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Trial results of Radar Positioning in Singapore for resilient positioning

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Agenda

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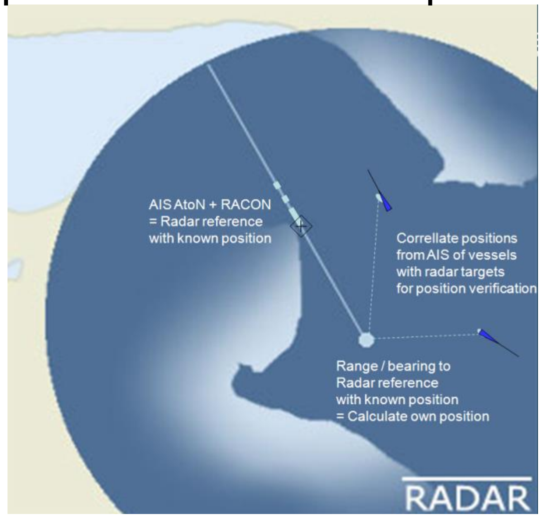
- Concept of Radar Positioning
- Singapore Trial Overview
- Trial Results
- Discussions
- Conclusion

Concept of Enhanced Radar Positioning

Enhanced radar positioning is a proposal for a position fixing system in maritime navigation, based on radar navigation. It is the automation of the process of determining own position by means of radar fixing, using a multitude of objects with known position as reference.
The proposal was originally made by Jens K. Jensen from the Danish Maritime Safety Administration in 2009, in relation to the need for an independent source for position fixing, due to the vulnerabilities of GPS and other satellite navigation systems, identified during the work at IALA on IMO's e-Navigation strategy.
This proposal is currently being brought forward to the maritime industry through IALA, and an opportunity for practical testing of the concept in 2011 is being considered in the EfficienSea project[1] partly financed by the Baltic Sea Region Programme[2] and coordinated by the Danish Maritime Safety Administration The second opportunity for practical testing was in 2013 and considered in the Resilient PNT stream of the ACCSEAS project and coordinated by the General Lighthouse Authorities of the UK and Ireland.
Both of these trials were successful and demonstrated the high potential for the concept.



[1] EU part-financed project: Efficient, Safe and Sustainable Traffic at Sea.
[2] Baltic Sea Region Programme 2007-2013 eu.baltic.net.

