GSGSE
FINAL PRESENTATION

GNSS SIGNAL GENERATOR STREAMING EXTENSION

20/04/2022

AGENDA

1 Project Overview

2 Simulator Details

3 Product Demonstration

4 Conclusions

5 Q & A

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PROJECT OVERVIEW

PROJECT OVERVIEW

FACTS & FIGURES

Programme

- NAVISP – EL2 – 060
- GNSS Signal Generator Streaming Extension (GSGSE)

Duration

- 18 months (original contract) + 6 months (CCN)
- 02/2020 – 03/2022

Project Team

- OHB Digital Solutions GmbH (OHB)
- Innovationszentrum für Telekommunikationstechnik GmbH (IZT)
- TeleOrbit GmbH (TOG)

MOTIVATION

PRODUCT HERITAGE & PROJECT GOALS

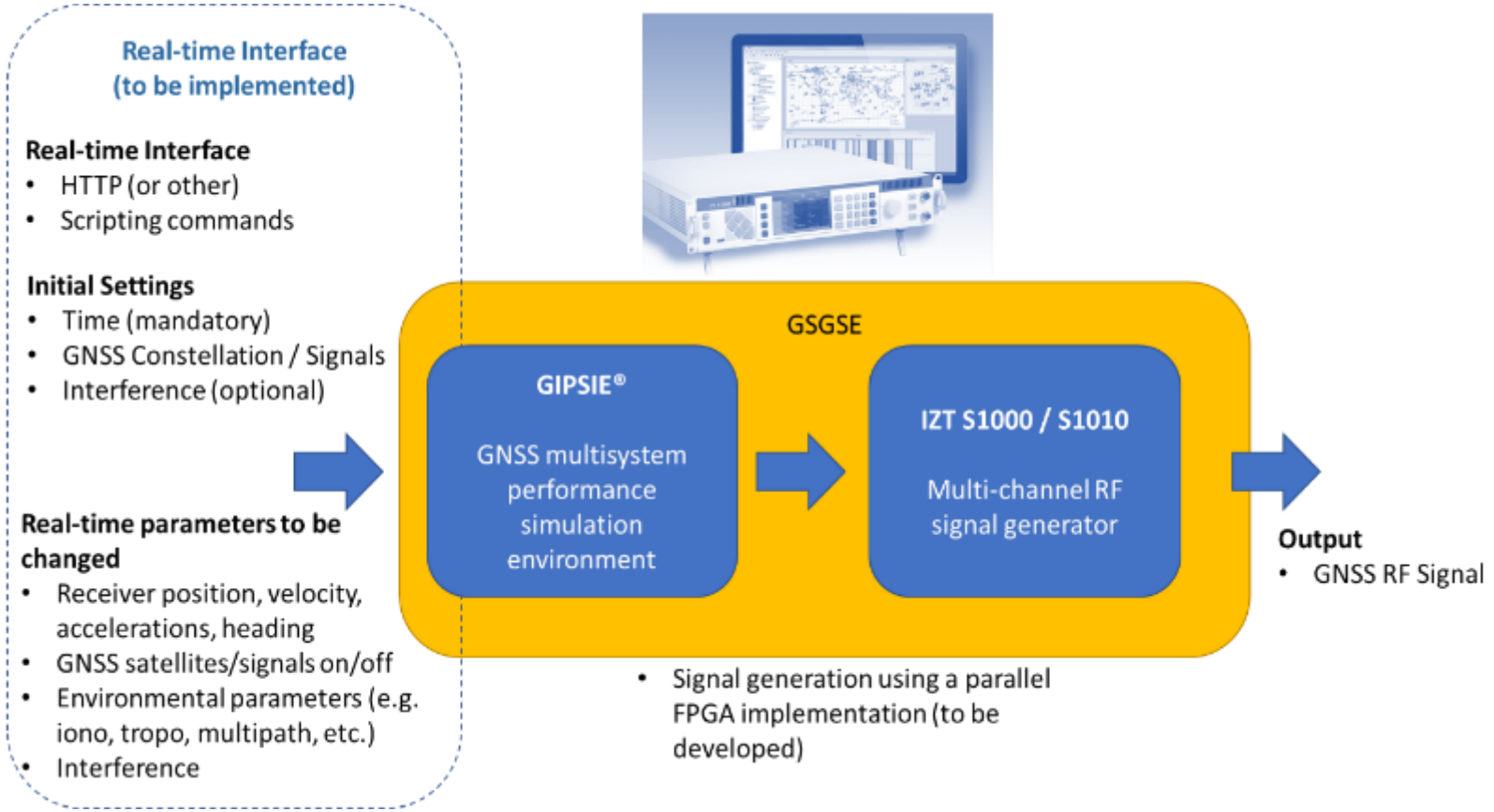
Product Heritage

- GIPSIE: Software-based GNSS simulator
- S1000: High-end signal generator

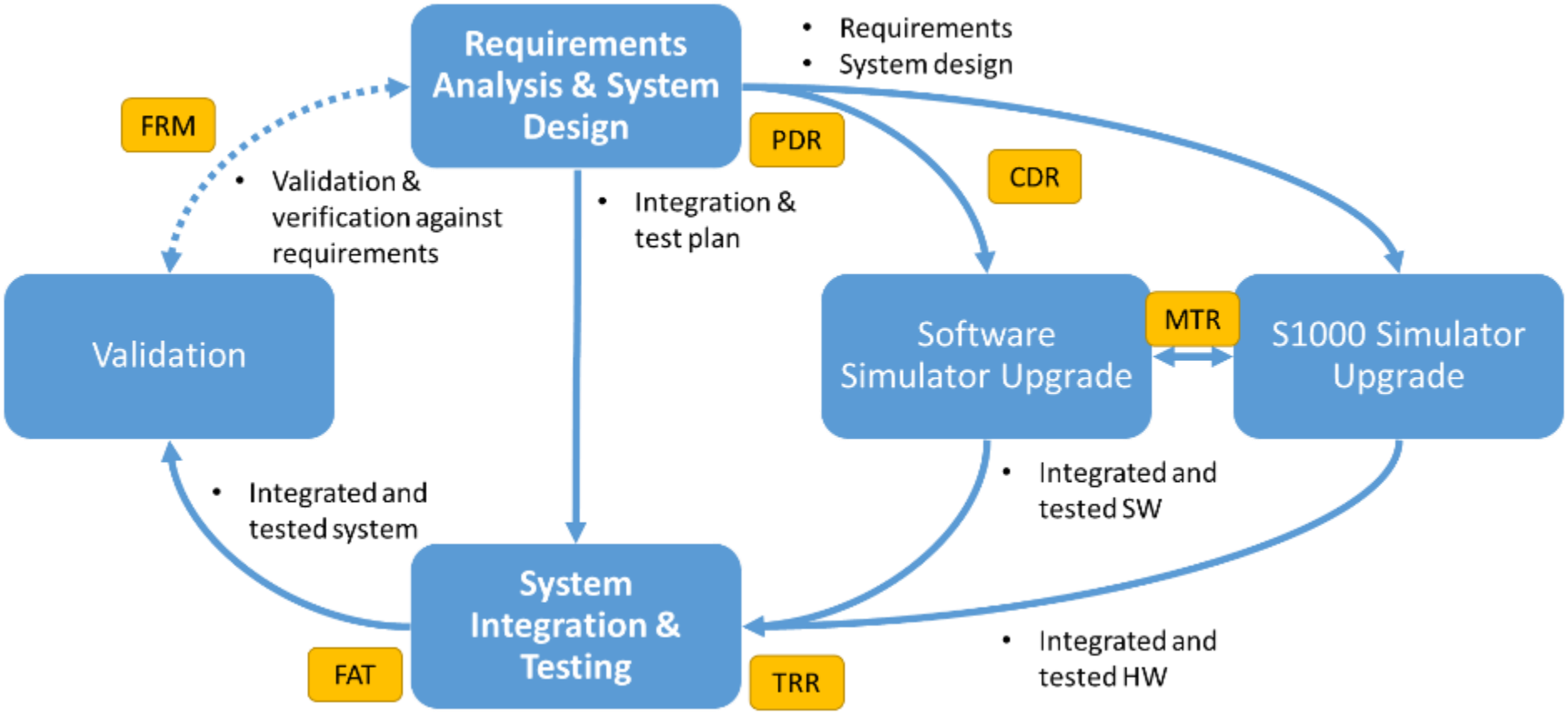
→ Non-real-time digital baseband signal generation and RF playback

