IPv6 Migration Framework – Case of Institutions in Ethiopia

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Abstract

In the 1970s, the IPv4 protocol was considered as a base for the modern Internet. At that time no one anticipated limited address space of IPv4 would have a huge impact on the development of Internet. In the 90s, the problem of limited IPv4 address space was noticed and this became a main reason to work on IPv6. The new users and applications of the Internet have the potential to rapidly increase the utilization of IPv4 address space and deplete it. Since the future growth and global connectivity of the Internet is highly dependent on the availability of IP addresses, it is affected by the late IPv6 deployment.

In this paper, IPv6's additional features and the well known IPv6 transition mechanisms are presented. It has also assessed the level of awareness of IPv6 among IT professionals of different IT stakeholders in the country like Ministry of Communication and Information Technology (MCIT), banks, and educational institutions through conducting a survey. Readiness for IPv6 migration of ethio telecom (the only ISP in the country) has also been assessed. This work has covered the issue of addressing the governing policy of the Ethiopian government in regard to the migration to IPv6.

Finally, the study has proposed IPv6 migration framework/strategy for organizations in the context of Ethiopia.

1. Introduction

Internet Protocol (IP) addresses are required for a computer or a network device to send data to another over the Internet. In the 90s, the problem of available IPv4 address space was noticed and this became the main reason to work on IPv6 [1, 2]. With this in mind, the Internet Engineering Task Force (IETF), a community that works on the evolution of Internet technologies, created IPv6 to accommodate the growing number of users and devices accessing the Internet by predicting the need for more IP address [2]. IPv6 has a very large address space and consists of 128 bits as compared to 32 bits in IPv4. Therefore, IPv6 enables more people and devices to access the Internet by providing IP addresses in higher number.

On February 03, 2011, the Internet Assigned Numbers Authority (IANA) allocated one of the final five blocks, which is about 16 million, to five Regional Internet Registries (RIRs) around the world. Today, there is no remaining IPv4 address space to be distributed in the Asia Pacific region and

Australia, and it is expected to run out around the end of 2012 in Europe; in America in 2013 and in Latin America in 2014. In the case of Africa, unless IPv4 addresses use increases in a big rate, the continent will be safe for at least another two or three years.

Similar to the rest of the world, IPv6 adoption is also a challenge for Africa. To support a sustainable Internet growth on the continent, AfriNIC has the opportunity to define its own policies and plans that will help IPv6 adoption. In point of fact, AfriNIC has been conducting trainings for the past five years to attract government representatives and the private sector to take the leading role in IPv6 deployment. Unfortunately, most African governments have not yet taken any action towards IPv6 migration [3].

Coming to Ethiopia, though Ethiopia was one of the countries in the world which has acquired telephone system just a few years after its invention, the telecommunication service penetration rate and development of the required infrastructures has relatively remained far behind as compared to other countries [4]. But the number of Internet users is still

growing very fast. The new users and usage of the Internet have the potential to rapidly increase the utilization of IPv4 address space and deplete it.

Any country or organization that (for whatever reason) does not migrate to IPv6 may not be in danger for the time being mainly due to the parallel co-existence of IPv6 and IPv4. However, in the long run, it will be difficult for them to connect to networks which support IPv6, or for people in other countries to connect to networks which support IPv4. At some point, deployment of IPv6 with proper readiness and migration strategy is a requirement, not an option for Ethiopia, too. To do IPv6 migration in systematic and careful way, it is necessary to have a guiding strategy towards IPv6 deployment in the context of Ethiopia and assess the awareness of IPv6 among IT professionals of selected IPv6 deployment stakeholders and infrastructure readiness of ISP as well as selected IPv6 deployment stakeholder organizations.

2. Transition from IPv4 to IPv6

The Internet requires overall architecture progress to accommodate new technologies.

IPv6 features (extended address space, auto configuration, simple header structure, extension headers, IPSec, mobility, quality of service, route aggregation, and efficient transmission) facilitate to meet the requirements of the new applications over the Internet and open up a broad field of technological development. Despite the fact that IPv6 has a lot of advantages over IPv4, it is not possible to throw away the existing IPv4 network and adopt IPv6 immediately.

Therefore, organizations should have to identify potential risk areas and their mitigation, and be prepared to migrate to IPv6 with an acceptable level of risk.

Security risk before and during maintaining interoperability, economic risk, and implementation risk are the different risks that were identified in this study which are associated with the IPv6 deployment.

Due to the incompatible nature of the two protocols (IPv4 and IPv6), the transition from IPv4 to IPv6 cannot be expected to be smooth. To facilitate

IPv6 transition, the IETF has set up a work group, NGtrans (Next Generation Transition), which specifies mechanisms for supporting interoperability between IPv4 and IPv6. The various IPv6 transition strategies can be broadly divided into three categories, dual stack, tunneling, and translation mechanisms [5].

