WG on
SERVICE QUALITY MONITORING
(status in November 2016)

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EUPOS
European Position Determination System

3rd EUPOS® Council and Technical Meeting

November 14-15, 2016. Prague, Czech Republic

EUPOS WG on Service Quality Monitoring

- Established by the resolution 25.5 of the 25th Conference of the EUPOS Steering committee which was held in Riga
- Aims:
  - creation of the uniform common network RTK quality monitoring tool based on virtual monitoring stations for all EUPOS member countries
  - set it up and do analysis on outputs
  - implementation into EUPOS TS

RESOLUTION 25.5 OF THE 25TH CONFERENCE OF THE EUPOS STEERING COMMITTEE OF MAY 6-7, 2014 IN RIGA, LATVIA; AGENDA ITEM NO. 14.1: SKPOS (EUPOS) NETWORK SOLUTION MONITORING APPLICATION.

The EUPOS International Steering Committee (ISC),

noting the importance of the EUPOS service quality monitoring,

appreciating the development of an early tool for the quality monitoring of the EUPOS Network RTK service that could supplement the necessity to implement physical monitoring stations into the GNSS reference stations network,

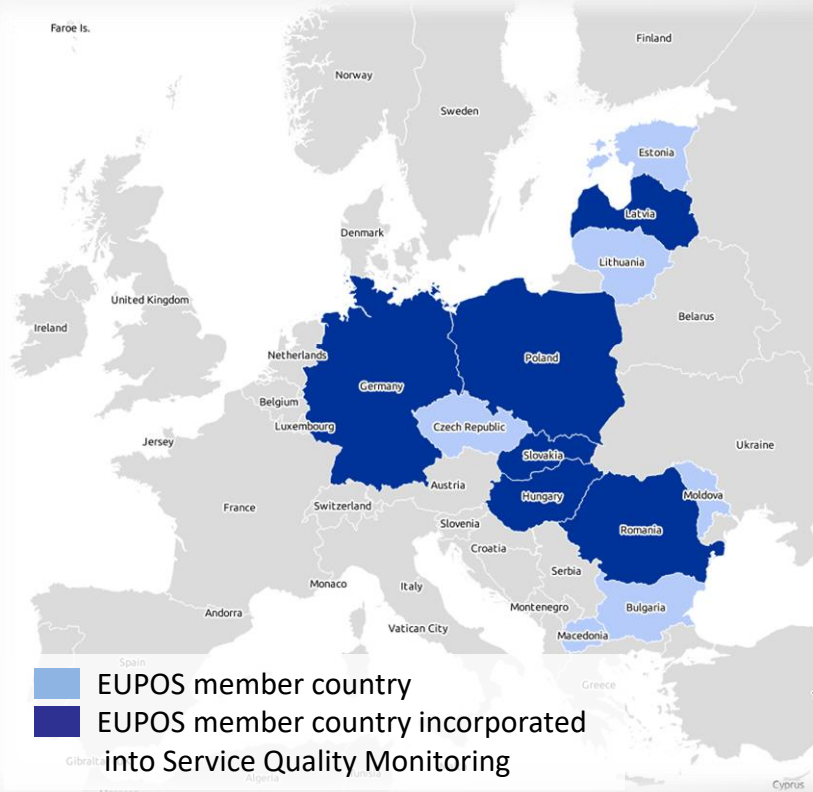
decides to create a EUPOS Working Group on Service Quality Monitoring and

requests Dr Branislav Droscak to chair this Working Group.

