MP080036

MITRE PRODUCT

MITRE

Aerodrome and Airspace FIS-B Product Definitions

Version 4.0

Robert C. Strain
Daniel V. Stapleton, Jr.

May 2009

CAASD

MP080036

MITRE PRODUCT

Aerodrome and Airspace FIS-B Product Definitions

Version 4.0

Robert C. Strain
Daniel V. Stapleton, Jr.

May 2009

Sponsor: The Federal Aviation Administration
Dept. No.: F044
Project No.: 0209FN13-31
Outcome No.:13
PBWP Reference: 13-3.B, Supplemental-2 Aerodrome and Airspace Product Description

Acknowledgements

The authors would like to express our appreciation for the contributions made by Brooke Lang at Trios Associates. Brooke's implementation of this Product Description (PD) in the Flight Information Service – Broadcast mode (FIS-B) Server for the Federal Aviation Administration (FAA) tests in Memphis in May 2002 was instrumental in refining the contents of this document. Additional significant improvements were made to this PD as a result of the implementation of the Graphical Temporary Flight Restriction (TFR) by Kevin Tsou, a Software Engineer at The MITRE Corporation.

The authors would like to recognize Robert Grapple at Lincoln Laboratory and Kevin Tsou and Alan Leung at The MITRE Corporation's Center for Advanced Aviation System Development (MITRE/CAASD) for their thorough reviews and insightful comments on the document. The quality of the PD is due in large part to their contributions.

Our thanks to Kin Chan, Gilbert Smoak, Tom Barber, Paul Freeman and Stephen Giguere, who worked to implement this PD for ITT Corporation and the FAA as part of the Surveillance and Broadcast Services (SBS) Program and assisted with identifying resolving previously undiscovered issues with the Graphical Overlay record format. Through their efforts, a more robust PD exists.

Thank you to Doug Havens for accomplishing the tedious and painstaking job of updating and verifying all of the examples in the appendices.

Table of Contents

List of Figures

List of Tables

1 Introduction

The flow of air traffic into and out of an airport is considered a significant bottleneck of the air transportation system. The airport is also one of the more hazardous operating domains, as suggested by the growth in runway incidents in the 1990's. Subsequently, there has been considerable attention from the National Transportation Safety Board (NTSB), the Federal Aviation Administration (FAA) and the aviation community over the last few years on improving airport surface safety while increasing the traffic throughput. The use of broadcasts services, such as Automatic Dependent Surveillance – Broadcast mode (ADS-B) and Traffic Information Service – Broadcast mode (TIS-B), plays prominently in the research addressing these concerns.

Flight Information Service – Broadcast mode (FIS-B) may also provide safety data services that complement the pilot's traffic situation awareness. FIS-B encompasses non-control aeronautical information of general use to pilots and addresses potential flight hazards other than traffic. Weather data, Notices to Airmen (NOTAMs) and the status of Special Use Airspace (SUA) are examples of FIS-B products.

This paper is a revision to this product definition and presents a new data link message formatting framework to accommodate products, such as NOTAMs and Service Status, Digital Automated Terminal Information Service (D-ATIS) and Terminal Weather Information for Pilots (TWIP) [8], Airmen's Meteorological Conditions (AIRMET), Significant Meteorological Conditions (SIGMET), convective SIGMET, and status of SUA. The format supports either text data alone or a combination of text data and a graphical overlay representation of the text data.

An operational goal is to enhance flight crew situational awareness in flight, during final approach and airport surface operations. The flight crew needs the following information to fully accomplish this goal:

- Airport/airspace map with ownship position
- Traffic information
- Airport/airspace operations information
  - Airport/airspace operational configuration
  - Airport/airspace systems status
  - Known hazards to aircraft operations
  - Known constraints to aircraft movement
- Environment information
  - Atmospheric observations
  - Precipitation
  - Severe weather indicators

FIS-B is a mechanism for delivering the airport and airspace operations and environment information to flight crews. Today, pilots must retrieve the information, which is disseminated by voice or audible means from a number of sources including: Flight Service Stations, aircraft systems, Automated Terminal Information Service (ATIS), Automated Weather Observations System (AWOS) or air traffic controllers. In its current form, this information is not always readily accessible to pilots, it can take considerable time to obtain and/or review, and it is often presented in a form that is difficult to assimilate with other information.

Recently, aviators in the United States have found a considerable number of restrictions placed on airspace around prominent landmarks and facilities. There have been numerous situations when changes to temporary flight restriction (TFR) NOTAMs have caught pilots off guard and the pilot subsequently transgressed an airspace unintentionally. The airspace around Camp David in Thurmont, MD is a good example of an airspace that changes regularly with little notice. FIS-B offers a mechanism to greatly simplify the delivery of TFR NOTAMs and do so in a manner compatible with available navigation display capabilities.

FIS-B provides an opportunity to package, deliver and present near real-time data about airport and airspace conditions to pilots. A challenge remains as to how to do so in a manner that is compatible with tasks being performed in the cockpit. For example, information that is deemed important for the safe operation on the airport surface may be graphically overlaid on an airport map display. A separate but related display window might provide descriptive text. The goal is to provide the information to the crew in a manner consistent with surface navigation tasks and complete the picture the crew needs to assess all of the hazards and constraints that may affect their operation.

1.1 FIS-B Products

The following FIS-B products are supported by the formats described in this document:

- NOTAMs and Service Status text/graphical overlay data
- D-ATIS text and graphical overlay data
- TWIP text data
- AIRMET text/graphical overlay data
- SIGMET and Convective SIGMET text/graphical overlay data
- Status of SUA text data

1.2 Purpose

The information in this document will be used by developers of the FIS-B Server ground system in taking data from various sources and formatting it into application-level FIS-B products for uplink broadcast. Avionics developers will apply this information to decode uplink data from the FIS-B Server.

1.3 Document Scope

This document defines a communication format to support aerodrome and airspace FIS-B products that can be represented as text as well as graphical overlays on a moving map display. The format is general to accommodate service provider design flexibility and so implementation alternatives are available. In the case of textual data provided, the service provider has the latitude to define the character formatting within the text data field. The graphical overlay has numerous optional fields and parameters at the designer's disposal if they choose to use them. The apparent verboseness of options and parameters is necessary to accommodate legacy FAA and National Weather Service systems and product definitions.

The formats defined in this document are application level formats and are, therefore, independent of communication technology used to deliver the products. These products and formats developed under the auspices of RTCA Special Committee 195 (SC-195), Minimum Aviation System Performance Standards (MASPS) for FIS-B Data Link [4] and the FAA's Safe Flight 21 and SBS Programs.

This document only addresses the formatting of products for communication and does not attempt to address the presentation of these products to flight crews. Significant operational evaluation and human factors analysis is required.

1.4 Principle for Providing Text/Overlay Products

The following principles have been derived to guide the definition of the products in this document.

- A product is composed of descriptive data disseminated as reports in the Application Protocol Data Unit (APDU) payload
- Each product report is delivered in one or more APDUs (i.e., segmentation of APDUs is possible)
- Each APDU may contain multiple reports, but they must be for the same product and use the same report format
- Each product that has a text form may also be provided in graphical overlay form
- A graphical overlay report will always reference the corresponding text report
- Not all reports can be represented in an overlay form

2 Requirements

2.1 Information Hierarchy

There are several levels of information associated with an FIS-B product and specific terms used to reference the elements that make up a product. Figure 2-1 provides a hierarchy of the information and a relationship between the terms used in this document. A product, such as an Airspace NOTAM, is made up of reports. A report is then composed of one or more records represented in either text or graphical overlay form. Finally, records are made up of fields, which are the most basic data elements and express the meaning of the report.

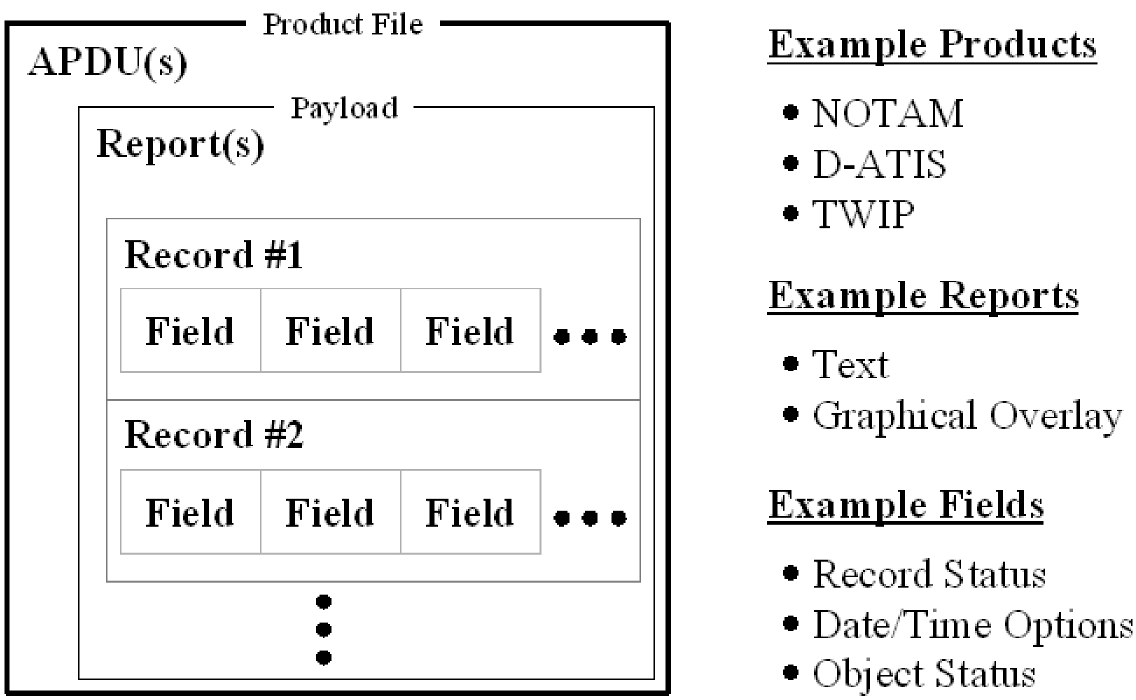

Figure 2-1. Information Hierarchy

2.2 General Requirements

The FIS-B MASPS [4] are the guiding document for requirements. However, since the standard does not address the products defined in this document, additional requirements are needed. Furthermore, any exceptions to the MASPS will be noted in this document as such. These products and the corresponding requirements have been incorporated into revision A of the MASPS.

The following are new requirements that are unique to the products defined in this Product Description:

a. Each product report **shall** contain a unique Product Version.

   Note: The Product Version allows for the evolution of each product by indicating to the avionics the version of the product definition used. The version is reported on a product-by-product basis.

b. Each text and overlay record **shall** reference the corresponding report from which the record or records are derived.

c. Each product report **shall** have, as a minimum, a text record.

d. Each overlay record **shall** be associated with a text record from which the overlay data is derived.

e. Each overlay record **shall** derive its status from the associated text record.

   Note: Since each overlay record is associated with a text record, the status of the records is also the same.

3 Application Protocol Data Unit

In accordance with the FIS-B MASPS, a report is contained in one or more APDUs. The APDU is defined in the FIS-B Data Link MASPS as the "smallest incremental units of data conveyed to the airborne FIS-B Application Layer." The APDU consists of a Header and a Payload. The Header for all Aerodrome FIS-B Products is the same with the exception of the Product Identifier field. There is a unique Product Identifier for each product (e.g., Airport NOTAM, TWIP, and D-ATIS). The header used for these products contains the minimum allowable content with no optional fields necessary. The APDU and the text and overlay record elements are described below.

3.1 APDU Header

The APDU header defined in the FIS-B Data Link MASPS is used. The header used for the products defined in this document contains the minimum allowable content with no optional fields included. Table 3-1 provides the value of each field of the header.

The APDU Identifier is used to uniquely identify FIS-B broadcast messages in accordance with the recommendations of ISO/IEC TR 9577. There are no Product Descriptor flags set. The FAA will assign the Product Identifier for each product. Segmentation of long reports across multiple APDUs is supported and indicated by setting the Segmentation Flag. The APDU Header time, which establishes the time the APDU was created for the products in this document, will only use the Hours and Minutes fields. The Segmentation Data Block is supported, but only applies when the Segmentation Flag is set.

Table 3-1. APDU Header Fields

Field	Value	Comment
APDU Identifier	0xFFFE	Defines FIS-B broadcast messages
Product Descriptor		Only Geographic Locator Option Included
Application Methods Flag	0	
Geographic Locator Flag	0 (1)	Geographic Locator supported. Default is 0
Provider-Specific Flag	0	
Product Identifier	8-13	8 = NOTAM and Service Status (graphical/text) 9 = D-ATIS (graphical/text) 10 = TWIP (graphical/text) 11 = AIRMET (graphical/text) 12 = SIGMET/Conv-SIGMET (graphical/text) 13 = SUA Status
Geographic Locator	X	Only used on Geographic Locator Flag is set
Segmentation Flag	0 (1)	Segmentation supported
APDU Header Time		
Time Option Bits	00	No month, day or seconds used
UTC Time Hours	XX	
Time Minutes	XX	
Segmentation Data Block		Only used if Segmentation Flag set NOTE: Deviates from DO-267A
Product File Identifier	NA (X)	Number to associate segmented APDUs with the appropriate Product File
Product File Length	NA (X)	Total size of the report before segmentation.
APDU Number	NA (X)	Sequential number for each APDU comprising the report.
Zero Padding Bits		As needed for byte alignment

The total length of the ADPU Header will either be six bytes, without segmentation, or nine bytes with segmentation. Figure 3-1 illustrates the APDU Header for Aerodrome and Airspace FIS-B Products without segmentation.

Product files that are too large for transmission in a single APDU are segmented into multiple APDUs. In this event, the Segmentation Flag is set and the Product File segments are individually numbered and sequenced. Figure 3-2 represents the APDU header if report segmentation is necessary. The format of the segmentation portion of the header deviates from the FIS-B MASPS (DO-267A) in that the MASPS version does not allow for multiple segments of a Product File to be reconstructed by the receiving application when transmitted from multiple ground stations. This capability requires a unique ID for each Product File segment.

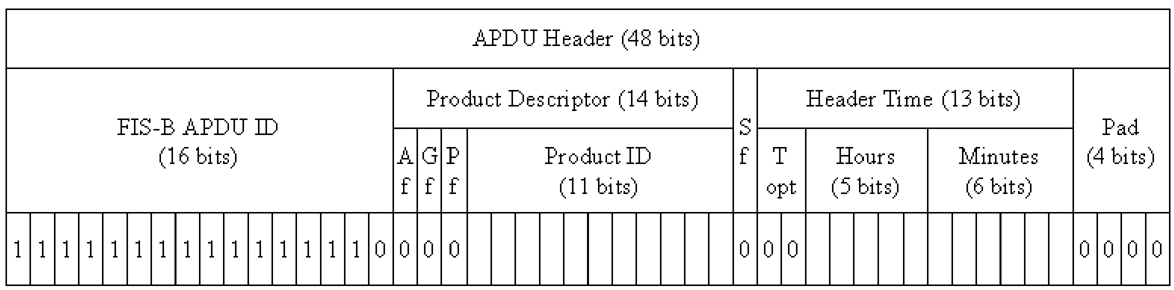

Figure 3-1. APDU Header for Aerodrome and Airspace FIS-B Products (No Message Segmentation)

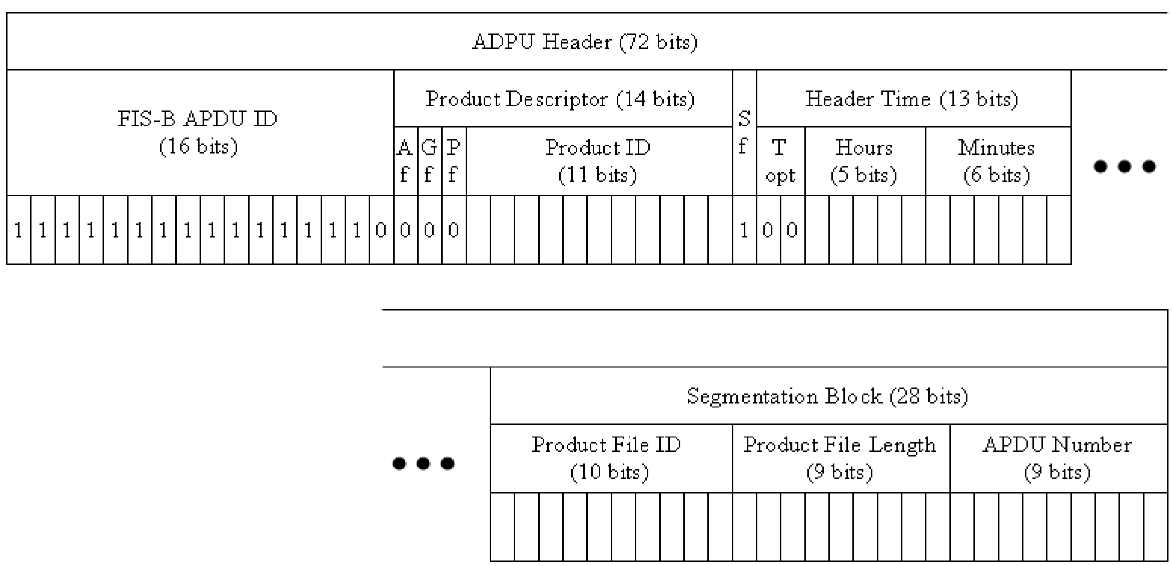

Figure 3-2. APDU Header for Aerodrome and Airspace FIS-B Products (Message Segmentation)

4 Aerodrome and Airspace FIS-B Payload

The APDU payload for Aerodrome FIS-B Products supports textual and graphical overlay representations within the same payload construct. There is a Payload Header that provides record-specific information.

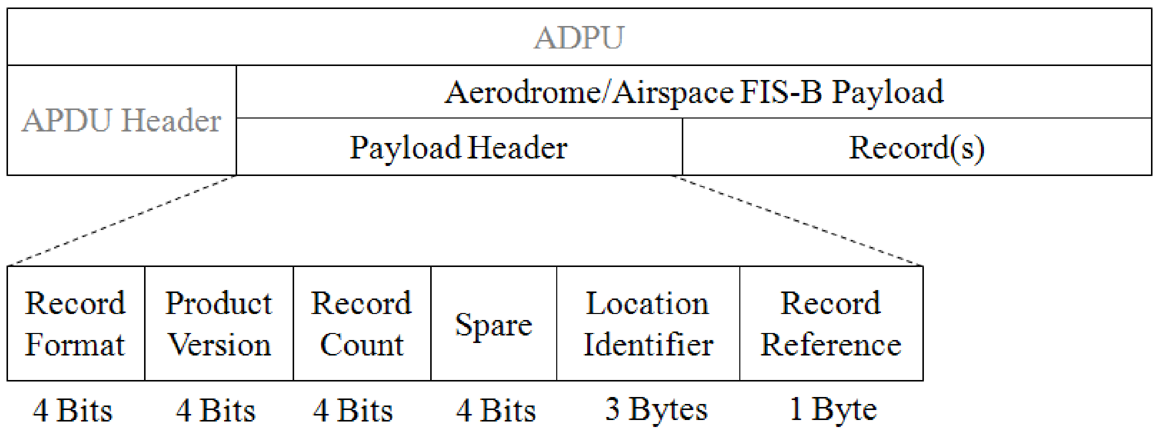

Figure 4-1. Aerodrome and Airspace FIS-B Payload

4.1 Payload Header

The Payload Header is composed of Record Format, Product Version and Record Count fields. There is also additional space reserved for future use. The Payload Header information appears once in an APDU and always is at the beginning of the Payload field. In the case of segmentation, the Payload Header appears in each segmented APDU. The Payload header stipulates the format and number of the records to follow and the version of the format being used.

4.1.1 Record Format

The Record Format field described in Table 4-1 indicates what type of product report is contained in the Payload. There are two basic types of product reports, textual and graphical overlay. This is the only place in the format that the report type is identified.

The Record Format field allows text reports that are organized in various forms to support existing report formats used in the NAS today, but also to support the transition to International Civil Aviation Organization (ICAO) standardized formats. Currently, there are several known encoding schemes for text reports. These include the highly structured Abstract Syntax Notation, version 1 (ASN.1)/Packed Encoding Rules (PER) and less structured free-flowing text that may or may not be organized in a machine-readable format. The latter may use either the ASCII (8-bit) or a modified Data Link Applications Coding (DLAC) (6-bit) character set. DLAC can also be accompanied by a specialized dictionary of commonly used terms that when used can significantly compress the transmitted data from the original text without loss of information. The DLAC character set, developed by Lincoln Laboratory, is provided in Appendix A.

Graphical overlay records are identified by a single option. The encoding of overlays is defined in Section 6.

The service provider will establish the format to be used and may provide multiple options. These options should not change once established.

Table 4-1. Record Format Options

Meaning	Value
No data	0
Unformatted ASCII Text	1
Unformatted DLAC Text	2
Unformatted DLAC Text w/ dictionary	3
Formatted Text using ASN.1/PER	4
Future Use	5-7
Graphical Overlay	8
Future Use	9-15

4.1.2 Product Version

The Product Version field is a one byte sequentially ordered number (1..15) used to maintain configuration control of changes to the product definitions. A value of zero (0) is reserved for experimental purposes only. Placing a version field within the report enables recipients to easily determine compatibility. Furthermore, during periods of transition, multiple versions can be supported and continuity of service can be maintained. **The Product Version corresponding to Revision 4 of this document is "2."**

4.1.3 Record Count

The Record Count field indicates the number of records using the same Record Format that can be grouped together. Up to 16 records, either Text or Graphical Overlay, can be grouped with each Payload Header.

4.1.4 Location Identifier

The Location Identifier references the location or facility that the report applies to or the overlay has originated from, such as an air traffic facility including (e.g., airports, navigation aids or control facilities). This field may also enable the association between the overlay and an onboard airport or navigation database. The 3-byte field contains four DLAC characters (See Appendix A for DLAC format). In cases when less than four characters are needed for the identifier or no identifier is present, the unused characters are set to End-of-Text (ETX) (0x00).

