TECHNICAL DESCRIPTION OF WEATHER RADAR FOR ROBERTS INTERNATIONAL AIRPORT, HARBEL, LIBERIA

Introduction

Weather radar is a type of radar used to locate precipitation, calculate its motion, and estimate its type. Radar constitute an integral element of all Automated Weather Observation System (AWOS) of airport weather observing network (Figure 1). Radars provide localized, highly detailed, timely and three dimensional sensing and observing capability that no other meteorological monitoring system can provide. They are able to measure variations in precipitation rates at a resolution of a few square kilometres or better, and at time cycles of the order of a few minutes. This is in addition to the capability of monitoring rapidly evolving weather events that is critical for the provision of early warnings of severe and hazardous weather. This includes heavy rain, hail, strong winds (for example tornadoes and tropical cyclones) and wind shear. Thus, radar has the highest impact on society of all the weather elements. Radar generated information is very useful for operations in aviation, agriculture and other weather-related practices.

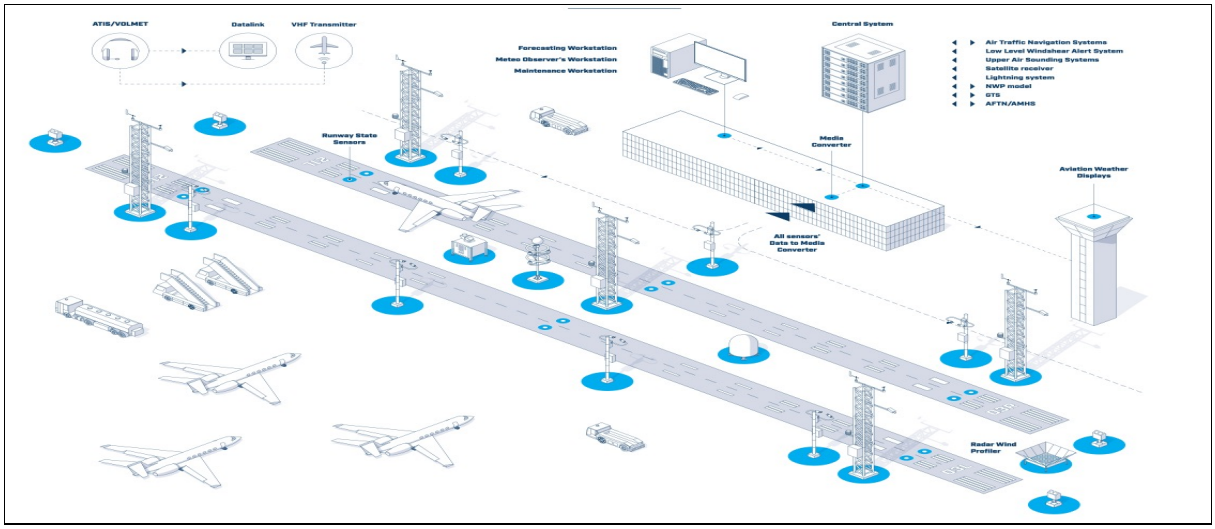

Figure 1: Setup for Automatic Weather Observation System of airport weather observing network

Roberts International Airport (RIA) is the sole international airport in Liberia owned by the Government. The airport is located near the town of Harbel, 35 miles from the capital of Monrovia. RAI is also known as Robertsfield, as it is named after Liberia's first president, Joseph Jenkins Roberts. In the last few years after the Civil war, the RIA has received considerable attention from the Government of Liberia and other international donors. This has resulted to the upgrade of its facilities into state-of-the-art systems and improvements in security equipment. Notwithstanding, The Meteorological Service Department at the RIA, which is central to air safety, and directly responsible for generating and delivering consistent, timely and accurate weather information for the Liberia and international airspace, is still lacking in terms of modern tools and systems required to deliver its services (Figure 2).

