EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

EUROCONTROL STANDARD DOCUMENT

FOR

RADAR SURVEILLANCE
IN
EN-ROUTE AIRSPACE
AND
MAJOR TERMINAL AREAS

SUR.ET1.ST01.1000-STD-01-01

Edition	**:**	**1.0**
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EUROPEAN AIR TRAFFIC CONTROL HARMONISATION AND INTEGRATION PROGRAMME

DOCUMENT IDENTIFICATION SHEET

DOCUMENT DESCRIPTION

Document Title

Radar Surveillance in En-Route Airspace and MAJOR TERMINAL AREAS

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PROGRAMME REFERENCE INDEX	EDITION :	1.0
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Abstract

This Standard contains the requirements for independent (primary) and cooperative independent (secondary) radar surveillance for application in the provision of Air Traffic Services.

The purpose is to contribute to the improvement of the capacity whilst maintaining, or improving, the present level of safety.

Keywords

Surveillance	Radar	Primary	Secondary
Safety	TMA	En-Route	Verification
Performance	Operational		
Requirements	Requirements		

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STATUS		CATEGORY		CLASSIFICATION	
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Proposed Issue	☐	Lower Layer Task	☑	Restricted	☐
Released Issue	☑				

ELECTRONIC BACKUP

INTERNAL REFERENCE NAME : rsurv

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DOCUMENT APPROVAL

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

AUTHORITY	NAME AND SIGNATURE	DATE
SURT Chairman	A. Sunnen	
Director EATCHIP Development	P. Escritt	
EATCHIP Project Leader	W.Philipp	

On the 28th January 1997 the Eurocontrol Permanent Commission adopted this Standard.

DOCUMENT CHANGE RECORD

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

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
1.0	March 1997	Adoption by Eurocontrol Permanent Commission Format changed to align with the other EATCHIP Deliverables.	ALL

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. This document constitutes the Eurocontrol Standard concerning the requirements for independent (primary) and cooperative independent (secondary) radar surveillance for application in the provision of Air Traffic Services (ATS). The purpose of this Standard is to contribute to the improvement of the capacity whilst maintaining, or improving, the present level of safety.

2. As an integral part of Air Traffic Management (ATM), radar positional data constitutes the principal means of surveillance of aircraft for the efficient execution of air traffic control. This Standard details common criteria, with the aim of achieving the optimal use of the radar surveillance function and the harmonised application of radar separation minima, in line with the objectives for radar surveillance as contained in the European Civil Aviation Conference (ECAC) En-Route Strategy for the 1990s adopted by Transport Ministers of ECAC States at Paris in April 1990 and in the EWPD and the EATCHIP Convergence and Implementation Programme Document (CIPD).

3. In accordance with the ECAC En-Route Strategy, comprehensive radar coverage is to be completed throughout the continental ECAC area, which includes the airspace of all ECAC Member States except for Iceland, by 1995 at the latest.   A common en-route radar separation of 5 nautical miles (NM) is to be implemented throughout high-density traffic areas. Elsewhere, en-route radar separation of not more than 10 NM is to be implemented.

4. In accordance with the ECAC Strategy and its related documents (EWPD and CIPD), a common radar separation standard of 3 NM is to be implemented in major terminal areas.

5. In order to ensure the uninterrupted provision of radar services on as wide a scale as possible, and the application of specific radar separation standards, it is essential to have comprehensive and continuous radar coverage of high quality and reliability. This may be achieved either by optimising the use of existing facilities, by installing new radar facilities or by sharing the use of radar stations.

6. Air Traffic Control (ATC) radar facilities within Europe vary from the minimal to state-of-the-art systems, and hence a stepped implementation programme is required with priorities defined according to the most urgent air traffic service requirements. This Standard therefore serves as the basis for the planning and implementation of radar facilities, and for obtaining the required improvements to existing systems. The material deals with state-of-the-art radar systems, though mention is made in context, of future developments.

7.   Target dates for the implementation of new radar equipment or the upgrading of existing radar facilities in accordance with this Standard are provided within the current edition of the CIPD.

The currently proposed overall implementation dates are given in the CIPD as follows:

- basic reference levels implementation by 1995;

- advanced reference levels implementation by 1998.

NOTE -   The definitions of these reference levels are given in the CIPD.

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FOREWORD

1.   Responsible Body

This Standard has been developed jointly by the Radar Applications Specialist Panel (RASP) and the Radar Systems Specialist Panel (RSSP) of the European Organisation for the Safety of Air Navigation (Eurocontrol) and is maintained by the Surveillance Team (SURT) of the European Air Traffic Control (ATC) Harmonization and Integration Programme (EATCHIP).

2.   EATCHIP Work Programme Document

This Standard is identified as deliverable 01 in the EATCHIP Work Programme Document (EWPD), Surveillance Domain, Executive Task 01, Specialist Task 01.

3.   Approval of the Standard

3.1   The Eurocontrol Permanent Commission adopted this Standard in accordance with the procedures outlined in the Directives for Eurocontrol Standardisation Ref. 002 -2 -93.

3.2   This Standard becomes effective from the adoption date of 28th January 1997.

4.   Technical Corrigenda and Amendments

This Standard is kept under review to ascertain required amendments or technical corrigenda. The procedure for the maintenance of this Standard is laid down in Annex H of the Directives for the Uniform Drafting and Presentation of Eurocontrol Standard Documents Ref. 000 - 1- 92.

5.   Editorial Conventions

5.1   The format of this Standard complies with the Directives for the Uniform Drafting and Presentation of Eurocontrol Standard Documents.

5.2   The following practice has been adhered to in order to indicate at a glance the status of each statement:

- Normative Elements have been printed in light face roman;

- *Recommended Elements* have been printed in light face italics, the status being indicated by the prefix **Recommendation.**

5.3   The following editorial practice has been followed in the writing of specifications:

- for Normative Elements the operative verb "shall" is used;

- for Recommended Elements the operative verb "should" is used.

6   Relationship to Other Standard Documents

This Standard is related to:

6.1   Eurocontrol   Standard   for   Radar   Data   Exchange   (ASTERIX)
Ref.: 005 - 93

6.2   International Civil Aviation Organization (ICAO) :

- Annex 5
  "Units of Measurement to be used in Air and Ground Operations"

- Annex 10
  "Aeronautical Telecommunications, Volume I"

- Annex 11
  "Air Traffic Services"

- Doc 4444
  "Rules of the Air and Air Traffic Services"

- Doc 7030
  "Regional Supplementary Procedures"

- Doc 7754
  "Air Navigation Plan - European Region"

7   Status of Annexes to This Standard

The Annexes to this Standard have the following status:

- Annex A - Informative

- Annex B - Informative

- Annex C - Informative

- Annex D - Informative.

- Annex E - Informative

- Annex F - Informative

8   Language Used

The English language has been used for the original text of this Standard.

1.   SCOPE

1.1   This Eurocontrol Standard specifies the essential criteria for radar surveillance in en-route airspace and major terminal areas.

The scope of the requirements pertains to the radar surveillance function for both en-route and major terminal areas, Secondary Surveillance Radar (SSR) code assignment and carriage of transponders.

1.2   The specific requirements for radar surveillance in the final approach phase to aerodromes in major terminal areas are not covered by this Standard.

1.3   This Standard applies to all aircraft except for the performance requirements of the tracker which are limited to the population defined in Annex A.

1.4   Figure 1 shows the relationship between airspace types and services, operational requirements and the surveillance equipment that need to be specified.

1.5   The illustration at Figure 2 gives a technical and functional overview of the radar chain. These functions can be performed using different system layouts. The radar station-to-centre transmission system is not shown.

1.6   The technical performance requirements within this Standard are limited to elements of the radar chain.   The elements involved in the radar chain are SSR transponders, radar sensors, radar data transmission system, radar data processing system, radar data display system. Technical performance requirements for the radar data processing system are limited to the tracking parts only, furthermore, those for the radar data transmission and the radar data display systems are not covered by this Standard.

1.7   The technical performance parameters laid down in this Standard are not intended to describe exhaustively the performance of a radar chain. Only those parameters which are measurable using Eurocontrol agreed analysis methods are included.

1.8   In addition to radar surveillance, other functions make use of data derived from the radar chain, such as:

- flight plan processing;

- code call sign association;

- conflict detection and alert;

- minimum safe altitude warning;

- flight profile calculation.

Performance requirements for radar data to be used by such functions are not taken into account in this Standard.

1.9   An indication of future developments in the field of radar surveillance is given in Annex B.

AIRSPACE TYPES
AND
SERVICES

A 1

A 2

A1 for
EN-ROUTE AIRSPACE

A2 for
TMA AIRSPACE

SENSORS

FPPS

RDPS

CWP

OPERATIONAL
REQUIREMENTS

for A1
A2

PROCESSED
RADAR DATA

BY-PASS

DEGRADED RADAR
DATA MODE

RADAR SENSOR DATA
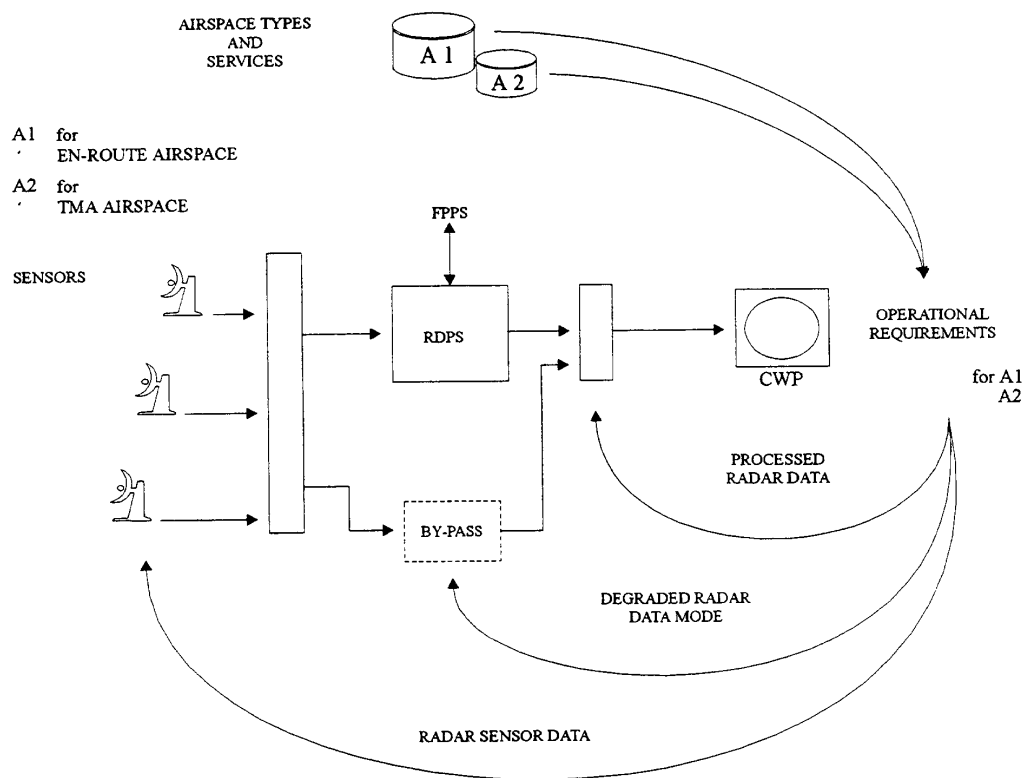
Figure 1 - Relationship between Airspace Types and Services, Operational
Requirements and the Surveillance Equipment.
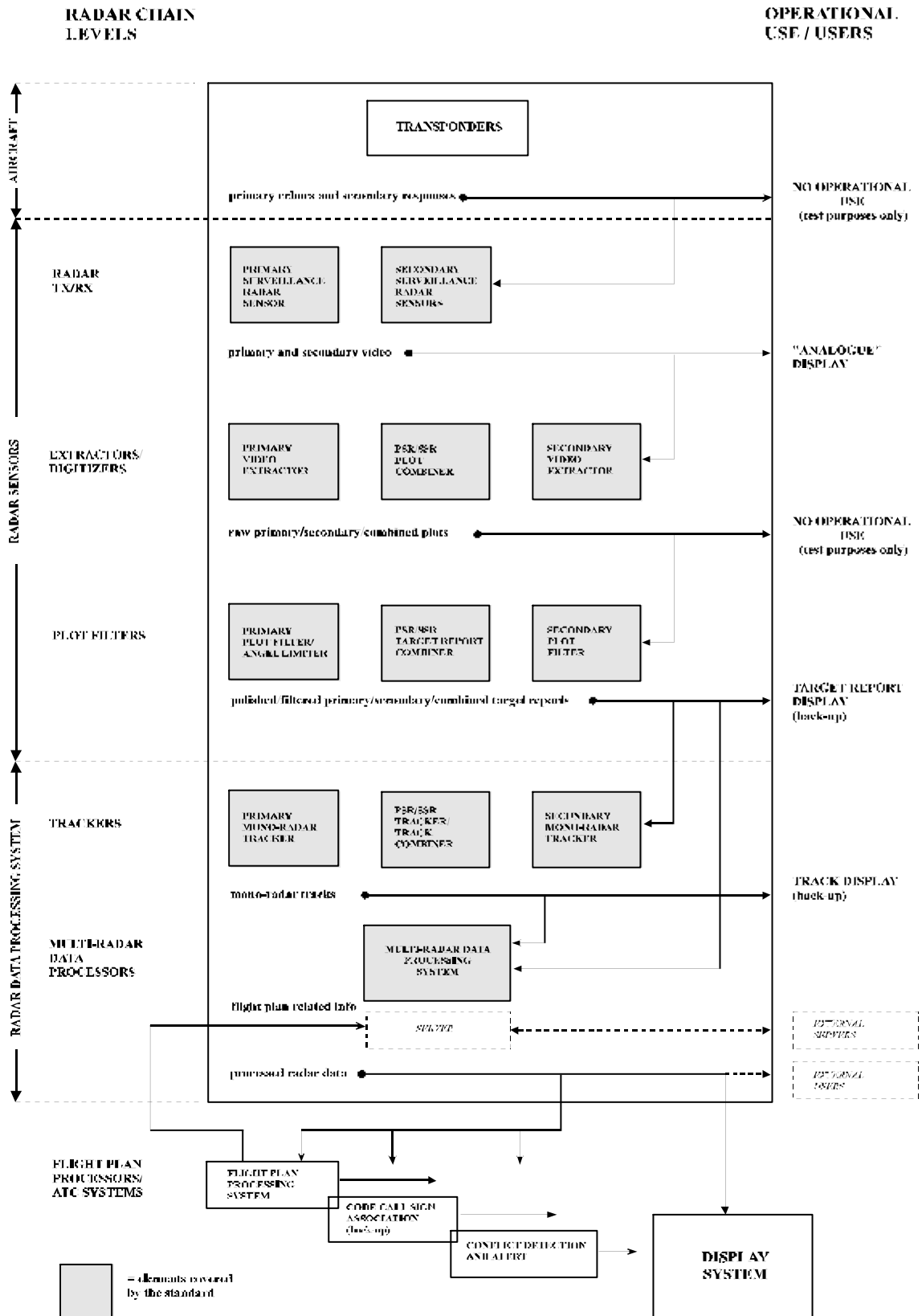
Figure 2 - Technical and Functional Overview of the Radar Chain

2.　　REFERENCES

2.1　　The following documents and standards contain provisions which, through reference in this text, constitute provisions of this Eurocontrol Standard.

