Future positioning services, geodetic reference frames, and the ISO Geodetic registry

NKG General Assembly 2022-09-05--08, Copenhagen Denmark.

Martin Lidberg

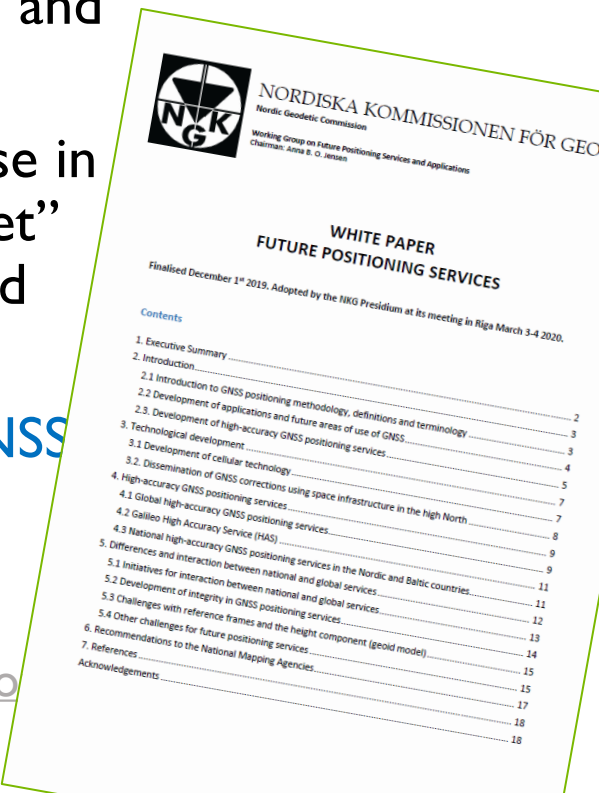
OUTLINE

- The development of GNSS positioning services and an up-coming mass-market for precise real-time GNSS
- Implications on Geodetic Reference Frames
- The ISO Geodetic Registry (and connection to EPSG and CRS-EU)

On the use of precise positioning services in the near future? – and implications on geodetic infrastructure?

- How will autonomous vehicles ("self driving cars") and a mass market for precise GNSS affect how geographic information (geodata) will be consumed?
- There is a feed back loop where changes/developments in the way geodata are consumed, will provide new expectations/demands on positioning services and geodetic infrastructure!
- A number of external projects and workshops indicate a significant increase in use of positioning services and geodata. We are approaching a "mass market" of connected devices (Internet of Things, IoT) which consumes geodata and precise positioninging services

- Our current professional users (surveyors etc) will still need the best GNSS positioning services and will probably ask for "more and better"
- But what will be the needs and solutions for the "mass market"?


NORDISKA KOMMISSIONEN FÖR GEO

Nordic Geodetic Commission

Working Group on Future Positioning Services and Applications

Chairman: Anna B. O. Jensen

WHITE PAPER

FUTURE POSITIONING SERVICES

Finalised December 1st 2019. Adopted by the NKG Presidium at its meeting in Riga March 3-4 2020.

Contents

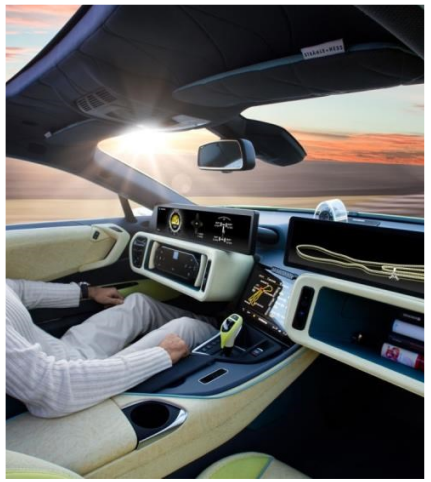
(http://www.nordicgeodeticcommission.com/wp-content/uploads/2021/08/NKG-White-Paper-o
Future-Positioning-Services-2019_adopted.pdf)

