



The European Organisation for Civil Aviation Equipment  
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

# TECHNICAL SPECIFICATION FOR WIDE AREA MULTILATERATION (WAM) SYSTEMS

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## **ED-142**

September 2010

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## FOREWORD

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## CHAPTER 1

### GENERAL

#### 1.1 PURPOSE AND SCOPE

This Technical Specification document specifies the minimum performance requirements for a Wide Area Multilateration (WAM) System that is part of a system providing airspace situational awareness to air traffic controllers and other users within the European Air Navigation Region.

*In the frame of this document the WAM system is primarily intended for ATM in the ECAC area to provide, in both high and low density environments, the following air traffic surveillance services:*

- 3 NM horizontal separation
- 5 NM horizontal separation

A WAM System compliant with this Technical Specification will be compatible with all relevant ICAO, EUROCONTROL and EUROCAE/RTCA specifications [REF1 - REF16].

It is recognised that a WAM system may also provide an ADS-B data reception and handling capability, but consideration of such capability is outside the scope of this document. More information on ADS-B ground station capability can be found in [REF16].

A list of document references can be found in section 1.7.

#### 1.2 DOCUMENT STRUCTURE

Chapter 1 of this document provides information required to understand the need for the equipment characteristics and tests defined in the remaining chapters. It describes typical equipment applications and operational objectives. Definitions essential to proper understanding of this document are also provided in Chapter 1.

Chapter 2 contains general design requirements. These are requirements for which no specific tests have been defined within this document. Compliance can be verified through manufacturer provided documentation.

Chapter 3 contains the minimum performance specification for the equipment, defining performance under standard operating conditions.

Chapter 4 prescribes the environmental test conditions, which provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.

Chapter 5 describes recommended factory test procedures for demonstrating compliance with Chapter 3.

Chapter 6 describes recommended site test procedures for demonstrating compliance with Chapter 3.

#### 1.3 APPLICATIONS OF THE DOCUMENT

Compliance with this technical specification by manufacturers, installers and users is recommended as a means of assuring that the equipment will satisfactorily perform its intended function(s).

### 1.3.1 Mandating and Recommendation Phrases

#### 1.3.1.1 'Shall'

The use of the word '**Shall**' indicates a mandated criterion; i.e. compliance with the particular procedure or specification is mandatory and no alternative may be applied.

#### 1.3.1.2 'Should'

The use of the word 'Should' (and phrases such as 'It is recommended that...', etc.) indicate that though the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

## 1.4 DESCRIPTION OF SYSTEM

### 1.4.1 General Introduction to Multilateration

This introduction to multilateration is intended for users of *Multilateration System* and those who procure the systems. It will help those parties to understand the system behaviour and the important factors in selecting a system. It is not intended as a designers guide for *Multilateration System*. Many details have been left out to keep the explanation fairly concise.

Air traffic surveillance systems use both cooperative and non-cooperative techniques to locate aircraft. While non-cooperative techniques rely on the reflection of energy directed at the aircraft, cooperative techniques require the carriage of a transponder on board the aircraft. The transponder receives an *Interrogation* signal from the cooperative surveillance system and replies with its own signal. Some transponders also make spontaneous transmissions (e.g. Mode S '*Squitter*') at defined intervals.

One method of locating an aircraft using the transponder signal is multilateration. In this technique, the transponder signal from the aircraft is received at multiple receivers at known locations. The signal arrives at the receivers at different times due to the different separation distances from the target. The *TDOA* can be calculated in a number of different ways, including cross-correlation of captured waveforms and differences between absolute *Time of Arrival (TOA)* measurements, and forms the basis of the multilateration technique. (Note that in *Multilateration System* which uses active *Interrogation*, this so-called 'time-hyperbolic method' can also be augmented by other techniques).

A *TDOA* measurement for a pair of receivers can be used to define a hyperboloid surface upon which the target lies; however a target at any point on this surface would exhibit the same *TDOA* and so further measurements are required to resolve this ambiguity. A third receiver gives rise to a second independent *TDOA* measurement, defining another hyperboloid which should, in the absence of excessive measurement errors, intersect with the first to reduce the ambiguity to a hyperbola curve.

Reduction of the target locus to a single point on this curve can then be achieved using a variety of methods: intersecting the curve with a horizontal plane of arbitrary height (usually zero); calculating the height of the target based on its Mode C replies and local meteorological data, and intersecting the curve with a horizontal plane at that height; or adding a fourth receiver to provide a third independent *TDOA* and its corresponding hyperboloid, the intersection of which with the curve reduces the ambiguity to a single point.

Further receivers can increase positional *Accuracy*, amongst other benefits.

### 1.4.2 WAM Minimum Operational Objectives

Wide Area Multilateration (WAM) systems provide independent cooperative surveillance.

