TIS-B Service Status

Chris Moody

RTCA SC-186 WG-5 Meeting #20, 9 Feb 2004

Working Paper UAT-WP-20-01A

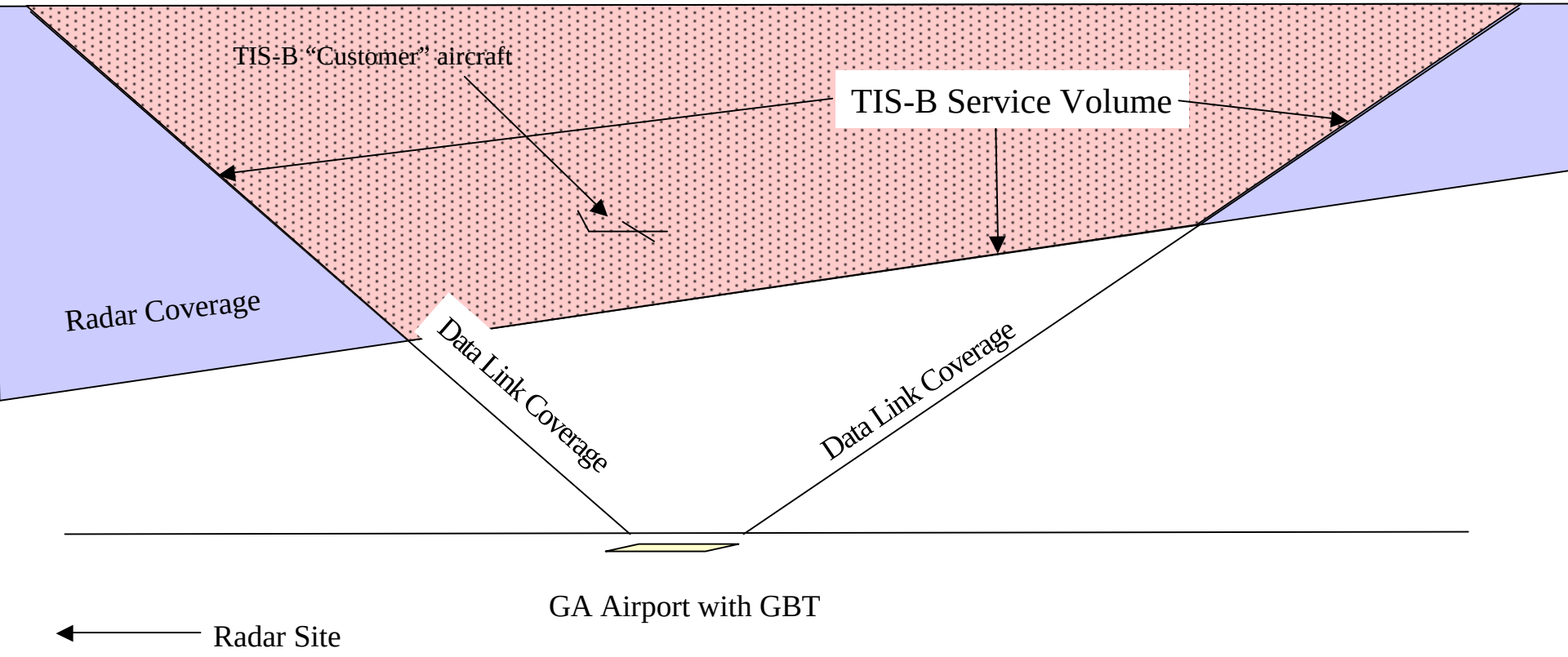
Background

- **FAA's Safe Flight 21 and Capstone programs are planning near-term deployment of TIS-B service**
  - **Traffic information provided on non-ADS-B equipped aircraft through surveillance by existing FAA radar sensors (known as the *Fundamental* TIS-B service in DO-286)**
  - **Intended to support only the Enhanced Visual Acquisition application**
- **Even with this initial implementation, the FAA will be able to provide a relatively comprehensive traffic information picture for *TIS-B customers* in *TIS-B service volumes***
- **"GBT" (Ground Based Transceiver) is the term used for the data link ground station**

