USER INTERFACE DEFINITION

of the

MADAP TRACK SERVER

Document: MAS-S/GD_0026_03

April 1998

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PREFACE

The TRACK SERVER capability can be considered as a value-added network function, which will evolve in a strategic building block of a distributive and cooperative Air Traffic Control (ATC) and Air Defense (AD) infrastructure.

Especially the implementation of radar data distribution networks, such as RADNET within the confines of the German/Benelux Integration Area and the French RENAR network, will evoke a considerable boost in the proliferation of the track server concept.

The track server function is the capability to create, maintain and dispatch in real-time a highly consistent and accurate air situation picture. The air situation picture is the result of processing information from many radar sensors and additionally by supplementing the resulting tracks with those essential flight details, which are normally visualized on the display of a radar or executive controller. The contents of the server data base, representing the current air situation, is disseminated over both local area (LAN) and wide area networks (WAN) to interested ATC/AD user systems.

RADNET provides the server function with the necessary cost-effective and high-speed data communication channels in order to allow it to have fast access to the sensor data of virtually **all** radars connected to the network and subsequently to dispatch the processed synthetic air situation picture in real-time to its user group at a suitable update frequency.

A technically limited forerunner of the track server concept is the so-called ADMAR/ADKAR system, being operational since end of 1980. This system provides the German Air Defense sites with a copy of the MADAP resp. KARLDAP air situation picture, via a star-type network consisting of leased telephone circuits with a rather limited bandwidth (9600 bps).
As a logical continuation of the experience obtained with the above network, the Maastricht UAC submitted the concepts of RADNET and the TRACK SERVER to the Working Group 2 within the framework of the 4-States Integration Project.

In the mid eighties it more and more became apparent that due to the obsolescence of the so-called EUROCONTROL plot format for the exchange of radar sensor data, and due to the lack of any standardization for the communications involved in the newer type of server applications, it was absolutely opportune to elaborate a proposal for a **standard** and **flexible** message composition facility, embracing the existing and the future applications of radar related communications. This resulted in the **ASTERIX** (All-purpose Structured Eurocontrol Radar Information eXchange) proposal, which MAS-UAC submitted to the RSSP by the end of 1984. The RSSP adopted this proposal and established the ASTERIX User Group, which is charged with the future elaboration, definition and promotion of ASTERIX standards for various types of applications. ASTERIX defines a standard set of message composition elements and a catalogue of well-defined data items for a number of so-called ASTERIX categories, each covering a particular type of application. This information can be referred to in the EUROCONTROL Standard Document for Radar Data Exchange- Part 1 (Ref. 1).

However, the adoption of the principles and definitions as contained in the Ref. 1 alone would allow any two communication partners to implement their own private version of ASTERIX messages. The members of the ASTERIX User Group (meanwhile replaced by the EATCHIP Surveillance Task Force on Radar Data Exchange - STFRDE) undertook therefore the work to attempt to define a higher level of standardization.

At present Standards are elaborated for the following ASTERIX categories:

- category 001 : Mono radar target reports from a radar surveillance system to a RDP system (plots, tracks)
  Eurocontrol Standard Document for Radar Data Exchange Part 2a
  SUR.ET1.ST05.2000-STD-02a-01

- category 002 : Radar service messages
  Eurocontrol Standard Document for Radar Data Exchange Part 2b
  SUR.ET1.ST05.2000-STD-02b-01

- category 008 : Monoradar derived weather information
  Eurocontrol Standard Document for Radar Data Exchange Part 3
  SUR.ET1.ST05.2000-STD-03-01

From the above it may be concluded that the standardization work is far advanced for the transmission of **sensor data to radar data processing systems**. No common standards exist at present for the track server data flows. However, three ASTERIX categories (0, 3, 9), together with their corresponding catalogues of data items were defined at an early stage to allow implementation of initial track server concepts.

This paper describes in detail the messages and the transmission techniques as provided by the MADAP track server.
The initial definition of the message transfer took place in the beginning of 1988 (see Ref. 6) for the planned exchange of MADAP track data to the PHAROS II system. As a result of modifications emerging from the ongoing work within the ASTERIX User Group, a first update of the track server user interface was provided by the document under Ref. 5.
The underlying document can be considered as version 2 of Ref. 5, providing additional details concerning the actual implementation of the MADAP track server facility.

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1. Architectural Outline of a Track Server

1.1 Track Server Data Flows

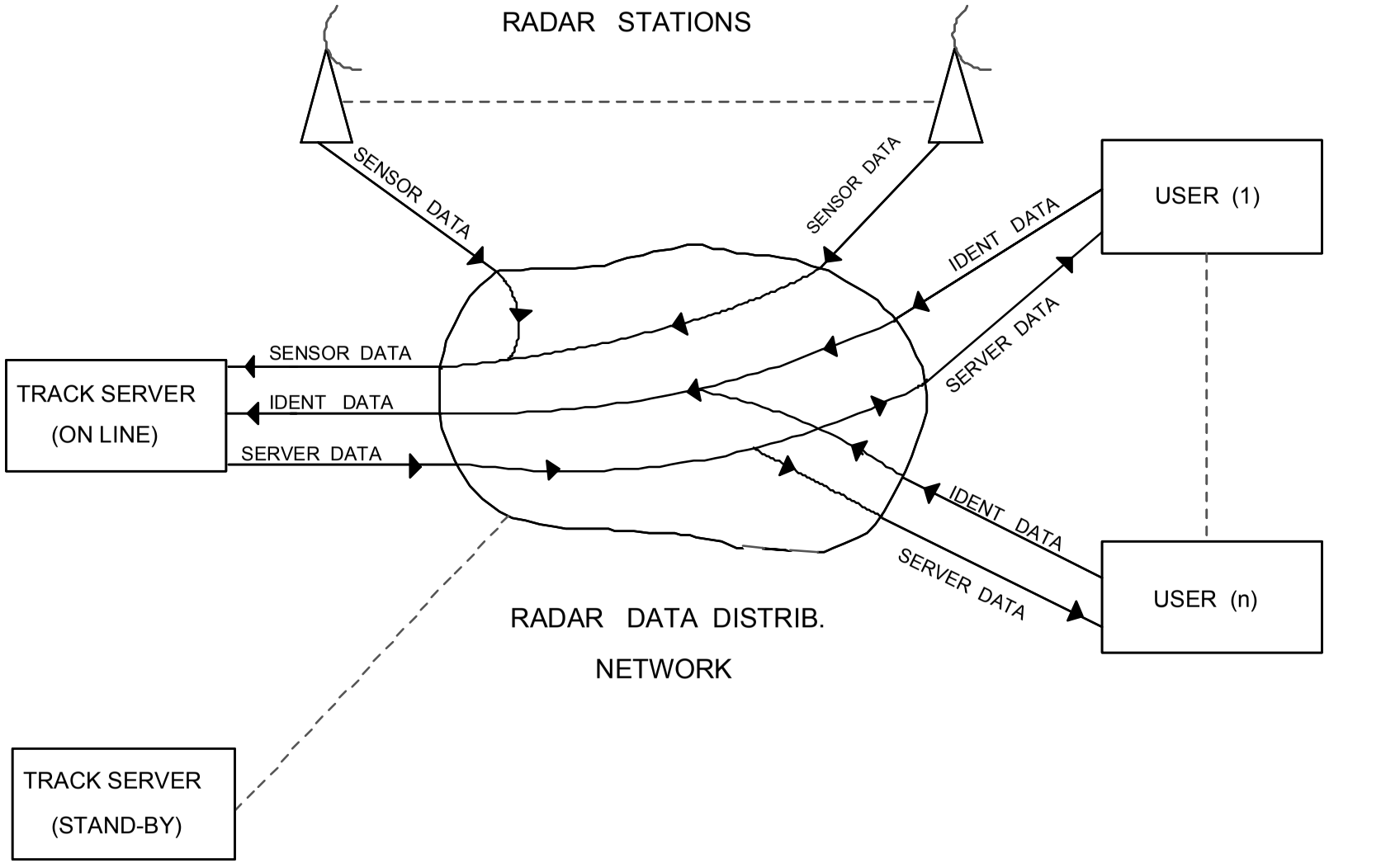
The main components and logical data flows of a distributed track server concept are depicted in **Figure 2**.

- The **track server** acquires via the radar data distribution network all the sensor data it needs, submits them to a suitable multi-sensor tracking process and disseminates periodically the resultant dynamic traffic and weather data base to the participating user RDPS's (radar data processing system) in the form of sequences of labelled track messages and multi-sensor weather images.

- The **radar distribution network**, which we assign the working title 'RADNET', provides the data communications link between the track server and its sensors on the one hand and between the participating users and the track server on the other hand.

- The **radar stations**. Both en-route (long range) and terminal area radars (TAR's) will be connected to the network. Both combined primary and SSR radars or single SSR or primary radars may be used. Radar stations may be of various equipment generations (conventional sliding window type versus monopulse SSR and primary MTD systems). The distributed filtering functions within the network allow the track server to make a cost-effective and optimal use of the prevailing radar coverage redundancy.

- The **user ATC/AD systems**. In a **cooperative** environment where the individual ATC systems provide the server with the appropriate flight **identification** data, the server provides in its turn an enhanced air situation data base in real-time to all interested users.


RADAR STATIONS
SENSOR DATA
SENSOR DATA
USER (1)
IDENT DATA
SERVER DATA
SENSOR DATA
TRACK SERVER
(ON LINE)
IDENT DATA
SERVER DATA
IDENT DATA
SERVER DATA
USER (n)
RADAR DATA DISTRIB.
NETWORK
TRACK SERVER
(STAND-BY)
DR92063.WPG

1.2 Acquisition and Processing of Sensor Data

Traditionally every ATC unit was sofar directly connected to a **rather limited** amount of radar stations via a set of dedicated leased telephone circuits, using low to medium transmission speeds. This system design approach is somewhat rendered out of date by recent developments in the field of data communications and computer networking. RADNET allows in principle a radar data processing system to make a much more efficient use of all available sensor data, without augmenting the data transmission costs.

To this end, the track server submits a set of filtering directives to the network, which are implemented at the relevant network nodes to which the corresponding radar stations are connected (cf. Ref. 7). As a result, only **selected** target reports (plots) are remotely retrieved and further routed to the track server function, thereby following the strategy that per individual target, at any time, only the plots from the N best sensors are transmitted to the server functions ($2 \leq N \leq 8$, default N=5).

The advantages of such an intelligent distributed filtering concept are straightforward:

- As far as physical limitations allow it, an excellent overall radar coverage is made available to the track server function. Per target, at any point in space, the plots from the N radar stations providing the best plot quality and detection probability at the space point concerned, are selected and routed to the track server for multi-radar tracking purposes.

- Connecting more sensors to the network therefore does not significantly increase the data flow to the track server. In the presence of excessive coverage overlaps (e.g. one aircraft in upper airspace seen by more than 12 radars), the superfluous plots are simply discarded at the access point to the network. The total data flow is therefore mainly determined by the number of targets in the airspace concerned and the applied effective coverage factor 'N'.

- The adoption of N in the order of 4 or 5 guarantees a high data sampling rate, which is extremely beneficial for the tracking system and system reaction times. Especially the connectivity to terminal area radars will result in tracker performance enhancements.

The track server consists basically of a sophisticated multi-radar tracking system, with automatic **multi-radar track initiation for both SSR and primary targets** in the airspace of responsibility. The output of that multi-radar data processing system is a real-time track data base, containing one and only one up-to-date system track per target. Also Mode-C tracking is applied. A track record contains therefore, inter alia, a best estimate of the aircraft position, groundspeed, heading, rate of climb/descent, last received Mode-C height, SSR code, etc.

Refs. 7, 9 and 10 contain a detailed definition of the interface from the server to the network for the inbound direction (session start-up, submission of filter tables).

1.3 Acquisition and Processing of Identification Messages

This paragraph deals with the inbound **identification** messages, sent by the **cooperating partner systems** to the common track server.

Sofar every individual ATC system establishes its own track data base (from a limited amount of sensors) and associates a number of tracks to corresponding **own** flight plans.
Consequently every ATC unit 'knows' only its own traffic i.e. it disposes only of a **subset of information** concerning the traffic in its own and surrounding airspace.

A logical extension to the server idea is therefore that every participating ATC unit communicates **identification** messages to the server, which will enable the latter to identify in principle all traffic.

The identification messages will contain items like callsign, SSR code, controller currently in charge, cleared flight level, possibly a track number and/or present position etc.
Those messages are exchanged ad-hoc each time an essential data item changes (e.g. upon 'assume control' input, new clearance level etc.) and periodically (e.g. every minute) in order to avoid complicated start-up processes after outages of the contributing ATC units or of the track server itself.

