Integrating a GNSS Receiver into a Product Design

How GNSS simulation can save you time and money

SPIRENT

The roles of GNSS simulation in testing "location"

Location awareness has become one of the "must-have" features for all manner of equipment in both the professional and consumer sectors. Whether for security reasons in tracking valuable assets or simply to enhance the social networking experience by highlighting the geographical location of a user's contacts, GNSS receivers can be used to add these facilities to a huge range of products at relatively little cost... in terms of hardware.

This growing demand for location awareness in many different classes of consumer and professional devices is providing both challenges and opportunities for equipment manufacturers. Many organisations have little or no experience in this field, they find themselves facing two fundamental problems:

Firstly, how to choose the correct GNSS receiver for the task; and secondly, how to integrate that receiver and be sure that the equipment functions as intended. Get either of these challenges wrong, and you are stuck with an inferior product. However, manufacturers who successfully negotiate both stages of the problem gain the opportunities that accrue from being first to market with innovative products that satisfy user demands for location-aware equipment.

Any company making its first foray into the world of location-aware products is faced with a wide array of options of GNSS receivers. These receivers can be sourced as complete modules or as chipsets and have varying capabilities (in terms of the satellite systems supported) and differing levels of performance. Clearly, the onus is on the equipment designer to choose the most cost-effective GNSS receiver design that will provide the level of performance required for the specific application.

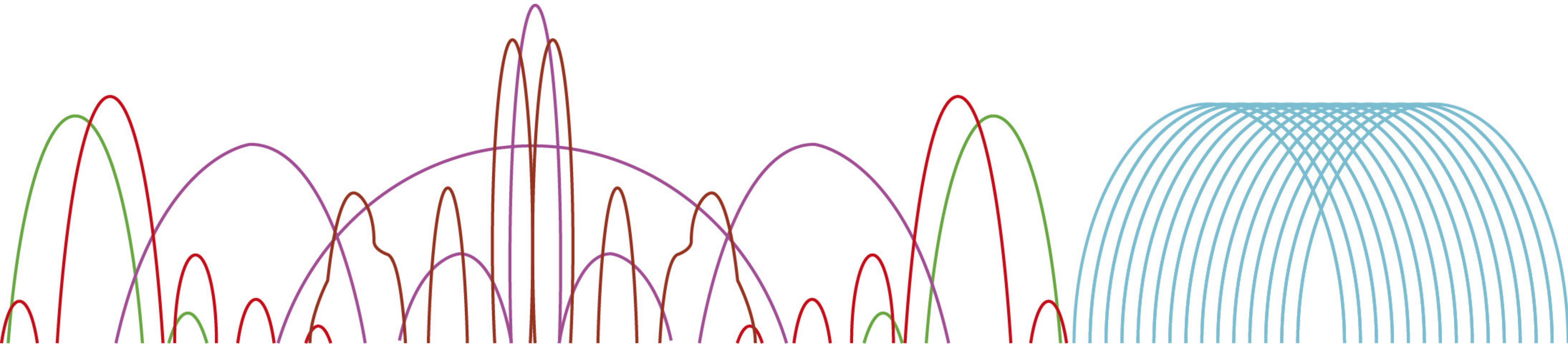
Certainly, for lower-volume professional applications, the modular route may well be applicable as the price premium of the module can be more than offset by the reduced effort in designing the receiver into the end equipment. However, while any GNSS receiver module may well be functionally complete, not all are created equal. Therefore even this simple decision does not remove the need to carefully evaluate the differences between the various modules available and the performance of the chosen module in the finished design.

However, for the vast majority of high-volume applications, the cost premium of the module will not be acceptable. The GNSS receiver will be designed (albeit not quite “from scratch”) using one of the many GNSS receiver chipsets available on the market, allowing the designer ample scope for savings in both cost and size. But before starting the design, the problem remains of choosing the GNSS receiver chipset (and allied components) that provides the level of performance required in the most cost-effective manner.

Making the choice

Those who are familiar with the world of component datasheets might feel competent to make an initial choice of chipset or module based on published data. However, the difference between the theory of the datasheet and real-world performance can be extreme. Also, the datasheet may not shed true evidence on the relevant parameters for the particular application.

There are a range of criteria on which GNSS receiver performance can be judged, and each different application will have varying demands on each aspect. Therefore, the first task of the designer is to work out which performance criteria are the most relevant. These will include time to first fix (TTFF), static navigation accuracy, dynamic navigation accuracy, acquisition sensitivity, tracking sensitivity, re-acquisition time and susceptibility to radio frequency interference.



