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SimHiL Datasheet

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Purpose of this document

This datasheet describes the functionality of Spirent SimHIL, a software solution that provides dedicated APIs to integrate Spirent GSS7000 and GSS9000 GNSS simulators with dynamic HIL environments.

This datasheet also provides technical product specification data and configuration information. Please speak to your Spirent sales representative to discuss your requirements.

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Glossary

API	Application Programming Interface
AV	Autonomous Vehicle
DoF	Degrees of Freedom
DSI	Dedicated Software Interface
ECU	Electronic Control Unit
FMU	Function Mock-up Unit
GLO	Glonass
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GUI	Graphical User Interface
HIL	Hardware-in-the-Loop
I/O	Input/Output
IP	Internet Protocol
NI	National Instruments
SIR	Simulation Iteration Rate
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

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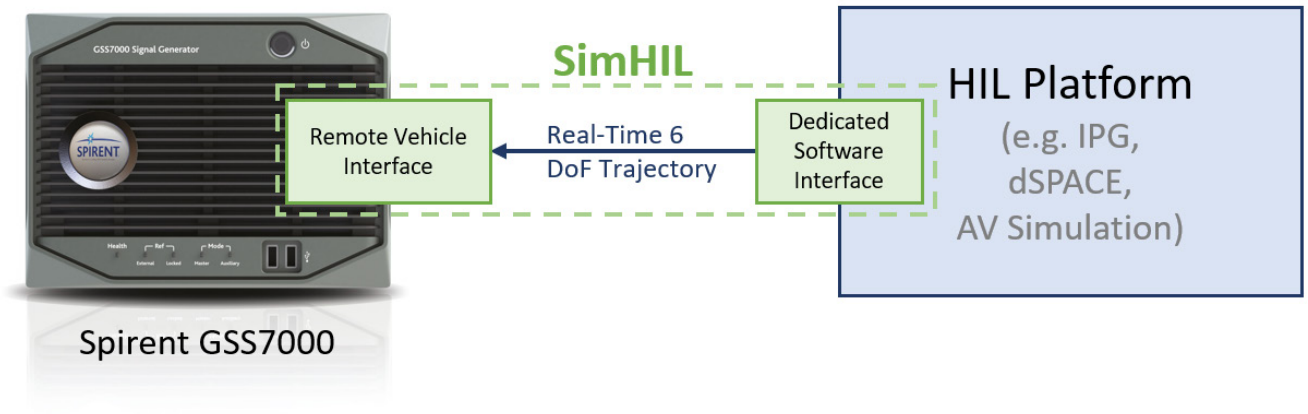
Introduction

SimHIL is a software solution that provides dedicated APIs to integrate Spirent GSS7000 and GSS9000 GNSS simulators with dynamic HIL environments. SimHIL enables *remote vehicle* capabilities in PosApp, allowing the user to remote control the movement of the vehicle by providing a 6 DoF trajectory from a third-party tool (see List of Supported Third-Party Tools).

In addition to the enablement of the remote control interface on PosApp, SimHIL also provides to the customer with Dedicated Software Interfaces (DSI) to successfully integrate the GNSS simulator with the HIL platform. DSIs are easily installed and configured on the third-party environment to ensure that the interface is fully operational on both ends (see Figure 1).



Features and Benefits

Integration Support: Spirent offers specific support for each of the interfaces provided with SimHIL. Our consolidated partnerships with third-party providers (e.g. dSPACE, IPG or AV Simulation) ensures that our customers receive all the support they need to set-up and run their simulations, and test their GNSS receivers or ECUs.

Ease of use: SimHIL can be easily set up from the third-party configuration environment (e.g. dSPACE ConfigurationDesk, IPG CarMaker and SCANeR Studio). Thanks to its open and rich API the user can configure and control the GNSS simulator from third-party tools.

Ultra-Low latency: Spirent GNSS simulators have a maximum Simulation Iteration Rate, or SIR, of 1 KHz (GSS9000) and 100 Hz (GSS7000). In the case of the GSS7000, which has a simulation step of 10 ms, the latest available data is used to update the antenna position, achieving motion synchronisation between the GNSS simulator and the HIL platform even when the GSS7000 is running at a lower rate. This guarantees a processing latency below

2 ms and an overall latency of the system lower than 4 ms for the GSS9000 and 40 ms for the GSS7000. In addition, Spirent GNSS simulators use interpolation and extrapolation techniques to compensate for unintentional loss of data-packets or HIL platforms with low update rate.

