Experience with Network RTK measurements with Galileo

EUPOS Technical Meeting

15 November 2018

Tallinn

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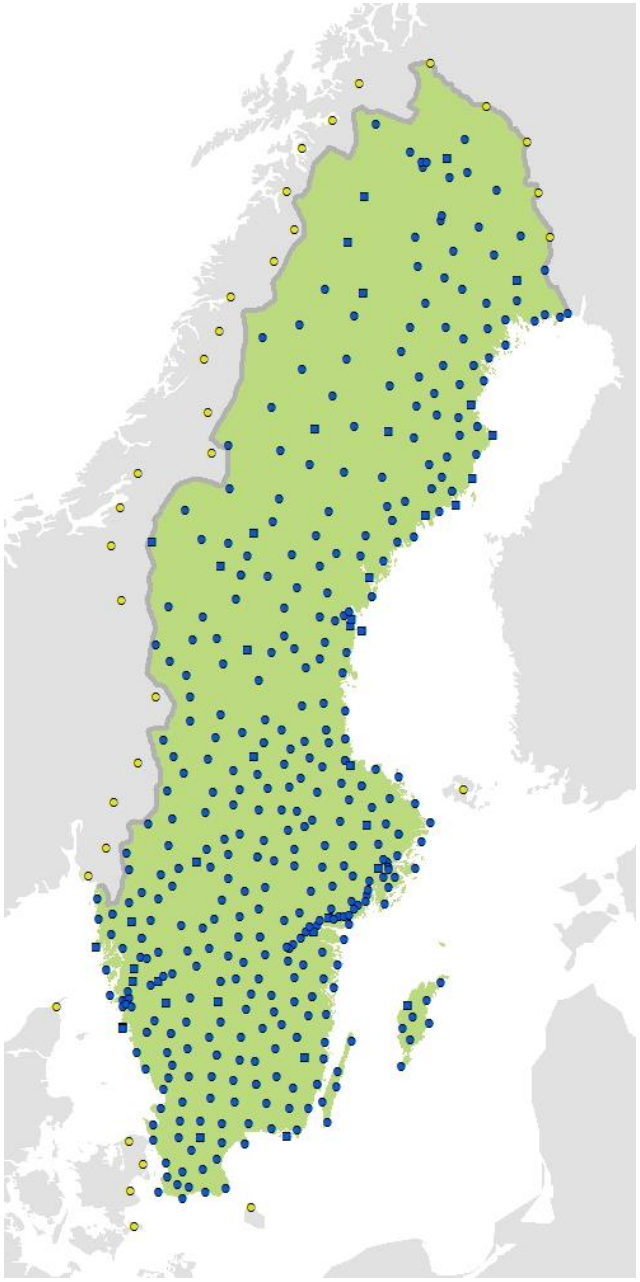
The Swedish mapping, cadastral and land registration authority's (Lantmäteriet)
SWEPOS

SWEPOS®



69 External

- Manages a network of Continuously Operating Reference Stations (CORS) that provide GNSS data consisting of carrier phase and code range measurements in support of three dimensional positioning, meteorology, space weather, and geophysical applications throughout Sweden. Established in cooperation with Onsala Space Observatory/Chalmers and SP Technical Research Institute of Sweden.
- The network contains 41 class A- and 362 class b-stations.
- 24/7 service with support 06:30-20.30 weekdays.

