## The Spirent Advantage

With experience amassed over twenty years of supporting GNSS development, Spirent is the only choice for comprehensive performance and support.

### Spirent offers:

- Comprehensive features as standard, built up over 20+ years of development
- High fidelity simulation across the full dynamic range
- Top quality systems, backed by regional support network
- An assurance of continued investment in new GNSS technologies and systems
- Tailored solutions available to support special applications and configurations

Standard features enabled by SimGEN include simulation of multipath reflections, terrain obscuration, antenna reception gain patterns, differential corrections, trajectory generators for land, air, sea and comprehensive error generation and system modelling. Also supplied as standard is a low-latency, high-rate hardware-in-the-loop capability.

### Documentation and Reference Table

| Product, Option or Document | Document Type | Document Reference |
|---|---|---|
| GSS8000 | Brochure<br>Datasheet | MCD00073<br>MS3057/MS3008 |
| GSS6560 | Brochure<br>Datasheet | MCD00078<br>MS3003 / MS3008 |
| STR4500 | Brochure<br>Datasheet | MCD00079<br>MS2980 / MS3051 |
| GSS7765 | Brochure<br>Datasheet | MCD00068<br>MS3055 |
| SimAUTO | Brochure<br>Datasheet | MCD00065<br>MS3023 |
| SimREMOTE | Datasheet | MS3015 |
| Testing GNSS Systems for Automotive Applications | Application Note | DAN001 |

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE 2004

ISO 14001 Reg. No. 059-C

ISO 9001 : 2000 Reg. No. 059-A



SALES AND INFORMATION
Spirent Communications
Aspen Way, Paignton
Devon, TQ4 7QR, England
T: +44 1803 546325
globalsales@spirent.com
www.spirent.com/positioning

Spirent Federal Systems Inc.
22345 La Palma Avenue
Suite 105, Yorba Linda
CA 92887
T: 1 714 692 6565
info@spirentfederal.com
www.spirentfederal.com

MCD00076 08/08

World leader in GNSS test and simulation systems

# Test Solutions for:
## In Vehicle Navigation Systems (IVNS) Using GNSS and DR sensors

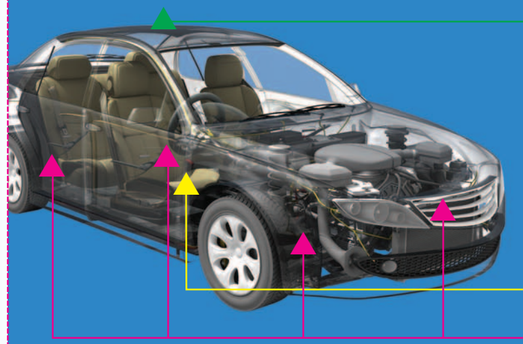
## Assessment of Navigation Performance in Vehicles

Navigation systems are subject to a number of limitations and sources of error which can degrade their usefulness. Delays in position availability or unflagged errors in position can severely limit the usefulness of the system. Before a navigation system can be deployed to market there are a number of key assessments required to ensure that it will perform its task acceptably. Quantative assessment of accuracy, time to first fix (TTFF) or integrity requires a systematic, planned approach to testing.

## Live Sky Trials

One way of assessing system performance is live-sky testing or field trials. Whilst this may seem an obvious way of testing a navigation system there are a number of issues to consider:

- How do you establish an accurate reference position to enable accuracy to be measured?



- With the satellites constantly moving how can you be assured that you have tested in all representative geometric situations (i.e. DOP values)?
- If a problem occurs it may be difficult to attribute the problem to an identified cause.
- Tests will be: (a) difficult to repeat and (b) impossible to repeat exactly due to the constantly changing satellite constellation and uncontrolled environmental factors.

For some, live-sky testing will always have a place as the final proof that the system works. But what's missing is the control and repeatability required for a useful means of determining performance and improvements during development.

