



# Analysis of the network RTK users initialisation times – experience from Slovakia

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**EUREF 2018 SYMPOSIUM**

AMSTERDAM 30 May – 1 June 2018



# Slovak real-time positioning service

**SKPOS**<sup>®</sup>



10 years  
of continuous operation

+1,500  
active users

54  
reference stations



# Application ASMARUP

- Application let us to monitor and analyses RTK users initialization times determined from NMEA messages according to:
  - date and time
  - particular user
  - length of the initialization time
  - number of satellites
  - used mountpoint
  - user position

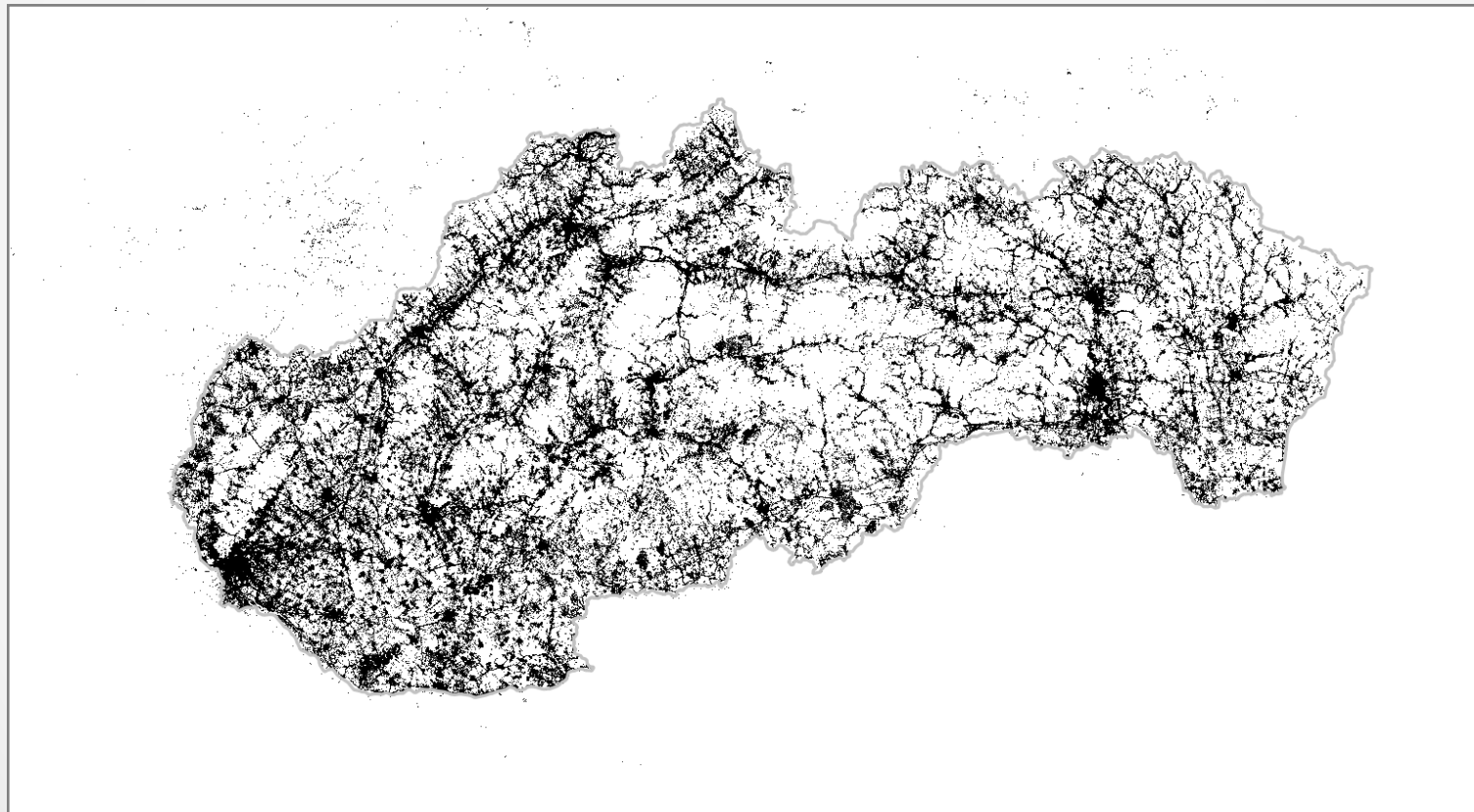


# Initialization time?

- The time needed to get a fixed solution (solving ambiguities)
- It depends on many factors:
  - number and position of satellites
  - ionosphere activity
  - location
  - mountpoint
  - ...



