MoRENet as a Platform for Intra-country Collaboration in Research and Education: Evidence Based on Analysis of Usage Patterns and Network Data Flows

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MoRENet CEO

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1. Introduction: MoRENet Context;

2. Research Objectives;

3. MoRENet Data Flow Analysis:
   2.1 Data Collection Method and Tools; and
   2.2 Results.

4. Conclusion
1. Introduction: MoRENet Context

- MoRENet – Mozambican NREN;
- Part of the Mozambique ICT Policy Implementation Strategy approved in 2002;
- MoRENet’s Operations started in 2005;
- Founding Member of UbuntuNet;
- In 2017 connects 109 Academic and Research Institutions; and
- Government supported initiative.
1. Introduction: MoRENet Context

**Network Architecture**

<table>
<thead>
<tr>
<th>Network Segments</th>
<th>Capacity [Mbps]</th>
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<tbody>
<tr>
<td><strong>Local Network</strong></td>
<td>16 Wireless LANs in University Campus</td>
</tr>
<tr>
<td>Last Mile</td>
<td></td>
</tr>
<tr>
<td>100 Mbps</td>
<td>Universities</td>
</tr>
<tr>
<td>60 Mbps</td>
<td>Research Institutions</td>
</tr>
<tr>
<td>20 Mbps</td>
<td>Technical Vocational Education Institutions</td>
</tr>
<tr>
<td><strong>Backbone</strong></td>
<td>500 Mbps 5 Points of Presence (PoPs)</td>
</tr>
<tr>
<td><strong>International Links</strong></td>
<td>3 Gbps WIOCC (Eassy): 1,25 Gbps</td>
</tr>
<tr>
<td></td>
<td>UbuntuNet/Seacom: 1,86 Mbps</td>
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</tbody>
</table>
1. Introduction: MoRENet Context

**Network Infrastructure and Management**

**Two Network Operation Centers (NOCs):**

- National Science and Technology Park, in Maputo Province;
- Ministry of Science and Technology, Higher and Technic Professional Education, in Maputo City.

**Two Network Management Tools:**

- **ZABBIX** - Monitors availability, latency and bandwidth occupation of links; and
- **WHATSUP GOLD** - Network data flow analysis.
1. Introduction: MoRENet Context

MoRENet Services

Current Services:

- Connectivity, including Internet Access;
- Hosting of web sites and applications;
- Co-Location
- E-Mail
- Eduroam
- Identity Federation (CAF-MOZ)
- Training (Capacity Building)

Planned Services:

- Virtual Libraries;
- VoIP;
- Video and Web Conferences;
- File Sender; and
- Cloud Services.
1. Introduction: MoRENet Context

MoRENet Services: MoRENet Eduroam Website

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Bem vindo ao site eduroam da MoRENet

eduroam - Acesso a rede sem fio

Principal iniciativa da MoRENet dedicada à questão da mobilidade, o eduroam (education roaming) é um serviço desenvolvido para a comunidade internacional de educação e pesquisa que oferece acesso sem fio à internet sem a necessidade de múltiplos logins e senhas, de forma simples, rápida e segura. Este serviço dispõe de ampla cobertura internacional e reúne instituições de mais de 60 países, unindo diversos usuários na troca de experiências e conhecimento.

Através de uma rede wi-fi, estudantes, pesquisadores, professores e outros funcionários das instituições cadastradas podem se conectar à internet dentro de seus campus e em qualquer localidade do mundo, desde que haja pontos de acesso. Basta ter o eduroam configurado em seu computador, celular ou tablet para detectar a rede sem fio de forma automática, garantindo comodidade e uma experiência de alta qualidade ao usuário.

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Powered by MoRENet
1. Introduction: MoRENet Context

Network Management: Bandwidth Usage

Link Connecting MoRENet to WIOCC PoP in Marseille

1st Link Connecting MoRENet PoP in Maputo City to UA PoP in Maputo
1. Introduction: MoRENet Context

Network Management: Bandwidth Usage

2nd Link Connecting MoRENet PoP in Maputo City to UA PoP in Maputo

Link Connecting MoRENet PoP in Maputo Province to UA PoP in Maputo
1. Introduction: MoRENet Context

Network Management: Bandwidth Usage

Link Connecting MoRENet PoP in Maputo Province to UA PoP in London

Traffic for SEACOM/Movitel Link to... (UA-UK-LDN1-01 ge-1/3/1)

- **In**: Max 9.72 Mbps Avg 1.42 Mbps Current 9.63 Mbps
- **Out**: Max 185.81 Mbps Avg 69.95 Mbps Current 179.41 Mbps

Line Speed 1.00 Gbps
1. Introduction: MoRENet Context

Network Bandwidth Growth

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</tr>
</thead>
<tbody>
<tr>
<td>Planned (Mbps)</td>
<td>20</td>
<td>155</td>
<td>310</td>
<td>620</td>
<td>1,870</td>
<td>3.120</td>
<td>5.620</td>
<td>6.870</td>
<td>9.370</td>
<td>10.620</td>
</tr>
<tr>
<td>Actual (Mbps)</td>
<td>20</td>
<td>155</td>
<td>310</td>
<td>620</td>
<td>3.120</td>
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Bandwidth growth

