# DANGO
# Danish National Galileo Overlay

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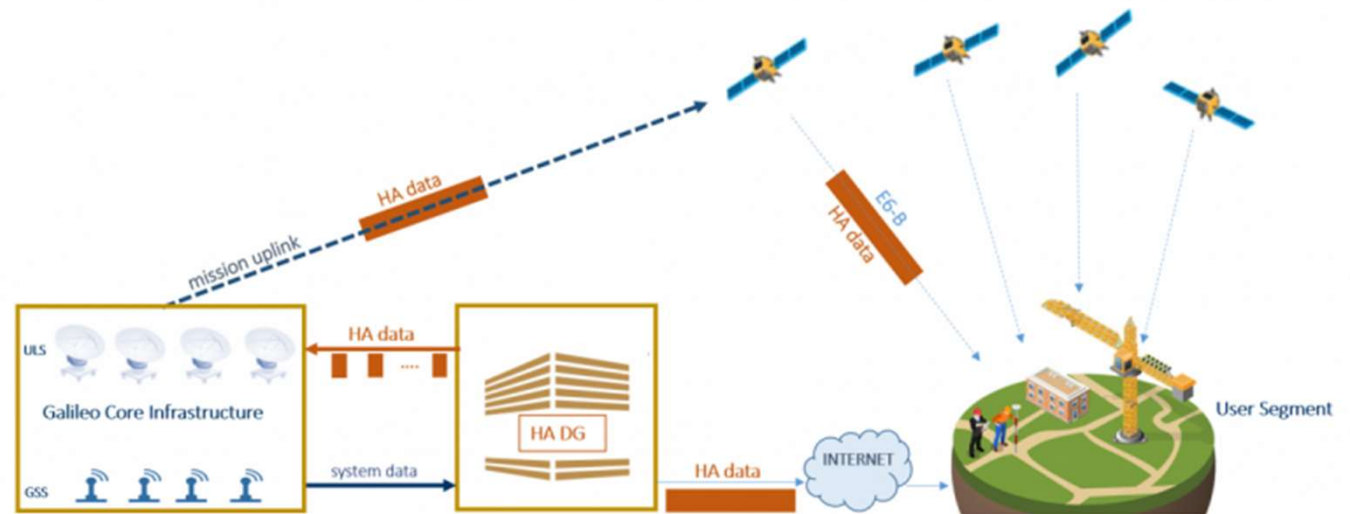
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DTU Space

# Galileo High Accuracy Service (HAS)

- Free high accuracy PPP corrections (decimeter level).

- Provided through the Galileo signal E6-B (Signal-In-Space) and through terrestrial means (Internet Data Distribution).

- Galileo HAS uses the GTRF (Galileo Terrestrial Reference Frame).

- Target coordinates are in ETRS89DK, so there is a need for transformations.



| | | Service Level 1 (SL1) | Service Level 2 (SL2) |
|---|---|---|---|
| 🌐 | Coverage | Global | European Coverage Area (ECA) |
| | Corrections | Orbit, clock, biases (code and phase) | Orbit, clock, biases (code and phase) + atmospheric corrections |
| | Horizontal Accuracy (95%) | <20cm | <20cm |
| | Vertical Accuracy (95%) | <40cm | <40cm |
| 🕐 | Converge Time | <300s | <100s |
| 📅 | Availability | 99% | 99% |
| | User HelpDesk | 24/7 | 24/7 |

Target performances for Galileo HAS Service Level 1 (SL1) and Service Level 2 (SL2).



