سلطنة عُمان
Sultanate of Oman

هيئة تنظيم الاتصالات
Telecommunications Regulatory Authority

Space Radio Monitoring Station

وحدة إدارة الطيف الترددي
Spectrum Managment Unit

http://smu.tra.gov.om/

Space Radio Monitoring Station

His Majesty
Sultan Qaboos bin Said

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1. Introduction

This booklet provides a brief description of the Space Radio Monitoring Station (SRMS) project, its main objectives and the stages of implementation, as well as a simple explanation of the basic components of the station and its systems. The booklet also explains the technical capabilities of the station that are necessary to make measurements of signals of space services, identify illegal uses and resolve radio interference, as well as the possibility to verify the licenses granted by the Authority.

2. Overview of the Station

The project included the establishment of a fixed radio monitoring station to monitor space services in the Downlink (Space-to-Earth), as well as the provision of a mobile space station to monitor radio communications in the Uplink (Earth-to-Space). The project also included the provision of systems and equipment necessary for space monitoring. The station is located in the Governorate of Muscat , at Al-Ansab Heights near Muscat Expressway facing Oman Convention and Exhibition Center (Figure 1 below shows the station's location).

Figure 1: Station location map

The project was completed and handed over to the Authority on 31st May 2017. The station becomes the latest of its kind in the world and the first in the Middle East operated by Telecommunications Regulatory Authorities. Additionally and in accordance with the International Telecommunication Union (ITU) Report ITU-R SM.2182-1(06/2017), on measurement facilities available for the measurement of emissions from both GSO and non-GSO space station, this station will become the ninth in the world of its kind after inclusion in the aforementioned report. (Figure 2: Locations of space radio monitoring stations around the world according to the report ITU-R SM.2182-1(06/2017) in addition to the Sultanate).

