EUROCONTROL Specification for Surveillance Data Exchange

ASTERIX Part 27 Category 238
Service Prediction Reports

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Abstract

This document specifies the contents of ASTERIX Category 238 messages used for the transmission of Service Prediction Reports.

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Data Category	Data Field	Data Item	
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DOCUMENT APPROVAL

This document has been approved by the ASTERIX Maintenance Group (AMG).

For management approval of the complete set of ASTERIX documentation refer to Part 1.

DOCUMENT CHANGE RECORD

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

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1. INTRODUCTION

1.1 Scope

This document describes the application of ASTERIX to Service Prediction Reports, used to convey the current and/or predicted service status of a surveillance system as a function of geographic location and time.

This document defines the data out of Category 238.

2. REFERENCES

2.1 General

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

At the time of publication of this EUROCONTROL Standard 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 Standard Document.

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

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

2.2 Reference Documents

1) EUROCONTROL Specification SPEC-0149, edition 2.2, 17 October 2014 “EUROCONTROL Specification for Surveillance Data Exchange – Part 1 All Purpose Structured EUROCONTROL Surveillance Information Exchange – ASTERIX”.

3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 Definitions

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

Catalogue of Data Items: List of all the possible Data Items of each Data Category describing the Data Items by their reference, structure, size and units (where applicable).

Data Category: Classification of the data in order to permit inter alia an easy identification.

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.

Data Item: The smallest unit of information in each Data Category.

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.

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 reports.

3.2 Acronyms and Abbreviations

For the purposes of this EUROCONTROL Document, the following shall apply:

°	Degree (angle)
AMG	ASTERIX Maintenance Group
ASTERIX	**A**ll Purpose **ST**ructured EUROCONTROL su**R**veillance **I**nformation E**X**change
CAT	Data Category
FRN	Field Reference Number
FSPEC	Field Specification
FX	Field Extension Indicator
ICAO	International Civil Aviation Organization
LEN	Length Indicator
LSB	Least Significant Bit
RE	Reserved Expansion Indicator
REP	Field Repetition Indicator
s	second, unit of time
SAC	System Area Code
SIC	System Identification Code
SP	Special Purpose Indicator
UAP	User Application Profile (see Definitions)
UTC	Co-ordinated Universal Time
WGS-84	World Geodetic System 1984

4. GENERAL PRINCIPLES

4.1 General

ASTERIX Category 238, Service Prediction Reports, defines a structure to convey the current and/or predicted service status of a surveillance system as a function of geographic location and time.

4.2 Time Management

Time-stamping shall comply with ICAO Annex 5.

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 Service Prediction Record Types

Two types of records are defined to support the transmission of service prediction information:

- Service Volume Definition Record
- Service Prediction Report Record

4.4.1 Service Volume Definition Records

The Service Volume Definition uses one or more records to describe a service volume as a set of tiles.

These records are sent periodically and each time a change is made to the Service Volume Definition.

Note: In some applications, the service volume may be pre-defined as configuration data within the client system, using the parameters for the Service Volume Definition. In such cases, the Service Volume Definition need not be sent using ASTERIX records.

4.4.2 Service Prediction Report Records

The Service Prediction Report uses one or more records to provide service predictions expressed as the expected service status of each tile in a service volume, for one or more time intervals. Only tiles with unserviceable or unknown status are explicitly reported.

The set of records constituting a Service Prediction Report is sent periodically and each time a change is made to the Service Volume Definition or to any of the associated service predictions.

4.5 User Application Profile and Data Records

A single User Application Profile (UAP) is defined and shall be used for Service Prediction records.

The composition of ASTERIX records of Category 238 shall follow the rules as described in Edition 2.2 (or later) of Part 1 of the ASTERIX documentation, chapter 4.3.2.5.

Data records shall have the following layout.

CAT = 238	LEN	FSPEC	Data Item	Data Item	Data Item

where:

- Data Category (CAT) = 238, is a one-octet field indicating that the record contains information defined for Service Prediction Reports;
- Length Indicator (LEN) is a two-octet field indicating the total length in octets of the record, including the CAT and LEN fields;
- FSPEC is the Field Specification.

Note: Blocking of multiple records sharing a single CAT and LEN field pair is not supported for Category 238 records.

4.6 Composition of Records

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

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

5. LAYOUT OF REPORTS

5.1 Standard Data Items

The standardised Data Items which shall be used for the transmission of Service Prediction records are defined in Table 1 and described in the following pages.

Table 1 - Data Items of Category 238

Data Item Reference Number	Description	Resolution
I238/000	Record Type	N.A.
I238/005	Message Identification	N.A.
I238/010	Data Source Identification	N.A.
I238/015	Service Identification	N.A.
I238/077	Time of ASTERIX Message Transmission	1/128 s
I238/080	Service Volume Description	N.A.
I238/085	Tile Definitions	N.A.
I238/090	Service Prediction Report Description	N.A.
I238/095	2D Service Predictions	N.A.
I238/096	3D Service Predictions	N.A.

5.2 Description of Standard Data Items

5.2.1 Data Item I238/000, Record Type

Definition: Identification of the component of the service prediction reporting structure conveyed in this record.

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
Record Type							

bits-8/1 Record Type

= 1: Service Volume Definition Record

= 2: Service Prediction Report Record

= 0, 3 – 255: Reserved for future use

The use of the different Data Items of Category 238, based on record type, shall be in accordance with Table 2.

Table 2 – Use of Data Items of Category 238 by Record Type

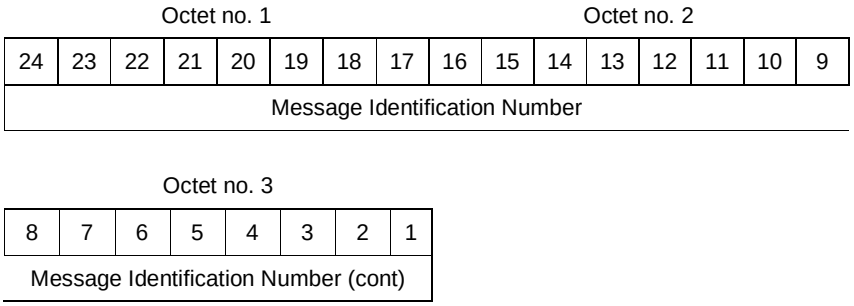
Data Item	Service Volume Definition Record	Service Prediction Report Record
I238/010	Mandatory	Mandatory
I238/077	Mandatory	Mandatory
I238/000	Mandatory (= 1)	Mandatory (= 2)
I238/005	Mandatory	Mandatory
I238/015	Optional	Optional
I238/080	Mandatory	N.A.
I238/085	Mandatory	N.A.
I238/090	N.A.	Mandatory
I238/095	N.A.	Optional
I238/096	N.A.	Optional

5.2.2 Data Item I238/005, Message Identification

Definition: Identification of a unique message.

Format: Three-octet fixed length Data Item.

Structure:



bits-24/1	Message Identification Number

Notes:

1. The Message Identification Number is to be used to uniquely identify each message. If messages are being sent on redundant links then this number must be identical for the same message on each link. This will allow the receiver to easily identify and discard duplicate messages.
2. The allocation of the Message Identification Number is performed by the system and is implementation specific. The algorithm applied to the allocation of the number shall be described in the respective Interface Control Document (ICD).

