2023 AFRICA DOMAIN NAME INDUSTRY STUDY

(COMMISSIONED BY ICANN)

15th December 2023

2023 AFRICA DOMAIN NAME INDUSTRY STUDY

(COMMISSIONED BY ICANN)

15th December 2023

Disclaimer

This report is furnished solely for information purposes.

The contents of this report, including, but not limited to the data, tables, graphs, maps, territorial boundaries, may not be relied upon or used as a base for any claim, demand, or cause of action and, also none is responsible for any loss incurred based upon.

Opinions expressed in this report are current as of the date appearing on the material only.

Further, the information in the document has been printed on the basis of publicly available information; internal data and other sources believed to be true and are for general guidance only, but which may have not been verified independently.

While every effort is made to ensure the accuracy and completeness of information contained, the company takes no responsibility and assumes no liability for any error/ omission or accuracy of the information.

Recipients of this material should rely on their own judgments and conclusions from relevant sources before making any decisions.

Contents

EXECUTIVE SUMMARY

I.I BACKGROUND

This Industry Study into the Domain Name System in Africa was commissioned to:

- Highlight the strengths and weaknesses in the Domain Name Service (DNS) industry sector in Africa,
- Develop recommendations on how to advance the industry to take better advantage of the opportunities available and address identified challenges; and
- Develop a Trial Observatory to demonstrate the potential for continuously monitoring the status and growth of the DNS Industry in Africa.

The Internet Corporation for Assigned Names and Numbers (ICANN) includes 54 countries in its "Africa" region[1] – comprising all independent countries on the continent and several neighbouring islands. Accessing consistently reliable statistical information from all these countries is inevitably challenging due to the large size of the continent, language differences and the huge disparities between and within countries in relation to, for example, levels of development, literacy and skills, infrastructure roll out and access to Internet resources. These disparities are mirrored in some ways in the membership of the African Network Information Centre (AFRINIC), the African Regional Internet Registry (RIR) for Internet number resources. It has, for example, only one member in Eritrea compared to 702 in South Africa.

This Study builds on the baseline established by the 2016 Study commissioned by ICANN.

I.II METHODOLOGY

To address the challenges of collecting reliable information, the research team utilised a range of mechanisms to access the information required to fulfil the objectives of the study. This included an online survey, zone file analysis of country code and generic top-level domain (ccTLD and gTLD) registries, extracts from Registrar's and domain monitoring services' databases and extensive desktop research. In addition, several of the research team members have decades of experience in the DNS industry in Africa, and their insights informed many of our conclusions.

Some 1 800 potential participants in the study were identified and all participants were specifically targeted and sent personal links to an online survey by a total of 40 team members distributed around the continent. We endeavoured to draw on the same people answering the 2016 survey, in order to ensure maximum consistency in the qualitative analysis. The online survey tool included seven different questionnaires for identified target groups (Registry, Registrar, Registrant, Regulator, Reseller, IXP Manager and Data Centre Manager) translated into six languages (English, French, Portuguese, Arabic, Swahili, and Spanish). A response rate of 22% was received - a total of 308 questionnaires were completed by 209 targeted respondents, noting that some completed more than one questionnaire. Responses were received from all six identified stakeholder groups, all six AFRINIC regions and all six language groups.

Finally, to improve understanding of the trends in the African DNS market, the Team built on the data gathered in 2016 with additional questions and languages, aiming to ensure that the reader is able to easily identify the changes over the 6-year time period between the two studies.

[1] https://www.icann.org/en/system/files/files/africa-strategy-implementation-2012-2017-03may18-en.pdf

I.III THE AFRICAN ECOSYSTEM

It is important to contextualise the DNS industry within the overall African Internet and digital communications infrastructure ecosystem. Key indicators in relation to this include the following:

- Although Africa is a very diverse region, most countries on the continent fall at the bottom of the global rankings of digital uptake and use. For example, of the 33 lowest ranked countries in the 2023 Networked Readiness Report, all are in Africa. Within Africa, differing rates of digital adoption now see Kenya surpassing South Africa to claim the top position in 2023 NRI.
- While it has significantly improved from 2016, Africa continues to lag behind other regions in relation to Internet access with an average penetration of 43% (29% in 2016) compared to a world average of 68% (50% in 2016). This average penetration level however masks big differences between countries in Africa with Internet access varying from 7% in Eritrea to 85% in Kenya.
- Backbone fibre networks are gradually spreading across most African countries, and all coastal countries except Eritrea have access to at least one submarine fibre cable and most countries have at least two. According to Hamilton Research, by mid-2022 there were over 1.1 million kilometres of terrestrial fibre cables installed on the continent, and cross-border fibre is also increasing. As a result, almost all countries are now connected to their neighbours by fibre – the only country left without cross border terrestrial fibre interconnection is Eritrea.
- Local access to broadband remains problematic in almost all African countries. Outside of South Africa, major deployments of metro fibre have largely focused on capital cities, particularly Accra, Dar es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka, and Nairobi, and more recently in some secondary cities. Wi-Fi deployments follow a similar distribution, often preceding Fibre to the Home (FTTH). However, even in these cities, the majority of people still rely on mobile access.
- Although broadband uptake in Africa has been increasing, high Internet access costs continue to be the biggest factor limiting usage in most countries. We estimate that for only 1 GB of monthly data — enough to watch just four minutes of video a day — the average African must pay about 4% of their monthly income, which is twice the Broadband Commission's target of 2%. This, together with the fact that African Internet access is primarily via mobile devices where every Byte of use adds to the bill, further contributing to a low demand for domain names.
- In terms of IP resources, out of the global usage, Africa accounts for only 2.4% of IPv4 and 1% of IPv6 addresses.
- Nevertheless, growth in local Internet infrastructure is speeding up, with 63 fully operational IXPs in 38 countries (up from 36 in 26 countries in 2016) and an increasing number of fully-fledged data centres being built. In 2016 the research had already confirmed that there is a correlation between the number of IXPs in a country and the maturity of the local industry: i.e. countries with more IXPs had a more mature DNS industry and respondents to the survey identified the absence of local IXPs as one of the barriers to development of the DNS industry. The 2023 study continues to underline these conclusions.
- An analysis of the volumes of web page content indexed by Google found that 66% of 644 million African pages indexed are in just ten African countries: - South Africa, Nigeria, Egypt, Morocco, Kenya, Tunisia, Tanzania, Algeria, Mauritius, Sao Tome & Principe. The spread is better, now, as previously 75% of content was concentrated in just seven countries.

I.IV AFRICAN DNS INDUSTRY

The African continent top level DNS address space consists of 54 top level country code ccTLDs plus six Internationalised Domain Names (IDNs): Algeria (الجزائر), Egypt (مصر), Mauritania (موريتانيا), Morocco (المغرب), Sudan (سودان) and Tunisia (تونس) as well three city codes (.CAPETOWN, .DURBAN and .JOBURG). No other African cities have been added since 2016.

ICANN delegated the .AFRICA domain to the South African administrator, the ZA Central Registry (ZACR), and registrations were fully opened in July 2017.

Data from November 2023 indicates that the total number of domains registered under African ccTLDs was just over 4.3 million. In addition, there are about 1.4 million registrations in the gTLDs by African entities.

Other key findings of the research are summarised below.

- Since 2016 the total number of African ccTLD domains has increased by 21%. However, the role of Freenom obscures the general trend for domestic ccTLD registrations because in 2016 almost all (93%) of the increase was in fact in the four Freenom 'domain hack' countries. Nevertheless, the statistics quoted in the remainder of this Report are based on the November 2023 figure of 4.3 million ccTLD domain names.
- Approximately 1% of gTLD domains are registered by Africans and registrations by Africans of gTLD domains total approximately 1.4 million, the bulk of which (~1.2 million) are .COM domains.
- According to responses to the survey, the use of IDNs is reasonably widespread with at least 46% of Registries offering non-Latin scripts and more than a third of Registrars (34%) doing so.
- Our research indicates that high Internet access costs, the lack of digital infrastructure and the fact that African Internet access is primarily via mobile devices has constrained demand for domain names. This was confirmed by responses to the survey, with respondents citing high prices as the biggest barrier to the development of the DNS industry in most African countries followed by lack of underlying Internet infrastructure.
- Other issues that were identified as high barriers by respondents include unreliability of Internet connections and unclear or restrictive policy and regulatory environments.
- The highest number of domain name registrations by African entities takes place mainly in countries where the local hosting industry and web development sector has developed sufficiently to create demand for local domains, i.e. mostly in South Africa, Egypt, Mauritius, Nigeria, Kenya, Zimbabwe, Uganda, Tunisia and Morocco. The research also confirmed zero or low levels of local hosting in a majority of countries in the region: 41 countries hosted over 95% of their gTLD domains outside Africa.
- The research found 51 functioning ccTLD Registries, leaving only Eritrea (ER), the Comoros (KM) and South Sudan (SS), which each have under 300 domains, but have no apparent method of registering new domains via the Internet.
- Compared to other regions, Africa has a very small number of ICANN accredited Registrars. According to the ICANN web site, in total, there are only 13 ICANN accredited registrars in the region - three in South Africa, two in Morocco and Nigeria and one each in Burundi, Ghana, Mauritius, Senegal, Seychelles and Tunisia out of a global total of 1,122.
- There are many more Registrars than 13 ICANN accredited ones, that are active in Africa. South Africa has the most, at 622 Registrars accredited by the ZARC, for example. Unless specified otherwise, in the remainder of this report, the term "accredited Registrar" means a Registrar accredited by the relevant ccTLD Registry.
- As indicated above, 52 countries now have at least one Registrar, with 16 countries having only one, (typically the Registry itself), whereas 36 countries have multiple Registrars. Our analysis shows the number of Registrars is clearly a factor in the number of ccTLD domains sold, although it is also true that a successful industry attracts more Registrars.
- For the Registrants, this review identified over 5 million African ccTLD and gTLD domains. This equates to some 4.4 domains / 1000 population, whereas the global average is about 45 domains per 1000 people.
- The top 10 African ccTLDs by domain numbers have 92% of the domains registered. In this regard it should be noted that there are a number of African countries that have relatively high numbers of domain registrations due to what are known as 'domain hacks' or vanity domains (where domains are utilised by entities or individuals outside these countries because the ccTLD forms part of a memorable word). These types of domain markets occur where these particular ccTLD Registrars offer

domain names that cost little or nothing to register, or are attractive for special purposes where registering a short or a common word in the ccTLD has more relevance than registration in the more popular gTLDs such as .COM or .NET.

- Most of these countries have non-restrictive rules that allow registration of domains from entities located outside the country.
- Based on international industry rates for domain renewals, the annual DNS industry roughly equates to a total value of about USD $1.5 billion for African ccTLD domain names alone, although when based on locally available rates, the industry size is probably less than USD $1 billion. At least 25% of the revenues are likely to accrue to the international registrars, and the remaining USD $.75 billion would be import or local revenue generated by the African ccTLDs and Registrars. Using international pricing, about 80% of the total annual revenue on the continent is made by just ten countries (Nigeria, Central African Republic, Equatorial Guinea, South Africa, Morocco, Zimbabwe, Kenya, Namibia, Botswana, and Cameroon). Including the gTLD domains with an African connection increases the total annual value of the industry in Africa by some USD $52 million.
- Most of the African ccTLDs are available for registration by offshore entities without the requirement for a local presence. In 16 countries there is a requirement for some form of local legal presence (corporate or individual) to register a domain name: Algeria, Benin, Botswana, Burkina Faso, Cabo Verde, Egypt, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Morocco, Senegal, Tanzania, Tunisia, and Zambia. In a few countries, including Kenya, there are additional requirements for Registrars to be locally based, but not Registrants.
- In all countries except South Africa (which is mature) there has been significant growth in the number of African domains as infrastructure rollout has increased in many countries, albeit off a low base. The research expects this trend to continue – projecting an average annual overall growth across the continent of 12%, based on the annualised growth of domains counted by Domaintools, averaged across all countries. However, it should be noted that this average obscures large variations between countries, ranging from -17% (Gabon) to 57% (Chad).
- This suggests significant growth opportunities for local providers in individual countries – noting that 91% of the Registrants that responded to the online survey said they preferred to deal with local Registrars.

I.V SUCCESS FACTORS

A “Country DNS Success Index” was developed by the researchers to rank countries in relation to the health of their DNS industries. The index used a range of factors to “score” countries:

- Number of domains registered under the ccTLD.
- Number of gTLD domains identified as having an African Registrant.
- Number of web pages indexed by Google.
- Price of registration; number of Registrars.
- Number of locally hosted websites.
- Presence of one or more functioning IXPs; and
- Internet usage as a percentage of the population.

In terms of this, South Africa ranked overall highest of all countries, followed by Nigeria, Kenya, Tanzania, and Morocco.

By assessing common factors in countries that scored highly and the characteristics of those that scored particularly low in relation to the index, researchers were able to identify several critical success factors for ccTLD Registries, namely: -

- Infrastructure of sufficient expanse and quality to facilitate access to the Internet.

- A general level of digital awareness among the population, with sufficient literacy – both conventional and digital.
- Conducive national policy, regulatory and governance frameworks are in place.
- Payment gateways ensure easy payment of fees. Note that responses to the online survey confirmed the need for easy payment mechanisms, with both Registrars and Registrants indicating they preferred bank transfer to credit/debit card. Respondents also ranked the absence of easy payment methods as one of the key barriers to growth in the DNS industry.
- Fees for registering a domain should be cost-based (but not zero).
- Registration is comparatively easy to complete (including simple automated systems in place for registration and fast payment mechanisms). Note that respondents to the user experience section of the questionnaire listed slow processing time as the third biggest challenge to development of the DNS industry, and the quality of technical support as the fifth most significant difficulty.
- Information on how to register a domain is easily available, promoting confidence and therefore facilitating a critical mass of domain names.
- Training of industry players in the technical aspects of good DNS management and implementation, as well as in content creation; and
- There must be an effective business model and a marketing / consumer awareness strategy.

I.VI RECOMMENDATIONS

Recommendations on strategies to advance the DNS industry in Africa include proposals on addressing issues in the wider environment that inhibit growth and suggestions specific to the DNS industry. These are summarised below.

I.VI.I INFRASTRUCTURE

The availability of the infrastructure necessary to enable uptake and usage of the Internet, of broadband, and of Internet-enabled goods and services is clearly critical. Without the availability of infrastructure and access to service providers, there is no DNS market.

Without infrastructure and service providers, there is no DNS industry.

The development of local infrastructure also includes the provision of IXPs and Data Centres. Also vital is the roll-out of fibre networks, likely initially in the more affluent urban centres (and supported by a clear set of universal access and service interventions to obviate the creation of a new digital divide), together with cross-border fibre and the provision of sufficient undersea cable capacity. These challenges have all improved dramatically since the publication of the 2016 Study.

Countries that do not have any local hosting facilities will need to build IXPs, Data Centres and fibre networks – but should ensure in doing so that underlying issues such as the willingness of network operators to interconnect are addressed. Building an IXP is neither technically difficult nor is it expensive. When local network operators sell access to “the Internet”, they are really selling access to everyone else’s networks, including their competitors. Often, they fail to recognise this, especially in less developed markets. It is thus essential that they agree to cooperate sufficiently to interconnect and exchange traffic. If they don’t do so locally, they will do so overseas, often at higher cost and always at lower performance. Once a functioning IXP exists, Data Centres become not only viable but essential. This then leads to the growth of a local hosting industry, and consequent demand for low cost domains, which in turn is expected to result in social and economic benefits.

Registries, Registrars and Registrants should therefore all engage with operators, Regulators and policymakers in support of measures that will: a) promote the provision of fixed and mobile networks and services; b) ensure the reduction of prices, in particular data pricing; and c) support a range of universal access and service interventions to promote Internet uptake by disadvantaged individuals and communities in under-serviced areas.

For example, almost all Africans access the Internet using a mobile cellular phone. Indeed, only 5 countries have fewer than 75% SIM subscription rates. It's thus essential that MNOs upgrade their entire networks to a minimum of 3G or 4G. Indeed, nine countries have already launched 5G networks in Africa.

I.VI.II INTERNET SERVICE DEMAND

Without a sufficient level of digital awareness on the part of individuals and communities, the uptake and usage of the Internet and the online services it enables will remain either stagnant or grow slowly. Similarly, in the absence of an environment where online services - such as e-commerce (online shopping, online banking and more), e-government (online access to government services, including e-filing of tax returns), e-learning and more - are prevalent, it is difficult to envisage a high degree of local DNS uptake. Local online activity stimulates the local DNS industry and drives Internet demand.

Ensuring and protecting both online freedom of expression and online privacy and security is also key. Such interventions will encourage the creation of local content, and act as an industry driver.

An effective business model and a marketing and consumer awareness strategy about domain name registrations, with appropriate regulatory and governance mechanisms, must be put in place. Registries, Registrars and Registrants should therefore engage with policymakers and with a range of other entities to promote the development of and demand for the fullest possible range of online goods and services. One of the most effective ways of doing this is to require government departments to have functional websites, and to provide their employees with email accounts – all using local ccTLD domain names, of course.

I.VI.III POLICY AND REGULATION

The crucial role that ICTs played during the COVID-19 pandemic drew global attention to the necessity for robust and globally integrated policies and regulations to enhance equal access to affordable broadband. Besides, the global trend toward adopting digital economics and digital transformation concepts pushes developing countries to revisit legacy ICT legislation and regulations such as competition, and licensing.

There are several areas where special efforts need to be made to improve access to ICT in the region, in particular, lack of trust in cyberspace, limited fixed and mobile broadband penetration, and poor affordability of digital.

In addition, while the need for cost-based interconnection regulation is declining, the need for cost-based access to infrastructure facilities is increasing.

Finally, digital transformation in ICT regulations assists in relaxing the complexity of legacy licensing approaches, which has recently hindered emerging technologies and the digital economy. African regulators are still granting service-specific licenses but are slowly moving toward a more open regulatory framework by adopting multiservice and unified licenses and license-exempt services. In this respect, an ex-post regulation model is crucial to accommodate the economies of scale and scope and the dynamism of the ICT industry.

Underlining these needs, the African Union has developed and published the "THE DIGITAL TRANSFORMATION STRATEGY FOR AFRICA (2020-2030)" aimed to "harness digital technologies and innovation to transform African societies and economies to promote Africa's integration, generate inclusive economic growth, stimulate job creation, break the digital divide, and eradicate poverty for the continent's socio-economic development and ensure Africa's ownership of modern tools of digital management". One of the specified objectives to drive the digital transformation in Africa is to "Promote the management and use of Country Code Top Level Domains as they are critical national resources whilst ensuring that technical and administrative operations are at international standards to foster trust and use of African Domain Names in order to bring financial, economic and sociocultural benefits to Africa".

I.VI.IV LOCAL CONTENT

Registration of (especially local) domain names with websites containing local content fosters the growth of the local digital economy in terms of the construction of Data Centres to accommodate the equipment hosting African websites, the IXPs to interchange local data, the telecommunications (especially fibre) infrastructure to interconnect these locations, and, of course, the need for skilled people to design, implement, manage and maintain these infrastructure elements. A second set of skills is required to develop, update, and maintain suitable content.

The lack of relevant local content in languages spoken in Africa must be addressed as this is crucial to drive uptake and penetration – and therefore to the development of the DNS industry. E-government is a crucial means for increasing local content and the drive to ensure government services are accessible and available online is essential. As an 'anchor client' for the local domain industry, government has an important role to play in fostering its health in this way.

I.VI.V INHIBITING FACTORS

Rules governing who may register a domain and how to do so should be as simple as possible and easily available. For example, rules in place in some countries requiring domain names to match the business / personal name of the entity should be removed. Similarly, those countries requiring registrants to have a legal presence in their country should review these with the aim of removing such requirements. Requirements, if any, relating to compliance prior to registration of all intellectual property rights laws should be removed and rules should instead focus on addressing violations through alternative dispute resolution mechanisms after registration.

Laws and practices inhibiting freedom of expression online must be scrutinised as these can inhibit content creation and hence demand for websites, blogs, and domain names.

I.VI.VI REGISTRY SPECIFIC RECOMMENDATIONS

The Registry should have a website with a functioning and easy to use registry landing page. It should provide:

1. Simple and automatic procedures for registration fulfilment and payment,
2. Include payment by bank transfer, credit card and/or mobile money as an option.
3. Fees for registering a domain should be cost-based (but not zero).

1 INTRODUCTION

This project was initiated by the Internet Corporation for Assigned Names and Numbers (ICANN) which commissioned PowerSoft Africa (PSA) and independent consultants to identify and define the strengths and weaknesses in the DNS industry ecosystem in Africa, and to develop recommendations on how to advance the industry and bring it closer to the opportunities available. The aims of the study were to assess:

- The enhancement of an online data gathering platform and detailed questionnaires to gather relevant information about the African DNS sector.
- Regional / country-based breakdown of domain name registrations, including ccTLD and gTLDs registrations (to the extent possible given the difficulties of identifying African registrants of gTLDs); and registrations by different stakeholder groups (e.g., business, governments, NGOs, education, individuals, etc.).
- The growth of African domain name registrations and the current ecosystem of local registrars and resellers for ccTLDs and gTLDs.
- The user experience at local registrars and resellers (e.g., support for local languages, payment gateways, IDN support and level of automation).
- The overall potential for growth of the domain name industry in Africa and factors that constrain take-up of domain names (e.g. awareness, infrastructure, policy and / or regulation, processes, payment gateways).
- Best practices that have had an impact in domain name industry growth, including those related to business models, regulatory and governance mechanisms, consumer awareness, amongst others.
- Current awareness of Premium Domain Names and strategies on how to develop this market.
- Design of a sample African ccTLD Observatory.

The beneficiaries of this project are ultimately the citizens of Africa and the domain name industry in Africa as a whole. The key DNS industry stakeholders and other groups consulted for this report were:

- Domain name holders / registrants.
- Domain name administrators: Registries, Registrars, Resellers.
- National Policy Makers.
- National Regulatory Authorities (NRAs) for ICT / Telecoms / Communications.
- Regional institutions, e.g. the African Union Commission, Regional Economic Communities (RECs), and other Economic Development and Educational Institutions.
- Internet Exchange Points (IXPs).
- Data Centre operators.
- NGOs and Civil Society Groups.
- Well-known African ICT industry representatives.

The PSA Team Members attended several African Internet-related events[2] and interacted with DNS industry role-players, gathering both quantitative and qualitative data through conducting surveys, interviews, and meetings to obtain the required data and information.

In addition, a variety of secondary research data were also obtained. The following were the chief data sources:

[2] These included the African DNS Forum 2023 (GH), ICANN 76 (MX), AIS'23 (ZA), Africa Engagement Forum 2023 and AfPIF 2023 (ZA).

- IANA.
- The institutions responsible for management of the ccTLD Registries.
- National Regulatory Authorities (NRAs).
- AFRINIC.
- AfTLD.
- Internet Service Providers (ISPs).
- International Registries, such as PIR.
- International Registrars.
- Internet industry analysts such as DomainTools and TeleGeography.

ICANN conducted two DNS studies like this study for the Latin American and Caribbean Region[3] and the Middle East and Adjoining Countries Region[4]. The former was conducted in 2015 to set the domain name industry and registration data in the wider context of the region's Internet development, Internet usage patterns and user preferences, the region's hosting industry and the importance of local language content. Subsequently, it drew on relevant benchmarks and best practices developed within the global ccTLD environment and led to some suggested actions that may stimulate wider uptake. It considered a total of 26 countries and provided detailed results for 13 of them.

The LAC study was commissioned in 2016 to identify and define the strengths and weaknesses in the industry ecosystem within the region and to develop recommendations on how to advance the industry and bring it closer to the opportunities available. A total of 40 countries are considered to be in the region, and the report again focussed on 13 of them.

In the same line, ICANN commissioned the African DNS Study in 2016 to conduct a market analysis in the Domain Name Service (DNS) industry and then provide recommendations on how to develop the industry. This study considered all 54 countries in the Africa region and provided detailed results for 20 of them. Accessing consistently reliable statistical information from all these countries is inevitably challenging; not only because of the size of the continent, but also the language differences, levels of development, literacy and skills, infrastructure roll out and access to resources. The study team developed an online tool to gather as much information as possible from a wide variety of respondents including representatives of all stakeholders, then automated the analysis process to improve the quality of the data and the results coming from the system.

This Study builds upon the 2016 Africa Study. It constitutes primary research in the following areas: -

1. Seven online surveys in six languages were answered by some 1800 persons, who provided valuable insights.
2. Domain data obtained from various sources was processed and analysed for a number of relevant characteristics.
3. The DNS Observatory provides an ongoing research tool, tracking the evolution of the DNS industry in Africa.

[3] https://www.icann.org/en/system/files/files/lac-dns-marketplace-study-13mar17-en.pdf

[4] https://www.icann.org/en/system/files/files/africa-dns-market-study-final-06jun17-en.pdf and A study on the Middle East and Adjoining Countries (MEAC) did include several North African Arabic countries: https://www.icann.org/en/system/files/files/meac-dns-study-26feb16-en.pdf

2 PROJECT BACKGROUND

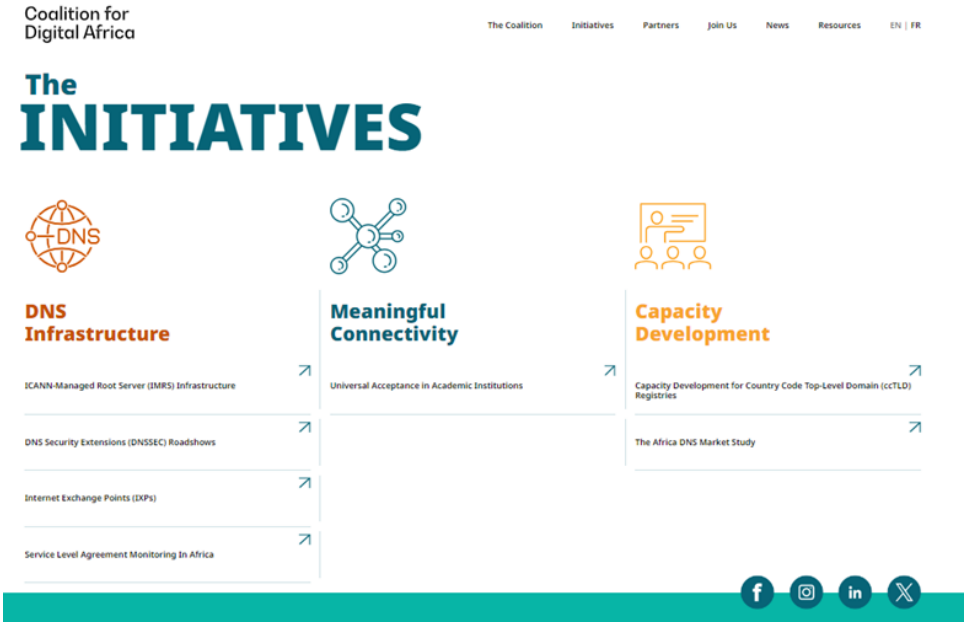
Conceived by the Internet Corporation for Assigned Names and Numbers (ICANN), in 2022, the Coalition for Digital Africa is an alliance of like-minded organizations committed to building a robust and secure Internet infrastructure to bring more Africans online.

More information is available at www.coalitionfordigitalafrica.africa.

The Coalition strategy includes local activities carried out in partnership and collaboration with governments and other stakeholders including capacity-development workshops; providing *ad hoc* advice on Internet matters such as connectivity infrastructure, meaningful connectivity, and digital literacy; and supporting participation in multistakeholder Internet policymaking processes.

Based on the three focus areas, the Coalition for Digital Africa seeks to expand the reach of information and knowledge while avoiding duplication of efforts.

Figure 2-1: Coalition for Digital Africa - Initiatives



Source: https://www.coalitionfordigitalafrica.africa/initiatives

Thus, this study under the Capacity Development pillar is leveraging the results and recommendations of the ICANN Africa DNS Study 2016[5], to examine the current realities of the African DNS landscape and to present a comprehensive and updated report. Moreover, the study project will ultimately lead to the establishment of a pilot observatory — a platform and software — to continuously monitor the growth, development, and emerging needs of the DNS industry in Africa. This data will help build a continental database on the DNS management, market, and security in Africa.

The study will document relevant data and provide analytical findings to enable ICANN and other participants in the Africa DNS industry to build a roadmap for the development of country code top-level domains (ccTLDs) and generic top-level domains (gTLDs) in Africa. Hence, by providing an understanding of the strengths and weaknesses of Africa's DNS ecosystem, further African national

[5] https://www.icann.org/en/announcements/details/icann-releases-its-final-report-on-africa-dns-market-study-24-6-2017-en

research can be conducted to develop strategic and action plans on how to advance the industry and realize its full potential.

The outcomes will help inform the Coalition for Digital Africa of future growth opportunities and development, both locally and regionally, in line with the Coalition's guiding principles.

This study will result in an assessment of the evolving DNS industry and economic trends in Africa that describes and quantifies the overall potential of the domain name industry in the region, including:

- A considered study of areas of importance to the DNS marketplace, including governance and registry models, and the readiness of Universal Acceptance, Email Address Internationalization (EAI), and DNS Security Extensions (DNSSEC).
- A regional or country-based breakdown of domain name registrations, including but not limited to ccTLD versus gTLD registrations; registrations by business, governments, non-government agencies, research and academic institutions, and individuals; percentage of active domains; and percentage of domains that use private (proxy) WHOIS.
- A description of the type of content hosted by these domains (e.g., commercial, governmental, educational) and percentage of the commercial sites that offer e-commerce services, including whether the content is hosted in-country or out of country.
- An assessment of the growth rate of domain name registrations for ccTLDs and gTLDs over the past five years (2016-2021), including Internationalized Domain Names (IDNs), as well as the current markets of local and global ccTLD and gTLD registrars and resellers, to gain insight into registrant behaviour.
- A better understanding of:
  - The user experience at local registrars and resellers (e.g., support for local language, payment gateways, IDN support, level of automation).
  - Factors that are holding back adoption of domain names (e.g., awareness, infrastructure, policy and/or regulation, payment gateways).
  - Current perceptions of Premium Domain Names and how to develop the DNS landscape.
- Validation of the economic potential for domain names sales (gTLDs and ccTLDs) in the next three to five years.
- Definition of the best practices that have made an impact on the growth of the domain name industry, including those related to business models, regulatory and governance mechanisms, and consumer awareness, among others.

An assessment of the feasibility of establishing a DNS observatory, leading to a proposal for a consequent mechanism and implementation of a trial observatory for the DNS marketplace in Africa

This version of the study is commissioned by ICANN and conducted by PowerSoft Africa.

3 METHODOLOGY

The **2023 Africa Domain Name Industry Study** aims to build on the 2016 Study, published in June 2017[6]. Results obtained from this iteration of the Study are therefore compared with those from the previous Study, whenever practical. To maximise the impact of the resources available for the project, the data gathering process was automated as much as possible by means of an online survey (see Section 3 below). In addition, using software tools developed for the project, DNS zone files were analysed, along with extracts from Registrars' databases and other related information extracted from Registrar websites and insights from industry analysts.

Acquiring data on the DNS industry for all 54[7] African countries, with widely differing levels of economic, social, political, telecommunications and Internet development was a daunting task. To address this, individual team members were each assigned one or more countries for which they acted as the 'Country Leader'. Country leaders were chosen based on:

- In-country knowledge and contacts.
- Understanding of the Internet in general and the DNS industry in particular.
- Ability to carry out a challenging assignment in a limited time.
- Relevant language skills.

Unfortunately, we were unable to recruit effective Country Leaders (CLs) for all countries, despite extending the deadline for their work several times, as well as more than doubling the stipend offered compared to the 2016 Study. Core Team members therefore carried out desktop research to fill in any significant gaps.

3.1 DEVELOPMENT OF TARGETS FOR DATA GATHERING

Initially, targets for the number of responses per country were based on the numbers of AFRINIC members in each country. AFRINIC members are either entities that use IP addresses and provide them to others, known as Local Internet Registries (LIRs), or they are entities that use IP addresses (and ASNs[8]) for their internal purposes, known as End Sites. AFRINIC members thus include ISPs (LIRs), academic institutions, banks, governments, and other business enterprises (End Sites). At the time of the 2016 project formulation, AFRINIC reported several data sets, of which the most significant were Local Internet Registries, which mainly list those who supply connectivity to others, and provide other services, including both IP addresses and names. We equated these to Registrars or Resellers. Other members are End Users (now called End Sites), which we equated to Registrants. We set targets for Registries which assumed the typical country had six registries: the ccTLD itself, plus COM.ccTLD, ORG.ccTLD, NET.ccTLD, EDU.ccTLD and AC.ccTLD or equivalent second level domains (2LDs). On this basis, we initially (2016) set a target of just over 5000 respondents to the questionnaire. This was based on as few as 13 potential respondents in very small markets such as Eritrea, which only has one AFRINIC member, to 454 respondents from South Africa, which has 643 AFRINIC members. As of 2023, these figures have changed as shown in the table below:

Table 3-1: Selected Target figures

Description	2016 Study	2023 Study

[6] icann.org/en/system/files/files/africa-dns-market-study-final-06jun17-en.pdf

[7] SS was delegated to South Sudan in 2019 https://www.iana.org/reports/2019/ss-report-20190108.html

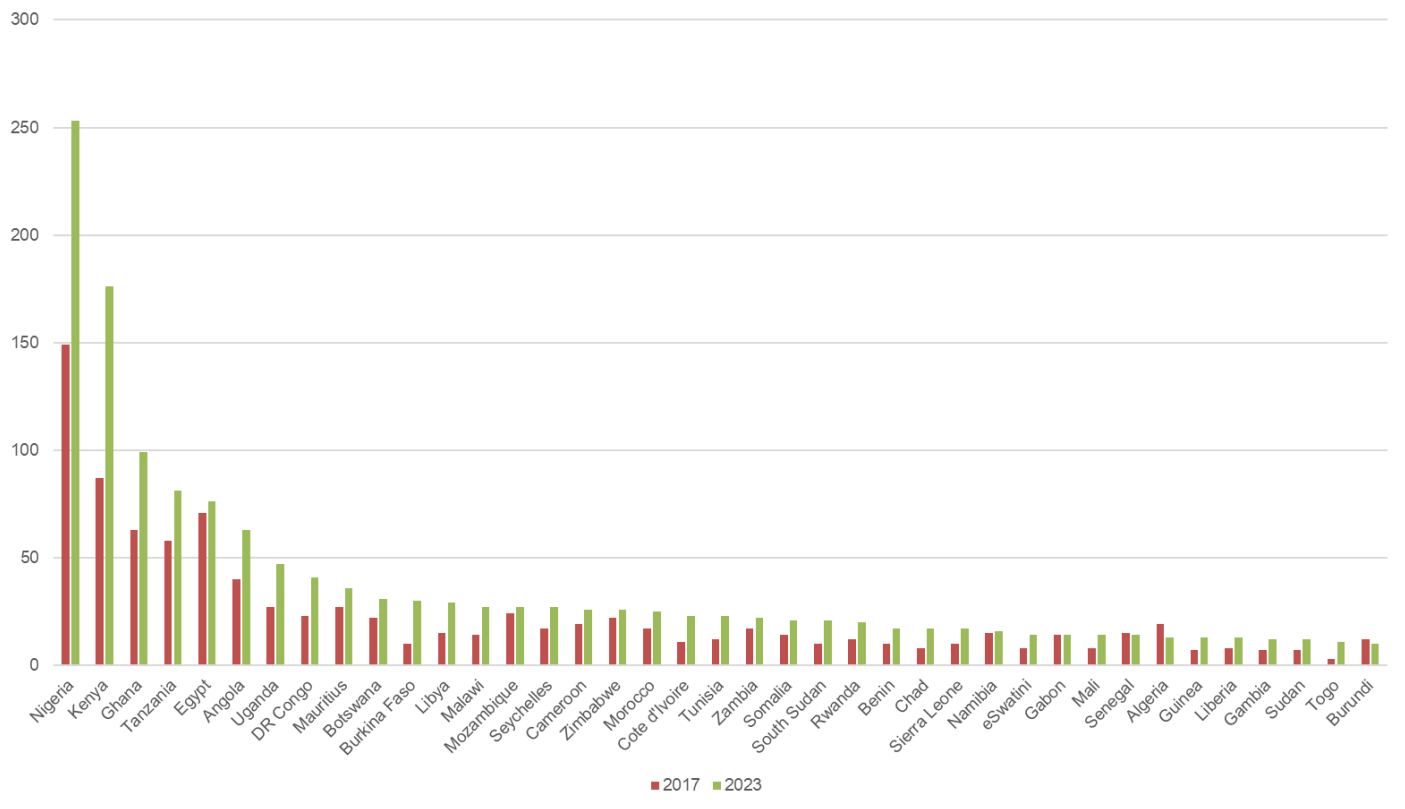
[8] Autonomous System Numbers, a globally unique index used to refer to all networks managed by one entity.

Total Respondent Target	5177	5238
Eritrea AFRINIC Members	1	1
Eritrea participants target	13	14
South Africa AFRINIC Members	643	702
South Africa participants target	454	549
Countries with 10 or more AFRINIC members	33	44
Total number of AFRINIC members	**1639**	**2256**

Source: Own Survey database

Figure 3-1 below illustrates those countries with 10 or more AFRINIC members. This number has increased from 33 to 44 countries, with only Eritrea still having only a single AFRINIC member. As can be seen, the number of AFRINIC members per country has increased in almost all cases.

Figure 3-1: Countries with at least 10 AFRINIC Members



Source:

Countries with 10 or more AFRINIC members are shown in the figure above. This number has increased from 33 to 44 countries, with only Eritrea still having only a single AFRINIC member. As can be seen, the number of AFRINIC members per country has increased in almost all cases.

The DNS industry in Africa has grown since the 2016 study, by about 37% in terms of AFRINIC members.

Resources were allocated for research in all 54 countries. Those countries which had significantly larger markets, based on AFRINIC membership, required more extensive focus, and are listed in the table below. It is clear from

the chart above and the table below that there is significant segmentation in the African DNS industry, with some countries having a far larger Internet sector compared to others.

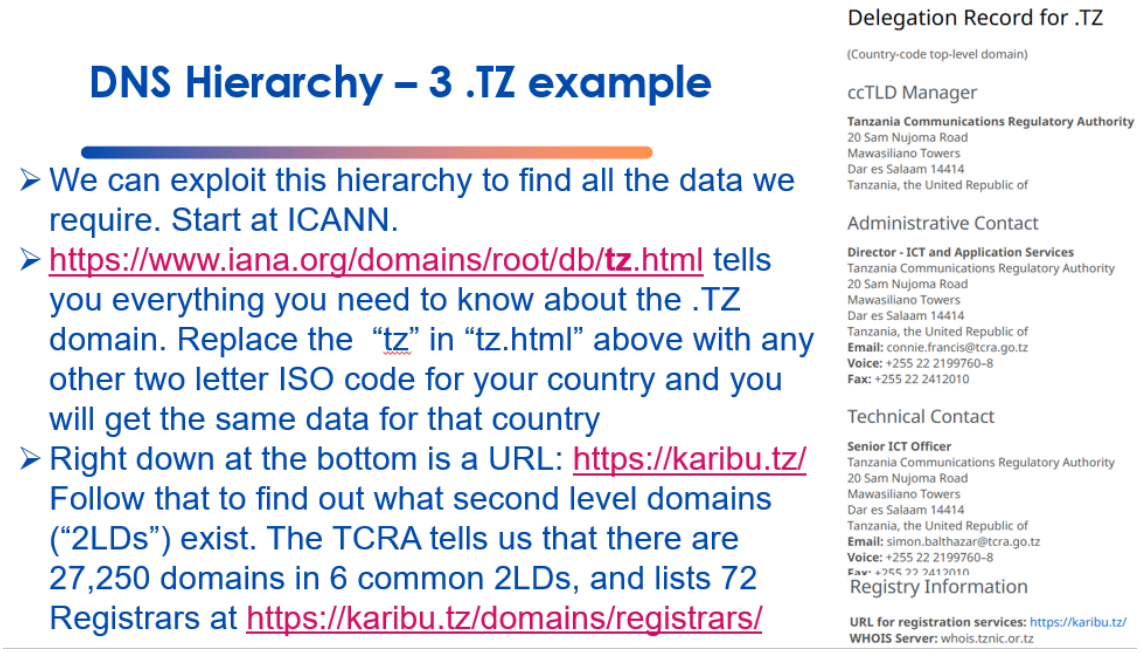
Table 3-2: Large AFRINIC members

Country	AFRINIC members 2016	AFRINIC members 2023
South Africa	643	702
Nigeria	149	253
Kenya	87	176
Egypt	71	76
Ghana	63	99
Tanzania	58	81

Source:

Desktop research, starting at IANA, provided data on the ccTLD for each country, which in turn lead us to the Registrars. In effect, we followed the hierarchical distributed database nature of the Domain Name System itself to identify potential targets for data gathering. A slide from one of the training courses developed for the Country Leaders demonstrates this process in Figure 3-2 below.

Figure 3-2: DNS Hierarchy example



As we investigated further, we found that the extent of the DNS industry in Africa has continued to grow. AFRINIC membership has grown by 37%, and the number of Registrars that we identified has increased to over 1200. This indicates significant interest in the African Doman name industry, by both local and international actors.

Several strands of research were used to come to these conclusions. They included:

- AFRINIC membership, as discussed above.
- IANA, to locate the ccTLD, if not already known.
- Data from the ccTLD registries, many of which publish lists of accredited Registrars.

- Searches on Google for Registrars of domains under a specific ccTLD, as well as searches for registration of a domain under a specific ccTLD. This identified many out-of-country Registrars.
- Identification of IXPs in each country, and examination of their members. All those peering at an IXP operate a network, and therefore are Registrants. Many of them are also ISPs and may therefore be Registrars.
- Similarly, lists of members of ISP Associations and ISOC Chapters were helpful in identifying, primarily, Registrars and Registrants, respectively.

3.2 THE ONLINE SURVEY TOOL

Several existing survey tools were considered for the 2016 Study, but it was decided that the study's particular requirements – especially the need for multiple languages – required the development of a new platform that could also serve as the basis for an ongoing observatory. This same platform was reused, with enhancements, for the 2023 Study. (Subsequently, it was found that the Online Survey Tool was not suitable for either 2023 Country Leader Reports, or for the Observatory, so other tools were developed. However, portions of the framework, particularly the multi-lingual facility, were re-used). As the skills were available within the team, this was carried out in house. In addition, this allowed considerable customisation and ongoing refinement to be applied, which would not have been possible using a third-party tool. This same 2016 Online Survey Tool was revised and expanded for the 2023 Study.

The survey tool is based on a PHP frontend and a MySQL backend (subsequently replaced with MariaDB for the 2023 Study). There is almost no static text on the site at all. All strings and other variables are stored in MariaDB tables, and the appropriate ones displayed as required. This allows the display of different strings for different languages, and multiple questionnaires can be displayed using the same mechanism - with different questions and section headers displayed according to the selection parameters from the MariaDB database.

The software was further enhanced to make it possible to present a selected subset of questions for each type of Respondent (Registry/Registrar/Regulator etc.), as well as for managing and monitoring the filing of completed questionnaires by Team Members and Administrators.

3.2.1 INTERFACE DESIGN

To the extent possible, the interface was kept clean and simple. There are two entry points to the site: https://dnsstudy.africa/ (for the survey respondents) and https://dnsafrica.study/admin (for the Country Leaders / administrators).

In both cases, a language selection option allowed the user to select the language of choice. The interface language defaults to the pre-defined language specified by the site visitor's browser but can be overridden at any time. Selecting another language changes all relevant text – headings, prompts, questions, and fixed answers[9]. When Arabic is selected, script reads from right to left, and is right justified instead of left justified.

Additional links on the respondent site led to the 2016 Draft and Final Reports. On the Admin site, links lead to the authorisation letter from ICANN, videos and transcripts of training sessions, sample letters, copies of training presentations and other useful information for Team Members.

3.2.2 QUESTION DEVELOPMENT

An extensive process of question development took place, with multiple iterations and inputs by Team Members with specific expertise and experience in this area. Ensuring consistency with the question format and response was emphasised, and there was a requirement to limit free-form responses as far

[9] "Fixed answers" refers to dropdown lists of possible answers to questions, such as "Yes" and "No".

as possible, to facilitate comparison of responses. To facilitate reuse, each question was given a unique ID, a sequence number (initially at intervals of 100, to allow the insertion of other questions), a language, a type, a category (this is a binary sum of all the questionnaires that the question appears in) and a maximum response size. The type and category have meanings as per the tables below.

Table 3-3: Questionnaire Types & Categories

Question Type	*Type Meaning*	*Category Value*	*Category Meaning*
S	Subject Heading	1	Registry
db	Drop-down list of countries	2	Registrar
tl	Text long	4	Registrant
dt	Date text	8	Regulator
dd	Drop-down List	16	Reseller
no	Number	32	IXP Manager
tb	Text box	64	Data centre
T	*Title (main heading)*	*E.g., 1 + 2 + 4 = 7 = Registry + Registrar + Registrant*	

A questionnaire on Data Centres, which are pivotal for local internet traffic growth, was added to this 2023 Survey Tool for Data Centres. The questionnaire was circulated in six languages, being: English, French, Arabic, Portuguese, Spanish and Swahili.

3.2.3 LANGUAGE AND TRANSLATION

The Africa region has the greatest concentrations of linguistic diversity in the world. The number of languages natively spoken in Africa is variously estimated over 3000[10]. However, English, French, Arabic, Spanish, Swahili, and Portuguese are widely spoken across various African countries. Most of the indigenous African languages are spoken languages with few technical and scientific words although they are widely used for day-to-day conversations including in lower schools where they are the medium of instruction in some countries.

While we mostly use English within our Study team, we have previously developed an online portal that provides the facility for correspondents from every African country to answer one or more pertinent questionnaires in six languages. The system includes a built-in method of automatic machine translation of website text, tokens, questions, and answers.

Translation of the questionnaires (initially written in English) into the five other languages was not without its challenges. As the subject matter was highly technical, with specific terminology, standard translation services were ineffective in 2016. This time around, automated translation services were considerable improved, and team members merely had to counter-check the machine translation. The translators had a very convenient method to execute the translation, whereby they could choose a question, and see all existing translations. The time required for translation was reduced significantly by starting with automated translations and relying on Language Experts to countercheck and correct where necessary.

[10] Epstein, Edmund L.; Kole, Robert, eds. (1998). *The Language of African Literature*. Africa World Press. p. ix. ISBN 0-86543-534-0. Retrieved 23 June 2011. Africa is incredibly rich in language—over 3,000 indigenous languages by some counts, and many creoles, pidgins, and lingua francas.

This was only required when a new language was added, or if questions / answers were changed. Free-form text input by correspondents is also machine translated back to English, and if not clear, was reviewed by a Language Expert.

In this study project, we have added Spanish and Swahili to the previously existing languages, i.e., English, French, Arabic and Portuguese. All text has been translated into these two new languages by applying the same methodology described above.

3.2.4 QUESTIONNAIRE STATISTICS

There were seven questionnaires, one each for:

- Registry
- Registrar
- Registrant
- Regulator
- Reseller
- IXP Manager
- Data Centre Manager

Each questionnaire was available in six languages:

Table 3-4: Questionnaire Statistics

Description	2016	2023
Questionnaires	6	7
Languages	4	6
Total Question text strings	1,056	2,100
Total Fixed Answer text strings[11]	1,315	2,348
Incidental text translations for website	171	534

Source: Internal

As can be seen, the total volume of data was approximately doubled, when looking at Question text strings, for example. However, the Incidental text translations were significantly increased due to more explanations added.

3.3 DATA GATHERING STRATEGY AND PREPARATION

The data gathering strategy was based on seven prongs: recruiting Respondents to complete the online surveys; Country Reports written by CLs for their country(s); obtaining suitable zone files for analysis; obtaining suitable Registrar database extracts, data obtained from various Domain Name Monitoring Services; data gathered via the DNS Observatory and desktop research. The first six of these constitute original, primary, research. Knowledge of the DNS industry in Africa was used to map out a strategy for Team Members to follow in contacting individual respondents.

In addition to the new Survey Participants identified by the Country leaders, those identified in the 2016 Study were also invited to take part in the 2023 Study.

[11] Predefined answer choices, typically in a drop-down list, such as “Yes”, “No”, etc

3.3.1 TRAINING

Training sessions were made available for all Team Members and conducted frequently. A slide presentation was made available to Team Members, with a total of 17 versions published as we added more functionality to our systems, and as we addressed questions raised.

A PSA sponsored Zoom licence was acquired and used for all training sessions, as well as progress meetings. Training sessions for Country Leaders were drafted and revised as needed. These were also translated into French. Additional training sections were drafted to cover other issues as they arose, such as the Bulk Addition of Respondents, the facility to send customised emails to Respondents and similar issues. New training sessions were drafted to cover issues such as completing the Country Reports and signing up Registry Operators to the Secondary Name Server behind the DNS Observatory. Recordings of all these training sessions were available for review by team members on the admin website.

3.3.2 FACILITIES SUPPLIED TO COUNTRY LEADERS

The Users section of the Survey Tool allows CLs to add new participants to the Survey. It generates a link which includes the email address of the new participant, together with a default password. This can simply be sent to the person in an email, WhatsApp message, or otherwise. In addition, there is a Bulk Add facility at the bottom of the same page. Details of the new user can be entered manually here, or more usefully, via the facility described next. We created a spreadsheet that allows the CLs to enter the names and addresses of prospective participants, and to select all those roles that the Participant might play. This generates the required code ("iCAT") that gives the participant access to the appropriate Questionnaires. This spreadsheet has two outputs: A CSV file, that can be copied and pasted into the Bulk Add facility described above. In addition, together with a source document (also supplied by us), the CL can run a MailMerge process. This will populate a document with all the appropriate data needed, such as name, email address, iCAT value and link. These are then sent out via the CL's email client and appear to come from him/her. In addition to this, MJE and WFS added many Participants on behalf of our CLs.

Finally, we had hoped to use the Survey Tool infrastructure to enable us to create a Country Report template. Unfortunately, it proved impractical to add the necessary complexity to include conditional processing. As a second choice, we produced a special spreadsheet for the CLs to enter the appropriate data to provide us with a Country Report. This is a fairly comprehensive view of the country in question, with a focus on Internet, connectivity and cost issues. We received eight completed Country Reports from our CLs. While far from the desired 54, it was a significant improvement on the zero received for the 2016 Study.

3.4 DATA ANALYSIS PROCEDURES

As in the previous study performed in 2016-2017, we use inductive reasoning to analyse data, where we will try to aggregate the findings to develop a model that best fits the most similar groups based on ICT ecosystem. To do so, we utilize various analysis tools including surveys, interviews, zone files analysis, country reports, and conducting research.

Deliberately, to give the reader an easy way to understand and follow the trends in the African DNS industry, we reuse the 2016 Study structure format, of course with additional questions and Languages. Thus, the 2023 Study shows the development of the sector and provides success stories and benchmarks that can help to sustain success in future.

Regarding the online survey tool, the developed database contains 350 unique questions (compared to 264 in 2016) in all six languages (was previously four). Some were also reused in other questionnaires, for a total of 1018), with 35,473 answers collected. Despite a large team which not only signed up more than 1800 potential respondents (database users), but also made a concerted effort to persuade users to complete their questionnaires, 442 questionnaires were completed by 321 individuals in time for analysis (some individuals answered multiple questionnaires on behalf of the different groups). An additional 62

Questionnaires were started but not completed. Thus, 17% of respondents provided a 24% response rate by questionnaires answered. This is a reasonable success rate under the circumstances.

Table 3-5: Survey Results Statistics

DESCRIPTION	2016	2023
Unique questions	264	350
Participants signed up	1,427	1,835
Completed Questionnaires	308	442
Completed by unique individuals	209	321
Respondents	15%	17%
Response Rate	22%	24%

Although at least two users per country were identified, with up to 401 for South Africa, for nearly a third of the countries – 17 in total (22 in 2016) – there were no completed questionnaires at all. Note there were responses from 72 countries (68 in 2016), including the UK, USA, and various European and Asian countries. Similarly, despite repeated requests to the Registries identified, only 15 (up from seven) were willing or able to provide their Zone Files – eleven countries, the three South African City gTLDs and .AFRICA.

17 countries did not respond at all, down from 22 in 2017.

To complement this questionnaire data, data from other sources was analysed to address some of the gaps. Wherever practical, the data is displayed in this report in graphical form, such as pie, bar, and frequency charts, to ease understanding for the reader. Although the paucity of data made correlation and regression analysis difficult, these powerful techniques were used where appropriate, and are often shown as X-Y Plots. Logarithmic scales were quite often needed due to the large range of values measured.

Table 3-6: Questionnaire Responses by Stakeholder Group

Respondent Type	Completed Responses 2016	Completed Responses 2022
Registry	26	29
Registrar	34	79
Registrant	176	283
Regulator	16	17
Reseller	20	18
IXP Manager	36*	6
DC Manager	N/A	9
TOTAL	**308**	**441**

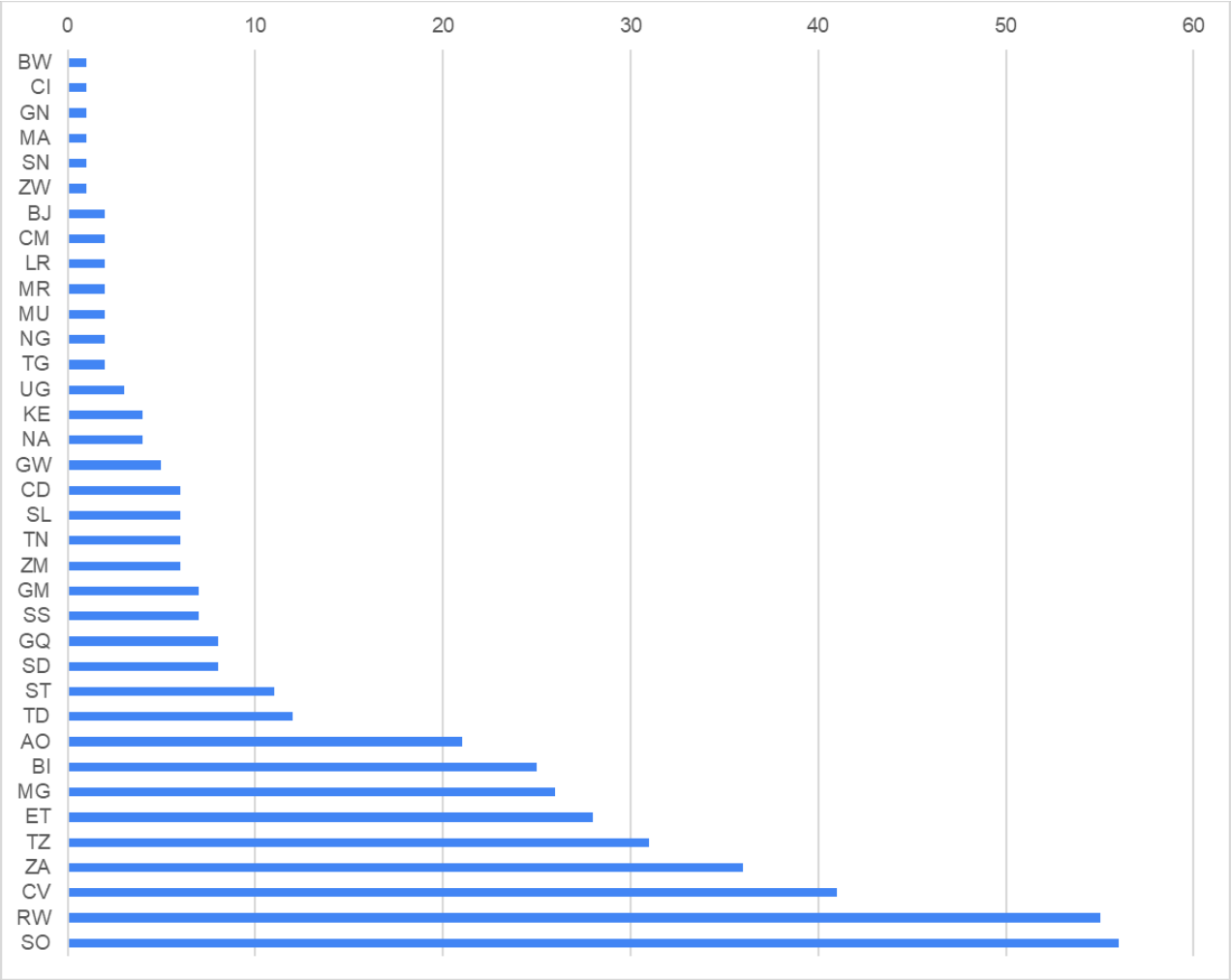
internal

*This figure includes multiple responses for a single IXP. There were in fact 17 unique responses.

Figure 3-3 below shows the number of respondents per country for those 32 countries with completed questionnaires:

:

Figure 3-3: Questionnaire Respondents by Country



Significantly more data was collected than in the previous Study, with a total of about 300 M domains considered. However, with the exception of those TLDs that have provided us with complete Zone Files, as well as complete database extracts with the 3 requested data per domain, all data presented here must be considered incomplete. Thus, when we say that a particular country hosts this many websites in-country and that many overseas, this must be interpreted to mean that those numbers represent the websites that we found. It is a reasonable assumption that while the absolute numbers may be an underestimation, one can expect the ratios to be fairly accurate.

Out of 227 million records from one source, we identified some 3.8 million with an African connection – or about 1.67%. To repeat ourselves – this did not involve seeing or processing any Personally Identifiable Information (PII).

4 THE AFRICAN DNS ECOSYSTEM

4.1 AFRICA IS RISING – BUT STILL NOT FAST ENOUGH

This section introduces the broader African social, economic and Internet environment, and its impact on the Domain Name System on the continent.

Early in 2023 the African Development Bank projected that as many as 18 African countries would experience annual growth rates of more than 5 per cent[12]. But by November 2023 the ADB revised its short to medium-term growth forecast for Africa down to 3.4% (from 4%) for 2023 and 3.8% (from 4.3%) for 202[13]. While growth is still projected to be positive overall, Africa is feeling the effects of global crises, climate change, and rising inflation. Added to this are the challenges posed in some countries by debt servicing (e.g., Ethiopia and Kenya[14]) and high rates of unemployment (e.g., Nigeria and South Africa)[15].

In other words, despite the 'Africa Rising' inspirational narrative, challenging conditions continue to test the continent. Most significantly in the context of this study, is the relatively slow growth in Internet penetration and use. According to provisional estimates the number of Internet users in Africa increased from 4.5 million in 2000[16] to nearly 600 million in 2022. Internet penetration, however, was still only 43% (2022) as compared to 68.6% in the rest of the world[17]. Insufficient availability of infrastructure, and the high cost of data and devices, continue to limit people's ability to connect to and use the Internet. Differences between African sub-regions, countries and sections of the population are dramatic. For example, in January 2022 Internet penetration ranged from, on the low end, 6.8% in Eritrea to 83.8 in Algeria[18]. Also significant, as illustrated in the table below, is that the gap between men and women using the Internet in 2020 was 11% in Africa, against a world average of only 5%. Rural Africans are particularly disadvantaged.

Table 4-1: Africa compared to the world: Percentage of people using the Internet in 2020

Location	By location: urban / rural	By sex	By age	Total
World	Urban – 76%	Women – 57%	Youth* - 71%	63%
	Rural – 39%	Men – 62%	Rest of popl.– 57%**	
Africa	Urban – 50%	Women – 24%	Youth – 40%	33%
	Rural – 15 %	Men – 35%	Rest of population – 27%	

Source: ITU, Fact and Figures 2021, ITU-D, 2021, https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2021.pdf .
Estimates of the total number of people using the Internet are for 2021 while the other figures are for 2020.
* Individuals aged 15 to 24 using the Internet as a percentage of the total population.
** Individuals below 15 years old or above 24 years old as a percentage of the population.

Governance is also not strengthening to the extent needed. When launching his foundation's 2022 Index of African Governance, Mo Ibrahim noted that African governance had flatlined since 2019 and that unless Africa quickly addressed this concerning trend, the progress made in the years since 2012 could be lost. The result would be that African countries would not achieve the Sustainable Development Goals

[12] African Economic Outlook 2023 | African Development Bank Group - Making a Difference (afdb.org)

[13] African Development Bank. 2023. Africa's Macroeconomic Performance and Outlook – Update. Published in November 2023. https://www.afdb.org/en/news-and-events/press-releases/african-development-bank-revises-economic-forecast-africa-downwards-amid-continued-global-shocks-66351

[14] Ibid, p.10

[15] Deutsche Welle. 2023. Africa's Deepening Unemployment Crisis. Published in Deutsche Welle in March 2023. https://www.dw.com/en/africas-deepening-unemployment-crisis/a-64994936

[16] https://www.statista.com/statistics/1124283/internet-penetration-in-africa-by-country/

[17] Internet World Stats. "Internet User Statistics for Africa https://www.internetworldstats.com/stats1.htm

[18] https://www.internetworldstats.com/stats1.htm

(SDGs) nor the goal of Agenda 2063, the African Union's strategy designed to alleviate Africa poverty and promote development[19].

Nevertheless, there are causes for optimism:

- Cross-border commerce, long suppressed by conflict and political rivalry, is growing[20]. In this regard the African Union has, in line with its Agenda 2063, established the African Continental Free Trade Area (AfCFTA)[21]. The main objective is to reduce the cost of cross border trade and to create a single market for goods and services to deepen regional economic integration[22].
- The number of middle-class Africans tripled to, by 2010, nearly 350 million people - more than 34 per cent of the continent's population. This phenomenon – which appears to have continued in the last decade - has boosted Africa's purchasing power and a robust economy for the continent [23].
- In its Atlas of African Health Statistics 2022 report the World Health Organization confirms that the health of millions of Africans is improving. For example, life expectancy at birth increased from 50 years in 2000 to 62 years in 2019, child mortality rates have declined from 172 deaths per 1000 live births in 2000 to 74 deaths per 1000 live births in 2019. Maternal mortality rates have declined from 870 deaths per 100,000 live births in 2000 to 462 deaths per 100,000 live births in 2019 The health of many millions of Africans has generally also improved[24].
- A generation of better-educated young people of working age is entering the job market and birth rates are beginning to decline, although Sub-Saharan population growth is still the fastest in the world[25].
- Nationals working abroad contribute to capital inflows into Africa. The World Bank reports that despite substantial pressures faced by Africa, including reduced wheat imports due to the Ukraine war, among others, especially in 2021, remittance inflows to Africa soared by about 14% to $49 billion, representing the strongest gain since 2018. (World Bank Migration and Development Brief 36/Global Knowledge Partnership on Migration and Development (KNOMAD))[26].
- The growth of cities is usually linked to economic growth. Megacities, cities with a population of at least 10 million, are fast sprouting in Africa. Cairo, Kinshasa, and Lagos are already megacities. Luanda, Dar-es-Salaam, and Johannesburg will attain this status by 2030[27]. While mega cities pose many challenges, they also attract investment.
- Where Africans do have effective access to the Internet, they make active use of it, in business, politics and social and cultural life. See section **4.3.5 Social Media**.

4.2 THE AFRICAN DOMAIN NAME SPACE

As of October 24, 2023, there are 1591 valid Top-level Domains worldwide in six categories as summarised in

Table 4-2 below[28].

[19] https://www.weforum.org/agenda/2016/05/africa-s-economies-are-growing-fast-this-one-skill-will-ensure-that- continues/

[20] Reducing cross-border trade costs will increase Africa's competitiveness and revamp growth (dailymaverick.co.za)

[21] https://au-afcfta.org/

[22] https://www.dailymaverick.co.za/article/2023-04-02-reducing-cross-border-trade-costs-will-increase-africas-competitiveness-and-revamp-growth/

[23] https://www.afdb.org/en/documents/document/market-brief-the-middle-of-the-pyramid-dynamics-of-the-middle-class-in-africa-23582

[24] https://www.afro.who.int/publications/atlas-african-health-statistics-2022-health-situation-analysis-who-african-region-0

[25] https://foreignpolicy.com/2023/08/26/demographics-africa-sub-sahara-population-boom-growth-aging-gender-inequality-climate-change/

[26] https://www.knomad.org

[27] https://www.un.org/africarenewal/magazine/april-2019-july-2019/africa%E2%80%99s-megacities-magnet-investors

[28] https://www.iana.org/domains/root/db

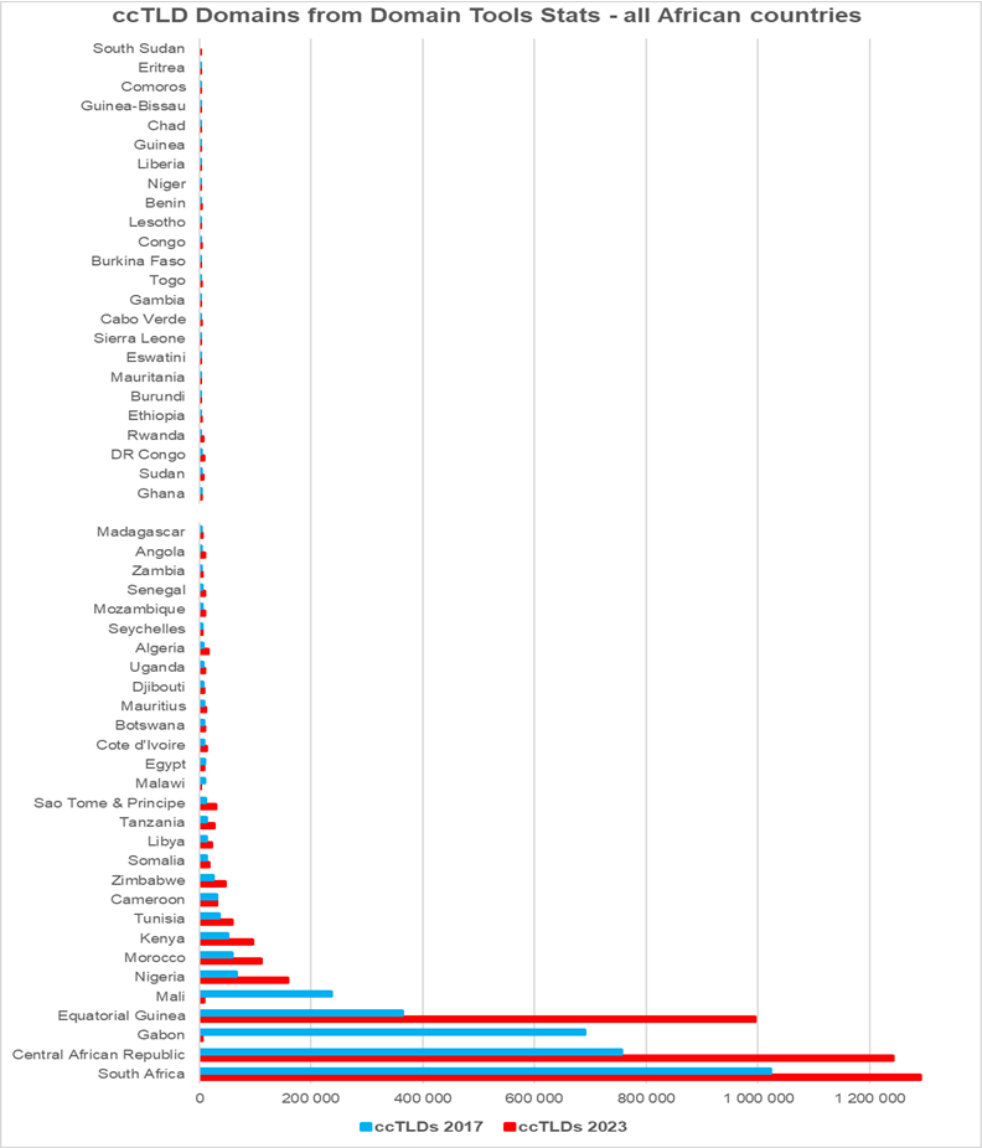
Table 4-2: Africa's contribution to the global number of ccTLDs

TLD Type	Global	Africa
Infrastructure	1	
Generic-Restricted	3	3
Test	11	
Sponsored	14	
Country Code	316	60
Latin Alphabet	255	54
IDN	61	6
Generic	1246	4
TOTAL	**1591**	**64**

All African domains fall in the Country Code or generic Top-Level Domain categories. The 54 African countries have their ccTLDs allocated and registered by ICANN. The newest African ccTLD is the South Sudan domain, .SS, which was allocated in 2011 following the country's declaration of independence. However, it was not added to the DNS root zone and was thus not operational until 2019, with general availability starting in 2020.

