

GPS Denied High Speed Navigation

*Harald Nilsonne, CEO
Sea Cross Marine AB, Sweden*

GPS Denied High Speed Navigation

1. Threats
2. Sensor and navigation system limitations
3. Mitigation using SeaCross[®] technologies

Threats

1. Jamming - Blocks GPS system

- GPS Transmitter ~ 500 W equivalent to a 20 Watt lightbulb at 21 000 km distance

2. Spoofing - Adds offsets

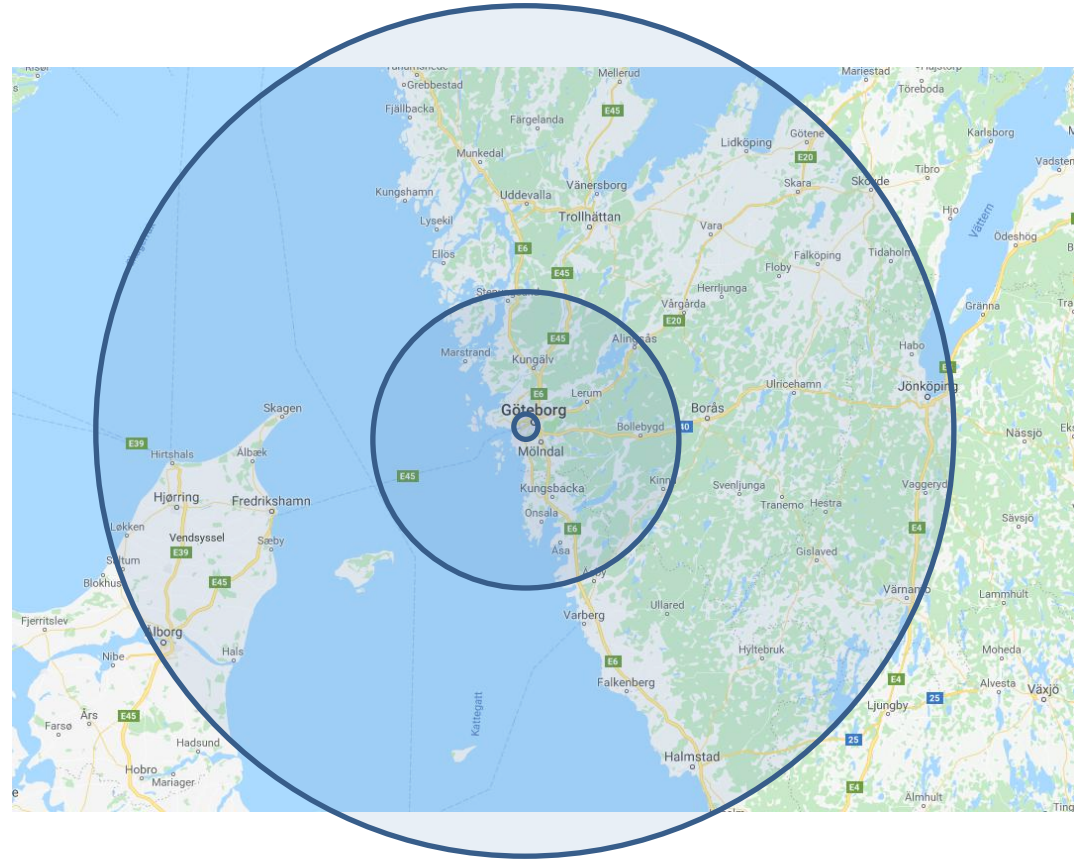
- Fixed position offsets
- Drifting position offsets
- GPS clock offsets



Jammers available from \$50 on the web...

1. “Civilian” jammers – range (estimates)

- 1/10th Watt < 1 Nm (1,5 km)
- 1 Watt 25 Nm (48 km)
- 10 Watt 80 Nm (150 km)



Reports of multiple incidents all over the world

- Disable tracking during criminal activities
- Disable fleet tracking
- Etc.

Gatwick, Newark

2. Military jammers – range ?

- Example: US Military jamming test in California 2016
FAA warned range of disturbance will be 250+ Nm at 50ft elevation



Reports of reoccurring incidents all over the world

- Russian / Belarus Zapad (“West”) exercise 2017 -> Latvia and Norway affected by jamming
- Jamming of US drones in Syria
- Crimea and Eastern Ukraine
- Etc.

Principles

Receive → Add offset → Transmit

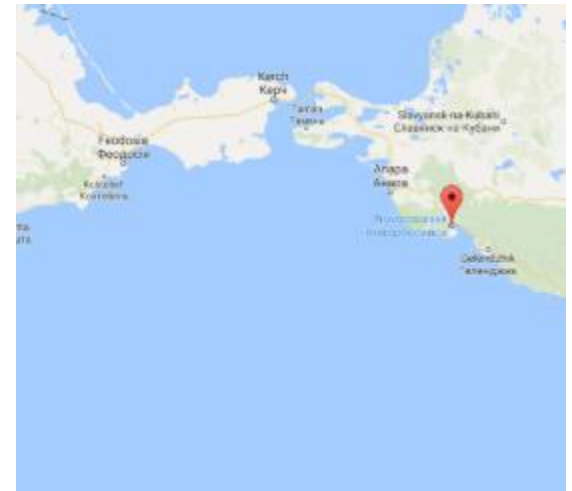
Receive → Record → Transmit with delay

Evolving and improving military technology

Example: Novorossiysk Black Sea, 22 June 2017

A commercial ships GPS' position was offset 32 km inland to the Gelendzhik Airport

Twenty nearby ships AIS positions were all also offset to the same Gelendzhik Airport location



Conclusions

1. A growing threat since many years
2. Jamming technology easily available, and cheap
3. Spoofing technologies will most likely improve



Alternative positioning systems like eLoran will have to complement the GNSS - system

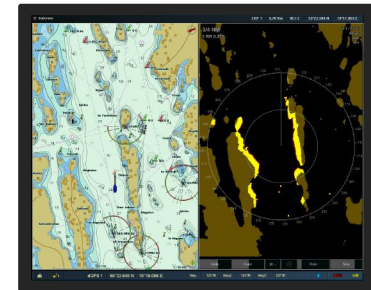
Sensor and navigation system limitations, GPS



Standard GPS



Position



Navigation System

Sensor and navigation system limitations, GPS

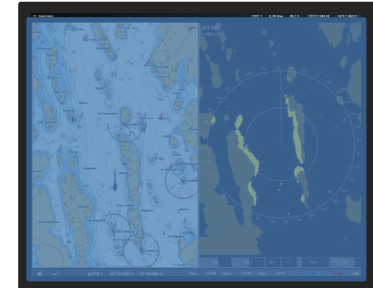
Jammed



Standard GPS



No Fix



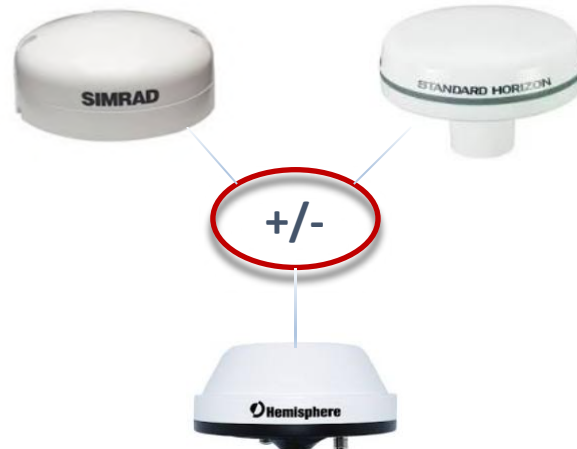
Navigation System

Sensor and navigation system limitations, GPS

Jammed



No Fix



Weighted Position

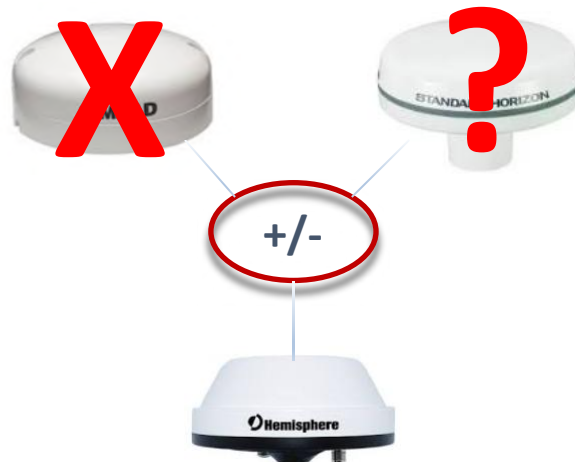
Sensor and navigation system limitations, GPS