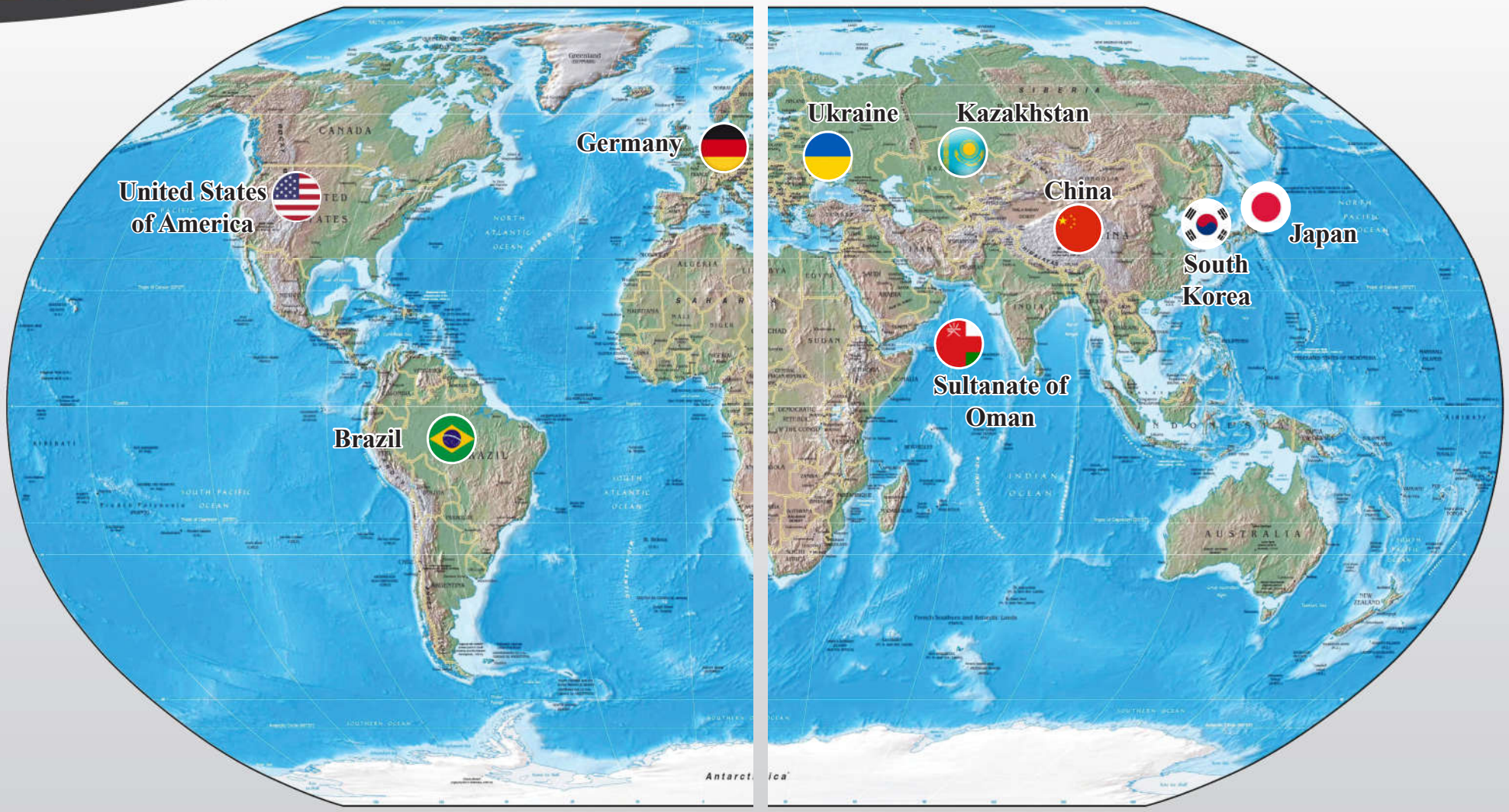


Figure 2: Locations of space radio monitoring stations around the world according to the report ITU-R SM.2182-1(06/2017) in addition to the Sultanate

This station is capable of monitoring signals from satellites located almost in the visible arc (16° W - 133° E) as shown in Figure (3) below:

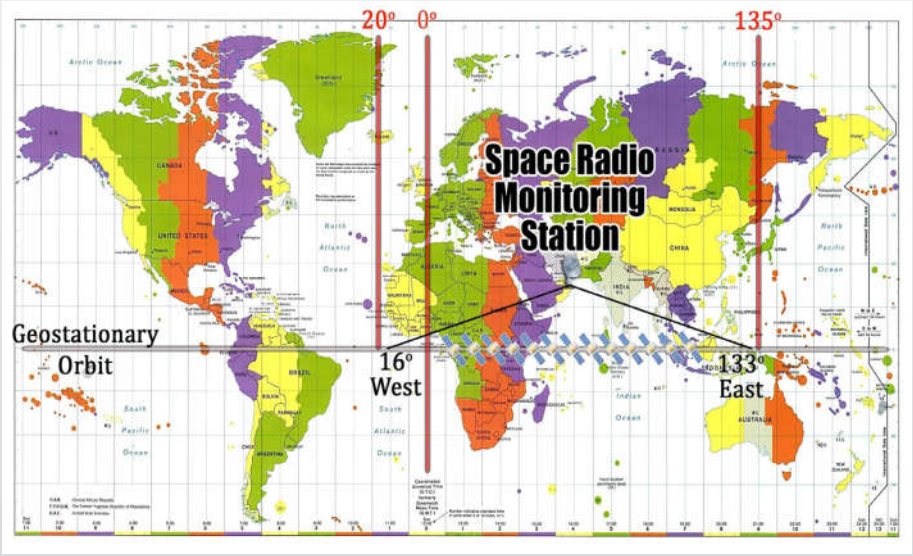


Figure 3: Visible arc of the Space Radio Monitoring Station

3. Objectives of the station

Recent significant developments in Satellite Telecommunications and the increase in satellites and small transmitters, lead to expansion of satellites services around the world and in the Sultanate.
This expasion had created several challenges for regulating such usage, particularly detecting the unlawful, which has a negative impact economically in terms of not benefiting from revenues generated from radio licenses in addition to the security threats related to unknown uses.
Serval years ago, the Authority began planning to establish a space radio monitoring station to achieve many goals, the most important of which are:

1) Control the use of frequency spectrum and space resources by verifying that existing uses are compatible with the licenses granted.
2) Monitor and measure space services signals received in the Sultanate.
3) Detect any unlawful use in the Downlink and Uplink.
4) Detect and resolve accidental and intentional interferences in space services.
5) Coordinate with ITU and other regulators on interference related to space services.
6) Support national projects and activities related to space services.