The graph below shows the total number of domains registered under each African ccTLD. Some countries report a disproportionately high number of domains registered. This is likely a result of registrars providing "free" domains, as they derive advertising revenue from expired domains, (Mali .ML, Equatorial Guinea .GQ, the Central African Republic .CF and Gabon .GA) or are attractive outside the country for exploiting meanings inherent in the domain name (such as .LY for common English words). These are referred to as "domain hacks" and are discussed later in **Section 5.3.3**.

Figure 4-1: ccTLDs per country in Africa – 2017 to 2023



[29]The most noticeable reductions in the number of recorded ccTLDs are in Mali (from 240 K domains in 2017 down to 8 K domains in 2023) and Gabon, which has dropped from 690 K down to 5 K. These enormous changes are most likely due to the demise of SafeCow,[30] which used to sell them as "domain hacks", which is discussed in **Section 5.3.3**.

The uptake of domain names locally is also affected by the individual country's ICT regulations and laws, for example fear of domain shutdown by the government has led to many users resorting to generic domain names.

There are only six African ccTLDs with IDNs, all for countries where Arabic is the official language. The IDNs for these countries are listed in Table 4-3 below:

Table 4-3: African IDNs

Country Name (English)	ISO	IDN
Algeria	DZ	الجزائر.
Egypt	EG	مصر.

[29] On the instruction of ICANN, PSA has excluded .NA DNS zone (ccTLD) data in this study report and observatory.

[30] See Section 5.3.3

Mauritania	MR	موريتانيا.
Morocco	ma	المغرب.
Sudan	SD	سودان.
Tunisia	TN	تونس.

Source:

The new gTLD .AFRICA was launched by the African Union Commission in 2017 to serve the African continent. As of November 2023, 70 accredited registrars have registered more than 135 000 .AFRICA domains[31].

Table 4-4 below reports those countries that have experienced significant growth in the number of ccTLDs registered since the original study conducted in 2017:

Table 4-4: Countries reporting significant growth in registered ccTLDs.

Country name	Growth in ccTLDS, 2017 to 2023	Share of total ccTLDs registered for Africa
Chad	57%	0.03%
Benin	52%	0.1%
Guinea-Bissau	33%	0.01%
Equatorial Guinea	33%	2.96%
DR Congo	26%	0.22%
Angola	25%	0.30%
Congo	25%	0.09%
Sao Tome & Principe	25%	0.87%
Algeria	23%	0.46%
Nigeria	23%	4.71%
Rwanda	23%	0.02%
Cabo Verde	21%	0.10%

Source:

4.3 INTERNET USE

While there is a wide variation in Internet use between the countries in Africa, the continent lags other regions in the use of the Internet and in the development of its local Internet industry. Although the number of Internet users in Africa has doubled from June 2014 to December 2021, the global number of Internet users has increased from 3 billion to 5 billion. As a result, Africa's share of the total has increased only marginally, from 9.8% to 11.7%.

Another variation can be seen most notably in Sub-Saharan Africa (with a population of 980 million people in 2015 versus 380 million in North Africa). Figures for 2022 are about 400 million and 980 million, respectively. Most Africans access the Internet using mobile phones. In 2015, the number of mobile

[31] https://registry.africa/about/

broadband subscriptions per hundred people in Africa was estimated at just over 10%[32] compared to a world average of about 47%[33]. By 2019, this figure had increased to 33.1%, compared to the then world average of 75%[34]. However, these figures obscure wide variation between countries. As shown in the chart below, 2015 Internet uptake varied from almost 70% in countries such as Kenya and Morocco, to less than 5% in countries such as Ethiopia, the DRC, Chad, Niger, and Eritrea. By 2022, Kenya exceeded 85%, with the Seychelles and Morocco around 70%. At the other end of the scale, Ethiopia, the DRC, Chad, and Niger are now all over 10%, with only Eritrea trailing at ≈7%

Almost every country shows a notable increase in the proportion of Internet users, except for Sudan and South Sudan, which have decreased the number of Internet users.

[32] http://www.gsma.com/newsroom/press-release/number-of-unique-mobile-subscribers-in-africa-surpasses-half-abillion-finds-new-gsma-study/ Mobile broadband subscriptions overestimate the extent of real use of broadband due to the high cost of the metered traffic business model which limits extensive use. However, it is the most up to date general indicator of Internet adoption. See https://www.apc.org/en/blog/inside-information-society-internet-governance-nee

[33] https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2015.pdf

[34] https://www.itu.int/dms_pub/itu-d/md/18/rpmafr/c/D18-RPMAFR-C-0002!!MSW-E.docx

Figure 4-2: Per Capita Internet Usage

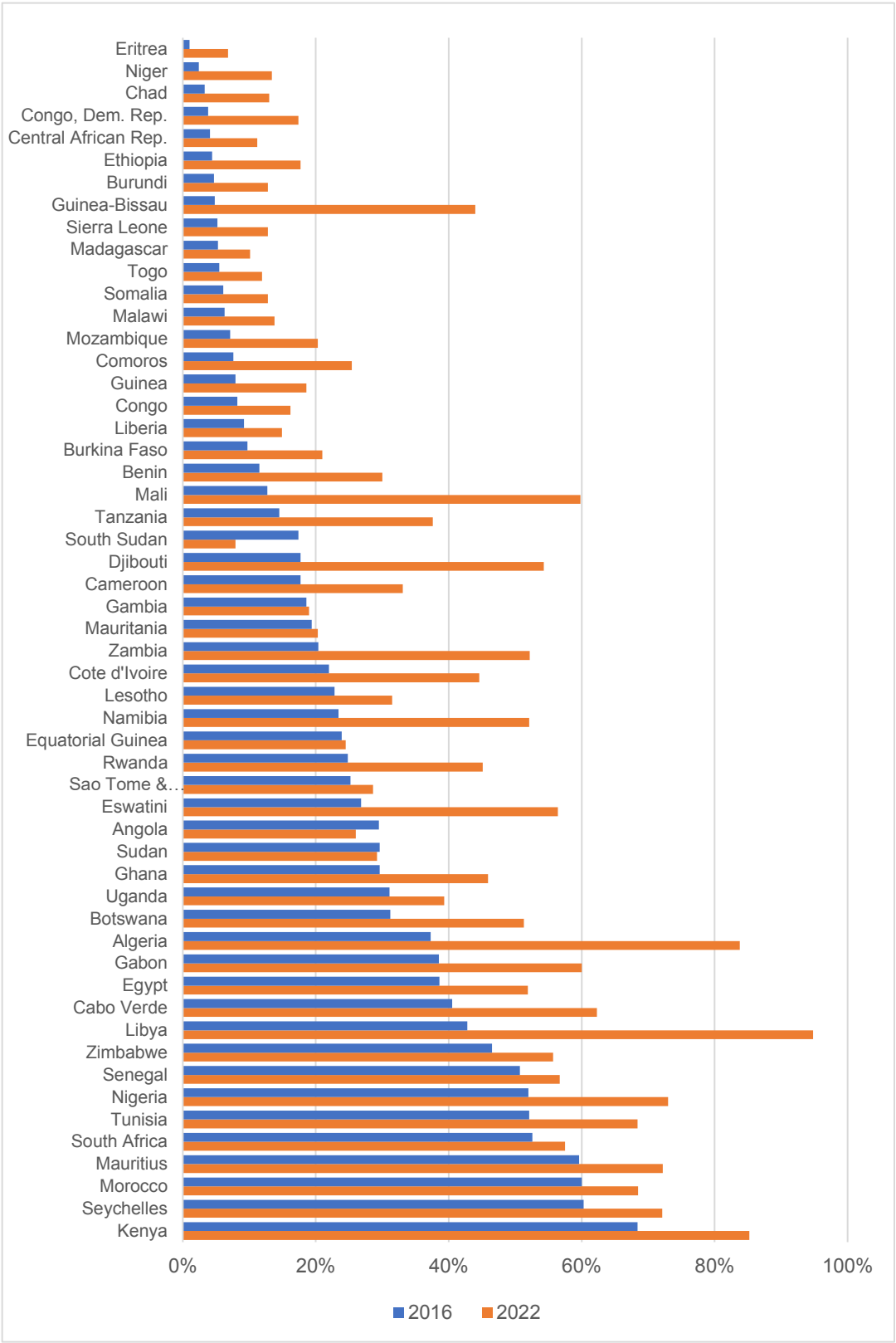
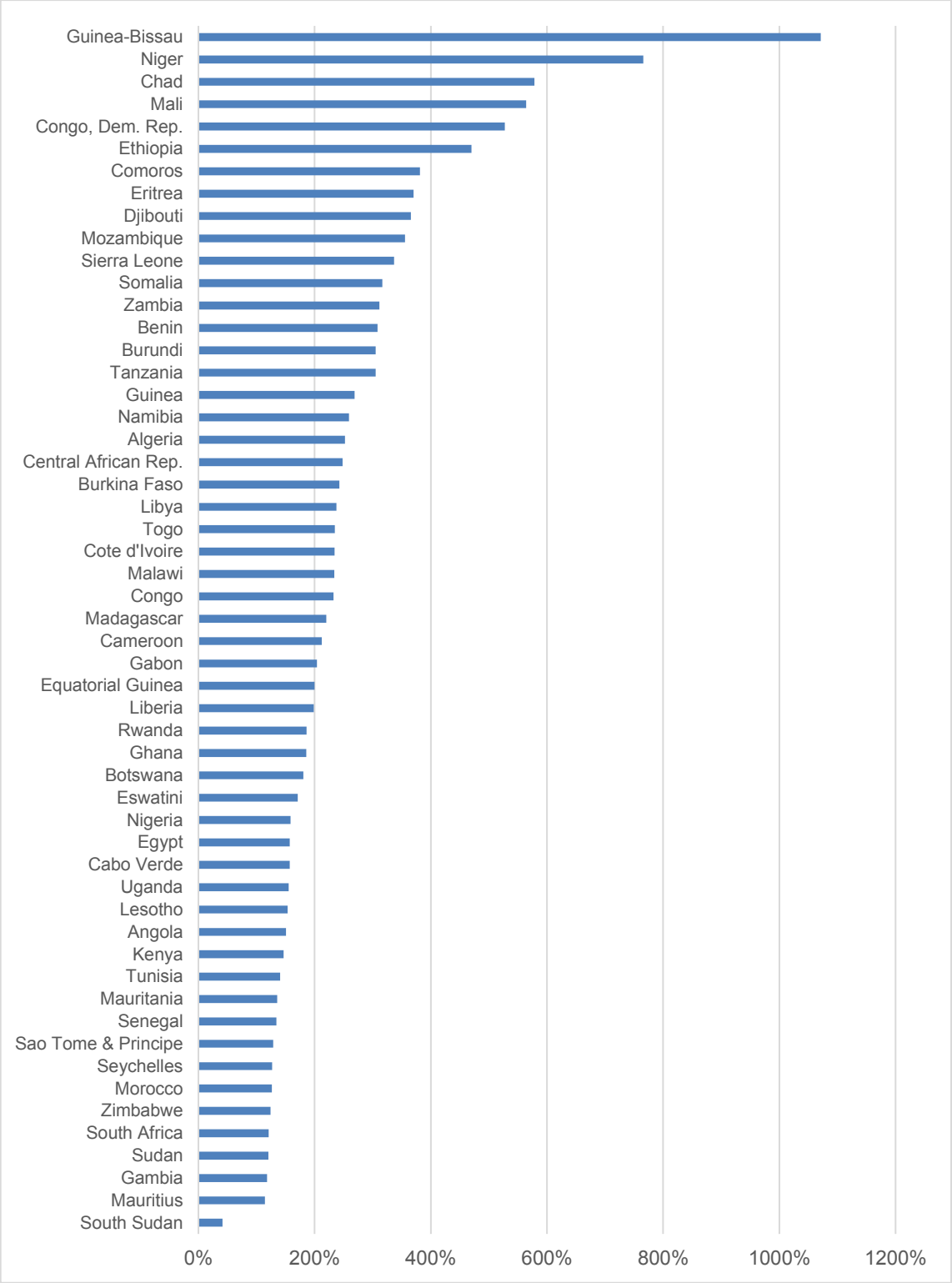


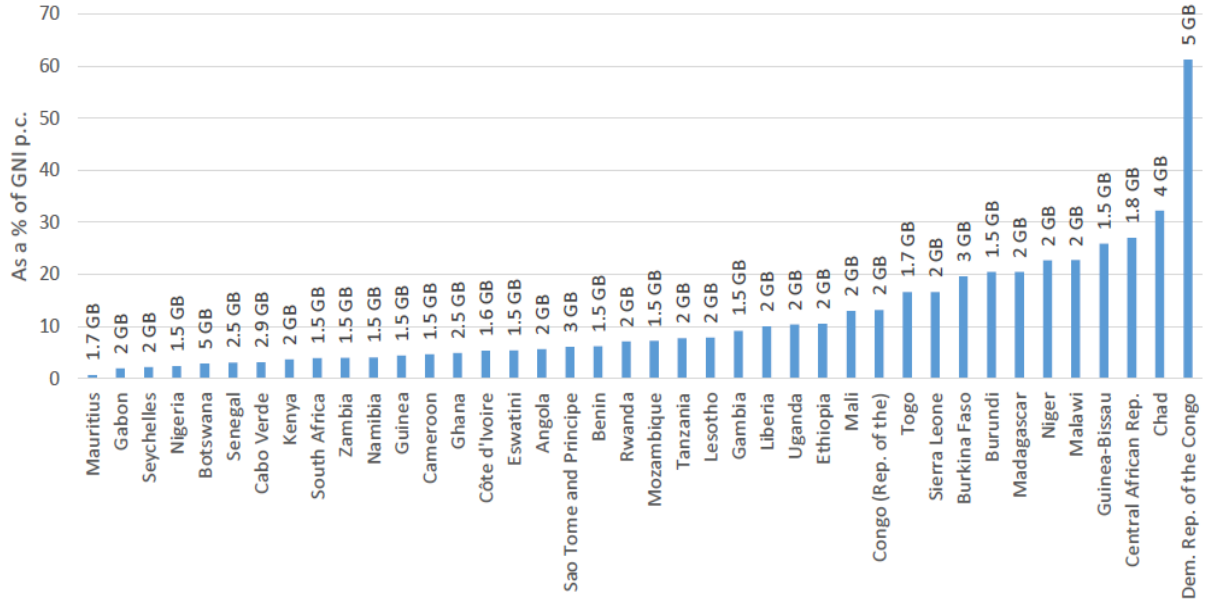
Figure 4-3: Internet User Growth, 2016-2022



Guinea-Bissau, Niger, Chad, Mali, the DRC, and Ethiopia all show high growth, albeit from a low base, quadrupling or more their number of Internet users. Even Eritrea increased by 370%.

Income is an important factor in determining Internet use, and further constraints are caused by the high cost of devices, limited relevant content and lack of digital literacy. However, the high cost of access and limited availability of infrastructure plays the major role in restricting Internet access, as discussed in the subsequent sections of this report, and as shown in the charts below, which underline the wide variation in mobile data cost and Internet uptake across the continent.

Figure 4-4: Mobile-data prices as % of GNI p.c. and monthly data allowance, Africa, 2019[35]



The varying levels of Internet uptake shown above are not simply a matter of those who are either connected or unconnected. It is also a matter of the type of connection used. While there are those connected on high-bandwidth unlimited connections, most people in Africa are connected on high-cost, low-speed metered mobile broadband links. Metered access and traffic caps severely constrain the amount of data that can be exchanged affordably and restrict the user's ability to manage costs of access effectively,- thus creating a further chilling effect on use.

Access to cost-effective local Internet infrastructure has a direct impact on the potential growth of demand and supply for local content, and in turn, on the use of domain names and services. The variations in Internet uptake between and within African countries is largely a reflection of the state of development of the underlying Internet infrastructure, as outlined in more detail in the following section.

4.3.1 DIGITAL LITERACY

Basic illiteracy, digital illiteracy and lack of Internet awareness are among consumer barriers to Internet adoption. The GSMA published the Digital Literacy Training Guide, March 2020, to address the knowledge, attitude and skills barriers and the Mobile Internet Skills training Toolkit (MISTT), September 2020, to teach people the basic skills to access and use mobile Internet. The GSMA has also worked with mobile industry partners in Sub-Saharan Africa to educate customers about smartphones and their effective use. The Association also invested in digital skills training via *Grow With Google* online courses. Over 5 million Sub-Saharan Africans have been equipped with digital skills[36].

Digital literacy covers users' ability to use digital tools to communicate, access, manage and integrate, synthesize, and use information to achieve learning and other life goals. In Africa, the significant investments made into ICT infrastructure, content and services, and the increasing proliferation of smart devices need to be matched by investments into digital literacy, if the continent is to maximize the opportunities presented by ICT. Digital literacy rate goes hand in hand with access to digital means. According to Internet World Stats, Internet penetration in Africa in 2022 was estimated to be 43 percent, with a recorded Internet growth rate of 12.98 % between 2000 and 2021[37]. The GSMA Mobile Economy Sub-Saharan Africa 2022[38] report has revealed that by the end of 2021, **515 million people** subscribed

[35] Measuring Digital Development: ICT Price Trends 2019 (itu.int)

[36] https://grow.google/intl/ssa-en/

[37] https://www.internetworldstats.com/stats1.htm

[38] https://www.gsma.com/mobileeconomy/wp-content/uploads/2022/10/The-Mobile-Economy-Sub-Saharan-Africa-2022.pdf

to mobile services in Sub-Saharan Africa, representing **46%** of the population. This is an increase of almost **20 million** on 2020. Despite the lag in Internet and mobile penetration in Africa, the curve of growth is increasing, and Africans are showing great zeal and commitment to embrace rapid technological change, its versatility and to bridge the global digital divide.

Literacy has risen to prominence both as a human resource issue and as an equity issue — limited literacy has been identified as perhaps the most formidable barrier to crossing the so- called “digital divide”, which is the gulf between those who have ready access to computers and the Internet, and those who do not. Digital inclusion continues to be a critical key to improving education and expanding the Domain Name System in Africa. However, lack of the use of native languages on the Internet prevents many native language speakers from using the mobile Internet which is English-oriented. This highlights that literacy outcomes must include proficiency in the English language as well as technology.

Lack of Knowledge, Access and Cost are huge impediments to get online as graphically illustrated in Figure 5-5 below. However, Africa is also beset with a lack of reliable and affordable electrical power. Without power, there is no Internet. The entire digital ecosystem relies entirely on reliable, affordable electricity, from home Internet connections to the base stations that underpin cellular networks to the data centres that store the Internet’s content. This means that Africa, with weak power infrastructure and which was already struggling to compete in the new digital economy, is facing bleak prospects in a post-lockdown world in which Zoom, Dropbox and Google Classroom are the new office or school. The GSMA’s report of October 2023 *Energy Challenges for Mobile Networks in Sub-Saharan Africa* stresses the need for clean and reliable energy for universal connectivity and digital transformation[39].

Sub-Saharan Africa, where the digital transition has long been touted to leapfrog traditional infrastructure, is especially vulnerable to falling behind. Chronic challenges in the power sector such as low electrification rates, high prices and appalling reliability have significantly impacted the region’s digital competitiveness. Source: Scientific American – Rose Mutiso, Katie Hill – August 11, 2020[40].

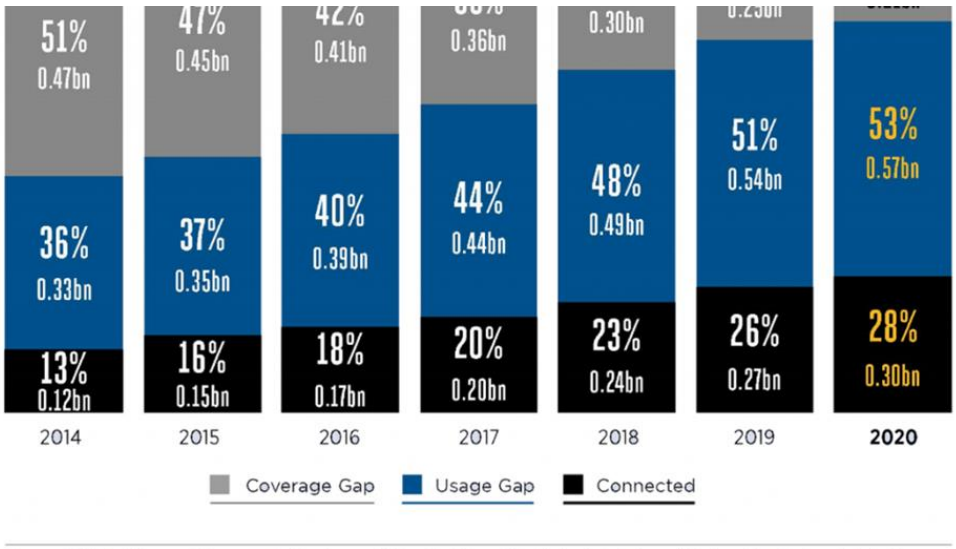
The GSMA report, *Mobile Internet Connectivity in Sub-Saharan Africa*, October 2021[41], reveals some positive digital developments in the region as depicted in Figure 4-5 below. The figure shows that Mobile internet adoption continues to increase although at a much slower pace than coverage expansion. Both are, nevertheless, riding on an upward trend.

[39] https://www.gsma.com/betterfuture/resources/energy-challenges-ssa

[40] https://www.scientificamerican.com/article/why-hasnt-africa-gone-digital/

[41] https://www.gsma.com/mobilefordevelopment/blog/the-state-of-mobile-internet-connectivity-in-sub-saharan-africa/

Figure 4-5: Coverage and Usage Gaps



Source: GSMA Intelligence. 'Usage gap' refers to populations that live within the footprint of a mobile broadband network but who are not using mobile internet. 'Coverage gap' refers to populations that do not live within the footprint of a mobile broadband network (3G or above).

NB: totals may not add up to 100% due to rounding.

The African Union (AU) has had to grapple with the reality that many of its member states' citizenry are not getting online. The digital revolution is not transforming the lives of citizens because they lack digital skills; they struggle to find an Internet that is relevant to them and critically they cannot afford it. Many AU member states have had to generate National ICT plans to get more of their citizens online. An urgent call has also been made to the African Union to urge its Member States to make digital literacy a basic right for their citizens.

The Digital Revolution is not transforming lives because citizens lack digital skills.

The AU **e-Africa Programme** is mandated with the task of leading the African ICT agenda to ensure that it responds to the technological changes that are taking place. Capacity development and the promotion of digital literacy, e- Learning and ICT for education (through digital literacy training programmes), are part of the AU's Comprehensive ICT Strategy for Africa 2015 – 2025. Skills development remains key towards addressing the challenges facing the continent, hence the need to promote digital literacy training programmes and develop e-learning based local and localised content and services.

One of the African Union's THE DIGITAL TRANSFORMATION STRATEGY FOR AFRICA (2020 – 2030)'s specific objective is to ensure that by 2030 all Africans should be digitally empowered and able to access safely and securely to at least 6 Mbps all the time where ever they live in the continent at an affordable price of no more than USD$0.01 per MB through a smart device manufactured in the continent at the price of no more than USD$100 to benefit from all basic e-services and content of which at least 30% is developed and hosted in Africa;

4.3.2 LANGUAGE LITERACY AND IMPACT OF LOCAL CONTENT

In general literature, "local content" usually refers to the content that is to serve a geographic area and uses local languages for communication. In the Internet context, this is an intended meaning, besides the usage of cyberspace in addressing local matters and to find solutions to local issues. Thus, for the purpose of this study, we will define local content as "the digital content that is generated locally or internationally to address local interest and mostly available in local languages".

The availability of local content is driven by the incentive to get online, and vice versa. This may comprise government and commercial services and socially generated content. In this regard, the development of local content inspires local hosting preferences. However, local content can still be hosted globally especially for social content including YouTube, Facebook, X (the former Twitter), etc. Conversely, the locally hosted content refers to digital content that is hosted in-country, either on servers, in caches, or delivered by content delivery networks (CDNs) with a presence in the country.

In Africa there are +3000 local languages spoken. The content that is most important to people is obviously in their own language and related to their local communities. Further, cyberspace defines new group structures that may share culture, religion, ethnicity, or any other common interest via the Internet. The Internet facilitates individuals as content creators. Several platforms are utilizing crowd-sourced content creation and verification concepts. This includes scientific publishing using the peer-reviewed methodology.

Some empirical research conducted by ISOC shows there is a strong correlation between the development of network infrastructure and the growth of local content, even after controlling for economic and demographic factors. However, this is not significantly reflected in the DNS industry, as most of the local content is hosted on social content type platforms. However, the usage of TLDs as an identity for community and groups is getting considerable attention, since the emergence of new gTLDs and .AFRICA is a good example, from African experience, of such development.

Research informs us that across the globe, Internet users are consuming more and more content through “apps” and the mobile Internet. Availability of local content plays a vital role in the adoption of the Internet in developing countries, but at present, most of the content is in English and is largely focused on data-heavy smartphone apps. Smartphone penetration is still low in the developing world and English is not the primary language, limiting the accessibility and usefulness of the content. To reach the widest audience, content needs to be available on as many devices as possible in languages the users understand, as well as being relevant to their local needs and interests. It is interesting to note that E-government services have emerged as a major source of local content for mobile Internet in developing countries, and as a driver for the use of mobile Internet[42]. Creating content that is specific and relevant for developing countries is a difficult task but is crucial as local content raises awareness and drives uptake of the mobile Internet, attracting developers, increasing innovation, creating more value for stakeholders, and increasing interest in generating more relevant content. This increases user engagement and pushes the uptake of mobile Internet further, creating a win-win situation for stakeholders across the entire ecosystem.

However, the bulk of Internet access using smartphones makes use of apps, which are typically tied to major websites such as Facebook, and therefore does not foster the sale of additional domain names.

4.3.3 ACCESS TO SMART DEVICES

Smart devices continue to drive Internet usage in Africa, as most Africans access the Internet using smart phones. It is estimated that there are 499 M smartphone connections out of 980 M SIM-connections in sub-Saharan Africa as of 2022, and mobile subscriber penetration stands at 46% of the population and with 287 M (25% penetration) mobile Internet users and smartphone adoption rate of 64% of the mobile phone users.

The GSMA further reports that sub-Saharan Africa will see the biggest increase in smartphone adoption by the end of 2028, reaching 87% by the end of 2030, up from 51% in 2022. These developments will arise from an increasing young population, competitive pricing in the mobile sector, and mobile power banks for rent/purchase – a market expected to grow to more than 600 million users over five years. Furthermore, mobile data traffic per mobile in Africa will nearly quadruple, increasing 3.9 times by 2028,

[42] https://au-afcfta.org/

growing from 4.6 GB per user per month to 18 GB[58]. At the same time, it is expected that business and consumers will experience a massive connectivity at the 5G level.

Smart devices include smartphones, phablets, tablets, smartwatches, smart bands, and smart key chains. The most widely used smart devices to access the Internet are smartphones and tablets. The increasing affordability of smart devices is driving the increase in mobile broadband uptake in Sub-Saharan Africa, according to the 2016 Ericsson Sub-Saharan Africa Mobility report. Furthermore, according to the Ericson Mobility Report for June 2023, Sub-Saharan Africa is forecast to be the region with the highest growth in total mobile data traffic, rising by 37% annually between 2022 and 2028 as service providers across the continent continue to invest in 4G networks and migrate customers from 2G and 3G. This increase in data traffic will primarily be driven by a four-times increase in smartphone traffic in the period, from 2.9 GB/month average data per active smartphone in 2021 reaching 19 GB per month in 2028.

By comparison, Statista reports that Internet access via laptop or desktop was reported by almost 62.6% of respondents; and that Ericsson predicted the number of smartphone subscriptions in Sub-Saharan Africa would reach 1.1 billion in 2028.

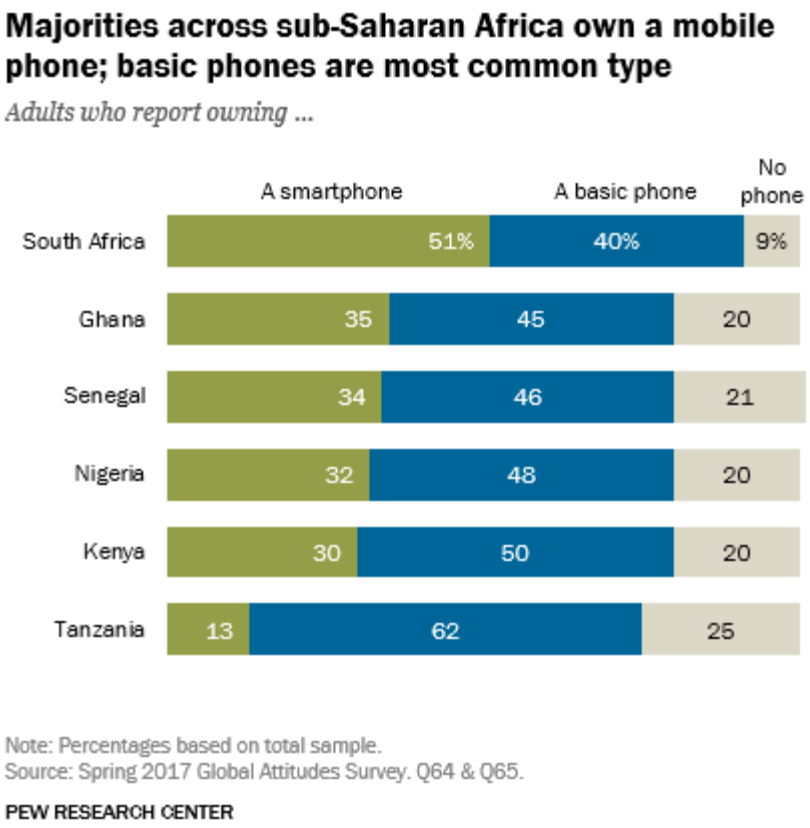
In January 2023 about 22 million South Africans used smartphones, about a third of the population, with a much higher number of overall mobile connections. Smartphone users are estimated to grow by more than five million to the end of 2023. According to the Communications Authority of Kenya, with about 55 million population, penetration in smartphone increased from 54% in June 2022 to 61% in June 2023. At a population of 16.49 million in January 2023 Zimbabwe had 5.74 million internet users in January 2023. Internet penetration stood at 34.8% of the population.

The number of smartphone users in Nigeria, with a population of more than 200 million, is forecast to grow to more than 140 million by 2025. Currently, early 2023, smartphone users are estimated at roughly 25 and 40 million. It is expected that this number will at least triple within the next five to six years.

The Uganda Communications Authority reported, for the first quarter of 2021, that mobile subscriptions stood at 67% of the population of Uganda. According to AfterAccess, less than 49% of Ugandans have access to a mobile phone. In 2021 the GSMA estimated that Uganda had a smartphone adoption rate of 16%, markedly lower than the 30% average of Sub-Saharan Africa. Datareportal's January 2021 report showed 60.3% of mobile connections in relation to the country's population, a 4% improvement from their similar report from the previous year[43]. GSMA's latest Mobile Connectivity Index (2023) placed the figure at 64%[44].

[43] https://datareportal.com/reports/digital-2021-uganda

[44] https://www.mobileconnectivityindex.com/%22%20/l%20%22year=2019&zoneIsocode=UGA



Although the Pew Research Center chart above was surveyed in 2017 it, however, largely depicts mobile phones ownership structure in the six Sub-Saharan African countries which shows that a sizable number of consumers own mobile phones. South Africa's ownership is the highest, with Tanzania coming in at the lowest level. Overall, smartphone ownership is increasing across Sub-Saharan Africa. For example, 34% of Senegalese report owning a smartphone. In Ghana, Senegal, Nigeria, and Kenya just about one third of consumers own smartphones.

Kenya will exceed 12 million (26% of the population) by the end of 2017. In Kenya, more than half of total Internet advertising revenue already comes from mobile devices as smartphone owners grow in number, helped by lower data costs coupled with growing 3G and 4G access[45].

The most significant finding from another study was that Internet browsing via smartphones reached an average of 40 per cent in Africa, with 51% of respondents in Ghana, 47% in Nigeria, South Africa at 40%, Kenya (34%) and Uganda (29%)[46].

Statista, in a publication by Petroc Taylor on 14 August 2023, reports that the smartphone penetration in South Africa was forecast to continuously increase between 2024 and 2028 by 2.7%. After the ninth consecutive increasing year, the penetration is estimated to reach 41% and therefore a new peak in 2028.

The above research reports confirm that access to smartphones in Africa is increasing over time. It is expected that this phenomenal growth will lead to the expansion of the Domain Name System in Africa.

4.3.4 COST TO COMMUNICATE

Affordability of telecommunications services is a critical issue either enabling or hindering the uptake of online services. The affordability threshold of spending 2% or more of personal income on access to

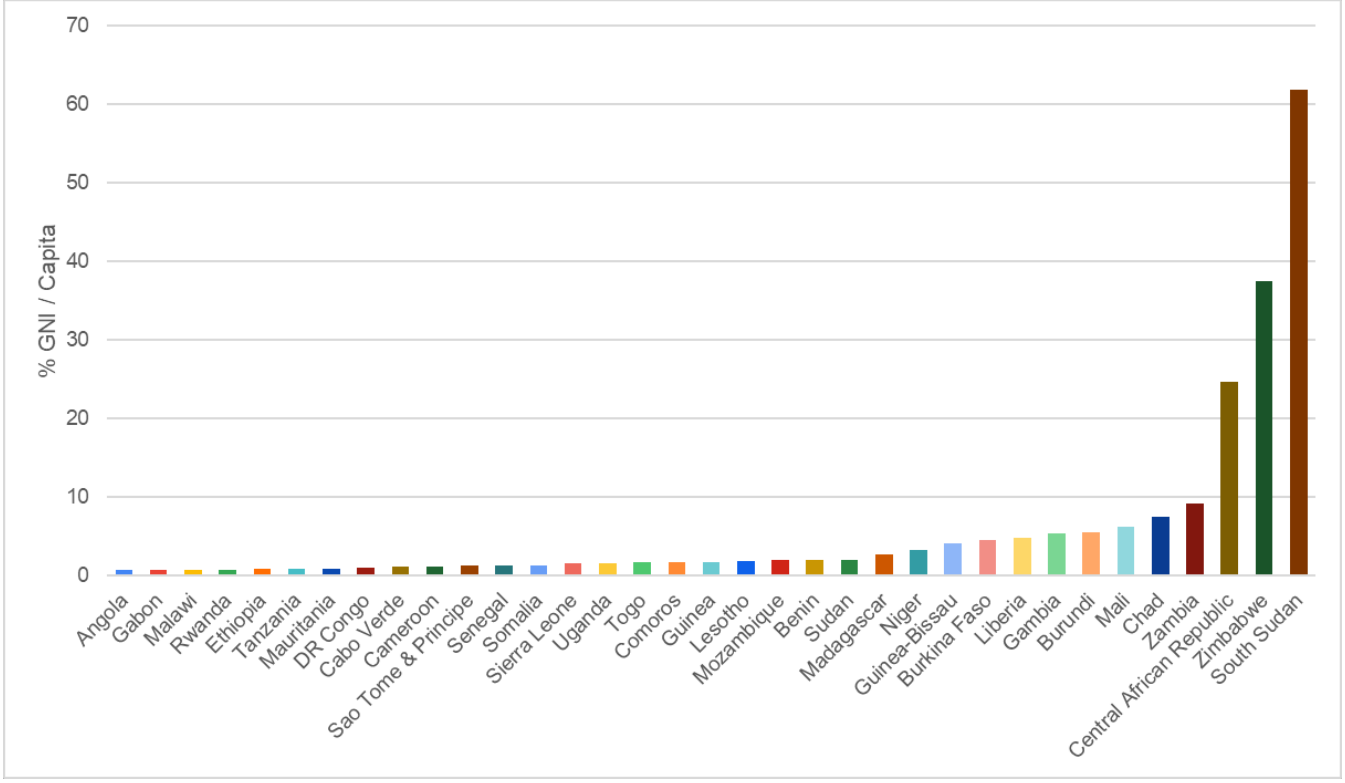
[45] https://www.pwc.co.za/en/assets/pdf/enm/entertainment-and-media-outlook-2016-2020.pdf , PwC South Africa, Nigeria and Kenya Entertainment and Media Outlook Report.
[46] http://www.worldwideworx.com/ , http://calleo.co.za/mobile-africa-2015-african-phone-use-decoded/

telecommunications services is widely considered a key barrier[47]. Households or individuals required to spend above this threshold are likely to be significantly inhibited in their ability to adopt and use services enabled on ICT platforms.

Affordability is also one of the issues tracked by the International Telecommunication Union (ITU) in its annual Information Society reports. The ITU 2022 report estimates that about 18% of the population in sub-Saharan Africa live within the footprint of mobile broadband network but are not using mobile internet services[48], while half the population in the region still lack access to 4G or 5G services.

Affordable access to mobile communications services is a key issue in relation to Internet access in Africa, where the access path is predominantly via mobile telephones. In countries where mobile services are unaffordable, Internet access and consequently DNS uptake is likely to be substantially inhibited. The graph below shows that there is a dramatic affordability divide across Africa for a defined basket of mobile cellular services, with costs of 1 GB of data per month ranging from 0.07% of Gross National Monthly Income per capita (Mauritius) to a prohibitively expensive 62% (South Sudan). [source: World Bank GNI/capita 2022 data with Cable.co.uk mobile broadband cost data[49]]. The raw US dollar prices for the same defined basket range from USD $0.38 (Malawi) up to USD $43.8 (Zimbabwe). [Source: Same as above]

Figure 4-6: Cost of Mobile Cellular Services Basket as % of GNI



Source: World Bank GNI/capita 2022 data with Cable.co.uk mobile broadband cost data[50].

Expensive Internet access results in more limited uptake of Internet and broadband services in Africa, which in turn is expected to reduce demand for Domain Names and a sluggish DNS market.

[47] ITU Broadband Commission recommends 2% of GNI/capita as target for mobile broadband for 1 GB of data https://www.broadbandcommission.org/

[48] https://www.itu.int/dms_pub/itu-d/opb/ind/d-ind-ict_mdd-2022-pdf-e.pdf

[49] https://data.worldbank.org/indicator/NY.GNP.PCAP.CD https://www.cable.co.uk/mobiles/worldwide-data-pricing/

[50] https://data.worldbank.org/indicator/NY.GNP.PCAP.CD https://www.cable.co.uk/mobiles/worldwide-data-pricing/

While affordability has improved significantly since the Commission set its initial target in 2011 of 5% of GNI per capita, costs remain high in many countries - the average cost across all African countries is still 4% of GNI/capita. Increasing the demand broadband with national ICT strategies that address the new target will help ensure lower income groups in gain connectivity.

On the supply side, conservative spectrum assignments have restricted the potential for new providers looking to make use of the latest technologies. For example, fixed broadband operators can use new wireless systems such as TV White Space (TVWS) and other dynamic spectrum-sharing approaches. However only South Africa, Mozambique and Kenya have so far authorised the use of TVWS on the continent, although TVWS regulatory frameworks have reached the consultative stage in Ghana, Malawi, Nigeria, and Uganda. if other countries follow the examples of South Africa, Malawi and Mozambique, hopefully other regulators will be encouraged to follow suit, thereby improving internet connectivity, especially in rural areas where connectivity is still very low.

Similarly, few countries in Africa have authorised the use of Starlink and its associated radio frequencies – Nigeria, Kenya, Rwanda, Mozambique and Zambia. LEO satellite networks such as Starlink, Kuiper and OneWeb offer significant potential for extending connectivity to anywhere on the continent, and it appears that regulatory environments in most countries in Africa still need to be adjusted so that the public in unconnected areas can take advantage of this.

By the same token, Registries and Registrars across Africa are therefore well advised to engage policymakers and regulators with respect to addressing the high cost of telecommunications services, the high prices of mobile data, and the lack of universal coverage.

Moves in this direction with regard to data pricing have taken place in a number of countries, where regulators – often under pressure from the consumers of mobile voice telephony - have moved decisively to lower mobile termination rates (e.g., Botswana, Kenya, Mozambique, South Africa, Tanzania, and Uganda), with the aim of increasing the affordability of mobile telephony for consumers[51].

Similar interventions regarding data prices are still in their infancy in many countries[52].

4.3.5 SOCIAL MEDIA AND MESSAGING APPS

Africans are active social media users. Patterns of use reflect the state of Internet access in Africa and are different from those in other parts of the world. Many Africans use both global and local platforms, and much of the discussion takes place on WhatsApp groups, often in local languages, and with the content only accessible to group members. Analysis of global social media usage in 2022 indicates that the average use of WhatsApp (as a percentage of overall social media use) in Africa was 35% higher than it was globally. When it comes to platforms, Facebook is the most widely used, followed by YouTube, Twitter, and Instagram. But TikTok is growing fast, and so are homegrown platforms like KenyaTalk in Kenya, Nairaland in Nigeria, and JamiiForums in Tanzania. JamiiForums stands out as the discussion there is mostly in Swahili. For this study, it is worth noting that even though these are locally run platforms, they use the .com gTLD as opposed to a country code domain or the .AFRICA gTLD.

More Africans use messaging apps for day-to-day communication than either SMS or voice calls. Landlines are rare and mobile phone voice calls and SMSs (Short Message Service) are much more expensive than short calls or voice and text messages sent over social media platforms like WhatsApp, Facebook Messenger, and WeChat. People do not just use social media for “social” purposes. They use it to access news, for formal and informal business, to access market prices of agricultural produce, and,

---

[51] Stork, C & Gillwald, A (2014) ‘Link between termination rates and retail prices in Namibia, Kenya and South Africa’, *Telecommunications Policy* No 38

[52] Mann, D (2016) ‘Data Prices Are Too Expensive For Most. You Should Care.’, Huffington Post, 28 November 2016, available online at http://www.huffingtonpost.co.za/dillon-mann/data-prices-are-too-expensive-for-most-you-should-care/

to talk about politics, particularly during elections or periods of political upheaval. An Afrobarometer survey released in early 2022 indicates that usage of digital sources for news has nearly doubled since 2015 with “more than four in 10 adults across 34 surveyed countries reporting that they turn to the Internet or social media at least a few times a week for news”. This reliance on social media for news is reinforced by a lack of confidence in the independence and reliability of print and broadcast media, many of which are either directly or indirectly controlled by governments. In their 2022 ranking, Reporters Without Borders scored only seven African countries as having a “satisfactory” level of press freedom. Talk radio is also popular and many radio stations use social media as a way for people to call in or send messages using WhatsApp or WeChat voice notes.

Because so many people use the same platforms for personal communications as they do for work and business purposes, it follows that they also use these platforms to participate in public and political life. This is a positive development. However, this also means that people are exposed to scams, harassment, misinformation, and fake news without the necessary digital safety or literacy skills to be able to respond to these effectively. Scams and fraud are common and mostly target the millions of Africans who use mobile money services like MPESA. These harms impact negatively on a free and open Internet and the role it can play in advancing human rights and democracy. All of them are committed by people, not by technology or the Internet, and addressing them sustainably requires online and offline actions by Internet Service Providers (ISPs) human rights defenders, educators, platforms, and law enforcement agencies. Misinformation is generally understood to be false or inaccurate information that is spread without the specific intention to create harm. Disinformation is deliberately created and distributed and includes malicious content, hoaxes, propaganda, and “deep fakes”, often designed to spread fear and suspicion and to deliberately disrupt political processes such as elections.

Child online safety is a major concern for many African governments and an impetus for content regulation. Child sexual abuse material (usually referred to as child pornography) is already illegal in most countries in the world so does not generally require new legislation – what it does require is effective law enforcement and cyber forensic capacity. But it is not the major cause of sexual harm experienced by children. Research done in 2021 by “Economist Impact”, part of the UNICEF-led “We Protect Alliance”, reveals that most online sexual harms against children happen in private -- 68% on private messaging platforms and 29% through private image sharing. Only 18% of harm took place through the public social media forums targeted by most online content regulation.

Xenophobic and religious hate speech on social media occur in several parts of Africa, and, from time to time, e.g. during periods of crisis, or elections, flareups can go as far as inciting physical violence. But it can also function as early warning of brewing conflicts which, if addressed in time, can save lives. Extremism is also manifest through groups like Al Shabaab using the Internet to recruit and communicate with cadres, including young women. Much of this takes place on private WhatsApp groups and effective responses can involve surveillance, which, in turn, raises human rights concerns. Collaboration between digital rights groups and law enforcement and intelligence actors is a difficult, but important area. Counter terrorism is important, but also open to abuse by authoritarian regimes.

DNS industry players should stay aware of these trends, even if most of these social media-linked online harms do not necessarily constitute domain name abuse. However, their interests and experience are vital to combating these challenges without resorting to over-regulation.

4.4 INTERNET INFRASTRUCTURE

As detailed in the following three sections, the state of Africa’s Internet infrastructure can be viewed at three levels:

1. The backbone infrastructure which consists of:
    a. the international submarine and cross-border fibre backbones, which are usually operated by consortia of national and international carriers.

   b. the international satellite links, used especially in landlocked countries, peri-urban and rural areas, and
   c. the copper, microwave and fibre national backbones operated by fixed and mobile retail broadband operators, and dedicated wholesale providers, some of which are government owned, others privately and some as private-public partnerships.
2. The local last-mile connection to the end user, dominated by the incumbent, national fixed and mobile operators, mainly using DSL, 3G/4G and Wi-Fi technologies, although there are also a significant number of satellite links and other fixed wireless services using licensed wireless spectrum. Fibre to the home (FTTH) is also beginning to be a factor in high value urban areas in several African countries. Increasing telecoms liberalisation in many African countries has led to a significant reduction in the role of national fixed line operators.
3. The interconnection (IXP) and data centre/hosting facilities necessary to support interconnection between networks and to online services.

4.4.1 BACKBONE INFRASTRUCTURE

As shown in the maps below, the penetration of backbone fibre infrastructure in Africa has increased rapidly over the last decade and a half, especially in terms of the large number of submarine cables that now encircle the continent. All the coastal countries[53] except Eritrea have direct access to at least one submarine cable and most countries have access to at least two. This has greatly increased the availability of international capacity (to far greater levels than are currently used) and has driven down the price of international capacity to as little as US $20 / Mbps / month in countries where there are multiple competing cable landings. By 2023, this has come down to about US $9 / Mbps / month. Only 15 years ago, prices were as high as US $20,000 / Mbps / month.[54] [55]

International bandwidth demand has demonstrated enormous price elasticity, with the continent's inbound Internet bandwidth consumption increasing by 51% during 2015 alone and reaching 26.9 Tbps by December 2021. Africa has been the fastest growing region in terms of international bandwidth and has shown a CAGR[56] of 52% from 2017 - 2021. Africa experienced a compound annual growth rate of 52% between 2017 and 2021 for submarine capacity[57]. During the last decade, the amount of Internet bandwidth consumed by Sub-Saharan Africa has increased by a factor of 230, from 12 Gbps in 2006 to 2,759 Gbps in 2015 to 12 Tbps (12,000 Gbps) in 2018. Recent submarine cables commissioned include, on the West coast: - SACS – Angola to Brazil (2018, 40 Tbps); and Equiano (2022, 140 Tbps). On the East coast: - METISS, South Africa to Madagascar & Mauritius (2021, 24 Tbps); DARE1 (2012, 36 Tbps); and PEACE (2022, 60 Tbps). The 2Africa cable circumvents Africa, with 29 landings on both coasts and 180 Tbps capacity it will approximately triple the total available capacity to Africa.

[53] Guinea-Bissau connected to the ACE cable in March 2023. https://www.africabandwidthmaps.com/?p=6929

[54] GISW2009Web_EN_1.pdf (apc.org)

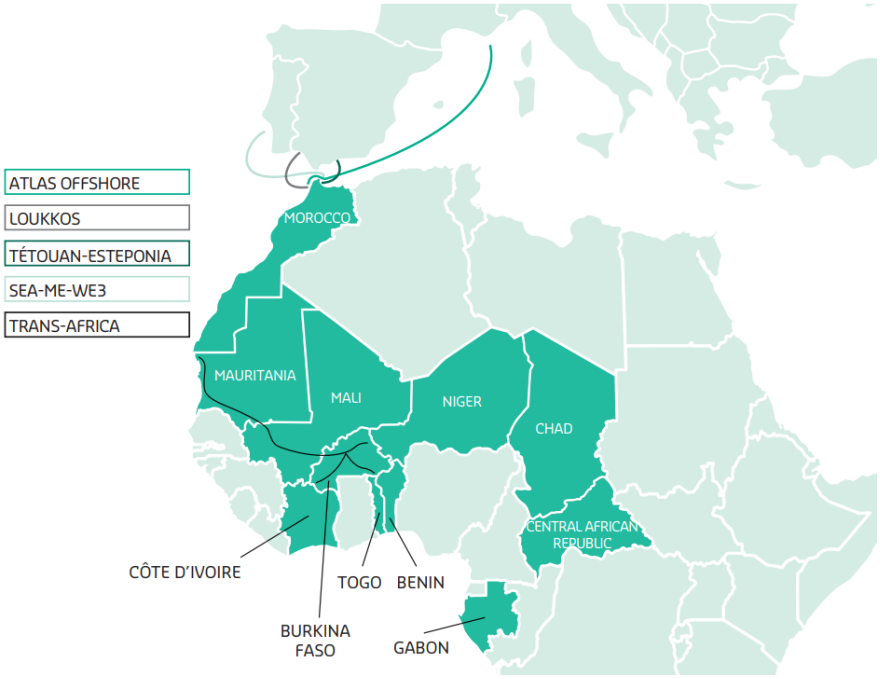
[55] https://www.apc.org/en/news/access/africa/east-africa-needs-fair-entry-ticket-afford-cybersp

[56] CAGR = Compound Annual Growth Rate

[57] https://www2.telegeography.com/hubfs/LP-Assets/Ebooks/state-of-the-network-2023.pdf

National fibre backbones are being extended, or are being built, in virtually all countries in Africa and now connect most secondary cities. Multiple cross border fibre links are, or will shortly be[58], present on all major routes[59], although it will still be some years before harmonisation of the regulatory environment for interconnections are in place to provide seamless terrestrial connectivity across the continent. Since 2016 big regional operators have emerged to exploit this new cross border infrastructure. In the North and West, we have Maroc Telecom.

Figure 4-7: Map of Maroc Telecom International Fibre Cables

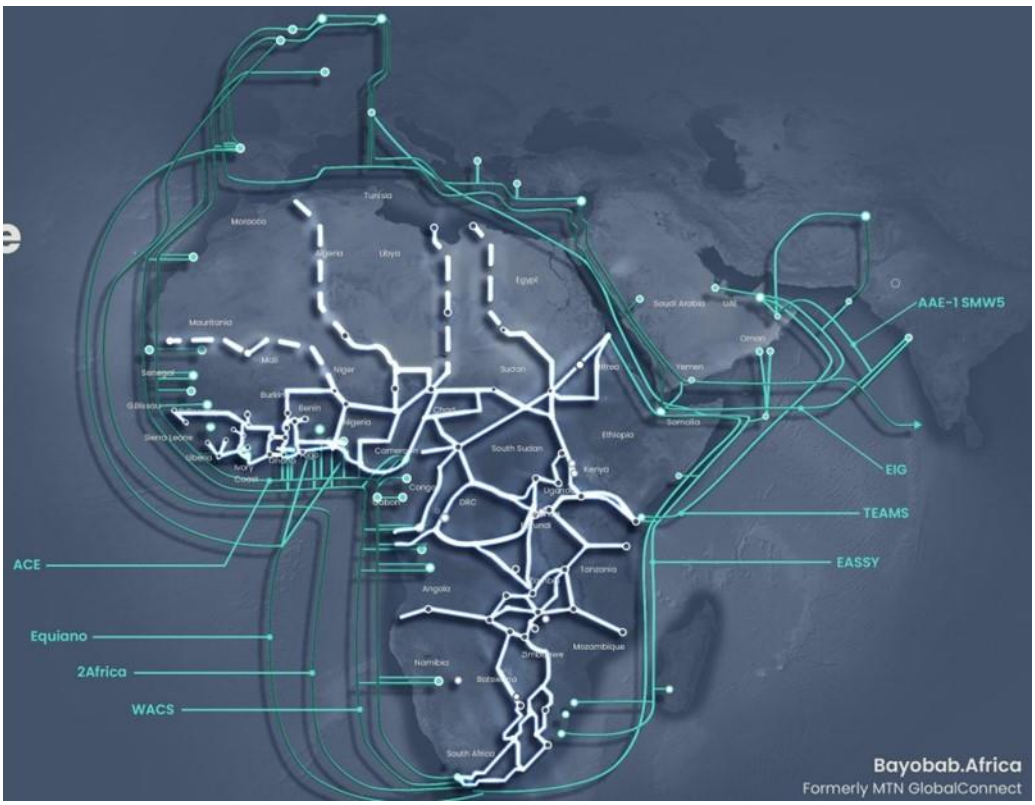


Source: *https://www.iam.ma/Lists/TelechargementFinance/Attachments/1347/Maroc-Telecom_2020-Universal-Registration-Document.pdf page 114*

MTN's Baobab Fibre network is expanding to 135,000 km across most of the continent.

Figure 4-8: MTN's Baobab network

[58] PIDA / ECOWAS infrastructure studies. Private communication
[59] As shown in the Afterfibre.nsrc.org map Figure 5-6 below.

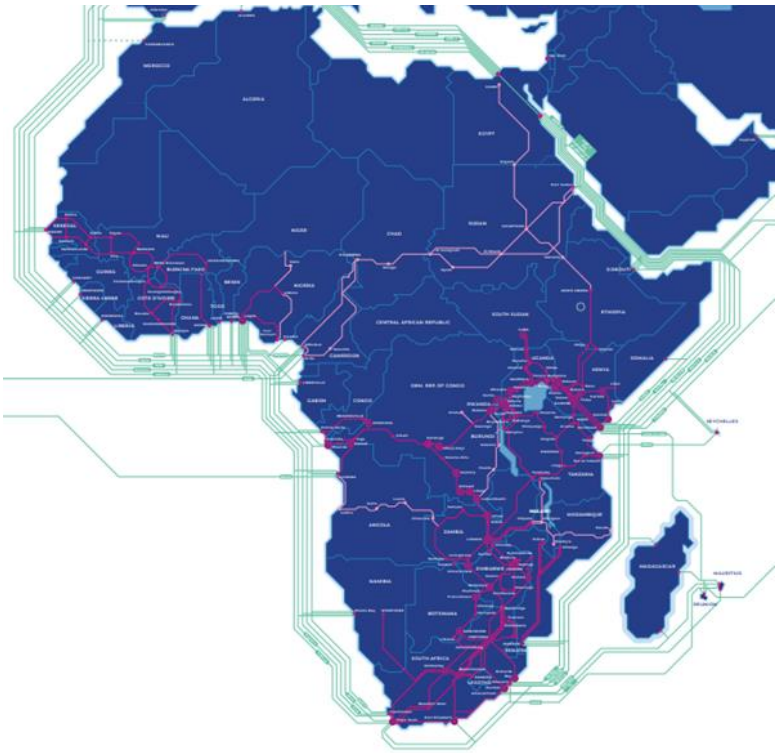


Source: Adapted from https://www.mtn-investor.com/mtn-cmd-2023/pdf/presentations/day2/fibreco.pdf

Liquid Telecom meanwhile is focussing on Southern and Central Africa.

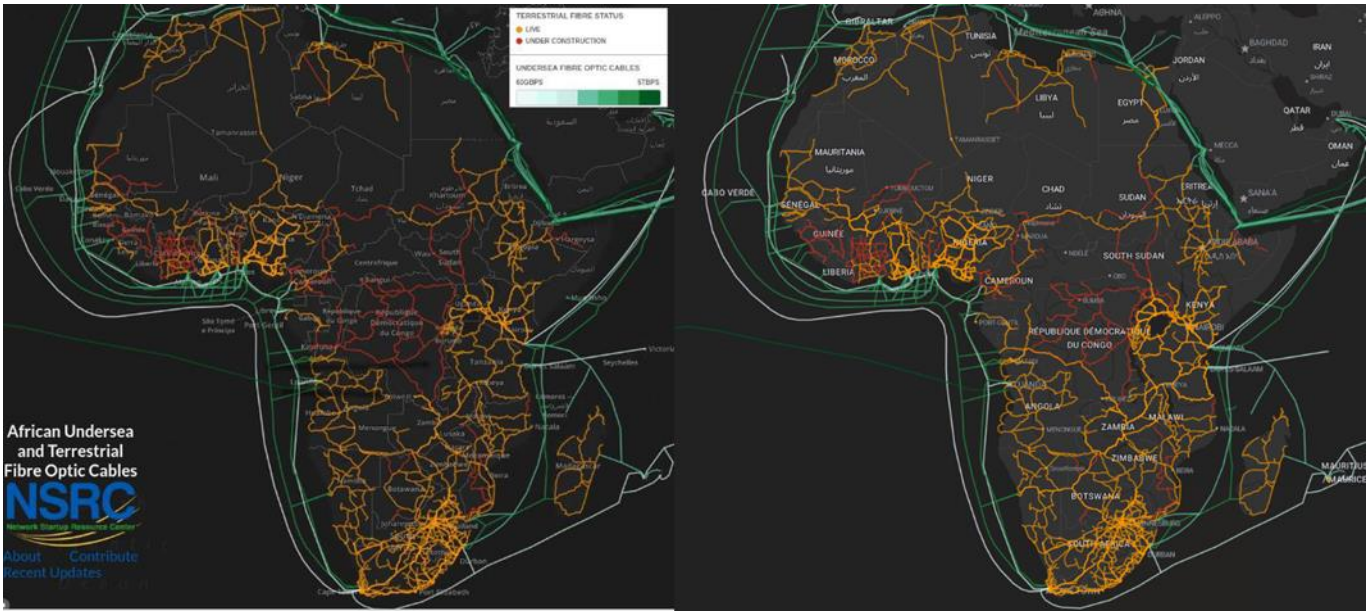
While these expansions of fibre networks are very significant, further extensions of national backbones to more remote areas are needed to ensure that the large rural populations present in Africa can be connected cost effectively. Limited investments in backbone telecommunications infrastructure have led to expensive inter-city links contributing to high costs of the Internet.

Figure 4-10: Liquid Telecom Fibre Network 2023



Source: https://www.liquiddataport.com/wp-content/uploads/2023/09/LIT-Fibre-Map-Sept23-Global.pdf dark pink = Liquid telecoms own fibre, light pink = leased fibre

Figure 4-11: African terrestrial and undersea cables, 2016 and 2022

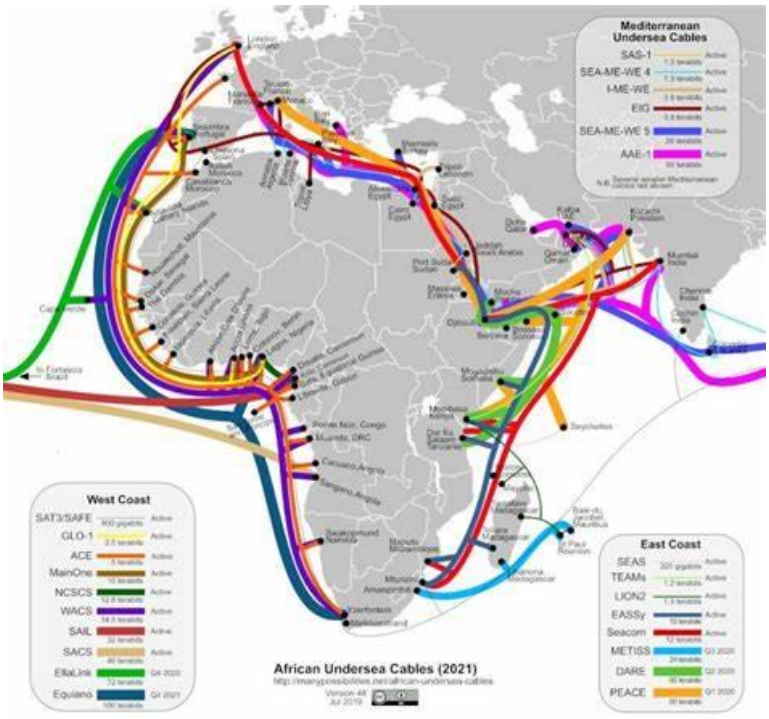


Source: Adapted from https://afterfibre.nsrc.org/

Comparing these two NSRC maps, even after 6 years have passed, significant portions of terrestrial fibre remain “Planned” and has not been completed. Some reasons for this are discussed in Terrestrial Fiber Networks in Africa - The Optical Illusion - Submarine Networks.[60]

[60] https://www.submarinenetworks.com/en/insights/terrestrial-fiber-networks-in-africa-the-optical-illusion

Figure 4-12: African submarine cables, 2022



Source: https://manypossibilities.net/african-undersea-cables/

Prices for domestic transit capacity now cheaper than international

Despite the impressive growth in domestic backbone infrastructure, prices for domestic capacity remained relatively high, usually much higher than the cost of international capacity. As a result, it was until very recently cheaper, for example, to connect from Lagos to London than it was to connect from Lagos to Abuja.

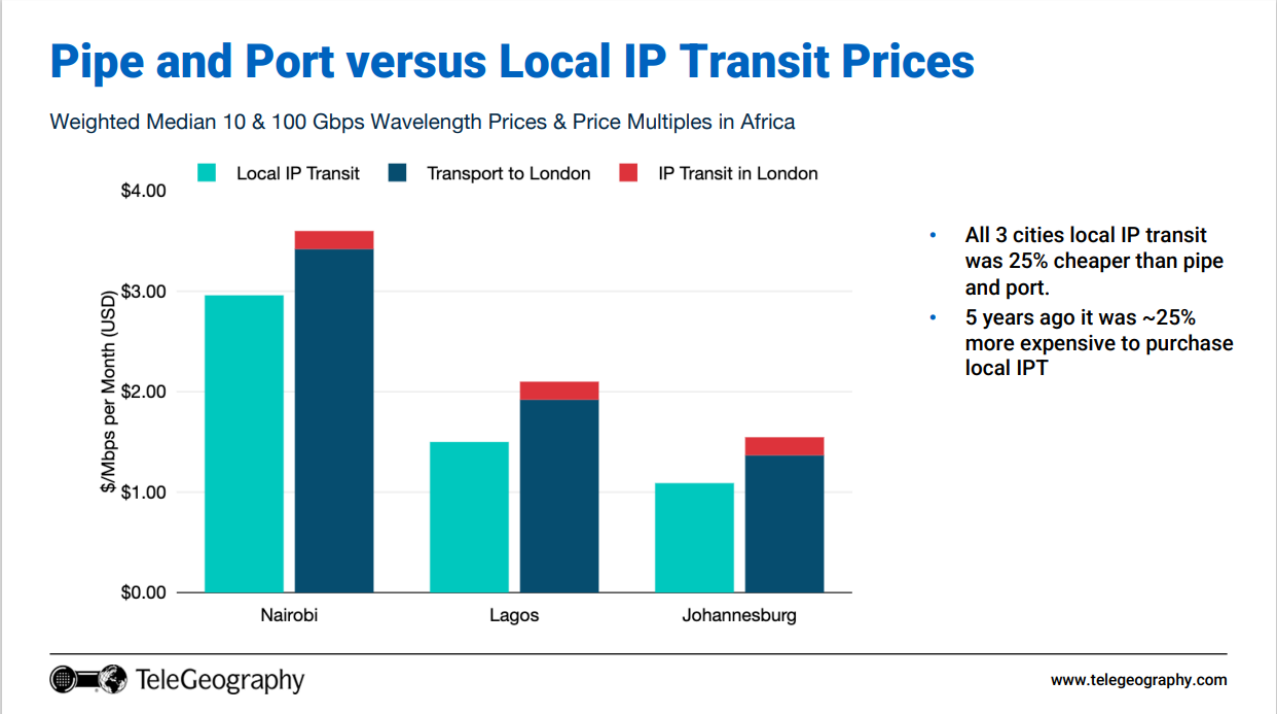
The market in many countries was limited by African operators which had adopted a 'High Price, Low Volume' business model. For some time now, however, international and regional operators such as SEACOM, EASSy and Liquid Telecom have disrupted the market with a 'High Volume, Low Cost' model which has reduced the cost of international traffic by several orders of magnitude. Indeed, costs of submarine fibre capacity per Mbps per month have reduced from as much as USD $20,000 15 years ago to as little as USD $20 in 2016 – less than 0.1% and are now around UD $8 in 2023. As a result of ever-expanding demand, submarine cable operators are continuing to invest in this lucrative market of exploding bandwidth needs, despite the falling margins.

In terms of terrestrial backbone networks, the maps above also highlight the extensive fibre networks present or under construction in most countries on the continent, although there is a lack of backbone and cross border infrastructure in central Africa in particular, as well as across the sparsely populated areas of the Sahel.

Several emerging hubs are also apparent - in Accra, Cairo, Cape Town, Johannesburg, Dar es Salaam, Djibouti, Lagos and Mombasa - where multiple international submarine cables interconnect with regionally linked terrestrial fibre backbones.

