Enhanced Real-Time Positioning System using e-Radar & e-Racon

Weylin Tang

Ops Tech

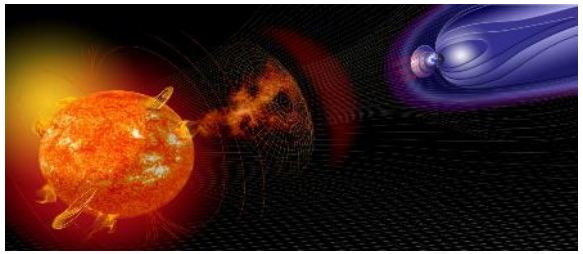
Outline

- Background
- e-Radar & e-Racon
  - Methodology
  - Advantages
  - Configuration
- Results of Sea Trials
- Roadmap
- Joint development

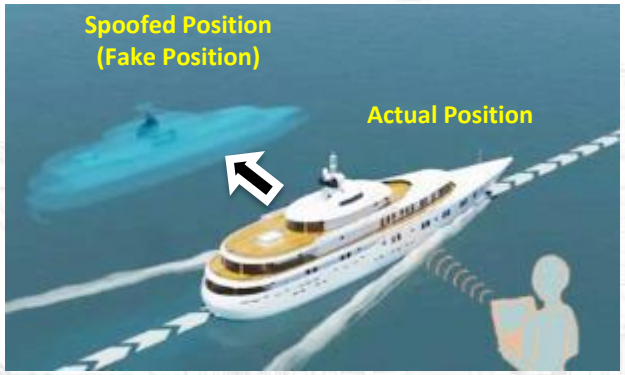
Background

GPS satellite signal:

- Relative weak signal that can be disrupted
- Vulnerable to intentional jamming and spoofing
- Loss of signal due to solar activity



Solar activity



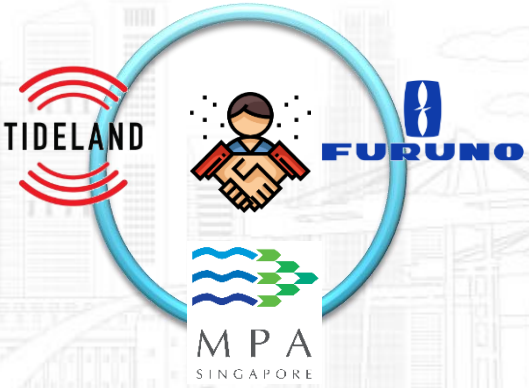
Vulnerable to spoofing

Methodology

- The need for an alternative backup system for real-time position terrestrial based navigation system to supplement GNSS.

- Enhancing use of modified racon to encode digital data for e-Racon identification and accurate positioning.

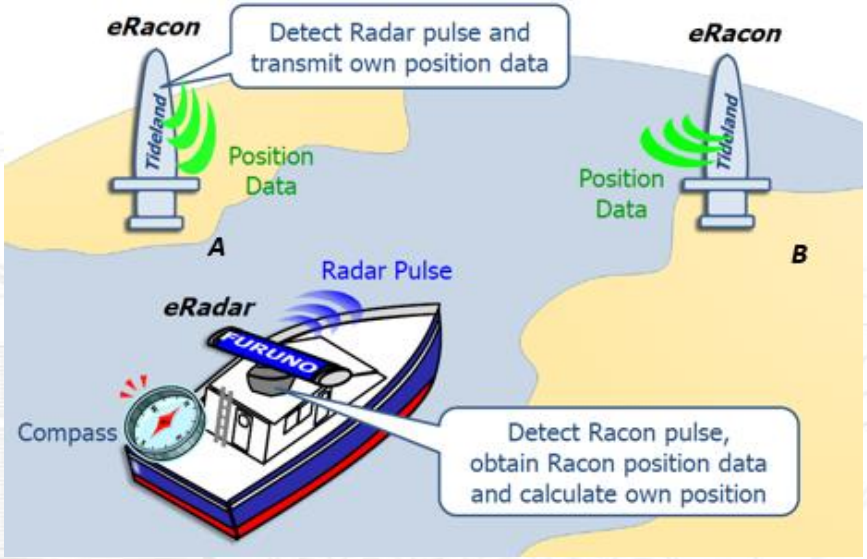
- Utilising a modified e-Radar to detect and demodulate the unique data, the receiver can calculate and report accurate positioning for the vessel in Singapore waters.