# 10 years of **SKPOS** operation



# 10 years of **SKPOS** operation from the application ASMARUP point of view

**1,5 bn**  
rows of NMEA  
messages

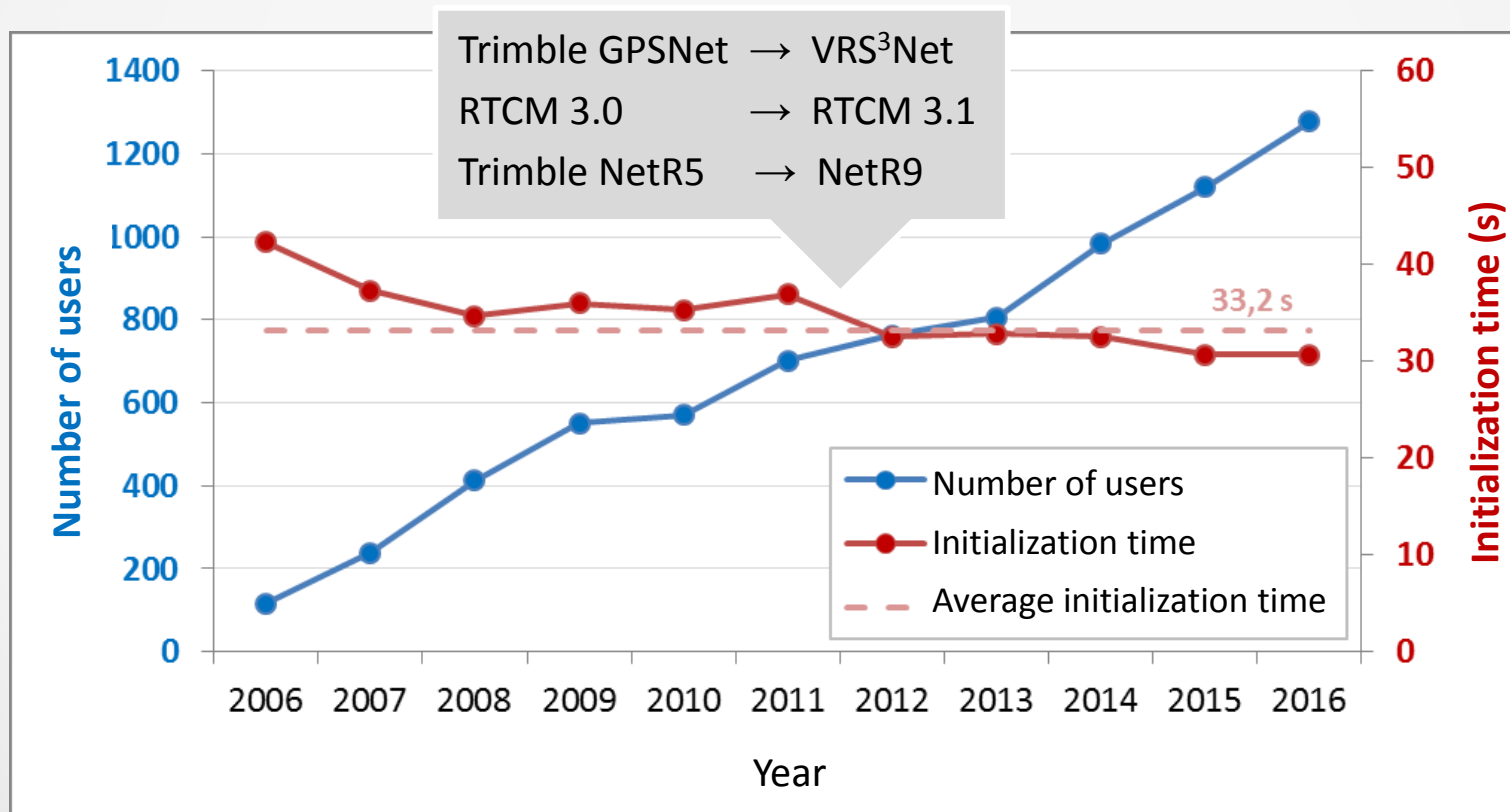
**250 MB**  
data in database

**54 days**  
permanent processing  
of data

