MASPS for ADS-B Rev. A

Tracking Information (committee secretary only)	
Change Issue Number	3Y
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Short Title for Change Issue:	TCP Update Rate Requirements

MASPS Document Reference:		Originator Information:	
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Section number(s)		Phone	206- 662- 8540 / 206-523-1584
Paragraph number(s)	2.1.2.3.3, 3.4.3.2,3.4.3.3	E-mail	Anthony.w.warren@boeing.com
Table/Figure number(s)		Other	Boeing ATM Services

Proposed Rationale for Consideration (originator should check all that apply):	
	Item needed to support of near-term MASPS/MOPS development
x	DO-260/ED-102 1090 MHz Link MOPS Rev A
x	ASA MASPS
	TIS-B MASPS
x	UAT MOPS
	Item needed to support applications that have well defined concept of operation
	Has complete application description
	Has initial validation via operational test/evaluation
	Has supporting analysis, if candidate stressing application
	Item needed for harmonization with international requirements
x	Item identified during recent ADS-B development activities and operational evaluations
x	MASPS clarifications and correction item
x	Validation/modification of questioned MASPS requirement item
	Military use provision item
	New requirement item (must be associated with traffic surveillance to support ASAS)

Nature of Issue:		Editorial		Clarity		Performance	X	Functional

Issue Description (attach additional sheets if necessary):

(1) Current requirements on update rate for TCP's are implicit requirements and are not directly related to the functional requirements for applications using TCP's:

- "The rate shall be sufficient to ensure continuous positive assessment by the receiving aircraft at least 2 minutes prior to reaching closest point of approach for class A2 equipage (5 minutes… for Class A3)."
- "For all elements of the MS report, the assembly function shall provide update when received or indicate "no data available" if none is received in the preceding 10 second period."

(2) Report rate should be lower for TCP's that are remote in time, e.g. whenever TTG to the TCP is larger than some threshold based on functional requirements for intent data.

(3) Most TCP intent data is static or slowly changing until the time to TCP is imminent, or the TCP data changes to reflect new flight plan intent. The reporting rate should reflect this redundancy in most TCP data and not waste transmission bandwidth to update TCP data that is highly redundant.

Originator's proposed resolution if any (attach additional sheets if necessary):

(1) Proposed resolution is to broadcast TCP and TCP+1 information at a higher rate when the aircraft is within 2.5 minutes TTG to the affected TCP or TCP+1, and at a lower rate for TTG's larger than 2.5 minutes. (The 2.5 minute criterion is based on a nominal time budget for a flight plan deconfliction application. The time budget includes time for pilot assessment of an assumed Deconfliction Advisory, communications to the ground controller or intruder aircraft, and time to apply a moderate maneuver such as a flight level change to resolve the detected conflict prior to closest approach. See the attached material for further details.)

(2) The high rate broadcasts must be sufficient for high probability of reception within a 10 second interval, i.e. 95% reception probability per 10 second interval. The low rate broadcasts are optional for level A2 equipage, and for level A3 equipage must be sufficient to receive at least one broadcast of TCP intent information with 99% probability between 5 minutes TTG and 2.5 minutes TTG to the affected TCP. (For example, this requirement may be achieved with a low rate broadcast of 30 seconds per transmission interval and a reception probability of at least 70% per broadcast.)

(3) The above 2.5 minute criterion is not a requirement for a level A2 system, i.e. the requirement in section 2.1.2.3.3.1 would become "The rate shall be sufficient to ensure continuous positive assessment by the receiving aircraft at least 2 minutes TTG to the current TCP for class A2 equipage. For class A3 equipage, the transmission rate shall be sufficient to ensure continuous positive assessment by the receiving aircraft at least 2.5 minutes TTG to the affected TCP or TCP+1, and to receive at least one reception of TCP information between 2.5 minutes and 5 minutes TTG to the affected TCP."

(4) Major changes in TCP or TCP+1 intent will be signaled by an appropriate indicator in the Mode Status report. Such changes may require modification of the transmission rate in order to assure reception of changed TCP or TCP+1 intent subject to the same requirements in (2) and (3) above.

