THE 2016 AFRICAN DOMAIN NAME SYSTEM MARKET STUDY

DRAFT REPORT

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AFRICA DOMAIN NAME SYSTEM MARKET STUDY

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1 EXECUTIVE SUMMARY

This market study into the domain name system in Africa was commissioned to, among other things:

- Highlight the strengths and weaknesses in the Domain Name Service (DNS) sector in Africa;
- Develop recommendations on how to advance the industry to better exploit the opportunities available and to address identified challenges; and
- Explore options for establishing an observatory to continuously monitor the growth, development and emerging needs of the DNS market in Africa.

The Internet Corporation for Assigned Names and Numbers (ICANN) includes 54 countries in its "Africa" region – including all countries on the continent and several neighbouring islands. Accessing consistently reliable statistical information from all these countries is inevitably challenging – given the 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 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 643 in South Africa.

This is a baseline study. No such study has, to the authors' knowledge, ever been carried out on the Domain Name Market for the entire African continent. Later studies will be able to make comparisons with these results in order to evaluate growth and progress[1].

1.1 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 set including an online survey, zone file analysis of country code and generic top level domain (ccTLD and gTLD) registries, interviews with selected key stakeholders and extensive desktop research. In addition, a number of the research team members have decades of experience in the DNS industry in Africa, and their insights informed some of our conclusions.

[1] 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

Some 1 400 potential participants in the study were identified through reviewing membership of AfriNIC, registrations by the Internet Assigned Numbers Authority (IANA), country code top-level domain registries (ccTLD), Google searches for registrars of domains and memberships of individual country Internet exchange points (IXPs), Internet Service Provider associations(ISPAs), Internet Society (ISOC) chapters and personal knowledge. All participants were specifically targeted and sent personal links to an online survey by a total of 40 team members.

The online survey tool included six different questionnaires for identified target groups (Registry, Registrar, Registrant, Regulator, Reseller and IXP Manager) translated into four languages (English, French, Portuguese and Arabic). 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)[2]. The response rate varied between countries – with no completed questionnaires received from targeted entities in 22 countries (41%) with 31% of the targeted respondents answering an average of 1.8 questionnaires each in for example Sudan - one of the 32 countries (59%) from which questionnaires were received. Responses were received from all six identified stakeholder groups, all AfriNIC regions[3] and all four language groups.

1.2 The African Ecosystem

It is important to contextualise the DNS market in relation to the total African Internet and communications ecosystem. Key indicators in relation to this include the following:

- Africa is lagging behind other regions in relation to Internet access with an average penetration of 28.7% compared to a world average of 50.1%[4]. This overall penetration level however masks big differences between countries in Africa with Internet access varying from 1% in Eritrea to 68% in Kenya
- Access is predominantly via mobile devices.
- Backbone fibre networks are gradually spreading across most African countries and all coastal countries except Guinea Bissau & Eritrea have access to at least one submarine fibre cable and most countries have at least two. There are over 1 million

[2] Note that this reflects the number of completed questionnaires submitted. Fifteen percent of those sent links to questionnaires completed the questionnaire.
[3] Indian Ocean, Eastern, Western, Central, Northern and Southern African regions. See https://www.afrinic.net/en/about/service-region
[4] http://www.internetworldstats.com/stats.htm as of June 2016

kilometres of terrestrial fibre installed and cross-border fibre is increasing so that almost all countries will be connected to their neighbours by fibre by 2018.

- Local access 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. Wi-Fi deployments follow a similar distribution, often preceding FTTH[5]. However, even in these cities, the majority of people still rely on mobile access.
- While broadband uptake in Africa has been increasing, high Internet access costs continue to be the biggest factor limiting usage in most countries. The Alliance for Affordable Internet[6] (A4AI) estimates that for only 500 MB of monthly data — enough to watch just two minutes of video a day — the average African has to pay over 15% of their monthly income, compared with 1% by the average European. This, together with the fact that African Internet access is primarily via mobile devices, results in a low demand for domain names.
- Growth in local Internet infrastructure is speeding up, with 36 fully operational IXPs7 in 26 countries and an increasing number of fully-fledged data centres being built. In terms of IP resources, Africa accounts for 2% of IPv4 and 1% of IPv6 addresses out of the total global usage. The research further 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 have a more mature DNS market and respondents to the survey identified the absence of local IXPs as one of the barriers to development of the DNS market.
- An analysis of the volumes of web page content indexed by Google found that 75% of 400 million indexed pages are in just 7 African countries - South Africa, Kenya, Zimbabwe, Uganda, Nigeria, Egypt and Morocco.
- In relation to assessment of the extent of offshore versus on continent hosting, the research team was unfortunately only able to access a very limited number of Zone Files[8] and Registrar database extracts. This data indicated that a number of countries have well developed local hosting facilities.

[5] FTTH = Fibre To The Home
[6] http://a4ai.org/affordability-report/report/2015/
[7] IXP = Internet Exchange Point
[8] At the time of writing, additional data for the .COM zone has been received but is not yet analysed.

1.3 African DNS Market

The African continent top level DNS address space consists of 54 top level country code ccTLDs, (of which one, Southern Sudan (SS) is not yet delegated) plus five Internationalised Domain Names (IDN)s: Egypt (مصر), Algeria (الجزائر), Tunisia (تونس), Sudan (سودان) and Morocco (المغرب) as well as three city codes (.CAPETOWN, .DURBAN and .JOBURG). ICANN recently delegated the .AFRICA domain to the South African administrator, the ZA Central Registry (ZACR), and registrations will be fully open in July, 2017. Note that according to responses to the survey, the use of IDNs is more widespread. Analysis of the responses shows that at least 46% of Registries offer the non-Latin script and more than a third of Registrars (34%) do.

Data from March 2016 indicates that a total of just over 4.1 million domains are active under the African ccTLDs. There are also many registrations in the gTLDs by African entities[9]. Key findings of the research are summarised below.

- The research indicates that high access costs, the lack of infrastructure and the fact that African Internet access is primarily via mobile devices, result in a lower 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 market in most African countries followed by lack of infrastructure. Other broader issues identified as high barriers by respondents include poor dependability of Internet connections and unclear or restrictive policy and regulatory environments. In addition, the research analysed the relationship, if any, between a country's ranking in relation to levels of freedom (using rankings by Freedom House and IIAG) and the number of domains registered. According to this, citizens of "free" countries in Africa register some 22 times as many domains as citizens in countries ranked "not free".
- Domain name registration 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 significant majority of countries in the region: 15 countries hosted 100% of their Afilias gTLD websites overseas and a

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

further 24 hosted 95% of such websites elsewhere[10]. Additional gTLD zone extracts have recently been received. These domains are currently being analysed and the full results will be included in the Final Report of this Study.

- The research found 51 functioning ccTLD Registries, with South Sudan (SS) not yet delegated and Eritrea (ET) and the Comoros (KM), which each have just over 100 domains, but have no apparent method of registering new domains via the Internet, and are also non-functional.
- Compared to other regions, Africa has a very small number of ICANN accredited Registrars. In total, there are only eleven ICANN accredited registrars in the region[11] - four in South Africa, two in Morocco and one each in Burundi, Ghana, Nigeria, Senegal and Tunisia out of a global total of 2,143. However, there are many more Registrars than this actually active in Africa, with 450 Registrars accredited by the ZACR alone, for example.

  In reality, 26 countries have only one Registrar (typically the Registry itself), whereas 13 countries are fully competitive, use EPP and have multiple Registrars, Registrar market, with the remaining 14 being partly competitive and Southern Sudan not yet delegated. This was a factor in the number of ccTLD domains sold, although it's also true that successful markets attract more Registrars.
- For the Registrant Market, this market review identified over 5 million African ccTLD and gTLD domains. This equates to some 4.5 domains / 1000 population, whereas some commentators claim 100 – 300 domains / 1000 population is the norm in Europe.
- In this regard it should be noted that there are a number of African countries (11 are most popular) that have unexpectedly high numbers of domain registrations due it seems to what are known as 'domain hacks' (where domains are utilised by entities or individuals not from these countries but rather because the ccTLD forms part of a word or similar unexpected uses). These occur because these countries have domain names that cost little 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. In addition these

[10] Note that the researchers were not able within the time frames to acquire access to a sufficient number of Zone Files and Registrar database extracts to be able to determine accurate figures for general local versus off-shore hosting.
[11] https://www.icann.org/registrar-reports/accredited-list.html & https://www.internic.net/alpha.html

countries have non-restrictive rules that allow registration of domains from entities located outside the country.

- Approximately 1% of gTLD domains are registered by Africans.
- The DNS market roughly equates to a total value of about USD $37 million per annum for African ccTLD domain names alone.[12] At least 25% of this is likely to accrue to the international registrars and the remaining USD $27 million would be import or local revenue generated by the ccTLDs and Registrars. About 73% of the total annual revenue on the continent is made by just ten countries (South Africa, Morocco, Nigeria, Zimbabwe, Egypt, Tanzania, Libya, Somalia, Cameroon and Ivory Coast). Including the gTLD domains with an African connection increases the total annual value of the industry to some USD $51 million.
- Most of the African ccTLDs are available for registration for offshore entities without the requirement for a local presence. In 15 countries there is a requirement for some form of local legal presence (corporate or individual) in order to register a domain name: Algeria, Angola, Benin, Burkina Faso, Cap Verde, Egypt, Gambia, Guinea, Liberia, Mauritania, Niger, Senegal, Tanzania, Tunisia, Zambia, whereas Kenya requires Registrars to be locally based. In a few countries, including Kenya, there is a requirement for Registrars to be locally based, but not Registrants.
- The study also considered the likely growth in the market. In all markets except South Africa (which is mature) there has been significant growth in the number of African domains registered by top-level domain registrars (e.g. .ORG and .INFO domains) as infrastructure rollout has increased in many countries, albeit off a low base. The research expects this trend to continue – projecting an 8 fold increase in annual registrations by 2019 and a potential 20 fold increase in domain name sales in Africa over 5 years.

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.

[12] This is calculated by multiplying the total number of domains registered in each country by the minimum registration fee for domains in each African ccTLD and excludes the gTLD domain names registered by Africans.

1.4 Success factors

A "Country DNS Success Index" was developed by the researchers to rank countries in relation to the health of their DNS markets. The index used a range of factors to "score" countries including the number of domains registered under the ccTLD; the number of gTLD domains registered under international registry operator, Afilias[13]; the number of webpages indexed by Google; price of registration; number of Registrars; number of locally hosted websites; the 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 Kenya, Nigeria, Tunisia and Zimbabwe.

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

- Infrastructure of sufficient expanse and quality to facilitate access to the Internet is available;
- There is generally a digital awareness among the population with sufficient literacy – both conventional and digital;
- Conducive policy, regulatory and governance frameworks are in place;
- Payment gateways have been put in place to ensure easy payment of fees. Note that responses to the online survey confirmed the need for easy payment mechanisms with both registrars and registrants that responded indicating they preferred paying by bank transfer then 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 low (though not at zero)[14];
- Registration is comparatively easy to complete (including simple automated systems in place for registration and fast payment mechanisms are available). 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 market and quality of technical support as the fifth most significant difficulty.

[13] Additional gTLD domains recently received will also be included after analysis in the Final Report. This may result in changes to the overall ranking of the 54 African countries.
[14] See Section 6.3.3 for an explanation of "domain hacks".

- Information on how to register a domain is easily available, promoting confidence & therefore facilitating a critical mass of domain names.

1.5 Recommendations

Research recommendations made on strategies to put in place to advance the DNS industry in Africa include proposals on addressing issues in the wider environment which inhibit growth and suggestions specific to the DNS market. These are summarised below.

- In relation to the wider environment:
    - Broader challenges relating to access to the Internet (including cost, availability and performance/reliability) must be addressed.
    - The lack of relevant local content in languages spoken in individual countries must be addressed as this is crucial to driving uptake and penetration – and therefore to development of the DNS market. E-government is a crucial means for increasing local content and the drive to ensure government services are accessible and available online is essential.
    - Policies to promote e-commerce must be developed in all countries and sufficient investment in implementing these policies must be made.
    - Laws and practices inhibiting freedom of expression online must be removed., as these inhibit content creation and hence demand for websites, blogs and domain names
    - Countries that do not have any local hosting facilities must build IXPs, data centres and fibre networks – but should ensure in doing so that underlying issues such as willingness of network operators to interconnect are addressed. Building an IXP is neither technically difficult nor is it expensive. It is mostly a question of ensuring that local network operators understand that when they are selling access to "the Internet", they are actually selling access to everyone else's networks, including their competitors. It's thus essential that they agree to cooperate sufficiently to interconnect and exchange traffic. If they don't do so locally, they will certainly do so overseas, often at higher cost and always at lower performance. Once a functioning IXP exists, data centres will become not only viable but essential. This then leads to the growth of a local hosting industry, with the resulting social and economic benefits.
    - The general ease of doing business in a country inevitably affects the DNS market as well, and possibilities relating to e-commerce. There is a need to

address factors identified in international and regional studies on the ease of doing business in Africa and in individual countries.

- In relation to addressing factors inhibiting domain name registration in countries:
    - 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 must include payment by bank transfer, credit card and/or mobile money as an option.
    - Fees for registering domains should be low (but not zero)[15].
    - 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.
    - Country policies must ensure separate roles for the Registry, Registrar and Registrant (the "3R Model"). There must in addition be a sufficient number of Registrars - at least 20 – to ensure adequate competition as well as a simple, quick and cheap dispute resolution system (Alternative Dispute Resolution) must be implemented and supported by appropriate legislation.
    - 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[16] 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[17] should be removed and rules should rather focus on addressing violations through alternative dispute resolution mechanisms after registration.

[15] Where domains are "given away" as discussed in Section 6.3.3, the benefit to the country is severely limited
[16] Guinea Bissau for example requires this according to information gathered through the research
[17] Zimbabwe for example requires that applicants prove compliance with intellectual property laws before registration

2 INTRODUCTION

This project was initiated by the Internet Corporation for Assigned Names and Numbers (ICANN) which commissioned the South African Communications Forum (SACF), in association with the Association for Progressive Communications (APC) 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 development 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 language, payment gateway, 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 market 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.
- Methods for setting up a DNS observatory in Africa.

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/Telecom/Communications
- Regional institutions, e.g. African Union Commission, Regional Economic Communities (RECs), and other Economic Development and Educational Institutions
- Internet Exchange Points (IXPs)
- NGOs and Civil Society Groups
- Well-known African ICT industry representatives

The SACF Team Members attended a number of African Internet-related events[18] and interacted with DNS industry role-players, gathering both quantitative and qualitative data through conducting of surveys, interviews and meetings in order to obtain the required data and information.

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

- IANA
- The institutions responsible for management of the ccTLD Registries
- National Regulatory Authorities (NRAs)
- AfriNIC
- AfTLD
- Internet Service Providers (ISPs)

[18] These included the African DNS Forum 2016 (MA), ICANN 55 (MA) & 56 (FI), ICANN Workshop on Emerging Issues in the DNS Industry (ZW), AIS / AfriNIC 24 (BW) and AfriNIC 25 (MU)

- International registrars, such as Afilias and 101 Domains
- Internet industry analysts such as DomainTools and Telegeography

3 PROJECT BACKGROUND

In June 2012, the African Internet community had a historic meeting in Prague (ICANN 44) that was chaired by Steve Crocker (Chairman of ICANN Board), Fadi Chehade (ICANN's incoming CEO at that time) and Moctar Yedaly from the African Union Commission. The outcome was a new approach to Africa that would focus on the following action lines:

- Develop a framework for ICANN's Africa strategy
- Support a stronger presence for ICANN in Africa
- Increase Africa's participation in ICANN

The Africa Strategy Working Group (ASWG) was set up during the meeting, and it developed the Africa Strategy document (2012 - 2015) which was presented during ICANN 49 in Toronto. The document became the cornerstone of ICANN's engagement in Africa.

In 2014, the Africa Strategy Review team convened again alongside AFRINIC 21 in Mauritius and revised the document as per the new ICANN 2016-2020 strategic plan, deemed the ICANN Africa Strategy Version 2.0 2016 – 2020[19]. This revised document was adopted at ICANN 52 (February 2015) after presentation to the community.

Two of the strategic projects (No 15 & 16) identified in the revised strategic plan[20] were:

- Commit and conduct a study on the business feasibility of growing the DNS industry in Africa
- Commission an observatory to develop new indices for DNS industry growth in Africa

This study aimed to support the implementation of these key recommendations and projects in the Africa Strategic plan, as expressly identified and approved by the ASWG and the African Internet community.

[19] https://www.slideshare.net/AfriNIC/01-pierre-d
[20] https://singapore52.icann.org/en/schedule/tue-africa-strategy/presentation-africa-strategy-plan-10feb15-en

3.1 Project Objectives

In summary, the overall objectives of this study were to identify 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 study also aimed to support setting up an observatory that can continuously monitor the growth, development and emerging needs of the DNS market in Africa.

4 METHODOLOGY

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 tool that could also ultimately form a key part of an African DNS Observatory (see Section 6.5 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 web sites and industry analysts.

Acquiring data on the DNS industry for all 54 African countries, with widely differing levels of economic, social, political, telecommunications and Internet development was a daunting task. In order to address this, individual team members were each assigned one or more countries for which they acted as the 'country leader'. Individual consultants were chosen on the basis of:

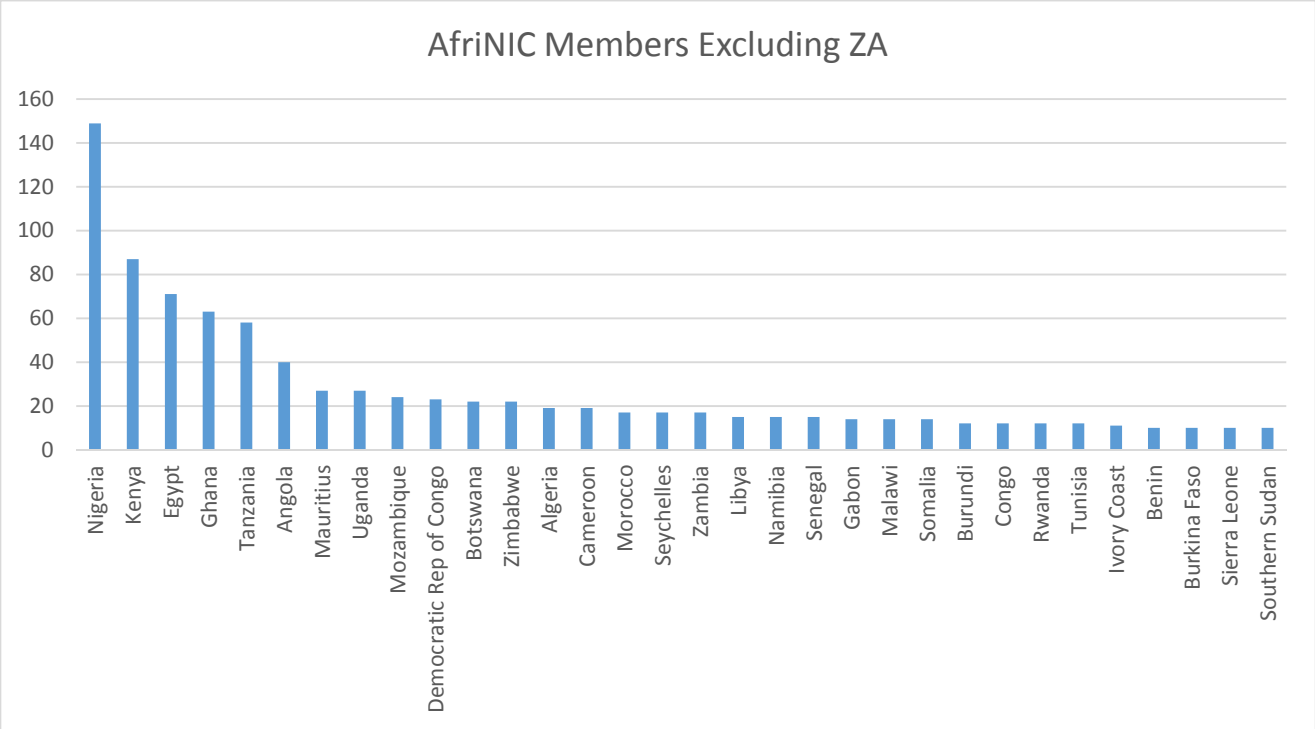
- In-country knowledge and contacts;
- Understanding of the Internet in general and the DNS industry in particular;
- Ability to carry out a challenging assignment in a limited time;
- Relevant language skills.

4.1 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 only use IP addresses (and ASNs), known as End Sites. They thus include ISPs, academic institutions, banks, governments and other business enterprises. At the time of the 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, ORG, NET, EDU and AC or equivalent 2LDs. On this basis, we came to a total of some 1700 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.

Figure 4.1: Countries with at least 10 AfriNIC Members



Countries with 10 or more AfriNIC members are shown in the figure above. The remaining 21 countries each have fewer than 10 members, with the Comoros and Eritrea having a single member each. This AfriNIC membership indicates that at least 1,639 organisations or individuals are using IP resources in Africa, namely IP addresses and / or Autonomous System Numbers (ASNs).

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 market, with some countries having a far larger Internet sector compared to others.

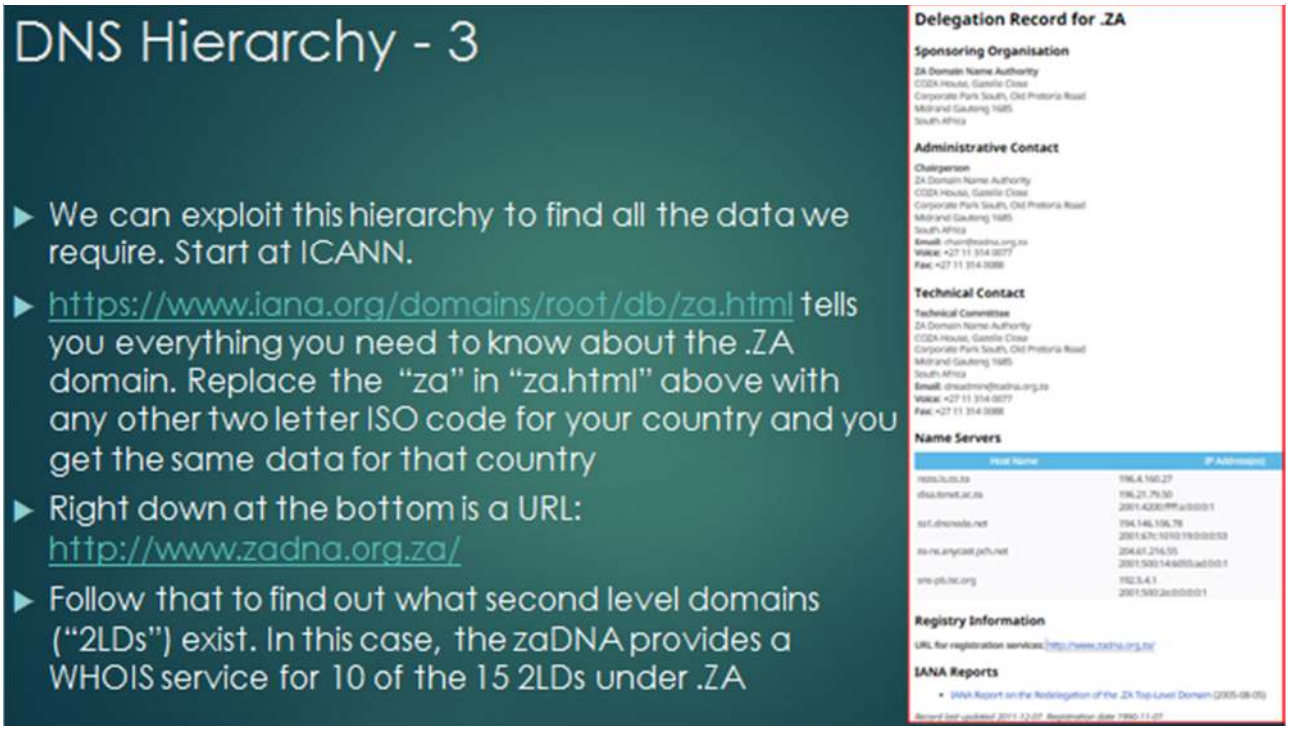
Table 1: Large AfriNIC members

Country	AfriNIC members
South Africa	
Nigeria	149
Kenya	87
Egypt	71
Ghana	63
Tanzania	58

In the period between the first assessment of AfriNIC membership for each country, and when country leaders began training, AfriNIC removed the details of individual members broken down by country from their website. This was done for privacy protection but made the task considerably harder, as other sources would be needed for Registrar data.

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 consultants demonstrates this process in the Figure below.

Figure 2: DNS Hierarchy



As we investigated further, we found that the extent of the DNS industry in Africa was considerably larger than had initially been assumed, at least for some countries. For example, we found that Tunisia had 20 2LDs and that Namibia had 61 accredited Registrars, while Zimbabwe had over 70 resellers. On the other hand, some countries had significantly smaller domain name numbers than expected.

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. 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.

4.2 The Online Survey Tool

A number of existing survey tools were considered, 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. 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.

The survey tool is based on a PHP frontend and a MySQL backend. There is almost no static text on the site at all. All strings and other variables are stored in MySQL 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 MySQL database.

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

4.2.1 Interface Design

To the extent possible, the interface was kept clean and simple. There are two entry points to the site: https://dnsafrica.study (for the survey respondents) and https://dnsafrica.study/admin (for the consultants/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. When Arabic is selected, script reads from right to left, and is right justified instead of left justified.

Additional links lead to the authorisation letter from ICANN and other useful information for Respondents and Team Members.

4.2.2 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 in

question format and response was emphasised, and there was a requirement to limit free-form responses as far as possible, to facilitate comparison of responses. When question development was frozen on 2016-05-16, there were a total of 264 unique questions, in the six questionnaires, or an average of 42 each. The ability to reuse questions was not initially envisaged, but as the number of questions grew, we implemented this both to reduce effort and to increase consistency. To this end, 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.

Question Type	Type Meaning
S	Subject Heading
db	Drop-down list of countries
tl	Text long
dt	Date text
dd	Drop-down List
no	Number
tb	Text box
T	Title (main heading)
ss	Slider question (0-5)

Category Value	Category Meaning
1	Registry
2	Registrar
4	Registrant
8	Regulator
16	Reseller
32	IXP Manager
E.g. 1 + 2 + 4 = 7 = Registry + Registrar + Registrant	

In hindsight, the total number of questions could have been reduced to a more manageable number, as well as excising the common questions from each questionnaire and having them as a single, seventh questionnaire to be answered once by all respondents.

4.2.3 Language and Translation

Translation of the questions (initially written in English) into the three other languages was not without its challenges. As the subject matter was highly technical, with specific terminology, standard translation services were unlikely be effective, instead team members were relied on for translation, with outside help enlisted in some cases. The translators had a relatively convenient method to execute the translation, whereby they could choose a question, and see all translations. By starting with automated translations and relying on translators to check and correct these, the time required for translation was reduced significantly.

4.2.4 Questionnaire Statistics

There were six questionnaires, one each for:

- Registry;
- Registrar;

- Registrant;
- Regulator;
- Reseller;; and
- IXP Manager.

Each questionnaire was available in four languages:

- English;
- French;
- Arabic;; and
- Portuguese

Table 2: Questionnaire Statistics

Questionnaires	6
Languages	4
Total Question text strings	1056
Total Fixed Answer text strings	1352
Incidental text translations for web site	171

4.3 Data Gathering Strategy and Preparation

The data gathering strategy was based on four prongs: recruiting Respondents to complete the online surveys; obtaining suitable zone files for analysis; interviews with relevant role players in the industry; and desktop research. Knowledge of the DNS industry in Africa was used to map out a strategy for Team Members to follow in contacting individual respondents.

4.3.1 Team Members

Three groups were used to address the 54 countries: the initial Team Members, most of whom are Johannesburg based (Loren Kabosha of the SACF[21] plus other SACF staff members; William Stucke of William Stucke Associates[22]; Mark Elkins of Posix Systems[23]); Sami Salih of the Sudan University of Science and Technology; Anriette Esterhuysen and Mike Jensen of the Association

[21] South African Communications Forum - one of several industry associations in South Africa
[22] A niche telecommunications consultancy. William is a long-standing campaigner for telecommunications liberalisation in Africa and is a former ISP and a former Regulator.
[23] One of South Africa's oldest ISPs. Mark wrote the original software that ran the .CO.ZA Registry for many years.

for Progressive Communications' (APC)[24] which has existing relationships with its African member organisation and partners, many of whom were specifically contracted for this project; and other prominent African Internet figures known to Team Members.

4.3.2 Training

Training sessions were made available for all Team Members and conducted weekly, for over 10 sessions. A slide presentation was made available to Team Members, and an online conferencing system provided by SudREN was used to go through the presentation, explaining the process and concepts. Participants were able to ask questions by text and speech, and recordings of the sessions were made available on the Admin website for Team Members.

4.4 Data Analysis Procedures

The database contains 264 unique questions (repeated in all four languages, and some also reused in multiple questionnaires, for a total of 1018), with 35,473 answers collected. The data was exported to MS Excel for further analysis. Despite a large team which not only signed up more than 1400 potential respondents (database users), but also made a concerted effort to persuade users to complete their questionnaires, a total of only 308 questionnaires were completed by 209 individuals in time for analysis (some individuals answered multiple questionnaires on behalf of the different groups). Thus, 15% of respondents provided a 22% response rate by questionnaires answered. This is a reasonable success rate under the circumstances.

Although at least 2 users per country were identified (except for Guinea-Bissau (GW)), with up to 296 for South Africa, for nearly half of the countries – 22 in total – there were no completed questionnaires at all. Note there were actually users from 68 countries, including the UK, USA and various European and Asian countries. Similarly, despite repeated requests to the Registries identified, only eight were willing or able to provide their Zone Files - five countries, and the three South African City gTLDs.

To complement this questionnaire data, analysis was made of data from other sources, which addressed some of the gaps. Wherever practical, the data was displayed 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

[24] APC is a worldwide network of social activists who use the Internet to make the world a better place. APC is both a network and an organisation. APC members are groups working in their own countries to advance the same mission as APC. APC has more than 47 members from five continents.

where appropriate, and often shown as X-Y Plots. Logarithmic scales were quite often needed due to the large range of values measured.

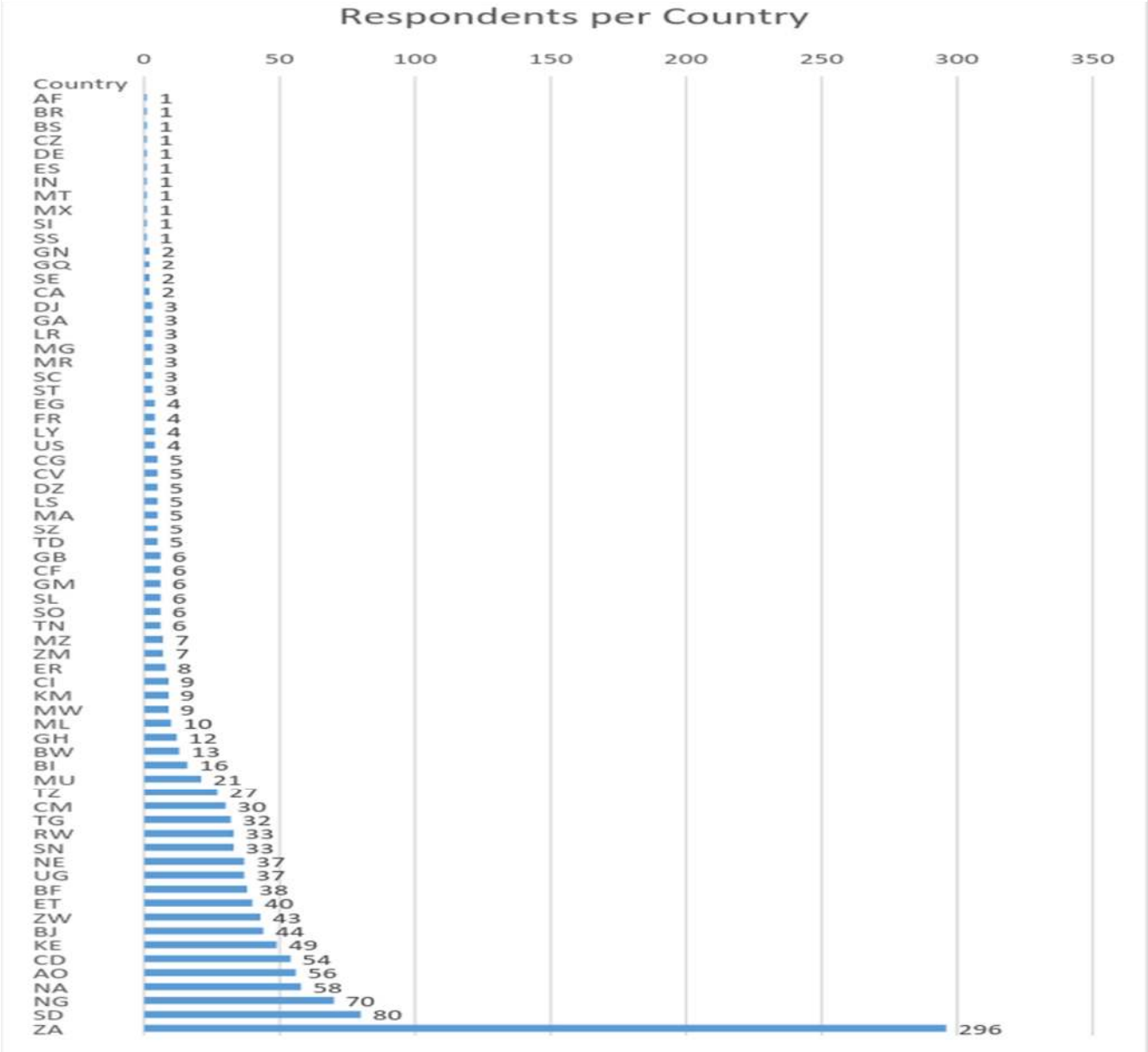
Table 3: Questionnaire Responses by Stakeholder Group

Stakeholder Group	Completed Responses
Registry	26
Registrar	34
Registrant	176
Regulator	16
Reseller	20
IXP Manager*	36
TOTAL	308

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

The graph below shows the number of respondents per country for those 32 countries which had completed questionnaires.

Figure 3: Questionnaire Respondents by Country



5 THE AFRICAN DNS ECOSYSTEM

5.1 Africa Rising

This section provides an introduction to the broader African social, economic and Internet environment, and its impact on the Domain Name System on the continent.

Of the world's 15 fastest-growing economies and countries in 2010, ten were African, albeit off a low base in some cases. In eight of the past ten years, Africa has grown faster than East Asia, including Japan. Africa will account for 80% of the projected 4 billion increase in the global population by 2100. According to Drummond et al, the accompanying increase in its working age population creates a window of opportunity, which if properly harnessed, can translate into higher growth and yield a demographic dividend (Drummond P, Thakoor, VJ, and Yu, Shu). In spite of this great optimism, the outlook of things however, seemingly still looks exceedingly challenging in much of the continent, with most Africans living on less than two dollars a day.

Since independence, African growth has been mainly driven by primary production and export, and only limited economic transformation, against a backdrop of high unemployment and worsening poverty. The economic crises which extended into the 1990s and then rebounded in 2008 exacerbated the declining terms of trade. Unemployment remains high, with official estimates of around 25% in South Africa and Nigeria.

Despite its many problems and much 'afro-pessimism', a number of factors have been identified by certain commentators[25] as causes for optimism:

- Africa now has a fast-growing middle class, around 60 million Africans have an income of USD $3,000 a year, with a further 100 million projected in 2015.
- The rate of foreign investment has soared about tenfold in the past decade;
- Cross-border commerce, long suppressed by political rivalry, is growing, as tariffs fall and barriers to trade are dismantled;
- Africa's enthusiasm for technology is boosting growth. It has more than 600 million mobile-phone users—more than America or Europe.
- The health of many millions of Africans has also improved,
- Skills are improving: productivity is growing by nearly 3% a year;

[25] E.g. Economist (2011) 'The hopeful continent: Africa rising', The Economist, 3 December 2011, available online at http://www.economist.com/node/21541015.

- A bulge of better-educated young people of working age is entering the job market and birth rates are beginning to decline;
- Nationals working abroad are now the leading source of capital inflow.
- A property boom in cities such as Accra, Ghana, Dar es Salaam in Tanzania and other cities of the continent;
- Growth has also been stimulated by the travel industry;

In spite of the 'Africa Rising' inspirational narrative, there remain glaring realities that continue to test the continent. The International Monetary Fund (IMF) has made a forecast that economic growth in sub-Sahara will fall to its lowest level in more than 20 years. Weak commodity prices and a tightening of the global financial markets are the cause for this gloomy outlook affecting most of the countries in the sub-Saharan region. "Terrorism and humanitarian crises in countries including Mali, Nigeria, Cameroon and Chad have also contributed to the malaise; while the drought in Southern Africa has affected Lesotho, Malawi, Zambia and Zimbabwe", Abebe Selassie (IMF: Africa Director). Selassie also added that 19 countries continue to enjoy robust growth, including Ethiopia, Senegal and Tanzania, with economic output set to expand by 6%.

The 2016 Ibrahim Index of African Governance[26] (IIAG) which was commissioned by the Mo Ibrahim Foundation, projected similar and cautious sentiments to those pronounced by Selassie. The index results indicate that the pace of progress across the continent is slowing down especially on levels of security and economic opportunities.

The report further suggests that African markets are increasingly open for business. The **2013** Ernst & Young Report titled "Doing business in Africa from strategy to execution"[27], reported that, "the size, diversity and inherent complexity of doing business across the continent will continue to test even the best-laid corporate strategies for growth in Africa. Yet the rewards to be had are very real, and African governments and communities will continue to welcome responsible and committed investment". The report concludes by stating that, fostering good, proper relations with all levels of government will continue to be vital to realizing strategic aims.

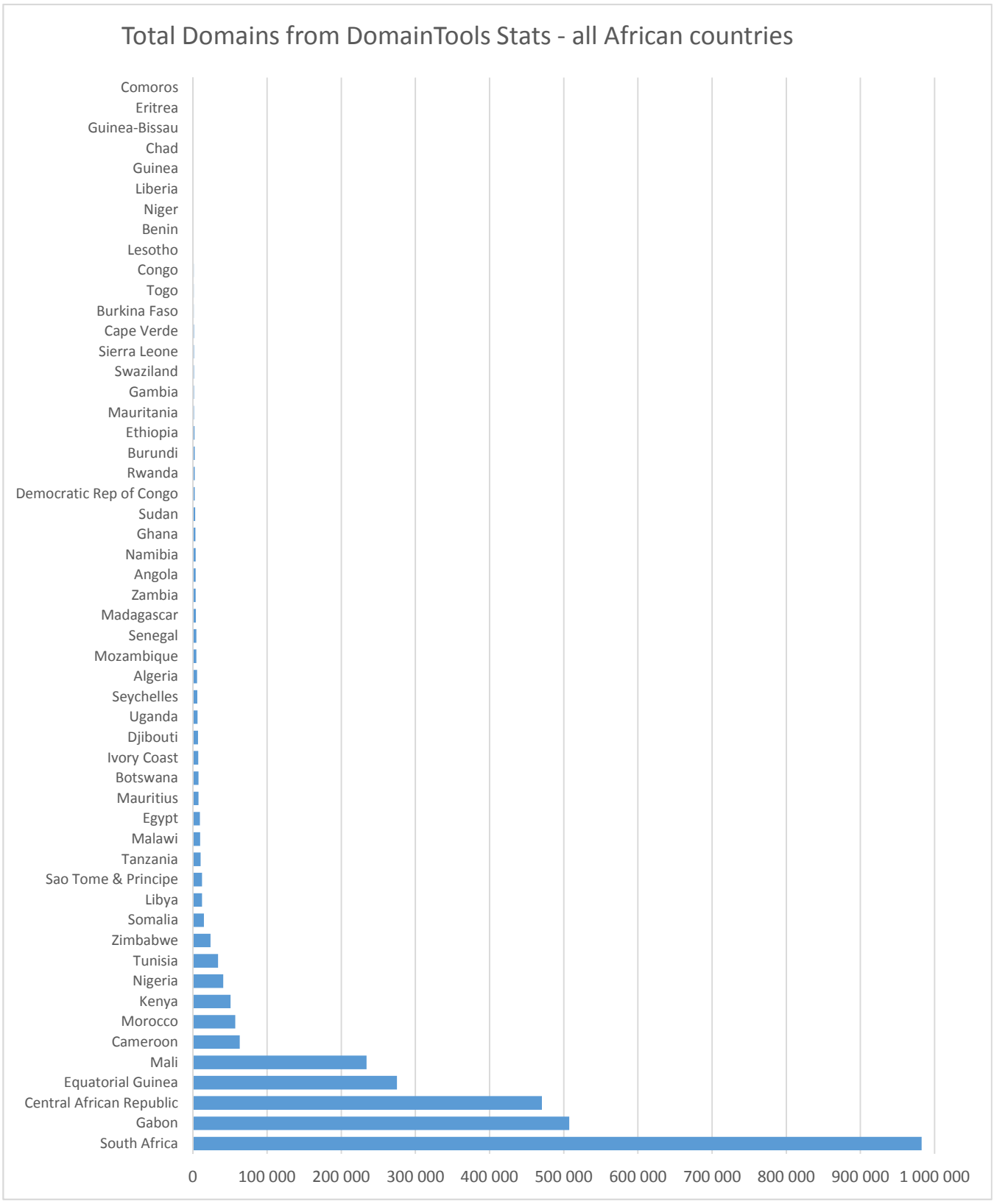
[26] http://mo.ibrahim.foundation/news/2016/progress-african-governance-last-decade-held-back-deterioration-safety-rule-law/
[27] http://www.ey.com/za/en/newsroom/news-releases/2013---press-release---march---african-markets-increasingly-open-for-business-but-positive-mindset-required

5.2 The African Domain Name Space

There are 54 countries counted as part of "Africa" by ICANN, and served by the African RIR, AfriNIC. They are countries on the continent of Africa, as well as certain Indian and Atlantic Ocean islands. The ccTLD for one country, Southern Sudan (SS) has not yet been delegated. There are three new "dotCITY" gTLD domains: .CAPETOWN, .DURBAN and .JOBURG, with the .Africa gTLD delegated very recently

In addition to traditional ccTLDs, a number of Arabic countries in Africa also have Internationalised Domain Name (IDN) ccTLDs, which are domain names that do not use the restricted subset of 63 ASCII characters as specified by RFC 883 of 1983 (since superseded).

The graph below shows the total number of domains registered under each African ccTLD. It will be noted that a number of countries have a disproportionately high number of domains registered. This is because domains under these ccTLDs are either provided "free" by registrars which 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 6.3.3.


Total Domains from DomainTools Stats - all African countries
Comoros
Eritrea
Guinea-Bissau
Chad
Guinea
Liberia
Niger
Benin
Lesotho
Congo
Togo
Burkina Faso
Cape Verde
Sierra Leone
Swaziland
Gambia
Mauritania
Ethiopia
Burundi
Rwanda
Democratic Rep of Congo
Sudan
Ghana
Namibia
Angola
Zambia
Madagascar
Senegal
Mozambique
Algeria
Seychelles
Uganda
Djibouti
Ivory Coast
Botswana
Mauritius
Egypt
Malawi
Tanzania
Sao Tome & Principe
Libya
Somalia
Zimbabwe
Tunisia
Nigeria
Kenya
Morocco
Cameroon
Mali
Equatorial Guinea
Central African Republic
Gabon
South Africa
0
100 000
200 000
300 000
400 000
500 000
600 000
700 000
800 000
900 000
1 000 000

5.3 Internet Use

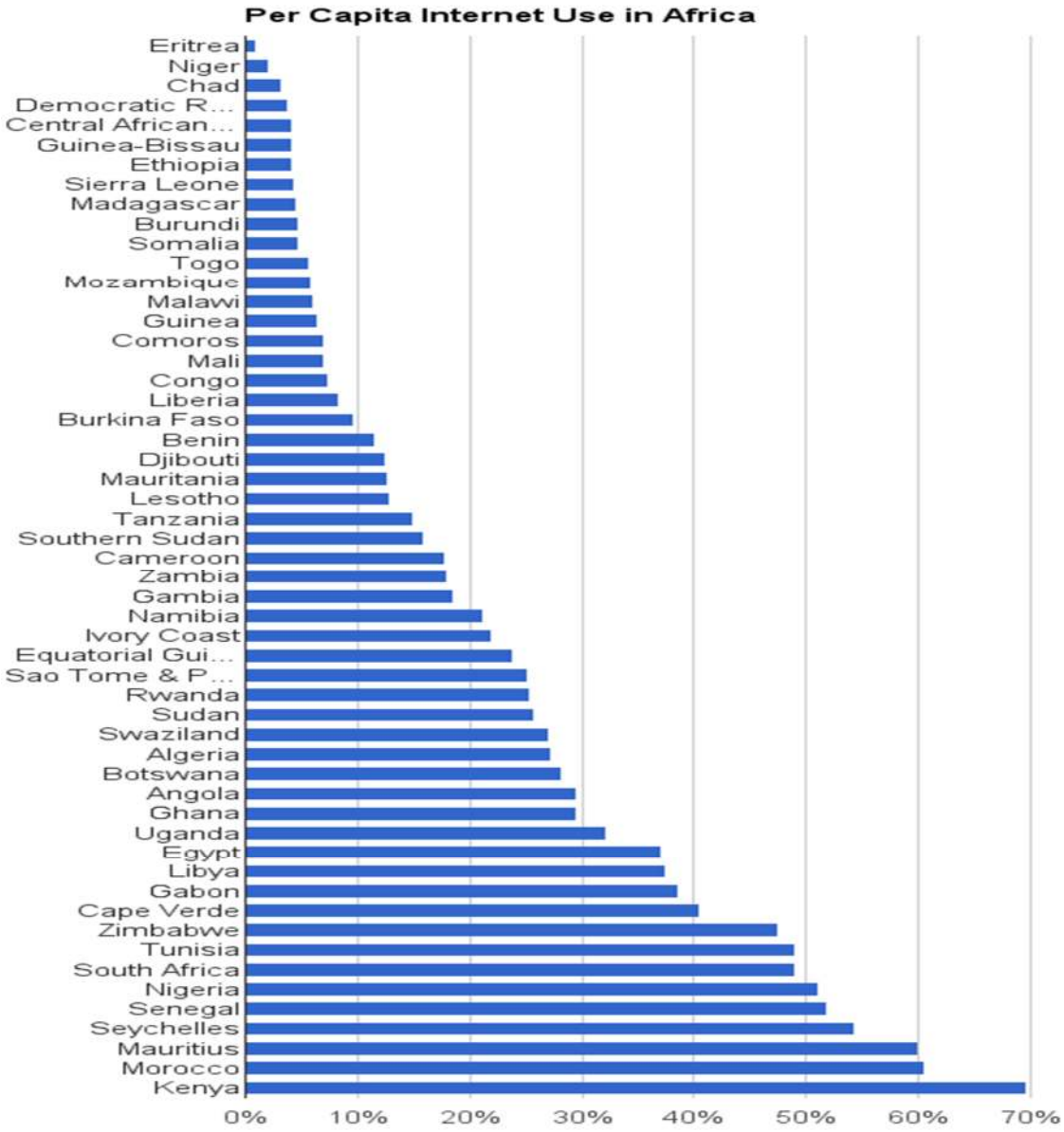
While there is a wide variation between the countries in Africa, as a whole the continent lags behind other regions in the use of the Internet and in the development of its local Internet industry. This variation can also be seen most notably in Sub-Saharan Africa, (which contained about 980 million people in 2015 versus 380 million in North Africa, which includes Sudan), which has a comparatively lower rate of development. Most Africans access the Internet using mobile phones. In 2015, the number of mobile broadband subscriptions per hundred people in Africa was estimated at just over 10%[28] compared to a world average of about 47%[29]. However this figure obscures wide variation between countries. As shown in the chart below, Internet uptake varies 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.