Jammed



No Fix

Jammed



Intermittent Fix

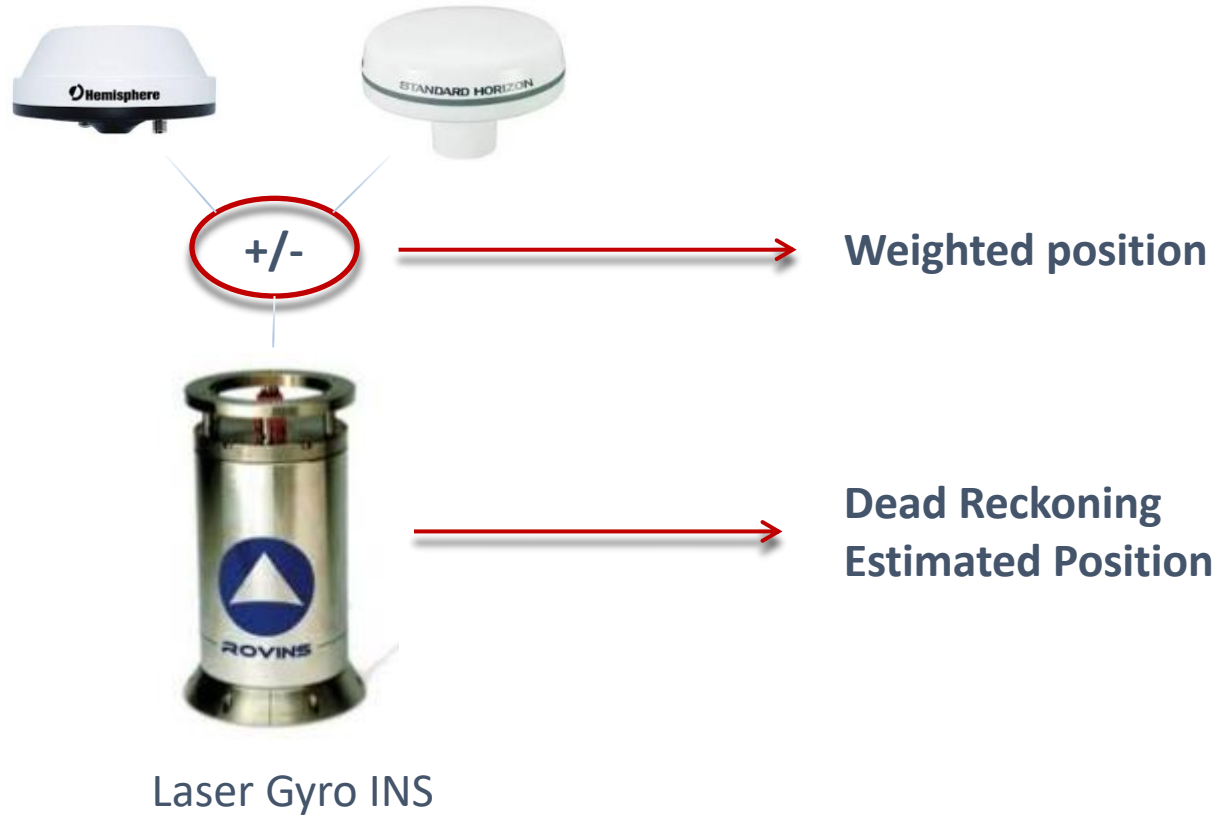


Inaccurate

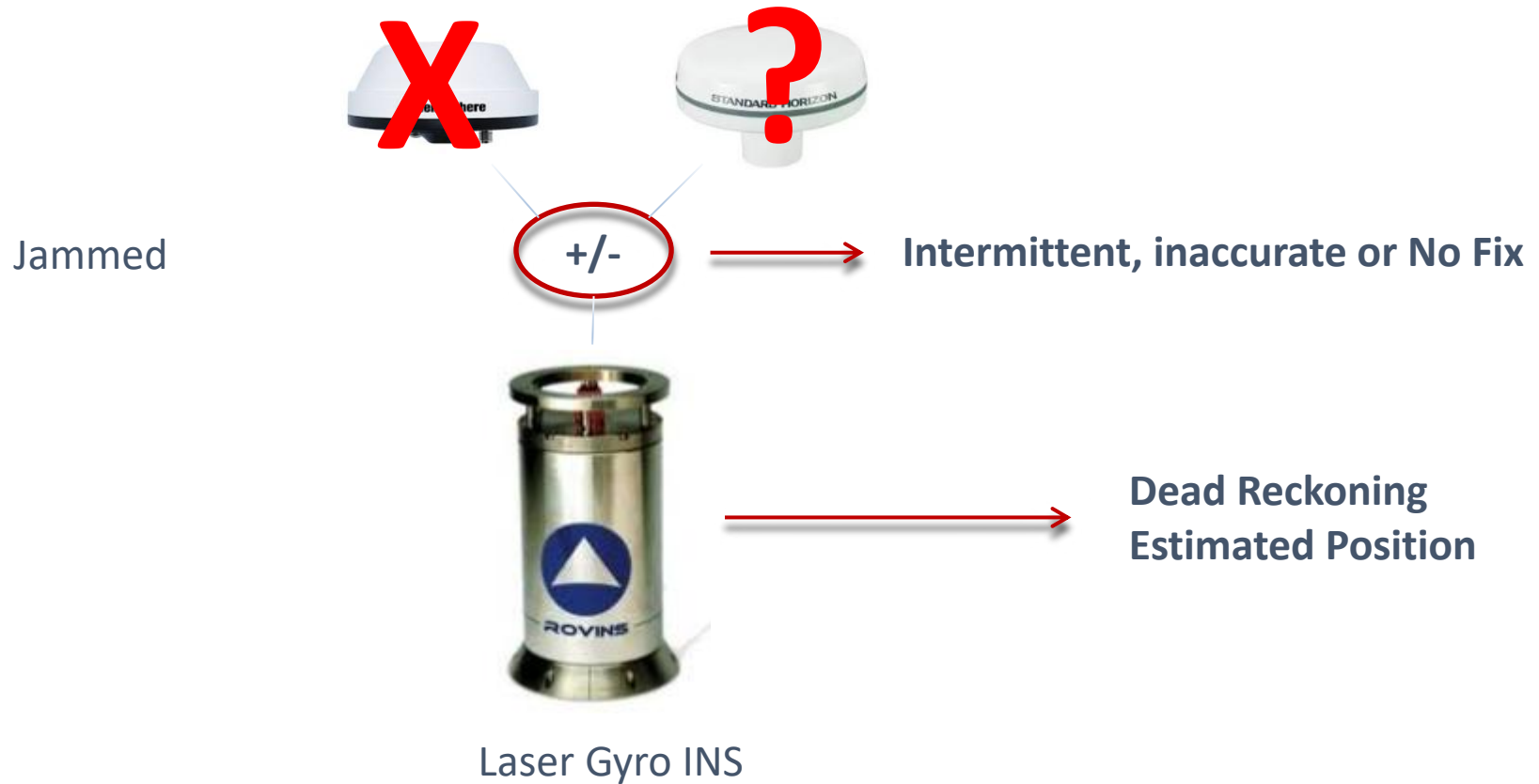


No Fix