5.2.3 Data Item I238/010, Data Source Identification

Definition: Identification of the station generating the ASTERIX record.

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

Notes:

1. The up-to-date list of SACs is published on the EUROCONTROL ASTERIX Web Site:

   (http://www.EUROCONTROL.int/services/system-area-code-list).

2. Optional Data Item I238/015, Service Identification may be used to differentiate between services or service volumes sharing a single combination of SAC and SIC.

5.2.4 Data Item I238/015, Service Identification

Definition: Identifies the service being reported.

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
SID							

bits-8/1 (SID) Service Identification

Notes:

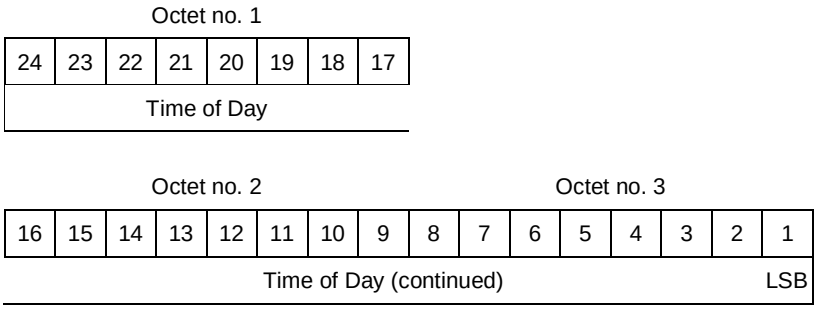
1. The service identification is allocated by the system.
2. This Data Item I238/015, Service Identification may be used to differentiate between different services or service volumes sharing a single combination of SAC and SIC in Data Item I238/010.

5.2.5 Data Item I238/077, Time of ASTERIX Message Transmission

Definition: UTC time of transmission of this ASTERIX message.

Format: Three-octet fixed length Data Item.

Structure



bits-24/1	(TOD)	Time of Day (UTC) at which the ASTERIX message was transmitted LSB = 2^{-7} s = 1/128 s

Notes:

1. The TOD value is reset to zero at every midnight UTC.

5.2.6 Data Item I238/080, Service Volume Description

Definition: Number and size of Tiles in Service Volume.

Format: Five-octet fixed-length Data Item.

Structure:

Octet no. 1

40	39	38	37	36	35	34	33
IODSVD							

Octet no. 2 Octet no. 3

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
TNT															

Octet no. 4 Octet no. 5

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TU	Tile Size														LSB

Bits-40/33	(IODSVD)	Issue of Data for Service Volume Definition Valid Range: 1 <> 255
bits-32/17	(TNT)	Total Number of Tiles for this service volume Valid Range: 1 <> 65,534
bits-16	(TU)	Tile Units: The LSB value and unit of measure for Tile Size. =0: LSB = 10 m =1: LSB = 2^{-13} degrees of latitude/longitude This corresponds to a resolution of at least 13.6 metres
bits-15/1		Tile Size: The dimension applicable to each side of each Tile, with LSB value and unit of measure as specified by TU.

Notes:

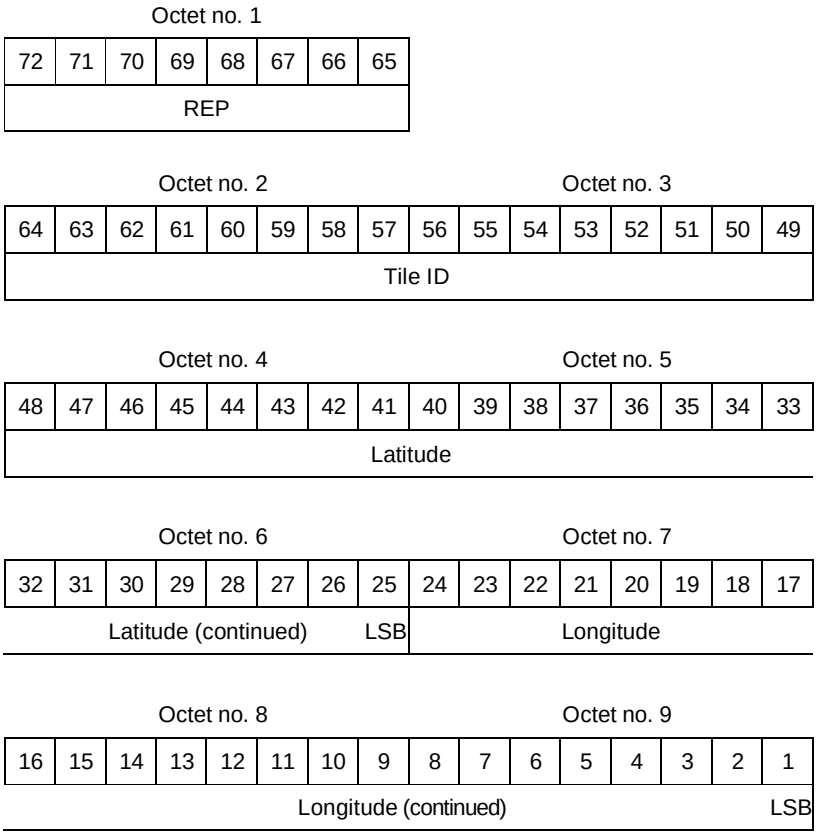
1. The value of IODSVD in Data Item I238/090 of associated Service Prediction Report records will match IODSVD of this Data Item I238/080, to ensure correct assignment of Tile IDs and tile locations.
2. Where more than one record is used to define the set of tiles for a service volume definition, TNT in this Data Item I238/080 will indicate the combined number of tiles in all records, whereas REP in each instance of Data Item I238/085 will indicate the number of tiles within that instance of the Data Item.
3. The orientations of the Tile Size dimension for each tile are parallel and perpendicular to the WGS-84 North-South direction at the tile centre.

5.2.7 Data Item I238/085, Tile Definitions

Definition: Tile locations in WGS-84 Co-ordinates.

Format: Repetitive Data Item starting with a one-octet Field Repetition Indicator (REP) followed by at least one eight-octet Tile Definition.

Structure:



bits-72/65	(REP)	Repetition Indicator for the number of tiles to follow in this data item.
bits-64/49		Tile ID: A unique number that identifies a tile within this service volume. Valid Range 1 <> 65,534

bits-48/25	Latitude: WGS-84 latitude at tile centre, in two's complement. Range -90 <= latitude <= 90 deg. LSB = $180/2^{23}$ degrees = 2.145767×10^{-5} degrees. This corresponds to a resolution of at least 2.4 metres
bits-24/1	Longitude: WGS-84 longitude at tile centre, in two's complement. Range -180 <= longitude <= 180 deg. LSB = $180/2^{23}$ degrees = 2.145767×10^{-5} degrees. This corresponds to a resolution of at least 2.4 metres.

