Stateless Automatic IPv4 over IPv6 Encapsulation / Decapsulation
Technology: Global SA46T Address Format
draft-matsuhira-sa46t-gaddr-11

Abstract

This document proposes Stateless Automatic IPv4 over IPv6
Encapsulation / Decapsulation Technology (SA46T) Global Address
Format.

SA46T can apply to organization’s network individually, but if
coordination between the organizations made, the total number of
times of encapsulations and decapussions can be reduced. That
coordination is achieved by using same SA46T address format, that is
Global address. This document proposes SA46T Global address format.

SA46T is a gateway technology, not protocol. But SA46T Global
Address needs IANA assignment, so this document should be categorized
standard track or experimental.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in RFC 2119 [RFC2119].

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1. Introduction

This document proposes Stateless Automatic IPv4 over IPv6 Encapsulation / Decapsulation Technology (SA46T) Global Address Format.

SA46T [I-D. draft-matsuhira-sa46t-spec] can apply to organization’s network individually. Figure 1 shows such example. Organization A applies SA46T and makes backbone network to IPv6 only, and this operation has no effect to Organization B and others.

Figure 1

If organization B applies SA46T, network is just like Figure 2. In this network configuration, communication between IPv4 host in organization A and IPv4 host in organization B, IPv4 packet is encapsulated to IPv6 Packet, and decapsulated to IPv4, and
encapsulated to IPv6, and decapsulated to IPv4. There are two times
encapsulations, and two times decapsulations. If number of
organization which applies SA46T increase, number of encapsulations
and decapsulation will increase.

\[
\begin{array}{c}
\langle------ Organization A -------> : \langle------ Organization B -------> \\
\end{array}
\]

\[
\begin{array}{c}
| \text{Router} +-----:----+\text{Router} \\
\langle\langle\langle (Dual) | : | (Dual) \rangle\rangle \rangle \\
\end{array}
\]

\[
\begin{array}{c}
\langle\langle\langle SA46T | : | SA46T \rangle\rangle \rangle \\
\end{array}
\]

\[
\begin{array}{c}
\langle\langle\langle \text{Backbone Network} \rangle\rangle \rangle \\
\langle\langle\langle (IPv6 \ only) \rangle\rangle \rangle \\
\end{array}
\]

\[
\begin{array}{c}
\langle\langle\langle \text{Stub Network} \rangle\rangle \rangle \\
\langle\langle\langle (IPv4 \ only) \rangle\rangle \rangle \\
\end{array}
\]

\[
\begin{array}{c}
\langle\langle\langle \text{Stub Network} \rangle\rangle \rangle \\
\langle\langle\langle (Dual \ Stack) \rangle\rangle \rangle \\
\end{array}
\]

Figure 2

But if coordination between the organizations are made, the total
number of times of encapsulations and decapsulations can be reduced.
Figure 3 shows such example. That coordination is achieved by using
same SA46T address format. This is the reason for the proposal of
SA46T Global address. When most of IPv4 node moves to IPv6 and few
IPv6 node exists, such coordination in the Internet scale is useful
and efficient to co-existing IPv6 and IPv4.
2. SA46T Global Address

Figure 4 shows SA46T address architecture[I-D.draft-matsuhira-sa46t-spec].

<table>
<thead>
<tr>
<th>96 - m bits</th>
<th>m bits</th>
<th>32 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA46T address prefix</td>
<td>IPv4 network plane ID</td>
<td>IPv4 address</td>
</tr>
</tbody>
</table>

2.1. Option 1: Allocate new SA46T address prefix

This option requests special IPv6 address prefix for SA46T. Figure 5 shows SA46T Global Address Format.
Table 1 shows SA46T IPv4 network plane ID length (m) and SA46T prefix length and number of plane.

<table>
<thead>
<tr>
<th>m</th>
<th>prefix length</th>
<th>number of plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>80</td>
<td>65536</td>
</tr>
<tr>
<td>32</td>
<td>64</td>
<td>4294967296</td>
</tr>
</tbody>
</table>

Table 1

Table 2 is an example of SA46T IPv4 network plane ID management table. Value 0 should be assigned to IPv4 Global Internet, and the other are reserved for IPv4 private networks.

<table>
<thead>
<tr>
<th>plane ID value</th>
<th>assign to</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Global IPv4 Internet (IPv4 Global address)</td>
</tr>
<tr>
<td>1</td>
<td>Reserved</td>
</tr>
<tr>
<td>2</td>
<td>Reserved</td>
</tr>
<tr>
<td>....</td>
<td>....</td>
</tr>
</tbody>
</table>

Table 2

These value except zero are reserved for stacking IPv4 private network over IPv6 Internet with SA46T. In future, if there are much demand for stacking IPv4 private network, These usage of reserved ID value may be defined. At that time, central coordination or assignment should be discussed too.