4. Timeline for implementation

The Authority started implementing this project several years ago. Figure (4) below illustrates the most important phases of implementation:

Figure 4: Timeline for implementation

Figure 5: Aerial Photo of the Station

Figure 6: Night view of the Station

5. The official opening of the Station

The SRMS was officially inaugurated on Wednesday, 17th January 2018 under the auspices of HE Dr. Ahmed Bin Mohammed Al-Futaisi, Minister of Transport and communications with the presence of HE Houlin Zhao, ITU Secretary-General.

Figure 7: Opening Cermony

6. Main components of the Station

The station consists of 10 main sections illustrated in Figure (8) below:

نظام تحديد الموقع الجغرافي

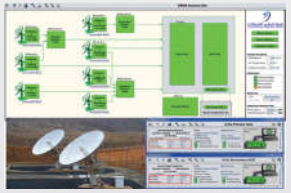
(Geolocation)

هوائيات الاستقبال

(Antennas)

المرسل المرجعي

(Reference Emitter)

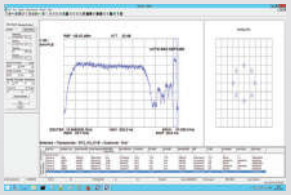


نظام المراقبة و التحكم

(Monitoring and Control)

محطة المراقبة المتنقلة

(Mobile Monitoring Unit)



نظام مراقبة وتحليل الإشارات الراديوية

(Carrier Monitorng)

طائرة بدون طيار

(Drone)

نظام مراقبة القنوات التلفزيونية

(DVB Receiver)

مبنى المحطة

(SRMS Building)

نظام المراقبة الجغرافي

(GeoMon)

Figure 8: Main components of the Station

6.1 Antennas

The station contains 7 antennas with the following technical details:

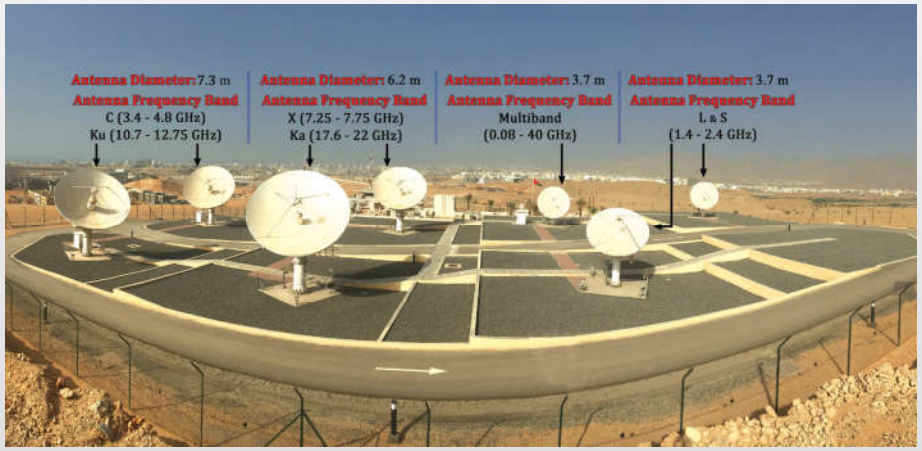
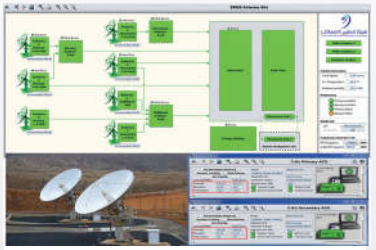


Figure 9: Technical details of antennas

During the project design, placing the antenna farm at the highest part of the site provided the station best orbital Arc visibility. Then, the exact location of each antenna was tuned to minimize its obscuration. In order to ensure a well and continues operation of the station in the coming period, it is very important to keep the antenna's circumference free of any obstacles or high buildings which may affect the reception of signals. To achieve this, the Authority requested the Ministry of Housing to avoid allocating plots adjacent to the project site.