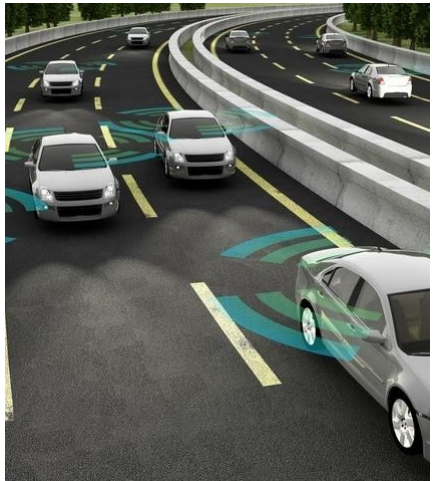
Some development projects in order to better understand the possibilities and needs from mass market applications

NPAD

Network-RTK Positioning for

Automated Driving

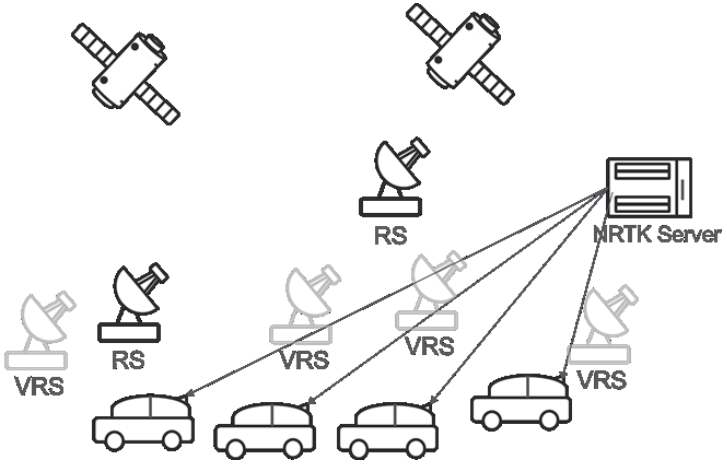




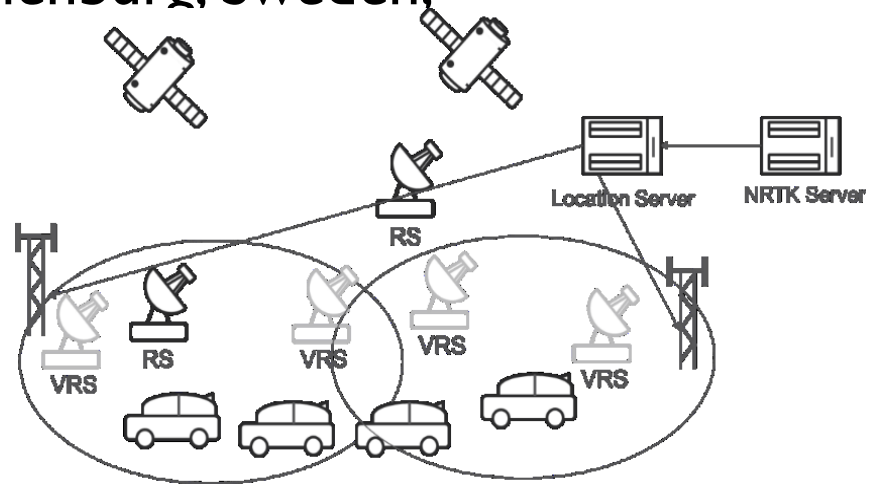
NPAD RI.SE SCANIA VOLVO ERICSSON waysure ASTAZERO LANTMÄTERIET EINRIDE caliterra ab

NPAD – it is about ”scalability” for many users

- Examine the possibility to in an effective way distribute network-RTK corrections to mass market applications and autonomous vehicles
- Network-RTK corrections are packaged and distributed trough a so called ”location server” to near by cellphone mast/antenna that distribute the corrections in a standardized format (3GPP – a format for cellphone networks) to all users within the coverage are of the antenna (cellphone network radio base station)
- It has been tested in practice outside Gothenburg, Sweden.



