WIDE AREA MULTILATERATION – WAM SYSTEM

Request for Proposal

Table of Contents

1. Introduction

CARC intends to procure, on a turnkey basis, MLAT/ WAM system with minimum 45 N.M coverage and Associated Equipment and Civil Works for the coverage of relevant areas of the airspace of the AQABA Sector and KHIA Aerodrome of Jordan (see operational requirements). The required Wide Area Multilateration -WAM System will be used to improve surveillance capabilities in the operational airspace. This document specifies the required functional and non-functional capabilities of the system.

2. SCOPE

The procurement consists of (TBD) ground stations, where the number and location of sites shall be determined based on optimal coverage-siting analysis performed by the Contractor. The procurement also includes one central control and data collection facility at KHIA Airport and associated equipment, and all services necessary to install, test, commission the system, as well as train operational, technical and maintenance personnel.

The MULTILATERATION output processed asterix data shall be integrated to INDRA-ATM (AIRCON2100) by tender responsibility.

The tenderer shall provide itemized prices for any added station after the project had been completed in terms of importation, installation, and operation with a commitment that this would be considered as an integrated project.

3. Reading Instructions

Conventions for denoting requirements are as follows:

'Shall' – indicates a statement of specification with which the full compliance is mandatory. It indicates a requirement that must be satisfied by the offered system claiming conformity to the specification. Such requirements are intended to be tested and their implementation audited. Failure to satisfy the requirement will almost certainly result in the proposed system being rejected.

'Should' - indicates a recommendation or best practice which will be subject to evaluation.

4. System Requirements

4.1 General System requirements

The System design shall comprise of a wide area multilateration surveillance system capable of detecting, identifying and tracking aircraft:

- Fitted with a SSR (Mode A/C and Mode S) transponder and ACAS downlink, compliant with ICAO Annex 10 Volume IV latest amendments.
- Fitted with ADS-B 1090 ES avionics, compliant with DO-260 or DO-260A and 260C.

The System shall operate automatically at unmanned Sites.

The System shall feature high availability, fault tolerant design, avoiding common points of failure to the extent possible. In addition, it shall be equipped with back-up power supply (UPS) for the WAM central processing and Battery charger for Remote Units (RUs).

As facilities supporting Air Traffic Control (ATC) operations, all aspects of the System, when established at properly prepared Sites, shall be capable of operating on a continuous basis (100% duty cycle) for the entire Operational Lifetime, excepting for scheduled maintenance outages.

All equipment installed at Sites shall automatically resume normal operation without intervention of any kind including the need to manually reset, manually reload software programs or change configuration following any event external to the Contractor supplied equipment including inter alias:

- Loss of power, brownout, or other non destructive power disturbance;
- Loss of communications bearer, missing clock or other non-destructive communications disturbance.

The WAM system shall use internal synchronization and N-1 redundancy concept (Transmitter and Remote units).

The System design shall allow data to be output to multiple ATC centers in ASTERIX20, 20

format.

The proposed WAM system shall be fully compliant with the following standards and specifications:

- ICAO Annex 10, Volume IV – Surveillance Radar and Collision Avoidance Systems
- EUROCAE ED-109A – Software Integrity Assurance Considerations for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems
- EUROCAE ED-142 - TECHNICAL SPECIFICATION FOR WIDE AREA MULTILATERATION (WAM) SYSTEMS
- EUROCAE ED-153 – Guidelines for ANS Software Safety Assurance
- RTCA DO-260C – Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)
- ICAO Doc. 4444/E/05/08/09/11 ATM Air Traffic Management
- ICAO Doc. 9426 Air Traffic Services Planning Manual
- ICAO Doc. 8168 Aircraft Operations

- RTCA DO260: Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (WAM) and Traffic Information Services – Broadcast (TIS-B).
- ICAO Doc.7030/E/17-31 Regional Supplementary Procedures
- ICAO Doc. 7444 Air Navigation Plan Africa-India Ocean Region
- ICAO Doc. 8071 Manual of Testing of Radio Navigation Aids, all Volumes

- The tenderer shall also state, where applicable, the standards to which the whole, or any specific part, of the equipment complies.

  The equipment shall be described in metric terms.

- The proposed WAM system shall be scalable and expandable and shall allow addition of new WAM receiving ground stations and transmitting ground stations in the future.

- The proposed WAM system shall restart automatically after a disruption of service due to transient power outages.

- The proposed WAM system shall enable receiving and processing signals of the following transponder modes:
  - Mode A/C/1/2
  - Mode S
  - Mode 4

- Standard industrial interface shall be used within the system wherever suitable. Preferably Ethernet connection with RJ-45 plugs should be used.

- Any external components connected to the system shall use Ethernet connection with SNMP diagnostic interface.

- Each WAM receiving ground station shall be capable of time stamping the received signals using the following global navigation satellite systems:
  - GPS
  - GLONASS
  - GALILEO
  - BEIDOU

- The integrity of the WAM system shall be verified based on guidelines stipulated in EUROCAE ED-142.

- The data storage space shall be redundant and expandable.

- The WAM system shall be capable of tracking not less than 250 targets.

- Each WAM receiving ground station shall be capable of being easily relocated and integrated back into the system.

4.2 Environmental conditions and Protection requirements

The WAM equipment (both indoor and outdoor equipment), shall be fully protected against the effects of destructive ambient conditions and shall be designed for continuous operation during the expected life cycle under the following environmental conditions:

Operating installed in controlled environment

Temperature	:	+10 to +40 degrees C
Relative Humidity	:	30 to 90%
Altitude	:	0 to 50,000 ft
Wind	:	N/A

Not operating installed indoors without damage

Temperature	:	0 to +50 degrees C
Relative Humidity	:	5 to 100%
Altitude	:	0 to 50,000 ft
Wind	:	N/A

Installed outdoors

Temperature	:	-30 to +70 degrees C
Relative Humidity	:	5 to 100%
Altitude	:	0 to 50,000 ft.
Wind	:	0 to 200 km/hr
Rainfall	:	1-hour average rain rate of 130 mm with maximum wind speed of 118 km/hr

All electrical, electronic and mechanical components shall be carefully protected from the most severe conditions that may prevail.

Printed circuit cards shall be keyed or designed to avoid damage if plugged into a wrong slot and possess a conformal coating to a recognized international standard, which must be identified.

Anti-corrosion of all metal shall be assured and described by the tenderer.

The equipment must be manufactured with state-of-the-art technology, using solid-state elements, semiconductors and high integration circuits.

The use of integrated circuit technology can be extended to the passive components (resistors, capacitors, inductors)

The equipment must use modular design techniques so that it allows the use of plug-in cards and can be easily accessible for maintenance to the various test points. Also, the units must be secured in place so they can retain their proper position.

The system must be made up of modular units that allow the exchange of functional units and sub-units without altering the interconnection of the remaining parts of the equipment and easy to service to ensure minimum time for their exchange.

In the design and construction aspects, the preferred equipment shall be that which requires minimum care and repair, such as easily accessible units, control by microprocessors and speed in replacing the exchange units (spare parts). Tests and routine measurements shall not affect in any way the normal operation of the equipment (minimum signal, power measurement, spectrum, etc.).

The units and measuring elements for the control of the equipment shall be an integral part of them.

Primary lightning/surge protection for all sites shall be provided.

4.3 Power Supply Requirements

a) Dual version, 18 – 48 VDC and/ or 95 – 260 VAC, 50 Hz. single phase.

b) Have the ability to be equipped with an UPS / DC Charger with battery with a minimum two (2) hour sustainable time for each ground station. The UPS for the CPS shall be successfully switched to battery power when necessary without any loss of WAM service.

c) The systems and equipment shall be capable of automatic start up at power on and automatic recovery as the result of a power failure (blackout and brownout).

4.4 Interfacing

The system shall have the following communication interface capability:

a. Two physically independent network interfaces (Ethernet 100/1000base T)

b. Two individually configurable Asterix output data streams, for operational and maintenance access.

c. One configurable raw data output stream.

It shall be the tenderer's responsibility to interface the equipment specified herein with all required external and existing systems including the provision and installation of any cabling. Note the communication are operational systems so minimum downtime is required when working with this equipment. The tenderer shall estimate the required down time to integrate the new WAM system.

4.5 Built-In Test Equipment:

The ground station equipment shall have built-in test equipment (BITE) and shall periodically carry out BITE tests to verify performance and operational status

The ground station equipment shall output the BITE status as a hardware signal, as a visual indicator at the front panel (e.g. LED) and via network to the remote control system

The ground station equipment shall distinguish between critical faults requiring immediate attention and corrective action, and warnings

The ground station shall be equipped with a test signal generator that periodically injects a test signal into WAM/MLAT antenna decoupled monitor ports.

