U.S. Department of Transportation

Federal Aviation Administration

Surveillance and Broadcast Services (SBS) Program Office

Surveillance and Broadcast Services Description Document

SRT-047, Revision 02

November 15, 2013

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Date 11/26/2013

Federal Aviation Administration
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Revision History for

Surveillance and Broadcast Services Description Document
SRT-042, Rev. 02

Revision #	Description	Document Date
Rev. 01	CM Baseline Version, DCR-SE-002	October 24, 2011
Rev. 02	Numerous changes to clarify TIS-B and FIS-B uplink behavior	November 15, 2013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Scope

This document discusses the design of the **air interface** between the Surveillance and Broadcast Services System (SBSS) and ADS-B equipped aircraft.

1.1 Summary: Background and Purpose

The overall purpose of this document is to describe the services provided by the Surveillance and Broadcast Services System (SBSS) over the Air Interface to ADS-B Equipped aircraft. It is oriented primarily to ADS-B avionics manufacturers. It documents the detailed design of the Air Interface to help ensure that vendor offerings of ADS-B avionics are fully compatible with the SBSS, and that they may be designed to take full advantage of the offered services.

In the NAS, there are two applicable ADS-B equipage types:

- 1090 Extended Squitter (1090ES): an extension of Mode-S technology in which 1090ES avionics periodically broadcast short messages at 1090 MHz that provide their identity (24-Bit Address), target state vector (position, velocity) and other aircraft status information.
- Universal Access Transceiver (UAT): a new technology in which UAT avionics periodically broadcast messages at 978 MHz that provide their identity, target state vector and other status information.

Each of the above equipage types may support only ADS-B-OUT services, or may be more comprehensive so that they support ADS-B-IN services as well. Table 1-1 introduces the ADS-B-OUT and -IN services that are provided by SBSS to aircraft with the different equipage types. It also describes the ADS-B air-to-air surveillance, which is complementary to, but independent of the broadcast services supported by SBSS. Each of these services will be described in increasing detail in Subsections 1 and 3 of this document.

Table 1-1 .SBSS Supported and Complementary ADS-B Services

Category	Service	Description
ADS-B-OUT Service (to Air Traffic Control)	ADS-B Surveillance (Air to Ground)	An SBSS service to FAA Air Traffic Control (ATC) that receives, formats, and forwards the received broadcast information of 1090ES and UAT ADS-B-OUT equipped aircraft
ADS-B-IN Services (to aircraft equipped with ADS-B-IN and ADS-B-OUT)	ADS-B Surveillance (Air-to-Air)	An 'in cockpit' service to 1090ES/UAT ADS-B-IN equipped aircraft that captures 1090ES/UAT squitters of proximate aircraft (independent of SBSS)
	ADS-B Rebroadcast (ADS-R)	An SBSS service to the cockpit of 1090ES/UAT ADS-B-IN equipped aircraft that supports ADS-B message translation and rebroadcast of the identity and state vector of proximate aircraft with UAT/1090ES ADS-B equipage
	Traffic Information Services - Broadcast (TIS-B)	An SBSS service to the cockpit of 1090 and UAT ADS-B-IN equipped aircraft that broadcasts the state vector of proximate aircraft that are not ADS-B equipped
	Flight Information Service – Broadcast (FIS-B)[1]	An SBSS service to the cockpit of UAT ADS-B-IN equipped aircraft that provides Meteorological and Aeronautical Information

The ADS-B-IN services of ADS-B (air-to-air), ADS-R and TIS-B, meet the requirements in the Aircraft Surveillance Applications Systems MOPS (ASAS MOPS, RTCA/DO-317A) to support a number of flight-deck based aircraft surveillance and separation assurance applications that may directly provide flight crews with surveillance information as well as surveillance-based guidance and alerts. Surveillance information consists of position and other state data about proximate aircraft, and also, when on or near the airport surface, position and other state data about appropriately equipped surface vehicles or obstacles. Numerous applications have been proposed, and it is expected that additional applications will be developed and standardized. Table 1-2 lists the currently planned applications with the corresponding SBS Service and/or Function that supports the respective applications along with the RTCA reference document(s).

[1] FIS-B services could actually be obtained with ADS-B IN only

Table 1-2. ADS-B Applications, Services, and Functions

Surveillance and Broadcast Services Enabled Applications	SBS Services				RTCA Reference(s)
	ADS-B	ADS-R	TIS-B	FIS-B	
ATC Surveillance for Enhanced Air Traffic Services in Radar-Controlled Areas Using ADS-B Surveillance (ADS-B-RAD)	X				DO-318
ATC Surveillance for ADS-B in Non-Radar-Airspace (NRA)	X				DO-303
Enhanced Traffic Situational Awareness During Flight Operations (ATSA-AIRB)	X	X	X		DO-319, DO-317A
Enhanced Visual Separation on Approach (ATSA-VSA)	X	X	X		DO-314, DO-317A
Airport Traffic Situation Awareness (ATSA) for Surface (SURF) Operations	X	X	X		DO-322, DO-317A
In-Trail Procedure in Oceanic Airspace (ATSA-ITP)	X				DO-312, DO-317A
Weather and NAS Situation Awareness				X	N/A
Ground-based Interval Management – Spacing (GIM-S)	X				N/A
Traffic Situation Awareness with Alerts (TSAA)	X	X	X		In Process
Airborne Spacing - Flight-Deck Based Interval Management–Spacing (FIM-S)	X	X	X		DO-328, In Process

Notes:

(1) The FAA ADS-B Out Rule Performance Requirements are only defined to support the ATC Surveillance application including RAD and NRA. Different requirements, which are more or less stringent, may apply to other applications.

(2) Applications highlighted in green are SBS baseline applications that are available NAS-wide with the rollout of ADS-B services and supporting avionics. Applications highlighted in Blue are currently being developed and anticipated to be supported in the 2014-2015 timeframe.

1.2 Subsystem Responsibility List: SBSS and External Interfaces

Figure 1-1 illustrates the SBSS in context with interfacing systems. The interfacing systems are as follows:

- ADS-B equipped aircraft in the National Airspace (NAS)
- The Meteorological and Aeronautical Data Source
- FAA service delivery points (SDP) for the pickup of target data (from radar and other sensors)
- FAA SDPs for the delivery of ADS-B target reports and other data that enables the FAA to independently monitor the status of services provides by the SBSS

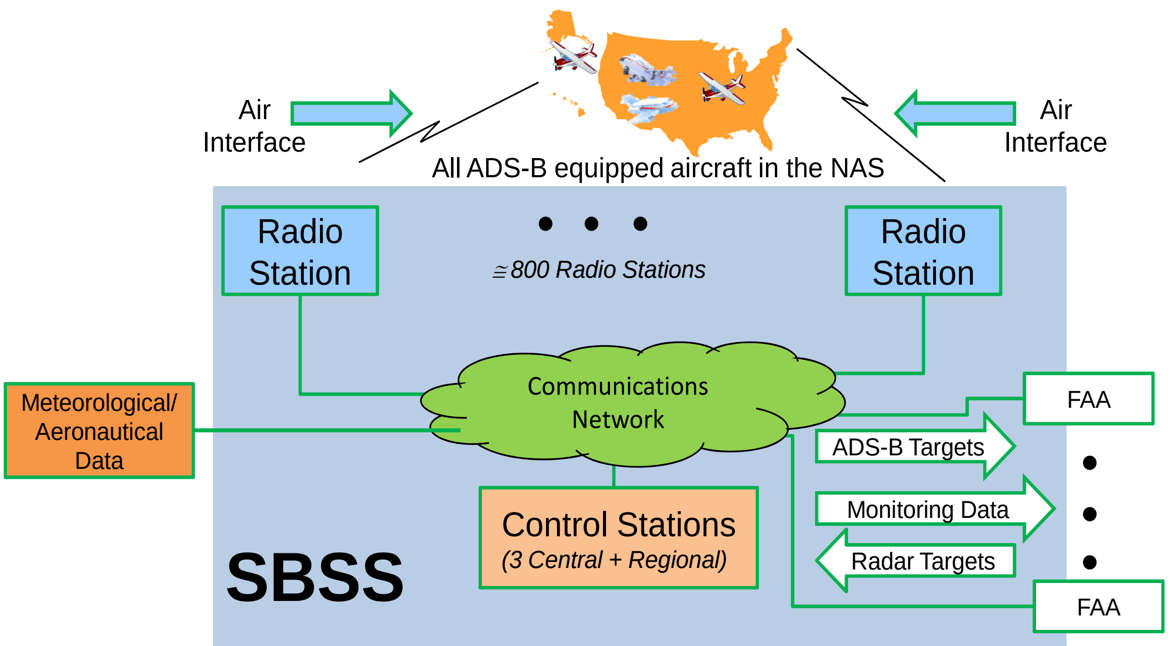

Figure 1-1. SBSS and External Interfaces

The basic components of the SBSS are also illustrated in Figure 1-1.

These are the following:

- Radio Stations that provide both uplink and downlink coverage over the air interface to all ADS-B equipped aircraft in the NAS
- Control Stations that process ADS-B reports, radar/sensor reports and meteorological/aeronautical data for distribution to end users
- A Communications network that provides the connectivity between all data sources (target, meteorological and aeronautical) the data processing Control Stations, and the end users

1.2.1 ADS-B Equipped Aircraft in the NAS

1.2.1.1 1090ES and UAT Equipages

The FAA ADS-B-OUT rule selected two acceptable ADS-B equipage types with different link technologies as indicated in Table 1-3 below. The requirements for 1090ES ADS-B avionics are specified in Technical Standards Order (TSO)-C166b and RTCA DO260-B MOPS. The requirements for UAT ADS-B avionics are specified in TSO-C154c and RTCA DO282-B MOPS. Aircraft with the same link technology are interoperable insofar as they 'see' each other when equipped with ADS-B-IN. Interoperability between aircraft with different ADS-B link technologies is provided by the SBSS via the ADS-R service or through dual receive capability in the aircraft.

Table 1-3. ADS-B Equipage Types in the NAS

Equipage Type	Description	Applicability
ADS-B 1090 Extended Squitter (ES)	An extension of Mode-S technology in which 1090ES avionics continuously broadcast short messages at 1090 MHz that provide their identity (24-Bit Address), target state (position, velocity, time-of-applicability) and other aircraft status information.	Aircraft that fly in high altitude airspace; 1090ES equipage has been coordinated with EUROCONTROL and other ANSPs as the globally harmonized interoperable link for ADS-B.
Universal Access Transceiver (UAT)	A technology in which UAT avionics broadcast messages at 978 MHz that provide their identity, target state and other status information	Mainly designated for GA aircraft that fly below FL180

1.2.1.2 Requirements of the Final Rule for ADS-B Equipage

The compliance date for the ADS-B-OUT FAA rule is January 1, 2020. The final rule requires aircraft flying at and above 18,000 feet MSL (flight level (FL) 180) (Class A airspace) to have ADS–B Out performance capabilities using the 1090 MHz ES broadcast link. The rule also specifies that aircraft flying in the designated airspace below 18,000 feet MSL may use either the 1090 MHz ES or UAT broadcast link.

In accord with the rule, compliant aircraft are only required to be equipped with ADS-B-OUT on a single link technology. However, it is envisioned that, though not required by the current rule, many aircraft would equip with ADS-B-IN as well in order to have access to the in-cockpit services afforded by ADS-B air-to-air service, as well as the SBSS services of ADS-R, TIS-B and FIS-B.

1.2.1.3 Dual Technology Link Equipage

Some use of dual-equipage by aircraft is also envisioned. While an aircraft may be fully dual equipped with ADS-B-IN and -OUT using both 1090ES and UAT, partial dual equipped configurations are also possible. For example, an aircraft equipped with 1090 ADS-B-OUT/IN and UAT ADS-B-IN, would be afforded FIS-B Service on the UAT link and, in addition, would be capable of receiving positions broadcast by UAT equipped aircraft in the vicinity without the need for ADS-R.

1.2.2 FAA SDP for Radar Data, ADS-B Target Delivery and Service Monitoring

At selected SDPs, SBSS picks up non ADS-B sensor target data that provides the basis for provision of the TIS-B Service. The sensor target data sources include En route Radars, Terminal Radars, ASDE-X, and MLAT systems. At some of the SDPS, the SBSS provides ADS-B targets to ATC, which uses this surveillance data in support of separation assurance services. Finally, the SBSS sends FAA Monitor SDPs a variety of data products that allow the FAA to independently monitor the performance of SBSS in its provision of ADS-B, ADS-R, TIS-B and FIS-B Services.

1.2.3 Meteorological and Aeronautical Data Source

Weather Services International (WSI) provides all FIS-B product data for the SBSS. The primary FIS-B Data Source, WSI's Andover MA facility, is a hardened facility with internal redundancy with a design uptime of well over 0.9999. This is complemented by the backup FIS-B Data Source at WSI's Atlanta GA facility.

1.3 SBSS Services Overview

1.3.1 ADS-B Surveillance Service

The Automatic Dependent Surveillance-Broadcast (ADS-B) service uses transmissions from ADS-B equipped aircraft to provide surveillance information to ground systems for air traffic control, and to other like-equipped aircraft with ADS-B-IN for use in aircraft situational awareness. The high level data flows for this service are highlighted in Figure 1-2 below. The figure illustrates both the air-to ground and air-to-air ADS-B[2].

[2] In Figure 1-2 through Figure 1-5, the "Non-Equipped" aircraft refers to ADS-B equipage. This aircraft does have a transponder.

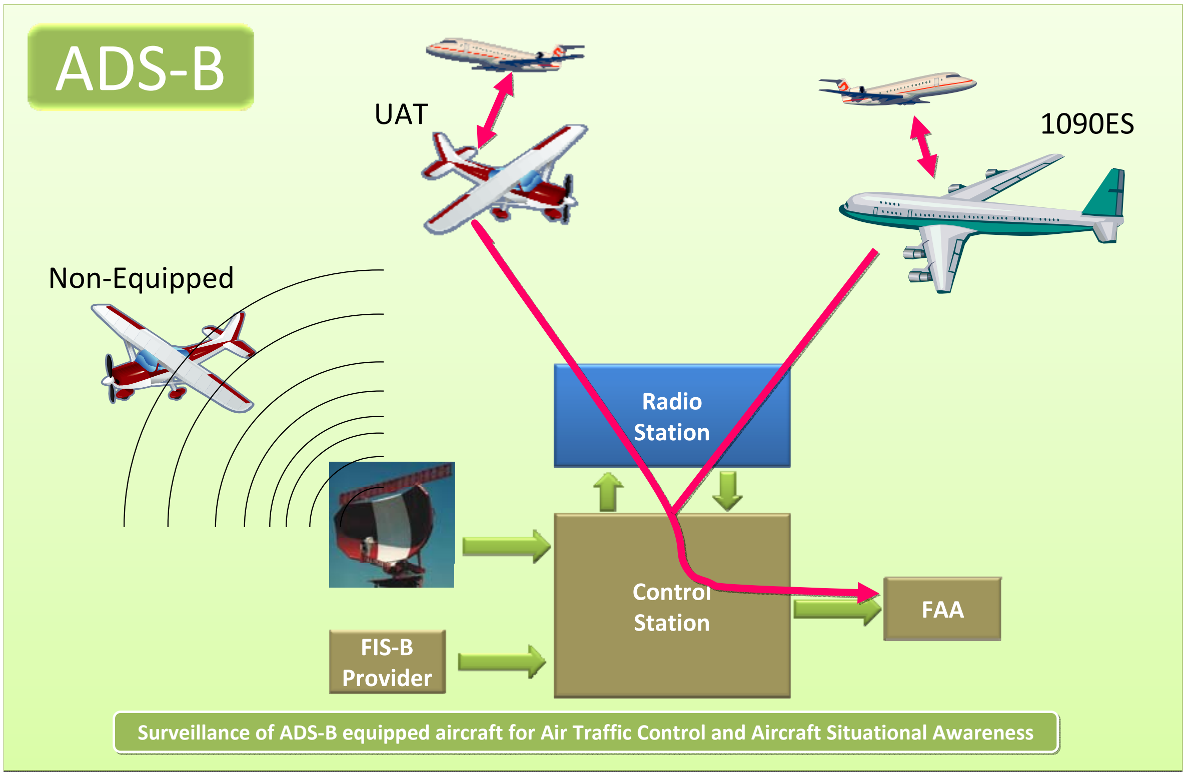

Figure 1-2. ADS-B Service Data Flows

1.3.1.1 Air-to-Air ADS-B

ADS-B-IN equipped aircraft are capable of receiving ADS-B transmissions from other aircraft equipped with the same link technology. This provides applications on board the aircraft with information about aircraft within range of the radio transmissions. The double arrows between aircraft in the above figure illustrate this transfer of position information between aircraft equipped with the same link technology. Note that air-to-air ADS-B is a complementary service to those provided by SBSS, but SBSS plays no part in air-to-air ADS-B other than to share access to the same RF channel.

1.3.1.2 Air-to-Ground ADS-B

The SBSS infrastructure of radio stations provides the capability of capturing surveillance information transmitted by ADS-B equipped aircraft anywhere in the NAS and providing the information to SBSS control stations. The control stations process received ADS-B reports, perform validity checks, and provide a low-latency feed of surveillance information to designated FAA SDPs for use in separation assurance and other ATC services.

1.3.2 ADS-R Service

Automatic Dependent Surveillance-Rebroadcast (ADS-R) is a service that relays ADS-B information transmitted by an aircraft using one link technology to aircraft within the proximity of active users of an incompatible link technology. The high level data flows supporting ADS-R are illustrated in Figure 1-3 below. The SBSS control station infrastructure monitors ADS-B transmissions by active ADS-B equipped aircraft and continuously monitors the presence of proximate aircraft with incompatible link technologies (i.e., UAT and 1090ES). When such aircraft are in proximity of each other, the SBSS control station infrastructure instructs ground radio stations within range of both aircraft to rebroadcast surveillance information received on one link frequency to aircraft on the other link frequency. The ADS-R Service currently supports only advisory level surveillance applications.

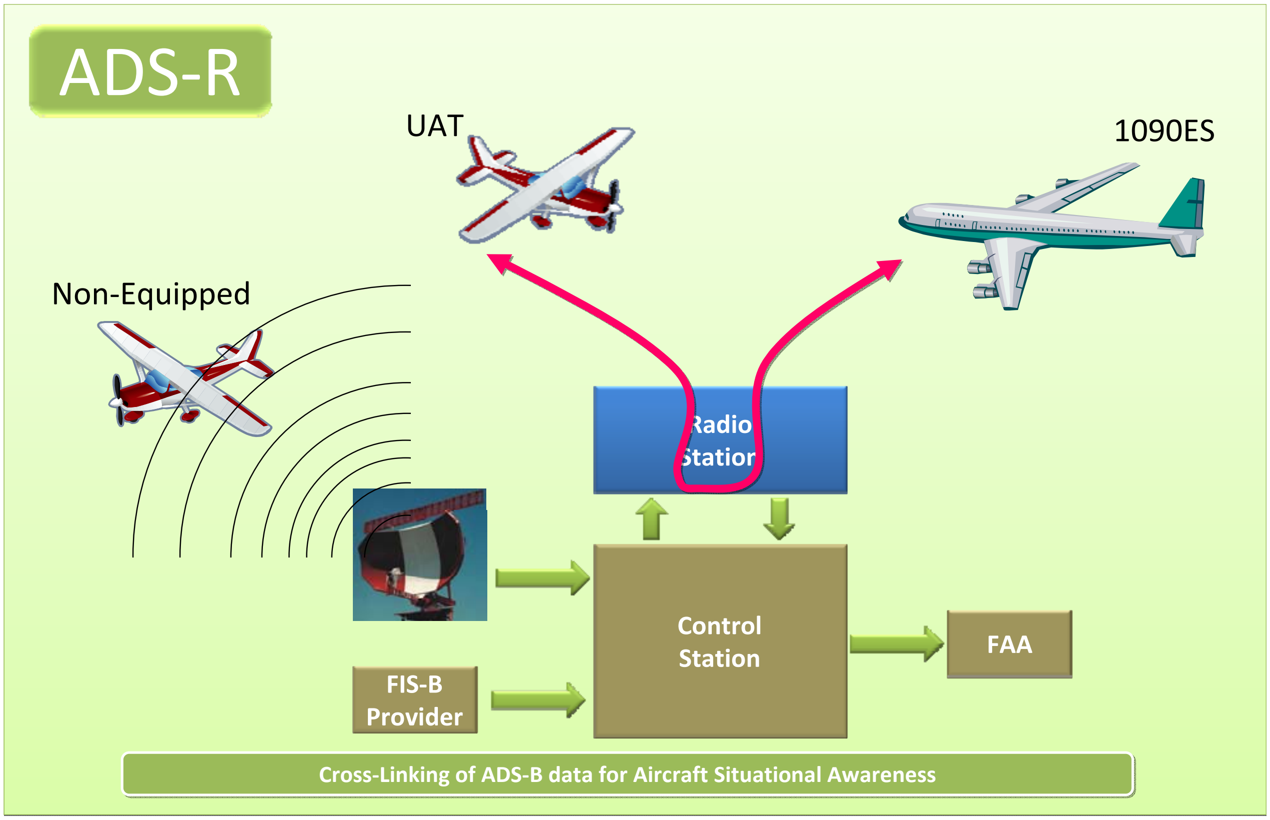

Figure 1-3. ADS-R Service Data Flows

1.3.3 TIS-B Service

Traffic Information Service-Broadcast (TIS-B) is a service provided by the SBSS that provides ADS-B equipped aircraft with surveillance information for aircraft that are not ADS-B equipped. This allows the aircraft to receive surveillance information for aircraft not equipped with ADS-B. The high level data flows supporting TIS-B are illustrated in Figure 1-4 below. At FAA SDPs, SBSS receives surveillance information from non-ADS-B surveillance systems, including radar, ASDE-X and multilateration systems. Within SBSS, this non-ADS-B surveillance information from multiple systems is fused with ADS-B and correlated to defined tracks. The SBSS system used this information to transmit TIS-B targets for non-ADS-B-equipped aircraft that are in proximity to active ADS-B-IN users. The TIS-B Service is complementary but orthogonal to the ADS-R service and ADS-B air-to-air such that ADS-B-IN users will see a complete picture of the nearby targets without redundancy. The TIS-B Service supports only advisory level surveillance applications.

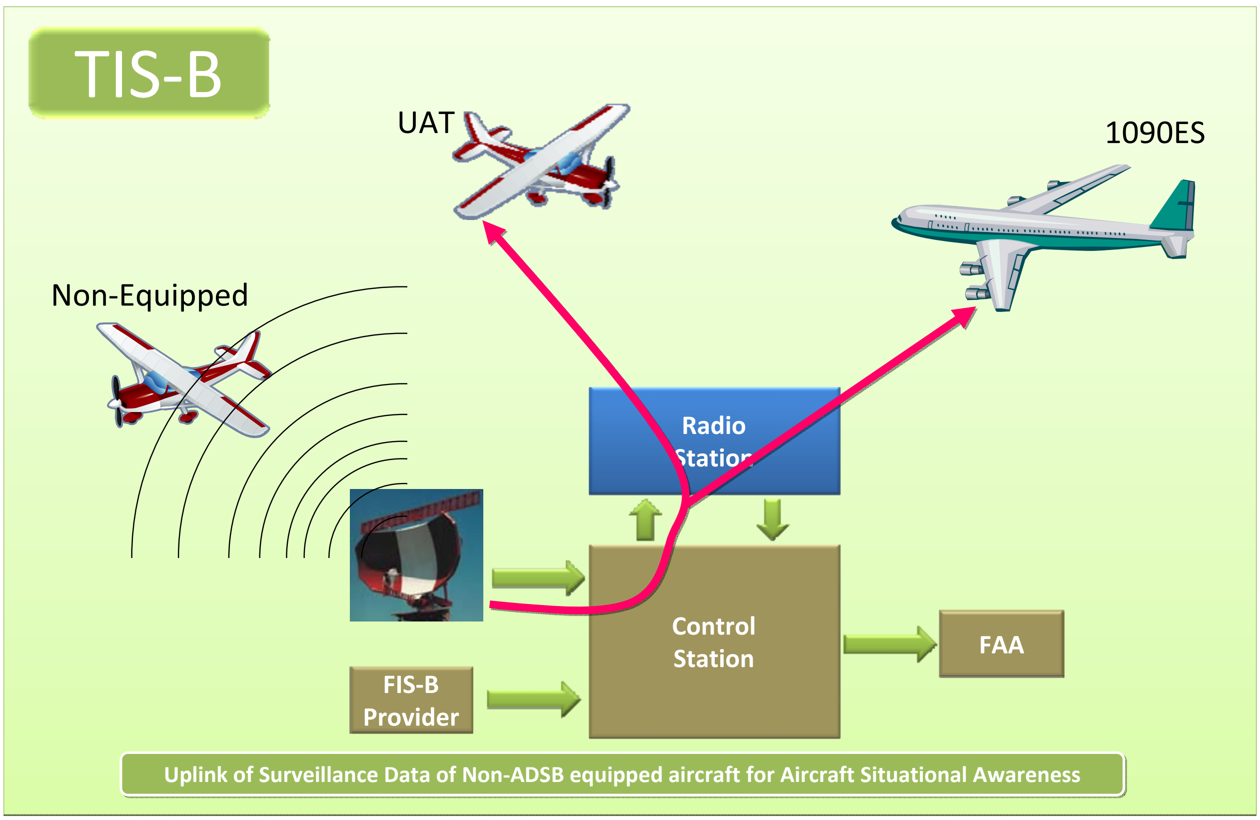

Figure 1-4. TIS-B Service Data Flows

1.3.4 FIS-B Service

Flight Information Service-Broadcast (FIS-B) service provides meteorological and aeronautical data to the cockpit. The high level data flows supporting FIS-B are illustrated in Figure 1-5 below. The SBSS control station ingests weather and aeronautical data and broadcasts generated sets of products specific to the location of a radio station. These products are broadcast over the UAT link, so pilots have timely information of regional weather and NAS status/changes that might impact flight.

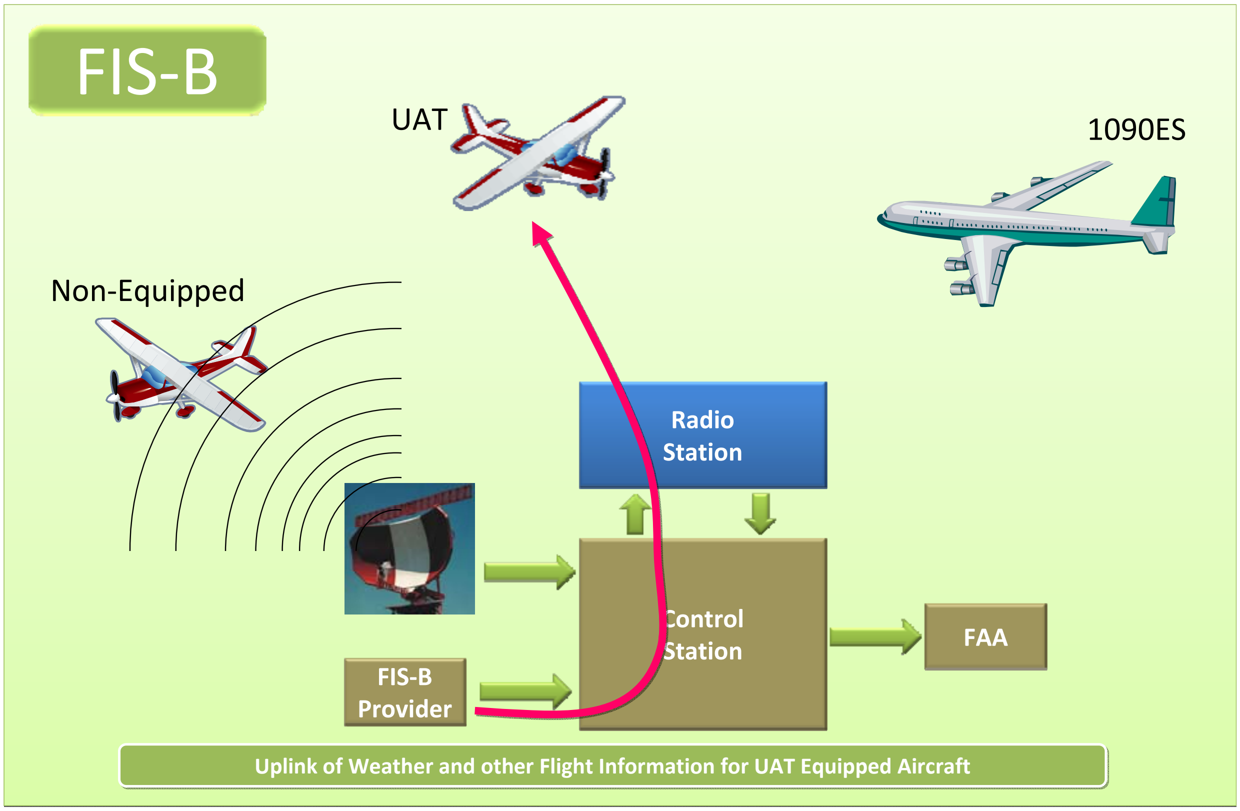

Figure 1-5. FIS-B Service Data Flows

1.3.4.1 Current FIS-B products

The subsection provides an overview of each of the currently-implemented FIS-B products in Table 1-4 below.

Table 1-4. FIS-B Products Provided by SBSS

Product	Description	Upstream Data Source
AIRMET	Airmen's Meteorological Information (AIRMET) is a weather advisory issued by a meteorological watch office for aircraft that is potentially hazardous to low-level aircraft and/or aircraft with limited capability. Compared to SIGMETs, AIRMETs cover less severe weather: moderate turbulence and icing, surface winds of 30 knots, or widespread restricted visibility.	NOAAport, FAA AIDAP
SIGMET	Significant Meteorological Information (SIGMET) is a concise description of the occurrence or expected occurrence of specified En Route weather phenomena which may affect the safety of aircraft operations. SIGMETs are intended for dissemination to all pilots in flight to enhance safety. SIGMETs will be issued by the responsible MWO as soon as practical to give notice to operators and aircrews of potentially hazardous en-route conditions.	
Convective SIGMET	A Convective SIGMET will be issued when the following conditions are occurring or, in the judgment of the forecaster, are expected to occur: a. A line of thunderstorms at least 60 miles long with thunderstorms affecting at least 40 percent of its length. b. An area of active thunderstorms affecting at least 3,000 square miles covering at least 40 percent of the area concerned and exhibiting a very strong radar reflectivity intensity or a significant satellite or lightning signature. c. Embedded or severe thunderstorm(s) expected to occur for more than 30 minutes during the valid period regardless of the size of the area.	
METAR	METAR (aviation routine weather report) is a format for reporting weather information. METARs are predominantly used by pilots in fulfillment of a part of a pre-flight weather briefing. METARs typically come from airports or permanent weather observation stations.	
CONUS NEXRAD	Next-Generation Radar (NEXRAD) is a nationwide network of high-resolution Doppler weather radars, which detect precipitation and atmospheric movement or wind. It returns data which when processed can be displayed in a mosaic map which shows patterns of precipitation and its movement. The "CONUS NEXRAD" FIS-B product is a summary composite of available NEXRAD radar imagery across the 48 states.	NOAAport, NWS Central Weather Service for single-site NEXRAD
Regional NEXRAD	Next-Generation Radar (NEXRAD) is a nationwide network of high-resolution Doppler weather radars, which detect precipitation and atmospheric movement or wind. It returns data which when processed can be displayed in a mosaic map which shows patterns of precipitation and its movement. The "Regional NEXRAD" FIS-B product is a composite of available NEXRAD radar imagery in a local area, showing a more detailed image than the "CONUS NEXRAD" product.	

Product	Description	Upstream Data Source
NOTAM	Notice To Airmen (NOTAM) is created and transmitted by government agencies under guidelines specified by Annex 15: Aeronautical Information Services of the Convention on International Civil Aviation. A NOTAM is filed with an aviation authority to alert aircraft pilots of any hazards En Route or at a specific location. The FIS-B NOTAM product consists of NOTAM-Ds and NOTAM-FDCs (including TFRs).	Text: FAA AIDAP, Graphic: NAIMES NIWS
PIREP	Pilot Report (PIREP) is a report of actual weather conditions encountered by an aircraft in flight. This information is usually radioed by a flight crew to the nearest Flight Service Station (FSS). The PIREP is then encoded and made available to other weather offices and air traffic service units.	NOAAport, FAA AIDAP
SUA Status	Special Use Airspace (SUA) is an area designated for operations of a nature such that limitations may be imposed on aircraft not participating in those operations. Often these operations are of a military nature. The designation of SUAs identifies for other users the areas where such activity occurs, provides for segregation of that activity from other users, and allows charting to keep airspace users informed of potential hazards. SUAs are usually depicted on aeronautical charts.	FAA SUA Gateway
TAF	Terminal Aerodrome Forecast (TAF) is a format for reporting aviation weather forecast information. Generally a TAF is a 9- or 12-hour forecast, though some TAFs can cover an 18- or 24-hour period. TAFs complement and use similar encoding to METAR reports. They are produced by a human forecaster based on the ground. For this reason there are fewer TAF locations than there are METARs. TAFs can be more accurate than Numerical Weather Forecasts, since they take into account local, small-scale, geographic effects.	NOAAport, FAA AIDAP
Winds and Temperatures Aloft	Winds and Temperature Aloft Forecast is forecast for specific atmospheric conditions in terms of wind and temperature in a specific altitude measured mostly in feet (ft) above mean sea level (MSL). The forecast is specifically used for aviation purposes.	
TIS-B/ADS-R Service Status	TIS-B Service Status provides users with a near real-time indication of the availability of TIS-B and ADS-R Service in their immediate operating area. The SBSS determines to which aircraft/vehicle the TIS-B and ADS-R service will be made available and transfers this data to the FIS-B Service, which formats and transmits the data in UAT Ground Uplink Messages.	Derived by SBSS TIS-B and ADS-R services

1.3.4.2 Growth Options: New FIS-B products

This subsection provides an overview of candidate FIS-B products in Table 1-5 below that may be provided by SBSS in the future.

Table 1-5. Candidate Future FIS-B Products

Product	Description
Echo Tops	The Echo Top radar-derived product depicts the tops of precipitation in an intuitive graphical image. The addition of cell movement speed and direction as well as storm features (such as the presence of hail or cyclonic rotation).
Cloud Tops	A Cloud Top product is particularly useful for the GA pilot to understand the sky conditions and how high the tops of clouds extend. This keeps the VFR pilot informed on potential problems in remaining clear of clouds or in helping pilots determine a comfortable cruising altitude. The product is derived from GOES satellite imagery.
Icing NowCast	The Icing NOWcast is a series of raster images that depict the most severe icing level within the band of altitudes covered by that range. These ranges cover from the surface to FL240, with each image depicting the worst level icing in that range. In addition, the product indicates the presence or absence of Supercooled Large Droplet formation in that altitude range.
OMO	One-Minute Observations (OMO) would provide a more-frequently updated and transmitted set of airport weather observations (for a subset of reporting points compared to the existing METAR product).
Lightning	Lightning summary data would present lighting strikes on a display map to assist pilots in determining the most severe areas of convective activity within areas of potentially dangerous weather. The data would be sourced from an existing nationwide commercial lightning detection network.
D-ATIS	Digital Automated Terminal Information System (D-ATIS) is a digital uplink of recorded non-control information in busier Terminal areas. ATIS broadcasts contain essential information, such as weather information, which runways are active, available approaches, and any other information required by the pilots, such as important NOTAMs.

1.4 Message Interchange Summary

Table 1-6. Message Interchange Summary

Applicable Service	Report Type	Format	Providing System	Receiving System
ADS-B Surveillance	ADS-B 1090ES Squitters	DO-260B MOPS	1090ES Avionics	SBSS and 1090ES Avionics
	ADS-B UAT Transmissions	DO-282B MOPS	UAT Avionics	SBSS and UAT Avionics
ADS-R Broadcast	ADS-R 1090ES Squitters	DO-260B MOPS	SBSS	1090ES Avionics
	ADS-R UAT Transmissions	DO-282B MOPS	SBSS	UAT Avionics
TIS-B Broadcast	TIS-B 1090ES Squitters	DO-260B MOPS	SBSS	1090ES Avionics
	TIS-B UAT Transmissions	DO-282B MOPS	SBSS	UAT Avionics
FIS-B	FIS-B Data Products	DO-282B MOPS, DO-267A MASPS, FIS-B Product Description documents	SBSS	UAT Avionics

2 Referenced Documents

2.1 The documents listed in this section can be referenced to give further details on the material provided in this document. Government Documents

Externally Referenced Documentation			
Organization	**Document Number**	**Title**	**Date**
FAA	NAS-IR-82530001	Surveillance and Broadcast Services (SBS) Service Delivery Point (SDP) Interface Requirements Document (IRD) – Version 3.5	April 18, 2012
FAA	FAA-E-3011	Automatic Dependent Surveillance-Broadcast (ADS-B) / ADS-B Rebroadcast (ADS-R) Critical Services Specification, Version 2.10	October 3, 2012
FAA	FAA-E-3006	Traffic Information Service – Broadcast (TIS-B) / Flight Information Service – Broadcast (FIS-B) Essential Services Specification, Version 2.7	October 3, 2012
FAA	FAA-STD-25F	U.S. Department of Transportation, Federal Aviation Administration, Standard, Preparation of Interface Documentation	December 30, 2007
FAA	FAA-STD-039C	U.S. Department of Transportation, Federal Aviation Administration, Standard Practice, National Airspace System (NAS) Open System Architecture and Protocols	August 14, 2003
FAA	NAS-SR-1000 Rev B	National Airspace System System Requirements Specification	June 2008
FAA	TAF2007-2025	Terminal Area Forecast Summary	2007
FAA/DOT	TSO-C166b	Technical Standards Order - Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)	December 2, 2009
FAA/DOT	TSO-C154c	Technical Standards Order - Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz	December 2, 2009
FAA/DOT	TSO-C195a	Avionics Supporting Automatic Dependent Surveillance – Broadcast (ADS-B) Aircraft Surveillance Applications (ASA)	Feb 29, 2012

Externally Referenced Documentation			
Organization	**Document Number**	**Title**	**Date**
FAA	SBS-006-05-20100823	National Airspace System Surveillance and Broadcast Services Concept of Operations (SBS CONOPS)	Aug 23, 2010
FAA/NWS	AC 00-45G Change 1	Aviation Weather Services	July 29, 2010

Copies of FAA specifications, standards, and publications may be obtained from The National Airspace System (NAS) Documentation Control Center (DCC). Federal Aviation Administration ACM-20-NAS Documentation Control Center 800 Independence Avenue, SW Washington, DC 20591 or http://www.faa.gov/ . Requests shall clearly identify the desired material by number and date and state the intended use of the material.

2.2 Non Government Documents

Externally Referenced Documentation			
Organization	**Document Number**	**Title**	**Date**
RTCA	DO-260B	1090 ADS-B MOPS Plus Corrigendum 1	December 2, 2009 December 13, 2011
RTCA	DO-282B	UAT ADS-B MOPS Plus Corrigendum 1	December 2, 2009 December 13, 2011
RTCA	DO-317A	ASA and MOPS	December 13, 2011
RTCA	DO-267A	FIS-B MASPS	April 29, 2004
RTCA	DO-338	Minimum Aviation System Performance Standards (MASPS) for ADS-B Traffic Surveillance Systems and Applications (ATSSA)	June 13, 2012
RTCA	DO-278	Guidelines for CNS/ATM Systems Software Integrity Assurance	March 5, 2002
RTCA	DO-318	Safety, Performance and Interoperability Requirements Document for Enhanced Air Traffic Services in Radar-Controlled Areas Using ADS-B Surveillance (ADS-B-RAD)	Sept 9, 2009
RTCA	DO-303	Safety, Performance and Interoperability Requirements Document for the ADS-B Non-Radar-Airspace (NRA) Application	Dec 13, 2006
RTCA	DO-319	Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness During Flight Operations (ATSA-AIRB)	March 17, 2010

Externally Referenced Documentation			
Organization	**Document Number**	**Title**	**Date**
RTCA	DO-314	Safety, Performance and Interoperability Requirements Document for Enhanced Visual Separation on Approach (ATSA-VSA)	Dec 16, 2008
RTCA	DO-322	Safety, Performance and Interoperability Requirements Document for ATSA-SURF Application	Dec 8, 2010
RTCA	DO-312	Safety, Performance and Interoperability Requirements Document for the In-Trail Procedure in Oceanic Airspace (ATSA-ITP) Application	June 19, 2008
RTCA	DO-328	Safety, Performance and Interoperability Requirements Document for Airborne Spacing – Flight Deck Interval Management (ASPA-FIM)	June 21, 2011

3 Air Interface Characteristics: Service Descriptions

3.1 General Air Interface Characteristics

This section provides the characteristics of the air interface between the SBSS and ADS-B equipped aircraft that defines the proper connectivity to support the offered services. A high level end-to-end picture is provided in Figure 3-1 below that highlights the SBSS and ADS-B equipped aircraft end systems, and the message transfer that takes place between them over the air interface. An aircraft or vehicle that is ADS-B-OUT and ADS-B-IN is considered to be an ADS-B *Client* since they can receive ADS-B messages from ADS-B *Targets* on the same link air-to-air as well as receive ADS-B data from the SBSS on that link.