Wide Area Multilateration uses the time difference of arrival (TDOA) multilateration principle to provide an accurate and reliable real-time location and identification of all aircraft, vehicles and other objects equipped with a Mode A/C/S transponder.

WAM is a modular system, adaptable to terminal and wide area surveillance requirements, as well as operation in difficult terrain. For each deployment, the most appropriate architecture configuration and related communication data link technology will be selected to meet the requirements of the customer, ensuring the optimal utilization of the available infrastructure.

In areas with sufficient Mode A/C/S *Interrogation* provided by local SSR or in areas with high transponder occupancy, WAM may utilize all available SSR replies to locate, identify and *Track* aircraft.

The WAM system may also serve as a means for surveillance provision duplication, as it is recommended that en-route airspace and major terminal areas require duplication of surveillance.

This document covers the WAM system requirements to provide at least the following surveillance applications:

- 'En-route service'. Minimum performance ensuring safe application of separation minima of 5 NM.
- 'TMA service'. Minimum performance ensuring safe application of separation minima of 3 NM.

Multilateration techniques have been successfully deployed for airport surveillance for many years now. More recently however, these same techniques are being utilized for wide area applications such as en-route or terminal control.

#### **Terminal areas**

A TMA (Terminal Manoeuvring 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 according to the way the airspace and the procedures for handling the air traffic flow are organized.

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

Provisions should be made for the *Continuity* of coverage in the areas interfacing with en-route airspace.

#### **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.

The horizontal extent of the coverage should 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.

### 1.4.3 Other Applications

#### Height monitoring equipment (HME)

Reduced Vertical Separation Minima (RVSM) is used to describe the standard vertical separation reduction from 2,000 ft to 1,000 ft for aircraft flying between FL 290 and FL410. With few exceptions, the vast majority of aircraft that operate in European airspace required certification to operate in RVSM airspace.

To validate the capability of the aircraft to maintain altitude to the RVSM requirement, height monitoring units are needed with an accurate height measuring capability. This is ideally achieved using a *Multilateration System*.

The barometric altitude information reported by an aircraft is compared to the geometric height measurement whenever that aircraft is within the vicinity of the HME. This allows the aircraft population to be subject to an ongoing monitoring process to help ensure that RVSM requirements are maintained.

#### Precision Runway Monitoring (PRM)

Independent parallel operations during Instrument Meteorological Conditions are typically limited by current radar surveillance to runways separated by 4,300 feet or more. PRM provides Air Traffic Control (ATC) with a display of arrivals along an extended centreline. In the event that an aircraft flies towards the adjacent runway's extended centreline, a PRM system automatically alerts ATC.

The potential for high accuracy and high update rate provided by a *Multilateration System* is ideally suited to PRM applications.

### 1.4.4 Update Interval and Output Period

The concepts of an "update interval" and "output period" are fundamental to the correct understanding of this document and an important difference between a WAM system and a radar system.

WAM system receives target updates aperiodically as replies to interrogations from both the WAM system itself, as replies to interrogations of other systems (e.g. SSR and TCAS systems) and from squitter messages spontaneously transmitted by the target transponder/transmitter device. This is fundamentally different behaviour to radar which only processes and outputs replies determined to have been received when its main beam points in the direction of the target. It also means that the WAM system can output target data either aperiodically (immediately after the target signal is measured, i.e. "data-driven" output) or periodically. This approach is different from the radar that can only output data at a rate based on its antenna rotation time or scan period.

The term *Output Period* is used to define the selectable period that the WAM system uses to output target reports periodically.

The variable nature of the WAM *Output Period* means that the *Output Period* cannot be used for assessing WAM performance in the way the fixed scan period of radar can because for different values of the *Output Period*, the WAM system will provide target data with different probability, accuracy and other performance characteristics.

The term *Update Interval* is used to define the time interval over which the performance of the WAM system is measured. This allows the performance of the WAM system to be assessed independently of the *Output Period* configured in the system and it allows a mechanism for a meaningful comparison of the WAM performance against the radar one.

Maximum values of the *Update Interval* for 3 NM and 5 NM separations are specified in this document. These allow compliance with EUROCONTROL Surveillance Standard [REF9]. All the surveillance performance parameters that depend on a time interval are then specified in terms of the defined *Update Interval*.

## 1.5 COMPOSITION OF THE WAM

WAM systems typically consist of the following main ground components (see also Figure 1-1):

- Ground station
- Reference and Monitoring Transponder
- Central processor
- Network connections
- CMS and interfaces

### 1.5.1 Ground station

#### 1.5.1.1 Receiving Unit (RXU)

The main tasks of the *Receiving Unit* are to receive signals from target SSR/Mode S transponders, digitize the signals, measure *TOA*, and transfer the digitized data over a suitable data link to the Central Processor (CP).