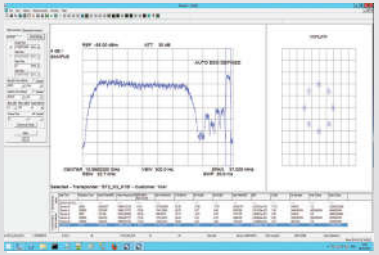
6.2 Monitoring and Control

This system directs antennas to satellite orbital positions, controls and monitors all equipment and information technology devices. It also issues warnings in the event of any problem or malfunction.



6.3 Carrier Monitoring

This system monitors and analyzes radio signals received from satellites and identifies the technical specifications of these signals for example: frequency, bandwidth, signal strength and type and modulation type.



6.4 DVB Receiver

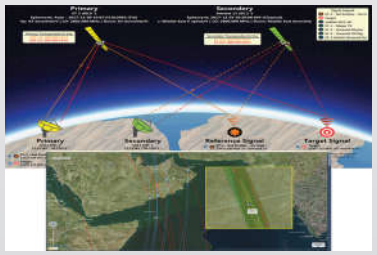
This system enables the display, identification and tracing the source of unscrambled satellite TV channels.

6.5 Geographical Monitoring System (GeoMon)

This system facilitates the verification of the actual usages with the radio licenses granted by the Authority and the measurement of how busy the geostationary satellite orbit is.

6.6 Geographical Location System (Geolocation)

This system is used to determine the geographical location on earth for the signals received in the Downlink (Space-to-Earth) to determine the location of unlawful usage transmission originating from Oman and the location of the radio signals that cause interference.



6.7 Reference Emitter

This device is used with the Geolocation system to assist in improving the accuracy of the results of determining the geolocation of the received signals, as the emitter may be shifted whenever needed by the mobile monitoring unit to any location in Oman.

6.8 Mobile Monitoring Unit

This unit can monitor the satellite services in the Uplink (Earth-to-Space) and the Downlink (Space-to-Earth), and determine the location of unlawful usage transmission and radio interference.

6.9 Drone

Drone is used to determine the location of unlawful usage and the radio interference of signals in the Uplink (Earth-to-Space) when it is not possible to use the mobile unit due to terrain constraints or the elevation of the transmission angle of earth station antennas.

6.10 SRMS Building

The Monitoring Station building is comprised of five key parts: Data Center, Control and Monitoring Center, Maintenance Workshop, Vehicle Garage and Electric Generator Unit.

The Control and Monitoring Center operates the Station and controls all the equipment and systems via four control platforms.
TRA has two centers for this purpose connected by a microwave link and fiber optic as follows:

- Main Center – located in SRMS building (Figure 10 A).
- Back-up Center – located in TRA building (Figure 10 B), whenever it is required to operate the station from TRA Head Office.

Figure 10 A: Main Center (Station's location)

Figure 10 B: Back-up Center (TRA Head Office)

7. Technical capabilities of the Station

The station has advanced technical capabilities through which the objectives of this important project can be achieved. The station has capabilities to provide measurement services for satellite signals received within the Sultanate and in neighbouring countries, with the possibility of verifying cases of interference not only at the national level, but also at the regional and international levels.

7.1 Control the use of frequency spectrum and space resources

The station can verify current uses with the radio licenses granted by the Authority by using the systems shown in the Figure (11). Geographical Monitoring System (GeoMon) connects to the database of licensed users to provide data to be verified. The Monitoring and Control System is then ordered to direct the receiving antenna to the target satellite specified in the license so that satellite signals can be received from this satellite. This is followed by another order for the Carrier Monitoring System to analyze and compare the technical specifications of the licenses to be verified with the technical specifications of the received signals (frequency, bandwidth, Equivalent Isotropically Radiated Power (e.i.r.p)) so as to identify any differences in the usage against the license granted by the Authority.