The current NRTK procedures scales badly.



Scalable solution with intermediate processing in a location server and provisioning based on the cellular network.

PNK 4 UTM

Positioning, Navigation, Communication for Unmanned Traffic Management

Focus on un-manned flying vehicles (drones)

Improve the functionality in the mobile networks in order to eventually carry out Traffic Management of Un-manned vehicles (UTM).

Use an existing Text bed for unmanned flying objects outside the town of Västervik.

Investigate the need for up-grading of mobile communication networks, and distribution of GNSS-data, for safe aviation

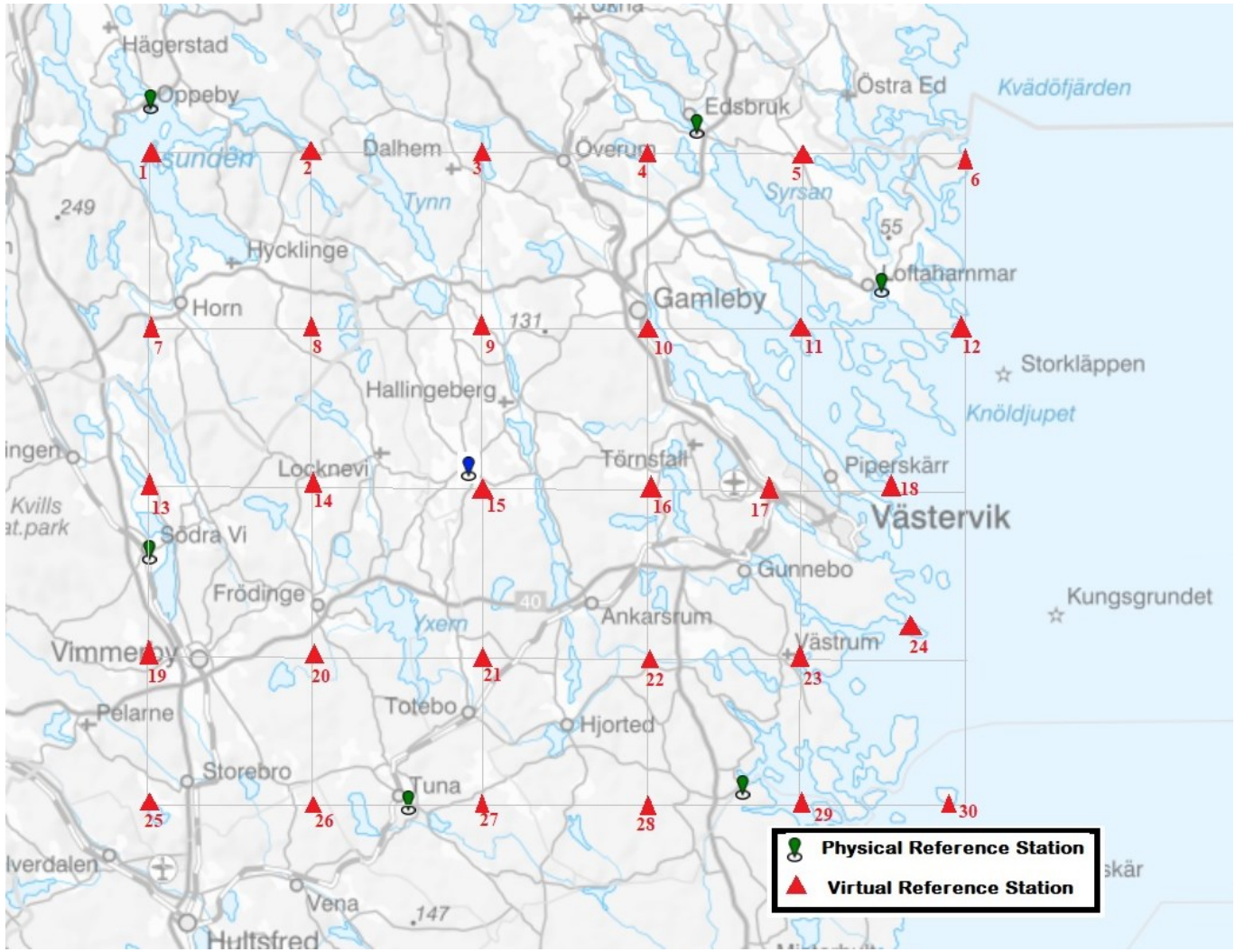
Network-RTK corrections from SWEPOS for precise positioning of the drones.

