

## Analysis of the future exhaustion of the Ipv4 Central pool in relation to IANA and its impact on the AfriNIC region

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By: Adiel A. AKPLOGAN and Alain Patrick AINA – April 2007

For some years now, studies have been done to try and assess the dates of exhaustion of the IPv4 central pool at the level of IANA and the Regional Registries. Geoff Huston's studies, for instance, published on <http://www.potaroo.net/tools/ipv4/> project the exhaustion of the IANA pool of addresses to around 26 July 2011. (Seen on 27 February 2007 at 7:59 UTC +10. Note: The website computes possible dates for the pool exhaustion in relation to IANA and RIR allocations in real time.

In light of this and other information available [1], there is undeniable concern for IP network operators with questions like: What will the situation be at the estimated date, if the operators cannot obtain public IPv4 addresses? Should there be reserves for addresses locally at the RIR level and/or even at the IANA level to cater for the most urgent?

Faced with such questions, operators in the APNIC region (Asia Pacific Network Information Center) proposed a policy aiming at coordinating and planning the exhaustion of the IPv4 central pool (<http://www.apnic.net/docs/policy/proposals/prop-046-v001.html>). But beyond the approach of centralized coordination for the transition, there remains concerns that are not expressly addressed and raised in the community especially in regions where the Internet is at its full development capacity such as Africa and Latin-America (under the management of AfriNIC and LACNIC respectively).

Some of these questions are:

1. *What can those "small" registries (like AfriNIC) do, to ensure access to IPv4 addresses to their communities even after exhaustion of the IANA central pool?*
2. *How will the Internet resource management system look like after the exhaustion of the IANA central Pool and that of AfriNIC?*
3. *What about the IPv6 solution?*

The objective of this document is to review different points based on data for the African Region and to set up foundations for some solutions whilst leaving the discussion open for contribution from the community.

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<sup>1</sup> A similar study done by CISCO using different methods:

[http://www.cisco.com/web/about/ac123/ac147/archived\\_issues/ipj\\_8-3/ipv4.html](http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_8-3/ipv4.html)

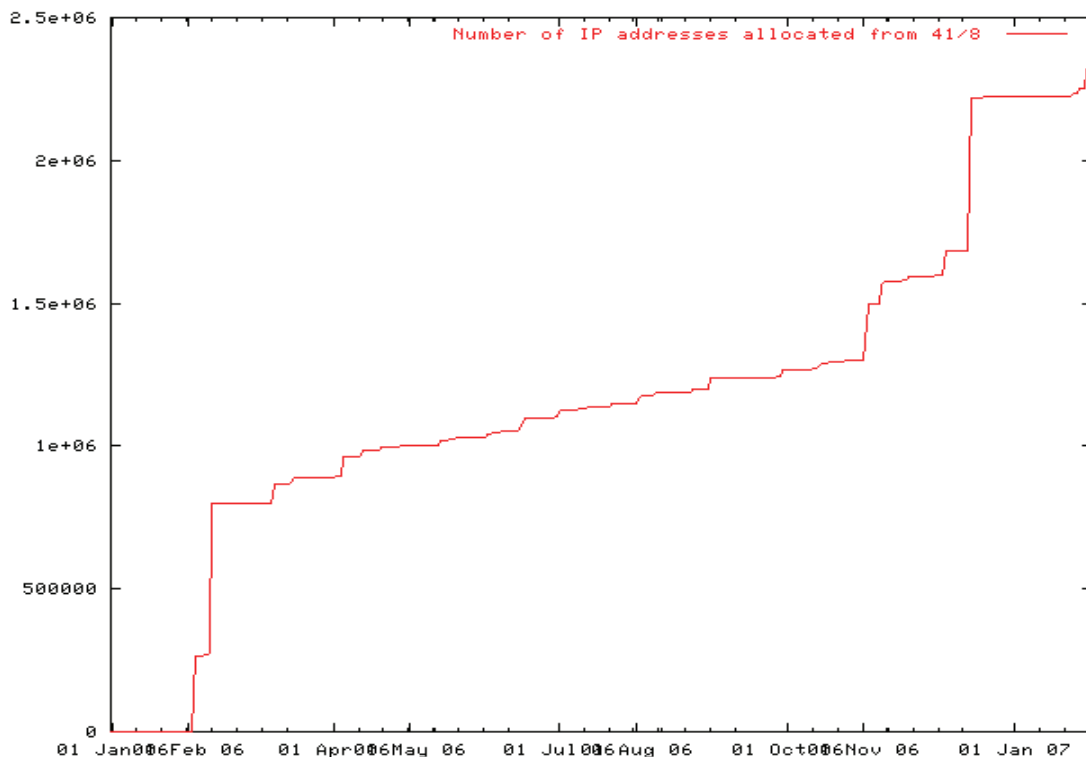
It is almost evident that with the exhaustion of the of IPv4 address pool, a black market will develop with its law of supply and demand and will not be favorable to ISPs in emerging regions.

