THE AFRICAN TELECOMMUNICATIONS UNION
FINAL REPORT - IXPS ASSESSMENT IN AFRICA

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Full Meaning
Af-IX	African Internet Exchange Point Association (formerly AfNOG)
AfriNIC	African Network Information Centre
ANTIC	Agence Nationale des Technologies de l'Information et de la Communication (Cameroon)
ART	Agence de Régulation des Télécommunications (Cameroon)
ARTAC	African Regional Telecommunications Association of Central Africa
ATU	African Telecommunications Union
AU	Africa Union
BFIX	Burkina Faso Internet Exchange
BGP	Border Gateway Protocol
CDNs	Content Delivery Networks
CEMAC	Economic and Monetary Community of Central Africa
CRASA	Communications Regulators' Association of Southern Africa
EAC	East African Community
EACO	East African Communications Organization
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EG-IX	Egypt Internet Exchange
ICANN	Internet Corporation for Assigned Names and Numbers
ICT	Information and Communication Technology
IGOs	Intergovernmental Organizations
ISPs	Internet Service Providers
ISOC	Internet Society
IXPs	Internet Exchange Points
IXPN	Internet Exchange Point of Nigeria
KIXP	Kenya Internet Exchange Point
MDAs	Ministries, Departments and Agencies
M&E	Monitoring and Evaluation
MMLPAs	Multi-Lateral Peering Agreements
MNOs	Mobile Network Operators
NOGs	Network Operator Groups
NRAs	National Regulatory Authorities
NRENs	National Research and Education Networks
NSRC	Network Startup Resource Center
PoPs	Points of Presence
PPP	Public-Private Partnerships
RASCI	Responsible, Accountable, Supportive, Consulted, Informed (Matrix)
RECs	Regional Economic Communities
RIXPs	Regional Internet Exchange Points
SADC	Southern African Development Community
USF	Universal Service Fund

1 EXECUTIVE SUMMARY

1.1 Background

The Internet's global significance drives the need for its utilization across various regions. Technologies like Internet Exchange Points (IXPs) enhance the Internet ecosystem by connecting multiple networks, reducing latency, and improving bandwidth efficiency. Africa requires a robust IXP ecosystem to achieve digital sovereignty, lower costs, and foster a resilient local internet economy.

1.2 Purpose

The primary purpose of this report is to provide a comprehensive strategic assessment of the Internet Exchange Point (IXP) landscape across Africa. The assessment focuses on their current state, challenges, impacts on connectivity, stakeholder roles, and strategies for expansion and optimization, particularly in underserved areas. It serves as a data-driven guide for the African Telecommunications Union (ATU), member state regulators, and industry stakeholders to understand the current state, economic impact, and growth potential of the continent's internet infrastructure.

1.3 Approach

In order to conduct the assessment, a mixed-methods approach was deployed. This involved a quantitative survey via Google Forms targeting ATU member states, telecommunications operators, telecommunications operators' associations, ISPs, and IXPs. Qualitative interviews with key informants from the above population were also conducted, and secondary data analysis from reputable sources such as Af-IX. Using purposive sampling, the survey was conducted on 30 ATU members who were represented by either the ministries, regulators, telecommunications operatorships, or IXPs based on who the country's focal point appointed as a respondent.

1.4 Key Findings (Challenges and Opportunities)

As of mid-2025, there were approximately 57 operational IXPs across 36 African countries. Figure 5 below shows the current distribution of IXPS in Africa. South Africa, Kenya, Nigeria, and Egypt lead in IXP maturity and distribution. The operational models vary between non-profit, community-driven models (e.g., KIXP in Kenya), government-led initiatives (e.g., EG-IX in Egypt), and private sector-led models. Most IXPs are neutral, but neutrality enforcement remains inconsistent.

Region	Ministries	Regulators	IXPs	Telco Associations	Telcos and ISPs	Total Response	Unique Responses
East Africa	6	1	1	2	0	10	6
Southern Africa	6	0	1	0	0	7	6
West Africa	4	0	3	0	0	7	6

Central Africa	1	2	1	0	0	4	3
North Africa	0	1	1	0	0	2	1
Total	17	4	7	2	0	30	22

Table 1: Survey Responses

Out of the sample of 30 countries, there were 22 unique responses from the ATU member states as shown in table 1 above.

Larger ISPs, CDNs, and multinational telecom providers are active in peering, while smaller ISPs and local content providers face challenges due to lack of incentives and capacity. This results in uneven participation across regions. Countries often lack clear national broadband and peering policies, leading to weak implementation and bureaucratic inefficiencies.

The shortage of trained network engineers and outdated technical infrastructure further hampers the development of Internet Exchange Points (IXPs). Many IXPs depend on donor funding or inconsistent government budgets, affecting their sustainability. Additionally, the absence of disaggregated national policy data and limited funding information negatively impacts IXP growth and development.

Performance benchmarking for IXPs is often inadequate, with limited recording of metrics such as throughput and latency. Government support varies, with some actively promoting IXPs while others face regulatory challenges. Organizations like the African Union and ISOC provide technical guidance, but coordination remains fragmented, hindering effective capacity building.

1.5 Recommendations

This study outlines recommendations for the growth of African Internet Exchange Points (IXPs), highlighting the importance of infrastructure investment in fiber optic cables and data centers, alongside supportive policies.

Capacity building through training and awareness is essential for IXP development. The report advocates for Public-Private Partnerships to fund IXPs in underserved regions and suggests a standardized reporting framework for improved data collection.

Strategic national IXP policies involving ISPs and CDNs are necessary, along with regional centers for landlocked countries. Enhancements in performance, cybersecurity, and governance are crucial, despite existing challenges in documentation and mapping.

1.6 Call To Action

High Priority (0–2 years): Enact clear national IXP policies, launch targeted capacity-building programs for IXPs engineers, and establish 3-5 new IXPs in priority underserved nations. Lead: National Regulators, ATU, Af-IX.

Medium Term (3–5 years): Develop 2-3 Regional IXPs (RIXPs) anchored by RECs like ECOWAS and SADC to reduce cross-border costs, and drive aggressive CDN localization campaigns. Lead: RECs, IXP Operators, Private Sector.

Long Term (5–10 years): Achieve full continental IXP interconnectivity and integrate IXPs into national cybersecurity frameworks, positioning Africa as a global peering hub. Lead: AU, ATU, All RECs.

1.7 Conclusion

Developing IXPs is crucial for Africa's economic future and digital resilience. We urge regulators to implement supportive policies, prioritize IXP infrastructure, and encourage ISPs to invest in local exchange points for inclusive digital growth.

2 INTRODUCTION

Internet Exchange Points (IXPs) emerged globally in the 1990s to facilitate local traffic exchange and reduce dependency on international transit links that were costly and with high latencies experienced via satellite connectivity. In Africa, IXPs began appearing in the late 1990s with South Africa launching JINX and CINX, with the Kenya Internet Exchange Point (KIXP), launched in 2001, serving as a pioneering example. Since 2010, the number of IXPs in Africa has tripled, driven by submarine cable landings, the rise of carrier-neutral data centers, increased internet demand, and policy advocacy by organizations such as the Internet Society, Af-IX, and regional regulatory associations such EACO, CRASA and WATRA.

Internet Exchange Points (IXPs) in Africa contribute to the reduction of transit costs and the enhancement of data speed, thereby reducing operational expenses for ISPs and end users. Additionally, they enhance the user experience for cloud services and video conferencing applications. IXPs assist Africa in the development of self-sufficient internet ecosystems, the maintenance of traffic within national borders, and the reduction of network susceptibility to international disruptions. It is essential to have a robust IXP ecosystem in order to address the digital divide in underserved areas, innovate, and implement broadband policies.

This report provides a detailed and comprehensive current state analysis of Internet Exchange Points (IXPs) in Africa, drawing on available data and identifying critical gaps for further research and makes recommendations for stakeholders on how to scale the number and capabilities of IXPs in Africa. It is also designed to support strategic planning, stakeholder engagement, and the formulation of targeted interventions to enhance internet infrastructure across the continent. This report is structured around the following six objectives related to the growth, distribution, performance, and challenges of IXPs in Africa and provides an initial baseline for assessment.

1. To assess the current state of IXPs in Africa, including the number, geographic distribution, operational models, and levels of participation.
2. To identify the key challenges and barriers to the establishment and growth of IXPs in Africa, such as regulatory frameworks, technical capacities, and funding mechanisms.
3. To evaluate the impact of IXPs on internet connectivity, network performance, and cost savings for internet service providers (ISPs) and end-users.
4. To analyze the role of various stakeholders, including governments, regional bodies, and the private sector, in the development and sustainability of IXPs.
5. To develop recommendations and actionable strategies to support the expansion, enhancement, and optimization of IXPs in Africa, tailored to the specific needs and contexts of different regions.
6. To provide guidance on the establishment of new IXPs in underserved areas and the strengthening of existing IXPs to improve their resilience and effectiveness.

The current state of the IXPs in Africa was mapped using Af-IX secondary data and quantitative surveys while the key challenges and barriers to establishment and growth of IXPs were

identified by semi-structured interviews with at 25-member states. IXPs impact on Internet connectivity in Africa was assessed utilizing performance indicators from ISOC, Af-IX and participating ISPs. Lastly, the analysis of the role of key stakeholders was assessed by stakeholder mapping and regulatory feedback.

3 LITERATURE REVIEW

3.1 Empirical Studies

3.1.1 Global IXP Landscape

A study done by Yamba et al (2022) found that since the 2000s, Europe had the world's highest IXP traffic and with 278 active IXPs. Africa as a region had the lowest number of IXPs. The objective of their study was to compile a comprehensive inventory of active IXPs in Africa. Their findings demonstrated that Africa had a mere 52 operational IXPs. The other objective of their study was to conduct a comparative analysis of African IXPs with a large IXP from Europe. The analysis demonstrated that the majority of African IXPs were unable to sustain local traffic and that Africa had not achieved the same level of success in operating IXPs as Europe. Their study concluded that the success of the IXPs on the continent could be achieved through the implementation of government policies and certain African IXP management techniques.

3.1.2 African IXP Landscape

In another study by Kende (2021) supported by ISOC, three phases of IXP development were identified, which are determined by the level of localized traffic and are influenced by the connections between and among content providers and Internet service providers (ISPs). The study demonstrated that Kenya and Nigeria had transitioned from the brink of Stage 2, with 30% local traffic in 2012, to the brink of Stage 3, with 70% local traffic in 2020. The study's evaluation demonstrated that South Africa has the most advanced Internet ecosystem in Africa, with an impressive 80% of localized traffic. Kenya and Nigeria are the next most developed countries in Africa with IXPs.