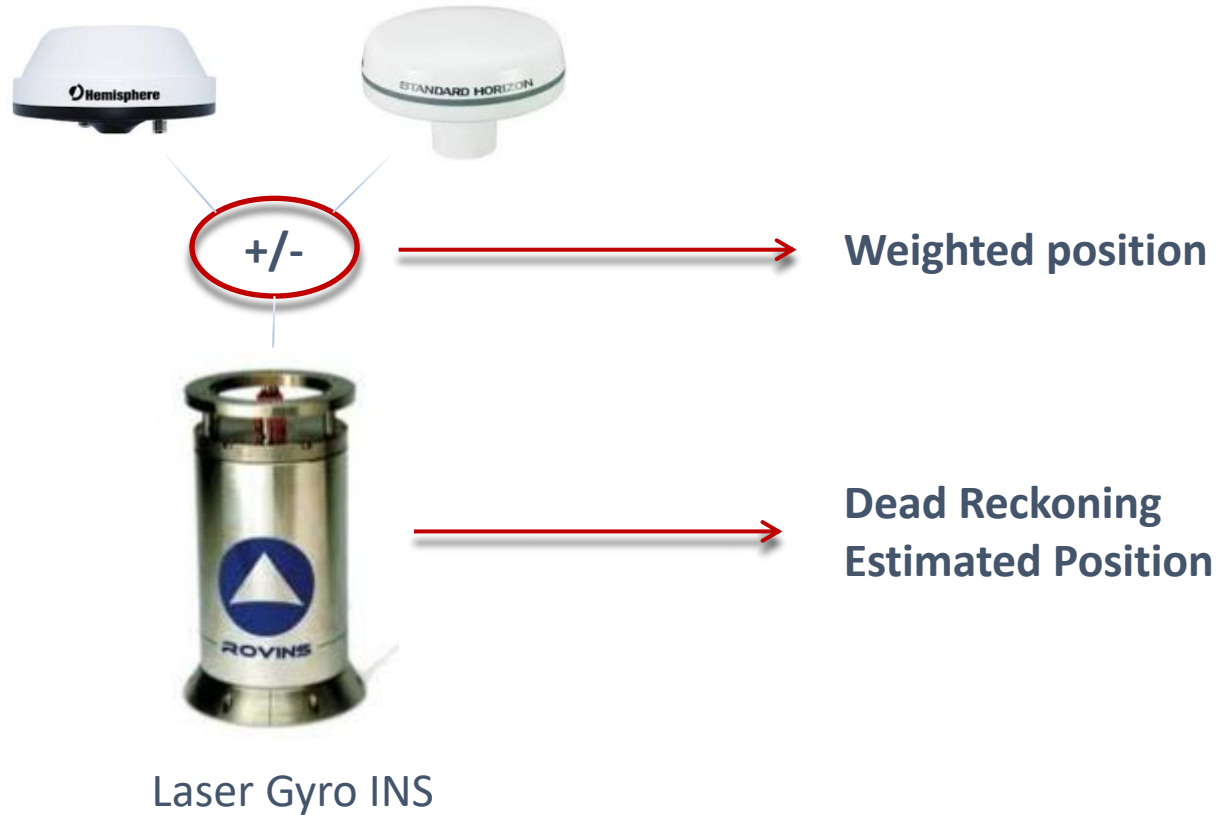
Sensor and navigation system limitations, GPS



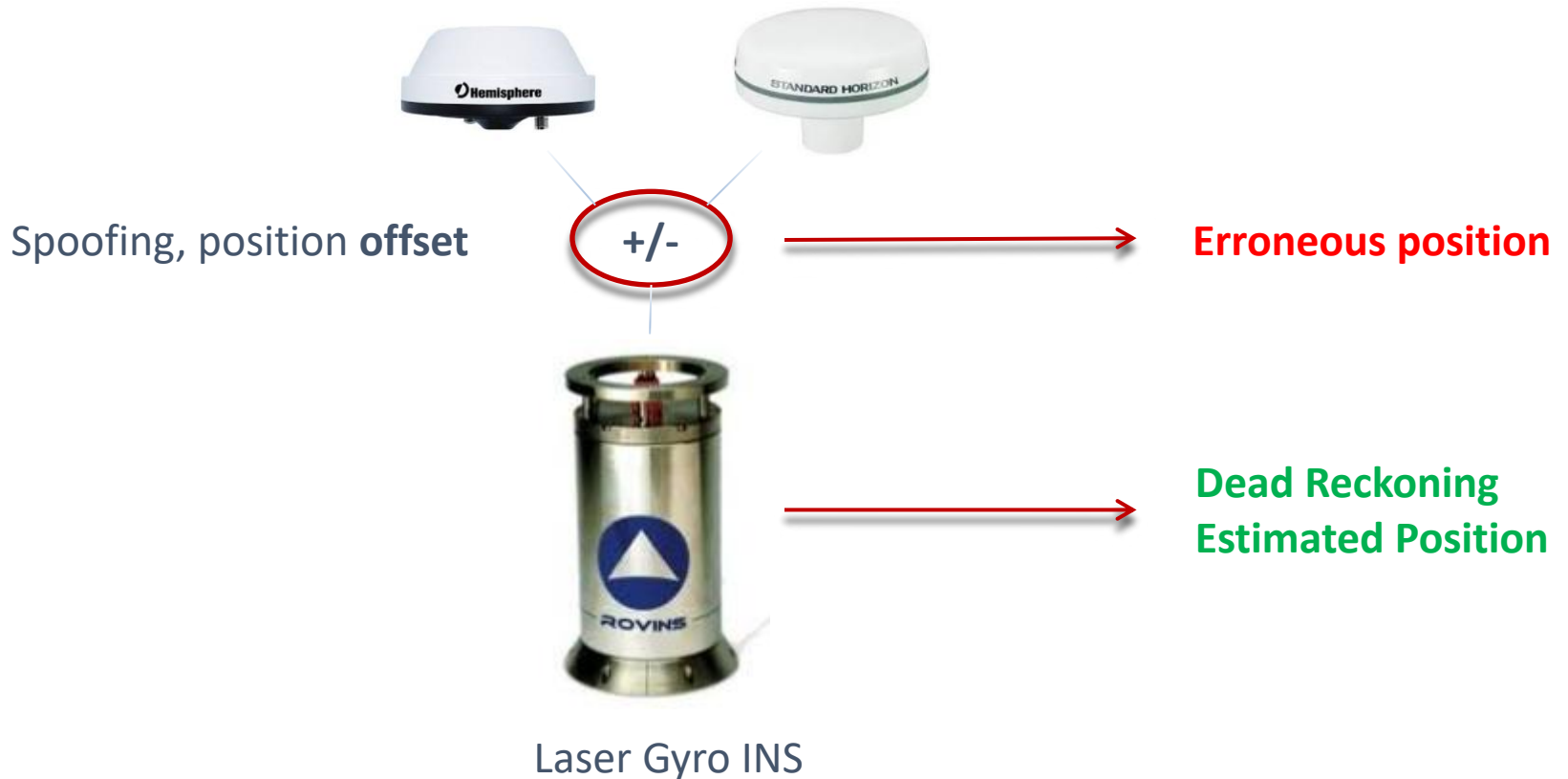
Sensor and navigation system limitations, GPS