The intent of this proposal is to emphasize the importance of TCP information within 2.5 minutes of reaching a TCP point, and to de-emphasize the relative value of any remote TCP information more than 5 minutes away from the affected TCP.

Additional supporting material is contained in the following attachment A pages.

Attachments for TCP Update Rate Requirements

March 26, 2001

Anthony Warren, Boeing Air Traffic Management

(1) Justification of shift from "closest point of approach" to TTG update criterion

The "closest point of approach (CPA)" criterion is a receiving side criterion, not a transmission side criterion for determining update rate. If the potential conflicting aircraft has a CPA before the TCP point and less than 2 min to CPA, then state vector information is adequate to judge conflict detection without resorting to TCP data. (Several studies show the adequacy of SV data for short lookahead times). If the potential conflicting aircraft has a CPA between 2 min and 5 min lookahead, then there may be some value in using both SV and TCP data to detect conflicts, and avoid false alarms. In this case we want to have transmission of TCP intent within 5 min TTG to the next TCP to assure enhanced conflict detection performance at somewhat longer lookahead times. If the potential conflicting aircraft has a CPA after the TCP point, then the 5 min TTG criterion provides some capability to extend deconfliction to even longer lookahead times, e.g. 10 min lookahead, even if the CPA occurs after the Trajectory Change Point. Thus, we can eliminate the awkward CPA criterion in the current MASPS and replace this criterion with a simpler to implement TTG to TCP criterion.

(2) Justification for high rate requirements, e.g. 95% reception per 10 second period

This requirement is primarily interpreting the current MASPS, e.g. "continuous positive assessment by the receiving aircraft". It is clear from the implicit requirement to deliver report data within 10 seconds, that a high probability of reception is desired for at least one Mode Status report containing TCP data within each 10 second interval, provided that TTG is sufficiently close (2 min for Class A2). We have assumed a value of 95% reception probability since this means that the probability of not receiving TCP data for 20 seconds or more is very low, i.e. >99.75% probability of receiving at least one TCP within a 20 second interval, given that a TCP should be received for intent assessment.

(3) Justification for 2.5 min Threshold Criterion for Low Rate / High Rate Broadcasts

The 2.5 minute criterion for changing from Low Rate to High Rate "continuous positive assessment" is based on the following crude time budget for a typical deconfliction application:

* Time for pilot to decide that a maneuver is necessary, given that a Conflict Detection has occurred and a Deconfliction Advisory is issued: 0.5 minute

* Time for pilot to communicate a maneuver request to a controller (or to the encounter aircraft in autonomous airspace): 0.5 minute

* Time for pilot to apply moderate maneuver to achieve desired separation, e.g. 1000 foot altitude separation: 1.5 minutes

Total time from Issuance of Conflict Advisory to maneuver completion = 2.5 minutes.
(Note: this time budget for intent based deconfliction needs to be validated /approved or revised as appropriate by the CD&R group.)

(4) Justification for Low Rate Criterion, e.g. one TCP reception for TTG >2.5 min

The TCP Intent data is mostly redundant except for TTG, which changes dynamically on each intent broadcast. There are situations where TCP intent can change dramatically, e.g. insertion of a new turn point or deletion of TCP values when a “Direct To” is used to bypass intermediate waypoints. In such cases, the Mode Status report should flag that some aspect of intent other than TTG has changed and previous Intent values may be invalid. However, in most cases Intent values such as latitudes and longitudes will not change at all or will change gradually over time such as a Top-of-Descent TCP point. Consequently, a low rate criterion is proposed such that for redundant intent data, only one reception in the interval from TTG < 5 min to TTG< 2.5 min is required. Only a major change in intent signaled by the Mode Status report should require a higher update rate in order to avoid using old, possibly invalid intent data. In this case, the update rate criterion should assure that at least one reception of changed TCP information is received for TTG>2.5 min, or the high update rate used, as appropriate.