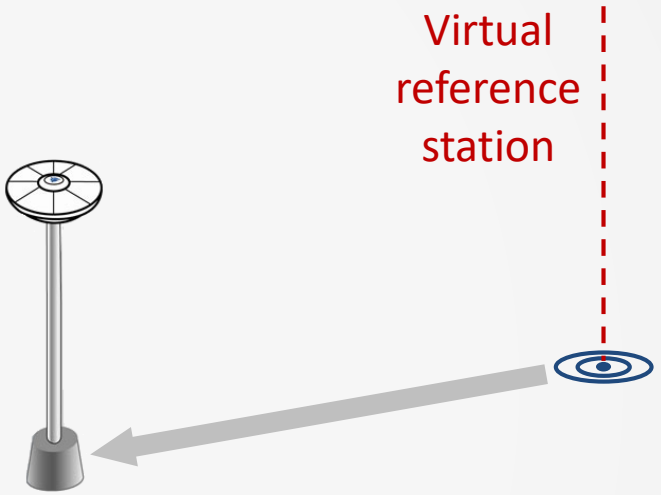
EUPOS WG on Service Quality Monitoring

- Members
  - Branislav Droščák (Slovakia) – chair
  - Karol Smolík (Slovakia)

- Cooperators
  - Szymon Wajda (Poland) – ASG-EUPOS
  - István Galambos (Hungary) – gnssnet.hu
  - Vlad Sorta (Romania) – ROMPOS
  - Christian Trautvetter (Germany) – SAPOS
  - Ivars Degainis (Latvia) – EUPOS-RIGA



Monitoring of the network solution
Two possibilities



Physical monitoring stations

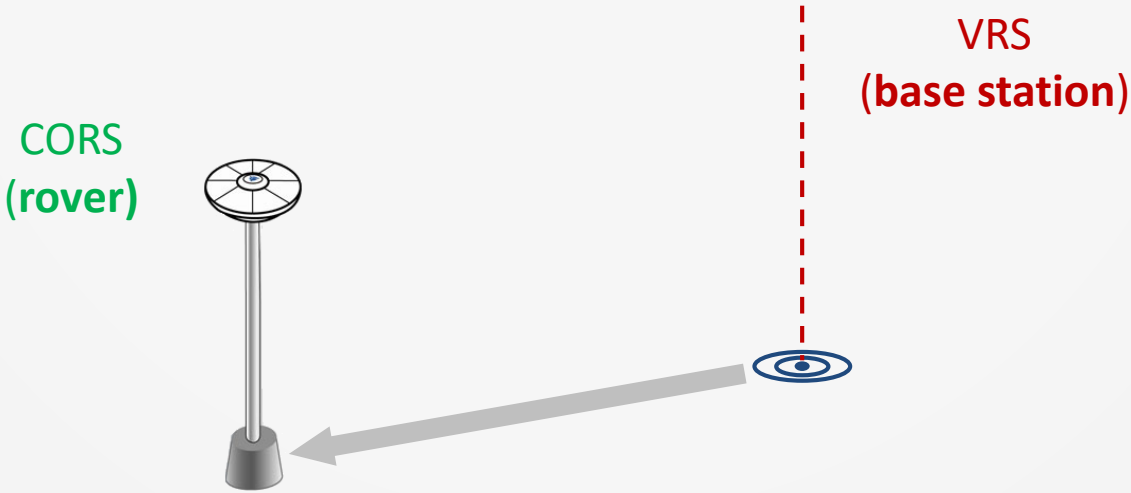
- real value of deviations
- high expenses
- impossibility to monitor entire network

Virtual principle

- no physical monitoring stations
- low cost
- monitoring of the entire network
- virtual principle ≠ real deviation

EUPOS service quality monitoring Principle

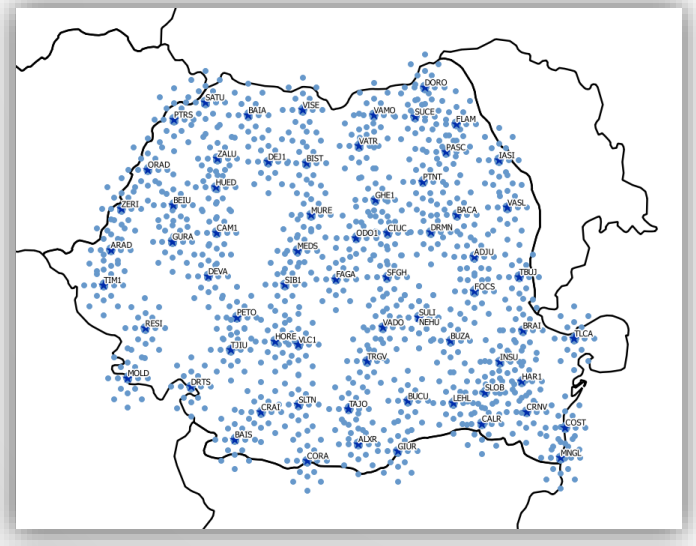
- Concept copies the design of SK*POS*® network solution quality monitoring application
- Monitoring independent from the GNSS service provider control software
- Fully automatic solution
- Virtual solution (no physical monitoring stations)

