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Handling New Subnetwork Types in the ATN

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SUMMARY

In order to meet AOC requirements, the ATN SARPs allow for the expression of subnetwork routing preferences for air/ground communications. On a per transport connection basis, a user can the air/ground data link that should be used for data sent over the connection, or identify multiple subnetwork types in order of preference. The AOC community has now identified new subnetwork types that need to be included in this functionality, and hence a need to update the ATN SARPs. This paper proposes a mechanism for extending the ATN SARPs to handle new subnetwork types that will be able to support further additions without necessitating more SARPs changes.

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1. Introduction

1.1 Background

In order to meet AOC requirements, the ATN SARPs allow for the expression of subnetwork routing preferences for air/ground communications. On a per transport connection basis, a user can the air/ground data link that should be used for data sent over the connection, or identify multiple subnetwork types in order of preference.

When the specification was developed, only those air/ground subnetworks that were defined by ICAO at that time were recognised by the specification. However, new subnetworks have now been developed for air/ground communications including more VDL modes and commercial services such as Iridium. Airlines have also indicated that they may wish to distinguish between (e.g.) VDL networks operated by different Service Providers.

There is thus a need to extend the specification to permit the inclusion of these new subnetwork types.

1.2 Scope

This paper reviews the requirements for extending the current set of subnetwork types and proposes the scope of SARPs changes required and the deployment strategy for the change.

2. Change Requirements

Currently the ATN SARPs recognise the following subnetwork types for use with air/ground preference selection:

- Gatelink
- VHF Digital Link
- AMSS
- HF Data Link
- Mode S

The following new subnetworks may also be used for air/ground communications:

- VDL Modes 3 and 4 (assuming that the VHF Digital Link referred to in the current SARPs is VDL Mode 2)

- Iridium (satellite communications network)

These changes could be achieved by extending the current specification to recognise these new subnetwork types i.e. by defining new values for the CLNP and IDRP security tag parameters. However, the impact of such a change is global. All ATN Routers will need to be able to recognise the extended parameters and route appropriately, as well as the End Systems that need to make these source routing requests.

This is highly undesirable as it makes for a carefully controlled and co-ordinated deployment and with no guarantee that the same exercise may not have to be repeated should more air/ground subnetworks be identified. The ATN was intended to be readily extensible. However, this is an example of poor extensibility and, it could even be argued, a defect.

It is therefore desirable that any change to support new air/ground subnetworks also removes this global dependency on new subnetwork types. Then the deployment of the change need only to be performed once and when the ATN is still relatively small.

3. Current Procedure for Handling Subnetwork Preferences

This section reviews the current SARPs specification for handling subnetwork connection preferences.

There are three parts to the implementation of subnetwork connection preferences:

1. Each route that passes over an air/ground data link contains information about the type of air/ground data link and any traffic type restrictions that apply to the data link.

2. User/application subnetwork preferences are included in the CLNP Header security parameter of every CLNP PDU. The subnetwork preferences given are those specified for the transport connection corresponding to the data conveyed by the CLNP PDU.

3. When a CLNP PDU is forwarded, the Router takes into account the user's subnetwork preferences recorded in the CLNP Header when choosing between alternative routes to the same destination i.e. choosing the one that is via the most preferred subnetwork.

3.1 Maintaining Routing Information

When an IDRP route is received from or advertised to an aircraft, it is the Air/Ground Router's responsibility to include, in the route's security path parameter, a record of the air/ground data link(s) supporting the adjacency. It may also include a list of traffic types (e.g. AOC) that are excluded from use of that data link.

This information then remains with the route as it is advertised through the ATN. Even if two routes to the same aircraft (via different Air/Ground Routers) are later merged, the merged route still contains this information.

3.2 Stating User Preferences

User/application requirements for air/ground subnetwork preferences are recording in a CLNP PDU's security parameter in addition to the traffic type. They are encoded as a single octet field as given in Table 3-1 (reproduced from the ATN SARPs). Note that this table also includes ATSC routing requirements which are separate from the AOC Routing Requirements.

