



SSRoverDAB+ project

Precise GNSS PPP-RTK correction data broadcasting via digital radio

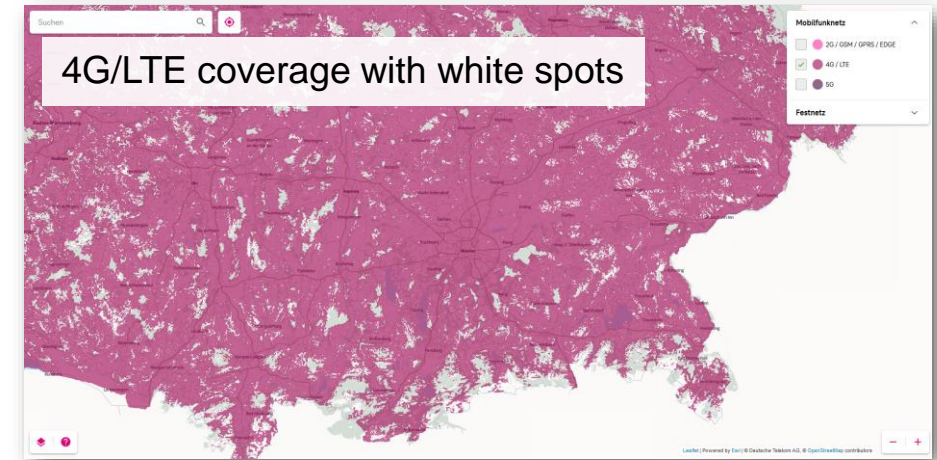


Bundesamt für
Kartographie und Geodäsie

Project motivation

- Modern digitisation and automation applications in **agriculture** and the **automotive industry** require continuous, highly accurate, real-time GNSS position data
- The **GNSS correction data** required for this is often not available to users due to **mobile internet dead spots**
- The growing demand for real-time corrections puts an increasing **computational** and **bi-directional communication burden** on network RTK service providers
- The parallel provision of GNSS corrections via mobile internet and **Digital Audio Broadcasting DAB+** should remedy the situation

Example area: southern Bavaria



https://t-map.telekom.de/tmap2/coverage_checker/



<https://www.dabplus.de/empfang/>

Project information

- Funded in the frame of the European Space Agency's Navigation, Innovation and Support Programme (ESA NAVISP Element 2)
- **NAVISP-EL2-069 "SSRoverDAB+"**
- Total budget: EUR 645,263.-
- ESA funding: EUR 558,497.-
- Project duration: 12 months (May 2022 – April 2023)
- Project partners: Alberding GmbH (lead), Fraunhofer IIS, Geo++ GmbH, inPosition gmbh
- Associated partners: Landesamt für Digitalisierung, Breitband und Vermessung Bayern (LDBV), Bundesamt für Kartographie und Geodäsie (BKG), BayWa AG



Roles of project partners

Alberding GmbH (DE)



- Project management
- Product provider
- Machine interface
- Field tests

Geo++ GmbH (DE)

- SSR correction generation
- SSR2OBS processing



LDBV (DE)*

- Reference network provider
- Correction service provider



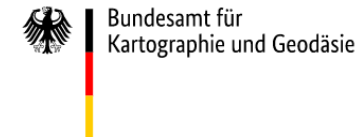
Fraunhofer IIS (DE)

- Galileo E5AltBOC position solution
- DAB+ encapsulation and decoding
- Sensor fusion



inPosition gmbh (CH)

- Receiver independent PPP-RTK solution



BKG (DE)*

- DAB+ data channel provider (Bundesmux)