The study's findings also indicate that Kenya, Nigeria, and South Africa share a common characteristic of having at least 50 members in their largest Internet Exchange Providers (IXPs). This indicates a diverse network mix, with limited access networks being ISPs or MNOs. A positive correlation was found between the number of members and traffic flow, indicating the benefits of more connected networks. Since 2010, the number of IXPs in Africa has tripled, with over half of the countries having an IXP and six having multiple ones. Twenty IXPs are non-profits, with 14 having one node, nine having two or more, six in the same city, three in multiple cities, 16 in carrier-neutral data centers, and eight using MMLPAs. The community should set a new goal for the coming decade, including proven membership enablers, to continue positively influencing the African IXP ecosystem.

3.1.3 Technical Readiness and Performance Benefits

Reduced latency of upto 70% which enables faster speeds in countries with active IXPs is one of the most significant benefits of IXPs. Without an IXP, a user in Nairobi trying to access a website hosted by an ISP also in Nairobi might have their data travel thousands of miles to a peering point in London or Amsterdam and back. With an IXP, that traffic stays local. This dramatically reduces round-trip delays (latency). For instance, after the Kenya Internet Exchange Point (KIXP) launched, latency between ISPs in Nairobi reportedly dropped from over 500 milliseconds (ms) to under 20 ms (Kende & Hurpy, 2012).This directly translates to:

- Faster website loading due to the fact that traffic stays within borders, improving user experience for local websites and services as a result of route optimization.
- Smoother streaming of video and audio content without buffering.
- Improved performance for real-time applications like video conferencing, online gaming, and Voice over IP (VoIP).
- More responsive cloud services and online transactions.
- Local traffic exchange increases (up to 80%), leading to better user experience.

IXPs create alternative, local routes for internet traffic. This is crucial for network stability. If an international submarine cable is cut (a common occurrence impacting African connectivity), local traffic can continue to flow unimpeded through the IXP, significantly improving the resilience of national internet infrastructure. Countries with robust IXP ecosystems demonstrate greater continuity of service during such outages contribute to improvement on bandwidth efficiency as domestic traffic remains local.

By bypassing expensive international transit providers for local traffic, IXPs free up international bandwidth for truly international communication. This allows networks to handle larger volumes of local traffic with less congestion. Finally, IXPs improve network resilience due to reduced dependence on international routes.

3.1.4 Economic Incentives and Cost Savings Impact

Reduced costs of bandwidth is the main economic reason for adoption and setting up of IXPs. Previously, ISPs had to pay international transit providers for every bit of data that could have been traded locally. By exchanging traffic directly at an IXP, they save a lot of money. ISPs have been able to offer reasonable prices since transit costs have gone down by 30–60%, according to the data collected for this study (Africa Data Centres, 2021).

In Kenya, for example, an IXP port might cost US0.45 per month per Mbps for a 1Gbps port. This is a lot less than international IP transit, which could cost over US25 per Mbps for the same capacity. It is thought that KIXP alone saves its users millions of dollars a year on international calls (Africa Data Centres, 2021). The realized cost savings on international transit capacity hence reduced operating costs allow ISPs to offer more competitive pricing, fostering increased adoption and making internet access more accessible to a wider population.

3.1.5 Technical Readiness and Capacity and IXP Success in Africa

Research reveals that technical capacity is a critical determinant of IXP sustainability and performance. A shortage of trained network engineers and IXP operators is an existential challenge to the growth of the internet ecosystem. Capacity improvements, such as digital skills training and technical instruction for personnel, can significantly enhance performance. Empirical data indicates a correlation between the effective development and operation of Internet Exchange Points (IXPs) across Africa and initiatives like the African Union's AXIS project and ISOC training programs, which emphasize Border Gateway Protocol (BGP) technology.

A study by Yamba et al. (2022) concluded that African IXP success is directly achievable through specific management techniques and the implementation of robust technical protocols. Success hinges on local technical expertise to operate complex BGP/routing and on reliable infrastructure (power, fiber). A lack of skilled engineers is a primary cause of failure or stagnation (Kende & Hurpy, 2012; Schumann & Kende, 2013).

3.1.6 Technical Readiness and Capacity, Policy and Regulation

The relationship between technical readiness and regulation often centers on how policies facilitate skill development and standard-setting. Effective IXP development requires national policies that specifically address the need for training, digital skilling, and capacity building for IXP personnel.

Regional regulator groups, such as WATRA, EACO and CRASA, have empirically fostered growth by training field personnel and coordinating technical work across regional borders. Supportive policy (e.g., cheap, reliable national backhaul) enables technical access. Conversely, technical advocacy from communities' shapes informed policy and the lack of either creates a bottleneck (Fanou et al., 2017; Kende, 2021).

3.1.7 Community Trust and IXP Success in Africa

Community-driven models are frequently cited as the most resilient and successful IXP frameworks in Africa. Numerous successful IXPs are driven by private sector entities working in close collaboration with Network Operator Groups (NOGs) and community networks. The Internet Exchange – South Africa (INX-ZA) and Kenya Internet Exchange Point (KIXP) are a primary empirical example of a non-profit, community-driven model that achieved self-sustainability and high participation.

Research by Ooi (2025) indicates that community-driven initiatives are particularly crucial for infrastructure development in regions with limited capital. Neutral, multi-stakeholder governance (ISPs, gov't, academia) builds the trust necessary for competitors to peer. IXPs failing to ensure neutrality see low participation (ISOC, 2014; Ooi, 2025).

3.1.8 Economic Incentives and IXP Success in Africa

Economic factors are arguably the most crucial determinants in the establishment and proliferation of Internet Exchange Points (IXPs). The principal economic motivation behind the creation of an IXP is the mitigation of bandwidth expenses, given that Internet Service Providers (ISPs) can circumvent the high costs associated with international IP transit for domestic traffic. Empirical data derived from ISPs suggests that transit expenditures generally diminish by 30–60% following their integration into a local IXP.

An ISOC study (2020) estimated that local traffic exchange saves Nigeria approximately USD 40 million annually and Kenya approximately USD 6 million. South Africa, with the most advanced ecosystem, has achieved 80% localized traffic. The direct driver. ISPs peer to reduce costly international transit. Documented savings of 30-60% provide the core business case for IXP establishment and participation (Africa Data Centres, 2021; Kende & Hurpy, 2012).

3.1.9 Community Trust, Policy, and Regulation

Regulatory frameworks often help establish trust between different groups. For this to function, the laws need to be straightforward and clear, and the processes must be transparent. Also, independent parties should monitor these processes to maintain fairness and build confidence among competing Internet Service Providers (ISPs). Regional regulatory associations like ARTAC play a vital role in ensuring interoperability and harmonizing technologies, which builds the trust necessary for cross-border peering.

A trusted community can co-develop effective policy. Conversely, transparent, participatory regulation fosters trust. Opaque or imposed regulations undermine community buy-in (Nyirenda-Jere & Biru, 2015).

3.1.10 Economic Incentives and Policy and Regulation

Regulation can either amplify or dampen economic incentives for peering. Research suggests that regulators can use USFs to support IXP development in underprivileged areas, leveraging the IXP's role in reducing the digital divide through improved affordability.

Conversely, regulatory hurdles, lack of awareness of economic benefits, and high taxes can discourage participation and hinder the growth of the internet economy. Policy can create incentives (tax breaks, use of Universal Service Funds) or remove barriers (high import duties on gear). Poor regulation (e.g., incumbent favoritism) can destroy the business case (Kende, 2021).

3.1.11 Policy and Regulation and IXP Success in Africa

Supportive policy environments are strongly correlated with the maturity and success of IXPs. The implementation of government policies is a primary driver for the inventory of successful IXPs on the continent. The absence of clear national broadband and peering policies leads to weak implementation and bureaucratic inefficiencies that stifle IXP growth.

A lack of clear legal frameworks for IXPs specifically hinders the broader growth of the national internet economy; the foundational enabler. Clear policies recognizing IXPs as critical infrastructure and ensuring operational neutrality are the strongest predictors of a country's IXP maturity (Kende, 2021; Nyirenda-Jere & Biru, 2015).

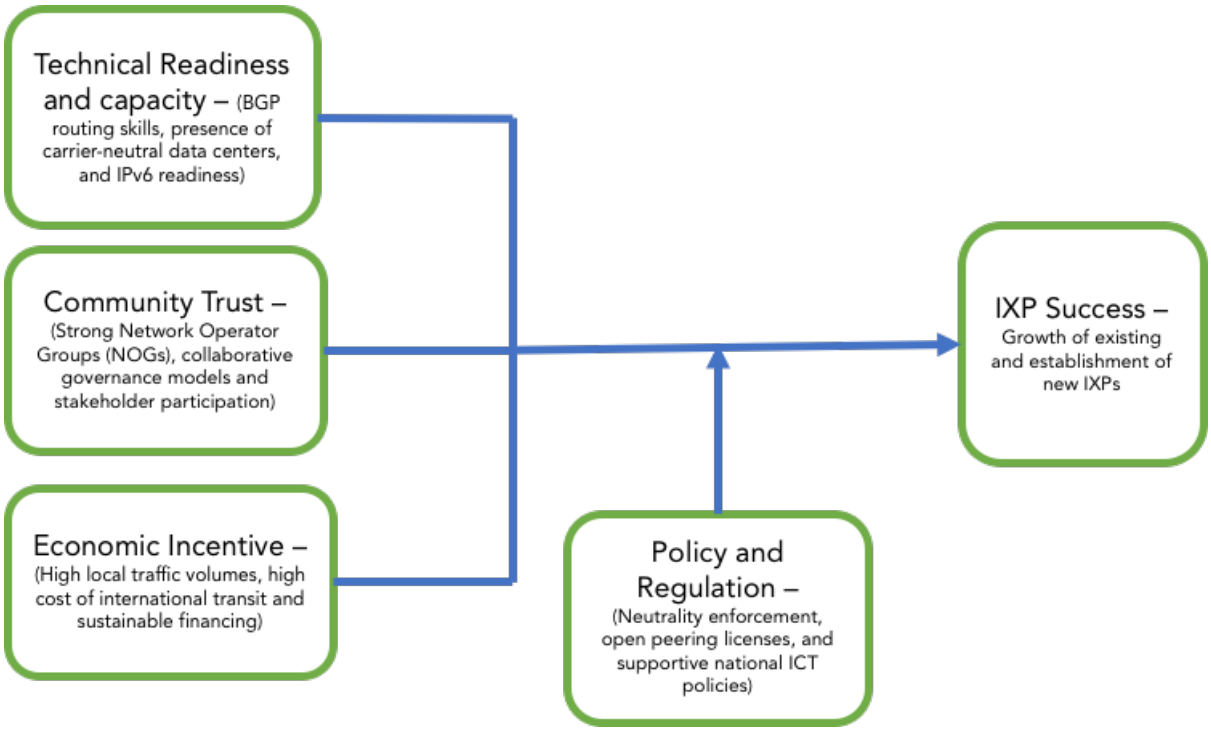

Figure 1: Drivers of IXP Success

4 METHODOLOGY

4.1 Research Design

A mixed-methods approach was employed to conduct this study, which included quantitative surveys, desk research, and qualitative interviews with key informants.

