Agency for
Data Supply and
Efficiency

National Report Denmark

NKG Science Week

Working groups Reference Frames & Future positioning services and applications

March 10, 2020

Positioning

General updates:

A national strategy underway:

- National strategy for dynamic positioning to be drafted in 2020.
- Aimed to set focus for current and future user needs of positioning (e.g. autonomy, smart city, indoor/outdoor)

DANGO

- A project set to enhance the use of the Galieo High Accuracy Service.
- The service will make a transformation between the Galileo reference frame and national reference frame.
- Project is Funded by ESA's NAVISP and lead by Lars Stenseng at Aalborg University.

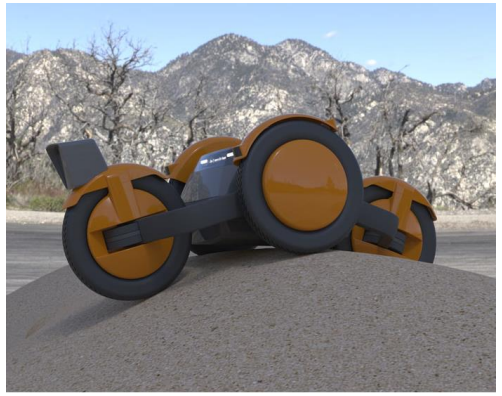
Big focus on using realtime GNSS data for smart city projects and green solutions

- Danish ESA BIC launched 4th of march. Including GNSS innovation track.
- Consortium underway to use real-time GNSS traffic information for green transport and logistics.
- Many cities aim to use GNSS for intelligent traffic monitoring. Green lights for ambulances etc.
- The robotic business environment sees big growth in DK. A lot of new users within solutions for drones and robots.

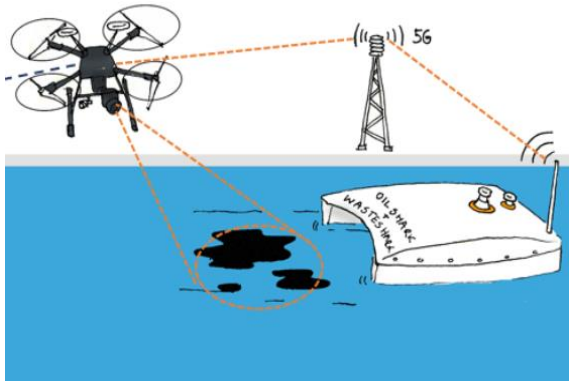
Testbed in Aarhus for Precision positioning and Autonomous Systems

Open research and development platform providing1cm3 accuracy GNSS in Aarhus. Over the last year TAPAS has had a great increase in user numbers. TAPAS now attracts a more broad and mainstream set of users, that tests the use of high accuracy GNSS in their business.

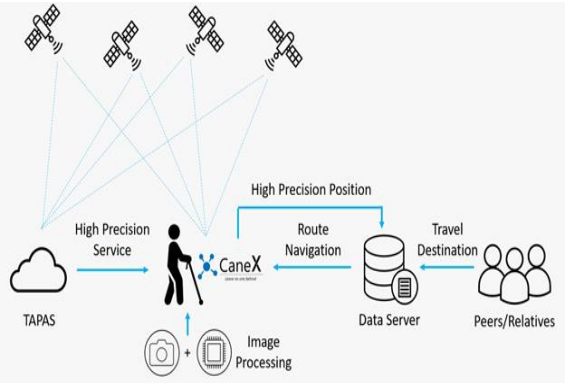
Voi: Aims to test TAPAS high accuracy for accuractely geofencing e-scooter parking spots in Aarhus



Capra Robotics: Develops steering of outdoor mobile robot frame for a wide range of applications



Aarhus, Oracle, Kinetica and Aarhus Port: Project to collect oil and trash from the harbor using a network of drones by the water and in the air.