Background (2)

- **Given the way TIS-B will operate, it is assumed to be highly desirable to provide the TIS-B customer with some indication of when TIS-B service can be expected—and when service should not be expected.**
  - **WG2 and WG3 agree in principle that supporting such an indication should be an objective of the TIS-B service.**
  - **The Mode S TIS service supports this capability.**
- **Objective should be to provide a service status indication to the pilot that reflects the situation relative to the TIS-B customer's aircraft.**
- **HOW TO SUPPORT THIS…?**

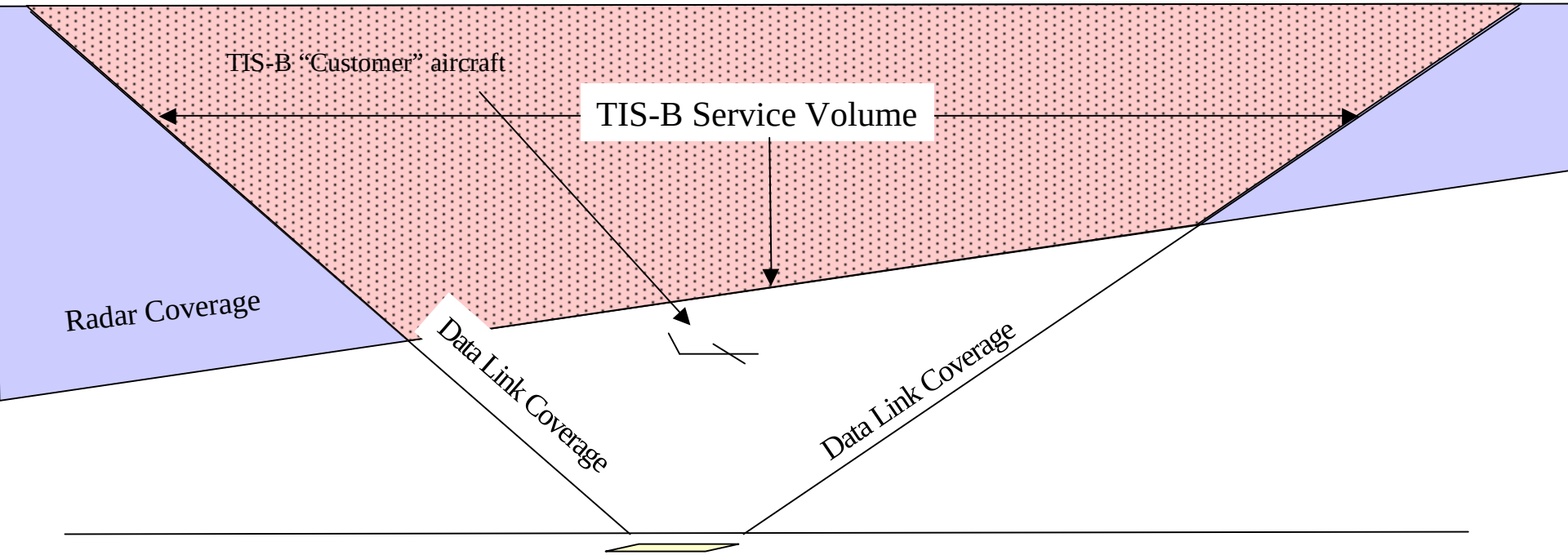
"SERVICE AVAILABLE"



MITRE

CAASD

“NO SERVICE”



GA Airport with UAT Ground Station

Radar Site

Avionics-Based Alternative

- **Avionics process with onboard representation of TIS-B service volume to provide service status indication**
  - **Complex for avionics to manage this in 3 dimensions as well as accounting for the fact that UAT ground stations (GBTs) will often not be sited at radars**
  - **Actual service volume dimensions will to some degree depend on performance of customer installed equipment that this approach will not reflect**
  - **Presents a maintenance item for FAA to distribute updates as service expands or as service outages occur**

