A Call to Arms: Motivating An Internet Measurements Observatory for Africa

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ABSTRACT

Despite decades of investment and regulatory efforts, Africa's Internet ecosystem still relies heavily on infrastructure far outside the continent, routing traffic through Europe and outsourcing critical services like DNS resolution. This dependence on foreign infrastructure exacerbates the impact of subsea cable cuts and exposes a deeper problem. That is, the continent's connectivity fabric remains externally dependent and structurally fragile. Existing measurement tools fail to illuminate this reality, either by missing key components or offering insufficient visibility. We argue for a rethinking of how we monitor and support Africa's Internet infrastructure. Our vision is a purpose-built testbed that combines crowd-sourced vantage points with intentional, context-aware targeting to better capture the unique Internet ecosystem of the continent. Rather than simply retrofitting global solutions, we propose building with the realities of Africa's ecosystem in mind.

CCS CONCEPTS

• **Networks** → **Network measurement**; **Network performance analysis**; *Network manageability*; • **Social and professional topics** → **Universal access**.

KEYWORDS

Network Measurement, Internet Resilience, Internet Policy, Digital Divide

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1 INTRODUCTION

Africa is home to the world's youngest and fastest-growing population, with its urbanized workforce projected to almost double from 1.3 billion in 2021 to 2.5 billion in 2050 [55]. This rapid demographic growth drives digital transformation across critical sectors such as FinTech, e-commerce, healthcare, education, and entertainment.

These digital transformation efforts are investing significantly in key critical infrastructures, ranging from IXPs and data centers to subsea cables. These investments have fundamentally transformed the shape of connectivity in Africa, with sources claiming significant improvement in end-user performance metrics (e.g., 4X improvement in download throughput over 5 years [7]), and adoption of government services (e.g., 100% in Rwanda [8]).

Although there is significant evidence of improved connectivity, the two subsea cables cuts in 2024 [20, 43], which took down on average 10 countries each for approximately several hours and degraded performance for several days, have highlighted a fragile ecosystem of hidden dependencies [3, 53]. These cuts crippled nation-scale economies, disrupted daily services that have now been digitalized, and cast doubts on the reliability of critical infrastructure in Africa. For example, Ghana's ministry noted that cable cuts disrupted banking transactions and digital payments of utilities such as water and electricity [28]. A widespread digital infrastructure outage result in significant economic, social, and civil disruptions.

The dichotomy between significant infrastructure investments and visible resilience challenges highlights the need to evaluate connectivity in Africa. Although much work has been done, these efforts are often limited in scope [59, 72] or dated [12, 16, 17, 23, 25, 26, 32, 33] – more generally, none address cable cuts or assess challenges in applying popular network measurement to Africa's unique infrastructure. The unique aspects include a heavy dependence on mobile networks for last-mile connectivity, a heavy reliance on Europe for transit, a lack of data centers, and many characteristics that often lead to suboptimal and inefficient network routes. However, such assessment is crucial as regulators, e.g., UN's ITU [37], ICANN/ATU's Digital coalition [38], and political entities, e.g., Nigeria's NCC [71], are looking to set working groups to assess internet infrastructure resilience,

identify opportunities, and invest in mechanisms to enhance resilience. We ask: *What is the state of connectivity in the continent? How have initiatives (e.g., IXP and content localization) improved connectivity? How does this improvement vary between regions?*

In this paper, we motivate the need for Africa-centric measurement primitives to analyze and assess connectivity within various countries in Africa and rich models to analyze interactions between protocols that engender the observed end-to-end resilience. Such models will prove instrumental in enabling what-if analysis, and crucial in directing investments. Although, as a community, we have a plethora of data capture mechanisms, few have been tailored to investigate inefficiencies in Africa and to focus on the unique aspects of connectivity in Africa. We motivate the case by highlighting Africa's unique internet ecosystem, illustrating how this unique ecosystem has rendered countries within the continent susceptive to outages, then empirical analyze and illustrate the drawback of popular network assessment and analysis methods (e.g., CAIDA's IP hitlist), platforms (e.g., NCC RIPE), and techniques (e.g., Nautilus' subsea cable inference).

We make several key observations.