#### 1.5.1.2 Transmitting Unit (TXU)

The main tasks of the *Transmitting Unit* are to interrogate target SSR/Mode S transponders, in accordance with requests received over a suitable data link from the CP.

### 1.5.2 Reference and Monitoring Transponders (RMTR)

If an RMTR is part of the system, it is used for *Integrity* checking, and is installed in and/or around the coverage area. It spontaneously transmits Mode S *Squitter* and/or responds to *Interrogation*. The transmitted *Squitters* can also be utilized for the *TOA* measurement synchronization.

### 1.5.3 Central Processor

A node within a WAM system where the information from multiple receiving stations is collated for the purposes of measuring target position through *TDOA* calculation, and assembling target reports for output from the WAM system. The Central Processor will also generally carry out other management functions.

### 1.5.4 Network connections

The communication links between the components of the WAM system. These may be dedicated links with fixed transmission delays, or may make use of general purpose communication infrastructure. The type of network connection used will generally be dictated by the timing method used by the particular WAM system.

### 1.5.5 CMS and interfaces

The required control and monitoring functions of the WAM system, together with the necessary interfaces to the other equipment.

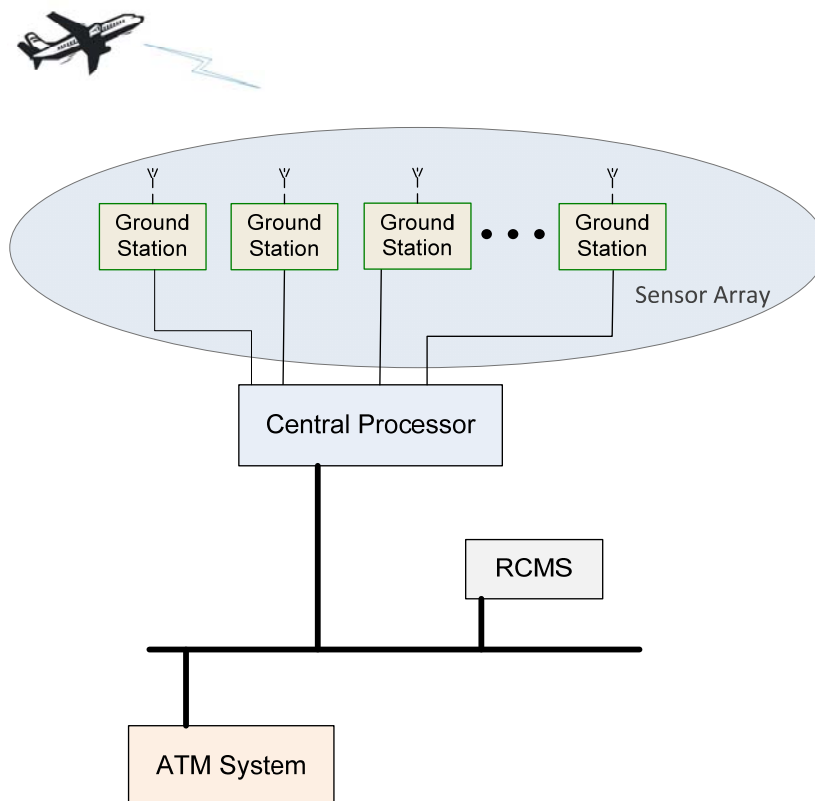


FIGURE 1-1: TYPICAL CONFIGURATION OF WAM

## 1.6 DEFINITIONS AND ABBREVIATIONS

### 1.6.1 Definitions

**NOTE:** *The use of italics within the definition indicates that the definition is described in terms of another definition.*

#### Accuracy

*Accuracy* is the quantitative bound of certainty in the calculated position for a target as related to the true position of that target.

**NOTE:** *Horizontal position Accuracy is expressed as a Root Mean Square (RMS) of an absolute distance error averaged over statistically significant set of measurements:*

$$RMS = \sqrt{(x - x')^2 + (y - y')^2}$$

*Where (x, y) is the target's true horizontal position and (x', y') is a horizontal position measured by the WAM system.*

#### Active Multilateration

A multilateration function carried out with signals obtained by *Interrogation* of target.

## ADS-B

ADS-B: Automatic Dependent Surveillance – Broadcast (ADS-B) is a means by which aircraft, aerodrome vehicles and other objects automatically transmit and/or receive identification, position, velocity and additional data in a broadcast mode via a data link

### Aircraft Address

A unique combination of twenty-four bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

### Aircraft Identification (ACID)

The operational identification of the flight as used in the Item 7 of the flight plan. It is either the ICAO designator for the aircraft operating agency followed by the flight Identification or the registration marking of the aircraft (when no flight plan is available or there is no aircraft operating agency designator).

E.g. as a result of *Squitter* or generated by external active interrogating systems.

### Approach

*Approach* is the area from the runway threshold out to a distance of 20 nautical miles and within the runway glide path.