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

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

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

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

2.2　　CIPD　　　　　EATCHIP Convergence and Implementation Programme Document. Edition 1, October 1993.

EWPD　　　　　EATCHIP Work Programme Document Level 2. Edition 2, June 1994

Directives for the Uniform Drafting and Presentation of Eurocontrol Standard Documents. Edition 1. Ref. 000 - 1 - 92

Directives for Eurocontrol Standardisation. Edition 1. Ref. 000 - 2 -93

Eurocontrol Standard for Radar Data Exchange (ASTERIX). Ref. SUR.ET1.ST05.2000-STD-01-01

ICAO Annex 5 :　　Units of Measurement to be used in Air and Ground Operations. 4th Edition, July 1979

ICAO Annex 10 :　　Aeronautical Telecommunications - Volume 1. 4th Edition, April 1985. Amendment Level 69

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3. DEFINITIONS, SYMBOLS AND ABBREVIATIONS

3.1 Definitions

For the purposes of this Eurocontrol Standard Document, the following

3.1.1 **Duplicated SSR Coverage:** Duplicated SSR coverage means that for a given point in space, the radar data used by an ATS unit for the surveillance function are derived from at least two independent Secondary Surveillance Radar (SSR) sources working simultaneously.

3.1.2 **En-Route Airspace:** En-route airspace is the volume of airspace outside terminal areas, where the climb, cruise and descent phases of flight take place and within which various types of air traffic services are provided.

3.1.3 **Major Terminal Area:** A major terminal area is the volume of airspace surrounding one or more principal aerodromes. The lateral extent will vary, depending on the disposition of aerodromes within, or adjacent to the terminal area. The vertical dimensions will vary with the way the airspace and the procedures for handling the air traffic flow are organised.

3.2 Symbols and Abbreviations

For the purposes of this Eurocontrol Standard document, the following are used :

ACC	Area Control Centre
ADS	Automatic Dependent Surveillance
AENA	Aeropuertos Espanoles y Navegacion Aerea
AFTN	Aeronautical Fixed Telecommunications Network
ARTAS	ATC Radar Tracker and Server
ASR	Airport Surveillance Radar
ASTERIX	All purpose STructured Eurocontrol Radar Information EXchange
ATARS	Automatic Traffic Avoidance and Resolution System
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATM	Air Traffic Management
ATS	Air Traffic Services
bit	Binary Digit
bps	bits per second
CAA	Civil Aviation Authority
CIPD	EATCHIP Convergence and Implementation Programme Document
CWP	Controller Working Position

dB	Decibels
DDE	Dynamic Data Exchange
Deg	Degrees
DGAC	Director/Directorate General of Civil Aviation
DOS	Disk Operating System
EASIE	Enhanced ATM and Mode S Implementation in Europe
EATCHIP	European ATC Harmonization and Integration Programme
ECAC	European Civil Aviation Conference
EEC	Eurocontrol Experimental Centre
EFP	Spain, France, Portugal
ETA	Estimated Time of Arrival
ETO	Estimated Time Over Significant Point
Eurocontrol	European Organisation for the Safety of Air Navigation
EWPD	EATCHIP Work Programme Document
FAA	Federal Aviation Administration
FDPS	Flight Data Processing System
FIR	Flight Information Region
FL	Flight Level
FPPS	Flight Plan Processing System
FTmn	False Track Length Mean
FTprob	False Track Probability
FTsd	False Track Length Standard Deviation
Gb	Gigabyte (equivalent to 1 073 741 824 bytes)
GTr	Ghost Track Rate
h	Hours
HSM	High Speed Modem
Hz	Hertz
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IOSS	Input-Output Sub-System
IRF	Interrogation Repetition Frequency
IRT	Interrogation Repetition Time
KARLDAP	Karlsruhe Automatic Data Processing System
km	Kilometres
kt	Knots
LAN	Local Area Network

m	Metres
MADAP	Maastricht Automatic Data Processing System
MB	Megabyte (equivalent to 1 048 576 bytes)
MHz	Megahertz (equivalent to 1 million hertz)
min	Minutes
MOF	Mode-of-Flight
ms	Milliseconds
MSAW	Minimum Safe Altitude Warning
MSSR	Monopulse Secondary Surveillance Radar
MURATREC	Multi Radar Trajectory Reconstitution Programme
NM	Nautical Mile
OAT	Operational Air Traffic
OC	Object Correlator
OLDI	On-Line Data Interchange
OM	Ministerial Order
ORCAM	Originating Region Code Assignment Method
PATs	PHARE Advanced Tools
PD	Probability of Detection
PDP	Polar Plot Diagram
PHARE	Programme for the Harmonisation of ATM Research in Eurocontrol
PSR	Primary Surveillance Radar
RADNET	RAdar Data NETwork
RASCAL	Radar Sharing Calculation
RASP	Radar Applications Specialist Panel
RASS-C	Radar Analysis Support System for ATC Centres
RASS-S	Radar Analysis Support System for ATC Sensors
RDPS	Radar Data Processing System
RF	Radio Frequency
RMS	Root Mean Square
RSS	Radar Sub-System
RSSP	Radar Systems Specialist Panel
RTQC	Real Time Quality Control
s	Seconds
SSR	Secondary Surveillance Radar
STCA	Short-Term Conflict Alert
STNA	Service Technique de la Navigation Aerienne
SURT	EATCHIP Surveillance Team

tau	Greek letter representing time
TAR	Terminal Area Surveillance Radar
TCAS	Traffic Alert and Collision Avoidance System
TDr	Track Drop Rate
TIDmn	Track Initiation Delay Mean
TIDsd	Track Initiation Delay Standard Deviation
TMA	Terminal Control Area
TSr	Track Swop Rate
TSS	Traffic Sub-System
TTL	Transistor-Transistor Logic
UAC	Upper Area Control Centre
UNIX	UNiplexed Information and Computing Service
UTC	Coordinated Universal Time
VFR	Visual Flight Rules

4.   GENERAL REQUIREMENTS

4.1   Radar Services

4.1.1   Radar services shall be provided for the separation of aircraft throughout European en-route airspace and in major terminal areas to ensure the efficient handling of increasing traffic volumes in a safe, orderly and expeditious manner.

4.1.2   The performance of the radar surveillance system shall enable the controller to provide a horizontal separation minimum of 5 NM in high density en-route airspace, 10 NM in other en-route airspace and 3 NM in major terminal areas.

> **NOTE** -   High density areas and major terminal areas are identified in the CIPD.

4.1.3   Areas where the volume or characteristics of the traffic do not warrant the provision of radar services to the level of this Standard are eligible for exemptions and shall be identified.

> **NOTE** -   The CIPD is the instrument for the endorsement of the exemptions.

4.1.4   **Recommendation** *The provisions of this Standard should apply for services to Operational Air Traffic (OAT) to the extent necessary for the flexible use of airspace and the joint use of radar facilities in accordance with arrangements agreed between the authorities concerned.*

4.2   Coverage

4.2.1.   In accordance with the ECAC Implementation Objective 1, the radar coverage required to support both terminal and en-route air traffic services shall be:

- EN-ROUTE AIRSPACE :
    - DUPLICATED SECONDARY SURVEILLANCE RADAR COVERAGE
- MAJOR TERMINAL AREA :
    - DUPLICATED SECONDARY SURVEILLANCE RADAR COVERAGE;
    - SINGLE PRIMARY SURVEILLANCE RADAR COVERAGE

> **NOTE -**   The definitions for the above will be found in paragraph 3.1, Definitions.

4.2.2   Areas of low traffic density where different coverage meets the specific local operational requirements for radar services could be eligible for exemption from 4.2.1 and shall be identified.

4.2.3   Areas where duplicated or even single SSR coverage is impossible to achieve
               due to geophysical limitations are eligible for exemption from 4.2.1 and shall be
               identified.

               NOTES

               1.   Examples of geophysical limitations are over the high seas and in the
                      vicinity of mountainous terrain.

               2.   The CIPD is the instrument for the endorsement of exemptions.

4.2.4   In implementing 4.2.1, radar data shall be shared to the maximum practicable
               extent.

4.3   Monopulse SSR

4.3.1   SSR equipment installed in order to fulfil the radar surveillance requirements of
               this Standard or to replace existing equipment shall be of the monopulse type.

4.3.2   **Recommendation** *New Monopulse SSR (MSSR) systems should be capable of
               upgrading to Mode S enhanced surveillance functions.*

               NOTE -   The requirements for Mode S enhanced surveillance functions of a
                            MSSR system are developed in the frame of the Eurocontrol
                            programme " Initial Implementation of Mode S Enhanced
                            Surveillance".

4.4   Radar Data Processing

               Recommendation *The Radar Data Processing System (RDPS), if necessary in
               conjunction with the Flight Plan Processing System (FPPS) should provide:*

               •   *Information to enable the complete display of aircraft trajectories to the
                      controllers, (plot information, track information, vertical position, predicted
                      position, vectors and speed).*

               •   *Data to support conflict detection and alert and minimum safe altitude
                      warning functions.*

               •   *The ability to automatically link aircraft positional data, derived from the
                      use of four digit Mode A SSR codes, with current flight plan data, for
                      display to the controller.*

               •   *Updating of the current flight plan data based on the continual comparison
                      of the aircraft's measured position by radar, and the calculated position
                      based on the flight plan data, for example, to provide an updated estimated
                      time over significant point (ETO) or an estimated time of arrival (ETA). It
                      may also provide warnings of any deviation between the calculated and
                      measured positions.*

               NOTE - This list is not exhaustive.

4.5　　　　　SSR Code Assignment

4.5.1　　　　In order to utilise the radar service provided to the maximum, an efficient and unambiguous code assignment function shall be provided, by which individual Mode A SSR codes are assigned to aircraft, as prescribed in the ICAO Regional Plan.

4.5.2　　　　**Recommendation** *An automated code assignment system should be provided in order to support the management and efficient utilisation of Mode A codes according to the Originating Region Code Assignment Method (ORCAM).*

4.6　　　　　SSR Transponders[1]

4.6.1　　　　For the provision of air traffic control, the surveillance function depends upon the acquisition of the SSR information transmitted by aircraft. The radar chain performances specified in this Standard depend upon correctly functioning transponders. The transponders shall operate within the limits specified in ICAO Annex 10 Volume 1.

4.6.2　　　　**Recommendations**

　　　　　　　1.　Airborne SSR equipment performance should be regularly verified and systematically monitored to ensure that the required functional standards are maintained.

　　　　　　　2.　The conformity of the technical performance of the transponder to ICAO specifications should be verified at the time of renewal of the aircraft Certificate of Airworthiness.

4.6.3　　　　The carriage and operation by aircraft of a transponder with Mode A 4096 Codes and automatic Mode C Pressure Altitude reporting capabilities shall be required for all flights conducted under instrument flight rules (IFR), in accordance with the ICAO European Regional Supplementary Procedures as implemented by National regulations.

4.6.4　　　　**Recommendations**

　　　　　　　1.　The carriage and operation of transponders by aircraft engaged in flights conducted in accordance with the visual flight rules (VFR) is recommended. National regulations should be framed to cater for all the various interests involved, allow for adequate flexibility in application and avoid the imposition of unwarrantable requirements on certain categories of airspace users.

　　　　　　　2.　In the interest of harmonization, regulations governing the carriage and operation of transponders should be decided and implemented, on a wide regional basis, in consultation with operators.

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[1]　　These requirements pertain to Mode A/C transponders. requirements concerning Mode S transponders are published in ICAO Document 7030, paragraph 7.5 on pages EUR/RAC -10 & 11

4.7   **Common Time Reference**

4.7.1   Coordinated universal time (UTC) as specified in ICAO Annex 5 shall be used to
time stamp radar data.

4.7.2   **Recommendation**   *Time Systems used for time stamping radar data should be
synchronised to a common standard UTC source operating to an accuracy of +/-
5ms.*

5. OPERATIONAL REQUIREMENTS

5.1 Coverage Requirements

5.1.1 General

5.1.1.1 Comprehensive and continuous radar coverage of high quality and reliability shall be constantly available in order to achieve radar operational separations of 3 NM, 5 NM and 10 NM.

> **NOTE -** Those defects in the radar coverage which do not hinder the provision of radar services are acceptable, e.g. gaps.

5.1.1.2 Radar stations shall be sited so that the zenithal gap in the radar coverage is either contained within the coverage of an adjacent radar, or is located so that the zenithal gap does not reduce the operational effectiveness of the radar service.

5.1.2 Major Terminal Areas

5.1.2.1 Duplicated secondary and single primary surveillance radar coverage shall be provided within major terminal areas. This combination assures the continuous availability of radar position information and enables provision of air traffic services to aircraft unable to respond to SSR interrogations.

5.1.2.1 The coverage within major terminal areas shall extend from the lowest altitudes of the intermediate approach segments for the principal aerodromes concerned. Coverage elsewhere will extend from the minimum levels at which radar services are required to be provided, up to the upper limit of the terminal area.

> **NOTE -** The coverage requirements below the lowest altitudes of the intermediate approach segments can be met in accordance with local aerodrome conditions, provided continuity of services for the major terminal area is ensured.

5.1.2.3 Provision shall be made for the continuity of radar coverage in the areas interfacing with en-route airspace.

5.1.3   En-Route Airspace

5.1.3.1   Except as provided for in 4.2.2 and 4.2.3, in en-route airspace, duplicated SSR coverage shall extend both from the minimum cruising levels up to the highest IFR cruising levels, and where radar services are required to be provided. Exemptions are detailed in sub-paragraphs 4.2.2 and 4.2.3.

5.1.3.2   The horizontal extent of the coverage shall be to at least 30 NM beyond the area of responsibility of the relevant Area Control Centre (ACC), except where this is impossible to achieve due to geographical limitations.

> **NOTE -**   Overlapping radar coverage in the areas of responsibility of adjacent air traffic control centres, or radar sharing, is a prerequisite for the systematic transfer of radar control of aircraft from one ACC to another while maintaining the required level of separation.

5.1.4   Shared Use of Radar Data

5.1.4.1   Radar surveillance data from existing or new radar equipment shall be shared wherever it is practically possible and advantageous, in particular across neighbouring Flight Information Regions (FIR) boundaries.

> **NOTES**
>
> 1.   Sharing of radar data can be done on two levels, either at the level of target reports or at the level of processed data.
>
> 2.   Radar sharing will not only limit the costs of implementation, but will also avoid technical problems such as over interrogation. This will also enable the provision of coherent data for transfer between adjacent units.

5.1.4.2   **Recommendation**   *Some ATS units may have access to more comprehensive data processing systems than neighbouring subsidiary civil or military units. Where such a situation exists, means of providing the processed data from the main to the subsidiary units should be considered.*

5.1.4.3   Establishment of an Agreement for the sharing of radar data shall be made using the Eurocontrol agreed guidelines.

> **NOTES**
>
> 1.   A requirement for Eurocontrol guidelines has been identified.
>
> 2.   These guidelines could also be used on a national basis for the shared use of civil and military radars.
>
> 3.   Two examples of   International Administrative Agreements relative to the shared use of radar coverage are shown in Annex C.

5.2 **Radar Surveillance Data Requirements**

5.2.1 The radar surveillance system shall provide the following information to be available for display to air traffic controllers:

- aircraft horizontal position and history;

- aircraft identification;

- aircraft vertical position;

- specific indication of Mode A special codes (i.e. 7500,7600,7700);

- ground speed;

- status of the Track whether it is primary, secondary, combined or extrapolated.