4.1.5 Record Reference Point

The Record Reference Point is a one-byte field defining the origin from which text records may be reference or overlay geometric vertices are based. There are several options available for establishing a Record Reference Point. These include the following:

- A facility location, such as an Airport Reference Point (ARP) or navigation aide (e.g., VOR)
- A designated runway endpoint
- An external reference not specified in this definition, such as the broadcast transmitter location (requires an alternative means of communicating the location with sufficient accuracy and integrity to meet the intended use of the overlay)

For most airport surface overlays, the ARP will be the preferred point of origin to base overlay vertices. However, there may be cases when the use of the ARP is inappropriate. For example, if the surveyed accuracy and integrity of the ARP is insufficient or the type and location of the overlay warrants an alternative reference. In these cases, there are alternative points that can be defined.

A runway endpoint may be used instead of the ARP. This may be a viable point since it is likely to be present in an airport or navigation database in the avionics. Also, runways are often surveyed with a high degree of accuracy.

The reference point may also be broadcast independently, in which case providing it here may introduce potential confusion or errors. Therefore, consideration has been made to indicate that the Record Reference Point field is not valid and an alternative source is provided. Coordination of the generation of a Record Reference Point and the overlay objects is required regardless of the source of the reference point.

There are two reserved values for this field. A value of zero (0x00) indicates the location of the identifier specified in the Location Identifier field should be used. A value of 255 (0xFF) indicates the reference point is to be obtained from a source other than this field.

When a runway endpoint is used as the Record Reference Point, the encoding shown in Figure 4-3 is used. The Runway Designator (1..36) provides the possible range of runway heading values in increments of 10 degrees. The Parallel Runway Designator (NA, L, C, or R) indicates whether the runway is a parallel runway and in which of three possible orientations it exists, namely left (L), center I, or rigI(R). A value of Not Available (NA) is used when parallel runways do not exist. Though other orientations are possible, these are sufficient to provide enough flexibility in selecting an available runway as the Record Reference Point. The vertex used for the reference point is the left-most vertex on the approach end of the runway designated in this field.

(MSB) Runway Designator	Parallel Runway Designator (LSB)
6 bits	2 bits
(1…36)	(00 = NA 01 = R 10 = L 11 = C)

Figure 4-2. Runway Endpoint Encoding of Record Reference Point Field

The following are a few examples for encoding possible reference points.

Use facility reference (e.g., ARP)	=>	000000 00
Runway 2R	=>	000010 01
Runway 27L	=>	011011 10
Runway 36	=>	100100 00
Use external reference	=>	111111 11

4.1.6 Payload Header Format

The organization of the Payload Header fields in a message is shown in Figure 4-3.

First Bit Transmitted ↓

Octet No.	8	7	6	5	4	3	2	1
1	Product Version			(MSB)	Record Format			(MSB)
2	Spare				Report Count			(MSB)
3	Location Identifier							(MSB)
4								
5	(LSB)							
6	(LSB)		Record Reference Point					(MSB)

Figure 4-3. Payload Header Format

5 Text Record

The Text Record fields provide a framework to support the communication of text reports, such NOTAM and Service Status, D-ATIS and SUA Status text reports. Table 5-1 presents a logical organization of Record fields and their characteristics. The bit mapping of these fields is presented in Figure 5-1.

Table 5-1. Text Record Fields

Field	Length	Data Type	Comments
Text Record Length	2 bytes	Unsigned Integer (0..65,535)	A value (5..65,535) indicating the length (in bytes) of the Text Record. The Length value includes this field.
Report Identifier	|		Unique identifier for each report. See following subfields.
Report Number	14 bits	Unsigned Integer (0..16,383)	A value (0000..16,383) indicating the number assigned to the report. A value of 0000 is reserved. Some products may use specific ranges.
Report Year	7 bits	Unsigned Integer (0..127)	A value (00..99) indicating the year the report was created.
Report Status	1 bit	(see Table 5-2)	Enumeration of the current status of this report. This field applies to both text and associated overlay records.
Text Data	Variable	(See Table 4-1)	Field containing the text, or an equivalent representation, for a single report that is formatted per the Record Format field of Payload Header.

5.1 Text Record Length

The Text Record Length field (2 bytes) indicates the number of bytes (5..65,535) contained in a single text record. The length includes the Text Record Length field. The minimum text record length is five (5) bytes and includes the Text Record Length, Report Identifier and Report Status fields.

5.2 Report Identifier

The Report Identifier field is composed of two subfields, the Report Year and the Report Number. When combined with the product type, this identifier provides a unique reference. The Report Year field (7 bits) indicates the last two digits of the year the report originated (e.g., 2004 is represented as 04). In cases when the source report does not contain a year value, this value is to be provided by the FIS-B service provider delivering the reports over the data link. The Report Number field (14 bits) supports a sequentially ordered number with a range of (0..16,383) used to uniquely identify each report. After reaching 16,383, the number begins again at 1. A value of zero (0) in this field is reserved and should not be used.

The Report Identifier fields are also used to associate text and graphical overlay records to a corresponding report (see Section 6.2).

Here are some examples of Report Identifiers used in existing products:

- D-ATIS reports presently use a range of report numbers (1..26) corresponding to the alphabetic identifier (A..Z) historically used. The Text Data field may still contain the alphabetic identifier.
- Each FDC NOTAM report issued in the United States is identified by the last two digits of the year it was issued (00..99) and a sequentially assigned four digit report number (0001..9999) separated by a virgule (i.e., yy/nnnn). The report number resets to 0001 on January 1st of each year. In the example, "04/0913 KIAD 1R/19L BA POOR," the NOTAM number is the 913th report issued in the year 2004. Since NOTAMs can persist for several years, the Report Year field should always represent the value provided in the source report and not altered independently by the FIS-B system.
- Recently the FAA stopped providing L NOTAMs and revamped how it sends D NOTAMs. As a result, D NOTAMs are not numbered like FDC NOTAMs and are not unique without the facility ID, which is contained in the report. To differentiate D NOTAMs from FDC NOTAMs, D NOTAMs will have a Report Identifier in the range (12000..12999) with the last three-digits representing the source number assigned to each D NOTAM.
- The reporting of FIS-B product outages are communicated in the NOTAM and Service Status product format and is generated by the FIS-B Service Provider. Each outage report will be assigned a five digit report number (10000..11999) along with the corresponding two digit year (i.e., yy/nnnnn).
- TWIP reports presently only use a sequentially assigned four digit number (0001..9999).

5.3 Report Status

The use of the Report Status enables the avionics to verify the current status of each record (text and associated overlay) and quickly purge those records that are terminated prematurely (i.e., not in accordance with the period of validity that may be provided in the record itself). Generally, reports reaching the end of their valid time are no longer transmitted. As shown in Table 5-2, the Report Status is either Cancelled or Active. NOTE: *Reports should contain a period of validity and the Report Status field should not be used for this purpose*. When the Report Status field contains "Cancelled" the report should be immediately purged from the avionics. A cancellation overrides the period of validity contained in the original records. As long as a report remains valid, the Report Status will contain "Active."

Table 5-2. Report Status

Meaning	Value
Cancelled Report	0
Active Report	1

A key feature of the Report Status is that it enables the status of all records associated with a single report (including overlay records) to be continuously transmitted without having to retransmit the entire record or set of records. This is accomplished by only transmitting the first five (5) bytes of the text record (see Section 5-5), which includes only those fields necessary to reference the record(s) and status. For example, the text record and associated overlay records of a NOTAM and Service Status report may be transmitted once every five minutes, but the status of this report can be transmitted every minute. This approach results in significant savings in uplink bandwidth. If there is a change in the report, such as an update, the entire record or set of records comprising the report are transmitted.

5.4 Text Data Field

The Text Data Field contains the text, or an equivalent representation, for a single report. The character set or encoding scheme used to represent the report is stipulated in the Record Format field (Table 4-1) of the Payload Header.

5.5 Text Record Message Format

The Text Record fields defined in Table 5-1 are organized into a message format for transmission. The format is provided in Figure 5-1.

First Bit Transmitted ↓

Octet No.	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1				Text Record Length				(MSB)
2	(LSB)							
3				Report Number				(MSB)
4		(MSB)	(LSB)					
5	Spare	Spare	Report Status	(LSB)		Report Year		
6	(LSB)							(MSB)
7	(LSB)			Text Data (Variable Length)				(MSB)
up to 65,536	(LSB)							(MSB)

Figure 5-1. Text Record Format

6 Graphical Overlay Record

The Graphical Overlay Record is a component of the Aerodrome and Airspace FIS-B Payload containing the fields for the graphical depictions of NAS Status information (e.g., TFR NOTAM and SIGMET reports). The field definitions are intended to be sufficiently general to encompass a broad range of report content while striving to simplify software processes and make efficient use of data communications bandwidth. Table 6-1 presents a logical organization of possible report fields and their characteristics. The bit mapping of these fields is in a different sequence, optimized for transmission and presented in Figure 6-1 and presented in the examples in the appendices. The inclusion and definition of the fields in Table 6-1 are based largely on RTCA, FAA and ICAO documents on formatting, processing and dissemination [1, 2, 3, 4, 5, 7]. Every attempt has been made to maintain consistency with existing information content requirements and standards to maximize the applicability of this work to both existing and planned enhancements to these services.

Table 6-1. Graphical Overlay Record Fields

Field	Length	Data Type	Comments
Overlay Record Length	10 bits	Unsigned Integer (0..1023)	Length (in bytes) of the Overlay Record. The Length value includes this field.
Report Identifier			The same Report Identifier for the corresponding Text Report. See following subfields.
Report Number	14 bits	Unsigned Integer (0..16,383)	A value (0000..16,383) indicating the number assigned to the report. A value of 0000 is reserved. Some products may use specific ranges.
Report Year	7 bits	Unsigned Integer (0..127)	A value (00..99) indicating the year the report was created.
Overlay Record Identifier	4 bits	Unsigned Integer (1..16)	Number assigned to each overlay record associated with a single text record.
Object Label Flag	1 bit	Binary (0/1)	Indicates whether the Object Label field is represented as a text or numeric label. 0 = Numeric index 1 = Alphanumeric name
Object Label	2 bytes or up to 9 bytes	Unsigned Integer (0..65,535) or DLAC (see Table 6-2)	Database index for a given object. Or Text label associated with a given object.
Object Type	4 bits	(see Table 6-3)	Enumeration of available objects.

Field	Length	Data Type	Comments
Object Element Flag	1 bit	Binary (0/1)	Indicator of whether the Object Element field is present in the report. 0 = Field not used 1 = Field used
Object Element	5 bits	(see Tables 6-4 through 6-15)	Enumeration of elements associated with a given object.
Object Status	4 bits	(see Table 6-16)	Enumeration of the state or status of the object in the report.
Object Qualifier Flag	1 bit	Binary (0/1)	Indicator of whether the Object Qualifier field is present in the report. 0 = Field not used 1 = Field used
Object Qualifier (optional)	3 bytes	(see Table 6-17)	A bit map of qualifying reasons for an object status.
Object Parameter Flag	1 bit	Binary (0/1)	Indicator of whether the Object Parameter Type and Value fields are present in the report. 0 = Fields not used 1 = Fields used
Object Parameter Type (optional)	5 bits	(see Table 6-18)	Enumeration of quantitative parameter types and respective units of measure.
Object Parameter Value (optional)	11 bits	Unsigned Integer (0..2047)	Parameter value encoded according to the Parameter Type field.
Record Applicability Options	2 bits	(see Table 6-19)	Enumeration of possible options for representing the period of validity for an overlay report.
Date/Time Format	2 bits	(see Table 6-20)	Enumeration of possible formats of data and time data contained in the Record Applicability fields.
Record Applicability Start (optional)			Date and time that the overlay goes into effect. The inclusion of this field is controlled by the Record Applicability Options. See following subfields.
Month (optional)	1 byte	Unsigned Integer (1..12)	Inclusion of this field is specified in the Date/Time Format field.
Day (optional)	1 byte	Unsigned Integer (1..31)	Inclusion of this field is specified in the Date/Time Format field.
Hour	1 byte	Unsigned Integer (0..23)	UTC time. Required sub-field

Field	Length	Data Type	Comments
Minutes (optional)	1 byte	Unsigned Integer (0..59)	UTC time. Inclusion of this field is specified in the Date/Time Format field.
Record Applicability End (optional)			Date and time that the overlay will expire or terminate. The inclusion of this field is controlled by the Record Applicability Options. See following subfields.
Month (optional)	1 byte	Unsigned Integer (1..12)	Inclusion of this field is specified in the Date/Time Format field.
Day (optional)	1 byte	Unsigned Integer (1..31)	Inclusion of this field is specified in the Date/Time Format field.
Hour	1 byte	Unsigned Integer (0..23)	UTC time. Required sub-field.
Minutes (optional)	1 byte	Unsigned Integer (0..59)	UTC time. Inclusion of this field is specified in the Date/Time Format field.
Overlay Geometry Options	4 bits	(see Table 6-21)	Enumeration of the existence and type of geometry used to define a graphical overlay for a region of interest.
Overlay Operator	2 bits	(see Table 6-23)	Enumerati6-3ooleanoolean operations that can be applied to multiple overlapping overlay objects.
Overlay Vertices Count (optional)	6 bits	Unsigned Integer (1..64)	Number of vertices used to define an overlay for a region of interest.
Overlay Vertices List [1..64] (optional)	Variable (3-896 bytes)	(see Table 6-22)	List of vertices for a geometry type specified in the Overlay Geometry Options field. Each vertex is set of coordinates repeated in the list to construct the overlay geometry.

6.1 Overlay Record Length

The Overlay Record Length field (10 bits) indicates the number of bytes in a single overlay record. The length includes the Overlay Record Length field.

6.2 Report Identifier

This identifier is used to enable graphical overlay records to reference a corresponding text report. The format, composed of two subfields, is the same as the text report, (see Section 5.2). A value of zero indicates that there is no association with a text record. Note that this is a different interpretation of a zero value than is used in the text record.

6.3 Overlay Record Identifier

The Overlay Record Identifier is a sequentially order number (1..16) identifying each, of potentially several, overlay records that are related in some manner, such as to a particular report. There may be up to 16 related overlay records. The decoding of this field requires that a one be added to the Overlay Record Identifier value to get the decimal value.

6.4 Object Label Flag

The Object Label Flag controls the approach used to represent the Object Label. This field is a binary field indicating whether the Object Label field is numeric (0) or alphanumeric (1).

6.5 Object Label

The Object Label field contains the means for referencing an object in a database, such as an airport surface map object (e.g., a taxiway segment). There are two ways to provide this reference. The first approach is to use a static index (0…65,535) for a given object that is tied to the database. Note that a value of zero (0) is reserved when referring to unlabeled airspace (e.g., TFRs) and a value of one (1) is for referencing an airport as whole. Using this indexing scheme would allow the referencing of any and all objects in the database with a number. Unfortunately, this requires capabilities and standardization in databases that may not exist initially.

The second approach refers to each object of interest by a text label. This approach uses a fixed length field of DLAC characters (see Appendix A). Up to nine (9) bytes in length (12 characters). If there are less than 12 characters in the field, the least significant characters are filled with ETX (0x00). Depending on the entry in the Object Type field, it is possible to reference an object this way. Some objects may not have a label, however.

There are some guidelines to ensure clarity in referencing runways and taxiways in particular. Object specific rules are listed in Table 6-2 below. As a rule, multiple runways and taxiways are linked together by either the virgule (/) or period (.) symbol. This nomenclature is consistent with other existing standards [1, 3].

Referencing airspace objects and special routes also have standard formats found in aeronautical publications today [7]. The uses of these formats are retained. Some examples of these are also provided in Table 6-2 for reference.

Table 6-2. Object Label Formats

Object	Description	Format Examples
Airport	The Location Identifier	KIAD, A09
Runways	A uni-directional runway reference applies only to one operating direction	09L, 04RC, 25
	A bi-directional runway reference applies to both operating directions. The smaller numbered runway will be listed first.	09L/27R, 04RC/22LC, 25/07 (or 09L.27R, 04RC.22LC, 25.07)
Taxiways	Full taxiway reference applies to entire length or extent of the taxiway as labeled	B4, E4, GG2
	Segment taxiway reference applies to a portion of a taxiway that lies between two intersecting taxiways. The segment of interest is first followed by the two intersecting taxiways with.	A1/E2/E4 (or A1.E2.E4)
	Intersecting taxiway reference applies to the area where two or more taxiways come together and/or cross. If more than two taxiways meet, only two taxiways should be referenced.	A1/E4, A1/G2 (or A1.E4, A1.G2)
Restricted Area	Special Use Airspace – access restricted by type, time or other factor	R-6611A
Prohibited Area	Special Use Airspace – Prohibited Area	P56
Warning Area	Special Use Airspace – Warning Area	W-122B
MTR	Special Use Airspace – Military Training Route	IR719, VR1758

6.6 Object Type

The Object Type field provides the notable parts of an airport or airspace environment. These airport/airspace objects comprise the collection of regions or things that can have an impact on flight operations if they become hazardous, if they fail, or if they are unavailable for some reason. Table 6-3 Object Types lists the available objects along with FAA approved contractions and the value of the Object Type field for each object [3].

Depending on the situation, additional detail may be required to fully illustrate the limitation. In these cases, the object elements can be referenced along with a status and/or condition. The following sections define the fields for these additional descriptors.

Table 6-3. Object Types

Object Type	Contraction	Value	Table
Airport (or Heliport)	AP	0	
Runway (or Helipad)	RWY	1	6-4
Taxiway	TWY	2	6-5
Apron		3	6-6
Frequency Area		4	
Signage		5	6-7
Approach Lighting		6	6-8
Airport Lighting		7	6-9
Obstruction	OBST	8	6-10
Construction Area		9	
Communication Equipment		10	6-11
Navigation Equipment		11	6-12
Surveillance Equipment		12	6-13
Weather Equipment		13	6-14
Airspace		14	6-15
Future Use		15	

6.7 Object Element Flag

The Object Element Flag field is a binary field used to indicate whether the Object Element field is used (1) or not (0).

6.8 Object Element

The Object Element field provides a particular feature or element of an Object Type of interest. Each Object Type may have a collection of Object Elements that can be referenced, if necessary, to more clearly identify a hazard, constraint or outage of some kind. If the Object Type does not contain any Object Elements, such as is the case with Airport, Frequency Area or Construction Area, the Object Element field is filled with zeroes. The following tables provide the available elements for each of the possible objects identified in Table 6-3 Object Types. Some elements (see Tables 6-4 to 6-15) have associated contractions that are currently FAA approved and used [3].

Table 6-4. Runway Object Elements

Object Element	Contraction	Value
Full Runway	RWY	0
Touchdown (First Third)		1
Midpoint (Middle Third)		2
Rollout (Last Third)		3
Threshold		4
Runway Intersection		5
Runway Shoulder		6
Stopway		7
Clearway		8
Touchdown/Liftoff Area (helipad/heliport)		9
Final Approach and Takeoff Area (helipad/heliport)		10
Marking		11
LAHSO Line		12
RAS – Arrival		13
RAS – Departure		14
Future Use		15-31

Table 6-5. Taxiway Object Elements

Object Element	Contraction	Value
Taxiway Segment	TWY	0
Taxiway Shoulder		1
Guidance Line		2
Intersection Marking		3
Holding Position (Stopbar)		4
Exit Line		5
Penalty Box		6
Future Use		7-31

Table 6-6. Apron Object Elements

Object Element	Contraction	Value
Apron Area		0
Parking Stand Area		1
Stand Guidance Line		2
Parking Stand Location		3
Deicing Stand		4
Future Use		5-31

Table 6-7. Signage Object Elements

Object Element	Contraction	Value
Runway Entry		0
Runway Distance		1
Taxiway		2
No Entry		3
Future Use		4-31

Table 6-8. Approach Lighting Object Elements

Object Element	Contraction	Value
Approach Lights	ALS	0
Sequence Flashing Lights	SFL	1
Runway Alignment Indicator Lights	RAIL	2
Runway Lead-In Lights	RLLS	3
Visual Approach Slope Indicator	VASI	4
Precision Approach Path Indicator	PAPI	5
Future Use		6-31

Table 6-9. Airport Lighting Object Elements

Object Element	Contraction	Value
All Airport Lighting	AP LGT	0
Threshold Lights	THR LGT	1
Touchdown Zone Lights	TDZ LGT	2
Stop Bar Lights		3
Runway End Identifier Lights	RENL	4
Runway Turnoff Lights		5
Runway Edge Lights	RWY LGTS	6
Runway Centerline Lights	RCLL	7
Runway Remaining Lights	RRL	8
Taxiway Centerline Lights	TWY CL LGT	9
Taxiway Edge Lights	TWY LGT	10
Rotating Beacon	BCN	11
Future Use		12-31

Table 6-10. Obstruction Object Elements

Object Element	Contraction	Value
Unknown		0
Tower	TWR	1
Crane		2
Vehicle		3
Future Use		4-31

Table 6-11. Communication Equipment Object Elements

Object Element	Contraction	Value
Airport Terminal Information Service	ATIS	0
Remote Communication Outlet	RCO	1
VHF Omni-directional Ranging (VOR) Voice		2
Remote Transmitter/ Receiver	RTR	3
Local Airport Advisory	LAA	4
Remote Communication Air/Ground Facility	RCAG	5
Hazardous Inflight Weather Advisory Service	HIWAS	6
Future Use		7-31

Table 6-12. Navigation Equipment Object Elements

Object Element	Contraction	Value
Outer Marker Beacon	OM	0
Middle Marker Beacon	MM	1
Inner Marker Beacon	IM	2
Glide Slope/Path	GP	3
Localizer	LLZ	4
Locator at Middle Marker	LM	5
Locator at Outer Marker	LO	6
Distance Measuring Equipment (DME)	DME	7
VOR/ VORTAC	VOR/VORTA C	8
Microwave Landing System (MLS) Elevation	MLS ELEV	9
MLS Azimuth	MSL AZM	10
Simplified Directional Facility	SDF	11
Localizer Directional Aid	LDA	12
LAAS/WAAS		13
Non-Directional Beacon	NDB	14
Future Use		15-31

Table 6-13. Surveillance Equipment Object Elements

Object Element	Contraction	Value
Airport Surface Surveillance		0
Terminal Surveillance	TAR	1
Precision Approach Radar	PAR	2
Ground Control Approach	GCA	3
Multilateration System		4
Traffic Information Service – Addressed		5
Traffic Information Service – Broadcast		6
Future Use		7-31

Table 6-14. Weather Equipment Object Elements

Object Element	Contraction	Value
D-ATIS		0
ATIS	ATIS	1
AWOS	AWOS	2
ASOS	ASOS	3
RVR – Touchdown	RVRT	4
RVR – Midpoint	RVRM	5
RVR – Rollout	RVRR	6
Terminal Weather Information for Pilots		7
Future Use		8-31

Table 6-15. Airspace Object Elements [7]

Object Element	Contraction	Value
Temporary Flight Restriction	TFR	0
Parachute Jumping /Sky Diving	PJE	1
Terminal Radar Service Area		2
Airport Advisory Area		3
VFR Flyway		4
VFR Corridor		5
VFR Transition Route		6
Terminal Area VFR Route		7
Prohibited Area		8
Restricted Area		9
Military Operations Area		10
Warning Area		11
Military Training Route		12
Air Defense Identification Zone		13
Future Use		14-31

6.9 Object Status

The Object Status field provides the state of an object. Only degraded states or state changes are reported. Normal states are not reported in most cases. Possible states are listed in Table 6-16.

