HD Ratio for IPv4

RIPE 48
May 2004
Amsterdam
Current status

- **APNIC**
  - Informational presentation at APNIC 16
  - Well supported, pending presentation at other RIRs
- **ARIN**
  - Similar proposal made at ARIN XIII
  - Not supported
- **LACNIC**
  - Informational presentation at LACNIC VI
  - Current status
- **RIPE NCC**
  - No consideration yet
Background – HD Ratio

• Measures utilisation in hierarchically managed address space (see RFC3194 and RFC1715)

\[ HD = \frac{\log(\text{utilised host addresses})}{\log(\text{total addresses})} \]

• Note: calculation requires registration of individual site addresses (/48)

• The HD-ratio has been adopted for IPv6
  • LIR may receive more IPv6 space when HD=0.80

• An HD-ratio value corresponds to a percentage utilisation which decreases as the size of the address space grows
Background - IPv6 (HD = 0.80)

\[
\frac{\log(\text{utilised})}{\log(\text{total})} = 0.80
\]

RFC3194 “The Host-Density Ratio for Address Assignment Efficiency”
Problem Summary

- IPv4 fixed utilisation requirement
  - Once 80% is sub-allocated or assigned, LIR can request additional block
  - Same requirement for all address blocks, regardless of size
- No allowance for hierarchical management
  - Address management efficiency decreases for large address blocks
  - Imposes unreasonable management overhead on larger LIRs
Proposal Summary

• HD-based IPv4 utilisation requirement
  • Allows lower % utilisation requirement for larger blocks
  • To make allowance for hierarchical management

• Variation of HD-Ratio proposed
  • Assignment Density (AD) Ratio
    • Consider total addresses assigned rather than individual host addresses in use

• Proposed value
  • Utilisation requirement AD=0.966
  • Calculated based on current 80% principle
Proposed IPv4 utilisation (AD 0.966)
# Proposed IPv4 utilisation (AD 0.966)

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Total addr</th>
<th>Utilised addr</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>/24</td>
<td>256</td>
<td>212</td>
<td>82.82%</td>
</tr>
<tr>
<td>/22</td>
<td>1024</td>
<td>809</td>
<td>79.00%</td>
</tr>
<tr>
<td>/20</td>
<td>4096</td>
<td>3087</td>
<td>75.37%</td>
</tr>
<tr>
<td>/18</td>
<td>16384</td>
<td>11780</td>
<td>71.90%</td>
</tr>
<tr>
<td>/16</td>
<td>65536</td>
<td>44949</td>
<td>68.59%</td>
</tr>
<tr>
<td>/14</td>
<td>262144</td>
<td>171518</td>
<td>65.43%</td>
</tr>
<tr>
<td>/12</td>
<td>1048576</td>
<td>654485</td>
<td>62.42%</td>
</tr>
<tr>
<td>/10</td>
<td>4194304</td>
<td>2497408</td>
<td>59.54%</td>
</tr>
<tr>
<td>/8</td>
<td>16777216</td>
<td>9529704</td>
<td>56.80%</td>
</tr>
</tbody>
</table>
Justification
Allocation Hierarchy - 1

RIR

ISP

... Customers and Infrastructure
Allocation Hierarchy - 2
Assignment Density (AD) Ratio

- Variation of HD ratio
  - Instead of measuring host addresses actually used, measures number of addresses assigned by LIR
    - For consistency with IPv4 policies, which do not track individual host address assignments

\[ AD = \frac{\log(\text{assigned addresses})}{\log(\text{total addresses})} \]

- Propose to use AD Ratio as utilisation measure for IPv4
  - Need to determine appropriate value
Selecting an AD-Ratio value

• Principles
  • Accept 80% as reasonable utilisation limit for single-level hierarchy
  • Accept corresponding lower utilisation limits for deeper hierarchies
    • 64% for 2-level hierarchy (80% x 80%)
    • 51.2% for 3-level hierarchy (80% ** 3)

• Apply to ISP internal hierarchy
  • We assume likely useful depth of hierarchy according to size of address space
  • Select values which appear reasonable
    • Values are assumed only, based on informal discussions with APNIC members
Allocation Hierarchy