NOTE - Aircraft are identified by the code/callsign association using flight plan related data. Only when the code/callsign association is not possible will the SSR Mode A code be used.

5.2.2 **Recommendations**

1. Although map information is not radar surveillance derived data it should be available for display at all times to the controller for the proper provision of radar services.

2. The following additional information should be available for display to the controller:

   − *recognition of additional special purpose Mode A codes;*

   − *track prediction vectors.*

NOTES

1. Additional flight information such as aircraft type, wake turbulence category, departure/destination aerodrome and routing may be displayed to the controller.

2. An indication of significant weather may be displayed to the controller.

3. The display of this data depends upon the specific requirements of the appropriate authority.

4. When Short-Term Conflict Alert (STCA) and Minimum Safe Altitude Warning (MSAW) are in operational use, it is expected that the relevant warnings are displayed to the controller.

5.2.3 The positional accuracy of the surveillance radar data available, at the control position, shall have an error distribution with a root mean square (RMS) value equal to or less than 500 metres (m) for en-route airspace and equal to or less than 300 metres (m) for major terminal areas.

5.2.4   Surveillance information updates shall enable the display updates to be no more than 5 seconds (s) for major terminal areas, and no more than 8 seconds (s) in en-route airspace. A maximum of 2 successive updates by extrapolation is acceptable for positional data.

5.2.5   Mode C shall not be extrapolated for display.

5.2.6   The radar surveillance infrastructure shall support the requirements in 5.2.

NOTE -   This can be achieved in a variety of ways:

−   high performance sensors;

−   the combination of information from co-located sensors (combined secondary and primary radar target reports);

−   the combination of the information from sensors in different locations (independent of the terminal area or en-route function) by the processing of multiple radar inputs;

−   high performance multi-radar tracking.

5.3   Radar Surveillance Data Availability Requirements

5.3.1   The following data are categorised as full and essential for the purposes of specifying the data availability requirements.

5.3.1.1   Full data are :

•   aircraft horizontal position and history;

•   aircraft identification;

•   aircraft vertical position;

•   specific indication of Mode A special codes (i.e. 7500,7600,7700);

•   ground speed;

•   status of the Track whether it is primary, secondary, combined or extrapolated.

5.3.1.2   Essential data are:

•   aircraft horizontal position and history;

•   aircraft identification or Mode A code;

•   aircraft vertical position.

NOTE -   Essential data for major terminal areas may not necessarily require the availability of Primary Surveillance Radar (PSR) data.

5.3.2   The radar surveillance data availability requirements are:

- full data availability shall be not less than 0.995, excluding periods of scheduled maintenance;

- essential data availability shall be not less than 0.99999;

- PSR data availability for major terminal areas shall be not less than 0.995.

5.3.3   The availability of radar surveillance data in full and reduced system performance status and maximum outage times shall be as given in Table 1.

NOTES

1.   Full performance means that all elements and functions of the radar chain are operating normally to the performance requirements of this Standard.

2.   Reduced performance means that the performance of some element of the radar chain is below full performance. Depending on the circumstances, the provision of a radar service may or may not be affected.

Table 1 - Radar Surveillance Data Availability

System Status	Availability (Equivalent Annual Outage* Time)	Maximum Instantaneous Outage* Time
Full Data / Full Performance	0.995 (44 h)	4 h
Full Data / Reduced Performance	0.999 (9 h)	10 min
Essential Data	0.99999 (6 min)	10 s

 NOTES
1.   The availability figures given above exclude all scheduled maintenance, all scheduled non-operational hours and "force majeure" events.
2.   The availability of the display system is not taken into account.

*   Outage time means the time that the system is not available. That means, for example, that the maximum allowed time for there to be no essential data is 6min per year and 10 seconds instantaneous.

5.3.4   **Recommendation**   *Technical measures should be employed to ensure graceful degradation of the system from full to reduced performance.*

> **NOTE** -   Graceful degradation at the radar sensor level can be achieved by using e.g. parallel transmitter power amplifiers and distributed processing techniques.

5.3.5   The performance of the display system shall be such that it will not degrade the quality of the surveillance data to the point of having an effect on the provision of a radar service.

5.3.6   Warnings of significant failures within the radar chain, which may have an impact on flight safety and provision of air traffic services, shall be provided at the relevant control positions.

5.3.7   Scheduled maintenance programmes which affect the provision of air traffic services shall be agreed and coordinated between ATS unit operational and technical staff and, when relevant, between adjacent ATS units.

5.3.8   **Recommendation**   *Scheduled maintenance should not exceed 24 hours over a period of 3 months.*

5.3.9   The radar surveillance infrastructure shall support the availability requirements in 5.3

> **NOTE** -   This can be achieved in a variety of ways:
>
> –   duplicating the sensors;
>
> –   automatic switch-over facilities to an autonomous (back-up) radar station;
>
> –   the introduction of additional radar stations;
>
> –   "back-up" facilities;
>
> –   direct access radar channels;
>
> –   use of processed radar data from another source (e.g. a central server).

5.3.10   The system architecture shall ensure that the failure of a single element in the radar chain will not seriously reduce ATC system capacity.

5.4 System Recording and Replay Facilities

5.4.1 Radar surveillance data supplied to the display system shall be recorded continuously.

> **NOTE -** Recording and replay facilities are required for incident and accident investigation, search and rescue support, noise abatement, training, technical analysis and statistics.

5.4.2 **Recommendation** *The recording medium and mechanism should be such that a complete reconstruction of the surveillance data presentation, display settings and selections can be produced at the controller's display position.*

5.4.3 Administrative procedures shall be established for the retention and utilisation of these recordings for analysis.

5.4.4 **Recommendation** *Radar data recordings should be retained for at least 30 days.*

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6.   PERFORMANCE REQUIREMENTS FOR INDIVIDUAL RADAR SENSORS

6.1   Sensor Performance Description

6.1.1   Radar coverage within a specified airspace shall be defined as being achieved when the detection, quality and availability performance requirements are satisfied.

NOTES

1.   The performance requirements set out below are based on experience in the evaluation of existing radars on various sites, in different European countries, with different configurations, with different types of opportunity traffic and with different measurement methods. Full details of all the source material used in the determination and derivation of the performance requirements in this section are given in Annex D - Supporting Documentation.

2.   The performance requirements stated in 6.3.2, 6.3.3, 6.4.2, 6.4.3 and 6.5 are currently recommended figures as commonly agreed measurement methods and tools are not yet available. When methods and tools have been agreed, normative figures will be specified.

3.   It is expected that the normative figures will differ only slightly from the currently recommended figures.

4.   The performances stated are related to target reports at the output of the radar station providing measured radar data after reduction of false data using mono-radar processing techniques (see Section 1, Figure 2: polished/filtered primary/secondary/combined target reports).

5.   It is accepted that the performance requirements for PSR may not be satisfied in case of very severe weather conditions or anomalous propagation conditions.

6.1.2   Maximum range requirements, antenna turning rate and location of the installation shall be determined by the required main operational use (major terminal area or en-route) of the facility.

> **NOTE** -   Coverage is mainly dependent upon the siting, the antenna type, the transmitted power, the pulse repetition frequency, the receiver/ extractor/ processing, and for SSR sensors, the interrogation rate and the performance of aircraft transponders.

6.2   **Sensor Performance Characteristics**

6.2.1   **General**

6.2.1.1   The characteristics hereafter shall apply to both PSR and SSR except where specifically mentioned otherwise.

    NOTES

    1.   For each characteristic the parameter(s) to be used is(are) given as well as the practical method used to measure this(these) parameter(s).

    2.   The principle on which these measurement methods are based is that for a given aircraft trajectory a reference trajectory using track continuity properties is reconstituted *a posteriori* from recorded target reports. The recorded reports are assessed against the expected reports of the reference trajectory, as defined by the measurement method.

6.2.1.2   "Overall", when used, means that the measurement method shall be applied without geographical restrictions to the whole sample of the recorded data obtained from opportunity traffic.

6.2.1.3   The sample taken shall be representative of the whole population of aircraft to which air traffic services are provided, irrespective of radar cross sections and clutter environments for PSR sensors, and irrespective of transponder deficiencies for SSR sensors.

6.2.2   **Detection**

6.2.2.1   **General**

    For the detection capability the following performance indicators shall be used:

- target detection;

- target horizontal position determination;

- false target reports;

also for SSR only:

- multiple target reports;

- code detection (identification and height).

    NOTE -   Due to the design of current radar systems all surveillance target data output includes position information; there are no detected targets that do not have this information included. Therefore the performance indicators **target detection** and **target position** when measured will yield identical results. They can therefore be considered to be replaced by a single performance indicator **target position detection.**

6.2.2.2 **Target Position Detection**

6.2.2.2.1 The target position detection performance shall be expressed by the overall probability of detection.

> **NOTE** - Probability of detection is the probability that for a given aircraft, at each scan, a radar target report with positional data is produced.

6.2.2.2.2 The probability of detection shall be determined by the ratio of the number of target reports to the total number of expected reports, as defined by the measurement method.

6.2.2.3 **False Target Reports**

6.2.2.3.1 SSR target reports generated by one or more of the following shall be classified as false target reports:

- asynchronous fruit;
- synchronous fruit;
- second time around replies.

NOTES

1. "Fruit" are replies received by a radar station generated by an aircraft transponder replying to an interrogation from a different radar station;

2. asynchronous fruit is generated if the interrogation repetition times (IRT) of the two stations are different;

3. synchronous fruit is generated if the IRT are identical;

4. "Second time around replies" are generated by an aircraft situated at a distance beyond the maximum range defined by the IRT of the receiving radar station.

6.2.2.3.2 The performance shall be expressed by the overall false target report ratio.

> **NOTE -** The false target report ratio is the number of false target reports in relation to the number of detected target reports.

6.2.2.3.3 False PSR target reports shall include those reports generated by:

- aircraft returns received through sidelobes of the antenna pattern;
- aircraft returns received during one scan of the antenna main beam through the target and split in several sequences either in azimuth or in distance;
- aircraft returns with large positional errors.

> **NOTE -** False PSR target reports may also be generated by weather, terrain, noise, clutter and other reflecting objects

6.2.2.3.4   The performance shall be expressed by the average number of false target reports per antenna scan.

6.2.2.4   **Multiple SSR Target Reports**

6.2.2.4.1   Multiple SSR target reports shall include all those reports generated by:

- replies from an aircraft interrogated by the radar station via an indirect path (reflection);

- replies from an aircraft interrogated through a sidelobe of the directional antenna pattern and which are not inhibited by the sidelobe suppression antenna pattern (sidelobes);

- replies from an aircraft received during one scan of the antenna main beam through the target and split in several sequences, either in azimuth or in distance (splits).

6.2.2.4.2   Performance shall be expressed by overall multiple SSR target report ratio and multiple SSR target report ratio classified by type, as shown in 6.2.2.4.1.

6.2.2.4.3   The multiple target report ratio shall be the number of multiple target reports in relation to the number of detected target reports.

6.2.2.5   **Code Detection**

6.2.2.5.1   The code detection performance shall be expressed by:

- overall Mode A probability of code detection;

- overall Mode C probability of code detection.

6.2.2.5.2   Probability of code detection shall be the probability that, at each scan, for a given aircraft, a radar target report with correct validated code data, corresponding to the interrogation modes, is produced.

6.2.2.5.3   The probability of Mode A/Mode C code detection shall be determined by the ratio of the number of target reports with correct Mode A/Mode C code data to the number of target reports used to calculate the target position detection.

6.2.3   **Quality**

6.2.3.1   **General**

The quality of the data provided shall be expressed by the following characteristics:

- positional accuracy;

- false code information;

- resolution.

6.2.3.2   **Positional Accuracy**

6.2.3.2.1   The positional accuracy performances shall be expressed in terms of positional errors categorised as follows:

- systematic errors;

- random errors;

- jumps.

NOTES

1. Positional accuracy is the measure of the difference between the position of a target as reported by the sensor and the true position of the target at the time of detection.

2. "Jumps" are target reports with positional errors higher than 1° in azimuth or 700 m in range.

6.2.3.2.2   Performance for systematic errors shall be expressed by:

- slant range bias;

- slant range gain error;

- azimuth bias;

- time stamp error.

NOTE -   Time stamp error is the constant time difference between the time system used for plot detection time stamping and a common reference time.

6.2.3.2.3   Performance for random errors shall be expressed by:

- slant range error standard deviation;

- azimuth error standard deviation.

NOTE -   Performance for height errors is provided by performance for false Mode C code information.

6.2.3.2.4   Performance for jumps shall be expressed by the overall ratio of jumps.

NOTES

1. The ratio of jumps is the number of jumps in relation to the number of detected target reports.

2. PSR jumps are considered within false target reports (see 6.2.2.3)

6.2.3.3   **False Code Information**

Performance for false code information shall be expressed by:

- overall false codes ratio;

- validated false Mode A codes ratio;

- validated false Mode C codes ratio.

NOTES

1.   Code information is considered as false, if in a target report, code information is provided which has been wrongly accepted as correct by the system (validated data).

2.   The false code information ratio is the number of target reports with false codes in relation to the number of detected target reports with code information.

6.2.3.4   **Resolution**

6.2.3.4.1   The resolution performance shall be expressed by the probability of target position detection and in addition, for SSR the probability of code detection.

> **NOTE** -   The resolution is the capability of the sensor to discriminate between two aircraft in close proximity and to produce target reports for both. The probability of detection is applicable to each individual aircraft.

6.2.3.4.2   Aircraft shall be considered in close proximity when their distance in slant range and azimuth is within the following limits:

- SSR:
  slant range: ≤ 2 NM
  azimuth: ≤ 2 x nominal 3 dB interrogation beamwidth

- PSR:
  slant range corresponding to: ≤ 2 x nominal (compressed) pulse width
  azimuth: ≤ 3 x nominal 3 dB beamwidth

> **NOTE** -   The 3 dB beamwidth is the azimuth extent of the horizontal main beam pattern for the antenna, PSR or SSR, as measured between the two points that are 3 dB below the peak of the horizontal main beam pattern. The measurement of the horizontal pattern being made at the elevation angle that corresponds to the vertical main beam peak.

6.2.4 **Availability**

6.2.4.1 The availability of the data shall be expressed by the following characteristics:

- maximum outage time due to any given failure;

- cumulative outage time due to all failures over a period of one year;

- outage times due to scheduled actions.

6.2.4.2 A sensor shall be considered unavailable if no radar target reports, including field monitor(s) are produced for more than 2 antenna scans.

6.2.4.3 **Recommendation** *The assessment of the sensor availability should be made using means to obtain confirmation of system status and operation to the level of performance required by this Standard.*

NOTES

1. Non availability due to "force majeure" events (e.g. lightning strike, exceptional winds, fire), or due to a major antenna system breakdown (e.g. replacement of the antenna), is not considered.

2. The availability performance requirements stated in this part of the document apply if the minimum number of radar stations necessary to fulfil the overall operational requirements are used for the radar surveillance function. Lower availability may be acceptable where a greater number of radar stations contribute, provided the overall operational availability requirements are satisfied.

6.2.5 **PSR/SSR Data Combining**

Performance for PSR/SSR data combining shall be defined by:

- overall probability of association;

- overall false association rate.

NOTES

1. PSR/SSR data combining is the capability of the radar system to associate at each antenna scan the target reports of the same aircraft detected by the two sensors and to combine these reports into a single target report.