Galileo system elements involved in the generation, provision and exploitation of Galileo HAS.
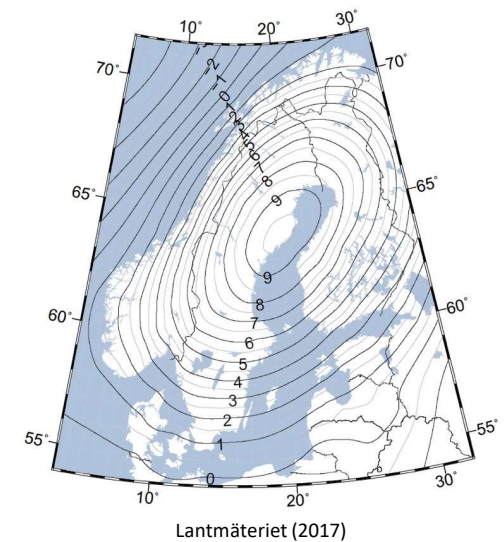
Galileo HAS: https://www.euspa.europa.eu/european-space/galileo/services/galileo-high-accuracy-service-has

# DANGO for CRS transformations

- Up-take of Galileo PNT services through national GNSS.

- PPP corrections are estimated in the global geodetic reference frame.

- Service for position transformations from GTRF to the Danish ETRS89(DK).

GTRF19v1(2020.5) => ITRF2014(2020.5) => ITRF92(2020.5) => ETRF92(2020.5) => ETRF92(1994.704)
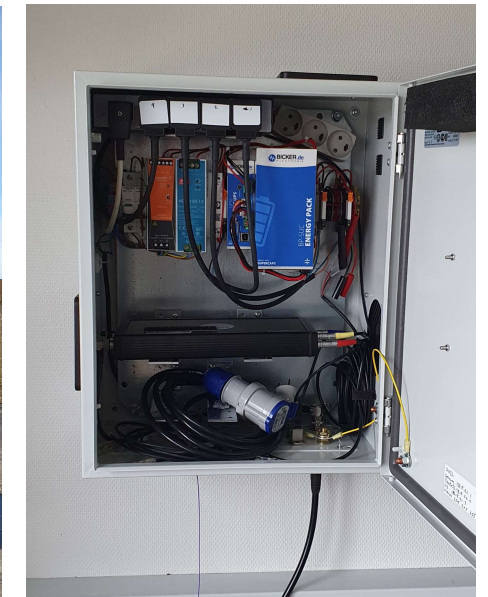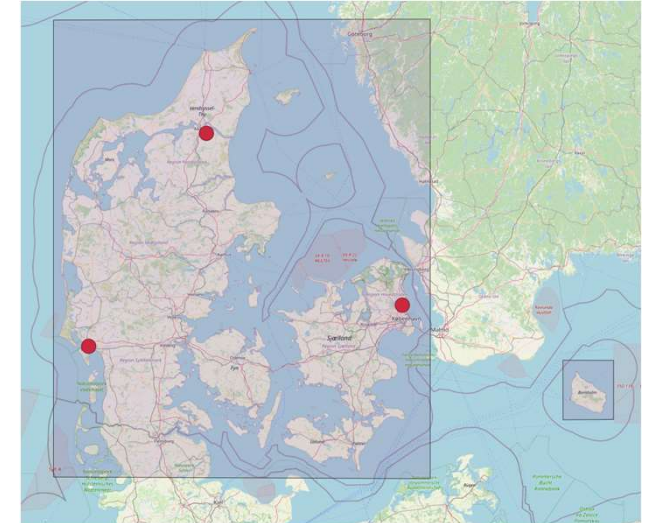
~ ETRS89(DK)

- GTRF is closely alligned to ITRF.

- Chain of transformation that includes the intraplate motion.

- Difference between GTRF and the Danish national system is ~70 cm.

- Expected station movement per year: ~2.5 cm.

Lantmäteriet (2017)

# DANGO CORS



Establishment of three permanent CORS in Lyngby, Esbjerg and Aalborg.

- Independent data in ITRS and ETRS89DK.

- Stations are consisting of LeicaAR20 antennas and Septentrio PolaRX5S receivers.

- The data from the stations will be used for derivation of the Helmert transformation parameters.