Simulation Configuration and Control: Spirent provides dedicated interfaces for each HIL integration, adapting to their API requirements and offering customers all the benefits for each solution.

Greater Realism: SimHIL is compatible with all the GNSS specific options and features available with Spirent GNSS simulators. This includes ionospheric and tropospheric modelling, antenna patterns, date and time setting, obscuration effects and multipath (also available through our realistic multipath and obscuration simulation, i.e. Spirent Sim3D).

SimHIL Overview

In HIL applications, the movement of the vehicle cannot be predetermined. The vehicle (or driver) must be able to react to any event occurring within the virtual environment (e.g. red lights, accident, sudden brake, etc.). Therefore, the movement of the vehicle moving on PosApp must be controllable in real-time to adapt to these changes in the trajectory. In this case-scenario, the HIL platform (or driving simulator) provides kinematic data to PosApp using its remote interface. This software feature has always been available on SimGEN and now it becomes available on SimTEST and SimREPLAY+ through SimHIL.

SimHIL acts as an interface between the motion generator and PosApp. This interface has two different parts (see Figure 1**Error! Reference source not found.**):

- **PosApp's Remote Vehicle Interface (SimREMOTE):** SimREMOTE is a software feature available by default on SimGEN. Now, thanks to SimHIL, SimTEST and SimREPLAY+ users can also use this powerful interface to receive vehicle motion from a number of third-party tools. SimGEN fully exploits the capabilities of the SimREMOTE interface with more than 500 commands available to configure and control the GNSS simulator. SimTEST and SimREPLAY+ have now access to those commands required to achieve a successful integration between the HIL platform and the GNSS simulator (e.g. start/stop simulation, set scenario date and time, configure PosApp display, send vehicle motion update, etc.).

- **Dedicated Software Interface (DSI):** Each integration (i.e. SimHIL for dSPACE, SimHIL for IPG and SimHIL for AV Simulation), includes a dedicated software interface compatible with the third-party software environment. This DSI acts as a simple GUI used to configure and control the GNSS simulator. These software interfaces are "dedicated" because they have been developed, and maintained, using the tools provided by the corresponding third-party.

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Operation

Each integration is unique for the third-party environment in which it is intended to work. Some common features are shared across all the DSIs in terms of configuration, application start, running stage and application termination.

Configuration

All the configuration aspects of the GNSS simulator are done from the DSI loaded in the third-party environment, before running the user application. Figure 2 shows an example on dSPACE ConfigurationDesk.

Some of the parameters that the user can set from the configuration window may include:

- IP addresses of the systems involved to establish the ethernet connection.
- Date and time information to configure the GNSS simulator.
- Information about the vehicle type and the display of the dials on PosApp (only available with SimGEN and SimREPLAY+).
- Information about the input parameters (i.e. vehicle dynamics). This includes the coordinate frames used during the simulation.