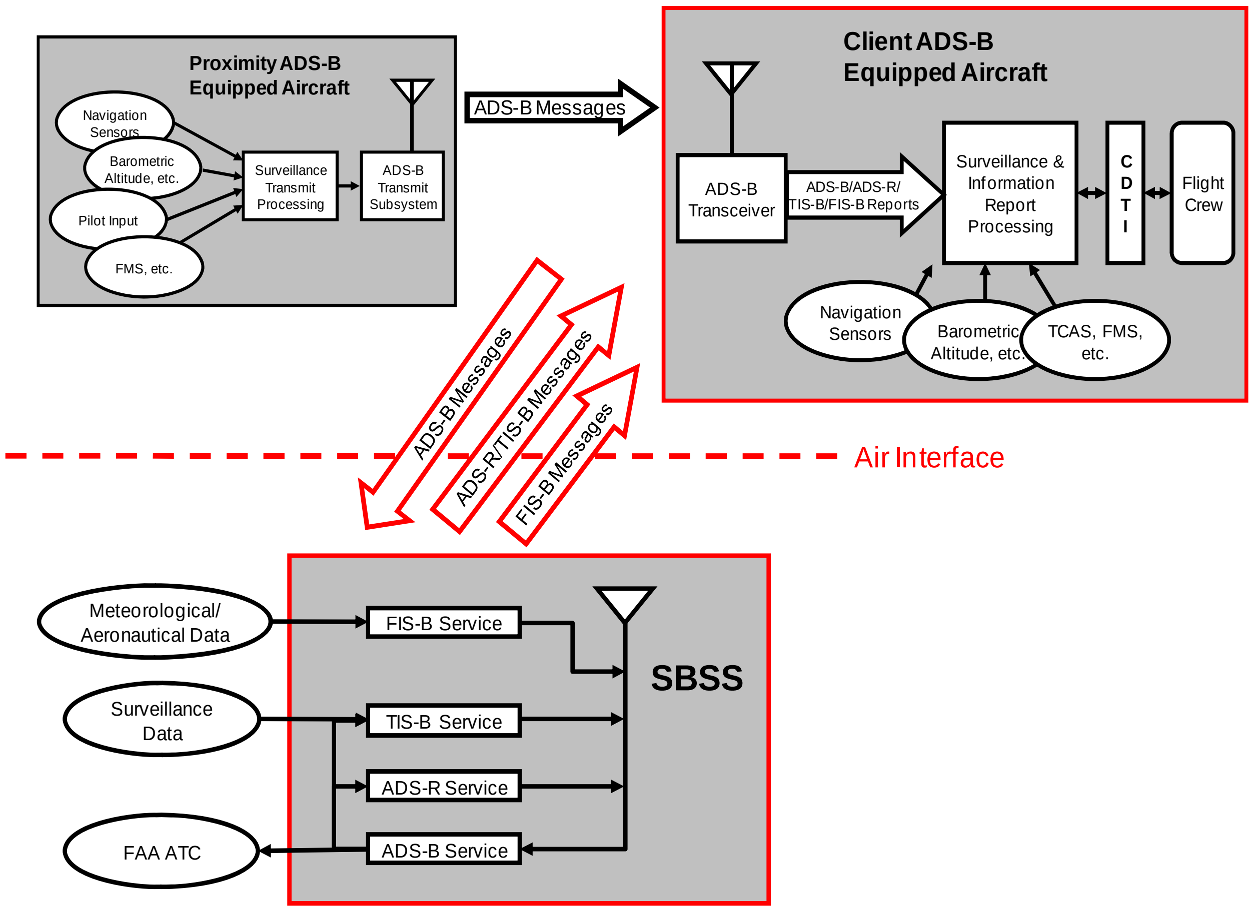

Figure 3-1. SBSS and ADS-B Aircraft Interconnectivity

3.2 Service Identification and Description

This subsection provides a complete description of each of the SBSS-provided ADS-B service from a user perspective.

As an introduction to the service descriptions, it is important to explain the concept of a Service Volume. A Service Volume (SV) is a defined volume of airspace in the NAS within which a set of ADS-B Services are provided and the required performance for the set of services is achieved. A key SV attribute is its airspace domain. SVs in three different domains are defined in SBSS and described in Table 3-1 and Table 3-2 below. As indicated, each SV has horizontal boundaries, as well as a ceiling and floor, between which, a specific ADS-B service or set of services is provided by the SBSS. All traffic above a ceiling is filtered out of the respective SBS service, whereas aircraft in En-route and Terminal domains are provided service to the lowest available coverage until an aircraft/vehicle reports that it is "on the surface". FIS-B data is available at altitudes above the ceiling of FL240, but it there may be cross radio channel interference at higher altitudes. Appendix E shows all En Route, Terminal and Surface SVs planned for implementation.

Table 3-1. Service Volume Boundaries and Airspace Domain

Domain	Horizontal Boundaries	Ceiling	Floor
En Route	En Route domain SVs are polygon shapes with vertices that define the SV boundaries – defined En Route SVs are in accord with division of airspace among En Route centers.	ADS-B:FL600 ADS-R:FL240 TIS-B: FL240 FIS-B: FL240 (see note)	Defined by specified set of En Route and Terminal radars that support surveillance in the defined En Route SV
Terminal	Terminal domain SVs are cylindrical in shape with a size defined by the SV radius (60 NM) relative to the fixed center point defining the SV	ADS-B:FL600 ADS-R:FL240 TIS-B: FL240 FIS-B: FL240 (see note)	Defined by specified set of Terminal radars that support surveillance in the defined Terminal SV.
Surface	Surface Domain SVs are cylindrical in shape with a size defined by the SV radius relative to the fixed center point defining the SV	Up to 2000 feet AGL above movement area of airport, and up to 2000 feet AGL above all approach/departure corridors out to five NM from the runway thresholds	Defined as the movement area of the airport surface

Note: While the required ceiling for FIS-B is FL240, it is expected that users can utilize the FIS-B service above that altitude. Some FIS-B products will only include data up to or near FL240 (e.g. Winds and Temps Aloft will extend up to FL390). In the present design, approximately 90% of the area of implemented SVs would have FIS-B coverage at FL400.

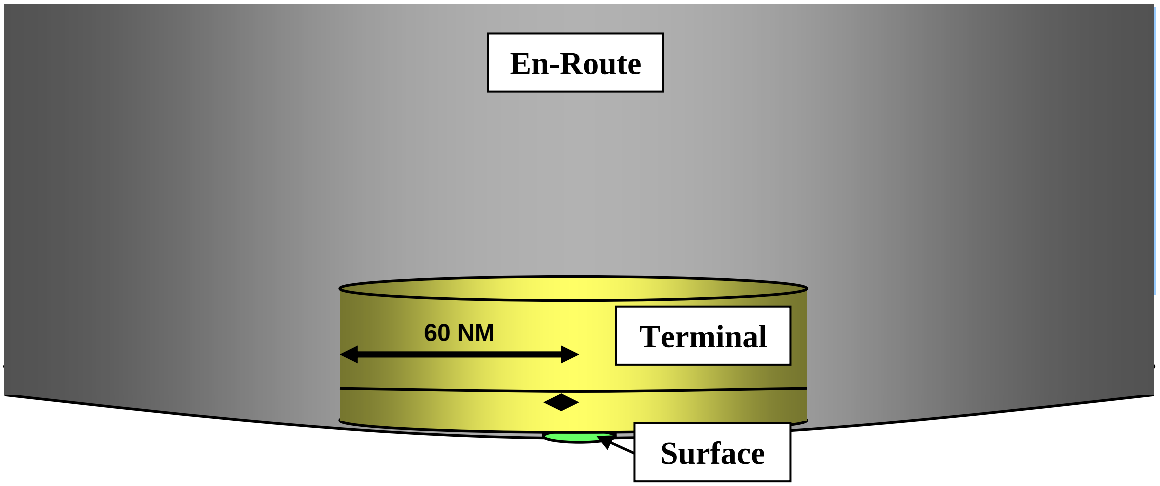

Figure 3-2. SBS Service Volumes

Another important concept to introduce is that while ADS-B air-to-air, ADS-R and TIS-B are separate and distinct services, all three are required to provide a complete picture of traffic situational awareness to the cockpit that contains all proximity aircraft regardless of their ADS-B-IN link the aircraft utilizes. Given the two types and ADS-B equipage, as well as different link versions (as defined in DO-260B and DO-282B), this is a complex task as illustrated in Table 3-2 below that shows which of the above services provides a proximity target to an ADS-B-IN client. This table is applicable in SVs where both ADS-R and TIS-B services are provided.

Table 3-2. Target Provision to ADS-B-IN Aircraft: Dependence on Equipage

Client Aircraft Equipage	Proximity Target Aircraft Equipage				
	Non ADS-B Radar (Mode C/Mode S)	1090ES (Version 0, Version 1)	1090ES (Version 2)	UAT (Version 1)	UAT (Version 2)
UAT (Version 2)	TIS-B Service	TIS-B Service	ADS-R Service	ADS-B Air/Air	ADS-B Air/Air
1090 ES (Version 2)	TIS-B Service	ADS-B Air/Air	ADS-B Air/Air	TIS-B Service	ADS-R Service
Dual UAT (Version 2) /1090ES (Version 2)	TIS-B Service (on UAT)	ADS-B Air/Air	ADS-B Air/Air	ADS-B Air/Air	ADS-B Air/Air

Note: Only 1090ES Version 2 (defined in DO-260B), and UAT Version 2 (defined in DO-282B) are supported. The 1090ES as defined by DO-260, often referred to as Version 0, is not supported.

3.2.1 ADS-B Surveillance Service

The ADS-B service provides a surveillance capability that can enhance existing radar by providing target data with higher update rates and accuracy and provide service in areas without radars. In this Service, ADS-B equipped aircraft (and vehicles) broadcast their state vector (horizontal and vertical position; and horizontal and vertical velocity) and other information over an approved ADS-B link technology. The approved ADS-B link technologies for use in the NAS are 1090ES and UAT data link. ADS-B message broadcasts may be received directly by other ADS-B equipped aircraft. Additionally, these ADS-B messages on both link technologies are received and processed by the SBSS. The SBSS formats and validates the received Messages for delivery to ATC for use in separation assurance and other services. It also filters data to remove redundant reports and non-compliant link versions (i.e. version 0) from the data stream delivered to ATC.

The provision of ADS-B Service by the SBSS includes two major SBSS subsystems, individual Radio Stations which receive ADS-B Messages and ADS-B processors in centralized SBSS processing (called “Control”) stations. The role of the Radio in ADS-B service provision to ATC is to receive and decode ADS-B Messages; to perform a message “reasonableness” test; and to forward all ADS-B reports (triggered by reception of either a 1090ES or UAT Message) to the central processing facility in a common message format. Note that received 1090ES Messages include those in the Version 0, 1 and 2 formats while received UAT Messages include those in the Version 1 and 2 formats. All received ADS-B reports identify the source target through the use of a 24-Bit address assigned to the aircraft/vehicle ADSB avionics. The 24-Bit address may be either an ICAO address or a self-assigned address (applicable to UAT only). The “reasonableness” test employed in the Radio Station identifies such conditions as incomplete ADS-B messages; messages associated with a specific 24-Bit address whose reported position is not in line with previously reported positions (called “position outlier” condition); and the anomalous condition of when two separate aircraft/vehicles are using a common 24-Bit address (called “duplicate address” condition).

When ADS-B reports are provided to the SBSS central processing facility, the ADS-B processing subsystem groups and filters the ADS-B reports; performs ADS-B report validation; and formats and sends ADS-B reports to ATC service delivery points (SDP) at specified update intervals. The grouping and filtering functionality requires clustering of ADS-B reports resulting from a single ADS-B transmission. This capability is required because the SBSS Radios provide overlapping coverage and a single aircraft ADS-B transmission is received at multiple radios. Additionally, filtering by geographically defined service regions or exclusion zones, or by a configured set of 24-Bit addresses, is performed by the ADS-B processing subsystem. The filtering process also reapplies the algorithm for identifying position outliers and duplicate addresses (described in the paragraph above). In this case, the test for outliers and duplicates is applied to ADS-B report receptions from different Radio Stations. A configurable capability of the SBSS is to perform ADS-B report validation. When implemented, the ADS-B processing subsystem uses one or more of the following validation methods: radar validation (using primary radar, secondary radar or both if available); passive ranging (if target report is based on a UAT ADS-B Message); and time-difference of message arrival. After grouping, filtering and validation processing, ADS-B reports are scheduled for delivery to the SDP. Reports are provided to the SDP in a common format and at update intervals that are dependent on Service Volume classification.

3.2.2 ADS-R Service

3.2.2.1 ADS-R Concept of Operations

Since two incompatible ADS-B link technologies are allowed, aircraft equipped with a single link technology input will not be able to receive ADS-B transmissions from the other link technology, and therefore will be unable to receive all ADS-B transmissions. The ADS-R service closes this gap. In defined airspace regions, the ADS-R service will receive ADS-B transmissions on one link, and retransmit them on the complementary link when there is an aircraft of the complementary link technology in the vicinity[3].

An aircraft or vehicle that is an active ADS-B user and is receiving ADS-R service is known as an ADS-R *Client*. An ADS-B equipped aircraft or vehicle on the opposite link of the ADS-R Client that has its messages translated and transmitted by the SBSS is known as an ADS-R *Target*.

3.2.2.2 ADS-R Client Identification

In order to receive ADS-R service an aircraft must be in an airspace region where the ADS-R service is offered, must be ADS-B-OUT, must have produced valid position data (see §3.3.1.2.5) within the last 30s to a SBSS ground station, and must be ADS-B-IN on only one link (If ADS-B-IN on both links, ADS-R is not needed). The SBSS monitors the received ADS-B reports to identify active ADS-B users, and the ADS-B-IN link technologies operating on the aircraft.

3.2.2.3 ADS-R Target Identification

The SBSS identifies all aircraft that need to receive ADS-R transmissions for each active ADS-B transmitter. It does this by maintaining a list of all active ADS-B users, and their associated input link technologies. For each transmitting ADS-B aircraft the SBSS determines all aircraft that do not have ADS-B-IN of the same link technology that are within the vicinity and need to receive ADS-R transmissions.

3.2.2.4 ADS-R in En Route and Terminal Airspace Domains

Proximity aircraft include all those within a 15 NM horizontal range and ± 5000 ft of altitude of a client aircraft. However, ADS-B targets in a ground state are not provided to ADS-B-IN airborne clients in En Route and Terminal SVs. The ADS-R client volume is independently configurable and currently larger than the TIS-B client volume (specified in §3.2.3.2) to support spacing applications which require an extended service volume. This ADS-R client volume is also configurable to support future applications but set initially for the baseline ADS-B applications for SBS.

[3] Some checks are made on the received ADS-B messages being rebroadcast; those failing these checks will not be rebroadcast.

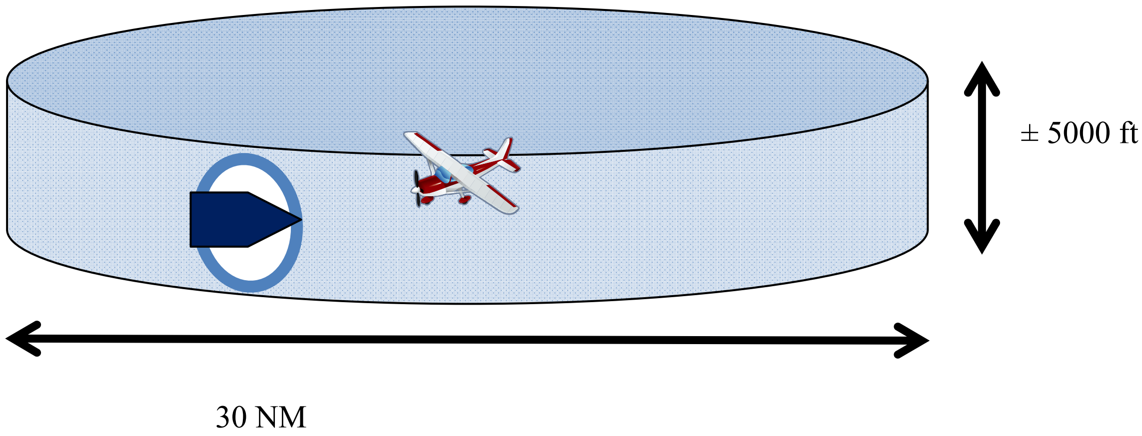

Figure 3-3. ADS-R Client Proximity Determination

3.2.2.5 ADS-R in Surface Domains

In a surface domain SV, a client is provided all applicable ADS-R targets in the SV. This includes all targets in the ground state within the movement area (runways and taxiways) as well as all airborne targets within 5 NM and 2000 ft AGL of the airport reference point (ARP).

3.2.2.6 Transmission of ADS-R Targets Over the Air Interface

Each ADS-R Target aircraft may have one or more client aircraft that need to receive ADS-R transmissions, possibly in different domains. The SBSS determines the ADS-R transmission rate required by the client in the most demanding domain. The SBSS control station also determines the radio or set of radios necessary to transmit ADS-R messages to all clients.

If a radio selected for transmissions to a client is also receiving transmissions from the client, the SBSS prepares a transmission schedule and submits it to the radio. The transmission schedule identifies the 24-Bit address of the target aircraft, and an update interval. When the radio receives transmissions from the target aircraft it will retransmit the report on the opposite link, according to the provided schedule. Most ADS-R transmissions are of this type. In the uncommon case where a client and target are not served by a common radio, the SBSS will receive the ADS-B report from the receiving radio, and forward the report to the transmitting radio.

A client aircraft that is receiving ADS-R service will receive reports for ADS-B aircraft on the opposite link within its vicinity. Since a single target may have multiple clients, sometimes in different domains, a client may receive ADS-R reports more frequently than required for the client's domain. An aircraft may also be in range of a ground radio station that is transmitting reports required by other aircraft. When this is the case it will receive reports of aircraft that are outside the altitude and horizontal range of its vicinity.

The cumulative number of messages transmitted by all SBSS radio stations within reception range of any aircraft in the NAS will not exceed 1,000 1090ES messages per second with received signal strength greater than -78 dBm. This limit applies to both the ADS-R and TIS-B Service combined (although ADS-R transmissions are prioritized over TIS-B when approaching capacity limits). The cumulative maximum number of UAT messages received by an aircraft will not exceed 400 messages per second with received signal strength greater than -82 dBm. These limits are achieved through a combination of the client proximity filter size, the density of radios, radio transmit power, the best radio selection algorithm, and the required update intervals.

3.2.2.7 ADS-R Service Status Notification

The SBSS will notify UAT Link Version 1 and 2 clients that ADS-R service is being provided. This notification is provided through the TIS-B/ADS-R Service Status, provided as an information product through FIS-B.

The SBSS will notify 1090ES link version 2 clients that ADS-R service is being provided. This notification is provided through the TIS-B/ADS-R Service Status message[4].

For message format descriptions and guidance on displaying this status message, see Appendix H of RTCA DO-317A.

3.2.3 TIS-B Service

3.2.3.1 TIS-B Service Concept of Operations

The TIS-B service provides active ADS-B users with a low-latency stream of position reports of non-ADS-B equipped aircraft. TIS-B service is available in supported Service Volumes when there is both adequate surveillance coverage from non-ADS-B ground sensors and adequate Radio Frequency (RF) coverage from SBSS ground radio stations.

An aircraft or vehicle that is an active ADS-B user and is receiving TIS-B service is known as a TIS-B *Client*. A non-ADS-B equipped aircraft or vehicle that has its position transmitted in TIS-B reports is known as a TIS-B *Target*.

3.2.3.1.1 TIS-B Client Identification

The SBSS control station monitors the ADS-B received reports to identify TIS-B Client aircraft. In order to be considered a TIS-B Client, an aircraft must be ADS-B-OUT, must have produced valid position data (see §3.3.1.2.5) within the last 30s to a SBSS ground station, and must be ADS-B-IN on at least one link. Two key safety benefits for requiring TIS-B Clients to transmit ADS-B-OUT is spectrum conservation by the SBSS system and the provision of the TIS-B Service Status message by the SBSS to indicate service availability for specific aircraft.

3.2.3.1.2 TIS-B Target Identification

The SBSS also monitors surveillance information from the FAA, and correlates and merges information from multiple surveillance sources into individual aircraft tracks. Aircraft tracks that are not correlated with an active ADS-B user are potential TIS-B Targets.

In most cases all transponder aircraft tracks identified by the tracker are uplinked as TIS-B traffic with a tracker-assigned ID (e.g. address). The SBSS has multiple trackers, deployed regionally such that there is an airborne tracker dedicated to the airspace of each FAA En Route Center and each Surface Service Volume. More details on identifying and managing the display of TIS-B tracks are provided in Sections 3.3.3.2.6 and 3.3.3.2.7.

[4] No Service Status Notification will be provided for 1090 ES v0 or v1 equipage because the service status message was not defined in these earlier version of the ADS-B MOPS. Service Status Notification will be provided for UAT v1 equipage.

3.2.3.2 TIS-B in En Route and Terminal Airspace Domains

The SBSS examines each potential TIS-B target to determine if it is within proximity of one or more TIS-B clients. In order to become a TIS-B target, a potential target must be contained in a cylinder defined by lateral and vertical distance from Client aircraft. The size of this cylinder depends on the airspace domain of the Client aircraft. TIS-B Service is provided to aircraft operating in the En Route and Terminal Service Volumes. There is a Service Ceiling of 24,000 ft, above which TIS-B clients will not be provided TIS-B service (targets will be provided up to 27,500 ft).

In the En Route and Terminal domains, proximity aircraft include all aircraft within a 15 NM radius and 3500 ft of altitude. Aircraft or vehicles determined to be operating on the surface will not be considered valid targets for aircraft operating in En Route and Terminal Service Volumes. TIS-B uses geographic filters to exclude surface coverage of airports in Terminal/En-Route airspace which do not have surface service volumes. TIS-B service in airports with surface service volume coverage is described in section 3.2.3.3.

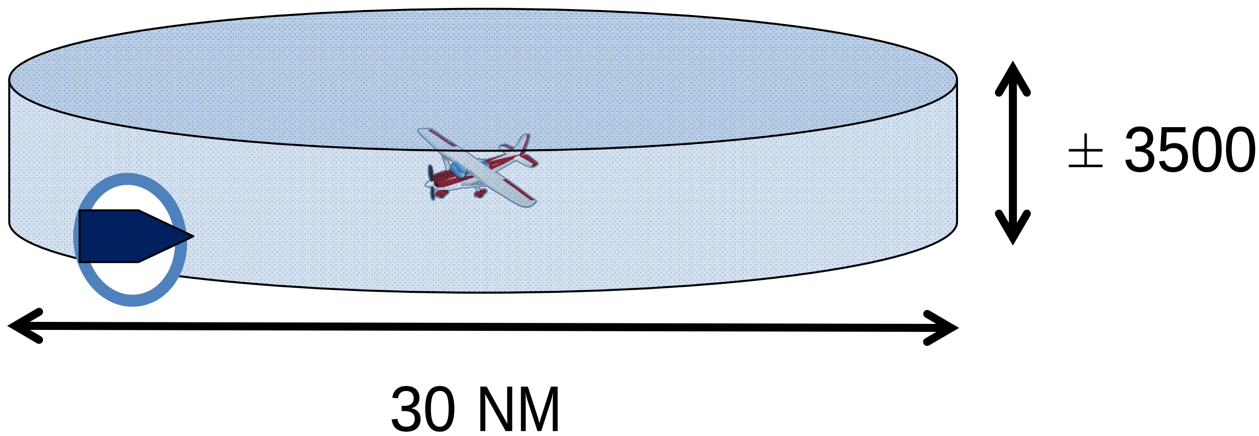

Figure 3-4. TIS-B Client Proximity Determination

3.2.3.3 TIS-B in Surface Domains

In a surface domain SV, a client is provided all applicable TIS-B targets in SV domain. This includes all targets in the ground state within the movement area as well as those airborne targets within 5 NM and 2000 ft AGL of the airport reference point (ARP) within an expanding volume along the approach and departure corridors. Those airports that are planned to have Surface Service Volumes are listed in Appendix E.

In some cases airports that do not have Surface SV status may still have good SBSS and radar coverage at low altitude. But in these cases TIS-B traffic will not be provided to clients that are reporting in the ON GROUND state. However, once they are airborne, TIS-B data will be provided except that ON GROUND surface traffic will not be transmitted to these clients.

3.2.3.4 Transmission of TIS-B Target Messages

The SBSS transmits TIS-B reports for every TIS-B Target that is in proximity of one or more Clients. An individual Target may be in proximity of multiple Clients, with the potential for the Clients to be in separate airspace domains, with differing update rates. The SBSS will transmit

TIS-B reports for a Target aircraft at the highest rate required by any of the clients of that aircraft. For example, if a Target aircraft has clients in both Terminal and En Route domains, TIS-B reports for that Target aircraft will be transmitted at the rate required for the Terminal domain.

The cumulative number of messages transmitted by all SBSS radio stations within reception range of any aircraft in the NAS will not exceed 1,000 1090ES messages per second with received signal strength greater than -78 dBm. This limit applies to both the ADS-R and TIS-B Service combined (although ADS-R transmissions are prioritized over TIS-B when approaching capacity limits). The cumulative maximum number of UAT messages received by an aircraft will not exceed 400 messages per second with received signal strength greater than -82 dBm. These limits are achieved through a combination of the client proximity filter size, the density of radios, radio transmit power, the best radio selection algorithm, and the required update intervals.

The RS selected for uplink of TIS-B to client aircraft is based on the ADS-B reception for that client.

3.2.3.5 TIS-B Service Status Notification

The SBSS will notify UAT Link Version 1 and 2 clients that are under surveillance of at least one secondary radar that TIS-B service is being provided. This notification is provided through the TIS-B/ADS-R Service Status, provided as an information product through FIS-B.

The SBSS will notify 1090ES link version 2 TIS-B clients that are under surveillance of at least one secondary radar that TIS-B service is being provided. This service status notification will be provided through the TIS-B/ADS-R Service Status message[5].

More information on the UAT and 1090ES Service Status messages can be found in Appendix H of RTCA DO-317A.

3.2.3.6 False Tracks and Incorrect Associations

False tracks and incorrect associations are unavoidable due to the uncertainty inherent in radar systems. Although such artifacts are minimized they will happen. If an ADS-B aircraft is not associated with its radar track it will be treated as a TIS-B Target, and its track information will be transmitted in TIS-B reports. This will cause the aircraft to receive TIS-B transmissions for itself, and aircraft in proximity will receive both ADS-B reports from that aircraft, and TIS-B reports for the unassociated track for that aircraft. ADS-B-IN avionics should consider these situations in processing of this traffic data.

Some examples of these false track scenarios in order of descending probability are:

1. When ADS-B aircraft incorrectly report the ground state but are truly airborne. This causes the ADS-B reports to be ignored by the SBSS multi-sensor tracker for airborne targets and the radar track data is uplinked as TIS-B potentially causing ghost targets.
2. A Radar has a position offset of a target far from the fused cluster of Radar tracks with the ADS-B aircraft. This can lead to split tracks and ghost targets on the aircraft display.

[5] No Service Status Notification will be provided for 1090 ES v0 or v1 equipage because the service status message was not defined in these earlier version of the ADS-B MOPS. Service Status Notification will be provided for UAT v1 equipage.

3. An ADS-B aircraft truly in the ground state incorrectly reports airborne and a proximate Radar only target becomes permanently associated with the ADS-B aircraft's ICAO address.
4. An ADS-B aircraft's position reports have an accuracy that exceeds the reported NAC_P. This results in a "good" Radar track being offset with a "bad" ADS-B track and can lead to split tracks or ghost tracks on the aircraft display.
5. Sharp maneuvers by the aircraft in coverage volumes with few integrated radar sensors can cause dual tracks. This can lead to split tracks and ghost targets on the aircraft display.

3.2.4 FIS-B Service

The FIS-B service is a broadcast (not client based) service in which weather and aeronautical information is broadcasted over the UAT link only (not 1090ES), regardless of whether or not there are any SBSS clients within the Service Volume. The FIS-B CONOPS is that a single radio station provides a specified set of data products, at a specified update, with a specified look-ahead range through a fixed set of UAT ground uplink slots or channels. An ADS-B-IN UAT equipped aircraft that captures all the allocated slots from a single radio station would be provided a set of data representing weather, aeronautical conditions, and NAS status information in the surrounding area.

FIS-B data consists of individual "FIS-B Products", each of which represent a different type of information. Currently implemented FIS-B products include: AIRMET, SIGMET, Convective SIGMET, METAR, PIREP, TAF, Winds/Temperatures Aloft, CONUS NEXRAD, Regional NEXRAD, NOTAM, SUA and TIS-B/ADS-R Service Status. Each of these products is broadcast at maximum update intervals and transmission intervals, and with a minimum latency.

The geographic scope of the uplinked products is specified with each FIS-B Product in the form of a minimum "look ahead" distance. This ensures that all available products of each type will be broadcast at a specified geographic radius from each UAT ground radio station.

An empty FIS-B message will be sent as a heartbeat, once per second, if no other FIS-B product messages are scheduled to be sent from a radio. This heartbeat takes the form of a valid UAT header, but with no product data. This heartbeat is sent to inform aircraft of the availability of the FIS-B service. A FIS-B heartbeat message can be distinguished from other FIS-B messages if the I-Frame length is encoded as 0 for the first I-Frame. When this is the case, the remaining bytes in the FIS-B message payload need not be processed (they will all be 0).

The radio stations that provide FIS-B service are configured in a tiered design. The general structure of the tiered approach established for SBSS is described in Appendix C. A brief summary is given here.

- Radio Stations will be grouped into four tiers as follows:
  - Surface: these radio stations will service aircraft in the immediate vicinity of major airports.
  - Low-altitude: services aircraft at low altitude: up to 3000 ft AGL.
  - Medium-altitude: services aircraft from low altitude up to 14,000 ft AGL.
  - High-altitude: services aircraft from low altitude up to 24,000 ft AGL.

- The products provided from a Radio Stations will depend upon its Tier under the following rules
  - A higher tier radio station will contain all the data products provided by a lower tier radio station.
  - Higher tier radio stations will provide additional data products not provided by lower tier radio stations that are of interest to the high altitude user.
  - Higher tier radio stations will provide greater 'look-ahead' ranges for data products – the look ahead range is the distance between the radio station and the geo-tagged products provided by the radio station.
  - Higher tier radio stations will have a greater number of UAT ground uplink slots assigned – the absolute maximum number of assigned slots allocated to a single radio station is 5 slots, but 4 is likely the practical maximum to mitigate co-channel interference.

The tier of a radio station which is being received can be identified through the use of the TIS-B Site ID Field, as described in Section C.2.

While the required ceiling for FIS-B is FL240, it is expected that users can utilize the FIS-B service above that altitude. In the present design, approximately 90% of the area of implemented SVs would have FIS-B coverage at FL400. Although there are no practical RF propagation limitations for receiving FIS-B at high altitudes, co-channel interference could cause some areas of spotty coverage for A3 UAT avionics with high Desired/Undesired reception requirements (> 9dB).

3.3 Service Messages and Performance

3.3.1 ADS-B Service Messages and Performance

ADS-B is a Critical service as defined by the SBS Critical Services Specification. The objective of the ADS-B Service is to provide ADS-B Reports to SDPs. To achieve this objective, the ADS-B Service has to successfully receive and decode ADS-B Messages broadcast by aircraft and vehicles. Some of the information received in an ADS-B Message is decoded and inserted directly into the corresponding ADS-B Report fields. Other Message information requires some additional processing before entering into the Report. Additionally, some Report information has to be ascertained by the ADS-B Service. The performance that has to be achieved in delivering the ADS-B Service is detailed in following paragraphs.

3.3.1.1 ADS-B Information Units—Message Content

The ADS-B Service SDP Report structure is shown in Table 3-3 with each data item associated with a Field Reference Number (FRN). The specific data item formats are described in the FAA SDP IRD (NAS-IR-82530001). For 1090ES, each SDP ADS-B Report is triggered by either a position message or a velocity message. The velocity message Report triggering is a configurable system option, which is typically not implemented. For UAT, each SDP ADS-B Report is triggered by either a "short" or a "long" UAT message. The SBSS maintains state variables, such as Flight ID, from the other ADS-B messages over specified validity times. Table 3-4 and Table 3-5 show how the specific ADS-B Messages and their content map to the SDP ADS-B Report data items.

Table 3-3. 1090ES ADS-B Message ME bit-mapping to SDP ADS-B Report Data Items

	Type (NIC)/Subtype	Surv. Status	NIC Supplement	Altitude	Time	CPR Format	Latitude	Longitude	Movement	Hdng/Gnd Track	Emitter Categ	Identity	NACv	E/W Velocity	N/S Velocity	Vert Rate	Reserved/Ignored	Diff from Baro	Intent/Status	Ops Status	Mode 3/A Code	Emergency State	TCAS RA Broadcast	TOTAL
Airborne Position	5	2	1	12	1	1	17	17																56
Surface Position	5				1	1	17	17	7	8														56
Airborne Velocity (1/2)	8												3	11	11	11	4	8						56
ID and Type	5										3	48												56
Target State and Status	7																		49					56
Operational Status	8																			48				56
Aircraft Status (1)	8																32				13	3		56
Aircraft Status (2)	8																						48	56
Flow to Report FRNs	6	14	6, 21	8	6		7	7	10	10	13	12	6	9	9	9		15	6,20	3,6 10,14 16,19 21	11	14	17	

Table 3-4. UAT ADS-B Message mapping to SDP ADS-B Report Data Items

<table>
<tr><th>Payload Type</th><th>Header</th><th colspan="7">State Vector (SV)</th><th colspan="7">Mode Status (MS)</th><th colspan="4">Target State (TS)</th><th>AUX SV</th></tr>
<tr><td>Elements</td><td>Target Address</td><td>Latitude</td><td>Longitude</td><td>Altitude</td><td>Velocity</td><td>Ground Movement</td><td>UTC Coupled</td><td>Uplink Feedback</td><td>Identity and Category</td><td>UAT MOPS Version</td><td>Emergency Status</td><td>SIL, NACp, NACv, etc.</td><td>Capability Codes</td><td>Operational Modes</td><td>Data Quality Parameters</td><td>Selected Altitude</td><td>Barometric Pressure Set.</td><td>Selected Heading</td><td>Mode Indicators</td><td>Secondary Altitude</td></tr>
<tr><td>0</td><td>✓</td><td colspan="7">✓</td><td colspan="7"></td><td colspan="4"></td><td></td></tr>
<tr><td>1</td><td>✓</td><td colspan="7">✓</td><td colspan="7">✓</td><td colspan="4"></td><td>✓</td></tr>
<tr><td>2</td><td>✓</td><td colspan="7">✓</td><td colspan="7"></td><td colspan="4"></td><td>✓</td></tr>
<tr><td>3</td><td>✓</td><td colspan="7">✓</td><td colspan="7">✓</td><td colspan="4">✓</td><td></td></tr>
<tr><td>4</td><td>✓</td><td colspan="7">✓</td><td colspan="7"></td><td colspan="4">✓</td><td></td></tr>
<tr><td>5</td><td>✓</td><td colspan="7">✓</td><td colspan="7"></td><td colspan="4"></td><td>✓</td></tr>
<tr><td>6</td><td>✓</td><td colspan="7">✓</td><td colspan="7"></td><td colspan="4">✓</td><td>✓</td></tr>
<tr><td>Report FRNs</td><td>5</td><td colspan="7">6, 7, 8/15, 9/10, 19, 21</td><td colspan="7">3, 6, 11, 12, 13, 14, 16, 21</td><td colspan="4">20</td><td>8/15</td></tr>
</table>

Table 3-5. FAA SDP ADS-B Report

FRN	Data Item
1	Service Volume Identifier
2	Version Number
3	Link Technology Indicator
4	Time of Applicability
5	Target Address
6	Integrity and Accuracy Parameters
7	Latitude/Longitude
8	Pressure Altitude

FRN	Data Item
9	Velocity (Airborne)
10	Velocity (Surface)
11	Mode 3/A Code
12	Target Identification
13	Emitter Category
14	Target Status
15	Geometric Altitude
16	Modes and Codes
17	TCAS RA Messages
18	Time of Message Reception
19	GPS Antenna Offset
20	Target State Data
21	ADS-B Data Quality Parameters
22	Data Source Qualifier

3.3.1.2 ADS-B Quality of Service

3.3.1.2.1 ADS-B Integrity

The probability that ADS-B Service introduces any error into an ADS-B Report received at an SDP is less than 10^{-5} per Report (equivalent to a System Design Assurance level of 2 – Major). The ADS-B service is also designed to meet Assurance Level 3 (AL3) objectives of RTCA DO-278.

3.3.1.2.2 ADS-B Position Update Interval

The ADS-B position update interval is the maximum allowed time between successive ADS-B Reports containing position information that are sent to each SDP for a specific aircraft/vehicle. The update interval varies by airspace domain. The update interval is determined by the rate of reception of ADS-B Messages containing position information. Even though the ADS-B Service may be configured to generate an ADS-B Report on reception of velocity Messages this additional reporting does not apply to the Update Interval.

3.3.1.2.2.1 Surface Update Interval

The ADS-B Service provides for each aircraft/vehicle in motion in the Surface domain an ADS-B Report containing position information on average at least once every 1.0 second at each SDP.

The ADS-B Service provides for each stationary aircraft/vehicle in the Surface domain an ADS-B Report containing position information at least once every 5.5 seconds (85%) for 1090-ES at each SDP. The update interval for UAT targets on the surface is typically 1.0 seconds on average and cannot exceed 5.5 seconds (95%).

3.3.1.2.2.2 Terminal Update Interval

The ADS-B Service provides for each aircraft/vehicle in the Terminal domain an ADS-B Report containing position information with an update interval no greater than 3.0 seconds (95%) at each SDP.

3.3.1.2.2.3 En-Route Update Interval

The ADS-B Service provides for each aircraft/vehicle in the En Route domain an ADS-B Report containing position information with an update interval no greater than 6.0 seconds (95%) at each SDP.

The ADS-B Service provides for each aircraft/vehicle in En Route domains identified as "En Route High Update (HU)" an ADS-B Report containing position information with an update interval no greater than 3.0 seconds (95%) at each SDP.

3.3.1.2.3 ADS-B Latency

The ADS-B Latency for the SBSS includes the ADS-B Service processing delay and the delay in communicating the ADS-B Reports to the Service Delivery Points (SDP). Latency is measured from the reception of the last bit of an ADS-B Message to the reception of the first bit of the corresponding ADS-B Report at the SDP.

The maximum delay between the reception of the last bit of an ADS-B Message, containing a State Vector or an emergency condition, and the reception of the first bit of the corresponding ADS-B Report at the Service Delivery Point is less than or equal to 700 ms within the various operating environments. UTC coupled aircraft allow the SBSS to compute the time of applicability of the horizontal position within ± 200 msec.

3.3.1.2.4 ADS-B Service Availability

The ADS-B service is a safety-critical service as classified by NAS-SR-1000 Rev B for surveillance services. This requirement is driven by the ATC Surveillance application.

The ADS-B Service meets a minimum Availability of 0.99999 in each defined service volume at SDPs identified as critical.

3.3.1.2.5 Independent Validation

In certain Service Volumes, the FAA will require that the ADS-B Service provide independent validation of the position information received in the ADS-B Messages. An independent ADS-B validation capability may assure to a specified probability that each ADS-B Message, and the position information contained within, is from a real aircraft/vehicle with a valid position source rather than from a source broadcasting erroneous information or a spoofer. The independent validation tolerances are defined to support 3NM separation in Terminal airspace and 5NM separation for En-Route airspace. In order of priority, the validation methods are:

1. Comparison to radar,
2. Comparing a one way "passive range" with range to target indicated by ADS-B (available for UAT equipped targets),
3. Use of time difference of arrival techniques.

Three validation states are possible when validation service is being provided: Valid, Invalid, and Unknown. If sufficient information is not available for validation, (e.g. in the case of radar failure) validation status will be Unknown. Valid and Unknown position reports are passed onto the FAA SDP and to the ADS-R service.

3.3.1.2.6 Enhanced Validation

In Certain Service Volumes, the FAA will require that the ADS-B Service provide Enhanced Validation as an independent check of the ADS-B reported position that is used to support avionics conformance monitoring. This check is made to a tighter tolerance than the “standard” validation described in Section 3.3.1.2.5 above. The default Enhanced Validation tolerance is 0.2 NM, which equates to a NIC 7. Due to the tighter tolerance requirement, Enhanced Validation airspace is limited to that within 15 NM of the center of the Terminal service volume. Enhanced validation is only supported with radar. (TDOA and ranging are not used).

3.3.2 ADS-R Service Messages and Performance

ADS-R is a Critical service as defined by the SBS Critical Services Specification. The ADS-R Service is dependent upon the ADS-B Service, in that the ADS-B Messages are first received on one data link before they can be rebroadcast on the other. The performance that is required in delivering the ADS-R Service is detailed in following paragraphs.

3.3.2.1 ADS-R Information Units—Message Content

UAT ADS-R Targets to 1090 Clients:

The ADS-R Service for 1090 Clients encodes the Message types contained in Table 3-6 and their corresponding message elements per DO-260B §2.2.18 and §A.3. If a UAT Target has an emergency condition (as indicated in its ADS-B message), then the 1090 Aircraft Status Subtype 1 message will also be broadcast for that Target during the course of the emergency. The 1090 ADS-R Downlink Format is 18 and the Control Field is set to 6. The ICAO/Mode A Flag field in the position messages denote whether the target has an ICAO address.

Table 3-6. 1090ES ADS-R Message Types to Encode Upon Receipt of UAT Message Types

1090ES Message Type	UAT Message Payload Type						
	0	1	2	3	4	5	6
Position	X	X	X	X	X	X	X
Aircraft ID and Category		X		X			
Velocity	X	X	X	X	X	X	X
Operational Status		X		X			
Aircraft Status: Subtype 1 (Only during emergencies)		X		X			

1090 ADS-R Targets to UAT Clients:

The ADS-R Service for UAT Clients could be "short" (Payload Type code 0) or "long" (Payload Type code 1 and 2) messages. ADS-R transmissions follow the A1H equipment class transmission cycle, which is a mixed population of short and long UAT messages (see §2.2.6.1.2 and §2.2.6.1.3 of RTCA DO-282B). The UAT ADS-R Address Qualifier is either set to 2 (target with ICAO address) or 6 (target with non-ICAO address). When the UAT Address Qualifier is 2, there are no other fields which convey whether the message is TIS-B or ADS-R.

3.3.2.2 Quality of Service

3.3.2.2.1 ADS-R Integrity and Accuracy

The probability that ADS-R Service introduces any error into a rebroadcast ADS-B Message is less than or equal to 10^{-5} per Message (equivalent to a System Design Assurance level of 2 – Major). This probability of error includes the linear position extrapolation process using the instantaneous velocity reported for a target on the opposite ADS-B data link.

The ADS-R Service limits the NIC value to 8 and NAC_P value to 9 in ADS-R Message transmissions. ADS-R uplink functions are not designed to support the precision mode of operation, i.e., NIC values greater than 8 and NAC_P values greater than 9.