Table 6-16. Object Status

Object Status	Contraction	Value
Closed	CLSD	0
Closed-Conditional	CLSD	1
Arrival Only	ARR	2
Departure Only	DEP	3
Displaced	DSPLCD	4
Braking Action	BA	5
Obscured/Missing		6
Unmarked	UNMKD	7
Unlighted	UNLGTD	8
In Service[1]		9
Inoperative	INOP	10
Unavailable	UNAVBL	11
Surface Condition		12
Reduced		13
Unsafe		14
In Effect		15

Notes: The intended use of this status is when the normal state of an object is inoperative or to identify a deviation from charted or published information.

6.10 Object Qualifier Flag

The Object Element Flag field is a binary field used to indicate whether the Object Qualifier field is used (1) or not (0).

6.11 Object Qualifier

The Object Qualifier is used to provide a condition or reason for a given status of an object. Table 6-17 Object Qualifier the possible qualifiers. A bit mapping of the qualifiers is used allowing multiple qualifiers to be applied to fully describe the condition of an object.

Table 6-17. Object Qualifier

Object Qualifier	Contraction	Bit
Medium	MED	1
Poor		2
Nil		3
Personnel and Equipment Working	PAEW	4
Debris, Equipment or Spill		5
Water		6
Ice		7
Packed Snow		8
Loose Snow		9
Wet Snow		10
Slush		11
Sand	SA	12
Mud	MUD	13
Cracks, ruts or loose pavement		14
Frost Heave		15
Below		16
At and Below		17
Above		18
Within (radius of)		19
Beyond (radius of)		20
Future use		21-24

6.12 Object Parameter Flag

The Object Parameter Flag field is a binary value indicating whether the Object Parameter Type and Object Parameter Value fields are present (1) or absent (0). Since each Parameter Type has a corresponding Value the flag covers the existence of both fields.

6.13 Object Parameter Type

The Parameter Type field is an enumerated field indicating a quantitative parameter associated with an overlay object. An overlay record may stipulate a numerical range for a particular condition being reported, which is provided in the Parameter Value field. The Object Parameter Type field is optional (see Table 6-18). Its inclusion is stipulated in the Object Parameter Flag field.

Table 6-18. Object Parameter Types

Object Parameter Type	Value	Range	Resolution
Reserved	0		
Distance in Nautical Miles	1	0…500 nmi	0.25 nmi
Distance in Statute Miles	2	0…500 mi	0.25 mi
Length in Feet	3	0…15,000 ft	10 ft
Length in Meters	4	0…6000 m	3 m
Height in Feet (MSL)	5	0…18,000 ft	10 ft
Height in Feet (AGL)	6	0…18,000 ft	10 ft
Height in Meters	7	0…6000 m	3 m
Width in Feet	8	0…10,000 ft	5 ft
Width in Meters	9	0…6000 m	3 m
Depth in Fractional Inches	10	0…0.75 in	0.25 in
Depth in Inches	11	1…35 in	1 in
Depth in Feet	12	1…100 ft	1 ft
Weight in Pounds	13	0…300,000 lbs	500 lbs
Friction Measure (MU)	14	0…100	1
Direction (Magnetic)	15	0…359 deg	1 deg
Direction (True)	16	0…359 deg	1 deg
Visibility in Feet	17	0…6000 ft	100 ft
Visibility in Meters	18	0…1500 m	25 m
Visibility in Statute Miles	19	0…50 smi	0.0625 smi
Speed in Knots	20	0…200 kts	1 kts
Speed in Meters	21	0…500 kph	1 kph
Frequency in Megahertz (25)	22	108…138 MHz	25 kHz
Frequency in Megahertz (8.33)	23	108…138 MHz	8.33 kHz
Future Use	24-31		

6.14 Object Parameter Value

The Parameter Value field contains an unsigned integer number that represents one of the parameter types and units of measure defined in the Parameter Type field. The smallest incremental unit (LSB) of the parameter listed in Table 6-18 Object Parameter Types implies the encoding of the value. This field is optional, but must be present if the Object Parameter Type field is present.

6.15 Record Applicability Options

The Record Applicability Options provide information about the timing of the reported event. Some events will have both beginning and ending times that the reported event is applicable. Other reports will be valid as long as they are being reported. Table 6-19 lists the options to cover possible reporting approaches.

Note that the Record Applicability field is specific to the contents of the report and is independent of the product transmission time, which is specified in the APDU Header Time fields.

Table 6-19. Record Applicability Options

Meaning	Contraction	Value
No times given	UFN	0
Start time only	WEF	1
End time only	TIL	2
Both start and end times	WEF	3

6.16 Date/Time Format

The Date/Time Format field provides format used in the Record Applicability fields (Section 6.17) enabling a subset of date/time information to be sent. For example, a D-ATIS report provides hour and minutes data, while a NOTAM report may provide a more complete date and time sequence. Table 6-20 provides the format options available for tailoring the Record Applicability fields. The selected format applies to both the start and end times (if both exist in the record).

Table 6-20. Date/Time Format

Meaning	Value
No Date/Time Used	0
Month, Day, Hours, Minutes	1
Day, Hours, Minutes	2
Hours, Minutes	3

6.17 Record Applicability

The Record Applicability fields include a starting and ending field that indicate the period the data in the overlay record are in effect. The Record Applicability Options field (Section 6.15) controls the inclusion of the Record Applicability Start and End fields in the record. The format for each field is stipulated in the Date/Time Format field (Section 6.16).

The Record Applicability fields contain multiple date and time sub-fields that can be used to represent the effective period of the report. The data in each sub-field is represented in one byte. (Note: The sub-field data can be represented in fewer bits, but to preserve the byte boundary with subsequent fields, there is marginal savings and there would be additional complexity in the format encoding/decoding processing.) Depending on the format selected, the Record Applicability fields may be from one to five bytes in length.

Overlay reports that are applicable on a regular basis during a specified period, such as daily, are managed by a service-level schedule to ensure their availability to users during applicable periods. This relieves the product report of having to specify repeated periods of applicability. The NOTAM overlay report will contain the most restrictive and/or pertinent date/time information. The corresponding text report will contain all the information. For example, if a NOTAM states, "…1200-1330 DLY TIL 0005172200," the report applicability will be 1200-1330 and the NOTAM service will ensure the report is broadcast every day until 2200 on 17 May 2000. The avionics will base the decision to display the overlay information on the current time compared to the date/time in the Record Applicability field(s).

6.18 Overlay Geometry Options

The Overlay Geometry Options indicates whether or not there is a geometry explicitly defined in the record. The geometry option provides the geometry type, resolution and vertex encoding to be used. Table 6-21 presents the geometry types and possible number of vertices. Each vertex is defined by the set of coordinates required to define a geometric point in space (e.g., x, y, z). For surface overlay geometries, the orientation of the Cartesian coordinate system is in alignment with the magnetic compass headings. Positive values of x and y are aligned with magnetic North and East, respectively. Table 6-22 shows the vertex coordinates and the corresponding encoding for each geometry.

The encoding and decoding for each geometry is different due to the number and type of coordinates and the resolution (least significant bit) for each coordinate. When encoding a coordinate into binary form, the decimal coordinate value may need to be rounded toward zero to a value that is a multiple of the resolution value. The procedure is necessary to ensure both encoding and decoding are performed consistently. The procedure for rounding toward zero is to modulus the magnitude of the coordinate value with the resolution and subtract the result from the magnitude of the coordinate value. Then perform the encoding specified by each geometry in the following sections.

The following is an example of the rounding procedure for any given geometry in Table 6-21:

X = original coordinate value in decimal

Y = rounded coordinate value in decimal

R = coordinate resolution as specified in Table 6-22

$Y = \pm (|X| - \mathrm{mod}(|X|,R))$

Table 6-21. Overlay Geometry Options

Meaning	Value	Vertices Count Range
No Geometry	0	NA
Low Resolution 2D Polygon	1	1-64
High Resolution 3D Polygon	2	1-64
Extended Range 3D Polygon (MSL)	3	1-64
Extended Range 3D Polygon (AGL)	4	1-64
Low Resolution 2D Ellipse	5	1-64
High Resolution 3D Ellipse	6	1-64
Extended Range Circular Prism (MSL)	7	1-64
Extended Range Circular Prism (AGL)	8	1-64
Extended Range 3D Point (AGL)	9	1-64
Future Use	10-15	

6.18.1 No Geometry

The No Geometry option means that there are no vertices used to define the overlay region of interest. In this case, the object boundaries or overlay region should be obtainable using data contained in an airport or navigation database stored within the avionics.

6.18.2 Low Resolution 2D Polygon

The Low Resolution 2D Polygon option is intended for use on the airport surface (within 5.5 nautical miles of the Record Reference Point). This option will likely satisfy a majority of the implementations that require good accuracy to ensure object alignment, but the data is intended to be advisory only (supplementing the visual scene).

The Low Resolution 2D Polygon option provides a vertex with a resolution of 5 meters laterally. There is no vertical dimension. Each coordinate is encoded using a 12-bit unsigned integer. The coordinates each have a range of up to 10,240 meters (approximately 5.5 nautical miles) from the reference point. The x and y coordinates of each vertex are decoded by subtracting 2048 from the field value and multiplying the result by 5 to yield the relative distance from the reference point. The relative distance is then added to the Record Reference Point to get the coordinate. See Table 6-22 for encoding details.

6.18.3 High Resolution 3D Polygon

The High Resolution 3D Polygon option is intended for use on the airport surface (within 5.5 nautical miles of the Record Reference Point). This option may be desirable in airport environments that require a high degree of accuracy and when perspective displays or 3D databases exist on aircraft to support low-visibility operations.

The High Resolution 3D Polygon option provides a vertex with a resolution of 1.25 meters laterally and 3 meters vertically. The x and y coordinate field values are each encoded using a 14-bit unsigned integer. The coordinates each have a range of up to 10,240 meters (approximately 5.5 nautical miles) from the reference point. The x and y coordinates are decoded by subtracting 8192 from the field value and multiplying the result by 1.25 to yield the relative distance from the reference point. The relative distance is then added to the Record Reference Point to get the coordinate.

The vertical dimension is contained a z coordinate that is represented by a 4-bit unsigned integer and having a range from -5 to 40 meters above ground level (AGL). To decode the z coordinate, multiply the field value by 3 and subtract 5 from the result. See Table 6-22 for encoding details.

6.18.4 Extended Range 3D Polygon

The Extended Range 3D Polygon provides a geometry independent of the Record Reference Point. This option is useful in defining various airspace objects in the airport terminal domain. The definition of this geometry should be consistent with special use airspace objects defined for non-aerodrome applications (e.g., en route airspace) to simplify avionics processing requirements.

The location of each vertex in this geometry is defined using latitude and longitude and is not tied to the Record Reference Point. The longitude and latitude coordinate field values are each encoded using a 19-bit unsigned integer providing 0.000687 degrees of position resolution. This encoding is consistent with the encoding standard used throughout many emerging navigation and surveillance systems (e.g., Aeronautical Radio Incorporated (ARINC) 743 GNSS units, ADS-B systems, and ADS-B/TIS-B ASTERIX report formats). Furthermore, the encoding is applicable worldwide without the need for compression algorithms. These fields are encoded using the Angular Weighted Binary Encoding, which is described in Appendix B.

The altitude (z) coordinate is encoded using a 10-bit unsigned integer providing 100 feet of resolution and representing a range of 0 to 102,400 feet Mean Sea Level (MSL) or AGL. The Overlay Geometry Option (Table 6-21) selected indicates the altitude reference used. Each z coordinate is decoded by multiplying the field value by 500. See Table 6-22 for encoding details. If this geometry is describing a range of altitudes (e.g., 3,000 ft to 17,999 ft), start with the higher altitude and complete its geometry. After the first geometry is closed, move down to the lower altitude and complete its geometry.

6.18.5 Low Resolution 2D Ellipse

The Low Resolution 2D Ellipse geometry is intended for use on the airport surface (originating within 5.5 nautical miles of the Record Reference Point). This option will likely satisfy a majority of the implementations that require good accuracy to ensure object alignment, but the data is intended to be advisory only (supplementing the visual scene). The Low Resolution 2D Ellipse option provides a vertex composed of the center point, the major and minor axis radii and the rotation angle for an ellipse. There is no vertical dimension.

The x and y (center point) coordinate field values are each encoded using a12-bit unsigned integer. The center point is accurate to within 5 meters. The center point coordinates each have a range of up to 10,240 meters (approximately 5.5 nautical miles) from the reference point. The x and y coordinates are decoded by subtracting 2048 from the field value and multiplying the result by 5 to yield the coordinate in meters. The ellipse center point is relative to the Record Reference Point.

There are two radius coordinates, r_x and r_y, used to represent the two possible dimensions of an ellipse. Each radius is encoded using an 8-bit unsigned integer. The radii are accurate to within 5 meters. The radii each have a range of up to 1275 meters from the center of the ellipse. The r_x and r_y coordinates are decoded by multiplying the field value by 5 to yield the coordinate in meters.

The orientation of the ellipse is specified by a rotation angle, □ , originating at magnetic North and increments in a clockwise direction between 0 and 179 degrees. The □ coordinate is represented by an 8-bit unsigned integer and has a resolution of 1 degree. The rotation angle is determined by the field value directly (i.e., no conversion necessary). See Table 6-22 for encoding details.

6.18.6 High Resolution 3D Ellipse

The High Resolution 3D Ellipse geometry is intended for use on the airport surface (originating within 5.5 nautical miles of the Record Reference Point). This option may be desirable in airport environments that require a high degree of accuracy and when perspective displays or 3D databases exist on aircraft to support low-visibility operations. The High Resolution 3D Ellipse option provides a vertex composed of the center point, the major and minor axis radii, the rotation angle for an ellipse and vertical dimensions.

The x and y (center point) coordinate field values are each encoded using a14-bit unsigned integer. Each radius, r_x and r_y, is encoded using a 14-bit unsigned integer. The center point is accurate to within 1.25 meters. The center point coordinates each have a range of up to 10,240 meters (approximately 5.5 nautical miles) from the reference point. The x and y coordinates are decoded by subtracting 8192 from the field value and multiplying the result by 1.25 to yield the coordinate in meters. The ellipse center point is relative to the Record Reference Point.

There are two radius coordinates, r_x and r_y, used to represent the two possible dimensions of an ellipse. Each radius is encoded using a 14-bit unsigned integer. The radii are accurate to within 1.25 meters. The radii each have a range of up to 1278.75 meters from the center of the ellipse. The r_x and r_y coordinates are decoded by multiplying the field value by 1.25 to yield the coordinate in meters.

The orientation of the ellipse is specified by a rotation angle, □ , that originates at magnetic North and increments in a clockwise direction between 0 and 179 degrees. The □ coordinate is represented by an 8-bit unsigned integer and has a resolution of 1 degree. The rotation angle is determined by the field directly (i.e., no conversion necessary).

There are two vertical coordinates (z_{bot} and z_{top}), one for the bottom of the cylinder and one for the top. Each z coordinate is encoded using a 4-bit unsigned integer providing 3 meters of resolution AGL and representing a range of -5 to 40 meters. The z coordinate is decoded by multiplying the field value by 3 and subtracting 5. See Table 6-22 for encoding details.

6.18.7 Extended Range Circular Prism

The Extended Range Circular Prism geometry is intended to describe airspace objects in the terminal or en route domain. A circular prism provides the flexibility to define a basic cylinder or a more complex parallelepiped with an elliptical cross-section. The top and bottom ellipsoids are the same shape and orientation, but the two centroids may not be aligned. The vertical boundaries of the prism are always parallel. The definition of this geometry should be consistent with special use airspace objects defined for non-aerodrome applications (e.g., en route airspace) to simplify avionics processing requirements.

The location of this geometry is defined using latitude and longitude and is not tied to the Record Reference Point. The longitude and latitude coordinate field values are each encoded using a 18-bit unsigned integer providing 0.001373 degrees of position resolution (~150 meters positional accuracy). This encoding is consistent with the encoding used is standard throughout many emerging navigation and surveillance systems (e.g., ARINC 743 GNSS units, ADS-B systems, and ADS-B/TIS-B ASTERIX report formats). Furthermore, the encoding is applicable worldwide without the need for compression algorithms. These fields are encoded using the Angular Weighted Binary Encoding, which is described in Appendix B.

The radius, r_{lng} and r_{lat}, are each encoded using a 9-bit unsigned integer providing a twentieth of a nautical mile (0.20 nmi) of position resolution. The radii have a range of up to approximately 102.2 nautical miles from the center of the ellipse. The r_{lng} and r_{lat} coordinates are each decoded by dividing the field value by 5 to yield the coordinate in nautical miles.

The orientation of the elliptical cross-section is specified by a rotation angle, □ , that originates at magnetic North and increments in a clockwise direction between 0 and 179 degrees. The □ coordinate is represented by an 8-bit unsigned integer and has a resolution of

1 degree. The rotation angle is obtained from the field value directly (i.e., no conversion necessary).

There are two altitude coordinates (z_{bot} and z_{top}), one for the bottom of the parallelepiped and one for the top. Each z coordinate is encoded using a 7-bit unsigned integer providing 500 feet of resolution and representing a range of 0 to 63,500 feet MSL or AGL. The Overlay Geometry Option (Table 6-21) selected indicates the altitude reference used. Each z coordinate is decoded by multiplying the field value by 500. See Table 6-22 for encoding details.

6.18.8 Extended Range 3D Point

The Extended Range 3D Point provides a singular geometry. This option is useful in defining locations within the airspace to identify or reference points of interest to pilots. The definition of this geometry should be consistent with special use airspace objects defined for non-aerodrome applications (e.g., en route airspace) to simplify avionics processing requirements.

The location of each vertex in this geometry is defined using latitude and longitude and altitude. The longitude and latitude coordinate field values are each encoded using a 19-bit unsigned integer providing 0.000687 degrees of position resolution. These fields are encoded using the Angular Weighted Binary Encoding, which is described in Appendix B.

The altitude (z) coordinate is encoded using a 10-bit unsigned integer providing 100 feet of resolution and representing a range of 0 to 102,400 feet Mean Sea Level (MSL) or AGL. The Overlay Geometry Option (Table 6-21) selected indicates the altitude reference used. Each z coordinate is decoded by multiplying the field value by 500. See Table 6-22 for encoding details.

Table 6-22. Overlay Geometry Encoding

Geometry	Vertex Coordinate	Resolution (LSB)	Value Range
Low Resolution 2D Polygon	x: y:	12 bits (5m) 12 bits (5m)	(-10,240..10,235) (-10,240..10,235)
High Resolution 3D Polygon	x: y: z:	14 bits (1.25m) 14 bits (1.25m) 4 bits (3m AGL)	(10,240..10,238.75) (10,240..10,238.75) (-5..40)
Extended Range 3D Polygon	lng: lat: z:	19 bits (0.000687deg) 19 bits (0.000687deg) 10 bits (100ft)	(0..±180) (0..±90) (0..102,400)
Low Resolution 2D Ellipse	x: y: r_x: r_y: α:	12 bits (5m) 12 bits5m) 8 bits5m) 8 bits (5m) 8 bits (1deg)	(-10,240..10,235) (-10,240..10,235) (0..1,275) (0..1,275) (0..179)
High Resolution 3D Ellipse	x: y: z_{low}: z_{hi}: r_x: r_y: α:	14 bits (1.25m) 14 bits (1.25m) 4 bits (3m AGL) 4 bits (3m AGL) 10 bits (1.25m) 10 bits (1.25m) 8 bits (1deg)	(-10,240..10,238.75) (-10,240..10,238.75) (-5..40) (-5..40) (0..1,278.75) (0..1,278.75) (0..179)
Extended Range Circular Prism	lng_{bot}: lat_{bot}: lng_{top}: lat_{top}: z_{bot}: z_{top}: r_{lng}: r_{lat}: α:	18 bits (0.001373deg) 18 bits (0.001373deg) 18 bits (0.001373deg) 18 bits (0.00137eg) 7 bits (5ft) 7 bits (500ft) 9 bits (0.2nmi) 9 bits (0.2nmi) 8 bits (1deg)	(0..±180) (0..±90) (0..±180) (0..±90) (0..63,500) (0..63,500) (0..102.2) (0..102.2) (0..179)
Extended Range 3D Point	lng: lat: z:	19 bits (0.000687deg) 19 bits (0.000687deg) 10 bits (100ft)	(0..±180) (0..±90) (0..102,400)

6.19 Overlay Operators

The Overlay Operators field specifies a set of Boolean operations that may be applied to multiple geometries. The Overlay Operator applies the Boolean operation specified in each overlay record to the previous associated overlay records (indicated by the Overlay Identifier). The available operations are defined in Table 6-23. These operators can be used to represent complex geometries (e.g., a polygon with a cut-out region).

Table 6-23. Overlay Operators

Operator	Value	Meaning
No Operator	0	Geometries are independent
"AND" this geometry	1	Geometry is added/concatenated
"NOT" this geometry	2	Geometry is subtracted/excluded
Reserved	3	

6.20 Overlay Vertices Count

The Overlay Vertices Count field indicates the number of vertices listed in the Overlay Vertices List field. The Overlay Count field is an optional field that is only present when the Overlay Geometry Option field is non-zero. The Overlay Vertices List can contain up to 64 polygon vertices. Since the ellipse and circular prism geometries have a single vertex, up to 64 of these geometries can be included in the Overlay Vertices List. The Vertices Count Range in Table 6-21 provides the number of vertices possible for each Overlay Geometry type. The decoding of this field requires that one be added to the Overlay Vertices Count value to get the decimal value.