Figure 2: Forecasting building and office at the Meteorological Service Department at the RIA, Liberia

This is one of the reasons why support is highly needed from the the Green Climate Fund to improve the service delivery of The Meteorological Service Department at the RIA. This will go a long way to improve its operations in terms of generating and delivering consistent, timely and accurate weather information for Liberia and the international airspace. These includes:

Automated Weather Observation System (AWOS)

Automated Weather Observation System (AWOS) is an integral component of airport weather observation system for regional, national and international airports. The AWOS measures, processes, stores, presents and communicates all meteorological data at the airport as shown in Figure 3.

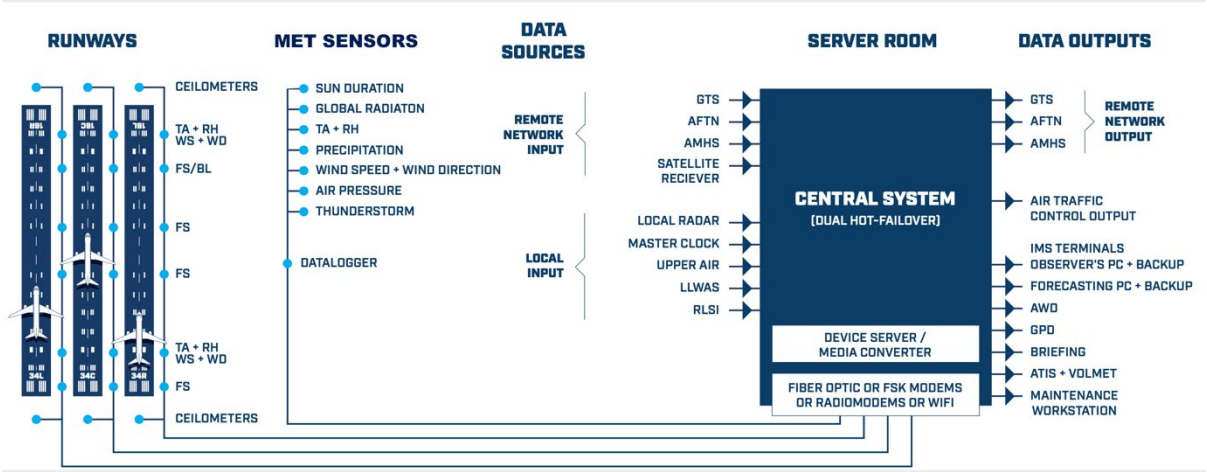

Figure 2: An ideal Automated Weather Observation System of airport weather observation

The system integrates and provides weather data to observers, air traffic controllers, pilots and other users in form of real-time screens, graphs, WMO codes, alarms and voice reports. It interfaces upper air systems, Low Level Wind shear Alert System and radars. The AWOS is setup to conform to all International Civil Aviation Organization (ICAO) and World Meteorological Organization (WMO) recommendations irrespective of the measurements and reporting. It calculates various derived meteorological data such as QNH, QFE and Runway Visual Range, generates alarms, METAR, SPECI, SYNOP reports as well as national codes if required. The system can interface numerous types of data loggers and sensors. It is designed to measure, calculate and process different meteorological quantities such as temperature (dry, surface, soil, soil under vegetation), wind speed and direction, pressure (station, QNH, QFE, QFF), relative humidity, precipitation (indicator and amount), runway surface temperature, freezing temperature for different deicing materials, runway condition (dry / damp / wet / ice, etc.), visibility and RVR, cloud height, sunshine duration, solar and gamma radiation, evaporation, O3 concentration and it is open for adjustments and addition of any other quantities if needed. The AWOS has a Central System that serve as a central node for all communication networks and interconnects field sensors, displays and individual stations installed on the airport, thus enabling to backup these networks. The Central System makes all preprocessed data available to remote workstations and displays, thick or thin clients.

