Multi-GNSS

Benefits, challenges and test considerations

for Technology Developers

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Scope

This Application Note discusses the benefits and challenges of Multiple Global Navigation Satellite Systems (Multi-GNSS) and presents the test solutions available today which are critical to the proper technology development of receiver systems that will use Multi-GNSS signals and services.

It is written for designers and developers of GNSS receivers and GNSS enabled devices and equipment, and for project and procurement managers responsible for sourcing test equipment.

Introduction

For 31 years, since the first navigation satellite made it into orbit and began transmitting signals, we have become used to – and even taken for granted – the ability to perform autonomous, 3-D satellite-based positioning virtually anywhere on (and in the vicinity of) the Earth. The variety of applications that have employed this technology has increased beyond anything envisaged in the early days of satellite navigation, and continues to grow. For a large proportion of those 31 years the American NAVigation System with Time And Ranging-Global Positioning System (NAVSTAR-GPS) was the sole, fully-operational system. GPS was originally created for military navigation requirements, but the discovery of the ability to navigate from the signal originally intended only for approximate acquisition of the 'main' ranging signal, led to the first commercial use of GPS, and much later, in the year 2000, the removal of the deliberate degradation of this signal kick-started the rapid increase of commercial GPS usage.

The Americans were not alone however, as the then Soviet Union developed its GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (GLONASS) system. GLONASS nearly made it, and was completed in 1995, but it subsequently fell into rapid disrepair, such that it could not be considered as having Full Operational Capability (FOC).

As the global use of GPS increased, and with the viability of using GLONASS in question, strategic and political questions about the increasing reliance on a system owned, operated and maintained solely by the USA began to be asked.

This situation led to the beginning of development of other GNSS systems. In 1998 The European Council called on the European Commission to explore the possibility of developing a common system with the United States. Discussions were held to clarify possible options. As the Americans were not prepared, for military reasons, to envisage joint ownership or an effective role for Europe in controlling the GPS system, cooperation would be possible;

"Either in the existing GPS system controlled by the United States; Or in the development of a GNSS based on two navigation systems using complementary interoperable satellites: GPS and Galileo". The commission selected the latter option, and Galileo was born.

More recently China has started developing its own system called Beidou (Compass) and there are other, regional systems in development.

In recent years, many believed that the introduction of Galileo, together with the existing use of GPS would bring the commercial world into the Multi-GNSS era. As it turns out, the two systems to do that will now be GPS and GLONASS, which after much investment is now rapidly approaching Full Operational Capability, and it is in fact GPS + GLONASS that is currently being used as a true GNSS system of systems. Today, leading manufacturers are following the GPS + GLONASS path. Spirent has extended its Multi-GNSS test systems to meet Commercial Market, R&D, Integration, Verification and production test needs.

It is also worth mentioning that the term Multi-GNSS may also be applied to additional signals within the same system in so far as they contribute to an improvement in navigation performance. For example, most civilian users of GPS, have relied on the single C/A-code signal on L1. Soon, they will have access to L1C, L2C, which officially supports civilian dual-frequency receivers, and L5, which is a robust signal allowing enhanced atmospheric error mitigation, certainly more than is possible with a single-frequency receiver.

Finally, we must not forget augmentation systems. The Wide Area Augmentation System (WAAS) was instigated by the US Federal Aviation Administration to improve the accuracy of GPS so that aircraft could rely on it more for all phases of flight. The International Civil Aviation Organization (ICAO) calls this type of system a Satellite Based Augmentation System (SBAS). Europe and Asia are developing their own SBASs, the European Geostationary Navigation Overlay Service (EGNOS) which will be operational by October 2009, and the Japanese Multi-functional Satellite Augmentation System (MSAS).

All three are designed to the same specification (RTCA/DO-229D) and are fully interoperable. Other regional systems include the Quasi-Zenith Satellite System (QZSS) in the Pacific region, the Indian GPS Aided Geo Augmented Navigation (GAGAN) and the Indian Regional Navigation Satellite System (IRNSS). Commercial systems include StarFire and OmniSTAR. Ground-based localised systems also exist, such as the Local Area Augmentation System (LAAS) for aiding aircraft navigation on final approach and landing, and Differential-GPS systems based on networks of ground monitoring stations.

Inertial Navigation Systems (INS) also play an important part in the augmentation of GNSS, and are already widely employed in airborne and automotive applications. Assisted-GNSS is also a critical feature in improving time to fix and accuracy, particularly in the use of GNSS in mobile phone systems where navigational assistance data valid for a mobile handset's specific location is sent to the handset via the backhaul telephone network in advance of de-modulation of such data from the GNSS satellites by the handset's on-board GNSS chip-set. The discussion of INS and A-GNSS is however outside the scope of this paper, which concentrates on Multi-GNSS in relation to stand-alone receiver performance improvement.

Why Multi-GNSS?

The strategic and political reasons for the development of 'other' GNSS systems were not the only ones. The technical benefits were of course a significant contributor. The fundamental requirements of any navigation system are still as summarised in Figure 1 and they also show the benefits brought by Multi-GNSS navigation.

It is clear that more signals can bring improvements to all four of these areas, what needs further understanding is how and why, and what are the situations where there is no improvement, or even a degradation.

Availability		*Percentage of time a position solution is available* • With more satellites visible, navigation becomes possible even in very challenging environments (e.g.. urban canyon or pedestrian navigation)
Continuity		*Performance without non-scheduled interruptions* • Three or more satellites are generally required to maintain a valid position fix. The chances of this being the case are multiplied with a receiver looking for satellites from more than one constellation.
Integrity		*Level of trust in information provided* • Diversity in GNSS systems used by a receiver offers integrity benefits, for example allowing a receiver to flag anomalies or unexpected results.
Accuracy		*The degree to which position data conforms to actual position* • Accuracy over GPS alone can be improved when using multi-GNSS in difficult environments with limited visibility. However, even then, relatively poor satellite geometry can lead to accuracy impairments compared to open sky situations.

Availability and Continuity

This is clearly where major benefits can be gained with Multi-GNSS. In the toughest operating environments, such as deep urban canyons, the availability of signals for use by standalone satellite navigation applications can be severely limited due to the simple fact that over a given period of time, less satellite signals can be seen in this environment than can be seen in an open-sky environment over the same time period. In many cases there are just not enough signals visible for a sufficient amount of time for a receiver to navigate. Adding ranging signals increases the availability and the likelihood of being able to see enough signals, continuously for successful navigation.

In this situation, providing the additional signals are useable, there is only gain, even if the signal is of a lower accuracy than the others, because it moves the situation from no navigation possible to navigation possible. This principle is illustrated to good effect below.

