Development of interface for GNSS and GIS integration by using free open source software

UNIVERSITY OF ARCHITECTURE CIVIL ENGINEERING AND GEODESY

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Motivation – Surveying and geodetic practice nowadays

The standard tasks in geodetic practice that are performed every day:

- Survey Control Networks – accuracy of 2-5 cm
- Surveys – accuracy of 5-10 cm
- Tracing – accuracy of 5-10 cm
- Geospatial data collection (incl. real time tracking) – accuracy of submeter or decimeter level

What is important for the practice:

- Time for obtaining the solution
- Accuracy
- Cost

GNSS and GIS – common use

Application of RTK/NRTK, DGPS and PPP methods for real time data collection:

- Survey Control Networks – accuracy of 2-5 cm – RTK/NRTK
- Surveys – accuracy of 5-10 cm – RTK/NRTK
- Tracing – accuracy of 5-10 cm – RTK/NRTK
- Geospatial data collection – accuracy of submeter or decimeter level – DGPS and PPP

What are the basic advantages of GIS:

- Data collection, maintenance, management, classification and analysis
- Data layers from many sources
- Works with databases
- Wide variety of coordinate systems and projections
- Wide variety of coordinate transformation methods

The use of open source software

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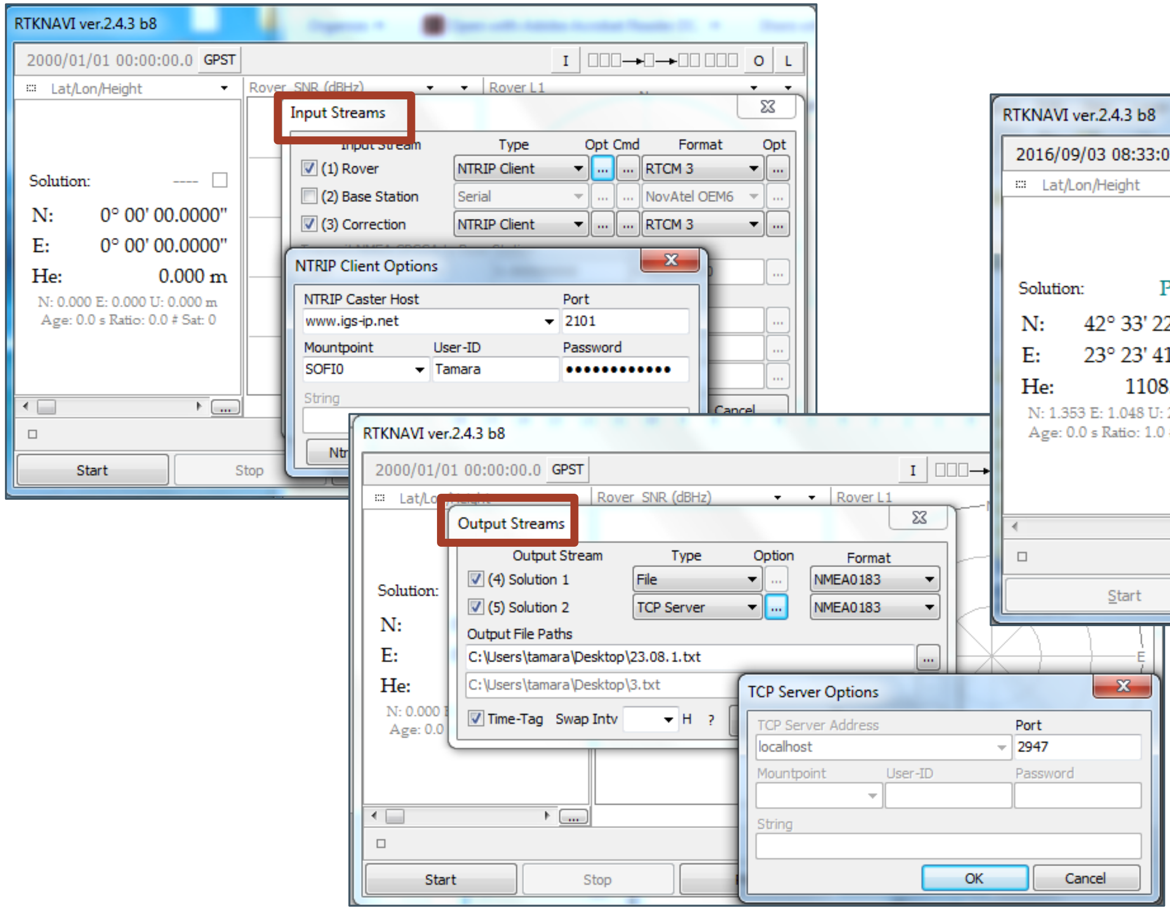
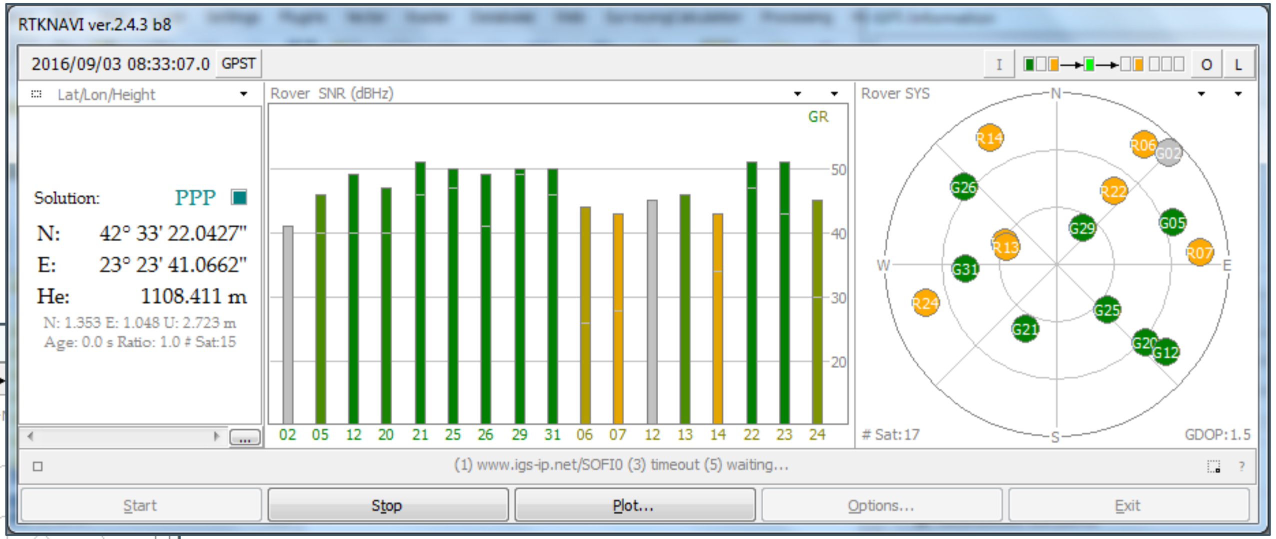
…

