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The Use of ATSC Traffic Types for CNS/ATM-1 Package

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The ATNP WG1 work program includes the definition of the end-to-end performance requirements for ATN services. These requirements are to be reflected in Part 1 of the CNS/ATM-1 Package SARPs. WG3 is developing the ATS air-ground application SARPs and will need to relate the performance requirements for each application with the requirements of Part 1 of the SARPs. WG2 will need to insure the ATN internetwork services (i.e., internetwork routing and transport) are consistent with the CNS/ATM-1 Package end-to-end operational requirements. The ADSP has produced draft Guidance Material that includes generic end-to-end performance values for an postulated end-state environment. This material does not address the specific performance requirements for CNS/ATM-1 Package and does not differentiate for the various ATC operational domains. One State has submitted to ATNP their operational requirements for end-to-end ATN services in the context of various operational domains. In reviewing this material, including the factors that influence the operational requirements for end-to-end service, it appears that for the ATS applications it may not be appropriate for ICAO to define global standards for the end-to-end performance on an application-by-application basis. At the third meeting of WG1 it was concluded that ATNP define ATSC "Traffic Types" to reflect the range of end-to-end performance desired. This will then permit each ATC authority (State or regional planning group) to define which Traffic Type is to be applied for each application when used within their airspace.

References: 1) Report of ATNP WG1 Third Meeting, October 1995

2) Aeronautical Data Link System Operational Requirements, U.S. information paper presented at Toulouse WG1 and WG3 meetings

3) Draft ATN Internetwork SARPs, version 3

1.0 Background

The ATNP WG1 work program includes the definition of the end-to-end performance requirements for ATN services. These requirements are to be reflected in Sub-Volume 1 of the CNS/ATM-1 Package SARPs. WG3 is developing the ATS air-ground application SARPs and will need to relate the performance requirements for each application with the system-level requirements of Sub-Volume 1 of the SARPs. The WG2 work program includes the definition of ATN-specific features allowing for the incorporation of differing air-to-ground and ground-to-ground subnetworks servicing differing user groups. To this end, the ISO/IEC 8473 CLNP interworking protocol has been augmented with ATN specific additions (extensions) to reflect the unique communications environments of the ATN. At the system level these requirements are to be reflected in Sub-Volume 1 of the CNS/ATM-1 Package SARPs, being prepared by WG1, while at the detailed level these ATN specific additional to CLNP have been defined by WG2.

WG1 at its third meeting in October 1995 accepted that use of ‘Traffic Types’ as the means for a user (e.g., application) to express the desired maximum end-to-end delay for ATSC. The application, upper layer and internetwork SARPs will need to support the use of such ATSC Traffic Types.

There are number of operational and economic constraints associated with the use of the ATN to support CNS/ATM-1 Package services that must be taken into account. The use of ATSC Traffic Types by the transport and internetwork services may help facilitate accomodating non-technical constraints such as:

a) When the AMSS is being employed as the the mobile subnetwork care must be taken to ensure that COTP keep alive traffic does not become a significant, or the predominate load on the subnetwork. The reporting interval for the ADS reports for the initial oceanic operations have been extended to 15 minutes in order to minimize the communication charges associated with AMSS. COTP inactivity timer values must be long enough so that COTP does not become the cost driver for the use of AMSS as an ATN subnetwork.

b) Certain ATSC traffic in tactical ATC environments will require relatively short end-to-end message delivery times otherwise the data link services will not be operationally usable. The same Package-1 applications (e.g., CPDLC) will have varing end-to-end message delivery time requirements depending on the operational domain (see section 2, below). Routing decisions need to be based on the user needs for end-to-end performance.

c) Short COTP acknowledge timer values may have a negative influence on meeting the operational requirements for two-way ATC application message/response times. Because of a combination of limited bandwidth and asysemetric throughput characteristics associated with certain mobile subnetworks, placing a COTP ACK into the delivery queue ahead of the application response (e.g., a pilot WILCO) may increase the delivery time of the application response to the point of being operationally unusable.