Figure 2 shows a sky plot of visible GPS satellites. If a 45 degree elevation mask is used (represented by the inner circle on the sky plots) it can be seen that there are only 3 visible satellites – not enough for a complete time-solved 3-D position fix. Adding GLONASS (G15) puts the critical 4th satellite in view as shown in Figure 3. Adding Galileo (A14, 16 & 20) further improves the situation, as shown in Figure 4
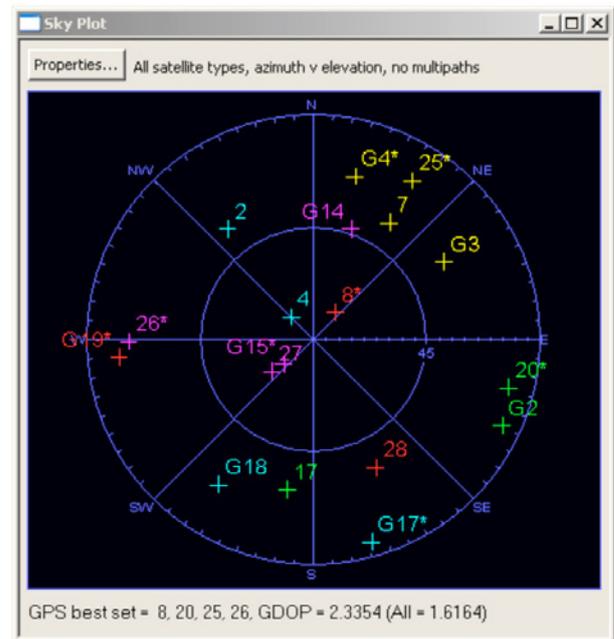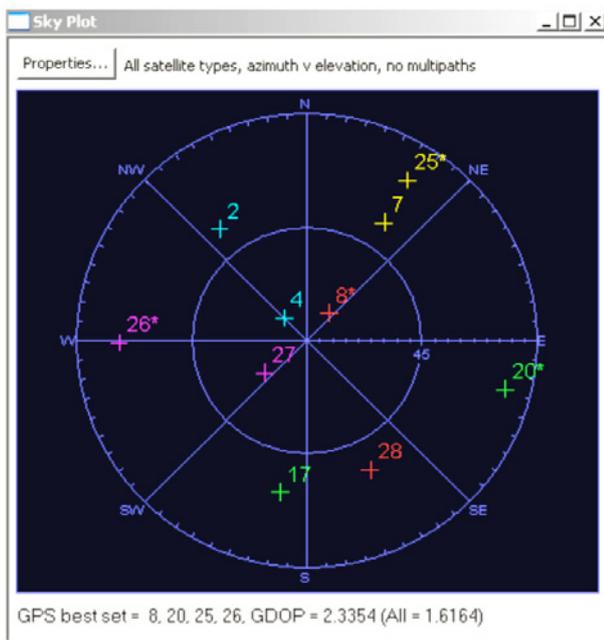

FIGURE 3: GPS & GLONASS
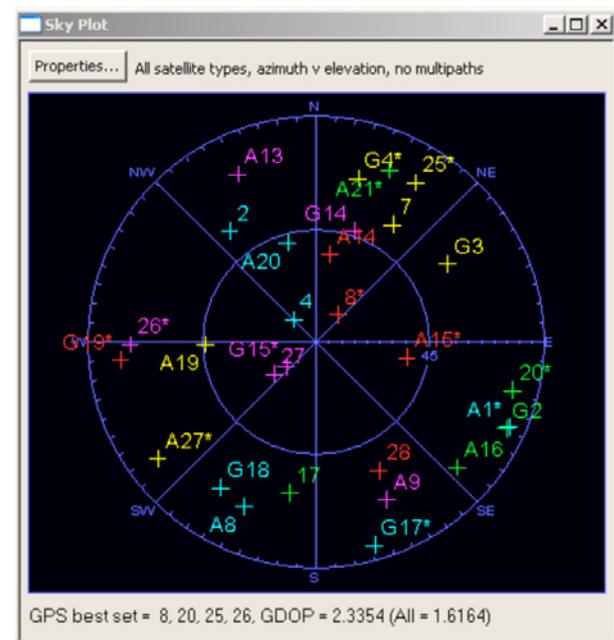

FIGURE 2: GPS ONLY

FIGURE 4: GPS, GLONASS & GALILEO

Integrity

The original GPS system lacked the level of in-built integrity monitoring demanded by today's safety-critical applications. Autonomous systems were introduced in an attempt to solve this problem, most notably RAIM (Receiver Autonomous Integrity Monitoring) which is an algorithm within a receiver intended to detect when a satellite's normally predictable behaviour becomes un-predictable.

New GNSS systems are designed with much more built-in integrity, especially on signals which carry specific critical services such as Galileo's safety-of-life service on E5b. There is also inter-GNSS integrity capabilities where a receiver compares fixes between different systems and issues an alert if the difference is greater than a certain threshold.

Accuracy

Stand-alone single-system GNSS navigation (i.e. GPS only) with no augmentation is suitable for many applications, but there are applications which demand greater accuracy. The development of Augmentations systems, whether for specific users, such as WAAS for aviation, or more general multi-application use such as Quazi-Zenith in the pacific region is well documented. These developments enable the use of GNSS in applications where otherwise it would not be accurate enough. The addition of GNSS satellites can sometimes bring an improvement, not least because the more satellites used in a navigation computation the less dilution of precision.

However, it may make accuracy worse unless the extra satellites offer the same performance. A lot of this depends on interoperability, which is discussed later. Newer designs of satellite and navigation signals which are more robust, coupled with improved models for atmospheric correction will also contribute to an overall improvement in accuracy. In the future a stand-alone receiver may well be using GPS + GLONASS + Galileo + Compass + Quazi-Zenith or another regional system + SBAS + improved models and corrections. This is a very different and much more complex environment than the time honoured L1 C/A code only situation that still dominates today.

Multi-GNSS Challenges

There are many challenges facing Multi-GNSS receiver developers, integrators and manufacturers. The most fundamental challenge is the need to design from scratch, adapt or re-design devices to operate using new GNSS systems.

A full understanding of each system's Interface Control document (ICD), which describes the system architecture and operation is essential, so is a test tool which precisely implements each ICD in order to generate authentic emulated signals.

Interoperability and Compatibility

Most challenges regarding Multi-GNSS relate to the topic of interoperability - how much improvement can be obtained by using different GNSS's together over just a single system? – and compatibility - the similarity between system operation. The greater the interoperability and compatibility, the simpler and cheaper the receiver technology. Ironically, the two systems likely to be the first to be used together are also the least interoperable and compatible, namely GPS and GLONASS. This is due to the lack of cooperation in earlier years as the two systems were being developed. The rest of the GNSS's are likely to be fairly interoperable.

The primary concerns regarding interoperability and compatibility are listed below (GPS, GLONASS and Galileo are assumed):

Signal modulation – GPS and all of the other GNSS's employ Code Division Multiple Access (CDMA) modulation techniques. GLONASS is the exception as it uses Frequency DMA (FDMA) for channelisation, although 'K-type' satellites – due for launch in 2010 - will transmit CDMA signals. Receivers using GPS and GLONASS will have more complex RF circuitry, as they need to operate over multiple frequencies for GLONASS. Recent development is chip technology now make mass-market CDMA + FDMA receivers a reality, and these are being introduced for applications such as Personal Navigation Devices (PND's) and Mobile Telephones.

Navigation data messages – each GNSS has its own Signal-in-Space Interface Control Document (ICD) which details the format of the messages contained in the navigation data.

A GNSS receiver must not only have the processing capability to de-modulate and correlate the RF signals, but also to process completely separate navigation data messages for each system.

Inter-system time offsets – Each GNSS operates on different time references. GPS uses a continuous, atomic timescale. GPS Time (GPST) which equaled UTC: (UNSO) when it started back in 1984, however, UTC is a varying timescale (to align with the rotation of the earth), so it is no longer the same as GPST. Galileo intends to use TAI, although there is some question over this approach as TAI is a scientific time reference and not recommended for broadcast.