Project Goals

- Achieve real-time signal generation (keeping the previous playback capabilities)
- Allowing full remote control of simulation environment (e.g., for HIL)
- Simplify user interaction and user interface by improved visualization of connected Rx
- Simulation of multiple receivers and antennas with attitude control
- ... and a few more



DEVELOPMENT LOGIC



WORK PACKAGES

PROJECT STRUCTURE

Original Contract

- WP 1000: Project & Quality Management [OHB]
- WP 2000: Requirements Analysis and System Design [OHB]
- WP 3000: Software Simulator Upgrade [OHB]
- WP 4000: S1000 Simulator Upgrade [IZT]
- WP 5000: System Integration & Testing [OHB]
- WP 6000: Product Management & Business Planning [TOG]

Contract Change Note

- CCN-01 WP 1000: Project & Quality Management [OHB]
- CCN-01 WP 2000: Attitude Simulation [OHB]
- CCN-01 WP 3000: EUT Visualization [OHB]
- CCN-01 WP 4000: Expert Mode [OHB]

MAIN FEATURES

HIGHLIGHTED PROJECT GOALS

REAL-TIME RF

Simulation Outputs:

- GNSS observables
- Baseband IF signal (digital)
- RF signal (analog)

All simulation outputs shall be generated in real-time.

HARDWARE-IN-THE-LOOP

Extended and sophisticated testing capabilities:

- Real-time simulation control via GUI and API
- Remote control via TCP

Real-time inputs enable hardware-in-the-loop simulation capabilities.

FLEXIBILITY

- Software-based or FPGA-based signal modulation
- Advanced interference and spoofing simulations
- Additional non-GNSS signals

Achieve highest flexibility by offering various operating modes.

GNSS QUALITY ASSURANCE

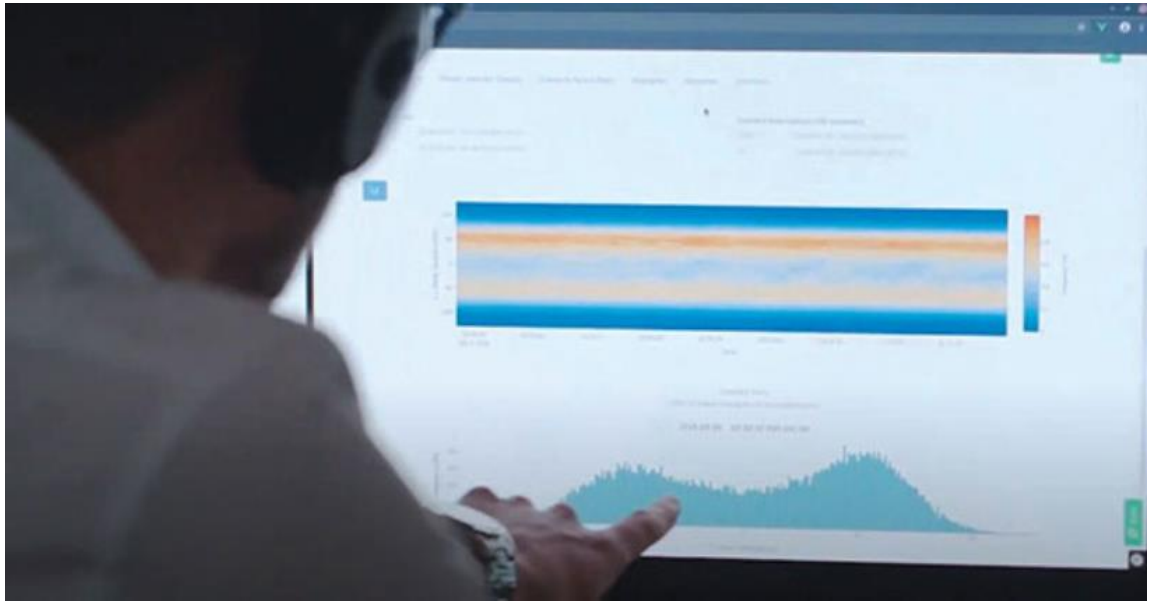
INTERFERENCE SIMULATION AND ANALYSIS TOOLCHAIN

GIPSIE

- Interference simulation capabilities:
  - Jamming/interference, sophisticated and multi-jamming
  - Meaconing
  - Spoofing (asynchronous, pseudo-synchronous, synchronous)

GIDAS

- GIDAS supports safety critical and mission critical GNSS applications:
  - Interference (jamming and spoofing) detection and classification
  - Localization of the interference source
  - Analysis and comparison of interference events



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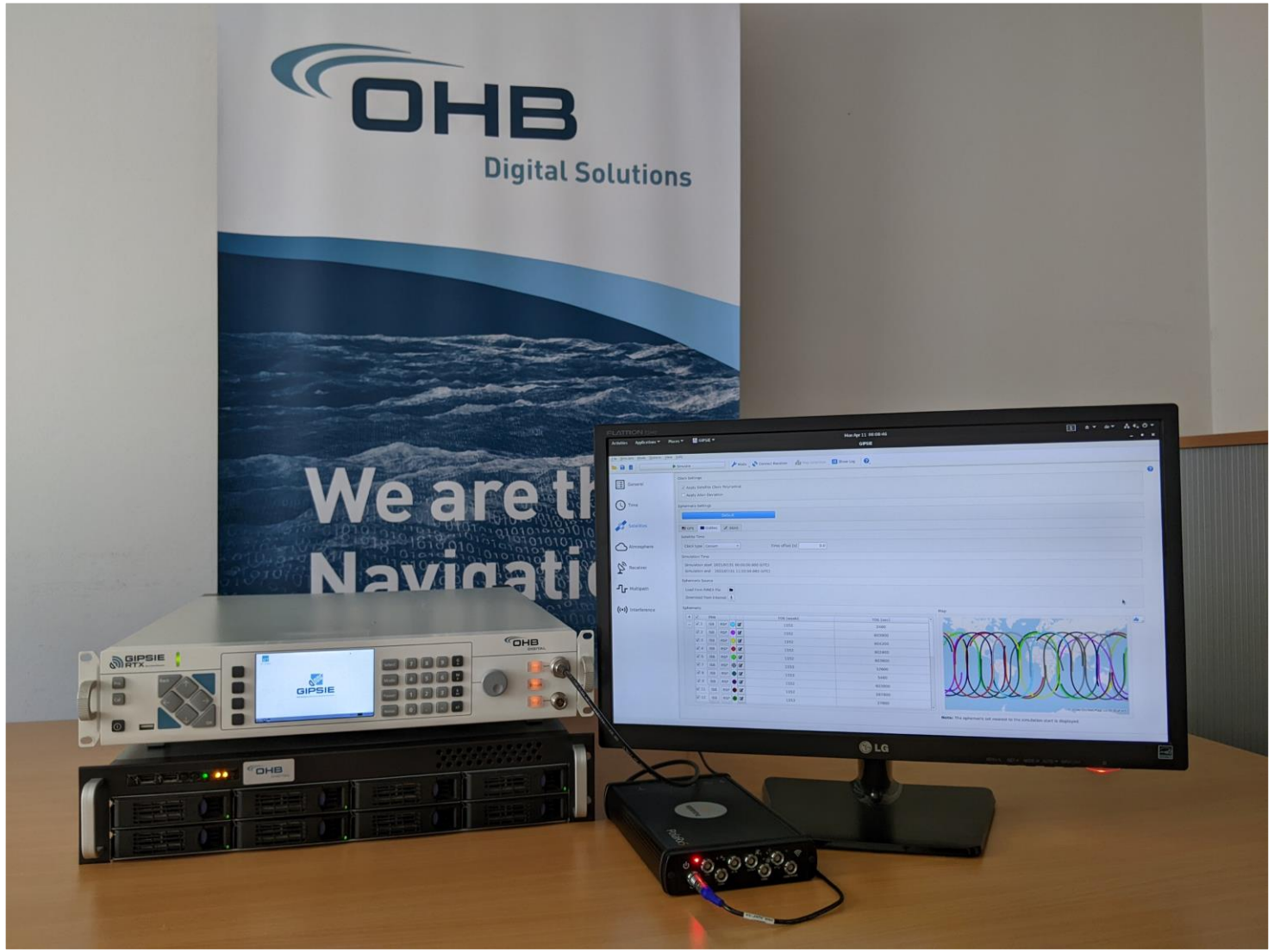
SIMULATOR DETAILS