Notes:

1. Tile IDs are not required to be consecutive. Logical groups of tiles may be assigned sets of consecutive numbers to allow more compact Service Prediction Report records employing the NumTiles field of I238/095 or I238/096 to reference several consecutively numbered tiles.
2. Where more than one record is used to define the set of tiles for a service volume definition, TNT in Data Item I238/080 will indicate the combined number of tiles in all records, whereas REP in each instance of this Data Item I238/085 will indicate the number of tiles within one instance of the Data Item.
3. Positive latitude indicates north. Positive longitude indicates east.
4. Latitude and Longitude correspond to the location of the tile centre. The extent of the tile to north, south, east and west of the tile centre is 50% of the Tile Size value given in Data Item I238/080.

5.2.8 Data Item I238/090, Service Prediction Report Description

Definition: Information describing the service prediction report for which service predictions will be provided.

Format: Thirteen-octet fixed length Data Item.

Structure:

Octet no. 1

104	103	102	101	100	99	98	97
IODSVD							

Date/Time at which the Service Prediction Report was generated:

Octet no. 2 Octet no. 3

96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
RGT															

Octet no. 4 Octet no. 5

80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
RGT (continued)															

Service Prediction Report Start Date/Time:

Octet no. 6 Octet no. 7

64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
Start Time															

Octet no. 8 Octet no. 9

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Start Time (continued)															

Number and duration of time intervals for Service Prediction Report:

Octet no. 10 Octet no. 11

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
NTI								TIL							

Total Number of Service Predictions:

Octet no. 12 Octet no. 13

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
TNSP															

bits-104/97	(IODSVD)	Issue of Data for Service Volume Definition. Valid Range: 1 <> 255
bits-96/65	(RGT)	Report Generation Time: the date and time at which this Service Prediction Report was generated, expressed as the number of seconds since 00:00:00 UTC, Jan 1, 1970 without counting leap seconds (Unix Time). LSB = 1 s
bits-64/33		Start Time: the date and time at the start of the first Time Interval to which this Service Prediction Report is applicable, expressed the number of seconds since 00:00:00 UTC, Jan 1, 1970 without counting leap seconds (Unix Time). LSB = 1 s
bits-32/25	(NTI)	Number of Time Intervals: the number of contiguous time intervals covered by this Service Prediction Report. Valid Range 1 <> 255
bits-24/17	(TIL)	Time Interval Length: Increment of time in units of which service prediction events may be offset from Start Time. Valid Range: 1 <> 255 (0.5 minutes <> 127.5 minutes) LSB = 0.5 minutes
Bits-16/1	(TNSP)	Total Number of Service Predictions to be included in this Service Prediction Report. Valid Range 0 <> 65,535

Notes:

1. The value of IODSVD in this Data Item I238/090 will match IODSVD in Data Item I238/080 of the corresponding version of the Service Volume Definition, to ensure correct assignment of Tile IDs and Tile locations.
2. All records in a single Service Prediction Report have a common Start Time and the same RGT.
3. An updated Service Prediction Report is indicated by a later Report Generation Time (RGT). The service predictions of the Service Prediction Report with later RGT supersede those with earlier RGT, for the time period covered by the newer report.
4. When more than one record is used to provide the set of service predictions for a Service Prediction Report, TNSP in this Data Item I238/090 will indicate the combined number of service predictions in all records, whereas REP in each instance of Data Item I238/095 or Data Item I238/096 will indicate the number of service predictions within that instance of the Data Item.
5. When all tiles of the service volume are expected to be serviceable for the entire period covered by the Service Prediction Report, TNSP is set to zero, and neither Data Item I238/095 nor Data Item I238/096 is sent.
6. A single Service Prediction Report covers a series of time intervals of equal duration. The first interval begins at Start Time. If NTI > 1, subsequent intervals will be offset from Start Time in increments of TIL.
7. TIL value is selected such that an integer multiple of TIL equals 24 hours.
8. Start Time values are selected based on TIL, such that UTC midnight each day will align with a time interval boundary.
9. Expiration: The service status is considered undefined by a particular Service Prediction Report for times beyond the last time interval for the report, that is, from (Start Time + NTI x TIL) onward.
10. 32-bit Unix time will reset to 0 in the year 2038. Server and client systems should anticipate this event and be robust to the transition.

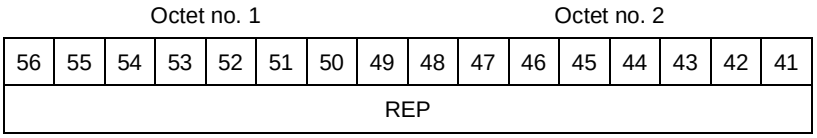
5.2.9 Data Item I238/095, 2D Service Predictions

Definition: Service prediction(s) for one or more Tiles

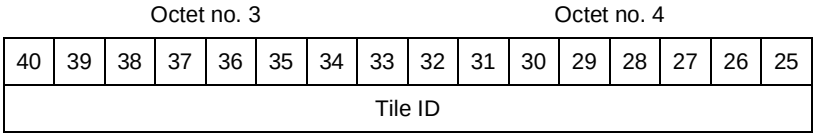
Format: Repetitive Data Item consisting of a two-octet Field Repetition Indicator (REP) followed by at least one five-octet service prediction.

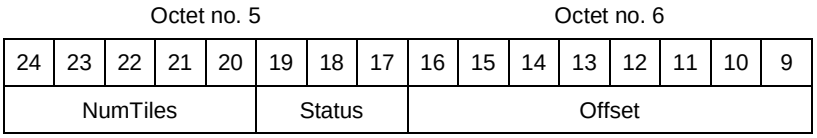
Structure:

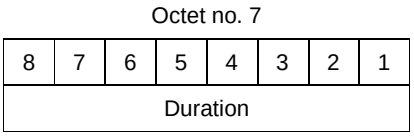
Number of Service Predictions:



Service Prediction:







bits-56/41	(REP)	Repetition indicator for the number of service predictions to follow in this Data Item.
bits-40/25	(Tile ID)	The first or only Tile ID for which this service prediction applies. Valid Range 1 <> 65,535 = 1 <> 65,534: Tile ID = 65,535: Prediction Status applies to all tiles defined for the service volume.

bits-24/20	(NumTiles)	Number of consecutive Tile IDs for which this service prediction applies. =0: All Tile IDs, used only when Tile ID is coded as 65,535 =1 – 31: Number of Tile IDs
bits-19/17	(Status)	Predicted status of this Tile = 0-5: Reserved for future use. = 6: Unserviceable = 7: Status unknown
bits-16/9	(Offset)	Offset time after Start Time at which this Service Prediction first applies. Offset is counted in time increments of TIL.
bits-8/1	(Duration)	Number of consecutive time intervals for which this Service Prediction applies. Valid Range 1 <> 255

Notes:

1. This Data Item is a variant of the repetitive data item as described in Part 1 of ASTERIX (chapter 4.3.4) in that it contains a 2-octet repetition factor. This modification is driven by the application.
2. This Data Item is not sent if TNSP =0 (all serviceable) in Data Item I238/090.
3. Where more than one record is used to provide the set of service predictions for a Service Prediction Report, TNSP in Data Item I238/090 will indicate the combined number of service prediction in all records, whereas REP in each instance of Data Item I238/095 or Data Item I238/096 will indicate the number of service predictions within that instance of the Data Item.
4. Each service prediction first applies at a time of Start Time + (Offset x TIL). Therefore, a Status applicable at Start Time will use Offset = 0, whereas a Status applicable to only the last time interval will use Offset = (NTI - 1). The Status is applicable for the number of time intervals indicated by Duration, after which the Status is considered serviceable (default), unless otherwise indicated by another service prediction for the same tile(s).
5. For any time interval within the period covered by the Service Prediction Report Description, all tiles for which Status is not provided are to be considered serviceable.