Ground-Based Alternative

- **Ground system sends signaling indicator directed to each TIS-B customer.**
  - **Special signaling message positively identifies the customer being signaled.**
  - **Makes avionics processing simple for annunciation of service status**
  - **Can also be simple for the ground system if limited to the airspace in the immediate vicinity of the customer**
    - **Signaling is based on ground system ability to correlate the customer's radar and ADS-B track**
    - **Signaling reflects real time customer status for service in immediate proximity—predicting future service or ability to see targets at range more difficult**
  - **TIS-B customers must be ADS-B equipped with this alternative**

SIMPLE GROUND-BASED IS PREFERRED

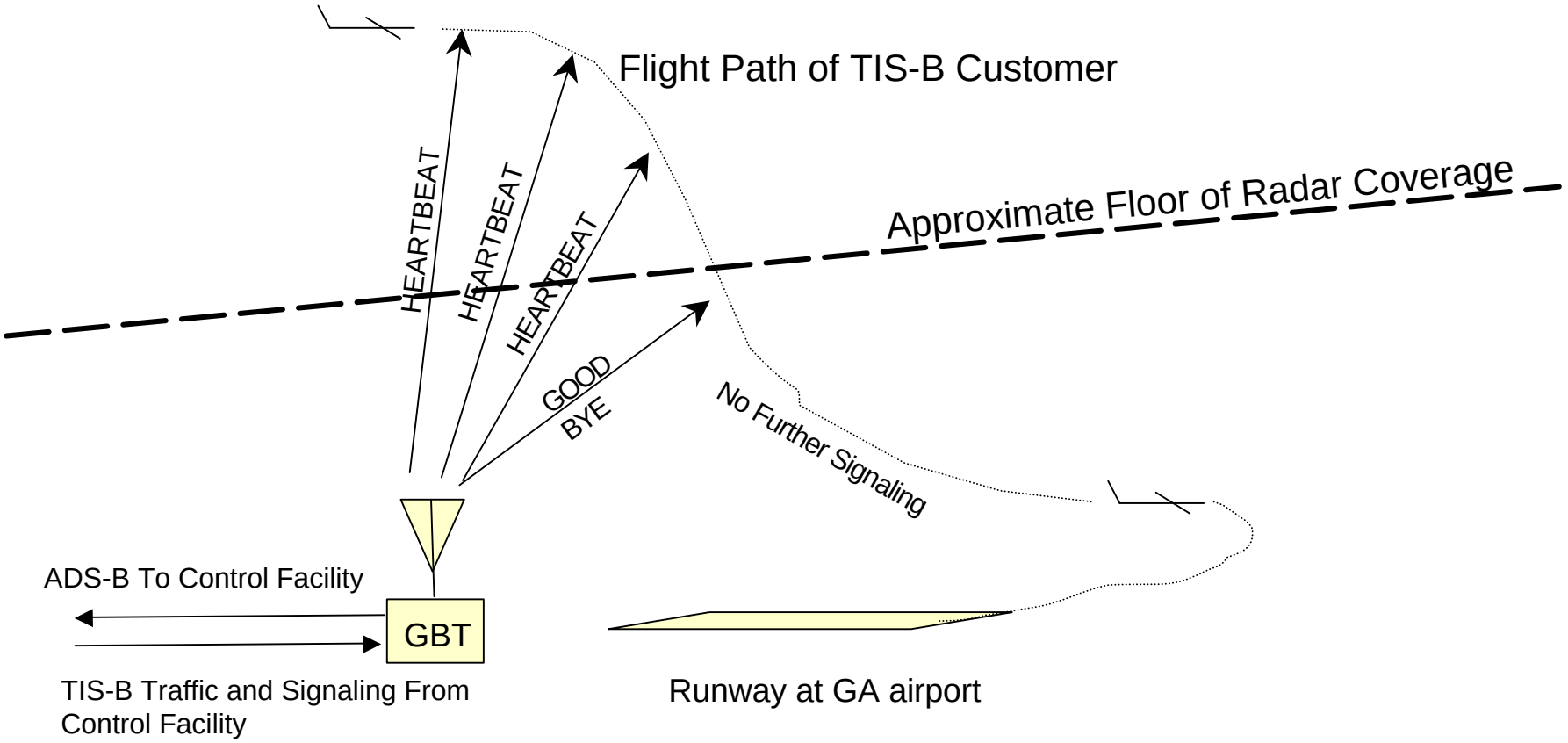
Signaling Message Possibilities

Signaling Type	Purpose
Heartbeat	Directed to customer. Confirms 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	Directed to customer. Explicit indication of loss of service—assuming data link coverage is still available. This is analogous to the "goodbye" message used in the Mode S TIS system.
