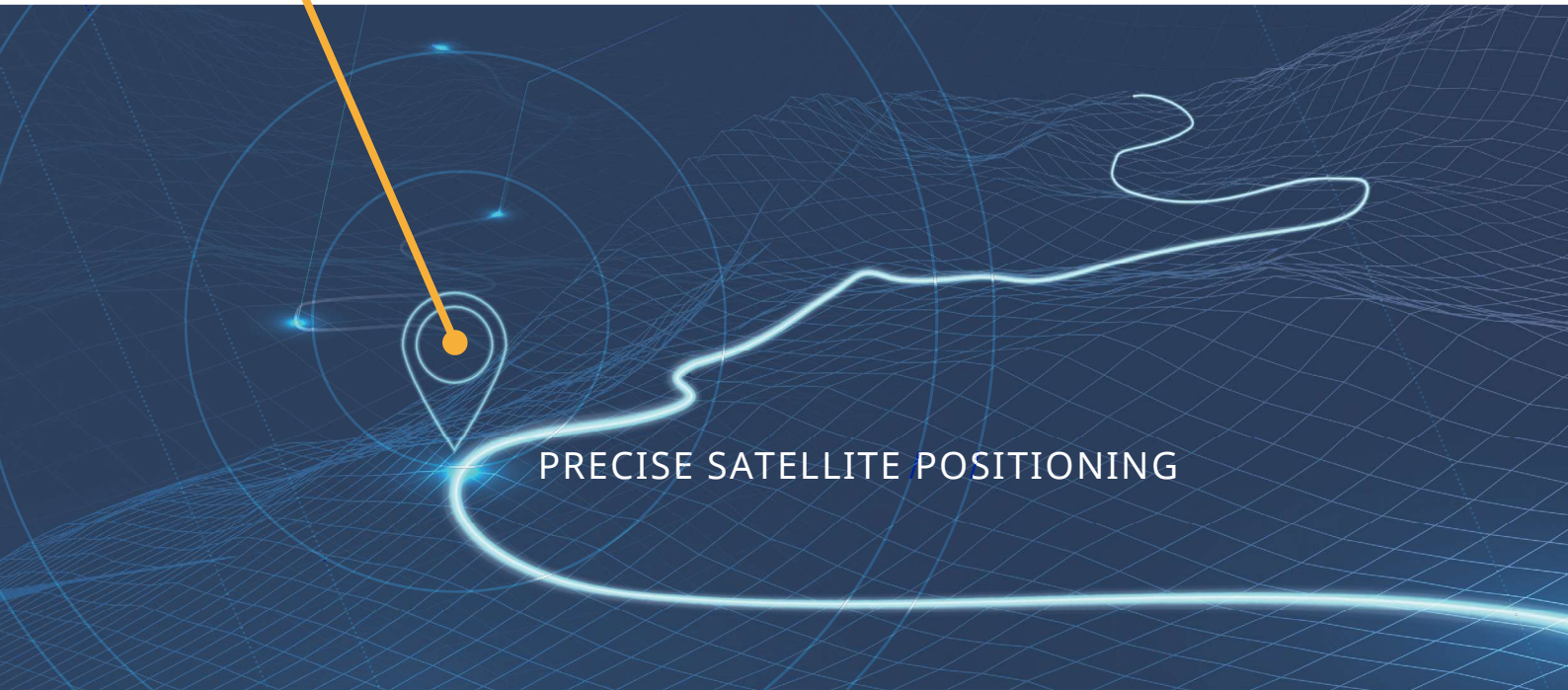
GNSMART2

Geo++®



THE “ACCURACY IN REAL-TIME” PROBLEM

- Global Navigation Satellite Systems (GNSS) like GPS, Galileo and others enable positioning by determining the range between a satellite and an observer.

  The apparent range (pseudo range) results from the observed travelling time of a signal transmitted from a satellite to a receiver multiplied by the speed of light.