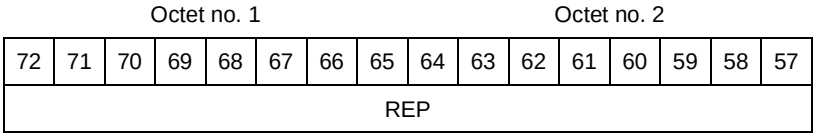
5.2.10 Data Item I238/096, 3D Service Predictions

Definition: Service prediction(s) for one or more Tiles, with associated altitude ranges.

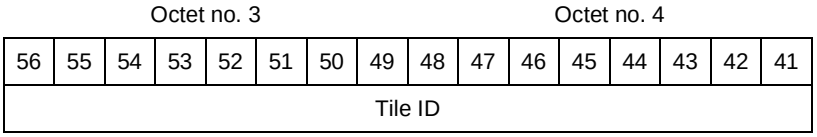
Format: Repetitive Data Item consisting of a two-octet Field Repetition Indicator (REP) followed by at least one seven-octet service prediction.

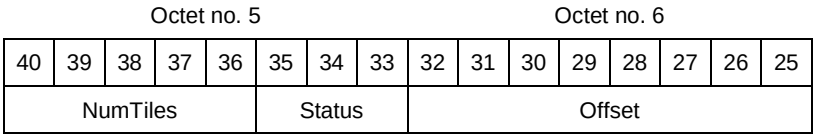
Structure:

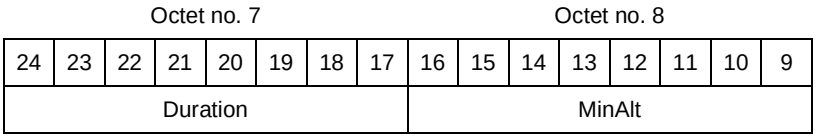
Number of Service Predictions:

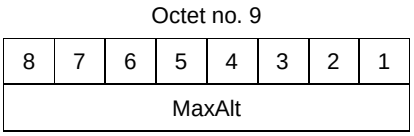


Service Prediction:









bits-72/57	(REP)	Repetition indicator for the number of service predictions to follow in this Data Item.

bits-56/41	(Tile ID)	The first or only Tile ID for which this service prediction applies. Valid Range 1 <> 65,535 = 1 <> 65,534: Tile ID =65,535: Service prediction applies to all tiles defined for the service volume.
bits-40/36	(NumTiles)	Number of consecutive Tile IDs for which this service prediction applies. =0: All Tile IDs, used only when Tile ID is coded as 65,535 =1 – 31: Number of Tile IDs
bits-35/33	(Status)	Predicted status of this Tile = 0-5: Reserved for future use. = 6: Unserviceable = 7: Status unknown
bits-32/25	(Offset)	Offset time after Start Time at which this service prediction applies. Offset is counted in steps of TIL.
bits-24/17	(Duration)	Number of consecutive time intervals for which this Service Prediction applies. Valid Range 1 <> 255
bits-16/9	(MinAlt)	Minimum altitude (MSL) from which this service prediction applies. Negative numbers are represented with 2's complement. Valid Range: -2,000 ft <> 127,000 ft in 1,000 ft increments.
bits-8/1	(MaxAlt)	Maximum altitude (MSL) to which this service prediction applies. Negative numbers are represented with 2's complement. Valid Range: -2,000 ft <> 127,000 ft in 1,000 ft increments.

Notes:

1. This Data Item is a variant of the repetitive data item as described in Part 1 of ASTERIX (chapter 4.3.4) in that it contains a 2-octet repetition factor. This modification is driven by the application.
2. This Data Item is not sent if TNSP =0 (all serviceable) in Data Item I238/090.
3. Where more than one record is used to provide the set of service predictions for a Service Prediction Report, TNSP in Data Item I238/090 will indicate the combined number of service prediction in all records, whereas REP in each instance of Data Item I238/095 or Data Item I238/096 will indicate the number of service predictions within that instance of the Data Item.
4. Each service prediction first applies at a time of Start Time + (Offset x TIL). Therefore, a prediction applicable at Start Time will use Offset = 0, whereas a prediction applicable to only the last time interval will use Offset = (NTI - 1). The Status is applicable for the number of time intervals indicated by Duration, after which the Status is considered serviceable (default), unless otherwise indicated by another service prediction for the same tile(s).
5. For any time interval within the period covered by the Service Prediction Report Description, all tiles for which prediction status is not provided are to be considered serviceable.

5.3 Transmission of Service Prediction Report Messages

5.3.1 User Application Profile for Category 238

The User Application Profile (UAP) of Table 3 shall be used for the transmission of Service Prediction reports.

Table 3 – UAP for Service Prediction Reports

FRN	Data Item	Information	Length
1	I238/010	Data Source Identification	2
2	I238/077	Time of ASTERIX Report Transmission	3
3	I238/000	Record Type	1
4	I238/005	Message Identification	3
5	I238/015	Service Identification	1
6	I238/080	Service Volume Description	5
7	I238/085	Tile Definitions	1+(n*8)
FX	-	Field Extension Indicator	-
8	I238/090	Service Prediction Report Description	13
9	I238/095	2D Service Predictions	2+(n*5)
10	I238/096	3D Service Predictions	2+(n*7)
11	SP	Special Purpose Field	1+
12	-	Not Used	-
13	-	Not Used	-
14	-	Not Used	-
FX	-	Field Extension Indicator	-

Notes:

1. The first column indicates the Field Reference Number (FRN) associated to each Data Item used in the UAP
2. 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 1 octet followed by n-octet extensions as necessary.

APPENDIX A. GUIDELINES FOR USE OF SERVICE PREDICTION REPORTS

A.1 General

The Category 238 message structure may be used by various surveillance systems, to communicate to ATM platforms the current and/or predicted surveillance service status, as a function of geographic location and time.

The general approach to conveying service prediction information is as two steps, each with its own record type:

1. Service Volume Definition: the service volume is represented as a set of “Tiles”.
2. Service Prediction Reports: for one or a series of time intervals, the predicted status of surveillance service is indicated for each tile in the set.

A.2 Service Volume Definition

The service volume is described by means of a set of tiles. The tiles may represent either squares (dimensioned in metres) or quadrangles (dimensioned in degrees of latitude and longitude) on the WGS 84 ellipsoid.

Data Item I238/080 provides Service Volume Description parameters. The “Issue of Data for Service Volume Definition” (IODSVD) parameter supports version control (see Section A.5 below). The “Total Number of Tiles” parameter identifies the number of tiles in the service volume. The tiles share a single “Tile Size” parameter representing the dimension of each tile.