The ground station equipment shall verify the received signal level of the site monitor signal at the ground station in order to verify the complete RF path

The ground station equipment shall verify the received signal of the site monitor signal at the ground station for correct signal level, content and periodicity

The ground station equipment shall verify the detected position of the internal GPS receiver in order to monitor operational status of GPS as a basis of ADS-B

The ground station equipment shall verify the time deviation between the internal GPS receiver and the ground station system time

The ground station equipment shall generate a test target using the detected GPS position, the site monitor signal level

The ground station should provide a simple remote digital storage oscilloscope functionality for signal analysis if possible.

The ground station should provide a simple remote spectrum analyser functionality for signal analysis if possible.

4.6 System Components

a) The WAM system shall be comprised of two choices determine by the technical study committee.

- ❖ The tenderer should provide itemized price for multiple ground stations in redundant configuration. Where Each station shall include:
    - Redundant receivers

- Redundant processing units
- Redundant GPS system and associated antennas

❖ The ground station is N-1 Redundancy concept

b) Central Processing Server for multilateration calculations and target reporting to ATM.

c) The central processing station shall be composed of two independent central target processors.

d) TWO Remote Control and Monitoring System (RCMS) with the capability of presenting WAM surveillance information shall be installed at Queen Alia International Airport. The RCMS will be located in the current ACC technical room of the QAIA ACC building and shall be used to monitor and control the WAM systems for each WAM ground station.

e) Two Laptops configured with OS & required Application.

f) The WAM system shall be composed of WAM ground stations and redundant central processing station.

4.7 Civil Work requirements

The tenderer shall finalize the requirement(s) for the project civil works.

It is the tenderer responsibility to determine the extent of civil works to be performed or support equipment.

The tenderer shall provide 19-inch rack for each MLAT stations and CPS. The following identified civil works are to be considered an exhaustive list by the tenderer:

- Electrical, fiber and Telephone Connections, Ethernet cables.
- Electrical Power Interconnection to Commercial Source.
- Trenching and Conduits as required.
- UPS and /or DC charger with battery

5 TECHNICAL REQUIREMENTS

5.1 System functionality and performance

a. Surveillance Applications: the System shall support wide area surveillance applications including MLAT and ADS-B processing.

b. The system shall have as a minimum the following functionality and configuration:

- Consist of remote ground based terminals and TWO remote control and monitoring systems
- One standalone working position shall be supplied and installed at the existing KHIA TOWER .
- Be able to operate on narrowband communication lines such as telephone lines, microwave links or VSAT connections.
- Receive and process 1090 MHz messages.
- Allow for provision of information for automatic billing statistics (i.e. aircraft registration and/or owner, time stamp, route taken, entry/exit points altitude, duration of flight, etc.)

c. WAM Interrogation of Aircraft: The System shall interrogate all aircrafts fitted with Mode A/C/S and ADS-B 1090ES transponders in order to meet the requirements of these Functional Specifications.

d. WAM Coverage Volume: The WAM System shall provide, as a minimum, continuous, gap-free coverage throughout the airspace within a 200 nautical mile radius. The lower limit of coverage shall be footprint feet, and upper one 65000feet.

e. Accuracy and Resolution: the probability that the System shall resolve two Targets with a horizontal separation of more than 300m shall be greater than or equal to 95%.

f. Probability of Detection: the probability of detection, defined as the ratio of the number of Target Reports with measured position to the number of total expected reports, shall be greater than 97% for the WAM Coverage Volume.

g. False Target Reports: the overall false Target Report ratio, defined as the number of false Target Reports in relation to the number of detected Target Reports shall be less than 0.1%.

h. Code Detection and Validation:

- The System shall solicit and detect replies from Mode 3/A, C only transponders and Mode S transponders within the WAM Coverage Volume.
- The System shall detect all Modes 3/A, C codes as defined in ICAO Annex 10 Vol.4 and shall perform a credibility check to remove the possibility of delivering erroneous data to the ATM.
- The System shall process all Mode S transmissions from transponders compliant with ICAO Annex 10 last Amendment.
- For aircraft tracked with selective Mode S transmissions the System shall extract Mode C information from those Mode S transponder equipped aircraft, in addition to any Mode 3/A code update.
- The System shall perform error correction of Mode S replies.
- As an overall maximum, the percentage of incorrect but validated SSR codes shall be lower than 0.2%.

- As a maximum the percentage of incorrect but validated Mode A codes shall be lower than 0.1%.
- As a maximum the percentage of incorrect but validated Mode C codes shall be lower than 0.1%.

6 Ground Stations

6.1 Configuration

The ground station equipment shall:

a. Be fully configurable via SNMP and locally at the site by means of command line interface. The tenderer shall utilize open architecture concepts as much as possible to ease interface requirements.

b. Allow up and down loading of the complete configuration as a text file.

c. Be able to receive software updates from a remote control and monitoring station in a failsafe way without interruption of service.

d. Allow filtering of the WAM targets according to the following criteria:

1. Altitude level(s)

2. airborne/ground

e. The proposed system shall process and interface in accordance with the ASTERIX data exchange protocol category 20.

f. The basic system data interface shall be a 10/100/1000 BaseT Ethernet. the following standard communication protocols shall be used:

1. UDP/IP for operational ASTERIX Category 020 MLAT target reports
2. UDP/IP or TCP/IP for remote configuration, maintenance, monitoring and control
3. UDP/IP for raw data

6.2 Functional Requirements

The ground station shall as a minimum have the following capabilities and equipment configuration:

a) Receive and process 1090 MHz Extended Squitter (1090 ES) and WAM messages as defined by ICAO Annex 10.

b) Generate Asterix Category 21 ed.0.23 ,1.8,2.1 and the latest edition target reports in a configured interval or continuously as the 1090 ES messages are received.

c) The Asterix Category 21 ed.0.23 ,1.8,2.1 and the latest version Target report should be selectable and easy configured by CARC .

d) Interface with the ATM systems through a redundant central equipment.

e) Be able to adjust the actual target report update rate to adapt to the available network capacity.

f) Detect when the actual data rate is close to the defined network transfer capacity.

g) Be equipped with a high gain WAM antenna providing at least 9-dBi gain within its main lobe.

h) Be equipped with a GPS receiver for system time synchronisation and time stamping, as well as monitoring GPS quality and integrity.

i) Be fully remote controlled and monitored via SNMP protocol.

j) Be designed for unattended operation.

k) Operate within the proximity of other systems without degrading its own performance as well as the performance of the existing systems.

l) Recover from short time frame transients in voltage and amperage without operational degradation.

m) Provide interfaces for operation with:

- Maintenance processor system (provide an SNMP summary status)
- Shall provide interface with the existing communications link.

7 Maintenance Design

The equipment specified herein shall possess hardware maintenance features to reduce repair time by providing the technical personnel with the capability to diagnose a fault rapidly identify the failed unit and replace it quickly in order to satisfy the availability requirements. Minimal preventive maintenance is a fundamental design requirement. The BIT capability should be sufficient to isolate the fault to the Line Replaceable Unit (LRU).

The system should be design with 19-inch rack Line Replaceable Units (LRU).

The tenderer shall provide a Maintenance Procedures document detailing all recommended preventive maintenance routines, test equipment and technical skills required by maintenance personnel to maintain the hardware.

Maintenance design features shall include on-line and off-line diagnostics, power-up diagnostics, test points, Built-In Test Equipment (BITE) and Fault Isolation Testing (FIT). All equipment shall be equipped with diagnostic programs as a part of the delivered software.

Specifically the system BITE shall have the following capabilities:

a) Periodically perform BITE tests to verify performance and operational status

b) Output the BITE status as a hardware signal, as a visual indicator at the front panel (e.g, LED) and via the communications network to the remote control and monitoring system

c) Be able to distinguish between critical failures requiring immediate attention or corrective action and warnings

8 System Integrity (Site Monitor)

The ADS-B Site Monitor shall not transmit signals of any kind that may adversely affect any other radar equipment that may be within reception range(interference) and shall not affect in any way the operation or response of any nearby TCAS equipment.

A failure of the ADS-B Site Monitor shall not adversely affect the operation of the ADS-B sub-system.

The ADS-B Site Monitor shall interface to the RCMS**.**

The Site Monitor shall be in LRU format allowing ease of replacement and maintenance - and shall not need dedicated power supply, antenna or communication for control and status (BITE).

The site monitor shall report any failure in the system signal.

The site monitor shall report anomalies to the RCMS.

9 Software

9.1 Software maintenance

Wherever possible, software failures shall be self-documenting. In the event a failure occurs, the system must have the capability to be reloaded and restarted from a remote control and monitoring system.

Provide secure access via password protection to the operating system level.

Prevent access to other networks, no routing.

9.2 Software Management:

a. The ground station equipment shall have separate partitions for operating systems and application software

b. The ground station equipment shall provide access on operating system level

c. The ground station equipment shall prevent access to other systems within the network

d. The ground station equipment shall allow uploading and downloading of the complete ground station configuration

e. The ground station equipment shall allow uploading the target restriction table that includes or excludes individual targets or groups of targets from ADS-B service.