# DANGO dissemination system

- Originally, open standards like NTRIP and RTCM were planned to be used for dissemination of the Helmert parameters for transformations from ITRS to ETRS89(DK).

- RTCM messages:
  - 1021 – Helmert / Abridged Molodenski Transformation Parameters
  - 1023 – Residuals, Ellipsoidal Grid Representation
  - However, these are not found in actual use.

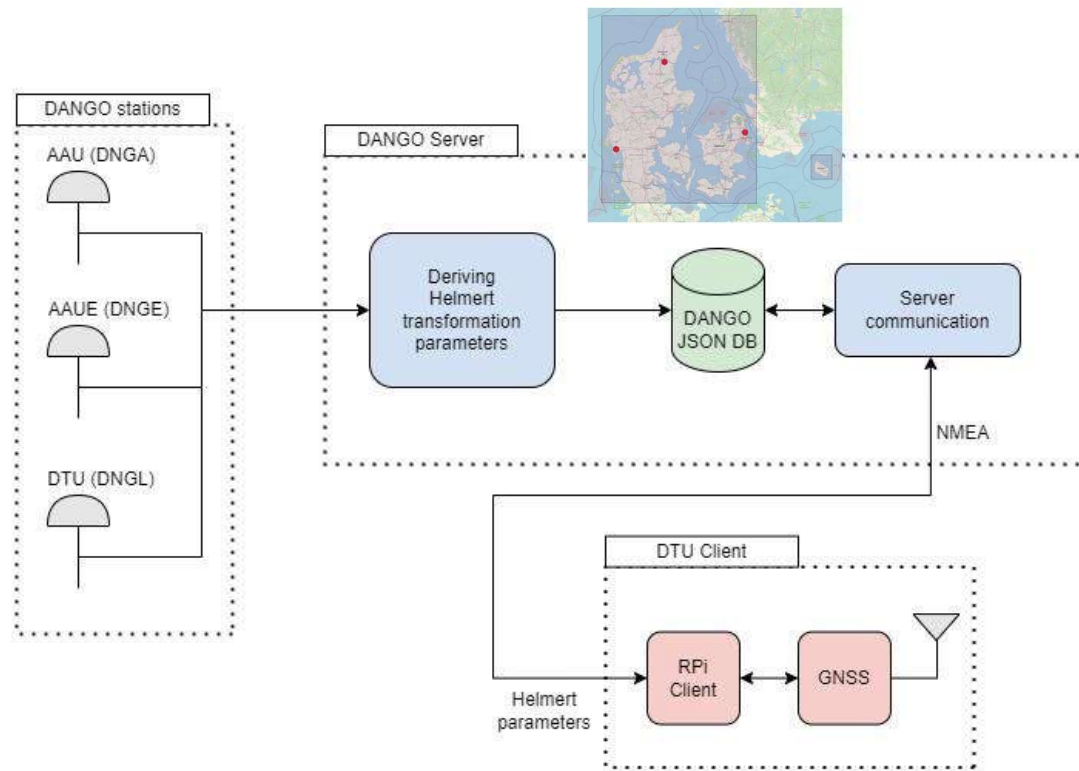| | |
|---|---|
| **1021** | **Helmert / Abridged Molodenski Transformation Parameters**<br>A classical Helmert 7-parameter coordinate transformation message. Not often found in actual use. |
| **1023** | **Residuals, Ellipsoidal Grid Representation**<br>A coordinate transformation message. Not often found in actual use. |

- According to SNIP, these messages are not implemented for receivers.

- Therefore, a de-risked strategy for disseminating parameters was proposed: TCP/IP system.

SNIP RTCM 3 message list: https://www.use-snip.com/kb/knowledge-base/rtcm-3-message-list/

# TCP/IP dissemination prototype

# Future DANGO goals

- Static and kinematic in-situ tests.

- Disseminating geoid heights together with Helmert parameters.

- Subregion definitions.