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# SECURING OMAN'S SPECTRUM

Tracing the journey to building the region's most ambitious Advanced Space Radio Monitoring Station

# SAFEGUARDING SPECTRUM

When Oman's frequency spectrum was under threat, Oman's TRA rose to the occasion by building one of the world's top Advanced Space Radio Monitoring Stations (ASRMS) in conjunction with Kratos. In a **SatellitePro ME** exclusive, Yousuf Al-Balushi, VP for Spectrum Management Affairs at Oman's TRA, and Jérôme Duboe of Kratos, take us through the milestones that led to the launch of the Middle East's only ASRMS, which went into operation last year

With a growing global satellite environment in the Middle East and North Africa (MENA) region and a rapid rise in the number of radio communication networks and wireless devices, an increasingly dense signal environment was emerging in the early part of this decade. This raised concerns that the frequency spectrum would become congested, leading to increases in interference and frequent illegal transmissions – a concern that the Telecommunications Regulatory Authority (TRA) of the Sultanate of Oman wanted to address before it got out of control. The environment also offered the perfect opportunity for the TRA to modernise its telecommunications infrastructure and regulate the telecom market so as to benefit the economy.

"Satellite spectrum is a scarce national asset that can be subject to unauthorised usage, interference and other threats," explains Yousuf Al-Balushi, Vice President for Spectrum Management Affairs at the TRA.

The broadcast industry in this region relies heavily on satellite technology to gather news and broadcast live events, especially with a very high volume of FTA channels. Over the last decade in the Middle East, there have been numerous cases of satellite interference. Satellite spectrum is a limited and precious resource, and telecommunication regulatory authorities are responsible for controlling legal transmissions according to licences, as well as addressing and mitigating deliberate jamming.

"Foreseeing an issue and to protect the satellite spectrum, the TRA put a plan in place to develop a one-of-a-kind satellite radio monitoring station in the region to guarantee reliable licensed satellite services and interference-free operation," clarifies Al-Balushi.

The aim was to build an Advanced Space Radio Monitoring Station (ASRMS) to monitor and enable better spectrum efficiency on the one hand (orbital slot scanning) and contribute to a smooth coexistence of terrestrial and satellite usage on the other.