9.3 Technology upgrade

Due to technology progress, the tenderer shall agree that the latest version of software, hardware and associated documentation shall be delivered at no extra cost if newer technology or developments have occurred between contract signature and time of delivery and/or installation. This is especially relevant to COTS hardware and software.

For the system software, this applies only to software upgrades that have been included in the latest software build and has been placed under configuration management by the tenderer. Prior approval from CARC is required before any upgrade substitution occurs. The tenderer shall guarantee the delivery of any documentation supporting these technical upgrades .

10 Hardware

It is highly desirable that commonality of hardware be considered to simplify logistic support, increase redundancy and reduce training costs during the life of the equipment.

Commercial off the Shelf (COTS) hardware shall be used as much as possible.

11 Reliability, Maintainability, and Availability

The tenderer shall, as part of the proposal, provide detailed information regarding technical specifications of each of the proposed equipment, materials, and accessories demonstrating integration among them. The system shall be designed for minimum maintenance and minimum downtime. The lifetime of the WAM system shall be at least 15 years. The supplier shall ensure availability of spare parts during this time.

The tenderer is also requested to provide the MTBF, MTTR, MTBCF, and availability figures of all the equipment proposed, indicating the method used for the calculation. If sub-system MTBF, MTTR, MTBCF, and availability numbers are submitted, these shall be rolled up into an overall system MTBF, MTTR, MTBCF and availability numbers. The tenderer shall provide the MTBF, MTTR, and the MTBCF numbers of other sites with similar types of equipment installed so the quoted numbers can be verified by CARC. The MTBF of the complete integrated system shall not be less than 2 years.

The system shall be sufficiently available to support air traffic control operations with an operational availability of at least 0.99998. The WAM equipment is considered to be fully available and operational when the respective surveillance data is correctly being provided to the TACC at Queen Alia International Airport, and that the operational status is being monitored correctly, through the remote RCMS located at the airport.

The system should allow for a dedicated maintenance mode without interruption of operational service. The system should be adequately cooled to support normal operations and if a forced air

cooling system is utilized the system must allow the exchange of the cooling fans during system operation.

The tenderer shall provide a list of parts which are unique to the system and which in case of failure would be considered critical and cause a suspension of service.

The system shall have a reliability of greater than 95%.

12 SPARE PARTS

The supply of spares shall be based upon the manufacturer's proven reliability figures for the equipment type and shall reflect the reliability expected in the intended service and location.

Spares will consist of Level 2 spares (this is considered the LRU level), consumable spares (fuses, lamps etc) and other spares where repair can be performed without specialized test equipment.

The supply of spares shall be consistent with all the spare components, modules and sub-assemblies required to enable all the Level 2 maintenance actions required to rapidly restore the supplied equipment, interfaces and systems to operational service.

The quality of spares shall be of the same quality as originally installed parts, either from OEM or third party OEM certified.

The spares shall be supplied in their original packaging, duly protected against moisture with dehydrating agents or silica. Each set of spares shall be labeled with its part number and name and quantity of spares in each package.

The tenderer shall include in the offer a list of the most important modules, cards and components, indicating their name, manufacturer, part number, suggested quantity, unit price.

13 Central Processing Server (CPS)

The system’s central processing server shall be at a central location and collect data from all ground stations (located at KHIA).

b. The CPS shall be implemented based on COTS equipment.

c. The CPS shall be software based on the latest available Linux/Unix operating system.

d. The CPS shall be fully redundant in its components. Redundant communication links with each ground station shall be implemented.

14 Control and Management System

- It shall be possible to control, monitor and manage the WAM system both locally and remotely.

- The Control and Monitoring system's HMI shall be web-based.
- The WAM system shall provide Simple Network Management Protocol (SNMP) v2c and v3 standard interface for its monitoring by external systems.
- The WAM system as well as individual WAM ground stations shall have Built-In Test Equipment (BITE) for continuous monitoring of its operating state.
- The WAM system shall enable to generate a file summarizing all information about the system configuration, software versions, firmware versions and hardware serial numbers for easier identification of a possible failure.
- The supplier shall provide a tool capable of displaying tracked WAM targets on a map background and related information derived from received WAM/ADS-B messages.

14.1 Remote control and monitoring system (RCMS)

The remote control and monitoring system (RCMS) shall as a minimum have the following capabilities and equipment configuration:

a) Be able to monitor, configure and control the remote ground station equipment via SNMP protocol providing access to all system parameters.

b) Upgrade or downgrade the new version of embedded software (load or image) of (TX, RX) stations through RCMS (REMOTLY).

c) Log system status for a minimum of 60 days. The log duration should be configurable.

d) Allow data recording of Asterix surveillance data from all or selected ground stations not less than 60 days.

e) Allow local replay (at the RCMS / laptop) of the recorded Asterix data for analysis purposes.

f) Allow local replay and conversion of recorded raw data (at the RCMS) into Asterix reports for analysis purposes and vice versa.

g) Implementation based on COTS equipment.

h) Software based on the latest available operating system.

i) Provide dual screen operation for system status and target reports.

j) Provide a technical situation display showing selected Asterix data from one or more ground stations.

k) Show a list of aircraft currently in coverage in an on screen menu with filtering capabilities of at least time of first plot, call sign, country of origin, etc. The tenderer shall fully describe the target filtering capabilities.

l) Provide the capability to log aircraft data to a database to support billing activities.

m) Provide the capability to produce daily reports sorted according to defined parameters such as time of entry, country of origin, aircraft type, etc. The tenderer shall fully describe the system reporting capabilities.

n) The Remote Control and Monitoring System shall allow to record Asterix output data of selected or all connected ground stations

o) The Remote Control and Monitoring System shall allow to record raw output data of selected or all connected ground stations.

p) The Remote Control and Monitoring System shall allow to locally replay recorded Asterix data for analysis purposes.

q) The Remote Control and Monitoring System shall allow to locally replay and convert recorded raw data into Asterix reports for analysis purposes.

r) The Remote Control and Monitoring System shall be based on a commercial off the shelf PC.

s) The Remote Control and Monitoring System shall run under a Linux operating system.

The RCMS shall also include the functions listed below as well as the ones the tenderer considers necessary to fulfil this system's functions.

a) Keep information in real time of the system's status.

b) It shall be capable of executing commands to the system, limiting access to the same with a key word or password.

c) It shall be possible to determine the anomalies presented by the system

d) It shall provide information regarding the system's fundamental parameters.

e) The alarm codes generated by the system shall be supported with the necessary information so they can be interpreted.

- The WAM system shall enable to be put into factory settings both locally and remotely

14.2 Technical Situation Display

The technical situation display will be located in the technical room of the ACC technical building. It will be used to assess the operational status of the WAM network.

The technical situation display shall exhibit the following functionality:

a) Be able to receive Asterix Category 20 and 21 target reports from one or more ground stations and display the message contents.

b) Be able to provide a simple map of coverage area and shall indicate target tracks as received within the target reports.

c) Attach a label to the most recent target position with the following minimum content information:

i) 24 bit Mode S address and registration

ii) Mode 3/A code data if available

iii) Flight level

iv) Call sign

v) Speed and other necessary target levels

d) Upon selecting a target, allow the display of the current Asterix target report content in a separate detailed menu list.

e) Allow panning, rotating, and zooming of the display content.

f) Present range, azimuth, and relative elevation between two selected targets and between targets and ground station site location.

g) All the selection of the layers to be displayed.

h) Be able to display a configurable history trail of target plots in steps of several seconds up to several hours.

i) Allow the indication of the speed vector present in the Asterix target message

j) be able to draw and editing Jordan MAPS and ROUTES by CARC in RCMS

15 ADS-B TARGET PROCESSING CAPACITY

Target Capacity/Characteristics

In addition to performing multilateration, the system shall be able to process extended squitter messages for 300 simultaneous targets. It shall output these messages relating to aircraft targets in a 360 degree scan out to a range of at least 200 NM.

The target processor shall have the capability to output as a minimum the following parameters as a target message, besides those, which the tenderer considers necessary for adequate signal processing:

A) Identification as:

I) Call sign

ii) ICAO 24 bit address or registration

b) Aircraft Category

c) Aircraft Size (length and width)

d) Position (from aircraft reference point):

i) Lat/Long (WGS-84)

ii) Barometric altitude

E) Velocity vector

i) Ground (or air) speed

ii) Vertical speed

f) Time stamp

g) Heading

The system shall be able to process extended squitter messages at the following rates:

a) Airborne position every 0.5 sec. This message also includes the integrity figure.

b) Ground position every 0.5 sec if the aircraft is moving, otherwise every 5 sec.

c) Identification and aircraft type every 5 sec.

d) Velocity and the accuracy quality indicator every 0.5 sec.

e) Aircraft status, including heading and other quality indicators if necessary every 1.25 sec.