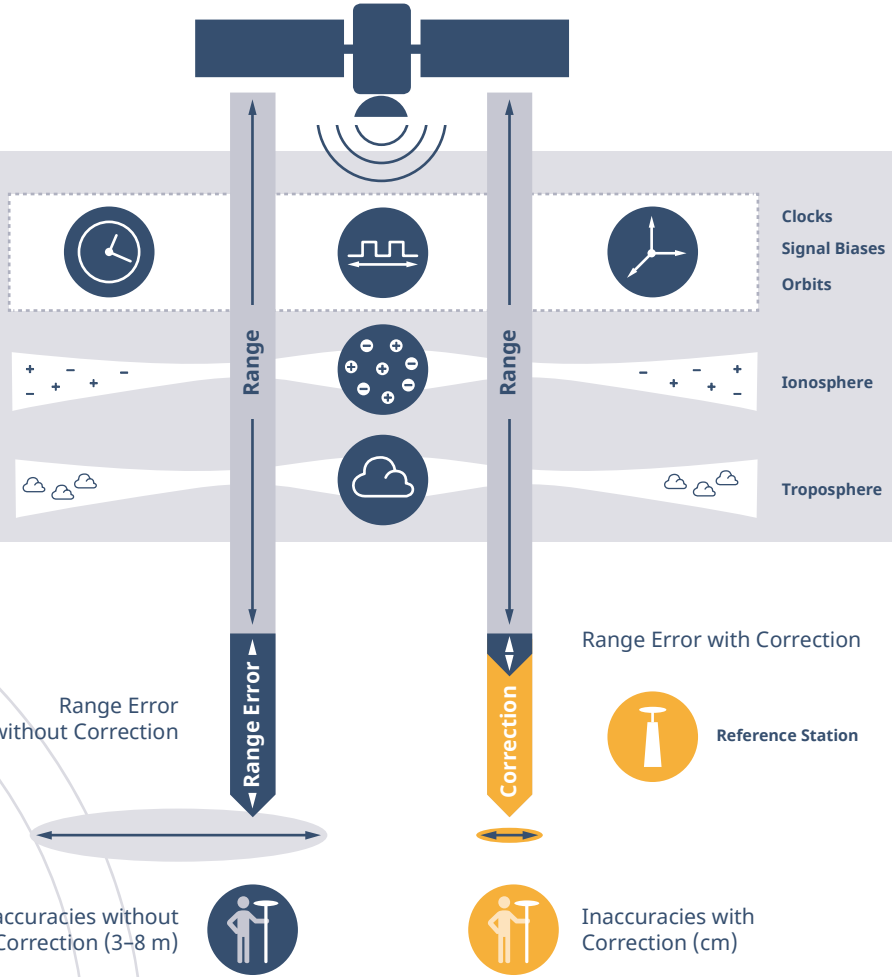
  The travelling time is affected by several error sources, including satellite orbit and clock errors, biases of the satellite and receiver hardware as well as ionospheric and tropospheric effects.

  These effects lead to inaccuracies in real-time positioning of about 3 to 8 meters when using the satellite signals only.

  GNSS augmentation service providers generate GNSS corrections by continuously monitoring the signals received by reference stations.

  With such GNSS real-time correction services, the inaccuracies are reduced down to centimeter or even millimeter level.

ERROR SOURCES



OSR AND SSR – TWO QUALITIES OF CORRECTIONS

+ **O**bservation **S**pace **R**epresentation (**OSR**)

  In conventional Real-Time-Kinematic (RTK) services the lump sum of all these errors is observed by a network of reference stations and provided to the rover as range corrections for each supported combination of satellite, frequency and signal. OSR requires the processing of the same signals on each reference station (homogeneous network) and the support of these signals by the user.