- Despite significant investments in IXPs for localization, traffic in Africa continues to detour through Europe due to peering complexity (Section 4.1) and a significant amount of content is also sourced from Europe (Section 4.2).
- The subsea cable outages have a unique footprint for two interesting reasons: first, cables are often laid next to each other, resulting in correlated failures. Second, in addition to content, critically different components required for loading pages, e.g., local DNS resolvers, have been outsourced. Furthermore, existing efforts to legislate and improve resilience ignore these factors. (Section 5).
- Regarding the applicability of measurement techniques, we observe that, first, the mismatch between the critical components of the African Internet ecosystem (e.g., use of IXP) and the target objectives for state-of-the-art internet scanning significantly reduces their efficacy (Section 6.1).
- Lastly, geographic bias in the platform deployments limits their representativeness, and consequently, this bias impacts the evaluation of our emerging methodologies in the internet measurement community (Section 6.2).

Inspired by these challenges, we have created a road map for the Internet Observatory, a connectivity measurement platform intentionally designed around the unique properties of Africa's Internet infrastructure. Unlike existing measurement techniques and platforms that prioritize broad IP coverage, our Observatory focuses on targeted, purpose-driven measurement: probe locations and measurement targets are explicitly selected to surface critical—but often invisible—components like locally hosted (or outsourced) DNS resolvers, subsea cable paths, and regional IXPs. Crucially, our Observatory is designed with the unique characteristics of African mobile networks in mind and aims to address the high costs of mobile data, prepaid usage patterns, and unreliable or intermittent power. Our measurement probing techniques are similarly tailored to the distinct constraints and dependencies of the ecosystem. This deliberate and infrastructure-aware approach provides visibility into operational blind spots and enables more grounded, region-specific interventions by network operators and policymakers alike.

2 OVERVIEW OF AFRICA'S UNIQUE INTERNET INFRASTRUCTURE

Despite Africa's growing infrastructure, the ecosystem remains relatively young and thus exists at a fundamentally different point in the Pareto frontier. Unlike N America, Europe, or Asia, Africa lacks tier-1 ISPs, has very few data centers, and also a small set of tier-2 ISPs. Consequently, traffic from Africa traverses Europe either due to peering reasons (the only common provider is in Europe) or because content is hosted in Europe. This external dependence is further reinforced by the higher cost of collocations in Africa, leading to a conscious choice to host services externally, and the poor terrestrial connectivity, leading to poor local performance and a need to use non-terrestrial routes, e.g., subsea cables or satellite links. During the last decade, significant efforts have been made to address the performance challenges associated with this European dependency.

- **More Subsea Cables:** The first is the addition of new subsea cables, e.g., Meta 2 Africa, which interconnects the continent with Europe but also interconnects different regions within Africa. This increased deployment of subsea cables has both reduced the cost of transit to Europe and improved performance.
- **IXPs:** The second, inspired by efforts by ISOC and ICANN, is the deployment of local IXPs, which directly address the lack of Tier-1 and Tier-2 by providing local peering. Often, these IXPs host off-net servers for content providers, which allows them to serve content locally [34].

To summarize, as a consequence, Africa's young ecosystem connectivity is characterized by a heavy reliance on subsea cables to provide connectivity to Europe and, more importantly, to provide connectivity within the continent as a replacement for terrestrial connectivity. More recently, in an attempt to localize traffic, there has been a tremendous shift to adopt IXPs to interconnect local ASes in an attempt to overcome the lack of Tier-1 and to address the need to

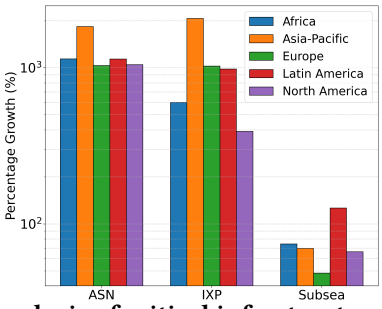


Figure 1: Analysis of critical infrastructure (IXPs, subsea cables, ASes) growth over the last 10 years.

leverage upstream providers in Europe. In fact, we observed an increase of 45% in the number of cables and a significant increase in the capacity to deliver to Africa in the last 10 years. Looking a bit deeper, we observe that regionally the increases are not evenly distributed. For IXP, we observe an increase of 600%. More generally, in Fig. 1, we compare Africa with S. America, Asia-Pacific, and Europe; from this, we observe significant growth relative to N. America and Europe, which is expected, given N. America and Europe's maturity. However, even compared to other developing regions in the global South, we observe that Africa's Internet ecosystem is developing at a slower pace, suggesting a lower level of maturity.