16 INSTALLATION

The contractor must ensure that there is no impact upon the existing Air Traffic Control service during installation, site testing and commissioning activities. The new and the existing equipment shall be capable of operating in parallel throughout the installation process and for a determined period, agreed upon with CARC, following the installation.

The contractor shall ensure that installation workmanship complies with the highest quality standard levels.

The contractor will be responsible for the installation of all equipment, consoles, cabling and accessories.

It is also the responsibility of the contractor to determine whether the existing or new civil works will permit access to all equipment under this tender.

All installation materials, services, personnel teams, test equipment and tools required for installation of the equipment shall be provided by the tenderer.

The tenderer shall specify in the tender documentation the estimated time, personnel requirements and costs for the installation and commissioning of the equipment. The cost of fares, accommodation, workers accident insurance and subsistence during the installation and commissioning phase shall be borne by the tenderer.

The tenderer shall individually identify all installation personnel in terms of qualifications, experience and designation. Individual names are not required at the tender stage.

The tenderer shall be responsible for obtaining work permits or visas for all their personnel.

Any spare parts used to replace faulty items during the installation and check out phases and until final acceptance of the equipment shall be replaced by the contractor free of charge, including insurance and freight costs, to and from factory, within 30 days of commissioning.

Any special tools and test equipment supplied and used during the installation must be returned to the "as new" condition by the tenderer free of charge within 30 days of commissioning.

At least 45 days prior to installation, the contractor shall submit for approval to CARC a detailed Site Installation Plan for the site. The Plan shall contain all necessary information required to correctly install the equipment and initiate operation. As a minimum it shall include:

a) Site plans showing all equipment locations;

b) Proposed cable routing and length of cable runs;

c) Block diagrams complete with inter-connecting cable diagrams between the different equipment's. Cables shall be marked as to source, destination, assignment of each conductor and terminal number;

d) Power requirements and current drain (average and peak) for each hardware unit;

e) Instructions for installing each hardware unit.

The installation plan is to be updated to reflect changes made to the equipment location, cabling drawings, installation instructions and test procedures during the installation. A marked up Installation Plan shall be left on site at the completion of the installation.

An updated copy (as built) of the Plan shall be provided within 45 days after completion of Site Acceptance Tests.

The contractor shall be responsible for cleaning the sites after completion of the Site Acceptance Tests. Care shall be taken.

-The installation of the WAM system shall be easy and intuitive.

-The setting and adaptation of the WAM system shall be easy and intuitive.

17 TECHNICAL DOCUMENTATION

The contractor shall provide (4) sets of technical manuals in the English language (Hard and Soft Copy).

These manuals shall contain all information, at the module level, for the installation, operation and maintenance, parts and components list, of all equipment supplied under this project. All hardware and software that is furnished by third parties and integrated with the system shall have all of its support documentation delivered in the language of the country in which it was developed or manufactured.

The tenderer shall include a set of technical manuals containing the description, replacements and main features of the system components.

The manuals shall include flow diagrams of the signals between the frames and the equipment, indicating the type and terminology used and the signal diagrams of any external interfaces.

18 FACTORY ACCEPTANCE TEST

a. The tenderer will be required to assemble and test the entire system at their own premises prior to shipment. This Factory Acceptance Test shall be performed in accordance with a prepared Factory Acceptance Test Plan incorporating specific test procedures which will clearly demonstrate compliance of the equipment with the technical specification in all general, operational and technical aspects.

b. The tenderer undertakes to submit for CARC's approval at least forty-five (45) days prior to the scheduled commencement of the factory acceptance tests, Factory Acceptance Test Plan and Procedures together with the proposed acceptance certificate format. CARC shall notify the tenderer of its decision within thirty (30) days there after, and after an agreement has been reached, the procedures shall form part of the eventual contract. Any changes in the procedures initiated by the tenderer will be without cost to CARC and subject to CARC's approval.

c. The test procedures shall contain step-by-step instructions with a concise but comprehensive explanation of each test, including test scenario and objective. Test equipment interconnection shall be explicitly described in graphical and textual form as necessary.

d. All test equipment used for the factory tests shall be standard commercial equipment and shall not be modified and all ancillary equipment required for testing shall be furnished by the contractor for the duration of the tests.

e. Factory Acceptance shall be required for all equipment, both hardware and software, before shipping. The Factory Acceptance shall verify all the equipment's functional and operational capabilities and physical characteristics as specified in the scope of compliance.

f. All results of the Factory Acceptance Test shall be duly recorded and shall be signed by the tenderer's QA representative and CARC.

g. All observations agreed on and discrepancies noted during the inspection are to be corrected by the tenderer prior to shipment of the equipment.

h. The tenderer shall arrange for four (4) CARC personnel to attend the design phase prior the FAT phase

i. The tenderer shall arrange for three (3) CARC personnel to attend Technical FAT.

j. CARC's representative(s) shall be entitled to enter the works of the tenderer at reasonable times during the normal working hours to witness the test of the equipment and work in progress.

k. For the design phase and FAT: two hundred EURO or equivalent per each person per day. Full accommodation including four-star hotel, three meals including meals at holidays, air tickets, transportation, visa and health assurance.

19 SITE ACCEPTANCE TESTS (SAT).

The SAT shall contain a series of tests to confirm that requirements and specifications are met in the Jordan environment. They shall commence after installation is completed.

The SAT shall be conducted in three (3) phases as follows:

a) Provisional Site Acceptance Test (PSAT)

b) Operational Readiness Demonstration (ORD) phase (30 days).

c) Final Site Acceptance Test (FSAT)

The contractor shall demonstrate at PSAT phase, using mutually agreed upon test procedures, that all the equipment provided within this project is compliant to the technical specification and requirements. There shall be a separate site acceptance for the civil works. All deficiencies identified at the PSAT phase shall be corrected by the contractor prior to the FSAT phase, including any outstanding civil works issues. The PSAT shall be then considered to have been successful.

The contractor shall give CARC representative(s) at least twenty (20) days advance notice of the date on which the equipment shall be ready for the PSAT and FSAT.

All results of the SAT shall be duly recorded and shall be signed by the contractor. These results shall form the basis for the installation acceptance and for station records.

20 TRAINING.

a. Maintenance course shall be given by the contractor in the English language. The detailed training plan, indicating the curriculum, number of hours of theoretical and practical training and the total duration of each course, shall be submitted by the tenderer with their proposal.

b. Basic equipment familiarization training for technical personnel shall be provided by the contractor at the factory during the latter stages of manufacture and assembly of the equipment.

c. The training plan shall be subject to CARC approval 60 days prior to the start of training. The training plan shall cover all equipment within this project.

d. Theoretical training shall be provided prior to the installation phase of the project, so that trained personnel can participate in this phase.

e. A maintenance factory course for eight (8) electronics technicians. This course shall be sufficiently comprehensive to enable routine maintenance, interpretation of on-line diagnostic messages, running of off-line diagnostics, manual testing, rapid fault finding and restoration of service and carry out the preventive and corrective maintenance required on the WAM network and all associated equipment provided in this tender.

f. The maintenance-training course shall be held at contractor premises for eight technical personnel held in two sessions for period of Two weeks for each session. One hundred EURO per each trainee per day. Full accommodation including four-star hotel, three meals including meals at holidays, air tickets, transportation, visa and health assurance.

21 On-the-Job Training (OJT)

The contractor shall provide OJT training for maintenance personnel as part of the pre-commissioning activities for period of one week.

The OJT shall be conducted in English during the installation and /or testing phase of the project.

22 PROJECT PLAN

The contractor shall submit the following for CARC's approval:

a) A complete and detailed work schedule, within thirty (30) days after contract award.

b) A transition plan describing how the proposed equipment can be implemented with minimum disturbance and disruption of air traffic operations.

c) A calendar presented in weekly segments from contract award to commissioning with the following minimum milestones: preliminary design

review, final design review, factory-manufacturing assembly, FAT, civil works, site preparation, training, installation, provisional SAT, ORD, final SAT, flight check and commissioning.

The contractor shall, at no extra cost, update this project plan on a monthly basis until contract completion.

23 Compliance statement:

All offers shall be accompanied by a correctly completed Compliance Statement in the form of this specification with the tenderer indicating in the right hand column, Compliant (C) or Non Compliant (NC). If compliance is indicated, any further references, statements, comments or notes, will not waive the liability of the tenderer on the stated Compliance. The tenderer shall refer the compliance statement to appropriate sections of their supporting documentation**. <u>Lack of such definitive indication for any requirement shall invalidate the offer('shall' in this tender means mandatory requirement).</u>**

24 System Output

- The System shall output both WAM and ADS-B system output.
- The WAM system shall be capable of outputting the following ASTERIX categories:
    - ASX CAT 019
    - ASX CAT 020
    - ASX CAT 021
    - ASX CAT 023
    - ASX CAT 025
    - ASX CAT 247
- The WAM system shall enable to independently configure several output channels.

