Geo++'s Experiments on Android GNSS Raw Data

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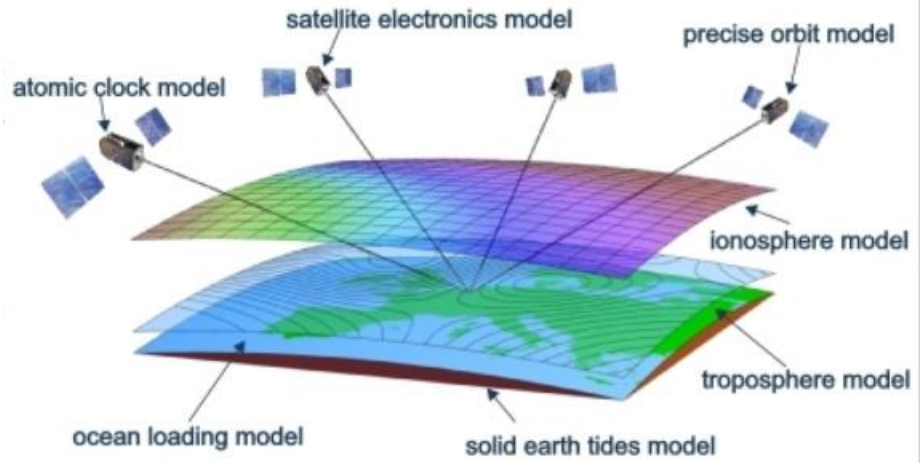
Outline

- SSRPOST concept
- Android Applications
- Absolute Positioning
- Ruler App
- Conclusions and Future Work

SSRPOST concept

State Space Representation (SSR)

- all physical errors acting on GNSS observations are separated, modelled and represented by an appropriate and flexible manner describing the GNSS state (SSR)



- effective corrections of GNSS errors from SSR
- possibility to support various scalable applications
- time and spatial information on the GNSS state stored in SSR files
- any correction data can be retrieved from SSR in real-time and post-processing

SSR based Post-Processing

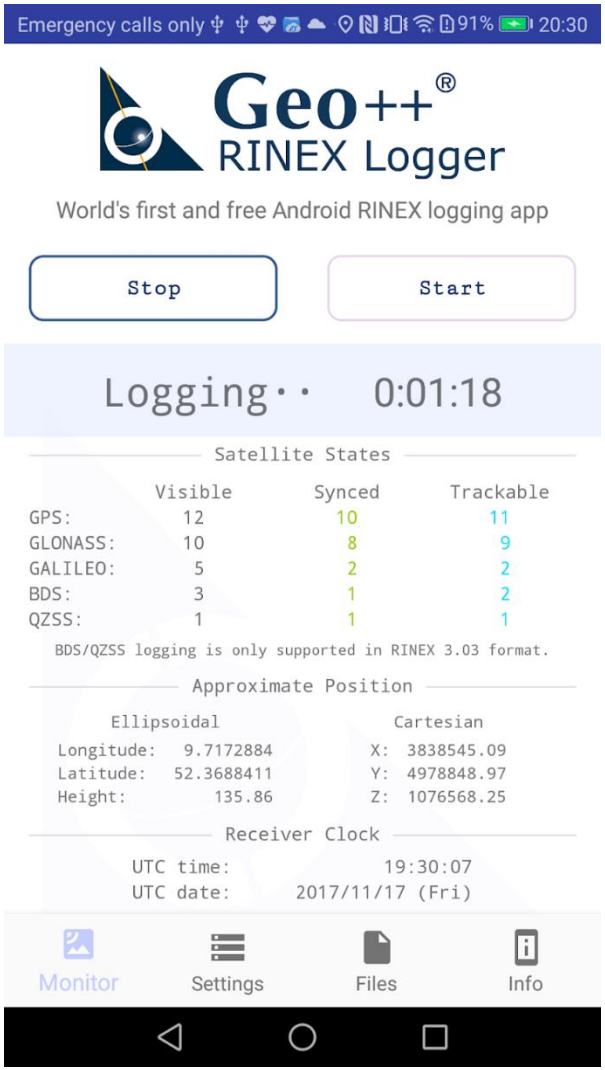
- Geo++® GNSMART performs State Space Monitoring providing SSR in real-time
- user uploads RINEX data to a service
- rover positioning algorithm using SSR based Network RTK run by the server
- user downloads coordinates and trajectories