The ASRMS was an ideal solution because it would include

The ARSMS in the Sultanate of Oman is one of only nine in the world

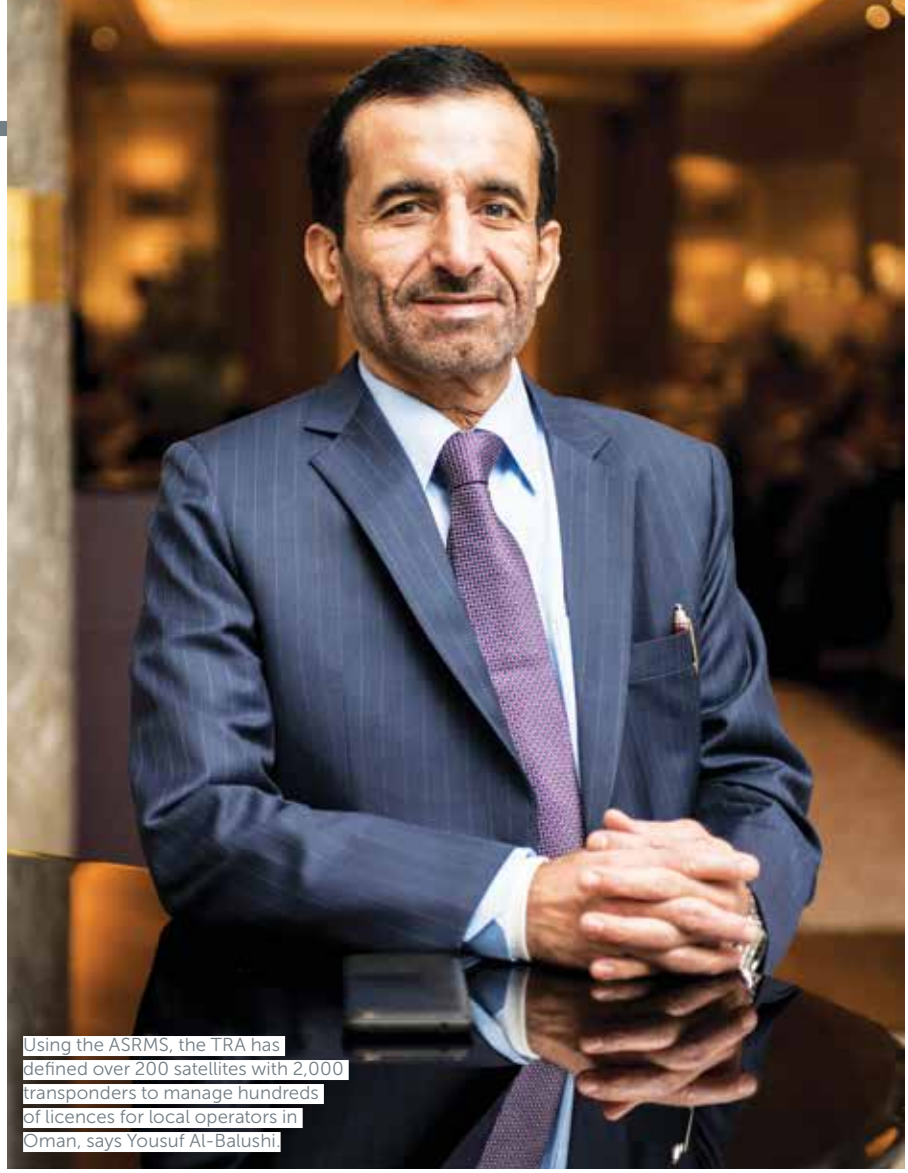
all the capabilities to monitor the spectrum over a country. It would have a building hosting a data processing centre, an operations centre, an engineering back office and a facility to set up vehicles and to repair them. It would need a set of antennas to capture signals from 80MHz to 40GHz; satellite signal data processing facilities for the identification of all carriers on a given satellite, the geolocation of the transmitters and the recording of signals; and facilities to automate operations and manage the TRA's mission.

Without doubt, a project of this magnitude would take many years to bring to fruition. The TRA chose Kratos, after evaluating offers from multiple vendors, to implement a turnkey ASRMS.

Kratos is a major global ground station solutions provider with more than 30 years of experience delivering satellite antennas and complete ground stations for customers around the world. Turnkey integration of ground systems is often supported by its carrier monitoring, signal cancellation and network and service monitoring products.

"The Kratos solution has been selected because of Kratos' extensive experience in the arena of space radio monitoring systems. The ASRMS will enable us to better manage the satellite spectrum used in the Sultanate and enhance cooperation with other telecommunications regulatory agencies," explains Al-Balushi.

The project, which required a very intricate design and a complex infrastructure, was finally launched last year in the Muscat Governorate, bringing more than 100 people with a variety of skills to the table. The monitoring station is one of only nine of its kind in the world and has been built in accordance with the International Telecommunication Union (ITU) Report ITU-R SM.2182-1 (06/2017) on facilities to measure emissions from both GSO and non-GSO. It is the first station of its kind in the Middle East.



Using the ASRMS, the TRA has defined over 200 satellites with 2,000 transponders to manage hundreds of licences for local operators in Oman, says Yousuf Al-Balushi.

> "Satellite spectrum is a scarce national asset that can be subject to unauthorised usage, interference and other threats"
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> **Yousuf Al-Balushi, Vice President for Spectrum Management Affairs, Oman TRA**

Today, the ASRMS can monitor an extremely wide area from Europe to Asia. Using the ASRMS, the TRA has defined over 200 satellites with 2,000 transponders to manage hundreds of licences for local operators in Oman (including satellite operators, mobile telecom backhaul operators and broadcasters).

