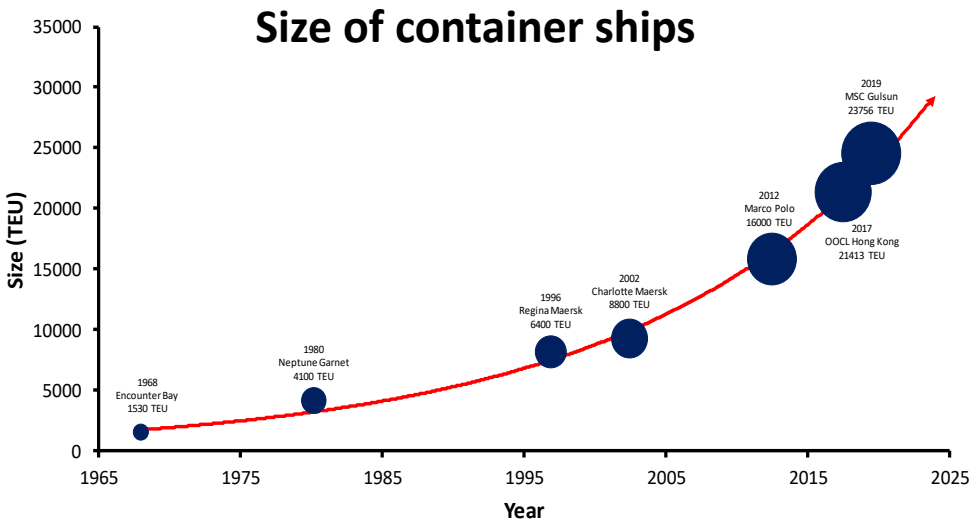
Background

Alan Grant GRAD

Where does INSPIRe fit in the grand scheme of things?

Introduction

The maritime world is becoming more and more complex and that complexity is due to increase over the next 5 – 10 years.



Source: Taylor Airey input to GRAD strategy workshop

Global number of container ships 2011-2021

Over the past decade, the number of container ships in the global fleet increased from 4,966 ships in 2011 to 5,534 ships in 2021

(www.statista.com)

