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INFORMATION & COMMUNICATION TECHNOLOGIES AUTHORITY

Information & Communication Technologies Authority

Consultation Paper on Issues Pertaining to Transition from IPv4 to IPv6 in Mauritius

Publication date: 17 March 2011
Deadline for submission of comments: 29 April 2011

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1. Introduction

One common element of the Internet architecture is the “Internet Protocol” (IP).The current version, IPv4, is now fully depleted. On 3rd February 2011, the IANA allocated the final five /8 blocks of IPv4 address space (that is, 5 * 16,777,216 individual IP addresses) to the five Regional Internet Registries (RIRs).

All Internet stakeholders must now take definitive action to deploy IPv6 being given that the available IPv4 address space is slipping away. The adoption of IPv6 is now of paramount importance, since it will allow the Internet to continue its amazing growth and foster global innovation, after all the future of the Internet is ours to choose. IPv6 has the capacity to expand the available address space on the Internet enormously, using 128 bits instead of the 32 bits of IPv4 as well as having the capability to provide better QoS.

In addition IPv6 is designed to promote higher flexibility, better functionality and enhanced security & mobility support. Because of these advantages, the service providers generally should be inclined to migrate to this newer version of Internet technology. .

Moreover, after years of promoting IPv6 equipment, vendors have also started to produce hardware which can handle “Native IPv6” routing. Cisco/Linksys, NetGear, Belkin, and others are finally stepping up to meet the needs of consumers. Mobile phone vendors and applications providers for iPhones, Androids, and Windows are being forced to produce IPv6-ready products. The tools are finally starting to become available.

Internet providers in Asia, Europe, and the Americas are finally putting IPv6 capability into their networks, and the topic is no longer responded to with indifference by network operators and administrators.

If we have to raise the question as a consumer or corporate user on what will happen should we not consider the need to implement IPv6 in our operating environment, then we may reach that point where by not having access to IPv6 will put everyone of us in a competitive, social, or professional risk position. At what point, if our Internet-connected world is not IPv6-connected, will we be denied access to our community? And, what are we going to do about it?

In fact, Facebook, Google and Yahoo are joining with major content delivery networks Akamai and Limelight Networks – along with the Internet Society – for the first global-scale trial of the new Internet Protocol, IPv6. On June 8, 2011, to be known as 'World IPv6 Day' participants around the world will enable IPv6 on their main services for 24 hours.

IPv6, the successor to the protocol currently used on the Internet, was developed more than ten years ago, but it's still not been deployment on a global scale (there are a few IPv6 enabled sites out there now, however). "By providing an opportunity for the Internet industry to collaborate to test IPv6 readiness we expect to lay the groundwork for large-scale IPv6 adoption and help make IPv6 ready for prime time," explained Leslie Daigle, the Internet Society's Chief Internet Technology officer.

Bearing in mind that the ICTA's focus in Internet regulation is to encourage the development of a competitive and dynamic environment in a light-handed manner with the minimum barriers to development and deployment of Internet services, we set out the objective of this paper as follows:-

1) to invite comments from the general public, amongst others;

2) to assess our readiness in Mauritius as well as the need for any regulatory intervention, and the extent to which it should be in the transition from IPv4 to IPv6.;

3) to assess the need for the setting up a neutral agency to manage IP addresses within Mauritius.

4) to take stock from the local ISPs on the status of the uptake of IPv6 in Mauritius; and.

5) to assess, subject to 4) above the need for any enabling policy initiatives

2. Background

IPv4 is today the most widespread version of the Internet Protocol. This is the protocol used across the Internet for all kind of communications, and any device wishing to connect to the Internet needs to have an IP address.

The global Internet address space offers hosts unique addresses within its defined space. For IPv4, there are $2^{32} = 4,294,967,296$ possibilities. This is the theoretical maximum, but in reality it is impossible to efficiently use all the possible addresses. It is also clear that even if we could use all of the addresses, they are insufficient to connect all the possible devices (and consequently people) that will soon require addresses.