6.21 Overlay Vertices List

The Overlay Vertices List field is a variable length field containing a list of vertices for the geometry specified in the Overlay Geometry Options. Only one geometry type can be included in each overlay record (e.g., polygon and ellipse geometries cannot exist in the same record). The Overlay Vertices List field is optional and is only present when the Overlay Geometry Option field is non-zero. The number of vertices in the list is specified in the Overlay Vertices Count field.

The vertices for polygon-type geometries are ordered in a counter-clockwise manner beginning with a start-node and ending with an end-node. The start and end nodes are only the same for a closed polygon. Alternatively, a line is represented by polygon-type geometry with two vertices.

The vertices for the ellipse, circular prism and point geometries are singular and therefore, multiple of these can be listed in accordance with the Overlay Vertices Count.

6.22 Graphical Overlay Record Format

The Record field definitions defined in Table 6-1 are reorganized below (Figure 6-1) into a message format for efficient transmission. The format for a graphical overlay report is provided in Figure 6-1. A field name followed by "(O)" indicates the field is optional. All other fields are required.

First Bit Transmitted ↓ (bit 1)

8	7	6	5	4	3	2	1
Overlay Record Length (MSB)							
(MSB)						(LSB)	
(LSB) Report Number							
Spare	(LSB) Report Year (MSB)						
Label Flag	Overlay Record Identifier				Spare	Spare	Spare
Object Label (2 – 9 bytes) (MSB)							
(LSB)							
(LSB) Object Element (MSB)					Param. Flag	Qualifier Flag	Element Flag
(LSB) Object Status (MSB)				(LSB) Object Type (MSB)			
Object Qualifier (O) (3 bytes) (MSB)							
(LSB)							
(MSB)			(LSB) Object Parameter Type (O) (MSB)				
(LSB) Object Parameter Value (O)							
(LSB) Overlay Geometry Options (MSB)				Date/Time Format		Record Applicability Options	
(LSB) Overlay Vertices Count (MSB)						Overlay Operator	
Record Applicability Start (O) (1 – 4 bytes)							

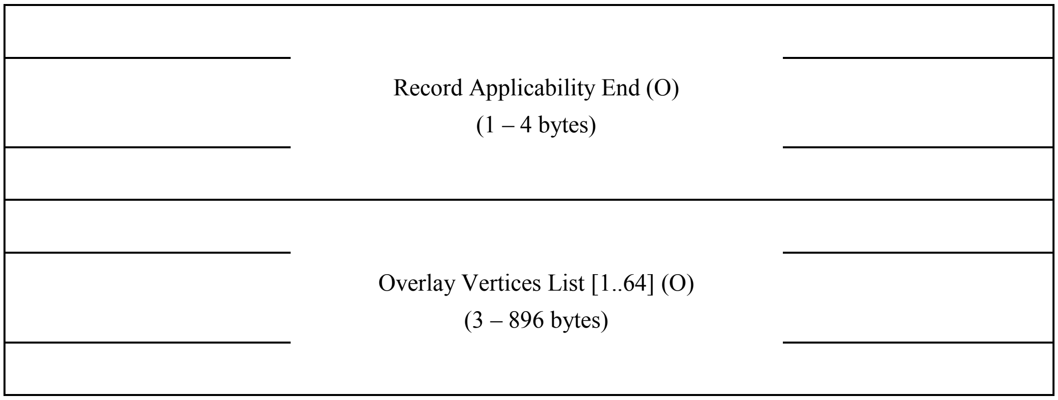

Figure 6-1. Graphical Overlay Record Format

7 Summary and Concluding Remarks

A general definition for the organization and content of several FIS-B products applicable to the airport surface and national airspace has been presented. There are numerous FIS-B products that can enhance aviation safety by providing crews timely information about known hazards and constraints to flight operations. These safety-related FIS-B products (e.g., NOTAMs, D-ATIS, TWIP, AIRMETs, SIGMETs, PIREPs, etc.) complement the traffic situation awareness that pilots will gain with the implementation of ADS-B and TIS-B. Furthermore, the FIS-B products can be delivered to aircraft using the same broadcast data links used for ADS-B and TIS-B. This multipurpose architecture minimizes aircraft and ground radio equipment and increases the benefits to operators.

Two record types were presented: text and graphical overlay. Separate records may be needed initially to accommodate existing services and facilitate the transition to a digital dissemination of the aforementioned products. However, it is foreseen that the graphical overlay record could be eliminated by encoding the products in a manner that enables the receiving avionics to reconstitute both the text and the graphical overlay from a single text record. The aerodrome and airspace product definitions described in this paper support this evolution while facilitating early implementation of these products in their current form.

The work on Aerodrome and Airspace FIS-B products is fairly new. This document addressed the formatting of data for communication, but does not attempt to cover many of the important elements required to successfully implement these products. Furthermore, there needs to be a comprehensive evaluation of the operational use of these products in the cockpit and the benefits from delivering them via data link. Additional research and development on the following elements is recommended:

- In the context of having a surface/navigation moving map display with the ownship position and possibly traffic information, an assessment of the benefits of adding FIS-B information
- Approaches for presenting Aerodrome and Airspace FIS-B products to pilots in the cockpit
- Ground system architecture for processing and disseminating the FIS-B products, considering both public and private service providers
- Mechanisms for gathering source data from the originating authorities in an electronic form that is standardized and readily usable by an FIS-B system

8 List of References

1. RTCA, Inc., October 2001, "User Requirements for Aerodrome Mapping Information," RTCA, DO-272.
2. ICAO, "Manual of Technical Provisions for the Aeronautical Telecommunications Network (ATN), Sub-Volume Two, Air/Ground Applications, Second Edition (Final Editor's Draft)" DOC 9705/AN956.
3. FAA, February 2000,"Notices to Airmen (NOTAM's)," FAA Order 7930.2G, Washington, D.C..
4. RTCA, Inc., April 2004, "Minimum Aviation System Performance Standards (MASPS) for Flight Information Services-Broadcast (FIS-B) Data Link," RTCA DO-267A.
5. ICAO, July 1997, "Aeronautical Information Services – Annex 15, Tenth Edition."
6. FAA, August 2000,, "Air Traffic Control," FAA Order 7110.65M, Washington, D.C.
7. FAA, July 2001, "Aeronautical Information Manual," Washington, D.C.
8. Strain, R., D. Stapleton, January 2006, *Aerodrome and Airspace FIS-B Product Definitions: NOTAMs, D-ATIS and TWIP*," MP 03W0000158R2, The MITRE Corporation, McLean, VA.

Appendix A Using the DLAC Character Set

A.1 DLAC Character Packing Format

Since a DLAC character doesn't use an entire byte (see Section A.2) in its representation, multiple DLAC characters can be packed together such that four characters can be carried in 3 bytes of data. This approach is derived from work done by UPS Aviation Technologies in the FAA's Capstone Program. Figure A-1 illustrates the character-packing scheme.

First Bit Transmitted ↓

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="2">(MSB)</td><td colspan="6">(LSB) Character 1 (MSB)</td></tr>
<tr><td colspan="4">Character 3 (MSB)</td><td colspan="4">(LSB) Character 2</td></tr>
<tr><td colspan="6">(LSB) Character 4 (MSB)</td><td colspan="2">(LSB)</td></tr>
</table>

Figure A-1. Character Packing Format

In the event there are an insufficient number of characters to fill a three-byte sequence, the last byte containing a character is padded with zeros and the remaining bytes in the sequence are dropped.

A.2 DLAC Character Set

The DLAC character set does not include lower case characters. Subsequently, the remaining characters can be represented by a six-bit value, representing a twenty-five percent saving over ASCII characters. The DLAC character set, developed by Lincoln Laboratory, is provided in Table A-1.

Table A-1. DLAC 6 Bit Character Set

Bit Encoding	Character	Bit Encoding	Character
000000	ETX	100000	SP
000001	A	100001	!
000010	B	100010	“
000011	C	100011	#
000100	D	100100	CS
000101	E	100101	%
000110	F	100110	&
000111	G	100111	‘
001000	H	101000	(
001001	I	101001	)
001010	J	101010	*
001011	K	101011	+
001100	L	101100	,
001101	M	101101	-
001110	N	101110	.
001111	O	101111	/
010000	P	110000	0
010001	Q	110001	1
010010	R	110010	2
010011	S	110011	3
010100	T	110100	4
010101	U	110101	5
010110	V	110110	6
010111	W	110111	7
011000	X	111000	8
011001	Y	111001	9
011010	Z	111010	:
011011	NC	111011	;
011100	TAB	111100	<

Bit Encoding	Character	Bit Encoding	Character
011101	RS	111101	=
011110	CRLF	111110	>
011111	|	111111	?

Notes:

SP = Space

ETX = End-of-Text

CR = Carriage Return/Line Feed

TAB = Tabulator (the binary value of the six bits following the TAB character define the number of blank characters to be inserted)

CS = Currency Sign (e.g., $)

NC = Null Character

RS = Record Separator

A.2.1 Control Characters

The ICAO DLAC character set contains control codes that govern the appearance and formatting of the text report. The following control characters are specified by the FIS-B MASPS for the DLAC character set.

- CRLF – This is the End-of-Line character (0x1E), which indicates a line break on the display.

  Note: The cockpit display application may insert line breaks as necessary for readability or display size limitations. In general, line breaks should be inserted only at logical separators.

- RS – This is the Record Separator character (0x1D). This character also implies a display line break, and can replace an End-of-Line character.
- ETX – This is the End-of-Text character (0x00), which denotes both a display line break as well as the end of the text report. It can also replace an End-of-Line and Record Separator characters in the last line of a multiple-report APDU.
- NC – The Null Character should be used to represent any characters not available using DLAC encoding (e.g., underscore or back slash).

Appendix B Encoding for Latitude and Longitude Fields

This section describes the encoding for latitude and longitude data used in the Overlay Geometry Encoding and specified in the Overlay Vertices List fields. This encoding is consistent with ARINC 743 avionics providing latitude/longitude on commercial aircraft (ARINC data labels 110, 111, 120,121), the ASTERIX Category 033 message exchange format and the ADS-B message format used by the Universal Access Transceiver (UAT) broadcast communication system.

Figure B-1 illustrates a representative format for latitude and longitude fields, but the resolution is specified by the particular Overlay Geometry Encoding. In the figure, 17 bits are used. The most significant bit of the latitude and longitude are transmitted first.

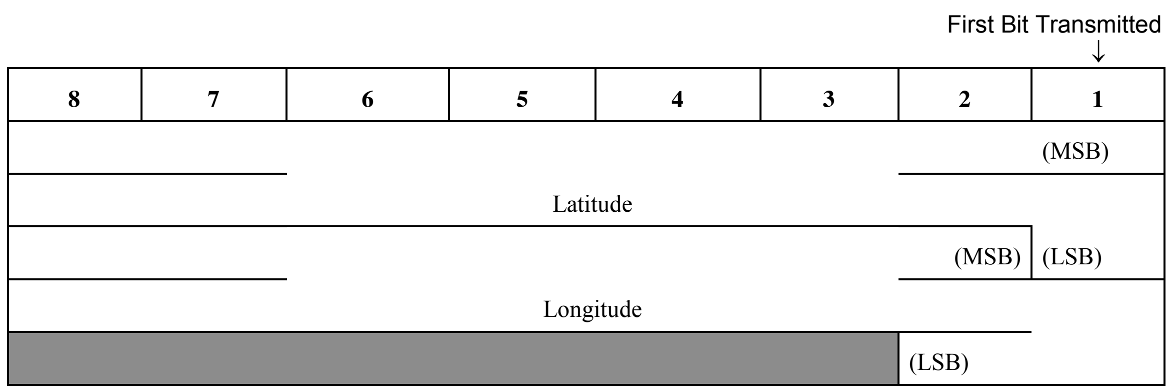

Figure B-1. Latitude and Longitude Bit Mapping

Latitude and longitude are encoded as angular weighted binary numerals. Table B-1 provides examples of the mapping between values and their binary representations. Figure B-2 provides a visual representation of the earth and how it is partitioned into the quadrants mentioned in Table B-1. Note that quadrants 2 and 3 represent invalid latitudes since the entire Northern Hemisphere is in quadrant 1 and the Southern Hemisphere is in quadrant 4. The quadrants are for used to assist the reader in understanding the encoding, but are not used as part of the encode/decode process.

Table B-1. Example Latitude and Longitude Encoding (b = 17)

Quadrant	Latitude or Longitude bits (MSB … LSB)	Meaning $INCR = Lsb = \frac{360}{2^b} = 0.002746582$ — Latitude	Meaning — Longitude
1st quadrant	0 0000 0000 0000 0000	ZERO degrees (Equator)	ZERO degrees (Prime Meridian)
	0 0000 0000 0000 0001	*INCR* degrees North	*INCR* degrees East
	…	…	…
	0 1111 1111 1111 1111	(90-*INCR*) degrees North	(90-*INCR*) degrees East
2nd quadrant	0 1000 0000 0000 0000	90 degrees (North Pole)	90 degrees East
	0 1000 0000 0000 0001	<Illegal Values>	(90+*INCR*) degrees East
	…	<Illegal Values>	…
	0 1111 1111 1111 1111	<Illegal Value>	(180-*INCR*) degrees East
3rd quadrant	1 0000 0000 0000 0000	<Illegal Value>	180 degrees East or West
	1 0000 0000 0000 0001	<Illegal Value>	(180-*INCR*) degrees West
	…	<Illegal Values>	…
	1 0111 1111 1111 1111	<Illegal Values>	(90-INCR) degrees West
4th quadrant	1 1000 0000 0000 0000	-90 degrees (South Pole)	90 degrees West
	1 1000 0000 0000 0001	(90-*INCR*) degrees South	(90-*INCR*) degrees West
	…	…	…
	1 1111 1111 1111 1111	*INCR* degrees South	*INCR* degrees West

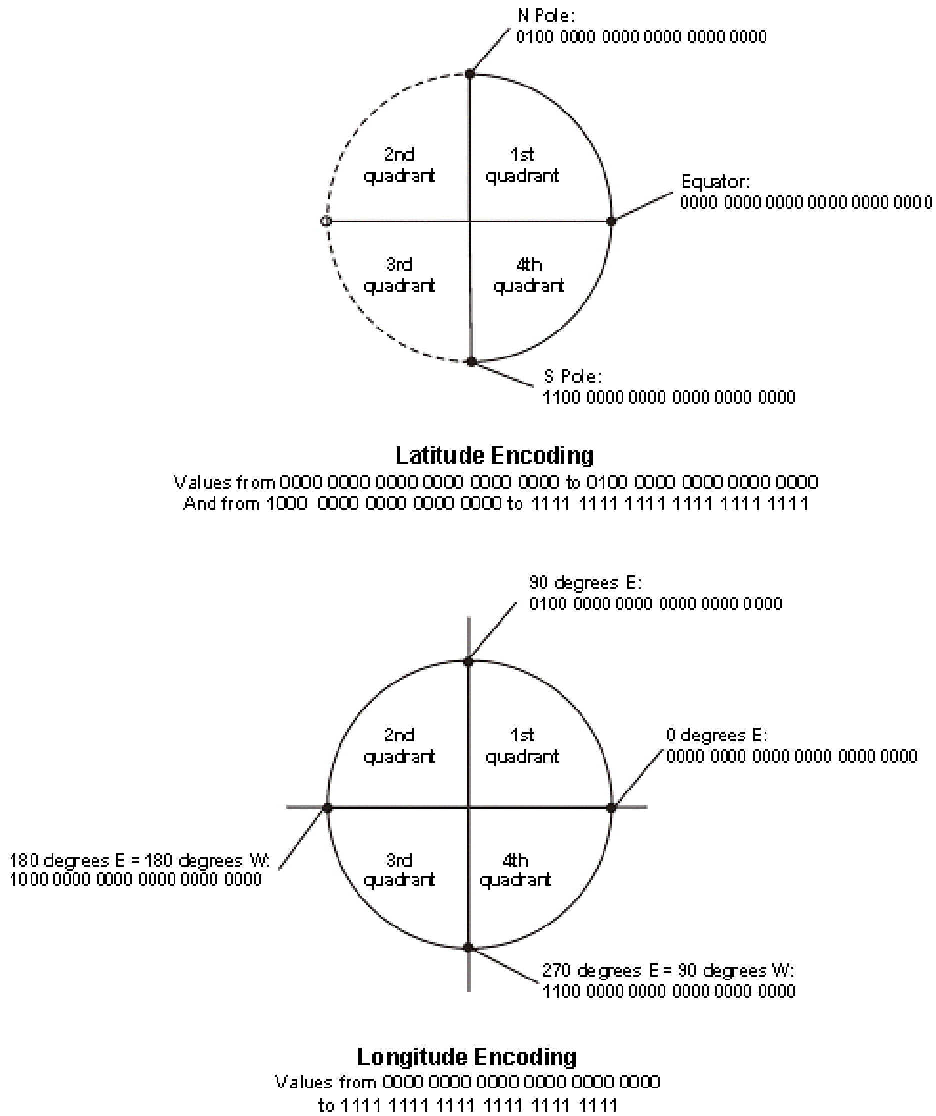

Figure B-2. Angular Weighted Binary Encoding Quadrants

The encoding for the latitude and longitude coordinates is a two's compliment representation of the binary values. The decimal coordinate values should be represented in degrees (e.g., 78.3862); positive for easterly longitude and northerly latitude values and negative for westerly longitude and southerly latitude values.

The decimal coordinate value that is encoded must be a multiple of the coordinate resolution (INCR=$360/2^b$), b = the number of bits used to represent the value. The following examples use b = 17 bits. The binary values are obtained by applying the following algorithm:

$$I = \pm (|D| - \mathrm{mod}(|D|, INCR))$$

D = original coordinate value in decimal (where | | is the magnitude symbol)

I = rounded coordinate value in decimal

The convention for rounding coordinate values is to round them toward zero by taking the modulus of the magnitude of the coordinate value and subtracting the result from the magnitude of the coordinate value. If the coordinate value is negative the sign is ignored during the rounding calculation and reapplied to the result.

The following are some example encodings of latitude and longitude values using this approach.

1. Encode 90.00 degrees East longitude (+90.00)

    a. Since the number is positive, it can be represented in binary directly.

$$90.00 – \mathrm{mod}(90.00,0.002746) = 90/0.002746 = 32768$$

    b. Represent the magnitude of the number (i.e., 32768).

0 1000 0000 0000 0000

So, 90.00_{10} is 0 1000 0000 0000 0000.

2. Decode 90.00 degrees West longitude (-90.00)

    a. First, note that the number is negative, since it has a 1 in the sign bit place.

    b. Change the sign to get the magnitude of the number by taking the two's compliment.

```
  1 1000 0000 0000 0000
¬0 0111 1111 1111 1111
+                     1
  0 1000 0000 0000 0000
```

    c. Convert the magnitude to decimal: $8000_{16} = 8 \times 4096 = 32768_{10} \times 0.002746 = 90.00$

    d. Since the original number was negative, the result is –90

3. Encode 89.53 degrees West longitude (-89.53)

a. First, note that the number is negative.

$$89.53 - \mathrm{mod}(89.53, 0.002746) = -89.5275879/0.002746 = -32596$$

b. Represent the magnitude of the number, then change the sign by taking the two's compliment.

```
 0 0111 1111 0101 0100
¬1 1000 0000 1010 1011
+                    1
 1 1000 0000 1010 1100
```

So, -89.53_{10} is 1 1000 0000 1010 1100 as a 17-bit, twos compliment number.

Appendix C Example NOTAMS

The following examples are proposed for the Memphis evaluations to illustrate the use of graphical overlays on airport maps. These reports are translated into messages and sent to a communication system for uplink to aircraft. These examples represent the APDU payload only.