SYSTEM OVERVIEW

THE GSGSE SYSTEM

- Hardware
  - IZT S1000 RF-Signal Generator
  - IZT P1100 Memory Extension
- Software
  - IZT S1000 GUI
  - OHB DS GIPSIE GUI
- Equipment under Test
  - Septentrio PolaRx5 GNSS Receiver



SYSTEM OVERVIEW

GSGSE HARDWARE

- **(1)** IZT S1000 Signal Generator
  - Generating and broadcasting GNSS RF-Signals
  - 2 modes:
    - DAC + up-converting signals from IF to RF
    - Live-generation of RF-Signals (GIPSIE-RTX)

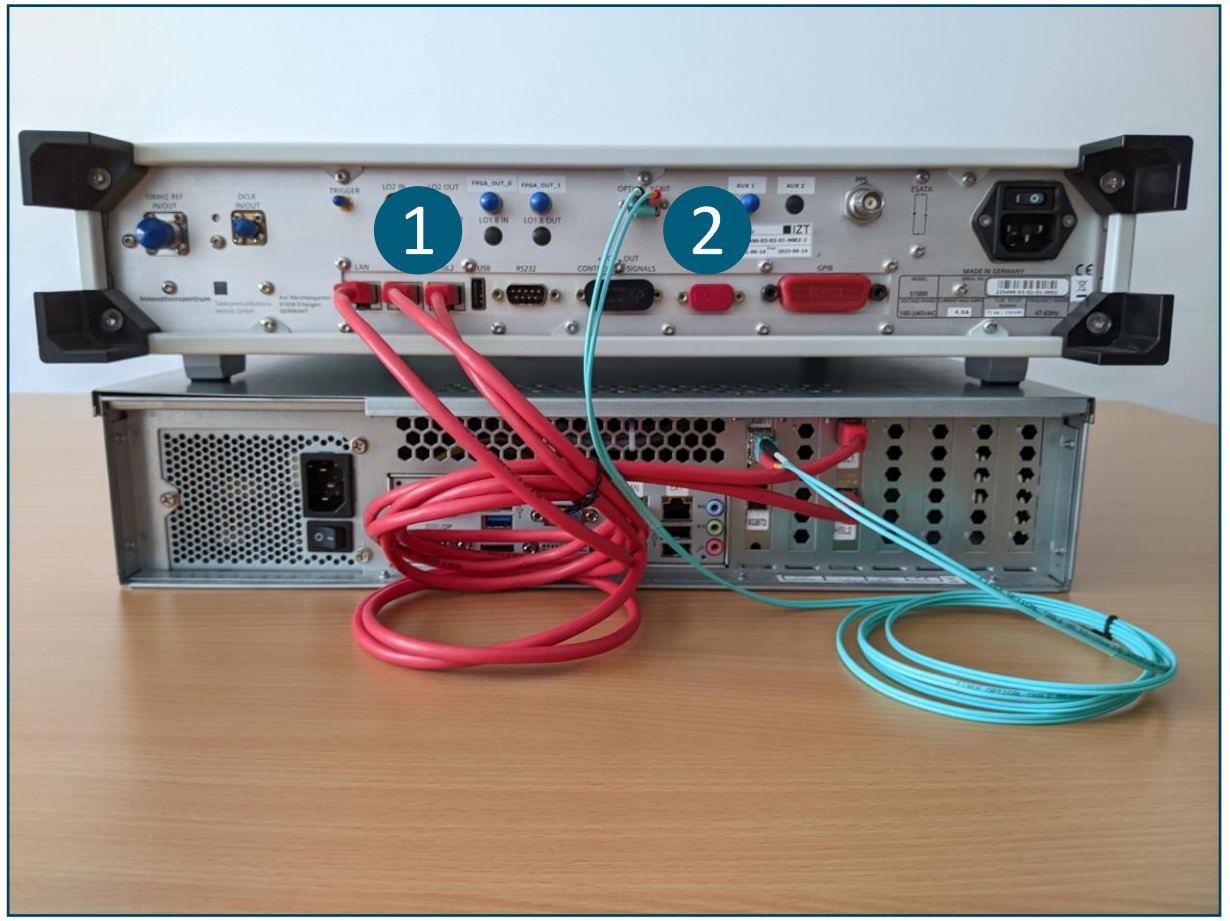
- **(2)** IZT P1100 Memory Extension
  - Controlling S1000 (streaming data)
  - Running S1000 GUI and GIPSIE GUI

SYSTEM OVERVIEW

GSGSE HARDWARE COMMUNICATION

- **(1)** 1GE ethernet interface
  - Streaming IF signal data to S1000 (S1000 GUI)

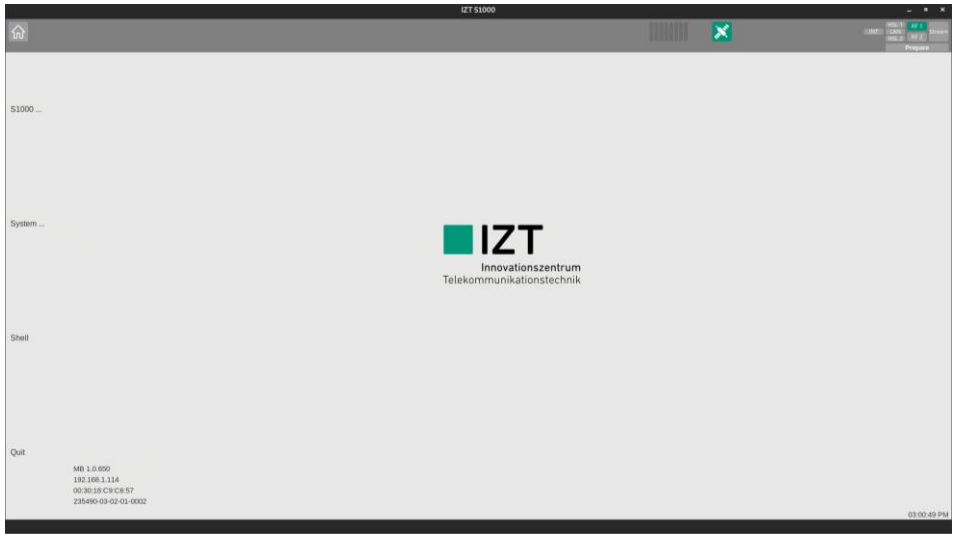
- **(2)** 10GE fiber optic interface
  - Streaming RF packets to S1000 (GIPSIE)
  - High data rates!