As a result of the communications outlined above, the server may establish a fully identified traffic situation picture, containing in addition to the parameters mentioned in 'ACQUISITION AND PROCESSING OF SENSOR DATA' for every aircraft its callsign, the identity of the responsible controller, its clearance data etc.

Dissemination at high update rates of such a fully labelled synthetic air traffic situation data base to all partners (both civil and military) operating in the same or adjacent/subjacent airspace has the following pronounced advantages:

- All partners dispose of the **same and identical** air traffic situation information, being a product of the processing of a maximum amount of sensor data by sophisticated three-dimensional tracking logic. The development of the best possible future tracking system, to be incorporated within the server, shall be a joint effort of the interested Eurocontrol Member-States (ARTAS project). Such an approach is considered to be the best guarantee to apply the same radar separation standard throughout the entire airspace (nominally 5 NM).
  This is particularly crucial for the radar handover between sectors located within different ATC centres. The real-time traffic data base, maintained by the server, is the logical link between the transferring ATC units. It allows to implement screen-to-screen dialogue procedures between control staff in different centres, equivalent to the practices currently applied between controllers of different sectors within the same centre.

- The optimal sharing of all radar resources allows a concerted planning of the siting of radar stations in future radar replacement programs, which ultimately leads to reduced overall investment budgets. Considering the implementation of a track server as a common investment in a pure technical infrastructure, thereby abandoning the traditional concept of an ATC centre being composed of an autonomous FPPS (Flight Plan Processing System) and RDPS, will lead to more substantial cost savings. The various administrations need not any more to maintain and further develop own tracking systems.

- The **complete** information allows every individual ATC unit to considerably improve the efficiency of its STCA (Short Term Conflict Alert) function. The attention of own controllers need not any more to be deviated for potential infringements with unknown traffic (unknown clearances, unknown responsible control sector etc.).

- The provision of a coherent, integrated and complete air traffic situation picture to all military partners is considered to be a major step ahead in safety and is the basis for harmonized civil-military coordination methods. This in contrary to the present practice where military units receive **subsets** of information from several civil partners in different ways, partially redundant and sometimes even ambiguous.

- The flexibility of the track server function in conjunction with the radar data distribution network is a perfect basis for the implementation of ad-hoc and longer duration contingency measures.

At this stage it is considered too premature to define in detail the messages and procedures involved with aircraft identification, radar hand-over etc.
Only after a wide acceptance of the underlying principles is obtained, a detailed interface for the inbound messages to the server has to be elaborated.

Questions which have to be answered at that time are:

- The nature and exact contents of the messages involved.
- Whether or not the messages involved may be composed of data items from ASTERIX category 3, or whether a separate ASTERIX category has to be defined for that purpose.
- Whether the messages are conveyed via RADNET or rather via a similar network for flight plan communications (CIDIN/INTNET).

As a result of the above, at present only a subset of the tracks is enhanced with the essential flight details, viz. those tracks which are associated with active MADAP flightplans.

1.4 The Dissemination of the Server Data

Interested user RDPS's may obtain two different types of data from the server:

- A synthetic traffic situation picture. (ASTERIX category 0 and 3 messages.)
- A composite picture of precipitation images, composed of the data from a set of weather radars. (ASTERIX category 9 messages.)

The following general principles thereby apply (cf. Ref. 7):

- The server **broadcasts** the **total** traffic and weather pictures into the network, **without** knowing the requirements of the individual users. Hence all users receive (a subset of) the same information.
- After setting-up a **session with the network**, the user defines its specific requirements by **submitting standard filter** tables (defined in Ref. 10):
- Both the traffic and weather pictures are encoded as a series of consecutive ASTERIX messages.
- Both pictures are updated in an incremental way, with an individual picture renewal rate.

The following chapters provide a detailed interface description for the provision of a traffic situation and weather picture from the server to local or remote users.

2. Transmission of a Real-time Air Traffic Situation Data Base

2.1 General Principles of the Transmission Method

The track server produces a real-time air traffic situation data base through automatic tracking of all SSR, primary and combined target reports (plots). The air traffic situation picture consists therefore of a number of multi-radar tracks.

Plots which are not used to update an established firm track are submitted to a plot chaining process. A plot chain which satisfies the track initiation criteria leads to the creation of a new system track. Separate track initiation criteria are applied according to the plot nature (primary versus SSR). As long as the track initiation criteria are not satisfied, the plot either updates an existing plot chain or creates a new one. Those plots are submitted to a plot display filter, which is a mosaic filter designed to avoid display of multiple plots for the same target. Plots passing the display filter are transmitted in the form of **tentative** tracks.

A provisional track number is assigned to a newly created plot chain (tentative track) which passes the display filter.
This track number is maintained by all succeeding plots updating the same plot chain, until the plot chain is promoted to become a firm track. At that time a final track number is assigned to the newly established track.

Tentative tracks are therefore transmitted for:

- Plots during the track initiation phase.
- Plots which do not satisfy the track initiation criteria (e.g. very high or very low speeds for primary targets, or very poor plot detection rates).
- Plots falling outside the track forecast windows (either spurious plots or during extreme violent aircraft manoeuvres).
- Ghost plots (e.g. primary clutter, SSR splits, residual SSR reflections etc.).

The individual track messages are composed of a **variable** number of data items of ASTERIX category 03. A number of track messages are assembled together into one data block for transmission purposes. The first track message is preceded by a one-byte category field (CAT = 03) for message routing and identification reasons, and a contiguous two byte length field (ASTERIX conventions, cf. Ref. 1).

The basic picture update cycle is 4.8 seconds. The picture update process is subdivided into 16 equidistant incremental steps of 300 mseconds.
In each step, only the tracks within a certain geographical sub-area are updated and subsequently transmitted to the user community. The geographical sub-areas are regularly adjusted, in such a way that each area lodges approximately an even amount of tracks. This method avoids the generation of high data volumes at repetitive discrete points in time, which might be overdemanding in terms of computer resources (buffer space needed, unbalanced processor load), but certainly is inadequate
vis-à-vis the data communications subsystem (voluminous buffer space needed; long data transmission delays).

The above mentioned sub-areas are organized in a south to north orientation, i.e. they extend over the whole X-axis, whereas their depths (Y-direction) are modulated according to the prevailing traffic density distribution.

The data renewal process restarts every 4.8 seconds by treating all traffic inside the most southern subarea, subsequently proceeded at 300 mseconds intervals by the handling of the next higher sub-area, until the most northern sub-area has been completed. The state variables for all tracks within the same subarea are assessed for the **same reference time**. Neighbouring tracks within adjacent areas have therefore an offset of 300 mseconds in reference time. It has, however, to be noted that plots, transmitted as tentative tracks, do not follow the update scheme as described above. They are immediately transmitted after having updated/created the plot chain, irrespective of the geographical position.

The basic picture renewal rate is 4.8 seconds, i.e. a particular track is updated every 4.8 seconds. However, not all data items are renewed with that frequency.

The subset of data items implemented, selected from the catalogue of category 03 data items, is divided into two classes:

- Short lifetime data items, such as position, speed, heading, height, are refreshed at every basic track update cycle (4.8 seconds).

- Data items which infrequently change (e.g. callsign, SSR code, controller in charge etc.) are generally repeated at a considerable lower update frequency i.e. once per minute.

Approximately every one-minute, a **long** track update message is transmitted, which contains **all available** data items. Thereafter the long track update message is generally followed by twelve consecutive **short** track update messages. The short track update message contains only the short lifetime data items, possibly supplemented by one or more data items of the long lifetime class after the occurrence of an event resulting in a change of the data items concerned.
The one-minute trigger for the transmission of a long message is determined per individual track, for reasons of further load balancing.

2.2 Layout of the Track Update (Create)/Cancel Messages

The air situation is described by messages of two distinct classes:

- track update (create) and track cancel messages
- picture synchronization messages.

The track update (create) and the track cancel messages are assembled with a variable number of data items, selected from a subset of data items contained in the catalogue of ASTERIX category 003 data items. The picture synchronization messages are composed of ASTERIX category 000 data items and are described in chapter 2.3.

2.2.1 Selected Data Items and Encoding Rules Adopted

The definition of all Data Items of Category 003 is provided in chapter 11.
This paragraph lists all the **implemented** data items from Cat 003, together with a detailed description of the encoding rules applied.

2.2.1.1 I003/010 - Data Source Identifier

This is a two-byte unique address identifying the track server involved. This data item must **always** be the first data item following the FSPEC field. The address is composed of two subfields:
- the high order byte contains the Source Area Code (SAC)
- the low order byte contains the Source Identification Code (SIC).

It has to be noted that MADAP can simultaneously connect two track servers to the RADNET environment. The following SAC, SIC codes are assigned:

SAC = X'04', SIC = X'F0' for the MADAP Track Server of the **ONLINE** system

SAC = X'04', SIC = X'F1' for the MADAP Track Server running on the **Standby/test** environment.

It has furthermore to be emphasized that end-users serviced via RADNET will receive server messages whereby the (SAC, SIC) code is replaced by a corresponding unique RSAP address (Radar Service Access Point).

The following address conversion is performed by RMCDE:

SAC, SIC = X'04F0' ---> RSAP = X'01F9'
SAC, SIC = X'04F1' ---> RSAP = X'65F7'

In order to obtain track server data, an end-user must submit his specific requirements in the form of standard filter tables, thereby indicating the **RSAP address** of the track server involved (cf. Ref. 9 and 10).

2.2.1.2 I003/020 - Calculated Position in Cartesian Coordinates

I003/020 is a 4-byte item providing the current track position expressed in Cartesian coordinates in the system grid of the MADAP track server (LSB = 1/64 NM).

The MADAP tracks are projected via the stereographical projection method on a plane which is tangential to the earth surface at the tangency point (51N, 08E).

This item is always transmitted in a track update (create) message.

Note: For firm tracks, the position item contains the **calculated** track position. However, for tentative tracks (plot chains), the item contains the last received **measured** position (after coordinate transformation).

2.2.1.3 I003/040 - Mode 3/A Code in Octal Representation

Firm tracks:

I003/040 is a two-byte data item, normally containing the last received Mode 3/A code converted into octal representation.

The data item is periodically transmitted in a long track update message and additionally in the first coming short message after the occurrence of an SSR code change.

This item is not transmitted for primary initiated tracks and SSR initiated unassociated tracks without validated mode 3/A code.

Tentative SSR tracks:

Data item I003/040 is sent at every update for a SSR plot chain with validated code.

2.2.1.4 I003/050 - Actual Flight Level

Firm tracks:

I003/050 conveys the last **reported**, validated and credible Mode C value, expressed in binary notation with a LSB = 0.25 Fl.

This item will only be sent if, since the previous update cycle, one or more plots were received containing validated and credible Mode C readouts.
This allows the user to keep track of the lifetime of the Mode C information.

Tentative SSR tracks:

Data item I003/050 is sent at every update, provided the last received plot contained a validated Mode C value.

2.2.1.5 I003/070 -Track Number

I003/070 is a 16-bit integer value, representing a unique reference to a particular track record within the track data base of the server. Every recipient of (a subset of) the server data must maintain a translation vector, providing a cross-reference to the corresponding internal track record within the recipient's data base.

The ASTERIX manual is not explicit concerning the actual encoding of the track numbers.
For the MADAP track server the following conventions were adopted:

A. The track number data item is split into two logical subfields:

- Bits 12-1 contain the actual track number
- Bits 16-13 contain the intermediate picture update step number (i.e. the sequence number of the geographical sub-area currently being updated; refer to para 2.3).

B. The track number range (0-4095) is again subdivided into the following classes:

0000-2047 : for **firm** primary or SSR tracks
2048-3071 : for tentative SSR tracks
3072-4095 : for tentative primary tracks

The data item I003/070 is always transmitted in every track update/cancel message.

Note: For tentative tracks the transmission event is the arrival and processing of a new plot updating the plot chain. The bits 16-13 (intermediate update step number) are therefore meaningless in the context of plot transmission and are set to zero.

2.2.1.6 I003/080 - Track Status

I003/080 is a variable length data item which is always transmitted in every track update/cancel message. The track status normally comprises merely a primary part of 1 byte. An extension with a second byte is transmitted in exceptional cases only.

