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Agenda Item xx: Xxx

Draft ICAO IPv6 Addressing Plan

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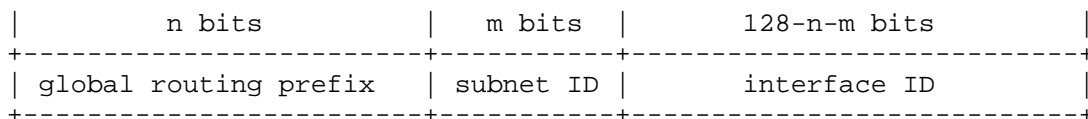| SUMMARY |
| --- |
| This paper proposes a draft IPv6 Addressing Plan for the ATN IPS. Two different options to define the ATN IPv6 address format are discussed. |
| **ACTION** |
| To review the material in this paper and develop further guidance and action, as required. |

1.   **INTRODUCTION**

IPv6 addresses are 128-bit identifiers for interfaces and sets of interfaces. There are three types of addresses: unicast, anycast, and multicast. This document presents two options for the definition of the IPv6 unicast address format in the ATN IPS.

IPv6 unicast addresses are designed assuming that the Internet routing system makes forwarding decisions based on a "longest prefix match" algorithm on arbitrary bit boundaries and does not have any knowledge of the internal structure of IPv6 addresses. The structure in IPv6 addresses is for assignment and allocation.

1.1   IPv6 Global Unicast Address Format

The general format for IPv6 global unicast addresses as defined in "IP Version 6 Addressing Architecture" [1] is as follows:

```
|           n bits         | m bits   |      128-n-m bits          |
+--------------------------+----------+----------------------------+
| global routing prefix    | subnet ID|        interface ID        |
+--------------------------+----------+----------------------------+
```

where the global routing prefix is a (typically hierarchically-structured) value assigned to a site (a cluster of subnets/links), the subnet ID is an identifier of a subnet within the site, and the interface ID is as defined in section 2.5.1 of [1].
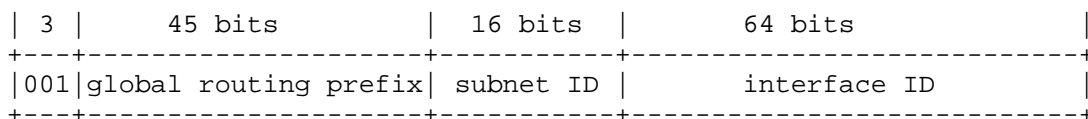
The global routing prefix is designed to be structured hierarchically by the RIRs and ISPs. The subnet field is designed to be structured hierarchically by site administrators.

[1] also requires that all unicast addresses, except those that start with binary value 000, have Interface IDs that are 64 bits long and to be constructed in Modified EUI-64 format. The format of global unicast address in this case is:

```
|           n bits         | 64-n bits|      64 bits               |
+--------------------------+----------+----------------------------+
| global routing prefix    | subnet ID|        interface ID        |
+--------------------------+----------+----------------------------+
```
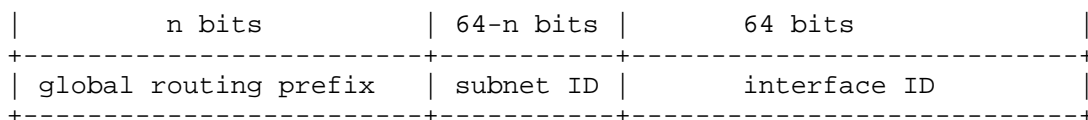
where the routing prefix is a value assigned to identify a site (a cluster of subnets/links), the subnet ID is an identifier of a subnet within the site, and the interface ID is a modified EUI-64 format as defined in [1].
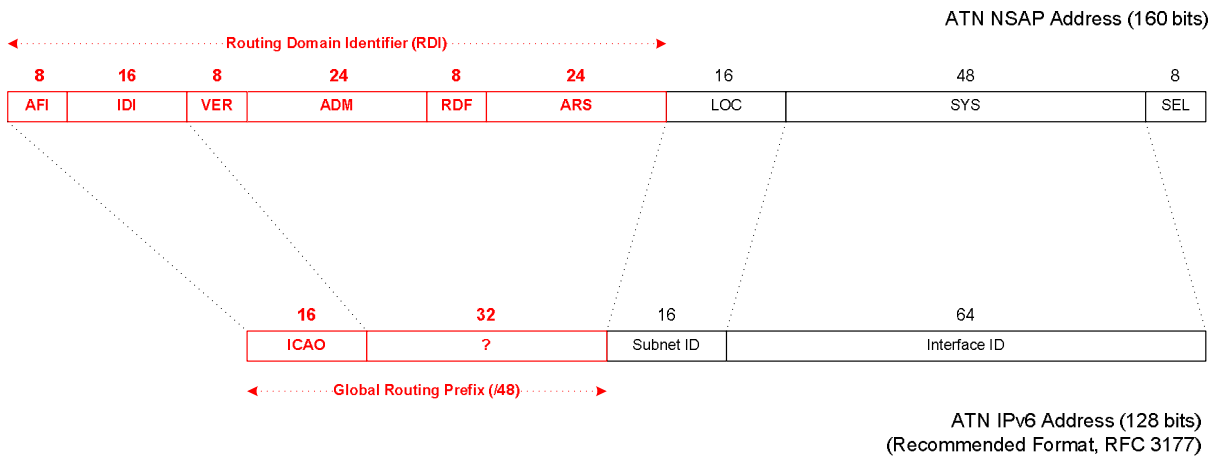
An example of the resulting format of global unicast address under the 2000::/3 prefix that is currently being delegated by the IANA and consistent with the recommendations in RFC 3177 [3] is:

```
| 3 |     45 bits          | 16 bits  |      64 bits               |
+---+----------------------+----------+----------------------------+
|001|global routing prefix | subnet ID|        interface ID        |
+---+----------------------+----------+----------------------------+
```

