GRAD Driving Innovation for Safer Maritime Navigation

Resilient positioning, navigation and timing – are you really where you think you are?

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R-Mode Baltic Conference – May 2021

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Complex sea space

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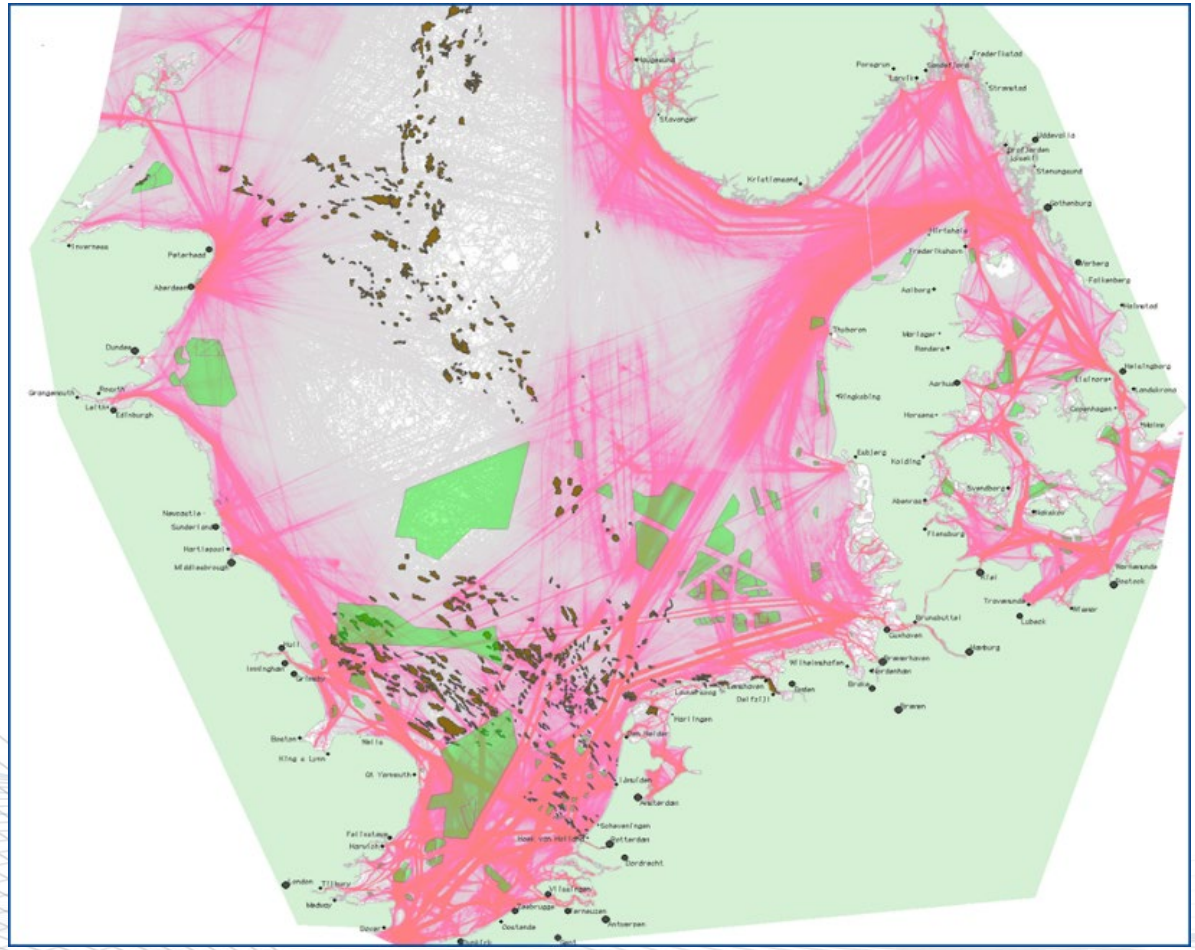

Source: ACCSEAS (2012-2015)

- Larger ships
- More ships?
  - 30% increase by 2030?
- Competing marine uses
- Autonomous vessels

