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SURVEILLANCE DATA EXCHANGE

Category 240

Radar Video Transmission



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Abstract

This document describes the application of ASTERIX messages to the transmission of rotating radar video.

Keywords

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The following table identifies all management authorities who have successively approved the present issue of this document.

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EXECUTIVE SUMMARY

This document describes the general concepts and the message layout for the application of ASTERIX category 240 for the transmission of video information from a rotating radar.

1. INTRODUCTION

1.1 Scope

This document describes the application of ASTERIX to the transmission of rotating radar video to local or remote maintenance displays or one or more Surveillance Data Processing (SDP) Systems.

Radar video is made of a stream of cells grouped by radials (i.e. cells of the same azimuth) sorted by increasing range. Radials are transmitted by increasing azimuth.

2. REFERENCES

2.1 General

The following Documents and Standards contain provisions which, through references in this text, constitute provisions of this Eurocontrol Document.

At the time of publication of this Eurocontrol Document, the editions indicated for the referenced documents and standards were valid.

Any revision of the referenced ICAO Documents shall be immediately taken into account to revise this Eurocontrol Document.

Revisions of the other referenced documents shall not form part of the provisions of this Eurocontrol Document until they are formally reviewed and incorporated into this Eurocontrol Document.

In case of a conflict between the requirements of this Eurocontrol Document and the contents of the other referenced documents, this Eurocontrol Document shall take precedence.

2.2 Reference Documents

1. Eurocontrol Standard 000-1-92. Directives for the Uniform Drafting and Presentation of Eurocontrol Standard Documents. 1992.
2. Eurocontrol Standard SUR.ET1.ST05.2000-STD-01-01. All Purpose Structured Eurocontrol Surveillance Information Exchange - ASTERIX. Edition 1.30, Released Issue, November 2007.
3. ICAO Annex 5

3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 Definitions

For the purposes of this Eurocontrol Document, the following definitions shall apply:

- 3.1.1 Cell:** The elementary information of radar video amplitude; each cell is defined by its range, azimuth and amplitude.
- 3.1.2 Cell range:** A slant range polar co-ordinate based on the propagation time of radar signal from the radar site location to the cell. (Radar site location serves as the origin of the polar co-ordinate system).
- 3.1.3 Cell azimuth:** An azimuth polar co-ordinate based on the azimuth of the burst, or the radar recurrence. The reference for the azimuth shall be local geographical north.
- 3.1.4 Cell amplitude:** Based on digital level or digitized analogous signal.
- 3.1.5 Cell spatial extensions:** The cell size, which depends on the radar and on the required resolution of the video.
- 3.1.6 Cell range extension:** The smallest distance between two consecutive cells located at the same azimuth.
- 3.1.7 Cell azimuth extension:** The smallest azimuth extension between two consecutive cells located at the same range.
- 3.1.8 Catalogue of Data Items:** List of all possible Data Items of each Data Category describing the Data Items by their reference, structure, size and units (where applicable).
- 3.1.9 Data Block:** Unit of information seen by the application as a discrete entity by its contents. A Data Block contains one or more Record(s) containing data of the same category.
- 3.1.10 Data Category:** Classification of the data in order to allow for, inter alia, an easy identification.
- 3.1.11 Data Field:** Physical implementation for the purpose of communication of a Data Item. It is associated with a unique Field Reference Number and is the smallest unit of transmitted information.
- 3.1.12 Data Item:** The smallest unit of information in each Data Category.
- 3.1.13 Measured Item:** A piece of information (e.g. the position of a target) derived from the sensor information and transmitted without any smoothing.

-
- 3.1.14 Record:** A collection of transmitted Data Fields of the same category preceded by a Field Specification field, signalling the presence/absence of the various Data Fields
- 3.1.15 User Application Profile:** The mechanism for assigning Data Items to Data Fields, and containing all necessary information which needs to be standardised for the successful encoding and decoding of the messages.

