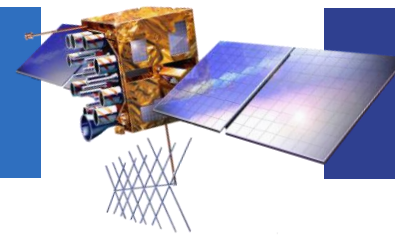


# PPP-RTK: Friend or Foe?

## from the network RTK service providers' point of view

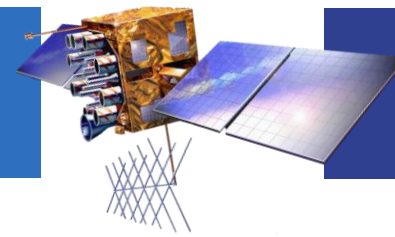
---

**Tamás Horváth**  
Head of GNSS Service Centre  
FÖMI, Hungary



# Is PPP-RTK good for us?

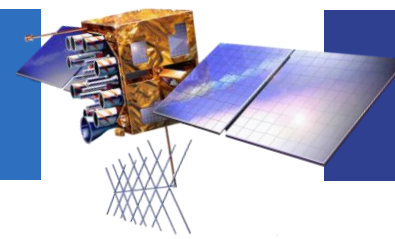
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# Is PPP-RTK good for us?

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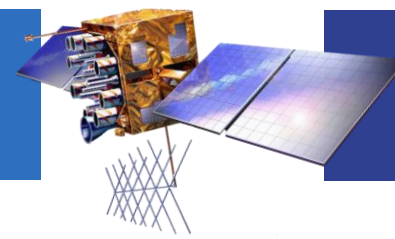
- End users  $\Rightarrow$  YES



## Is PPP-RTK good for us?

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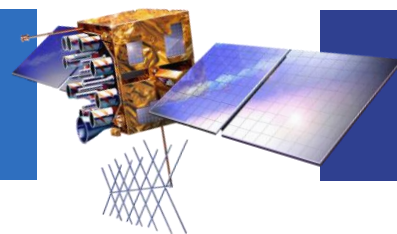
- End users  $\Rightarrow$  YES
- Network RTK service providers  $\Rightarrow$  NOT SURE



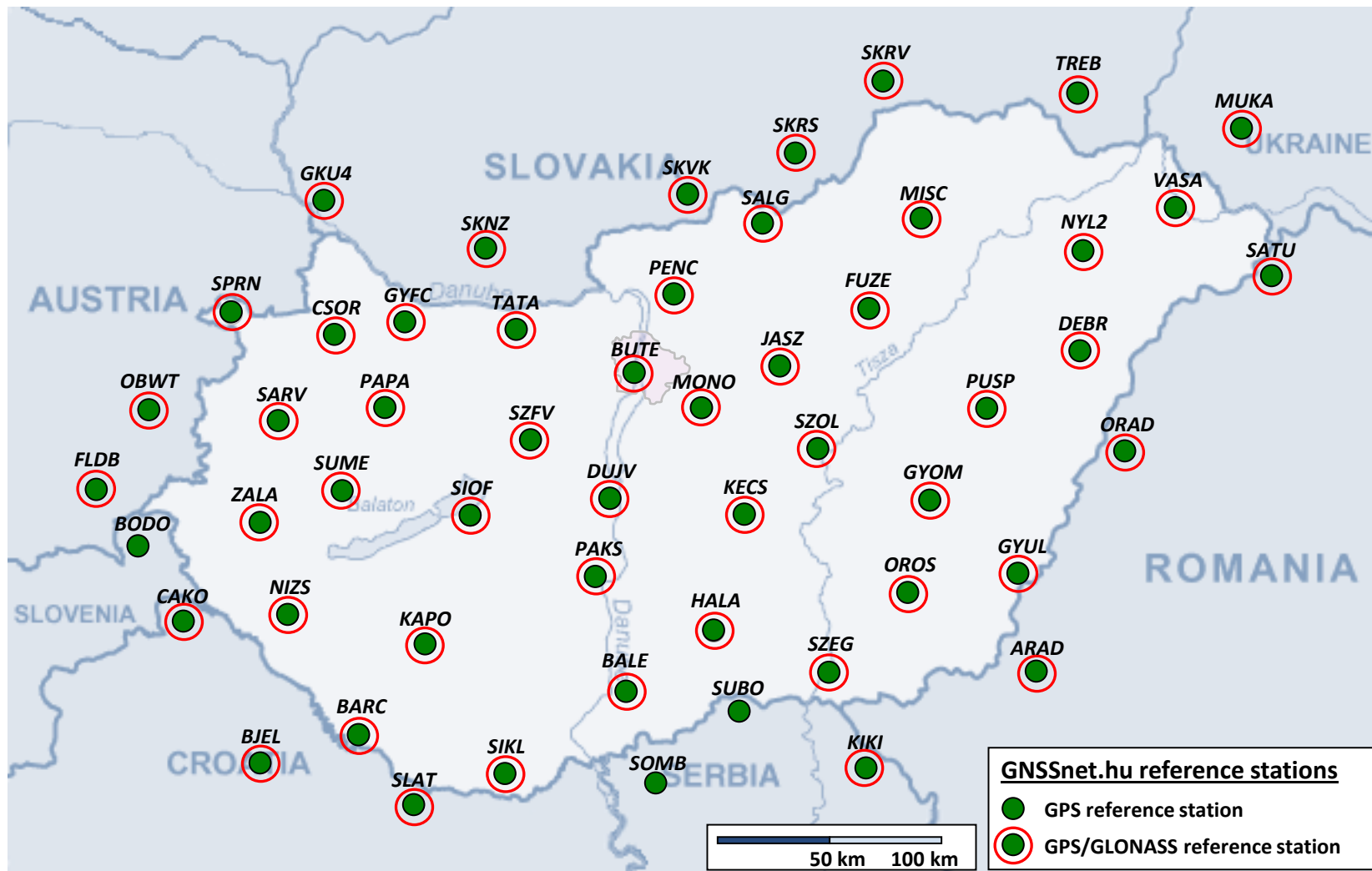
## Is PPP-RTK good for us?

