INTERNATIONAL CIVIL AVIATION ORGANIZATION

AFI PLANNING AND IMPLEMENTATION REGIONAL GROUP
EIGHTEENTH MEETING (APIRG/18)
Kampala, Uganda (27 – 30 March 2012)

Agenda Item 3: Performance Framework for Regional Air Navigation Planning and Implementation
3.4 Communications, Navigation and Surveillance (CNS)

SURVEILLANCE SYSTEMS

(Presented by the Secretariat)

SUMMARY
This working paper presents the report of the Fourth Meeting of APIRG Communications, Navigation and Surveillance Sub-group (CNS/SG/4, Dakar, Senegal, 25-29 July 2011) on Aeronautical Surveillance, for consideration by APIRG/18.
Action by the meeting is at **paragraph 3.**
REFERENCES : • APIRG/17, Report • CNS/SG/4, Report Note: References can be downloaded from ***www.icao.int***
Related ICAO Strategic Objective: C

1. INTRODUCTION

1.1 The Fourth Meeting of the APIRG Communications, Navigation and Surveillance Sub-group (CNS/SG/4) was held in Dakar, Senegal from 25 to 29 July 2011. It was attended by sixty one (61) delegates from twenty four (24) Contracting States and three (3) international Organizations.

2. DISCUSSION

Review of the status of implementation of the current aeronautical surveillance plan

2.1 The meeting reviewed the status of implementation of aeronautical surveillance requirements for en – route operations against the AFI Air Navigation Plan requirements, in accordance with APIRG Decision 16/26 (Review of CNS system performance). The meeting noted that operational automatic dependent surveillance – contract (ADS-C) procedures were being implemented by States and Organization in their managed FIRs[1], in order to improve

[1] In 2011, ADS-C procedures were operational/planned in Accra, Algiers, Antananarivo, Brazzaville, Dakar Terrestrial, Dakar Oceanic, Johannesburg, Mauritius, Ndjamena, Niamey, Sal Oceanic, and Seychelles.

aeronautical surveillance. It recalled that the requirement for AFI ACCs was introduced in the Regional Air Navigation Plan (ICAO Doc 7474) by APIRG/13 in 2001, to support en-route operations, as well as APIRG Conclusion 17/31 reiterating this requirement.

2.2 The meeting was presented with ASECNA plans to implement ADS-C its six managed flight information regions covering 18 AFI States.

Review of the Report of the Second Meeting of the AFI Surveillance Implementation Task (AS/I/TF/2)

Draft AFI Surveillance Strategy

2.3 The meeting reviewed the Second AFI Surveillance Implementation Task Force Meeting which took place on 20-21 June 2011 in Dakar, Senegal. It endorsed the Draft AFI Surveillance Strategy as amended by the Task Force, as shown at **Appendix A** to this working paper. However, the CNS Sub-group, in conjunction with the ATM/AIM/SAR Sub-group, established an Ad Hoc Working Group to determine the separation minima to be supported by selected surveillance technologies. The meeting formulated the following draft Conclusion 4/17:

DRAFT CONCLUSION 4/17: AFI SURVEILLANCE STRATEGY

That the draft of the AFI Surveillance Implementation Strategy shown at Appendix A to this Working Paper be adopted for the AFI Region.

Exchange and monitoring of surveillance data

2.4 The meeting discussed the need for neighboring States/ACCs to exchange surveillance data to enhance aeronautical surveillance in the region, and for the AFI Region to implement a monitoring system to address reported problems. These issues were included in the Task Force future work programme.

Categorization of terminal areas (TMAs) and aerodromes

2.5 The meeting noted that a limited number of States had participated in the survey conducted by the Secretariat as a follow up to APIRG Conclusion 17/33, by providing the data that were needed for the categorization of terminal areas (TMAs) and aerodromes. It therefore urged States having not yet done so to task designated contact persons with collecting and providing the required data.

Automatic dependent surveillance – Broadcast (ADS-B)

2.6 The meeting was briefed on the progressive evolution of ADS-B standards up to Version 2 (DO-260B) which incorporates changes aimed to address the various problems identified from operational experience and application development activities. It also noted that the future work of ICAO would include the development of low-power and low-cost ADS-B OUT/IN units, as well as multistatic radar which uses the emissions of other radio transmitters (e.g. broadcasting stations) to get a fix on the aircraft. Accordingly, the meeting requested AFI States planning to implement ADS-B to establish a proper regulatory framework based on applicable standards.

Future work programme and composition of the AFI Aeronautical Surveillance Implementation Task Force

2.7 The meeting reviewed and updated the future work programme and composition of the Task Force as shown at **Appendix B** to this report.

3. CONCLUSION

3.1 The meeting is invited to:

a) Note the report of the Fourth Meeting of the APIRG Communications, Navigation and Surveillance Sub-group on Surveillance systems as presented in this working paper and;

b) Review and adopt the above CNS/SG/4 Draft Conclusion 4/17 on the AFI Surveillance Implementation Strategy.

---END---

APPENDIX A

AFI SURVEILLANCE STRATEGY

Draft - Revision 0.1

23 June 2011

REVISION INDEX SHEET

Version	Revision	Date	Reason for Change	Pages Affected
Draft	0	23/06/11	New Document	All

PROLOGUE

Air traffic is growing at a significant rate. There is also an increasing demand for more operating flexibility to improve aircraft efficiency and to reduce the impact of air travel on the environment. Improved tools are required to safely manage increasing levels and complexity of air traffic. Aeronautical surveillance is one such important tool in the air traffic management (ATM) process.

Surveillance plays an important role in air traffic. The ability to accurately determine, track and update the position of aircraft has a direct influence on the minimum distances by which aircraft must be separated (i.e. separation standards), and therefore on how efficiently a given airspace may be utilized.

In areas without electronic surveillance, where air traffic management is reliant on pilots reporting their position verbally, aircraft have to be separated by relatively large distances to account for the uncertainty in the reported position because of the delivery delay and the low rate at which the information is updated.