3.2 Acronyms and Abbreviations

For the purposes of this Eurocontrol Document the following shall apply:

°	Degree (angle)
ASTERIX	All Purpose ST ructured Eurocontrol suR veillance Information EX change
CAT	Data Category
EATM	European Air Traffic Management
FRN	Field Reference Number
FSPEC	Field Specification
FX	Field Extension Indicator
ICAO	International Civil Aviation Organization
LEN	Length Indicator
LSB	Least Significant Bit
NM	Nautical Mile, unit of distance (1852 metres)
PSR	Primary Surveillance Radar
RDE-FG	Radar Data Exchange Focus Group
RE	Reserved Expansion Indicator
REP	Field Repetition Indicator
s	second, unit of time
SAC	System Area Code
SIC	System Identification Code
SP	Special Purpose Field
SURT	Surveillance Team (EATM)
UAP	User Application Profile (see Definitions)
UTC	Coordinated Universal Time

4. GENERAL PRINCIPLES

4.1 General

The transmission of radar video information shall require the transmission of two types of messages:

- video summary (to deliver stream meta data: a label)
- video cells (to deliver the stream cells)

4.2 Time Management

4.2.1 Definition

The time stamp shall be consistent with the time of report transmission.

4.2.2 Requirements for Time Stamping

The time stamping shall comply with the following requirements:

- every radial shall have its own individual timestamp;
- co-ordinated Universal Time (UTC) as specified in ICAO Annex 5 shall be used to time stamp radar data.

4.3 Unused Bits in Data Items.

Decoders of ASTERIX data shall never assume and rely on specific settings of spare or unused bits. However in order to improve the readability of binary dumps of ASTERIX records, it is recommended to set all spare bits to zero.

4.4 Definitions and Addressing Concepts

In order to address sources in an unambiguous way, a simple abstract model for concepts like sensors or systems has been designed.

4.4.1 System

In the framework of category 240 a System is any device delivering or receiving ASTERIX data.

4.4.2 Addressing Concepts: Assigning SAC/SIC Codes

By convention a dedicated and unambiguous SAC/SIC code shall be assigned to every System.

4.5 User Application Profile and Data Blocks

4.8.1 A single User Application Profile (UAP) is defined.

4.8.2 A Video Data Block shall contain one or more radar video messages (i.e. one or more records) in line with the following layout.

CAT = 240	LEN	FSPEC	Items of the video record
------------------	------------	--------------	----------------------------------

where:

- CAT = 240 is a one-octet field indicating that the Data Block contains a video message;
- Length Indicator (LEN) is a two-octet field indicating the total length in octets of the Data Block, including the CAT and LEN fields;
- FSPEC is the Field Specification (one or two-octet field).

4.6 Composition of Messages

4.9.1 Messages shall be composed of Data Items assembled in the order defined by the Field Reference Number (FRN) in the associated UAP.

4.9.2 When sent, items shall always be transmitted in a record with the corresponding FSPEC bits set to one.

5. LAYOUT OF MESSAGES

5.1 Standard Data Items

The standardised Data Items, which shall be used for the transmission of Radar Video Messages are defined in Table 1 and described on the following pages.

Table 1 - Standard Data Items of Category 240

Data Item Ref. No.	Description	Resolution
I240/000	Message Type	N.A.
I240/010	Data Source Identifier	N.A.
I240/020	Video Record Header	N.A.
I240/030	Video Summary	N.A.
I240/040	Video Header Nano	N.A.
I240/041	Video Header Femto	N.A.
I240/048	Video Cells Resolution	N.A.
I240/049	Video Blocks Counter	N.A.
I240/050	Video Block	N.A.
I240/140	Time of Day	1/128 s

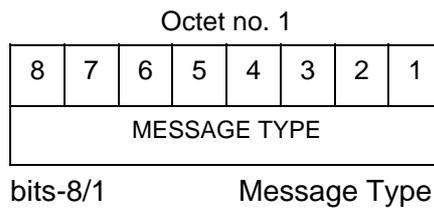
5.2 Description of Standard Data Items

5.2.1 Data Item I240/000, Message Type

Definition : This Data Item allows for a more convenient handling of the messages at the receiver side by further defining the type of transaction.

