A Second Look at APNIC and IPv4 Address Exhaustion

It has been said often enough that its easy to make predictions; the tough part is getting them right! And in trying to predict the manner that APNIC will exhaust its remaining supply of IPv4 addresses I’m pretty sure that I did not get it right in the most recent article on this topic. So I’ll try and correct that in a more detailed look at the situation.

A Simple Exhaustion Model

Let’s look at what the oracle bones had been saying. This is the picture of the consumption of IPv4 addresses in APNIC since the start of 2013.

The blue line in Figure 1 tracks the consumption of IPv4 addresses as they are allocated by APNIC to end entities. In 2013 some 1,257,904 addresses were allocated by APNIC, and the actual monthly allocation rate was relatively consistent with the average of 106,000 addresses per month. However, there was a change in the address consumption rate in late May 2014, and the overall address consumption rate tripled. After three months the consumption rate slowed down somewhat to a steady state that was approximately double the 2013 address consumption rate.

APNIC is now allocating an average of some 13,500 addresses per day. There are some 11,054,592 addresses marked as “available” in the APNIC registry, so this pool will last a further 818 working days,
or 3.2 years. If we also take into account a steady increase in the address allocation rate at an average rate of increase of an additional 8 addresses per day then we get to 2.5 years if we continue allocations in future years at the same rates as we have observed in the middle of 2014. There may well be some element of rush on the registry as the address pool dwindles, so the prediction I made was that APNIC had some 2 to 2½ years to go in IPv4.

All well and good, but unfortunately it’s wrong.

**APNIC’s Address Pools**

There are four pools of addresses held by APNIC:

- “available” and “reserved” addresses in the last /8, 103.0.0.0/8: **10,629,888** addresses (out of a total of 16,777,216 addresses).
- “available” and “reserved” addresses in the set of legacy IPv4 addresses that have been returned to IANA and subsequently re-assigned to APNIC: **753,664** addresses (out of a total of 3,670,016 addresses).
- “reserved” addresses that are held by APNIC, based on withdrawal of registration from non-contactable holders from previous legacy allocations that were subsequently transferred to APNIC: **2,685,696** addresses (out of a total of 51,817,728 addresses).
- “reserved” addresses that are held by APNIC, based on withdrawal of registration from non-contactable holders from previous APNIC allocations: **1,596,928** addresses (out of a total of 803,663,616 addresses).

The status of each of these pools is shown in Table 1.

<table>
<thead>
<tr>
<th>Pool</th>
<th>Assigned</th>
<th>Available</th>
<th>Reserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last /8</td>
<td>16,777,216</td>
<td>6,147,328</td>
<td>10,317,312</td>
</tr>
<tr>
<td>IANA Returns</td>
<td>3,670,016</td>
<td>2,916,352</td>
<td>737,280</td>
</tr>
<tr>
<td>Various</td>
<td>51,817,728</td>
<td>49,132,032</td>
<td>0</td>
</tr>
<tr>
<td>APNIC Allocations</td>
<td>803,663,616</td>
<td>802,066,688</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>875,928,576</td>
<td>860,262,400</td>
<td>11,054,592</td>
</tr>
</tbody>
</table>

*Table 1 – APNIC Address Pool status*

The first pool, including the 10,629,888 available and reserved addresses, in the last /8 will be allocated according to the Last /8 policy:

https://www.apnic.net/policy/resources, Section 6.1

Since Friday, 15 April; 2011, each APNIC account holder is only eligible to receive IPv4 address delegations totaling a maximum /22 from the APNIC 103/8 IPv4 address pool. [...] To receive delegations from [this pool], they must demonstrate their eligibility by meeting the criteria specified below.

The second pool, including 753,664 available and reserved addresses operates under a the IANA recovered IPv4 pool address policy:

https://www.apnic.net/policy/resources Section 6.1

On Tuesday, 27 May 2014, each APNIC account holder became eligible to receive additional delegations up to a maximum of /22 address space from the APNIC non-103/8 IPv4 address pool. [...] To receive delegations from [this pool], they must demonstrate their eligibility by meeting the criteria specified below.
The third pool of 2,685,696 currently reserved addresses appears to be outside the scope of APNIC address allocation policies and presumably will be returned to the IANA as part of the IANA-managed recovered address pool. Parts of this pool would presumably be returned to APNIC (and other RIRs) as part of IANA’s distribution of recovered pool addresses.

