



Test results for Resilient PNT in the NSR - R-Mode -

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The R-Mode Idea

- R-Mode (Ranging Mode) is the transmission of accurate synchronized **timing** signals from **existing** terrestrial maritime radio infrastructure
- Use of terrestrial radio links which are standardized and already **globally distributed** for **maritime** usage
 - **MF:** IALA Radiobeacon Service (DGNSS)
 - **VHF:** AIS-shore based service

Brief results of R-Mode within EU ACCSEAS Project in NSR

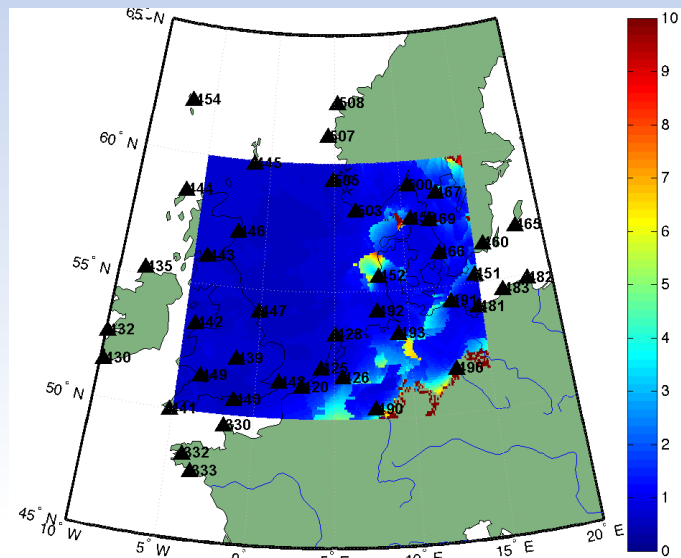
- **Feasibility Study**
 - Part 1: Investigation of R-Mode based on existing **MF IALA radio beacons** infrastructure
 - Part 2: Investigation of R-Mode based on existing **AIS shore** infrastructure (VHF)
 - Part 3: **Combination** of R-Mode Signals from radio beacon, AIS and eLoran transmissions
- **R-Mode Test Bed using MF transmissions**
 - R-Mode transmitting site in Ijmuiden
 - R-Mode receiver site in Noordwijk

Results from Feasibility study R-Mode (MF radio beacons)

Concept:

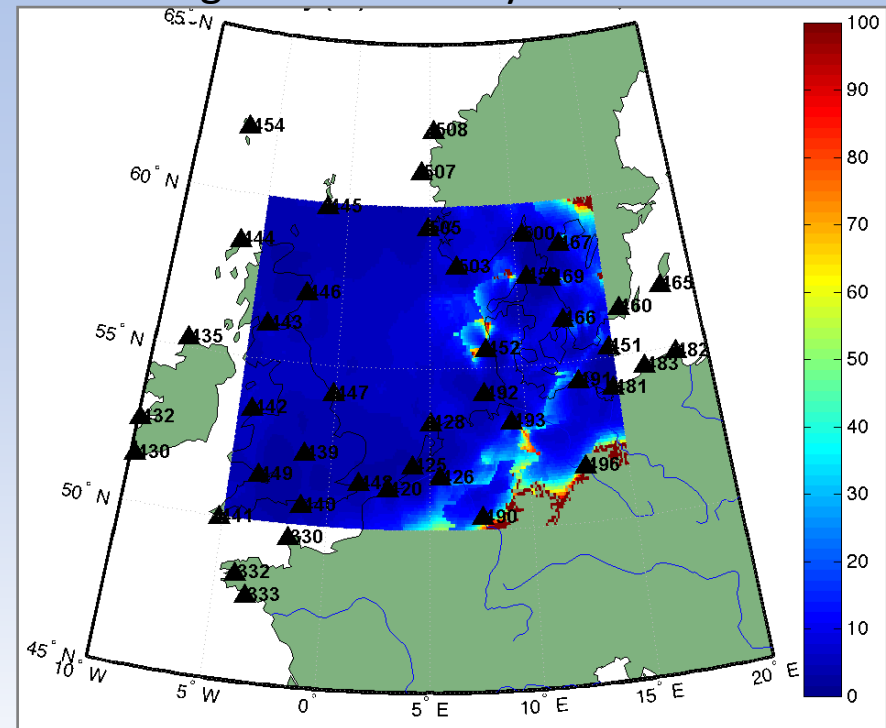
- Using CW's within the existing DGNSS Signal (MSK)
- Add accurate timing and synchronization