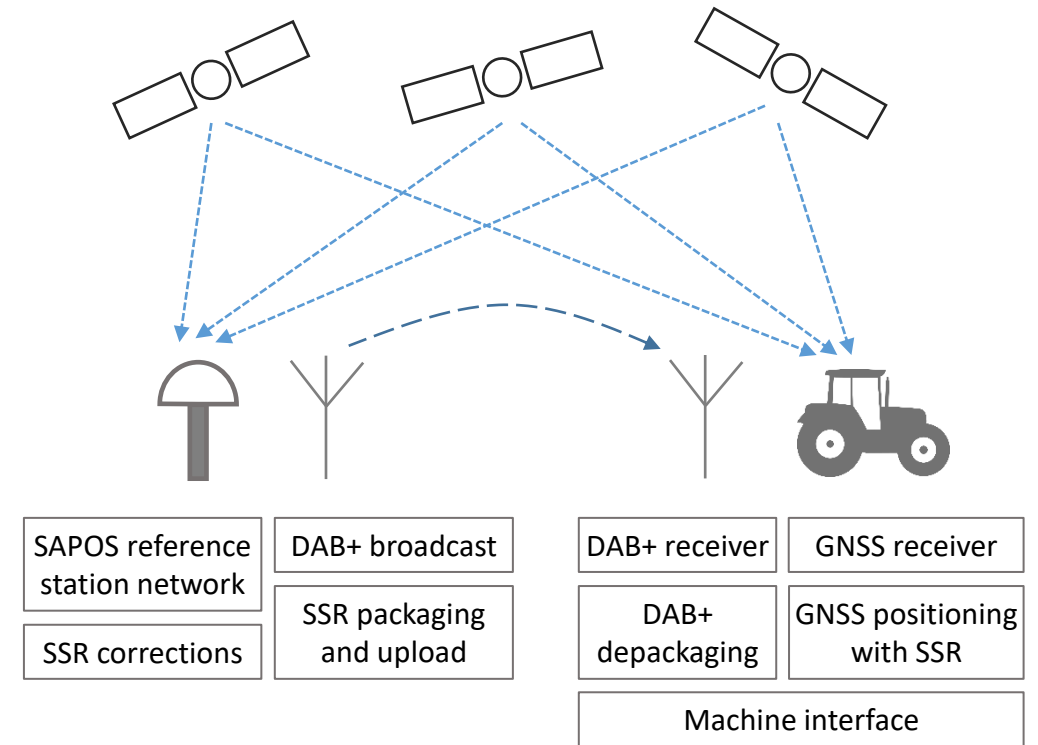
BayWa AG (DE)*

- Support of agricultural field tests



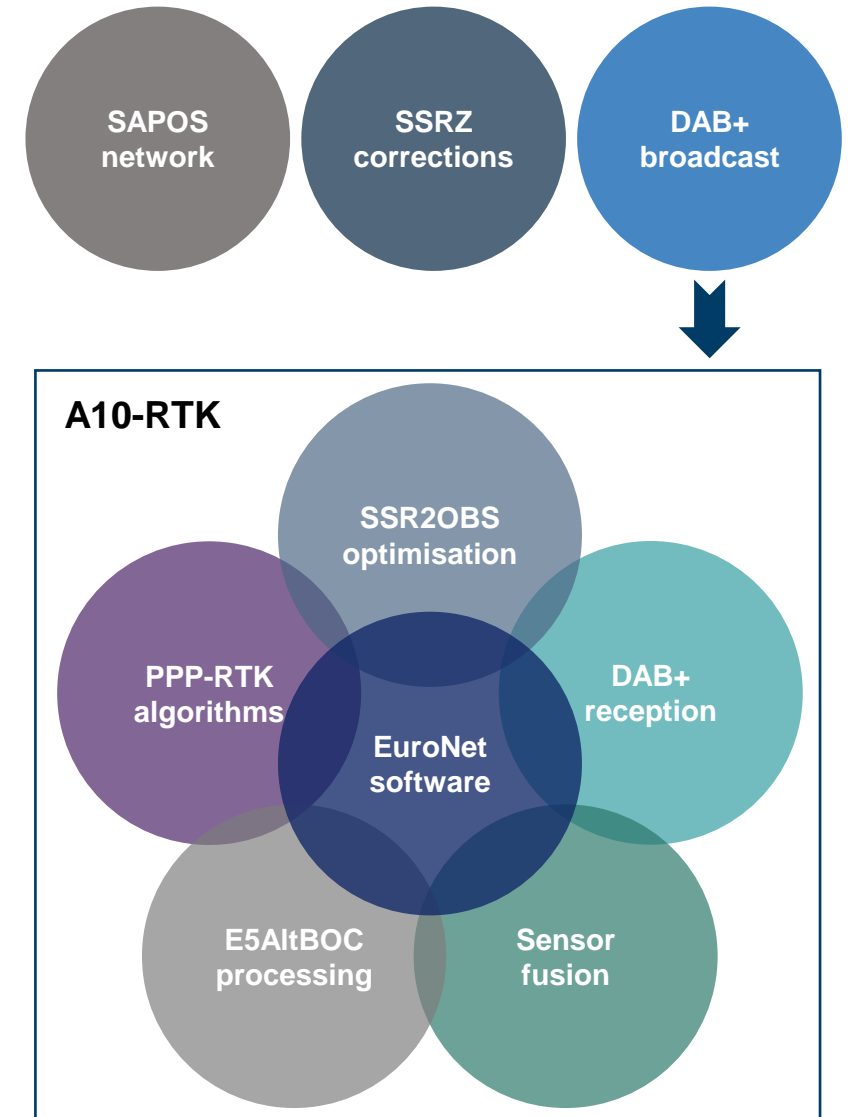
Project goals

- **Increase the availability** of high-accuracy GNSS corrections in rural regions using DAB+ transmission
- **Overcome** computational and bi-directional communication **limitations of network RTK**
- Compute and compare **different SSR-based GNSS position solutions**
 - COTS receiver internal RTK solution using SSR2OBS conversion
 - External PPP-RTK solution optimised for SSR
 - Robust E5AltBOC code-based solution using SSR corrections
- Demonstrate the complete solution in a **market-ready user product**



