Prepare Ships

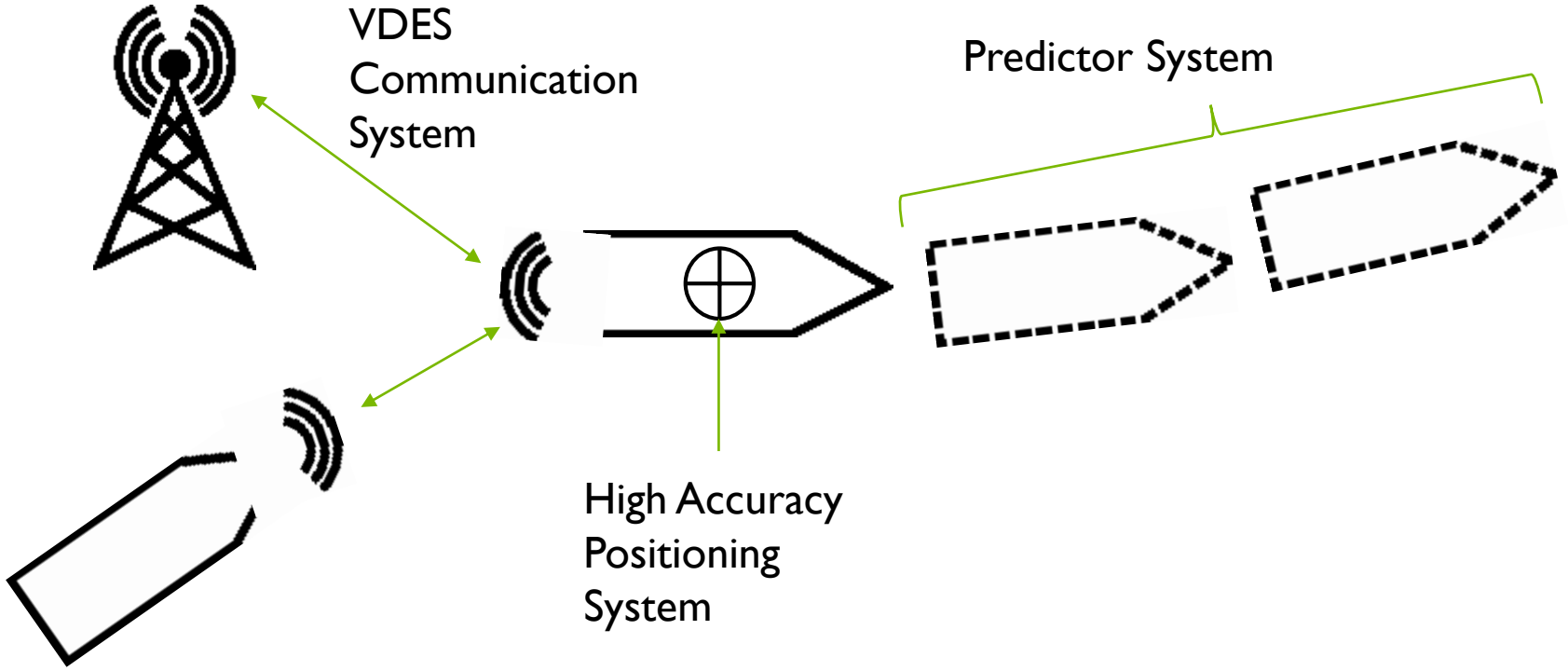
PREPARE SHIPS

SAFER NAVIGATION AT SEA ENABLED BY PRECISE GNSS POSITIONING

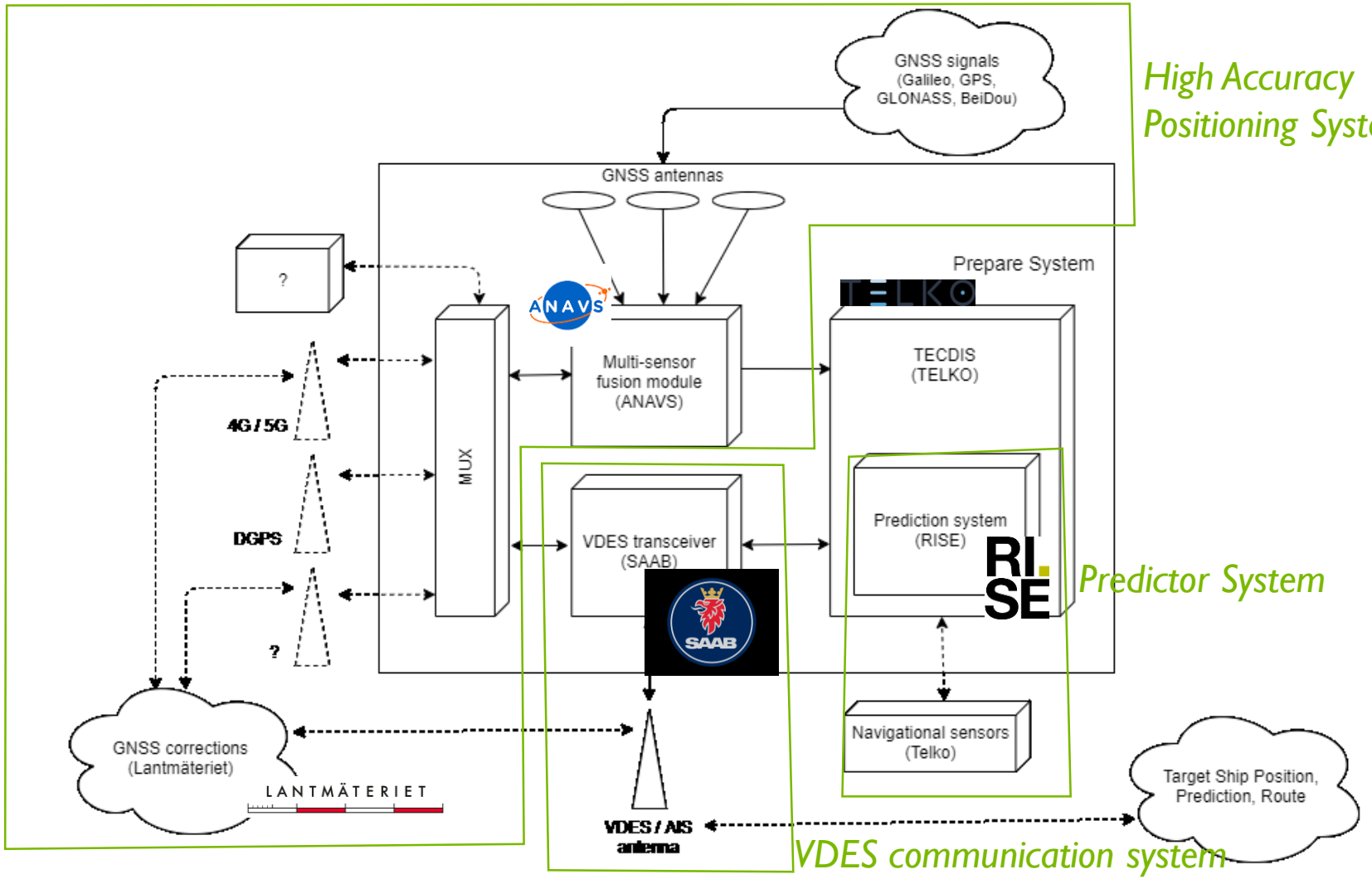
Martin Håkansson

PURPOSE OF PREPARE SHIPS

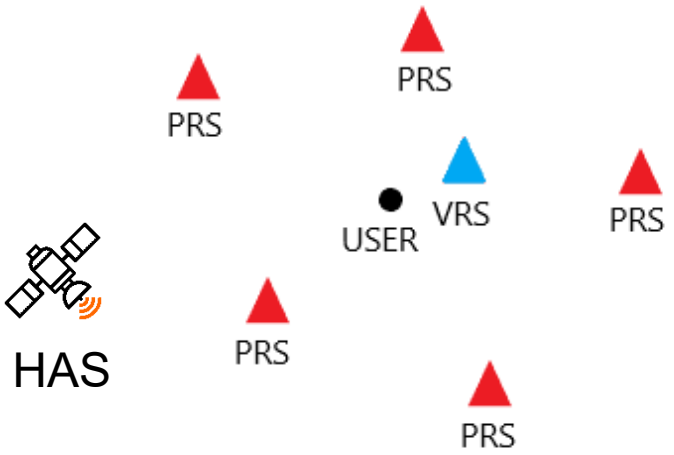
Situational awareness on the bridge is enhanced by the provision of predicted positions of ships in the vicinity