Format : One-octet fixed length Data Item.

Structure:



Encoding Rule : This data item shall be present in every ASTERIX message.

NOTES

1. In applications where transactions of various types are exchanged, the Message Type Data Item facilitates the proper report handling at the receiver side.
2. All Message Type values are reserved for common standard use.
3. The following set of Message Types are standardised for Category 240 messages:
 - 001 Video Summary message
 - 002 Video message
4. The list of items present for the two message types is defined in the following table.
M stands for mandatory, O for optional, X for never present.

Table 2 - Message Types

Type Item	001 Video Summary Message	002 Video Message
I240/000 Message Type	M	M
I240/010 Data Source Identifier	M	M
I240/020 Video Record Header	X	M
I240/030 Video Summary	M	X
I240/040 Video Header Nano	X	O *
I240/041 Video Header Femto	X	O *
I240/048 Video Cells Resolution	X	M
I240/049 Video Blocks Counter	X	M
I240/050 Video Block	X	M
I240/140 Time of Day	O	O

* Either item I240/040 or I240/041 shall be present in each video message

5.2.2 Data Item I240/010, Data Source Identifier

Definition: Identification of the system from which the data are received.

Format: Two-octet fixed length Data Item.

Structure:

Octet no. 1								Octet no. 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SAC								SIC							

bits-16/9 (SAC) System Area Code

bits-8/1 (SIC) System Identification Code

Encoding Rule : This item shall be present in each ASTERIX message

NOTE: The up-to-date list of SACs is published on the Eurocontrol Web Site (<http://www.eurocontrol.int/asterix>)

5.2.3 Data Item I240/020, Video Record Header

Definition : Contains a message sequence identifier.

Format : Four-Octets fixed length data item.

Structure:

Octet no. 1								Octet no. 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
MSG_INDEX															

Octet no. 3								Octet no. 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
MSG_INDEX															

Bits 32/1 (MSG_INDEX) Message Sequence Identifier (video record cyclic counter)

Encoding Rule : This item shall be present in each Video message

NOTE: The Message Sequence Identifier is used by the receiving application to detect lost messages.

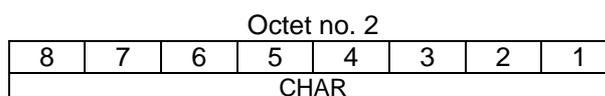
MSG_INDEX have a length of 32 bits to ease real time encoding.

5.2.4 Data Item I240/030, Video Summary

Definition : Contains an ASCII string (free text to define stream meta data).

Format : Repetitive Data Item, starting with a one-octet Field Repetition Indicator (REP) followed by at least one sub-field of one octet (ASCII character).

Structure:



bit-16/9 (REP) Number of characters following

bit-8/1 (CHAR) Character in ASCII representation

Encoding Rule : This item shall be present in each Video Summary message

5.2.5 Data Item I240/040, Video Header Nano

Definition : Defines a group of video cells corresponding to a video radial: all cells have the same size in azimuth and range and are consecutive in range.

Format : Twelve-Octets fixed length data item.