25 Safety and Security

- The access of authorized users into the system shall be controlled.
- The system shall, as minimum, enable to set the following levels of access:
    - Regular user
    - Administrator
- The WAM system shall have means to detect ADS-B spoofing.
- The system shall be capable to utilize the received signal power (signal amplitude) for ADS-B spoofing detection.

26 Certification

- The WAM system shall comply with the following international standards and directives:
    - IEC 61000-6-2 - Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
    - IEC 61000-6-3 - Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
    - EN 55022 - Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
    - EN 55024 - Information technology equipment - Immunity characteristics - Limits and methods of measurement
    - EN 50160:1999 - Voltage characteristics of electricity supplied by public distribution system
    - 2006/95/EC
    - 2004/108/EC
- The WAM system shall comply with the Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018, on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency.
- The WAM system shall comply with all safety requirements stated in ESSAR6 – Software in ATM Functional Systems.
- The system shall be compliant with EUROCAE ED-109 AL4[Ref6] and EUROCAE ED-153 SWAL3 for all software elements which could corrupt the target data.

27.STANDARDS

All designs, materials, manufacturing techniques and workmanship shall be in accordance with the highest accepted international standards for this type of equipment, including the construction, building codes and electrical standards for all civil works.

Where applicable, the equipment shall fully comply with or exceed:

a) ICAO Annex 10 Aeronautical Telecommunications, all Volumes with amendments

b) ICAO Doc. 4444/E/05/08/09/11 ATM Air Traffic Management

c) ICAO Doc. 9426 Air Traffic Services Planning Manual

d) RTCA DO260: Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (WAM) and Traffic Information Services – Broadcast (TIS-B).

e) ICAO Doc. 8168 Aircraft Operations

f) ICAO Doc.7030/E/17-31 Regional Supplementary Procedures

g) ICAO Doc. 7444 Air Navigation Plan Africa-India Ocean Region

h) ICAO Doc. 8071 Manual of Testing of Radio Navigation Aids, all Volumes

The tenderer shall also state, where applicable, the standards to which the whole, or any specific part, of the equipment complies.

The equipment shall be described in metric terms.

28.Operational requirement

- **Multilateration System Operational Requirements**

- ICAO recommends that the ground domain of the surveillance system has the capability to receive, process and display, in an integrated manner, the data from all sources DOC4444 Para (8.1).
- Multilateration systems used in the provision of air traffic services shall have a very high level of reliability, availability and integrity. The possibility of system failures or significant system degradations which may cause complete or partial interruptions of service shall be very remote. Quantification of requirements and analysis of Multilateration system failures will be set out in Backup facilities shall be provided.
- Multilateration shall provide quality of information contained in the ADS-B message according to or exceeds ICAO values, in terms of integrity, availability, reliability and continuity.
- Labels associated with displayed targets shall, as a minimum, include example, information relating to the identity of the aircraft, pressure altitude, TAS, IAS aircraft speed and heading, this information shall be obtained via ADS-B data link, and MODE S.
- The Multilateration systems shall provide for a continuously updated presentation of surveillance derived information, including position indications.
- Whilst implementation of Multilateration will not bring any changes to the controllers' display distinct symbols should be used for presentation of :
  a) Unintentionally duplicated aircraft identifications;
  b) Predicted positions for a non-updated track; and
  c) Plot and track data.
- Reserved SSR codes, including 7500, 7600, 7700, operation of IDENT and Multilateration emergency and /or urgency modes, safety related alerts and warnings shall be presented in a clear and distinct manner, providing for ease of recognition.
- Operation of IDENT, emergency and/or urgency modes, safety-related alerts and warnings SUCH AS STCA,MSAW,AREA PROXIMITY WARNING,EST whether from Multilateration or a radar source, as well as information related to automated coordination shall be presented in a clear and distinct manner, providing for ease of recognition
- Track labels associated with displayed targets should be used to provide, in alphanumeric form, relevant information derived from Multilateration surveillance for the standalone working positions.
- Track labels shall be associated with their position indications in a manner precluding erroneous identification by, or confusion on, the part of the controller. All label information shall be presented in a clear and concise manner.

- The Multilateration application is designed to support, and in some cases enhance, Air Traffic Services through the addition of ADS-B surveillance, in areas where radar surveillance currently does not exist.
  - The application is designed to support the following ICAO Air Traffic Services. AS follows:
    - Area Control Service and
    - Approach Control Service
    - Flight Information Service
    - Alerting Service,

- **Use of Multilateration Level data**

  The accuracy and integrity of pressure altitude derived level information provided by Multilateration are equivalent to Mode C level data provided through an SSR sensor The Multilateration level data presented on the controllers situation display shall normally be derived from barometric pressure altitude. In the event that geometric altitude data is presented on the situation display, the controller should be alerted to the fact that this data should not be used for vertical separation.

The limitations of our current radar system within Aqaba control area and control zone:

1- limited or no conventional surveillance at low altitudes due to blind areas, terrain est. that will cause traffic delay since the radar service ends below FL 150.

2- extreme terrain challenge creates complex operational requirements.

3- RNP procedures implementation.

4- NO radar vectoring for sequencing.

5- NO monitoring procedure within the area of responsibility to avoid traffic penetration with the adjacent.

The MALAT system shall provide the coverage for the following areas according to the provided service as follows:

1. Provide optimum coverage within Aqaba SECTOR , and more accurate tracking down to the runway surface.
2. Aqaba approach within at least a 45nm from AQB/ARP, Initial approach segment to include final approach segment till touchdown point.
3. The provision of radar surveillance approaches, and able to provide precision approach for 2 RWs thresholds.
4. The system is able to detect targets from general aviation that are not ADS-B equipped.
5. Improved automated conformance monitoring.
6. The system shall be able to detect targets within the west and south of Aqaba control area outside FIR.

- **ATS services included are:**

Air Traffic Control Service, Flight Information Service and Alerting Service;

The MLAT system shall provide the following functionalities, according to the operational requirements mentioned above, and described in ICAO DOC 4444, and can be summarized in the following:

i. Operation of air traffic control service:

a) Vectoring (doc 4444, Section 8.6.5);

b) Separation (for radar controlled airspace the coordination of traffic is detailed in doc 4444, section 8.7.2, the application of radar separation minima in doc 4444 section 8.7.3 and the minima themselves in section 8.7.4);
c) Monitoring (Safety level management in section 2.4, controller functions in tactical operations section 3.2.5).

ii. Flight information service:

a) Provide traffic information
b) Provide navigational assistance

iii. Alerting Service, principally for the following functions

a) Notification of rescue co-ordination centers (Sections 7.1.2.1, 9.2.1.1, 9.2.2, 11.4.1 and 15.1.3);
b) Plotting of aircraft in a state of emergency (Sections 9.2.1, 11.4.1 and 15.1.2)

