Monitoring of SKPOS® network solution (network RTK) quality

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Motivation

- SKPOS® presents active geodetic controls of Slovakia
- Aim of the GKU is to improve activity on the field of georeference service providing
- GKU decided to create independent tool for online monitoring of SKPOS® network solution (SKPOS® network RTK) quality and to provide its results to public

- Task was succesfully solved by Diploma thesis (Karol Smolik – GKU colleague)
- http://monitoringskpos.gku.sk

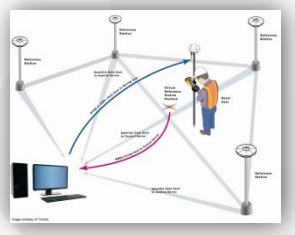
Requests of the GKU on the new tool

GKU (SK*POS*® administrator) requests:

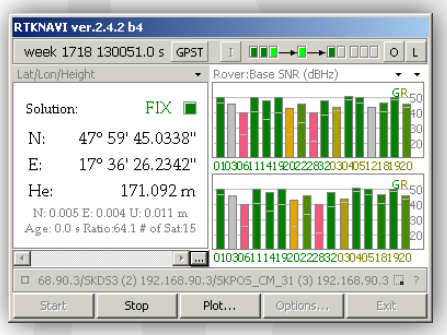
- Monitoring have to be done of whole Slovakia
- Monitoring have to automatic
- Results from monitoring have to be available to users
- If it will be possible, avoid to built too much monitor stations
- If it will be possible, avoid to use expensive software solutions

Tool design

- Virtual solution (no real monitor stations)



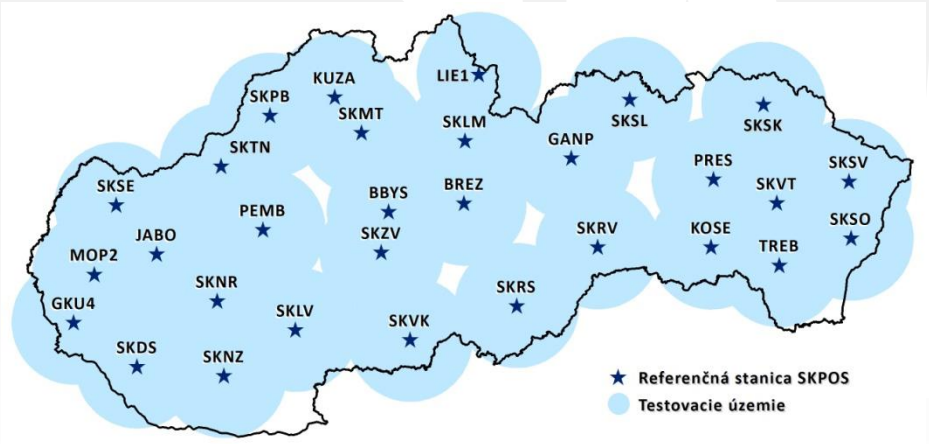
- Open source software RTKNAVI (part of RTKLib)

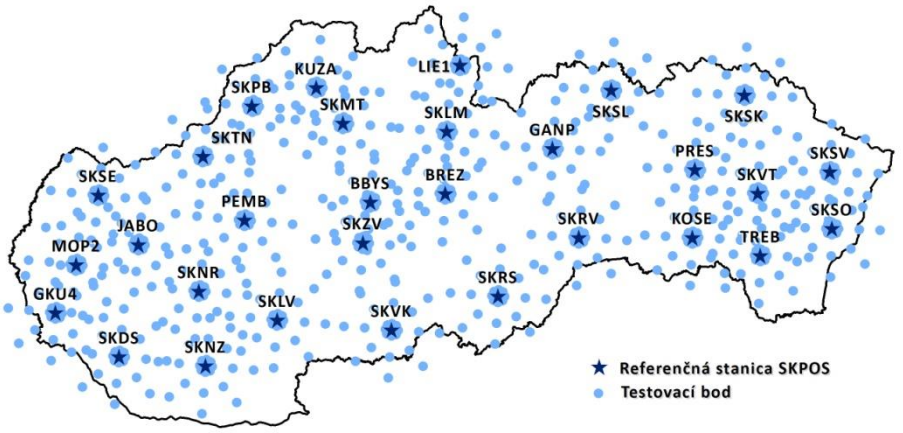


- Principle: RTKNAVI simulates rover (stand on the know point) which connects to **SKPOS®** and computes baseline composed of VRS (rover = FIX point) and **SKPOS®** reference station
- Quality criteria: deviation between determined coordinates of **SKPOS®** permanent station and reference coordinates of **SKPOS®** station.

