

SENDAI

Satellite Navigation Data Mining

SENDAI project

SENDAI is a project funded by ESA under the European GNSS Evolution programme to develop algorithms and models for estimation of navigation satellites orbit and clock errors, and their failure rates.

SENDAI Features

- Reconstruction of broadcast navigation message parameters
- Modelling of satellite orbit and clock errors
- Anomalies detection and analysis
- Estimation of satellite failure rates
- Queryable results accessible via web-interface

Sendai Architecture





SENDAI web-interface allows users to select, filter, group and aggregate their results by various parameters.

Navigation Data		
GNSS:	GPS	-
GPS Source:	LNAV	-
Parameters:	A (semi-major axis) 🕷	-
Satellite:	G05	•
Period:	Day	•
Date:	2016-01-01	
	Reset	Show
Sendai Web-Interface Form		

Broadcast Navigation Parameters

Params reconstructed from Navigation RINEX files (version 2.0-3.03)

Supported GNSS:

 GPS, Glonass, Galileo, Beidou, QZSS and IRNSS

Broadcast parameters



Orbit & clock errors Analysis

Satellites' orbit and clock errors are computed as difference between solution computed from broadcast ephemerides and solution computed from precise products. For GPS, Galileo, Glonass, Beidou, QZSS and IRNSS, the positions of satellites are calculated according to the algorithms in their respective ICDs using database of cleansed ephemerides from Navigation RINEX files. Precise positions are interpolated from precise orbit & clock products—we are using products from various analytic centres including NGA, IGS, IAC and products from MGEX campaign. The errors are calculated with a sample rate of 30 seconds.

SENDAI provides statistics of position errors in along-track, cross-track, radial directions, clock errors as well as combined errors — total position error, worst errors projected on the Earth and Signal-in-Space Range Errors. The statistics per individual statistics can be easily grouped by satellite block type or constellation.

SENDAI Database

The core of SENDAI system is a database. It contains:

- Reconstructed Navigation
 Parameters
- Cleansing statistics
- Station Site logs
- IGS ATX file content
- SP3 products
- Orbit & Clock Errors
- Summarized results & statistics
- Satellite statuses Time Series
- Parsed Notice Advisories
- And more ...



SENDAI database



SENDAI Anomalies Analysis

Regarding detected anomalies, SENDAI provides information about the affected satellite by reporting:

- the PRN;
- the SVN;
- the Satellite age and year of launch.

The anomaly itself is as well characterized in terms of:

- date;
- time;
- length;
- satellite data validity and health status
- User Range Accuracy
- operational status of a satellite before, during and after event occurred;
- user range errors of stations observing the anomaly;
- signal outages during the event.



Anomalies

One of the goals of SENDAI is to detect anomalies in the ranging measurements provided by Galileo. The expected satellite positions are computed from broadcast ephemeris and precise orbits (if available in SP3 files) and when we expect anomalies to be present based on observed ephemeris and clock differences, the system further investigates the situation to confirm that these anomalies are actually present and don't originate from errors in the precise orbits, data is validated using ranging measurements.

The final anomaly test is then based on the comparison of the expected geometric distance between the station and the satellite on one hand, and the measured pseudorange (corrected for both satellite and receiver clocks, and troposphere ionosphere delays).

Knowledge of the occurrence rates and failure magnitudes of GNSS signal-inspace (SIS) anomalies has a great importance for assessing the general performance of signal integrity, but also is important to validate systems that rely on assumptions on these parameters such as advanced receiver autonomous integrity monitoring (ARAIM).



Satellite Statuses Statuses

lguassu Software Systems



Iguassu Software Systems (ISS) excels in design and development of technology software applications and in aerospace marketing consultancy for Latin America and central Europe. Its core business is with the European Space Agency (ESA) and other space customers. ISS works predominantly on space R&D projects, both from the Prague base and on sites of our partners or primes abroad.

We participate in international consortia in aerospace and EU projects. At times ISS also provide our consultants on a time & material basis. The focus and the bulk of our space experience since the start of the Czech participation in ESA in 2005 has been on Satellite Navigation (GNSS), Earth Observation (EO), Space Situation Awareness (SSA), Telecommunications (TeleCom), Mission Operations (MO) and Electronical Ground Segment Equipment (EGSE).



Integricom

Iguassu Software Systems(CZ) & Integricom(NL)

Integricom is a sole proprietary company that provides technical consultancy in the field of navigation systems. It was founded in 1998. Integricom provides technical consultancy in the field of navigation systems. It specialises in performance-related issues and has a proven track record with Eurocontrol, national aviation authorities, industry and navigation service providers.

It has undertaken studies in the use of navigation systems for different modes of transport, has performed performance analysis studies and has designed and developed positioning and integrity monitoring algorithms. Integricom actively participates in the Eurocae Working Group 62 on Galileo.

Contact Us

Give us a call for more information about our services and products

Iguassu Software Systems Evropská 120, 160 00 Praha 6, Czech Republic

+420 23535 1000

info@iguassu.cz

Visit us on the web at www.iguassu.cz

Integricom

Tjalkenwerf 30, Leiden, Netherlands

info@integricom.nl

Visit us on the web at www.integricom.nl



SENDAI map