EUROCONTROL ADS PROGRAMME

TIS-B Functional Architecture Discussion Paper

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Abstract

This document describes the EUROCONTROL functional architecture for TIS-B. It identifies a series of functions and sub-systems that make up the TIS-B system, and defines functional requirements for them.

Keywords

TIS-B	Surveillance	Functional	Architecture
SFA	Role	Traffic Information Volume	Service Volume

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DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.1	13/08/01	Initial draft	All
0.2	02/10/01	For discussion at 2nd TIS-B SAC meeting	All
0.3	30/10/01	Updated to address comments received against version 0.2, plus align with latest version of the TIS-B requirements.	All
0.4	23/11/01	Updated to match latest requirements document and internal comments received.	All
0.5	04/12/01	To be consistent with latest update to the TIS-B requirements document (version 0.3d).	All
0.6	14/12/01	Change in terminology to allow clearer differentiation between functional architecture sub-systems and future physical architectures. The TIS-B Server is now called the TIS-B Service Manager, and the 'groundstation' is now called the 'Transmitter'.	All.
0.7	14/03/02	Comments received during SAC meeting #2, plus some changes in terminology to ensure consistency with RTCA documents: The TIS-B Service Domain of Interest is now referred to as the TIS-B Traffic Information Volume, and the Ground SDPD sub-system is now referred to as the Ground Surveillance Processing sub-system.	All
0.8	22/03/02	Updated to include comments made during SAC TIS-B #3.	All
0.9	16/05/02	Updated to include comments made during SAC TIS-B #4.	

TABLE OF CONTENTS

References:

1: Surveillance Functional Architecture. SUR.ET2.ST03.1100. Edition 12a. April 2001.

2: Traffic Information Service - Broadcast Requirements. ADS/URD/TISB/0001. Edition 0.3d.

3: NUP TIS-B Service Description. DFS_NUP_WP9_05-0.41. Version 1.2

Acronyms

FPPS	Flight Plan Processing System
GSP	Ground Surveillance Processing sub-system
NUP	NEAN Update Programme
OOI	Object Of Interest
SCV	Surveillance Coverage Volume
SDPD	Surveillance Data Processing and Distribution
SV	TIS-B Service Volume
TIS-B	Traffic Information Service - Broadcast
TSM	TIS-B Service Manager sub-system
TIV	Traffic Information Volume
Tx	Transmitter
UAT	Universal Access Transceiver
VDL	VHF Data Link

1. INTRODUCTION

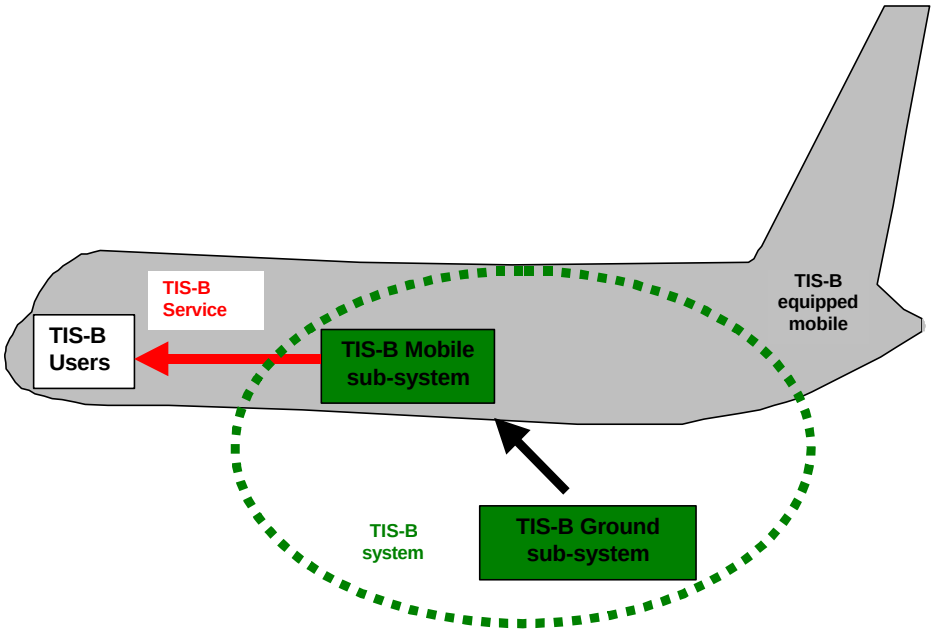
1.1 Purpose

The purpose of this discussion paper is to propose a functional architecture for TIS-B.

The intention is for the material described in this paper to be integrated into the overall ADS-B/TIS-B Functional Architecture which will then be included at an appropriate level of detail into the Surveillance Functional Architecture [Ref 1] once the content of this paper has been agreed by the SAC. The hope is that by presenting TIS-B separately from the overall functional architecture, it will be easier to understand and agree the TIS-B architecture.

1.2 Scope

The objective of the TIS-B system is to provide the TIS-B Services in accordance with the TIS-B Requirements document [Ref 2]. The scope of this document is to describe the functional and non-functional requirements of the TIS-B system necessary to provide the required TIS-B Services. The scope of the TIS-B system is illustrated in green in the diagram below.



The current version of this document presents a high level view of the functions necessary for TIS-B. Further versions of this paper are not planned; the work will be progressed through the production of an overall ADS-B/TIS-B functional architecture document.

1.3 Terminology

The following terms are used throughout this document with the meanings as described below:

System: The collection of all sub-systems that make up TIS-B. The system is made up of a number of sub-systems.

Sub-system: is an element of the system. Each sub-system performs a cohesive set of functions. When the name of a sub-system is abbreviated, the abbreviation is capitalised. For example, the TIS-B Transmitter Sub-system may be abbreviated to the Transmitter.

Functions: are the activities that comprise each subsystem.

2 TIS-B System Overview

2.1 The TIS-B Service

The TIS-B System will provide multiple 'TIS-B Services'. Each TIS-B Service will provide a stream of TIS-B Reports with certain pre-defined characteristics, and will be identified by a Service Identifier included within each TIS-B report. The TIS-B User will determine which TIS-B Services are required and will identify and select the appropriate TIS-B reports using the Service Identifier.