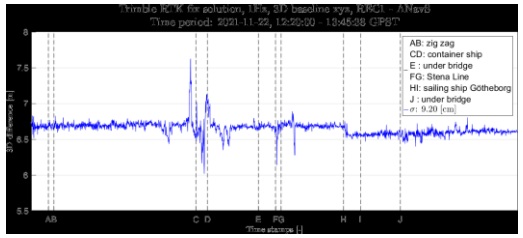


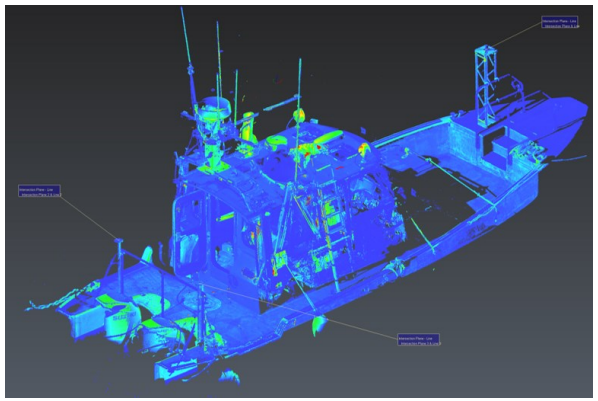
SYSTEMS OVERVIEW



HIGH ACCURACY POSITIONING







- Multi-GNSS, multi-frequency RTK/PPP positioning (ANavS)
- Generation and provision of GNSS correction data (Lantmäteriet)
- Results on positioning, heading and more (ANavS)
- Validation and its challenges at sea (RISE Mätteknik)
- Integrity (Lantmäteriet)

ANAVS MULTI-SENSOR RTK/ PPP MODULE

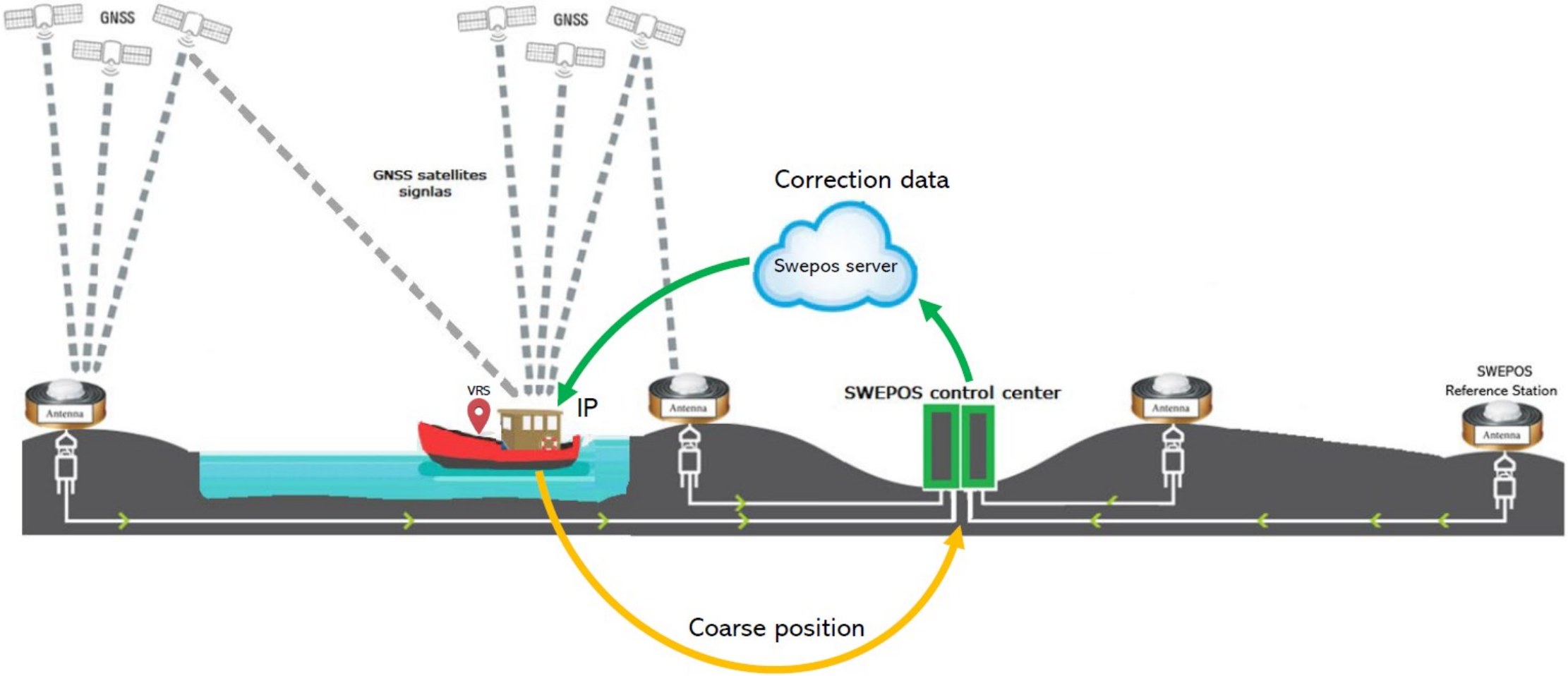
- Up to 3 integrated Multi-frequency, lti-GNSS receivers