In Data Item I238/085, a numerical “Tile ID” uniquely identifies each tile among the set of tiles for the service volume. Each tile is positioned by the WGS-84 latitude and longitude of its centre. Whether dimensioned in metres or degrees, the orientation of each tile is parallel and perpendicular to the WGS 84 North-South direction at the tile centre. Although not explicitly required, it is expected that tiles will typically be arranged in a regular pattern to avoid or minimize overlaps or gaps between adjacent tiles, to the extent supported by LSB values.

Individual Service Volume Definition messages will include the Service Volume Description parameters of Data Item I238/080, followed by one or several Tile Definitions per Data Item I238/085. Individual messages may define subsets of the total number of tiles; the client system can determine when the complete set has been received by counting unique Tile IDs and comparing the count against the Total Number of Tiles parameter.

Depending upon the particular implementation, it may not be necessary to actually transmit the Service Volume Definition as ASTERIX messages. The option exists to pre-define the tile set as configuration data in both the surveillance system and the client system using the parameters defined for the Service Volume Definition (IODSVD, shared Tile Size, plus Tile ID, Latitude and Longitude for each tile).

A.3 Service Prediction Reports

The Service Prediction Report is designed to convey the current and/or predicted status for the set of tiles over one or a consecutive series of time intervals of equal length.

Data Item I238/090 provides Service Prediction Report Description parameters. The Report Generation Time (RGT) parameter of the Service Prediction Report indicates when the information in the report was originally generated. The "Start Time" parameter identifies the date/time at the beginning of the time period for which the Service Prediction Report will apply. The "Number of Time Intervals" (NTI) indicates how many consecutive time intervals will be covered, and the "Time Interval Length" (TIL) parameter indicates the duration of each. Thus, a report with NTI of 24 and TIL of 5 minutes will cover a two-hour period.

The TIL value is selected such that an integer multiple of TIL equals 24 hours (e.g. TIL may be 2.5 min or 3 min, but not 3.5 min). Once a TIL value is selected, it should not change in subsequent Service Prediction Reports unless coordinated with client systems, since a change of TIL may require a restart of the client system.

Start Time values are selected based on TIL such that UTC midnight each day will align with a time interval boundary (e.g. if TIL is 15 min, Start Time may be at 10:00 or 10:15, but not at 10:05). In systems that use fixed time periods (i.e. constant NTI) for all Service Prediction Reports, Start Time may sometimes be earlier than RGT (illustrated in Example 2 of Section A.6).

Status is reported on an exception basis. The status is interpreted as serviceable for all tiles for the period covered by the Service Prediction Report, except for those tiles and time intervals explicitly reported otherwise.

Each service prediction assigns a particular Status to a specific Tile ID. This Status is first applicable at a specified elapsed time after the Start Time of the Service Prediction Report, as indicated by the "Offset" parameter, measured in time increments of TIL. The Status is applicable for the number of time intervals indicated by the "Duration" parameter. Thus, in the case of a Service Prediction Report with a Start Time at 15:00 UTC and a TIL of 5 minutes, a service prediction for a given tile with an Offset equal to 8 and Duration equal to 4 would apply for a 20-minute time interval starting at 15:40.

The "Number of Tiles" (NumTiles) parameter provides a compact way to assign a common status to up to 31 tiles with consecutive Tile ID numbers (see Section A.4).

A special significance is applied to the Tile ID value of 65,535 (all ones). This value is interpreted as addressing all tiles in the service volume. Thus, the status of all tiles can be set as unserviceable or unknown with a single service prediction. When Tile ID is set to 65,535 to address all tiles, NumTiles is set to zero.

To allow for cases where service status may depend upon altitude, service predictions may be coded as two-dimensional or three-dimensional. The two are the same, except that the 3D service prediction includes lower and upper altitude bounds between which Status applies. The altitude bounds are coded in 1,000 ft increments relative to mean sea level (MSL).

Individual Service Prediction Report messages will include the Service Prediction Report Description parameters of Data Item I238/090, optionally followed by one or several 2D Service Predictions per Data Item I238/095 and/or one or several 3D Service Predictions per Data Item I238/096. Individual messages may contain subsets of the total number of service predictions; the client system can determine when the complete set has been received by counting unique service predictions and comparing the count against the "Total Number of Service Predictions" (TNSP) parameter. If TNSP equals zero, neither Data Item I238/095 nor Data Item I238/096 is sent, and all tiles are considered serviceable for the entire period covered by the Service Prediction Report.

A single Service Prediction Report or set of reports with the same RGT should not provide conflicting service predictions applicable to the same tile for the same time interval. 3D service predictions (I238/096) may provide different predicted status for the same tile within non-overlapping altitude bands.

A.4 Efficient Messages

Where beneficial, the number and size of service prediction messages can be reduced by choosing the appropriate tile size and by assigning tile numbers in logical groups.

A.4.1 Size of Tiles

The selected tile size should be appropriate to the particular application. For example, an airport surface system need not create a precise outline of the airport movement areas using very small tiles. The client system can define operationally significant zones by a set of accurately drawn service polygons, and assign a status based a relatively coarse overlay of tiles. (Status for each zone would then be assigned based on the worst tile in that zone.) The association between tiles and polygons may be preconfigured in the client system or automatically calculated based on geographic locations. Figure A-1 illustrates the concept of an overlay of relatively large tiles on polygons created in the client system to represent operational zones.

If a surveillance system serves both an airport and a surrounding terminal area, these may be treated as two separate and independent, albeit partially overlapped, service volumes, using the "Service Identification" (SID) parameter. This will allow use of relatively small tiles for the airport and large tiles for the much larger terminal area.

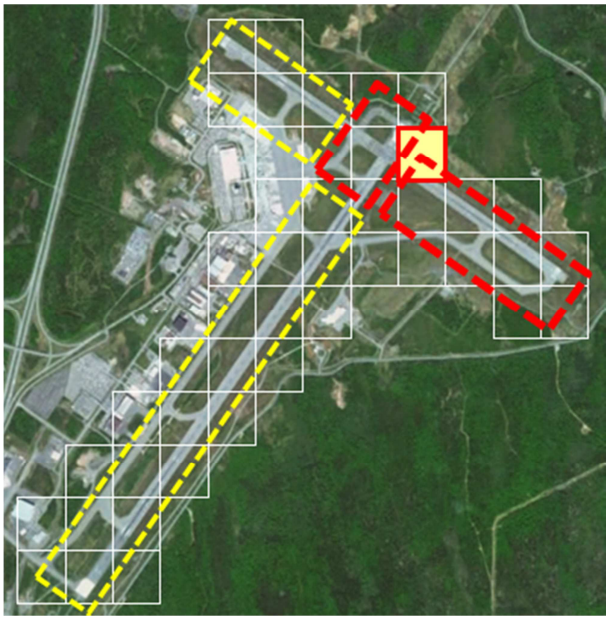


Figure A-1. Tile Overlay on Polygons Defined by Client System

A.4.2 Grouping of Tile IDs

Where specific groups of tiles are likely to change status at the same time, these tiles can be assigned sequential Tile IDs. Grouping of tiles in this way will allow prediction reports for typical outages to address up to 31 tiles with a single prediction, using the NumTiles parameter. Figure A-2 illustrates this concept for a simple scenario with two sensors. The group of 24 tiles affected by an outage of Sensor 1 can be set unserviceable by specifying the Tile ID of 11 (the first number in the sequence of affected tiles) and NumTiles equal to 24.