4.1.1 Data Collection Tools

The below data collection instruments have been used for the purpose of collecting data from respondents for the study.

- Survey Instrument: Likert-scale questionnaire on Google Forms with 38 items tailored to stakeholders including ISPs, IGOs and IXPs.
- Key Informant Interviews: Semi-structured interviews using Microsoft teams, zoom and in-person meetings with representatives from ICT ministries of members states, regulators, ISPs, and regional bodies.
- Secondary Data Review: Analysis of reports from Af-IX IXP portal, Internet Society, and other credible sources.

4.1.2 Population and Sample Size

The population of the study is made up of the fifty-two (52) African Telecommunication Union's (ATU) member states. Purposive sampling was used to come up with a sample size of 30-member states. Out of the 30-member states sample size 30-member states responded. Purposive sampling was selected to ensure representation across geographic regions, levels of IXP maturity, and regulatory environments. Thirty (30) ATU member states were selected based on IXP presence, data availability, and stakeholder accessibility. Therefore, the sample size was derived from at least 50% of the ATU members states from EAC, ECOWAS, SADC, CA, NA and the Island Nations.

4.1.3 Validity and Reliability of Data

To ascertain the veracity and reliability of the African Telecommunications Union (ATU) IXP Assessment's conclusions, a robust Data Quality Assurance (DQA) framework was implemented. This framework encompassed procedures for data validation, cleaning, and verification. Crucial validation stages involved focal point verification via ATU member representatives, methodological triangulation employing both quantitative and qualitative data, and stakeholder participation assessments with regional entities such as Af-IX.

Data cleaning protocols were employed to rectify inconsistencies and standardize responses, concurrently addressing the influence of a 26.7% non-response rate (22 out of 30 responses) by concentrating on regional trends.

The verification process for secondary data entailed cross-referencing with resources like Af-IX and external investigations, including the Yamba et al. (2022) inventory and Kende's (2021) stage-based development analysis, to facilitate empirical comparison, alongside periodic reviews of historical data.

Reliability and validity were ensured through purposive sampling of thirty-member states and the implementation of a structured questionnaire to maintain consistent metrics. This report recommends the establishment of a standardized reporting framework and a centralized data repository to improve automated data collection for future evaluations.

4.1.4 Limitations

The following limitations on the data collection process was experienced during the study

- Inconsistent data availability in certain countries
- Non-response or limited participation from some key stakeholders
- Limited documentation on operational and performance data of some IXPs

5 DATA COLLECTION

5.1 Introductory activities:

A kickoff meeting was held between the consultant and the customer in which the consultant explained their understanding of the project and the customer was able to provide clarifications on the scope and objectives of the project. A RASCI matrix and schedule for updates were developed. The customer consented to provide focal points from all member states sates of ATU for contacting. These focal points, IXP contacts and ISPs were identified as key participants and respondents to the survey. Interview questions were developed for qualitative survey and Likert scale questions were developed for quantitative survey. Additional secondary data was identified as a source of data to be collected. The secondary data was to be collected from the Af-IX portal. The questionnaires were also shared with the leaders of Af-IX formally AfNOG.

5.2 Information gathering:

Interview questions were sent to over 30-member states through the identified focal points by the client. Initially the customer had identified the focal points through direct contact with member states. In addition, the customer facilitated contact to the focal point during a member states meeting in Dakar, Senegal where over 23-member states were present. The qualitative questionnaire was shared with the present member states. An online meeting with the focal points was also conducted to provide support to the focal pints on the process of responding to the questions and also asked them to share the quantitative questions with the ISPs. The focal points were also asked to share the qualitative survey questions with the IXPs.

5.3 Identification of participants:

All the member states of ATU were identified as participants. In addition, the other participants included IXPs and ISPs from the ATU member states. The other participants are the association of IXPs under the Af-IX.

5.4 Focal Point meeting:

A focal point virtual meeting was conducted where the consultant took the focal points through the process of responding to the questionnaire and how to send to the IXPs.

5.5 Af-IX meeting:

A meeting with the Af-IX officials was conducted in order to have them respond to the quantitative questionnaire and also support to disseminate the quantitative questionnaire to their membership who constitute the ISPs.

5.6 Participation

22 out of 30 countries which received the questionnaire and the interview questions responded. 17 Ministries, 7 IXPs, 2 telecommunications associations and 4 regulators

participated in the survey by responding to the questionnaire and the interview with 10 from East Africa, 7 from Southern Africa, 7 from West Africa 4 from Central Africa and 2 from North Africa. In total 25 questionnaires were completed and 5 interviews were conducted. In some countries the regulators also operate the IXPs and in other countries IXPs are operated independently. Several identified focal points were unavailable to respond to the survey despite numerous reminders by the consultant and ATU. There were delayed responses for those who were able to fill out the questionnaire and respond to the interview questions many due to unavailability of the respondents and clashing schedules. This had a negative impact on the overall time it took to complete the study.

6 FINDINGS AND ANALYSES

This study's findings indicate that there're 57 IXPs in 36 countries and 48 cities as per the information available on the Af-IX portal. South Africa (e.g., JINX, CINX, DINX, NAPAfrica), Kenya (KIXP, LINX Nairobi, KIXP Mombasa), Tanzania (TIX – Dar es Salaam MIXP – Mwanza AIXP – Arusha ZIXP – Zanzibar DIXP – Dodoma MIXP – Mbeya), and DRC (KINIX – Kinshasa, LUBIX – Lubumbashi, GOMIX – Goma), and Nigeria (IXPN - Lagos, Abuja, Kano, Port Harcourt and Warri) are leading the continent in the number of IXPs and peering networks. These countries also show higher levels of local content hosting.

However, underserved regions like Central Africa, West Africa, and Island nations still lack adequate IXP coverage or low participation rates. Some IXPs are transitioning to function as regional interconnection points, decreasing their reliance on international hubs for intra-African traffic.

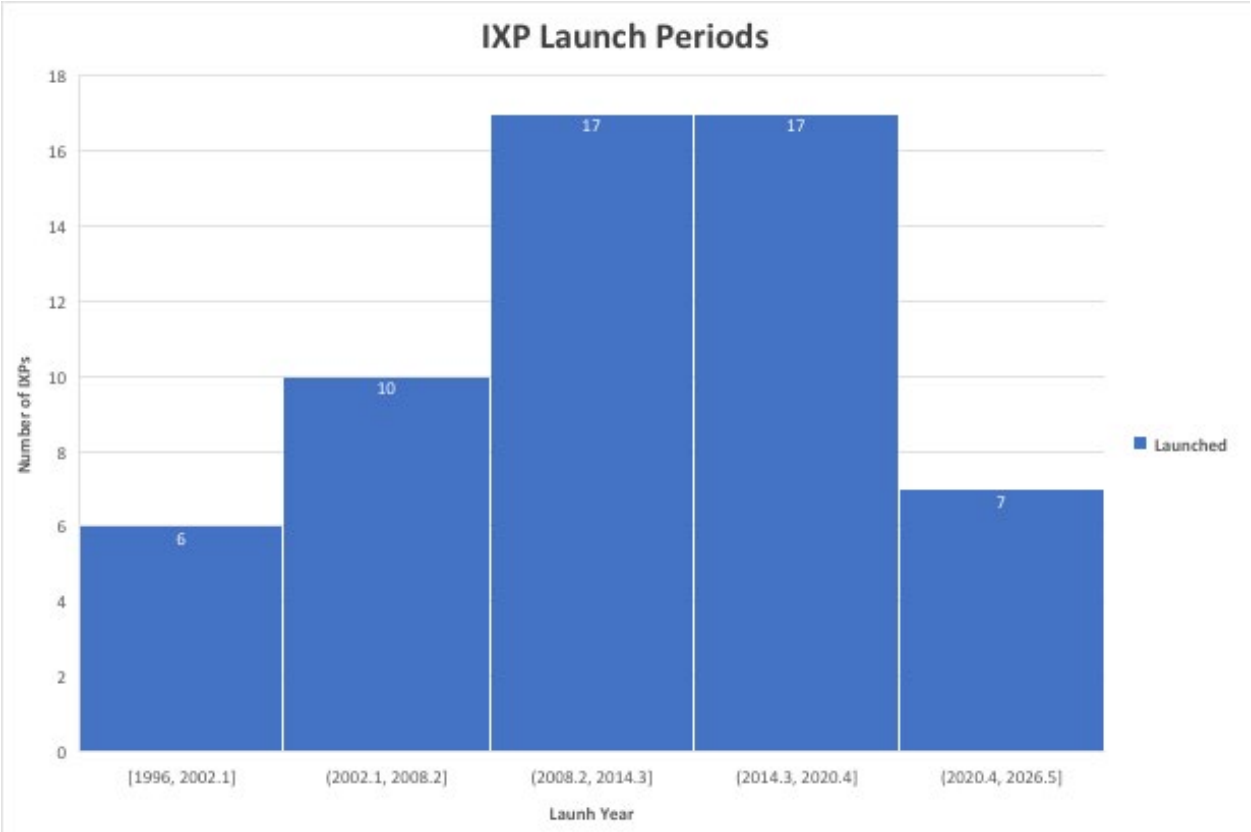

Figure 2: IXPs Launch Periods

This study, using the data available of the Af-IX portal, found that on two (2) IXPs in South Africa (JINX and CINX) were launched before the year 2000. Fourteen IXPs were established between 2000 and 2010, while 34 IXPs were established between 2010 and 2020. Only 7 IXPs have been established so far in this decade as indicated in Figure 2 above.