The Internet Assigned Numbers Authority (IANA) is the organisation responsible for the allocation of addresses to the Regional Internet Registries (RIRs), which it does in /8 blocks or 16,777,216 individual addresses blocks. Each RIR serves a different region, and the RIRs, in turn, distribute addresses to each of the five regions: Africa (AFRINIC), Asia Pacific (APNIC), North America (ARIN), Latin America and the Caribbean (LACNIC), and Europe and the Middle East (RIPE NCC). Each of the five RIRs have signed a MoU to become part of the Number Resource Organization (NRO). The purpose of the NRO is to undertake joint activities of the RIRs, including joint technical projects, liaison activities and IPv4 address allocation policies co-ordination but still with these measures there is relative certainty that the little “guy” such as Mauritius is not going to be in a very strong position when those last blocks of addresses are issued.

Short-term workaround solutions were developed to slow the rate of IPv4 address depletion until the work on IPv6 (Next Generation Internet Protocol) could be completed. One short-term solution was Network Address Translation (NAT). NAT resides between the Internet and a group of hosts on a server, firewall, or router. Through a manipulation of port numbers, NAT allows a large number of hosts to share a single unique IPv4 address. However, NAT was never intended as a long-term solution as it creates a number of problems in modern networks. Most significantly, NAT affects a key benefit of the Internet as a network of ‘Always-on, Equally-connected’ peers. Peer-to-Peer capability provides a powerful tool, empowering users to become active contributors to the Internet, rather than just users. Peer-to-Peer systems assume that a user can find and connect to another user anytime, but if a user is hidden behind a NAT device this assumption may not always be valid.

Another method, Classless Inter-Domain Routing (CIDR), sometimes known as Supernetting is a way to allocate and specify the Internet addresses used in inter-domain routing more flexibly than the original system of IP address classes. As a result, the increased number of Internet addresses becomes available. CIDR is the routing system used by virtually all gateway hosts on the Internet's backbone network. However, CIDR is also supposed to have its associated problems, as it does not guarantee an efficient and scalable hierarchy.

The methodologies like NAT and CIDR were utilised to overcome the shortage of IP addresses. However, these were supposed to be only short-term remedy to IP address shortage. The long-term solution to the IP address depletion problem was to create a new version of IP with an expanded address space. Originally called IPng for IP next generation, this proposed version eventually became to be known as IPv6. It makes use of 128 bits in place of 32 bits used in IPv4 and therefore provides enormous addressing capabilities.

Discussions are popping up all over the Internet on how we can step back and find more efficient ways to use the existing IPv4 address space, squeezing more time out of it through global cooperation, emergence of trading and markets for the buying and selling of IPv4 addresses, and even more creative use of network address translation. We believe that we could have spent the same amount of energy to deploy IPv6 in our networks.

3. IPv6 Transition

IPv6 is a new version of the data networking protocol on which the Internet is based. The IETF developed the basic specifications during the 1990s. The primary motivation for the design and deployment of IPv6 was to expand the available addressing space of the Internet, thereby enabling billions of new devices (PDAs, cellular phones, appliances, cars, etc.), new users and 'always-on' technologies (xDSL, cable, Ethernet-to-the-home, fiber-to-the-home, Power Line Communications, etc.).

IPv6 has a 128-bit address space that can uniquely address 2^{128} network interfaces. So the new address space supports 2^{128} (approximately 340 undecillion or 340,282,366,920,938,000,000, 000,000,000,000,000,000) address spaces. This expansion allows for many more devices and users on the Internet as well as extra flexibility in allocating addresses and efficiency for routing traffic.

IPv6 has been designed with the principle of being able to coexist with IPv4 for a long period of time, avoiding breaking IPv4 networks and allowing all the existing services and applications to keep working without any disruption. At the same time, the way this coexistence works should allow a smooth transition from IPv4 to IPv6. In short, the basis of this coexistence and transition is having both protocols in the hosts at the same time (this is called dual-stack), and allowing the operating systems and/or applications to choose which protocol they use for each communication.