1.2   Comparison of IPv6 address and ATN NSAP address

ICAO is the ultimate administrative authority of the ATN internetwork addressing plan and administers this plan through Sub-volume V of the Manual of Technical Provisions for the ATN (Doc 9705 -AN/956) [2]. That document defines and administers the ATN NSAP address syntax (i.e. field boundaries, field sizes and field formats), the ATN NSAP address semantics (i.e. the field content and interpretation), and the ATN NSAP address encoding procedures (i.e. the representation of the abstract field syntax and semantics).

Figure 1 shows the formats of the ATN NSAP address and the IPv6 unicast address, as recommended by RFC 3177.

ATN NSAP Address (160 bits)

Routing Domain Identifier (RDI)

8	16	8	24	8	24	16	48	8
AFI	IDI	VER	ADM	RDF	ARS	LOC	SYS	SEL

16	32	16	64
ICAO	?	Subnet ID	Interface ID

Global Routing Prefix (/48)

ATN IPv6 Address (128 bits)
(Recommended Format, RFC 3177)

Figure 1 Comparison of IPv6 and NSAP address formats

Apart from the obvious reduction in size (from 20 bytes to 16 bytes), the following points are worth noting:

a. The SEL field in the NSAP address, used to identify either a network layer entity (such as the IDRP protocol machine) or a network service user within the context of a given ATN system, is not required in the IPv6 address. This functionality is realized in the ATN IPS via the TCP and UDP ports.

b. The LOC and SYS fields have similar counterparts in the IPv6 address: the Subnet ID and the Interface ID, respectively. The size of the Interface ID is increased from 6 bytes in the NSAP address to 8 bytes in the IPv6 address.

c. The ICAO IPv6 global prefix for aviation, obtained from IANA, is similar to the AFI and IDI fields in the NSAP address. At the time of this writing, the size of this prefix has not been determined yet, although the expectation is that it will be in the range of a /16.

d. Given the smaller size of the IPv6 address and the larger Interface ID field, the functionality of the VER, ADM and ARS fields must fit into a considerably smaller block (4 bytes, instead of 8 bytes).
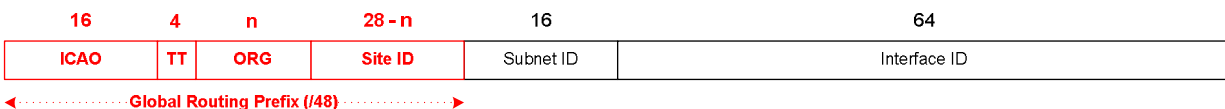
2. PROPOSED ATN IPv6 ADDRESS FORMAT

This paper presents two options for the definition of the IPv6 unicast address format in the ATN IPS.

2.1 Option 1

The first option is shown in Figure 2. The VER field in the NSAP address is replaced by the Traffic Type (TT) field in the IPv6 address, which is used to indicate whether this address corresponds to an airborne or ground system, and what type of service this system is used for (e.g. ATS, AOC, AAC, APC, etc.). The 4-bit TT field effectively partitions the ICAO IPv6 address space into 16 logically separate equally sized subspaces.

Airborne or Ground IPv6 Site (/48)

16	4	n	28 - n	16	64
ICAO	TT	ORG	Site ID	Subnet ID	Interface ID

◄········· Global Routing Prefix (/48) ·················►

Figure 2 Proposed ATN IPv6 Address Format (Option 1)

The TT field could be encoded, for example, as shown in Table 1.

TT value	*Meaning*
0000	Airborne ATS Systems
0001	Ground ATS Systems
0010	Airborne AOC Systems
0011	Ground AOC Systems
0100	Airborne AAC Systems
0101	Ground AAC Systems
0110	Airborne APC Systems
0111	Ground APC Systems
1xxx	Reserved

Table 1 TT field encoding

The least significant bit in the TT field indicates whether the address corresponds to an airborne or ground system. The rationale for having separate address spaces for airborne and fixed systems is as follows. Without this separation, an organization (airline or state) advertising itself would cause all traffic from the ATN directed to its aircraft (CA or GA) to be routed to its routing domain, instead of being routed directly to the current point of attachment of the aircraft. Even with Mobile IPv6, this is undesirable, since it forces the airline or state to deploy a Home Agent in its routing domain, which could otherwise be deployed by a contracted organization, such as a service provider. For example, Lufthansa could contract Deutsche Telekom to connect their ground infrastructure to the ATN, and a different service provider (e.g. SITA) to act as Home (Mobility Service Provider) for all Lufthansa aircraft (as opposed to having to deploy the Home Agent themselves).