Test bedding of e-Radar & e-Racon

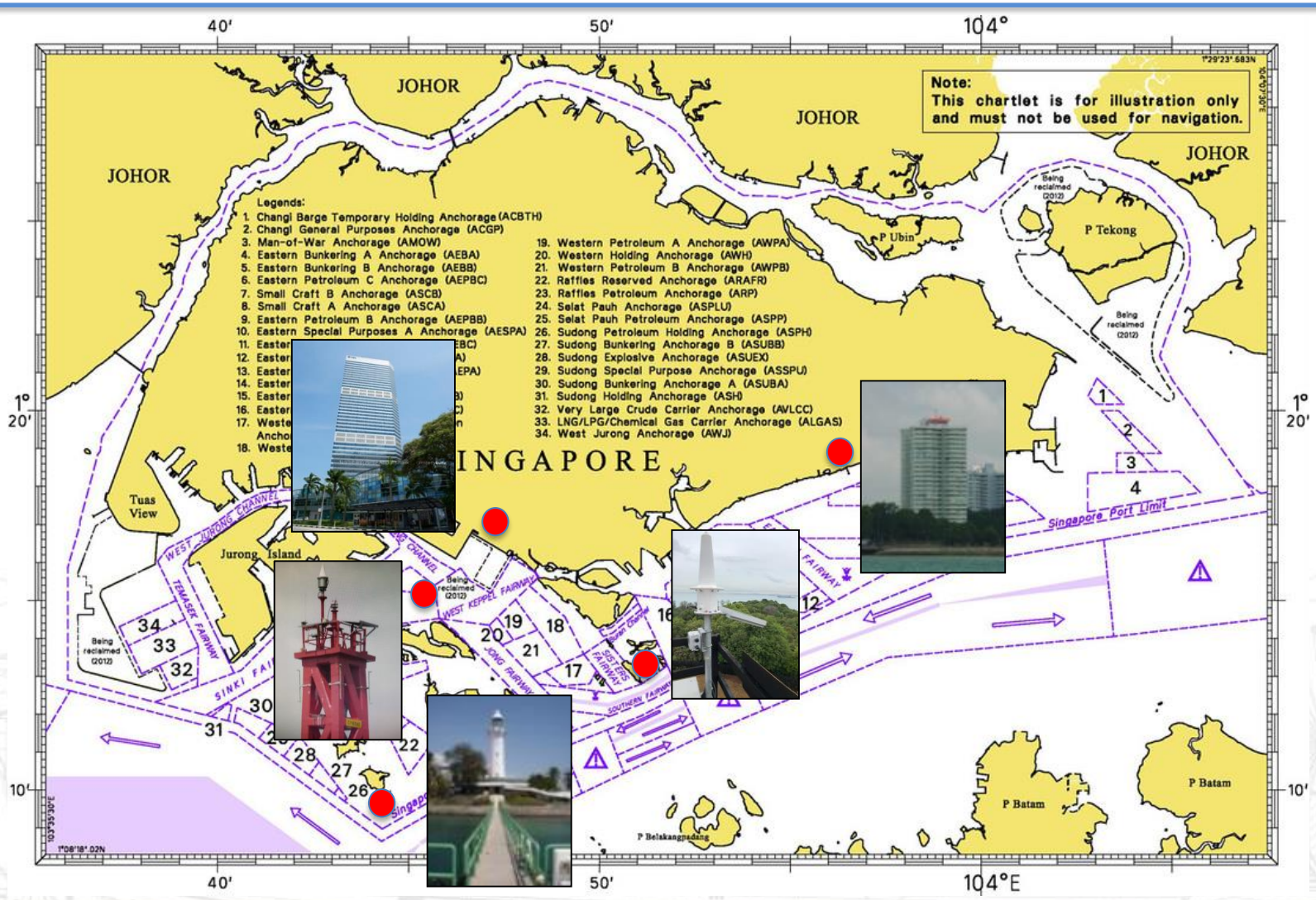
Advantages of e-Racon & e-Radar:

1. Terrestrial based radar system, independent of GNSS
2. Provide real time, accurate and reliable positioning data
3. Radio signal stronger and difficult to jam
4. Runs on solar power
5. Ease of application (Upgrade to e-Racon and e-Radar)
6. Good signal range per e-Racon (About 10 NM) – Suitable within port areas



Furuno's Real Time e-Radar

Locations of e-Racons for 3rd Sea Trial (Singapore)



Sea Trials Results

Others trials were done in Denmark (2011) and UK (2013). These trials were concept proofs for e-Radar positioning system.