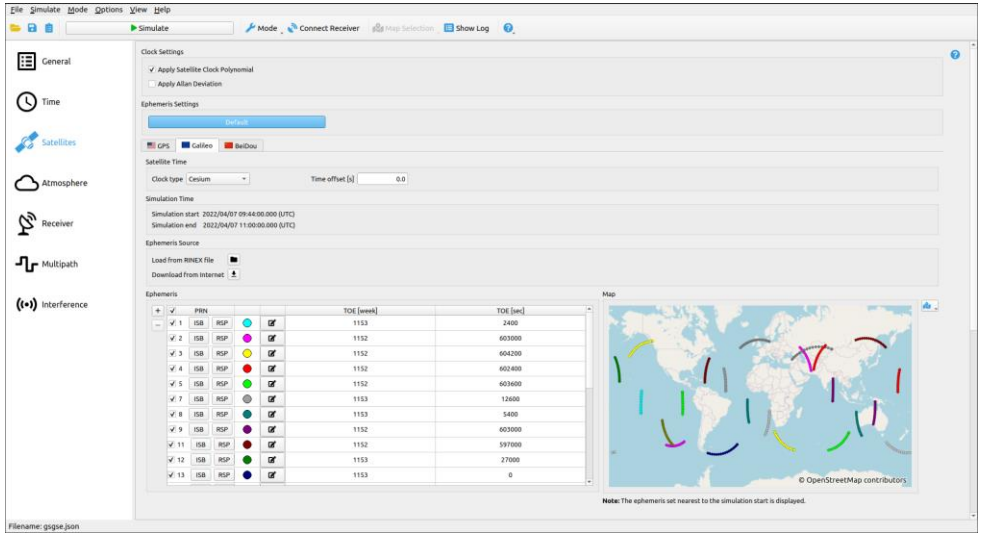
SYSTEM OVERVIEW

GSGSE SOFTWARE COMPONENTS

- S1000 GUI
  - Controlling the Hardware components of S1000
  - Streaming RF packets from GIPSIE to S1000



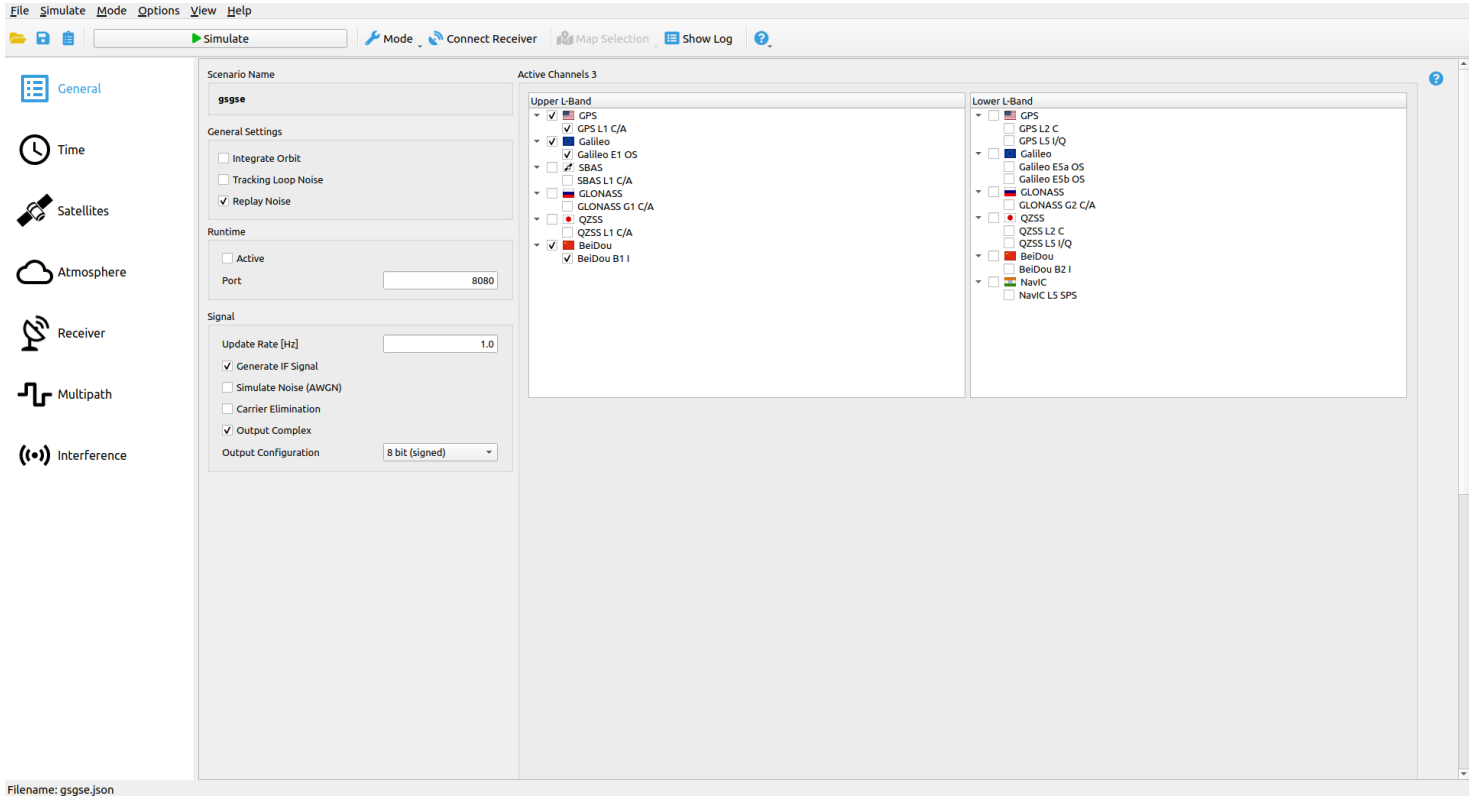
- GIPSIE GUI
  - Satellite Constellation Simulator
  - Generating:
    - Pseudoranges
    - Doppler
    - Navigation Message Bits
    - …



SETTINGS

OVERVIEW

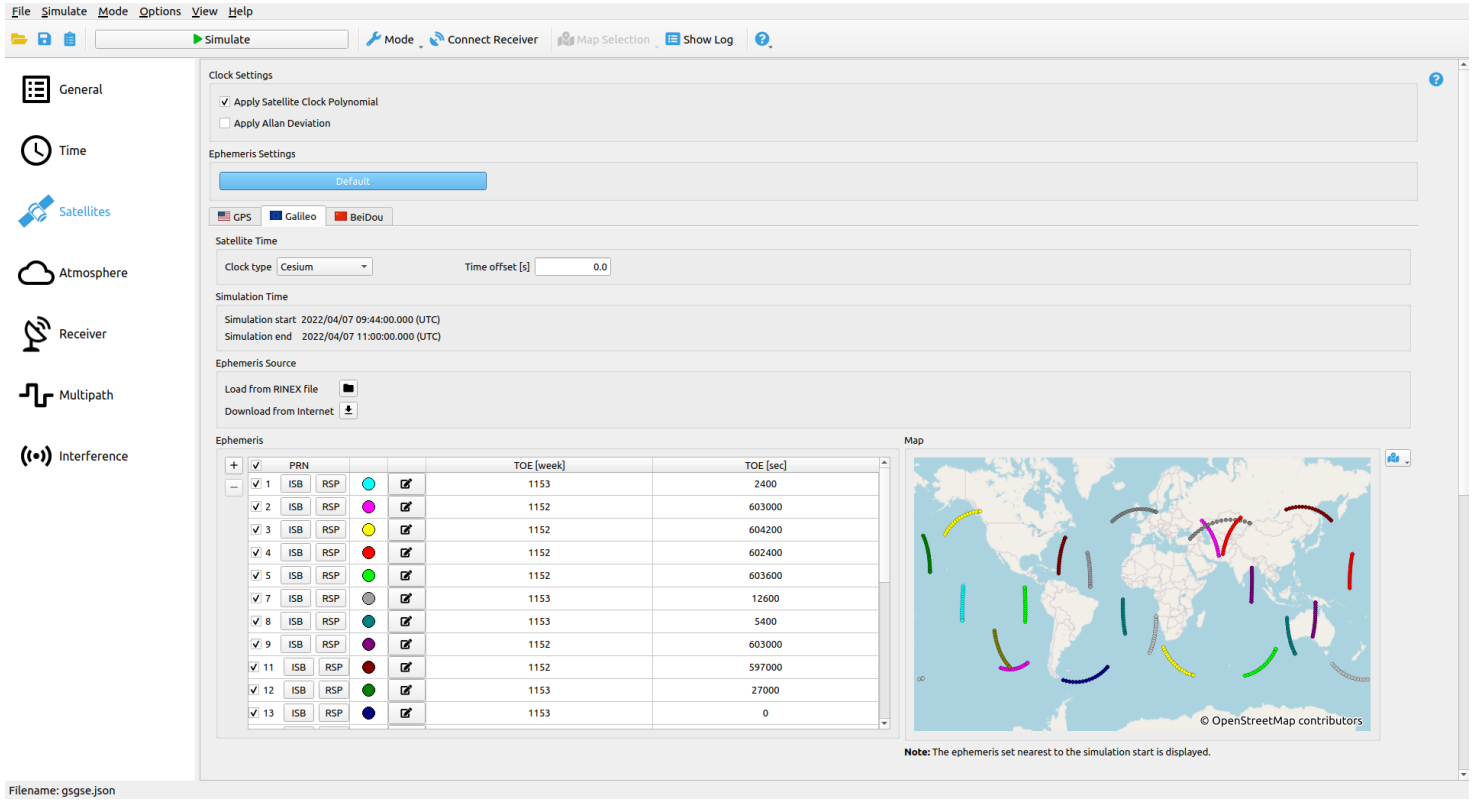
- General Settings & Simulation Time
  - e.g., Update Rate, Quantization, Simulation Noise (AWGN)
- GNSS Channels
  - GPS, Galileo, GLONASS, BeiDou, SBAS, QZSS, NavIC
- Satellite Constellations
- Atmosphere Settings
- Receiver Settings
  - Trajectory & Attitude
  - Antennas & Front-End
- Multipath & Interference
  - Jammer, Spectrum Jammer & Spoofer



