NEWS

LEO/GEO interference: Kratos execs on how to address this

Vijaya Cherian

11 Min Read 5 days ago

Add Comment

Share This!

With the launch of several thousand smallsats into space and the rise of the LEO constellations, the risk of LEO/GEO satellite interference is on the rise, and the need to coexist and neutralise interference is driving cooperation. One key player with solutions in this space is Kratos. SatellitePro ME offers a background into the current status quo and asks Guido Baraglia, Business Director, EMEA of Kratos, and Bob Potter, VP Signals and Ground System Technology, to shed more light on RF issues both globally and in the Middle East.

Small satellites (smallsats) are creating new and disruptive opportunities in today's space industry – applications once only provided by traditional satellites in geosynchronous equatorial orbit (GEO), such as Earth observation and imaging, are in a growing number of cases being performed by smallsats in low Earth orbit (LEO).

Thousands of smallsats will add to a growing RF interference issue. Big satellite programmes take decades to procure, build, launch and operate, at price tags in excess of a billion dollars. In contrast, the benefits of smallsats can be significant – lower costs to acquire and launch, plus a higher refresh cycle that supports rapid technology insertion as programmes and technology evolve.

Additionally, the reduced communication time lag (latency) of LEO satellites means they require less energy to place into LEO orbit and less powerful amplifiers for successful transmission. As such, they will be used for an increasing number of existing applications for communication applications in the future. However, unlike GEO satellites, LEO satellites are in non-geostationary (NGSO) orbits and thus require a constellation of smallsats to provide continuous coverage.

Rising demand for high-resolution imaging services, lower costs and continuing technological advances are some of the factors driving the market. However, the deployment of LEO constellations is apt to significantly escalate interference issues with GEO networks.

As constellations are launched and the number of LEO satellites increases exponentially, so too does the risk of LEO/GEO satellite interference. This is caused when a LEO satellite crosses the path between a GEO Earth station and a GEO satellite. This problem was first recognised during an earlier wave of proposed LEO constellations some 20 years ago. At that time, the International Telecommunications Union (ITU) stated that NGSO craft bore the responsibility for avoiding interference with GEO satellites.

Per the ITU, the responsibility was with the NGSOs to undertake measures, including power management pursuant to equivalent power flux density (EPFD) limits, repointing beams so as not to interfere with the beam footprint of a GEO beam, and changing frequency bands to avoid interfering with GEO transmissions.

Fast forward 20 years. Among the advances in GEO satellite technology is a significant increase in the sensitivity of GEO satellites, enabling satellite operators to use smaller antennas – 2m versus 6m. As LEO satellites are closer to Earth, they also use smaller antennas.

While the smaller antennas have a big upside, including smaller footprint and reduced costs, they also have their downside. Smaller antennas have higher side-lobe gain, increasing the possibility of interference of operational power requirements. In the larger GEO antennas, side-lobe gain might be 60dB down.

As a result, GEO satellites previously protected from interference by LEO EPFD limits are now more susceptible to LEO satellite interference, even though they operate within the EPFD limits established by the ITU. Another concern is that the deployment of smallsat constellations will make the identification of LEO satellites violating ITU rules – whether accidentally or intentionally – much more difficult.

Frequency Sharing: To optimise the frequency spectrum, GEO and LEO satellite operators sometimes share the same Ku-/Ka-band frequency band once the LEO operators, in their licensing application, demonstrate how they plan to minimise this potential conflict. In this instance, LEO satellites crossing the equator have to change bands to avoid interfering with the GEO satellite, whose frequency rights take precedence. Once past the equatorial belt, they can resume frequency sharing with the GEO satellite. Should LEO satellites achieve the numbers forecast for them, frequency sharing between LEO satellites and existing GEO satellites could become the norm rather than the exception.