GPL V2, GPL V3

Integration of GNSS and GIS by using RTKLIB and QGIS open source software

Standard Functionality





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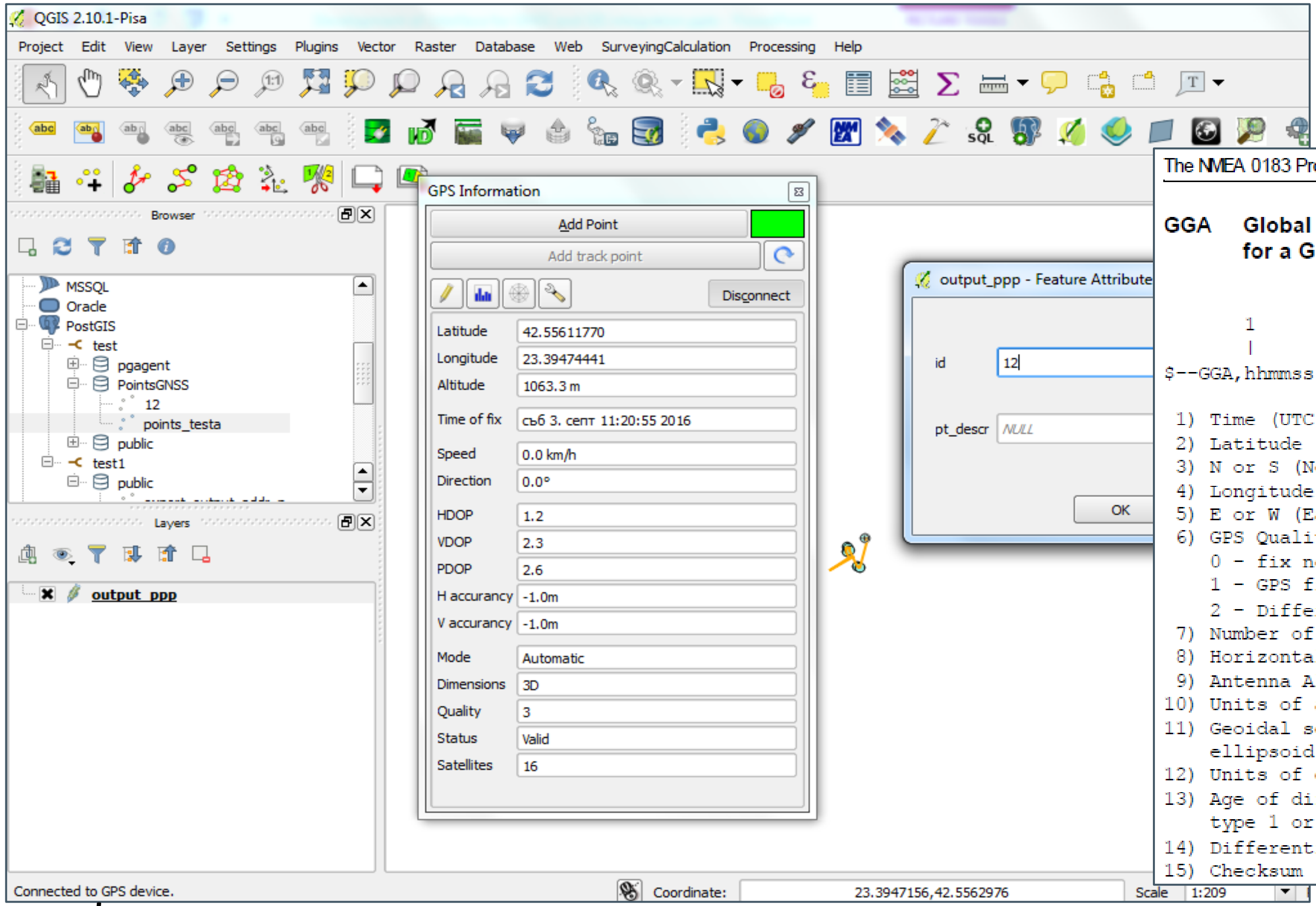
Standard Functionality



The NMEA 0183 Protocol

GGA Global Positioning System Fix Data. Time, Position and fix related data for a GPS receiver

```
                                                      11
       1         2       3 4        5 6 7  8   9  10 |  12 13  14   15
       |         |       | |        | | |  |   |   | |   | |   |    |
$--GGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh
```

1) Time (UTC)
2) Latitude
3) N or S (North or South)
4) Longitude
5) E or W (East or West)
6) GPS Quality Indicator,
   0 - fix not available,
   1 - GPS fix,
   2 - Differential GPS fix
7) Number of satellites in view, 00 - 12
8) Horizontal Dilution of precision
9) Antenna Altitude above/below mean-sea-level (geoid)
10) Units of antenna altitude, meters
11) Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level below ellipsoid
12) Units of geoidal separation, meters
13) Age of differential GPS data, time in seconds since last SC104 type 1 or 9 update, null field when DGPS is not used
14) Differential reference station ID, 0000-1023
15) Checksum

