

BROCHURE

# GNSS Testing for LEO

Enabling the next generation of constellations



## LEO opportunities and challenges

Low Earth Orbit (LEO) satellite constellations are already offering a multitude of benefits, from communications to earth imaging and disaster detection and mitigation. The next generations of LEO constellations will deliver specialized positioning, navigation and timing services to users around the world, high-speed wireless data connections, and open up new opportunities for restricted communications technology. With these great opportunities comes a range of challenges, including:

- Satellite precision orbit determination (POD)
- Satellite attitude and manoeuvring at ultra-high dynamics
- Environmental challenges (and differences to any on-earth test facility)
- Developing and testing new signals
- Developing and testing ground control elements

Spirent solutions are designed to meet the stringent requirements of next-generation technologies, and are perfectly placed to enable your LEO project.



## Testing GNSS for LEO

### Conducted

The operation of LEO constellations depends on the positioning, navigation and timing (PNT) solution provided by the satellites' onboard engines. Spirent's PNT test solutions deliver unrivalled performance and fidelity, providing users with the perfect baseline to perform critical functionality tests, including:

- Time to First Fix (TTFF)
- Tracking sensitivity
- PVT precision
- Multi-frequency and multi-constellation viability and performance
- Orbit estimation and testing

In addition, Spirent's simulation solutions have a number of features and capabilities that enable performance testing in sub-optimal LEO-specific conditions. These include:

- Multipath and obscuration – including from the satellite itself
- Off-pointing of antenna
- Spacecraft rotation
- Ionospheric errors and scintillation
- LEO-specific orbital model

### Control segment development and verification

Interoperability of the space segment and the control segment is critical in any LEO constellation. From timing synchronisation to resiliency, this means that both segments must be tested independently and in concert, and this presents significant challenges to developers.

Spirent's highly flexible multi-output capability offers the precision and synchronicity needed to supply a truly realistic GNSS signal environment to both segments in concert. With the most precise signal modelling and the lowest latency of any GNSS simulation system, Spirent provides the perfect baseline for evaluation and optimisation.

## Over-the-air (OTA)

The unique nature of LEO challenges and the lack of opportunity for live sky testing means OTA simulation is a critical element of LEO satellite development. Considerations for developers include:

- Antenna performance
- RF interference from sat comms subsystems
- Electromagnetic interference
- Temperature and pressure testing

Spirent's simulation systems support the most advanced anechoic chamber installations around the world, including zoned chambers to provide extended duration and greater realism. These can also be applied to thermal vacuum anechoic chamber (TVAC) setups.

## SimORBIT high accuracy LEO orbit generation tool

- Highly accurate orbital model that takes into consideration the Earth's complex gravitational effects, as well as atmospheric impacts such as 'drag'
- LEO constellation orbit generation of up to 85 satellites
- Fully consistent with IERS 2010 conventions
- Predefined satellite types

## GSS9000 Series multi-frequency, multi-GNSS simulator

- Highly configurable architecture proven in the most advanced labs around the world
- Support for advanced 3D multipath and obscuration testing
- Unrivalled controlled, unmatched precision, ultra-low latency
  - 120 km/s relative velocity
  - 193 km/s<sup>2</sup> relative acceleration
  - 890km/s<sup>3</sup> relative jerk
  - 60 rad/s angular rate
- Onboard interference capability
- Customizable vehicle models that incorporate internal and external influences (including gravity and solar radiation)
- Flexible generation of non-ICD signals



## GSS7000 multi-frequency, multi-GNSS simulator

- High precision simulation across all current and planned GNSS and SBAS signals
- Highly configurable architecture
- Support for advanced 3D multipath and obscuration testing
- Onboard interference capability
- Native and customizable vehicle models
- Flexible generation of non-ICD signals



