

# Modernization of the Finnish Permanent GNSS Network FinnRef and its open positioning service

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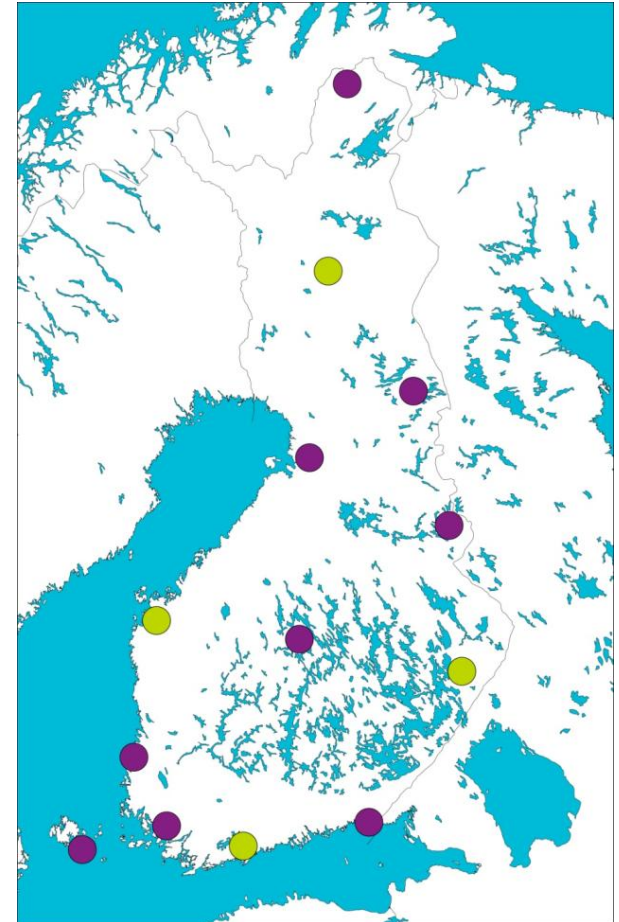


FINNISH GEODETIC  
INSTITUTE

NKG General Assembly 2014

# FinnRef 1996-2015

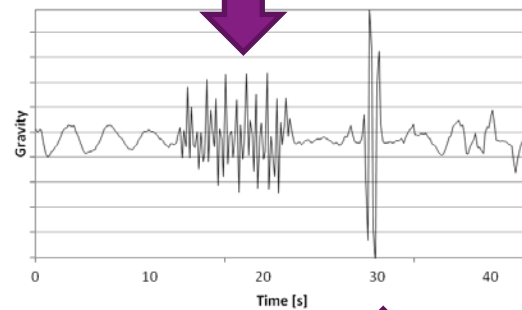
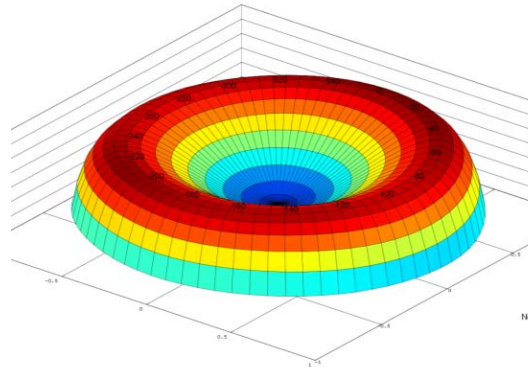
- EUREF-FIN
  - ETRS-GKn
  - ETRS-TM35FIN
- JHS 153, JHS 154, JHS 184
- EPN (4) IGS (1), BIFROST (13)



# Renewal of the FinnRef 2012-2013

- Outdated receiver technology
- Funding from the Ministry
  
- Goal
  - Modern GNSS network
  - Basis of EUREF-FIN coordinate system
  - Tool for studying phenomena deforming the coordinate system