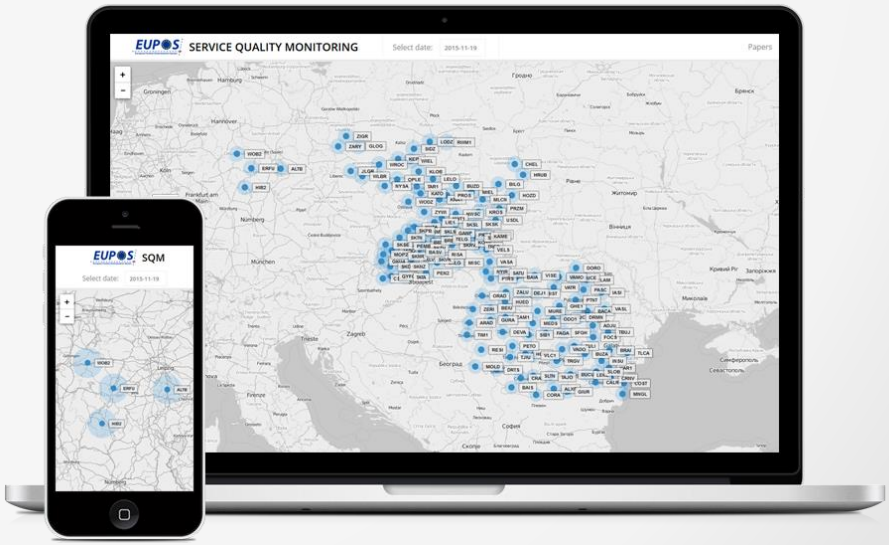


EUPOS service quality monitoring Principle

- Monitoring of the whole territory of countries
- Random generation of (virtual) test points
- Baseline processing by open source RTKNAVI software
- Results available via web/mobile application

RTKNAVI
www.rtklib.com



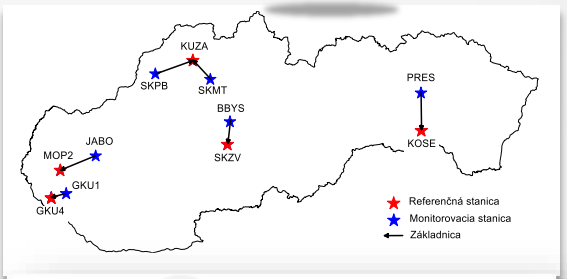


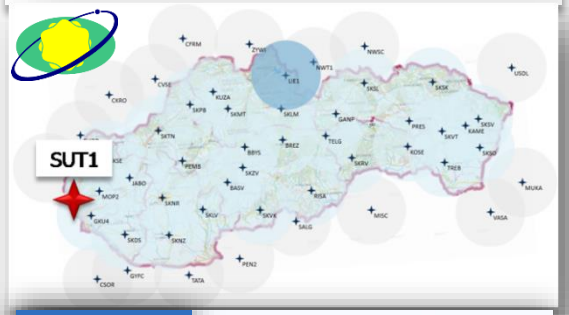
Verification of the virtual monitoring reliability and accuracy