C.1 Distant NOTAM Example 1–Airport Closure

C.1.1 Text Record Encoding

Text 913/02 KMEM AD CLSD WEF 020412080000-020601000000

Table C-1. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	38	00000000 00100110
Report Identifier		
Report Number	12913	11001010 000101
Report Year	02	0000010
Report Status	1 (active)	1
Text Data	KMEM AD CLSD WEF 020412080000-020601000000 (42 characters)	001011 001101 000101 001101 100000 000001 000100 100000 000011 001100 010011 000100 100000 010111 000101 000110 100000 110000 110010 110000 110100 110001 110010 110000 111000 110000 110000 110000 110000 101101 110000 110010 110000 110110 110000 110001 110000 110000 110000 110000 110000 110000 000000 (43 characters, 33 bytes)

C.1.2 Overlay Record Encoding

Table C-2. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Overlay Record Length	20	0000010100
Report Identifier		
Report Number	12913	11001010 000101
Report Year	02	0000010
Overlay Record Identifier	1	0000
Object Label Flag	1 (alphanumeric)	1
Object Label (DLAC)	KMEN	001011 001101 000101 001101
Object Type	0 (airport)	0000
Object Element Flag	0 (no element)	0
Object Element (optional)	0	0000
Object Status	0 (closed)	0000
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	3 (start/end times)	11
Date/Time Format	1 (month, day, hours, mins)	01
Record Applicability Start (optional)		
Month (optional)	4 (April)	00000100
Day (optional)	12	00001100

Field	Actual Value	Binary APDU Encoding
Hour	8 (8am UTC)	00001000
Minutes (optional)	00	00000000
Record Applicability End (optional)		
Month (optional)	6 (June)	00000110
Day (optional)	1	00000001
Hour	0 (12am UTC)	00000000
Minutes (optional)	NA	
Overlay Geometry Options	0 (no geometry)	0000
Overlay Operator	NA	
Overlay Vertices Count (optional)	NA	
Overlay Vertices List (optional)		
X Value	NA	
Y Value	NA	
Z Value	NA	

C.2 Distant NOTAM Example 2–Displaced Threshold

C.2.1 Text Record Encoding

Text 012/02 KMEM 36R THR DSPLCD 600

Table C-3. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	29	00000000 00011101
Report Identifier		
Report Number	12012	10111011 101100
Report Year	02	0000010

Field	Actual Value	Binary APDU Encoding
Report Status	1 (active)	1
Text Data	KMEM 36R THR DSPLCD 600 (23 characters)	001011 001101 000101 001101 100000 110011 110110 010010 100000 010100 001000 010010 100000 000100 010011 010000 001100 000011 000100 100000 110110 110000 110000 000000 (24 characters, 18 bytes)

C.2.2 Overlay Record Encoding

Table C-4. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Overlay Record Length	14	0000001100
Report Identifier		
Report Number	12012	10111011 101100
Report Year	02	0000010
Overlay Record Identifier	1	0000
Object Label Flag	1 (alphanumeric)	1
Object Label	36R <DLAC>	110011 110110 010010 000000
Object Type	1 (runway)	0001
Object Element Flag	1 (element exists)	1
Object Element (optional)	4 (threshold)	0100
Object Status	4 (displaced)	0100
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	1 (parameter exists)	1

Field	Actual Value	Binary APDU Encoding
Object Parameter Type (optional)	3 (length in feet)	00011
Object Parameter Value (optional)	600	001001011000
Record Applicability Options	0 (no times given)	00
Date/Time Format	0 (not used)	00
Record Applicability Start (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	0 (no geometry)	0000
Overlay Operator	NA	
Overlay Vertices Count (optional)	NA	0000 (to fit byte boundary)
Overlay Vertices List (optional)		
X Value	NA	
Y Value	NA	
Z Value	NA	

C.3 Distant NOTAM Example 3–Taxiway Segment Closure

C.3.1 Text Record Encoding

Text 008/02 KMEM TWY A CLSD BTN TWY S AND TWY B

Table C-5. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001

Field	Actual Value	Binary APDU Encoding
Spare	NA	0000
Location Identifier	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	41	000000000 0101001
Report Identifier		
Report Number	12008	10111011 101000
Report Year	02	0000010
Report Status	1 (active)	1
Text Data	KMEM TWY A CLSD BTN TWY S AND TWY B (35 characters)	001011 001101 000101 001101 100000 010100 010111 011001 100000 000001 100000 000011 001100 010011 000100 100000 000010 010100 001110 100000 010100 010111 011001 100000 010011 100000 000001 001110 000100 100000 010100 010111 011001 100000 000010 000000 (36 characters, 27 bytes)

C.3.2 Overlay Record Encoding

Table C-6. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Overlay Record Length	20	00000110 11
Report Identifier		
Report Number	12008	10111011 101000
Report Year	02	0000010
Overlay Record Identifier	1	0000

Field	Actual Value	Binary APDU Encoding
Object Label Flag	1 (alphanumeric)	1
Object Label	A/S/B <DLAC>	000001 101111 010011 101111 000010 000000 000000 000000
Object Type	2 (taxiway)	0010
Object Element Flag	0 (no element)	0
Object Element	NA	00000 (to fit byte boundary)
Object Status	0 (closed)	0000
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	0 (no times given)	00
Date/Time Format	0 (not used)	00
Record Applicability Start (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	1 (low res geometry)	0001
Overlay Operator	0 (no operator)	00
Overlay Vertices Count (optional)	2 (line)	000010
Overlay Vertices List (optional)		
X Value	-190 (from ref pt [m]) Evaluate: (-(190 – mod(190, 5)) / 5) + 2048	10000010 0110 (2086)

Field	Actual Value	Binary APDU Encoding
Y Value	+533 (from ref pt [m]) Evaluate: ((533 – mod(533, 5)) / 5) + 2048	10000110 1010 (2154)
X Value	-398 (from ref pt [m]) Evaluate: (-(398 – mod(398, 5)) / 5) + 2048	01111011 0001 (1969)

C.4 Distant NOTAM Example 4–Closed Runway

C.4.1 Text Record Encoding

Text 091/02 KMEM RWY 18R/36L CLSD JET

Table C-7. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	27	00000000 00011011
Report Identifier		
Report Number	12091	10111100 111011
Report Year	02	0000010
Report Status	1 (active)	1

Field	Actual Value	Binary APDU Encoding
Text Data	KMEM RWY 18R/36L CLSD JET (25 chars)	001011 001101 000101 001101 100000 010010 010111 011001 100000 110001 111000 010010 101111 110011 110110 001100 100000 000011 001100 010011 000100 100000 001010 000101 010100 000000 (26 characters, 19 bytes)

C.4.2 Overlay Record Encoding

Table C-8. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Overlay Record Length	30	00000100 00
Report Identifier		
Report Number	12091	10111100 111011
Report Year	02	0000010
Overlay Record Identifier	1	0000
Object Label Flag	1 (alphanumeric)	1
Object Label	18R/36L <DLAC>	110001 111000 010010 101111 110011 110110 001100 100000
Object Type	1 (runway)	0001
Object Element Flag	0 (no element)	0
Object Element (optional)	NA	0000 (to fit byte boundary)
Object Status	1 (closed-conditional)	0001
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0

Field	Actual Value	Binary APDU Encoding
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	0 (no times given)	00
Date/Time Format	0 (not used)	00
Record Applicability Start (optional)	NA	
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	1 (low res 2D Polygon)	0001
Overlay Operator	0 (no operator)	00
Overlay Vertices Count (optional)	2 (line)	000010
Overlay Vertices List (optional)		
X Value	+905 (from ref pt [m]) Evaluate: ((905 – mod(905, 5)) / 5) + 2048	10001011 0101 (2229)
Y Value	-2175 (from ref pt [m]) Evaluate: (-(2175 – mod(2175, 5)) / 5) + 2048	01100100 1101 (1613)
X Value	+965 (from ref pt [m]) Evaluate: ((965 – mod(965, 5)) / 5) + 2048	10001100 0001 (2241)
Y Value	+650 (from ref pt [m])	10001000 0010

Field	Actual Value	Binary APDU Encoding
	Evaluate: ((650 – mod(650, 5)) / 5) + 2048	(2178)

C.5 NOTAM Example 5–Temporary Flight Restriction

C.5.1 Text Record Encoding

Text 0032/02 KMEM TFR ALL ACFT AT AND BLW 8000 FT MSL WI 2 NM OF 3504N/8953W OR MEM VORTAC 080 DEG RADIAL AT 5 NM

Table C-9. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	106	00000000 01101010
Report Identifier		
Report Number	32	00000000 100000
Report Year	02	0000010
Report Status	1 (active)	1

Field	Actual Value	Binary APDU Encoding
Text Data	KMEM TFR ALL ACFT AT AND BLW 8000 FT MSL WI 2 NM OF 3504N/8953W OR MEM VORTAC 080 DEG RADIAL AT 5 NM (100 characters)	001011 001101 000101 001101 100000 010100 000110 010010 100000 000001 001100 001100 100000 000001 000011 000110 010100 100000 000001 010100 100000 000001 001110 000100 100000 000010 001100 010111 100000 111000 110000 110000 110000 100000 000110 010100 100000 001101 010011 001100 100000 010111 001001 100000 110010 100000 001110 001101 100000 001111 000110 100000 110011 110101 110000 110100 001110 101111 111000 111001 110101 110011 010111 100000 001111 010010 100000 001101 000101 001101 100000 010110 001111 010010 010100 000001 000011 100000 110000 111000 110000 100000 000100 000101 000111 100000 010010 000001 000100 001001 000001 001100 100000 000001 010100 100000 110101 100000 001110 001101 000000 (101 characters, 76 bytes)

C.5.2 Overlay Record Encoding

Table C-10. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Overlay Record Length	75	01001011
Report Identifier		
Report Number	32	000000 00100000
Report Year	02	0000010
Overlay Record Identifier	1	0000
Object Label Flag	1 (alphanumeric)	1
Object Label	0<Integer>	00000000 00000000
Object Type	14 (airspace)	1110
Object Element Flag	1	1
Object Element (optional)	0 (TFR)	0000
Object Status	0 (closed)	0000
Object Qualifier Flag	0	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	0 (no times given)	00
Date/Time Format	0 (not used)	00
Record Applicability Start (optional)		
Month (optional)	NA	
Day (optional)	NA	

Field	Actual Value	Binary APDU Encoding
Hour	NA	
Minutes (optional)	NA	
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	7 (Extended Range Circular Prism)	110
Overlay Operator	0 (no operator)	00
Overlay Vertices Count (optional)	1	0001
Overlay Vertices List (optional)		
lng:	89^o 53'W (-89.8833) [(89+(53/60)) = 89.8833] Evaluate: two's compliment of{ binary of [(89.8833-mod(89.8833,(360/2^18)))/(360/2^18)] }	110000000001010101 (two's complement of (binary of 65451) = 110000000001010101) = 196693
lat:	35^o 4' N (+35.07083333) [(35 + (4/60)) = 35.06666666] Evaluate: binary of [(35.06666-mod(35.0666,(360/2^18)))/(360/2^18)]	111001110001000010 (two's complement of (binary of 25534) = 111001110001000010 = 236610
z_{low}	0 Evaluate: [0 / 500]	000000 (0)
z_{high}	8000 Evaluate: [8000 / 500]	010000 (16)
r_{lng}	2 Evaluate: (2 * 5)	00000101 0 (10)
r_{lat}	2 Evaluate: (2 * 5)	00000101 0 (10)
α	0	00000000

C.6 NOTAM Example 6–Temporary Flight Restriction w/ Multiple Records

C.6.1 Text Record Encoding

Text

FDC 3/2126 ZDC PART 1 OF 4 FLIGHT RESTRICTIONS WASHINGTON DC. THIS IS A MODIFICATION OF INFORMATION PREVIOUSLY ISSUED IN FDC NOTAM 3/1850. EFFECTIVE 0303182000 UTC (MARCH 18 AT 1500 LOCAL) UNTIL FURTHER NOTICE. PURSUANT TO 14 CFR SECTION 99.7, SPECIAL SECURITY INSTRUCTIONS; AND 91.139, EMERGENCY AIR TRAFFIC RULES; THE FOLLOWING PROCEDURES ARE IN EFFECT. PART I. DEFINITIONS. A. THE WASHINGTON DC METROPOLITAN AREA AIR DEFENSE IDENTIFICATION ZONE (DC ADIZ) FOR PURPOSES OF THIS NOTAM ONLY, IS THAT AREA OF AIRSPACE OVER THE SURFACE OF THE EARTH WHERE THE READY IDENTIFICATION, LOCATION, AND CONTROL OF AIRCRAFT IS REQUIRED IN THE INTERESTS OF NATIONAL SECURITY. SPECIFICALLY, THE DC ADIZ IS THAT AIRSPACE, FROM THE SURFACE TO BUT NOT INCLUDING FL180, WITHIN THE OUTER BOUNDARY OF THE WASHINGTON DC TRI-AREA CLASS B AIRSPACE AREA; AND THAT ADDITIONAL AIRSPACE CONTAINED WITHIN AN AREA BOUNDED BY A LINE BEGINNING AT 383712N/0773600W; THENCE COUNTER CLOCKWISE ALONG THE 30-MILE ARC OF THE DCA VOR/DME TO 384124N/0762548W; THENCE WEST ALONG THE SOUTHERN BOUNDARY OF THE WASHINGTON DC TRI-AREA CLASS B AIRSPACE AREA TO THE POINT OF BEGINNING. END PART 1 OF 4

FDC 3/2126 ZDC PART 2 OF 4 FLIGHT RESTRICTIONS WASHINGTON DC. B. THE WASHINGTON DC METROPOLITAN AREA FLIGHT RESTRICTED ZONE (FRZ) IS DEFINED AS AN AREA BOUNDED BY A LINE BEGINNING AT THE WASHING- TON /DCA/ VOR/DME 300 DEGREE RADIAL AT 15 NM 385655N/0772008W THENCE CLOCKWISE ALONG THE DCA 15 NM ARC TO THE DCA 022 DEGREE RADIAL AT 15 NM 390611N/0765751W THENCE SOUTHEAST VIA A LINE DRAWN TO THE DCA 049 DEGREE RADIAL AT 14 NM 390218N/0765038W THENCE SOUTH VIA A LINE DRAWN TO THE DCA 064 DEGREE RADIAL AT 13 NM 385901N/0764832W THENCE CLOCKWISE ALONG THE DCA 13 NM ARC TO THE DCA 282 DEGREE RADIAL AT 13 NM 385214N/0771848W THENCE NORTH VIA A LINE DRAWN TO THE POINT OF BEGINNING; EXCLUDING THE AIR- SPACE WITHIN A 1 NM RADIUS OF FREEWAY AIRPORT /W00/ MITCHELLVILLE, MD, FROM THE SURFACE UP TO BUT NOT INCLUDING FL180. THE FRZ IS WITHIN AND PART OF THE

WASHINGTON DC METROPOLITAN ADIZ. PART II. THE FOLLOWING PROCEDURES APPLY WITHIN THE WASHINGTON DC METROPOLITAN ADIZ: END PART 2 OF 4

FDC 3/2126 ZDC PART 3 OF 4 FLIGHT RESTRICTIONS WASHINGTON DC. A. EXCEPT AS PROVIDED IN PART II. B, BELOW, NO PERSON MAY OPERATE AN AIRCRAFT, INCLUDING ULTRALIGHT VEHICLES, CIVIL AIRCRAFT, AND PUBLIC AIRCRAFT, IN THIS ADIZ, UNLESS, IN ADDITION TO ALL OTHER APPLICABLE RULES OF 14 CFR, THE AIRCRAFT OPERATOR ENSURES THAT THE FOLLOWING REQUIREMENTS ARE MET: 1. THE AIRCRAFT IS EQUIPPED WITH AN OPERABLE TWO-WAY RADIO CAPABLE OF COMMUNICATING WITH ATC ON APPROPRIATE RADIO FREQUENCIES; 2. THE FLIGHT CREW ESTABLISHES TWO-WAY RADIO COMMUNICATIONS WITH THE APPROPRIATE ATC FACILITY BEFORE OPERATING IN THIS ADIZ AND THE FLIGHT CREW MAINTAINS THE CAPABILITY OF CONTINUING TWO-WAY RADIO COMMUNICATIONS WITH THE APPROPRIATE ATC FACILITY WHILE OPERATING IN THIS ADIZ; AIRCRAFT OPERATING IN AN AIRPORT TRAFFIC PATTERN AT NON-TOWERED AIRPORTS ARE EXEMPT FROM THE ATC COMMUNICATION REQUIREMENT, PROVIDED THEY MONITOR THE AIR- PORT CTAF. 3. THE FLIGHT CREW, PRIOR TO OPERATING WITHIN CLASS B, C, OR D AIRSPACE THAT IS WITHIN THIS ADIZ, RECEIVES A SEPARATE ATC CLEARANCE TO ENTER THE CLASS B, C, OR D AIRSPACE; 4. THE AIRCRAFT IS EQUIPPED WITH AN OPERATING TRANSPONDER WITH AUTOMATIC ALTITUDE REPORTING CAPABILITY AS SPECIFIED IN 14 CFR SECTION 91.215; END PART 3 OF 4

FDC 3/2126 ZDC PART 4 OF 4 FLIGHT RESTRICTIONS WASHINGTON DC. 5. PRIOR TO OPERATING THE AIRCRAFT IN THIS ADIZ, THE FLIGHT CREW OBTAINS A DISCRETE TRANSPONDER CODE FROM ATC; 6. THE AIRCRAFTS TRANSPONDER CONTINUOUSLY TRANSMITS THE ATC ISSUED DISCRETE TRANSPONDER CODE WHILE THE AIRCRAFT IS OPERATING IN THIS ADIZ; 7. PRIOR TO OPERATING AN AIRCRAFT IN THE DC ADIZ, PILOTS MUST FILE THEIR FLIGHT PLAN WITH AN AFSS; MUST ACTIVATE THEIR FLIGHT PLAN PRIOR TO DEPARTURE OR ENTERING THE DC ADIZ; AND CLOSE THEIR FLIGHT PLANS UPON LANDING OR LEAVING THE DC ADIZ. B. AIRCRAFT OPERATIONS BY THE U.S. MILITARY, LAW ENFORCEMENT, AND AEROMEDICAL FLIGHTS ARE EXEMPT FROM THE REQUIREMENTS OF PART II A. PARAGRAPH 7. PART III. THE FOLLOWING PROCEDURES APPLY WITHIN THE WASHINGTON DC METROPOLITAN FRZ. A. UNLESS SPECIFICALLY AUTHORIZED BY THE FAA IN CONSULTATION WITH THE UNITED STATES SECRET SERVICE AND THE TRANSPORTATION SECURITY ADMINISTRATION, ALL PARTS 91, 101, 103, 105, 125, 133, 135,

137 FLIGHT OPERATIONS ARE PROHIBITED WITHIN THE WASHINGTON D.C. METROPOLITAN FRZ. B. THESE RESTRICTIONS DO NOT APPLY TO DOD, LAW ENFORCEMENT, OR AEROMEDICAL FLIGHT OPERATIONS THAT ARE IN CONTACT WITH ATC AND ARE DISPLAYING AN ATC ASSIGNED DISCRETE TRANSPONDER BEACON CODE. END PART 4 OF 4

Table C-11. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier	ZDC	011010 000100 000011 000000
Record Reference Point	255 (Ext Ref)	11111111
Text Record Length	4663	00001101 10101011
Report Identifier		
Report Number	2126	00100001 001110
Report Year	03	00 00011
Report Status	1 (active)	1
Text Data	[See text message above] (4658 characters)	000110 100000 000110 100000 000110 100000 000110 000100 100000 000100 100000 000100 100000 000100 000011 100000 000011 100000 000011 100000 000011 100000 100000 100000 100000 100000 100000 100000 110011 100000 110011 100000 110011 100000 110011 101111 100000 101111 100000 101111 100000 101111 110010 100000 110010 100000 110010 100000 110010 110001 100000 110001 100000 110001 100000 110001 110010 100000 110010 100000 110010 100000 110010 110110 100000 110110 100000 110110

Field	Actual Value	Binary APDU Encoding
		100000 110110 100000 100000 100000 100000 100000 100000 100000 011010 100000 011010 100000 011010 100000 011010 000100 100000 000100 100000 000100 100000 000100 000011 100000 000011 100000 000011 100000 000011 100000 100000 100000 100000 100000 100000 100000 010000 100000 010000 100000 010000 100000 010000 000001 100000 000001 100000 000001 100000 000001 010010 100000 010010 100000 010010 100000 010010 010100 100000 010100 100000 010100 100000 010100 100000 100000 100000 100000 100000 100000 100000 110001 100000 110010 100000 110011 100000 110100 100000 100000 100000 100000 100000 100000 100000 001111 100000 001111 100000 001111 100000 001111 000110 100000 000110 100000 000110 100000 000110 100000 100000 100000 100000 100000 100000 100000 110100 100000 110100 100000 110100 100000 110100 100000 100000 100000 100000 100000 100000 100000 000110 100000 000110 100000 000110 100000 000110 001100 100000 001100 100000 001100 100000 001100 001001 100000 001001 100000 001001 100000 001001 000111 100000 000111 100000 000111 100000 000111 001000 100000 001000 100000 001000 100000 001000

Field	Actual Value	Binary APDU Encoding
		010100 100000 010100 100000 010100 100000 010100 100000 100000 100000 100000 100000 100000 100000 010010 100000 010010 100000 010010 100000 010010 000101 100000 000101 100000 000101 100000 000101 010011 100000 010011 100000 010011 100000 010011 010100 100000 010100 100000 010100 100000 010100 010010 100000 010010 100000 010010 100000 010010 001001 100000 001001 100000 001001 100000 001001 000011 100000 000011 100000 000011 100000 000011 010100 100000 010100 100000 010100 100000 010100 001001 100000 001001 100000 001001 100000 001001 001111 100000 001111 100000 001111 100000 001111 001110 100000 001110 100000 001110 100000 001110 010011 100000 010011 100000 010011 100000 010011 100000 100000 100000 100000 100000 100000 100000 010111 100000 010111 100000 010111 100000 010111 000001 100000 000001 100000 000001 100000 000001 010011 100000 010011 100000 010011 100000 010011 001000 100000 001000 100000 001000 100000 001000 001001 100000 001001 100000 001001 100000 001001 001110 100000 001110 100000 001110 100000 001110 000111 100000 000111 100000 000111 100000 000111 010100 100000

Field	Actual Value	Binary APDU Encoding
		010100 100000 010100 100000 010100 001111 100000 001111 100000 001111 100000 001111 001110 100000 001110 100000 001110 100000 001110 100000 100000 100000 100000 100000 100000 100000 000100 100000 000100 100000 000100 100000 000100 000011 100000 000011 100000 000011 100000 000011 101110 100000 101110 100000 101110 100000 101110 100000 100000 100000 100000 100000 100000 100000 010100 100000 000010 100000 000001 100000 110101 001000 100000 101110 100000 101110 100000 101110 001001 100000 100000 100000 100000 100000 100000 010011 100000 010100 100000 000101 100000 010000 100000 100000 001000 100000 011000 100000 010010 001001 100000 000101 100000 000011 100000 001001 010011 100000 100000 100000 000101 100000 001111 100000 100000 010111 100000 010000 100000 010010 000001 100000 000001 100000 010100 100000 100000 100000 100000 010011 100000 100000 100000 010100 001101 100000 001000 100000 000001 100000 001111 001111 100000 001001 100000 010011 100000 100000 000100 100000 001110 100000 100000 100000 001111 001001 100000 000111 100000 010000 100000 010000 000110 100000 010100 100000

Field	Actual Value	Binary APDU Encoding
		010010 100000 000101 001001 100000 001111 100000 001111 100000 010010 000011 100000 001110 100000 010110 100000 000001 000001 100000 100000 100000 001001 100000 010100 010100 100000 000100 100000 000100 100000 001001 001001 100000 000011 100000 000101 100000 001110 001111 100000 100000 100000 000100 100000 000111 001110 100000 001101 100000 100000 100000 100000 100000 100000 000101 100000 001001 100000 010100 001111 100000 010100 100000 001110 100000 001000 000110 100000 010010 100000 100000 100000 000101 100000 100000 001111 100000 010000 100000 100000 001001 100000 010000 100000 000001 100000 000001 001110 100000 001111 100000 010010 100000 001001 000110 100000 001100 100000 010100 100000 010010 001111 100000 001001 100000 100000 100000 000011 010010 100000 010100 100000 001001 100000 010010 001101 100000 000001 100000 001001 100000 000001 000001 100000 001110 100000 101110 100000 000110 010100 100000 100000 100000 100000 100000 010100 001001 100000 000001 100000 000010 100000 100000 001111 100000 010010 100000 101100 100000 001001 001110 100000 000101 100000 100000 100000