Having ascertained the important performance features of the end application, the task is to benchmark the performance of each different GNSS receiver (be it a complete module or a reference design made up from a chipset) against a set of tests that will demonstrate the required performance criteria. And, clearly, each different receiver must be subjected to exactly the same set of tests for any meaningful comparison to be made between the results.

At this point, the uninformed might reason that simply performing tests on each receiver in the same physical location (on the test bench) would mean that the tests would be the same. However, such "live-sky" testing can never be relied on to be repeatable. While the location of the receiver may be the same in each case, the satellite constellation will have moved on, and so the conditions are anything but repeatable. What's more, each receiver could only be tested against the existing GPS constellation – a further limiting factor in that the next generations of location-enabled devices will be expected to work with multiple GNSS systems as they become available.

One alternative might be to “capture” live-sky signals* and play them back under controlled conditions so that each receiver was subject to exactly the same set of test conditions. However, this hardly amounts to performance testing under all conditions. Indeed, only a very limited set of conditions could be captured in this way, and the lack of control could severely compromise the results of any benchmarking exercise. The one completely controllable and repeatable test strategy for benchmarking receivers is to use a GNSS simulator that can produce perfectly repeatable GNSS signals under software control, ensuring that each receiver is tested with exactly the same set of performance criteria.

* More information on Recording and Playback of Live Sky Signals can be found by downloading this Spirent E-book.

Instruments such as Spirent's GSS6700 GPS simulator with its SimREPLAYplus software, enables a wide variety of tests in different locations and conditions.

Ready-written test routines are available for all major performance criteria, and tests can be set to run overnight if necessary, freeing up valuable resources and reducing engineering effort.

Spirent GSS6700

Multi-GNSS Constellation Simulator System

Integration issues

Having chosen the best possible receiver for the task, the equipment designer is then faced with the not inconsiderable task of integrating the GNSS receiver within the design. And while RF engineering is no longer the "black art" it was once considered, there are still many traps for the unwary.

In particular, because a GNSS receiver is inherently a highly sensitive device that is designed to capture weak signals from distant satellites, it is all too easy for the receiver to be swamped by other RF signals that can be thousands of times stronger. The resultant interference can either corrupt the operation of the receiver, leading to inaccurate results, or even jam it completely. Worse still, these signals may not be external: the end equipment may have other RF sections – or even be producing its own interference from poorly laid out digital circuitry. Either way the result will be a poorly performing GNSS receiver and customer dissatisfaction with the end equipment.

Right by design

Conservative engineering practices would dictate a well partitioned design, with all subassemblies isolated from each other to minimise the possibility of interference. However, the practicalities of market may well dictate that this is not possible. The drive for miniaturisation, reduced component count and lower costs may well dictate that the GNSS receiver will 'share' a number of components – oscillator, power supply, antenna etc – with other portions of the overall design. Therefore, the possibility for internal interference is greatly increased. And while careful filtering can overcome any or all problems of such a design approach, the designer will need to repeatedly test the overall design during the integration process to assess the correct filtering measures.

The case for simulation

Clearly, to make repeatable and accurate comparisons between multiple receivers each receiver must be provided with an identical set of signals for each performance test. The task can also be simplified by the ability to select from a range of pre-defined scenarios including static, dynamic (land, sea, air, space) signals as well as impaired signals. This will allow accurate comparisons to be made after collecting and analysing the data generated by the receivers.

Logically, then, the only acceptable solution for comparing the performance of GNSS receivers is to use GNSS simulation. Not only can the simulator be relied on to produce exactly the same output for each test, the tests can be programmed to accelerate the process by running a series of pre-defined scenarios designed to fully exercise the required performance parameters.

Benchmark trials using a simulator can be run at weekends or overnight and do not require resources to be deployed on field trips.

With careful choice of tests, designers can be assured that they are choosing the correct GNSS receiver for application in their end equipment

Return on investment

Of course, selecting the correct receiver for the job is only half the story. Integrating the receiver circuits with the other circuitry of the equipment is not exactly a “walk in the park” for the uninitiated. However, the same GNSS simulator used to test the various receivers will have a major role to play in ensuring that the end equipment performs exactly as intended.

Indeed, simulators have been repeatedly demonstrated to be the most efficient method of testing during the development and integration process. The lessons learned during the development of stand-alone GNSS receivers are all the more applicable to other equipment that integrates such receivers.

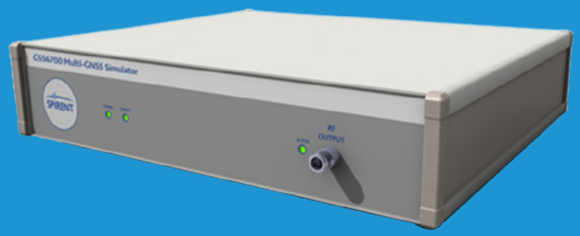
“The cost of taking the equipment out into the field for live-sky testing is nearly always hugely underestimated. Indeed, a major global manufacturer of car navigation systems has reduced its testing programme from an average of eight to ten weeks, to an average of four to five weeks by changing from driving test-cars to using GNSS simulators.”

