Double stations and network densification experience

EUPOS Technical Meeting

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Tallinn

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

Improving the NRTK performance in SWEPOS

- Double stations
- Network densification
- Availability and redundency
- New measurments and projects

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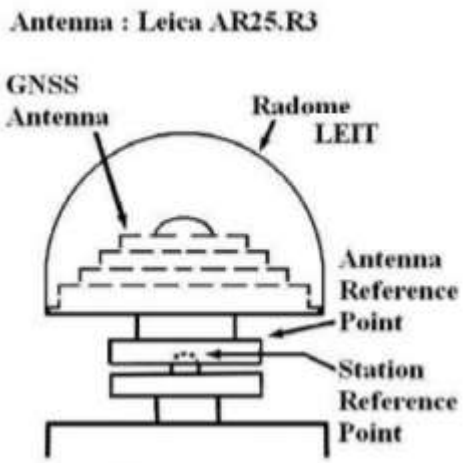
Twin monuments at SWEPOS fundamental stations

Choke ring antennas



21 fundamenal sites in SWEPOS

Pillar monuments in use since 1993. Define the national reference frame SWEREF 99 and used for geodynamic studies

Mast monuments installed 2011 to modernize the SWEPOS network and at the same time continue the long unbroken time series at the pillar stations

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Double stations

Pillar vs Mast installation

+ OSOD radome with small impact on observations, smooth surface and possibility to install fan for snow melting. Protects upper part of pillar and tribrach.

- Antenna and radome could not be calibrated as a set

- The large metal plate has an impact on the observations

+ Antenna & radome could be calibrated as a set (ind.cal.)

+ Smaller metal contruction below the antenna and an acryllic plate for insulation

- The LEIT radome has a larger impact on the observations and algae/moss as well as snow stuck easier to LEIT than OSOD

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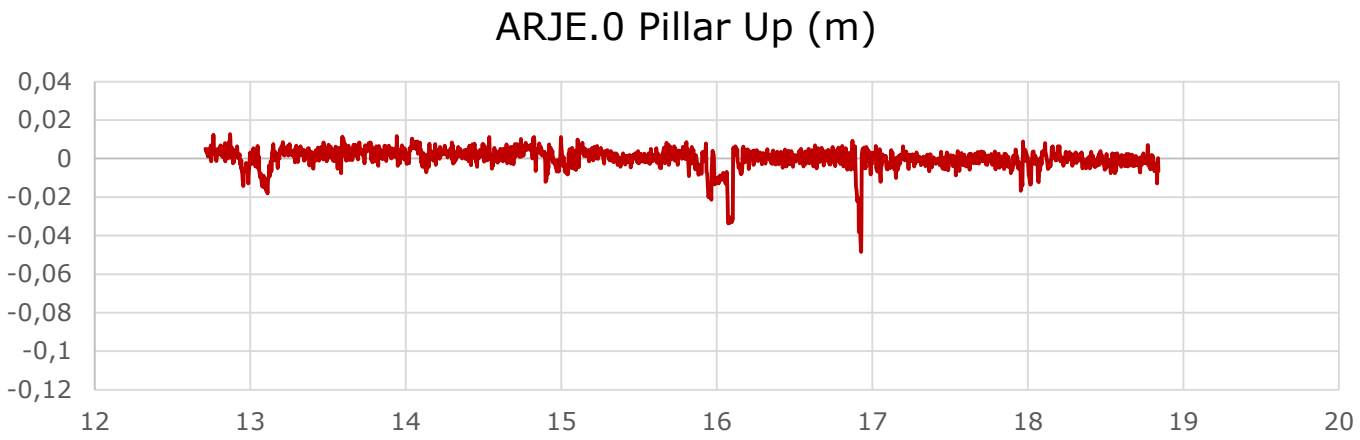
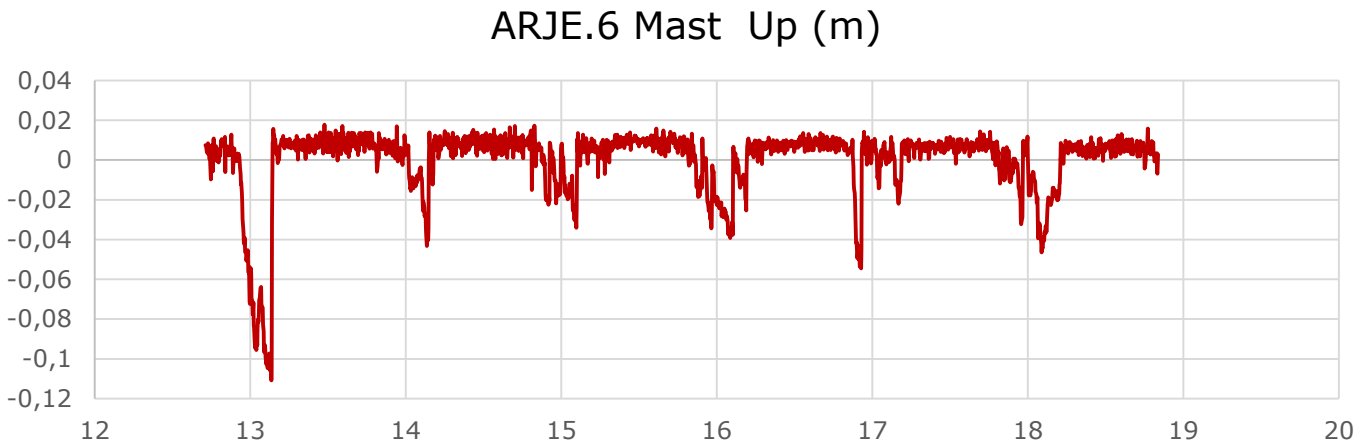
Double stations