3.3.2.2.2 ADS-R Position Update Interval

The ADS-R Service broadcasts state vector updates for aircraft/vehicles transmitting on one data link to aircraft/vehicles on the other data link at an interval that will support the aircraft/vehicle based applications that are to be performed in the Service Volume. The state vector update intervals required to support each application are detailed in the SBS CONOPS and summarized as follows:

- ATSA-AIRB: 5 seconds
- ATSA-VSA: 5 seconds
- ATSA-SURF: 2 seconds
- Traffic Situation Awareness with Alerts (TSAA): 10 seconds

- Airborne Spacing - Flight-Deck Based Interval Management–Spacing (FIM-S): 10 seconds

The ADS-R update interval requirements are based upon the most stringent application that is to be supported within each domain. The update intervals apply to the reception by a client aircraft of all eligible ADS-R aircraft/vehicles within the range and altitude limits at any point within the Service Volume. Thus, the 1090 interference environments had to be considered to meet the update intervals.

The ADS-R update interval is limited by the ADS-B Message reception rate from each aircraft/vehicle (as rebroadcasts may be made only when Messages are received), the UAT uplink capacity, spectrum restrictions for 1090ES, the performance characteristics of the aircraft/vehicle ADS-B equipment, and the interference environment.

The maximum message transmission rate for a 1090 Target ADS-R to a UAT client is 2 times per second since a Ground Station will receive a 1090 position message approximately every 0.5 seconds. The actual uplink rate may be configured to be less than this depending on the airspace and applications to be supported. The expected minimum power received by UAT avionics is -93 dBm. The ADS-R link margin for UAT clients is expected to be > 11 dB for the majority of the NAS airspace.

The nominal message packet transmission rate for a UAT Target ADS-R to a 1090 client is 1 time per second since a Ground Station will receive a UAT message approximately every 1 second. A 1090 ADS-R message packet consists of 2 position messages, 1 Aircraft ID and Category message, 1 Velocity message (if airborne), and 1 Operational Status message. All of the 1090 ADS-R messages in the packet are transmitted within milliseconds of each other. The expected minimum power received by 1090 avionics is -79 dBm in low interference environments and -72 dBm in high interference environments. The ADS-R link margin for 1090 clients is expected to be > 5 dB for the majority of the NAS airspace.

As the system becomes loaded with more than 250 ADS-R targets on each link, these target message transmission rates will decrease in a process known as Graceful Degradation. The purpose of Graceful Degradation (GD) is to gradually throttle the ADS-R messages sent to Aircraft/Vehicles based on load. The GD algorithm uses several configurable parameters to control the flow of reports and messages until the maximum load is reached.

3.3.2.2.2.1 Surface Update Interval

The ADS-R Service transmits the number of ADS-R Messages necessary to meet an update interval of no greater than 2 seconds (95%) for each client aircraft for all traffic within 5 NM and within ± 2000 feet of each client within the Surface Service Volume.

3.3.2.2.2.2 Terminal Update Interval

The ADS-R Service transmits the number of ADS-R Messages necessary to meet an update interval of no greater than 5 seconds (95%) for each client aircraft for all traffic within 15 NM and within ± 5000 feet of each client within the Terminal Service Volume.

3.3.2.2.2.3 En-Route Update Interval

The ADS-R Service transmits the number of ADS-R Messages necessary to meet an update interval of no greater than 10 seconds (95%) for each client aircraft for all traffic within 15 NM and within ± 5000 feet of each client within the En-Route Service Volume.

3.3.2.2.3 ADS-R Latency

The additional latency introduced by the ground infrastructure is less than the latency required by the most stringent applications in the SBS CONOPS minus the inherent airborne latencies on both ends.

The maximum delay between the time of message received of an ADS-B Message that results in the generation of ADS-R Uplink Messages and the transmission of the first bit of any corresponding broadcast Message on the opposite link technology is less than or equal to 1 second. The service provider ground infrastructure design is such that the time it takes for a received ADS-B message to be processed into ADS-R format and sent to the ADS-R transmission scheduler is 400 milliseconds or less. This ADS-B to ADS-R transmission latency is compensated in the ADS-R horizontal position by linearly extrapolating to the time of transmission.

3.3.2.2.4 ADS-R Service Availability

The ADS-R service is currently a safety-essential service as classified by NAS-SR-1000 Rev B for surveillance services. The ADS-R Service meets a minimum Availability of 0.999 at SDPs (in this case, SDP refers to client aircraft that are receiving ADS-R).

3.3.2.2.5 ADS-R Media Access

1090 ADS-R transmissions contend with air-to-air 1090 ADS-B transmissions and potentially with nearby SBSS Ground Station 1090 transmissions. However, 1090 transmissions are randomized to minimize interference and each SBSS Ground Station has a maximum 1090 transmission duty cycle of 6% (combines all 1090 TIS-B and ADS-R messages).

UAT ADS-R transmissions contend with air-to-air UAT ADS-B transmissions since they are in the ADS-B segment of the UAT Frame (not the Ground Segment) and potentially with nearby SBSS Ground Station UAT transmissions. However, UAT transmissions are randomized to minimize interference and each SBSS Ground Station has a maximum UAT transmission duty cycle of 12.5% (combines all UAT TIS-B and ADS-R messages).

Although ADS-R transmissions are event-driven by receptions of ADS-B messages, both 1090 and UAT have configurable minimum ADS-R transmit intervals (currently set to 1.5 ms) with an added random time (up to 3 ms) appended to the minimum interval. Additionally, typically only one radio rebroadcasts a particular target at any given time.

3.3.3 TIS-B Service Messages and Performance

TIS-B is an Essential service as defined by the SBS Essential Services Specification. The TIS-B Service provides users equipped with ADS-B avionics the ability to receive, process, and display state information on proximate traffic that are not ADS-B equipped and are only tracked by other ground-based surveillance systems (i.e. radar and multilateration systems). The performance that is required in delivering the TIS-B Service is detailed in following paragraphs.

3.3.3.1 TIS-B Information Units—Message Content

The 1090 TIS-B Service encodes the TIS-B Message types contained in Table 3-7 and their corresponding message elements per DO-260B §2.2.17 and §A.2. The format of the DO-260B TIS-B message is identical to the DO-260A TIS-B message with the exception of the Ground Speed/Movement field encoding (see §2.2.3.2.4.2 in DO-260B). TIS-B Velocity messages are also transmitted for Surface targets in order to convey the NAC_P to ADS-B-IN users for surface applications (although velocity data is ZERO'd out). The 1090 TIS-B Downlink Format is 18 and the Control Field is either set to 2 (target with ICAO address) or 5 (target with track file identifier). Three squitters (even position, odd position, and velocity) are sent for every TIS-B report transmitted over the 1090 link. These transmissions are sent as a group, close together in time (as specified in §3.3.3.2.5), and if necessary will be repeated to ensure probability of detection. The 1090 TIS-B/ADS-R Service Status message format is defined in DO-317A and will be broadcast for 1090 ADS-B-IN Link Version 2 clients.

Table 3-7. Transmitted 1090 TIS-B Message Types

Message Types	RTCA/DO-260B Reference Paragraphs
TIS-B Fine Airborne Position	§2.2.17.3.1 & §A.2.4.1
TIS-B Fine Surface Position	§2.2.17.3.2 & §A.2.4.2
TIS-B Velocity	§2.2.17.3.4 & §A.2.4.4
TIS-B/ADS-R Service Status Management	§2.2.17.2 & §A.2

Table 3-8. Payload Composition of 1090ES TIS-B Messages

TIS-B Message	Encoding Used	TIS-B Message Field	MSG Bit #	DO-260B Reference
All	Set to decimal 18 (10010) for all TIS-B Messages	DF TYPE	1-5	§2.2.17.2.1
	"2" for Fine TIS-B Message with AA=24-bit ICAO address and "5" for Fine TIS-B Message with AA=TIS-B Service generated 24-bit track ID	Control Field (CF)	6-8	§2.2.17.2.2
	A 24-bit address; ICAO address or service generated track ID	Address Announced (AA)	9-32	§2.2.17.2.3
	Algorithm that operates on the first 88 bits of the message	Parity / Identity (PI)	89-112	§2.2.3.2.1.7
TIS-B Fine Airborne Position	Determined from altitude type and NIC	TYPE	33-37	§2.2.3.2.3.1
	Set to 00 for all TIS-B Messages	Surveillance Status	38-39	§2.2.3.2.3.2
	"0" to indicate a 24 bit address Note: This flag is always set to 0 since Mode 3/A code is not allowed to be embedded in the 24-bit address	ICAO Mode Flag (IMF)	40	§2.2.17.3.1.2
	12 bits of barometric altitude data.	Pressure Altitude	41-52	§2.2.3.2.3.4.1
	Set to ZERO	Reserved	53	-
	Transmit Function to alternate between "0" = even; "1" = odd.	CPR Format	54	§2.2.3.2.3.6
	CPR encoded Latitude and Longitude of target position.	CPR Latitude	55-71	§2.2.3.2.3.7
		CPR Longitude	72-88	§2.2.3.2.3.8
TIS-B Fine Surface Position	Determined from altitude type and NIC	TYPE	33-37	§2.2.3.2.4.1
	Ground Speed of target on surface (Note: the movement field is different in DO-260B)	Movement	38-44	§2.2.3.2.4.2
	Validity of heading/ground track	Heading Status	45	§2.2.3.2.4.3
	Ground Track/Heading of target on surface	Heading	46-52	§2.2.3.2.4.4
	"0" to indicate 24 bit ICAO address	ICAO Mode Flag	53	§2.2.17.3.1.2
	Transmit Function to alternate between "0" = even; "1" = odd.	CPR Format	54	§2.2.3.2.4.6
	CPR encoded Latitude and Longitude of target position.	Latitude	55-71	§2.2.3.2.4.7
		Longitude	72-88	§2.2.3.2.4.8
TIS-B Velocity	Set to 19 (10011) for all Velocity Messages	TYPE	33-37	§2.2.3.2.6.1.1
	Determined based on availability of data on target velocity over ground and whether target is supersonic	Subtype	38-40	§2.2.3.2.6.1.2

TIS-B Message	Encoding Used		TIS-B Message Field	MSG Bit #	DO-260B Reference
	“0” to indicate 24 bit ICAO address		ICAO Mode Flag	41	§2.2.17.3.1.2
	TIS-B Service generated NAC_P value		NAC_P	42-45	§2.2.17.3.4.4
	Velocity data on target (Always set to ZEROs for Surface Targets)	Subtype 1& 2	E/W Direction	46	§2.2.3.2.6.1.6
			E/W Velocity	47-56	§2.2.3.2.6.1.7
			N/S Direction	57	§2.2.3.2.6.1.8
			N/S Velocity	58-67	§2.2.3.2.6.1.9
		All Subtypes	Vertical Rate Source (GEO Flag)	68	§2.2.3.2.6.1.10
			Vertical Rate Sign	69	§2.2.3.2.6.1.11
			Vertical Rate	70-78	§2.2.3.2.6.1.12
	Based on position TYPE codes and integrity containment radius for target position		NIC Supplement	79	§2.2.17.3.4.3
	For Messages with GEO Flag = 0	Currently set to “0” (Note: The FAA is processing a Requirements Change Request to set the NAC_V based on the actual velocity performance of the surveillance source)	NAC_V	80-82	§2.2.3.2.6.1.14
		Configured Value (default is “2”)	SIL	83-84	
		Set to decimal 0 (0000)	Reserved	85-88	
	For Messages with GEO Flag = 1	Set to 0	Reserved	80	§2.2.3.2.6.1.15
		Based on altitude difference between barometric and geometric sources	Diff from Baro. Alt Sign	81	
			Diff. from Baro. Alt.	82-88	

Note: The 1090 TIS-B Coarse Position and TIS-B Identification and Category Messages are not used by SBSS.

UAT TIS-B Messages transmit only a single “long” (Payload Type code 1) message. The UAT TIS-B Address Qualifier is either set to 2 (target with ICAO address) or 3 (target with track file identifier). When the UAT Address Qualifier is 2, there are no other fields which convey whether the message is TIS-B or ADS-R.

Table 3-9. Payload Composition of UAT TIS-B Messages

Encoding	TIS-B Message Field	DO-282B Reference
Always Encode as ONE	“PAYLOAD TYPE CODE”	§2.2.4.5.1.1
Encoded based on address type available consistent with referenced section of DO-282B	“ADDRESS QUALIFIER”	§2.2.4.5.1.2
A 24-bit ICAO address, or service-generated track ID number	“ADDRESS”	§2.2.4.5.1.3
Encoded consistent with referenced section of DO-282B §2.2.4.5.2.1	“LATITUDE” and “LONGITUDE”	§2.2.4.5.2.1
Encode as ZERO if Pressure Altitude data is available; otherwise encode as ONE if the “Geometric Altitude” data is available	“ALTITUDE TYPE”	§2.2.4.5.2.2
Pressure Altitude if available, otherwise Geometric Altitude if available.	“ALTITUDE”	§2.2.4.5.2.3
Encoded based on determined NIC value	“NIC”	§2.2.4.5.2.4
Service generated and encoding consistent with DO-282B §2.2.4.5.2.5	“A/G STATE”	§2.2.4.5.2.5
	“HORIZONTAL VELOCITY”	§2.2.4.5.2.6
	“VERTICAL VELOCITY”	§2.2.4.5.2.7
Service generated and encoding consistent with DO-282B §2.2.4.5.3.1, excluding a value of “0000”. Also, see Appendix C.2 of this document.	“TIS-B SITE ID”	§2.2.4.5.3.1
Encoded per relevant section of DO-282B when data available	“EMITTER CATEGORY AND CALL SIGN CHARACTERS #1 AND #2”	§2.2.4.5.4.1, §2.2.4.5.4.2
	“CALL SIGN CHARACTERS #3, #4 AND #5”	§2.2.4.5.4.2
	“CALL SIGN CHARACTERS #6, #7 AND #8”	§2.2.4.5.4.2
Encode as UNKNOWN	“EMERGENCY/PRIORITY STATUS”	§2.2.4.5.4.4
Encode as TWO	“UAT MOPS VERSION”	§2.2.4.5.4.5
Configured Value (default is “2”)	“SIL”	§2.2.4.5.4.6
The 6 LSBs of the MSO selected for this TIS-B Message	“TRANSMIT MSO”	§2.2.4.5.4.7
Set to “2”	“SDA”	§2.2.4.5.4.8
Encoded consistent with DO-282B §2.2.4.5.4.9	“NAC$_P$”	§2.2.4.5.4.9

Encoding	TIS-B Message Field	DO-282B Reference
Currently encoded as ZERO (Note: The FAA is processing a Requirements Change Request to set the NAC_V based on the actual velocity performance of the surveillance source)	"NAC_V"	§2.2.4.5.4.10
Always encode as ZERO	"NIC_{BARO}"	§2.2.4.5.4.11
Always encode as: - CDTI Traffic Display Capability: NO - TCAS/ACAS Installed and Operational: YES(1)	"CAPABILITY CODES"	§2.2.4.5.4.12
Always encode as ALL ZERO	"OPERATIONAL MODES"	§2.2.4.5.4.13
Always encode as ZERO	"TRUE/MAG"	§2.2.4.5.4.14
Always encode as ONE	"CSID"	§2.2.4.5.4.15
Always encode as ONE	"SIL_{SUPP}"	§2.2.4.5.4.16
Always encode as ZERO	"GVA", "SA Flag", and	
Encoded based on determined NIC value	"NIC_{SUPP}"	§2.2.4.5.4.19
Always encode as ZERO	Reserved	§2.2.4.5.4.20

Notes:

1. *TCAS Installed and Operational is set to "Yes" because the TCAS status of the aircraft being broadcast in TIS-B is unknown and the DO-260A/282A MOPS assumed that ADS-B receiving subsystems could issue vertical resolution advisories on aircraft that were not TCAS equipped. However, potential future ADS-B In applications should not issue vertical resolution advisories on TIS-B without knowing the TCAS status of aircraft. By setting the indication to "Yes" the TIS-B data indicates to potential ADS-B In applications that there should not be a vertical resolution advisory issued. This issue was corrected in DO-260B/282B wherein the avionics would not issue a vertical advisory without knowing the TCAS status of an aircraft.*

3.3.3.2 TIS-B Quality of Service

The TIS-B Service supports several Surveillance and Broadcast Services applications identified in the SBS CONOPS, including:

- Traffic Situation Awareness – Basic (12.1 seconds)
- Airport Traffic Situation Awareness (2 seconds)
- Airport Traffic Situation Awareness with Indications and Alerts (2 seconds)
- Traffic Situation Awareness for Visual Approach (5 seconds)
- Traffic Situation Awareness with Alerts (10 seconds)
- Flight-Deck Based Interval Management–Spacing (10 seconds)
- The TIS-B/ADS-R Service Status message will be broadcast such that each client will receive this message with their 24-bit address with an update interval of 20

seconds (95%). The TIS-B/ADS-R Service Status message will only be provided to clients that are eligible for both TIS-B and ADS-R service.

3.3.3.2.1 TIS-B Integrity and Accuracy

The probability that TIS-B Service introduces any error into a TIS-B Message is less than or equal to 10^{-5} per Message (equivalent to a System Design Assurance level of 2 – Major). This probability of error includes the linear position extrapolation process using the instantaneous velocity reported for a target. The Source Integrity Level (SIL) is a SBSS-wide configured value and is set to 2 by default. The Navigation Integrity Category (NIC) is computed for TIS-B messages based on the configured SIL value, the target's NAC_P (described below), and the containment error 'tail' based on radar plot error assumptions. Radar PARROTs and the ASDE-X system will be monitored for faults and excessive biases. The SIL supplement will always be encoded as 1 to indicate that the probability of a TIS-B target exceeding the NIC containment radius is calculated on a per sample basis. Although the SDA and SIL supplement are not transmitted over the 1090ES link, they should be assumed to be the values stated in this document by avionics processors in support of the relevant applications.

TIS-B reports are currently sent with a NAC_V of 0. The FAA is working a requirements change that is expected to be implemented in the future. Once this change is enacted, the NAC_V in TIS-B messages will be set based on the performance of the surveillance source. TIS-B for surface Multilateration sources will support NAC_V of 2 on the surface and NAC_V of 1 on approach. TIS-B for targets detected by Terminal radars will likely support a NAC_V of 1. TIS-B for targets only detected by En Route radar sources are will likely have a NAC_V of 0.

The altitude included in TIS-B reports is the uncorrected Mode C reported altitude transmitted by the Target.

The TIS-B Service computes a NAC_P, as defined in DO-242A Table 2-3 (excluding the Vertical Estimated Position Uncertainty*)*, for each target at each track state vector update. For the applications supported by TIS-B, Navigation Accuracy Category - Position (NAC_P) is limited to the horizontal position information. NAC_P for a TIS-B target is based on the surveillance sources used to derive the target position rather than navigation sources used to supply ADS-B position. Therefore, the derivation of NAC_P for TIS-B will likely be different from that for ADS-B. For example, the NAC_P value must include the uncertainty in converting slant range measurements to horizontal position estimates.

Track angle and position accuracy in the Surface environment are based upon the accuracy provided by ASDE-X. The TIS-B Service sets the Track Angle to Invalid when the target ground speed drops below a defined threshold (currently set to 11.84 Knots). Ground TIS-B Targets provided by ASDE-X in the Surface domain will typically have a NAC_P of 9 or better. Airborne targets provided by ASDE-X in the Surface environment will typically have a NAC_P of 6 or better.

In En Route and Terminal environments the track accuracy will meet or exceed the values shown below.

Table 3-10. Requirements for Track Accuracy

Central Sensor	Flight Path	Speed (kts)	Rng. (NM)	Position Error (NM)		Heading Error (°)		Speed Error (kts)	
				Peak RMS Position Error	Mean Position Error	Peak RMS Heading Error	Mean RMS Heading Error	Peak RMS Speed error	Mean RMS Speed error
Short Range Sensor (ATCBI-5)	Linear Acceleration†	650->250->650	Center	0.4		13		37	
			All	0.6		19		60	
	180°	100	48 (case 3)	0.4(0.4+)		97 (70+)		20 (10+)	
		250-700		0.4(0.4+)		32 (30+)		20 (10+)	
	Radial	100	50*** (case 2)		0.1 (0.1#)		7 (2#)		5 (4#)
	Tangential	100			0.1 (0.1#)		5 (5#)		9 (7#)
Long Range Sensor (ATCBI-5)	Linear Acceleration†	650->250->650	n/a	0.5		13		60	
	90° turn	100-400	84 (case 2)	1.1 (0.4+)		70 (38+)		60+	
		700***		1.8 (0.4+)		34 (14+)		54 (14+)	
	Radial	100-700	100		0.5				11
	Tangential	100-700	80		0.4		7		15

Notes:

1. *Table symbology:*

   † *These scenarios were generated and the values in this table are based on best engineering judgment.*

   \+ *These multisensor cases use existing scenarios (because they are not spatially distributed).*

   \# *These multisensor cases use a single target path from existing scenarios and are run multiple times through the standalone filter algorithm, with independent noise generated each time (i.e., run Monte Carlo iterations).*

3.3.3.2.2 TIS-B Position Update Interval

The TIS-B Service updates target position and velocity data based on surveillance measurement events and is therefore dependent on the availability of source sensors for new data. The following specifications apply only when sensor data is available to the TIS-B Service to support the performance requirements. Under lightly-loaded conditions the TIS-B service may transmit reports at a rate higher than the minimum specified rate. Graceful Degradation algorithms are implemented which will throttle transmissions back to the required update rate as the system reaches maximum capacity (see §3.3.2.2.2 for GD description). Sometimes it will be necessary to transmit the same report multiple times in order to ensure the required update rate and probability of detection.

The maximum message transmission rate for a TIS-B Target to a 1090 and UAT clients is 1 time per second (this is the expected rate for targets in Surface Service volumes where ASDE-X sends track updates at approximately 1 Hz). Transmit intervals outside of Surface Service volumes will be less than or equal to 1 Hz depending on the number of radars tracking a target and their scan rates. Similar to ADS-R, each TIS-B track update event triggers the transmission of a 1090 TIS-B message packet. Each 1090 TIS-B message packet consists of 2 position messages and 1 velocity message (both surface and airborne targets). All of the 1090 TIS-B messages in the packet are transmitted within milliseconds of each other.

The expected minimum power received by UAT avionics is -93 dBm. The TIS-B link margin for UAT clients is expected to be > 11 dB for the majority of the NAS airspace.

The expected minimum power received by 1090 avionics is -79 dBm in low interference environments and -72 dBm in high interference environments. The TIS-B link margin for 1090 clients is expected to be > 5 dB for the majority of the NAS airspace.

3.3.3.2.2.1 Surface Update Interval

The TIS-B Service transmits the number of TIS-B Messages necessary to meet an update interval of no greater than 2 seconds (95%) for each client aircraft for all traffic within 5 NM and within ± 2000 feet of each client within the Surface Service Volume.

3.3.3.2.2.2 Terminal Update Interval

The TIS-B Service transmits the number of TIS-B Messages necessary to meet an update interval of no greater than 6 seconds (95%) for each client aircraft for all traffic within 15 NM and within ± 3000 feet of each client within the Terminal Service Volume. Airborne TIS-B targets in a Surface SV will also be provided to those in a Terminal SV. However, ground state targets will not be provided to clients in Terminal SVs.

3.3.3.2.2.3 En-Route Update Interval

The ADS-R Service transmits the number of ADS-R Messages necessary to meet an update interval of no greater than 12.1 seconds (95%) for each client aircraft for all traffic within 15 NM and within ± 3000 feet of each client within the En-Route Service Volume.

3.3.3.2.3 TIS-B Latency

The latency for TIS-B Service processing of TIS-B data is less than 1.5 seconds as measured from the FAA Surveillance SDP (for surveillance data to the Service Provider) to the start of the TIS-B Message transmission. This SDP to TIS-B transmission latency is compensated in the TIS-B horizontal position by linearly extrapolating to the time of transmission.

Overall end-to-end latency from sensor measurement to start of the TIS-B transmission is less than 3.25 seconds. The Essential Services Specification states: “This requirement applies to services delivered to the airport surface, Terminal airspace and En Route airspace. The TIS-B MASPS allocates 3.25 s from sensor measurement to TIS-B Message transmission. The expected maximum delay associated with getting target measurements from a radar sensor is 1.725 seconds, leaving the balance of time to the TIS-B Service.” Analysis of En-Route/Terminal tracker cross-track/along-track errors indicates that the uncompensated latency for these Service Volume types is typically less than 0.5 seconds. For Surface Service Volumes with ASDE-X, the uncompensated latency is less than 0.5 seconds and the maximum total latency for ASDE-X data between aircraft signal transmission and the arrival of the target reports at the SBSS control station is 1.6 seconds.

3.3.3.2.4 TIS-B Service Availability

The TIS-B service is a safety-essential service as classified by NAS-SR-1000 Rev B for surveillance services. The availability of the TIS-B Service specified in this section is limited to the SBSS. It includes the ADS-B Receive Function, but does not include FAA surveillance sensors providing sensor data. The TIS-B Service meets a minimum Availability of 0.999 at SDPs.

3.3.3.2.5 TIS-B Media Access

1090 TIS-B transmissions contend with air-to-air 1090 ADS-B transmissions and potentially with nearby SBSS Ground Station 1090 transmissions. However, 1090 transmissions are randomized to minimize interference and each SBSS Ground Station has a maximum 1090 transmission duty cycle of 6% (combines all 1090 TIS-B and ADS-R messages).

UAT TIS-B transmissions contend with air-to-air UAT ADS-B transmissions since they are in the ADS-B segment of the UAT Frame (not the Ground Segment) and potentially with nearby SBS Ground Station UAT transmissions. However, UAT transmissions are randomized to minimize interference and each SBSS Ground Station has a maximum UAT transmission duty cycle of 12.5% (combines all UAT TIS-B and ADS-R messages)

Although TIS-B transmissions are event-driven by receptions of radar/ASDE-X updates, both 1090 and UAT have configurable minimum TIS-B transmit intervals (currently set to 1.5 ms) with an added random time (up to 3 ms) appended to the minimum interval. Additionally, typically only one radio rebroadcasts a particular target at any given time.

3.3.3.2.6 TIS-B Track ID Changes

In En Route and Terminal SVs, the ground infrastructure will use a tracker assigned address for all TIS-B traffic. This tracker-assigned address will change as the TIS-B traffic transitions En-Route SV boundaries. To prevent the transient appearance of dual tracks at the transition avionics will have to make a correlation of the 2 addresses. (see RTCA DO-317A section 2.2.3.2.4)

The surveillance system used in the Surface SVs is aware of the ICAO 24-bit address for TIS-B traffic equipped with a Mode S transponder. TIS-B traffic equipped with a Mode S transponder departing a Surface SV will use the ICAO 24-bit address until around 25 NM from the airport at which time a tracker assigned address will be used. All arrival traffic destined for an airport with a Surface SV will stay with its tracker assigned address to the gate area. See Figure 3-5.

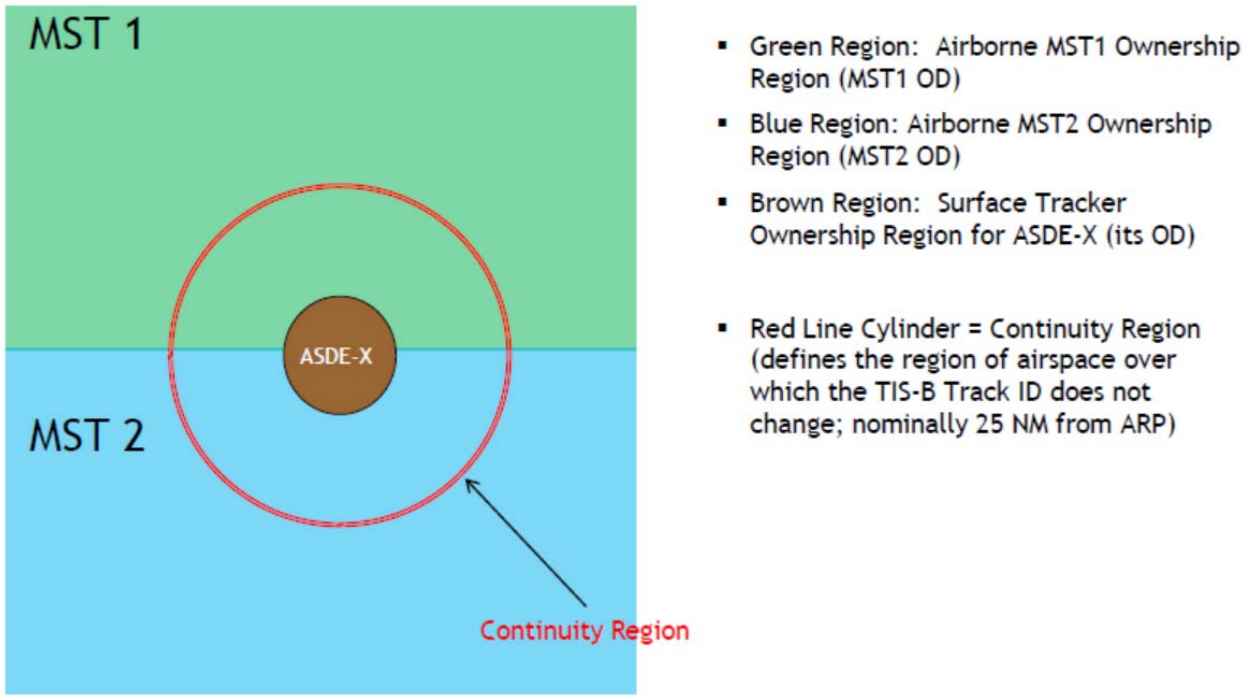

Figure 3-5. Continuity Region around Airport with Surface SV

3.3.3.2.7 Appearance of TIS-B Dual Traffic Tracks

Due to the client-based nature of the TIS-B service, certain TIS-B traffic near an En Route SV border could be uplinked redundantly. This would occur when the same traffic is uplinked separately to clients on each side of the boundary. The most uplink redundancy would occur at a point where 3 separate En Route SV areas come together. In boundary areas it is possible one of the clients could hear multiple uplinks for the same traffic. Each uplink will use a different tracker assigned ID since a different tracker is used on each side of the boundary. To prevent the transient appearance of multiple tracks at the transition, avionics will have to make a correlation of the multiple uplinks (e.g. multiple tracker assigned addresses).

The surface surveillance system will not associate its tracks with ADS-B if the ADS-B installation does not meet the requirements for surface operations[6]. This will cause the reception of direct ADS-B as well as a TIS-B track for these aircraft. Since departing TIS-B tracks use the 24-bit address as described, the 24-bit address will be identical so avionics can make the correlation using the address. Arriving traffic will have a TIS-B address that is tracker assigned, resulting in different addresses for the ADS-B and TIS-B tracks of the same aircraft. In this case avionics will need to make the correlation spatially.

It is possible that individual radar sensors could (for numerous reasons) report a single aircraft as two. The SBSS tracker used for TIS-B has requirements that the dual track rate output is less than 0.1% and that any dual tracks output will be eliminated within 30 seconds.

[6] For ADS-B transmissions to be used by SBSS in Surface SVs, they must meet all the requirements of FAR 91.227 including providing a NAC_P of 8 or better.

3.3.3.2.8 Determination of Air-Ground State for TIS-B In Surface Service Volumes

A/G state determined based on a combination of speed and altitude of the traffic. For most traffic, if the speed is >100 knots AND height above the surface is >100 feet the traffic is AIRBORNE; otherwise it is determined to be ON GROUND. If the traffic can be determined to be a rotorcraft, then it will always be reported as AIRBORNE.

Notes: 1. The ON GROUND/AIRBORNE status reported by the Mode S transponder can falsely report the ON GROUND state in some aircraft. For this reason the above speed and altitude tests are used to determine the ON GROUND/AIRBORNE state for TIS-B in surface SV.
2. The speed and altitude thresholds for the Air-Ground state algorithm are configurable and may be adjusted in the future to better determine aircraft state.

3.3.4 FIS-B Service Messages and Performance

FIS-B is an Essential service as defined by the SBS Essential Services Specification. The FIS-B service provides NAS users with accurate, reliable and timely data on weather phenomina occuring in the NAS and non-control aeronautical information regarding the status of NAS systems and resources. The performance that is required in delivering the FIS-B Service is detailed in following paragraphs.

FIS-B is advisory in nature, and considered non-binding advice provided to assist in the safe and legal conduct of flight operations. FIS-B is not intended to replace existing voice networks, Flight Service Station (FSS) services, or usurp any joint duties or responsibilities required by part 121 operators. Loss or non-receipt of FIS-B service would have no regulatory impact. (See DO-267A section 1)

3.3.4.1 FIS-B Information Units—Message Content

UAT FIS-B Messages are formatted in accordance with the Ground Uplink Application data Information Frames described in §2.2.3.2.2.2 of DO-282B. The UAT Frame Type field (Byte 2: Bits 5 through 8) is a 4-bit field that contains the indication for the format of the Frame Data field. The Frame Types are defined in Table 3-11.

Table 3-11. UAT Frame Types

MSb	Value (binary)	LSb	Frame Data Format
0000			FIS-B APDU
0001			Reserved for Developmental Use
0010 – 1110			Reserved for future use
1111			TIS-B/ADS-R Service Status

The formatting of FIS-B products is defined in the FIS-B Product Registry version 4.0 that is currently available at (http://fpr.tc.faa.gov). The URL of the FIS-B Product Registry is subject to change. Should this link not be functioning, it is recommended that operators contact the FAA at adsb@faa.gov to obtain the current FIS-B product documents.

3.3.4.1.1 FIS-B Information Units –FIS-B APDU

When the Frame Type is the binary value "0000", the Frame Data contains FIS-B data packaged as an Application Protocol Data Unit (APDU) as described in RTCA DO-267A §3.6.1, and Appendix D (also in the FIS-B Product Definitions at the FIS-B Product Registry, http://fpr.tc.faa.gov).

Note that there is an exception in how the APDU is transmitted by SBSS as follows:

> *As described in the SBS Essential Services Specification, the UAT transmission of the APDU header does not include the 16-bit FIS-B APDU ID field. Per RTCA DO-267A, this field is a fixed 2-byte field of 0xFF and 0xFE. Since FIS-B APDUs are fully identified as such by the Frame Type field, these 2 bytes are not transmitted over the air interface. If this 2-byte field is required for interoperability reasons on board the aircraft, this 2-byte field can be reconstituted after receipt onboard.*

3.3.4.1.2 FIS-B Information Units –TIS-B/ADS-R Service Status

When the Frame Type is the binary value "1111", the Frame Data contains TIS-B/ADS-R Service Status data. The remaining values are reserved for future application data.

The UAT TIS-B/ADS-R Service Status is conveyed in a UAT Ground Uplink Message as a list of client addresses for aircraft/vehicles transmitting UAT ADS-B to which the status pertains. The presence of a status message for a TIS-B/ADS-R client indicates that TIS-B and ADS-R Services are available for traffic in the immediate proximity to the client. Upon entry into airspace where the TIS-B and ADS-R Services have both surveillance coverage and UAT RF coverage (i.e., ADS-B Messages received), these status messages are transmitted.

The format in Table 3-12 is used to represent the combined TIS-B and ADS-R Service Status to individual aircraft/vehicle transmitting UAT ADS-B Messages. The Address Qualifier and Address fields are populated with the same values reported by the ADS-B target. Each TIS-B/ADS-R Service Status is client centric and packed sequentially into the Frame Data portion of the UAT Information Frame. A single Ground Uplink message could convey a maximum of 105 TIS-B/ADS-R client addresses if the entire payload of the Ground Uplink message is used for this data. Typically, the TIS-B/ADS-R Service Status message will pack the TIS-B/ADS-R client addresses under a single Information Frame (instead of 1 I-Frame per address).

Table 3-12. UAT TIS-B/ADS-R Service Status Format

<table>
<tr><th>Tx order</th><th>Bit 1</th><th>Bit 2</th><th>Bit 3</th><th>Bit 4</th><th>Bit 5</th><th>Bit 6</th><th>Bit 7</th><th>Bit 8</th></tr>
<tr><td>1st</td><td colspan="4">Reserved
)</td><td>Sig. Type</td><td colspan="3">Address Qualifier</td></tr>
<tr><td>2nd</td><td>(MSB)A1</td><td>A2</td><td>A3</td><td>. . .</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3rd</td><td colspan="8">Address</td></tr>
<tr><td>4th</td><td></td><td></td><td></td><td></td><td>. . .</td><td>A22</td><td>A23</td><td>A24(LSB)</td></tr>
</table>

The SIGNAL TYPE (Sig.) bit is always encoded as "1".

3.3.4.2 FIS-B Quality of Service

The FIS-B Products supported by the SBSS are shown in Table 3-13. The FIS-B quantity of products and report-specific idiosyncrasies are described in detail in Appendix B:

Table 3-13. FIS-B Products Supported by SBSS

Product	Registry Product ID
AIRMET	11
SIGMET / Convective SIGMET	12
METAR, PIREP, TAF, and Winds/Temperatures Aloft	413
CONUS NEXRAD	64
Regional NEXRAD	63
NOTAM	8
SUA Status	13

3.3.4.2.1 FIS-B Integrity

The probability that FIS-B Service introduces any error into a FIS-B Message is less than or equal to 10^{-5} per Message.

3.3.4.2.2 FIS-B Transmission Interval

Transmission Interval is defined as the time between the broadcast of a specified FIS-B product from a radio station. This interval depends upon the product as indicated in Table 3-14 below.

Table 3-14. FIS-B Product Transmit Intervals

Product	Transmission Interval
AIRMET, SIGMET/Convective SIGMET, and METAR	5 minutes
CONUS NEXRAD	15 minutes
Regional NEXRAD	2.5 minutes
NOTAM, PIREP, SUA Status, TAF, and Wind and Temperature Aloft	10 minutes[7]
TIS-B Service Status	10 seconds

[7] Long text NOTAMs are transmitted in full at 20 minute intervals (see B.2.8)

3.3.4.2.3 FIS-B Update Interval

Update interval is defined as the time between updates of FIS-B products. This interval depends upon the product as indicated in Table 3-15 below.

Table 3-15. FIS-B Product Update Intervals

Product	Update Interval
AIRMET	As Available (Typically ≤ 20 minutes)
SIGMET/Convective SIGMET	As Available (Typically ≤ 20 minutes), then at 15 minute intervals for 1 hour
METAR	1 minute (where available), As Available otherwise (Typically ≤ 20 minutes)
CONUS NEXRAD	15 minutes
Regional NEXRAD	5 minutes (10 minutes for clear air mode)
NOTAM, PIREP, and SUA Status	As Available (Typically ≤ 20 minutes)[8]
TAF	6 Hours
Wind and Temperature Aloft	12 Hours

3.3.4.2.4 FIS-B Service Availability

The FIS-B service is a safety-essential service as classified by NAS-SR-1000 Rev B for surveillance services. The service availability reflects the availability of each individual FIS-B product being processed and broadcast to users in each designated Service Volume. The availability does not include product source data or the systems providing these data. The FIS-B Service meets a minimum Availability of 0.999.

The FIS-B Service will notify aircraft/vehicles of a FIS-B Service outage in a Service Volume within 30 seconds of the outage occurrence (via a NOTAM) and continue to provide the notification until service is returned (assuming the communications link is still intact). Requirements in the FIS-B MASPS accommodate lost link conditions. Service availability does not apply to outages that may occur on individual aircraft or to individual product sources.

3.3.4.2.5 FIS-B Media Access

UAT FIS-B transmissions occur during the Ground Segment portion of the UAT Frame. Each Ground Station is assigned a maximum of 4 channels for FIS-B transmissions with a minimum of 4 unused channels in between each assigned channel. Each of the 32 FIS-B Data Channels is 22 Message Start Opportunities (MSOs) in length with Slot 1 starting MSO at 0 and ending MSO at 22 and Slot 32 starting MSO at 682 and ending MSO at 704 (see §1.3.1 of RTCA DO-282B for additional UAT MSO description). FIS-B data channels are assigned and reused in a cellular reuse pattern similar to the description in Appendix D of RTCA DO-282B.

8

The set of FIS-B data channels from each Ground Station will be assigned a TIS-B Site ID (populated in the UAT-Specific Header, see Table 2-4 of RTCA DO-282B) to identify the tier of FIS-B products it is transmitting (see Appendix C.2 of this document). UAT FIS-B transmissions from each Ground Station have a maximum UAT transmission duty cycle of 2.75% (assumes 5 slots per second). See Appendix F for more details on FIS-B media access.

3.4 Protocol Implementation

3.4.1 ADS-B Service

Figure 3-6 illustrates the communications protocols used in direct air-to-air ADS-B communication between aircraft. This is not part of the SBS service, but is presented to offer a complete picture of the ADS-B-IN function for the aircraft receiving state information provided directly by another aircraft.

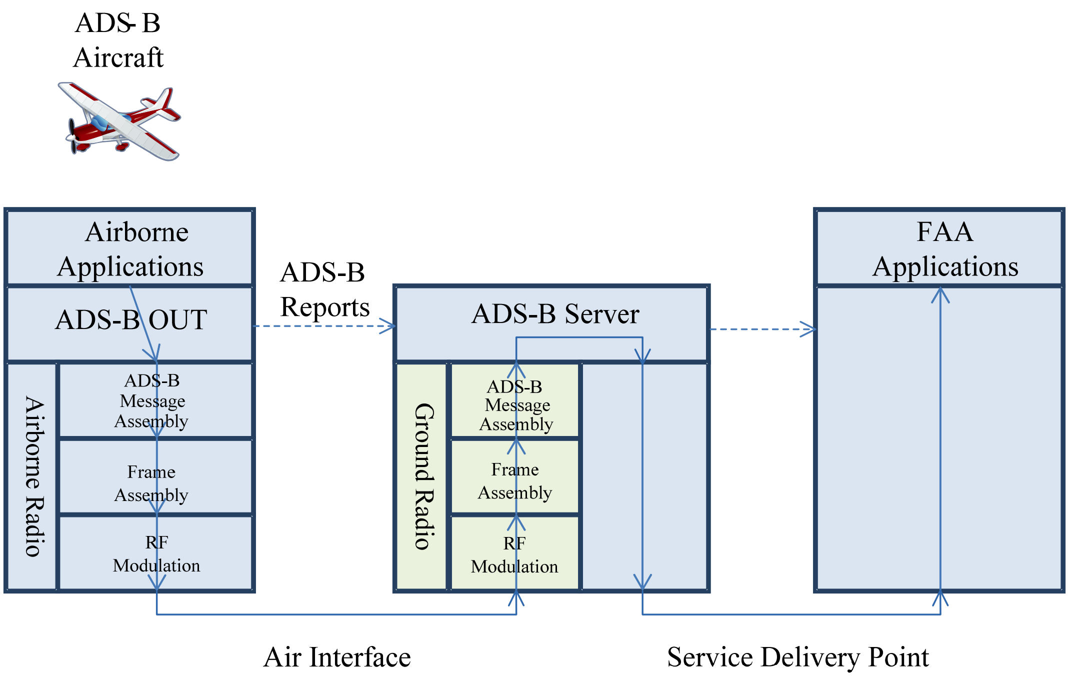

Figure 3-7 illustrates the communications protocols and path used in providing ADS-B reports to the FAA SDP. The ADS-B service receives and processes ADS-B reports from aircraft radio reports, processes them, formats them, and provides them to the SDP[9].