Although 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, 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 the report, and as shown in the chart below, which underlines the wide variation in Internet uptake across the continent.

[28] http://www.gsma.com/newsroom/press-release/number-of-unique-mobile-subscribers-in-africa-surpasses-half-a-billion-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. https://www.apc.org/en/blog/inside-information-society-internet-governance-nee

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

Figure 4: Per Capita Internet Use



The varying levels of Internet uptake shown above also needs to take into account that it is 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, the majority of 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 - as costs cannot be predicted, thus creating a further chilling effect on use.

Access to cost-effective local Internet infrastructure has a direct impact on the potential growth of local content demand and supply, 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.

5.3.1 Digital Literacy

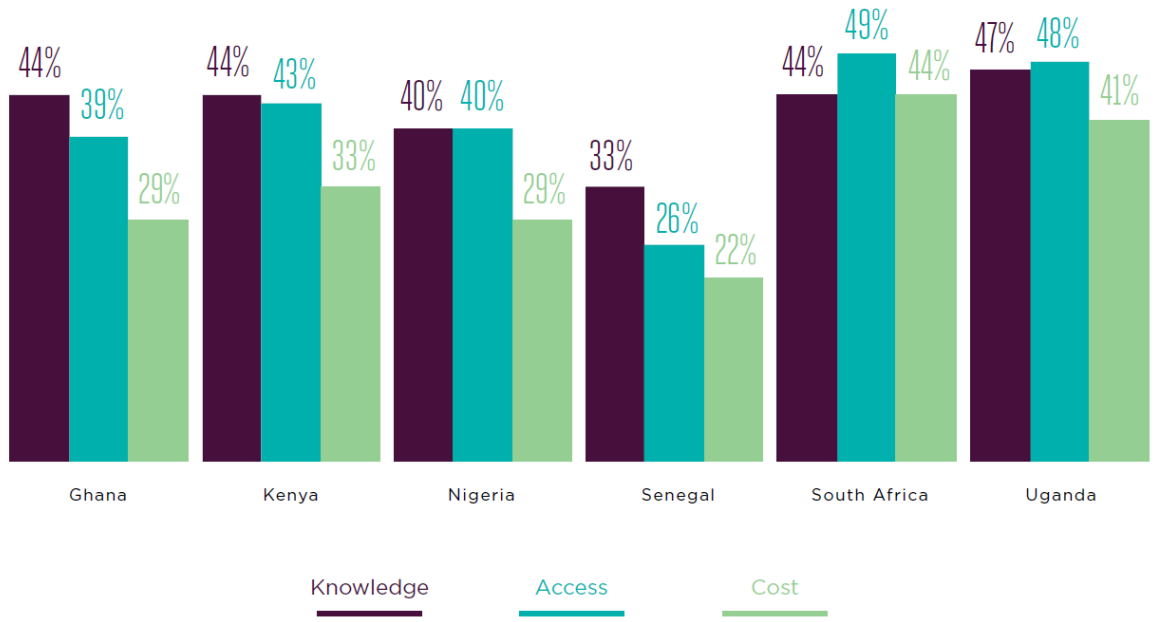
Basic illiteracy, digital illiteracy and lack of Internet awareness are said to be among the consumer barriers to Internet adoption (2014 GSMA Digital Inclusion Report). Digital Literacy covers users' ability to use digital tools to communicate access, manage, integrate, synthesize and use information in order to achieve learning and other life goals within their unique context. 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's.

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," (Scardamalia, 2003). According to the 2014 GSMA Digital Inclusion Report, in 2011 there were 774 million illiterate adults globally, with developing countries accounting for the majority of this population. Further the report notes that lack of English literacy prevents many native language speakers from using the mobile Internet. This highlights that literacy outcomes must account for proficiency in basic language as well as technology. This suggests that "a set of skills that allows a user to not only access the Internet, but to navigate websites, and evaluate and create information through digital devices" is required, added the report.

According to the 2014 GSMA Digital Inclusion Report lack of English literacy further prevents many native language speakers from using the mobile Internet. This highlights that literacy outcomes must account for proficiency in basic language as well as technology. This suggests that "a set of skills that allows a user to not only access the Internet, but to navigate websites, and evaluate and create information through digital devices" is required, added the report.

Figure ?? below outline findings on the reasons why people in 6 African countries (Ghana, Kenya, Nigeria, Senegal, South Africa and Uganda) do not use the Internet. Knowledge, access and costs were cited as some of the reasons for the lack of use.

Figure?? Why do people not use the Internet?



Source: Google and Basis Research as cited in the 2014 GSMA Digital Inclusion Report

In pursuit of better understanding of the state of digital literacy across the continent, a study titled 'The African Digitalization Maturity Report 2017', was carried out by Siemens. Its findings were that South Africa has the highest digital literacy levels in Africa. The other countries that were included in the survey are Kenya, Nigeria, and Ethiopia. South Africa scored highest in the digital maturity assessment, except for digital training (Internet access in schools). South Africa's score was very close to the international benchmark in the area of access and use, with 100% mobile network coverage and 93% 3G coverage. It is also important to note that South Africa is supported by a macro-economic environment that is relatively more "digitally ready" than its African neighbours.

The African Union (AU) has had to grapple with the reality that many of its member state's citizenry are not getting online. Also, that the digital revolution is not transforming the lives of the citizens because they lack digital skill; they grapple to find an Internet that is relevant to them and critically; and that they cannot afford it. Many AU member states have had to generate ICT plans in order 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 AU **e-Africa Programme** is mandated with the task of leading the African ICT agenda in order 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 African Union's Comprehensive ICT Strategy for Africa 2015 – 2025. Capacity development remains key towards addressing the challenges that are facing the continent. Hence the need to promote digital literacy training programmes and also the development of e-learning based local and localised content and services.

Figure?? Below maps out the AU's strategic goals and envisaged outputs.

Figure xx Capacity Development

Strategic Goal/Theme	Strategy	Output
Capacity Development	Promote Digital Literacy, e-learnig and ICT for Education	ICT for Education and e-learning Policy Framework
		e-Learnining Capability and capacity
		Online Centres of Learning
		Digital Literacy Training Programmes
		Developed eLearning Based Content
	Promote development of specialist/expert capacity in Post & ICT	ICT and Postal Training needs identified
		ICT and Postal Training programmes developed and delivered
		Make a list of Training Institutions in the field of Post and ICT in the continent
	Promote and facilitate Knowledge Development and Management	Knowledge Collection and dissemination Platform
		Communities of practice and knowledge networking platforms
		Integrated Portals and Platforms across Regional and continental institutions
	Harness skills and expertise of African Diaspora in ICT development (cross-cutting across all strategic themes)	Database of ICT Experts in the Diaspora
		Increased participation of Diaspora in Programme Development and Implementation

Source: African Union Comprehensive ICT Strategy for Africa 2015 – 2025

5.3.1.1 Language Literacy and Impact of Local Content

One of the drivers of digital literacy is the availability of local content, which can be defined as content and information that has a direct impact on the everyday lives of people and can specifically address key needs and challenges in the communities where individuals live and work (2014, GSMA Digital Inclusion Report). Local content has a combination of local language, local relevance and is created locally. According to the report, the majority of 'local' content at present is international content simply translated, and a smaller volume of content is locally created and locally relevant.

Research informs us that across the globe, 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 Internet in developing countries. However, at present, the majority of content is in English and is largely focussed on data-heavy smartphone apps. The 2014 GSMA Digital Inclusion Report states that smartphone penetration is still low in the developing world and that English is not the primary language for the majority of the population, thereby limiting accessibility and usefulness of the content. In order 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 are a driver for use of mobile Internet.

The 2014 GSMA Digital Inclusion Report suggests that local content in developing countries should be relevant to rural populations, since approximately 50% of the population in these countries live in rural areas. The report affirms that creating content that is specific and relevant for developing countries is a difficult task.

Relevant 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, added the report.

5.3.2 Access to Smart Devices

Smart devices continue to drive Internet usage in Africa. Most African access the Internet using smart phones. Smart devices include smartphones, phablets, tablets, smartwatches, smart bands and smart key chains. However, in Africa, the most widely used smart devices to access the Internet are smartphones and tablets.[30] Moreover, 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.

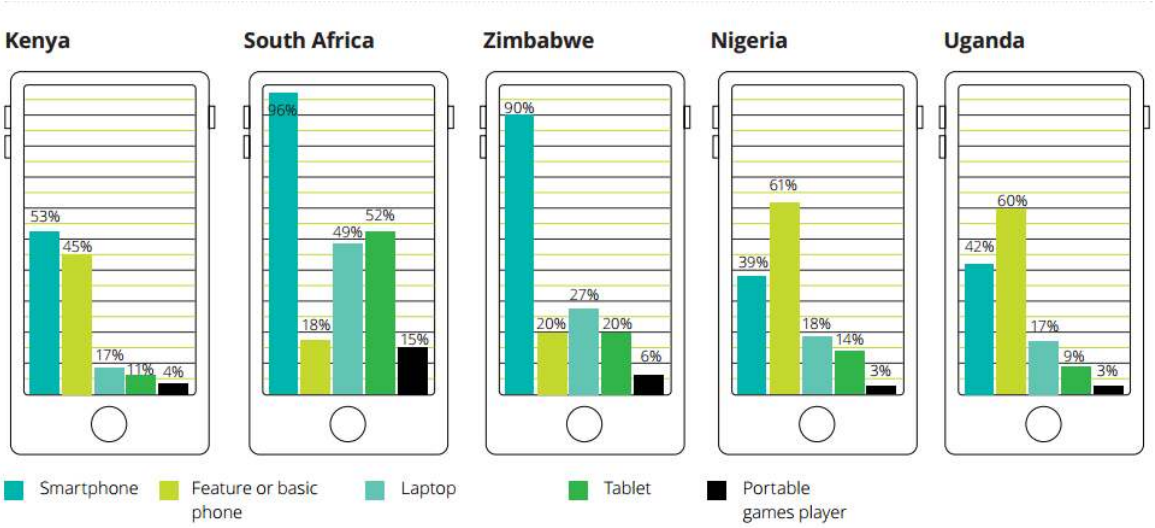


Figure 14. Proportion of Respondents who own Feature Phones vs Other Devices

Figure 1-1: Deloitte Mobile Consumer Survey[31]

Both South Africa and Zimbabwe have high smartphone penetration compared to countries such as Kenya, Nigeria and Uganda. There are also countries with low smartphone penetrations in Africa. Pew Global Research[32] indicated that the lowest levels of smartphone ownership are in poorer countries concentrated in sub-Saharan Africa. This includes smartphone ownership rates of two-in-ten or less in Senegal (19%), Burkina Faso (14%), Tanzania (11%) and Ethiopia (4%).

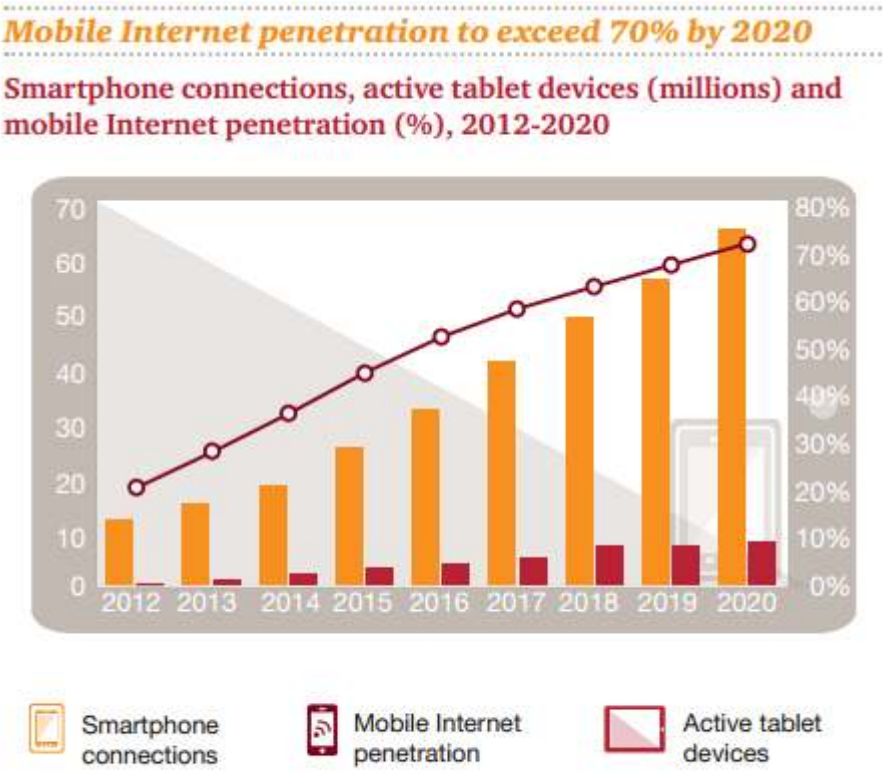
[30] https://www.ericsson.com/assets/local/mobility-report/documents/2016/ericsson-mobility-report-november-2016-rssa.pdf , Ericsson Sub-Saharan Africa Mobility Report.
[31] https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology-media-telecommunications/ZA_Deloitte-Mobile-consumer-survey-Africa-300816.pdf, Deloitte Mobile Consumer Survey Report
[32] http://www.pewglobal.org/2016/02/22/smartphone-ownership-rates-skyrocket-in-many-emerging-economies-but-digital-divide-remains/ , Pew Global Research Report

The availability of cheap smartphones over the next few years will enable segments of the population that are currently unconnected to incorporate Internet browsing into their daily experience, according to the Price Waterhouse Coopers (PwC) Entertainment and Media Outlook: 2015-2019 report33. In South Africa, some operators have launched basic entry-level smartphones[34]

Informa Telecoms & Media[35] projects that the number of smartphone connections in Kenya will exceed 12 million by the end of 2017. In Kenya, more than half of total Internet advertising revenue comes from mobile devices as smartphone owners continue to grow in number, helped by lower data costs coupled with growing 3G and 4G access[36]. 'Vodacom Group Limited trading update for the quarter ended 31 December 2016' attributes its data revenue growth to smartphone sales.

The PwC Report also estimates that Smartphone connections in South Africa will grow by around 160% from 24.8 million in 2015 to 64.6 million in 2020, leading to a penetration rate of 60% that will continue to fuel mobile Internet access revenue growth, and it says mobile Internet penetration will exceed 70% by 2020[37].

[33] 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.
[34] Such as Vodacom's Alcatel One Touch Fire smartphone for USD $7 per month on post-paid or USD $120 on a prepaid, and MTN's Steppa 2 smartphones ranging from USD $60 to USD $75 on prepaid
[35] Reference?
[36] 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.
[37] http://www.gsma.com/mobileeconomy/ GSMA Mobile Economy 2016



Sources: Entertainment and media outlook: 2016 – 2020 • South Africa – Nigeria – Kenya, PwC, Ovum

The most significant finding from another study was that Internet browsing via phones 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%)[38].

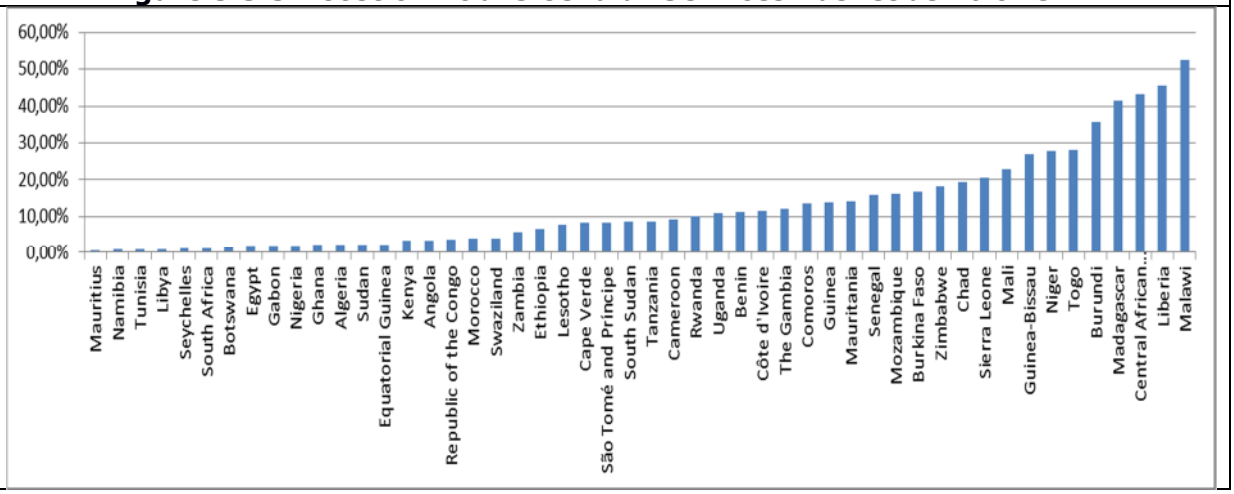
5.3.3 Cost to Communicate

Affordability of telecommunications services is a critical issue either enabling or hindering the uptake of online services. The affordability threshold of spending 2% or less of household income on access to telecommunications services is widely considered a key barrier. Households or individuals required to spend above this threshold for a pre-defined basket of services are considered to be substantially inhibited in their ability to uptake and use services enabled on ICT platforms. Affordability is one of the issues tracked by the International Telecommunication Union in their annual Information Society reports.

[38] http://www.worldwideworx.com/ , http://calleo.co.za/mobile-africa-2015-african-phone-use-decoded/

Affordable access to mobile communications services is a key issue in relation to Internet access in Africa, where the access path is so predominantly via mobile telephones. In countries where mobile services are costly, 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 pre-defined basket of mobile cellular services, with costs ranging from 0.6% of Gross National Income per capita (Mauritius) to a prohibitively expensive 53% (Malawi). The raw US dollar prices for the same pre-defined basket range from USD $1.13 (Seychelles) up to USD $23.87 (Cap Verde).

Figure 5.3.3: Cost of Mobile Cellular Services Basket as % of GNI[39]



When it comes to Internet access more specifically, affordability is similarly a key issue affecting Internet access, uptake and usage. The ITU reports that African users can expect to pay on average 9.5% of gross national income for 500 MB of handset-based prepaid data, an order of magnitude more than the cost of the same amount of data in Europe (0.59%). The gap is similarly staggeringly large for 1 GB of post-paid fixed link data, which costs 21% of gross national income in Africa compared to 0.7% in Europe[40]. The range of prices across Africa also varies far more widely than in other regions, with the most expensive countries costing between 40 times and 107 times more than the cheapest.

[39] ITU (2016) 'Measuring the Information Society Report 2016', International Telecommunication Union, Geneva, available online at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf, p 107.
[40] ITU (2016) 'Measuring the Information Society Report 2016', International Telecommunication Union, Geneva, available online at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf, p 135.

Expensive Internet access and costly data translates into limited uptake of Internet and broadband services. This in turn means limited demand for Domain Names and a sluggish DNS market.

Registries and Registrars across Africa would, therefore, be well advised to engage policy-makers and regulators with respect to the high cost of telecommunications services and the high prices of data. Moves in this direction have already taken place in a number of countries, where regulators - under pressure from the consumers of mobile voice telephony - have moved decisively to lower mobile termination rates (e.g. Botswana, Kenya, Mozambique, Namibia, South Africa, Tanzania, Uganda), and hence have increased the affordability of mobile telephony for consumers[41]. Similar interventions with regard to data prices are still in their infancy[42].

5.4 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, and
    b. 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 connection to the end user, usually provided by the 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 spectrum. Fibre to the home (FTTH) is also beginning to be a factor in several African countries.
3. The interconnection (IXP) and data centre/hosting facilities necessary to support interconnection between networks and to online services.

[41] Stork, C & Gillwald, A (2014) 'Link between termination rates and retail prices in Namibia, Kenya and South Africa', *Telecommunications Policy* No 38
[42] 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/

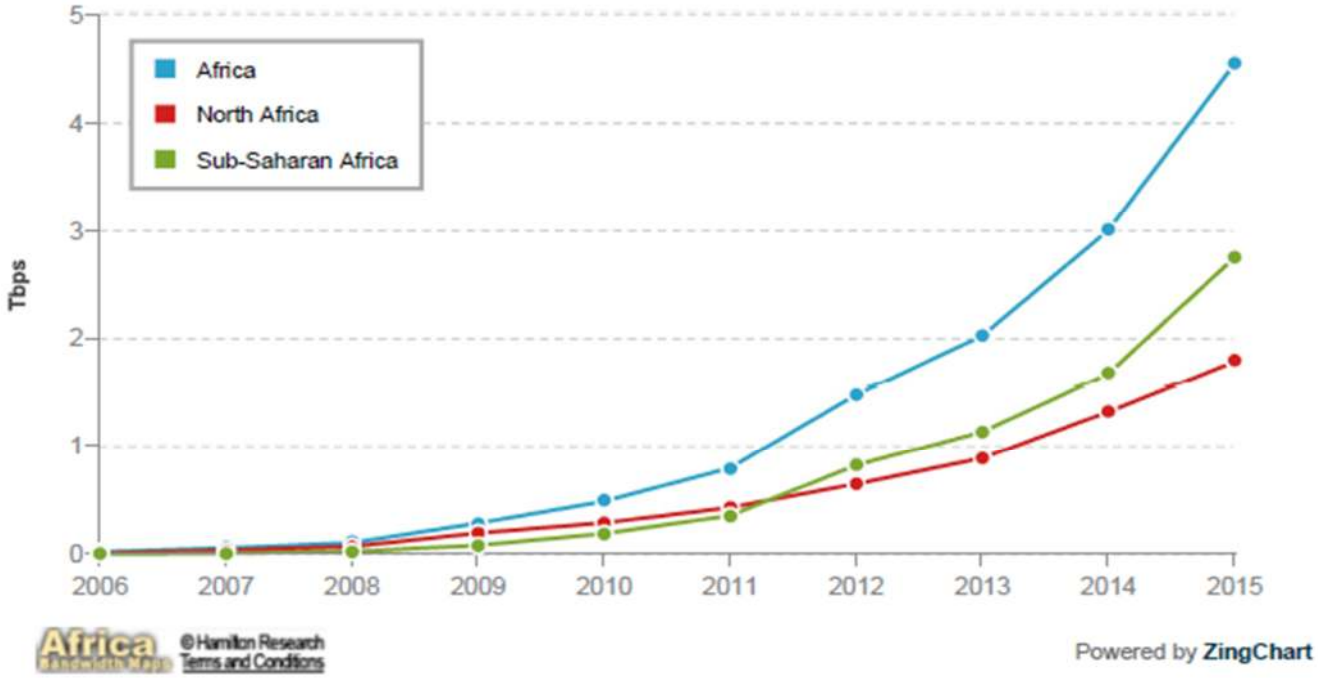
5.4.1 Backbone Infrastructure

As shown in the map below, the penetration of backbone fibre infrastructure in Africa has increased rapidly over the last decade, especially in terms of the large number of submarine cables that now encircle the continent. All the coastal countries except Guinea Bissau and 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 this in turn has driven down the price of international capacity to levels of as little as US $20 / Mbps / month in countries where there are multiple competing cable landings. Only a decade ago, prices were as high as US $20,000 / Mbps / month[43] [44] [45]

International bandwidth demand has demonstrated enormous price elasticity, with the continent's inbound Internet bandwidth consumption increasing by 51% during 2015, and reaching 4.555 Tbps by December 2015. Africa has shown a CAGR[46] of 55.8% from 2010 - 2015, which implies that it should have exceeded 7 Tbps by December 2016.[47] 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.

[43] http://www.saide.org.za/resources/0000000390/Fair%20Access%20to%20Internet%20Report.pdf
[44] https://www.siemens.be/cmc/newsletters/index.aspx?id=13-451
[45] https://www.apc.org/en/press/east-africa-needs-fair-entry-ticket-afford-cybersp
[46] CAGR = Compound Annual Growth Rate
[47] http://www.africabandwidthmaps.com/?p=5186

Figure 5: Africa International Internet Bandwidth, 2006 - 2015

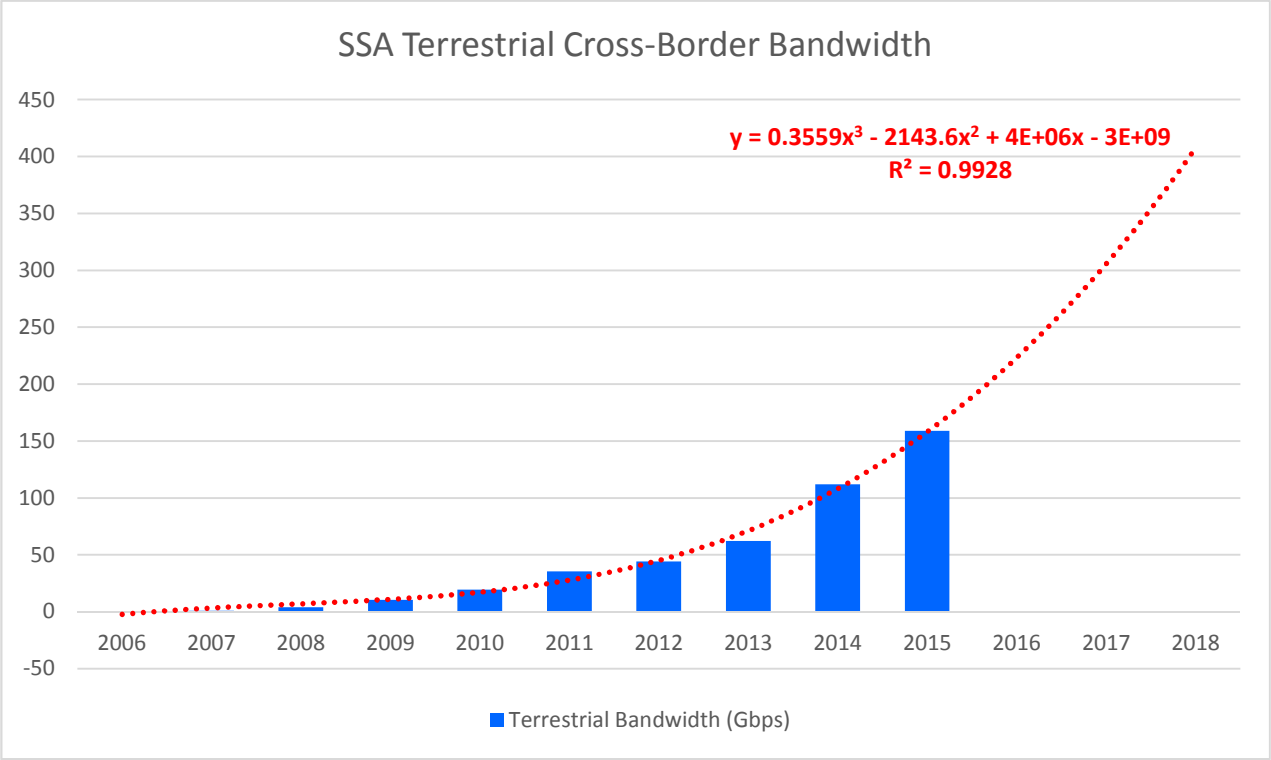


National fibre backbones are being further extended or are being built in virtually all countries in Africa and now connect most secondary cities. Multiple cross border fibre links are, or will shortly be, present on all major routes[48], although it will still be some years before all the necessary interconnections are in place to provide seamless terrestrial connectivity across the continent. Further extensions of national backbones to more remote areas are still needed to ensure that the large rural populations present in Africa can be connected cost effectively.

Of the total bandwidth of 2.759 Tbps in Sub-Saharan Africa by December 2015, 159 Gbps (5.7%) was supplied by terrestrial cross-border networks connected to submarine cables. The completion of new cross-border links, and the expansion of capacity on others, has seen the volume of intra-regional traffic backhauled to submarine cable landing points increase by 42% in the last year to reach 159 Gbps in December 2015.[49]

[48] As shown in the Afterfibre.nsrc.org map below
[49] http://www.africabandwidthmaps.com/?p=5186

Figure 6: Sub-Saharan Cross-Border Bandwidth



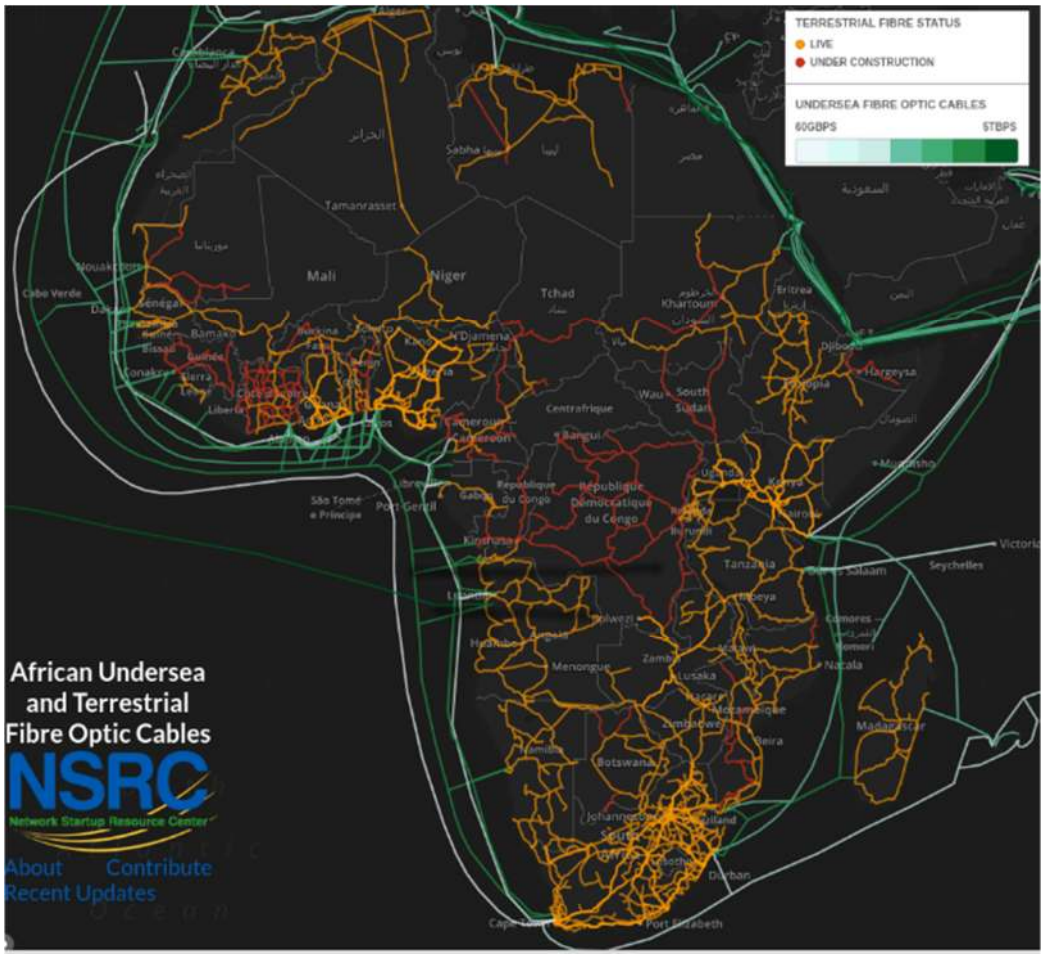
Despite the impressive growth in domestic backbone infrastructure, prices for domestic capacity still remain relatively high, usually much higher than the cost of international capacity. As a result it is cheaper, for example, to connect from Lagos to London than it is to connect from Lagos to Abuja. The relatively high cost of domestic capacity will continue to be one of the chief constraints to providing affordable high bandwidth services until more regional operators emerge and increased competition takes place, or wholesale price controls or similar measures are imposed on dominant operators by regulators. This also has special importance for the landlocked countries, which must pay for transit through their neighbours to gain access to the submarine cables. To remedy this, ECOWAS countries in West Africa are in the process of implementing an agreement to ensure that the land locked countries of Mali, Burkina Faso and Niger are able to obtain equal access to submarine capacity.

Currently the market in many countries has been limited by African operators which have adopted a 'High Price, Low Volume' business model'. Nevertheless, international and regional operators such as SEACOM, EASSy and Liquid Telecom are now disrupting the market with a 'High Volume, Low Cost' model which has resulted in reductions in the cost of international traffic of several orders of magnitude. Indeed, costs of submarine fibre capacity per Mbps per month

have reduced from as much as USD $20,000 just over a decade ago to as little as USD $15 – less than 0.1%. As a result 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 map below also highlights the extensive fibre networks present or under construction in most countries on the continent[50], although there is currently a lack of backbone and cross border infrastructure in central Africa in particular, as well as across the sparsely populated areas of the Sahel.

Figure 7: African Undersea & Terrestrial Fibre



[50] Egypt is 'dark' due to the lack of public information on fibre infrastructure in the country.

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

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

Because of the high cost of domestic capacity, currently traffic between different countries and regions in Africa largely transits over submarine cables. But over the next two years it is expected that cross-regional fibre infrastructure will be in place that can carry traffic terrestrially between most countries on the continent. Combined with the additional cables that are planned to link Africa directly with South America, and the potential to carry traffic to Europe via North Africa and the Mediterranean cables, it is expected that the cost of transit will drop sufficiently to encourage the establishment of more local and regional hosting and related DNS services (see Section 4.2.3 below).

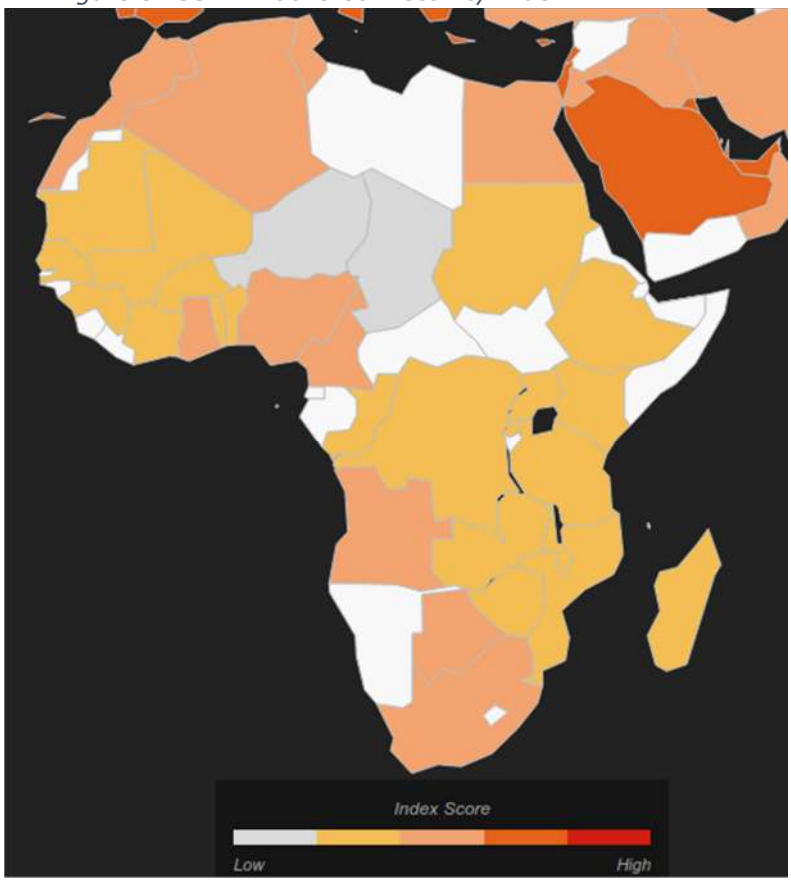
5.4.2 Local Access Infrastructure - the Retail/Local Loop

It is currently estimated that only about 29% of the African populace has Internet access[51], primarily access via smartphones. With the limited deployment of copper cable in Africa, most Internet connections are provided by national mobile operators. The GSMA estimates that 2G mobile voice uptake reached 54% of the population on the continent 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 estimated that 3/4G mobile subscriptions in Africa will rise to 573 million by 2019, up from 23% of total mobile subscriptions to 42%[52].

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.

[51] http://www.internetworldstats.com/stats1.htm
[52] http://isoc-ny.org/afpif2015/AfPIF2015_Teleography.pdf

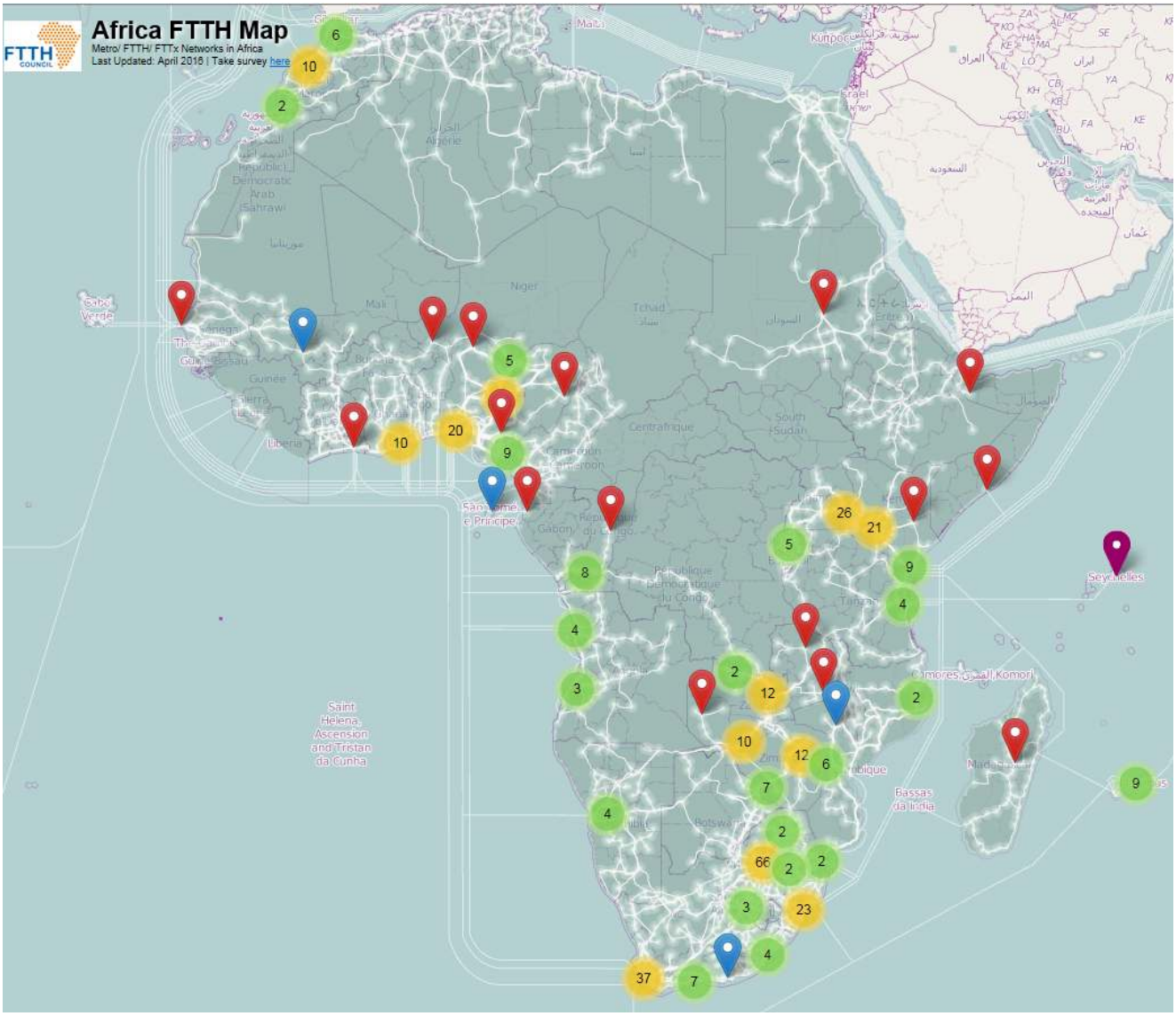
Figure 8: GSMA Mobile Connectivity Index



Source: GSMA[53]

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 on the continent, 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 in Africa. 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

[53] http://www.mobileconnectivityindex.com/#globalRankings=overall



es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka and Nairobi. As a result these cities also lead in provision of fibre to the premises (FTTx) as shown in the map above[54] [55].

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

[54] http://www.africabandwidthmaps.com/ftth/

[55] 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

trials using dynamic spectrum assignment technologies have now successfully taken place in Ghana, Kenya, Malawi, Namibia, South Africa, Tanzania and Zimbabwe, and along with Wi-Fi, TVWS technology is likely to be increasingly used for connecting rural areas, due to the superior propagation characteristics of the radio frequencies available in the largely unused VHF and UHF 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.[56] [57]

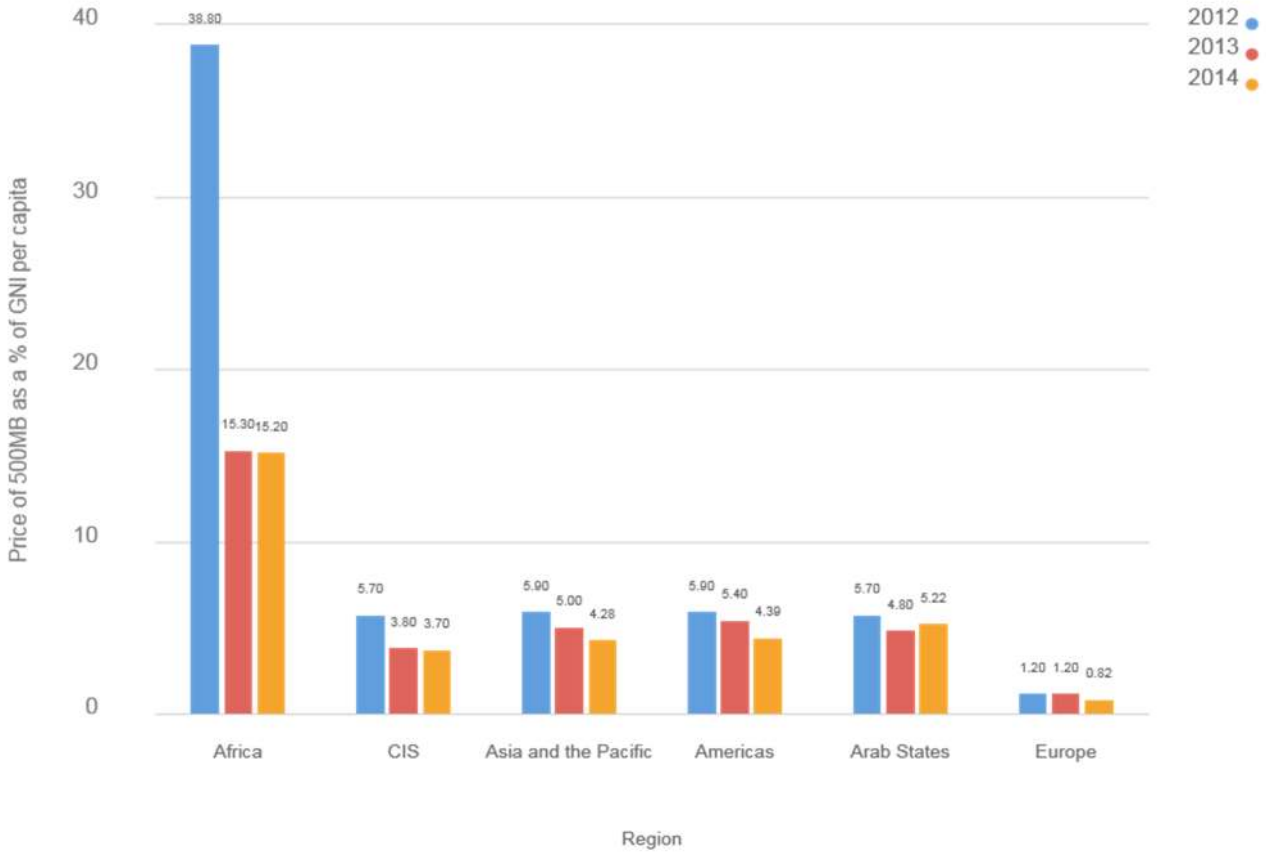
Conservative spectrum assignments continue to restrict the potential for new providers looking to make use of the latest technologies. For example, fixed broadband operators can use new wireless systems such as TV white spaces (TVWS) and other dynamic spectrum-sharing approaches. However, so far only the Philippines has had the vision to make it a national priority to use these systems to help address connectivity issues. In many countries national regulators are not aware that most of the frequencies in TV wavebands are unoccupied, and the traditional occupants of the frequencies – the broadcasters – often do not understand the technology that makes it possible to share the frequencies without interference. In addition, incumbent operators use their high spectrum licence fees as a way of obtaining commitment from regulators to maintain their exclusivity over wireless markets.

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.

This is due a variety of reasons, but in particular due to high usage costs, as well as slow speeds. The mobile services used by most people usually have metered access and tariff caps which constrain the amount of data that can be exchanged affordably. In addition, complex tariff packages can limit competition and restrict the user's ability to manage costs effectively. The Alliance for Affordable Internet[58] (A4AI) estimates that for only 500 MB of monthly data — enough to watch just two minutes of video a day — the average African has to pay over 15% of their monthly income, compared with the average European, who pays less than 1%.

