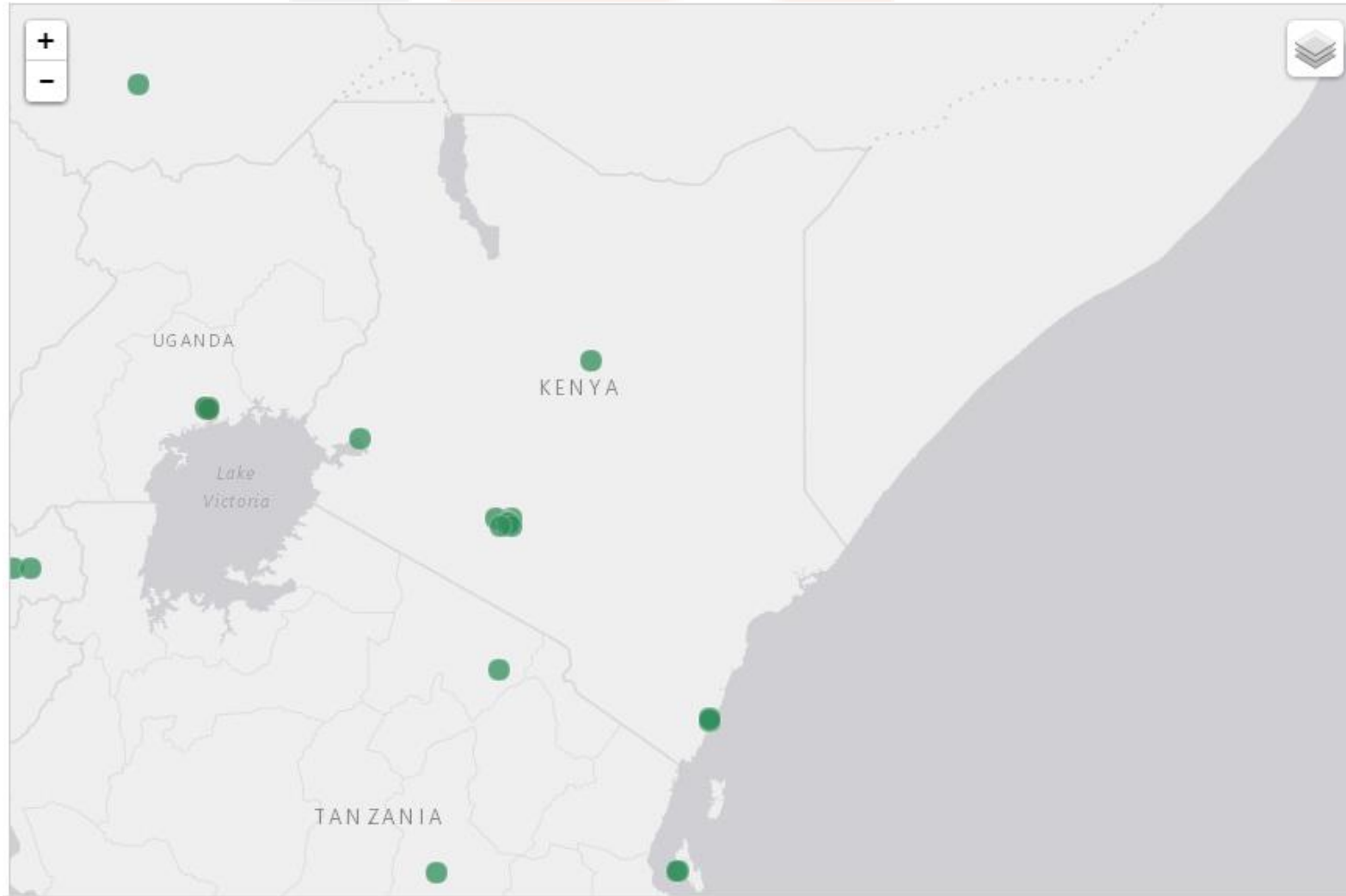
How are Atlas Probes being used by academic community?

- KENET has installed Atlas probes for the African and Global Internet community
- University of Cape Town CS research teams using it to measure inter-African latencies
 - And the impact of IXPs
 - Papers presented at IST-Africa 2016 in Durban, South Africa
- Interesting that only for NRENs in Africa have installed Atlas probes
 - And some operators are yet to install Atlas probes
- Who will fund Internet measurements research? ICT regulators? Governments? Consumer groups?