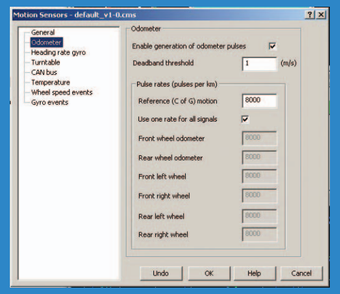
***This is the challenge addressed by simulation.***

## Lab Testing Using a Simulator

A GNSS RF Constellation Satellite Simulator enables the simulation of the obscuration and multipath conditions in a controlled and repeatable way. In turn, this allows a GNSS receiver and/or GPS + INS system to be tested in a structured and progressive way for use in automotive applications.

An RF Constellation Simulator reproduces the environment of a GNSS receiver on a dynamic platform by modelling the vehicle and satellite motion, signal characteristics, atmospheric and other effects, such that the receiver will actually navigate according to the parameters of the test scenario.

Spirent offers test systems for integrated in-vehicle navigation system testing that include simulated GPS signals coherent with inertial and dead reckoning sensors. Our systems can be controlled remotely, facilitating integration with other vehicle test rigs. Real-time hardware in the loop simulation is also possible, for example, to allow synchronisation with driving simulators. Systems are also available that are optimised for vendor selection, integration and verification testing.




*Car motion sensors controlled via a Graphical User Interface (GUI)*

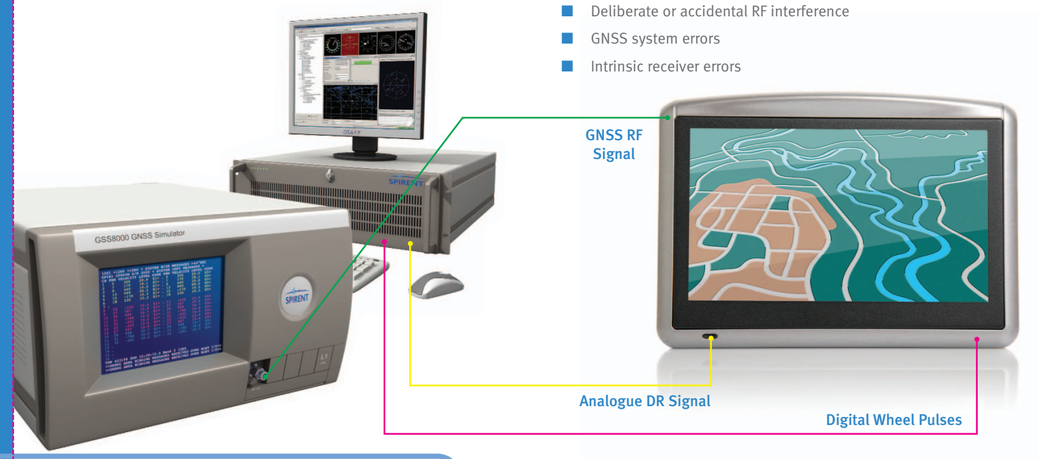
### Live Testing with Actual GNSS Constellations

| |
|---|
| No control over constellation signals |
| Limited control over environmental conditions |
| Not repeatable; conditions are always changing |
| Unintended interference from FM, radar, etc. |
| Unwanted signal multipath and obscuration |
| No way to test with GNSS constellation errors |
| Expensive field testing and vehicle trials |
| Limited to signals available in GNSS constellations |
| Competitors can monitor field testing |

Simulated vehicle motion can be developed using the vehicle trajectory models built into the Spirent's simulator controller software (SimGEN) or imported from files saved by other applications or derived from data logged during real journeys or previous trials. Because Spirent's SimGEN operates in real time without the need to pre-compute scenarios, it is even possible to use motion generated in another application such as a car simulator. This allows testing with a driver in the loop if human factors are being explored.

In simulated lab testing the signals from a variety of sensors are reproduced by the Spirent simulator system. RF from the GPS antenna, wheel ticks from the ABS, speed signals from odometers and heading signals from gyros are coherently generated by the simulator and fed into the unit under test in place of the live signals.