Combined with additional cables that now link Africa directly with South America, and the potential to carry traffic to Europe via North Africa and the Mediterranean cables, the cost of transit is dropping sufficiently to encourage the establishment of more local and regional hosting and related DNS services (see Section 5.5.5 below). Indeed, a turning point has been reached, as shown in the figure below where in three major African centres local IP Transit is now cheaper than backhauling over international cables.

Figure 4-13: Local IP Transit now cheaper than backhaul - 2023.



Source: *AfPIF23_Patrick_Christian_Ghana_TG.pdf*

4.4.2 LOCAL ACCESS INFRASTRUCTURE - THE RETAIL/LOCAL LOOP

It is currently estimated that only about 40% of the African populace has Internet access[61], primarily accessed via smartphones. With the limited deployment of copper cable, most Internet connections are provided by national mobile operators. The GSMA estimates that 2G mobile voice uptake reached 54% of the population by mid-2016, of which about a quarter were mobile broadband links, usually 3G, and sometimes 4G/LTE services in many of the major urban areas, with 2.5/2.75G GPRS/EDGE services in some of the more remote areas.

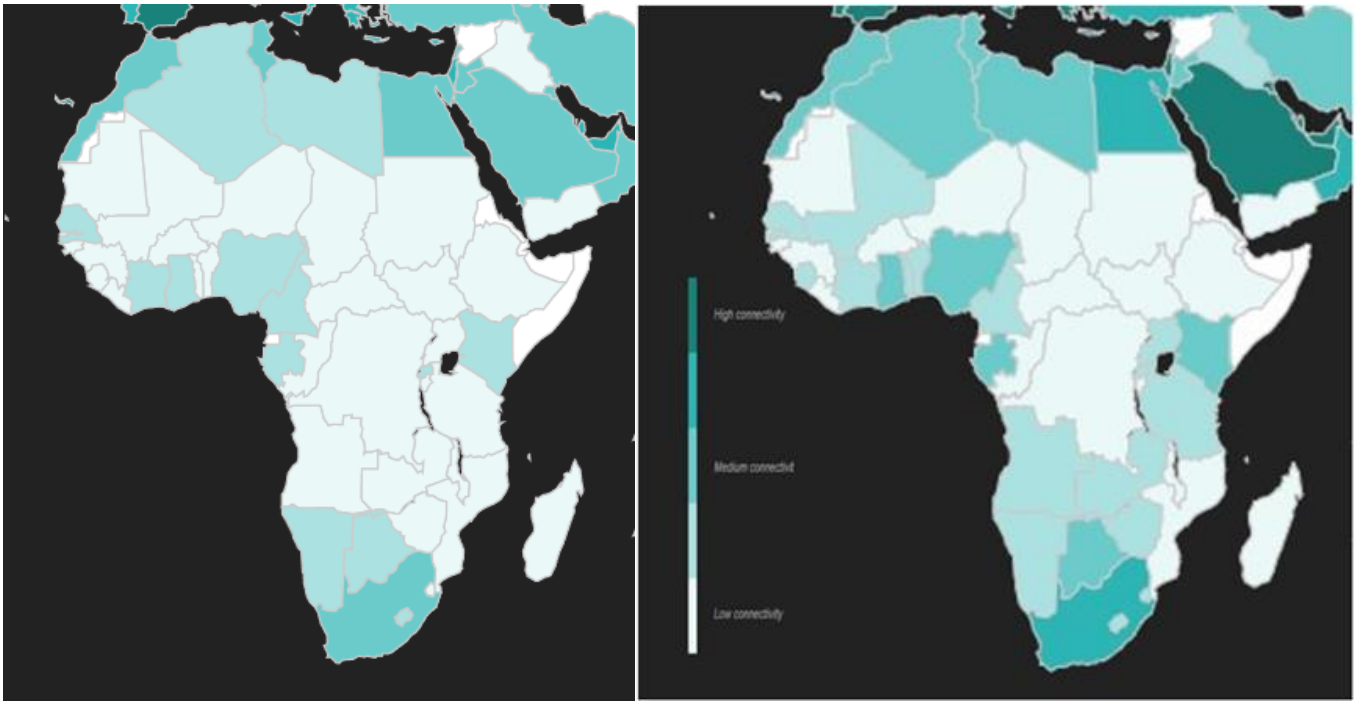
It is anticipated that about 470 million people on the continent would be using 4G by the end of 2023, overtaking 3G. In Africa, 4G subscriptions will soon overtake both 2G and 3G as the most widely used network. 4G will continue to gain traction as 3G usage declines; by the end of 2028, 730 million 4G subscriptions are expected.[62]

As shown in the map below of the GSMA Mobile Connectivity Index, only eight countries in Africa even reach median values - Morocco, Algeria and Egypt in the north, Ghana and Nigeria in the West, and Angola, Botswana, and South Africa in the South. It is important to note that GSM / 3G/ LTE last mile access makes use of licensed wireless spectrum. Suitable spectrum is in short supply in many countries and is therefore referred to as “high demand spectrum”.

[61] http://www.internetworldstats.com/stats1.htm

[62] Africa’s Mobile Sector: Still Room for Growth (telegeography.com)

Figure 4-14: 2016 (L) and 2022 (R) GSMA Mobile Index



Source: GSMA Mobile Connectivity Index

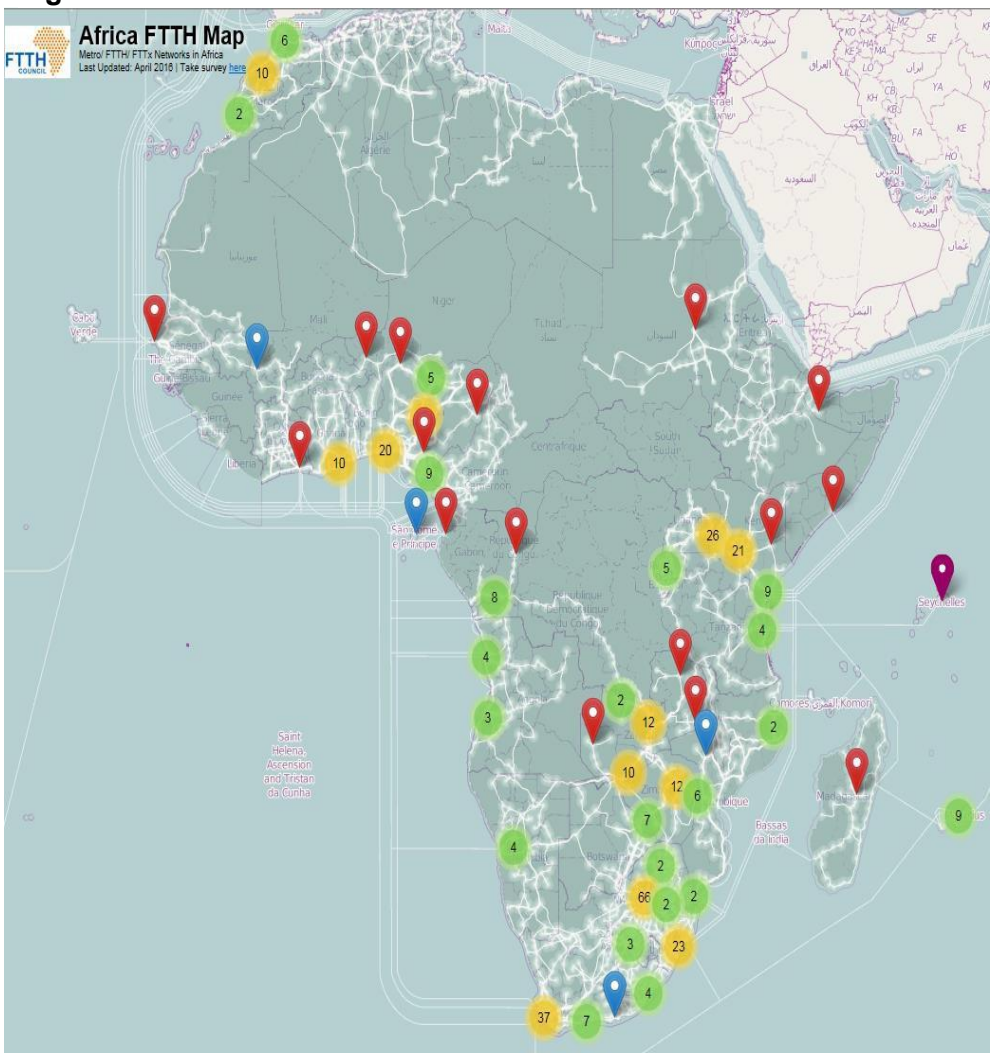
A few countries have more extensive fixed line infrastructure, such as Senegal and South Africa, which provide a significant number of copper DSL-based fixed broadband links. Cable/Coax based connectivity is a rarity, except for the Seychelles, Mauritius, Mozambique, and Angola.

However, a growing number of metro fibre deployments has resulted in fibre to the premises being deployed in major urban areas in some countries. Aside from serving business and residential customers directly, metro fibre infrastructure is also a key component for encouraging more interconnection between major networks, development of local hosting facilities and cheaper access to international capacity. Outside of South Africa, major deployments of metro fibre have largely been seen in capital cities so far, particularly Accra, Dar es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka, and Nairobi. As a result, these cities lead in provision of fibre to the premises (FTTx) as shown in the map below[63] [64].

[63] Adapted from http://www.africabandwidthmaps.com/ftth/

[64] The blue pins in the FTTH map represent FTTH, the red pins, Metro fibre and the purple pins, FTTx. The coloured circles represent the indicated number of fibre networks at that location. The white lines represent fibre networks, and the white highlights represent areas covered by a fibre node. FTTH = Fibre To The Home, and FTTx = Fibre To The (non-specific) premises

Figure 4-15: Fibre Networks in Africa



Source:

Other fixed wireless technologies are also in use, both in licensed and unlicensed bands, with free and pay-per-use Wi-Fi hotspots now relatively common in larger African cities. TV White Space (TVWS) trials using dynamic spectrum assignment technologies have successfully taken place in Ghana, Kenya, Malawi, Namibia, South Africa[65], Tanzania and Zimbabwe. Along with Wi-Fi, TVWS technology may be used for connecting rural areas, due to the superior propagation characteristics of the radio frequencies available in the largely unused VHF and UHF terrestrial TV bands. African Regulators are following the example of their colleagues around the world, such as the USA, UK and Singapore, and are in the process of devising suitable licensing frameworks for TVWS technologies.[66] [67]

While broadband uptake in Africa has been increasing, high Internet access costs continue to be the biggest factor limiting usage in most countries, particularly for more isolated and disenfranchised groups. This also affects the many who may be 'connected' but are unable to make use of the full power of the Internet.

High usage costs are compounded by slow speeds, with the mobile services used by most people usually having metered access and tariff caps that constrain the amount of data that can be exchanged

[65] http://www.tenet.ac.za/tvws/recommendations-and-learnings-from-the-cape-town-tv-white-spaces-tria

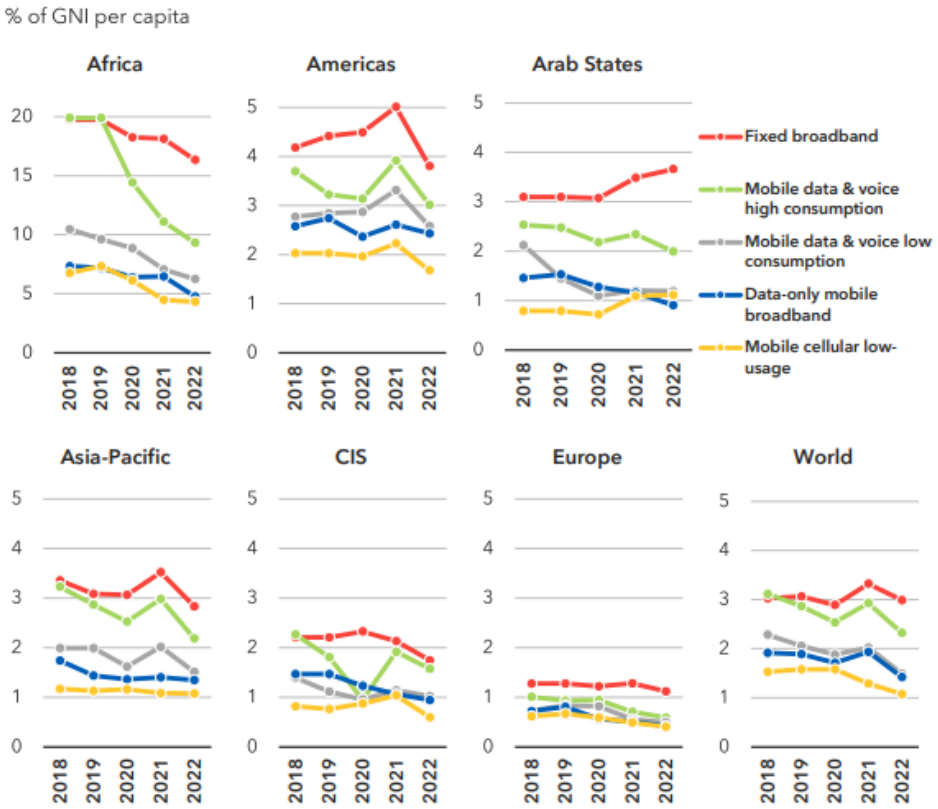
[66] http://www.gpwonline.co.za/Gazettes/Gazettes/39302_19-10_Icasa.pdf

[67] http://www.apec.org/~/media/Files/Groups/TEL/DSG/2015/15_tel51_dsg_wksp1_002.pdf

affordably. In addition, complex tariff packages can limit competition and restrict the user's ability to manage costs effectively.

The average price of a 500 MB (prepaid, mobile) broadband plan as a % of GNI per capita, by Region[68] is shown in the chart below. This shows substantial improvement since 2012 in Africa but highlights how much more expensive Internet access continues to be, compared to other regions.

Figure 4-16: Affordability trends by regions of the World



Fixed line broadband services are even more expensive in most countries, due to the high cost of terrestrial capacity. As a result, the ITU estimates uptake of fixed broadband across Africa in 2016 at just 0.7%[69]. Landlocked countries exhibit the highest prices on the continent, as shown in the chart below from the World Bank's Digital Dividends 2016 report[70].

Despite notable advancements for ICT service affordability, Africa continues to be the region with the highest costs for every basket since 2019. Price reductions were greatest in the mobile data and voice high-consumption basket, which went from 20% to 10%, reducing the difference from other movable baskets.

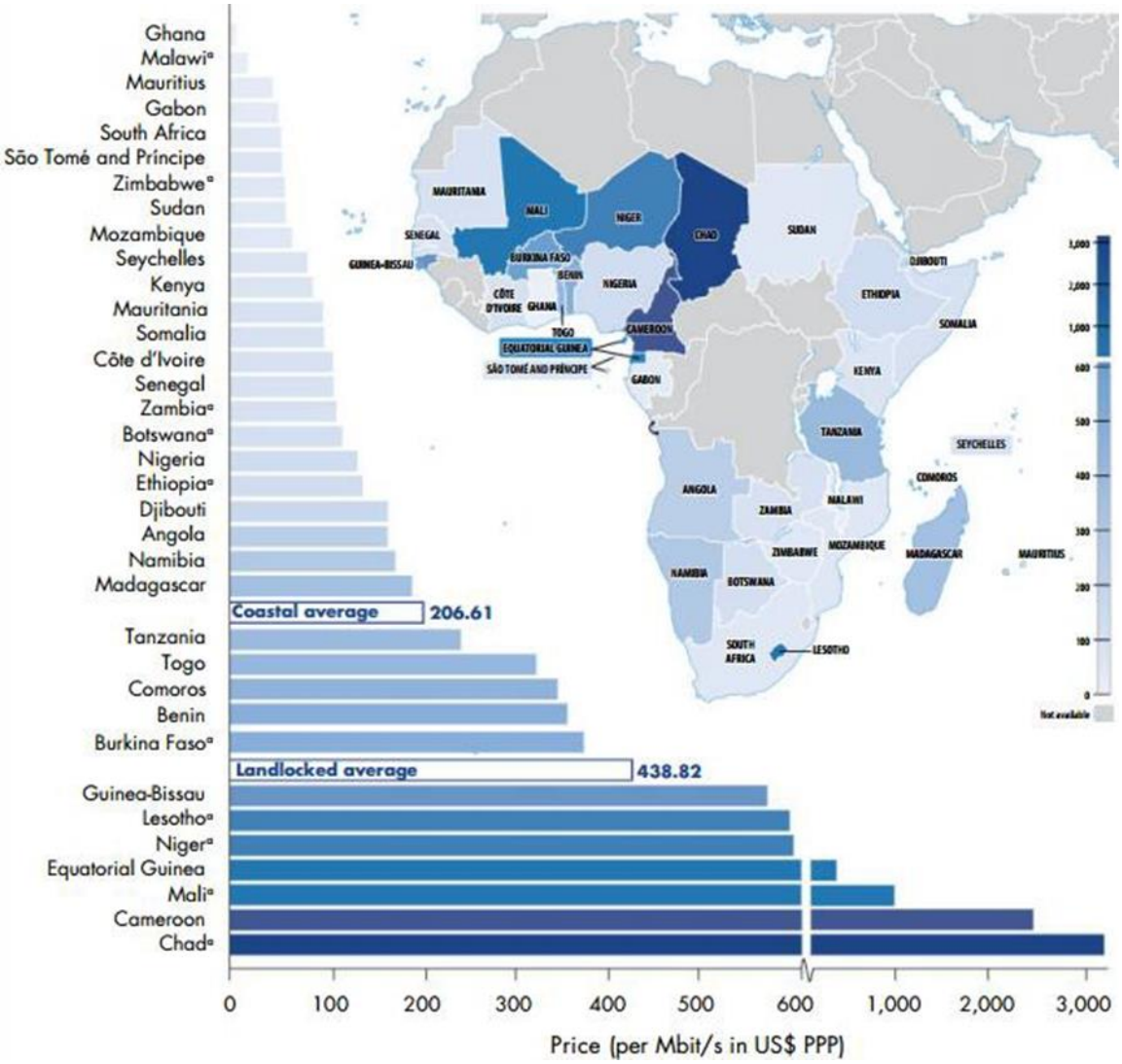
In the interim, the average cost of fixed-broadband services hardly changed in the Africa region, declining from 20 per percent to 16 percent, and it remains an obstacle to significant regional connectedness.

[68] http://a4ai.org/affordability-report/report/2015/#highest_adi_scores_among_least_developed_countries_(ldcs)

[69] http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2016/ITU_Key_2005-2016_ICT_data.xls

[70] http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement- PUBLIC.pdf#page=238

Figure 4-17: International Bandwidth 2015



High access cost has two important impacts on domain name demand:

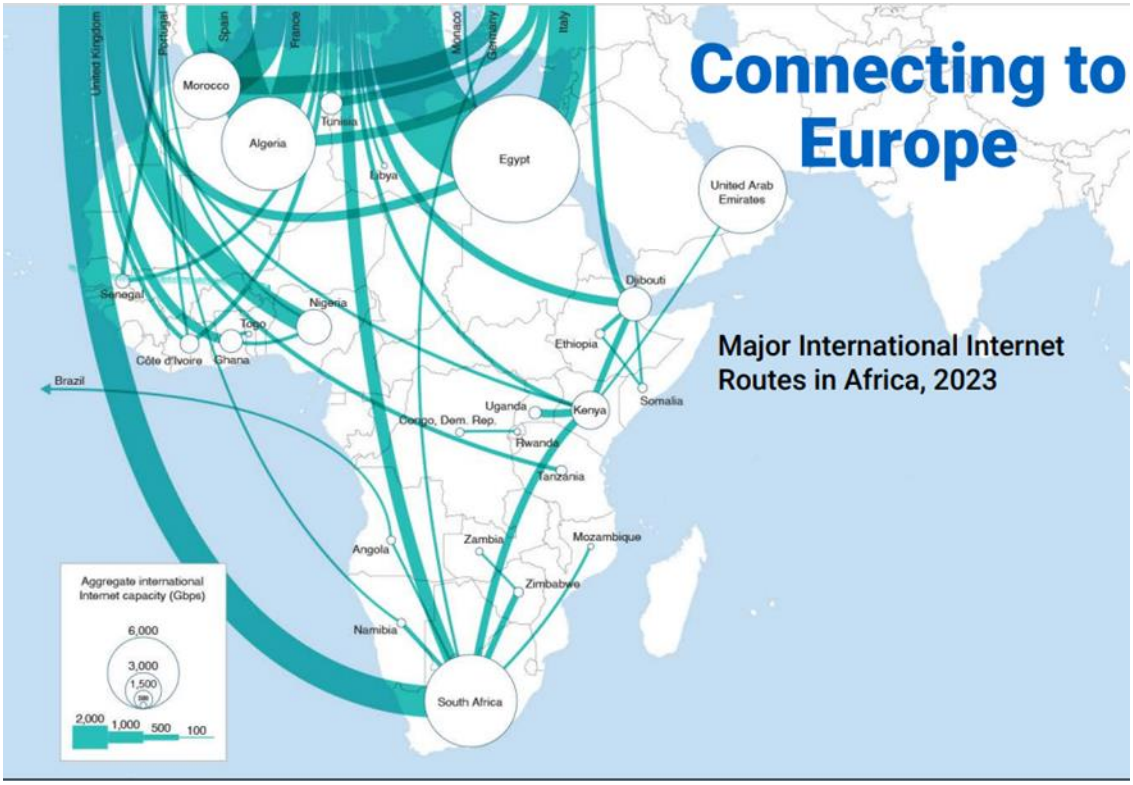
- it confines extensive use of the Internet to the very small proportion of the population that can afford it, and acts as a brake on in-country provision of Internet enabled goods and services.
- it may limit demand for domain names because sites with less well-known domain names are less likely to be part of a Zero-Rated service[71] such as Facebook or Wikipedia.

In addition, mobile network operators do not normally provide Registrar services, so for most broadband users in Africa, marketing and fulfilment of domain name registrations is minimal, and would not take place via these access providers.

Because most broadband providers only publish the number of subscribers, and do not make traffic data public, it is not possible to estimate the real extent of Internet use by the public. However international bandwidth consumption does provide a broad indication of aggregate levels of use, as shown in TeleGeography's map below, which highlights the relatively high levels of use in Northern Africa and South Africa compared to other regions or countries.

[71] At least one operator provides zero rated Internet access in each of 24 African countries: https://en.wikipedia.org/wiki/Zero-rating

Figure 4-18: Top Internet Routes[72]



Source: AfPIF23_Patrick_Christian_Ghana_TG.pdf

4.4.3 IXPS, DATA CENTRES AND CDNS

The presence of Data Centres, IXPs and related hosting and caching infrastructure is a critical building block for supporting the development of local content online services and domain name servers, and in turn, demand for domain names. Without IXPs and related local services such as DNS, often referred to as "the building blocks of the Internet"[73] [74], much domestic traffic must flow over expensive and slower international links, including domain name lookups.

The more recent advent of Content Data Networks (CDNs) has dramatically reduced the distance between a user of the Internet and the source Server. Thus, someone in Johannesburg visiting www.bbc.co.uk, no longer must wait for a 300 mS round trip time via a submarine cable to the UK but can instead receive the content within a few milliseconds from a CDN connected to JINX. CDNs act as "mirrors" and cache distant content locally. In addition, they add important security and resilience benefits. As local networks grow, and IXPs gain more peers and exchange more traffic, it becomes worthwhile for "them" to come to "us"[75].

4.4.3.1 INTERNET EXCHANGE POINTS (IXPS)

As of October 2023, there are 63 IXPs located in 316 African countries. This means there are still 16 countries using international links for their local traffic. In contrast, there are 19 African countries with more than one IXP with South Africa leading this group followed by Tanzania, with 7 and 5 active

Figure 4-19: Number of IXPs per Country

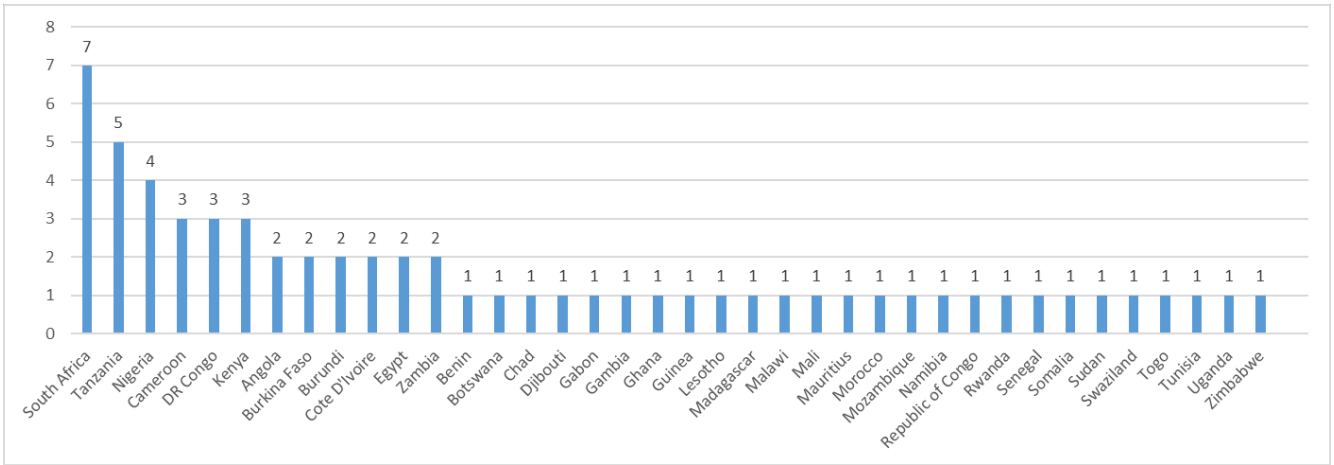
[72] https://africa-map-2017.telegeography.com

[73] https://www.ifex.org/kenya/2000/12/21/telecommunications_service_providers/

[74] http://www.broadbandforamerica.com/sites/default/themes/broadband/images/mail/AMKInternetPeeringandTransit_FINAL.pdf

[75] http://afix.afridns.org/technicaltraining/T1/AFRISPA_Halfway%20Proposition.pdf

exchange points respectively76. The N'Djamena Internet Exchange Point in Chad is the latest established IXP that is serving 16 local members starting from February 2023[77].



Source: own research

There is an argument that if one national IXP keeps national traffic local, several provincial IXPs will further localise traffic exchange. This is why several countries have multiple IXPs, namely South Africa, Tanzania, Angola, Kenya, and Nigeria. This is shown in the graphic above.

Historically, cost savings by avoiding expensive international transit was the main driver for an IXP. However, since around 2010, international capacity has been cheaper than local transit in most African countries. This has only reversed in the last five years. A valid business case[78] to convince local stakeholders to participate in the IXP includes a shorter path to the hosted CDNs and e-government services and higher reliability, as well as alternative routes. There are virtually no circumstances in which every IXP peer does not gain an economic benefit from participating. For landlocked countries setting up an IXP and peering with neighbours is even more essential to be able to provide Internet service.

Of the 16 landlocked African countries, only the Central Africa Republic has not yet set up an IXP. This is severely affecting the affordability of Internet service which costs 16% of the average income for 1 GB.[79]

The setup of a local IXP can be entirely justified by the enhancement of the user experience when accessing locally hosted content. This effort will quickly improve the welfare of the community by facilitating access to e-government services. Indeed, more Internet services with local content means more demand for domain names. This may be responsible for the breakthrough in domain name registration in Africa compared to the study made in 2016.

Having a successful IXP with sufficient traffic will motivate the operators of root name server, local ccTLD DNS, CDN servers, and caching servers to pay the capital and transit costs to bring their equipment to the IXP. In this case, end users will experience a dramatic performance improvement. The resultant increase in the quality of service makes local applications such as Internet banking, online ticket sales, online job markets and online tax returns feasible. The IXP may also offer a redundant path to international transit providers, thus increasing reliability.

IXPs in Africa usually follow the European model of a non-profit facility established by its members (the network operators), usually in a neutral location where retail network operators and service providers can

[76] https://www.iana.org/domains/root/db

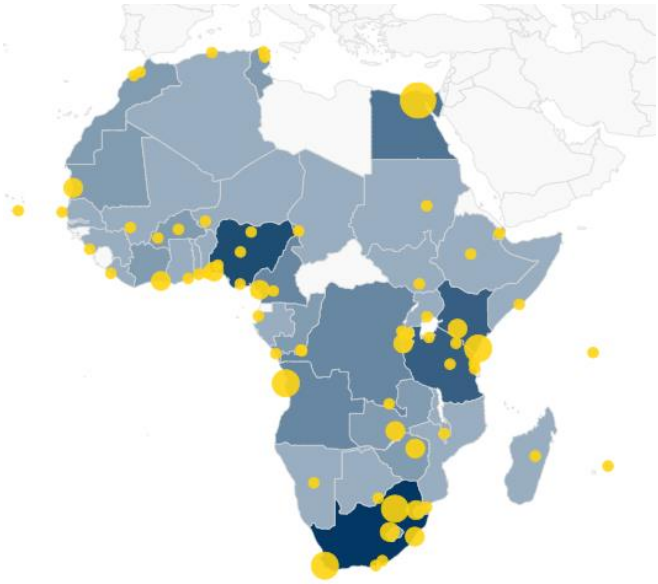
[77] https://www.pch.net/services/internet_exchange_points

[78] As the basic cost of an IXP's "infrastructure" is simply a suitable switch in a rack in a Data Centre, which may easily involve capital expenditure of under $1,000, the "business case" is trivial. The challenge lies in persuading competing ISPs to cooperate sufficiently to agree on the terms and location of the IXP.

[79] https://www.dw.com/en/why-mobile-internet-is-so-expensive-in-some-african-nations/a-55483976

connect to each other to exchange data between their networks. Other kinds of interconnection and services occur at many African IXPs, such as commercial transit agreements and sharing of common services such as a route reflector, NTP server, etc.

Figure 5-14: IXP Locations



Source: Adapted from https://www.pch.net/ixp/dir

Over the last three decades the number of IXPs in Africa has significantly increased. Although there are some 88 IXPs purportedly operating in Africa, after extensive research we have determined that many are either still in the planning stage, defunct, or are transit sales marketing campaigns, with no real traffic being exchanged.

Table 5-1 show an extensive list of all 68 known African IXPs with information related to the number of members peering at the exchange, the peak recorded traffic, the prefixes announced, and the year of its establishment.

Table 5-4: Operational IXPs in Africa

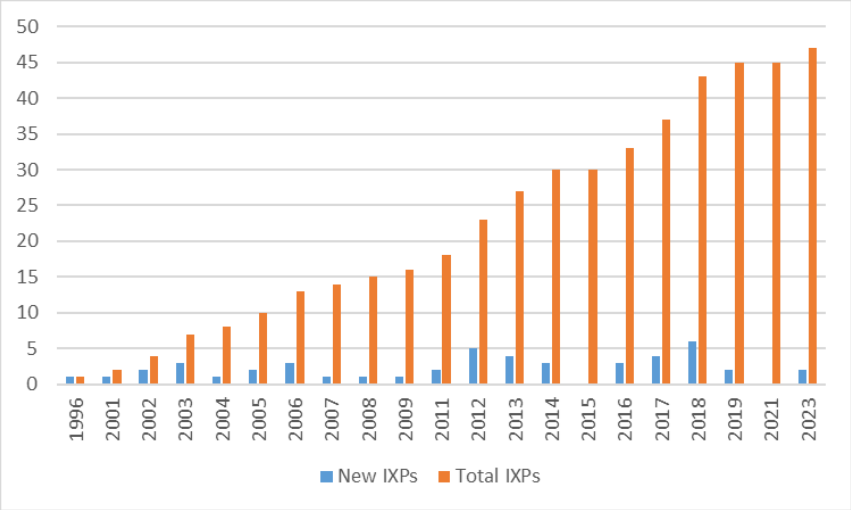
IXP Name	Country	City	Peers	Traffic (Mbps)	Prefixes	Established
Johannesburg Internet Exchange	South Africa	Johannesburg	156	320 000	392 668	1996
Kenya Internet Exchange Point	Kenya	Nairobi	86	70 400	390 989	2001
Cairo Internet Exchange	Egypt	Cairo	7	15 400	2 209	2002
Mozambique Internet Exchange	Mozambique	Maputo	15	7	5 384	2002
Rwanda Internet exchange	Rwanda	Kigali	9	1 040	1 831	2003
TIX Tanzania - Dar es Salaam	Tanzania	Dar es Salaam	42	22 400	9 245	2003
Uganda Internet Exchange	Uganda	Kampala	33	28 900	18 239	2003
Swaziland Internet Exchange	Swaziland	Mbabane	0	-		2004
Botswana Internet Exchange	Botswana	Gaborone	14	456	277	2005
Ghana Internet Exchange	Ghana	Accra	21	4 800	9 585	2005
Mauritius Internet Exchange	Mauritius	Ebene	10	228	773	2005
Zambia Internet Exchange Point	Zambia	Lusaka	13	47		2006
AngolaIXP -- Angola Internet Exchange Point	Angola	Luanda	21	1 555	676	2006

IXP Name	Country	City	Peers	Traffic (Mbps)	Prefixes	Established
Internet Exchange Point of Nigeria - Lagos	Nigeria	Lagos	61	207 000	381 419	2006
TIX Tanzania - Arusha	Tanzania	Arusha	6	46	4 183	2006
Middle East Internet eXchange	Egypt	Cairo	10	0		2007
Malawi IXP	Malawi	Blantyre	9	5	445	2008
Cape Town Internet Exchange	South Africa	Cape Town	73	25 100	358 159	2009
Tunisian Internet Exchange Point	Tunisia	Tunis	24	294 000	1 464	2011
Sudan Internet Exchange Point	Sudan	Khartoum	7	7	353	2011
Internet Exchange Point of Nigeria - Port Harcourt	Nigeria	Port Harcourt	4	79		2012
Internet Exchange Point of Nigeria - Abuja	Nigeria	Abuja	10	307		2012
NAPAfrica Cape Town	South Africa	Cape Town	280	391 000	426 721	2012
Durban Internet eXchange	South Africa	Durban	77	19 000	343 804	2012
Kinshasa Internet Exchange	DR Congo	Kinshasa	18	7 220	869	2012
NAPAfrica Johannesburg	South Africa	Johannesburg	559	2 220 000	457 040	
Congo Brazzaville IX	Republic of Congo	Brazzaville	7	15	189	2013
Serekunda Internet Exchange Point	Gambia	Serekunda	7	229	202	2013
Côte d'Ivoire Internet Exchange Point	Cote D'Ivoire	Abidjan	6	210	1 070	2013
Côte d'Ivoire Internet Exchange Point	Cote D'Ivoire	Abidjan	6	210	1 070	2013
Benin IX	Benin	Cotonou	6	621	33	2013
Cameroon Internet Exchange Point - Yaoundé	Cameroon	Yaoundé	10	3		2014
Windhoek IXP	Namibia	Windhoek	12	269	267	2014
Gabon Internet Exchange	Gabon	Libreville	10	80	165	2014
NAPAfrica Durban	South Africa	Durban	136	60 100	378 900	2014
ANGONIX	Angola	Luanda	21	5 336	26 391	2015
BFIX Ouagadougou	Burkina Faso	Ouagadougou	12	7 780	1 331	2015
Madagascar Global Internet Exchange	Madagascar	Antananarivo	9	5	1 514	2016
Djibouti Internet Exchange	Djibouti	Djibouti City	18	282	269 691	2016
Mombasa Internet Exchange Point	Kenya	Mombasa	25	52 200	525 078	2016
Mwanza Internet Exchange Point	Tanzania	Mwanza	12	0		2016
Lesotho Internet Exchange Point	Lesotho	Maseru	8	70		2017
Togo Internet Exchange Point	Togo	Lome	6	42	334	2017
Senegal IX	Senegal	Dakar	6	254	48	2017
BurundiX Internet Exchange Point	Burundi	Bujumbura	8	166		2017
Burundi Internet Exchange Point	Burundi	Bujumbura	8	1	166	2017

IXP Name	Country	City	Peers	Traffic (Mbps)	Prefixes	Established
Harare Internet Exchange	Zimbabwe	Harare	10	636	274	2017
Dodoma Internet Exchange Point	Tanzania	Dodoma	4	14	596	2018
Mali IXP	Mali	Bamako	4	296	67	2018
Zanzibar Internet Exchange Point	Tanzania	Zanzibar	3	6		2018
Cameroon Internet Exchange Point - Douala	Cameroon	Douala	7	32	785	2018
AMS-IX Lagos	Nigeria	Lagos	31	10 700		2018
Somali Internet Exchange Point	Somalia	Mogadishu	6	0	50	2018
Asteroid Mombasa	Kenya	Mombasa	32	2 294	255 386	2018
IXP-GUINEE	Guinea	Conakry	11	30	148	2019
Casablanca Internet Exchange	Morocco	Casablanca	3	-	68	2019
Lubumbashi Internet Exchange	DR Congo	Lubumbashi	10	8 300	254	2019
BFIX Bobo-Dioulasso	Burkina Faso	Bobo-Dioulasso	6	100	93	2021
Goma Internet Exchange	DR Congo	Goma	7	6 750		2021
Douala Internet Exchange	Cameroon	Douala	4	0		2021
N'Djamena Internet Exchange Point	Chad	N'Djamena	16	0	212	2023
Nelson Mandela Bay Internet Exchange Point	South Africa	Gqeberha	9	55	153	2023
Lusaka IXP	Zambia	Lusaka	13	39		2023

Analysis of this data shows the growth of operational IXPs in Africa, displayed graphically below.

Figure 4-20: Growth of Operational IXPs in Africa



It is expected that the presence of one or more properly functioning IXPs, (by which we mean several peers exchanging meaningful amounts of traffic) would result in more domains being registered, and vice versa. Indeed, there is a clear relationship: Countries with an IXP that has sufficient peers exchanging meaningful amounts of traffic have, on average, 12 times as many domains as those without, as shown in the table below.

Figure 4-21: Value of IXPs in terms of Domains

Status	Countries	ccTLDs	Average ccTLDs
With an IXP	36	1 934 348	53 732
Without an IXP	14[80]	79 689	4 427

Countries with an IXP have 12 x as many domains.

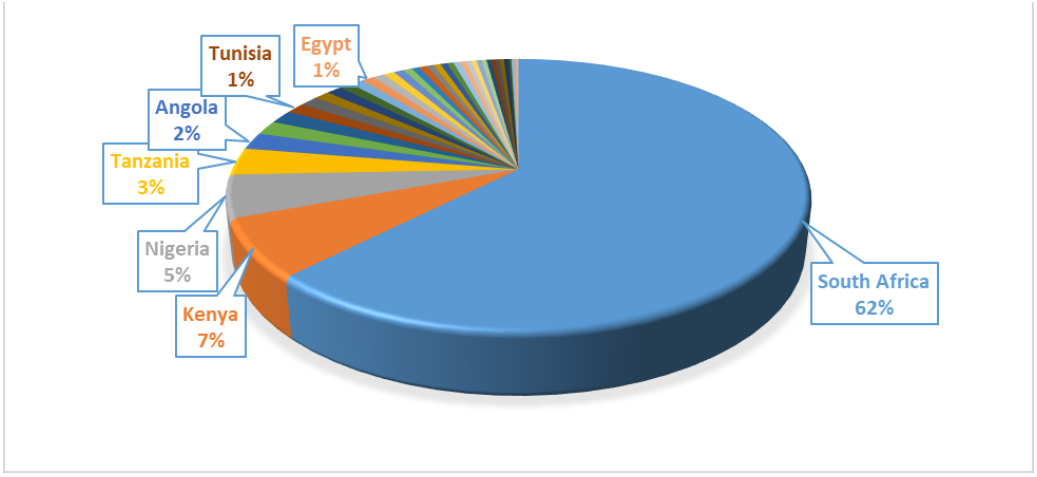
Finding a simple numeric relationship between IXPs and domain name numbers was more challenging. In assessing the "value" of the 88 functioning IXPs, we looked at:

- Participants: How many entities peering
- Traffic: Peak traffic in Mbps[81]
- Age (days & years since establishment): A brand new IXP is unlikely to have an immediate impact.
- IXPs: The number of IXPs in a country. ZA, TZ, KE, NG and AO all have more than one functional IXP
- Prefixes: A measure of how many / how large the networks connected to the IXP are.

The following figures provide a graphical interpretation of these metrics. Firstly, the pie and bar charts facilitate visualisation of the differences between results for African countries for the metrics listed above. In some cases, we exclude asymptomatic or outlier countries, indicated by "Excl." in the chart title. Secondly, in all cases where a correlation between two or more variables exists, an X-Y Plot and a calculated trend line was made (i.e. if the correlation is high, then the trend line is likely to be a good fit to the facts. If not, one should look for other causes).

We began by looking at the number of entities peering at African IXPs.

Figure 4-22: Participants at Operational IXPs



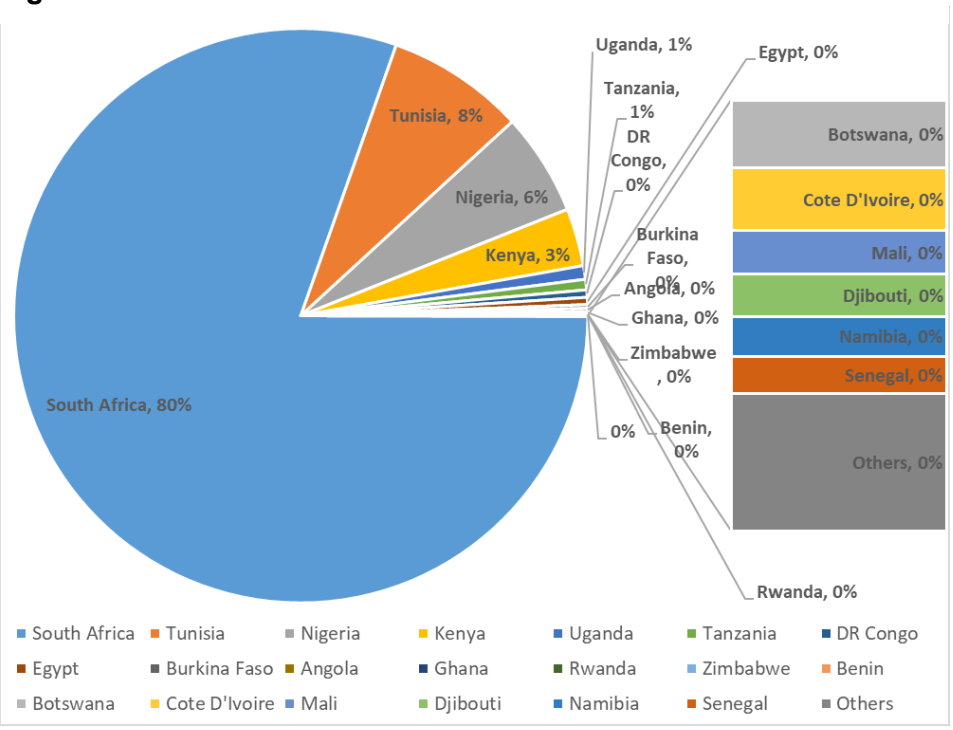
As shown in the Figure above, with 62% of peers, South Africa has more peers at its seven exchanges than the rest of Africa put together, with Kenya, Nigeria, and Tanzania following distantly behind. However, this can be misleading, as larger networks will connect to several IXPs.

[80] Excluding the four Freenom countries

[81] Angola is a good example. **AO-IXP** was established in 2006. It has 23 participants exchanging 1,300 Mbps of traffic. This is quite significant. By contrast, **ANGONIX** was established in 2015, also in Luanda, but with 16 peers and 2,400 Mbps. Both IXPs are located at non-carrier-neutral locations, the former being hosted by the incumbent telco and the later by the submarine cable operator. Both hosts sell transit services. However, peers at the latter include the three mobile operators.

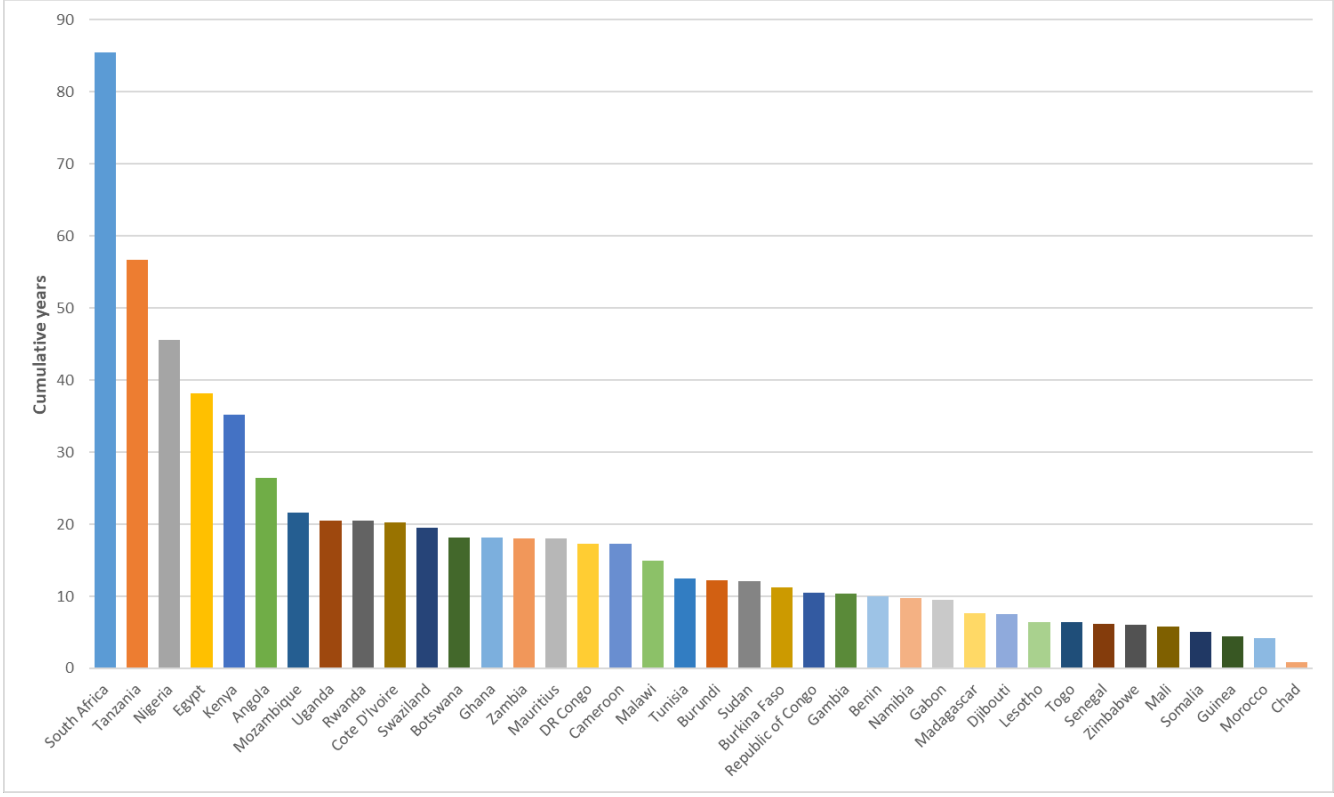
In terms of total traffic flowing over the exchanges, South Africa again dominates the continent, followed by Tanzania, Angola, Nigeria, and Uganda, as seen in the chart below which shows peak traffic measured at the various African IXPs, compared to total traffic interchanged in Africa.

Figure 4-23: Total IXP Traffic



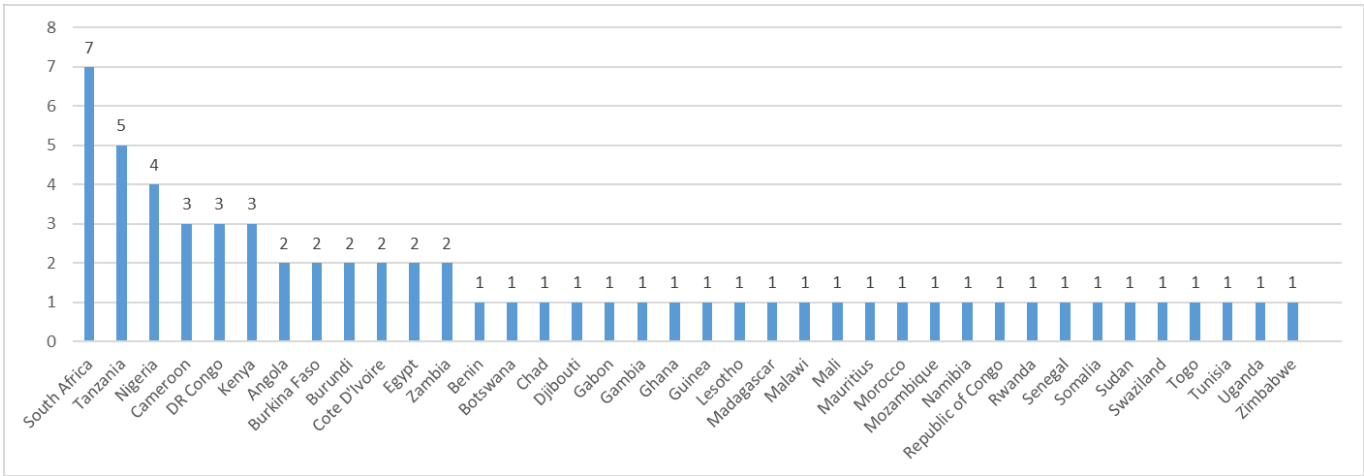
Where more than one IXP exists in a country, their ages are added together in the graphic below.

Figure 4-24: Cumulative IXP Age



The longer an IXP has been operating within a country, the more effect one would expect it to have in terms of building up a local hosting and data centre industry, and hence contribute to the sale of domain names. This is shown in the column chart above. Once again, South Africa leads, followed by Tanzania, Nigeria, Egypt, and Kenya. Although Kenya was the second country (2001) to have an operating IXP in Africa, its second IXP was only commissioned in 2016, so the other countries with multiple IXPs score more highly. It is noteworthy that of the 15 countries with more than 18 years cumulative IXP age shown above, all of them are in the Top 20 countries.

Figure 4-25: Number of IXPs per Country

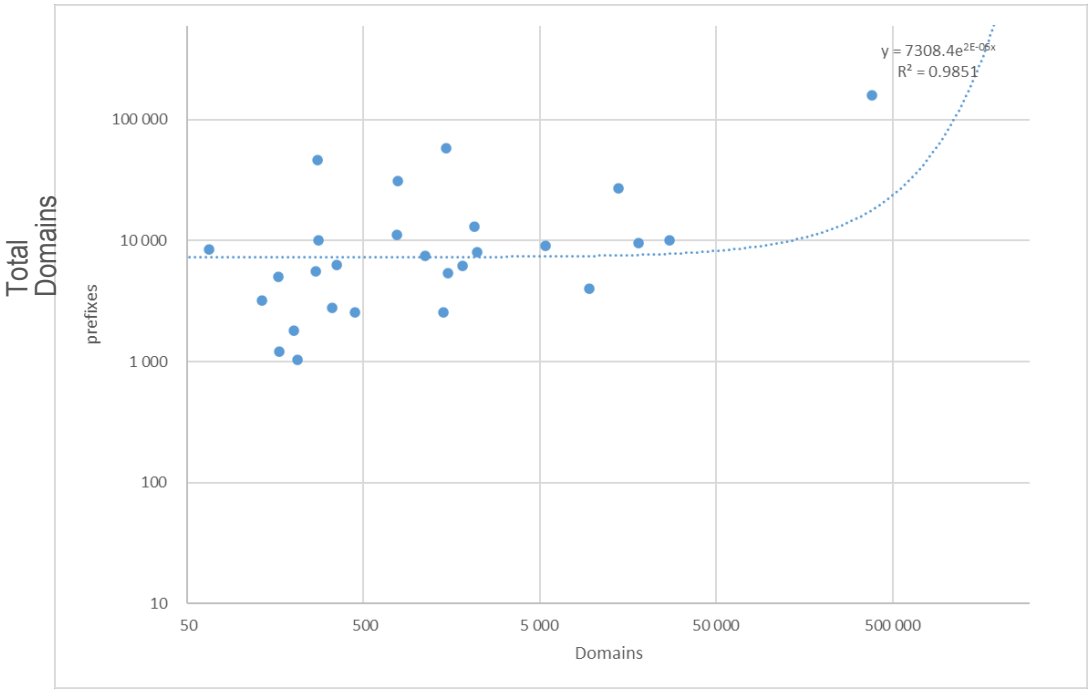


South Africa leads with seven IXPs, followed by Tanzania with five IXPs, Nigeria with four and Cameroon, DRC and Kenya with three IXPs each. Although none of the individual parameters of an IXP have a good correlation with the number of domain names, there is a clear – and logical - correlation between the total number of domain names registered in a country, and the total number of network prefixes routed over the IXPs in that country.

The number of network prefixes and the number of domain names are effective measurements of the size of the Internet ecosystem within the country. Domain names are labels for IP addresses, and prefixes are groups of IP addresses. As can be seen below, there is a significant correlation[82] between the number of domains issued by a country (a measure of the size of the DNS industry) and the number of prefixes announced by the country at its IXPs (a measure of the size of the Internet in that country). This is not surprising as they are both measures of the size of the Internet in that country.

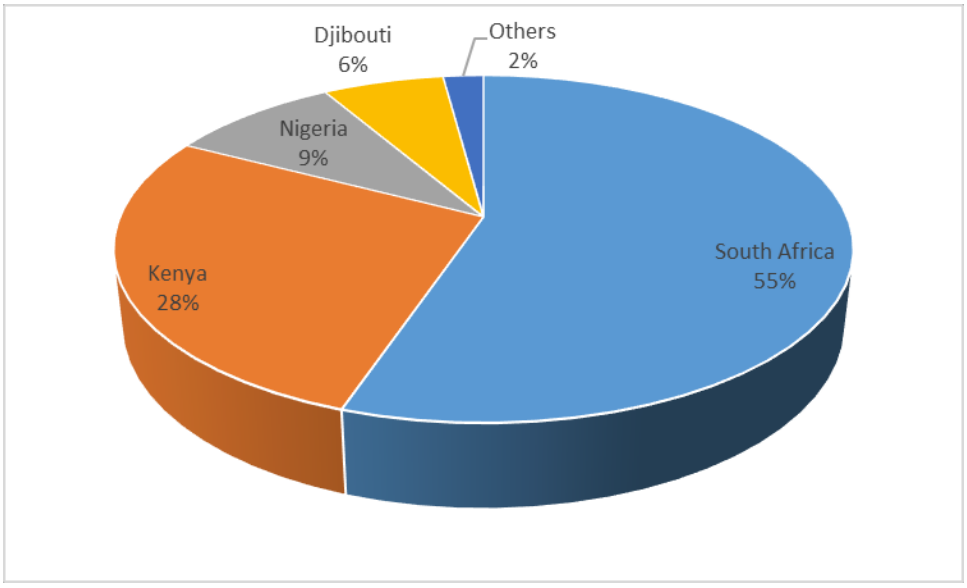
Figure 4-26: Domains versus prefixes

[82] The **coefficient of determination** (denoted by R^2) is a key output of regression analysis. It is interpreted as the proportion of the variance in the dependent variable that is predictable from the independent variable. The closer to unity it is, the better the correlation.



As can be seen in the pie chart below, almost 90% of the IPv4 Network Prefixes[83] exchanged at IXPs in Africa are exchanged at the seven South African IXPs.

Figure 4-27: Prefixes at IXPs



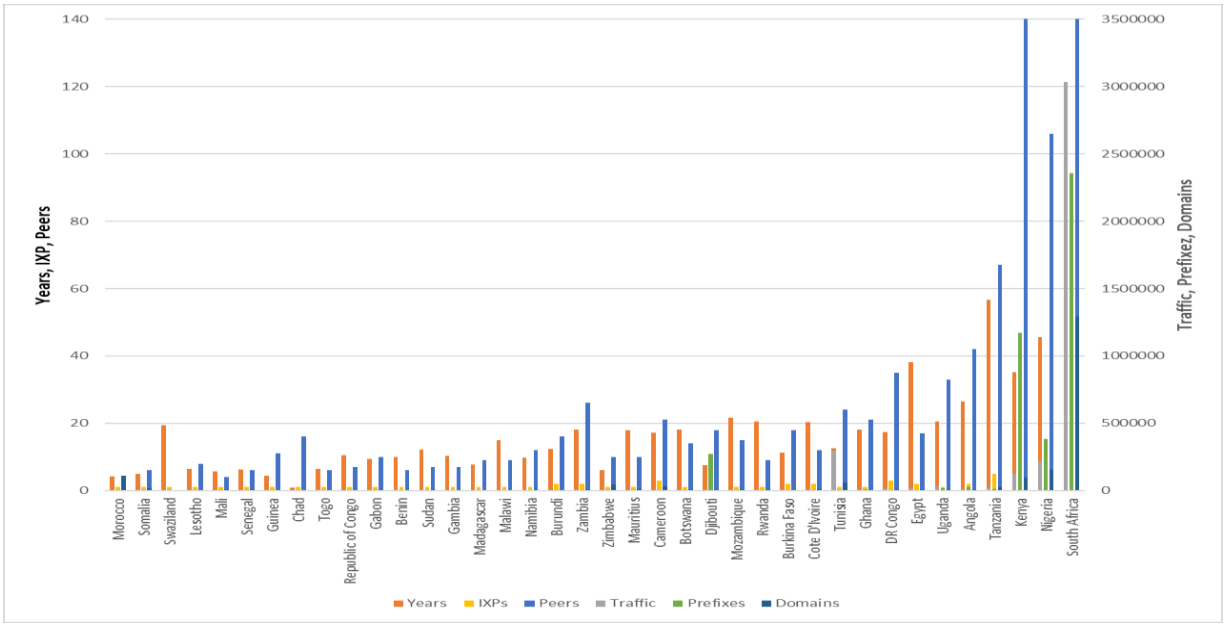
It's of interest to consider the situation where multiple IXPs exist in one country. Where do operators peer? In the case of South Africa, the seven IXPs are in two sets, one operated by INX-ZA in each of Johannesburg, Cape Town, Durban and Gqeberha, and the other operated by NAPAfrica, again in the first three cities. In both cases, some operators peer at more than one city. Of the 345 peers listed at NAPAfrica, only 233 of them have unique ASNs. In other words, a number of these operators peer at more than one NAPAfrica IXP.

Although the numbers are clearly rising towards the right of the summary column chart below, this is irregular and none of these metrics on their own give a sufficiently good correlation with the number of

[83] A network prefix is the address of an IP network – so called because it consists of the first portion (of variable length) of the IP address. All addresses within the network start with the same prefix.

domains registered in the ccTLD. South Africa and Kenya have metrics which are off the chart in the infographic below, as the scale of some metrics is much higher and obscures the variation between other countries.

Figure 4-28: Summary Infographic for IXPs 2023



Combining these metrics (as a simple sum) gives us what we may call a "Figure of Merit" (**FoM**) for each IXP.

However, there are still significant differences between the predicted number of domains and the actual value. This is to be expected, as this metric does not consider several other issues that have a significant impact on domain sales, such as registration method, payment method, cost of a domain, provision of a WHOIS[84] service and the registration policies applied.

19 out of the Top 20 countries have an IXP.

Overall, it can be observed that characteristics of the IXPs in a country are not a particularly accurate predictor of the number of ccTLD domains registered – at least not on their own. The reason for lack of any clear mathematical correlation is due to other variables that also influence the number of domains registered. In addition, there may be some inaccuracies in the traffic data (not all IXPs have recorded data available), and there is large variability in the proportion of local networks that are actually participating at the IXPs - some large networks do not participate at all, or may exchange traffic bilaterally. As a result, the actual volume of traffic being exchanged (locally or not), is not accurately indicated by the amount of traffic passing through the IXP. And, as noted above and discussed further below, there are a multitude of other factors that influence the number of domains sold in a country.

However, a comparison of the ranking of the top 20 countries shown in Table 7-2 with the ages of first IXPs in Table 5-1 shows a very clear link. Of the 20 top ranked countries, 14 are early adopters of IXPs and four are North African countries with nearby access to IXPs in Portugal, Spain, and France. Of the remaining two countries, one has established an IXP recently. Thus, 19 out of the 20 top ranked countries

in Africa operate a meaningful IXP, which has no doubt contributed to having a vibrant and expanding Internet industry.

4.4.3.2 DATA CENTRES

As indicated above, IXPs are often hosted at data centres, which may or may not be “carrier neutral”. These also provide a convenient hosting environment for shared services such as DNS, CDN and caching facilities.

Registration of (especially local) domain names foster the growth of the economy in terms of the construction of data centres to accommodate the machines hosting African websites, the IXPs to interchange local data, the telecommunications (especially fibre) infrastructure to interconnect these locations, and, of course, the need for skilled people to design, implement, manage and maintain these infrastructure elements.

In the Registry, Registrar, Reseller and IXP sections of the questionnaire, respondents were asked whether they used data centres for their service, how many data centres there were in the country and the approximate cost of a single cabinet in USD. The most common count for the number of data centres estimated by the questionnaire respondents was used for each country and is plotted below. Data from other sources on the Internet was also used to provide figures for a further seven countries from which there were no responses to the questionnaire.

This data produced an estimate of 127 data centres in 24 countries, as shown in the chart below.

Cabinet prices range from US $100 to US $2000 per month, although the bundled services provided with the cabinets were not noted in the questionnaire. In South Africa at Teraco for example a full cabinet plus 2 kW of power but no data connection, costs USD $700 a month. However, peering is free, and many transit providers are available to connect with the data centre.

Although there were many unique responses (it was a free form answer), the reasons behind a lack of data centres were:

- Lack of secure power supply
- Monopoly telecommunication providers
- Lack of local need (content is housed overseas)
- Distrust of government
- High prices

The reports quoted below, and our own questionnaire responses, give differing answers for the number of data centres, largely because there is not a commonly accepted standard for data centres. Some only count “carrier neutral” facilities, others count any data centre at which colocation may be purchased by a third party, and others count any facility that has a raised floor. It is for this reason that we have not presented a single consolidated set of figures for data centres in Africa. Nevertheless, it is clear that although data centres are still only present in a minority of countries in Africa, it is the fastest growing market in the world for these facilities, with demand outstripping supply by a factor of two or three[85]

Data centre pricing is almost always more expensive in Africa than in more developed countries. One commercial report lists 137 separate data centres in nine countries, operated by 65 providers. The countries are:

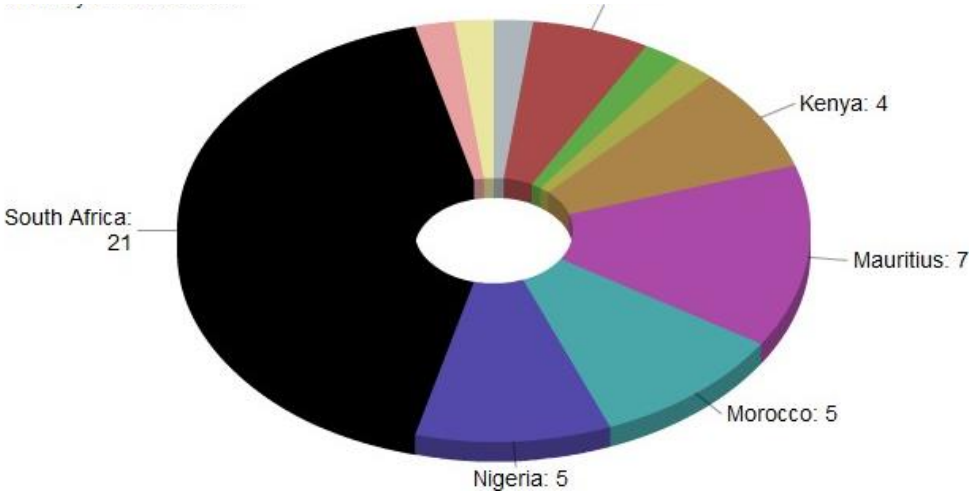
[85] http://www.africantelecomsnews.com/Products/African_Data_Centres.html and http://www.itweb.co.za/index.php?option=com_content&view=article&id=153049
This subject alone is worth a report on its own, for future research

- Algeria
- Egypt
- Ghana
- Kenya
- Morocco
- Nigeria
- South Africa
- Tunisia
- Uganda

Data Center Africa[96] identifies 91 data centres in 16 countries, operated by 74 players. The report highlights Egypt, Kenya, Nigeria and South Africa as leaders in the development of regional data centres, achieving a faster level of growth than other countries included in the study.

Colocation Africa identifies 50 data centres from 11 countries as shown in the image below:

Figure 4-29: Colocation Africa Datacentre Distribution



Source: http://www.datacentermap.com/

Another source, Data Centre Research (DCR)[86], a Danish consultancy, monitors the presence of “carrier neutral” data centres around the world. Their locations have increased from 14 to 19 countries since 2016, with significantly more Data Centres all told. There are more than ten in each of South Africa, Nigeria, and Egypt. As would be expected, these are among the countries with the most vibrant exchange points and largest number of domain name registrations.

[86] DCR - http://www.datacentermap.com/

Figure 4-30: DCR Data Centre Map 2017

Source: Adapted from http://www.datacentermap.com/

Local caching infrastructure and 'Content Distribution Networks' (CDNs), such as the Google Global Cache (GGC) and Akamai, which minimise upstream capacity requirements by eliminating the duplication of downloads of the same data, are now present in many locations in Africa.

Figure 4-31: DCR Data Centre Map 2023

[99] Adapted from http://www.datacentermap.com/

These servers are often installed at an IXP or inside a large access provider's network.

CDN operators usually lead the way, with Google often one of the first into a country with a cache server because of the major improvements in performance and distribution cost reduction achieved by caching the high volume of YouTube video data.

The following map[87] shows the presence of GGC infrastructure in Africa identified by Google. As can be seen the caching infrastructure is clustered in four groups - one each in west, east, north and southern Africa, with very limited presence in the landlocked countries as yet.

Figure 4-32: Google Caching Infrastructure in Africa

4.4.4 NRENS

A REN (Research and Education Network) is an Internet infrastructure supporting academia. In most African cases, the National REN (NREN) is considered a dedicated Internet Service Provider (ISP) distinguished by providing a broadband backbone network to higher education campuses. In Africa, the 29 RENs are grouped into three alliances for North and East, South, and West Africa.

The UbuntuNet Alliance[88], which represents Eastern and Southern Africa is the largest alliance with 14 member countries. It was founded in 2005 by four NRENs with the vision of securing high-speed but affordable Internet service for academia.

WACREN[89] is the West and Central African Research and Education Network. Incubation of the regional network started at the Africa Network Operation Group (AfNOG) in 2006 and at the Regional Workshop on Research and Education Networks organized by the Association of African Universities (AAU) in Accra in November 2006. WACREN is registered in Accra as a not-for-profit organization (NPO) with ten members.