2.2. Option 2: Adjustment with IPv6 address with Embedded IPv4 addresses

RFC4291 define IPv6 addresses with Embedded IPv4 addresses. SA46T address is such addresses. Therefore merging SA46T global address into IPv6 addresses with Embedded IPv4 addresses may be possible.
Figure 6 shows IPv4 Compatible IPv6 address, and Figure 7 shows IPv4-Mapped IPv6 address.

|                80 bits               | 16 |      32 bits        |
|+--------------------------------------+--------------------------+
|0000..............................0000|0000|    IPv4 address     |
|+--------------------------------------+----+---------------------+

Figure 6

|                80 bits               | 16 |      32 bits        |
|+--------------------------------------+--------------------------+
|0000..............................0000|FFFF|    IPv4 address     |
|+--------------------------------------+----+---------------------+

Figure 7

It seems that 80 bits prefix (all zero) shows IPv6 addresses with Embedded IPv6 addresses, and continued 16 bits shows more detail, 0x0000 means IPv4-Compatible addresses and 0xFFFF means IPv4-Mapped addresses.

Adjustment with such format, IPv6 addresses with Embedded IPv4 addresses may redefine such format. Figure 8 shows such format.

|                80 bits               | 16 |      32 bits        |
|+--------------------------------------+--------------------------+
|0000..............................0000| EID|    IPv4 address     |
|+--------------------------------------+----+---------------------+

Figure 8

Where

IPv4 Embedded address prefix

IPv4 Embedded prefix. 80 bits long, value is zero.

EID

Embedded ID. Indicates Type of IPv6 addresses with Embedded IPv4 address. This value MUST be globally unique. See below for more detail.
IPv4 address
IPv4 address

Table 3 shows EID value of proposed IPv6 addresses with Embedded IPv4 addresses and the detail usage. EID = 0x0000 shows this IPv6 addresses with Embedded IPv4 address is the IPv4-Compatible IPv6 address, and EID=0xFFFF shows this IPv6 addresses with Embedded IPv4 address is the IPv4-Mapped address.

In this proposal, EID value except 0x0000 and 0xFFFF is for SA46T usage, and EID=0x0001 shows this IPv6 addresses is used for SA46T for IPv4 Internet, that mean, IPv4 address is limited for global and inhibit for private address.

In this proposal, EID value except 0x0000, 0x0001 and 0xFFFF are reserved for SA46T. These value are reserved for stacking IPv4 private network over IPv6 Internet with SA46T. In future, if there is much demand for stacking IPv4 private network, these usage of reserved EID value may be defined. At that time, central coordination or assignment should be discussed too.

<table>
<thead>
<tr>
<th>EID</th>
<th>detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0000</td>
<td>IPv4 Compatible IPv6 address</td>
</tr>
<tr>
<td>0x0001</td>
<td>SA46T address for IPv4 Internet (IPv4 Global Addresses)</td>
</tr>
<tr>
<td>0x0002</td>
<td>Reserved for SA46T</td>
</tr>
<tr>
<td>....</td>
<td>....</td>
</tr>
<tr>
<td>0xFFFF</td>
<td>Reserved for SA46T</td>
</tr>
<tr>
<td>0xFFFF</td>
<td>IPv4-Mapped IPv6 address</td>
</tr>
</tbody>
</table>

Table 3

3. IANA Considerations

This document may requests IANA to assign IPv6 prefix for SA46T Global address.

This document proposes two option. One is New IPv6 address prefix for SA46T. Another is adjustment with IPv6 address with Embedded IPv4 addresses.

The Well-known prefix 0000::/8 is reserved by IETF [RFC4291]. If new IPv6 address prefix for SA46T is allocated from 0000::/8 space by IETF, this document request no actions for IANA. And also, if
adjustment with IPv6 address with Embedded IPv4 addresses is approved by IETF, this document request no actions for IANA.

Note to RFC Editor: this section may be removed on publication as an RFC.

4. Security Considerations

SA46T uses automatic Encapsulation / Decapsulation technologies. Security consideration related tunneling technologies are discussed in RFC2893 [RFC2893], RFC2267 [RFC2267], etc.

5. Acknowledgements

This document is based on Naoki Matsuhira’s original ideas and an individual effort of the author.

Review and encouragement have been provided by many others. Particularly Akira Kato at WIDE Project / Keio University and Masanobu Katoh at Fujitsu.

Originally, SA46T is an abbreviation for "Stateless Automatic IPv4 over IPv6 Tunneling". Now, SA46T is an abbreviation for "Stateless Automatic IPv4 over IPv6 Encapsulation / Decapsulation Technology". This change was made in response to the indication from the softwire WG chair at 4th softwire interim meeting in September 2011.

6. References

6.1. Normative References

[I-D.draft-matsuhira-sa46t-spec]


6.2. Informative References


Author's Address

Naoki Matsuhira
Fujitsu Limited
1-1, Kamikodanaka 4-chome, Nakahara-ku
Kawasaki, 211-8588
Japan

Phone: +81-44-754-3466
Email: matsuhira@jp.fujitsu.com