UK Offshore Wind Energy

now: 10GW

UK Targets:

40GW by 2030

70-100GW by 2050

e-Navigation as technology mitigation

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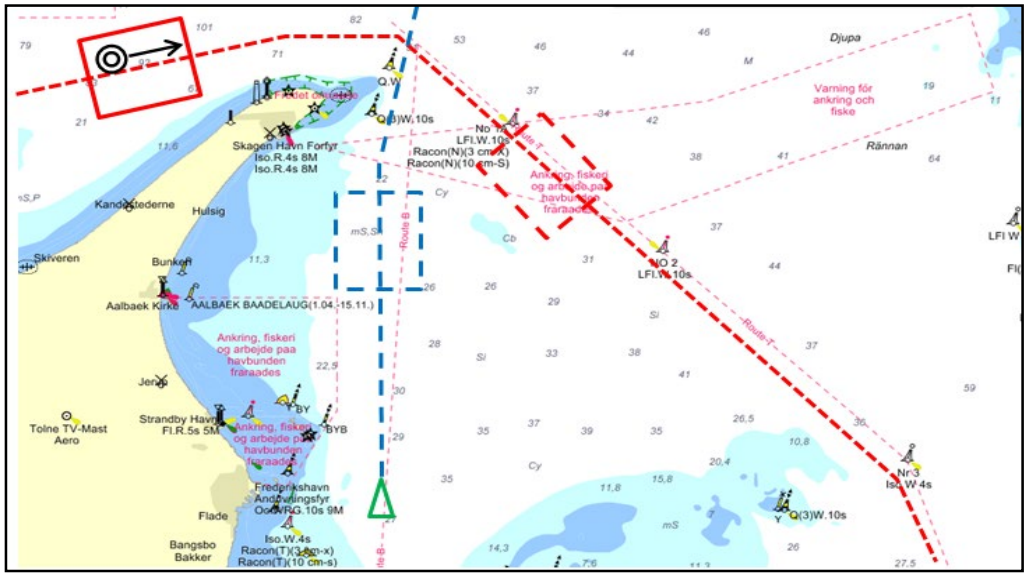
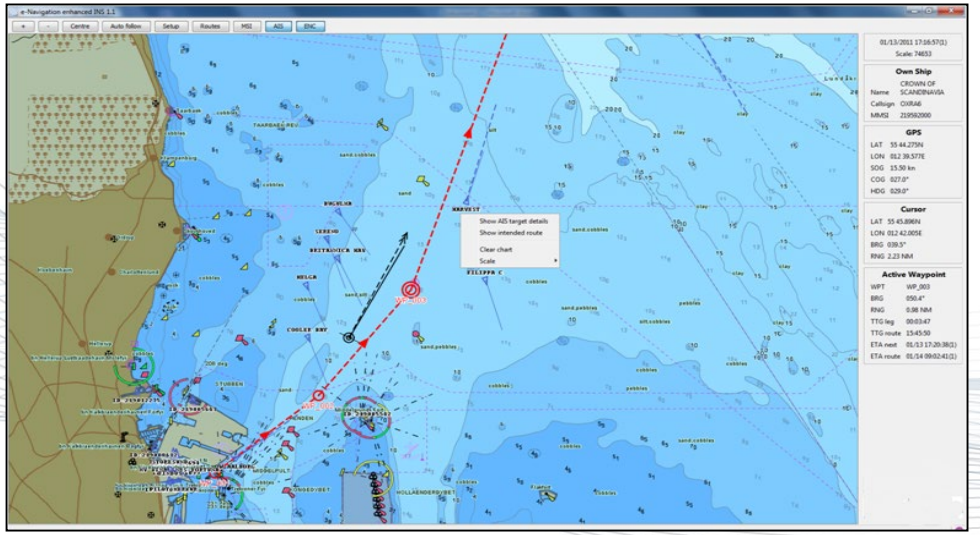
Digitisation of the marine space

- shared situational awareness
- collaborative decision support
- route advisory services