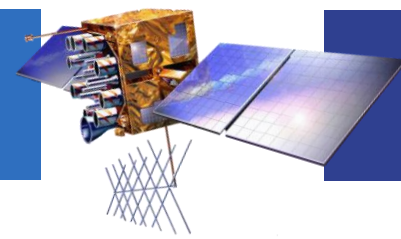
---

- End users  $\Rightarrow$  YES
- Network RTK service providers  $\Rightarrow$  NOT SURE
- Existing infrastructures and services
  - Hundreds of RTK networks, number is rapidly growing
  - > 10.000 networked reference stations
  - > 150.000 clients

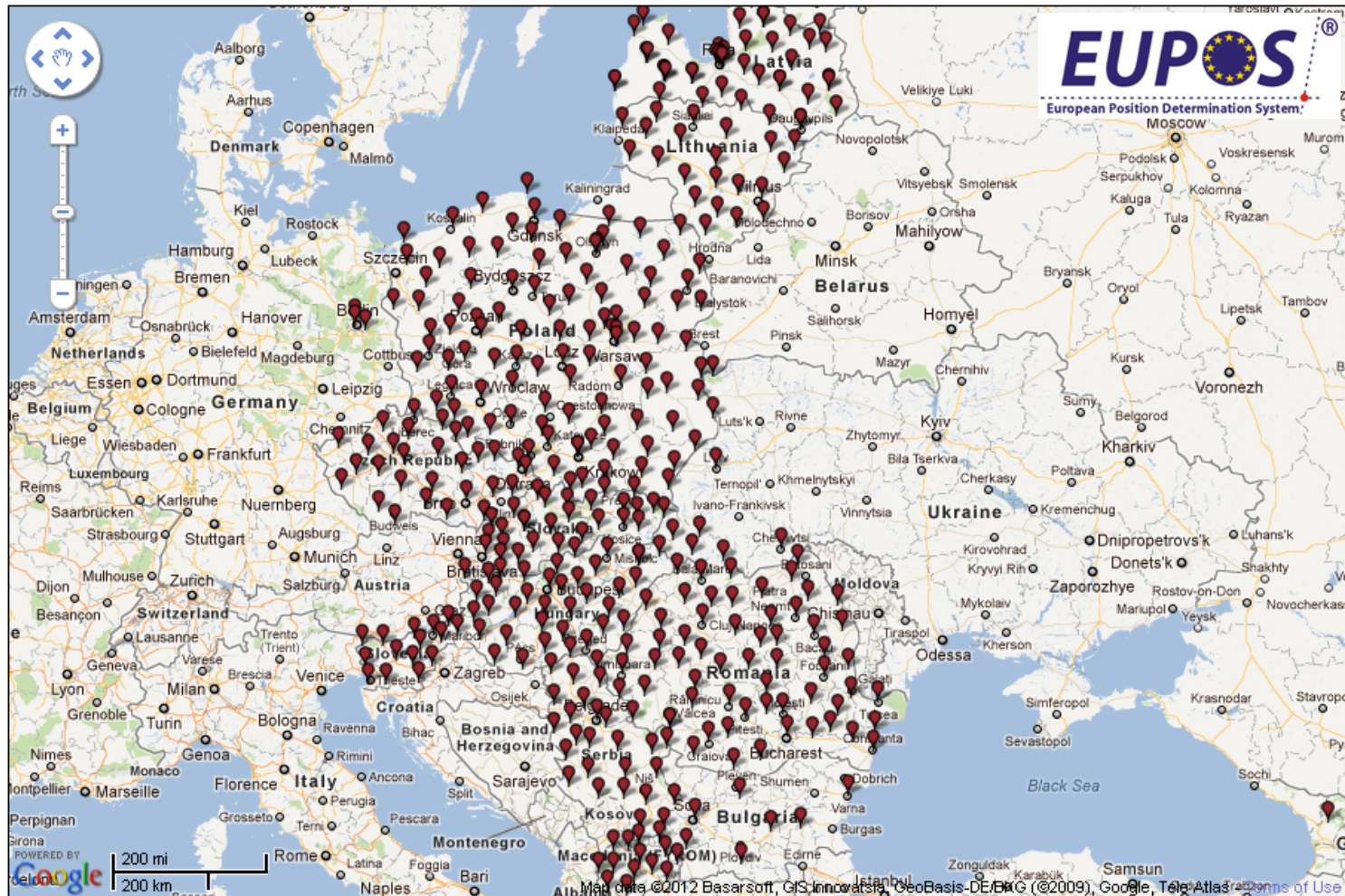


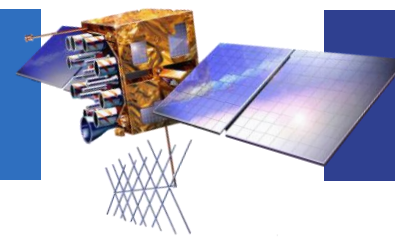
# The Hungarian network RTK infrastructure