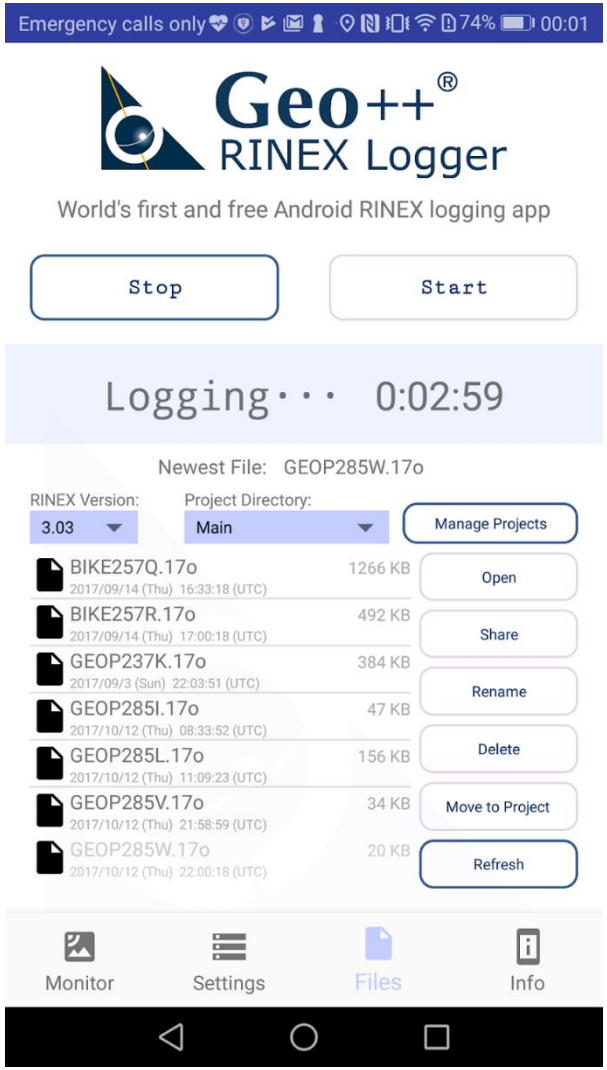
Android Applications

Android Applications (1/2)

- with Android 7.0 (Nougat) possibility to process GNSS raw data
- Geo++®RINEX Logger app which can write observation data into RINEX files to allow post processing and precise positioning
- chance to investigate precise positioning with smartphones and tablet computers
- focus on possible application in real-time

Android Applications (2/2)