[1] Panel discussion on GNSS Interoperability, 36th annual PTTI meeting, Torino, Italy

Reference frames – Each GNSS computes position with reference to different reference frames (GPS uses WGS-84, Galileo uses the GTRF and GLONASS uses PZ-90). While the latest releases of these frames align more closely to the International Earth Rotation and Reference Systems Service's Terrestrial Reference Frame (ITRF), there are still differences. Any receiver using two GNSS's must understand and apply any offsets between reference frames and between the ITRF in order to compute position properly.

[2] Panel discussion on GNSS Interoperability, 36th annual PTTI meeting, Torino, Italy

Understanding the Need for RF Emulation in Testing

Before discussing the use of an RF Constellation Simulator as a test tool for addressing Multi-GNSS challenges, it is important to understand why it is the best option.

This section looks briefly at the key important points which show why RF emulation is the preferred methodology.

The popular name for this type of equipment is a 'simulator'. In reality it is more accurately described as an emulator. However, being more widely recognised, the convention of 'simulator' is used here.

Whose Constellation is it anyway?

Where no constellation currently exists:

• A lack of real signals prevents testing

• Evaluation is limited to software modeling only

• There is no confidence in the system performance of a receiver

• There is no way of conducting dynamic testing

Even if a fully operational real constellation exists in space:

• You have no control over it, so you cannot alter it in an way in order to perform certain tests

• There are many unknown errors

• It is always changing, and is never repeatable

o Atmospheric conditions change

o Satellite orbits change

These issues rule out methods such as live-sky or record and replay testing for all but a quick sanity-check test.

# What are the Most Important Characteristics of Proper Test Methodologies?

Any product test, at any stage of a product's life cycle must have the following characteristics to make it meaningful, robust, accountable and reliable:

• Precision emulation of signals to a given ICD

• Lacking ambiguity

• A High degree of control

• Highly accurate test signals

• Inherent and exact repeatability

• Great flexibility

• Allows stressing of a product /application in a controlled environment

• Allows introduction of errors in a quantifiable way

RF constellation simulation is the only test methodology that has all these characteristics, and in the context of GNSS receiver development, a simulator is effectively your GNSS under your control for your specific test requirements.

Figure 5 illustrates the test process involving the simulator and device under test

FIGURE 5: SIMULATOR TEST SET-UP
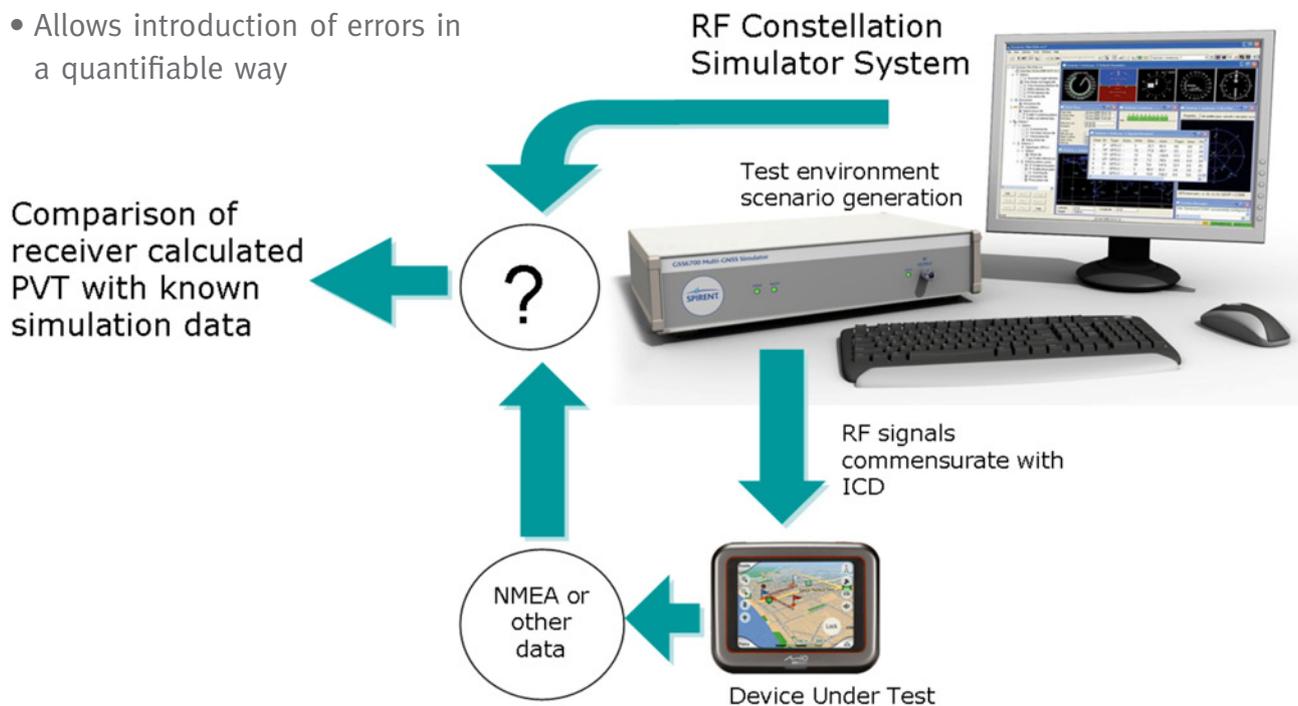
Using a Spirent GNSS Simulator to Test Interoperability and Compatibility Issues

Spirent's GSS6300, GSS6700 and GSS8000 series of GNSS RF constellation Simulators are essential tools for testing a GNSS device's ability to cope with interoperability issues. Not only are the proven advantages of RF emulation over other methods of testing applicable, but more fundamentally, the present absence of signals in space for all new GNSS systems except for GPS and GLONASS (FDMA) make this approach impossible in any case. In some ways this is good, as it ensures proper test methods are employed, and saves time that may otherwise be spent gathering meaningless results using the instantaneously unknown and un-controllable 'live' signals.

Each of the individual GNSS systems with their appropriate constellation, orbits, signals, timing and navigation data are produced by the simulator in accordance with the relevant Interface Control Document (ICD) and combined to present a signal to the receiver-under-test's antenna, just as it would see for real. Practically any parameter can be manipulated, allowing signals and data messages to be changed, inter-system timing to be adjusted and transformation matrices between reference frames to be adjusted.

Full flexibility and control of test definition and execution is afforded by Spirent's SimGEN™ software, which controls the GSS6700 and GSS8000 series simulators. Some examples of the capabilities SimGEN™ has for creating scenarios to test GNSS interoperability issues are shown below. The full complexity of scenarios is also carried down in an embedded way to Spirent's SimREPLAY software, which runs the GSS6700 simulators.

Signal Content Control

SimGEN™ allows the user to control signal content parameters for each simulated GNSS. Figure 6 shows the Signal Control windows of SimGEN™ or GLONASS and Galileo.