The concept is based on the same technical platform that was developed in the NPAD project

PNK 4 UTM

A grid of virtual reference stations have been established within the project for the distribution of RTK streams.

I the project, distribution is done in the mobile network of Telia (the largest network operator in Sweden)



PNK4UTM Partners

TRAFIKVERKET

Telia

[redacted]

LANTMÄTERIET

Västerviks Kommun

RI.SE

T2 DATA

COMBITECH

Drone Center SWEDEN

WABEMA AB

WASP | WALLENBERG AI, AUTONOMOUS SYSTEMS AND SOFTWARE PROGRAM

WASP Research Arena – Public Safety (WARA-PS)

CHALMERS

KTH VETENSKAP OCH KONST

LINKÖPINGS UNIVERSITET

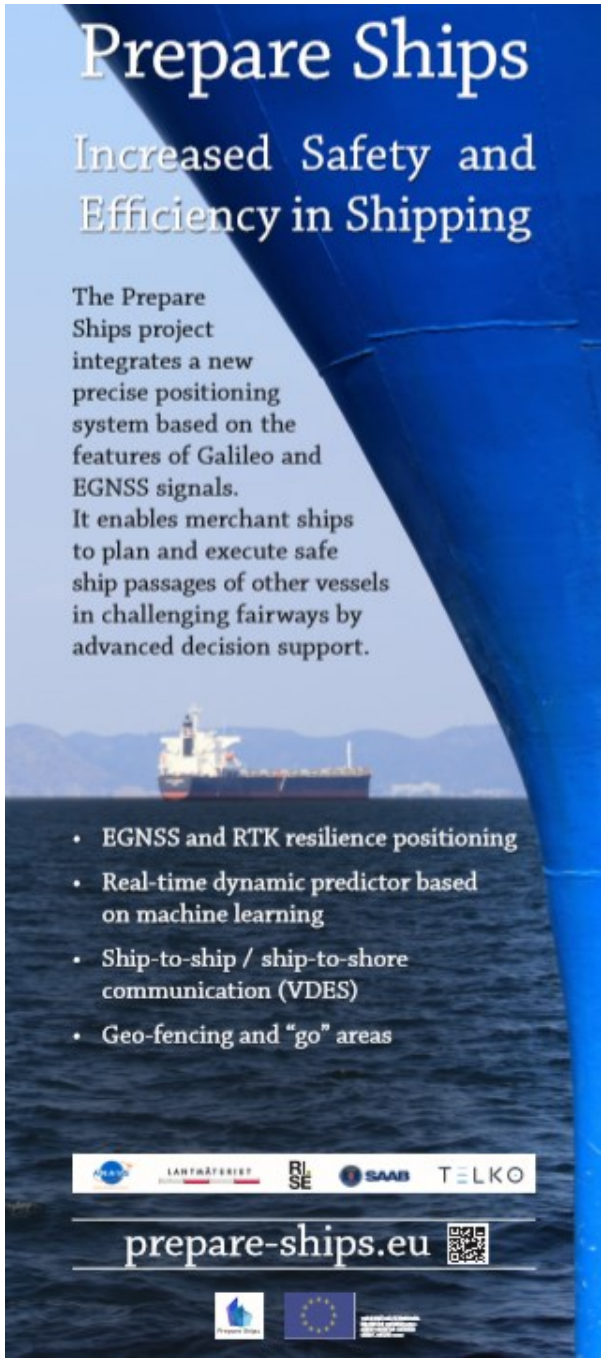
LUNDS UNIVERSITET

UMEÅ UNIVERSITET

PrePare-Ships - a EU-H2020 project

Create solutions for safe navigation ”ship to ship” and “ship to land” and establish possibilities for future autonomous marine transport through the use of Galileo and EGNSS.