Where inertial sensors are built into the unit under test it can be difficult to inject the simulated test signals. If required the UUT can be mounted on a turntable driven by Spirent's SimAUTO application. In this way the built-in sensors are directly stimulated with motion consistent with the simulated GPS signals.




### Laboratory Testing with GNSS Simulators

| |
|---|
| Complete control over constellation signals |
| Complete control over environmental conditions |
| Fully repeatable |
| No unintended interference signals |
| No unwanted signal effects |
| Easily test scenarios with GNSS constellation errors |
| Cost-effective testing in laboratory |
| Testing of present and future GNSS signals |
| Testing conducted in secure laboratory |

## Vehicle Navigation

In Vehicle Navigation Systems (IVNS) are increasingly relied upon by individuals, commercial organisations and emergency services. They are expected to be accurate and instantly available. However, the underlying satellite navigation technology is subject to numerous sources of impairment leading to delays in establishing position or position errors.

## Sources of impairment for GNSS systems

- Signal blocking by buildings, structures and terrain
- Local, on-vehicle obscuration from door pillars, roof and other vehicle structure
- Multipath errors where reflected signals confuse ranging measurements
- Signal attenuation due to interruptions in the transmission path
- Deliberate or accidental RF interference
- GNSS system errors
- Intrinsic receiver errors

## Additional Sensors

Many designers are incorporating data from other available sensors (such as ABS) to supplement the satellite data to improve overall accuracy, availability and integrity of their navigation systems.

## Additional sensors used include:

- Heading sensors
- Compasses or magnetometers
- Accelerometers
- Gyros
- Wheel pulses (e.g. ABS)
- Vehicle Speed Signal (e.g. VSS or odometer)

## Spirent Test Systems

**GSS8000:** Spirent's most capable range of simulators, the GSS8000 series covers multiple constellations and signals. Running SimGEN for Windows® a simulator from the GSS8000 series can form the heart of a fully functioned, multi-sensor simulator system. Extensive control of the simulated constellation and propagation effects make the GSS8000 with SimGEN Spirent's most powerful option for researchers and developers of multi-constellation GNSS systems. The GSS8000 is compatible with a wide range of Spirent system extensions including SimAUTO and the GSS7765.

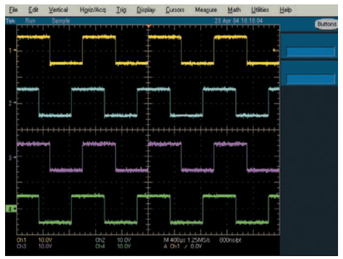
**GSS6560:** Running the same powerful software as the GSS8000 (SimGEN for Windows®), the GSS6560 is ideal for users working exclusively with GPS L1 C/A and SBAS signals. The GSS6560 is compatible with SimAUTO and other Spirent system extensions.

**STR4500:** The STR4500 and the controlling application, SimPLEX45 provides a test solution targeted at commercial GPS L1 C/A only applications. A reduced functionality replay only version using the SimPLEX application is available which can be a cost effective option where multiple repeats of a fixed test scenario is required such as in production test or QA.

**SimAUTO:** Emulated signals from additional motion sensors such as wheel ticks and gyros are provided by SimAUTO. The SimAUTO option is available on any Spirent system running Spirent's SimGEN for Windows® software suite such as the GSS6560 or GSS8000 series. Fully integrated with SimGEN, SimAUTO allows parameters such as wheel track, wheel base, wheel ticks, odometer pulse rate & dead band to be set and saved to a vehicle personality file for future use. Emulated dead-reckoning sensor outputs are precisely coordinated with the RF GPS signals to provide a complete test environment for integrated navigation systems.

**GSS7765:** The effect of noise and interference effects can be explored using the GSS7765 Interference Simulation, an optional extension for any Spirent simulator running SimGEN. The system is fully supported by SimGEN with interference sources integrated into the test scenario. Extensive control of interference types and dynamics are provided.

*Typical test system using a GSS6560 with SimAUTO driving a rate table & producing wheel ticks*



*Oscilloscope traces of wheel ticks produced by SimAUTO*

## SimAUTO