CaneX: Winner of innovation challenge. Using high accuracy GNSS to guide visually impaired people

Status GNSS stations

New stations:

- RIKO 2019-12-19
- SKEJ 2019-01-31

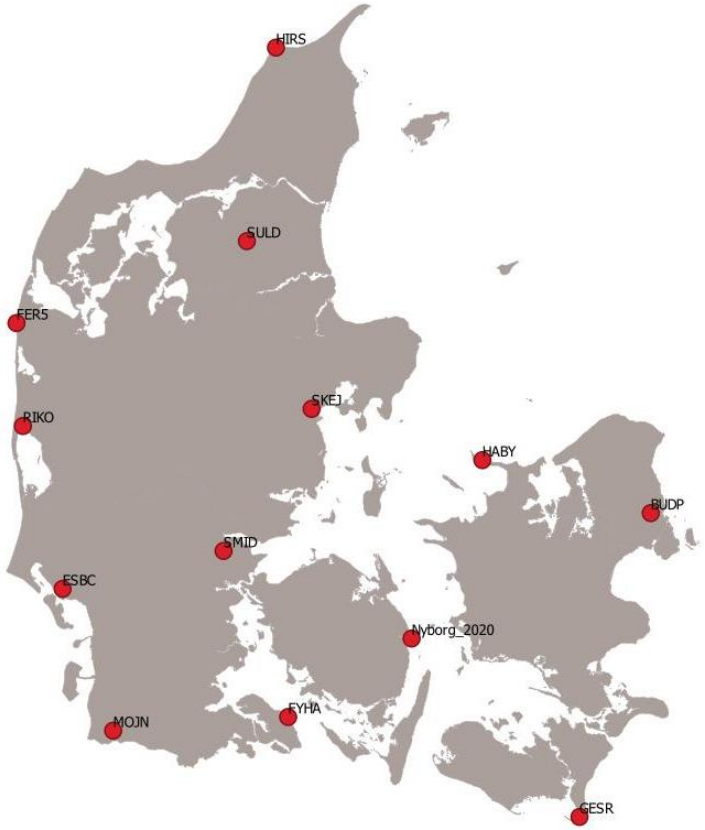
Antenna changes:

- SULD: 2019-01-31
- GESR: 2019-03-13

New ETRS89 coordinates:

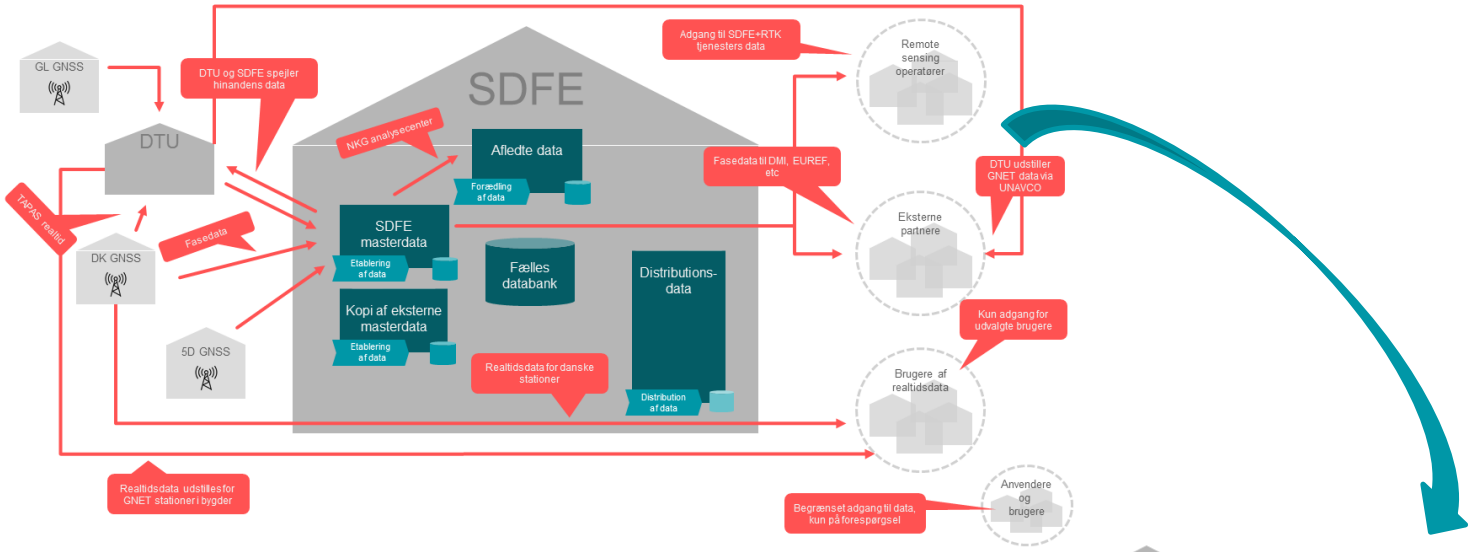
BUDP, ESBC, FER5, FYHA, GESR, HABY, HIRS, SMID, SMI2, SULD, SUL5, TEJH