### Availability

The probability that a system is able to perform its intended function at the initiation of the intended operation.

It is quantified as the proportion of time the system is actually available to the time the system is planned to be available. Periods of planned maintenance are discounted from *Availability* figures.

**NOTE:** *This definition is consistent with EUROCAE ED-126.*

### Assurance Level (AL)

A measure of software assurance of ground based systems used for Communication, Navigation and Surveillance in an Air Traffic Management context (CNS/ATM).

**NOTE:** *Assurance Level is defined in ED-109 and are numbered AL1 to AL6 with AL1 being the most stringent.*

### Cartesian Coordinates

[Within this document] Coordinates X, Y, Z in a local 3D *Cartesian Coordinates* system with an origin at a system *Reference Point* defined in WGS-84 coordinates, where:

- X and Y – axes define a plane which is tangential to the WGS-84 Ellipsoid at the location of the origin
- Y – axis points to the geographical north at the origin
- X – axis is perpendicular to the Y – axis and points to the geographical east at the origin
- Z – axis is perpendicular to the X, Y plane and points away from the centre of the Earth

**NOTE:** *This 3D Cartesian Coordinates system is consistent with the 2D system that is defined in Cat020 Standard document [REF7].*

The system *Reference Point* is defined in WGS-84 coordinates and may be published in ASTERIX Category 019 using data items I019/600 and I019/610.

### Central processor

A node within a WAM system where the information from multiple *receiving stations* is collated for the purposes of measuring target position, assembling *target reports*, and carrying out other management functions of the WAM system.

### Continuity of Service

The ability of a system or an item to perform its required function without unscheduled interruption throughout the duration of the intended operation, assuming the system is available when the procedure is initiated.

**NOTE:** *This definition is consistent with EUROCAE ED-126.*

### Data Age

The interval between the *Time of Applicability* of a piece of information and the time of output.

### Data Driven Mode

The interval between successive *Target Reports* from the same target is governed by the rate at which successful *Position detection* are achieved by the WAM system.

### Detection

A successful decode of a target transmission.

**NOTES:** 1. See also *Position detection*.  
2. Includes SSR interrogator replies and Squitter (1090MHz).

### DOP (Dilution of Precision)

The influence of the geometrical configuration of the *Multilateration System* relative to the target on the *Accuracy* of the measured position of that target.

**NOTE:** *The locations of the receivers can be favourable or unfavourable for a given target location. An unfavourable location can greatly increase the error even if the TDOA Accuracy is maintained. A low DOP value represents a better positional Accuracy and relates to wider angular separation between the receivers used to calculate target position.*

### Extrapolation [persistent data]

The continued use of parameters that remain constant or changes infrequently for inclusion in *Target Reports* when these parameters have not been explicitly refreshed or updated from the target source.

**NOTE:** *Such parameters should normally have a maximum acceptable Data Age beyond which Extrapolation should not be continued.*

### Extrapolation [variable data]

The calculation of the value of a parameter at a specified point in time based upon a historical sequence of values for that parameter for inclusion in *Target Reports* when the parameter has not been explicitly refreshed or updated from the target source.

**NOTE:** *The calculations will require a tracking function to be performed on historical data in order to generate the extrapolated data.*

### False Target Report

Either:

A *Target Report* at a position of greater distance from the true position than:

- 2100m for 5NM separation
- 1690m for 3NM separation.

Or

- A *Target Report* that is spurious i.e. does not relate to any target within the *Operational Coverage Volume*.

### Ground station

A *Receiving Unit* or a *Transmitting Unit* or an arrangement of co-located *Receiving Unit* and *Transmitting Unit* with all supporting infrastructure.

**NOTES:**

1. This would include antennae; masts; communication links; power; environmental housing; etc as appropriate to the operating requirements.
2. In Asterix specifications this is sometimes referred to as a Remote Sensor.

### Identity

Operational identification consisting of either Aircraft Identity (ACID) or SSR Mode A code.

### Integrity

An attribute of a system or an item indicating that it can be relied on to perform correctly on demand. (It includes the ability of the system to inform the user in a timely manner of any performance degradation.

**NOTE:** This is consistent with EUROCONTROL Surveillance Standard definition B-3.2.

### Interrogation

Generation of signals for the purpose of eliciting a transmission from target.

### Illegal Aircraft Address

An address consisting of all zeros or all ones.

### Multilateration System

A *Multilateration System* is any group of equipment configured to provide position and identification derived from target transmitted signals using Time Difference of Arrival (TDOA) techniques.

### Multipath

The phenomenon whereby signals arrive at the antenna of a *Receiving Unit* by more than one route.

**NOTE:** Multipath can create a number of different interference effects to the detriment of multilateration performance. Where the path length differences are very large or where the direct (line-of-sight) path is obscured Multipath can create False Targets.