From Wikipedia, the free encyclopedia

Purposes of trial-ENAV17-13.16-

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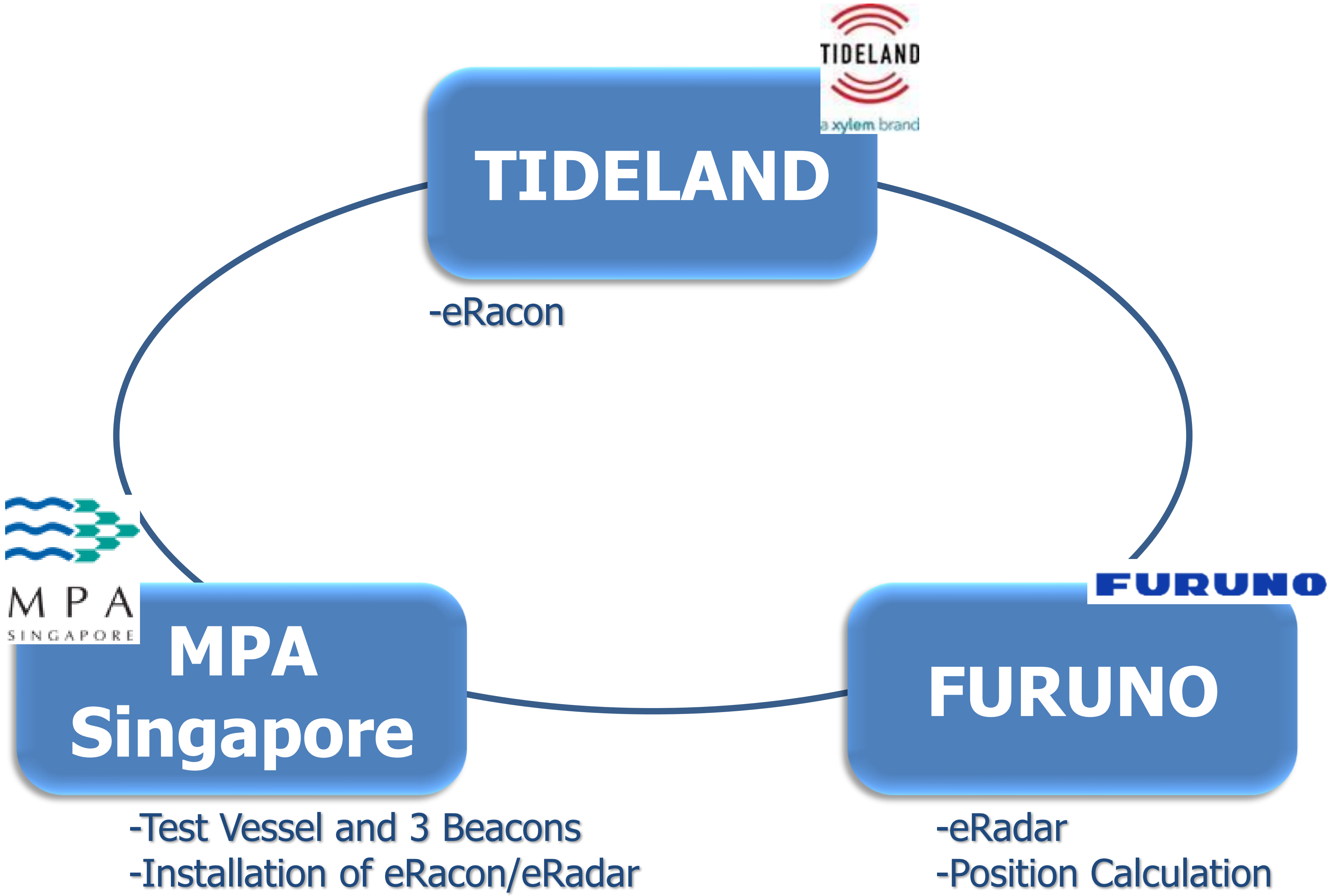
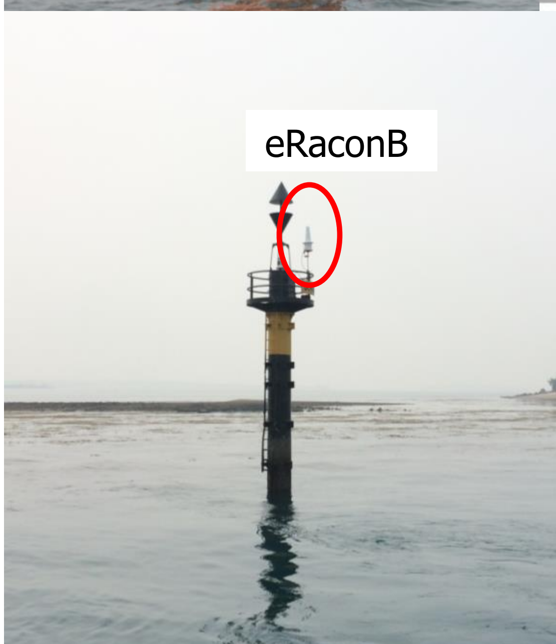
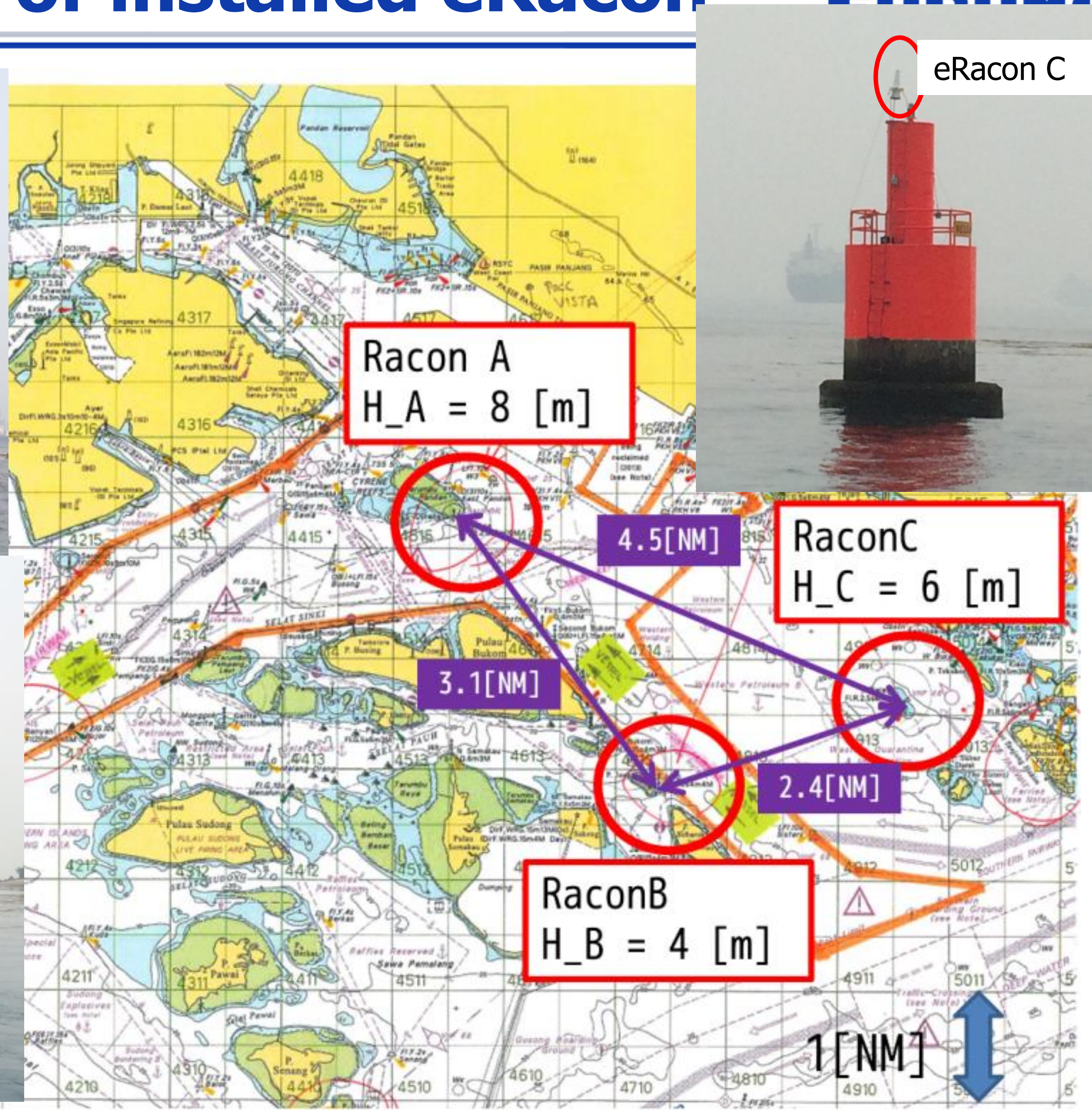
- Recognizing the critical need for real time accurate, terrestrial based positioning to complement GNSS positioning (Resilient PNT), especially in port and coastal areas.
- The positions of the vessel to be displayed in real time based on a modified ECDIS.
- This sea trial area has been selected in a busy channel environment (Singapore port)so as to evaluate the performance of the e-Racon system under real world conditions.
- To study the various eRacon modulation parameters to evaluate the visual quality and effect of modulation on performance.
- To study the accuracy and robustness of the positioning accuracy of eRadar/eRacon (both static and dynamic positioning) as compared to DGPS positioning(within +/- 2.5 meters).