According to the responses received in this study operational models for African IXPs include non-profit industry associations, commercial models, and hybrid/subsidized models. Some IXPs may begin with government or donor subsidies to achieve self-sustainability over time. Community-driven IXPs are crucial for infrastructure development in regions with limited capital(Ooi, 2025).
Growth and participation in African IXPs have shown significant increase, with a survey revealing a total of 563 participants in 2015 (Spencer, 2015). However, many IXPs still operate with low numbers of peers, restricting their full impact. A positive trend is the increasing peering of major global content providers at African IXPs.

Analyses of the responses also indicates that the growth of Internet Exchange Points (IXPs) in Africa faces numerous obstacles, including inconsistent regulatory frameworks, lack of clear policies, resistance from incumbents, and cross-border issues. Technical capabilities, such as the skills gap and infrastructure gaps, are also significant challenges. The high cost of last-mile fiber or microwave connections and transport costs can discourage potential participants, especially smaller ISPs.

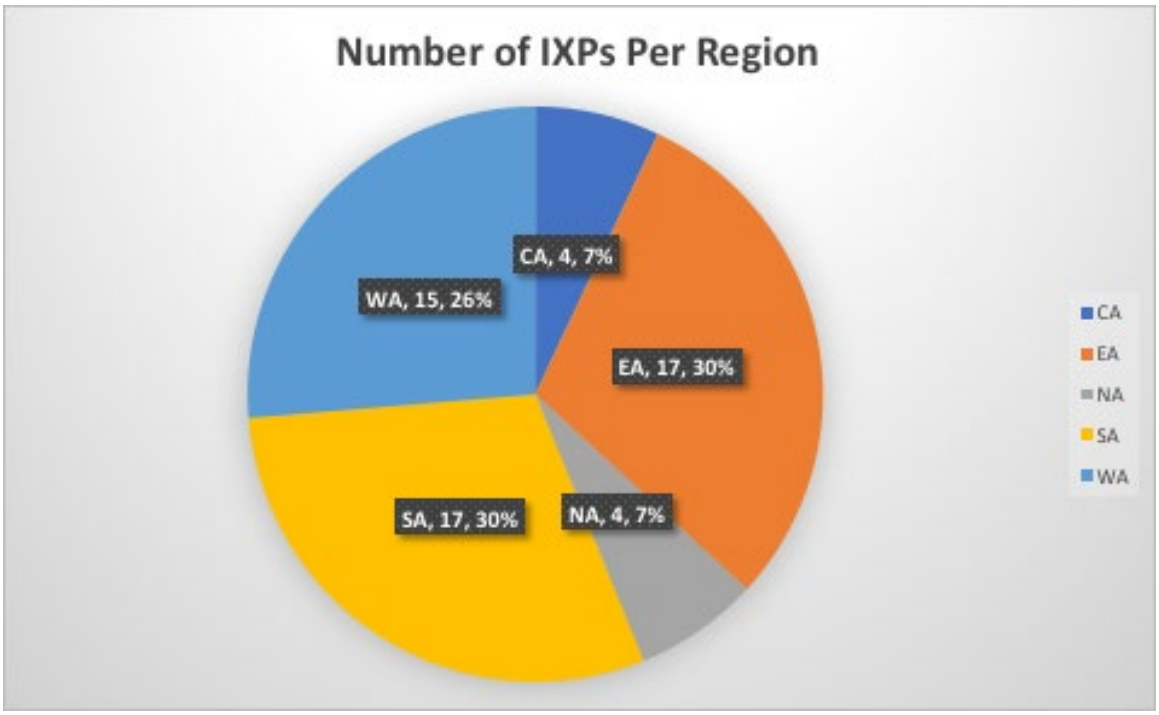

Figure 3:Percentage Regional Distribution of IXPs

Key: CA -Central Africa, EA – East Africa, NA – North Africa, SA – Southern Africa, WA – West Africa.

Figure 3 above shows that Eastern and Southern Africa have more IXPs account for 60% of all established IXPs followed by West Africa region account for 26%. Central Africa and North Africa (NA) has the least number of IXPs at 4 each. However, some countries such as Morocco and Algeria from North Africa are not captured on the Af-IX portal.

Sustainability is a key challenge for many IXPs, with securing sustainable funding beyond initial grants or donations being a persistent issue, however a significant number of respondents including from Uganda, Ghana, Namibia, Nigeria and DRC indicate that their sustainability through members' contributions and service payments from participants. However, they indicate that, initial investment in equipment, data center space, and skilled personnel can be substantial, leading to high start-up costs.

A review of extant literature indicates that low traffic levels and a lack of local content can diminish the incentive for local peering, as a significant portion of African internet traffic originates or terminates outside the continent. Content hosting portals, such as Google often hosting content abroad, undermine the advantages of local IXPs. South Sudan, for instance, mentioned that trust and collaboration are also crucial when there are competitive concerns, as ISPs may be hesitant to peer with competitors despite their advantages. Establishing a collaborative community and trust can be time-consuming, but it is essential for the growth of IXPs in Africa.

Most of the respondents in this study revealed that Internet Exchange Points (IXPs) in Africa improve connectivity and performance by enabling local traffic exchange, reducing latency, and enhancing resilience. The Kenyan ISP KIXP for example reduced Nairobi ISP latency from 200 ms to 20 ms, resulting in faster browsing, streaming, cloud, and VoIP performance. IXPs also reduce dependency on international underwater cables, allowing them to be more resilient to subsea cable cuts. ISPs can save money by exchanging traffic locally at IXPs, reducing international transit costs.

The study also found that ISPs pass on cost reductions to consumers, improving end-user experiences and supporting e-commerce, e-learning, and e-health. IXPs promote local content growth, promoting local website, application, and digital service development and deployment.

Countries such as Kingdom of Eswatini, Congo Brazzaville, Namibia, Mozambique among other confirmed that the growth of Internet Exchange Platforms (IXPs) in Africa is influenced by various groups, including states, governments, regional bodies, private sector players, and the technical community and civil society. State-based policies promote open peering, guarantee openness, and simplify licensing. However, research suggests that governments need to collaborate with IXPs and the internet community to address participation issues. Evidence from the respondents show that regional bodies like the African Union, ECOWAS, EAC, and SADC are essential for connecting countries across borders and ensuring rules are consistent for easier regional trade. Some like SADC and EAC have facilitated this through CRASA and EACO respectively.

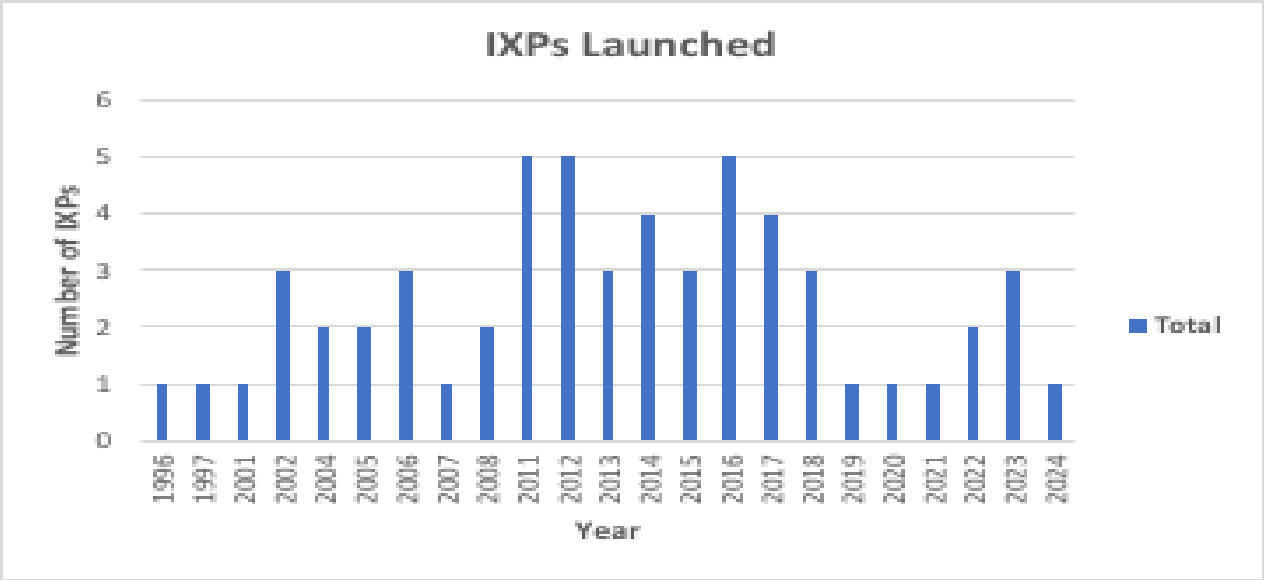

Figure 4:Number of IXPs Established Per Year

The figure 3 above indicates that 2011, 2012 and 2016 had the highest number of IXPs that were established in Africa in a single year, equaling 5 apiece. This is followed by 2014 and 2017. The available data does not indicate why this is case hence the researchers will continue to investigate why these events took place from the key informants. The following countries launched IXPs in 2011; Lesotho, Nigeria, South Africa, Sudan and Tunisia. In 2012, it was Democratic Republic of Congo, Nigeria, South Africa and 2016 Cameroon, Djibouti, Madagascar, Tanzania launched new IXPs.

The above findings indicate that the "digital divide" is not just between Africa and the world, but between African regions; Central Africa requires urgent prioritization for infrastructure development.

6.1 Impact of IXPs on Connectivity, Performance, and Cost

Internet Exchange Points (IXPs) play a transformative role in improving internet connectivity, network performance, and reducing costs across Africa. By facilitating the direct exchange of internet traffic between local networks, IXPs eliminate the need to route data internationally, even for local communication. Below is a breakdown of the impact of IXPs (ISOC, 2021).

Key informants in this study indicate that the quality of service has significantly improved, particularly in delivering local content and accessing CDN content with lower delay. ISPs can save 50% on costs by sending most content through sharing instead of expensive transit links, as most local content is served locally. This has resulted in lower connectivity costs for most end users, as IXPs allow 99% of local traffic to stay local, and big CDN operators host their own content locally.