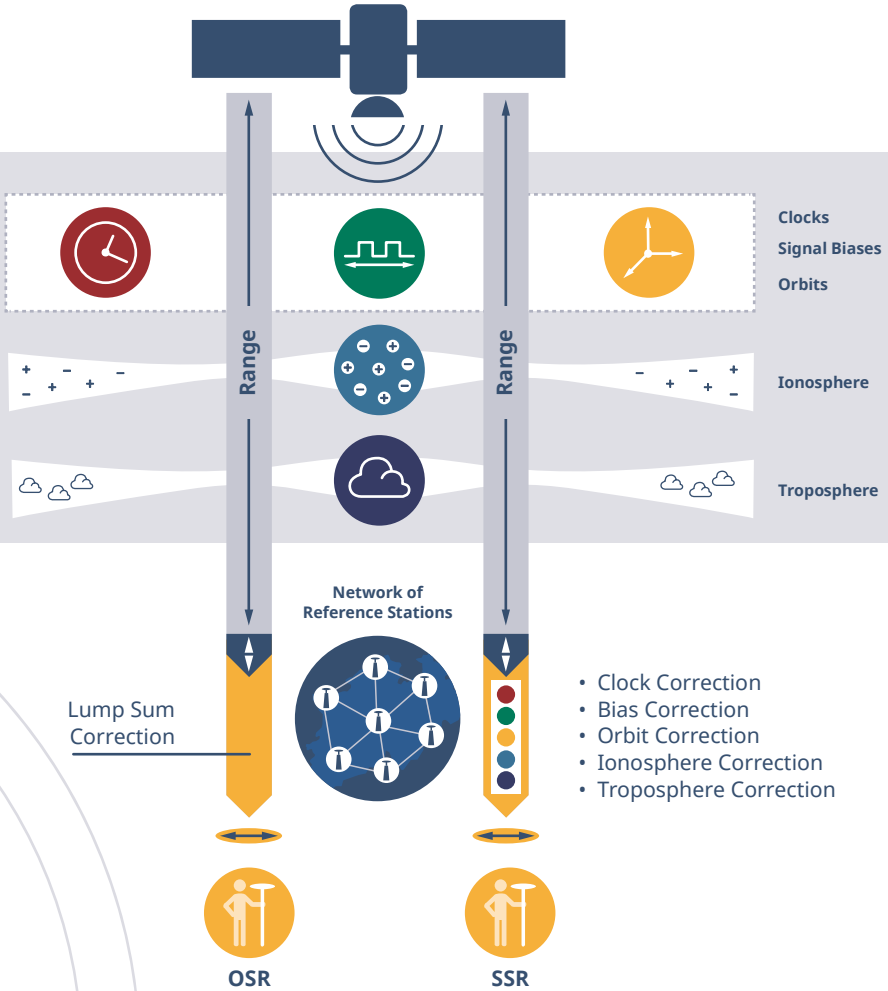
+ **S**tate **S**pace **R**epresentation (**SSR**)

  A network of reference stations is used to decorrelate and estimate the different GNSS error components (states):

  - Satellite Clocks
  - Satellite Orbits
  - Satellite Signal Biases
  - Ionospheric Delay/Advance
  - Tropospheric Delay

  With **SSR** users can compute GNSS corrections valid for their position.

  Additionally, statistical accuracy information can be transmitted to support the rover algorithm.


Clocks
Signal Biases
Orbits
Range
Range
Ionosphere
Troposphere
Network of
Reference Stations
Lump Sum
Correction
• Clock Correction
• Bias Correction
• Orbit Correction
• Ionosphere Correction
• Troposphere Correction
OSR
SSR