Singapore Trial



Conditions of installed eRacon





eRadar Installation on Panduan

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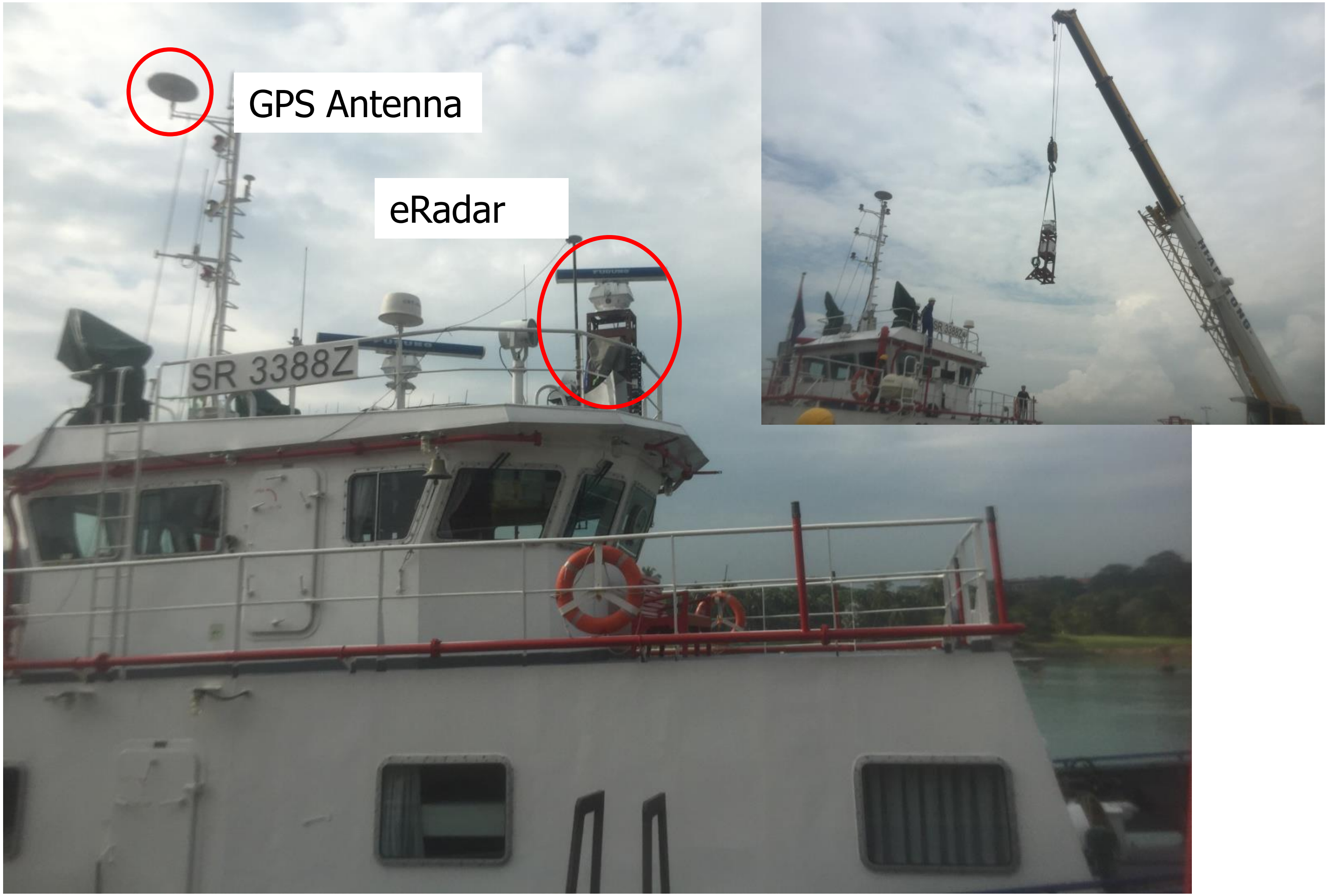
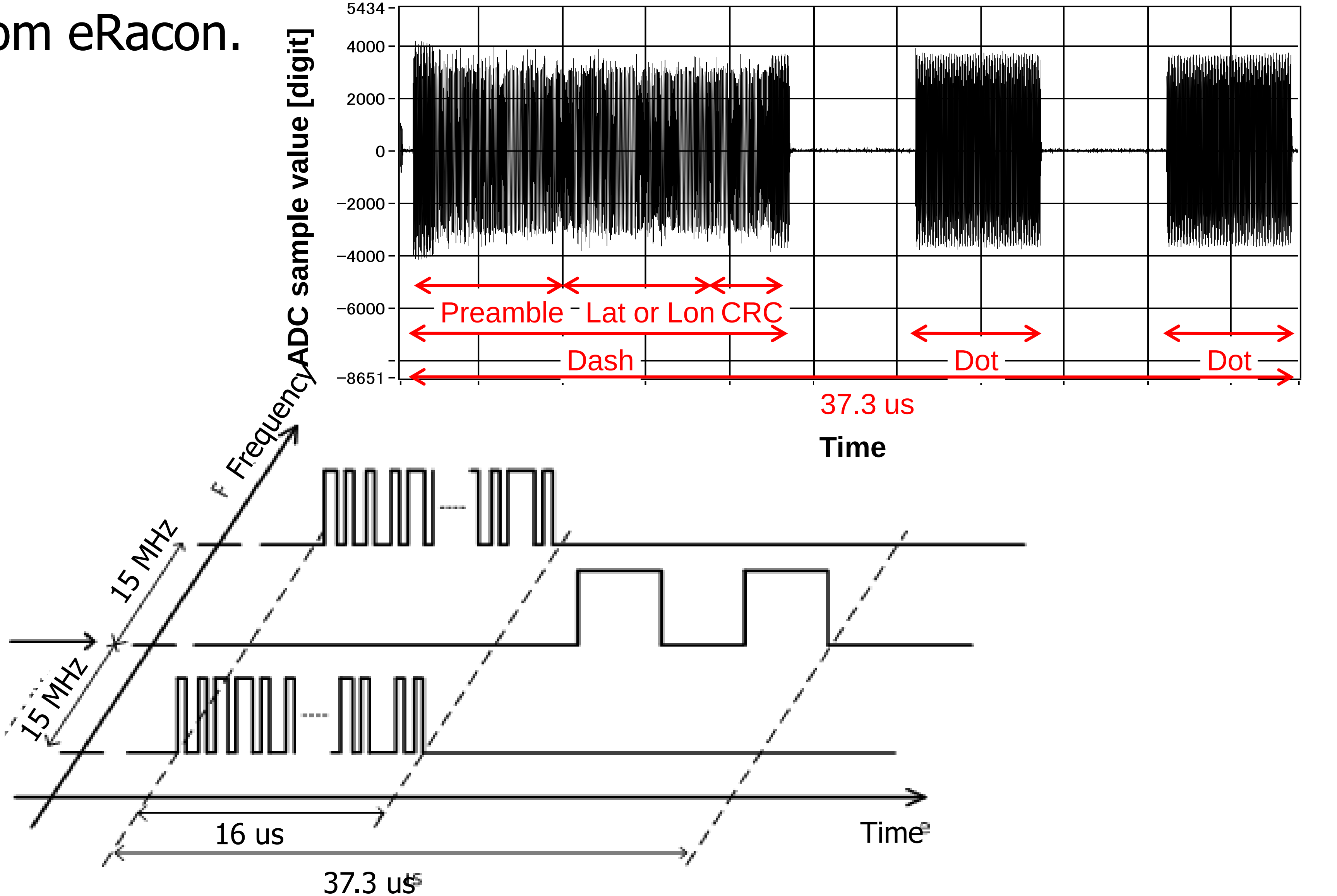