Test and develops also precision GNSS further out at sea.

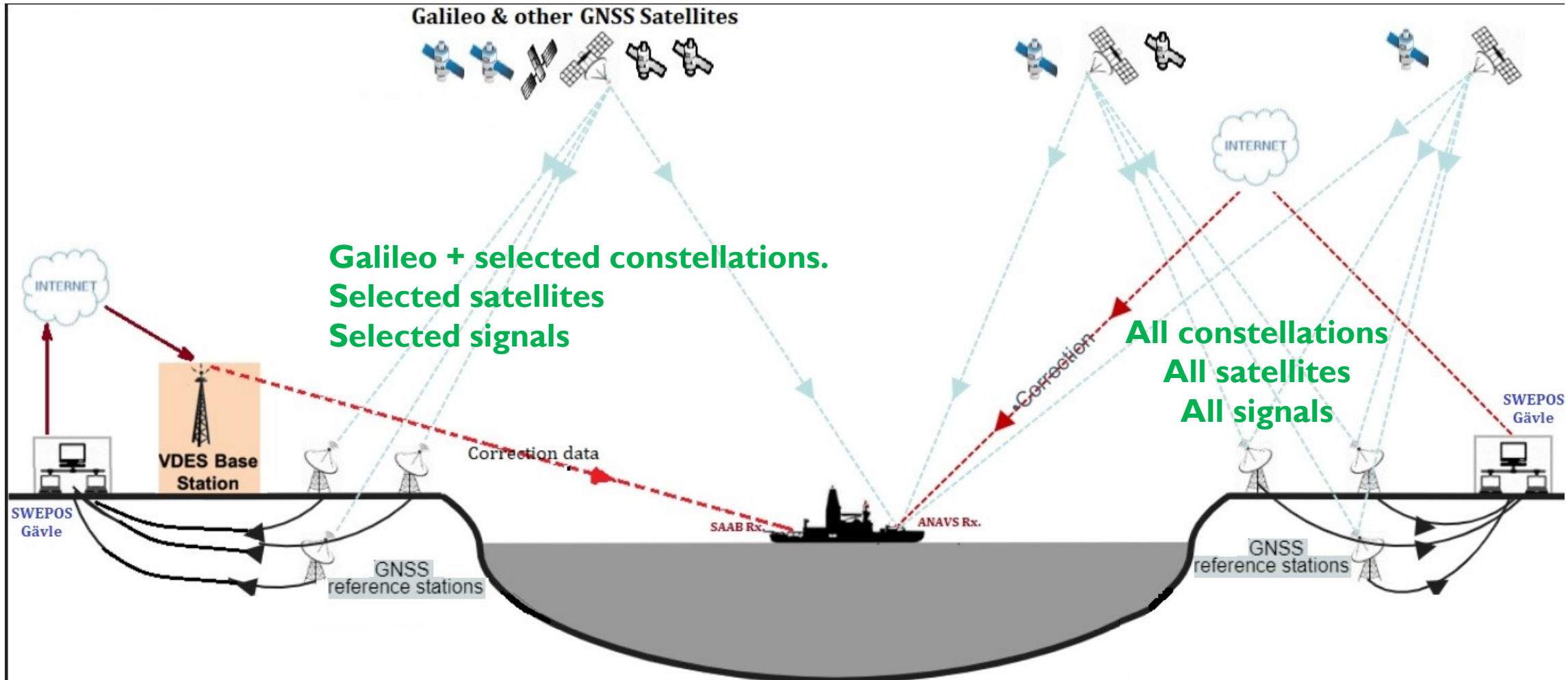


Prepare Ships

Distribution of RTK corrections through VDES

Software development for the optimization of RTK in VDES

(VDES – communication link with better range at sea, but reduced data capacity)