Conversely, in areas where electronic surveillance systems are used, and aircraft positions are updated frequently, the airspace can be used more efficiently by safely accommodating a higher density of aircraft through reduced separation minima. In this way the surveillance function provides an indication of any unexpected aircraft movements and is an important safety function.

Accurate surveillance can furthermore be used as the basis for automated alerting systems. The ability to accurately track aircraft enables air traffic controllers to be alerted when an aircraft is detected to deviate from its assigned altitude or route or when the future positions of two or more aircraft are predicted to fall below minimum acceptable separation standards. Alerts may also be provided when the aircraft strays below the minimum safe altitude or enters a restricted area.

The existing fixed route structure provides increased certainty of aircraft movements making it easier for controllers to manage air traffic. With improved navigation performance on board aircraft, airspace users are demanding greater flexibility to determine the most efficient routes to satisfy their operating conditions. There is a push for restrictions associated with flying along fixed routes to be lifted. In such an environment, accurate surveillance is required to assist controllers in the detection and resolution of any potential conflicts associated with the flexible use of airspace which will result in a more dynamic environment.

The main objective of this strategy is to propose the surveillance systems that are suitable to be applied in short and medium terms within the AFI Region and to define an evolutionary path that will promote safety, interoperability and cost effectiveness of the required infrastructure to meet the future air traffic management needs. The surveillance strategy should be seen as a guidance document to all stakeholders, without any regulatory or mandatory requirements. Appropriate regulations should be published by Air Navigation Authorities when the use of new surveillance techniques is to be introduced in the States.

This strategy is a live document and should be reviewed and updated every two years.

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AFRICA-INDIAN OCEAN SURVEILLANCE STRATEGY

Introduction

Purpose

The surveillance strategy should be seen as a link between the Global Air Navigation Plan for CNS/ATM Systems (Doc. 9750), the AFI Plan and the individual stakeholders' strategy for the air surveillance applications.

Implementation of surveillance systems should be based on a harmonized strategy for the AFI Region that would take into account the operational requirements and relevant cost-benefit analyses. It should also be based on action plans to ensure that AFI States, Regional and International Organizations implement the necessary systems in accordance with consistent timescales.

The surveillance technologies considered in this strategy, to meet present and future ATM expectations are:

- Voice Reporting;
- Primary Radar (PSR);
- Secondary Surveillance Radar (SSR);
- Multilateration (MLAT);
- Automatic Dependent Surveillance-Contract (ADS-C); and
- Automatic Dependent Surveillance-Broadcast (ADS-B).

In order to provide a global view of the surveillance strategy, the operational drivers, the required surveillance infrastructure and the regional studies and trials proposed in this document have been displayed in each chapter in a chronological presentation.

The timeframes illustrated in this document define the tentative dates when surveillance systems are estimated to become regionally operational. Nevertheless, some of the surveillance systems described in this strategy will be used to solve local issues prior to the timescales in this document, and thereby will migrate from pioneer areas into bigger regional areas.

Applicability

This strategy was developed for use by the following stakeholders group within the Africa-Indian Ocean (AFI) Region:

- The departments of the National Supervisory Authorities of AFI countries who are responsible for verifying ATM Surveillance Systems;
- The departments of the civil and military ANSP of AFI states who are responsible for procuring/designing, accepting, and maintaining ATM Surveillance Systems;
- The Airport Operators, who are responsible for procuring/designing, accepting, and maintaining Surveillance Systems at airports level; and
- The Airspace Users, who are the final client of the ATM Surveillance Systems chain.

Reference Documents

- Doc 9924, Aeronautical Surveillance Manual;

Aeronautical Surveillance – Air-Ground Surveillance Systems

The aeronautical surveillance system may be broadly divided into four parts:

- a "remote surveillance subsystem" installed within the target under surveillance, which has two main functions: to collect the data from different onboard sensors/interfaces and to transmit them to other parts of the system or to other users;

- a sensor system that receives and collects surveillance information about targets under surveillance;

- a communication system which connects the sensor systems to an SDP system and allows transfer of the surveillance data. Ground communication may also support control and monitoring of the sensor; and

- an data processing system that combines the data received from the different sensors in one data stream, optionally integrates the surveillance data with other and provides/distributes the data to the users in a specified manner removing the possible different specificities of the different types of sensors.

The sensor is a significant part of the aeronautical surveillance system. It provides surveillance information which is then presented to air traffic controllers. The available sensors/systems can currently be categorized as:

- Non-Cooperative
- Independent Cooperative
- Dependent Cooperative

The remainder of this section provides an high level overview of the sensors available for aeronautical surveillance applications.

Non-Cooperative Sensors / Systems

Primary Surveillance Radars (PSR)

Primary Surveillance Radars works by detecting reflections to transmitted pulses of radio frequency energy. The ground station typically consists of a transmitter, receiver and rotating antenna. The system transmits the pulses and then detects and processes the received reflections. The slant range of the target is determined by measuring the time from transmission of the signal to reception of the reflected pulses. The bearing of the target is determined by noting the position of the rotating antenna when the reflected pulses are received. Reflections are obtained from targets of interest and fixed objects (e.g. buildings) which tend to create clutter. Special processing techniques are used to remove the clutter.

In the 1960s and 1970s, Primary Surveillance Radars was widely used for en-route surveillance. From the late 1970s many air navigation service providers decided to discontinue use of Primary Surveillance Radars for that application mainly because of its high cost and inability to provide identification, which became more important with increasing traffic densities. Also, mandatory requirements for aircraft to carry transponders in airspace with high traffic meant that surveillance could be provided using Secondary Surveillance Radars. In many countries the use of Primary Surveillance Radars is retained for defence or for weather-monitoring purposes rather than for the provision of civil ATC services.

Primary Surveillance Radars has not been standardized by ICAO, but remains a useful tool in busy terminal areas where it provides surveillance of aircraft not equipped with a transponder (intruder detection). The future use of traditional Primary Surveillance Radars is expected to decrease mainly due to widespread transponder carriage and the introduction of other surveillance technologies.