3 DATA SETS

Here we describe the data sets to characterize connectivity (Section 4) and the effectiveness of various measurement tools (Section 6).

Outage Analysis with Cloudflare Radar [19] To characterize outages and their impact, we explored data from the Cloudflare Radar outage center. Cloudflare Radar lists outages detected based on observed drops in traffic and validated by "checking status updates and related communications from ISPs, or finding news reports related to cable cuts, government orders, power outages, or natural disasters" [20].

ISOC Pulse [53] To identify and understand the use of remote versus local application servers, we leverage a tool we previously developed and deployed with ISOC [53]. In summary, the tool uses residential VPNs in each country to download the top 1000 popular websites in that country [31]. Note that we exclude censored content [49]. The tool uses an improved version of FindCDN [21] to detect CDN usage, then geo-locates the application server using a combination of techniques described in our recent publication [53].

APNIC lab [5] To identify and understand the use of remote and local infrastructure services, i.e., DNS, we explored APNIC's DNS resolver use data [5]. In summary, APNIC uses online ads and services to track DNS resolver usage by analyzing how clients (such as web browsers or devices) reach authoritative DNS servers. We focus on data from 2024 to capture resolver usage around the outages.

RIPE Atlas [64] We use traceroute and ping measurements collected by RIPE Atlas probes and anchors in Africa. In particular, we used two snapshots: one around the March outages (March 2024) to analyze outages and one from this year (March 14-16, 2025) to characterize peering and routing behavior. We use this data to analyze the network layer, specifically, routing behavior and server availability.

4 REVISITING CONNECTIVITY IN AFRICA

Previous studies show that Internet traffic from Africa detours through Europe with a significant dependence on infrastructure, data centers, and clouds in Europe [24, 32, 33]. Given the significant transformation of network performance and infrastructure deployments (i.e., subsea cables and IXPs), naturally, there is a need to revisit the dependence.

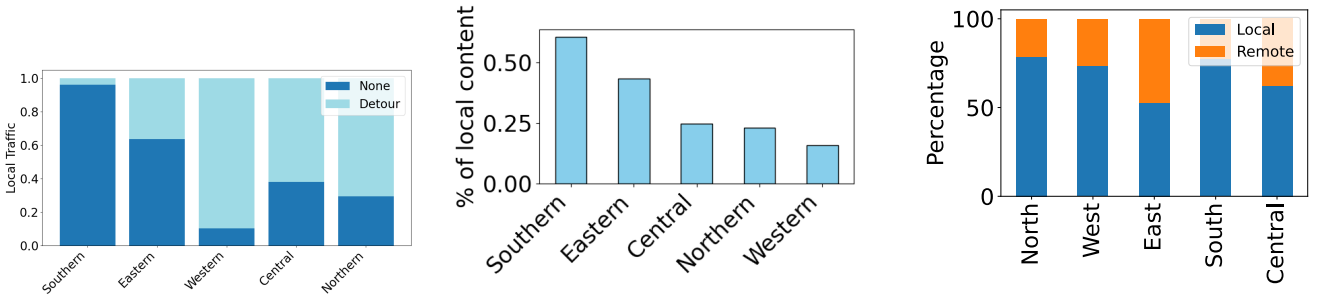
In this section, our aim is to answer several key questions: *(1) For traffic between two locations in Africa, how often does traffic detour outside of Africa? Given the growth of IXPs, how often are IXPs used? (Section 4.1) (2) Given the significant growth in content server deployment, how often are services cached locally? (Section 4.2) (3) How do the different regions of Africa differ in terms of maturity? (Section 4.3).*

4.1 Peering Ecosystem and Failures

In this section, we analyze traffic between the source and destination hosts in Africa. We specifically focus on intra-African traffic because this traffic should stay, naturally, within the continent.