Prepare Ships

INTEGRITY – NEXT PART IN THE PROJECT

Integrity – to know if you can trust the information

Integrity at several levels:

- The Satellite segment
- The Positioning Service
- At the user, the own receiver and system; "user segment"

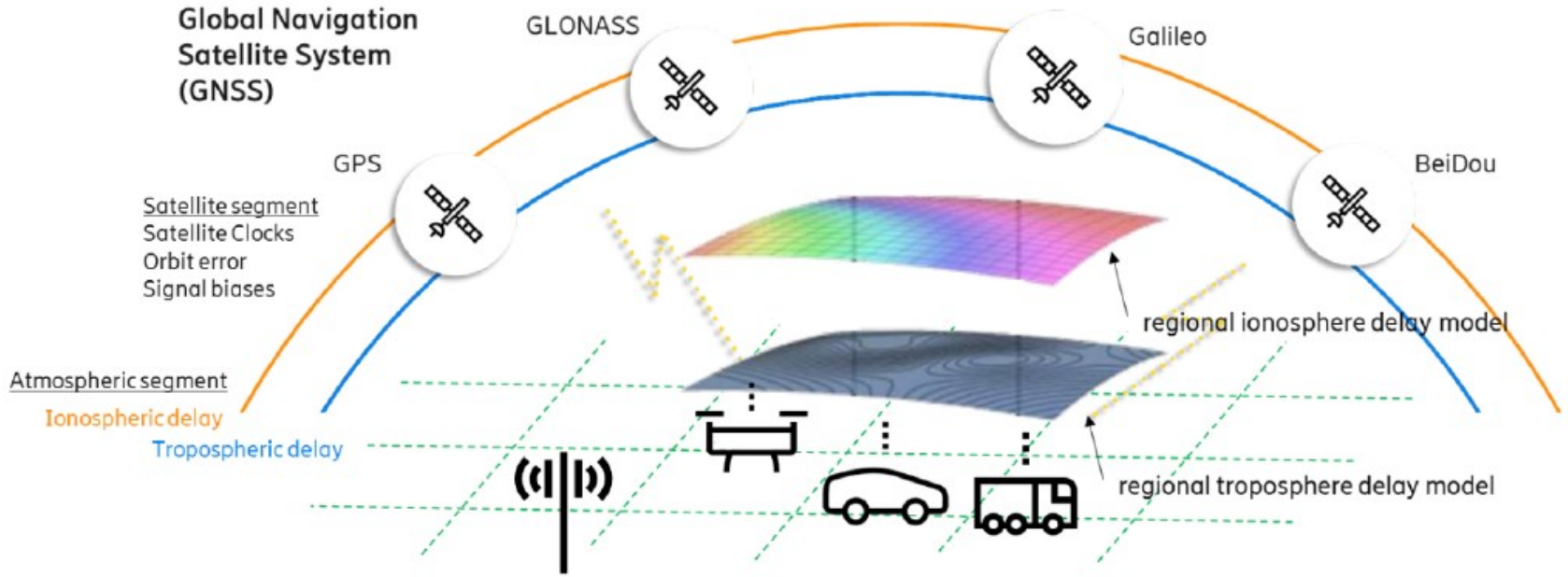
LANTMÄTERIET

DINPAS *Digital Infrastruktur för Noggrann Positionering av Autonoma System*

A continuation of the NPAD-project

Purpose: To meet the demand on precise and reliable positioning in focus area "autonomous airport, with scalablility for a large number of mobile units in order to promote next generation industrial digital solutions

"PPP"-service (Precise Point Positioning) based on SWEPOS, distribution in mobile network "for many" and implemented in user unit (u-Blox)



SOME GENERAL CONCLUSIONS SO FAR

- We think it is good to benefit from the existing SWEPOS GNSS infrastructure for future precise GNSS mass market services!
- Standards are needed! There are possibilities in the new "mobile phone standards" (3GPP) for distribution to many.
- Which technology (PPP or RTK) will "win" the mass market race?
  - (Lantmäteriet work on a pre-study… and we do see benefit of cooperation!!!)