Pulse configurations

- FSK modulation scheme is used in first dash of signal from eRacon.



Real time position display on ECDIS

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Summaries of test results

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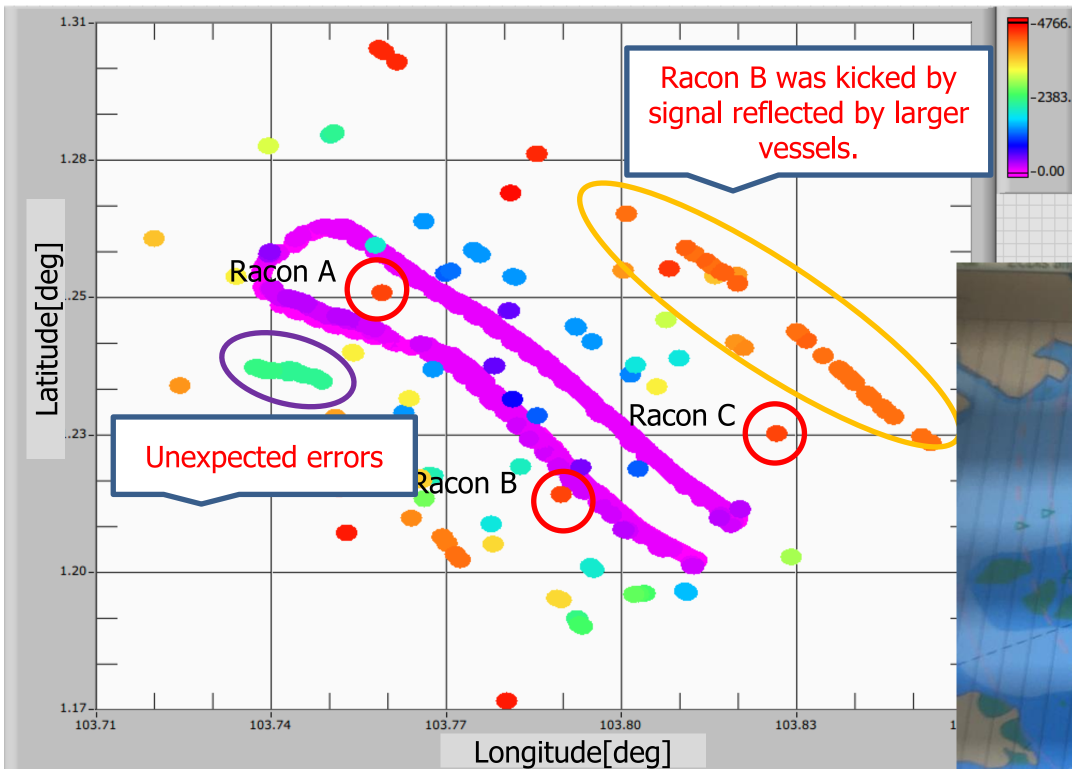
	One eRacon	Two eRacons	Remarks
Dynamic	**59.67 m**	**26.84 m**	Not compensate effects of vessel SOG and timing differences between GNSS and RP system.
Static	**63.22 m**	**13.89 m**	Effects by angles between lines to eRacons.
Berth	**60.22 m**	**7.67 m**	3σ position deviation is just 2.9 m

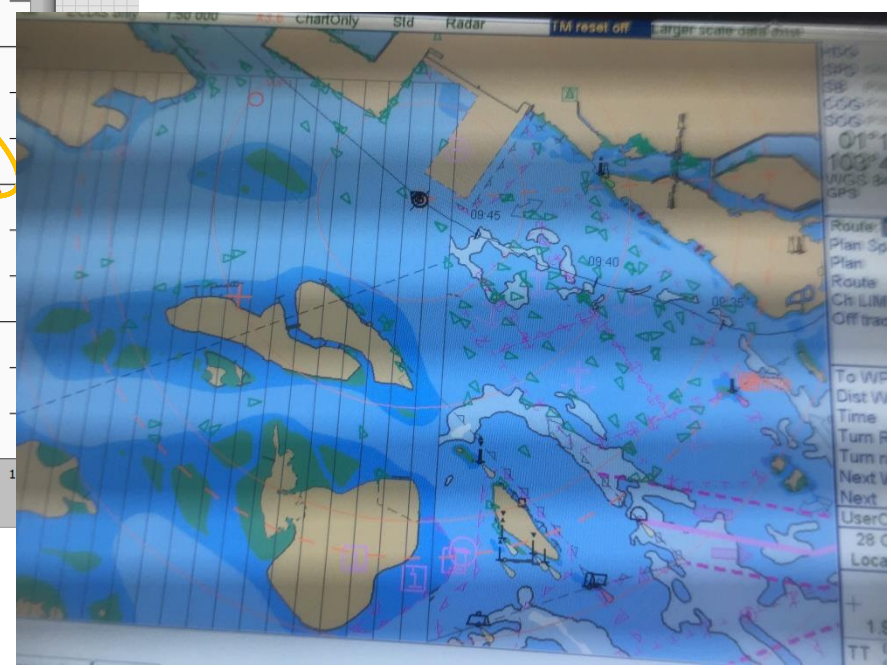
- More than 250 m errors have been eliminated.
- Calculated errors are averaged.
- Offset between GPS receiver and eRadar has not been considered.

Calculated positions using one eRacon

- Racons were sometimes turned on by reflected radar signals while showing no responses by directed signals.