The final address pool of 1,596,928 currently reserved addresses is evidently to be treated in the same manner as the IANA recovered IPv4 pool:

https://www.apnic.net/policy/resources Section 6.1.1

Address space returned to APNIC, or allocated to APNIC from the ‘IANA Recovered IPv4 Pool’ will be added to the non-103/8 IPv4 address pool. If address space in this pool becomes sufficient to delegate a further /22 to each APNIC account holder, additional delegation rounds will be announced.

In working through the exhaustion scenario for APNIC we need to model two address consumption models. The first is the consumption of the 10,629,888 addresses that remain in the last /8. The second is the consumption of the total of 2,350,592 currently available and reserved addresses, plus an anticipated additional 962,752 addresses, that will be allocated from IANA to APNIC as part of the operation of the IANA Recovered IPv4 address pool.

As these two models operate in parallel we can look at their anticipated operation independently.

**Consumption of the Last /8**

The daily record of the allocations from 103.0.0.0/8 is shown in Figure 2.

![Daily Allocations from 103.0.0.0/8](image)

*Figure 2 – APNIC allocations in 103.0.0.0/8*

This figure also shows a least squares best fit to the allocation data, showing a linear growth in address consumption over the past four years.

There are two models can be used to project future levels of consumption of addresses from this pool.

The first is the model of an increasing consumption rate of addresses as given by the best fit to the data accumulated so far. This is a consumption rate of an average of 5,500 addresses allocated per day in mid 2015, rising by a constant 2.47 addresses per day. In four years time this equates to a rise in the address allocation rate of an average of 9,100 addresses per day.
The second model uses a constant consumption rate, taking the average daily address consumption rate in 2015 of 5,704 addresses per day, and projecting forward with that constant consumption rate.

The results of these models are shown in Figure 3.

The increasing consumption rate forecasts that the last /8 will last for a further 4 years, exhausting the pool in mid 2019 (Projection (1) in Figure 3). The constant consumption rate shows that exhaustion of this pool will occur at the end of the third quarter of 2020, or 5 years and 2 months from now (Projection (2) in Figure 3).

These models indicate that a reasonable exhaustion prediction of this address pool is between 4 and 5 years hence, or around the start of 2020.

**Consumption of the IANA Return Pool**

The model of the consumption of this pool has to take into account a number of additional factors.

The first of these is the anticipated schedule of additional address allocations to APNIC. While the current pool size is 753,664 addresses, we need to add the anticipated schedule of the return of address space currently held by the IANA. At present, the current holdings in this IANA pool will generate the following schedule of address allocations to APNIC.

<table>
<thead>
<tr>
<th>Date</th>
<th>Block</th>
<th>Address Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 2015</td>
<td>/14</td>
<td>262,144</td>
</tr>
<tr>
<td>March 2016</td>
<td>/15</td>
<td>131,072</td>
</tr>
<tr>
<td>September 2016</td>
<td>/18</td>
<td>16,384</td>
</tr>
<tr>
<td>March 2017</td>
<td>/19</td>
<td>8,192</td>
</tr>
<tr>
<td>September 2017</td>
<td>/20</td>
<td>4,096</td>
</tr>
<tr>
<td>March 2018</td>
<td>/21</td>
<td>2,048</td>
</tr>
<tr>
<td>September 2018</td>
<td>/22</td>
<td>1,024</td>
</tr>
<tr>
<td>March 2019</td>
<td>/23</td>
<td>512</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>425,472</strong></td>
</tr>
</tbody>
</table>

However, APNIC is holding some 2,685,696 addresses that have had their registration entries removed by APNIC through non-contactability of the address holder, and are part of pre-APNIC assigned address pools. Were APNIC to take the decision to return these resumed addresses to the IANA, as it has done already with other blocks of returned addresses from these pre-APNIC address pools, and
were it to do so by the end of 2015, then the future schedule of IANA allocations to APNIC would be altered to be as follows:

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>September 2015</td>
<td>/14</td>
<td>262,144</td>
</tr>
<tr>
<td>March 2016</td>
<td>/13</td>
<td>524,288</td>
</tr>
<tr>
<td>September 2016</td>
<td>/15</td>
<td>131,072</td>
</tr>
<tr>
<td>March 2017</td>
<td>/17</td>
<td>32,768</td>
</tr>
<tr>
<td>September 2017</td>
<td>/19</td>
<td>8,192</td>
</tr>
<tr>
<td>March 2018</td>
<td>/20</td>
<td>4,096</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>962,752</td>
</tr>
</tbody>
</table>

The next factor is the reserved pool in APNIC-allocated blocks. There are a total 1,596,928 addresses marked as “reserved” in address blocks allocated to APNIC. The reason for these reservations appears to be that the address holders are uncontactable, and this marking of the registration entry to “reserved” is part of APNIC’s address reclamation process. An option for APNIC is to return these addresses back into the available pool, in which case they would be part of the recovered IPv4 address pool in terms of future allocations.

Let’s look at the allocation rate from these address blocks (Figure 4).

![Daily Allocations from the IANA Recovered Pool](image)

**Figure 4 — APNIC allocations from the Returned Address pool**

The allocation rate is slowly declining over time, from an average of just under 10,000 addresses per day in May 2014, when allocations from this pool commenced, to 4,000 addresses per day in mid 2015. The average daily allocation in 2015 from this pool was 5,226 addresses.

We can use this to generate a model of projected consumption of the remainder of the address pool (Figure 5). Using a constant consumption model of projected allocations from this pool, the remaining 737,280 addresses will last until December 2015. The trend of decreasing allocations projects a longer anticipated lifetime for this address pool, as it projects that demand will taper off to zero before exhausting the pool. This is a somewhat unlikely scenario.
However this does not take into account the expectation of further allocations from IANA’s recovered address registry. What if we add in the currently anticipated IANA allocations? A slightly different model of this address pool is shown in Figure 6, showing both the previous and anticipated allocations as well as the previous and anticipated allocations. The model used for the allocation projections is the constant consumption model.

There are a number of additional IANA return allocations after 2016, but they are so small as to be insignificant when compared to the modelled average demand of some 5,226 addresses per day. Effectively this pool ceases to be useful for APNIC in early 2016, extending the effective utility of this address pool by some 3 months.

We can also model a scenario where the currently reserved addresses are recycled back into the available address pools. There are 16,384 reserved addresses held by APNIC in APNIC-allocated space, and a further 2,685,596 reserved addresses held by APNIC in legacy space. What if APNIC were to recycle the 16,384 reserved addresses back into the IANA recovered pool, and return the 2,685,596 addresses back to IANA before March 2016?
The result is an additional 0.5M addresses passed back to APNIC from the IANA as part of its return process. This would allow a further 500 entities to obtain a /22 allocation from this pool. The March 2016 allocation would provide addresses for a further 4 months of operation of this pool, and the September allocations would provide for a further month of operation (Figure 7).

![Figure 7 – Projections of APNIC allocations from the Returned Address pool (3)](image)

Finally, we can factor in the reassignment of the 1,596,928 currently reserved addresses as being available. If this were to take place at the end of 2015 then the model of the projected use of the Returned Address pool would be as shown in Figure 8. This would extend the effective life of this pool to March 2017 before it would be fully depleted.

![Figure 8 – Projections of APNIC allocations from the Returned Address pool (4)](image)
Exhaustion

The final /8 in APNIC will last for a further 4 to 5 years, assuming the continuation of a demand model at a level commensurate with current demands. This pool is projected to be fully depleted some time between mid 2019 and mid 2020.

The IANA Recovered Address Pool will not last as long. At current demand levels the pool will last until early 2016, or some 6 months from now. If APNIC is able to reassign all the currently reserved address blocks in its registry, and clear them for potential recycling, then the Returned Address pool will be remain available for allocations until early 2017, or some 1 ½ years from now.

What’s the message?

If we are talking IPv4 then it’s over.

Its time to get serious about IPv6.
Author

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