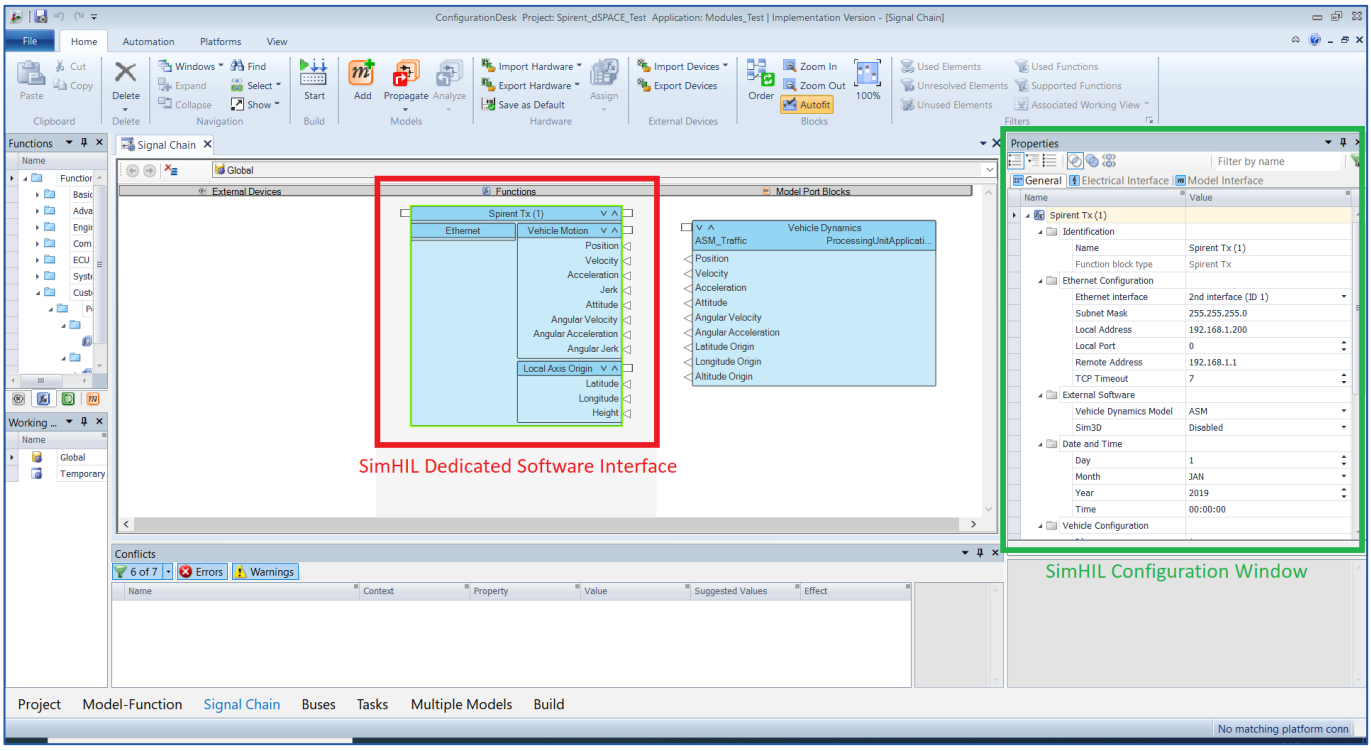

Figure 2: dSPACE ConfigurationDesk with SimHIL Loaded

Application Start

Once the DSI is configured, the application can be started as usual from the third-party environment.

On start, the DSI automatically opens the corresponding UDP and TCP sockets required to connect to PosApp. When the connection is established between the GNSS simulator and the HIL system, the DSI sends TCP messages to the GNSS simulator containing any additional instruction to configure PosApp's scenario before starting the simulation. This is based on the user input given in the configuration stage.

Finally, the DSI sends a run command (TCP) to PosApp to start the simulation.

Application Running

Once the third-party application and PosApp are running, the DSI enters in an infinite loop that only stops when the application terminates. This loop acts as a function, with its inputs and its outputs:

Input: Vehicle dynamics produced by the third-party tool.

Output: Vehicle motion update sent to PosApp.

By default, this "function" is executed at the same rate that the vehicle motion is produced by the third-party tool. E.g., if the HIL platform runs at 1 KHz, the DSI generates the vehicle motion updates at 1 KHz (more information about SIR and SIR compatibility can be found in

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System Iteration Rate).

There are three main steps taken by the DSI to transform the inputs into outputs:

1. **Read:** The DSI reads the vehicle dynamics from the third-party environment.

2. **Transform:** The DSI takes into account the vehicle body frame, local frame (ENU or NED) and global frame (ECEF) to transform the vehicle dynamics into the motion that PosApp requires.

3. **Send:** The DSI packs all the information into a vehicle motion update and sends it to PosApp as a UDP message.

Application Termination

When the running application in the third-party environment terminates, the DSI closes all the open sockets and stops the communication with PosApp.