Both UbuntuNet Alliance and WACREN are serving only African NRENs, while ASREN[90] is serving the African part of the Arab countries. Hence, it's justifiable to find Sudan NREN as a member of two alliances, UbuntuNet and ASREN.

[87] https://peering.google.com/#/infrastructure

[88] https://ubuntunet.net/

[89] https://wacren.net/

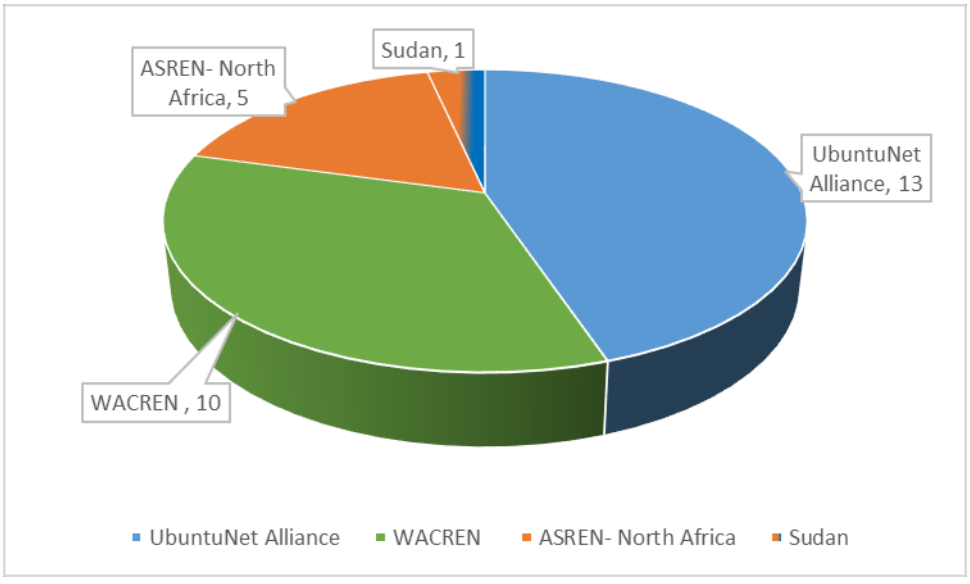
[90] https://asrenorg.net/

The Arab States Research and Education Network, ASREN, is a non-profit organization established in 2011 by Talal Abu-Ghazaleh Global (TAG.Global) in Germany under the umbrella of the League of Arab States. Six of the northern African countries are members of ASREN besides the Middle East countries.

Figure 4-33: National RENs and Alliances in Africa

East and Southern Africa	West and Central Africa	North Africa
UbuntuNet Alliance	**WACREN - West & Central African REN**	**ASREN - Arab States REN**
Eb@le - DRC NREN	GARNET - Ghanaian NREN	TUREN - Tunisian NREN
EthERNet - Ethiopian NREN	TogoRER - Togolese NREN	MARWAN - Moroccan NREN
iRENALA - Malagasy NREN	GhREN - Ghanaian NREN	EUN - Egyptian Universities Network
KENET - Kenyan NREN	MaliREN - Mali NREN	ARN (Algeria) - Algerian NREN
MAREN - Malawian NREN	Niger-REN - Nigerien NREN	SudREN - Sudanese NREN
MoRENet - Mozambican NREN	RITER - Côte d'Ivoire NREN	SomaliREN - Somali NREN
RENU - Ugandan NREN	SnRER - Senegalese NREN	
RwEdNet - Rwanda NREN	NgREN - Nigerian NREN	
SomaliREN - Somali NREN	Eko-Konnect REN - Nigerian NREN	
SudREN - Sudanese NREN	LRREN - Liberia REN	

Figure 4-34: Members of NREN Alliances in Africa



NRENs become a valuable national asset that is independent and knowledgeable. Thus, various countries use NRENs to coordinate and sometimes operate national entities including the Computer Emergency Response Team (CERT), Internet Exchange Point (IXP), and the country code top-level domain (ccTLD) registry. Unfortunately, few African NRENs have so far gone down this role. ARN and EUN are managing the ccTLD for Algeria (.DZ) and Egypt (.EG) respectively[91].

4.4.5 IP INFRASTRUCTURE

As indicated above in the section on IXPs, Autonomous System Numbers[92] and IP address space allocation provide an up-to-date picture of the level of development of Africa's Internet industry. As can be seen from the table below, Africa's use of Internet address space is far lower than any other region.

Table 4-5: Utilisation of IP Resources by Region

Source:

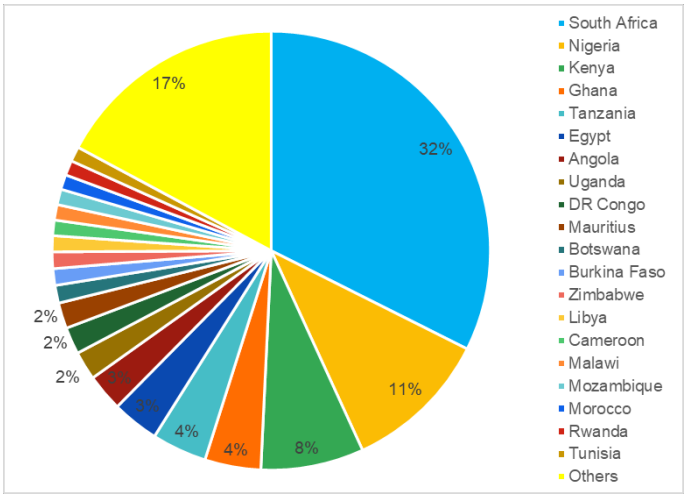
Name	IPv4 ASNs	IPv4 ASNs	IPv6 ASNs	IPv6 ASNs
Americas	19 673	42%	2 802	33%
Asia	6 185	13%	1 115	13%
Europe	19 078	40%	4 136	49%
Oceania	1 397	3%	330	4%
Africa	792	2%	119	1%
Unclassified	2	0%	0	0%

100

AS Numbers in particular are a good indicator[93] of the development of independent networks in the country, as the more independent networks there are, the more ASNs will exist. The OECD pioneered the use of ASNs as a measure of the development of the Internet sector in their member states.

The pie chart below shows that a third of the ASNs resource is allocated by South African LIRs. Moreover, the data shows more than half of the ASNs in Africa are allocated to three countries, namely South Africa, Nigeria, and Kenya. Thus, compared to our study in 2015, the gap is further widened.

Figure 4-35: AS Number Distribution



Source (https://www-public.imtbs-tsp.eu/~maigron/rir-stats/rir-delegations/afrinic/afrinic-asn-by-number.html

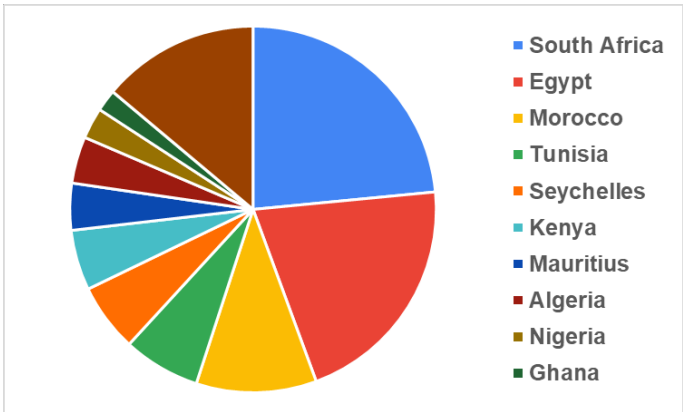
[91] https://icannwiki.org/

[92] An ASN is a globally unique index used to refer to all networks managed by one entity.

[93] https://www-public.imtbs-tsp.eu/~maigron/rir-stats/rir-delegations/afrinic/afrinic-asn-by-number.html

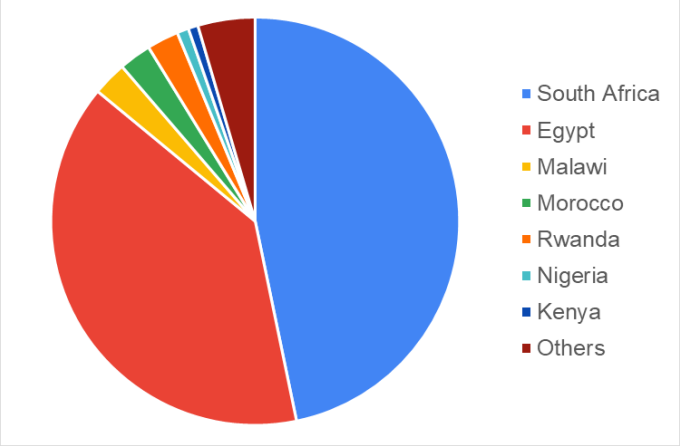
Furthermore, when looking at IP resources we notice asymmetry in both IPv4 and IPv6. Three countries are utilizing more than 55% of the IPv4 resource, namely South Africa, Egypt, and Morocco.

Figure 4-36: IPv4 Allocation per African Country



Two of them, South Africa, and Egypt, are assigned 86% of the IPv6 assigned in Africa so far. Other countries have been very slow to apply.

Figure 4-37: IPv6 Allocation per African Country



To examine the potential correlation between the number of Internet resources assigned to a country by AFRINIC and the number of domain names registered, the graph below plots the relationship between the number of IPv4 addresses[94] and domain names. Both axes are logarithmic.

As can be seen, the four Freenom domain hack countries (labels highlighted in Orange) are clearly atypical. A ‘domain hack’ is the additional use of a ccTLD for deriving third party advertising revenue, or for purposes more like the use of gTLDs, and as a result can make comparative analysis more difficult. These domains are discussed in detail in section 6.3.3. Other domain hacks are also highlighted in Yellow. Indeed, inclusion of any of the “domain hack” countries would distort the analysis and are removed in the subsequent graphs.

[94] The uptake of IPv6 addresses in Africa is still very low indeed.

Figure 4-38: IPv4 Allocations versus Domain Names – All Countries

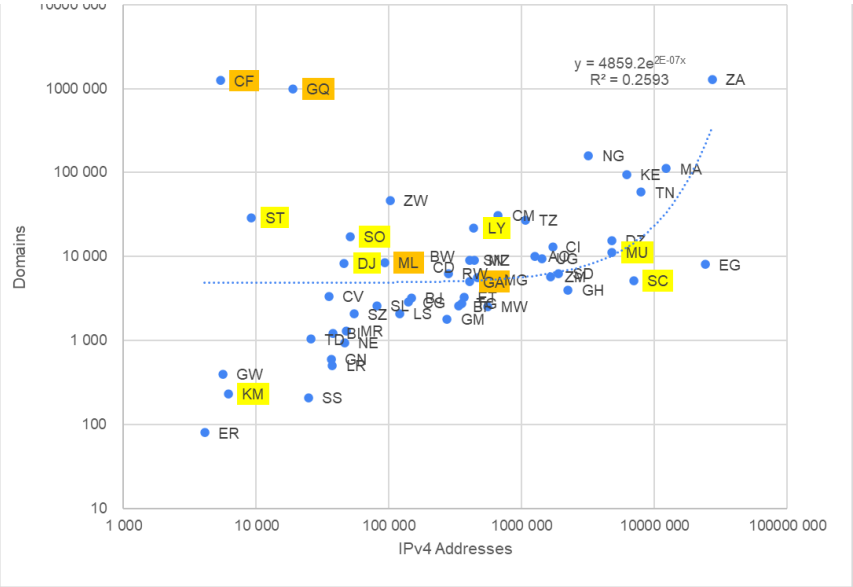
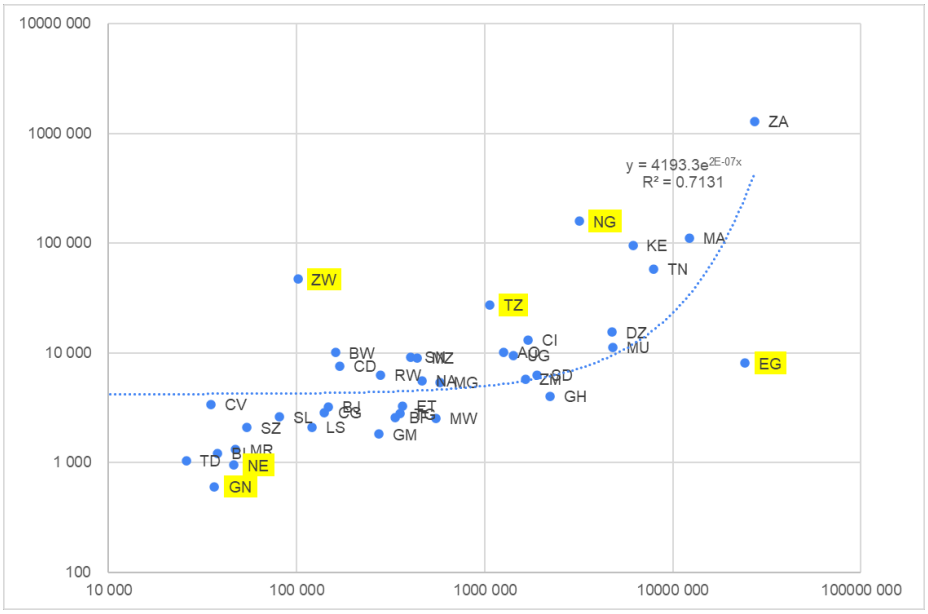


Figure 4-39: IPv4 Allocations versus Domain Names – Excluding Domain Hacks



By removing the outliers mentioned above, a reasonably good correlation between the number of IPv4 addresses and domains registered becomes apparent. The reasons why the highlighted countries: EG, NG, TZ, GN, NE, and ZW are so far off the trend-line are discussed in sections 7.3 and 7.4. Removing them from the graph increases the correlation from 72% to 97%.

4.4.6 ISP ASSOCIATIONS AND IXPS

The inter-relationship and co-dependence among Internet Exchange Points (IXPs) and ISP Associations (ISPAs) is well established. As the number of IXPs in Africa increased , so too did the number of Internet Service Providers Associations (ISPAs). While IXPs deal with the exchange of internet traffic, the ISPAs address the relationships with government on licensing and regulatory issues and the overall management of the IXPs. Then stepped in the African Internet Service Providers Association (AfrISPA) which helped to

ISPs need an IXP in order to exchange traffic efficiently.

formulate policies regarding the Internet in Africa, including the development of IXPs. During the first decade of this century, AfrISPA[95] amongst others) was one of the organisations that provided training workshops in over 20 African countries. AfrISPA not only conducted training courses on the technical, economic, regulatory and political aspects of IXP formation, but also conducted simultaneous courses on industry association formation. According to the Internet Society report of 6 July 2021 (Washington DC) the number of IXPs increased from 19 in 2012 to 46 in 2020. It is noted, in the same report that the most developed Internet ecosystems are in South Africa, Kenya and Nigeria. with a similar increase in the number of ISPAs. Africa has experienced – and in many cases is still experiencing – a considerable liberalisation of the telecommunications industry. In most countries the state-owned monopoly fixed line operator no longer has absolute power over internal and external communications. This liberalisation process has not been without its growing pains. In most African countries ISPs are licensed. As a result, if an ISP was too outspoken in opposition to government policy or regulations, such opposition might result in risk to its business. By forming an ISPA or other industry association when the ISPA representative speaks, it does so on behalf of an entire industry, and not simply as an individual or as a representative of a company. This reduces both personal and corporate risk.

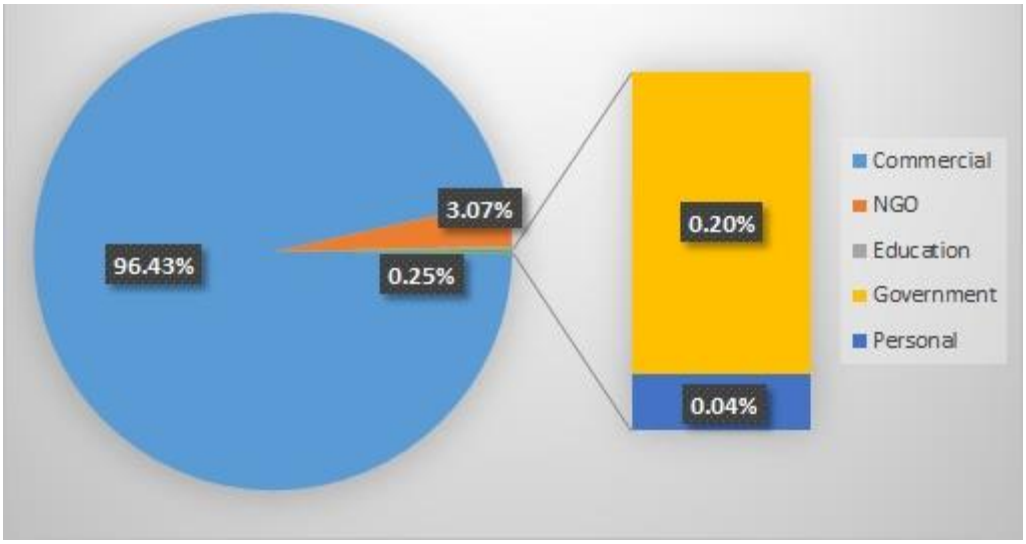
To an increasing extent policy makers and regulators in many African countries take their industry associations seriously, and actively solicit their views before promulgating new regulation or legislation. This is a very welcome development and bodes well for countries that adopt this approach.

4.5 CONTENT AND THE AFRICAN DNS

4.5.1 TYPES OF CONTENT HOSTED

As a means of identifying the various types of content hosted under African DNS, the domains registered under second levels were categorised. For those zone files that were made available to analyse, domains were characterised as commercial, NGO, educational, government and personal. This produced a range from 1.1 million commercial domains down to a few hundred personal domains, as shown graphically in the expanded pie chart below, for the 10 countries for which detailed figures were available.

Figure 4-40: Types of Website by Domain



Source: Own analysis of domain data.

It is quite clear that almost all the content analysed was commercial in nature.

[95] The African Association of ISP Associations. Now defunct.

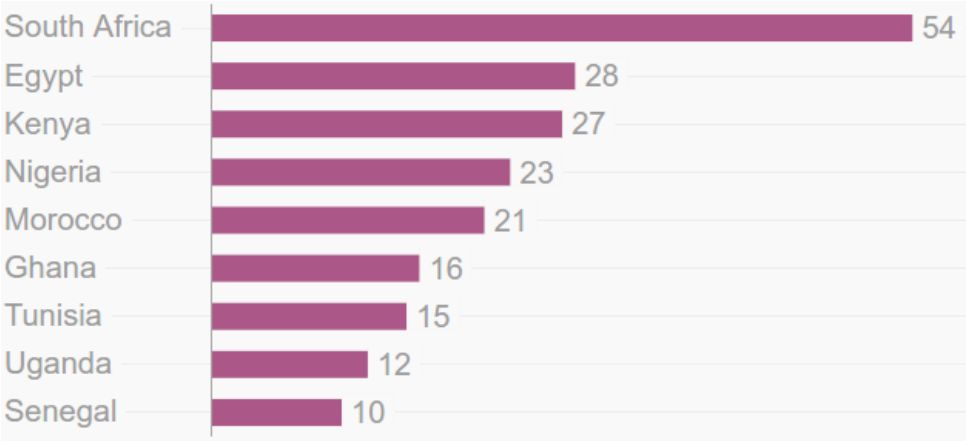
4.5.2 DIGITAL ENTREPRENEUR DEVELOPMENT

Demand for local domains is often driven by application developers who need to access affordable high bandwidth network services and to share other resources, ideas, and contacts to build their businesses. These needs are being increasingly met in Africa through the development of technology hubs and incubators which provide shared office space and other resources where start-up IT-enabled businesses can be supported, developed, and launched into the market. The importance of these facilities is underscored by the 2018 Ecosystem Accelerator survey conducted by mobile telecom industry body, GSMA, which found that the number of active technology hubs across Africa had grown by over 50 percent, from 314 in 2016 to 442 hubs in 2018, with a few more due to launch beyond 2018. The hubs are spread across several cities on the continent. However, most hubs are still relatively young, with the average year of formation being 2012. The Top-tier countries, according to the survey remain the same as those identified in the 2016 Report, namely: South Africa (59), Egypt (33), Kenya (30), Nigeria (55) and Morocco (35). These five destinations accounted for 45 percent of Africa's technology hubs, according to the survey.

The new research conducted by the GSMA Ecosystem Accelerator[96] aimed to quantify the number of tech hubs operating in Africa in 2018, including incubators, accelerators, co-working spaces, fab labs, makerspaces, hackerspaces and other innovation centres.

4.5.3 SMES AND E-COMMERCE

Figure 4-41: Technology Hubs and Incubation Centres



Source: GSMA | A few things we learned about tech hubs in Africa and Asia | Mobile for Development

The rise of small and medium enterprises (SMEs) has been a growing trend since the 1990s, when they became drivers for economic development. Now, these SMEs, right across the world, are increasingly relying on eCommerce channels to create and capture value. Although data on SMEs in Africa is limited, it is estimated that there are at least 40 million micro, small and medium enterprises on the continent[97], and their importance is widely acknowledged. For example, about 96% of Nigerian businesses are SMEs, according to statistics from the Central Bank of Nigeria. In the same vein a study conducted by Bastiat Ghana, a liberal economy think tank, shows that 92% of companies registered in Ghana are SMEs.

Most SMEs operate informally and are unlikely to have registered their own domain names or to use e-commerce services. Instead, they are more likely to use instant messaging like WhatsApp or WeChat, mobile text messaging, mobile payments and possibly an email address from a free service such as Gmail or MSN. A few may even have a Facebook page. This market is likely to represent a large,

[96] http://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/things-learned-tech-hubs-africa-asia

[97] https://african.business/2016/05/technology-information/exchanges-give-smes-helping-hand

potentially unmet demand for domain names, as some of these businesses move into the formal economy. Nonetheless, a concerted effort to study the behavioural patterns of non-digitised African SMEs should make it possible to bridge the gaps that keep this demographic offline and accelerate the digital transformation of this African mass market.

The extent to which SMEs are non-digitized largely depends on the effectiveness of fiscal authorities in making it simpler and more attractive for SMEs to enter the formal economy through more streamlined business registration procedures. A big incentive in this regard will be the ability to win more business through e-commerce.

Currently, the use of e-commerce by SMEs remains low. In 2021 7% of all purchases in Nigeria were made online. This was the highest share of e-commerce retail among the five African countries considered. South Africa and Kenya followed with four percent, while e-commerce in Egypt and Morocco accounted for three percent and two percent of the total retail, respectively (Africa: e-commerce retail as share of total retail 2021).

The banking sector will also need to be more conducive to small businesses, especially when receiving international payments is a key part of trade, whether online or offline. In countries with restrictive regulations governing cross-border transactions that involve foreign currencies, and without access to an international bank account or credit card, enterprises may have less incentive to put up websites and domains listing their products and services.

To be successful SMEs also need to better understand the markets they are serving, whether they are local or international, and be able to readily access those markets. This can be facilitated by, among other things, more reliable and affordable broadband infrastructure, and a regulatory framework that takes SMEs' specific circumstances into account.

Registrars should offer website hosting packages with domain registration.

Finally, it should also be pointed out that Registrars have an important role to play in making SMEs aware of the potential for registering domains and should combine these with appropriate website hosting packages and applications to help them build their online presence.

4.5.4 VOLUMES OF CONTENT BY COUNTRY

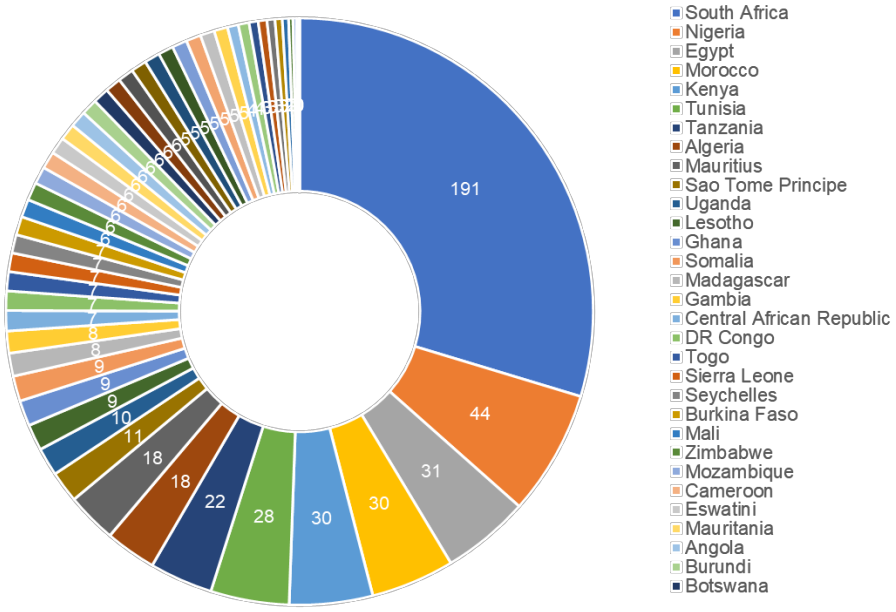
Increasing local content increases the demand for local domain names. The development of e-government services, the presence of e-commerce and payment gateways, and digital literacy have large roles to play in demand and supply of local content. These factors vary considerably between different countries, and combined with the infrastructure variations described above, has resulted in African web pages being concentrated among just a few ccTLDs.

Of the 54 ccTLDs surveyed, only South Africa and the Central African Republic had more than 1 million domain names, with most having less than 5 domains per 1,000 people except for the domain hack countries and South Africa[98].

As shown in the chart below, over three quarters of the over 650 million web pages with African ccTLD URLs indexed by Google are in just seven countries - South Africa, Kenya, Zimbabwe, Uganda, Nigeria, Egypt, and Morocco. South Africa and Kenya together are responsible for over 50% of these web pages.

[98] Own analysis

Figure 4-42: Millions of Webpages under African ccTLDs, 2023



Source: Own data analysis

When population size is considered most of the same countries are indicated, although the spread is a little broader. The table below divides the total web pages tracked by Google by the 2022 population, with just 12 countries found to have more than 0.5 pages per capita[99].

Note that the countries shaded red are Freenom domain hacks, and the other shaded countries represent other domain hacks. (see section 5.3.3, where the high use of domain names by entities unrelated to the country is discussed). Excluding these gives a much shorter list of countries – only five countries in Africa have more than 0.5 web pages / capita.

Table 4-6: Indexed Web Pages per capita

Country	ccTLD pages/ capita 2016	ccTLD pages/ capita 2023
Seychelles	59.2	60.7
Sao Tome Principe	22.1	47.9
Mauritius	5.5	13.7
Equatorial Guinea	4.5	3.3
South Africa	2.8	3.2
Djibouti	2.3	1.1
Libya	1.9	0.6
Zimbabwe	1.8	0.4

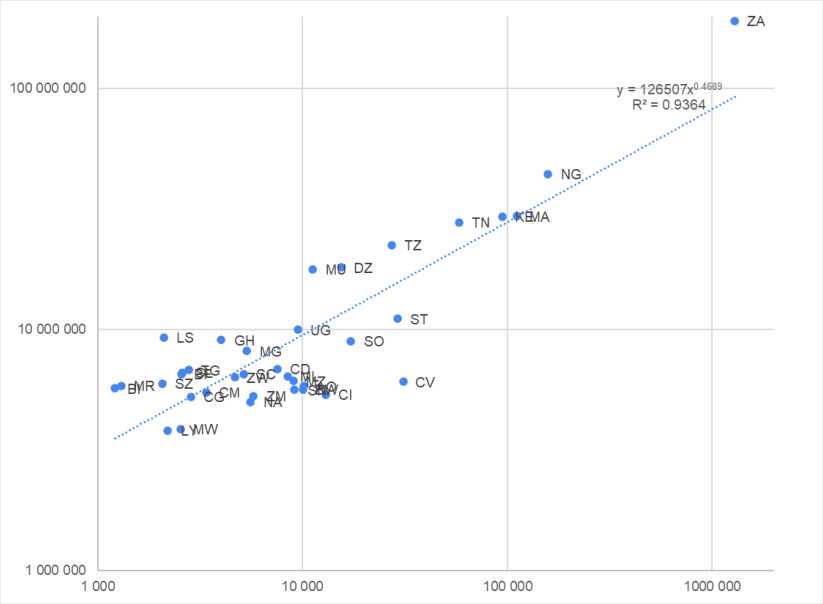
[99] Source: World Bank, Google.com Nov 2016

Gabon	1.3	1.3
Cape Verde	1.2	9.2
Kenya	0.9	0.5
Uganda	0.5	0.2

Source: Own analysis.

A plot of the total number of domains and the number of indexed web pages gives a good level of correlation as shown in the graph below. Only those countries where there are more than 1,000 domains are included.

Figure 4-43: Indexed Web Pages versus Domains > 1000



4.5.5 OFFSHORE AND ON-CONTINENT HOSTING

To study the hosting location of African content, analysis took place of zone files from eleven (up from four in 2016) African countries, plus the three South African .CITY gTLDs, the .AFRICA gTLD, as well as an extract of gTLD domains with an African Registrant from a large international Registrar and from several domain analysis houses. For a complete analysis more zone files and extracts are needed. Unfortunately, the researchers only had access to ccTLD zone files from eleven countries. While the level of cooperation was very low, it was significantly improved since the last Study, primarily due to the DNS Observatory being operational and providing valuable information to ccTLD managers. No WHOIS lookups or identification of individuals were required by the Study Team to produce the analysis presented here.

At the time of writing this Draft Report, we had completed the analysis of some 5.5 million websites, of which 4.1 million (75%) were shown to be working. From these figures, some 53% (up from 51%) of working websites are hosted overseas.

4.5.5.1 PIR GTLD DOMAINS

Previously, Afilias/PIR was able to provide us with three pieces of data about 147,000 domains in 21 gTLDs. The data consisted of a Domain Name, a Creation Date, and the African country with which the

Registrant is associated. The data was analysed without any WHOIS lookups by the Study Team (other than Geo-Location for the IP address), and we did not obtain, have, process or require any personal information about the Registrant.

In 2023, PIR supplied us with 71,846 domains. Of these, 71,454 were .ORG domains. (99.5%) The balance was made up of .FOUNDATION, .NGO, .ONG, .GIVES, .CHARITY, as well as two IDN zones, with one domain each. This distribution, excluding the .ORG domains, is shown in Figure 4-44 below.

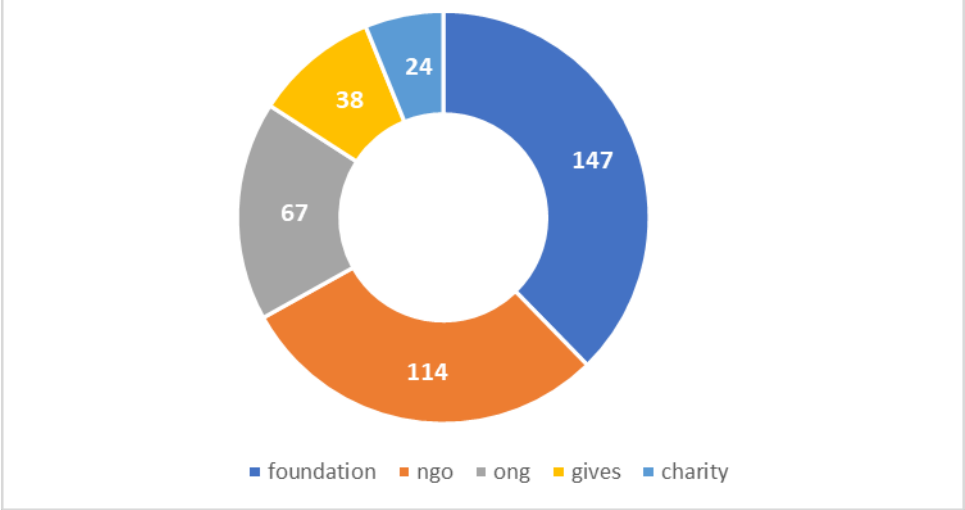
Of the domains provided, 77% pointed to a web server and 52% had websites with significant content[100]. 3% of the domains were configured with IPv6 and 0.2% with DNSSEC. All 54 African countries were represented.

The Study Team did no WHOIS lookups.

Although there are now only 6 gTLDs involved, 99.5% of the domains were concentrated in just .ORG. Note that the biggest gTLD zone, .COM, isn't included in this sample. A summary of the data is shown in the following graphics.

In the 2023 Study, we received much more country Data than previously. PIR also gave us all their data as well so .ORG figures are correct. We essentially had no .COM data but were able to acquire general domain name data from DomainNameStats[101]. There were about 270 million names and it included ISO Codes. After extracting all the African Country Codes – we had a sample of 3.5 million domain names – of which 2.5 million were associated with South Africa. These were duly processed.

Figure 4-44: PIR gTLD Zone Size Distribution 2023

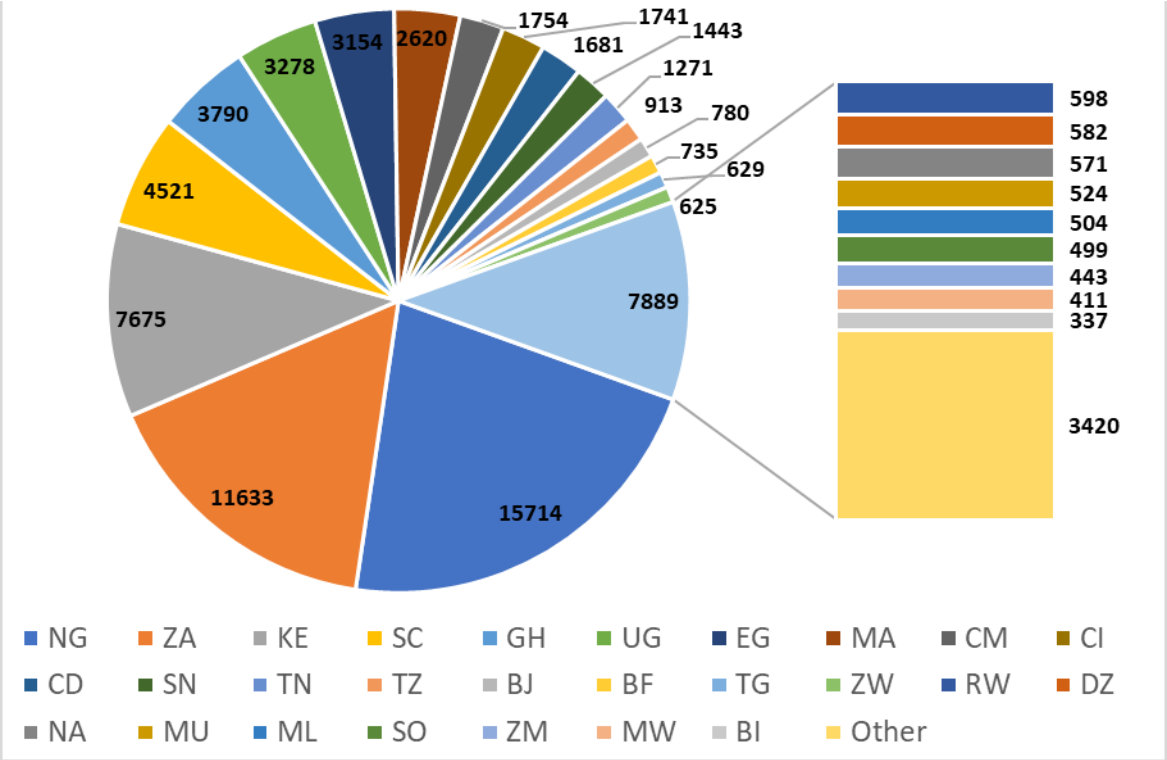


Of the 71,846 Afilias/PIR domains, 11,633 were associated with South Africa which is now surpassed by Nigeria at 15,714 (a swap in places since 2017), followed by Kenya at 7,675 Domains. The complete distribution is shown below.

[100] We counted a "real" website as one that has more than 2000 characters returned from the root document, as well as at least five internal links, to ensure we weren't looking at a single page "place holder" website.

[101] https://domainnamestat.com/statistics/country

Figure 4-45: Distribution of PIR gTLDs by Registrant Country 2023



South Africa hosts 61% of its Afilias domains locally, followed by Libya with 37% (38 out of 104) websites hosted locally, and then Malawi at about 17%. Guinea, Kenya, Tunisia, Morocco, Mali, Zimbabwe, and Botswana then all follow, at about 6-8%.

Moving on to those Afilias websites hosted by another African country, Lesotho leads with 43%, all of which are hosted in South Africa. Other smaller African countries follow: Sao Tome & Principe, Swaziland, Botswana, and Namibia. The overall distribution is again in the bar chart below.

In terms of overseas hosting, 15 countries hosted 100% of their Afilias gTLD websites overseas and another 24 countries hosted over 95% of websites overseas. This is indicative of the very low levels of local hosting – and hence Internet ecosystem health – in most African countries.

Figure 4-46: Where African Registrants host their .ORG Domains in Africa

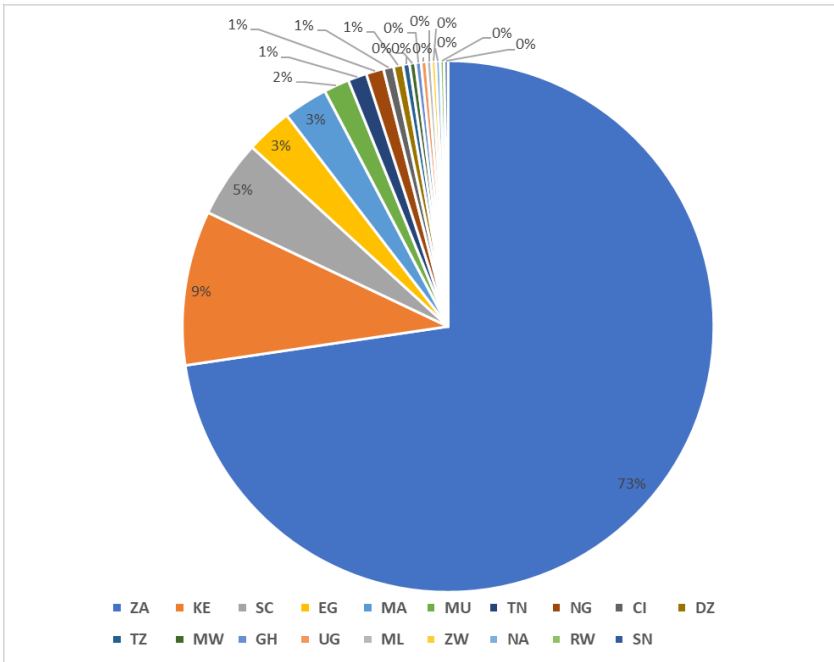
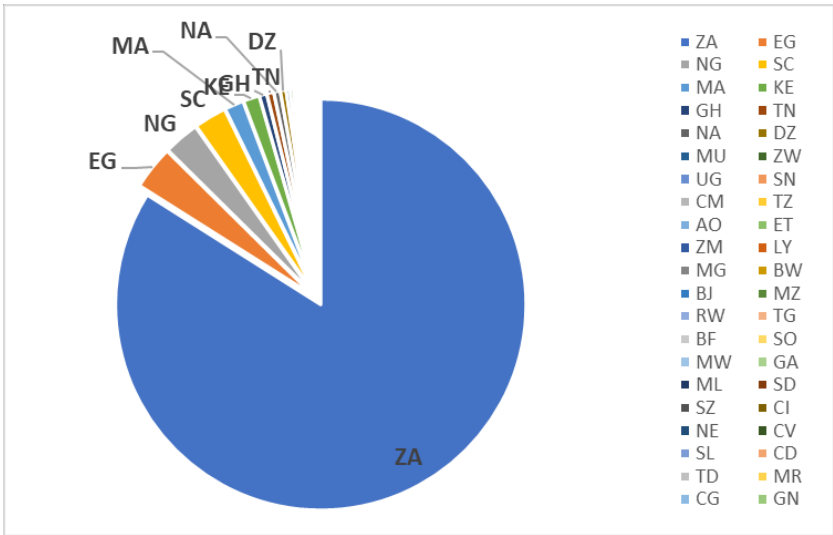


Figure 4-47: Where .COM Domains are Hosted in Africa



The ranking of the Top 10 countries by number of Afilias / PIR gTLD domains; the highest total number of websites; and the highest proportion of locally hosted gTLD domains is shown in the table below.

Table 4-7: Ranking by Afilias Domains

Total Afilias Domains	Total Websites	% Locally Hosted
South Africa	South Africa	South Africa
Nigeria	Nigeria	Libya
Egypt	Egypt	Malawi
Kenya	Kenya	Gambia
Morocco	Ghana	Kenya
Seychelles	Morocco	Tunisia

Ghana	Seychelles	Morocco
Uganda	Uganda	Mali
Tunisia	Ivory Coast	Zimbabwe
Ivory Coast	Cameroon	Botswana

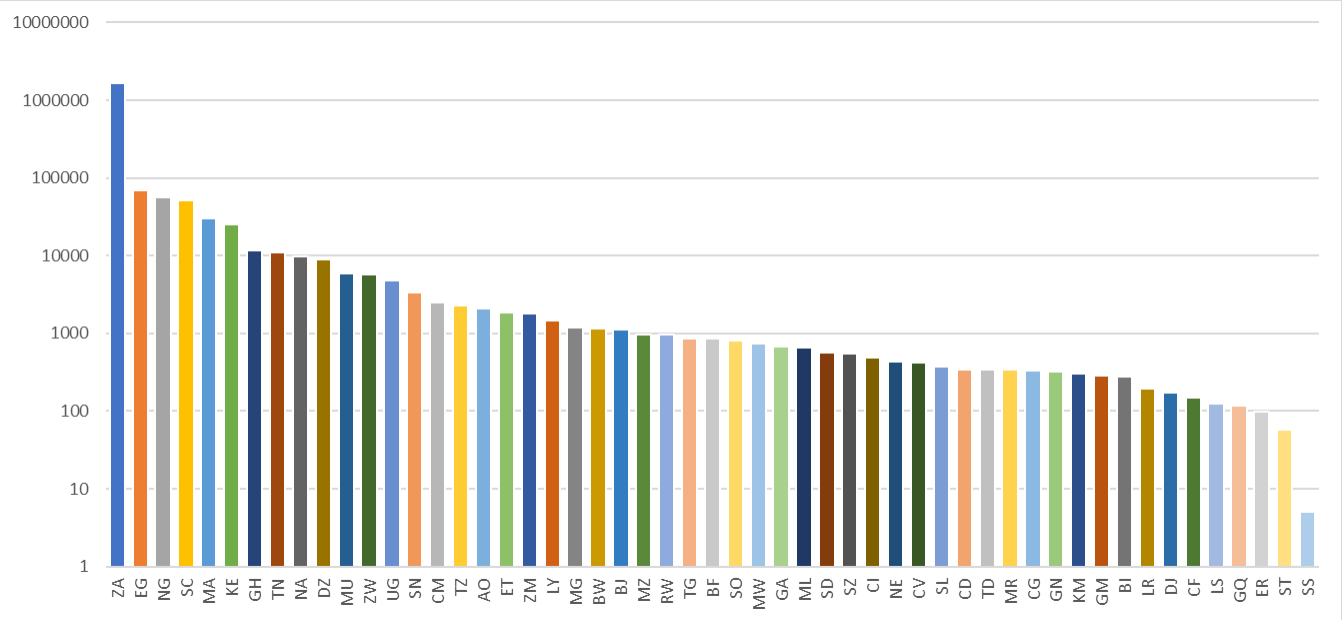
4.5.5.2 DOMAIN MONITORING GTLD DOMAINS

Previously, EyeDomain was also able to provide us with three pieces of data about 988,000 domains in the.COM gTLD, which consisted of a Domain Name, a Creation Date, and the African country with which the Registrant is associated. The data was analysed by the Study Team without any further WHOIS lookups (other than Geo-Location for the IP address), and we did not obtain, have, process or require any personal information about the Registrant.

Of the domains provided 52% had websites with significant content. 0.4% of the domains were configured with IPv6 and 0.32% with DNSSEC. Only 51 African countries were represented, with no .COM domains.

With such large differences in scale, the logarithmic chart below shows the numbers of domains hosted by each country, for the 53 countries identified with at least one locally hosted domain.

Figure 4-48: Locally Hosted .COM domains (Log Scale)

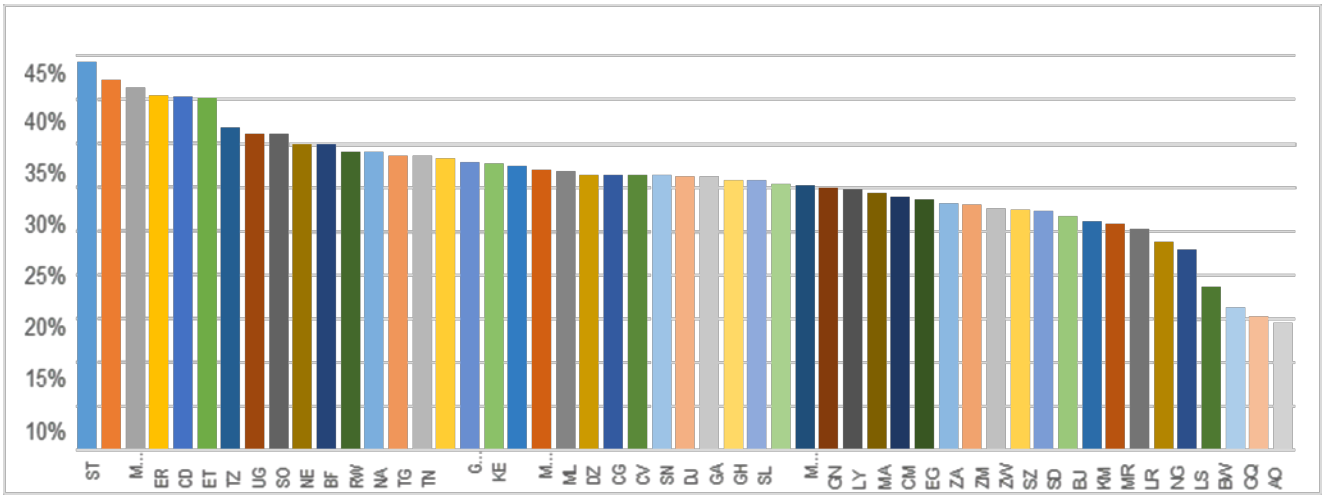


Moving on to those EyeDomain .COM websites hosted by another African country, Lesotho leads with 40%, all of which are hosted in South Africa. Other smaller African countries follow: Swaziland, Botswana, and Zimbabwe. The overall distribution is again in the bar chart below.

In terms of overseas hosting, 12 countries hosted 100% of their EyeDomain .COM websites overseas and another 24 countries hosted over 95% overseas. This is indicative of the very low levels of local hosting – and hence Internet ecosystem health – in many African countries.

Of those who have registered an EyeDomain .COM domain there is a reasonably high proportion of websites operating on those domains (i.e. not squatted, or just used for mail), ranging from 44% (27 out of 61) for Sao Tome & Principe, to 42% for Madagascar and 41% for Malawi. The distribution is again shown below.

Figure 4-49: Substantial .COM Websites as % of Domains



The ranking of the Top 10 countries by number of EyeDomain .COM domains, the highest total number of websites and the highest proportion of locally hosted gTLD domains is shown in the table below.

Table 4-8: .COM Domain Ranking

Total .COM Domains	Total Websites	% Locally Hosted Websites
South Africa	South Africa	Libya
Nigeria	Nigeria	South Africa
Egypt	Egypt	Malawi
Morocco	Morocco	Tunisia
Seychelles	Kenya	Morocco
Kenya	Ghana	Kenya
Ghana	Seychelles	Algeria
Algeria	Algeria	Tanzania
Tunisia	Tunisia	Zimbabwe
		Gambia

This table is similar to that for the Afilias domains, with Uganda, Mali, Cameroon and Ivory Coast falling away.

4.5.5.3 GTLD SUMMARY

With two different sets of gTLD data, it's interesting to compare the ranking of African countries in terms of these numbers. As the graph below indicates, although there are minor changes in position at either end of the scale, a country with many PIR gTLD domains is likely to have proportionally as many .COM gTLD domains. In both cases, this indicates a more vibrant Internet ecosystem. Conversely, those countries with few PIR gTLD domains also tend to have few .COM gTLD domains. Again, this illustrates a relatively moribund Internet ecosystem. However, there are wide variations in some cases, with the countries that fall between these two extremes.

Figure 4-50: Correlation between Afilias and .COM gTLD Domains

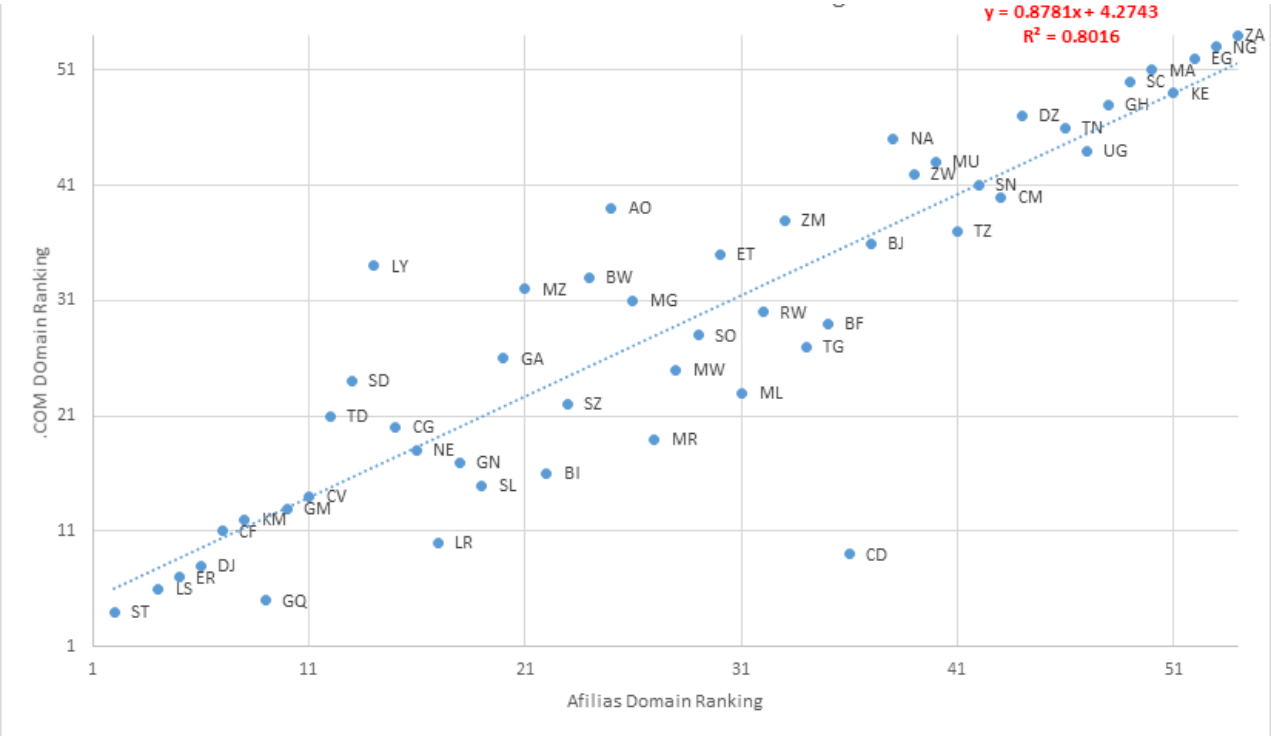
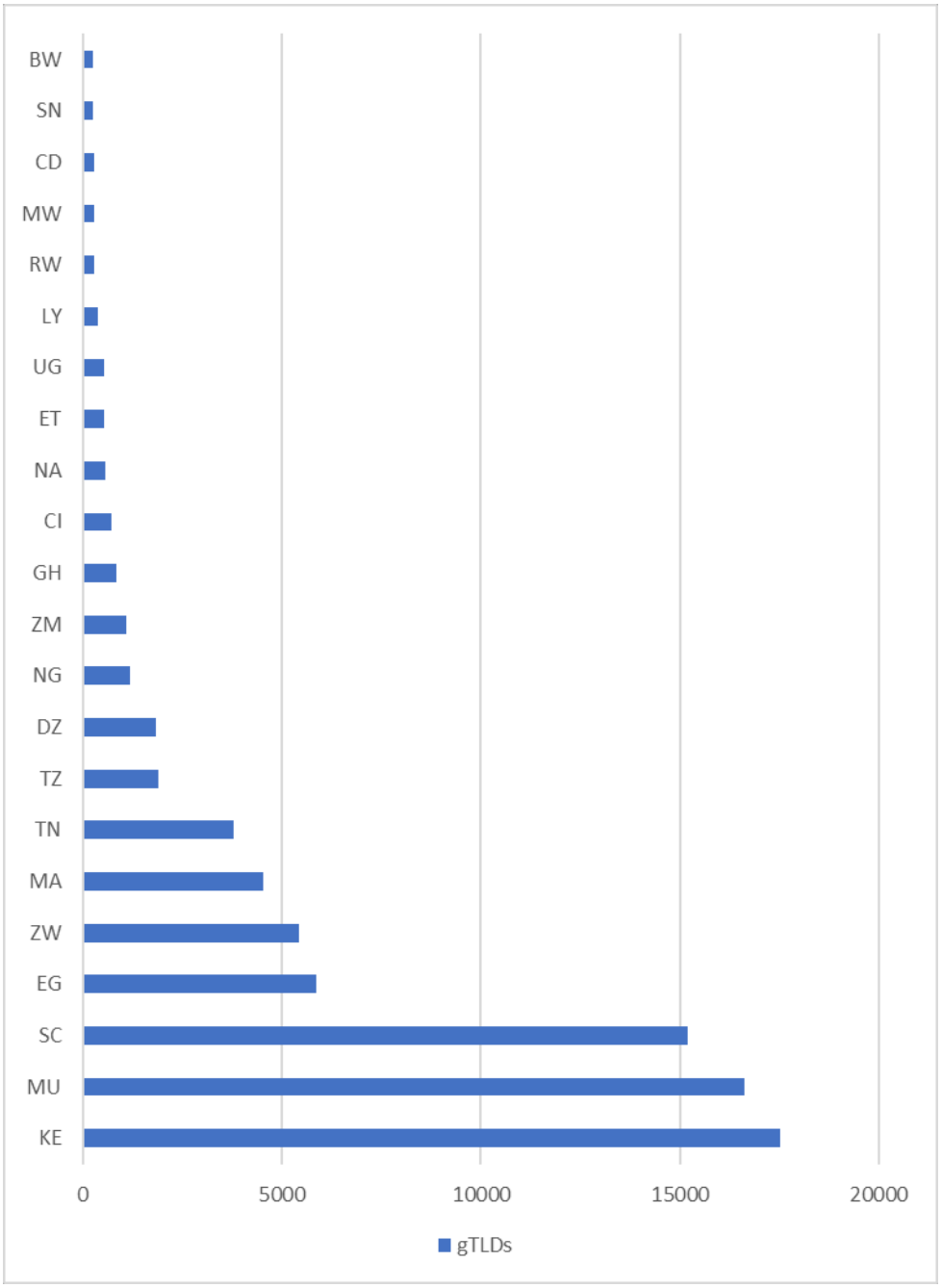


Figure 4-51: 200 or more gTLDs in Africa (except ZA)



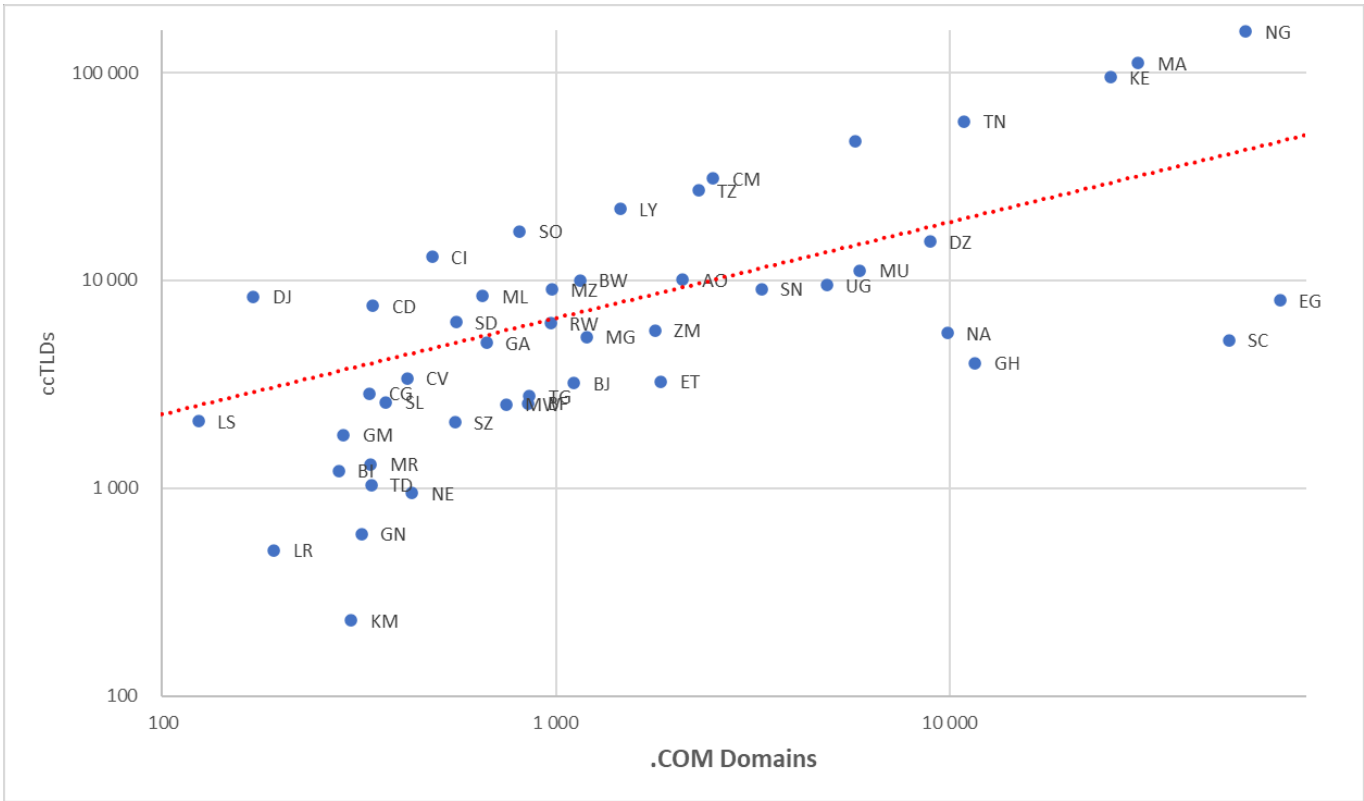
Countries with at least 200 gTLDs – excluding the 1.8 million for South Africa

4.5.5.4 COMPARISON OF CCTLD AND GTLD DOMAINS

When we compare the number of ccTLD domains counted by DomainTools, versus the number of gTLD domains identified as associated with Africa by Domain Name Stats, there are considerable differences. In the graphic below, the ratio between these two numbers of domains is shown for those countries with more than 1,000 domains in each category excluding the “domain hack: countries. Its value is indicated in the column labels. From the point of view of the local domain name industry, the left of the graph may be considered as “good”, and the right considered as “bad”.

Note that the gTLD data is as of November 2023, and the ccTLD data is also as of November 2023.

Figure 4-52: ccTLDs vs.COM domains (Log / Log Scale)

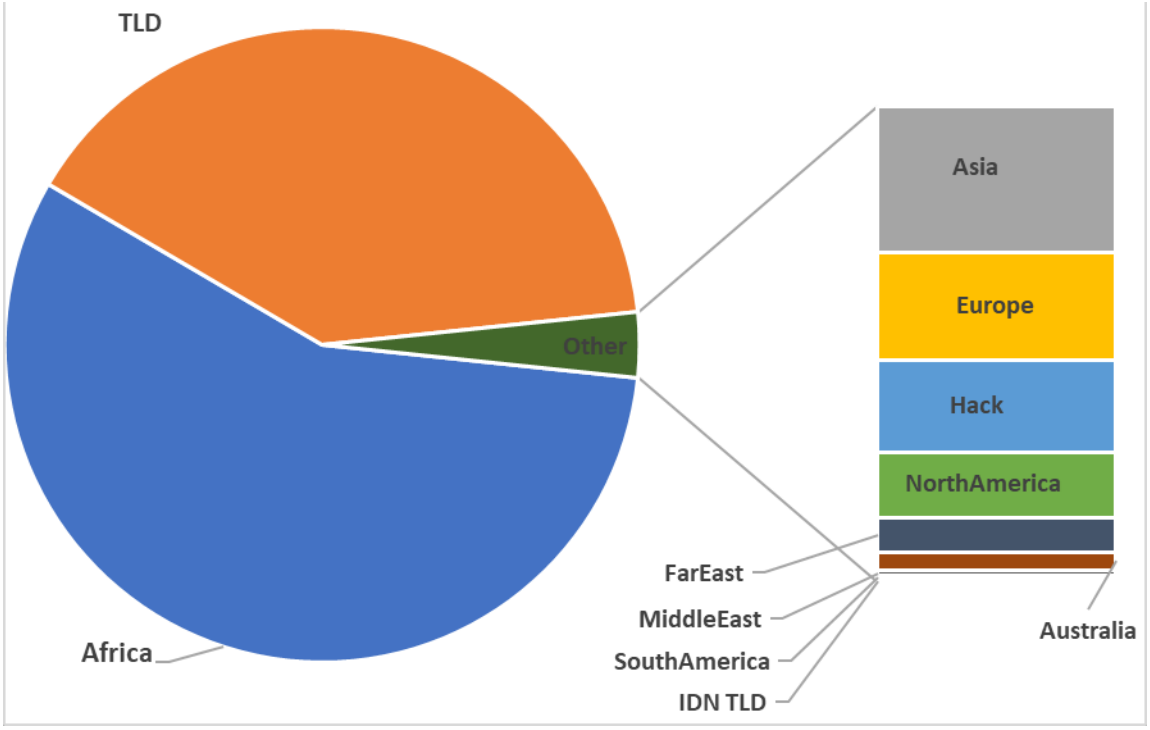


The data from Doman Name Stat[102] was particularly useful in this comparison, as it included a total of just over 3 million domains with a Registrant associated with Africa. It included summary data for all 54 African countries. We looked at the top 25 zones for each, giving us a total of 141 zones registered by Africans. The figure below shows these domains allocated to one of 11 “regions” or groups. There were some quite surprising preferences in some countries.

When ZA was included, 57% of domains were African, with 40% gTLDs. Excluding ZA, these changed to 33% and 62%, respectively.

[102] https://domainnamestat.com/

Figure 4-53: Total Domains per region



4.5.6 CCTLD AND GTLD DOMAINS WITH COMPLETE DATA

We were able to obtain domain data from countries in the following sections. These are slightly different to the countries in the 2016 Study's data. The previous study gave the numbers of Domains per Country and then indicated where the websites were most probably hosted. With the advent of Cloud Storage – the country that hosts the data becomes somewhat irrelevant. From this, we also discovered the Country Code of "WW" being used to signify when the IP address being used was managed by organisations such as Google or other parties providing Cloud Storage. However, the WW counts may not yet be completely accurate. We are still providing data regarding where Websites are hosted. The Line Graphs and Pie Charts are from the Observatory system which can be found at https://observatory.dnsstudy.africa

The Graphs here will be different from the Observatory as the Observatory updates every month around the start of each month.

We believe this information to be much more comprehensive per domain as, apart from the count of Domains and Websites, our data also includes growth counts for SSL (HTTPS) secured web sites, DNSSEC Enabled domains and where Web Sites have IPv6 addresses. We also display where websites are hosted – something that is becoming important to country's governments. Regarding the "Working Domain Count" being lower than the Domain Count provided, all Registry operators have customers who have paid for more domains than have actual working domains. This is often (as an example) because the Child DNS for those domains is no longer working, often because the customer has moved away. This value is around 15%-20% of Domains. The data below was correct for the first week of November 2023.

4.5.7 AFRICAN ZONE FILES

Previously, we obtained data for 19 zone files from four countries.

Partially due to better cooperation because of motivated Country Leaders, as well as increased credibility after the publication of the 2016 Study, we have obtained zone files from 12 countries. However, the visible benefit of the DNS Observatory has also played a significant role in encouraging cooperation with ccTLD managers.

We now have on the DNS Observatory, from a variety of sources including the research carried out elsewhere in this Report, some 3.55 million domains, in 199 zones. Some of these are very sparse indeed, with 11 having fewer than 20 domains included.

The complete list of Zone Files that had been made available by the time of writing is shown in the table below, although even for these eleven countries, we were not able to acquire all zone files.

Table 4-9: African Zone Files

ZONE	COUNT 2017	COUNT 2023
CO.ZA	1 001 013	1 268 484
CO.KE		71 898
AFRICA		35 534
CO.ZW	22 794	33 733
ORG.ZA	22 203	24 339
CO.TZ		17 493
KE		5 482
RW		5 130
ME.KE		4 232
CAPETOWN	4 407	3 608
JOBURG	3 407	2 413
DURBAN	2 459	1 897
NET.ZA		2 176
OR.TZ		1 924
OR.KE		1 601
SD	2 110	3 963
WEB.ZA	1 713	1 150
ORG.ZW	1 208	
CO.LS	1 045	
GO.TZ		852
AC.ZW	477	
GOV.SD	474	127
NOM.ZA	351	465
AC.ZA		394
COM.SD	316	
COM.ZM		293
GOV.ZM		267
ORG.ZM		266
ORG.LS	166	
EDU.SD	142	

[103] The single ".KE" zone file actually contains a number of SLDs: ac.ke, co.ke, go.ke, info.ke, me.ke, mobi.ke, ne.ke, or.ke, and sc.ke.

ZONE	COUNT 2017	COUNT 2023
EDU.ZA	94	181
ORG.SD	75	
NET.SD	33	

In terms of where websites are hosted, the following table summarises the locations in 2016:

Table 4-10: ccTLD Hosting Locations - 2016

Country	Total Domains	Total Websites	Hosted Locally	Hosted in Africa	Hosted Overseas
LS	1 168	400	81	135	184
SD	3 153	1 082	379	3	700
ZW	24 479	7 367	1 964	511	4 892
ZA	1 025 410	504 223	358 388	118	145 717

The table above also highlights two other trends:

- About 70% of domains have websites behind them, the remainder are inactive.
- With the relatively well-developed hosting ecosystem in South Africa, about 70% of the websites are hosted in-country.