RIR
ISP

Internal Hierarchy*

Customers and Infrastructure
Selecting an AD-Ratio value

- Likely depth of ISP addressing hierarchy

<table>
<thead>
<tr>
<th>Size Range (Prefix)</th>
<th>Depth (n)</th>
<th>Utilisation (0.80**n)</th>
<th>AD Ratio (calculated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>/24 to /20</td>
<td>1</td>
<td>80%</td>
<td>.960 to .973</td>
</tr>
<tr>
<td>/20 to /16</td>
<td>1.5</td>
<td>72%</td>
<td>.961 to .970</td>
</tr>
<tr>
<td>/16 to /12</td>
<td>2</td>
<td>64%</td>
<td>.960 to .968</td>
</tr>
<tr>
<td>/12 to /8</td>
<td>2.5</td>
<td>57.2%</td>
<td>.960 to .966</td>
</tr>
<tr>
<td>/8 to /4</td>
<td>3</td>
<td>51.2%</td>
<td>.960 to .966</td>
</tr>
</tbody>
</table>

- Common AD Ratio value
  - Most conservative: 0.966
  - Least conservative: 0.961
IPv4 utilisation (AD = 0.966)
Impact
Impacts

• Administrative
  • LIR needs to incorporate new method of calculating utilisation in procedures
  • LIR would need to register infrastructure assignments/sub-allocations
  • RIRs Secretariat update internal policies, procedures and documentation

• Address space consumption
  • Initial impact
  • Ongoing impact
Impact - Address Consumption

• Initial impact
  • Maximum impact (address “wastage”) can be calculated as difference in utilisation expectation for all allocated address space

<table>
<thead>
<tr>
<th>Total LIRs in sample</th>
<th>788</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total address space held (/8s, actual)</td>
<td>4.17</td>
</tr>
<tr>
<td>Utilised addresses (80%)</td>
<td>3.32</td>
</tr>
<tr>
<td>Utilised addresses (AD 0.966)</td>
<td>2.53*</td>
</tr>
<tr>
<td>Extra “wasted” space</td>
<td>0.79</td>
</tr>
<tr>
<td>Extra “wastage” as proportion of total</td>
<td>19%</td>
</tr>
</tbody>
</table>

* Figure calculated from sample of 788 APNIC LIRs, according to actual address space holdings
Impact - Address Consumption

- Ongoing impact
  - Calculated by modeling the distribution of an additional /8 proportionally to all LIRs

<table>
<thead>
<tr>
<th>Total LIRs in sample</th>
<th>788</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial address space held (/8s, actual)</td>
<td>4.17</td>
</tr>
<tr>
<td>Additional address space allocated</td>
<td>1.00</td>
</tr>
<tr>
<td>Total address space now held</td>
<td>5.17</td>
</tr>
<tr>
<td>Utilised addresses (AD 0.966)</td>
<td>3.11</td>
</tr>
<tr>
<td>Additional addresses utilised</td>
<td>0.58</td>
</tr>
<tr>
<td>Additional addresses utilised (80%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Extra “wasted” space</td>
<td>0.22</td>
</tr>
<tr>
<td>Extra “wastage” as proportion of total</td>
<td>22%</td>
</tr>
</tbody>
</table>
Implementation (APNIC)

• RIR-LIR procedures
  • Replace 80% utilisation with 0.966 AD ratio
  • Implement AD Ratio reporting in MyAPNIC
    • Trivial automatic calculation
  • LIRs systems using 80% may continue to do so (since 80% > AD .966 in all cases)

• Assignment procedures
  • Calculations rely on assignment and sub-allocation registration information
    • Including infrastructure
Summary

• Accept HD-Ratio based to measure utilisation requirement for hierarchical address management
  • Use AD-Ratio in case of IPv4
  • Use 0.966 as AD-Ratio utilisation requirement
• Benefit impacts larger ISPs
  • Improves address manageability
  • Overcome current penalty
• Address space consumption impact (APNIC)
  • Initial impact - up to 19% additional space required (maximum eventual impact)
  • Ongoing impact - up to 22% increase in consumption rate (maximum)
Thanks

Questions?