[9] The arrows in the figure are shown bidirectional to represent that each aircraft is ADS-B IN and OUT capable

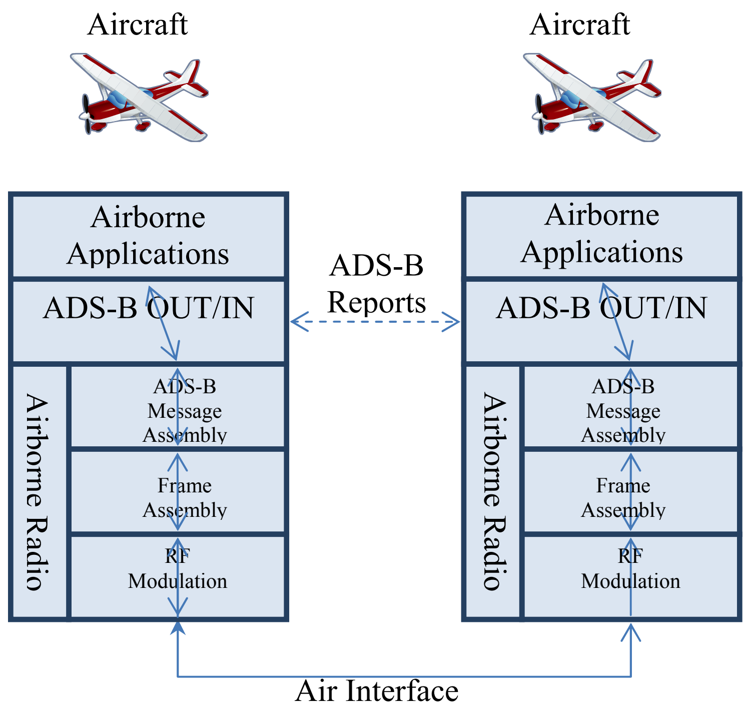

Figure 3-6. ADS-B Air-to-Air Protocol Stack

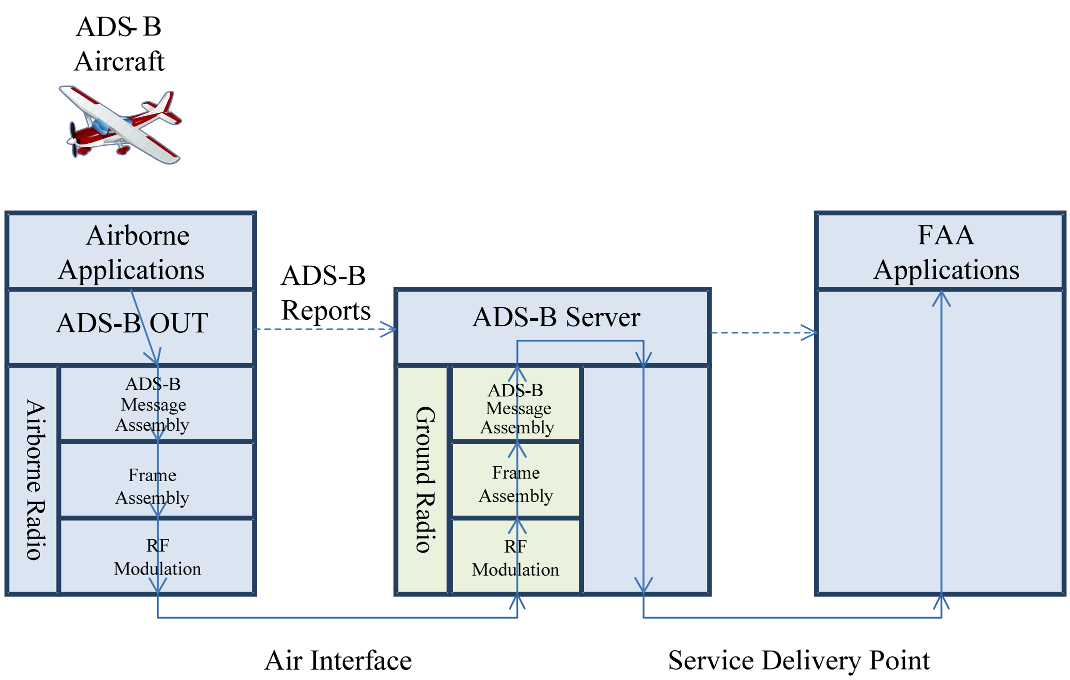

Figure 3-7. ADS-B Service Air-to-Ground Protocol Stack

3.4.2 ADS-R Service

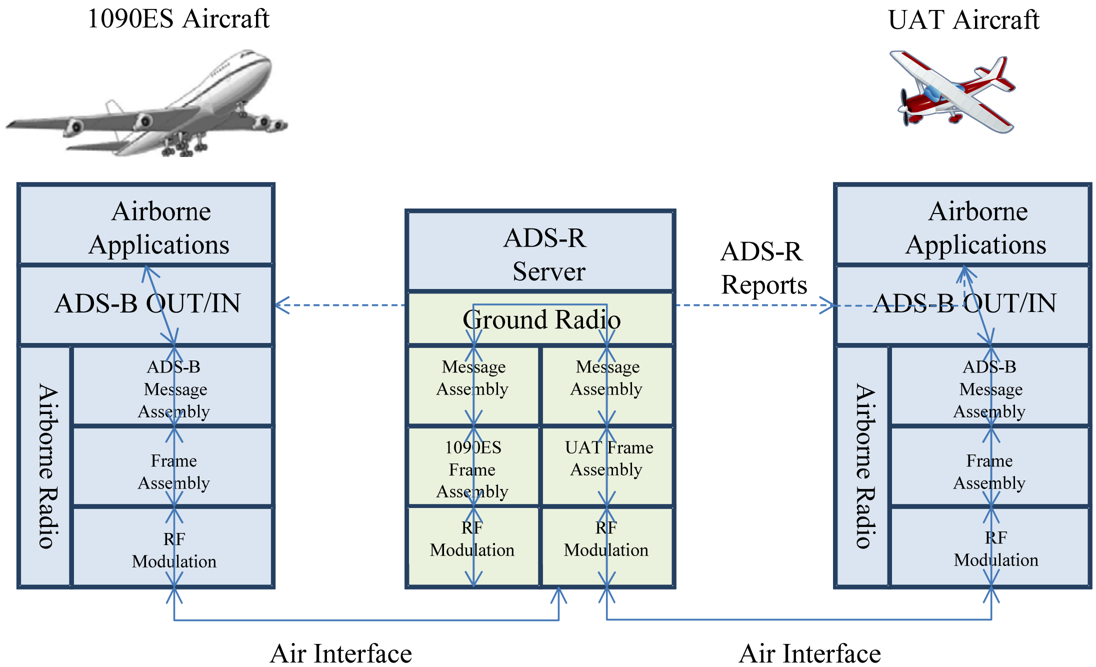

Figure 3-8 illustrates the communications protocols and path used by the ADS-R service in receiving 1090ES ADS-B reports and preparing them for rebroadcast on UAT, as well as receiving UAT reports and rebroadcasting them on 1090ES.[10]

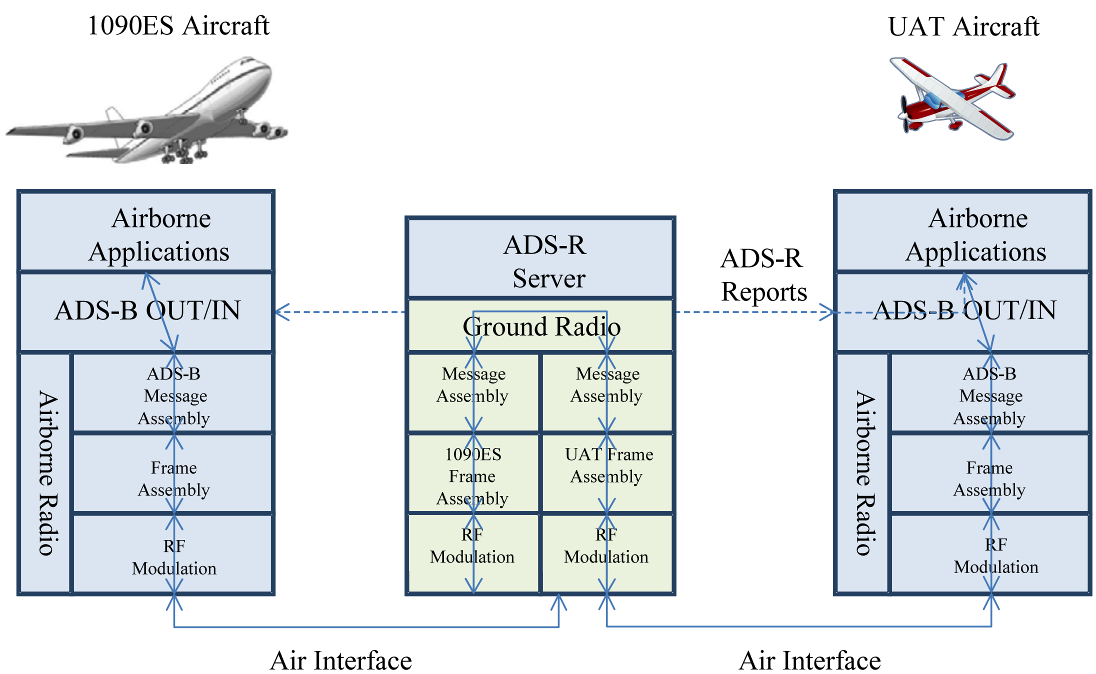

Figure 3-8. ADS-R Service Protocol Stack

[10] The arrows in the figure are shown bidirectional to represent that each aircraft is ADS-B IN and OUT capable

3.4.3 TIS-B Service

Figure 3-9 illustrates the communications path and conversions used by the TIS-B service in receiving non-ADS-B surveillance reports and transmitting them to ADS-B-IN equipped aircraft.

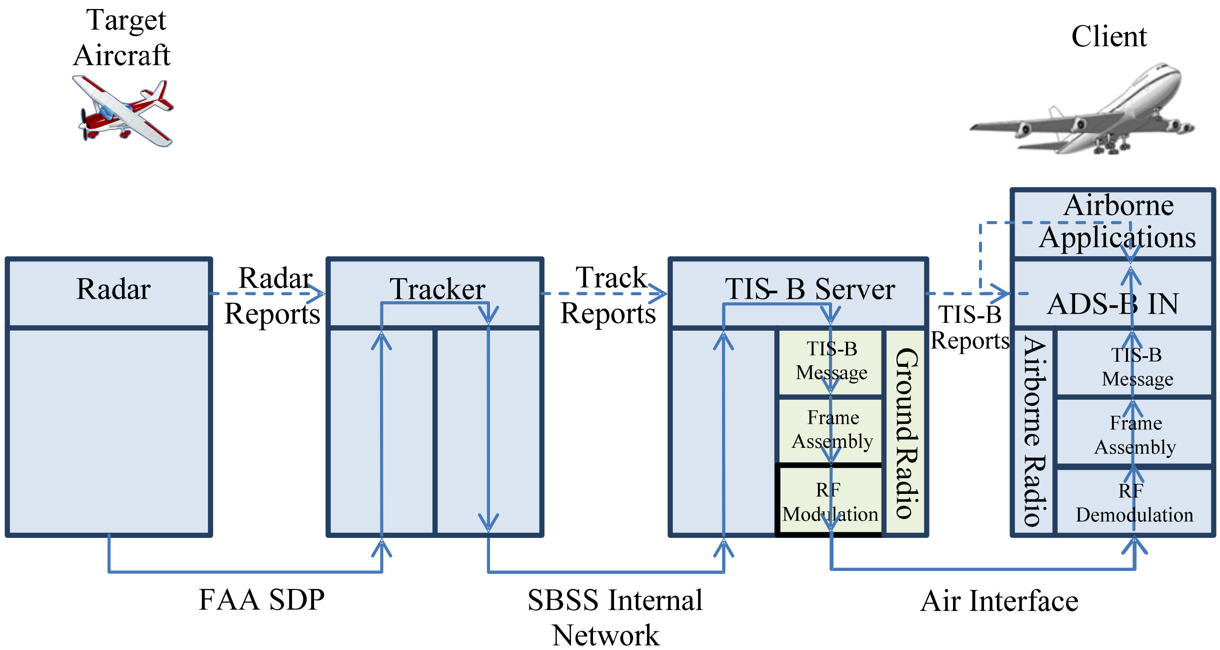

Figure 3-9. TIS-B Service Protocol Stack

3.4.4 FIS-B Service

Table 3-16. FIS-B Service Protocol Stack

<table>
<tr><th colspan="10">FIS-B Elements</th></tr>
<tr><th colspan="4">Text/Graphic Products</th><th colspan="4">Generic Text (DLAC) Products (Prod. ID 413)</th><th colspan="2">Graphical Products</th></tr>
<tr><td>Prod. ID 8
NOTAM</td><td>Prod. ID 11
AIRMET</td><td>Prod. ID 12
SIGMET/
Convective SIGMET</td><td>Prod. ID 13
SUA</td><td rowspan="2">METAR</td><td rowspan="2">PIREP</td><td rowspan="2">TAF</td><td rowspan="2">Winds/Temperatures Aloft</td><td>Prod. ID 63
Regional NEXRAD</td><td>Prod. ID 64
CONUS NEXRAD</td></tr>
<tr><td colspan="4">Segmented Messages</td><td colspan="2">Global Block Format Products</td></tr>
<tr><td colspan="10">APDU</td></tr>
<tr><td colspan="10">FIS-B Block Encoding</td></tr>
<tr><td colspan="10">UAT RF transmission</td></tr>
</table>

The above table represents the protocol stack of the FIS-B service.

FIS-B products are divided into 3 overall product types:

- Text/Graphic products consist of the following:
  - FIS-B Product ID 8: NOTAM
  - FIS-B Product ID 11: AIRMET
  - FIS-B Product ID 12: SIGMET / Convective SIGMET
  - FIS-B Product ID 13: SUA[11]
- Generic Text (DLAC) products consist of the following (all using FIS-B Product ID 413):
  - METAR
  - PIREP
  - TAF
  - Winds/Temperatures Aloft
- Global Block Format products consist of the following:
  - FIS-B Product ID 63: Regional NEXRAD
  - FIS-B Product ID 64: CONUS NEXRAD

[11] SUA is provided only in text form at this time

The formatting of these products is defined in the FIS-B Product Registry (http://fpr.tc.faa.gov/productidtable.asp) in the following documents:

FIS-B Product IDs	**Document File Name**	**Remarks**
8-13	Aero_FISB_ProdDef_Rev5.0.pdf	Describes the encoding framework used for the Text with Graphic Overlay class of products (i.e., NOTAM, AIRMET, SIGMET, SUA)
413	5_8.pdf	Describes the encoding of the Generic Text Class of products (i.e., METAR, TAF, PIREP, WIND/TEMP ALOFT)
63-64	Encoding_Section_2.pdf	Describes the encoding of the Regional and CONUS NEXRAD imagery.

3.5 Uplink Interface Design Characteristics Summary

SBSS air uplink interface characteristics are summarized below. For 1090, the Application Level Data Payload Size contains 88 bits of data per message with parity bits excluded (see Table 3-17). The Transmission Frequency peak for 1090 is the total number expected message receptions by a given aircraft from ADS-R and TIS-B combined (not each).

For UAT, the Application Data Payload Size excludes Sync and FEC Parity bits and assumes 144 bits of data per basic message, 272 bits of data payload per long message, and 422 bytes of data payload per FIS-B Ground Uplink message (see Table 3-18). The Transmission Frequency peak for UAT is the number of expected message receptions by a given aircraft from ADS-R or TIS-B of all targets combined (not each). TIS-B and ADS-R transmissions are always long UAT messages.

UAT Avionics may receive FIS-B Ground Uplinks from more than one Radio Station depending on altitude. Each Radio Station delivers a full complement of FIS-B products relative to its Tier. The FIS-B Tiering implementation will limit the maximum number of slots, assigned to a particular Radio Station, to 4. See Appendix C for more details on FIS-B Tiering and the processing of FIS-B reports received from multiple Radio Stations.

Table 3-17. 1090 Uplink Interface Requirements Table

Report Type	Format	Type	Application Level Data Payload Size per Message	Message Reception Frequency (peak)
ADS-R/TIS-B	1090	Position	88 bits	400 msgs/s
ADS-R/TIS-B	1090	Velocity	88 bits	200 msgs/s
ADS-R	1090	ID & Cat	88 bits	200 msgs/s
ADS-R	1090	Ops Status	88 bits	200 msgs/s

Table 3-18. UAT Uplink Interface Requirements Table

Report Type	Format	Type	Application Level Data Payload Size per Message	Message Reception Frequency (peak)
ADS-R/TIS-B	UAT	Long	272 bits	400 msgs/s
FIS-B	UAT	Ground Uplink	422 bytes	4 slots/sec from one Ground Station.

4 Abbreviations and Acronyms

Acronym	Definition
1090ES	1090 MHz Extended Squitter
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-R	Automatic Dependent Surveillance –Rebroadcast
AGL	Above Ground Level
AIDAP	Aeronautical Information Data Access Portal
AIRMET	Airmen's Metrological information
ANSP	Air Navigation Service Provider
APDU	Application Protocol Data Unit
ARP	Airport Reference Point
ASDE-X	Airport Surface Detection Equipment
ASSC	Airport Surface Surveillance Capability (i.e. ASDE-X)
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
CDTI	Cockpit Display of Traffic Information
CONOPS	Concept of Operations
CONUS	Contiguous United States
D-ATIS	Digital Automated Terminal Information System
DLAC	Data Link Applications Coding
FIS-B	Flight Information Services - Broadcast
FRN	Field Reference Number
ICAO	International Civil Aviation Organization
IRD	Interface Requirement Document
MASPS	Minimum Aviation System Performance Specifications
METAR	Metrological Aviation Report, (French origins)
MLAT	Multilateration
MSL	Mean Sea Level
MSO	Message Start Opportunity (for UAT media access)
MWO	Meteorological Watch Office
NAC	Navigational Accuracy Category, NAC_p = position, NAC_v = velocity
NAIMES	NAS Aeronautical Information Management Enterprise System
NAS	National Airspace System
NEXRAD	Next generation Radar

Acronym	Definition
NIC	Navigation Integrity Category
NM	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notices to Airmen
NWS	National Weather Service
OMO	One Minute Observations
PIREP	Pilot Reports as defined in FAA Order 7110
RF	Radio Frequency
RS	Radio Station
SBS	Surveillance and Broadcast Services (FAA program, program documents, services, service volumes or applications)
SBSS	Surveillance and Broadcast Services System (the implementation)
SDP	Service Delivery Points
SIGMET	Significant Metrological Information
SIL	Source Integrity Level
SSR	Secondary Surveillance Radar
SUA	Special Use Airspace
SV	Service Volume
TAF	Terminal Aerodrome (Airport) Forecast
TIS-B	Traffic Information Services - Broadcast
UAT	Universal Access Transceiver
UTC	Coordinated Universal Time or
WSI	Weather Services International
Z	Zulu time, Universal Coordinated Time

Appendix A. Coverage Maps

Note: The following figures are an overall guide intended to depict the scale of system deployment, but are not an official coverage depiction, and are not to be used in-flight.

A.1 Current Coverage

Figure A1 depicts predicted system coverage in the 1090 and UAT bands provided by the set of CONUS radio stations implemented as of 9/18/2013, at 500', 1500', 3000', 5000', and 10000' AGL.

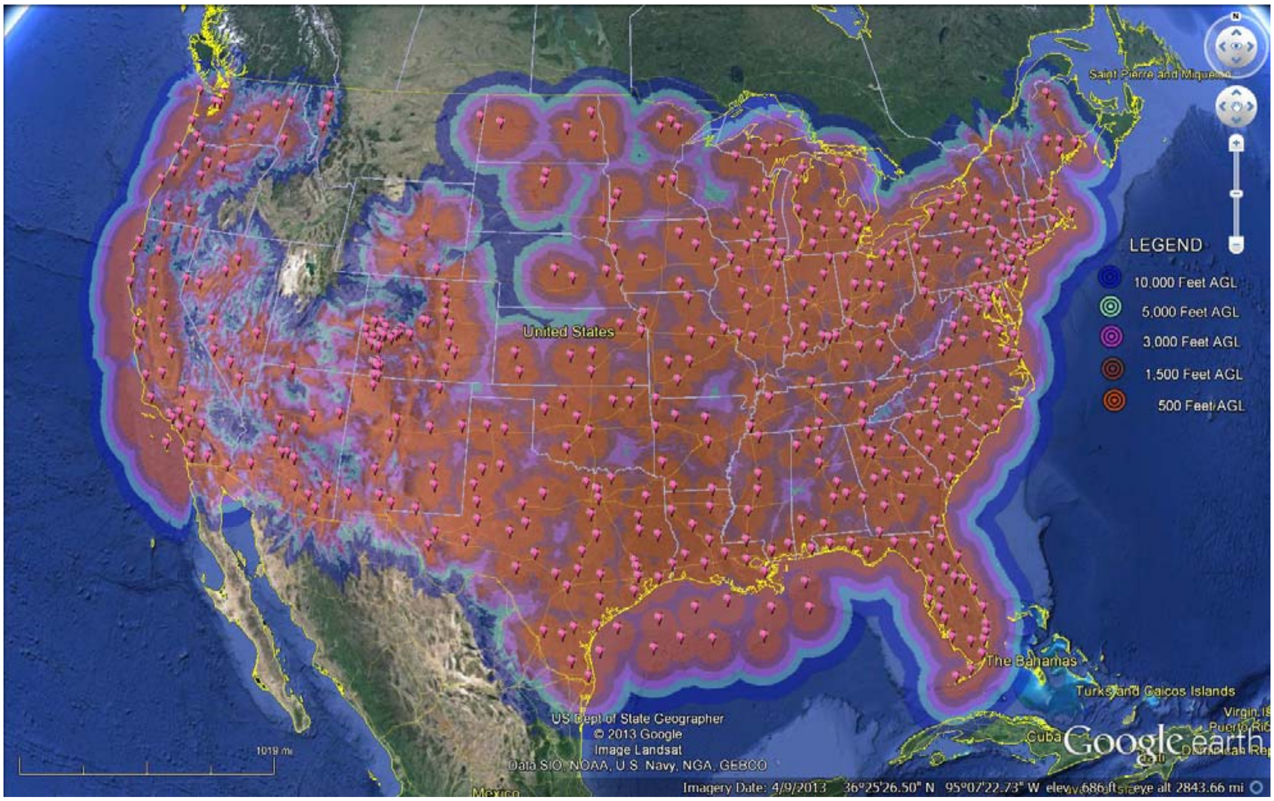

Figure A-1.Current CONUS UAT and 1090 Coverage @ Various Altitudes

A.2 End-state Coverage

Additional Radio Stations are planned to be deployed throughout the remainder of 2013 and 2014 in areas of the western mountains which will fill the holes currently without coverage as evident in Figure A1. A final end state coverage chart including these final Radio stations as well as coverage charts for areas outside CONUS will be available at:

http://www.faa.gov/nextgen/implementation/programs/adsb/broadcastservices/ or,

http://www.faa.gov/nextgen/flashmap/

Appendix B. FIS-B Quantity of Available Products and Other Aspects

B.1 FIS-B Quantity of Available Products

The following subsections will describe the typical quantity of products which are available within the NAS for each of the current FIS-B products. Note that among this quantity of available product data, the subset of product data which is actually transmitted from a particular ground station is a function of the look-ahead range for each particular FIS-B product.

B.1.1 SIGMET / Convective SIGMET

SIGMET / Convective SIGMETs are issued on as as-needed basis, and thus do not have a finite quantity of products. The SIGMET / Convective SIGMETs which are broadcast by FIS-B include all valid SIGMET / Convective SIGMETs (within the applicable Look-Ahead Range).

B.1.2 AIRMET

AIRMETs are issued on as as-needed basis, and thus do not have a finite quantity of products. The AIRMETs which are broadcast by FIS-B include all valid AIRMETs (within the applicable Look-Ahead Range).

B.1.3 METAR

The file “BaselineMetarTaf.xls” lists 1945 domestic US METAR locations that are currently uplinked by SBSS. This is the current SBSS adapted set of METAR stations being uplinked. METAR stations commissioned since this baseline set was established time will be added to the service at periodic internals with the next set being added in 2014.

B.1.4 CONUS NEXRAD

There were a total of 145 NEXRAD radar locations in the 48 contiguous United States as of 11/24/08. The imagery from these locations are combined to form one composite picture of NEXRAD reflectivity for the CONUS NEXRAD product. CONUS NEXRAD uses the medium resolution bin scale factor Global Block Representation format (see §D.2.3.5 of RTCA DO-267A). The CONUS NEXRAD uplink transmission is sent as a tight group of messages, typically completing in < 30s. Therefore, a timeout interval of 10 seconds with no reception of CONUS NEXRAD data could be used in the avionics to indicate that the transmission of the full CONUS dataset is complete. A CONUS NEXRAD update will have an updated cutoff time for all of the Global Blocks in the data set.

Figure B-1. Locations of CONUS NEXRAD Radar Sites

B.1.5 Regional NEXRAD

There were a total of 158 U.S. NEXRAD locations as of 11/24/08, including 145 NEXRAD radars in the 48 contiguous United States, and 13 NEXRAD radars located outside of the 48 contiguous United States as shown in Figure B-2[12]. Regional NEXRAD uses the high resolution bin scale factor Global Block Representation format (see §D.2.3.5 of RTCA DO-267A). The Regional NEXRAD uplink transmission is sent as a tight group of messages, typically across several channels, usually completing in < 30s. Therefore, a timeout interval of 10s could be used in the avionics to indicate that the transmission of the full Regional dataset is complete. A Regional NEXRAD update will have an updated cutoff time for all of the Global Blocks in the data set.

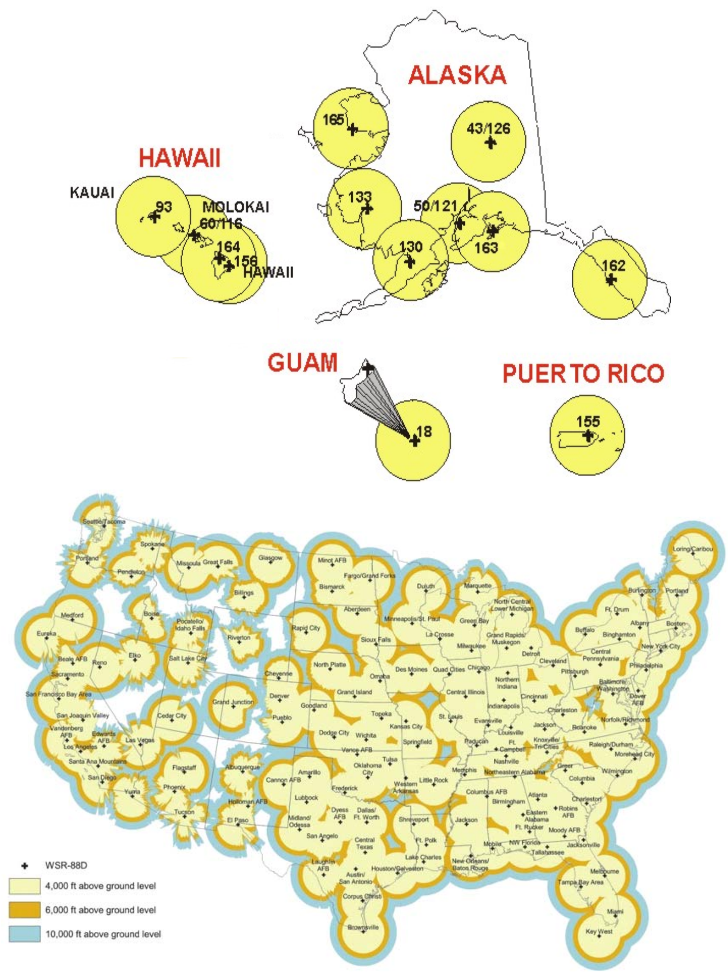

Figure B-2. Locations of U.S. NEXRAD Radar Sites

B.1.6 NOTAM

NOTAMs are issued on as as-needed basis, and thus do not have a finite quantity of products. The NOTAMs which are broadcast by FIS-B include all those that have been received by the

[12] Note that the circles in the upper portion of the figure are not representing coverage

FIS-B ground system that do not meet the NOTAM purge criteria of B.2.5.2.3. NOTAMs that exist as Military NOTAMs only are not included in the uplink.

Pilots should be aware of the following disclaimer applicable to uplinked TFR information:

- Depicted TFR data may not be a complete listing. For the latest information, contact Flight Service.

B.1.7 PIREP

PIREPs are issued on as as-needed basis, and thus do not have a finite quantity of products.

B.1.8 SUA Status

SUA Status is issued on as as-needed basis, and thus does not have a finite quantity of products. The SUA Status products which are broadcast by FIS-B include the status of SUA within the applicable Look-Ahead Range. FIS-B only broadcasts the SUA Status as a text product and does not broadcast the SUA Status graphic overlay. SUAs uplinked are the set of currently active SUAs or those SUAs expected to be active within the next 24 hours. This set is then geographically filtered for each RS.

Note: Some SUA Status reports are also uplinked as D-NOTAMS.

B.1.9 TAF

The file "BaselineMetarTaf.xls" lists the 777 domestic US TAF locations that are currently uplinked by SBSS. This is the current SBSS adapted set of TAF stations being uplinked. TAF stations commissioned since this baseline set was established time will be evaluated on a case-by-case basis for inclusion in this adapted set

B.1.10 Winds and Temperatures Aloft

There were a total of 233 domestic Winds and Temperatures Aloft forecast locations as of 11/24/08 (including CONUS, Alaska, Hawaii, Guam, Atlantic Ocean, and Gulf of Mexico). Note that there are no Winds and Temperature Aloft forecasts produced for Puerto Rico and the U.S Virgin Islands. A list of the Wind and Temp Aloft locations can be found in the file "WindTempAloftLocations.doc".

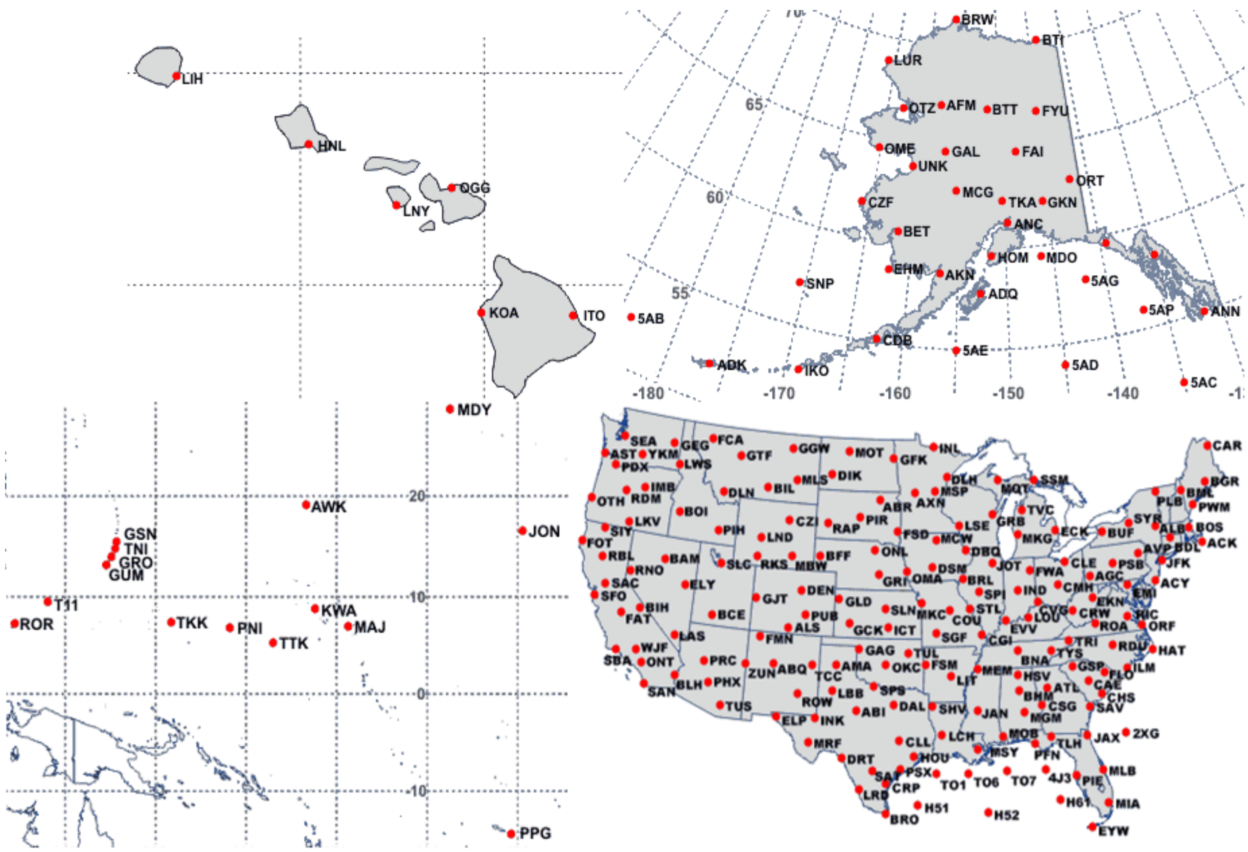

Figure B-3. Locations of U.S Winds/Temperatures Aloft Forecast Locations

B.2 FIS-B Report-specific Idiosyncrasies, Filtering, Special Handling

The following subsections will describe any specific idiosyncrasies, special filtering, or special handling for each of the current FIS-B products.

B.2.1 Truncation of Long Product 413s

B.2.1.1 Background

There is a maximum of 422 bytes of payload available for FIS-B Product Registry 413 products (which include METAR, PIREP, TAF, and Winds and Temperatures Aloft).

B.2.1.2 Solution

For products which exceed 417 bytes after DLAC encoding, transmit the first 408 bytes of payload, discard the remainder of the product, and append an indication that the resultant product is incomplete. This is expected to be an unusual occurrence in the coding of these products.

B.2.1.3 Algorithm Description of Truncation

There are a total of 422 bytes available in the APDU. Subtracting 4 bytes for the APDU Header and an additional 1 byte for the DLAC Record Separator leaves a total of 417 bytes available for the payload. Therefore, if the message totals 417 bytes or less after being DLAC-encoded, the entire message will be sent.

If the message is greater than 417 bytes after DLAC encoding, truncation will be performed:

The first 408 bytes of the DLAC-encoded payload will be stored, with all further bytes discarded.

The next 6 bytes of the payload will be filled with the string "(INCMPL)", after it is DLAC-encoded. The 8-character string "(INCMPL)" translates to the following pattern of 48 bits in DLAC encoding:

```
101000 001001 001110 000011 001101 010000 001100 101001
 ( I N C M P L )
```

A 1-byte Record Separator will be the last byte of the APDU.

The resultant 419 bytes of the APDU with truncation will be:

4 bytes	APDU Header	1 bit	Application Mode
		1 bit	Geographic Locator
		1 bit	Provider-specific flag
		11 bits	Product ID
		1 bit	Segmentation Flag
		13 bits	Header Time
		4 bits	Pad
408 bytes	DLAC-encoded APDU payload	…DLAC-encoded message text…	
6 bytes	DLAC-encoded terminator "(INCMPL)"	101000001001001110000011001101010000001100101001	
1 byte	DLAC-encoded Record separator	6 bits	011101
	Padding	2 bits	00

B.2.2 PIREP With No Airport Identifier

B.2.2.1 Background

The syntax of Pilot Reports (PIREPs) is defined in FAA Order 7110, "Flight Services":

http://www.faa.gov/airports_airtraffic/air_traffic/publications/at_orders/media/Basic7110.10T.pdf

Section 9-2-15 of this document states that the location field (/OV) of a PIREP is to contain either:

- Location in reference to a VHF NAVAID or an airport, using the 3 or 4 letter identifier.
  - Examples:
    1. /OV KJFK
    2. /OV KJFK107080
- Route segment. Two or more fixes.
  - Example: /OV KSTL-KMKC

Those are the only 2 options for syntax of the /OV parameter, and both of them are supposed to contain a 3- or 4-letter Location Identifier.

Note: All URLs in this section are subject to change.

B.2.2.2 Problem Summary

In contradiction to the PIREP location syntax described in Order 7110, PIREPs have been received which do not contain a 3 or 4-letter identifier in their location field, but instead a latitude/longitude.

- Example: /OV 3934N 7732W

In order for cockpit avionics to properly decode and display a PIREP, they expect each Type 2 DLAC Text Product to have a Location Identifier. Section 5.2.3 of the FAA GDL 90 Public Data Interface Specification:

http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/EnRoute/surveillance_broadcast/wsa/media/GDL90_Public_ICD_RevA.PDF

says: “LocID: One or more characters that can not contain <sp> or <RS>, required. Recommended but not limited to standard location Identifiers (i.e., ILN, SDF).”

Therefore when a latitude/longitude is specified in the /OV location parameter, passing the unmodified value of “3934N 7732W” would violate the cockpit avionics expectation of not having spaces within the LocID field, causing parsing problems.

B.2.2.3 Solution

Use the “NIL=” location identifier.

Section 5.2.3 of the FAA GDL 90 Public Data Interface Specification:

http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/EnRoute/surveillance_broadcast/wsa/media/GDL90_Public_ICD_RevA.PDF

says: “METAR and TAF messages may contain the string “NIL=” to indicate a report that is missing or delayed. The “NIL=” string may replace the LocID. The display processor should be capable of gracefully handling these conditions.”

Therefore in cases of a PIREP which does not have a 3 or 4-letter identifier in its /OV field, the value NIL= will be sent as the LocID value.

B.2.3 FIS-B Outage Message

B.2.3.1 Purpose

The FIS-B Outage Message provides notification to users of outages for individual FIS-B Products or the entire FIS-B service. It is transmitted as FIS-B Product ID 8 (the same ID used for NOTAMs). Although this signifies a FIS-B data outage of updates to FIS-B products, transmissions of pre-outage data will continue until the respective product data age expires.

Note that this notification is intended to cover outages of the upstream FIS-B data or outages involving the FIS-B server – it is not intended to provide notification of outages of the RF link itself.

B.2.3.2 Format of FIS-B Outage Message

- [report_year]/[report_number] `FIS-B SERVICE OUTAGE` [start_time] [geographic_scope] [product(s)_affected] `UNAVAILABLE`

- [report_year] – The last 2 digits of the year the report was issued (i.e. 08 for 2008, 09 for 2009, etc.).
- [report_number] – A sequentially-assigned 5-digit number for each report in a year, with a range of 10000 – 11999:
  - The first message in the new calendar year will be assigned report_number 10000.
  - Report_number values are incremented for each new message by 1, to the upper limit of 11,999.
  - If report_number reaches 11,999, the next report_number during the calendar year will rollover to 10,000.
- [start time] – The day and UTC time at which the outage starts (the same time format as used by METAR, TAF, etc.):
  - 2 digits for day
  - 2 digits for hour
  - 2 digits for minute
  - "Z" – represents "Zulu" (UTC) time.
  - Example to represent September 11, 12:23 UTC: 111223Z
- [geographic_scope] – List of Location Identifiers affected, delimited by ",":
  - Examples: ZMA,ZJX,ZTL
- [product(s)_affected] – Which FIS-B products are unavailable. Possible values are:

`AIRMET PRODUCT`	`TAF PRODUCT`
`PIREP ICING PRODUCT`	`PIREP TURBULENCE PRODUCT`
`PIREP WIND SHEAR PRODUCT`	`PIREP URGENT PRODUCT`
`ROUTINE PIREP PRODUCT`	`D-NOTAM PRODUCT`
`FDC-NOTAM PRODUCT`	`METAR PRODUCT`
`NEXRAD IMAGERY PRODUCT`	`SIGMET / CONVECTIVE SIGMET PRODUCT`
`TFR NOTAM PRODUCT`	`SUA PRODUCT`
`ALL PRODUCT`	`WINDS AND TEMPERATURE ALOFT PRODUCT`
`NOTAM-FDC-CANCEL PRODUCT`	`NOTAM-D-CANCEL PRODUCT`
`SAN JUAN NEXRAD PRODUCT`	`HAWAII NEXRAD PRODUCT`
`ALASKA NEXRAD PRODUCT`	`GUAM NEXRAD PRODUCT`

- Example: For a FIS-B outage in which NEXRAD imagery products are unavailable for ZMA, ZJX, and ZTL En Route airspace, starting on September 11, 12:23 UTC:

```
FIS-B SERVICE OUTAGE 13/10000 ZMA,ZJX,ZTL NEXRAD IMAGERY PRODUCTS
UNAVAILABLE
```

Notes:

1. *The FIS-B Outage messages are filtered for uplink only at the Control Station level. Therefore an outage of even relatively narrow geographic scope would at minimum still be broadcast through at least roughly 1/3 of the RSs in the NAS (since there are 3 control stations for the NAS).*

2. *Multiple products being unavailable will result in multiple FIS-B Outage messages.*

3. *Outages of the "NEXRAD IMAGERY PRODUCT" means loss of NEXRAD imagery within CONUS. This would result in the unavailability of both products 63 and 64 within CONUS.*

B.2.4 Winds and Temperatures Aloft Header

B.2.4.1 Background

Reduce end-user confusion of Winds and Temperature Aloft product when forecasts for individual altitude bands are not provided.