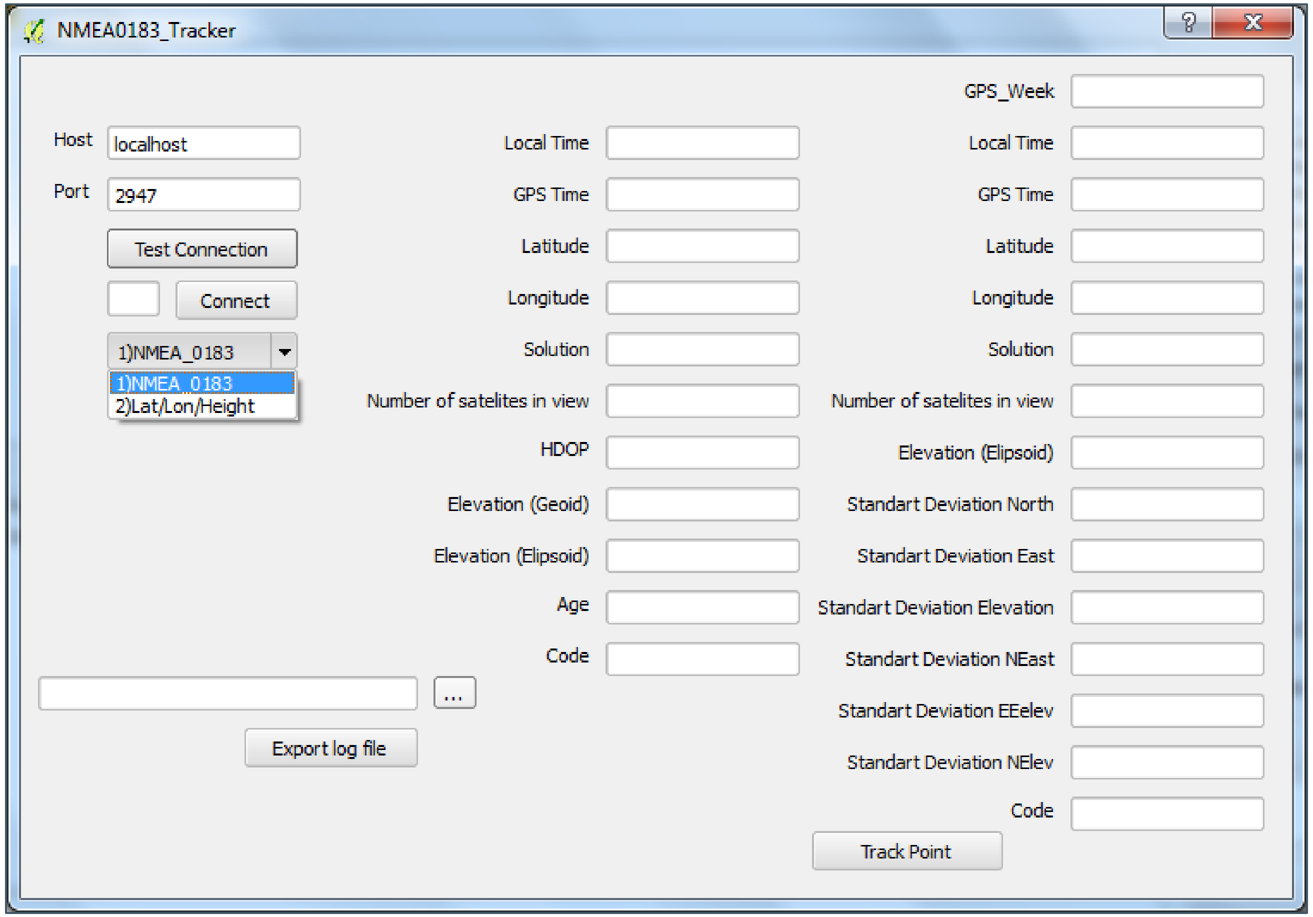
$GPGGA,113709.00,4233.3670286,N,02323.6847774,E,3,16,1.0,1061.320,M,43.657,M,0.0,*7E