Note.- By reserving the bit combinations 1xxx, ICAO reserves 50% of its available /16 address space for future use.

The ORG field is a variable length field indicating the organization to which the system belongs (e.g. airline, state, service provider, etc.). This makes it possible for large organizations (e.g. FAA) to have a shorter ORG field and therefore a larger number of sites, whereas small organizations (e.g. CAAs of very small countries), which are likely to have a very small number of sites, are assigned a longer ORG field. This approach is similar to that used by the ICAO 24-bit aircraft address structure.
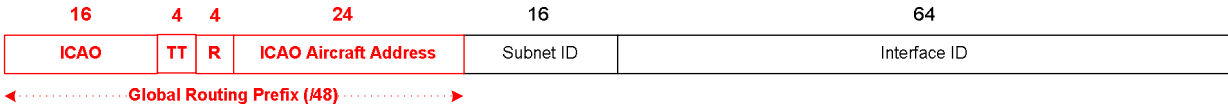
Note.- Note that this precludes the use of the ICAO 24-bit aircraft address in airborne IPv6 addresses, since the Site ID field may be shorter than 24 bits, e.g. for small countries.
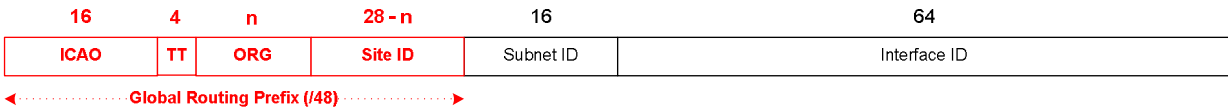
2.2   Option 2

The second option, shown in Figure 3, proposes a different format for airborne and ground sites. The

ground site format is the same as in Option 1, but airborne sites are identified by the 24-bit ICAO aircraft address. A 4-bit R field is reserved for future use and set to 0000. This field could be used in the future to indicate the aircraft type, e.g. commercial, general aviation, military, UAV, experimental, etc.

Airborne IPv6 Site (/48)

16	4	4	24	16	64
ICAO	TT	R	ICAO Aircraft Address	Subnet ID	Interface ID

◄············ Global Routing Prefix (/48) ············►

Ground IPv6 Site (/48)

16	4	n	28 - n	16	64
ICAO	TT	ORG	Site ID	Subnet ID	Interface ID

◄············ Global Routing Prefix (/48) ············►

Figure 3 Proposed ATN IPv6 Address Format (Option 2)

The problem with this approach is that it prevents aggregation based on the ORG field for airborne sites. Some amount of aggregation is possible given the state-based hierarchical structure of the ICAO 24-bit aircraft address. However, for commercial aircraft, it is desirable to include the organization (airline) in the airborne site prefix, in order to be able to advertise airline-based aggregates. For example, all Lufthansa airborne sites could be advertised from SITA as a single aggregate prefix, if SITA acts as Lufthansa's Mobility Service Provider.

3.   **CONCLUSION**

The WGI is invited to consider the options described above for the ATN IPv6 address format definition.

This paper recommends Option 1.

This paper raises three main points for discussion:

1. Should the ICAO 24-bit aircraft address be used in the airborne site prefix?

    We recommend that the ICAO 24-bit aircraft address not be used in the airborne site prefix.

2. Should all Organizations (states, airlines, service providers) be allocated the same prefix length (e.g. /32), regardless of their size, or shall we use variable length fields and entropy encoding?

    We recommend using variable length fields.

3. Should airborne addresses contain the ORG field (same as ADM in NSAP address) if the ICAO aircraft address is included?

We recommend that the ICAO address not be used, and therefore always include the ORG field.

4. REFERENCES

[1] RFC 4291 "IP Version 6 Addressing Architecture", February 2006.

[2] Manual of Technical Provisions for the ATN (Doc 9705 -AN/956), Sub-volume V.

[3] RFC 3177 "IAB/IESG Recommendations on IPv6 Address Allocations to Sites", September 2001.

[4] RFC 2374 "An IPv6 Aggregatable Global Unicast Address Format", July 1998.

[5] RFC 3587 "IPv6 Global Unicast Address Format", August 2003.

[6] RIPE NCC, "IPv6 Address Allocation and Assignment Policy", ripe-421, November 2007, http://www.ripe.net/ripe/docs/ipv6policy.html

[7] NEWSKY – *Networking the Sky for Aeronautical Communications*, http://www.newsky-fp6.eu