Beacon	NOT directed. Applicable to all TIS-B customers only for telling the TIS-B customer that they are in range of the TIS-B broadcasting ground station identified in the beacon transmission. Use of the beacon assumes there is the ability for the avionics to associate received TIS-B messages with the ground station from which they were transmitted.

Signaling Concepts

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.	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 periodic 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.	Data link load	-Heartbeat
Heartbeat-based with "Goodbye"	Like above except includes a 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

Operational Example: Descent to Pattern Altitude at GA Airport with GBT



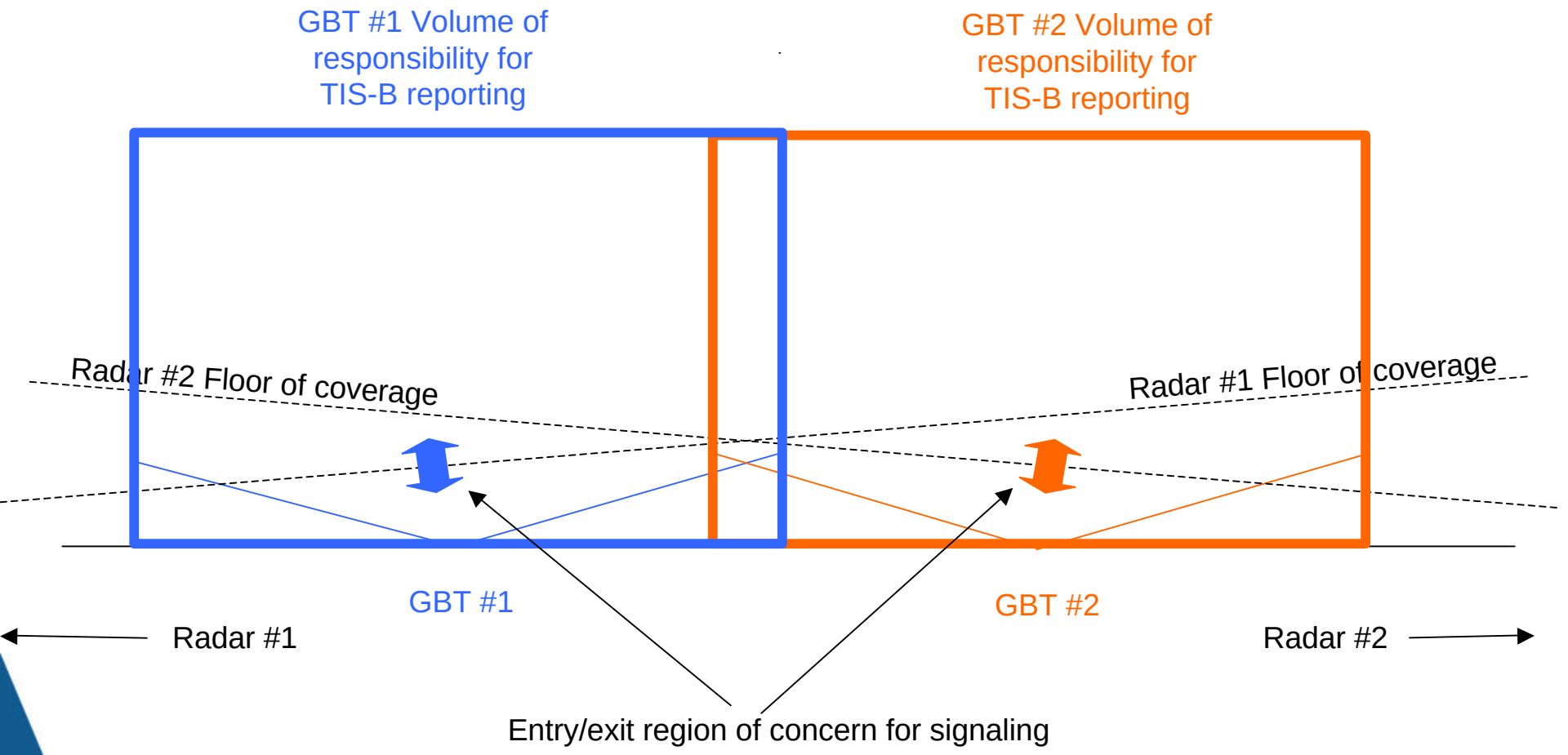
Options for Implementing *Heartbeat* and *Goodbye* Signals

