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Towards Evaluating The Level Of Ipv6 Migration In Africa: A Nigeria Perspective

Osa, E.
[1]Department of Electrical/Electronic Engineering
University of Benin
Benin City, Nigeria
edosa.osa@uniben.edu
Phone: +2348168307508,+2348058813708.

Erameh, K. B
Department of Computer Engineering
University of Benin
Benin City, Nigeria
kachikwu.erameh@uniben.edu
Phone: +2347061694781.

ABSTRACT

The internet has become an inevitable component of modern day society, with huge amounts of users jostling to connect their phones, tablets, laptops and other devices by the second for various purposes. Internet connectivity requires a device to be identified on the network with an internet protocol (IP) address. The earlier version of IP, IPv4 has its general use pool exhausted in every other part of the world except Africa and the long term solution to this dilemma is migration to the new version of IP, IPv6. However the extent to which Africa as a region has undertaken this task leaves much to be desired. This study is towards an evaluation of the current state of IPv6 migration and the surrounding issues in Africa. The country Nigeria has been taken as a case study. This paper describes the research concept and the methodology to be implemented. The methodology involves literature review and data collection via interviews and questionnaires to various IT stakeholders. The report will give an insight into how much IPv6 has penetrated the African region.

Key words: Internet, Africa, IP address, IPv4, IPv6.

Aims Research Journal Reference Format:
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1. BACKGROUND TO THE STUDY

The Internet Protocol (IP) is an Open Systems Interconnect layer three routed protocol (Todd, 2007). It represents a set of technical rules that define how computers communicate over a network (ARIN 2008). An IP address is a numerical identity that enables routers to identify devices on a network. There are two versions of the IP addressing scheme deployed in networks today: an earlier version known as IP version4 and a later version known as IP version6.

1.1 IPv4 VS IPv6

Initially, when the Internet Protocol (IP) was developed back in the 1980's, IP addresses were defined using 32-bit addresses. This IP came to be what we refer to today as IPv4. This IP resource is arranged in four octets of binary numbers and has a capacity of 4.3 billion addresses, and out of this only 3.7 billion are usable by ordinary Internet access devices. The others are used for special protocols like IP multi-casting. Unlike IPv4, IPv6 uses a 128-bit address space with numbers arranged in hexadecimal providing 340 undecillion (340 x 10 ^36) addresses. To put this in perspective: consider our galaxy, the Milky Way has estimated 300 billion stars (300 x 10 ^9). This is to say that there are a trillion IPv6 addresses than stars in our galaxy. IPv6 will be able to cater for present and future expansion of the Internet, an aspect that will spur a thriving environment for the Internet of Things (IoT) – a term referring to the potential to connect to the Internet anything and everything capable of having IP addresses (Boniface .W. 2015).

1.2 IPv4 Depletion

The depletion of IPv4 addresses in the Internet could be seen as one of the longest slow motion train wrecks in history. The IANA exhausted its remaining pool of unallocated IPv4 addresses over five years ago in early 2011, and since then there has been the exhaustion of the address pools in the Asia Pacific region in April 2011, in the European and the Middle Eastern region in September 2012, in Latin America and the Caribbean in May 2014 and the North American region in September 2015.The only region left with available IPv4 addresses in its general use pool is AFRINIC which serves Africa and parts of the Indian ocean. Back in 1989, even when the Internet was still being portrayed as an experiment in packet switched networks, predictions were being made of address depletion by the turn of the millennium based on the rate at which it was growing. Two responses were formulated for this impending disaster. A couple of short term mitigations such as Network Address Translation (Srisuresh & Holdrege,1999) or Classless Interdomain Routing (Tanenbaum,1996) and a long term answer. NAT was built as an approach to sharing IP addresses, which was intended to buy a small amount of time to assist in the preparation of the longer term response, namely a new Internet Protocol that could uniquely address a vastly larger Internet.