Project tasks

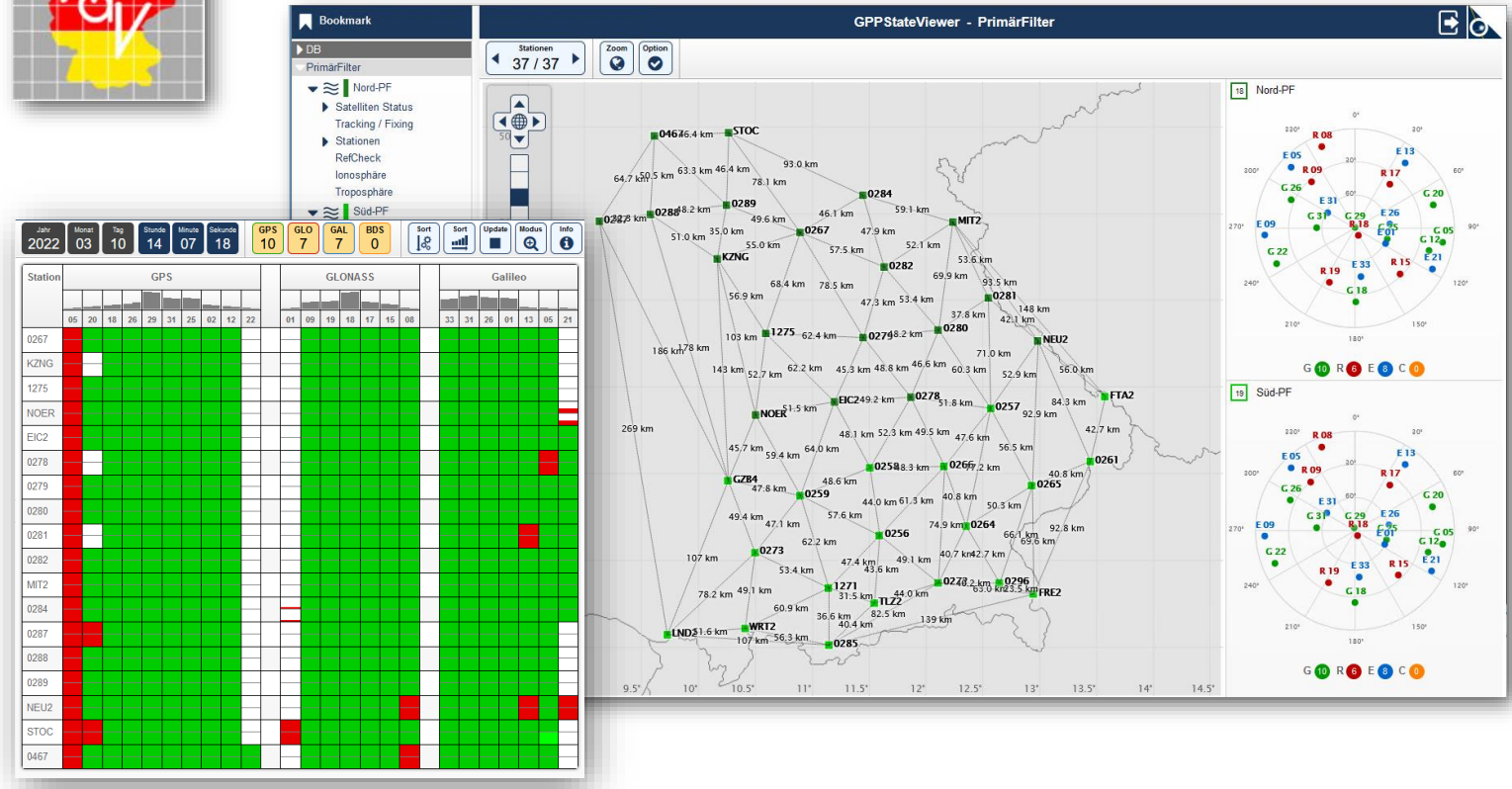
- Generation of a broadcast-capable **SSR (PPP-RTK) correction** data stream with optimised bandwidth
- Encoding and decoding of **DAB+ transmission** data
- Development and adaptation of **algorithms for precise real-time positioning**
 - SSR2OBS optimisation
 - PPP-RTK rover positioning algorithms
 - Galileo E5AltBOC processing with SSR correction data
- Implementation of software modules on the embedded computer of the Alberding **A10-RTK** GNSS sensor
- Conducting agricultural and automotive **field tests**