Primary Surveillance Radars is also used in airport surface surveillance applications to detect objects that stray onto the active areas of the airport and those aircraft with transponders that are configured to ignore SSR interrogations when on the ground.

Presently Primary Surveillance Radars are generally not the main means of providing surveillance because of its inability to provide target identification (this is mitigated to some extent by voice communication and specific procedures).

Independent Cooperative Sensor Systems

Secondary Surveillance Radars (SSR)

The Secondary Surveillance Radar system consists of two main elements, a ground-based interrogator/receiver and an aircraft transponder. The ground station typically consists of a rotating antenna. The aircraft's transponder responds to interrogations from the ground station enabling the aircraft's range and bearing from the ground station to be determined independantly. The bearing of the aircraft from the radar is determined by measuring the position of the rotating antenna when the reply is received. The range accuracy is generally constant within the coverage volume. However the bearing, being an angular measurement, is less accurate for aircraft that are further away from the radar.

The transponder is allowed a fixed delay within which to decode the interrogation and prepare the reply for transmission. This fixed delay is taken into account by the ground sensor when processing the reply.

Reference transponders, installed at known locations on the ground are used to confirm that the radar is operating correctly. The system is usually configured to generate an alert if the radar fails to receive a reply from the site monitor or reports its position outside a predefined area centred on its true position.

Secondary Surveillance Radars evolved from military applications that required an aircraft to be identified as friendly or hostile. The Mode A/C service was subsequently developed for civil aviation. Since then, Secondary Surveillance Radars has been significantly enhanced to include the Mode S service. Secondary Surveillance Radars share the frequencies 1 030 MHz for interrogations and 1 090 MHz for replies with other systems:

- Mode A/C transponders provide an identity (Mode A) code and pressure altitude (Mode C) code in response to radar interrogations. The spacing of the interrogation pulses determines the mode and hence controls the transponder response. The Mode A identity code, in the form of a four-digit octal number, is assigned by ATC and entered into the transponder by the flight crew. The transponder receives altitude from an on-board pressure altitude encoder or air data computer.

- Mode S allows selective addressing of aircraft through the use of a 24-bit aircraft address that uniquely identifies each aircraft and has a two-way data link between the ground station and aircraft for the exchange of information. It was designed to be backward compatible with and supports all functions of Mode A/C. data link allows additional information such as airspeed, heading, ground speed, track angle, track angle rate vertical rate and roll angle to be obtained from the aircraft. Such aircraft derived data may be used to improve the tracking of the aircraft and to alleviate the need for radio calls for obtaining the information. Other information that may be obtained via the Mode S data link includes the aircraft ID, the altitude selected by the flight crew on the aircraft's mode control panel and an ACAS RA report.

Multilateration (MLAT)

A multilateration system relies on signals from an aircraft's transponder being detected at a number of receiving stations. MLAT uses a technique known as TDOA to establish surfaces that represent constant differences in distance between the target and pairs of receiving stations. The aircraft position is determined by the intersection of these surfaces.

Multilateration can theoretically be performed using any signals transmitted periodically from an aircraft. However, systems used for civil purposes are based only on Secondary Surveillance Radars transponder signals. A multilateration system requires a minimum of four receiving stations to calculate an aircraft's position. If the aircraft's pressure altitude is known then the position may be resolved using three receiving stations. However, in practice, operational multilateration systems have many more receiving stations to ensure adequate coverage and performance.

The accuracy of a multilateration system is non-linear within the coverage volume. It is dependent on the geometry of the target in relation to the receiving stations and the accuracy to which the relative time of receipt of the signal at each station can be determined. A multilateration system needs a common time reference to determine the relative TOA of the signal at the receiving stations. This is normally done in one of two ways:

- Centralized: all the received signals are sent to a central processing station where they are time-stamped by a common clock. In this case, the system must determine and make allowance for the message transit time between each receiving station and the central station. The system transmits messages between the central and receiver stations to monitor and adjust the transit time; or

- De-centralized: the clocks in all of the receivers are kept in synchronism by a common reference such as GNSS, or through the use of a transmitter at a known location. The distance between this transmitter and the receiving stations is known, and by monitoring the time of receipt of the signals from this transmitter at each receiving station, adjustments can be made to ensure the receiver clocks remain synchronized.

Multilateration systems may include transmitting stations capable of interrogating aircraft transponders. This may be necessary if there are no other interrogations in the coverage area of the system to generate SSR reply signals. It may also be necessary to obtain Mode A code, pressure altitude and possibly other (through Mode S replies) aircraft data. Some systems also use the interrogations and subsequent replies to measure the range of the aircraft from the transmitting station in a similar manner to radar. This range measurement supplements the multilateration TDOA information.

Multilateration systems can also process extended squitter signals in two ways:

- by using TDOA, as with all other transponder signals; and
- by decoding the message content to determine the aircraft's position (latitude and longitude), pressure altitude and velocity.

MLAT therefore provides a transition to an environment where the majority of aircraft will be equipped with ADS-B.

Multilateration may be used for airport surface, terminal area and en-route surveillance. Its use for surface surveillance applications relies on aircraft transponders being active while being on the ground. In many aircraft, the transponder's operation is controlled by the weight-on-wheels switch, also known as the squat switch. Mode S transponders continue to transmit squitters and may be selectively interrogated while they are on the ground. However, Mode A/C transponders are often inhibited from replying to interrogations while the aircraft is on the ground to reduce the impact on nearby radar systems.

Dependent Cooperative Systems

Automatic Dependant Surveillance – Contract (ADS-C)

In ADS-C the aircraft uses on-board navigation systems to determine its position, velocity and other data. A ground ATM system establishes a "contract" with the aircraft to report this information at regular intervals or when defined events occur. This information is transmitted on point-to-point data links. This means the information cannot be accessed by other parties (i.e. other aircraft or other ATM systems). The aircraft operator and ATM provider each establish agreements with a data link service provider for delivery of the ADS-C messages. Information that may be transmitted in ADS-C reports includes:

- present position (latitude, longitude and altitude) plus time stamp and FOM;
- predicted route in terms of next and (next +1) waypoints;
- velocity (ground or air referenced); and
- meteorological data (wind speed, wind direction and temperature).