Options	Pros	Cons
Use TIS-B message format with the 24-bit address reported by the TIS-B customer. Heartbeat message 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.	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 with a heartbeat (i.e., address plus a few status bits). Specifically pack this info into a new frame format for the UAT Ground Uplink message	More bandwidth efficient than using a full TIS-B message.	-No way to resolve address ambiguity if it occurs

Assumptions for Estimating Bandwidth Requirements for Signaling

- Control facility is regional in scope and handles boundaries between overlapping radar coverage within its region
  - Provision of heartbeat and goodbye signals is coordinated across boundaries by control facility
- Each GBT homed to a single control facility
- *Heartbeat* signal issued twice on entry and every 30 seconds thereafter to "hold up" the SERVICE AVAILABLE indication in the avionics.
- Maximum GBT load is 207 TIS-B customers (per JHU/APL report)
  - Very conservative since it assumes all but one aircraft are equipped
- Heartbeat timeout set for 1 minute.
  - On timeout, avionics reverts to NO SVC indication
- *Goodbye* signal issued twice on exit (in rapid succession)
- 10% TIS-B customers enter/leave TIS-B Service volume per minute
  - Likely to be conservative since with more density we get more radar coverage and hence more continuity of service

Context for Assumptions on Entering/Leaving Service



Bandwidth Estimates for Signaling (2)

- **Using TIS-B message format:**
  - **(207 *2/min)*periodic heartbeat* + (21*2) *on entering/leaving* = 7.6 extra TIS-B messages per second per GBT for signaling—competing with transmissions from near full ADS-B equipage**
- **Using a newly created format:**
  - **Assume we format heartbeat and goodbye signals with a new frame format packed into the Ground Uplink message @ 4 bytes per signal (3 for ADDRESS; 1 for ADDR QUALIFIER and other status bits including one to distinguish *Heartbeat* from *Goodbye* resulting in 106 signals that can be packed into one Ground Uplink message**
  - **Periodic heartbeat displaces 4 Ground Uplink opportunities per minute. On condition (entering/leaving) requires another 42 signals or about ½ of a Ground Uplink message per minute but spread out in time. We assume its an entire additional Ground Uplink to be conservative.**
  - **Since each GBT should nominally have access to 4 time slots per second, the 5/minute used for signaling represents 2-3% of the capacity of the Ground Uplink payload available to a given GBT**

Recommendation

- **Support TIS-B signaling in UAT by creating a new frame type in the Ground Uplink message**