It is also observed from International practices that IPv6 migration is not forced on the existing ISPs through a mandate but its deployment is facilitated by the Governments by setting up IPv6 test-beds, backbones and also conducting training & awareness programmes.

In this consultation paper, public views are sought as to whether the regulator should adopt a technology-neutral, light-handed approach or should it mandate ISPs for an IPv6 migration plan.

4. Transition to IPv6 for ISPs

For making a transition from IPv4 to IPv6, ISPs have to upgrade their networks, provide training to their system administrators and related staff and also have to conduct trial on their network before commercially deploying IPv6. This may involve certain amount of capital and operational cost. Presently ISPs in different countries are reluctant to invest in transition to IPv6 as they are not finding any compelling business case and feel that deploying a dual stack IPv4-IPv6 infrastructure, which is required for smooth transition and coexistence of IPv4 & IPv6, will increase the costs initially till IPv6 based operation becomes streamlined and financially viable. One major objective of this consultation paper is to get a clear indication of the status of the transition process of the Mauritian ISPs.

A survey questionnaire to be filled in by the ISPs has been designed (see Annex 1). The outcome of this survey will give a better idea if there is a need to establish a body to address various issues related to transition to IPv6 and help ISPs in this migration process.

5. Allocation of permanent IP addresses for Broadband

With the anticipated increase in broadband penetration, the number of IP access devices and other customer premises terminals is likely to increase manifold. Such devices will also require some kind of identification like telephone number in telecom networks and allocating permanent IP address to such devices can provide a mean for such identification. IPv6 has been designed to provide a simple, high-performance solution for configuring terminals and a basic mechanism to enable “plug and play” type of environment, wherein a system auto configuration facility enables a user to access the network without need for any configuration. Allocation of permanent IP address is supposed to provide an easy solution to the need for mobility without interrupting running communication sessions while moving a terminal from one IP network to another IP network,. Therefore it needs to be deliberated if the choice of permanent IP address should be made available to the end users who can opt for the same in accordance with their applications needs. Also in case a user opts for a permanent IP address, he/she should have choice to change it like a telephone number.

From the ISP standpoint, the assignment of static or dynamic IP addresses to end users is an operational decision based on issues such as overhead incurred when assigning static addresses, customer requirements, and many technical concerns based on the network infrastructure and applications being used which will also need to be taken into account.

Consequently, a customer must also be informed about all such charges at the time of subscribing for an Internet connection with a permanent IP address and same should be allocated only in case it is opted for by the customer.

In view of the above, public views are sought as to whether there is a need for the regulator to mandate allocation of a permanent IP address to a broadband subscriber or should this option to be left to the user.

6. Function of the Authority with respect to numbering

Under section 18(1)(q) of the ICT Act 2001, as amended, one of the functions of the ICT Authority is to "determine the numbering system to be used for every information and communication services including telecommunication service, and manage, review, and, where appropriate, reorganise the numbering system."

In the furtherance of the above mandate, the Authority has so far looked into the management of the E.164 numbering system which caters for circuit-switched voice networks. Over the past years, our telecoms sector has experienced a gradual shift from the traditional circuit-switched technology to packet-switched technology and more specifically to IP technology. In Mauritius, IP is today the core network technology in the mobile and International Long Distance telephony sector and recently also in the local fixed telephony sector with the incumbent operator migrating its core network to Next Generation Networks.

With the introduction of the 3/3.5G and future LTE networks and services in the mobile sector, IP data services is gradually gaining momentum and widespread take-up. The growth of Voice over IP is also expected with the migration towards end-to-end IP networks. For VoIP specifically, IPV6 offers the potential for achieving the end-to-end interworking, reachability, security support and QoS that is currently unachievable and reason for which voice still relies on the traditional TDM networks. In the highly competitive market scenario, the deployment of IP-based services and applications are expected to increase in near future.