The airborne and ground systems negotiate the conditions under which the aircraft submits reports (i.e. periodic reports, event reports demand reports and emergency reports). Reports received by the ATM system are processed to track the aircraft on displays in a way similar to surveillance data obtained from SSR. The reporting rate for current oceanic operations is normally about 15 to 25 minutes. It is however possible for controllers to manually increase the reporting rate to support specific operations.

ADS-C is typically used in oceanic and remote areas where there is no radar. As a result, it is mainly fitted to long-range air transport aircraft and could support more efficient separation standards than in a case where ATC is reliant only on pilot reports. ADS-C is usually used in conjunction with CPDLC, which allows electronic data communication between ATC and flight crew as an alternative to voice communications.

Note: ADS-C is currently used entirely to provide procedural separation.

Automatic Dependant Surveillance – Broadcast (ADS-B)

ADS-B is the broadcast by an aircraft of its position (latitude and longitude), altitude, velocity, aircraft ID and other information obtained from on-board systems. Every ADS-B position message includes an indication of the quality of the data which allows users to determine whether the data is good enough to support the intended function.

The aircraft position, velocity and associated data quality indicators are usually obtained from an on-board GNSS. Current inertial sensors by themselves do not provide the required accuracy or integrity data, although future systems are likely to address this shortcoming. ADS-B position messages from an inertial system are therefore usually transmitted with a declaration of unknown accuracy or integrity. Some new aircraft installations use an integrated GNSS and inertial navigation system to provide position, velocity and data quality indicators for the ADS-B transmission. These systems are expected to have better performance than a system based solely on GNSS, since inertial and GNSS sensors have complementary characteristics that mitigate the weaknesses of each system. Altitude is usually obtained from the pressure altitude encoder (also used as the data source for Mode C replies).

Since ADS-B messages are broadcast, they can be received and processed by any suitable receiver. As a result, ADS-B supports both ground-based and airborne surveillance applications. For aeronautical surveillance, ground stations are deployed to receive and process the ADS-B messages. In airborne applications, aircraft equipped with ADS-B receivers can process the messages from other aircraft to determine the location of surrounding traffic in support of applications such as the CDTI. Other, more advanced ASAs are under development and are expected to have a significant impact on the way in which air traffic is managed.

Three ADS-B data links (or signal transmission systems) have been developed and standardized:

Mode S[2] 1 090 MHz ES (1 090 ES) was developed as part of the Mode S system. The standard Mode S acquisition squitter is 56 bits long. The 1 090 MHz ES contains an additional 56-bit data block containing ADS-B information. Each ES message is 120 microseconds long (8

[2] The manual on Technical Provisions for Mode S Services and Extended Squitter (Doc 9871) contains details on Mode S ES

microseconds of preamble and 12 microseconds of data). The signals are transmitted at a frequency of 1 090 MHz, and have a data transmission rate of 1 Mbps. The ADS-B information is broadcast in separate messages, each of which contains a related set of information (e.g. airborne position and pressure altitude, surface position, velocity, aircraft ID and type, emergency information). Position and velocity are transmitted twice per second. Aircraft ID is transmitted every 5 seconds. The transmission of ES ADS-B is an integral part of many Mode S transponders, although it may also be implemented in a non-Mode S transponder device as well. There is international agreement that Mode S ES will be used for air transport aircraft worldwide to support interoperability, at least for initial implementation.

Universal access transceiver[3] (UAT) has been designed as a general purpose aviation data link to allow uplink of information in addition to the transmission of ADS-B data. Since each UAT transceiver is allocated a time slot, the receiver is able to perform a range check, based on the time of receipt of the message, to provide a rudimentary validation of the broadcast position. This feature also allows aircraft receiving messages to determine their range from the ground station.

VHF digital link Mode 4[4] (VDL Mode 4) was developed as a generic data link supporting CNS functions. The applicability was initially restricted to surveillance applications like ADS-C and ADS-B, but the regulatory restrictions were later removed so that VDL Mode 4 is now available as a CNS data link. The system supports broadcast and point-to-point communications for air-ground and air-air applications.

ATS Services – Evolution of Aeronautical Surveillance

Aeronautical surveillance systems are designed to be used by ATS to improve capacity and to enhance safety. In support of applications, the ATS surveillance system should provide for a continuously updated presentation of surveillance information, including position indications.

En-route control service

En-route control services usually encompass large volumes of airspace (including oceanic areas) where aircraft are well established on their flight paths and are typically in cruise mode. Aircraft generally fly at high speeds in this phase.

A surveillance system for area control typically needs to provide surveillance over large volumes of airspace including remote areas where ground infrastructure may be limited or non-existent. The surveillance system should support controller safety net alerts such as cleared level monitoring, route adherence monitoring and restricted area monitoring. The provision of medium-term conflict detection tools is desirable. Position updates may not need to be as frequent as in other environments.

Surveillance systems suitable for area control include ADS-C, particularly in oceanic and remote areas, SSR, MLAT and ADS-B. The following table summarises the proposed evolution of air traffic surveillance solutions in the region:

[3] The Manual on the Universal Access Transceiver (UAT) (Doc 9861) contains details of UAT.
[4] The Manual on VHF Digital Link (VDL) Mode 4 (Doc 9816) contains details of the VDL Mode 4.