The short term measure, Network Address Translation, or NAT, has proved to be unbelievably successful. Current estimates have some 10 billion devices attached to the Internet, yet the address space only spans some 4 billion addresses and we believe that between 1 to 2 billion of these addresses are in use. There is a huge amount of address sharing going on, and all of this is via NATs. But address sharing makes some things hard, and other things impossible. It's impossible to call back users if they are behind a NAT. It's possible for users to call each other if both of them are behind NATs. NATs work in an asymmetric world of servers and clients. If we want any other model, such as true peer-to-peer models of communications and services, then we need to enlist brokers and intermediaries to try and force the NATs to behave in ways that are unnatural. NATs only support TCP and UDP. If you find DCCP, or SCTP, of interest then it's not going to work. If we want to push the network back into the role of a simple packet pushing operation, then we need to remove this dependency of network-based address transforms. And the only approach on the table that can achieve this is IPv6 (Geoff 2015).

1.3 IPV6 MIGRATION

In order to allow networks, systems and software to work with the IPv6 protocol it is necessary to provide an access to the IPv6 Internet and ensure a proper configuration of the network protocols and network services (Murphy and Malone, 2005; Hermann and Fabian, 2014). Migration in this context means such a change of settings of already existing IPv4 network elements (i.e. reconfiguration) which provides proper operation for both IPv4 and IPv6 or IPv6 only in a version as equivalent as possible to the IPv4 configuration. In general, we can distinguish two methods of migration: working in Dual Stack technology or complete switch to the IPv6 only network (Native IPv6). The migration to the IPv6 networks may not be done in just any order. Some of the services related to the network configuration and name resolution required for the functioning of the network infrastructure and operating systems themselves should be migrated before transport protocols necessary for operation of application services such as web or file sharing.

2. RELATED WORKS

Muhammed Rudman (2010) examined the challenges of IPv6 deployment in Nigeria. A number of reasons were highlighted such as; ISPs need a business case, Lack of technical know-how, Core equipment compatibility issues (Muhammed, 2010). Kidist & Taye (2015) investigated the IPv6 migration framework with reference to Ethiopian institutions. Based on survey result, an IPv6 migration strategy/framework was developed for institutions in the context of Ethiopia. They purported that organizations that delay their IPv6 migration plan to put themselves at risk, the risk of being unable to communicate with customers. However none of the studies above have focused on IPv6 migration in Africa as a continent and thus compared to level of migration in other continents. This is necessary in order to assess Africa's readiness to be a major player in the future internet. This research focuses on the migration issue in the African region from a continental perspective with the expectation of proposing a fundamental unified strategy to facilitate the migration process.

2.1 Statement of Problem

There is a comparatively low level of general awareness about the benefits of IPv6 in Africa, also there is a huge sole dependence on purely IPv4 deployed solutions despite the fact that IPv4 addressing scheme is soon to suffer extinction. This may be due majorly to the fact that Africa still has some millions of IPv4 addresses available. This perception could however prove to be misleading in the long run. In order to accelerate the migration to IPv6, many governments in other regions of the world have produced mandates and policies with associated deadlines for migration such as that given by the Office of Management and Budget (OMB) in the United States amongst others.

In this regard, little can be said of African countries as the involvement of governments in IPv6 migration is minimal. African organizations must prepare for IPv6 now to ensure their future success in an ever changing web environment (CircleId Reporter 2015). However IPv6 adoption is not easy and it is not a single step that can be achieved in a short time but one which requires a great amount of thorough planning and preparation to develop and adjust to IPv6 business (Kidist & Taye, 2015). According to the Internet Assigned Numbers Authority (IANA), the body responsible for the global coordination of the Domain Name System (DNS) Root, IP addressing, and other Internet protocol resources, the IPv4 resources have been exhausted and gradually going into extinction this now makes the migration to IPv6 a must for countries.(Adeyemi, 2015). There is therefore the need to investigate the level of IPv6 deployment in the African region. Also relevant stakeholders such as governments and IT organisations need an informative tool to aid implementation of decisions and strategies towards IPv6 migration in Africa.