Continuing returns on investment

Once the design has been completed, the simulator once again comes into its own. Spirent's GNSS simulators have been used to characterise countless stand-alone GNSS receiver designs, and they are equally applicable for characterising the design of equipment that integrates a GNSS receiver.

Spirent GSS6300

Multi-GNSS Signal generator



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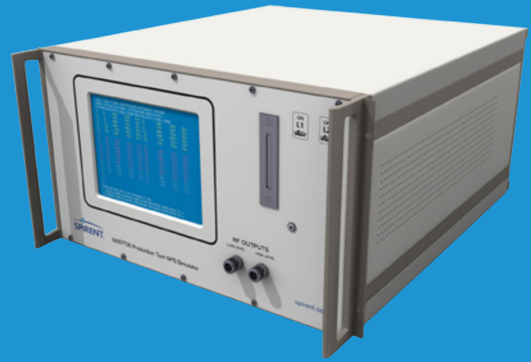
Multi-GNSS Constellation Simulator System



Spirent GSS7735

Multi-Channel GPS L1/L2 Production Test Simulator

Ready-written libraries of tests can be run under the controlled conditions of the test laboratory, removing the need to take the equipment on an extended road test. This is a major advantage as companies inevitably underestimate the time and costs involved in road testing of new products, As with the benchmarking process, the tests can be programmed to run overnight with the results saved for later analysis.

What's more, it is only by taking complete control of the test process using a simulator that the design can be reliably assessed under both "normal" and "extreme" conditions. Tests are available that simulate conditions of interference that are way beyond those likely to be experienced in the real world. But it is only by going beyond the norm that the designer can be assured the design will function as desired under all normal operating conditions.