SCALABLE SERVICES – VARIOUS APPLICATIONS

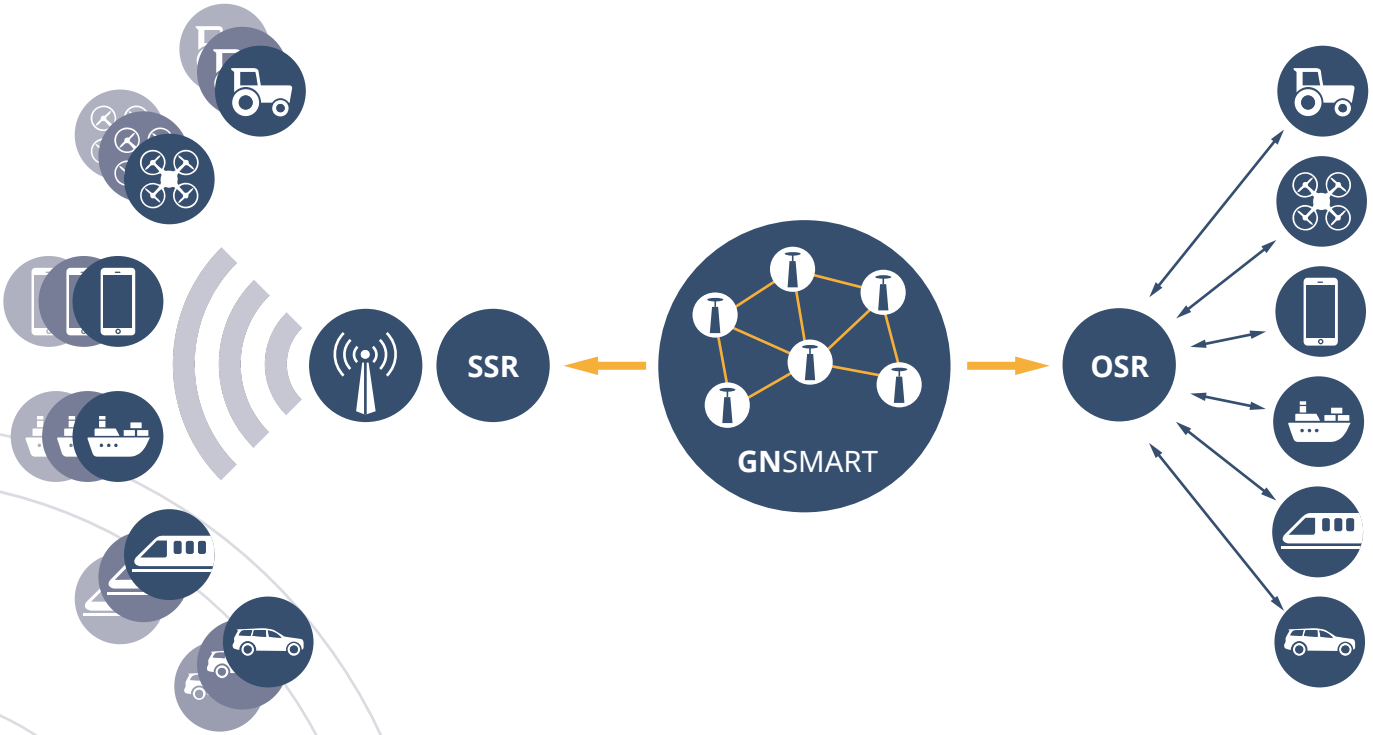
GNSMART2
enables the consistent and seamless estimation of GNSS errors (rigorous solution) and provides both **OSR** and **SSR** corrections.

OSR corrections are exchanged via duplex communication media since the user needs to transmit its approximate position to the service provider to generate the corrections.

SSR based network-RTK enables the use of simplex communication media (satellite and ground based broadcast) using only a single data stream for all users. Thereby, an SSR service can in principle supply an unlimited number of users at the same time, making it ideally suited for future mass market applications as e.g. autonomous cars or drones.

The structure of **SSR** allows scalable RTK services with respect to accuracy and with respect to various specific applications in numerous GNSS market segments, including:

- Agriculture
- Aviation
- Location Based Services
- Mapping and Surveying
- Maritime
- Rail
- Road


SSR
GNSMART
OSR

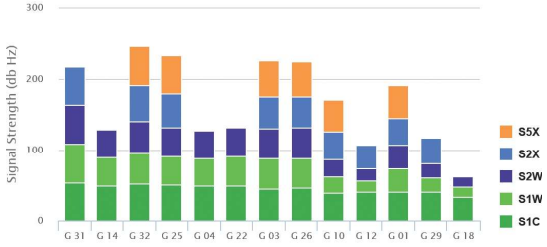
RATIONALE

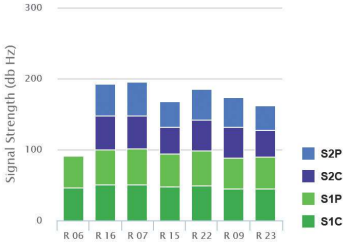
GNSMART**2** **is the best solution for high accuracy real-time positioning without GNSS hardware restrictions.**