Complementary to elements of Sea Traffic Management (STM) & routing interventions





e-Navigation service examples

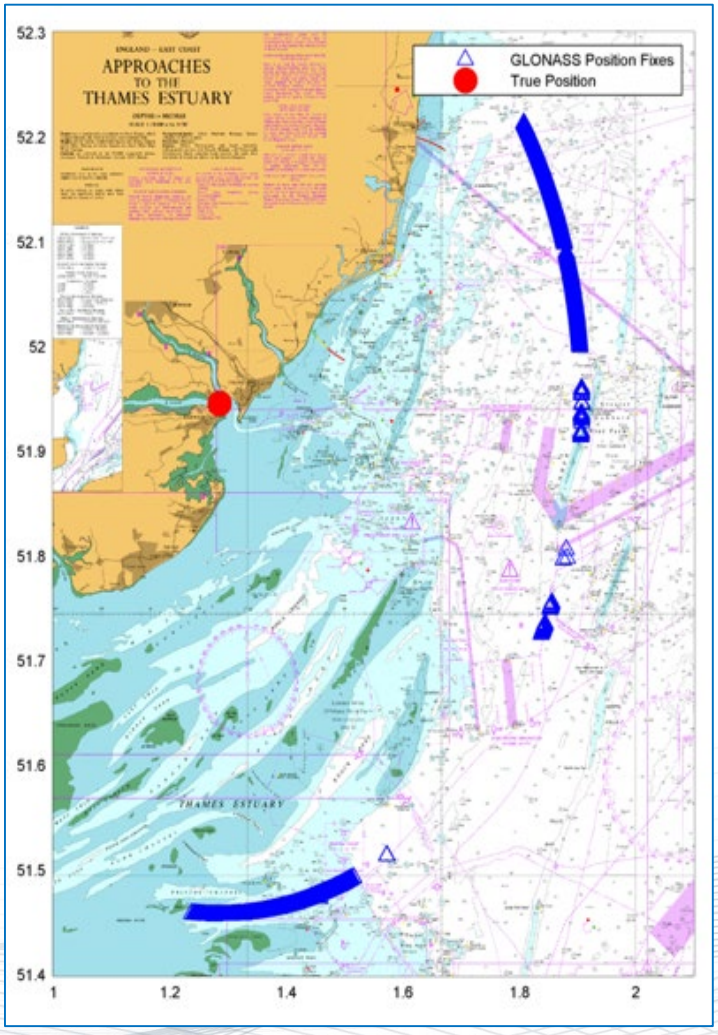
- route exchange - ship-to-ship
- volumetric navigation
- support to extended VTS coverage

Are you really where you think you are?

GNSS is the primary source of PNT information today.

All GNSS are vulnerable to errors.

- GLONASS
  - April 2014: ephemeris upload error, resulted in the constellation reporting significant position errors (~50km) before going off-air for 11 hours.
- GPS
  - January 2004: a clock error in a satellite resulted in significant position errors.
  - January 2016: a 13 microsecond timing error affected most timing users and some position users.
- Galileo
  - July 2019: a problem at the precise timing facility caused the system to be off-air for several days.
  - December 2020: the system was off-air for 6 hours due to time determination problem.



Source: General Lighthouse Authorities of the UK and Ireland

Position and timing information can be lost, or deteriorate, without warnings and can last a long time.