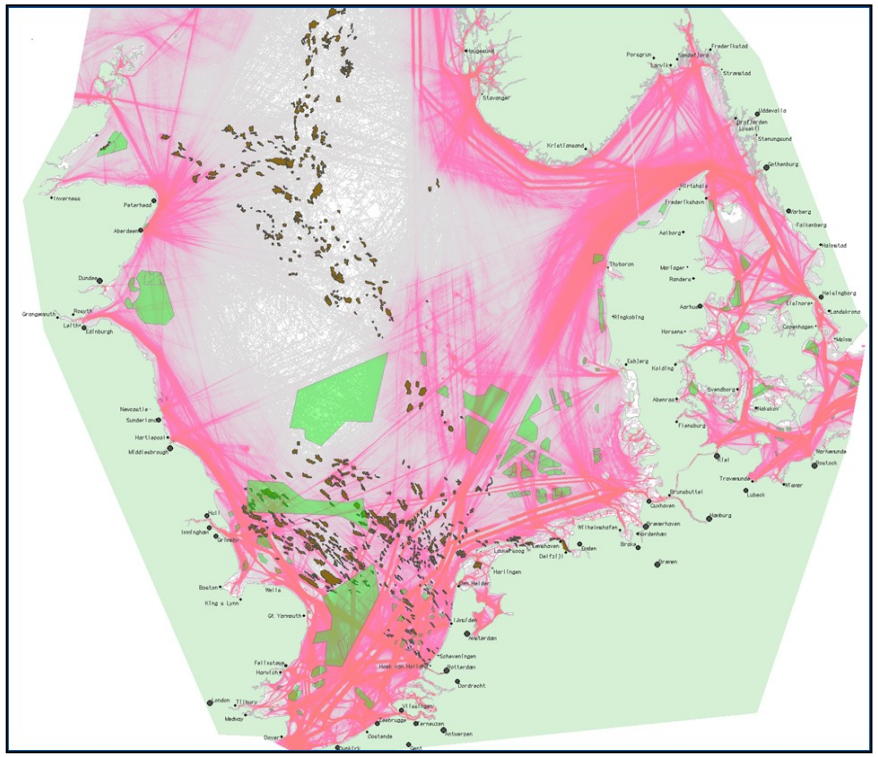


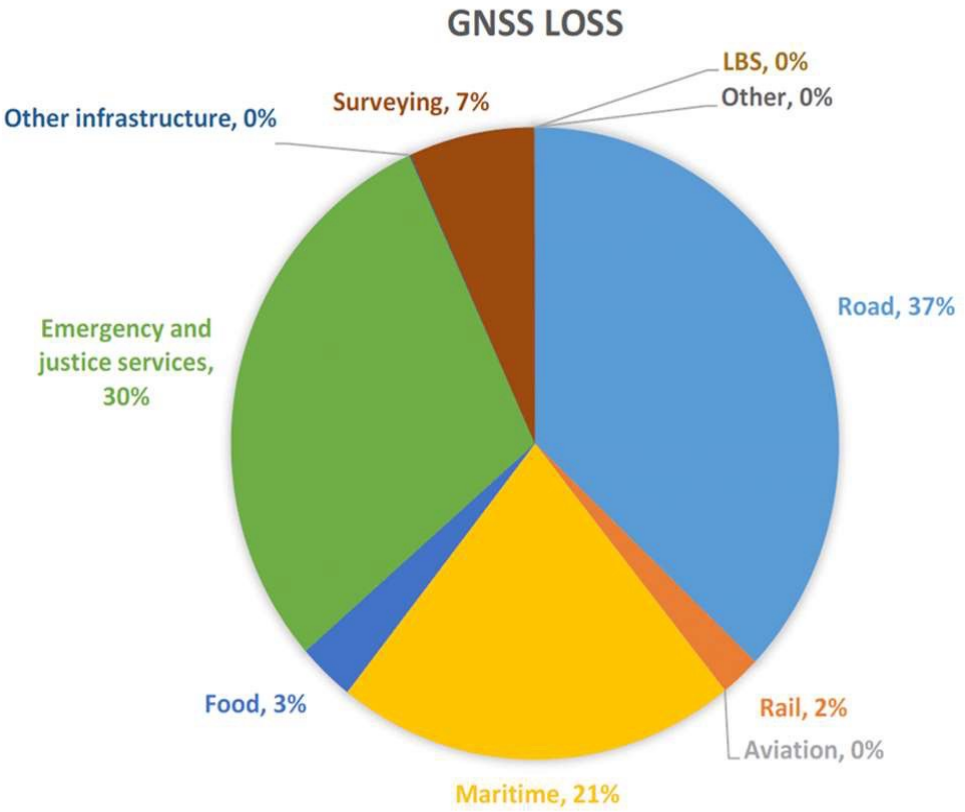
Image source: www.marrinav.com

Autonomous vessels

A mix of autonomy levels on board vessels

GNSS Vulnerabilities

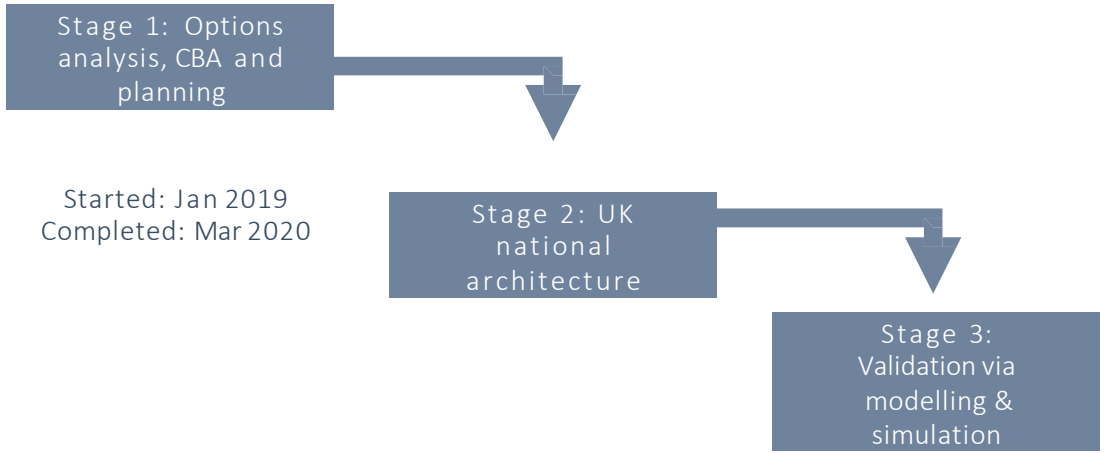
- Most vessels use GNSS to determine their position anc to support navigation and timing applications.
- GNSS are vulnerable to signal interference and the cost of outages is significant.
- The economic impact to the UK of a 5 day disruption of GNSS is estimated at £5.2Bn. Maritime is ~£1Bn.



Source: London Economics report

MarRINav project

- Maritime Resilience and Integrity of Navigation (MarRINav)
- Overall aim was to build resilience and integrity into UK critical national infrastructure that supports maritime navigation
- Funded by the European Space Agency (ESA) as part of the NAVISP element III programme



Candidate Systems considered

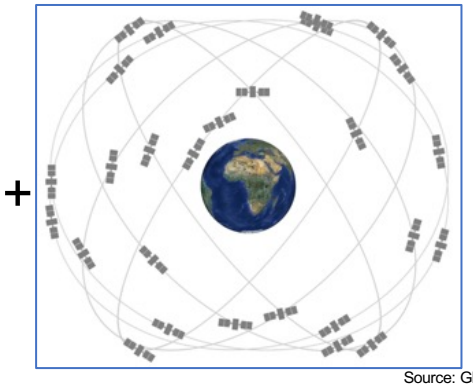
Requirement set (arbitrary numbers)	1	2	3	4	5	6
Accuracy (95%)	1000 m	100 m	100 m	10 m	10 m	10 m
