RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision B

Meeting #18

Teleconference 01.21.04

TIS-B Alternatives

Presented by: Andy Zeitlin and Chris Moody

SUMMARY
Methods are compared for indicating TIS-B Service Status to airborne users. Advantages and disadvantages are discussed for exception-based and regularly updated ("heartbeat") indications. Link considerations will also influence the choice of method.

Providing an Indication of TIS-B Service Status

The FAA's Safe Flight 21 and Capstone programs are both planning near-term deployment of the Fundamental TIS-B service as defined in DO-286. The Fundamental TIS-B service will provide TIS-B traffic information only on non-ADS-B equipped aircraft ADS-B reports through surveillance provided by existing FAA surveillance sensors. (While the ADS-B Rebroadcast Service is part of the TIS-B concept, its implementation would be subsequent to this initial implementation). This service is also intended to support only the Enhanced Visual Acquisition application as defined in the ASA MASPS.

Even with this initial TIS-B implementation, the FAA will be able to provide a relatively comprehensive traffic information picture for TIS-B customers in many TIS-B service volumes[1]. For this reason, it is assumed to be highly desirable for even this initial TIS-B implementation to support a *TIS-B service status* indication so that pilots will know when TIS-B service can be expected and when there should be no such expectation[2].

Furthermore, it is assumed that providing a TIS-B service status to the flight crew should reflect the relationship of the TIS-B customer location to that of the TIS-B service volume. That is, the service status indication is specific to the individual TIS-B customer's situation.

Finally, as a practical matter, supporting the approach to providing the TIS-B service status indication should be simple, especially for the required avionics processing. An approach that broadcasts service volume dimensions is likely to get complex for the following reasons:

- broadcast ground stations may not be collocated with FAA radars making the representation of the intersection of the surveillance coverage volume and the RF coverage volume complex.
- There is a three dimensional aspect to the volume (i.e., how to represent floor of service).
- The volume may be slightly different for different TIS-B customers (due to TIS-B receiver sensitivity, ADS-B transmit power, and transponder performance)

The limited scope of the Fundamental TIS-B deployment and the assertions above argue for an approach whereby the TIS-B ground system signals TIS-B customers as to their TIS-B service status. This would simplify avionics processing since no *a priori* knowledge of TIS-B service volumes within the avionics would be required. It is also simple for the ground system to support this signaling if it is limited to signaling TIS-B service status for the airspace in the immediate proximity of each TIS-B customer rather than doing any prediction.

Three possible types of signaling are identified in Table 1.

[1] The term "TIS-B service volume" refers to the intersection of the *surveillance coverage volume* and *RF coverage volume* where these terms in italics are defined in DO-286

[2] No similar expectation of a relatively complete traffic picture can exist for ADS-B (for some time at least) due to its dependence on ADS-B equipage.

Table 1. Possible Types of Signaling for TIS-B Service Status

Signaling Type	Purpose
Heartbeat	Message directed to individual TIS-B customer. Confirms to TIS-B customer that service is available in a continuous way. This is somewhat analogous to the "keep alive" message used in the Mode S TIS system.
Loss of service	Message directed to individual TIS-B customer. Explicit indication to TIS-B customer of loss of service—assuming data link coverage is still available. This is somewhat analogous to the "goodbye" message used in the Mode S TIS system.
Beacon	A way for any TIS-B customer to ascertain they are in coverage of a broadcast ground station. This could be achieved with any TIS-B traffic message that contains the ground station identifier. In the absence of actual TIS-B traffic, a special beacon message would be needed in order for the beacon function to be continuous

With this basic set of signals established, four alternative concepts are identified in Table 2 for supporting the TIS-B service status signaling.

Table 2. Alternative Approaches for TIS-B Service Status Signalling

Signalling Approach	Operating Concept	Pros	Cons	SignalingTypes Used
Exception-based	If no explicit loss of service signal is received on ownship from all ground stations from which a beacon is being heard, the avionics assumes that service is available.	Most bandwidth efficient where it matters (i.e., high density radar covered airspace) as ADS-B equipage ramps up	Relies on positive action of ground system and avionics to indicate lack of service. (System is spring loaded to indicate SVC AVAIL).	-Beacon -Loss of Service
Exception-based with heartbeat	Like above except includes a one time* heartbeat signal on entering TIS-B service volume.	Same as above except improves notification of entering service when data link coverage is still available. Marginal increase in data link load.		-Beacon -Loss of Service -Heartbeat
Heartbeat-based	Avionics assumes service is not available unless it receives an explicit heartbeat signal on ownship. Loss of service would be indicated by a timeout of the heartbeat signal.	Simple and positive indication that is spring loaded to a NO SVC indication.	Could add 10-20% to message load on the link in the long term as full equipage is realized. Notification of exiting service has to wait for heartbeat timeout	-Heartbeat
Heartbeat-based with "Goodbye"	Like above except includes a one time* loss of service signal on exiting TIS-B service volume.	Same as above except improves notification of exiting service when data link coverage is still available. Marginal increase in data link load.		-Heartbeat -Loss of Service