egrated industrial-grade MEMS-IMU.
tional: High-grade MEMS-IMU with
roved bias stability

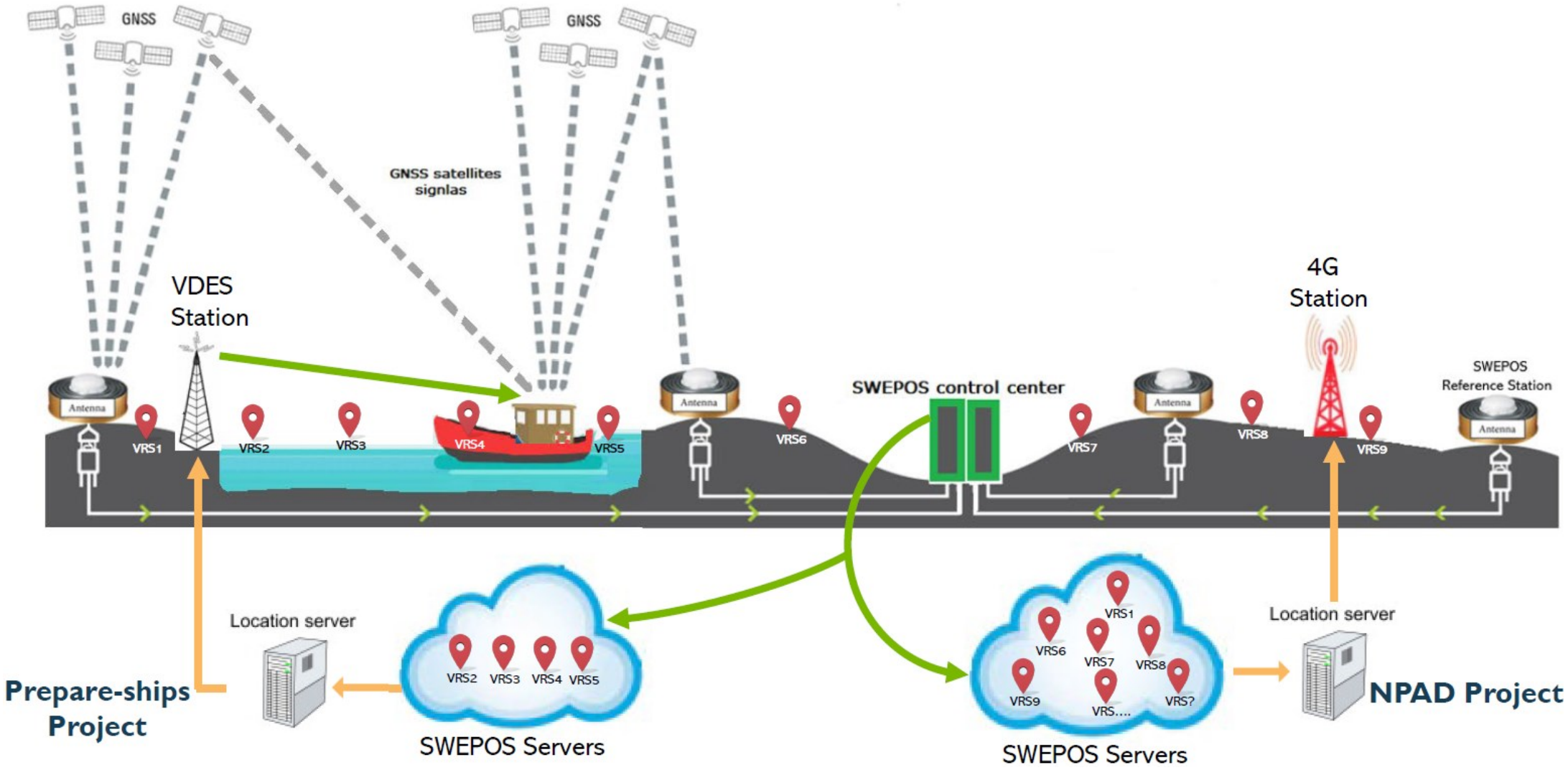
egrated Quad-core processor
5 GHz, 8 GB RAM, 16 GByte
mory) running
avS GNSS / INS tightly coupled
sitioning engine

