

AERONAUTICAL NETWORK PANEL

Working Group 2

Brisbane 5-9 February 1996

**Need for More Complete Definition of TP4 Timer
Settings and Usage**

Prepared by: Ed Dillon, Ron Cossa

Presented by: Ron Cossa

SUMMARY

This paper presents a discussion of TP4 timer requirements and issues related to the Transport Layer, as applicable to the ATN. Several recommendations for further research to investigate static vs. dynamic timer value implementations are proposed. In addition, a set of interim recommendations for CNS/ATM-1 (Package 1) implementations of TP4 timer capabilities is proposed.

REVISION HISTORY

Section	Date	Issue	Reason for Change
	19 January 1996	Issue 1.0	Document Creation
	22 January 1996	Issue 1.1	Initial Document Review and Edit
	25 January 1996	Issue 1.2	Final Document Review and Edit

TABLE OF CONTENTS

1. SCOPE AND PURPOSE OF THIS PAPER	1
2. REFERENCES	1
3. ACRONYMS	1
4. BACKGROUND	1
4.1. APPLICATIONS-RELATED COTP TIMER REQUIREMENTS	2
4.2. END-TO-END PERFORMANCE FACTORS	2
4.3. ALTERNATIVE OPTIONS	3
5. DISCUSSION	3
6. CONCLUSIONS	4
7. PROPOSAL	4
7. PACKAGE 1 RECOMMENDATION	5
APPENDIX A - UPDATE ON THE TP4 TIMER SETTING ANALYSIS	7
APPENDIX B - RECOMMENDED SETS OF STATIC TP4 TIMER VALUES	9

This page intentionally left blank

Need for More Complete Definition of TP4 Timer Settings and Usage

1. Scope and Purpose of this Paper

This paper presents a discussion of TP4 timer requirements and issues on a global basis as applicable to the ATN, and proposes several recommendations for further investigation in this area. In addition, a set of Interim Recommendation for CNS/ATM-1 (Pkg 1) implementation are proposed.

2. References

Please refer to the CNS/ATM-1 Package SARPS, Sub-Volume 5 - Internet Communications Service, Chapter 5, "Transport Service and Protocol Specification" for TP4 requirements referenced in this document.

Also refer to ISO/IEC 8073:1992 "Information Technology - Telecommunications and Information Exchange between Systems - Open Systems Interconnection - Connection Oriented Transport Protocol Specification" for the specific protocol requirements for providing such COTP service.

3. Acronyms

APRL	ATN Profile Requirements List
ATSC	Air Traffic Services Communications
BIS	Boundary Intermediate System
CC	Connect Confirm
CLNP	Connectionless Mode Network Protocol
COTP	Connection Oriented Transport Protocol
CR	Connect Request
ED	Expedited Data
TPDU	Transport Protocol Data Unit
TS	Transport Service

4. Background

The ATNP 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 different user groups. To accomplish this objective, the ISO/IEC 8473 CLNP Internetworking protocol and the ISO/IEC 8073 Transport protocol have been augmented with ATN-specific requirements (extensions) to reflect the unique communications environments of the ATN sub-networks.

In order to ensure the reliable and efficient transmission of applications data, the ATN Transport and Internet layers must incorporate the use of varying COTP timer values consistent with the specific requirements of the ATSC traffic supported by the different ATN subnetworks.

4.1 Applications-Related COTP Timer Requirements

The following examples illustrate differing applications-related COTP timer requirements for different applications:

- Using AMSS as the mobile subnetwork, care must be taken to ensure that COTP keep-alive traffic does not become a significant, or the predominant load, on the subnetwork. The reporting interval for the ADS Reports for initial oceanic operations has been extended to 15 minutes in order to minimize the communication charges associated with AMSS. The 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.
- Certain ATSC traffic in tactical ATC environments will require relatively short end-to-end message delivery times so that the datalink services will remain operationally usable. The same Package-1 applications (CPDLC) will have varying end-to-end message delivery time requirements depending on the operating domain. Routing decisions will need to be based upon user needs for end-to-end performance.
- Short COTP acknowledgment timer values may have a negative effect on meeting the operational requirements for two-way ATC application message/response times. Because of a combination of limited bandwidth and asymmetric throughput characteristics associated with mobile subnetworks, placing a COTP AK TPDU 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.

4.2 End-to-End Performance Factors

A number of factors influence the end-to-end performance requirements for ATN services when used to support ATS datalink 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 datalink integration (e.g., workload impact on the controller, ability to integrate CPDLC with controller-to-controller sector handoffs)
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 predominant characteristic that will determine the operational suitability of the communication service.