# Quality of the stations



# Equipment

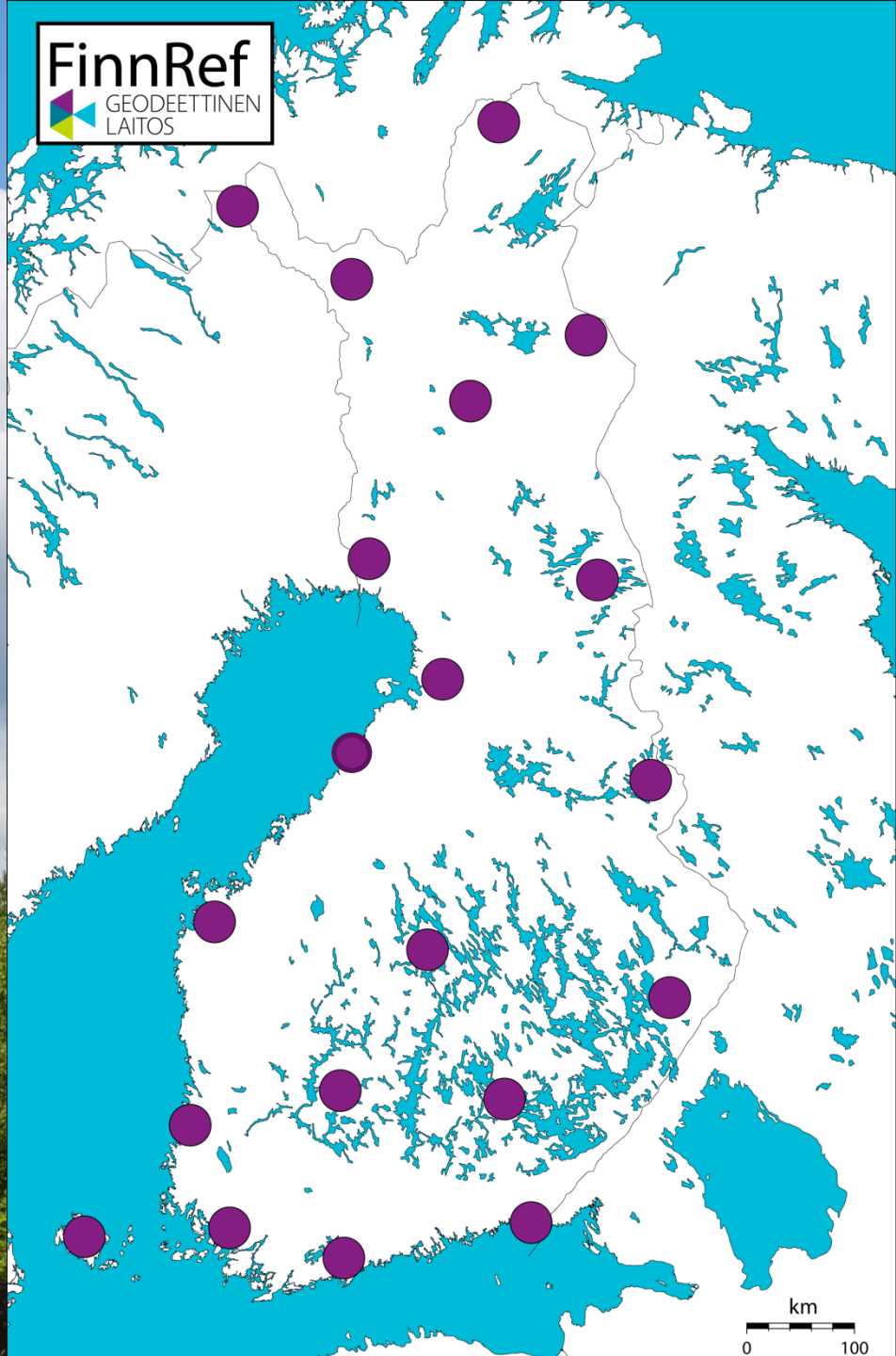


Javad Delta-G3T

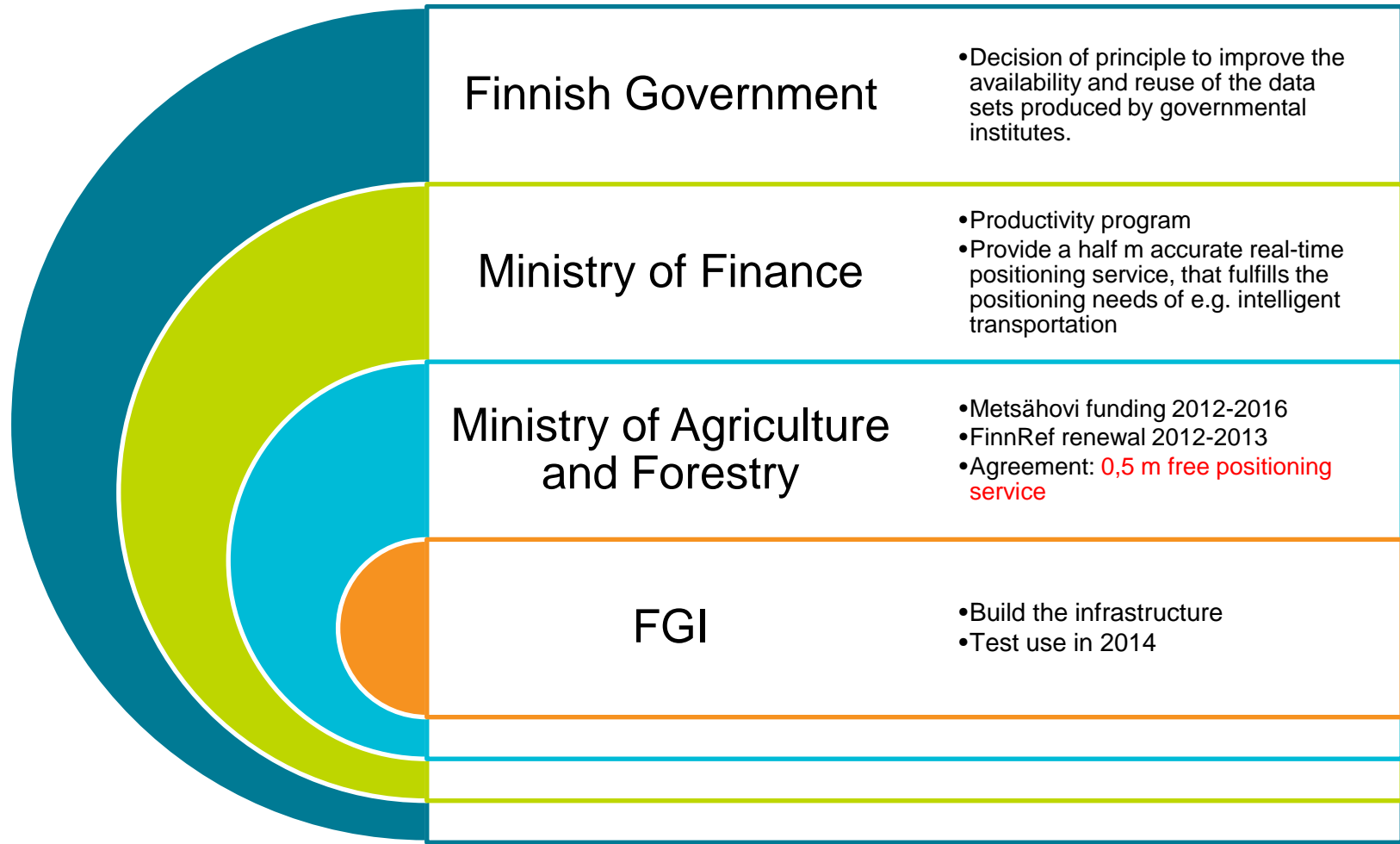


Javad Choke Ring antenni ja SCIGN radome

GNSS	Signaalit
GPS	L1, L2, L2C, L5
Glonass	L1, L2, L3
Galileo	E1, E5a, E5b, AltBOC
SBAS	EGNOS, WAAS, MSAT
BeiDou	B1, B2
Datasreams 7x	JPS, RTCM SC104 v. 2.x and 3.x, CMR, NMEA 0183 v. 2.x and 3.0 or BINEX