2.2 Research Objectives

The main aim of this study is to provide information on the current state of IPv6 migration in the African region using Nigeria as a case study. It is expected that at the conclusion of the research, an informative tool will be made available to all relevant stakeholders to aid decisions and implementation of strategies in the deployment of IPv6. This will be implemented under the following objectives:

i. To investigate the extent of IPv4 address depletion in Africa.
ii. To assess the awareness of IPv6 address and its significance.
iii. To review the challenges to IPv6 migration in Nigeria.
iv. To evaluate the level of adoption of IPv6 in Nigeria
v. To evaluate the role of the Nigerian Government in fostering IPv6 deployment.

3. RESEARCH DESIGN

3.1 Design Stages

The research design is in stages as shown in Fig 1.

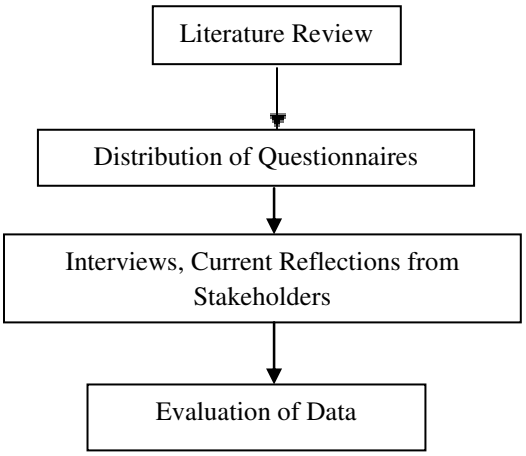

Figure 1. Research Design.

3.2 Literature

Extensive review of academic journals, publications and various web information on migration of IPv6 and related issues was carried out. Below is a summary of the review:

Akamai's Third Quarter, 2015 State of the Internet Report on IPV6 Adoption:

Table1. Akamai's Third Quarter, 2015 State of the Internet Report on IPv6 Adoption

COUNTRY	IPv6 TRAFFIC %
Belgium	35
Switzerland	20
United States	18
Peru	17
Germany	17
Portugal	16
Luxembourg	14
Greece	14
Estonia	10
Czech Republic	8.6

European countries continued to dominate the top 10 countries/regions, taking eight of the top 10 spots with the largest percentage of content requests made to Akamai over IPv6 in the third quarter of 2015 (Akamai State of the Internet, Q3 2015). From this report no African country ranks among the top ten.
(Akamai is a leading Content Delivery Network provider).

3.3 IPv6 Prefixes

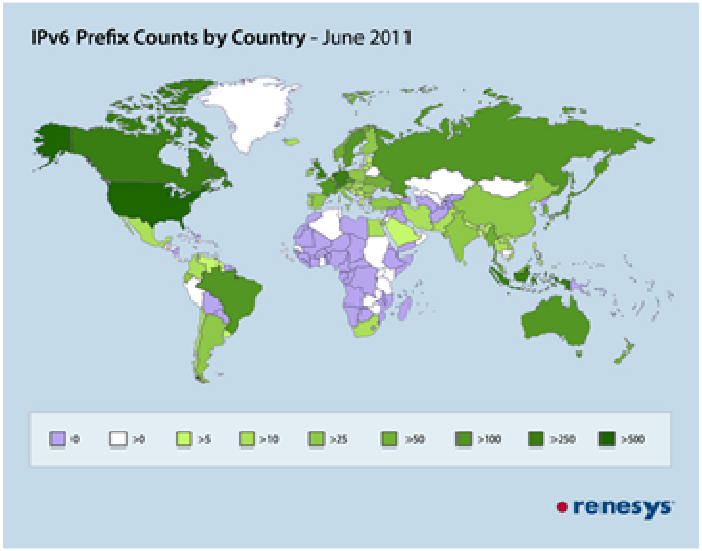

Figure 1. IPv6 Prefix Count by Country (Dyn Research, 2011)

The map above shows an approximate distribution of IPv6 prefixes, we only have around 6,500 prefixes with a concentration in the developed world and only few African countries having between 5-10 prefixes as shown (Earl, 2011).