A.4.3 Multiple Service Prediction Reports

Although a single Service Prediction Report may be used to cover the entire period for which service predictions are provided, some applications may find it more efficient to use a set of separate non-overlapping Service Prediction Reports. (For example, predictions for 24 hours may be sent using a single 24-hour Service Prediction Report, or a set of 24 Service Prediction Reports covering 1 hour each.) The advantage of using a set of reports is that changes to the predicted status affecting a small fraction of the total time period would not require update and retransmission of predictions for the entire period.

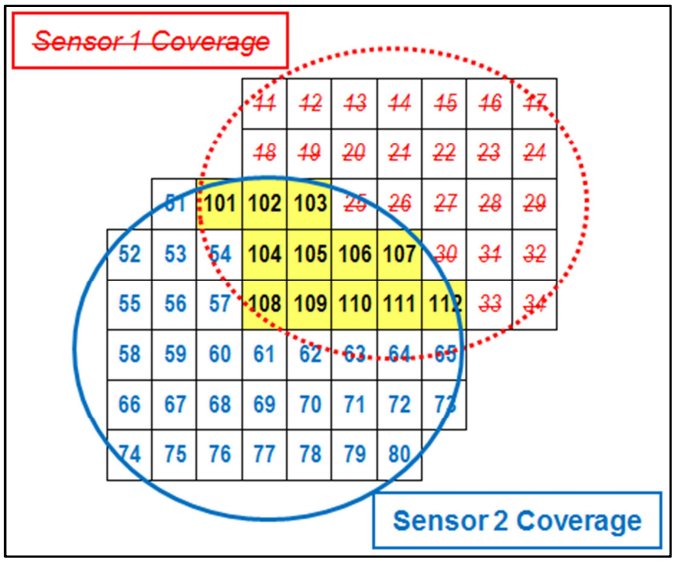


Figure A-2. Use of Sequential Tile IDs for Logical Groups of Tiles

A.5 Version Control

The message structure provides mechanisms to support orderly updates of the tile definitions and service predictions.

A.5.1 Updating the Tile Set

The Issue of Data for Service Volume Definition (IODSVD) parameter is included in both Service Volume Definitions and Service Prediction Reports, matching service predictions to a particular version of the tile set. On the relative infrequent occasions when the tile set may be redefined or expanded, a different IODSVD value is assigned. To allow for updates without a service interruption, the option exists for the surveillance system to send both versions of the Service Volume Definition, each with its own IODSVD, for a brief transition period. The client system can acquire and store the new definition while still using the older definition and associated service prediction reports. At the end of the transition period, the surveillance system can then switch service predictions to the new definition, keyed by the new IODSVD for which the client system will have already received the Service Volume Definition.

A.5.2 Updating Service Predictions

Periodic retransmissions of the same Service Prediction Report information will carry the same RGT and Start Time; the only Data Items that will change are the Message Identification I238/005 and the Time of ASTERIX Message Transmission I238/077.

Updates of service predictions, whether to amend previous predictions or to cover a different time period (with or without overlap of the previous period), are communicated by means of a new Service Prediction Report, with a new

(later) RGT. The service predictions of the Service Prediction Report with later RGT supersede those with earlier RGT, for the time period covered by the newer Report.

As noted in Section A.3, status is interpreted as serviceable for all tiles for the period covered by a new Service Prediction Report, except for those tiles and time intervals explicitly reported otherwise. Therefore, when a new Service Prediction Report is issued, there is no need to explicitly cancel any previously predicted service outage within the period covered by the new report; the fact of issuing the new report will by default cancel all such outage predictions. On the other hand, any previously predicted outages that are still expected to occur during the period of the new report must be restated in the new report.

A.6 Examples of Service Prediction Reporting

In this section, three examples are presented to illustrate concepts and options in coding Service Prediction Reports.

The three examples are based on a single scenario. The scenario has a service volume with the tile layout and Tile IDs shown in Figure A-3. (Coding of the Service Volume Definition would use Data Items I238/080 “Service Volume Description” and I238/085 “Tile Definitions”, not illustrated in these examples.)

In this scenario, service predictions are to be supplied and maintained for a period of not less than 6 hours into the future. A Time Interval Length (TIL) of 2 minutes is to be used to report service predictions. Service predictions are to be routinely transmitted at intervals not exceeding 30 minutes (in the examples, routine transmissions are illustrated as being sent 1 minute before the time needed), and any changes to predictions are to be transmitted immediately. A series of three events impacting service prediction occur over the course of a particular day, as listed in Table A-1.

The three examples communicate exactly the same information related to the events listed in Table A-1, but use different approaches to package this information.

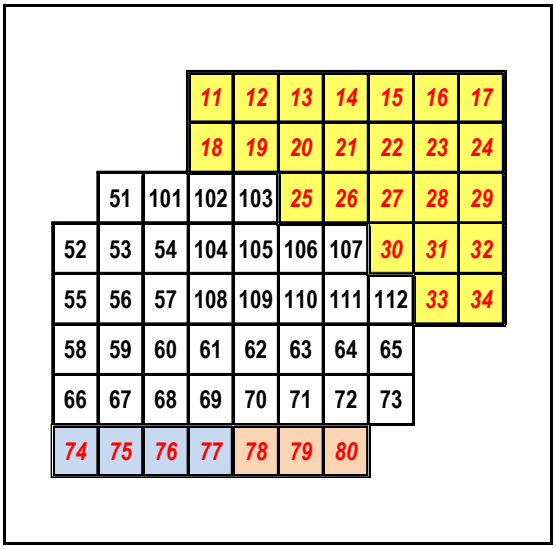


Figure A-3. Tile Layout for Examples

Table A-1. Service Prediction Events for Examples

Event No.	Event Time	Event Description
1	09:10	Service prediction application is initialized (cold start), without knowledge of prior status of surveillance service. Tiles 74-80 are expected to experience a service outage at 14:34 today. This outage is expected to last 18 min for Tiles 74-77 and 28 min for Tiles 78-80. (Predicted times are adjusted to 2-minute boundaries to match TIL.) A maintenance activity scheduled for 15:50 today will cause a 30 min service outage for Tiles 11-34.
2	11:05	Service prediction application is made aware of new information such that the previously predicted outage of Tiles 74-80 is no longer expected to occur.
3	13:08	The maintenance activity originally scheduled for 15:50 today will delayed by 20 min, to start at 16:10.

For each example, a table shows the coding of Data Items I238/090 “Service Prediction Report Description” and I238/095 “2D Service Predictions” to communicate the events of Table A-1. An accompanying figure shows the times of transmission for each message in the table and the period of

applicability for the content of each message. Report labels (A, B, J1, J2, etc.) are shown to relate items in the tables to those in the figures; these report labels are not part of the actual message structure.

Example 1 (Table A-2, Figure A-4) follows a simple convention that every Service Prediction Report will cover a period of 8 hours from its Start Time.