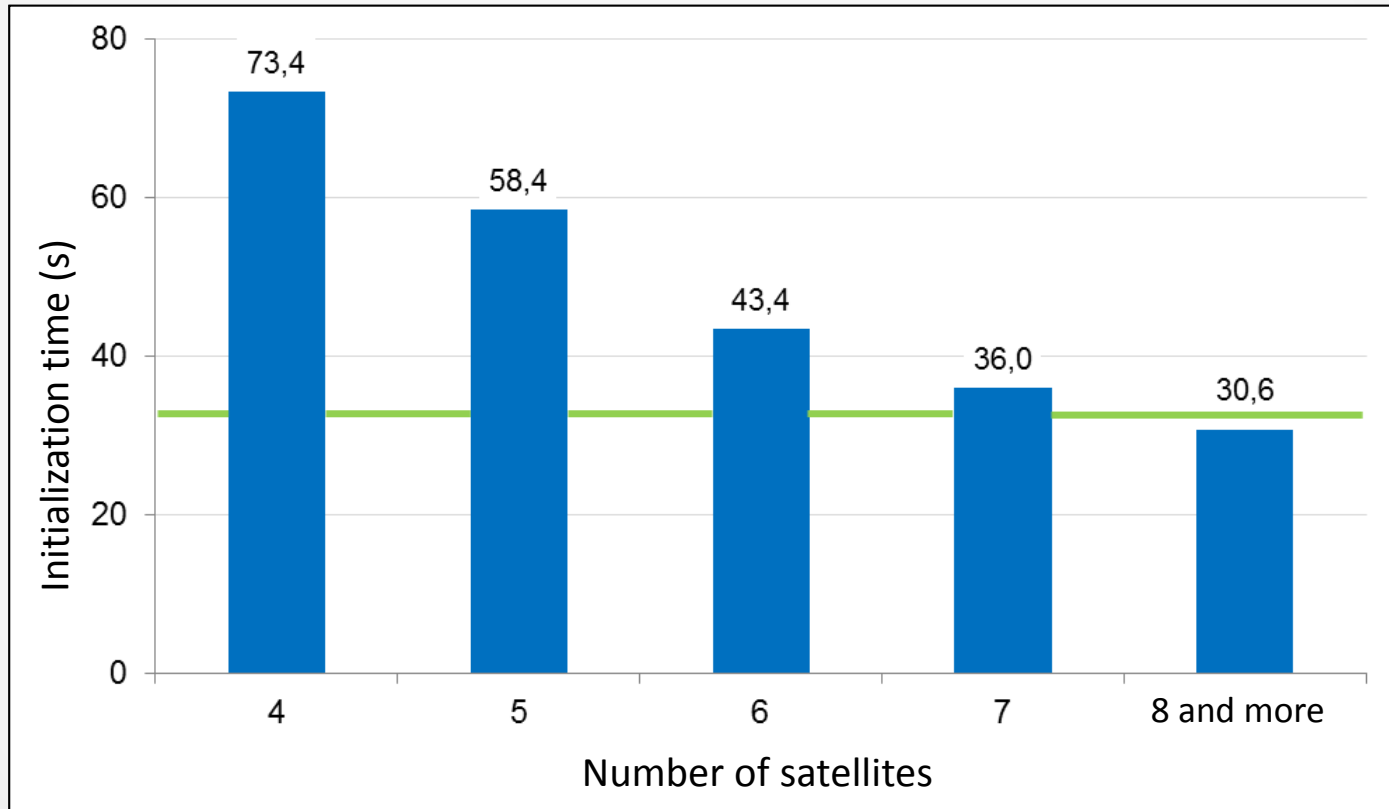
**1 818**  
unique users

# 10 years of SKPOS operation

## Number of users and initialization time

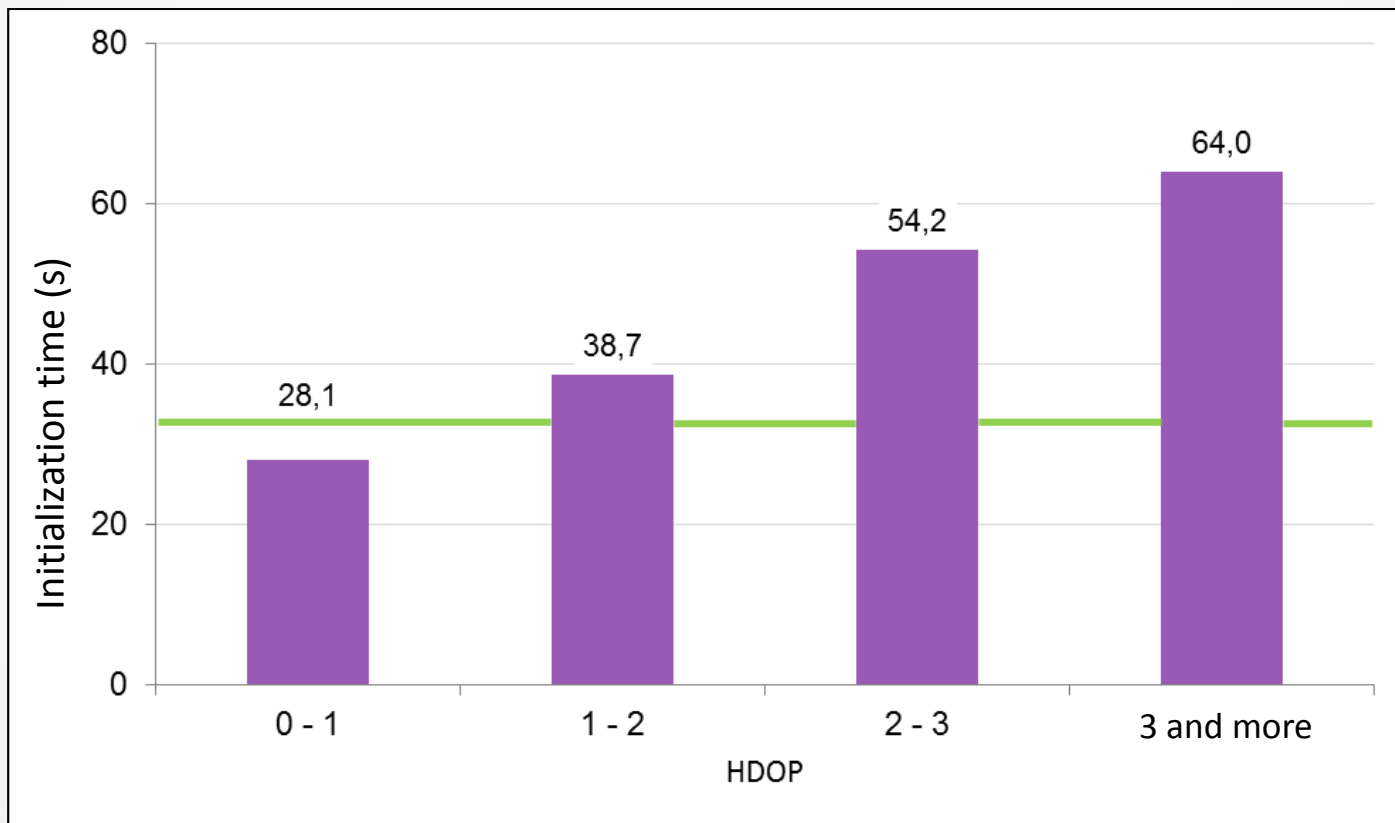


# Dependency of the length of initialization times on the number of used satellites





# Dependency of the length of initialization times on HDOP



# Dependency of the length of initialization times on the used mountpoint

- Mountpoint = access point to SKPOS, varies with formats of corrections - content, structure and size of transmitted correction data