Structure:

Octet no. 1								Octet no. 2							
96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
START_AZ														LSB	

Octet no. 3								Octet no. 4							
80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
END_AZ														LSB	

Octet no. 5								Octet no. 6							
64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
START_RG															

Octet no. 7								Octet no. 8							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
START_RG														LSB	

Octet no. 9								Octet no. 10							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
CELL_DUR															

Octet no. 11								Octet no. 12							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
CELL_DUR														LSB	

Bits 96/81	(START_AZ)	Start azimuth of the cells group LSB = $360/2^{16}$, Range: [0;360]
Bits 80/65	(END_AZ)	End azimuth of the cells group LSB = $360/2^{16}$, Range: [0;360]
Bits 64/33	(START_RG)	Starting range of the cells group, expressed in number of cells. 0 is the radar location without any bias.
Bits 32/1	(CELL_DUR)	Video cell duration in nano-seconds. LSB = 10^{-9} s

Encoding Rule : Either item I240/040 or I240/041 shall be present in each Video message

5.2.6 Data Item I240/041, Video Header Femto

Definition : Defines a group of video cells corresponding to a video radial: all cells have the same size in azimuth and range and are consecutive in range.

Format : Twelve-Octets fixed length data item.

Structure:

Octet no. 1								Octet no. 2							
96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
START_AZ														LSB	

Octet no. 3								Octet no. 4							
80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
END_AZ														LSB	

Octet no. 5								Octet no. 6							
64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
START_RG															

Octet no. 7								Octet no. 8							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
START_RG														LSB	

Octet no. 9								Octet no. 10							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
CELL_DUR															

Octet no. 11								Octet no. 12							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
CELL_DUR														LSB	

- Bits 96/81 (START_AZ) Start azimuth of the cells group
LSB = $360/2^{16}$, Range: [0;360]
- Bits 80/65 (END_AZ) End azimuth of the cells group
LSB = $360/2^{16}$, Range: [0;360]
- Bits 64/33 (START_RG) Starting range of the cells group, expressed in number of cells. 0 is the radar location without any bias.
- Bits 32/1 (CELL_DUR) Video cell duration in femto-seconds.
LSB = 10^{-15} s

Encoding Rule : Either item I240/040 or I240/041 shall be present in each Video message

5.2.7

Data Item I240/048, Video Cells Resolution

Definition : This Data Item defines the bit resolution used in the coding of the video signal amplitude in all cells of the video group.

Format : Two-octets fixed length Data Item.

Structure:

Octet no. 1								Octet no. 2							
16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01
SPARE								(RES)							

Bits 8/1 (RES) Bit resolution used for the coding of the amplitude of the video signal in every cell of a video group.

Bits 09/16 (SPARE) Spare bits that can be used for growth potential (for example to describe the compression method: jpeg, tif, png...)

RES	Resolution	Coding Length in bits
1	Normal_Resolution	4
2	Monobit_Resolution	1
3	High_Resolution	8
4	Composite_Resolution	32

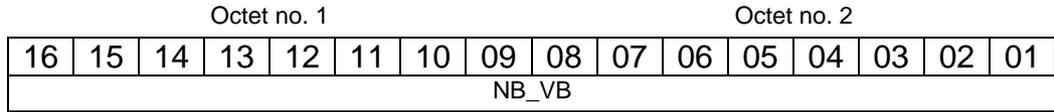
Encoding Rule: This data item shall be present in every Video Message.

5.2.8 Data Item I240/049, Video Blocks Counter

Definition : This Data Item contains the number of video blocks (i.e. number of repetitions of Item I240/050) used in the coding of the video signal amplitude in all cells of the video group.

Format : Two-octets fixed length Data Item.

Structure:



Bits 16/1 (NB_VB) If I240/049 (RES) = 1 then NB_VB = NB_CELLS/8
 If I240/049 (RES) = 2 then NB_VB = NB_CELLS/32
 If I240/049 (RES) = 3 then NB_VB = NB_CELLS/4
 If I240/049 (RES) = 4 then NB_VB = NB_CELLS
 NB_CELLS: Number of cells in the video group