Time series example, Arjeplog up-component





Densification rates in SWEPOS Network-RTK

- **Normal Configuration (NC):** It's the orignal form of our NRTK which was built through establishing NRTK service in 2002-2010. The distances between the stations are **70 km**.

- **Densified Configuration (DC):** It's the densified form of NRTK service. The distances between the stations are **35 km**. The densification from 70 to 35 started in 2010 for improving the network performance.

- **High-Densified Configuration (HDC):** It's a special form of NRTK service and implemented for the areas that need very high performance (project-oriented positioning services). The distances between the stations are **10 km**.

Network densification

Position Uncertainty (1σ)

- **NC-Net**

	Distance <10 km	Distance 10-20 km	Distance 20-40 km
Horizontal Determination (2D)	0,012	0,015	0,018
Vertical Determination (1D)	0,022	0,026	0,030

- **DC-Net**

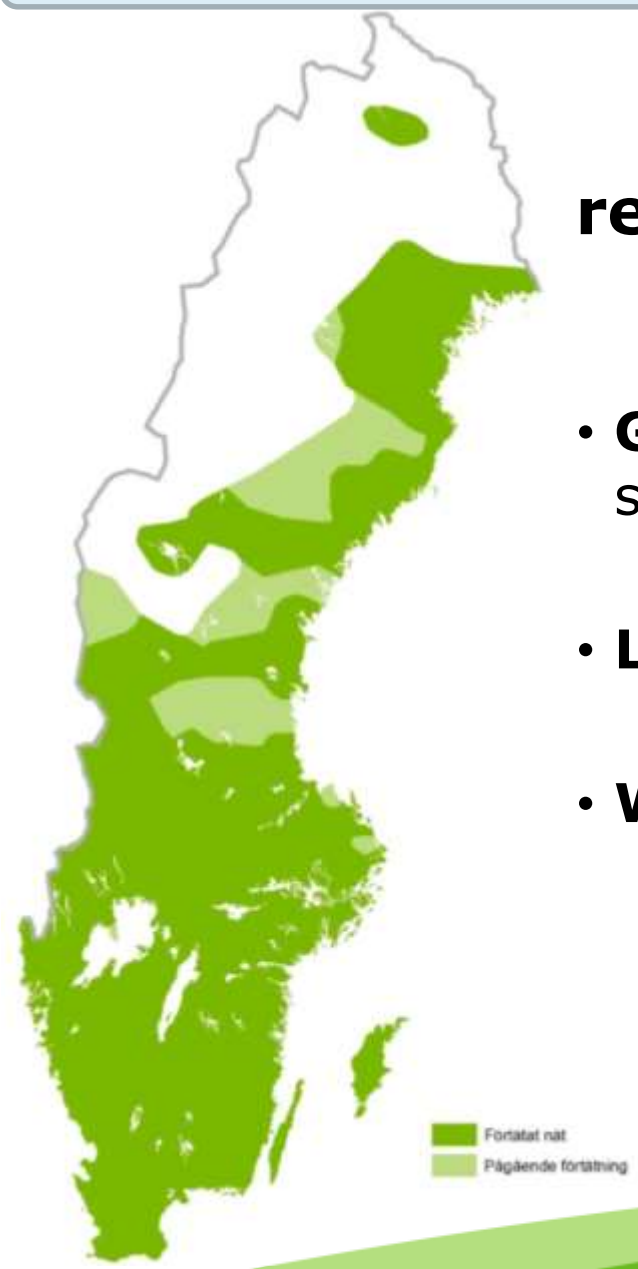
	Distance <5 km	Distance 5-10 km	Distance 10-20 km
Horizontal Determination (2D)	0,008	0,009	0,010
Vertical Determination (1D)	0,014	0,016	0,018

- **HDC-Net**

	Distance <2 km	Distance 2-3 km	Distance 3-6 km
Horizontal Determination (2D)	0,005	0,006	0,007
Vertical Determination (1D)	0,008	0,009	0,010

Leica-receiver (GS14)

Network densification



Improved accuracy and redundancy by densification of the network

- **Green areas** – densified to 35 km, in some areas to 10-15 km
- **Lightgreen areas** – ongoing densification
- **White areas** – no planned densification