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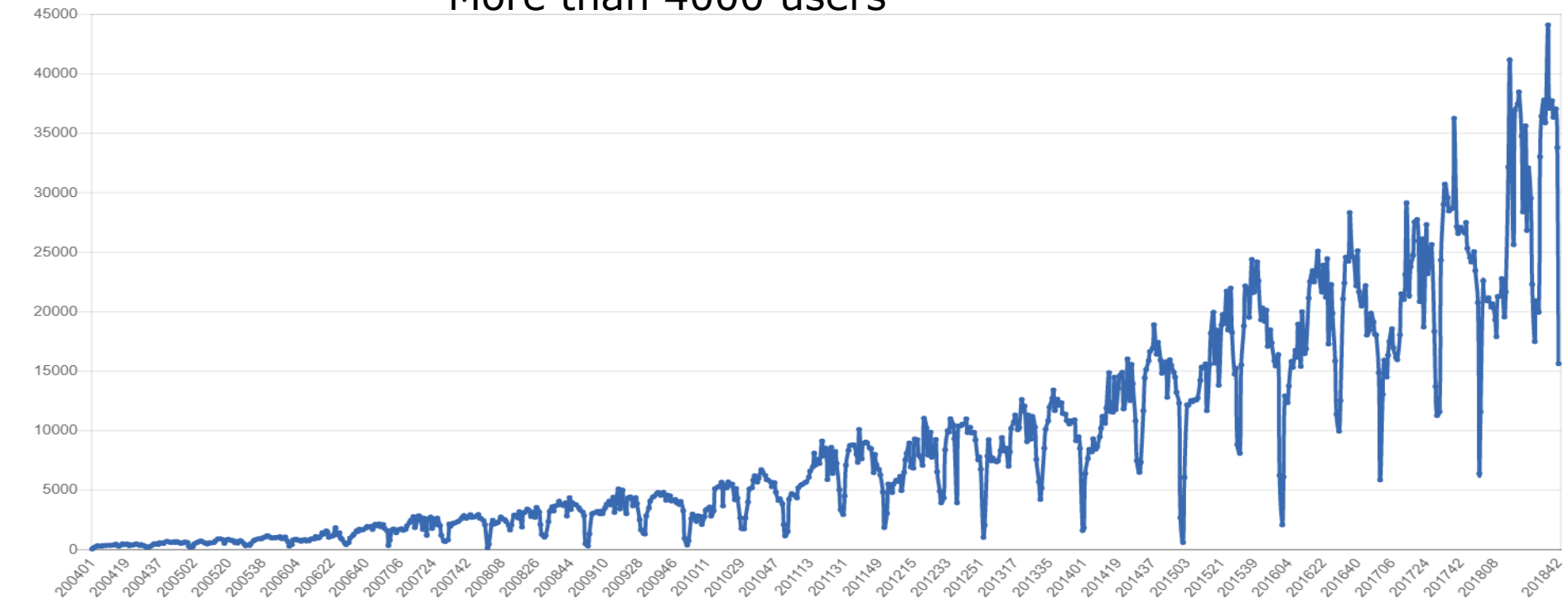
Real-time RTK service use

Hours/Week

More than 4000 users



Partners

SmartNet Sweden powered by Leica Geosystems

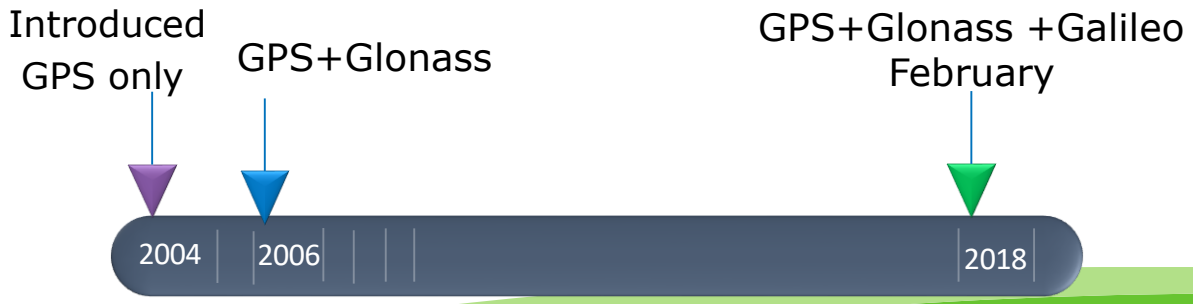
Trimble VRS Now

TopNET live

Dataexchange with Norway, Finland and Denmark

SWEPOS™ services

- Real time services (Network RTK, DGNSS free of charge from January 2016)
- Post processing data (RINEX data)
- Virtual RINEX data
- SWEPOS Automatic Processing service
- On www.SWEPOS.se (Ionospheric monitor, Satellite prediction and Monitor stations)