Table 4-11: ccTLD Hosting Locations - 2023

Country	Total Domains	Total Websites	Hosted Locally	Hosted in Africa	Hosted Overseas
KE	107 509	73 524	5 338	8 801	64 723
RW	7 134	4 138	635	715	3 423
TZ	28 052	18 677	1 107	1 407	17 270
MG	5 448	3 255	191	207	3 048
SD	8 501	2 379	27	34	2 345
ZW	34 800	26 878	1 217	6 361	20 517
ZA	1 879 984	1 114 331	784 736	801 819	312 512
ZM	6 148	2 654	694	964	1 690
JOBURG	2 964	1 647	1 276	1 279	368
DURBAN	2 366	1 238	937	943	295
CAPETOWN	4 242	2 760	2 116	2 123	637
AFRICA	62 915	29 397	13 636	13 960	15 437

The 2023 table shows more countries from which we received proper data. Please note that the “Hosted in Africa” column includes data from the Host Country as well.

The countries supplied us with their complete African data are analysed in the following sections. Not that they are presented in the order of the Regions of which they are part.

These are slightly different to the countries in the 2016 Study’s data. The previous study gave the numbers of Domains per Country and then indicated where the websites were most probably hosted. With the advent of Cloud Storage – the country that hosts the data becomes somewhat irrelevant. From

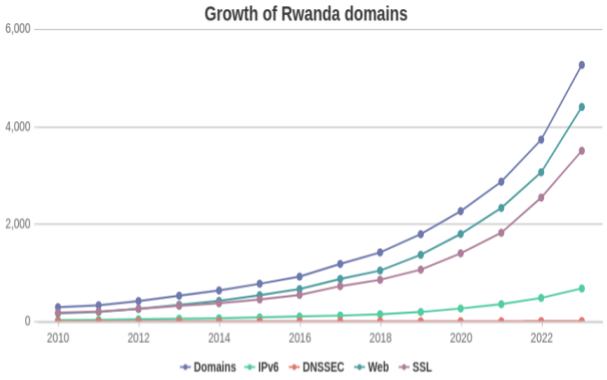
this, we also discovered the Country Code of “WW” being used to signify when the IP address being used was managed by organisations such as Google or other parties providing Cloud Storage. However, the WW counts may not yet be completely accurate. We are still providing data regarding where Websites are hosted. The Line Graphs and Pie Charts are from the Observatory system which can be found at https://observatory.dnsstudy.africa

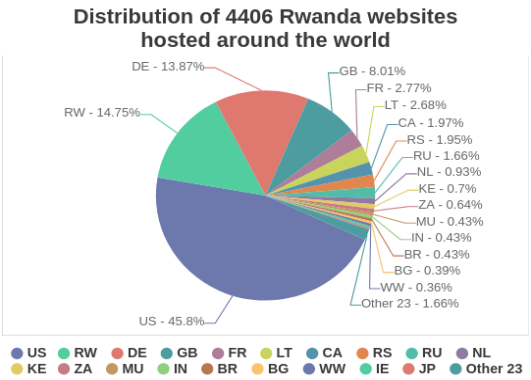
The Graphs here will be different from the Observatory as the Observatory updates every month around the start of each month.

We believe this information to be much more comprehensive per domain as, apart from the count of Domains and Websites, our data also includes growth counts for SSL (HTTPS) secured web sites, DNSSEC Enabled domains and where Web Sites have IPv6 addresses. We also display where websites are hosted – something that is becoming important to country’s governments. Regarding the “Working Domain Count” being lower than the Domain Count provided, all Registry operators have customers who have paid for more domains than have actual working domains. This is often (as an example) because the Child DNS for those domains is no longer working, often because the customer has moved away. This value is around 15%-20% of Domains. The data below was correct for the first week of November 2023.

4.5.7.1 RWANDA

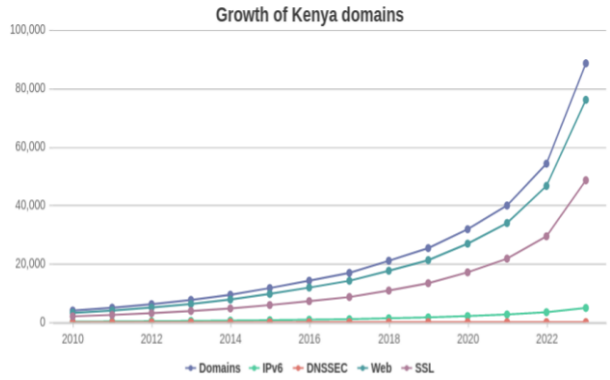
Rwanda out of 6,754 domains has 5,130 working domains covering 4,006 websites, of which 14% have IPv6 addresses. 78% of these websites have SSL Certificates. There is also a very low take-up on DNSSEC (3 domains). However, there are another 45 domains with CDS records that could be added to the DNSSEC score. 49.3% of websites are hosted in the USA and 12.6% in Rwanda. The UK (10%) and Germany (8.9%) follow.

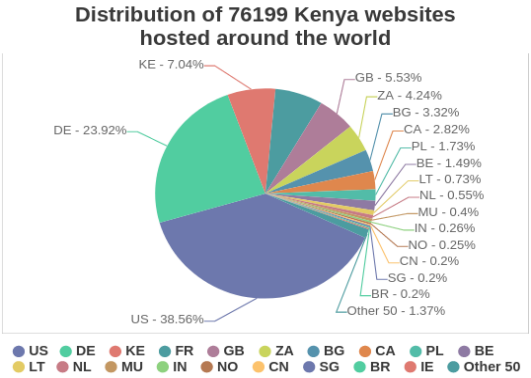




4.5.7.2 KENYA

Kenya out of 88,148 domains has 85,588 working domains covering 73,522 websites, of which 5.8% have IPv6 addresses. This is a lowish IPv6 count – where often 10% of all domains have IPv6 addresses. 63% of these websites have SSL Certificates. There is also a very low take-up on DNSSEC (45 domains) possibly due to the DNSSEC issues that Kenya has gone through. However, there are another 43 domains with CDS records that could be added to the DNSSEC score. Most websites are hosted in the USA (38.5%) or Germany (23.4%) with only 7.63% being hosted in Kenya.



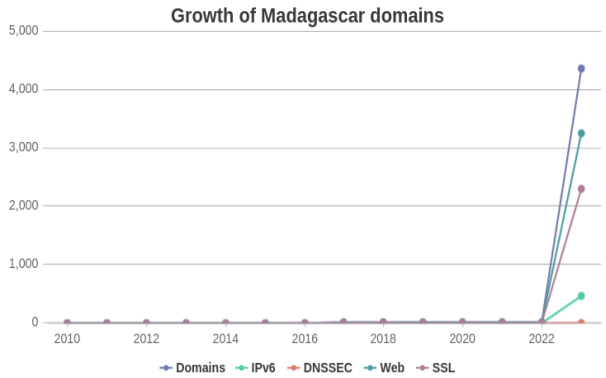


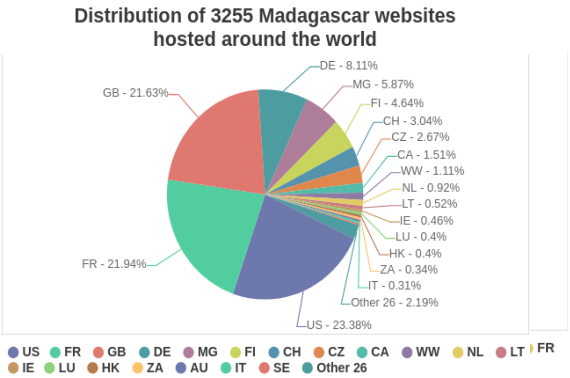
4.5.7.3 TANZANIA

Tanzania out of 28,015 domains has 22,121 working domains covering 18,681 websites, of which 10.8% have IPv6 addresses. 65.7% of these websites have SSL Certificates. There is also a reasonable take-up on DNSSEC (1027 domains). However, there are another 45 domains with CDS records that could be added to the DNSSEC score. 55.2% of all website hosting is in the USA, 11.2% in the UK, 7% in Germany and 5.9% in Tanzania. This is followed by Canada (2.5%), Lithuania (2.1%) and Sweden (1%).

4.5.7.4 MADAGASCAR

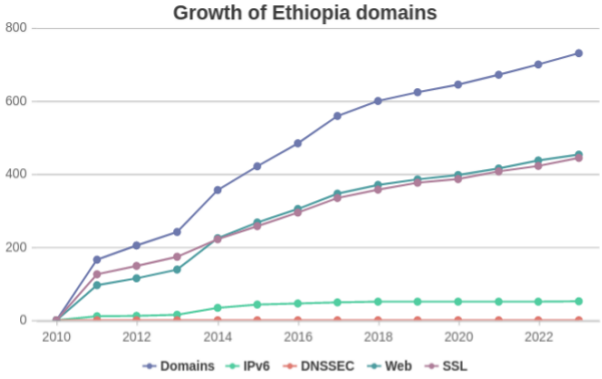
Madagascar in the .MG and the COM.MG domains has 4,652 working domains out of the 5,332 domains provided, covering 3,851 websites, of which 12% have IPv6 addresses. 65% of these websites have SSL Certificates. Take-up on DNSSEC at 4 domains is very low. The reason the chart seems to start in 2022 is because the ccTLD provided only a list of domains with no starting dates. 23.4% of websites are hosted in the USA, 22% in France, 21.7 in the UK, 8% in Germany and then 5.4% in Madagascar.

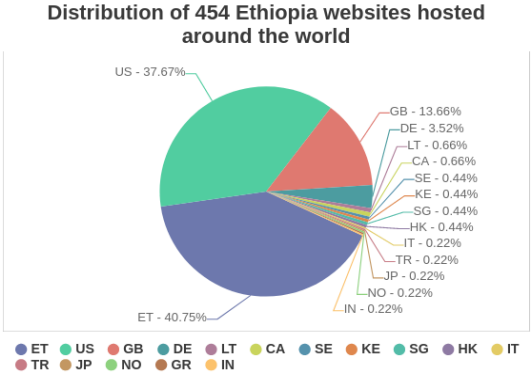




4.5.7.5 ETHIOPIA

Ethiopia supplied us with a list of 3,859 domains but only 611 are working domains covering 378 websites, of which 9% have IPv6 addresses. 97% of these websites have SSL Certificates. There is no

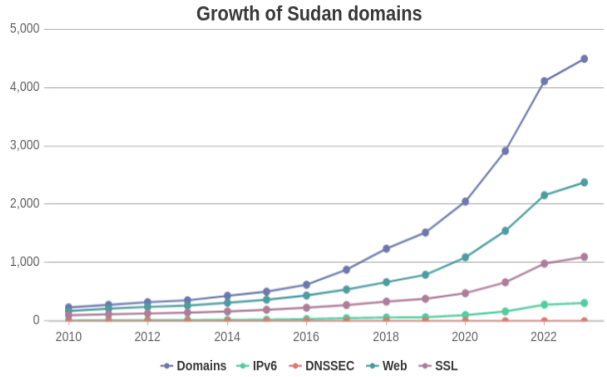


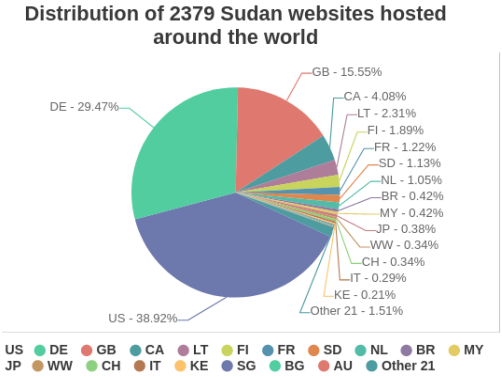


DNSSEC. However, it is understood that Ethiopia is privatising the ccTLD and will hopefully be rebuilding the ccTLD to better than before. 45% of Websites are hosted in the USA with 30.2% being hosted in Ethiopia. The UK hosts 15.6% whilst Germany hosts 4%.

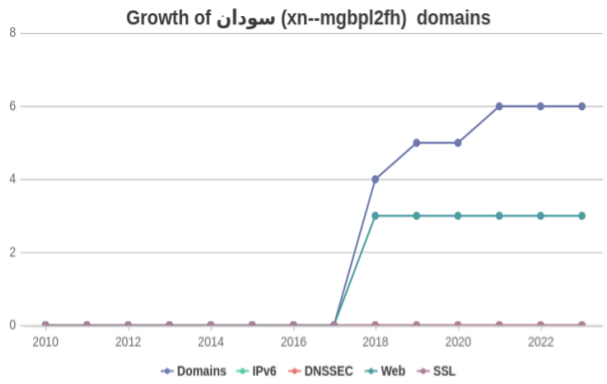
4.5.7.6 SUDAN

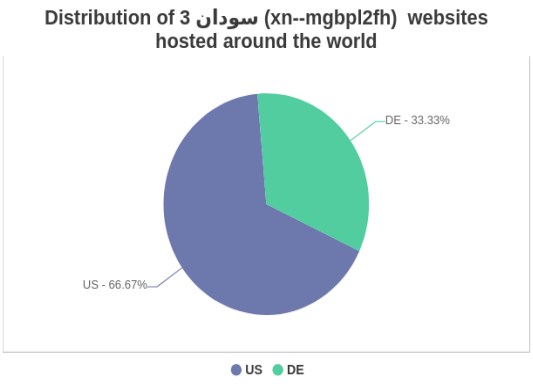
Sudan supplied us with a list of 6,982 domains and have 4,496 working domains covering 2,352 websites. There are very few IPv6 addressed websites. 47% of these websites have SSL Certificates. There is currently no DNSSEC but a conversation with the ccTLD administrator indicated that they were about to DNSSEC sign the zone – until the current conflicts hit the country. The ccTLD administrator has left the country with his family until the political climate calms down. Various servers are down – which is probably also why so many Domains have gone dark. 38.8% of Websites are hosted in the USA, 29.4% in Germany, 15.6% in the UK and 4.1% in Canada. There are 26 (1.1%) websites in Sudan – probably an anomaly due to the current political situation.





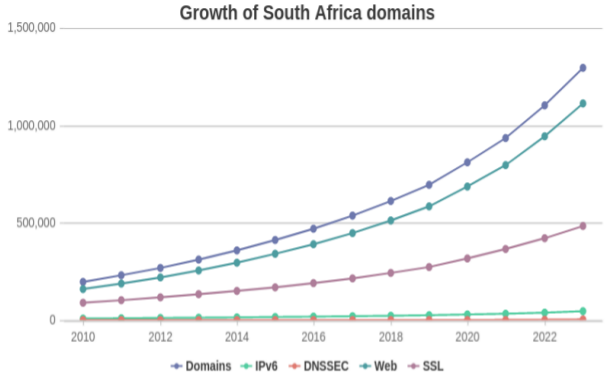
We also have some data on سودان **(xn--mgbpl2fh)** which is the IDN Sudanese gTLD. There are six working domains out of 15 domains of which three have web sites. Two of these are in the USA and one is in Germany. The Zone is not DNSSEC Signed.

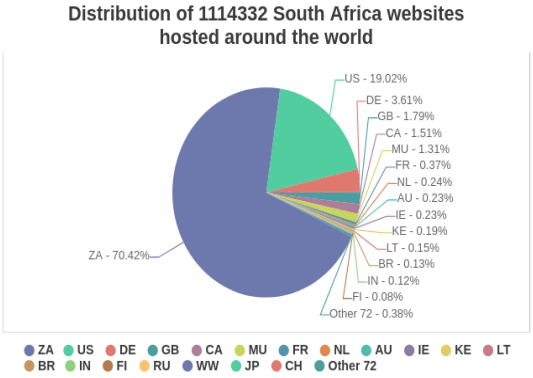




4.5.7.7 SOUTH AFRICA

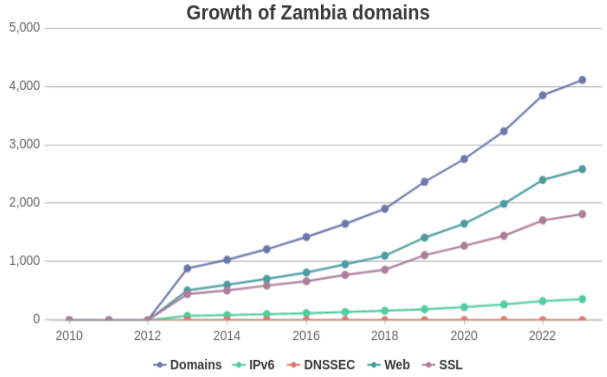
South Africa has 1,300,958 working domains covering 1,114,801 websites. IPv6 deployment at Websites is low at 3%. 43% of websites have SSL Certificates. DNSSEC deployment sits at 0.32% so is extremely low. South Africa is managed quite differently to other ccTLDs as the Second Level domains are managed by multiple organisations. 70.4% of Websites are in South Africa, 19% are in the USA, 3.6% in Germany, 1.8% in the UK, 1.5% in Canada and 1.3% in Mauritius.

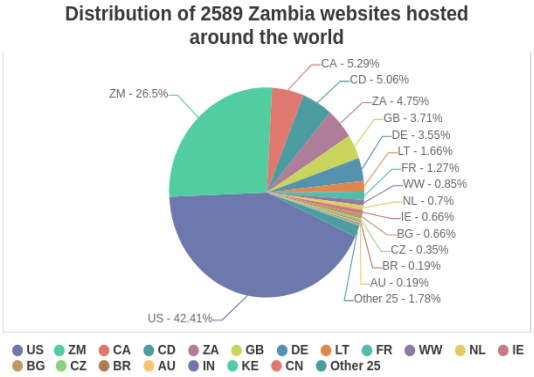




4.5.7.8 ZAMBIA

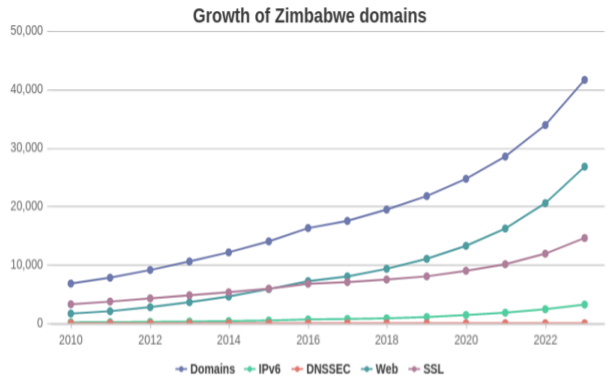
Zambia provided us with 6,112 domains of which 4,288 are working domains giving 2644 websites. About 12% of websites have IPv6 addresses. 68% of websites have SSL Certificates. There is only one DNSSEC signed domain (a bank), so DNSSEC deployment is extremely low. 42.9% of Websites are in the USA whilst 25.9% of Websites are in Zambia. Canada (5.2%), DRC (5.1%), South Africa (4.5) and the UK (3.7%) also host websites.

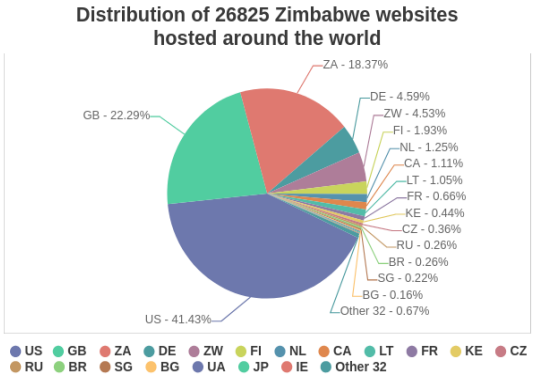




4.5.7.9 ZIMBABWE

Zimbabwe provided us with 50,623 domains of which 41,695 are working domains giving 26,825 websites. About 9.36% of websites have IPv6 addresses. 54.44% of websites have SSL Certificates. Zimbabwe is not yet DNSSEC Signed. The CO.ZW zone has two IDN names. CO.ZW domain names are very low cost – around US$1 - which makes them very popular.

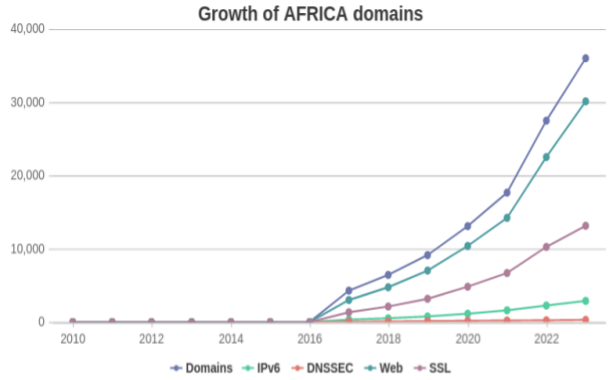


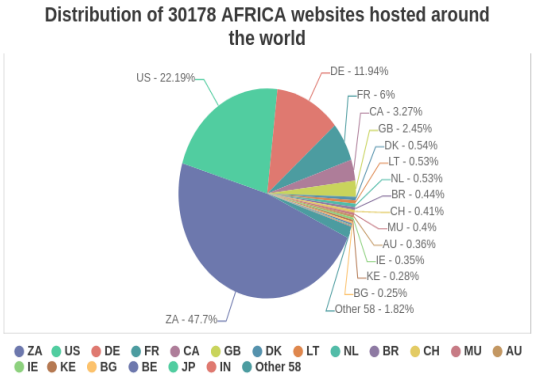


4.5.7.10 AFRICA

Africa (opened 2017-07-04) provided us with 62,716 domains of which 35,054 are working domains giving 29,210 websites. About 9% of websites have IPv6 addresses. 44.3% of websites have SSL Certificates. Africa is DNSSEC Signed and there are 307 signed domains.

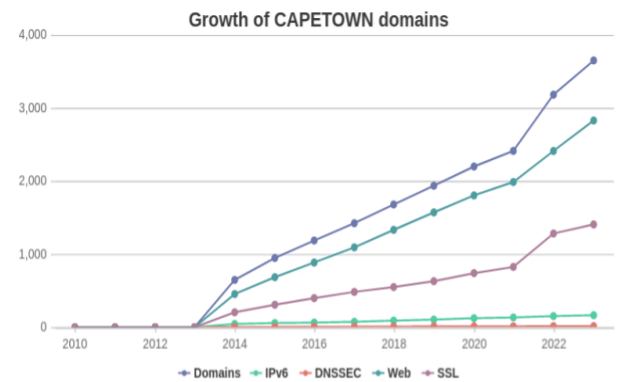
46.1% of Websites are in South Africa, 22.9% are in the USA and 12.3% are in Germany. 6.2% of websites are in France, 3.4% in Canada and 2.5% in the UK.

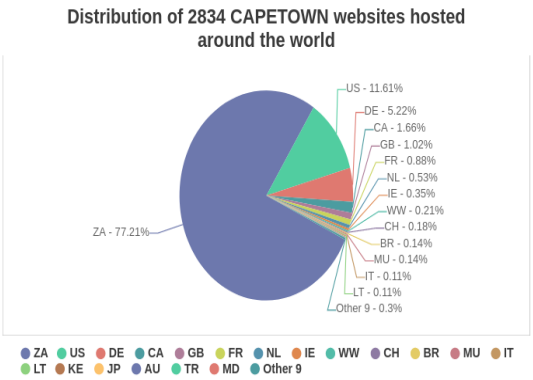




4.5.7.11 CAPETOWN

.CAPETOWN (Cape Town) (Cities opened 2014-11-04) provided us with 4,228 domains of which 3,569 are working domains giving 2,834 websites. About 8.9% of websites have IPv6 addresses. 50.5% of websites have SSL Certificates. .CAPETOWN is DNSSEC Signed and there are 15 signed domains. 76.6% of Websites are in South Africa, 11.9% are in the USA and 5.4% are in Germany. 1.7% of websites are in Canada, 1.1% in the UK and 0.9% in France.

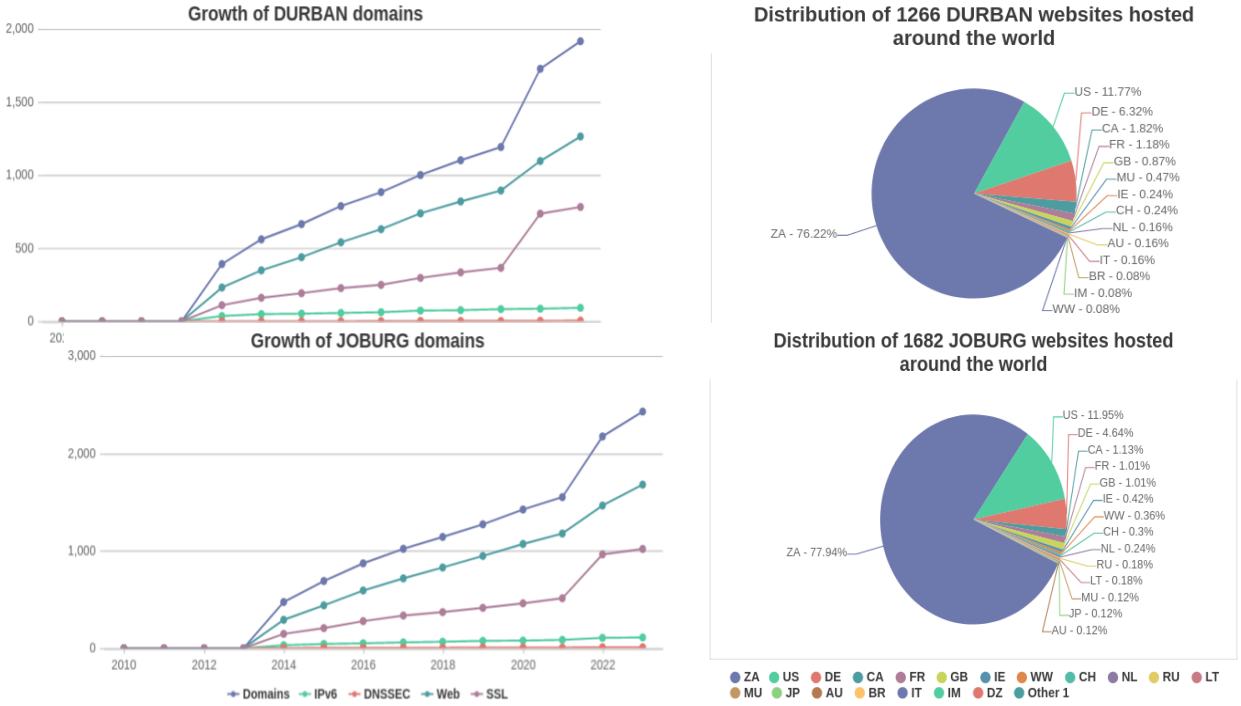




4.5.7.12 DURBAN

Durban provided us with 2,362 domains of which 1,886 are working domains giving 1,236 websites. About 5.6% of websites have IPv6 addresses. 63% of websites have SSL Certificates. Durban is DNSSEC Signed but there are only 4 signed domains.
75.7% of Websites are in South Africa, 12.1% are in the USA and 6.5% are in Germany. 1.9% of websites are in Canada, 1.2% in France and 0.9% in the UK.

4.5.7.13 JOBURG



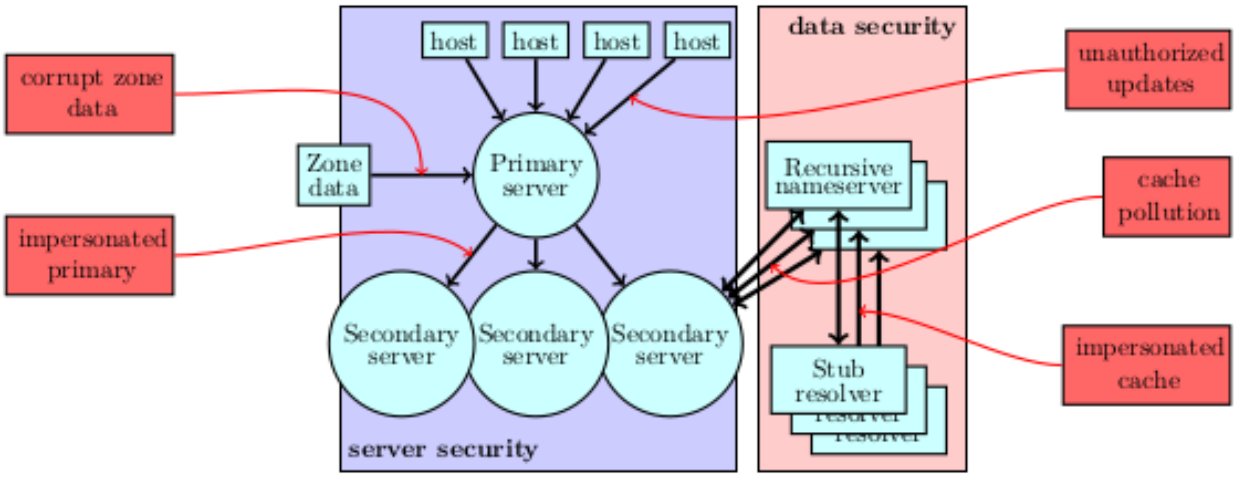
Joburg (Johannesburg) provided us with 2,954 domains of which 2,238 are working domains giving 1,638 websites. About 5.33% of websites have IPv6 addresses. 61% of websites have SSL Certificates. Joburg is DNSSEC Signed but there are only 10 signed domains.
77.4% of Websites are in South Africa, 12.3% are in the USA and 4.8% are in Germany. 1.2% of websites are in Canada, 1.0% in France and 1% in the UK.

4.6 DNS SECURITY

DNS is an old protocol and initially lacked security, but it was designed with extensibility. Yet, it is one of the most fundamental protocols of the Internet. DNS Security can be largely split into three areas, (1) between Primary and Secondary servers, covered by TSIG, (2) between the authoritative servers and recursive servers, DNSSEC and (3) between the Recursive server and the Stub Resolvers (the user) – covered by Encrypted Transports: DoT (DNS over TLS, DTLS), DoH (DNS over HTTPS) and DoQ (DNS over QUIC[104])[105]. It is beyond the scope of this report to describe exactly how all this works, but some details are worth noting. The Study itself uses both TSIG and DNSSEC in its own operation.

[104] https://datatracker.ietf.org/doc/rfc9000/

[105] https://labs.apnic.net/presentations/store/2023-11-16-quic-twopm.pdf



4.6.1 TSIG – DNS TRANSACTIONAL SIGNATURES

The Study includes becoming a Secondary Nameserver to potentially all African ccTLDs/gTLDs. The primary reason for this is to make periodical updates possible so that once a month, a localised Zone Transfer happens that is used to update our data to keep the Observatory data up to date (proactive observations). It also allows the Study to potentially become a proper Secondary Nameserver to these domains and to look at becoming an AnyCast Nameserver for these domains in a similar fashion to that which AFRINIC provides. To make the Zone Transfer secure, the Zone is signed with a Symmetrical key. The same key is used to check that the Zone is successfully retrieved on the other side. Keys can be generated by using the command:

tsig-keygen -a HMAC-SHA256 -b 256 “valid.domain.name”

The generated key is then inserted into the Nameserver configuration files on both sides of the link. As this is a shared key, the Study provides a password and SSL signed website for this to be managed by Study participants. The Keys are automatically managed locally but must be managed manually (with full instructions) on the participant’s side. Participants are hopefully already following this behaviour anyway to protect their own infrastructure.

4.6.2 DNSSEC – DOMAIN NAME SECURITY

The Study project uses DNSSEC Signed domains. This only seems appropriate – as we also look for DNSSEC signing of Domains as part of the Study. Websites all have SSL Security Certificates as well. Even the email systems used here use TLSA records to implement DANE (DNS-Based Authentication of Named Entities) to secure email between the Study and participants.

Signing a Domain has become much easier with BIND introducing their KASP (Key and Signature Policy) stanza into their configuration files. An example[106] could look like:

```
dnssec-policy "ecdsa256-policy" {
    signatures-refresh 5d;
    signatures-validity 14d;
    signatures-validity-dnskey 14d;
    dnskey-ttl 3600;
    publish-safety 1h;
    retire-safety 1h;
```

[106] See: https://dnssec.edu.za for further information.

```
        purge-keys 10d;
        keys {
            ksk lifetime 370d algorithm ecdsa256;
            zsk lifetime 34d algorithm ecdsa256;
        };
        zone-propagation-delay 300s;
        max-zone-ttl 86400s;
        parent-propagation-delay 1h;
        parent-ds-ttl 3600;
    };
```

Some domains are also hosted by providers such as Cloudflare that offer DNSSEC at the touch of a switch. However, there are still many unsigned participant domains in Africa. There are currently 29 DNSSEC signed domains out of the 64 ccTLDs/gTLDs being studied (45%). The Study also shows the DNSSEC Algorithm in use by the participant as well as what their customers are using. There is a gradual move from Algorithm 8 to 13 – which is good as the keys are smaller yet more secure.

As stated, our web-based systems are DNSSEC signed but are you using a DNSSEC aware resolver? If you are, then a green padlock with DNSSEC Secure will appear at the top left of the website. If you see an unlocked red padlock, chat to whomever runs your Recursive Nameservers! They probably just need to upgrade the software as the default is to enable DNSSEC Security.

4.6.3 DOH/DOT/DOQ

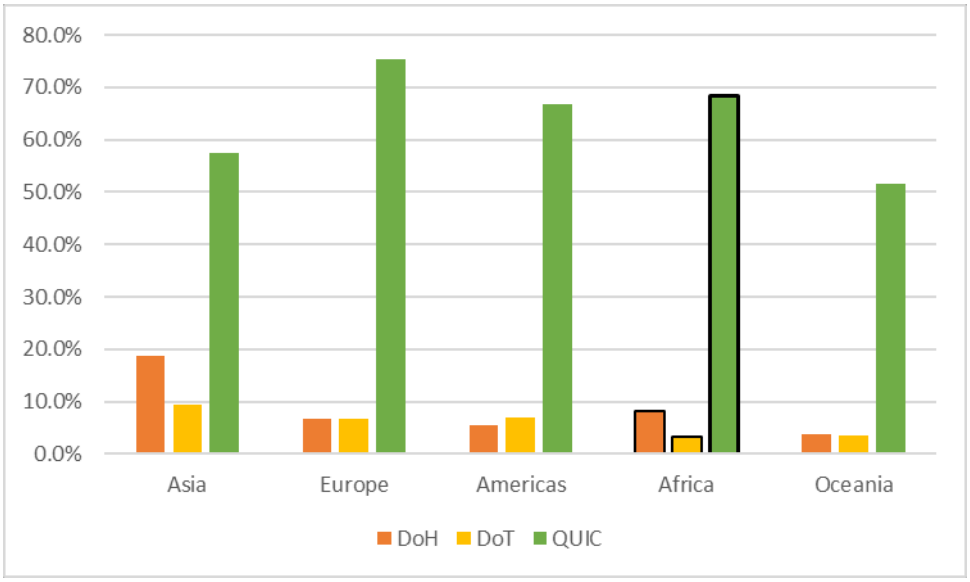
DNS over HTTPS (DoH) and DNS over TLS (DoT) are both security protocols used to provide encryption between the DNS client and the DNS server, enabling data privacy and integrity for DNS queries over the Internet.

Recently, DoQ which is similar to DoT but is using the stream capability of QUIC instead of the DNS over TCP framing, became available.

DoT and DoQ use a special port number (TCP/853 and UDP/8853 respectively) that is easily detected and blocked, while doh uses the normal HTTPS web traffic port (TCP/443), making it harder to block or even detect. Thus, DoT and DoQ are preferred from a security perspective, as they allow for better web content filtering. DoH is preferable from a data privacy perspective due to difficulties in differentiating its traffic from the normal HTTP data.

Measurements from APNIC show that DoH is most deployed with (12.17%) encrypted queries followed by DoT with (7.83%). We don’t find authenticated measurements for DoQ, however, APNIC labs show (62%) deployment of QUIC protocol worldwide.

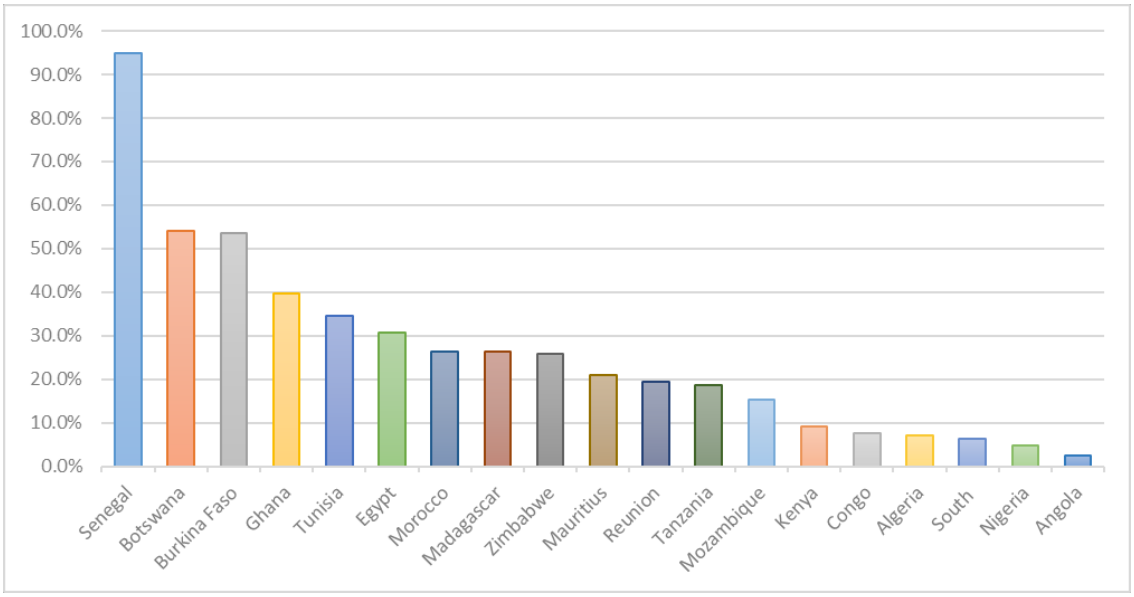
Figure 4-54: DNS Query Encryption



Source: APNIC Labs Measurements

Surprisingly, Africa is above the world average adoption of QUIC protocol, and the following Asia region is in DoH adoption with (8.26%). However, the African region is the least regarding DoT implementation with only (3.25%). Overall, only 19 African countries implemented DoH and/or DoT. As in the below graph, Senegal is leading this practice by (95%). This implies that there is a trend in African administrations to prefer privacy over security, but this conclusion needs to be carefully examined when the remaining 35 (65%) countries decide to adopt DNS encryption.

Figure 4-55: DoH/DoT Adoption in Africa



5 KEY FEATURES OF THE AFRICAN DNS MARKET

5.1 INTERNET SERVICES - INSTITUTIONAL ROLES

5.1.1 REGIONAL AND NATIONAL ICT POLICY, STRATEGIES AND REGULATORY AUTHORITIES

5.1.1.1 ICANN

ICANN's formal presence in Africa was solidified by the publication of the ICANN Africa Strategic Plan for 2016 to 2020.[107] This was followed by the 2021 to 2025 plan.[108] ICANN's overall aim is to increase the participation of Africa in the DNS ecosystem and in ICANN. The plans are aimed at the granular level, to strengthen ccTLD development, enhance cooperation with Computer Emergency Response Teams (CERTs) for better handling of DNS related incidents, and promote new gTLD registries.

Strategic objective is to strengthen ccTLD development.

5.1.1.2 AFRINIC

AFRINIC has also contributed to ICT strategy development in Africa by developing an ICT Strategy Matrix. It highlights four areas: a) DNS stability and security; b) Core operations including IANA; c) Competition, consumer trust and consumer choice; and d) A healthy governance ecosystem.

Other ICT community initiatives have been supported by AFRINIC regarding the IPv6 transition, the establishment of CERTs, and the implementation of DNSSEC.

AFRINIC directly supports African Internet infrastructure development, online and offline, via its Deployathon and Do-Helpdesk programmes. The Deployathon guides members in the implementation of IPv6 or any protocol following the best common practices in the industry. The Do-Helpdesk provides tailor-made support to members, such as network operators, to share their specific challenges and receive hands-on guidance from AFRINIC experts in the implementation of IPv6, RPKI (Resource Public Key Infrastructure) and other Internet technologies/services on the networks.

Unfortunately, AFRINIC's institutional management is going through difficulties at present, where it is without a CEO or a quorum on its Board. In September 2023 a court formally appointed the Official Receiver of Mauritius to maintain the status quo of AFRINIC, which is under receivership at present, with the mandate to hold elections within six months.[109] ICANN is continuing to closely monitor the situation and aims to provide whatever support the Official Receiver requests to restore AFRINIC's functional governance, long-term stability, and operations[110].

5.1.1.3 THE AFRICAN UNION (AU)

The African Union Commission (AUC), based in Ethiopia and its associated NEPAD Planning and Coordinating Agency[111] based in South Africa have continent-wide ICT support strategies. Most notable are the Programme for Infrastructure Development in Africa (PIDA), cybersecurity capacity building,

[107] https://www.icann.org/resources/pages/strategic-plan-fy2016-2020-2023-11-22-en

[108] https://www.icann.org/resources/pages/strategic-plan-fy2021-2025-2023-11-22-en

[109] https://www.capacitymedia.com/article/2c6pnx4ymt7sd5c493wg0/news/exclusive-afrinic-placed-in-receivership-board-elections-to-be-held-in-six-months

[110] https://www.icann.org/en/announcements/details/icann-update-on-afrinic-22-09-2023-en

[111] www.nepad.org

regional policy and regulatory frameworks, electronic postal systems, the .AFRICA gTLD[112] and the AXIS project to support the development of IXPs.

The AU and the AUC work closely with the UN Economic Commission for Africa (UNECA), national governments and regional entities in the implementation of its programmes, which are often supported by interested donor agencies such as the European Commission. The the ZA Central Registry (ZARC)created the DotAfrica gTLD domain (referred to as ".AFRICA" in this document) in March 2017 for utilisation by Africa, after it was awarded by ICANN, after a long drawn-out process It is used by the worldwide audience of companies, organizations and individuals interested in, associated with, and connected with the African community and market. The African Union notably supported ZARC in its application for registration by ICANN.

5.1.1.4 THE REGIONAL ECONOMIC COMMUNITIES (RECS)

At a regional level, the African Regional Economic Communities (RECs) all have a variety of programmes to support the development of ICT infrastructure in their Member States, often in collaboration with the regional regulatory associations. For example, the Southern African Development Community (SADC) has developed a comprehensive ICT infrastructure development plan which is being supported by the Communication Regulators Association of Southern Africa (CRASA). As in other sub-regions in Africa, the SADC's plan prioritises capacity building in technology, broadband connectivity, and services and affordability.

SADC prioritises technology, broadband connectivity, and services affordability.

Similarly in West Africa, ECOWAS has developed an integrated infrastructure master plan which includes a set of proposals on cross-border projects in ICT, energy, transport, and water resources to support regional integration. ICT projects include additional backbone fibre cable infrastructure where needed, and a regional IXP. The latter project was published as a request for proposals by the ECOWAS Secretariate in October 2023.

The other key regional bodies with ICT related programmes are the Arab Maghreb Union (AMU/UMA), the East African Community (EAC), the Intergovernmental Authority on Development (IGAD), the Common Market for Eastern and Southern Africa (COMESA) and the Economic Community of Central African States (ECCAS).

5.1.1.5 NATIONAL POLICY AND REGULATORY BODIES

Most African governments have recognised the vital role of ICTs in their socio-economic development. Thus, most African governments have developed a national ICT strategy, others have made plans to address more specific policy and regulatory issues according to their priorities and immediate needs, such as universal access to broadband, cybersecurity, and data privacy. Indeed, each national strategy is tailored to address local issues and achieve the objectives of the national community, often developed through multi-stakeholder consultation, and they share some common challenges and ambitions. These strategies are being supported globally, such as through the Broadband Commission's[113] Connecting Africa through Broadband Strategy.[114]

Aiming to unify efforts, the African Union has developed and published the "The Digital Transformation Strategy For Africa (2020-2030)"[115] aimed to "harness digital technologies and innovation to transform African societies and economies to promote Africa's integration, generate inclusive economic growth,

[112] The .AFRICA zone is actually held by the ZA Central Registry (ZACR), now called ZARC, the ZA Registry Consortium.

[113] The State of Broadband Report 2022 - Broadband Commission

[114] https://broadbandcommission.org/wp-content/uploads/2021/09/WGDigitalMoonshotforAfrica_Report2020-1.pdf

[115] https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf

stimulate job creation, break the digital divide, and eradicate poverty for the continent's socio-economic development and ensure Africa's ownership of modern tools of digital management".

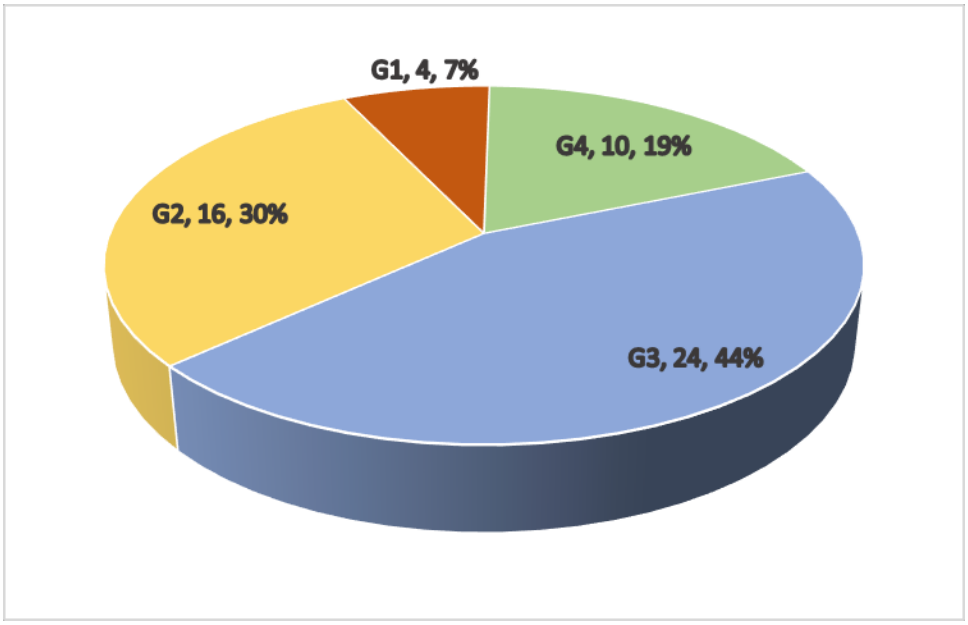
[116] One of the AU's specified objectives to achieve digital transformation in Africa is to "Promote the management and use of Country Codes Top Level Domains as they are critical national resources whilst ensuring that technical and administrative operations are at international standards to foster trust and use of African Domain Names in order to bring financial, economic and sociocultural benefits to Africa".

Without a doubt, efficient and effective regulations practice is the key enabler to digital transformation, which leads to consideration of the vital role National Regulatory Authorities (NRAs) play in determining the uptake of digital services which in turn foster needs for efficient DNS markets.

Since 2016 the ITU has promoted "collaborative regulation", supported by the ICT Regulatory Tracker[117] and its associated Benchmark of 5th Generation Collaborative Regulation (G5 Regulation), towards fast digital transformation reform since 2019. Collaborative regulation is driven by leadership, incentives, and evidence rather than by command-and-control schemes. In this framework the ICT tracker defines 4 scores: G1 for Command & control approach, G2 for Early open markets, G3 for Enabling investment & access, and G4 for Integrated telecom regulation.

For the last round of evaluation in 2023, nearly 2/3 of the African regulators have focused on G2 and G3. The good news is that 10 African countries achieved the higher rank, while only 4 countries still maintain the legacy command and control approach in ICT regulation. Figure 5-2 and Table 5-1 show the score of each country based on ITU G5 scoring.

Figure 5-2: Percentage of ITU 5G Regulatory Maturity for African Countries , 2023



Source:

[116] https://afripoli.org/what-is-africas-digital-agenda

[117] https://app.gen5.digital/tracker/metrics

Table 5-1: ITU 5G Regulatory Maturity – African Countries Scores

G4 (10 Countries)	G3 (24)	G2 (16)	G1 (4)
Burkina Faso	Angola	Algeria	Djibouti
Egypt	Botswana	Benin	Eritrea
Kenya	Cabo Verde	Burundi	Ethiopia
Malawi	Cameroon	Central African Rep.	Libya
Morocco	Comoros	Chad	
Nigeria	Congo (Rep. of the)	Equatorial Guinea	
Rwanda	Côte d'Ivoire	Eswatini	
Senegal	Dem. Rep. of the Congo	Gabon	
South Africa	Gambia	Guinea	
Uganda	Ghana	Guinea-Bissau	
	Lesotho	Madagascar	
	Liberia	Mauritania	
	Mali	Seychelles	
	Mauritius	Sierra Leone	
	Mozambique	Somalia	
	Namibia	South Sudan	
	Niger		
	São Tomé and Príncipe		
	Sudan		
	Tanzania		
	Togo		
	Tunisia		
	Zambia		
	Zimbabwe		

Source:

Regulators are usually provided with some degree of independence and financial autonomy, although the executive body of councillors or boards are usually appointed by government. Many regulatory authorities have also taken steps to manage the country's ccTLD registry, while some ccTLD registries in Africa have no direct oversight by the Regulator, as discussed further in the next section of the report.

5.1.2 DNS GOVERNANCE

As for other regions, all African countries have country code Top Level Domains (ccTLDs) assigned by IANA, and almost all of them have consistent name server records as seen from the IANA data base and NS records.

It is common that local authorities consider ccTLDs as national identity, so they need to oversee it to ensure the sovereignty of the country's data. Hence, the ICT regulatory authorities mandate is often extended to manage the national ccTLD registry. However, the majority (84%) of African anycast traffic is handled by non-profit foundations and/or organizations using resources from other RIRs such as RIPE-NCC and ARIN.

According to the Zone File analysis part of this study, domains under the ccTLDs represent the majority of registered domains in Africa. The survey shows that Regulators are responsible for managing about 40% of ccTLDs. Examples include Sudan (.SD), managed by an NGO established in 2001 to manage the country's domain. The ccTLD of Egypt (.EG) and Algerian (.DZ) are delegated to the Egyptian Research

and Education Network (EUN) and the (ARN) Algerian NREN, an intergovernmental agency providing ICT services to academia.

In South Africa, there is a special regulator solely for domain names, the ZA Domain Name Authority (ZADNA[118]). However, the ccTLD and many other 2LD domains are managed by the ZA Registry Consortium[119] (ZARC), a private non-profit entity that manages the registries under contract.

Some effort has been made by AFRINIC to analyse the effect of lame delegation, a DNS server misconfiguration that affects the responsiveness of the DNS service which could lead to delayed responses or failed queries. They discovered that 40% of AFRINIC region's reverse DNS misconfigurations related to lame delegation and their work has been used to implement a policy[120] in the AFRINIC region. Our new DNS Observatory provides visibility on this.

Overall, the African ccTLDs have enough IPs to handle authoritative DNS queries which helps in ccTLD scalability and resiliency. Unlike IPs, ASNs, and Anycast usage, DNSSEC signing is not driven by external DNS providers, thus only 30% (16) of African ccTLD have signed their zone. Further, with more than 70% of African ccTLD Anycast traffic flagged as out of the region, the advantages given by using Anycast seem not to benefit African Internet users as much as it might.

5.1.3 THE INFLUENCE OF POLITICS ON TELECOMMUNICATIONS AND THE INTERNET

Before Internet access in Africa became relatively widespread among the middle classes, governments did not pay much attention to it. The Internet provided a free and unmonitored space for free expression and innovation. It became widely used by tech entrepreneurs, and journalists, human rights defenders, anti-corruption organisations, and proponents of democracy. At the time, authoritarian African regimes might have had the "will" to monitor who was doing what on the Internet, but they lacked "the way". In general, they did not have sufficient in-house ICT capacity and, in particular, they lacked the skills and tools needed for Internet surveillance, monitoring, and interception.

This context has changed dramatically in the last 10 years. African governments are far more aware of the positive potential the Internet holds for economic development, as pointed out elsewhere in the study. But they are also aware of the link between the Internet and democratic participation. While a handful might welcome this link, authoritarian regimes in Africa fear it and actively monitor and control how people use the Internet by investing in restrictive policy, regulation, and sophisticated surveillance technology.

Some of the ways in which politics, and in particular authoritarian politics, are influencing the Internet in Africa at present, include:

- Regulation: Content control and restrictions on freedom of expression are commonly found in cybercrime, cybersecurity and even e-commerce legislation. Vague definition of terms such as "terrorism", "insult" or "dignity" can easily be abused by government to silence opposition party politicians or journalists.[121]
- "Internet shutdowns": Intentional full or partial disruptions that make the Internet -- or part of it -- inaccessible. Governments tend to introduce shutdowns during elections or times of protest. In 2021 the Nigerian government banned Twitter (now known as X) for 7 months simply because the platform removed a post by the Nigerian president based on Twitter's content regulation guidelines that restricted posts that threatened violence.[122] Shutdowns are blunt instruments and there is very little evidence that they meet their intended objective, which is to reduce conflict and quell social protest.

[118] http://www.zadna.org.za/

[119] https://registry.net.za/

[120] https://afrinic.net/20210428-lame-dns-delegation-policy

[121] https://www.gp-digital.org/publication/laws-restricting-disinformation-in-sub-saharan-africa-impacts-of-their-enforcement-on-freedom-of-expression/

[122] https://www.nytimes.com/2022/01/13/world/africa/nigeria-lifts-twitter-ban.html

Both civil society[123] and the private sector have gathered data on the harm caused by shutdowns. In 2021 in Nigeria, the total cost was estimated to be 1.5 billion USD. The table below reflects the financial cost of Internet shutdowns in Africa during 2021[124]

Table 5-2: The impact of Internet "shutdowns" in 2021

	Country	Total Cost	Duration (Hrs)	Internet Users Affected
1	Nigeria	$1.5 BN	5,040	104.4 M
2	Ethiopia	$164.5 M	8,864	21.3 M
3	Sudan	$157.4 M	777	13.2 M
4	Uganda	$109.7 M	692	10.6 M
5	Burkina Faso	$35.9 M	192	10.9 M
6	eSwatini	$2.9 M	218	0.5 M
7	Republic of Congo	$2.5 M	72	1.5 M
8	Zambia	$1.8 M	48	2.6 M
9	Chad	$1.6 M	29	1.1 M
10	Senegal	$0.3 M	7	4.9 M
12	South Sudan	$0.3 M	24	0.9 M

Source: Woodhams S. Migliano S. 2022.

The Internet Society has created NetLoss Calculator, a tool to make it easier to calculate the cost of shutdowns.[125] Shutdowns also have a human cost. Not being able to communicate with family and friends during times of instability can increase people's sense of insecurity which, in turn, can amplify conflict.

The number of Internet shutdowns in Africa decreased from 2021 to 2022. Access Now's #KeepItOn campaign reports that only seven countries-imposed shutdowns nine times in 2022 as opposed to 12 countries doing so 19 times in 2021.126 But, by the end of the November 2023, nine countries — Algeria, Chad, Ethiopia, Gabon, Guinea, Mauritania, Senegal, Sudan, and Tanzania — had shut down the Internet more than ten times. At 960 days long, the shut down in the Tigray region of Ethiopia, with a population of more than 6 million, was the longest in the world.127

- Taxation of social media: In some countries, governments introduced taxes on social media use. These taxes must be paid by individual users; people who use apps like WhatsApp for messaging or VOIP calls precisely because they cannot afford to pay for SMS or mobile calls. Taxing users has tended to stifle demand for mobile Internet among low-income users. In Uganda, research done by Analysis Mason showed that user numbers declined by 5.7% in the three-month period after the social media taxes were first introduced in July 2018.[128] Over the longer term it is difficult to measure the impact of such taxes, but they are unlikely to have a positive impact on Internet uptake.

There is convincing evidence of a link between Internet freedom and the number of domains registered. Freedom House's 2023 "Freedom on the Net" report rates only one African country as fully "free", South Africa. Partially free countries include Ghana, Kenya and Nigeria, all countries with relatively large numbers of domains. On the other hand, countries such as Rwanda, Sudan, and Ethiopia, rated as "not

[123] https://www.accessnow.org/keepiton/

[124] Woodhams S. Migliano S. 2022.

[125] https://pulse.internetsociety.org/netloss

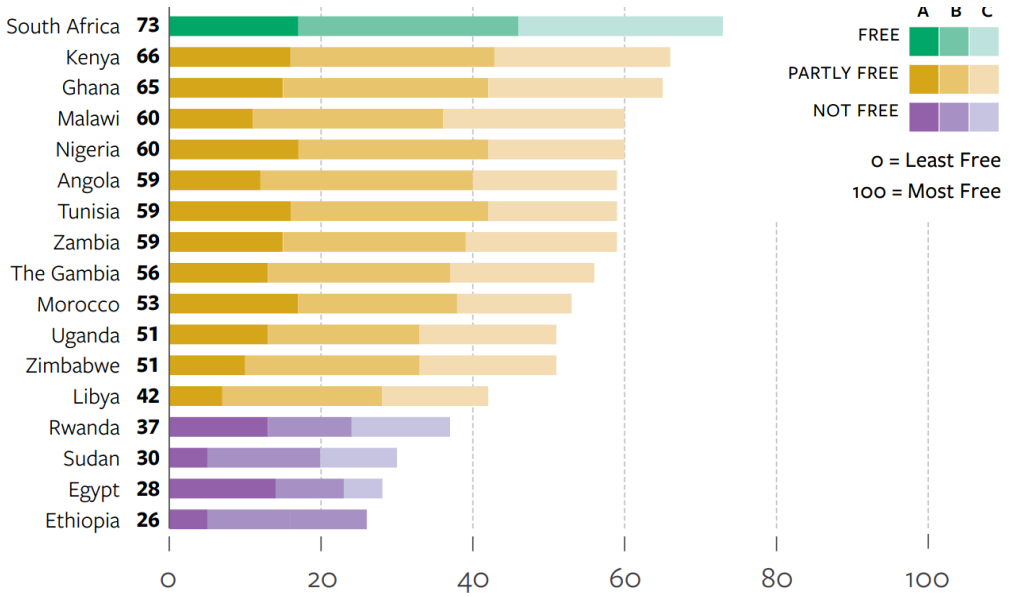
[126] https://www.accessnow.org/press-release/keepiton-internet-shutdowns-2022-africa/

[127] https://pulse.internetsociety.org/shutdowns/ethiopia-2

[128] Kende M. Abecassis D. 2019. "Impact of taxation on social media in Africa". Analysys Mason. March 2019. p.2.

free", have far fewer registered domain names.[129] Figure 5-3 below provides the Freedom House ranking for major African countries as of 2023:

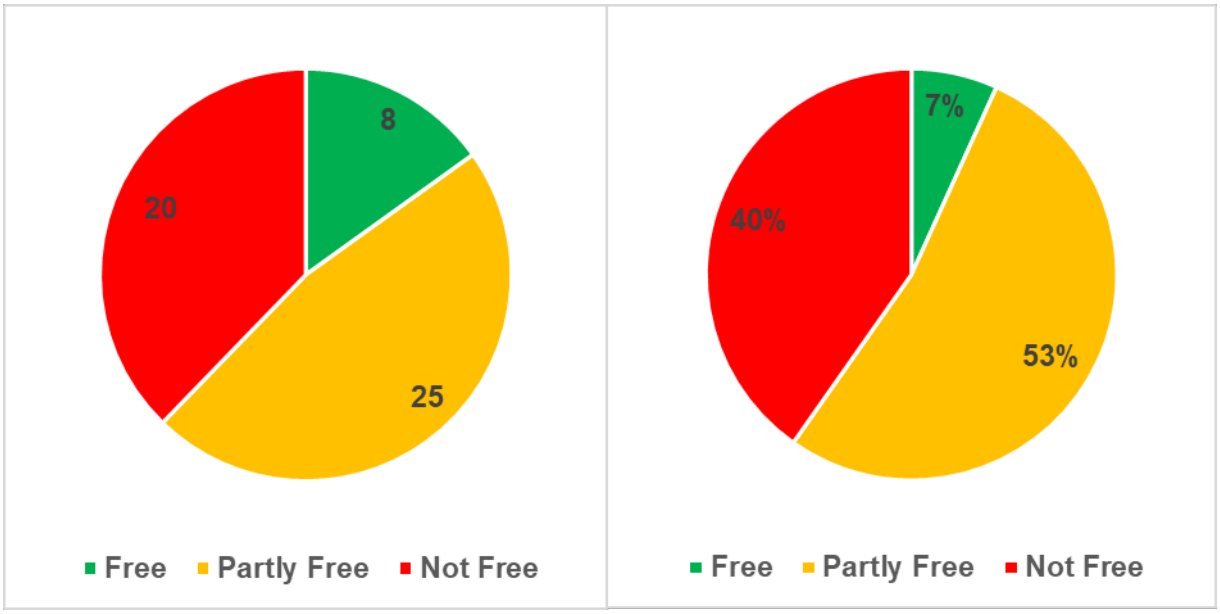
Figure 5-3: Freedom House's 2023 "Freedom On The Net" ranking for African countries.



Source: Freedom on the Net 2023: The Repressive Power of Artificial Intelligence. P 28. https://freedomhouse.org/sites/default/files/2023-11/FOTN2023Final.pdf

Freedom House ranks 8 countries, representing 7% of the African Population, as Free. The figures below illustrate this.

Figure 5-4: Freedom House categories of Countries (L) and Population (R)



Source: Freedom House

[129] Not included in this report and graphic are Botswana, Cabo Verde, Lesotho, Mauritius and São Tomé & Príncipe, all of which are also rated as "Free" by Freedom House.

Considering all African countries, we see the following relationship between Freedom House categories, total domains, and domains / 1000 population.

Table 5-3: Internet Freedom versus number of domain names

FOTN Status	Total ccTLD Domains	Domains / 1000 population
Free	1 357 901	13.8
Partly Free	534 216	0.7
Not Free	1 462 575	2.5

Source: Own analysis of countries as categorised by Freedom House[130]

However, if the four Freenom countries are excluded, the result is very different.

Table 5-4: Internet freedom versus number of domain names, excl. Freenom

FOTN Status	Domains Excl. Freenom	Domains / 1000 population
Free	1 357 901	13.8
Partly Free	534 216	0.7
Not Free	108 248	0.2

Source: Own analysis of countries as categorised by Freedom House

Clearly the number of domains per capita is hugely greater in the Free countries in Africa than either the Partly Free or the Not Free, and Freenom artificially inflates the latter figure. If one extrapolates this to a global view, then this relationship generally holds true, although there are some exceptions. For example, .CN, .RU and .BR are all listed as “Not Free” by Freedom House, but they fall in the top 10 by domain names. However, it’s important to recognise that freedom is not the only factor that determines the number of domains registered, as discussed elsewhere in this Report. These three countries also fall in the top 10 by population.

It is worth noting that many African governments do respect human rights online and that African human rights institutions are taking the role of the Internet as a driver for democracy and development seriously. A notable achievement of the last few years is the African Commission on Human and People’s Rights 2019 Declaration of Principles on Freedom of Expression.[131] It is a soft law instrument with a powerful message. It conveys clearly for the Internet to drive social and economic development and the enjoyment of human rights, it must be open and accessible, and telecommunications needs to be regulated transparently and independently, with government playing an enabling role (e.g. by ensuring effective broadband backbone) rather than a restrictive and controlling role.

5.2 THE CCTLD ADDRESS SPACE IN AFRICA

[130] https://freedomhouse.org/

[131] https://achpr.au.int/en/node/902

The African continent top level DNS address space consists of 54 top level country code ccTLDs, plus six IDNs: Egypt (مصر), Algeria (الجزائر), Tunisia (تونس), Sudan (سودان), Mauritania (**موريتانيا**) and Morocco (المغرب) as well as four gTLDs .CAPETOWN, .DURBAN and .JOBURG and .AFRICA.

Although not covered by this study, there are some other ccTLDs that are geographically associated with Africa, but do not relate to an independent African country. These are:

- .IO - (British Indian Ocean Territory - the Chagos Islands, a protectorate of the United Kingdom in which the military base on the island of Diego Garcia is located),
- .RE (the Indian Ocean Island of Reunion – a territory of France),
- .SH (the South Atlantic islands of Saint Helena, Ascension, and Tristan da Cunha - another British protectorate).
- .YT (the Indian Ocean Island of Mayotte – a territory of France)

Research data[132] from November 2023 indicates that a total of just over 4.3 million domains are active under the African ccTLDs, with 2.9 million active in 2016. This represents a CAGR of 4.2%. There are also many registrations in the gTLDs by African entities, which are currently estimated at about 1 million. Some of these from the PIR database extract are analysed in section 5.5.5.1.

5.3 THE DEMAND FOR AFRICAN DOMAIN NAMES

As is evident from the above discussion, the overall use of domain names in Africa is relatively small. Personal domain name registration in Africa is relatively insignificant due to the low Internet uptake and income levels relative to the costs of overseas hosting. This must often be paid for in foreign currency with a credit card, to which local citizens may not have access. Even in those countries with a more vibrant local hosting industry, the incidence of personal domain names is relatively low.

The local business market and consequent demand for DNS registrations is constrained by a wide range of factors ranging from the high cost of setting up a business, to the lack of local hosting infrastructure. These and many other factors can be seen as part of an ‘ecosystem’ in which each component of the value chain needs to be in place for the market to function efficiently, which in turn creates demand for local domains.

In general, it can be observed that there are two quite different markets for Africa’s domain names – local / African entities and offshore (out of continent) entities, each with their own characteristics.

Nevertheless, Africa has seen significant growth in domains, with totals increasing from 2.9 million in 2017 to 3.55 million in 2023. This growth of 22% over 6 years represents a CAGR of 3.4% in ccTLDs. While not huge, this is positive, especially considering that the Freenom and SafeCow domain hacks are no longer providing “free” domains under African ccTLDs.

5.3.1 LOCAL ENTITIES

As indicated in Section 5, domain name registration by African entities mainly takes place in countries where the local hosting industry and web development sector has developed sufficiently to create demand for local domains. These are concentrated in a few countries where many competing networks have access to cost effective international and national backbones. This primarily comprises South Africa, Egypt, Mauritius, Nigeria, Kenya, Zimbabwe, Uganda, Tunisia, and Morocco. In addition, the presence of one or more IXPs in the country makes local hosting more viable, which in turn drives up the demand for domain names. Local domain name business also consists of the relatively high number of registrations by African entities of domains under the legacy gTLDs due to their ‘intrinsic default’

[132] http://research.domaintools.com/statistics/tld-counts/

attraction, as well as effective marketing and efficient / cost effective service provision, and lack of reliable (perceived or real) and affordable local domain registration and hosting options within Africa.