[56] http://www.gpwonline.co.za/Gazettes/Gazettes/39302_19-10_Icasa.pdf
[57] http://www.apec.org/~/media/Files/Groups/TEL/DSG/2015/15_tel51_dsg_wksp1_002.pdf
[58] http://a4ai.org/affordability-report/report/2015/

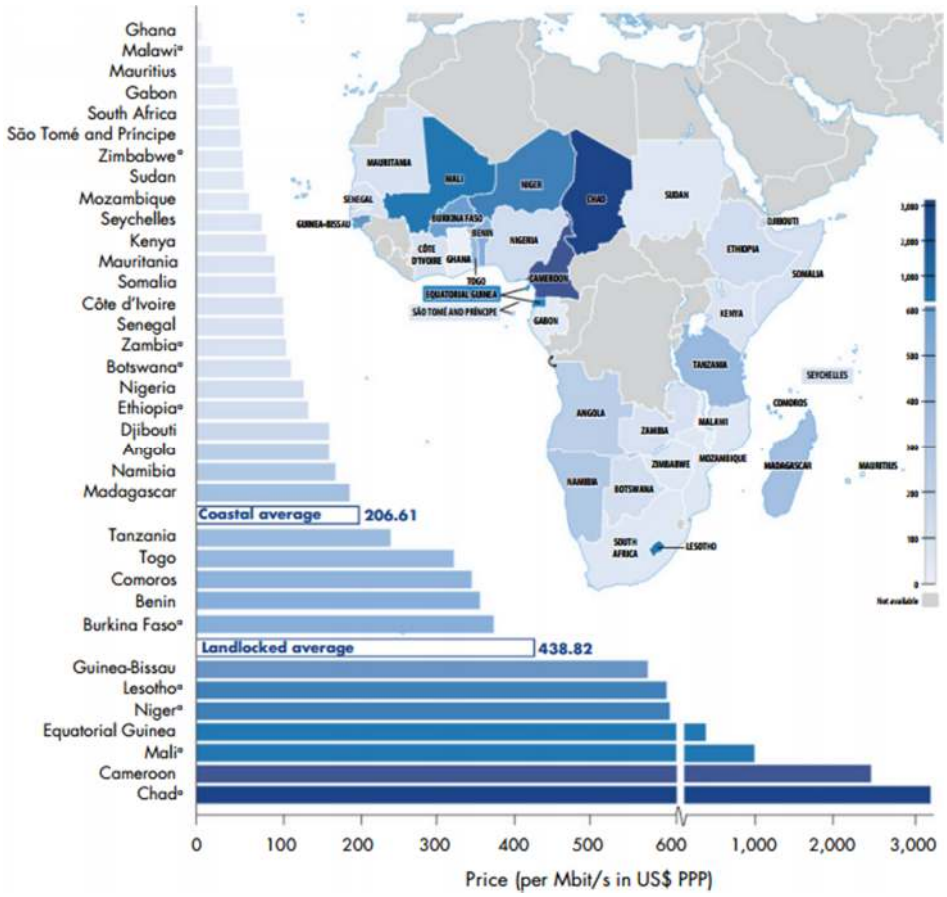
The average price of a 500 MB (prepaid, mobile) broadband plan as a % of GNI per capita, by Region[59] is shown in the chart below, which shows substantial improvement since 2012 in Africa, but still highlights how much more expensive Internet access continues to be, compared to other regions.



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%[60]. Landlocked countries exhibit the highest prices on the continent, as shown in the chart below from the World Bank's Digital Dividends 2016 report[61].

[59] http://a4ai.org/affordability-report/report/2015/#highest_adi_scores_among_least_developed_countries_(ldcs)
[60] http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2016/ITU_Key_2005-2016_ICT_data.xls
[61] http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement-PUBLIC.pdf#page=238

Figure 12: International Bandwidth 2015



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

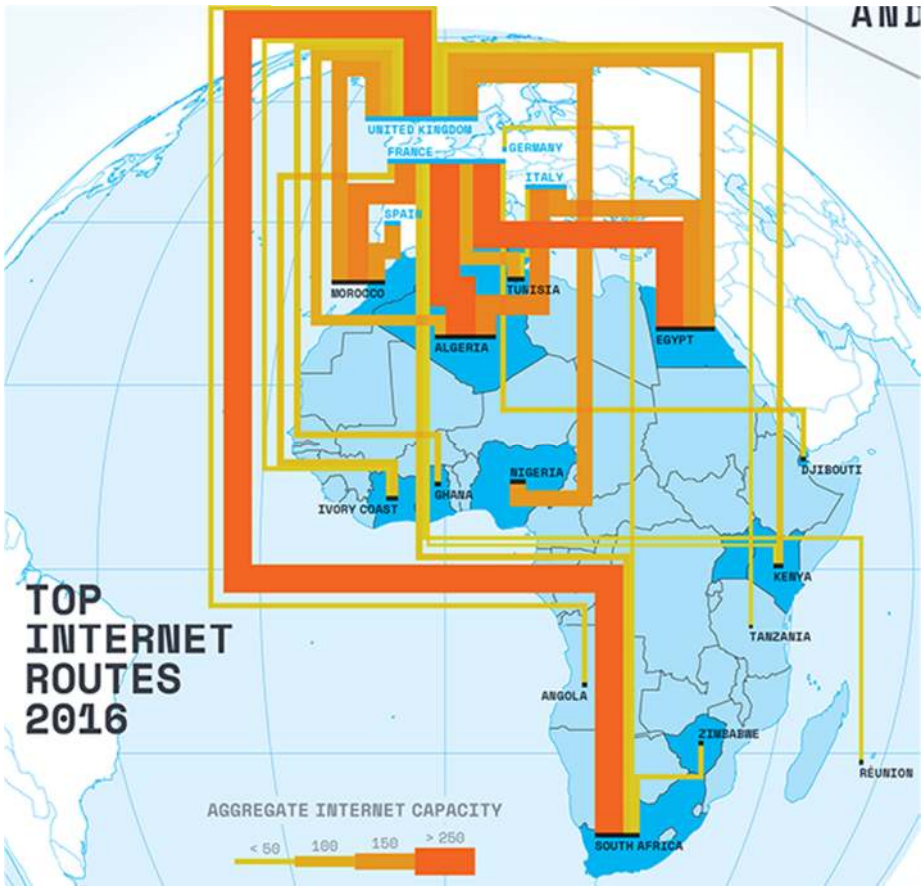
- it confines extensive use of the Internet to the very small proportion of the population that can afford it, and hence acts as a brake on in-country provision of Internet enabled goods and services;
- it may limit demand for domain names, because sites with less well-known domain names are less likely to be part of a Zero Rated service[62] such as Facebook or Wikipedia.

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

In addition, mobile network operators do not normally provide Registrar services, so for the majority of 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.

Figure 14: International Bandwidth 2015



Source: Telegeography 2016[63]

Based on the Hamilton Research data for total international bandwidth used in Africa - estimated at about 7 Tbps by the end of 2016 - this works out at only about 5.6 Kbps per capita.

5.4.3 IXPs and Data Centres

The presence of data centres, IXPs and related hosting and caching infrastructure is a critical building block for supporting the development of online services and domain name servers, and in turn, demand for domain names. Without IXPs and related local services such as DNS, o often referred to as "the building blocks of the Internet"[64] [65], much domestic traffic must flow over expensive and slower international links, including domain name lookups.

5.4.3.1 IXPs

While the potential cost savings was usually the primary reason for building and joining an IXP – exchanging local data locally, rather than over expensive international links[66]. This is no longer true, and in many African countries international traffic is significantly cheaper than local traffic. While this was indeed important, and in the early days of IXPs in Africa the potential volume of this data was grossly underestimated, there are other factors which are equally compelling. The first of these is the enormous decrease in latency resulting from reducing intercontinental hops, down from ~200 milliseconds (fibre) or ~ 600 milliseconds (satellite), to a few milliseconds when data is exchanged in the same location.

For the end user, loading a web page with dozens of embedded web services and associated domain names, performance improves dramatically if the DNS lookups and the data are available locally (IXPs are usually the location for caching servers of content providers). This leads to a dramatic increase in network efficiency. 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, and thus increases reliability. Finally, once the shortest path between two local ISPs is no longer via the UK, US, or other intercontinental route, it makes sense to host websites locally.

[63] africa-map-2017.telegeography.com
[64] https://www.ifex.org/kenya/2000/12/21/telecommunications_service_providers/
[65] http://www.broadbandforamerica.com/sites/default/themes/broadband/images/mail/AMKInternetPeeringandTransit_FINAL.pdf
[66] The Halfway Proposition - http://hdl.handle.net/10568/57550

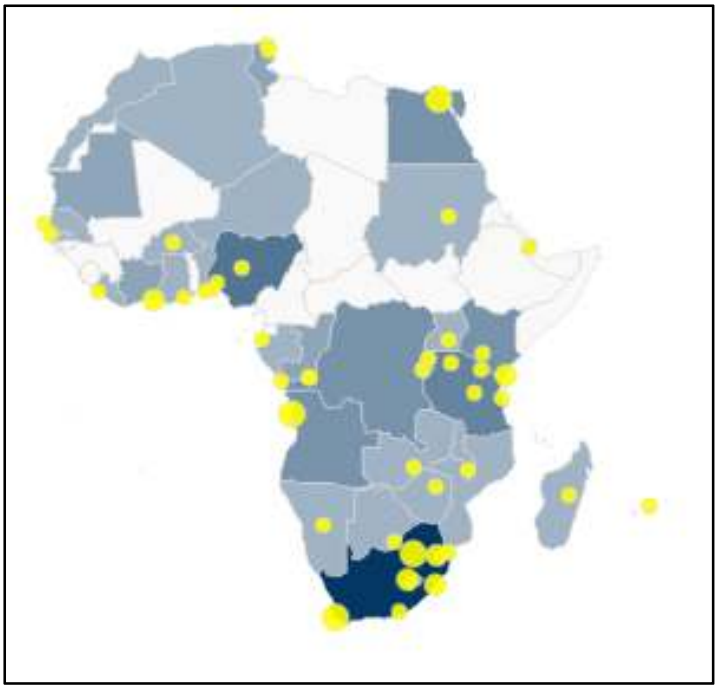
Hosting websites locally in turn drives the demand for domain names, as well as driving the demand for data centres and for a range of related skills. Although many website owners still prefer overseas hosting (by which we mean outside the African continent), in countries where local infrastructure is more developed, it is clear that local web hosting is more common. For example, analysis of the zone files for this report shows that for .ZA 71% of the registered websites are locally hosted in South Africa, while a few .ZA sites are hosted in other African countries. For .SD 35% of websites are locally hosted and almost all others are overseas.

IXPs in Africa usually follow the European model of a non-profit facility established by its members (the network operators), in a usually neutral location where retail network operators and service providers can 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 root name servers, local ccTLD DNS, CDN[67] servers and caching servers. There are also a number of bilateral peering links between networks in some countries, but these are private interconnections. In this respect an IXP would be expected to have at least three parties connected at a common point and actively exchanging data with each other.

Despite the fact that an IXP is neither technically hard to build, nor need it be expensive to set up, about a third of the countries in Africa still do not have them, and many of those that have been established are functioning sub-optimally. It turns out that IXPs are sensitive to a broad range of inhibiting factors that are often present in less mature African markets, such as a dominant fixed or mobile operator, high costs for leasing domestic links to the IXP, or lack of local hosting facilities, which are in turn affected by external factors such as the high costs and unreliability of energy supply. Thus the reasons for the low levels of IXP development in most countries on the continent are related to the lack of enabling policy and regulatory environments that foster a vibrant Internet industry ecosystem[68], [69], [70].

Figure 202: African IXP Locations

[67] Content Distribution Networks, such as Akamai, CloudFlare, RackSpace and others
[68] These conclusions come directly from the data gathered by the Survey carried out as part of this Study.
[69] https://www.internetsociety.org/sites/default/files/Promoting%20the%20use%20of%20IXPs.pdf
[70] https://www.isoc.org/educpillar/resources/docs/promote-ixp-guide.pdf



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

Nevertheless, over the last two decades, the number of IXPs in Africa has increased significantly[71].A. Although there are some 66 IXPs purportedly operating in Africa, after extensive research we have determined that many of them are either still in the planning stage, defunct, or are transit sales marketing campaigns, with no real traffic being exchanged. Where available, the IXP (and ISPA) websites and their reported statistics were examined, as well as the data from a number of IXP listings, as well as extensive research on the Internet for reports of traffic, peers, and operational status. On this basis, thirty IXPs have been excluded from the table below, which lists the 36 IXPs in Africa verified to be exchanging significant amounts of traffic, sorted by date established.[72]

Table 4: Operational IXPs in Africa

Country	City	IXP Name	Short Name	Peers	Traffic	Prefixes	Established
South Africa	Johannesburg	Johannesburg Internet Exchange	JINX	65	13.6 Gbps	176315	1996/06/01
Kenya	Nairobi	Kenya Internet Exchange Point	KIXP	30	1.33 Gbps	6276	2001/02/01

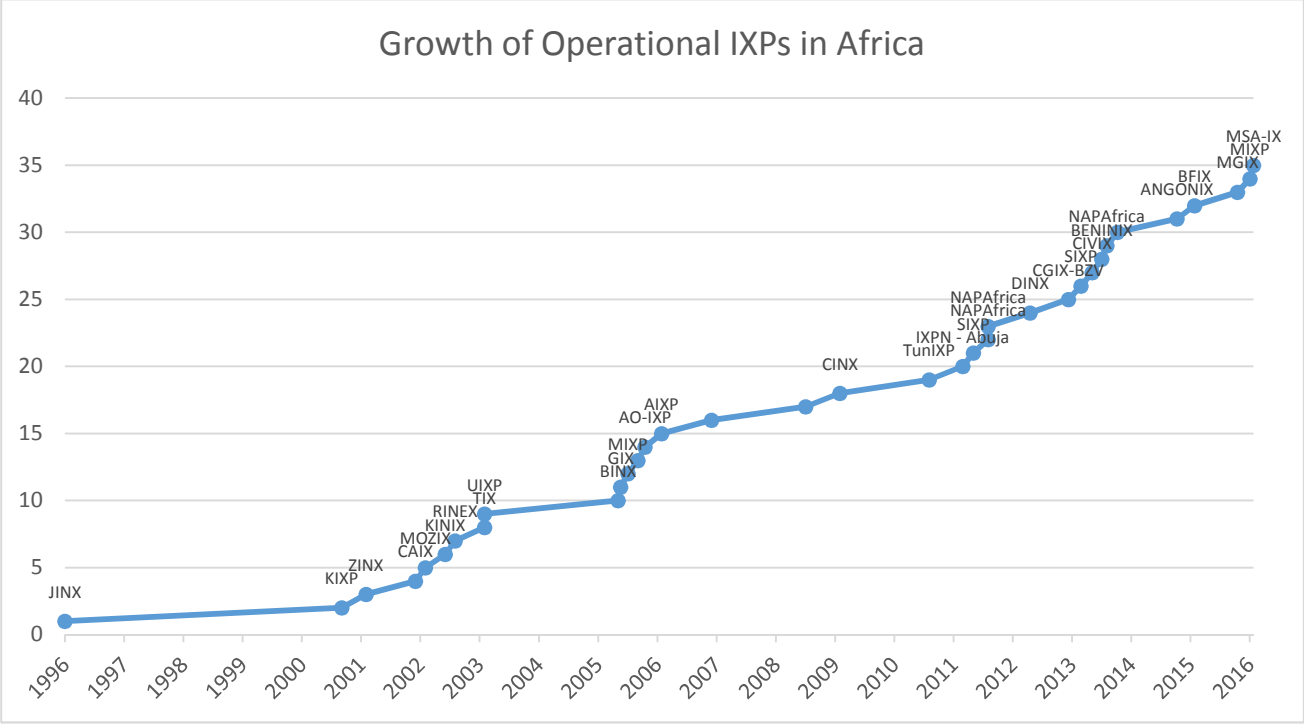
[71] Some of the authors of this study were directly involved in the formation of several of these new African IXPs
[72] Data from https://prefix.pch.net/applications/ixpdir , http://www.af-ix.net/ and https://en.wikipedia.org/wiki/List_of_Internet_exchange_points and verification on individual IXP websites

Zimbabwe	Harare	Zimbabwe Internet Exchange	ZINX	5			2001/07/01
Egypt	Cairo	Cairo Internet Exchange	CAIX	7	1.39 Gbps	3447	2002/05/01
Mozambique	Maputo	Mozambique Internet Exchange	MOZIX	17	72.4 Mbps	1331	2002/07/01
Congo-DRC	Kinshasa	Kinshasa Internet Exchange	KINIX	9	618 Mbps		2002/11/01
Rwanda	Kigali	Rwanda Internet exchange	RINEX	14	1.36 Gbps	611	2003/01/01
Tanzania	Dar es Salaam	Tanzania Internet Exchange	TIX	36	4.59 Gbps	1858	2003/07/01
Uganda	Kampala	Uganda Internet Exchange	UIXP	8	1.55 Gbps	2692	2003/07/01
Botswana	Gaborone	Botswana Internet Exchange	BINX	14	1 Gbps	340	2005/10/01
Ghana	Accra	Ghana Internet Exchange	GIX	17	1 Gbps		2005/10/18
Mauritius	Ebene	Mauritius Internet Exchange	MIXP	10	30 Mbps	286	2005/12/01
Zambia	Lusaka	Zambia Internet Exchange Point	ZIXP	13	103 Mbps		2006/02/01
Angola	Luanda	Angola Internet Exchange	AO-IXP	12	600 Mbps		2006/03/17
Tanzania	Arusha	Arusha Internet Exchange Point	AIXP	6	100 Mbps	301	2006/06/26
Nigeria	Lagos	IXPN - Lagos	IXPN - Lagos	30	1.6 Gbps	2741	2007/05/01
Malawi	Blantyre	Malawi IXP	MIXP	36	10 Mbps	168	2008/12/01
South Africa	Cape Town	Cape Town Internet Exchange	CINX	180	3.6 Gbps	6462	2009/07/01
Tunisia	Tunis	Tunisian Internet Exchange Point	TunIXP	15		1150	2011/01/01
Nigeria	Abuja	IXPN - Abuja	IXPN - Abuja	4			2011/07/28
Sudan	Khartoum	Sudan Internet Exchange Point	SIXP	7	16.4 Mbps	683	2011/10/01
South Africa	Cape Town	NAPAfrica Cape Town	NAPAfrica	101	25.2 Gbps	9364	2012/01/01
South Africa	Johannesburg	NAPAfrica Johannesburg	NAPAfrica	204	108 Gbps		2012/01/01
South Africa	Durban	Durban Internet eXchange	DINX	6	16.2 Mbps	1430	2012/09/14
Congo - Brazzaville	Brazzaville	Congo Brazzaville IX	CGIX-BZV	7	4 Mbps		2013/05/10
Gambia	Serrekunda	Serrekunda Internet Exchange Point	SIXP	14	560 Mbps	113	2013/07/25
Côte D'Ivoire	Abidjan	Côte d'Ivoire Internet Exchange Point	CIVIX	6	79 Mbps		2013/10/03
Benin	Cotonou	Benin IX	BENINIX	6	952 Mbps	139	2013/12/01
South Africa	Durban	NAPAfrica Durban	NAPAfrica	41	6 Gbps	5807	2014/01/01

Namibia	Windhoek	Windhoek IXP		5	50 Mbps	109	2014/03/07
Angola	Luanda	ANGONIX	ANGONIX	16	3.2 Gbps	420	2015/03/09
Burkina Faso	Ouagadougou	Burkina Faso IXP	BFIX	9			2015/06/26
Madagascar	Antananarivo	Madagascar Global Internet Exchange	MGIX	6	16 Mbps	584	2016/03/16
Tanzania	Mwanza	Mwanza Internet Exchange Point	MIXP	3			2016/06/01
Kenya	Mombasa	Mombasa Internet Exchange Point	MSA-IX	3			2016/06/23
Djibouti	Djibouti City	DJIX	DJIX	0			???

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

Figure 223: Growth of Operational IXPs in Africa



It is expected that the presence of one or more properly functioning IXPs, (by which we mean a number of 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 have sufficient peers exchanging meaningful amounts of traffic have, on average, six times as many domains as those without, as shown in the table below.

Table 5: Value of IXPs in terms of Domains

Country Status	Average number of ccTLD Domains per country
Countries without a properly functioning IXP	8 207
Countries with a properly functioning IXP	47 541

The only country without a fully functioning IXP that has more than 15,000 domains (other than those with "domain hacks" discussed in section 6.3.3) is Morocco with some 57,137 domains. Packet Clearing House (PCH)[73] indicates that an IXP ("CAS-IX") exists[74] in Morocco, but has no information about it. A number of press reports claimed that it "will be operational in March 2016", but none were found to confirm that it is actually functioning. Other causes must be sought to explain Morocco's domain name uptake.

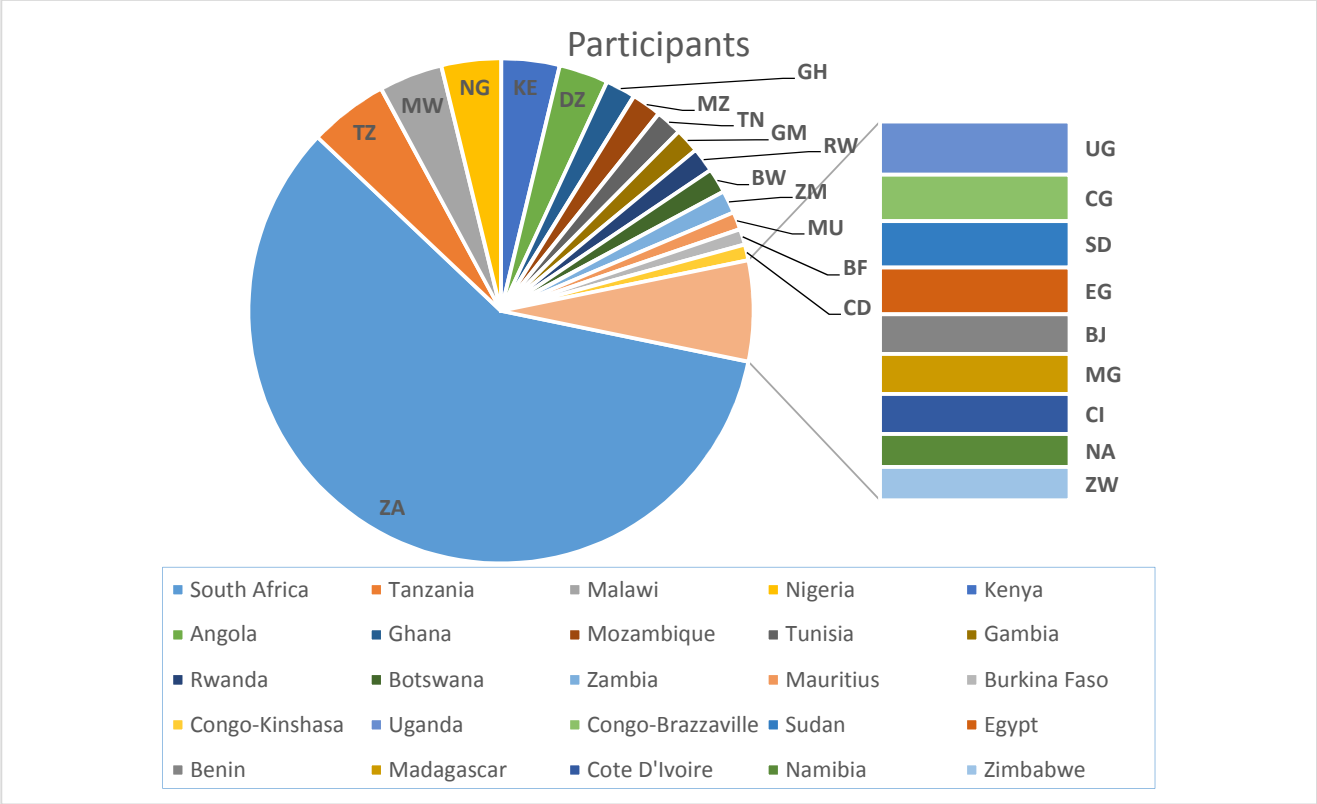
However, finding a causal / numeric relationship between IXPs and domain name numbers, was more challenging. In assessing the "value" of the 36 functioning IXPs, we looked at: -

- Participants How many entities peering
- Traffic Peak traffic in Mbps[75]
- 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).

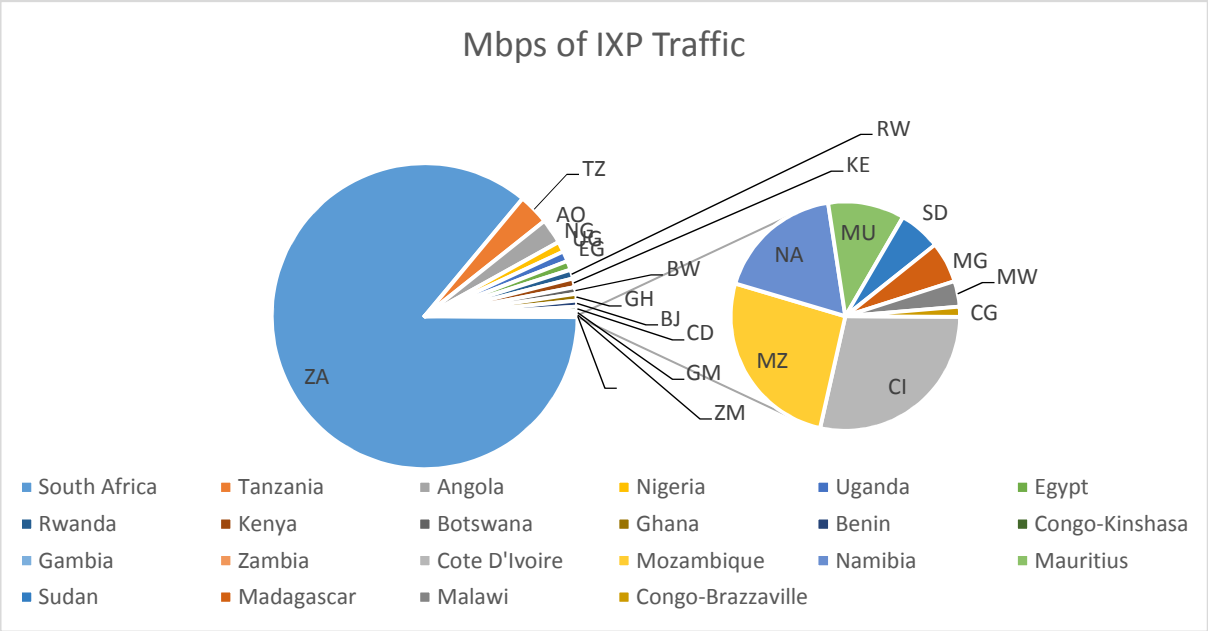
[73] https://www.pch.net/ixp/dir
[74] https://prefix.pch.net/applications/ixpdir/detail.php?id=1917
[75] Angola is a good example. **AO-IXP** was established in 2006. It has 23 participants exchanging 1,300 Mbps of traffic. This is quite significant. By contrast, **ANGONIX** was established in 2015, 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.

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

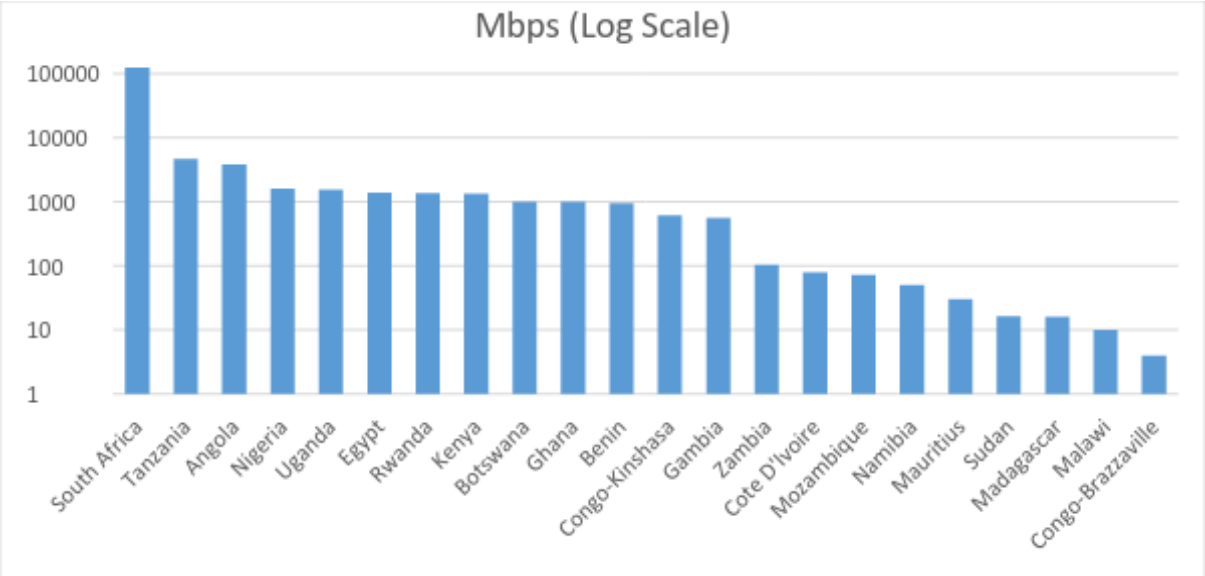


As can be seen, South Africa has more peers at its 6 exchanges than the rest of Africa put together, with Tanzania, Malawi, Nigeria, and Kenya following distantly behind. However, this can be misleading, as larger networks will connect to several IXPs. Indeed, of the 345 participants listed as peering at the three NAPAfrica IXPs in South Africa, there are only 233 unique participants, a number of which also peer at the INX-ZA IXPs.

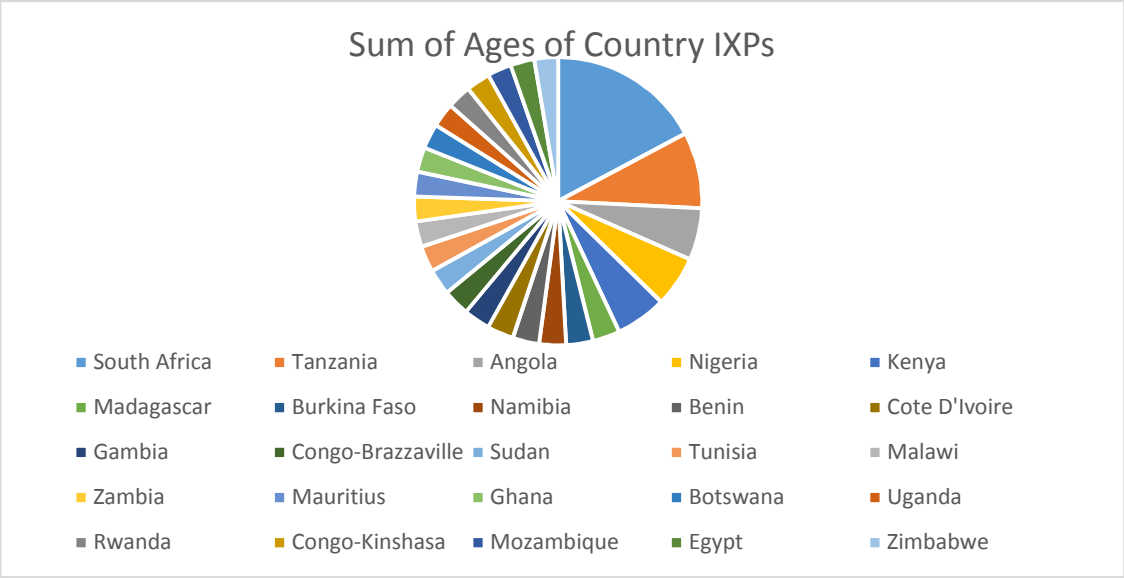
In terms of total traffic flowing over the exchanges, South Africa again dominates the continent, followed by Tanzania, Angola, Nigeria and Uganda, as seen in the chart below which shows Peak traffic measured at the various African IXPs, compared to total traffic interchanged in Africa

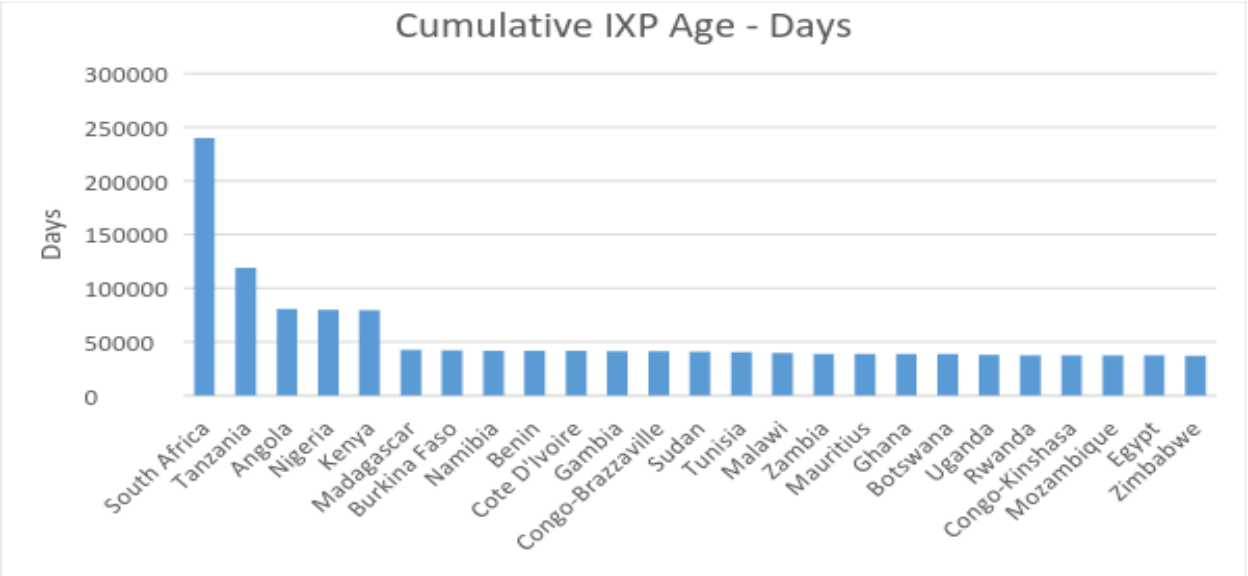


This same graph is shown below as a bar graph with a logarithmic scale, in order to highlight the numeric values indicated for the traffic levels.



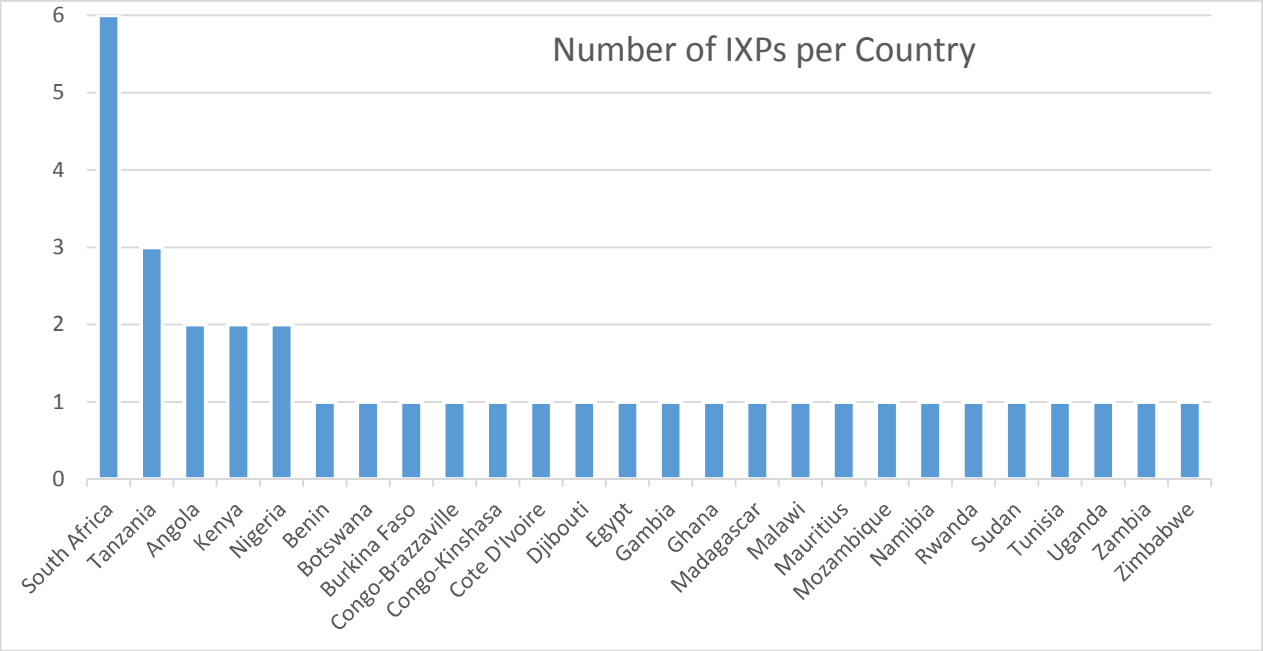
Where more than one IXP exists in a country, their ages are added together in the graphic below





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 both pie and column charts above. Once again, South Africa leads, followed by Tanzania, Angola, Nigeria 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.

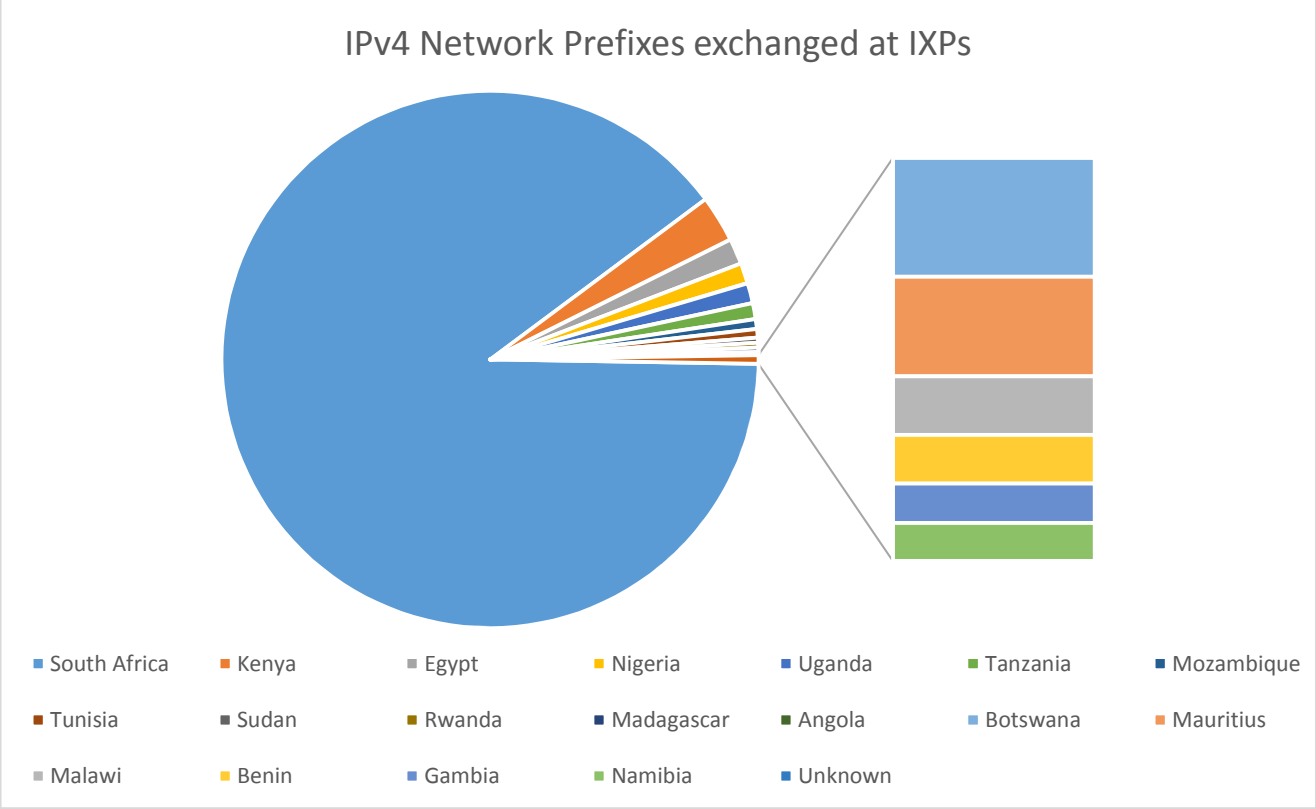
There is an argument that if one national IXP keeps national traffic local, several provincial IXPs will further localise traffic exchange. This is why several countries have multiple IXPs, namely South Africa, Tanzania, Angola, Kenya and Nigeria. This is shown in the graphic below.



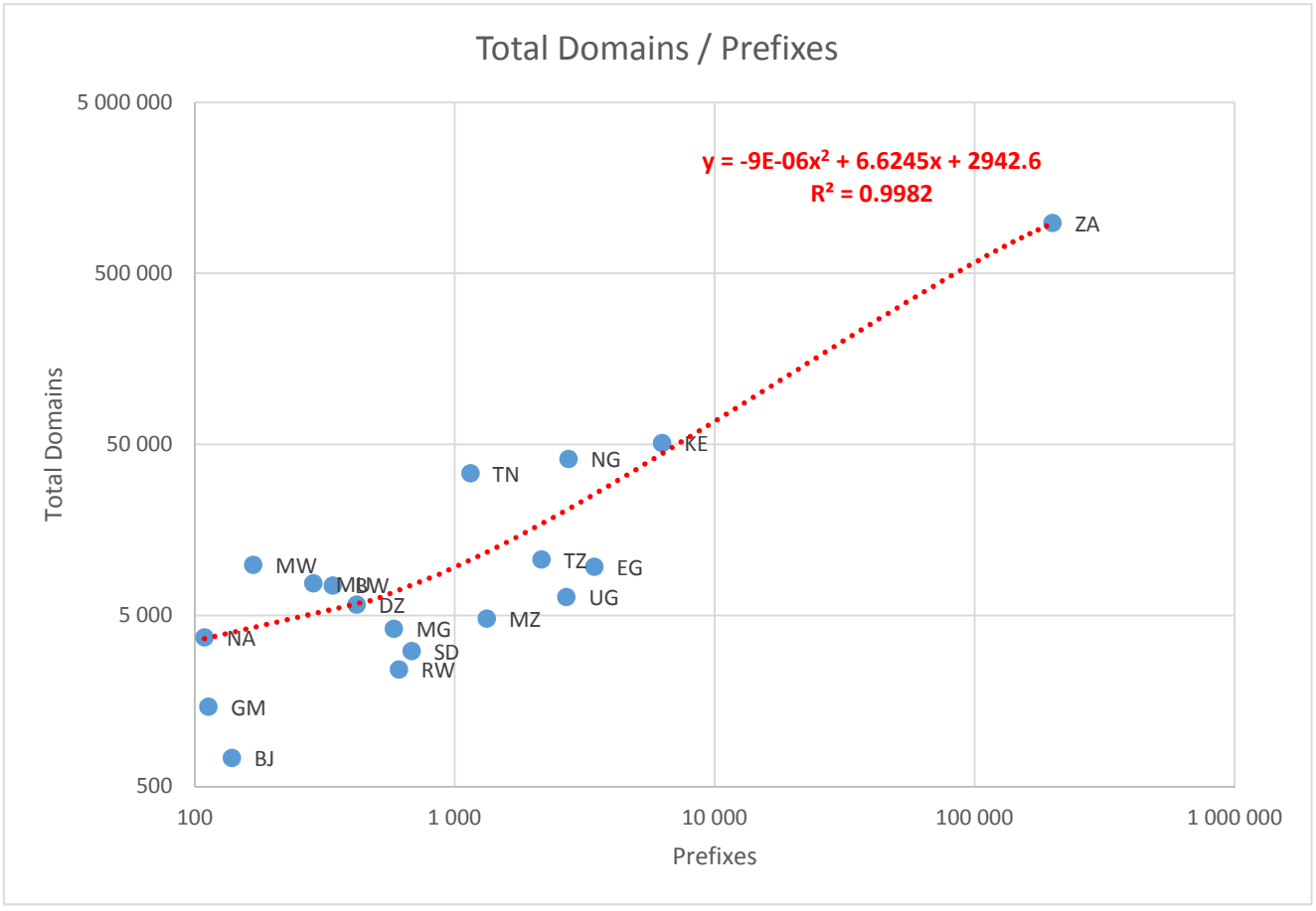
South Africa leads with 6 IXPS, followed by Tanzania with 3 IXPs and Angola, Kenya and Nigeria with 2 IXPs each. All other countries shown above have a single operating IXP so far. Although none of the parameters of an IXP have a good correlation with the number of domain names, as shown in the chart below, 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 effectively 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. The correlation between the number of domains and prefixes is shown below.

As can be seen in the pie chart below, almost 90% of the IPv4 Network Prefixes[76] exchanged at IXPs in Africa are exchanged at the 6 South African IXPs.