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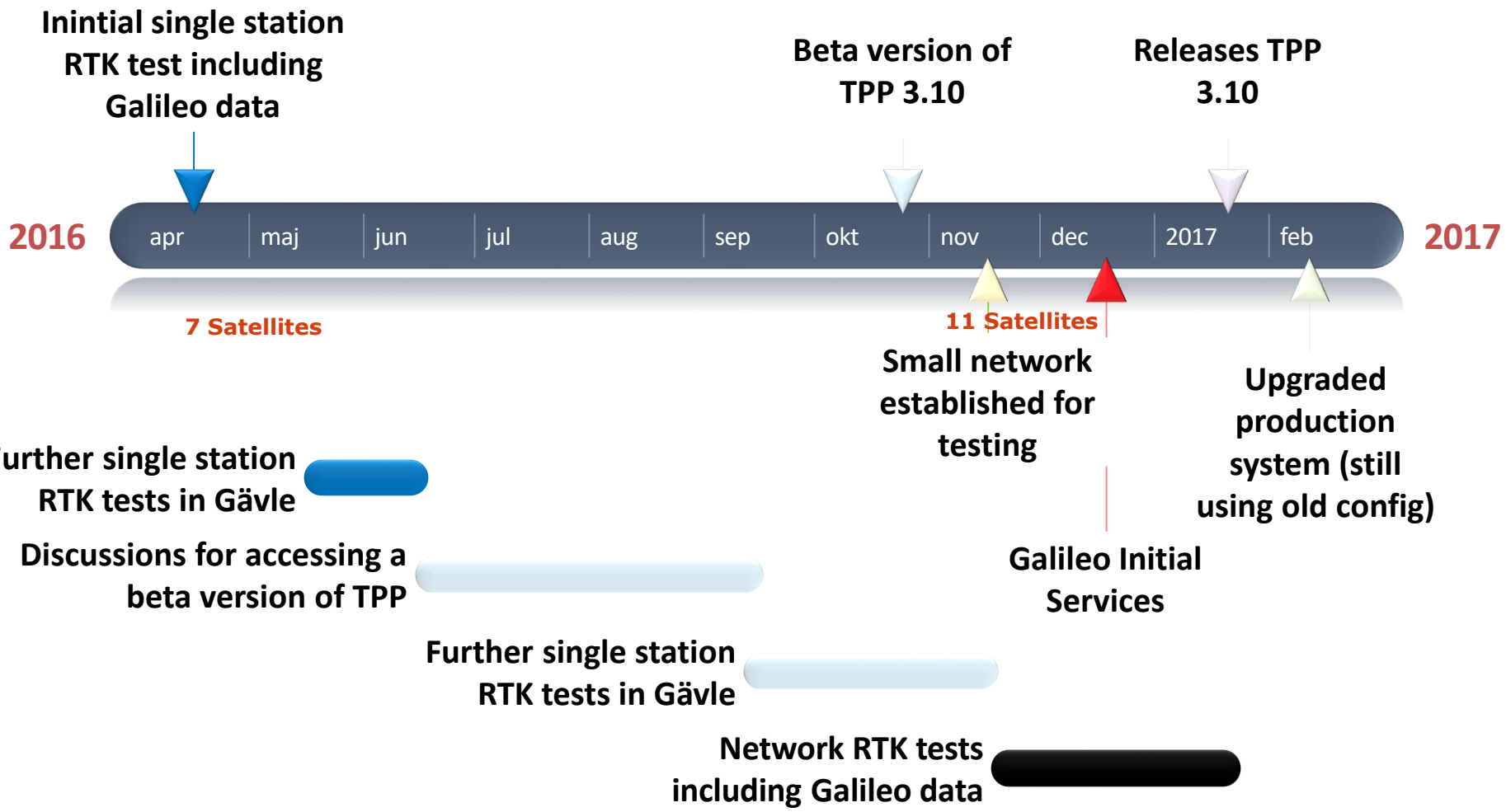
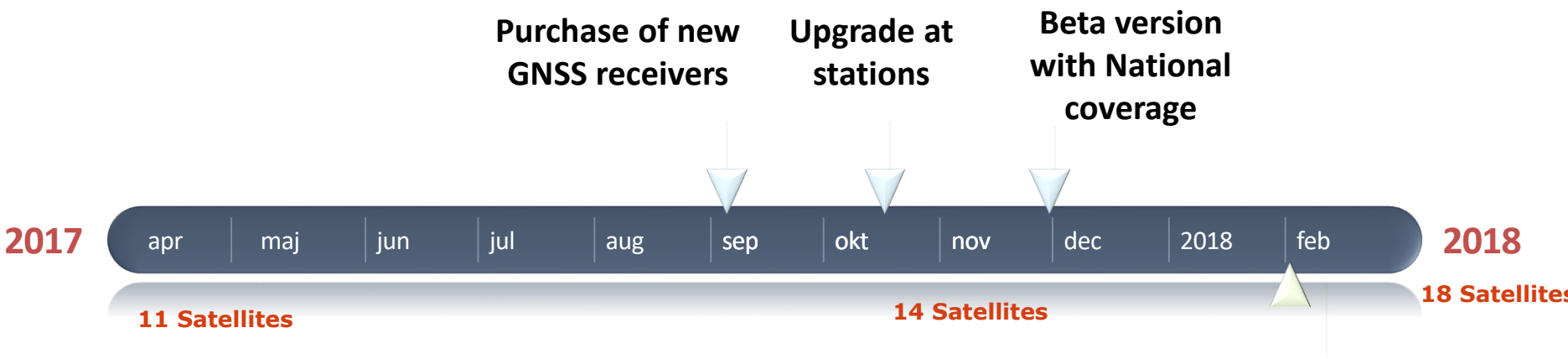
Current status of Galileo