2.0 Discussion

A number of factors influence the end-to-end performance requirements for ATN services when used to support ATS data link applications. The major factors are:

1. Type of Application (e.g., CPDLC, FIS, etc.)
2. Operational Domain (e.g., oceanic, terminal, tower, en route)
3. Traffic organization (e.g., oceanic track system, domestic airways, free flight, etc.)
4. Operational Procedures/Standards (e.g., separation standards, etc.)
5. Level of ground ATC automation (e.g., which subset of the CPDLC services are supported
6. Level of data link integration (e.g., workload impact on controller, ability to integrate CPLDC with controller-to-controller sector handoffs, etc.)
7. Number of aircraft an ATC controller is responsible for, including mix of data link/non-data link equipped aircraft

The characteristics associated with factors 3 through 7 may vary between ICAO regions and between ICAO States responsible for providing air traffic services. Also note that the two-way application message/response times provided may become the predominate characteristic that will determine the operational suitability of the communication service.

ATNP WG1 was task by ATNP/1 with “the definition end-to-end performance requirements” (ref. ATNP/1 report, para. 7.3.2.1 (d). This definition was intended to go into Part 1 of the CNS/ATM-1 Package SARPs, as per the structure for the SARPs previously adopted by the working groups. Given the above considerations it does not appear appropriate to define the specific end-to-end performance requirements on a global basis for each of the CNS/ATM-1 applications.

In Section 5 of the Internet SARPs, the requirements for COTP need to be modified/extended. While ground ATSC end systems may typically support only a single Traffic Type, airborne ATSC end systems will need to support varying Traffic Types, at least for certain types of applications (e.g., CPDLC). The alternative options present themselves for consideration by WG2 for inclusion in the Package-1 SARPs.

a) The first alternative would be to permit ground ATSC end systems to select COTP timer values consistent with the specific type of ATSC traffic supported by that end system. In this case a ground ATSC end system would select the single fixed set of COTP timer values consistent with its operational requirements . With this alternative airborne ATSC end systems would also select a single fixed set of COTP timer values, not necessarily the same as a given ground ATSC end system but with values that would provide operational compatibility, but perhaps not optimum performance. While simple to implement, this alternative has some operational limitations and technical risk associated with it. It must be verified operational requirements can be satisfied and compatibility can still be achieved while permitting the ground and airborne ATSC end systems to use differing COTP timer values.

b) The second alternative is to use knowledge of Traffic Type at the time of COTP connection establishment to allow the ground and airborne ATSC end systems to select the same, or compatible, COTP timer values. Since for some ATSC applications, only the ground end system will know the appropriate Traffic Type, either the COTP connect request (with an associated Traffic Type) would need to originate from the ground ATSC end system or in the case of an airborne originated COTP connect request the airborne COTP would need to select the appropriate timer values based the Traffic Type associated with the connect confirm received from the ground peer COTP. This approach while more complex to implement than the first alternative, would be more flexible and potentially of lower overall technical risk since compatible airborne and ground COTP timer values would be assured.

c) The third alternative is to use algorithms within COTP to dynamically monitor peer-to-peer performance parameters and to set the COTP timers accordingly. This approach is routinely used for COTP implementations where high speed ground networks are providing the end system-to-end system connectivity. This approach may not be appropriate to support air-ground ATSC over limited bandwidth mobile subnetworks given the asyemetric delay/throughput characteristics, the non-technical (operational/economic) constraints and the convergence time for such algorithms.

3. 0 Conclusions

WG2 has identified the assignment of Traffic Types for ATSC but has not provide any specific details in version 3 of the ATN Internetwork SARPs. WG1 at it third meeting in Oct. 1995 accepted the definition of ATSC Traffic Types on the basis of the desired maximum end-to-end transit delay (in seconds). The table below reflects the defination of Traffic Types proposed for the CNS/ATM-1 Package to support the air-ground applications:

Traffic Type	Desired Maximum End-to-End Transit Delay (Seconds)*
A	Reserved
B	13
C	18
D	74
E	95
F	Reserved
G	Reserved
H	Reserved

The major ATN-specific CLNP protocol extension in the internetworking area, that was added by WG2, is the procedure for ensuring that information is conveyed about Traffic Type and Routing Policy Requirements pertaining to user data in NPDUs. To this end, the CLNP Options Security Parameter is used in the ATN to convey information about the Traffic Type and the Routing Policy for user data, in addition to being used to convey a security classification.