GNSS reference station network



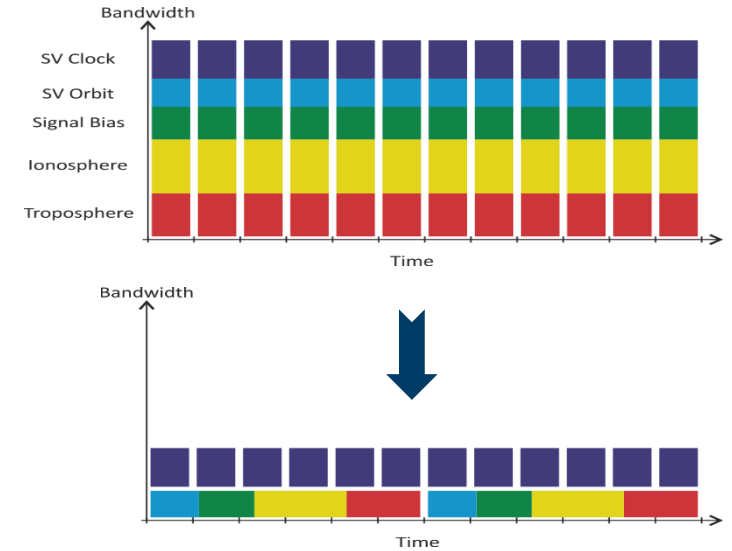
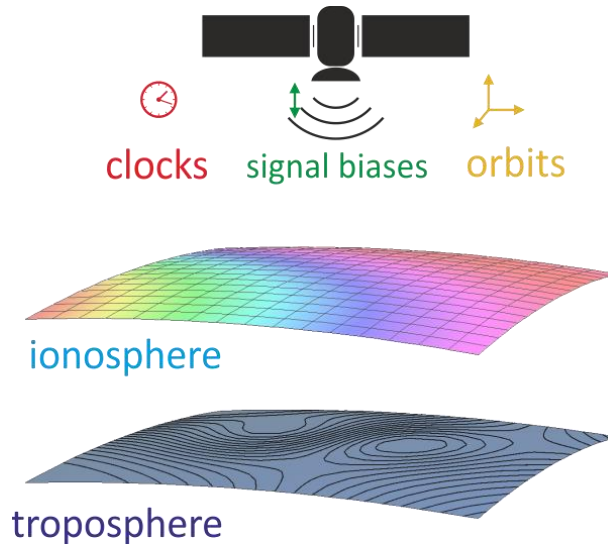
- SAPOS reference station GNSS data provided by LDBV (Bavaria)
- Network serving as AdV PPP-RTK testbed in Germany
- SSR networking of Bavarian reference stations within two networks North and South
- SSR service provided using Geo++ SSRZ format via Ntrip and DAB+ (Bayerischer Rundfunk)