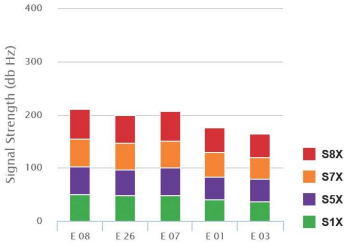

+
ALL SYSTEMS
ALL SIGNALS
ANY REFERENCE STATION
ANY ROVER

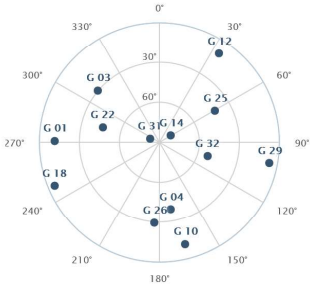
SUPPORTS ALL SIGNALS FROM ALL GNSS

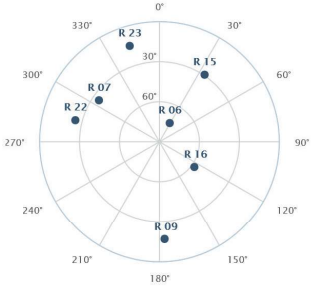
GPS + GLONASS + GALILEO

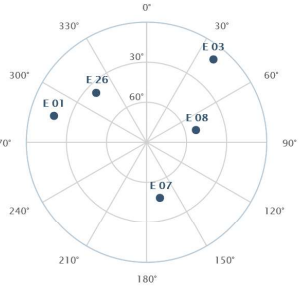




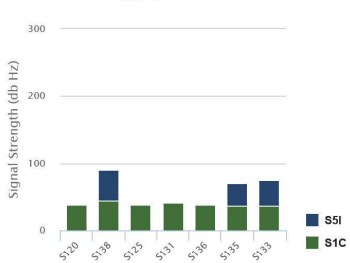


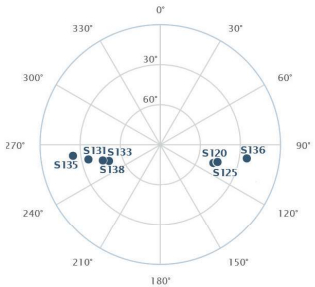


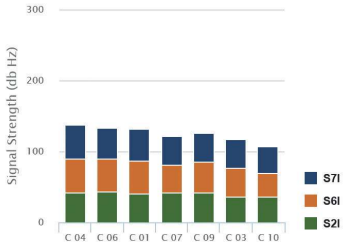


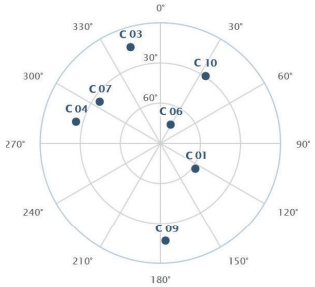


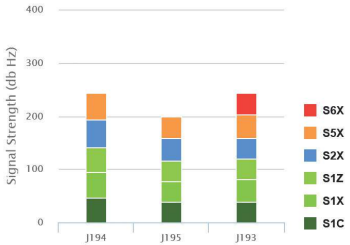
SBAS + BDS + QZSS

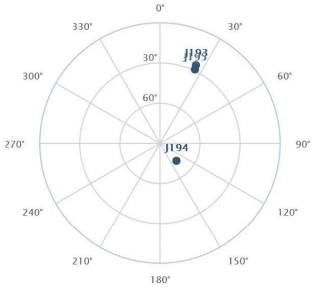






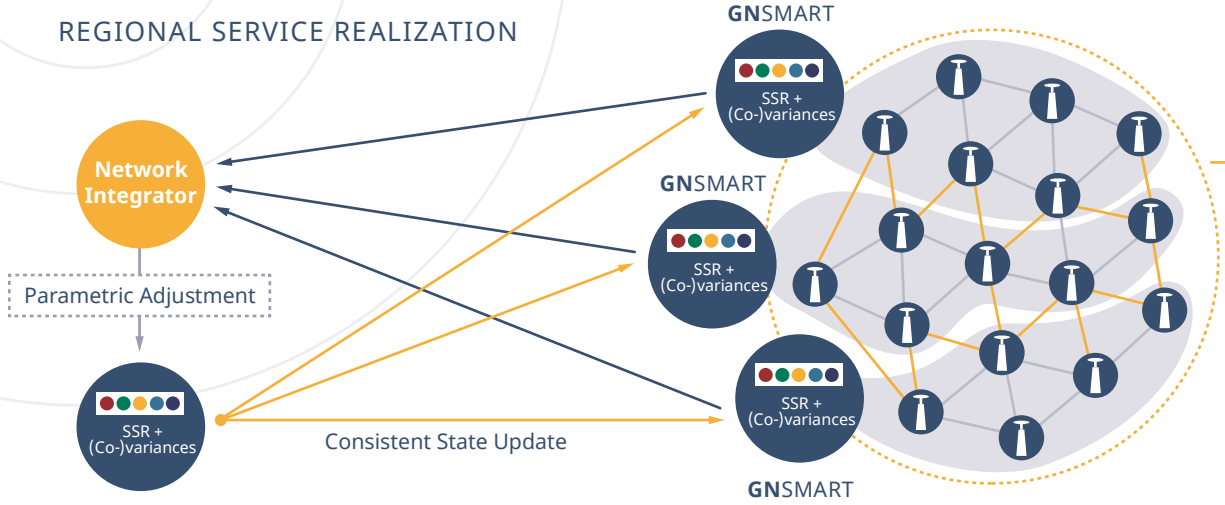






INTEGRATING GNSS NETWORKS

REGIONAL SERVICE REALIZATION



GNSMART**2** uses a unique and sophisticated technique that integrates states from multiple networks with a federated filter approach.

With this approach, local networks can be combined on different scales for different GNSS service realizations:

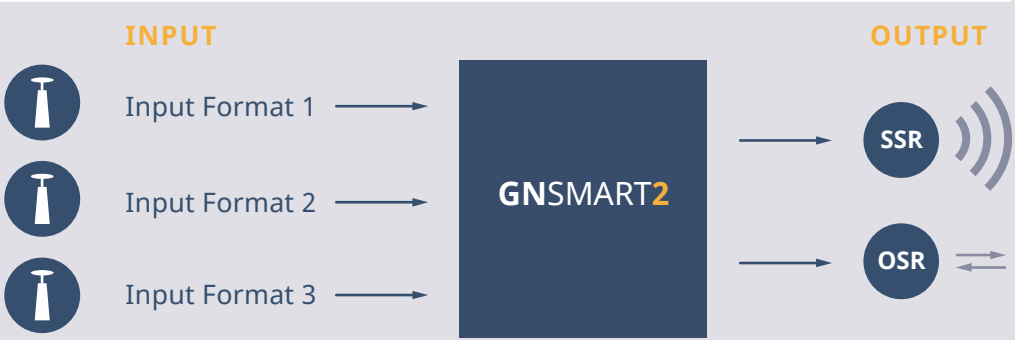
- Regional coverage combining cooperative (adjacent) networks for consistent SSR corrections without (total) network size limitations.
- Global coverage using hierarchically connected networks. This allows a basic high-accuracy service while keeping the full service in the local networks.

+ GLOBAL SERVICE REALIZATION

GNSMART2 IS INDEPENDENT OF GNSS HARDWARE

+ **GN**SMART**2** supports
  - more than 20 proprietary receiver interfaces
  - standardized interfaces (RINEX, RTCM) and others (e.g. BINEX)
  - heterogenous networks – networks consisting of
    - · different receivers from different types/brands
    - · different inter-station distances
    - · reference stations not providing the same signals

GNSMART**2** creates GNSS corrections for all signals tracked in the network.



VARIOUS REAL-TIME OUTPUT FORMATS

+ **GN**SMART**2** supports various RTCM standard and customer defined open output formats.