Signal parameters can be adjusted on a per-satellite basis, and/or applied to all satellites. This flexibility enables the user to test receivers with different carrier, code and data combinations, and to assess possible signal interference issues.
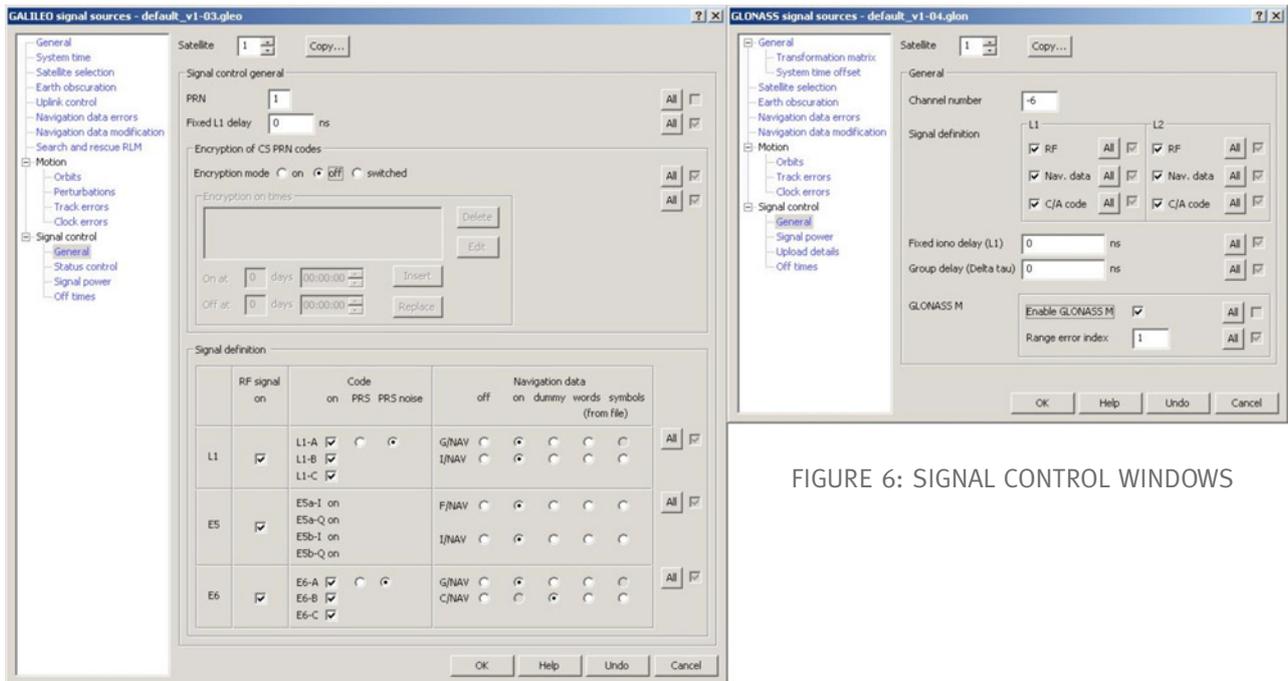

FIGURE 6: SIGNAL CONTROL WINDOWS

Timing Control

SimGEN™ gives full control of inter-system timing offsets. Figure 7 shows both the Galileo and GLONASS system time settings. It is possible to set the time offset to UTC (leap seconds), and apply a rate of change to this as the scenario runs.

For Galileo, the time offset to GPS (declared in the GGTO message in the navigation data) can be set, as well as a divergence between the simulated (RF) signal timing and that declared in the navigation data. As happens with a real system as time advances after a navigation data upload.
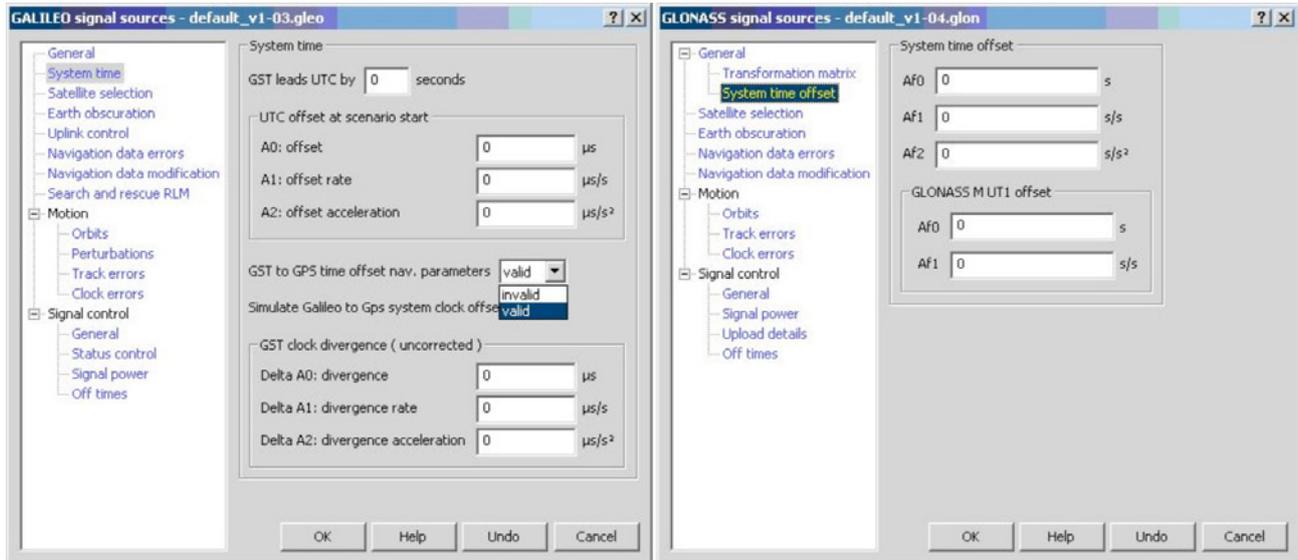

FIGURE 7: SYSTEM TIME OFFSET WINDOWS

These features provide great flexibility in defining tests to ensure receivers are correctly applying the necessary offsets and timing, which are critical to accurate navigation.

Figure 8 shows the options available for setting different matrices to transform the GLONASS reference frame into the GPS WGS-84 frame. Different transform types are available, as well as the ability to adjust the individual matrix parameters via a Generic Helmert transformation. The Galileo reference frame is treated the same as GPS by the simulator, as they both align very closely to each other.
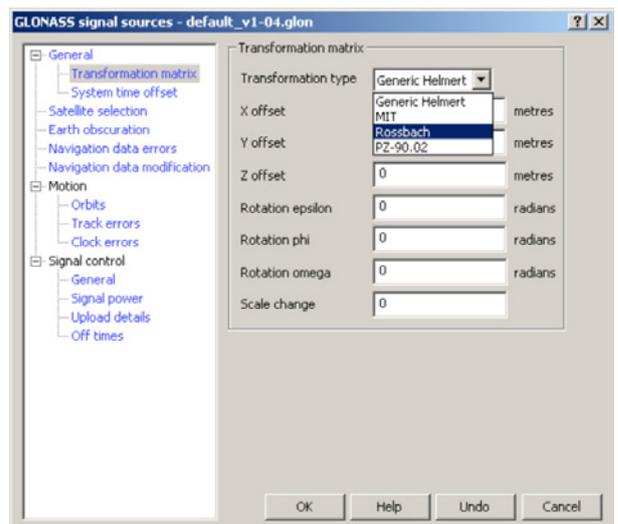
Navigation Data Modification

An important capability for the simulator is the ability to modify and apply errors to the navigation messages of each GNSS. SimGEN™ has comprehensive editors allowing manipulation of any bit of the navigation message, as well as adjustment of specific messages and their scheduling, and the control of integrity and health messages.