It is also almost obvious that as for IPv4, the natural deployment of IPv6 in the communities concerned will have some difficulties, in spite of the measures taken to encourage it.

### 1) Analysis of the situation:

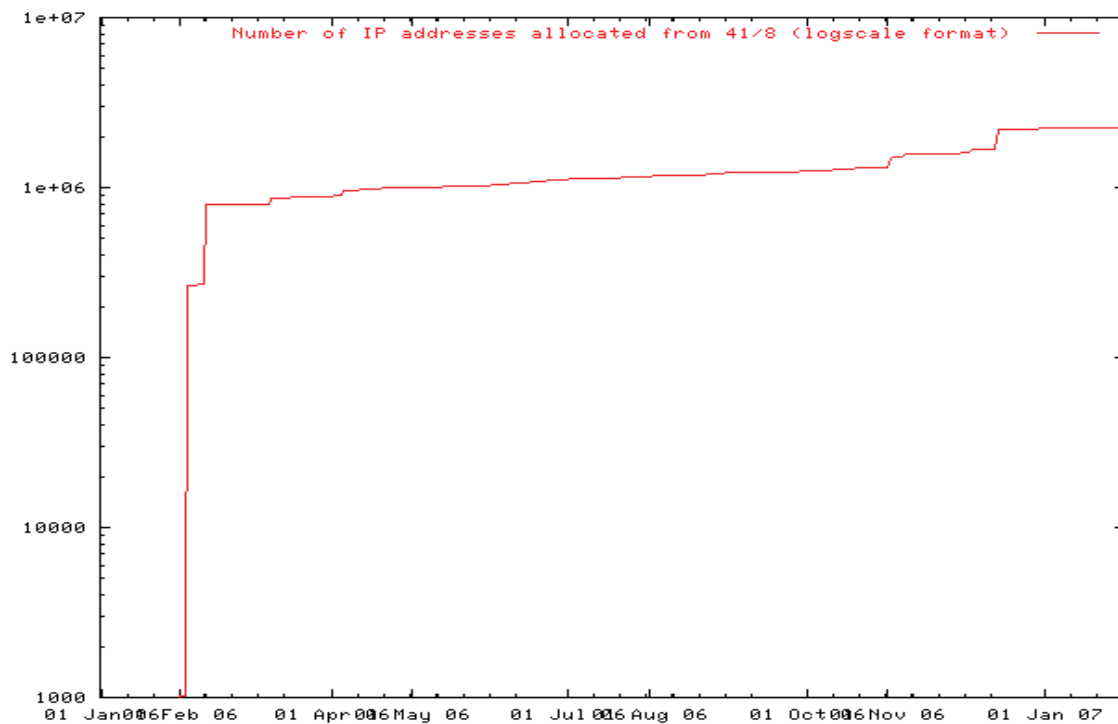
To answer the questions raised above in the context of AfriNIC, we have chosen to analyze the allocation of IPv4 addresses by AfriNIC, to make projections on the final exhaustion of the AfriNIC pool following that of IANA, and to prepare to manage this predicament.

For this we have analyzed allocations made from the prefix 41/8 allocated to AfriNIC in April 2005 by IANA and used since February 1st 2006. We have analyzed allocations over a period of 12 months (February 1st 2006 on February 1st 2007), to determine the rate of consumption and make projections (Figure 1).



**Figure 1:** Number of IP addresses allocated from January 1st 2006 to February 1st 2007

In order to study the model used to analyze the allocations, we represented the data in a logarithmic scale (Figure 2). The period from April 9th 2006 to November 1st 2006 (211 days) shows a linear behavior indicating an exponential growth.