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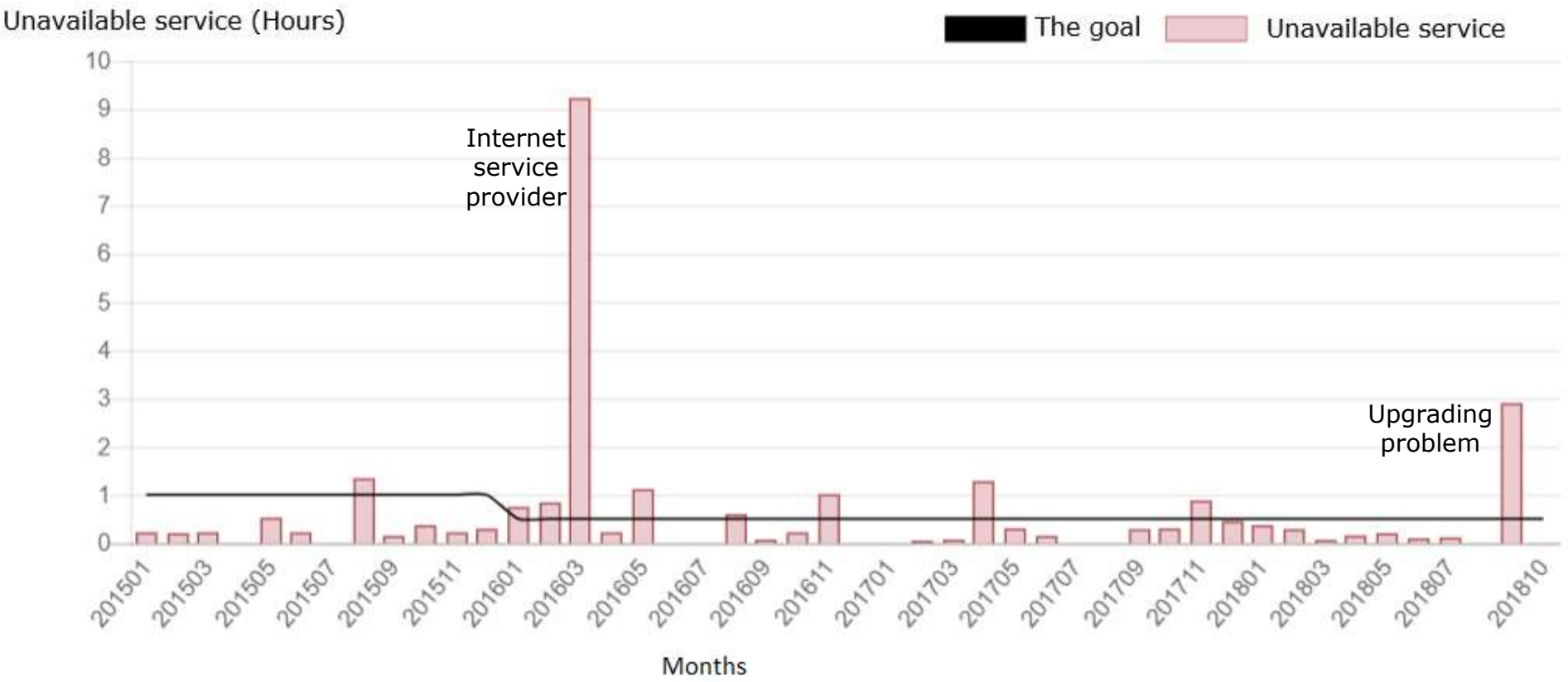
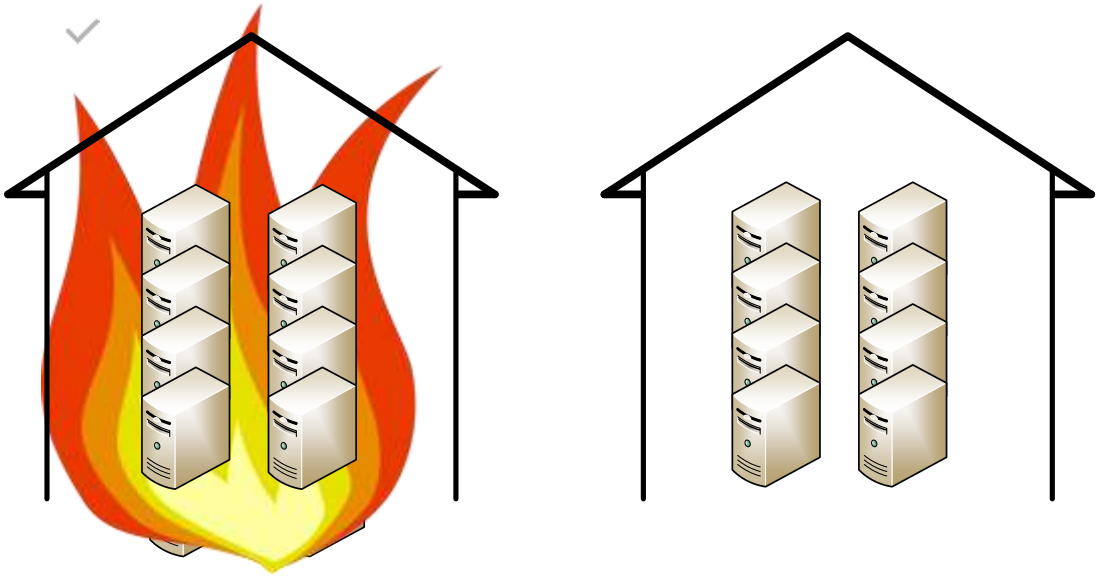
Availability of SWEPOS NRTK (Real-time service)