It is also possible to simulate the effects of the age of the navigation data, such as diverging ephemeris and degradation of clock correction parameters. Figure 9 shows a typical editor used for modifying navigation data. Figure 10 shows a typical editor for applying errors to navigation data
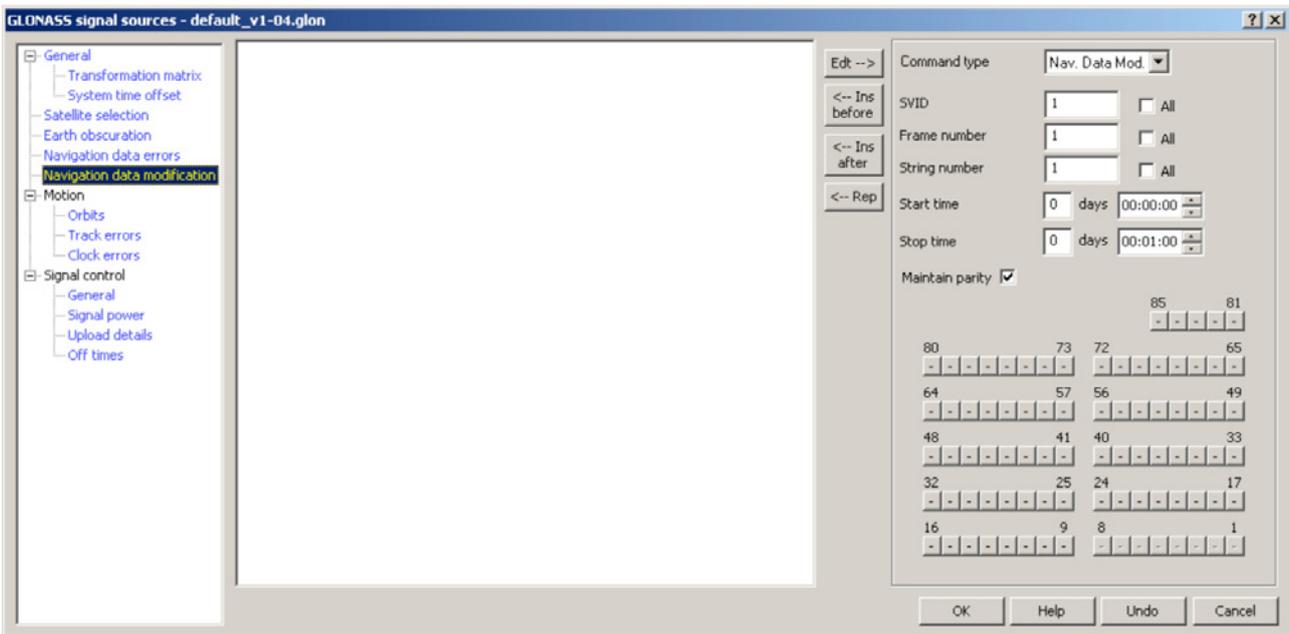
FIGURE 9: NAVIGATION DATA MODIFICATION EDITOR

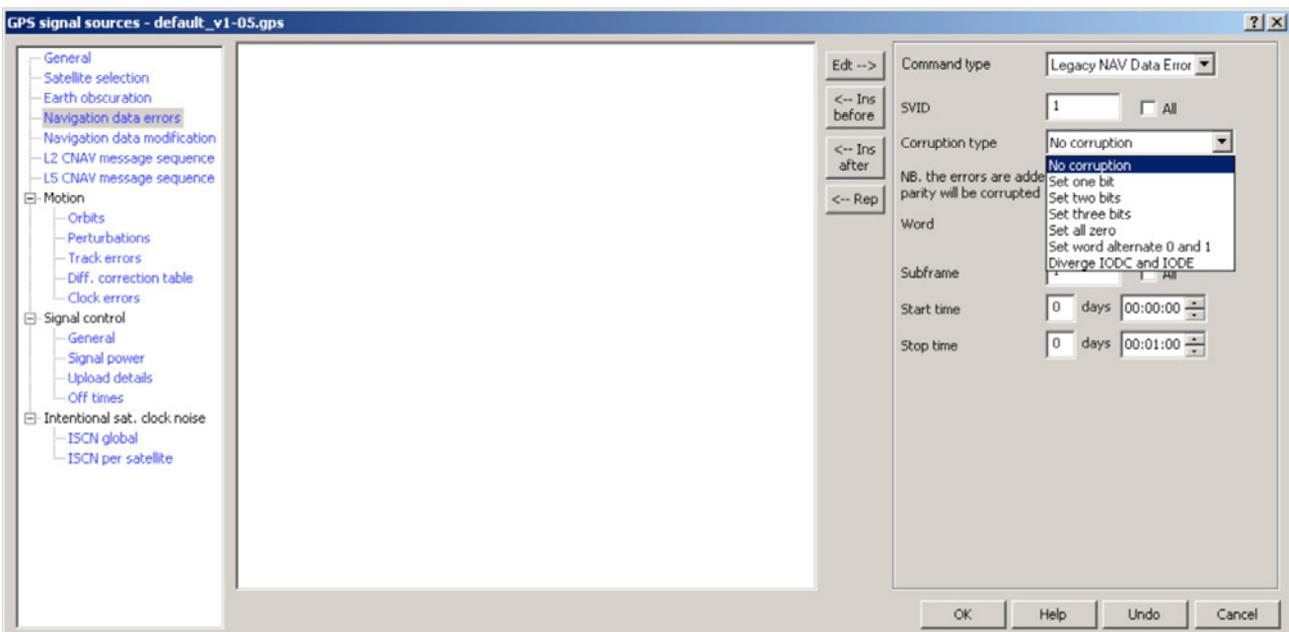FIGURE 10: NAVIGATION DATA ERROR EDITOR

Figure 11 shows the entry page for defining the content and timing of navigation data uploads, which is another method for scheduling changes to the navigation message.
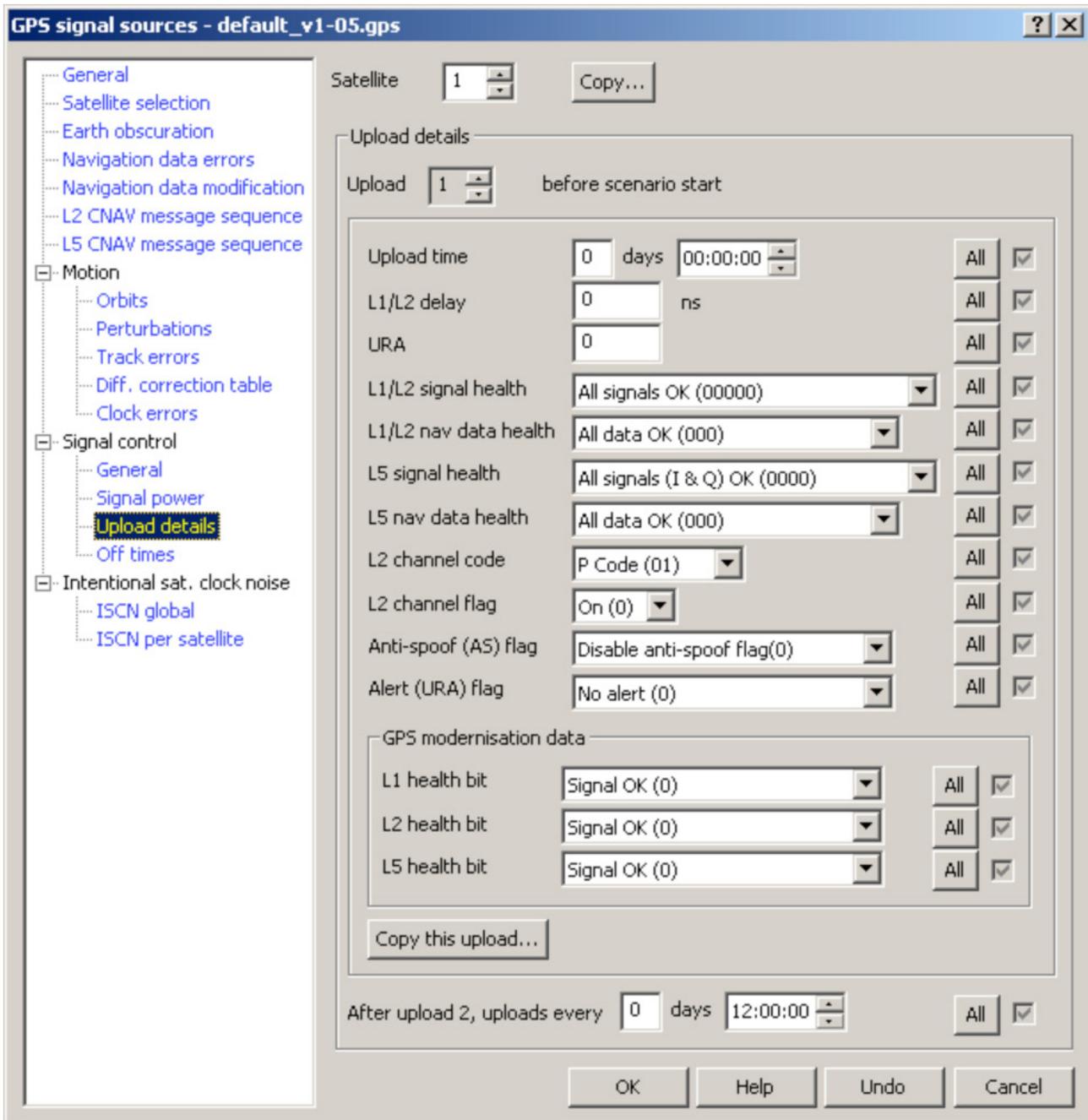