B.2.4.2 Summary of Changes

A 1-row header has been added above the Winds and Temperatures Aloft forecast data to specify the altitudes for the product. This helps to make it obvious to users when a specific altitude data point is missing. If a specific altitude data point is missing, the corresponding altitude is also missing in the header.

Example (as it would appear on the cockpit display):

```
FT 3000 6000 9000 12000 18000 24000 30000 34000 39000
MIA 2243 2441+16 2337+12 2437+07 2627-03 2732-13 252528 242939 232252
```

Note that the "space" character remains as the delimiter in the Wind/Temps Aloft product, so as to retain compatibility with existing (fielded) ADS-B avionics.

B.2.5 FIS-B Time Stamping

B.2.5.1 Problem Summary

SBSS Ground System Provider was directed to implement consistent use of the APDU Time Stamp field to align with FIS-B product needs and reduce FIS-B receiver complexity.

B.2.5.2 Solution

B.2.5.2.1 APDU Time of FIS-B Products: Modified System Behavior

Time \ Type of FIS-B Products	Time Observed	Time Issued	Start Time	Time First Received from FIS-B Data Source	Cut-off Time
Individual Reports / Observation	METAR/ SPECI PIREP				

Time \ Type of FIS-B Products	Time Observed	Time Issued	Start Time	Time First Received from FIS-B Data Source	Cut-off Time
Forecast Advisories		TAF/AMEND WIND/TEMP SIGMET AIRMET	SUA (note 1) NOTAM-D NOTAM-FDC NOTAM-TFR	NOTAM-D (note 2) NOTAM-FDC NOTAM-TFR	
Composite / Mosaic Observation					NEXRAD

Notes:

1. *Payload for SUA always contains both start and stop times; APDU header stores only start time.*

2. *For some NOTAMs that do not contain any creation/start time, FIS-B will use the time when they are first received from the FIS-B Data Source.*

FIS-B APDU Header Time will use up to 28 bits (month, day, hours, minutes, seconds, as described below). The use of these fields for specific products will be explained below.

APDU header time (13 or 28 bits)					
T opt 2 bits	Mth of Yr (opt 4 bits)	Day of Mth (opt 5 bits)	Hours (5 bits)	Minutes (6 bits)	Seconds (opt 6 bits)

Time Option Flag (2 bits)	Description
00	Mon, Day, Sec omitted
01	Mon, Day omitted; Sec included
10	Mon, Day included; Sec omitted
11	Mon, Day, Sec included

B.2.5.2.2 APDU Header Time for FIS-B Products

For METAR, TAF, PIREP and WINDS/TEMP ALOFT, only day, hour and minute are provided by the FIS-B Data Source. However, there is no such format in Time Option Flags. Since these products don’t exist for more than 24 hours, only the Hour and Minute fields will be used, as follows:

T Opt 2 b		**Hours 5 bits**					**Minutes 6 bits**					
0	0											

NEXRAD will also use the time format below:

T Opt 2 b		**Hours 5 bits**					**Minutes 6 bits**					
0	0											

AIRMET, SIGMET, SUA, and NOTAM will use the following time format:

T Opt 2 b		**Month 4 bits**				**Day 5 bits**					**Hours 5 bits**					**Minutes 6 bits**					
1	0																				

B.2.5.2.3 NOTAM Purging

- The following describes how and when NOTAMs are purged by the FIS-B ground system: For NOTAM-D, NOTAM-FDC and NOTAM-TFR: if the expiration time is available, the NOTAM is purged at the expiration time
- For NOTAM-D and NOTAM-FDC: If the FIS-B ground system received a NOTAM Cancellation, the NOTAM text record header will be uplinked with the status bit set to Cancelled for a configurable time interval, then purged
- For NOTAM-TFR: If the FIS-B ground system receives no refreshes for a particular NOTAM-TFR for a configurable period (30 minutes), FIS-B will purge the NOTAM-TFR

B.2.6 Overlay Geometry Options for Graphic Products

The document “Aero_FISB_ProdDef_Rev5.0.pdf” describes the formatting of the FIS-B products 8-13. The graphical form of these products contains a field called “Overlay Geometry Options”. Some of the options listed are not used by the SBSS at this time. Table B-1 below lists each option with an indication of whether it is used or not by SBSS. An asterisk indicates whether the example products provided in Appendix D includes that option.

Table B-1. SBSS Usage of Overlay Geometry Options

Overlay Geometry Options Meaning	Geometry implemented by SBSS FIS-B?
No Geometry	Implemented and commonly seen
Low Resolution 2D Polygon	Not implemented
High Resolution 3D Polygon	Not implemented
Extended Range 3D Polygon (MSL)	Implemented and commonly seen *
Extended Range 3D Polygon (AGL)	Implemented and commonly seen
Low Resolution 2D Ellipse	Not implemented
High Resolution 3D Ellipse	Not implemented
Extended Range Circular Prism (MSL)	Implemented and commonly seen *
Extended Range Circular Prism (AGL)	Implemented and commonly seen
Extended Range 3D Point (AGL)	Implemented and commonly seen *

Note: An asterisk indicates whether the example products provided in Appendix D includes that option.

B.2.7 Rules for Generating and Rendering Graphical Objects

The following set of rules apply to the graphical objects uplinked by the SBSS FIS-B service. These rules simplify and supersede those implied by the referenced document "Aero_FISB_ProdDef_Rev5.0.pdf". The SBSS will apply the rules below for creating and encoding the uplinked geometries:

1) For Polygons:
   a. Vertices can span multiple records
   b. Pen stays down within a record
   c. Pen lifts between records (when traversing records SBS FIS-B will repeat the last vertex to effectively keep the pen down—unless starting a new geometry)
   d. All polygon geometries will be closed by SBS FIS-B (at least as it appears to the pilot)

2) For 3D Points and Circular Prisms:
   e. Each vertex point corresponds to a "geometry"
   f. Each vertex/geometry is independent of others within a record and across records
   g. Multiple geometries/vertices can be packed as multiple per record

B.2.8 Statically set Fields for Graphic Overlay Products

- D-NOTAMs will always have the "Object Type" field statically set to ZERO (Airport)
- D-NOTAMs will always have the "Object Status" field statically set to 15 (In effect)

B.2.9 Retransmit Schedule for Textual NOTAMs

Some textual NOTAM TFRs can be quite large. Since these NOTAM TFRs do not change rapidly and to conserve bandwidth utilization, a special retransmit pattern is used for text NOTAMs TFRs. Section 3.3.4.2.2 indicates that the transmission interval for NOTAMs is 10 minutes. For textual NOTAM TFRs every other retransmission uses an abbreviated form of the product encoding which identifies the NOTAM by Record Number and indicates its status as Active but does not contain the body text of the product. An example of this abbreviated form of the encoding of textual NOTAM TFRs is provided in Appendix D. This abbreviated form of the product encoding indicates a length of five bytes even though the Text Data field is NULL to account for the length of the Text Record Length, Report Identifier, and Report Status fields.

This modified transmit schedule does not affect the uplink of Graphical NOTAM TFRs which are transmitted in their entirety every 10 minutes.

B.2.10 "Outlook" Portion of SIGMETS/AIRMETs

Some SIGMETs and AIRMETs are created with an "Outlook" section as the final portion of the report. This Outlook portion is omitted in the uplinked version.

B.2.11 CONUS NEXRAD Scaling

B.2.11.1 Definition

This description provides the format for encoding a conterminous (CONUS) NEXRAD graphic product using the Global Block Representation format described in Section D.2.3.5 of RTCA DO-267A (FIS-B MASPS). The description further defines the 2 spare bits in the first byte of the Block Reference Indicator to enable multiple image resolutions. This two-bit field will be referred to as the Bin Scale Factor.

B.2.11.2 Assumptions

The receiving system can assume that when this product is received from multiple ground stations offering overlapping coverage, the areas of overlap will be assured to register and can be simply merged on the cockpit display. Each broadcasting ground station will typically broadcast The CONUS NEXRAD product covering subsets / regions of the total image. Depending on the value of the Bin Scale Factor, the resolution of the product image will be different and needs to be accommodated by the receiving application.

B.2.11.3 Payload

The Global Block Representation can represent image data at multiple resolutions. This is useful for NEXRAD images in particular because it allows larger scale images to be encoded with lower resolutions and regional images to have higher resolutions. This approach is both consistent with the intended use of the information by the pilot and the cockpit display presentation constraints that exist (i.e., viewing larger geographic areas reduce the ratio of display pixels per unit area).

The following Block Reference Indicator format supersedes Figure D-3 in RTCA DO-267A. The Bin Scale Factor indicates the relative scale factor for the image represented by the encoding. The possible values of this field are:

Bin Number		Usage Label	Meaning
5	4		
0	0	High Resolution	Base encoding; each bin 1 min (lat), 1.5 min (lon) 0-60 deg latitude or 3 min (lon) 60-90 deg latitude
0	1	Medium Resolution	5X encoding; each bin 5 min (lat), 7.5 min (lon) 0-60 deg latitude or 15 min (lon) 60-90 deg latitude
1	0		Reserved
1	1		Reserved

The Global Block Representation geo references individual "bins" of the NEXRAD image to latitude and longitude rather than on a projection requiring a point of tangency.

B.2.11.4 Block Numbering

Block numbering for the CONUS NEXRAD product utilizes the same underlying numbering scheme as for the Regional NEXRAD. The one exception is that the CONUS NEXRAD product will only reference one in every 25 blocks as the scaling factor creates CONUS NEXRAD blocks that are 25 times the geographic region of each Regional NEXRAD block. Note that due to the curvature of the Earth, the geographic ratios may not be exact. An example of relative block sizes is given below with references at the origin of the numbering scheme, i.e. the Prime Meridian and the Equator. Whereas the Regional NEXRAD product may make use of every block number in Figure B-4, the CONUS NEXRAD would only use Block Number 1800. The next 5x scaled block to the east would be 1805 with the next scaled block to the north being 3600. Note that CONUS NEXRAD blocks are numbered according to the Regional NEXRAD block that is anchored to the same northwest corner.

1800	1801	1802	1803	1804
1350	1351	1352	1353	1354
900	901	902	903	904
450	451	452	453	454
0	1	2	3	4

Figure B-4. CONUS NEXRAD Block Numbering

B.2.12 Determining Bin Intensity for CONUS NEXRAD

The geographic area covered by each bin within a CONUS NEXRAD block is equivalent to 25 bins covered by a Regional NEXRAD block due to the 5x encoding resolution of the CONUS NEXRAD product. To construct the CONUS NEXRAD product, the underlying Regional

NEXRAD intensity values are analyzed. For each bin of a CONUS NEXRAD product the 25 Regional NEXRAD bins that cover the same geographic region are inspected. The greatest intensity value found from the 25 Regional NEXRAD bins is assigned as the intensity bin value for that particular bin within the CONUS NEXRAD product that covers the same geographic region as the inspected Regional bins. Note that this may overstate the NEXRAD intensity for that area. Figure B-5 below shows one possible example of this promotion of intensity.

0	0	0	0	1
0	0	0	1	1
0	0	1	1	2
0	1	2	2	3
0	1	1	2	4

4

Figure B-5. Regional-CONUS Bin Intensity Comparison

B.2.13 METAR Cutoff Time

In cases where METAR updates are not available from their source, the FIS-B system will retransmit the last available METAR from that reporting station for 120 minutes.

B.2.14 Updates to AIRMET and SIGMET

Sometimes AIRMETs and SIGMETs are updated at the source prior to the expiration of the previous AIRMET or SIGMET reporting on the same hazard. There is no reliable "tag" in the AIRMET or SIGMET that allows association of the update with the previous report. This can result in multiple contours showing the progression of the hazard.

B.2.15 Processing of NOTAMS Older than One Year

Below is a description of the SBSS FIS-B processing of NOTAMs that are older than one year:

- If both start and expiration times are unavailable, the NOTAM is not purged[13].
- If start time is unavailable, but expiration time is available, purge the NOTAM at the expiration time.
- If start time is available, but expiration time is unavailable, the NOTAM is not purged after 1 year.
- If both start and expiration times are available, purge the NOTAM at the expiration time.
- If SBSS receives a NOTAM-D or NOTAM-FDC cancellation:
  - Uplink the NOTAM text record header with the status bit set to cancelled for an CI time interval, then purge.
- For NOTAM-TFR, if FIS-B receives no refreshes for a particular NOTAM-TFR for CI (1800) seconds, FIS-B purges the NOTAM-TFR.

[13] "Purge" in this context means purged from the set of uplinkable NOTAMs by the SBSS

Appendix C. FIS-B Tiering

C.1 Tiering Summary

To make more efficient use of the available bandwidth for the FIS-B uplink, "tiers" of UAT radio stations are established, in which UAT radio stations are assigned to one of 4 altitude tiers: high, medium, low, and surface. This allows the system to provide tailored sets of products which most-effectively serve the various customer groups that operate within each altitude tier.

Under this scheme, all En Route and Terminal UAT ground stations are configured in a cellular arrangement, divided into 3 different types each serving a distinct altitude tier, and each of which have different FIS-B look-ahead ranges, and different numbers of assigned slots. This cellular arrangement is shown in Figure C-1.

Some radios are not part of the cellular structure but provide FIS-B service to localized areas. Surface radios are assigned to a Surface Tier and are not part of the cellular arrangement. The low tier also includes an L3 data channel block. This L3 data channel block is also not part of the cellular arrangement. It is used for filling in low tier coverage gaps as needed. The surface and low L3 tiers are mainly implemented at airport locations where low altitude coverage is required and the airport location does not fit into the higher tier cellular arrangement.

(high altitude cells, medium altitude cells, and low altitude cells).

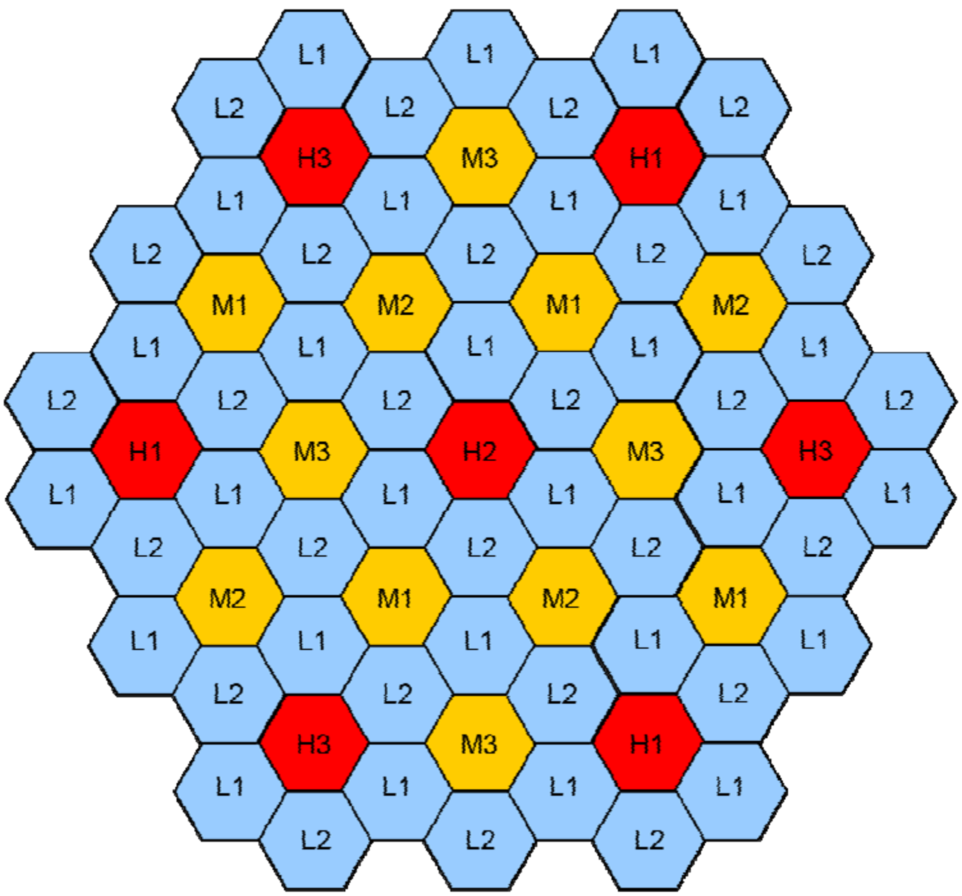

Figure C-1. A Generic Layout of 3 Altitude Tiers

Table C-1. Altitude Tiers

Tier	Altitude range	Description	# of slots
High-altitude	surface - 24,000' MSL	This altitude band extends up to the upper limit of FIS-B service (24,000' MSL). These ground stations serve some higher-performance general aviation aircraft (turbocharged or turbine) operating in an En Route environment, and also serve commercial aircraft in climb/descent (and some En Route).	4
Medium-altitude	surface - 14,000' AGL	These ground stations serve the majority of general aviation aircraft operating in an En Route environment. The upper band of 14,000' was chosen as this would typically be above the service ceiling of the world's most-produced aircraft (Cessna 172: over 43,000 built), thus this band includes the largest quantity of aircraft. It also includes some commercial aircraft in climb/descent (and some En Route).	3
Low-altitude	surface - 3,000' AGL	These ground stations serve the majority of aircraft (of all types) operating in a Terminal environment.	2
Surface	surface	These ground stations consist of Surface Service Volume radios which serve aircraft in the immediate vicinity of major airports.	1

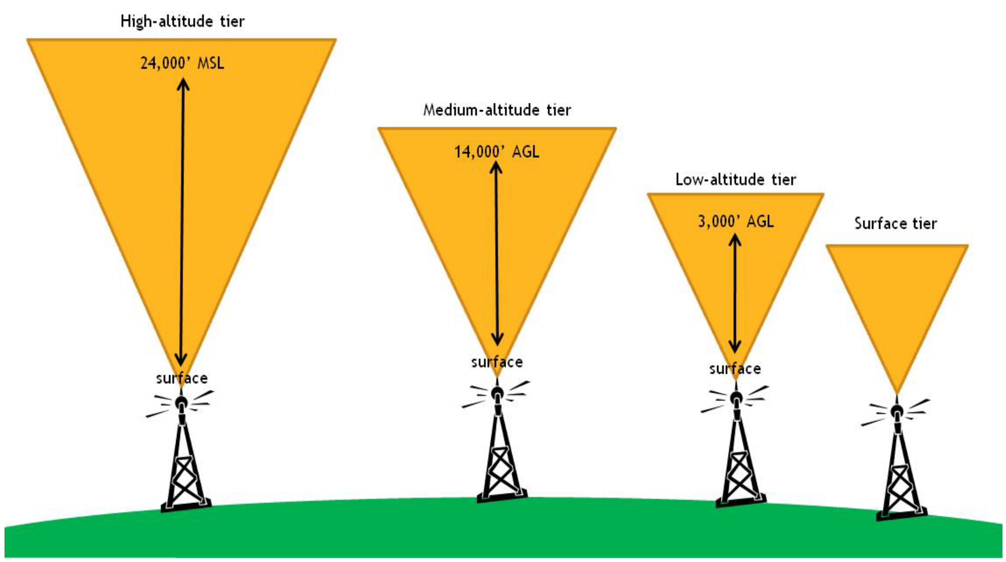

Figure C-2. Vertical profile of altitude coverage of tiered radios

In a "perfect", theoretical breakdown of cells into the 3 tiers (with a uniform distance between radios, no terrain, etc.), the proportions of cells would be the following:

- High altitude: 1/9th (11%) of all cells.
- Medium altitude: 2/9th (22%) of all cells.
- Low altitude: 2/3rd (67%) of all cells.

In a real-world example (a preliminary analysis of 289 contiguous United States En Route and Terminal radio stations), the following is a breakdown of assignments of actual radio stations into altitude tiers:

- High altitude: 60 radio stations (21%)
- Medium altitude: 87 radio stations (30%)
- Low altitude: 142 radio stations (49%)

The Surface tier radios will be located at the 35 airports supported by SBS services. These surface tier radios are not counted in the proportions above since the airport locations cannot be modeled as part of a generalized cellular structure.

For each FIS-B product, two parameters affect the product set broadcast by each tier of radio:

- The look-ahead range of each product,
- A subset of reporting stations of the product, based on airport size (as detailed in the following section).

Thus the look-ahead range of each product:

is (a function of) =F(tier),

and the set of data (stations) to be provided for each product:

is (a function of) =F(look-ahead range, airport size).

C.2 TIS-B Site ID Field

The 4-bit TIS-B Site ID field will be used to indicate to avionics the type of radio station which is being received.

Table C-2. TIS-B Site ID field values

Tier	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
High-altitude														X	X	X
Medium-altitude											X	X	X			
Low-altitude								X	X	X						
Surface		X	X	X	X											
Reserved	X					X	X									

Different data channel blocks within each tier are represented by the multiple Site ID field values available within each tier, i.e. values 13/14/15 will represent the 3 data channel blocks available for high altitude radios. See Table C-3 for the FIS-B Data Channel Assignment mapping to the TIS-B Site ID values.

Table C-3. FIS-B Data Channel Assignment

FIS-B Tier	Block Name	Assigned Data Channels				TIS-B Site ID
High	H1	1	9	17	25	15
	H2	2	10	18	26	14
	H3	3	11	19	27	13
Med	M1	4	12	20		12
	M2	28	5	13		11
	M3	21	29	6		10
Low	L1	14	22			9
	L2	30	7			8
	L3	15	23			7
Surface	S1	31				4
	S2	8				3
	S3	16				2
	S4	24				1
Unallocated		32				0, 5, 6

C.3 Reception of Complete Product Set

If cockpit avionics have product bandwidth limitations, and it is going to implement filtering of any of the FIS-B channels, it must ensure that there is at least one complete block of channels received from at least one radio station. Any filtering algorithm must include at least one entire block, otherwise it is not ensured delivery of a complete product set. Each tier is a superset of the lower tiers. If you are receiving FIS-B channels from a high tier Ground Station, then all of the products in the lower tiers are already included in this high tier and it is unnecessary to process any other data channels. Therefore, avionics should prioritize the Ground Station they are listening to for FIS-B products based on Tier and range. Combining data from multiple Ground Stations could result in redundant reports to avionics displays (see C.7 for further discussion on this). For bandwidth considerations, see §3.5 (each data channel will add 422 bytes per second of bandwidth needs that is necessary for receiving and processing the FIS-B data).

C.4 Use of Airport Size as a Parameter

For selected FIS-B products (METAR and TAF), the size of the airport is used as a filtering parameter for FIS-B broadcasts.

Out of the total of 2,146 U.S. METAR reporting locations:

- Less than 2% (39 airports) are Class B airports (with the highest volume of air traffic).
- Less than 6% (123 airports) are Class C airports (with medium traffic volume).

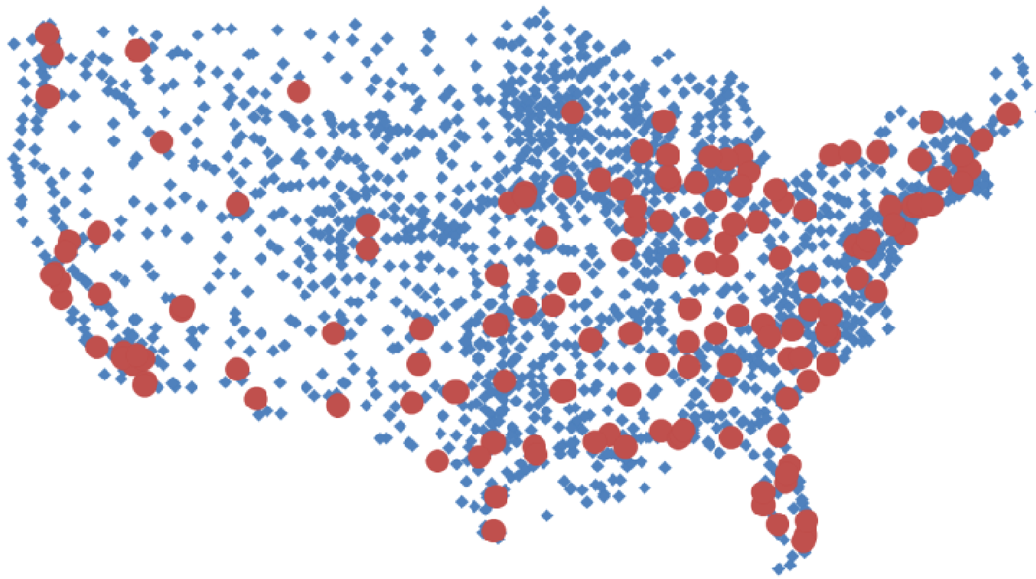

Figure C-3. Location of All 1,941 CONUS METAR Locations (Blue), with 158 CONUS Class B and C Airports Highlighted in Red

High altitude radio stations provide METARs for the largest number of airports across all of CONUS (all class B and C airports), while low altitude radio stations provide METARs for all stations (regardless of airport size) within a more limited look-ahead range. This provides high-altitude En Route users with nationwide weather information (as every location in CONUS is within at most 382 NM of a Class B or Class C airport), at a significant savings in radio bandwidth.

The same airport size filtering applies to the TAF product.

The Table C-4 below shows how the METAR and TAF products are "Airport Size" filtered for uplink by each RS tier. Airport-size filtering is only applied to high-altitude CONUS radio stations, as locations outside of CONUS do not have the same bandwidth concerns (due to much lower geographic density of reporting stations), and locations outside of CONUS do not have a sufficient number of Class B and C airports to offer a reasonable En Route view of weather.

Example from the user (pilot) perspective:

- On a 650 NM flight from Dulles to Orlando Executive Airport (KORL), receiving the METAR for Orlando International Airport (KMCO) would be sufficient in the early portion of the flight (while within coverage of high-altitude tier radios). Once arriving within a closer radius, the METAR for the smaller airport that is the specific destination would become available.

C.5 Product Parameters for Low/Medium/High Altitude Tier Radios

The following table presents the product look-ahead ranges for radios stations supporting Low, Medium, and High altitude tiers, along with the subset of each product based on airport size.

Table C-4. Product Parameters for Low/Medium/High Altitude Tier Radios

<table>
<tr><th rowspan="2">Product</th><th colspan="4">Product Look-ahead Range for Each Tier of Radio</th></tr>
<tr><th>Low-altitude Tier</th><th>Medium-altitude Tier</th><th colspan="2">High-altitude Tier</th></tr>
<tr><td>CONUS NEXRAD</td><td>CONUS NEXRAD not provided</td><td colspan="3">entire CONUS NEXRAD imagery</td></tr>
<tr><td>Winds and Temps Aloft</td><td>500 NM look-ahead range</td><td>750 NM look-ahead range</td><td colspan="2">1,000 NM look-ahead range</td></tr>
<tr><td rowspan="2">METAR</td><td rowspan="4">All METAR* and TAF within 250 NM look-ahead range</td><td rowspan="4">All METAR* and TAF within 375 NM look-ahead range</td><td>CONUS:</td><td>All 158 CONUS Class B and C airport METARs + 500 NM look ahead range for all METARs</td></tr>
<tr><td>Outside of CONUS:</td><td>500 NM look-ahead range</td></tr>
<tr><td rowspan="2">TAF</td><td>CONUS:</td><td>All 158 CONUS Class B and C airport TAFs + 500 NM look ahead range for all TAFs</td></tr>
<tr><td>Outside of CONUS:</td><td>500 NM look-ahead range</td></tr>
<tr><td>AIRMET, SIGMET, PIREP, and SUA</td><td>250 NM look-ahead range</td><td>375 NM look-ahead range</td><td colspan="2">500 NM look-ahead range</td></tr>
<tr><td>Regional NEXRAD</td><td>150 NM look-ahead range</td><td>200 NM look-ahead range</td><td colspan="2">250 NM look-ahead range</td></tr>
<tr><td>NOTAM</td><td colspan="4">100 NM look-ahead range</td></tr>
</table>

**Note: Look ahead ranges for METAR may change in the future as more METAR reporting stations are included.*

C.6 Product Parameters for Surface Radios

The following table presents the product look-ahead ranges for Surface radio stations.

Table C-5. Product Parameters for Surface Radios

Product	Product Look-ahead Range for Surface Radios
CONUS NEXRAD	N/A
Winds and Temps Aloft	500 NM look-ahead range
METAR, TAF, AIRMET, SIGMET, NOTAM	100 NM look-ahead range
PIREP and SUA	N/A
Regional NEXRAD	150 NM look-ahead range

C.7 Avionics Processing of FIS-B From Different RS

By design, the FIS-B tiering will limit the number of simultaneous radio stations received for FIS-B uplink products. However some RS diversity as well as temporal diversity will exist for most users at altitude. This section provides guidance on how that diversity can be used if desired to maximize robustness to link fading and or to minimize acquisition times for the fullest possible set of FIS-B products.

C.7.1 Minimum RS Processing Requirement

It is recommended to process all RSs heard to obtain the best FIS-B performance. However, if there are bandwidth limitations between the receiver and the FIS-B processing / display system such that the system needs to discard some received information, then the minimum capability necessary to reliably obtain FIS-B products is to select and fully decode a single RS then build the FIS-B report set from only that RS.

C.7.2 Considerations for FIS Report Integration Across RS

Improved acquisition time will result if bandwidth and processing capacity is available within the avionics system to support all uplinks received in addition to those from any selected single RS. Improved acquisition is particularly true for FIS-B reports conveyed in segmented APDUs. Some NOTAM reports in particular can take up to nearly 30 segments; all of which must be present before the APDU can be correctly decoded. Faster acquisition is possible because proximate RS's will be uplinking many of the same FIS reports (or segments of reports) due to the large degree of overlap of their FIS-B product look ahead areas, thus giving more opportunities to assemble a full report set.

The following products are guaranteed to have FIS-B reports that are fully consistent across all RS that uplink them:

- All Product ID 413 text products

- Regional and CONUS NEXRAD where each Global Block is considered a FIS-B report (Product IDs 63 and 64 respectively).

The processing of other products are discussed in the sections below.

C.7.2.1 Processing Segmented APDUs

FIS-B reports large enough to require a Segmented APDU are not guaranteed to always be fully consistent across RSs. Specifically, the “Product File ID” could vary for the same FIS-B reports uplinked from different RS.

Within CONUS, there are 3 FIS-B Control Station (CS) areas with current boundaries as shown in Figure C-4.[14] Each CS is assigned its own block of “Product File ID” codes used for reassembly of segmented APDUs uplinked within that CS area. The Product File ID is contained in the Segmentation Block of the APDU Header. Avionics manufacturers should be aware that an aircraft that is receiving RSs on both sides of a CS boundary could receive segmented ADPUs for the same FIS-B report with a different Product File ID. This forces the avionics to decode the same segmented APDU twice with different Product File IDs. These would then need to be processed at the FIS-B report level as described in one of the two sections below to eliminate the FIS-B report redundancy.

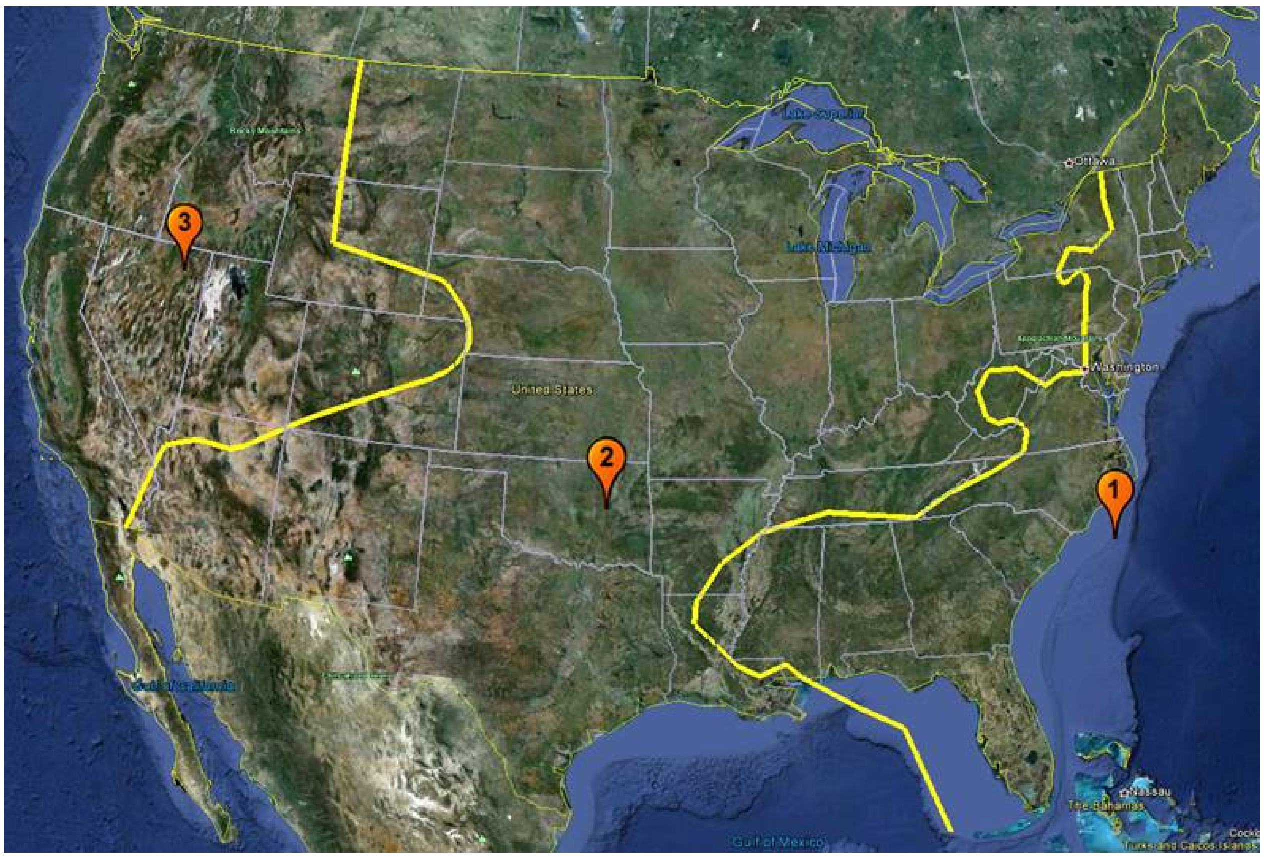

Figure C-4. FIS-B Control Station Areas

[14] Figure for illustration only. Boundaries may change in the future. Each RS is associated with only one of the three CS areas.

C.7.2.2 Processing FIS Reports for SUA, SIGMET, AIRMET

FIS-B reports for SUA, SIGMET and AIRMET have a "Report Number" field contained in the Text or Graphical Overlay record that is generated within the SBSS. The Report Number is assigned within a block of numbers allocated to each CS area in a manner similar to that of the Product File ID described above. Therefore, avionics manufacturers should not rely on the Report Number for detecting and purging redundant FIS-B reports for SUA, SIGMET and AIRMET. Other aspects within the FIS-B report need to be considered to eliminate duplicate reports.

C.7.2.3 Processing FIS Reports for NOTAMs

FDC NOTAMs can be uniquely identified by a combination of "Report Year" and "Report Number" contained in the Text or Graphical Overlay record. These are derived from information in the FIS-B report and thus are generated uniquely at the source.

D-NOTAMs can be uniquely identified by the Report Number field in conjunction with the "Report Month" and the "Location ID" field. Location ID comes from the Payload Header and references the location or facility to which the report applies. The Report Month field is found in the APDU Header Time. Note: report numbers range from 12,000-12,999.

Appendix D. FIS-B Product Formatting and Data Examples

This section describes the format of the text and graphical payload of FIS-B products, to help in the uniform parsing of these products.

Furthermore, to assist in the verification of correct avionics parsing and cockpit display of FIS-B products, binary data sets of example FIS-B products will be posted as part of this document.

These data examples will be representative of what cockpit avionics would expect to receive via the RF interface with the FIS-B service. This section provides an explanation of those data examples, including the source of each data example (date, place/station, etc.), screen shots / graphical depictions of how each decoded / displayed product should appear, etc.

The description of FIS-B products in the following sections is organized along a breakdown of Product Type and Registry Product ID, as follows:

Table D-1. FIS-B Products Characterized by Product Type

Product Type	Registry Product ID	Product
Text / Graphic	8	NOTAM-D
		NOTAM-FDC
		NOTAM-TFR
		FIS-B Outage Notification
	11	AIRMET
	12	SIGMET
	13	SUA Status
Graphic	63	Regional NEXRAD
	64	CONUS NEXRAD
Generic Text Type 2 (DLAC)	413	METAR and SPECI
		PIREP
		TAF and AMEND
		Wind and Temperature Aloft
Binary	N/A	TIS-B Service Status

D.1 Text/Graphic Products: Product IDs 8-13

D.1.1 Background

To maintain consistency with the Generic Text products (product 413), the FIS-B application formats the text record report in Aerodrome and Airspace products (Product IDs 8, 11, 12 and 13) into the following syntax.

<Product Type> space <Location ID> space <Timestamp> space <Text Report>

Where:

<Product Type> = NOTAM-D, NOTAM-FDC, NOTAM-TFR, AIRMET, SIGMET, WST (Convective SIGMET), or SUA

<Location ID>= XXXX.YYYYY for D-NOTAM or FDC-NOTAM products, where:

XXXX = 4-letter airport ID
YYYYY = report ID for the NOTAM report

or = YYYYYY for NOTAM-TFR, where:

YYYYYY = report ID for the NOTAM report

or = XXXX for AIRMET, where:

XXXX = site id for the AIRMET report from the FIS-B Data Source

or = XXXX for SIGMET, where:

XXXX = site id for the SIGMET report from the FIS-B Data Source

or = XXXX for WST (i.e. Convective SIGMET), where:

XXXX = site id for the Convective SIGMET report from the FIS-B Data Source

or = SSSSSS for SUA where:

SSSSSS = unique ID assigned to the SUA report

<Timestamp> = UTC time in the format ddHHMM, where:

dd = day of the month
HH = hour of the day
MM = minutes of the hour

It is noted that the encoding for products with Product ID 8-13 (NOTAM, AIRMET, SIGMET/CONVECTIVE SIGMET, and SUA) follow the specification document “Aerodrome and Airspace FIS-B Product Definition” Version 4.0. However, the Time Option field is set to 2, instead of 0, in the APDU Header Time. For Time Option 2, the Month, Day, Hours, and Minutes are included in the Header Time field based on the FIS-B MASPS (DO-267A). As a result, the number of bytes for the APDU Header, excluding the APDU ID, is 5 (for no message segmentation) and 9 (for segmentation).

D.1.2 Implementation

The following sections show how each of the text/graphics products (NOTAM, AIRMET, SIGMET, and SUA) are formatted.

D.1.3 NOTAM

The month, day, hours, and minutes of the start time for the NOTAM report are used in the APDU header timestamp, where the time option field is set to a value of two (2) which indicates inclusion of month, day, hours and minutes. In cases where the start time is not provided, the FIS-B application uses the initial time that the NOTAM product is received from the FIS-B Data Source. This time or the start time, if it is provided, will be used in the APDU header in the subsequent retransmission of this NOTAM report, until it is cancelled or expired. The start time or received time (which does not include the month of the report) is inserted into the Timestamp field of the NOTAM text messages as shown in the examples below.

D.1.3.1 D-NOTAM Examples

This D-NOTAM product contains both text and its associated graphical overlay record. The text and graphical overlay records are stored in two separate binary files.

D.1.3.1.1 D-NOTAM Text Record

Filename: notam_d_text.bin

The binary file notam_d_text.bin contains the 424-byte Application Data, which consists of the I-Frame and its APDU with the text record for the D-NOTAM product, in the Ground Uplink Message. The decoded message should contain the following information.

Decoded message:

```
I-Frame Header:
   - length: 79
   - type: 0 (APDU)
APDU Header:
   - Product ID: 8
   - Segmentation Flag: 0 (No segmentation required for this product)
   - Time Option: 2 (Month, Day, Hour and Minutes included)
   - Time: Month: 12 Day: 20 Hour: 19 Minutes: 27
APDU Payload:
 Header:
   - Record Format: 2 (Unformatted DLAC Text)
   - Product Version: 2
   - Record Count: 1
   - Location ID: KMVY
   - Record Reference: 0
 Record:
   - Length: 68
   - Report Number: 12021
   - Report Year: 10
   - Report status: 1 (Active)
```

- Text Data:

NOTAM-D KMVY.12/021 201927Z !MVY 12/021 MVY RWY 15/33 THN PSR BRAP WEF 1012201927

D.1.3.1.2 D-NOTAM Graphical Overlay Record

Filename: notam_d_overlay.bin

The binary file notam_d_overlay.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the graphical overlay record for the D-NOTAM product, in the Ground Uplink Message. The decoded message should contain the following information.

Decoded message:

I-Frame Header:

- length: 39
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 12 Day: 20 Hour: 19 Minutes: 27

APDU Payload:

Header:

- Record Format: 8 (Graphical Overlay)
- Product Version: 2
- Record Count: 1
- Location ID: KMVY
- Record Reference: 0

Record:

- Length: 28
- Report Number: 12021
- Report Year: 10
- Overlay Record ID: 0
- Label Flag = 1 (alphanumeric name)
- Object Label: KMVY
- Object Element Flag: 0
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 0 (Airport – **always statically set for D-NOTAM**)
- Object element: 0 (Not used since Object Element Flag = 0)
- Object Status: 15 (In Effect – **always statically set for D-NOTAM**)
- Record Applicability Options: 1 (Start time only)

- Date/Time Format: 1 (Month, day, hours and minute only)
- Overlay Geometry Option: 9 (Extended range 3D point (AGL))
- Overlay Operator: No
- Overlay Vertices Count: 1
- Record Applicability Start:

Month: 12
Day: 20
Hours: 19
Minutes: 27

- Overlay Vertices List:
- Vertice[1]:
- Longitude = -70.616683 degree
- Latitude = 41.399917 degree
- Altitude = 0.000000 ft

D.1.3.2 FDC-NOTAM Examples

This FDC-NOTAM product contains both text and its associated graphical overlay records. The text and graphical overlay records are stored in two separate binary files.

D.1.3.2.1 FDC-NOTAM Text Record

Filename: notam_fdc_text.bin

The binary file notam_fdc_text.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the FDC-NOTAM product, in the Ground Uplink Message. The decoded message should contain the following information.