### Multiple Targets

The condition whereby transmissions from a single target result in the simultaneous reporting of more than one target position.

**NOTE:** This effect may be caused by Multipath or by unresolved incorrect solutions. If the target is non-ambiguous through other Identity information then the condition will be readily identified and may be resolvable. If the target is ambiguous then it may not be possible to resolve that the Multiple targets are not valid.

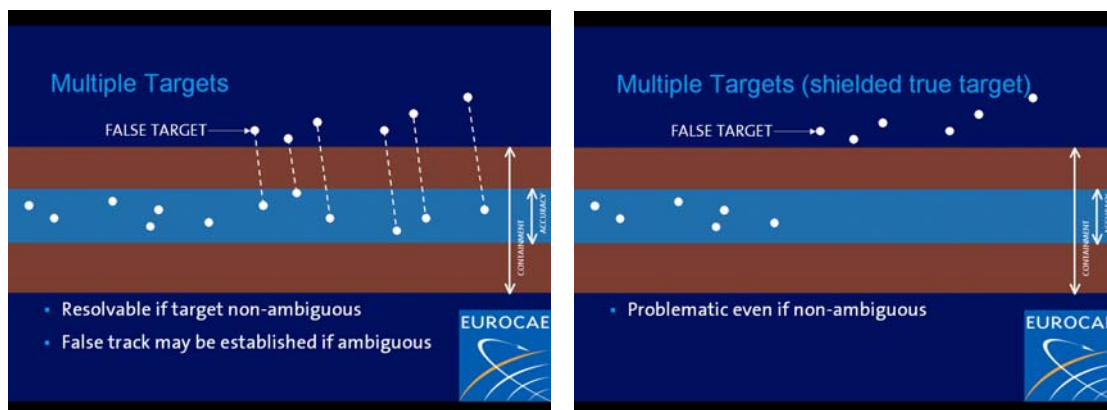


FIGURE 1-2: ILLUSTRATION OF MULTIPLE WHERE TRUE POSITION MAY OR MAY NOT BE PRESENT

### Non-transponder device

Device capable of broadcasting 1090 extended *Squitter* (DF18) that is not part of a Mode S transponder.

### Operational Coverage Volume

The geographic volume of interest within which the system provides surveillance with required performance.

### Output Period

Time between successive *Target Reports* for the same target.

**NOTE:** This term is applied to a WAM system operating in a Periodic Mode. (i.e. where a regular time interval between *Target Reports* is required). The *Output Period* should not exceed the *Update Interval*.

### Periodic Delayed Mode

The system operates a fixed time interval between successive *Target Reports* for the same target. The most recent measurement is delayed to the *Output Period* boundary. The *Time of Applicability* of the most recent measurement is preserved.

**NOTE:** This mode will be used where a regular time interval between the outputs of *Target Reports* is required by the end user.

### Periodic Predicted Mode

The system operates a fixed time interval between successive *Target Reports* for the same target. The *Target Report* contains predicted information based upon previous data. *Time of Applicability* will be set to the time the *Target Report* is created.

**NOTE:** This mode will be used where a regular time interval between the *Time of Applicability* of *Target Reports* is required by the end user.

### Position detection

A successful decoding of a target transmission at a sufficient number of sensors to allow calculation of the multilateration position in at least the lateral dimension.

### Predicted Position

A position obtained from an *Extrapolation* process when operating in Periodic Mode such that output data generated on each *Output Period* is applicable at the time of output.

**NOTE:** *If Predicted Position does not include a Position detection made within that Output Period then that target position will be considered to be extrapolated.*

### Probability of position detection (PD)

The probability of generating a *Target Report* during the defined *Update Interval* where the *Target Report* has derived the target position from at least one *Valid Position Detection* occurring within the *Update Interval*.

### Probability of false detection (PFD)

The ratio of the total number of *False Target Reports* to the number of all *Target Reports* output by the WAM system.

### Probability of code detection (PCD)

The probability of outputting at least one correct and validated code (Mode A, Mode C) within an *Update Interval* in which a *Target Report* has been output.

For Mode S target, the ratio of *Target Reports* with correct *Aircraft Address* to the total number of Mode S *Target Reports*.

**NOTE:**

1. *Separate probability figures will normally be applied to the PCD of Mode A, the PCD of Mode C, and the PCD of Aircraft Address.*
2. *For a Mode S Target Report, the Mode A Code may be an Extrapolation [persistent data].*
3. *For a Mode S Target Report there will be a Pressure Altitude report instead of a Mode C code.*

### Probability of false code detection (PFCD)

The ratio of the number of *Target Reports* containing an incorrect but validated code to the total number of *Target Reports* which contain a code (Mode A, pressure altitude);

For Mode S target, the ratio of the number of *Target Reports* containing an incorrect *Aircraft Address* to the total number of Mode S *Target Reports*.