1st Trial (Oct 2015):

- First authority in the world to prove independent **REAL**-time positioning system
- Trial done in busy port environment
- Positioning accuracies – **Static**: 20m **Dynamic:** 55m

2nd Trial (Aug 2017):

- Better e-Radar algorithm
- Auto computation of vessel position on the fly
- Addressed multi-path and height installation issues
- Positioning accuracies – **Berthing**: 2.5m **Static:** 12m **Dynamic**: 26m

Sea Trials Results

3rd Trial (Aug 2019):

5 e-Racons installed and available

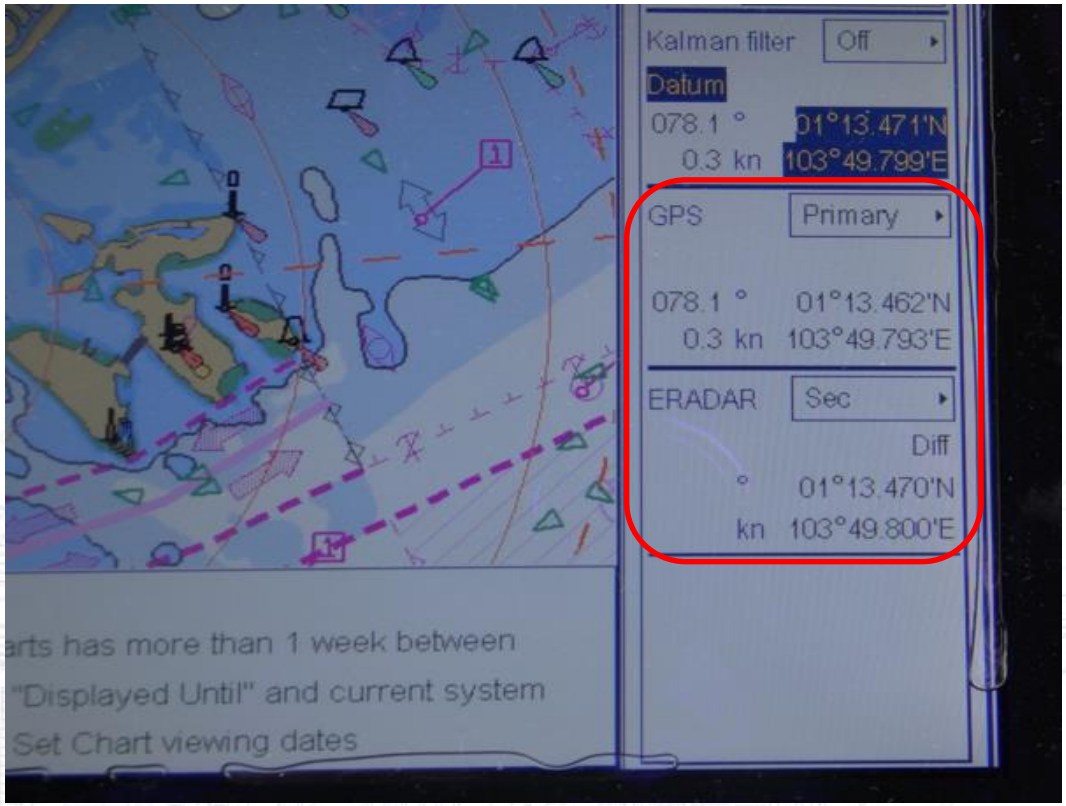
- Better e-Radar and e-Racon communication package and algorithm
  - Frequency Agile
  - 3 e-Racon LOP using 'best' three e-Racon signals recevied
  - Reliable data transmission
- Addressed multi-path and height installation issues
- Preliminary results
  - Positioning accuracies – **Berthing**: 2.5m **Static:** 12m **Dynamic**: 26m

Test Bedding results

- Position of vessel is displayed in real time on a modified ECDIS

Test Bedding results

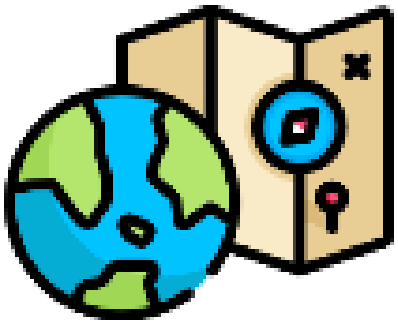
- Positioning accuracies:
  - Berth: 2.5m, Static: >12m, Dynamic: >26m