Geometry (HDOP) in North Sea Area



Accuracy estimation (day Time);

At night time the position accuracy will degrade due to sky wave



Predicted daytime bound on R-Mode positioning accuracy is very good (< 10 m)

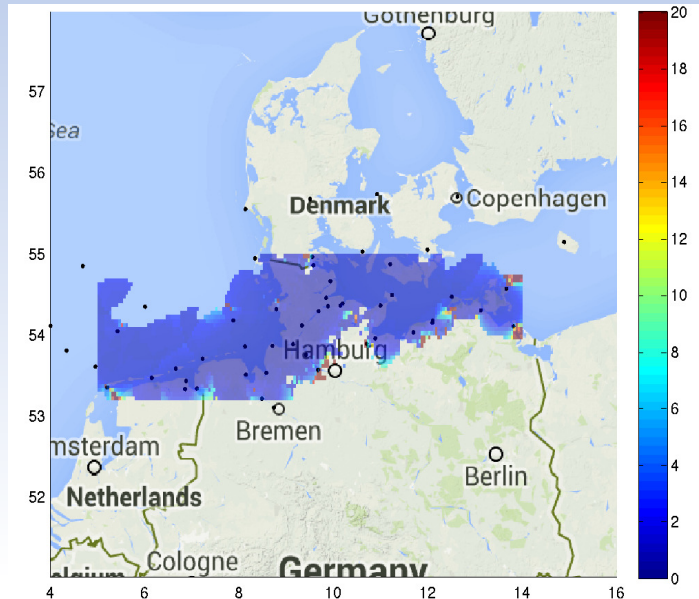