FIGURE 11: NAVIGATION DATA UPLOAD CONTENT

Other considerations for Multi-GNSS Testing

Assessing the True Benefit

As we discussed earlier, the fundamental requirements of any navigation system have not changed with the arrival of the Multi-GNSS age, in fact the added complexity of Multi-GNSS being used simultaneously increases the amount of testing required, particularly when it comes to assessing the improvement (or otherwise) of adding additional signals.

Spot the difference

An RF constellation simulator is the perfect tool for performing comparative tests. Complete repeatability is a powerful feature that only a simulator can offer. It is possible to run and re-run tests with one GNSS, then add another, and another, and measure the change in performance, while keeping all other test parameters the same.

It is also very easy to add or remove signals from a particular GNSS, this can even be done in real-time. Figure 12 shows the power control window for a simulation containing Galileo, GLONASS and GPS signals. As can be seen, the GLONASS signals have been turned off. This is achieved in just two mouse clicks. In the same way, all satellites for another GNSS could be disabled or enabled, and individual satellites could be enabled or disabled. Power level control in 0.1dB steps per channel is also very easy to apply.

There are also several alternative methods available, such as pre-scripted commands to be actioned at specific times into a scenario. This finite control is echoed throughout SimGEN™, making it extremely powerful and controllable.
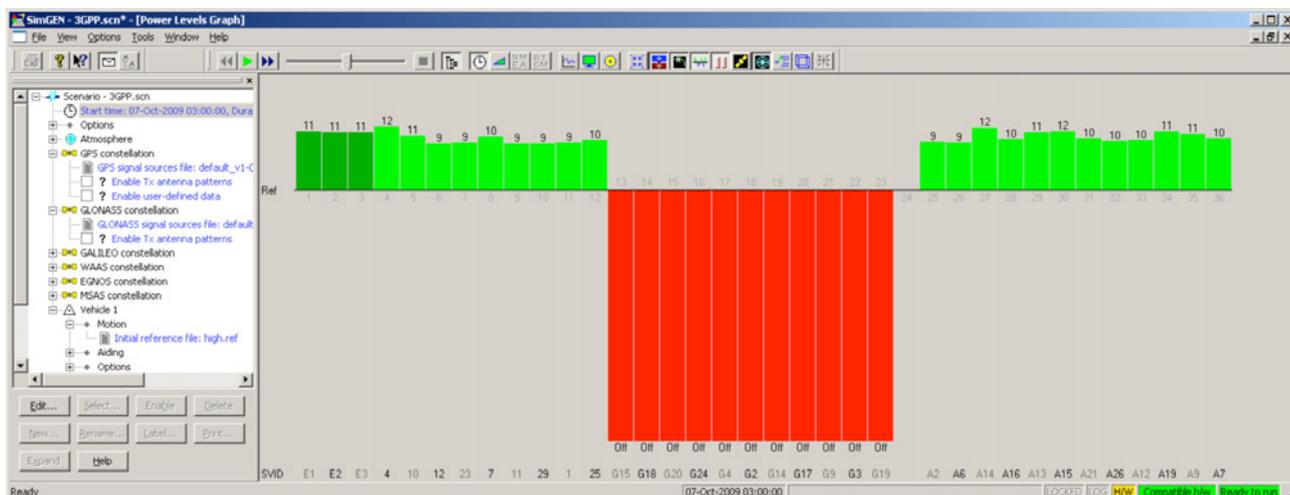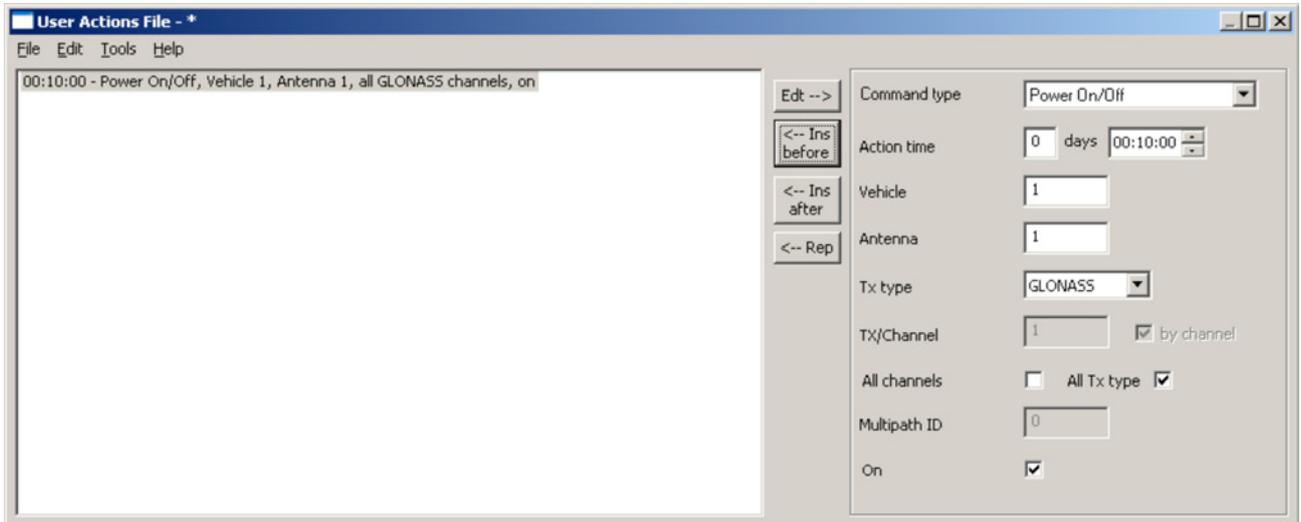
Figure 13 shows an alternative method.
A single command is listed in the User
Actions file to turn on all GLONASS signals
at a pre-determined time.