SSR correction generation

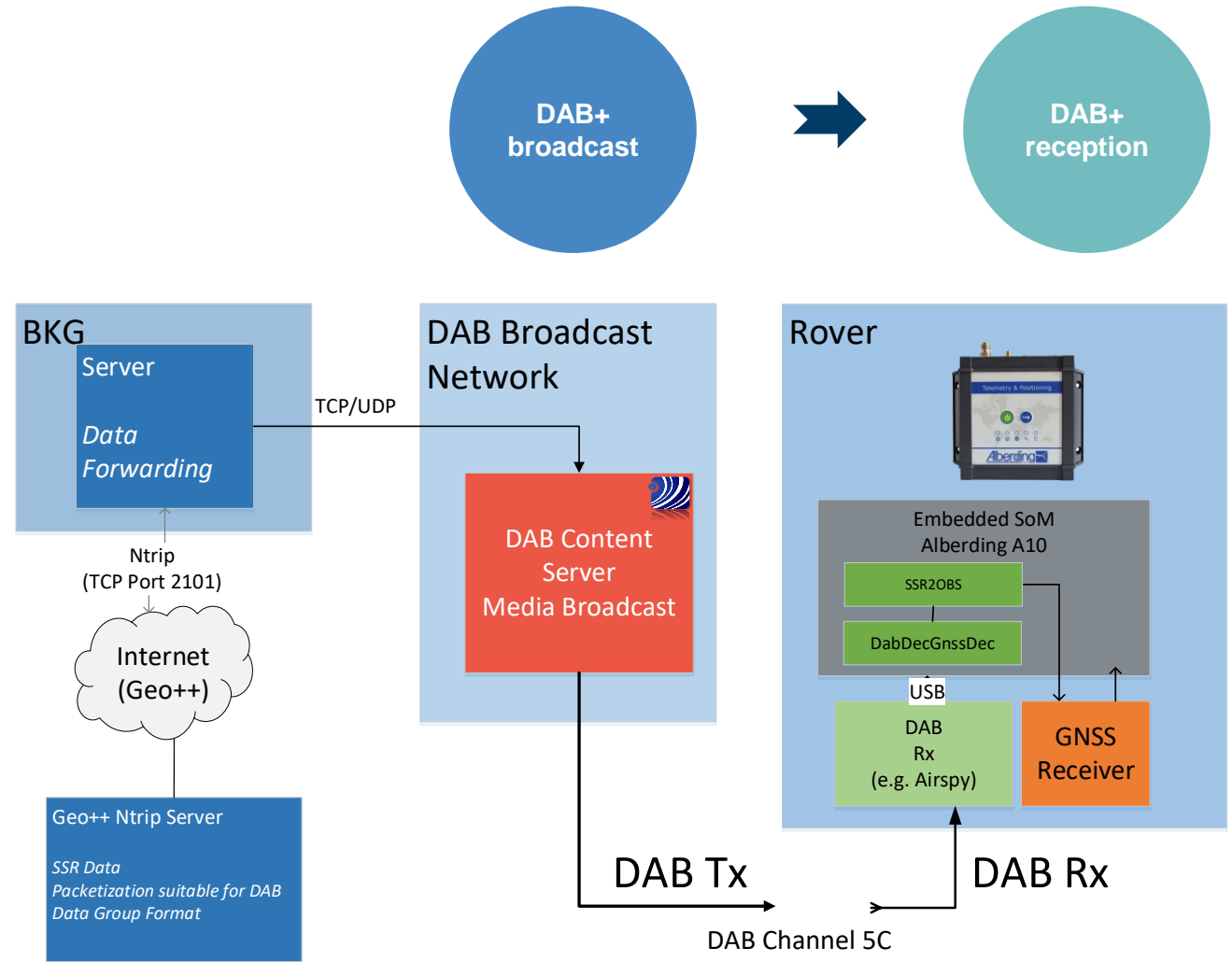
SSRZ corrections

- Geo++ SSRZ format uses individual characteristics of GNSS error components to reduce bandwidth
- SSRZ data format to be optimised for DAB+ data broadcasting



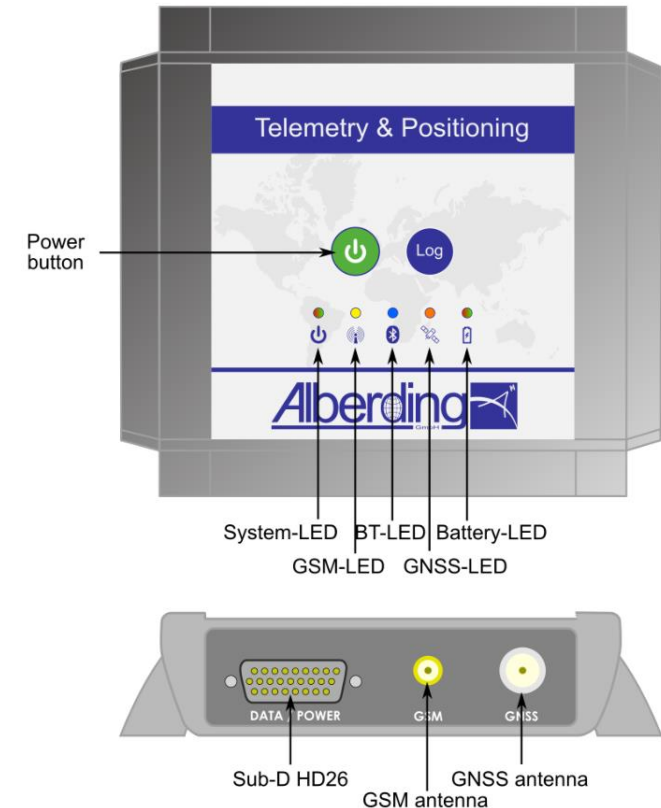
DAB+ data transmission

- Transmission: SSRZ transfer over DAB+
 - Interface definition and implementation
 - SSRZ data optimisation for DAB+ transmission (e.g. handling of data losses)
 - Use of the DAB+ channel from BKG (Bundesmux)
- Reception: DAB+ receiver module
 - Hardware interface of DAB+ tuner to A10-RTK
 - Software interface of DAB+ receiving software to the EuroNet software on the A10-RTK