2nd Trial – Aug 2017: DGPS and eRACON positioning

Impact of e-Radar and e-Racon

- Ability to provide real time terrestrial based accurate and reliable positioning for ships
- Serves as a supplementary navigational system to GNSS
- Enhanced navigational safety in Singapore Port waters
- Practical and suitable for port waters and approaches
- Positive impact to international shipping



What's Next: Proposed Roadmap

2019

- **3rd Sea Trial**
  - 1. Enhancing the capabilities of e-Radar to received and process 3 or more e-Racon signals
  - 2. Upgrading of the software with improved transmission
  - 3. Provide more locations of e-Racons for more reliable network

2020

- **Testing and Development**
  - 1. Extending the test bedding site areas to Malacca Straits for refined simulation
  - 2. Integration with AIS and ECDIS
  - 3. Presentation at 21st IALA Conference (ENG & ENAV)
  - 4. Feedback for Future sea trials in 2021 for enhancement

2022

- **Development of Standards and Specifications**
  - 1. Propose Standards and Specifications
  - 2. Submission of Standards and Specifications to IALA / relevant organizations for approval / recommendations
  - 3. IEC Testing of equipment and certification

2023

- **Maturity**
  - 1. e-Radar and e-Racon system is Approved for commercial usage
  - 2. Maritime community to adopt and comply as a supplementary to GNSS

2025

- **Support and Enhancement**
  - 1. Initiatives to provide support to end user / authorities
  - 2. Recommend enhancements to existing e-Racon and e-Radar system