The following status flags are implemented:

Primary part:

bit-8 : LIV = 0 for a track originating from the MADAP simulator
= 1 for a track from real radar data

bit-7 : CNF = 0 to signal a tentative track (plot)
= 1 to signal a firm track

bit-6 : MAN = 0 no manoeuvre sensed
= 1 aircraft is sensed to be manoeuvring

bit-5 : MDA = 0 no plot with valid Mode A code received since previous update cycle
= 1 at least one plot with valid Mode A code received since previous update cycle

bits-4/3 (SUD, PUD) : The encoding rules are as follows:

a) for **firm** tracks:

00: no plot update since previous update cycle
01: only primary updates since previous update cycle
10: only SSR solo updates since previous update cycle
11: updated with a combination of solo SSR and primary plots and/or combined plots since previous update cycle.

b) For **tentative** tracks:

10: for solo SSR plot
11: for combined plot
01: for primary plot

bit-2 : ASS = 0 if track not associated to a (mini) flightplan
= 1 if track associated to a (mini) flightplan

bit-1 : FX = 0 in case of single-byte status field
= 1 in case of multiple-byte status field

Secondary part:

bit-8 : spare, always 0

bit-7 : spare, always 0

bit-6 : GHO = 0 always (not used sofar)

bit-5 : TRE = 0 default
= 1 indicates the end of lifetime of the track concerned

bit-4 : SPI = 0 if most recent SSR plot used for track update does not contain the SPI condition
= 1 if most recent SSR plot used for track update contains SPI condition

bits-3/2 :(DS1/DS2) = 00 no distress condition
= 01 unlawful interference
= 10 radio communication failure
= 11 emergency conditions

bit-1 : FX = 0 always

Note 1. The following flags are meaningless (always zero) for **SSR tentative** tracks: MAN, MDA, ASS.

2. The following flags are meaningless (always zero) for **primary tentative** tracks: MAN, MDA, ASS, SPI, DS1, DS2.

2.2.1.7 I003/090 - Track Category

The present encoding of the 1-byte track category item is reflected in the table below:

	OAT	GAT	FR1	FR2	SP3	SP2	SP1	FX
Uncorrelated tracks:								
- with a scrambled code	1	0	1	0	1	0	0	0
- otherwise	0	0	1	0	0	0	0	0
Associated GAT tracks:	0	1	0	0	0	0	0	0
Associated OAT tracks:								
- without special conditions	1	0	0	0	0	0	0	0
- scrambled flight	1	0	0	0	1	0	0	0
- non-deviation flight	1	0	0	0	0	1	1	0

I003/090 is only sent on a repetitive basis (every 1 minute), and immediately at the first coming update cycle whenever a change is encountered.

2.2.1.8 I003/120 - Calculated Track Velocity

This 4-byte item consists of two parts:

- the first two bytes contain the calculated groundspeed in resolution units of (2 exp -14) NM/sec
- the remaining two bytes contain the estimated aircraft heading, with a LSB = 360/(2 exp 16) degrees.

This item is always transmitted for **firm** tracks in every track update message. It is, however, never sent for **tentative** tracks (i.e. plots).

2.2.1.9 I003/130 - Attitude/Intention Indicator

This is a fixed 1-byte data item which is only sent for firm tracks under the following conditions:

- cyclically, at the one-minute cycle
- at the next update opportunity in case of a change.

The encoding rules are as follows:

bits-8/7 (IT1, IT2) : Intention expressed
= 00 when aircraft level at cleared flight level
= 01 when intention to descend was inserted
= 10 when intention to climb was inserted
= 11 no intention expressed

bits-6/5 (AT1/AT2) : Status of vertical action
= 00 no intention declared or previous action correctly terminated
= 01 intention declared, however, action not yet started
= 10 not applicable

= 11 action in progress according to intention declared

bits-4/3 (RA1, RA2) : Mode C derived attitude
= 00 aircraft levelled off
= 01 aircraft descending
= 10 aircraft climbing
= 11 unknown attitude (e.g. no Mode C readouts received)

bit-2 (CON) : Conflict between Mode C derived attitude and planned intention
= 0 no conflict
= 1 conflict between actual attitude and intention expressed

bit-1: spare bit, always set to 0

Remark: for tracks not associated to a flightplan the bits 8-5 and 2-1 are always set to 0.

2.2.1.10 I003/140 - Calculated Rate of Climb/Descent

I003/140 is a two-byte value containing the Mode C derived instantaneous rate of climb/descent, expressed in (2 exp-10) Fl/sec.
The ROC/D is sent for firm tracks at every update cycle, provided a **firm** height track exists.

2.2.1.11 I003/150 - Track Quality

Whereas in principle the track quality item is a variable length data item, the actual implementation entails only the 1-byte primary part.
The detailed encoding rules are reflected hereafter:

bits-8/7 (CV1, CV2) : coverage factor
= 00 not applicable
= 01 system track currently updated by one radar system (1 firm local track)
= 10 system track currently updated by two radar systems (2 firm local tracks)
= 11 system track currently updated by three or more radar systems (at least 3 firm local tracks)
bits-6/2 (Q1, Q5) : a measure for track quality, expressed as a value between 0 and 21 (high quality)

bit-1 (FX) : 0, always

The track quality figure is calculated as follows:

$$TQ = \frac{SUM[W(i) * TQ(i)]}{SUM[W(i)]} \quad ; i = 1 \text{ to } N$$

TQ(i) = 4 * CF(n) + 2 * CF(n-1) + 1 * CF(n-2)

CF(n) = credibility factor at last antenna scan

CF(n-1) = credibility factor at last but one antenna scan

CF(n-2) = credibility factor at last but two antenna scan

CF(i) = 0 in case of plot miss
= 1 if updated with solo primary plot or solo SSR plot without a validated Mode A code

= 2 if updated with a combined plot without a validated Mode A code
= 3 if updated by a solo SSR or a combined plot with a validated Mode A code

N = the number of firm local tracks participating in the update process of the system track

W(i) = weighing factor, which represents the reciprocal value of the position variance of the local track concerned

The data item track quality is sent at **every update cycle** for **firm** tracks (hence never for tentative tracks).

2.2.1.12 I003/160 - Callsign

The data item I003/160 is a 7-byte fixed length data item, containing the left-adjusted callsign represented as seven consecutive ASCII characters. For callsigns consisting of less than 7 characters the remaining right-most character positions are padded with blanks.

The data item I003/160 is sent only in the following cases:

- for tentative SSR tracks at every update as long as the SSR code of the plot matches either the present or next SSR code contained in an unassociated active MADAP mini flightplan (the so-called code/callsign correspondence function of the plot display complex)
- for firm tracks as long as the track is associated to a MADAP mini flightplan. The item is only transmitted in a **long** track update message, containing all available data items (refer to para 3.2.3.1).

2.2.1.13 I003/170 - Current Control Position

I003/170 provides an internal identity of the controller who is currently in charge of the aircraft i.e. the last controller who made the 'assume control' input (or equivalent). The item is transmitted for firm tracks which are associated to an active MADAP mini flightplan after the first MADAP controller took the aircraft under control. The item is at present a 1-byte internal controller identity. A correspondence between that internal identity and the corresponding functional controller name is listed in chapter 6.

Remark: A 1-byte controller identity will become inadequate as soon as cooperating partners start with the provision of identification messages in order to update the server and hence indirectly all other interested partners. In that case the item I003/170 must be extended to two bytes, where the controller identity is preceded by a centre identity.

The item I003/170 is provided at a periodical basis (1 minute) in a long track update message, however, also in a short track update message at the next update step as soon as a change occurs.

2.2.1.14 I003/180 - Current Cleared Flight Level

Item I003/180 is a two-byte item, containing the current cleared flight level in binary representation (LSB = 1FL). The conditions for the provision of a current cleared flight level are:

1) the track is associated to a MADAP mini flightplan
2) the current cleared flight level is available.

Normally the item is transmitted within a long track update message (every 1 minute), but also at the first coming short track update message after the occurrence of a change.

2.2.1.15 I003/SP - Special Purpose Field

Item I003/SP is temporarily used for the benefit of ADMAR in order to reflect that an UNASSOCIATED SSR-initiated track is ASSOCIATED as a result of a code/callsign input by one of the remote ADMAR stations.
Item I003/SP is an eleven-byte item, containing:

- a one-byte length subfield, providing the total length of the SP field in bytes
- a one-byte TYPE subfield
- a seven-byte callsign, represented as seven left-adjusted ASCII characters
- two-bytes providing the input source

2.2.2 User Application Profile (category 003)

In the Ordered Field Sequencing (OFS) message structure, it is attempted to assign low field reference numbers (FRN) to frequently used data items, for the sake of minimizing the overhead created by the FSPEC header field.
Bearing this guideline in mind, the adopted **USER APPLICATION PROFILE** is as described in the table 1 below:

Table 1: UAP for ASTERIX Category 003

FRN	DATA ITEM
1	I003/010 : Data Source Identifier
2	I003/070 : Track Number
3	I003/020 : Calc. Position in Cartesian Coord.
4	I003/120 : Calc. Track Velocity
5	I003/050 : Actual Flight Level
6	I003/080 : Track Status
7	I003/150 : Track Quality
8	I003/140 : Calc. Rate of Climb/Descent
9	I003/130 : Attitude/Intention Indicator
10	I003/160 : Callsign
11	I003/040 : Mode 3/A code in octal repres.
12	I003/170 : Current Control Position
13	I003/180 : Current Cleared Flightlevel
14	I003/090 : Track Category
15-19	Spare
20	Special purpose field
21	RFS-field

FRN = 20 is reserved as SP bit, indicating the presence/absence of an explicit length field, intended to convey special-purpose data (on rare occasions or non-standardized data for test/evaluation purposes etc.). The actual meaning of the data contents is necessarily a bilateral agreement between data source and data sink(s). As a consequence of the broadcast transmission mode, data sinks which are not concerned should disregard the SP data field.

FRN = 21 is reserved for the use of randomly organized field sequencing. The RFS organization is at present not used.

2.2.3 Detailed Contents of Track Messages

2.2.3.1 Long Track Update Messages

2.2.3.1.1 Definition

Long track update (create) messages are sent for tracks which are **associated** to a mini flightplan (or in future to an identification message) and contain **all available** data items.

2.2.3.1.2 Transmission Events

A long track update message is transmitted at the following discrete events:

- at the next coming update event after a mini flightplan to track association action
- thereafter, every 13th (approx. 1 minute) update cycle, on a per individual track basis.

2.2.3.1.3 Detailed Message Contents

The contents of the long track update message is reflected in table 2 below:

Table 2: Contents of a long track update message.

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		2
1	I003/010 : Data Source Identifier	y	2
2	I003/070 : Track Number	y	2
3	I003/020 : Calc. Position in Cartesian Coord.	y	4
4	I003/120 : Calc. Track Velocity	y	4
5	I003/050 : Actual Flight Level	C(1)	2
6	I003/080 : Track Status	y	1 or 2
7	I003/150 : Track Quality	y	1
8	I003/140 : Calc. Rate of Climb/Descent	C(2)	2
9	I003/130 : Attitude/Intention Indicator	y	1
10	I003/160 : Callsign	y	7
11	I003/040 : Mode 3/A code in octal repres.	C(3)	2
12	I003/170 : Current Control Position	C(4)	1
13	I003/180 : Current Cleared Flightlevel	C(5)	2
14	I003/090 : Track Category	y	1
15-19	Spare	n	0
20	Special purpose field	n	0
21	RFS-field	n	0

	"Normal" maximum length in bytes		34

Conditional data items:

C(1) : The item I003/050 is only transmitted in case a reliable Mode C value is received since the previous update cycle.

C(2) : Data item I003/140 is only transmitted in case a **firm** height track exists.

C(3) : Data item I003/040 is transmitted for SSR initiated tracks and contains the last known Mode 3/A code, if available.

C(4) : Data item I003/170 is only transmitted for associated tracks, provided the first 'assume control' was made.

C(5) : Data item I003/180 is only transmitted for associated tracks, provided a CFL value is available.

2.2.3.2 Medium Track Update Messages

2.2.3.2.1 Definition

Medium track update (create) messages are sent for tracks which are **not associated** to a mini flightplan (or an identification message) and contain **all available** data items of a non-associated track.

2.2.3.2.2 Transmission Events

A medium track update message is transmitted at the following discrete events:

- at the next coming update event, after a track creation event
- at the next coming update event, after a preceding plan-track de-association action
- otherwise, every 13th (approx. 1 minute) update cycle, on a per individual track basis.