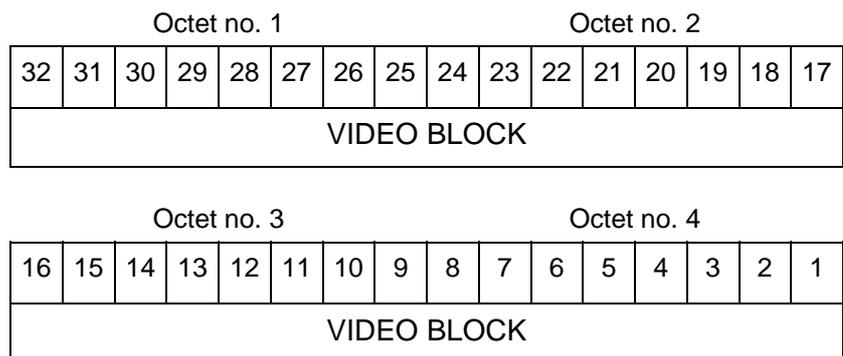
Encoding Rule : This item shall be present in each Video message

5.2.9 Data Item I240/050, Video Block

Definition : Contains a group of video cells corresponding to a video radial; all cells have the same size in azimuth and range and are consecutive in range.

Format : Four-octets fixed length Data Item.

Structure:



Bits 32/1 (VIDEO BLOCK) Video signal amplitude of the cells in the group, coded according to the resolution defined in Item I240/048

Encoding Rule : This item shall be present in each Video message

NOTES:

1. The first cell in the block is always the nearest of the sensor and the following cells are in increasing range order.
2. The length of each Video Block has been defined as 4-octets for performance reasons (use of 32-bit processors).
3. To get the range in meters of the cell at position “NU_CELL” in the data stream, the following formula shall be used:

$$D = CELL_DUR_{(in\ seconds)} * (START_RG + NU_CELL - 1) * c/(2.)$$

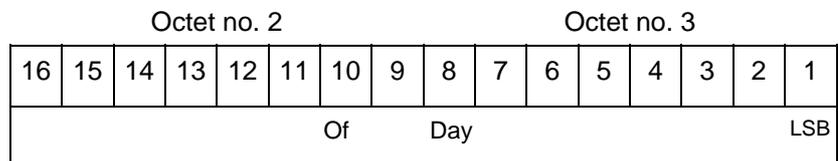
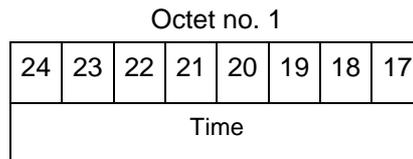
where $c = 299\ 792\ 458\ m/s$: light celerity.

5.2.10 Data Item I240/140, Time of Day

Definition: Absolute time stamping expressed as UTC.

Format: Three-octet fixed length Data Item.

Structure:



bit-1 (LSB) 1/128 s

Encoding Rule : This data item is optional.

NOTE - The time of day value is reset to zero each day at midnight.

NOTE: The time information, shall reflect the exact time of an event, expressed as a number of 1/128 s elapsed since last midnight.

5.3 Standard User Application Profile

5.3.1 The following UAP shown in Table 3 shall be used for the transmission of reports:

Table 3 - Standard UAP

FRN	Data Item	Information	Length in Octets
1	I240/010	Data Source Identifier	2
2	I240/000	Message Type	1
3	I240/020	Video Record Header	4
4	I240/030	Video Summary	1+n
5	I240/040	Video Header Nano	12
6	I240/041	Video Header Femto	12
7	I240/048	Video Cells Resolution	2
FX	-	Field Extension Indicator	n.a.
8	I240/049	Video Blocks Counter	2
9	I240/050	Video Block	4*n
10	I240/140	Time of Day	3
11	-	Spare	-
12	-	Spare	-
13	RE	Reserved Expansion Field	1+
14	SP	Special Purpose Field	1+
FX	-	Field Extension Indicator	n.a.

where:

- the first column indicates the FRN associated to each Data Item used in the UAP;
- the fourth column gives the format and the length of each item. A stand-alone figure indicates the octet count of a fixed-length Data Item, 1+ indicates a variable-length Data Item comprising a first part of one-octet followed by n-octet extents as necessary.

The maximum length of the corresponding FSPEC is two octets.