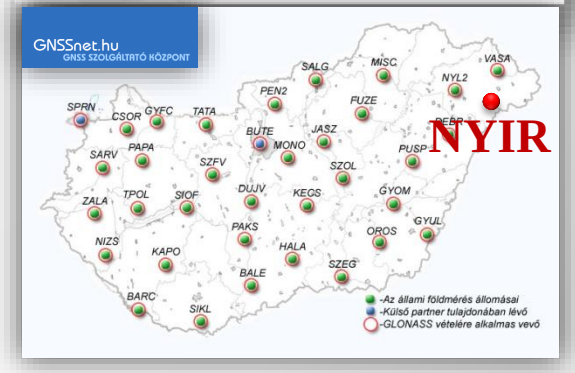
Hypothesis:

virtual principle results = physical monitoring station results

- Test 1
  - 6 monitor station in Slovakia
  - Test took: 5 days
  - Baselines length: 20 m – 32 km
- Test 2
  - 1 monitor station in Slovakia
  - Test took: 5 months
  - Baselines length: 4 km
- Test 3
  - 1 monitor station in Hungary
  - Test took: 37 days
  - Comparison one time per hour







AVerification of the virtual monitoring reliability and accuracy

Test	Baseline	Number of values	Deviations		
			n	e	u
Test 1	GKU1 – GKU4 JABO – MOP2 BBYS – SKZV SKPB – KUZA PRES – KOSE SKMT – KUZA	777	**0.4 cm**	**0.3 cm**	0.5 cm
Test 2	GKU4 – SUT1	41 334	**0.6 cm**	**0.4 cm**	1.0 cm
Test 3	VRS – NYIR	720	**0.6 cm**	**0.6 cm**	1.8 cm

Very good coincidence!

EUPOS service quality monitoring
Status in November 2016

SKPOS®

ASG eupos

GNSSnet.hu GNSS SZOLGÁLTATÓ KÖZPONT

ROMPOS Romanian Position Determination System

SAPOS®

RIGA EUPOS®

34 stations

32 stations

8 stations

68 stations

4 stations

5 stations

152 stations

GNSS receiver manufacturers

- Trimble
- Leica
- Topcon
- Javad
- Astech

Network softwares:

- Trimble Pivot Platform
- Geo++ GNSMART
- Leica Spider

EUPOS networks deviations comparison Statistics

RTK network		SKPOS	ASG eupos	GNSSnet.hu GNSS SZOLGÁLTATÓ KÖZPONT	ROMPOS Romanian Position Determination System	SAPOS	RIGA EUPOS	EUPOS European Position Determination System
Software		Trimble Pivot Platform	Trimble Pivot Platform	Geo++ GNSMART	Leica Spider	Trimble Pivot Platform	Geo++ GNSMART	Σ
Time period		2013-07-01 - 2016-10-31 (1 218 days)	2014-07-26 - 2016-10-31 (828 days)	2014-10-30 - 2016-10-31 (732 days)	2014-12-05 - 2016-10-31 (696 days)	2015-07-03 - 2016-10-31 (484 days)	2015-10-19 – 2016-10-31 (378 days)	
Number of monitored stations		34	34	7	68	4	5	**152**
Number of values		1 246 012	435 800	120 741	1 009 813	36 789	46 757	**2 895 912**
Maximal	ne	49.9 cm	44.6 cm	42.4 cm	49.7 cm	13.0 cm	28.6 cm	
	u	49.8 cm	48.7 cm	47.6 cm	49.9 cm	39.2 cm	49.3 cm	
Average	ne	1.1 cm	1.0 cm	1.3 cm	1.3 cm	0.9 cm	1.0 cm	**1.1 cm**
	u	2.4 cm	1.2 cm	1.4 cm	2.6 cm	1.3 cm	1.9 cm	**1.8 cm**
No fix		16%	8%	17%	18%	10%	25%	**16%**

HZ RMS ≤ 2 cm
EUPOS TS Confirmed!

EUPOS SQM is not only for determination of deviations

- Archived results can serve for different analysis and can reveal interesting connections and experience

- EUPOS SQM WG have done analyzes of deviations according to:
  - GNSS service provider control software
  - reference stations density
  - dependency on high ionosphere (day/night deviation comparison)
  - testing points extrapolation (on RIGA-EUPOS network)
  - type of receiver

Analyzes of deviations according to GNSS service provider control software

RTK network		SKPOS, ASG eupos, SAPOS	GNSSnet.hu GNSS SZOLGÁLTATÓ KÖZPONT, RIGA EUPOS	ROMPOS Romanian Position Determination System
Software		**Trimble Pivot Platform**	**Geo++ GNSMART**	**Leica Spider**
Number of monitored stations		72	12	68
Maximal	ne	49.9 cm	42.4 cm	49.7 cm
	u	49.8 cm	49.3 cm	49.9 cm
Average	ne	**1.0 cm**	**1.2 cm**	**1.3 cm**
	u	**1.6 cm**	**1.7 cm**	**2.6 cm**
No fix		**11%**	**21%**	**18%**

Only slight differences!