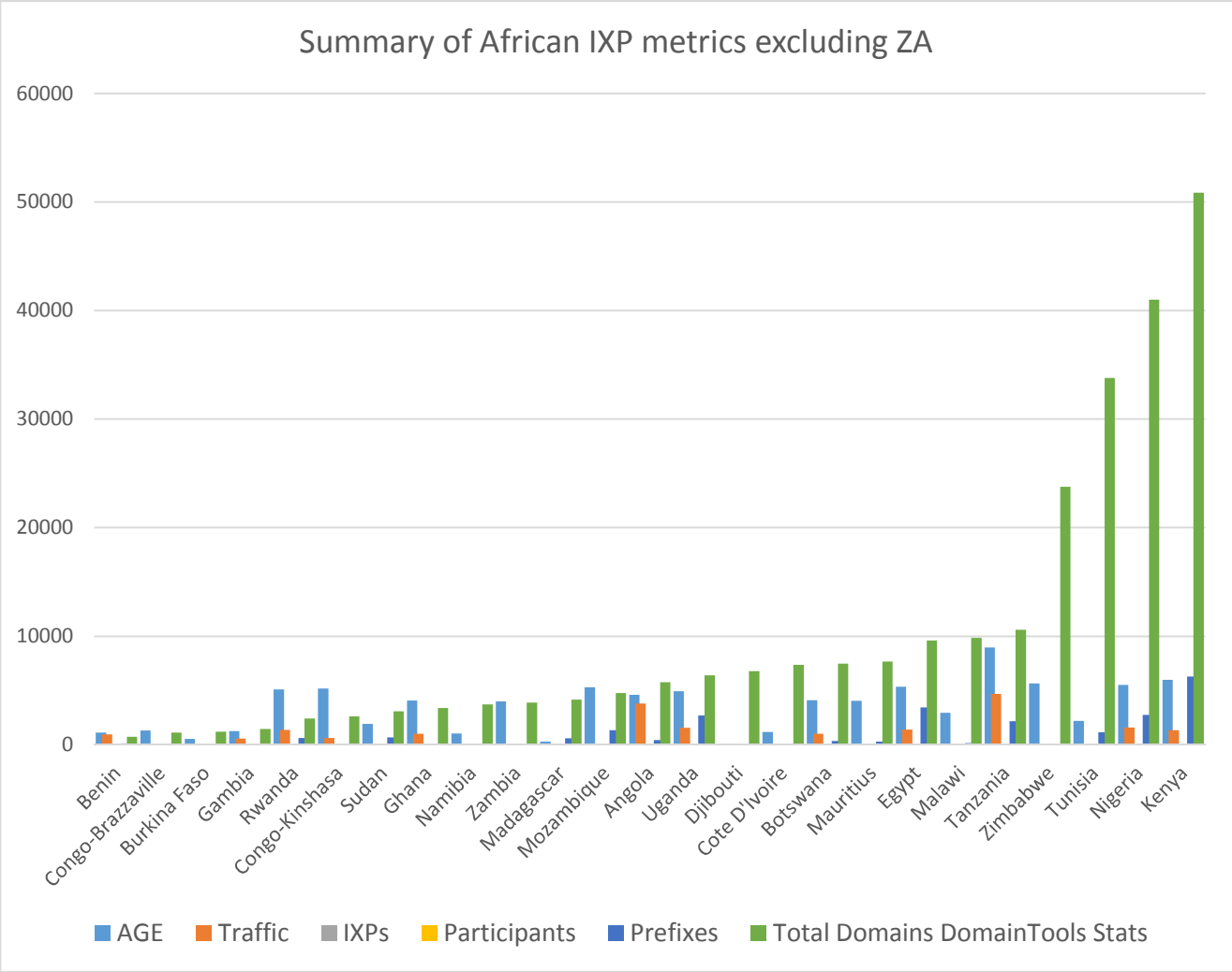


[76] A network prefix is the address of an IP network – so called because it consists of the first portion (of variable length) of the IP address. All addresses within the network start with the same prefix.



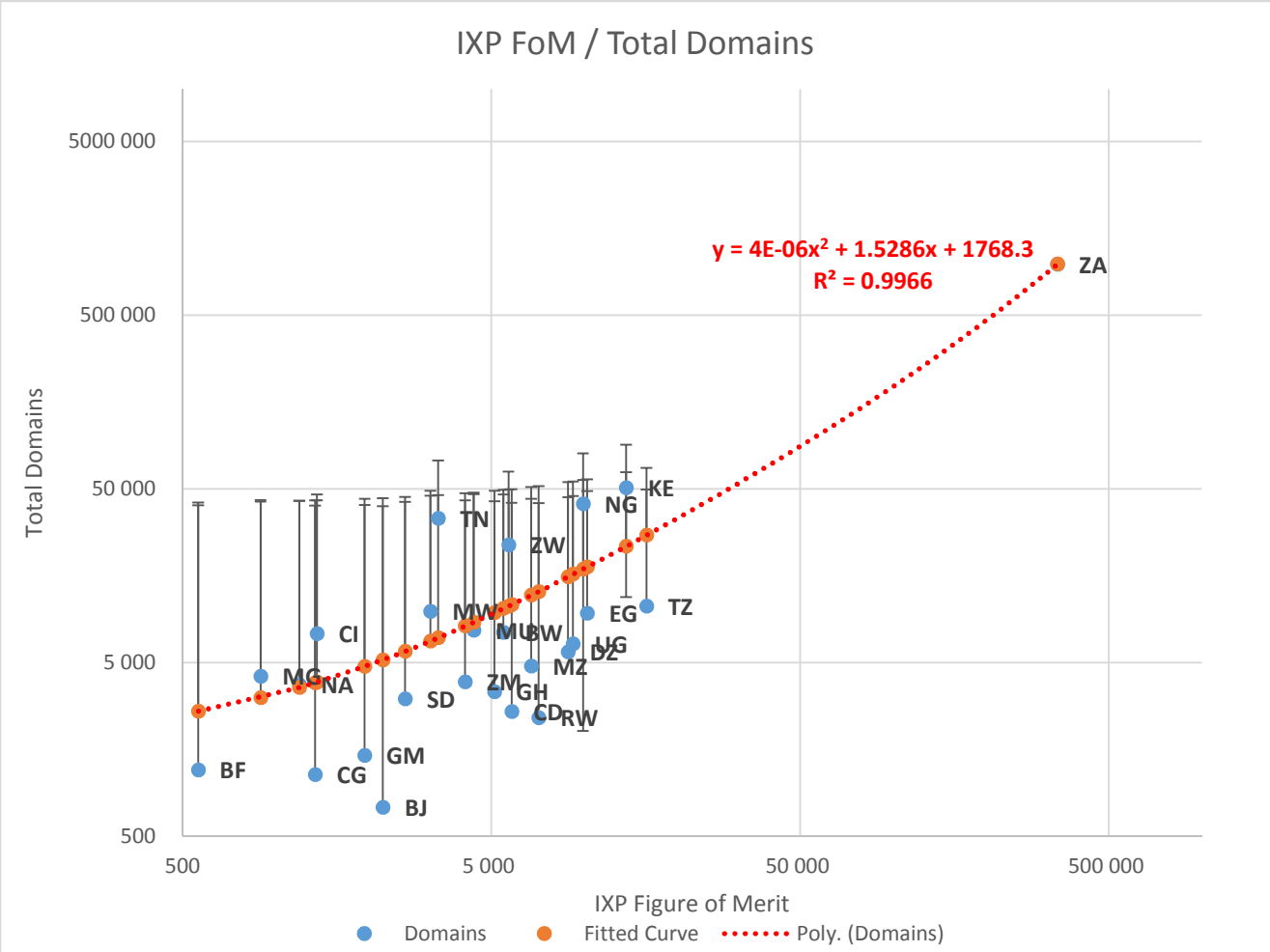
b[77]

[77] 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.

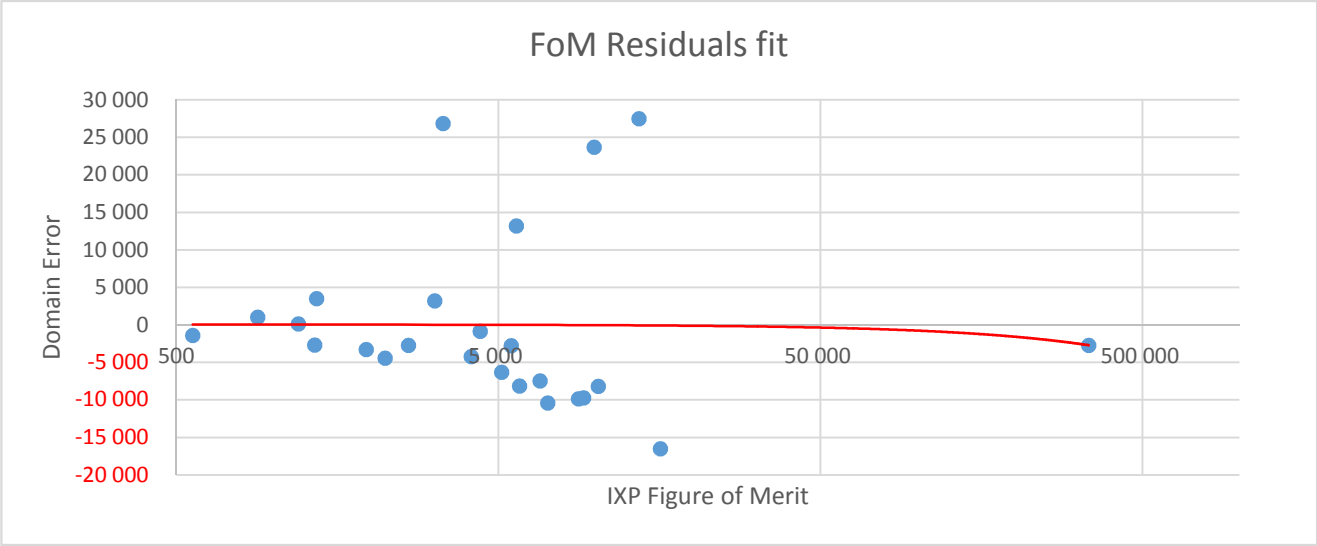


Although the numbers are clearly rising towards the right of the summary column chart above, this is irregular and none of these metrics on their own give a sufficiently good correlation with the number of domains registered in the ccTLD. South Africa is excluded from the above graph, as the scale of most metrics is much higher and obscures the variation between other countries.

Combining these metrics (as a simple sum) gives us what we may call a "Figure of Merit" (**FoM**) for each IXP if we add all of these metrics together. Thus, we can now find a significant correlation between the metrics of an IXP and the country's domain names.



With a value of more than 99%, this appears to be a good correlation. This is confirmed by measuring how far the actual observed values are from the predicted. This is shown in the graph below, where we plot the differences between the predicted and the actual values (the "residuals"). Note that there are no particular areas where errors congregate and that the scale on the Y Axis at 30,000 is very small in comparison to the 500,000 above. This is further indicated by the trend line shown which is very nearly on the X-axis (indicating zero relationship between the X and Y axes), except near the isolated data point on the far right.



These two factors indicate that the relationship shown in red for the trend line on the IXP FoM / Total Domains graph is a good predictor, on average, for the number of domains, given a particular IXP Figure of Merit. Thus, the second order polynomial: -

$$y = 0.000004x^2 + 1.5286x + 1768.3$$

Where **y** = Total Domains and **x** = IXP Figure of Merit (FoM) is a good approximation to the relationship between these two variables: the IXP FoM and the number of domains.

However, as shown by the vertical error bars, 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 take into account a number of other issues that have a significant impact on domain sales, such registration method, payment method, cost of a domain, provision of a WHOIS[78] service and the registration policies applied.

Overall it can be observed that characteristics of the IXPs in the country are not a particularly accurate predictor of the likelihood of more ccTLD domains being registered – at least not on their own. The reason for lack of any clear correlation is probably because there are other variables that are currently more influential on 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

[78] A WHOIS service enables one to find out details about the people and machines involved in the registration of a domain name. Originally defined by RFC 812 in 1982, the current standard is RFC 3912. See https://tools.ietf.org/html/rfc3912

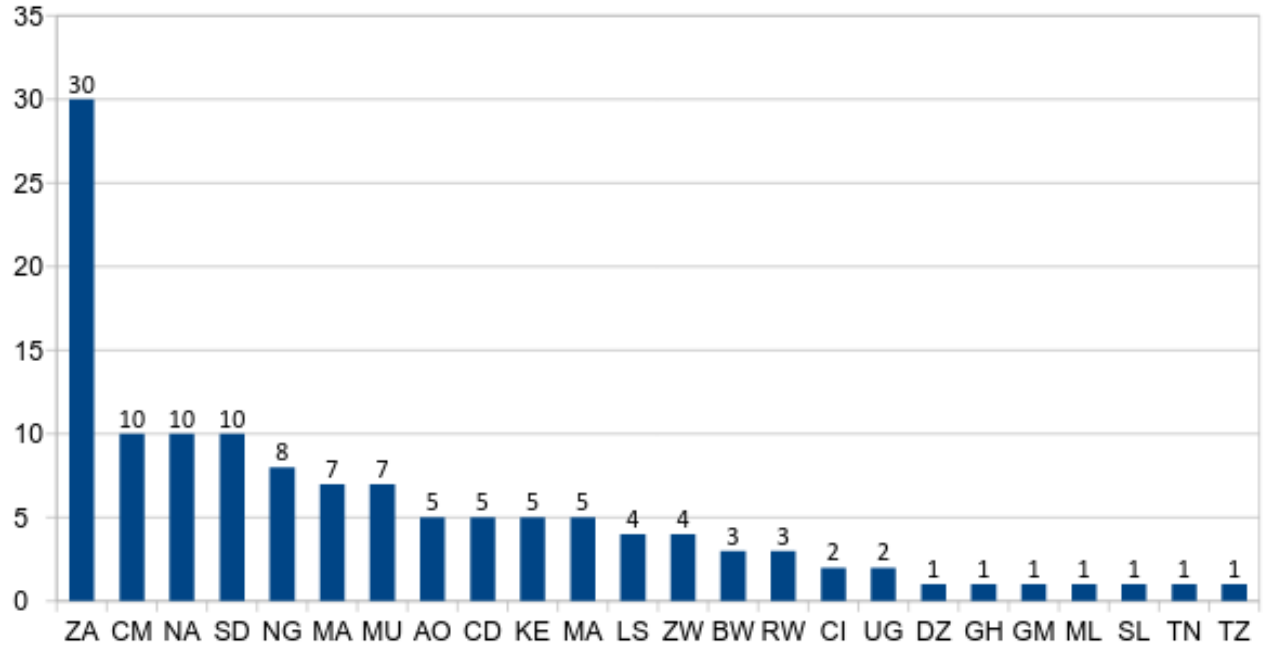
the IXPs - some large networks do not participate at all, or may exchange traffic bilaterally. As a result the actual volume of traffic being exchanged (locally or not), is not accurately indicated by the amount of traffic passing through the IXP. And, as noted above and discussed further below, there are a multitude of other factors that influence the number of domains sold in a country.

5.4.3.2 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.

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 a large number of transit providers are available to connect with there.

Although there were a large number of unique responses (it was a free form answer), quoted reasons behind a lack of data centres most commonly cited were:

- Poor electrical supplies
- Monopoly telecommunication providers
- Lack of local need (content is housed overseas)
- Distrust of government
- High prices,

Data centre pricing is also almost always more expensive in Africa than in more developed countries. Several other sources gave differing numbers for data centres. One commercial report[79] lists 137 separate data centres in nine countries, operated by 65 providers. The countries are:

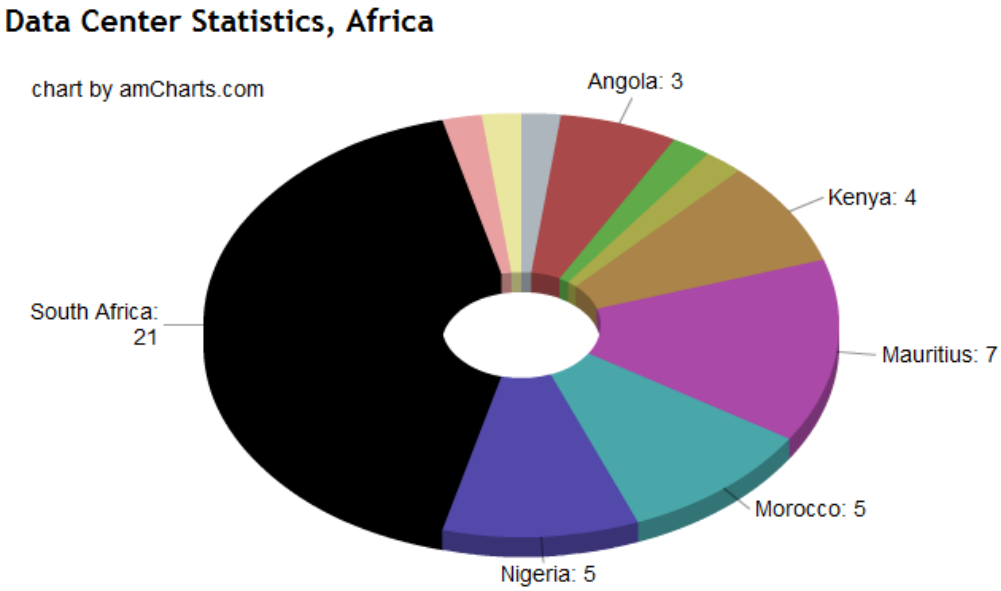
- Algeria
- Egypt
- Ghana
- Kenya
- Morocco
- Nigeria
- South Africa
- Tunisia
- Uganda

Data Center Africa[80] 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

[79] http://www.datacentre.me/downloads/Documents/Data%20Centre%20Africa%202015%20Report%20-%20table%20of%20contents.pdf
[80] http://www.broad-group.com/reports/data-center-africa

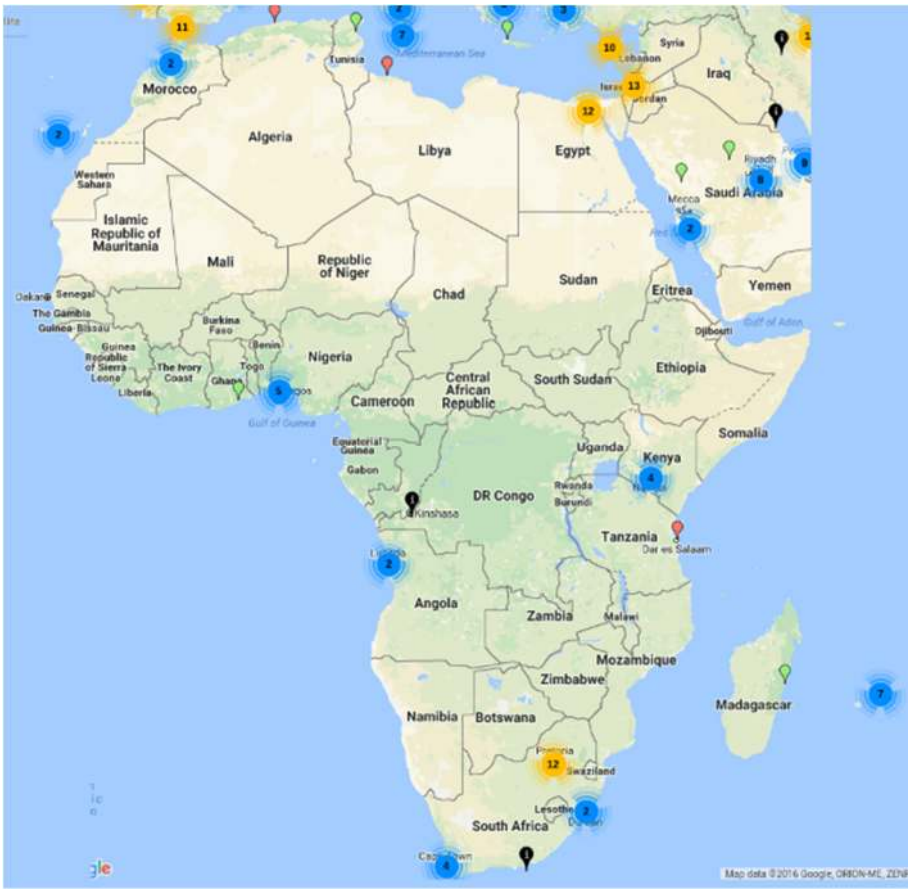
regional data centres, achieving a faster level of growth than other countries included in the study.

Colocation Africa identifies 50 data centres from 11 countries[81]



Another source, Data Centre Research (DCR), a Danish consultancy, monitors the presence of carrier neutral data centres around the world and counts 60 in Africa, but these are concentrated in just 14 countries. As shown in the map below - the majority are located in South Africa (20), followed by Egypt (12), Mauritius (7), Nigeria (5), and Kenya (4) which have 48 between them. The remainder are in Angola, Algeria, Cap Verde, DRC, Ghana, Morocco, Tanzania and Tunisia. As would be expected, these are among the countries with the most vibrant exchange points and largest number of domain name registrations.

[81] http://www.datacentermap.com/africa/



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

These reports, 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.[82]

Local caching infrastructure and 'Content Distribution Networks' (CDNs), such as the Google Global Cache (GGC) and Akamai, which minimise upstream capacity requirements by eliminating

[82] 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

the duplication of downloads of the same data, are now present in many locations in Africa. 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 shows the presence of GGC infrastructure in Africa identified by the University Of Southern California[83] (USC) in April 2016. 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.

Google Caching Infrastructure in Africa

Source: USC[84]

5.4.4 IP Infrastructure

As indicated above in the section on IXPs, Autonomous System Numbers[85] and IP address space allocation provide an up-to-date picture of the level of development of Africa's Internet industry.

[83] https://mappinggoogle.cs.usc.edu/
[84] https://storage.uscnsl.net/mapping-google/public/google_data/2016-04/2016-04-23/mapv2-2016-04-23.pdf
[85] An ASN is a globally unique index used to refer to all networks managed by one entity

As can be seen from the table below, Africa's use of Internet address space is far lower than any other region.

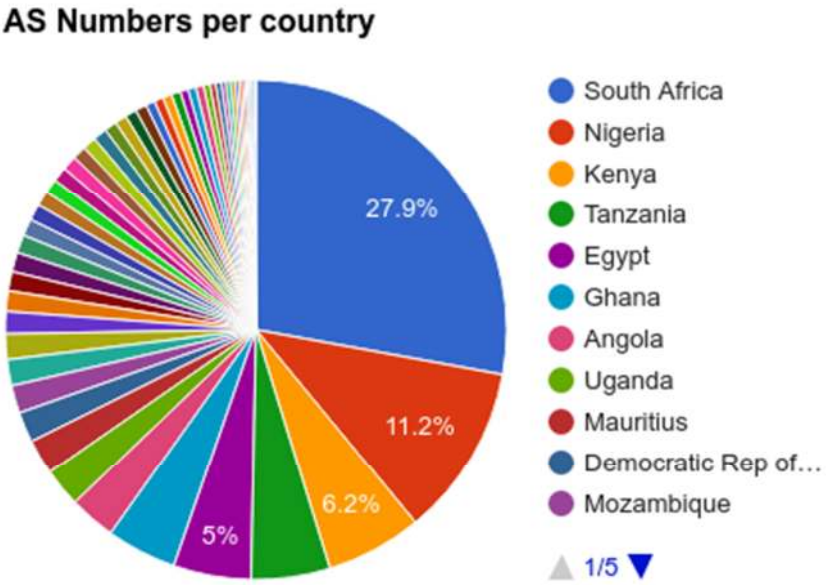
Utilisation of IP Resources by Region[86]

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%

Source:

AS Numbers in particular are a good indicator 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 about two thirds of all African AS Numbers are concentrated in just 10 countries - South Africa, Nigeria, Kenya, Tanzania, Egypt, Ghana, Angola, Uganda, Mauritius, Democratic Rep of Congo.

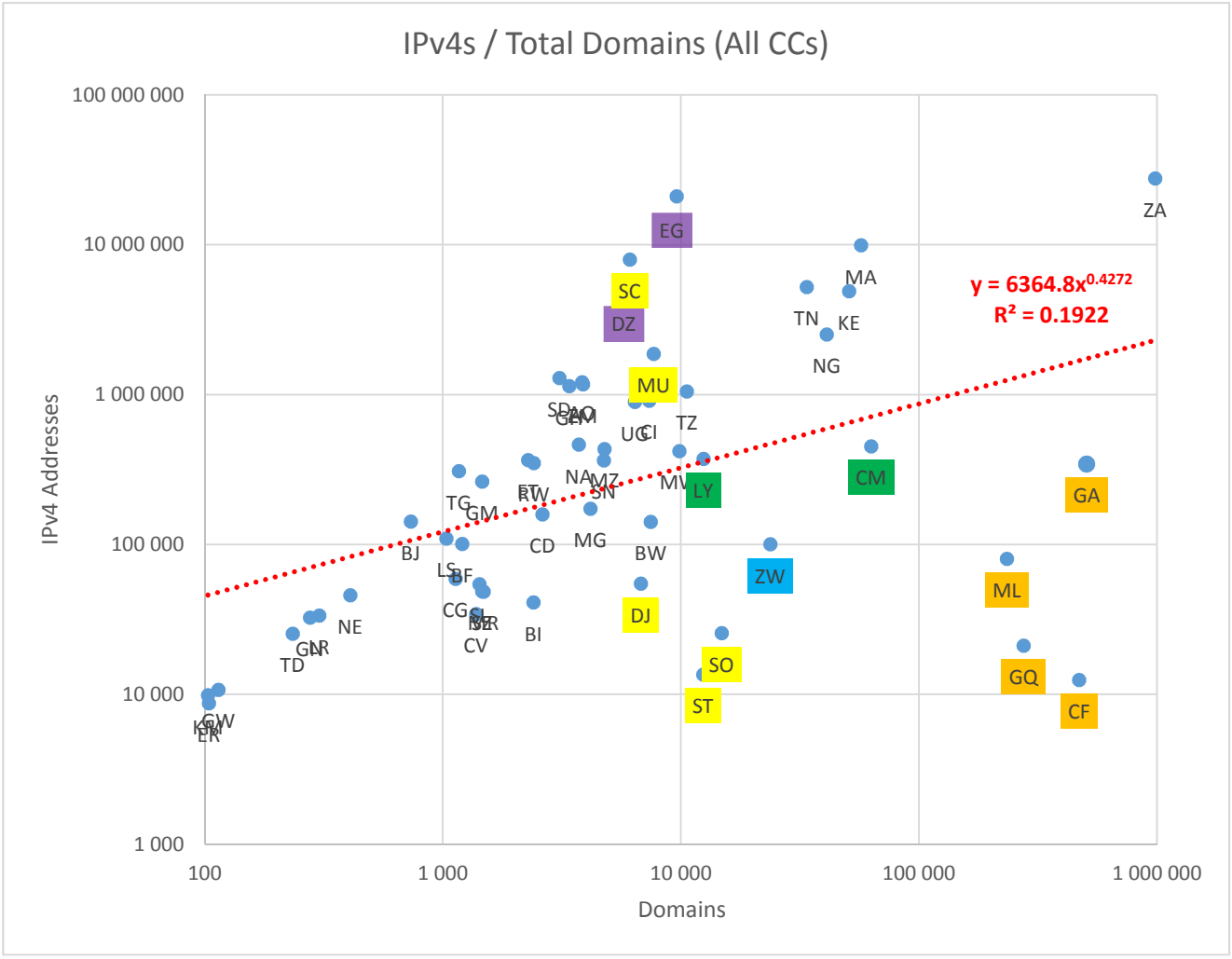
[86] http://stats.labs.apnic.net/bgp

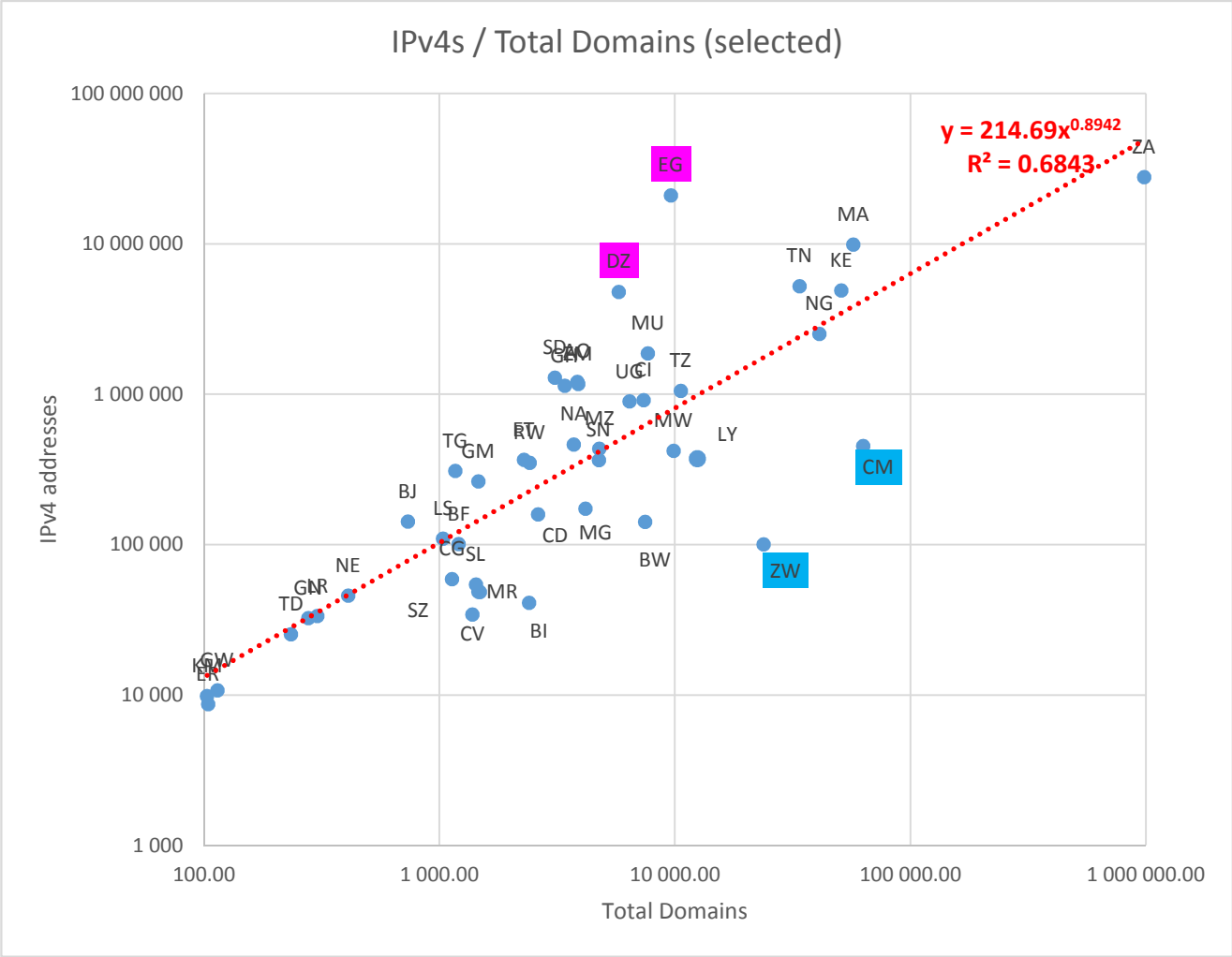


To examine the potential correlation between the number of Internet resources assigned to a country by AfriNIC and the number of domain names registered, the graph below plots the relationship between the number of IPv4 addresses[87] and domain names. Both axes are logarithmic.

As can be seen, the four Freenom[88] 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 similar to 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.

[87] The uptake of IPv6 addresses in Africa is still very low indeed
[88] Freenom and Safecow are two registrars that offer free registration of a number of ccTLDs, including four in Africa


IPv4s / Total Domains (All CCs)
IPv4 Addresses
Domains
100 000 000
10 000 000
1 000 000
100 000
10 000
1 000
100
1 000
10 000
100 000
1 000 000
y = 6364.8x^0.4272
R² = 0.1922
ZA
EG
SC
DZ
MA
TN
KE
NG
MU
TZ
UG
CI
CM
GA
LY
MV
NA
MZ
SN
TG
GM
BJ
CD
MG
BW
ZW
ML
LS
BF
DJ
NE
TD
BI
CV
SO
GQ
ST
CF



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, DZ, ZW and CM are so far off the trend-line are discussed in sections 7.3 and 7.4

5.4.5 ISP Associations and IXPs

As the number of IXPs in Africa rose, so too has the number of ISP Associations (ISPAs). Indeed, they are intimately related. ISPs need an IXP in order to exchange traffic. They need an industry association to manage the IXP, and also as a representative body for negotiating with government. During the first decade of this century, organisations such as AfrISPA[89] (amongst

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

others) held 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. During this period, the number of IXPs rose from 5 to 22, with a similar increase in the number of ISPAs. IXP formation is a process strongly influenced by industry politics– it is often said that it is 10% technology and 90% politics. For example, the establishment of Benin's IXP took 8 years of negotiations from initial agreement in 2005 to full operation in 2013.

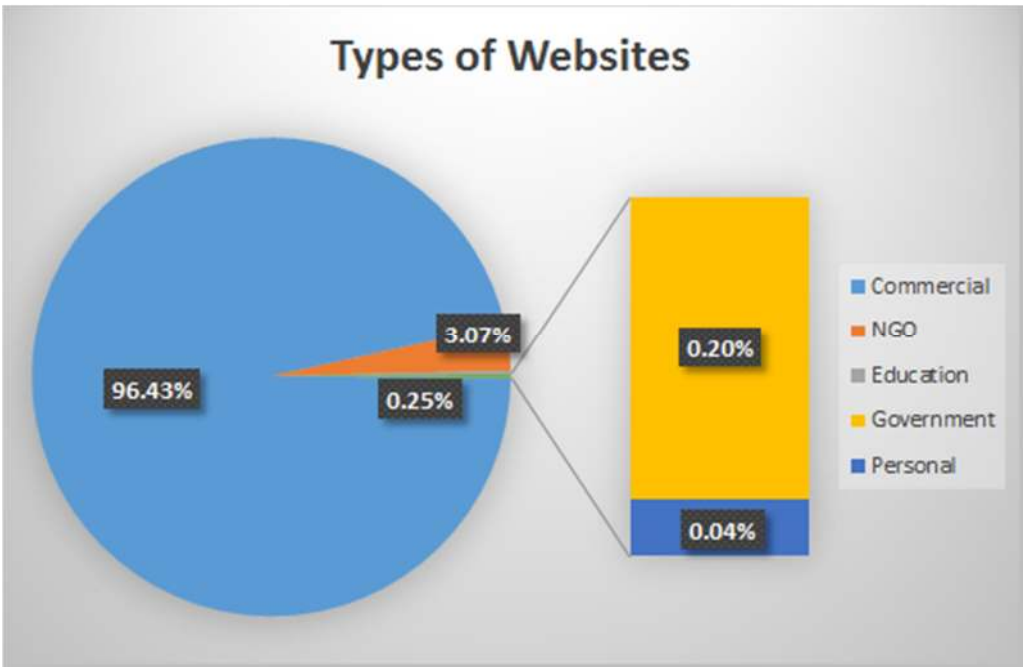
Africa has experienced – and in many cases is still experiencing – a considerable liberalisation of the telecommunications market. In most countries the state-owned monopoly operator now no longer has absolute power over internal and external communications. This liberalisation process has not been without 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 the 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, in many African countries, policy makers and regulators 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.

5.5 Content and the African DNS

5.5.1 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 categorized. 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.

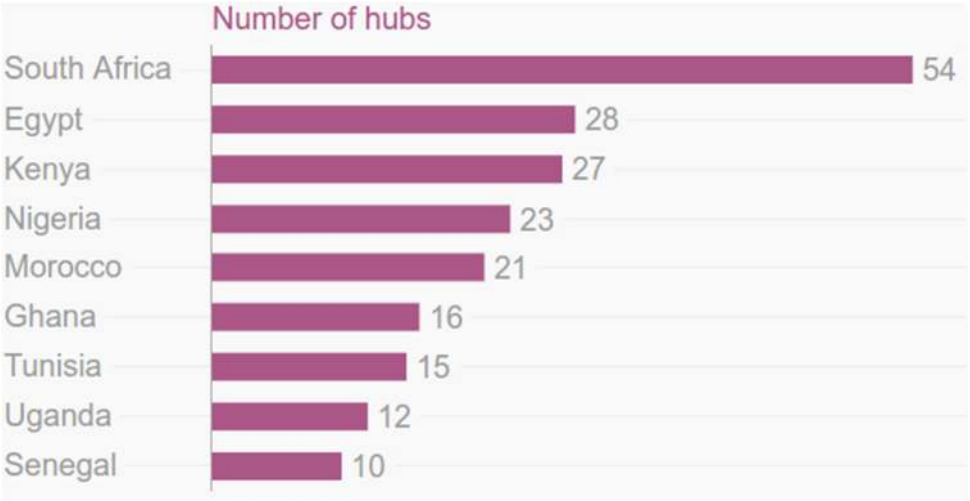


It is quite clear that the vast majority of the content analysed was commercial in nature.

5.5.2 Digital Entrepreneur Development

Demand for local domains is often driven by application developers who also need to access affordable high bandwidth network services and to share other resources, ideas and contacts to build their businesses. These needs are increasingly being met in Africa through the development of technology hubs and incubators, which provide a shared office space and other resources where new start-up IT-enabled businesses can be supported, developed and launched into the market. The importance of these facilities is underscored by the recent Ecosystem Accelerator survey conducted by mobile telecom industry body GSMA, which found a total of 314 tech hubs and incubation centres in Africa in July 2016[90]. The hubs are spread across 93 cities in 42 countries across the African continent. However, most hubs are still relatively young (average year of formation is 2012) and more than half of the hubs are concentrated in only 5 countries, namely: South Africa, Egypt, Kenya, Nigeria and Morocco.

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



5.5.3 SMEs and E-Commerce

Although data on SMEs in Africa is limited, there are an estimated 40 million micro, small and medium enterprises on the continent[91], and their importance is widely acknowledged. For example about 96% of Nigerian businesses are SMEs, according to statistics from the Central Bank of Nigeria.

Most SMEs operate informally, and are unlikely to have registered their own domain or use e-commerce services. Instead they are more likely to use 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. While no specific surveys have been carried out in Africa, as such this market is likely to represent a large potential unmet demand for domain names, as some of these businesses move into the formal economy.

The extent to which this takes place largely depends on the effectiveness of fiscal authorities in making it simpler and more attractive for SMEs to enter the formal economy. Aside from more streamlined business registration procedures, a big incentive in this regard is also the e-commerce driver.

Currently, use of e-commerce by SMEs remains low. The current share of consumer e-commerce by African enterprises, for example, is currently below 2%, but has 'enormous potential'

[91] http://africanbusinessmagazine.com/african-banker/exchanges-give-smes-helping-hand/#sthash.RvzB2kks.dpuf

estimates Intracen[92], which says that by 2018, the African e-commerce market is projected to reach USD $50 billion, from just USD $8 billion in 2013. 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 web sites 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.

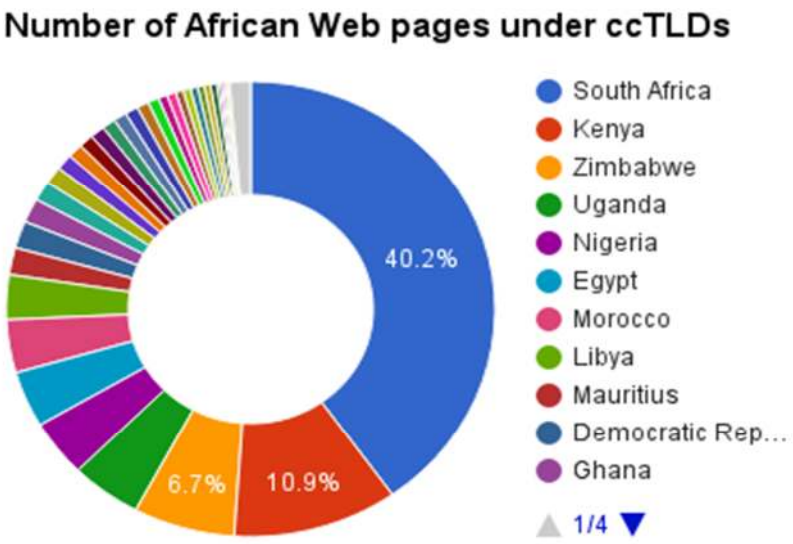
Finally, it should also be pointed out that Registrars have an important role to play in making SMEs aware of the potential for registration of domains and to combine these with appropriate web site hosting packages and applications to help them build their online presence.

5.5.4 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.

As shown in the chart below - over three quarters of the almost 400 million web pages with African ccTLD URLs indexed by Google are located in just 7 Countries - South Africa, Kenya, Zimbabwe, Uganda, Nigeria, Egypt and Morocco. South Africa and Kenya together are responsible for over 50% of these web pages.

[92] http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/International%20E-Commerce%20in%20Africa_Low-res.pdf



When population size is taken into account, most of the same countries are indicated, although the spread is a little broader, as shown in the table below, which divides the total web pages tracked by Google, by the 2015 population, in which just 14 countries were found to have more than 0.5 pages per capita[93].

Country	Population	Google Web Pages Indexed under ccTLD Nov 5 2016	Pages / capita
Seychelles	92,430	5,470,000	59.2
Sao Tome & Principe	194,006	4,280,000	22.1
Mauritius	1,339,827	7,390,000	5.5
Equatorial Guinea	759,451	3,450,000	4.5
South Africa	54,777,809	155,000,000	2.8
Djibouti	846,687	1,920,000	2.3
Libya	6,411,776	12,200,000	1.9
Zimbabwe	14,229,541	25,900,000	1.8
Namibia	2,212,307	3,750,000	1.7
Botswana	2,209,208	3,360,000	1.5
Gabon	1,738,541	2,300,000	1.3

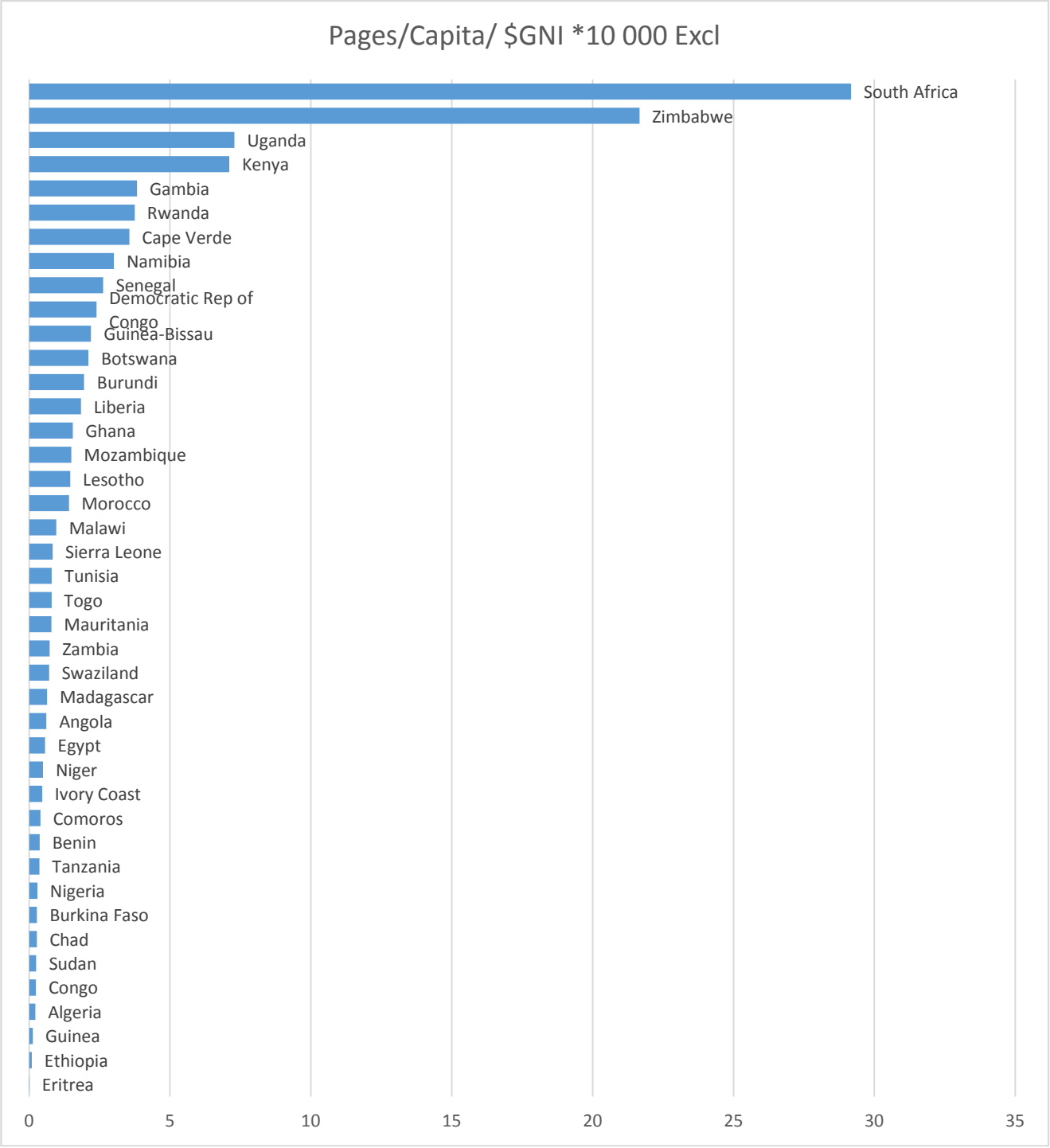
[93] Source: World Bank, Google.com Nov 2016

Cape Verde	553,432	679,000	1.2
Kenya	45,925,301	42,100,000	0.9
Uganda	37,101,745	18,100,000	0.5

However, of these, seven are "domain hacks" (see section 6.3.3, where the subject of high use of domain names by entities unrelated to the country is discussed). Excluding these results in a much shorter list of countries – only 7 countries in Africa have more than 0.5 web pages / capita, as shown in the table below.