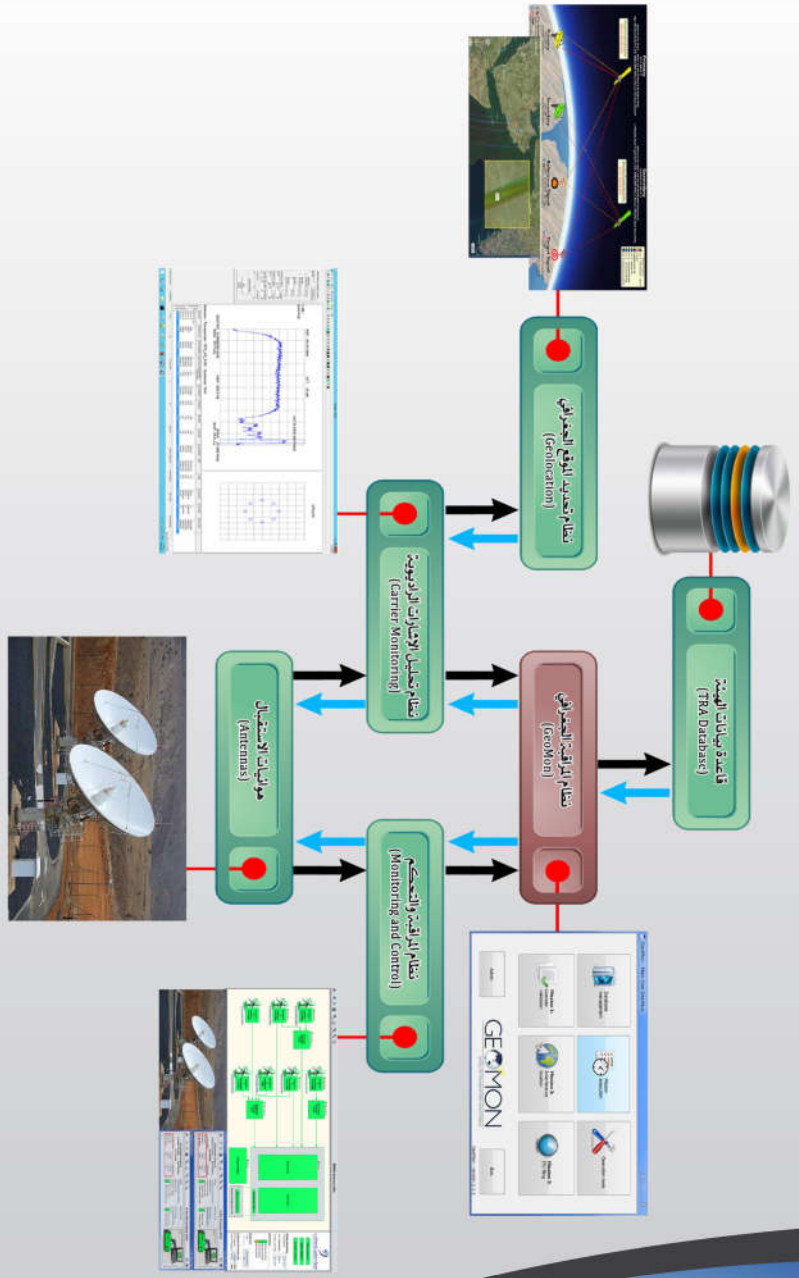


Figure 11: Components of the station used to verify the current uses

7.2 Monitoring and measuring satellite signals

The station measures satellite signals from satellites that are received within the Sultanate.

The measurements are made by using the receiving antennas and the systems shown in Figure (12) in a manner similar to the explanation in section 7.1. In this context, a DVB receiver can also be used to analyze, identify and trace the source of unscrambled TV signals.