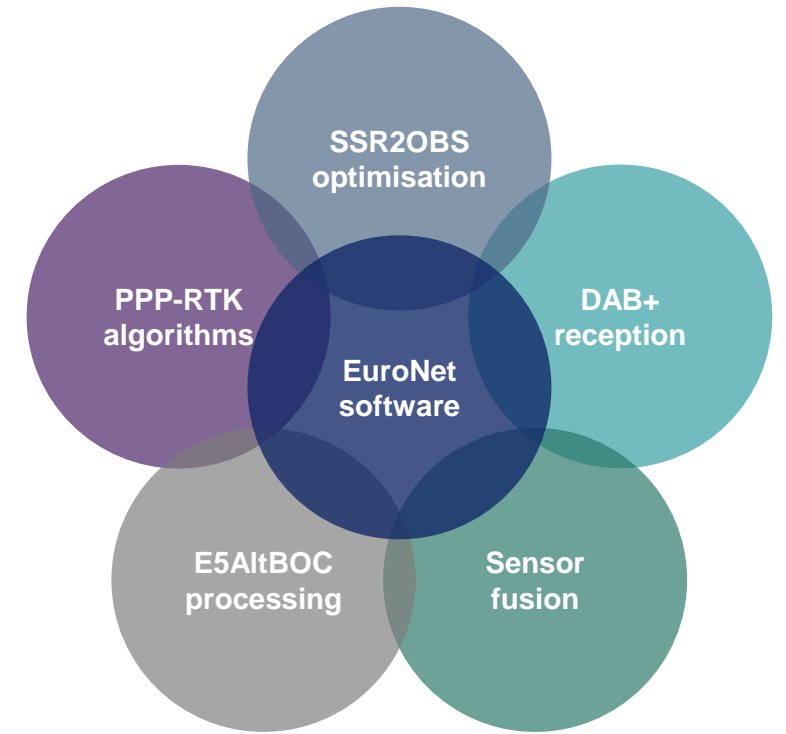
Product for SSRoverDAB+ users

- Alberding A10-RTK – a versatile GNSS sensor
 - Integrated multi-frequency GNSS RTK-board
 - Supported suppliers: u-blox / Trimble / Septentrio / Others
 - Integrated 4G LTE modem
 - Integrated memory (SD-card)
 - Integrated Bluetooth + WiFi module
 - Integrated Cortex M4 processor
 - 26-pin connector with multiport adapter (Ethernet, RS232, power) or octopus cable (Ethernet, RS232, 1PPS output, Event in, USB, power)
 - External GNSS- and GSM-Antenna
- Optional embedded PC with Linux OS and EuroNet software for
 - Data conversion (e.g. signal decoding, SSR2OBS)
 - Customer algorithms (RTK, sensor fusion, monitoring, etc.)