3. Empirical Data and Analysis

A successful migration of IPv6 requires the coordinated effort of all stakeholders throughout the country. Anyone who is associated with the Internet, either as a user or as a service provider, has to be involved in this process. Hence, evaluating the IPv6 awareness as well as readiness of the IT environment in the relevant stakeholders (government, ISPs, software/hardware vendors and end users) is an essential first step in defining the transition framework. The awareness of IPv6 readiness is a crucial point to guide IPv6 deployment in Ethiopia. Questionnaires as well as various publications and interviews were used to compile the qualitative data collected and analyzed in this paper.

a. Government

Governments, as sources of driving policies, have key roles to play in raising awareness and promoting the deployment of IPv6 throughout a country. Lack of awareness with regard to issues of IPv4 depletion and IPv6 adoption could be risky on national competitiveness and continuity of government services. In the case of Ethiopia, this government organ is the Ministry of Communication and Information Technology (MCIT). MCIT has a mission of developing and utilizing the communication and information technology broadly throughout the country, and strives to optimize the role of the sector in political, economical, and social development thereby improving the living standard of the society [6].

Accordingly in this work, the status of MCIT towards IPv6 migration has been assessed. As a result of interviews of relevant employees in the Ministry, IPv6 had no impacts on software development process and because of this understanding, there was no work done by MCIT. It is in the process of starting development of IP

address and DNS Administration and Utilization guideline. It is explained that IPv6 is one of the issues which would be covered in that assignment.

b. Internet Service Provider (ISP)

The telecommunication industry in Ethiopia is currently fully owned by the government. The government owned operator, formerly known as Ethiopian Telecommunication Corporation (ETC) and now ethio telecom, provides PSTN, mobile telephone, Internet, and data communication services. The rate of penetration of telecom services of the country is among the lowest in Africa and even among Sub-Saharan African countries.

ethio telecom, the only Internet Service provider in the country, should play a key role in the national adoption of IPv6. For ethio telecom, IPv6 deployment is even more important to set itself as market leader than for other industries to follow.

In the rest of the world, as IPv6 deployment progresses, those ISPs who have not invested in adopting IPv6 in their networks may find attracting new customers difficult, and may begin to lose existing customers who wish to proceed with their own IPv6 deployment. Despite the fact that there is no other ISP in the country that competes with ethio telecom (and hence no market to lose), IPv6 deployment helps to boost ethio telecom's services using the new IPv6 features.

As a result of interviews of relevant employees, ethio telecom has implemented dual stack on its backbone network (core network) which enables it to support IPv6 services. This clearly shows that the company is on the way towards IPv6 in order to prepare for the future. It was also explained that they assumed that IPv6 will be available as a standard service for all the customers in two years. On the other hand, none of the interviewees have any information as to when the public IPv4 address in their network as well as for customers will run out. However, increasing awareness of the technical benefits of IPv6 among the technical personnel should be one big task for ethio telecom. According to most of the interviewees' understanding, there is no plan to deploy IPv6 fully and also IPv6's new features are not that much of a drive for IPv6 deployment. By exercising proper use of NAT, the interviewees believe that ethio telecom can manage the IPv4 addressing problem without thinking of IPv6 deployment. It was also mentioned that IPv4 address depletion should not be an issue for ethio telecom in any case. As far as the knowledge of the all the interviewees is concerned, there is no nationwide initiative towards IPv6 migration.

c. End Users

For end user organizations, the question of whether their ISP can provide IPv6 services is one of the most significant factors in deciding whether or not to commit resources to their own IPv6 initiatives. The transition from IPv4 to IPv6 will become a must for organizations, especially to those that currently provide online services based on IP addresses. The intention of this survey is to demonstrate how IT professionals of the stakeholders think about IPv6 and how far they have gone in the process of implementing the new protocol. Using a self administrated questionnaire, the information has portrayed the respondents' knowledge of IPv6 technology and status of and plans for IPv6 deployment as well. Knowledge about IPv6, infrastructure readiness of IPv6, training about IPv6, and IPv6 transition plan are the main aspects covered by the questionnaire.

In general, based on the survey result, we have noticed that the knowledge and awareness about IPv6 (what it is and how it works) as well as IPv6 ready equipment are minimal.

As it is noted from the interviewee's response, almost all participant organizations' network hardware and software are IPv6 ready. Most of these IPv6 ready hardware and software are enabled by default.

This study identified that this situation creates a critical security issue for organizations which have not prepared and implemented security policy for IPv6 as the same security degree as of IPv4.