3.4. Reflections from Stakeholders

3.4.1 CEO AFRINIC, 2015

The announcement by ARIN about its IPv4 exhaustion in 2015 now means that AFRINIC is the only RIR with a non-critically low supply of IPv4 address space. CEO of AFRINIC Adiel Akplogan says, "This however does not mean we can be complacent about our supply of IPv4 address space. Consumption levels in the region are increasing rapidly – it is no coincidence that four of the largest IPv4 allocations made worldwide in 2013 were to African nations: Algeria, Egypt, Nigeria and the Seychelles.

Africa also has one of the world's highest penetrations of mobile Internet users, all of whom need IP addresses to get online, and this user-base is growing fast . We simply cannot afford to think that IPv4 exhaustion is something that affects other regions. In the near future, it is inevitable that AFRINIC will become the only region where, with correct justification, significant amounts of IPv4 address space can be obtained." "It is up to the community to define how we move forward at this crucial point in the history of the Internet and we look forward to your input." As the supply of IPv4 address space continues to dwindle, more and more new connections will be made over IPv6 as opposed to IPv4. The future of the Internet will be over IPv6 and, unless African networks and businesses also transition, they risk becoming isolated from the global Internet. As the rest of the world moves to IPv6, Africa also has to make sure its networks, services and content are IPv6 ready to remain a global player. "As we move into a future where large quantities of IPv4 address space will be unobtainable in many parts of the world, I take this opportunity to reiterate the message that IPv6 deployment cannot wait: you need to ensure that your networks, devices and content are IPv6 ready or enabled sooner rather than later." (AFRINIC 2015).

3.4.2 ATCON President 2015

Speaking during the network engineers' training session, hosted by the Association in partnership with VDT Communications and African Network Information Centre (AFRINIC), the President of ATCON, Lanre Ajayi, said though there is no deadline to IPv6 transition, but that the NCC can opt to set the tune to help bring the issue to the front burner. Ajayi, who is bitter about Nigeria's slow process towards the transition, stressed that the country could be left behind in the Internet world. According to Ajayi, an engineer, not transiting is very dangerous. He observed that Nigeria and most African nations, with consumerism posture, stand to lose their places in the Internet community, "hence the OEMs after transiting will simply stop manufacturing them and we will be completely left out."(The Guardian, 2015).

3.5 Distribution of Questionnaires

Questionnaires containing directed questions will be distributed to various IT stakeholders such as the Nigerian Communication Commission, ISPs, Telecom operators, Public Internet centres and educational institutions within Nigeria. They will also be distributed to international respondents that hold relevant opinions within and outside Nigeria via email.

Questionnaires will be distributed as applied to the different environments. Sample questions to be in the questionnaire include:

- What do you understand by IPv6?
- Are there any advantages of IPv6 over IPv4? If yes what are they?
- Do you see the need to migrate to IPv6? If yes why?
- Does your organization have the capacity to migrate to IPv6?
- Which constraints does your organization have in migrating to IPv6?
- Which constraints does your country have in migrating to IPv6?
- Can the above constraints be overcome? If yes how?
- What role is the government playing in the migration process?

3.6 Interview with Stakeholders

There will be interviews with various IT managers, members of IT management boards, field operators and other relevant staff of various IT companies in Nigeria. The research will also involve interviews with government agents and relevant persons in the academia all in line with the stated objectives.

4. DATA PRESENTATION

At the end of the research data collected will be presented in a tabular form as shown in Table 2.

Table 2: Level of IPv6 Migration in Nigeria.

State	IPv6 awareness %	IPv6 Capability %	IPv6 migration %	Role of Government in IPv6 %

5. DISCUSSION OF FINDINGS

At the conclusion of the survey, data gathered through questionnaires, interviews and current reflections from various IT stakeholders will be used to make an overall evaluation of the level of awareness, readiness, capability and deployment status of IPv6 in Africa with Nigeria as a case study.

6. CONCLUDING REMARKS

This paper describes the concept and the methodology of the study. Further findings are expected at the completion of the research in order to complete the set objectives of the study and thus fulfil the overriding aim. Information in this regard is pertinent as migration to IPv6 cannot be overemphasized. A lot of preparations have to be made in terms of awareness programmes, capacity building and experiments in order to facilitate the process. However, how well Africa is positioned to face this challenge is an issue, hence this study.

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