Performance Specification

Our GNSS Simulators

Table 1: SimHIL Performance Specifications

Parameter	Value	Note
Supported constellations	GPS L1, L2, L5 GLO L1, L2 GAL E1, E5, E6 BEI B1I, B2I, B1c, B2a, B3I QZSS L1, L2, L5, L6 SBAS L1, L5	Constellations are subject to separate Spirent licenses
Supported codes	GPS L1: C/A, P, M noise, L1C Pilot, L1C Data GPS L2: P, C/A (L2C), M noise GPS L5: I, Q GALILEO E1: E1-A, E1-A PRS Noise, E1-B, E1-C GALILEO E5A E5B: E5a-I, E5a-Q E5b-I, E5b-Q GALILEO E6: E6-A, E6-A PRS Noise, E6-B, E6-C BEIDOU: B1I, B2I, Ba1, B1c, B3I	
Supported simulator	GSS9000 GSS7000	GSS9000: SIR 1KHz – up to 160 channels GSS7000: SIR 100 Hz – up to 256 channels
Supported software Level	SimGEN® SimREPLAY+	Requires PosApp v7.04

	SimTEST	
Type of vehicle supported in SimGEN scenario	Static Rover Remote	Remote vehicle is supported and required to use SimHIL

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System Iteration Rate

Table 2: SimHIL System Iteration Rate

Parameter	Value	Note
Supported PosApp Iteration Rate	100 ms – 10Hz 10 ms – 100Hz 1 ms – 1KHz*	The rate at which PosApp computes the required data and update the hardware. *GSS7000: Up to 10 ms (100 Hz) *GSS9000: Up to 1 ms (1 KHz)
Supported SimGEN® Logging Rate	100 ms 10Hz 10 ms 100Hz 1 ms – KHz	The rate at which SimGEN® logs the data
Supported Third-Party Application Iteration Rate	Up to 1 ms - 1 KHz	The rate at which the third-party application computes the vehicles dynamics and sends a vehicle motion message to PosApp

List of Supported Third-Party Tools

SimHIL is compatible with the third-party tools listed in Table 3. Third-party tools hardware and software compatibility must always be checked with your Spirent representative prior to order. If the variant you are interested in is not listed, please contact Spirent for further information.

Table 3: Supported 3rd-Party Tools

PRODUCT	HW SUPPORTED	SW SUPPORTED	VEHICLE MODELS SUPPORTED
SimHIL for dSPACE	dSPACE SCALEXIO 2.0 (Firmware: 4.4.1)	dSPACE Release 2019-A	dSPACE ASM IPG CarMaker Matlab Simulink
SimHIL for IPG	NI PXIe 8840 13.1	IPG CarMaker 8.0.1 (Windows) IPG CarMaker HIL 8.0.1 (Windows) IPG CarMaker 9.1.2 (Windows) IPG CarMaker HIL 9.1.2 (NI RT Linux OS)	IPG CarMaker Matlab Simulink
SimHIL for AV Simulation		SCANeR Studio 1.7 SCANeR Studio 1.8 SCANeR Studio 1.9r65	CALLAS

Ordering Information

Table 4: SimHIL Part Numbers

Description	Part number for GSS7000	Part number for GSS9000
SimHIL for dSPACE	7000-3125	9000-3153
SimHIL for IPG	7000-3245	9000-3154
SimHIL for AV Simulation	7000-3325	9000-3155

Deliverables

SimHIL for dSPACE (7000-3125 and 9000-3153)

Table 5: SimHIL for dSPACE Deliverables

Item No.	Quantity	Description
1	1	Dedicated Software interface: Spirent Custom I/O function for dSPACE
2	1	SimTEST, SimREPLAY+ or SimGEN license update

SimHIL for IPG (7000-3245 and 9000-3154)

Table 6: SimHIL for IPG Deliverables

Item No.	Quantity	Description
1	1	Dedicated Software interface: Spirent 'C' integration for IPG CarMaker
2	1	SimTEST, SimREPLAY+ or SimGEN license update

SimHIL for AV Simulation (7000-3325 and 9000-3155)

Table 7: SimHIL for AV Simulation Deliverables

Item No.	Quantity	Description
1	1	Dedicated Software interface: Spirent module for SCANeR Studio
2	1	SimTEST, SimREPLAY+ or SimGEN license update

For more information

For more information on any aspect of the GSS7000, please contact your Spirent representative or Spirent directly:

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