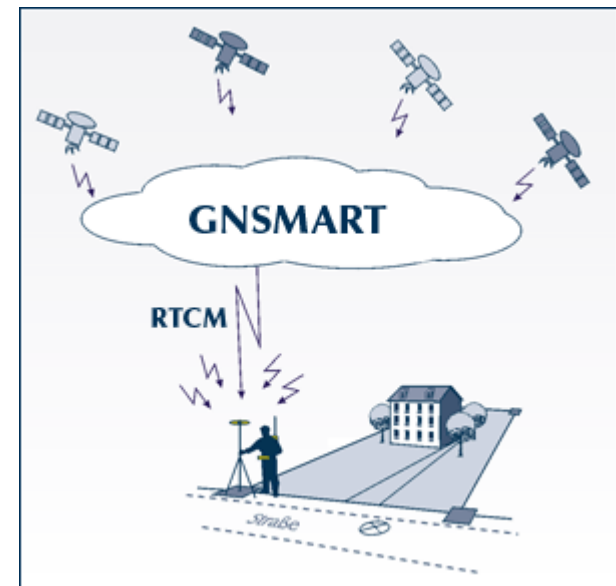
# Free Positioning service



# Software



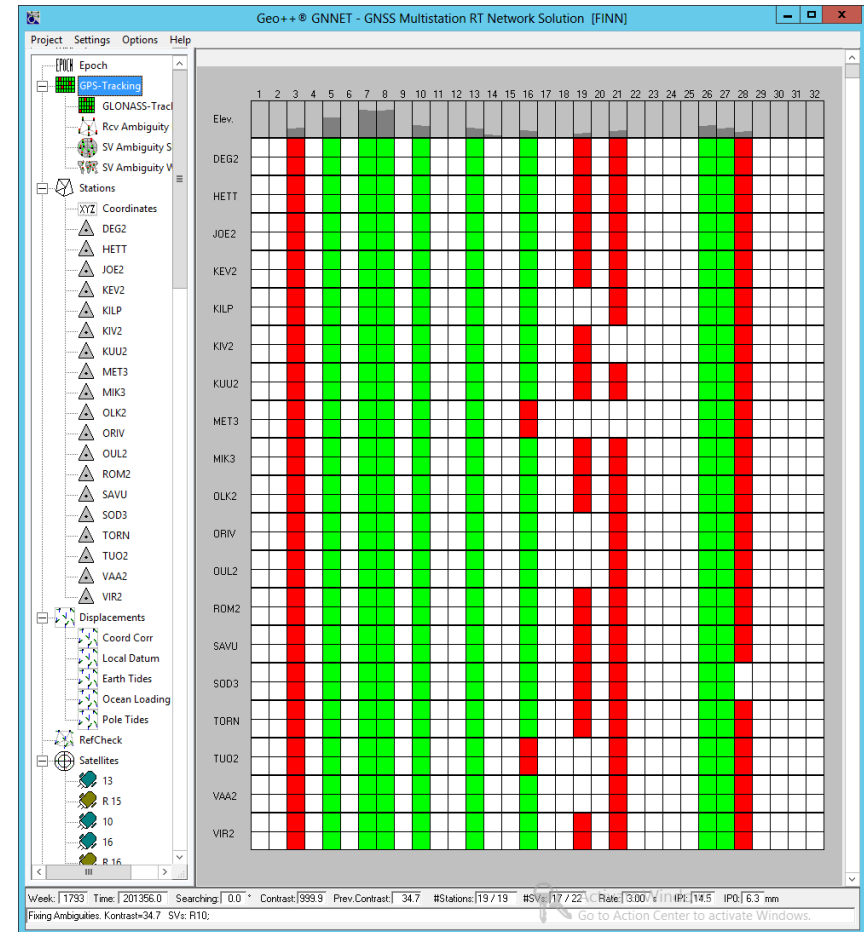
- GNSMART from Geo++
  - GNss - State Monitoring And Representation Technique
- State monitoring
  - Solves station and distance dependent errors
  - Solves ambiguities
- Representation
  - Delivers the data to the clients
  - DGNSS, FKP, MAC, PRS, SSR
    - RTCM, NTRIP



