GNSMART 2.0

ready for the next decade(s) of GNSS

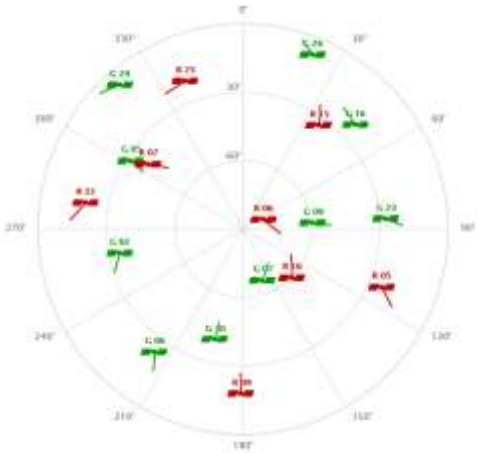
Jannes B. Wübbena, Gerhard Wübbena

Geo++® GmbH

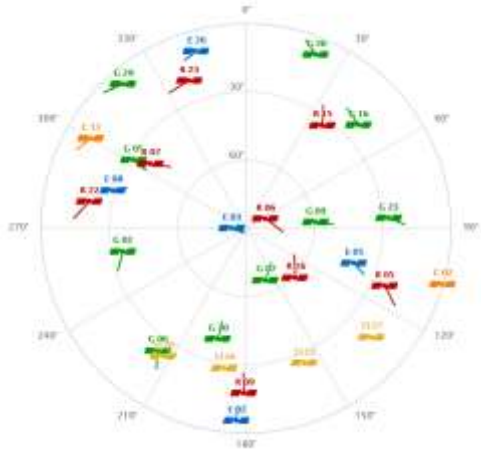
30827 Garbsen, Germany

www.geopp.de

The evolution of GNSS



18 satellites



29 satellites

Non GPS/GLONASS satellites can contribute significantly to accurate GNSS services!

New signals – blessing and burden

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The following observation types are
defined in RINEX Version 2:

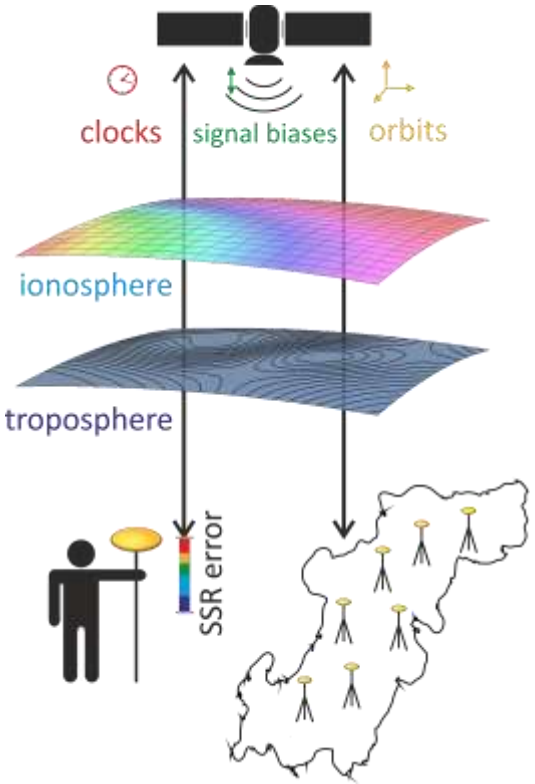
L1, L2: Phase measurements on L1 and L2
C1    : Pseudorange using C/A-Code on L1
P1, P2: Pseudorange using P-Code on L1,L2
D1, D2: Doppler frequency on L1 and L2
```

7 Observables

GNSS System	Freq. Band /Frequency	Channel or Code	Observation Codes			
			Pseudo Range	Carrier Phase	Doppler	Signal Strength
GPS	L1/1575.42	C/A	C1C	L1C	D1C	S1C
		L1C (D)	C1S	L1S	D1S	S1S
		L1C (P)	C1L	L1L	D1L	S1L
		L1C (D+P)	C1X	L1X	D1X	S1X
		P (AS off)	C1P	L1P	D1P	S1P
		Z-tracking and similar (AS on)	C1W	L1W	D1W	S1W
		Y	C1Y	L1Y	D1Y	S1Y
		M	C1M	L1M	D1M	S1M
		codeless		L1N	D1N	S1N
	L2/1227.60	C/A	C2C	L2C	D2C	S2C
		L1(C/A)+(P2-P1) (semi-codeless)	C2D	L2D	D2D	S2D
		L2C (M)	C2S	L2S	D2S	S2S
		L2C (L)	C2L	L2L	D2L	S2L