One of the countries in East African region indicates that they are receiving quick and reliable service, with ISPs earning $4 a month for every 1Mbps they send, resulting in savings of around $6.7 million over a year. Internet latency has also decreased due to

IXPs, allowing operators' and businesses' networks to connect nearby. However, the cost savings have become less of a selling point for IXPs as the price of IP transit has dropped quickly in the area.

International content providers use caches and local IXPs to send their material to people around the world, making the internet less latency-prone. Local traffic is now handled well without having to rely on cross-border routes, saving about 25% on costs. ISPs are talking with each other, controlling local traffic within the country and some international material being cached locally, which cuts down on outbound (cross-border) traffic.

An ISOC study of Nigeria and Kenya in 2020 estimated that the cost savings from exchanging traffic locally rather than using expensive international transit Nigeria was around USD 40 million USD a year and around US$ 6 million a year for Kenya. An IXP that is not fully built yet may save up to 25% on service costs. IXPs have helped make the service available in the two regions, offering local caches and encouraging hosting in one's own country (Kende, 2020).

IXPs have made networks in the two countries more reliable and efficient by putting the exchange of local traffic in one place, reducing the chances of problems with foreign transit and making the best use of bandwidth. This not only makes the network more reliable but also gives people more stable and faster connections.

Internet Exchange Points (IXPs) enhance internet connectivity in Africa by enabling direct local traffic exchanges, resulting in cost reductions for Internet Service Providers (ISPs). In addition to these cost savings due to decreasing IP transit prices, IXPs also improve local traffic management.

6.2 Role of Stakeholders

In some countries such as Zimbabwe, the study found that their governments have consistently supported the creation of Internet Exchange Points (IXPs) through various initiatives, including the establishment of IXPs through the regulators. AFRINIC's supported the initiatives through supply of switching and routing equipment. In Rwanda for example, public and private institutions have collaborated to support the growth of IXPs, with groups like ISOC and Network Startup Resource Center (NSRC) playing a crucial role in their development.

National governments have made it easier for IXPs to be created, for example the first IXP in Republic of Congo was launched with the support of the Republic of Congo's government. The African Union Commission has also been involved in the AXIS project, providing training classes on setting up and running IXPs in the country. ISOC has also set up training classes for IXP members to improve their skills, particularly in Border Gateway Protocol (BGP) technology and Internet resource management.

In Africa, IXPs have grown significantly due to the work of regional regulator groups like EACO and CRASA. They have helped create policies, trained field personnel,

coordinated work across the region, and secured technical and financial partners. This has led to improved local connections, reduced internet access costs, and a stronger digital environment in Africa.

In Cameroon, IXPs have grown with government support, but certain decisions have hindered their success, such as the need to connect to the CAMPOST datacenter and the conditions set by CAMTEL. State institutions and the private sector often work together well in their regions. Regional regulatory associations like ARTAC play a vital role in the growth of IXPs in Africa, ensuring IXPs interoperability, data security, harmonizing technologies, and working with ICANN.

The growth of Internet Exchange Points (IXPs) in Africa has been facilitated by various strategies, including funding, transparency about infrastructure construction and sharing, making regulations easier to follow, and monitoring IXP projects. To improve IXPs, a simple set of rules and a clear process should be implemented, monitored by nonpartisan groups like ART and ANTIC.

Governments, content providers, and ISPs can work together better by joining projects and sharing information effectively. IXP expert staff must participate in training programs to build their skills before, during, and after the project setup. Independent players are what stakeholders want, and a CEMAC decision could speed up and harmonize the process in the Central African sub-region.

In Uganda, the government and business sector have worked together well, with donations from organizations like the Internet Society (ISOC) and Ndejje University of Science and Technology (NUST) and other private organizations. However, there is a lack of collaboration between public and private stakeholders, as seen in South Sudan.

The government of Burkina Faso has provided equipment and datacenter spaces, which has greatly helped the development of BFIX. However, there is a lack of clear IXP management provisions, and national administrations have not taken significant actions to facilitate or hinder the development of IXPs. Regional economic communities, such as the African Union (AU), ECOWAS, SADC, and the Economic Community of Central African States (ECCAS), do not play an active or direct role in promoting the development of IXPs in the region.

The growth of IXPs in Africa requires a simple set of rules, clear processes, and collaboration between government, content providers, and ISPs. However, more collaboration and support from regional associations of regulators like EACO, ARTAC and CRASA are needed to ensure the success of IXPs in the region.

6.3 Patterns and Trends

Distinct trends in the geographic distribution, regulatory frameworks, and operational models of Internet Exchange Points (IXPs) in Africa are revealed by a thorough pattern analysis. It is essential to comprehend these trends in order to create expansion and sustainability plans that work.

6.3.1 Geographic Trends

IXPs' geographic distribution in Africa is marked by both advancements and enduring inequalities.

6.3.1.1 New Hubs and Focus

East and South Africa are leading in number and maturity of IXPs for instance in Kenya there is KIXP and LINX Nairobi and South Africa has several sizable IXPs, including NAPAfrica, JINX, and CINX which are important regional centers. They draw a significant number of local and foreign participants, including significant Content Delivery Networks (CDNs) and hyperscale cloud providers, due to the high number of IXPs they host and the highest volumes of peer traffic (Kende, 2020).

In West Africa Nigeria (IXPN) has experienced impressive growth, establishing itself as a significant hub in West Africa. IXP ecosystems are also being actively developed in other West African nations (Kende, 2020).

A key observable characteristic of the presence of IXPs is that coastal nations which have easy access to submarine cable landing sites, have more IXPs in what is known as “coastal bias”. Hence there’s a correlation between coastal nations and the number of IXPs they have. Similarly, there’s a correlation between the size of African cities in population and the existence of IXPs in these cities. IXP development is naturally drawn to large cities with high population densities and economic activity.

6.3.1.2 Underprivileged Areas

This study and other recent studies indicate that Island nations and Central Africa typically have lower participation rates, fewer IXPs, and a greater reliance on international transit for even local traffic. This can be attributed to factors like lower population density, less developed terrestrial infrastructure, and sometimes less conducive regulatory environments (Fanou et al., 2017).

6.3.1.3 Inland Challenges

Because national fiber backhaul is expensive, inland regions find it difficult to connect to the major IXPs, even in nations with IXPs contributing to the inland challenges.

6.3.1.4 IXP Location Influencing Factors

To be successful in Internet Exchange Platforms (IXPs), a critical mass of peering content providers and active ISPs is required, often in large commercial hubs. Infrastructure availability, including reliable power, carrier-neutral data centers, and established fiber optic networks, is crucial. Government policies that promote local interconnection and a supportive business environment are also crucial. A committed local community, often led by an ISP Association or technical community, is also essential (Kende & Hurpy, 2012).

6.3.2 Patterns of Regulation

The success of IXPs in Africa is also influenced by the regulatory environment, which can range from supportive to restrictive. African regulators are increasingly acknowledging IXPs as vital national infrastructure, and best practices emphasize impartial regulatory frameworks to promote widespread involvement and trust. Policies that recognize IXPs as vital infrastructure are becoming more prevalent.

The development of Internet Exchange Points (IXPs) faces several challenges, including unnecessary licensing, lack of uniformity in licensing requirements across borders, and interconnection requirements. Governments are increasingly considering tax incentives to encourage investment, such as tax holidays and lower equipment taxes. Some nations are also considering using Universal Service Funds (USF) to support IXP development in underprivileged areas. Content localization policies also benefit IXPs by promoting local content hosting. However, dominant incumbent telecom operators may stifle IXP development in some markets, posing a threat to their revenue from international transit. To ensure equitable interconnection, regulatory bodies must be strong (Nyirenda-Jere & Biru, 2015).

Regulatory environments significantly impact Internet Exchange Points in Africa, with supportive frameworks needed to enhance participation and investment.

6.3.3 Patterns of Operations

African IXPs' operational models have also changed over time, mirroring the development of the internet ecosystem in various geographical regions. African Internet Service Providers (IXPs) have traditionally operated through non-profit organizations, such as ISP associations, academic/research institutions, and commercial data center operators. These models prioritize community benefit over profit, neutrality, and cost-sharing. However, as carrier-neutral data centers become more prevalent, some IXPs are now hosted and managed by commercial data center operators.

Hybrid models may begin with government or donor funding, gradually transitioning towards a more self-sustaining model. Most IXPs use Layer 2 (Ethernet-based) switching fabrics, while Layer 3 (IP-based) may be less common due to scalability and control concerns. Staffing and resource issues include volunteer-based operations, lack of full-time personnel, technical capacity shortages, and emphasis on best practices. International best practices, such as route servers, transparent peering guidelines, and public traffic data, are becoming more popular, but there are differences in application consistency. Value-added services are also being offered by established IXPs to attract more users and boost income (Schumann & Kende, 2013).

Region	Status	Strengths	Challenges
East Africa	Functional IXPs in Kenya, Uganda, Tanzania and Rwanda	Policy support, active NOGs	Limited cross-border interconnects

West Africa	Nigeria, Ghana lead	Large traffic volumes	Sparse national coverage
Southern Africa	South Africa dominant	Mature IXP ecosystem	Dominance can suppress regional IXPs
Central Africa	Underdeveloped	Emerging interest	Policy vacuum, infrastructure gaps
Northern Africa	Underdeveloped	Emerging interest	Policy vacuum, infrastructure gaps

Table 2: Regional patterns and trends

African IXPs are evolving from non-profit models to hybrid structures, increasingly hosted by commercial data centers, while adopting international best practices and offering value-added services to enhance sustainability and attract users.

7 OPERATIONAL STRENGTHS AND WEAKNESSES

Some of the findings of this study indicate that existing IXPs exhibit several operational strengths and weakness as summarized in table 3 below.