2. The probability of association is determined by the ratio of the number of combined target reports in relation to the number of total expected combined reports, as defined by the measurement method.

3. The association is defined as false, if the target reports from two unrelated targets detected by the two sensors have been associated.

4. The false association rate is the number of combined target reports resulting from a false association in relation to the total number of combined target reports.

5.   If this function is performed at the centre level, the same performance requirements apply.

6.2.6 On-Site Processing Delay

The target report on-site processing delay shall be the time expressed in seconds between the moment a radar target for a given aircraft is detected and the moment when the corresponding report starts to be transmitted (see 6.1.1 note 4).

6.3 **Performance Requirements for SSR Sensors**

6.3.1 **General**

Recommendation   *The SSR sensors should satisfy the performance requirements detailed in 6.3.2 and 6.3.3 below.*

NOTE -   The currently recommended figures are considered to be relevant to monopulse SSR systems.

6.3.2 **Detection Requirements**

6.3.2.1 **Target Position Detection**

Overall probability of detection: *> 97 %*

6.3.2.2 **False Target Reports**

Overall false target report ratio: *< 0.1 %*

6.3.2.3 **Multiple SSR Target Reports**

Overall multiple SSR target report ratio: *< 0.3 %*

Multiple SSR target report ratios:

    –   *from reflections :*   *< 0.2 %*

    –   *from sidelobes :*   *< 0.1 %*

    –   *from splits :*   *< 0.1 %*

6.3.2.4 **Code Detection**

Overall Mode A probability of code detection: *> 98 %*

Overall Mode C probability of code detection: *> 96 %*

6.3.3 Quality Requirements

6.3.3.1 Positional Accuracy

Systematic errors:

- *slant range bias:*   *< 100 m*
- *azimuth bias (degree):*   *< 0.1°*
- *slant range gain error:*   *< 1 m/NM*
- *time stamp error:*   *< 100 ms.*

Random errors (standard deviation values):

- *slant range:*   *< 70 m*
- *azimuth (degree):*   *< 0.08°*

Jumps:

- *overall ratio of jumps:*   *< 0.05 %*

6.3.3.2 False Code Information

- *Overall false codes ratio:*   *< 0.2 %*
- *Validated false Mode A codes:*   *< 0.1 %*
- *Validated false Mode C codes:*   *< 0.1 %*

6.3.3.3 **Resolution**

The resolution requirements are given in Table 2.

Table 2 - Resolution Requirements

Area	1	2	3
Probability of target position detection	*>98%*	*> 98%*	*> 60%*
Probability of correct code detection	*>98%*	*> 90%*	*> 30%*

The different areas are shown below:

$\mathbf{Dr}$(NM)
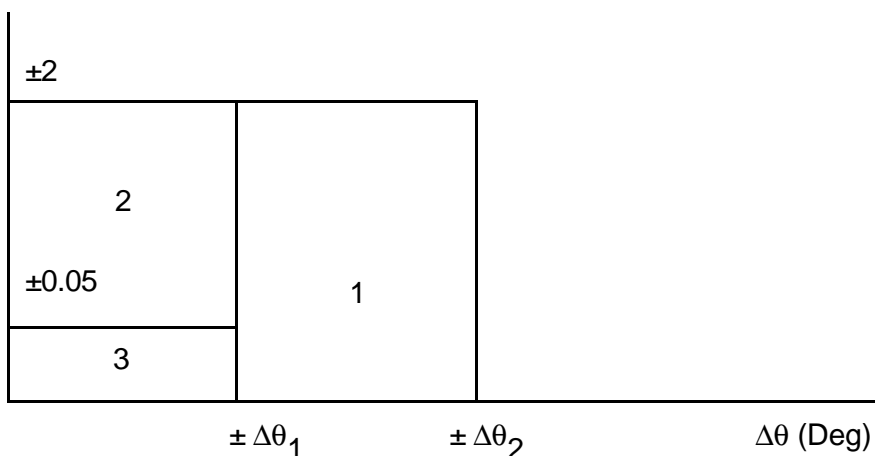
$\Delta\rho$, $\Delta\theta$ are the differences of the two aircraft true positions in slant range and azimuth.

$\Delta\theta_2$ = 2 x nominal 3 dB interrogation beamwidth.

NOTES

1. The figures of Table 2 correspond to performances averaged over the whole considered area.

2. These figures can be achieved when operating under the following conditions:

    –   number of SSR interrogation mode (n) :   2

    –   interrogation repetition frequency (f) :   240Hz

    –   antenna rotation time (t) :   10s

    –   100% reply detection

    –   same azimuthal extension for both aircraft.

    –   a typical value of $\Delta\theta_1$ is to be expected at 0.6^o

    – $\Delta\theta_1$ is obtained by the following formula: $\Delta\theta_1 = \dfrac{2 \times n \times 360}{f \times t}$

3. Improved performances independent from operating conditions are expected when making full use of monopulse derived data.

6.3.4   Availability Requirements

6.3.4.1   The requirements for outage time availability shall be as follows:

*   Maximum outage time ≤ 4 hours

*   Cumulative outage time ≤ 10 hours / year.

6.3.4.2   Outage times due to scheduled actions shall be agreed with the users on a case by case basis.

6.3.4.3   **Recommendation**   *Although different station configurations and different maintenance strategies are possible to achieve the availability requirements, the following should be applied as a minimum:*

*   *a single highly reliable antenna system with a mean time between major breakdowns of at least 40 000 hours;*

*   *duplicated electronics including extractors and processing units with automatic failure detection and switch-over to be achieved within 2 seconds;*

*   *a local or remote monitoring and control unit for localising of the failing sub-unit within 0.5 hours and replacing failed duplicated units, if possible, within 24 hours;*

*   *at least one field monitor equipment to be used for failure detection and permanent alignment monitoring.*

6.3.5 **SSR Interrogation Frequency Plan**

6.3.5.1 The Interrogation Repetition Frequencies (IRF) used shall be coordinated, for all users, between the responsible authorities, both within States and between adjoining States to at least the following standards.

6.3.5.2 An SSR shall be based on the following rules:

- stagger to be applied to the nominal IRF;

- any two stations with adjoining or partially overlapping cover to use IRF's that are separated by at least one Hertz (Hz);

- no stations to use an IRF which is either a multiple or submultiple of the IRF used by any other station with adjoining or partially overlapping cover.

NOTE - Application of the above rules reduce the risk of:

– false targets from synchronous fruit and second time around replies;

– loss of detection through synchronous capture.

6.4 **Performance Requirements For PSR Sensors**

6.4.1 **General**

Recommendation *PSR sensors should satisfy the performance requirements detailed in 6.4.2 and 6.4.3 below.*

6.4.2 **Detection Requirements**

6.4.2.1 **Target Position Detection**

Overall probability of target position detection: *> 90 %*

6.4.2.2 **False Target Reports**

Average number of false target reports per antenna scan: *< 20*

6.4.3 Quality Requirements

6.4.3.1 Positional Accuracy

Systematic errors:

- *slant range bias:*   *< 100 m*
- *azimuth bias:*   *< 0.1°*
- *slant range gain error:*   *< 1 m/NM*
- *time stamp error:*   *< 100 ms.*

Random errors (standard deviation values):

- *slant range (m):*   *< 120 m*
- *azimuth (degree):*   *< 0.15°*

6.4.3.2 Resolution

6.4.3.2.1 *The detection probability of the positions of both targets will be identical to the detection probability of an isolated target if either their corresponding difference in slant range is > 2 x nominal (compressed) pulse width <u>or</u> the difference in azimuth is > 3 x nominal 3 dB beamwidth.*

6.4.3.2.2 *The area in which no resolution capabilities are required is defined by a corresponding difference in slant range < 1.5 x nominal (compressed) pulse width <u>and</u> a difference in azimuth < 1.5 x nominal 3 dB beamwidth.*

6.4.4 Availability Requirements

6.4.4.1 Requirements for outage time availability shall be as follows:

Maximum outage time :   ≤4 hours

Cumulative outage time :   ≤ 40 hours / year

> **NOTE -** The availability performance requirements stated in this part of the document apply if the minimum number of radar stations necessary to fulfil the overall operational requirements are used for the radar surveillance function. Lower availability may be acceptable where a greater number of radar stations contribute, provided the overall operational availability requirements are satisfied.

6.4.4.2 Outage times for scheduled technical activities shall be agreed with the users on a case by case basis.

6.4.4.3   **Recommendation**   *Although different station configurations and different maintenance strategies are possible to achieve the availability requirements, the following should be applied as a minimum:*

- *a single highly reliable antenna system with a mean time between major breakdowns of at least 40 000 hours;*

- *duplicated electronics including extractors and processing units with automatic failure detection and switch-over to be achieved within 2 seconds;*

- *a local or remote monitoring and control unit for localising of the failing sub-unit within 0.5 hours and replacing failed duplicated units, if possible within 24 hours.*

6.5   PSR/SSR Data Combining

Recommendation   *The plot combination function may be carried out at either the PSR or the SSR and should satisfy the performance requirements below:*

- *Overall probability of association :*   *³ 95%.*

- *Overall false association ratio :*   *£ 0.1%.*

6.6   Transmission of Target Reports

The transmission of target reports shall be in accordance with the Eurocontrol Standard for Radar Data Exchange (ASTERIX).

6.7   On-Site Processing Delay

The maximum target report delay shall be: $\leq$ 2 seconds

7. PERFORMANCE REQUIREMENTS FOR RADAR DATA PROCESSING

7.1 Radar Data Processing Performance Description

7.1.1 The radar data processing system (RDPS) shall be able to receive and process radar target reports from all radar sensors required to fulfil the radar surveillance requirements.

> **NOTE** - Radar data processing is defined as an element in the radar chain situated between the radar sensors and the users of processed radar data.

7.1.2 Performance requirements shall be limited to the tracking part of the radar data processing.

> **NOTE -** The performance requirements figures are presently only guidance but will migrate to normative as methods and tools become available.

7.1.3 When the tracking function is partially performed at the radar station, the same appropriate performance requirements shall apply.

> **NOTE** - It is assumed that errors induced from parts of the processing elements not covered by this Standard (e.g. coordinates transformation) do not compromise the required operational performances.

7.2 Tracking Performance Characteristics

7.2.1 General

The tracking performance requirements shall be expressed by the following characteristics:

- track initiation;
- track continuity;
- track data accuracy.

7.2.2   **Track Initiation**

             Recommendation *Track initiation performances should be expressed
by:*

- *track initiation delay mean (TIDmn) in seconds or scans;*

- *track initiation delay standard deviation (TIDsd) in seconds or scans;*

- *false track probability (FTprob) by tracks/false target report.*

NOTES

1.   **Initiation delay** is the time or number of scans between the moment the
     first target report of an object is received by the tracker and the first moment
     of availability of a track-state vector corresponding with that object at the
     output of the Tracker. Objects may be aircraft, birds or cars.

2.   **False tracks** are tracks started on false target reports, originated inter alia
     by measurement noise or clutter in the case of PSR, or by multiple target
     reports in the case of SSR.

7.2.3   **Track Continuity**

             Recommendation *Track continuity performances should be expressed
by:*

- *track drop rate (TDr);*

- *track swop rate (TSr);*

- *ghost track rate (GTr);*

- *false track length mean (FTmn);*

- *false track length standard deviation (FTsd).*

NOTES

1.   **Track drop** is defined as the situation in which, while the object is still inside
     the radar coverage area, the track is stopped.

2.   **Track swop** is defined as the situation that a track is continued with target
     reports corresponding to a different object.

3.   A **ghost track** is defined as a track that was initiated on object target reports
     and, for some reason or another, continued with non-object target reports.
     This parameter applies to primary radar only tracks.

7.2.4   **Accuracy**

7.2.4.1   **Recommendation** *Accuracy performances should be given for:*

- *position;*

- *ground speed;*

- *course;*

- *vertical speed.*

taking into account the following types of aircraft motions:

- *uniform motion;*

- *standard turn;*

- *uniform speed change;*

- *uniform climb/descent.*

as well as the transitions between these types of motions.

NOTES

1.   The characteristics of the different types of aircraft motions are given as informative material in Annex A.

2.   The accuracy of the track-state vector elements is described by RMS errors.

3.   Positional errors are expressed as along-and-across-trajectory position RMS errors.

7.2.4.2   During transitions between different types of motions, the performances shall be described by the peak value of the error and the time (tau) required to decrease from the peak value to a value equal to a fraction of this peak value above the value of this type of motion.

7.3   **Availability**

7.3.1   The availability of the processed radar data shall be expressed by the following characteristics:

- maximum outage time due to any given failure;

- cumulative outage time due to all failures over a period of one year;

- outage times due to scheduled actions.

7.3.2   The radar data processing system shall be considered   unavailable if no processed radar data is produced for more than one time interval between information updates on the display.

7.4   **Tracking Performance Requirements**

The tracking performance requirements shall be developed in accordance with the characteristics defined in 7.2.

NOTES

1. Performance values based on results of simulations are given as informative material in Annex E. The specific scenarios used are assumed to be representative of the whole population of aircraft to which air traffic services are provided in all kinds of circumstances and in all parts of the concerned airspace.

2. It is the future intention to consolidate these tracking performance requirements when actual values are available

7.5   **Availability Requirements**

7.5.1   The requirements for outage time availability shall be as follows:

- Maximum outage time: $\leq$ 10 mins

- Cumulative outage time: $\leq$ 9 hours / year.

7.5.2   Outage times due to scheduled actions shall be agreed with the users on a case by case basis.

7.5.3   **Recommendations**

1. *In case of total failure of a part of the equipment, failure detection and switch-over to standby equipment should be achieved in less than one time interval between information updates of the display.*

2. *In case of total failure of the complete radar data processing system, users should be provided with radar data obtained directly from the radar stations.*

8. PERFORMANCE VERIFICATION REQUIREMENTS[1]

8.1 General

8.1.1 Performance verification of the various elements of the radar chain shall be made using procedures and analysis methods agreed within the Eurocontrol organisation.

> **NOTE** - A requirement for comprehensive Eurocontrol Standards for radar data performance analysis has been identified. Account will be taken of the latest issue of all ICAO Documents relevant to this subject.

8.1.2 The performances of the radar chain shall be verified prior to making operational use of the radar data.

8.1.3 The performances of the radar chain shall be re-assessed at regular intervals. This re-assessment can be made either by permanent monitoring (real-time quality control) or by annual performance measurements campaigns.

> **NOTE** - Performances may alter over time, for example, due to changing environmental conditions or ageing of equipment.

8.1.4 Changes in operational requirements or replacement of any element of the radar chain, which may have an impact on radar data quality shall require re-verification of performance.

8.2 Verification Process

8.2.1 General

The following three elements shall be specified for the verification process:

- the data to be used;
- the measurement methods to be used;
- the tools to be used.

---

[1] This Section is providing general performance verification requirements. Reference is made, where appropriate, to the bodies in charge of the measurement methods and tools.

8.2.2 **Data**

8.2.2.1 The data to be used for performance verification shall be live radar data obtained from opportunity traffic or from special test flights.

> **NOTE** - Special test flights will normally be used only in two cases:
> - to measure performance parameters which require special aircraft configurations;
> - to measure performances in parts of the airspace where opportunity traffic rarely passes.