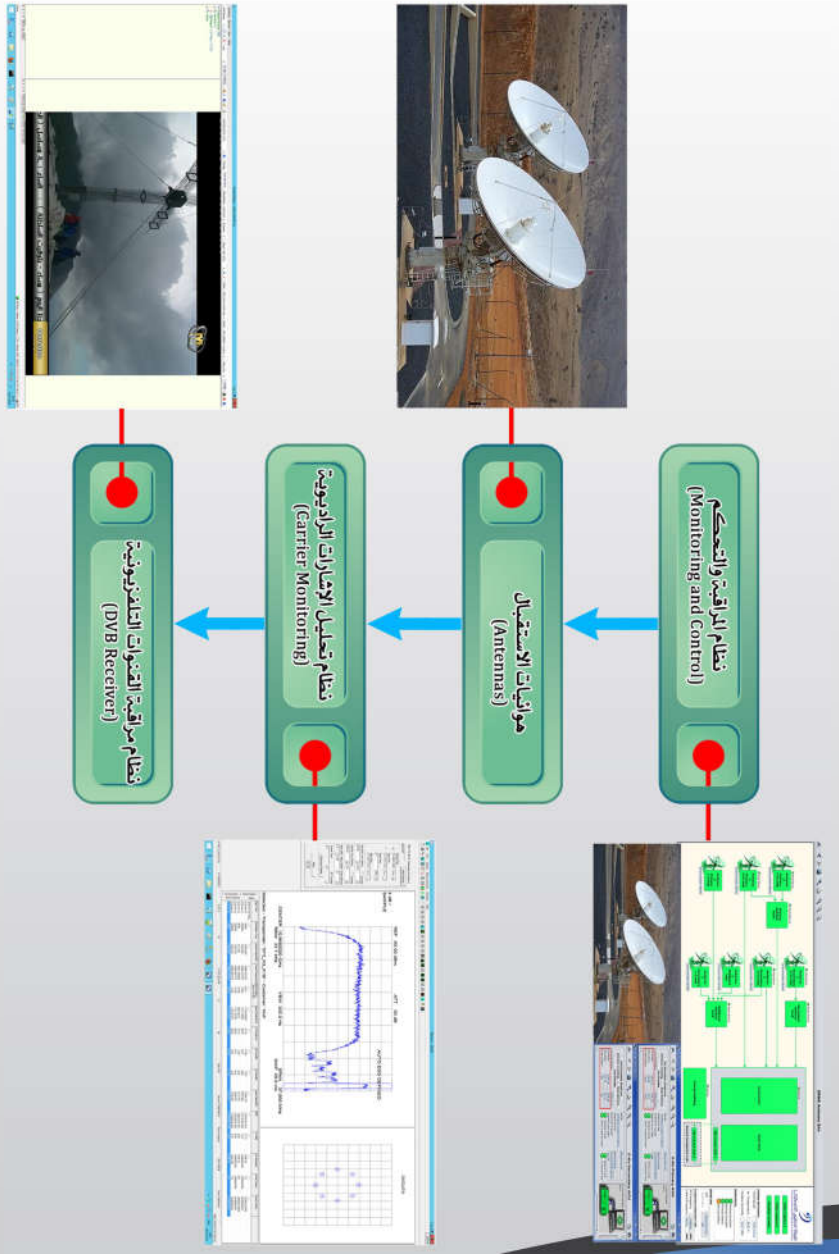


Figure 12: Components of the station used to monitor and measure satellite signals

7.3 Detect unlawful uses and resolve radio interference

Resolving interferences in satellite services and identifying their source are one of the main objectives of this project. As satellite services coverage often spill over national borders, the source of such interference can be from anywhere in the world, not just from within Oman.

The station has all technical systems and capabilities for conducting such measurements.

In order to verify unlawful uses or resolve interference in space services, this is achieved by using the systems shown in Figure (13) where satellite signals are received by receiving antennas and analyzed by Carrier Monitoring System, and then Geolocation system is used to determine the approximate location of the signals on the ground. Mobile Monitoring Unit and Drone are used next to determine the location of the transmitting station accurately if the source is within the territory of the Sultanate.

However, if the source is outside the Sultanate, this requires international coordination with the International Telecommunication Union (ITU) and the country from which the transmitting station is broadcasting. In this case, the ITU is provided with a report of measurements from the Geolocation system to coordinate with and inform the concerned country to stop the source of the interference, which may sometimes require a coordination meeting to discuss the matter.