A TIS-B Service will be defined by:

- A Service Identifier
- A TIS-B Traffic Information Volume (TIV)
- A TIS-B Service Volume (TSV)
- The Service Track Selection Criteria
- The Service Level
- The Service Quality

There are two volumes of airspace that are of interest to a TIS-B User. They are the 'Service Volume' and the 'TIS-B Traffic Information Volume'. The Service Volume is the volume of airspace in which the corresponding TIS-B Service is available to the users. The TIS-B Traffic Information Volume is the volume of airspace for which the TIS-B service will provide traffic information.

The Service Track Selection Criteria define which tracks are to be broadcast by the service. The Service Level defines which set of data items are to be sent in each TIS-B Report and at what frequency the TIS-B Reports are to be broadcast, and the Service Quality defines the expected availability, integrity, latency, accuracy, and report resolution for the service.

The TIS-B Services definitions will be published in paper form and made available to the Air Traffic Controllers, pilots and ground vehicle operators to inform them where a TIS-B Service is available, what service is available, and how to identify it. It is not proposed to broadcast any of this information as part of a TIS-B Service.

2.2 Airspace Volumes.

The functional architecture introduces two volumes of airspace which constrain the size of the Service Volume and the TIS-B Traffic Information Volume. They are called the 'RF Coverage Volume' and the 'Surveillance Coverage Volume'.

The RF Coverage Volume is the volume of airspace in which the groundstation infrastructure will provide reliable Radio Frequency coverage i.e. in which aircraft are guaranteed (within a certain probability) to be able to receive the TIS-B service being broadcast. The RF Coverage Volume constrains the Service Volume, i.e. the Service Volume must be contained within the RF Coverage Volume.

The Surveillance Coverage Volume is the volume of airspace in which the surveillance infrastructure (e.g. primary and secondary radars, Mode S, ADS-B groundstations) can provide reliable tracking of all targets i.e. the volume in which the Ground Surveillance Processing can generate tracks. The Surveillance Coverage Volume constrains the TIS-B Traffic Information Volume i.e. the TIS-B Traffic Information Volume must be contained within the Surveillance Coverage Volume.

The various volumes are illustrated in Figure 1 below. The diagram shows a TMA that is covered by a single Service Volume and with a larger TIS-B Traffic Information Volume. The RF coverage volume shows the extent of reliable transmission. The Surveillance Coverage Volume shows the extent of the radar coverage.

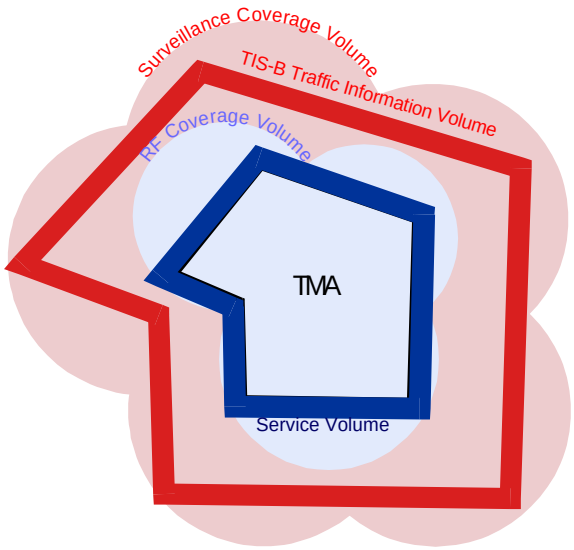


Figure 1 :TIS-B Volumes

The TIS-B Traffic Information Volume is defined separately from the TIS-B Service Volume to allow more flexible services to be defined. There could be circumstances where the TIV would be larger than TSV, for example a TSV could be defined to cover the airport surface that allows ground vehicles to see approaching aircraft as well, as illustrated in the diagram below. By allowing the SV to be defined separately from the TIV the range of the transmissions can be smaller and hence require a smaller transmission infrastructure to support it as well reducing the RF pollution.

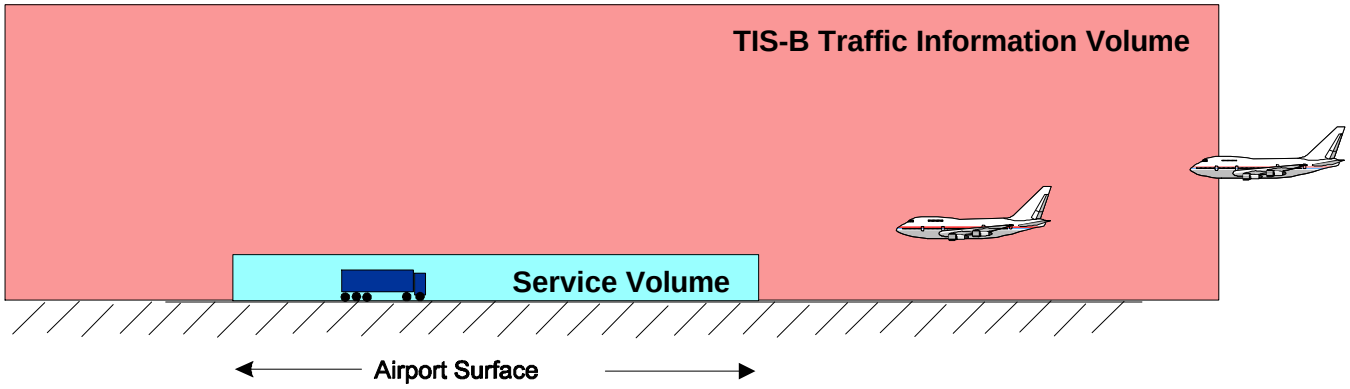


Figure 2: Example of different TIV and SV

Another example where it might be useful for the Service Volume to be smaller than the Traffic Information Volume is the case of blindspot in normal ADS-B reception. In this case a local TIS-B service could be defined to provide coverage in that area. This is illustrated below with an example of a blind spot between two buildings on the airport surface where an aircraft would not be able to receive normal ADS-B broadcasts from other ground traffic. In this case a simple transmitter covering the space between the buildings could provide a TIS-B service providing traffic information for the entire airport surface.