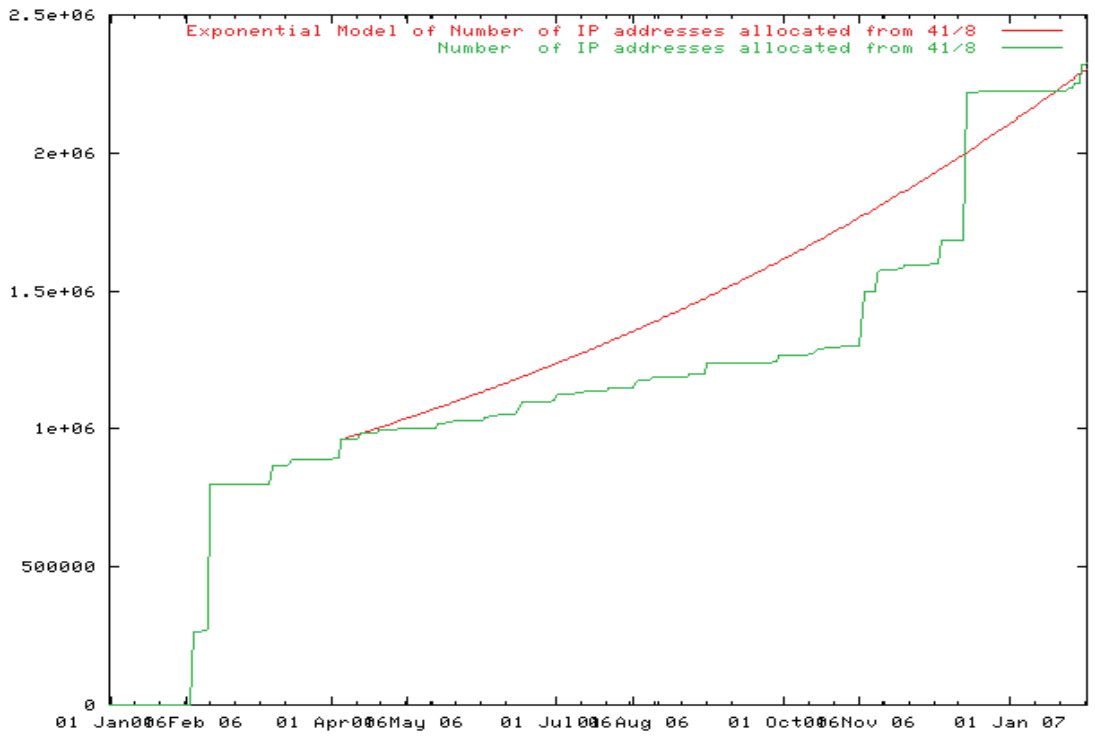
**Figure 2:** *Number of IP addresses allocated from 41/8 (log-scale format)*

The instantaneous growth rate of allocations derived from the formula  $X(t) = X_0 e^{kt}$  is of 0.29 %. The rest of the graph shows a similar behavior. A way of modeling the global evolution is to extend the exponential model in the remaining period (from November 2nd 2006 till February 1st 2007), 302 days in total.