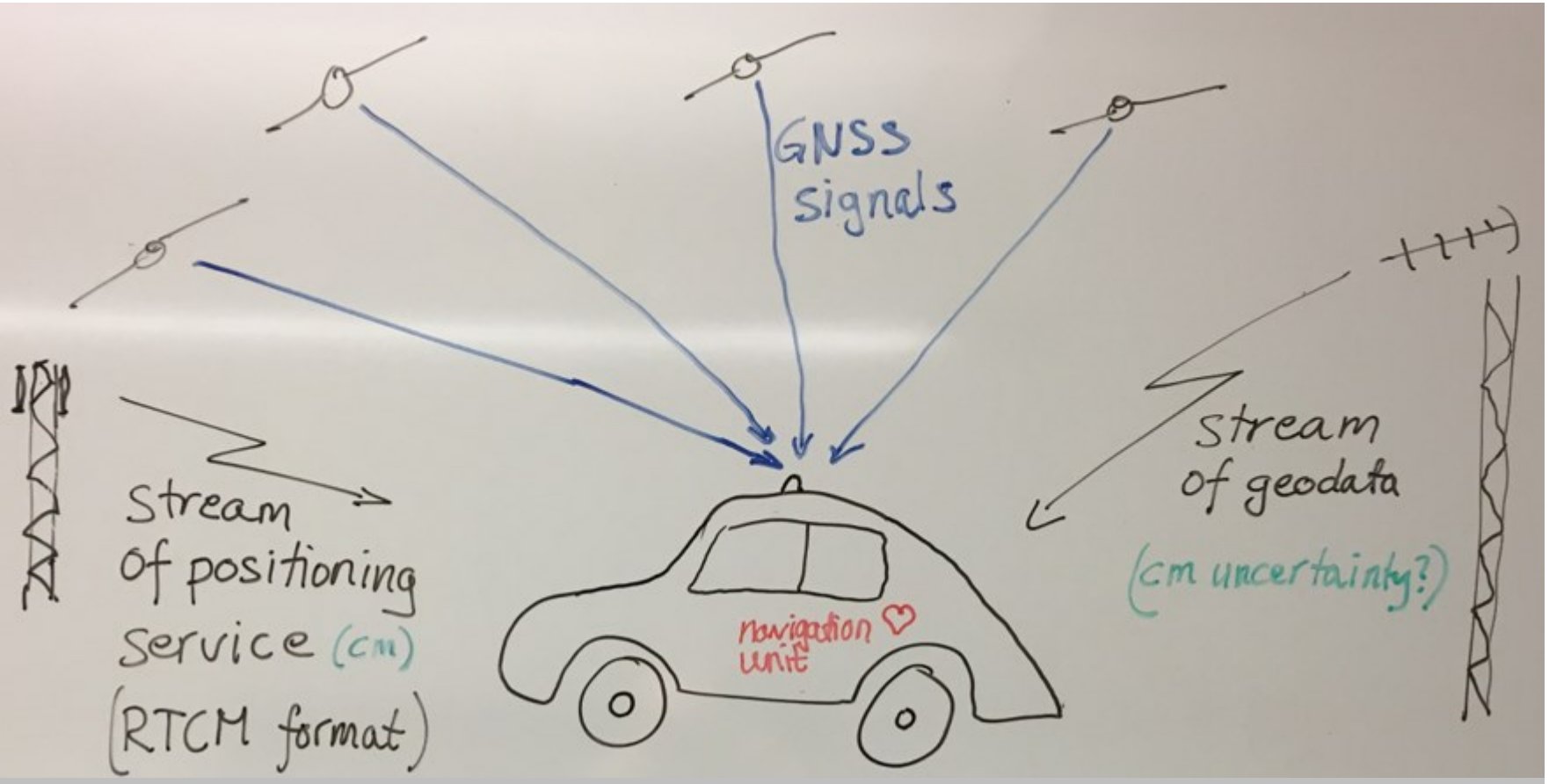
- Lantmäteriet are generously supporting research and innovation projects with data and services from SWEPOS. But when do the "market" want an operational mass market service?

