Non-random Generator for IPv6 Tables

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IPv6 Tables are Needed

- Lookup algorithms => routing table structures => address allocation
- IPv6 deployment needs IPv6 tables
- Current IPv6 tables are not sufficient
- Tables using random numbers are not representative

=> Need a model of the structure of IPv6 tables
Outline

• IPv6 addressing
• Address allocation
• Routing table structure: IPv4 table analysis
• IPv6 table generation:
  – Schemes
  – Results

IPv6

• 128-bit address => 3.4 x 10^{38} addresses
• First 64-bit: network prefix
  Second 64-bit: interface ID
• Addressing:
  – Unicast: global unicast (001)
  – Anycast: one to nearest
  – Multicast: one to many
  – Reserved
  – No broadcast
IP Address Allocation Hierarchy

Internet Assigned Number Authority

Regional Internet Registries
(ARIN, RIPE, APNIC, AfriNIC, LACNIC)

Local Internet Registries
(ISP’s)

End Users

Current Allocation Policies

IPv4

/8

/10 -- /20

various
Current Allocation Policies

- IANA
- RIR
- ISP/LIR

<table>
<thead>
<tr>
<th>IPv4</th>
<th>IPv6</th>
</tr>
</thead>
<tbody>
<tr>
<td>/8</td>
<td>/23</td>
</tr>
<tr>
<td>/10 -- /20</td>
<td>/32</td>
</tr>
<tr>
<td>various</td>
<td>/48</td>
</tr>
</tbody>
</table>

Address Lookup

- Routing table format:
  Prefix value/Prefix length  Port number
  Ex: 171.64.0.0/16  Port 2

- Longest Prefix Match:
  Find the most specific prefix that matches with the address
Routing Table Structure

- Overall prefix distribution
- Prefix value and entropy
- Prefix length and parent-children relationship
- Table size

IPv4 and IPv6

- Many features observed in IPv4 routing tables are expected to emerge in IPv6 routing tables:
  - Allocation policies
  - Routing practices
  - Evolution of the Internet
- Factors for differences:
  - Aggregation, multi-homing, …
IPv4 Prefix Distribution

IPv4 Prefix Distribution – Zoom In
Fermi Dirac Distribution

IPv4 Prefix Value – Bit Value Distribution
Prefix Value Distribution

- Bit entropy

\[ H(p) = -p \log_2 p - (1 - p) \log_2(1 - p). \]

where \( p \) is the probability of this bit being 0.

- A measure of the randomness of prefix values

Prefix Length Distribution

128.0.0.0/8
(10000000.00000000.00000000.00000000/8)

128.0.0.0/9
(10000000.00000000.00000000.00000000/9)

128.128.0.0/9
(10000000.10000000.00000000.00000000/9)
Parents and Children

All 91.5% of the nodes have parents
38.0% stand alone
38.1% branch len=1
13.1% branch len=2
1.3% branch len=3
0.1% branch len=4
0.002% branch len=5

Sample IP tree from MAE
Children of 24.116.0.0/17

Prefix length
IP address (24.116.xxx.0)
IPv4 Prefix Length
– Parent-Children Relationship

![Graph showing IPv4 prefix length distribution and parent-child relationships.](image-url)

- The graph displays the distribution of IPv4 prefix lengths, categorized by their level in the parent-child hierarchy.
- Levels range from Level 0 (stand-alone) to Level 5, with Level 0 being the highest and Level 5 being the lowest.
- The x-axis represents the prefix length, ranging from 8 to 32.
- The y-axis represents the count of prefixes.
- Each level is color-coded for easy identification.

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*Note: The image contains the actual visual representation of the data distribution and hierarchy, which complements the textual explanation.*
IPv6 Table Generation Schemes

- Prefix value
  - Group A: Insert or repeat bits in IPv4 prefixes
    - IPv4: 171 | 64 | 14 | 237
    - IPv6: 001 | 171 | 64 | 14 | 237
  - Group B: AS number (ASN) + IPv4 prefix
    - IPv6: 001 | 1682 | 171 | 64 | 14 | 237
IPv6 Table Generation Schemes (Cont’d)

• Prefix value:
  AS: Autonomous System, a group of IP networks having a single clearly defined routing policy, run by one or more network operators.
  ASN: 16 bits, globally unique identifiers for Autonomous Systems.

• Prefix length
  – IPv6 prefix length = IPv4 prefix length x 2
  – Convert ¼ prefix lengths into odd numbers

• Table size

Synthesized IPv6 Table Prefix Value – Bit Value Distribution
Modified IPv6 Bit Value Distribution

Synthesized IPv6 Table
Prefix Length Distribution
Prefix Length Distribution of Current IPv6 Table

Performance Comparison for IPv6 Tables
Conclusions

• Analyzed IPv4 routing table structure in terms of prefix value and prefix length distributions
• Synthesized IPv6 routing tables that inherit features of IPv4 tables. The mechanism of using AS number + IPv4 prefix gives more representative IPv6 tables.

Q & A

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