Decoded message:

I-Frame Header:

- length: 210
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 1 Day: 16 Hour: 19 Minutes: 45

APDU Payload:
Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID: KSBY
- Record Reference: 0

Record:

- Length: 199
- Report Number: 974
- Report Year: 1
- Report status: 1 (Active)
- Text Data:

```
NOTAM-FDC KSBY.1/0974 161945Z !FDC 1/0974 SBY FI/T SALISBURY-OCEAN CITY
WICOMICO RGNL, SALISBURY,
MD.
 ILS OR LOC RWY 32, AMDT 8...
 VOR RWY 5, AMDT 9A...
 VOR RWY 23, AMDT 10A...
 VOR RWY 32, AMDT 10...
 ALTERNATE MINIMUMS NA, SBY VORTAC UNMONITORED.
```

D.1.3.2.2 FDC-NOTAM Graphical Overlay Record

Filename: notam_fdc_overlay.bin

The binary file notam_fdc_overlay.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the graphical overlay record for the FDC-NOTAM product, in the Ground Uplink Message. The decoded message should contain the following information.

Decoded message:

I-Frame Header:

- length: 35
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 1 Day: 16 Hour: 19 Minutes: 45

APDU Payload:

Header:

- Record Format: 8 (Graphical Overlay)
- Product Version: 2
- Record Count: 1
- Location ID: KSBY
- Record Reference: 0

Record:

- Length: 24
- Report Number: 974
- Report Year: 1
- Overlay Record ID: 0

```
-  Label Flag = 1 (alphanumeric name)
-  Object Label: KSBY
-  Object Element Flag: 0
-  Qualifier Flag: 0
-  Parameter Flag: 0
-  Object Type: 0 (Airport)
-  Object element: 0 (Not used since Object Element Flag = 0)
-  Object Status: 15 (In Effect)
-  Record Applicability Options: 0 (No time given)
-  Date/Time Format: 0 (No Date/Time used)
-  Overlay Geometry Option: 9 (Extended range 3D point (AGL))
-  Overlay Operator: No
-  Overlay Vertices Count: 1
-  Overlay Vertices List:
-   Vertex[1]:
-   Longitude = -75.516585 degree
-   Latitude = 38.332672 degree
-   Altitude = 0.000000 ft
```

D.1.3.3 TFR-NOTAM Examples

This TFR NOTAM product contains both text and its associated graphical overlay records. Since both the text and graphical overlay records are too large to fit in a single APDU and Application Data in a Ground Uplink Message, they require segmentation into smaller segments. After segmentation, the text record consists of four segments and the graphical overlay record contains two segments. The two records are stored in two separate binary files.

D.1.3.3.1 TFR-NOTAM Text Record

Filename: tfr_0_9839_text.bin

The binary file tfr_0_9839_text.bin contains the four segments for the text record. The segments are sent in four 424-byte Application Data, which consists of the I-Frame and APDU with the text record for this TFR-NOTAM product, in four Ground Uplink Messages. The Product File ID, Product File Length and APDU number in the APDU header are used to link and reassemble the entire text record. The decoding process of this text record should only be started after all four segments are received, since any DLAC character in the record could be broken into 2 separate segments. The decoded messages below show the decoded I-Frame and APDU headers associated with each of the four segments, but only display this TFR NOTAM text when the last segment is received and the entire text record is reassembled.

Decoded message:

Application Data (Ground Uplink Message) #1 with the first segment
I-Frame Header:

- length: 422
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 1 (Segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 6 Hour: 14 Minutes: 0
- Product File ID: 0
- Product File Length: 4
- APDU Number: 1

APDU Payload:
Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

- (Note: part of the text data in the record, do not decode yet, but save the data to memory and wait for other segments to arrive)

Application Data (Ground Uplink Message) #2 with the second segment
I-Frame Header:

- length: 422
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 1 (Segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 6 Hour: 14 Minutes: 0
- Product File ID: 0
- Product File Length: 4
- APDU Number: 2

APDU Payload:
Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2

- Record Count: 1
- Location ID:
- Record Reference: 255
- Record:

(Note: part of the text data in the record, do not decode yet, but save the data to memory and wait for other segments to arrive)

Application Data (Ground Uplink Message) #3 with the third segment

I-Frame Header:

- length: 422
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 1 (Segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 6 Hour: 14 Minutes: 0
- Product File ID: 0
- Product File Length: 4
- APDU Number: 3

APDU Payload:

Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

(Note: part of the text data in the record, do not decode yet, but save data to memory and wait for other segments to arrive)

Application Data (Ground Uplink Message) #4 with the fourth segment

I-Frame Header:

- length: 144
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 1 (Segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 6 Hour: 14 Minutes: 0
- Product File ID: 0
- Product File Length: 4
- APDU Number: 4

```
APDU Payload:
 Header:
   -  Record Format: 2 (Unformatted DLAC Text)
   -  Product Version: 2
   -  Record Count: 1
   -  Location ID:
   -  Record Reference: 255
 Record:
 (Note: last part of the text data in the record)
   -  Length: 1350
   -  Report Number: 9839
   -  Report Year: 0
   -  Report status: 1 (Active)
   -  Text Data: (for the entire Text Record with all four of the segments)
NOTAM-TFR 0/9839 061400Z PART 1 OF 2 FLIGHT RESTRICTIONS GRAND FORKS AFB, ND,
JULY 6, 2010 LOCAL. PURSUANT TO 49 USC 40103(B), THE FEDERAL AVIATION
ADMINISTRATION (FAA) CLASSIFIES THE AIRSPACE DEFINED IN THIS NOTAM AS
APOS;NATIONAL DEFENSE AIRSPACE APOS;. ANY PERSON WHO KNOWINGLY OR WILLFULLY
VIOLATES THE RULES CONCERNING OPERATIONS IN THIS AIRSPACE MAY BE SUBJECT TO
CERTAIN CRIMINAL PENALTIES UNDER 49 USC 46307. PILOTS WHO DO NOT ADHERE TO
THE FOLLOWING PROCEDURES MAY BE INTERCEPTED, DETAINED AND INTERVIEWED BY LAW
ENFORCEMENT/SECURITY PERSONNEL. PURSUANT TO TITLE 14 CFR SECTION 99.7,
SPECIAL SECURITY INSTRUCTIONS, ALL AIRCRAFT FLIGHT OPERATIONS ARE PROHIBITED
WITHIN AN AREA BOUNDED BY THE FOLLOWING COORDINATES: 480840N/0972230W OR THE
GRAND FORKS /GFK/ VOR/DME 317 DEGREE RADIAL AT 13.7 NM TO 474640N/0972230W OR
THE GRAND FORKS /GFK/ VOR/DME 207 DEGREE RADIAL AT 13.1 NM THEN CLOCKWISE ON
A 11 NM ARC CENTERED ON 475740N/0972230W OR THE GRAND FORKS /GFK/ VOR/DME 264
DEGREE RADIAL AT 7.7 NM TO THE POINT OF BEGINNING FROM AND INCLUDING 3400 FT
MSL UP TO AND INCLUDING 18000 FT MSL EFFECTIVE 1007061400 UTC (0900 LOCAL
07/06/10) UNTIL 1007070200 UTC (2100 LOCAL 07/06/10). EXCEPT AS SPECIFIED
BELOW AND/OR UNLESS AUTHORIZED BY ATC: END PART 1 OF 2. WIE UNTIL UFN.
CREATED: 02 JUL 18:47 2010 PART 2 OF 2 FLIGHT RESTRICTIONS GRAND FORKS AFB,
ND, 1. ALL AIRCRAFT ENTERING OR EXITING THE TFR MUST BE ON A DISCRETE CODE
ASSIGNED BY AN AIR TRAFFIC CONTROL (ATC) FACILITY. 2. AIRCRAFT MUST BE
SQUAWKING THE DISCRETE CODE AT ALL TIMES WHILE IN THE TFR. 3. ALL AIRCRAFT
ENTERING OR EXITING THE TFR MUST REMAIN IN TWO-WAY RADIO COMMUNICATIONS WITH
ATC. 4. MINNEAPOLIS CENTER, PHONE 651-463-5580, IS THE FAA COORDINATION
FACILITY. END PART 2 OF 2. WIE UNTIL UFN. CREATED: 02 JUL 18:47 2010
```

D.1.3.3.2 TFR-NOTAM Graphical Overlay Record

Filename: tfr_0_9839_overlay.bin

The binary file tfr_0_9839_overlay.bin contains the two segments of the graphical overlay record. The segments are sent in two 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the TFR-NOTAM product, in two Ground Uplink Messages. The Product File ID, Product File Length and APDU number in the APDU header are used to link and reassemble the entire graphical overlay record. The decoding process of this graphical overlay record should only be started after all two segments are received. The decoded messages below show the decoded I-Frame and APDU headers associated with each of the two segments, but only display this TFR NOTAM graphical overlay record when the last segment is received and the entire graphical overlay record is reassembled. The decoded message should contain the following information.

Decoded message:

```
Application Data (Ground Uplink Message) #1 with the first segment
I-Frame Header:
   -  length: 422
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 8
   -  Segmentation Flag: 1 (Segmentation is required for this product)
   -  Time Option: 2 (Month, Day, Hour and Minutes included)
   -  Time: Month: 7 Day: 6 Hour: 14 Minutes: 0
   -  Product File ID: 1
   -  Product File Length: 2
   -  APDU Number: 1
APDU Payload:
 Header:
   -  Record Format: 8 (Graphical Overlay)
   -  Product Version: 2
   -  Record Count: 2
   -  Location ID:
   -  Record Reference: 255
 Record:
   (Note: Only part of the graphical overlay record, does not decode yet, but
   save to memory and wait for the rest of the segments to arrive)
Application Data (Ground Uplink Message) #2 with the second segment
I-Frame Header:
   -  length: 70
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 8
   -  Segmentation Flag: 1 (Segmentation is required for this product)
   -  Time Option: 2 (Month, Day, Hour and Minutes included)
   -  Time: Month: 7 Day: 6 Hour: 14 Minutes: 0
   -  Product File ID: 1
   -  Product File Length: 2
   -  APDU Number: 2
APDU Payload:
 Header:
   -  Record Format: 8 (Graphical Overlay)
```

- Product Version: 2
- Record Count: 2
- Location ID:
- Record Reference: 255

(Note: the second part of the graphical overlay record for this product, now the entire overlay record is re-assembled, and the decode)

Record #1:

- Length: 403
- Report Number: 9839
- Report Year: 0
- Overlay Record ID: 0
- Label Flag: 0 (numeric index)
- Object Label: 0
- Object Element Flag: 1
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Temporary Flight Restriction)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 3 (Extended range 3D polygon (MSL))
- Overlay Operator: 1 (AND this geometry)
- Overlay Vertices Count: 64
- Record Applicability Start:

Month: 7
Day: 6
Hours: 14
Minutes: 0

- Record Applicability End:

Month: 7
Day: 7
Hours: 2
Minutes: 0

- Overlay Vertices List:

Vertex[1]:
Longitude = -97.374572 degree
Latitude = 48.144149 degree
Altitude = 18000.0 ft
Vertex[2]:
Longitude = -97.376632 degree
Latitude = 48.144149 degree
Altitude = 18000.0 ft

```
Vertex[3]:
Longitude = -97.388991 degree
Latitude = 48.144149 degree
Altitude = 18000.0 ft
Vertex[4]:
Longitude = -97.401351 degree
Latitude = 48.143463 degree
Altitude = 18000.0 ft
Vertex[5]:
Longitude = -97.413710 degree
Latitude = 48.142089 degree
Altitude = 18000.0 ft
Vertex[6]:
Longitude = -97.426070 degree
Latitude = 48.140716 degree
Altitude = 18000.0 ft
Vertex[7]:
Longitude = -97.438430 degree
Latitude = 48.139343 degree
Altitude = 18000.0 ft
Vertex[8]:
Longitude = -97.450103 degree
Latitude = 48.137283 degree
Altitude = 18000.0 ft
Vertex[9]:
Longitude = -97.462462 degree
Latitude = 48.134536 degree
Altitude = 18000.0 ft
Vertex[10]:
Longitude = -97.474135 degree
Latitude = 48.131790 degree
Altitude = 18000.0 ft
Vertex[11]:
Longitude = -97.485122 degree
Latitude = 48.128356 degree
Altitude = 18000.0 ft
Vertex[12]:
Longitude = -97.496795 degree
Latitude = 48.124923 degree
Altitude = 18000.0 ft
Vertex[13]:
Longitude = -97.507781 degree
Latitude = 48.120803 degree
Altitude = 18000.0 ft
Vertex[14]:
Longitude = -97.518081 degree
Latitude = 48.116683 degree
Altitude = 18000.0 ft
Vertex[15]:
Longitude = -97.528380 degree
Latitude = 48.111877 degree
Altitude = 18000.0 ft
Vertex[16]:
Longitude = -97.538680 degree
Latitude = 48.107070 degree
Altitude = 18000.0 ft
Vertex[17]:
```

```
Longitude = -97.548293 degree
Latitude = 48.102264 degree
Altitude = 18000.0 ft
Vertex[18]:
Longitude = -97.557906 degree
Latitude = 48.096771 degree
Altitude = 18000.0 ft
Vertex[19]:
Longitude = -97.566832 degree
Latitude = 48.091278 degree
Altitude = 18000.0 ft
Vertex[20]:
Longitude = -97.575759 degree
Latitude = 48.085098 degree
Altitude = 18000.0 ft
Vertex[21]:
Longitude = -97.583999 degree
Latitude = 48.078918 degree
Altitude = 18000.0 ft
Vertex[22]:
Longitude = -97.591552 degree
Latitude = 48.072051 degree
Altitude = 18000.0 ft
Vertex[23]:
Longitude = -97.599105 degree
Latitude = 48.065185 degree
Altitude = 18000.0 ft
Vertex[24]:
Longitude = -97.605971 degree
Latitude = 48.058319 degree
Altitude = 18000.0 ft
Vertex[25]:
Longitude = -97.612151 degree
Latitude = 48.051452 degree
Altitude = 18000.0 ft
Vertex[26]:
Longitude = -97.617644 degree
Latitude = 48.043899 degree
Altitude = 18000.0 ft
Vertex[27]:
Longitude = -97.623137 degree
Latitude = 48.036346 degree
Altitude = 18000.0 ft
Vertex[28]:
Longitude = -97.627944 degree
Latitude = 48.028793 degree
Altitude = 18000.0 ft
Vertex[29]:
Longitude = -97.632750 degree
Latitude = 48.021240 degree
Altitude = 18000.0 ft
Vertex[30]:
Longitude = -97.636184 degree
Latitude = 48.013000 degree
Altitude = 18000.0 ft
Vertex[31]:
Longitude = -97.639617 degree
```

```
Latitude = 48.005447 degree
Altitude = 18000.0 ft
Vertex[32]:
Longitude = -97.642363 degree
Latitude = 47.997207 degree
Altitude = 18000.0 ft
Vertex[33]:
Longitude = -97.644423 degree
Latitude = 47.988967 degree
Altitude = 18000.0 ft
Vertex[34]:
Longitude = -97.645797 degree
Latitude = 47.980728 degree
Altitude = 18000.000000 ft
Vertex[35]:
Longitude = -97.647170 degree
Latitude = 47.972488 degree
Altitude = 18000.0 ft
Vertex[36]:
Longitude = -97.647857 degree
Latitude = 47.964248 degree
Altitude = 18000.0 ft
Vertex[37]:
Longitude = -97.647170 degree
Latitude = 47.955322 degree
Altitude = 18000.0 ft
Vertex[38]:
Longitude = -97.647170 degree
Latitude = 47.947082 degree
Altitude = 18000.0 ft
Vertex[39]:
Longitude = -97.645797 degree
Latitude = 47.938842 degree
Altitude = 18000.0 ft
Vertex[40]:
Longitude = -97.643737 degree
Latitude = 47.930602 degree
Altitude = 18000.0 ft
Vertex[41]:
Longitude = -97.641677 degree
Latitude = 47.922363 degree
Altitude = 18000.0 ft
Vertex[42]:
Longitude = -97.638930 degree
Latitude = 47.914810 degree
Altitude = 18000.0ft
Vertex[43]:
Longitude = -97.635497 degree
Latitude = 47.906570 degree
Altitude = 18000.0ft
Vertex[44]:
Longitude = -97.631377 degree
Latitude = 47.898330 degree
Altitude = 18000.0ft
Vertex[45]:
Longitude = -97.626571 degree
Latitude = 47.890777 degree
```

```
Altitude = 18000.0ft
Vertex[46]:
Longitude = -97.621764 degree
Latitude = 47.883224 degree
Altitude = 18000.0ft
Vertex[47]:
Longitude = -97.616271 degree
Latitude = 47.875671 degree
Altitude = 18000.0 ft
Vertex[48]:
Longitude = -97.610091 degree
Latitude = 47.868804 degree
Altitude = 18000.0ft
Vertex[49]:
Longitude = -97.603911 degree
Latitude = 47.861251 degree
Altitude = 18000.0ft
Vertex[50]:
Longitude = -97.597045 degree
Latitude = 47.854385 degree
Altitude = 18000.0ft
Vertex[51]:
Longitude = -97.589492 degree
Latitude = 47.847518 degree
Altitude = 18000.0 ft
Vertex[52]:
Longitude = -97.581252 degree
Latitude = 47.841339 degree
Altitude = 18000.0ft
Vertex[53]:
Longitude = -97.573012 degree
Latitude = 47.835159 degree
Altitude = 18000.0 ft
Vertex[54]:
Longitude = -97.564772 degree
Latitude = 47.828979 degree
Altitude = 18000.0ft
Vertex[55]:
Longitude = -97.555846 degree
Latitude = 47.823486 degree
Altitude = 18000.0ft
Vertex[56]:
Longitude = -97.546233 degree
Latitude = 47.817993 degree
Altitude = 18000.0ft
Vertex[57]:
Longitude = -97.536620 degree
Latitude = 47.813186 degree
Altitude = 18000.0ft
Vertex[58]:
Longitude = -97.526320 degree
Latitude = 47.808380 degree
Altitude = 18000.0ft
Vertex[59]:
Longitude = -97.516021 degree
Latitude = 47.804260 degree
Altitude = 18000.0ft
```

Vertex[60]:
Longitude = -97.505034 degree
Latitude = 47.799453 degree
Altitude = 18000.0ft
Vertex[61]:
Longitude = -97.494048 degree
Latitude = 47.796020 degree
Altitude = 18000.0ft
Vertex[62]:
Longitude = -97.483062 degree
Latitude = 47.792587 degree
Altitude = 18000.0ft
Vertex[63]:
Longitude = -97.471389 degree
Latitude = 47.789154 degree
Altitude = 18000.0ft
Vertex[64]:
Longitude = -97.459716 degree
Latitude = 47.786407 degree
Altitude = 18000.0ft

Record #2:

- Length: 60
- Report Number: 9839
- Report Year: 0
- Overlay Record ID: 1
- Label Flag: 0 (numeric index)
- Object Label: 0
- Object Element Flag: 1
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Temporary Flight Restriction)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 3 (Extended range 3D polygon (MSL))
- Overlay Operator: 1 (AND this geometry)
- Overlay Vertices Count: 8
- Record Applicability Start:

Month: 7
Day: 6
Hours: 14
Minutes: 0

- Record Applicability End:

Month: 7

```
Day: 7
Hours: 2
Minutes: 0
  -  Overlay Vertices List:
Vertex[1]:
Longitude = -97.448043 degree
Latitude = 47.784347 degree
Altitude = 18000.0 ft
Vertex[2]:
Longitude = -97.435683 degree
Latitude = 47.782287 degree
Altitude = 18000.0 ft
Vertex[3]:
Longitude = -97.424010 degree
Latitude = 47.780227 degree
Altitude = 18000.0 ft
Vertex[4]:
Longitude = -97.411651 degree
Latitude = 47.778854 degree
Altitude = 18000.0 ft
Vertex[5]:
Longitude = -97.399291 degree
Latitude = 47.778167 degree
Altitude = 18000.0 ft
Vertex[6]:
Longitude = -97.386931 degree
Latitude = 47.777481 degree
Altitude = 18000.0 ft
Vertex[7]:
Longitude = -97.374572 degree
Latitude = 47.777481 degree
Altitude = 18000.0 ft
Vertex[8]:
Longitude = -97.374572 degree
Latitude = 48.144149 degree
Altitude = 18000.0 ft
```

D.1.3.3.3 Example of TFR-NOTAM Requiring Segmentation

This TFR NOTAM product contains both text and its associated graphical overlay records. The text record is too large to fit in a single APDU and Application Data in a Ground Uplink Message; it requires segmentation into smaller segments. After segmentation, the text record consists of two segments. The graphical overlay record consists of four associated records, each with different start and end times, but does not require segmentation. The text and graphical overlay records are stored in two separate binary files.

D.1.3.3.3.1 TFR-NOTAM Requiring Segmentation Text Record

D.1.3.3.3.1.1 Full Uplink

Filename: tfr_0_9468_text.bin

The binary file tfr_0_9468_text.bin contains the two segments for the text record. The segments are sent in two 424-byte Application Data, which consists of the I-Frame and APDU with the text record for this TFR-NOTAM product, in four Ground Uplink Messages. The Product File ID, Product File Length and APDU number in the APDU header are used to link and reassemble the entire text record. The decoding process of this text record should only be started after all four segments are received, since any DLAC character in the record could be broken into 2 separate segments. The decoded messages below show the decoded I-Frame and APDU headers associated with each of the two segments, but only display this TFR NOTAM text when the last segment is received and the entire text record is reassembled.

Decoded message:

Application Data (Ground Uplink Message) #1 with the first segment
I-Frame Header:

- length: 422
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 1 (Segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 8 Hour: 18 Minutes: 0
- Product File ID: 2
- Product File Length: 2
- APDU Number: 1

APDU Payload:
Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record: *(Note: part of the text data in the record, cannot be decoded yet, but after saving the data to memory and waiting for other segments to arrive a complete decode can be performed)*

Application Data (Ground Uplink Message) #2 with the second segment
I-Frame Header:

- length: 342
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 1 (Segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 8 Hour: 18 Minutes: 0
- Product File ID: 2
- Product File Length: 2

```
   -  APDU Number: 2
APDU Payload:
 Header:
   -  Record Format: 2 (Unformatted DLAC Text)
   -  Product Version: 2
   -  Record Count: 1
   -  Location ID:
   -  Record Reference: 255
 Record:
 (Note: last part of the text data in the record)
   -  Length: 734
   -  Report Number: 9468
   -  Report Year: 0
   -  Report status: 1 (Active)
   -  Text Data: (for the entire Text Record with its two segments)
NOTAM-TFR 0/9468 081800Z FL.. FLIGHT RESTRICTIONS. PENSACOLA BEACH, FL. DUE
TO AERIAL DEMONSTRATIONS BY THE U.S. NAVY BLUE ANGELS AND OTHER TEAMS,
EFFECTIVE 1007081800 UTC UNTIL 1007082100 UTC, 1007091545 UTC UNTIL
1007092100 UTC, 1007101545 UTC UNTIL 1007102100 UTC, AND 1007111545 UTC UNTIL
1007112100 UTC. PURSUANT TO 14 CFR SECTION 91.145, MANAGEMENT OF AIRCRAFT
OPERATIONS IN THE VICINITY OF AERIAL DEMONSTRATIONS AND MAJOR SPORTING
EVENTS, AIRCRAFT OPERATIONS ARE PROHIBITED WITHIN A 5 NMR OF 301936N/0870823W
OR THE CRESTVIEW /CEW/ VORTAC 216 DEGREE RADIAL AT 38.2 NM, AT AND BELOW
15000 FT MSL UNLESS AUTHORIZED BY ATC. THIS AIRSPACE DOES NOT INCLUDE ANY
AIRSPACE CONTAINED IN GULF OF MEXICO OIL SPILL RESPONSE FLIGHT RESTRICTIONS,
IF APPLICABLE. CHECK NOTAMS FOR SPILL RESTRICTION STATUS. BUCK LEE, PHONE
850-393-0580, IS THE POINT OF CONTACT. THE PENSACOLA /PNS/ APCH, PHONE 850-
266-6921, IS THE COORDINATION FACILITY. WIE UNTIL UFN. CREATED: 01 JUL 13:11
2010
```

D.1.3.3.3.1.2 Abbreviated Uplink

Filename: abbrev_tfr_0_9468_text.bin

The binary file abbrev_tfr_0_9468_text.bin contains the 424-byte Application Data, which consists of the I-Frame and its APDU with the text record header for the TFR-NOTAM product, in the Ground Uplink Message. This is an abbreviated version of the original textual TFR-NOTAM (0/9468). The decoded message should contain the following information.

Decoded message:

```
Application Data (Ground Uplink Message)
I-Frame Header:
- length: 16
- type: 0 (APDU)
APDU Header:
- Product ID: 8
- Segmentation Flag: 0 (No segmentation is required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 7 Day: 8 Hour: 18 Minutes: 0
```

```
APDU Payload:
 Header:
- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255
 Record:
- Length: 5
- Report Number: 9468
- Report Year: 0
- Report status: 1 (Active)
```

D.1.3.3.3.2 TFR-NOTAM Requiring Segmentation Graphical Overlay Record

Filename: tfr_0_9468_overlay.bin

The binary file tfr_0_9468_overlay.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the graphical overlay record for the TFR NOTAM product, in the Ground Uplink Message. This graphical overlay record is associated with the text record mentioned in section D.1.3.3.3.1 above. This graphical overlay record consists of four records, each with different start and end times. The decoded message should contain the following information.

Decoded message:

```
I-Frame Header:
   - length: 143
   - type: 0 (APDU)
APDU Header:
   - Product ID: 8
   - Segmentation Flag: 0 (No segmentation is required for this product)
   - Time Option: 2 (Month, Day, Hour and Minutes included)
   - Time: Month: 7 Day: 8 Hour: 18 Minutes: 0
APDU Payload:
 Header:
   - Record Format: 8 (Graphical Overlay)
   - Product Version: 2
   - Record Count: 4
   - Location ID:
   - Record Reference: 255
 Record #1:
   - Length: 33
   - Report Number: 9468
   - Report Year: 0
   - Overlay Record ID: 0
   - Label Flag: 0 (numeric index)
```

- Object Label: 0
- Object Element Flag: 1
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Temporary Flight Restriction)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 7 (Extended range circular prism (MSL))
- Overlay Operator: 1 (AND this geometry)
- Overlay Vertices Count: 1
- Record Applicability Start:

```
Month: 7
Day: 8
Hours: 18
Minutes: 0
```

- Record Applicability End:

```
Month: 7
Day: 8
Hours: 21
Minutes: 0
```

- Overlay Vertices List:

```
    circle[1]:
Longitude (floor) = -87.139434 degree
Latitude (floor) = 30.326385 degree
Longitude (ceiling) = -87.139434 degree
Latitude (ceiling) = 30.326385 degree
Altitude (floor): 0 ft
Altitude (ceiling): 15000 ft
Radius (longitude): 5.000000 nmi
Radius (latitude): 5.000000 nmi
Rotation angle: 0
```

Record #2:

- Length: 33
- Report Number: 9468
- Report Year: 0
- Overlay Record ID: 1
- Label Flag: 0 (numeric index)
- Object Label: 0
- Object Element Flag: 1
- Qualifier Flag: 0

- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Temporary Flight Restriction)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 7 (Extended range circular prism (MSL))
- Overlay Operator: 1 (AND this geometry)
- Overlay Vertices Count: 1
- Record Applicability Start:

Month: 7
Day: 9
Hours: 15
Minutes: 45

- Record Applicability End:

Month: 7
Day: 9
Hours: 21
Minutes: 0

- Overlay Vertices List:

circle[1]:
Longitude (floor) = -87.139434 degree
Latitude (floor) = 30.326385 degree
Longitude (ceiling) = -87.139434 degree
Latitude (ceiling) = 30.326385 degree
Altitude (floor): 0 ft
Altitude (ceiling): 15000 ft
Radius (longitude): 5.000000 nmi
Radius (latitude): 5.000000 nmi
Rotation angle: 0

Record #3:

- Length: 33
- Report Number: 9468
- Report Year: 0
- Overlay Record ID: 2
- Label Flag: 0 (numeric index)
- Object Label: 0
- Object Element Flag: 1
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Temporary Flight Restriction)

- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 7 (Extended range circular prism (MSL))
- Overlay Operator: 1 (AND this geometry)
- Overlay Vertices Count: 1
- Record Applicability Start:

Month: 7
Day: 10
Hours: 15
Minutes: 45

- Record Applicability End:

Month: 7
Day: 10
Hours: 21
Minutes: 0

- Overlay Vertices List:

circle[1]:
Longitude (floor) = -87.139434 degree
Latitude (floor) = 30.326385 degree
Longitude (ceiling) = -87.139434 degree
Latitude (ceiling) = 30.326385 degree
Altitude (floor): 0 ft
Altitude (ceiling): 15000 ft
Radius (longitude): 5.000000 nmi
Radius (latitude): 5.000000 nmi
Rotation angle: 0

Record #4:

- Length: 33
- Report Number: 9468
- Report Year: 0
- Overlay Record ID: 3
- Label Flag: 0 (numeric index)
- Object Label: 0
- Object Element Flag: 1
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Temporary Flight Restriction)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)

```
   -  Overlay Geometry Option: 7 (Extended range circular prism (MSL))
   -  Overlay Operator: 1 (AND this geometry)
   -  Overlay Vertices Count: 1
   -  Record Applicability Start:
 Month: 7
 Day: 11
 Hours: 15
 Minutes: 45
   -  Record Applicability End:
 Month: 7
 Day: 11
 Hours: 21
 Minutes: 0
   -  Overlay Vertices List:
    circle[1]:
 Longitude (floor) = -87.139434 degree
 Latitude (floor) = 30.326385 degree
 Longitude (ceiling) = -87.139434 degree
 Latitude (ceiling) = 30.326385 degree
 Altitude (floor): 0 ft
 Altitude (ceiling): 15000 ft
 Radius (longitude): 5.000000 nmi
 Radius (latitude): 5.000000 nmi
 Rotation angle: 0
```

D.1.3.3.4 Example of NOTAM-TFR without Geographic Information

Some NOTAM-TFRs are provided from the FIS-B Data Source without any graphic overlays, and thus are broadcasted only with the text record and no associated graphical overlay component. FIS-B sends these NOTAM-TFRs for broadcasting to every UAT radio served by the Control Station since they can't be filtered geographically.

Filename: tfr_0_4299_text.bin

The binary file tfr_0_4299_text.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the TFR NOTAM product, in the Ground Uplink Message. The decoded message should look like the following.

Decoded message:

```
I-Frame Header:
   -  length: 156
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 8
   -  Segmentation Flag: 0 (No segmentation is required for this product)
   -  Time Option: 2 (Month, Day, Hour and Minutes included)
   -  Time: Month: 1 Day: 17 Hour: 23 Minutes: 13
```

APDU Payload:
 Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

 Record:

- Length: 145
- Report Number: 4299
- Report Year: 0
- Report status: 1 (Active)
- Text Data:

NOTAM-TFR 0/4299 172313Z AIRSPACE SHINE FIVE ARRIVAL, VXV TRANS; REVISE MEA BETWEEN VXV VORTAC AND BURLS INT TO 14500 MSL; ADD MOCA 11000 MSL. WIE UNTIL UFN. CREATED: 29 OCT 19:02 2010

D.1.3.3.5 NOTAM-D and NOTAM-FDC Cancellation

When a NOTAM-D or NOTAM-FDC report is cancelled before its expiration, the Report Status field in the Text Record header is set to 0 (i.e. cancelled). Only the 6-byte payload header and the 5-byte Text Record header are broadcasted. It will be broadcasted for a configurable time interval before it is purged from the system. On the other hand, if a product has expired, FIS-B will purge that product from the system immediately and will not broadcasted it anymore.

Note that there is no cancellation message for TFR-NOTAM.

Filename: notam_cancellation.bin

The binary file notam_cancellation.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the Payload header and the first five bytes of the text record for the cancelled NOTAM, in the Ground Uplink Message. The decoded message should look like the following.

Decoded message:

I-Frame Header:

- length: 16
- type: 0 (APDU)

APDU Header:

- Product ID: 8
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 12 Day: 20 Hour: 19 Minutes: 28

APDU Payload:
 Header:

- Record Format: 2 (Unformatted DLAC Text)

```
  -  Product Version: 2
  -  Record Count: 1
  -  Location ID: KMVY
  -  Record Reference: 0
 Record:
  -  Length: 5
  -  Report Number: 12018
  -  Report Year: 11
  -  Report status: 0 (Cancelled)
```

D.1.3.4 Outage Notification

The Outage Notification message uses Product ID 8 in the APDU header and the text record format for the Aerodrome and Airspace Product. This message only contains the text record and does not have a graphical overlay component. FIS-B starts broadcasting this message within 30 seconds of the product outage and keeps retransmitting it periodically until the product has come back online. The purpose of this message is to inform the users that a particular product is unavailable from the FIS-B Data Source, therefore there will not be any update for this product type beginning at the time specified in the message. However FIS-B continues to retransmit the unexpired products of this type to the avionics. Note that there is no notification message uplinked to avionics when the product has become available. Instead FIS-B just stops sending the outage notification message at the next scheduled transmission time.

Filename: outage.bin

The binary file outage.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the Payload header and the text record for the Outage Notification, in the Ground Uplink Message. The decoded message should look like the following.

Decoded message:

```
I-Frame Header:
  -  length: 85
  -  type: 0 (APDU)
APDU Header:
  -  Product ID: 8
  -  Segmentation Flag: 0 (No segmentation required for this product)
  -  Time Option: 2 (Month, Day, Hour and Minutes included)
  -  Time: Month: 1 Day: 17 Hour: 17 Minutes: 54
APDU Payload:
 Header:
  -  Record Format: 2 (Unformatted DLAC Text)
  -  Product Version: 2
  -  Record Count: 1
  -  Location ID:
```

- Record Reference: 255

Record:

- Length: 74
- Report Number: 10002
- Report Year: 11
- Report status: 1 (Active)
- Text Data:

```
FIS-B SERVICE OUTAGE 171754Z ZMP,ZAU,KKC,ZAB,ZME,ZFW,ZHU/GOMEX AIRMET PRODUCT
UNAVAILABLE
```

D.1.4 AIRMET

The month, day, hours and minutes of the issue time for the AIRMET report are used in the APDU header timestamp, where the time option field is set to 2 to include month, day, hours and minutes. This issue time, which does not include the month of the report, is inserted into the Timestamp field of the AIRMET messages as shown in the examples below.

The AIRMET product contains both text and its associated graphical overlay records. The text and graphical overlay records are stored in two separate binary files.

D.1.4.1 AIRMET Text Example

Filename: airmet_text.bin

The binary file airmet_text.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the AIRMET product, in the Ground Uplink Message. The decoded message should look like the following.

Decoded message:

I-Frame Header:

- length: 304
- type: 0 (APDU)

APDU Header:

- Product ID: 11
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 1 Day: 17 Hour: 14 Minutes: 45

APDU Payload:

Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

- Length: 293
- Report Number: 1
- Report Year: 11
- Report status: 1 (Active)
- Text Data:

```
AIRMET KBOS 171445 BOST WA 171445
AIRMET TANGO UPDT 2 FOR TURB VALID UNTIL 172100
AIRMET TURB...MA RI CT NY NJ PA OH WV MD DC DE VA NC SC GA AND
CSTL WTRS
FROM 40E ALB TO 150ENE ACK TO 200SE ACK TO 160SE SIE TO 20NE ECG
TO 30NNW RDU TO IRQ TO LGC TO GQO TO HMV TO HNN TO 50WNW HNN TO
30E JHW TO 40E ALB
MOD TURB BTN FL280 AND FL400. CONDS DVLPG 15-18Z. CONDS CONTG
BYD 21Z THRU 03Z
```

D.1.4.2 AIRMET Graphical Example

Filename: airmet_overlay.bin

The binary file airmet_overlay.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the graphical overlay record for the AIRMET product, in the Ground Uplink Message. The decoded message includes the following information.

Decoded message:

I-Frame Header:

- length: 198
- type: 0 (APDU)

APDU Header:

- Product ID: 11
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 1 Day: 17 Hour: 14 Minutes: 45

APDU Payload:

Header:

- Record Format: 8 (Graphical Overlay)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

- Length: 187
- Report Number: 1
- Report Year: 11

- Overlay Record ID: 0
- Label Flag = 0 (numeric index)
- Object Element Flag: 0
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Not used since Object Element Flag = 0)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 3 (Extended range 3D polygon (MSL))
- Overlay Operator: No
- Overlay Vertices Count: 28
- Record Applicability Start:

```
Month: 1
Day: 17
Hours: 14
Minutes: 45
```

- Record Applicability End:

```
Month: 1
Day: 17
Hours: 21
Minutes: 0
```

- Overlay Vertices List:

```
Vertex[1]:
Longitude = -72.895660 degree
Latitude = 42.754669 degree
Altitude = 40000.0 ft
Vertex[2]:
Longitude = -78.586577 degree
Latitude = 42.160720 degree
Altitude = 40000.0 ft
Vertex[3]:
Longitude = -83.022994 degree
Latitude = 39.076995 degree
Altitude = 40000.000000 ft
Vertex[4]:
Longitude = -82.036971 degree
Latitude = 38.746719 degree
Altitude = 40000.0 ft
Vertex[5]:
Longitude = -82.138595 degree
Latitude = 36.442337 degree
Altitude = 40000.0 ft
Vertex[6]:
Longitude = -85.160521 degree
Latitude = 34.967422 degree
```

```
Altitude = 40000.000000 ft
Vertex[7]:
Longitude = -85.080871 degree
Latitude = 33.002929 degree
Altitude = 40000.000000 ft
Vertex[8]:
Longitude = -82.157821 degree
Latitude = 33.697815 degree
Altitude = 40000.000000 ft
Vertex[9]:
Longitude = -79.016418 degree
Latitude = 36.323547 degree
Altitude = 40000.000000 ft
Vertex[10]:
Longitude = -75.879821 degree
Latitude = 36.485595 degree
Altitude = 40000.000000 ft
Vertex[11]:
Longitude = -72.432861 degree
Latitude = 37.176361 degree
Altitude = 40000.000000 ft
Vertex[12]:
Longitude = -66.992568 degree
Latitude = 38.879928 degree
Altitude = 40000.000000 ft
Vertex[13]:
Longitude = -66.938323 degree
Latitude = 42.174453 degree
Altitude = 40000.000000 ft
Vertex[14]:
Longitude = -72.895660 degree
Latitude = 42.754669 degree
Altitude = 40000.000000 ft
Vertex[15]:
Longitude = -72.895660 degree
Latitude = 42.754669 degree
Altitude = 28000.000000 ft
Vertex[16]:
Longitude = -78.586577 degree
Latitude = 42.160720 degree
Altitude = 28000.000000 ft
Vertex[17]:
Longitude = -83.022994 degree
Latitude = 39.076995 degree
Altitude = 28000.000000 ft
Vertex[18]:
Longitude = -82.036971 degree
Latitude = 38.746719 degree
Altitude = 28000.000000 ft
Vertex[19]:
Longitude = -82.138595 degree
Latitude = 36.442337 degree
Altitude = 28000.000000 ft
Vertex[20]:
Longitude = -85.160521 degree
Latitude = 34.967422 degree
Altitude = 28000.000000 ft
```

```
Vertex[21]:
Longitude = -85.080871 degree
Latitude = 33.002929 degree
Altitude = 28000.000000 ft
Vertex[22]:
Longitude = -82.157821 degree
Latitude = 33.697815 degree
Altitude = 28000.000000 ft
Vertex[23]:
Longitude = -79.016418 degree
Latitude = 36.323547 degree
Altitude = 28000.000000 ft
Vertex[24]:
Longitude = -75.879821 degree
Latitude = 36.485595 degree
Altitude = 28000.000000 ft
Vertex[25]:
Longitude = -72.432861 degree
Latitude = 37.176361 degree
Altitude = 28000.000000 ft
Vertex[26]:
Longitude = -66.992568 degree
Latitude = 38.879928 degree
Altitude = 28000.000000 ft
Vertex[27]:
Longitude = -66.938323 degree
Latitude = 42.174453 degree
Altitude = 28000.000000 ft
Vertex[28]:
Longitude = -72.895660 degree
Latitude = 42.754669 degree
Altitude = 28000.000000 ft
```

D.1.5 SIGMET / Convective SIGMET

The month, day, hours, and minutes of the start time for the SIGMET and Convective SIGMET reports are contained in the APDU header timestamp, where the time option field is set to a value of two (2) which indicates that the time includes month, day, hours and minutes. This issue time, which does not include the month of the report, is inserted into the Timestamp field of the SIGMET/Convective SIGMET messages as shown in the examples below.

Both SIGMET and Convective SIGMET products use the Product ID 12 in the APDU header. They are distinguished by parsing the first word in the message. For SIGMET product, the first word in the message is “SIGMET”. For Convective SIGMET product, “WST” is the first word in the message.

The SIGMET and Convective SIGMET products contain both text and associated graphical overlay records. The text and graphical overlay records are stored in two separate binary files.

D.1.5.1 SIGMET Text Example

Filename: sigmet_text.bin

The binary file sigmet_text.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the SIGMET product, in the Ground Uplink Message. The correctly decoded message contains the following information.

Decoded message:

```
I-Frame Header:
   -  length: 180
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 12
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 2 (Month, Day, Hour and Minutes included)
   -  Time: Month: 1 Day: 6 Hour: 20 Minutes: 35
APDU Payload:
 Header:
   -  Record Format: 2 (Unformatted DLAC Text)
   -  Product Version: 2
   -  Record Count: 1
   -  Location ID:
   -  Record Reference: 255
 Record:
   -  Length: 169
   -  Report Number: 3
   -  Report Year: 11
   -  Report status: 1 (Active)
   -  Text Data:
SIGMET KSLC 062035 SIGMET UNIFORM 2 VALID UNTIL 070035
NM
FROM 40WNW RSK TO 30SSE TBE TO TCC TO 70SSW RSK TO 40WNW RSK
OCNL SEV TURB BTN FL280 AND FL350. DUE TO WNDSHR ASSOCD WITH
JTST. RPTD BY B737. CONDS ENDG 0035Z
```

D.1.5.2 SIGMET Graphical Example

Filename: sigmet_overlay.bin

The binary file sigmet_overlay.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the graphical overlay record for the SIGMET product, in the Ground Uplink Message. The correctly decoded message contains the following information.