With the advent of convergence in media, telephony and communication technologies, there is a need to also look into the numbering system of "Internet Protocol" IP-based networks which underpins the converged communication systems as well as next generation network systems.

In order to fulfill this extended mandate, there is a need, at the national level, to properly manage the pool of IP addresses and to undertake appropriate coordination work with existing organisations operating under the aegis of ICANN and which are responsible for the management of IP addresses at the international and regional levels. In the case of Mauritius, AFRINIC is the agency with which proper coordination need to be ensured.

Public views are sought as to whether the regulator should extend its present mandate of managing the numbering system to IP addressing within the country and if so to propose the required coordination mechanisms with AFRINIC.

7. Creation of a national Internet Registry

In Mauritius, in order to procure IP addresses from AFRINIC, local ISPs either need to take membership of AFRINIC or approach upstream ISP. Each member of AFRINIC (Local Internet Registry) is required to pay annual membership fee in the range of USD 1,400 to 38,400 in addition to a one-time initial fee in the range of USD 1750 to 10,000.

A National Internet Registry (NIR) is a national resource allocation agency that provides IP registration and other supporting services to the service providers. A Mauritian National Internet Registry is likely to be the single point of contact and control over the usage of IP addresses. It is also likely to aid policy making by giving an overall perspective of Mauritian requirements, use and demand of IP addresses.

Such national registry would also help in streamlining the allocation of the IP address pool of Mauritius as per the demands and policies of the nation. It is also expected that such National Registry may help in the allocation of the IP addresses in a contiguous manner within the nation.

Also, one of the biggest advantages of having the proposed registry will be of tremendous value for the law enforcement agencies in Mauritius. Whenever a cyber crime is committed, it is traced with the help of IP addresses. Today, in a number of cases, the law enforcement has numerous problems in getting access to the registration information of the IP addresses. However, when a national Internet registry is established in Mauritius, it would ensure that all the IP addresses will be allocated locally and that the registration information of the same will be instantaneously accessible to the law enforcement agencies. This is likely to have a positive impact on the investigation and detection of cyber crime.

Another important outcome of this public consultation would be to get feedback from stakeholders on the need for the creation of the above mentioned agency and if so, the most effective way to move ahead on the establishment and constitution of the proposed Mauritian National Internet Registry.

8. "Whois" for domains and IP addresses

Another major issue that the setting up of a NIR can tackle is inaccurate, outdated or incomplete "Whois"[1] for domains and IP addresses for Mauritius – IP addresses and domains are supposed to have complete and up-to-date records in the Whois database maintained by the domain registrars and RIRs. However, this is often not the case – this is something that RIRs and individual domain registrars are trying to correct, but the problem is widespread. ISPs often do not sub-allocate (SWIP)[2] IP blocks that they allocate to their customers. That is, they do not explicitly register smaller blocks at the RIR as assigned to a particular customer and instead have one large omnibus record for all their IP space.

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[1] *The Whois utility looks up records relating to domain and IP address ownership, administrative, technical and general contacts, in the publicly queryable and authoritative databases maintained by several Network Information Centers (NICs) and Regional Internet Registries (RIRs) such as APNIC for the asiapac region, LACNIC for Latin America and AFRINIC for Africa, and domain registrars such as Network Solutions and OpenSRS.*

[2] *SWIP (Shared WHOIS Project) is a process used by ISPs to submit customer IP reassignment Information to ARIN's WHOIS database. It ensures the effective and efficient maintenance of records for IP address space.*

Another alternative to sub-allocating IP blocks to customer ISPs is to maintain a publicly accessible Referral Whois "RWhois" database of IP assignments made to their customers. A simple analogy would be the management of a large complex of apartment buildings that does not let their tenants publish their addresses and phone numbers in the city telephone directory (comparable to an ISP sub-allocating IP Whois records for its customers in the RIR maintained Whois database). Nor do they maintain a central directory of their tenants (comparable to operating a RWhois server). So, any letters addressed to a tenant in this complex gets delivered only to the building management, which then has to contact the owner of the apartment and deliver the letter to him. Furthermore, when the tenant of an apartment is wanted by the police for an offence, they have to contact the building management and find out just where in the complex the man they want lives, rather than just looking up the directory and going straight to his apartment.