Results from Feasibility study

R-Mode using AIS shore service

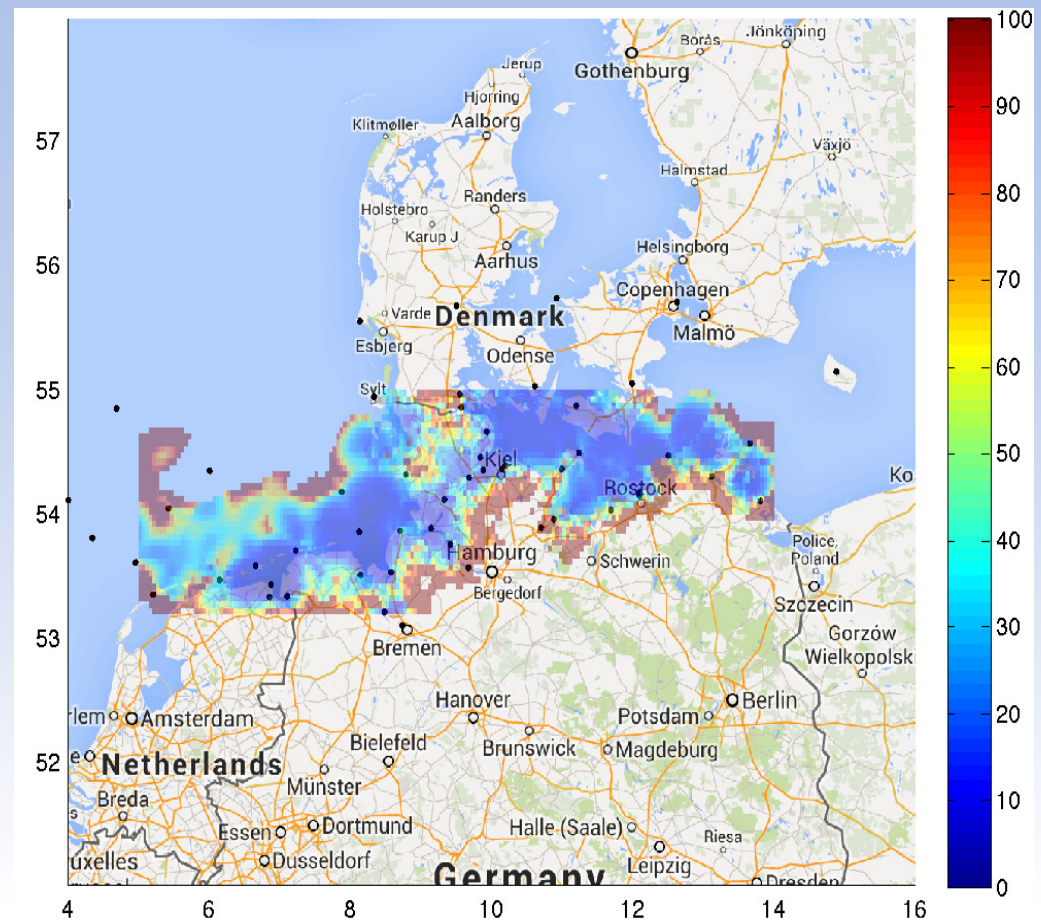
Concept:

- Using standard transmissions without any modifications
- Add accurate timing and synchronization

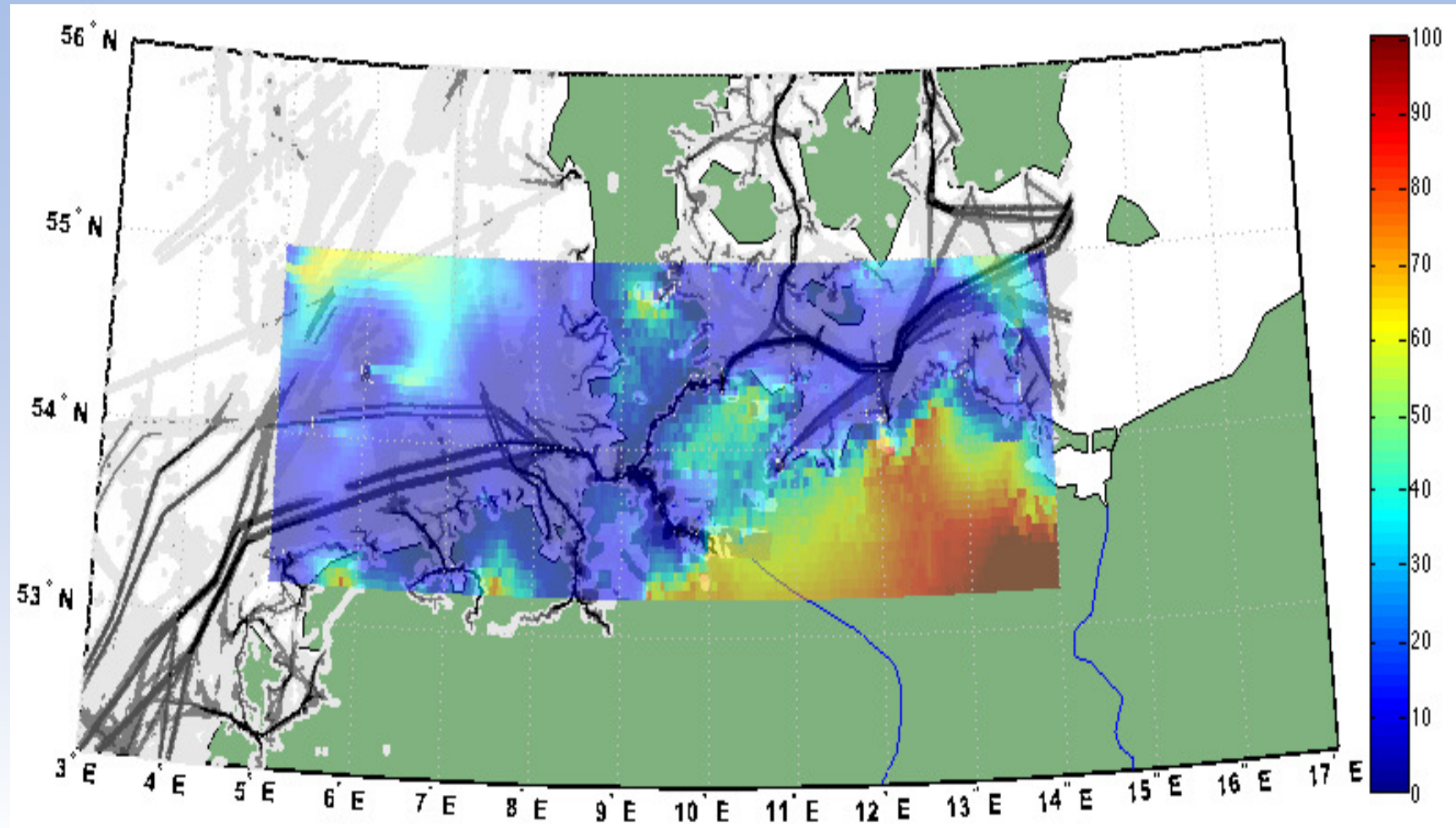
Geometry (HDOP)