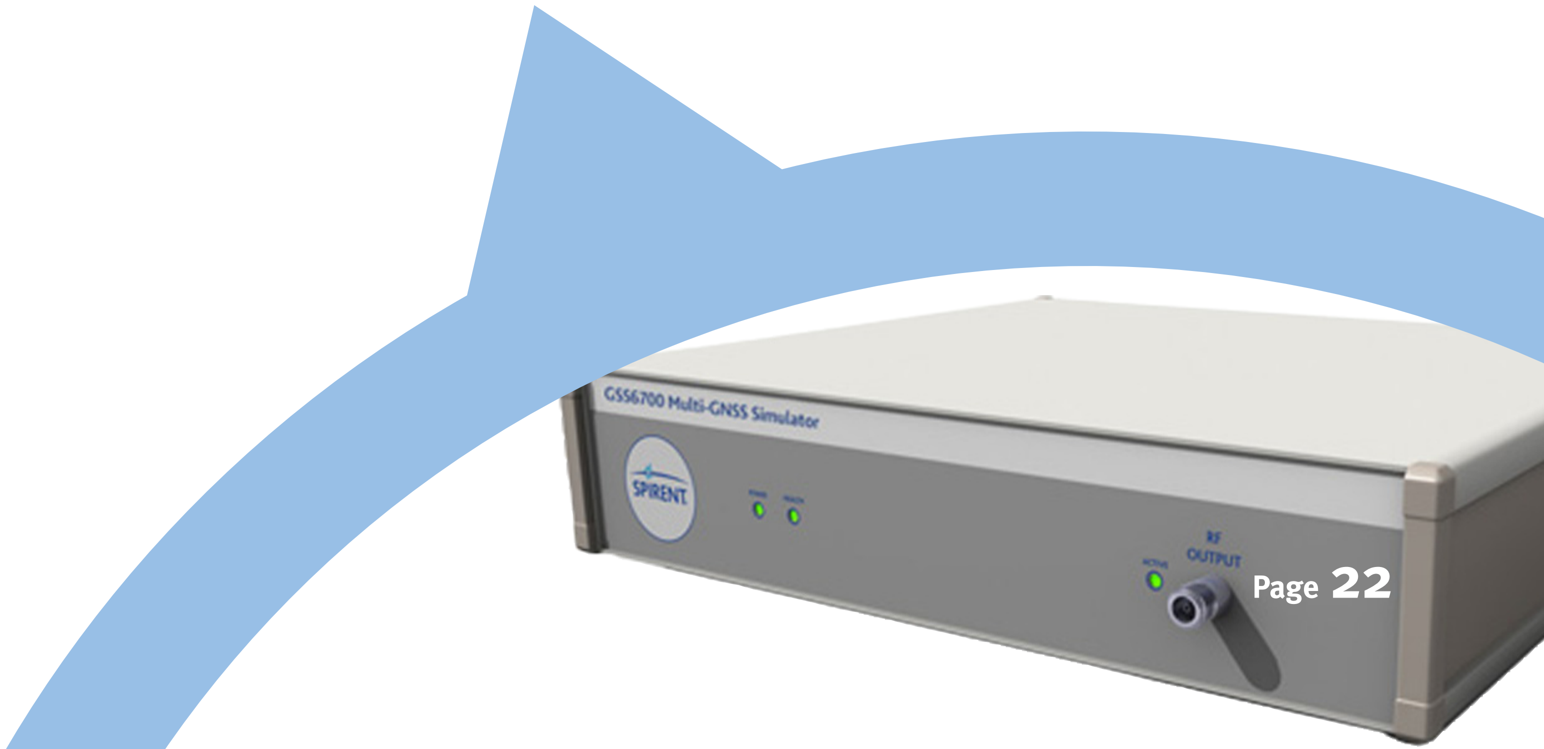
And so to profit

What's more, the investment in GNSS simulator hardware and software does not end with the completion of the design. Test routines prepared for benchmarking receivers, integration testing and final design characterisation can be used later on, in production testing of the final equipment as it rolls off the line.

So while it may seem a significant investment, a GNSS simulator has an important role to play at many stages of the process of designing and manufacturing location aware products. And with the confidence of knowing that the end product will perform exactly as intended, companies can go to market with new classes of equipment that will give their customers new experiences of location awareness.

This application of the GNSS simulator through the entire process from design through integration to production ensures speedy returns on the hardware investment.

And the confidence of repeatable and accurate test results provides manufacturers with the confidence that their location-aware products will perform as designed under all operating conditions.



Spirent GNSS Simulators

Spirent is the industry leader for GNSS simulator products. Spirent offers several different models of GNSS simulators that support a variety of different applications and cover the full spectrum of civilian and military GNSS testing needs. Spirent products range from basic single-channel simulators, suitable for simple production testing, through multi-channel, multi-constellation simulators, suitable for the most demanding research and engineering applications.

For more comprehensive testing, Spirent also offers products that simulate additional system elements simultaneously with the GNSS constellation signals, such as inertial sensors, various automotive sensors, Assisted GPS (A-GPS) data, SBAS and GBAS augmentation system signals, and interference signals.

With almost 25 years of GNSS simulator experience, Spirent provides GNSS simulators with unparalleled performance, features and comprehensive support.

Spirent's Multi-GNSS simulation platforms

Spirent offers a wide range of test systems and capabilities to meet your Multi-GNSS test needs. Our Multi-GNSS systems are designed with future development in mind and are expandable to address tomorrow's test requirements as well as todays. Whether you are undertaking R&D performance testing, integrating devices into your product line, verifying performance or assessing manufacture of Multi-GNSS devices, Spirent has a Multi-GNSS test system available today to match your needs.

The *GSS8000* Multi-GNSS Constellation Simulator; Up to three RF carriers, selected from a range of constellations and signals (GPS, Galileo, GLONASS and Quazi Zenith Satellite System), can be accommodated in a single signal generator chassis. This enables multiple signals from a single constellation or hybrid systems with signals from multiple constellations to be tested. The architecture supports future Compass signals.

Spirent GSS8000

Multi-GNSS Constellation Simulator

The *GSS6700* Multi-GNSS Simulation System offers up to 36 channels of combined GPS/SBAS, GLONASS and Galileo L1 signals from a single chassis, 12 channels for each constellation. The GSS6700 is available with one, two or three constellations enabled. Different software capabilities and flexibility are available to suit different test needs. For existing Spirent STR4500 or GSS6560 customers who today test GPS/SBAS L1 only, the GSS6700 offers the ability to simulate not only GPS/SBAS but also GLONASS and Galileo.

Spirent GSS6700

Multi-GNSS Constellation system

The *GSS6300* Multi-GNSS Signal Generator is designed specifically for production test applications where a single channel is required for controlled GNSS testing. The GSS6300 can generate a single, combined GPS/SBAS, GLONASS and Galileo signal to enable testing of GPS only or Multi-GNSS devices in a production environment. For existing Spirent GSS6100 customers, the GSS6300 has an identical capability, form factor and interfaces when specified in GPS/SBAS configuration. In addition, the GSS6300 offers the benefit of on-site (even in-rack) upgradability to add GLONASS and Galileo generation capability concurrently with GPS/SBAS.

Spirent GSS6300

Multi-GNSS Signal generator

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