Field	Actual Value	Binary APDU Encoding
		001110 100000 100000 000001 100000 000010 100000 100000 010000 100000 100000 100000 000101 100000 010100 010010 100000 000110 100000 001100 100000 001000 000101 100000 001100 100000 001111 100000 001001 010110 100000 001001 100000 010111 100000 010011 001001 100000 000111 100000 101100 100000 100000 001111 100000 001000 100000 100000 100000 000001 010101 100000 010100 100000 001110 100000 000100 010011 100000 100000 100000 001111 100000 001001 001100 100000 010010 100000 100000 100000 011010 011001 100000 000101 100000 010000 100000 101100 100000 100000 010011 100000 000101 100000 100000 001001 100000 010100 100000 010010 100000 010100 010011 100000 010010 100000 010011 100000 001000 010011 100000 001001 100000 001111 100000 000101 010101 100000 000011 100000 001110 100000 100000 000101 100000 010100 100000 100000 100000 000110 000100 100000 000101 100000 001101 100000 001100 100000 100000 000100 100000 000001 100000 001001 001001 100000 100000 100000 011001 100000 000111 001110 100000 011010 100000 100000 100000 001000 100000 100000 001111 100000 001111 100000 010100 000110

Field	Actual Value	Binary APDU Encoding
		100000 001110 100000 010000 100000 100000 000100 100000 000101 100000 000101 100000 000011 000011 100000 100000 100000 010010 100000 010010 100000 100000 101000 100000 000001 100000 000101 001110 100000 000110 100000 010100 100000 010111 001111 100000 010010 100000 000101 100000 100000 010100 100000 011010 100000 100000 100000 001111 000001 100000 101001 100000 000001 100000 000010 001101 100000 100000 100000 001110 100000 010100 100000 100000 001001 100000 100000 100000 000001 110011 100000 010011 100000 000001 100000 001001 101111 100000 100000 100000 001001 100000 001110 110001 100000 000100 100000 010010 100000 010011 111000 100000 000101 100000 000011 100000 100000 110101 100000 000110 100000 010010 100000 000001 110000 100000 001001 100000 000001 100000 100000 101110 100000 001110 100000 000110 100000 000100 100000 100000 000101 100000 010100 100000 001001 000101 100000 000100 100000 101100 100000 010011 000110 100000 100000 100000 100000 100000 000011 000110 100000 000001 100000 001001 100000 010010 000101 100000 010011 100000 001110 100000 000101 000011 100000 100000

Field	Actual Value	Binary APDU Encoding
		100000 000011 100000 010100 010100 100000 000001 100000 001100 100000 000101 001001 100000 001110 100000 010101 100000 100000 010110 100000 100000 100000 000100 100000 010100 000101 100000 000001 100000 001001 100000 010010 100000 100000 010010 100000 001110 100000 000001 110000 100000 000101 100000 000111 100000 001110 110011 100000 000001 100000 100000 100000 010011 110000 100000 100000 100000 010101 100000 010000 110011 100000 000010 100000 001100 100000 001111 110001 100000 001111 100000 010100 100000 001110 111000 100000 010101 100000 010010 100000 000100 110010 100000 001110 100000 000001 100000 000101 110000 100000 000100 100000 001100 100000 010010 110000 100000 000101 100000 001001 100000 100000 110000 100000 000100 100000 000111 100000 000011 100000 100000 100000 100000 001000 100000 001111 010101 100000 000010 100000 010100 100000 000100 010100 100000 011001 100000 100000 100000 000101 000011 100000 100000 100000 010110 100000 100000 100000 100000 000001 100000 000101 100000 000110 101000 100000 100000 100000 001000 100000 010010 001101 100000 001100 100000 001001

Field	Actual Value	Binary APDU Encoding
		100000 001111 000001 100000 001001 100000 000011 100000 001101 010010 100000 001110 100000 001100 100000 100000 000011 100000 000101 100000 000101 100000 000001 001000 100000 100000 100000 010011 100000 010100 100000 100000 000010 100000 101100 100000 000011 110001 100000 000101 100000 100000 100000 111011 111000 100000 000111 100000 000011 100000 100000 100000 100000 001001 100000 001001 100000 110110 000001 100000 001110 100000 010110 100000 101110 010100 100000 001110 100000 001001 100000 100000 100000 100000 001001 100000 001100 100000 010100 110001 100000 001110 100000 100000 100000 001000 110101 100000 000111 100000 000001 100000 000101 110000 100000 100000 100000 001001 100000 100000 110000 100000 0000 (4658 characters, 3494 bytes)

C.6.2 Overlay Record Encoding

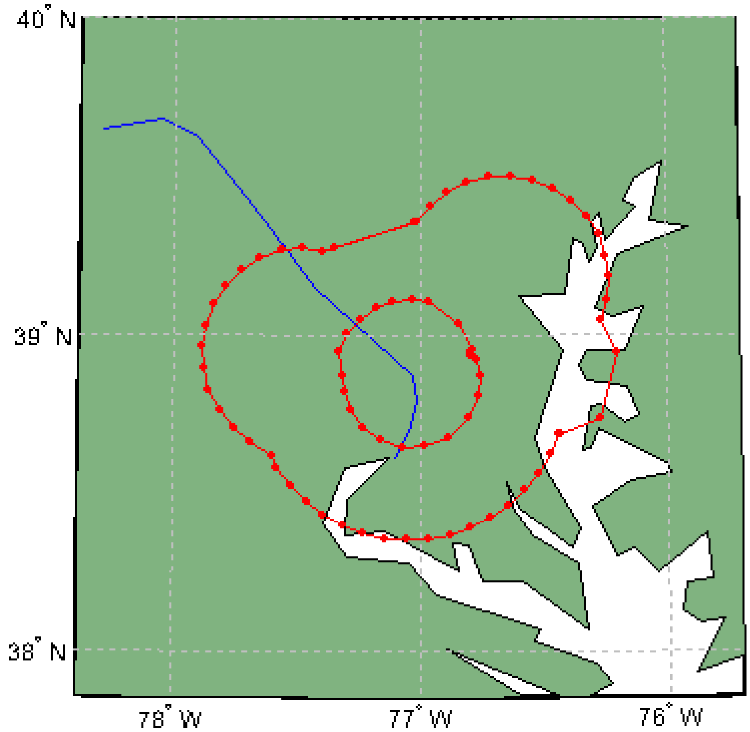

Figure C-1. Combined Overlays of the ADIZ and FRZ over Washington, DC

Table C-12. Overlay Record Encoding for ADIZ

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	ZDC	011010 000100 000011 000000
Record Reference Point	255 (Ext Ref)	11111111
Overlay Record Length	344	0101011000
Report Identifier		
Report Number	2126	00100001 001110
Report Year	03	0000011
Overlay Record Identifier	1	001
Object Label Flag	1 (alphanumeric)	1
Object Label	R-6611A (restricted area)	010010 101101 110110 110110 110001 110001 000001 000000
Object Type	14 (airspace)	1110
Object Element Flag	0 (no element)	0
Object Element	00000	00000
Object Status	15 (in effect)	1111
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	1 (start time given)	01
Date/Time Format	1 (month, day hours, minutes)	01
Record Applicability Start (optional)		
Month (optional)	03 (March)	00000011
Day (optional)	18	00010010

Field	Actual Value	Binary APDU Encoding
Hour	15 (3:00PM EST)	00001111
Minutes (optional)	00	00000000
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	3 (Extended Range 3D Polygon)	0011
Overlay Operator	1 (AND operator)	01
Overlay Vertices Count (optional)	54	110110
Overlay Vertices List (optional)		
lng:	76 º 25'48" W [(76 + (25/60) + (48/3600)) = 76.43)] Evaluate: two's compliment of { binary of [(76.43 – mod(76.43, (360/2^19)))/(360/2^19)]}	1100100110100110011 (two's complement of (binary of (111309) = 1100100110100110011) = 412979
lat:	38 º 41'24" N [(38 + (41/60) + (24/3600)) = 38.69)]	0001101110000011010
z:	0	00000000 00
lng:	76 º 26'25" W	1100100110100100100
lat:	38 º 41'14" N	0001101110000010110
z:	0	00000000 00
lng:	76 º 28'36" W	1100100110011101111
lat:	38 º 37'28" N	0001101101110111010
z:	0	00000000 00
lng:	76 º 31'16" W	1100100110010101111
lat:	38 º 33'49" N	0001101101101100010
z:	0	00000000 00
lng:	76 º 34'44" W	1100100110001011010

Field	Actual Value	Binary APDU Encoding
lat:	38 ^{o} 30'40" N	0001101101100010101
z:	0	00000000 00
lng:	76 ^{o} 38'40" W	1100100101111111011
lat:	38 ^{o} 27'45" N	0001101101011001111
z:	0	00000000 00
lng:	76 ^{o} 43'05" W	1100100101110010000
lat:	38 ^{o} 25'20" N	0001101101010010100
z:	0	00000000 00
lng:	76 ^{o} 47'49" W	1100100101100011101
lat:	38 ^{o} 23'32" N	0001101101001101000
z:	0	00000000 00
lng:	76 ^{o} 52'44"W	1100100101010100110
lat:	38 ^{o} 22'07" N	0001101101001000110
z:		00000000 00
lng:	76 ^{o} 57'57" W	1100100101000100111
lat:	38 ^{o} 21'18" N	0001101101000110010
z:	0	00000000 00
lng:	77 ^{o} 03'21" W	1100100100110100100
lat:	38 ^{o} 21'07" N	0001101101000101110
z:	0	00000000 00
lng:	77 ^{o} 08'36" W	1100100100100100100
lat:	38 ^{o} 21'25" N	0001101101000110101
z:	0	00000000 00
lng:	77 ^{o} 13'52" W	1100100100010100101
lat:	38 ^{o} 22'29" N	0001101101001001111
z:	0	00000000 00
lng:	77 ^{o} 18'50" W	1100100100000101100
lat:	38 ^{o} 23'55" N	0001101101001110010
z:	0	00000000 00
lng:	77 ^{o} 23'29" W	1100100011110111011
lat:	38 ^{o} 25'58" N	0001101101010100011
z:	0	00000000 00

Field	Actual Value	Binary APDU Encoding
lng:	77 ^{o} 27'41" W	1100100011101010101
lat:	38 ^{o} 28'24" N	0001101101011011110
z:	0	00000000 00
lng:	77 ^{o} 31'35" W	1100100011011110111
lat:	38 ^{o} 31'21" N	0001101101100100110
z:	0	00000000 00
lng:	77 ^{o} 34'42" W	1100100011010101011
lat:	38 ^{o} 34'40" N	0001101101101110110
z:	0	00000000 00
lng:	77 ^{o} 36'00" W	1100100011010001011
lat:	38 ^{o} 37'12" N	0001101101110110100
z:	0	00000000 00
lng:	77 ^{o} 41'13" W	1100100011000001101
lat:	38 ^{o} 39'49" N	0001101101111110011
z:	0	00000000 00
lng:	77 ^{o} 45'17" W	1100100010110101010
lat:	38 ^{o} 42'30" N	0001101110000110101
z:	0	00000000 00
lng:	77 ^{o} 48'44" W	1100100010101010110
lat:	38 ^{o} 45'41" N	0001101110010000010
z:	0	00000000 00
lng:	77 ^{o} 51'14" W	1100100010100011010
lat:	38 ^{o} 49'31" N	0001101110011011111
z:	0	00000000 00
lng:	77 ^{o} 52'39" W	1100100010011110111
lat:	38 ^{o} 53'30" N	0001101110101000000
z:	0	00000000 00
lng:	77 ^{o} 52'56" W	1100100010011110000
lat:	38 ^{o} 5 7'45" N	
z:	0	00000000 00
lng:	77 ^{o} 52'06" W	1100100010100000101
lat:	39 ^{o} 01'46" N	0001101110110100111

Field	Actual Value	Binary APDU Encoding
z:	0	00000000 00
lng:	77 ^{o} 50'08" W	1100100010100110100
lat:	39 ^{o} 05'40" N	0001101111001100111
z:	0	00000000 00
lng:	77 ^{o} 47'11" W	1100100010101111100
lat:	39 ^{o} 09'14" N	0001101111010111101
z:	0	00000000 00
lng:	77 ^{o} 43'25" W	1100100010111010111
lat:	39 ^{o} 12'10" N	0001101111100000101
z:	0	00000000 00
lng:	77 ^{o} 38'59" W	1100100011001000011
lat:	39 ^{o} 14'30" N	0001101111100111101
z:	0	00000000 00
lng:	77 ^{o} 33'53" W	1100100011010111111
lat:	39 ^{o} 15'58" N	0001101111101100001
z:	0	00000000 00
lng:	77 ^{o} 28'36" W	1100100011100111111
lat:	39 ^{o} 16'40" N	0001101111101110010
z:	0	00000000 00
lng:	77 ^{o} 23'45" W	1100100011110110101
lat:	39 ^{o} 15'49" N	0001101111101011101
z:	0	00000000 00
lng:	77 ^{o} 01'08" W	1100100100111011010
lat:	39 ^{o} 21'20" N	0001101111111100011
z:	0	00000000 00
lng:	77 ^{o} 20'50" W	1100100011111111011
lat:	39 ^{o} 16'32" N	0001101111101101111
z:	0	00000000 00
lng:	77 ^{o} 23'45" W	1100100011110110101
lat:	39 ^{o} 15'49" N	0001101111101011101
z:	0	00000000 00
lng:	77 ^{o} 01'11" W	1100100100111011000

Field	Actual Value	Binary APDU Encoding
lat:	39 º 21'26" N	0001101111111100110
z:	0	00000000 00
lng:	76 º 57'42" W	1100100101000101101
lat:	39 º 24'36" N	0001110000000110010
z:	0	00000000 00
lng:	76 º 53'23" W	1100100101010010110
lat:	39 º 27'16" N	0001110000001110011
z:	0	00000000 00
lng:	76 º 48'35" W	1100100101100001010
lat:	39 º 29'04" N	0001110000010011111
z:	0	00000000 00
lng:	76 º 43'16" W	1100100101110001011
lat:	39 º 30'07" N	
z:	0	00000000 00
lng:	76 º 37'57" W	1100100110000001100
lat:	39 º 30'17" N	0001110000010111000
z:	0	00000000 00
lng:	76 º 32’37" W	1100100110010001110
lat:	39 º 29'28" N	0001110000010101001
z:	0	00000000 00
lng:	76 º 27'36" W	1100100110100001000
lat:	39 º 27'52" N	0001110000010000010
z:	0	00000000 00
lng:	76 º 23'13" W	1100100110101110010
lat:	39 º 25'32" N	0001110000001001001
z:	0	00000000 00
lng:	76 º 19'28" W	1100100110111001101
lat:	39 º 22'33" N	0001110000000000001
z:	0	00000000 00
lng:	76 º 16'33" W	1100100111000010100
lat:	39 º 19'04" N	0001101111110101100
z:	0	00000000 00

Field	Actual Value	Binary APDU Encoding
lng:	76^{o} 14'44" W	1100100111001000000
lat:	39^{o} 15'04" N	0001101111101001011
z:	0	00000000 00
lng:	76^{o} 14'03" W	1100100111001010000
lat:	39^{o} 10'57" N	0001101111011100111
z:	0	00000000 00
lng:	76^{o} 14'30" W	1100100111001000110
lat:	39^{o} 06'42" N	0001101111010000000
z:	0	00000000 00
lng:	76^{o} 15'55" W	1100100111000100011
lat:	39^{o} 02'41" N	0001101111000011110
z:	0	00000000 00
lng:	76^{o} 12'19" W	1100100111001111011
lat:	38^{o} 56'51" N	0001101110110010001
z:	0	00000000 00
lng:	76^{o} 16'04" W	1100100111000011111
lat:	38^{o} 44'15" N	0001101110001011111
z:	0	00000000 00
lng:	76^{o} 25'48" W	1100100110100110011
lat:	38^{o} 41'24" N	0001101110000011010
z:	0	00000000 00

Table C-13. Overlay Record Encoding for FRZ

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	ZDC	011010 000100 000011 000000
Record Reference Point	255 (Ext Ref)	11111111
Overlay Record Length	164	0010100100

Field	Actual Value	Binary APDU Encoding
Report Identifier		
Report Number	2126	001000 01001110
Report Year	03	0000011
Overlay Record Identifier	2	010
Object Label Flag	1 (alphanumeric)	1
Object Label	R-6611A (restricted area)	010010 101101 110110 110110 110001 110001 000001 000000
Object Type	14 (airspace)	1110
Object Element Flag	0 (no element)	0
Object Element	00000	00000
Object Status	15 (in effect)	1111
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	1 (start time given)	01
Date/Time Format	1 (month, day, hours, minutes)	01
Record Applicability Start (optional)		
Month (optional)	03 (March)	00000011
Day (optional)	18	00010010
Hour	15 (3:00PM EST)	00001111
Minutes (optional)	00	00000000
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	3 (Extended Range 3D Polygon)	011

Field	Actual Value	Binary APDU Encoding
Overlay Operator	1 (AND operator)	01
Overlay Vertices Count (optional)	24	010111
Overlay Vertices List (optional)		
lng:	7’ º”09'44" [(77 + (9/60) + (44/3600)) = 77.16)] Evaluate: two’s compliment of { binary of [(77.16– mod(77.16, (360/2^19)))/(360/2^19)]}	1100100100100001001 (two’s compliment of (binary of (112375) = 1100100100100001001) = 411913
lat:	3’ º”40'08" [(38 + (40/60) + (8/3600)) = 38.67)]	0001101101111111011
z:	0	00000000 00
lng:	7’ º”14'01"	1100100100010100001
lat:	3’ º”42'38"	0001101110000111000
z:	0	00000000 00
lng:	7’ º”17'09"	1100100100001010101
lat:	3’ º”46'00"	0001101110010001010
z:	0	00000000 00
lng:	7’ º”18'30"	1100100100000110100
lat:	3’ º”49'21"	0001101110011011011
z:	0	00000000 00
lng:	7’ º”18'48"	1100100100000101101
lat:	3’ º”52'14"	0001101110100100001
z:	0	00000000 00
lng:	7’ º”20'08"	1100100100000001100
lat:	3’ º”56'55"	0001101110110010011
z:	0	00000000 00
lng:	7’ º”18'10"	1100100100000111100
lat:	3’ º”00'05"	0001101110111011111
z:	0	00000000 00

Field	Actual Value	Binary APDU Encoding
lng:	7’ º”14'43"	1100100100010010000
lat:	3’ º”03'04"	0001101111000101000
z:	0	00000000 00
lng:	7’ º”10'47"	1100100100011101111
lat:	3’ º”05'08"	0001101111001011010
z:	0	00000000 00
lng:	7’ º”06'34"	1100100100101010110
lat:	3’ º”06'17"	0001101111001110110
z:	0	00000000 00
lng:	7’ º”01'52"	1100100100111001000
lat:	3’ º”06'39"	0001101111001111111
z:	0	00000000 00
lng:	7’ º”57'51"	1100100101000101001
lat:	3’ º”06'11"	0001101111001110011
z:	0	00000000 00
lng:	7’ º”50'38"	1100100101011011000
lat:	3’ º”02'18"	0001101111000010101
z:	0	00000000 00
lng:	7’ º”47'16"	1100100101100101010
lat:	3’ º”57'12"	0001101110110011001
z:	0	00000000 00
lng:	7’ º”47'35"	1100100101100100011
lat:	3’ º”56'48"	0001101110110010000
z:	0	00000000 00
lng:	7’ º”47'33"	1100100101100100011
lat:	3’ º”56'06"	0001101110101111111
z:	0	00000000 00
lng:	7’ º”46'59"	1100100101100110001
lat:	3’ º”55'35"	0001101110101110010
z:	0	00000000 00
lng:	7’ º”46'15"	1100100101101000011
lat:	3’ º”55'28"	0001101110101101111

Field	Actual Value	Binary APDU Encoding
z:	0	00000000 00
lng:	7’ º”45'32"	1100100101101010100
lat:	3’ º”52'25"	0001101110100100101
z:	0	00000000 00
lng:	7’ º”45'57"	1100100101101001010
lat:	3’ º”48'27"	0001101110011000101
z:	0	00000000 00
lng:	7’ º”48'26"	1100100101100001110
lat:	3’ º”44'18"	0001101110001100000
z:	0	00000000 00
lng:	7’ º”53'11"	1100100101010011011
lat:	3’ º”40'43"	0001101110000001001
z:	0	00000000 00
lng:	7’ º”58'52"	1100100101000010001
lat:	3’ º”38'58"	0001101101111011111
z:	0	00000000 00
lng:	7’ º”04'14"	1100100100110001110
lat:	3’ º”38'43"	0001101101111011001
z:	0	00000000 00

Appendix D Example D-ATIS

The following example illustrates the encoding of D-ATIS text and graphical overlay reports into messages that are sent to a communication system for uplink to aircraft. These examples represent the APDU payload only.

D-ATIS messages are unique in that they often include NOTAM information in addition to D-ATIS information. Until the advent of the FIS-B data link, these two distinct sets of information have been carried in a common broadcast because it was the only means of timely delivery of safety related information. Once the NOTAM has either been terminated or placed in the appropriate publications, the NOTAM is removed from the D-ATIS message. Since FIS-B data link will deliver both Airport NOTAMs and D-ATIS products, there is no longer a need to combine the two sets of information in a single report. The two remain combined in this example to illustrate how this may work until such time as they can be separated.

D.1 D-ATIS Example 1 (With Land and Hold Short Depiction)

D.1.1 Text Record Encoding

Text: KMEM ATIS INFO G 1556Z. 18011KT 10SM OVC200 29/21 A2986. ARR EXP VECTORS ILS RWY 27 APCH. LAND AND HOLD SHORT OPERATIONS ARE IN EFFECT. RWY 27 ARR PLAN TO H/S OF RWY 36C, 5 THSD 8 HND FT AVBL. ADVS YOU HAVE INFO G.