Accuracy estimation

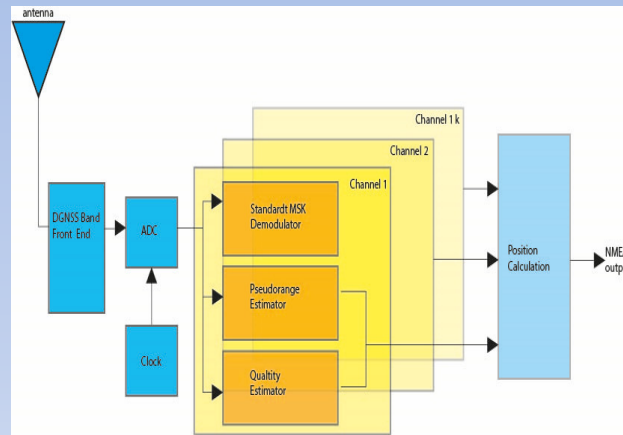
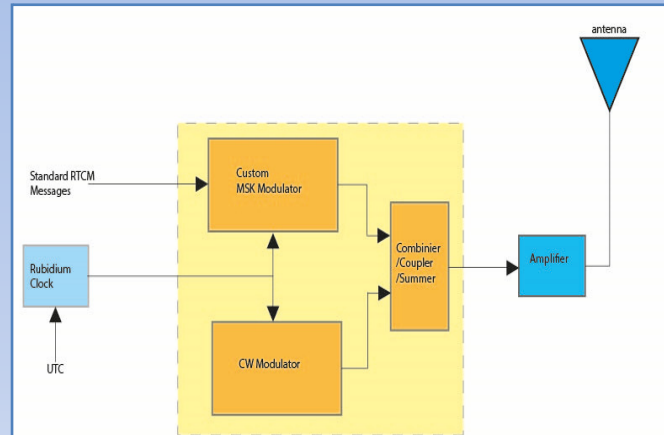


Results from Feasibility study **combination** of MF, AIS and eLoran*



*) 1 eLoran site in Sylt

First on air tests (R-Mode on MF) in IJmuiden and Noordwijk (NL)