EN ROUTE AIRSPACE OPERATIONS

	Short term (2008-2015)	**Mid- term (2016-2020)**	**Long term (2020 and beyond)**
	Surveillance technologies*	**Surveillance technologies***	**Surveillance technologies***
Type 1	SSR where implemented ADS-B MLAT	SSR where implemented ADS-B MLAT	Reduced number of SSRs ADS-B MLAT
Type 2	ADS-C SSR where implemented ADS-B MLAT	SSR where implemented ADS-B MLAT	Reduced number of SSRs ADS-B MLAT
Type 3	ADS-C Voice Reporting	ADS-C Voice Reporting	ADS-C Reduced Voice Reporting
Remote	ADS-C Voice Reporting	ADS-C Voice Reporting	ADS-C Reduced Voice Reporting
Oceanic	ADS-C Voice Reporting	ADS-C Voice Reporting	ADS-C Reduced Voice Reporting

*** Only when and where operationally justified and cost-effective.**

Note:

- **Type 1: Complex traffic pattern and a high density traffic;**
- **Type 2: Complex traffic pattern and a medium density traffic; and**
- **Type 3: Low density traffic.**

Approach control service

Approach control services are provided to controlled flights arriving or departing from one or more aerodromes. Vectoring may be performed at higher traffic density levels, and changes in altitude and heading are frequent. Arriving traffic may be placed in holding patterns when demand for services exceeds the aerodrome or airspace capacity.

In this environment, the role of ATM is to manage the flow of traffic to and from the aerodrome, to separate arriving traffic from departing traffic. Aircraft are typically separated by lesser minima than in the case of area control. Aircraft speeds are lower than in the en-route phase of flight.

Surveillance systems suitable for approach control include primary radar, SSR, multilateration (MLAT) and ADS-B. The following table summarises the proposed evolution of air traffic surveillance solutions in the region:

APPROACH AIRSPACE OPERATIONS

	Short term (2008-2015)	Mid- term (2016-2020)	Long term (2020 and beyond)
	Surveillance technologies*	**Surveillance technologies***	**Surveillance technologies***
Type 1	SSR where implemented PSR MLAT ADS-B	SSR where implemented PSR MLAT ADS-B	MLAT ADS-B
Type 2	SSR where implemented PSR MLAT ADS-B	SSR where implemented PSR where justified MLAT ADS-B	MLAT ADS-B
Type 3	Voice Reporting	Voice Reporting	Voice Reporting

*** Only when and where operationally justified and cost-effective.**

Note:

- **Type 1: Complex traffic pattern and a high density traffic;**
- **Type 2: Complex traffic pattern and a medium density traffic; and**
- **Type 3: Low density traffic.**

Aerodrome control service

Aerodrome control service is, inter alia, responsible for preventing collisions between aircraft in the vicinity of the aerodrome and between aircraft and vehicles in the manoeuvring area and between aircraft landing and taking off. Visual sighting of aircraft from the control tower is the primary means of determining position. During busy periods and in low visibility conditions, a surveillance system may be used to improve the safety and efficiency of aerodrome operations.

It also needs a high update rate in order to present a current picture in a rapidly changing environment.

A surveillance system supporting an aerodrome control service needs to have a high degree of accuracy to determine the location of targets on relatively narrow runways and taxiways, with the ability to detect both aircraft and vehicles, and to distinguish between closely spaced targets. The system also needs a high update rate in order to present a current picture in a rapidly changing environment. Aircraft and vehicles need to be clearly labelled on controller displays to avoid confusion. The surveillance system should support runway incursion monitoring and other alerting tools.

Surveillance systems suitable for aerodrome control include primary radar, secondary surveillance, multilateration and ADS-B. The following table summarises the proposed evolution of air traffic surveillance solutions in the region:

TERMINAL AIRSPACE OPERATIONS

	Short term (2008-2015)	Mid- term (2016-2020)	Long term (2020 and beyond)
	Surveillance technologies*	**Surveillance technologies***	**Surveillance technologies***
Type 1	SSR where implemented PSR MLAT ADS-B	SSR where implemented PSR MLAT ADS-B	MLAT ADS-B
Type 2	SSR where implemented PSR MLAT ADS-B	SSR where implemented PSR MLAT ADS-B	MLAT ADS-B
Type 3	Voice Reporting	Voice Reporting	Voice Reporting

*** Only when and where operationally justified and cost-effective.**
Note:

- **Type 1: Complex traffic pattern and a high density traffic;**
- **Type 2: Complex traffic pattern and a medium density traffic; and**
- **Type 3: Low density traffic.**

Data Exchange Format

Motivation on the use of ASTERIX to be included here

Data Sharing Agreement – Template

Proposed data sharing agreement to be included in this section, with the necessary motivation.

Surveillance Performance Framework

En-Route Surveillance

SURVEILLANCE SYSTEMS PERFORMANCE FRAMEWORK	
Performance Benefits	
Safety	Timely availability of reliable infrastructure capabilities will improve ***safety*** and efficiency in aviation as well as improving airspace and aerodrome capacity. Timely availability of adequate radio spectrum will ensure the provision of viable air navigation services on a global basis and thus improve ***safety*** and efficiency in aviation.
Environment	Optimal routing will reduce carbon ***emissions***.
Efficiency	Timely availability of reliable communication capabilities will improve safety and ***efficiency*** in aviation as well as improving airspace and aerodrome capacity. Timely availability of adequate radio spectrum will ensure the provision of viable air navigation services on a global basis and thus improve safety and ***efficiency*** in aviation.
Capacity	Timely availability of reliable infrastructure capabilities will improve safety and

	efficiency in aviation as well as improving airspace and aerodrome ***capacity***.			
Cost Effectiveness	Optimal routing will reduce ***operating cost***			
ATM Operational Concept Components	**Tasks / Project / Initiative**	**Timeframe Start-End**	**Responsibility**	**Status**
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
Risk Management				
Risk Factors	Lack of Funding. Delay of Aircraft Equipage. System inter-operability & Harmonization. Lack of SARPS. Insufficient Data.			
Risk Mitigation	Identification and application of different funding resources. Proactive consultation with ATM Community. Proactive consultation with Regulators. Access to ATM Community planning forums.			
Linkage to GPI's				
GPI-9: Situational Awareness		AO, TS, CM, AUO		