- **Planned**
- **Actual**

Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional
2. Research Objectives

1. Investigate the usage of MoRENet as a platform to promote and support the collaboration between different actors of the scientific and academic community within Mozambique;

2. Provide Evidence of the potential role of MoRENet’s policies, strategies, architecture, and controls in promoting or hindering the growth of the academic network; and

3. Provide advice for policy recommendations and management decisions about the usage of applications, their localization and the possible peering agreements between MoRENet and other networks, including African NRENs.
Protocols for data flow analysis considered:

- IPFIX (IP Flow Information Export) – IETF;
- NETFLOW – CISCO Systems, Inc;
- Netstream – Huawei;
- Jflow – Juniper-

Netflow Advantages:

- Operations as cache; and
- Export of information in cache, facilitating collection of data for future analysis without having to place an analyzer in every link.

- For this analysis, Netflow has been configured in the entrance direction, in the interfaces of the POP routers directly connected to the international transit providers, in the Maputo province POP, Maputo city POP and PoPs of the center and north provinces of Mozambique;

- Address block of 41.94.0.0/16 defined as MoRENet’s internal addresses and all other as external.

- Netflow export data flow to the WHATSUP GOLD collector in port 9999, and the collector monitors the devices in port 161.

- The configured tool highlights the tendencies on the network traffic, which allows change to be done in an anticipated and smart manner in overloaded links.

- Also provides reports about the main applications (protocols) being used, the origin and destinations of most of the traffic by domain, Autonomous System Number (ASN) and IP address groups.
Overview of the statistical analysis collected by Netflow per application, on the Maputo Province POP.
3. MoRENet Data Flow Analysis Using Netflow

Results: Flow of the Main Applications

- Approximately 69% of the data flow in the international links in Maputo Province POP originate from encrypted web pages;
- 33% from unencrypted web pages;
- 2% from applications using UDP protocols;
- 2% from DNS requests, and;
- Remaining percentage have their origin in applications using TCP.

This information aids the network infrastructure managers in making decisions related to the creation of policies for the prioritizing or blocking of data flow from certain applications which are useful to the network users.
3. MoRENet Data Flow Analysis Using Netflow

Results: Flow of the Main Domains

Overview of the statistical analysis collected by Netflow per domain, on the Maputo City POP.
Approximately 63% of the data flow in the international links of Maputo City POP have their origin in .net domains - Network technology organizations;

- 21% in .com domains mainly hosted in the US;
- 6% in .jp domains - from Japan,
- 2% in .fr domains from France;
- 1% in .de domains from Germany;
- 8% distributed amongst other countries.
Overview of the statistical analysis collected by Netflow per domain, on the Maputo City POP
3. MoRENet Data Flow Analysis Using Netflow

Results: Flow of the Main ASNs

- Approximately 2% of the data flow in the international links in Maputo Province POP have their origin at ASN15169 - Google;
- 1% at ASN32934 - Facebook;
- 0.5% at ASN23456 – Nipa Technology; and
- 96% on the various ASNs.

With this information managers can easily decide to which ASN MoRENet should establish direct links, with the aim of reducing latency.
3. MoRENet Data Flow Analysis Using Netflow

Results: Flow of the main transactions between IP Groups

Overview of the statistical analysis collected by Netflow per IP transaction, on the Maputo City POP.
3. MoRENet Data Flow Analysis Using Netflow

Results: Flow of the main transactions between IP Groups

- Around 7% of the data flow in the international link to Maputo Province POP was generated by the conversation between the IP addresses 209.85.230.234 and 41.94.122.5;
- 4% between address on network 173.194.0.0 and 41.94.122.5;
- 78% between the various internal and external addresses.

This statistical data may indicate the occurrence of a denial of service attack during the period of data collection with origin at 173.194.0.0 network to the machine 41.94.122.5;
3. MoRENet Data Flow Analysis Using Netflow

Results: Flow of the Main cities

Overview of the statistical analysis collected by Netflow per City, on the Maputo City POP.
3. MoRENet data flow analysis using Netflow

Flow of the main cities

- Approximately 50% of the data flow in the links of Sofala province PoP have their origin in networks located in Mozambican cities;
- 34% in networks located in California/US;
- 6% in networks located in other cities of US,
- 2% in networks located in cities of Romania;
- 2% in networks located in cities of Italy;
- 7% distributed amongst many cities from other countries.

- Large amount of the traffic that circulates in the MoRENet backbone corresponds to the transactions between the institutions directly connected to MoRENet.
- This can be an indication that MoRENet has been contributing significantly to the collaboration between the national research and education institutions.
4. Conclusion

- MoRENet network has been playing a growing role in Intra-country Collaboration between research and higher education institutions in Mozambique;
- There is insignificant traffic flow between MoRENet and African universities (African NRENs);
- Data Flow Analysis helps in:
  - Understanding “how”, “what”, “when”, and “by who” the MoRENet bandwidth is used;
  - Generating data and information that can help in making strategic decisions to improve network performance;
  - Identifying possible network malware infections; and
  - Evaluating the impact of new services implemented on the network.
Thank you!

Muito Obrigado

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