Feedback from local ISPs and AFRINIC on the above situation in Mauritius will shed light on the way forward on this matter and also assess the extent to which the NIR can mitigate this problem.

9. Consultation procedure

In this consultation paper the ICT Authority would like to invite views and comments from the public on the issues raised herein. In order to facilitate this consultation process, questions have been asked for the public's careful consideration. Notwithstanding this, members of the public are not confined to these questions and are encouraged to raise any issues pertinent to them.

Members of the public are welcome to submit their comments on this consultation paper to IPv6consultation@imail.icta.mu at latest by 29 April 2011 at 16:00 hrs. The comments will be most useful if they are substantiated with rationale, examples and alternative proposals. Kindly also include full contact particulars such as full name, designation and organisation name (if relevant), postal address, e-mail address and contact numbers. The comments will then be compiled as well as the way forward on this issue will be posted on the ICT Authority's website, www.icta.mu.

10. Summary of questions being released for public consultation

1) Should the regulator play a regulatory role in the transition from IPv4 to IPv6 for the country or do you think the industry has the capability handle it on its own?
2) If yes, what are the regulatory steps and policy initiatives that you believe are required?
3) Which transition mechanism/strategy do you consider is best suited for migration from IPv4 to IPv6?
4) Do you consider that the allocation of permanent IP addresses to a broadband user is a must or not?
5) Do you believe that the present mandate of the regulator regarding numbering administration is by extension applicable to IPv6?
6) Do you find or have you ever encountered any problem with the existing system of IP address allocation in Mauritius?
7) If yes, is there a need to create a neutral entity to handle IP address allocation at the national level?
8) Are Mauritian ISPs presently involved in any experimentation programme with IPv6 in an effort to move towards commercial IPv6 based services?
9) Any other issue/ comments pertaining to transition to IPv6 in Mauritius that you may wish to flag out.

Annex 1

Survey questionnaire to be filled in by Mauritian ISPs

The purpose of this survey is to obtain a view of the IPv6 experience, plans, and requirements of Mauritian ISPs. This questionnaire is based on RFC 6036 - Emerging Service Provider Scenarios for IPv6 Deployment. Replies to this questionnaire will be kept strictly confidential and only combined results will be published without identifying information about individual ISPs in any published results.

I. General questions about IP service

1. Do you offer origin-only (stub, end-user) IP service, transit IP service, or both?
2. Approximate number of private/small office customers (one IPv4 address)
3. Approximate number of corporate customers (block of IPv4addresses, not included in Q2)
4. Do you offer IP multicast service?
5. Do any of your customers require multihoming to multiple ISPs?
6. Access technologies used (ADSL,etc.)
7. Do your customers use CPE that you supply?
    - 7.1. What % of customers?
    - 7.2. Does the CPE that you provide support native IPv6?
8. When do you expect to run out of public IPv4 address space inside your own network?
    - 8.1. Do you run private (RFC1918) addresses and NAT within your network (i.e., a second layer of NAT in the case of customers with their own NAT)?

8.2. What % of your IPv4 space is needed for your own use (not for customers)?

9. When do you expect to run out of public IPv4 address space for customers?

9.1. Do you offer private (RFC1918) addresses to your customers?

II. Questions about requirements for IPv6 service

10. Are some big customers requesting IPv6?

11. When do you predict 10% and 50% of your customers to require IPv6 service?

12. When do you require IPv6 to be a standard service available to all customers?

13. When do you predict IPv6 traffic to reach 50% of total traffic?

III. Questions about status and plans for IPv6 service

14. Do you currently offer IPv6 as a regular service?

14.1. What % of your customers currently use IPv6?

14.2. When do you plan to start IPv6 deployment?

14.3. When do you plan to offer IPv6 as a special or beta-test service to customers?

15. When do you plan to offer IPv6 as a regular service to all customers?

IV. Questions about IPv6 technologies

16. Which basic IPv6 access method(s) apply:

16.1. dual stack routing backbone?