# EUPOS<sup>®</sup> reference stations

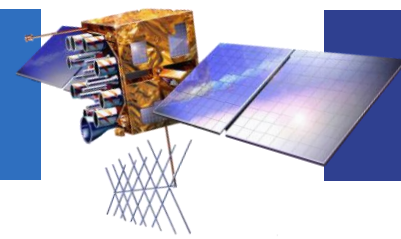




# Are these investments in danger?

---

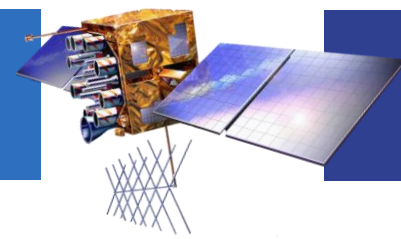




# Are these investments in danger?

---

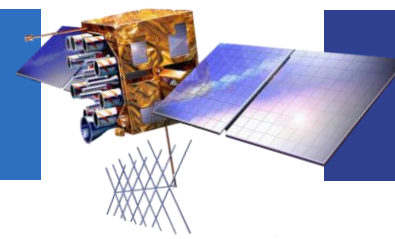
- Similar effect to SA turn-off?



# Are these investments in danger?

---

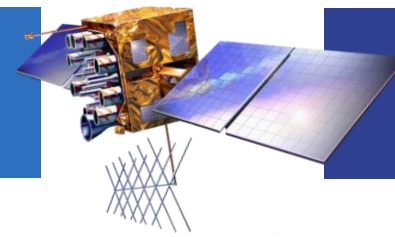
- Similar effect to SA turn-off?
- Target markets



# Are these investments in danger?

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- **Similar effect to SA turn-off?**
- **Target markets**
- **Achievable PPP performance**

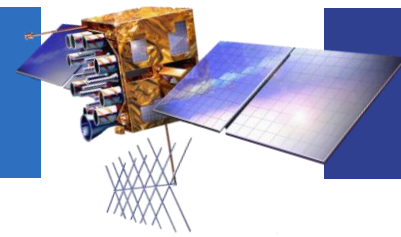


# Markets

---

## Network RTK

- Survey
- Engineering
- Construction
- Utilities
- Machine control
- Deformation monitoring
- ...
- Precision agriculture
- Mapping/GIS
- Airborne laser scanning
- GNSS meteorology
- ...



# Markets

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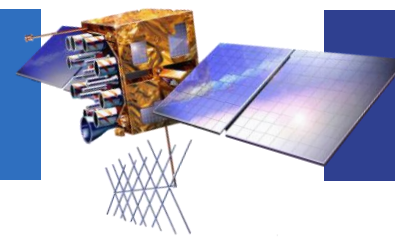
## Network RTK

- Survey
- Engineering
- Construction
- Utilities
- Machine control
- Deformation monitoring
- ...

- Precision agriculture
- Mapping/GIS
- Airborne laser scanning
- GNSS meteorology
- ...

## Standard PPP

- Offshore positioning
- Disaster monitoring
- Glacier monitoring
- LEO orbit determination
- ...



# Markets

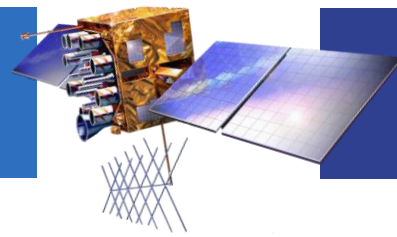
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## Network RTK

## PPP-RTK

- Survey
- Engineering
- Construction
- Utilities
- Machine control
- Deformation monitoring
- ...

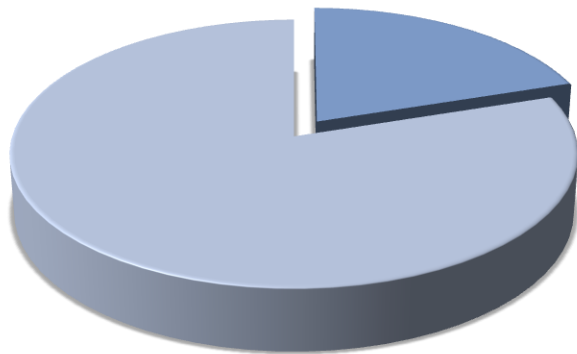
- Precision agriculture
- Mapping/GIS
- Airborne laser scanning
- GNSS meteorology
- ...