Table D-1. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	220	00000000 11011100
Report Identifier		
Report Number	7 (G)	00000000 000111
Report Year	NA	00 00000
Report Status	1 (active)	1
Text Data	KMEM ATIS INFO G 1556Z. 18011KT 10SM OVC200 29/21	001011 001101 000101 001101

Field	Actual Value	Binary APDU Encoding
	A2986. ARR EXP VECTORS ILS RWY 27 APCH. LAND AND HOLD SHORT OPERATIONS ARE IN EFFECT. RWY 27 ARR PLAN TO H/S OF RWY 36C, 5 THSD 8 HND FT AVBL. ADVS YOU HAVE INFO G. (214 characters)	100000 000001 010100 001001 010011 100000 001001 001110 000110 001111 100000 000111 100000 110001 110101 110101 110110 011010 101110 100000 110001 111000 110000 110001 110001 001011 010100 100000 110001 110000 010011 001101 100000 001111 010110 000011 110010 110000 110000 100000 110010 111001 101111 110010 110001 100000 000001 110010 111001 111000 110110 101110 100000 000001 010010 010010 100000 000101 011000 010000 100000 010110 000101 000011 010100 001111 010010 010011 100000 001001 001100 010011 100000 010010 010111 011001 100000 110010 110111 100000 000001 010000 000011 001000 101110 100000 001100 000001 001110 000100 100000 000001 001110 000100 100000 001000 001111 001100 000100 100000 010011 001000 001111 010010 010100 100000 001111 010000 000101 010010 000001 010100 001001 001111 001110 010011 100000 000001 010010 000101 100000 001001 001110 100000 000101 000110 000110 000101 000011 010100 101110 100000 010010 010111 011001 100000 110010 110111 100000 000001
		010010 010010 100000 010000 001100 000001 001110 100000 010100 001111 100000 001000 101111 010011 100000 001111

Field	Actual Value	Binary APDU Encoding
		000110 100000 010010 010111 011001 100000 110011 110110 000011 101100 100000 110101 100000 010100 001000 010011 000100 100000 111000 100000 001000 001110 000100 100000 000110 010100 100000 000001 010110 000010 001100 101110 100000 000001 000100 010110 010011 100000 011001 001111 010101 100000 001000 000001 010110 000101 100000 001001 001110 000110 001111 100000 000111 101110 000000 (215 characters, 162 bytes)

D.1.2 Overlay Record Encoding

There are 5 elements of this D-ATIS message that may be represented as graphical overlay reports. These elements include each arrival (reports 1 and 2) and departure runway (reports 3 and 4) and the LAHSO being in effect (report 5). A separate overlay report is used for each element, but they all may be grouped into one payload as illustrated below.

Table D-2. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (graphical overlay)	1000
Product Version	1	0001
Record Count	2	0010
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Overlay Record Length	21	0000010101
Report Identifier		
Report Number	7 (G)	00000000 000111
Report Year	NA	0000000
Overlay Record Identifier	1	0000
Object Label Flag	1 (alphanumeric)	1

Field	Actual Value	Binary APDU Encoding
Object Label	27 <DLAC>	110010 110111 000000 000000
Object Type	1 (runway)	0001
Object Element Flag	0 (no element)	0
Object Element	00000	00000
Object Status	2 (arrival only)	0010
Object Qualifier Flag	0 (no qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	0 (no times given)	00
Date/Time Format	0 (not used)	00
Record Applicability Start (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	NA	
Hour	NA	
Minutes (optional)	NA	
Overlay Geometry Options	1	0001
Overlay Operator	0 (no operator)	00
Overlay Vertices Count (optional)	2 (line)	000010
Overlay Vertices List (optional)		
X Value	-130 (from ref pt [m]) Evaluate: (-(130 – mod(130, 5)) / 5) + 2048	01111110 0110 (2022)

Field	Actual Value	Binary APDU Encoding
Y Value	+1700 (from ref pt [m]) Evaluate: ((1700 – mod(1700, 5)) / 5) + 2048	(2388)
X Value	-130 (from ref pt [m]) Evaluate: (-(130 – mod(130, 5)) / 5) + 2048	11111100110 (2022)
Y Value	+1550 (from ref pt [m]) Evaluate: ((1550 – mod(1550, 5)) / 5) + 2048	100100110110 (2358)

Appendix E Example TWIP

The following examples illustrate the encoding of TWIP text reports into messages that are sent to a communication system for uplink to aircraft. These examples represent the APDU payload only.

E.1 TWIP Example 1

E.1.1 Text Record Encoding

Text: KMEM 0033
TDWR TERMINAL WX INFO
*WIND SHEAR ALERTS
25KT LOSS
BEGAN 0033
–STORM(S)
APRT HVY PRECIP
APRT MOD PRECIP
1NM E-SE HVY PRECIP
PREVIOUS MICROBURST
BEGAN 0028 END 0029

Table E-1. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KMEM	001011 001101 000101 001101
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	136	00000000 10001000
Report Identifier		
Report Number	33	00000000 100001
Report Year	NA	0
Report Status	1 (active)	1

Field	Actual Value	Binary APDU Encoding
Text Data	KMEM 0033 TDWR TERMINAL WX INFO *WIND SHEAR ALERTS 25KT LOSS BEGAN 0033 –STORM(S) APRT HVY PRECIP APRT MOD PRECIP 1NM E-SE HVY PRECIP PREVIOUS MICROBURST BEGAN 0028 END 0029 (174 characters)	
		(176 characters, 132 bytes)

Appendix F Example AIRMET

F.1 AIRMET Example

F.1.1 Text Record Encoding

AIRMET KSFO 161445Z ISSUED AT 161445 VALID UNTIL 162100

NO SGFNT IFR EXP OUTSIDE CNVTV ACT. AIRMET MTN OBSCN...WA OR

FROM 30SSE YDC TO 40NNW DSD TO 50WNW LKV TO 30SE OED TO 30SW OED

TO 60SW EUG TO 50SSE HQM TO TOU TO HUH TO 30SSE YDC

MTNS OCNL OBSC BY CLDS/BR. CONDS CONTG BYD 21Z THRU 03Z.

Table F-1. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KSFO	001011 010011 000110 001111
Record Reference Point	0 (Use LocID)	00000000
Text Record Length	292	00000001 00100100
Report Identifier		
Report Number	1	00000000 000001
Report Year	08	0001000
Report Status	1 (active)	1

Field	Actual Value	Binary APDU Encoding
Text Data	AIRMET KSFO 161445Z ISSUED AT 161445 VALID UNTIL 162100 NO SGFNT IFR EXP OUTSIDE CNVTV ACT. AIRMET MTN OBSCN...WA OR FROM 30SSE YDC TO 40NNW DSD TO 50WNW LKV TO 30SE OED TO 30SW OED TO 60SW EUG TO 50SSE HQM TO TOU TO HUH TO 30SSE YDC MTNS OCNL OBSC BY CLDS/BR. CONDS CONTG BYD 21Z THRU 03Z. (286 characters)	000001 001001 010010 001101 000101 010100 100000 001011 010011 000110 001111 100000 110001 110110 110001 110100 110100 110101 011010 100000 001001 010011 010011 010101 000101 000100 100000 000001 010100 100000 110001 110110 110001 110100 110100 110101 100000 010110 000001 001100 001001 000100 100000 010101 001110 010100 001001 001100 100000 110001 110110 110010 110001 110000 110000 001110 001111 100000 010011 000111 000110 001110 010100 100000 001001 000110 010010 100000 000101 011000 010000 100000 001111 010101 010100 010011 001001 000100 000101 100000 000011 001110 010110 010100 010110 100000 000001 000011 010100 101110 100000 000001 001001 010010 001101 000101 010100 100000 001101 010100 001110 100000 001111 000010 010011 000011 001110 101110 101110 101110 010111 000001 010010 001111 001101 100000 110011 110000 010011 010011 000101 100000 011001 000100 000011 100000 010100 001111 100000 110100 110000 001110 001110 010111 100000 000100 010011 000100 100000 010100 001111 100000 110101 110000

Field	Actual Value	Binary APDU Encoding
		010111 001110 010111 100000 001100 001011 010110 100000 010100 001111 100000 110011 110000 010011 000101 100000 001111 000101 000100 100000 010100 001111 100000 110011 110000 010011 010111 100000 001111 000101 000100 010100 001111 100000 110110 110000 010011 010111 100000 000101 010101 000111 100000 010100 001111 100000 110101 110000 010011 010011 000101 100000 001000 010001 001101 100000 010100 001111 100000 010100 001111 010101 100000 010100 001111 100000 001000 010101 001000 100000 010100 001111 100000 001111 010010 000110 100000 110011 110000 010011 010011 000101 100000 011001 000100 000011 001101 010100 001110 010011 100000 001111 000011 001110 001100 100000 001111 000010 010011 000011 100000 000010 011001 100000 000011 001100 000100 010011 101111 000010 010010 101110 100000 000011 001111 001110 000100 010011 100000 000011 001111 001110 010100 000111 100000 000010 011001 000100 100000 110010 110001 011010 100000 010100 001000 010010 010101 100000 110000 110011 011010 101110 000000 (287 characters, 216 bytes)

F.1.2 Overlay Record Encoding

Table F-2. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	KSFO	001011 010011 000110 001111
Record Reference Point	0 (Used LocID)	00000000
Overlay Record Length	83	0001010011
Report Identifier		
Report Number	01	000000 00000001
Report Year	08	0001000
Overlay Record Identifier	0	0000000
Object Label Flag	1 (Alphanumeric)	0
Object Label (DLAC)	161445Z	110001 110110 110001 110100 110100 110101 011010 000000
Object Type	14 (Airspace)	1110
Object Element Flag	0 (No Element)	0
Object Element	NA	
Object Status	15 (In Effect)	1111
Object Qualifier Flag	0 (No Qualifier)	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (No Parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	3 (Start and End Time Given)	11
Date/Time Format	2 (Day, Hours, Minutes)	10
Record Applicability Start (optional)		
Month (optional)	NA	
Day (optional)	16	00010000
Hour	14	00001110

Field	Actual Value	Binary APDU Encoding
Minutes (optional)	45	00101101
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	16	00010000
Hour	21	00000011
Minutes (optional)	00	00000000
Overlay Geometry Options	3 (Extended Range 3D Polygon)	0011
Overlay Operator	NA (none)	00
Overlay Vertices Count (optional)	10	010111
Overlay Vertices List (optional)		
lng:	-120.224761	1010101010000001111
lat:	49.003829	0010001011011000110
z:	60000	0001111000
lng:	-122.582701	1010100011010100101
lat:	48.948898	0010001011001110110
z:	60000	0001111000
lng:	-124.616545	1010011101100010011
lat:	48.299331	0010001001011000100
z:	60000	0001111000
lng:	-123.471907	1010100000110010110
lat:	46.195449	0010000011011001100
z:	60000	0001111000
lng:	-124.188765	1010011110110000010
lat:	43.404922	0001111011011101100
z:	60000	0001111000
lng:	-123.375777	1010100001000100010
lat:	42.111969	0001110111110010010
z:	60000	0001111000
lng:	-122.422713	1010100011110001110
lat:	42.111969	0001110111110010010
z:	60000	0001111000
lng:	-121.442870	1010100110100100001

Field	Actual Value	Binary APDU Encoding
lat:	42.480011	0001111000110101010
z:	60000	0001111000
lng:	-121.659850	1010100101111100101
lat:	44.864730	0001111111100111010
z:	60000	0001111000
lng:	-120.224761	1010101010000001111
lat:	49.003829	0010001011011000110
z:	60000	0001111000

Appendix G Example SIGMET

G.1 SIGMET Example

G.1.1 Text Record Encoding

ISSUED AT 101700

SIGMET OSCAR 1 VALID UNTIL 102100

FL GA AL

FROM LKT TO 40W DBS TO 40SE TWF TO 50WSW TWF TO DNJ TO LKT OCNL SEV MXD ICGICIP BTN 120 AND 060. RPRTD BY ACFT. CONDS CONTG BYD 2100Z

Table G-1. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	NA	000000 000000 000000 000000
Record Reference Point	255 (Ext Ref)	11111111
Text Record Length	196	00000000 11000100
Report Identifier		
Report Number	01	00000000 000001
Report Year	08	0001000
Report Status	01 (active)	1
Text Data	ISSUED AT 101700 SIGMET OSCAR 1 VALID UNTIL 102100 FL GA AL FROM LKT TO 40W DBS TO 40SE TWF TO 50WSW TWF TO DNJ TO LKT OCNL SEV MXD ICGICIP BTN 120 AND 060. RPRTD BY ACFT. CONDS CONTG BYD 2100Z (190 Characters)	001001 010011 010011 010101 000101 000100 100000 000001 010100 100000 110001 110000 110001 110111 110000 110000 010011 001001 000111 001101 000101 010100 100000 001111 010011 000011 000001 010010 100000 110001 100000 010110 000001 001100 001001 000100 100000 010101 001110 010100

Field	Actual Value	Binary APDU Encoding
		001001 001100 100000 110001 110000 110010 110001 110000 110000 000110 001100 100000 000111 000001 100000 000001 001100 000110 010010 001111 001101 100000 001100 001011 010100 100000 010100 001111 100000 110100 110000 010111 100000 000100 000010 010011 100000 010100 001111 100000 110100 110000 010011 000101 100000 010100 010111 000110 100000 010100 001111 100000 110101 110000 010111 010011 010111 100000 010100 010111 000110 100000 010100 001111 100000 000100 001110 001010 100000 010100 001111 100000 001100 001011 010100 100000 001111 000011 001110 001100 100000 010011 000101 010110 100000 001101 011000 000100 100000 001001 000011 000111 001001 000011 001001 010000 100000 000010 010100 001110 100000 110001 110010 110000
		100000 000001 001110 000100 100000 110000 110110 110000 101110 100000 010010 010000 010010 010100 000100 100000 000010 011001 100000 000001 000011 000110 010100 101110 100000 000011 001111 001110 000100 010011 100000 000011 001111 001110 010100 000111 100000 000010 011001 000100 100000 110010 110001 110000 110000 011010 000000 (191 characters, 141 bytes)

G.1.2 Overlay Record Encoding

Table G-2. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	NA	000000 000000 000000 000000
Record Reference Point	255 (Ext Ref)	11111111
Overlay Record Length	97	0001100001
Report Identifier		
Report Number	01	00000000 000001
Report Year	08	00001000
Overlay Record Identifier	0	0000000
Object Label Flag	1	1
Object Label	OSCAR 1	001111 010011 000011 000001 010010 100000 110001 000000
Object Type	10 (Communication Equipment)	1010
Object Element Flag	1	1
Object Element	6 (Hazardous In Flight Weather Advisory Service)	00110
Object Status	15	1111
Object Qualifier Flag	0	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (no parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	03	11
Date/Time Format	2 (Day, Hours, Minutes)	10
Record Applicability Start (optional)		
	NA	
Month (optional)	NA	

Field	Actual Value	Binary APDU Encoding
Day (optional)	10	00001010
Hour	17	00010001
Minutes (optional)	00	00000000
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	10	00001010
Hour	21	00010101
Minutes (optional)	00	00000000
Overlay Geometry Options	3 (Extended Range 3D Polygon)	0011
Overlay Operator	0 (none)	00
Overlay Vertices Count (optional)	12	001100
Overlay Vertices List (optional)		
lng:	-81.066	1100011001011010100
lat:	27.0161	0001001100110110001
z:	12000	0000011000
lng:	-81.127	1100011001001111011
lat:	27.079	0001001101000001100
z:	12000	0000011000
lng:	-81.849	1100010111001011111
lat:	27.01	0001001100110101000
z:	12000	0000011000
lng:	-81.522	1100011000000111011
lat:	27.1595	0001001101010000001
z:	12000	0000011000
lng:	-81.2	1100011001000010000
lat:	27.7663	0001001110111110101
z:	12000	0000011000
lng:	-81.066	1100011001011010100
lat:	27.0161	0001001100110110001
z:	12000	0000011000
lng:	-81.066	1100011001011010100

Field	Actual Value	Binary APDU Encoding
lat:	27.0161	000100110011011 0001
z:	6000	0000001100
lng:	-81.127	1100011001001111011
lat:	27.079	0001001101000001100
z:	6000	0000001100
lng:	-81.849	1100010111001011111
lat:	27.01	0001001100110101000
z:	6000	0000001100
lng:	-81.522	1100011000000111011
lat:	27.1595	0001001101010000001
z:	6000	0000001100
lng:	-81.2	1100011001000010000
lat:	27.7663	0001001110111110101
z:	6000	0000001100
lng:	-81.066	1100011001011010100
lat:	27.0161	0001001100110110001
z:	6000	0000001100

G.2 SIGMET Example 2

G.2.1 Text Record Encoding

ISSUED AT 101655

CONVECTIVE SIGMET 16C

VALID UNTIL 1855Z

FL MS AL GA

FROM 20ENE DYR-50W BNA-30NNW MSY-20N LCH-20ENE DYR AREA SEV TS MOV FROM 24035KT. TOPS TO FL450. TORNADOES...HAIL TO 2 IN...WIND GUSTS TO 60KT POSS.

Table G-3. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	NA	000000 000000 000000 000000
Record Reference Point	255 (Ext Ref)	11111111
Text Record Length	218	00000000 11011010
Report Identifier		
Report Number	01	00000000 000001
Report Year	08	0001000
Report Status	01	1
Text Data	ISSUED AT 101655 CONVECTIVE SIGMET 16C VALID UNTIL 1855Z FL MS AL GA FROM 20ENE DYR-50W BNA-30NNW MSY-20N LCH-20ENE DYR AREA SEV TS MOV FROM 24035KT. TOPS TO FL450. TORNADOES...HAIL TO 2 IN...WIND GUSTS TO 60KT POSS. (212 Characters)	001001 010011 010011 010101 000101 000100 100000 000001 010100 100000 110001 110000 110001 110110 110101 110101 000011 001111 001110 010110 000101 000011 010100 001001 010110 000101 100000 010011 001001 000111 001101 000101 010100 100000 110001 110110 000011 010110 000001 001100 001001 000100 100000 010101 001110 010100 001001 001100 100000 110001 111000 110101 110101 011010 000110 001100 100000 001101 010011 100000 000001 001100 100000 000111 000001 000110 010010 001111 001101 100000 110010 110000 000101 001110 000101 100000 000100 011001 010010 101101 110101 110000 010111 100000 000010 001110 000001 101101 110011 110000 001110 001110 010111 100000 001101 010011 011001 101101 110010 110000 001110 100000 001100 000011 001000 101101 110010 110000 000101 001110 000101 100000

Field	Actual Value	Binary APDU Encoding
		000100 011001 010010 100000 000001 010010 000101 000001 100000 010011 000101 010110 100000 010100 010011 100000 001101 001111 010110 100000 000110 010010 001111 001101 100000 110010 110100 110000 110011 110101 001011 010100 101110 100000 010100 001111
		010000 010011 100000 010100 001111 100000 000110 001100 110100 110101 110000 101110 100000 010100 001111 010010 001110 000001 000100 001111 000101 010011 101110 101110 101110 001000 000001 001001 001100 100000 010100 001111 100000 110010 100000 001001 001110 101110 101110 101110 010111 001001 001110 000100 100000 000111 010101 010011 010100 010011 100000 010100 001111 100000 110110 110000 001011 010100 100000 010000 001111 010011 010011 101110 (213 characters, 160 bytes)

G.2.2 Overlay Record Encoding

Table G-4. Overlay Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	8 (Graphical Overlay)	1000
Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	NA	000000 000000 000000 000000
Record Reference Point	255 (Ext Ref)	11111111
Overlay Record Length	48	0000110000
Report Identifier		

Field	Actual Value	Binary APDU Encoding
Report Number	01	00000000 000001
Report Year	08	00001000
Overlay Record Identifier	0	0000000
Object Label Flag	1	1
Object Label	16C	110001 110110 000011 000000
Object Type	10 (Communication Equipment)	1010
Object Element Flag	1	1
Object Element	6 (Hazardous In Flight Weather Advisory Service)	00110
Object Status	15 (active)	1111
Object Qualifier Flag	0	0
Object Qualifier (optional)	NA	
Object Parameter Flag	0 (parameter)	0
Object Parameter Type (optional)	NA	
Object Parameter Value (optional)	NA	
Record Applicability Options	03	11
Date/Time Format	2 (Day, Hours, Minutes)	10
Record Applicability Start (optional)		
Month (optional)	NA	
Day (optional)	10	00001010
Hour	16	00010000
Minutes (optional)	55	00110111
Record Applicability End (optional)		
Month (optional)	NA	
Day (optional)	10	00001010
Hour	18	00010010
Minutes (optional)	55	00110111
Overlay Geometry Options	3 (Extended Range 3D Polygon)	0011
Overlay Operator	0 (none)	00
Overlay Vertices Count (optional)	5	000101
Overlay Vertices List (optional)		

Field	Actual Value	Binary APDU Encoding
lng:	-81.0184	1100011001100011001
lat:	27.1431	0001001101001101010
z:	60000	0001111000
lng:	-81.7142	1100010111100100100
lat:	27.112	0001001101000111100
z:	60000	0001111000
lng:	-81.4714	1100011000010000101
lat:	27.4446	0001001110000100001
z:	60000	0001111000
lng:	-81.2162	1100011000111111001
lat:	27.4663	0001001110001000000
z:	60000	0001111000
lng:	-81.0184	1100011001100011001
lat:	27.1431	0001001101001101010
z:	60000	0001111000

Appendix H Example SUA Status

H.1 SUA Status Example 1

H.1.1 Text Record Encoding

SUA 081748Z
1394595|4610|H|R|5201|0801290500|0805300459|001|230|A|Y|723|5201|FL5201|FORT DRUM, FL

Table H-1. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	NA	000000 000000 000000 000000
Record Reference Point	255 (Ext Ref)	11111111
Text Record Length	103	00000000 01100111
Report Identifier		
Report Number	1	00000000 000001
Report Year	08	0001000
Report Status		1
Text Data	SUA 081748Z 1394595|4610|H|R|5201|0801290500|0805300459|001|230|A|Y|723|5201|FL5201|FORT DRUM, FL (97 Characters)	010011 010101 000001 100000 110000 111000 110001 110111 110100 111000 011010 100000 110001 110011 111001 110100 110101 111001 110101 011111 110100 110110 110001 110000 011111 001000 011111 010010 011111 110101 110010 110000 110001 011111 110000 111000 110000 110001 110010 111001 110000 110101 110000 110000 011111 110000 111000 110000 110101 110011 110000 110000 110100 110101 111001 011111 110000 110000 110001 011111 110010 110011 110000 011111 000001 011111 011001 011111 110111 110010 110011 011111

Field	Actual Value	Binary APDU Encoding
		110101 110010 110000 110001 011111 000110 001100 110101 110010 110000 110001 011111 000110 001111 010010 010100 100000 000100 010010 010101 001101 101100 100000 000110 001100 000000 (98 Characters, 74 bytes)