Country	**Population**	**Google Web Pages Indexed under ccTLD, Nov 5 2016**	**Pages / capita**
South Africa	54 777 809	155 000 000	2.83
Zimbabwe	14 229 541	25 900 000	1.82
Namibia	2 212 307	3 750 000	1.70
Botswana	2 209 208	3 360 000	1.52
Cape Verde	553 432	679 000	1.23
Kenya	45 925 301	42 100 000	0.92
Uganda	37 101 745	18 100 000	0.49

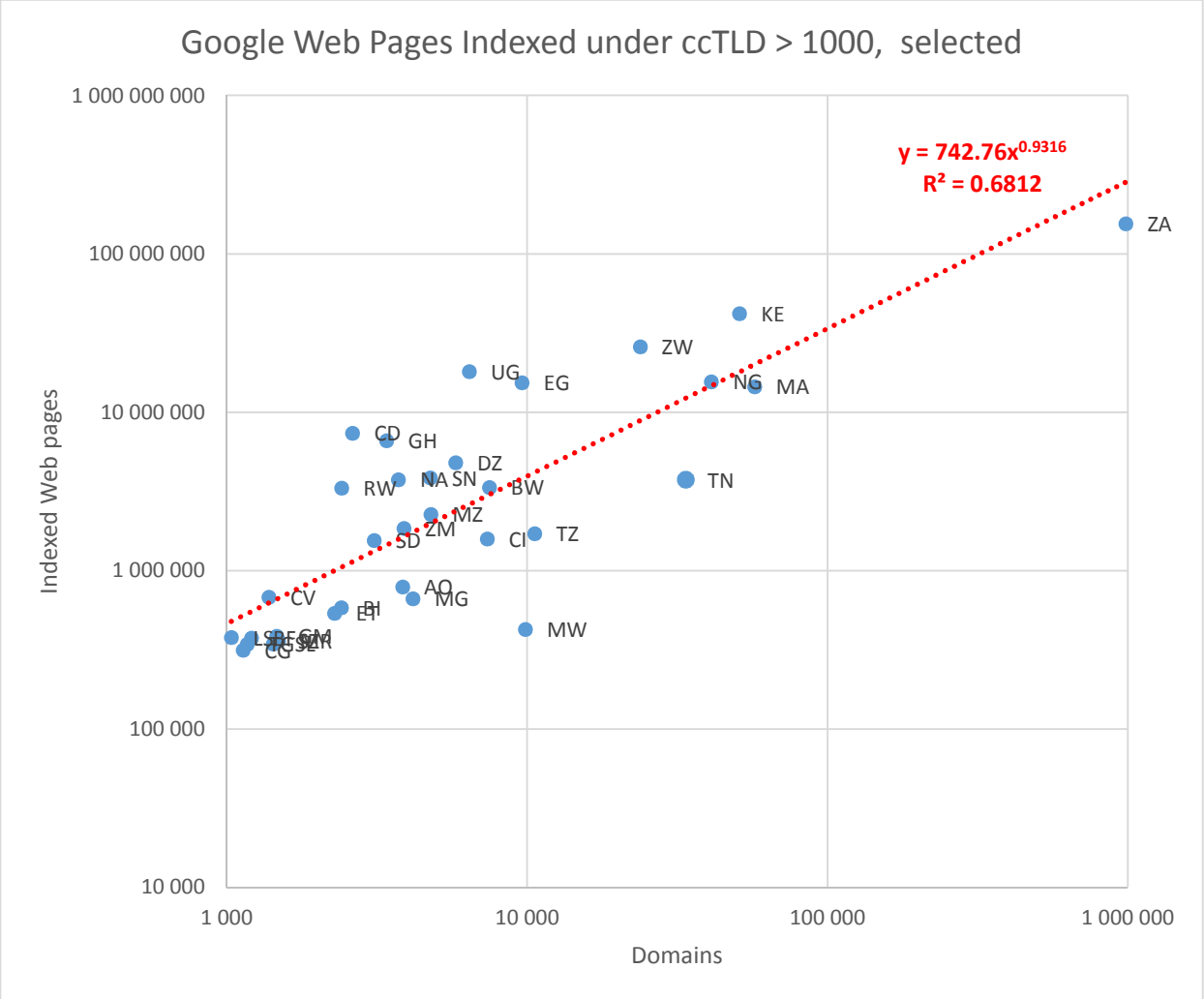
The chart below lists the number of websites per country, while also taking into account the wealth of the country (GNI / capita), as well as population size. By removing 'domain hack' countries, it is possible to see more clearly the different levels of use of African domains for website purposes.



As the chart above indicates, the top 10 countries in Africa with the largest web page presence per Gross National Income (GNI) per capita are (in order): South Africa, Zimbabwe, Uganda,

Kenya, Gambia, Rwanda, Cap Verde, Namibia, Senegal and Botswana. This measure of the volume of local content is an important measure of the vibrancy of the Internet ecosystem in these countries.

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



5.5.5 Offshore and On-Continent Hosting

To study the location of hosting of African content, analysis took place of about 20 zone files from four African countries, plus the three South African .CITY gTLDs, as well as an extract of gTLD domains with an African Registrant from a large international Registrar. This was kindly provided to us by Afilias. Additional gTLD extracts have recently been received. These results will

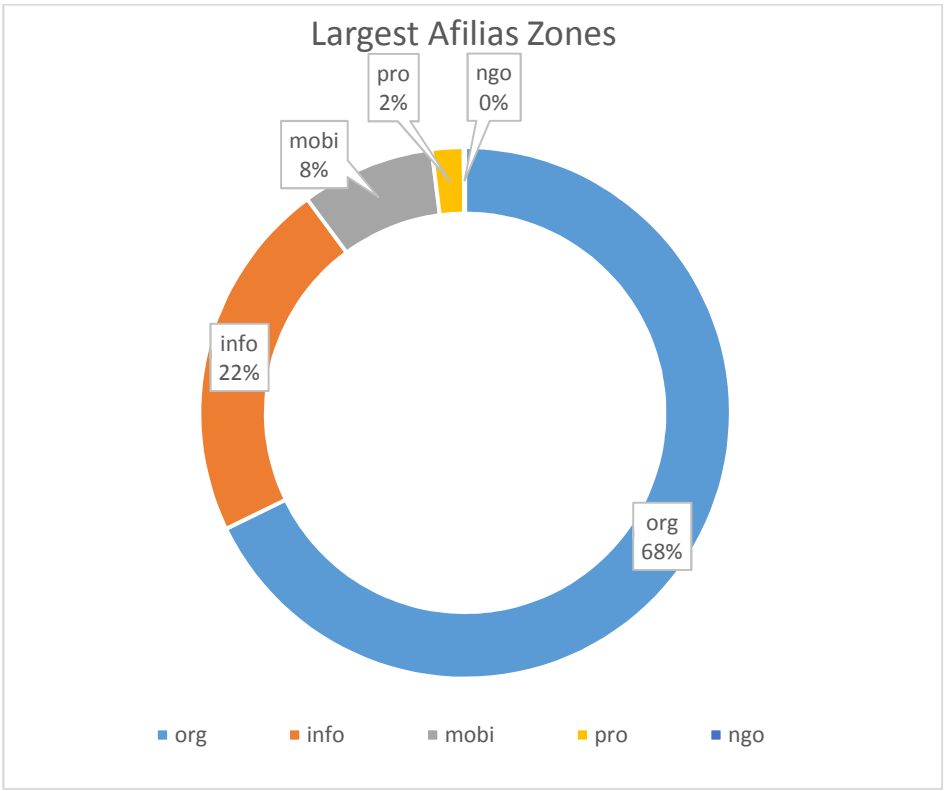
be include here in the Final Report of this Study. For a complete analysis more zone files and extracts are needed, particularly from the .COM and .NET domains. No WHOIS lookups or identification of individuals was required in order to produce the analysis presented here.

5.5.5.1 Afilias gTLD Domains

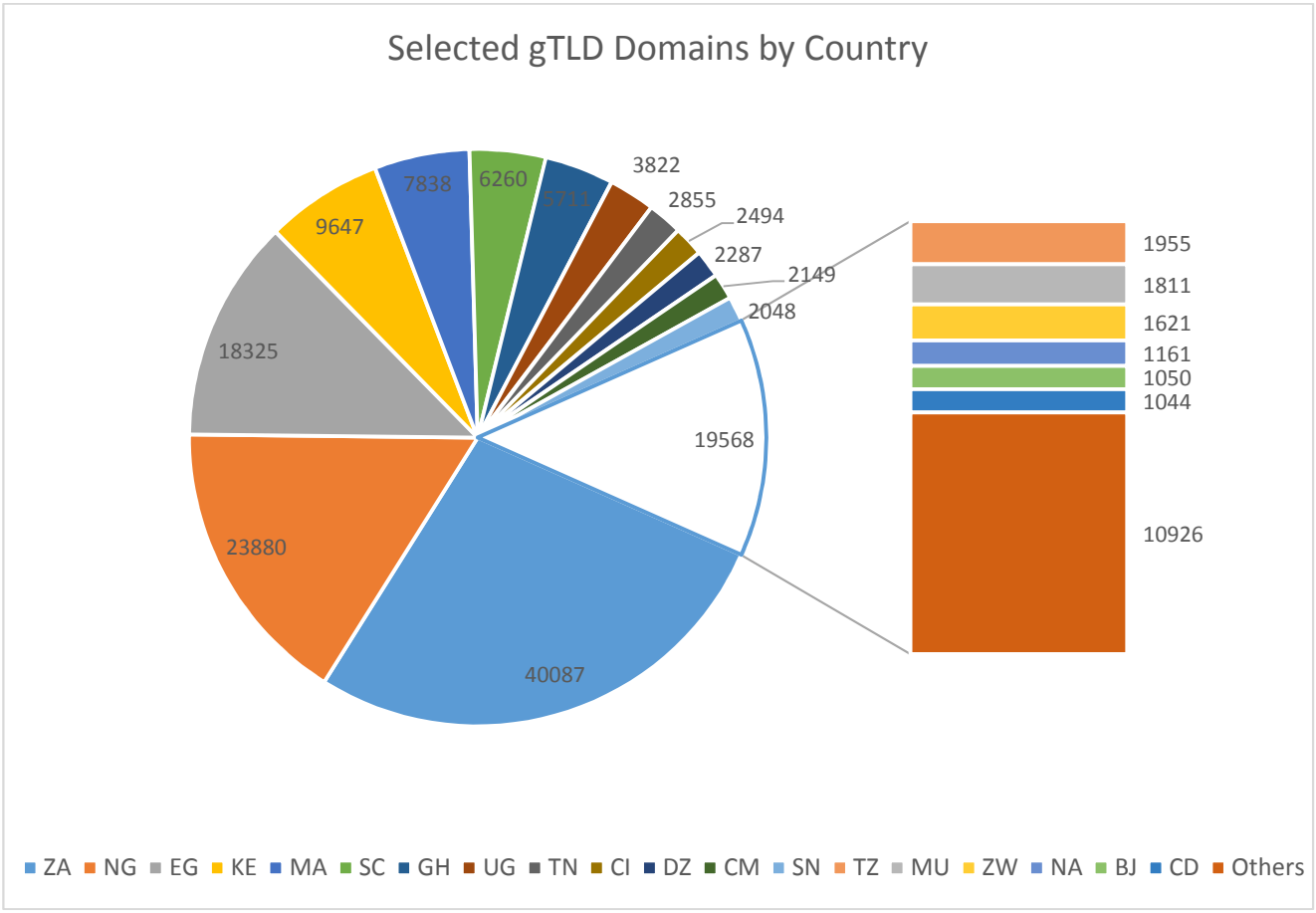
Afilias was able to provide us with three pieces of data about 147,000 domains in 21 gTLDs. The data consisted of a Domain Name, a Creation Date and the African country with which the Registrant is associated. The data was analysed without any WHOIS lookups (other than Geo-Location for the IP address) and did not obtain, have, process or require any personal information about the Registrant.

Of the domains provided 11% pointed to a web server and 7% had websites with content. 0.4% of the domains were configured with IPv6 and 0.32% with DNSSEC. All 54 African countries were represented, including two domains from Southern Sudan (SS), even although its ccTLD has not been delegated yet.

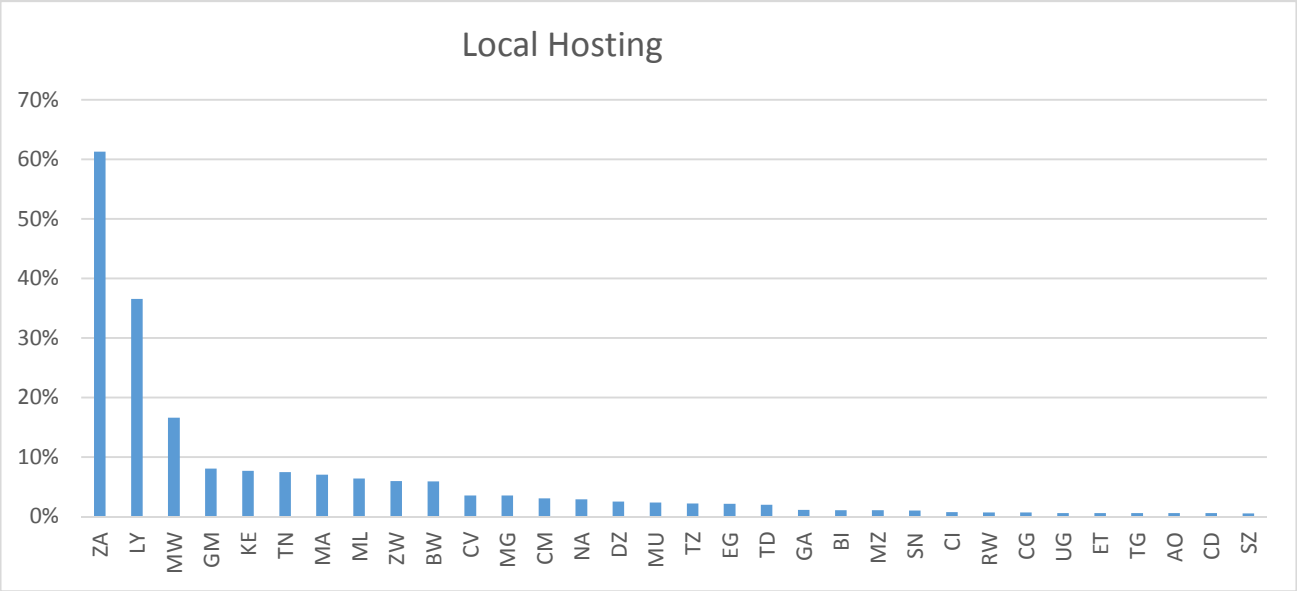
Although there were 21 gTLDs involved, 98% of the domains were concentrated in just 3 zones: .ORG, .INFO and .MOBI. Note that the biggest gTLD zone, .COM, isn't included in this sample. A summary of the data is shown in the following graphics.



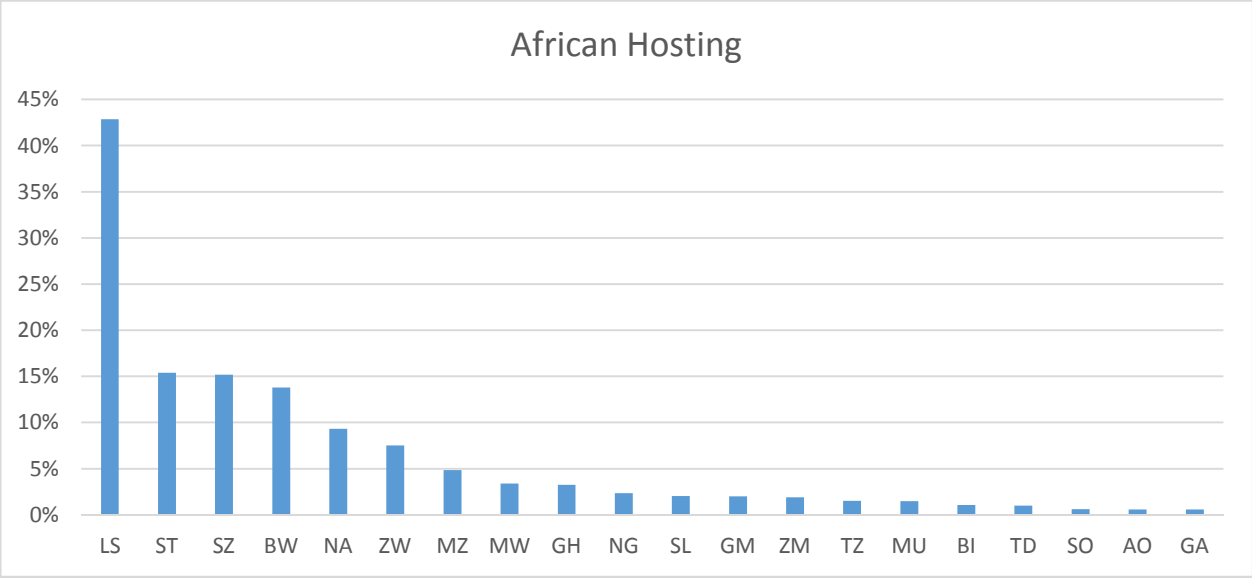
Of the 146,989 Afilias domains, 40,087 were associated with South Africa, followed by 23,880 with Uganda, 18,325 with Egypt, 9,647 with Kenya and 7,838 with Morocco. The complete distribution is shown below.



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%. The overall distribution is shown in the pie chart below. The presence of some countries such as Guinea and Mali, which are not known for their local hosting facilities, may be an artefact of the sampling method and the small sample size.

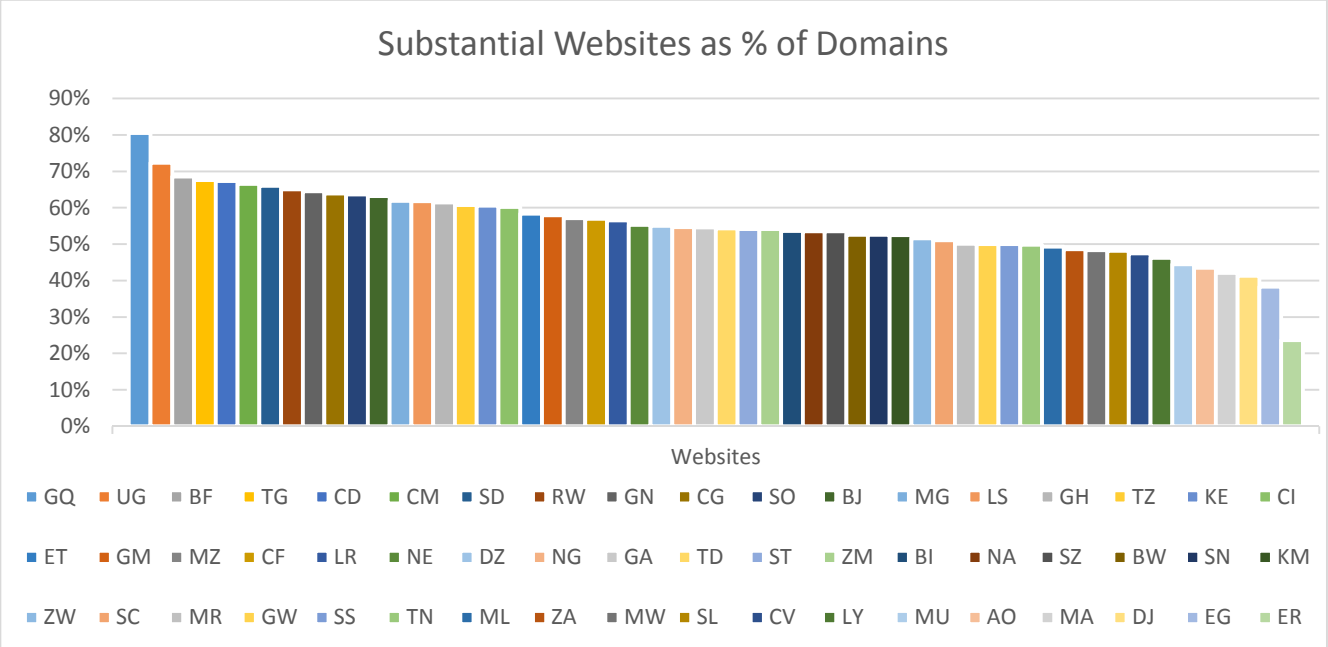


Moving on to those Afilias websites hosted by another African country, Lesotho leads with 43%, all of which are hosted in South Africa. Other smaller African countries follow: Sao Tome & Principe, Swaziland, Botswana and Namibia. The overall distribution is again in the bar chart below.

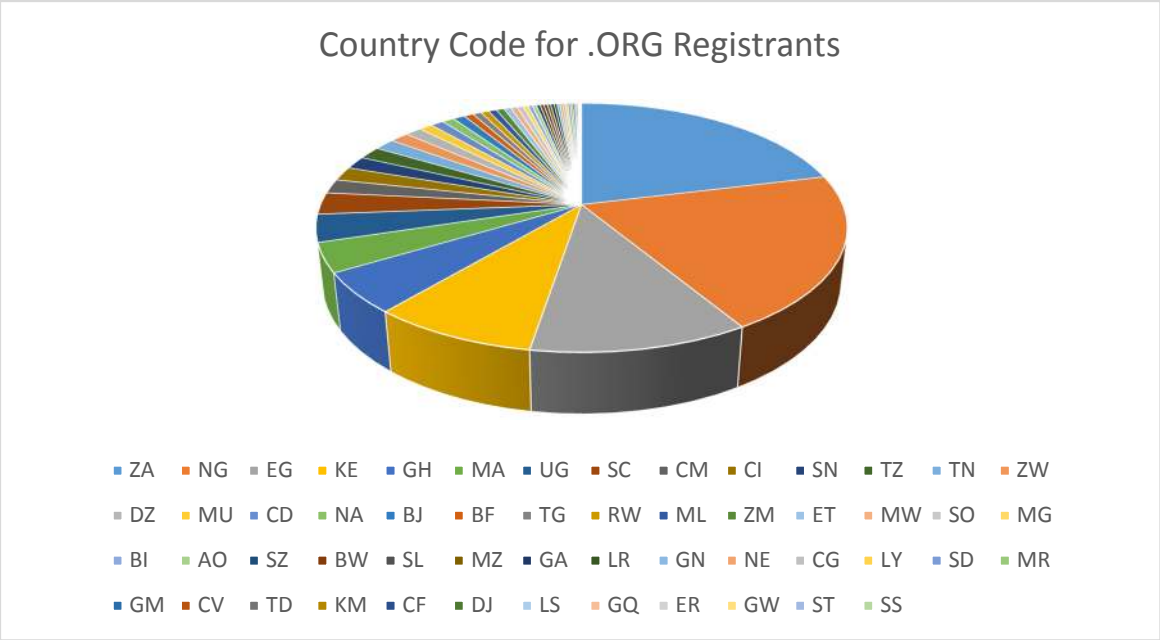


In terms of overseas hosting, 15 countries hosted 100% of their Afilias websites overseas and another 24 countries hosted over 95% of websites overseas. This is indicative of the very low levels of local hosting – and hence Internet ecosystem health – in a majority of African countries.

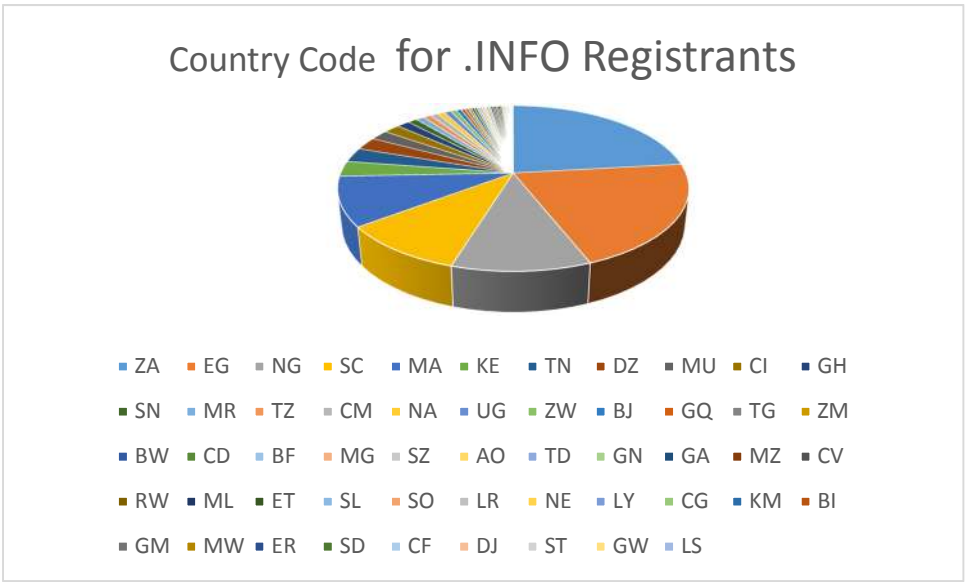
Of those who have registered an Afilias domain there is a reasonably high proportion of websites operating on those domains (i.e. not squatted, or just used for mail), ranging from 81% (128 out of 159) for Equatorial Guinea, 72% for Uganda and 69% for Malawi. The distribution is again shown below.



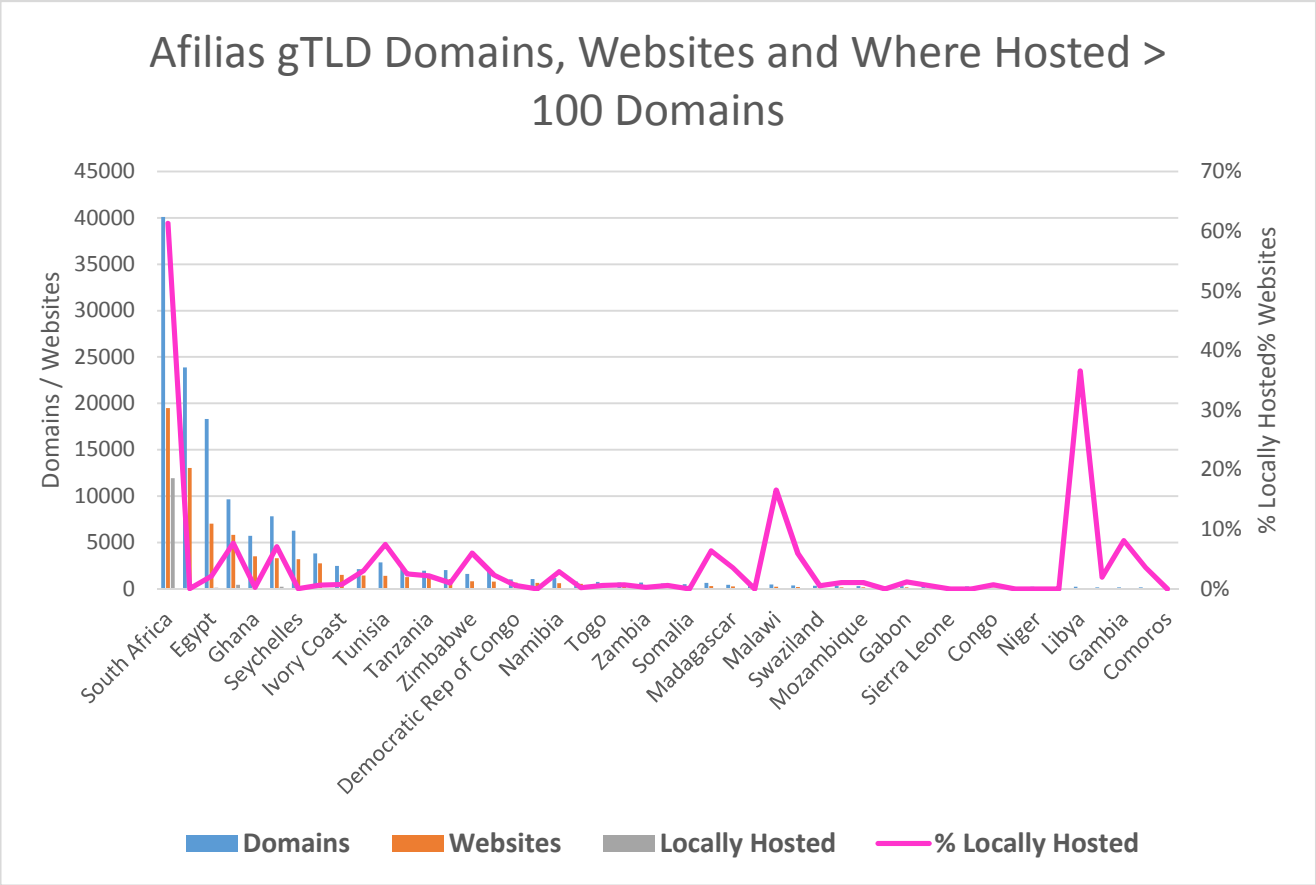
Looking at individual zones, the largest of these was the .ORG zone (99 445 African domains), with most domain registrants from South Africa, followed by Nigeria, Egypt, Kenya and Ghana.



The order changed slightly for the second largest Afilias zone, .INFO (32 339 African domains). South Africa leads again, followed by Egypt, Nigeria, Seychelles and Morocco.



The two charts below show how many domains are registered, how many have websites, how many websites are locally hosted and the percentage of websites locally hosted, for those African countries that have more than 100 Afilias domains registered.



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

Afilias Domains	**Local Hosting**	**Indexed Webpages**
South Africa	South Africa	South Africa
Nigeria	Kenya	Kenya
Egypt	Morocco	Zimbabwe
Kenya	Egypt	Uganda
Morocco	Tunisia	Nigeria
Seychelles	Zimbabwe	Egypt
Ghana	Cameroon	Morocco
Uganda	Malawi	Libya
Tunisia	Libya	Mauritius

Ivory Coast	Algeria	Democratic Rep of Congo

5.5.5.2 EyeDomain gTLD Domains

Approximately one million gTLD domains with an African Registrant have recently been received. Analysis of this data is currently underway, and the results will be included in the Final Report of this Study.

5.5.5.3 African Zone Files

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 countries, we were not able to acquire all zone files.

ZONE	COUNT
CO.ZA	1 001 013
CO.ZW	22 794
ORG.ZA	22 203
CAPETOWN	4 407
JOBURG	3 407
DURBAN	2 459
SD	2 110
WEB.ZA	1 713
ORG.ZW	1 208
CO.LS	1 045
AC.ZW	477
GOV.SD	474
CO.NA	439
NOM.ZA	351
COM.SD	316
ORG.LS	166
EDU.SD	142
EDU.ZA	94
ORG.SD	75
NET.SD	33

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

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:

- Only between a third and a half of the domains have web sites behind them, the remainder are inactive
- Despite the relatively well developed hosting ecosystem in South Africa, about one third of the web sites are hosted off-shore – even Zimbabwe, which has direct fibre connections with South Africa, chooses to host most of its web sites off-continent.

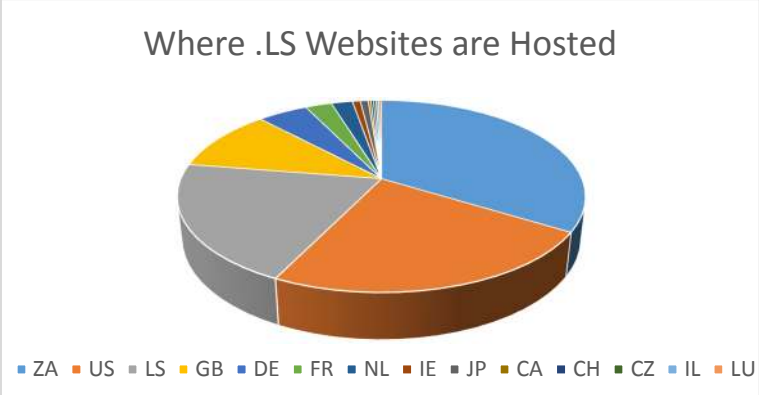
5.5.5.4 Lesotho

Lesotho had a total of 1 168 domains in the Zone Files provided. Of these, 510 had configured web servers, and 400 (34%) had websites.[94] Of these, 81 are hosted in Lesotho itself, with 135 hosted elsewhere in Africa (all of them in South Africa), leaving 184 (46%) websites hosted overseas. Although LS websites are hosted in a total of 14 countries, being surrounded by South Africa, with its well-developed hosting infrastructure, it is not surprising that Lesotho's ccTLD has the highest percentage of both ccTLD and Afilias domains being hosted by another country on the African continent - South Africa leads in terms of hosting domain names registered in Lesotho, with 34%, followed by the US with 24% and Lesotho itself with 20%.

Host	Count	Percentage
ZA	135	34%
US	94	24%
LS	81	20%
GB	42	11%
DE	19	5%
FR	10	3%
NL	8	2%
IE	3	1%
JP	3	1%
CA	1	

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

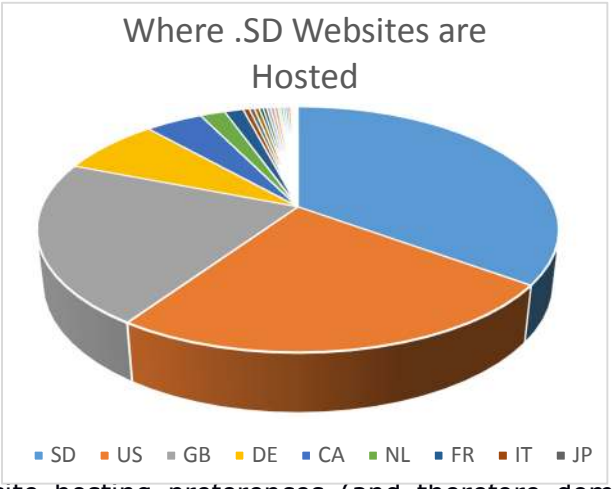
CH	1	
CZ	1	
IL	1	
LU	1	



5.5.5.5 Sudan

Afilias' Zone File with entries relating to Sudan had 3 153 domains in 9 zones, including one IDN. A total of 1 082 entries (34%) had functioning websites. Of these, 379 were hosted locally, 3 elsewhere in Africa and the balance of 700 overseas, in a total of 26 countries. The top 7 of these are:

Host	Count	Percentage
SD	379	35%
US	265	24%
GB	232	21%
DE	81	7%
CA	46	4%
NL	20	2%
FR	15	1%

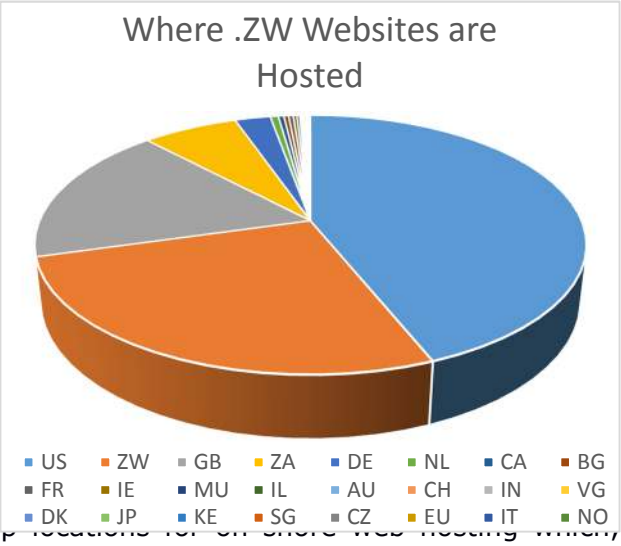


The Sudan case provides a good example of site hosting preferences (and therefore domain registration trends) that are not strongly influenced by geographic proximity, backbone routes or colonial ties – thus it is noteworthy that more than 1 third of the web sites are hosted locally, while the US and the UK are roughly equal contenders for the majority of the remaining web sites. The relatively high proportion of local web hosting may be partially the result of the international boycott on Sudan, although the large number of US-based sites belies this conclusion.

5.5.5.6 Zimbabwe

Zimbabwe has 24,479 domains in the 3 zones that were provided, with 7,367 (30%) having websites. Of these, 1,964 (27%) are hosted locally, 511 elsewhere in Africa (7%) and 4892 (66%) overseas. ZW websites are hosted in a total of 29 countries. The top countries are: -

Host	Count	Percentage
US	3235	44%
ZW	1964	27%
GB	1285	17%
ZA	493	7%
DE	183	2%
NL	41	1%



As with Sudan, the UK and the US are the top locations for off-shore web hosting which, as indicated above, is somewhat surprising given the apparently well-developed hosting environment in South Africa, a country with which Zimbabwe also has close economic, cultural and infrastructure ties.

5.5.5.7 South Africa

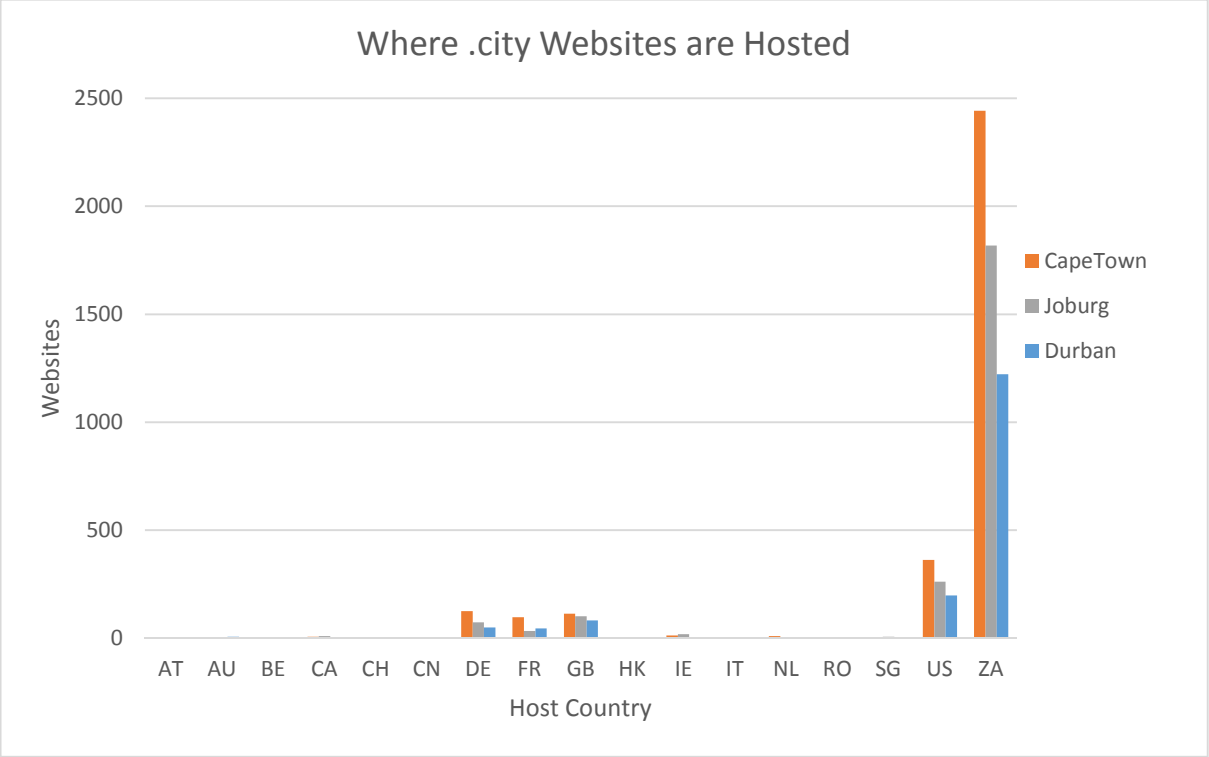
South Africa has 1,025,410 domains in the 5 zones which were provided. Of these, 49% have websites and 71% of those are hosted locally. Altogether, .ZA websites are hosted in 75 countries, the most popular of which are the US, Germany and the UK (aside from a large majority of in-country hosting).-

Host	Count	Percentage
ZA	358388	71%
US	83051	16%
DE	33537	7%
GB	14312	3%
IE	3279	1%

5.5.5.8 City gTLDs: .CAPETOWN, .DURBAN & .JOBURG

The 10273 city gTLDs have a total of 7139 or 69% websites. This high proportion is indicative of the importance placed on these new gTLD domains. Most of the websites - 77% - are hosted in South Africa, but there are a total of 17 countries hosting pages for these domains. The top six are shown in the table below, with a graphical representation of the distribution.

Host Country	.DURBAN	.CAPETOWN	.JOBURG	Totals	Percentage
ZA	1 223	2 442	1 818	5 483	77%
US	198	362	262	822	12%
GB	83	114	102	299	4%
DE	50	126	74	250	4%
FR	45	97	33	175	2%
IE	5	13	18	36	1%



6 KEY FEATURES OF THE AFRICAN DNS MARKET

6.1 Internet Services - Institutional Roles

6.1.1 Regional and National ICT Policy, Strategies and Regulatory Authorities

6.1.1.1 ICANN

ICANN published its five year plan in Africa starting from 2016, which aims to increase the participation of Africans and to support a stronger presence for ICANN in Africa. The strategy objectives are to strengthen ccTLD development in Africa, enhance cooperation with Computer Emergency Response Teams (CERTs) for better handling of DNS related incidents, and promote new gTLD registries.

6.1.1.2 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.

6.1.1.3 The African Union (AU)

The African Union Commission (AUC), based in Ethiopia and its associated NEPAD Planning and Coordinating Agency[95] based in South Africa have continent-wide ICT support strategies, most notably the Programme for Infrastructure Development in Africa (PIDA), cybersecurity capacity building, regional policy and regulatory frameworks, electronic postal systems, the .AFRICA gTLD 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.

[95] www.nepad.org

6.1.1.4 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 affordability.

Similarly in West Africa, ECOWAS is in the process of developing an integrated infrastructure master plan which focuses on cross-border projects in ICTs, energy, transport and water resources to support regional integration.

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).

6.1.1.5 National Policy and Regulatory Bodies

National policy and regulatory authorities are responsible for developing and implementing an enabling environment for the development of ICT services in the country. Virtually all countries in Africa have a specific body (ministry) responsible for policy development, and an independent authority responsible for regulating the ICT sector, although some of them are relatively new[96], [97].

The strategies and capacity of these institutions vary widely across the continent – in some cases, such as Ethiopia, the government has continued to maintain a single monopoly telecom operator for all voice and Internet services. However in most countries, the retail market has been opened to multiple mobile operators while retaining one or two fixed operators. In a few cases technology and service neutral licenses have been issued, which effectively creates an open market, although there may be high license fees or other restrictions on market entry. Some countries have also created wholesale operators, either simply by licensing private providers or

[96] The Swaziland Communications Commission (SCCOM), for example, was set up by legislation in 2013, but in 2015 was still setting up its licensing framework: http://www.sccom.org.sz/ It took over from the previous combined regulator / incumbent , which it is now required to regulate: www.sptc.co.sz

[97] A fairly complete, but outdated (as far as SZ is concerned) list can be found at http://www.africantelecomsnews.com/Operators_Regulators/List_of_African_telecommunications_regulators.html

through government or PPP initiatives in creating national backbone operators (e.g. Tanzania's NICTBB) or wholesale 4G operators (e.g. Rwanda's ORN).

Regulators are usually provided with some degree of independence and financial autonomy, although the executive body of councillors is 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 below.

The majority of African countries realise the important role of ICT in the socio-economic development of their nations, thus most governments have developed an ICT related strategic planning process which may have a broad integrated focus, while others have made sub-plans to address specific issues according to their priorities, such as a national broadband plan or a cyber security strategy.

Little research has been conducted on the scope and effectiveness of these strategies, however the ITU Broadband Commission 2016 annual report[98] includes a survey of recent ICT plans around the world. It found that 14 countries in Africa had not yet adopted this planning instrument, as shown in the table below. Given the fast pace of developments in the technologies, it is also likely that a majority of these plans will be updated in the short-to-medium term, which will provide opportunities for better inclusion of domain name management strategies for the countries concerned.

Country	Year	Plan
Algeria	2008	E-Algérie 2013`
Angola	2013	White Book of Information and Communication Technologies, Information Society National Plan 2013-2017
Benin	2014	Projet de Développement des Infrastructures et des TIC
Botswana	2014	Botswana's National Broadband Strategy
Burkina Faso	2013	Réseau national de fibre optique
Cameroon	no	
Cape Verde	2005	Programme Stratégique pour la Société de l'Information (PESI) accompagné du Plan d'Action pour la Société de l'Information (PAGE)
Central African Rep.	2006	Politique Stratégies et plan d'actions de l'édification de la Société de l'Information en République Centrafricaine
Chad	2007	Plan de développement des technologies de l'Information et de la Communication au Tchad or (PLAN NICI)
Comoros	2014	Loi N° 14-031/AU du 17 Mars 2014 relative aux communications électroniques et Décret N° 08-019/PR

[98] http://broadbandcommission.org/Documents/reports/bb-annualreport2016.pdf

Congo	2011	Projet de Couverture Nationale (PCN), Projet West Africa Cable System (WACS), Projet réseau national de fibre optique
Congo (Dem. Rep.)	no	
Côte d'Ivoire	2016	Le Réseau National Haut Débit (RNHD) 2016. Objectifs Strategiques du Government de Côte d'Ívore en Matiere de Telecommunications et de TIC 2010
Djibouti	2004	Plan d'action national pour l'exploitation des TIC en République
Egypt	2012	eMisr National Broadband Plan
Equatorial Guinea	2012	Nuevas Tecnologias: national project aimed at the popularization of technologies Information and communication (TICGE) 2012-2020
Eritrea	no	
Ethiopia	2013	National Broadband Master Plan
Gabon	2011	Digital Gabon - Gabon Industriel, Gabon vert et Gabon des Services
Gambia	2008	The Gambian ICT4D-2012 Plan
Ghana	2010	Broadband Wireless Access
Guinea	2009	Plan National de fréquences/Plan de développement de l'infrastructure nationale d'information et de communication de la République de Guinée 2001 – 2004
Guinea-Bissau	no	
Kenya	2013	National Broadband Strategy - Vision 2030
Lesotho	2014	National Broadband Policy 2014-2018
Liberia	2010	Policy for the Telecommunications and Information Communications Technology (ICT) 2010-2015
Libya	no	
Madagascar	2014	Loi n° 2005-023 du 17 octobre 2005
Malawi	2013	National ICT Policy
Mali	no	
Mauritania	no	
Mauritius	2012	National Broadband Policy 2012 - 2020 (NBP2012)
Morocco	2012	Plan national pour le développement du haut et très haut débit au Maroc
Mozambique	2006	National ICT Policy Implementation Strategy 2002 and 2006 - Digital Inclusion in Mozambique
Namibia	2009	Telecommunications Policy for the Republic of Namibia
Niger	2005	Plan de développement des Technologies de l'Information et de la Communication au Niger / Plan NICI du Niger
Nigeria	2013	National Broadband Plan 2013-2018
Rwanda	2006	Regional Connectivity Infrastructure Program (RCIP)
S. Tomé & Principe	no	
Senegal	no	
Seychelles	no	
Sierra Leone	no data	
Somalia	no	

South Africa	2013	National Broadband Policy
South Sudan	no	
Sudan	2012	Sudan's National Strategic Development Plan 2012-2016
Swaziland	no	
Tanzania	2004	National Information Communication and Technology Broadband Backbone (NICTBB)
Togo	planning	
Tunisia	2015	Tunisie Digitale 2018
Uganda	2009	Uganda Broadband Infrastructure Strategy National Position Paper
Zambia	2006	National Information and Communication Technology Policy
Zimbabwe	2005	National ICT Policy

Source: Broadband Commission 2016 Annual Report

6.1.2 DNS Governance

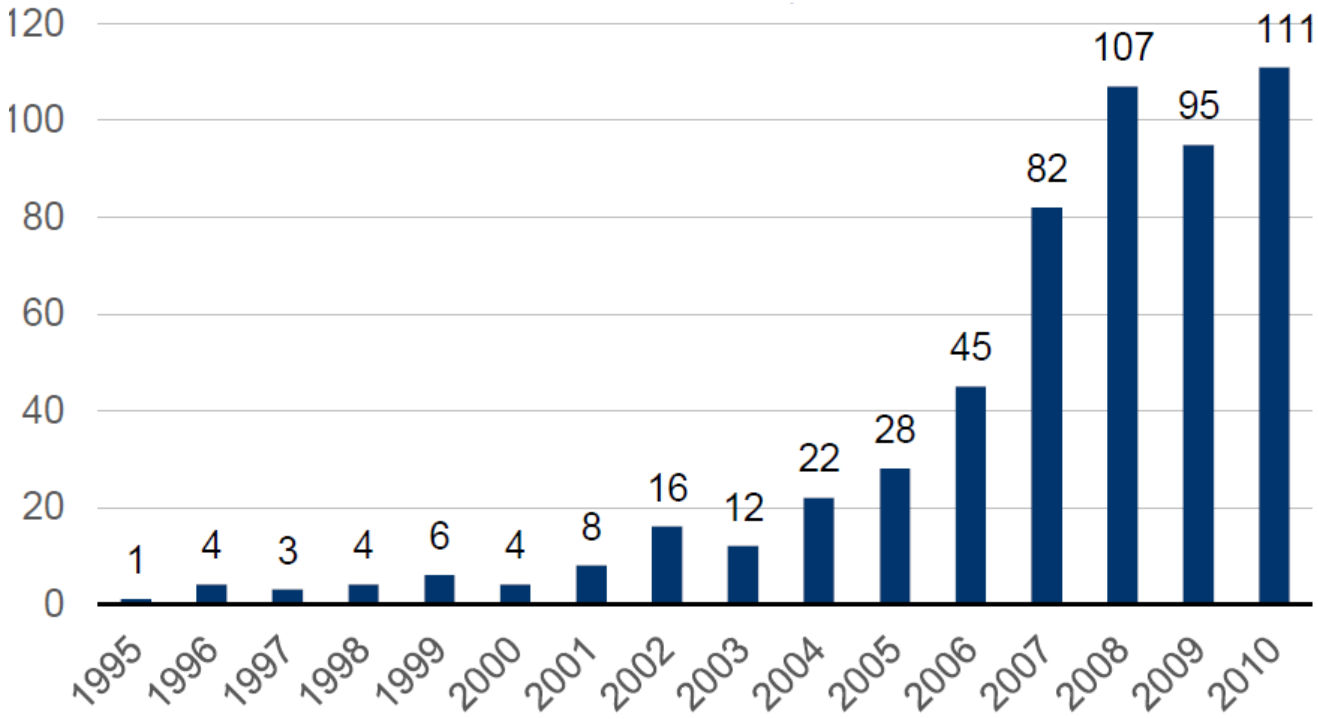
As indicated above, the role of the national ICT regulatory authorities may go beyond basic infrastructure and include management of their ccTLD registries. In these cases the value of a country domain has been recognised by government as providing greater flexibility in Internet naming and supports aspirations for ensuring the data sovereignty of the country.