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C11  25707000.914     2632651.9701        -3473.166        28.563
C13  38933416.657      975309.2941        -1468.388        35.564
C14  26489497.303    -1699872.7871         2215.120        34.015
E02  24308735.313     1714112.8071        -2374.753        33.494
E22  22516229.139    -1339282.4181         1668.318        28.542
E30  21871502.374     -511577.3221          547.641        42.319
> 2017  8 10  8 59 57.9999772  0 22
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G12  25373240.171     3037319.1481        -3991.406        32.465
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G21  22953097.801    -1919886.3651         2443.252        29.002
G23  25192030.620      -74862.4941         -105.620        36.829
G25  22392900.218     2467161.1391        -3341.849        40.876
G26  22327693.260    -1838668.9691         2333.768        43.488
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G31  21408472.623     1054220.1931        -1603.704        41.212
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R20  20255964.887     2108766.4151        -2952.753        40.275
R21  19547284.297    -1072851.8431         1170.158        36.823
R03  23635900.007     1194546.9411        -1856.146        36.794
C11  25708333.791     2639599.3051        -3472.984        27.909
```

Absolute Positioning

Absolute Positioning (1/3)

Idea:

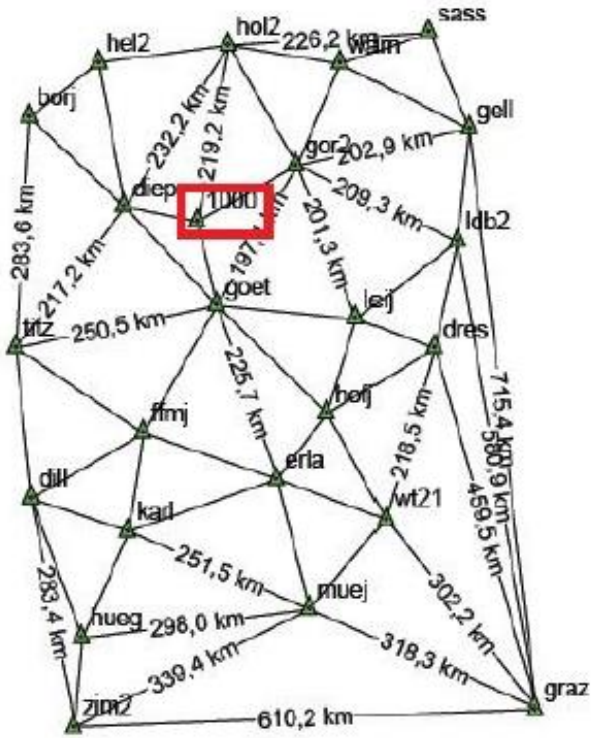
- logging of RINEX 2.11 files
- use of SSR Post concept

Objective:

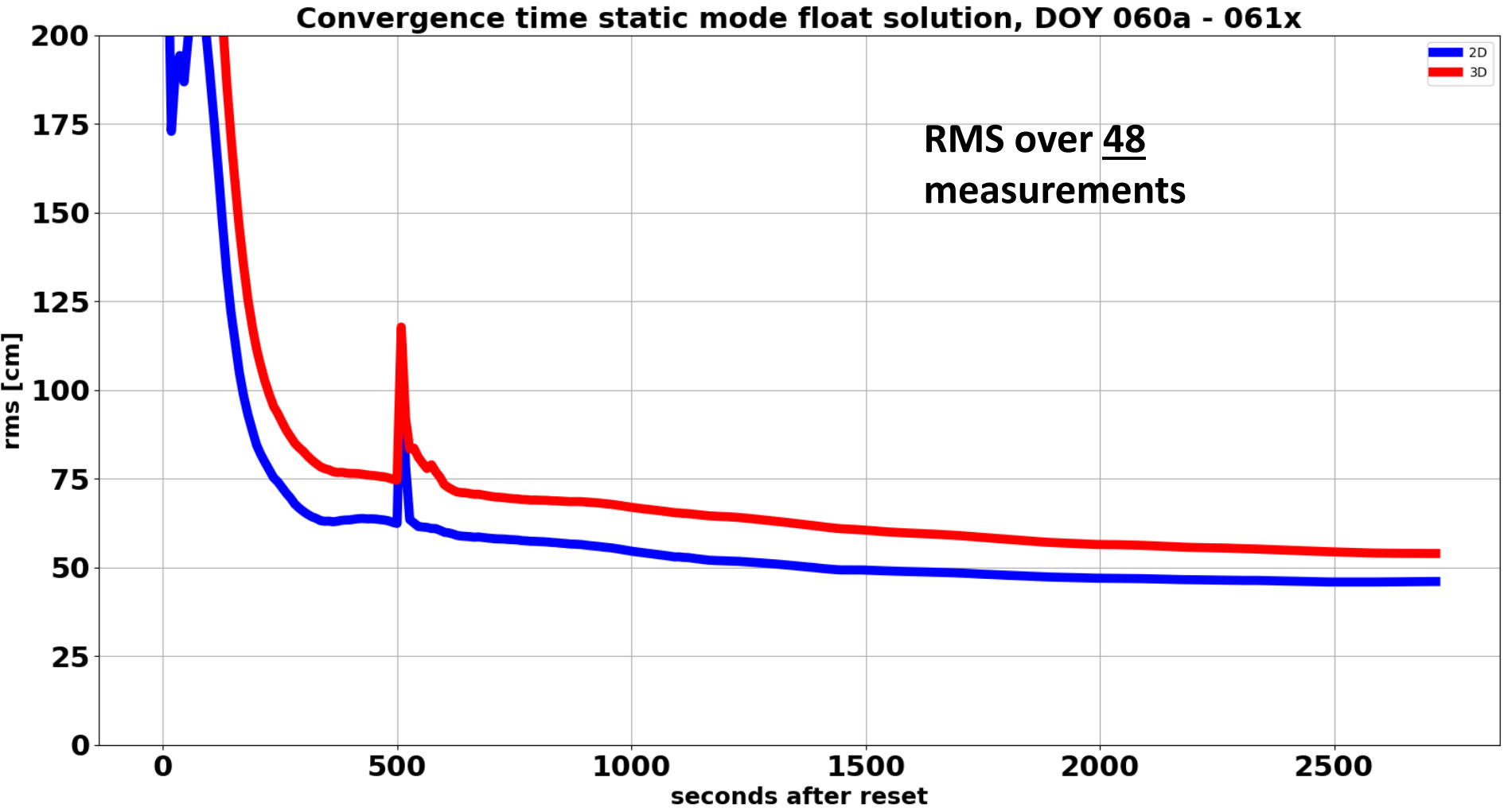
- get the absolute position of a Android device on the roof of the Geo++ building

Problem settings:

- device used: tablet computer Nexus 9
- network: extended German BKG GREF network
- average stations distance: 211 km
- technique: SSR based Network RTK



Absolute Positioning (2/3)



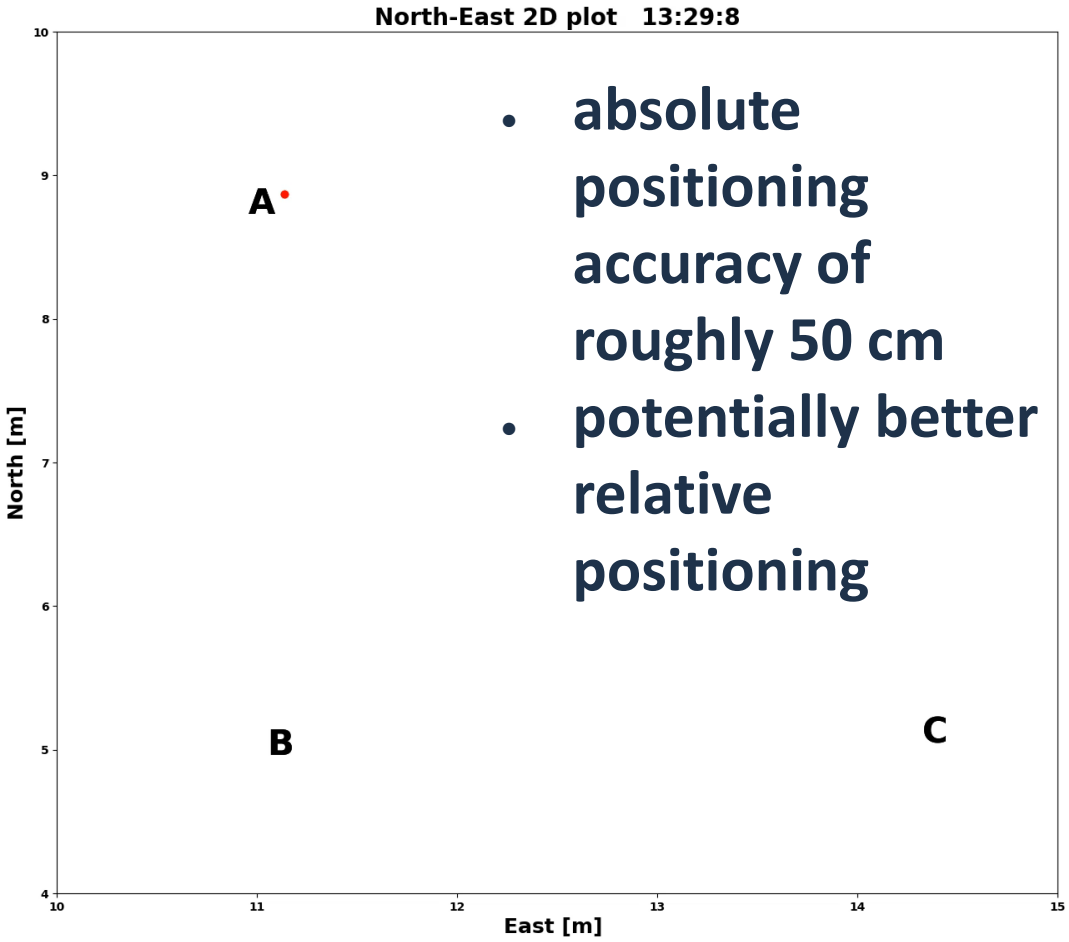
Absolute Positioning (3/3)

Comments:

- **no ambiguity fixing possible → float solution**
- **after 5 min roughly 60 cm 2D positioning precision**
- **no real time application for absolute positioning**