ious interfaces:
ernet, Wi-Fi, LTE, LWE

Virtual reference stations – current approach



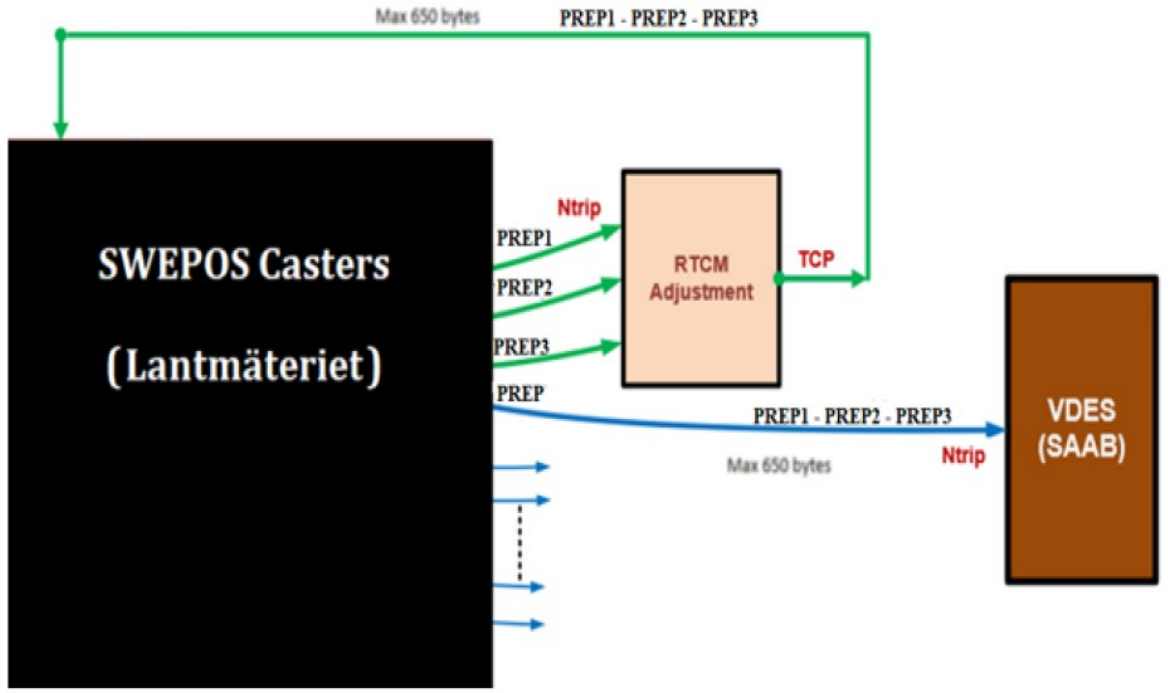
Virtual reference stations – adapted for mass-market