Test points distribution

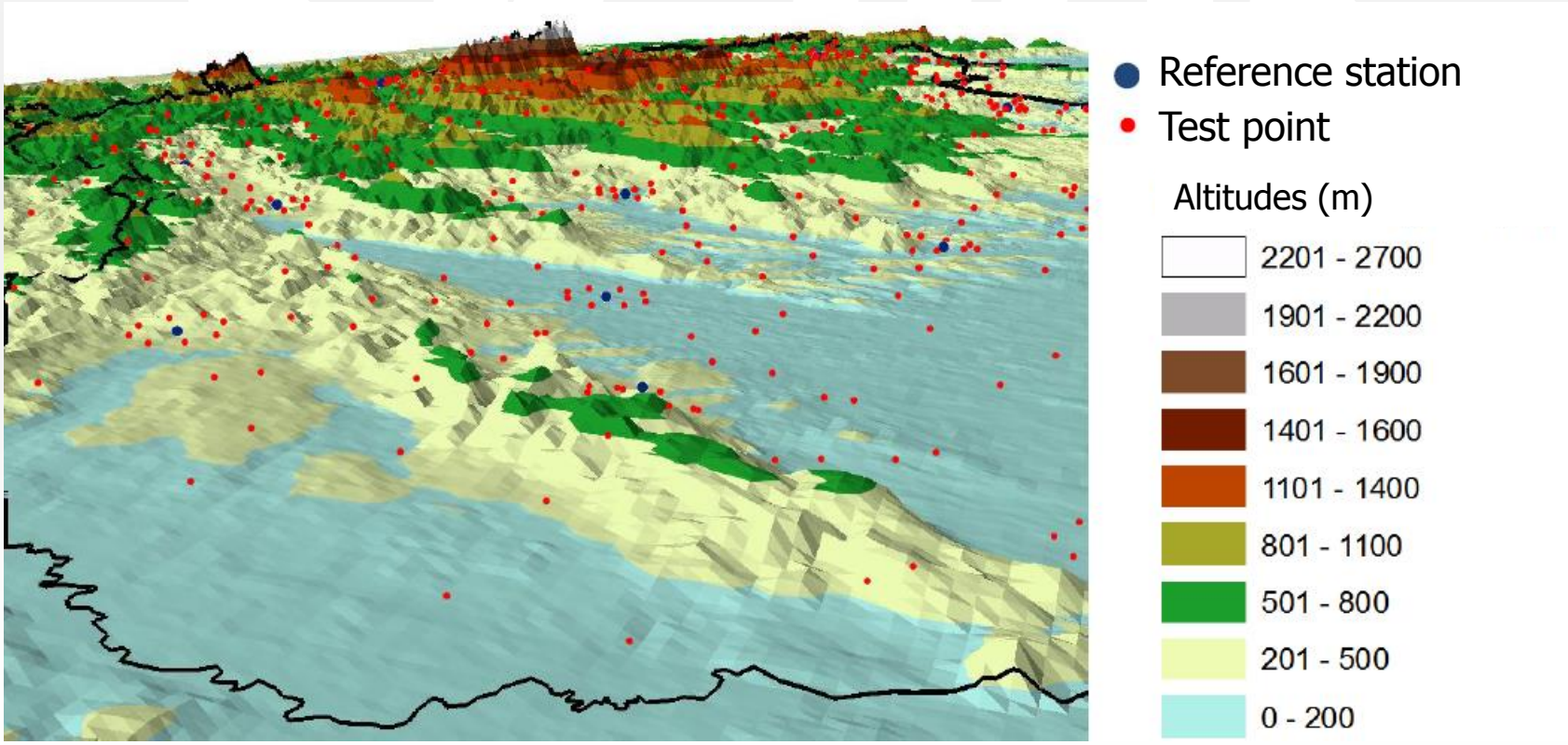
- Slovakia is divided into circle regions with SKPOS stations in centres
- Testing points are in direction from centre: 3km, 11km or 20km
- Azimuth of testing baselines are: 0°, 45°, 90°, ..., 315°