Integration of GNSS and GIS by using RTKLIB and QGIS open source software

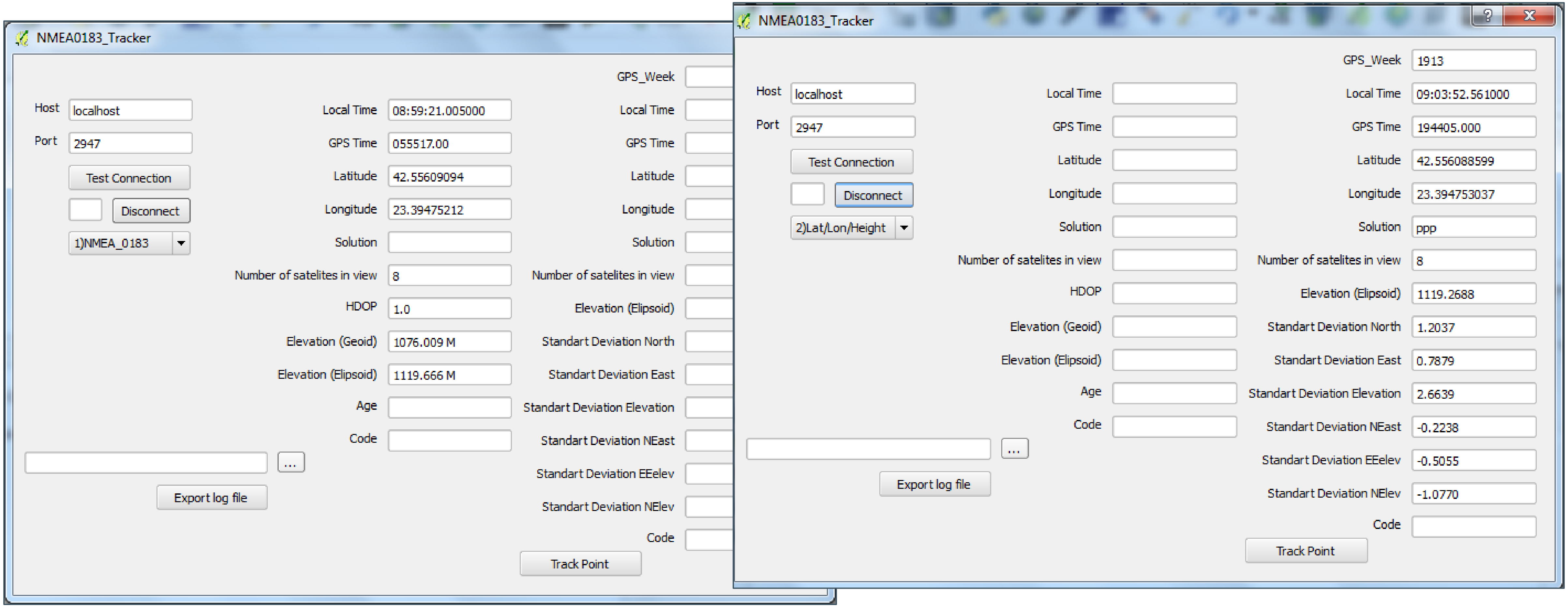
Why Standard Functionality is not enough?