- **good result considering a network of 210 km average distance**
- **static mode test**
- **can we track a path in kinematic mode?**

Path tracking

- objective: follow a trajectory
- location: roof of the Geo++ building, 3 pillars of known coordinates are considered



- absolute positioning accuracy of roughly 50 cm
- potentially better relative positioning

Ruler App

Ruler App(1/3)

Idea:

- logging of Rinex 2.11 files
- use of SSRPOST concept
- download a trajectory

Objective:

- measure the distance between two points

Problem settings:

- devices used: tablet computer Nexus 9, smartphone Samsung Galaxy S9
- network: extended BKG German GREF network
- average stations distance: 211 km
- technique: SSR based Network RTK

Ruler App(2/3)

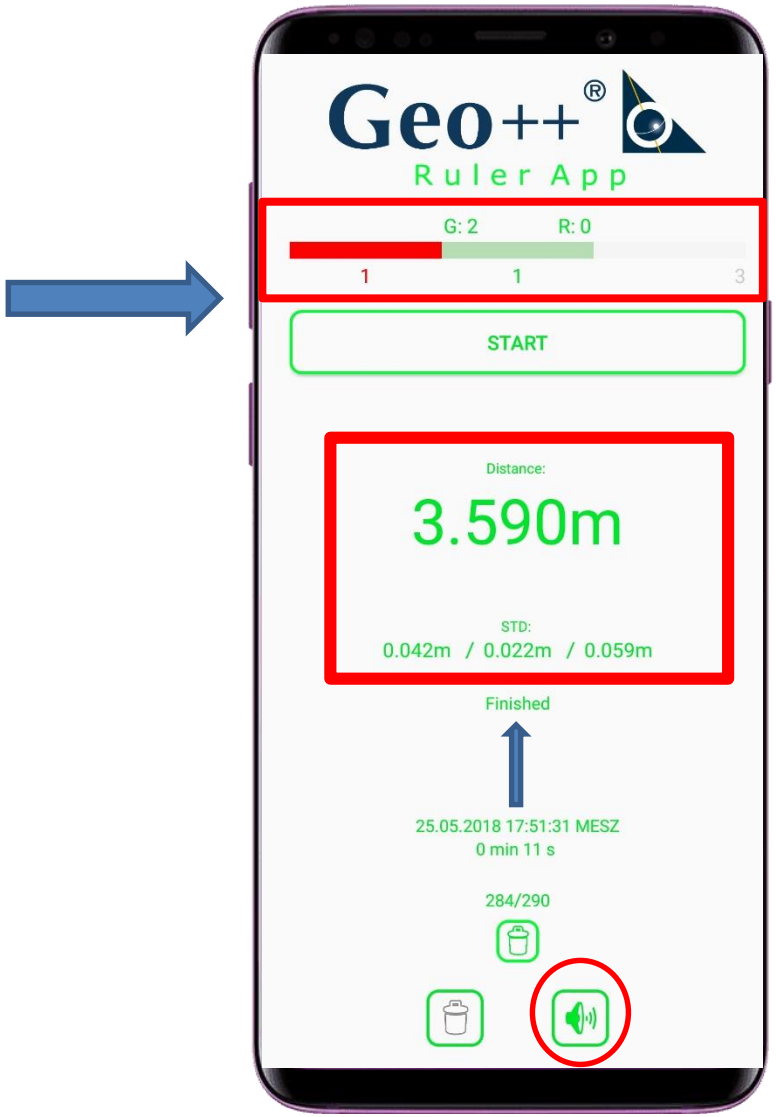
Device:

- **Smartphone Samsung galaxy 9 (Android 8)**

Results w.r.t. a known length (9.87 m and 2.39 m) over 37 measurements:

- **RMS = 7.74 cm**
- **STD = 4.47 cm**

Ruler App(3/3)



- volume down button: start/stop
- indicators of:
  - satellites
  - distance value and accuracy