Decoded message:

```
I-Frame Header:
   -  length: 90
   -  type: 0 (APDU)
```

APDU Header:

- Product ID: 12
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 1 Day: 6 Hour: 20 Minutes: 35

APDU Payload:
Header:

- Record Format: 8 (Graphical Overlay)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

- Length: 79
- Report Number: 3
- Report Year: 11
- Overlay Record ID: 0
- Label Flag = 0 (numeric index)
- Object Element Flag: 0
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Not used since Object Element Flag = 0)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 3 (Extended range 3D polygon (MSL))
- Overlay Operator: No
- Overlay Vertices Count: 10
- Record Applicability Start:

Month: 1
Day: 6
Hours: 20
Minutes: 35

- Record Applicability End:

Month: 1
Day: 7
Hours: 0
Minutes: 35

- Overlay Vertices List:

```
   Vertex[1]:
   Longitude = -108.869704 degree
Latitude = 37.000579 degree
   Altitude = 35000.0 ft
   Vertex[2]:
   Longitude = -108.647917 degree
   Latitude = 35.669860 degree
   Altitude = 35000.0 ft
   Vertex[3]:
   Longitude = -103.602446 degree
   Latitude = 35.182342 degree
   Altitude = 35000.0 ft
   Vertex[4]:
   Longitude = -103.360747 degree
   Latitude = 36.796646 degree
   Altitude = 35000.0 ft
   Vertex[5]:
   Longitude = -108.869704 degree
   Latitude = 37.000579 degree
   Altitude = 35000.0 ft
   Vertex[6]:
   Longitude = -108.869704 degree
   Latitude = 37.000579 degree
   Altitude = 28000.0 ft
   Vertex[7]:
   Longitude = -108.647917 degree
   Latitude = 35.669860 degree
   Altitude = 28000.0 ft
   Vertex[8]:
   Longitude = -103.602446 degree
   Latitude = 35.182342 degree
   Altitude = 28000.0 ft
   Vertex[9]:
   Longitude = -103.360747 degree
   Latitude = 36.796646 degree
   Altitude = 28000.0 ft
   Vertex[10]:
   Longitude = -108.869704 degree
   Latitude = 37.000579 degree
   Altitude = 28000.0 ft
```

D.1.5.3 Convective SIGMET text example

Filename: wst_text.bin

The binary file wst_text.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the Convective SIGMET product, in the Ground Uplink Message. The correctly decoded message contains the following information.

Decoded message:

```
I-Frame Header:
   -  length: 142
   -  type: 0 (APDU)
APDU Header:
```

- Product ID: 12
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 12 Day: 24 Hour: 19 Minutes: 55

APDU Payload:
Header:

- Record Format: 2 (Unformatted DLAC Text)
- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

- Length: 131
- Report Number: 2
- Report Year: 11
- Report status: 1 (Active)
- Text Data:

```
WST KMKC 241955 CONVECTIVE SIGMET 20C
VALID UNTIL 2155Z
TX
FROM 40SSW ACT-50SE ACT-40N LRD-50NNW LRD-40WSW SAT-40SSW ACT
AREA EMBD TS MOV FROM 27015KT. TOPS TO FL350.
```

D.1.5.4 Convective SIGMET Graphical Example

Filename: wst_overlay.bin

The binary file wst_overlay.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the graphical overlay record for the Convective SIGMET product, in the Ground Uplink Message. The correctly decoded message contains the following information.

Decoded message:

I-Frame Header:

- length: 66
- type: 0 (APDU)

APDU Header:

- Product ID: 12
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 2 (Month, Day, Hour and Minutes included)
- Time: Month: 12 Day: 24 Hour: 19 Minutes: 55

APDU Payload:
Header:

- Record Format: 8 (Graphical Overlay)

- Product Version: 2
- Record Count: 1
- Location ID:
- Record Reference: 255

Record:

- Length: 55
- Report Number: 2
- Report Year: 11
- Overlay Record ID: 0
- Label Flag = 0 (numeric index)
- Object Element Flag: 0
- Qualifier Flag: 0
- Parameter Flag: 0
- Object Type: 14 (Airspace)
- Object element: 0 (Not used since Object Element Flag = 0)
- Object Status: 15 (In Effect)
- Record Applicability Options: 3 (Both start and end times)
- Date/Time Format: 1 (Month, day, hours and minutes)
- Overlay Geometry Option: 3 (Extended range 3D polygon (MSL))
- Overlay Operator: No
- Overlay Vertices Count: 6
- Record Applicability Start:

Month: 12
Day: 24
Hours: 19
Minutes: 55

- Record Applicability End:

Month: 12
Day: 24
Hours: 21
Minutes: 55

- Overlay Vertices List:

Vertex[1]:
Longitude = -97.566832 degree
Latitude = 31.045990 degree
Altitude = 35000.0 ft
Vertex[2]:
Longitude = -99.174956 degree
Latitude = 29.276504 degree
Altitude = 35000.0 ft
Vertex[3]:
Longitude = -99.822463 degree
Latitude = 28.312454 degree

```
Altitude = 35000.0 ft
Vertex[4]:
Longitude = -99.461974 degree
Latitude = 28.209457 degree
Altitude = 35000.0 ft
Vertex[5]:
Longitude = -96.542357 degree
Latitude = 31.020584 degree
Altitude = 35000.0 ft
Vertex[6]:
Longitude = -97.566832 degree
Latitude = 31.045990 degree
Altitude = 35000.0 ft
```

D.1.6 SUA

The month, day, hours and minutes of the start time for the SUA report are used in the APDU header timestamp, where the time option field is set to 2 to include month, day, hours and minutes. The valid time (does not include the month of the report) is inserted into the Timestamp field of the Convective SUA messages as shown in the examples below.

Note that the SUA product is provided only in textual form.

D.1.6.1 SUA text example

Filename: sua.bin

The binary file sua.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the SUA product, in the Ground Uplink Message. The correctly decoded message contains the following information.

Decoded message:

```
I-Frame Header:
   -  length: 105
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 13
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 2 (Month, Day, Hour and Minutes included)
   -  Time: Month: 12 Day: 21 Hour: 19 Minutes: 25
APDU Payload:
 Header:
   -  Record Format: 2 (Unformatted DLAC Text)
   -  Product Version: 2
   -  Record Count: 1
   -  Location ID:
   -  Record Reference: 255
 Record:
```

- Length: 94
- Report Number: 7
- Report Year: 11
- Report status: 1 (Active)
- Text Data:

SUA 211925 2233071|5550|W|M|ANNE LOW MOA|1012211925|1012212125|001|069|A|Y|53|ANNE LOW|MOA US 01022|ANNE LOW MOA, AR

The SUA text record consists of fields separated either by a single space or a pipe “|” character. The following table describes the meaning of each field.

Table D-2. SUA Fields Description

Field	Name	Description
1	Product Type	SUA
2	Valid time	UTC Time that SUA schedule list last verified by the FIS-B Data Source, of the format ddHHMM. dd = day HH = hour MM = minutes
3	Schedule ID	Unique value assigned to the SUA report
4	Airspace ID	Unique value - Airspace Catalog ID
5	Schedule Status	P = Pending Approval W = Waiting to Start H = "Hot" / Activated for Use
6	Airspace Type	W = Warning Area R = Restricted Area M = Military Operations Area P = Prohibited Area L = Alert Area A = ATCAA I = Instrument Route V = Visual Route S = Slow Route B = Military Route (Refueling) O = Other T = Refueling Track
7	Airspace Name	Airspace Name should be at most 50 characters
8	Start Time	yymmddHHMM yy = the last 2 digits of the year mm = month dd = day HH = hour MM = minutes

Field	Name	Description
9	End Time	yymmddHHMM yy = last 2 digits of the year mm = month dd = day HH = hour MM = minutes
10	Low Altitude	x 100 feet MSL or AGL. However whether MSL or AGL is not provided by the vendor to the FIS-B Data Source.
11	High Altitude	x 100 feet MSL or AGL. However whether MSL or AGL is not provided by the vendor to the FIS-B Data Source.
12	Separation Rule	Blank = Unspecified Rule A = Aircraft Rule O = Other Rule
13	Shape Indicator	N = Airspace has no shape defined Y = Airspace has a shape defined and is displayed on sua.faa.mil if scheduled
14	NFDC ID	NFDC Airspace ID
15	NFDC Name	NFDC Airspace Name
16	DAFIF ID	DAFIF Airspace ID
17	DAFIF Name	DAFIF Airspace Name

D.1.6.2 SUA with Missing Fields

One or more fields can be missing in some SUA reports. In these cases, the field is left empty instead of filled with a space.

Filename: sua_unavail_data.bin

The binary file sua_unavail_data.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the text record for the SUA product, in the Ground Uplink Message. This binary file contains a SUA product in which two fields are unavailable: nfdc_id and nfdc_name. The correctly decoded message contains the following information.

Decoded message:

```
I-Frame Header:
  - length: 82
  - type: 0 (APDU)
APDU Header:
  - Product ID: 13
  - Segmentation Flag: 0 (No segmentation required for this product)
  - Time Option: 2 (Month, Day, Hour and Minutes included)
  - Time: Month: 12 Day: 21 Hour: 18 Minutes: 30
```

```
APDU Payload:
 Header:
   -  Record Format: 2 (Unformatted DLAC Text)
   -  Product Version: 2
   -  Record Count: 1
   -  Location ID:
   -  Record Reference: 255
 Record:
   -  Length: 71
   -  Report Number: 8
   -  Report Year: 11
   -  Report status: 1 (Active)
   -  Text Data:
SUA 211830
2236964|23946|P|B|AR117V|1012211830|1012212130|070|090|A|Y|||AR117V|AR117V
```

D.2 Graphic Products: Product IDs 63 and 64

D.2.1 Background

The Regional NEXRAD and CONUS NEXRAD products are provided in graphical format using Product IDs 63 (Regional NEXRAD) and 64 (CONUS NEXRAD). Product 63 (within CONUS) and Product 64 are based on a mosaic of the NEXRAD Composite Reflectivity product from the network of NEXRAD radars. These mosaics are "masked" to 120 NM range from each operating NEXRAD radar. Areas masked out of the mosaic based on this range limit are to be rendered in the cockpit as areas of "No Data" to distinguish them from clear air. Outside CONUS, the full 240 NM range of each NEXRAD sensor is used, i.e., AK, HI, Guam, Puerto Rico.[15]

FAA AC 00-45G Section 4 provides more information on the interpretation and limitations of NEXRAD information.

Each NEXRAD radar contributing to the mosaic can take up to 10 minutes to complete its scan and present its output to the mosaic processor. Each NEXRAD radar performs this scan asynchronously with other NEXRAD radars. The timestamp reported in the APDU header for product 63 and 64 is the "cutoff time" i.e., the time at which the mosaic processor stops accepting new NEXRAD radar output. Therefore pilots should be aware that the oldest portions of the contributing NEXRAD site's data being uplinked could range from 0-20 minutes *older* than the APDU timestamp indicates (see section 3.8.1.2.1.c of DO-267A). Figure D-1 below shows the delays involved from the time the weather is sensed to the time it arrives in the cockpit for a worst case NEXRAD sensor. The mosaic processor creates a new mosaic every five (5) minutes using the latest output available from each NEXRAD sensor. Since the CONUS NEXRAD product is only uplinked once every 15 minutes, in practice this means that every third mosaic output will be used to update the CONUS NEXRAD uplinked image.

[15] Within CONUS, masking at 120 NM is to give good coverage of weather conditions at lower altitudes in areas without NEXRAD overlap.

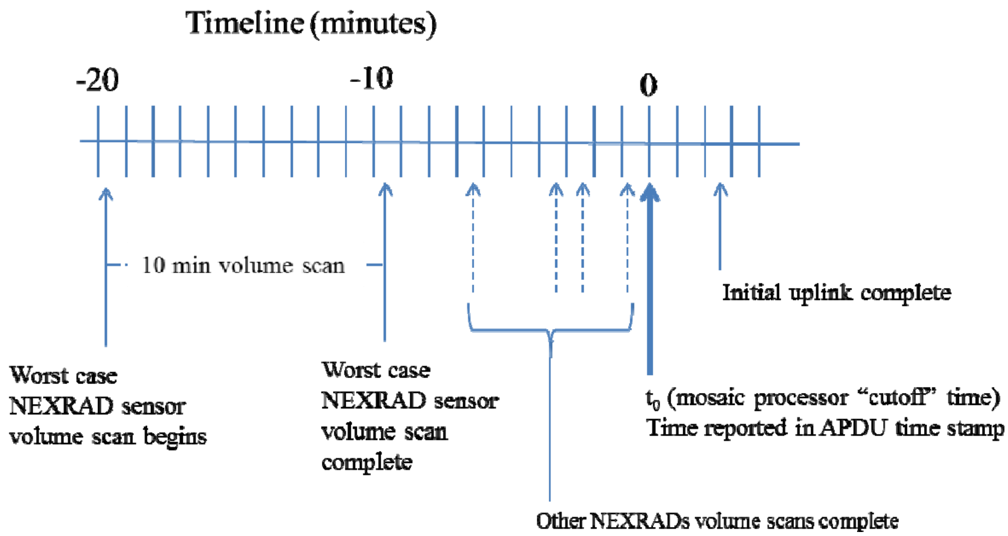

Figure D-1. Worst Case NEXRAD Timing—Sensing to Cockpit

D.2.2 Examples

D.2.2.1 Regional NEXRAD

For Regional NEXRAD, the clear air intensity value is 0. If there are any bins with no data (i.e. missing data) or no coverage within a Global Block Representation (GBR) formatted block, that entire GBR block will not be sent.

Filename: r_nexrad.bin

The binary file r_nexrad.bin contains forty-one 424-byte Application Data Blocks, which consists of the I-Frame and APDU with Global Blocks, in the 41 Ground Uplink Messages. The scaling factor field is set to 0 (for no scaling) in the Block Reference Indicator (BRI) for each Global Block in this product type. FIS-B uses Run Length Encoding of cells (or bins) within a Global Block, as well as Empty Block Encoding of Global Blocks with all (128) cells whose encoded intensity values are 0. It is noted that even though both encoded intensity values 0 and 1 are treated as "No Precipitation" on the picture below, only 0 value Global Blocks are Empty Block Encoded.

Note that the image provided below is a representative depiction of the imagery for the accompanying binary data file, for the same time period. The image below is not a pixel-for-pixel criteria.

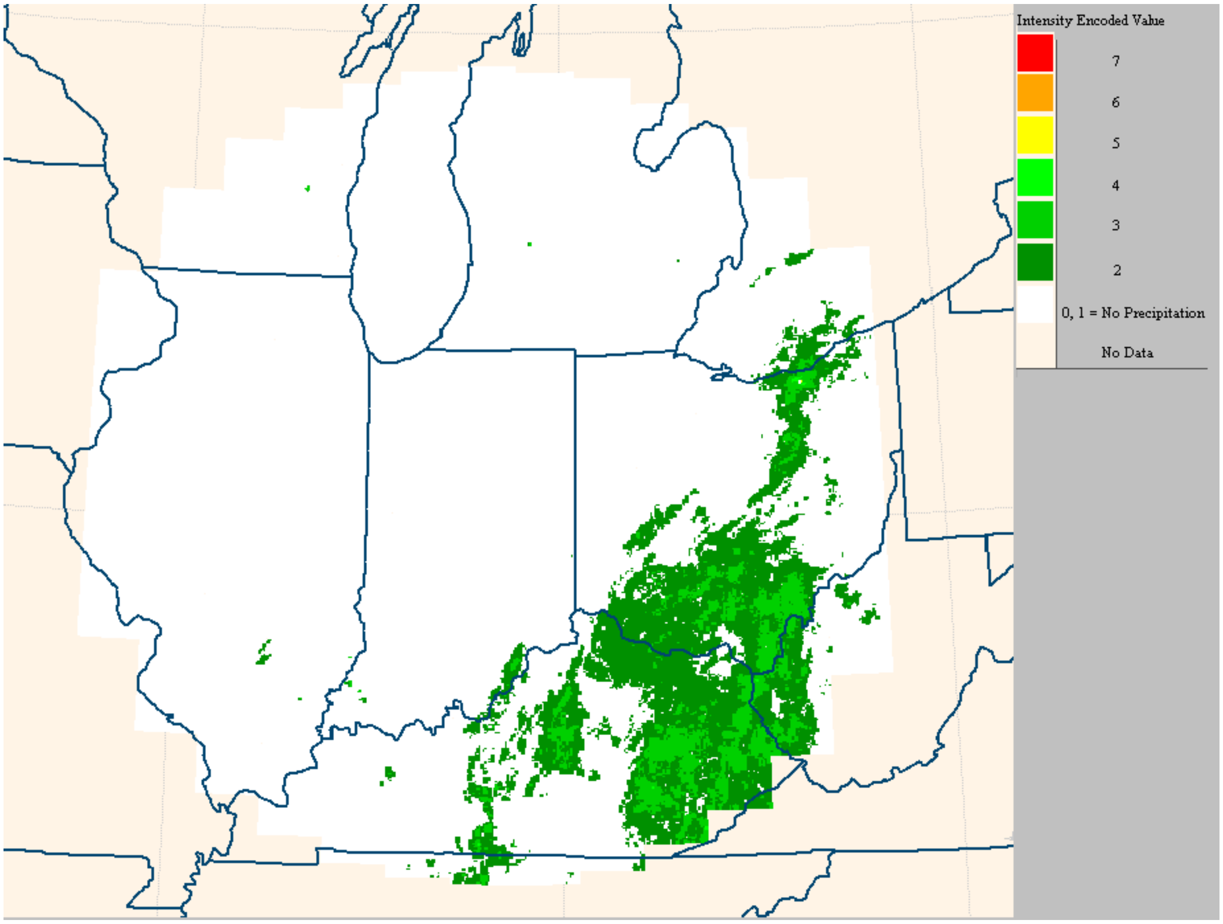

Figure D-2. Regional NEXRAD Example

D.2.2.2 CONUS NEXRAD

For CONUS NEXRAD, the clear air intensity value is 1. For no data (i.e. missing data) bin within a Global Block Representation (GBR) block, that bin is assigned the value of 0. For an area of no coverage (such as Canada, or over an ocean), there will be no GBR blocks sent. Note: Each bit in the Empty Element bitmap for CONUS NEXRAD represents a group of 5x5 GBR blocks, since the scaling factor is set to 5 for this product.

Filename: n_nexrad.bin

The binary file n_nexrad.bin contains forty four 424-byte Application Data Blocks, which consists of the I-Frame and APDU with Global Blocks, in the 44 Ground Uplink Messages. The scaling factor field is set to 1 (indicating a scaling of 5) in the Block Reference Indicator (BRI) for each Global Block in this product type. FIS-B supports Run Length Encoding of cells (or bins) within a Global Block, and Empty Block Encoding of Global Blocks with all (128) cells whose encoded intensity values are 1. It is noted that the encoded intensity value of 0 is used for a missing cell (bin) in a Global Block for the CONUS NEXRAD product. Each Global Block in this product is scaled by 5 (i.e. x 5) from its original counterparts. If overlaid onto Regional NEXRAD GBR blocks, (i.e. blocks with no scaling) there are 25, or 5 x 5, Regional NEXRAD GBR blocks that make up the same geographic area of one GBR block in the CONUS NEXRAD image. Due to the five times scaling of the CONUS GBR block, the block numbers in the Block Reference Indicator (BRI) for horizontally adjacent CONUS NEXRAD GBR blocks is 5.

Note that the image provided in

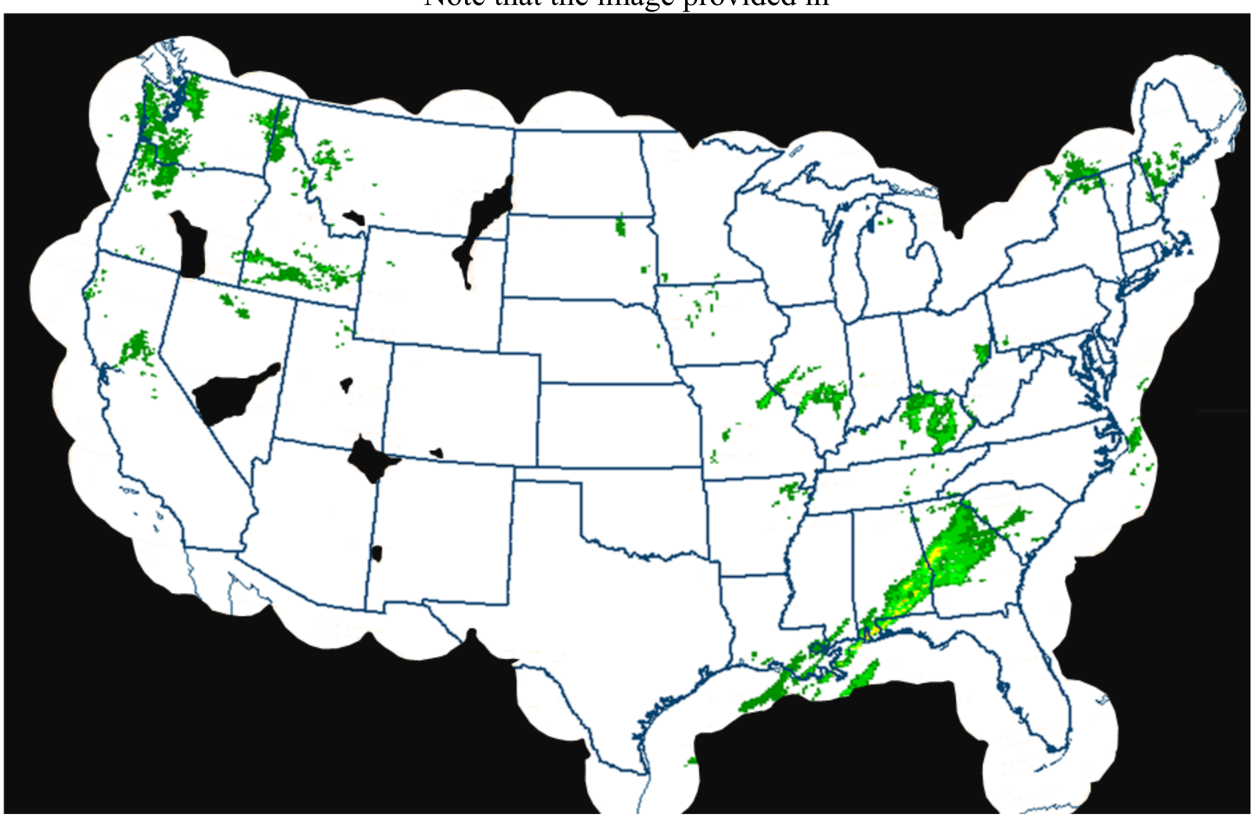

Figure D-3 below is a representative depiction of the imagery for the accompanying binary data file, for the same time period. The black shading represents areas of "no data". It can be seen that several of these no data areas exist within the Western portion of CONUS.

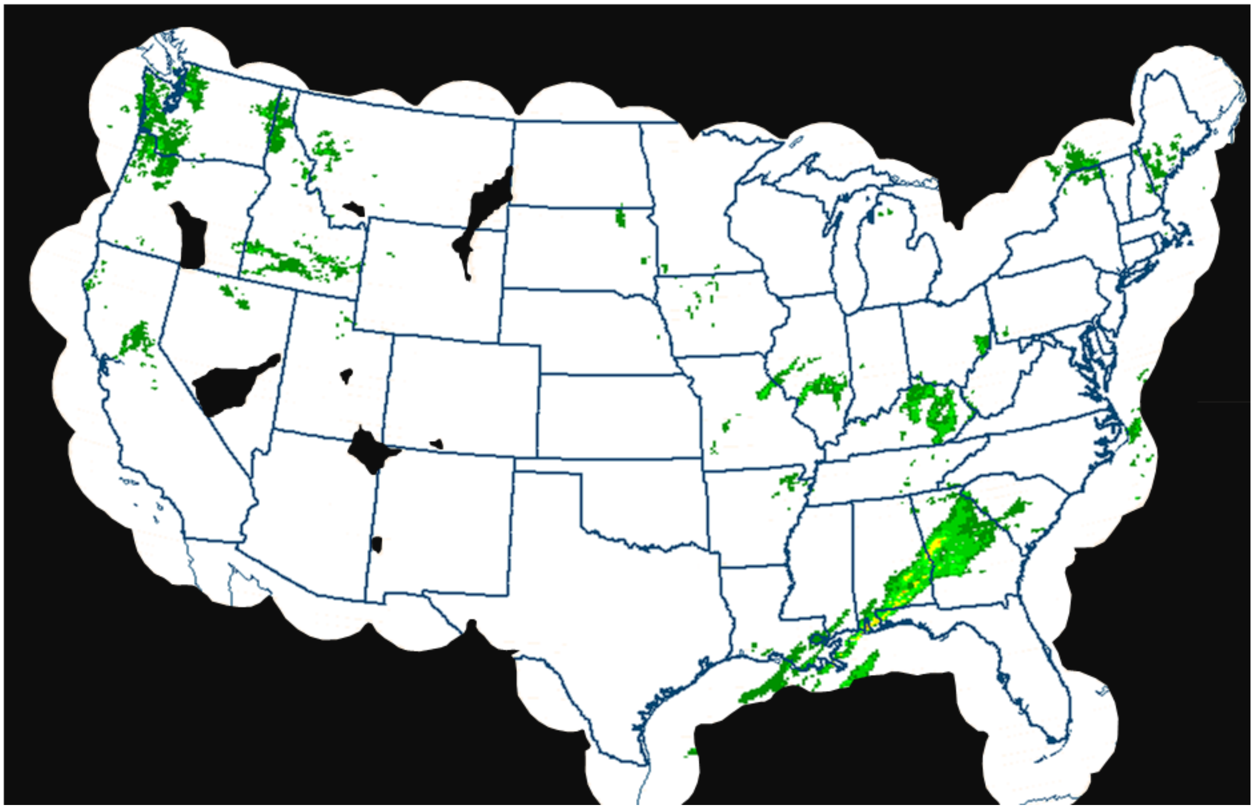

Figure D-3. CONUS NEXRAD Example Showing Areas of No Data

D.2.3 NEXRAD Test Patterns

D.2.3.1 Regional NEXRAD Below 60° North Latitude

For Regional NEXRAD, the clear air intensity value is 0. If there are any bins with no data (i.e. missing data) or no coverage within a GBR block, that entire GBR block will not be sent.

Filename: r_nexrad_phl_iframes.bin

The binary file r_nexrad_phl_iframes.bin contains seven (7) concatenated I-Frames with each I-Frame containing one (1) APDU with one (1) Global Block run-length encoded. The scaling factor field is set to 0 (for no scaling) in the Block Reference Indicator (BRI) for each Global Block in this product type. FIS-B uses Run Length Encoding of cells (or bins) within a Global Block, as well as Empty Block Encoding of Global Blocks with all (128) cells whose encoded intensity values are 0. It is noted that even though both encoded intensity values 0 and 1 are treated as "No Precipitation" in Figure D-4, only 0 value Global Blocks are Empty Block Encoded.

Note that the image provided below is a representative depiction of the imagery for the accompanying binary data file.

The encoding of the seven blocks shown in Figure D-4 places them, as depicted in Figure D-5, just west of Philadelphia International Airport (PHL). The target blocks are numbered, in Figure D-5, in both hexadecimal and decimal with a north hemisphere identifier of “N” included. Only the values of block bins corresponding to zero (0) are fully represented to Figure D-4 to reduce clutter in the image and to distinguish those bins from the bins with value one (1). The colors used in the image are only for display within this document and do not correspond to guidance found in avionics requirements or recommendation documents.

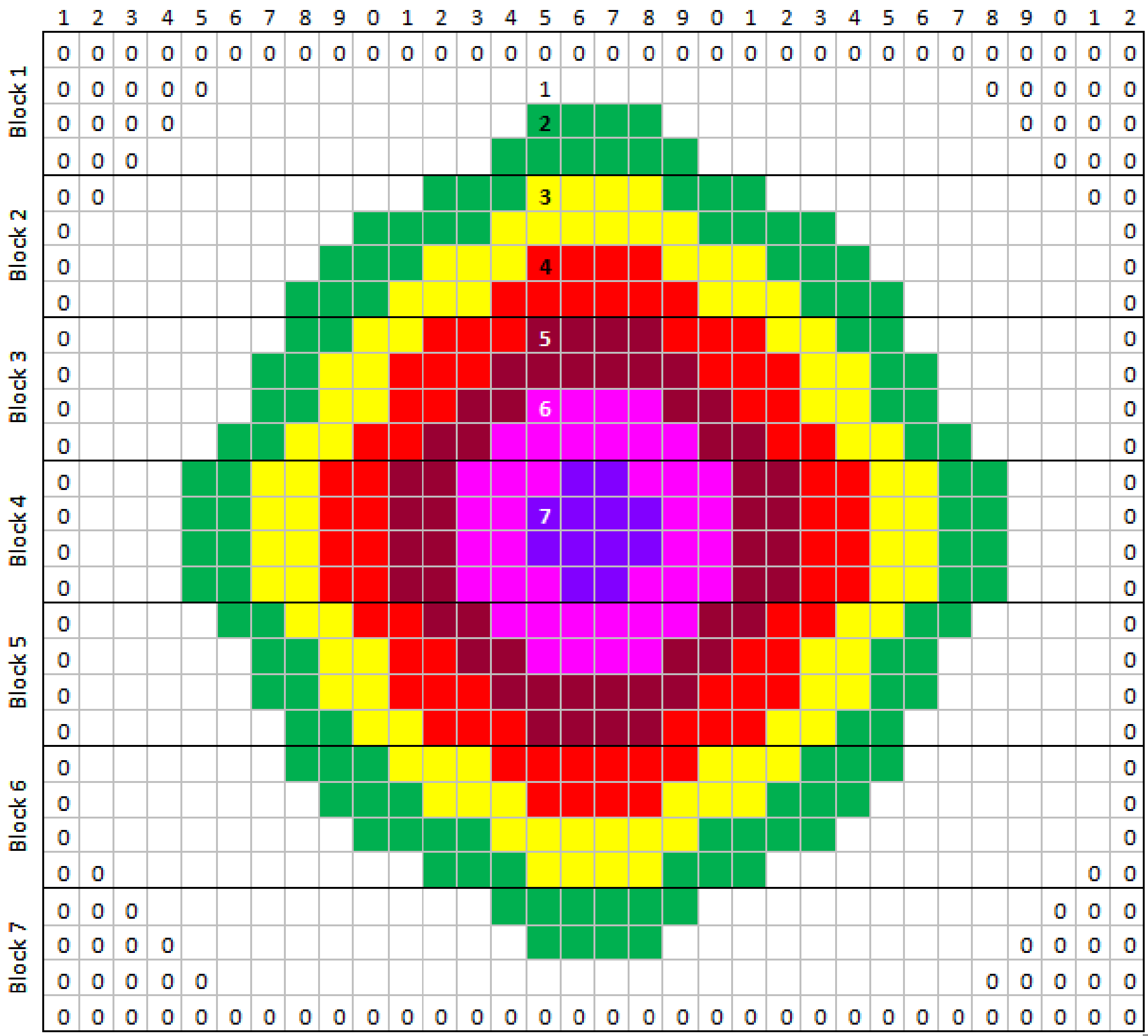

Figure D-4. Regional NEXRAD Test Pattern (without Geo-location)

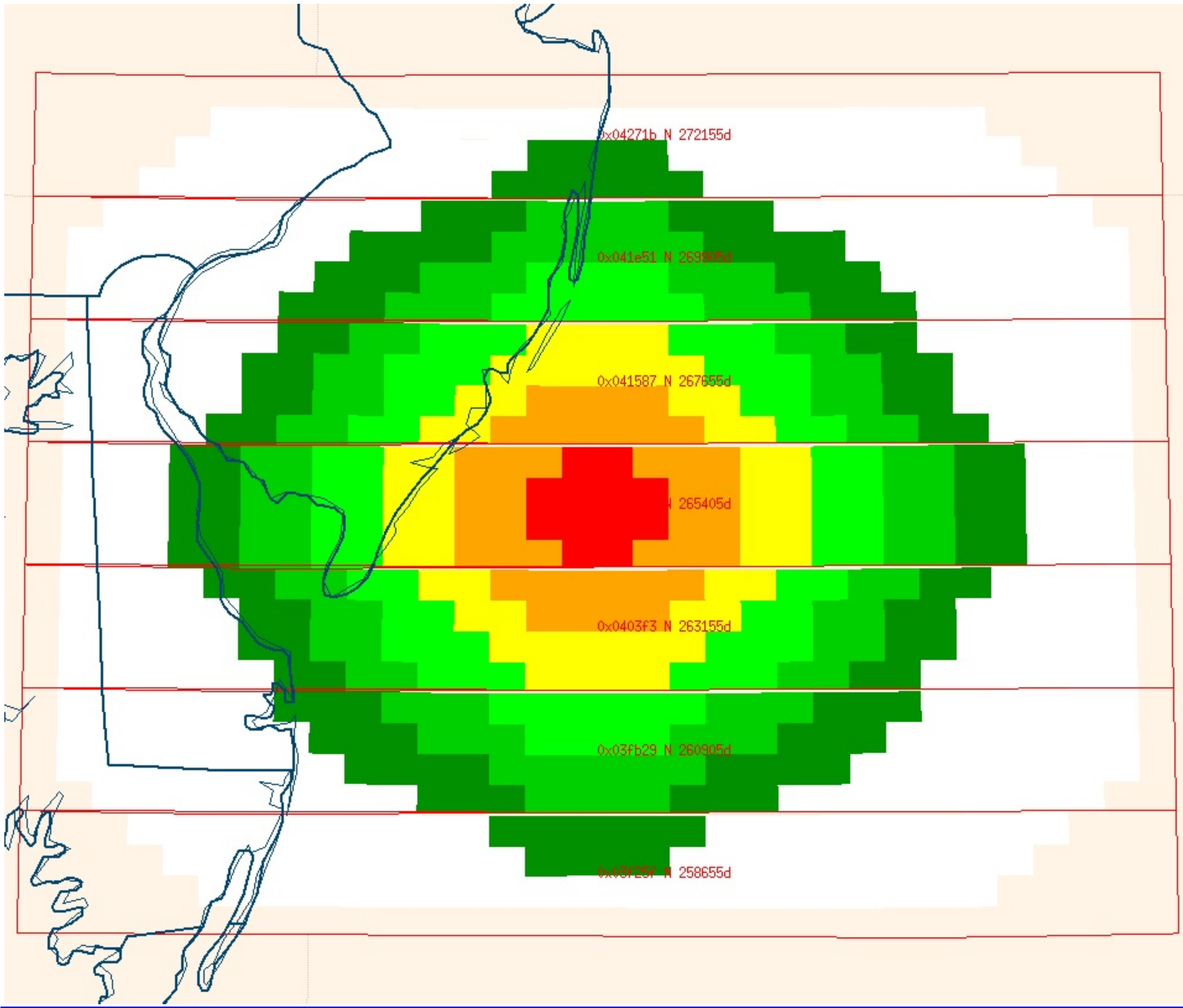

Figure D-5. Geo-location of Regional NEXRAD Test Pattern (PHL Area)

Decoded message:

```
I-Frame Header (block #1):
   -  length: 19
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 63
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hours and Minutes included)
   -  Time: Hour: 21 Minutes: 42
APDU Payload:
 Header:
   -  Element Identifier: 1 (Run Length Encoded)
```

- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x042013 (decimal 270355)
- Run Length Payload:
    - 0xF8,0x20,0xA9,0x40,0x49,0x1A,0x49,0x30,0x49,0x2A,0x49,0x10

I-Frame Header (block #2):

- length: 36
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x041E51 (decimal 269905)
- Run Length Payload:
    - 0x08,0x41,0x12,0x1B,0x12,0x41,0x10,0x39,0x1A,0x2B,0x1A,0x39,0x08,0x31,0x12,0x13,0x1C,0x13,0x12,0x31,0x08,0x29,0x12,0x13,0x2C,0x13,0x12,0x29,0x00

I-Frame Header (block #3):

- length: 52
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x041C8F (decimal 269455)
- Run Length Payload:

- 0x00,0x29,0x0A,0x0B,0x14,0x1D,0x14,0x0B,0x0A,0x29,0x08,0x21,0x0A,0x0B,0x14,0x2D,0x14,0x0B,0x0A,0x21,0x08,0x21,0x0A,0x0B,0x0C,0x0D,0x1E,0x0D,0x0C,0x0B,0x0A,0x21,0x08,0x19,0x0A,0x0B,0x0C,0x0D,0x2E,0x0D,0x0C,0x0B,0x0A,0x19,0x00

I-Frame Header (block #4):

- length: 64
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x041ACD (decimal 269005)
- Run Length Payload:
  - 0x00,0x11,0x0A,0x0B,0x0C,0x0D,0x16,0x0F,0x16,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D,0x0E,0x1F,0x0E,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D,0x0E,0x1F,0x0E,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D,0x16,0x0E,0x16,0x0D,0x0C,0x0B,0x0A,0x11,0x00

I-Frame Header (block #5):

- length: 52
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x04190B (decimal 268555)
- Run Length Payload:

- 0x00,0x19,0x0A,0x0B,0x0C,0x0D,0x2E,0x0D,0x0C,0x0B,0x0A,0x19,0x08,0x21,0x0A,0x0B,0x0C,0x0D,0x1E,0x0D,0x0C,0x0B,0x0A,0x21,0x08,0x21,0x0A,0x0B,0x14,0x2D,0x14,0x0B,0x0A,0x21,0x08,0x29,0x0A,0x0B,0x14,0x1D,0x14,0x0B,0x0A,0x29,0x00

I-Frame Header (block #6):

- length: 36
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x041749 (decimal 268105)
- Run Length Payload:
  - 0x00,0x29,0x12,0x13,0x2C,0x13,0x12,0x29,0x08,0x31,0x12,0x13,0x1C,0x13,0x12,0x31,0x08,0x39,0x1A,0x2B,0x1A,0x39,0x10,0x41,0x12,0x1B,0x12,0x41,0x08

I-Frame Header (block #7):

- length: 19
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x041587 (decimal 267655)
- Run Length Payload:
  - 0x10,0x49,0x2A,0x49,0x30,0x49,0x1A,0x49,0x40,0xA9,0xF8,0x20

D.2.3.2 Regional NEXRAD Spanning 60° North Latitude

For Regional NEXRAD, the clear air intensity value is 0. If there are any bins with no data (i.e. missing data) or no coverage within a GBR block, that entire GBR block will not be sent.

Filename: r_nexrad_ak_iframes.bin

The binary file r_nexrad_ak_iframes.bin contains seven (7) concatenated I-Frames with each I-Frame containing one (1) APDU with one (1) Global Block run-length encoded. The scaling factor field is set to 0 (for no scaling) in the Block Reference Indicator (BRI) for each Global Block in this product type. FIS-B uses Run Length Encoding of cells (or bins) within a Global Block, as well as Empty Block Encoding of Global Blocks with all (128) cells whose encoded intensity values are 0. It is noted that even though both encoded intensity values 0 and 1 are treated as "No Precipitation" in Figure D-4, only 0 value Global Blocks are Empty Block Encoded.

Note that the image provided in Figure D-4 is a representative depiction of the imagery for the accompanying binary data file.

The encoding of the seven blocks in Figure D-4 places them, as depicted in Figure D-6, roughly 60 miles south of Anchorage International Airport (ANC). The target blocks are numbered, in Figure D-6, in both hexadecimal and decimal with a north hemisphere identifier of "N" included. Only the values of block bins corresponding to zero (0) are fully represented, in Figure D-4, to reduce clutter in the image and to distinguish those bins from the bins with value one (1). The colors used in the image are only for display within this document and do not correspond to guidance found in avionics requirements or recommendation documents.

Note that for block numbers 0x063292, 0x0630D0, and 0x062F0E, the width of the displayed block will be twice as wide as the remaining four (4) blocks that reside below 60° north latitude. This is due to the change in the encoding algorithm for blocks that exist above 60°. This is an expected visual artifact.