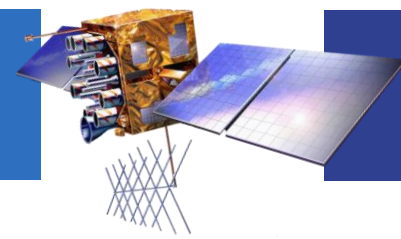
# Market shares in 2012

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**Network RTK**      **Standard PPP**



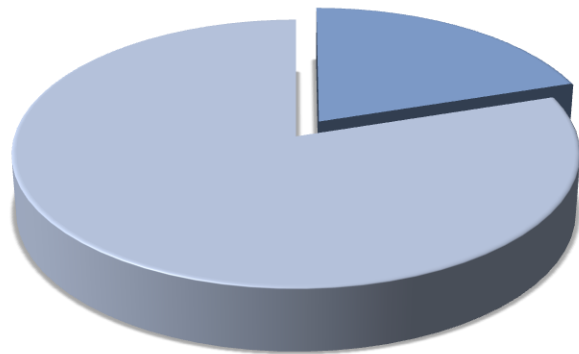
2012



## Market shares in 2015

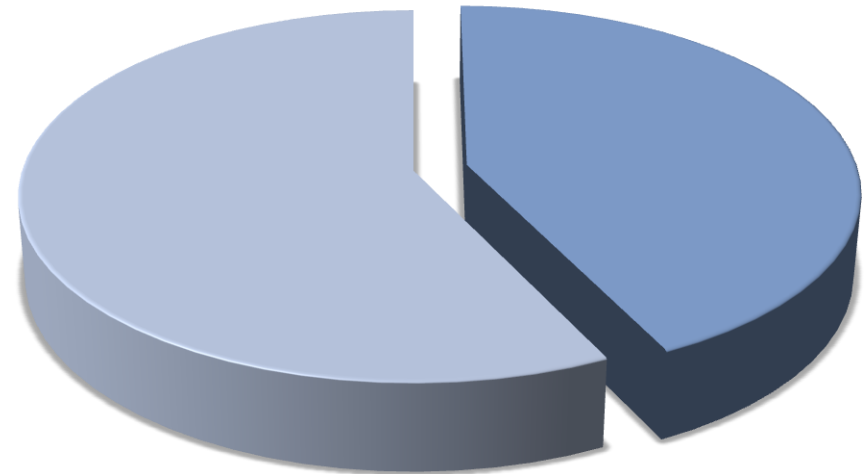
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**Network RTK**      **Standard PPP**