		L2C (M+L)	C2X	L2X	D2X	S2X
		P (AS off)	C2P	L2P	D2P	S2P
		Z-tracking and similar (AS on)	C2W	L2W	D2W	S2W
		Y	C2Y	L2Y	D2Y	S2Y
		M	C2M	L2M	D2M	S2M
		codeless		L2N	D2N	S2N
	L5/1176.45	I	C5I	L5I	D5I	S5I
		Q	C5Q	L5Q	D5Q	S5Q
		I+Q	C5X	L5X	D5X	S5X

90 Observables

The GNSMART State Space Model



Simultaneous estimation of all relevant state parameters in a stasticially rigorous approach

- satellite clocks
- satellite orbits
- satellite signal biases
- ionospheric delay/advance
- tropospheric delay
- reference station clocks
- reference station signal biases
- reference station coordinates
- …

The challenge

2010

Number of States

×3

Number of Satellites

Number of Frequencies

Time for GNSMART 2

Number of Signals

×5

2020

30 – 50 times larger state vector

GNSMART 2 Features
Supported GNSS

Supporting GPS, GLONASS, BDS, GALILEO, QZSS, SBAS, IRNSS

GNSMART 2 Features
Supported Signals

GNSMART 2 supports all available signals

GNSMART 2 Features
Hardware Independence

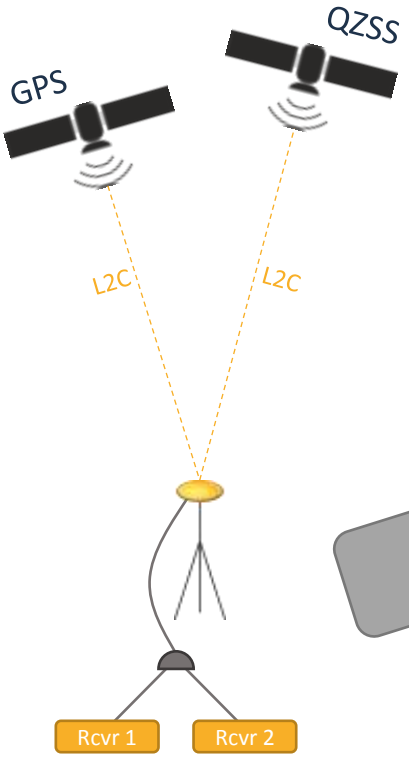
GNSMART Philosophy:
Any Reference Station, Any Rover

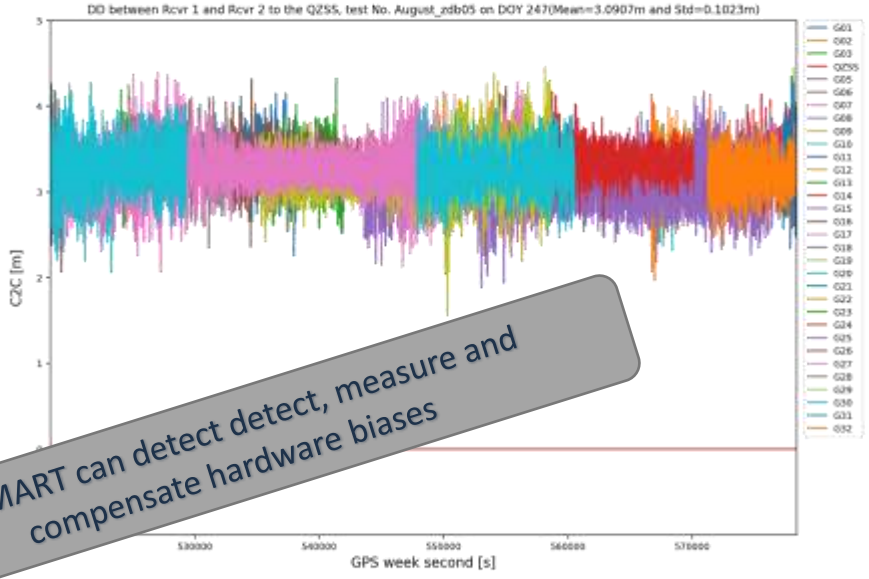
More than 20 proprietary receiver interfaces supported, including Javad, Septentrio, Leica, Topcon, Trimble, Novatel, Hemisphere, u-blox, NVS, Sokkia, Garmin, Android, …

Additionally, standardized interfaces such as: Binex, Rinex, RTCM, ...

Supporting any receiver means supporting **every bias**

GNSMART 2 Features
Hardware Independence





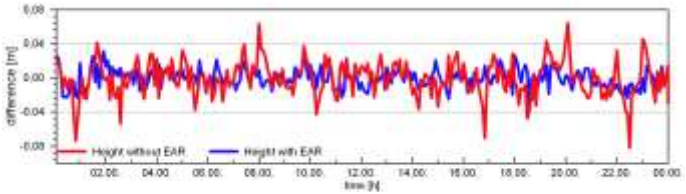
