GEO, MEO, AND LEO

How orbital altitude impacts network performance in satellite data services

"An entire multi-orbit satellite ecosystem is opening up above us, driving new opportunities for high-performance gigabit connectivity and broadband services."

Stewart Sanders
Executive Vice President of Technology at SES

COMMUNICATION OVER SATELLITE

is now well accepted as a key enabler across the telecommunications industry. Satellite networks can supplement existing infrastructure by providing global reach where terrestrial networks are unavailable or not feasible.

But not all satellite networks are created equal. Providers offer different solutions depending on the orbits available to them, and so understanding how the distance from Earth affects performance is crucial for decision making when selecting a satellite service. The following pages give an overview of the three main orbit classes, along with some of the principal trade-offs between them.

Key terms

GEO – Geostationary Earth Orbit.

NGSO – Non-Geostationary Orbit. NGSO is divided into MEO and LEO.

MEO – Medium Earth Orbit.

LEO – Low Earth Orbit.

HTS – High Throughput Satellites designed for communication.

Latency – the delay in data transmission from one communication endpoint to another. Latency-critical applications include video conferencing, mobile data backhaul, and cloud-based business collaboration tools.

SD-WAN – Software-Defined Wide Area Networking. Based on policies controlled by the user, SD-WAN optimises network performance by steering application traffic over the most suitable access technology and with the appropriate Quality of Service (QoS).

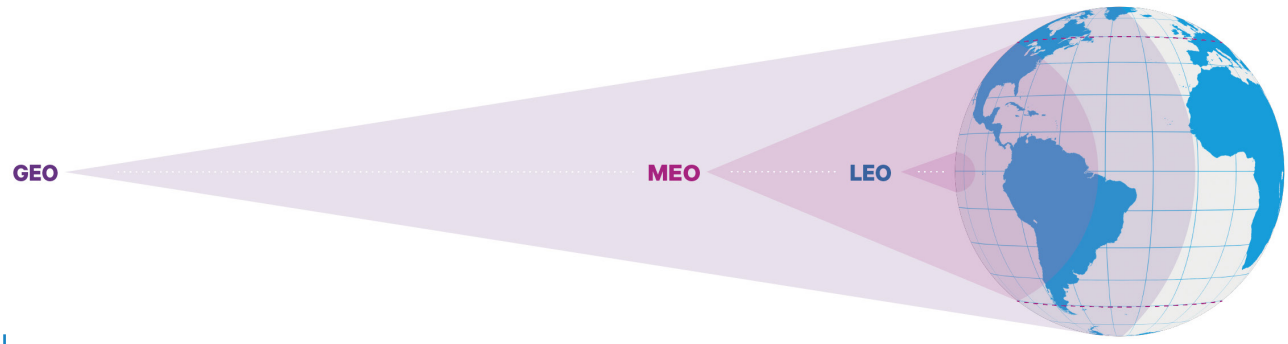

Figure 1: Schematic of orbital altitudes and coverage areas

GEOSTATIONARY EARTH ORBIT
Altitude 36,000km

GEO satellites match the rotation of the Earth as they travel, and so remain above the same point on the ground. Hundreds of GEO satellites are in orbit today, traditionally delivering services such as weather data, broadcast TV, and some low-speed data communication. Over the past few years, GEO has been significantly enhanced by High Throughput Satellites (HTS), which are purpose-built for data.

MEDIUM EARTH ORBIT
Altitude 5,000 to 20,000km

MEO has historically been used for GPS and other navigation applications. More recently, HTS MEO constellations have been deployed to deliver low-latency, high-bandwidth data connectivity to service providers, government agencies, and commercial enterprises.

MEO satellites bring fibre-like performance to remote areas where laying fibre is not viable, such as cruise, commercial maritime, aero, offshore platforms, network backhaul in difficult terrain, and humanitarian relief operations.

LOW EARTH ORBIT
Altitude 500 to 1,200km

LEO is densely populated with thousands of satellites in operation today, primarily addressing science, imaging, and low-bandwidth telecommunications needs. The next generation of HTS LEO satellites intends to serve communication markets such as mass-consumer and enterprise broadband internet.

COMPARING ORBITS
Table of main characteristics

	GEO (36,000km)	MEO (5,000-20,000km)	LEO (500-1,200km)
Altitude latency[1]	High	Low	Very low
Earth coverage	Very large	Large	Small
Satellites required	Three	Six	Hundreds
Data gateways	Few fixed	Regional flexible	Local numerous
Antenna speed	Stationary	1-hour slow tracking	10-minute fast tracking
Advantages	High throughput (HTS) technologies enable basic broadband internet applications	Proven low latency comparable to terrestrial networks, offers fibre-equivalent performance	Claims support for high-frequency trading, virtual gaming, and high-performance computing applications
	Fewer satellites over very large fixed geographical areas	Simple equatorial orbit covers 96% of global population	Smaller, lower power satellites batch-launched more cheaply than GEO
Disadvantages	High altitude and distant ground networking impacts latency-sensitive applications	Dual tracking antennas required to maintain continuous connectivity	Very complex tracking and ground network, plus complete constellation must be in place before service starts
	Signal power losses require larger satellites and antennas	Inclined plane orbits needed to cover high latitudes	Unproven business model, risky technology, and space debris risk

[1]Total end-to-end network latency is dependent on ground infrastructure

Table 1: Comparison of GEO, MEO, and LEO satellites

A HARMONISED MULTI-ORBIT APPROACH

SES is the global leader in content connectivity solutions, enabling service providers, enterprises, and governments to expand their coverage through our satellite networks. We are uniquely positioned to offer the only fully-funded, hybrid NGSO-GEO communication network operating today.

Latency is clearly a major determiner of data performance, and LEO satellites can ostensibly offer low-latency connectivity. However, the limited coverage, complex inter-satellite networking, and elaborate ground infrastructure call into question the possibility of achieving tangible, consistent performance gains with LEO networks.

MEO satellites by contrast are an established and proven solution, already delivering reliable high-bandwidth communication. With the implementation of SD-WAN, data paths can be automatically switched between MEO, GEO, and terrestrial networks to match application needs, provide resilience, or increase coverage. Rather than being limited by a single altitude, this type of adaptive technology empowers telcos, mobile operators, and large organisations to capitalise on the merits of these two tried-and-tested orbit classes.

To learn more about
our medium earth orbit (MEO) solutions,
please visit ses.com/O3b-mPOWER

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