1. **QGIS only uses NMEA as data input**
2. **The tool makes points with geometry characteristics only, but further information about the solution is not available**
3. **There are many others things that matter, so if we want to compare the results we should keep in mind:**
   - Positioning mode
   - Solution type
   - Satellite systems
   - Frequency type
   - Elevation mask
   - Ionosphere correction
   - Troposphere correction
   - Ephemeris
   - Clocks
4. **The use of coordinate systems and projections – the results must be in the same system and frame**

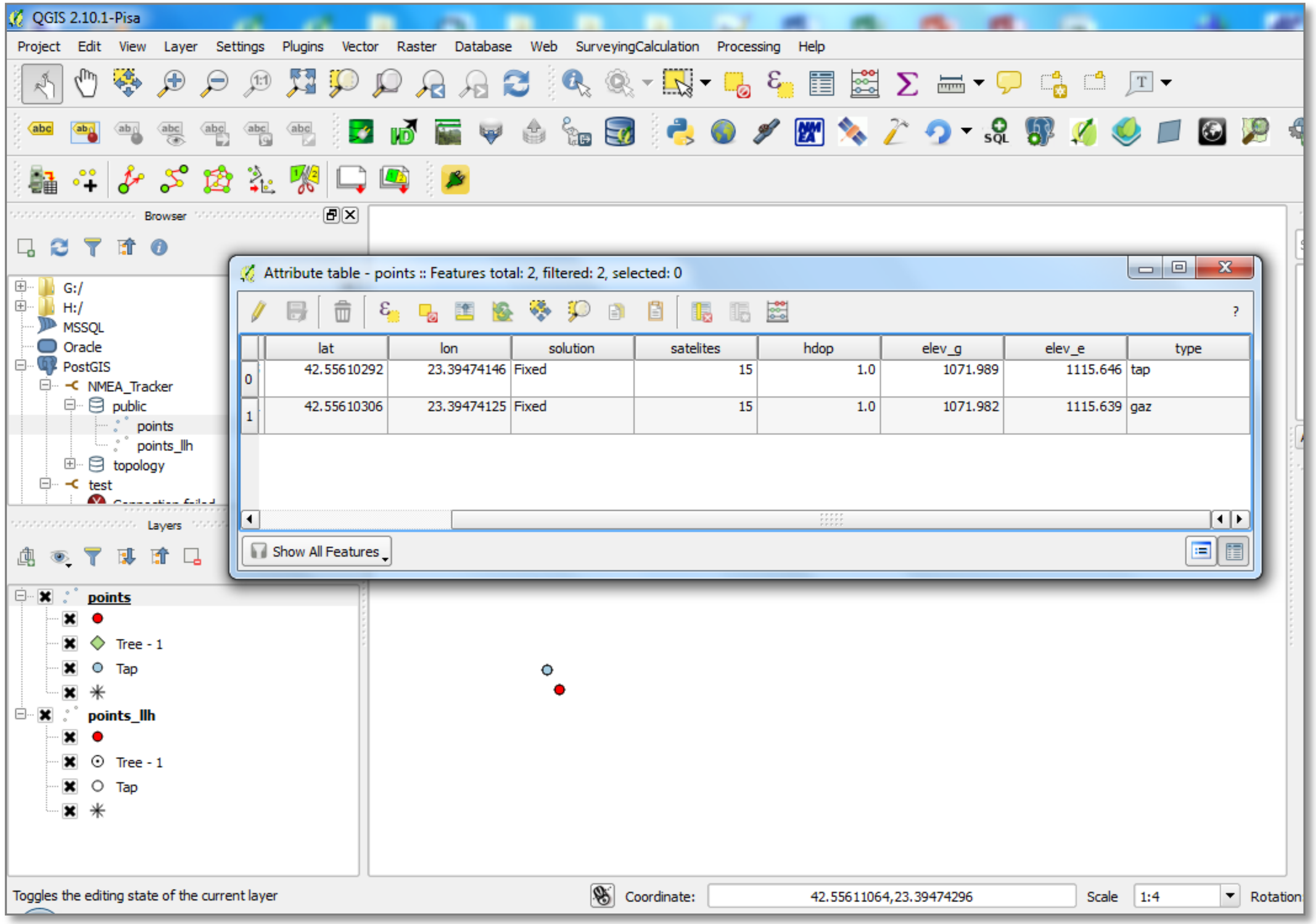
Development of interface for real time GNSS measurements in GIS environment



Development of interface for real time GNSS measurements in GIS environment



Development of interface for real time GNSS measurements in GIS environment



Spatial database – PostgreSQL with extension PostGIS, EPSG coordinate systems

Usually, we don't use only GNSS data but make combinations with other types of data.