Beam Pointing: In the northern hemisphere, GEO antennas point to their satellite in a mostly southerly direction, while LEO antennas point in a northerly direction so as not to interfere with GEO signals. As LEO satellites cross the equator, their payload is switched off so as to not interfere, or be interfered with by, the GEO antenna beam footprint. Once clear of the footprint, the LEO satellite is switched back on.

Power Management: Power management on the part of the LEO operator is another means to avoid LEO/GEO interference. The potential issue is that as satellites become more sensitive due to beam shaping, the ground GEO antennas are getting smaller, which means lower equivalent isotropically radiated power (EIRP) to the satellite, and also less gain on the receive side.

The consequence is that the side-lobe gain of the antenna becomes higher, compared to larger antennas. As a result, they are more susceptible to interference from legal third-party transmissions such as frequency sharing terrestrial systems, as well as LEO communication systems.

The question is: Will EPFD limits for LEO satellites need to be reduced… and will that power reduction have any negative effect on their ability to adequately perform their mission?

The bottom line is that while there are approaches to minimising LEO/GEO interference (power management, beam management and frequency sharing), these are going to become more difficult to manage as space is flooded with hundreds, if not thousands, of smallsats in multiple constellations. The majority of GEO satellite operators worldwide employ carrier monitoring and interference detection products such as Monics, which can provide early warning of potential LEO interference so that cooperative preventive/corrective action can be taken.
Today, a number of GEO satellite operators are either working with or investing

in LEO operators. Cooperation is driven by their common need to coexist and neutralise interference.

"LEO and MEO satellites should be equipped with some sort of active ID signature," Guido Baraglia, Business Director, EMEA, Kratos.

Guido Baraglia, Business Director, EMEA, Kratos.

How are RF issues in the Middle East different from those in other international markets?

Guido Baraglia: Given the nature of new space, the RF congestion will be pretty much similar worldwide. What might change will be the interaction with existing or new terrestrial services. The Middle East, by nature, can use a number of different frequencies, although Ka-band in tropical regions will be a stretch. The industry is generally younger, and might be more aware of such issues.

Is RF regulation in the Middle East up to date?

GB: Middle East representatives are fairly active in the field of regulation; events hosted by national agencies and the ITU are always attended by a high number of officials. The Space Radio Monitoring System deployed by the Telecommunications Regulatory Authority (TRA) of Oman is a clear indication of the region's interest in protecting the spectrum and mitigating interference.

How will the growth of LEO and MEO constellations create a congested spectrum environment that must be monitored and managed to prevent interference?

GB: The frequency spectrum is a finite resource. To avoid mutual interference, frequency bands are licensed by service and operator; it would be catastrophic if the industry were to attempt any level of deregulation in this field. Each constellation, independently from the type of service (communication, Earth observation, radar, electronic emission detection and more), will have to be strictly coordinated and managed, to allow each of the operators a safe and sustainable radio frequency environment.

There is a second issue, not strictly related to spectrum frequency management, that will have to be considered – that is the possibility of collisions between spacecraft, with unfortunate consequences. Orbit determination and collision avoidance should be part of the same discussions.

BP: Space situational awareness, in the form of spectrum space situation awareness, will become key for any of the LEO/MEO operators to be successful. The existing LEO/MEO operators have successfully coordinated spectrum usage in the shared band of Ka-band (18.8-19.3GHz D/L and 28.6-29.1GHz U/L), and mitigated spectrum usage in the LEO/MEO secondary band (17.8-18.6GHz D/L and 27.6-28.4GHz U/L), by use of special diversity techniques such as beam pattern, antenna pointing angles and power levels, complying with the ITU Article 22 of the Radio Regulations.

Article 22 will be the reference point for spectrum sharing between the LEO/MEO constellations and existing GEO satellite constellations. We can expect updates to this article as we learn more about how many satellites and in what orbit and frequency bands they are deployed. TRA of Oman is perfectly located to act on behalf of the Middle East, to measure and determine compliance to RR Article 22 and be a key reference point for updates as needed for the region.