For ATSC communications, the encoding of the Security Tag Set for Traffic Type and Associated Routing Policies allows for identification of ATSC routes with assigned categories of Classes A through H. It should be noted that no specific characteristics for these route categories are currently specified in version 3.0 of the SARPS. As was discussed and accepted by WG1, a general set of such ATSC traffic types could be defined to express the desired maximum end-to-end transit delay that would span the range of operational requirements for the CNS/ATM-1 Package air-ground applications across the various operational domains.

A further extension of this concept is also possible, whereby routing classes A through H would represent not just desired maximum end-to-end transit delay parameters but would also point to related tables of Transport Layer TP4 Timers. In the current version 3.0 of the SARPS no procedures have been defined to allow specification of other than one set of "global" TP4 timer values. Based upon differing applications requiring specification of differing end-to-end delay parameters, it is expected that other TP4 timer values would also need to be adjusted to maximize efficiency. These timer values, as shown in the examples in Appendix A attached, would be applicable on a per-connection basis and would be consistent with each of the specified ATSC Traffic Type delay parameters.

In order to support the proposed use of traffic type there are a number of extensions that need to be considered for the ATN protocols as they are now specified in version 3.0 of the SARPs. Figure 1 depicts a map of the general changes that need to be considered. Traffic Type needs to be added to the list of primitives to transport, class 4 (COTP) and to the list for the CLNP network service.

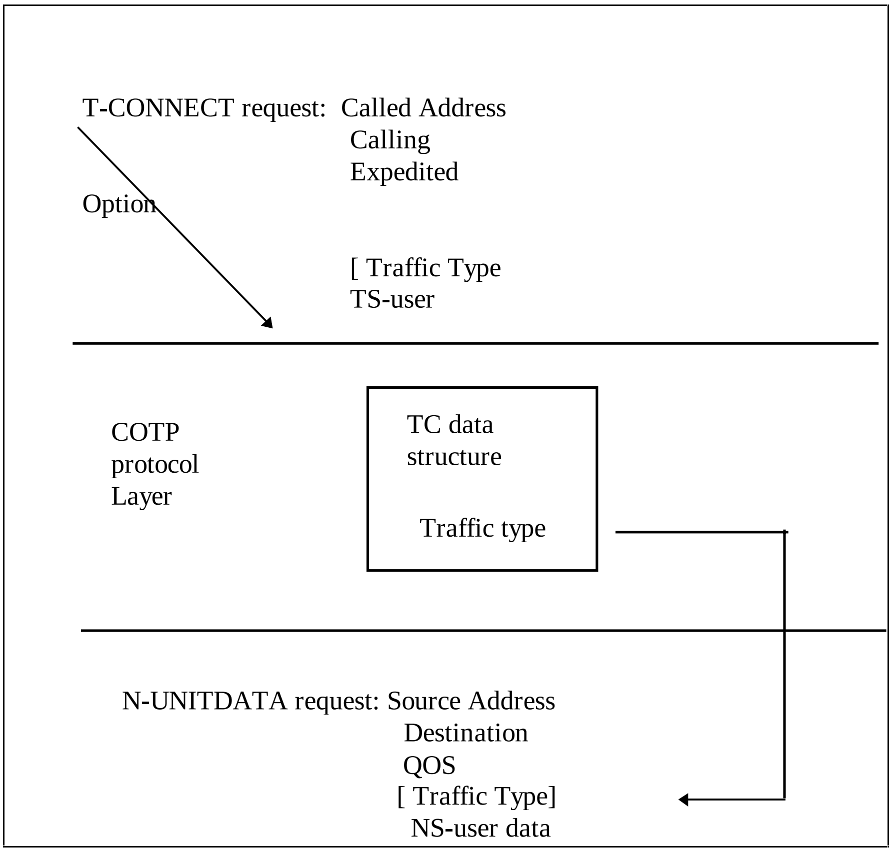

Figure 1. Protocol Extensions

To accomplish these proposed objectives of linking end-to-end transit delay and also TP4 timer values to the existing procedures for Traffic Type selection within the CLNP Security Option, it would be necessary to expand upon procedures now outlined in Section 6, Internetwork Service and Protocol Specifications of the SARPS relating to encoding of the Security Tag Set and to section 5, Transport Service and Protocol Specification of the SARPS relating to TP4 timer information now specified to be provided to the TS-PROVIDER on a per Transport connection basis.