Dynamic Trial





Calculated position using 2 eRacons

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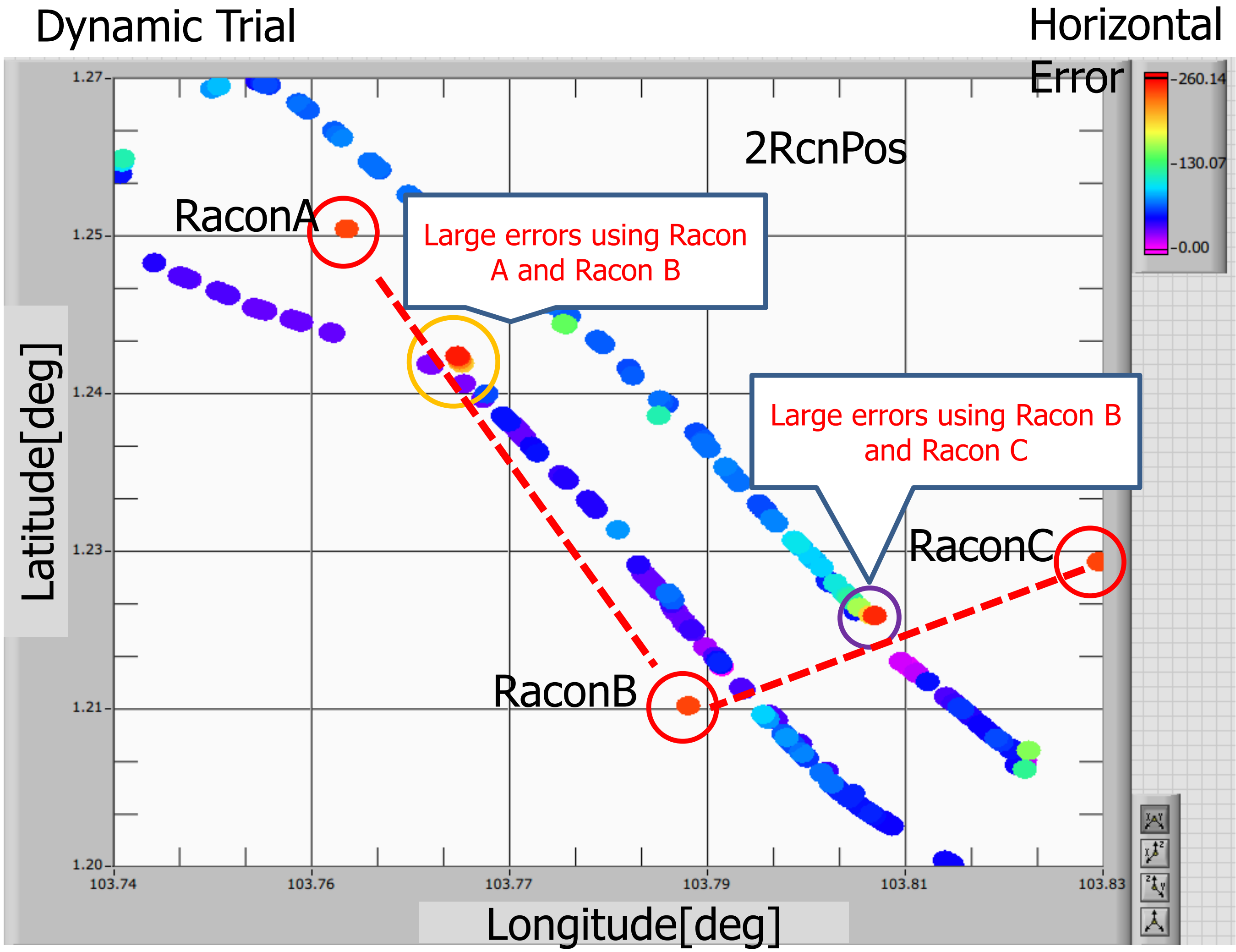
- Position accuracies are determined by angles between lines to eRacons.