INTERNATIONAL RTCM STANDARD	OPEN FORMATS
RTCM2	SSRZ
RTCM3	SAPA
RTCM3-Network RTK Correction • FKP • Non-Physical Reference Station • MAC	Compact SSR
RTCM3-MSM	…
RTCM3-SSR	

SOFTWARE CHARACTERISTICS

+ **Individual configurable** and **transparent** software structure

+ **Simplified** and **modernized** visualization/interface for **operators** and **users**

MODERNIZED OPERATION AND USER MANAGEMENT

+ Optimized service status overview

  Detailed status information about satellites, reference stations and rovers

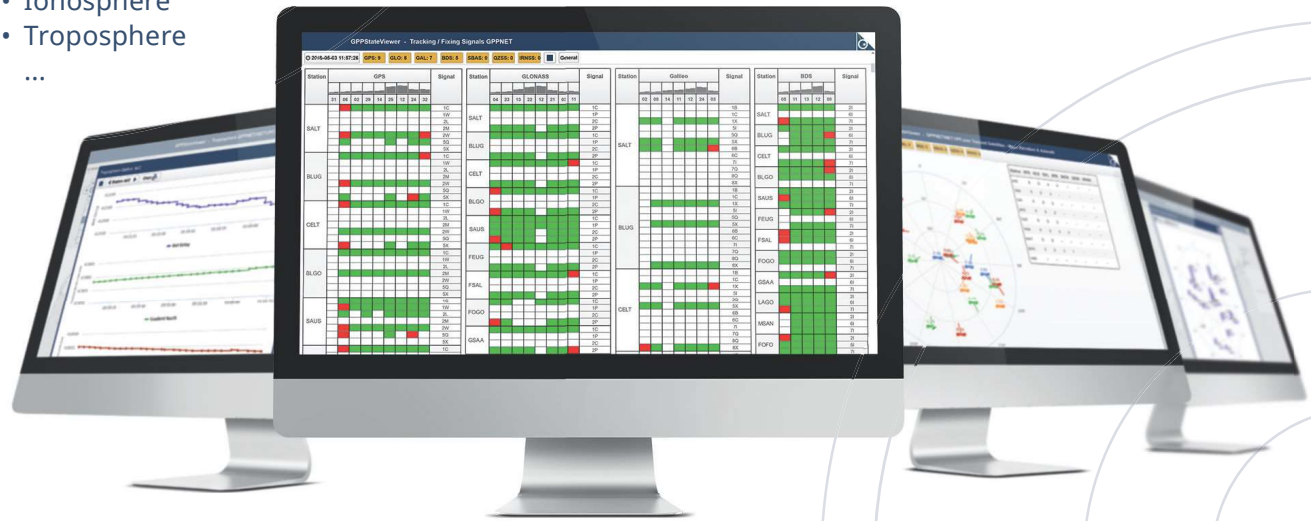
  Web-based user management

GNSMART2 STATE VIEWER

+ Detailed information about states

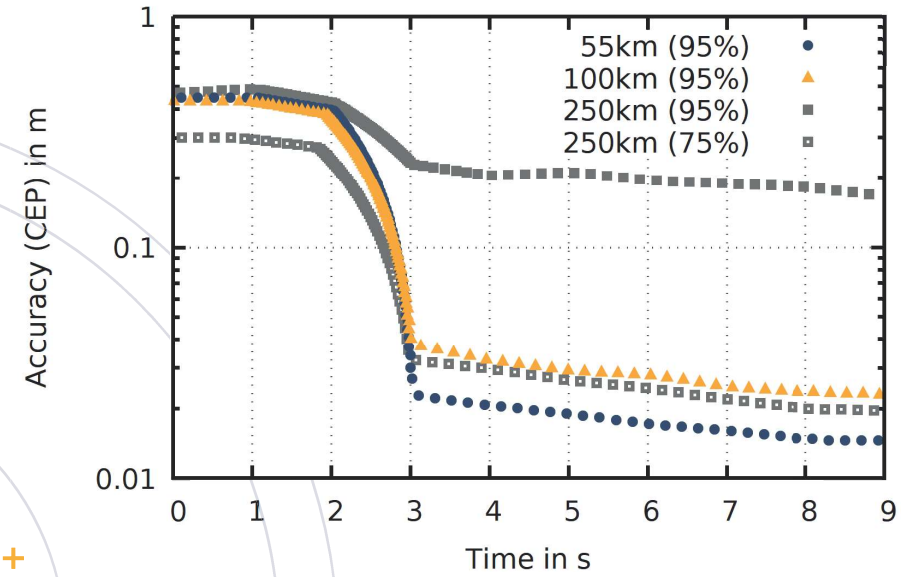
  - Satellite clock, orbit, biases
  - Tracking fixing status
  - Reference station states
  - Ionosphere
  - Troposphere

  ...