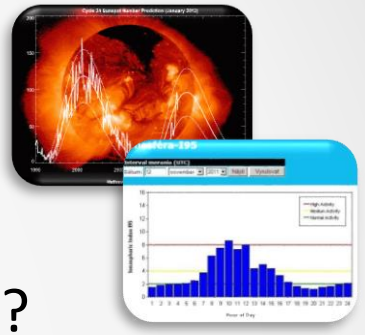
Analyzes of deviations according to reference stations density

- **Density** means: one station per xy km^2
- Density values get from fraction: country area/number of CORS

RTK network		RIGA EUPOS	SKPOS / SAPOS	ASG eupos / GNSSnet.hu / ROMPOS
Density		**< 1000 km^2**	**1000 km^2 – 2000 km^2**	**> 2000 km^2**
Number of monitored stations		5	38	109
Average	ne	1.1 cm	1.0 cm	1.2 cm
	u	1.9 cm	1.9 cm	1.7 cm
No fix		25%	13%	14%

Assumtion not confirmed!

Analyzes of „No fix“ values according to dependency on high ionosphere Day/night comparison



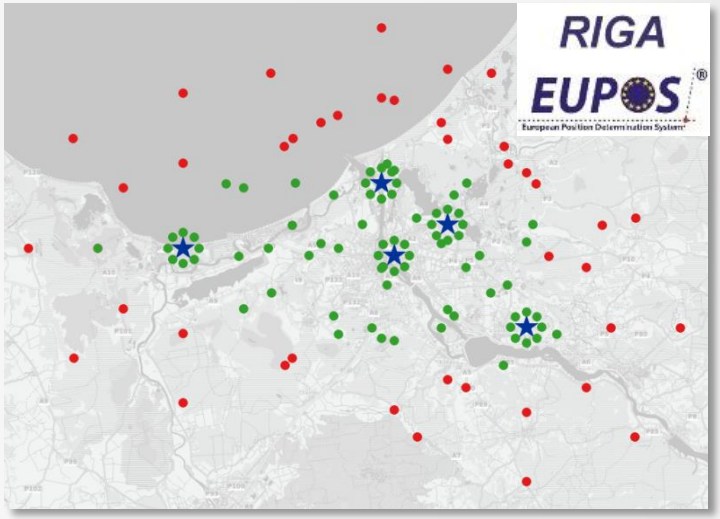
- Test assumption: Ionosphere is during night lower!
- Q: Are „no fix“ values from monitoring lower at nights?

		SKPOS	ASG eupos	ROMPOS	GNSSnet.hu	SAPOS	RIGA EUPOS	EUPOS
Number of values		1 246 012	435 800	120 741	1 009 813	36 789	46 757	2 895 912
Average value „day“	ne	1.3	1.2	1.6	1.6	1.1	1.3	1.4
	u	2.4	1.3	1.3	1.4	1.4	1.9	1.6
Average value „night“	ne	0.9	0.7	1.2	1.0	0.7	0.8	0.9
	u	2.4	1.2	1.3	1.3	1.2	1.8	1.5
No fix „day“		19%	11%	20%	21%	14%	30%	19%
No fix „night“		12%	6%	16%	12%	6%	20%	12%

Assumtion confirmed

Analyzes of deviations according to testing points extrapolation

- RIGA-EUPOS = regional city network
- Only 5 reference stations
- Many testing points are extrapolated



Test points		Inside the network	Outside the network
Average	ne	1.0	1.1
	u	1.8	1.9
No fix		25%	25%