4.0 Proposal

In Sub-Volumes 4 and 2 of the CNS/ATM-1 SARPs the required functions need to be defined to permit an application to specify a Traffic Type and for the ULA to pass the Traffic Type down to the transport service at the time a transport connection is requested.

In Section 5 of Sub-Volume 5 the CNS/ATM-1 SARPs, the requirements for COTP need to be modified in the following ways:

- An application will specify an Traffic Type which will be passed by the ULA to the COTP at the time a transport connection is requested.

- For each transport connection, the Traffic Type associated with the COTP connect request primitive needs to be stored so that it may be supplied in the primitive for each network data send request (N-UNITDATA) associated with all TPDUs using that transport connection.

- If multiple Traffic Types are supported by a given end system, then Traffic Type must be used at the connection setup phase to select (or index) the associated set of timer values to be used during the data transfer phase.

- When the ground end system initiates the COTP connect request the peer airborne end system will select the TP4 timer set defined for the Traffic Type provided in the N-UNITDATA conveying the COTP Connect Request. All subsequent TPDUs over that transport connect shall be of the same traffic type.

- When the airborne end system initiates the COTP connect request the peer ground end system is permitted to respond with the same or a different Traffic Type provided in the N-UNITDATA conveying the COTP Connect Confirm. The airborne COTP will select the TP4 timer set defined for the Traffic Type provided in the N-UNITDATA conveying the Connect Confirm. All subsequent TPDUs over that transport connect shall be of this traffic type.

Appendix A provides proposed TP4 timer setting for each of the four ATSC Traffic Types.

For BIS routers, the Internet SARPs will need to specify that routing policy invoked for a given CLNP packet shall be consistent with the specified Traffic Type. The intent of the proposal to specific ATSC Traffic Types in terms of the desired maximum transit delay is not for a BIS to guarantee delivery within the specified deliver time. Rather the intent is to permit a BIS in apply a routing policy that will result in the selection of subnetworks (especially mobile subnetworks) that could be expected to support the desired performance. This would be determined a prior and not on a dynamic basis. For a ground BIS the responsible administration could determine the appropriate routing policy for each ATSC Traffic Type that satisfies that administration’s operational goals. For the airborne BIS the routing policy associated with each ATSC Traffic Type will need to be standardized by the SARPs. For example the routing policy could be defined that for ATSC Traffic Types B and C as defined in Section 3 above, only Mode S and VDL (Mode 2 or Mode 3) subnetworks will be used. Perhaps Gatelink could also be specified but it is not an ICAO defined subnetwork therefore a more generic terminology would be needed such as an “industry local area network for aircraft an the gate”. For ATSC Traffic Types D and E the applicable ICAO mobile subnetworks could include Mode S, VDL (Mode 1, 2 and 3), AMSS, and HF Data Link (the above comment on Gatelink also applies).

Additionally, guidance material will need to be added to the SARPs to define how to set routing policies such that they are consistent with the use of the specified ATSC Traffic Types (i.e., a mobile subnetwork should be selected consistent with a) ATSC traffic and b) the specified end-to-end transit delay expected

Appendix A

TP4 Timer Values

Table 1 presents a recommended set of COTP timer values for use with the proposed end-to-end performance requirements specified through the CLNP Security Option extension for traffic types. The end-to-end delay for each traffic type is represented in the ELR and ERL values in the table. Values are assigned for the maximum NSDU lifetime (MLR and MRL), for the acknowledgement time (AL and AR), and the inactivity timer (IR and IL), and for the total number of transmissions (N). From these components the values for T1, L and W timers are calculated. In most implementations, A, I T1, L, and W are represented as countdown timers while the other table entries are used to establish the timer values.

There are two suggested values for W, the window timer that functions as a "keepalive" message timer. In these suggested values, the emphasis is on minimizing the message traffic. In most implementations for ground-to-ground traffic, the W timer is set at 1/2 or 1/3 the value of IR to assure that the keepalive messages (COTP ACKs) are received to prevent the transport connection from being inadvertently dropped.