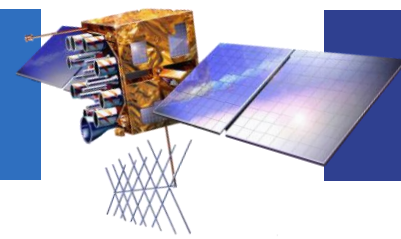
2012

**Network RTK**      **Standard PPP +  
PPP-RTK**



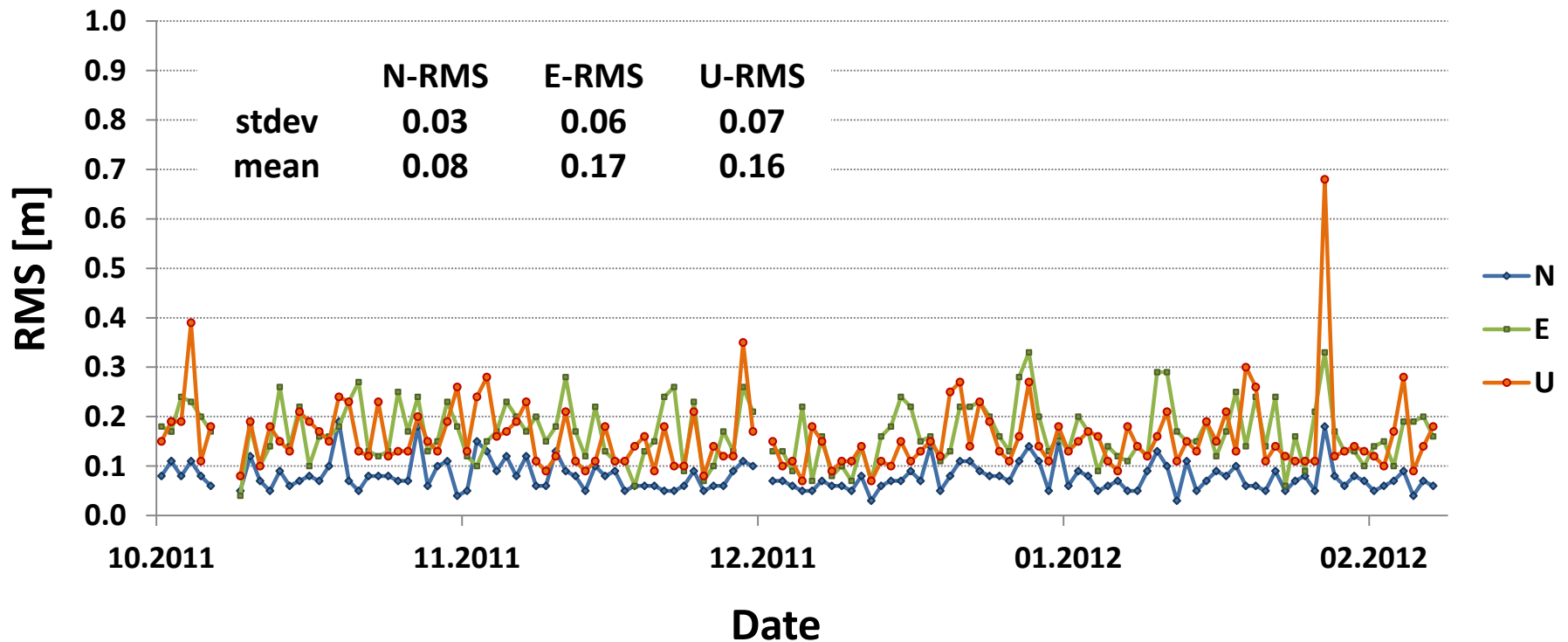
2015

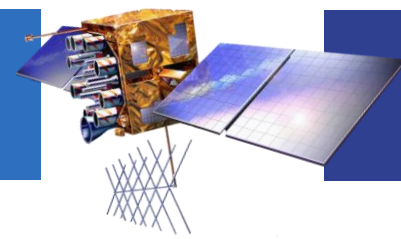




# Standard real-time PPP performance

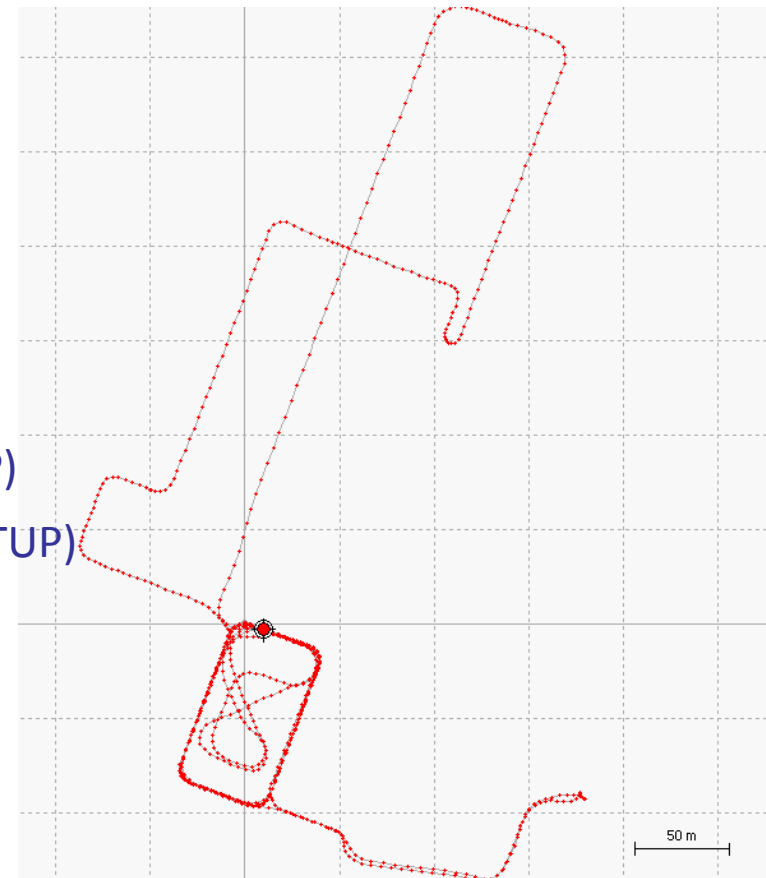
## RMS of displacements - CMB1

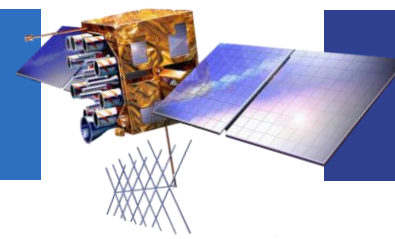