**NOTE:**

1. *Separate probability figures will normally be applied to the PFCD of Mode A, the PFCD of Mode C, and the PFCD of Aircraft Address.*
2. *For a Mode S Target Report, the Mode A Code may be an Extrapolation [persistent data].*
3. *For a Mode S Target Report there will be an altitude report instead of a Mode C code.*

### Probability of Position Long Gap (PLG)

The probability of two or more consecutive *Update Intervals* where no *Valid Position Detection* is obtained for a target.

**NOTES:**

1. *The calculation of PLG excludes false target reports.*

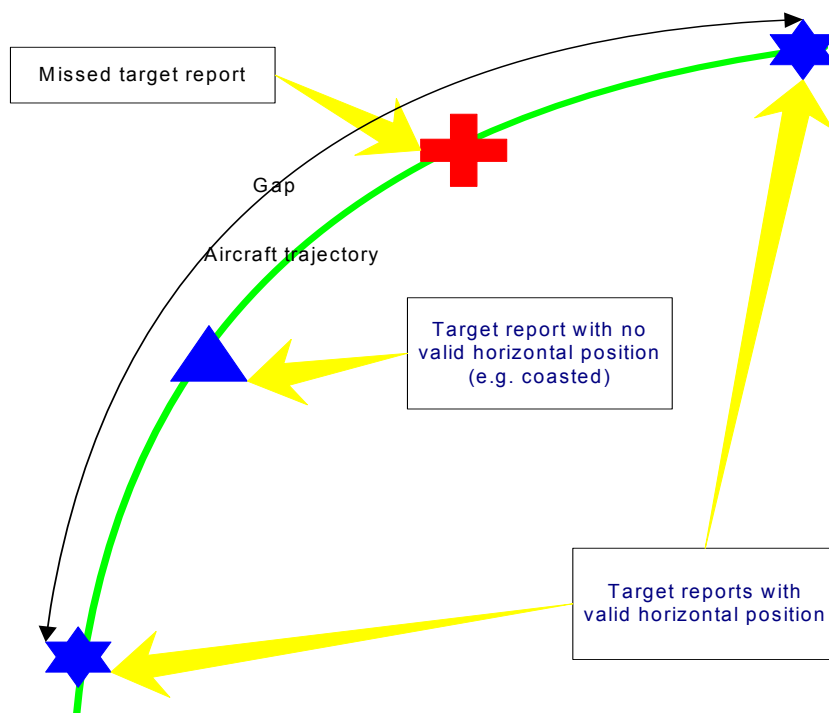


**FIGURE 1-3: ILLUSTRATION OF A LONG POSITION GAP**

### Processing delay

The delay between the signal arriving at the *Receiving Unit* and the time at which a *Target Report* is output by the *Multilateration System*.

- NOTE:**
1. The time difference between receiving a signal at multiple *Receiving Unit* is assumed negligible (generally shorter than one millisecond) as a component of *Processing delay*.
  2. *Processing delay* is a measure of WAM performance. *Processing delay* requirements should have an associated probability.
  3. This definition applies to *Data Driven Mode* only.

### Positional Resolution

The distance between two targets below which the surveillance system can no longer achieve specified performance.

### Receiving Unit

A device capable of *Detection* of signals-in-space and processing these into a form suitable for onward transmission.

### Reference Point

The origin of the co-ordinate system of a multilateration system from which all positional information is measured.

### Smoothing

Smoothing is the process of averaging/filtering by the WAM system of multiple measurements for a single target to produce consolidated output data.

- NOTE:** *Smoothing may be used to reduce the measurement noise in Position detection. It may also be used in circumstances of high position detection rates to limit Target Report rates to an acceptable level.*

### Squitter

A spontaneous transmission generated at a pseudo random rate by a Mode S transponder.

### System Capacity

System capacity is defined as the minimum number of target that the system must process within a specified time interval.

### Target

Any vehicle or aircraft equipped with an SSR transponder or equivalent, which has been turned on and is functioning in compliance with its Minimum Operating Performance Standards.

### Target Report

An output of a *Multilateration System* providing position, *Identity* and potentially additional information for a target obtained by multilateration calculation on one or more target transmission received at a number of sensors (see also *Position detection*).

**NOTE:** *A Target Report may be generated from a single Position detection. Alternatively it may be derived from a number of target transmissions through a Smoothing or Extrapolation process.*

### Target Trajectory

A reconstruction of a single target's movement within the coverage of a surveillance system by means of associating a sequence of *Target Reports*.

**NOTE:** *An analysis function capable of generating target trajectories from recordings of surveillance data may be used in the analysis of system Accuracy, and also in the measurement of probabilities of Position detection/false detection.*

### Time of Applicability

The time at which a measurement or *Extrapolation* of any varying parameter can be considered as true within the bounds of expected error.