## Designing a LEO PNT system

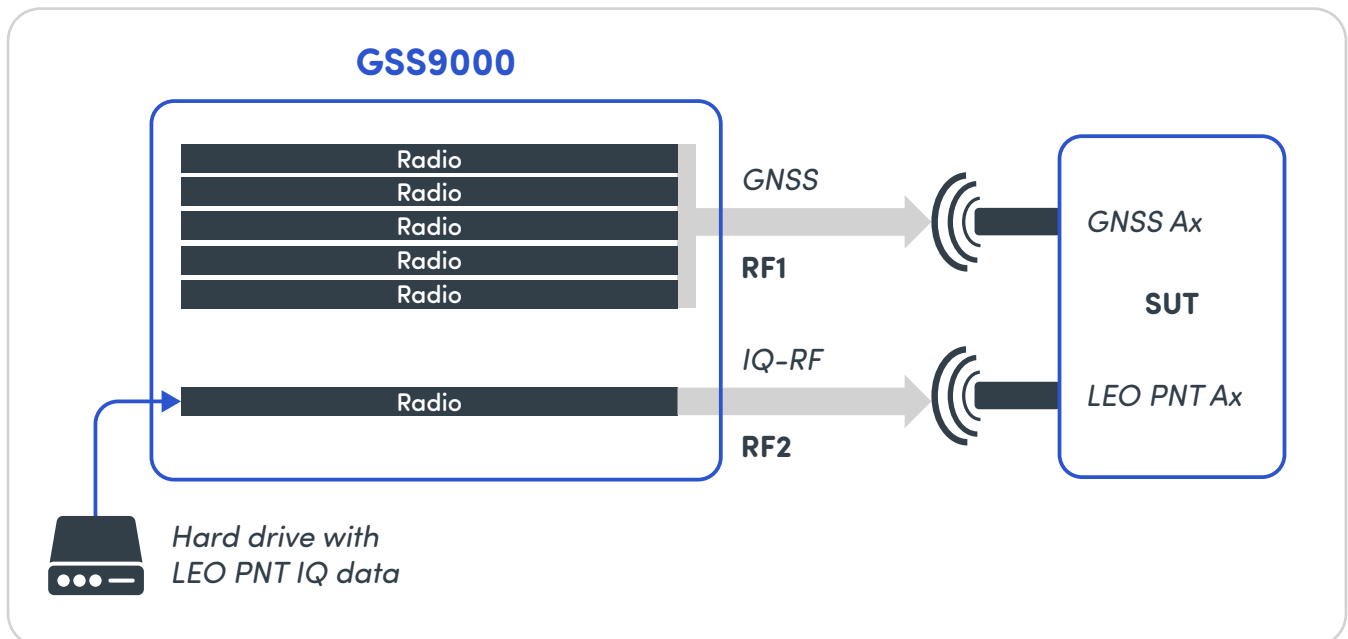
LEO presents a significant opportunity for PNT service provision. A dedicated LEO constellation could operate as a system complementary to GNSS, or as a standalone alternative. In either case, the development of a LEO PNT provision places demanding requirements on test and innovation tools. Primary requirements could include:

- Early feasibility testing
- Interoperability testing with other PNT sources
- Holdover capability in GPS denial of service/outages

Spirent test solutions provide a critical range of capabilities to meet these requirements. Using a 2RF GSS9000 or GSS7000 employing SimIQ Replay—which enables the generation of RF based on externally supplied IQ data in concert with internally generated GNSS—developers can configure several important test functions:

**1. Test LEO satellite receiver:** determining position, orbit, and attitude is a crucial element of every satellite-based positioning technology. Using a single RF output, users are able to carry out comprehensive testing of the receiver to be used in the LEO constellation. Via use of a mixture of conducted and OTA testing, this can be carried out iteratively as additional elements are added to the product, including testing in a TVAC.

- 2. Test downlink for new LEO based PNT signal:** using a single RF output employing SimIQ Replay, users are able to generate L-band RF from IQ files. These are then broadcast at the highest possible fidelity, and with tight control over variables such as power level and centre frequency. With this signal being broadcast (whether conducted or OTA) to a compatible receiver, users are able to assess the tracking and precision offered and find any potential flaws or improvements in the novel signal design.
- 3. Interoperability testing:** Due to the reliability, coverage and low cost of existing GNSS signals it is likely that any new PNT signal would need to work in conjunction with GNSS in devices. Using dual RF outputs of a Spirent simulator, users can configure one output to generate required GNSS signals from existing constellations/frequencies, while using SimIQ Replay on the second output enables the generation of the novel PNT signals from externally provided IQ data—in concert with the GNSS simulation. With these signals both being output to the compatible device under test, sensor fusion algorithms could be assessed and honed, with key factors such as reliable holdover times comprehensively determined.



Interoperability testing—dual RF simulator employing SimIQ Replay



**Americas**

**Europe**

**Asia**

**About Spirent  
Positioning Technology**

Spirent enables innovation and development in the GNSS (global navigation satellite system) and additional PNT (positioning, navigation and timing) technologies that are increasingly influencing our lives.

Our clients promise superior performance to their customers. By providing comprehensive and tailored test and assurance solutions, Spirent assures that our clients fulfil that promise.

**Why Spirent?**

Over five decades Spirent has brought unrivalled power, control and precision to positioning, navigation and timing technology. Spirent is trusted by the leading developers across all segments to consult and deliver on innovative solutions, using the highest quality dedicated hardware and the most flexible and intuitive software on the market.

Spirent delivers

- Ground-breaking features proven to perform
- Flexible and customisable SDR technology for future-proofed test capabilities
- World-leading innovation, redefining industry expectations
- First-to-market with new signals and ICDs
- Signals built from first principles — giving the reliable and precise truth data you need
- Unrivalled investment in customer-focused R&D
- A global customer support network with established experts



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**About Spirent Communications**

Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks. We help bring clarity to increasingly complex technological and business challenges. Spirent’s customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled. For more information visit: [www.spirent.com](http://www.spirent.com)

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