Test points altitudes

- SRTM is used for generating test points altitudes

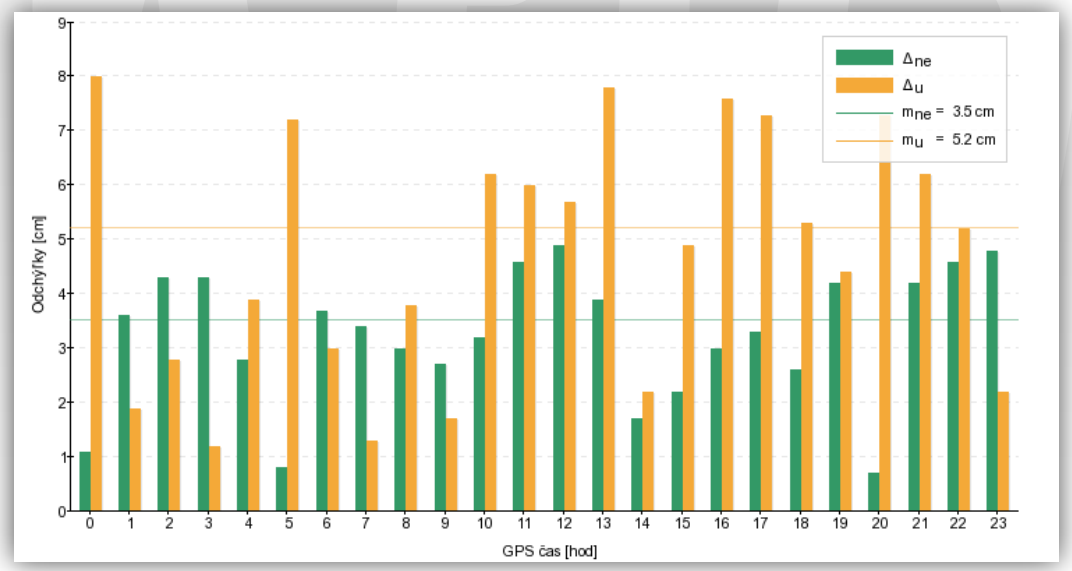


Test points selection

- Combination of distance and azimuth = 24 possibilities of test points within one circle region
- Every locality tests one time per hour
- Random generation of azimuth/distance combination
- Length of one locality test: 2 minutes

Criteria quality output

- Only fix solutions
- Remote values elimination (Grubbs test)
- Deviations computation: ellipsoidal coordinates average transformed into topocentric coordinates
  - Horizontal plane ne
  - Vertical component u
- Graphical output: chart of deviations



Automatization

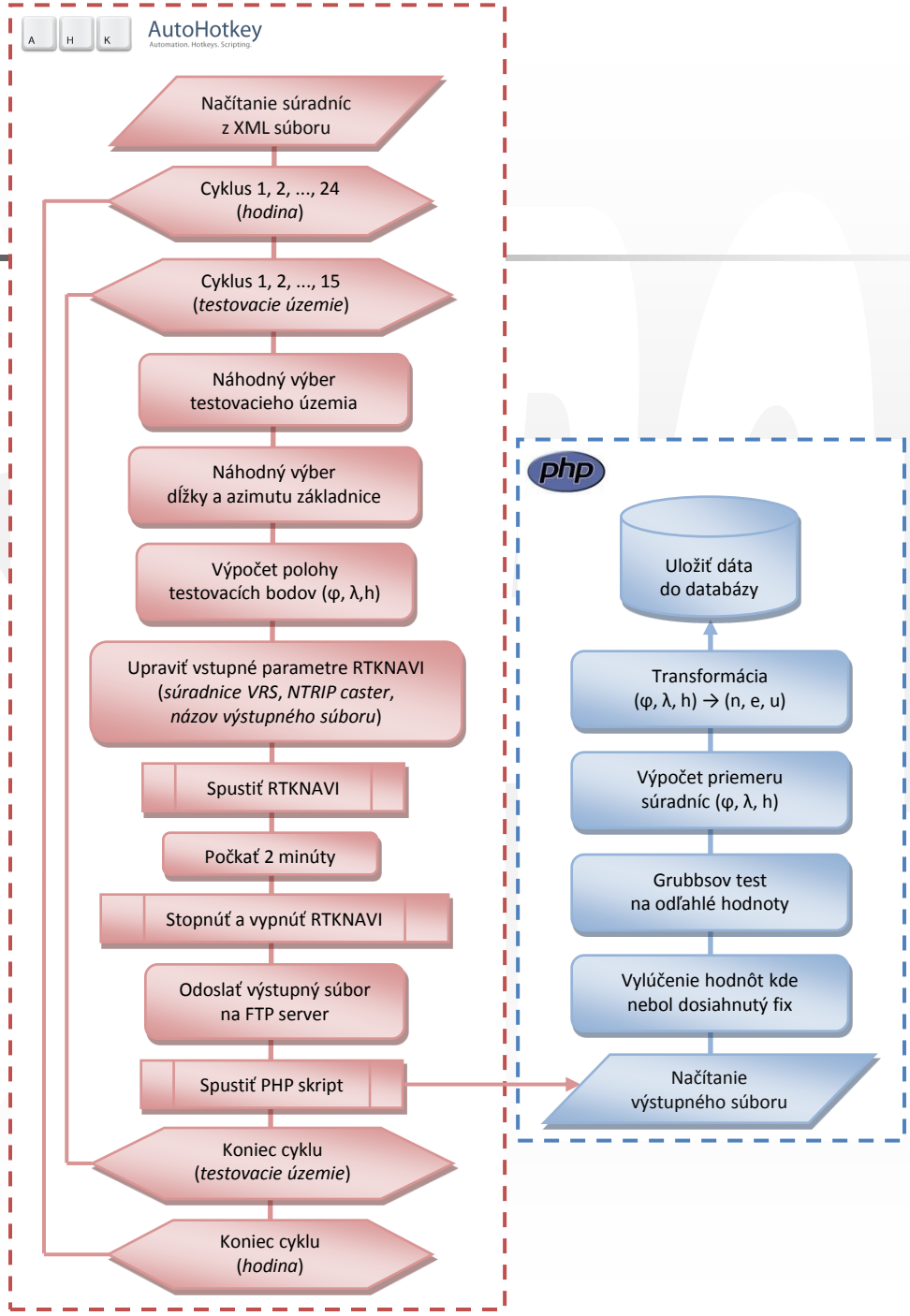
AutoHotkey
Automation. Hotkeys. Scripting.