5.3.2 OFFSHORE ENTITIES

AFRINIC, in a report of the 5th of November 2020, on the African ccTLD technical environment, notes that 94% of African TLDs support IPv6 due to the extensive adoption of out of the region or offshore DNS Anycast providers; that 84% of African Anycast traffic is handled by non-profit foundations and/or organizations using resources from other RIRs such as RIPE-NCC and ARIN. Furthermore, that less than 30% (16) of African ccTLD have signed their zone (DNSSEC). It has also been possible for African ccTLD sub-domains to be registered by entities located outside Africa, usually because the special characteristics of the domain results in demand from special interest groups which may be present in other parts of the world, or because multi-national businesses have registered domains under the ccTLDs as a strategy for securing their intellectual property interests.

In a small number of cases domains have been registered by diaspora Africans. However, many offshore registrations are concentrated in the countries with ccTLDs that are amenable to ‘domain hacks’, often using a ccTLD as part of a word, as described below.

5.3.3 DOMAIN HACKS

A surprisingly large number of African countries have high numbers of domain registrations because these countries charge little to register a domain, or the particular letters of the ccTLD are attractive for special purposes with more relevance than registration in the gTLDs such as .COM or .NET. In addition, these countries have non-restrictive rules that allow registration of domains from entities located outside the country. These practices are known as ‘domain hacks’, and in Africa, the 11 most popular of these are:

- **Central African Republic** (.**CF**) - This domain is part of the ‘suite’ of free African ccTLDs, along with .GQ, .GA and .ML, which were developed as free domains by registrars Freenom[133] and SafeCow[134] [135]. These domains are free to register, and some are for use by both individuals and corporations, while others are only available to companies. The domains must point to a working site with real content (no ‘under construction’ sign) while the registrars’ revenue models involve monetising the traffic from abandoned domains - domains that are no longer used by the registrant or are expired. The registrars continue to maintain these domains and sell the residual traffic to advertisers. The registrars also generate revenue by upselling customers to paid domains or other services (such as hosting or SSL certificates). SafeCow is based in Algeria and South Africa, while Netherlands-based Freenom has an office in Dakar, Senegal. This seems to have been a successful ccTLD, as it had 756 k domains in 2017, which has increased to 1.24 M domains in 2023. Google indexed only 2 million pages in 2017, but this has increased to 5.9 million pages by 2023. This represents 5 pages per domain. Compare this with the average for Africa of 1678 pages per domain.
- Cameroon (.CM) - a domain that has been sold internationally for many years for use mainly by advertising sites aiming to take advantage of user errors when typing the .COM gTLD, or the .CN ccTLD for China. It is also used by organisations, such as the CyanogenMod project which uses http://get.cm as an easily remembered shortened URL for distributing versions of its software. Google indexes 6 million pages, up from 3 million. The .CM domain has decreased slightly in popularity from 32 k to 31 k, giving 190 pages per domain.
- Djibouti (.DJ) - is marketed by many commercial registrars for use by music- related sites due to the common use of "DJ" to mean disc jockey. A project was also under development to use it for "Data Journals"; however, this has not proven popular. Google indexed 2 million pages, or a reasonable 283

[133] http://www.freenom.com/en/freeandpaiddomains.html
[134] Now defunct and itself for sale at https://www.hugedomains.com/domain_profile.cfm?d=safecow.com
[135] Now both have shutdown. https://www.icann.org/uploads/compliance_notice/attachment/1219/hedlund-to-zuubier-9nov23.pdf

pages per domain, which has now dropped to 1.3 million domains according to the method used in October, and has now increased to 3.5 million domains, giving 400 pages per domain.

- Equatorial Guinea (.GQ) - a domain that is free to register, operated in the same way as .CF,
- .GA and .ML by registrars Freenom and SafeCow (see above). Google indexed 3.5 million pages, or a very low 13 pages per domain, now up to 5.6 million pages but with only 6 pages per domain.
- Gabon (.GA) - Like .GQ, .ML and .CF, Gabon's ccTLD is available as a free domain by Freenom and SafeCow (see above), but can only be registered by corporations, not by individuals. Google indexed 2.3 million pages, or a very low 5 pages per domain, now increased to 3.2 million pages. However, probably as a result of the demise of SafeCow, .GA registrations have dropped from 700 000 in 2017 to 5 000 in 2023.
- Libya (.LY) - Many Libyan domains have been used for words that end with the suffix "ly", such as name.ly, sil.ly and sincere.ly. Popular URL shortening services are registered in the .LY domain, such as: brief.ly, adf.ly, bit.ly (former default for Twitter), ow.ly (default for Hootsuite), and 3.ly. The annual fee for .LY domains is USD $75 a year so many domain names remain available on the premium domain market, and some popular domains can be bought on the secondary domain market from domain name speculators. Google indexed 12 million pages, or a high 979 pages per domain in 2017. This indicates that the .LY ccTLD is actually being used for viable content. However, its popularity has evidently dropped, with only 4.3 million pages indexed in 2023 at 190 pages per domain.
- Mali (.ML) - Similar to .GQ, .GA and .CF, Mali's ccTLD is a free domain marketed by Freenom and SafeCow (see above). Although it was the first African country to give its domain away for free, it can only be registered by companies (legal entities). In comparison to the others, relatively few offshore web pages are hosted under the .ML domain, which has gained a reputation for fraudulent use by the 'phishing' industry. Google indexed 0.5 million pages, or an extremely low 2 pages per domain in 2017. This has increased dramatically to 3.4 million pages in 2023, giving 400 pages per domain.
- Mauritius (.MU) - while most domains registered under this domain are domestic, this is not a requirement, and some registrars market it for use in the music industry, and as a shorter alternative to the .museum TLD. Google indexed 7.4 million pages, or a high 963 pages per domain. This has increased considerably, to 18.2 million pages and 1630 pages per domain. It should be borne in mind that Mauritius has undergone a boom in businesses relocating there over the last seven years.
- Seychelles (.SC) - is registered by many of the large number of off-shore companies that are registered in the Seychelles due to its popularity as an international business location. It is also marketed by many registrars for use by entities in Scotland and the US state of South Carolina. Google indexed 5.5 million pages, or a high 895 pages per domain, slightly up to 7.2 million pages.
- Sao Tome et Principe (.ST) - marketed by many registrars as a domain for applications such the abbreviation of "street", short for "Star Trek", and to create domain names that spell words ending in "st". In addition, the Washington Post uses .ST as part of their URL shortening domain, wapo.st, and it is also used by people of the state of Styria, in Austria, and the Swedish city of Stockholm. Google indexed 4.3 million pages, or 345 pages per domain, now considerably increased to 9.2 million pages.
- Somalia (.SO) - a relatively large number of international websites such as phy.so, comics.so and retire.so use the Somalia ccTLD as a domain hack for creating memorable domain names. Google indexed 3 million pages, now up to 6 million pages.

5.3.4 LOCAL PRESENCE AND OTHER REQUIREMENTS

In the AFRINIC publication, *A First Look at Africa's ccTLDs' Technical Environment*[136], it is highlighted that root DNS servers' latency from Africa and South America were 3 to 4 times slower than those of

[136] https://afrinic.net/research/african-cctlds-technical-environment

Europe and North America. It was further found that 80% of web servers using African TLDs were offshore (out of the home country) and more than half of these were in Europe. This situation exacerbates a significant aspect of the digital divide problem in Africa. It also heightens the risk of an African ccTLDs' inability to apply their own policies and regulations. It is further observed that top African websites prefer to host content abroad due to poorly configured DNS resolvers, major bottlenecks to host content and lack of peering among networks. Improving connectivity in Africa is only one part of the solution.

The above scenario could partly explain why most of the African ccTLDs are available for registration for offshore entities without the requirement for a local presence. Indeed, as recommended in our 2016 Study, this is best practice. In a few countries corporate registrants are required to provide evidence such as a copy of business registration, tax identification document or a trademark matching the domain name and may occasionally be required to provide a copy of a passport, if an individual.

Many offshore registrars offer 'trustee services' to get around requirements for local presence in some countries.

Nonetheless, a few African countries require some form of local legal presence (corporate or individual) to register a domain name. These include Algeria, Benin, Botswana, Burkina Faso, Cabo Verde, Egypt, Gambia, **Ghana**, Guinea, **Guinea-Bissau** Liberia, Mauritania, **Morocco**, Senegal, Tanzania, Tunisia, and Zambia. Those three countries highlighted in bold have recently instituted this requirement, whereas two have withdrawn it. In the authors' view, this is a regressive step. Except for Botswana, Ghana, Tanzania and Zambia, these countries can be seen to be predominantly concentrated in West and North Africa and are mostly French speaking.

5.4 AFRICAN DNS FEE STRUCTURES

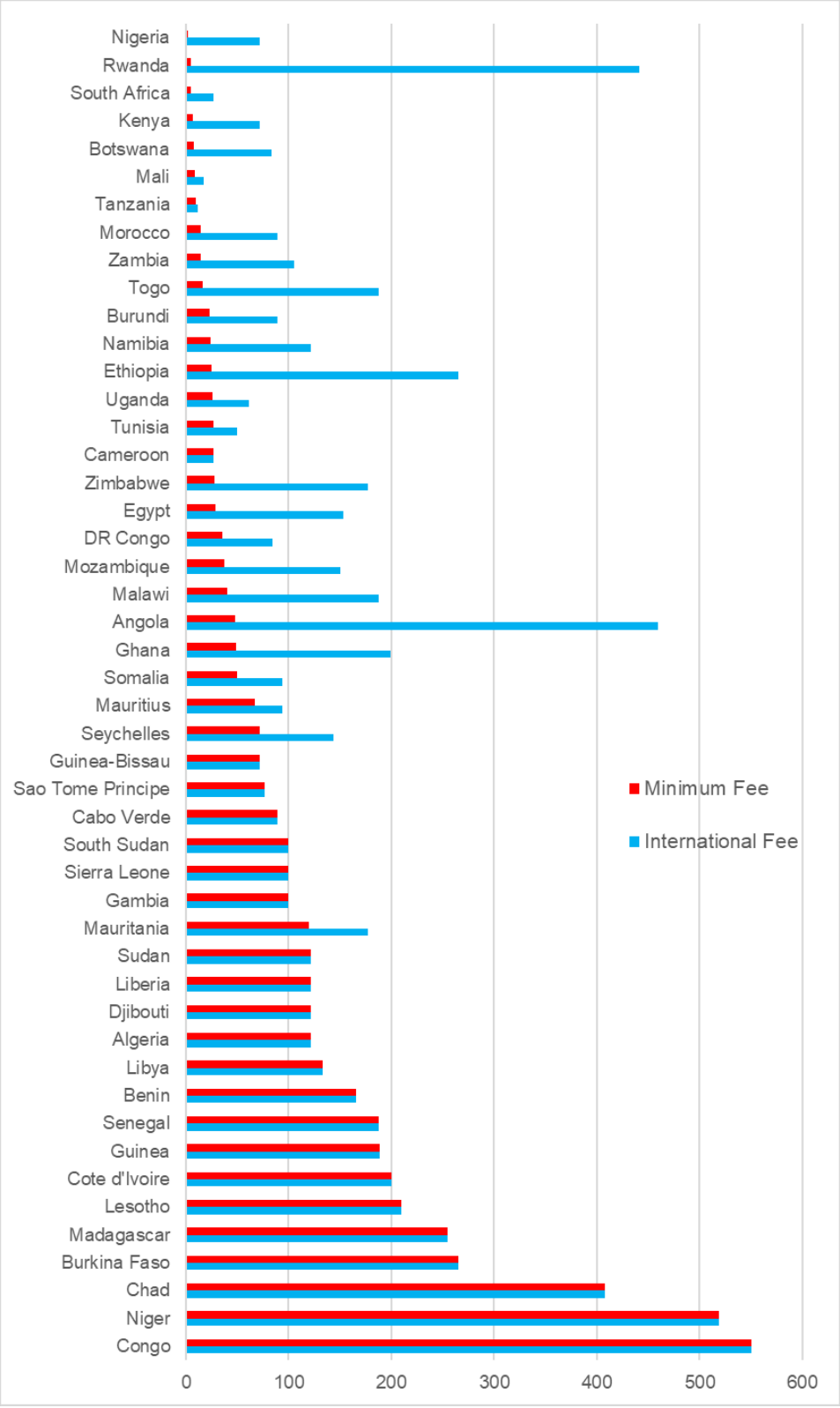
Economies of scale play an important role in the status of African DNS fee structures. There are fewer African ccTLDs registered than legacy gTLDs like.COM, .NET and .ORG. The legacy value of these type of gTLDs also tends to attract Africans. The fees in Africa also tend to vary widely. 101domain.com's annual domain fees for 2023 are US$27 in South Africa, a hefty US$550 in the Congo, and US$177 in Zimbabwe. By comparison, the local prices for domains are US$5, US$36, US$28, respectively.

Only 19 countries have annual fees of $50 or less.

In terms of fees charged for domain registration, for comparative purposes, the chart below lists the lowest fees found charged by registrars for domains in African ccTLDs, for which the average fee across Africa is about USD $103 per annum. As can be seen from the chart below, only 19 countries have annual fees of USD $50 or less and five countries have annual fees of over USD $200 (Chad, Lesotho, Rwanda, Niger, and Congo). Prices are often lower for in-country registration; however, the international price was used to provide a uniform basis for comparison. Two countries are not available for domain registration by international registrars: Comoros and Eritrea.

International fees are typically about 5 times higher than local fees. The figure below compares local and international fees for domain names across the 54 African countries:

Figure 5-5: Local and International Domain Fees (US$)

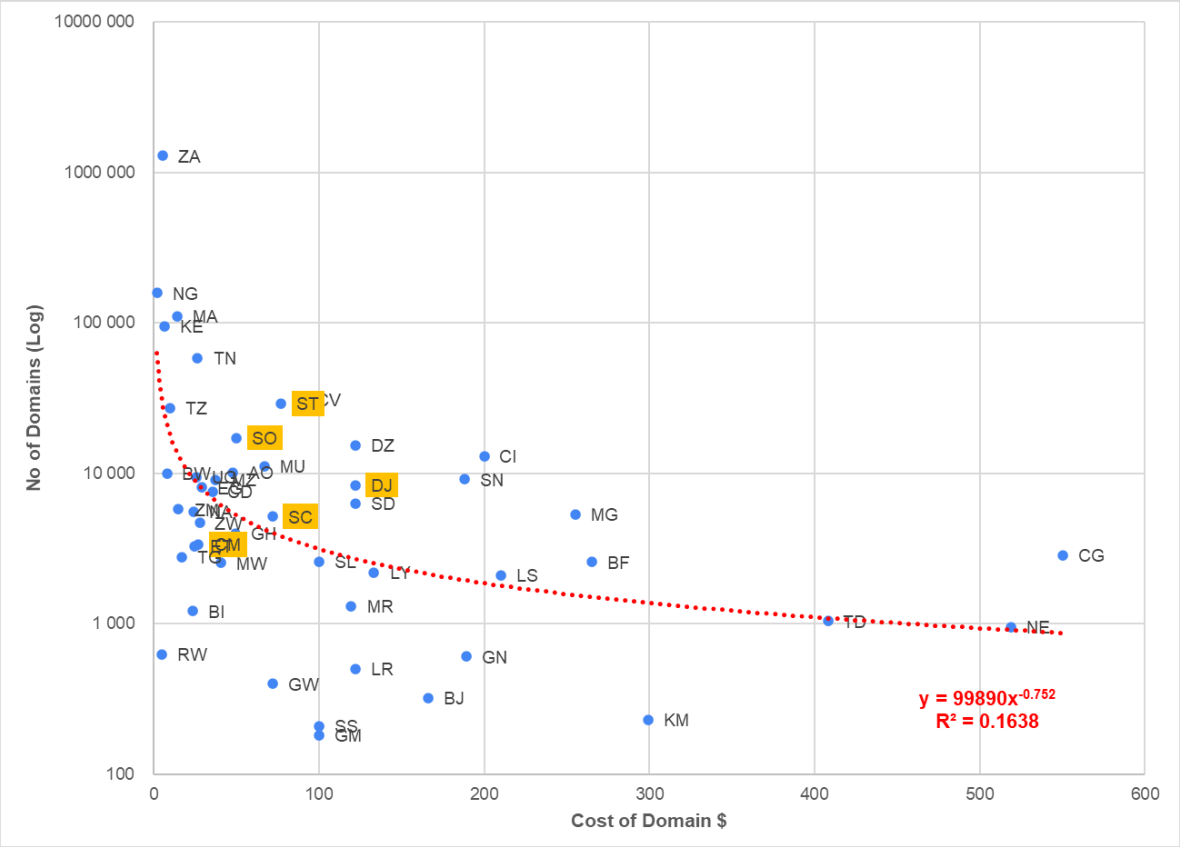


Source: Own research

The chart below plots the price of domains against the number of domains registered, which shows a clear relationship - low prices usually mean high volumes, while high prices mean low volumes. The four Freenom countries are excluded, and other domain name hacks are highlighted in orange. As would be expected there are a number of ccTLDs that do not conform to the relationship trend between price and

number of registrations. Apart from the variations in size of population, and levels of Internet uptake and development of broadband infrastructure, the other reasons for this are analysed further below.

Figure 5-6: Domains Registered versus Price



Source: Own research

Note that certain countries have very few domains. The reasons for these very low numbers are examined in section 7.4, together. As is to be expected, price is by no means the only factor determining domain name sales, and therefore the coefficient of determination (denoted by R^2) is quite low at 16%.

5.4.1 WHY ARE FREE DOMAINS NOT GOOD?

Why is it not a good idea to have free domains? In the real world, nothing is free. The model used by Freenom, and others is that the Registrant has no rights to the domain. If the website attracts significant traffic – or insufficient traffic - it may be removed from the control of the original Registrant without any notice or compensation, and his content replaced with advertising[137]. This is the "Freemium" business model and is clearly stated in the terms & conditions of contract. Secondly, free domains attract the underworld – phishing scams and the like[138]. Thirdly, because of their poor reputation, it's very hard to achieve a good ranking with Google and other search engines for a website on a free domain. Fourthly, Registrars such as Freenom add an additional revenue stream by offering website and email hosting. This means that this source of revenue – and its concomitant growth of data centres and the skills required to build, manage, and maintain data centres, servers and websites – is enjoyed overseas, and not in Africa.

This is borne out by ICANN withdrawing Freenom's registration as Registrar, with effect from the 25th of November 2023 – a week before this was written.

[137] https://hostingpill.com/domain-registrar/freenom/

[138] https://www.netnames.com/insights/blog/2013/10/are-free-domains-really-a-good-idea/

It is thus far preferable to charge a small but real fee for registration and renewal of a domain name. This can be as low as $2 per annum but gives the Registrant real rights in exchange for his money and ensures that he keeps his contact details with the Registry updated. In addition, it considerably increases the likelihood that the ccTLD's country will gain secondary economic benefits from the registration.

Domain prices should be set at no more than a cost recovery level, in order to maximise economic benefit to the country as a whole. However, some ccTLDs charge outrageous prices for their domains. Hence, they have very low growth.

An interesting exception to this is Algeria, which provides domains to Registrars free of charge. The Registrars are free to charge a fee, although some don't. This works because registrations are confined to entities with a presence in Algeria[139].

5.5 VALUATION OF THE AFRICAN DNS INDUSTRY

To derive a rough indication of the total value of the domain name sector in Africa, the total number of domains registered in each country can be multiplied by the indicative registration fee[140]. This does not take into account premium domain revenues, or the small number of domains that may be provided for free (such as under .AC.ccTLD in some countries), nor those sub-domains which are not free even under the Freenom model[141]. Nevertheless, this calculation provides a general indication of the value of the ccTLD domain industry on the continent – about USD $38 million per year in 2017.

At least 25% of this is likely to accrue to the international registrars and the remaining $29 million would be either local revenue or capital inflow generated by the ccTLDs and Registrars. It is also possible that up to $14 million a year is paid by African entities to foreign registrars for domains under the gTLDs[142]. This gives a total valuation of the domain name industry in Africa of some USD $52 million.

About 73% of the total annual ccTLD revenue on the continent is made by just ten countries, as shown in the table below.

Figure 5-7: Annual ccTLD Revenue 2017

Country	Minimum Fee	Annual DNS Revenue	% of Total
South Africa	$10	$16 043 410	43%
Morocco	$38	$2 171 358	6%
Nigeria	$45	$2 031 300	5%
Zimbabwe	$49	$1 131 165	3%
Egypt	$109	$1 055 338	3%
Tanzania	$97	$1 054 875	3%
Libya	$82	$1 027 132	3%
Somalia	$60	$867 420	2%
Cameroon	$19	$849 148	2%
Ivory Coast	$99	$758 835	2%

Source:

[139] http://www.nic.dz/en/ , which shows 16,867 domains registered as of 2023-12-06.

[140] The fee calculated includes either the initial registration fee or annual renewal, as well as the DNS hosting for a year but not web hosting.

[141] Freenom sells Premium Domain Names at a premium.

[142] Based on 1 million .com/.net/org domains @ USD 10/year

Figure 5-8: Annual ccTLD Revenue 2023[143]

Country	Minimum Fee 2023 $	ccTLD Domains 2023	Annual ccTLD Revenue	% of Africa
South Africa	$5.04	1 114 330	$5 615 987	68%
Madagascar	$255.00	3 255	$830 025	10%
Kenya	$6.53	73 524	$480 068	6%
Sudan	$122.00	2 379	$290 238	4%
Zimbabwe	$27.63	6 800	$187 897	2%
Tanzania	$9.96	18 677	$186 100	2%
Algeria	$122.00	1 088	$132 736	2%
Lesotho	$210.00	365	$76 650	1%
Cote d'Ivoire	$200.00	285	$57 000	1%

Source:

At the time of writing, we had completed the geolocation processing of some 3.5 million domains, with another 2 million to go. This provided us with 1.2 million African ccTLD domains (all with websites). The annual renewal revenue (at lowest cost found) provides a gross income of $8.2 million. As can be seen above, 96% of all African ccTLD revenue is derived by ten countries, with South Africa taking 68% of this. As an aside, in analysing the >350 million domains in total that we had access to, we found .CO.ZA domains all over Africa.

This sample of 3.5 million domains gave an additional 720,000 gTLD domains, and hosted websites, with African Registrants. At a conservative $10 each, that represents another $7 million in income for the African DNS industry.

Looking at the income earned from domain names per capita, the Seychelles earns USD $5.42 per head, followed by Sao Tome & Principe, Djibouti and Mauritius. All of these are “domain hack” countries. South Africa follows with USD $0.29. The top 10 per capita DNS industry earning countries are shown in the chart below.

5.6 REGISTRATION SERVICES

Compared to other regions, Africa has a relatively small number of registrars. In total, there are 13 ICANN accredited registrars in Africa[144] an increase of only 2 additional ICANN accredited registrars since the 2016 survey. These 13 African ICANN accredited registrars represent a very small proportion (0.1%) of the total 1,122 ICANN accredited Registrars, of which 603, or about half, are from the USA. Of the 13, the largest number (three) are in South Africa, with two in Morocco, two in Nigeria, and one each in Burundi, Ghana, Mauritius, Senegal, Seychelles and Tunisia:

1. AFRIREGISTER S.A. – Burundi.
2. Arcanes Technologies – Morocco.
3. ATI – Tunisia.
4. Diamatrix C.C. - South Africa.
5. Domain Name Services (Pty) Ltd - South Africa.
6. Genious Communications SARL/AU – Morocco.

Only 13 of the 1200 ICANN accredited Registrars are from Africa.

[143] On the instruction of ICANN, PSA has excluded .NA DNS zone (ccTLD) data in this study report and observatory.

[144] https://www.icann.org/registrar-reports/accredited-list.html & https://www.internic.net/alpha.html

7. Gdnt – Seychelles.
8. Ghana Dot Com Ltd – Ghana.
9. Internet Solutions (Pty) Ltd. South Africa.
10. Kheweul.com SA – Senegal.
11. Upperlink Limited – Nigeria.
12. Whogohost – Nigeria.
13. Web4Africa Inc. - South Africa.

Looking at locally accredited registrars, the research gathered directly for this report found about a 25% decrease in number of registrars since 2016 to 1187 listed by the national registries (where available). It is worthy of note that the IANA listing of ccTLD registries at https://www.iana.org/domains/root/db is not consistently provided on the relevant IANA ccTLD page. Many of the registrar web sites listed were unavailable or down, necessitating use of other secondary sources of information. Some were found through guess work (e.g. nic.[cctld] or DNS), or by using Google search or on archive.org. It should also be noted that there is significant duplication in the count of African registries, with some organisations whose primary business is acting as a Registrar selling domains for several dozen African ccTLDs.

In total 51 African countries now have locally accredited registrars, of which 24 new countries appeared with local registrars since the 2016 assessment, leaving only Guinea-Bissau and Comoros without a locally accredited registrar.

Table 5-5: Locally Accredited Registrars[145]

Country	Number	% change since 2016
South Africa	622	38%
Botswana	98	390%
Tanzania	72	33%
Nigeria	68	19%
Morocco	59	69%
Madagascar	53	-43%
Zimbabwe	49	36%
Senegal	42	None in 2016
Cote d'Ivoire	36	None in 2016
Tunisia	31	55%
Rwanda	28	-7%
Burundi	25	32%
Somalia	25	-52%
Gambia	23	-62%
Mauritania	20	None in 2016
Zambia	18	None in 2016
Cameroon	16	-69%
Kenya	16	-89%
Malawi	16	None in 2016
Algeria	12	-50%
Benin	10	None in 2016

[145] On the instruction of ICANN, PSA has excluded .NA DNS zone (ccTLD) data in this study report and observatory.

Lesotho	7	133%
Mauritius	7	-93%
Mozambique	7	-30%
South Sudan	6	None in 2016
Burkina Faso	5	None in 2016
Sudan	5	-94%
Chad	4	None in 2016
Egypt	4	0%
Uganda	4	None in 2016
Angola	3	200%
Seychelles	3	0%
Togo	3	None in 2016
Ghana	2	0%
Sierra Leone	2	None in 2016
Cape Verde	1	None in 2016
Central African Republic	1	None in 2016
Congo	1	-50%
Djibouti	1	None in 2016
DR Congo	1	-97%
Equatorial Guinea	1	None in 2016
Eritrea	1	None in 2016
Eswatini	1	-90%
Ethiopia	1	-95%
Gabon	1	None in 2016
Guinea	1	None in 2016
Liberia	1	None in 2016
Libya	1	None in 2016
Mali	1	None in 2016
Niger	1	None in 2016
Sao Tome Principe	1	None in 2016

Source: Own research

South Africa has the largest number of ccTLD Accredited Registrars[146] at 622[147], followed by Botswana at 98, Tanzania at 72 and Nigeria at 68. At the other end of the spectrum, there are 16 ccTLDs with only one Registrar each, usually the Registry itself. These ccTLDs are using the “2R” Model.

The Registrars for 18 of the ccTLDs do not take registrations for entities without a local presence by the Registrant in the relevant country, although for 9 countries this information was not available. In total 31 ccTLDs are available for out of country registration.

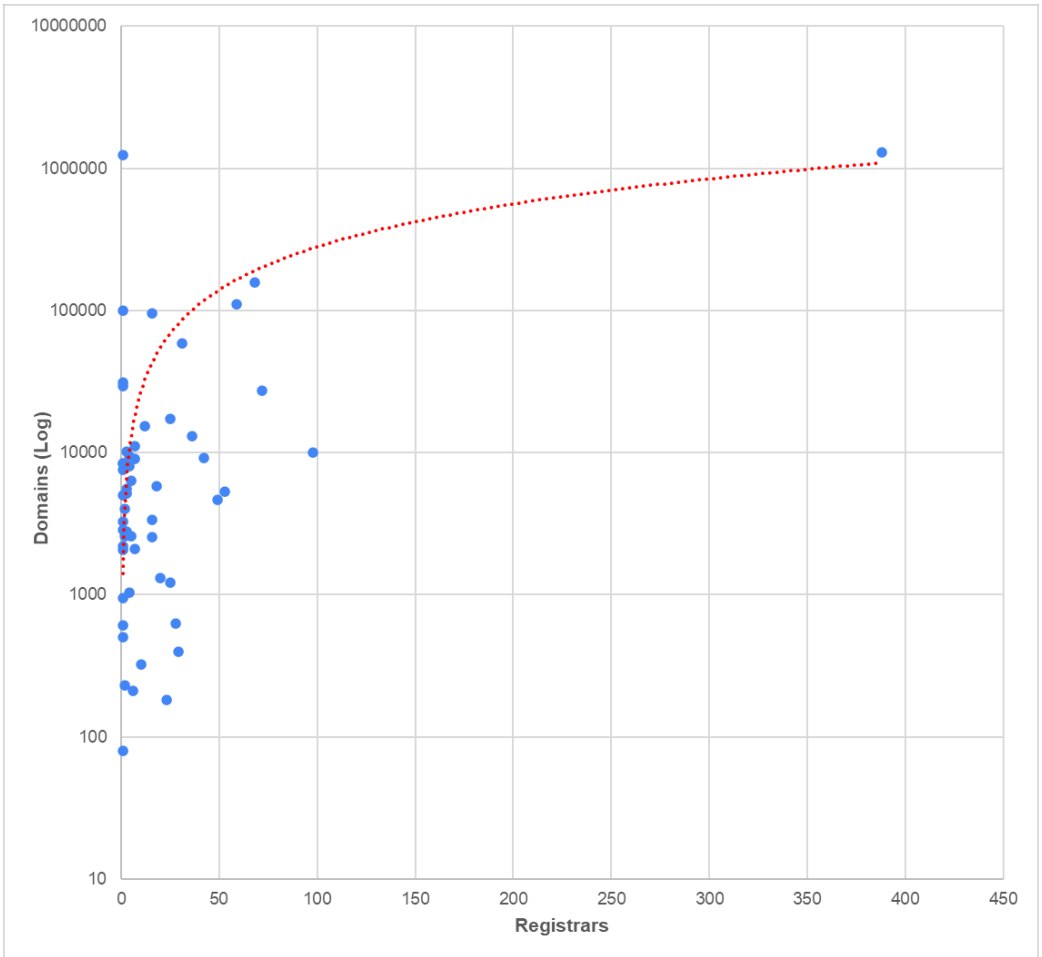
In two countries no local or foreign registration process were identified (Comoros (KM) or Guinea Bissau (GW)) at all.

[146] In the 3R model, it is usual for the Registry to “accredit” Registrars as having signed the appropriate contracts and passed conformance tests. In the South African case, this is by the ZARC.

[147] https://www.registry.net/zarc_domain_stats.php

It would seem logical that the more Registrars there are selling a ccTLD, the more domains will be sold – at least up to some limit. However, if we consider all countries then the graph is very “noisy”, with 16 countries on the Y Axis with only one Registrar (Usually the Registry itself) and the correlation is correspondingly low. Note that this is a logarithmic plot.

Figure 5-9: Total Domains versus Registrars (Log Plot) 2023



Source: Own Research

As can be seen from the trend line above, there are diminishing returns with the addition of more Registrars. This accords well with the discovery in the 2016 Study that there is little benefit in having more than about 25 Registrars, although below this infection point, more is better.

5.7 IDNS

An internationalized domain name (IDN) is an Internet domain name that contains at least one label displayed in software applications, in whole or in part, [a] in non-Latin script or alphabet or [b] in Latin alphabet-based characters with diacritics or ligatures. These writing systems are encoded by computers in multibyte Unicode. Internationalized domain names are stored in the Domain Name System (DNS) as ASCII strings using Punycode transcription.

IDN was originally proposed in December 1987 by Martin Dürst and implemented in 1990 by Tan Juay Kwang and Leong Kok Yong under the guidance of Tan Tin Wee.[148] After much debate and many competing proposals, a system called Internationalizing Domain Names in Applications (IDNA) was adopted as a standard and has been implemented in several top-level domains.

Internationalized Domain Names (IDNs) enable people around the world to use domain names in local languages and scripts. IDNs are formed using characters from different scripts, such as Arabic, Chinese, Cyrillic or Devanagari. These are encoded by the Unicode standard and used as allowed by relevant IDN protocols.

ICANN has instituted the IDN Program[149] to assist in the development and promotion of a multilingual Internet using IDNs. The program is primarily focused on the planning and implementation of IDN top-level domains (TLDs), including IDN country code TLDs and generic TLDs. The IDN Program also supports projects geared towards effective use of IDNs at the second level of the Domain Name System, as guided by the community. IDN continues growing in Africa for Arabic, Amharic, Tifinagh, NKO, and Vai.

What is an IDN?

The Domain Name System only allows the characters 0 to 9, A to Z and the hyphen to be used to make up a word in a Domain Name (the portion of text between dots). The A-to-Z characters are also case insensitive. The dot character is used to separate between the different levels (words) of a fully qualified domain name. The hyphen cannot be used as the first or last character of any word. The Underscore character is sometimes used as the first character in service identifiers but is otherwise not considered to be an allowable character in a Domain Name. This has not changed with the introduction of IDN Names.

If we look at the word **café** (the '**e**' having an acute accent '´' over it), to represent this in the rules discussed, it needs to be encoded (named "Punycode"[1]) in some manner so that only allowed characters are used. In this case, **café** becomes **xn--caf-dma** or **café.africa** becomes **xn--caf-dma.africa**. An obvious resulting rule from all this is that the initial string **xn--** is reserved for IDN names only, for example, one should not be able to register **xn--123**.

The Arabic script is the second most widely used alphabetic writing system in the world after the Latin alphabet.[150] Moreover, Arabic script has been adapted to such diverse languages as Persian, Urdu, Turkish, Spanish and Swahili. Nevertheless, it remains below 1% of the total IDN used worldwide.

In the Middle East North Africa (MENA) region the Arabic Internet Names Consortium (AINC) is leading initiatives to foster the usage of Arabic alphabet. Of the 10 Arab countries located on the African continent, only six of them implement an Arabic IDN to their ccTLD as depicted in the table below.

Table 5-6: IDNs in Africa

IDN ccTLD	ISO	Country
.الجزائر	DZ	Algeria
.مصر	EG	Egypt
.موريتانيا	MR	Mauritania
.المغرب	ma	Morocco
.سودان	SD	Sudan

[148] Internationalized domain name - Wikipedia

[149] https://www.icann.org

[150] Arabic alphabet | Chart, Letters, & Calligraphy | Britannica

تونس.	TN	Tunisia

Source: IDN World Report 2023 | IDN World Report

See section 7.5 for statistics on the use of different languages by African websites.

5.8 PRIVACY SUPPORT IN DOMAIN REGISTRATION

A Privacy System (in the WHOIS system) is where the Registry hides the identity of (usually) the Registrant. The usual reason is that the Registrant does not want to have his / her personal contact information visible in the WHOIS system that anyone with Internet access can potentially see. One example could be that the Registrant is a minor, another is to minimise spam.

In the questionnaire, we asked the following questions and received the following responses:

- Registry: Do you provide Proxy Privacy facilities for WHOIS?
  - In 2016, Zero Registries out of 26 said “Yes”.
  - In 2023, 10 Registries out of 29 now say “Yes", however, since the European privacy act, the majority of commercial Registries now redact personal information.
- Registrar & Reseller: Do you offer Proxy registration services?
  - In 2016, 13 out of 54 Registrars and Resellers said “Yes”.
  - In 2023, 51 out of 97 Registrars and Resellers said “Yes”.
- Registrant: Have you ever been offered Proxy Registration services?
  - In 2016, 83 out of 176 Registrants said “Yes”.
  - In 2023, 158 out of 283 Registrants said "Yes".

In some Registry systems, it may be possible to ask the Registry to hide certain fields. No one who answered the questionnaire seemed to indicate this would be possible. This should not be seen as a problem, as hiding personal data can be done in other ways.

The easiest way to implement this is for the Registrant to use a proxy contact instead of their own contact details. This would be like having a Post Office Box rather than street delivery for your postal mail. A variety of people can offer these services, from the parents of minors to the company lawyer.

Privacy Support though is a generally moot discussion point with the General Data Protection Regulation (GDPR) which is a European law that established protections for privacy and security of personal data about individuals in European Economic Area (“EEA”)-based operations and certain non-EEA organizations that process personal data of individuals in the EEA. [151]

5.9 THE USER EXPERIENCE

A positive user experience of the DNS registration system is, unquestionably, likely to be a key factor in the uptake of Domains. Registrants who experience the process of DNS registration as simple, speedy, and effective are likely to be encouraged to register more domains than those who find the experience complicated, time-consuming, and full of pitfalls.

[151] The European Union Continues to Tackle the WHOIS Issue - International Trademark Association (inta.org)

Registrants who find the process simple, quick, and effective are likely to register more domains.

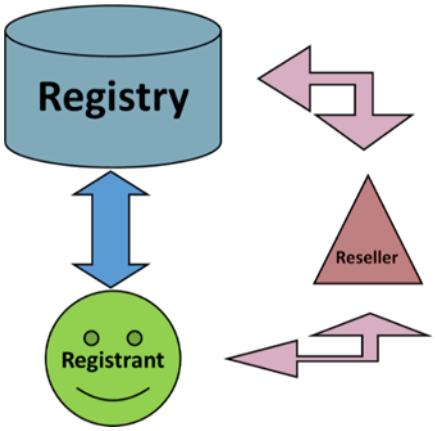
Conversely, a negative user experience is likely to provide an equally negative key metric of the health of the DNS ecosystem. Those countries with well-performing DNS industries are likely to see this reflected in the levels of user satisfaction within that system.

Consequently, with the view to improve and upscale the performance of DNS registration and user experience, The Internet Society and ICANN met in South Africa in 2013 to launch the Africa Domain Name System (DNS) Forum[152] to improve the technical and governance levels in Africa Country code domains (ccTLD) and to foster Internet ubiquity and resilience. In 2019 the Africa Registrars Association was formed in Senegal, Africa. Consequently over 90% of ccTLDs are now automating to ICANN's registry systems that support IPv6 and DNSSEC.

Before the 2013 launch conference referred to above, there were 12 ICANN accredited registrars in Africa. The figure had risen to 25 in May 2022 as researched by Israel Nyoth, former Communication and Outreach Manager, Internet Society, 11 May 2022. These developments have led to a wider, healthy, and positive user experience.

The DNS registration system features two models, namely the two-tier 2R or RR model which consists of Registrants, some of whom may be resellers, and the Registry and the more complex 3R or RR model which comprises the Registrar, Registry and Registrant. The 2R model is much simpler to handle since it enables direct interaction between the Registrar or Reseller and Registrant. This model is used in the 16 countries that still do not have any Registrars (Down from 26 in 2016). This model is illustrated in Figure 5-11 below.

Figure 5-10: "2R" Model



[152] https://dnsforum.africa/

Figure 5-11" "3R" Model

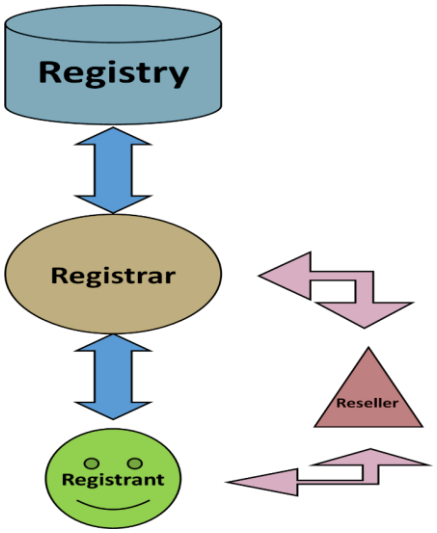


Figure 5-12 above illustrates the more complex 3R model (**R**egistrar -**R**egistry – **R**egistrant)[153] usually seen in more developed DNS industries and considered international best practice, presents two interfaces that need to be managed (Registrar-Registry and Registrant-Registrar).

Note that while the image depicts only one Registrar, in practice there are likely to be many.

Problems or bottlenecks at either of these interfaces are likely to impair the function of the process. However, by separating the widely differing requirements of the Registry from those of the many Registrants, the 3R model usually improves efficiency.

While a Registrar is usually accredited by the Registry as conforming to the required technical, financial, and legal standards, a reseller does none of these. Note that in both cases, a reseller can interpose itself between the Registrant and the next layer above. However, for this to be successful in the long term, the reseller must add value to the transaction for the Registrant. The Reseller will frequently do so by offering better value web hosting and email packages to the Registrant, for example.

For these reasons, several questions pertaining to factors influencing the user experience were included in the questionnaires. Questions covered issues such as:

- Preference for local or international registrars.
- Preferred payment methods.
- Understanding of the Domain Name registration system.
- Ease of use and awareness of the Domain Name registration system[154].
- The turnaround time for local Domain Name registration.
- The availability and functioning of an EPP (or another API[155]).
- The availability of Premium Domain registration.

Responses were received at all levels: from 29 Registries from 11 countries,

[153] E.g. Kenya, Sudan, South Africa, and Malawi.

[154] Worded differently for Registrars, who were asked to judge whether their system was “intuitive, automated and user- friendly”.

[155] Extensible Provisioning Protocol and Application Program Interface, respectively

from 79 Registrars from 25 countries, from 284 Registrants from 32 countries. The responses are discussed below, supported by graphs where this is useful.

5.9.1 REGISTRIES, REGISTRARS AND REGISTRANTS

Most Registrars (68% - down from 71%) support languages other than English, something likely to facilitate DNS uptake in non-Anglophone countries. Well over half (65%) say they offer a Content Management System with their website hosting packages, which simplifies website development, and again facilitates DNS uptake.

92% of Registrants prefer to deal with local Registrars.

The availability of Internationalised Domain Names (IDNs), which is likely to facilitate uptake in countries with non-Latin script, especially Arabic-speaking countries, is more common than might be expected, reportedly being offered by just over half of Registries (52%)[156] and just over half of Registrars (52%). However, this is likely in response to demand from Registrants, for over half of whom (59% up from 49%) report having made use of IDNs. Overwhelmingly, Registrants (92%) prefer to deal with local Registrars, suggesting the importance of developing the in-country DNS industry.

Registrants were asked to rank how easy they found it to locate a local service provider on a Likert-type scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). The most common response (mode) was the intermediate score of three, but the scores average out at 3.5[157], indicating a fair degree of ease with which local service providers were able to be found.

Most Registrants work with either a single Registrar (56%) or two Registrars (21%). It is unclear why as many as 10% report working with no Registrar unless these responses are from countries with a 2R model. A small minority (3%) work with five or more Registers, with one working with as many as 30. All these figures show a logical improvement over the previous study.

5.9.2 PAYMENT METHODS

Registrars and registrants were asked their preferred method for payment[158]. In 2016 Bank Transfer, followed by Credit / Debit card, were the clear favourites. This has changed with Credit/Debit Cards taking first place at 56% and Bank Transfer with Mobile Money both coming in at 18%. Cash came in pretty much last at 4% along with PayPal (2%) and Cheques (<1%).

5.9.3 UNDERSTANDING DNS REGISTRATION

Registrants were asked to rate whether they understood the choice of Domain Name available to them on a Likert-type scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”)). Most Registrants understood this aspect of the DNS environment well, with the most common response (mode) being ‘strongly agree’, and the average score coming in at 4.07, with very few strongly negative views.

5.9.4 EASE OF USE

A surprisingly low number of Registrants (45%) rated their process as being “intuitive, automated [and] user-friendly”, given that an effective registration interface is likely to be key to ease of DNS uptake. It is not clear whether they saw the fault as being their own or lying with the Registries.

Registrants were asked to rate how easy they found it to register their Domain Name ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). The responses show that almost all Registrants found the DNS process easy to use, with and average score of 4.09 and only three negative ratings.

---

[156] Including some surprising ones such as Burundi, DRC, Kenya, and Rwanda.

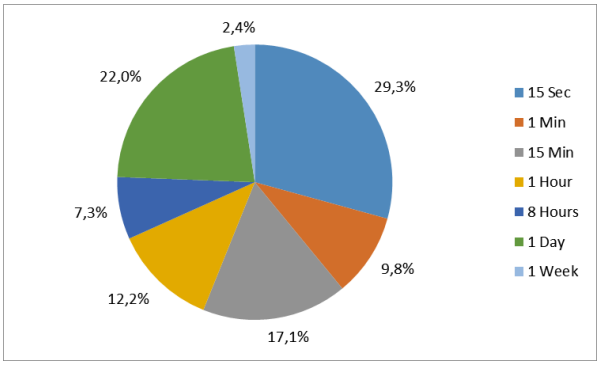
[157] Mean = 3.52, with a standard deviation of 1.05, showing few outlying (negative) scores.

[158] Unfortunately, this question was not posed to Registrants. And it was unclear, for Registrars, whether the question referred to incoming (from Registrants) or outgoing (to Registries) payments.

5.9.5 TURNAROUND TIME

A surprisingly large percentage of registries reported very fast turnaround times for the registration of local Domain Names, with 48% saying it takes a minute or less, and only a tenth (10%) saying the process takes a day or more. Registrants were asked to rate their ability to make immediate use of their Domain Name, once it was registered ranging from 1("strongly disagree") to 5 ("strongly agree"). Again, most respondents found they were able to make immediate use of their newly registered Domain Name. The intermediate rating of 5 (at 40%) was the most common response (mode), with the average score being 3.9159, and relatively few negative scores.

Figure 5-12: Time to register a local Domain Name (Registrars)



5.9.6 AUTOMATED REGISTRATION

84% of Registrants say automated registration is available via EPP or another API.

5.9.7 THE AVAILABILITY OF PREMIUM DOMAIN REGISTRATION

Fewer Registries (54%) now say they offer Premium Domain Name registration.

5.9.8 BARRIERS TO GROWTH IN THE DNS INDUSTRY

All respondents were asked to rank the most significant potential barriers to the development of the DNS industry, from most significant barrier (5) down to least significant barrier (1). The results are presented in the graph below for the 2017 study.

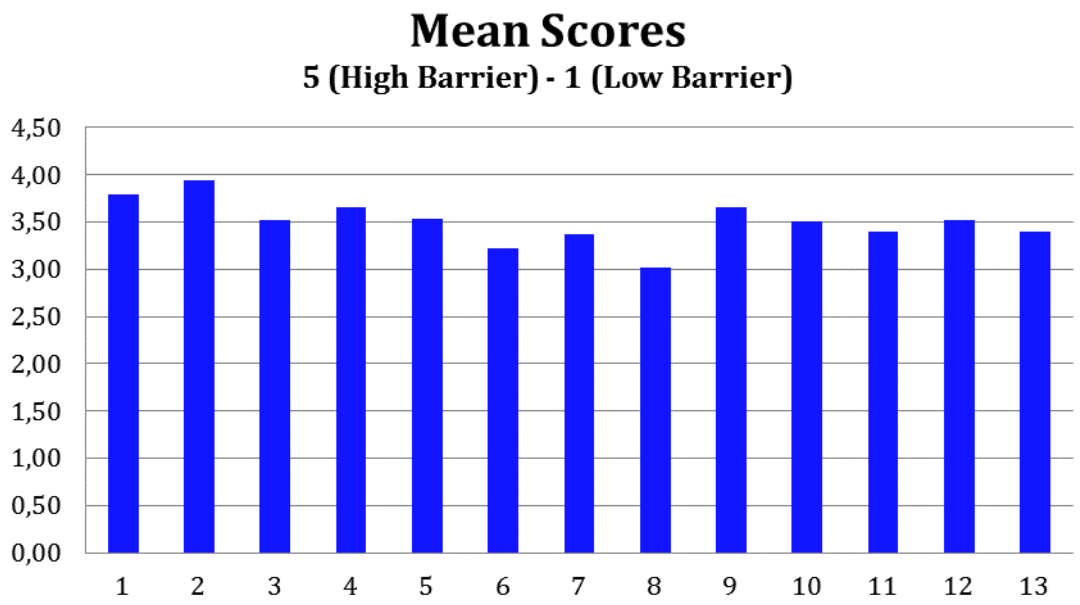
In 2017 the distribution of the mean responses is surprisingly even, suggesting that all the issues listed rate as significant barriers in most DNS markets, and that no single issue dominates across all countries. However, price does emerge as the most significant barrier by a small margin, ahead of low levels of Internet penetration, and the lack of easy payment mechanisms.

It seems prudent that Registries and Registrars should reduce DNS pricing and simplify payment mechanisms as first steps to promote DNS uptake, and that regulators and policymakers should promote Internet infrastructure development and uptake. However, each of the issues identified below seems to require attention.

Price was the most significant barrier to buying domain names in both 2017 and 2023.

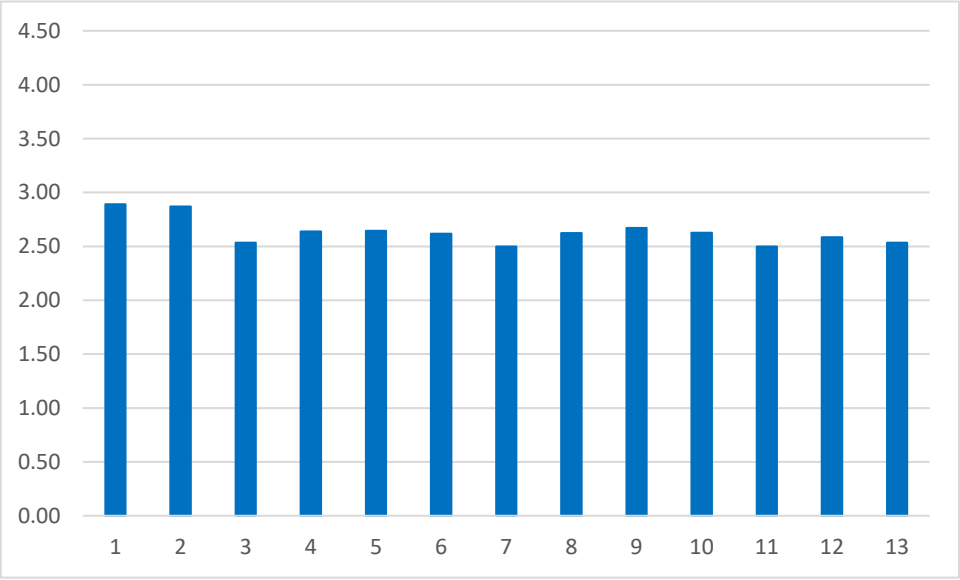
[159] Mean = 3.63, with a low standard deviation of 1.04.

Figure 5-13: Barriers to Growth - 2017 Survey



By contrast, results of the 2023 Online Survey show that many of these issues are much less of a problem for the 472 questionnaires completed. Speed of processing, government interference and clarity of the policy environment are no longer considered to be significant problems.

Figure 5-14: Barriers to Growth - 2023 Survey



Source: PSA Survey Results

1. Low Internet penetration (Mode = 3, Mean = 2.89, Std dev = 1.58)
2. High price (Mode = 3, Mean = 2.87, Std dev = 1.53)
3. Slow processing time (Mode = 3, Mean = 2.53, Std dev = 1.40)
4. Lack of simple Payment Mechanisms (Mode = 3, Mean = 2.64, Std dev = 1.52)
5. Quality of Technical Support (Mode = 3, Mean = 2.62, Std dev = 1.44)
6. Availability of local Registrars/Resellers (Mode = 3, Mean = 3.32, Std dev =1.32)
7. Government interference (Mode = 3, Mean = 2.50, Std dev = 1.46)

8. Absence of local IXPs (Mode = 3, Mean = 2.62, Std dev = 1.49)
9. Poor dependability of Internet connections (Mode = 3, Mean = 2.67, Std dev = 1.50)
10. Clarity of Policy Environment (Mode = 3, Mean = 2.63, Std dev = 1.43)
11. Restrictiveness of Policy Environment (Mode = 3, Mean = 2.50, Std dev = 1.36)
12. Clarity of Regulatory Environment (Mode = 3, Mean = 3.52, Std dev = 1.22)
13. Restrictiveness of Regulatory Environment (Mode = 3, Mean = 2.53, Std dev = 1.36)

In 2023 the distribution of the mean responses is much more nuanced, and in general the values are lower. Whereas in 2017 the most common response was a 5 (Mode = 5), in this case all modes are now reduced to 3. This clearly indicates the perception by Survey Respondents that the barriers to growth of domain names in Africa are significantly reduced.

Low levels of Internet penetration, and high prices are slightly ahead of the other issues as barriers perceived by Survey Respondents.

5.9.9 IN CONCLUSION

Taken together, the responses at all three levels indicate a DNS registration process (in the countries that responded to the survey) that is well-understood, appropriate to the local environment, easy and quick to use. It still seems that moving entirely to electronic payment systems and reducing the price of registration to a .COM price level will be well supported by the market. The role of policy and regulation in providing a stable environment conducive to increased levels of Internet uptake and usage should also be noted.

As a caveat, it should be noted that responses to the questionnaire are likely to be weighted in favour of those countries with relatively effective and efficient DNS industries. Further research is required to pinpoint the problems in poorly performing DNS industries.

5.10 PREMIUM DOMAIN NAMES

A Premium Domain name is a Domain that the Registry sells at a higher cost than normal domain names, from the same zone. The types of names that may be considered Premium are usually either short names (three or fewer letters) or common dictionary words, also known as generic names (e.g. green, travel, shopping). Thus, short[160] or generic names usually cost more. This can be regarded as a tool to reduce Domain Name speculation, so that the Registry receives the income rather than the speculator[161]. It can also be regarded as a controlled levelling mechanism for pricing under Registry control rather than under speculator control. Premium Domains do not necessarily help increase Domain Numbers, but they may well increase Registry profits. As time has gone by, there are fewer Premium names left which has also decreased public interest in them.

In the questionnaire, we asked the following questions, with the answers shown:

- Registry: Do you sell Premium Domain Names (using the EPP[162] Premium Domain Name extension)?

[160] Technically, in the standard 7-bit ASCII alphabet, there are 36 one-character names (0-9 and a-z), 1,296 (36^2, that is 36 to the power of 2) two-character names and 47,952 three-character names (36^3+36^2). The three-character names can also include the hyphen character ('-') in the middle position (the "+36^2" factor in the formula above). The hyphen character is not allowed to be either the first or last character of a Domain name. This could thus allow for 49,284 Premium names in total – with three or fewer characters in the Latin alphabet set. The number of permutations would be increased if other accented characters are included, where IDN (Internationalised Domain Name) is allowed.

[161] There are many companies that specialise in selling Premium Domains – e.g. http://www.domainmarket.co.za/ . In many cases these are sold simply as an investment, so "squatting" must also be allowed.

[162] Extensible Provisioning Protocol RFC https://tools.ietf.org/html/rfc5730

  - 3 of the 13 country Registries that responded said “Yes”: South Africa, Burundi and Morocco. At least Nigeria is also known to provide Premium Domains. The AFRICA domain also has Premium and Reserved Domains.
- Registrar & Reseller: Can you register Premium Domains, for example in EPP via appropriate extensions?
  - 18 out of 35 Registrars offer Premium Domains to their customers – 16 of which use EPP to do this. The other two Registrars probably unknowingly use EPP via the Registry web interface.
- Registrant: Were any of your Domain Names purchased as Premium Names (e.g. short or generic names)?
  - 65 out of 179 Registrants have purchased Premium Domains

One common and effective way to implement Premium Domains Names is for a Registry to use an EPP based Registry System. The Registrar is also most likely to use an EPP based client in order to register such domains. The EPP specification forces the Registrar to first look up and then confirm the price of a Premium Domain in the purchase process – so that the Registrant is made well aware at the time of purchase that the domain name is a Premium Domain Name rather than just a standard name.

It is also often true that many countries operating a hierarchical zone structure, with registration allowed at the 3rd level, under the usual .CO.ccTLD, .ORG.ccTLD, etc., also accept registrations at the 2nd level of the ccTLD, often at premium prices.

Of the 15 countries that we obtained detailed sub-domain numbers for, some 78% appear to offer Premium Domain Names. Two case studies are outlined below.

5.10.1 SOUTH AFRICA

South Africa has over 1 300 000 domain names registered. The bulk of these are in the CO.ZA registry. There is no Registry-based Premium Domain Name system for the CO.ZA Registry as all the “good ones” have already been taken. Several years ago, the ZACR (South African Central Registry) or now the ZARC (South African Registry Consortium) also took over .NET.ZA, .ORG.ZA and WEB.ZA and added these Registries into its EPP system. These 2LDs (Second Level Domains) were re-released and a Premium Domain Name system was activated for each Registry. The system was simple – a single, constant price for Premium Domains and only when it was purchased as a new domain. When the three city Domains and Africa (DURBAN, JOBURG, CAPETOWN and AFRICA) were added in the expansion of the new gTLD system, they too had their own Premium Domain Name systems. So, in South Africa, Premium Domains include three and fewer letters as well as a number of Generic names.

5.10.2 .AFRICA

When the gTLD .AFRICA was brought into existence, it received the approval of the AU (African Union). The AU also influenced how AFRICA was to be run. This included the Reservation of a list of “reserved” names per African country. This included such names as “oyo.africa” – which in this case was reserved by the AU itself. This arrangement of reserved names was initially for a period of 12 months but has been extended indefinitely for now. A customer of Posix Systems at the Steve Biko Foundation wished for this name. It took about three months to have this released to the Foundation, which included asking the AU for clearance. The Domain was then sold onwards to the Steve Biko Foundation at the normal (non-Premium price) despite it being a three-letter word. This reserved name list consists of political names, names of cities and such like. This seems to be a unique restriction in the Domain Name space.

5.10.3 NIGERIA

In 2015, to grow the .NG namespace the Nigerian Internet Registration Association (NIRA) issued over 1,851 .NG Premium Domain Names through an auction process. Although there was interest in those domain names, the cost of acquiring them became a stumbling block to many Nigerian citizens, as the domain names were auctioned at a rate of N15, 000, which at that stage was about USD $75.

Although Premium Domain Names are valuable, as they are the catchiest, there is a need to make them affordable for African entrepreneurs, as the cost of acquiring a Premium Domain Name is still a barrier for many small businesses, non-profit organisations, and students.

Apart from South Africa and Nigeria, the continent's leading economies, not many countries in the continent have released Premium Domain Names by auction. There needs to be a multi- stakeholder approach in ensuring that the growth of the Premium Domain Name ecosystem is enabled.

5.10.4 ANOTHER TYPE OF PREMIUM DOMAIN USAGE

Domaineers[163] some time ago saw that not all Domains were equal and registered them for themselves for the express purpose of monetising them in some way. They are resold at a premium price on the open market - often to a purchaser with a similar name to the Domain. They are often found on systems like Sedo Parking, where they can also be used to run Google Advertising (Domain referrals) from. If a Registry allows for Domain Tasting (the purchase of a Domain for a short period or use of the Domain before having to pay for it, then Domaineers may register numerous Domains with the express purpose of running them to see if Domain Referrals will be profitable for that name or not, for example, the incorrect spelling of an existing Domain.

5.10.5 EMOJI DOMAINS

An Emoji is a pictorial symbol that is typically presented in a colourful cartoon form and used inline in text. Since 2001 there has been community interest in the use of emojis in domain names. Some ccTLDs allow emojis to be registered at the second level. For an emoji to work as a domain name, it must be converted into Punycode. Punycode is a character encoding method used for Internationalised Domain Names (IDNs). Each emoji has a unique Punycode representation. For example, "😉" in an IDN is represented as (xn--n28h).

There are at least 25 worldwide TLD and second-level domains allowing emoji domain registration, five of them are related to African country ccTLDs: Central Africa Republic (.CF), Gabon (.GA), Equatorial Guinea (.GG), Mali (.ML), and São Tomé and Príncipe (.ST)

Very few registrars support emoji domain names. This is due to the security concerns as emoji can look different depending on the operating system, applications, and fonts used.

The ICANN Security and Stability Advisory Committee (SSAC) provides two recommendations concerning emoji domains[164].

- Because the risks identified in this Advisory cannot be adequately mitigated without significant changes to Unicode or IDNA (or both), the SSAC recommends that the ICANN Board reject any TLD (root zone label) that includes emoji.
- Because the risks identified in this Advisory cannot be adequately mitigated without significant changes to Unicode or IDNA (or both), the SSAC strongly discourages the registration of any domain name that includes emoji in any of its labels. The SSAC also advises registrants of domain names with emoji that such domains may not function consistently or may not be universally accessible as expected.

[163] Domaineering is the web-based marketing business of acquiring and monetizing Internet domain names for their use as an advertising medium

[164] https://itp.cdn.icann.org/en/files/security-and-stability-advisory-committee-ssac-reports/sac-095-en.pdf

6 ANALYSIS OF DOMAIN NAME UPTAKE ACROSS THE CONTINENT

6.1 AFRICAN DNS INDUSTRY

While domain names are the primary focus of this study, there are several inter-related factors that contribute to the health – or lack thereof – of the DNS industry within each African country. We found that the various countries were very diverse in how they have succeeded under various metrics. For example, Mali, Equatorial Guinea, Central African Republic, and Gabon have high numbers of domains because of these being given away by Freenom and SafeCow, some have had some success in exploiting their ccTLD's potential for a domain hack, while others have not.

Freenom provided a supposed win-win partnership that made a free domain model available to partner countries as offering to their local Internet population the tools to get online quickly and at no cost. The expectation of the innovative model was to facilitate the creation of local content and to stimulate the Registries in these four countries listed above. In practice, Freenom has been closed down by ICANN for repeatedly breaching their registration terms[165].

While many indices of various types are published, none of them met the specific requirement of this study to quantify success in the DNS Industry in Africa. In addition, few of them consider all 54 countries. For example, one of the best known is the ITU's ICT Development Index[166].

However, it only had data for 39 Africa countries and was discontinued in 2018. As a result, we have developed a Country DNS Success Index (CDSI) based on a combination of the rankings of all 54 countries in Africa on each of the following criteria:

- Number of domains registered under the ccTLD.
- Number of gTLD domains identified as having an African Registrant.
- Number of webpages indexed by Google.
- Price of registration (Lower is better).
- Number of Registrars.
- Number of locally hosted websites.
- Figure of Merit (FoM) derived from the presence of one or more functioning IXPs.
- Internet usage as a percentage of the population.

Note that a simple ranking was used for each criterion, which eliminates some of the enormous differences in scale between African countries. Some explanation of each of these results is outlined in the following sections.

Due to the difficulty in obtaining complete zone files, we used a variety of sources to list domains hosted in or associated with Africa. Sifting through some 300 million domains gave us 5.5 million valid domains associated with Africa. We further processed these domains to identify those with websites. Most of our figures therefore refer to domains with websites, rather than simply domains. The reason is that when a website exists, one can determine where that site is hosted – even when it's "in the Cloud".

[165] https://www.icann.org/uploads/compliance_notice/attachment/1219/hedlund-to-zuubier-9nov23.pdf

[166] http://www.itu.int/net4/ITU-D/idi/2016/

6.1.1 NUMBER OF CCTLD DOMAINS

While this may seem an obvious measure, a few countries have an unusually high number of domains, as discussed in section 6.3.3. In addition, there are several countries with unusually low numbers of domains, as discussed in section 7.4. Thus, while the number of ccTLD domains is important, it isn't sufficient. The total number of domains is counted, irrespective of the population size of the country. As will be shown later, this does not seem to disadvantage countries with smaller populations.

6.1.2 NUMBER OF GTLD DOMAINS

Having more gTLD domains than ccTLD domains for a country could be seen as an indication that the ccTLD is not doing well. While this is true, the mere fact that domains are being registered is an indication of the vibrancy of the local ICT ecosystem.

While we were unable to gain access to as many Registry or Registrar extracts as we wished, we did get enough to provide us with meaningful figures on this metric.

6.1.3 NUMBER OF WEB PAGES INDEXED BY GOOGLE

This is a crude measure of the total volume of content appearing under a ccTLD. For those countries not listed in Section 6.3.3 as a "domain hack", this is indeed a useful measure of the quantity (if not the quality) of local content. Several of the "domain hack" countries have a higher volume of webpages than expected. This is presumably because those entities that have taken the trouble to register a clever domain name have also taken the trouble to use it effectively.

It should be noted that we discovered that the results obtained in late November 2023 were in some case significantly different to those obtained a few weeks earlier, so an entire new set was recorded. This is presumably because of some internal change in Google's algorithms.

6.1.4 COST OF REGISTRATION

For this important metric, countries were ranked from cheapest to most expensive. It should be noted that analysis showed two different measures of price: that offered by a typical international Registrar[167]; and that offered by local Registries, Registrars and Resellers. In both cases we picked the lowest figure, so the results were not distorted by Premium Domain Names, for example.

We found that, on average, 101Domain charged 4.7 times more than a domain which was registered locally. The average local price was $14.62, whereas 101Domain charged an average of $103. By comparison, a .COM domain from 101Domain costs $14. We chose not to allocate any score to those countries for which we could not find an in-country local price.

6.1.5 NUMBER OF REGISTRARS

While this is an important metric, it can be overplayed. Clearly, 25 Registrars is better than one Registrar. But are 50 Registrars better than 25? In section 6.6 we attempted to answer this question, concluding that having the highest number of registrars is not necessarily the ideal, but that there was a distinct difference between those countries that had significantly fewer than 25 Registrars versus those with more. For the index, countries were simply ranked on the number of Registrars we were able to identify. The 16 countries with a single Registrar each were ranked equally.

[167] We used 101Domain as our example in both Studies: https://www.101domain.com/

6.1.6 LOCAL HOSTING

Countries where few domains and websites are hosted locally do not have a healthy ICT ecosystem. This metric is ranked in descending order of the total number of websites hosted locally, which almost matches the proportion of websites that are hosted locally.

6.1.7 IXP FIGURE OF MERIT

As discussed in section 5.4.3 above, the presence of an IXP is without doubt a very important factor in the ICT ecosystem of a country. However, the effect of an IXP can be complex, and clouded by many issues. We thus derived a Figure of Merit (FoM) for those countries that have one or more functioning IXPs. Those without a qualifying IXP scored nothing on this metric.

6.1.8 INTERNET PENETRATION

As discussed in Section 4.3 above, the percentage per capita of Internet usage, or penetration, is an important measure of how developed the ecosystem is. While we have used InternetWorldStats[168] throughout, their figure for Libya[169], at 95% Internet penetration seems to be in error. We therefore leave Kenya, at 85% of its population having access to the Internet as the leading country. The simple fact of having access leads to many economic benefits.