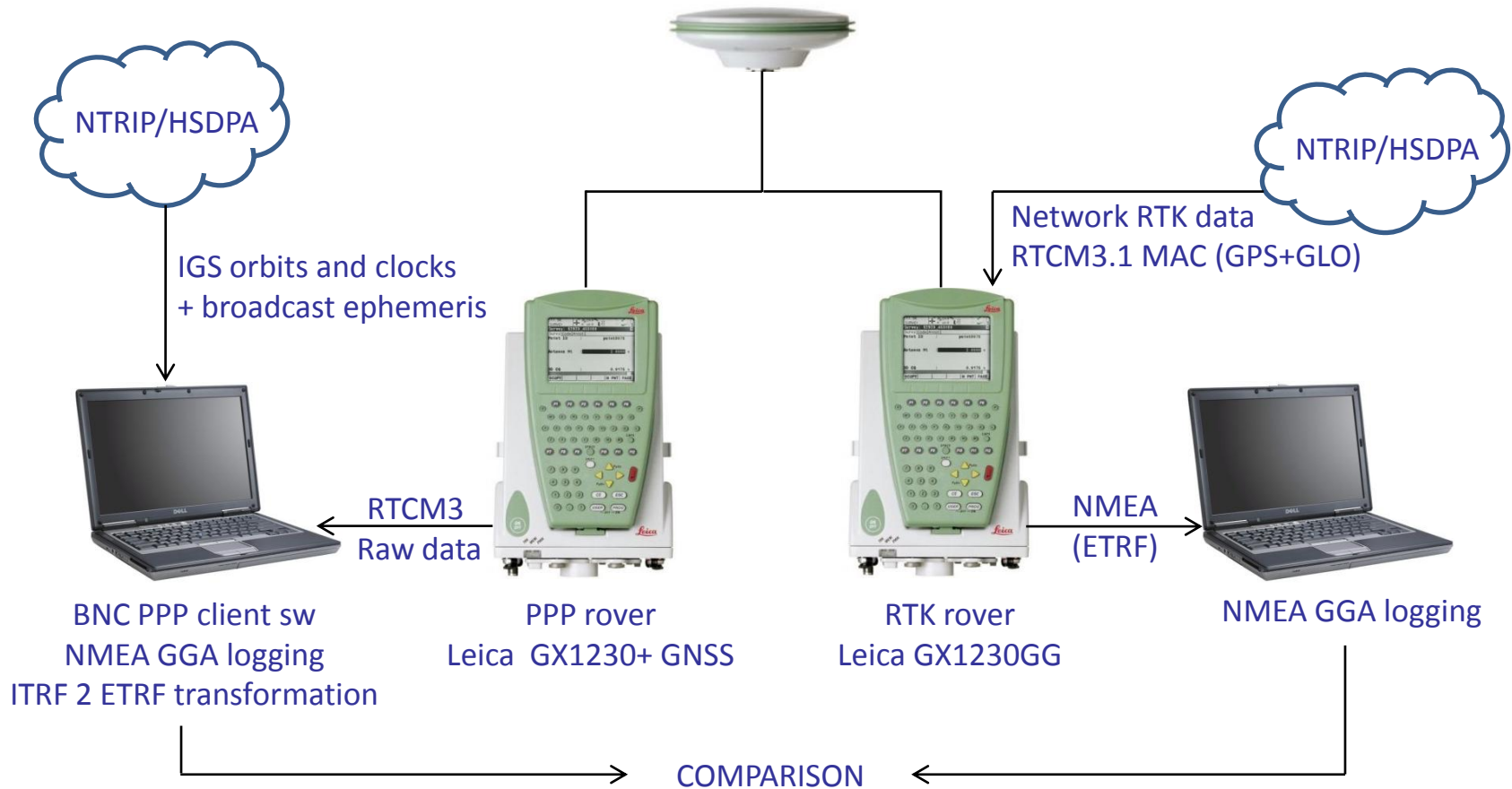
# Real-time kinematic PPP test in Budapest

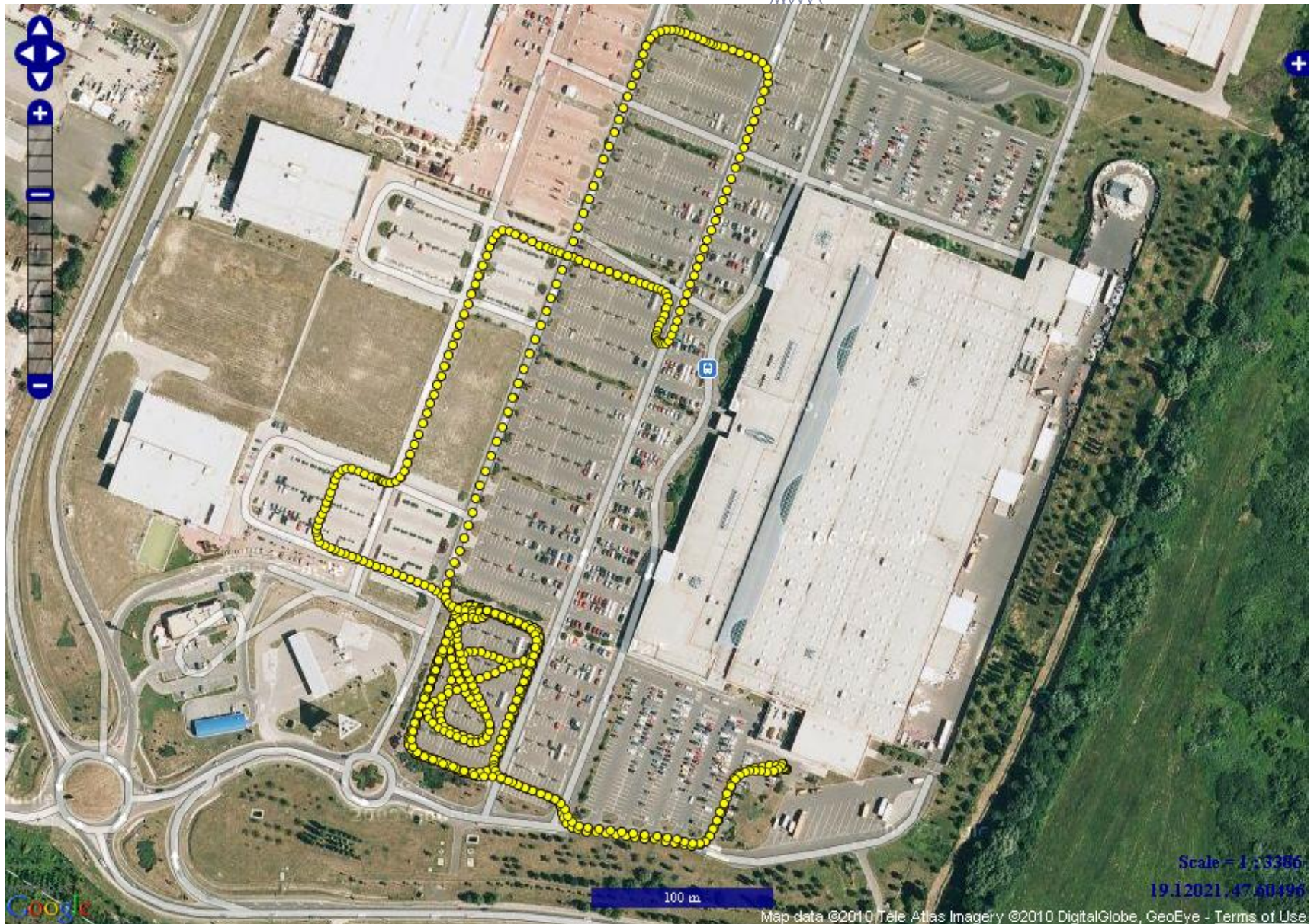
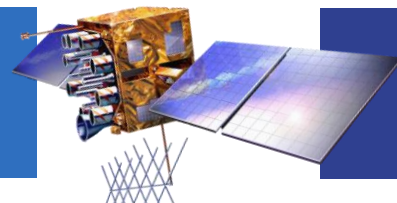
- **Date:** 28 September 2010
- **PPP client sw:** BKG Ntrip Client (BNC)
- **Location:** Budapest, Hungary
- **Reference frame:** ITRF2005 → ETRF2000
- **Observations:** 1Hz, dual frequency, GPS+GLONASS
- **Orbit/clock corrections sw:** RTNet (GPS Solutions)
- **Orbit/clock corrections stream:** CLK11 (BKG & TUP)
- **Broadcast ephemeris stream:** RTCM3EPH (BKG & TUP)
- **PPP mode:** Fully kinematic
- **A priori  $\sigma$  code/ $\sigma$  carrier-phase:** 250
- **Network RTK reference:** RTCM3.1 MAC GPS+GLO
- **Vehicle speed:** 15-30 km/h