16.2. separate IPv4 and IPv6 backbones?

16.3. 6to4 relay?

16.4. Teredo server?
16.5. Tunnel broker? If so, which one?

16.6. Something else? Please briefly describe your method:

16.7. If possible, please briefly explain the main reasons issues behind your choice.

17. Which types of equipment in your network are unable to support IPv6?

    17.1. Can they be field-upgraded to support IPv6?

    17.2. Is any equipment 100% dedicated to IPv6?

18. Is IPv6 an opportunity to restructure your whole topology?

19. Do you include support for DNS AAAA queries over IPv6?

20. Do you include support for reverse DNS for IPv6 addresses?

21. What length(s) of IPv6 prefix do you have or need from the registry?

22. What length(s) of IPv6 prefix are offered to customers?

    22.1. Do any customers share their IPv6 prefix among multiple hosts?

23. Do any of your customers prefer to use PI IPv6 prefixes instead of a prefix from you?

24. How are IPv6 prefixes delegated to CPEs? (Manual, PPPoE, RADIUS, DHCPv6, stateless autoconfiguration/RA, etc...)

25. Are your SMTP, POP3 and IMAP services dual-stack?

26. Are your HTTP services, including caching and webmail, dual-stack?

27. Are any other services dual-stack?

28. Is each of the following dual-stack?

    28.1. Firewalls

    28.2. Intrusion detection

    28.3. Address management software

28.4. Accounting software
28.5. Monitoring software

28.6. Network management tools

29. Do you or will you have IPv6-only customers?

30. Do you have customers who have explicitly refused to consider IPv6?

31. How many years do you expect customers to run any IPv4-only applications?

32. Is IPv6-IPv4 interworking at the IP layer needed?

33. Do you include a NAT-PT IPv6/IPv4 translator?

    33.1. If yes, does that include DNS translation?

    33.2. If not, do you plan to operate an IPv6/IPv4 translator?
    33.3. If not, how do you plan to connect IPv6-only customers to IPv4-only services?
    33.4. If you offer IP multicast, will that need to be translated too?

34. Any plans for Mobile IPv6 (or Nemo mobile networks)?

35. What features and tools are missing today for IPv6 deployment and operations?

36. Any other comments about your IPv6 experience or plans? What went well, what was difficult, etc.

List of Abbreviations

ADSL – Asymmetric Digital Subscriber Line

CIDR - Classless Inter-Domain Routing

CPE – Customer-premises equipment

DHCPv6 – Dynamic Host Configuration Protocol for IPv6

DNS – Domain Name System

HTTP – Hypertext Transfer Protocol

IANA - Internet Assigned Numbers Authority

ICANN – Internet Corporation for Assigned Names and Numbers

IETF - Internet Engineering Task Force

IMAP – Internet message application protocol

IP - Internet Protocol

IPng - IP next generation

ISP – Internet service providers

LIR - Local Internet Registry

NAT- Network Address Translation

NAT-PT – Network Address Translation/Protocol Translation

Nemo - Network Mobility

NIR – National Internet Registry

PDA – Personal digital assistant

PI – Provider Independent

POP – Post Office Protocol

PPPoE – Point-to-Point Protocol over Ethernet

QoS – Quality of Service

RADIUS – Remote Authentication Dial In User Service

RIRs - Regional Internet Registries

SMTP – Simple Mail Transfer Protocol

SWIP – Shared Whois Project

TDM - Time-division multiplexing

VoIP – Voice over Internet Protocol

xDSL – Digital Subscriber Line (collectively to the various types of digital subscriber technologies, such as ADSL, SDSL and HDSL)