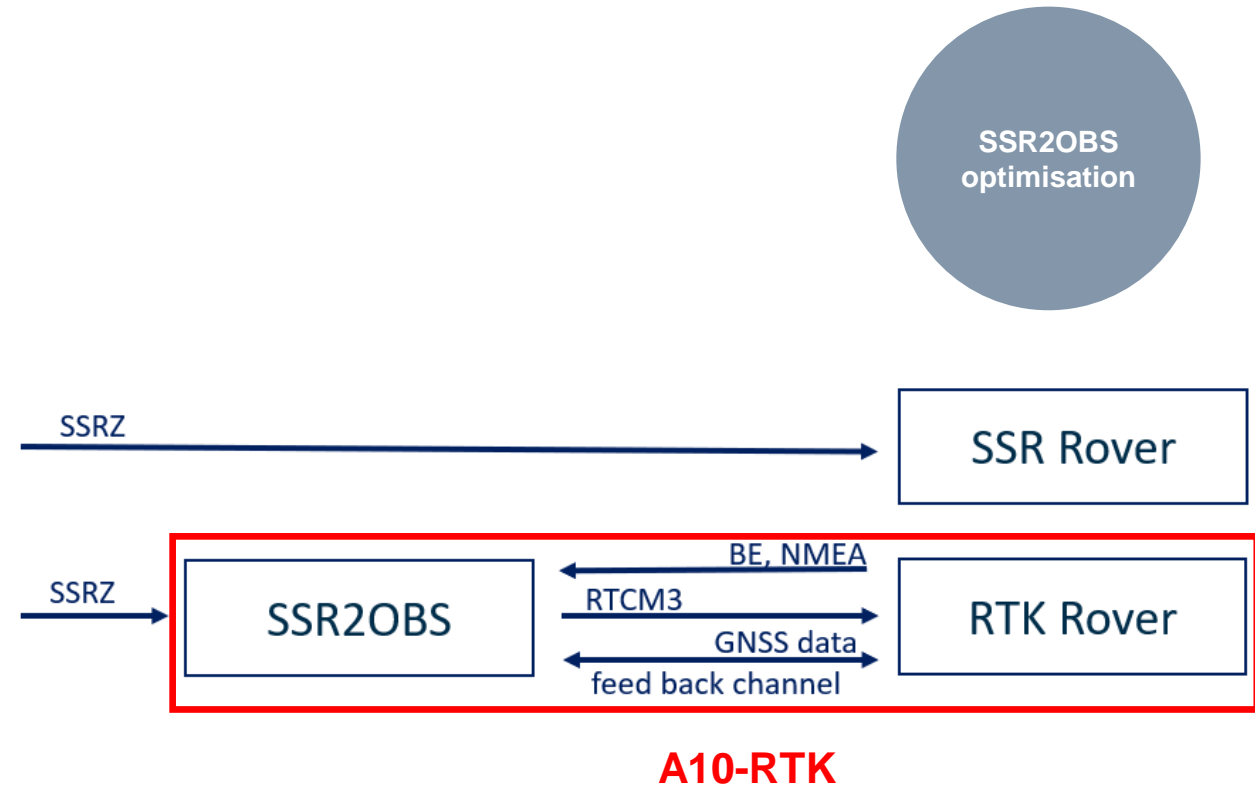
Receiver integration

- Integration of external software into the Alberding A10-RTK receiver
 - Integration of the SSR corrections via DAB+ (Fraunhofer IIS)
 - Integration and optimisation of the SSR2OBS data conversion module (Geo++)
 - Integration of the PPP-RTK positioning algorithms (inPosition)
 - Integration of the E5AltBOC code-based positioning algorithms (Fraunhofer IIS)
 - Integration of the INS sensor and the fusion algorithms (Fraunhofer IIS)
- Integration of the A10-RTK receiver into an agricultural machine
- Setup of the SSRoverDAB+ demonstrator
- Agricultural field tests (BayWa, universities, other interested parties)



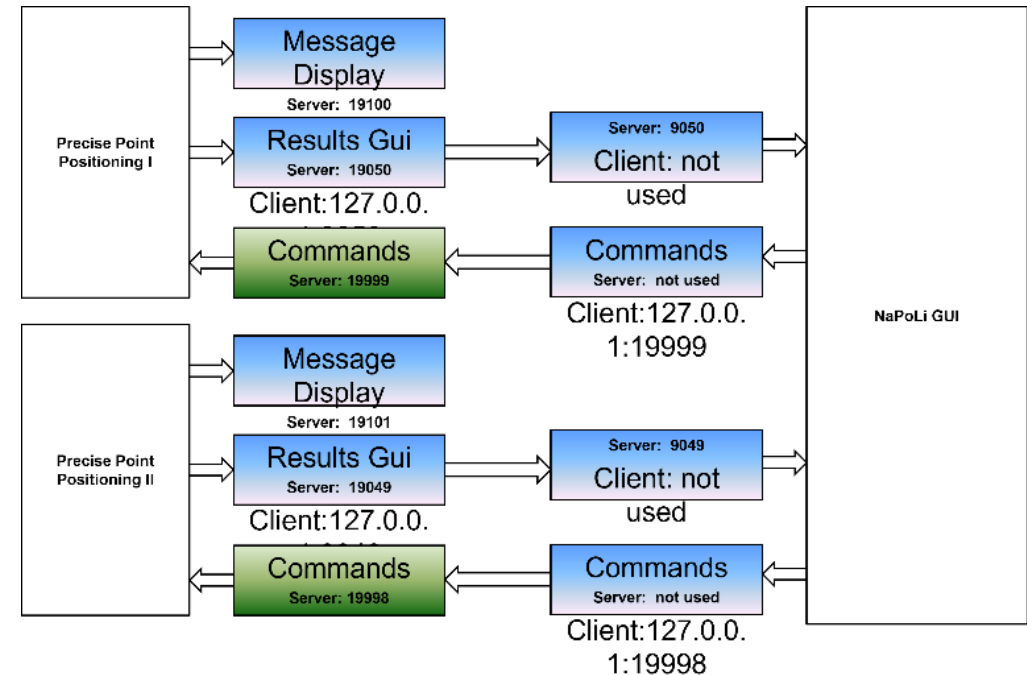
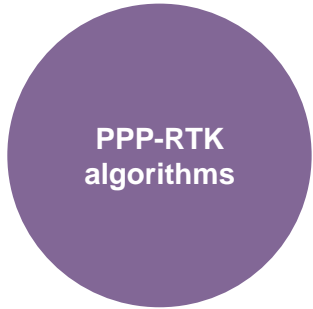
SSR2OBS improvement