The goal: 0.5 h/month

Project of increasing the availability and redundency

- 2 parallel ben -> Service Evening without any disruption
- DR – Disaster Recovery
  - Under 2019
- Dual data center
- Routines and processes



New receivers

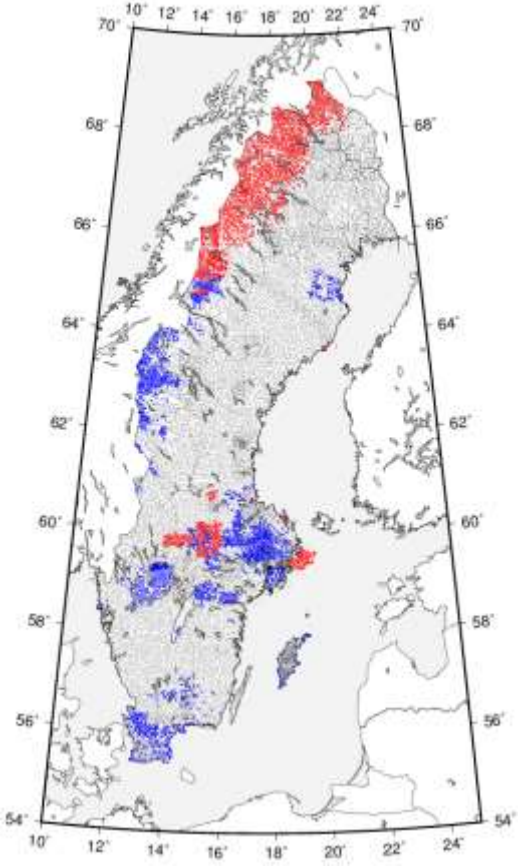
Ongoing work (2018-2019) changing all the Javad Sigma receivers to:

- Trimble Alloy
- Septentrio PolaRx5

Develping the RTK-Network Service in Sweden

- Introduced, GPS only, 2004
- GPS+Glonass, 2006
- GPS+Glonass+Galileo, februari 2018
- **GPS+Glonass+Galileo+BeiDou 2019 (Planed)**

3481 new gravity measurements performed (blue 2010-2013, red 2014-2018)



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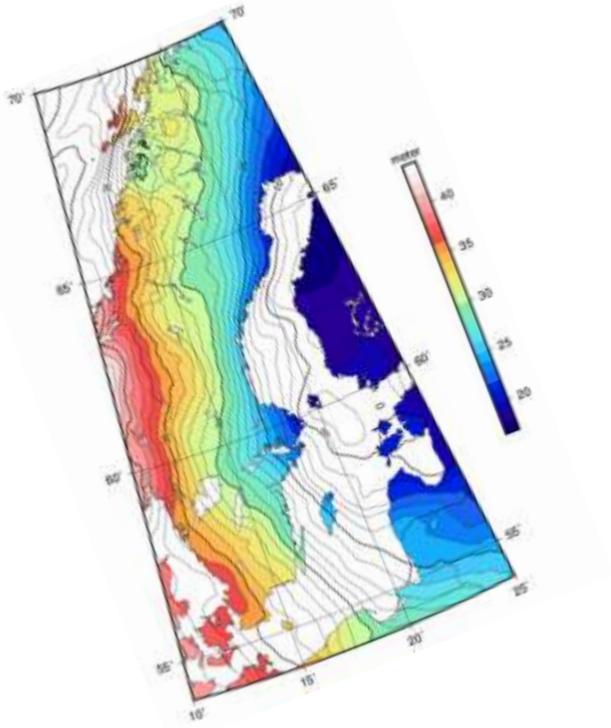
SWEN17_RH2000 – a new National geoid model, important for accurate GNSS height mesurements



–Replaces old model SWEN08_RH2000

Standard error (68 %) approximately 8-10 mm over land

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Co-financed by the European Union
Connecting Europe Facility

SWEPOS

FAMOS

FINALISING SURVEYS FOR THE BALTIC MOTORWAYS OF THE SEA

- EU-project for improved **efficiency**, **safety** and navigation **accuracy** in the Baltic Sea.
- Partners: most maritime administrations and some geodetic institutions around the Baltic Sea
- Four activities
  1. Hydrographic surveying
  2. Improving vessel navigation for the future
  3. Improving surveying infrastructure
  4. Data workflow from sounding to brigde