GNSMART can detect detect, measure and compensate hardware biases

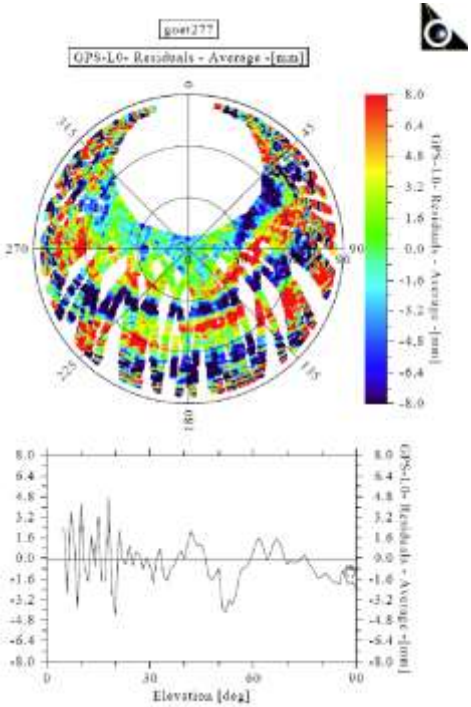
Bias depends on:
Receiver Type, Receiver Firmware,
Receiver Settings (Multipath Mitigation)

GNSMART 2 Features – On the Job station calibration

Near field multipath needs to be corrected for highest accuracies

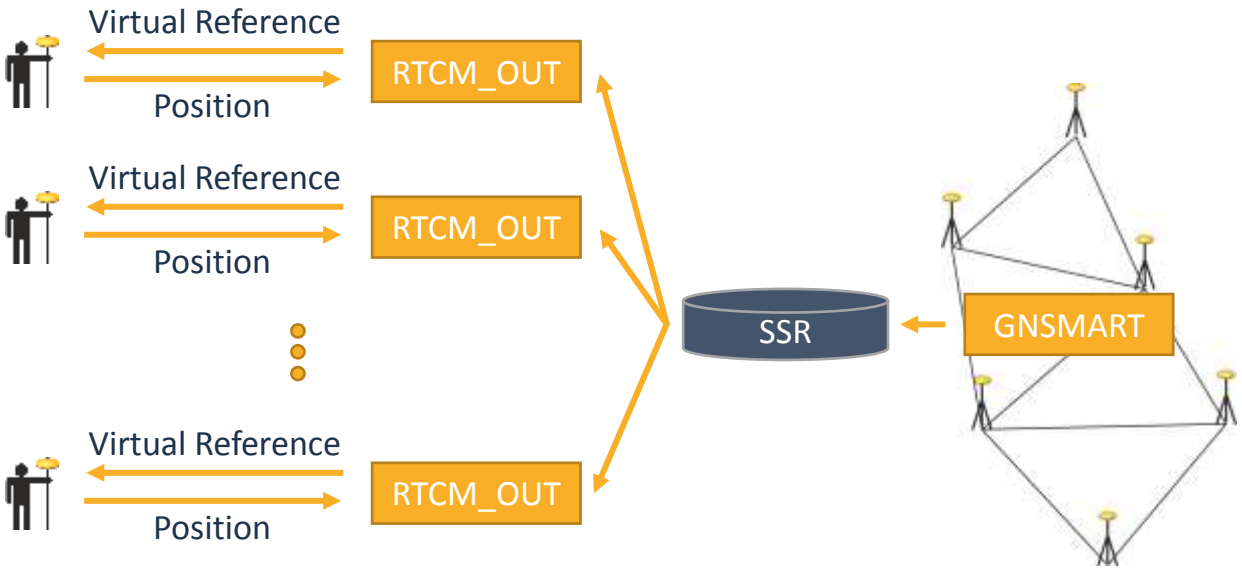
BKG station Göttingen, Foto: BKG





GNSMART 2 Features
SSR Output

Typical way of network RTK data dissemination



Individual VRS computation for every rover

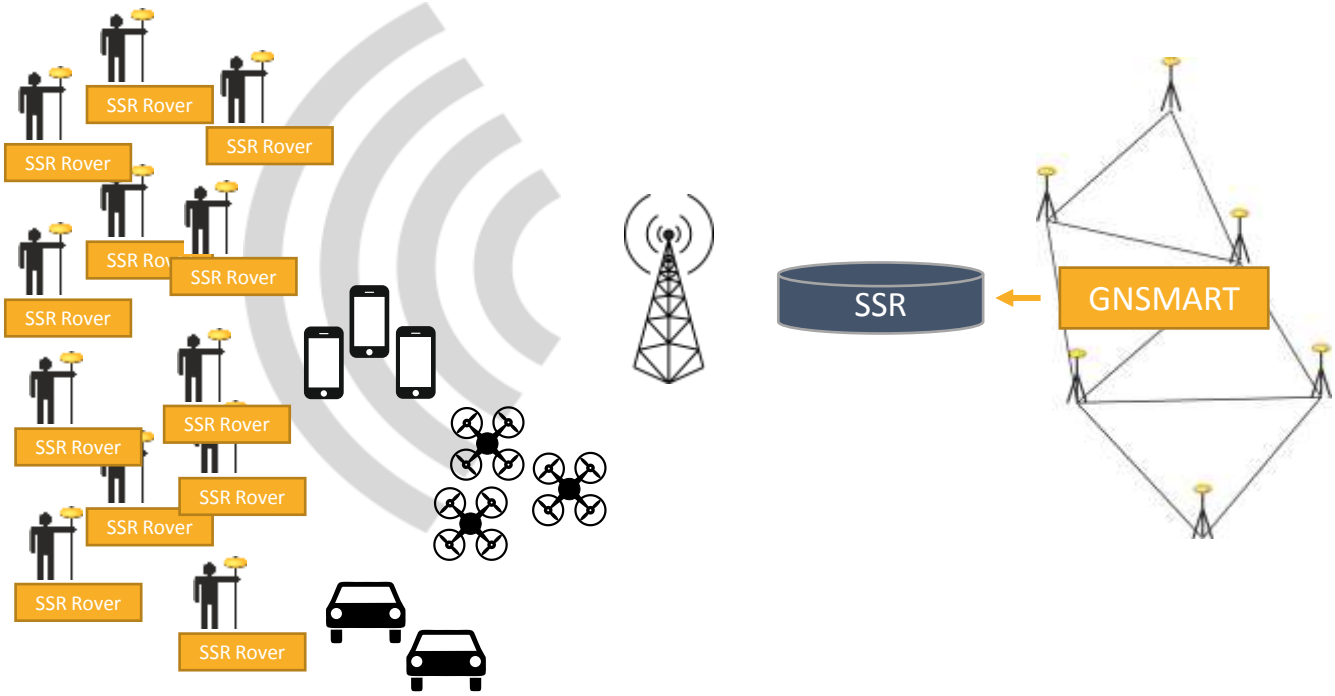
GNSMART 2 Features
SSR Output

Outputting SSR allows for efficient scaling of user amount

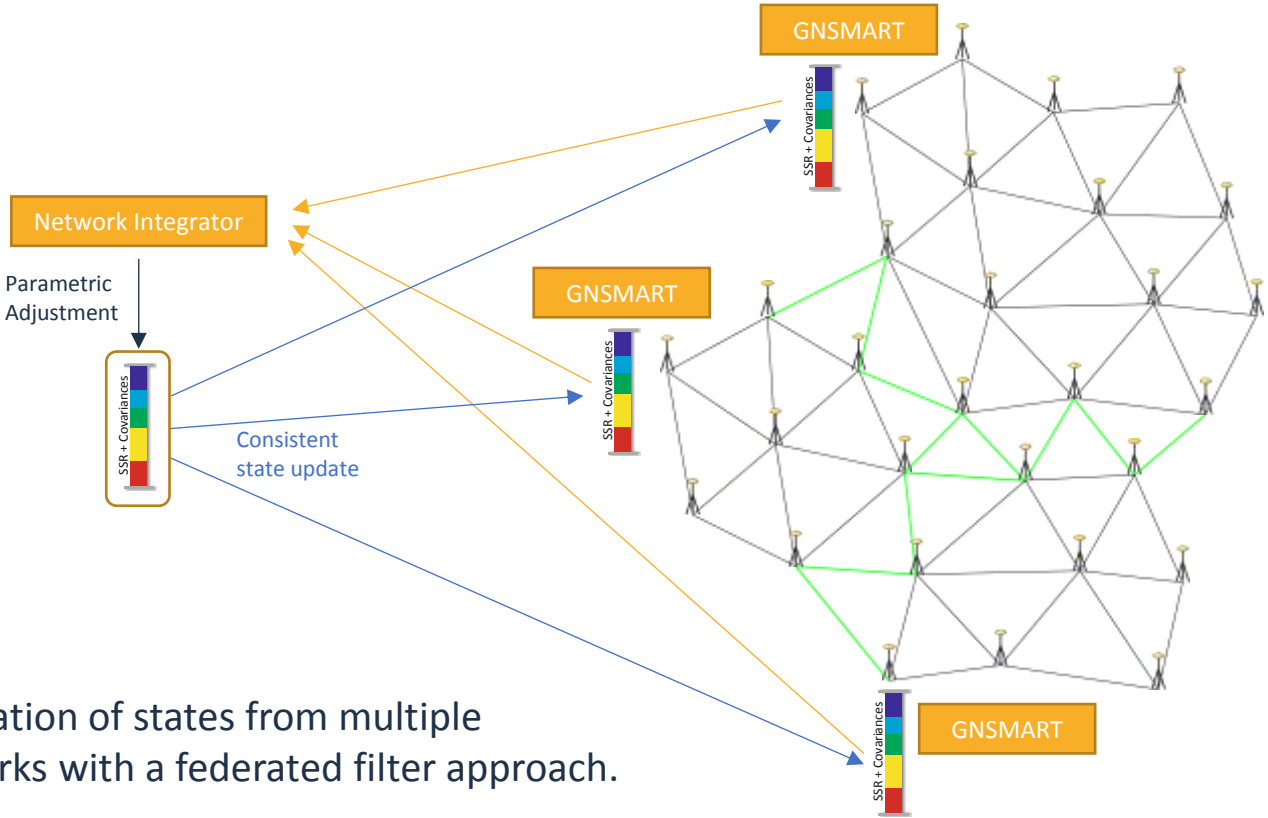
SSR is intrinsically broadcast compatible

GNSMART 2 Features