Approach Surveillance

SURVEILLANCE SYSTEMS PERFORMANCE FRAMEWORK	
Performance Benefits	
Safety	Timely availability of reliable infrastructure capabilities will improve ***safety*** and efficiency in aviation as well as improving airspace and aerodrome capacity. Timely availability of adequate radio spectrum will ensure the provision of viable air navigation services on a global basis and thus improve ***safety*** and efficiency in aviation.
Environment	Optimal routing will reduce carbon ***emissions***.
Efficiency	Timely availability of reliable communication capabilities will improve safety and ***efficiency*** in aviation as well as improving airspace and aerodrome capacity. Timely availability of adequate radio spectrum will ensure the provision of viable air navigation services on a global basis and thus improve safety and ***efficiency*** in

	aviation.			
Capacity	Timely availability of reliable infrastructure capabilities will improve safety and efficiency in aviation as well as improving airspace and aerodrome ***capacity***.			
Cost Effectiveness	Optimal routing will reduce ***operating cost***			
ATM Operational Concept Components	**Tasks / Project / Initiative**	**Timeframe Start-End**	**Responsibility**	**Status**
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
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AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
Risk Management				
Risk Factors	Lack of Funding. Delay of Aircraft Equipage. System inter-operability & Harmonization. Lack of SARPS. Insufficient Data.			
Risk Mitigation	Identification and application of different funding resources. Proactive consultation with ATM Community. Proactive consultation with Regulators. Access to ATM Community planning forums.			
Linkage to GPI's				
GPI-9: Situational Awareness		AO, TS, CM, AUO		

Terminal Surveillance

SURVEILLANCE SYSTEMS PERFORMANCE FRAMEWORK	
Performance Benefits	
Safety	Timely availability of reliable infrastructure capabilities will improve ***safety*** and efficiency in aviation as well as improving airspace and aerodrome capacity. Timely availability of adequate radio spectrum will ensure the provision of viable air navigation services on a global basis and thus improve ***safety*** and efficiency in aviation.
Environment	Optimal routing will reduce carbon ***emissions***.
Efficiency	Timely availability of reliable communication capabilities will improve safety and

	efficiency in aviation as well as improving airspace and aerodrome capacity. Timely availability of adequate radio spectrum will ensure the provision of viable air navigation services on a global basis and thus improve safety and ***efficiency*** in aviation.			
Capacity	Timely availability of reliable infrastructure capabilities will improve safety and efficiency in aviation as well as improving airspace and aerodrome ***capacity***.			
Cost Effectiveness	Optimal routing will reduce ***operating cost***			
ATM Operational Concept Components	**Tasks / Project / Initiative**	**Timeframe Start-End**	**Responsibility**	**Status**
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
AOM, DCB, AO, TS, CM, AUO, ATMSDM				
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Linkage to GPI's				
GPI-9: Situational Awareness		AO, TS, CM, AUO		

List of Acronyms and Abbreviations

3D	Three Dimensional
3G	Third Generation
3GPP	Third Generation Partnership Project
AAIM	Aircraft Autonomous Integrity Monitoring
ABAS	Aircraft –based Augmentation
ACARS	Aircraft Communications, Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ADF	Automatic Direction Finder
ADS	Automatic Dependent Surveillance
ADS – B	Automatic Dependant Surveillance – Broadcast
ADS – C	Automatic Dependant Surveillance – Contract
AERMAC	Aeronautical Message and Communication (Software Product)
AFI	Africa – Indian ocean area
AFN	ATC Facilities Notification (Fans 1/A Message)
AFS	Aeronautical Fixed Service
AFTN	Aeronautical Fixed Telecommunications Network
AGC	Automatic Gain Control
AIDC	Air Traffic Services Inter – Facility Data Communications
AIMU	Aeronautical Information Management Unit
AIP	Aeronautical Information Publication
AIREP	Air Report
AMC	Airspace Management Cells
AMCP	Aeronautical Mobile Communications Panel
AMHS	ATS message Handling System
AMS	Aeronautical Mobile Service
AMS® S	Aeronautical Mobile-Satellite (R) Service
AMSS	Aeronautical Mobile-Satellite Service
ANR's	Air Navigation Regulations
AO	Aircraft Operators
AOC	Aircraft Operating Company / Committee
AORRA	Atlantic Ocean Random Route Area
APIRG	AFI Planning and Implementation Regional Group
APN	Access Point Name
APP	Approach
APR	Automatic Position Reporting
APV	Approach with Vertical Guidance
AR	Area of Routing
ASM	Airspace Management
A-SMGCS	Advanced Surface Movement Guidance & Control System
ASP	Aeronautical Surveillance Panel
ATA	Actual Time of Arrival
ATD	Actual Time of Departure
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Service
ATN	Aeronautical Telecommunications Network

ATOM	ADSAT Trials Operations Manual
ATS	Air Traffic Services or Aircraft Tracking System
ATS/DS	Air Traffic Service / Direct Speech
ATSMHS	Air Traffic Services Message Handling System
BA	Business Analyst
BER	Bit Error Rate / Beyond Economical Repair
BITE	Build-in Test Equipment
BOM	Bill of Material
BSA	Business Systems Administrator
CAMU	Central Airspace Management Unit
CAPEX	Capital Expenditure
CATS-ACCID &INCID	Civil Aviation Technical Standards / Accidents and Incidents
CATS-AIRS	Civil Aviation Technical Standards / Met Information And Aeronautical Info Services
CATS-ARM	Civil Aviation Technical Standards / Aircraft Registration Markings
CATS-ATO	Civil Aviation Technical Standards / Aviation Training Organisations
CATS-ATS	Civil Aviation Technical Standards / Air Traffic Services
CATS-DG	Civil Aviation Technical Standards / Dangerous Goods
CCA	Commissioner Civil Aviation
CDI	Course Deviation Indicator
CDP	Communications Data Processor
CDR's	Conditional Routes
CDRL	Contract Document Requirement List
CDU	Control and Display unit
CEU	Central Executive Unit
CFE	Customer Furnished Equipment
CFIT	Controlled Flight Into Terrain
CFMU	Central Flow Management Unit
CLD	Clearance Delivery
CM	Context Management
CNS	Communications, Navigation and Surveillance
COM	Communications
CPDLC	Controller Pilot Data Link Communication
CRC	Cycle Redundancy check
CRM	Customer Relationship Management
CRM	Collision Risk Modelling
CSD	Circuit Switched Data
CTA	Control Area
CTR	Control Zone
CUG	Closed User Group
DAIW	Danger Area Infringement Warning
DARPs	Dynamic user preference re-routes
D-ATIS	Digital Automatic Terminal Information System
DCPC	Direct Controller Pilot Communications (voice/data)
DCW	Digital Chart of The World
DDP	Delivered Duty Paid
DECT	Digital Enhanced Cordless Telecommunications
DEP	Departure