Fixed VRSs in archipelago of Gothenburg

VDES for dissemination of GNSS corrections

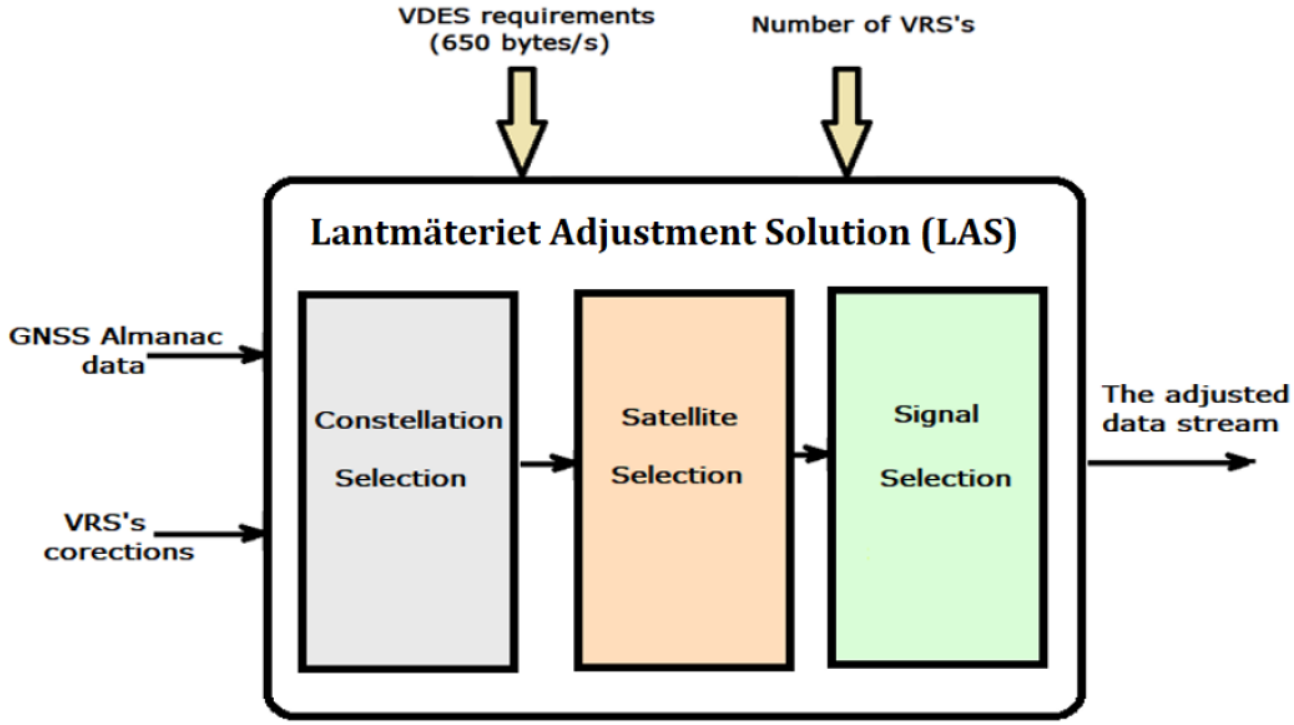
- Standardized communication protocol over VHF based on AIS
- AIS is widely employed and often mandatory in maritime operations
- This makes VDES suitable for dissemination of GNSS corrections
- However, dissemination via VDES imposes additional constraints on the GNSS correction data:
  - Limited bandwidth (650 bytes/s)
  - Require transmission of several VRSs in the same correction data



LANTMÄTERIET ADJUSTMENT SOLUTION (LAS)

- Reduces data rate by constellation-wise, satellite-wise, and signal-wise removal correction data

- Merges correction data from several VRSs to one single correction data stream.