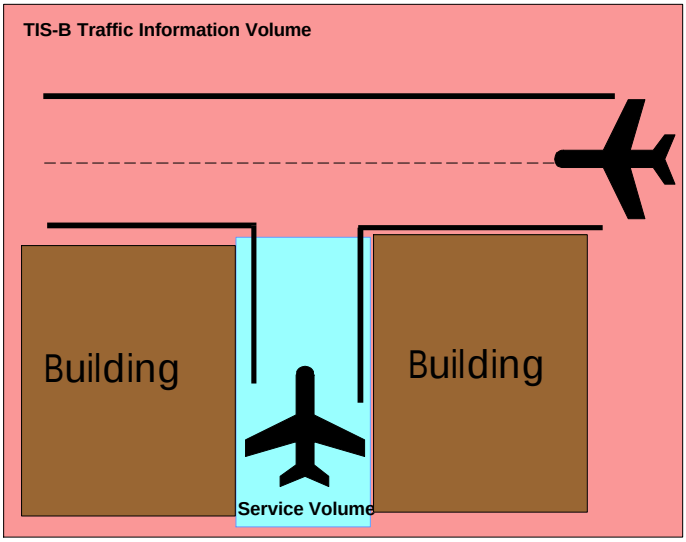


Figure 3: TIV and SV for Blindspot

2.3 TIS-B Sub-Systems

Figure 4 below shows the functional blocks that constitute the TIS-B system. The yellow boxes represent the ground sub-systems and the green box the mobile sub-system

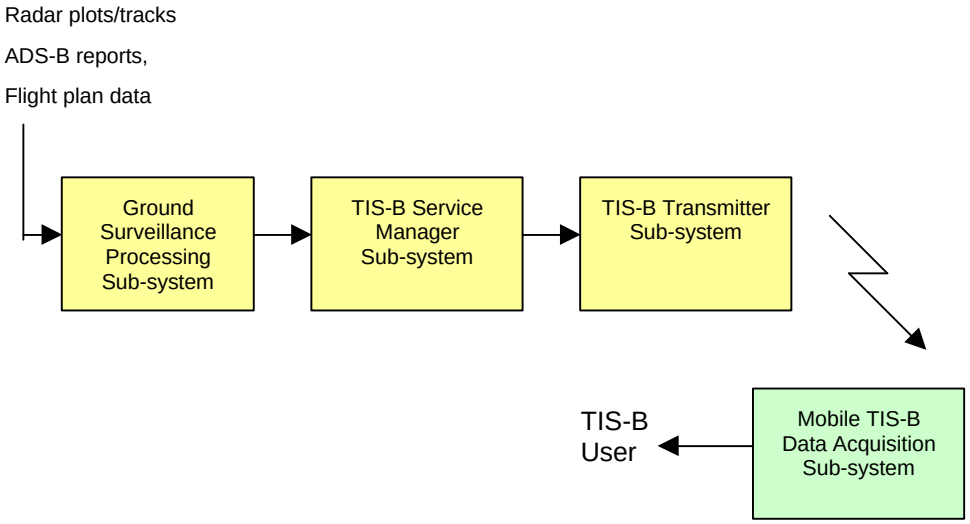


Figure 4: TIS-B Sub-systems

Figure 4: TIS-B Sub-systems will be used as the basis for the description of TIS-B functionality in this document. Section 3 of this document describes the system level requirements for TIS-B. Section 4 covers the ground sub-systems functions, and section 5 covers the mobile sub-system functions.

2.4 Definitions

For the definitions of 'Mobile', 'TIS-B User', 'TIS-B Report', 'Object of Interest (OOI)', and 'Track' please refer to the TIS-B requirements document [Ref 2]:

Additionally the following definitions are proposed:

TIS-B System

Definition: TBD. We need to define the scope of the system so that we can define appropriate requirements.

Status: Proposed.

TIS-B Service

Definition: a TIS-B Service is an identified stream of TIS-B reports with predefined characteristics made available to TIS-B Users.

Status: Proposed.

Surveillance Coverage Volume

Definition: The volume of airspace within which the Ground Surveillance Processing sub-system is able to provide tracks for all Objects of Interest.

Status: Proposed.

TIS-B Traffic Information Volume

Definition: the volume of airspace for which a TIS-B Service provides traffic information.

Status: Proposed.

TIS-B Service Volume

Definition: the fixed volume on the ground or in the air within which it is guaranteed (TBD - with a specified probability) to be possible to receive the corresponding TIS-B Service.

Status: Proposed.

RF Coverage Volume

Definition: The volume of airspace within which the TIS-B System can provide reliable transmission of the TIS-B reports. An RF Coverage Volume is the union of the individual Transmitter Coverage Volumes.

Status: Proposed.

Transmitter Coverage Volume

Definition: The volume of airspace within which a transmitter can provide reliable transmission of the TIS-B reports, given the characteristics of a reference receiver (TBD).

Status: Proposed.

2.5 Assumptions

The following assumptions have been made during the preparation of this document:

- Each individual track will need an indication of its accuracy. The current NUP TIS-B Service Description appears to assume the level of track quality will be determined by its source (e.g. multi-radar tracker). Although this is true to a degree in fact track quality can vary significantly between individual tracks depending upon the quality of the input data from which the track is created. So it is assumed that the applications will need an indication of track quality per track, although this will clearly depend upon the accuracy and integrity requirements of the chosen applications.
- In the gap filler role ADS-B equipped aircraft that are receiving a TIS-B service will be able to 'see' the other ADS-B equipped aircraft (using the same link technology) in the corresponding TIS-B Traffic Information Volume.

3 TIS-B System Level Requirements

This section describes requirements placed on the TIS-B System as a whole. This does not include availability, integrity, or performance requirements. These requirements will be defined in the TIS-B Requirements document and their allocation will have to be covered in the physical architecture design.

The TIS-B System shall be able to support multiple TIS-B Services.

This section needs some work!

3.1 TIS-B System Input Requirement:

Surveillance data for all Object Of Interest. Surveillance data include:

- radar plots/tracks (Including Multi-lateration, Fixed Field Transponder data)
- ADS-B reports

Flight Identification from the FPPS.