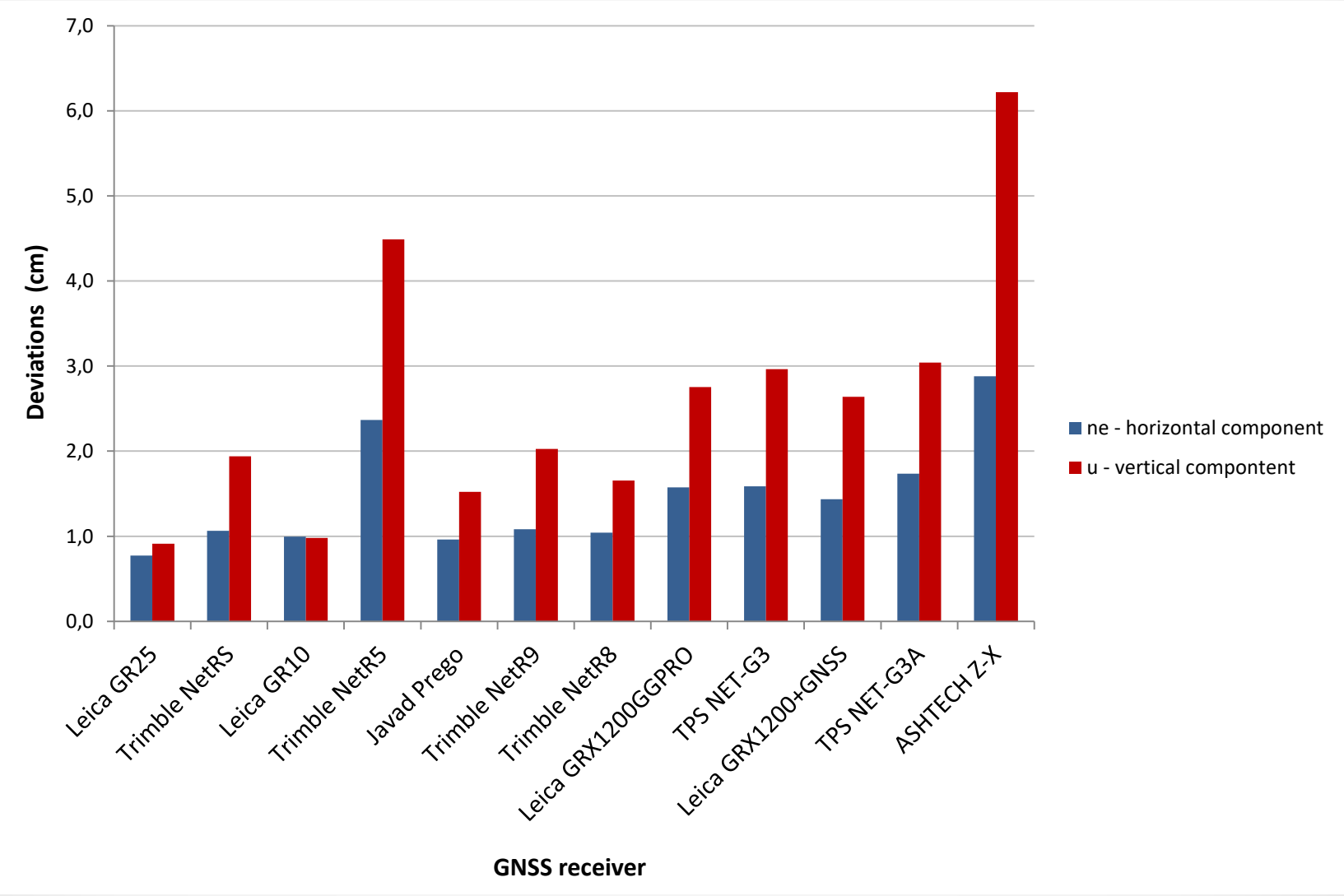
Assumption not confirmed!