Mountpoint	Mountpoint validity	Number of initialization times	Average initialization time
SKPOS_CM_23	2006 – up to now	84,666	39.1 s
SKPOS_CM_30	2006 – 2011	439,835	34.2 s
SKPOS_CM_31	2011 – up to now	632,068	30.9 s
SKPOS_CM_32	2016 – up to now	1,372	24.5 s
SKPOS_CM_CM_Rplus	2012 – up to now	176,004	38.5 s
SKPOS_CM_CM_Rx	2012 - up to now	8,608	26.8 s

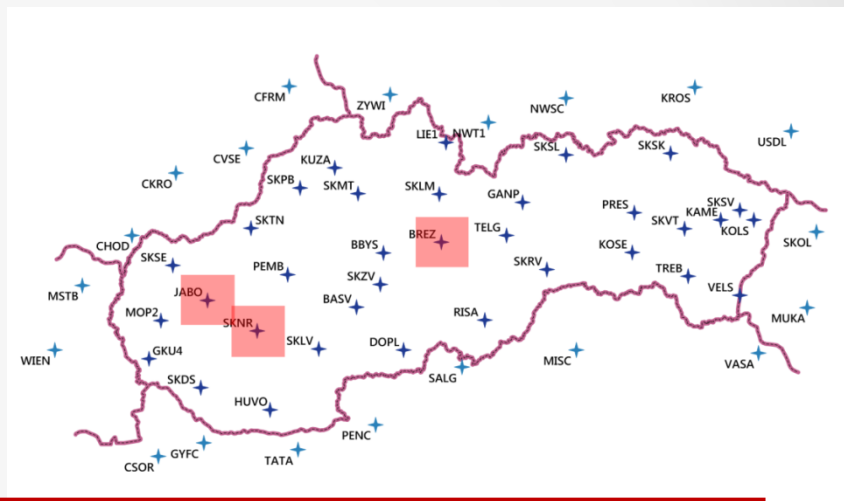
# Dependency of the length of initialization times on receiver manufacturer

- Five manufacturers with the largest number of measurements

Receiver manufacturer	Number of initialization times	Average initialization time
Manufacturer 1	274,548	27.3 s
Manufacturer 2	50,452	28.2 s
Manufacturer 3	341,764	32.0 s
Manufacturer 4	54,042	35.6 s
Manufacturer 5	260,790	35.9 s

# Dependency of the length of initialization times on network densification

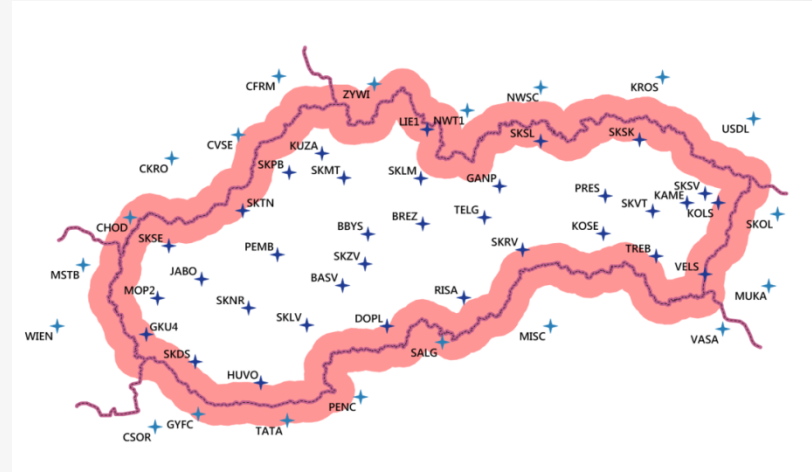
- Localities 10x10 km around the reference stations that were added to the network during the SKPOS operation