4 TIS-B Ground Sub-Systems

4.1 Ground Sub-Systems Overview

In the interests of a conceptually simple design and clear partitioning of the required functionality, the following principles have been applied to the distribution of functionality across the three ground sub-systems:

- The Ground Surveillance Processing sub-system should perform all tracking functions.
- The TIS-B Service Manager sub-system should manage all aspects of defining the TIS-B services and creating the appropriate messages for each service and each transmitter.
- The TIS-B Transmitter should handle aspects related to the successful transmission of the data e.g. format conversion, message scheduling, health monitoring and message transmission, as well as extrapolation of the state vector information to the time of transmission.

The Ground Surveillance Processing will generate tracks for all possible objects of interest, based on all available sensors (including ADS-B), indicate the accuracy of the state vector information, and send this information to the TIS-B Service Manager.

The TIS-B Service Manager will manage the service definition, select the appropriate tracks and data items required for each service, and then distribute the appropriate sub-set of tracks to each transmitter at a suitable update rate.

The TIS-B Transmitter will convert the data received from the TIS-B Service Manager into the appropriate format , extrapolate the state vector information to the time of transmission and broadcast the data..

Figure 5 below shows the allocation of functions to the ground sub-systems. The functions are described in the following paragraphs.

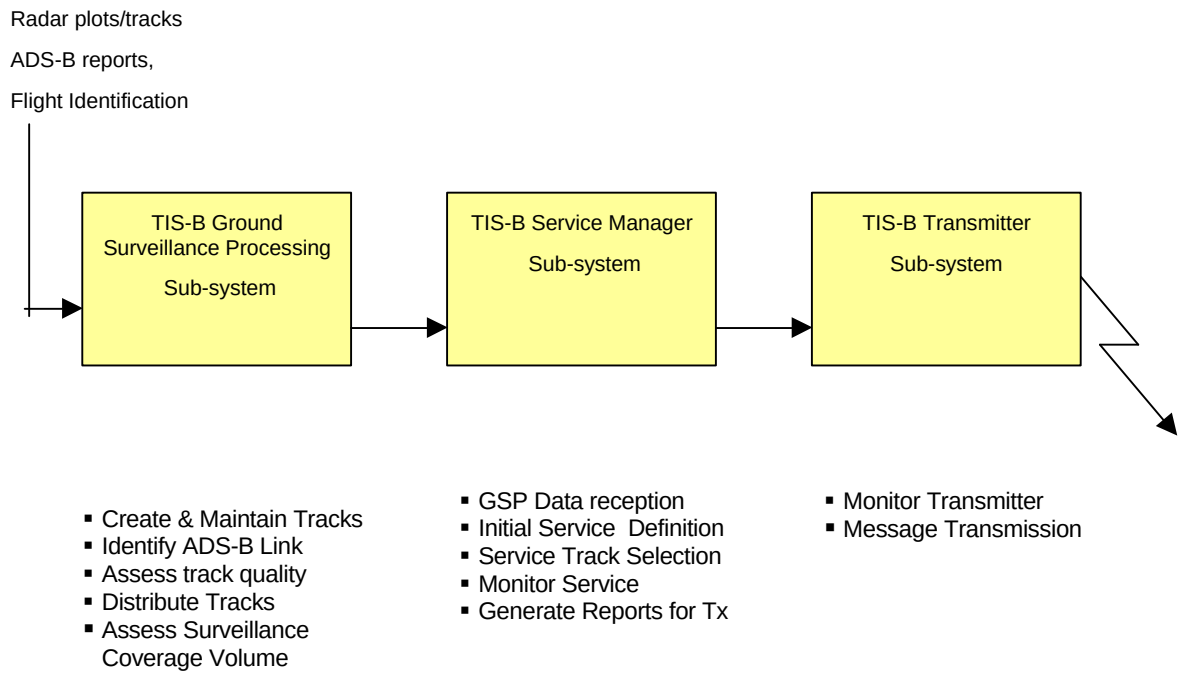


Figure 5: TIS-B Ground Sub-system Functions

4.2 TIS-B Ground Surveillance Processing sub-system

4.2.1 Create and Maintain Tracks

This function creates and maintains tracks, for each Object Of Interest, from the different input sensors (including radar, ADS-B) and merges the flight identification data from the FPPS.

4.2.2 Identify ADS-B Link

This function identifies the tracks whose associated Objects of Interest are transmitting ADS-B data. It also determines for each track how recently a target report has been received for each link technology (i.e. UAT, VDL4, ES). For example, a VDL4 target report has been received for track A 5 seconds ago, the last ES target report for track A was received 2 seconds ago, and a UAT target report has not been received for track A. This age data will be used by the TIS-B Service Manager to determine which tracks to include in a gap filler service.

4.2.3 Assess Track Quality

This function provides an indication of the track quality for each track.

4.2.4 Distribute Tracks

This functions distributes the track information to the TIS-B Service Manager as frequently as required to satisfy all the services of the TIS-B Service Manager. The data items required for all required service levels are sent.

4.2.5 Assess Surveillance Coverage Volume

The Surveillance Coverage Volume is the 3D volume of airspace for which the Ground Surveillance Processing can generate tracks. In the event that this is no longer possible for part or all of the existing SCV, for example because of a radar failure in an area where there is single radar coverage, this function will inform the TIS-B Service Manager of this change. The function will provide sufficient information to allow the TIS-B Service Manager to determine the new SCV. it is left to the design to determine how best to do this, but there are at least the two following possibilities: 1) this function sends a 3D map giving the available SCV, or 2) this function informs the TSM of the availability of individual sensors and the TSM determines the SCV itself.

4.3 TIS-B Service Manager Sub-system

The diagram below presents the high level functions of the TIS-B Service Manager.