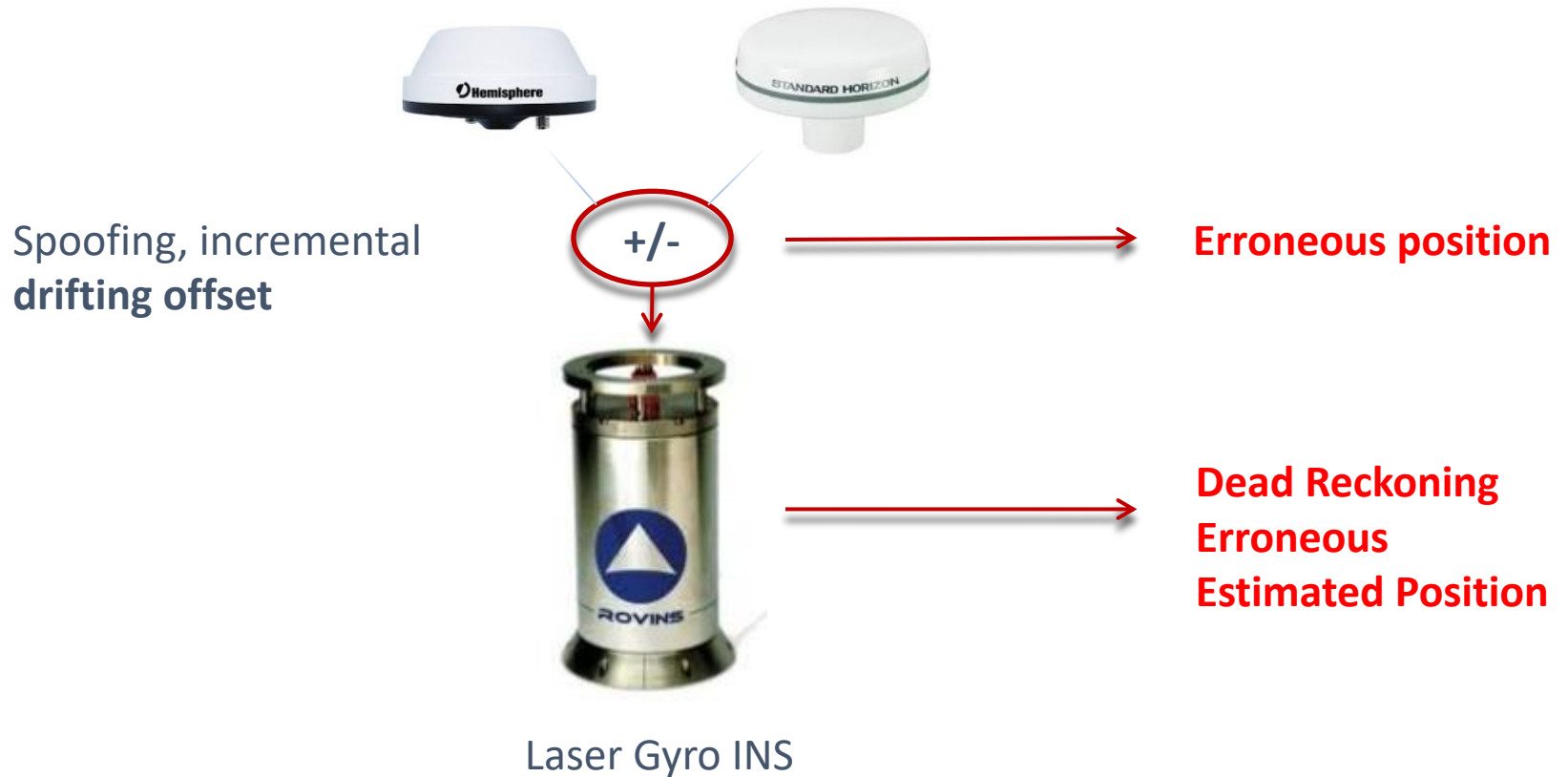
Sensor and navigation system limitations, GPS



Sensor and navigation system limitations, GPS



Sensor and navigation system limitations, GPS



Not encouraging at all

Mitigation

SeaCross[®] - AAN

Assisted Active Navigation

Capabilities

1. No latency Jamming detection
2. No latency Spoofing detection and corrections
3. Combines passive and active sensor input
4. Manual, semi automatic and automatic corrections