The TRA worked in cooperation with Kratos on the site design, with civil work architects and satellite field engineers providing an optimised site design for the antenna farm and site layout. This cooperation was performed in parallel with the overseas (factory) design, assembly, and integration of the system components.

Finally, design and testing allowed the integration of 14 hardware and software sub-systems into a comprehensive system.

"The project was very extensive, including civil works," explains Jérôme Duboe, Director of Middle East Delivery, Kratos Oman. "The site was very complicated, and it was a huge effort to prepare it, and construct the building and the

antenna site. The project followed some well-defined stages to ensure the design fit the needs of the TRA."

But let's start at the beginning. In the engineering phase, the TRA led the effort in completing the Critical Design Review (CDR), with the support of Kratos.

"The CDR is a critical milestone in such a project. It is aimed at demonstrating to the customer that all requirements are met in the design and that the operational concept fits the customer needs. The completion of this phase demonstrated that the team could move to the full-scale fabrication, assembly, integration and testing of the ASRMS," explains Duboe.

The next phase was the build-out. Starting with a completely barren site, Kratos managed the build-out to support the ASRMS. This included the installation of seven antennas, one of the most critical parts of the implementation.

> "The challenge was to cover all available extended frequency ranges with all polarisations, using full-motion antennas or large antennas with very advanced and reliable tracking systems"
>
> **Jérôme Duboe, Director of Middle East Delivery, Kratos Oman**

"The TRA wanted to monitor signals from geostationary satellites in the orbital arc covering an extremely wide area from Europe to Asia. The challenge was to cover all available extended frequency ranges with all polarisations, using full-motion antennas or large antennas

The large scale build-out of the ASRMS included engineering and construction.





Seven multi-band antennas from Kratos covering L-, S-, C-, X-, Ku- and Ka-bands were deployed to support regulatory operations.

The ASRMS was inaugurated by HE Dr Ahmed Bin Mohammed Al-Futaisi, Minister of Transport & Communications in the presence of Houlin Zhao, ITU's Secretary General.

with very advanced and reliable tracking systems," explains Duboe.

"To meet this need, Kratos developed and installed seven separate multi-band antennas for us, ranging in diameter from 3.7m to 7.3m. They are covering L-, S-, C-, X-, Ku- and Ka-bands, but a dedicated antenna also enables the analysis of signals between these commercial bands. This enabled the ASRMS to cover a range of signals from 80 MHz to 40GHz. Most of the monitoring is performed on geostationary satellites; however, three of them can also track MEO satellites since they are full-motion and driven by an advanced tracking controller."

Following that, Kratos constructed a data centre, a control and monitoring centre, back-up power generation and inter-site connectivity to protect against outages and assure connectivity.