SPECIFIC CHALLENGE

– example sea traffic, but similar example on land and in the air

- At navigation at sea the ship use global positioning service that provide position in global reference frame
- Closer to the coast and for precision navigation in narrow waterways and approaching harbor and pier, the ship could use a regional positioning service with better performance (e.g. SWEPOS Network RTK or similar) that provide ger position and vertical position in reginal reference frame (national realizations of ETRS89 and EVRS) that agree in detail to the sea charts
- The challenge is then to automatic and seamless handle the transition from navigating at "open sea" to precise navigation in waterways and harbor.

Standardization issues



"Autonomous Navigation Integrity Monitoring"

The navigation unit needs to be able to verify that geodata and positioning service use the same reference frames!

Therefore, we need reference frame information in the data streams.

And we need standards that supports this!

ISO GEODETIC REGISTRY

- AND OTHER REGISTRIES ON GEODETIC REFERENCE FRAMES

THE ISO GEODETIC REGISTRY

- The ISO implementation of the standards
  - ISO 19111 (Geographic information – Referencing by coordinates) and
  - ISO 19127 (Geographic information – Geodetic register
  - ..and some more..
- ISO Geodetic Registry (ISOGR) (https://geodetic.isotc211.org)

*"The main purpose is to serve as the primary source for **authoritative** data on coordinate reference systems and transformations that can be used not only by end users but also other registries, including the ubiquitous EPSG Geodetic Parameter Dataset and Registry."*

"The concept of an ISO Geodetic Register (ISOGR) goes back many years, and the International Association of Geodesy (iag-aig.org) (IAG) has been active in supporting this by nominating the convenors for the Control Body of the ISO Geodetic Register." *(i.e. Mike Craymer)*

BENEFITS OF ACKNOWLEDGED GEODETIC RF

- For geographical information (e.g. GIS) applications, identifiers and description of the reference frame (or the "Coordinate Reference System" – CRS) together with transformations are important
- While "CRS" describe "coordinates" (numbers), Geodetic Reference Frames have not really defined how to express this (X,Y,Z) or (lat, long, h)
- We have identified the benefit of having the Reference Frame included in real time GNSS streams, and for this the **Identifiers** are needed
- The implementation of INSPIRE request known identifier for the geodetic reference frame (EPSG codes are used) while testing/accepting services for geodata

SEVERAL REGISTRIES ON "CRS"

- The **ISO GR** ISO Geodetic Registry (ISOGR) (isotc211.org)
- The **IOGP** (International Association of Oil & Gas Producers) **EPSG** register (https://epsg.org/home.html)
- The **CRS-EU** *"Information and Service System for European Coordinate Reference Systems"* (http://www.crs-geo.eu/)
- The **OGC CRS** register (http://www.opengis.net/def/crs) "*Open GIS Consortium – focus on machine readable information*"
- *Guide to Coordinate Reference System (CRS) Resources* (https://committee.iso.org/files/live/sites/tc211/files/Resources/GuideToCRSRegistries3.pdf) *give some information on the relation between the registers above!*
- The widely used **PROJ** transformation tool should also be mentioned in this context

Benefits of the ISO Geodetic Registry

- Authoritative information on geodetic reference frames
- The responsible for the reference frame (Coordinate Reference System) provide the information or acknowledge the information (*we have control of the information*)
- Description/definition of the CRS
- And transformation (to ITRF) or link to a publication

- The value of ISO may be important!
- And we have got request from the ISO Geodetic registry Control Body to promote national realizations of ETRS89 to be included/uploaded into the ISO GR

THANKS FOR YOUR INTEREST!

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