- 26 Galileo satellites now in orbit for improved EU satellite navigation signal. But there are 8 satellite not active (2 not in the correct orbit, 2 are unavailable, and 4 are in the initial test operation).
- 18 satellite are available (active) for service provision.
- It is still difficult to test RTK performance with only Galileo satellites
- No new satellities before 2020.

Galileo - Implementation process



Galileo – Implementation process



Diploma work at HiG

GNSS suppliers performs compatibility tests

Users are allowed test accounts

Galileo release in SWEPOS NRTK-service (RTCM-MSM)

Users who made the test-measurments have reported on better measurements in a more difficult environment as forests and buildings.

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April 2016 (GPS + Galileo)

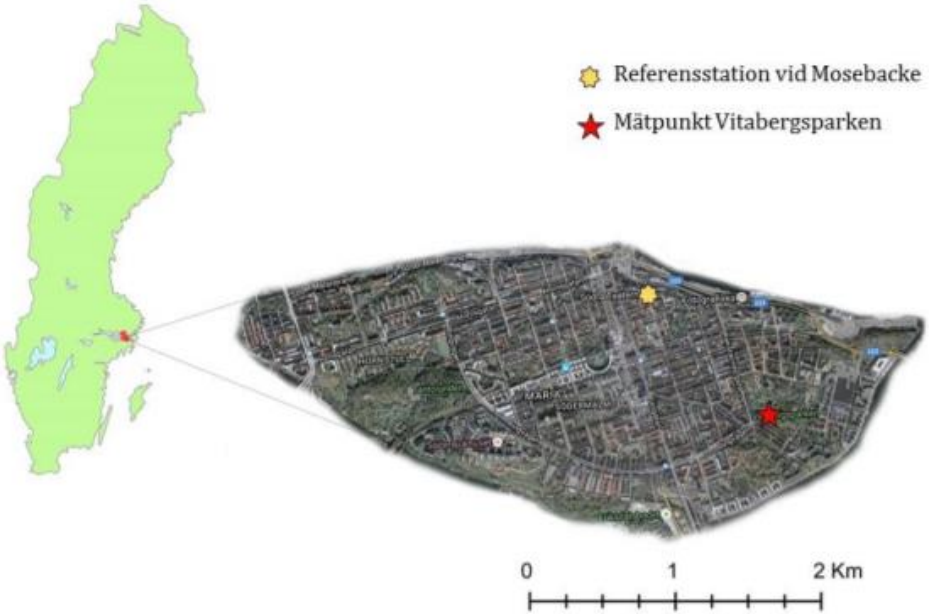
-**Single Reference station RTK**.