AAN Core – Dead Reckoning Module



Self calibrating compass and log

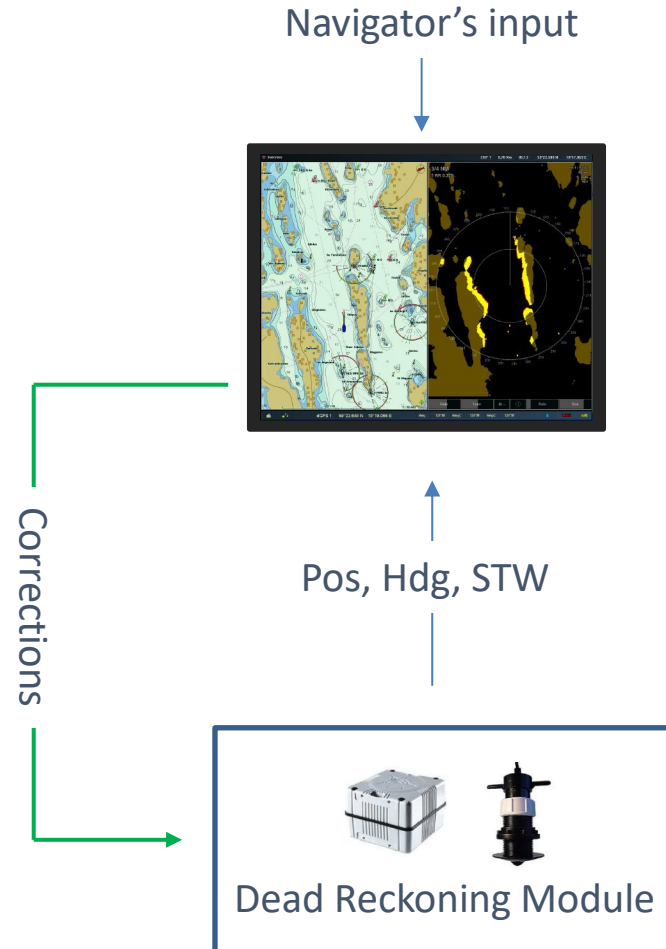
\$

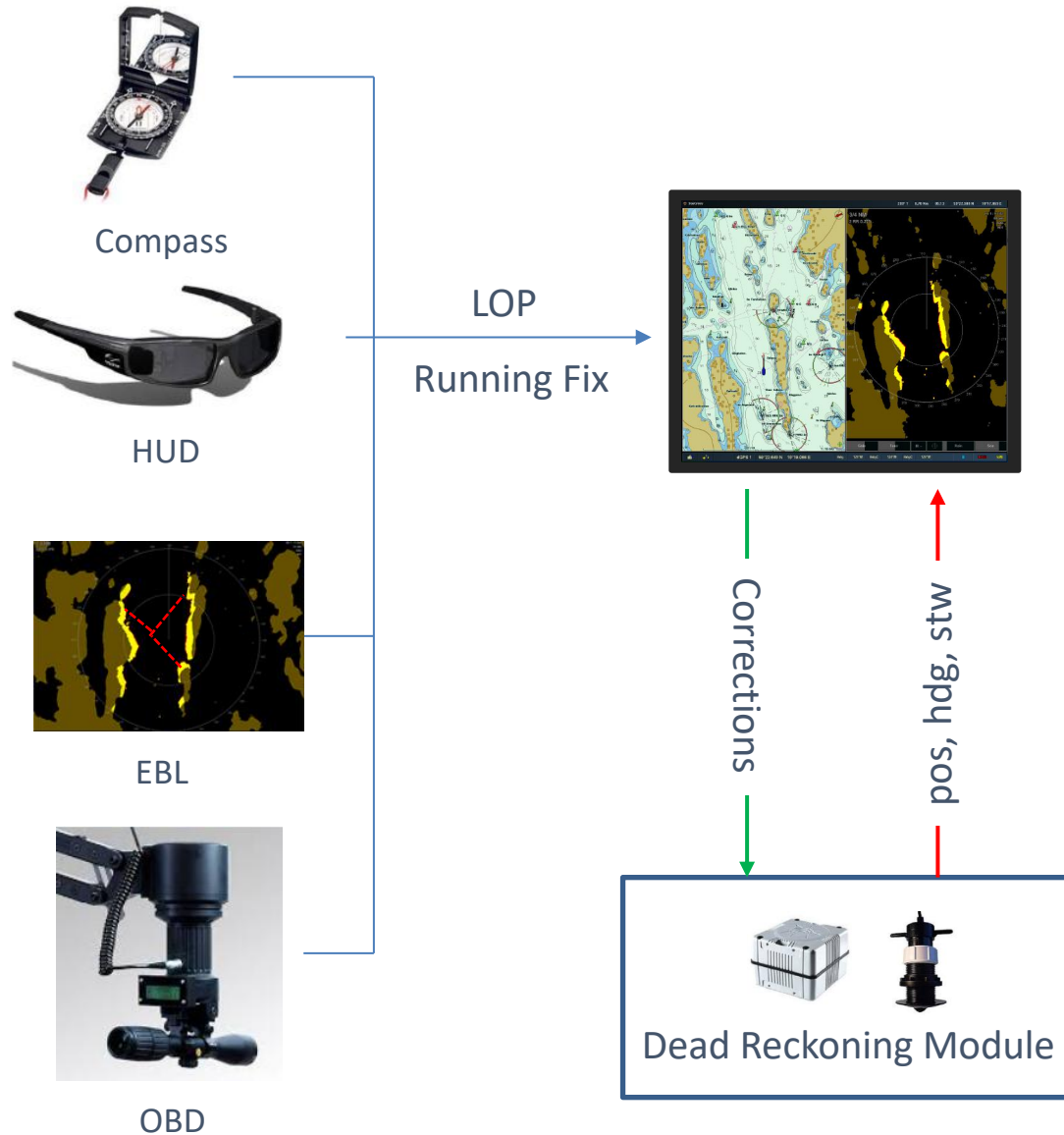
AND / OR

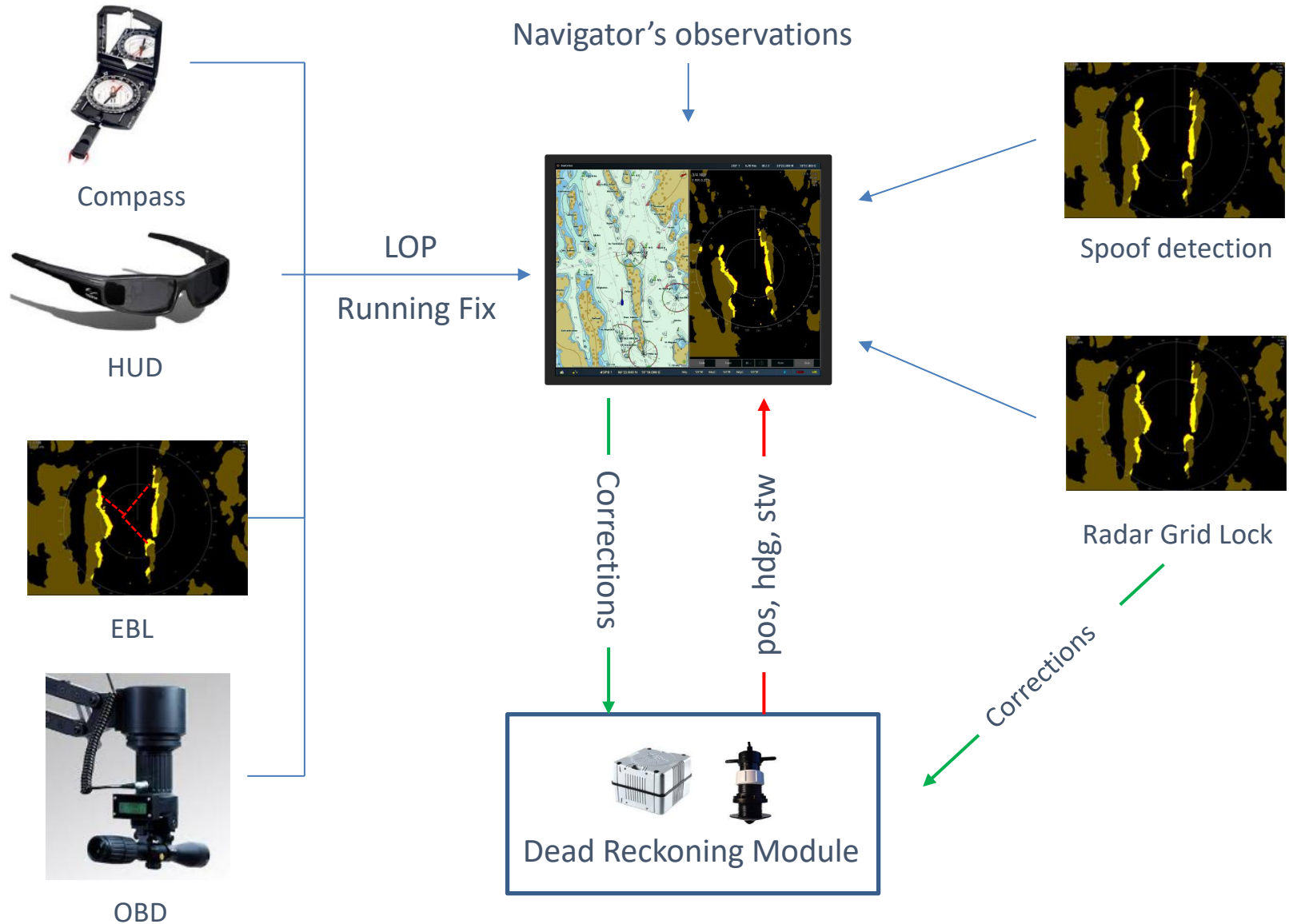


INS

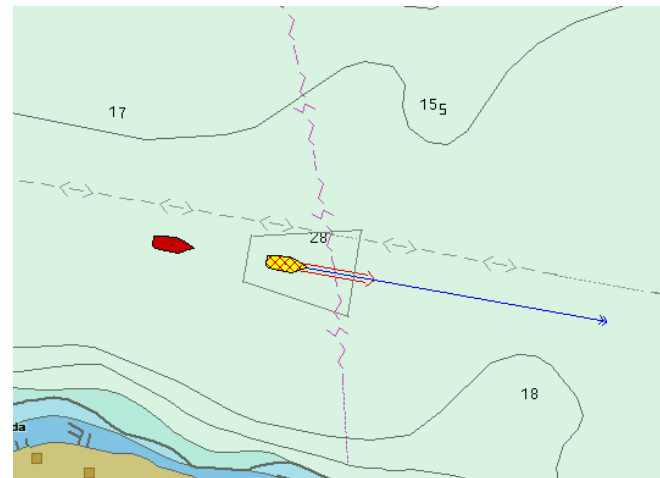
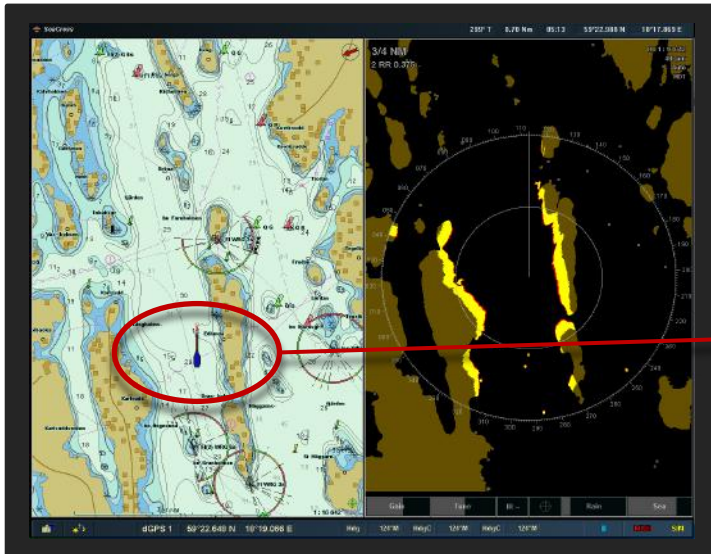
\$\$\$\$\$