R-Mode (MF) Test Bed

- Results -

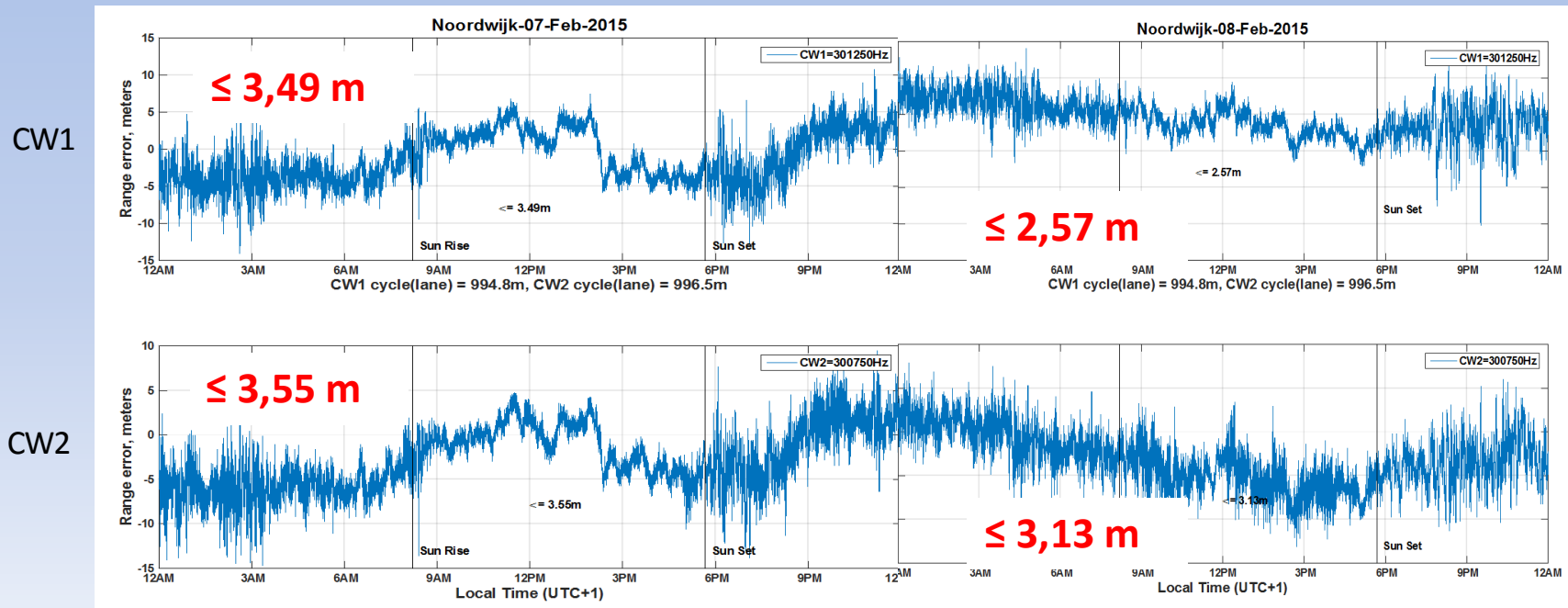
The first on air test started in Ijmuiden at 27th January 2015 The initial R-mode tests consists of:



- ✓ Usability of standard installations (MF transmitter/antenna)
- ✓ Proof of R-Mode concept (validation of feasibility study)
- ✓ Achievable accuracy (range and timing)
- ✓ Mutual influence of (R-Mode and DGNSS signal)

R-Mode (MF) Test Bed

- Results of measurement campaign (7-8.02.15) -



Very **encouraging results** which validate the theoretical findings of the feasibility study

R-Mode

- Next steps planned-

R-Mode using MF transmissions

- Extend test bed to enable positioning tests
- Further develop the existing R-Mode receiver to perform position calculations in a user friendly receiver design
- Start regulatory work