Migration from IPv4 to IPv6 is also a concern in the software development environment. Because IPv6 does not modify the Application Programming Interface (API) between an application and the IP stack, applications which are IP address dependent like banking applications should need modification to work with IPv6 network environment. In this case,

vendors and developers of those applications should be trained well to modify their applications to support IPv6.

4. Proposed IPv6 Institutional Migration Framework

The proposed framework has been designed under a national context taking into account the following factors to be done by the responsible organs. The Government (MCIT) should take the initiative in designing nationwide IPv6 awareness campaign and set policies and procedures for IPv6 migration and controlling compliance of IPv6 ready hardware and software. ethio telecom (the ISP) should work to help facilitate the address space acquisition process.

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. Organizations should consider the proposed framework shown in Figure 1 as a guide when deciding on IPv6 migration.
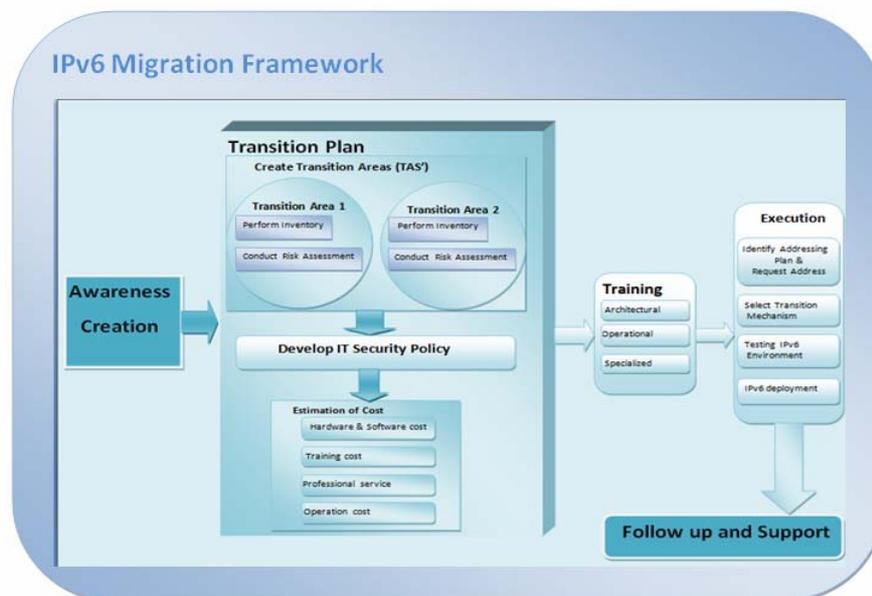

Figure 1: IPv6 Migration framework for Organizations

5. Conclusions, Recommendations, and Future work

Transitioning from IPv4 to IPv6 is a sensitive issue worldwide, and devising an IPv6 migration plan is important for organizations to maintain customer productivity. Organizations that delay their IPv6 migration plan put themselves at risk, the risk of being unable to communicate with customers. Throughout the study, IPv6 features, well known IPv6 transition mechanisms, and review of IPv6 transition framework were presented. IPv6 awareness and readiness is also assessed among IT professionals of selected IPv6 stakeholder organizations. The survey result indicated that we still have unresolved issues on IP address management and still struggling to properly deploy IPv4 Networks. It is also noted that there is continuing extensive usage of NAT in the country.

However, one can take this as an opportunity to start the IPv6 migration and not to invest much on the current IPv4 infrastructure.

In Addition, it is very important that each country has enough IPv4 addresses to manage the transition to IPv6 while running dual-stack configurations. Since Africa has enough IPv4 addresses for at least the coming two years, now is the ideal time for countries like Ethiopia to plan their migration to IPv6. Based on survey result, IPv6 migration strategy/framework was developed for institutions in the context of Ethiopia.

This study serves as an initial step in disseminating awareness on IPv6 and triggers some initiatives from policy makers and service providers. It also provides a framework which helps on guiding the migration for organizations towards IPv6.

For a successful IPv6 migration, the government should play a role in coordinating and supporting the dissemination of IPv6 standards, protocols, and conformance. Otherwise competitiveness and IT leadership will suffer.

With respect to developing IPv6 expertise, the other most important recommendation of this study is for academia. Academia should design a short course of its own that covers all aspects of IPv6 and setting up pure IPv6 backbones for testing and experimentation. Software and hardware vendors should also put greater efforts into marketing IPv6 and conduct IPv6-related training for their customers and users.

Since it is critical that organizations have information as well as support from their ISP about IPv6 services, ethio telecom should develop a plan to support organizations to test IPv6 migration strategy. Future studies also need to be carried out in developing frameworks on IPv6 migration for different industries and assessment of the different IPv6 transition mechanisms for a specific case.

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