8.2.2.2 **Recommendations**

> *1. In order to provide an adequate sample size for verifications using opportunity traffic, the collected data should cover a number of time periods of approximately one hour each and include at least 50 000 data samples.*
>
> *2. The data collection should be made during peak traffic hours.*
>
> *3. Data collected during conditions of severe weather or anomalous propagation should not be used to verify PSR performance.*

8.2.2.3 In some cases, it shall be possible to use simulated data for equipment tuning and verification of exceptional flight configurations (e.g. to test the resolution capabilities of extractors, or to tune the various tracking parameters of the tracker).

8.2.3 **Measurement Methods**

8.2.3.1 The measurement methods defined in the Eurocontrol Standards for radar data performance analysis shall be used for each of the parameter in Sections 6 and 7.

8.2.3.2 Each measurement method shall provide all necessary information to collect the data representative for the verification of the parameter.

8.2.3.3 Each measurement method shall provide all necessary information to derive the performance values from the collected data.

8.2.4 **Tools**

8.2.4.1 Only certified and accepted tools shall be used.

8.2.4.2 **Recommendation** *The radar data analysis tools developed by Eurocontrol should be used.*

> **NOTE** - Information of radar data analysis tools developed by Eurocontrol are provided in Annex F.

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ANNEX A (INFORMATIVE)
CHARACTERISTICS OF DIFFERENT TYPES OF AIRCRAFT MOTIONS

A.1   Uniform Motion

The aircraft is considered to be in **uniform** motion if simultaneously the course and ground speed changes are contained within the following upper limits:

- transversal acceleration $\leq 10^{-1}$ m/s^2

- longitudinal acceleration $\leq 10^{-2}$ m/s^2.

A.2   Standard Turn

The aircraft is considered to be in **standard turn** if simultaneously the transversal acceleration is between 1 and 6 m/s^2 and the longitudinal acceleration £10^{-1} m/s^2.

A.3   Uniform Speed Change

The aircraft is considered to be in **uniform speed change** if the course is constant and the ground speed increasing/decreasing with a constant longitudinal acceleration between 10^{-1} and 2 m/s^2.

A.4   Uniform Climb/Descent

The aircraft is considered to be in **uniform climb/descent** if the rate of climb/descent is between 1.5 and 40 m/s.

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ANNEX B (INFORMATIVE)
FUTURE DEVELOPMENTS

B.1   SSR Mode S

B.1.1   The next major development, in the field of radar surveillance, will be the introduction of SSR Mode S services. In accordance with the ECAC Strategy, Mode S is to be operational, in a central area, from 1998 onwards. Progressive extension of implementation of these advanced systems to other zones will follow.

B.1.2   SSR Mode S is an enhanced surveillance system with the following attributes:

a)   The selective address capability eliminates garbling situations which may occur in high traffic density areas and will enhance the general reliability of SSR information.

b)   The coding of altitude data in 25-foot increments improves the ability of ground systems to monitor and predict the movement of aircraft in the vertical plane.

c)   The data link capability, associated with transponder Level 2 and above, permits the ground system to acquire automatically aircraft call signs, thus overcoming the problems connected with SSR code allocation and assignment, code/call sign correlation, radar identification and transfer procedures.

d)   The data link capability also permits the ground system to acquire automatically certain airborne data which improve the ground tracking of aircraft, thus ensuring that the required level of safety is maintained when improved radar separation minima can be used.

e)   Electronic scanning techniques may permit the renewal rate of information on each aircraft to be selectively adapted according to ATC needs.

B.1.3   Mode S will be introduced initially for surveillance purposes. Since Mode S will be implemented progressively, procedures for operations in a mixed environment require development. The timetable for aircraft capability requirement concerning Mode S, and the associated airborne equipment needed for digital air-ground communications, will be defined at an early stage, and will be closely related to the availability of Mode S ground functions. These developments are being coordinated within the framework of the Eurocontrol programme for Enhanced ATM and Mode S Implementation in Europe (EASIE).

B.2   **Automatic Dependent Surveillance (ADS)**

B.2.1   The introduction of air-ground satellite data links, together with accurate and
                 reliable aircraft navigation systems, will create the opportunity to provide
                 surveillance services in some overwater areas, remote land areas and at low
                 altitudes, where either the provision of radar is difficult or uneconomic, or where
                 radar coverage is impossible due to the physical limitations of propagation.

B.2.2   Automatic Dependent Surveillance (ADS) is a function for use by the ATS in
                 which aircraft automatically transmit, via a data link, data derived from on-board
                 navigation systems. As a minimum, the data will include aircraft identification and
                 three-dimensional position. Additional data may be provided as appropriate.

B.2.3   The ADS data could be used by the ATC system to present a traffic situation
                 display to the controller. In addition to its obvious usefulness in areas which are
                 devoid of traffic position information other than the pilot provided voice position
                 reports, ADS may also have applications in other areas where it may serve as an
                 adjunct or back-up for secondary surveillance radar.

B.3   **ATC Radar Tracker and Server (ARTAS)**

B.3.1   ARTAS is a multi-radar tracker and server system currently in the developmental
                 stage and foreseen for implementation from 1996 onwards.

B.3.2   At the present time, a multitude of different radar data processing systems exist
                 varying from mono-radar, mosaic to real multi-radars with a large variation in
                 process sophistication and performance. Furthermore, all the existing systems
                 are more or less autonomous, i.e. that they do not liaise in any way with
                 neighbouring systems.

                 Due to this present incompatibility of systems, at the transfer of traffic from one
                 ATC unit to another considerably larger separation minima have to be applied than
                 would be the case if these centres had compatible and coordinated systems.

B.3.3   Furthermore, present day radar data processing systems suffer from one or more weaknesses as listed below:

- non-optimum use of all available radar information;

- insufficient capability to estimate with sufficient accuracy the full aircraft state-vector, i.e. including speed and longitudinal and transversal accelerations;

- insufficient capability to follow accurately certain types of aircraft manoeuvres;

- insufficient robustness against outliers causing track interrupts and track jumps;

- insufficient suppression capability for tracks build-up from various categories of false radar information;

- insufficient capability to estimate and correct for systematic and/or slowly changing radar errors;

- inaccurate methods of coordinate transformation and projection;

- no correction or inaccurate correction of slant-range errors.

The main aims of ARTAS are to overcome all known present RDPS shortcomings, and to have a system which has the potential to be the basis for a harmonised and integrated ATC system in a large and expandable geographical area.

B.3.4   Important advantages created by the introduction of ARTAS will be the very powerful provisions for contingency, the potential for an enhanced civil/military coordination and, above all, the capability to present an accurate and continuous picture of the air situation to the users. It provides to the controllers and ATC sub-systems making use of radar derived aircraft data all required information with the required level of availability and accuracy.

B.4   Radar Data Networks

B.4.1   Radar data between radar stations and ATC Centres is nowadays transmitted using dedicated point-to-point landlines. As a radar station normally provides data to different ATC Centres, the distribution of radar data has led to complex and costly star configurations. The situation is becoming more complex in view of the requirement to transmit processed radar data.

B.4.2   The requirement for sharing radar data in a more efficient way and the availability of high performance transmission networks using standardised transmission protocols led to the concept of a wide area network for radar data transmission.

B.4.3   At the present time several such networks are in an advanced implementation phase e.g. "RADNET" (Radar Data NETwork) in the BENELUX/Germany Area.

B.4.4   Such networks are based on the same concept:

- use of specialised Access Nodes to which the radar data sources are connected;

- use of a general purpose packet switching network to which the Access Nodes are connected;

- use of the "ASTERIX" Eurocontrol standard transmission format;

- use of the X.25 standard transmission protocol.

  NOTE -   They are compatible and can be interconnected.

B.4.5   The replacement of the star distribution system by a wide area network for radar data distribution will:

- increase radar data distribution reliability;

- allow for easy sharing of radar data between different users;

- meet the requirement for multi-radar coverage in an economic manner;

- permit easy access by the various users (civil and military) to processed and/or non processed radar data;

- increase the integrity of displayed radar data.

ANNEX C (INFORMATIVE)
EXAMPLES OF ADMINISTRATION AGREEMENTS RELATING TO THE SHARING OF
RADAR COVERAGE

C.1   **General**

This Annex gives two examples of possible agreements relating to the sharing of radar coverage. Example 1 contains one attachment giving details of the maintenance points of contact and Example 2 contains two attachments giving details of the technical specifications and the maintenance protocols.

C.2   **Example 1**

ADMINISTRATION A (hereafter called "A") and ADMINISTRATION B (hereafter called "B").

Prompted to maintain the redundancy of the radar services, at a level compatible with efficiency and to avoid costly duplication;

Considering that it is desirable to maintain co-operation in order to enhance air safety;

Desirous of regulating, by these terms, the use of "A" radar by the "B" authorities, and "B" radar by the "A" authorities to complement the radar coverage necessary for the exercise of control in the said region;

Have agreed as follows:

Article 1

1.   "A" undertakes to supply "B" with the existing X radar data. The transmitted data shall be that used by the "A" authorities.

2.   "B" undertakes to supply "A" with the future Y radar data, as soon as this becomes operational. The transmitted data shall be that used by the "B" authorities.

Article 2

1.   "B" shall make available to "A" the equipment necessary for remoting the X radar data. "A" undertakes to have this equipment installed and operated.

2.   "A" shall make available to "B" the equipment necessary for remoting the Y radar data. "B" undertakes to have this equipment installed and operated.

3.   It is agreed that the administration who is supplying radar data takes no responsibility over the usage and possible consequences of that usage. The receiving administration shall assure that the incoming data is of sufficient quality to be exploited.

Article 3

1. The remoting of X radar data shall be via special lines rented from the telecommunications service providers. The rental costs in respect thereof being payable by "B" authorities.

2. The remoting of Y radar data shall be via special lines rented from the telecommunications service providers. The rental costs in respect thereof being payable by "A" authorities.

Article 4

1. "B" may, in the interest of national security, or for other reasons fundamental to the safeguarding of "B" sovereignty, cease to supply data without notice.

2. "A" may, in the interest of national security, or for other reasons fundamental to the safeguarding of "A" sovereignty, cease to supply data without notice.

Article 5

1. Any unforeseen operating change, or any failure of a component in the chain, which could disturb the proper functioning of remote data shall be notified to the units concerned, at the centre(s), in the other country listed in attachment 1 to this Agreement.

2. In the event of foreseeable outages, or alteration to the system function, notification shall be given at the earliest possible moment, with an indication of the expected downtime, to the units concerned, at the centre(s), in the other country.

3. Modifications may be proposed by either administration. Funding responsibility will be in accordance with Articles 1 and 2 above.

Article 6

This agreement shall be binding at the time of signature for an indefinite period. It may be cancelled subject to one years notice and should be reviewed after a defined period.

Done in two originals in the (English) language.

Director   Director
Administration A   Administration B

Place & Date   Place & Date

ATTACHMENT 1   Maintenance Points of Contact

ATTACHMENT TO EXAMPLE 1 :   MAINTENANCE POINTS OF CONTACT

Telephone numbers of persons in charge of radar data remoting, and of duty system control technicians:

<u>"A"</u>

<u>AA Centre</u>

Name:-   Title:-
Tel........   Extension .....
Fax..........
During normal working hours (0800 to 1700)

Duty Technician
Tel .... H-24   Fax ....

The service XXXX is responsible for supplying the centre(s) of "B" with the annual and quarterly planning schedule for shutdowns of X radar remote to "B".

<u>"B"</u>

<u>BB Centre</u>

Name:-   Title:-
Tel........   Extension .....
Fax..........
During normal working hours (0800 to 1700)

Duty Technician
Tel .... H 24   Fax ....

The service XXXX is responsible for supplying the centre(s) of "A" with the annual and quarterly planning schedule for shutdowns of Y radar remote to "A".

NOTE -   This attachment will be updated, as necessary, by the units concerned.

C.3   **Example 2**

          ADMINISTRATION A (hereafter called "A") and ADMINISTRATION B (hereafter called "B") have made the following agreement with regard to the sharing of secondary radar coverage from station "C" in Administration "A".

The present Agreement is made by and between:

          On the one part "A" Directorate General of Civil Aviation, represented by ...(name)......, Director General of Civil Aviation, hereafter referred to as the "A DGAC".

                                   and

          On the other part the "B" Directorate General of Civil Aviation, represented by   . .....(name)......., Director General of Civil Aviation, hereafter referred to as the " B DGAC".

          They mutually recognise each other's capacity to enter into contracts and bind themselves by the terms of the present Agreement, and

                         DECLARE

          That they act within the framework of the EFP (Spain, France and Portugal) technical cooperation Plan to guarantee the safe and rapid management of the growing traffic volume, in application of the objectives set forth in said document (EFP Plan), and in accordance with the recommendations of ICAO, ECAC and other International Agencies involved in obtaining a radar systems coverage beyond National boundaries, and

                        SUBSCRIBE

          The present Agreement regarding the sharing of radar coverage provided by the station located at "C" which is operated by the Public Entity belonging to "A", hereafter referred to as AENA, created by law..(no).....of ....(date)....as the Organization responsible by Ministerial Order (OM) dated .....

TEXT

Article 1

"B DGAC" will request the requisite authorisation from the "A DGAC" to receive radar data from the station at "C", located in the territory belonging to the State of "A".

Article 2

"A DGAC" as the institution exercising authority for the Civil Aeronautics policy planning and directive, will provide through AENA, as the air navigation services management Organization, the requested radar data, at no economic charge, to the "B DGAC".

Article 3

AENA will provide service to the "B DGAC" in an efficient manner, not being responsible, in any case for the quality of the radar data or misinterpretation of the same, as received by the "B DGAC", bearing the latter any liability that might be derived to third parties from the said utilisation of radar data.

Article 4

These services will be established by mutual Agreement of the interested parties; nevertheless, either of the parties may, at any time, notify the other of the rescissions of the service on justified grounds. The rescissions of the service in case of defence, crisis and conflict situations, will not need previous notice.

Article 5

AENA will provide, at no economic charge, the conservation and maintenance of its equipment, as well as all that is referred to as supervision and safeguarding of the same, within the sovereign territory of "A".

Article 6

"B DGAC" will be responsible for any costs arising from the use of the communication line.

Article 7

"B DGAC" will be responsible for any costs arising from any additional equipment considered necessary, e.g. Clock Rate Adapters and High Speed Modems. AENA being responsible for on-site maintenance.

Article 8

Specifics regarding technical conditions inherent to the systems to which the present Agreement refers are governed by the technical specifications detailed in Attachment 1 to this Agreement.

Article 9

Specifics regarding operational conditions inherent to the maintenance of the equipment to which the present Agreement refers are governed by the maintenance protocol detailed in Attachment 2 to this Agreement.

Article 10

Attachment 1 and Attachment 2 to this Agreement are signed by the respective authorities at the "A" and "B" ATC Centres who will be responsible for the accomplishment of the Annexes. They, in mutual consent and formal acceptance, are allowed to amend and update, as circumstances deem necessary, the content of the Attachments, in so far as the amendments are not contradictory or outside of the scope of the Text of the Agreement.

NOTE - For the purposes of this Example these two specific centres will be abbreviated to "A ATCC" and "B ATCC" in the two Attachments to this Example Agreement.

Article 11

The present Agreement will take effect on the date on which the Parties have mutually notified each other of compliance with the requirements of their internal laws in this regard.

In witness whereof, the subscribers hereof, duly authorised by their respective governments, sign the present Agreement.

Executed in two original copies in the English Language.

In ....   In ....

Date ....   Date ....