SCALABLE PERFORMANCE

Convergence vs. Mean Station Distance

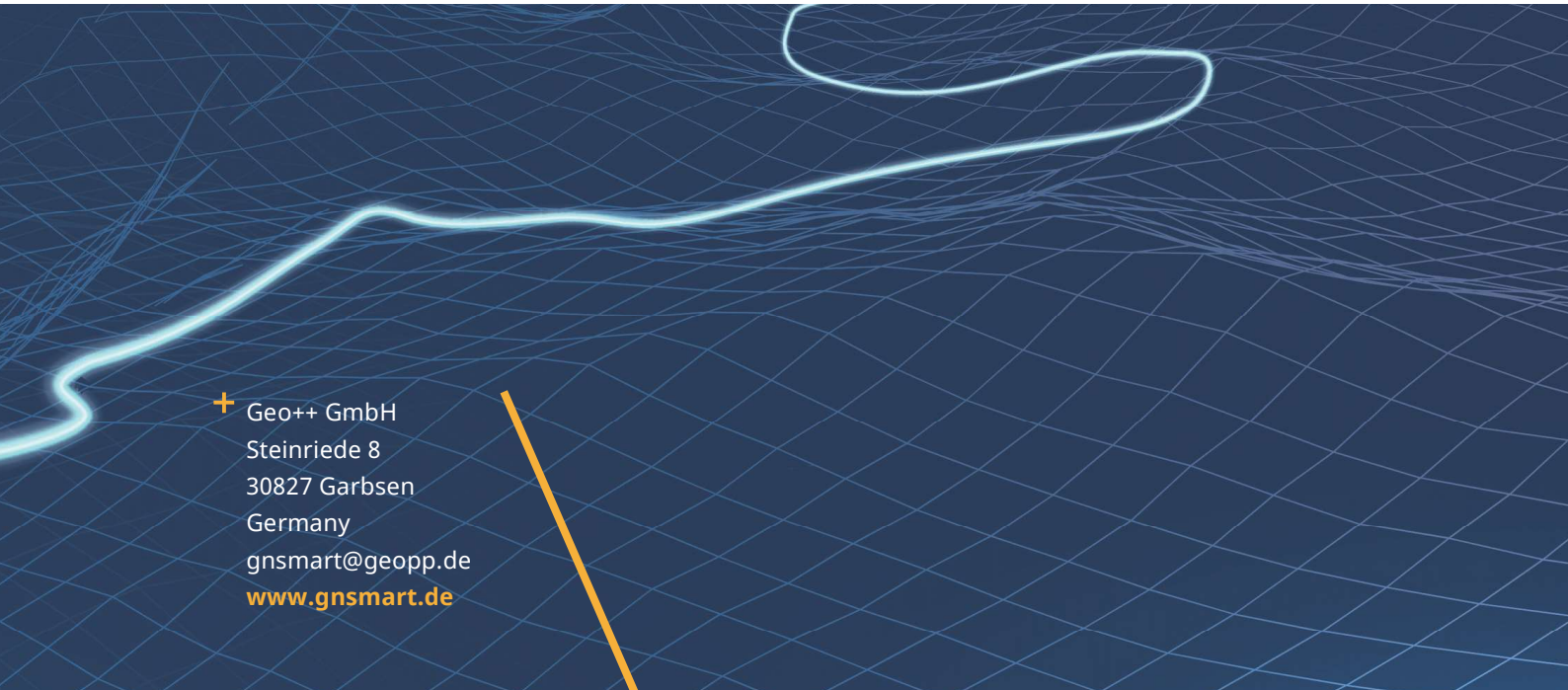


Experimental data over more than 1000 sample runs.

GNSMART2

GNSS **S**tate **M**onitoring **a**nd **R**epresentation **T**echnique

Design: creanovo, Hanover



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