SETTINGS

SATELLITE CONSTELLATIONS

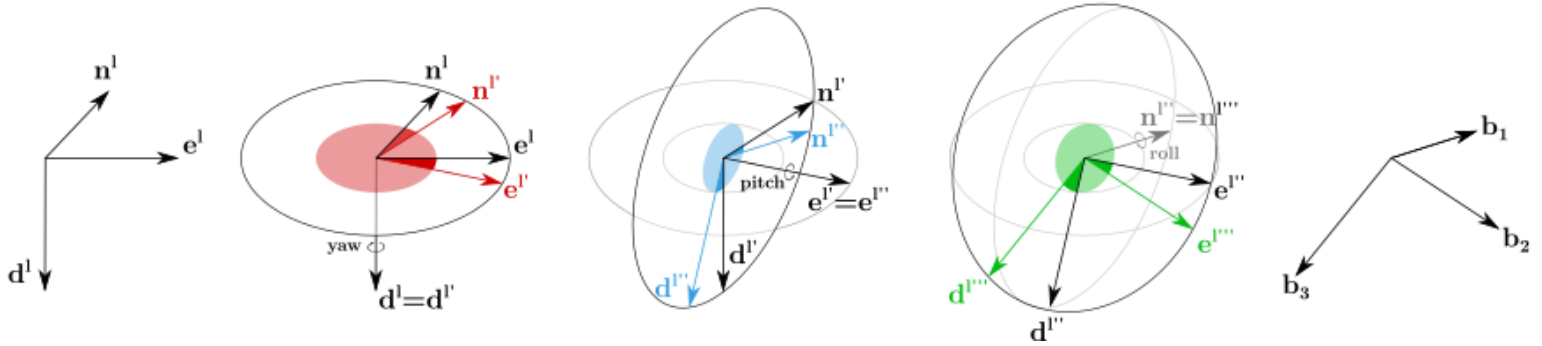
- Satellite Ephemeris and Clock Parameters
- Import:
  - RINEX or SP3 file formats
  - Internet sources
- All Ephemeris data can be edited
- New Features:
  - Simplified Ephemeris Table
  - Satellite Ground Track Plot
  - Default Constellations available

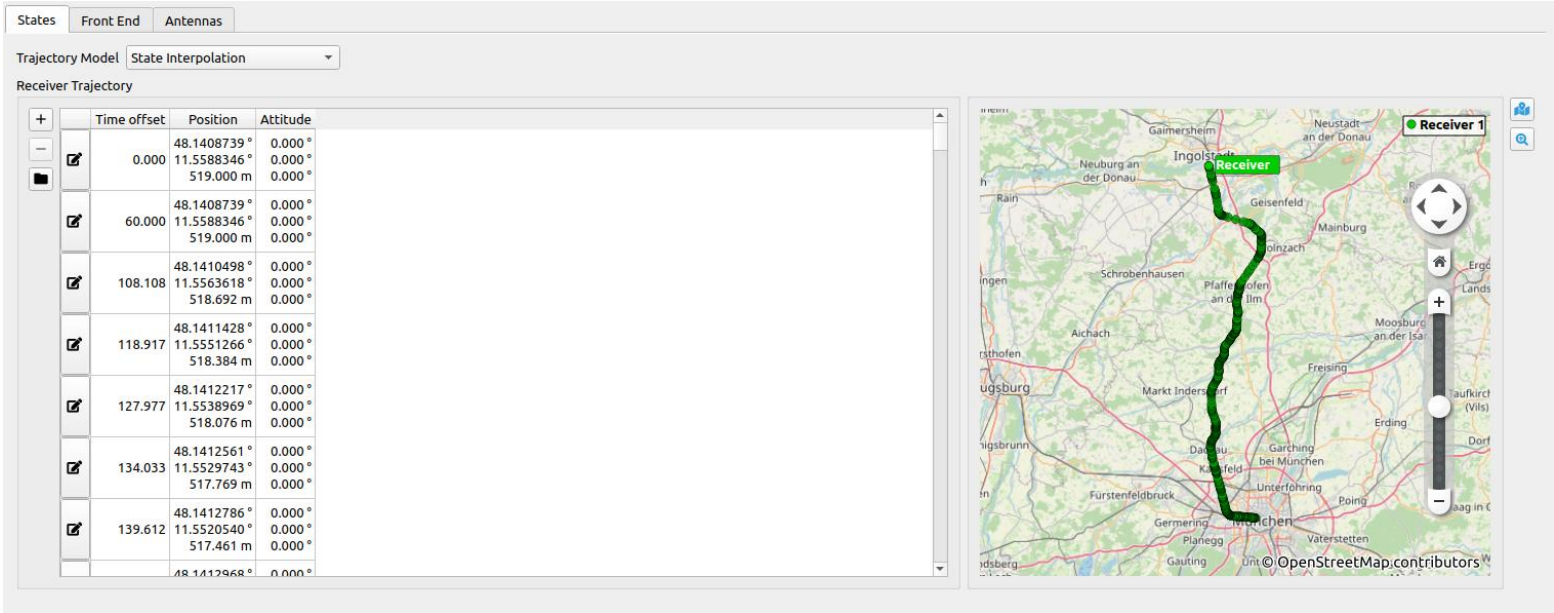


SETTINGS

RECEIVER

- Receiver Trajectory supports two models
  - Interpolation
  - Propagation
- New Features:
  - Receiver Attitude Simulation:
    - Attitude: Euler Angles in the receiver's body frame
    - Angular Velocity