[168] https://www.internetworldstats.com/stats1.htm

[169] https://www.internetworldstats.com/af/ly.htm

6.2 RANKING OF AFRICAN COUNTRIES

Looking at all 53 countries[170], for all eight (nine) parameters, allows us to rank all African countries in terms of their success in the DNS Ecosystem. The results are reflected in the table below:

Table 7-1: Ranking of African Countries (2023)[171]

Country	ccTLD	Total ccTLD Domains	Total gTLD Domains	Webpages / Capita	Price (Foreign)	Price (Local)	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total	Rank
South Africa	ZA	54	54	54	51	52	54	54	54	44	**471**	**1**
Nigeria	NG	51	53	53	46	54	43	51	53	52	**456**	**2**
Kenya	KE	49	51	50	47	51	53	37	52	54	**444**	**3**
Morocco	MA	50	49	51	40	47	50	50	16	49	**402**	**4**
Tanzania	TZ	44	30	48	54	48	45	52	51	29	**401**	**5**
Tunisia	TN	48	47	49	50	12	48	45	44	48	**391**	**6**
Botswana	BW	37	31	24	44	50	29	53	37	36	**341**	**7**
Mauritius	MU	39	33	46	39	3	52	32	35	51	**330**	**8**
Uganda	UG	36	43	44	49	13	36	26	49	30	**326**	**9**
Egypt	EG	31	48	52	25	10	49	26	47	37	**325**	**10**
Zimbabwe	ZW	47	26	31	22	11	47	48	32	41	**305**	**11**
Algeria	DZ	41	45	47	33		46	34		53	**299**	**12**
Rwanda	RW	28	25	20	10	53	40	43	40	33	**292**	**13**
Cote d'Ivoire	CI	40	46	19	16		41	46	43	32	**283**	**14**
Zambia	ZM	27	32	18	34	18	42	38	33	39	**281**	**15**
Mali	ML	33	21	32	53	49	27	16		45	**276**	**16**
Cameroon	CM	21	42	21	52		34	37	36	28	**271**	**17**
Ghana	GH	22	44	42	17	5	38	19	45	34	**266**	**18**
DR Congo	CD	30	35	37	43	9	31	16	46	14	**261**	**19**
Seychelles	SC	24	50	34	27	2	51	23		50	**261**	**20**
Senegal	SN	35	41	23	20		30	47	20	43	**259**	**21**
Mozambique	MZ	34	36	30	26	8	25	32	38	18	**247**	**22**
Madagascar	MG	25	28	40	14		32	49	42	3	**233**	**23**
Angola	AO	38	23	26	9	6	26	23	50	23	**224**	**25**
Libya	LY	43	38	13	28		44	16		35	**217**	**26**
Somalia	SO	42	27	41	38	4	16	41		6	**215**	**24**
Cabo Verde	CV	46	5	29	41		24	16		47	**208**	**27**

[170] On the instruction of ICANN, PSA has excluded .NA DNS zone (ccTLD) data in this study report and observatory.

[171] On the instruction of ICANN, PSA has excluded .NA DNS zone (ccTLD) data in this study report and observatory.

Country	ccTLD	Total ccTLD Domains	Total gTLD Domains	Webpages / Capita	Price (Foreign)	Price (Local)	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total	Rank
Benin	BJ	19	39	15	24		21	33	28	26	**205**	**28**
Burundi	BI	9	15	25	42	16	13	42	34	8	**204**	**29**
Sudan	SD	29	19	8	29		37	28	27	25	**202**	**30**
Gambia	GM	11	10	39	37		17	40	29	17	**200**	**31**
Burkina Faso	BF	15	22	33	13		23	28	41	20	**195**	**32**
Sao Tome & Principe	ST	45	11	45	45		8	16		24	**194**	**33**
Djibouti	DJ	32	8	6	32		15	16	39	40	**188**	**34**
Togo	TG	17	24	36	19	17	22	23	24	5	**187**	**35**
Lesotho	LS	13	7	43	15		28	32	19	27	**184**	**36**
Malawi	MW	14	14	14	21	7	35	37	30	11	**183**	**37**
Gabon	GA	23	52	12	0		19	16		46	**168**	**38**
Mauritania	MR	10	17	27	23	1	18	39		19	**154**	**39**
Sierra Leone	SL	16	34	35	36		7	19		7	**154**	**40**
eSwatini	SZ	12	12	28	0		20	16	18	42	**148**	**41**
Ethiopia	ET	20	18	11	12	14	33	16		15	**139**	**42**
Guinea-Bissau	GW	4	1	5	48		4	44		31	**137**	**43**
Congo	CG	18	29	17	7		11	16	25	13	**136**	**44**
Equatorial Guinea	GQ	52	2	22	0		12	16		21	**125**	**45**
Central African Republic	CF	53	4	38	0		5	16		4	**120**	**46**
Chad	TD	8	20	9	11		6	26	23	9	**112**	**47**
Guinea	GN	6	16	4	18		9	16	22	16	**107**	**48**
Liberia	LR	5	9	7	31		10	16		12	**90**	**49**
Comoros	KM	3	37	2	0		3	19		22	**86**	**50**
Niger	NE	7	13	10	8		14	16		10	**78**	**51**
South Sudan	SS	2	3	3	35		2	29		2	**76**	**52**
Eritrea	ER	1	6	1	0		1	16		1	**26**	**53**

Each country received a score for each ranking, starting at 53 for the top-ranked country and decreasing to 1 for the bottom ranked. The total score per country is simply the sum of the scores for each metric. If a country doesn't qualify under that metric (for example, no IXPs as all, then it scores zero. If several countries achieve the same score in a metric, then they are ranked equally. The same small group of countries score well on almost all metrics.

However, in each one, there are some surprising results.

Table 6-1 below provides the scores for the top twenty countries:

Table 6-1: Movement in the rank of the Top 20 countries

Country	ccTLD	Total	Language	Region	Rank	Change
South Africa	ZA	471	English	South	1	
Nigeria	NG	456	English	West	2	+1
Kenya	KE	444	English	East	3	-1
Morocco	MA	402	Arabic	North	4	+4
Tanzania	TZ	401	English	East	5	+7
Tunisia	TN	391	Arabic	North	6	-1
Botswana	BW	341	English	South	7	+4
Mauritius	MU	330	English	Indian Ocean	8	-2
Uganda	UG	326	English	East	9	+1
Egypt	EG	325	Arabic	North	10	-1
Zimbabwe	ZW	305	English	South	11	-7
Algeria	DZ	299	Arabic	North	12	-5
Rwanda	RW	292	English	East	13	+7
Cote d'Ivoire	CI	283	French	West	14	**New**
Zambia	ZM	281	English	South	15	**New**
Mali	ML	276	French	West	16	**New**
Cameroon	CM	271	French	Central	17	-4
Ghana	GH	266	English	West	18	-3
DR Congo	CD	261	French	Central	19	-2
Seychelles	SC	261	French	Indian Ocean	20	-1

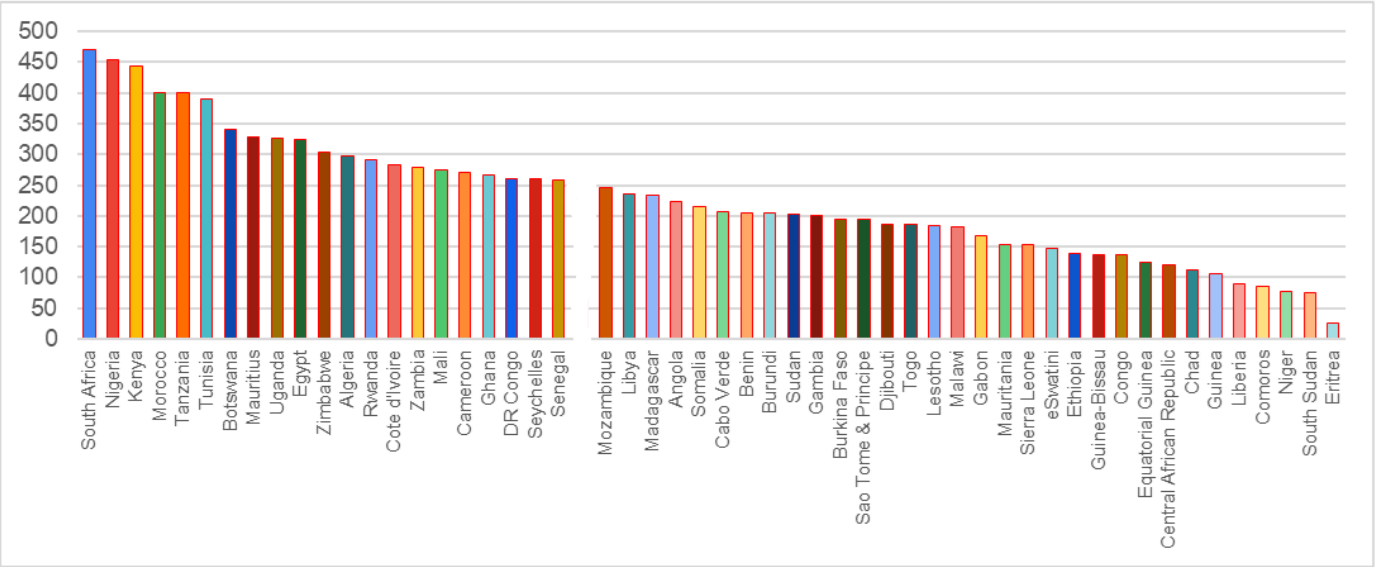
Source: Internal

19 out of the top 20 countries have access to an IXP.

The table above indicates there are no obvious advantages according to region, but language does seem to have an influence. It is worth noting that 17 of the 20 high performing countries listed above appear in the first 20 entries of Table 5-4 as being earlier adopters of IXPs and still have at least one viable IXP in operation today. A summary of the results by region and language follows in Section 6.5.

The scores achieved by all African countries are shown in the bar chart below.

Figure 6-1: Ranking Scores by Country[172]



Although not included in the scoring, other factors that could affect how well a country fares include:

- Number of AFRINIC Members
- Number of ASNs
- Literacy rate of the population
- Government Stability and level of Democracy
- Average income
- State of ICT sector reform
- Level of regulatory effectiveness
- Relevant legislation on e.g. e-commerce, digital signatures, DNS management & regulation, and privacy protection.
- International submarine and terrestrial connectivity.

6.3 HIGH PERFORMING CCTLDS

An examination of the top ten countries in terms of the Study's ranking of DNS ecosystem success follows below.

For each country, we provide:

- Scores for each of the eight ranking criteria in a table, with the total score highlighted.
- Where both an international and a local price rank are available, these are shown in the Price column.
- Statistics from Africa Telecommunications Map 2022 (telegeography.com)
  - Operational international bandwidth (Gbps) in [2015 --> forecast for 2018] 2023 Gbps
  - Population (millions) / Households (millions) [2016], Population 2023
  - Users by technology: Fixed line,% Broadband%, Mobile (millions of SIMS)

[172] On the instruction of ICANN, PSA has excluded .NA DNS zone (ccTLD) data in this study report and observatory.

- Undersea cable names (where appropriate)
- GNI per capita estimate (World Bank) as shown at http://www.internetworldstats.com/af/XX.htm (where XX denotes the two letter ISO code for the country)
- Statistics from: http://www.internetworldstats.com/stats1.htm Internet penetration %

Figures in [square brackets] refer to those quoted in the 2016 Study.

6.3.1 SOUTH AFRICA (ZA)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
ZA	54	54	54	51/52	54	54	54	44	471

- International Bandwidth: [512 --> 1,414] 27,000
- Population: [55 / 15.3] 60
- Technology: [26%, 12%, 164]
- Cables (8): (West Coast) WACS, SAT-3/WACS, ACE, 2Africa, Equiano (East Coast) EASSy, SEACOM, SAFE METISS, 2Africa (Far East)
- GNI: US$ 6,440 for 2022
- Internet penetration: 57.5 %, barely up from 56.6% in 2016

South Africa scored the highest marks in every category except for:

- Price, where Tunisia scored best, and
- Internet penetration, where it dropped down to 12th place. South Africa has won an award for best African ccTLD.

The reasons for ZA's success include:

- Amongst the first country with:
  - Automated registry systems
  - Relatively highly developed Internet infrastructure and uptake
  - Multiple Internet exchange points and data centres
- Early adopters of:
  - ccTLD delegated in 1993.
  - IPv6 addressing from 2006.
- Largest number or amount of
  - Domains
  - AFRINIC Members
  - ASNs
  - IP Address space
  - Local Hosting
  - Data Centres

However, despite having by far the highest quantity of submarine bandwidth landing, the effect of this is no longer translating into significantly lower consumer prices, particularly for mobile data, which is still used by most of the population. Combined with extremely high unemployment and a worsening economy, South Africa risks losing its position as the leading industrialised country on the continent.

The availability of high-capacity broadband infrastructure in South Africa has improved considerably in urban areas over the last few years. There are now many undersea cables connecting South Africa via both East and West coasts. The telecommunications sector and laws governing it are relatively well developed, and it is also home to over 400 licensed telecommunication providers. There is currently a race to deploy fibre to the home in many suburbs, gradually replacing the copper ADSL infrastructure, which Telkom has all but abandoned. The quality of data centres has attracted many international Content Delivery Network providers such as Cloudflare, which makes a large portion of the content of the Internet available locally to South Africans with low latency. However, South Africa has fallen behind some other African countries in the last two decades.[173] Google indexes 191 million pages for ZA, which results in 158 pages per domain. Compared with the average of 555 for Africa, this is on the low side.

Although South Africa scores highest in the Study's overall country DNS success ranking as shown above, it is likely to be challenged by several other African countries in the future, which are growing faster.

6.3.2 KENYA (KE)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	**Total**
KE	49	51	50	47/ 51	53	37	52	54	456

- International Bandwidth: [228 → 699]
- Population: [44.2 / 12.4] 55
- Technology: [0.7%, 1%, 83]
- Cables (3): EASSy, SEACOM, TEAMS
- GNI: [US$ 1,290 (2014)] US$ 2,010 (2022)
- Internet penetration: [68%] 85%

Kenya is supporting e-government.

Kenya scored consistently well in all the metrics and maintained its position as second on the list with a well-developed Internet industry. There are now six (up from 3) undersea cables that link Kenya to the world and other cables that interconnect neighbouring countries. There is a well-established FTTH industry within Nairobi and emerging in Mombasa and other major towns. KIXP was the second operational IXP on the continent, with a new one in Mombasa commissioned in June 2016. There are now three, putting Kenya behind South Africa, Tanzania, and Nigeria. Often, Internet services can be more competitively priced than in South Africa. The Government of Kenya is supporting e-government using the Internet so that services such as visas, passports and driving licence renewals can all take place electronically has led to both an explosion in Internet penetration and greater efficiency in providing services and collecting tax revenue. Google indexes a total of 29.5 million web pages under the .KE domain, down from 42.

6.3.3 NIGERIA (NG)

CC	Total Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
NG	51	53	53	46/54	43	51	53	52	456

- International Bandwidth: [141 --> 425] Population: [178.7 / 38.7] 223.8

[173] For example, ZA had over half of all Internet users in Africa in 2000. Today, it's in fifth place. See http://www.internetworldstats.com/stats1.htm

- Technology: 0.05%, 0.03%, 195 m (2021)[174]
- Cables (5): ACE, GLO-1, SAT-3/WACS, Main One, WACS
- GNI: US$ 5,650 (2022)
- Internet penetration: 67.5%

Nigeria moved up to 2nd place and is now two points ahead of Kenya. As with South Africa and Kenya, Nigeria has multiple undersea cables. The ccTLD is well run, there are now six IXPs and multiple Data Centres. Nigeria's biggest advantage is its huge population and large economy. It is, however, heavily reliant on oil revenue, which has taken a battering. Recently its dependence on oil almost crippled the economy in 2020, as the pandemic highlighted the losses to the Federal government's revenue[175] The Nigerian economy has recovered from the COVID-19 pandemic and has gradually seen an increase in non-oil revenue especially from the ICT sector, which contribute almost 16% in 2022.[176] Nigeria has the highest number of Internet users on the continent.

Coming in just after Kenya on the number of ccTLD domains but ahead on gTLD domains, Nigeria also has a high score from its four IXPs. Despite having good Data Centres, 98% of the websites identified were hosted overseas. In fact, of the top 6 web hosting companies, only one has a .NG domain name, and all of them host their own websites in the USA or South Africa. The latter may be a function of Nigeria's large population size, or perhaps is driven by avoiding the stigma of the .NG domain and its association with "419" scams. Although Table 5-1 lists the Lagos IXP at 2007, the now defunct Ibadan IXP started contributing to the growth of the Internet industry in Nigeria in 2002. Google indexes a total of 44.3 million web pages under the .NG domain, significantly up from 16 million.

6.3.4 TANZANIA

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
TZ	44	39	52	36	49	43	44	46	353

- International Bandwidth: [170 → 2350]
- Population: [61.7 / 14.3] 67.4
- Technology: 2.2%, ??%, 64 (2023)
- Cables (3): Seacom, EASSY, 2Africa
- GNI: [US$ 920 (2014)] US$ 1,20 (2022)
- Internet penetration: 53.6%

Tanzania is a new entrant to the African Top 10, having risen 7 places. Buoyed by government initiatives to build National ICT Broadband Backbone (NICTBB)[177] covering all districts headquarters, and several national fibre backbone initiatives by the consortium of mobile network operators, the reach and competition on the national backbone spur the uptake on broadband beyond major cities.

Tanzania has three undersea cables with two operational and one coming into commercial operation in early 2024. There is a well-run ccTLD and IXP initially funded by the regulator and operated by the not-for-

[174] https://www.worlddata.info/africa/nigeria/telecommunication.php

[175] https://resourcegovernance.org/articles/ending-nigerias-oil-dependency-not-if-whenand-how

[176] https://nigerianstat.gov.ng/elibrary/read/1241219).

[177] http://nictbb.co.tz/

profit organisation with the ISP Association as one of the two founding members. The other is the regulator. Currently the ccTLD operations are fully under the regulator and the IXP are under the ISP Association. The success of eGovernment in digitalising all government payment and most of the services except a handful, and the building of commercial data centres, improved the Internet usage and uptake of domain name services. Policy instability of the usage of Internet among others the demand

for registration of VPN in-country originating end-users, Internet monitoring and filtering has an impact on domain names uptake.

6.3.5 MOROCCO (MA)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
MA	50	49	51	40/47	50	50	16	49	402

- International Bandwidth: 598 --> 1,917
- Population: 33.5 / 6.4
- Technology: 34%, 18%, 124
- Cables (3): SeaMeaWe-3, Atlas Offshore (and one more)
- GNI: US$ 2,970 (2011)
- Internet penetration: [60%] 68.5%

Morocco owes its rise of 4 places to the implementation of an IXP in Casa Blanca in October 2019, although data on its performance are sparse. As a relatively wealthy country, being close to Europe on the north-west corner of Africa and with a large tourism industry, Morocco has a relatively high Internet penetration rate of about 69%. It was the only country in the Top Ten without an IXP, but with the proximity of Europe it has good access to international connectivity and European IXPs. Morocco ranks 66th at 39 Mbps for mobile download speeds and 128th at 25 Mbps for fixed broadband speeds[178]. There are also multiple 4G cell phone operators. Google indexes a total of 14.5 million web pages under the .MA domain, or 254 pages per domain.

6.3.6 TUNISIA

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
TN	48	47	49	50/12	48	45	44	48	391

- International Bandwidth: [117 --> 324]
- Population: [11.1 / 2.5] 12.5
- Technology: [35%, 19%, 133]
- Cables (4): SeaMeWe-4, Trapani-Kelibia, Didon, Hannibal
- GNI: [US$ 3,970 (2016)] US$ 3630
- Internet penetration: [52.1%] 68.4%

Tunisia has dropped by one place and is now behind Tanzania.

Tunisia is situated in the North of the African continent and has a well-developed and sophisticated telecommunications and broadband infrastructure. The Internet remains partly free, and while the state-

[178] https://www.speedtest.net/global-index

controlled telecom operator maintains a monopoly over the country's domestic Internet backbone, two other service providers have deployed Tunisia's first privately operated fibre optic submarine cable. Tunisia's telecoms regulator, the INT, introduced new licensing regulations recently and continues to make strides towards ensuring greater transparency and accountability.

These regulatory measures and good international bandwidth have led to consumers benefiting from reasonable prices. The Government sees the Internet as an opportunity for e-commerce, e- learning and e-medicine. Google indexes a total of 27.8 million web pages under the .TN domain, a considerable increase from 3.7 million previously.

6.3.7 BOTSWANA (BW)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
BW	37	31	24	44 / 50	29	53	37	36	341

- International Bandwidth: 100
- Population: [2.2 /] 2.7 /
- Users by Technology: 60% Fixed Wireless
- Underseas cables: None
- GNI per Capita: [US$ 7,240] US$6,940

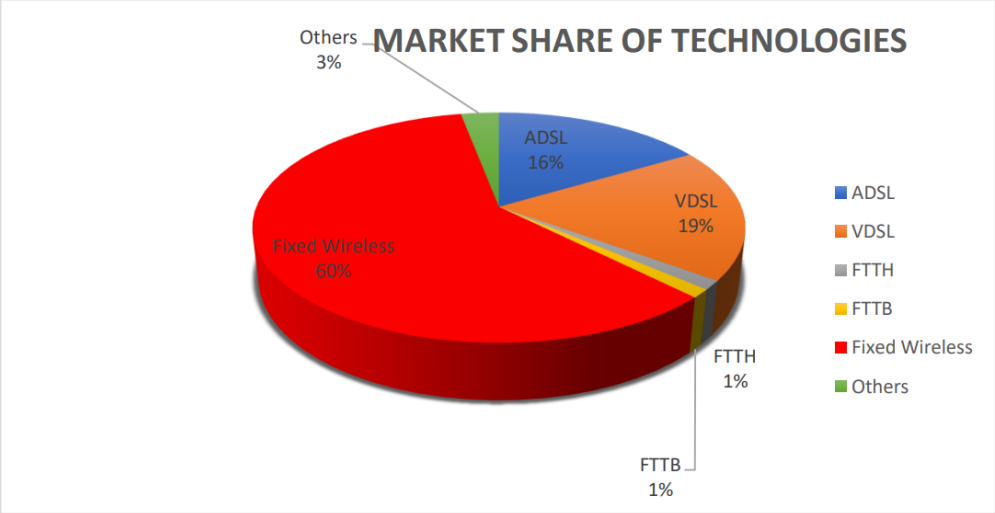


Figure 6-2: Market Share of Internet access technologies in Botswana
Source: BOCRA, 2021

Botswana is a landlocked country in Southern Africa, bordering South Africa, Namibia, and Zimbabwe, with a 150 m long border with Zambia at Kazungula. Very flat, some 70% of the country is desert. Since independence, Botswana has had one of the fastest growth rates in per capita income in the world. Botswana has transformed itself from one of the poorest countries in the world to an upper middle-income country. GDP per capita grew from $1,344 in 1950 to $15,015 in 2016. Although Botswana is resource-abundant, a good institutional framework allowed the country to reinvest resource-income to generate

stable future income. By one estimate, it has the fourth highest gross national income at purchasing power parity in Africa, giving it a standard of living around that of Mexico.[179]

Diamond mining plays a large role in Botswana's economy, with the government owning 50% of Debswana, the largest mining company, which operates Orapa, the largest gem diamond mine in the world. The other main industries are tourism and beef. Botswana has a very small population of only 2.7 million people and is one of the least densely populated places in the world, with fewer than 5 people / km^2.

The Botswana Internet Exchange (BIX) was formed in 2005 by BISPA, with help from AfrISPA. (several of the authors of this Study were involved). BIX is a thriving IXP with 14 peers and over 1 Gbps in peered traffic. Connectivity was mostly via South Africa but the proliferation of submarine cable on Africa's shores has increased Boswana's choices.

6.3.8 EGYPT

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
EG	31	48	52	25 / 10	49	50	47	36	348

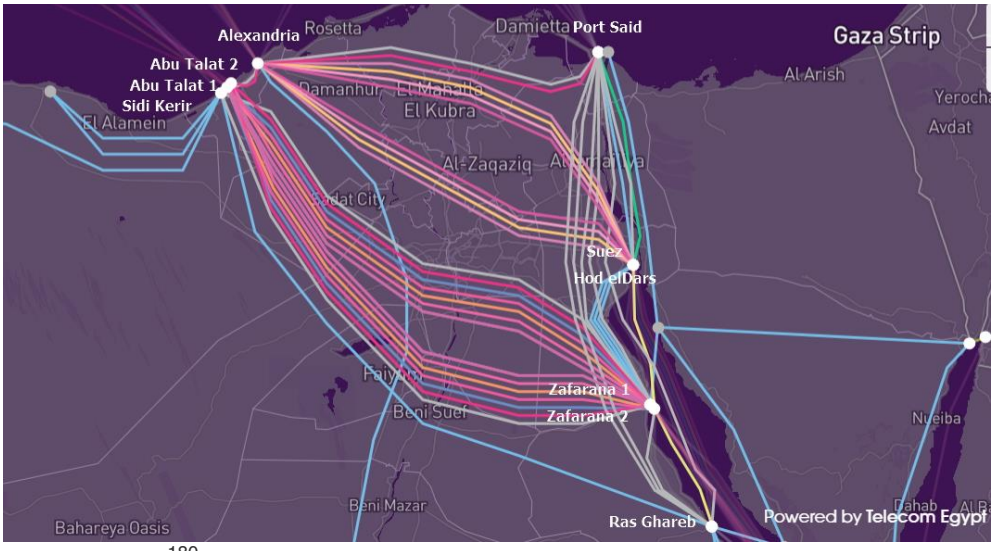
- International Bandwidth: [602 --> 1599]
- Population: [88.4 / 18] 112.7
- Technology: [36%, 22%, 106]
- Cables: 15 cables run through the Suez Canal area, but FLAG, SeaMeWe (3,4,5) AAE-1, ALETAR, MENA, EIG, Flag Falcon, Flag FEA, TE North, Hawk, I-ME-WE are explicitly mentioned as landing in Egypt[159]
- GNI: [US$ 3,210] US$ 3,510
- Internet penetration: 38%

Egypt has moved down 1 place to 10th place. It scored poorly on the price of domains and on the number of Registrars.

Egypt has experienced a 25% increase in population since the 2016 Study. Surprisingly, GNI per capita has also increased, although only by 15% over the same period. As Egypt is on both the Mediterranean and Red Seas, undersea fibre access to Europe is reasonably low cost, and a number of cables passing through the Red Sea to Africa and Asia land here on their way to Europe. Internet though is controlled largely by the government, as was seen when the country's Internet was switched off during the Arab Spring. On the other hand, the government at one time implemented free (home) Internet access to those with phone lines.

[179] https://en.wikipedia.org/wiki/Botswana#Economy

Figure 6-3: Trans-Egypt Routes and Cable Landing Stations



Source: Telecom Egypt[180]

Egypt scores well with PIR domains, local hosting and its two remaining operational IXPs. Google indexed a total of 15.4 million web pages under the .EG domain, or a very high 1603 pages per domain. Only the DRC (.CD) has more, with 2 822 pages per domain. This has now doubled to 31.1 million pages.

6.3.9 MAURITIUS (MU)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
MU	39	33	46	39/3	52	32	35	50	330

- International Bandwidth: [41 --> 130]
- Population: [1.3 / 0.4] 1.3
- Technology: [104%, 56%, 149]
- Cables (3): LION, SAFE (both to the East and West), METISS
- GNI: [US$ 9,630 (2015)] US$ 10,860
- Internet penetration: [59.6%] 7.2.%

Mauritius has dropped by 2 places, to 8th. This is partly due to its high domain costs, which are the 3rd highest for locals. The new METISS cable links it to South Africa.

The island of Mauritius is on the eastern side of the African continent and ranks among the highest in Africa on Internet penetration. Like Singapore, Mauritius has reinvented itself from a very poor basic commodity (sugar) exporting economy to one with a sophisticated commercial sector. This is primarily due to its very friendly policies towards foreign business. It has an export processing zone and companies Mauritius is also becoming one of the wealthiest countries in Africa. The business registration, taxation and banking (foreign exchange) laws are oriented to attracting offshore business to the country. The island is connected to three different fibre cables with more planned. Mauritius has established a digital campus development

[180] https://www.te.eg/interactivemap/#/the-digital-hub

called Cyber City, which is the location for the headquarters of AFRINIC, the Regional Internet Registry (RIR) for Africa, as well as several IT companies, including SEACOM (an undersea fibre cable company).

Mauritius is let down on its score by its high domain price but does well on the number of Registrars. Google indexes a total of 17.8 million web pages under the .MU domain, a little over double the previous figure.

6.3.10 UGANDA (UG)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
UG	36	43	44	49 / 13	36	26	49	30	326

- International Bandwidth: [65 --> 265]
- Population: [39.9 / 8.2] 48.5
- Technology: [4%, 2%, 47]
- Cables (0): Landlocked, access via Kenya
- GNI: [US$ 670 (2016)] US$ 840
- Internet penetration: [31%] 39.3%

Uganda has moved up 1 place.

Being a land-locked country, international access for Uganda is provided via Kenya and Tanzania. There are also onward fibre links to neighbouring countries Rwanda and the eastern DRC. Google has invested in a metro fibre project known as Project Link in Kampala. There is a local IXP in Kampala along with several Data Centres. It is not surprising to see Uganda, Tanzania and Kenya in this list – the three countries work closely together as members of the East African Community (EAC).

Uganda does well on gTLD domains, price, hosting and its IXP. It does exceptionally well on the number of web pages. This is despite it having the lowest GNI per capita of the Top Ten. Uganda's population has increased by 30% since the 2016 Study, and its GNI per capita by 25% over the same period. Google indexes a total of 18 million web pages under the .UG domain, or 536 pages per domain.

6.4 UNDERPERFORMING CCTLDS

This section provides an analysis of underperforming ccTLDs – those with less than 1,000 registrations – with the aim of identifying countries that need special support and issues which could be addressed to improve the performance of the domain name industry. Although these countries are presented here in ascending order of the total number of ccTLD domains, this does not directly correlate with their overall rankings as shown in Section 7.2 above. It is worth noting that none of these countries has a functional IXP, except for new IXPs in Chad and Guinea, which carry tiny amounts of traffic, although they have 16 and 11 peers, respectively.

Note that similar statistics are presented here for each country as were shown in the top performing countries in Section 7.2. The headline number of domains is that found by Domain Tools.

6.4.1 ERITREA (ER) – 80 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs-FoM	Internet Penetration	Total
ER	1	6	1	0	1	6	0	1	26

- International Bandwidth: [0.1 --> 3] 0.64
- Population: [6.7 / 1.2] 3.6
- Technology: [5%, 0.9%, 8]
- Cables (0): No Cables.
- GNI: [US$ 480] US$ 680
- Internet penetration: [1.0%] 6.8%

Eritrea does not have any submarine fibre connections.

Eritrea is the lowest scoring country in terms of the Country DNS Success Index, with a score of 16, down from 46 previously. This is just over a quarter of the score of the next country up, South Sudan (SS). The Eritrea registry is maintained by the incumbent state telecom operator (and only Internet service provider). The IANA database has no URL for the registry and guessing at names such as “nic.er” and “noc.net.er” gave no replies. The administrative and technical contacts now have email addresses using their ccTLD and did not respond to requests to fill in the survey questionnaire.

Several second level domains exist although there is no information available about their exact purposes or restrictions. The domains are: .COM.ER, .EDU.ER, .GOV.ER, .MIL.ER, .NET.ER, .ORG.ER and .IND.ER. Although several international Registrars list .ER domains, and some even give a price, they all state that registration is not possible. Given the large number of English language words that end in ‘er’, it appears that Eritrea is missing a major opportunity to gain ‘domain hack’ revenue from its ccTLD.

Eritrea does not have a connection to any submarine or terrestrial fibre cables and depends on expensive satellite capacity. As a result, Internet connectivity is minimal, and its web presence is virtually non-existent – Google indexes a total of 10 web pages under 10 .ER domains. Other factors are a low level of literacy (20%), no independent media and the predominant languages being Tigrigna and Arabic, neither of which were easily used in the digital world until very recently. The generally isolationist policies of the current regime along with the relatively small population and low per capita income further suppresses investment in ICT infrastructure. Despite its small population (variously estimated as between 3.6 million and 6.7 million), With an oppressive political system and mandatory national service, Eritreans are among the most numerous refugees, with a net emigration rate estimated at 1% per year.

6.4.2 SOUTH SUDAN (SS) – 209 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
SS	2	3	3	35		29		2	76

- International Bandwidth: [14 --> 58] 0.8
- Population: [12 / 2] 11.1
- Technology: [10%, 0.6%, 85]
- Cables (2): ACE, GLO-1
- GNI: US$ 460
- Internet penetration: 7.9%

The Republic of South Sudan became the world’s youngest nation and Africa’s 54th country on July 9, 2011. However, outbreaks of civil war in 2013 and 2016 have undermined the post-independence development gains it made, as well as making its humanitarian situation worse. More than a decade after independence, South Sudan remains impacted by fragility, economic stagnation, and instability. Poverty is ubiquitous, exacerbated by conflict, displacement, and external shocks. South Sudan is a landlocked country in eastern Central Africa. It is bordered by Ethiopia, Sudan, the Central African Republic,

the Democratic Republic of the Congo, Uganda, and Kenya. Its population was estimated at 11,088,796 in 2023. Juba is the capital and largest city.

The SS domain was delegated to the National Communications Authority in January 2019. The Registry website https://nic.ss/ is unresponsive. Registrations via international registrars appear to be possible at £ 70 for .COM.SS, .BIZ.SS and .NET.SS, with personal domains in ME.SS at a reduced price of £ 54.

Google returns 36 000 results for 128 .SS domains, or 281 per domain.

6.4.3 COMOROS (KM) – 231 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs-FoM	Internet Penetration	Total
KM	3	37	2	0	3	19	0	22	86

- International Bandwidth: [1 --> 2] 15
- Population: [0.8 / 0.2] 0.9
- Technology: [13%, 0.5%, 55]
- Cables (3): EASSy, LION2 (and Comoros Domestic Cable System and Avassa interconnecting the various islands)
- GNI: [US$ 790] US$ 1,485
- Internet penetration: [6.5%]25.4%

Out of 865 websites associated with the Comoros, we found only 14 locally.

Comoros has recently enjoyed a dramatic increase in international bandwidth. ITU figures show it increasing from 769 Mbps in 2016, to 5,000 Mbps in 2021 to 15,000 Mbps in 2022. This is due to the landing of the new 2Africa cable. The Comoros registry is managed by Comoros Telecom – the national incumbent operator in this Indian Ocean island state. There were no answers to the questionnaire from the Comoros. There were many options under which domains can be registered, as shown in the table below. Domains cost upwards of USD $68/ year. Of these, only EDU.KM, GOUV.KM, GOV.KM and ORG.KM were found by Google.

Table 7-3: .KM Sub-Domains

Sub-domain	Description
.km	Business and Trademarks
.coop.km	Cooperatives
.asso.km	Associations
.nom.km	Individuals
.presse.km	Media organisations
.tm.km	Trademarks
.medecin.km	Medical Professionals
.notaires.km	Legal Professionals
.pharmaciens.km	Pharmacies

.veterinaire.km	Veterinary Professionals
.edu.km	Universities and research institutions
.gouv.km	Government
.mil.km	Military

The Registry / Registrar website http://www.domaine.km has now ceased to function, giving a “Forbidden” message. Previously, we determined that domain registration takes place by completing a paper document, but there is no obvious address to send the application to. This is probably one of the reasons why there are so few domains, exacerbated by the low level of Internet penetration (only 6.5% in 2013 up to 25.4% in 2022), the lack of hosting facilities and the limited number of Internet service providers in the industry. Google indexes a total of 4 970 web pages under the KM domain, for 231 identified domains, giving 22 pages per domain.

6.4.4 GUINEA BISSAU (GW) – 399 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
GW	4	1	5	48 / 0	4	44	0	31	137

- International Bandwidth: [1 --> 27] 18.9
- Population: [1.7 / 0.2] 2.1
- Technology: 2%, 0.7%, 74
- Cables (1): ACE
- GNI: [US$ 550] US$ 780
- Internet penetration: 44%

Guinea Bissau signed an agreement to connect to the ACE submarine cable in March 2023. This is likely to have far reaching consequences to its economy and to democracy. In the short period since the cable was connected Internet penetration has increased from under 5% to 44%.

The Guinea Bissau registry is managed by the national telecom regulator – ARN (Autoridade Reguladora Nacional) in partnership with the Portuguese Associação DNS.PT, which is also responsible for managing the registry for the Portuguese ccTLD, .pt. There were 5 answers to the questionnaire from 3 people from Guinea Bissau.

Although the IANA database still has no URL for the registry, it was found that http://nic.gw goes to a well-designed landing page with both Portuguese and English language support. It appears that the administrators of the registry need to update the IANA Database with the correct Registry URL. The landing page and technical back end is run from Portugal (dns.pt) and runs EPP. It also offers both IDN and DNSSEC support, so is likely to also support IPv6.

There are 29 accredited registrars, and domain applications are also available directly, via a web front end. Web applications may take a few days before a domain is delegated.

Applications are accepted from anywhere in the world and domains are registered at the second level, although there is also a generic second level used by government (.GOV.GW). Several of the previous rules have been relaxed and providing a Citizen ID number is no longer required.

Connectivity has improved dramatically in Guinea Bissau with a penetration of only 3% recorded in 2013, but this is much higher today at 44% due to the recent availability of 3G broadband and competitive

backhaul connections to neighbouring Senegal and Guinea (Conakry), and the recent connect to the ACE submarine cable. Although low connectivity levels are likely to be a contributing factor, there is no immediately apparent reason why this ccTLD does not have more domains, especially considering the domain registration fee is relatively low, at USD $34. Google indexes a total of 82 300 web pages under 90 domains, or 866 per domain.

There were previously several very restrictive rules on who may register a domain, which no doubt restricted the growth of this domain. We look forward to seeing .GW grow in coming years.

6.4.5 GUINEA (GN) – 604 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs-FoM	Internet Penetration	Total
GN	6	18	4	10	8	27	0	15	88

- International Bandwidth: [4 --> 15] 42
- Population: [11.7] 14.2
- Technology: [2%, 2%, 73]
- Cables (1): ACE
- GNI: [US$ 470] US$ 1010
- Internet penetration: [7.9%] 18.6%

The administration of the GN domain is the responsibility of the National Centre of Fisheries Sciences of Boussoura, while the technical support is now provided in-country. There were no answers to the questionnaire from Guinea.

Domains are registered under the third level, with standard generic 2nd level domains of .GOV/.GOUV.GN, (unusually, they allow both) .COM.GN, .EDU.GN, .ORG.GN and .NET.GN. Applications are processed via email using a simple text form, which may be downloaded. There is a link to a web form, which links back to the text form. Registrations must be from organisations with a real presence in the country and with a demonstrable intent to use the domain name on a regular basis, and, as per RFC 2182, it is required that at least one secondary nameserver is on a different international backbone than the primary server.

Guinea's Internet penetration is not dissimilar to other countries that have many more domains. However, the cost of registering a domain is high – over USD $189. This is double the African average and given the low income levels in the country, lack of hosting facilities and high cost of connectivity, is likely to be a major reason for the low number of domains registered, especially when the requirement for in-country presence by the domain holder is considered. Google indexes a total of 2 760 000 web pages under 152 domains, or a very high 18 000 per domain.

6.4.6 LIBERIA (LR) – 503 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs-FoM	Internet Penetration	Total
LR	8	20	9	11	6	26	23	9	112

- International Bandwidth: [1 --> 6] 1.1
- Population: [4.3 / 0.8] 5.4
- Technology: [0.4%, 0.8%, 66]
- Cables (1): ACE

- GNI: [US$ 370] US$ 620
- Internet penetration: 14.9%

The official administrator of the Liberia ccTLD is a private company called Data Technology Solutions, while the technical contact and registration process are handled by Randy Bush. There were two answers to the questionnaire from Liberia and mail to the address listed in the IANA database for the administrative contact murey@liberia.net was returned undeliverable. As with Guinea, domain registrations require at least one secondary nameserver on a different international backbone than the primary server. In addition, registrations must be from organisations with a real presence in Liberia and with a demonstrable intent to use the domain name on a regular basis on the Internet. Applications cost about USD $122 and are made via email on a simple text form. Domains can only be registered under the generic second level domains of COM.LR, GOV.LR, EDU.LR, ORG.LR and NET.LR.

Liberia is in the process of developing a new national ICT policy and associated regulations which includes plans to redelegate the ccTLD according to ICANN procedures, to an official government structure, most likely the national regulator – Liberia Telecommunications Authority (LTA). This process will include a multi-stakeholder consultation process and a drop in charges for domain registration is expected, along with an agreed set of policies for the types of registrations that will be accepted[181]. However, at the time of writing, this does not seem to have happened.

Given the low level of communications infrastructure development in the country, which has suffered from decades of civil strife followed by the Ebola crisis, it is not particularly surprising how few domains have so far been registered under the ccTLD. Hopefully the recent efforts to improve local infrastructure, including plans for a metro fibre backbone, along with the new strategy for managing the domain, will improve prospects for registrations in future. Google indexes a very large total of 5390000 web pages under 143 domains, or 18 200 per domain.

6.4.7 NIGER (NE) – 947 DOMAINS

CC	ccTLD Domains	gTLD Domains	Webp ages	Price	Local Hosting		Registrars	IXPs FoM	Penetration	Total
NE	7	13	10	8	10	1014	16	0	10	78

- International Bandwidth: [2 --> 16] 7.4
- Population: [17.6 / 2.3] 27
- Technology: [7%, 0.6%, 43]
- Cables (0): Landlocked, Fibre connectivity is mentioned.
- GNI: US$ 410
- Internet penetration: 13.4%

Niger is a landlocked country in West Africa. Although the ITU shows it as having 7.4 Gbps of international connectivity in 2017 (all technologies), Hamilton Bandwidth Maps[182] states that it reached 18.8 Gbps in December 2020. There are two ISPS offering FTTP (Fibre To The Premises). However, Internet penetration remains low at 13%.

The administration of the ccTLD is managed by Sonitel, the incumbent state-owned telecom operator. There were no registrant responses to the questionnaire from Niger. The URL listed in the IANA database

[181] http://a4ai.org/november-23-2016-a4ai-liberia-meeting-to-review-ict-policy-2017-2021

[182] Niger: Niger's International Bandwidth Reaches 188 Gbps, December 2020 « Africa Bandwidth Maps

http://www.intnet.ne is broken. Nevertheless, some international commercial registrars appear to have negotiated with Sonitel for domain sales at relatively high prices, ranging from USD $230 to as much as USD $412 / year. Domains may be registered under the top level for the same price as domains under five generic second level domains - com.ne, org.ne, info.ne, int.ne and perso.ne.

Similar to Chad, considering the high prices for domains, the low level of ICT infrastructure development and low income levels of the country, along with the lack of a functioning domestic registrar, it is not surprising that Niger has so few domains registered under the ccTLD. Hopefully with the government apparently planning development of a national backbone and a more competitive market[183], the situation will improve if pricing for domains can be dropped. Google indexes a total of 364 000 web pages under the .NE domain, or 890 per domain.

6.5 REGIONAL & LANGUAGE RESULTS

It is readily apparent that the choice of a Domain Name is often a reflection of the language group in which the domain will be used. As connectivity in Africa continues to extend to the many people speaking the diverse range of languages on the continent, it is expected that the range of domain names in use and the choices available will continue to grow, especially in cultural and social activities aiming to reflect the particular language group or heritage. This potential appears considerable when it is considered that the number of African languages still spoken is between *1,250 and 2,100*, although by some counts it is over 3,000[184].

In terms of official languages, most African countries list one or two colonial languages, principally English, French or Portuguese. Ethiopia and Mali list no official colonial languages, and Mali, South Africa and Zimbabwe list a total of more than ten official languages each[185]while Nigeria has more than 400 unofficial languages. Almost half (48 per cent) of Sub-Saharan African countries have an African language that is spoken by over 50 per cent of the population as a mother tongue. Sixteen of Africa's cross-border languages have more than 150 million speakers. Outside the education sector, at least 56 African languages are used in administration and at least 63 African languages are used in the judicial system (26 sub-Saharan nations allow African languages in legislation). In written business communication, at least 66 African languages are used, and at least 242 African languages are used in the mass media.

The table below lists the nine languages which are both official languages and are national (or primary) languages in more than one country. It shows for how many countries a language is either an official language or a primary language, as well as how many people speak each language.

Table 6-2: Distribution of Official & Primary Languages in Africa

Language	Countries where an Official Language	Countries where a Primary Language	Population speaking language	% of African Population
English	24	20	1365134214	94%
French	21	19	1182605474	81%
Arabic	12	9	476740472	33%
Portuguese	6	5	200247985	14%
Spanish	1	1	114431269	8%

[183] Unpublished on-going research for ECOWAS by a Study member

[184] https://en.wikipedia.org/wiki/Languages_of_Africa https://unesdoc.unesco.org/ark:/48223/pf0000188642/PDF/188642eng.pdf.multi

[185] https://en.wikipedia.org/wiki/List_of_official_languages_by_country_and_territory

Swahili	4		76812754	5%
Sotho	1		55100586	4%
Somali	1		8791092	1%
Berber	2		1300557	0.1%

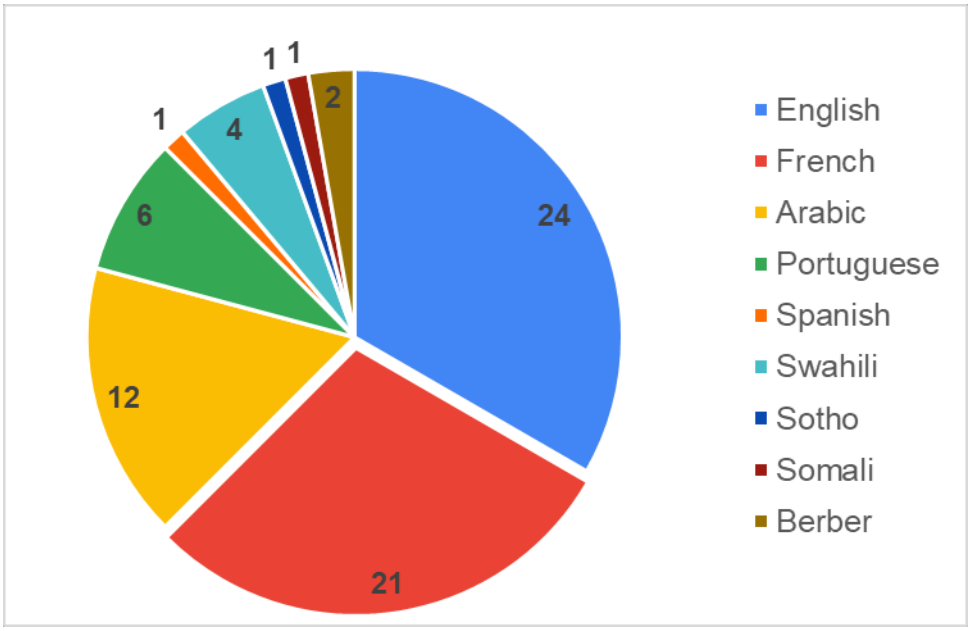
As is evident from the table above, a very high proportion of the population of Africa comes from a country where either English or French is an official or primary language (95% to almost 80% respectively), noting that this does not necessarily mean that 94% of the population of Africa speak English, only that they live in a country where this is one of the official languages.

The online survey was conducted in six of these nine major languages – the least common - Sotho, Somali and Berber were omitted.

6.5.1 CCTLD DOMAINS

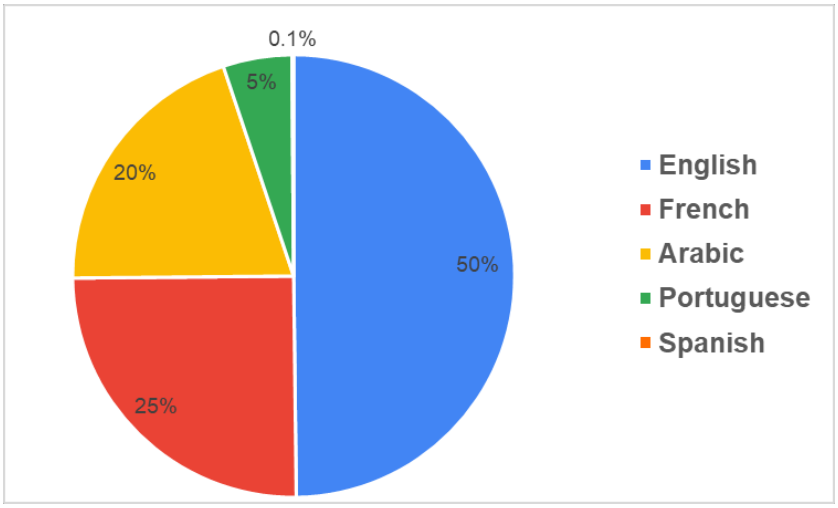
The analysis of the African DNS Industry by region and by official language was initiated with an examination of how many African countries use each of the six primary languages: Arabic, English, French, Portuguese, Spanish and Swahili. As can be seen, almost equal numbers of countries have English (24) and French (21) as their primary colonial language, followed by Arabic (9), Portuguese (5) and Spanish (1).

Figure 6-4: Official Language by Countries



In terms of population, 50% of the population has English as their first official language, followed by French at 25%, Arabic at 20%, then Portuguese at 5%, with a negligible number for Spanish speakers.

Figure 6-5: Official Language by Population



For the regional analysis, the study used the AFRINIC regions which divide its members into one of six Regions as depicted in Figure 6-4 below. These roughly reflect the regional economic groupings on the continent – North Africa, West Africa, Central Africa, East Africa, Southern Africa, and the Indian Ocean Island nations.

Figure 6-6: AFRINIC Regions Map

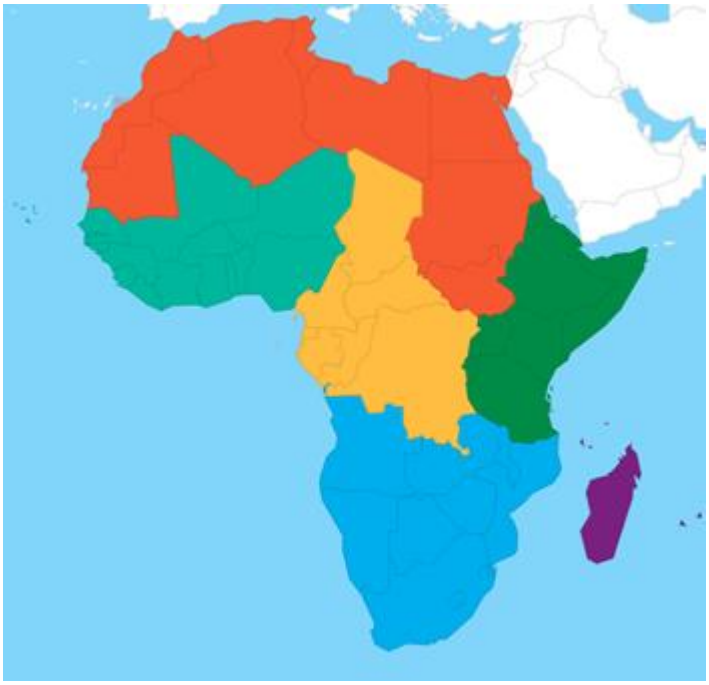


Figure 6-7: Countries by Region

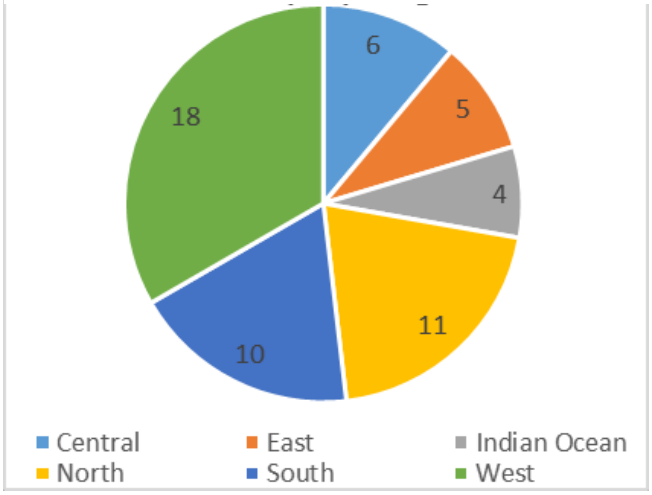
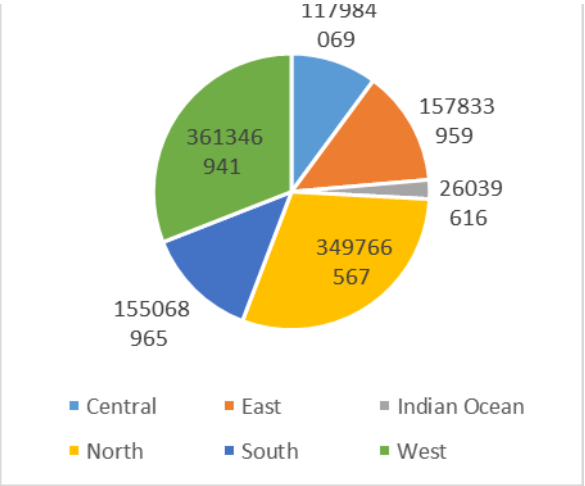
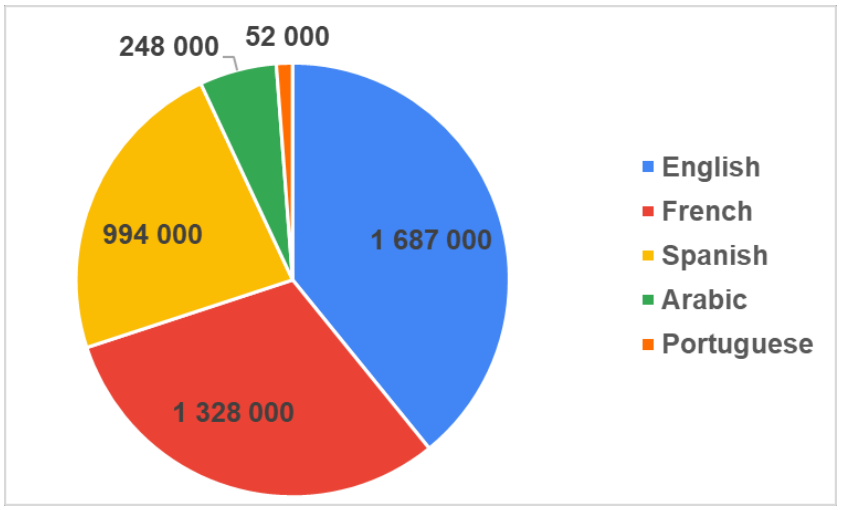


Figure 6-8: Population by Region



This Study's results show a significant shift in results compared to the 2016 Study. Results from the 2016 Study are shown in (brackets), with 39% (40%) of all African ccTLD domains analysed assigned to countries with English as its official language, followed by French with 31% (45%) Spanish comes next with 23%, significantly up from (9%) followed by Arabic with 6% (5%) and Portuguese trailing with only 1% (unchanged).

Figure 6-9: Domains by Official Language

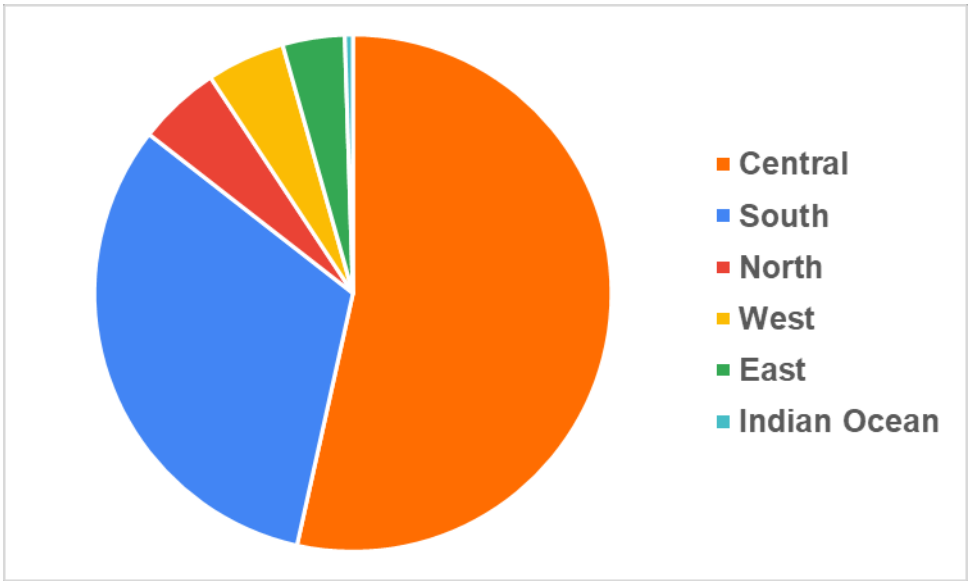


In considering each country's Main (most spoken) Language, we see Tigrinya come in with 80 domains found by Domain Tools, with the other results unchanged.

On a regional basis, Central Africa leads with 53% of all ccTLD domains registered, followed by Southern Africa with 32%. The large number of domains in the Central African region is because

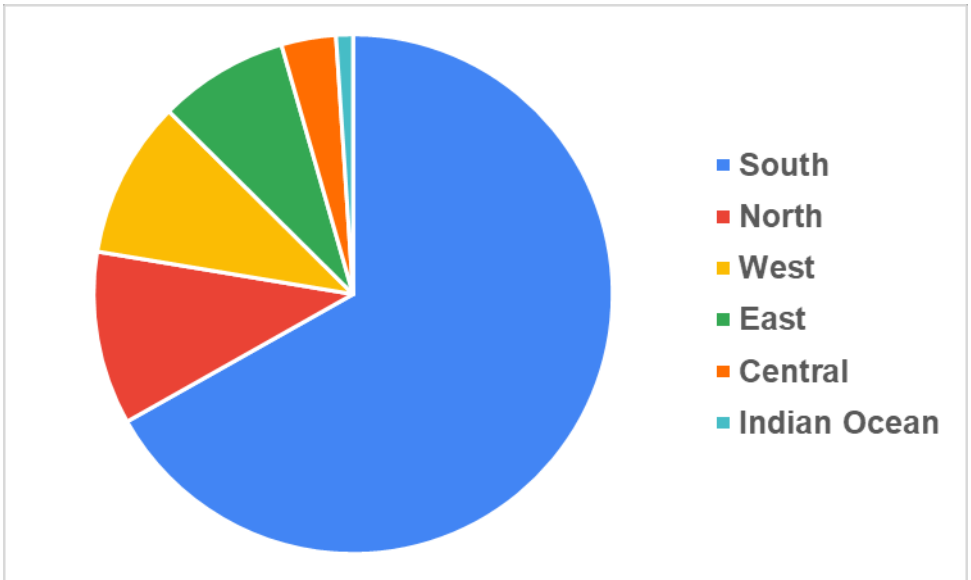
this region contains three of the internationally popular Freenom hack domain ccTLDs – Gabon (.GA) Central African Republic (.CF), and Equatorial Guinea (.GQ). See section 5.3.3 for further details on these domains.

Figure 6-10: All African ccTLD Domains by Region



Removing these 2.25 M domains gives a very different picture, with Southern African leading with 67%, followed by North Africa with 11%, West Africa with 10%, East Africa with 8%, Central Africa with 3% and the Indian Ocean islands with 1%.

Figure 6-11: African ccTLDs Domains, excluding Freenom countries.



More meaningful, perhaps, are the statistics of the number of domains registered per capita in each language group, excluding the four Freenom countries:

Figure 7-8: Domains by Language, Normalised

Figure 7-9: Domains by Region, Normalised

From the charts above, it is clear that English and Southern Africa dominate in both of these per capita measures, largely due to the influence of South Africa holding about 1/3 of all ccTLD domain names in Africa.

6.5.2 GTLD DOMAINS

In addition to the ccTLD data discussed above, the over three million gTLD domains provided by Afilias and other sources were also extensively analysed for language characteristics. Every domain was checked for the existence of a website, and if so, of a substantial website (i.e. more than just a placeholder). A number of parameters of each domain were analysed and recorded, including the language indicated by the HTML tags within the websites found. Only about 20% of the domains had a “real” website with a valid Language Tag, and it would appear that quite a few of those were in error, with a number of single websites having strange languages specified, such as Haitian Creole (ht) or Welsh (cy). Interestingly, 334 were tagged as Thai (th) and 603 as Vietnamese (vi), for example.

Table 7-4: gTLD Websites sample analysed with Language Tag

DESCRIPTION	DOMAINS	%
Total gTLD Domains analysed	4 585 788	
Total websites	2 302 625	50%
"Real" websites	936 751	20%
With Language Tag	938 852	20%

A total of 938 852 websites with apparently valid Language Tags were identified. These covered a total of 115 languages, of which 23 can be considered “African”. Excluding six “colonial” languages, that leaves websites in 17 indigenous African languages. These research results are indicated in the following graphics.

Figure 7-10: gTLD Website Language Distribution

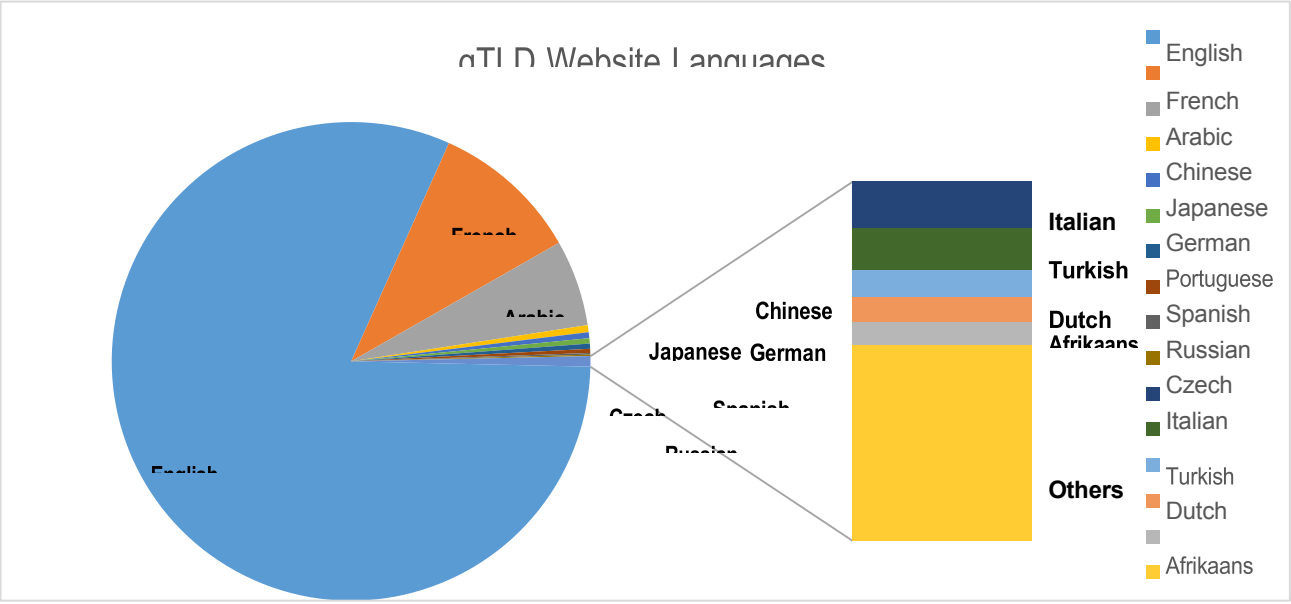
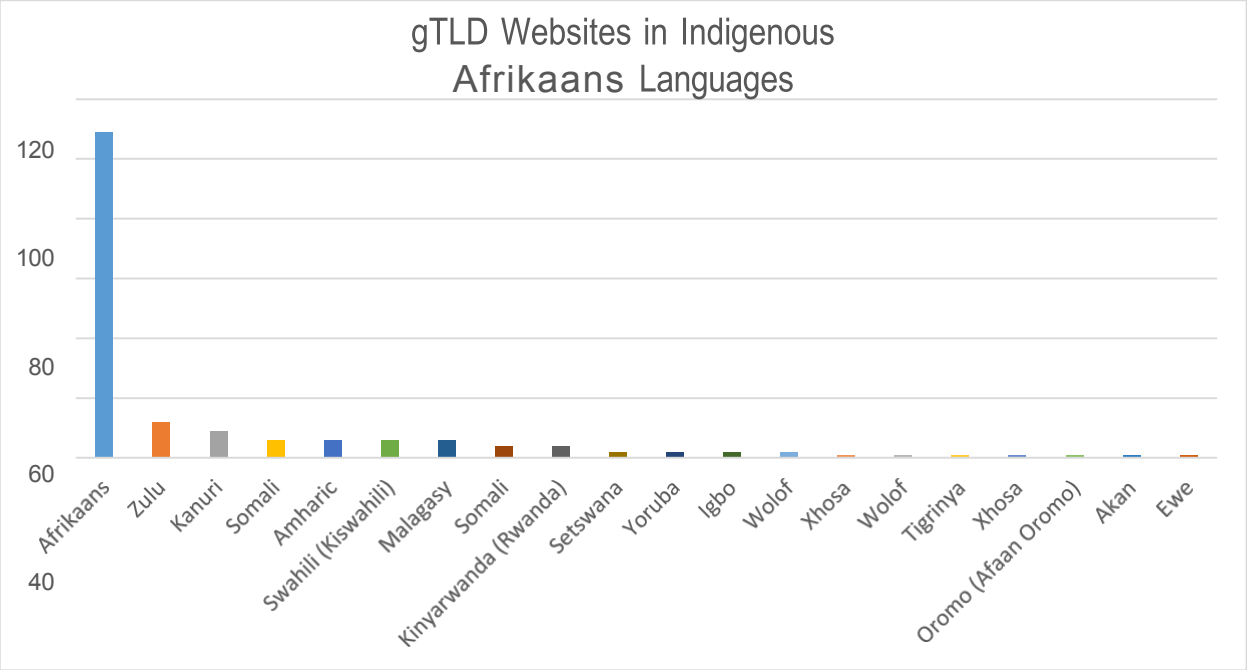


Figure 7-11: gTLD Website Indigenous Language Distribution



7 KEY SUCCESS FACTORS – REGISTRIES & REGISTRARS

The data from the DNS Study shows that 92% of the respondents who intend to register a domain in the coming twelve (12) months, would prefer to use the local registrar. The goal of the national registry is to convince the local Internet community to utilize the ccTLD for their web portal and email addresses. This goal can be supported by requiring government and public sector entities to register a local domain name. In this regard many African ICT policy makers and/or regulators have issued resolutions to adopt local domains for government-related e-services.

The African Union considers the use of the Country Code Top Level Domains (ccTLDs) and the Africa Top Level Domain (.AFRICA) to be important to promote and support the development of the local Internet ecosystem. Hence, the Addis Ababa Declaration on Information Communication Technologies adopted by the Summit of the African Union Heads of State and Government held in Addis Ababa in January-February 2010 directed the Commission to promote better utilization and management of critical Internet resources. Furthermore, The Extraordinary Session of the African Union Conference of Ministers in charge of Communications and Information Technologies (CITMC) held in Johannesburg in 2009 acknowledged the benefits of the dotAfrica domain name to Africa and adopted a resolution (in the Oliver Tambo Declaration) to "Establish dot Africa as a continental Top-Level Domain for use by organizations, businesses and individuals with guidance from African Internet agencies".