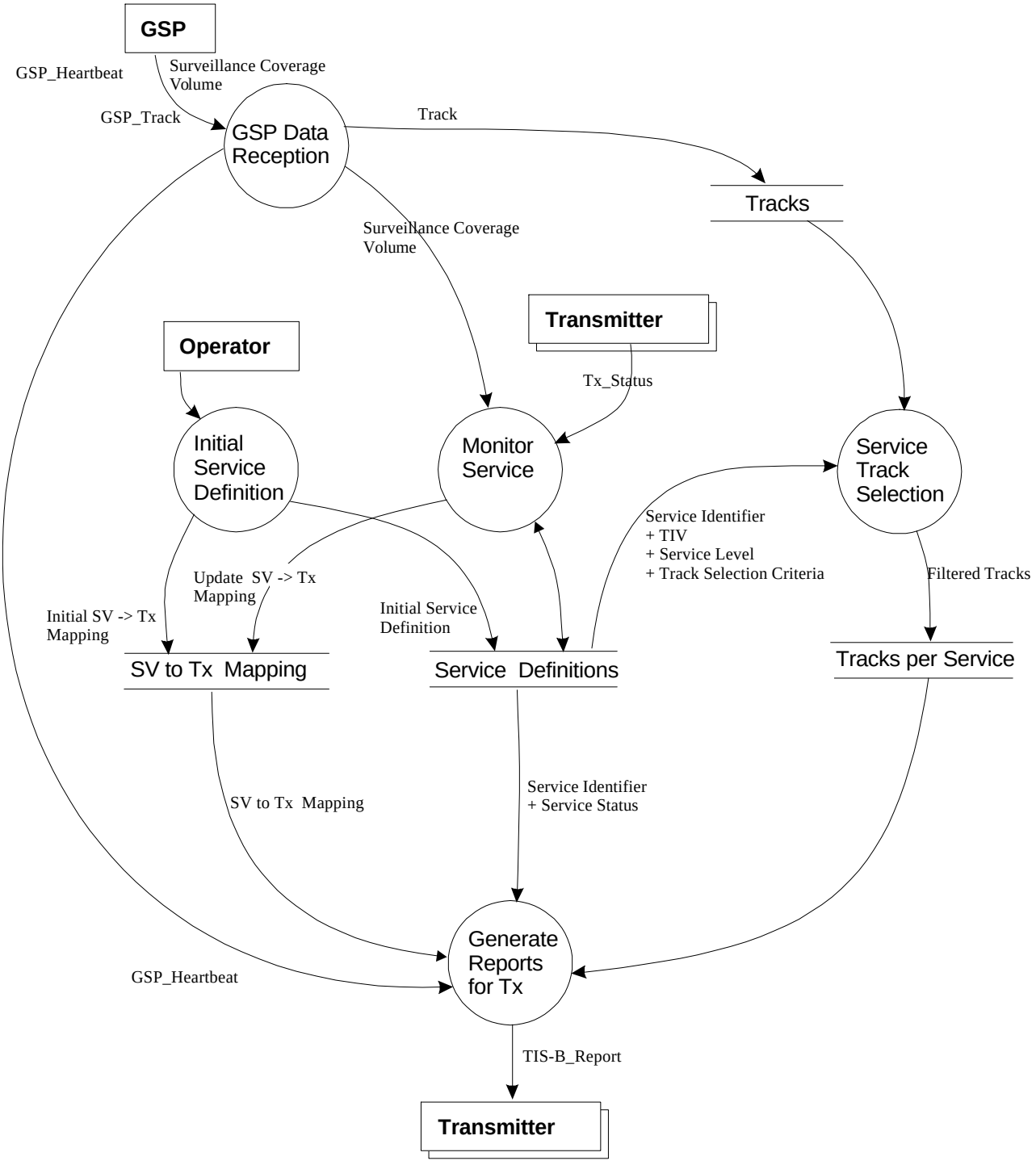


Figure 6: TIS-B Service Manager Data Flow Diagram

Data Store Descriptions:

Tracks:	This contains the complete set of tracks sent by the GSP, including all data items that may be required by any TIS-B Service, plus the Unique Identifier and the link age information.
Tracks Per Service:	This contains a set of tracks for each operational TIS-B Service defined in the Service Definitions data store.
Service Definitions:	This contains a definition of each TIS-B Service and its status.
SV to TX Mapping:	This contains a mapping from each Service Volume to the set of transmitters currently being used to cover that Service Volume. The initial mapping is defined by the operator, who also defines possible back-up transmitters for each transmitter. The mapping may then be changed by the 'Monitor Service' function to introduce one of the back-up transmitters in the event of a transmitter failure.

4.3.1 GSP Data Reception

This function handles the reception of tracks and GSP_heartbeat messages from the TIS-B Ground Surveillance Processing sub-system. It stores all GSP_tracks received and forwards the GSP_heartbeat messages to the Generate Heartbeat function.

This function also creates the unique identifier for each track. This identifier will be unique within the scope of a TIS-B service i.e no two aircraft within the same service may have the same the identifier, but the same aircraft may have different identifiers in different TIS-B Services, for example in the case where the different services are provided by different TIS-B Service Manager sub-systems.

4.3.2 Initial Service Definition

This function defines the TIS-B Service attributes: Service identifier, the Track Selection Criteria, the TIS-B Traffic Information Volume, the Service Volume, the Service Level to be supported (and hence which data items are to be sent in each TIS-B report and at what frequency), and the Service Level Quality .

This function also defines the Transmitter to Service Volume mapping based on the TIS-B Service definitions and the Transmitter Coverage Volumes data.

Each Service Volume shall be contained within the RF Coverage Volume.

Each TIS-B Traffic Information Volume shall be contained within the Surveillance Coverage Volume.

Service Volumes may overlap.

TIS-B Traffic Information Volumes may overlap.

The relationship between a TIS-B Service, Service Volume, TIV, and Transmitter Coverage Volume is illustrated below.