Need for Resilient PNT

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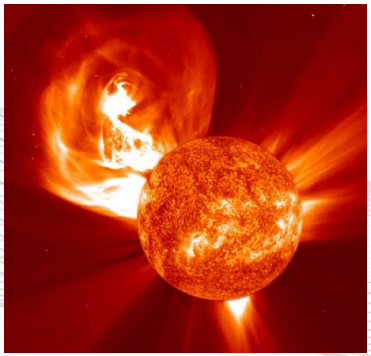
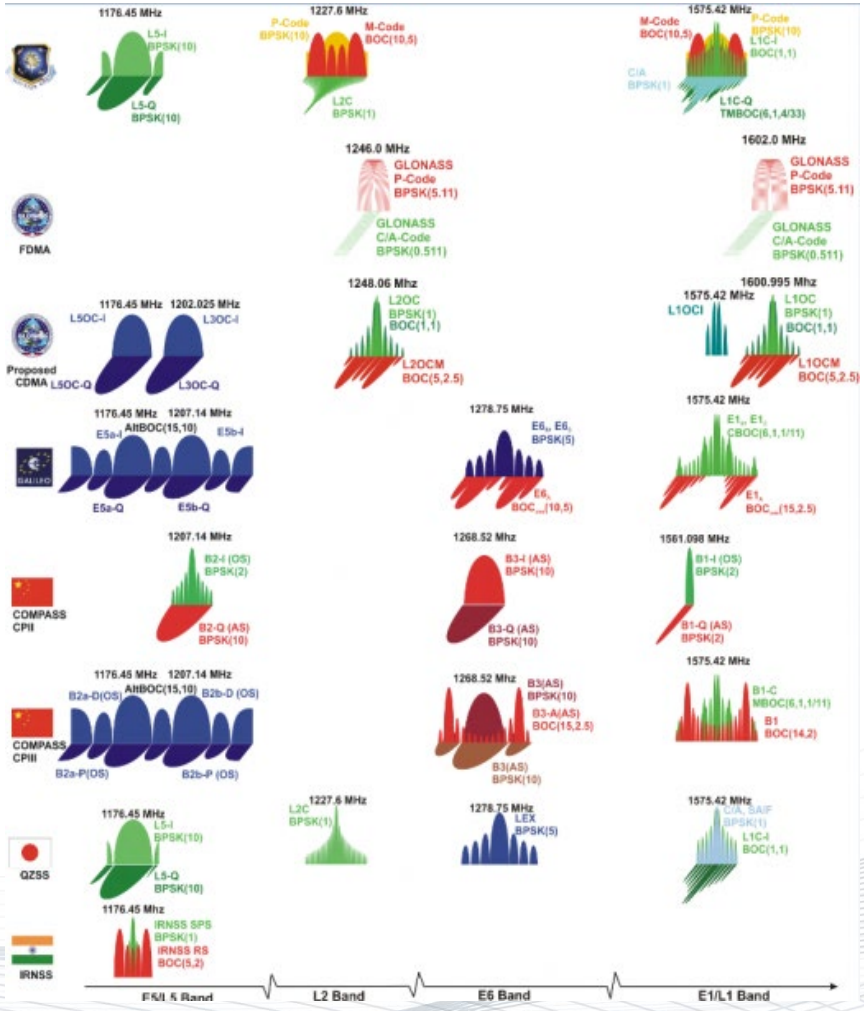
Access to multiple GNSS can mitigate some of these, but does not protect against signal interference.

Interference can be caused by natural and man-made sources.

- Space weather
- Accidental signal jamming
- Deliberate signal jamming
- Spoofing



Source: sohowww.nascom.nasa.gov, www.jammer4uk.com



Source: https://gssc.esa.int/navipedia/index.php/GNSS_signal.