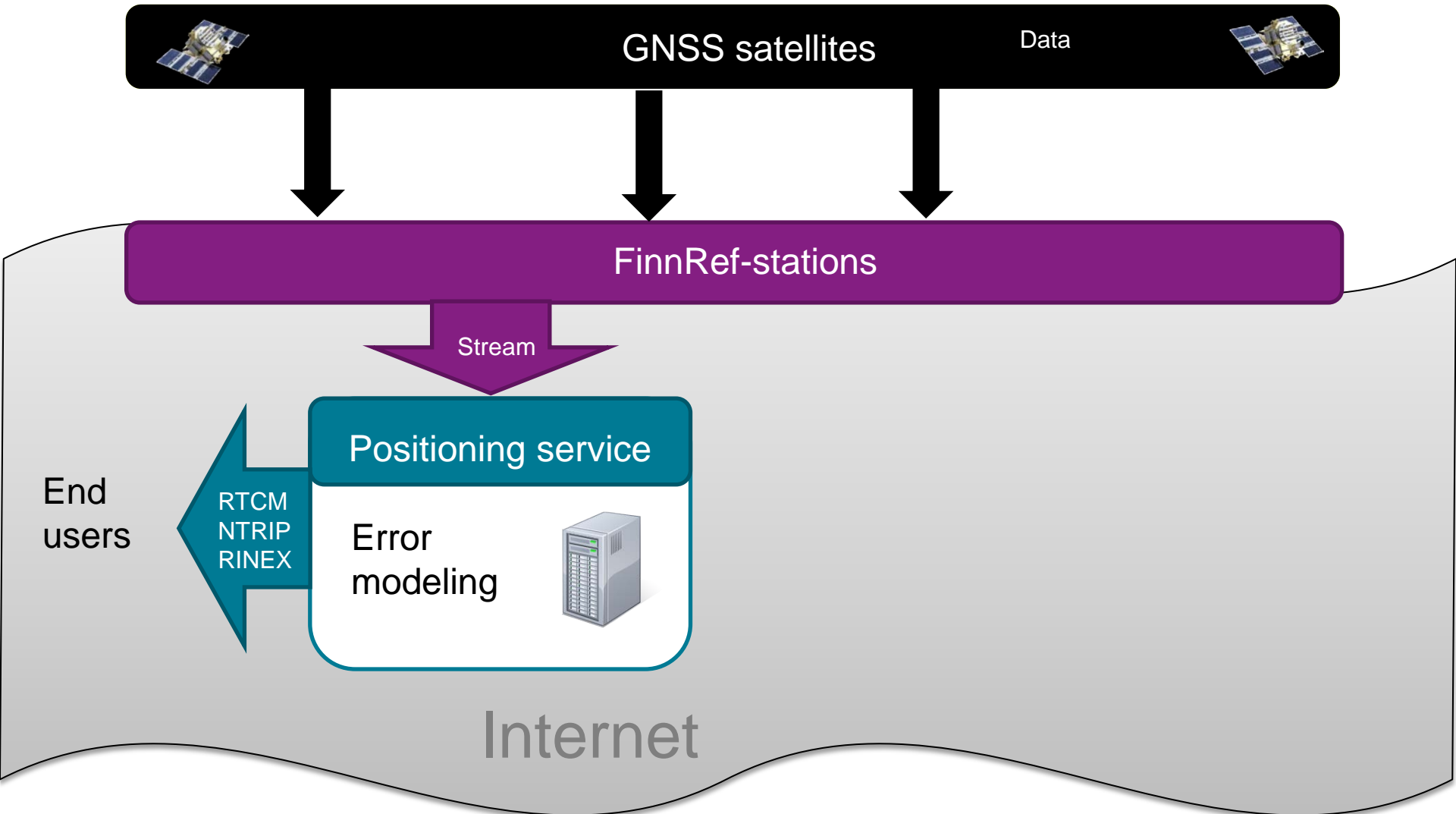


# Schedule of service

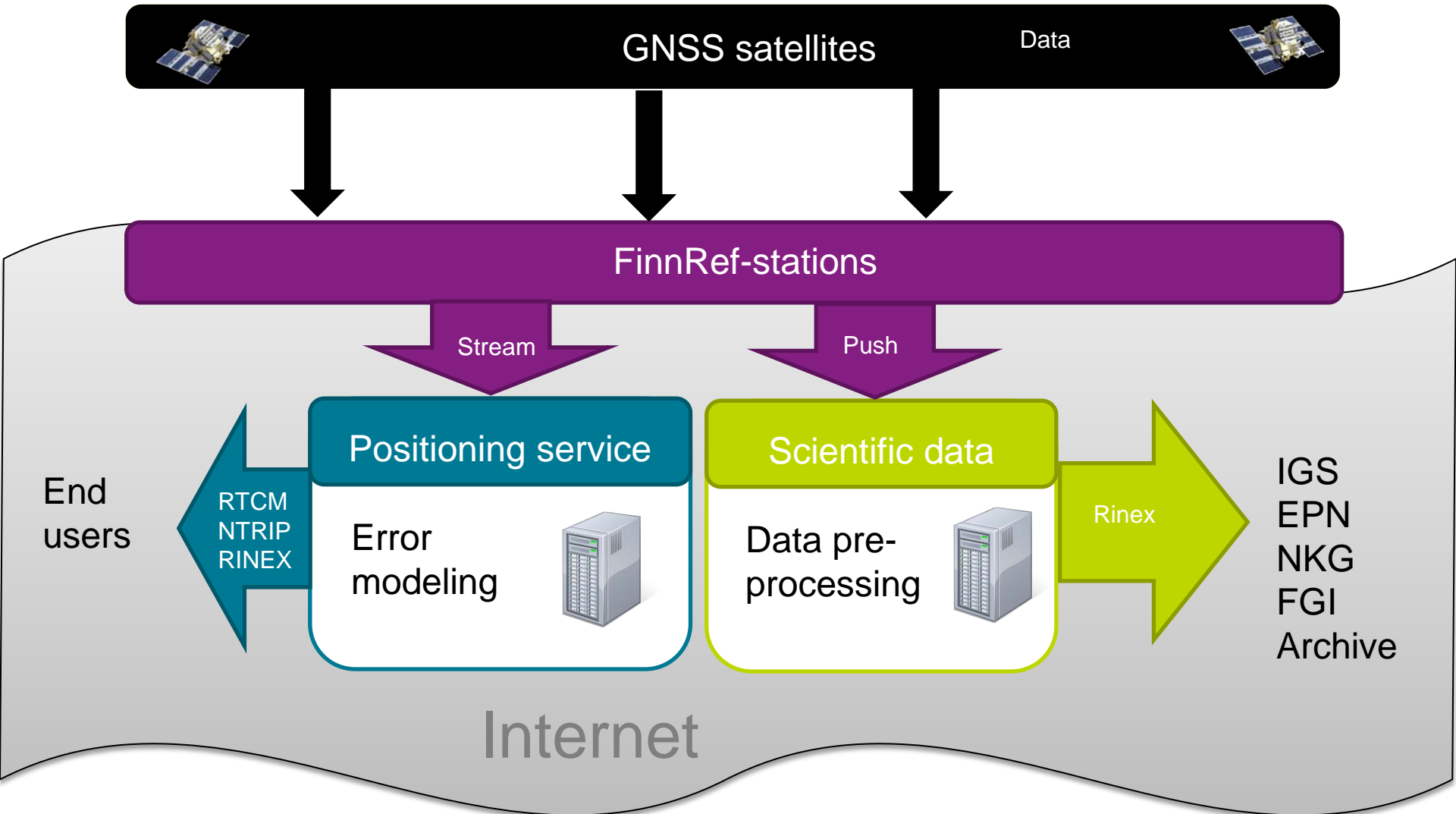
- January 2014
  - DGNSS service
  - From individual station or for user location
- June 2014
  - RINEX data server
  - Network-RTK streams for test users
- Service level during 2014: best effort