Even if we perform GNSS measurements only => Coordinate conversion and transformations are to be applied

Every GNSS measurement, ever taken, is related to current measurement epoch and if the obtained coordinates must be compared with previously obtained ones, where the time between the two epochs is more than a few months, an epoch-conversion model must be used. The static measurements for example, due to the post processing, the coordinates obtained for the newly determined points are related to the coordinates of the known ones. Similar is the situation with the Real time Kinematic measurements, but this is not the case for the stand alone positioning, especially for precise point positioning. **It is necessary such conversion to be applied when using global reference frames, because of the velocities of the points.**

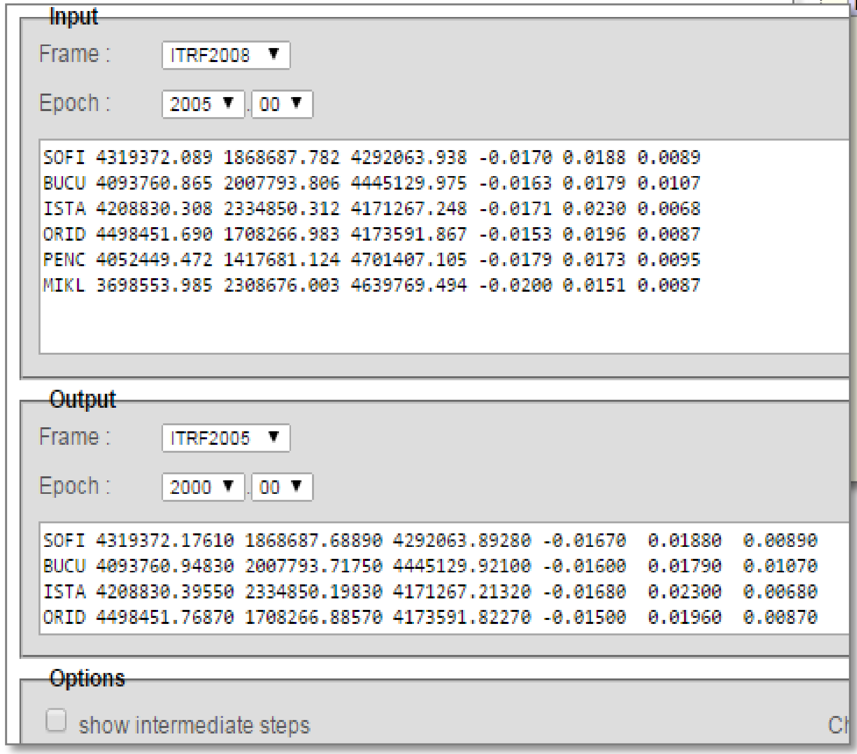
If the time period between the two measurements is few years or even more the transformation most probably will include and change of the realization of the system – change of the reference frame. In addition, for analysis or other purposes the X,Y,Z coordinates of the points could be used, but also B,L,H, or projected coordinates, related to some specific type of projection, so coordinate conversion is commonly used for such case.