MPA SINGAPORE

MARITIME SINGAPORE

For Information

Joint Development and Partnership

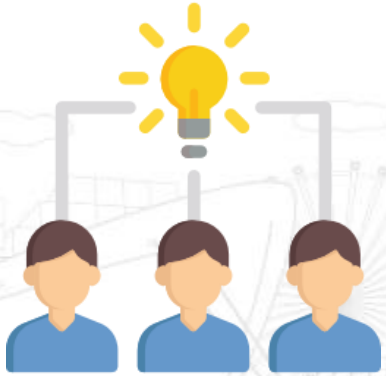
TIDELAND

e-Racon

FURUNO

e-Radar

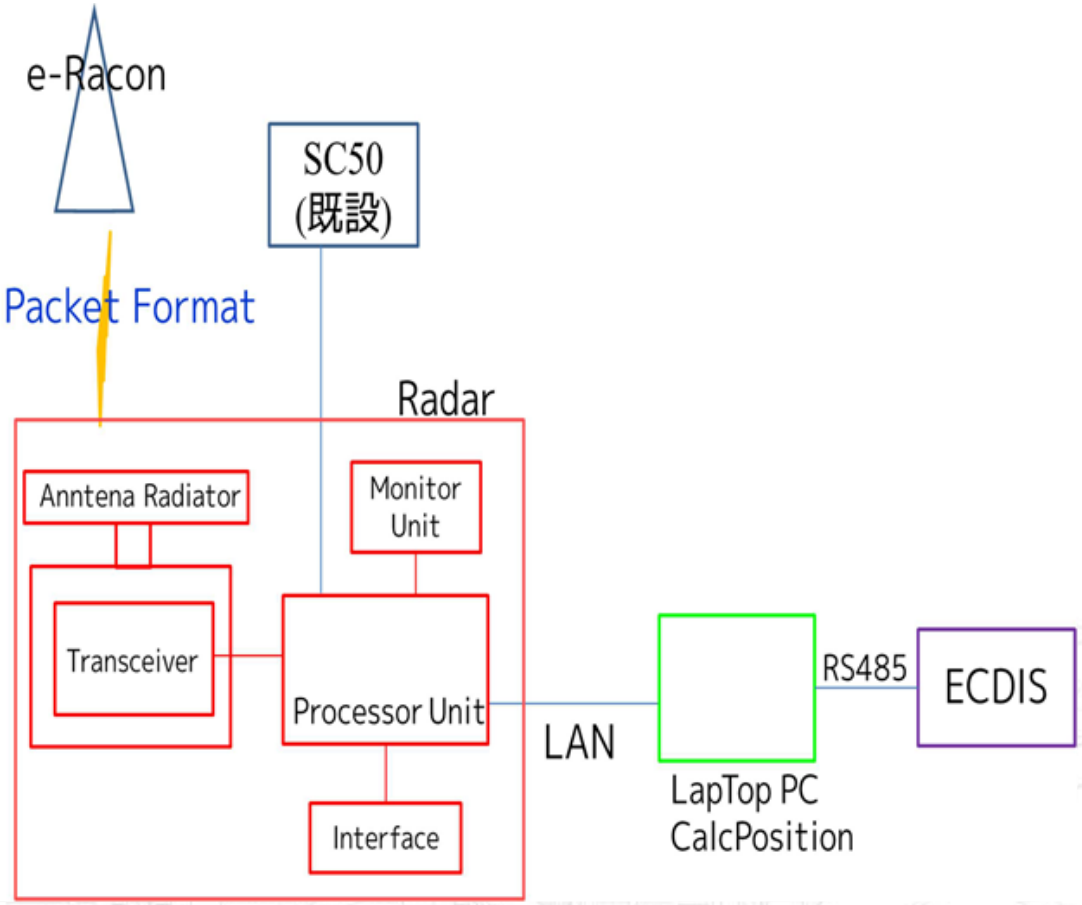
MPA
SINGAPORE



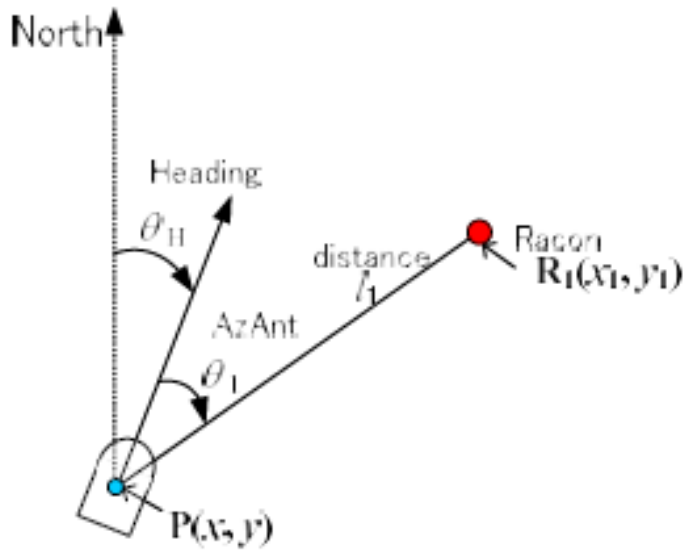
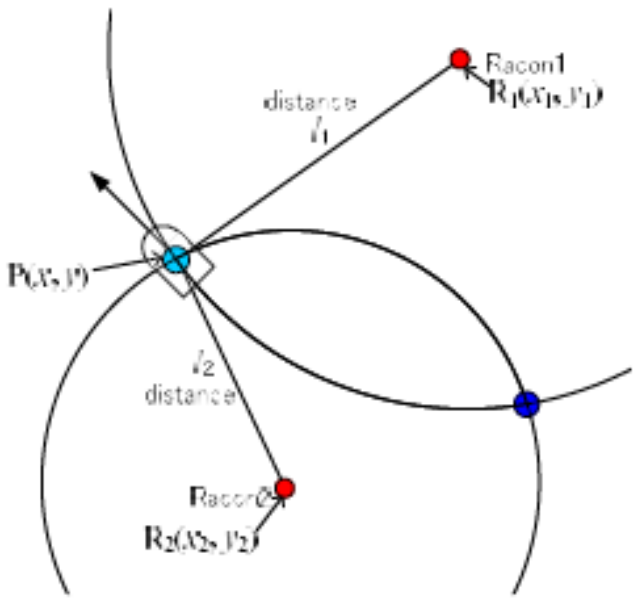
Furuno's e-Radar System specification

Item	Specifications	Remarks
Transceiver	X-band Solid State	
Output Power	150 W	
Transmit Frequency	9370 MHz	
Pulse Width	0.3 us	
Pulse Repetition Frequency	1250 Hz	
Modulation	Non modulated (PON)	same as conventional Shipborne radar (no pulse compression technique)
Antenna	4 feet, 27.5 dBi	
Antenna Rotation Speed	24 rpm	

Furuno's e-Radar System configuration



Furuno's e-Radar System calculation

1Racon Positioning	2Racon Positioning
$\begin{cases} x = x_1 - l_1\cos(\pi/2 - \theta_H - \theta_1) \\ y = y_1 - l_1\sin(\pi/2 - \theta_H - \theta_1) \end{cases}$	$\begin{cases} (x - x_1)^2 + (y - y_1)^2 = l_1 \\ (x - x_2)^2 + (y - y_2)^2 = l_2 \end{cases}$
	

Furuno's e-Radar System

- Enhance safety of navigation.
- Security and create awareness in the marine industry.
- Expand the usage of e-Radar