**NOTE:** *Error in estimating Time of Applicability is a contribution to overall error and should therefore be minimised by design. Processing delay beyond the point where Time of Applicability has been applied does not contribute to error, but contributes to Data Age.*

### Time Difference of Arrival (TDOA)

The *TDOA* is the difference in relative time that a transmission from the same target is received at different *Receiving Unit*

**NOTE:** *TDOA relates directly to path length difference between a targets and a number of sensors and is the principle upon which multilateration is performed.*

### Time of Arrival (TOA)

The *Time of Arrival* is the time a transmission from a target is received at a *Receiving Unit*.

### Track

A progressive series of *Target Reports* that have been associated with a single target.

### Transmitting Unit

A device capable of generating signals for the purpose of target *Interrogation* in accordance with ICAO Annex 10 Volume IV for Secondary Surveillance Radar.

### Transponder

A device compliant with ICAO Annex 10 Volume IV for reception of, and response to *Interrogation* from a Secondary Surveillance Radar.

**NOTE:** *Of particular relevance to WAM systems is a device that does not receive or respond to Interrogation but emulates some or all transponder transmission types (e.g. Mode S Extended Squitter).*

### Update

A renewal of *Target Reports* relating to all targets under surveillance.

### Update Interval

The maximum permissible time interval between successive *Target Reports* for the same target.

**NOTE:** *Use of Update Interval and an associated probability is a measure of WAM performance that is equivalent to radar performance measured in terms of the probability of detection of a target in a single rotation period.*

### Valid Position Detection

A *Position Detection* that indicates the true position of a target within the expected bounds of *Accuracy*.

**NOTE:** *A Position Detection which is not a Valid Position Detection may give rise to a False Target Report.*

### Validation

The determination that the requirements for a product are sufficiently correct and complete.

### Verification

The evaluation of an implementation of requirements to determine that they have been met.

## 1.6.2

### Abbreviations

|                |                                                                      |
|----------------|----------------------------------------------------------------------|
| <b>ACAS</b>    | Airborne Collision Avoidance System                                  |
| <b>ACC</b>     | Area Control Centre                                                  |
| <b>ACID</b>    | Aircraft Identification                                              |
| <b>ADS-B</b>   | Automatic Dependent Surveillance - Broadcast                         |
| <b>AL</b>      | Assurance Level                                                      |
| <b>ANS</b>     | Air Navigation System                                                |
| <b>ASTERIX</b> | All purpose STructured EuRocontrol surveillance Information eXchange |
| <b>ATC</b>     | Air Traffic Control                                                  |
| <b>ATM</b>     | Air Traffic Management                                               |
| <b>BDS</b>     | comm-B Data Selector                                                 |
| <b>BITE</b>    | Built In Test Equipment                                              |
| <b>CA</b>      | Communication Capability                                             |
| <b>CE</b>      | Conformité Européenne (European CE mark)                             |
| <b>CMS</b>     | Control and Monitoring System                                        |
| <b>CNS</b>     | Communication, Navigation and Surveillance                           |
| <b>CP</b>      | Central Processor                                                    |
| <b>DF</b>      | Downlink Format                                                      |

|                |                                                               |
|----------------|---------------------------------------------------------------|
| <b>DOP</b>     | Dilution of Precision                                         |
| <b>DPR</b>     | Data Phase Reversals                                          |
| <b>EEC</b>     | European Economic Community                                   |
| <b>EHS</b>     | Enhanced Surveillance                                         |
| <b>ELS</b>     | Elementary Surveillance                                       |
| <b>EMC</b>     | Electromagnetic compatibility                                 |
| <b>ETSI EN</b> | European Telecommunications Standards Institute European Norm |
| <b>EU</b>      | European Union                                                |
| <b>FAA</b>     | Federal European Authority                                    |
| <b>FAT</b>     | Factory Acceptance Test                                       |
| <b>FL</b>      | Flight level                                                  |
| <b>FS</b>      | Flight Status                                                 |
| <b>GBS</b>     | Ground Bit Status                                             |
| <b>HME</b>     | Height monitoring                                             |
| <b>ICAO</b>    | International Civil Aviation Organisation                     |
| <b>IFR</b>     | Instrumental Flight Rules                                     |
| <b>ILS</b>     | Instrument Landing System                                     |
| <b>LRU</b>     | Line Replaceable Unit                                         |
| <b>LVD</b>     | Low Voltage Directive                                         |
| <b>MB</b>      | Mode S comm-B data                                            |
| <b>MLAT</b>    | Multilateration                                               |
| <b>MOPS</b>    | Minimum Operational Performance Specification                 |
| <b>MSL</b>     | Mean Sea Level                                                |
| <b>MTBCF</b>   | Mean Time Between Critical Failures                           |
| <b>MTTR</b>    | Mean Time To Repair                                           |
| <b>NM</b>      | Nautical Miles                                                |
| <b>OVL</b>     | Overload Indicator                                            |
| <b>PCD</b>     | Probability of Code Detection                                 |
| <b>PD</b>      | Probability of Position Detection                             |
| <b>PFCD</b>    | Probability of False Code Detection                           |
| <b>PFD</b>     | Probability of False Detection                                |
| <b>PLG</b>     | Probability of Long position Gap                              |
| <b>PRM</b>     | Parallel Runway Monitoring                                    |
| <b>RA</b>      | Resolution Advisory                                           |
| <b>RF</b>      | Radio Frequency                                               |
| <b>RMS</b>     | Root Mean Square                                              |
| <b>RMTR</b>    | Reference and Monitoring Transponder                          |
| <b>RTCA</b>    | Radio Technical Commission for Aeronautics                    |
| <b>RVSM</b>    | Reduced Vertical Separation Minima                            |
| <b>RXU</b>     | Receiving Unit                                                |