FAMOS
FINALISING SURVEYS FOR THE BALTIC MOTORWAYS OF THE SEA

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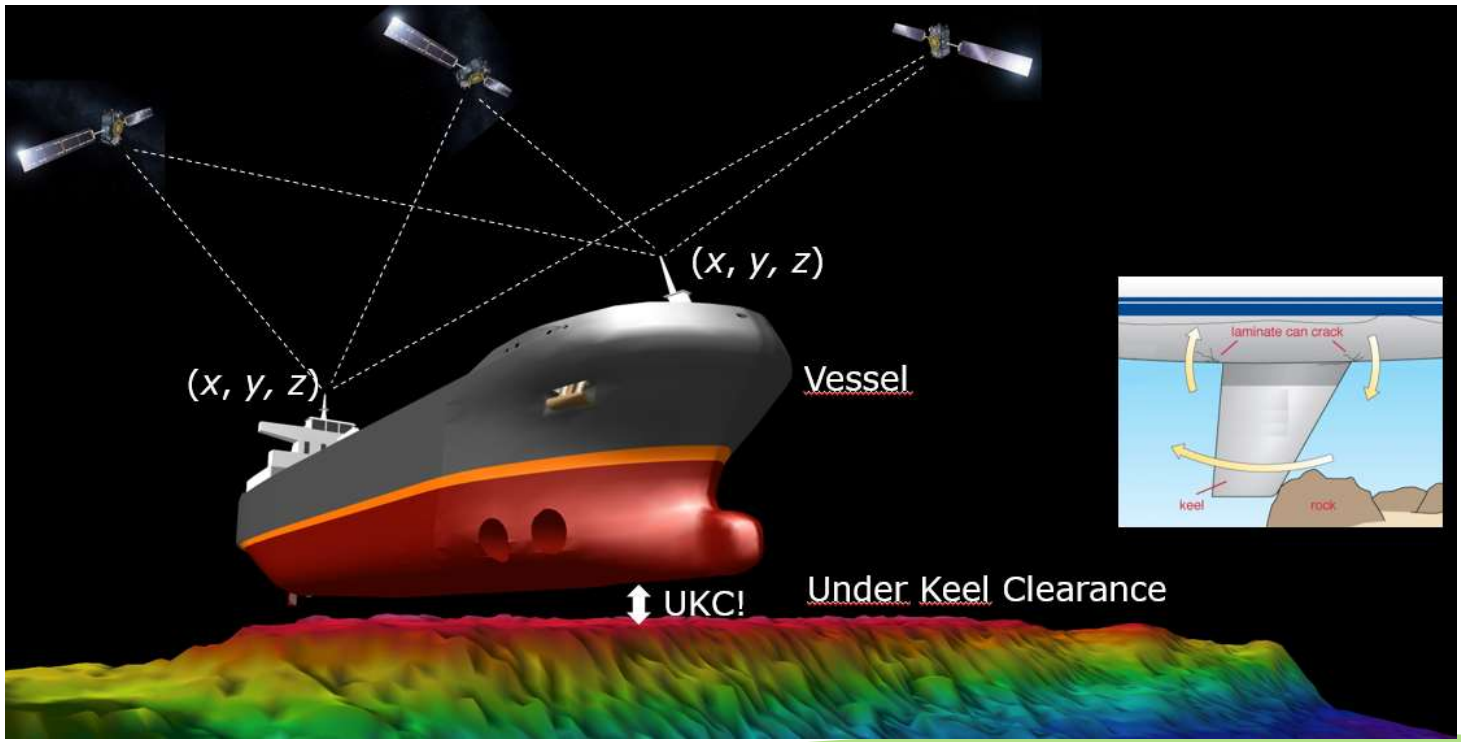
SWEPOS

Activity 2:

Improving vessel navigation for the future/harmonising vertical datum

- Supporting the Baltic Sea Chart Datum 2000 (BSCD2000) as the common unified chart datum in the Baltic Sea. BSCD2000 is a geodetic height system that uses an equipotential surface (the geoid) as zero level.
- Offshore, BSCD2000 will be realized by GNSS (NRTK) and a height reference surface constructed based on a gravimetric geoid model.



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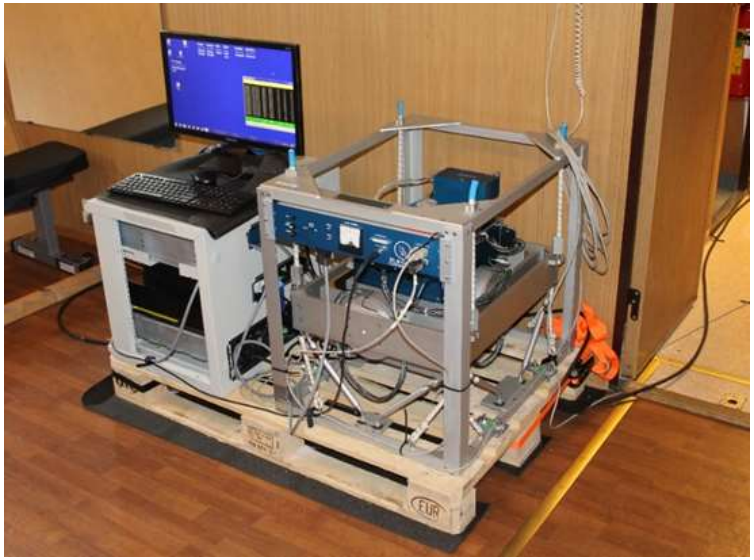
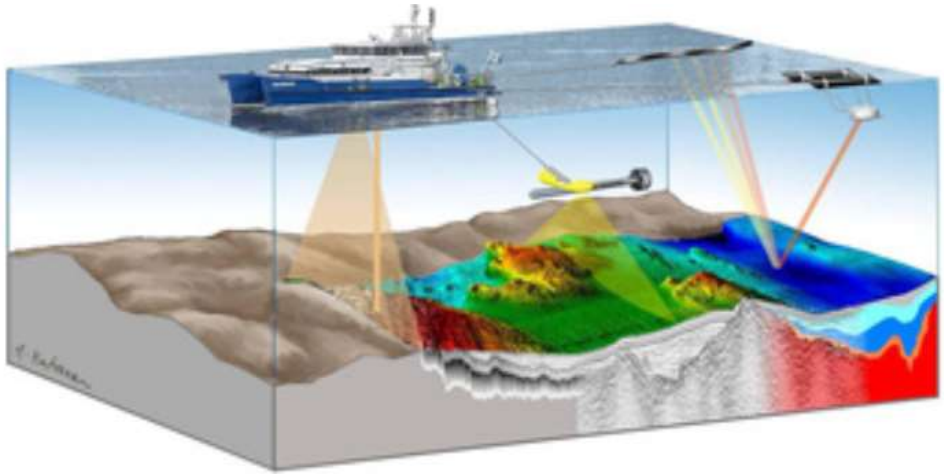
Activity 2:

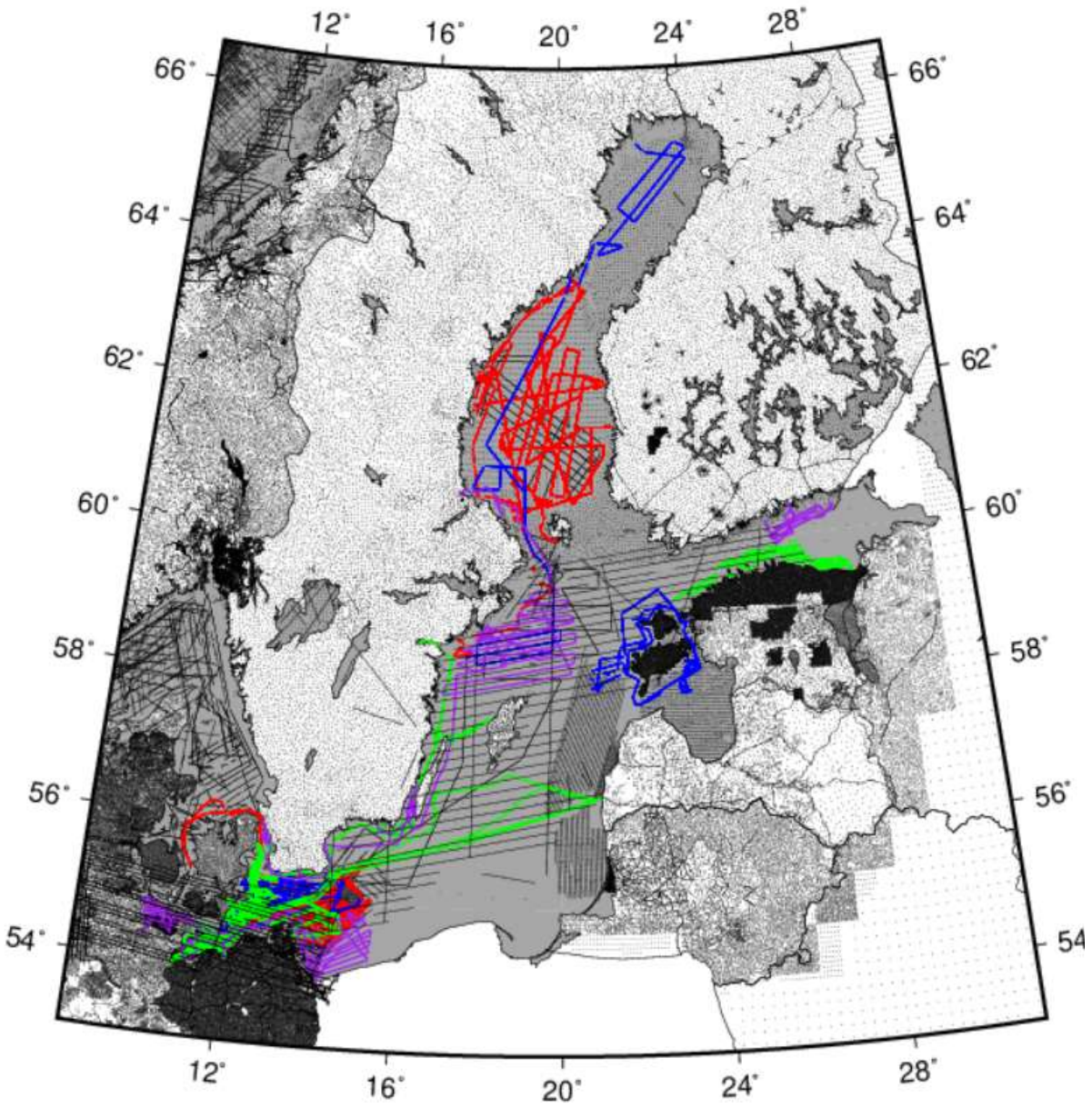
Improving vessel navigation for the future/harmonising vertical datum