DF	Directional Finder
D-FIS	Digital Flight Information Service
DGNSS	Differential Global Navigation Satellite System
DHCP	Dynamic Host Configuration Protocol
DI	Direction Indicator
DL	Data Link
DLC	Departure Clearance
DME	Distance Measuring Equipment
DTED	Digital Terrain Elevation Data
DTM	Dual Transfer Mode
DTMF	Dual Tone Multi Frequency
DVD	Digital Versatile Disk
DVOR	Doppler VOR
DVR	Digital Video Recorder
EASA	European Aviation Safety Agency
EATCHIP	European Air Traffic Control Harmonisation and Integration Program
EATMS	European Air Traffic Management System
ECAC	European Civil Aviation
ECP	Engineering Change Proposal
EGNOS	European Geostationary Navigation Overlay System
ETA	Estimated Time of Arrival
EUR	European Region
EUROCAE	European Organisation for Civil Aviation Equipment
Eurocontrol	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
FANS	Future Air Navigation Systems
FAT	Factory Acceptance Tests
FDP	Flight Data Processor
FDPS	Flight Data Processing System
FET	Further Education & Training
FIC	Flight Information Centre
FIR	Flight Information Region
FIS	Flight Information Service
FL	Flight Level
FMC	Flight Management Computer
FMECA	Failure Mode Effect and Critical Analyses
FMP	Flow Management Position
FMS	Flight Management System
FOB	Free on Board
FOR	Free on Rail
FPL	Flight Plan
FRACAS	Failure Mode Effect and Corrective Action System
FRT	Fixed Radius Transition
FTA	Fault Tree Analyses
FTE	Flight Technical Error
FUA	Flexible Use of Airspace
GAAP	General Aviation Accident Prevention
GBAS	Ground Based Augmentation System

GES	Ground Earth Station
GIC	GNSS Integrity Channel
GLONASS	Global Navigation Satellite System (Russian Federation)
GNSS	Global Navigational Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GS	Ground Speed
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
HDL	HF Data Link
HF	High Frequency
HFDL	High Frequency Data Link
HFP	Human Factors Practitioner
HFS	Human Factor Specialist
HME	Height Monitoring Equipment
HMI	Human Machine Interface
HMU	Height Monitoring Unit
HTTP	Hyper Text Transfer Protocol
IAS	Indicated Air Speed
ICG	Implementation Coordination Group
ICT	Information Communication Technology
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMAP	Internet Message Access Protocol
INS	Inertial Navigation System
IORRA	Indian Ocean Random Route Area
IP	Internet Protocol
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISD	Integrated Service Digital Network
ISS	Investigation and Standards Specialist
IT	Information Technology
JAA	Joint Aviation Authorities
JIT	Just In Time
KSIA	King Shaka International Airport
LAAS	Local Area Augmentation System
LAN	Local Area Network
LCC	Life Cycle Cost
LCD	Liquid Crystal Display
LIS	Logistic Information System
LNAV	Lateral Navigation
LRU	Line Replaceable Unit
LS	Logistic Support
LSA	Logistic Support Analyses
LSP	Logistic Support Plan
LSPP	Logistic Support Programme Plan
MACS	Minimum Acceptable Communication Service
MARS	Minimum Acceptable Radar Service
MASPS	Minimum Aviation System Performance Standards

MCDU	Multi Purpose Control and Display Unit (Acars and FMC)
MCO	Marketing communications Officer
MCOMS	Marketing and Communications Specialist
MDF	Main Distribution Frame/ Management Development Facilitator
MDP	Management Development Program
MEL	Minimum Equipment List
MER	Manager Employee Relations
MET	Meteorological
METAR	Aviation routine weather report
MLS	Microwave Landing System
MMR	Multimode Receiver
MMS	Maintenance Management System (Software product)
MNPS	Minimum Navigation Performance Specifications
MNT	Mach Number Technique
MODE S	Mode S SSR Data Link
MRT	Multi Radar Tracking
MSA	Minimum Sector Altitude
MSAW	Minimum Safe Altitude Warning System
MSSR	Monopulse Secondary Surveillance Radar
MTBF	Mean Time Before Failure
MTCA	Medium Term Conflict Alert
MTTR	Mean Time To Repair
NAVAID	Navigation Aids
NDB	Non Directional Beacon
NM	Nautical Mile
NOTAM	Notice To Airmen
NPA	Non-precision Approach
NQF	National Qualifications Framework
NSE	Navigation System error
NSTB	National Satellite Test Bed
OEM	Original Equipment Manufacturer
OLDI	On Line Data Interchange
OPS	Operations
ORTIA	OR Tambo International Airport
PANS-OPS	Procedure for ANS-Aircraft Operations
PBN	Performance Based Navigation
PBU	Period Of Beneficial Use
PBX	Private Branch eXchange
PCM	Pulse Code Modulation
PCUG	Private Closed User Group
PDA	Personal Digital Assistant
PDC	Pre Departure Clearance
PHS&T	Packaging, Handling, Storage and Transportation
POP	Post Office Protocol
POTS	Plain Old Telephone System
PPP	Point-to-Point Protocol
PSR	Primary Surveillance Radar
PSTN	Public Switched Telephone Network
PTN	Private Telecommunication Network