R-Mode using AIS transmissions

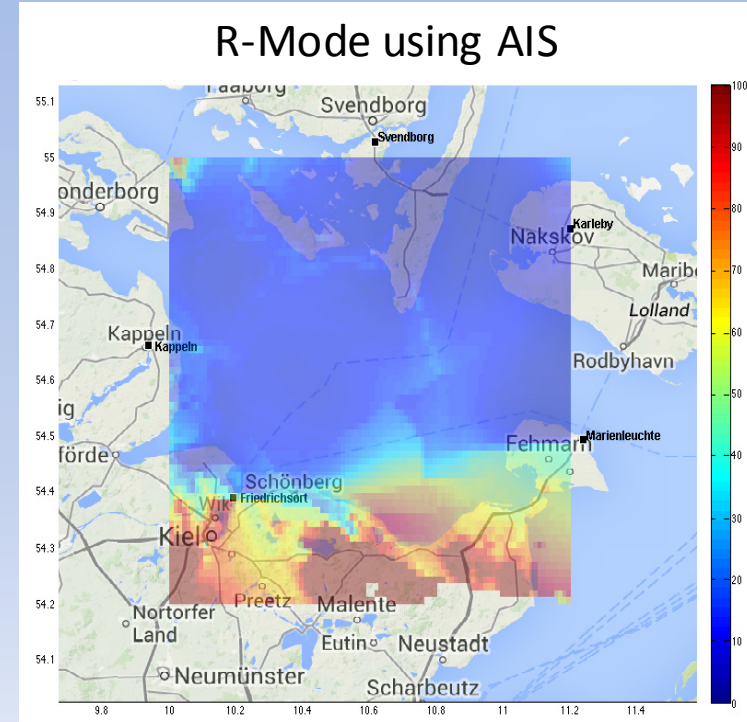
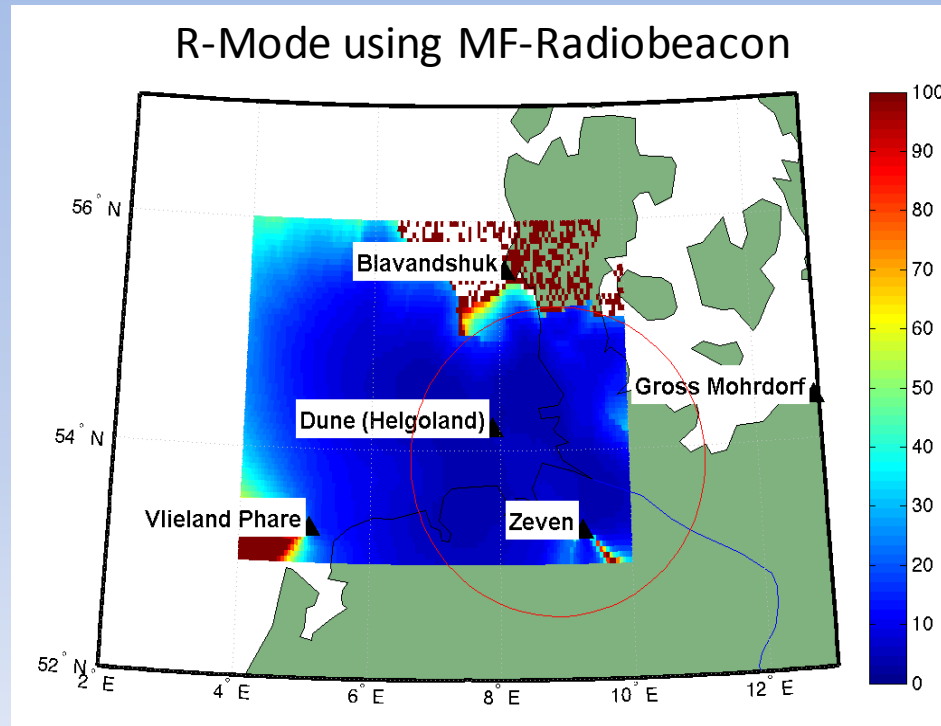
- Establish test bed for R-Mode using AIS transmissions
- Further develop the R-Mode receiver to use AIS transmissions