- RTKNAVI is controlled by script tool **AutoHotkey**
- Processing is controlled by PHP script
- MySQL database

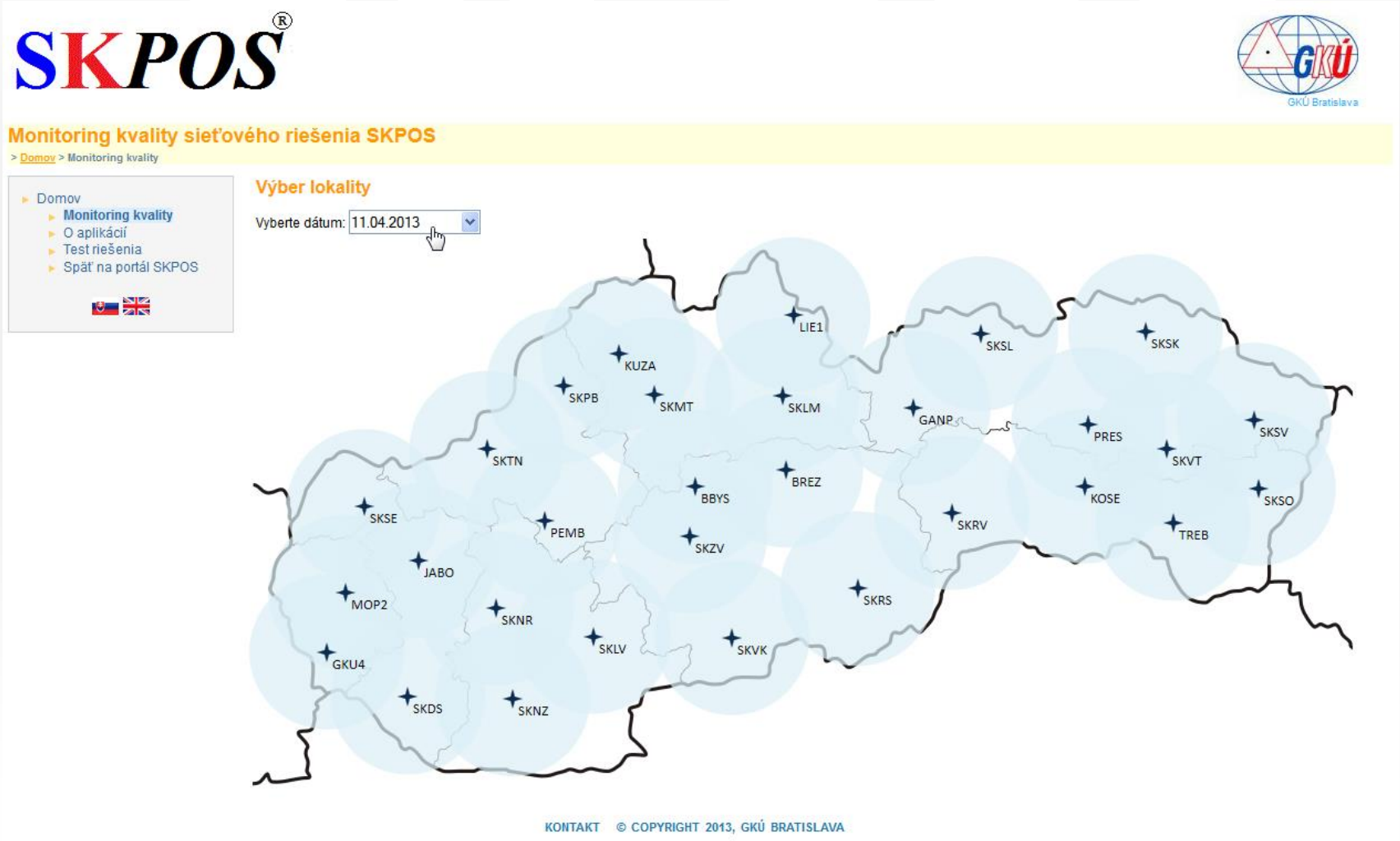
Monitoring1

DATE	TIME	STATION	DISTANCE	ANGLE	LATITUDE	LONGITUDE
2013-04-11	14:00:21	JABO	13	225	48.399138	17.540874
2013-04-11	14:03:42	SKDS	13	180	47.878925	17.607287
2013-04-11	14:07:04	SKTN	3	0	48.915970	18.032948
2013-04-11	14:10:25	SKNR	13	315	48.392352	17.959952
2013-04-11	14:13:47	GKU4	3	225	48.138021	17.143393
2013-04-11	14:17:08	SKMT	3	180	49.055299	18.933680
2013-04-11	14:20:30	KUZA	13	315	49.306023	18.612505
2013-04-11	14:23:51	SKSE	23	0	48.886837	17.373121
2013-04-11	14:27:13	SKNZ	13	180	47.872697	18.170138
2013-04-11	14:30:34	PEMB	13	270	48.622421	18.164294
2013-04-11	14:33:56	BBYS	23	45	48.885800	19.372809
2013-04-11	14:37:18	SKPB	3	270	49.115094	18.403315
2013-04-11	14:40:39	SKLV	3	315	48.232327	18.577020
2013-04-11	14:44:01	MOP2	3	135	48.353412	17.302452
2013-04-11	14:47:22	SKZV	13	180	48.457719	19.122585