PVN	Private Voice Network
PWT	Personal Wireless Telecommunications
QNH	Pressure Setting for Altimeters (Usually In Hecta Pascals)
R/T	Radiotelephony
RA	Resolution Advisory (ACAS A\C Warning)
RAFC	Regional Area Forecasting Centre
RAIM	Receiver Autonomous Integrity Monitoring
RAM	Reliability, Availability and Maintainability
RAN	Regional Air Navigation
RCMMS	Remote Control Monitoring & Maintenance System
RCMS	Remote Control and Monitoring System
RCP	Required Communication Performance
RDP	Radar Data Processor
RF	Radius to Fix Area Navigation
RFC	Request for Change
RFP	Request for Proposal / Radar Front Processor
RFQ	Request for Quotation
RFT	Request for Tender
RNAV	Required Area Navigation
RNP	Required Navigation Performance
ROD	Record of Decision
ROI	Registration of Interest
ROT	Runway Occupation Time
ROX	Rate of Exchange
RPL	Repetitive Flight Plan/ Recognition of prior Learning
RPS	Recording And Playback System
RSP	Required Surveillance Performance
RTCA	Requirements and Technical Concepts for Aviation
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minima
SAM	South American Region
SARP's	Standards and Recommended Practices
SAT	Site Acceptance Tests or South Atlantic
SATCOM	Satellite Communications
SBAS	Satellite – based Augmentation System
SBAS	Space Based Augmentation System
SDH	Synchronous Digital Hierarchy
SE	Systems Engineer
SID	Standard Instrument Departure
SIGMET	Information concerning en-route phenomena which may affect the safety of aircraft operations
SIGWX	Significant Weather
SLA	Service Level Agreement
SME	Small and Medium Size Enterprise
SMS-C	Short Message Service Center
SNMP	Simple Network Management Protocol
SRA	Special Rules Airspace / Surveillance Radar Approach
SRE	Surveillance Radar Element
SRU	Shop Replace able Unit / Surveillance Radar Unit

SSR	Secondary Surveillance Radar
SSS	System Support Suite
STAR	Standard Terminal Arrival Route
STCA	Short Term Conflict Alert
SWC	Soccer World Cup
TA	Traffic Advisory (TCAS A/C Warning, Tactical Manoeuvre Required)
TAAMS	Total Airport And Airspace Modelling Software
TAF	Terminal Area Forecast
TAR	Terminal Approach Radar
TAS	True Air Speed
TAT	Turn Around Time
TCAS	Traffic Collision Avoidance System
TCP	Transmission Control Protocol
TDM	Track Definition Message (Time Division Multiplex)
TET	Trainee Engineering Technician
TGO	Target generating Officer
TL	Technologist Logistics
TLS	Target Level of Safety
TMA	Terminal Control Area (Terminal Maneuvering Area)
TMS	Air Traffic Management Specialist
TOS	Traffic Orientation Scheme
TSA	Temporary Segregated Area
TSE	Total System Error
UHF	Ultra High Frequency
URS	User Requirement Statement / Specification
USB	Universal Serial Bus
VCCS	Voice Communication and Control Switch
VCR	Visual Control Room
VDF	VHF Directional Finder
VDL	VHF Data Link
VFR	Visual Flight Rules
VHF	Very High Frequency
VNAV	Vertical Navigation
VoIP	Voice Over Internet Protocol
VOR	VHF Omni directional Range
VOR	VHF Omni directional Radio Range
VPN	Virtual Private Network
VSAT	Very Small Aperture Terminal
WAAS	Wide Area Augmentation System
WAFS	World Area Forecast System
WAN	Wide Area Network
WANA	Wide Area Network A
WAP	Wireless Application Protocol
WBS	Work Breakdown Structure
WGS-84	World Geodetic Reference System 1984
WiFi	Wireless Fidelity
WLAN	Wireless Local Access Network
WWW	World Wide Web

APPENDIX B

Terms of Reference, Composition and Work Programme of AFI Aeronautical Surveillance Implementation Task Force

Term of Reference

The AFI Aeronautical Surveillance terms of reference are to:

1. Determine the operational performance requirements for aeronautical surveillance in the AFI Region, en-route, terminal areas (TMAs) and aerodromes operations.

2. Identify and quantify near term and long term benefits of relevant candidate surveillance systems.

3. Develop a draft AFI Surveillance plan including recommended target dates of implementation, taking into account:

   - Availability of SARPs,
   - Readiness of airspace users and air navigation service providers
   - Relevant RAN and APIRG recommendations, conclusions and decisions pertaining to aeronautical surveillance.
   - Work done by ICAO Surveillance Panel with the view to avoiding any duplication

Note: *The Task Force should report to the next APIRG meeting with preliminary report to the ATM/AIM/SAR and CNS sub-groups*.

Composition:

- Core members: ATNS (South Africa), ASECNA, IATA, Algeria, Ghana, Kenya, Nigeria, Rwanda, Tanzania and IFALPA.

  - States with large oceanic FIRs interface with other ICAO Regions and large continental coverage to be added to the composition as core members. (Democratic Republic of Congo, Mauritius and Seychelles)

Working Groups:

Working Group for the development of the AFI En-route Surveillance strategy

- Seychelles (Team Leader)
- South Africa
- Nigeria
- Ghana
- DRC
- IATA
- Mauritius
- Angola

Working Group for the development of the AFI Terminal Area Surveillance strategy

- ASECNA (Team Leader)
- Zambia
- South Africa
- IATA
- Tanzania

Future Work Programme

No.	Activity	Target dates
1.	Review and amend the AFI Surveillance Strategy as necessary, based on available ICAO SARPs and relevant guidance material	CNS SG5 2013
2.	Collect relevant data to support categorization of AFI Terminal Areas (TMAs) and Aerodromes, in coordination with the ATM/AIM/SAR Sub-group.	CNS/SG/5 2013
3.	Develop Surveillance Distribution Data Format (ASTERIX)	CNS SG/5 2013
4.	Develop Guidelines for Surveillance Data Exchange Agreements based on other regions best practices	CNS SG/5 2013
5.	Develop Surveillance Data Distribution Format	CNS SG/5 2013
6.	Monitor the status of implementation of the AFI Surveillance Plan	CNS/SG/5 2013
7.	Develop amendment proposals to the AFI Air Navigation Plan (Doc 7474), FASID, CNS Tables 4A and 4B	CNS SG/5 2013
8.	Develop regional performance objectives and metrics	CNS/SG/5 2013

-END-