The Status of APNIC’s IPv4 Resources: Exhaustion & Transfers

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1. IPv4 Exhaustion
What’s Left in IPv4

RIR IPv4 Address Run-Down Model

- AFRINIC
- APNIC
- ARIN
- RIPE NCC
- LACNIC

Date

RIR Address Pool(/8s)
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

[Graph showing IPv4 address depletion for different RIRs over time]
RIPE NCC’s final /8

RIPE NCC IPv4 Address Run-Down Model
LACNIC’s 2 final /11’s
ARIN’s IPv6 Transition /10
ARIN’s IPv6 Transition /10
APNIC’s final /8
Where Are We?

- LACNIC running a split pool of two /11 blocks
  6 – 9 months to go

- APNIC running out of their last /8
  2 – 3 years to go

- AFRINIC still have a pool of 1.5 /8s to go
  2 years to go

- RIPE NCC running out of their last /8
  4 ½ years to go

- ARIN reserved a /10 for V6 transition
  345 years to go
Where Are We?

- LACNIC running a split pool of two /11 blocks
  6 – 9 months to go

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  4 ½ years to go

- ARIN reserved a /10 for V6 transition
  345 years to go

Let's take a more detailed look at APNIC's situation
2. APNIC’s Last /8
<table>
<thead>
<tr>
<th>Pool</th>
<th>Assigned</th>
<th>Available</th>
<th>Reserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last /8</td>
<td>16,771,584</td>
<td>8,798,720</td>
<td>7,790,336</td>
</tr>
<tr>
<td>IANA Returns</td>
<td>4,060,160</td>
<td>4,020,224</td>
<td>0</td>
</tr>
<tr>
<td>Various</td>
<td>120,366,336</td>
<td>117,288,448</td>
<td>0</td>
</tr>
<tr>
<td>APNIC Allocations</td>
<td>738,150,656</td>
<td>737,881,088</td>
<td>0</td>
</tr>
<tr>
<td>RIR Transfers</td>
<td>383,488</td>
<td>383,488</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>879,732,224</td>
<td>868,371,968</td>
<td>7,790,336</td>
</tr>
</tbody>
</table>
APNIC Allocation from the last /8

“This means that Members can still get IPv4 address space; however, each Member is entitled to a total maximum of a /22 (or 1,024 addresses) from each pool.”
Status of 103/8

Assigned: 8,798,720
Available: 7,790,336
Reserved: 182,528

As of mid August 2016
APNIC’s Last /8

Allocations from 103/8

Oldest

Most Recent

Second Octet (103.X/16)

Third Octet (103.x.Y/24)
Allocation Sizes - APNIC

Size Distribution of Allocations from 103/8

Number of Allocations

Prefix Size

2011
2012
2013
2014
2015
2016 (to August)
Larger Holdings in 103/8?

There are 100 instances where the same end entity is listed as holding more than 1,024 addresses assigned from 103/8.

These are probably the result of post-allocation mergers, acquisitions and transfers.

 Cumulatively, this accounts for 66,368 addresses, or 8.5% of all addresses that have been assigned from 103/8.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Block Size</th>
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<tbody>
<tr>
<td>1</td>
<td>1,280</td>
</tr>
<tr>
<td>17</td>
<td>1,536</td>
</tr>
<tr>
<td>1</td>
<td>1,792</td>
</tr>
<tr>
<td>185</td>
<td>2,048</td>
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<tr>
<td>1</td>
<td>2,304</td>
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<tr>
<td>1</td>
<td>2,560</td>
</tr>
<tr>
<td>26</td>
<td>3,072</td>
</tr>
<tr>
<td>8</td>
<td>4,096</td>
</tr>
<tr>
<td>1</td>
<td>4,352</td>
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<tr>
<td>3</td>
<td>5,120</td>
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<tr>
<td>1</td>
<td>7,168</td>
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<td>1</td>
<td>8,192</td>
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<tr>
<td>1</td>
<td>10,240</td>
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<tr>
<td>1</td>
<td>13,312</td>
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<tr>
<td>1</td>
<td>14,336</td>
</tr>
<tr>
<td>1</td>
<td>67,840</td>
</tr>
</tbody>
</table>
Country Allocations from 103/8
Country Allocations from 103/8