- The requirements: FAMOS geoid model is finished by 2020 with uncertainty better than 5 cm.
- To reach this goal, new marine gravity measurements are made on the FAMOS hydrographic surveying vessels. The plan is to complement the existing datasets and fill data gaps.
- Purchase of a marine-gravimeter during 2017 (from the company ZLS in Texas), Installed on the ”survey vessel” Jakob Hägg





Marine gravity campaigns in FAMOS till September 2018



- Deneb (Germany) 2015
- Airisto (Finland) 2015
- Jacob Hägg (Sweden) 2015
- Jens Sørensen (Denmark) 2015
- Deneb (Germany) 2016
- Jacob Prei (Germany) 2016
- Jacob Hägg (Sweden) 2016
- Jens Sørensen (Denmark) 2016
- Deneb (Germany) 2017
- Sektori (Estonia) 2017
- Jacob Hägg (Sweden) 2017a
- Jacob Hägg (Sweden) 2017b
- Jens Sørensen (Denmark) 2017
- Urd (Denmark) 2017
- Deneb (Germany) 2018
- Jakob Hägg (Sweden) 2018
- Geomari (Finland) 2018
- Fyrbyggaren (Sweden) 2018
- Jens Sørensen (Denmark) 2018

The European Navigation Conference 2018

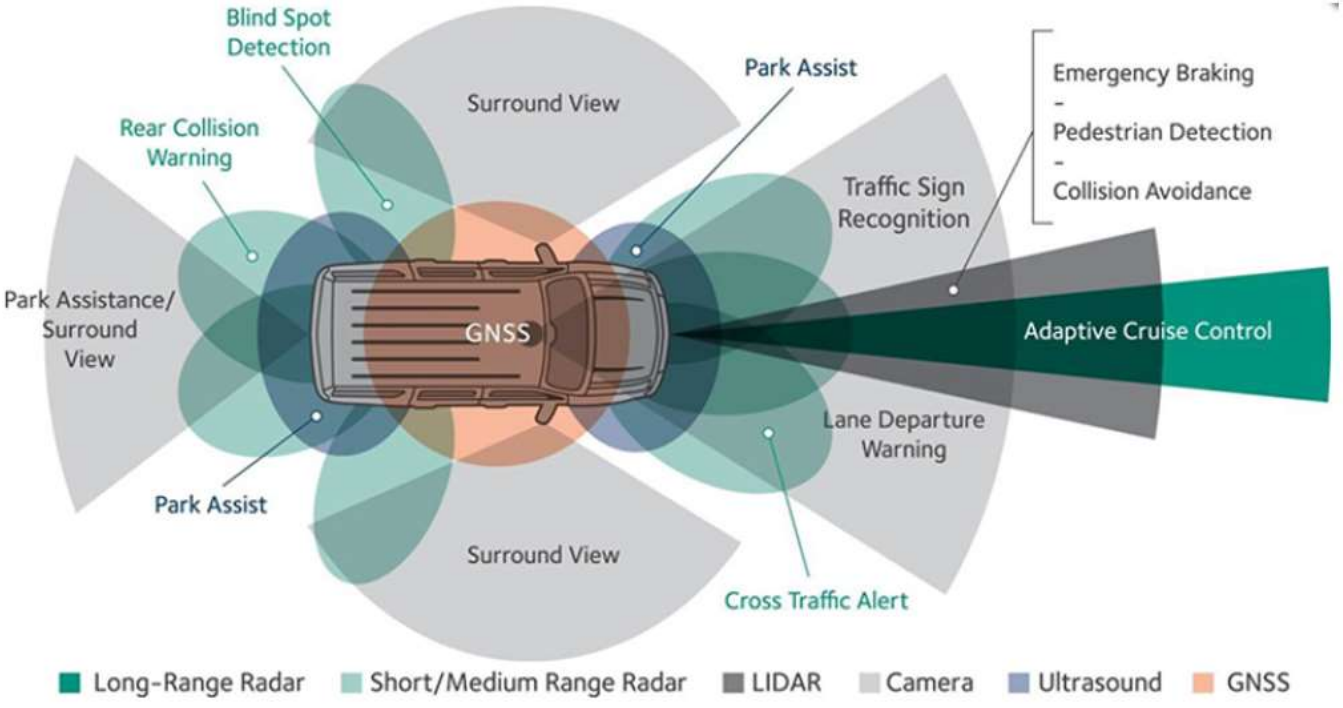
Lantmäteriet, Chalmers University of Technology, and RISE Research Institutes of Sweden.