What kind of solutions to address this new ecosystem are available in the

market?

GB: Here again there is a two-fold approach, one in space and a second on the ground. LEO and MEO satellites should be equipped with some sort of active ID signature, similar to the aviation ADS-B or the maritime AIS, to be easily detected and traced. Currently this activity is mostly passive, with little input from the constellations, resulting in limited accuracy. Secondly, agencies and regulatory authorities should equip themselves with RF monitoring capabilities that allow permanent tracking and detection of LEO and MEO satellites.

RF spectrum is precious. Which industries benefit the most from allocation, and who is losing out?

GB: Most people have no idea how this resource is fundamental to all of mankind, not necessarily limiting the use to the mere communication capabilities. Every morning, we watch news that comes from the other side of the world, most of which has travelled through space to get into our living room. We check the weather before deciding how to get dressed, not knowing that a bunch of satellites in the sky have collected data throughout the previous days that are used to forecast it. We jump in the car and set a destination into the navigation system, not necessarily knowing about those objects orbiting our planet that help us reach our destination. Even the simplest businesses rely on information that can be delivered through space.

BP: Spectrum should not necessarily be a tug of war between terrestrial and satellite, although at times the interplay with satellite and IMT in WRC12 and WRC15 would indicate that this might be the case. Terrestrial can be made to look like it's serving national interests, and satellite ultimately now serves global interests, but 5G and its associated applications will need satellite bandwidth to operate efficiently and may change this perspective.

The C-band discussions at WRC12 and 15 show how lack of cooperation can ultimately cause spectrum problems. C-band has effectively become a regional resource rather than a global resource, with much of the northern hemisphere moving to Ku- and Ka-band, but C-band is still a very important resource in the tropical regions. The wide bandwidth provided by Ku- and Ka-bands (and future V- and Q-bands) are global resources, and cooperation between terrestrial and satellite will benefit all at national level as well as global level.

"There needs to be a realisation that spectrum is not just a national resource," Bob Potter, VP Signals and Ground System Technology, Kratos.

Bob Potter, VP Signals and Ground System Technology, Kratos.

How do we address cross-border RF interference issues?

GB: Coordination is the key. The ITU will have to step up its role of recommendation, to make sure all countries put the maximum effort in harmonising frequency usage (not only for space).

BP: There needs to be a realisation that spectrum is not just a national resource. In today's interconnected world, it is incumbent upon national regulators to work together on regional and global policy.

What level of interference is considered permissible?

GB: It's hard to quantify a permissible level of interference. ITU recommendations call for specific protection of high-profile services, but it is always down to national authorities to license services following specific technical requirements and interference avoidance rules, and to enforce those. In the end, interference disturbs the users of the affected service and may cause revenue loss for the company running the service with a consequent loss of jobs; it cannot be overlooked.

BP: Today's waveforms, terrestrial or satellite-based, can work through a certain level of interference, but at the cost of lower data throughput. Data throughput will ultimately be the measure of acceptable levels of interference. RR Article 22 provides current acceptable power levels for secondary spectrum users to avoid interference with the primary spectrum users. There are already calls to update this document – as satellite beams become smaller, meaning higher gain, ground-based antennas become smaller, which means wider beams, so the possibility of interference based on current power levels increases.

Which verticals can benefit the most from RF?

GB: This is so embedded in everyday life that not having access to RF would have a disastrous impact on many operations. DTH television, satellite B2B communication, satnav, weather prediction, tracking of goods, security services, disaster relief and humanitarian operations – and many more – base their success on the use of reliable and affordable RF spectrum. Any disruption to this, even minimal, would have dire consequences for the affected vertical.

BP: Global mobility will certainly be a winner in the new space revolution. We already see aircraft and shipping connected. The advent of ESA antennas will shortly see the car connected, with all the benefits of wideband streaming to and from the car.

Tags featuredpost GEO kratos LEO RF Interference space