Huh?
Transfer Activity in the Last /8

6 Inter-RIR transfers:
- 2,048 addresses transferred to RIPE NCC, Netherlands (2015)
- 1,024 addresses transferred to RIPE NCC, Iran (2016)
- 3,072 addresses transferred to ARIN, United States (2016)

195 APNIC transfers:
- 172,032 addresses transferred
Advertised vs Assigned in 103/8

Assigned Addresses: 8,804,352
Advertised Addresses: 5,865,984
Unadvertised Addresses: 2,938,368

1/3 of the assigned space from the last /8 is not advertised.
Advertised/Unadvertised Map of 103/8
103/8 Consumption Modelling

APNIC's Daily Address Assignments from 103/8

- Linear: \( a(x) = 2367.09547 + (x \times 0.0000651317) \)
- Exponential: \( b(x) = 0.0825 \times (e^{0.089 \times x}) \)
Projection for the last /8

We probably have 2 - 3 years left!
3. IANA Recovered Space: Returns to APNIC
## APNIC’s IPv4 Address Pools: August 2016

<table>
<thead>
<tr>
<th></th>
<th>Pool</th>
<th>Assigned</th>
<th>Available</th>
<th>Reserved</th>
</tr>
</thead>
<tbody>
<tr>
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<td>8,798,720</td>
<td>7,790,336</td>
<td>182,528</td>
</tr>
<tr>
<td>IANA Returns</td>
<td>4,060,160</td>
<td>4,020,224</td>
<td>0</td>
<td>39,936</td>
</tr>
<tr>
<td>Various</td>
<td>120,366,336</td>
<td>117,288,448</td>
<td>0</td>
<td>3,077,888</td>
</tr>
<tr>
<td>APNIC Allocations</td>
<td>738,150,656</td>
<td>737,881,088</td>
<td>0</td>
<td>269,568</td>
</tr>
<tr>
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<td>383,488</td>
<td>383,488</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>879,732,224</strong></td>
<td><strong>868,371,968</strong></td>
<td><strong>7,790,336</strong></td>
<td><strong>3,569,920</strong></td>
</tr>
</tbody>
</table>
## Recovered Pool Status

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Pool</th>
<th>Advertised</th>
<th>Unadvertised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Pool</td>
<td>4,063,232</td>
<td>2,241,536</td>
<td>1,821,696</td>
</tr>
<tr>
<td>Transferred</td>
<td>3,072</td>
<td>2,048</td>
<td>1,024</td>
</tr>
<tr>
<td>APNIC Pool</td>
<td>4,060,160</td>
<td>2,239,488</td>
<td>1,820,672</td>
</tr>
<tr>
<td>Available</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reserved</td>
<td>40,960</td>
<td>4,096</td>
<td>36,864</td>
</tr>
<tr>
<td>Assigned</td>
<td>4,019,200</td>
<td>2,235,392</td>
<td>1,783,808</td>
</tr>
</tbody>
</table>

- **Transferred**:
  - Advertised: 2,048
  - Unadvertised: 1,024

- **Available**:
  - Available: 0

- **Reserved**:
  - Reserved: 36,864

- **Assigned**:
  - Assigned: 1,783,808

Allocation Size Distribution

APNIC Allocations from the IANA Returned Space

Allocation Prefix Size

Number of Allocations (Log Scale)
Economy Distribution

Distribution of Address space by Country

Total Assigned Address space (24s) (log scale)

Last /8
IANA Recovered Space

[Graph showing distribution of address space by country]
## Advertised vs UnAdvertised

<table>
<thead>
<tr>
<th></th>
<th>Last /8</th>
<th>IANA Returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertised</td>
<td>5,865,984</td>
<td>2,239,488</td>
</tr>
<tr>
<td>UnAdvertised</td>
<td>2,938,368</td>
<td>1,820,672</td>
</tr>
<tr>
<td>Total</td>
<td>8,804,352</td>
<td>4,060,140</td>
</tr>
</tbody>
</table>

66% advertised    55% advertised
Who Has What

Of the 6,803 distinct holders of pre-exhaustion address space, only 2,159 entities also hold last /8 and/or IANA recovered space.