|             |                                           |
|-------------|-------------------------------------------|
| <b>SAC</b>  | The System Area Code                      |
| <b>SAE</b>  | the Society of Automotive Engineers       |
| <b>SAT</b>  | Site Acceptance Test                      |
| <b>SDP</b>  | Standard Deviation of Position            |
| <b>SIC</b>  | System Identification Code                |
| <b>SPI</b>  | Special Position Identification           |
| <b>SPR</b>  | Synch Phase Reversal                      |
| <b>SSR</b>  | Secondary Surveillance Radar              |
| <b>SWAL</b> | Software Assurance Level                  |
| <b>TDOA</b> | Time difference of arrival                |
| <b>TMA</b>  | Terminal Manoeuvring Area                 |
| <b>TOA</b>  | Time of Arrival                           |
| <b>TP</b>   | Test Procedure                            |
| <b>TPL</b>  | Test Plan                                 |
| <b>TR</b>   | Test Result                               |
| <b>TT</b>   | Type Test                                 |
| <b>TXU</b>  | Transmitting Unit                         |
| <b>UF</b>   | Uplink Format                             |
| <b>UTC</b>  | Coordinated Universal Time                |
| <b>WAM</b>  | Wide Area Multilateration                 |
| <b>WEEE</b> | Waste electrical and electronic equipment |
| <b>WGS</b>  | World Geodetic System                     |

## 1.7 REFERENCES

### 1.7.1 ICAO

- REF1** Annex 10 — *Aeronautical Telecommunications Volume IV — Surveillance and Collision Avoidance Systems*
- REF2** Annex 11 — *Air Traffic Services*
- REF3** *Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)*
- REF4** Technical Provisions for Mode S Services and Extended Squitter (Doc 9871)

### 1.7.2 Eurocontrol

- REF5** EUROCONTROL Standard Document for Surveillance Data Exchange, Part 1, All Purpose Structured Eurocontrol Surveillance Information Exchange (ASTERIX), SUR.ET1.ST05.2000-STD-01-01
- REF6** EUROCONTROL Standard Document for Surveillance Data Exchange, Part 18: Category 019, Edition 1.2, Multilateration System Status Messages, SUR.ET1.ST05.2000-STD-18-02
- REF7** EUROCONTROL Standard Document for Surveillance Data Exchange, Part 14: Category 020, Edition 1.5, Multilateration Target Reports, SUR.ET1.ST05.2000-STD-14-02

- REF8** EUROCONTROL Standard Document for Surveillance Data Exchange, Part 14: Category 020, Appendix A, Coding Rules for "Reserved Expansion Field", Edition 1.2, SUR.ET1.ST05.2000-STD-14-02
- REF9** EUROCONTROL Standard Document for Radar Surveillance in En-Route Airspace and Major Terminal Areas, Edition 1.0 March 1997, SUR.ET1.ST01.1000-STD-01-01
- REF10** European Mode S Station Coverage Map Interface Control Document SUR/MODES/EMS/ICD-03 edition 1.16

### 1.7.3

#### **EUROCAE/RTCA**

- REF11** EUROCAE, Guidelines for Communication, Navigation, Surveillance and Air Traffic Control (CNS/ATM) Systems Software Integrity Assurance ED-109
- REF12** EUROCAE, Guidelines for ANS Software Safety Assurance ED-153
- REF13** Minimum Aviation System Performance Standards for ADS-B, RTCA/DO-242, February 19, 1998
- REF14** Minimum Operational Performance Standards for 1090 MHz Extended Squitter ADS-B and TIS-B, ED-102A/DO-260B, 2010
- REF15** Minimum Operational Performance Standards for Secondary Surveillance Radar Mode S Transponders ED-73C; Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment, DO-181D
- REF16** Technical Specification for a 1090 Mhz Extended Squitter ADS-B Ground station ED-129