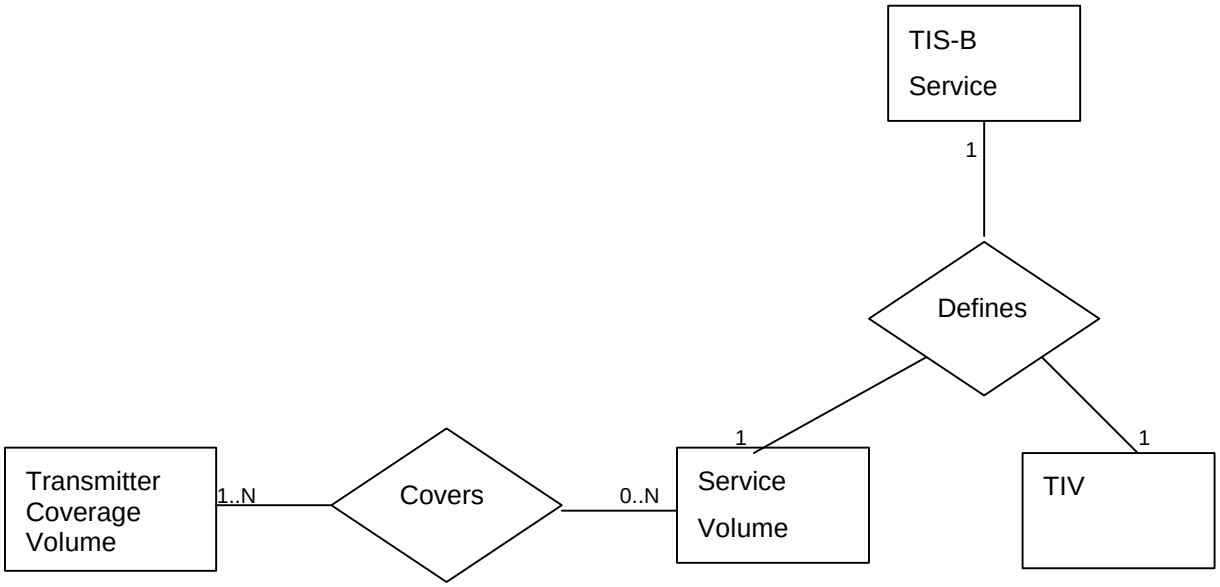


Figure 7: TIS-B Volumes Relationship

Each Transmitter Coverage Volume may cover up to 'n' Service Volumes.

Each Service Volume shall be covered by one or more Transmitter Coverage Volumes.

Each TIS-B Service defines a single Service Volume and a single TIS-B Traffic Information Volume (TIV).

Each TIV is defined by a single TIS-B Service.

Each Service Volume is defined by a single TIS-B Service.

A Service Volume shall be able to overlap with up to a maximum of 15 other Service Volumes.

4.3.2.1 Track Selection Criteria Definition

This function allows the definition of filters based on National Security and Defence requirements. These "National Security" filters may include the suppression of identified tracks, the suppression of specified data items for identified tracks, or the changing of certain data items for identified tracks.[1]

The filter will be characterised by both a 'Track Discriminator' to identify which tracks are to be considered and a 'National Security Action' which will identify what is to be done to the identified tracks.

The following can be used as the basis for a 'Track Discriminator':

- Callsign
- SSR Code
- 24 Bit Address

The following 'National Security Actions' are required:

- *Track Suppression*: where the identified track(s) are not provided by the TIS-B Service.

[1] This has yet to be properly addressed in the TIS-B requirements. This presents the results of some discussion within the TIS-B SAC meetings.

- *Data Item Suppression*: where an identified list of data items are no longer provided for the identified tracks.
- *Data Modification*: where an identified list of data items are allocated new values.

4.3.3 Service Track Selection

This function selects the tracks and the associated data items that are appropriate for each service based on the TIV, track selection criteria and service level defined in each service definition. For each service this function filters out tracks that are outside the TIS-B Traffic Information Volume then, if the gap filler role is specified, it filters out additional tracks based on the link technologies supported[2] and finally it applies any national security filters that are defined. For each track finally selected it selects the set of data items defined by the service level.

The data items identified by the Service Level are included in each track.

4.3.3.1 Filter tracks according to 3-D TIS-B Traffic Information Volume

This is a 3-D geographical filter that will filter out all tracks outside the TIS-B Traffic Information Volume. This implies that the “Create and Maintain track “ function should provide altitude and its accuracy with each track update .

The accuracy of the altitude information will be taken into account when determining whether a track update should be considered within a TIV. A track update should be served to all TIVs contained within the bounds of its error (do we want to specify how this error is to be quantified e.g. 2 standard deviations?). In the example below the track would be considered within TIV #1 and TIV #2.

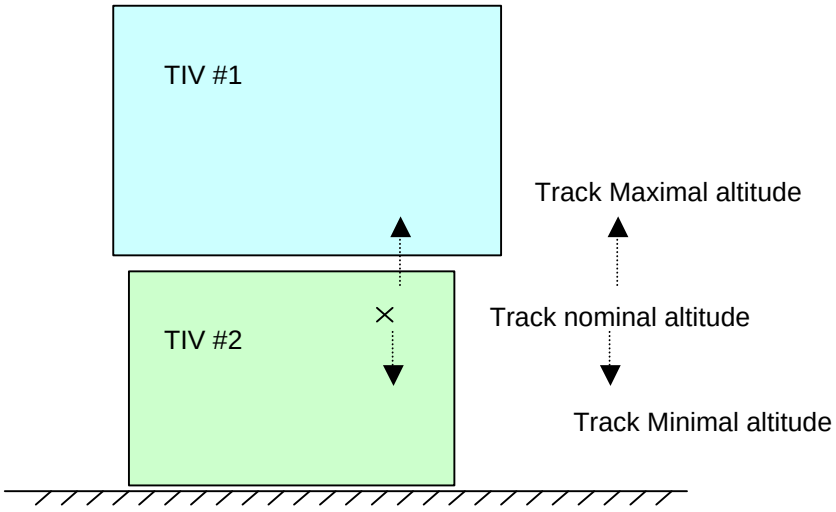


Figure 8: Allocation of track with poor vertical accuracy

Tracks that contain no altitude information at all (e.g. primary only tracks) will be considered within a TIV only if the 'include tracks with no altitude' flag is set as part of the service definition. If this flag is not set then the track

[2] There may be requirements for additional filtering out of military or 'anonymous' aircraft, and also to include tracks that have sent a 'bad' ADS target report. This is to be discussed in the concepts and requirements task force.

will not be included in the TIV. If the flag is set the track will be included in the TIV for the service irrespective of the vertical limits defined for the TIV of the service.

4.3.3.2 Filtering of Tracks by Role

If the service role is full picture, no further filtering is performed.

If the service role is 'Gap filler' tracks for ADS-B equipped mobiles that have transmitted using a link technology supported by the service within a parameter[3] time are filtered out.

4.3.3.3 National Security Filters

This function applies any National Security Filters that are defined.

4.3.4 Monitor Service

This function is responsible for monitoring each service. It monitors the status of the following items and updates the Service Status to 'suspended' when the service can no longer be provided:

- The health of the Transmitters
- The health of the TIS-B Service Manager
- The Surveillance Coverage Volume
- The quality of the tracks provided.