Developing receivers that integrate Multi-GNSS technology is not a new concept. GPS + GLONASS receivers for example have been readily available for over ten years. For this reason many of the challenges are well understood, and there are many papers discussing them. What is new is the transition of Multi-GNSS designs from 'high-end' receiver platforms into chipsets suitable for the mass-market.

The common constraints of cost, size, power consumption and processing power all play their part in raising the bar when it comes to achieving the desired result.

Certain trade-offs will inevitably have to be made, most likely in the resources devoted to tracking and integrated processing of Multi-GNSS signals.

While expensive receivers such as those used for geodesy applications will be sophisticated enough to employ code-phase or RTK type techniques using best multi-carrier Ambiguity resolution algorithms, and true multi-frequency tracking, not all devices can afford to be this capable. RF performance is often compromised because Multi-GNSS capability is needed but with increase in overall cost prohibited.

A common problem, especially in GNSS-enabled phones, is use of one common clock oscillator (TCXO) for both the telecommunications operation and the GNSS operation. This is not an ideal solution by any means, as variations to the TCXO frequency are undesired from the GNSS receiver's point of view. Unfortunately, the oscillators are often the most expensive single items in the design, and economics often forces designers down the fateful single-clock route. They then have to spend time developing techniques that advise the GNSS receiver of clock changes in sufficient time for them to be corrected for in the PVT calculation. In addition, a very close watch on phase noise is required, as this directly affects code and carrier loop tracking performance by inducing jitter. The quality of the TXCO will also determine its sensitivity to dynamic stress (G-sensitivity), which is yet another contributor to tracking error.

Much of the performance analysis and manipulating of a design to accommodate these design trade-offs can be thoroughly examined using a simulator.

[3] GNSS on the GO: Sensitivity and performance in receiver design. Lomer, Fulga & Gammel SIGE, Inside GNSS article, spring 2008

Testing the limits of the chip

With an RF constellation simulator it is possible to stimulate a receiver with a 'full' sky of GNSS signals – something not possible in the 'real' world today. This will push the tracking and processing capability of the chip-set to its limits.

It is even possible, through manipulation of the satellite positions or the vehicle height within the simulator to place more satellites in view of the receiver antenna than may ever be seen for real – thus testing the theoretical performance of the receiver. Accurate design de-rating figures can then be obtained.
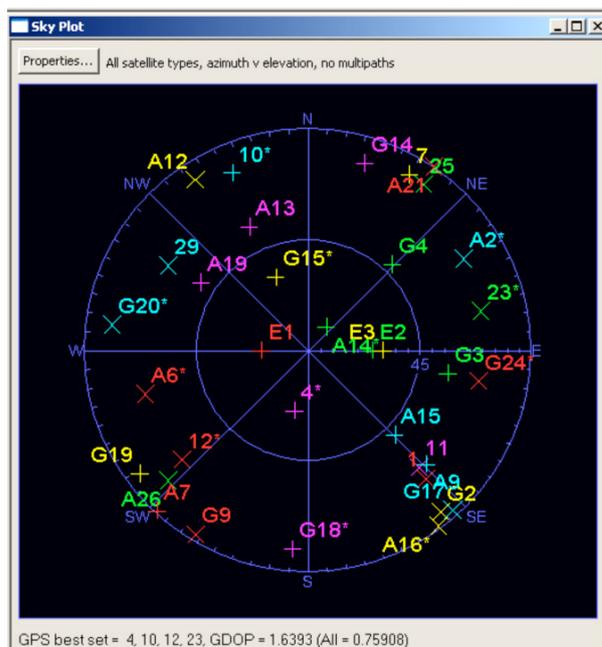

Figure 14 shows a crowded SimGEN™ sky plot. The simulator will be generating complete signals (sometimes with several different codes) for each satellite, making a complex composite signal for a receiver to de-modulate and process.

The simulator is able to introduce the effects of dynamic stress. This will be absent in a receiver which is not moving. The known G-sensitivity of the receiver's clock oscillator can be added to the test scenario to compensate for this. Figure 15 shows the entry window in SimGEN™.

A combination of effects can be built into a scenario, and detailed measurement of C/No performance can then be made. Errors can then be very easily removed, one at a time, to identify the main causes of performance deterioration. Focus can then be put on areas of the design where changes will have the most benefit.
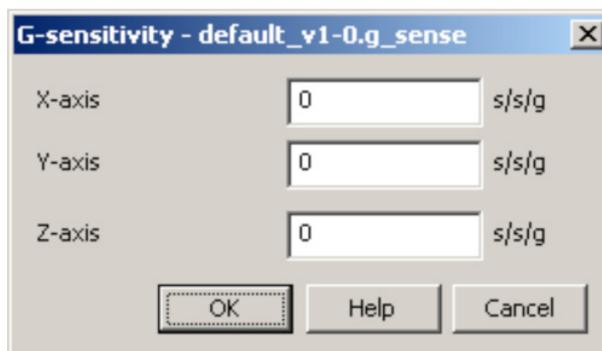

FIGURE 15: G-SENSITIVITY PARAMETERS

Be Sensitive to the Environment

Good sensitivity is still the most important consideration for any receiver. With Multi-GNSS, there will be more signals entering a receiver's front end. This will lead to an increase in noise, which will affect the receiver by increasing the bit error rate and code / carrier loop jitter.

Also, in devices such as mobile phones, the dominant source of interference will be from the telecommunications radio part of the device. A typical handset will transmit over a watt (>+30dBm) in the designated band, but due to the form of the device, interference from the telecommunications radio signals can easily interfere in the GNSS band and overpower the relatively weak GNSS signals, directly impacting the GNSS receiver's sensitivity. Good RF isolation is essential.

Another consideration is that of the Low Noise Amplifier (LNA). Due to cost constraints it is most common for a device to use one LNA to cover both the telecommunications signals and GNSS signals. The large dynamic range in power between the two services means the LNA must be very linear, whilst not consuming too much supply current, in order to avoid gain compression, which may well result from high-level telecommunications signals, but is certainly not desired for the GNSS signals.

A classic receiver test, but just as critical for a Multi-GNSS receiver.

A simple to execute, yet fundamental test is the sensitivity test. SimGEN™ offers several easy methods for precisely controlling the satellite power so that the point where a receiver loses lock (its minimum sensitivity level) can be determined. Equally, the point of re-acquisition can also be determined*.

*For more information , download the Spirent Application Note "Fundamental GNSS Receiver Characterisation".

Figure 16 shows SimGEN™'s real-time power control window, with sliders allowing precise adjustment of the satellite powers. An alternative method is to use a User action file to adjust the powers in a timed way.
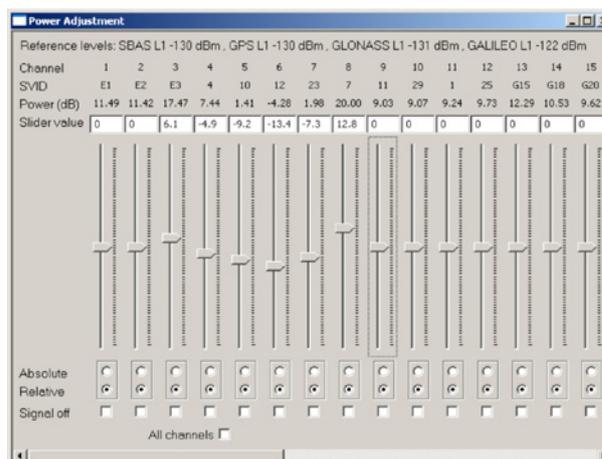

FIGURE 16: PER-SATELLITE POWER CONTROL

Jamming and Interference

One of the benefits of Multi-GNSS operation is the increased resilience to interference brought about by multi-frequency operation. The vulnerability of the GPS C/A code on L1 is well documented. A receiver may still suffer similar vulnerability when using Multi-GNSS signals only at L1, but using L1, E5, L2 or other combinations and more robust codes will improve its capability, as it is less likely that an interference source will obliterate all signals on all frequencies.