2.2.3.2.3 Detailed Message Contents

The contents of the medium track update message is depicted in table 3 below:

Table 3: Contents of the medium track update message

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		2 or 3
1	I003/010 : Data Source Identifier	y	2
2	I003/070 : Track Number	y	2
3	I003/020 : Calc. Position in Cartesian Coord.	y	4
4	I003/120 : Calc. Track Velocity	y	4
5	I003/050 : Actual Flight Level	C(1)	2
6	I003/080 : Track Status	y	1 or 2
7	I003/150 : Track Quality	y	1
8	I003/140 : Calc. Rate of Climb/Descent	C(2)	2
9	I003/130 : Attitude/Intention Indicator	y	1
10	I003/160 : Callsign	n	0
11	I003/040 : Mode 3/A code in octal repres.	C(3)	2
12	I003/170 : Current Control Position	n	0
13	I003/180 : Current Cleared Flightlevel	n	0
14	I003/090 : Track Category	y	1
15-19	Spare	n	0
20	Special purpose field	C(10)	(11)
21	RFS-field	n	0

	"Normal" maximum length in bytes		24

Conditional data items:

C(1): The data item I003/050 is only transmitted in case a reliable Mode C value is received, since the previous update cycle..

C(2): Data item I003/140 is only transmitted in case a **firm** height track exists.

C(3): Data item I003/040 is transmitted for SSR initiated tracks and contains the last known Mode 3/A code, if available.

C(10): Data item I003/SP is transmitted for SSR-initiated tracks, whose Mode A code matches a valid ADMAR code/callsign association.

2.2.3.3 Short Track Update Messages

2.2.3.3.1 Definition

Short track update messages basically contain the data items with a short lifetime (e.g. position, speed etc.). In addition to the short lifetime data items, the short track update message may contain one or more of the remaining data items in case of a changed contents. Short track update messages are sent both for associated and unassociated tracks.

2.2.3.3.2 Transmission Events

In between two consecutive long resp. medium track update messages, a series of twelve short track update messages is sent per individual track (every 4.8 seconds).

2.2.3.3.3 Detailed Message Contents

The contents of the short track update message is depicted in table 4 below:

Table 4: Contents of the short track update message

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		1, 2 or 3
1	I003/010 : Data Source Identifier	y	2
2	I003/070 : Track Number	y	2
3	I003/020 : Calc. Position in Cartesian Coord.	y	4
4	I003/120 : Calc. Track Velocity	y	4
5	I003/050 : Actual Flight Level	C(1)	2
6	I003/080 : Track Status	y	1 or 2
7	I003/150 : Track Quality	y	1
8	I003/140 : Calc. Rate of Climb/Descent	C(2)	2
9	I003/130 : Attitude/Intention Indicator	C(6)	(1)
10	I003/160 : Callsign	n	0
11	I003/040 : Mode 3/A code in octal repres.	C(6)	(2)
12	I003/170 : Current Control Position	C(6)	(1)
13	I003/180 : Current Cleared Flightlevel	C(6)	(2)
14	I003/090 : Track Category	C(6)	(1)
15-19	Spare	n	0
20	Special purpose field	C(10)	(2)
21	RFS-field	n	0

	"Normal" maximum length in bytes		20

Conditional data items:

C(1): The data item I003/050 is only transmitted in case a reliable Mode C value is received, since the previous update cycle.

C(2): Data item I003/140 is only transmitted in case a **firm** height track exists.

C(6): The relevant data items are transmitted once, immediately after a change of their contents is discovered.

C(10): Data item I003/SP is transmitted for SSR-initiated tracks, whose Mode A code matches a valid ADMAR code/callsign association.

2.2.3.4 Track Cancellation Messages

2.2.3.4.1 Definition

A track cancellation message is sent whenever a track record is cancelled (firm or tentative track) within the track data base of the server.

2.2.3.4.2 Transmission Event

- for a **firm** track after the cancellation of that track within the track data base of the server

- for a **tentative** track
  - after the transition to a firm track
  - upon cancellation of the corresponding plot chain (tentative track)
  - as soon as the plot chain does not pass the mosaic plot display filter anymore

2.2.3.4.3 Detailed Message Contents

The contents of the track cancellation message is depicted in table 5 below:

Table 5: Contents of the track cancellation message.

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		1
1	I003/010 : Data Source Identifier	y	2
2	I003/070 : Track Number	y	2
3	I003/020 : Calc. Position in Cartesian Coord.	n	0
4	I003/120 : Calc. Track Velocity	n	0
5	I003/050 : Actual Flight Level	n	0
6	I003/080 : Track Status	y	2
7	I003/150 : Track Quality	n	0
8	I003/140 : Calc. Rate of Climb/Descent	n	0
9	I003/130 : Attitude/Intention Indicator	n	0
10	I003/160 : Callsign	n	0
11	I003/040 : Mode 3/A code in octal repres.	n	0
12	I003/170 : Current Control Position	n	0
13	I003/180 : Current Cleared Flightlevel	n	0
14	I003/090 : Track Category	n	0
15-19	Spare	n	0
20	Special purpose field	n	0
21	RFS-field	n	0

	"Normal" maximum length in bytes		7

Remarks:

- A track cancellation message contains a special track status field which merely signals the track cancellation request in addition to the firm or tentative track status.

- It is recommended that the recipient of the track server data secures himself against an occasional loss of a track update resp. a track cancellation message (time-out feature on an individual track basis). In order to bridge short (partial) outages of the communications medium, the tracks must autonomously be extrapolated during N display cycles and thereafter be removed from the recipient's internal track data base. This entails also a correct handling in case of a su/dden total failure of the track server itself.

2.2.3.5 SSR Tentative Tracks

2.2.3.5.1 Definition

An SSR tentative track represents the contents of the last received SSR plot, creating resp. updating an SSR plot chain (process which precedes a possible creation of an SSR initiated firm track).

2.2.3.5.2 Transmission Event

Tentative track updates do not follow the incremental update scheme of the firm tracks (in general multi-radar tracks); they are rather transmitted when the plot is received and processed to either create a new plot chain, or to update an existing plot chain, provided the plot passes the mosaic SSR plot display filter.

2.2.3.5.3 Detailed Message Contents

The contents of a SSR tentative track update message is reflected in table 6 below:

Table 6: Contents of the SSR tentative track update message.

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		1 or 2
1	I003/010 : Data Source Identifier	y	2
2	I003/070 : Track Number	y	2
3	I003/020 : Calc. Position in Cartesian Coord.	y	4
4	I003/120 : Calc. Track Velocity	n	0
5	I003/050 : Actual Flight Level	C(7)	2
6	I003/080 : Track Status	y	1 or 2
7	I003/150 : Track Quality	n	0
8	I003/140 : Calc. Rate of Climb/Descent	n	0
9	I003/130 : Attitude/Intention Indicator	n	0
10	I003/160 : Callsign	C(8)	7
11	I003/040 : Mode 3/A code in octal repres.	C(9)	2
12	I003/170 : Current Control Position	n	0
13	I003/180 : Current Cleared Flightlevel	n	0
14	I003/090 : Track Category	n	0
15-19	Spare	n	0
20	Special purpose field	n	0
21	RFS-field	n	0

	"Normal" maximum length (in bytes), if code/callsign correspondence		22
	"Normal" maximum length (in bytes) if no code/callsign correspondence		15

Conditional data items:

C(7): The data item I003/050 is only transmitted if the corresponding SSR plot contained a validated Mode C report.

C(8): In case the corresponding SSR plot contains a validated four-digit Mode A code, which matches with either the present or next code contained in a not (yet) associated active mini flightplan, the callsign is added to the tentative track message.

C(9): The data item I003/040 is only transmitted if the corresponding SSR plot contained a validated Mode A code.

2.2.3.6 Primary Tentative Tracks

2.2.3.6.1 Definition

A primary tentative track represents the contents of the last received primary plot, creating resp. updating a primary plot chain (process which precedes a possible creation of a primary initiated firm track).

2.2.3.6.2 Transmission Event

Tentative track updates do not follow the incremental update scheme of the firm tracks (in general multi-radar tracks); they are rather transmitted when the plot is received and processed to either create a new plot chain or to update an existing plot chain, provided the plot passes the primary mosaic plot display filter.

2.2.3.6.3 Detailed Message Contents

The contents of a primary tentative track update message is reflected in table 7 below:

Table 7: Contents of the primary tentative track update message.

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		1
1	I003/010 : Data Source Identifier	y	2
2	I003/070 : Track Number	y	2
3	I003/020 : Calc. Position in Cartesian Coord.	y	4
4	I003/120 : Calc. Track Velocity	n	0
5	I003/050 : Actual Flight Level	n	0
6	I003/080 : Track Status	y	1
7	I003/150 : Track Quality	n	0
8	I003/140 : Calc. Rate of Climb/Descent	n	0
9	I003/130 : Attitude/Intention Indicator	n	0
10	I003/160 : Callsign	n	0
11	I003/040 : Mode 3/A code in octal repres.	n	0
12	I003/170 : Current Control Position	n	0
13	I003/180 : Current Cleared Flightlevel	n	0
14	I003/090 : Track Category	n	0
15-19	Spare	n	0
20	Special purpose field	n	
21	RFS-field		

	"Normal" maximum length in bytes		10

2.3 Synchronisation of the Air Picture Renewal process and Time Management

2.3.1 Objectives of the Supervisory Messages

It is recalled here that the airpicture renewal process is sliced into sixteen consecutive update steps, nominally spaced by 300 mseconds.

In a particular update step all firm tracks within a corresponding geographical sub-area are updated and prepared for transmission to the radar distribution network (RADNET), for subsequent dissemination to the interested users.

However, the actual track messages (CAT 003 ASTERIX) of a particular step are preceded by a supervisory message composed of ASTERIX Category 000 data items.

The purpose of such a supervisory message is twofold:

- **picture synchronisation**; this is implemented in the form of an update step reference number (ranging from 0 to 15). Step number 0 signals the start of a new update cycle. In step number 0 the tracks are transmitted of the most southern sub-area.
  At the next step, step number 1, the tracks of the neighbouring northern sub-area are dealt with, and so on until the total picture has been renewed when completing the transmission for step number 15. The geographical confines of the 16 sub-areas are dynamically adapted in order to safeguard approximately an evenly distributed volume of traffic in every update step.

- **time management**; for the sake of transmission efficiency no timestamp is added to the track update messages. All the firm tracks processed and transmitted within a particular update step are calculated for a **common reference time** (i.e. the nowtime at the start of the update step concerned).
  Besides the update step number, the supervisory message contains therefore also the previously mentioned reference time, as a **UTC** time expressed in units of 1/128 seconds.
  The link between a particular track and the relevant timestamp can be made via the step number, which is for this reason an integral part (four high-order bits) of the track number.

2.3.2 Layout of the Supervisory Messages

2.3.2.1 Selected Data Items and Encoding Rules Adopted

The definition of all Data Items of Category 000 is provided in chapter 10.
This paragraph lists al the **implemented** data items from cat 000, together with a detailed description of the encoding rules applied.

2.3.2.1.1 I000/010 - Data Source Identifier

This is a two-byte unique address identifying the track server involved. This data item must **always** be the first data item following the FSPEC field. The address is composed of two subfields:
- the high order byte contains the Source Area Code (SAC)
- the low order byte contains the Source Identification Code (SIC).

It has to be noted that MADAP can simultaneously connect two track servers to the RADNET environment. The following SAC, SIC codes are assigned:

SAC = X'04', SIC = X'F0' for the MADAP Track Server of the **ONLINE** system
SAC = X'04', SIC = X'F1' for the MADAP Track Server running on the **Standby/test** environment.

It has furthermore to be emphasized that end-users serviced via RADNET will receive server messages whereby the (SAC, SIC) code is replaced by a corresponding unique RSAP address (Radar Service Access Point).

The following address conversion is performed by RMCDE:

SAC, SIC = X'04F0' ---> RSAP = X'01F9'
SAC, SIC = X'04F1' ---> RSAP = X'65F7'

In order to obtain track server data, an end-user must submit his specific requirements in the form of standard filter tables, thereby indicating the **RSAP address** of the track server involved (cf. Ref. 9 and 10).

2.3.2.1.2 I000/020 - Time of Day

I000/020 is a three-byte data item containing the UTC timestamp, valid for all tracks renewed within a particular incremental update step (LSB = 1/128 seconds).
This data item is sent in every supervisory step message.

2.3.2.1.3 I000/030 - Step Reference Number

I000/030 is a one-byte data item, signalling the sequence number of the current incremental update step (ranging from 0 to 15).
I000/030 is present in every supervisory step message.

2.3.2.1.4 I000/040 - Radar Configuration and Status

I000/040 has the structure of a repetitive data item, starting with a one-byte repetition factor indicating the number of radars actually used to establish the traffic situation picture, followed by a series of three-byte subfields, each comprising a two-byte radar identity followed by a one-byte radar station status.

I000/040 is only transmitted at the start of a new picture update cycle, i.e. within the step 0 message.