# Kinematic PPP test setup

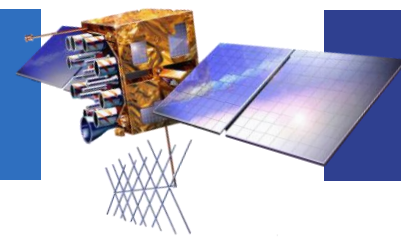




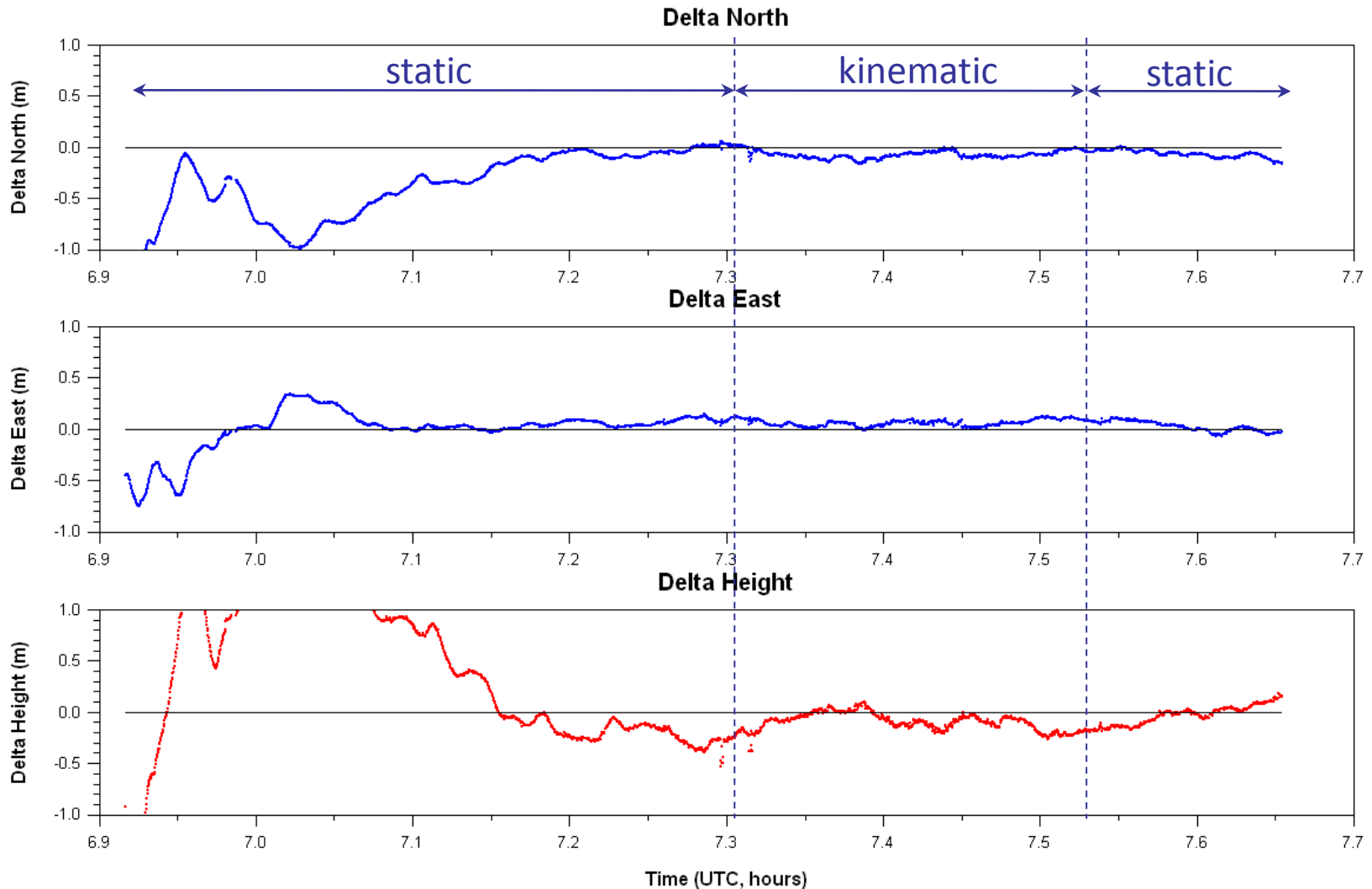
Scale = 1 : 3386

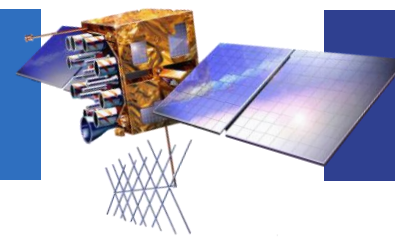
19.12021, 47.60496

Map data ©2010 Tele Atlas Imagery ©2010 DigitalGlobe, GeoEye - Terms of Use



# Standard PPP kinematic performance



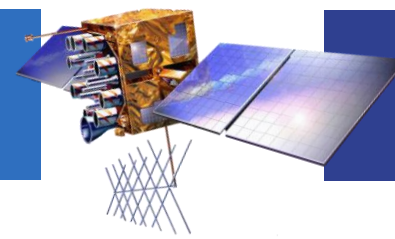


# Standard PPP kinematic performance

---

	N	E	U	[m]
Mean	-0.03	0.09	-0.09	
Stdev	0.05	0.03	0.12	
RMS	0.05	0.10	0.15	

Time period: UTC 07:18 - 07:32



# Service quality

---

We offer three kinds of service:

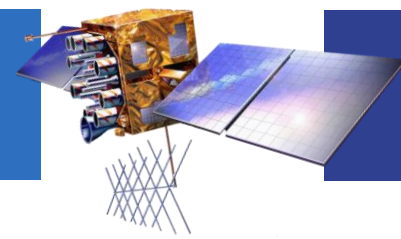
**GOOD – CHEAP – FAST**

You can pick any two

GOOD service CHEAP won't be FAST

GOOD service FAST won't be CHEAP

FAST service CHEAP won't be GOOD

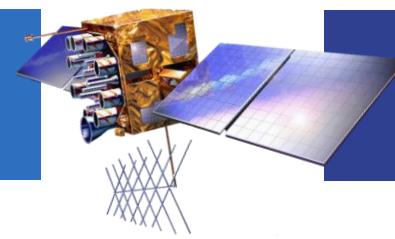


# Service quality in a PPP context

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- **GOOD**      cm-level accuracy
- **FAST**      within a few seconds
- **CHEAP**      no need for reference station infrastructure

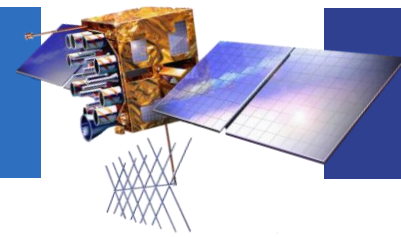




# Different limitations

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- **Network RTK**
  - cm-level accuracy
  - Quick initialisation
  - Requires dense network
- **Standard PPP**
  - dm-level accuracy
  - Requires continuous open sky coverage
  - Long convergence time
  - No need for reference stations
- **PPP-RTK**
  - cm-level accuracy
  - Quick convergence
  - Requires sparse(?) network
  - Integrity?

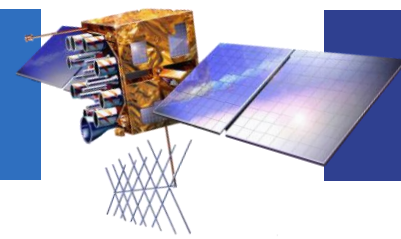


# Replace or complement?

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## Symbiosis of network operators and PPP-RTK service providers

- **Benefits of coexistence for network RTK service providers**
  - market boom
  - more robust services - PPP-RTK as fall-back solution
  - independent monitoring of reference station coordinate stability
- **Benefits of coexistence for PPP-RTK service providers**
  - PPP-RTK will not be possible without local or regional augmentation
  - transformation from global reference to local grid required



## Friend or foe?

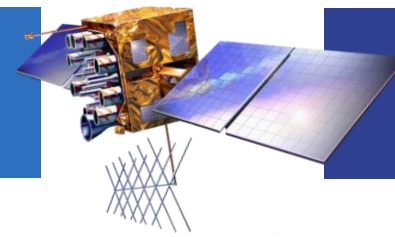
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**Friend, but it's not a pure friendship...**

**Network RTK service providers be prepared,**

- start cooperating early with PPP-RTK service providers,
- provide local augmentation, etc. data,

or else you may have to do something else in 4-5 years time...



# Thank you for your attention!

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