Strengths	Weaknesses
Existing IXPs facilitate CDN and cloud presence. Mature IXPs now attract global CDNs (Google, Meta, Akamai, Cloudfare), which further localizes content. (e.g. IXPN, NAPAfrica and KIXP)	Low awareness among smaller ISPs and operators. These has negatively impacted participation in IXPs by some ISPs which continue to use expensive international connectivity, (e.g. community networks in Kenya)
Strong collaboration in some regions which enables reginal conectivity across borders and reduces international bandwidth costs (e.g., KIXP, IXPN, SAIX).	Limited automation, poor monitoring, and outdated equipment. A critical lack of BGP and peering expertise persists in underserved markets.
Some countries have operational NOGs and training bodies that support technical capacity buidling for the IXPs. (e.g.SAFNOG, KeNOG, ngNOG)	Few IXPs operate on a cost-recovery or neutral basis (e.g. NAPAfrica)

Table 3: IXPs strengths and weaknesses

7.1 Challenges

This study reveals some of the key challenges affecting the growth of IXPs in Africa as infrastructure limitations for example lack of fiber connectivity in some areas. In some countries power outages is a challenge that make IXP services unavailable in some instances. Certain ISPs and telcos prefer only to peer with specific ISPs or telcos hence limiting participation. Funding through the participating members and government is limited in some member countries. Awareness and policy where regulatory hurdles or lack of awareness about IXP benefits is also a challenge to the growth of IXPs. Technical capacity of the personnel managing the IXPs is a key issue requiring for training, digital skilling and capacity building of IXP staff.

In some countries, there is a lack of a clear legal framework for Internet Exchange Points (IXPs), which can hinder the growth of the internet economy. The changing market can affect traffic optimization, and some providers may not show all their resources at IXPs to save money. Technology and structure concerns, such as data safety, are also a concern. Competitive ISPs in the retail market help IXPs grow by lowering service costs and improving service quality. However, infrastructure growth in rural areas is slowed down by concession companies controlling access. Cultural or faith barriers can also hinder operational partners' decisions. Legal boundaries, particularly regarding licenses, make it difficult to use new IXPs. High taxes and government overreach can also hinder the growth of the internet economy.

In addition to these challenges, there is a lack of investment cash, sufficient fiber optic links, expensive technology, and unreliable power. To build trust and share the market, ISPs should work together, but this is not always possible. The Internet Society's membership fees and support for tools and training are influenced by the growth of IXPs. Infrastructure issues and a lack of multi-stakeholder administration are also issues. Operators are legally uncertain due to the lack of a clear regulatory framework for IXPs. Despite these challenges, there is still a lack of funding and support for IXP establishment or operation within the country.

Therefore, the key challenges hindering the growth of Internet Exchange Points (IXPs) in Africa include infrastructure limitations, power outages, limited funding, regulatory hurdles, and insufficient technical capacity among personnel managing IXPs.

7.2 Opportunities for Scaling

Key informants of this study intimate that underserved areas are places where IXPs can grow by finding places that don't have the right facilities for them. Potential for new IXPs in places that aren't currently served opens new markets and partnerships by collaborating with NGOs, private companies, and governments.

7.3 Research data gaps

The survey identified key data gaps in the African Internet Exchange Points (IXPs) ecosystem, including scattered figures on new active IXPs, operational models, peering participants, traffic volumes, local content hosting percentages, regulatory barriers in some instances and skills gaps. It also identified data gaps in the financial models and sustainability assessments, factors hindering local content development, monetary savings for ISPs. There’s also limited causal link between IXP establishment and growth and data gaps in network performance improvements, inter-stakeholder collaboration mechanisms, case studies, private sector investment, regional body initiatives, and case studies of successful strategies.

The survey also highlighted the need for a consolidated repository of best practices and actionable playbooks for different IXP development scenarios, assessments of challenges faced by existing IXPs, and metrics for evaluating the effectiveness of an IXP beyond just traffic volume. A centralized repository of guidance documents, best practices, and success stories for IXP establishment and strengthening in the African context is also essential.

The survey also highlighted the need for standardized metrics for measuring network performance improvements attributed to IXPs across the continent, evaluating the impact of regional body initiatives on IXP development and cross-border peering, and assessing the effectiveness of specific recommendations and strategies implemented in different contexts. Additionally, UCC proposes that ATU establish a coordinated, periodic data-submission framework led by NRAs. Mapping existing national policies (such as Uganda’s peering policy) to continental KPIs would help measure progress and improve data completeness.

Lack of complete, real-time, and standardized data from all current IXPs in Africa is the main data gap across all goals. A lot of IXPs don't regularly put out thorough reports on things like traffic, the number of peers, or operational models.

In conclusion this survey reveals significant data gaps in Africa's Internet Exchange Points, emphasizing the need for standardized metrics, a centralized repository of best practices, and improved reporting for effective IXP development.

8 RECOMMENDATIONS

8.1 Scaling IXPs

There are several recommendations that this study has developed based on its findings. On infrastructure development IXPs, IXP associations and IXP membership need to invest in fiber optic cables and data center infrastructure, especially, to cover the unserved and the underserved regions on the continent of Africa.

a) Infrastructure Development: IXPs, IXP associations, and members should invest in fiber optic cables and data center infrastructure to serve unserved and underserved regions in Africa. Growth of local internet infrastructure requires changes like open access peering, low entry fees, and cost-effective operations.

b) Policy and Regulation: African countries need to develop supportive policies and regulatory frameworks for IXPs, encouraging ISPs to peer with national and regional IXPs, especially concerning data privacy and sovereignty in the context of AI and IoT. A standardized framework governed by impartial organizations is necessary for IXP development. Noteworthy to mentioned that countries such United Republic of Tanzania have established these regulations that mandate licenseess to peer at the TIXPs.

c) Capacity Building and Training: Training programs for IXP staff and awareness campaigns about the benefits of IXPs are essential. Technicians managing IXPs require specialized training, and continuous skill development is critical for effective infrastructure management.

d) Public-Private Partnerships (PPP): Collaboration between ISPs, government, and content suppliers through PPPs can reduce costs and enhance digital infrastructure. These partnerships should focus on Corporate Social Responsibility (CSR) and Environmental, Social, and Governance (ESG) considerations.

e) Content Providers and ISPs Engagement: Content providers should establish caches and CDNs at IXPs, maintain transparency with ISPs, and facilitate hosting for users. More ISPs are encouraged to engage in peering, share routing information, and support smaller ISPs.

f) Funding and Financial Management: Strategies for IXP enhancement include funding initiatives, transparency in infrastructure development, and easing regulatory hurdles. Financial management training is vital for IXP operations, and incentives like tax breaks can stimulate private sector investments.

g) Collaboration and Best Practices: Enhanced collaboration among government entities, content providers, and ISPs through joint initiatives and sharing best

practices is essential. Acknowledging IXPs as vital services and fostering ISP marketplace competition will facilitate cooperation.

h) Sustainable IXPs: Sustainable IXPs rely on adaptable membership options, PPPs, crowdfunding, and a clear non-profit model. Continuous skill development for technical staff is critical amid industry transformations.

i) Technical Enhancements and Service Diversification: Strengthening existing IXPs requires upgrading equipment, implementing redundant systems, and improving security protocols. Service diversification with value-added services beyond basic peering is necessary.

j) Community-Driven Approach: Establishing new IXPs in underserved areas should involve feasibility studies to assess market demand and infrastructure. A community-driven approach with phased rollouts is recommended, supported by funding programs like ISOC-SPIF.

k) Governance and Resilience Planning: Strengthening governance structures, ensuring transparency, and investing in professional management are recommended. Direct links between national or regional IXPs can enhance network robustness, and resilience planning through disaster recovery plans is essential.

In summary, the key recommendations include implementing national peering policies, launching training programs, establishing Regional IXPs, incentivizing local content hosting, and achieving full regional fiber integration with high traffic localization. The sctructure of the implementation prioritization is captured in Chapter 10 under the implementation roadmap for this study.

8.2 Partnership and Collaboration Strategies

Strong partnership and collaboration strategies are essential to the expansion and sustainability of Internet Exchange Points (IXPs) in Africa. A wide range of stakeholders must work together to drive IXP development; no one organization can do it alone. Below is a summary of successful tactics:

8.2.1 Multi-Stakeholder Cooperation

The most crucial strategy for promoting Internet Exchange Points (IXPs) is a strong, multi-stakeholder approach. This involves assembling network operators and Internet service providers (ISPs), establishing ISP associations, organizing peering forums, removing entry barriers, establishing a supportive regulatory environment, and promoting public support through incentives like tax exemptions and seed money. Enterprise networks, content providers, and data center operators should be included in the private sector, collaborating with neutral data centers, using content delivery networks (CDNs), and encouraging major cloud providers to establish local regions or points of presence (PoPs) in Africa.

International and regional organizations offer crucial financial, strategic, and technical assistance. The African IXP Association (Af-IX) helps African IXP operators coordinate and share knowledge, best practices, resources, and collectively represent African IXPs worldwide. The Internet Society (ISOC) offers funding, training, and technical support for IXP development, especially in emerging economies. The African Network Information Centre (AFRINIC) contributes to the development of the entire internet ecosystem by offering IP addresses and technical know-how(ISOC, 2014).

Regional Economic Communities (RECs) and the African Union (AU) can facilitate the creation of new IXPs through initiatives like the African Internet Exchange System (AXIS) project. Development partners like the World Bank, ITU, and national development agencies can offer financial grants and technical assistance for IXP infrastructure and capacity building.

8.2.2 Collaboration Strategies for Partnerships in Training and Growth in Capacity Building

Network Operators Groups (NOGs) are crucial for establishing and operating regional Internet Exchange Points (IXPs), providing a forum for knowledge exchange and technical instruction. Collaborations with global NOGs like AfNOG are essential. Technical workshops and mentorship programs can improve the knowledge and abilities of IXP employees, ISP engineers, and regulatory officials. Partnerships for sustainability and strategic funding include seed funding and grants, various revenue streams, and public-private partnerships (PPPs).

Content localization can be achieved through direct communication with content providers, local hosting initiatives, and developer outreach. Regional interconnection can be achieved by physically connecting national IXPs in close nations, supporting the creation of regional internet exchange points (RIXPs). Advocacy campaigns should involve joint advocacy, including involving academia, and sharing success stories and data sharing to promote investment and involvement. These initiatives aim to expand regional peering ecosystems and lower transit costs (Mitchell, 2024).

9 BESPOKE REGIONAL STRATEGIES

Given Africa's enormous geographic, economic, regulatory, and sociopolitical diversity, it is imperative to customize growth strategies for Internet Exchange Points (IXPs) in the continent. A "one-size-fits-all" strategy rarely works. Rather, tactics must be modified to fit the unique requirements and environments of various locations. An outline of customized regional strategies is provided below:

Figure 5: African IXPs Map

9.1 Central Africa (e.g. DRC, Cameroon, Gabon and Chad)

Central Africa, such as the DRC, Cameroon, Gabon, and Chad, has an underdeveloped IXP landscape, limited infrastructure, economic and political instability, and high international bandwidth cost. Customized approaches include prioritizing investments in foundational infrastructure, relying on international organizations for funding, building communities, and engaging with regulators and governments (Kende, 2021).