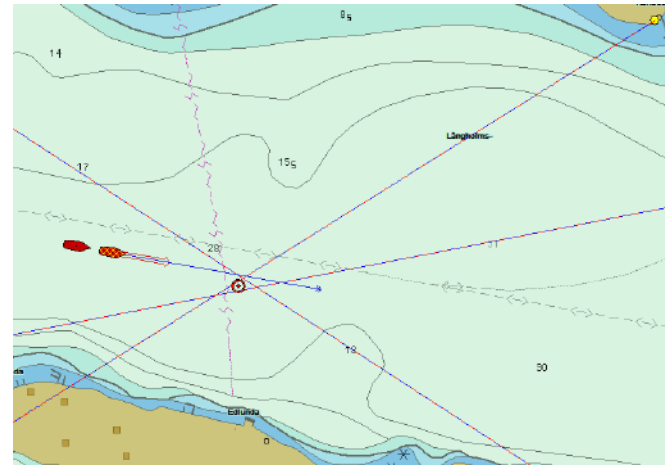
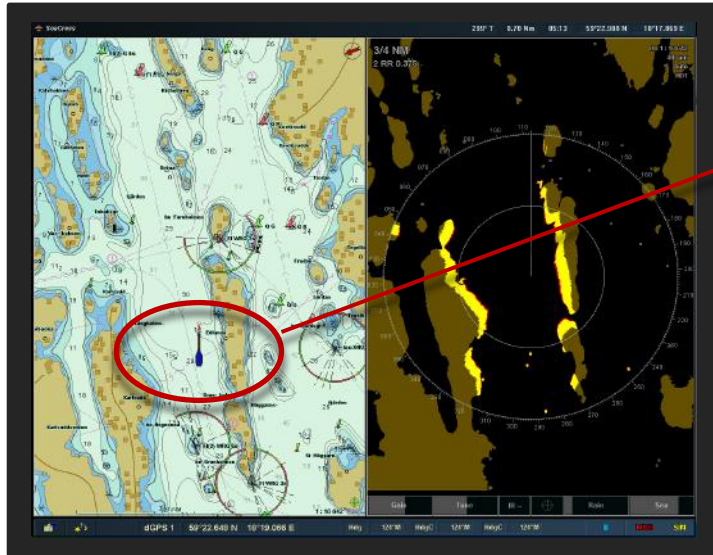
How it works