- **COVERAGE REQUIREMENTS**

Figure 1

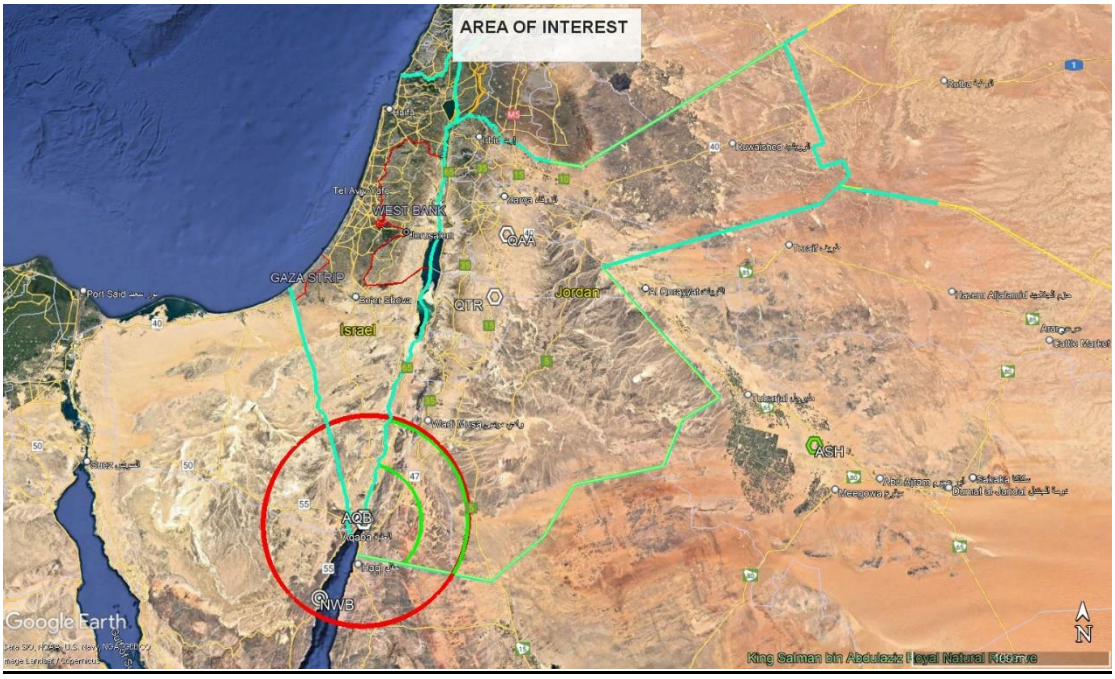

Figure 2

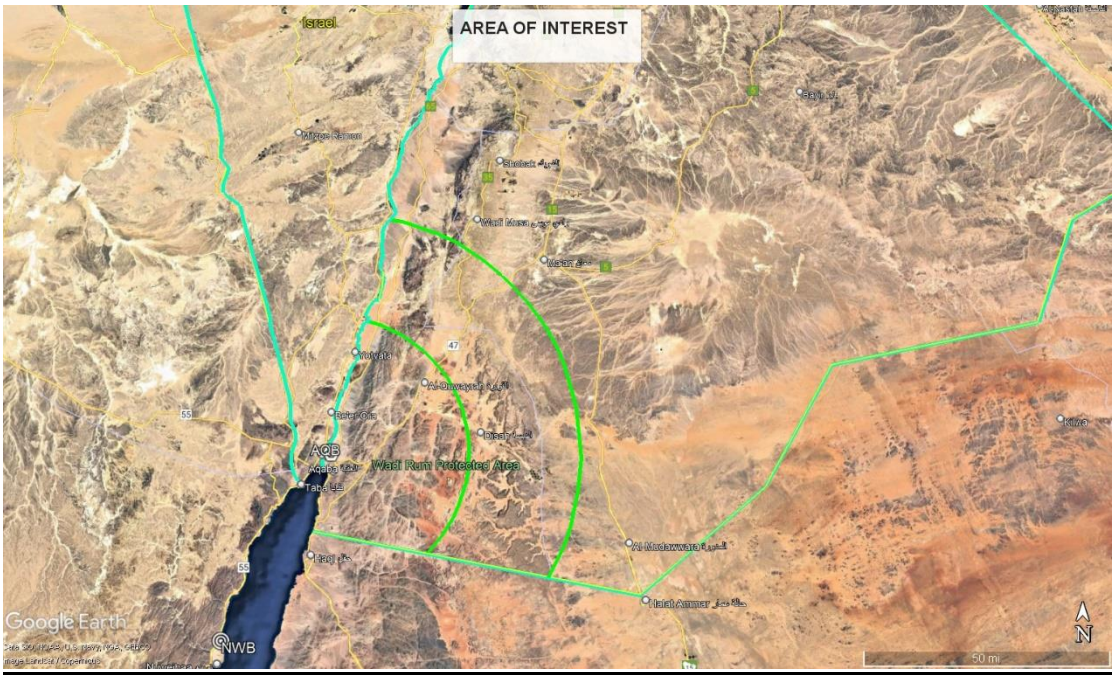

Figure 3

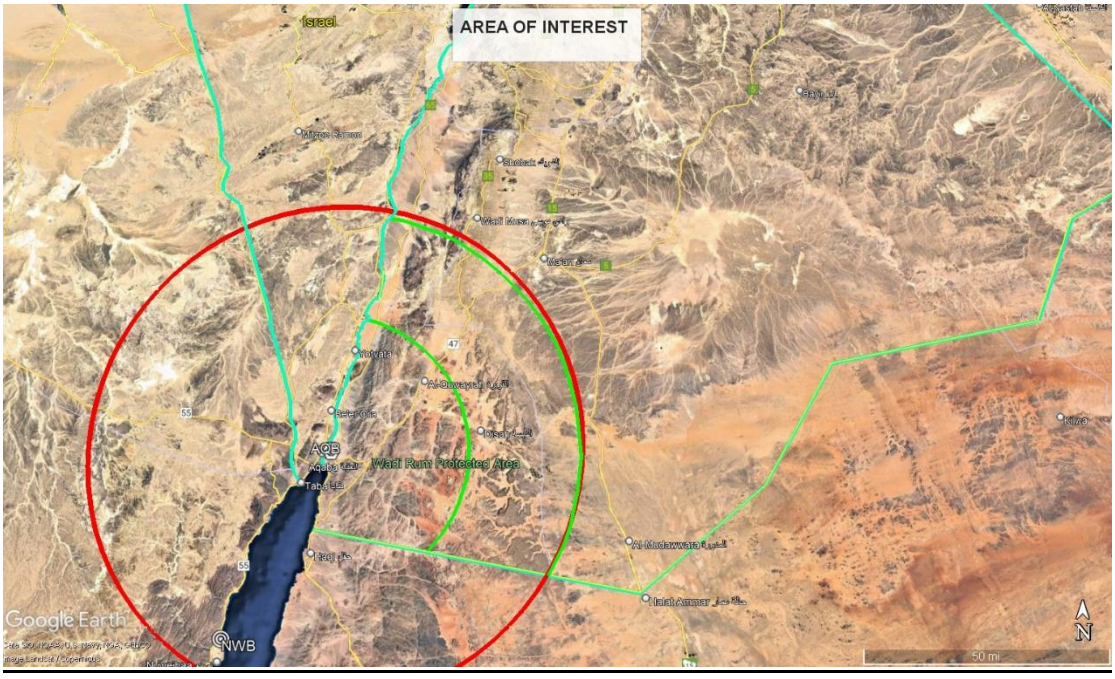

Figure 4

The coverage criteria for the Aqaba control area, specifically, will encompass the altitudes at entry points within a 45 nautical mile radius (as specified from Aerodrome Reference Point (29°36'41.83"N 35° 1'5.04"E)), extending all the way to the altitudes at the commencement of final approach segments, including their Decision Altitude/Height (DA/H).

The radar coverage will encompass the entire area of concern, considering the VFR routes within that specific region that are most likely not ADS-B equipped.

The MLAT/WAM coverage needs to be extended to encompass expansive regions to the west and south, utilizing distributed MLAT/WAM antennas with omni-directional coverage.

And also the MLAT/WAM system will be able to detect the region frequently used by low-altitude flights, which extends along the Araba Valley and reaches up to a point 40 nautical miles west of the QTR VOR.

The RADAR coverage prerequisites within the Aqaba control area and zone will be partitioned into multiple zones, each having distinct altitude minima above Mean Sea Level (MSL), tailored to meet specific operational demands. However, the idea of this partitioning is to provide a comprehensive understanding while studying the area of interest about the needed level based on our operational needs while in fact real MLAT coverage would exceed those distinct zones. These zones are delineated as follows:

In Zone (1), depicted in Figure (5), the yellow region commences at an altitude of 176 meters above Mean Sea Level (MSL) and follows the curvature of the Earth within this specified area. It takes into consideration the varying ground elevations, which may begin from 1000 meters MSL and may not be identical to the airport's elevation However, within this zone, the coverage criteria are met at specific segments of the flight, whether it's along the runway heading or during the final approach, even at points located distant from the airport.

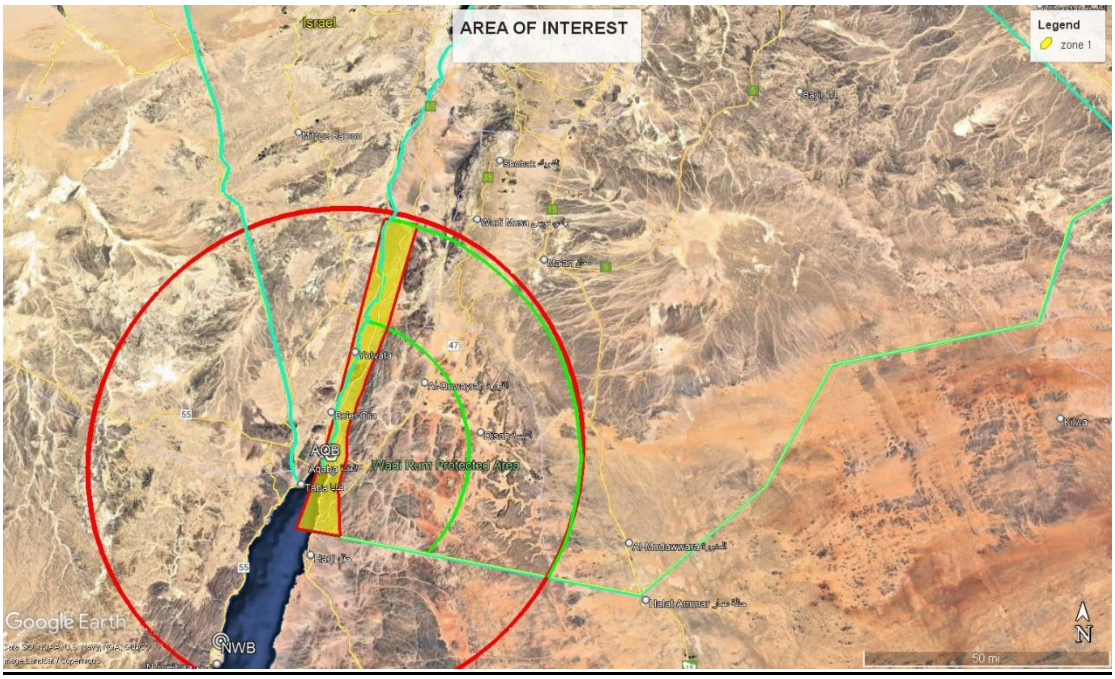

Figure 5

In Zone (2), the red region as shown in figure (6), the radar coverage requirements apply to altitudes from 6000 feet above Mean Sea Level (MSL) and above.