9.2 East Africa (e.g. Kenya, Uganda, Tanzania, Rwanda, and Ethiopia)

Leading Internet Exchange Points (IXPs) like KIXP in Kenya, TIX in Tanzania and UIXP in Uganda are thriving in Africa due to their significant submarine cable connectivity and rapid expansion in digital economies. The East African Community (EAC) advocates for regional economic integration, but challenges include varying regulatory frameworks, high-power costs, and national backhaul costs.

To address these issues, IXPs can focus on increasing and expanding services, deepening regional peering, focusing on content localization, addressing national backhaul costs, and building capacity for emerging IXPs. These approaches aim to increase enterprise and content traffic, foster cross-border peering, and support local content production and hosting. Additionally, promoting laws to lower terrestrial fiber network prices can help address these challenges (Kende, 2020).

9.3 West Africa (e.g. Senegal, Nigeria, Ghana, and Côte d'Ivoire)

Nigeria is a big market with immense potential for IXPN, a technology that enables global connectivity. However, the regulatory landscape is fragmented, and the country faces challenges such as high operating costs and inconsistent regulations. To overcome these, countries like Ghana should focus on developing strong, redundant, carrier-neutral IXP infrastructure. CIVIX in Côte d'Ivoire is upgrading infrastructure, ensuring link redundancy, establishing a third PoP at RAXIO CI, and hosting major companies like NETFLIX and AKAMAI, positioning Côte d'Ivoire as a regional internet hub.

ECOWAS has already conducted a feasibility study for a regional IXP (RIXP) that is in the approval process which will support partnerships and investments, with a phased rollout by 2027, reflecting a growing regional recognition of digital infrastructure's competitiveness benefits. If successful, the RIXP could serve as a model for other blocs seeking to balance technological sovereignty with integration into the global digital economy. The project is expected to cost US$ 300,000/= however, challenges remain, including funding gaps, uneven national infrastructure readiness, and harmonizing regulatory frameworks across 15-member states.

Aggressive content localization can be achieved by partnering with international content providers, gaming platforms, and local media companies. Large nations like Nigeria should support the growth of secondary IXPs outside commercial centers. Investing in technical training for network engineers and IXP operators can ensure long-term sustainability and operational excellence (ISOC, 2012).

9.4 Southern Africa (e.g. South Africa, Botswana, Zambia, and Zimbabwe)

South Africa is home to some of the continent's most advanced Internet Exchange Points (IXPs), including NAPAfrica and JINX. The region has advanced infrastructure, including national fiber networks and data center ecosystems. However, challenges include regulatory barriers and high cross-border fiber costs for landlocked countries. To address these, South Africa's leadership should encourage IXPs and ISPs to assist in the growth and development of IXPs in neighboring countries.

Addressing landlocked connectivity involves lowering the price and boosting the capacity of terrestrial fiber. IXPs should recruit enterprises and cloud service providers to join and peer, increasing local business-to-business and cloud traffic. SADC-level policies should simplify cross-border interconnection agreements and ease data and content flow within the region. Promoting diverse traffic sources, such as government

networks, educational networks, and OTT providers, can increase the traffic base (Kende, 2021).

9.5 North Africa (e.g. Algeria, Morocco, Egypt, and Tunisia)

There exist strong connections to Europe and the Middle East, and persistent opposition to peering. There's need for customized approaches to promote neutrality and competition, demonstrate economic benefits of local peering, use academic and research networks to host IXPs, and emphasize Arab and European content.

There's need for training for managing large-scale peering, security, and IXP operations optimization. Collaboration between universities and NRENs to advocate for open peering and encourage content producers from the Middle East and North Africa to participate is an imperative (Kende & Hurpy, 2012). There's also need to conduct specific explanatory research based on case study methodology to confirm the reasons for limited number of IXPs in these countries.

9.6 Expansion and strengthening of IXPs in Africa

A multifaceted strategy that focuses on both expansion (building new IXPs) and optimization (improving existing ones) is needed to help Internet Exchange Points (IXPs) grow in Africa. Given the different situations on the continent, these suggestions are based on the IXPs current status and pattern analysis.

9.6.1 Establishing new IXPs (Expansion)

The goal is to find and support underserved communities in order to create new, long-lasting IXPs.The table below outlines some of the strategies to be employed in order to achieve this goal.

	Recommendation	Action	Strategy	Partnerships/Policy Support/Approach/Capacity Building/Member States
1	Conduct targeted feasibility research in underprivileged areas	Proactively identify nations and major cities in Central Africa, Island nations with emerging or nonexistent IXPs, and regions of West Africa	Evaluate the number of active ISPs, mobile network operators (MNOs), prospective local content producers, community networks and enterprise demand by conducting thorough market analyses. This will establish the new IXPs' viability and ideal location.	To collect information and garner early support, work with regional economic communities (such as ECCAS for Central Africa), emerging ISP associations, and local regulatory bodies. Target member states include: Benin, Burkina Faso, Comoros, Gambia, Guinea, Liberia, Madagascar, Mali, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Sudan, Tanzania, Togo, Uganda, and Zimbabwe
2	Develop Robust Local Advocates and Community Support:	Locate and enable local technical communities, passionate people in ISPs, academic institutions, or governmental organizations who can support the IXP project.	Give these champions access to tools, instruction, and guidance from seasoned IXP operators (such as those from KIXP, IXPN, JINX and NAPAfrica). Promote study visits to prosperous IXPs.	Through specialized initiatives and modest funding, the Internet Society, ITU, Af-IX, ATU and AFRINIC can take the lead in locating and assisting these champions.

3	Prioritize Neutrality and Transparent Governance from Inception:	Make certain that any new IXP is founded as a non-profit, impartial organization, ideally overseen by a board comprising representatives from academia, civil society, ISPs, and the government.	Create transparent financial models and peering policies that are open to the public in order to foster trust among prospective participants and ward off capture by powerful firms.	Provide regulatory assurances to all prospective peers by promoting laws that require or strongly encourage IXP neutrality.
4	Obtain Operational Support and Sustainable Seed Funding:	Create strong business plans that show new IXPs how to become financially sustainable after receiving initial grants.	To cover the initial setup costs (equipment, basic facility), use seed funding from international development partners (such as the Internet Society Foundation, FCDO, GIZ, AfDB and World Bank) and, if appropriate, look into national universal service funds (USFs).	Advocate for a phased rollout that begins with a lean operational model and necessary equipment and grows as participation and traffic increase.
5	Pay attention to fundamental technical best practices.	Putting into practice fundamental IXP technical best practices right away, such as a dedication to IPv6 readiness, a strong Layer 2 switching infrastructure, and redundant power.	To draw in and keep peers, make use of open-source tools such as IXP Manager for effective operations, automation, and statistics reporting.	Give the founding technical team specialized technical training on network security, BGP peering, and IXP operations.

Table 4: Establishing new IXPs

9.6.2 Enhancing existing IXPs (Optimization)

The main goals of enhancing existing IXPs are to boost traffic, strengthen resilience, and improve the value offered by already-existing IXPs as indicated in table 5 below.

	Recommendation	Action	Strategy	Partnerships/Policy Support/Approach/Capacity Building/Member States
1	CDN engagement and aggressive content localization:	Proactively seek and encourage hyperscale cloud providers (such as Google, Meta, Akamai, Cloudflare, Microsoft Azure, and AWS) and major global and regional content delivery networks (CDNs) to set up points of presence (PoPs) and peer at the IXP.	Draw attention to the expanding user base in Africa, the advantages of lower latency, and the financial savings for these providers. Provide alluring colocation incentives or peering agreements at carrier-neutral data centers that are linked to the IXP.	Work together to develop enticing packages for content providers with regional and national data center operators. Targeted member states include South Africa, Nigeria, Kenya, Tanzania, Morocco, Egypt, Algeria, Tunisia and Ghana.
2	Encourage government peering and enterprise:	Reach out to government organizations, financial institutions, educational networks (NRENs), and large corporates in addition to traditional ISPs.	Inform these organizations about the advantages of direct peering at the IXP for enhanced cost control, security, and performance for their internal and external digital services. Governments should be	Advocate for policies and regulations that require or incentivize government organizations to establish connections with regional IXPs. Identify mechanisms with Telecom operators to facilitate the construction of

			encouraged to peer at the IXP and host their services locally.	links for public enterprises to the various IXP Points of Presence (PoP).
3	Improve operational maturity and technical resilience:	Invest in modernizing the current IXP infrastructure to improve security (physical security, DDoS mitigation), guarantee redundancy (power, cooling, network links), and get ready for future traffic expansion.	Install reliable monitoring systems, incident response procedures, and ongoing education for IXP employees on sophisticated network security and operations.	Explore relevant industry certifications or compliance standards to demonstrate operational excellence and attract more demanding peers.
4	Create diversified revenue and Value-Added Services:	To increase participation and diversify revenue sources, implement a portfolio of value-added services beyond basic peering.	Provide services like managed security services, dark fiber cross-connects, route servers (to make peering easier), remote peering (if economically and strategically feasible), or expert BGP consulting.	Work together with cybersecurity companies or other service providers to provide IXP members with integrated solutions.
5	Boost cross-border and regional interaction:	Examine the possibility of establishing virtual or physical connections between national IXPs that are close to one another (for example, within	Promote regional policy unification that lowers transit costs within the continent and enables smooth cross-border traffic exchange. Regional	Networks from nearby nations can connect to mature IXPs (such as those in South Africa, Kenya, and Nigeria) by serving as regional peering hubs.

		the SADC, ECOWAS, or EAC regions).	peering agreements and lower cross-border fiber tariffs may be part of this.	
6	Ongoing marketing and community engagement:	Through frequent forums, workshops, and open communication, continue to actively engage both current and prospective members.	To show value and draw in new members, promote IXP data, success stories, and case studies (such as cost savings for particular ISPs). Run marketing campaigns that are specifically targeted to the various stakeholder groups.	To promote benevolent policies and draw in additional funding, use data gathered on traffic volumes, latency reduction, and cost savings.