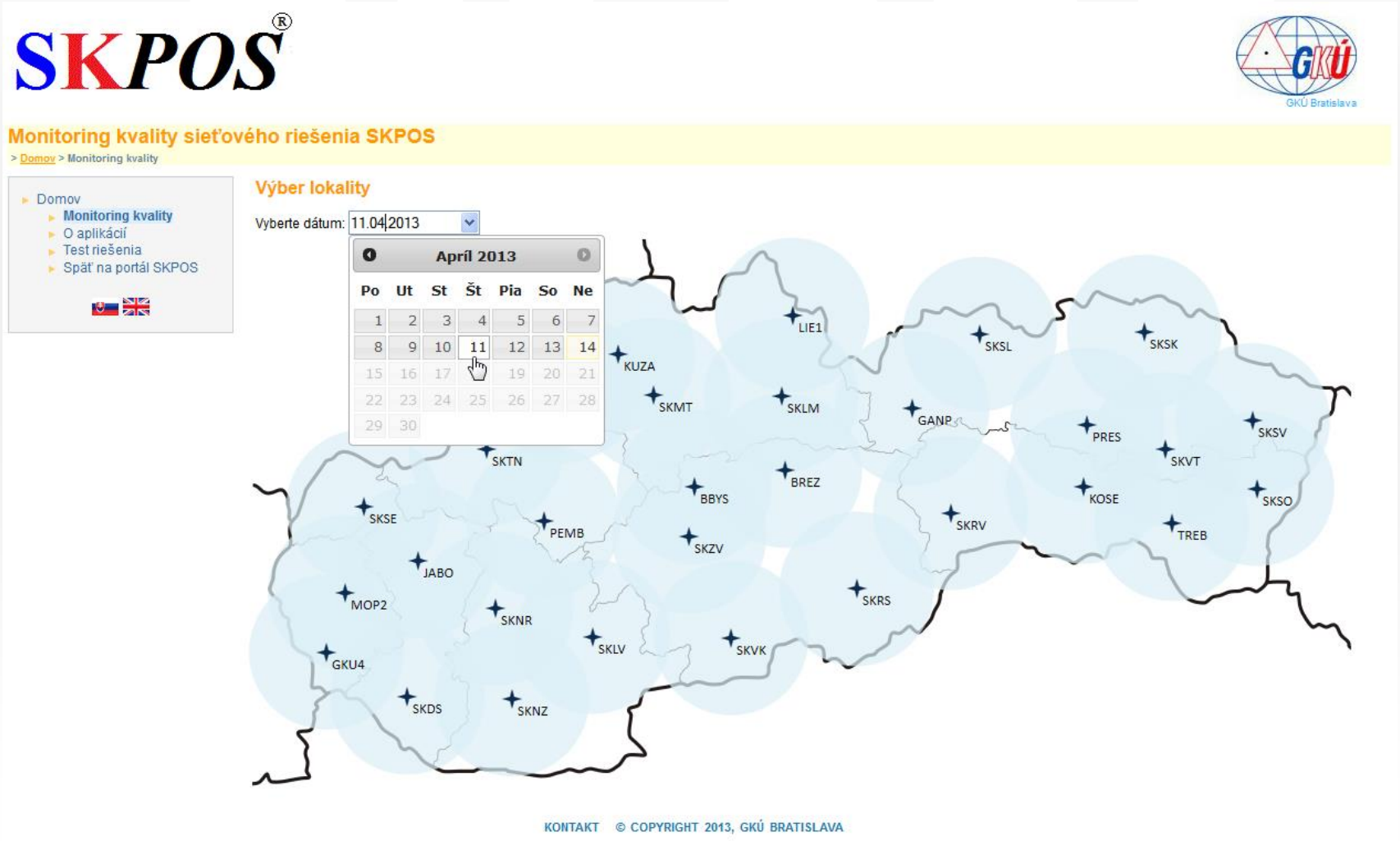
Flowchart


AutoHotkey
Automation. Hotkeys. Scripting.
Načítanie súradníc z XML súboru
Cyklus 1, 2, ..., 24 (hodina)
Cyklus 1, 2, ..., 15 (testovacie územie)
Náhodný výber testovacieho územia
Náhodný výber dĺžky a azimutu základnice
Výpočet polohy testovacích bodov (φ, λ,h)
Upraviť vstupné parametre RTKNAVI (súradnice VRS, NTRIP caster, názov výstupného súboru)
Spustiť RTKNAVI
Počkať 2 minúty
Stopnúť a vypnúť RTKNAVI
Odoslať výstupný súbor na FTP server
Spustiť PHP skript
Koniec cyklu (testovacie územie)
Koniec cyklu (hodina)
php
Uložiť dáta do databázy
Transformácia (φ, λ, h) → (n, e, u)
Výpočet priemeru súradníc (φ, λ, h)
Grubbsov test na odľahlé hodnoty
Vylúčenie hodnôt kde nebol dosiahnutý fix
Načítanie výstupného súboru