H.2 SUA Status Example 2

H.2.1 Text Record Encoding

SUA 081748Z
1395161|24099|P|B|AR609|0801301800|0805301845|240|280|A|Y|||AR609|AR609

Table H-2. Text Record Encoding

Field	Actual Value	Binary APDU Encoding
Record Format	2 (DLAC text)	0010
Product Version	1	0001
Record Count	1	0001
Spare	NA	0000
Location Identifier (DLAC)	NA	000000 000000 000000 000000
Record Reference Point	255 (Ext Ref)	11111111
Text Record Length	84	00000000 01010100
Report Identifier		
Report Number	28	00000000 011100
Report Year	08	0001000
Report Status		1

Field	Actual Value	Binary APDU Encoding
Text Data	SUA 081748Z 1395161|24099|P|B|AR609|0801 301800|0805301845|240|280|A| Y|||AR609|AR609 (83 Characters)	010011 010101 000001 100000 110000 111000 110001 110111 110100 111000 011010 100000 110001 110011 111001 110101 110001 110110 110001 011111 110010 110100 110000 111001 111001 011111 010000 011111 000010 011111 000001 010010 110110 110000 111001 011111 110000 111000 110000 110001 110011 110000 110001 111000 110000 110000 011111 110000 111000 110000 110101 110011 110000 110001 111000 110100 110101 011111 110010 110100 110000 011111 110010 111000 110000 011111 000001 011111 011001 011111 011111 011111 000001 010010 110110 110000 111001 011111 000001 010010 110110 110000 111001 000000(84 characters, 63 bytes)

Appendix I Document Changes

Table I-1. Document Changes

Version	Comment	Status
0.5	It appears to me that the "End-of-Record" byte (hex 1E) in the Graphical Overlay Payload Format (Figure X) serves no real function. Since this bit pattern may occur anywhere throughout the data (binary bytes which can take on any value), the End-of-Record pattern is not necessarily unique.	Accepted – Closed
.5	Page 2 About the 4th line "also be provided graphical overlay form" "also be provided graphical in overlay form"	Accepted – Closed
.5	Page 3 – Figure Xa Is the FIS-B APDU ID the same for all FIS-B messages? If so, should it be identified here?	Accepted – Closed
.5	Page 4 Payload Header Paragraph "appears once is an APDU" "appears once in an APDU"	Accepted – Closed
.5	Page 5 Should Table Title be "Report Format Options" vice "Payload Format Options"	Accepted – Closed
.5	Page 5 Overlay Parameters Paragraph – 2nd line ""an Overlay Report Count and a few spare bits for future use" I do not see these in the Figure and they are not discussed in the text, should these be dropped.	Accepted – Closed
.5	Page 5 Location Identifier Paragraph "when there are less four characters needed" "when less than four characters are needed"	Accepted – Closed
.5	Page 6 Record Reference Point Definition Figure Suggest adding LSB/MSB identifiers.	Accepted – Closed
.5	Page 7 Text Report Identifier Paragraph "will be assigned a number." "will be sequentially assigned a number starting with 27."	Partially Accepted – Closed All Text Identifiers will be reset to 1 on Jan 1st.
.5	Page 10 Object Identifier Label Formats Table 4th row -"segment if interest" "segment of interest"	Accepted – Closed
.5	Page 11 Object Types Paragraph 2nd line "impact of flight operations" "impact on flight operations"	Accepted – Closed

Version	Comment	Status
.5	Page 17 Overlay Parameter Value Paragraph Should this be titled Object Parameter Value, also reference to table 10 , is this meant to be to table 9?	Accepted – Closed
.5	Appendix C: D-ATIS Example 1, 2 The report format says the value is “DLAC text” (2). The binary is 6 ?? The report format says the value is “Graphical Overlay” (6). The binary is 12 (1100) ??	Accepted – Closed
.5	Appendix D: TWIP Example The report format says the value is “DLAC text” (2). The binary is 6	Accepted – Closed
.5	Do we need a time of applicability field?	This is addressed in Report Applicability field of the overlay definition. Text reports will include a time if it is germane.
.5	Why not just use the Generic Text Product definition?	This format requires a product name in ASCII to precede the record. In the case of a NOTAM would require 5 bytes. A defined text product for NOTAMs and D-ATIS would be preferable.
.5	Use ASCII or DLAC-6 for text?	The MASPS requires ASCII or ASN.1/PER, but SF21 Broadcast Services WG has selected DLAC-6 for the fact that UPS AT already uses DLAC-6 for text and it offers a 25% reduction in bandwidth, which was seen as significant.
.5	Why is some much detail needed in the time fields?	It really isn’t needed in most cases, but it was felt that the applicability time formats used by the existing services should be supportable. Several optional fields allow maximum flexibility. With regard to each time/date field, a few bits could be saved, but the savings was not seen as significant and when weighed against other factors, was not worth the added complexity.
.5	You should consider a length field for the overlay reports since you don’t have an end-of-report flag. Even though the length can be implied from the format, you are asking the parser to work at different levels at the same. Having an explicit length will simplify things for the parser.	Accepted – Closed
1	The End-of-Text field will need to be different depending on whether the format is ASCII or DLAC since characters are represented by a different number of bits.	Accepted – Closed

Version	Comment	Status
1	What is the reference point for the Z-coordinate of a 3D vertex and how are negative elevations relative to the ref pt handled?	Accepted-Closed
1	The high-resolution 2D vertices are only 28 bits. Why not utilize the remaining 4 bits?	Accepted-Closed The High 2D option has been removed. An equivalent representation is the High 3D with the z-component always zero.
1	It is common to use the term "report" to reference data that is passed between automation systems over a physical medium and the term "message" for RF data content. Therefore, to be consistent, I recommend you change "report" to "record" to avoid confusion.	Accepted-Closed
1	In Figure 4, show that multiple reports can be carried in the same payload.	Accepted-Closed
1	In appendix A.2 there are several notes under Table A-1 describing the DLAC character set. The "Change Cipher" character (CC) provided a function in DLAC that is not relevant to FIS-B. (CC was part of the DLAC protocol for switching between character encoding and dictionary encoding.) This is where the "CPH" and "WSTRING" references come in. Since these mechanisms are not part of FIS-B, the "CC" note should probably be replaced with something like: "The CC character is not used in FIS-B."	Accepted-Closed
1	In reference to figure 1, clarify that system components and interface this document affects.	Accepted-Closed
1	The Object Status value of 'Up" is not specific enough. Suggest changing.	Accepted-Closed Value changed to "In Service"
1	No Object Elements table exists for weather equipment.	Accepted – Closed New table of elements added. RVR elements moved from the Runway Object Elements to the Weather Equipment Object Elements.

Version	Comment	Status
1	Consider including airspace restrictions germane to the terminal airspace. Such airspace status could include TFRs and parachute jump areas.	Accepted-Closed Several changes were made to various fields to support this addition. 1) The Object Qualifier field was increased to 3 bytes. 2) The Object Identifier was altered to assign the reserved value of zero to airspace objects, thus changing the airport object to a reserved value of one. 3) Object Elements for the Airspace Object have been defined. 4) An example has been added to Appendix B. 4) The Record Reference Point field was expanded (in scope only) to support alternative referencing of overlays.
1	Units for Range and Resolution for Distance are Statute Miles in Table 20 incorrect.	Accepted-Closed Also increased range to 500 from 200.
1	In figure 2, the relationship between the FIS-B message framing structure and the FIS-B information hierarchy is unclear.	Accepted-Closed New figure provided to more directly associate the two things. Reworked the text accordingly.
1	Why not allow Geographic Locator as an optional field?	Accepted-Closed It is an optional field in the APDU, but there was no value seen for the products in thus document. Table 1 has been changed to support this option.
1	Make Apron and object with Elements to include parking stand and location and guidance line. This will be more consistent with the SC-193 document	Accepted-Closed New table (10) created for apron elements. Also removed the penalty box object and placed it as an element of the taxiway object.
1	Remove contractions that are not included in the set of FAA approved contractions in FAA order 7930.2G.	Accepted-Closed
1	Expand Overlay Geometry Options to allow more flexibility in defining shapes other than polygons to include typical restricted airspace geometries (e.g., cylinders).	Accepted-Closed Additional overlay geometries added along with changes to the Vertices List to accommodate the new geometries.
1	Table 4-1 Entries 9-15 should be labeled as “Future Use” rather than “Undefined.” (This is in keeping with the reset of the document.)	Accepted – Closed

Version	Comment	Status
1	Section 4.2.1 Location Identifier Why is this field forced to contain 4 ASCII characters (32 bits) in all cases? I would suggest using the DLAC 6-bit character set (Appendix A) and not requiring null padding if the identifier is less than 4 characters (as many may be – they are typically 3 characters in length). DLAC coding saves 2 bits per character. To enforce byte alignment, one could simply pad the field with zero bits to the nearest byte boundary. The typical savings here would be 6 bits.	Accepted – The Location Identifier has been change to a fixed length 3 byte field using the DLAC character set. If the identifier is less than 4 characters, the field is padded with zeros.
1	Table 6-1 Suggest changing the Object Identifier field from ASCII to DLAC when using a text label rather than a database index. Also, make this field variable-length when the Object Identifier is shorter than 9 characters (worst-case). This would save 2 bits/character (up to 18 bits worst-case). Allowing variable-length (with an ETX terminator) would save bits too.	Accepted – Closed
1	The table format for Record Applicability Start and Record Applicability End suggest that these are separate 5-byte fields, rather than a heading for the sub-fields (Year, Month…) shown below them. Also, why are these times coded with a byte per field, instead of using bit fields? For example: hour would be a 5-bit field and minutes a 6-bit field (saving 5 bits). "Month" could be coded in 4 bits and "Day" in 5 bits. Such time coding is already used in the APDU header.	Not Accepted – Closed We looked at the potential savings in bits relative to the additional encode/decode complexity and believe that the existing approach is equally efficient for all but one case (year, month, day, hour), which requires an additional byte over the proposed approach in the comment. All other cases yield the same number of bytes in order to maintain alignment with adjacent data items.
1	Section 6.1 Overlay Record Length (note) There is an ISO standard transparency protocol that may be used to insure that the flag sequence does not appear in the message. ISO 3309 provides such a protocol – it is described in the RTCA DO-267 section 3.4.3.2 (the FIS-B MASPS). True, having a length field is probably simpler – suggest removing or rewording the note.	Accepted – Closed

Version	Comment	Status
1	Table 6-12 Navigation Equipment Object Elements While I can't think of any other potential entries for this table, it is probably a good idea to allow for some expansion space (even though it would cost an extra bit!).	Accepted – Closed VOR/VORTAC and TACAN elements combined due to their similarity. This made space an additional element in the future.
1	Table 6-16 Object Status Similar comment to Table 6-12 above.	Not Accepted – Closed Though there is presently no additional room, there are also no known items missing. If Additional items come to light, the field can be extended at a later date and the version of the format changed without significant consequence.
1	Table 6-22 Object Parameter Types Shouldn't we include a parameter type for 8.33 kHz radios too? (Not just 25 kHz)	Accepted – Closed
1	Sections 6.18.2-7 Last sentence, 2nd paragraph. Grammatically, I'd suggest writing it as "See Table 6.22 "Overlay Geometry Encoding" for encoding details." (Omit the period after the table number – it is confusing!)	Accepted – Closed
1	Section 6.18.4 Extended Range 3D Polygon I have a disagreement with the design decision to divorce the extended range polygon vertex definitions from a reference point. Having to define each vertex independently on a global scale wastes a lot of bits. Remember that the end application is the graphical display of NOTAMs – it is unlikely that any such polygon will extend more than 10's of nautical miles, especially if high-resolution (e.g., 1.25 meter) resolution is required! The proposed encoding of latitude/longitude requires 48 bits for each vertex. Note that the "Compact Position Reporting" (CPR) algorithm used for Mode S ADS-B "1090 Squitter" (surface format) requires only 34 bits for the same resolution (1.25 meters) over a 90-mile radius from its reference point. A very simple reduced form of CPR encoding would save at least 14 bits per vertex. If the 90-mile radius is reduced to 45 nautical miles (probably still overkill for the NOTAM application), then 16 bits/vertex would be saved. Also, using angle measurements for vertex geographic definition	The design decision was to be consistent with the representation of latitude and longitude used in other systems (e.g., ARINC 743 GPS), and maintain consistency with Airspace NOTAMs and Special Use Airspace product representations. Specifying position to full resolution unambiguously allows consistent reporting and processing and avoids the need for compression algorithms. The Extended Rang Polygon is only used for airspace products. The resolution for each vertex has been reduced to 305.2 m (34 bits for lat/lng) and the altitude coordinate resolution has been reduced to 1000 ft. Furthermore, the altitude floor has been changed to 0.

Version	Comment	Status
	yields differing actual East-West distance resolution as a function of latitude. The CPR algorithm deals with this problem appropriately to yield a consistent distance resolution for all latitudes. I could provide documentation of the CPR algorithm (from ICAO or the RTCA) and an implementation (about 100 lines of C). Even if CPR is not used (for simplicity?), I would still suggest reducing the number of bits used for vertex definition by having a reference point. Why should each vertex have global range – no real polygon is going to span more than the US!!? The last paragraph defines the altitude component of each vertex. Why have the range go to –1000 feet? Is there anything of interest to a pilot down there? (I realize that aircraft altitude encodings actually allow for –1200 feet, but how would that be used in a practical NOTAM? I suggest using a 7-bit encoding with 0 as the base and 38,400 feet as the top. The top encoding would be defined as ≥ 38,400 feet. A bit here, a bit there… eventually it adds up. Finally – it is spelled “Sea” Level, not “See.”	
1	Section 6.18.5 Low Resolution 2D Ellipse What is intended by the definition of a negative radius? The major and minor axes should be defined using 11-bit fields (only positive values)…saves 2 bits per ellipse.	Accepted – Closed
1	Section 6.18.6 High Resolution 3D Ellipse What is intended by the definition of a negative radius? The major and minor axes should be defined using 13-bit fields (only positive values)…saves 2 bits per ellipse.	Accepted – Closed
1	Section 6.18.7 Extended Range Circular Prism Same comment as for 6.18.4 above – use a reference point for encoding vertex positions. Suggest using CPR – could save at least 14 bits for each vertex.	See comments to changes in Extended Range Polygon.
1	Same comment as for 6.18.4 above – suggest recording altitude representations to save a bit for each vertex.	See comments to changes in Extended Range Polygon.

Version	Comment	Status
1	Appendix A-1 Using the DLAC Character Set It appears that the document requires DLAC encodings to have multiples of 3-byte (4 DLAC character) sequences. This is quite wasteful … why not simply pad the last DLAC character out to the next byte boundary with zero bits? In the worst case, there would be 18 wasted null bits (only one DLAC character in the grouping) as opposed to a worst case of 6 padding bits (if the DLAC character only used 2 bits of the last byte). The whole purpose of using DLAC is bit-efficiency – why give up so much, just for byte alignment?	Accepted – Closed
1	Table A-1 DLAC 6-bit Character Set The definition of DLAC encoding 011110 is labeled "CR" in the table and notes – it is labeled "CRLF" in section A.2.1 below. Be consistent – I'd suggest "CRLF" be used in both places.	Accepted – Closed
1	Appendix C.4 NOTAM Example 4 There are several spelling errors in this example. It's "AUTHORIZED," not "OTHERIZED." It's "COORDINATION", not "COORDINTATION." I'm not sure whether "MATHEWS" should have a double "T" or not.	Accepted – Closed

Version	Comment	Status
1	Appendix C.4 NOTAM Example 4 The "Data Link Applications Coding" (DLAC) algorithm includes a word-dictionary procedure as well as the 6-bit character set defined in Appendix A-1. I tested its performance on the example text (after correcting the two spellings). There are 507 characters in the example NOTAM. This would yield 381 bytes of DLAC characters (assuming just padding to a byte boundary – see comments to A-1 above). Using the DLAC word-dictionary feature, DLAC compressed this example NOTAM to 304 bytes – a savings of more than 25% (77 bytes) beyond the DLAC 6-bit character representation. There were 33 DLAC dictionary words found in the given example – a rather typical result for 'wordy' NOTAMS. The DLAC encoding and decoding software is simple (it takes less than 500 lines of C total). I can provide C-language implementations and documentation. Both the encoding and decoding are very efficient (times measured in a few milliseconds). It seems that this compression could be valuable in saving space without much hardship here.	Not Accepted. The additional processing required to implement the dictionary is not believed to be warranted.
1	Section 5.5 Suggest using a record length field as you've done with the overlay to avoid any potential for the ETX bit pattern showing up in a formatted/encoded bit stream. This approach would also unnecessarily constraining future formats.	Accepted – Closed ETX field removed from Text record and Text Record Length field added.
1	You can avoid the need for a record status field for both the test and overlay records since the overlay record is always associated with a text record. Therefore, you can generalize the Text record Status as a Report Status and eliminate the Overlay Record Status field.	Accepted – Closed Overlay Record Status field removed and Text Record Status changed to Report Status.
1	Add words to section 5.2 to describe the fact that you don't always need to send full text and overlay records. By periodically sending the full records to ensure reception by all aircraft, you can just send a truncated Text Record with the Report Status and provide the avionics with enough information to indicate the currency of all records associated with a product report.	Accepted – Closed Additional explanation added.

Version	Comment	Status
1	The Overlay Record Length is too small to account for a record with all fields used and Extended Polygon with 16 vertices (requires 158 bytes).	Accepted – Closed Overlay Record Length field expanded
1	Encoding of latitude and longitude is not clearly described in appendix B.	Accepted – Closed Addition explanation provided.
1	Why complicate the encoding of the Runway Endpoint Encoding in figure 4-3 with the sign bit? Why not just use 6 bits to specify the runway?	Accepted – Closed
2	If the Object Element Field is not used, what should be done, zero fill the bits or remove the field?	Accepted – Closed Object Element field is no longer optional. If an Object Type doesn't have a corresponding Element, the Object Element field is zero filled. This approach preserves the byte boundary.
2	How are NOTAMs with more than 8 graphical components handled? Suggest means to handle more, such as for power plants and large outdoor gatherings.	Accepted – Closed The Record Identifier range has been expanded to four bits, allowing 16 related records for a single NOTAM report. Furthermore, the numbers of ellipses and circular prisms per record have been expanded to allow up to 64 of these geometries per record. These changes have minimal impact on the Graphical Overlay format while enabling up to 16x64=1024 ellipse/circular prism geometries per NOTAM report.
2	Appendix B illustrates the encoding of latitude and longitude, but the size of each field doesn't match the sizes set in the Overlay Geometry Encoding table.	Accepted – Closed The lat/lon encoding in Appendix B is meant as an example for illustrative purposes only and the actual encoding will vary according to the particular geometry used. Figure B-1 was changed so that the sizes of the lat/lon fields were equal and matched the rest of the section. Clarifying text added to section about this being just an example.
2	FIS-B Service Provider product outage notification shouldn't use the NOTAM product ID.	Accepted – Closed The product ID for NOTAMs (PID 8) has been renamed NOTAMs and Other Service Status. Furthermore, FIS-B Service Status reports have been allocated identification range of 10000-11999.

Version	Comment	Status
2	The FAA's new NOTAM-D reference scheme requires both a location ID and a number for uniqueness. The current PID 8 scheme in this document doesn't have away to represent the location ID in NOTAM Reports.	Accepted – Closed The Aerodrome/Airspace FIS-B Payload Header has been modified to always include the Location Identifier and Record Reference Point (formerly called the Overlay Reference Point) fields.
2	Segmented APDUs don't yield unique segments when the same product is received over a data link from multiple ground stations by an aircraft.	Accepted – Closed The segmented APDU extension in the APDU header has been modified to provide a unique segmentation number and APDU reference. This change deviates from the FIS-B MASPS, but is necessary. The FAA will modify the FIS-B TSO to reflect this change.
2	The new D-NOTAM numbering is not the same as the FDC NOTAM numbering.	Accepted – Closed A number range of 12000-12999 has been set aside for D NOTAMs using their three digit range as the three least significant digits. Also since D NOTAMs have an associated location ID, the payload header has been changed to always include the record location ID. The FAA will modify the FIS-B TSO to reflect this change.
3	The Overlay Record Identifier is limited to 16 records per Report. NOTAM/TFRs with many point geometries associated with a single NOTAM cannot be represented with this limited number of records.	Accepted – Closed A new geometry has been defined for a singular point geometry (section 6.18., 6.18.8, and 6.21). This enables 64 point geometries per Record Identifier, thus 64 points x 16 Records per Report, or 384 singular point geometries per Report (e.g., NOTAM/TFR).
3	Version 3 of this document (section 5.1) requires the first 5 bytes of the Text Record be repeated in each segmented APDU, but there is no such requirement on the Overlay Record.	Accepted – Closed The requirement to include the Text Record header (i.e., Record length, Report number and year) has been removed as it has been deemed unnecessary. Furthermore, there is no such requirement on the Overlay Record either.

Appendix J Glossary

ADS-B	Automatic Dependent Surveillance – Broadcast mode
ADIZ	Air Defense Identification Zone
AGL	Above Ground Level
AIRMET	Airmen's Meteorological Conditions
APDU	Application Protocol Data Unit
ARINC	Aeronautical Radio Incorporated
ARP	Airport Reference Point
ASN.1	Abstract Syntax Notation, version 1
ATIS	Automated Terminal Information Service
AWOS	Automated Weather Observations System
C	Center
CAASD	Center for Advanced Aviation System Development
CR	Carriage Return/Line Feed
CS	Currency Sign (e.g., $)
D-ATIS	Digital Automated Terminal Information Service
DLAC	Data Link Applications Coding
ETX	End-of-Text
FAA	Federal Aviation Administration
FIS-B	Flight Information Service – Broadcast mode
ICAO	International Civil Aviation Organization
L	Left
LSB	Incremental Unit
MASPS	Aviation System Performance Standards
MSL	Mean Sea Level
NA	Aeronautical Radio Incorporated
NC	Null Character
NOTAM	Notices to Airmen
NTSB	National Transportation Safety Board

PD	Product Description
PER	Packed Encoding Rules
R	Right
RS	Record Separator
SBS	Surveillance and Broadcast Services
SIGMET	Significant Meteorological Conditions
SP	Space
SUA	Special Use Airspace
TFR	Temporary Flight Restriction
TIS-B	Traffic Information Service – Broadcast mode
TWIP	Terminal Weather Information for Pilots
UAT	Universal Access Transceiver