The radar station identities are provided in the form of their (SAC, SIC) codes. The provisional list of SAC, SIC codes of the radar stations currently used by the MADAP server is contained in chapter 7.

The status sub-field has been coded as follows:

bits 8-6 :	CF1,	CF2,	ANT	
	0	0	0	single station radar
	0	1	0	main station of main/sby conf.
	0	1	1	sby station of main/sby conf.
	1	0	0	front radar of Janus conf.
	1	0	1	back radar of Janus conf.
	1	1	0	radar 1 of radar pair
	1	1	1	radar 2 of radar pair

Note: The radar pair concept is at present not used.

bit-5 :	SSR	= 0	if SSR channel **not** in operation
		= 1	if SSR channel in operation
bit-4 :	PR1	= 0	if primary radar channel 1 not in operation
		= 1	if primary radar channel 1 in operation
bit-3 :	PR2	= 0	if primary radar channel 2 not in operation
		= 1	if primary radar channel 2 in operation

bit-2 : PAP = 0 signals that the antennae constituting either a Janus pair or a genuine radar pair are processed separately as independent radar stations

= 1 signals that the front and back antennae of a Janus radar are processed in the back-to-back processing mode, or that the single radars constituting a radar pair are processed in the pair processing mode.

bit-1 : spare always 0

Note : **1**. In the list of **operational** radars, constituting together the current radar configuration, it may occur that a particular SAC, SIC code is encountered twice. This is the case if both the front and back antennae of a Janus radar are operationally used (either as two single radars or as a back-to-back pair). The status field allows then to discriminate between the two antennae and to determine the selected processing mode.

2. For a configuration of a main/standby radar, where only one is operational at a time, the status subfield enables the receiver to determine which of the two radar stations is actually used at present.

2.3.2.1.5 I000/050 - Processing Status

The encoding of I000/050 is at present as follows:

bits 8-6 : spare; all bits are zero

bits 5-2 : provide the **current** value of the dynamic effective coverage factor N used by the track server i.e. N determines the current setting of the maximum number of radars which are simultaneously updating a particular system track.

bit 1 : extension bit, always zero

2.3.2.2 User Application Profile for Category 000

The following User Application Profile for category 000 messages is proposed:

FRN	DATA ITEM
1	I000/010 : Source identity
2	I000/020 : Time of day
3	I000/030 : Step reference number
4	I000/040 : Radar configuration and status
5	I000/050 : Processing status
6-13	Spare
14	Special purpose field

TABLE 8 : UAP for ASTERIX Category 000

FRN= 14 is reserved as Special Purpose (SP-bit), signalling the presence of an explicit length field, which may freely be used for non-standardized applications. The data conveyed will only be used by interested recipients, which mutually agreed with the track server provider the contents of the SP-field.

2.3.2.3 Composition of the Supervisory Messages

A **special** supervisory message is composed and transmitted at the start of every new 4.8-seconds display cycle (**SOP**-start of picture message).

It precedes the track update messages of step 0, and has the following contents:

			LENGTH (bytes)
FSPEC			1
I000/010	:	Source identity	2
I000/020	:	Time of day	3
I000/030	:	Step reference number	1
I000/040	:	Radar configuration and status	(1 + 3n)
I000/050	:	Processing status of server	1

		Total length of SOP	(9 + 3n) bytes

n represents the actual number of radars used by the server to produce the traffic situation picture.

At the start of the remaining 15 update steps a short supervisory message is transmitted (**IUS**-intermediate update step). They precede the track update messages of the corresponding geographical sub-area.

The IUS-messages have the following contents:

			LENGTH (bytes)
FSPEC			1
I000/010	:	Source identity	2
I000/020	:	Time of day	3
I000/030	:	Step reference number	1
I000/050	:	Processing status of server	1

		Total length IUS	8 bytes

3. The Transmission of a Multi-Sensor Weather Picture

3.1 General Principles of Multi-Sensor Weather Processing and Transmission

The various weather radars connected to the radar data distribution network, are generally of different types, provided by different manufacturers and consequently heterogeneous in terms of processing, data formats and nature, data renewal rates, resolution cells and precision, data recombination and reduction techniques, number of intensity levels, etc.

Irrespective of the particular type of weather contours or vectors provided, every radar uses its site coordinates as the coordinate reference point (local coordinates).
In order to amalgamate the partly overlapping precipitation images, received in different representations and expressed in local coordinate systems from the various weather radars, the server converts all vectors resp. contours into an identical representation, namely horizontal vectors of various intensity levels, expressed in the server system grid.

The total area of responsibility of the server is therefore subdivided into n contiguous Y-stripes, each having a width of 2 NM (e.g. n = 256 for a server window with a width of 512 NM in y-direction).

All converted vectors, falling in the same Y-stripe are chained together within the server weather data base, irrespective of the originating radar.

The n corresponding 'head of chains' are organized in ascending Y-order. The combined weather 'page' thus constituted is asynchronously updated by the operational weather radars, at their individual picture renewal rate. The server requests weather data from a particular radar by submitting a standard filter table to its network access node, after having established a session with the network.

The extraction of a composite multi-sensor weather image from the server's internal weather vector data base, is a periodical process which is asynchronous with respect to the data delivery of the individual weather radars.

Similar to the exchange of the traffic situation picture the same principles are adopted for the transmission of composite weather images:

- The server does not know the individual user requirements. Hence a unique and complete picture is injected into the network. Appropriate filtering and possibly format conversion occur at the destination access nodes.

- The picture renewal rate (T_p) is a system parameter, which has to be agreed by the community of the users of the weather server function.

- The picture update process is not a single-shot process, invoked at the picture update time, but rather an incremental (line-scanning) process. Every d(t) seconds the vectors of a particular geographical sub-area are extracted and submitted to the network. At the maximum 64 subareas are foreseen. A typical value is m = 60 sub-areas and hence 60 incremental steps. With m = 60 and T_p = 60 seconds, the corresponding value for d(t) = 1 second.

As a result of the above, the total geographical area covered by the server is organized in m sub-areas, each of which is made up of an integral number of contiguous Y-stripes of 2 NM width. Starting with the most southern sub-area, every d(t) seconds all the vectors within the next higher sub-area are extracted and delivered to the network, until the whole picture has been renewed in T_p seconds. When extracting the vectors, overlapping vectors of the same intensity level, however originating from different radars, are recombined into one composite vector. A variable number of vectors of the same intensity level are assembled within one ASTERIX record. A number of ASTERIX records are packed together into one ASTERIX data block, which always starts with a one-byte ASTERIX category (= 09) field.

In addition to the weather vectors themselves, a number of process synchronisation messages are needed (also defined as ASTERIX category 09 records).
Within a particular data block, the actual weather vectors are in fact always preceded by a corresponding **intermediate update step message (IUS)**. The IUS message provides the current update step number, time stamp and possibly status information etc.

Two special versions of the IUS exist. The first IUS is called the **start-of-picture (SOP)** message, signalling the start of a new data renewal cycle and providing additionally information concerning the actual weather radar configuration in use, supplemented with relevant status data for the radars concerned.
The second special version IUS is the **end-of-picture (EOP)** message, transmitted as the very last ASTERIX record of a picture renewal cycle. The EOP signals the completion of an update cycle and contains furthermore a count of the total number of vectors constituting the complete transmitted weather image. The latter value allows the receiver to verify whether all vectors were actually received. (cf

Considering that transmission of ASTERIX data blocks via a packet switching backbone network may occasionally cause a reverse order of message reception, it seems appropriate that the interpretation of the EOP is done with some precautions.

It is suggested that in case not all vectors are received when processing the EOP, a time-out of several seconds is applied to await the missing vectors. In case a number of vectors are definitely lost (rather unlikely case, due to HDLC protocols), the user may decide to display the incomplete weather picture together with an appropriate warning message or to simply abort it, awaiting the next update cycle.

The receiver has basically two alternative methods to update his own displays:

- either stepwise, in synchronism with the arrival of the server data,

- or as a single-shot process, after the receipt of the EOP (double buffering mode).

3.2 Layout of the Weather Messages

3.2.1 Selected Data Items and Encoding Rules Adopted

The definition of all Data Items of Category 009 is provided in chapter 12.
This paragraph lists all the **implemented** data items from category 009, together with a detailed description of the encoding rules applied:

3.2.1.1 I009/000 : Message type

I009/000 is used in all types of weather messages and allows the receiving unit to discriminate between the various message types.

The following message types are actually implemented:

002 - for Cartesian vector messages
253 - to identify an intermediate-update-step message
254 - to identify a start-of-picture message
255 - to identify an end-of-picture message

3.2.1.2 I009/010 - Data Source Identifier

This is a two-byte unique address identifying the track server involved. This data item must **always** be the first data item following the FSPEC field. The address is composed of two subfields:

- the high order byte contains the Source Area Code (SAC)
- the low order byte contains the Source Identification Code (SIC).

It has to be noted that MADAP can simultaneously connect two track servers to the RADNET environment. The following SAC, SIC codes are assigned:

SAC = X'04', SIC = X'F0' for the MADAP Track Server of the **ONLINE** system
SAC = X'04', SIC = X'F1' for the MADAP Track Server running on the **Standby/test** environment.

It has furthermore to be emphasized that end-users serviced via RADNET will receive server messages whereby the (SAC, SIC) code is replaced by a corresponding unique RSAP address (Radar Service Access Point).

The following address conversion is performed by RMCDE:

SAC, SIC = X'04F0' ---> RSAP = X'01F9'
SAC, SIC = X'04F1' ---> RSAP = X'65F7'

In order to obtain track server data, an end-user must submit his specific requirements in the form of standard filter tables, thereby indicating the **RSAP address** of the track server involved (cf. Ref. 9 and 10).

3.2.1.3 I009/020 - Vector Qualifier

The vector qualifier is a 1-byte data item, which defines the orientation of the following sequence of Cartesian vectors, their intensity level and the relevant coordinate system.
At present, the server uses only horizontal vectors, of two intensity levels and expressed in the server system grid.
This results in the following bit settings:

bit -8 (ORG)	:	1
bits 7-5 (I1, I2, I3)	:	001 for intensity 1 vectors
		010 for intensity 2 vectors
bits 4-2 (S1, S2, S3)	:	100 (horizontal vectors only)
bits -1 (FX)	:	0 (no extension used sofar)

3.2.1.4 I009/030 - Sequence of Cartesian vectors

Item I009/030 allows to assemble a series of vectors, **all of the same type and intensity level**, in one and the same ASTERIX record. The item consists of a one-byte vector count N, followed by a sequence of N Cartesian vectors, described by six bytes each.
Each vector is defined by its start position and the length of the vector, all expressed with a LSB = 1/64 NM.

For practical reasons it has been decided to limit the number of vectors to a **maximum of 20** per ASTERIX record.

3.2.1.5 I009/060 - Synchronisation/Control Signal

A total picture renewal cycle is subdivided into 60 incremental steps, separated by 1 second.
I009/060 is part of every picture synchronisation message and provides the serial step number.

The contents of the various bits is as follows:

bits -8/3 (S6-S1)	:	serial step number, ranging from 0 to 59
bit -2	:	spare, always 0
bit -1 (FX)	:	always 0

3.2.1.6 I009/070 - Time of day

I009/070 is present in **all** picture synchronisation messages and is a three-byte item, containing the UTC timestamp in resolution units of 1/128 sec.

3.2.1.7 I009/080 - Processing status

The primary quantity of three bytes contains presently only default information, as described below:

bits -24/20 (f) : B'00000'; scaling factor always 0, i.e. LSB=1/64 NM
bits -19/17 (R) : B'000'; no reduction step used at present
bits -16/2 (Q) : all zero; no processing parameters implemented at present
bit -1 (FX) : always 0

3.2.1.8 I009/090 - Radar Configuration and Status

I009/090 has the structure of a repetitive data item, starting with a one-byte repetition factor indicating the number of weather radars actually used to establish composite precipitation images, followed by a series of three-byte subfields, each comprising a two-byte radar identity succeeded by a one-byte radar station status.

I009/090 is only transmitted at the start of a new picture update cycle i.e. within the Start-Of-Picture (SOP) message at step 0.

The radar station identities are provided in the form of their (SAC, SIC) codes. The provisional list of (SAC, SIC) pairs for the weather radar stations currently integrated by the MADAP server is contained in chapter 8.

The status sub-field has been coded as follows:

bits -8/6 : spare, always 0
bit -5 (CPOL) : 1, if circular polarisation is used
bit -4 (WCOL) : 1, to signal weather channel overload conditions
bits 3-1 (R1, R2, R3) : a binary value ranging from 0 to 5, signalling the reduction step in use at the radar station concerned

The actual meaning of the successive reduction stages is described in chapter 9.