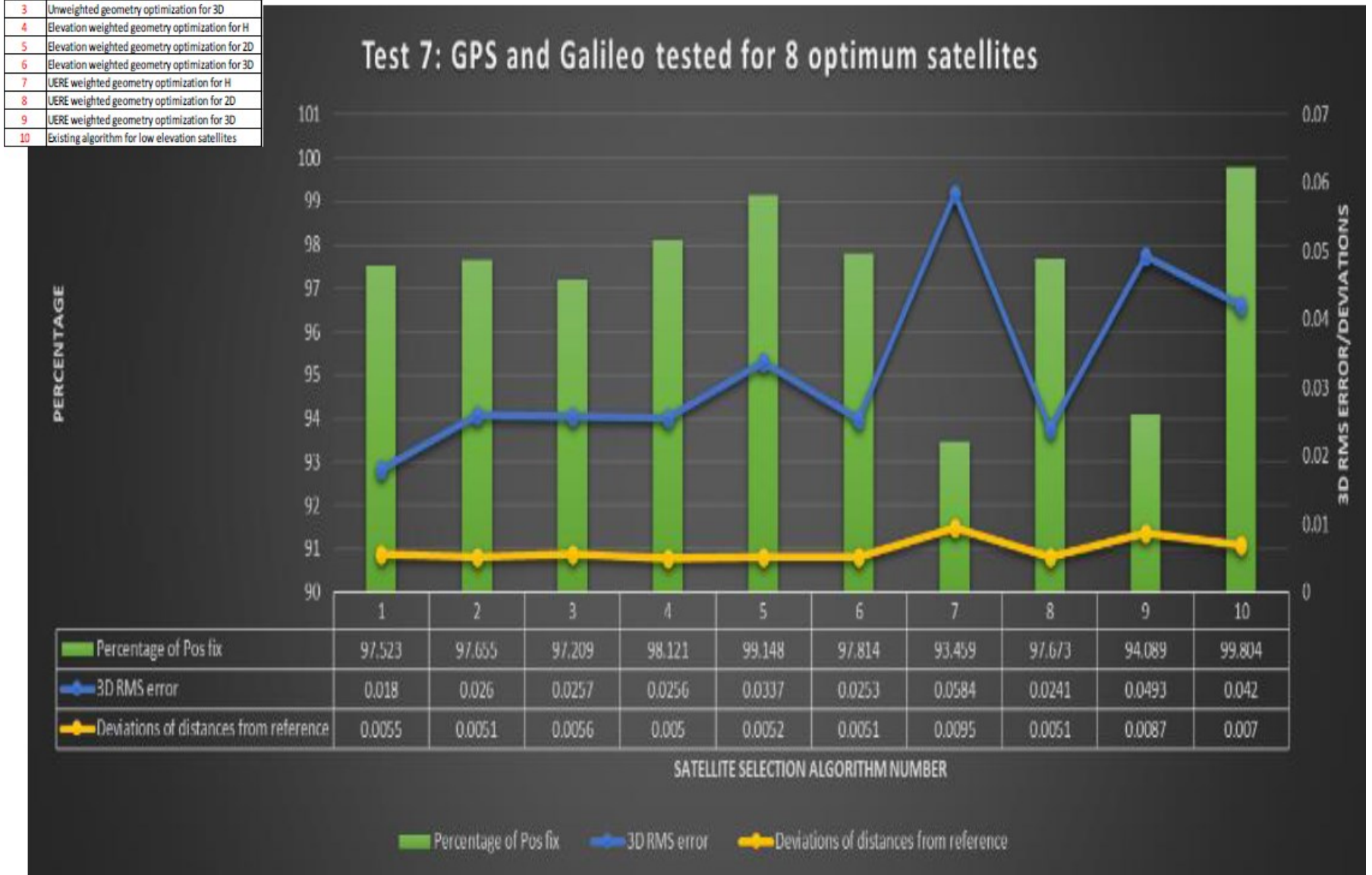


OPTIMIZING SATELLITE GEOMETRY

- An algorithm for optimizing satellite geometry, given a maximum allowed number of satellites, was developed.
- The proposed algorithm supports optimization with regard to either
  - HDOP
  - VDOP
  - PDOP
- 3 options of weighting of satellites are supported
  - No weighting
  - Elevation weighting by $\sin(\theta)^2$
  - Weighting by UERE