From Figure 2a, we observe that a non-trivial number of routes continue to detour out of the continent. Recall that these are routes where both the source and destination are in Africa, and thus detouring is especially costly. A closer analysis of peering relationships, using CAIDA's AS relationship [15] and HE's Tier-1 list, shows that only 40% of the detour can be attributed to EU-based Tier-1 and IXP, which highlights a lack of sufficient Tier-2 providers in Africa, leading Africa's ISPs to rely on Tier-2 providers in Europe for transit. We note that some traffic detours through N. America and Asia, but with such low traffic that we defer analysis to future work.

We note that although IXP deployments are growing, they are not prevalent. Specifically, using well-defined IXP detection methods [57, 58] , we identify the percent of routes between each pair of probes that traverses at least one IXP. Figure 3 shows that only about 10% of the traceroutes traverse an IXP, while in the best scenario in Central Africa, only 55% do.



(a) Prevalence of Detours (b) Content Localization in Africa (c) Local DNS Resolver use across Africa.

Figure 2: Localization of network routes, content servers, and DNS resolver.

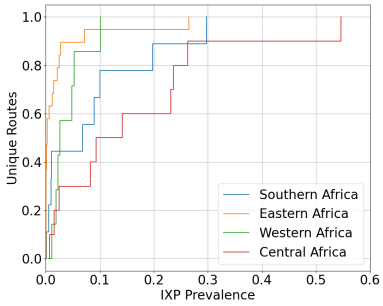


Figure 3: Prevalence of IXPs in Local Traffic. Northern Africa is excluded due to lack of IXPs showing up in our data set.

Implications for Resilience From a resilience perspective, a consequence of this young ecosystem is that during cable cuts, many ASes are cut off from their providers and will need to re-negotiate new peering relationships. This was documented by Ghana's Ministry of Communication [50] as the country needed to re-negotiate with several different providers to get connectivity to Europe during the outage in March 2024. These manual negotiations are one of the key sources of prolonged outages during these subsea cable cuts. While many others prearrange backup negotiations, e.g., KENET's backup through S. Africa, during these subsea cable cuts, their backups are often over-subscribed, rendering them ineffective and forcing negotiations with more expensive carriers [18].

4.2 Content Locality Revisited

Next, we analyze ISOC's data set on the locality of ISOC [53] content to characterize the locality of traffic in Africa. From our analysis, we observe that only 30% of the content is local to Africa. Exploring a bit deeper (Figure 2b), we perform our analysis on the region level and found distinct regional differences. We note that previous work on Government websites [48] focuses on 6 countries in Africa and makes similar conclusions.

4.3 Regional Maturity

Across the analysis conducted in this section, the southern region of Africa has shown the highest maturity (i.e., highest locality of both content and routes), closely followed by Eastern while Western shows the least maturity. These findings align with the infrastructure deployed: companies start out building infrastructure in South Africa, then often expand to Kenya, which serve as the anchor for southern and eastern Africa, respectively. A key observation from our analysis is that different regions may require different strategies to improve resilience. For example, while efforts to enhance traffic locality could be beneficial in Western Africa, such measures may yield diminishing returns in Southern Africa due to South Africa's already mature Internet ecosystem.

5 CABLE OUTAGE UNDER THE LENS

Next, we analyze Cloudflare's outage report and APNIC DNS data to characterize outages and understand their impacts. We observe that in Africa, subsea cable outages impact a large number of countries and, generally, across all types of outages, subsea cable outages take the longest to resolve. Surprisingly, many organizations do not have a local resolver, and thus when disconnected from other countries, they are unable to make the DNS queries required to connect to the local infrastructure.

5.1 Subsea Cable Outage Analysis

In Figure 2c, we observe that Africa experiences 4x more outages than the EU or N. America and even S. America. More relevant, subsea cable cuts have the most drastic effect in Africa; about 30 countries have been impacted by cable cuts over the last two years. Although Africa is not unique in being affected by cable cuts, it is unique in the magnitude of impact. This occurs because many cables are laid along

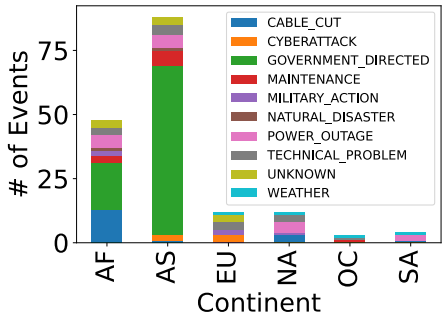


Figure 4: Characterization of the impact of outages.