ENC 2018 organized annually by the **European Group of Institutes of Navigation**

NETWOEK-RTK POSITIONING FOR AUTOMATED DRIVING (NPAD)

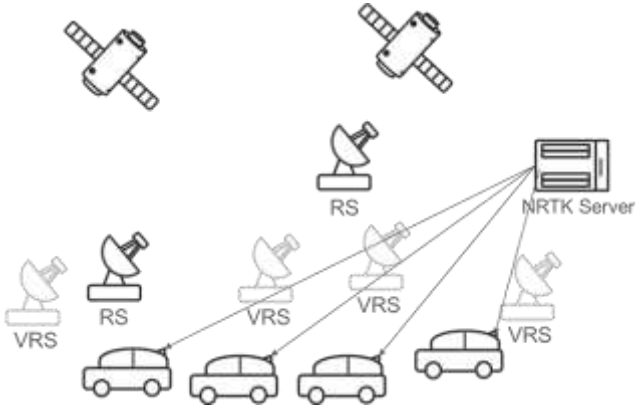
Project together with RISE Research Institute of Sweden and the automobile industry.

The objective of the project is to enable cm-level Network-RTK GNSS positioning for a large number of automated vehicles or other mobile platforms by applying the standard developed by 3GPP and adapting the existing infrastructure provided by Lantmäteriet/SWEPOS.



Why NPAD?

Mass market scenarios



The current NRTK procedures scales badly.

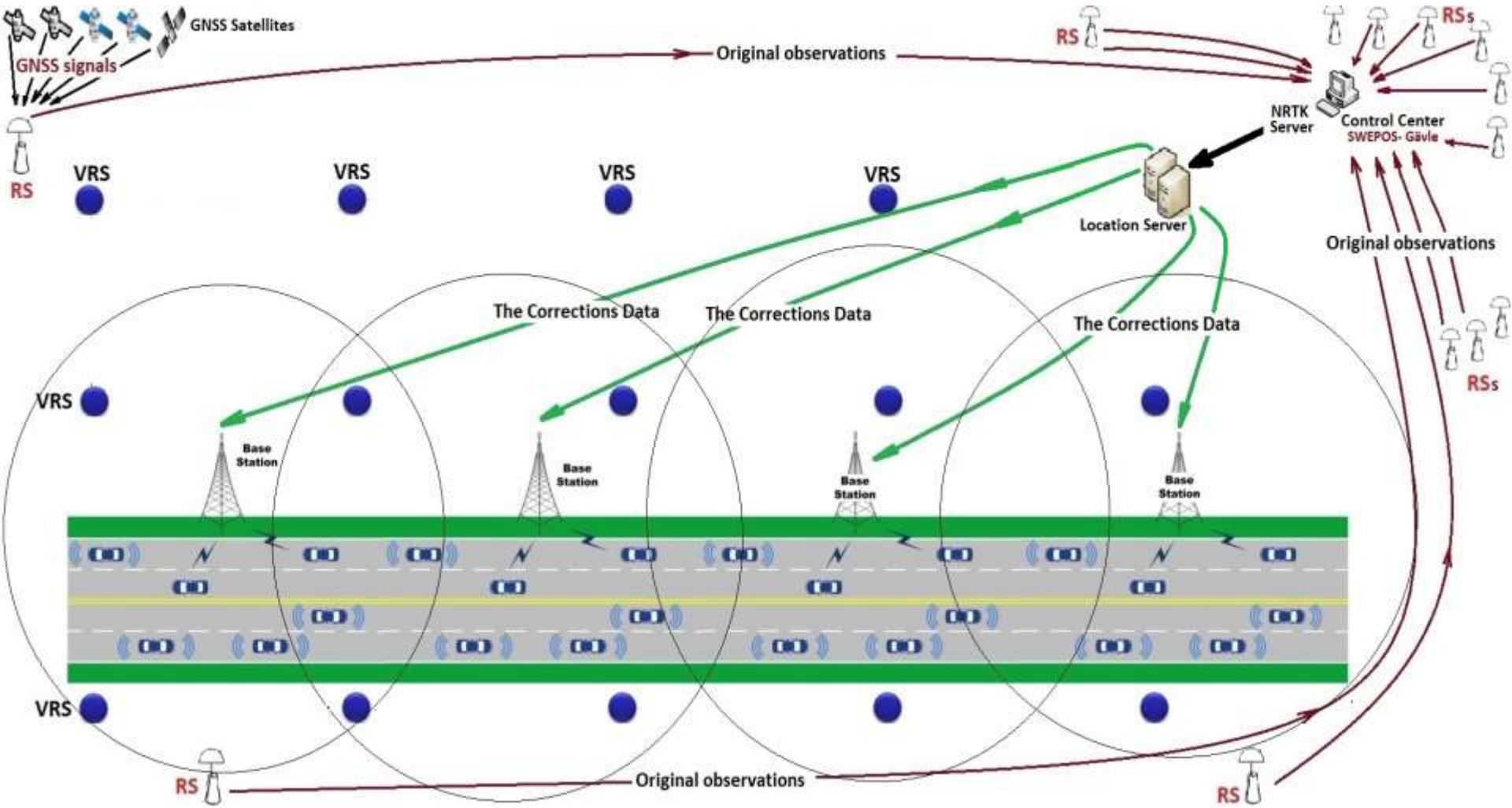
NRTK provides individual handling and signaling for each user (vehicle).

Extensive exchange of messages between the devices and the NRTK server

NRTK server will face challenges processing all the requests for each device.

High **communication links load** (causing delays in the supplying of the corrections)

The project idea:



Thank you for your attention

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