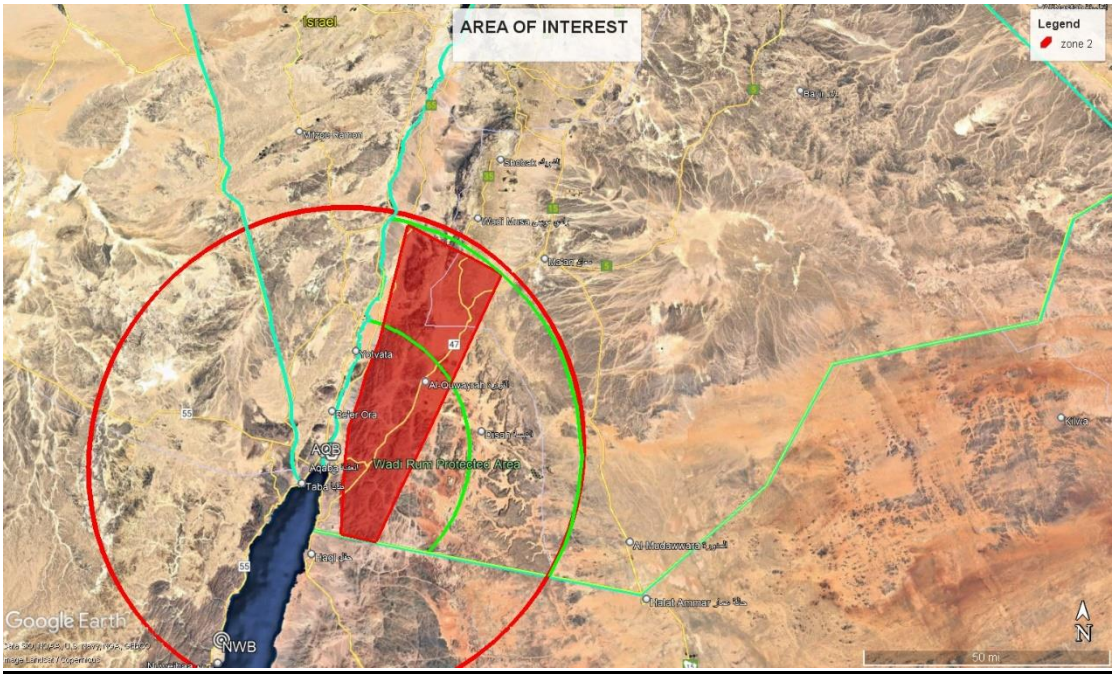

Figure 6

In Zone (3), the light blue region as depicted in Figure (7), the radar coverage requirements pertain to altitudes starting from 7000 feet above Mean Sea Level (MSL) and above. In this specific zone and beyond, the MLAT radar system's coverage will be integrated with the existing radar system to ensure comprehensive radar coverage throughout the FIR of Jordan.

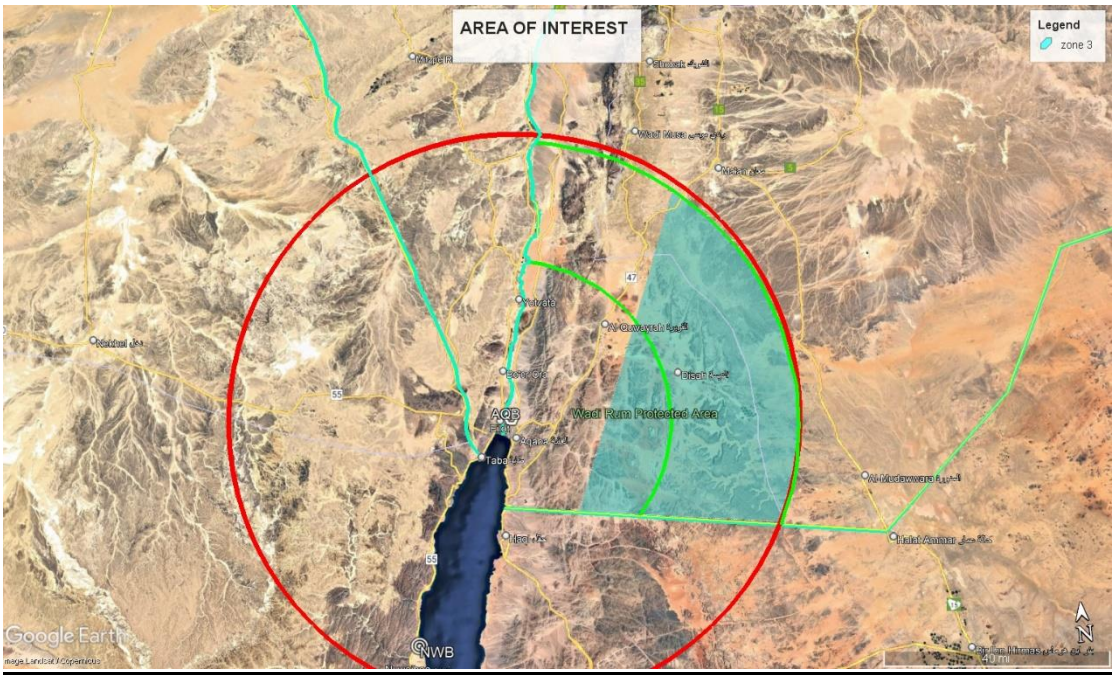

Figure 7

The VFR area, as in Figure (8), will be encompassed within both Zone (1) and Zone (2). VFR flights will ascend within Zone (1), reaching an altitude of up to 6500 feet before initiating a southward turn to enter Zone (2), where they will maintain an altitude of 7000 feet. They will continue at this altitude until they reach the last point marked by the blue line, at that point they will begin their descent within Zone 1 in preparation for landing.

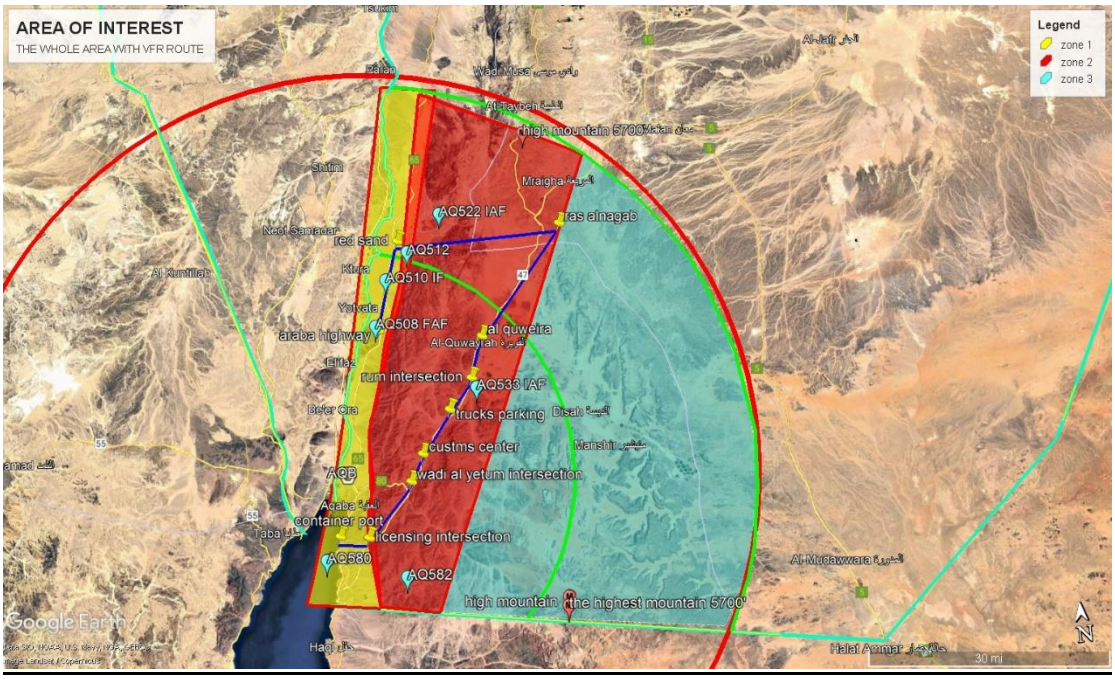

Figure 8

Figure (9) provides a comprehensive overview of all the zones along with their respective coordinates, facilitating the simulation process. The low-level area, represented by the green region in figure (10), is frequently utilized for low level flights and stretches from a point located 40 nautical miles west of the QTR VOR, extending to the juncture with the endpoints where Zone (1) concludes.