SSR Output

Outputting SSR allows for efficient scaling of user amount



GNSMART 2 Features
Integrating Networks



Integration of states from multiple networks with a federated filter approach.

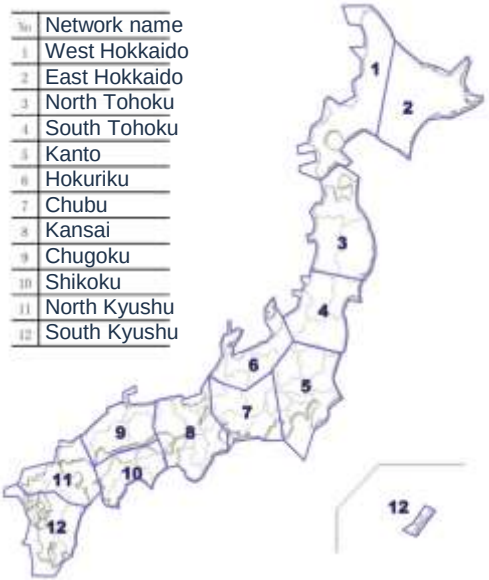
GNSMART 2 Features
Cascading Networks

Example: The L6 CLAS signal of QZSS

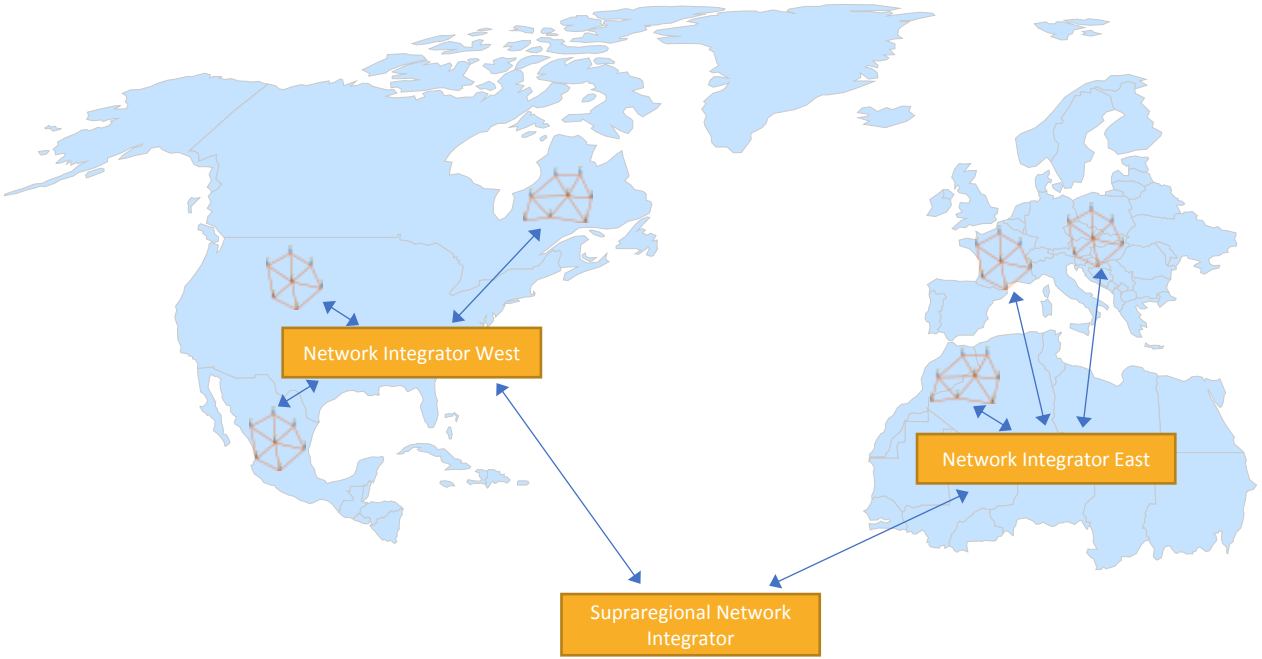
- 300 Reference Stations
- 12 Sub-Networks
- 12 GNSMART
- 12 different SSR datasets every 5s

Network Integration

One consistent SSR data set for Japan
(1700 bit/second)

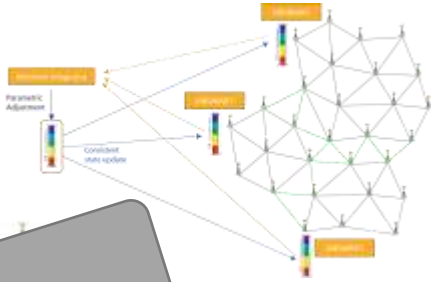


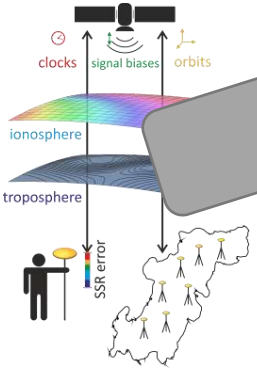
GNSMART 2 Features
Cascading Networks



GNSMART 2

The rigorous, powerful and scalable solution for high accuracy GNSS





Available Q1 / 2018