similar paths and thus failures are correlated. For example, during the outage in March 2024, over the course of a few days, four cables (WACS, MainOne, SAT3, ACE) were cut due to a rock slide under the sea near Abidjan [40, 41]. Additionally, while certain governments, e.g., Ghana, legislated that mobile providers maintain backup connectivity, these laws do not make any diversity requirements regarding subsea cables themselves. Thus, while there are backups, the correlated nature of subsea cable deployment often renders them ineffective, as it did in March 2024. We note similar correlated failures on the east side due to a cable cut that affected three cables (EIG, Seacom, AAE-1) [40, 41].

Implication. There is a strong need to explore geographic diversity when deploying new cables (as Equiano and 2Africa have done) and, more importantly, to evolve legislation to explicitly account for diversity at various layers. We note that legislation may mandate backup paths through international subsea cables; these cables may still be correlated due to physical collocation, and this correlation needs to be explicitly accounted for.

5.2 Hidden Dependency Analysis

Access to digital services involves contacting a large set of servers hosting web content and also a large set of servers providing infrastructure services (e.g., certificates and DNS). Prior work has shown that in Africa, content is localized to a small set of services [45] and often hosted remotely [51, 53]. In this section, we focus on exploring the locality of infrastructure dependencies and explore DNS as a case study.

Results. Figure 2c, we observe an alarming pattern that many regions rely heavily on resolvers in other countries and on cloud resolvers. The use of cloud resolvers is unsurprising given their impressive performance and reliability properties; however, during subsea cable cuts, many of these clouds become unavailable because few large public clouds exist in Africa. Moreover, they are generally centralized in South Africa. Although the use of local resolvers in other countries appears counterintuitive, prior work [51] has shown that in the global south, DNS resolvers are treated as a cost center and thus often outsourced to reduce cost.

Takeaway Abstractly, there are many dependencies of digital services (web page or mobile application), ranging from DNS servers and certificate servers to webpage content. Although significant efforts have been made to legislate localization of content and user data, as well as to legislate subsea cable redundancy, these dependencies remain largely unaddressed. We argue that similar efforts should be made to legislate these critical dependencies and that watchdogs should be created to continuously assess policy adherence.

6 ASSESSING STATE OF THE ART MEASUREMENT TECHNIQUES

Next, we aim to characterize the feasibility of using a popular network investigation methodology to assess critical infrastructure in Africa. We start with an assessment of IXPs and the identification of subsea cables. We observe that: *(1) Existing measurement scanning methods provide impressive coverage over ASes but poor coverage for IXPs. We observe that these limitations are due to the nature of IXPs. (2) Techniques for probing and identifying subsea cables face challenges due to known geolocation accuracy problems in Africa.*

6.1 Network Scanning and assessment

Methodology We evaluate the coverage of the following three popular common approaches to measuring network paths: First, a hitlist-based approach, ANT IPv4 Hitlist [70], where a list of addresses is used to guide the network scanner. Second, a prefix-based approach, CAIDA IPv4 Routed /24 Topology [11], where random addresses are probed within a list of prefixes. Finally, an approach that randomly probes addresses (i.e., YARRP [9]).

For ANT IPv4 and for CAIDA, we can evaluate their coverage statically by analyzing their hitlists. However, for YARRP, we needed to run it to determine the probed addresses. Thus, we configured it to traceroute to all /24 prefixes in AS 6447's global BGP routing table [9, 62]. We run in Rwanda using both a residential network and a campus network.

To calculate coverage, we map IPs to ASNs and geolocate them using IPInfo, then we restrict our analysis to just the subset in Africa. Next, we classify each African ASN into one of three groups: Mobile (Cloudflare Radar ≥65% mobile-originated traffic [19]), IXP (LAN prefixes from PCH and PeeringDB [60, 61]), or Non-Mobile/Non-IX. Finally, for each group, we compute coverage as: $coverage = |observed\ ASNs| / |expected\ ASNs|$ We compute these coverage numbers on a regional level. To determine expected ASNs, we use AfriNIC delegated statistics for assigned African IPs and ASNs [4].