Atlas Probes – Global Map



Atlas Probes – Kenya



perfSONAR

- **What Is It?**
 - A software product to monitor networks for performance discrepancies, on an end-to-end basis, ensuring friction-free use for scientific applications.
 - Network measurement toolkit designed to provide federated coverage of network paths.
 - It provides an interface that allows for the scheduling of measurements, storage of data and generate visualizations
- **How It Helps?**
 - Design of Networks
 - A global monitoring framework is required in order to reliably discover and mitigate network issues.
 - The End-to-end Problem
 - Used to identify problems that are exacerbated when latency and paths increase, and protocols react adversely
 - Soft Failures
 - Congestion can cause fair protocols, such as TCP, to moderate their performance. Infrastructure flaws, such as damaged cabling or hardware, can introduce errors that must be corrected. Configuration that doesn't account for network buffering is also common, along with applications not designed for high performance.

perfSONAR – Global Map

perfSONAR

Lookup Service Directory

Search

Filter results by searching for specific terms:



Search

Show All

Browser

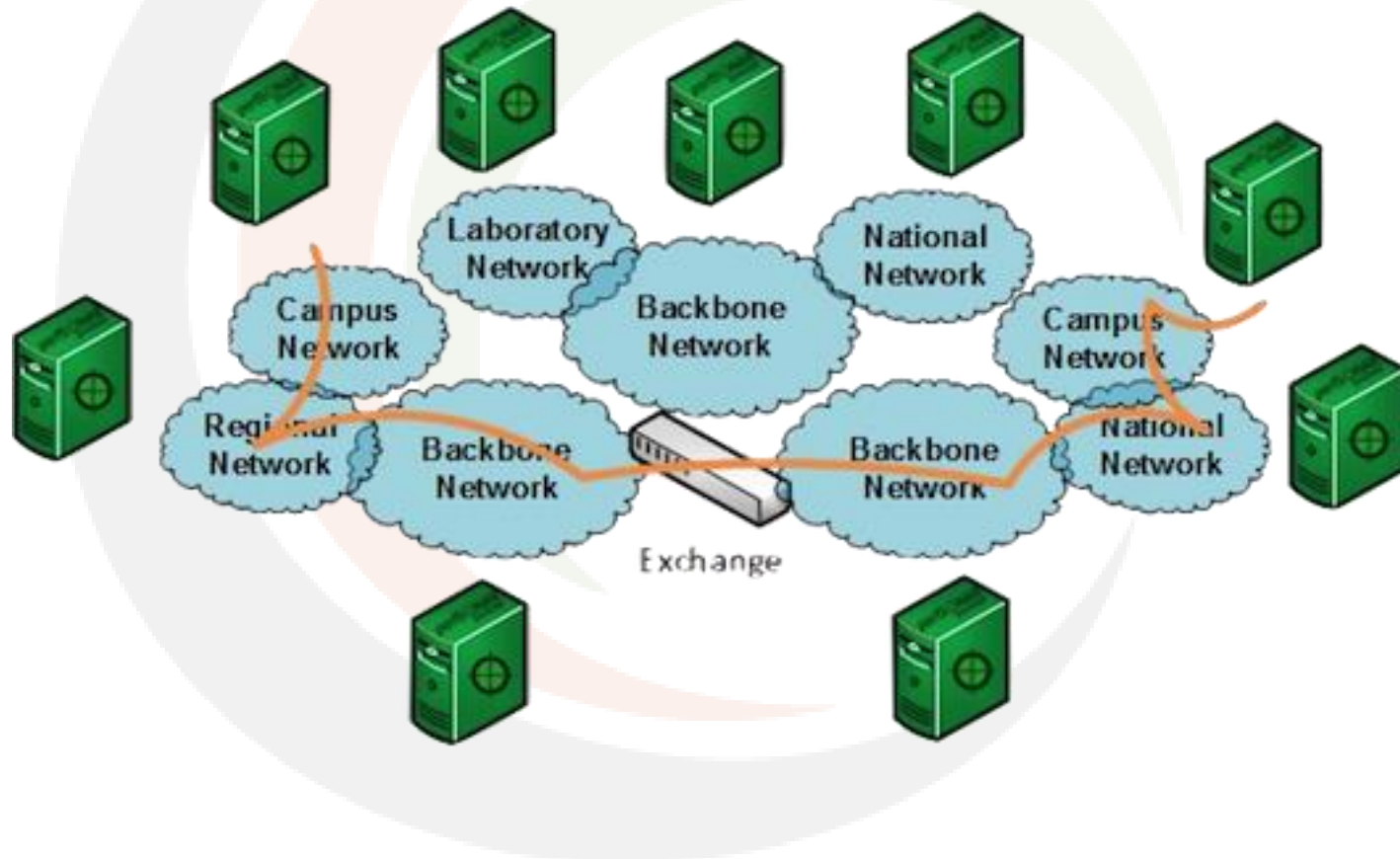
- ▶ BWCTL Server 1356
- ▶ OWAMP Server 1413
- ▶ NDT Server 827
- ▶ NPAD Server 645
- ▶ Ping Responder 1614
- ▶ Traceroute Responder 1605
- ▶ MA 1397
- ▶ BWCTL MP 1287
- ▶ OWAMP MP 1286
- ▶ bwctl10g 9