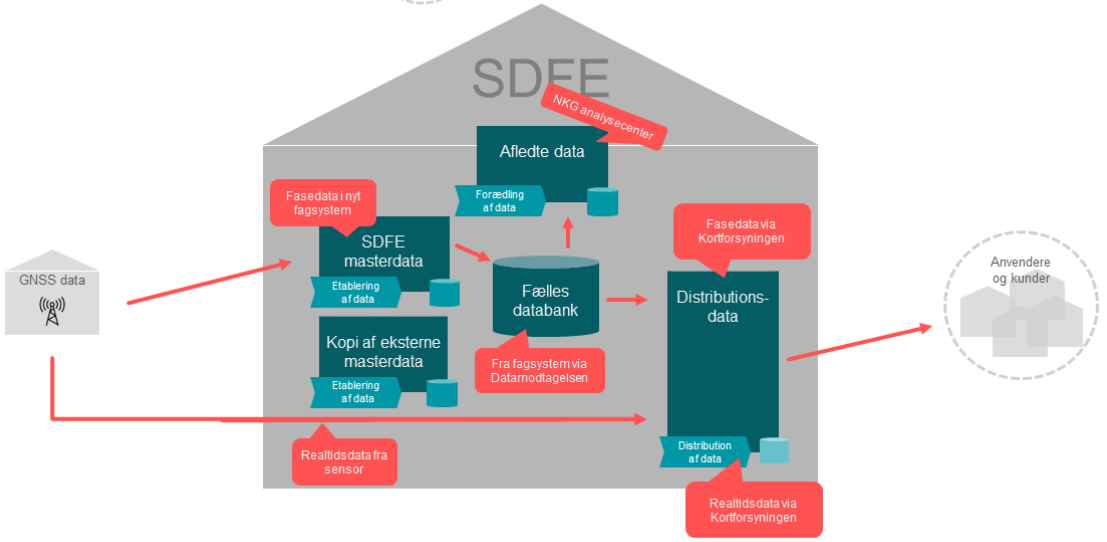
3D difference between old and new coordinates: 1 to 8 mm



Harmonizing the GNSS IT infrastructure in SDFE

- Decrease complexity
  - From two to one processing center
  - From several distribution channels to just one
- Make GNSS data publicly available, not just for select partners
- Use modern IT technology that scales better