According to the Zone File analysis as part of this study, domains under the ccTLDs represent the majority of registered domains in Africa and the survey shows that many Regulators are responsible for managing ccTLDs. There are some exceptions such as Sudan (.SD), which is managed by an NGO established in 2001 to manage the country domain. Also the ccTLD of Egypt (.EG) was delegated to the Egyptian Research and Education Network (EUN) 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). However, the ccTLD and many other 2LD domains are managed by the ZA Central Registry (ZACR), a private non-profit entity that manages the registries under contract.

6.1.3 The Influence of Politics on Telecommunications and the Internet

There is an increasing trend for some governments to shut down the Internet within their countries at times, despite the high economic costs that result. The Brookings Institute[99] gives these figures for the number of Internet shutdowns globally -

[99] https://www.brookings.edu/wp-content/uploads/2016/10/intenet-shutdowns-v-3.pdf



The shutdowns shown in the table below represent an economic cost to the African countries involved of a total of some USD $428 million in 2015 – 2016. Out of 81 instances of Internet Shutdowns worldwide, Africa was responsible for 9 shutdowns during the period 2015 - 2016

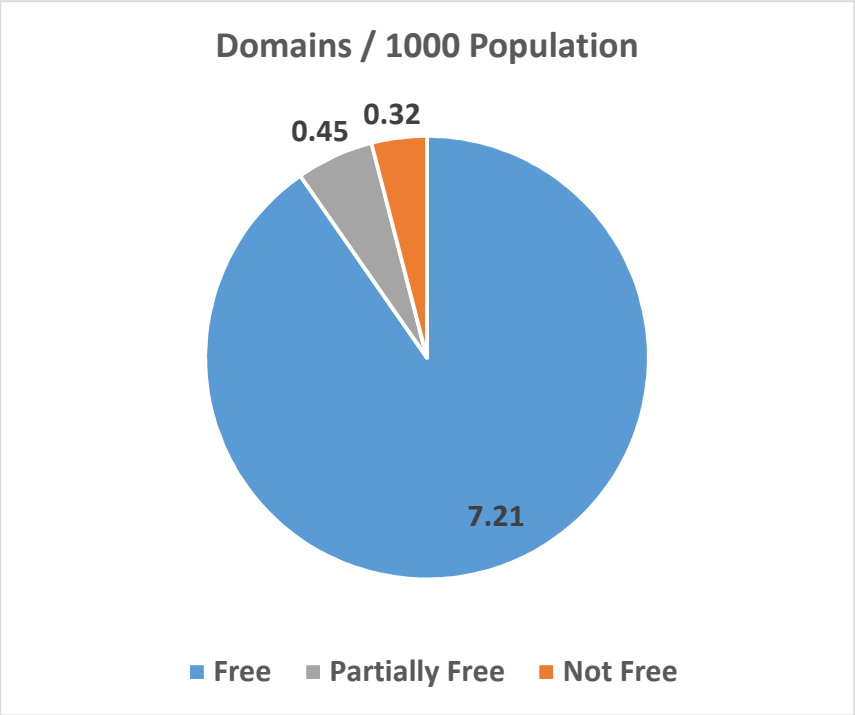
Country	Shutdowns	Cost USD $millions
Morocco	1	320.5
Congo	2	72.5
Algeria	1	20.5
Ethiopia	1	8.5
Chad	1	3.7
Uganda	2	2.2
Libya	1	0.4
Total Cost to Africa		428.3

It would appear that there is a positive correlation between how democratic a country is, and how well developed its Internet infrastructure is. This can be seen with some of the African countries with particularly low numbers of domain names.

The following figures suggest a relationship between political freedom as determined by Freedom House[100] and domain names[101]

Status	Total ccTLD Domains	Domains excl. Freenom	Number of Countries	Domains / Country	Domains / 1000 Population
Free	1065220	1065220	11	96838	7.21
Partially Free	453609	219316	21	10443	0.45
Not Free	1390760	137671	21	6555	0.32
TOTALS	**2909589**	**1422207**	**53**		

The last of these is particularly telling



Citizens of "Free" countries register some 22 times as many domains as citizens of "Not Free" countries[102].

[100] Political data from Freedom House 2016 report retrieved from https://freedomhouse.org/sites/default/files/FH_FITW_Report_2016.pdf
[101] . In all cases, the DRC is excluded, as it isn't ranked by Freedom House, and the domains from the four Freenom countries are also excluded, as they distort the results significantly.
[102] This study has not examined whether there is a causal relationship between these numbers.

6.2 The ccTLD Address Space in Africa

The African continent top level DNS address space consists of 54 top level country code ccTLDs, plus five IDNs: Egypt (مصر), Algeria (الجزائر), Tunisia (تونس), Sudan (سودان) and Morocco (المغرب) as well as three city codes (.CAPETOWN, .DURBAN and .JOBURG). Western Sahara is a disputed territory, and as such it has no ccTLD, although (EH) is reserved for this purpose. Currently IANA has no sponsoring organisations assigned to this domain.

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 (Reunion - a territory of France),
- .SH (Saint Helena, Ascension and Tristan da Cunha - another British protectorate).

In addition, the .AFRICA domain, which has been in planning for some time, is now on the point of going live.

Research data[103] from November 2016 indicates that a total of just over 3.1 million domains are active under the African ccTLDs. There are also many registrations in the gTLDs by African entities. Some of these from the Afilias database extract are analysed in section 5.5.5

6.3 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, which must often be paid for in foreign currency with a credit card, to which the 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

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

component of the value chain needs to be in place in order for the market to function efficiently, which in turn creates demand for local domains.

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

6.3.1 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 mainly 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' 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.

6.3.2 Offshore Entities

There are many African ccTLD sub-domains that are 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 the vast majority of off-shore registrations are concentred in the countries with ccTLDs that are amenable to 'domain hacks', often using a ccTLD as part of a word, as described below.

6.3.3 Domain Hacks

There are a surprisingly large number of African countries that 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 eleven most popular of these use the following countries' ccTLDs:

- Central African Republic (.CF) - This domain is one of the 'suite' of free African ccTLDs, along with .GQ, .GA and .ML, which were developed as free domains by registrars Freenom[104] and Safecow[105]. 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 need to 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.
- 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.
- Djibouti (.DJ) - is marketed by a large number of 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.
- 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).
- Gabon (.GA) - Similar to .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.
- 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

[104] http://www.freenom.com/en/freeandpaiddomains.html
[105] http://www.safecow.com/free-hosting.php

names remain available on the premium domain market, and some popular domains can be bought on the secondary domain market from domain name speculators.

- 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.
- 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.
- 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.
- 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.
- Somalia (.SO) - a relatively large number of international web sites such as phy.so, comics.so and retire.so use the Somalia ccTLD as a domain hack for creating memorable domain names.

6.3.4 Local Presence and Other Requirements

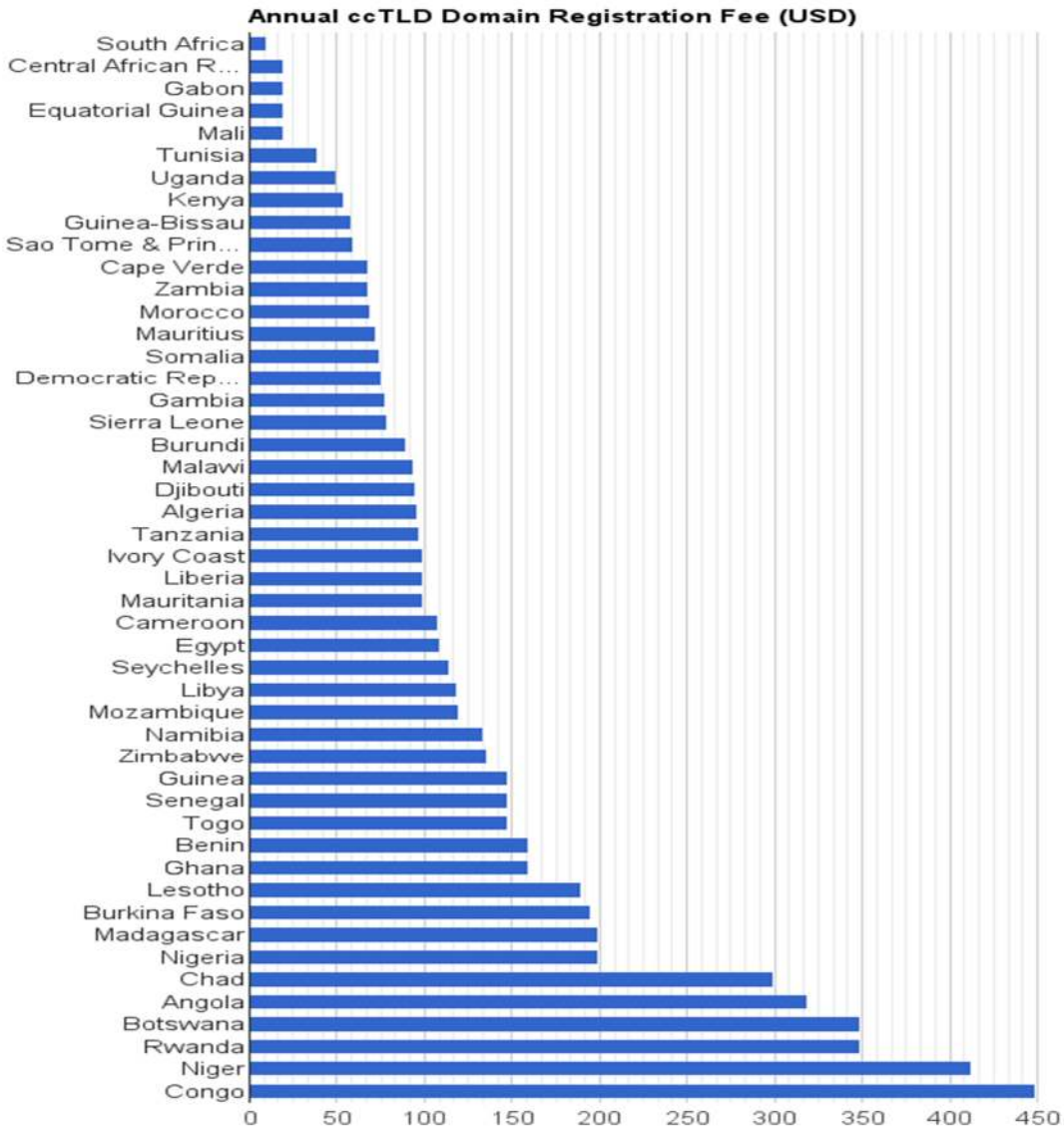
Most of the African ccTLDs are available for registration for offshore entities without the requirement for a local presence. In a few countries corporate registrants are required to provide evidence such as a copy of business registration, tax identification document or a trademark matching the domain name, and may occasionally be required to provide a copy of a passport. Many offshore registrars offer 'trustee services' to get around requirements for local presence in some countries.

A total of 15 countries in Africa require some form of local legal presence (corporate or individual) in order to register a domain name: Algeria, Angola, Benin, Burkina Faso, Cap Verde, Egypt, Gambia, Guinea, Liberia, Mauritania, Niger, Senegal, Tanzania, Tunisia, Zambia. With the

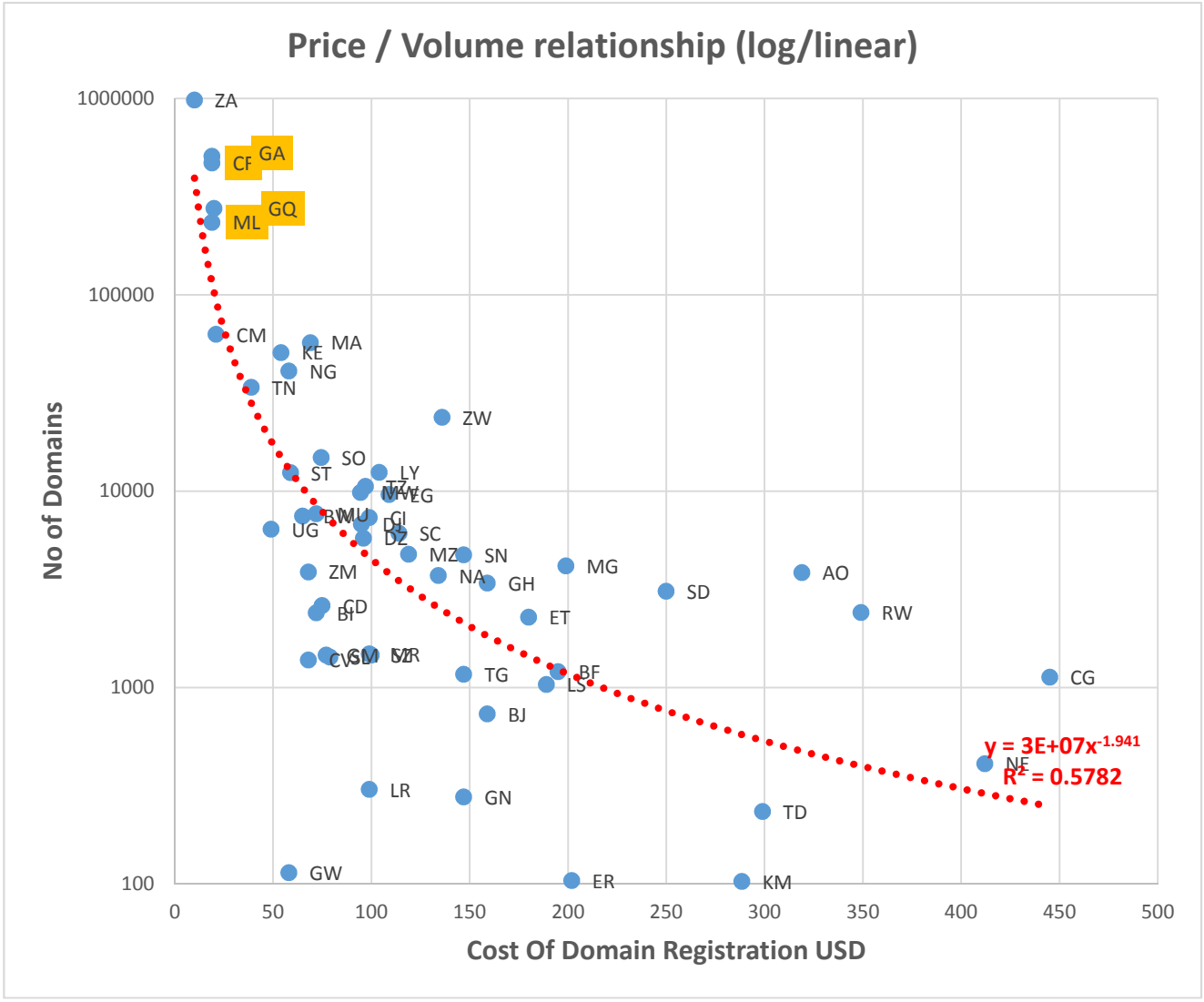
exception of Angola, Tanzania and Zambia, these countries can be seen to be predominantly concentrated in West and North Africa and are mostly French speaking.

6.4 African DNS Fee Structures

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 $84 per annum. As can be seen from the chart below, only 8 countries have annual fees of USD $50 or less (Central African Republic, Equatorial Guinea, Gabon, Kenya, Mali, South Africa, Tunisia, Uganda), and five countries have annual fees of over USD $300 (Angola, Botswana, 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.



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 highlighted in orange. As would be expected there are a number of ccTLDs that do not conform to the trend - naturally not all ccTLDs will conform to the relationship 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.



Note that Guinea-Bissau (GW), Eritrea (ER) and the Comoros (KM) have around 100 domains each, while Liberia (LR), Guinea (GN) and Chad (TD) have about 300 domains each. The reasons for these very low numbers are examined in section 7.4, together with a few other underperforming ccTLDs. 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 only moderate at 58%.

6.5 Valuation of the African DNS Industry

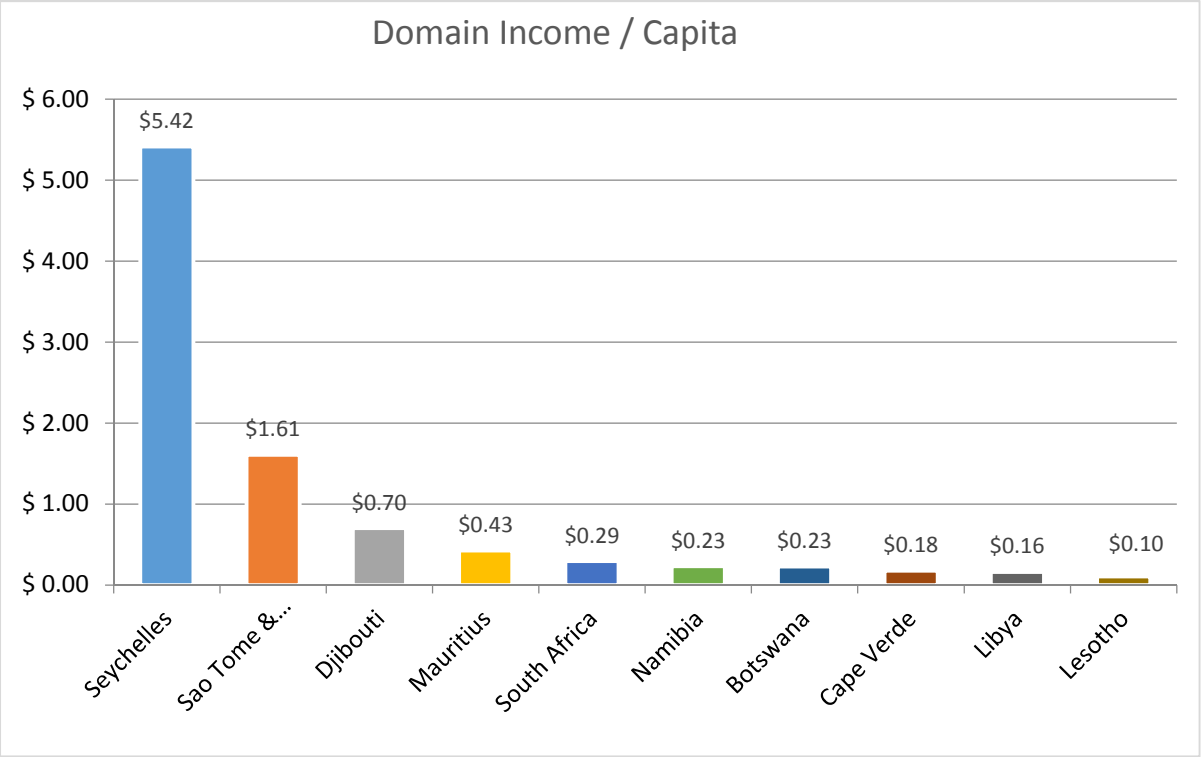
To derive a rough indication of the total value of the domain name sector in Africa, the total number of domains registered in each country can be multiplied by the indicative registration fee[106]. This does not take into account premium domain revenues, or the small number of domains that may be provided for free (such as under .AC.ccTLD in some countries), nor those sub-domains which are not free even under the Freenom model[107]. Nevertheless, this calculation provides a general indication of the value of the ccTLD domain industry on the continent – about USD $37 million per year. At least 25% of this is likely to accrue to the international registrars and the remaining $27 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[108]. This gives a total valuation of the domain name industry in Africa of some USD $51 million.

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

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%

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.

[106] 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.
[107] Freenom sells premium domain names at a premium.
[108] Based on 1 million .com/.net/org domains @ USD 10/year



6.6 Registration Services

Compared to other regions, Africa has a very small number of registrars. In total, there are only eleven ICANN accredited registrars in Africa[109] - 4 in South Africa, two in Morocco and one each in Burundi, Ghana, Nigeria, Senegal, 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;
7. Ghana Dot Com Ltd – Ghana;
8. Internet Solutions (Pty) Ltd. South Africa;
9. Kheweul.com SA – Senegal;

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

10. Upperlink Limited – Nigeria; and
11. Web4Africa Inc. - South Africa.

These eleven are a tiny proportion (0.5%) of the total 2,143 ICANN accredited Registrars, of which 1653 or 77% are from the USA.

Research gathered directly for this report identified 1490 Registrars, including off-shore Registrars that are taking registrations for African ccTLDs. There is significant duplication in this number, with some organisations whose primary business is acting as a Registrar selling domains for several dozen African ccTLDs. There are also a number of African Registrars who are accredited by or resellers for multiple African ccTLDs.[110]

Country	**Registrars**	**Total Domains**
South Africa	450	982 520
Kenya	144	50 867
Mauritius	96	7 677
Madagascar	93	4 165
Sudan	80	3 091
Namibia	61	3 721
Gambia	60	1462
Nigeria	57	40 997
Tanzania	54	10 582
Somalia	52	14 827
Cameroon	51	63 023
Zimbabwe	36	23 770
Democratic Rep of Congo	35	2 619
Morocco	35	57 137
Rwanda	30	2 412
Algeria	24	5 768
Botswana	20	7 474
Ethiopia	20	2 282
Tunisia	20	33 791
Burundi	19	2 401
Mozambique	10	4 773
Egypt	4	9 607

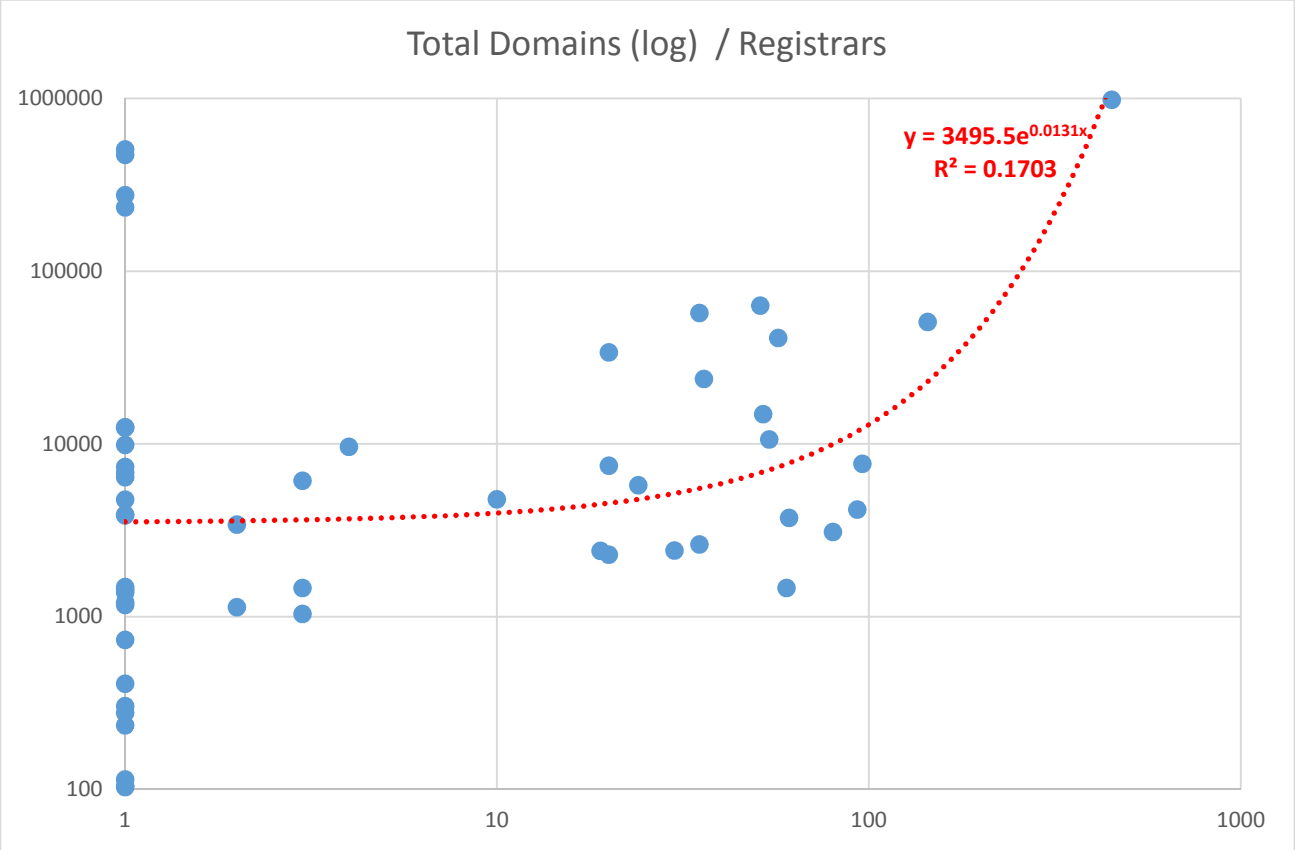
[110] This is additional work that could usefully be carried out in future.

Lesotho	3	1 035
Seychelles	3	6 110
Swaziland	3	1 462
Congo	2	1 131
Ghana	2	3 400
Angola	1	3 847
Benin	1	734
Burkina Faso	1	1 206
Cap Verde	1	1 380
Central African Republic	1	470 431
Chad	1	234
Comoros	1	103
Djibouti	1	6 793
Equatorial Guinea	1	275 269
Eritrea	1	104
Gabon	1	507 389
Guinea	1	277
Guinea-Bissau	1	114
Ivory Coast	1	7 353
Liberia	1	303
Libya	1	12 464
Malawi	1	9 862
Mali	1	234 293
Mauritania	1	1 484
Niger	1	409
Sao Tome & Principe	1	12 421
Senegal	1	4749
Sierra Leone	1	1427
Togo	1	1167
Uganda	1	6410
Zambia	1	3881
Southern Sudan		n/a

South Africa has the largest number of Accredited Registrars[111] at 450, followed by Kenya at 144, Mauritius at 96 and Madagascar at 93. On the other hand, there are 26 ccTLDs with only one Registrar each, usually the Registry itself.

The Registrars for 15 of the ccTLDs do not take registrations for entities without a local presence by the Registrant in the relevant country. In total 33 ccTLDs are available for out of country registration. For four countries, it is unclear whether local presence is required, and in two countries no local or foreign registration process was identified (Comoros (KM) or Eritrea (ER)) at all.

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 26 countries on the Y Axis with only 1 Registrar (Usually the Registry itself) and the correlation is correspondingly low. Note that this is a logarithmic plot

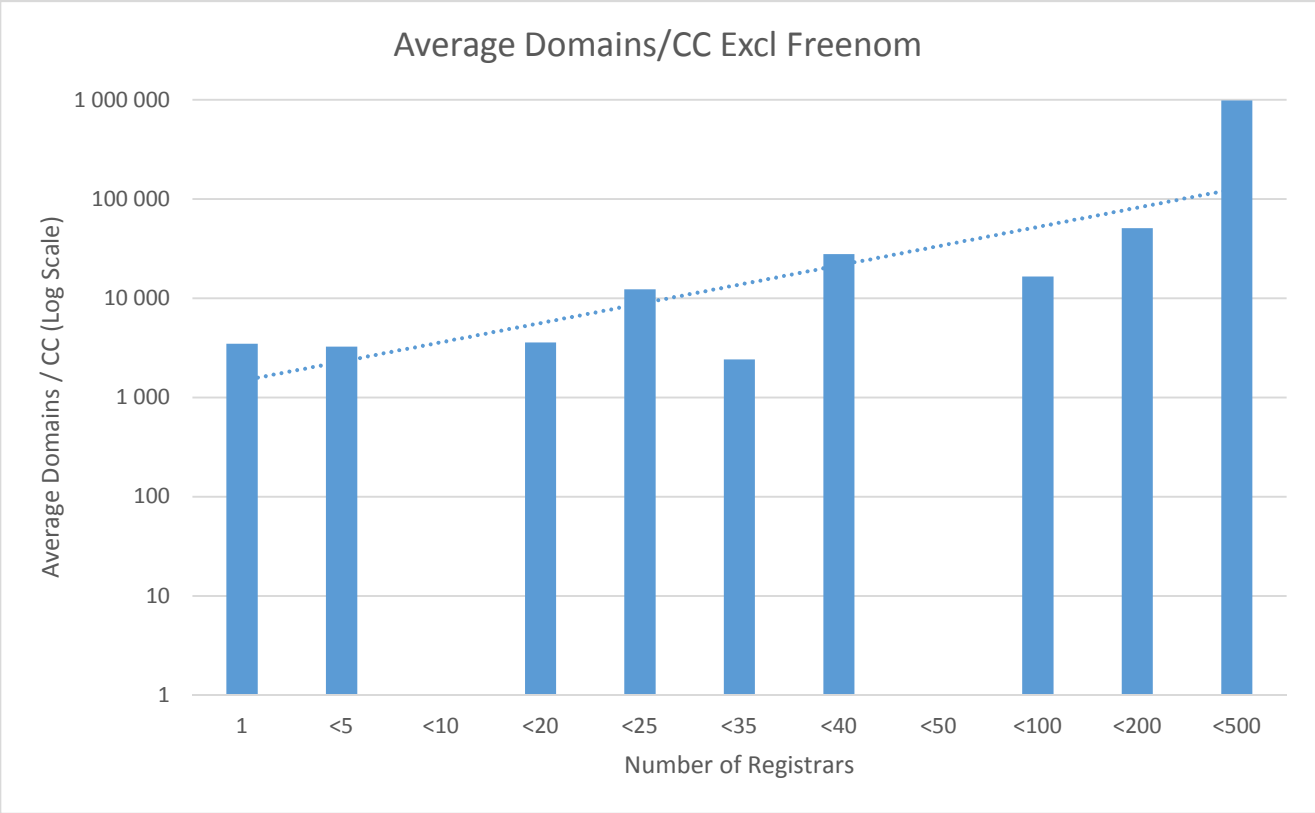


[111] In the 3R model, it is usual for the Registry to "accredit" Registrars as having signed the appropriate contracts and passed conformance tests. In the South African case, this is by the ZACR

If the Freenom countries are excluded, it would appear that there is no difference in the average number of domains registered per country, for up to 20 Registrars, at about 3,000 domains each. However, as the table below shows, those countries with more than 20 Registrars have more than triple the number of domains per country. It would appear that there is an inflection point between the 20 to 25 Registrar figures (Rwanda is an exception in this regard, as is Namibia). This may be because the larger number of Registrars forces them to be more competitive, or the causality could operate in the other direction – when a ccTLD's domains are popular, it could attract more Registrars. However firm conclusions on this relationship cannot be made as the last two rows in the table are Kenya and South Africa, which although they have many Registrars, also have many domains for many other reasons.

Table XX: Average Domains per Country by Number of Registrars

Bucket	Total Domains	Count of Countries	Average Domains / CC	Country Names
=1	76 722	22	**3 487**	(The rest, excluding the 4 Freenom countries)
<5	22 745	6	**3 791**	CG, EG, GH, LS, SC, SZ
<10	0	0		
<20	7 174	2	**3 587**	BI & MZ
<25	49 315	4	**12 329**	DZ, BW, ET & TN
<35	2 412	1	**2 412**	RW
<40	85 938	3	**27 842**	CD, MA & ZW
<100	149 545	9	**16 616**	CM, GM, MG, MU, NA, NG, SO, SD, TZ
<200	50 867	1	**50 867**	KE
<500	982 520	1	**982 520**	ZA



6.7 IDN

Support for the IDN initiatives in non-Latin alphabets such as Arabic and Amharic (Ethiopia) is growing in Africa. In North Africa the official language is Arabic, so the orthography employs Arabic script. This system is also used in Middle East countries. The Arabic Internet Names Consortium (AINC) led the initiative to foster the usage of Arabic alphabet.

The Arabic script is the second most widely used alphabetic writing system in the world after the Latin alphabet. 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.

The first implementation was made by Egypt (مصر) in 2010 followed by Algeria (الجزائر) and Tunisia (تونس) in 2012, and then Sudan (سودان) and Morocco (المغرب) in 2014. Libya is the most notable Arabic speaking African country without an IDN.

World report on Internationalised Domain Names 2015[112]

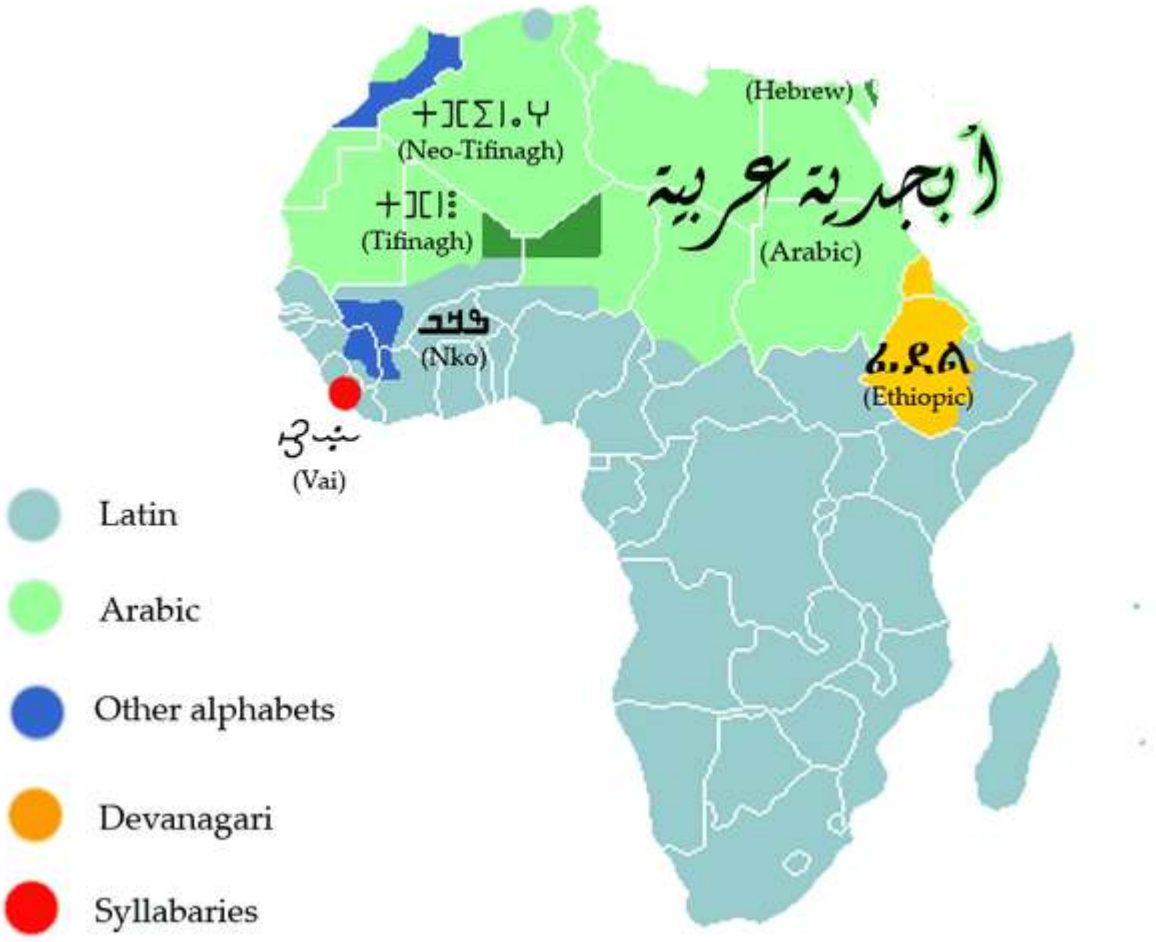


Figure XX: Writing Systems in Africa[113]

6.7.1 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 for this is that the Registrant does not want to have their personal contact information visible in the WHOIS system that anyone with Internet access can potentially see. An appropriate example could be that the Registrant is a minor, although most often this is to minimise spam.

[112] https://eurid.eu/media/filer_public/d0/ad/d0ad22df-e168-47f3-a647-ea1bd44391d6/idnworldreport2015_interactive.pdf
[113] Source: http://en.wikipedia.org/wiki/File:WritingSystemsoftheWorld4.png

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

- Registry: Do you provide Proxy Privacy facilities for WHOIS?
  - No (zero) Registries said "Yes"
- Registrar & Reseller: Do you offer Proxy registration services?
  - 13 out of 35 Registrars said "Yes"
- Registrant: Have you ever been offered Proxy Registration services?
  - 83 out of 179 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.

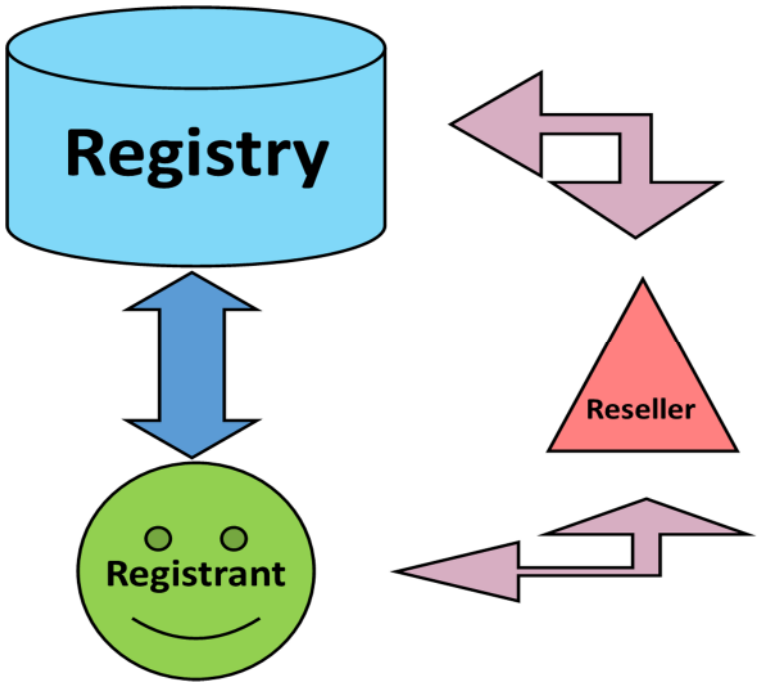
The easiest way to implement this is for the Registrant to use a proxy contact instead of their own contact details. This would be like having a Post Office Box rather than Street delivery for your postal mail. A variety of people can offer these services, from the parents of minors to the company lawyer.

6.8 The User Experience

A positive user experience of the DNS registration system is 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.

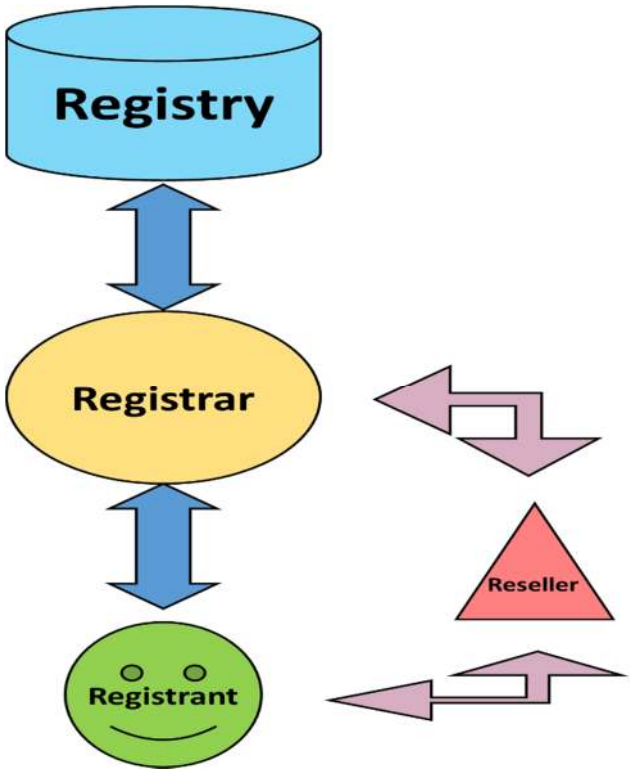
Conversely, the user experience is likely to provide a key metric of the health of the DNS ecosystem. Those countries with well-performing DNS markets are likely to see this reflected in the levels of user satisfaction within that system.

The nature of the user experience is rather simpler in the two-tier 2R model, where Registrants (some of whom may be resellers) interact directly with the Registry, and where there is a single interface to manage effectively.



The more complex 3R model[114], usually seen in more developed DNS markets and considered international best practice, presents two interfaces that need to be managed (Registrar-Registry and Registrant-Registrar). Note that while the image below depicts only one Registrar, in practice there are likely to be many

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



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

For these reasons, a number of 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[115];

[115] Worded differently for Registrars, who were asked to judge whether their system was "intuitive, automated user-friendly".

- The turnaround time for local Domain Name registration;
- The availability and functioning of an EPP (or another API[116]);
- The availability of Premium Domain registration.

Responses were received at all levels: from 13 Registries, from 41 Registrars across 14 countries, and from 164 Registrants across 25 countries. The responses are discussed below, supported by graphs where this is useful.

6.8.1 Registries, Registrars and Registrants

A substantial majority of Registrars (71%) support languages other than English, something likely to facilitate DNS uptake in non-Anglophone countries. About half (51%) say they offer a Content Management System, which simplifies website development, and again facilitates DNS uptake.

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 nearly half of Registries (46%)[117] and a third of Registrars (34%). However, this is likely in response to demand from Registrants, about half of whom (49%) report having made use of IDNs.

Overwhelmingly, Registrants (91%) prefer to deal with local Registrars, suggesting the importance of developing the in-country DNS market.

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[118], indicating a fair degree of ease with which local service providers were able to be found.

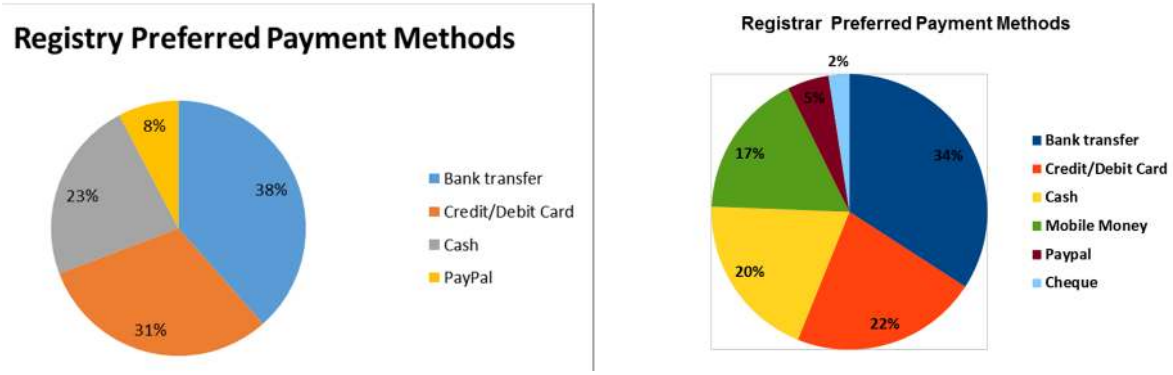
The vast majority of Registrants work with either a single Registrar (41%) or two Registrars (20%). It is unclear why as many as 16% report working with no Registrar. A small minority (8%) work with 5 or more Registers, with two working with as many as 30.

[116] Extensible Provisioning Protocol and Application Program Interface, respectively.
[117] Including some surprising ones such as Burundi, DRC, Kenya and Rwanda.
[118] Mean = 3.52, with a standard deviation of 1.05, showing few outlying (negative) scores.

6.8.2 Payment methods

Registrars and registrants were asked their preferred method for payments[119]. In both cases, as the pie chart below shows, bank transfer, followed by credit / debit card, are the clear favourites. Somewhat surprisingly, given its inhibiting impact on the speed and efficiency of registration transactions, cash comes in third for both entities. Mobile money was the unanimous preference for Kenyan Registrars, which is perhaps unsurprising given the role of M-Pesa in the Kenyan economy[120].

Figure 6.8.2: Preferred Payment Methods, Registries & Registrars



6.8.3 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")). It is clear that 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 3.86[121], with very few strongly negative views.

6.8.4 Ease of use

A surprisingly low number of Registrants (37%) rated their process as being "intuitive, automated [and] user-friendly", given that an effective registration interface is likely to be key to

[119] 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.
[120] It was also favoured in Côte d'Ivoire and Cameroun.
[121] Mean = 3.86, with a standard deviation of 1.02, showing limited variation in the responses.