Results Our empirical analysis (Table 1) shows that ANT achieves the highest coverage in all dimensions. A regional

Dataset	Entries	Coverage (in Africa)		
		Mobile ASN	Non-mobile ASN	IXP
CAIDA Hitlist [11]	3,908,236	64.4%	35.45%	7.8%
ANT Hitlist [70]	5,999,014	96%	71.4%	23.5%
YARRP [9]	766,263	56.10%	27.2%	2.9%

Table 1: Dataset size and coverage.

analysis reveals that Northern Africa leads in coverage, with ANT providing 52. 6% for mobile and 15.1% for non-mobile ASNs. ANT's superior performance stems from its substantial dataset, enabling comprehensive network measurements. However, IXP coverage remains limited across all tools: ANT reports only 23.5% coverage, while YARRP and CAIDA detect fewer prefixes, impairing network visibility and hindering instability detection at IXPs [67, 74]. This persistent gap is not surprising, as most IXP LAN prefixes are not advertised on the global BGP routing table [22], making them difficult to capture without targeted measurement designs [13, 30, 54].

Implication Achieving full African IXP coverage requires careful selection of vantage points and target IPs such that measurements are generated from deployed within an ASN that peers at one or more African IXPs and targeted at a customer of the IX (e.g. a CDN). [1].

6.2 Subsea Cable Identification

Methodology Next, we employ a state-of-the-art approach [63] to identify subsea cables within our RIPE dataset (Section 4.1).

Results Our analysis of Nautilus [63], shows that it maps over 40% of the network paths to more than one submarine cable and often maps a network path to up to 40 submarine cables. This level of precision is insuffiecient for regulatory engagements where identification of specific phyisical routes is essential for assessing infrastructure resilience. Consequently, simply using external mechanisms will not accurately assess adherence to policies centered around the physical layer.

Implication Rather than creating policies and regulations that rely solely on passive measurements, we believe that regulations and policies should be based on a combination of active measurements and statistical approaches (a generalized version of previous work [52]) or based on an auditing approach where metrics from the network are analyzed for compliance.

7 TOWARDS AN AFRICAN INTERNET OBSERVATORY

To help improve connectivity across the continent, we envision an internet measurement observatory that consists of a combination of physical probes (i.e., RaspberryPis and mobile devices) and proxies (i.e., residential proxies and VPNs similar to prior works [48, 53]) distributed throughout the continent. These devices will be equipped with software that allows for both traditional network measurements and the deployment and analysis of rich application frameworks. We envision using a container-based system, e.g., EdgeNet [56, 68], for orchestration and management.

7.1 Unique Challenges (Beyond RIPE Atlas)

An obvious approach to building the observatory is to take advantage of existing measurement platforms and focus on a subset of measurements from Africa. However, existing platforms suffer from two key issues. First, they lack coverage. Second, while we can address coverage by expanding their deployments, they are often limited in the set of experiments they support. Finally, they overlook several key aspects of Africa's unique landscape. There are several additional requirements for our measurements over existing measurement frameworks (e.g., RIPE Atlas).

Mobile-focus: Last-mile connectivity in Africa is dominated by mobile carriers, with wired broadband accounting for a small fraction of the population. Thus, for representativeness, we aim for largely mobile endpoints. For our physical probes, we aim to equip them with both a cellular (via a USB dongle) and a wired link.

Cost-conscious: A key challenge in performing network measurements is the cost of mobile devices, which is significantly higher in developing regions. Thus, there is a need to judiciously allocate the bandwidth budget to the different measurement tasks in a manner that simultaneously achieves the desired goals while maximizing reuse and meeting a predefined budget. We plan to build on a rich literature on active measurements [6, 47, 65, 66] and plan to extend them to support: (1) multiple pricing models as different countries have different pricing models, and (2) modeling low-level network usage rather than application-level network usage, since billing generally occurs at the application level.

Rich Measurements: Measurement platforms must explicitly trade off flexibility and control. Consequently, platforms like RIPE Atlas limit users' experiments; however, at such a nascent phase, we require flexible measurements, e.g., ability to perform transport level experimentation. We envision that experiments will need to be vetted and run by a small, trusted cohort. As we grow the size of the deployment and as the demand grows, we will revisit this design choice.