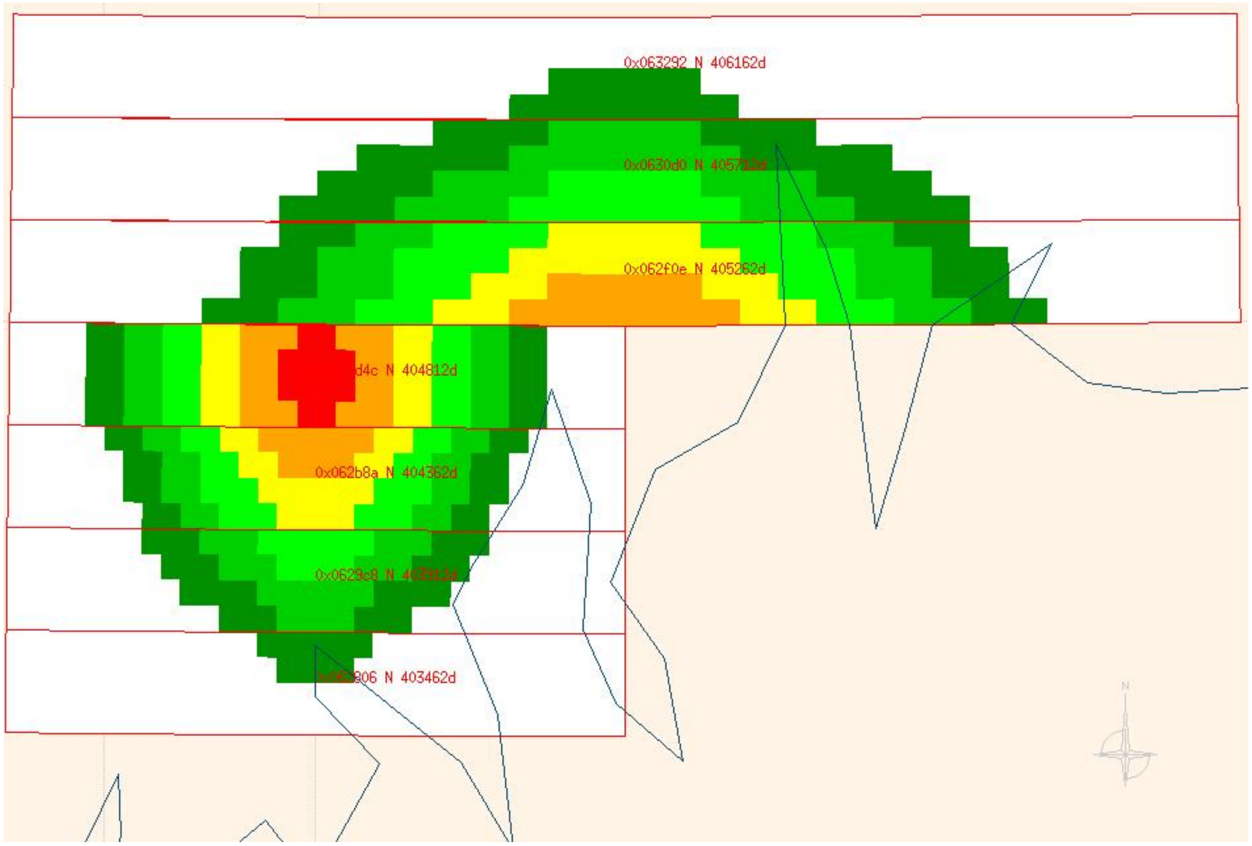

Figure D-6. Geo-location of Regional NEXRAD Test Pattern (ANC Area)

Decoded message:

```
I-Frame Header (block #1):
    -  length: 19
    -  type: 0 (APDU)
APDU Header:
    -  Product ID: 63
    -  Segmentation Flag: 0 (No segmentation required for this product)
    -  Time Option: 0 (Hours and Minutes included)
    -  Time: Hour: 21 Minutes: 42
APDU Payload:
 Header:
    -  Element Identifier: 1 (Run Length Encoded)
    -  North/South: 0 (North)
    -  Scaling: 0 (No Scaling)
    -  Block Number: 0x063292 (decimal 406162)
    -  Run Length Payload:
```

- 0xF8,0x20,0xA9,0x40,0x49,0x1A,0x49,0x30,0x49,0x2A,0x49,0x10

I-Frame Header (block #2):

- length: 36
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x0630D0 (decimal 405712)
- Run Length Payload:
    - 0x08,0x41,0x12,0x1B,0x12,0x41,0x10,0x39,0x1A,0x2B,0x1A,0x39,0x08,0x31,0x12,0x13,0x1C,0x13,0x12,0x31,0x08,0x29,0x12,0x13,0x2C,0x13,0x12,0x29,0x00

I-Frame Header (block #3):

- length: 52
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x062F0E (decimal 405262)
- Run Length Payload:
    - 0x00,0x29,0x0A,0x0B,0x14,0x1D,0x14,0x0B,0x0A,0x29,0x08,0x21,0x0A,0x0B,0x14,0x2D,0x14,0x0B,0x0A,0x21,0x08,0x21,0x0A,0x0B,0x0C,0x0D,0x1E,0x0D,0x0C,0x0B,0x0A,0x21,0x08,0x19,0x0A,0x0B,0x0C,0x0D,0x2E,0x0D,0x0C,0x0B,0x0A,0x19,0x00

I-Frame Header (block #4):

- length: 64
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x062D4C (decimal 404812)
- Run Length Payload:
    - 0x00,0x11,0x0A,0x0B,0x0C,0x0D,0x16,0x0F,0x16,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D,0x0E,0x1F,0x0E,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D,0x0E,0x1F,0x0E,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D,0x16,0x0E,0x16,0x0D,0x0C,0x0B,0x0A,0x11,0x00

I-Frame Header (block #5):

- length: 52
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x062B8A (decimal 404362)
- Run Length Payload:
    - 0x00,0x19,0x0A,0x0B,0x0C,0x0D,0x2E,0x0D,0x0C,0x0B,0x0A,0x19,0x08,0x21,0x0A,0x0B,0x0C,0x0D,0x1E,0x0D,0x0C,0x0B,0x0A,0x21,0x08,0x21,0x0A,0x0B,0x14,0x2D,0x14,0x0B,0x0A,0x21,0x08,0x29,0x0A,0x0B,0x14,0x1D,0x14,0x0B,0x0A,0x29,0x00

I-Frame Header (block #6):

- length: 36
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x0629C8 (decimal 403912)
- Run Length Payload:
    - 0x00,0x29,0x12,0x13,0x2C,0x13,0x12,0x29,0x08,0x31,0x12,0x13,0x1C,0x13,0x12,0x31,0x08,0x39,0x1A,0x2B,0x1A,0x39,0x10,0x41,0x12,0x1B,0x12,0x41,0x08

I-Frame Header (block #7):

- length: 19
- type: 0 (APDU)

APDU Header:

- Product ID: 63
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 42

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 0 (No Scaling)
- Block Number: 0x062806 (decimal 403462)
- Run Length Payload:
    - 0x10,0x49,0x2A,0x49,0x30,0x49,0x1A,0x49,0x40,0xA9,0xF8,0x20

D.2.3.3 CONUS NEXRAD

For CONUS NEXRAD, the clear air intensity value is 1. In contrast to the Regional NEXRAD product, if there are some bins with no data (i.e. missing data represented with intensity value of 0) or no coverage within a GBR block, that GBR block will still be sent unless the entirety of the block consists of intensity values of 0. In the latter case, the block will not be sent.

Filename: n_nexrad_phl_iframes.bin

The binary file n_nexrad_phl_iframes.bin contains seven (7) concatenated I-Frames as shown in Figure D-7 with each I-Frame containing one (1) APDU with one (1) Global Block run-length encoded. The scaling factor field is set to 1 (for 5x scaling) in the Block Reference Indicator (BRI) for each Global Block in this product type. FIS-B uses Run Length Encoding of cells (or bins) within a Global Block, as well as Empty Block Encoding of Global Blocks with all (128) cells whose encoded intensity values are 0. In Figure D-7, encoded intensity values of 0, or "No Data", are represented with a grey stipple pattern with intensity values of 1, or "No Precipitation", represented with solid white.

Note that the image provided in Figure D-7 is a representative depiction of the imagery for the accompanying binary data file.

The encoding of the seven blocks in Figure D-7 places them, as depicted in Figure D-8, centered roughly 80 miles southeast of Philadelphia International Airport (PHL). The colors used in the image are only for display within this document and do not correspond to guidance found in avionics requirements or recommendation documents.

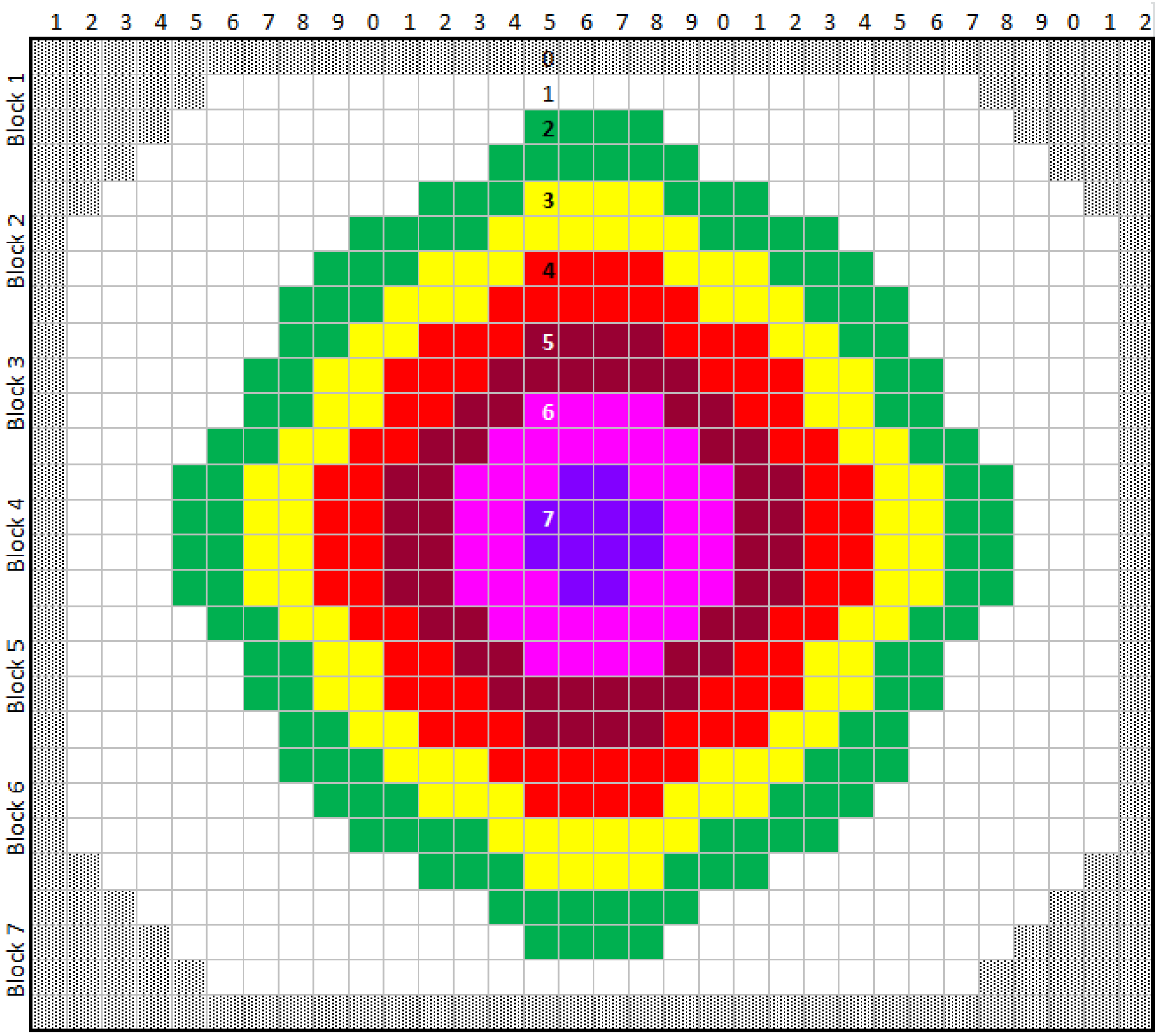

Figure D-7. CONUS NEXRAD Test Pattern (without Geo-location)

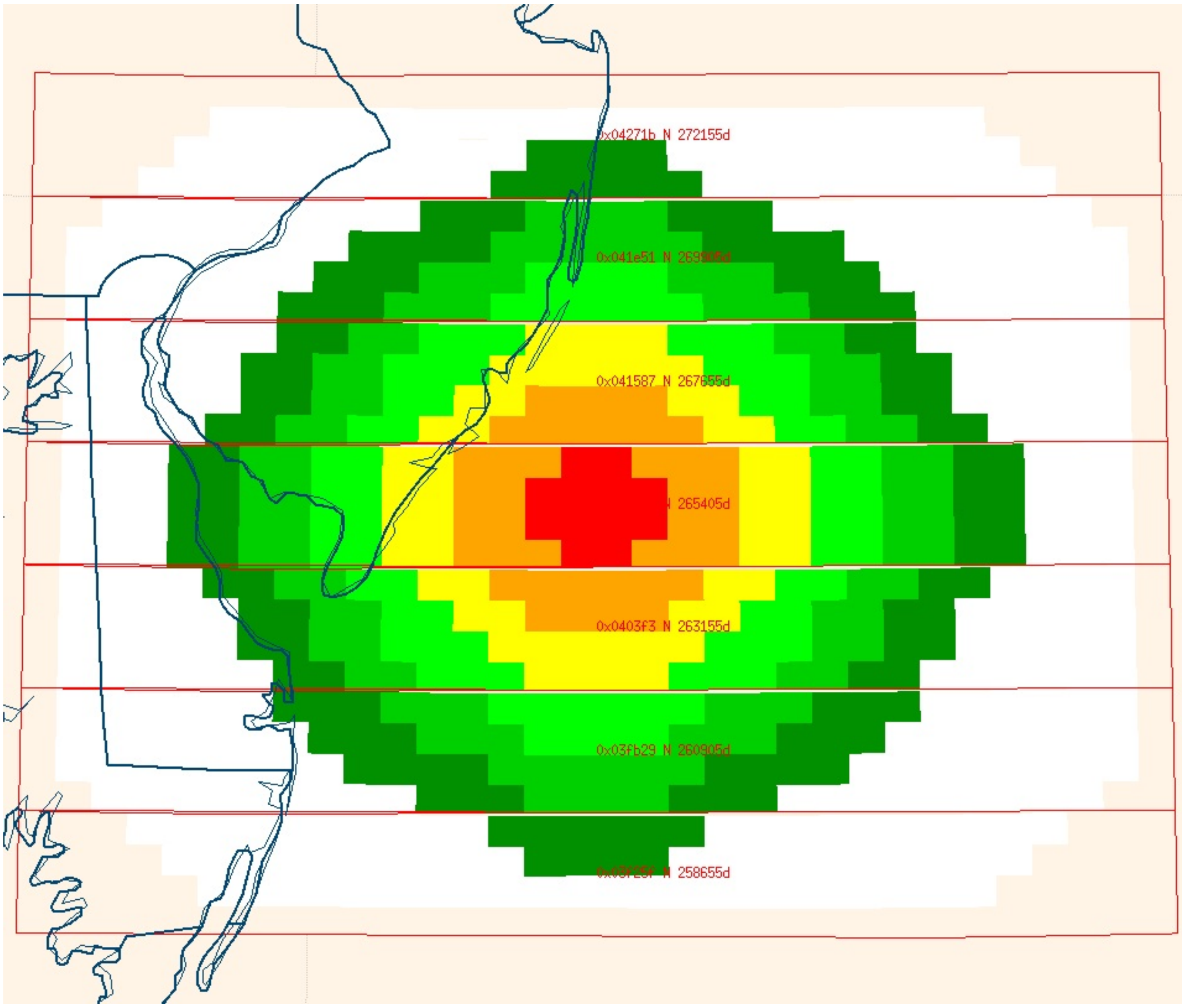

Figure D-8. Geo-location of CONUS NEXRAD Test Pattern (PHL Area)

Decoded message:

```
I-Frame Header (block #1):
   -  length: 19
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 64
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hours and Minutes included)
   -  Time: Hour: 21 Minutes: 43
APDU Payload:
 Header:
   -  Element Identifier: 1 (Run Length Encoded)
   -  North/South: 0 (North)
```

- Scaling: 1 (5x Scaling)
- Block Number: 0x04271B (decimal 272155)
- Run Length Payload:
    - 0xF8,0x20,0xA9,0x40,0x49,0x1A,0x49,0x30,0x49,0x2A,0x49,0x10

I-Frame Header (block #2):

- length: 36
- type: 0 (APDU)

APDU Header:

- Product ID: 64
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 43

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 1 (5x Scaling)
- Block Number: 0x041E51 (decimal 269905)
- Run Length Payload:
    - 0x08,0x41,0x12,0x1B,0x12,0x41,0x10,0x39,0x1A,0x2B,0x1A,0x39,0x08,0x31,0x12,0x13,0x1C,0x13,0x12,0x31,0x08,0x29,0x12,0x13,0x2C,0x13,0x12,0x29,0x00

I-Frame Header (block #3):

- length: 52
- type: 0 (APDU)

APDU Header:

- Product ID: 64
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 43

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 1 (5x Scaling)
- Block Number: 0x041587 (decimal 267655)
- Run Length Payload:

- 0x00,0x29,0x0A,0x0B,0x14,0x1D,0x14,0x0B,0x0A,0x29,0x08,0x21,0x0A,0x0B,0x14,0x2D, 0x14,0x0B,0x0A,0x21,0x08,0x21,0x0A,0x0B,0x0C,0x0D,0x1E,0x0D,0x0C,0x0B,0x0A,0x21, 0x08,0x19,0x0A,0x0B,0x0C,0x0D,0x2E,0x0D,0x0C,0x0B,0x0A,0x19,0x00

I-Frame Header (block #4):

- length: 64
- type: 0 (APDU)

APDU Header:

- Product ID: 64
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 43

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 1 (5x Scaling)
- Block Number: 0x040CBD (decimal 265405)
- Run Length Payload:
  - 0x00,0x11,0x0A,0x0B,0x0C,0x0D,0x16,0x0F,0x16,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11, 0x0A,0x0B,0x0C,0x0D,0x0E,0x1F,0x0E,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B, 0x0C,0x0D,0x0E,0x1F,0x0E,0x0D,0x0C,0x0B,0x0A,0x11,0x08,0x11,0x0A,0x0B,0x0C,0x0D, 0x16,0x0F,0x16,0x0D,0x0C,0x0B,0x0A,0x11,0x00

I-Frame Header (block #5):

- length: 52
- type: 0 (APDU)

APDU Header:

- Product ID: 64
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 43

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 1 (5x Scaling)
- Block Number: 0x0403F3 (decimal 263155)
- Run Length Payload:

  - 0x00,0x19,0x0A,0x0B,0x0C,0x0D,0x2E,0x0D,0x0C,0x0B,0x0A,0x19,0x08,0x21,0x0A,0x0B,0x0C,0x0D,0x1E,0x0D,0x0C,0x0B,0x0A,0x21,0x08,0x21,0x0A,0x0B,0x14,0x2D,0x14,0x0B,0x0A,0x21,0x08,0x29,0x0A,0x0B,0x14,0x1D,0x14,0x0B,0x0A,0x29,0x00

I-Frame Header (block #6):

- length: 36
- type: 0 (APDU)

APDU Header:

- Product ID: 64
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 43

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 1 (5x Scaling)
- Block Number: 0x03FB29 (decimal 260905)
- Run Length Payload:
  - 0x00,0x29,0x12,0x13,0x2C,0x13,0x12,0x29,0x08,0x31,0x12,0x13,0x1C,0x13,0x12,0x31,0x08,0x39,0x1A,0x2B,0x1A,0x39,0x10,0x41,0x12,0x1B,0x12,0x41,0x08

I-Frame Header (block #7):

- length: 19
- type: 0 (APDU)

APDU Header:

- Product ID: 64
- Segmentation Flag: 0 (No segmentation required for this product)
- Time Option: 0 (Hours and Minutes included)
- Time: Hour: 21 Minutes: 43

APDU Payload:
Header:

- Element Identifier: 1 (Run Length Encoded)
- North/South: 0 (North)
- Scaling: 1 (5x Scaling)
- Block Number: 0x03F25F (decimal 258655)
- Run Length Payload:
  - 0x10,0x49,0x2A,0x49,0x30,0x49,0x1A,0x49,0x40,0xA9,0xF8,0x20

D.3 Generic Text Products: Product ID 413

D.3.1 Background

To support backward compatibility with existing avionics displays, the FIS-B application formats the APDU payload for the free text products (Product ID 413) in the following syntax.

<Product Type> space <Location ID> space <Timestamp> space <Text Report>

where:
<Product Type> = METAR, SPECI, TAF, TAF.AMD, PIREP or WINDS
SPECI = Special METAR
TAF.AMD = Amended TAF

<Location ID> = 4-letter airport ID for METAR, SPECI, TAF, and TAF.AMD
or = 3-letter reporting station for Wind and Temperature Aloft
or = 3- or 4-letter reference location or “NIL=” for PIREP

<Timestamp> = UTC time in the format of ddHHMM, where:
dd = day of the month
HH = hour of the day
MM = minutes of the hour.

Note: *For TAF and TAF.AMD product, the timestamp may be missing from the data received by the SBS Ground System Provider from the FIS-B Data Source.*

D.3.2 Implementation

The following sections show how each of the free text products (METAR / SPECI, TAF / TAF AMEND, PIREP, and Winds and Temperatures Aloft) is formatted to meet the backward compatibility objective.

D.3.3 METAR / SPECI

The hours and minutes of the valid time for the METAR or SPECI report are used in the APDU header timestamp, where the time option field is set to 0 for hours and minutes only. These times along with the day of the report are inserted into the Timestamp field of the METAR or SPECI messages as shown in the examples below.

D.3.3.1 METAR Example

Filename: metar.bin

The binary file metar.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the METAR product, in the Ground Uplink Message. The correctly decoded message for this METAR product should look like the following.

Decoded message:

```
I-Frame Header:
   -  length: 52
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 413
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hour and Minutes included)
   -  Time: Hour: 19 Minutes: 35
APDU Payload:
METAR KRQO 201935Z AUTO 21011KT 10SM CLR 19/03 A2960 RMK AO2=
```

D.3.3.2 SPECI (Special METAR) Example

Filename: speci.bin

The binary file speci.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the Special METAR product, in the Ground Uplink Message. The correctly decoded message for this Special METAR should look like the following.

Decoded message:

```
I-Frame Header:
   -  length: 61
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 413
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hour and Minutes included)
   -  Time: Hour: 21 Minutes: 2
APDU Payload:
SPECI KHRI 212102Z AUTO 03003KT 1/2SM FZFG VV001 M01/M02 A2984 RMK AO2=
```

D.3.4 TAF / TAF AMEND

The hours and minutes of the issue time for the TAF or TAF Amend report are used in the APDU header timestamp, where the time option field is set to 0 for hours and minutes only. These times along with the day of the report are inserted into the Timestamp field of the TAF or TAF Amend messages as shown in the examples below.

D.3.4.1 TAF / Amended TAF Example

Filename: taf_amd.bin

The binary file taf_amd.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the Amended TAF product, in the Ground Uplink Message. The correctly decoded Amended TAF message should look like the following.

Decoded message:

```
I-Frame Header:
   - length: 179
   - type: 0 (APDU)
APDU Header:
   - Product ID: 413
   - Segmentation Flag: 0 (No segmentation required for this product)
   - Time Option: 0 (Hour and Minutes included)
   - Time: Hour: 22 Minutes: 51
APDU Payload:
TAF.AMD KBIS 062251Z 0623/0718 31007KT P6SM OVC080 TEMPO 0700/0702
 3SM -SN BLSN OVC010
 FM070200 31020G30KT 6SM -SN BLSN OVC012
 FM070400 32020G30KT P6SM OVC015
 FM071200 32015G25KT P6SM SCT005 OVC010 AMD NOT SKED
 0706/0712=
```

D.3.4.2 Truncated TAF Example

Filename: taf_truncated.bin

The binary file taf_truncated.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the TAF product, in the Ground Uplink Message. This TAF product, after DLAC encoding, is too large to fit in an APDU within a single 424-byte Application Data of a Ground Uplink Message Payload. In this case, FIS-B truncates the TAF product and inserts the marker "(INCMPL)" at the end of the incomplete text message. The truncated TAF message after being correctly decoded should look like the following.

Decoded message:

```
I-Frame Header:
   - length: 419
   - type: 0 (APDU)
APDU Header:
   - Product ID: 413
   - Segmentation Flag: 0 (No segmentation required for this product)
   - Time Option: 0 (Hour and Minutes included)
   - Time: Hour: 21 Minutes: 3
APDU Payload:
TAF KNUW 2121/2221 14010KT 9999 FEW040 SCT080 BKN140 OVC200 640309
 641202 540009 540906 QNH2960INS
 TEMPO 2121/2202 16018G25KT
 BECMG 2200/2202 15018G28KT 9999 SCT040 BKN080 OVC150
```

```
640309 641202 540009 540906 QNH2956INS
BECMG 2206/2208 14018G28KT 9999 SCT035 BKN050 BKN080
OVC100 640309 641202 540009 540906 QNH2952INS
BECMG 2209/2211 15020G30KT 9999 VCSH SCT020 BKN030 OVC080
640309 641202 540009 540906 QNH2948INS
TEMPO 2210/2216 17015G20KT 8000
SHRA BKN015 OVC030
BECMG 2216/2218 17012KT 9999 VCSH BKN020 OVC040 640309
(INCMPL)
```

D.3.4.3 TAF / TAF AMEND with Missing Timestamp Field

Occasionally the Timestamp field is missing in the TAF or TAF Amend message from the data received by the SBSS from the FIS-B Data Source. However, the issue time is resolved by the FIS-B Data Source using the hours and minutes of the issue time in the APDU header timestamp for these messages.

D.3.5 PIREP

The hours and minutes of the valid time for the PIREP report are used in the APDU header timestamp, where the time option field is set to 0 for hours and minutes only. These times along with the day of the report are inserted into the Timestamp field of the PIREP messages as shown in the examples below.

The Location ID field in a PIREP product is the reference location, if there is one provided, in the /OV field of the report. If only the latitude and longitude are provided in the /OV field, FIS-B will insert a marker “NIL=” into the Location ID field in the PIREP message.

D.3.5.1 PIREP with Reference Station Example

Filename: pirep.bin

The binary file pirep.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the PIREP product, in the Ground Uplink Message. The decoded message of this PIREP should look like the following.

Decoded message:

```
I-Frame Header:
   -  length: 94
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 413
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hour and Minutes included)
   -  Time: Hour: 19 Minutes: 11
APUU Payload:
PIREP AIR 201911Z HLG UA /OV AIR/TM 1911/FL270/TP MD88/SK CLEAR/TA M42/WV
316119KT/TB LGT CHOP/IC NONE/RM AWC-WEB:DAL
```

D.3.5.2 PIREP with marker "NIL=" Example

Filename: pirep_nil.bin

The binary file pirep_nil.bin contains the 424-byte Application Data Block, which consists of the I-Frame and APDU with the PIREP product, in the Ground Uplink Message. This PIREP product does not contain a reference reporting station in the /OV field in the report. Instead it provides the approximated location in terms of latitude and longitude. In this case, FIS-B uses the marker “NIL=” as the reference station field in the message header. The decoded message of this PIREP should look like the following.

Decoded message:

```
I-Frame Header:
   -  length: 77
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 413
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hour and Minutes included)
   -  APDU Header Time: Hour: 22 Minutes: 7
APDU Payload:
PIREP NIL= 202207Z SNS UA /OV 3632N 11858W/TM 2207/FL250/TP MD83/TA M25/IC
LGT RIME/RM ZOA CWSU
```

D.3.6 Winds and Temperatures Aloft

The hours and minutes of the issue time for the wind and temperature aloft report are used in the timestamp field in the APDU header, where the time option field is set to 0 for hours and minutes only. However the valid time (including the day of the report) is inserted into the Timestamp field of the wind and temperature aloft messages as shown in the examples below.

Spaces are used as delimiters between altitude labels in the heading and the data that follow. As the following examples (one for Contiguous US and one for Hawaii) show, the spaces between altitude labels are not even, and the data does not align with the beginning of the altitude heading. These special arrangements are made to properly fit the altitude heading and data on existing some displays, such as the MX20 and GMX200.

D.3.6.1 Example of Wind and Temperature Aloft Message for the Contiguous US Region Report

Filename: winds_aloft_us.bin

The binary file winds_aloft_us.bin contains the 424-byte Application Data Block, which consists of the I-Frame and APDU with the Winds and Temperatures Aloft product, in the Ground Uplink Message. This file contains binary data for the Winds and Temperatures Aloft product for area in the continental US. The correctly decoded message should look like the following.

Decoded message:

```
I-Frame Header:
```

```
    -  length: 118
    -  type: 0 (APDU)
APDU Header:
    -  Product ID: 413
    -  Segmentation Flag: 0 (No segmentation required for this product)
    -  Time Option: 0 (Hour and Minutes included)
    -  Header Time: Hour: 13 Minutes: 57
APDU Payload:
WINDS JAN 291800Z FT 3000 6000 9000 12000 18000 24000 30000 34000 39000
 2026 2030+06 2329+00 2338-04 2546-17 2561-30 257546 740851 750657
```

D.3.6.2 Example of Wind and Temperature Aloft Message for the Hawaii Region Report

Filename: winds_aloft_hi.bin

The binary file winds_aloft_hi.bin contains the 424-byte Application Data, which consists of the I-Frame and APDU with the Winds and Temperatures Aloft product, in the Ground Uplink Message. This file contains binary data for the Winds and Temperatures Aloft product for the area in Hawaii. The correctly decoded message should look like the following.

Decoded message:

```
I-Frame Header:
    -  length: 121
    -  type: 0 (APDU)
APDU Header:
    -  Product ID: 413
    -  Segmentation Flag: 0 (No segmentation required for this product)
    -  Time Option: 0 Hour and Minutes included.
    -  Time: Hour: 13 Minutes: 57
APDU Payload:
WINDS HNL 301200Z FT 1000 1500 2000 3000 6000 9000 12000 15000 18000 24000
 0512 0511 0410 0307 0413+12 0508+09 9900+04 1506-01 1715-09 1623-19
```

D.3.6.3 Example of Winds and Temperatures Aloft with Missing Altitude

In some cases, the wind and temperature aloft data for a particular altitude is missing from a reporting station. In this situation, the altitude label that is corresponding to that data is also missing in the heading.

Filename: winds_aloft_us_unavail_data.bin

This file contains binary data for the Winds and Temperatures Aloft product with the forecasted data for 3,000 and 6,000 feet unavailable. The correctly decoded message should look like the following.

Decoded message –

```
I-Frame Header:
   -  length: 100
   -  type: 0 (APDU)
APDU Header:
   -  Product ID: 413
   -  Segmentation Flag: 0 (No segmentation required for this product)
   -  Time Option: 0 (Hour and Minutes included)
   -  Time: Hour: 13 Minutes: 57
APDU Payload:
WINDS PRC 291800Z FT 9000 12000 18000 24000 30000 34000 39000
 2340-04 2548-06 2564-15 2567-26 245441 257852 258660
```

D.4 Binary Products: TIS-B/ADS-R Service Status

The status of the TIS-B/ADS-R Service is provided to UAT users via a FIS-B product.

Filename: tisb_ss.bin

The binary file tisb_ss.bin contains the 424-byte Application Data, which consists of the I-Frame with the TIS-B/ADS-R Service Status, in the Ground Uplink Message. The correctly decoded message should look like the following.

Decoded message:

```
I-Frame Header:
length: 12
type: 15 (TIS-B Service Status)
List of Target Addresses:
Target[1]
 Sig Type: 1
 Address Qualifier: 0
 Address: FAA112 (hex)
Target[2]
 Sig Type: 1
 Address Qualifier: 0
 Address: FAA113 (hex)
Target[3]
 Sig Type: 1
 Address Qualifier: 0
 Address: FAA114 (hex)
```

Appendix E. Listing of Service Volumes (SV)[16]

E.1 En Route SVs

The set of En Route SV boundaries can be seen in Figure E-1. The only significance of these boundaries to the airborne user of SBSS is that within CONUS these boundaries represent the domains of each multisensor tracker system used for TIS-B. This causes a TIS-B track transiting a boundary to experience a change in its 24-bit address. All En Route SVs in AK are served by a single multisensor tracker system so there are no TIS-B address transitions across these SV boundaries.

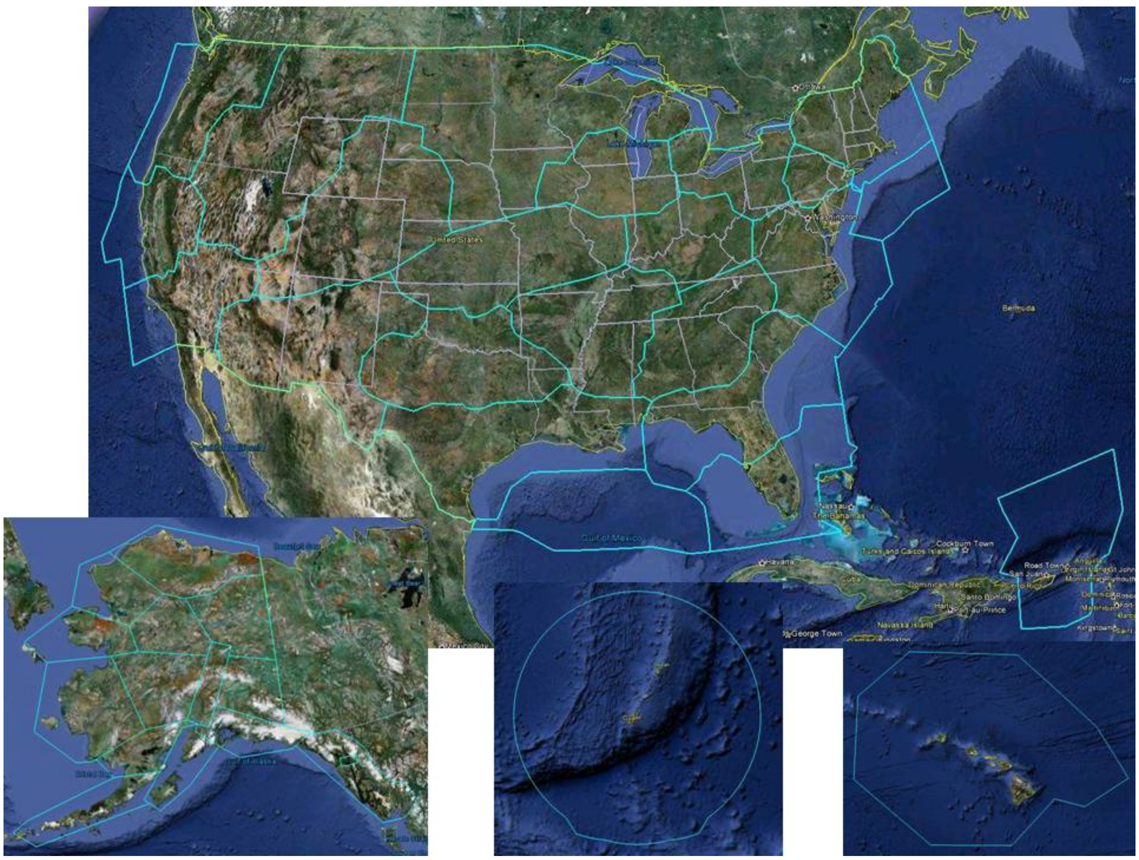

Figure E-1. En Route Service Volume Boundaries

E.2 Terminal SVs

All airports supported by Terminal SVs are listed below. The major significance of a Terminal SV to the airborne user is that in most cases TIS-B can be expected with an update interval of at most 5 seconds because these SVs are served by Terminal radars which scan at an approximate 4.8 second rate.

[16] This appendix lists all Service Volumes planned for implementation under Segments 1 and 2 of the SBS Program. All SVs listed in this appendix are planned for implementation by late 2013

Table E-1. List of Airports Supported by Terminal SVs

ABE	BDL	CID	DTW	FWA	ICT	LIT	MLU	ORF	ROA	SLC	YUM
ABI	BFL	CKB	DYS	GCK	ILM	LNK	MOB	PBI	ROC	SMX	
ABQ	BGM	CLE	ELM	GEG	ILN	LYH	MRY	PDX	ROW	SNA	
ACK	BGR	CLT	ELP	GFK	IND	MAF	MSN	PHL	RST	SPI	
ACT	BHM	CMH	ERI	GGG	ISP	MBS	MSO	PIA	RSW	SRQ	
ACY	BIL	CMI	EUG	GJT	ITO	MCC	MSP	PIT	SAT	STL	
ADW	BIS	COF	EVV	GNV	IWA	MCE	MTC	PNS	SAV	STT	
AGS	BNA	COS	EWR	GPT	JAN	MCI	MWH	POB	SAW	SUX	
ALB	BOI	COU	FAI	GRB	JAX	MCN	MXF	PSC	SBA	SWF	
ALO	BPT	CPR	FAR	GRR	JFK	MDT	MYR	PSP	SBN	SYR	
AMA	BTR	CRP	FAT	GSO	LAN	MDW	NFG	PUB	SCK	TIK	
ANC	BTV	CRW	FAY	GSP	LAS	MEM	NHK	PVD	SDF	TLH	
APN	BUF	CSG	FHU	GTF	LBB	MER	NPA	PVU	SEA	TOL	
ASE	BUR	CYS	FLL	HRL	LBF	MFD	NSE	PWM	SFB	TRI	
AUS	BWI	DAB	FLO	HSV	LCH	MFR	OAK	RDG	SGF	TUL	
AVL	CAE	DAY	FMH	HTS	LEX	MHT	OFF	RDU	SHV	TUS	
AVP	CAK	DCA	FNT	HUB	LFI	MIB	OGG	RFD	SJC	TYS	
AZO	CHA	DFW	FSD	HUF	LFT	MKE	OKC	RIC	SJT	XNA	
BAB	CHO	DLH	FSI	IAD	LGA	MKG	OMA	RME	SJU	YKM	
BAD	CHS	DSM	FSM	IAH	LIH	MLI	ONT	RNO	SKA	YNG	

E.3 Surface SVs

All airports supported by surface SVs are listed below. The main significance of a surface SV to the airborne user is that within surface SVs TIS-B will be available for aircraft on the surface.

Table E-2. List of Airports Supported by Surface SVs

ATL	HOU	MSP	PIT
BDL	IAD	ORD	CLE
BOS	IAH	PHL	CVG
BWI	JFK	PHX	MCI
CLT	LAS	PVD	MSY
DCA	LAX	SAN	ANC
DEN	LGA	SDF	SFO
DFW	MCO	SEA	PDX
DTW	MDW	SLC	
EWR	MEM	SNA	
FLL	MIA	STL	
HNL	MKE	ADW	

Appendix F. Ground Radio Station Media Access

This appendix describes the media access approach used by the SBSS Radio stations for uplink of FIS-B data.

SBSS Radio Stations transmit FIS-B information using the 32 time slots established for Ground Uplink Messages. Table F-1 shows the span of each of the 32 time slots in terms of Message Start Opportunities (MSO). Both the UAT Ground Uplink Message and the MSO is described in RTCA DO-282B.

Table F-1. Transmission Time Slot Definition for the UAT Ground Segment

Slot ID #	Transmission Time Slot Span		Slot ID #	Transmission Time Slot Span	
	Starting MSO	Ending MSO		Starting MSO	Ending MSO
1	0	22	17	352	374
2	22	44	18	374	396
3	44	66	19	396	418
4	66	88	20	418	440
5	88	110	21	440	462
6	110	132	22	462	484
7	132	154	23	484	506
8	154	176	24	506	528
9	176	198	25	528	550
10	198	220	26	550	572
11	220	242	27	572	594
12	242	264	28	594	616
13	264	286	29	616	638
14	286	308	30	638	660
15	308	330	31	660	682
16	330	352	32	682	704

Note: *MSOs represent discrete points in time within the UTC second.*

Transmission Time Slot resources assignable to the RSs are made on a continually shifting basis. This assignable resource is referred to as a "Data Channel[17]" to distinguish it from a Transmission Time Slot. Each RS will be assigned 1, 2, 3, or 4 fixed Data Channels for uplink of FIS-B depending on the class (tier) of RS.

[17] The Data Channel Number (1-32) is a fixed number for a particular radio station where the time slot number changes each second.

The Transmission Time Slot used for a given data channel increments by 1 Time Slot per second according to the following rule:

Transmission Time Slot = 1+ (Data Channel number +UTC second -1) mod 32

The Data Channel number and Transmission Time Slot number are equal at midnight UTC time and every 32 seconds thereafter (Figure F-2).

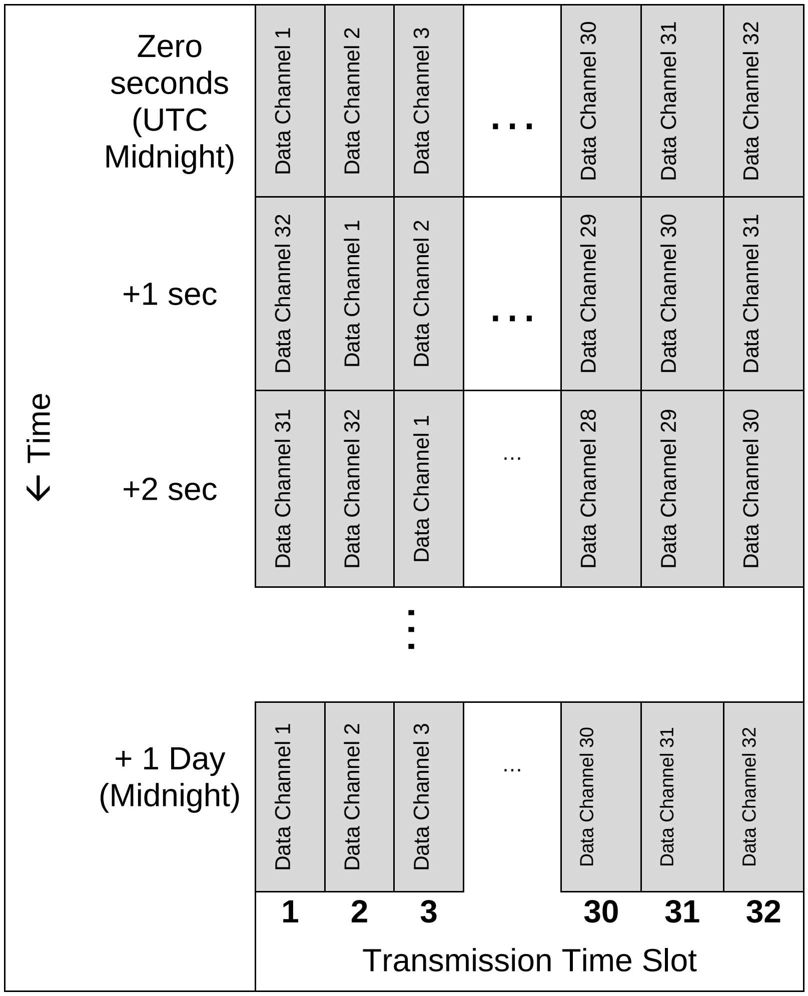

Figure F-1. Relationship of "Data Channel Numbers" to Transmission Time Slot Numbers

Notes:

1. *The reason for the Transmission Time Slot rotation is to make aircraft reception of Ground Uplink Messages robust in the presence of time synchronized sources of interference in the band.*

2. *With the addition of a leap second, the RS does not shift slots from the previous second. With the subtraction of a leap second, a shift of slots is omitted.*

Ground Uplink Message transmissions begin at the start of the Transmission Time Slot determined by the next available assigned Data Channel.

Note: The duration of a Ground Uplink Message is approximately 1.5 milliseconds less than the Transmission Time Slot duration. This additional time provides a propagation guard time when adjacent Data Channels (Transmission Time Slots) are assigned to transmission sites with common line of sight to the same aircraft.

The RS will transmit a Ground Uplink Message every second for each specified Data Channel.

Note: Regardless of the availability of application data, the Ground Uplink Message contains location and timing data useful to the aircraft/vehicle.