-**Distance 1.2 km.**

-**Open-sky site**, **Södermalm in Stockholm city.**

- **7 Satellites active (Galileo).**

-**Master thesis, (Stockholms university+Lantmäteriet).**



LANTMÄTERIET

April 2016 (GPS + Galileo)

Satellites		Number of Measurements	Successful Fixing	Average time until fixed solution	Horizental RMS error	Vertical RMS error	Mean value of PDOP
GPS	Galileo		(%)	(s)	(mm)	(mm)	(-)
5	**0**	41	88	28	7	16	4,1
5	**2**	61	93	16	11*	17	3,2
5	**3**	43	100	23	7	15	2,6
5	**4**	7	100	13	8	8	2,2
6	**0**	35	94	10	6	12	3,0
6	**2**	41	98	12	8	14	2,4
6	**3**	27	96	8	5	11	2,2
6	**4**	5	100	8	4	4	2,1

* 8 mm if a large deviation of 57 mm was removed

Nov 2016 – Jan 2017 (GPS + Galileo)

-**Mini RTK Network**.

-**Open-sky site**, Gävle city.

-11 Satellites active (Galileo).

-Lantmäteriet.

Nov 2016 – Jan 2017 (GPS + Galileo)

Satellites		Number of Measurements	Successful Fixing	Average time until fixed solution	Horizontal RMS error	Vertical RMS error	Mean value of PDOP
GPS	Galileo		(%)	(s)	(mm)	(mm)	(-)
5	0	29	93	10	10	10	3,6
5	2	57	91	8	12	12	3,2
5	3	62	100	11	6	11	2,5
5	4	131	100	3	7	12	2,5
5	5	46	100	6	9	13	2,8
6	0	54	96	9	7	15	3,5
6	2	0	-	-	-	-	-
6	3	56	100	2	4	13	2,9
6	4	89	100	2	7	11	2,4
6	5	14	93	15	10	14	2,5

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Oktober 2018
GPS + Glonass **vs** GPS + Glonass + Galileo

-Network-RTK.

-Rörberg, Gävle.

-Continus measring with observation/secund.

-Forest environment

-Lantmäteriets.

- 16 km.

LANTMÄTERIET

Oktober 2018

GPS + Glonass **vs** GPS + Glonass + Galileo

Elevation angle	Satellites number G + G	Successful Fixing (%)	Average time until fixed solution (s)	Horizental RMS error (mm)	Vertical RMS error (mm)	Mean value of PDOP (-)
13°	9+6	97	17	17	21	1,5
25°	7+4	97	18	26	38	2,4

Elevation angle	Satellites number G + G + G	Successful Fixing (%)	Average time until fixed solution (s)	Horizental RMS error (mm)	Vertical RMS error (mm)	Mean value of PDOP (-)
13°	9+5+3	97	30	22	30	1,5
25°	7+4+3	99,9	14	23	28	2,1

Oktober 2018
GPS + Glonass **vs** GPS + Glonass + Galileo

-Network-RTK.

-Lantmäteriet, Gävle.

-Continus measring with observation/secund.

-forest environment

-Lantmäteriets.

- 0,2 km.

LANTMÄTERIET

Oktober 2018

GPS + Glonass **vs** GPS + Glonass + Galileo

Elevation angle	Satellites number G + G	Successful Fixing (%)	Average time until fixed solution (s)	Horizental RMS error (mm)	Vertical RMS error (mm)	Mean value of PDOP (-)
13°	9+5	99	17	17	25	1,5
25°	8+3	92	22	20	32	2,3

Elevation angle	Satellites number G + G + G	Successful Fixing (%)	Average time until fixed solution (s)	Horizental RMS error (mm)	Vertical RMS error (mm)	Mean value of PDOP (-)
13°	9+5+4	95	34	18	25	1,5
25°	8+3+2	99	23	18	21	2,2

Experiences from Galileo testmeasurements

- Test-measurements so far do not show any great improvements (Accuracy) by adding the Galileo satellites.
- But test-measurements indicate improved availability when adding the Galileo satellites:
  - More fixed solutions.
  - Shorter time to initialisation, especially at 25 – 35 degree elevation cutoff angle.
- More test-measurements should be done.

New receivers for tracking the Galileo signals

Ongoing work (2018-2019)

Replacing all the Javad Sigma receivers to:

- Trimble Alloy
- Septentrio PolaRx5

Thank you for your attention

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