  - processing status (up to 30 s)
  - GNSS measurements (acoustic indicator)

Conclusions and Future Work

Conclusions

- no chance to fix ambiguities due to different phase biases
- 5 min convergence time to get 60 cm precision absolute positioning in static mode using SSR data from a sparse network → too slow for real time applications
- Ruler App to measure distances in near real time
- error roughly 8 cm RMS w.r.t. known distance
- performance depends on the satellites availability → it will improve with Galileo
- performance dependency on the device and Android version (7 or 8)

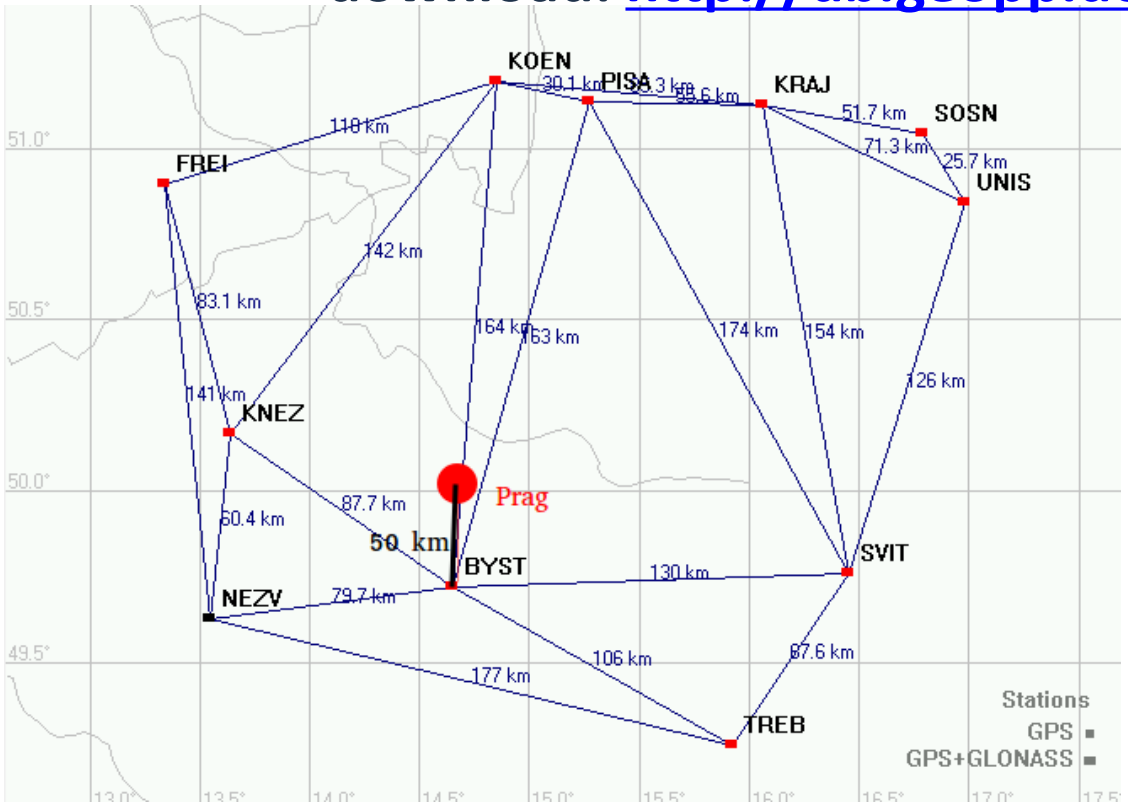
- part of the present work is protected by patents

Future Work

- solve the phase bias issue to fix ambiguities and do high accuracy positioning
- setting up the Ruler App in real time
- find future applications

Test the App

- available DEMO: test the Ruler App in Prague
- download: http://db.geopp.de/ruler.html



acknowledgements
to CNH Industrial
to provide
reference stations
data access

Thank you for your attention