The data centre has several racks of equipment, including commercial

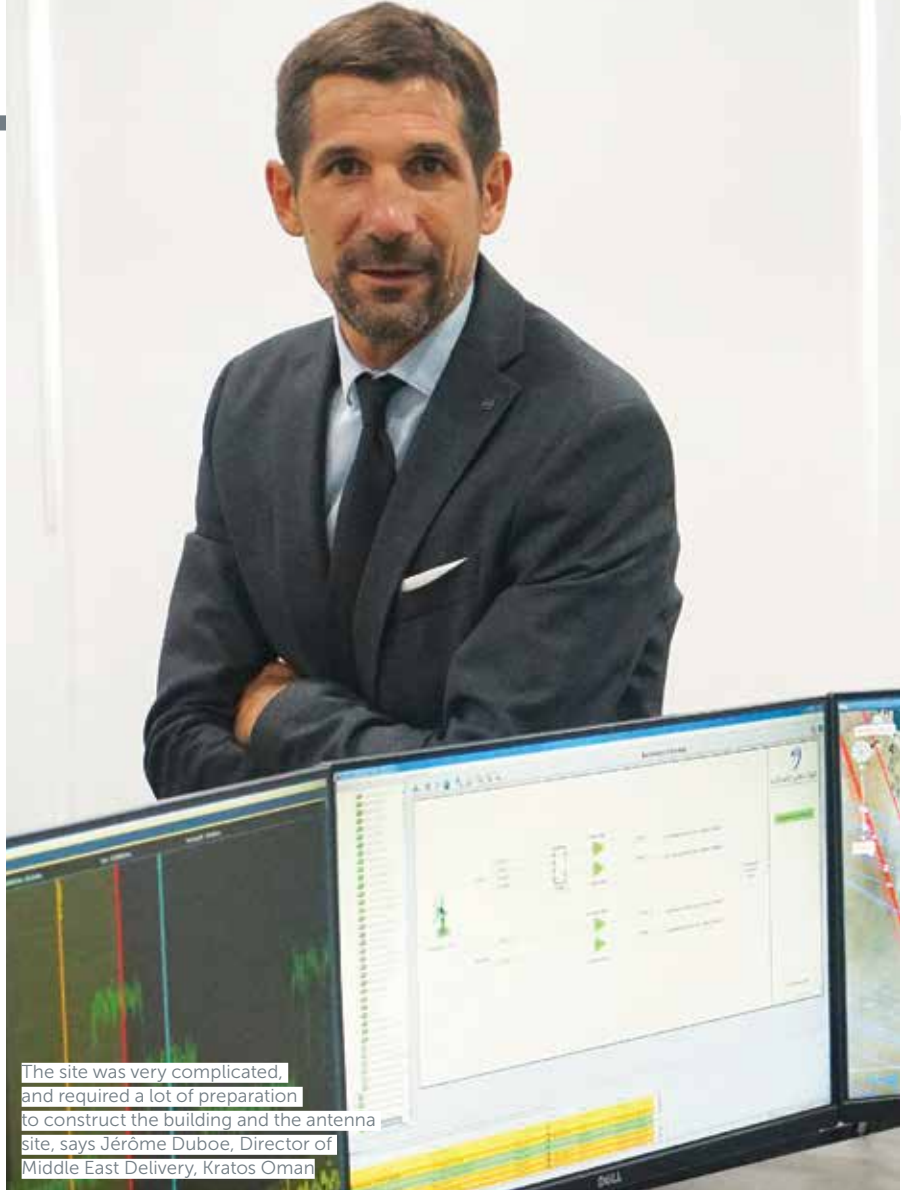
servers and switching equipment; the Monics Carrier Monitoring System (CMS) to scan and monitor satellite carriers; the satID product to geolocate transmitters of detected satellite signals; the Compass Monitor and Control (M&C) solution to centralise the management of all hardware, from antennas and servers to software and temperature sensors; the Geographical Monitoring Solution (GeoMon) to identify authorised and unauthorised satellite communication signals; and a signal recorder to enable recording and playback of signals for further analysis and trouble-shooting.

The overall ASRMS system is a fixed site, but this core system can also be networked with mobile units. These mobile subsystems include a 4WD truck that analyses both transmitting stations and satellite reception from anywhere in the country. This subsystem can be directly operated from the Muscat main operations centre as a local sensor.

Beyond fixed site monitoring, Kratos delivered mobile RF monitoring capabilities.

"This included using a vehicle designed with our partner Megahertz in the UK with antennas and monitoring equipment to track the satellite services in the uplink (Earth to space) and the downlink (space to Earth), to determine the location of authorised or unauthorised transmissions. In addition, in areas with rough terrain and high elevation, Kratos provided a remote-controlled RF monitoring drone named Moscito that performed last-mile geolocation to identify unlawful usage of the spectrum and interference in the uplink," says Duboe.

This vehicle can receive signals at C-, X-, Ku- and Ka-bands in any polarisation. This special feature addresses the new technology of high-throughput satellites (HTS).