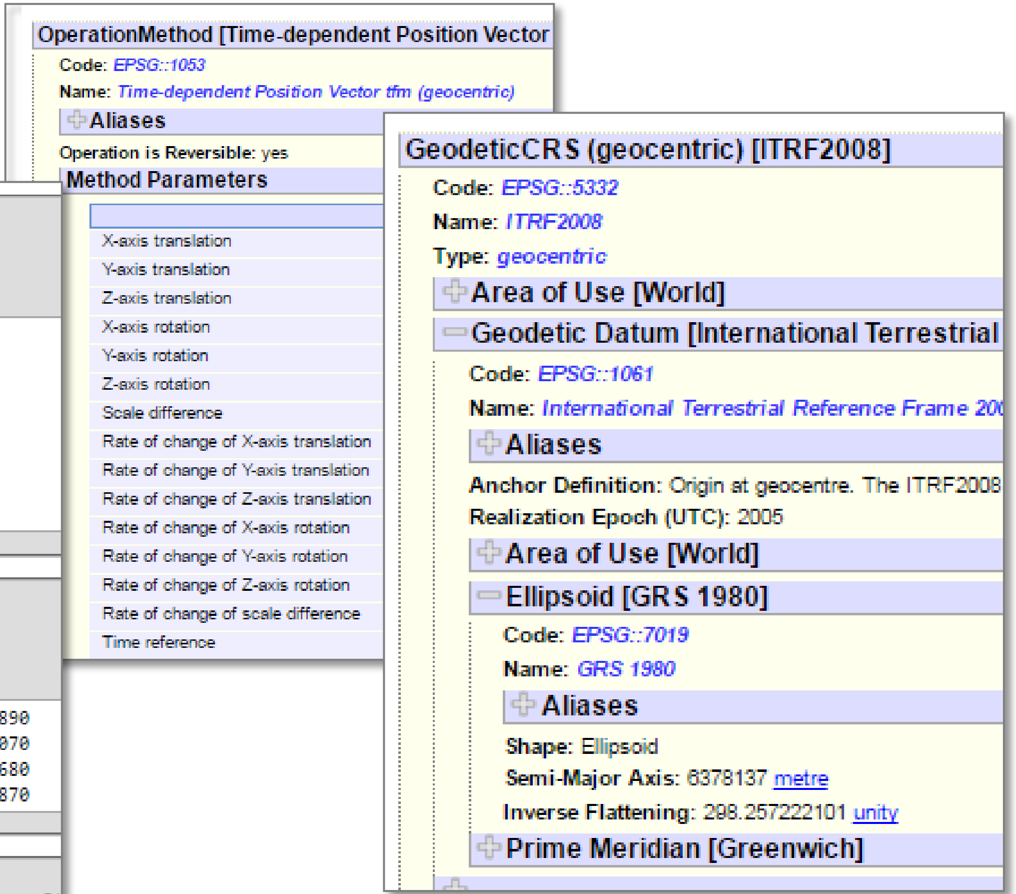
This is possible with the use of spatial database with applying transformations with predefined parameters.

Working with Spatial database – PostgreSQL with extension PostGIS, EPSG coordinate systems

ITRS, ITRF 2008, Epoch 2005.0			
Name	X [m]	Y [m]	Z [m]
SOFI	4319372.089	1868687.782	4292063.938
BUCU	4093760.865	2007793.806	4445129.975
ISTA	4208830.308	2334850.312	4171267.248
ORID	4498451.690	1708266.983	4173591.867
PENC	4052449.472	1417681.124	4701407.105
MIKL	3698553.985	2308676.003	4639769.494

ITRS, ITRF 2005, Epoch 2000.0			
Name	X [m]	Y [m]	Z [m]
SOFI	4319372.175	1868687.690	4292063.892
BUCU	4093760.948	2007793.719	4445129.920
ISTA	4208830.395	2334850.199	4171267.213
ORID	4498451.768	1708266.887	4173591.822
PENC	4052449.563	1417681.039	4701407.056
MIKL	3698554.086	2308675.930	4639769.449





Further works

Making modifications of the output of RTKLIB software

Making modifications of the solutions

Making modifications

Analyzing the different types of solutions and make comparison in order to be obtained the most efficient ones

Applying the coordinate conversion and transformations as a part of the interface

References

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3. http://postgis.net/
4. http://www.postgresql.org/
5. https://www.epsg-registry.org
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Thank You for Your Attention!