PROJ 7.0.0

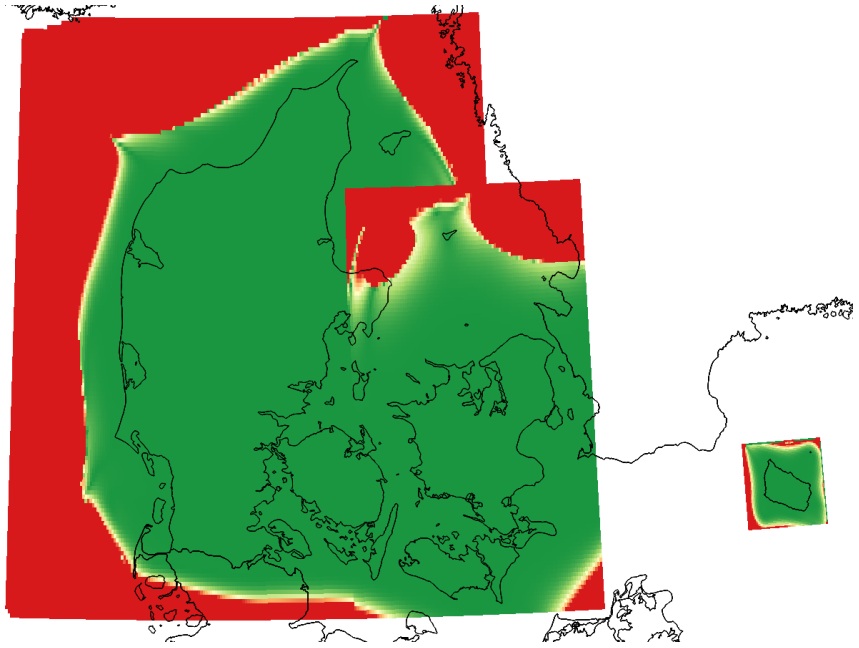
- EUREF Tutorial May 2019
- Graduated OSGeo incubation
  - PROJ is now a proper OSGeo project
- Version 7.0.0 just released
- Updated and added transformations to the EPSG registry
  - Clarifications of some coordinates reference systems
  - New System 34 transformations (next slide)

Updated System 34 transformations

The Danish cadastral system, S34, was defined as **"mostly transverse mercator", but the orientation wrt. North was slightly off**, and the integral datum was based on a preliminary, crude, 1920s, partial adjustment of the Danish 1st order triangulation network

Hence, **the system suffered from decimeter level tensions**, and the misalignment made it hard to construct a rigorous transformation from S34 to, say, geographical coordinates in ETRS89.

So until recently, the **only viable transformation was through sets of high order polynomials**, defining a direct transformation, **integrating the corrections for the** (in principle) **deterministic misalignment and the** (mostly) **stochastic network tensions.**



Now, with the ubiquitous access of the PROJ transformation system, it is realistically **possible to distribute a transformation properly handling the two different kinds of errors, in a two step process by**:

Deterministically transform from S34 to approximate geographical coordinates by application of **the inverse of the Oblique Hotine Mercator projection, modelling the slight orientation error**.
Apply a tiny (typically decimeter level) **grid based datum shift, correcting for the remaining network tension**.

The grid used in step 2 is based on the original polynomial transformation, since, due to a large number of local redefinitions of S34, the polynomials are actually our best representation of the real state of the network. Due to lack of control points, the polynomials did, however, oscillate wildly on the wet side of the shoreline, so to arrive at a practically useful transformation, the oscillations have been tapered off linearly when they exceed 3 m, i.e. slightly more than the worst actually observed correction, found on the isolated island of Anholt in central Kattegat.

The figure shows the deviation between the original transformations and the new. Darkest green is 0 mm, darkest red is 2 mm. The apparent large error in the eastern Jutland should be ignored: S34 consists of 3 zones, and the red parts of Jutland is an artefact from the Zealand zone overlapping the Jutland zone here**. In general, on the dry side of the shoreline, the difference is way below 0.5 mm**

WEBPROJ 1.0 OAS3

https://docs.kortforsyningen.dk/openapi-webproj.yaml

API til koordinattransformationer

APIet **webproj** giver adgang til at transformere multidimensionelle koordinatsæt.

Til adgang benyttes Kortforsyningens brugeradgang som ved andre tjenester.