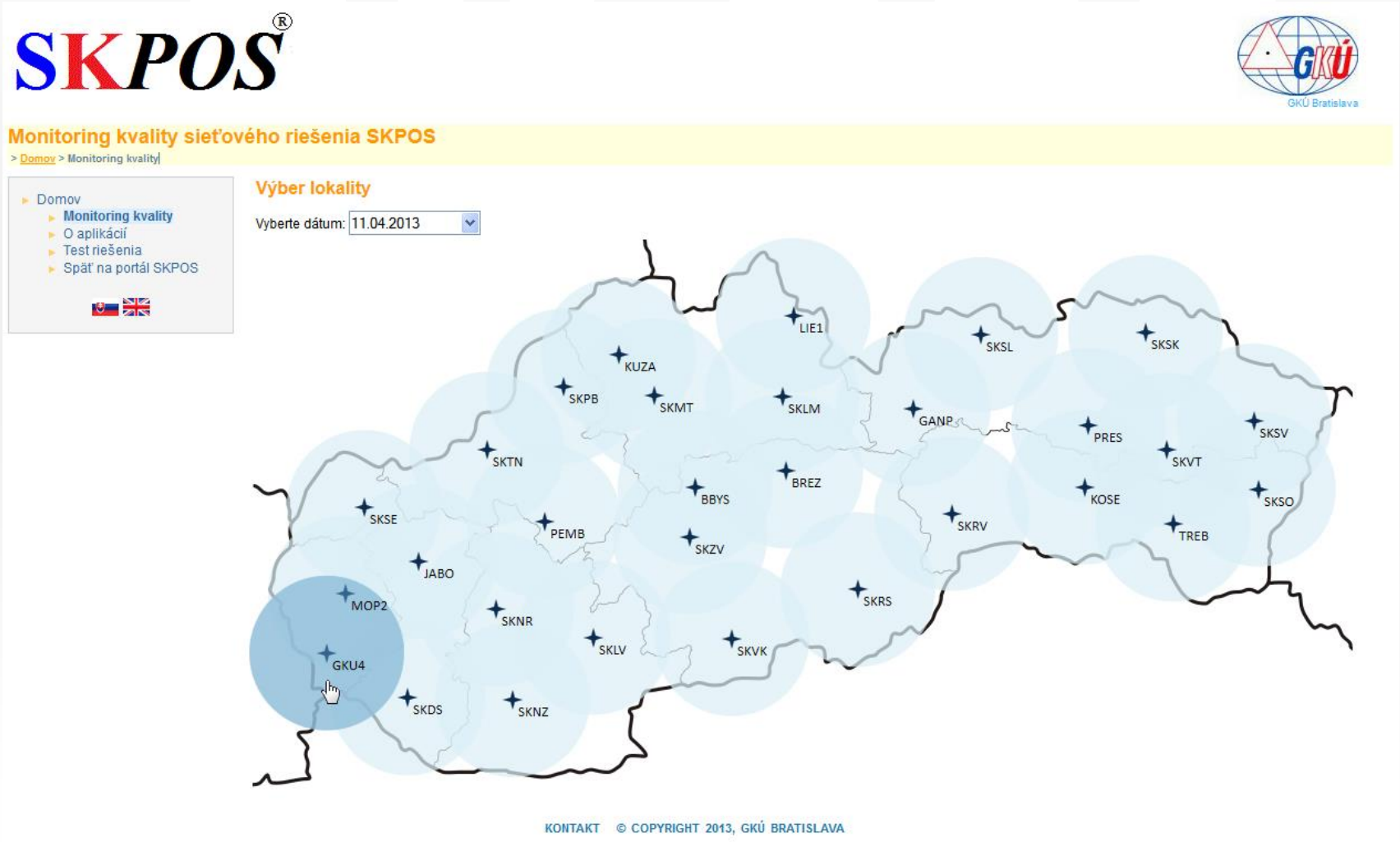
User interface



User interface



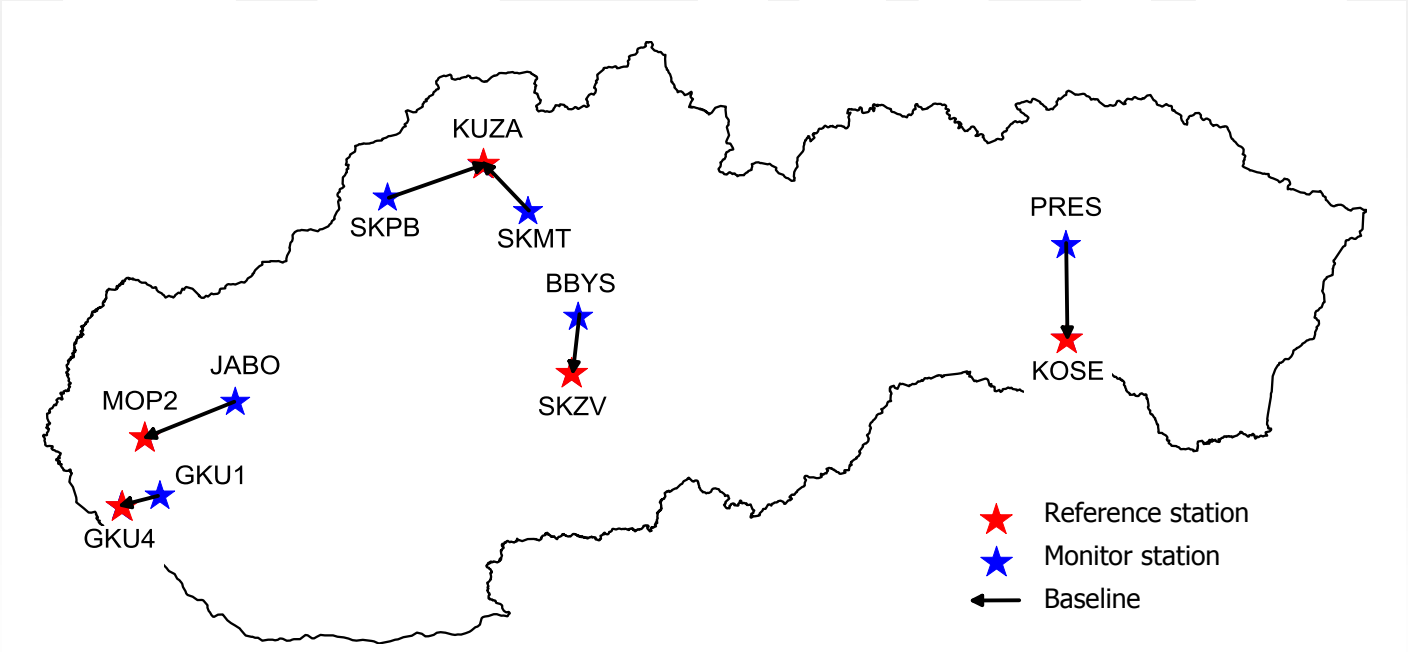
User interface



User interface

Verifying of virtual solution

- Hypothesis: Virtual solution data = real measurement?
- Test: comparison of results from virtual solution with real monitor station data