Loss of GNSS on the bridge

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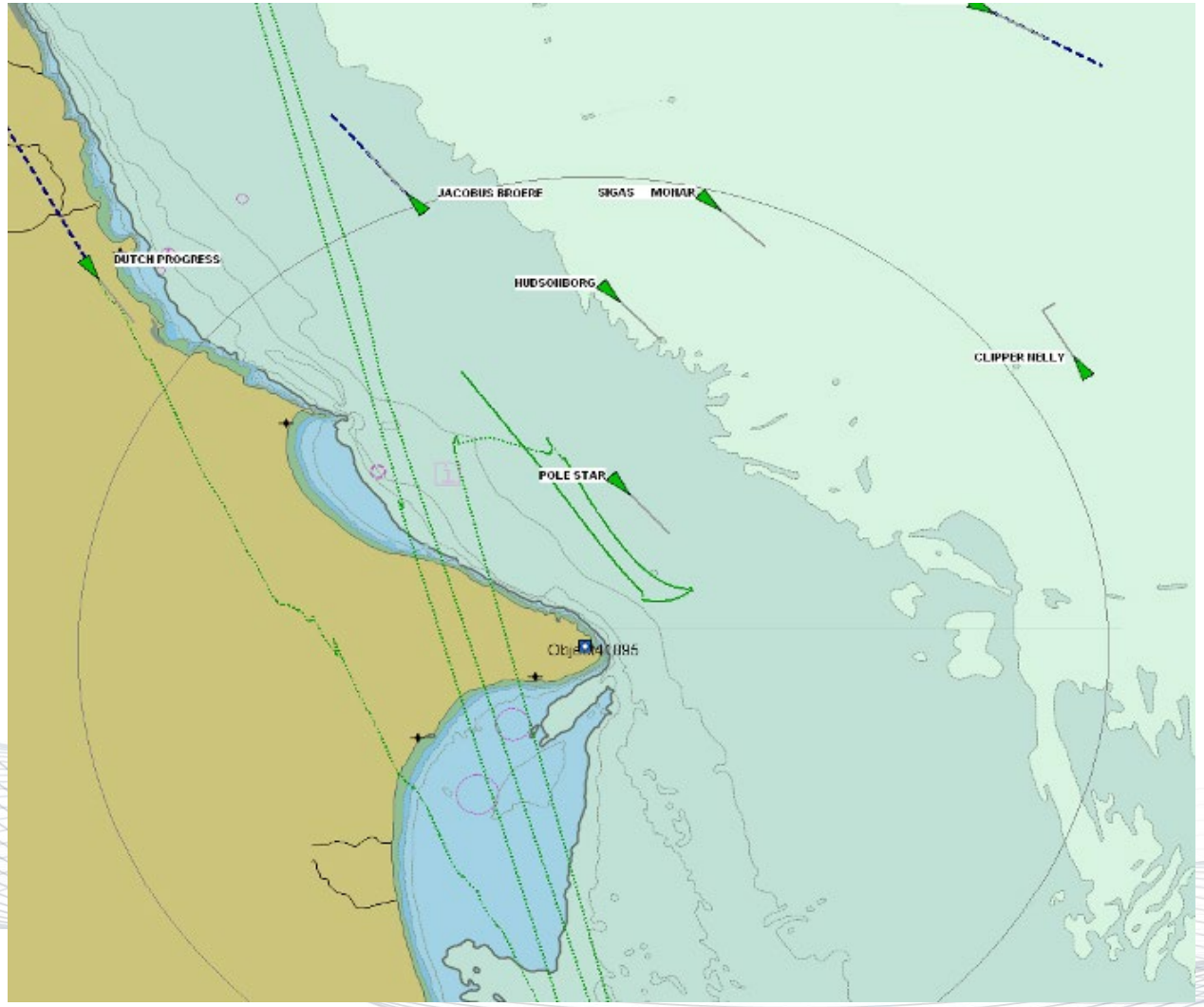