Analyzes of deviations according to GNSS receiver manufacturers

GNSS receiver manufacturers:

- Trimble
- Leica
- Topcon
- Astech
- Javad

Analyzes of deviations according to brand of receiver

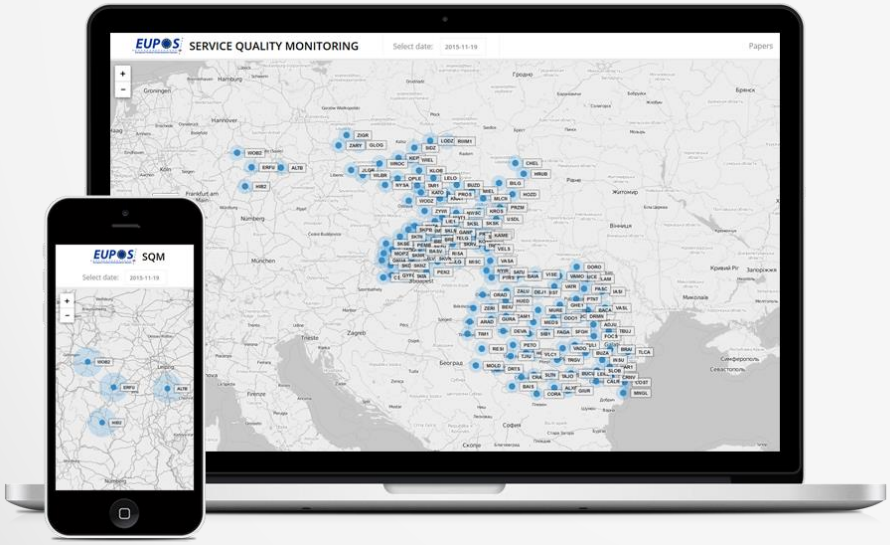


Conclusions

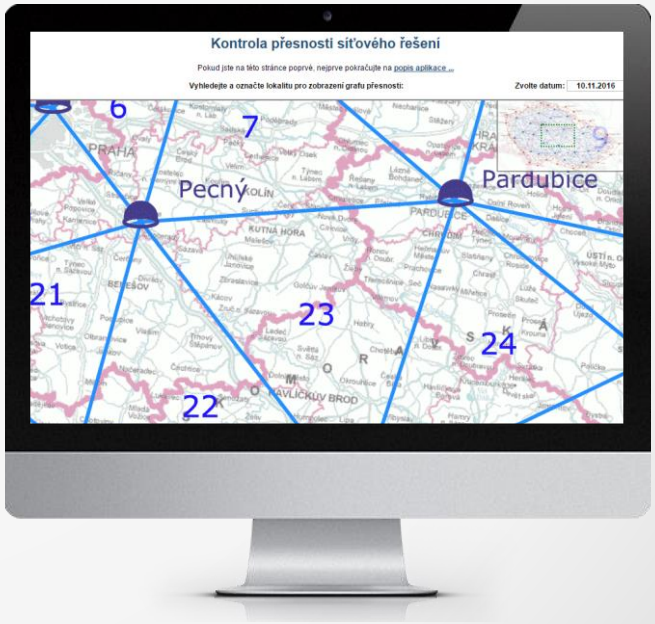
- EUPOS network RTK quality monitoring tool is working right and the results is available here http://monitoringEUPOS.gku.sk
- results from the monitoring confirm „cm“ quality of the EUPOS countries network RTK
- performed analysis confirm:
  - „no fix“ values dependency on high ionosphere
- analysis do not confirm deviations dependency on:
  - GNSS service provider control software
  - reference stations density
  - brand of receiver

Near future

- Comparison of EUPOS SQM solution with Czech MLS solution
- till now no access to CZEPOS (promised in 2015)



VS.



Near future

- Check why Slovakian and Romanian vertical accuracy is worser than the average

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Call for more contributors

- What we need from candidates / national service operators:
  - user name/login and password which alows us
    - access to the RTK network solution (VRS concept)
    - access to all permanent stations via NTRIP Caster
  - corrections provided in RTCM 3.x format
  - CORS coordinates (e.g. we can use up to date information from ESDB)

- Candidates can contact us on mails:
  - branislav.droscak@skgeodesy.sk
  - karol.smolik@skgeodesy.sk

Thank you for your attention