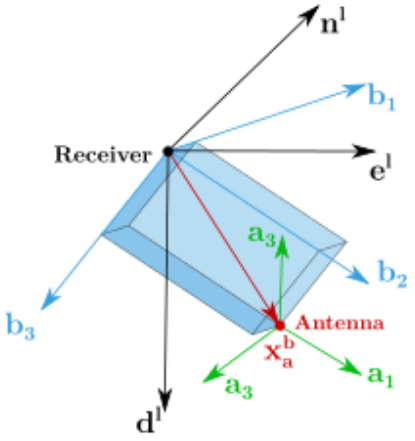


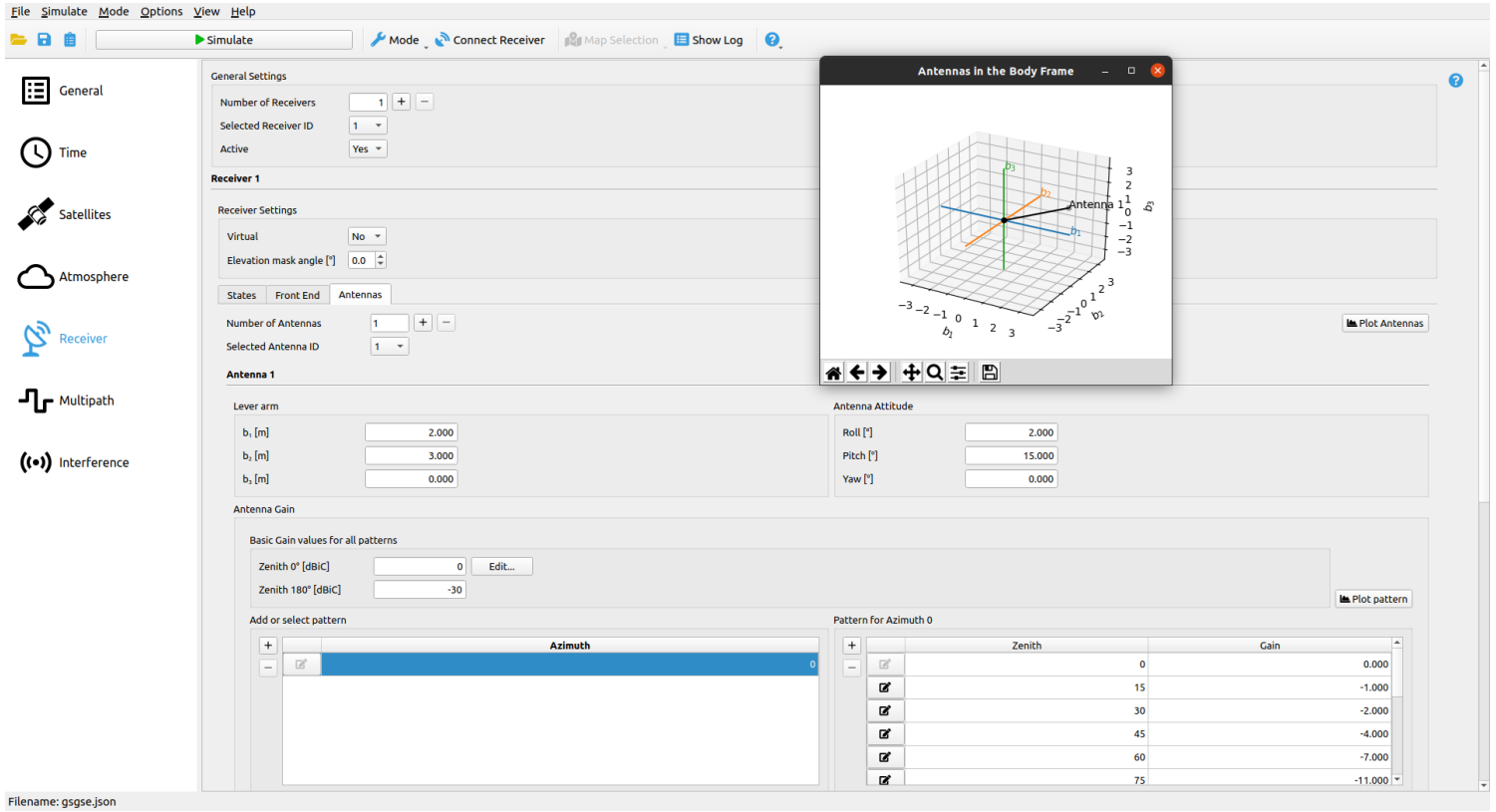


SETTINGS

RECEIVER – MULTIPLE ANTENNAS

- New Features:
  - Simulate multiple antennas:
    - Considering lever arms for different antenna positions
    - Considering antenna attitude