Example 2 (Table A-3, Figure A-5) uses reports covering 4-hour time periods. These time periods are anchored to fixed 4-hour intervals of UTC time. To maintain a minimum of 6 hours of predictions, there are always two or three active Service Prediction Reports covering successive time periods. The first Service Prediction Report ("A") in this example has a Start Time 70 minutes prior to initialization of the service prediction application, so reports the status of all tiles as unknown for the first 70 minutes.

Example 3 (Table A-4, Figure A-6) also uses 4-hour time periods anchored to fixed 4-hour intervals of UTC time for routine reports. When event-driven changes occur, however, it sends an update covering only the period of time affected by the event (Reports "U" and "W"). It then updates the appropriate 4-hour report(s) at the next routine transmission time. In Example 3, any historical time is truncated when a new report is generated (Reports "S1" and "X1"), so the Start Time is never earlier than the Report Generation Time.

A.7 Client System Processing

In a basic implementation to track service predictions, a client system could maintain a vector of time marks at regularly spaced UTC times, in increments of Time Interval Length (TIL), for each tile defined for the service volume. Associated with each time mark would be the predicted status of the Tile, if received, and the Report Generation Time (RGT) associated with that status.

Upon reception of a new Service Prediction Report, the client system would generate new time vectors for each tile for the period covered by the new report. It would then update the predicted status and RGT for any time marks for which the RGT in the new report was more current than the previously stored RGT.

In the event that a report indicates an unknown status for a time period prior to its RGT, the client system may choose not to change the status and RGT for those historical time marks, for record-keeping purposes, if it had previously stored a valid status. (This could apply in cases such as of Section A-6 Example 2, Report "J1". In that example, the service prediction application performed a cold start at 9:10, but may have previously been operating normally and providing valid predictions stored by the client system.)

Table A-2. Service Prediction Message Coding – Example 1

Report Label	A	B	C	D	E	F	G	H	
Time(s) of Transmission	9:10 9:29	9:59 10:29	10:59	11:05 11:29	11:59 12:29	12:59	13:08 13:29	13:59 14:29	
I238/090 Service Prediction Report Description									
Report Generation Time (RGT)	9:10	9:59	10:59	11:05	11:59	12:59	13:08	13:59	
Start Time	9:10	10:00	11:00	11:06	12:00	13:00	13:08	14:00	
Number of Time Intervals (NTI)	240	240	240	240	240	240	240	240	
Time Interval Length (TIL) [x 0.5 min]	4	4	4	4	4	4	4	4	
Total No. of Service Predictions (TNSP)	3	3	3	1	1	1	1	1	
I238/095 2D Service Predictions									
REP	3	3	3	1	1	1	1	1	
1. Tile ID	74	74	74	11	11	11	11	11	
Number of Tiles (NumTiles)	7	7	7	24	24	24	24	24	
Status	6	6	6	6	6	6	6	6	
Offset [Intervals]	162	137	107	142	115	85	91	65	
Duration [Intervals]	9	9	9	15	15	15	15	15	
2. Tile ID	78	78	78						
Number of Tiles (NumTiles)	3	3	3						
Status	6	6	6						
Offset [Intervals]	171	146	116						
Duration [Intervals]	5	5	5						
3. Tile ID	11	11	11						
Number of Tiles (NumTiles)	24	24	24						
Status	6	6	6						
Offset [Intervals]	200	175	145						
Duration [Intervals]	15	15	15						

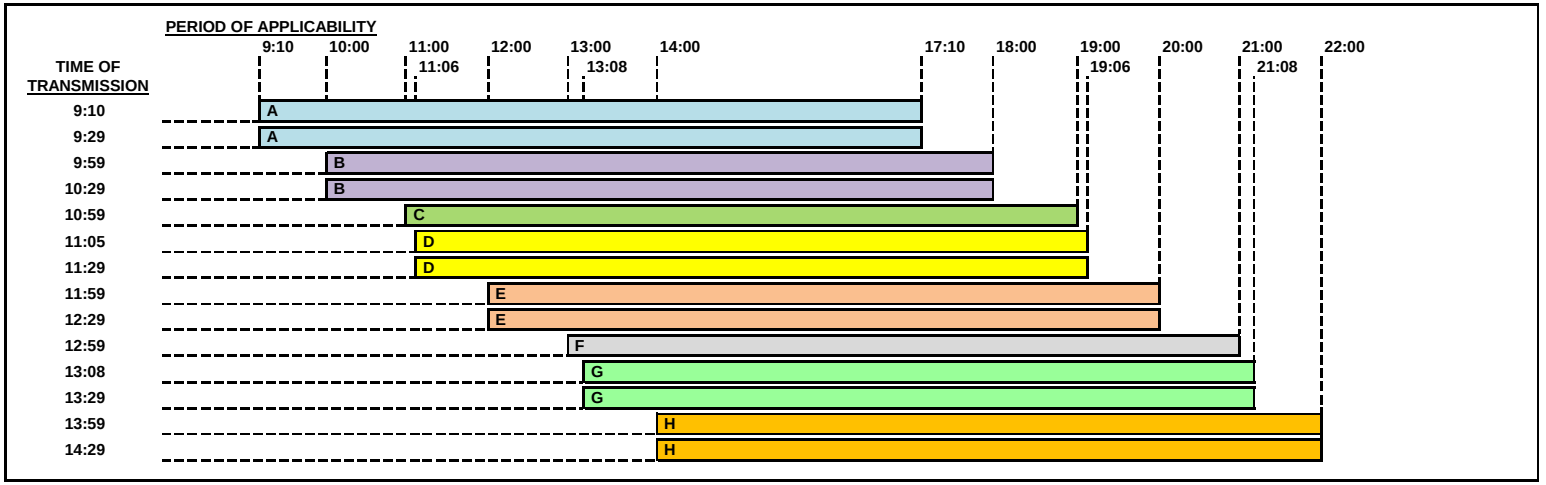


Figure A-4. Message Timeline – Example 1

Table A-3. Service Prediction Message Coding – Example 2

Report Label	J1	J2	K	L	M1	M2	N		
Time(s) of Transmission	9:10 9:29 9:59 10:29 10:59 11:05 11:29	9:10 9:29 9:59 10:29 10:59	9:59 10:29 10:59 11:05 11:29 11:59 12:09 12:59	11:05 11:29 11:59 12:09 12:59	13:08 13:29 13:59 14:29	13:08 13:29 13:59 14:29	13:59 14:29		
I238/090 Service Prediction Report Description									
Report Generation Time (RGT)	9:10	9:10	9:59	11:05	13:08	13:08	13:59		
Start Time	8:00	12:00	16:00	12:00	12:00	16:00	20:00		
Number of Time Intervals (NTI)	120	120	120	120	120	120	120		
Time Interval Length (TIL) [x 0.5 min]	4	4	4	4	4	4	4		
Total No. of Service Predictions (TNSP)	1	3	1	1	0	1	0		
I238/095 2D Service Predictions									
REP	1	3	1	1		1			
1. Tile ID	65535	74	11	11		11			
Number of Tiles (NumTiles)	0	4	24	24		24			
Status	7	6	6	6		6			
Offset [Intervals]	0	77	0	115		5			
Duration [Intervals]	35	9	10	5		15			
2. Tile ID		78							
Number of Tiles (NumTiles)		3							
Status		6							
Offset [Intervals]		77							
Duration [Intervals]		14							
3. Tile ID		11							
Number of Tiles (NumTiles)		24							
Status		6							
Offset [Intervals]		115							
Duration [Intervals]		5							