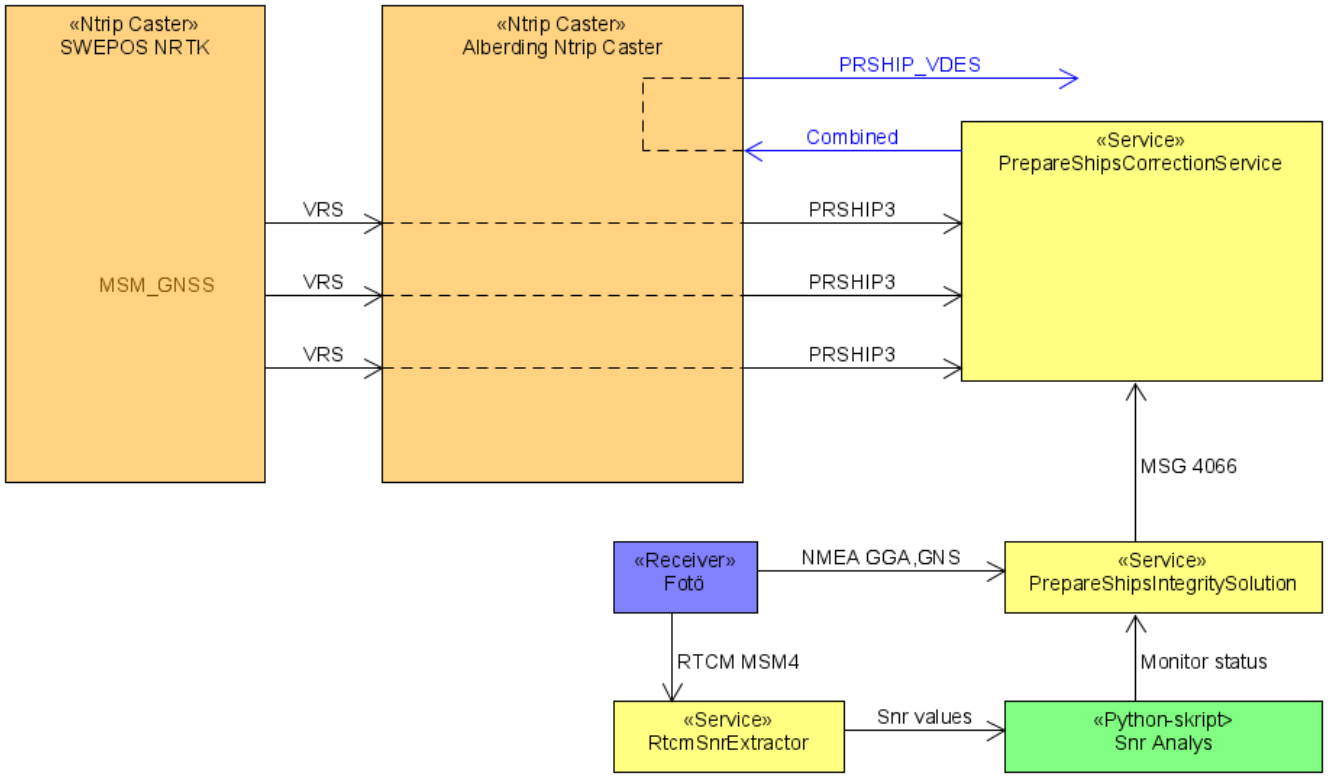
RESULTS FROM STATIC TESTING

Satellite selection Algorithm	
Number	Name
1	Unweighted geometry optimization for H
2	Unweighted geometry optimization for 2D
3	Unweighted geometry optimization for 3D
4	Elevation weighted geometry optimization for H
5	Elevation weighted geometry optimization for 2D
6	Elevation weighted geometry optimization for 3D
7	UERE weighted geometry optimization for H
8	UERE weighted geometry optimization for 2D
9	UERE weighted geometry optimization for 3D
10	Existing algorithm for low elevation satellites



INTEGRITY INFORMATION SUPPLIED FROM LANTMÄTERIET

- Provides quality indicators for horizonal and vertical accuracy
- State of monitoring and health of service are communicated with an additional integrity flag parameter
- Message small in size, 11 bytes in total with message frame included



CONCLUDING REMARKS AND OUTLOOK

- Precise GNSS positioning plays a crucial role for the predictor in the system proposed in Prepare Ships
- Precise GNSS positioning from correction data provided by VDES is possible with a bandwidth of 650 bytes/s and even lower.
- Integrity data was provided but not fully utilized at the user side at this stage.
- SSR and PPP-RTK should be evaluated in future work as it would be even more beneficial than OSR for this kind of application.

THANK YOU!

WEBBPLATS	www.lantmateriet.se
LINKEDIN	www.linkedin.com/company/lantmateriet
FACEBOOK	www.facebook.com/lantmateriet
INSTAGRAM	www.instagram.com/lantmateriet

KONTAKT	kundcenter@lm.se
TELEFON	0771-63 63 63