The site was very complicated, and required a lot of preparation to construct the building and the antenna site, says Jérôme Duboe, Director of Middle East Delivery, Kratos Oman

> "Most of the monitoring is performed on geostationary satellites; however, three of them can also track MEO satellites since they are full-motion"
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> **Jérôme Duboe, Director of Middle East Delivery, Kratos Oman**

Kratos cites the example of how large antennas in Muscat can analyse the main beams while the vehicle is parked in the eastern part of the country, on a different spot beam not visible from Muscat.

The vehicle and drone each have their own sensors to analyse radio signals in surrounding areas, in order to pinpoint the exact location of satellite transmitters in any band. This enables the mobile unit and drone to go anywhere in the country to analyse radio signals.

From this phase on, it was a matter of optimising regulatory missions. With GeoMon's capabilities, the TRA's operators were able to plan, schedule, execute and automate missions, as well as create reports for licence validation, interference resolution and ITU filings.

"In just a few clicks, we were able to do a number of things. We could generate results and reports that validate carriers or licences by automatically checking expected EIRP, centre frequency and bandwidth based on an RF

## Critical functions of the ASRMS

The ASRMS allows Oman's TRA to effectively safeguard the RF spectrum as a national resource, and to:

- Control the use of frequency spectrum and space resources by verifying that existing users are compatible with the radio licences granted by the TRA
- Monitor and measure satellite signals within the Sultanate, with the capability to verify cases of interference at regional, national and international level
- Detect and resolve accidental and intentional interference by identifying and then geolocating the source from within the country or from neighbouring nations
- Coordinate with the ITU and other regulators by providing monitoring services and satellite data to minimise cases of interference
- Support national projects and activities related to space services such as national satellite launches and allocations of orbital positions and frequencies, in accordance with the ITU

downlink measurement. We could locate interference by collecting interference events and booking antenna resources to perform a geolocation mission to pinpoint the source. Our operators could also undertake an ITU filing or scan orbital slots by automatically performing a blind scan and comparing the spectrum measurements with all known satellites in this specific space position to identify any issues," explains the TRA's Al-Balushi.

With state-of-the-art RF monitoring and geolocation in place, the final acceptance tests were completed by Kratos, and the station was officially opened last year under the auspices of HE Dr Ahmed Bin Mohammed Al-Futaisi, Minister of Transport and Communications, in the presence of Houlin Zhao, Secretary-General of the International Telecommunication Union (ITU).

One of the biggest challenges in this project was the civil works, explains Duboe.

"With our partner Zajel Communications LLC (part of the IBD Group), we had to solve many issues related to local legislation. The second challenge was to integrate the overall system on-site, taking into account the civil works. What aided the process was that our core products were pre-integrated with the entire system."

A critical element of the success of the project was training, Duboe points out.

"Kratos provided some initial training during the early phases of the project, on the key products, so that the TRA project team could get a better understanding of the design. Then a large training package was provided to the TRA team along with the installation of the system. In addition, to service a contract for a long period of





TRA operators monitoring the spectrum and supporting regulatory missions in the control and monitoring centre.

The TRA on a regulatory mission with the RF monitoring vehicle.

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maintenance, Kratos established a local office in Muscat providing a permanent presence to help the transfer of knowledge to Omani engineers. To support the Omanisation process, Kratos also collaborated with and relied on local Omani resources, a key priority for the Sultanate. This localised approach of a global services company was a key factor in the success of this complex project."

Kratos continues to work closely with the TRA, sharing spectrum monitoring expertise and supporting the Sultanate in running the most advanced regulatory operation in the region.

In building the first monitoring station in the GCC, Oman's TRA has increased international cooperation. It now occupies an elite international position, and coordinates with the ITU and other regulatory authorities on satellite monitoring issues.

"With this launch, the Sultanate has been placed on the world map in the field of space radio monitoring. The ASRMS has exceeded all our expectations, and we are very pleased with Kratos' ability to deliver on time and within budget on such a large-scale effort. They were uniquely positioned in the industry to deliver on this project," concludes Al-Balushi. - *Vijaya Cherian* PRO