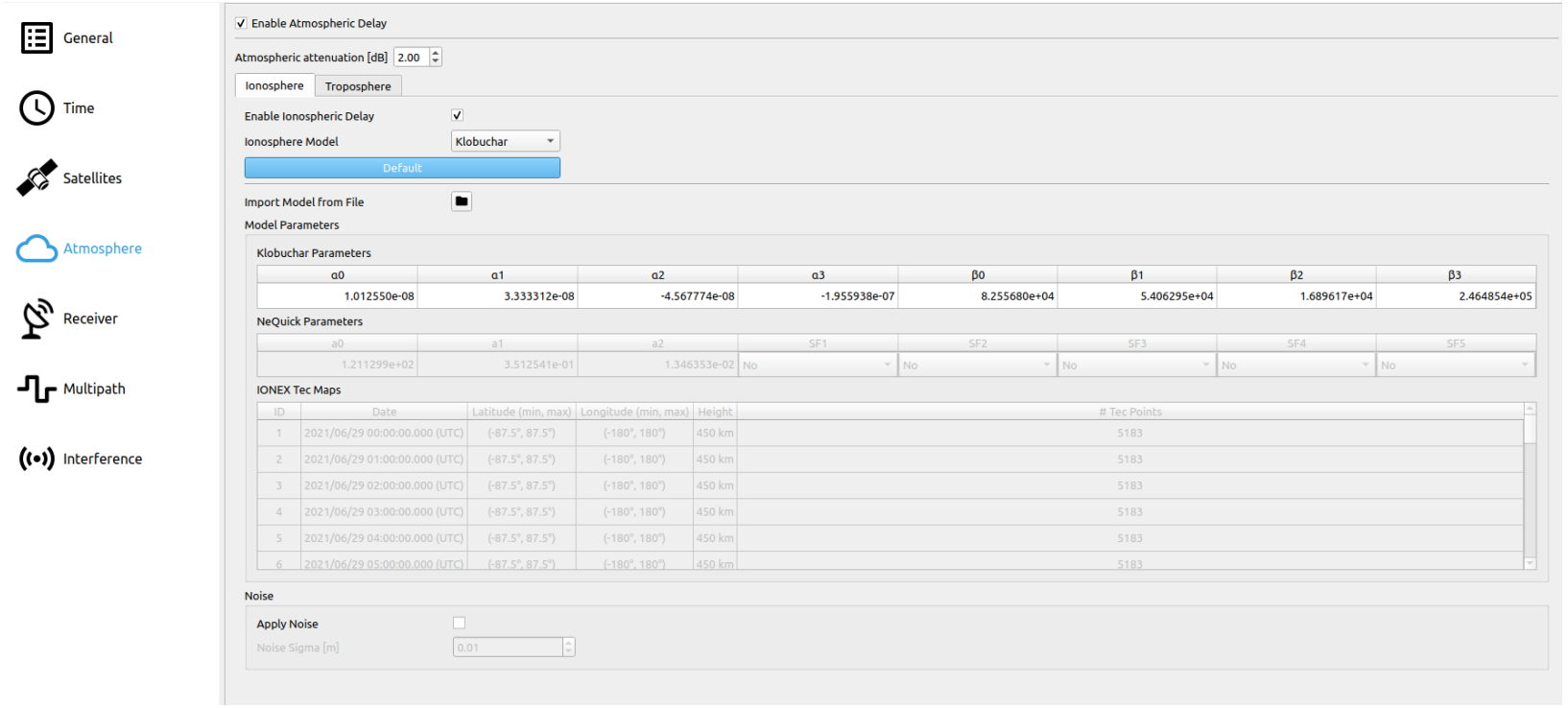




SETTINGS

ATMOSPHERE

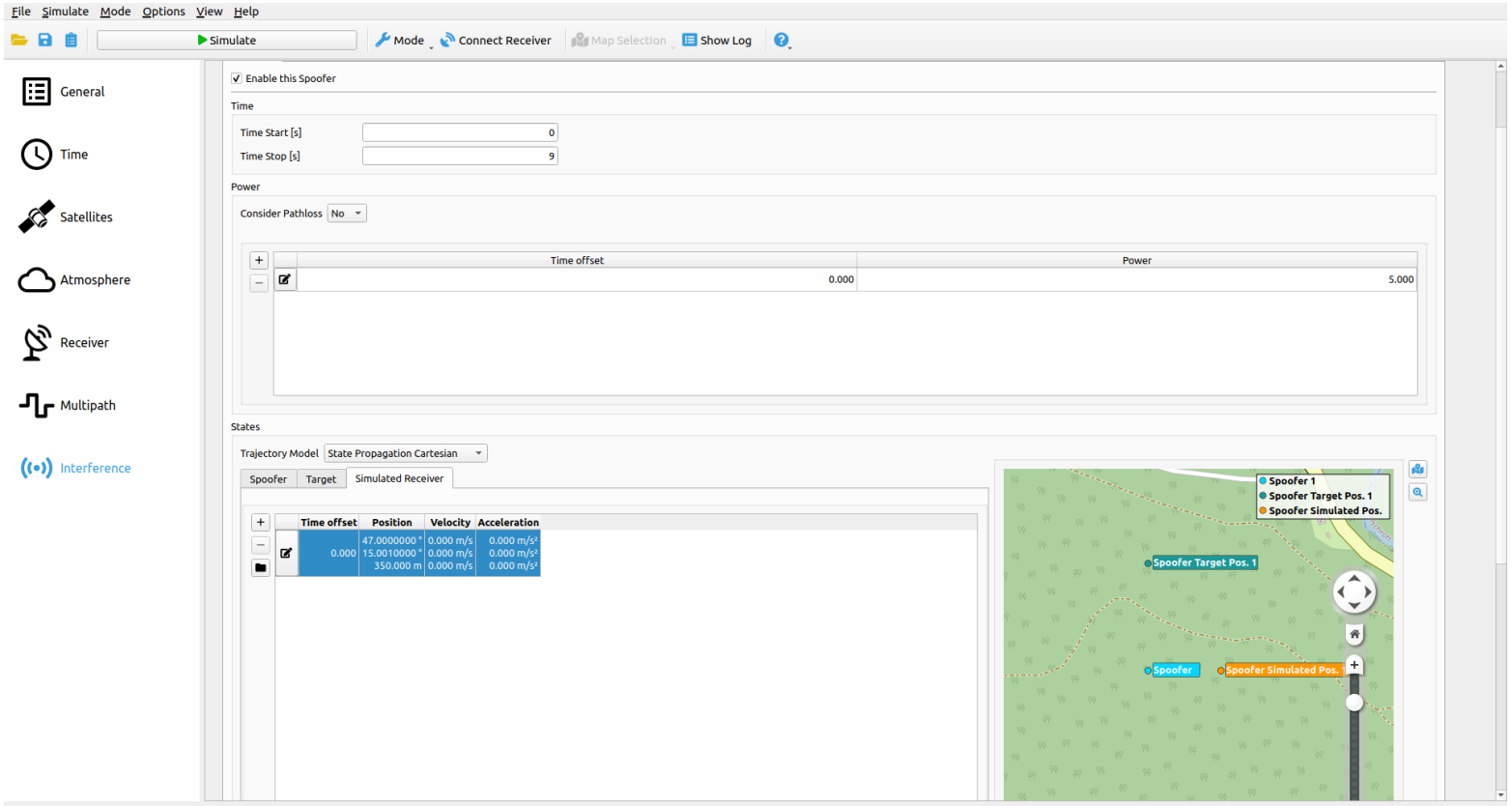
- Ionosphere Models:
  - Klobuchar
  - NeQuick
  - IONEX Tec Maps
  - Automatic conversion between models
- Troposphere Models:
  - Galileo Reference Model
  - GPT2w
  - Saastamoinen
- Default Values for all Models
- Import from RINEX navigation or IONEX files



SETTINGS

INTERFERENCE

- Different Interference Sources
  - Jammer: AM, FM, SCW, WGN
  - Spectrum-matched Jammer
  - Spoofer
- Affects all receivers configured



SIMULATION MODES

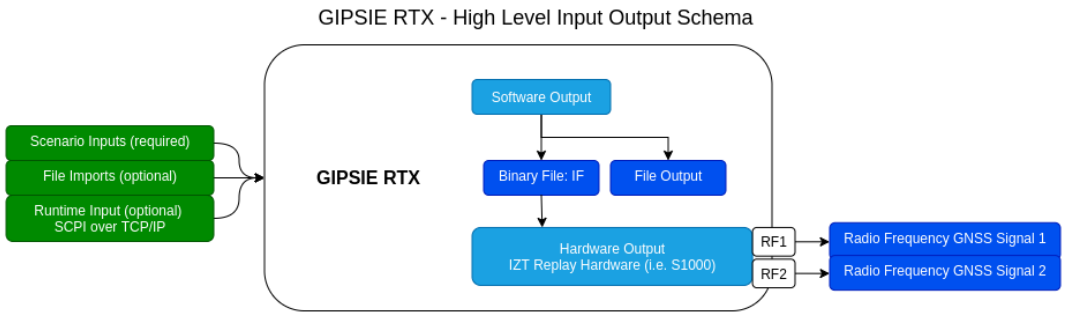
Base Mode

- Offline mode
  - Generates IF file on hard-disk (optional)
  - Generates additional outputs (i.e. RINEX)
- IF file can be replayed by Signal Generator

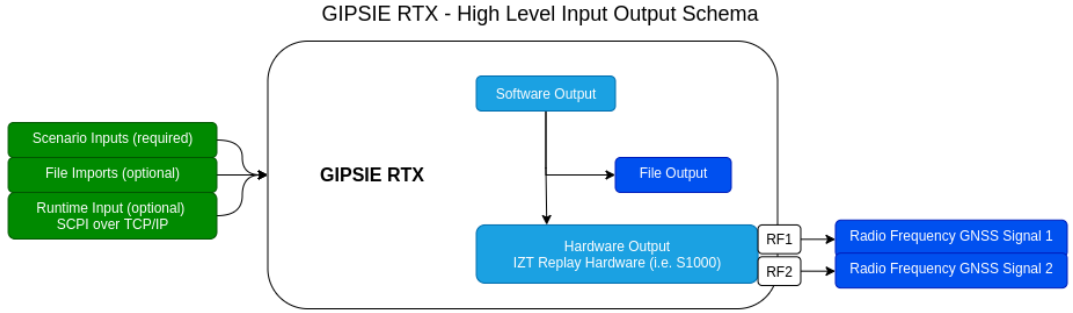
RTX

- Realtime Mode
  - Generates additional outputs (i.e. RINEX)