There are more entities holding only last /8 and/or IANA recovered space (7,090) than holders of the pre-exhaustion address space.
Returned Pool Consumption

[Graph showing Returned Pool Consumption with dates from April 14 to October 16, with peaks and troughs indicated by red and blue lines and a question mark highlighted.]
4. Transfers
IPv4 Address Transfers

Total Transfers Registered with APNIC: 1,672
  Internal (APNIC -> APNIC): 1,425
  Inter-RIR: ARIN->APNIC 229
    APNIC ->ARIN 9
    APNIC->RIPE NCC 9

Total Address Volume Transferred: 21,702,400
  Internal (APNIC -> APNIC): 12,554,944
  Inter-RIR: ARIN->APNIC 8,012,288
    APNIC->ARIN 19,456
    APNIC->RIPE NCC 115,712
Transfers started in APNIC in late 2010

The average number of transfers per month has risen from 2 – 3 per month to 30 – 80 per month in 2016

The volume of addresses transferred has risen from some 10 x /24s per to a total monthly volume of 1,000 – 6,000 /24s in 2015 - 2016.
Original Allocation (Registration) date of the Transferred Addresses

There are two visible peaks here: one is the so-called “legacy” space which was originally allocated pre 1994. The other is the address blocks allocated in 2009 – 2011, immediately prior to APNIC address exhaustion.

These relative peaks are visible when looking at the volumes of transferred addresses,
Age (since initial allocation) of the Transferred Addresses

There are again two visible clusters here: one is the so-called “legacy” space which is transferred some 20 - 25 years after the initial allocation and the second is a peak of transferred addresses that were transferred within 2 - 8 years following the initial allocation.
An Economy View of Transfers

- The next few slides look at transfers from a national perspective.
- An “Import” is where the receiver of the transferred address is registered within the country.
- An “Export” is where the disposer of the transferred address is registered within the country.
- A “Domestic” transfer is where the disposer and receiver are both in the same country.
## Imports and Exports

<table>
<thead>
<tr>
<th>CC Code</th>
<th>Imports</th>
<th>Exports</th>
<th>Internal</th>
<th>Total</th>
<th>Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Addresses</td>
<td>Number</td>
<td>Addresses</td>
<td>Number</td>
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<td>150,784</td>
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<td>545,024</td>
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<td>467,968</td>
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<td>1,447,936</td>
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<td>8,192</td>
<td>128</td>
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<td>1,225,984</td>
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<tr>
<td>MM</td>
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<td>0</td>
<td>0</td>
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<td>MN</td>
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<td>MY</td>
<td>20</td>
<td>187,136</td>
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<td>1,536</td>
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<td>1</td>
<td>2,048</td>
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<td>NZ</td>
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<td>0</td>
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<td>4,096</td>
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<td>1</td>
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<tr>
<td>TW</td>
<td>4</td>
<td>4,096</td>
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<td>1,536</td>
<td>8</td>
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<td>WS</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2,048</td>
<td>0</td>
</tr>
</tbody>
</table>
Imports and Exports

• The Asia Pacific region is a net importer of IPv4 addresses (8.0M addresses have been imported from ARIN via transfers)

• Japan is the largest domestic market for IPv4 addresses

• Singapore is the largest regional exporter of addresses, and China is the largest regional importer
How Many are Buying and Selling?

502 different sellers
478 different buyers
913 participants
Transfer Size

• The transfer log records a transfer in terms of individual CIDR blocks
• We can group these together by using a common key of source entity, destination entity and date.
• Using this we see that the transfer log contains distinct 740 transactions
Transfer Size Distribution

The graph shows the distribution of transfer sizes across different years. The x-axis represents the transfer size, and the y-axis represents the number of transfer transactions. The bars indicate the number of transactions for each size category, with years ranging from /12-13 to /24-25. The distribution is skewed, with a notable peak around /22-23.
Transfers in APNIC

This is still a relatively small scale activity in this region.

Out of the 879,732,224 addresses in the APNIC registry, transfers account for the movement of 21,702,400 addresses (2.5%)

Transfers involved 913 entities out of a total of 13,897 unique holders of IP addresses (6.6%)
Questions?