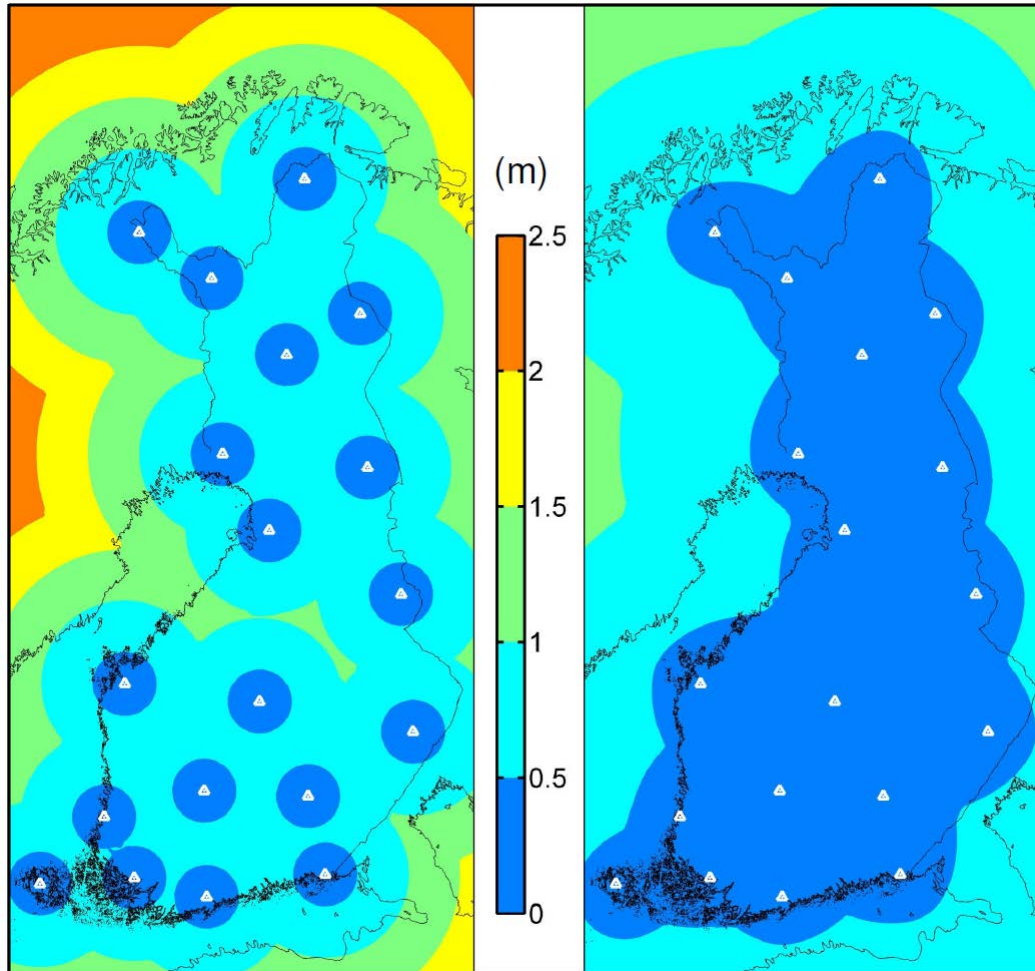
# Positioning service/FinnRef dataflow



# Positioning service/FinnRef dataflow



# On accuracy



The Finnish Geodesic Institute has assessed the Finnish GNSS network during 2012-2013. Based on the data reports from the Finnish network and GNSSRTT software the FIO provides the following accuracy estimates during 2013 for the Finnish open positioning service. The accuracy estimates are based on the experimental results and the test results in the service evaluation. The accuracy estimates are based on the test results and the test results in the service evaluation. The accuracy estimates are based on the test results and the test results in the service evaluation.

## Positioning service

- Data obtained from all regional stations to the Geodesic Institute (Geodesic Institute)
- Identification of the stations
- Software allows different correction types
- GNSS data used for test
- Accuracy estimates of the FIO
- Network coverage
- Accuracy estimates of the FIO
- Accuracy estimates of the FIO

## Test fields

- Selected testfields are measured by the national GNSS network
- Official GNSSRTT software
- Corrections are in real-time mode (both) and accuracy is in real-time mode (both)
- Accuracy estimates of the FIO
- Accuracy estimates of the FIO
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- Accuracy estimates of the FIO

## GNSS and network GNSS

- Open network
- GNSS correction is received from internet or Geodesic Institute
- Network GNSS correction is received from Geodesic Institute
- GNSS data used for test
- Accuracy estimates of the FIO
- Accuracy estimates of the FIO
- Accuracy estimates of the FIO
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- Accuracy estimates of the FIO

## Network RTK

- Accuracy estimates of the FIO
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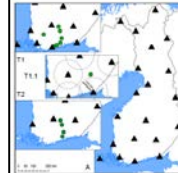


Fig. 1. The network of stations

F1: Complete network and results  
 F2: Accuracy estimates of the FIO  
 F3: Accuracy estimates of the FIO