Base mode



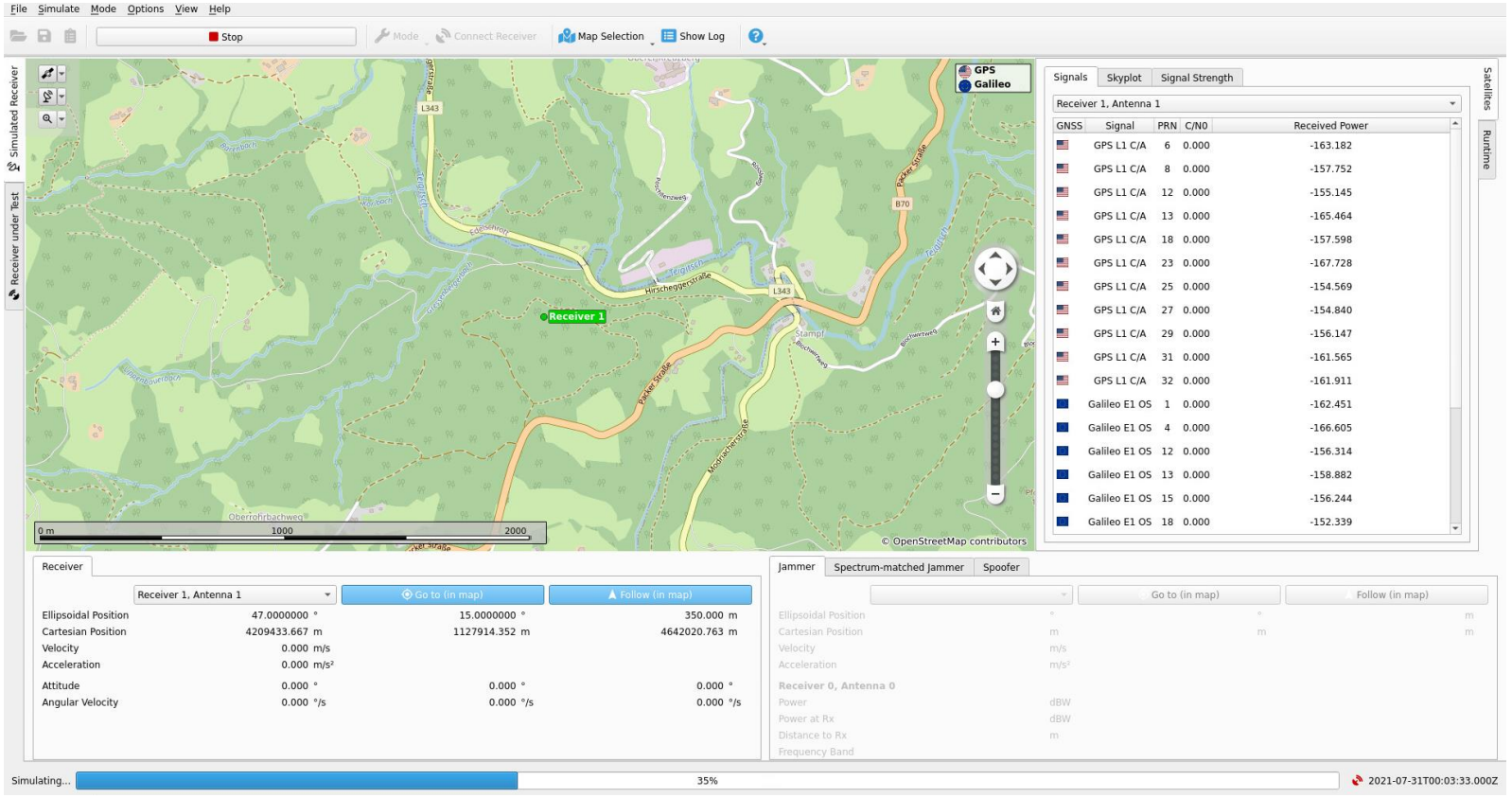
RTX Mode



SIMULATION

SIMULATED RECEIVER

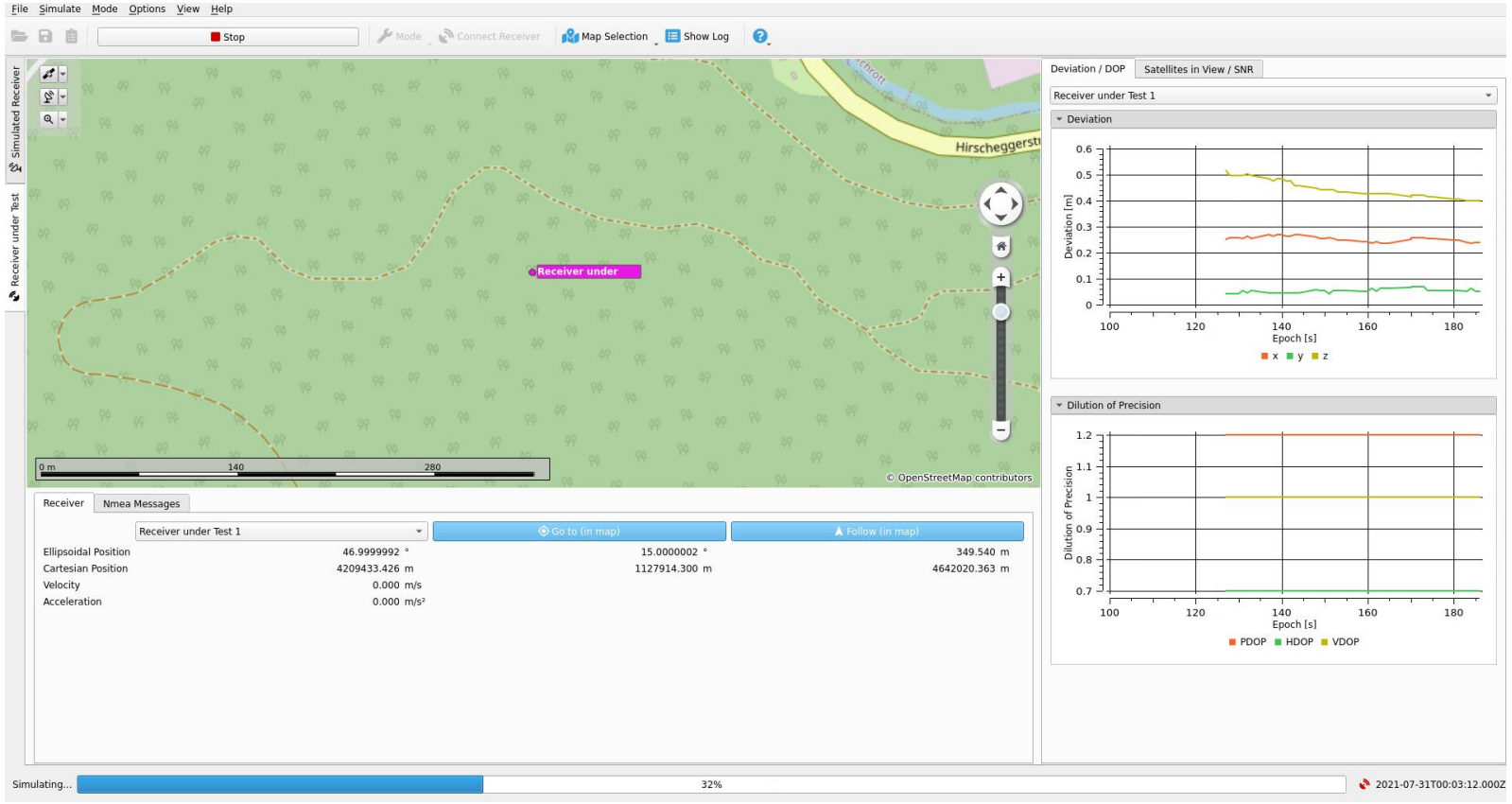
- Overview of simulated satellites and receivers
- Runtime Amendment:
  - Changing simulation parameters while simulating possible
  - Receiver trajectory
  - Satellite parameters
  - Multipath obstruction masks
  - Interference parameters
  - Parameters can be changed via TCP/IP commands from API



SIMULATION

RECEIVER UNDER TEST

- Receiver under test data is visualized
- NMEA Messages supported
  - GSA, GGA, GSV
- Connection via TCP/IP or Serial Port
- Available Time Series
  - Position Deviation
  - Dilution of Precision
  - Number of Satellites in View
  - Signal to Noise Ratio



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PRODUCT DEMONSTRATION

LIVE DEMONSTRATION

GIPSIE-RTX CAPABILITIES AND USER INTERFACE

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CONCLUSIONS

CONCLUSIONS

CURRENT STATUS AND NEXT STEPS

Conclusions

- Project successfully completed by End of March 2022
- Product launched and actively marketed by all three project partners
- Numerous enquiries received already
- First unit already sold

GIPSIE enables GNSS receiver and application testing and development.

Next Steps

- Build a whole product family to cover all GNSS simulation needs!

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Q & A

THANK YOU!

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