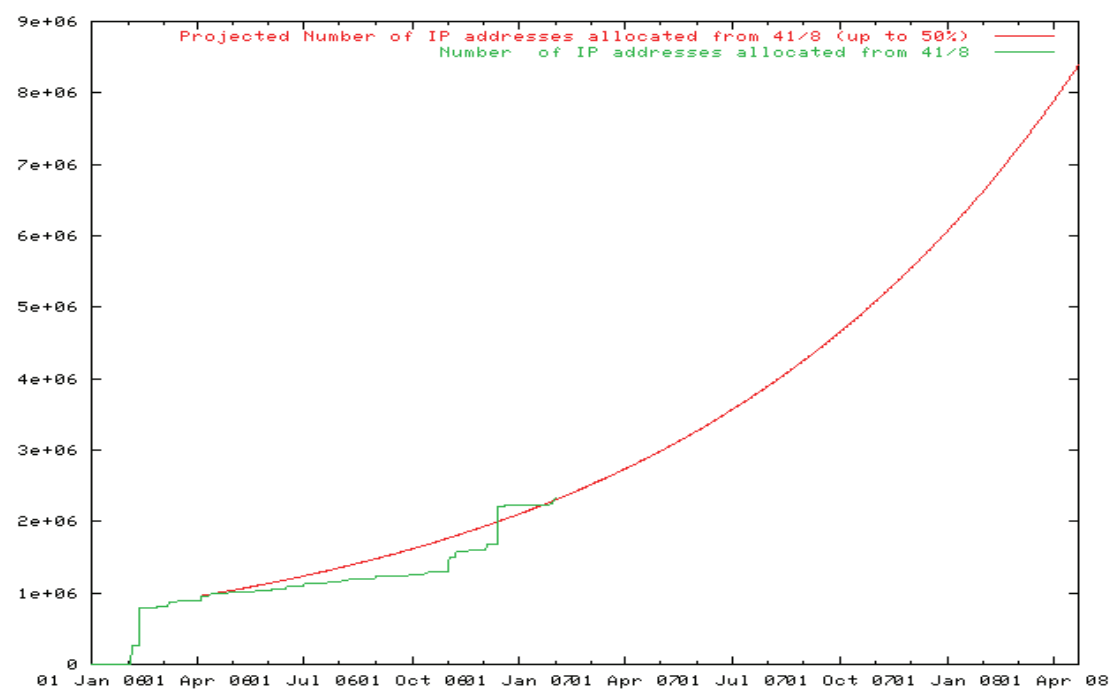
Figure 3 represents the graphs of real data and that of the data obtained with our model. The result on February 1st 2007 of both graphs reassures us on the applicability of our model and we can use it to make projections on the following dates:

- 1- Date of qualification for a new /8 from IANA (50 % of utilization of the actual block),
- 2- Date of exhaustion of the 41/8 block

As mentioned at the beginning, we first study the hypothesis of the constancy of conditions and actual rates of allocation. The model shows that AfriNIC will be at 50 % utilization of the 41/8 block, (8,388,608 IP addresses) at around April 22<sup>nd</sup> 2008 (after about 2 years and 2 months), and this is the date at which AfriNIC will qualify to receive a new /8 from IANA. See graph of Figure 4.