Reference station	Number of initialization times	Average initialization time	Number of initialization times	Average initialization time
	Before station was added to network		After station was added to network	
BREZ	2,126	48.7 s	9,970	35.7 s
JABO	4,426	34.8 s	16,398	26.2 s
SKNR	28,191	33.9 s	21,823	24.4 s

# Dependency of the length of initialization times on network densification – border areas

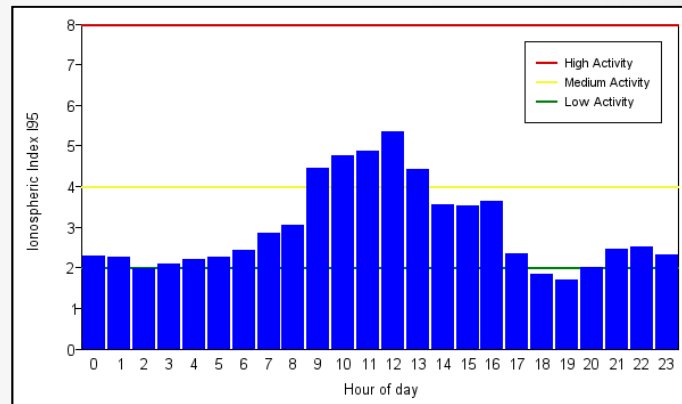
- Locations along the national border within 10 km before/after the involvement of foreign reference stations



Number of initialization times	Average initialization time	Number of initialization times	Average initialization time
Before stations were added to network		After stations were added to network	
138,911	39.3 s	133,377	34.4 s

# Dependency of the length of initialization times on ionosphere activity

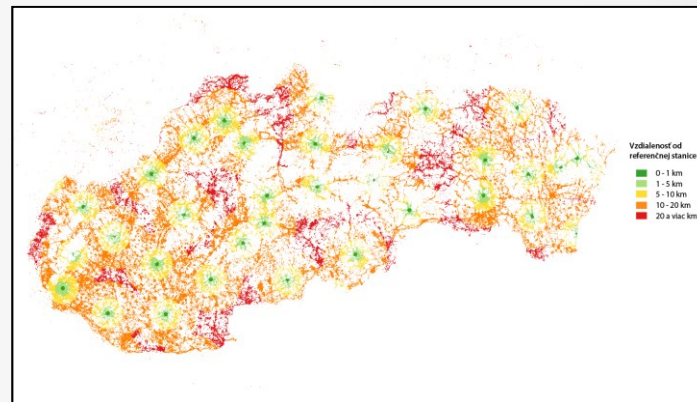
- Ionosphere activity categorized by i95 model



Ionosphere activity Model i95	Number of initialization times	Average initialization time
0 – 4	1,581,920	30.1 s
4 – 8	231,165	33.2 s
8 and more	2,823	<b>45.2 s</b>

# Dependency of the length of initialization times on the user's distance from the reference station

- For each measurement the distance to the nearest reference station was determined



Distance to reference station	Number of initialization times	Average initialization time
0 – 1 km	61,063	32.5 s
1 – 5 km	285,775	30.3 s
5 – 10 km	417,950	30.5 s
10 – 20 km	810,989	33.9 s
20 km and more	239,802	35.4 s

# Conclusion

- Data analysis of 10 years of SKPOS operation was confirmed:
  - the positive impact of upgrading the service control software and receiver exchanges,
  - the positive impact of network densification
  - the negative effect of using mountpoint SKPOS\_CM\_23,
  - the negative impact of the low number of observed satellites,
  - negative impact of inappropriate configurations of satellites,
  - negligible impact of the receiver's manufacturer,
  - negative impact of ionosphere activity,
  - negligible impact of the distance from the reference station... on the length of initialization times.



**Thank you for your attention**

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