(EP) Jammed – Automatically invoked

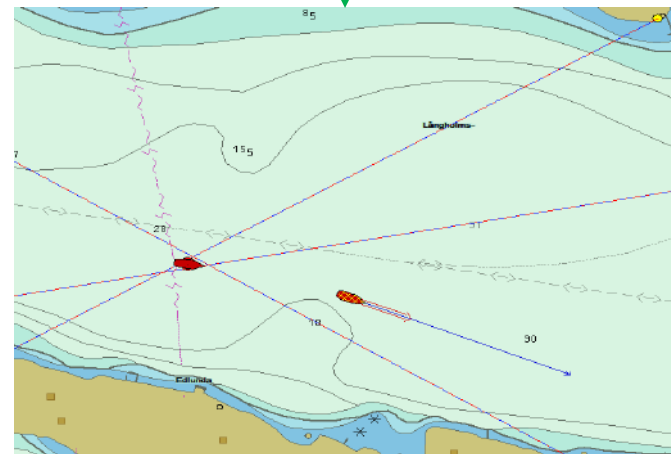
(AEP) Spoofed – Invoked by navigator

Position correction

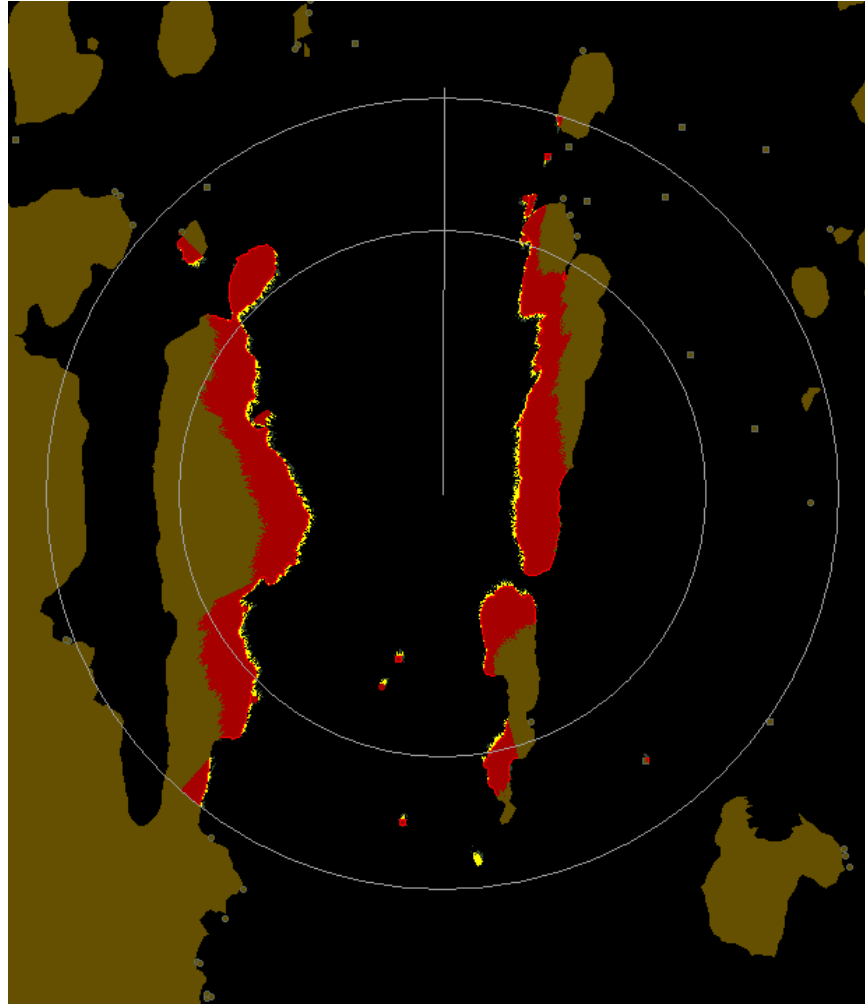


Establish position using LOP or Running Fix

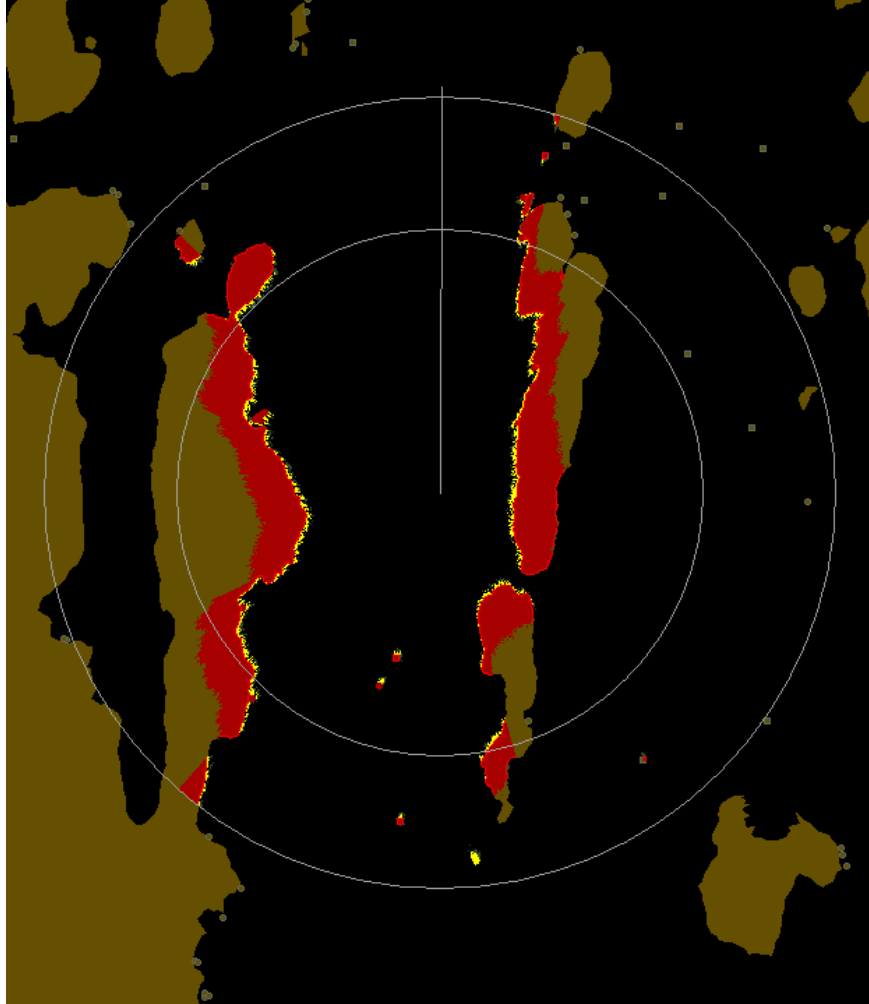
Double click marker



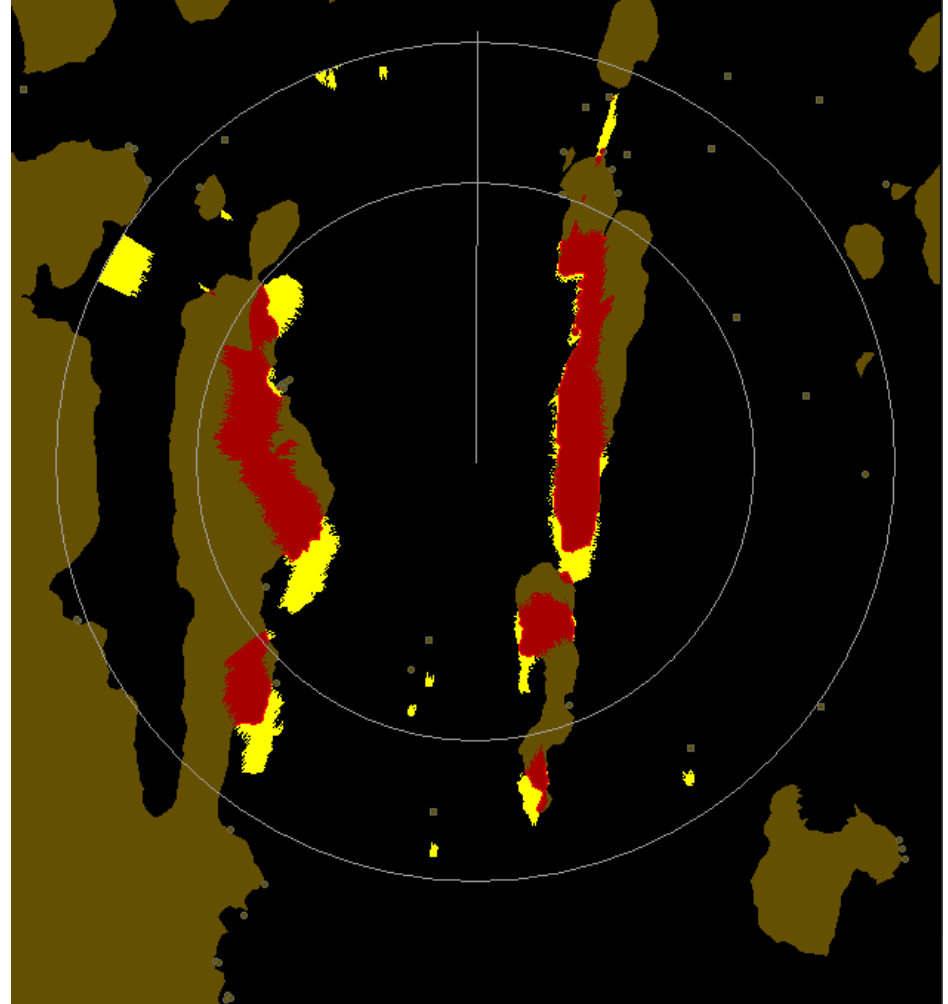
← Corrections →



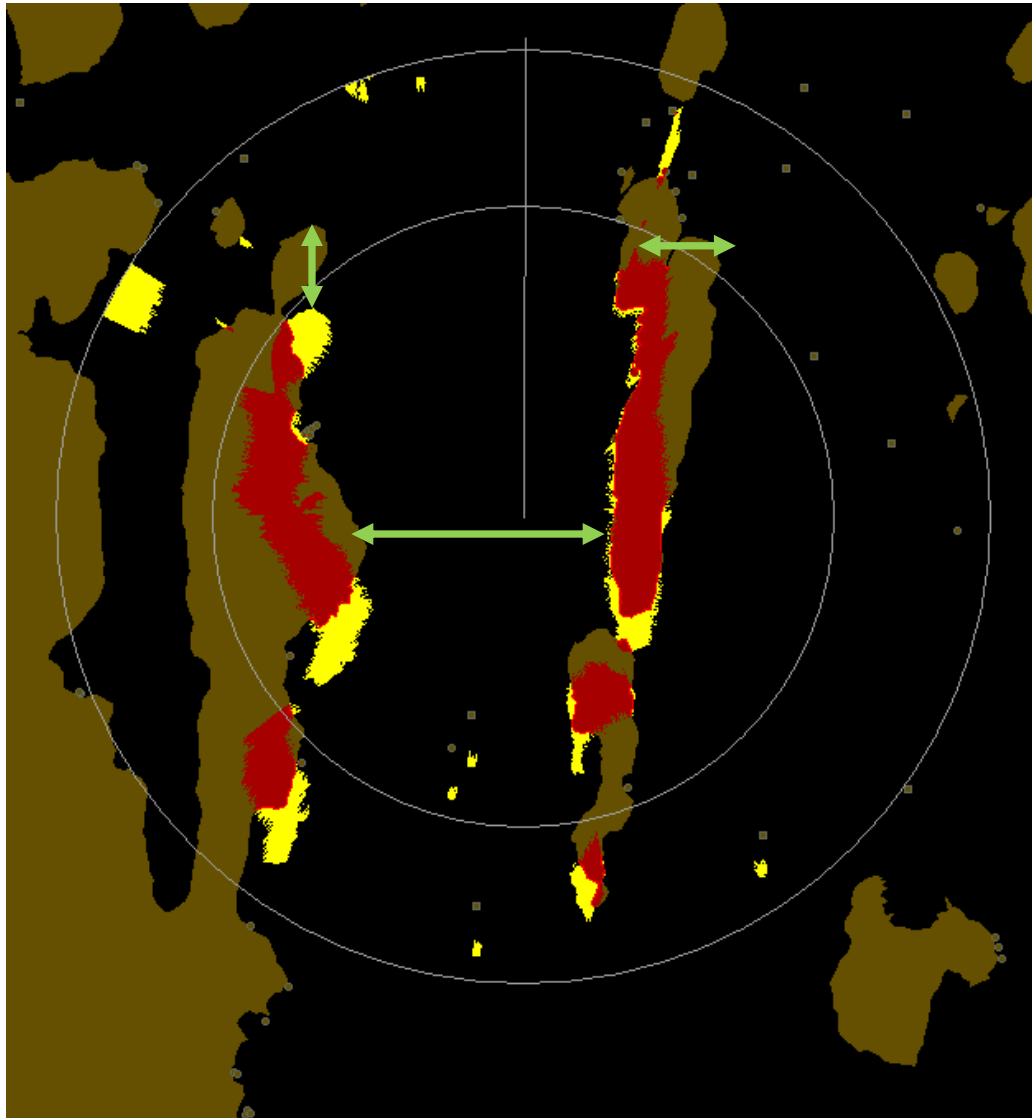