3.2.1.9 I009/100 - Total Number of Vectors, defining one complete weather picture

I009/100 is only transmitted in the last message of a particular picture renewal cycle, the so-called End-Of-Picture (EOP) message.
It consists of a two-byte counter, giving the total number of vectors constituting together the complete weather image for the current update cycle.

3.2.2 User Application Profile for Category 009

For the distribution of composite weather images, the User Application Profile of category 009 was defined as described by table 9 below:

Table 9: UAP for ASTERIX Category 009

FRN	DATA ITEM
1	I009/010 : Data Source Identifier
2	I009/000 : Message Type
3	I009/020 : Vector Qualifier
4	I009/030 : Sequence of Cartesian Vectors
5	I009/060 : Synchronisation/Control Signal
6	I009/070 : Time of Day
7	I009/080 : Processing Status
8	I009/090 : Radar Configuration and Status
9	I009/100 : Vector Count

3.2.3 Composition of the Weather Messages

3.2.3.1 Weather Vector Messages

3.2.3.1.1 Definition

Up to 20 vectors, described by the same vector qualifier located within the same geographical sub-area are assembled together into one ASTERIX record.

3.2.3.1.2 Transmission events

At every incremental update step, the corresponding IUS message may be followed by zero, one or more ASTERIX records for intensity 1 vectors, succeeded by zero, one or more ASTERIX records of intensity 2 vectors.

3.2.3.1.3 Detailed Message Contents

The contents of a weather vector message is depicted in table 10 below:

Table 10: Contents of weather vector messages

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		1
1	I009/010 : Data Source Identifier	y	2
2	I009/000 : Message Type	y	1
3	I009/020 : Vector Qualifier	y	1
4	I009/030 : Sequence of Cartesian vectors	y	(1+6n)
5	I009/060 : Synchronisation/Control signal	n	0
6	I009/070 : Time of Day	n	0
7	I009/080 : Processing Status	n	0
8	I009/090 : Radar Config/Status	n	0
9	I009/100 : Vector Count	n	0

	Maximum length in bytes		6+6n

Note: **1**. n represents the total number of vectors assembled into one ASTERIX record. The allowed range for n is: $1 \leq n \leq 20$.

2. If a geographical sub-area contains more than 20 vectors of a particular intensity level, the remaining vectors are transmitted into one or more additional ASTERIX records.

3. For an average value of n = 6 the **resulting length per vector is 7 bytes**.

3.2.3.2 Start-Of-Picture Message (SOP)

3.2.3.2.1 Definition

The SOP message is the very first message, transmitted to signal the start of a new picture renewal cycle. In addition the SOP informs the receiver concerning the current weather radar configuration and the status of the radars concerned, further supplemented with processing status information.

3.2.3.2.2 Transmission event

A new picture update cycle starts every T_p = 60 sec. The SOP is the very first ASTERIX record, which precedes the vector messages, if any, for the most-southern geographical subarea.

3.2.3.2.3 Detailed Message Contents

The contents of the SOP message is reflected in table 11 below:

Table 11: Contents of the SOP message.

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		2
1	I009/010 : Data Source Identifier	y	2
2	I009/000 : Message Type	y	1
3	I009/020 : Vector Qualifier	n	0
4	I009/030 : Sequence of Cartesian vectors	n	0
5	I009/060 : Synchronisation/Control signal	y	1
6	I009/070 : Time of Day	y	3
7	I009/080 : Processing Status	y	3
8	I009/090 : Radar Config/Status	y	1+3n
9	I009/100 : Vector Count	n	0

	Maximum length in bytes		13+3n

Note: n represents the total number of weather radars in operational use by the server.

3.2.3.3 Intermediate Update Step Message (IUS)

3.2.3.3.1 Definition

The IUS message defines the serial incremental update step within a particular picture renewal cycle. It precedes the vector messages, if any, for the corresponding geographical sub-area.

3.2.3.3.2 Transmission event

Every second the vectors for a particular sub-area are transmitted, if any. Prior to the transmission of the weather vectors, a corresponding IUS message is sent, with the exception of the very first step where the SOP replaces the IUS0. Every geographical sub-area covers 5 stripes of 2 NM each (in Y-direction). The total useful area is composed of 272 stripes, plus two dummy stripes. This results in the following sequence of supervisory messages:

SOP (= IUS0), IUS 1-54, EOP.

For steps 55, 56, 57, 58 and 59 no messages are transmitted.

Note: The sequence of supervisory messages as described above is always transmitted, even in case of total absence of vector messages.

3.2.3.3.3 Detailed Message Contents

The contents of the IUS message is depicted in table 12 below:
Table 12: Contents of the IUS message.

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		1
1	I009/010 : Data Source Identifier	y	2
2	I009/000 : Message Type	y	1
3	I009/020 : Vector Qualifier	n	0
4	I009/030 : Sequence of Cartesian vectors	n	0
5	I009/060 : Synchronisation/Control signal	y	1
6	I009/070 : Time of Day	y	3
7	I009/080 : Processing Status	y	3
8	I009/090 : Radar Config/Status	n	0
9	I009/100 : Vector Count	n	0

	Maximum length in bytes		11

3.2.3.4 End-Of-Picture Message (EOP)

3.2.3.4.1 Definition

The EOP message is the last message transmitted and signals the termination of a particular picture renewal cycle. In addition to the contents of an IUS message, the EOP provides a count of the total number of vectors composing the complete precipitation image transmitted.

3.2.3.4.2 Transmission event

The EOP is extracted and transmitted after the transmission of the vector messages of step number 54, if any. If no vectors are present in the 55th sub-area, the EOP follows immediately IUS 54.

3.2.3.4.3 Detailed Message Contents

The contents of the EOP message is depicted in table 13 below:

Table 13: Contents of the EOP message:

FRN	DATA ITEM	PRESENCE	LENGTH
	FSPEC		2
1	I009/010 : Data Source Identifier	y	2
2	I009/000 : Message Type	y	1
3	I009/020 : Vector Qualifier	n	0
4	I009/030 : Sequence of Cartesian vectors	n	0
5	I009/060 : Synchronisation/Control signal	y	1
6	I009/070 : Time of Day	y	3
7	I009/080 : Processing Status	y	3
8	I009/090 : Radar Config/Status	n	0
9	I009/100 : Vector Count	y	2

	Maximum length in bytes		14

4. Load Considerations

4.1 General Assumptions

In this chapter an attempt is made to assess the **average** transmission load, expressed in bits/sec., when the total volume of messages generated by the server were to be disseminated to a remote user over a transmission line using an X.25 protocol. It is assumed that the packet length is limited to 256 bytes.
The overhead per packet is assumed to be 12 bytes and composed as follows:

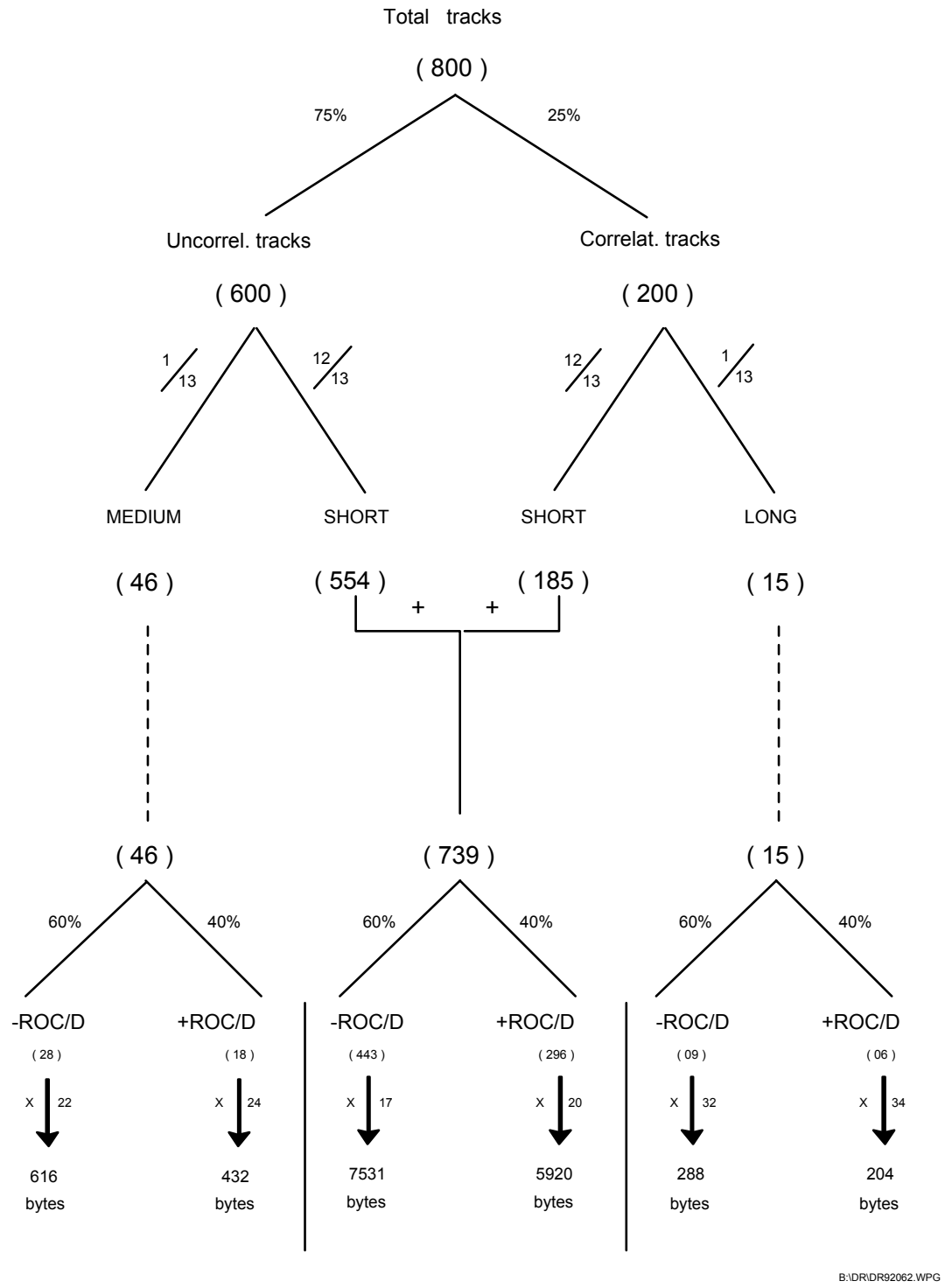
HDLC header/trailer	:	6 bytes
X.25 header	:	3 bytes
ASTERIX category	:	1 bytes
length field ASTERIX block	:	2 bytes
		---
total overhead		12 bytes

4.2 Load Resulting from Firm Track Transmission

The following scenario constitutes the basis for the load calculations as a result of the transmission of the firm track data base:

- in total 800 firm tracks have to be broadcast
- for reasons of convenience the worst-case assumption is made that all 800 tracks are SSR tracks and all SSR tracks have Mode C height available
- as a result of the hypothesis above primary track update messages and track cancellation messages are disregarded
- it is furthermore assumed that 25% of the tracks are correlated to an active flightplan
- from experience it is known that approximately 40% of the tracks are in a vertical transitioning flightphase
- finally the tracking system organizes the total amount of 800 tracks such that in every 300 mseconds update step an evenly distributed subset of tracks is dealt with
- the transmission of a long resp. medium track update message is followed by a sequence of 12 short update messages.

The hypotheses given above result in the following sub-division of track update message classes:



The aggregate net data load per 4.8 seconds is therefore 14991 bytes.
This corresponds to 937 bytes per incremental update step, which leads to the assumption that three data packets per step are exchanged i.e. 4 x 12 bytes overhead per step and hence per picture renewal cycle 16 x 4 x 12 = 768 bytes. The total load per 4.8 seconds is therefore 14991 + 768 = 15759 bytes. This corresponds to a **load per second** of **3283** bytes/sec. or 26265 bps.

4.3 Load Resulting from Tentative Track Transmission

In a running system the load of the transmission of SSR tentative tracks is very marginal and will therefore be disregarded

A rather pessimistic assumption is made in which 500 tentative primary tracks (mainly clutter) are exchanged with an average update rate of 10 seconds

Tentative tracks can be sent every 200 mseconds; assuming an approx. even distribution this would mean that 50 packets are exchanged, with 10 primary plots each, during 10 seconds.