Berth trial

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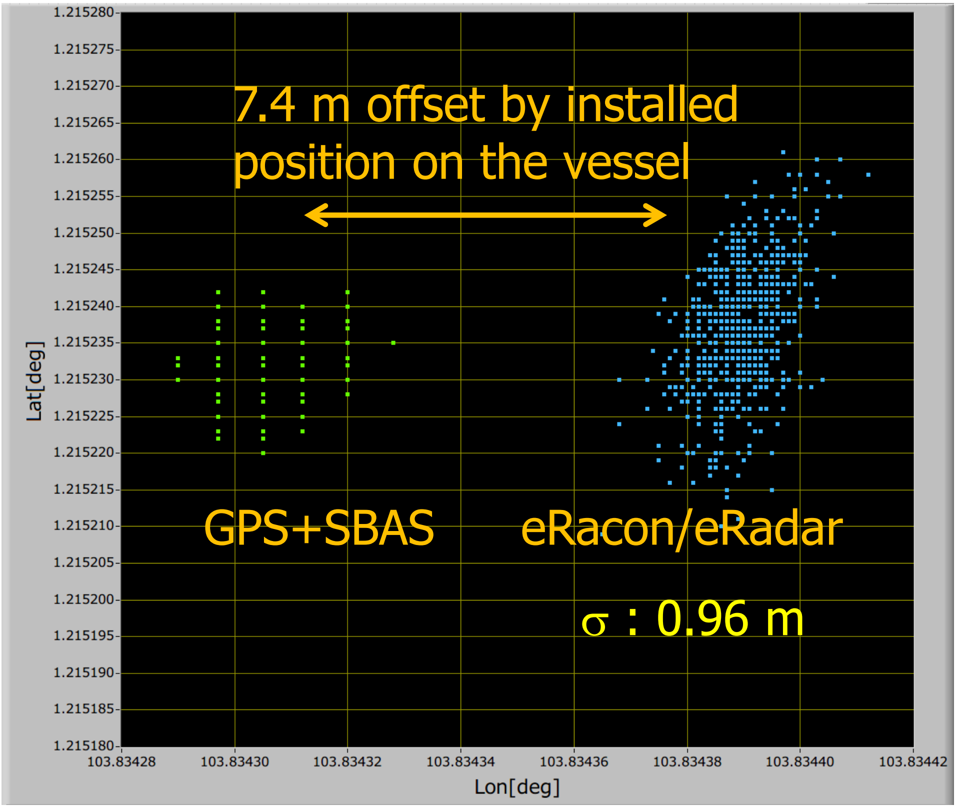
- 3σ of deviation during berth trials reaches to 2.88 m comparable with GNSS sensor with SBAS augmentation.
- This deviation still includes some ranging errors caused by non synchronized sampling and uncertain jitter of eRacon responses.



Conclusions

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- E-Racon/e-Radar positioning demonstration had been done from October 26th to 30th at Singapore port. During the demonstration, real time position calculated by this method has been successfully displayed on ECDIS display.
- Obtained accuracies of positions were 27 m using two Racons during the dynamic trial, less than 13 m during the static trial, and 7.8 m during berth trial.
- Reflections seem to be the bulk of the problems. Reflections can lead to large range and angle errors. Blocking of signals by other vessels could contribute to the large number of "missing" responses.
- For berth trial, obtained 3σ deviation is 2.88 m. This shows higher potential accuracy because we have some rooms to improve performances.
- **Parties have willingness to improve this system and confirm at next opportunities.**

Note: eRacon's operation difficulties

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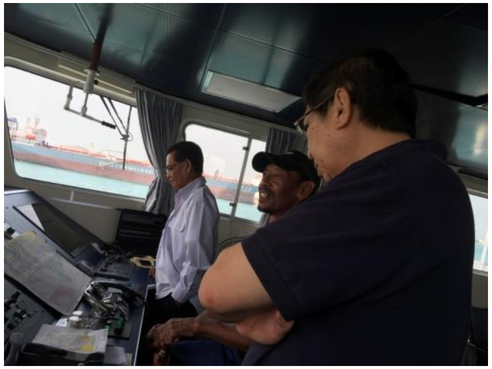
- Racons were initially set to operate in frequency agile mode, but the racons appeared to be nonoperational to the Furuno test radar. Operating mode was changed to fixed frequency and the test radar was able to receive responses.

- The most likely problems in frequency agile mode are blocking due to:
  - With a huge number of radars, the racon is continuously responding, which blocks reception of new radar signals. The response rate to a given radar will be very low.
  - Side Lobe Suppression (SLS) may be blocking response to radars of similar frequency, but with lower signal strength. This could cause a given radar to never receive racon response.

- Operating at fixed frequency worked better because of the following
  - The frequency acceptance band for the racon was narrowed considerably – essentially the racon is not responding to any radar but the test radar.
  - SLS issues are not applicable as there are no other radars at the chosen frequency.



Thank you
for your kind attention.