Radar System

Radar are highly sophisticated equipment with broader applications in weather monitoring, military operations and navigation, among others. It constitutes a vital part of the AWOS that will be provided at the Roberts International Airport weather observation system through GCF support. Radar use could vary in terms of platform, application, frequency band, component, dimension and regional. In terms of frequency band, it can cover VHF, UHF and L. Regarding its components, it can consist of Antenna, Transmitter, Duplexer, Receiver, Display, Digital Signal Processor and Stabilization System. Also, its dimension can be 2D Radars, 3D Radars and 4D Radars. For Liberia, GCF proceeds will be used to procure a unique and modern X-band Weather Radar with large functionalities to support weather monitoring and forecast at the RIA. The radar will provide real time insight to weather situation and is capable to detect precipitation 10 dBz at distance 200km (see prototype in Figure 4).

Figure 4: Phototype and functions of the modern X-Band Radar for RIA

Some key features of the X-Band Radar to be procured for the RIA are listed below while the minimum specification needed is provided in Table 1.

- Radar Studio Software for displaying meteorological spatial data in user-friendly graphic form (Figure 4);
- Programmable scan of echoes from the radar range (including but not limited to full 3D volume scan, PPI scan, RHI scan);
- Data transformation into spatial matrix;
- Input data processing;
- Data distribution to customer graphic workstation;

Table 1:Technical Specification of the modern X-Band Radar to be procured for RIA

Height	1630 mm
Width	1310 x 1310 mm
Weight	125kg
Antenna	Parabolic, diameter 1160mm
Antenna elevation	-1 to +90°, angle span
Antenna scanning speed	0 to 15 rpm
Transmitter tube	Magnetron
Receiver sensitivity	-111 dBm 10dBz at 200km
Modulator type	Solid-state
Dynamic range	90 dB
Operating frequency range	9410 MHz (X-band)
Half power beam width	1.8°
Polarization	Horizontal
Antenna gain	40 dBi typical
Transmitter power peak	40 kW
Raw data resolution	32 bit
RF pulse width	2 μs
Pulse repetition frequency	250 Hz
Maximum range	200 km
Radial resolution	600 m
Consumption	250 W
Data update rate	3D full scan 1 min (depending on configuration)
Data transfer	TCP/IP (LAN, private networks, internet, etc)
Operating temperature range	-40 to +60°C without AC

Radar Studio Software

The data processing is based on web server architecture that allows all products to be available over HTTP interface and easily accessible to any user using web browser. The access to the web interface is secured by encrypted (https) protocol, and protected by password. The data processing software takes the earth curvature and atmospheric refraction into account. During the data processing, the non-meteorological data, like ground clutters, are removed (filtered) in final visualization products. The output can be stored in different file format, such as, BUFR, GRIB, HDF5, OPERA ODIM, UF data formats. Images produces by the radar can be exported to GIF, GeoTiff, PNG and JPG.

Radar products

The product of the radar includes:

1) Standard meteorological products such as;
   - Plan Position Indicator (PPI) one radar elevation
   - Constant Altitude PPI (CAPPI) horizontal cross section
   - Range Height Indicator (RHI) vertical cross section
   - Echo Tops heights of cloud tops
   - Composite Reflectivity (Column max) maximas in columns
   - Vertically Integrated Liquid Water (VIL) column sums

2) Hydrological products of which;
   - Quantitative Precipitation Estimate (QPE)
   - Rainfall Accumulation
   - River basin statistics

3) Composite products from multiple radars such as;
   - Generation of the composite products from the heterogenous radar networks

4) Nowcasting
   - Storm cell identification and nowcasting
   - Tracking radar echoes by correlation (TREC) nowcasting up to 2 h including QPE

Radar map server

This includes, but not limited to;

- Zoomable maps with layers,
- Integration of Openly Licensed Maps for Offline use,
- Radar product layers,
- OGC Web Map Service

In addition, low emitted power will enable the device to comply with standards for operation in settled areas (towns, airports, highways, ports, etc.). Despite the low emitted power the radar is able to monitor small precipitation up to distance of 200 km.

Proposed Budget (GCF Financed)

Component Description	Unit	Cost (USD)
X-band Weather Radar System including a map server, radar studio software, workstations, technical training and maintenance fee, an AWOS and other auxiliary accessories.	1	900,000.00
TOTAL COST		900,000.00

*****_The radar system will be procured through International Competitive Bidding (ICB) method_