7.2 Call to Arms for Various Stakeholders

Our vision requires active participation of a broad range of stakeholders (illustrated in Figure 5), from a community of volunteers to host devices or software and a community of researchers to conduct experiments, to a set of regulatory agencies and policy makers willing to use the measurement

[1]Using a greedy set-cover analysis of peering data, we identified a minimal set of 34 ASNs that jointly cover all 77 African IXPs [10, 44, 60]

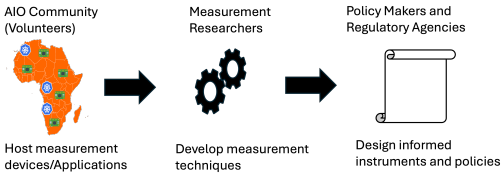


Figure 5: The various stakeholders involved in the African Internet Observatory initiative.

results to make more informed decisions. Next, we discuss our experience working with these stakeholder groups and plan on doing so to engender a more fruitful relationship going forward.

Incentives for community volunteers: Ideally, we would reuse the infrastructure created by existing initiatives, for example, the ITU's Giga project [29], to support our measurements. However, in our conversations, their device setup is limited, and additional equipment is required. Instead, we plan to build our own deployment and incentivize community volunteers using a model similar to Bismark [69]. The group running Bismark used payments of monthly Internet bills to grow their deployment. We intend to start by engaging local operators and administrators at various NOG events and then work with volunteers from ICANN [39] and ISOC [42]. A key goal is to maintain sustained community participation through quarterly virtual town halls. We envision that these town halls and our continued participation in local NOGs (e.g., South Africa's ZANOG [73], Kenya's KeNOG [46]) and continental peering forums (e.g., AFPIF [2]) will further strengthen and grow the community.

Researchers and Measurement Analysis: The easier stakeholder to engage with, in our experience over the past years, has been the measurement researcher, both in academia and industry. Many of them already have rich research areas that analyze critical infrastructure components (subsea cables [51, 52], IXP [26, 30, 58], ANYCAST [35, 36], and general wide area connectivity [27, 52]) and are exploring work in the global south. Many of these researchers have already expressed interest in using data collected by our infrastructure or conducting joint experiments between our infrastructure and theirs.

Engaging with Policy Makers and Regulator Agencies: Our ultimate goal is to transform the internet ecosystem in Africa; to do this, we need regulatory agencies and policy makers to use the results of our analysis to make more informed decisions. Our initial approach to this, thus far, has ranged from engaging with them at the continental peering forums and continental conferences (e.g., AIS [1]). We plan to continue to do this. However, observations thus far have shown that these annual events are insufficient and that there is a need for more frequent engagement. To this end, our goal is to partner with non-profits (e.g., ICANN and ISOC) and multilateral state holders (e.g., World Bank, ITU), then focus on specific regions, e.g., Eastern Africa, to perform a series of localized events over the course of a year.

7.3 Preliminary Results

We have recruited a volunteer to host a Raspberry PI device and recently partnered with Upanzi Networks [14], which is expanding our efforts to a couple of locations (Senegal and Rwanda) in Africa; for instance, in Senegal, the probes span across six broadband service providers. In our experiment, traceroutes from a Kigali vantage point on ASN AS36924 detected 14 additional IXPs (IXPs with which the probe's providers peer) compared to RIPE Atlas approaches. We believe that further deployment on client mobile networks will further increase coverage and our ability to more thoroughly assess connectivity.

8 CONCLUSION

This paper revisits connectivity in Africa and illustrates that its young peering ecosystem continues to include routes that detour through Europe and that surprisingly key infrastructure components (e.g., local DNS resolvers) are often hosted remotely. The unique attributes of connectivity in Africa help explain why cable cuts have a significant impact, even given the significant legislative effort to localize key web services. Unfortunately, our analysis shows that recent efforts to enhance connectivity via monitoring and legislation fall short because of two key issues: First, our measurement methods do not target certain key components or are highly inaccurate. Second, existing infrastructure significantly under serves Africa limiting their applicability. Motivated by these shortcomings, we envision a research agenda that includes the design of a unique testbed, Internet measurement techniques, and a set of "what-if" simulators tailored to the realities of Africa's current ecosystem. We believe that this vision, if realized, will provide various stakeholders with a data-driven platform whose output they can use to discuss ways to meaningfully enrich the Africa's Internet ecosystem.

9 ACKNOWLEDGMENTS

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