"A DGAC"   " B DGAC "

ATTACHMENTS

ATTACHMENT 1   Technical Specifications
ATTACHMENT 2   Maintenance Protocol

ATTACHMENT 1 TO EXAMPLE 2 : TECHNICAL SPECIFICATIONS

1.   Objective

The objective of this Document is to describe the technical characteristics and operating conditions pertaining to the installations to be located at "A ATCC" for the transmission of radar data, originating from the SSR Sensor at "C" to the "B ATCC".

As agreed the necessary data transmission equipment required to implement the data link referred to will be provided by "B DGAC", whilst on-site first stage maintenance will be provided by AENA.

The equipment, although located in "A", remains the property of "B DGAC".

Transmission of SSR information from "A ATCC" to "B ATCC" will be conducted through a dedicated line to be rented from the National telecommunication services concerned. Fees for line rental and other user charges will be payable by "B DGAC" for the total segment (point to point).

In addition to the above, the RADAR line provided must also be capable of exchanging digital information in full duplex for simultaneous conveyance of OLDI messages, acting as a back-up in case of failure of the OLDI dedicated line from "A ATCC" to "B ATCC", which is subject to its own particular Agreement. Likewise, the said OLDI dedicated line shall in turn have the capability of acting as a back-up in case of failure of the RADAR line, conforming to all comprehensive RADAR/OLDI architecture.

2.   Selected Architecture

For the function of SSR data transmission on Dynamic Data Exchange (DDE) format, the selected architecture will comprise the installation of "B DGAC" data transmission equipment at the provider facility "A ATCC", as indicated:

- two (2) Clock Rate Adapters. One module on each radar feeder channel (2 400 bps);

- one (1) Long Range High Speed Modem (up to 19 200 bps).

This architecture will also ensure an OLDI message interchange line back-up, in full duplex, without interruption of radar data transmission, in case of failure of the OLDI dedicated line.

3.   Equipment Description And Mode of Operation

3.1   Adaptor

3.1.1   The radar information Clock Rate Adaptor is an electronic model designed by the "B DGAC" to solve clock synchronisation problems when re-transmitting radar data.

3.1.2   Two (2) Adaptors are installed at the "A ATCC", one module on each DDE radar feeder channel at 2 400 bps.

3.1.3   One (1) extra module is also available at the "A ATCC" as a spare component.

3.2   High Speed Modem

3.2.1   Outputs from the two Adaptors are fed into one (1) CODEX 2683 High Speed Modem (HSM) which merges the two 2 400 bps lines and produces output of radar data on DDE format for transmission to the "B ATCC". A third input port of the HSM can be connected to the Flight Data Processing System (FDPS) for provision of simultaneous OLDI back-up. A fourth port can be used for technical testing.

3.2.2   Remote control functions are provided for HSM signalling and control from the " B ATCC".

3.2.3   One (1) extra HSM CODEX 2683 is also available at the "A ATCC" as a spare component for both RADAR and OLDI configurations.

3.3   Long Distance Line

The HSM is connected to a four-wire line type M-1020, referred to as " 36029510 DPE 4" for the "B" Telecommunication Company and referred to as " 1937079 DP-1" for the "A" Telecommunication Company.

4.   Documentation

The following technical documents and their updated revisions are to be delivered to the   "A ATCC" by the "B ATCC" .

•   CODEX 2683 Modem User's Manual - Motorola 1989.

•   Notice de Mise en Oeuvre et Utilisation du Convertisseur de Debit -

•   STNA/4TX Sept 1989

In ....   In...............................

Date ....   Date ....

"A DGAC"   "B DGAC"

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Attachment 2 to
Example 2

</div>

ATTACHMENT 2 TO EXAMPLE 2 :   MAINTENANCE PROTOCOL

1.   Objective

The objective of the Document is to define the maintenance procedures and coordination actions to be followed in order to provide the optimal conditions for continuous operation of the installation located at both "A ATCC" and "B ATCC", dedicated to the transmission of radar data originated by the sensor at "C" to the "B ATCC" as described in Attachment 1 of this Agreement.

2.   Maintenance Procedures

On-site first stage maintenance in "A ATCC" will be dependant on the centre technical staff belonging to AENA. This support is offered free of charges to the "B DGAC". It involves the procedures as outlined below.

2.1   Equipment Surveillance

The "A ATCC" radar systems technician on duty H -24, will keep a regular watch on the "C" to "B ATCC" radar data link configuration performance.

In case a warning or alarm is detected to be active, remedial action will be immediately taken by the Technician or by the Technical Supervisor on duty, always within the limited range of local capabilities. If no direct corrective measure is practicable, alerting and coordination action will take effect with the correspondent Technical Supervisor at the "B ATCC".

2.2   Failure and Malfunction

In case of non-recovery failure or proven malfunction of a component. the technical staff at "A ATCC" will proceed to replace the defective component by the available spare element, in coordination with the technical staff at "B ATCC".

In case of appreciable loss of service due to line or modem failure, full operation of data link will be recovered by activating the back-up mode by manual access to both extremities of the line, connecting the Adaptors output to the OLDI HSM free input ports, in coordination with the "B ATCC" Technical Supervisor.

In case of a proven malfunction of the four-wire line, "A ATCC" and "B ATCC", after preliminary coordination between themselves, will contact their respective telecommunication companies for action. They will inform each other about the evolution of the failure, taking into account the elements transmitted to them by their respective telecommunication companies.

Defective proven components, once removed, are to be dispatched to the "B ATCC" facility by the transport firm listed hereafter. "B DGAC" will assume all financial cost of transport and repair and the "B ATCC" will procure as soon as possible a new or revised component to substitute the spare element.

Before these components are sent, tests will be organised between "A ATCC" and "B ATCC", by the correspondents listed in 5.1.b and 5.2.b, in order to confirm their malfunction.

2.3   Data Transmission Configurations

In order to avoid any misunderstanding between the technical staff at "A ATCC" and "B ATCC", three data transmission configurations are defined as below:

Configuration: NOVEMBER

OLDI data link on OLDI dedicated modem and line.
RADAR data link on RADAR dedicated modem and line.

Configuration: ROMEO

OLDI date link on RADAR dedicated modem and line.
RADAR data link on RADAR dedicated modem and line.

Configuration: OSCAR

OLDI data link on OLDI dedicated modem and line.
RADAR data link on OLDI dedicated modem and line.

2.4   Interruptions

Any programmed interruption of service or provision of function modification will be notified to the collateral party in due time, normally three months in advance.

Non-programmed interruption of service will be notified to the collateral party as soon as possible.

3.   Training

Initial instruction and familiarisation training will be granted by "B DGAC" skilled personnel to field engineers and technicians assigned to the "A ATCC".

Follow up training will be imparted by AENA to its own personnel.

Maintenance User's manuals and circulars will be kept up-dated by the "B ATCC" and current information delivered to the "A ATCC" as produced.

4.   Communication Channels

First line of contact is the telephone. Basic English is considered the coordination speech to be employed by the correspondents. A technical specific glossary should be defined for this purpose.

Telefax and Aeronautical Fixed Telecommunications Network (AFTN) are always considered as a second line of contact.

5. Correspondents

The correspondents listed below are to be contacted on the circumstances previously described.

5.1 Correspondent List " A ATCC"

a) For immediate action (H-24):
Technical Permanent - Phone: ....

b) For non-immediate action (0900 - 1700 / Mon - Fri):
Head of Systems:
Name: .... Phone : ....

Head of Maintenance Section:
Name: ....Phone : ....

Head of Maintenance Division:
Name: .... Phone: ....
Fax: ....AFTN: ....

c) For expedition of equipment:
Postal Address
....

5.2 Correspondent List "B" Centre

a) For immediate action (H-24):
Technical Supervisor -   Phone : ....

b) For non-immediate action (0900 - 1700 / Mon - Fri):
Head of Technical Service Area:
Name: ....Phone : ....

Head of Radar Visualisation SubDivision:
Name: ....   Phone : ....

Head of Air Traffic Coordination and Information SubDivision:
Name: ....   Phone : ....
Fax : ....AFTN: ....

c) For expedition of equipment:
Postal Address :
....
Transport Company :
....

In.................................

In ....

Date ....

Date ....

"A DGAC"

"B DGAC"

ANNEX D (INFORMATIVE)
SUPPORTING DOCUMENTATION

EEC Ref. No.	Title	Date	Classification (if any)
13	Rapport d'evaluation des six radars primaires et secondaires integrés au centre de contrôle UAC de Maastricht	Sep - 79	
4/80	Note technique sur l'évaluation des performances des radars primaires et secondaire de Lûdenscheid	Feb - 80	
6/80	Note technique sur les performances des radars primaires et secondaires dont les données sont opérationnellement utillsées dans le centre de Karlsruhe en juillet 1979	Apr - 80	
12/80	Note technique sur l'évaluation des performances des radars primaire et secondaire de Lûdenscheid (Dûsseldorf) en Allemagne fédérale	Aug - 80	
3/81	Evaluation des performances des radars et des extracteurs installés à Soller (Ile de Majorque) et du système de traitement des donnèes radar " TARBAL" de Barcelona	Feb - 81	
3/82	Note technique sur les performances du système radar primaire èquipant le centre de contrôle d'approche et le contrôle d'aérodrome de l'aéroport international de Luxembourg	Mar - 82	
5/82	Evaluation of 3 " En-Route" and 1 Terminal Control Area Radars: Buschberg, Felchtberg and Koralpe PSRs/SSRs and Schwechat ASR/SSR	July - 82	
7/82	Evaluation des performances de la station radar en-route de St-Hubert	Nov - 82	
10/83	Evaluation of the Performance of the Woodcock Hill Radar Station in Preparation of a Data Collection on Navigation Performance	Oct - 83	
3/84	Evaluation of the Performance of the MADAP Radar Stations	Mar - 84	

6/84	Evaluation of the Performance of the Mt Gabriel Radar Station in Preparation of a Data Collection on Navigation Performance	Jul - 84	
7/84	Evaluation of the Performance of the New Extraction System of the Leerdam Radar Station	Jul - 84	
9/84	Check of Woodcock Hill Radar Extracted Data after Tuning	Oct - 84	
2/85	Routine Evaluation of the Performance of the KARLDAP Radar Stations	Feb - 85	
4/85	Verification of Performance Characteristics and Assessment of Systematic Errors for the 4 Austrian Radars	Jul - 85	
7/85	Evaluation of the Performance Characteristics of two CAA Radar Stations	Jul - 85	
4/86	Evaluation of the Performance Characteristics of the Bertem Radar Station	May - 86	
9/86	Evaluation of the Performance Characteristics of three FAA Radar Stations	Jul - 86	
10/86	Evaluation of the Performance Characteristics of the St Hubert Radar Station	Aug - 86	
11/86	Brief Study of the Performance of the Deister Radar	Aug - 86	
13/86	Evaluation of the Performance Characteristics of the New Leerdam Radar Station	Sep - 86	
14/86	Evaluation of the Performance Characteristics of the Mount Himittos Radar Station	Oct - 86	
17/86	Brief Study of the Performance of the Boosted Radar	Nov - 86	
19/86	Evaluation of the Performance Characteristics of the Buschberg, Feichtberg, Koralpe and Wien Radar Stations	Dec - 86	
1/87	Brief Study of the Performance of the Bertem Radar	Jan - 87	
2/87	Brief Study of the Performance of the Leerdam Radar	Feb - 87	

4/87	Evaluation of the Leerdam Autonomous Radar	Jul - 87	
5/87	Evaluation of Lisbon TAR SSR Radar	Apr - 87	
8/87	Evaluation of the Lisbon TAR Primary Radar	Aug - 87	
10/87	Evaluation of the Bertem Autonomous Radar	Sep - 87	
16/87	Evaluation of Austrian Radars	Nov - 87	
6/88	Evaluation of Feichtberg Radar	Apr - 88	
13/88	Evaluation of Bertem and St Hubert Radars		
4/89	Evaluation of Salzburg and Kolomannsberg Radars	Apr - 89	
10/89	Evaluation of Lisbon TAR Radar	Jul - 89	
18/89	Evaluation of Mt Himittos Radar	Dec - 89	
3/90	Evaluation of Bertem and St Hubert Radars	Apr - 90	
7/90	Evaluation of Den Helder SSR	Jul - 90	
8/90	Evaluation of Barcelona Radars	Sep - 90	
3/91	Evaluation of Mt Himittos Radar	Jan - 91	
7/91	Evaluation of Leerdam SSR	May - 91	
4/92	Portugal Radar Evaluation	Feb - 92	
5/92	Evaluation of Den Helder monopulse and sliding window plot extractors	Feb - 92	
8/92	Mt Himittos Radar Evaluation	Feb - 92	
16/92	Leerdam Radar Evaluation	Jul - 92	
24/92	Izmar Radar Evaluation 1991	Nov - 92	
26/92	Greek ATARS Evaluation	Dec - 92	
1/93	Malta Radar Evaluation 1992	Jan - 93	
2/93	Ireland Radar Evaluation	Jan - 93	
8/93	Ireland radar Evaluation (SSR Plot Evaluation and Plot v Local Track Comparison)	Jun - 93	
1/94	Antalya Radar Evaluation 1992	Jan - 94	Confidential

2/94	ATARS PATs Radar Evaluation 1993	Jan - 94	
13/94	Ankara Radar Evaluation 1992	Apr - 94	Restricted

ANNEX E (INFORMATIVE)
TRACKING PERFORMANCE VALUES

E.1   The performance values are based on the results of simulations using specific representative scenarios in the following conditions:

- radar sensor data in accordance with the performance requirements given in Section 6 of this Standard.

- aircraft operating characteristics within the following limits:

    - aircraft ground speed:
        - PSR: 40 - 800 kt
        - SSR: 0 - 1500 kt

    - transversal acceleration: $2.5 - 6 \text{ m/s}^2$

    - longitudinal acceleration: $0.3 - 1.2 \text{ m/s}^2$

    - rate of climb/descent: 1.5 - 40 m/s

    - aircraft orientation of the flight
      with respect to the radar: no limitation.

- radar station configurations:
  Major Terminal Area:

    - two radar stations:
        - one combined PSR/SSR station with positional data derived from the SSR for combined target reports;
        - one SSR only station;
        - both stations are separated from each other by 30 NM.

  En-Route Airspace:

    - two independent SSR only stations separated from each other by 50 NM.

E.2   The performance values are given in Tables 1 to 7 as follows:

Table Number	Table Title	Aircraft Detection
1	Track Initiation Requirements	
2A	Track Continuity Requirements	
2B	Track Continuity Requirements	
3A	Accuracy Requirements Major Terminal Area	PSR only
3B	Accuracy Requirements Major Terminal Area	PSR only
4A	Accuracy Requirements Major Terminal Area	One SSR
4B	Accuracy Requirements Major Terminal Area	One SSR
5A	Accuracy Requirements Major Terminal Area	Two SSR's
5B	Accuracy Requirements Major Terminal Area	Two SSR's
6A	Accuracy Requirements En-Route	One SSR
6B	Accuracy Requirements En-Route	One SSR
7A	Accuracy Requirements En-Route	Two SSR's
7B	Accuracy Requirements En-Route	Two SSR's

NOTE -   The specific scenario is shown with each table.

Table 1 - Track Initiation Requirements

Parameters	Major Terminal Area		En-Route	Units
	PSR	**PSR/SSR**	**SSR**	
TIDmn	14 (3.5)	10 (2.5)	30 (2.5)	seconds (scans)
TIDsd	4 (1)	2 (0.5)	6 (0.5)	seconds (scans)
FTprob	0.001	0.001	0.001	tracks/false report

Scenario

- Aircraft detected by:
    - Major Terminal Area: PSR only
      PSR/SSR (combined)
    - En-Route: SSR only
- Antenna revolution time:
    - Major Terminal Area: 4 seconds
    - En-Route: 12 seconds

NOTE - Track initiation normally takes place in a monoradar situation.