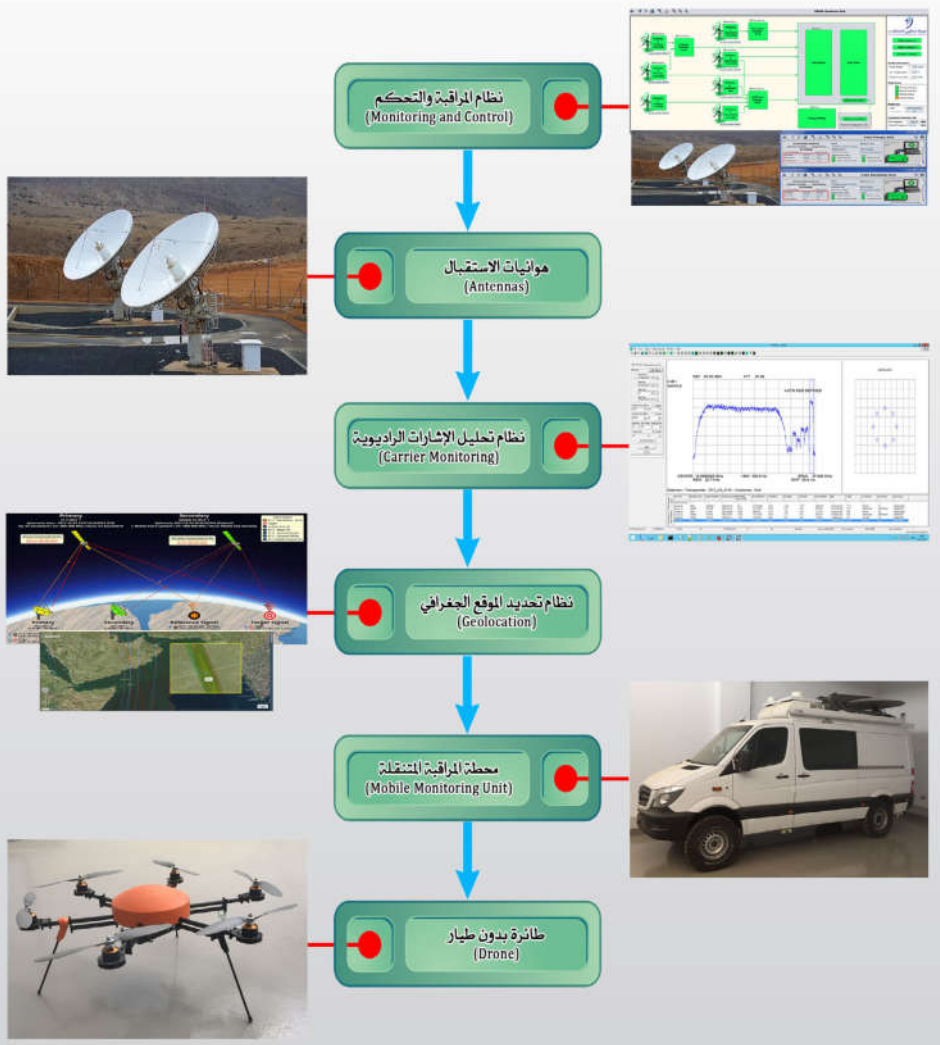


Figure 13: Components of the station used to detect unlawful uses and resolve radio interference

8. International coordination

As satellite services coverage often spill over national borders and the services become regional or international services, satellite service monitoring work requires close international coordination with the relevant bodies and organizations such as ITU, regulators or satellite service operators.

It is very crucial to communicate with these parties in order to obtain all satellite data and information that are very necessary to identify sources of interference.

The Authority has also started meetings with other regulators that have similar stations to discuss possible cooperation.
A meeting was held during the period from 24 to 25 January 2018 with the German Administration which has a similar station to provide services to several countries in the European continent. In case of harmful interference, this requires coordination and meetings with the concerned countries as explained above.

9. Support national projects

The implementation of the Space Radio Monitoring Station project would support national activities related to these services, for example national satellite launches, which would contribute to any required measurements. The project will also enable the Authority to monitor the Sultanate's allocations of orbital positions and frequencies in accordance with the regional plans issued by the ITU.