As a result of the above the following load arises:

5 packets of 10 prim. plots	= 5 x 10 x 10	=	500 bytes/sec
overhead	= 5 x 12	=	60 bytes/sec
			---
total load			560 bytes/sec.
			==========

4.4 Load as a Result of CAT 0 Messages

During one picture renewal cycle the following sequence of supervisory messages is sent: SOP + 15 IUS.
The length of the SOP is dependent on the number of operational radars. It is assumed here that 32 radars are operationally used.
This results in transmission load of on a per 4.8 secs. basis:

SOP	:	(9 + 3*32) + 12	=	117 bytes
15 IUS	:	15*(8 + 12)	=	300 bytes
				---
				417 bytes/4.8 sec.

The average load per sec. is therefore: 87 bytes/sec.

4.5 Load as a Result of Weather Data Transmission

The following rather pessimistic scenario is assumed:

960 vectors of intensity level 1 are transmitted
540 vectors of intensity level 2 are transmitted

As a result of the above it is assumed that per incremental update step of 1 second the following ASTERIX records are transmitted within one packet:

1 IUS	11 bytes
18 Vectors I1 = 6 + 6*18	114 bytes
10 Vectors I2 = 6 + 6*10	66 bytes
overhead	12 bytes

Resulting **average** load per sec.	203 bytes/sec.
	==========

4.6 Aggregate Load

Summarizing the following load contribution were found:

- firm tracks	3283 bytes/sec
- tentative tracks (plots)	560 bytes/sec
- supervisory messages (CAT 00)	87 bytes/sec
- weather data	203 bytes/sec

	4133 bytes/sec
	==========

The overall average load is therefore estimated to be **33064** bits/sec.

5. References

1. Eurocontrol Standard Document for Radar Data Exchange Part 1.
   All Purpose Structured Eurocontrol Radar Information Exchange (ASTERIX).
   Document Number: SUR.ET1.ST05.2000-STD-01-01.

2. Eurocontrol Standard Document for Radar Data Exchange Part 2b.
   Transmission of Monoradar Service Messages.
   Document Number: SUR.ET1.ST05.2000-STD-02b-01.

3. Eurocontrol Standard Document for Radar Data Exchange Part 2a.
   Transmission of Monoradar Target Reports.
   Document Number: SUR.ET1.ST05.2000-STD-02a-01.

4. Eurocontrol Standard Document for Radar Data Exchange Part 3.
   Transmission of Monoradar derived Weather Information.
   Document Number: SUR.ET1.ST05.2000-STD-03-01.

5. Recommended Practice for the Implementation of a Track Server, by W. JANSSEN.
   Document Number: TS-0012-01. July 1989.

6. Radar Data Exchange between MADAP and PHAROS II, by W. JANSSEN.
   Document Number: MAS-S/212, dated 30.03.1989.

7. Routing and filtering of radar data within RADNET.
   Document Number: TS-0009-01, dated 28.03.1989.
   Author : W. JANSSEN.

8. Presentation Layer Aspects of RADNET.
   Document Number: GD-0039-01, dated 09.06.1989.
   Author : W. JANSSEN.

9. An Introduction to RADNET.
   Document Number: GD-0053-02. dated March 1992.
   Authors : W. JANSSEN & R. MISSAULT.

10. RMCDE USER INTERFACE DESCRIPTION.
    Document Number: GD-0048-02, dated December 1992.
    Author : RADNET Implementation Team (RIT)

6. Correspondence list between Controller numbers and the corresponding executive Controller in MADAP

CONTROLLER NUMBER	CONTROLLER MNEMONIC	CONTROLLER FUNCTION	CIVIL/ MILITARY
19	WE	BRUSSELS WEST EXECUTIVE	C
25	OE	OLNO EXECUTIVE	C
29	LE	RUHR EXECUTIVE	C
34	RE	LUXEMBURG EXECUTIVE	C
39	CE	COASTAL EXECUTIVE	C
45	SE	SOLLING EXECUTIVE	C
49	HE	HAMBURG EXECUTIVE	C
54	DE	DECO EXECUTIVE	C
63	FE	FOXTO EXECUTIVE	C
69	BE	BRUSSELS HIGH EXECUTIVE	C
74	ME	MÜNSTER EXECUTIVE	C
104	T	SOUTH RADAR2	M
105	G	TRA MONITOR	M
106	P	SPECIAL1	M
112	E	WEST RADAR1	M
116	B	EAST RADAR1	M
124	A	NORTH RADAR1	M

7. Provisional list of (SAC,SIC) Codes for the Radar Stations used by the Server

Listed below are the radar stations currently integrated into the MADAP track server, together with the provisional (SAC, SIC) codes assigned to them (in hexadecimal notation).

RADAR	SAC/SIC (HEX)
Leerdam (main)	X'0400'
Leerdam (standby)	X'0401'
Den Helder	X'040A'
Schiphol (main)	X'0414'
Schiphol (standby)	X'0415'
Brussels	X'0602'
Bertem (main)	X'0603'
Bertem (standby)	X'0604'
St. Hubert (main)	X'0605'
St. Hubert (standby)	X'0606'
Luxembourg	X'7001'
Düsseldorf	X'6208'
München Süd	X'6210'
Boostedt (B-to-B)	X'6220'
Bremen (B-to-B)	X'6221'
Neubrandenburg	X'6222'
Deister	X'6224'
Lüdenscheid	X'6226'
Neunkirchen	X'6227'
Mittersberg (B-to-B)	X'6228'
Pfälzerwald	X'6229'
Grosshaager Forst	X'622A'
Gosheim (B-to-B)	X'622B'
Tempelhof	X'6231'
Feichtberg	X'320A'
Chaumont	X'0801'
Boulogne	X'080E'

8. Provisional list of (SAC,SIC) Codes for the Weather Radar Stations used by the Server

Listed below are the weather radar stations currently integrated into the MADAP track server, together with the provisional (SAC, SIC) codes assigned to them (in hexadecimal notation).

WEATHER RADAR	SAC/SIC (hex)
Leerdam	X'0402'
Bremen	X'6221'
Düsseldorf	X'6208'
München Süd	X'6210'
Mittersberg	X'6228'
Gosheim	X'622B'

9. List of data reduction filters, applied by the weather radars before transmission of data to the server

<R1, R2, R3>

0 : no data reduction active

1 : a) recombination of two or more weather vectors of the same intensity level if their mutual separation is only one raster element (300/128 NM)
b) suppression of isolated intensity 1 vectors which occupy merely one raster element.

2 : a) recombination of two or more weather vectors of the same intensity level if their mutual separation does not exceed two raster elements
b) suppression of isolated intensity 1 vectors whose length does not exceed two raster elements.

3 : Provision of maximally 500 vectors of intensity level 2 without data reduction and simultaneously a complete suppression of intensity level 1 vectors.

4 : Provision of maximally 500 vectors of intensity level 2 through a recombination of two or more vectors which are mutually separated by one raster element only, while intensity 1 data are completely suppressed.

5 : Complete suppression of all vectors. Only framing messages are transmitted with an appropriate error/warning indicator.

10. Definition of all Data Items of ASTERIX Category 000

Data Item I000/010, Data Source Identifier

Definition: Identification of the Track Server from which the data are received.

Format: Two-octets 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) = Source Area Code

bits-8/1 (SIC) = Source Identification Code

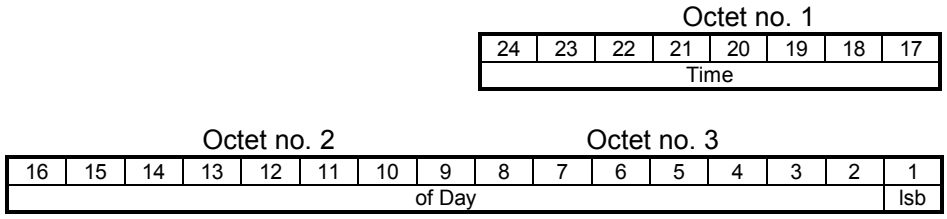
NOTE-

Data Item I000/020, Time of Day

Definition: Absolute time stamping expressed as UTC time.

Format: Three-octets fixed length Data Item.

Structure:



bit-1 (lsb) = 2exp(-7) sec.

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

Data Item I000/030, Step Reference Number

Definition: Sequence number of the current incremental update step.

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
Step Reference Number							

bits-8/1 = Step reference number (range 0 to 15)

NOTE-

Data Item I000/040, Radar Configuration and Status

Definition: Current radar configuration and status of all operational radars.

Format: Repetitive Data Item, starting with a one-octet Field Repetition Indicator followed by at least one radar-configuration-and-status field of three-octets length.

Structure:

Octet no. 1

32	31	30	29	28	27	26	25
REP							

Octet no. 2 Octet no. 3

24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9
SAC								SIC							

Octet no. 4

8	7	6	5	4	3	2	1
C1	C2	AN	SR	P1	P2	PP	0

bits-32/25	(REP)	=	Repetition factor
bits-24/17	(SAC)	=	SAC of radar concerned
bits-16/9	(SIC)	=	SIC of radar concerned
bits-8/6	(C1/C2/AN)	=	000 single radar station
		=	010 main station of main/sby configuration
		=	011 sby station of main/sby configuration
		=	100 front antenna of Janus configuration
		=	101 back antenna of Janus configuration
		=	110 radar 1 of radar pair
		=	111 radar 2 of radar pair
bit-5	(SR)	=	SSR channel in operation
bit-4	(P1)	=	primary channel 1 in operation
bit-3	(P2)	=	primary channel 2 in operation
bit-2	(PP)	=	back-to-back or pair processing
bit-1		=	Always 0

NOTES

1) For a configuration of a main/sby radar, the status subfield enables the receiver to determine which of the two radars is presently used.
2) In the list of operational radars it may occur that a particular SAC/SIC is encountered twice. This is the case if both the front and back antennae of a Janus radar are operationally used (either as two single radars or as back-to-back pair). The status field allows then to discriminate between the two antennae and to determine the selected processing mode.
3) The defined SAC/SIC codes are listed in Chapter 7.

Data Item I000/050, Processing Status

Definition: Processing status of the Track Server.

Format: Variable length Data Item.

Structure of first part:

Octet no. 1

8	7	6	5	4	3	2	1
0			COV				FX

bits-8/6 = 0 Always
bits-5/2 (COV) = Current effective coverage factor (range 2 to 8)

bit-1 (FX) = 0 End of Data Item
= 1 Extension into first extent

NOTE- COV determines the current setting of the maximum number of radars which are simultaneously updating a particular system track.

11. Definition of all Data Items of ASTERIX Category 003

Data Item I003/010, Data Source Identifier

Definition: Identification of the Track Server from which the data are received.

Format: Two-octets 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) = Source Area Code

bits-8/1 (SIC) = Source Identification Code

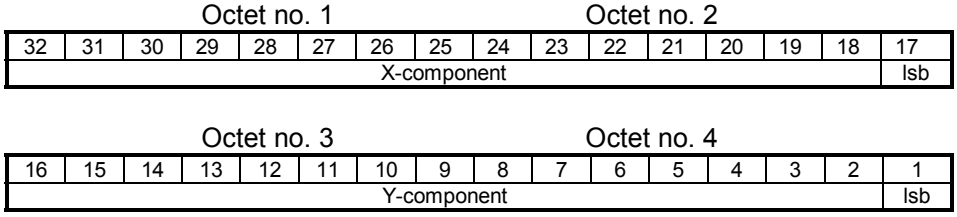
NOTE-

Data Item I003/020, Calculated Position in Cartesian Coordinates

Definition: Calculated position of an aircraft in Cartesian coordinates.

Format: Four-octets fixed length Data Item.

Structure:



bit-17 (lsb) = 2exp(-6+f), where f is the scaling factor applied, modifying the standard quantisation unit.
Range: -2exp(9+f)=<X<2exp(9+f) NM.

bit-1 (lsb) = 2exp(-6+f), where f is the scaling factor applied, modifying the standard quantisation unit.
Range: -2exp(9+f)=<Y<2exp(9+f) NM.

NOTES

1) f shall be set to f = 0 to obtain a default quantisation unit of 1/64 NM.

2) Negative values are expressed in two's complement form.

Data Item I003/040, Mode 3/A Code in Octal Representation

Definition: Mode 3/A code converted into octal representation.

Format: Two-octets 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
0	0	0	0	A4	A2	A1	B4	B2	B1	C4	C2	C1	D4	D2	D1

bits-16/13 = Spare bits set to 0

bits-12/1 = Mode 3/A reply in octal representation

NOTE-

Data Item I003/050, Actual Flight Level

Definition: Last reported mode C value.

Format: Two-octets 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
Actual Flight Level															lsb

bit-1 (lsb) = 1/4 FL = 25 ft

NOTES

1) Negative values are expressed in two's complement form.