SeaCross® - NTE functionality



SeaCross® - NTE functionality



Spoofed position

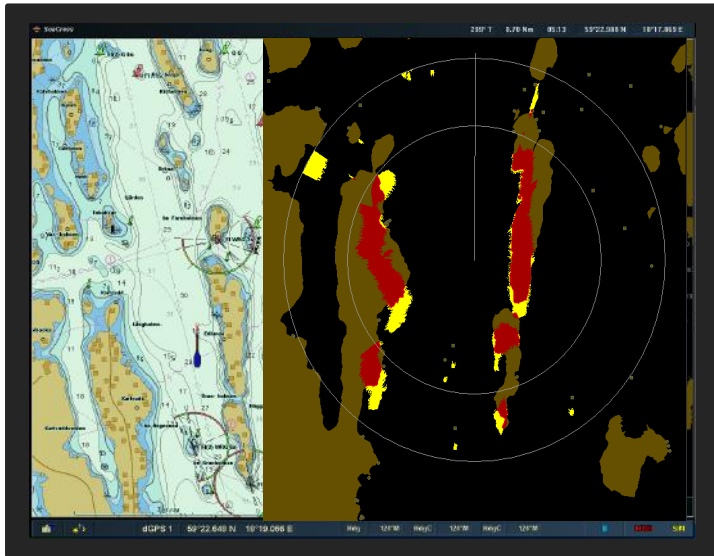


Automated
image recognition

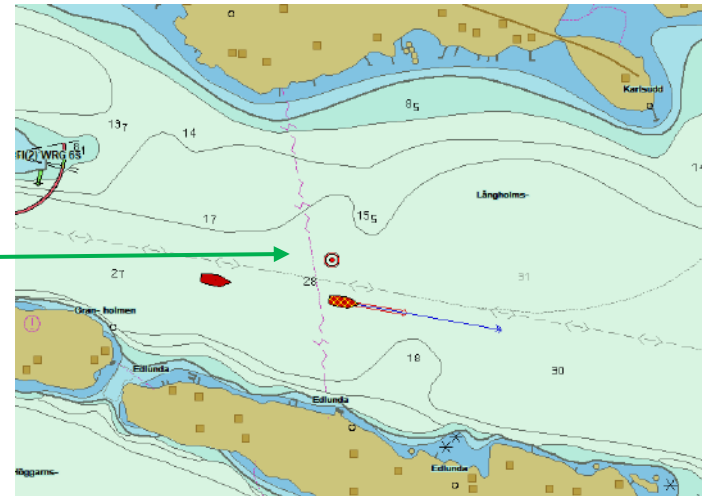


Estimated position

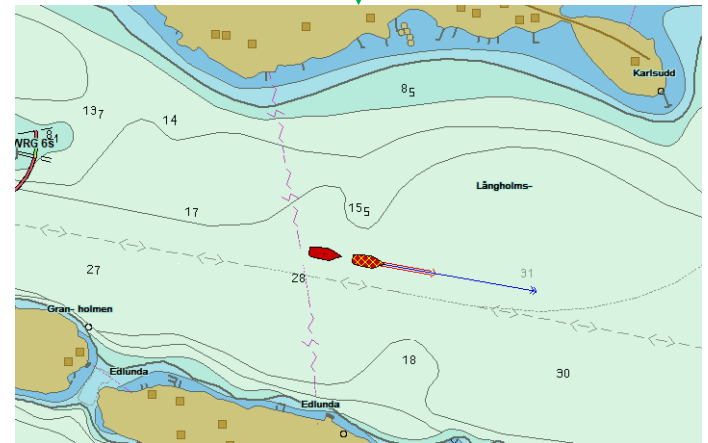
Spoofer position



RGL Position

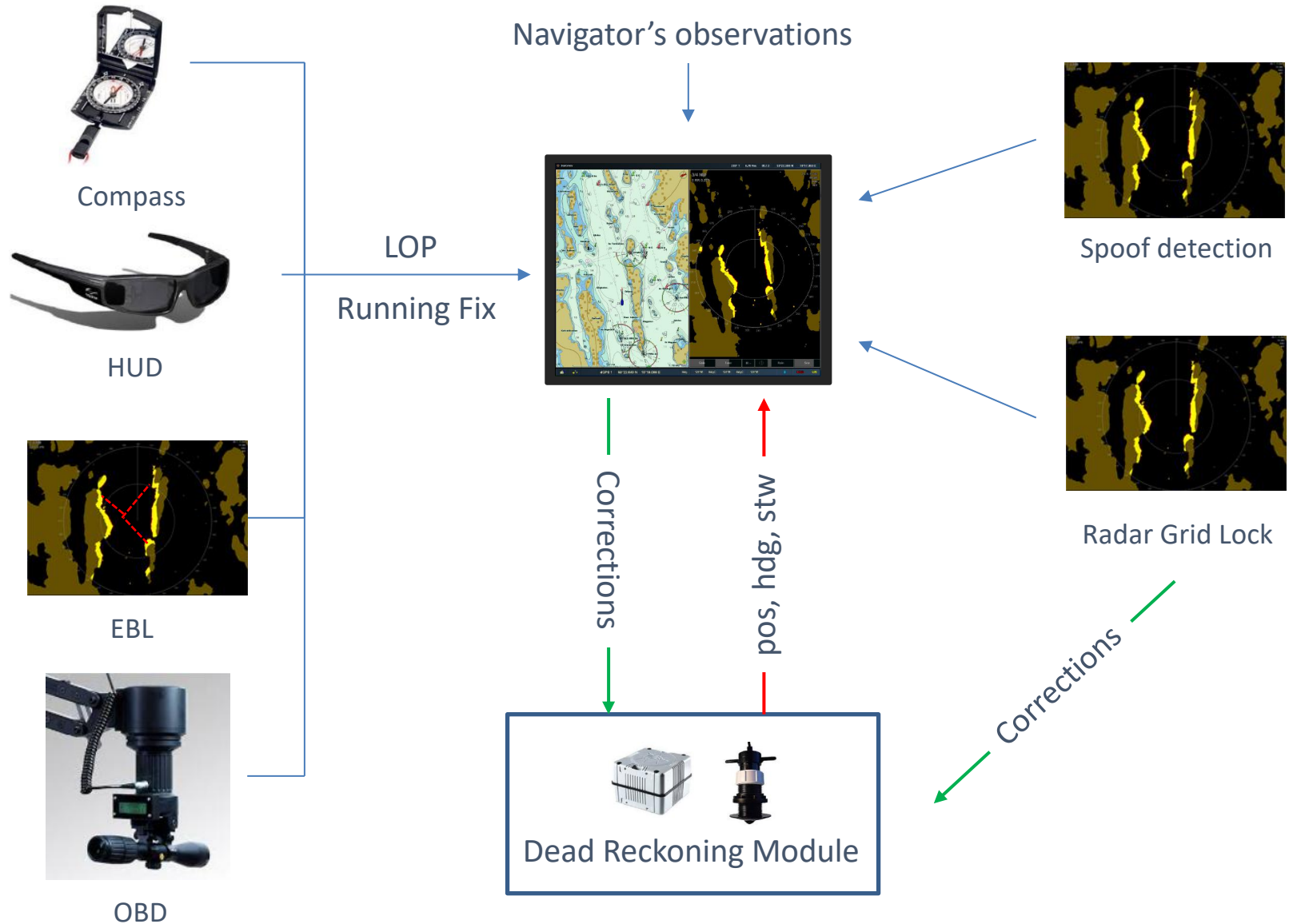


Double click marker



Corrections





Questions ?