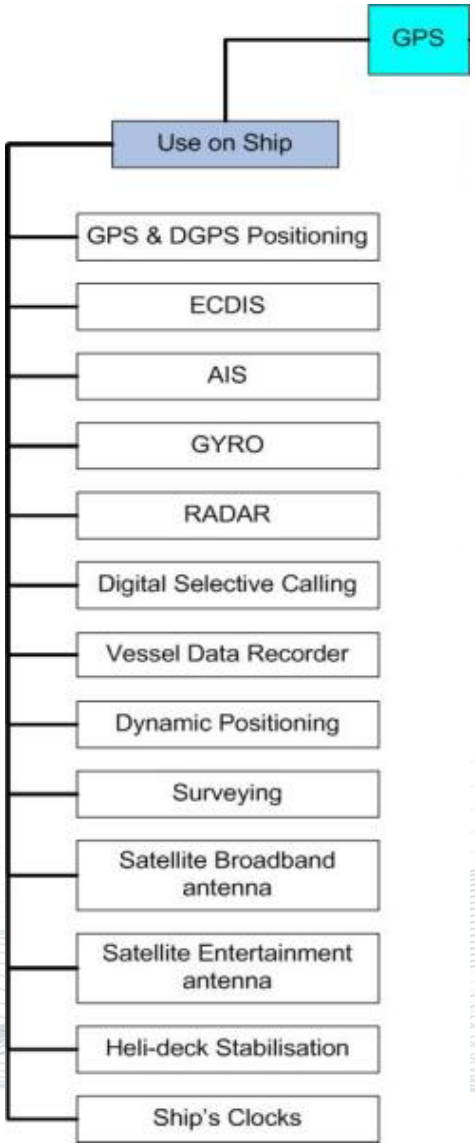

Image courtesy of the MCA

A system of systems approach

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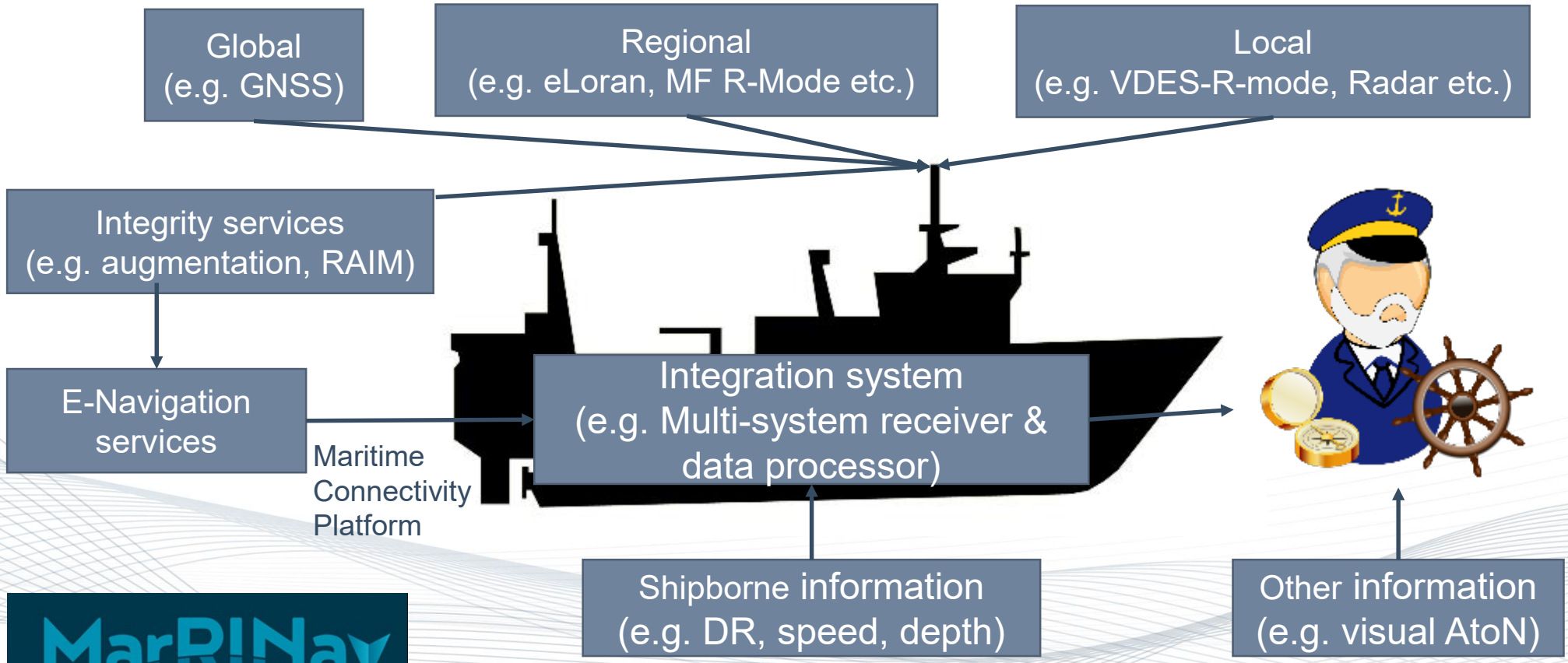
- Recognising that one solution does not fit all requirements
- Strength and resilience is achieved through using multiple systems in combination



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Moving from theory to available systems