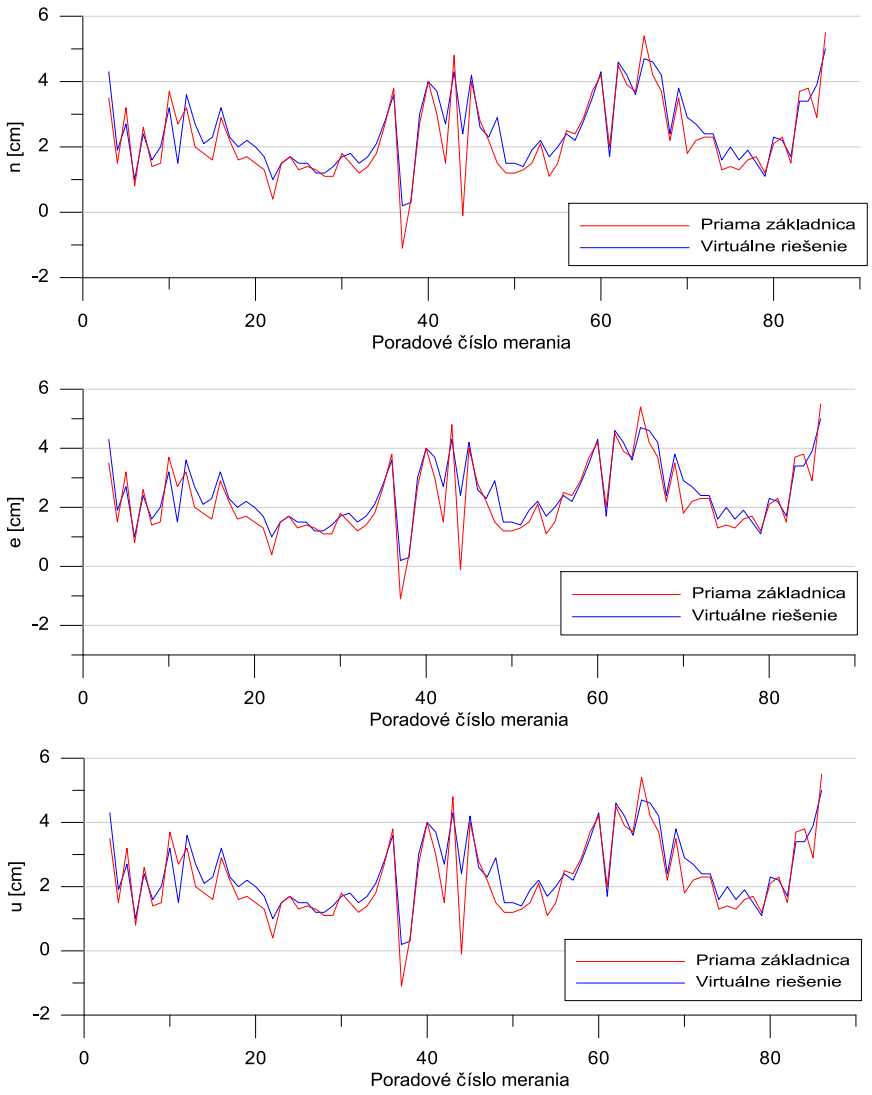


Verifying of virtual solution

- Length of test: 5 days
- Average values
  - HZ position: 0.3 cm;
  - V position: 1.7 cm

	n	e	u
Values	777	777	777
Minimal value	-3.2 cm	-1.7 cm	-3.0 cm
Maximal value	2.3 cm	2.7 cm	4.7 cm
Average	0.3 cm	0.3 cm	1.7 cm
Standard deviation	0.74 cm	0.99 cm	2.19 cm
Mean error	0.09 cm	0.05 cm	0.28 cm

Verifying of virtual solution



First results - statistics

- Date: 1.7.2013 – 15.9.2013
- Over 46,000 values
- Statistics in table

	Horizontal component ne	Vertical component U
Values	46,388	46,388
Maximal value	19.4 cm	19.3 cm
Average value	1.1 cm	2.3 cm
Standard deviation	1.54 cm	2.90 cm

Conclusion

- Monitoring tool without need to built real monitor stations
- Fully automated solution
- Results available for users via web application
- Provides important information about network solution quality in particular regions in Slovakia
- Introduction of monitoring = important step in service improvement

Thank you for your attention