When the service is available again, this function re-instates the service by setting its Service Status to 'Online'.

Transmitters

This function handles the reception of the status message from each Transmitter.

If a Transmitter is out of service or degraded, the SV to Tx mapping will be updated to include an alternative Transmitter if one is available. If no alternative Transmitter is available then this function suspends the associated services.

TIS-B Service Manager .

This function detects when the TIS-B Service Manager is overloaded and then suspends the service of the lowest priority service (priority based on a pre-configured priority?).

The Surveillance Coverage Volume

This function assesses whether the Surveillance Coverage Volume as received from the Ground Surveillance Processing covers the TIS-B Traffic Information Volume of all services, and suspends those services for which surveillance coverage is no longer provided.

Quality of the Tracks

This function assesses whether the quality of the tracks matches the required performance for each service, and will suspend the service when the quality is not sufficient (TBD: precisely what this means/if it necessary. For example: Does the track data items accuracy distribution in the TIS-B Traffic Information Volume matches the required performance for this service, also should consider the timeliness of the track update i.e. the time of applicability of a track update must be within 'n' seconds of the current time)

[3] The inclusion of this parameter time is to include mobiles whose ADS-B equipment is no longer available (due to failure, being switched off, going outside ADS-B coverage etc.)

4.3.5 Generate Reports for Transmitter

This function addresses the selection and generation of the TIS-B Reports to be broadcast by each Transmitter. These reports consist of tracks and heartbeat messages.

This function selects the tracks for each transmitter, generates the heartbeat message and then forwards the appropriate tracks and heartbeat message to each transmitter.

4.3.5.1 Track Selection

There are two reasons why it may be necessary to divide the tracks between more than one Transmitter:

1. because a single Transmitter does not provide sufficient broadcast coverage.

   In this case all the tracks are sent to each Transmitter (or a transmitter set, see below).

2. because a single Transmitter cannot handle the expected load

   In this case a number of Transmitters will have to share the load. This grouping of Transmitters is referred to as a 'transmitter set'. The tracks shall be divided among the Transmitters that make up a transmitter set so that no individual Transmitter is overloaded. There are various ways in which the tracks could be divided among the available Transmitters (for example based on a geographical split, or equally shared etc) but there is no need to define a requirement on how this is done.

4.3.5.2 Generate Heartbeat

A heartbeat message is generated for each online service and sent to each Transmitter supporting the service. The heartbeat message will contain the Service Identifier and a count of the number of TIS-B reports generated for this service since the last heartbeat message. The heartbeat message is generated at the start of every broadcast update period.

If no GSP_Heartbeat message is received then no heartbeat messages are generated for the Transmitters.

4.3.5.3 Send Reports to Transmitter

This function handles the transmission of the tracks and heartbeat messages to each individual Transmitter.

It is responsible for ensuring the data load sent to the Transmitter is smoothed. It will divide the required Broadcast Update Period of the service into a number of sub-periods and transmit a batch of tracks each sub-period. The number of tracks contained within each batch will be approximately equal, so as to normalise the data load.

This will allow the slot allocation of the Transmitter to be designed to be efficient in terms of minimising the delay between reception of a track by the Transmitter and its transmission, and in terms of maximising the number of tracks that can be transmitted by a Transmitter.

This is illustrated for VDL4 in the figure below. The TSM output is smoothed so that every sub-period (in this case every 250ms) a batch of tracks is sent by the TSM. The TSM also ensures that the number of tracks sent in each batch are approximately the same (in this case 3). The Tx allocates a number of slots to the transmission of TIS-B targets (in this case three slots every 250ms). The fact that the TSM will output its tracks asynchronously from the Tx means that there will be delay, equal on average to half the batch period, introduced between when the Tx receives the tracks and when they are transmitted. The TSM and the slot allocation of the Tx will need to be tuned so that sufficient slots are available to handle the expected load without imposing an unacceptable delay in the transmission.

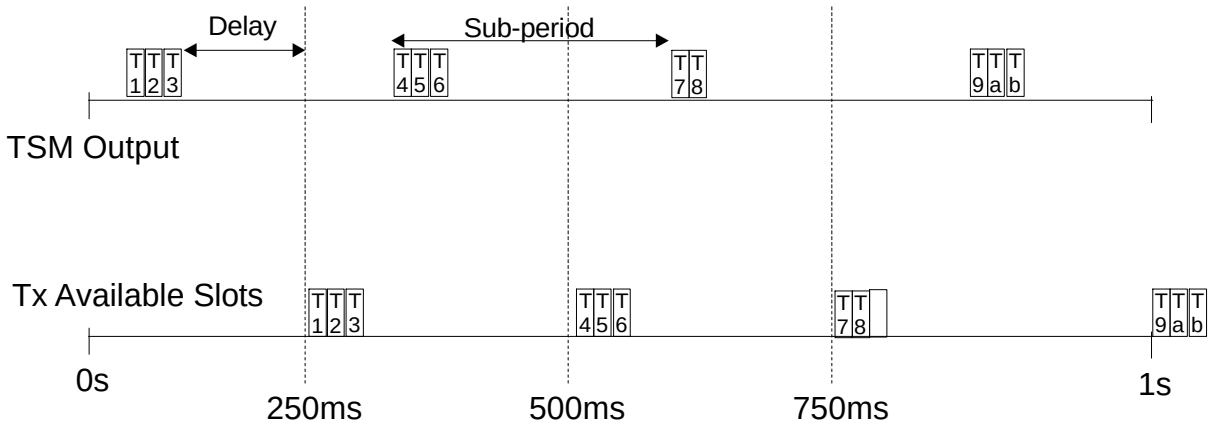


Figure 9: TSM Output for VDL4 Slot Allocation

The 1090 Extended Squitter link would also benefit from having a smoothed load. Extended Squitter has no concept of slots, and so assuming a ES transmitter would transmit the TIS-B Reports as soon as possible, there may be a need for a more frequent sending of smaller batches than in the VDL4 case. This tuning is left to the implementation to consider.