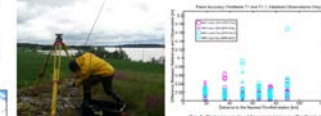


Fig. 2. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

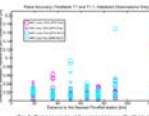


Table 1. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

Station	Accuracy (m)
F1	0.5
F2	1.0
F3	1.5
F4	2.0
F5	2.5

Table 2. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

Station	Accuracy (m)
F1	0.5
F2	1.0
F3	1.5
F4	2.0
F5	2.5

Table 3. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

Station	Accuracy (m)
F1	0.5
F2	1.0
F3	1.5
F4	2.0
F5	2.5

Table 4. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

Station	Accuracy (m)
F1	0.5
F2	1.0
F3	1.5
F4	2.0
F5	2.5

Table 5. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

Station	Accuracy (m)
F1	0.5
F2	1.0
F3	1.5
F4	2.0
F5	2.5

Table 6. Accuracy estimates of the FIO

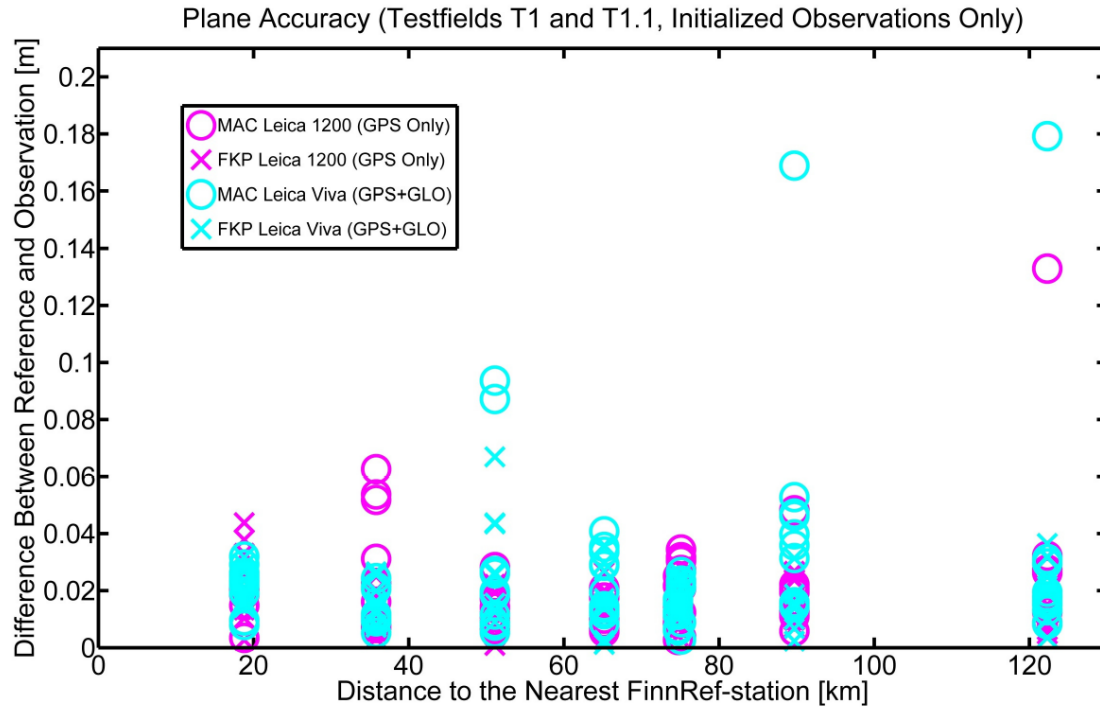
• Accuracy estimates of the FIO

Station	Accuracy (m)
F1	0.5
F2	1.0
F3	1.5
F4	2.0
F5	2.5

Table 7. Accuracy estimates of the FIO

• Accuracy estimates of the FIO

# On accuracy



**Fig. 3:** First test results of Complete Network (Testfields 1-1.1). Plane accuracies of different methods and receivers. Plot contains 95 % of initialized observations. See Table 1.

The Finnish Geodetic Institute has assessed the Finnish GNSS network during 2010-2012. Based on the data received from the Finnish network and GNSSRTK, we have assessed the accuracy of the Finnish open positioning service. The results are presented in this report. The report contains the results of the accuracy studies and the results of the accuracy studies. The report also contains the results of the accuracy studies and the results of the accuracy studies.

## Positioning service

- Data obtained from all regional reference to the Geomatics Centre of the Finnish Geodetic Institute
- Software allows different correction types
- Accuracy of the service
- Accuracy of the service
- Accuracy of the service
- Accuracy of the service

## GNSS and network GNSS

- Open network
- GNSS correction is broadcast from internet or satellite
- GNSS correction is broadcast from internet or satellite
- GNSS correction is broadcast from internet or satellite
- GNSS correction is broadcast from internet or satellite
- GNSS correction is broadcast from internet or satellite

## Network RTK

- RTK correction is broadcast from internet or satellite
- RTK correction is broadcast from internet or satellite
- RTK correction is broadcast from internet or satellite
- RTK correction is broadcast from internet or satellite
- RTK correction is broadcast from internet or satellite

## Test fields

- Detailed coordinates are measured by the national Geomatics Centre of Finland
- Official EUREF frame coordinates
- Coordinates are in EUREF frame (ETRS89) and WGS84
- Accuracy of the service
- Accuracy of the service
- Accuracy of the service

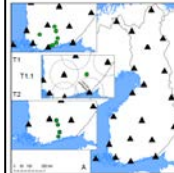


Fig. 1: The testfields and Finnish network

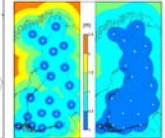


Fig. 2: Accuracy of the positioning service

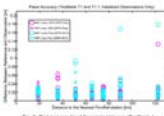


Fig. 3: First test results of Complete Network (Testfields 1-1.1)

Distance to the Nearest FinnRef-station [km]	MAC Leica 1200 (GPS Only)	FKP Leica 1200 (GPS Only)	MAC Leica Viva (GPS+GLO)	FKP Leica Viva (GPS+GLO)
20	0.035	0.045	0.030	0.035
35	0.055	0.065	0.025	0.030
50	0.030	0.045	0.025	0.035
75	0.035	0.040	0.020	0.025
90	0.055	0.060	0.015	0.020
125	0.175	0.135	0.035	0.040

Table 1: First test results of Complete Network (Testfields 1-1.1) plane accuracy

# Future perspective

- Beginning of 1.1.2015 FGI will be Finnish Geospatial research Institute at National Land Survey of Finland
  - Coordinates remain
  - Abbreviation remain
  - Research remain
- Now we have implemented the service and shown that the concept works
- Next steps
  - Towards guaranteed service for ...
  - Duplicated servers
  - More stations
  - Operation center
  - Etc.
- Science
- Apply stations to IGS/EPN