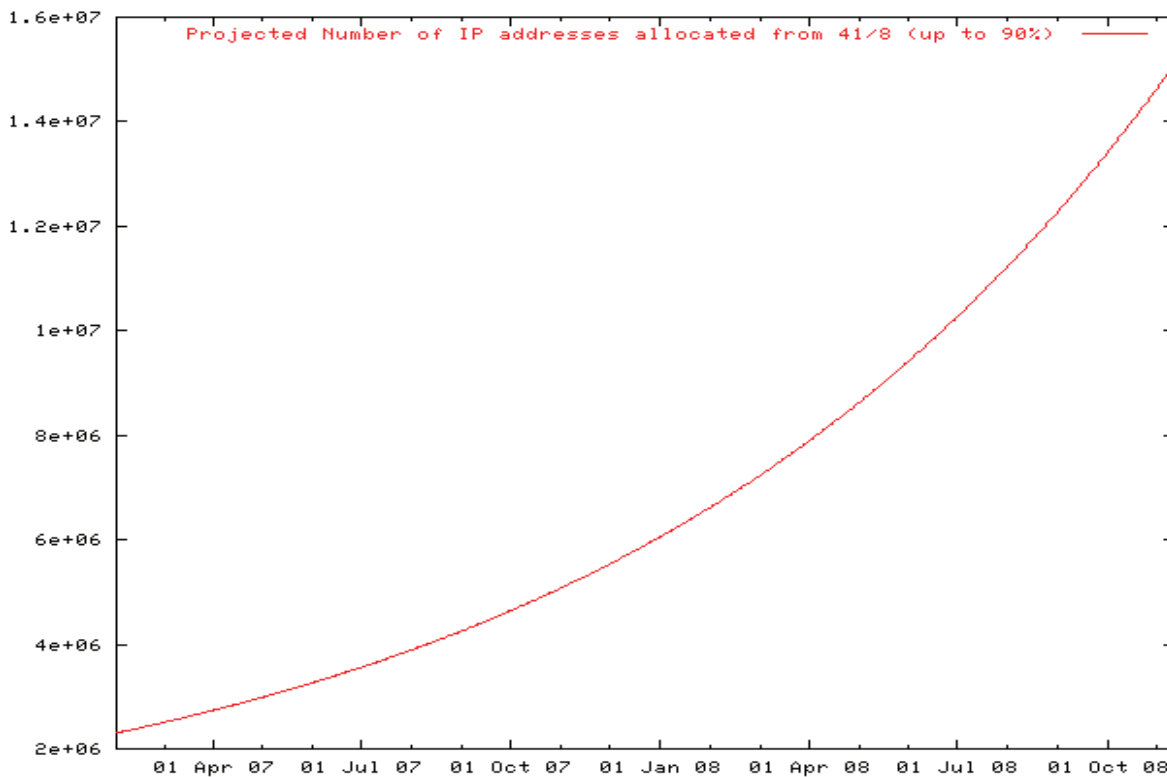


**Figure 3:** Exponential Model of Number of IP addresses allocated from 41/8



**Figure 4:** Projected Number of IP addresses allocated from 41/8 (up to 50%)

By taking a fragmentation rate of 10 % in the allocation (unallocated addresses), AfriNIC will exhaust the pool (after an allocation of 15,099,494.4) by November 11th 2008, **that is after 2 years 9 months.**



**Figure 6:** Projection of the exhaustion of the actual pool

AfriNIC should request for a new /8 from IANA by April 22<sup>nd</sup> 2008 as the IANA pool should be able to meet this request. The new block will be operational by November 11th 2008. By January 11th 2011, AfriNIC should also request a new /8 which can also be obtained. The new block will be effective on August 11th 2011 and will be exhausted by April 11th 2014. This is the situation if the actual rate of utilization is maintained and that everything works as predicted on the IANA pool.

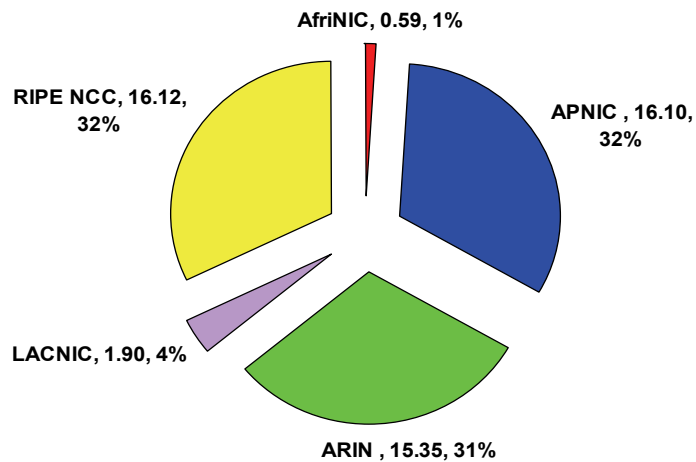
But, what will it look like in reality?

## **2) Some history on the IP addressing in the AfriNIC region.**

In fact, our continent was probably the last to be connected "full IP" to the internet. The first notion to be spread about IP addresses in the region was about their scarcity hence a very extensive use of NAT. Some networks are even subjected to several levels of NAT. It is not uncommon to see big operators supplying a whole country with small PA assignments behind of NAT. These issues still persist despite the evolution of time and knowledge. Other factors include the size of our ISPs which according to the market and especially the economic situation of the countries are quite insignificant. This situation was also emphasized by the inadequacy of the IP address allocation

policies applied by the RIRs that served the various regions of the continent before the establishment of AfriNIC.

- It should however be noted that utilization and consumption of public IP addresses started to evolve recently due to several factors such as creation of the African Regional Internet Registry, availability of large bandwidth connections to an increasing number of African countries and access to fiber links in several countries.



**Figure 7:** *IPv4 Address distribution*

Despite this sensible progress, our region still holds the lowest IP address consumption rate. All this is accompanied by a significant indifference by the majority of the actors in our community to the problems linked to the system of IP addressing particularly and Internet governance in general.

