Internet Measurement
@AFRINIC

Amreesh Phokeer
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Why measure?

● Internet measurement purposes
  ○ Reachability and latency
  ○ Routing (Routing stability, convergence)
  ○ Adoption of technologies (IPv6, DNSSEC, etc)

● Consumers
  ○ Network operators
  ○ Policy makers
  ○ Academics
  ○ Activists/Data Journalists
Measurement @ AFRINIC

- Our members
  - Registration statistics
  - Routability
  - Health status of resources

- Regulators
  - State of national connectivity
  - Level of peering
  - QoS and QoE

- Larger community
  - Overall state of the Internet
  - Outages and impact
Africa Internet Measurement Programme (AIM)

- **RIPE Atlas ambassador**
  - Deployment of RIPE Atlas probes and anchors

- **Statistics portal**
  - AIRRS
  - AFRINIC Stats (stats.afrinic.net)

- **Measurement WG**
  - Workshops (AIS/AFRINIC)
  - Hackathons
  - Webinars on research topics

- **Measurement studies**
  - Latency, content hosting, QoS, QoE
  - Security aspects (RPKI, DNSSEC, etc)

- **Dissemination**
  - Scientific publications, blog posts
  - Presentations at regional/international fora
AFRINIC Research Collaborations (ARC)

- Research ICT Africa (Policy think tank)
  - Internet use, content hosting
  - Performance of cloud computing services in Africa
- RIPE NCC / APNIC
- ISOC

- Previous academic partners
  - University of Cambridge
  - Queen Mary University of London
  - University of Cape Town
  - Princeton University
  - Simula Research
  - Aalto University
Past studies
Research in the African context

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gilmore et al.</td>
<td>2007</td>
<td>Internet connectivity from South Africa to all IP blocks that are allocated by AFRINIC</td>
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<tr>
<td>Chavula et al.</td>
<td>2014</td>
<td>Active network measurements to quantify the level of local peering and inter-continental traffic</td>
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<tr>
<td>Fanou et al.</td>
<td>2015, 2017</td>
<td>View of the AS level topology interconnecting African ISPs using RIPE Atlas</td>
</tr>
<tr>
<td>Gupta et al.</td>
<td>2014</td>
<td>Traceroutes between South Africa, Kenya, and Tunisia to investigate the interconnectivity between African ISPs</td>
</tr>
<tr>
<td>Chetty et al.</td>
<td>2013</td>
<td>Performance of mobile and fixed broadband connectivity in South Africa</td>
</tr>
<tr>
<td>Zaki et al.</td>
<td>2014</td>
<td>Measured webpage loading performance for users in Ghana</td>
</tr>
</tbody>
</table>
Regional Connectivity

1. **Insight Into Africa’s Country-level latencies**
   IEEE Africon 2017

2. **Deep Diving into Africa’s Inter-country latencies**
   IEEE Infocom 2018

- Poor level of interconnectivity within some countries
- Some subregions are better connected than others
- Some countries have bottlenecks

https://afrinic.net/research/africa-country-level-latencies

https://afrinic.net/research/africa-inter-country-latencies
Content hosting and Cloud Computing (2018)

- Where is local content/cloud services hosted?
- Impact on QoE for African users
- Which is the impact of circuitous routin on delay?
- Lack of competitive local infrastructure to support cloud services and content hosting.

https://afrinic.net/research/african-local-content-development

https://afrinic.net/research/african-cloud-services-performance-barriers
Content delivery in Africa (2019)

- CDNs in Africa
- QoE to access local content
- Challenges faced by CDNs
  - Cache filling
  - Unstable infrastructure
  - Heavy mobile phone usage

<table>
<thead>
<tr>
<th>Source Country</th>
<th>AMP Cache Location</th>
<th>Average Latency (ms)</th>
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</thead>
<tbody>
<tr>
<td>Nigeria</td>
<td>Lagos</td>
<td>1.022</td>
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<tr>
<td>Tanzania</td>
<td>Mombassa</td>
<td>6.262</td>
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<td>Kenya</td>
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<td>6.581</td>
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<td>Uganda</td>
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<td>15.344</td>
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<td>Algeria</td>
<td>Milan</td>
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<td>South Africa</td>
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<td>Zimbabwe</td>
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<td>68.419</td>
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<td>Libya</td>
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<td>Egypt</td>
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<td>Angola</td>
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<td>Benin</td>
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<td>Ethiopia</td>
<td>Stockholm</td>
<td>207.943</td>
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<td>Reunion</td>
<td>Amsterdam</td>
<td>211.792</td>
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<tr>
<td>Ghana</td>
<td>London</td>
<td>236.224</td>
</tr>
</tbody>
</table>
State of Internet Measurement in Africa (2019)

- Surveyed 100+ operators from 34 countries (2 months)
- Lack of interest/knowledge in measurement platforms
- Need to build a culture/community around measurements
- More awareness from AF* bodies (including AFRINIC)
- Business use cases

https://afrinic.net/research/state-of-internet-measurement-in-africa
Current projects
Country Dashboard

- Data from the Internet Resilience project
- Country reports
  - State of national/regional/international connectivity
  - Performance of ISPs
  - Identification of bottlenecks (topological, physical)
- Workshop for regulators
  - Mobile measurements
  - QoE monitoring
  - Price/QoS Observatory
DNS Best practice - Compliance

- DNS Flag Day has a list of best practices/recommendations
  - Check the status on AFRINIC Reverse DNS name servers
  - Check the status on African ccTLDs name servers

- Sanity check
  - Are AFRINIC members name servers redundant?
  - Are African networks hosting public open DNS resolvers? Prone to DDOS

- Inform AFRINIC members
- Inform ccTLD operators
Challenges

● Infrastructure
  ○ Poor coverage
  ○ Africa mostly mobile
  ○ Power issues

● Research funding
  ○ Internally
  ○ External collaboration

● Interference
  ○ Shutdowns
  ○ Censorship

● Lack of interest

Opportunities

● Growing interest in Internet measurements
  ○ Last-mile connectivity (ITU)
  ○ Internet Security (Regulators)
  ○ Internet shutdowns (Civil Society)

● Africa’s own measurement infrastructure?
Thank you :)