Data Item I003/070, Track Number

Definition: An integer value representing a unique reference to a track record within the track database of the Track Server.

Format: Two-octets 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
Step number				Track number											

NOTE- The track number range (0-4095) is again subdivided into the following classes:

0000 - 2047 for **firm** primary or SSR tracks
2048 - 3071 for **tentative** SSR tracks
3072 - 4095 for **tentative** primary tracks

Data Item I003/080, Track Status

Definition: Status of the track as derived by the Track Server.

Format: Variable length Data Item comprising a first part of one octet, followed by one-octet extents as necessary.

Structure of first part:

Octet no. 1

8	7	6	5	4	3	2	1
LIV	CNF	MAN	MDA	SUD/PUD		ASS	FX

bit-8 (LIV) = 0 Simulated track
= 1 Real track

bit-7 (CNF) = 0 Tentative track
= 1 Firm track

bit-6 (MAN) = 0 Default
= 1 Manoeuvring track

bit-5 (MDA) = 0 No plot with valid Mode A code received since previous update cycle
= 1 At least one plot with valid Mode A code received since previous update cycle

bits-4/3 (SUD/PUD) = 00 No plot update since previous update cycle
= 01 Only primary updates since previous update cycle
= 10 Only SSR solo updates since previous update cycle
= 11 Updated with a combination of solo SSR, and primary plots and/or combined plots since previous update cycle

bit-2 (ASS) = 0 Track not associated with a mini flightplan
= 1 Track associated with a mini flightplan

bit-1 (FX) = 0 End of Data Item
= 1 Extension into first extent

NOTE- The settings of the bits (SUD/PUD), as given above, are valid for initiated firm tracks. for the tentative tracks the settings are:
01 - for primary plot update
10 - for solo SSR update
11 - for combined plot update

Structure of first extent:

Octet no. 1

8	7	6	5	4	3	2	1
		GHO	TRE	SPI	DS1/DS2		FX

bit-8 (Spare) = 0 Default

bit-7 (Spare) = 0 Default

bit-6 (GHO) = 0 Always (not used up to now)

bit-5 (TRE) = 0 Default
= 1 End of lifetime of track

bit-4 (SPI) = 0 Default
= 1 Most recent SSR plot used for track update contained SPI condition

bits-3/2 (DS1/DS2) = 00 No distress condition
= 01 Unlawful interference
= 10 Radio communication failure
= 11 Emergency conditions

bit-1 (FX) = 0 End of Data Item
= 1 Extension into first extent

NOTES

1) The following flags are meaningless (always 0) for SSR tentative tracks:
MAN, MDA, ASS.

2) The following flags are meaningless (always 0) for primary tentative tracks:
MAN, MDA, ASS, SPI, DS1, DS2.

Data Item I003/090, Track Category

Definition: Category of the track as derived by the Track Server.

Format: Variable length Data Item comprising a first part of one octet, followed by one-octet extents as necessary.

Structure of first part:

Octet no. 1

8	7	6	5	4	3	2	1
OAT/GAT		FR1/FR2		SP3/SP2/SP1			FX

bits-8/7 (OAT/GAT) = 00 Unknown
= 01 GAT
= 10 OAT
= 11 Not applicable

bits-6/5 (FR1/FR2) = 00 IFR
= 01 VFR
= 10 Unknown
= 11 CVFR

bits-4/2 (SP3/SP2/SP1) = These 3 bits allow for the definition of upto 7 sub-categories.

bit-1 (FX) = 0 End of Data Item
1 Extension into first extent

NOTE- At present 3 sub-categories (SP3/SP2/SP1) are defined :

000 - No special conditions
100 - Scrambled flight
011 - Non-deviation flight

Data Item I003/120, Calculated Track Velocity

Definition: Calculated track velocity of an aircraft in polar coordinates.

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
Calculated groundspeed															lsb

Octet no. 3 Octet no. 4

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

bit-17 (lsb) = 2exp(-14) NM/s = 0.22 kt

bit-1 (lsb) = 360/2exp(16) = 0.0055 degrees

NOTE- Negative values are expressed in two's complement form.

Data Item I003/130, Attitude/Intention Indicator

Definition: Attitude/intention of the track as derived by the Track Server.

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
IT1/IT2		AT1/AT2		RA1/RA2		CON	0

bits-8/7 (IT1/IT2) : Intention expressed
= 00 Aircraft at cleared flight level
= 01 Intention to descend inserted
= 10 Intention to climb inserted
= 11 No intention expressed

bits-6/5 (AT1/AT2) : Status of vertical action
= 00 No intention declared or previous action ended
= 01 Intention declared, action not yet started
= 10 Not applicable
= 11 Action in progress according to intention

bits-4/3 (RA1/RA2) : Mode C derived attitude
= 00 Aircraft levelled off
= 01 Aircraft descending
= 10 Aircraft climbing
= 11 Unknown attitude

bit-2 (CON) : Conflict between Mode C derived attitude and planned intention
= 0 Default
= 1 Conflict between attitude and intention

bit-1 = 0 Always

NOTE- For tracks not associated to a mini flightplan the bits 8/5 and 2 are always set to 0.

Data Item I003/140, Calculated Rate of Climb/Descent

Definition: Mode C derived instantaneous rate of climb/descent.

Format: Two-octets 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
Rate of Climb/Descent															lsb

bit-1 (lsb) = 2exp(-10) FL/s = 5.86 feet/min

NOTES

1) The ROC/D is sent for firm tracks, provided a firm height track exists.

2) Negative values are expressed in two's complement form.

Data Item I003/150, Track Quality

Definition: Quality of the track as derived by the Track Server.

Format: Variable length Data Item.

Structure of first part:

Octet no. 1

8	7	6	5	4	3	2	1
CV1/CV2		Q1/Q2/Q3/Q4/Q5					FX

bits-8/7	(CV1/CV2)	=	00 Not applicable
		=	01 Track updated by 1 radar
		=	10 Track updated by 2 radars
		=	11 Track updated by at least 3 radars
bits-6/2	(Q1 - Q5)	=	Track quality, expressed as a value between 0 and 21 (high quality)
bit-1	(FX)	=	0 End of Data Item
		=	1 Extension into first extent

NOTE-

Data Item I003/160, Callsign

Definition: Callsign of the mini flightplan associated to the track .

Format: Seven-octets fixed length Data Item.

Structure:

Octet 1	Octet 2	Octet 3	Octet 4	Octet 5	Octet 6	Octet 7
Callsign						

octets-1/7 = Callsign in ASCII

NOTE- The callsign is left-adjusted, padded with blanks if applicable.

Data Item I003/170, Current Control Position

Definition: Internal identity of the controller currently in charge of the aircraft.

Format: One-octet fixed length Data Item.

Structure:

Octet no. 1

8	7	6	5	4	3	2	1
Current controller							

bits-8/1 = Current controller identity

NOTE- The list of controller identities can be found in chapter 6.

Data Item I003/180, Current Cleared Flight Level

Definition: Current cleared flight level converted into binary representation.

Format: Two-octets 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
Current Cleared Flight Level															lsb

bit-1 (lsb) = 1 FL = 100 feet

NOTE-

12. Definition of all Data Items of ASTERIX Category 009

Data Item I009/000, 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:

Octet no. 1

8	7	6	5	4	3	2	1
Message Type							

bits-8/1 = Message type

NOTE- The following Message Types are standardised for category 009 records:

002, Cartesian vector
253, Intermediate-update-step message
254, Start-of-picture message
255, End-of-picture message

Data Item I009/010, Data Source Identifier

Definition: Identification of the Track Server from which the data are received.

Format: Two-octets 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) = Source Area Code

bits-8/1 (SIC) = Source Identification Code

NOTE-

Data Item I009/020, Vector Qualifier

Definition: This Data Item defines the orientation of the following sequence of Cartesian vectors, their intensity level and the relevant coordinate system.

Format: Variable length Data Item.

Structure of first part:

Octet no. 1

8	7	6	5	4	3	2	1
ORG	I1/I2/I3			S1/S2/S3			FX

bit-8 (ORG) = 0 Local coordinates
1 System coordinates

bits-7/5 (I1/I2/I3) = Intensity level (range 0 to 7)

bits-4/2 (S1/S2/S3) = Shading orientation with respect to North:

000 - 0 degrees
001 - 22.5
010 - 45
011 - 67.5
100 - 90
101 - 112.5
110 - 135
111 - 157.5

bit-1 (FX) = 0 End of Data Item
= 1 Extension into first extent

NOTE- For polar vectors bits-4/2 are meaningless and shall be set to zero.

Data Item I009/030, Sequence of Cartesian Vectors

Definition: Sequence of weather vectors in local or system Cartesian coordinates.

Format: Repetitive Data Item, starting with a one-octet Field Repetition Indicator indicating the number of vectors, followed by a series of six-octets (vector components) as necessary.

Structure:

Octet no. 1

56	55	54	53	52	51	50	49
REP							

Octet no. 2 Octet no. 3

48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
X-coordinate															lsb

Octet no. 4 Octet no. 5

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Y-coordinate															lsb

Octet no. 6 Octet no. 7

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

bits-56/49 (REP) = Repetition factor

bit-33 (lsb) = 2exp(-6+f), where f is the scaling factor applied, modifying the standard quantisation unit.
Range:-2exp(9+f)=<X<2exp(9+f) NM.

bit-17 (lsb) = 2exp(-6+f), where f is the scaling factor applied, modifying the standard quantisation unit.
Range:-2exp(9+f)=<Y<2exp(9+f) NM.

bit-1 (lsb) = 2exp(-6+f).
Max. range = 2exp(9+f) NM.

NOTES

1) f shall be incorporated as a parameter in the SOP message.

2) Negative values are expressed in two's complement form.

Data Item I009/060, Synchronisation/Control Signal

Definition: This Data Item provides the serial Step Number.

Format: Variable length Data Item.

Structure of first part:

Octet no. 1

8	7	6	5	4	3	2	1
Step number						0	FX

bits-8/3 = Serial Step Number (range 0 to 59)

bit-2 = Spare bit (always 0)

bit-1 (FX) = 0 End of Data Item
= 1 Extension into first extent

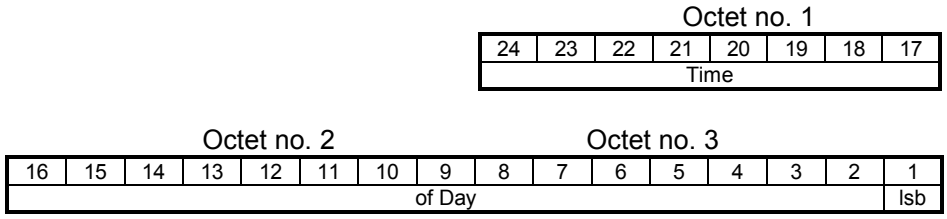
NOTE-

Data Item I009/070, Time of Day

Definition: Absolute time stamping expressed as UTC time.

Format: Three-octets fixed length Data Item.

Structure:



bit-1 (lsb) = 2exp(-7) sec.

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

Data Item I009/080, Processing Status

Definition: Processing status of the Track Server.

Format: Variable length Data Item.

Structure of first part:

Octet no. 1

24	23	22	21	20	19	18	17
f					R		

Octet no. 2 Octet no. 3

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

bits-24/20 (f) = Scaling factor

bits-19/17 (R) = Reduction step

bits-16/2 (Q) = Processing parameters

bit-1 (FX) = 0 End of Data Item
1 Extension into first extent

NOTE- A negative value for the scaling factor (f) is expressed in two's complement.

Data Item I009/090, Radar Configuration and Status

Definition: Current radar configuration and status of all operational radars.

Format: Repetitive Data Item, starting with a one-octet Field Repetition Indicator followed by at least one radar-configuration-and-status field of three-octets length.

Structure:

Octet no. 1

32	31	30	29	28	27	26	25
REP							

Octet no. 2 Octet no. 3

24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9
SAC								SIC							

Octet no. 4

8	7	6	5	4	3	2	1
0	0	0	CP	WO	R1/R2/R3		

bits-32/25 (REP) = Repetition factor

bits-24/17 (SAC) = SAC of radar concerned

bits-16/9 (SIC) = SIC of radar concerned

bits-8/6 = Spare (always 0)

bit-5 (CP) = Circular polarisation

bit-4 (WO) = Weather channel overload

bits-3/1 (R1/R2/R3) = Reduction step in use by radar concerned (range 0 to 5)

NOTE- The defined SAC/SIC codes are listed in chapter 8.

Data Item I009/100, Vector Count

Definition: Total number of vectors defining a complete weather picture.

Format: Two-octets 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
Vector count															

NOTE-