Based upon the above considerations, it does not appear appropriate to define solely one set of specific end-to-end performance requirements on a global basis applicable to all CNS/ATM-1 applications, without consideration for the COTP timer requirements of specific operational domains.

4.3 Alternative Options

As presented at the WG2/6 meeting in Banff, there are three alternative options for consideration by WG2:

1. The first alternative is to permit ground ATSC end systems to select COTP timer values consistent with the specific type of ATSC traffic supported by that end system. Using this alternative, a ground ATSC end system would select the a fixed set of COTP timer values consistent with its operational requirements. Airborne ATSC end systems would also select a fixed set of COTP timer values, not necessarily the same as a given ground ATSC end system, but which would provide operational compatibility. It must be verified, however, that operational requirements could be satisfied and compatibility achieved with the use of differing ground and air COTP timer values.
2. The second alternative is to use knowledge of Traffic Type at the time of COTP session establishment to allow ground and airborne end systems to select the same, or compatible, "sets" of COTP timer values. Since for some ATSC applications, only the ground end system will know the appropriate traffic type, either the COTP Connect Request (CR) 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 on the Traffic Type associated with the Connect Confirm (CC) received from the ground peer COTP. This approach, while possibly more complicated to implement, would be more flexible and potentially of lower overall technical risk, since compatible airborne and ground COTP timer values would be assured.
3. The third alternative is to use dynamically established COTP timer values, based on algorithms which monitor round trip delay time parameters and set COTP timers accordingly. This approach may not be workable within the ATN, however, due to the need to support air-ground ATSC over limited bandwidth mobile subnetworks with asymmetric delay/throughput characteristics. Also, the convergence time for such algorithms and the operational and economic constraints involved will be influencing factors

5. Discussion

In reviewing currently available COTS software incorporating COTP, it is observed that there is an inconsistent approach to handling TP4 timer values. All such products use one universal set of timers for all connections. At least one product allows a systems administrator action to modify timer values. Another requires that code be modified to make such changes. In all cases, it is difficult to determine the timer settings since it involves reading of program code.

Simulation studies done in support of FAA program requirements, by MITRE and Mayflower Communications, show that the successful and efficient operation of the transport protocol over various subnetworks is sensitive to the settings of transport timer values. In one study, in order to get the AMSS model to perform well, the Acknowledgment Timer value was set to 20 seconds, which varies greatly from standard procedures. In terms of the inactivity timer and the window timer (which acts as a keep alive) settings, they have been shown to require much longer than "normal" timer values for efficient and reliable network operation.

In terms of the Acknowledgment Timer, the ISO 8073 standard, section 13.3.4.j, specifies a maximum parameter length and value. A parameter length of two octets (16 bits) is specified with a value to be expressed in milliseconds. A maximum specification of 65,565 milliseconds (65 seconds) is therefore allowed for the Acknowledgment timer. A recent simulation analysis performed for the FAA, included as Appendix A, evaluated the impact on AMSS end-to-end transit delay of various TP4 Acknowledgment Timer settings. The conclusion of the analysis indicates that, even for the maximum allowed acknowledgment timer of 65 seconds, flight safety traffic service is degraded because of high AMSS channel load due to excessive AK TPDU generation. Optimal results were achieved only when using much higher Acknowledgment Timer settings of between 160 and 400 seconds. These larger timer

settings allowed for acknowledgment of multiple TP4s with one AK TPDU. Other types of subnetworks however may require much shorter AK Timer settings for efficient operation.

6. Conclusions

Considering these findings, an ATN requirement for one standard or "static" set of TP4 timer values does not seem feasible to allow for efficient operations in the various ATN subnetworks. Clarification is needed in the SARPS, however to ensure that transport timer settings are easily accessible for changes required under differing operational scenarios. The SARPS should also include an extension to the ISO 8073 standard to express the value of the Acknowledgment timer in seconds (not milliseconds).

Additional research is needed to determine what COTP TP4 timer values should be, especially in light of previous simulation studies that show that vastly different values are required for efficient operations in some subnetworks. This issue currently remains an open question for further investigation.

As indicated previously in this document, utilizing a dynamic algorithm for assessment of round trip delay time, would be useful in tuning a particular transport connection when starting from a fixed set of timer values (a presumptive static set). Use of such a dynamic algorithm however, will not affect the Acknowledgment Timer values, which have been shown to greatly affect service performance.

Analysis done by U.S. experts has also indicated that using a dynamic procedure may be detrimental in that a certain amount of "jitter" in the round trip delay time is normal and the proposed dynamic algorithm may recommend unrealistic timer values based upon this "jitter" factor. There is concern that operating in such an open loop end-to-end fashion could seriously interfere with the correct operation of a transport connection.