It should be noted that there are a strictly limited number of ways in which air/ground subnetwork preferences can be expressed and these correspond to those originally requested by IATA representatives.

3.3 Packet Forwarding

The ATN SARPs require that Routers respect AOC routing requirements and to only route a CLNP PDU when those requirements can be met. For example, if a CLNP PDU has a security parameter that specifies routing via VDL only, that packet can only be forwarded on a route which was advertised with a security path parameter that indicates that the route passes over a VDL air/ground subnetwork. If no such route can be found then the packet is discarded. The forwarding procedure is largely the same when an ordered preference is specified, except that the router will first look for a route that passes over the most preferred air/ground subnetwork, then the second and so on until all possibilities are exhausted and the packet is discarded.

	Category	Security Tag Value	Semantics
ATN Operational Communications	Air Traffic Service Communications (ATSC)	000 00001	No Traffic Type Policy Preference.
		000 10000	Traffic preference for Class A ATSC route(s).
		000 10001	Traffic preference for Class B ATSC route(s).
		000 10010	Traffic preference for Class C ATSC route(s).
		000 10011	Traffic preference for Class D ATSC route(s).
		000 10100	Traffic preference for Class E ATSC route(s).
		000 10101	Traffic preference for Class F ATSC route(s).
		000 10110	Traffic preference for Class G ATSC route(s).
		000 10111	Traffic preference for Class H ATSC route(s).
	Aeronautical Operational Control (AOC)	001 00001	No Traffic Type Policy Preference.
		001 00010	Route Traffic only via Gatelink.
		001 00011	Route Traffic only via VHF Data Link.
		001 00100	Route Traffic only via Satellite Data Link.
		001 00101	Route Traffic only via HF Data Link.
		001 00110	Route Traffic only via Mode S Data Link.
		001 00111	Route Traffic using an ordered preference of Gatelink first, then VHF Data Link.
		001 01000	Route Traffic using an ordered preference of Gatelink first, then VHF Data Link, then Satellite.
		001 01001	Route Traffic using an ordered preference of Gatelink first, then VHF Data Link, then HF Data Link, then Satellite Data Link.
ATN Administrative Communications	No category defined	001 10000	No Traffic Type Policy preference.
General Communications	No category defined	N/A	*Note. — General Communications traffic does not require encoding of security parameters within created NPDUs. Specification of a Security Tag Value for such General communications is therefore not applicable.*
ATN Systems Management Communications	No category defined	011 00000	No Traffic Type Policy preference.

Table 3-1 Encoding of User Routing Requirements

3.4 Global Significance of Subnetwork Information

The encoded values in both the CLNP security parameter and the IDRP security path parameters are defined in SARPs and are thus globally known. If new values are defined then these have to be globally implemented. Although ATNP/WG2 has been considering mechanisms that allow the interoperability of ATN systems compliant with different SARPs

versions, for a new subnetwork type to added to the above mechanism, it will be necessary for:

1. The Air/Ground Routers supporting such subnetworks to be able to encode information about that subnetwork in the IDRP Security Parameter.

2. The airline End Systems in both aircraft and on the ground that need to encode new preference values in the CLNP security parameter to be upgraded to do so.

3. All ATN Routers in the path between aircraft and airline host be upgraded to forward CLNP PDUs that include subnetwork routing preferences that refer to new subnetwork types.

The support in Air/Ground Routers is not necessarily a major issue as these will be deployed to support the new subnetwork types. The upgrade of the End Systems is discretionary and dependent on the need to use the new subnetwork type. However, the dependency on intermediate ATN Routers is a major issue as any such routers that do not recognise new subnetwork types may reject or mis-route CLNP PDUs that refer to them. IDRP routing information that refers to new subnetwork types is also likely to be lost when advertised to such routers.

It is also an issue as to why this is so. Clearly, Air/Ground Routers need to know the subnetworks they are attached to and how to record the fact that a route passes over such a subnetwork. Similarly, End Systems clearly need to know how to encode their routing requirements. However, intermediate Air/Ground Routers are only using this information in the IDRP path and the CLNP header to discriminate between routes to the *same* aircraft and not between routes to different aircraft. The subnetwork identifiers used in both IDRP and CLNP could identify different air/ground subnetworks in the context of different aircraft without making any difference to the routing decisions made by intermediate ATN Routers.