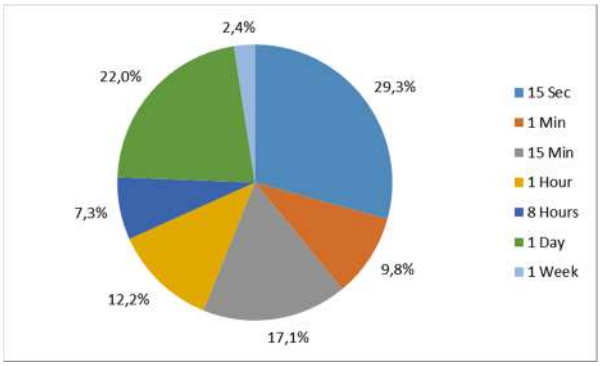
ease of DNS uptake. It is not clear whether they saw the fault as being their own, or lying with the Registries.

Registrants were asked to rate how easy they found it to register their Domain Name on a Likert-type scale 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 3.9[122] and few negative ratings.

6.8.5 Turnaround time

However, a surprisingly large percentage of registries reported very fast turnaround times for the registration of local Domain Names, with 39% saying it takes a minute or less, and only a quarter (24%) saying the process takes a day or more.

Figure 6.8.4: Time to register a local Domain Name (Registrars)



Registrants were asked to rate their ability to make immediate use of their Domain Name, once it was registered, on a Likert-type scale, 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 3 was the most common response (mode), with the average score being 3.6[123], and relatively few negative scores.

6.8.6 Automated registration

73% of Registrants say automated registration is available via EPP or another API.

6.8.7 The availability of Premium Domain registration

Most Registries (59%) say they offer Premium Domain Name registration.

[122] The mode (most common response) was a high 5, with a mean of 3.88 and a very low standard deviation of 0.96.
[123] Mean = 3.63, with a low standard deviation of 1.04.

6.8.8 Barriers to Growth in the DNS Market

All respondents were used to rank the most significant potential barriers to the development of the DNS market on a Likert-type scale, from most significant barrier (5) down to least significant barrier (1). The results are presented in the graph below.

Figure 6.8.8: Barriers to DNS Market Development

Key

1. Low Internet penetration (Mode = 5, Mean = 3.79, Std dev = 1.20)
2. High price (Mode = 5, Mean = 3.94, Std dev = 131)
3. Slow processing time (Mode = 5, Mean = 3.53, Std dev = 1.33)
4. Lack of simple Payment Mechanisms (Mode = 5, Mean = 3.66, Std dev = 1.25)
5. Quality of Technical Support (Mode = 5, Mean = 3.53, Std dev = 1.28)
6. Availability of local Registrars/Resellers (Mode = 3, Mean = 3.32, Std dev = 1.32)
7. Government interference (Mode = 5, Mean = 3.37, Std dev = 1.39)
8. Absence of local IXPs (Mode = 3, Mean = 3.02, Std dev = 1.35)
9. Poor dependability of Internet connections (Mode = 5, Mean = 3.65, Std dev = 1.24)
10. Clarity of Policy Environment (Mode = 3, Mean = 3.51, Std dev = 1.27)
11. Restrictiveness of Policy Environment (Mode = 3, Mean = 3.40, Std dev = 1.28)
12. Clarity of Regulatory Environment (Mode = 3, Mean = 3.52, Std dev = 1.22)
13. Restrictiveness of Regulatory Environment (Mode = 3, Mean = 3.40, Std dev = 1.26)

The distribution of the mean responses is surprisingly even, suggesting that all of the issues listed as choices rate as significant barriers in a number of 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 policy-makers should promote Internet infrastructure development and uptake. However, each of the issues identified above seems to require attention.

6.8.9 In conclusion

Taken together the responses at all three levels indicates 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 seems that moving entirely to electronic payment systems, and reducing the price of registration, 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 markets. Further research is required to pinpoint the problems in poorly performing DNS markets.

6.9 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), common dictionary words, also known as generic names (e.g. green, travel, shopping). Thus, short[124] or generic names usually cost more. This

[124] 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

could be regarded as a tool to reduce Domain Name speculation, so that the Registry receives earns the income rather than the speculator[125]. It could 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.

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

- Registry: Do you sell Premium Domain Names (using the EPP[126] Premium Domain Name extension)?
  - 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.
- 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

The most 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 of the countries operating a hierarchical zone structure, with registration allowed at the 3rd level, under the usual .COM.ccTLD, .ORG.ccTLD, etc., also accept registrations at the 2nd level of the ccTLD, often at premium prices.

The most pronounced version of these is in Namibia, where the premium for a domain at 2nd level - i.e. [name].NA is available for USD 5,749.99/year, while a domain under .COM.NA costs USD $799 per year, and a .CO.NA domain only costs USD $134. Similarly in Nigeria, .NG costs

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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.

[125] There 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.

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

USD $199 per year versus .COM.NG at USD $58 per year. An example of the premium charged for 1 and 2 letter domains is in Sao Tome e Principe (ST), where 1-letter domains are available for USD $6,500 per year and 2-letter domains are available for USD $2,000 per year.

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.

6.9.1.1 South Africa

South Africa has over 1 100 000 domain names registered. The bulk of these are in the CO.ZA registry. There is, as yet, no Premium Domain Name system for the CO.ZA Registry. This is probably because all the best names (short and generic names) have already been registered. A few years ago, the ZACR (South African Central Registry) 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 (DURBAN, JOBURG and CAPETOWN) 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.

The ZACR only have 45,403 three character names, so perhaps not all possibilities have been permutated. They have 49,890 potential premium names in their EPP reserve name list, which includes an additional 3,155 generic names.

6.9.1.2 Nigeria

In 2015, in order 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 most catchy domain names, there is a need to make them affordable for African entrepreneurs to be able to register them, 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, there have not been many countries in the continent that have released premium domain names by auction. There needs to be a multi-stakeholder approach from the continent in ensuring that the growth of the domain name ecosystem is enabled.

7 ANALYSIS OF DOMAIN NAME UPTAKE ACROSS THE REGION

7.1 -African DNS Market

While domain names are the primary focus of this study, it is clear that there are a number of interrelated factors that contribute to the health – or lack thereof – of the DNS market within each African country. We found that the various African 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 as a result of these being given away by Freenom, some have had some success exploiting their ccTLD's potential for a domain hack, while others have not..

We have developed a Country DNS Success Index (CDSI) is 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 registered under Afilias
- Number of webpages indexed by Google
- Price of registration
- 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.

7.1.1 Number of ccTLD Domains

While this may seem an obvious measure, there are a number of countries that 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 in itself. 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.

7.1.2 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.

7.1.3 Number of Webpages 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. Surprisingly, a number 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.

7.1.4 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; and that offered by local Registries, Registrars and Resellers. In both cases we picked the lowest figure, so that the results were not distorted by Premium Domain Names, for example.

These two ranges of figures are not strictly comparable. The former typically includes the full cost of registration and annual DNS hosting, whereas the latter often only includes the cost of the first part of the registration process.

7.1.5 Number of Registrars

While this is an important metric, it can be overplayed. Clearly, 20 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. For the purposes of the index countries were simply ranked on the number of Registrars we were able to identify. The 26 countries with a single Registrar each were ranked equally.

7.1.6 Local Hosting

Countries few local domains and websites that are hosted locally do not have a healthy ICT ecosystem. This is ranked in descending order of the total number of websites hosted locally, which corresponds reasonably well with the proportion of websites that are hosted locally, with the exceptions of Malawi and Libya, ranked 8th and 9th, with percentages of 8% and 17% resulting from 39 and 38 websites hosted locally respectively, out of very small totals.

7.1.7 IXP Figure of Merit

As discussed in Section 5.5.3.1 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 countries without a qualifying IXP scored nothing on this metric.

7.1.8 Internet Penetration

As discussed in Section 5.3, the percentage per capita Internet usage, or penetration, is an important measure of how developed the ecosystem is in a country. Kenya leads in this metric, with 60% of its population having access to the Internet. The simple fact of having access leads to a number of economic benefits.

7.2 Ranking of all 54 Countries

Looking at all 54 countries, for all 8 parameters, allows us to rank all African countries in terms of their success in the DNS Ecosystem. The results are as follows: -

Total ccTLD Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Rank
ZA	ZA	ZA	TN	ZA	ZA	ZA	KE	1
GA	NG	KE	ZA	KE	KE	TZ	MA	2
CF	EG	ZW	KE	MA	MU	KE	MU	3
GQ	KE	UG	CF	EG	MG	EG	SC	4
ML	MA	NG	GA	TN	SD	NG	SN	5

CM	SC	EG	ML	ZW	NA	UG	NG	6
MA	GH	MA	GQ	CM	GM	DZ	ZA	7
KE	UG	LY	ET	MW	NG	RW	TN	8
NG	TN	MU	CM	LY	TZ	MZ	ZW	9
TN	CI	CD	ST	DZ	SO	CD	CV	10
ZW	DZ	GH	DZ	TZ	CM	ZW	GA	11
SO	CM	SC	SN	MU	ZW	BW	LY	12
LY	SN	DZ	UG	NA	CD	GH	EG	13
ST	TZ	ST	GW	UG	MA	MU	UG	14
TZ	MU	SN	TG	BW	RW	ZM	GH	15
MW	ZW	NA	MA	SN	DZ	TN	AO	16
EG	NA	TN	NG	CI	BW	MW	BW	17
MU	BJ	GQ	BI	MG	ET	SD	DZ	18
BW	CD	BW	ZW	GH	TN	BJ	SZ	19
CI	BF	RW	CD	GM	BI	GM	SD	20
DJ	TG	SO	SD	NG	MZ	CI	RW	21
UG	ZM	CM	SO	CD	EG	CG	ST	22
SC	RW	GA	BW	CV	LS	NA	GQ	23
DZ	ML	MZ	SL	RW	SC	MG	CI	24
MZ	ET	CF	MW	TG	SZ	BF	NA	25
SN	SO	DJ	CV	TD	CG	DJ	GM	26
MG	MW	ZM	ZM	MZ	GH		ZM	27
ZM	MR	TZ	KM	BI	AO		CM	28
AO	MG	CI	MU	ET	BF		SS	29
NA	AO	SD	GM	CG	BJ		TZ	30
GH	BW	AO	LY	SZ	CF		LS	31
SD	SZ	CV	SC	AO	CI		MR	32
CD	BI	MG	BJ	ZM	CV		DJ	33
RW	MZ	BI	DJ	BF	DJ		BJ	34
BI	GA	ET	TZ	SC	ER		BF	35
ET	SL	ML	CI	SS	GA		LR	36
MR	GN	MW	LR	SO	GN		CG	37
GM	LR	GM	MR	ST	GQ		KM	38
SZ	NE	LS	SZ	DJ	GW		ML	39
SL	CG	BF	MG	SD	KM		GN	40
CV	LY	NE	EG	MR	LR		MW	41
BF	SD	MR	MZ	SL	LY		MZ	42
TG	TD	SZ	NA	LS	ML		TG	43
CG	CV	BJ	BF	BJ	MR		BI	44

LS	GM	SL	GN	NE	MW		SO	45
BJ	GQ	TG	GH	LR	NE		MG	46
NE	KM	TD	AO	GN	SL		SL	47
LR	CF	CG	LS	GW	SN		ET	48
GN	DJ	LR	ER	ML	ST		CF	49
TD	ER	GW	NE	GQ	TD		GW	50
GW	LS	GN	RW	CF	TG		CD	51
ER	GW	KM	CG	GA	UG		TD	52
KM	ST	ER	TD	ER	ZM		NE	53
	SS			KM			ER	54

Each country received a score for each ranking, starting at 54 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. It is clear that the same small group of countries score well on almost all metrics. However, in each one, there are some surprising results.

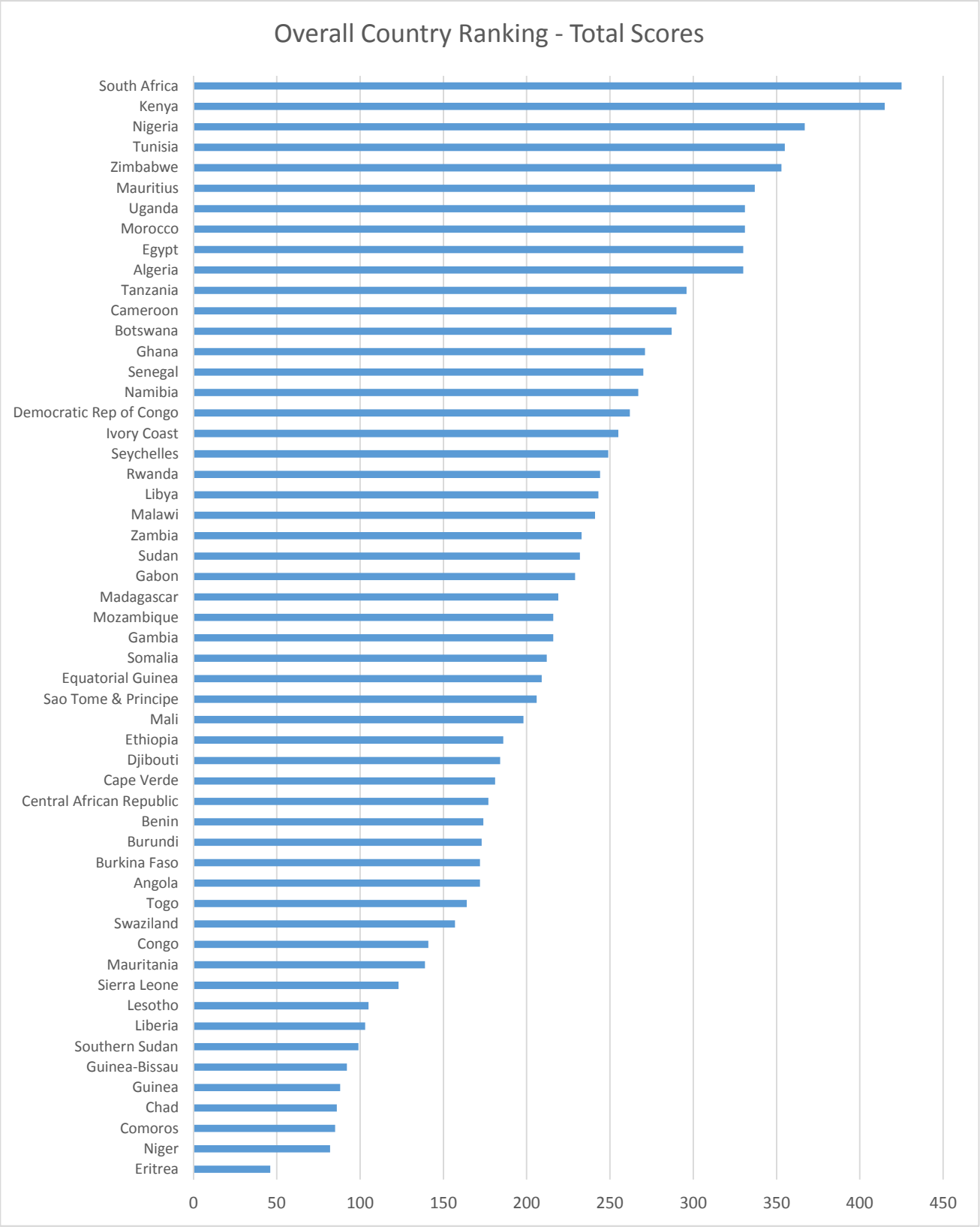
The top twenty countries by total score were: -

Country	Total Score	Language	Region
South Africa	425	English	South
Kenya	415	English	East
Nigeria	367	English	West
Tunisia	355	Arabic	North
Zimbabwe	353	English	South
Mauritius	337	English	Indian Ocean
Uganda	331	English	East
Morocco	331	Arabic	North
Algeria	330	Arabic	North
Egypt	330	Arabic	North
Tanzania	296	English	East
Cameroon	290	French	Central
Botswana	287	English	South
Ghana	271	English	West
Senegal	270	French	West
Namibia	267	English	South
Democratic Rep of Congo	262	French	Central
Ivory Coast	255	French	West

Seychelles	249	French	Indian Ocean
Rwanda	244	English	East

The chart indicates there are no obvious advantages according to region, but language does seem to have an influence. A summary of the results by region and language follows in Section 7.5.

The scores achieved by all African countries are shown in the bar chart below.


Overall Country Ranking - Total Scores
South Africa
Kenya
Nigeria
Tunisia
Zimbabwe
Mauritius
Uganda
Morocco
Egypt
Algeria
Tanzania
Cameroon
Botswana
Ghana
Senegal
Namibia
Democratic Rep of Congo
Ivory Coast
Seychelles
Rwanda
Libya
Malawi
Zambia
Sudan
Gabon
Madagascar
Mozambique
Gambia
Somalia
Equatorial Guinea
Sao Tome & Principe
Mali
Ethiopia
Djibouti
Cape Verde
Central African Republic
Benin
Burundi
Burkina Faso
Angola
Togo
Swaziland
Congo
Mauritania
Sierra Leone
Lesotho
Liberia
Southern Sudan
Guinea-Bissau
Guinea
Chad
Comoros
Niger
Eritrea
0
50
100
150
200
250
300
350
400
450

7.3 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:

- Statistics from http://africa-map-2017.telegeography.com (2015)
  - Operational international bandwidth (Gbps) in 2015 --> forecast for 2018
  - Population (millions) / Households (millions)
    - Users by technology Fixed line% / Broadband% / Mobile (millions of SIMS)
- 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

7.3.1.1 South Africa (ZA)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
ZA	54	54	54	53	54	54	54	48	425

- International Bandwidth: 512 --> 1414
- Population: 55 / 15.3
- Technology: 26%, 12%, 164
- Cables (5): (West Coast) WACS, SAT-3/WACS. (East Coast) EASSy, SEACOM, SAFE (Far East)
- GNI: US$ 6,050 for 2016
- Internet penetration: 56.6%

South Africa scored the highest marks in every category except for price, (where Tunisia scored best) and 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

Winners of the first ever African Domain Name Industry Awards[127] at ICANN (Durban) July 2012 with the award panel, sponsored by ICANN in partnership with AfTLD and ISOC Africa.

The availability of high capacity broadband infrastructure in South Africa has improved considerably in urban areas over the last few years. There are now a large number of undersea cables connecting South Africa via both East and West coasts. The telecommunications sector

[127] ttp://www.africanncommunity.org/index.php/award-nomination?showall=&limitstart=

and laws governing it are relatively well developed, with 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. 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 decade or so, due to a policy vacuum. vacuum which has seen little concrete action at government level to address issues such as shortages of spectrum, strategies for improving rural access and general affordability.

Nevertheless, South Africa scores highest in the Study's country success ranking as shown below:

7.3.1.2 Kenya (KE)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
KE	47	51	53	52	53	53	52	54	415

- International Bandwidth: 228 --> 699
- Population: 44.2 / 12.4
- Technology: 0.7%, 1%, 83
- Cables (3): EASSy, SEACOM, TEAMS
- GNI: US$ 1,290 (2014)
- Internet penetration: 68%

Kenya scored well in all the metrics except for total domains. This is due to the Freenom "domain hack" countries having significantly more domains registered. Coming in second, Kenya has a well-developed Internet industry. There are three undersea cables that link Kenya to the world and other cables that interconnect neighbouring countries. There is also an emerging FTTH industry within Nairobi. KIXP was the second operational IXP on the continent, with a new one in Mombasa commissioned in June 2016. Often, Internet services can be more competitively priced

that in South Africa. The Government of Kenya is supporting e-government using the Internet so that services such as visas, passports and driving license renewals can all take place electronically. This is in contrast with when the Kenyan IXP in Nairobi was first opened and then immediately shut down by government for a few months. Through the support of the Authority and UNESCO, The Institute of Curriculum Development has begun a digital literacy programme that is expected to connect all 22,000 public schools and equip them with 1.2 million digital devices by the end of 2017. One of the biggest single sources of local traffic is online taxation submissions, which has improved Kenya's revenue collection considerably, with over 2 million users by July 2016, and collection of over Kshs 1 trillion Exchequer Revenue. The next local elections will be relying on Internet connectivity to aid in vote collection. Nigeria (NG)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
NG	**46**	**53**	**50**	**38**	**34**	**47**	**50**	**49**	**367**

- International Bandwidth: 141 --> 425
- Population: 178.7 / 38.7
- Technology: 0.5%, 0.4%, 83
- Cables (5): ACE, GLO-1, SAT-3/WACS, Main One, WACS
- GNI: US$ 2,950 (2015)
- Internet penetration: 52%

As with South Africa, Kenya, Nigeria has multiple undersea cables. The ccTLD is well run, there is a distributed IXP in Lagos and multiple Data Centres. Nigeria's biggest advantage is its huge population size and large economy. It is, however, heavily reliant on oil revenue, which has taken a battering recently. Nigeria has the highest number of Internet users on the continent. There is little evidence of Government interference of the Internet

Coming in just after Kenya on the number of domains, Nigeria also has a high score from its two IXPs and the exceptionally large number of Afilias domains. 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.

7.3.1.3 Tunisia

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
TN	45	46	38	54	50	36	39	47	355

- International Bandwidth: 117 --> 324
- Population: 11.1 / 2.5
- Technology: 35%, 19%, 133
- Cables (4): SeaMeWe-4, Trapani-Kelibia, Didon, Hannibal
- GNI: US$ 3,970 (2016)
- Internet penetration: 52.1%

Tunisia is situated in the north of the African continent. The Internet remains partly free in Tunisia. Although the state-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.

Tunisia has a well-developed and sophisticated telecommunications and broadband infrastructure, while regulatory measures and good international bandwidth has led to consumers benefiting from reasonable prices. The Government sees the Internet as an opportunity for e-commerce, e-learning and e-medicine.

7.3.1.4 Zimbabwe[128] (ZW)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
ZW	44	39	52	36	49	43	44	46	353

- International Bandwidth: 73 --> 174
- Population: 13.4 / 3.2
- Technology: 10%, 3%, 96

[128] With additional information from the CO.ZW Registry

- Cables (0): Landlocked, Liquid Telecom runs fibre from Zambia to South Africa via Zimbabwe and on to EASSy and SEACOM
- GNI: US$ 640 (2011)
- Internet penetration: 46.5%

Zimbabwe is a land-locked Southern African country. It has eight licensed international Internet Access Providers (IAPs) which use two main international links - SEACOM and the Eastern Africa Submarine Cable System (EASSy) via links to South Africa and Mozambique. In addition to the IAPs there are a further nine Internet Service Providers (ISPs) who obtain their Internet bandwidth from the IAPs.

There are approximately 50 local Resellers in the .CO.ZW namespace, which has a total of just under 25,000 registered domain names. There is no Registrar accreditation process in place. The other .ZW subdomains are .ORG.ZA (1,350 domains), .AC.ZW (550 domains) and .GOV.ZW (unknown). .CO.ZW registrations can be purchased for as little as $2 per year.

The country has a single IXP – ZINX in Harare. It is currently used for local connectivity between members only. However consideration is being given to linking it with regional IXPs, such as JINX in South Africa.

As in many parts of Africa, the Internet Café is a popular method of accessing the Internet. Some of the major cyber cafés in the city centre include Quick n' Easy, InTouch, DC Africa, Telco and the state operated ComOne. In June 2004 President Mugabe asked ISPs to monitor all email traffic passing through their systems for "anti-national activities". ISPs protested that this was an impossible task.[129]

Aside from the country's economic difficulties, the relatively low number of domain name registrations is likely to be a result of the laborious manual registration process, in which a check is made for possible trademark infringements before a .CO.ZW domain is granted. Compare this with South Africa, where out of over one million automatically registered domains, there have been 193 domain name disputes between 2007 and 2016 using the Alternative Dispute Resolution (ADR) service. Before 2007, there were only a handful of Dispute Resolutions that were processed through court.

[129] https://www.theguardian.com/international/story/0,3604,1230096,00.html

7.3.1.5 Mauritius (MU)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
MU	37	40	46	26	43	52	41	52	337

- International Bandwidth: 41 --> 130
- Population: 1.3 / 0.4
- Technology: 104%, 56%, 149
- Cables (2): LION, SAFE (both to the East and West)
- GNI: US$ 9,630 (2015)
- Internet penetration: 59.6%

The island of Mauritius is on the eastern side of the African continent. The country ranks among the highest in Africa on Internet penetration. Mauritius is also becoming one of the wealthiest countries in Africa. The business registration, taxation and banking (foreign exchange) laws are oriented to attracting off-shore business to the country. The island is connected to two different fibre cables with more planned. Mauritius has established a digital campus development called Cyber City, which is the location for the headquarters of AfriNIC, the Regional Internet Registry (RIR) for Africa, as well as a number of IT companies, including SEACOM (an undersea fibre cable company)

Mauritius is let down on its score by its high domain price, but does very well on the number of Registrars.[130]

7.3.1.6 Uganda (UG)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
UG	33	47	51	42	41	27	49	41	331

- International Bandwidth: 65 --> 265
- Population: 39.9 / 8.2
- Technology: 4%, 2%, 47

[130] http://www.bbc.co.uk/blogs/worldhaveyoursay/2007/11/prince_and_free_speech.html

- Cables (0): Landlocked, access via Kenya
- GNI: US$ 670 (2016)
- Internet penetration: 31%

Being a land-locked country, international access is 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 a number of Data Centres. It is not surprising to see Uganda, Tanzania and Kenya in this list – the three countries work closely together as members of EAC.

Uganda does well on Afilias 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.

7.3.1.7 Morocco (MA)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
MA	48	50	48	39	52	41	0	53	331

- 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%

As a relatively wealth 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 60%. It is the only country in the Top Ten without an IXP, but with the proximity of Europe it can has good access to international connectivity. Maroc Telecom[131] launched ADSL in October 2003 after tests in November 2002. Subscribers are able to get up to 20 Mbps connections. There are also multiple 3G+ cell phone operators.

131 - https://en.wikipedia.org/wiki/Internet_in_Morocco

7.3.1.8 Algeria (DZ)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
DZ	31	44	42	44	45	39	48	37	330

Algeria is in North Africa and borders the Mediterranean Sea. This should allow easy undersea fibre connections into Europe. It is the second largest country in Africa. It is bordered by Tunisia in the north-east, Libya in the east, Niger in the south-east, Mali and Mauritania in the south-west, and Morocco in the west. To improve the Internet penetration rate, the government has started a number of initiatives, including its approval in January 2008 of a €100 million plan to implement Internet networks in every high school in the country. Algérie Télécom is the main telecommunications provider. There appears to be no evidence of Internet blocking except for the al-Qaeda websites.[132]

7.3.1.9 Egypt

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
EG	38	52	49	14	51	33	51	42	330

International Bandwidth: 602 --> 1599

Population: 88.4 / 18

Technology: 36%, 22%, 106

Cables (?): 10 cables run through the Suez canal area, but FLAG, SeaMeaWe (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[133]

GNI: US$ 3,210

Internet penetration: 38%

As Egypt is on the Mediterranean Sea, undersea fibre access to Europe is reasonably low cost, and also 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

132 - https://en.wikipedia.org/wiki/Internet_in_Algeria
133 - https://en.wikipedia.org/wiki/List_of_international_submarine_communications_cables

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.

Egypt scores well with Afilias domains, local hosting and its single remaining operational IXP.

7.4 Underperforming ccTLDs

This section provides 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 found under each country, this does not directly correlate with their overall rankings as shown in Section 7.2 above.

7.4.1 Comoros (KM) – 103 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
KM	2	8	3	27	1	27	0	17	85

- International Bandwidth: 1 --> 2
- Population: 0.8 / 0.2
- Technology: 13%, 0.5%, 55
- Cables (3): EASSy, LION2 (and Comoros Domestic Cable System and Avassa interconnecting the various islands)
- GNI: US$ 790
- Internet penetration: 7.6%

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 are a large number of options under which domains can be registered, as shown in the table below. Domains cost upwards of USD $68/ year.

.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 web site (http://www.domaine.km) appears to have been designed many years ago and has not been updated since. A ticker tape display lists a "new" event dated April 2011. Domain registration takes place by completing a paper document, but there is no obvious email 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), the lack of hosting facilities and the limited number of Internet providers in the market.

7.4.2 Eritrea (ER) – 104 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
ER	3	5	2	6	2	27	0	1	46

- International Bandwidth: 0.1 --> 3
- Population: 6.7 / 1.2
- Technology: 5%, 0.9%, 8
- Cables (0): No Cables.
- GNI: US$ 480
- Internet penetration: 1.0%

Eritrea is the lowest scoring country in terms of the Country DNS Success Index, with a score of 46. This is just over half of the score of the next country up, Niger (NE). 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" give no replies. The administrative and technical contacts have Yahoo and Gmail based email addresses, rather than addresses using their ccTLD, and did not respond to requests fill in the survey questionnaire.
A number of 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 319 web pages under the .ER domain. 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 militates against investment in ICT infrastructure.

7.4.3 Guinea Bissau (GW) – 114 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
GW	4	3	5	41	7	27	0	5	92

- International Bandwidth: 1 --> 27
- Population: 1.8 / 0.2
- Technology: 2%, 0.7%, 74
- Cables (0): No cables
- GNI: US$ 550
- Internet penetration: 4.8%

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 management of the registry for the Portuguese ccTLD, .pt. There were no answers to the questionnaire from Guinea Bissau.

Although the IANA database 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 site is about two years old and is well documented. 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 19 accredited registrars, and domain applications are also available directly, via a web front end. Web applications may take a number of 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). In testing of the online domain registration application process, a number of the stipulated rules, such as providing a Citizen ID number were not enforced.

Connectivity is quite limited in Guinea Bissau with a penetration of only 3% recorded in 2013, but this is likely to be higher today due to the recent availability of 3G broadband and competitive backhaul connections to neighbouring Senegal and Guinea (Conakry). 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.

One explanation could be due to the rules on domain names which indicate that it is only possible to have a domain name that matches the business name, trade mark or personal name. This would hinder many domain names from being registered. For example, in South Africa it was initially expected that the number of domains would be limited to about the same as the number of registered companies, however South African Breweries (SAB) has the sab.co.za domain but now also has domain names for each product - castle.co.za, amstel.co.za, etc. In practice many more domain names than company names are likely to be registered - people have come up with a wide variety of innovative names for many different reasons. However

under the GW domain application rules, these and other generic or descriptive domains such as whitepages.gw would appear to be prohibited.

7.4.4 Guinea (GN) – 277 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
GN	6	18	4	10	8	27	0	15	88

- International Bandwidth: 4 --> 15
- Population: 6.3 / 1.2
- Technology: 2%, 2%, 73
- Cables (1): ACE
- GNI: US$ 470
- Internet penetration: 7.9%

The administration of the GN domain is the responsibility of the National Centre of Fisheries Sciences of Boussoura, while the technical support is provided by well-known Internet guru Randy Bush. 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. 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 $140. This is almost 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 taken into account.

7.4.5 Chad (TD) – 234 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
TD	5	12	8	2	29	27	0	3	86

- International Bandwidth: 1 --> 9
- Population: 17.6 / 2.3
- Technology: 7%, 0.6%, 43
- Cables (0): Landlocked, There appears to be at least one fibre connection.[134]
- GNI: US$ 980
- Internet penetration: 3.3%

The Chad ccTLD is administered by the national regulatory authority - Office Tchadien de Régulation des Télécommunications (OTRT). There were no answers to the survey questionnaire from Chad. The URL provided in the IANA database is incorrectly stated as http://www.sotel.td (which does not function). The correct site is at http://nic.td and contains many useful elements, however much of it is still under construction.

Domains may be registered at the second level (*.td) and under 4 generic second level domains – .com.td, .net.td, tourism.td, and org.td. Registrations in each case costs almost USD $300.

Chad is one of the poorest countries in the world: it is landlocked and is still developing its national and international backbone connectivity with Cameroon and Sudan. While these factors are undoubtedly part of the cause for the low number of domains registered, the major factor is likely to be the very high price for domain registration – almost 4 times the African average, and the highest on the continent.

7.4.6 Liberia (LR) – 303 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
LR	7	17	6	18	9	27	0	19	103

134 - https://www.budde.com.au/Research/Chad-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses

- International Bandwidth: 1 --> 6
- Population: 4.3 / 0.8
- Technology: 0.4%, 0.8%, 66
- Cables (1): ACE
- GNI: US$ 370
- Internet penetration: 9.2%

The official administrator of the Liberia ccTLD is a private company called Data Technology Solutions, while the technical contact and registration process is handled by Randy Bush, in a similar manner to the Guinea ccTLD. There were no 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 $100 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 and an agreed set of policies for the types of registrations that will be accepted[135].

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.

[135] http://a4ai.org/november-23-2016-a4ai-liberia-meeting-to-review-ict-policy-2017-2021/

7.4.7 Niger (NE) – 409 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
NE	8	16	14	5	10	27	0	2	82

- International Bandwidth: 2 --> 16
- Population: 17.6 / 2.3
- Technology: 7%, 0.6%, 43
- Cables (0): Landlocked, Fibre connectivity is mentioned[136]
- GNI: US$ 410
- Internet penetration: 2.4%

The administration of the ccTLD is managed by Sonitel, the incumbent state-owned telecom operator. There was one registrant response to the questionnaire from Niger. The URL listed in the IANA database (http://www.intnet.ne) is a general hosting website that only gives the output of the phpinfo() function for the home page, and provides a few hosted pages for a variety of organisations unrelated to domain management. 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 plans for the national backbone development and a more competitive market[137], the situation will improve if pricing for domains can be dropped.

7.4.8 Benin (BJ) – 734 Domains

CC	Total Domains	Afilias Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
BJ	9	37	11	22	11	27	36	21	174

136 - https://www.liptinfor.net/en/internet-services-niger/fibre-internet/
[137] Unpublished on-going research for ECOWAS by a Study member

- International Bandwidth: 14 --> 58
- Population: 10.9 / 2
- Technology: 10%, 0.6%, 85
- Cables (2): ACE, GLO-1
- GNI: US$ 890
- Internet penetration: 11.5%

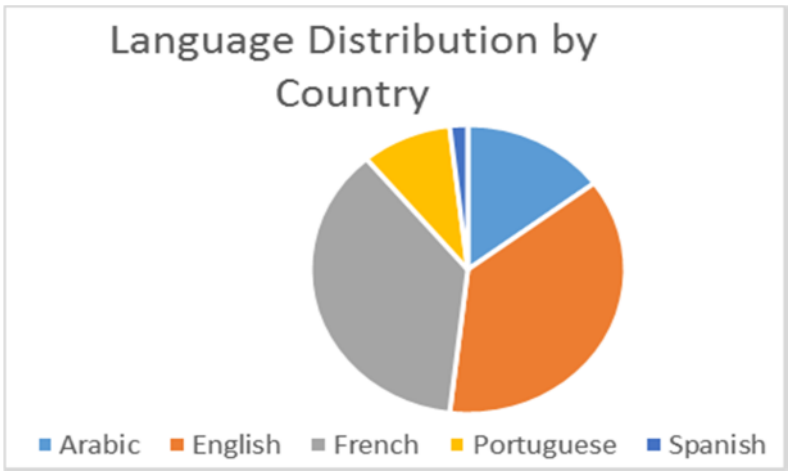
The Benin ccTLD is managed by the incumbent state-owned fixed line operator Benin Telecoms. There was one reseller response to the questionnaire from Benin. However, there was little useful information provided by the responder. The URL provided by IANA (http://www.nic.bj/) goes to a login page which states (in French only) that the site is undergoing maintenance. There is no further information on the page, but a functioning WHOIS server, which is active at http://whois.nic.bj, was found via Google search. This page also lists a URL for registrations and policy information at http://www.coccaregistry.org, however this New Zealand site is non-functional.

Domains are all registered at the second level directly under the .BJ ccTLD, except for government agencies, which are registered under gouv.bj. The lowest domain registration fee offered by international registrars is USD $82.

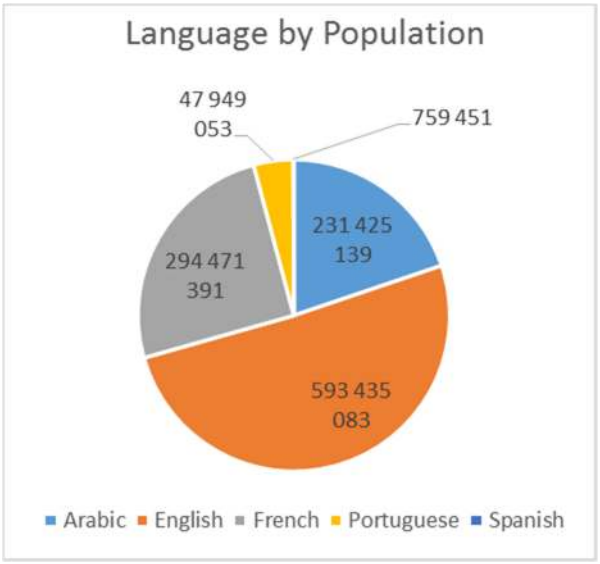
Compared to the other countries discussed here, Benin has relatively more ICT infrastructure (including a recently commissioned IXP) and a consequently high level of Internet penetration. This is the likely cause for the slightly higher number of domain registrations in the country, and it is likely that this would increase significantly if prices for registration were dropped and the registry site made functional.

7.5 Regional & Language Results

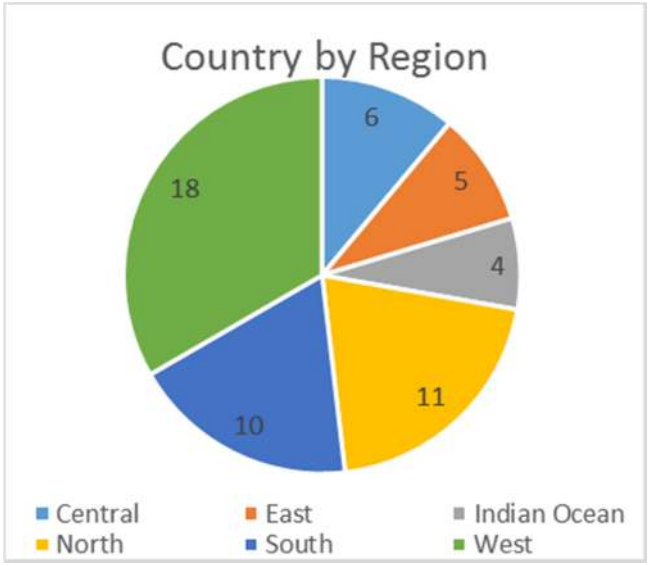
The analysis of the African DNS Market by region and by official language was initiated with an examination of how many African countries use each of the four primary languages: Arabic, English, French and Portuguese (Equatorial Guinea uses Spanish, but also uses French and Portuguese). As can be seen, equal numbers (20) of countries have English and French as their primary colonial language, followed by Arabic (8), Portuguese (5) and Spanish (1).

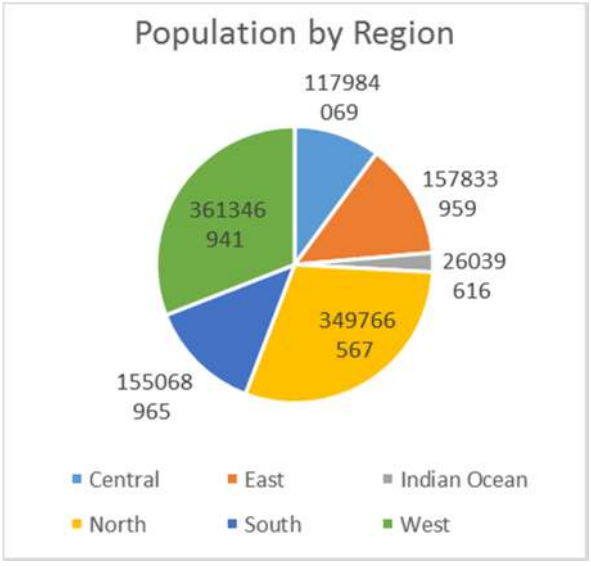


In terms of population, 51% of the African population have English as their official language, followed by French at 25%, then Arabic at 20% with a negligible number for Spanish.

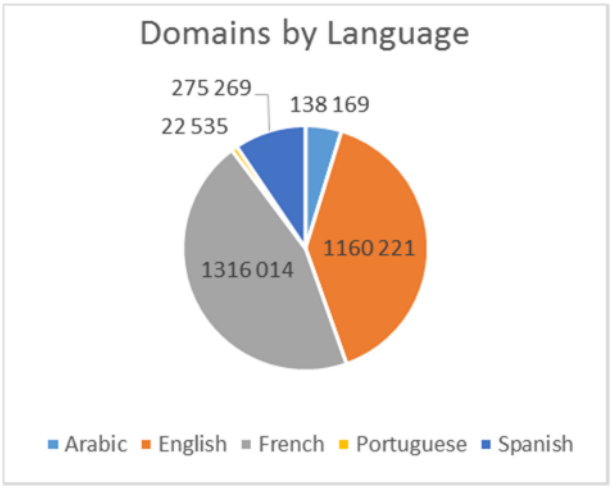


Looking at the regions, the largest is West Africa with 18 countries and 31% of the population. This is closely followed by North Africa, with 11 countries and 30% of the population. East Africa comes in with five countries and 14% of the population, followed by Southern Africa with 10 countries and 13% of the population.

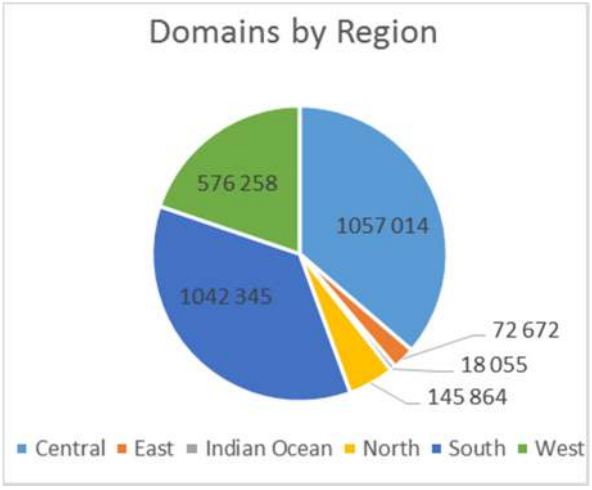




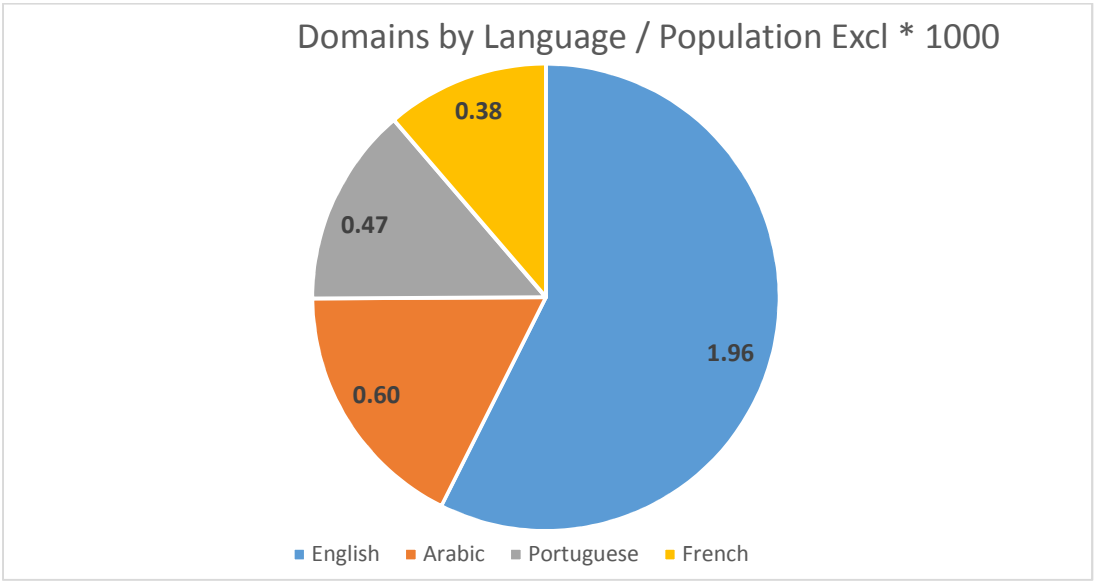
Analysis of the Study results, shows that 45% of all Afilias gTLD domains analysed accrue to French speaking countries, closely followed by English with 45%. Spanish comes next with 9%, followed by Arabic with 5% and Portuguese trailing with only 1%. The reason for apparent popularity of Spanish domains is no doubt the "domain hack" for the .GQ domain

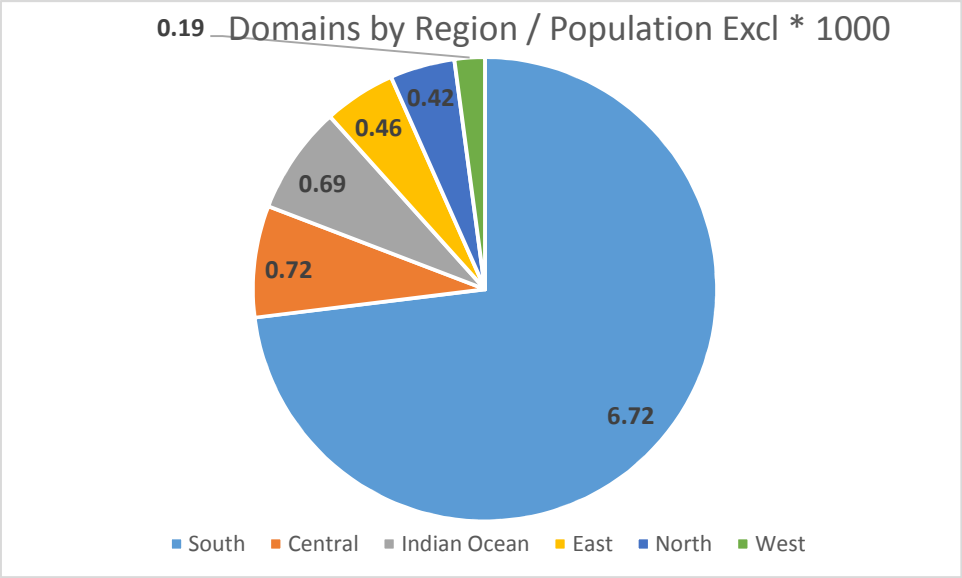


On a regional basis, Central and Southern Africa lead with 36% of ccTLD domains registered each, followed by West Africa at 20% and North Africa at 14%.



More meaningful, perhaps, are the statistics of the number of domains registered per capita in each language group, excluding the 4 Freenom countries:





From the charts above, it is very 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.