Service Map

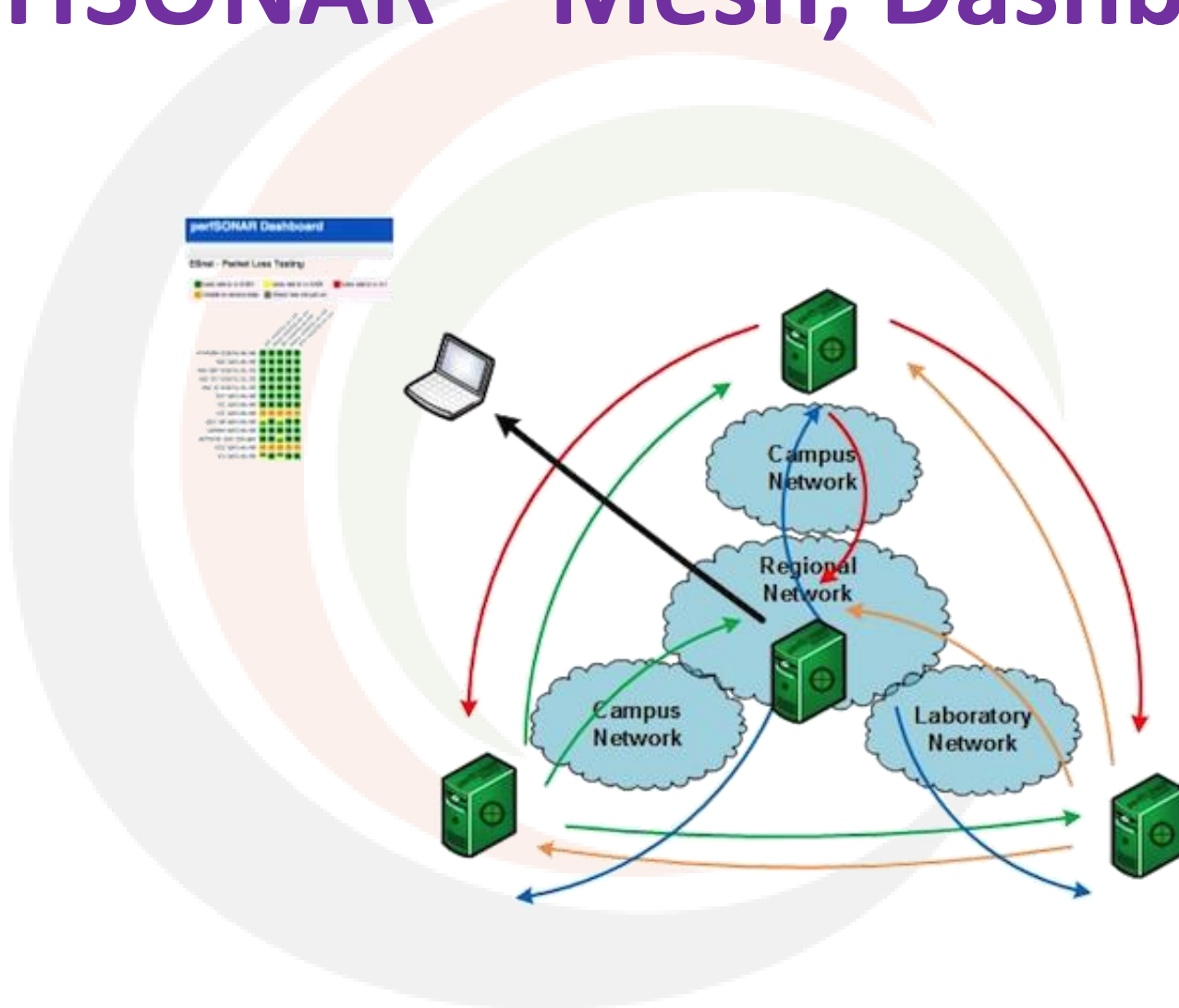


stats.es.net/ServicesDirectory/#collapse-map

perfSONAR – End-To-End Test



perfSONAR – Mesh, Dashboard



How does KENET use perfSONAR?

- **Testing end-end links for research communities or demanding member institutions**
 - See <http://maddash-uon.kenet.or.ke/maddash-webui/>
 - Able to measure latencies, packet losses between say UoN node and a node in Washington or London
- **Testing long-distance Inter-PoP links – throughput, latencies, packet loss etc**
 - UoN PoP < > Nakuru (200 KM)
 - UoN PoP < > Mombasa PoP (500 KM)
 - Network engineers diagnose end-end problems much faster

Conclusions

- **KENET has established the Internet Measurements Infrastructure**
 - for policy makers, Internet regulators and consumer groups in the region
 - Global Internet research community (e.g., PhD student at UCT using Atlas Probes to measure latency among Africa countries)
- **Measurement Lab – consumer groups, regulators, policy groups, researchers**
- **RIPE Atlas Probes – Global Internet researchers**
- **perfSONAR – mainly NRENs and collaborating universities, doctoral ICT students**
- **Emerging Internet research working group in Kenya**

Questions



*Transforming education
through ICT*

Thank You

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