Further analysis and simulation studies are therefore needed to determine whether using one (or more) dynamic algorithms to fine tune timer settings will be feasible in the context of ATN subnetwork operations.

6. Proposal

Based upon the considerations and possible risks related to implementation of TP4 timers as outlined in this paper, the following recommendations are proposed for consideration by WG2:

1. Perform analysis and testing to determine a well thought-out sets of TP4 timer values, with easy access to timer settings, which would be operational for different transport implementation. This alternative would permit ground ATSC end systems to select the single fixed set of COTP timer values consistent with its operational requirements. 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 which would provide operational compatibility. It must be verified that operational requirements could be satisfied and compatibility achieved with the use of such differing ground and air static COTP timer values.
2. Analyze and test procedures that would allow ground and airborne end systems to use knowledge of traffic type at connection establishment to select the same, or compatible, "sets" of COTP timer values. These sets of values would be chosen to be compatible with other subnetwork delay values, when known on an *a priori* basis.
3. Analyze whether the use of dynamic algorithms, which would monitor peer-to-peer performance parameters and fine tune COTP timer values, is workable in the ATN environment.

It is not expected that the analysis and testing required by these proposals can be reasonably completed in the CNS/ATM-1 (Pkg.1) time frame and would therefore constitute development work for inclusion in Package 2.

7. Package 1 Recommendation

For the CNS/ATM-1 Package 1 time frame, it is recommended that a default set of static COTP timer values be recommended for the four ATSC Traffic Types identified in section 2.7.1.1.b, Table 2-2, ATN Transit Delay Semantics. Initial timer values were presented in Appendix A of WP167, at the WG2 Banff meeting. A modified version of these timer values, incorporating Acknowledgment Timer settings based on recent simulation test results, is included as Appendix B of this document.

Authentication and verification of the applicability of such static value “sets” must be performed during the validation activities for the CNS/ATM-1 version of the Internet SARPS.

This page intentionally left blank.

Appendix A

Update On the TP4 Timer Setting Analysis

This page intentionally left blank

Appendix B

Recommended Sets of Static TP4 Timer Values

Table 1 presents four recommended sets of COTP TP4 timer values for use with the end-to-end performance requirements specified through the CLNP Security Option extension for Traffic Types.

The end-to-end delay indicated for ATSC Classes C, D, F and G is based upon the specification of transit delay as presented in Table 2-2 of section 2.7.1.1.b of version 3.1 of the Internet SARPs. These delays are represented in the ELR and ERL values in the table.

Values are also assigned for the maximum NSDU lifetime (MLR and MRL), for the Acknowledgment Time (AL and AR) and the Inactivity Time (IR and IL), and for the total number of transmissions (N).

from these components, the values for T1, L and W timers are represented as calculated. In most implementations, A, I, T1 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 "keep-alive" 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 $\frac{1}{2}$ or $\frac{1}{3}$ the value of IR to assure that the keep-alive messages (COTP AKs) are received to prevent the transport connection from being inadvertently dropped.

B.1 COTP TP4 Timer Values

Symbol for Component	ATSC Traffic Type C	ATSC Traffic Type D	ATSC Traffic Type F	ATSC Traffic Type G	Definition	Justification
MLR	26	40	120	180	Max NSDU life, local to remote	Sub - Network specific
MRL	26	40	120	180	Max NSDU life, remote to local	Sub - Network specific
ELR	13	18	74	95	Max transit delay, local to remote	Based on 95% 1 way transmission in ORD, w/ fudge factor (35%)
ERL	13	18	74	95	Max transit delay, remote to local	Same as Above
AL	20	200	400	800	AK time - local	See Text
AR	20	200	400	800	AK time - remote	See Text
IL	600	600	600	3000	Inactivity timer-local	Based on cost and # of Aircraft
IR	600	600	600	3000	Inactivity time-remote	Same as above
N	3	2	2	3	No. of trans - missions	Agree upon # of re-tries
x	1	1	1	1	Processing time fudge factor	Fudge Factor
Computed Values						
T1	77	237	548	990	ELR+ERL+AR+x	Computed
R	155	238	549	1981	T1*(N-1)+x	Computed
L	257	518	1189	3141	MLR+MRL+R+AR	Computed
W	599	599	599	2999	IR-1 (ATN)	
W(sim)	540	645	367	2714	IR-(3*ELR+x)	Used in Simulation
NOTE: all times are in seconds						

TABLE 1