### 3) What will happen?

It is very much probable that the perspective of this exhaustion will trigger in the other regions (ARIN, RIPE and APNIC) pressure on LIRs and RIRs leading to accelerated consumption and as thus, faster exhaustion of the IANA pool which is envisaged by July 25th 2011. If this occurs one year beforehand that is on July 25th 2010 then AfriNIC's /8 request for January 11th 2011 will not be fulfilled due to the exhaustion of the IANA pool. The AfriNIC pool would therefore completely empty in August 2011 instead of April 2014.

Coming back to the initial questions that drove us to these long and perhaps boring studies and analyses.

1. What can the "small" registries (like AfriNIC) do to ensure continued access to IPv4 Addresses to their communities once the IANA pool is exhausted?
2. What will the global number resource management look like after the exhaustion of the central IANA Pool and that of AfriNIC?
3. What about the IPv6 solution?

The Results of our analyses envisage the exhaustion of the IANA pool for approximately July 25<sup>th</sup> 2010 and the AfriNIC pool for August 2011 that is after 4 years and 6 months.

#### **4) How can AfriNIC plan for this date which will most probably occur earlier than envisaged?**

Several actions are possible, requiring local, regional, but also global action. Let us try to define the foundations of some possible approaches.

- a. **To Sensitize** the community about the situation in order to enable the operators avoid the related surprises and emergencies so that they can get ready for the exhaustion. This sensitization should include short and long term solutions. In this context, the creation of a SIG (Specific Interest Group) dedicated to this problem and to solutions focused on the realities of our region is recommended.
- b. **To Start** an active campaign to recover unrouted allocated addresses in the AfriNIC pool. How much will there be? For how many months or years will the life of the pool be extended? What resources does AfriNIC have to recover those blocks for which the significant part is derived from the allocations made before the RIR system and identified as legacy space?  
  
→ *Here are series of questions which deserve extensive consideration in the coming days.*
- c. **To constitute** a reserve in the remaining pool to be used to supply critical infrastructure for which their sustainability and development are vital for the stability of network after August 11th 2011. What size should this reserve be? **Will the global community support the allocation of IP to RIRs to satisfy this reservation?**

A new definition of the term "critical infrastructure" would perhaps be necessary. Beside the classic and known definition (Root servers, and IXPs), what will the others be in 2011? Governmental or inter-governmental networks? Research Center Networks? Medical networks? Networks for the measure and prevention of natural disasters? ...

- d. **To Open** a global debate on the use of the 16 /8s reserved by the IETF for "future use"
- e. **To Open** discussions on a global level for the management of the remaining pool. Will an equitable distribution of the remaining pool among the 5 RIRs be conceivable?

## **5) What will the situation after August 11th 2011 be?**

AfriNIC would probably be able to satisfy the "critical infrastructure", but may not be able to do much for the other categories. The latter will be confronted by the black market of IP addresses. It will be very hard and expensive to get IP addresses and there will be an excessive inclination to the usage of NAT which will negatively impact the network.

Will the certification of used numbers by the registries help in the regulation of the market that will have emerged then? In fact, with resource certification deployed and utilized, it could allow to provide services such as the integrity of transferred resources, Transfer of ownership and Exclusivity of transfers.

## **6) What about the IPv6 solution?**

All the suggested actions listed above and those that will be based on IPv4 will only be temporary and will in reality be a transition solution to extend the use of IPv4 for a while. The solution resides in the long-term perspective, the availability of a broader range of addresses offered by IPv6. It is imperative and otherwise vital for the survival of the Internet that particular attention is paid to IPv6 in the deployment of networks in our region.

This mobilization must be at all development chain levels in Communication Technologies. Governments have a primordial role to play in this domain aiming clearly at the appropriation and deployment of IPv6-ready networks and applications in our countries. It will be necessary to get firmly involved in the campaigns of information and training on IPv6.

The SIG above will have among others, a role to establish a reliable document database aimed at the operators on the transition and migration mechanisms of IPv4 networks to IPv6. Since December 2005, AfriNIC has launched an information campaign which followed the removal of financial charges for the allocation of IPv6 addresses. AfriNIC has been able to train network operators in 8 African countries and to increase the number of IPv6 allocations in the region by more than 400 %, but this still represents only less than 10% of the networks using IPv4. Daily BGP statistics (<http://airrs.afrinic.net/bgp/reports6.html/>) show that less than 30 % of IPv6 allocations are visible on the internet. The path is still long and requires collective responsibility.