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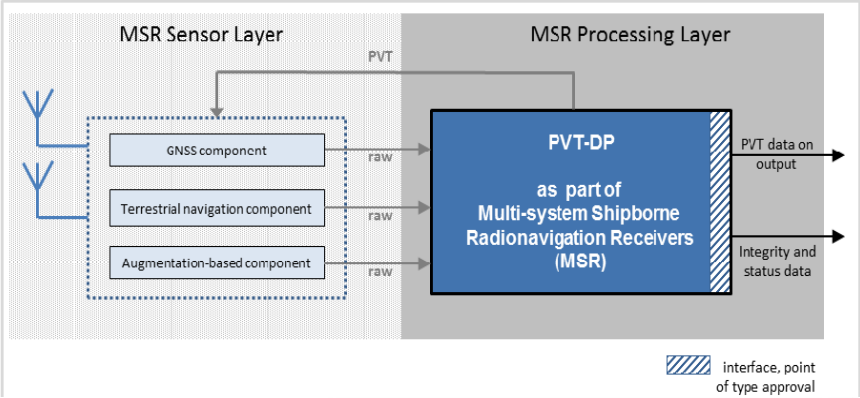
A multi-system radionavigation receiver performance standard (MSC.401 as amended) has been developed to:

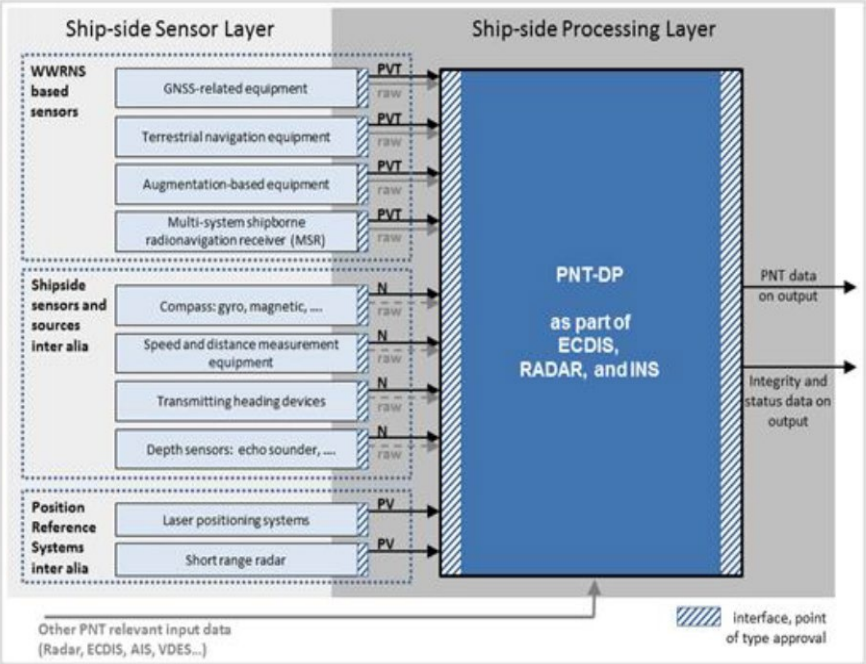
- Enable and support resilient PNT
- Define minimum performance requirements without defining systems to be used
- Enable further system development

Allows for use of:

- All GNSS (existing and future)
- All sources of augmentation (marine radiobeacon and SBAS)
- All terrestrial signals (existing and future)

Supported by IMO PNT Guidelines and the use of the PNT data processor.





Source: IMO MSC.1/Circ.1575

Summary

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All radionavigation system have vulnerabilities, no system is perfect.

GNSS will continue to be the main source of PNT, supported by augmentation and terrestrial PNT sources to provide resilience.

Resilient PNT is a fundamental requirement of future maritime navigation, it underpins safe navigation and enables e-Navigation services.

We need move resilient PNT from something that's discussed in reports to something tangible.

Projects like this show how this can be done and move the technology forward, bringing us one step close to having resilience at sea.

When we get to that stage, the mariner will know that they really are where they think they are.

R MODE BALTIC

Thank you

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