- The software module SSR2OBS converts the SSRZ corrections in standardised RTCM 3.x format
- COTS RTK boards integrated in the A10-RTK sensor can use the converted correction messages with their RTK algorithms
- The SSR2OBS software will be improved in SSRoverDAB+ for handling SSRZ corrections with a reduced data rate



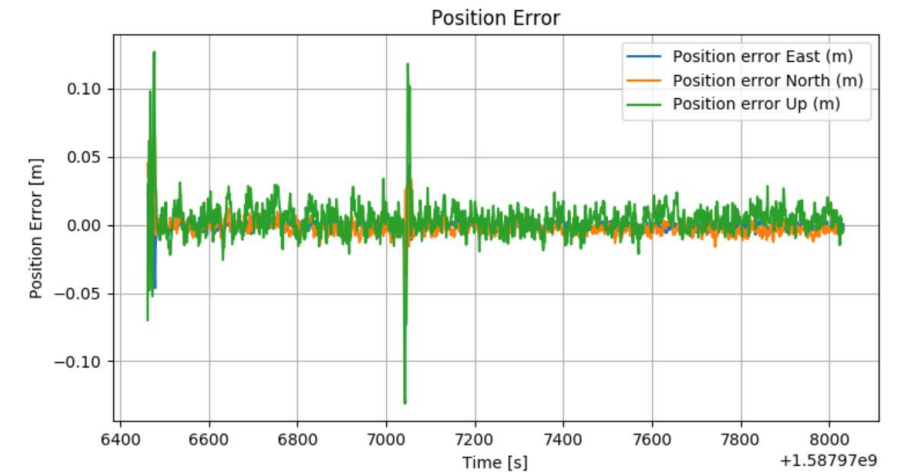
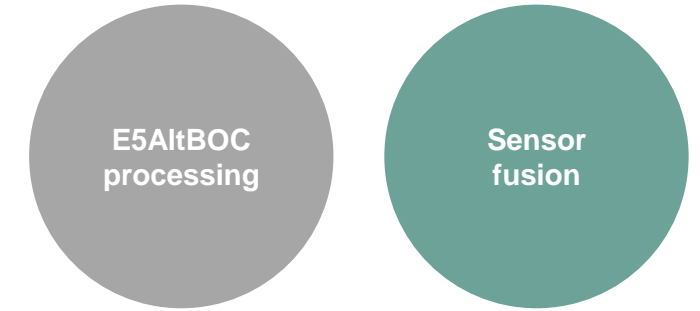
PPP-RTK position solution

- Cross-compilation of inPosition algorithms for ARM Linux on A10-RTK
- Implementation of SSRZ data format and contents
- Optimisation for delayed and sparse transmission via DAB+ channel
- Interface to Alberding EuroNet software on the A10-RTK
- Optimisation for u-blox or alternative receiver observations
- Simulation and testing



Galileo E5AltBOC position solution

- Cross-compilation of Fraunhofer algorithms for ARM Linux on A10-RTK
- Interface to Alberding EuroNet software on the A10-RTK
- Robust, decimetre-accurate position solution using the Galileo E5AltBOC signal
- Alternative position calculations
 - Use SSR2OBS to correct the E5AltBOC raw data of A10-RTK
 - Use SSRZ corrections directly with A10-RTK E5AltBOC code measurements
 - Use SSRZ corrections directly in the Fraunhofer IIS GOOSE platform
- Additional sensor fusion (loosely coupled)



E5AltBOC only position solution
(simulation without atmosphere)

GNSS target markets

Target market of the project: Agriculture



Other market segments could take profit from the project:

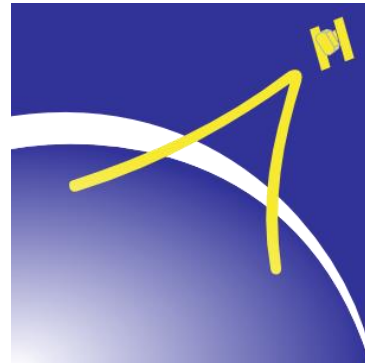


icons: image courtesy of Flaticon

- 1) Forestry
- 2) Construction machines
- 3) Automotive (autonomous driving, tolling)
- 4) Surveying and GIS
- 5) Inland waterways
- 6) Railway applications
- 7) Precise IoT applications (e.g. geomonitoring)
- 8)

GNSS correction delivery via DAB+ could provide a value in terms of **service area extension** (see slide 2) and **price (no data volume issues)** to a wide range of GNSS users in different market segments.

Interested in the project results or would like to participate in field testing?



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