Hence, it is possible for new subnetwork types to be defined that are locally significant (i.e. defined in the context of an aircraft) rather than defined globally in SARPs. This is much more desirable as new subnetwork types could then be deployed without necessarily requiring ATN SARPs changes or upgrades of all ATN Routers.

4. Proposed Handling of New Subnetwork Types

It is proposed that the specifications of the IDRP Security Path Information and the CLNP security parameter are extended to include a number of additional subnetwork types (e.g. eight) that are defined in the context of the route's destination (IDRP) and PDU destination (CLNP). These may be referred to as User Subnetwork #1 through #8. In addition:

- The CLNP security parameter specification must also allow for the expression of preference orders that include such destination defined subnetwork types mixed with the existing globally defined subnetwork types. A limited length list of subnetwork types identifiers may be necessary to achieve this.

- Aircraft must know *a priori* the new subnetwork types defined in their local context and which user subnetwork numbers are assigned to them.

- The user subnetwork number assigned to each such subnetwork by a given aircraft has to be communicated to an Air/ground Router so that it may correctly generate the security path information. It has already been proposed in WG2 that the ISH PDU exchange that takes place during Route Initiation is used to declare router capabilities and information about the subnetwork. It is therefore proposed that the aircraft informs the Air/Ground Router about the assignment of user subnetwork numbers to subnetworks by including an additional parameter in the ISH PDU it transmits over that subnetwork.

Clearly, all ATN Routers will also need to be required to recognise path information and CLNP user/application routing requirements that refer to user subnetwork numbers, but they do not need to have any knowledge of the actual subnetwork that they refer to.

End Systems on both aircraft and the ground will need to know the meaning of a user subnetwork number in the context of each aircraft. However, as this mechanism is intended for airline use and between an airline and its own aircraft, the same administrator can therefore be assumed to be in charge of both ends of the connection and hence *a priori* knowledge of this relationship is reasonable to assume. Airlines would, of course, be well advised to be internally consistent in their assignment of user subnetwork numbers by their aircraft.

The SARPs changes implied by this proposal appear to be well contained and straightforward:

1. In SV5 Chapter 8, the definition of the IDRP “Air/Ground Subnetwork Type” security tag will need to be extended to include user subnetworks #1 through to #8 in addition to the current list of air/ground subnetworks.

2. In SV5 chapter 6, the security tag set for “Traffic type and associated routing policies” will need to be extended to include user subnetworks #1 through to #8 in addition to the current list of air/ground subnetworks.

3. In SV5 chapter 2, the CLNP forwarding procedures for AOC Traffic will need to be extended to include reference to user subnetworks #1 through to #8.

4. The use and definition of a new ISH PDU parameter to communicate the assignment of a user subnetwork number to an air/ground subnetwork will need to be specified.

5. Deployment

The claimed advantage of this proposal is that it will permit new air/ground subnetwork types to be introduced without always requiring an ATN SARPs change or global change to ATN Routers. However, global deployment of this change will be required before it can become effective.

ATNP/WG2 has been discussing mechanisms to support the adoption of new features without causing interoperability problems. Such mechanisms will be necessary to support the deployment of this proposal and to permit interoperability between older systems that do not recognise user subnetwork numbers, and those that do.

However, end-to-end interoperability will require the adoption of this proposal by all intermediate ATN Routers.

This can be regarded as a commercial matter between an airline and its Service Providers for intermediate ATN Routers. Although, support should be mandatory for aircraft and Air/Ground Routers that also support new subnetwork types.

6. Recommendations

It is recommended that:

1. WG2 recognises the need to handle new subnetwork types and that a procedure should be adopted that does not require ATN SARPs changes every time a requirement is raised for referencing new Air/Ground subnetwork types in AOC routing preferences.

2. WG2 adopts the proposal in this paper to adopt a procedure whereby new subnetwork types are defined in the context of each aircraft thus permitting future new subnetwork types to be introduced without necessitating SARPs changes.