* Could be multiple transmissions in rapid succession to improve reception probability

Next we can examine the options available for conveying each of the three basic signaling types. Table 3 presents these options.

Table 3. Options for Implementing the Various Signal Types

Signaling Type	Options for Implementing	Pros	Cons
Beacon	Ground station id in every TIS-B message can serve as beacon. New message (or dummy TIS-B message) needed for "no traffic" conditions.	May or may not be link independent.	
	Let Ground Uplink message serve as beacon		Applicable only to UAT
Heartbeat	Use TIS-B message format with the TIS-B customer's 24-bit address obtained through ADS-B. Otherwise there are no other distinguishing characteristics of the message: it accurately reflects the surveillance data.	While the 24 bit address cannot be absolutely guaranteed unique* with the set of TIS-B targets, having the signal in form of TIS-B message also allows a proximity check to resolve any address ambiguity. SVC AVAIL indication provides high confidence entire system is operating normally (including ADS-B transmission)	Uses a full TIS-B message to convey a small amount of information
	Create new message that contains minimal data on each customer being signaled (i.e., address plus a few status bits)	Bandwidth efficient.	-Address ambiguity possible*.
Loss of Service	Use TIS-B message format with the TIS-B customer's 24-bit address obtained through ADS-B. Loss of Service message **uses a state in an already defined field** to distinguish it from a heartbeat message	While the 24 bit address cannot be absolutely guaranteed unique with the set of TIS-B targets, having the signal in form of TIS-B message also allows a proximity check to resolve any address ambiguity.	Uses a full TIS-B message to convey a small amount of information
	Create new message that contains minimal data on each customer being signaled (i.e., address plus a few status bits)	Bandwidth efficient.	-Address ambiguity possible*.

* This is because there are only two ADDRESS QUALIFIER codes for TIS-B (target has ICAO 24 bit address; target has track file identifier). Signaling messages for TIS-B customers that elect to use the UAT temporary randomly generated address will have to use one of these. Ambiguity is also possible (but less likely) due to installation error even with fixed (ICAO) address.

Recommended approach:
The heartbeat-based signaling approach using TIS-B message format is recommended due to its simplicity, positive mode of operation, lack of dependence on a new message format and the potential for it to be link independent. While not absolutely necessary, it is recommended that the format for a Loss of Service (i.e., a "goodbye" message) also be defined. That would hold open the option for rapid signaling of loss of TIS-B service. This requires the use of some existing message field that would be defined to signal the "loss of service" when used in a TIS-B message. To support the desired near-term implementation it is desirable that the field should be provisioned in the ground interface specification for the Ground-Based Transceiver (GBT) now being procured by FAA[3]. The list of fields supported in the GBT specification are as follows: Address, Address Qualifier, Latitude/Longitude, Pressure Altitude, Velocity (N/S E/W), Vertical Rate, Call Sign, Emitter Category, Emergency/Priority Status, IDENT Switch Active(1 bit), Receiving ATC Services(1 bit), NACp, NIC, SIL and Geometric Altitude.

Recommendation: reuse of one of the Operational Mode Parameters created exclusively for air-ground ATC use would be a good candidate. Either the Receiving ATC services bit or the IDENT Switch Active could assume the new definition when the Address Qualifier identifies the message as TIS-B. This should cause no future conflict. The Receiving ATC Services bit would seem the most logical choice. Table 4 is a proposed interpretation of the bit.

Table 4. Proposed Meaning of Receiving ATC Services Bit

Receiving ATC Services bit	Meaning (ADS-B Context)	Meaning (TIS-B Context)
0	Not Receiving ATC Services	Goodbye message
1	Receiving ATC Services	Heartbeat (or traffic message)

[3] This contract is now underway with Sensis Corporation. Delivery of production units is scheduled to begin in December 04.