R-Mode using MF, AIS and eLoran transmissions

- Further develop the R-Mode receiver to a combined “all in view” receiver

R-Mode

- Possible future test beds -



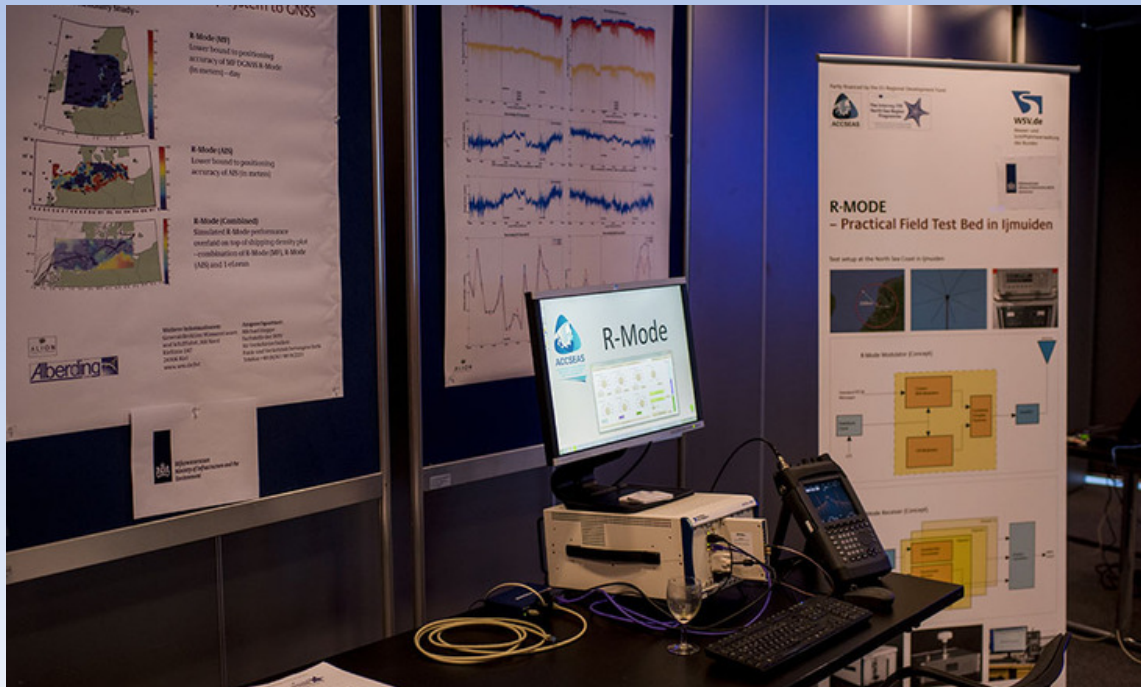
- Test bed equipment (MF) was developed during ACCSEAS
- Efforts and Costs are moderate to enable R-Mode transmissions
- Partners are invited to join a test bed (MF, AIS, Combined solution)

Conclusions

- DGNSS **R-Mode** is a potential terrestrial backup to GNSS that **can meet the resilient PNT** requirements of e-Navigation
- To achieve widespread resilient PNT, the **best solution is** to use all signals available (**signals of opportunity**).
- First **on air test** are **very encouraging** and validates the results from the R-Mode feasibility study.
- It is important to **continuing work on R-Mode** to show the full potential of R-Mode as a terrestrial backup system using existing maritime infrastructure

Thank you

Further information are provided in the lounge area (**R-Mode Demonstrator**)



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The Interreg IVB
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