4.4 TIS-B Transmitter sub-system

This sub-system handles the transmission of the track updates and heartbeat messages. It converts the data from the ASTERIX format sent by the TIS-B Service Manager into the appropriate format for the link technology used and broadcasts the data as quickly as possible after reception. Also it monitors the health of the Transmitter and reports the status back to the TIS-B Service Manager.

4.4.1 Monitor Transmitter

The TIS-B Transmitter sub-system has to report it's status to the TIS-B Service Manager to allow the TIS-B Service Manager to take whatever recovery action may be required.

The TIS-B Transmitter sub-system shall periodically report it's status. The following statuses shall be supported:

- Offline: Which indicates that the Transmitter has been deliberately taken out of service.
- Online: Which indicates the Transmitter is available and functioning correctly.
- Failed: Which indicates that the Transmitter is unable to perform its function.
- Degraded: Which indicates that the Transmitter is temporarily unable to provide its normal level of service (for example it may be overloaded and unable to broadcast all data that it has received). Whether it is necessary to report several degraded modes is TBD.

4.4.2 Message Transmission

This function handles the reception of tracks and heartbeat messages from the TIS-B Service Manager, changes the format to the link specific format according to the service resolution, extrapolates the state vector information to the time of transmission and broadcasts the data.

5 TIS-B Mobile Sub-Systems

Figure 10 below shows the allocation of functions to the mobile sub-systems.

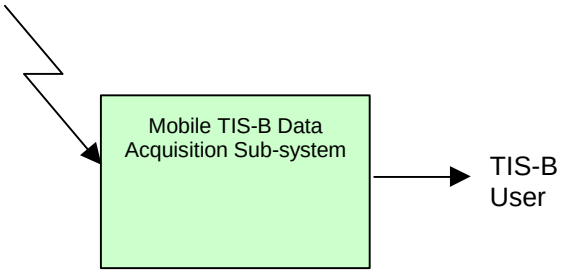


Figure 10: Mobile Sub-systems Functions

The mobile TIS-B data acquisition sub-system handles the reception of the TIS-B data from the link and forwards the data to the TIS-B User. It also monitors the TIS-B service and informs the TIS-B user when the service is no longer available. Two functions are identified:

- Airborne Service Monitoring
- Airborne Message Forwarding

5.1 Airborne Service Monitoring

The Airborne Service Monitoring function monitors the availability of the TIS-B service.

If either of the following two criteria are met then the Service is declared unavailable:

- QoS_{TIS-B}< 95%. Where QoS_{TIS-B} is the percentage of TIS-B targets[4] received for this Service within the TIS-B update period compared to the number announced by the following heartbeat message.
- Number of consecutive missed TIS-B heartbeat messages >= 3

QoS_{TIS-B} shall be calculated by the Airborne Service Monitoring function every time a heartbeat message is correctly received.

5.2 Airborne Message Forwarding

The TIS-B data acquisition sub-system shall forward the TIS-B reports to the TIS-B user in the required format (TBD).

[4] The aircraft may receive TIS-B reports for the same service from more than one transmitter so this function has to count the number of targets (i.e. aircraft or ground vehicles) not simply the number of TIS_B reports received.

APPENDIX A: Data Dictionary

The following is a partial data dictionary to describe the terms used in this document.

The following syntax is used:

:= means 'is composed of'

+ means 'in addition to'

a | b means a choice between a or b

n[a]m means " between 'n' and 'm' instances of 'a' "

(a) means "optionally 'a' "

Data_Item_Modification:=
    1[TIS-B_Data_Item + New_Value_for_data_item] n

Data_Item_Suppression:=
    1[TIS-B_Data_Items] n

Filtered_Tracks:=
    0 [Tracks_per_Service] max_no_of_services

Gap_Filler:=
    (VDL4)
    + (Ext_Squitter)
    + (UAT)

GSP_Heartbeat:= Some regular transmission that is present only while the GSP sub-system is functioning correctly.

GSP_Track:=
    State_Vector_Information
    + Link_Age_Information

Heartbeat:=
    Service_Identifier
    + TIS-B_Report_Count

Link_Age_Information:=
    UAT_Age
    + VDL4_Age
    + Ext_Squitter_Age

National_Security_Action:=
    Track_Suppression | Data_Item_Suppression | Data_Item_Modification

National_Security_Filter:=
    Track_Discrimintor
    + National_Security_Action

Role:=
    Full_Picture | Gap_Filler

Service_Level:=

1[TIS-B_Data_Items*]n
+ Broadcast_Update_Period

Service_Volume:=
3[Lat +Long]n
+Maximum Altitude
+ Minimum Altitude

Service_Quality:=
Expected_Service_Availability
+ Expected_Service_Integrity
+ Expected_Service_Latency
+ Expected_Service_Accuracy
+ Required_Report_Resolution

SV_to_Tx_Mapping:=
0 [Tx_Per_SV] max_no_of_SVs

TIS-B_Report:=
TIS-B_Target_Report | Heartbeat

TIS-B_Service:=
TIS-B_Service_Definition
+ Service_Status
+ 0[TIS-B_Report]n

TIS-B_Service_Definition:=
Service_Identifier
+ Traffic_Information_volume
+ Service_Volume
+ Track_Selection_Criteria
+ Service_Level
+ Service_Quality

TIS-B_Service_Status:=
Online | Suspended | Offline

TIS-B_Target_Report:=
1[TIS-B_Data_Items*]n

Track_Discriminator:=
0 [SSR Code] n
+ 0 [Callsign] n
+ 0 [24 bit address] n

Track_Selection_Criteria:=
Role
+ Include_tracks_with_no_altitude_flag

---

* See TIS-B requirements document for the definition of the possible data items.

* See TIS-B requirements document for definition.

+ National_Security_Filter

Traffic_Information_Volume:=
3[Lat +Long]n
+(Maximum Altitude + Minimum Altitude)

Track:=
GSP_Track
+ Track_Unique_Identifier

Tracks_per_Service:=
Service_Identifier
+ 0 [Track] max_no_of_tracks_per_service

Transmitter_Set:=
2[Tx] max_Txs_per_transmitter_set

Tx_Per_SV:=
Service_Volume
+ 1 [Tx | Transmitter_Set] max_no_of_Txs_per_SV

Tx:=
Main_Tx
+ (Backup_Tx)

Tx_Status:=
Offline | Online | Failed |Degraded