Table 5: Optimizing Existing IXPs

9.7 Monitoring & Evaluation Metrics

The findings of this study indicate that monitoring, evaluation and learning processes and tools are not comprehensive. The following metrics are recommended to be applied in the management of existing and new IXPs. Some existing IXPs already have tools that provide the KPIs that align with these metrics. However, a substantial number do not have these tools. From the secondary data collected on the Af-IX portal, the research finding show that some of the KPIs are not properly updated with most indicating hyperlinks that cannot be followed or opened. The following table provides summary of the metric for M,E&L metrics for IXPs.

KPI Type	Key Performance Indicator	Metric	Description	Monitoring
Technical	Traffic Volume	Peak and average daily/monthly traffic (in Mbps or Gbps) exchanged at the IXP	Total traffic exchanged at IXPs (Gbps) – primary indicator	Automated traffic graphs (e.g., via IXP Manager, Cacti, Prometheus, MRTG)
	Number of Connected Peers/Members (Participant Count)	Total count of Autonomous System Numbers (ASNs) connected to the IXP	Number and diversity of connected networks (Indicates the level of interconnection and community participation)	IXP database, public peer list.
	Reachable ASNs/Prefixes	Number of unique ASNs and IP prefixes visible through the IXP's route server(s)	Shows the global and local reachability through the IXP	Route collector data analysis (e.g., AFRINIC's ARDA tool, RIPE Atlas probes
	Latency	Average Round-Trip Time (RTT) between IXP participants before and after connecting to the IXP, and	Average round-trip time between peers (Quantifies performance improvement for end-users)	Probes (e.g., RIPE Atlas, PerfSONAR, looking glass) deployed at IXP and participant networks.

		compared to international routes		
	Packet Loss/Jitter	Percentage of packet loss and variation in delay for traffic exchanged over the IXP.	Indicates network quality and reliability.	Continuous network performance monitoring tools. (e.g. SolarWinds)
	Uptime/Availability:	Percentage of time the IXP infrastructure is operational.	Critical for trust and reliability of the IXP as a peering point.	Internal monitoring systems, external probes.
	IPv6 Adoption	Percentage of peers announcing IPv6 prefixes, and IPv6 traffic volume	Tracks readiness for future internet growth	IXP traffic statistics, route collector data
Financial and Economic	Estimated Cost Savings for ISPs	Calculated savings on international transit costs for participating ISPs based on traffic volumes exchanged locally vs. international transit rates.	Demonstrates the direct financial benefit for IXP members.	Surveys of ISPs, financial modeling, comparison of pre/post-IXP transit costs.
	IXP Financial Sustainability	Ratio of self-generated revenue (e.g., membership fees, port charges, value-	Indicates the IXP's ability to operate without external grants.	Regular financial audits and reports.

		added services) to operational expenses		
	Investment in Local Infrastructure	Growth in local data center capacity, fiber deployment to IXPs, and content hosting.	Measures indirect economic stimulus.	Industry reports, surveys of data center operators.
	Internet Price Trends (End-User)	Average cost of internet subscriptions for end-users over time.	Indicates if ISP savings are being passed on to consumers.	Regulator reports, market research.
Social and Development	Local Content Hosting Growth	Number of locally hosted websites, streaming services, and cloud instances.	Shows the development of a local digital economy.	Web analysis tools, surveys of content providers.
	New Digital Services/Applications:	Number of new local online services or applications enabled or significantly improved by the IXP.	Qualitative measure of innovation	Case studies, anecdotal evidence, market observation.
	E-Government/E-Learning/E-Health Adoption:	Increased usage of online public services, educational platforms, and health applications.	Measures broader societal benefits.	Government statistics, sector-specific reports.
	Policy and Regulatory Support:	Number of supportive policies or regulations enacted, and	Measures the enabling environment.	Policy reviews, stakeholder interviews.

		their perceived effectiveness by stakeholders.		
	Community Engagement:	Participation in IXP governance meetings, workshops, and training programs.	Indicates the strength of the multi-stakeholder ecosystem	Attendance records, feedback surveys.

Table 6: Monitoring, Evaluation and Learning for IXPs

9.8 Addressing study data gaps

The report suggests a standardized reporting framework for African Internet Exchange Points (IXPs) to address data gaps. It suggests a centralized data repository to collect and aggregate data from all participating IXPs. Regular surveys and benchmarking are also suggested, with annual or biennial surveys being conducted to gather qualitative and quantitative data. In-depth case studies are suggested to identify drivers of success and lessons learned, particularly in diverse regional contexts.

Longitudinal studies are suggested to track the impact of IXPs over time, focusing on cost savings for ISPs and end-user benefits. Stakeholder mapping and engagement analysis are also suggested, with a focus on analyzing the effectiveness of collaboration. Finally, policy analysis and advocacy are suggested to identify barriers or enablers for IXP growth and advocate for necessary reforms. Eliminating data gaps in the African IXP landscape can improve future assessments, allowing more focused actions to support their growth and improvement.

10 STRATEGIC ROADMAP FOR IXP DEVELOPMENT

As part of the Strategic Roadmap for IXP Development in Africa, Internet Exchange Points (IXPs) will be expanded, improved, and made more efficient. This will improve connectivity, lower prices, and make Africa a global digital hub. It is organized into three-time frames with clear, actionable priorities:

10.1 Phased Strategic Roadmap for the Growth of IXPs in Africa

10.1.1 Short-Term – 2 years

i. Policy Harmonization: Enhance/develop national IXP guidelines and mandate open peering policies.
ii. Feasibility Research: Identify underprivileged areas and launch pilot IXPs in Central Africa and island nations.
iii. Technical Upskilling: Conduct BGP and IXP management training for local engineers.

10.1.2 Long-Term - 5 years

i. Content Localization: Aggressively recruit CDNs (Google, Meta, AWS, Akamai) to establish PoPs at regional IXPs.
ii. Government Peering: Transition all government and NREN traffic to local IXPs.
M&E Integration: Establish a centralized data repository and standardized reporting framework.

10.1.3 Long-Term - 10 years

i. Regional Interconnectivity: Establish Regional IXPs (RIXPs) to facilitate cross-border peering.
ii. Financial Sustainability: Implement diversified revenue models to eliminate donor dependency for the IXPs not yet sustainable.

This roadmap is summarized in the RASCI table below with specific key performance indicators and owners

Phase	Key Activities	Key Performance Indicators (KPIs)	Lead Actors
Short-Term (0–2 Years)	Policy Harmonization: Enhance/develop national IXP guidelines and mandate open peering policies.	Number of member states with specific IXP/peering policies (Target: 30+).	African Telecommunications Union (ATU)
	Feasibility Research: Identify underprivileged areas and launch pilot IXPs in Central Africa and island nations.	Launch of at least 5 new IXPs in underserved regions (e.g., CAR, Chad, Niger).	National Regulatory Authorities & MDAs

	Technical Upskilling: Conduct BGP and IXP management training for local engineers.	Number of certified IXP operators and staff trained across the continent.	African Internet Exchange Point Association (Af-IX) & AfriNIC
Medium-Term (2–5 Years)	Content Localization: Aggressively recruit CDNs (Google, Meta, AWS, Akamai) to establish PoPs at regional IXPs.	Percentage of localized traffic (Target: 70% in 50% of member states).	Internet Service Providers (ISPs) & MNOs, Content Delivery Networks (CDNs):
	Government Peering: Transition all government and NREN traffic to local IXPs.	Number of government agencies and educational networks peering at local nodes.	National Regulatory Authorities & MDAs
	M&E Integration: Establish a centralized data repository and standardized reporting framework.	Successful deployment of a regional IXP performance dashboard for transparency.	ATU, ISPs & MNOs, CDNs
Long-Term (5–10 Years)	Regional Interconnectivity: Establish Regional IXPs (RIXPs) to facilitate cross-border peering.	Reduction in intra-African latency to sub-20ms across regional borders.	ATU, ISPs & MNOs, (CDNs), NRAs and MDAs
	Financial Sustainability: Implement diversified revenue models to eliminate donor dependency for the IXPs not yet sustainable.	Percentage of IXPs achieving 100% operational self-sufficiency.	IXPs

Table 7: Strategic Roadmap

The responsibilities of the lead actors in the above recommended expansion of Africa IXPs are as listed below.

Lead Actors	Responsibilities
African Telecommunications Union (ATU	Regional policy coordination, advocacy for cross-border peering, and overseeing the standardized reporting framework.
National Regulatory Authorities (NRAs) & MDAs	Formulation of national broadband and peering policies, licensing of neutral IXPs, and providing initial financial or policy support for new nodes

Internet Service Providers (ISPs) & MNOs:	Joining local IXPs to exchange traffic, sharing infrastructure for backhaul, and collaborating on technical resilience.
African Internet Exchange Point Association (Af-IX) & AfriNIC:	Technical capacity building, facilitating the "skills inventory," and providing technical guidance on peering infrastructure
Content Delivery Networks (CDNs):	Investing in local PoPs and caches to drive traffic localization and reduce International transit reliance

Table 8: Lead Actors

11 CONCLUSION

The results of this survey emphasize on investment infrastructure such as fibre optic cables, enhancement of policies and regulations, capacity building, awareness and promotion and public private partnerships in the sustainability, strengthening of current IXPs and establishment and growth of new IXPS especially in the marginalized regions on the continent. There's need to have inclusion strategies to support community-driven network initiatives in unserved areas. Establishment of performance metrics for regular assessment to support monitoring an evaluation to measure IXP performance and impact is fundamental in identifying areas for improvement for increased meaningful Internet coverage.

African countries through the regulators should also consider using Universal Service Funds (USF) to support IXP development in underprivileged areas give the central role IXPs play in the reduction of the digital divide through increased broadband coverage as a result of affordability, availability and reliability of localized Internet services. All these require involvement of all the stakeholders in the Internet ecosystem, including ISPs, MNOs, regulators, RECs, NOGs, community networks and governments.

12 CALL TO ACTION

To secure Africa's digital sovereignty, regulators must mandate open peering, governments must treat IXPs as critical national infrastructure, and ISPs must transition from competitive to collaborative peering models. The top strategic opportunities—Regional IXPs, CDN localization, and Community-driven models—are the keys to a connected Africa.

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ANNEXES

Annex 1 - Survey Questionnaire

This section is well detailed in the attached document called: Annex 1 Final IXPs Assessment Report

Annex 2 – Survey Respondents

This section is well detailed in the attached document called: Annex 2 Final IXPs Assessment Report

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