On the downside, GNSS signals that are not being used (M-code, Galileo PRS for example) are still present at the receiver's antenna, and are effectively interference, as they do not convey any information required by the receiver.

Test the effects

A simulator can be used readily to test the effects of interference. Some of Spirent's models are available with an interference option, allowing a range of interfering signals to be added to the GNSS signal. CW, AM, FM, pulsed and Noise signals with full control over each one's settings can be generated. The effects of noise in a dynamic environment can also be tested, as the characteristics of the interfering signal are adjusted dynamically in harmony with the simulated vehicle's position in relation to the interference source.

The presence of un-used GNSS signals can also be simulated with M-Noise and PRS-Noise functions, enabled via a single check-box in SimGEN™. Figure 17 shows M-Noise enabled in SimGEN™.
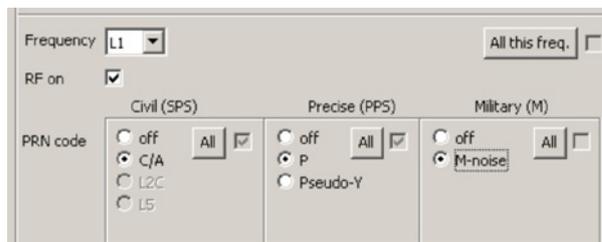

FIGURE 17: CODE AND CARRIER CONTROL WINDOW

The sky's the limit

A statement that is not only true for the future of GNSS, but also true of the test capabilities or a Spirent RF constellation simulator. This Application Note has introduced some of the key topics relating to Multi-GNSS, and shown just some snap shots of how a simulator is the right choice for testing the effects of these issues on a GNSS receiver. The business of designing, manufacturing, integrating and selling GNSS technology is driven more and more by tough commercial requirements, especially in a world starting to tentatively emerge from economic recession.

The business cases for such products need to stand up to testing like never before. No one can afford to make mistakes at any point along the way, not least when it comes to product testing. Investment in RF simulation as a test and verification methodology helps keep projects safely away from the cliff edge on the right path. How do you test your GNSS?

Test Solutions

Below is a summary of Spirent's current simulator products

GSS8000 Multi-GNSS Constellation Simulator

The GSS8000 series has been designed to meet all the demanding requirements of research and development teams involved in satellite navigation and positioning systems. Due to its modular design, the GSS8000 can be readily adapted to the requirements of different applications. Up to 3 RF carriers, selected from a range of constellations and signals, can be accommodated in a single signal generator chassis.

A GSS8000 system comprises a controller computer running Spirent's powerful simulation software SimGEN™, and a signal generator configured to meet specific test needs. Multiple chassis can be combined to form an integrated, coherent signal generator if more signals or outputs are required. An extensive range of system extensions allows users to tailor their system to their specific needs, today and in the future.

Standard capabilities enabled through SimGEN™ include simulation of atmospheric effects, multipath reflections, terrain obscuration, antenna reception gain and phase patterns, differential corrections, trajectory generation for land, air, sea and space vehicles and comprehensive error generation.

An easy to use graphical user interface (GUI) allows modification of a wide range of variables from pre-set defaults, enabling the user to focus their time on the areas of test important to them. Complete scenarios are readily shared between systems, supporting collaborative activities and speeding up the R&D cycle.

GSS6700 Mulit-GNSS Constellation Simulator

The GSS6700 supports any combination of GPS/SBAS, GLONASS and Galileo L1 signals and provides accurate, repeatable combined Multi-GNSS signals. The GSS6700 can be configured with up to 12 channels of one constellation only or with multiple constellations, for example:

• GPS only

• GLONASS only

• Galileo only

• GPS and GLONASS

• GPS and Galileo

• GPS, GLONASS and Galileo

Up to 36 channels are supported with 12 channels of simulation per constellation.

The GSS6700 is available with a range of software capability to suit differing test requirements.

SimGEN™ is Spirent's fully flexible simulator software suite and would typically
be required in technology development and R&D applications. SimGEN™ offers a complete and flexible scenario generation capability including control of the constellations, propagation, terrain obscuration, antenna patterns, multipath, vehicle trajectory and a range of error models.

For environments where repeat testing using the same test cases is needed, for example verification testing, Spirent's SimREPLAY software is available. SimREPLAY supports operation of the simulator replaying pre-defined scenarios and is ideal for repeat comparative measurements. Scenarios for use with SimREPLAY can be obtained from a number of sources including an online scenario generation tool available at no additional charge to customers under warranty or with a support contract.

SimREPLAYplus allows users to generate scenarios locally with features comparable to the online tool available to supported SimREPLAY users. In addition, SimREPLAYplus enables the user to define vehicle motion remotely or using a file in the required format.

GSS6300 Multi-GNSS Constellation Simulator

The GSS6300 Multi-GNSS Signal Generator has been designed specifically for high volume production test applications for devices that use commercial GPS/SBAS, GLONASS and/or Galileo receivers. Controlled testing is vital in ensuring correct assembly and verification of expected performance parameters in GPS only and Multi-GNSS manufacturing environments. Spirent's GSS6300 provides a robust single channel testing solution with the minimum of operator intervention.

The GSS6300 can be configured with one channel of a specific constellation or with multiple constellations, for example:

• GPS only

• GLONASS only

• Galileo only

• GPS and GLONASS

• GPS and Galileo

• GPS, GLONASS and Galileo

For GPS L1 C/A code test applications, the GSS6300 features, interfaces and specification are the same as the Spirent GSS6100 product that is widely specified for manufacturing test applications.

Generation of signals from the various constellations is enabled by licence key. If all licence keys are present the GSS6300 can generate a single GPS signal, a single GLONASS signal and a single Galileo signal concurrently.

The GSS6300 is designed for easy integration into production test environments. A comprehensive remote control interface enables control of the unit via standard interfaces, including IEEE488 and USB.

For operation in the laboratory, for example as a single channel precision GNSS signal generator for RF design work, a GUI-driven software utility, SimCHAN, is supplied.

GSS6400 Record & Playback System

Bring the Complexity of the GNSS World Back Into Your Lab

Consumer navigation and positioning products often need to perform under extremely challenging signal environments, from inside office buildings to urban canyons and rural mountain tops. Recreating these environments synthetically using a simulator, for example, takes a considerable amount of time, knowledge and skill.

Now you can capture and replay the full richness of these enviroments at the push of a button with the GSS6400 Record & Playback.

Benefits:

• Complete solution designed to capture complex real-world environments and replay with optimal fidelity & performance

• Reduces time and money spent on field tests

• Improves device performance by eliminating run-to-run changes

• Compatible with a wide range of test applications

Key Features:

• One touch record and replay

• 500 GB internal hard drive (up to 30 hours of signal recording)

• Internal battery allows up to one hour of in-field recording

• Two-bit Sampling

• 24 Hour Testing

• Remote Control

• Test Automation

Learn more about the GSS6400 Record Playback System

For More Information

Please visit our website: http://www.spirent.com/positioning and do not hesitate to contact your nearest Spirent representative for more detailed information. To find the appropriate contact details please visit the 'Contact Us' page on the website and select your location and application.

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