Flexible IP: An Adaptable IP Address Structure

Yihao Jia
jiayihao@huawei.com

IETF – INTAREA WG
https://datatracker.ietf.org/doc/draft-jia-flex-ip-address-structure/
Gap Analysis

Scenarios potentially prefer a flexible IP address structure

- Internet of Things (IoTs)
- Satellite Network
- Dynamic Service and Resource
- Policy-based Traffic Control
- Robust Trust and Security
- … …

Based on the *rationality* of scenarios requirements
Targeted Scenario

Physical Location
- IPv6 remains the mainstay of the Internet backbone
- Various network is supposed to evolve to IPv6, with only a small number of legacy IPv4 networks
- New network scenario are located at the edge of Internet
- Edge Network can be depicted as limited domain in RFC8799
- FlexIP is expected to be used at limited domain only.

Logical Position
- FlexIP is a replacement of the global IPv6 address system, but only a supplementary of it.
Design Considerations

• Multi-Semantics
  • According to the gap analysis, a semantic enabled address structure can enrich advanced network functions, e.g., semantics-based routing.

• Elastic Address Space
  • Different semantics may require different address length, while a short address is a dramatic energy saving for constrained devices.

• Scalability
  • Boundless space may lead to routing table explosion. To makes the address practically values, balance must be reached between expansive address space and efficient routing performance.

• Interoperability
  • Since such address should only act as a supplementary of the global IPv6 address system, transformation must be conducted at the boundary of IPv6 and the new address structure.

Translator

FlexIP (Length X, Semantic A)  IPv6 [Internet Backbone]
FlexIP (Length Y, Semantic B)
...
FlexIP Address Structure

For short address length only
- length: 1-byte (0-239)
- One segment, topology semantic

For extendable address length
- length: Any-byte
- One segment, topology semantic

For multi-segment address
- length: accord with each segment
- Multiple segments, topology semantic

For non-topology semantic address

CH: (1) hierarchical (2) self-explanatory

<table>
<thead>
<tr>
<th>Index</th>
<th>Type</th>
<th>Structure (default by topology semantic and 1 segment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x01</td>
<td>Restrained Space</td>
<td>topology address - address 1</td>
</tr>
<tr>
<td>0x02</td>
<td>Restrained Space</td>
<td>topology address - address 2</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>0xEF</td>
<td>Restrained Space</td>
<td>topology address - address 239</td>
</tr>
<tr>
<td>0xF0</td>
<td>Extendable Space</td>
<td>followed by address with 16-bit length</td>
</tr>
<tr>
<td>0xF1</td>
<td>Extendable Space</td>
<td>followed by address with 32-bit length</td>
</tr>
<tr>
<td>0xF2</td>
<td>Extendable Space</td>
<td>followed by address with 64-bit length</td>
</tr>
<tr>
<td>0xF3</td>
<td>Extendable Space</td>
<td>followed by address with 128-bit length</td>
</tr>
<tr>
<td>0xF4</td>
<td>Extendable Space</td>
<td>followed by address with 256-bit length</td>
</tr>
<tr>
<td>0xF5</td>
<td>Extendable Space</td>
<td>followed by address with X-bit length</td>
</tr>
<tr>
<td>0xF6</td>
<td>Hierarchical Segments</td>
<td>followed by address with 2 segments</td>
</tr>
<tr>
<td>0xF7</td>
<td>Hierarchical Segments</td>
<td>followed by address with 3 segments</td>
</tr>
<tr>
<td>0xF8</td>
<td>Hierarchical Segments</td>
<td>followed by address with Y segments</td>
</tr>
<tr>
<td>0xF9</td>
<td>Multi-Semantics</td>
<td>followed by Non-topological semantic address</td>
</tr>
<tr>
<td>0xFA - 0xFF</td>
<td>None</td>
<td>reserved</td>
</tr>
</tbody>
</table>
# FlexIP Examples and Text Representation

<table>
<thead>
<tr>
<th>Formal Representation</th>
<th>Text Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8</td>
<td>[1]C8</td>
</tr>
<tr>
<td>F1/2A00012F</td>
<td>[4]2A::12F</td>
</tr>
<tr>
<td>F9/01/F2/A32F84C981002E9B</td>
<td>[8]&lt;GEO&gt;A32F84C981002E9B</td>
</tr>
</tbody>
</table>

Table 2: Examples of Flexible IP Address Text Representation

"/" is for readability only and must be omitted in practical use.

- **First Segment, Segment length: 1-byte, Segment: C8**
- **Second Segment, Segment length: 8-byte, Segment: 2001::12F**
  - 4 Segments, 2-byte length for each Segment length
- **[8]<GEO>A32F84C981002E9B**
  - 1 Segments, Segment length: 8-byte, Segment semantic: Geolocation

Used by Computer program

Used by human being
Interoperability

• **A translator** is deployed at the **boundary** of the FlexIP limited domain.

• The translator is mainly constructed by a **address mapper**.

• For packet transiting address mapper, the address will be **transformed** between **IPv6** and **FlexIP**.

• Till now, only **address structure** is discussed.

• **Header structure** is leave to future consideration.

• Example:
  

  FlexIP: [8]A2F7::12F
Recap. FlexIP

- **Gap analysis:**
  - Increasingly network scenarios long for **TCP/IP for global reachability.**
  - New network scenarios → **advance network features** <GAP> IPv6 capability

- **Target scenario location**
  - **Limited domain** (edge network)

- **Logic Position**
  - a **supplementary** of the IPv6 address, not replacement

- **Draft includes:**
  - FlexIP **address structure**: hierarchical, self-explanatory
  - FlexIP-IPv6 **Interoperability**: an address mapper

- **Draft excludes:** (not yet)
  - FlexIP **packet header**: to be designed and discussed in the future
THANKS!

Questions / Comments?

Yihao Jia
jiayihao@huawei.com

IETF 109 – INTAREA WG
https://datatracker.ietf.org/doc/draft-jia-flex-ip-address-structure/