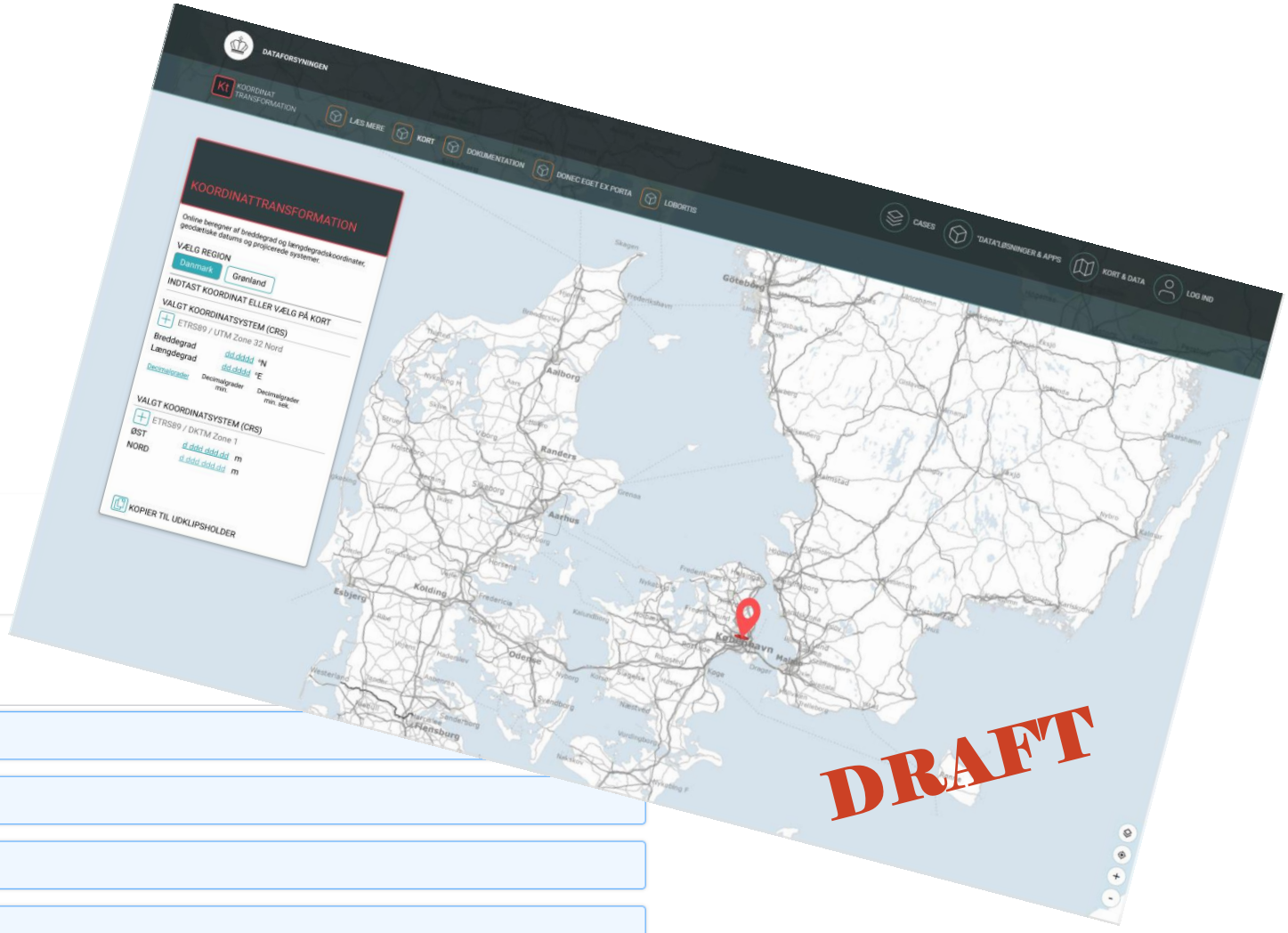
Versionshistorik

SDFE Support - Website
Send email to SDFE Support

Vilkår for brug

Servers

https://services.kortforsyningen.dk/rest/webproj/



webproj API for coordinate transformation

GET	`/`	
GET	`/v1.0/crs/`	List available coordinate reference systems
GET	`/v1.0/crs/{crs}`	Retrieve information about a given coordinate reference system
GET	`/v1.0/trans/{src}/{dst}/{v1},{v2}`	Transform a 2D coordinate from one CRS to another
GET	`/v1.0/trans/{src}/{dst}/{v1},{v2},{v3}`	Transform a 3D coordinate from one CRS to another
GET	`/v1.0/trans/{src}/{dst}/{v1},{v2},{v3},{v4}`	Transform a 4D coordinate from one CRS to another

https://docs.kortforsyningen.dk/#webproj

https://github.com/Kortforsyningen/WEBPROJ

GR96 transformations

- Transformations to and from the Greenlandic GR96 doesn’t exists
  - Can be estimated through ITRF2014 plate motion model, but
  - Significant intra-plate deformation, both from GIA and current-day mass loss from the icesheet
- GR96 is a passive reference frame - not connected to GNET
- Geodetic infrastructure neglected for ~20 years (see next slide)
- Driven by current topographical re-mapping of Greenland