The AU developed and published “The DIGITAL TRANSFORMATION STRATEGY FOR AFRICA (2020-2030)” which recommends the following policy to support local domains:

“Mobilize and capacitate Accredited Registrars in Africa and develop future growth strategies with the aim of growing the African ccTLDs and dotAfrica (.AFRICA).”

Further, for the private sector, the national registry should have a marketing campaign to populate the local domain. The campaign needs to highlight the benefit of using the local domain. One of the strongest points is approaching academia to have an SLD (.ac.ccTLD) to be globally recognized and benefit from the services provided exclusively, or with considerable discount, for educational institutes. It’s also important for academia to use the .ac.ccTLD domain for the certificate verification systems.

As we have seen, Africa is a highly diverse region, with DNS Industries ranging from the highly developed, highly sophisticated, and very dynamic at one end of the spectrum to the most rudimentary at the other. It is also a challenging environment economically and in development terms, with much poverty and instability, but with growing prospects for growth and political stability. The African DNS industry remains very small, with a mere 4.5 domains per 1000 people, compared with more than 100 in most other regions of the world. Yet this industry is growing fast in some places.

In the context of Africa, based on the preceding discussion in this report a number of key issues can be identified for engagement and action by Registries.

7.1 PRICING

It is clear from the analysis elsewhere in this report that high local prices for Domain Name registrations are a leading inhibitor in the uptake of local Domain Names. The burgeoning of Freenom registrations is clearly since they are free. Similarly, despite a clear preference by users for local suppliers and local Domain Names, the fact that these sometimes cost fees that are many multiples of international Domain Names prices, is clearly also an inhibitor. The fact that the average cost to register a Domain in Africa is $102, compared to about $10 for a .COM domain speaks for itself. From the 2023 figures they are an average of $161 via a foreign Registrar, versus about $14 for a .COM domain from the same Registrar. It should be noted that domains bought via a local Registrar are often significantly cheaper, averaging $30.

High prices for domain names are a clear inhibitor.

By reducing pricing for DNS registration to align with local affordability and international tariffs, the short-term losses clearly are going to be compensated for by a greatly increased uptake for local Domain Names - the countries with the highest revenue have the lowest (non-zero) prices.

7.2 PAYMENT GATEWAYS

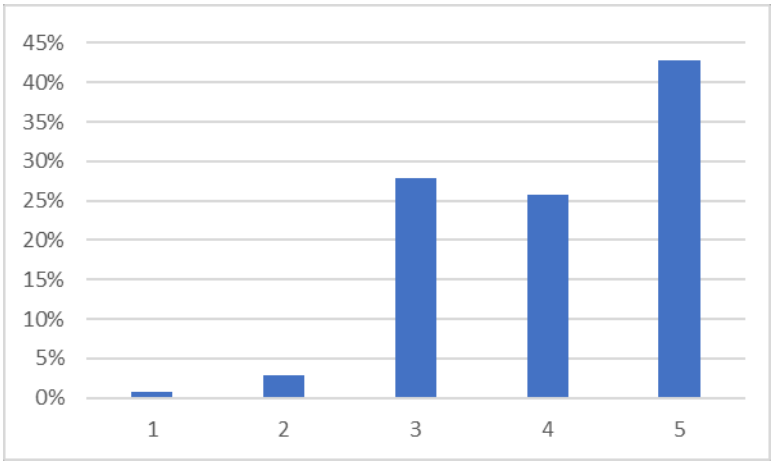
The analysis of responses to questions regarding the user experience of the DNS ecosystem indicates an overwhelming preference (94% of Respondents) for electronic payment channels (bank transfers, credit or debit cards, mobile money, and PayPal). Respondents also ranked the absence of easy payment methods as one of the key barriers to growth in the DNS industry.

The solution is in the hands of the Registries and the Registrars to implement properly functioning payment gateways to ensure easy payment of fees, which will in turn facilitate the uptake of local Domain Names.

7.3 EASY-TO-USE REGISTRATION SYSTEMS

As we saw, just over a 2/3 of Registrants responding to the user experience section of the questionnaire were able to describe their registration experience as “intuitive, automated [or] user-friendly”. This is a doubling compared to the 2016 Study. Similarly, respondents listed slow processing time as the third biggest challenge to development of the DNS industry, and quality of technical support as the fifth most significant difficulty.

Figure 7-1: Responses to Ease of Domain Name Registration Question



Source; Analysis of Online Survey responses. 1 = Hard, 5 = Very easy.

Once again, the solution lies directly in the hands of the Registries and the Registrars. Ensuring that the systems and processes required to register Domain Names are readily accessible, simple, easy to use, as well as robust and efficient may require some investment of time, money, and person-power. But it is likely to be repaid in the growth of the local DNS industry and in greater uptake of local Domain Names.

7.4 PROVISION OF INFORMATION

Another inhibiting factor in the development of the local DNS industry is the lack of online access to information and registration, in their local language of preference, by Registrants regarding the choice of Domain Names available to them, and the process to be followed to register their choice of Domain Name, along with cost and reduced turnaround time.

Registries and Registrars need, therefore, to ensure that all the information (including contact details and pricing) necessary to enable Domain registration is clearly visible and available online, in all local languages, and via a variety of channels. Active marketing is likely to be helpful in this regard.

7.5 ZARC CASE STUDY

7.5.1 ABOUT ZARC

The South Africa Registry Consortium (ZARC) is the largest registry operator in Africa with 27 years of domain name administration and management services experience. ZARC is a consortium between the ZA Central Registry (ZACR) and Domain Name Services Pty Ltd (DNS-ZA.

ZARC was appointed as the new registry administrator for the four commercial .za second-level domains (SLDs) on 1 October 2022 by the .za Domain Name Authority (ZADNA). This appointment affected the administration of co.za, net.za, org.za and web.za domain names and their Accredited Registrars.

Besides this, historically, ZARC, in collaboration with its partners, has prioritised expanding internal institutional capacity while implementing world-leading business methodologies. The latter include long-term partnerships with the best available technical talent. Key to ZACR's continued success in registration numbers is the now bedded-down city domains of .JOBURG, .CAPETOWN and .DURBAN. The AFRICA domain, operated utilising the same systems and partners, is very much in demand with over 62,000 registered domains on record.

7.5.2 KEY EARLY SUCCESSES

One of the early success factors of ZACR (as UniForum SA) was early automation of its processes and systems. This allowed for ease of access to domain name products, improved quality of service and delivered consistent solutions that built trust and loyalty among domain name users. In June 1992 bksinc.co.za became the first domain to be registered under .CO.ZA which had been delegated to UniForum SA to run. By 1994, when South Africa became a democratic country, a mere 450 .CO.ZA domain names were in existence. UniForum SA took over the CO.ZA Domain name system in September 1995. Today, ZARC, (with the same heritage as “UniForum SA”, ZARC and DNS-ZA to better reflect its responsibilities), has continued to develop, maintain, and operate an efficient Central Registry that administers over 1.3 million domain names, over 95% of which fall under .CO.ZA.

An interesting reflection on perhaps the success story of the CO.ZA registry is that it grew its staff according to its income. Initially, it was calculated that one bookkeeper working for half a day each day of the week would be paid R3,500 a month – based on one new domain a day priced at R200 per domain. However, there were initially two new domains a day. A key factor that has contributed to ZARC being the largest and most successful registry in Africa is that it sized the organisation according to the available income. Only when there was a sufficient income did it employ full time staff. Additionally, it never received government

subsidies of any kind. In fact, the reverse is true: ZARC has sponsored government officials to attend ICANN and AFRINIC meetings to enable them to learn more about the domain name industry. ZARC has over the years been instrumental in supporting the South African and greater African domain name industry through skills development initiatives and smart corporate social investment initiatives [186].

7.5.3 ZARC DOMAIN COUNT

Table 7-1: ZARC domain count: around 1.44 M in Nov 2023 compared to <1.125 M in Jan 2017

#	Namespace	Domain Total 2016	Percentage of Total 2016	Domain Total 2023	Percentage of Total 2023	Difference
1	CO.ZA	1,076,254	95.891%	1,335,604	92.9%	259,350
2	.ORG.ZA	32,560	2.901%	25486	1.7%	-7074
3	WEB.ZA	1,805	0.161%	1375	0.1%	-430
4	NET.ZA	1,432	0.128%	2315	0.2%	883
5	CAPETOWN	4,561	0.406%	4228	0.3%	-333
6	JOBURG	3,344	0.298%	2954	0.2%	-390
7	DURBAN	2,419	0.216%	2361	0.2%	-58
8	.AFRICA	0	0	62716	4.2%	62,716
	Totals	**1,122,375**		**1,437,039**		**314,664**

As can be seen, the CO.ZA domain dominates the .ZA ccTLD, largely because of its early automation and its simple rules and processes for registration of domains. In 2014, the organisation also assumed responsibility for managing the registry function for the following three City TLDs: .CAPETOWN, .DURBAN and .JOBURG. In 2017, .AFRICA was also added. These were a result of the second initiative by ICANN to increase the number of gTLDs available. This issue has been a long time in the genesis, and the subject was raised at the second IGF meeting in 2007, for example .

From 2005 to 2015, ZACR/UniForum S.A. gave free training on DNS to about 500 local participants. There were two courses, the "DNS Intro Course" and the "DNS Advanced Course" (which included DNSSEC). They were both given every six months, the Intro course followed by the Advanced Course. Courses were presented in Johannesburg and Cape Town. If the Intro Course was in Johannesburg in the first half of the year, then the Intro would be in Cape Town in the second half of the year. The DNS Training courses were resumed in 2021 but are now under the financial management of the ZADNA, so are not scheduled as frequently as before.

Table 7-2: Key Success Factors for ZACR

Key Success Factor	Impact on DNS industry

[186] E.g. https://www.fid.org.za/about-us/our-partners/43-coza-cares-foundation

Policy certainty	ZARC enforces policies that ensure users are protected. This has resulted in increased confidence in the business and its products, which ultimately leads to increased use of South African domain names. Users are confident that disputes will be resolved speedily, and unnecessary conflict will be eliminated. Consulting the market is at the forefront of ZARC's policy formulation processes. Both local and international industry players are consulted to ensure that the organisation benchmarks itself against best international practices.
Pricing	The domain name pricing in South Africa is very competitive in relation to other countries and registries. There is a concerted effort to keep the wholesale price affordable for all and this has contributed to the growth of the domain name space in the country.
Market access	It has always been quick and easy to register a CO.ZA 2LD domain name. With the move to the 3R model with multiple registrars providing a competitive registration environment, registering a domain name is even easier and more convenient. Currently ZARC has over 450 registrars primarily in South Africa but also in many other countries.
Strong technical competence	ZARC's EPP Registry system is based on open standards and incorporates current world best practices and has been further enhanced to cater to the needs of the ZARC stakeholders. The organisation prides itself in having strong, reliable, safe, and secure technological infrastructure that has resulted in increased trust levels from the Internet community.
Political freedom	The ZARC is not a government entity and the model followed in the management of the domain name business is that of Registry, Registrar and Registrant. The Regulator (ZADNA) is a new player to the South African domain name industry due to the political importance of the ZA national identifier. The Electronic Communications and Transactions (ECT) Act of 2002 established this regulator for the purpose of assuming responsibility for the .ZA domain name space. However, the ZARC is a separate independent entity. There is however collaboration between all industry players and government which embraces and encourages freedom of expression on the Internet. Government does not prescribe which services are provided on the Web, which technologies are used, or what kind of content will be available. The result has been an innovative and competitive environment for the domain name space.
Training	The ZARC has in the past trained network operators in the intricacies of the DNS system, which has resulted in an increase in skill levels and ultimately in the demand for domain names.
Marketing	The ZARC engages in use of social media, above the line and below the line marketing and advertising to promote uptake of DNS names it offers

7.6 SUMMARY OF BEST PRACTICE RECOMMENDATIONS FOR REGISTRIES

- Based on the research undertaken and confirmed by this Study, the following recommendations are made:
- Ensure that contact details at IANA are up to date and that the landing page URL is correct – which should ideally be https://www.nic.[ccTLD].
- Ensure that the information Registrants need is easily found from the Home Page.
- Have an information page on who the registrars are and how to become accredited.
- Run a 3R model.
- Run EPP Software, or software of a similar nature that allows for automation.
- Provide a WHOIS system.

- Keep pricing per domain to be within ±$5 of the cost of a .COM domain.
- Only employ full time staff once sufficient income is available. Do not appoint a Board of Directors, for example, who need to be paid. Keep things on a volunteer basis until the Registry grows.
- Allow payments to be made electronically, including by credit card.
- Allow international registrars and registrants.
- Keep the rules of registration simple – allow people to be creative with the names they choose.
- Keep to a simple pricing structure - don't discriminate against international registrants.
- DNSSEC Sign your ccTLD (and any second level Domains) – and allow customers to also add the appropriate DNSSEC records.
- Run everything dual stacked (IPv4 and IPv6) and support IPv6 glue records (as well as IPv4 glue records)
- Ensure that you have three to five Name Servers. One primary, usually on the ccTLD's premises and several secondary name servers, each on a different network and in a different geographic location. Consider using an Anycast DNS system for the secondary name servers to improve lookup speed, resilience, and reliability. We suggest all three of the options below are used:
  - One from AFRINIC.
  - One from the ICANN DNS Observatory; and
  - One of the commercial providers.

8 GROWTH OUTLOOK

In calculating the growth of African domains, the Study made use of several sets of data: extracts of gTLD zone files where the Registrant had some African identifying data from Afilias, PIR or other sources; Zone files from twelve countries; and summary ccTLD totals from DomainTools.com, MyIP.ms and ZoneFiles.io and elsewhere. In the first three cases, domain names with creation dates were available. The DomainTools data is simply a snapshot of domain counts. We were fortunate enough to have a very large data set of these, which allows us to estimate growth. There was a considerable increase in African ccTLD domains registered during this period. In 2016, almost all of these came from the four Freenom countries, almost all of which are hosted outside Africa and therefore contribute very little to either the growth of the Internet industry in Africa or the GDPs of the countries involved. Freenom is in the process of being closed down by ICANN, yet we still see a sizable increase in domain numbers.

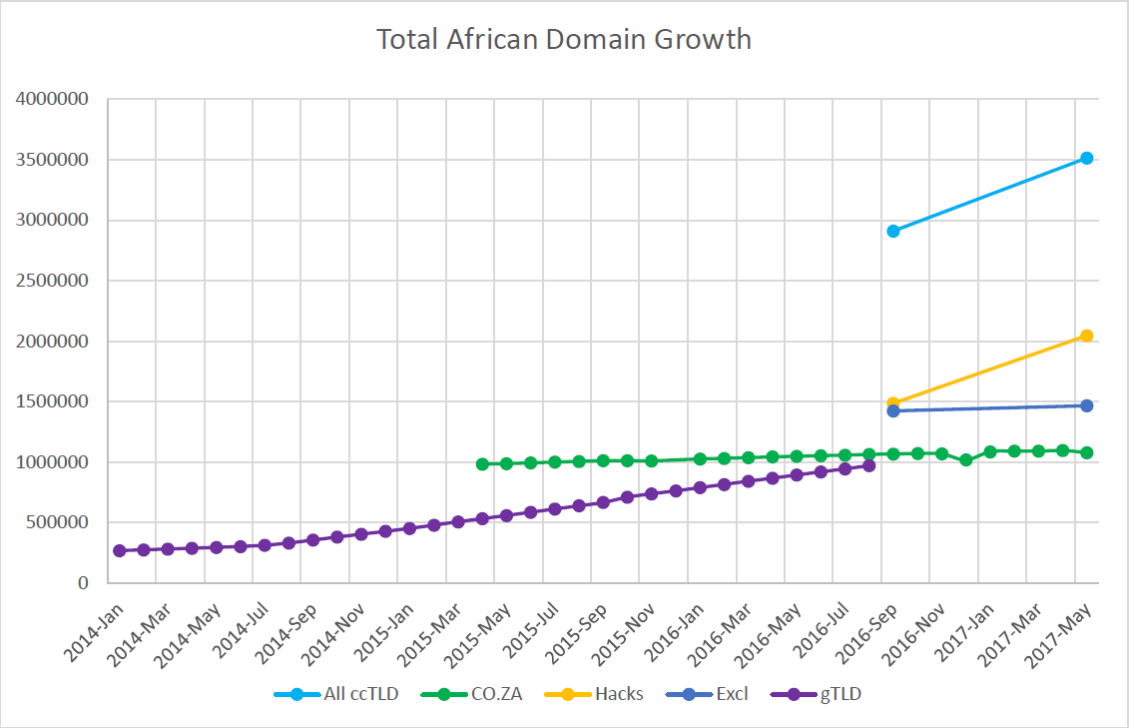
Annualised growth figures for the various categories of domain names are shown in the table below with the latest available total numbers, and the totals depicted graphically in the chart following.

It is worth noting that between the two studies, although the numbers have gone up, the CO.ZA zone lost 556,681 domains. These names were never renewed or re-created after they were deleted. There are also currently 8,076 CO.ZA Domains that are “broken” (e.g. The Child Nameservers no longer respond) which is actually a very low proportion (0.67%).

Table 8-1: Domain Growth Rates

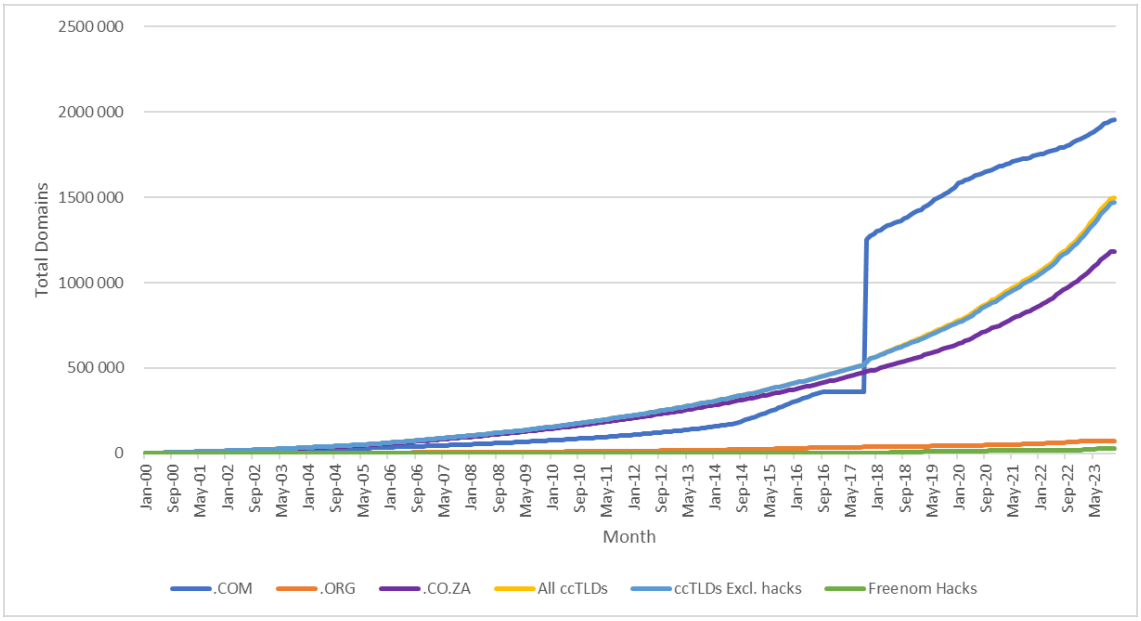
Category	All ccTLDs	CO.ZA	Hacks	ccTLDs Excl. Hacks	gTLDs
2017 Total	3 514 833	1 080 375	2 047 369	1 467 464	972 406
2017 Growth	31%	5%	56%	5%	52%
2023 Total	4 135 803	1 193 040	1 510 141	2 249 179	2 560 351
2023 Growth	18%	10%	-26%	53%	163%

Figure 8-1: Total Domains by Category - 2017



At the time of 2016 Study, it appeared that gTLD registrations would soon exceed CO.ZA domains. This did indeed happen, as shown below.

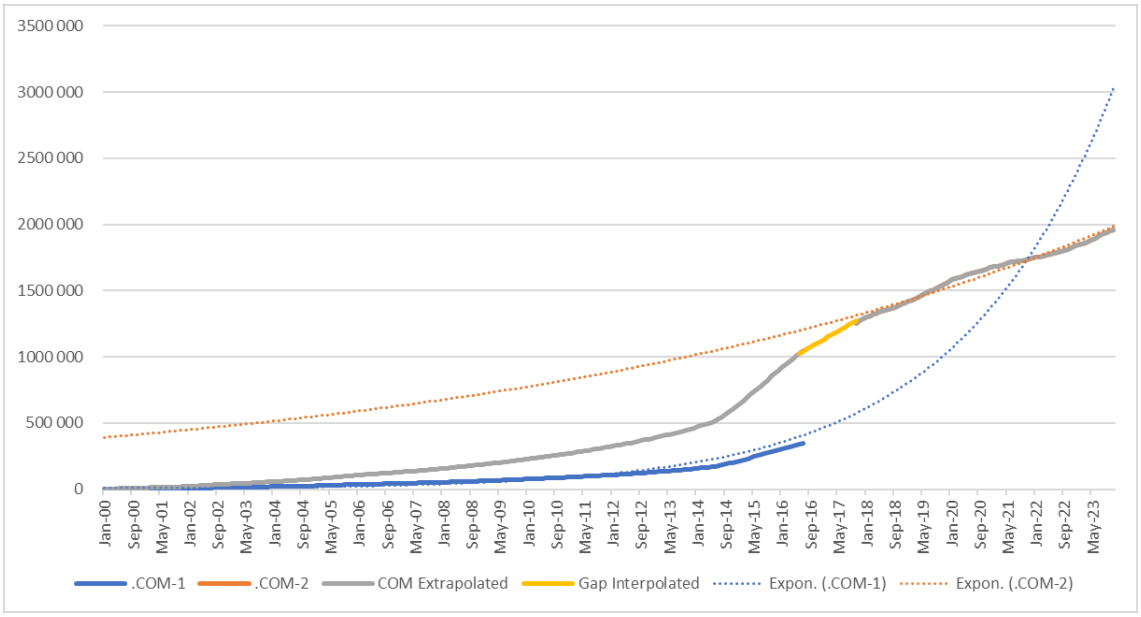
Figure 8-2: Total Domains by Category - 2023



Something odd has happened with the .COM domains collected by our various sources – presumably a change in methodology. Indeed the monthly rate of new .COM domains detected more than doubles between September 2019 and November 2017. The step

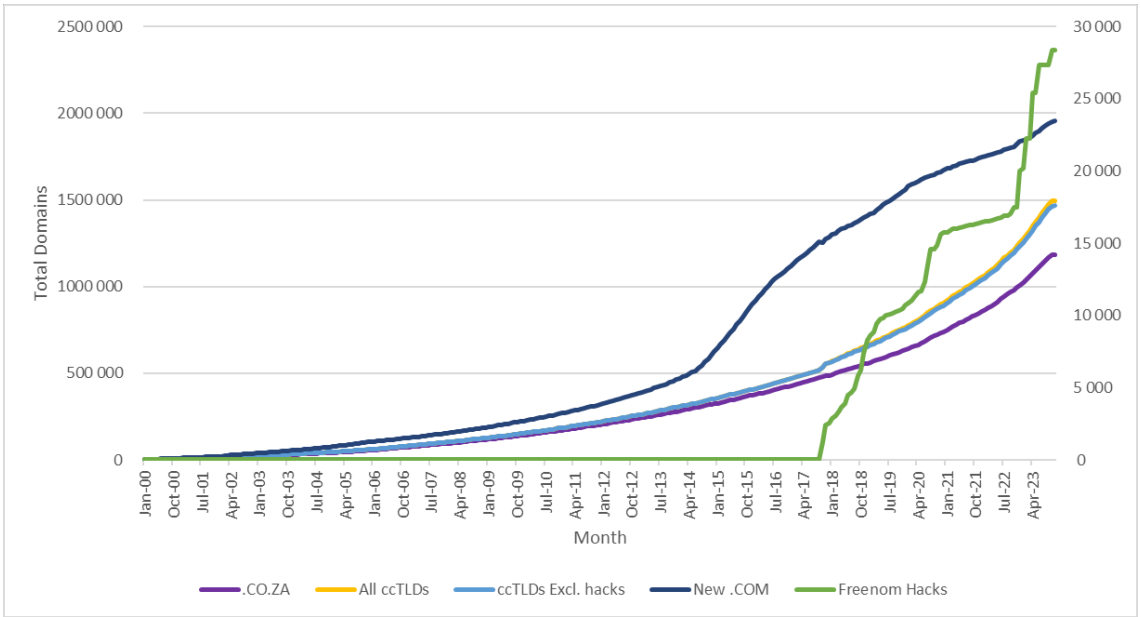
change clearly visible accounts for the number not collected during this period. We modelled this as shown below.

Figure 8-3: Model of Change in .COM Domain Detection Methodology



Combining these, we get a more sensible looking graph,

Figure 8-4: Total Domains by Category, corrected .COM - 2023

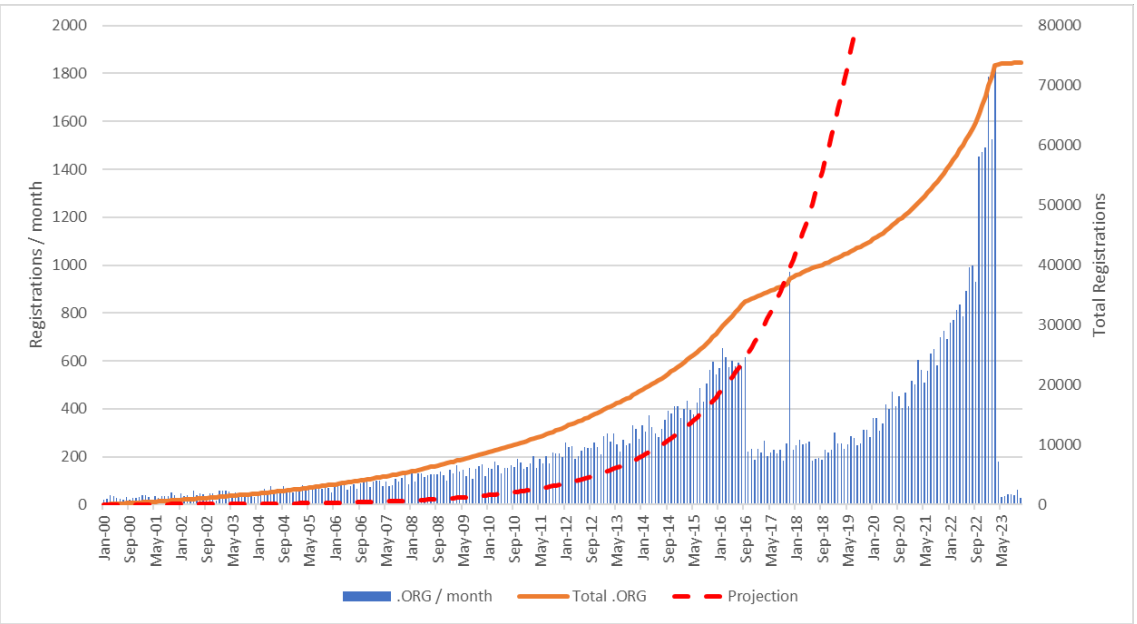


As can be seen in Figure 9-1, African gTLD domains still have not overtaken .CO.ZA domains, the largest single category. The CO.ZA zone is the largest in Africa, and one of

the oldest, with registrations dating from June 1992[187]. As a result, its growth has matured and become almost linear. Future growth in CO.ZA may be linked to economic growth as well as increasing Internet uptake.

However, the growth in domain names generally in the African region seems to have accelerated significantly over the last few years. This is clearly illustrated by the figures for African registrations of .ORG gTLDs, below.

Figure 8-5: Rate of Registration of .ORG Domains



The red dotted line is the projection made in the 2016 Study. As can be seen, African sales of .ORG domains collapsed in 2017, before recovering from 2021.

Other ccTLDs are growing at 4.5%

Aggregating the ccTLD and gTLD figures gives an average growth rate of 33% per annum in domain names. There is thus considerable market potential for domain name sales over the next three to five years in Africa. It is likely that the current very uneven Domain Name Industry in Africa will continue for some time, until most countries reach suitable levels of Internet penetration, infrastructure, and income levels. As this is likely to take some time – perhaps decades - some countries will still have their growth before them, while parts of the continent will be on the steep part of the "S" curve of growth, even when others have reached the growth plateau and are only growing at a rate constrained by GDP growth, as South Africa now is.

[187] https://www.registry.net.za/downloads/early_coza_registrations.txt

A note of caution: the headline figure of 33% growth in African domain names hides the perhaps more significant but far less impressive growth figure of less than 5% for other ccTLD domains.

9 ESTABLISHING A DNS OBSERVATORY IN AFRICA

An African DNS Observatory has been spoken about for numerous years now.

Recognising this, ICANN's 2014 Africa Strategy envisaged, inter alia, the establishment of an "observatory to develop new indices for DNS industry growth in Africa"[188].

This has also been mentioned in the African DNS Market Study 2016[189] and the project team have since noticed (July 2023) a French-backed development[190].

An observatory in its simplest form, could collect, collate, and analyse quantitative data from African zone files and Registry databases (ccTLD, gTLD and IDN) to measure and quantify the DNS market, and thereby track trends, such as (a) Domains, (b) Websites, (c) IPv6 and (d) DNSSEC Growth.

The Trial DNS Observatory is part of Milestone Three of this project and will be presented as a separate document then.

[188] https://www.icann.org/en/system/files/files/africa-strategic-plan-20oct18-en.pdf

[189] https://www.icann.org/en/system/files/files/africa-dns-market-study-final-06jun17-en.pdf

[190] https://www.onda.africa/

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS AND RECOMMENDATIONS FROM THE STUDY

10.1.1 FINDINGS: UNDERSTANDING AFRICA'S INTERNET ECOSYSTEM

ICT Infrastructure is an important indicator to measure the development of a nation. This includes penetration of fixed and mobile networks, broadband networks, optic fibre, submarine cables, satellite links, Data Centres, IXPs, Digital Broadcasting, and smart devices. All those are needed, as are affordable Devices and ICT services.

Statistics from various organisations show a noticeable enhancement in Internet usage in Africa. With about 600 M Internet users the penetration reaches 43%[191]. However, due to the high diversity, there is an imbalance in Internet user's numbers. For instance, Kenya has 85.2% while South Sudan and Eritrea have only 7.9% and 6.8% Internet penetration respectively. This gap has widened since the last study in 2016/ between the leading and the underperforming countries.

The cost of access remains the highest in the world compared to the average expense measured by GDP/Capita. This is due to the high usage of mobile data over other affordable technologies. In Africa, over 75% of Internet traffic comes from mobile devices, with the only exception in Eritrea where mobile data is restricted by the government.

Like Internet penetration, the price of mobile Internet varies greatly between African countries. Mobile data costs less than a dollar in 12 African countries including Libya, Ghana, Somalia, Morocco, Nigeria, Tanzania, Sudan, Kenya, and Egypt. These all come out well below the continent's average of $3.51 per 1 GB.

Nevertheless, more than half of Africans are still disconnected, with connectivity spread unevenly across the continent. And those who can connect often still only do so through expensive, unreliable connections.

The cost of access in Africa is very high.

In the first decade of the 21st century, the mantra "Africa Rising" became popular. However, the 2008-2009 financial crisis reduced Africa's prospects due to a substantial decline in demand for raw materials, which is still a primary source of foreign exchange in many African countries. "Africa Rising" became "Aspiring Africa". While growth levels are not as high as they were, they are nevertheless still very attractive. Some of the relevant metrics are: -

- Internet penetration grew from 29% to 43% in five years.
- Smartphones doubled to 226 million over the last two years; (Need updated figures)
- More than 2/3 of African countries had 10 or more years of uninterrupted growth.
- There are 314 Innovation Hubs in 42 African countries.
- 200 Tbps of international submarine capacity is installed.

Except for Eritrea, all other 37 African countries that have a seashore also have at least one submarine cable landing. For landlocked countries, setup of an IXP and peering with neighbours is essential to be able to provide affordable Internet service. Of the 16 African landlocked countries, only the Central Africa Republic has not yet setup an IXP. However, in terms of IP resources, Africa only accounts for 116 M IPv4

[191] https://www.internetworldstats.com/stats.htm

(3.14 %) addresses, 692 M (2.38%) IPv6 addresses, and 2,413 (2.09%) ASNs out of the total global allocation[192].

As of October 2023, there are 63 IXPs located in 38 African countries. This means there are still 16 countries that use international links for their local traffic. In contrast, there are 19 African countries that set up more than one IXP with South Africa leading this group followed by Tanzania with 7 and 5 active exchanges respectively. The N'Djamena Internet Exchange Point in Chad is the latest established IXP that serves 16 local members starting from February 2023.

During the last year, 7 African authorities suspended Internet services either completely or partially. Fortunately, even this is better than in 2021, when 12 countries disrupted the Internet 19 times.

This decrease can be seen as a development of citizen's rights and the rule of law. This assumption can be supported by 3 case scenarios from different African countries.

In Nigeria in 2021, the government announced a nationwide shutdown of Twitter. The Economic Community of West African States (ECOWAS) Court of Justice declared the shutdown to be “unlawful and inconsistent with the country’s international obligations” and ordered the government “to ensure the unlawful suspension would not reoccur and to take necessary steps to amend its laws to be in conformity with the rights and freedoms enshrined” in international law. The government has refused to promise that such violations will not happen again though no network disruptions were reported during Nigeria’s general elections.

In Sudan, following a military coup and subsequent protests, the government shut down the Internet in October 2021. A Sudanese court ordered the country’s telecom firms to restore access, but this did not stop the authorities from once again shutting down the Internet in June 2022, ahead of planned protests. Most recently, the Internet was cut off on April 23 during the ongoing violence in Khartoum between the army and the Rapid Support Forces, according to NetBlocks, a cybersecurity monitoring organization. NetBlocks also reported that the military claimed that paramilitaries “sabotaged the telecom exchange in Khartoum.”

In Zimbabwe, the government shut down the Internet for three days in January 2019 to quell citizens’ protests against rising fuel prices. Later that week, the government requested that telecommunications companies implement a second shutdown, but a judge ruled that the shutdown was illegal, forestalling further government action. However, this did not prevent authorities from ordering another round of shutdowns in July 2020[193].

Analysing the volumes of web page content as indexed by Google shows that 66% of 640 million indexed pages is in just ten African countries. This is a significant spreading from 2016, when 75% was in just seven countries. While specific analysis of e-government initiatives in Africa was not covered in this research, the study recognises that such services have been a crucial means in many countries across the world to increase local content on the web and to ensure content is relevant and available in users’ language of preference.

The research further notes the potential for growth in the e-commerce market in Africa – in particular in relation to small, medium and micro enterprises. Currently, use of e-commerce by SMEs in Africa remains low. The current share of consumer e-commerce by African enterprises, for example, is currently below 2%,

[192] https://www-public.imtbs-tsp.eu/~maigron/rir-stats/rir-delegations/rir-stats-by-zone.html

[193] https://carnegieendowment.org/2023/04/25/how-africans-can-prepare-for-internet-shutdowns-pub-89595

but has ‘enormous potential’ estimates says that by 2028, the African e-commerce market is projected to reach USD $45 billion, from just USD $8 billion in 2013.

10.1.2 THE AFRICAN DNS INDUSTRY

As for other regions, all African countries have country code Top Level Domains (ccTLDs) assigned by IANA. The newest African ccTLD is the South Sudan Domain (.SS), allocated in 2011 following the country's declaration of independence. However, it was not added to the DNS root zone and was thus not operational until 2019, with general availability starting in 2020.

Since the last African DNS Study conducted in 2016/2017, both Eritrea (.et) and Comoros (.km) haven’t shown progress regarding the availability of the registration service online.

Most Africans have a single Registry for their ccTLDs, widely known as the 2R model. However, the privatization in the DNS market is slowly moving toward the recommended 3R model for Registry, Registrar, and Registrants. As usual, South Africa leads the open competition in the DNS industry with 622 accredited registrars (460 in ZA)[194] followed by Nigeria with about 100 registrars.[195] For the Registrant Market, over 2 million African ccTLD domains were identified, plus some 2.1 million gTLD domains with an African Registrant. This equates to some 4.4 domains / 1000 population, whereas some commentators have observed that 100 – 300 domains / 1000 population is the norm in Europe. Nevertheless, despite its small size relative to other regions, this is still a valuable market, bringing in an estimated total value of USD $38 million per annum for African ccTLD domain names alone, and a total of USD $52 million per annum is spent when the gTLDs are included.

Statistics from ICANN show that the size of the domain name industry exceeded 350 million records, more than one-third are the old famous .COM TLD. However, it’s worth mentioning that the new gTLDs are growing faster. Statistics also show that the world's leading registrar is GoDaddy with nearly 20% market share.

In Africa, there is a noticeable growth of 15% in 2021 mostly a contribution of the local ccTLD which has a 63% market share compared to only 30% for .com TLD in Africa. Such an unexpected figure can be justified by the effect of “quasi-ccTLDs” that are sold as generic TLDs.[196]

10.1.3 KEY SUCCESS FACTORS FOR CCTLD REGISTRIES

As most of the registries in Africa are ccTLD registries with no real competition in place, the success factors can be for the country to establish, maintain, and post the national domain for the content directed toward the digital transformation and the welfare of the local community. Thus, the following KPIs groups can be considered when evaluating a national ccTLD registry:

10.1.3.1 ESTABLISHMENT

Since all African countries have established a national ccTLD registry we can look to the operational model and the legislation of the organization as well as the government oversight of the registry. In this regard, several KPIs are crucial for the sustainability of the registry including the governance of the firm to allow independence from the government to minimize the effect of politics and other non-technical issues. To do

[194] https://www.registry.net.za/zarc_domain_stats.php

[195] https://registry.net.za/accredited/ and https://nira.org.ng/

[196] The Global Domain Name Market in 2021 (afnic.fr)

so, a preferred NGO or not-for-profit firm model is widely adopted and shows continuous success and evolution.

10.1.3.2 TECHNICAL INFRASTRUCTURE

An important measure of a ccTLD server's scalability and resilience is to have enough IP resources. IPv6 support is related to this measure as well. Moreover, this measure is only realized if the allocated resources are from diverse RIRs (topologically diverse).

Furthermore, Anycast servers are also crucial to the stability and performance of the ccTLD. However, African ccTLD Anycast seems not to target Africans as most of the traffic is out of the region. Currently, AFRINIC probably has the largest pro-African Anycast system. This study, via the African DNS Observatory, also plans to provide an African based Anycast system in Africa.

In addition to the IP resources and traffic, securing DNS infrastructure is as crucial as the system establishment. Hence, DNSSEC zone signing should be included in any evaluation process. DNSSEC implementation differs from IPs, ASNs, and Anycast usage, in the sense that DNSSEC signing is not driven by external DNS providers.

Overall, technical KPIs can be benchmarked with the minimum requirements for operating a TLD as stated in BCP-16[197].

10.1.3.3 MARKET CAPACITY

The above KPIs will be worth nothing if no request comes from a critical mass of Africans to utilize the national ccTLDs for their digital services. Several parts are collaborative and co-operatively affect the market capacity as follows:

1. Affordable infrastructure which facilitates reliable access to the Internet is in place.
2. There is widespread digital awareness among the population, and the public is aware of the value of the Internet.
3. Citizens have sufficient literacy – both conventional and digital.
4. Conducive policy, regulatory and governance frameworks are in place which create the necessary enabling environment to foster growth in the Internet sector; Payment gateways are in place to ensure easy electronic payment of fees. Responses to the online survey confirmed the need for easy payment mechanisms with both Registrars and Registrants indicating they preferred paying by bank transfer than by credit/debit card. Respondents also ranked the absence of easy payment methods as one of the key barriers to growth in the DNS market; Fees for registering a domain are cost based (though not zero); Registration is comparatively easy to complete (including simple automated systems in place for registration, and fast payment mechanisms available).
5. Respondents to the user experience section of the questionnaire cited slow processing time as the third biggest challenge to development of the DNS market and quality of technical support as the fifth most significant difficulty.
6. Information on how to register a domain is easily available, promoting confidence and helping to facilitate a critical mass of domain names that fosters general awareness of the domain.
7. Training of industry players in the technical aspects of good DNS management and implementation takes place regularly.
8. An effective business model and a marketing / consumer awareness strategy is in place.

---

[197] rfc-editor.org/rfc/rfc2182.txt

9. No manual intellectual property rights evaluation prior to registering a domain. It is far cheaper and easier to resolve the few cases that will occur afterwards using an ADR mechanism.
10. The Registry has a website with functioning and easy to use registry landing pages including simple and automatic procedures for registration fulfilment and payment, and payment by credit card as an option.
11. The rules governing who may register a domain and how this is carried out are as simple as possible. For example, rules must not require domain registrants to have a legal presence in the country; nor should rules require domain names to match the business or personal name.

10.2 RECOMMENDATIONS

The two key recommendations based on the success factors identified above are:

- There is a strong need to simplify, automate and expedite domain registration processes.
- Many countries need to lower the cost of ccTLD registration - the average registration cost is $101 for an African ccTLD domain compared to about $10 for a .COM domain. An ideal price would be between $5-$10. It is noteworthy that the countries with the highest revenue have the lowest (non-zero) prices. This recommendation is, for example, being actively followed by Nigeria.

10.2.1 RECOMMENDATIONS: WIDER ENVIRONMENT

Some success factors apply to the wider enabling environment for growth of the Internet sector and ICTs more generally. Firstly, and most obviously, Internet access constraints must be addressed. The issues here are not only cost, but also availability and performance within each country, and indeed connectivity between countries. These may be addressed by: -

- stimulating rollout of fixed and mobile infrastructure.
- encouraging LTE / 4G / FTTx deployment.
- encouraging PC uptake.
- reduce prices especially for data.
- supporting deployment of undersea cables, cross-border-fibre ,and domestic backbones.

Reduce costs by market liberalisation and interconnection via local IXPs.

In addition, these should be supported by the following actions -

- Initiatives to build digital literacy.
- Initiatives to facilitate e-government and assist countries in moving government services online should be supported. This would include a range of digital services, for example, promotion of e-learning and e-health.
- Similarly, specific strategies to implement and invest in building e-commerce across Africa should be developed – with a specific focus on developing strategies to facilitate an increased presence on the Internet by African SMEs and to facilitate innovative initiatives to promote e-commerce within this sector.
- Countries should focus on ensuring that it is easy to do business in the region.

Those countries without sufficient local hosting facilities need to build IXPs[198], data centres and metro fibre networks. It is important to note that the degree of success of an IXP is contextual - dependant on an enabling and supportive environment. An allied point is that cross-border fibre is vital to all.

Governments should aim for on-line delivery of all e-government

Unless there is sufficient local content – by which we mean content that is not only locally written but that is relevant to citizens and is available in the languages of their choice - Internet penetration will not take off dramatically, nor will local hosting and interchange of content by data centres and IXPs boom. An important demand driver for this is governments committing to deployment of e-government - online delivery of services. This will increase their accessibility and substantially reduce costs for both government and citizens. Finally, governments should ensure freedom of expression online as it encourages content creation and acts as an industry driver. Examples of these would include the purchase of on-line Visas for Kenya (although they charge more) or for Car licenses/Driver licenses – etc, in South Africa (although you pay for Courier fees).

- A concerted effort also needs to be made to address impediments in relation to terms of policy, regulation, and governance. Policymaking, regulatory and registry functions should be separated where they are not and these entities should encourage participation by all stakeholders and, for example, recognise and engage with their national ISP Associations.
- Appropriate light handed regulatory and governance mechanisms.
- Sufficient Internet penetration.
- Sufficient Internet infrastructure.

10.2.2 RECOMMENDATIONS: DOMAIN NAME INDUSTRY

The most important recommendations for the DNS industry itself are:

- There should be cost-based (but not zero) fees for registering a domain; (between $5 - $10)
- No manual intellectual property rights evaluation prior to registering a domain.
- ccTLDs should use the “3R” Model, i.e. separate roles for each of the Registry, Registrar and Registrant.
- Multiple registrars should be encouraged. Analysis shows that if there are enough Registrars - at least 20 – this ensures adequate competition.
- A simple, quick, and cheap dispute resolution system – commonly called an ‘Alternative Dispute Resolution’ (ADR) – should be implemented and supported by appropriate legislation.

The Registry should have a website with functioning and easy to use registry landing pages. It should provide simple and automatic procedures for registration fulfilment and payment and should include payment by credit card as an option.

There should be an effective business model and a marketing / consumer awareness strategy, with appropriate regulatory and governance mechanisms.

[198] Note especially that building an IXP is neither complicated nor expensive. It can easily be done for < $1000. The fundamental issue to be resolved is the willingness of network operators to interconnect with each other.

10.2.3 BASIC INTERNET INFRASTRUCTURE IMPROVEMENT

There are a variety of areas that need to be addressed by the authorities in some countries in Africa. These are:

10.2.3.1 POOR MARKET ACCESS AND NETWORK PROVISIONING MODELS

Among the most common reasons for limited infrastructure is the lack of competitive open markets and barriers to market entry for basic infrastructure providers, along with limited access to sufficient radio spectrum. Incumbent fixed-line national operators and a few mobile operators continue to dominate markets for broadband in many countries. This affects coverage, cost, and quality of services. Many governments continue to protect legacy fixed-line operators and existing mobile operators from new players wishing to use innovative technologies and business models. Moreover, the 'new incumbents' – the mobile operators - are usually subsidiaries of large international companies and can use their superior resources to influence the regulatory environment so that it favours their investments in older technologies over potential new entrants. For example, in many cases licensing requirements and fees can be too onerous for smaller private operators and community-driven initiatives such as 'village fibre' or municipal Wi-Fi.

10.2.3.2 INADEQUATE SPECTRUM MANAGEMENT

One of most important issues in terms of expanding the market for domain names is increasing access to the Internet. Conservative spectrum assignment methods continue to restrict the potential for new providers looking to make use of the latest technologies. For example, fixed broadband operators can use new wireless systems such as TV white spaces (TVWS) and other dynamic spectrum-sharing approaches where regulation allows this.

10.2.3.3 LACK OF PUBLIC ACCESS FACILITIES

For people who cannot afford their own equipment and connectivity, or who only have access in their place of work, public access facilities could offer an effective alternative. However, there is limited investment in libraries, telecentres, and multi-purpose community centres amenable to the provision of public Internet access. Support for the provision of public access has unfortunately fallen off the agenda in most countries because of the rapid growth of Internet- connected mobile phones, which has reinforced the widely held view that public access is just a stepping stone to private access. Nevertheless, Internet Cafés remain popular – and profitable – in many African countries.

In addition, some countries provide free Internet access at public schools.

10.2.3.4 ACCESS TO STARLINK AROUND AFRICA (AND THE WORLD)

Starlink is a low orbit satellite system operated by SpaceX. It relies upon thousands of Satellites, so failure is difficult because of the numbers. The End users' dish is a phased array antenna that appears flat and is very compact. With large dishes at base stations at places like open access Data Centres (where there is usually an IXP and good fibre connectivity) – Round Trip Latency can be very low – 20-40 mS. Many African countries have or are in the process of licensing Starlink. Systems such as Starlink will help connect the unconnected – especially in remote areas. Dishes can be shared to reduce costs.

11 SUMMARY

The 2023 Africa Domain Name System Industry Study examined the DNS market in all 54 African countries, including several Indian and Atlantic Ocean Islands. The objective was to identify strengths and weaknesses in the industry ecosystem within this highly diverse region and to develop recommendations on how to advance the industry.

The methodology included an online survey in six languages and analysis of Zone Files. Responses to the survey were received from 72 countries. However, 17 African countries provided no response at all. Zone files, Registrar database extracts and Domain Monitoring Services database extracts were analysed, and pertinent data obtained without doing WHOIS lookups, such as the presence and location of hosted websites and the languages used. In addition, extensive research was carried out on all 54 ccTLDs, their Registries, Registrars and the numbers of domains registered.

Several factors for each country were examined, including Internet penetration rates and the presence of functional IXPS. All 54 countries were ranked on a Country DNS Success Index. Detailed results are presented for 20 of the countries. A clear link was found between the presence of an established IXP and a lively Internet industry and high score in the Success Index.

We found that there are, as of December 2023, some 5.5 million domain names associated with Africa. This total is currently growing at 33% per annum, although less than 5% of this growth is in ccTLD domains from countries other than the four Freenom ‘domain hack’ countries. The total annual value of the African Domain Name industry is some $52 million.

Many countries could usefully remove or reduce barriers to growth of the Internet industry generally and the Domain Name industry.

Only one market, South Africa, may be regarded as “mature”, in that its growth rate is linear and seems to be constrained by GDP growth. All other countries are either in the steep “growth phase” or have yet to reach this. There is thus considerable potential for growth in the Domain Name industry in Africa for the foreseeable future.

Appendices

A. Table of Figures

B. Table of Tables

C. Glossary of Terms

2R Model	In order for a person (a Registrant, the second 'R') to acquire a Domain Name from a Registry (the first 'R') the Registrant purchases the Domain directly from the Registry.
3R Model	In order for a person (a Registrant, the third 'R') to acquire a Domain Name from a Registry (the first 'R') the Registrant purchases the Domain via a Registrar (the second 'R'), that is, there is a (usually accredited) middleman.
CIDR	Classless Inter-Domain Routing – a network prefix can fall on any bit boundary, as opposed to the older Class 'A', 'B' and 'C' networks.
IPv4	Internet Protocol version Four. The original 32 bit address given to a computer as a unique identifier, split up into 4 by 8 bits. It looks like 192.168.10.30 Any one part has the range from 0 to 255.
IPv6	Internet Protocol version Six. The much larger replacement for an IPv4 address, is 128 bits long and split into 8 parts each of 16 bits in length. Representation is in hexadecimal using the hex characters of 0-9 and A-F. Each part is from 0000 to FFFF (0-65536 in decimal). Around the world, we are on the last few remnants of IPv4 addresses.
IXP	When three or more organisations interconnect and exchange traffic with each other via a common switching fabric. Peering is often free- except perhaps to cover the shared infrastructure costs where the exchange of traffic actually happens. Usually, peering reduces transit time (things are faster) and improves quality of service.
Mean	The average value of a set of data.
Mode	The most common response or value within a set of data.
Network Prefix	The modern standard form of specification of the network prefix is CIDR notation, used for both IPv4 and IPv6. It counts the number of bits in the prefix and appends that number to the address after a slash (/) character separator: e.g. 192.168.0.0, netmask 255.255.255.0 is written as 192.168.0.0/24.
Peering	When two networks exchange data originating or terminating on their networks, or those of their customers. See also Transit.
Premium Domain Names	Not all domain names are created equal. If it is a short name (three or less letters) or a generic name (travel, green, diver), it can simply be worth more. If the Registry has no formal Premium Domain Name system, entrepreneurially inclined people may buy such names in the hope of reselling them at profit. If the Registry does run a Premium Domain Name service, then the names are sold more directly to the customer but at a Premium Price.
Punycode	Punycode is a special encoding used to convert Unicode characters to ASCII. See https://www.punycoder.com/
"Real" Website	In the study, when analysing the Domains in a Zone file, we queried whether the Domain pointed to a Website or not. However, the website could just be a place holder ("Website coming soon"). We thus define a Website as a "Real Website" if the

	first page is more than 1000 bytes (characters) long and has more than four links of some sort.
Registrant	The Registrant is the person who is the "owner" or rather the user of the name that is registered in the Registry Database. In most systems, Users "rent" the ability to use the name and if they fail to keep up the payments, they can lose the name, potentially to a different user.
Registrar	As there are more and more Registrants for a particular Registry, it becomes easier for the Registry to use an intermediary agent, the Registrar, to deal with the Registrants. Registrars can also be agents for multiple Registries which can make the Registrants life easier if he wishes to rent domains from a number of Registries, he can do so via one point of contact. Registrars are often legally bound by contract to the Registry, to act in a certain way such as levels of service.
Registry	The Registry operator is (usually) a natural monopoly. The Registry maintains the unique Database of Names that have been Registered (or acquired) along with the appropriate contact information for the domain names in the Database.
Reseller	A Reseller in the Domain Name supply chain sits just above the Registrant. He can often act like a Registrar but usually does not carry the Registrars' legal requirements. In "2R" models that migrate to "3R" models, the Reseller often becomes the Registrar.
Transit	When traffic leaves the local ISP, crosses over multiple other upstream Internet Providers and eventually reaches its destination, we call the intermediary networks "Transit Providers". There is almost always a cost involved. From an African perspective, this often means our traffic will be routed overseas via the USA and/or Europe before getting to its destination. Without Peering, this could be to the building across the road from you. Transit is thus often slow and expensive.
WHOIS	There are servers that when asked who owns a Domain Name, will reply with the contact details for that Domain. These are WHOIS servers. Other objects apart from Domain Names can also be queried, such as IP Addresses. See RFC 3912

D. Acronyms

2R Model	Registry and Registrant
3G	Third Generation
3R Model	Registry, Registrar and Registrant
4G	Fourth Generation
A4AI	Alliance for Affordable Internet
ADR	Alternative Dispute Resolution
ADSL	Asynchronous Digital Subscriber Line
AFRINIC	African Network Information Centre
AINC	Arabic Internet Names Consortium
AMU/UMA	Arab Maghreb Union
APC	Association for Progressive Communications
API	Application Program Interface
ASN	Autonomous System Number
ASWG	Africa Strategy Working Group
AU	African Union
AUC	African Union Commission
AXIS	African Internet Exchange System
BIND	Berkeley Internet Name Domain
CAGR	Compound Annual Growth Rate
ccTLD	Country Code Top Level Domain (e.g. 'KE' for Kenya, the country's two letter ISO Code)
CDN	Content Distribution Network
CDSI	Country DNS Success Index
CERT	Computer Emergency Response Team
COMESA	Common Market for Eastern and Southern Africa
CRASA	Communication Regulators Association of Southern Africa
DB	Data Base
DCR	Data Centre Research
DNS	Domain Name System / Domain Name Services (Backend Registry provider for ZACR/ZARC)
DNSSEC	Domain Name Security
DRC	Democratic Republic of Congo
DSL	Digital Subscriber Line
EAC	East African Community
EASSy	Eastern African Submarine Cable System
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States

ECT	Electronic Communications and Transactions
EDGE	Enhanced Data for GSM Evolution
EPP	Extensible Provisioning Protocol
EUN	Egyptian Research and Education Network
FoM	Figure of Merit
FTTH	Fibre to the Home
FTTx	Fibre to all possible optical fibre topologies
Gbps	Gigabits per second, a transmission speed
GGC	Google Global Cache
GNI	Gross National Income
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GSMA	Global System for Mobile communications Association
gTLD	Generic Top Level Domain (e.g. COM, ORG, NET, …)
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IANA	Internet Assigned Numbers Authority
IAP	Internet Access Provider
ICANN	Internet Corporation for Assigned Names and Numbers
ICT	Information and Communications Technologies
IDN	Internationalised Domain Name
IGAD	Intergovernmental Authority on Development
IIAG	Ibrahim Index of African Governance
IMF	International Monetary Fund
INX	INternet eXchange
IP	Internet Protocol / Intellectual Property
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISOC	Internet Society
ISP	Internet Service Provider
ISPA	Internet Service Providers' Association
IT	Information Technology
ITU	International Telecommunications Union
IXP	Internet eXchange Point
KIXP	Kenyan Internet Exchange Point
kW	Kilo Watt - a measure of electrical power
LAC	Latin American and Caribbean countries
LIR	Local Internet Registry
MB	Mega Byte - a measurement of the amount of data (e.g. on a disk)
Mbps	Megabits per second, a transmission speed

MEAC	Middle East and Adjoining Countries
MS	Microsoft
MSN	Microsoft Network
MySQL	My Structured Query Language, an open-source database
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NRA	National Regulatory Authorities
OECD	Organisation for Economic Co-operation and Development
PCH	Packet Clearing House
PHP	recursive acronym for PHP: Hypertext Pre-processor
PIDA	Programme for Infrastructure Development in Africa
PwC	Price Waterhouse Coopers
REC	Regional Economic Communities
RFC	Request for Comment
RIR	Regional Internet Registry
SAB	South African Breweries
SADC	Southern African Development Community
SME	Small and Medium Enterprise
SSL	Secure Sockets Layer
SudREN	Sudan Research and Education Network
Tbps	Terabits per second, a transmission speed
TEAMS	The East African Marine System
TSIG	Transactional Signalling
TV	Television
TVWS	Television white space (the unused space between TV channels)
UK	United Kingdom
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
US	United States
USA	United States of America
USC	University of Southern California
USD	United States Dollar
WACS	West Africa Cable System
Wi-Fi	Wireless Local Area Network
ZACR	South African Central Registry (renamed from UniForum SA)
ZARC	South African Registry Consortium (ZACR & DNS)
ZADNA	ZA Domain Name Authority

E. ccTLD Country Codes

Country	ISO	ISO	Country
Algeria	DZ	AO	Angola
Angola	AO	BF	Burkina Faso
Benin	BJ	BI	Burundi
Botswana	BW	BJ	Benin
Burkina Faso	BF	BW	Botswana
Burundi	BI	CD	Democratic Rep of Congo
Cameroon	CM	CF	Central African Republic
Cape Verde	CV	CG	Congo
Central African Republic	CF	CI	Ivory Coast
Chad	TD	CM	Cameroon
Comoros	KM	CV	Cape Verde
Congo	CG	DJ	Djibouti
Democratic Rep of Congo	CD	DZ	Algeria
Djibouti	DJ	EG	Egypt
Egypt	EG	ER	Eritrea
Equatorial Guinea	GQ	ET	Ethiopia
Eritrea	ER	GA	Gabon
Ethiopia	ET	GH	Ghana
Gabon	GA	GM	Gambia
Gambia	GM	GN	Guinea
Ghana	GH	GQ	Equatorial Guinea
Guinea	GN	GW	Guinea-Bissau
Guinea-Bissau	GW	KE	Kenya
Ivory Coast	CI	KM	Comoros
Kenya	KE	LR	Liberia
Lesotho	LS	LS	Lesotho
Liberia	LR	LY	Libya
Libya	LY	MA	Morocco
Madagascar	MG	MG	Madagascar
Malawi	MW	ML	Mali
Mali	ML	MR	Mauritania
Mauritania	MR	MU	Mauritius
Mauritius	MU	MW	Malawi
Morocco	MA	MZ	Mozambique
Mozambique	MZ	NA	Namibia

Country	ISO	ISO	Country
Namibia	NA	NE	Niger
Niger	NE	NG	Nigeria
Nigeria	NG	RW	Rwanda
Rwanda	RW	SC	Seychelles
Sao Tome & Principe	ST	SD	Sudan
Senegal	SN	SL	Sierra Leone
Seychelles	SC	SN	Senegal
Sierra Leone	S L	SO	Somalia
Somalia	SO	SS	Southern Sudan
South Africa	ZA	ST	Sao Tome & Principe
Southern Sudan	SS	SZ	Swaziland
Sudan	SD	TD	Chad
Swaziland	SZ	TG	Togo
Tanzania	TZ	TN	Tunisia
Togo	TG	TZ	Tanzania
Tunisia	TN	UG	Uganda
Uganda	UG	ZA	South Africa
Zambia	ZM	ZM	Zambia
Zimbabwe	ZW	ZW	Zimbabwe

F. Study Team Members

The team for the study included:

- William Stucke of William Stucke Associates, a niche telecommunications consultancy focusing on regulatory and spectrum issues. William is a long-standing campaigner for telecommunications liberalisation in Africa and is a former ISP and a former Regulator. He was Project Leader and Chief Editor.
- Mark Elkins of Posix Systems; one of South Africa's oldest ISPs. Mark wrote the original software that ran the .CO.ZA Registry for many years. Mark also teaches an Intro/Advanced DNS Training course (including DNSSEC), is part of the ICANN DNSSEC and Security Workshop program committee and an ICANN Universal Acceptance Ambassador. He was also on the AFRINIC Board for 6 years.
- Rodney Tintinger, director of PowerSoft Africa (Pty) Ltd and Project Manager for this study. Rodney is a seasoned project manager with executive management experience, with over 22 years of ICT sector experience and Telecommunications is 14 thereof.
- Anton Kotze, director of PowerSoft Africa (Pty) Ltd and Ellipsis Consulting (Pty) Ltd. Anton's experience of practising law and exco level management of large and start-up ISP businesses gives him a unique blend of legal and commercial experience allowing him to understand all regulatory and commercial aspects of his client's requirements and the fulfilment thereof.
- Dominic Cull, director of Ellipsis Consulting (Pty) Ltd. Dominic has extensive experience in advising on the commercial and regulatory aspects of new technology, broadcasting, and electronic communications ventures for local and international companies and policy and regulation in the ICT and telecommunications sectors, having spent 14 years advising the public and private sector on ICT legal issues. Dominic is involved at all stages of the communications law and regulation-making process and liaises closely with, inter alia, the Independent Communications Authority of South Africa (ICASA), the Department of Communications, the Department of Justice and Constitutional Development, SAPS Cybercrime Division, National Gambling Board, Department of Telecommunications and Postal Services, Portfolio Committee on Telecommunications and Postal Services and the Film and Publications Board on an ongoing basis.
- Sami SALIH, PhD., PMP®, ICT Regulatory Expert. A pracademic in ICT Regulation with more than fifteen years of engagement in the ICT sector with STC (Saudi Telecom. Company), TPRA (Sudanese telecom. regulatory authority), SUDREN (Sudanese NERN), and active participant and contributor at various international organizations including ITU, ETSI, ICANN, ISOC, UbuntuNet Alliance, and AFRINIC. Along with six years of teaching ICT for undergraduate and postgraduate.
- Bill Sangiwa – IT& Network Specialist, Disruptor, Visionary & Serial Entrepreneur. the first Registrar of .TZ ccTLD registry for over 16 years responsible for .TZ nameservers and the domains ending with co.tz. or.tz, ne.tz. First vice-Chairman of the tzNIC

registry Policy Advisory Committee. co-founded several Internet Services Providers (ISP) in Tanzania and Zambia, including the first ISP in Tanzania. A recipient of Commonwealth Telecommunications Organization (CTO) Award “Internet Pioneering in Africa”.

- Anriette Esterhuysen served as the chairperson of the Multistakeholder Advisory Committee of the United Nations Internet Governance Forum (IGF) from 2019 to 2021. She was executive director of the Association for Progressive Communications (APC) from 2000 to 2017 and continues to work with APC as Senior Advisor on Internet Governance and, in this capacity, convenes the African School on Internet Governance. She serves on the governing bodies of the IGF Support Association, Connect Humanity, the Digital Empowerment Foundation and the South African Tertiary Education Network (TENET). Anriette was inducted into the Internet Hall of Fame as a Global Connecter in 2013 for her work in extending internet connectivity in Africa and received the Electronic Frontier Foundation Pioneer Award in 2015 for her work on defending and promoting human rights online.
- Mike Jensen is a South African ICT expert currently working as the Association for Progressive Communications' (APC) Internet access specialist. Mike has assisted in the establishment of internet-based communication systems in more than 40 developing countries over the last 20 years, mainly in Africa. He provides advice to international development agencies, the private sector, NGOs and governments in the formulation, management and evaluation of their Internet and telecommunication projects, ranging from national ICT policy development to international fibre and rural wireless telecommunication feasibility studies. Mike was inducted into the Internet Hall of Fame in 2017.
- Thabo Makhakhe, Economist, Former Investigations and Compliance Officer and Divisional Manager and Corporate Services Executive at the Mpumalanga Gaming Board, South Africa. Former Head of the Economic and Financial Analysis Division and subsequently Executive Board Member (Councillor) at the Independent Communications Authority of South Africa and Project Manager for the Licensing Process for the third Cellular Operator in South Africa, Cell C. Held Regulatory Executive positions at Telkom SA and MTN SA.
- Victoria Slinger lent us her excellent English editing skills.
- Other prominent African Internet figures known to Team Members acted as Country leaders, such as Avis Momeni (CM), Baudoin Schombe (CD), Cade Zvavanjanja (ZW), Dotemin Konate (CI), Ernesto Alberto (AO), Gbenga Sesan (NG), Melaku Girma (ET) and Olévié Kouami (TG BF); and

The Study Team included native Arabic, English, French, Portuguese, Spanish and Swahili speakers.

G. Analysis by country/region:

- Breakdown of domain name registrations (including ccTLD versus gTLD registrations; registrations by business, governments, non-government, research and academic, individuals, etc.; percentage of active domains)
- Type of content hosted by these domains.
- Share of the commercial sites that offer e-commerce services.
- Whether this content is hosted within country or outside.

H. Methodological Observations

We relied on responses to questionnaires, analysis of Zone Files, registry and Registrar database extracts, interviews with relevant role players in the industry and desktop research. There were several mechanisms used to recruit respondents to the questionnaires. Firstly, some Team members attended various African Internet events during the course of the year and took every opportunity to publicise the Survey at these events. In this, they were ably assisted by ICANN staff members, who also publicised the Survey. Secondly, a number of channels were used to publicise the Survey, including African mailing lists and a blog article on the AFRINIC website and mention in its newsletter. These two measures generated some 20% of the potential respondents (DB Users) who signed themselves up for the questionnaire.

For the balance of respondents, we recruited a Team of some 40 people, each of whom was assigned responsibility to identify and sign-up suitable people from the countries for which they were responsible. Unfortunately, our results fell far below expectations. Our large team identified, contacted and invited more than 1800 potential respondents (database users). Significant efforts were made to persuade users to complete their questionnaires, and a total of only 422 questionnaires were completed by 321 individuals in time for analysis.

I. Challenges

We are extremely privileged to be able to do this study for a second time, and if we or anyone else thought it would be easier, you would be disappointed. The 2016 study provided a guideline and framework from which this study could further operate.

Some of the main challenges encountered were:

- Although we had names from the 2016 study, it was a challenge to identify and obtain sufficient suitable role players to be potential respondents.
- A lack of understanding of the value of outcomes of this survey to the respondents themselves.
- A misplaced emphasis on confidentiality of data on the part of some Registries and others, who seem to be unaware that their peers publish statistics that they consider “secret”.
- In some cases, a lack of trust, to the extent that several countries demanded specific letters of authorisation, over and above the original authorisation provided by ICANN.
- A lack of sense of importance and urgency from respondents.
- Training of various team members on using electronic communication.

A special thank you to all those people who will take the time to read this report, and hopefully provide thoughtful and helpful comments, corrections, and suggestions.

Wherever possible we will take these into account and implement such as best we can into the Final Version of this Report.

For whoever follows in our footsteps, we hope we have left you a comprehensive starting point from whence to continue this most interesting African journey.