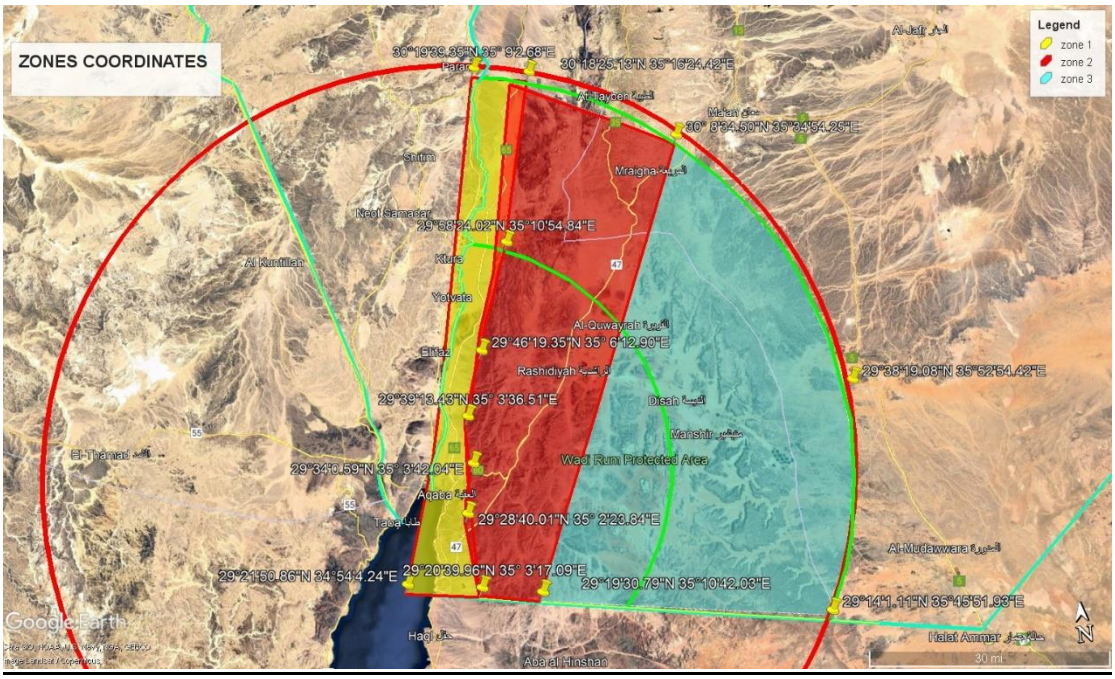

Figure 9

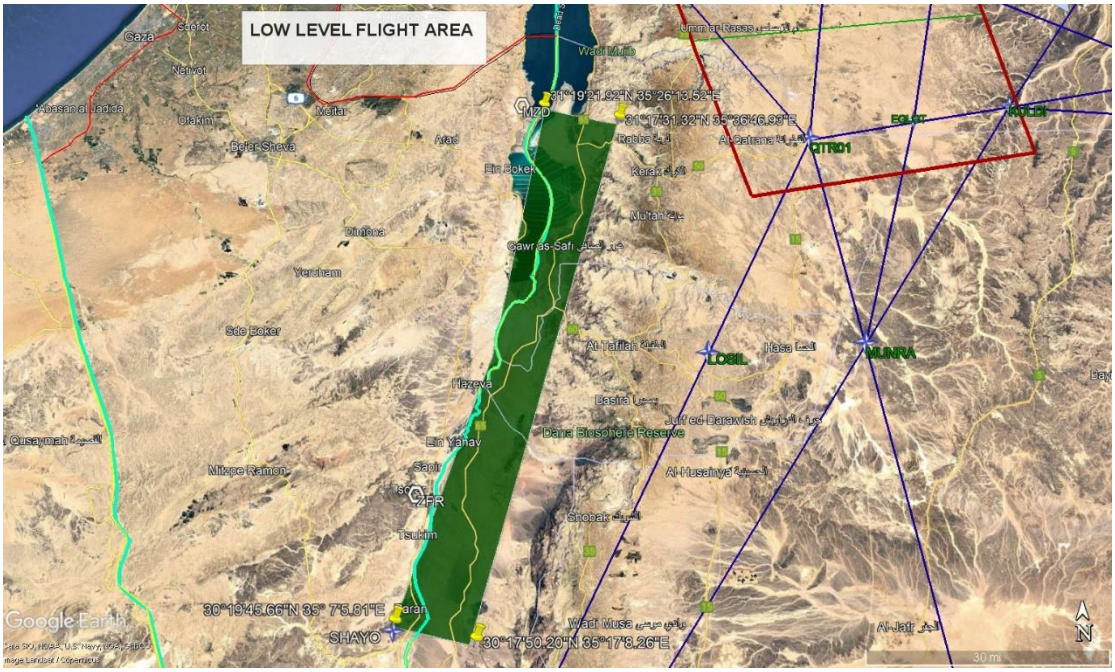

Figure 10

Lastly, beyond these specific zones, the radar coverage requirements will be integrated with the existing radar systems to ensure the continuous provision of radar services across the entire FIR region.

No.	Site ID	Site Height	Latitude	Longitude
1	087	60	31 46 25.20	35 34 30.60
2	089	60	30 53 08.15	35 25 14.47
3	090	60	30 16 01.00	35 17 13.84
4	091	60	30 16 01.00	35 13 30.00
5	092	60	30 02 42.26	35 09 16.99
6	093	60	29 43 45.08	35 02 13.68
7	094	60	29 34 35.80	34 58 55.20
8	018	30	29 23 45.00	34 58 00.99
9	049	46	29 21 26.54	34 57 46.86
10	012	90	29 30 07.07	35 05 27.30
11	011	46.6	29 59 49.04	35 30 25.36
12	040	60	30 20 10.69	35 30 57.31
13	010	46.6	30 39 54.85	35 37 22.50
14	048	46	29 11 41.00	36 04 18.00
15	109	60	30 18 28.27	36 11 40.17
16	042	75	30 37 03.57	36 19 29.35
17	008	30.6	31 24 16.67	36 05 58.67
18	009	60	31 03 24.15	35 41 22.57
19	039	30	30 49 34.32	35 36 47.47
20	097	60	31 17 48.00	36 41 36.00
21	148	30	31 04 20.70	36 00 24.30

APPENDIX (1) : Proposed MLAT/WAM sites location

- **EUROCONTROL**

Reference Documents:

- Description of a First Package of GS/AS Applications, CARE/ASAS Ref. CA-02-040(2.2), version 2.2, September 2002.
- Standard Document for Surveillance Data Exchange Part 12: Category 021 ADS-B Messages, Version 0.23, November 2003.
- Standard Document for Surveillance Data Exchange Part 16: Category 023 CNS/ATM Ground Station Service Messages, Version 0.11, December 2002.
- Standard Document for Surveillance Data Exchange Part 20: Category 247 Version Number Exchange, Version 1.1, November 2007.

EUROCAE Reference Documents:

- EUROCAE ED-129:
  Technical specification for a 1090MHz extended squitter ADS-B Ground Station.
- EUROCAE ED-142 technical specification for wide area Multilateration (WAM) systems
- EUROCAE ED-126:
- Safety, Performance and Interoperability Requirements Document for ADS-B NRA Application.
- EUROCAE ED-161:
- Safety, Performance and Interoperability Requirements Document for ADS-B RAD Application.
- EUROCAE ED-102 / RTCA DO-260:
- Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance –Broadcast (ADS-B) and Traffic Information Services (TIS-B).

RTCA
Reference Documents:

- RTCA DO-260A: Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance –Broadcast (ADS-B) and Traffic Information Services (TIS-B).
- RTCA DO-208: Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS).

- RTCA DO-229C: Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment.

- RTCA DO-242A: Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS B).

- Generic Safety Assessment for ATC Surveillance using Wide Area Multilateration (EUROPEAN AIR TRAFFIC MANAGEMENT PROGRAMME).

- The tender has an ex- WAM projects installation and certified by the customers and such certifications will be provided as evidence.

ملحق مواصفات

1-The tenderer shall provide not less than five references for a completed installed MLAT project.

2-Ground stations shall be time synchronised using GNSS as a primary source of synchronisation and reference transponder (using 1090 MHz transmissions) as a back-up time synchronisation method. GNSS synchronisation shall enable using at least the following GNSS constellations for redundancy - GPS, Galileo, GLONASS or Beidou.