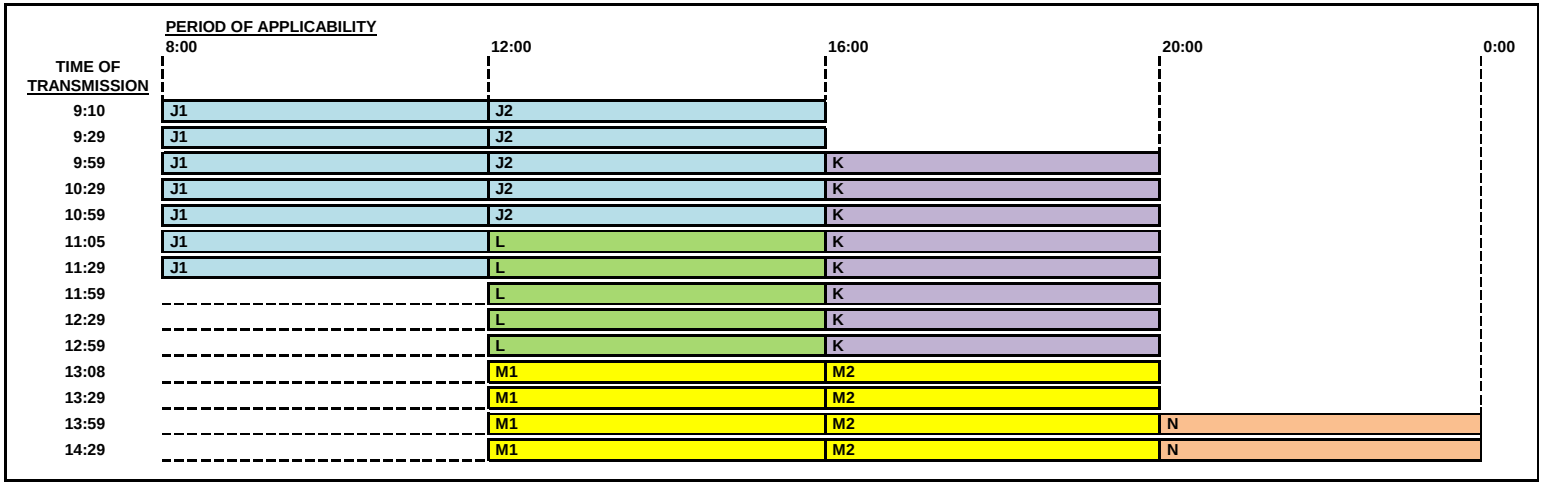


Figure A-5. Message Timeline – Example 2

Table A-4. Service Prediction Message Coding – Example 3

Report Label	S1	S2	T	U	V	W	X1	X2	Y
Time(s) of Transmission	9:10 9:29 9:59 10:29 10:59 11:29	9:10 9:29 9:59 10:29 10:59	9:59 10:29 10:59 11:29 11:59 12:09 12:59	11:05	11:29 11:59 12:09 12:59	13:08	13:29 13:59 14:29	13:29 13:59 14:29	13:59 14:29
I238/090 Service Prediction Report Description									
Report Generation Time (RGT)	9:10	9:10	9:59	11:05	11:29	13:08	13:29	13:29	13:59
Start Time	9:10	12:00	16:00	14:34	12:00	15:50	13:30	16:00	20:00
Number of Time Intervals (NTI)	85	120	120	14	120	25	75	120	120
Time Interval Length (TIL) [x 0.5 min]	4	4	4	4	4	4	4	4	4
Total No. of Service Predictions (TNSP)	0	3	1	0	1	1	0	1	0
I238/095 2D Service Predictions									
REP		3	1		1	1		1	
1. Tile ID		74	11		11	11		11	
Number of Tiles (NumTiles)		4	24		24	24		24	
Status		6	6		6	6		6	
Offset [Intervals]		77	0		115	10		5	
Duration [Intervals]		9	10		5	15		15	
2. Tile ID		78							
Number of Tiles (NumTiles)		3							
Status		6							
Offset [Intervals]		77							
Duration [Intervals]		14							
3. Tile ID		11							
Number of Tiles (NumTiles)		24							
Status		6							
Offset [Intervals]		115							
Duration [Intervals]		5							

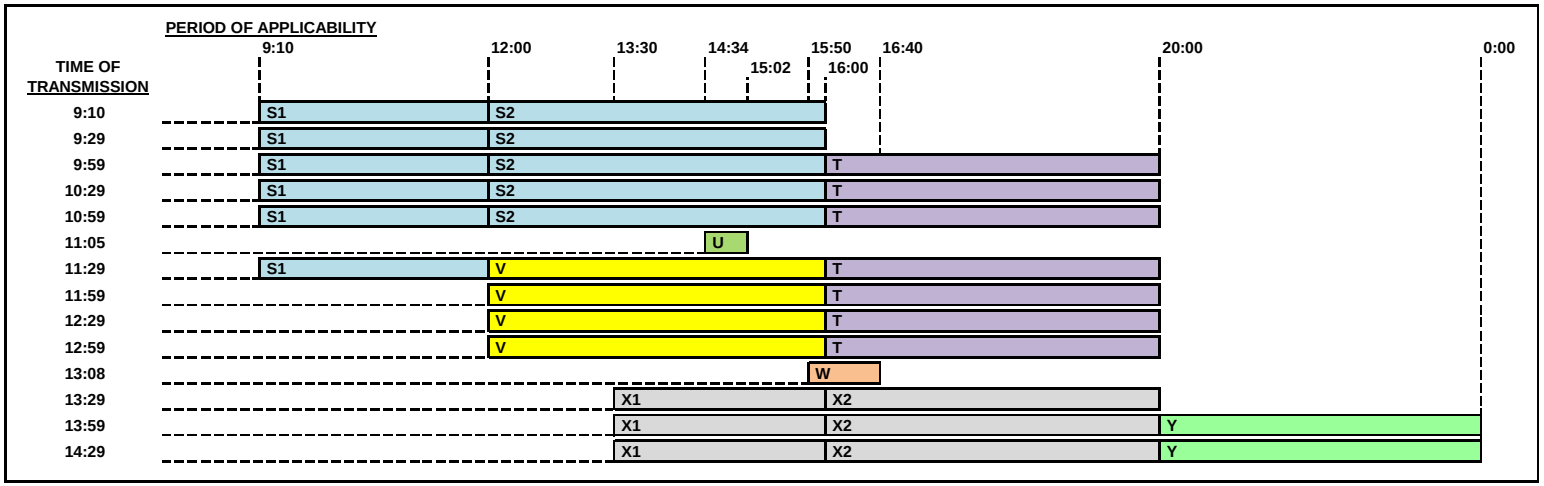


Figure A-6. Message Timeline for Example 3