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

8 KEY SUCCESS FACTORS – REGISTRIES

Limited empirical research has been conducted worldwide into critical success factors impacting on the uptake of DNS registrations and the growth of the DNS markets.

Selamat[138] looked at critical factors influencing the registration of Domain Names in Malaysia, and identified four not very helpful clusters of issues: technical issues (such as the Registry / Registrar system, Internationalised Domain Names (IDNs), the transition to IPv6 and more); DNS marketing; availability of DNS services; and, additional factors (ranging from population growth to culture).

The discussion of Pope and his associates[139], looking at the future of the DNS system, identifies a range of challenges. Their discussion looks at: technical issues, security concerns, structural arrangements, political considerations, governance matters and commercial issues.

Arabas and his colleagues[140] attempted to model demand for Domain Names in the Polish environment in order to guide DNS marketing strategies and to forecast demand, finding both weekly and seasonal cycles within and overall environment of exponential growth.

None of these analyses is particularly helpful as a practical guide to Registries. The lack of comprehensive research and analysis suggests the need for more empirical work in this area, to identify a clear set of critical factors that can form the basis of international best practice and guide the Registries and Registrars with in national jurisdictions going forward.

As we saw previously, Africa is a highly diverse region, with DNS markets 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 market remains very small, with a mere 4.5 domains per 1000 people, compared with more than 100 in most other regions of the world. It may be a small market, but it is growing fast in some places.

In the context of Africa, on the basis of the preceding discussion in this report, however, a number of key issues can be identified for engagement and action by Registries.

[138] Selamat, H (2014) 'Critical Factors and Comparative Analysis that Influencing the Registration of Domain Name', *International Journal of Digital Information and Wireless Communications*, Vol 4 No 1
[139] Pope, M, Warkentin, M, Mutchler, L, & Luo, X (2012) 'The Domain Name System—Past, Present, and Future', *Communications of the Association for Information Systems*, Vol 30, No 1
[140] Arabas, P, Jaskóła, P, Kamola, M & Karpowicz, M (2012) 'Analysis and modelling of domain registration process], *Journal of Telecommunications and Information Technology*

8.1 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.

The development of local infrastructure also includes the provision of IXPs and data centres. Similarly support for the roll-out of fibre networks, likely initially in the more affluent urban centres (but 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, is vital to all.

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

8.2 Internet Service Demand

With a sufficient level of digital awareness on the part of individuals and communities uptake and usage of the Internet and the online services it enables, will remain either stagnant or slow. 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 market.

Ensure 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.

Registries and Registrants should therefore engage with policy-makers and with a range of other entities to promote the development of and demand for the fullest possible range of online goods and services.

8.3 Policy and Regulation

In the absence of a fully reformed ICT environment - where there is full and dynamic competition, where there is a strong and independent supported by effective legislation, where

the incumbent state-owned provider has been privatised and exposed to the exigencies of a competitive market - it is hard to see how the DNS market can grow quickly and dynamically. An effective ICT environment also requires both regulatory certainty and a forward-looking approach.

Registries and Registrants should therefore develop the necessary capacity to engage with policy-makers and regulators in order to ensure that conducive policy, regulatory and governance frameworks are in place going forward.

8.4 Pricing

It is clear from the analysis elsewhere that high prices for Domain Name registrations are an inhibitor in the uptake of local Domain Names. The burgeoning of FreeNom registrations is clearly due to the fact that 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 multiples of international Domain Names is clearly also an inhibitor. The fact that the average cost to register a Domain in Africa is $84, compared to less than $10 for a .COM domain speaks for itself.

Here the solution lies directly in the hands of the Registries and the Registrars. Reducing pricing for DNS registration to align it with international tariffs is clearly going to be compensated for by a greatly increased degree of uptake for local Domain Names - the countries with the highest revenue have the lowest (non-zero) prices.

8.5 Payment Gateways

The analysis of responses to questions regarding the user experience of the DNS ecosystem indicates an overwhelming preference (78% of Registrants) 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 market.

Again the solution lies directly in the hands of the Registries and the Registrars. Properly functioning payment gateways need to be put in place to ensure easy payment of fees, which will in turn facilitate the uptake of local Domain Names.

8.6 Easy-to-use Registration Systems

As we saw, just over a third of Registrants responding to the user experience section of the questionnaire were able to describe their registration experience as "intuitive, automated [and]

user-friendly". Similarly, respondents listed 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.

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 market and in greater uptake of local Domain Names.

8.7 Provision of Information

The lack of ready access to information, in their local language of preference, on the part of 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 turnaround time, also emerges as an inhibiting factor in the development of the local DNS market.

Registries and Registrars need, therefore, to ensure that all the information (including contact details and pricing) necessary to enable Domain registration is readily and clearly available, in all local languages, and via a variety of channels.

8.8 Comparison with MEAC & LAC Studies

ICANN conducted two DNS studies similar to this study for the Latin American and Caribbean Region and the Middle East and Adjoining Countries Region. 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 draws on relevant benchmarks and best practices developed within the global ccTLD environment, and leads to some suggested actions that may stimulate wider uptake. The later 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.

In the same line, ICANN commissioned the African DNS Study in 2016 to conduct a market analysis in the Domain Name Service (DNS) industry then provide recommendations on how to

develop the industry. This study considered all the 54 countries in Africa region, thus 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. So the study team developed an online tool to gather as much information from wide and varied respondents' including all stakeholders, and then automated the analysis process to improve the quality of the data and then the results coming from the system. This methodology allows the owner of the study, i.e. ICANN, to update the study in future and got many interesting histogram finding by repeating the distribution of the survey tool and running the analysis again.

8.9 ZACR Case Study

8.9.1 About ZACR

The ZA Central Registry NPC (ZACR) is the largest registry operator in Africa with a solid two-decade history of domain name administration and management services. There are currently over one million domain names registered in the CO.ZA second level domain name space alone. Over the past few years, ZACR has prioritised expanding internal institutional capacity while implementing world-leading business methodologies. The latter include long-term partnerships with the best available technical talent. In particular, ZACR has expanded its South African footprint by assuming the registry function for the following three unmoderated 2LDs in addition to CO.ZA: WEB.ZA, NET.ZA and ORG.ZA. This effectively saw the organisation embracing its original function as the Central Registry for the majority of 2LDs within the .ZA ccTLD space. Key to ZACR's continued success in registration numbers is the now bedded-down city domains of .JOBURG, .CAPETOWN and .DURBAN.

8.9.2 Key Early Successes

One of the early success factors of ZACR 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 www.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. Today, UniForum's successor, ZACR, has

built an efficient Central Registry that administers over 1.1 million domain names, over 95% of which fall under .CO.ZA.

A key factor that has contributed to ZACR being the largest and most successful registry in Africa is that it never received government subsidies of any kind. In fact, the reverse is true: ZACR has sponsored government officials to attend ICANN and AfriNIC meetings to enable them to learn more about the domain name industry. ZACR 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[141].

8.9.3 **ZACR Domain Count**

ZACR domain count: 1,122,375 (as of 21st Jan 2017)

Namespace		Total Domains	Percentage of Total
1	CO.ZA	1,076,254	95.891%
2	ORG.ZA	32,560	2.901%
3	.CAPETOWN	4,561	0.406%
4	.JOBURG	3,344	0.298%
5	.DURBAN	2,419	0.216%
6	WEB.ZA	1,805	0.161%
7	NET.ZA	1,432	0.128%

As can be seen, the .CO.ZA domain dominates the .ZA ccTLD, largely as a result 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. 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[142]. A

[141] E.g. https://www.fid.org.za/about-us/our-partners/43-coza-cares-foundation
[142] http://www.intgovforum.org/multilingual/

related gTLD is .AFRICA, which was the subject of a long-running dispute, which was only finalised in February 2017.

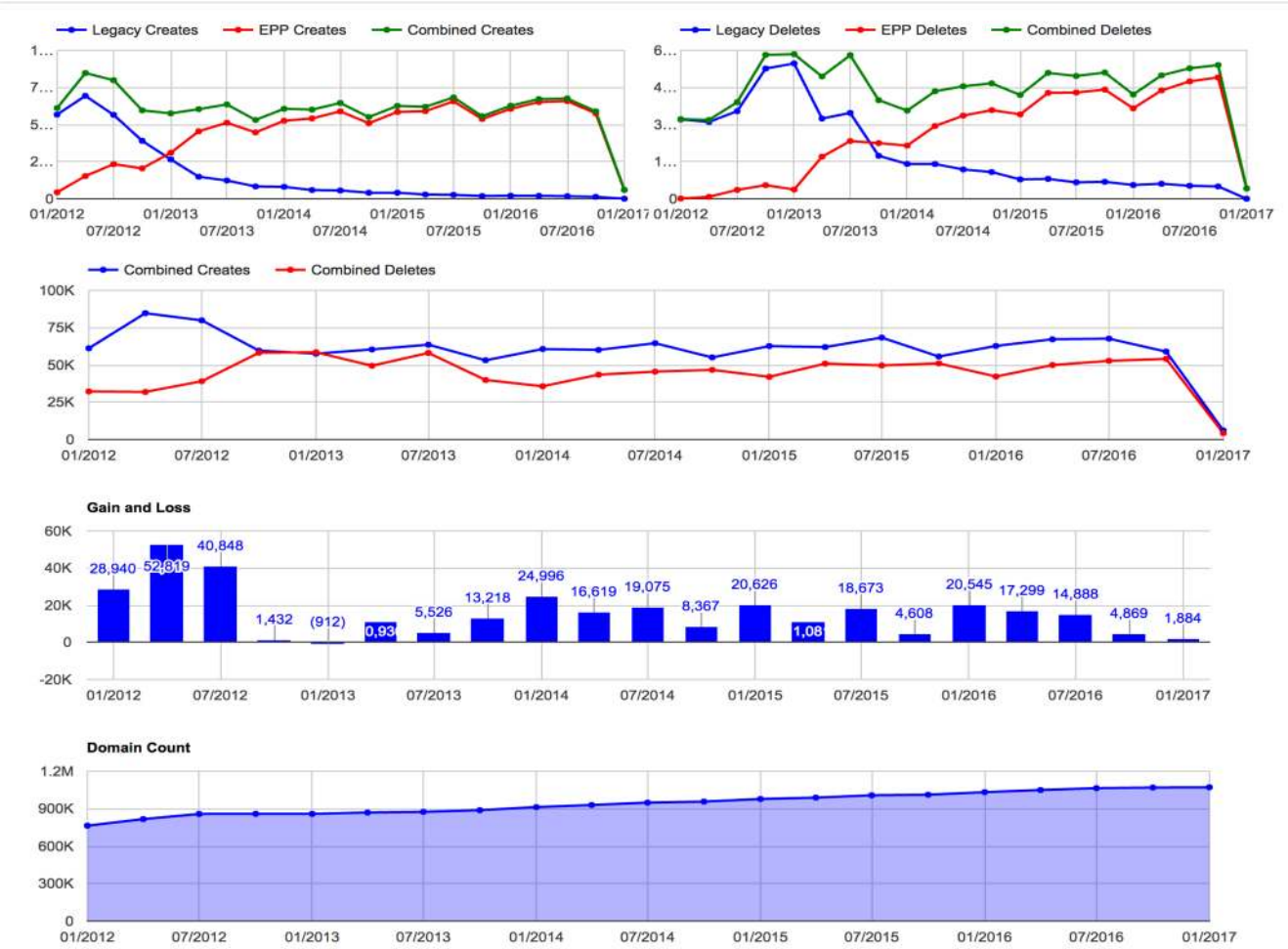
ZACR's growth can be attributed to the following key success factors

Key Success Factors	
Policy certainty	ZACR enforces policies that ensure that 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 ZACR'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 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 ZACR has over 450 registrars primarily in South Africa but also in many other countries.
Strong technical competence	ZACR'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 ZACR 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 ZACR 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 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 the regulator for the purpose of assuming responsibility for the .ZA domain name space. 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.

9 GROWTH OUTLOOK

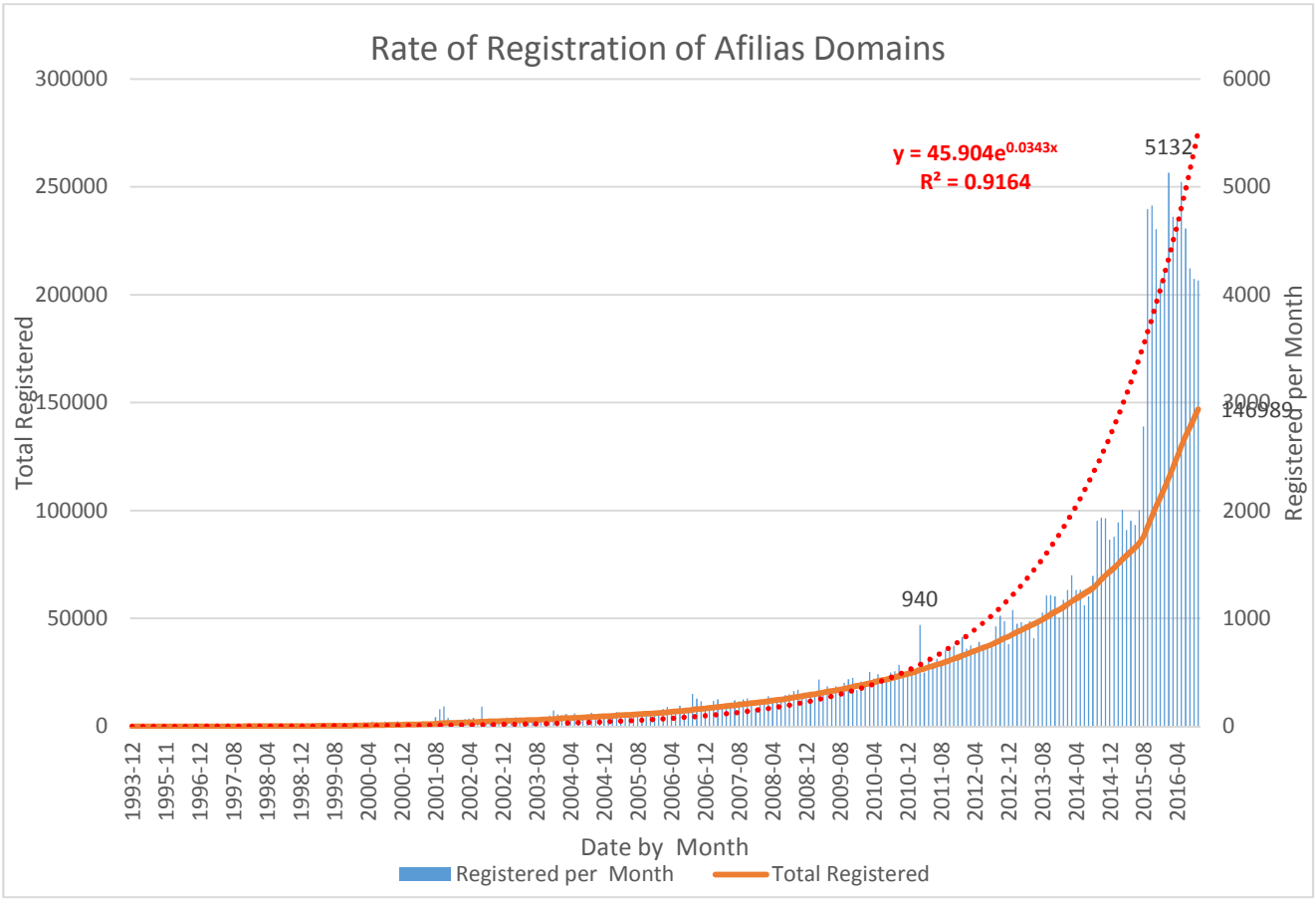
The CO.ZA zone is the largest in Africa, and one of the oldest, with registrations dating from June 1992.[143] As a result, its growth has matured and become almost linear. It added a net 57,601 domains or about 5% in 2016, off a very high base.



[143] https://www.registry.net.za/downloads/early_coza_registrations.txt

(The Q1 2017 figures on the right hand side appear very low, as they only represent one week of registrations, rather than a full quarter)

Like most things related to Internet infrastructure, the growth in domain names seems to be exponential, unlike CO.ZA. This is clearly illustrated by the figures for African registrations of Afilias gTLDs[144], below.

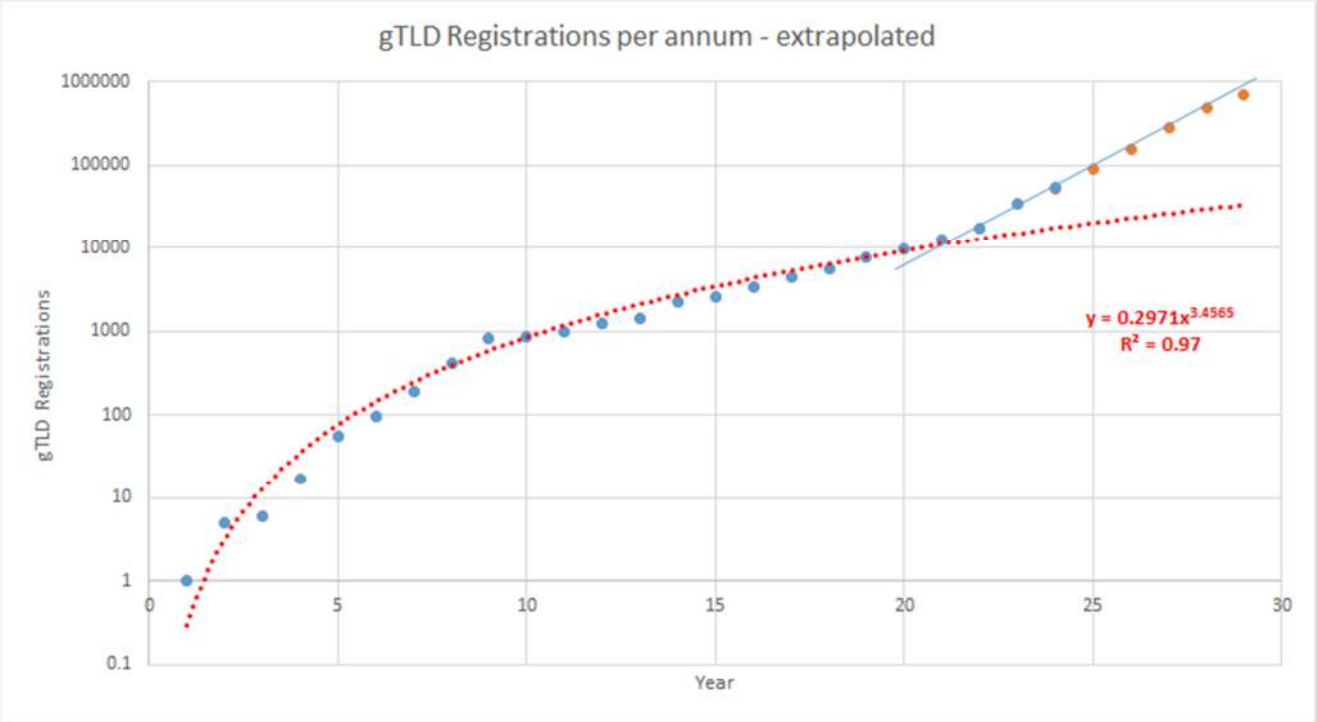


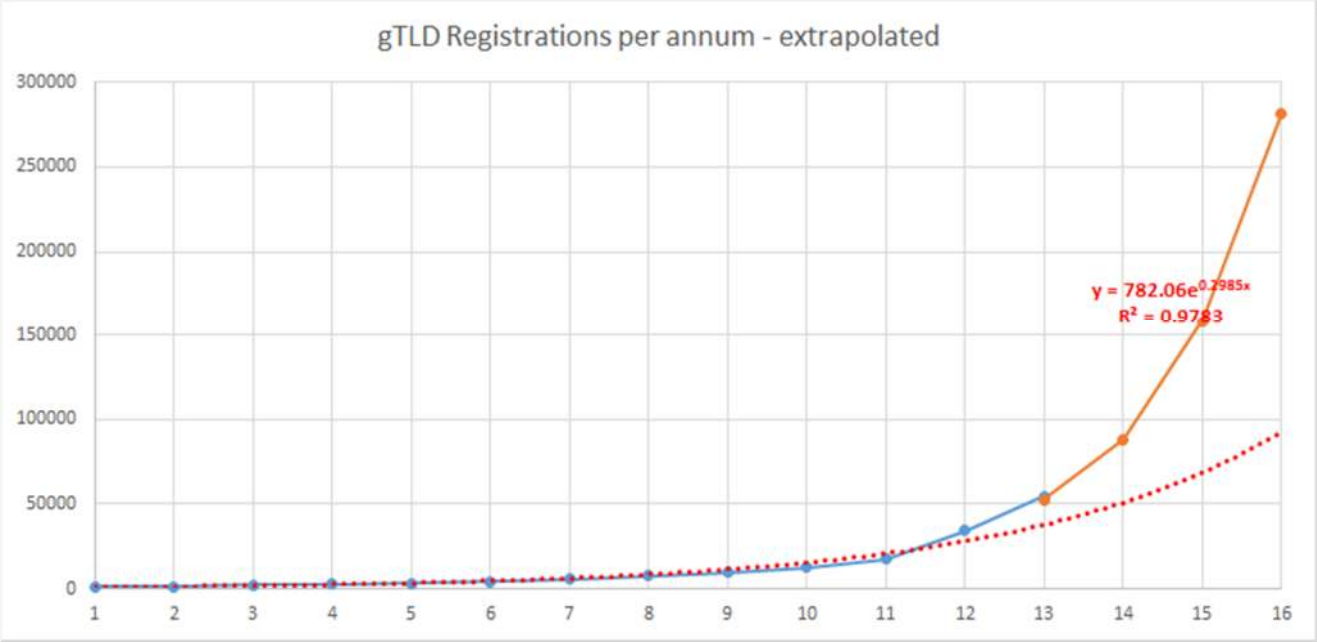
Plotting this on a logarithmic scale shows that there is a distinct acceleration in the rate of registrations from 2013 onwards.

Based on current trends, it is necessary to project forecast growth in the DNS market. In the graphs below, the data has been extrapolated by 3 to 5 years. The extrapolation is shown in two different views below, in both cases as orange data points on the graph. The first graph allows us to interpolate the values against a logarithmic Y-axis, and the second graph shows

[144] Note that extracts of other gTLD zones have been received recently, but are not yet fully analysed.

the exponential growth against a linear Y-axis. The red and orange lines give, respectively, Low Road and High Road estimates of future growth in African Domain Names.





Taking 2015 as the baseline, the growth rates represented by the extrapolated points shown in orange above are significant, giving us an 8 fold increase in annual registrations by 2019 and a 20 fold increase after 5 years. These figures are shown in the table below.

Year	Low Road Growth	High Road Growth
2015		100%
2016		150%
2017		250%
2018		450%
2019		800%
2020		1400%
2021		2000%

It is a reasonable assumption that this sort of growth will continue for some time, at least until Africa catches up with the global averages. There is thus considerable market potential for domain name sales over the next 3 to 5 years in Africa. However, it is likely that the current very uneven Domain Name Market 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.

9.1.1 General Conclusions

Overall it can be seen that the countries discussed above suffer from a combination of factors that have led to low levels of in-country domain registrations. In summary the key factors are:

- High fees for registering a domain;
- Rules which restrict domain registrations to entities with a legal presence in the country, or only names which match the business or personal name;

- Non-functioning registry landing pages;
- Manual procedures for registration fulfilment and payment;
- Lack of marketing and critical mass of credible domain users;
- Low levels of local broadband infrastructure development;
- Low general income levels of the population.

9.2 Setting up a DNS observatory in Africa

As this report and the research process which underpinned it has shown, there is very limited data available on the DNS market in Africa. 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"[145]. The research project undertaken in this report is explicitly intended to underpin the setting up of an observatory that will continually monitor the growth, development and emerging needs of the DNS market in Africa.

The very nature of an African DNS market analysis, coupled with the challenges faced by the research team in compiling this baseline study, has meant that what is presented here is preliminary and partial. There are a number of reasons for this.

9.2.1 Access to qualitative data

Africa's 54 countries alone constitute a daunting challenge, complicated by its multi-lingual nature (at least five international languages - Arabic, English, French, Portuguese, Spanish - are used, along with some 1 500 local languages). As noted previously, responses to the comprehensive set of questionnaires developed for the qualitative component of project were received from only 32 of the 54 countries. Long-term engagement and the development of relationships with a fuller range of stakeholders from a much more representative sample of countries are necessary to identify and understand the full spectrum of issues, trends and developments underpinning the DNS market.

9.2.2 Access to quantitative date

Access to domain zone files is essential for in-depth quantitative analysis of the DNS market, its current size and trends in relation to types of content, numbers of Domains, Registrars and Resellers. As noted previously, within the limited time for the research, the team was only able

[145] ICANN (2014) 'ICANN Africa Strategic Plan July 2016 – June 2020 Version 2.0', Internet Corporation for Assigned Names and Numbers, Los Angeles CA.

to access a very limited number of zone files from only a handful of the 54 African Registries, almost all in Southern Africa (Lesotho, South Africa, Sudan, Zimbabwe), along with a limited number of Registrar database extracts, and supplemented by some international zone files. The ability to engage in structured, long-term formal institutional arrangements with a far greater number of Registries and Registrars across the continent is likely to result in a far more comprehensive set of quantitative data. This, in turn, will enable a far more accurate analysis of current phenomena and trends, along with a far greater ability to make medium to long-term forecasts.

9.2.3 Access to comparative research

The field of research into the DNS market is relatively in its infancy. Desktop research related to this study was only able to uncover a very limited number of expert and academic research reports relevant to the study and its objectives. Long-term engagement with academic institutions and entities working in the field is necessary to formulate an ongoing research agenda, covering at least the range of research questions addressed by the current research project. This will need to be supplemented by ad hoc bespoke research involving academics and consultants as the landscape changes and needs evolve and arise.

9.2.4 Case study data

The research team engaged in the current project had no access to any case study material on any of the 54 countries, and were forced to write a number of mini case studies with limited resources and little access to the key role players or primary documents. The development of case studies, covering both 'successful' Registries and their markets, and those with limited scope and low levels of development, is essential to understand DNS markets in the African context and to identify remedial interventions designed to grow local markets.

9.2.5 DNS Observatory Mandate

The establishment of an African DNS Observatory has the potential to address and obviate a number of the research challenges identified above. Some of the functions of such a structural entity, housed on the continent, with limited but dedicated staffing and an earmarked budget, would include:

- Undertaking qualitative (online and face-to-face) surveys and interviews through engagement with the key stakeholders, from Registrants to policy-makers, in order to understand the user experience, and the factors and issues influencing DNS registration trends;

- Collecting, collating and analysing quantitative data from zone files and Registrar databases in order to measure and quantify the DNS market, at both national and regional levels, in order to track trends and make forecasts;
- Engaging with relevant academic and research entities in order to establish a research agenda relevant to the DNS market, and to collect and disseminate research reports, journal articles and the like of interest and relevance to the stakeholders in the DNS market;
- Undertaking, developing and sharing research case studies of DNS markets in the various African countries;
- Compiling and disseminating a database of research reports, research data and press reports, not only from Africa, but worldwide, of interest to the stakeholders in the African DNS environment and beyond;
- Publishing and circulating a regular newsletter, identifying, highlighting and sharing all of the above;
- Attending relevant meetings, conferences and stakeholder fora to make presentations and other contributions highlighting the research observatory agenda set out above.

9.2.6 Automating data collection

Minimising the human interface in the collection of quantitative data will both save costs and ensure that data provides real-time information. A DNS Observatory would need to establish a data collection server that allows ccTLD zone managers to configure automated real-time upload and transfer of zone data. After the data has been collected, it can be analysed according to requirements, both on an ongoing basis for the production of quarterly, etc., reports, and periodically as needed. Once populated with the relevant ccTLD nameserver information, data collection would require very little maintenance while automatically generating up-to-date data, graphs and tables showing the development of the DNS market on the continent.

The automated data collection mechanism can be implemented by using the DNS Zone Transfer features of BIND (or other similar) software. All ISPs, and others, run such software in order to provide Primary and Secondary Name Servers. Secondary Name Servers must be on different physical and logical networks to the primary and to each other. A version of this system already runs on the dnsafrica.study server. This can act as an additional Secondary Name Server to African ccTLDs, which allows ccTLD Administrators to log in on https://secdns.dnsafrica.study

and add their credentials and Primary Name Server details. They can then add their domains at their leisure. Zone Transfers can be protected by using the optional "TSIG" Transactional Signalling system. This system already includes a few African ccTLD zones and a working snapshot of this software for this purpose can be provided.

In more detail, the DNS Observatory quantitative data functionality would include:

- ccTLD owners receive credentials that allow them to add their domains to the system;
- Domain data is automatically updated whenever there is a zone change;
- The analysis software updates its database periodically – initially more frequently for new domains (once a week), then perhaps once a month;
- The ccTLD registry can examine trends and growth via the Web portal on demand which would include data on:
  - Total number of Domains;
  - Domains with Websites;
  - Where Websites are hosted;
  - How many Websites have:
    - IPv6 addresses;
    - DNSSEC;
    - HTTPS;
- The data can be displayed as a current snapshot or plotted as a time trend for analysis;
- Data for public consumption can be extracted as and when necessary which could include the summaries of the above, suitably anonymised and aggregated.
-

9.2.7 Obtaining ccTLD Registry Buy-in

Considering that it has already proven difficult to obtain copies of zone files, some sort of *quid pro quo* should be considered to encourage ccTLD Managers to allow their zones to be collected by the collector system. The most appropriate reward mechanism would be for the Collector to also potentially become an official Secondary Name Server for the ccTLDs, and perhaps in time, even an Anycast instance with locations around the African continent or even the world, or perhaps linked to the AfriNIC Anycast project.

Further to this, the system could be linked to the Zone Analysis software that the Study team has been using so that the ccTLD owners could be given detailed reports on their own growth and other appropriate statistics such as what percentage of domains have websites, whether they are locally hosted or not, etc.

Some generalised data – perhaps updated monthly or quarterly, could be provided via a web interface to any other interested party.

Thus, this sub-project would be a longish term project with a minimum term of three years – probably extending indefinitely in the event that the project runs as an Anycast system.

In conclusion, buy-in would be achieved by:

- Providing Secondary Name Services;
- Providing Data Analysis on various aspects of value to the ccTLD Managers;
- Growing the System into an Any Cast service.

To create a single instance of an Anycast service, the Observatory would need the following:

- Its own IPv4 address space (/24) – free from AfriNIC (once off);
- Its own IPv6 address space (/48) – free from AfriNIC (once of);
- Its own ASN – free from AfriNIC (once off);
- Appropriately configured Server for Hosting;
    - Dual Gigabit Ethernet (Peering and Management);
    - 8 GB RAM;
    - 500 GB mirrored Hard Drive sub system;
    - Intel i7 CPU;
- Location at a suitable location – e.g. a major Internet Exchange Point in Africa;
- Local Peering (for the Anycast);
- Internet Connectivity (Transit) for Management and Web Site.

Another possible solution to get data from those that do not participate is to use the services of Google. As Google spiders criss-cross websites, they collect the Domain Names of the sites they

visit. It is possible to repetitively work though the Domain names returned, collecting the names until no more unique names are harvested. This will only collect names that have associated websites – but this should account for about 80% of all names. A more direct approach to Google could make this challenge easier.[146]

9.2.8 Institutional Arrangements

Institutional arrangements governing the establishment of a DNS Observatory are outside the purview and mandate of this report, and would need to be considered and agreed to by the relevant stakeholders at the appropriate forum.

Issues for consideration would include:

- Process for the establishment of the DNS Observatory, including timeframes, and whether this should be by appointment, subject to competitive tender, or by some other process;
- Staffing and budget for the DNS Observatory for the first 5 years;
- Location of the DNS Observatory, possibly under AfriNIC, or housed under one of the Registries on the continent;
- Language(s) of communication, possibly Arabic, English and French;
- Funding arrangements for the DNS Observatory, including start-up funding, and ongoing funding arrangements and fund-raising plans.

9.2.9 DNS Observatory Recommendation

- It is recommended that ICANN support the establishment of an African DNS Observatory.
- It is recommended that the mandate of the African DNS Observatory include, as outlined above: qualitative and quantitative research; engagement with other DNS research entities; collection and dissemination of research reports, press reports and data, including by means of a regular newsletter; stakeholder engagement at relevant fora.
- It is recommended that a full proposal for the establishment of an African DNS Observatory be drafted, approved by ICANN and tabled at the appropriate stakeholder forum.

[146] This postulated concept has not been discussed with Google at the time of writing

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Overall Conclusions from the Study

The 2016 African Domain Name System Market Study examined the DNS market in 54 African countries, including several Indian and Atlantic Ocean Islands. The objective was to identify strengths and weaknesses in the industry ecosystem within the region and to develop recommendations on how to advance the industry.

The methodology consisted of four streams of research: -

- An online survey to which some 1,400 participants were invited;
- Zone File analysis of available ccTLD and gTLD zones;
- Interviews with selected high profile figures in the industry, and;
- Desk-top research.

10.1.1 Survey (54 Countries)

The online survey was made available in four languages: Arabic, English, French and Portuguese. Responses received are classified under our six target sectors as follows: -

- Registry (26)[147];
- Registrant (176);
- Registrar (34);
- Reseller (20);
- Regulator (16);
- IXP Manager (17).

Responses were received from participants self-identified as coming from 69 countries. This was verified by IP address geo-lookups. Note that a number of survey participants took part from outside Africa, for a number of reasons, such as: travelling, diaspora, or providing various services (such as Registry operator, or Registrar), when based outside the continent.

10.1.2 File Analysis

Where we had direct access to African zone files, we analysed all domains to identify the locations of the names servers and web server (if any). We also determined if a web site that

[147] Figures in brackets are the number of completed unique responses to survey questionnaires. Other methods of collecting data were also used.

was significantly more than just a placeholder existed, and in what language the website content was written. For those zones where we didn't have direct access, we relied on the registry or registrar responsible to identify those domains where the registrant has some identifying data associated with Africa. We found that approximately 1% of gTLD domains had an African connection. We analysed these domains in exactly the same way. It is noteworthy that this was achieved without requiring any WHOIS lookups or recording of personal identifying data.

10.1.3 Interviews

Interviews were conducted with a number of ICT representatives and role players in the industry, both based in Africa and elsewhere. These yielded valuable insights into the problems faced by the DNS industry in Africa, as well as a number of important success factors.

10.1.4 Desktop research

Extensive desktop research was carried out. This ranged from identifying and examining the websites of all African Registries, and where possible, many of the Registrars, to investigation of the regional ecosystem. Key measures from respected publications, such as population, income, literacy, Internet penetration and cost to communicate were gathered and used as input data to our analysis processes.

We carried out specific studies on premium domain names, payment gateways, ccTLD processes, Registrars – local, African and international, pricing and infrastructure in the various African countries.

We examined as many as possible of the 66 IXPs reported to be operating on the continent and found that just over half of them were fully operational IXPs in more than just name. Many of the balance seem to be planned or defunct IXPs, or marketing ploys for the sale of transit.

10.1.5 Methodology – Quantitative Analysis

We recorded metrics for each ccTLD & gTLD domain, such as the website location, language and whether IPv6 and / or DNSSEC were used by either the nameserver or webserver. As part of this, we analysed whether websites are hosted in-country, in Africa or overseas.

In addition, we also analysed the results by region and by language. We produced detailed statistics on where websites were hosted and what languages they used.

10.1.6 Findings: Understanding Africa's Internet Ecosystem

Africa is a very diverse region, with widely varying income, literacy, language, culture, development and infrastructure. It is lagging in Internet access, with Africa having an average of

28.9% Internet penetration whereas the rest of world averages 54.2%. Between African countries, Internet access varies from 1% to 60% penetration.

The cost of access in Africa is very high. The average African pays 15% of income versus 1% for the average European[148]. Adding in the fact that African Internet access is primarily via mobile devices, this results in a low demand for domain names.

In the first decade of the 21st century, the mantra "Africa Rising" became popular. However, the 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. "African 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 11% to 29% in 5 years;
- Smartphones doubled to 226 million over the last 2 years;
- More than 2/3 of African countries had 10 or more years of uninterrupted growth;
- There are 314 Innovation Hubs in 42 African countries;
- 80 Tbps of international submarine capacity is installed.

Backbone fibre networks are gradually spreading across most African countries and all coastal countries except Guinea Bissau and Eritrea have submarine fibre. There are over 1 million km of terrestrial fibre installed and cross-border fibre is increasing so that almost all countries will be connected to their neighbours by fibre by 2018.

Local access remains problematic in almost all African countries. Outside of South Africa, major deployments of metro fibre have largely been seen only in capital cities so far, particularly Accra, Dar es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka and Nairobi. Wi-Fi deployments follow a similar distribution, often preceding FTTH. However, even in these cities the majority of people use mobile access, which is very expensive in most parts of Africa.

Growth in local Internet infrastructure is speeding up, with 36 fully operational IXPs in 26 countries and an increasing number of fully-fledged data centres being built. In terms of IP resources, Africa accounts for 2% of IPv4 and 1% of IPv6 addresses out of the total global usage. In terms of policy, regulation and governance, we recommend the separation of policy-

[148] http://a4ai.org/affordability-report/report/2015/

making, regulatory and registry functions. All these entities should all recognise and engage with their national ISP Associations.

A number of African (and other) countries have recently engaged in switching off access to the Internet during elections or other stressful times. This trend is very costly to the economy of those countries.

We analysed the volumes of web page content as indexed by Google. We found that 75% of 400 million indexed pages are in just 7 African countries. While specific analysis of e-government initiatives in Africa was not covered in this research, the report recognises how 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%, but has 'enormous potential' estimates Intracen[149], which says that by 2018, the African e-commerce market is projected to reach USD $50 billion, from just USD $8 billion in 2013.

10.1.7 The African DNS Market

We found 51 functioning ccTLD Registries. Only South Sudan (SS) is not yet delegated. Eritrea (ET) and the Comoros (KM), which each have just over 100 domains, have no apparent method of registering new domains via the Internet, and are also non-functional. In terms of the Registrar Market, 26 countries have only one Registrar (usually the Registry itself), whereas 13 countries have a fully competitive Registrar market, with the remaining 14 countries being partly competitive and using older technology and Sothern Sudan not yet delegated. This was a factor in the number of ccTLD domains sold, although it is also true that successful markets seem to attract more Registrars.

For the Registrant Market, we identified over 3.7 million African ccTLD domains plus some 1.4 million gTLD domains with an African Registrant[150]. This equates to some 4.5 domains / 1000 population, whereas some commentators claim 100 – 300 domains / 1000 population is the norm in Europe. Nevertheless this is a valuable market, adding up to an estimated total value of

[149] http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/International%20ECommerce%20in%20Africa_Low-res.pdf

[150] Additional gTLD zone extracts have recently been received but are not yet analysed. These results will be included in the Final Report

USD $37 million per annum for African ccTLD domain names alone and a total of USD $51 million per annum. Research indicates that approximately 1% of gTLD domains are registered by Africans. Registration of (especially local) domain names fosters 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 skilled people to design, implement, manage and maintain these infrastructure elements.

10.1.8 Key Success Factors

The research identified a number of Key Success Factors for ccTLD Registries. These include:

- Infrastructure to facilitate reliable access to the Internet is in place;
- There is generally a digital awareness among the population and people are aware of the value of the Internet. Citizens also have sufficient literacy – both conventional and digital.
- Conducive policy, regulatory and governance frameworks are in place
- Payment gateways have been put in place to ensure easy payment of fees. Note that responses to the online survey confirmed the need for easy payment mechanisms with both registrars and registrants that responded indicating they preferred paying by bank transfer than 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 low (though not at zero).
- Registration is comparatively easy to complete (including simple automated systems in place for registration and fast payment mechanisms available). 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 market and quality of technical support as the fifth most significant difficulty.
- Information on how to register a domain is easily available promoting confidence & therefore facilitating a critical mass of domain names.-

10.2 Recommendations

Africa is a highly diverse region, with much poverty and instability. The African DNS Market is very small at 4.5 domains / 1000 people, compared with >100 elsewhere. However, the market

is growing fast in some places. There are far too many hindrances to growth, most of which are unnecessary if one takes a broader view. There is a strong need to simplify, automate and expedite domain registration processes.

Some countries need to lower the cost of ccTLD registration, with an average registration cost of $84 for an African ccTLD domain compared to <$10 for a .COM domain. It is noteworthy that the countries with the highest revenue have the lowest (non-zero) prices. Some countries have evidently got it right, as discussed in Section 7.3.

10.2.1 Recommendations: Wider Environment

Some success factors apply to the wider environment. Firstly and most obviously, Internet access issues must be addressed. The issues here are not only cost, but also availability and performance within each country, and indeed connectivity between countries. In addition: -

- Initiatives to facilitate e-government and assist countries in moving government services online must be support. This must include a range of digital services, including, for example, promotion of e-learning and e-health.
- Similarly, specific strategies to implement and invest in building e-commerce across Africa must be developed – with a specific focus on developing strategies to facilitate increased presence on the Internet by African SME's and facilitate innovative initiatives to promote e-commerce among this sector.
- Countries should focus on ensuring that it is easy to do business in the region.

Those countries without sufficient local hosting need to build IXPs[151], data centres and 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. Although the AU is currently supporting the concept of "Regional IXPs", this is misleading and perhaps misguided. If an existing IXP in a country is attractive enough, in terms of the number of potential peers, the volume of traffic exchanged and reasonable pricing and terms, then provided cross-border fibre exists, network operators in neighbouring countries will make the economic – not political – decision to interconnect at that IXP.

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

[151] Note especially that building an IXP is neither complicated nor expensive. The fundamental issue to be resolved is the willingness of network operators to interconnect with each other.

penetration will not take off dramatically, nor will local hosting and interchange of content by data centres and IXPs boom, respectively. An important demand driver for this is that governments must embark on e-government online delivery of all 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.

A concerted effort must also be made to address impediments in relation to terms of policy, regulation and governance. Policy-making, regulatory and registry functions should be separated where they are not and these entities must encourage participation by all stakeholders and, for example, recognise and engage with their national ISP Associations.

10.2.2 Recommendations: Domain Name Market

Firstly and most importantly, there should be low (but not zero) fees for registering a domain. The rules governing who may register a domain and how this is carried out need to be 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. There is no need to carry out any 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[152] mechanism.

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 must include payment by credit card as an option.

There must be an effective business model and a marketing / consumer awareness strategy, with appropriate regulatory and governance mechanisms. ccTLDs must use the "3R" Model, i.e. separate roles for each of the Registry, Registrar and Registrant[153]. Analysis shows that there must be a sufficient number of Registrars - at least 20 – to ensure adequate competition and a simple, quick and cheap dispute resolution system – commonly called an 'Alternative Dispute Resolution' (ADR) - must be implemented and supported by appropriate legislation.

[152] Alternative dispute resolution, the use of methods such as mediation and arbitration to resolve a dispute instead of litigation.
[153] Malawi has recently followed international best practice and upgraded from a 2R to a 3R model: http://www.nic.mw/advert.php

10.3 Strategies on How to Develop the DNS sector in Africa Generally

10.3.1 Summary of Best Practices and Recommendations

Based on the analysis of the successes and failures described above, the following are identified as key factors encouraging growth in domain name registrations.

- Low (but not zero) fees for registering a domain;
- Rules which do not require domain Registrants to have a legal presence in the country;
- Rules which do not require domain names to match the business or personal name
- Functioning and easy to use registry landing pages;
- Automatic procedures for registration fulfilment;
- Payment gateway;
- An effective business model and marketing/consumer awareness strategy;
- Appropriate light handed regulatory and governance mechanisms;
- A sufficient number of Registrars - at least 20;
- A simple, quick and cheap dispute resolution system – commonly called an 'Alternative Dispute Resolution' (ADR) system, as opposed to using lawyers and courts;
- Sufficient Internet penetration;
- Sufficient Internet infrastructure.

10.3.2 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:

10.3.2.1 Poor Market Access and Network Provisioning Models

Among the most common reasons for limited infrastructure is the lack of competitive open markets and burdens on 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 are able to 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.

10.3.2.2 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 assignments 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.

10.3.2.3 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 provision of public Internet access. Support for provision of public access has unfortunately fallen off the agenda in most countries as a result 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 a number of African countries.

However, there is now growing recognition that there will continue to be a need for public access for the foreseeable future. Large-format screens and high-definition multimedia provide a more immersive learning, professional or entertainment experience, but may be too slow or costly via a mobile connection. In addition, it may take many years for some countries to reach high levels of household connectivity, and therefore public access will remain a critically important service.

10.3.3 Summary of Best Practice Recommendations

- Ensure that contact details at IANA are up to date and that the landing page URL is correct – which should ideally be http://www.nic.[ccTLD];

- Incorporate as many of the landing page suggestions above as possible;
- Run a 3R model – and have an information page on who the registrars are and how to become accredited;
- Run EPP Software;
- Provide a WHOIS system;
- Allow payments to (also) be done 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 DNSSEC records;
- Run everything dual stacked (IPv4 and IPv6) and support IPv6 glue records (as well as IPv4 glue records);
- Ensure that you have 3 to 5 Name Servers. One primary, usually on the ccTLD's premises and several secondary name servers, each on a different network and in a different location. Consider using an Anycast DNS system for the secondary name servers in order 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 from
    - One of the commercial providers.

11 ANNEXES

Glossary of Terms

Further resources and references

Summary of Questionnaire Results by Country)

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)
- Percentage of domains that use private (proxy) WHOIS
- 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.

Results of the Questionnaire

Methodological Observations

We relied on responses to questionnaires, analysis of Zone Files, 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 1400 potential respondents (database users).,

Significant efforts were made to persuade users to complete their questionnaires, and a total of only 308 questionnaires were completed by 209 individuals in time for analysis.

Challenges

While there is a wide variation between the countries in Africa, as a whole, the continent lags behind other regions in the use of the Internet and in the development of its local Internet industry. As a result, this sort of survey is significantly more difficult in Africa than in other regions. As this was the baseline survey, in many cases, role-players were not familiar with the concept of a market survey. The main challenges encountered were:

- Identifying 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";
- A lack of trust, to the extent that several countries demanded specific letters of authorisation, over and above the original authorisation provided by ICANN;
- Keeping the number of questions down to a manageable number;
- Training of team members using electronic communication. Over 15 training sessions were held in total - this is an example of where funding for face to face training would have been useful;
- Insufficient funding and time for a project of this magnitude, especially in the African context, which is particularly challenging.