Table 2A - Track Continuity Requirements

Parameters	Major Terminal Area						En-Route			Units
	PSR			PSR			Two SSRs			
	Uniform Motion	Standard Turn	Uniform Speed Change	Uniform Motion	Standard Turn	Uniform Speed Change	Uniform Motion	Standard Turn	Uniform Speed Change	
TDr	0.1	1		0.01	0.1		0.01	0.1		/track hours
TSr	0.15	-		0.01	-		0.01	-		/swop opportunities
GTr	0.01	0.1		0.01	0.1		0			/track hours
FTmn	8 (2)			4			12			seconds (scans)
FTsd	4 (1)			2			6			seconds (scans)

Scenario

- Aircraft detected by:
    - Major Terminal Area:　　　　　　　one PSR
    　　　　　　　　　　　　　　　　　　　two SSRs
    - En-Route:　　　　　　　　　　　　　two SSRs
- Antenna revolution time:
    - Major Terminal Area:　　　　　　　4 seconds
    - En-Route:　　　　　　　　　　　　　12 seconds

Table 2B - Track Continuity Requirements

Parameters	Major Terminal Area						En-Route			Units
	PSR/SSR			One SSR			One SSR			
	Uniform Motion	Standard Turn	Uniform Speed Change	Uniform Motion	Standard Turn	Uniform Speed Change	Uniform Motion	Standard Turn	Uniform Speed Change	
TDr	0.01	0.1		0.04	0.4		0.02	0.2		/track hours
TSr	0.01	-		0.01	-		0.01	-		/swop opportunities
GTr	0.01	0.1		0			0			/track hours
FTmn	4 (1)	4 (1)		4 (1)			12 (1)			seconds (scans)
FTsd	2			2			6			seconds (scans)

Scenario

- Aircraft detected by:

    – Major Terminal Area: one PSR/SSR (combined)
                                      one SSR

    – En-Route: one SSR

- Antenna revolution time:

    – Major Terminal Area: 4 seconds

    – En-Route: 12 seconds

NOTE - The performance requirements for PSR only detected aircraft are given in Table 2A.

Table 3A - Accuracy Requirements Major Terminal Area

Accuracy		Type of Motion		
Elements	**Parameters**	Uniform Motion	Uniform Speed Change	Standard Turn
Position	Along trajectory position RMS errors	85 m	250 m	150 m
	Across trajectory position RMS errors	85 m	100 m	150 m
Ground speed	Ground speed RMS error	1.25 m/s	20 m/s	5 m/s
Course	Course RMS error	0.8°	2°	6°

Scenario

- Aircraft detected by PSR only

- Antenna revolution time: 4 seconds

- Average values for:

  - range: 150 km (81 NM)

  - direction: $|V_t| = |V_r|$

  - ground speed: V = 555 km/h (300 kt)

  - transversal acceleration: 4 m/s^2

  - longitudinal acceleration: 1 m/s^2

Table 3B - Accuracy Requirements Major Terminal Area

Accuracy			Type of Transition		
Elements	Parameters		Uniform Motion to Standard Turn	Standard Turn to Uniform Motion	Uniform Motion to Uniform Speed Change
Position	Along trajectory position	Peak RMS errors	180 m	140 m	480 m
		tau	-	100 s (0.1)	60 s (0.1)
	Across trajectory position	Peak RMS errors	320 m	220 m	210 m
		tau	24 s (0.5)	100 s (0.1)	65 s (0.1)
Ground Speed	Ground speed peak RMS errors		6 m/s	6 m/s	30 m/s
	tau		-	100 s (0.1)	60 s (0.1)
Course	Course peak RMS errors		21°	10°	4.5°
	tau		28 s (0.5)	50 s (0.1)	65 s (0.1)

Scenario

- Aircraft detected by PSR only

- Antenna revolution time: 4 seconds

- Average values for:

    - range: 150 km (81 NM)

    - direction: $|V_t| = |V_r|$

    - ground speed: V = 555 km/h (300 kt)

    - transversal acceleration: 4 m/s^2

    - longitudinal acceleration: 1 m/s^2

Table 4A - Accuracy Requirements Major Terminal Area
Table 4A - Part 1

Accuracy		Type of Motion		
Elements	**Parameters**	**Uniform Motion**	**Uniform Speed Change**	**Standard Turn**
Position	Along trajectory position RMS errors	60 m	180 m	100 m
	Across trajectory position RMS errors	60 m	60 m	100 m
Ground speed	Ground speed RMS error	0.6 m/s	17 m/s	4 m/s
Course	Course RMS error	0.7°	1.5°	6°

Table 4A - Part 2

Accuracy		Type of Motion
Elements	**Parameters**	**Uniform Climb/Descent**
Vertical speed	Vertical speed RMS error	1 m/s

Scenario

- Aircraft detected by one SSR

- Antenna revolution time: 4 seconds

- Average values for:

    - range: 150 km (81 NM)

    - direction: $|V_t| = |V_r|$

    - ground speed: V = 555 km/h (300 kt)

    - transversal acceleration: 4 m/s^2

    - longitudinal acceleration: 1 m/s^2

    - vertical speed: 10 m/s (2000 ft/min)

Table 4B - Accuracy Requirements Major Terminal Area
Table 4B - Part 1

Accuracy			Type of Transition		
Elements	**Parameters**		**Uniform Motion to Standard Turn**	**Standard Turn to Uniform Motion**	**Uniform Motion to Uniform Speed Change**
Position	Along trajectory position	Peak RMS errors	140 m	110 m	310 m
		tau	-	65 s (0.1)	50 s (0.1)
	Across trajectory position	Peak RMS errors	230 m	180 m	120 m
		tau	24 s (0.5)	65 s (0.1)	60 s (0.1)
Ground Speed	Ground speed peak RMS errors		6 m/s	5 m/s	26 m/s
	tau		-	65 s (0.1)	50 s (0.1)
Course	Course peak RMS errors		17°	9°	2.5°
	tau		24 s (0.5)	65 s (0.1)	65 s (0.1)

Table 4B - Part 2

Accuracy		Type of Transition	
Elements	**Parameters**	**Uniform Motion to Climb/Descent**	**Climb/Descent to Uniform Motion**
Vertical speed	Vertical speed RMS errors	10 m/s	10 m/s
	tau	20 s (0.1)	16 s (0.1)

Scenario

- Aircraft detected by one SSR
- Antenna revolution time: 4 seconds
- Average values for:
  - range: 150 km (81 NM)
  - direction: $|V_t| = |V_r|$
  - ground speed: V = 555 km/h (300 kt)
  - transversal acceleration: 4 m/s^2
  - longitudinal acceleration: 1 m/s^2

– vertical speed:	10 m/s (2000 ft/min)

Table 5A - Accuracy Requirements Major Terminal Area
Table 5A - Part 1

Accuracy		Type of Motion		
Elements	**Parameters**	**Uniform Motion**	**Uniform Speed Change**	**Standard Turn**
Position	Along trajectory position RMS errors	50 m	125 m	70 m
	Across trajectory position RMS errors	50 m	50 m	70 m
Ground speed	Ground speed RMS error	0.6 m/s	13 m/s	3 m/s
Course	Course RMS error	0.5°	1°	4.5°

Table 5A - Part 2

Accuracy		Type of Motion
Elements	**Parameters**	**Uniform Climb/Descent**
Vertical speed	Vertical speed RMS error	1 m/s

Scenario

- Aircraft detected by two SSRs
- Antenna revolution time: 4 seconds
- Average values for:
  - range: 150 km (81 NM)
  - direction: $|V_t| = |V_r|$
  - ground speed: V = 555 km/h (300 kt)
  - transversal acceleration: 4 m/s^2
  - longitudinal acceleration: 1 m/s^2
  - vertical speed: 10 m/s (2000 ft/min)

Table 5B - Accuracy Requirements Major Terminal Area
Table 5B - Part 1

Accuracy			Type of Transition		
Elements	Parameters		Uniform Motion to Standard Turn	Standard Turn to Uniform Motion	Uniform Motion to Uniform Speed Change
Position	Along trajectory position	Peak RMS errors	100 m	80 m	220 m
		tau	-	46 s (0.1)	35 s (0.1)
	Across trajectory position	Peak RMS errors	165 m	130 m	85 m
		tau	17 s (0.5)	46 s (0.1)	43 s (0.1)
Ground Speed	Ground speed peak RMS errors		5 m/s (6)	4 m/s	19 m/s
	tau		-	46 s (0.1)	35 s (0.1)
Course	Course peak RMS errors		12°	6.5°	1.8°
	tau		17 s (0.5)	46 s (0.1)	46 s (0.1)

Table 5B - Part 2

Accuracy		Type of Transition	
Elements	Parameters	Uniform Motion To Climb/Descent	Climb/Descent to Uniform Motion
Vertical speed	Vertical speed RMS errors	7 m/s	7 m/s
	tau	16 s (0.1)	16 s (0.1)

Scenario

- Aircraft detected by two SSRs
- Antenna revolution time: 4 seconds
- Average values for:
  - range: 150 km (81 NM)
  - direction: $|V_t| = |V_r|$
  - ground speed: V = 555 km/h (300 kt)
  - transversal acceleration: 4 m/s^2
  - longitudinal acceleration: 1 m/sec^2

– vertical speed: 10 m/s (2000 ft/min)

Table 6A - Accuracy Requirements En-Route
Table 6A - Part 1

Accuracy		Type of Motion		
Elements	**Parameters**	**Uniform Motion**	**Uniform Speed Change**	**Standard Turn**
Position	Along trajectory position RMS errors	170 m	400 m	250 m
	Across trajectory position RMS errors	170 m	200 m	250 m
Ground speed	Ground speed RMS error	2 m/s	27 m/s	7 m/s
Course	Course RMS error	0.7°	1.5°	4°

Table 6A - Part 2

Accuracy		Type of Motion
Elements	**Parameters**	**Uniform Climb/Descent**
Vertical speed	Vertical speed RMS error	1 m/s

Scenario

- Aircraft detected by one SSR
- Antenna revolution time: 12 seconds
- Average values for:
  - range: 300 km (162 NM)
  - direction: $|V_t| = |V_r|$
  - ground speed: V = 1110 km/h (600 kt)
  - transversal acceleration: 4 m/s^2
  - longitudinal acceleration: 1 m/s^2
  - vertical speed: 5 m/s (1000 ft/min)

Table 6B - Accuracy Requirements En-Route
Table 6B - Part 1

Accuracy			Type of Transition		
Elements	Parameters		Uniform Motion to Standard Turn	Standard Turn to Uniform Motion	Uniform Motion to Uniform Speed Change
Position	Along trajectory position	Peak RMS errors	340 m	220 m	600 m
		tau	-	100 s (0.1)	85 s (0.1)
	Across trajectory position	Peak RMS errors	530 m	280 m	310 m
		tau	50 s (0.5)	120 s (0.1)	95 s (0.1)
Ground Speed	Ground speed peak RMS errors		9 m/s	10 m/s	36 m/s
	tau		-	100 s (0.1)	85 s (0.1)
Course	Course peak RMS errors		11°	7°	3°
	tau		50 s (0.5)	75 s (0.1)	100 s (0.1)

Table 6B - Part 2

Accuracy		Type of Transition	
Elements	Parameters	Uniform Motion to Climb/Descent	Climb/Descent to Uniform Motion
Vertical speed	Vertical speed RMS errors	5 m/s	5 m/s
	tau	60 s (0.1)	48 s (0.1)

Scenario

- Aircraft detected by one SSR

- Antenna revolution time: 12 seconds

- Average values for:

  - range: 300 km (162 NM)

  - direction: $|V_t| = |V_r|$

  - ground speed: V = 1110 km/h (600 kt)

  - transversal acceleration: 4 m/s^2

  - longitudinal acceleration: 1 m/s^2

    –   vertical speed: 5 m/s (1000 ft/min)

Table 7A - Accuracy Requirements En-Route
Table 7A - Part 1

Accuracy		Type of Motion		
Elements	**Parameters**	**Uniform Motion**	**Uniform Speed Change**	**Standard Turn**
Position	Along trajectory position RMS errors	120 m	285 m	180 m
	Across trajectory position RMS errors	120 m	145 m	180 m
Ground speed	Ground speed RMS error	1.5 m/s	20 m/s	5 m/s
Course	Course RMS error	0.5°	1.1°	3°

Table 7A - Part 2

Accuracy		Type of Motion
Elements	**Parameters**	**Uniform Climb/Descent**
Vertical speed	Vertical speed RMS error	1 m/s

Scenario

- Aircraft detected by two SSRs

- Antenna revolution time: 12 seconds

- Average values for:

    – range: 300 km (162 NM)

    – direction: $|V_t| = |V_r|$

    – ground speed: V = 1110 km/h (600 kt)

    – transversal acceleration: 4 m/s^2

    – longitudinal acceleration: 1 m/s^2

    – vertical speed: 5 m/s (1000 ft/min)

Table 7B - Accuracy Requirements En-Route
Table 7B - Part 1

Accuracy			Type of Transition		
Elements	Parameters		Uniform Motion to Standard Turn	Standard Turn to Uniform Motion	Uniform Motion to Uniform Speed Change
Position	Along trajectory position	Peak RMS errors	240 m	160 m	425 m
		tau	-	70 s (0.1)	60 s (0.1)
	Across trajectory position	Peak RMS errors	375 m	200 m	220 m
		tau	35 s (0.5)	85 s (0.1)	68 s (0.1)
Ground Speed	Ground speed peak RMS errors		7 m/s	7 m/s	26 m/s
	tau		-	75 s (0.1)	60 s (0.1)
Course	Course peak RMS errors		8°	5°	2.5°
	tau		35 s (0.5)	55 s (0.1)	72 s (0.1)

Table 7B - Part 2

Accuracy		Type of Transition	
Elements	Parameters	Uniform Motion to Climb/Descent	Climb/Descent to Uniform Motion
Vertical speed	Vertical speed RMS errors	3.5 m/s	3.5 m/s
	tau	48 s (0.1)	48 s (0.1)

Scenario

- Aircraft detected by two SSRs

- Antenna revolution time: 12 seconds

- Average values for:

  - range: 300 km (162 NM)

  - direction: $|V_t| = |V_r|$

  - ground speed: V = 1110 km/h (600 kt)

  - transversal acceleration: 4 m/s^2

– longitudinal acceleration: 1 m/s^2

– vertical speed: 5 m/s (1000 ft/min)

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ANNEX F (INFORMATIVE)
RADAR DATA ANALYSIS TOOLS

F.1   **Radar Analysis Support System for ATC Centres (RASS-C)**

F.1.1   Eurocontrol is developing a tool to perform standardised evaluations of radar surveillance sensors and radar surveillance sensor data processing systems. This tool will be used at a centre level on a Local Area Network (LAN). The relevant tool is called Radar Analysis Support System for ATC Centres (RASS-C).

F.1.2   RASS-C determines the quality of the radar sensors which are connected to the centre. By using the same incoming radar sensor information, the tool also determines the behaviour of each aircraft with respect to Mode-of-Flight (MOF). Subsequently, the derived radar sensor quality characteristics and the derived aircraft behaviour characteristics are used as input conditions to relate them to the tracker performance characteristics. The analysis will be based on live or on simulated data sets.