Reestablishment of KELY station

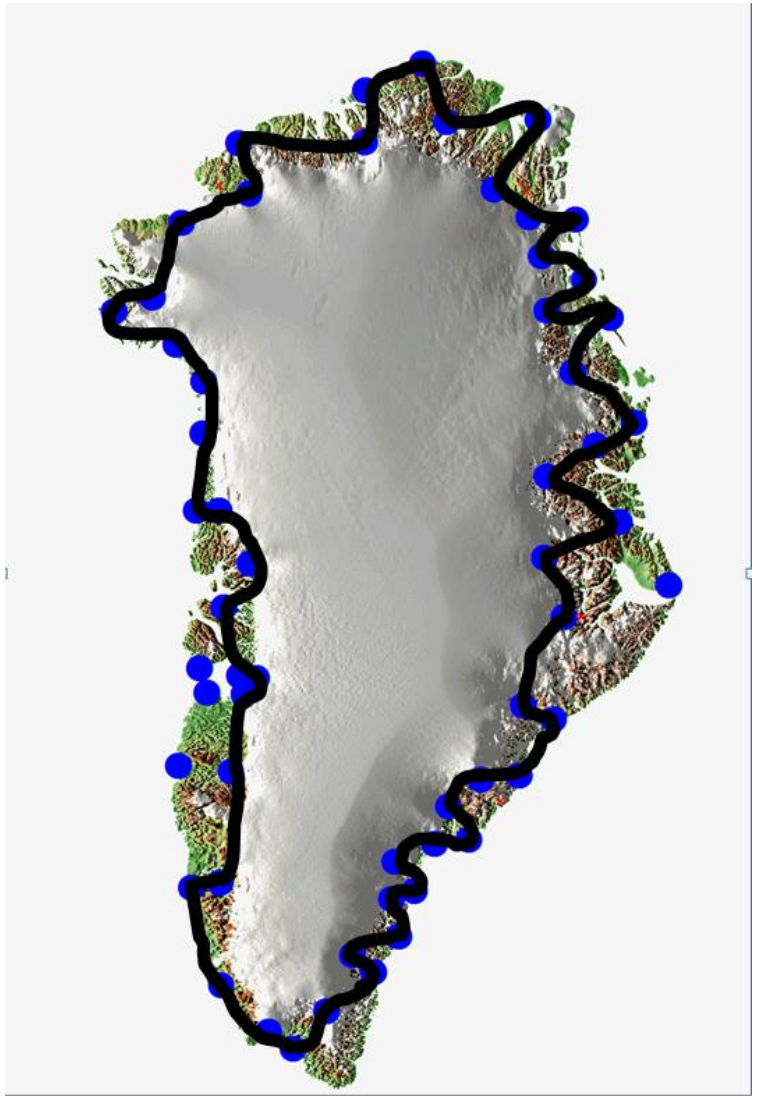
- Old ”KELY” (1996) was dismantled due to outdated receiver and monument.
  - Compromise was the GNET KLSQ site, which unfortunately cannot be compared to KELY site.
  - Many publications (Nature/Science)
  - Unique data over the last two decades

- New “KELY”
  - Newest GNET GNSS standards
  - Establishment planned in May 2020

https://go-gnet.org/

Field season 2020

- Deployment of materials and fuel with Twin Otter prior to helicopter campaign.
- Circumnavigating Greenland with Air Greenland AS350-B3 helicopter visiting all autonomous stations (and some others).
  - In order to secure the highest network performance and data availability



https://go-gnet.org/