F.1.3   The main objective of this tool is to provide Eurocontrol with a capability to support the evaluation of radar systems and to support developers of ATC systems in the analysis and evaluation of mono- and multi-radar trackers using large scale and/or simulated data.

F.1.4   A block diagram of the overall RASS-C system is presented as Figure 1. The Input-Output Sub-System (IOSS) provides a standardised LAN interface to the various RASS-C centre LAN environments. The RASS-C IOSS will also be able to emulate the behaviour of certain elements of such an LAN environment.

F.1.5   The SMART Realistic Radar Environment Simulator consists of a Traffic Sub-System (TSS) and a Radar Sub-System (RSS). The TSS provides all functionality to generate simulated aircraft trajectories for both large scale route-based scenarios and for very specific user definable flight manoeuvres. To generate simulated plots, the RSS functionality maps various user definable mono- and multi-radar characteristics on top of the aircraft trajectories. Also a simulated aircraft reference trajectory is produced for each simulated aircraft contributing to a simulated scenario.

F.1.6   The Object Correlator (OC) chains plots. A chain is basically defined as a time-ordered sequence of plots and/or local tracks which belong to a certain aircraft. Plots, not belonging to an aircraft, such as for example clutter plots, will be classified as false plots. False plot classification is implemented in the OC as well as in the Analysis Programs. The OC also relates the tracks produced by the tracker under test to its aircraft chains (chain to track association).

F.1.7   By using the aircraft chains, the MURATREC II trajectory reconstitution program reconstitutes and classifies the aircraft state. The aircraft state, represented by the aircraft reference trajectories, contains positional information, related accuracy information and time sequences of prevailing MOFs.

F.1.8   The Geographical Classification Program applies geographical classification to plots, plot events, aircraft chains and trajectories. The Analysis Programs are dealing with the plot quality analysis and classification related to False Plots, Probability of Detection (PD), Accuracy and Resolution.

F.1.9   The MTRAQ Program relates the tracker performance to the radar environmental input conditions and the aircraft behaviour. For this purpose, MTRAQ uses user-definable input classifications and selections. Those can also be applied to the other Analysis Programs, the Object Correlator and MURATREC I/II.

F.1.10   The Radar Sharing Calculation (RASCAL) Program calculates the radar coverage as a function of the Flight Level (FL). This information can be used to make simulations as realistic as possible and to support the Analysis Programs.

F.1.11   The Inventory Pre-Checking Program can be used to quickly assess the quality of the data recording and feasibility to use it for further analysis.

F.1.12   Future baselines of the RASS-C system will include functionality for centre-based Real Time Quality Control (RTQC). Such an RTQC system will be used for monitoring, in real time, the quality of the incoming radar sensor data and the quality of the produced radar sensor data processing output.
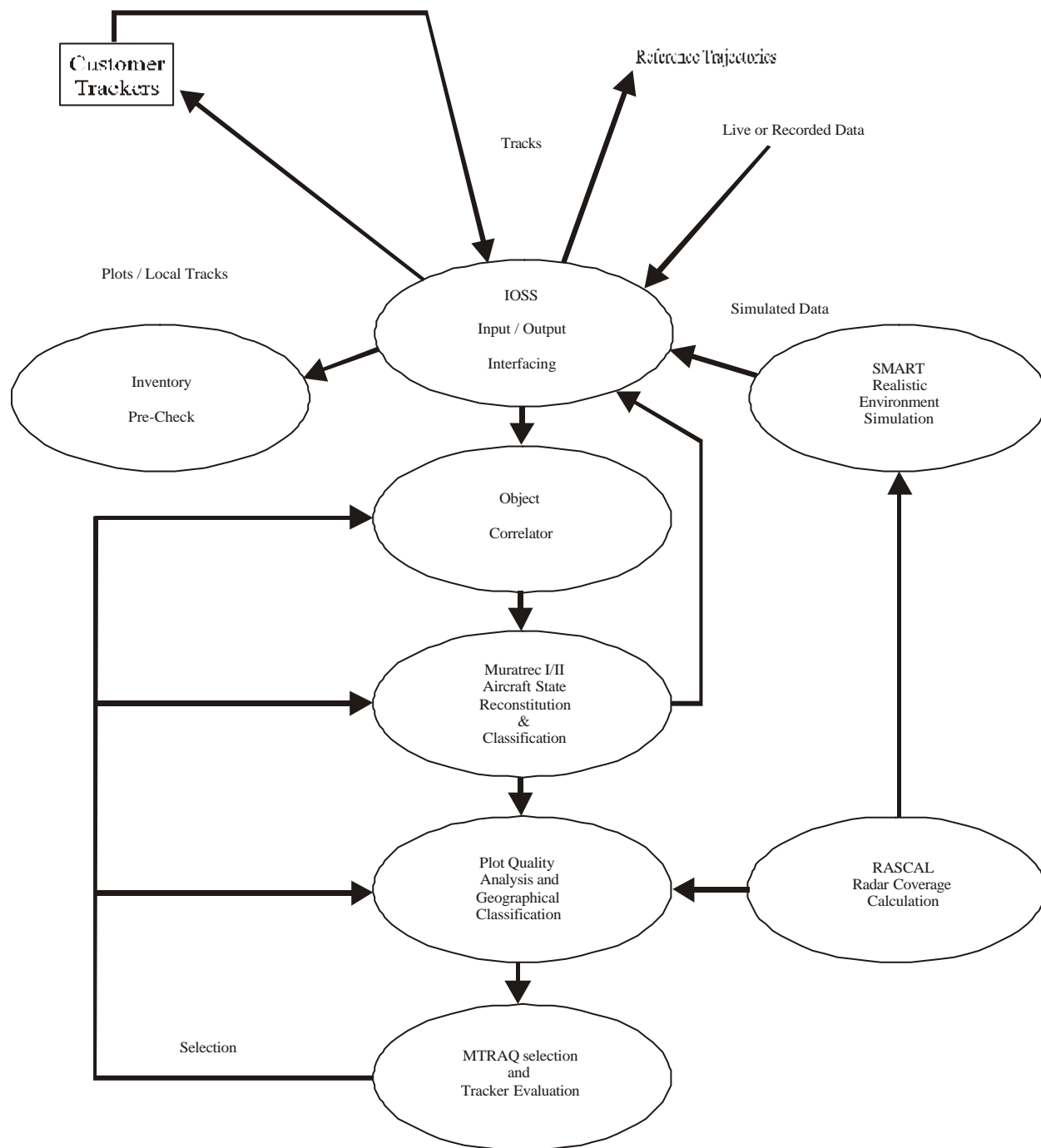
Customer
Trackers

Reference Trajectories

Tracks

Live or Recorded Data

Plots / Local Tracks

IOSS
Input / Output
Interfacing

Simulated Data

Inventory
Pre-Check

SMART
Realistic
Environment
Simulation

Object
Correlator

Muratrec I/II
Aircraft State
Reconstitution
&
Classification

Plot Quality
Analysis and
Geographical
Classification

RASCAL
Radar Coverage
Calculation

Selection

MTRAQ selection
and
Tracker Evaluation

Figure 1 - Block Diagram of the RASS-C System

F.2   RADAR ANALYSIS SUPPORT SYSTEM FOR ATC SENSORS (RASS-S)

F.2.1   Eurocontrol is developing a tool to perform standardised evaluations of radar surveillance sensors at site level. The relevant tool is called Radar Analysis Support System for ATC Sensors (RASS-S). Although some of the RASS-S system features outlined below are now in the process of specification and realisation, their description has been written as if all features already exist.

F.2.2   The main objective of this tool is to provide Eurocontrol with a capability to support the evaluation of radar systems and to support developers of radar systems in the analysis and evaluation using live and/or simulated data.

F.2.3   Amongst other features, the RASS-S system comprises the existing Polar Plot Diagram (PDP) functionality for the measurements of antenna pattern characteristics (Uplink and Downlink for the horizontal antenna pattern; Downlink for the vertical antenna pattern).

F.2.4   A block diagram of the RASS-S system is presented at Figure 2. In principle, RASS-S has possibilities to inject or to receive data at different levels of the processing stages of a single radar under test. RASS-S analyses the performance of the different processing stages and their relationships. For example, it is possible to relate the performance of the Monopulse Plot Extractor to the conditions of the signals at video or at reply level. In addition to the previously mentioned PDP features, the RASS-S system provides functionality   to :

- record, replay and analyse video and reply signals;

- measure the PSR/SSR (mis-)alignment;

- measure cross polarisation;

- analyse and detect malfunctioning antennas;

- compare measured antenna pattern characteristics against patterns with known defects (antenna finger printing);

- perform resolution analysis including garbling and false reply analysis;

- perform single radar plot and local track analysis;

- perform remote field monitoring;

- analyse site-based Mode-S functionality;

- analyse the interoperability at site level;

- perform RTQC checking of the system under test;

- perform to be defined User Requirements.

Although illustrated in the block diagram, no interface is currently foreseen to interface to the RF signals Sigma, Delta and Omega.

F.2.5   Both the software and firmware of RASS-S are fully portable. The software of RASS-S is based on Labview III while the firmware of RASS-S is accessed through standardised interfaces like SCSI and Ethernet. The RASS-S Program should therefore be hardware and vendor independent. It is possible to run the RASS-S system on a Macintosh host, on a DOS-based environment and in a Unix environment.

F.2.6   RASS-S digitally records the video and reply signals on a 1Gb harddisk or on a 270MB removable disk with sample rates up to 32MHz. 10 bits are recorded per sample.

F.2.7   In addition to the recording of the 3 analog video inputs, RASS-S can record, at the same time, up to 8 transistor-transistor logic (TTL) signals and relate them to the video inputs. It is possible to define trigger events based on those TTL signals.

F.2.8   The analysis of live data recordings is based on derived reference information. The purpose of a reference extractor is to determine, out of the live data, the best estimate of aircraft-related data such as position, speed, MOF, Mode A/C Codes and Mode-S information. Also interferences such as, for example, TCAS are to be classified by the reference extractor.

F.2.9   RASS-S includes also features to measure the (mis-)alignment of PSR/SSR antennas and to measure the antenna pattern characteristics in the case that energy with an orthogonal polarisation is scattered back into the antenna. The PDP uplink equipment can be used to produce the signals with the required polarisation characteristics.

F.2.10   Resolution problems can be simulated and combined with live data. The generation is driven by pre-defined parameters.

F.2.11   With the plot and local analysis facility, it is possible to record plots, local track or filtered plots. The local track analysis capability includes functionality to determine events like for example track swop, track drop, false track and track accuracy deviation. Average track initiation delay is determined as well as other relevant characteristics, describing the tracker performance as a function of for example the plot characteristics and resolution cases.

F.2.12   RASS-S can generate simulated test flights and mix these with previously recorded data which can be replayed at a later stage. Modifications or additions to the data to be replayed are possible on a single video reply or on the basis of one or more simulated trajectories.

F.2.13   The generation of simulated trajectories will be based on predefined parameters. The parametrized characteristics of the simulated signals take into account, the measured or synthesized PDP antenna pattern characteristics, the step encoder quality, the receiver noise, the transponder characteristics (e.g. power and frequency deviation), a simple model for aircraft dynamics and other relevant parameters.

F.2.14   A Remote Field Monitoring is part of RASS-S as well. With this type of equipment it will be possible to inspect signals at RF level and to inject test or simulated signals into the antenna of the system under test.

F.2.15   RASS-S includes features to test the site-based Mode-S functionality and to test the inter-operability at site level. It also includes functionality to perform RTQC checking of the operational system under test.
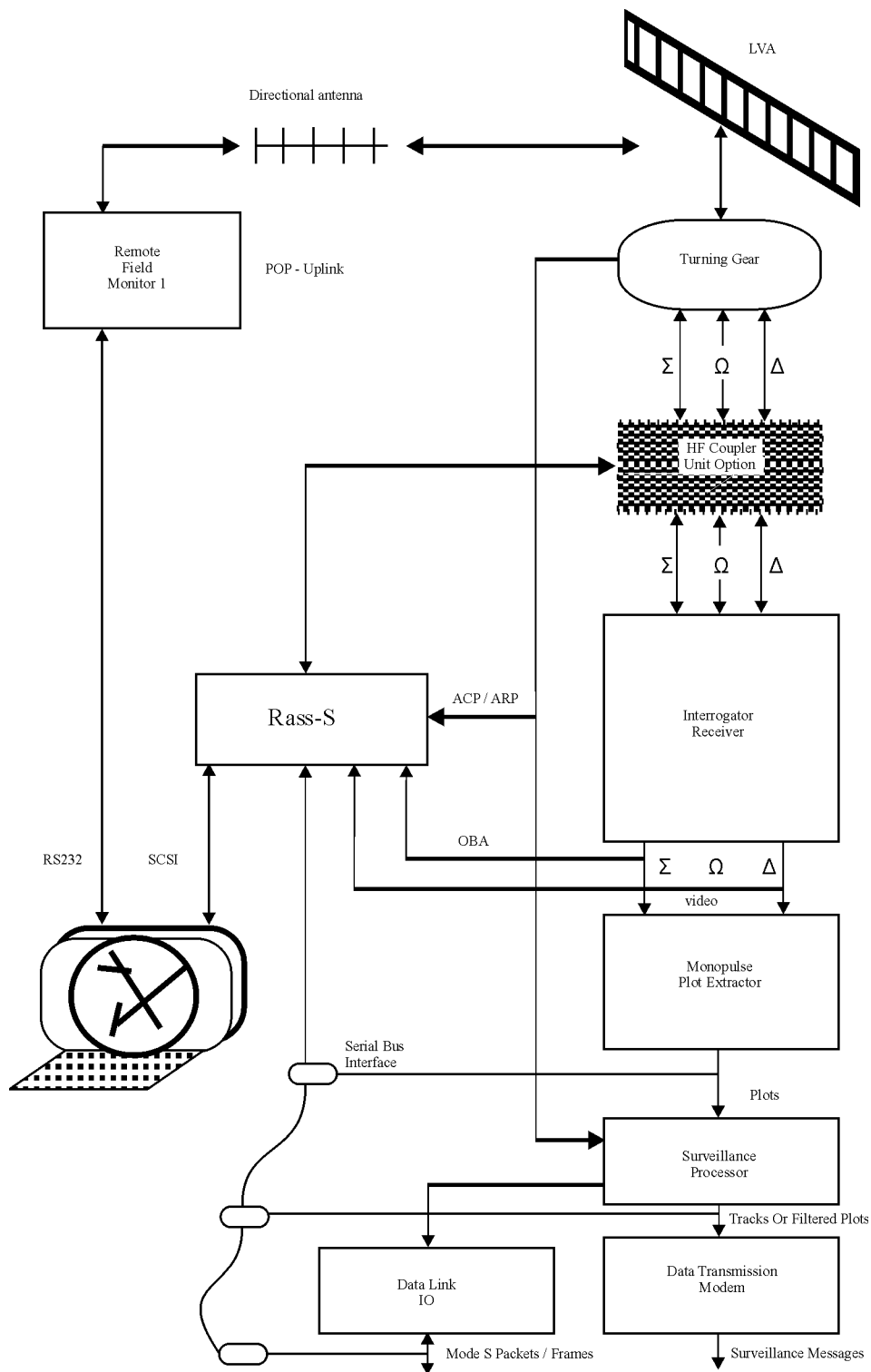
Figure 2 - Block Diagram of the RASS-S System

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