Integrity Limit with 10^{-5} risk	2500 m	250 m	250 m	25 m	25 m	25 m
Distance from coast	Any	<100 km	Any	<10 km	<100 km	Any
GNSS	Yes	Yes	Yes	Yes	Yes	Yes
Differential eLoran	No	Yes	Note 1	Yes	Note 3	No
Differential eLoran with VDES R	No	Yes	Note 1	Yes	Note 3	No
eLoran	No	Yes	Note 1	No	No	No
eLoran with VDES R-mode	No	Yes	Note 1	No	No	No
MF, VDES or MF/VDES R-mode	No	Note 1	No	No	No	No
Coherent radar ranging with DR	No	No	No	Note 2	No	No
Dead Reckoning (DR) for 15 min	Yes	Yes	Yes	No	No	No
Dead Reckoning (DR) for 3 hours	Yes	No	No	No	No	No
DR + Star Tracker	Yes	No	No	No	No	No

- Note 1: Theoretically possible, but impractical to achieve this level of coverage.
- Note 2: Subject to maturity of the technology
- Note 3: Requirements are met within 30 km of the coast, but not in the 30-100 km range

Much more information on each system within MarRINav deliverables D4 and D6 available from www.marrinav.com.

MarRINav proposed solution

DR +



Source: GPS.gov

GNSS + Augmentation

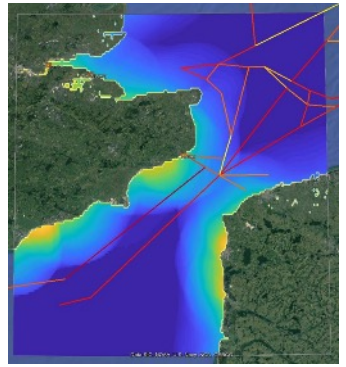
+

eLoran

+

R-Mode (VDES)

+



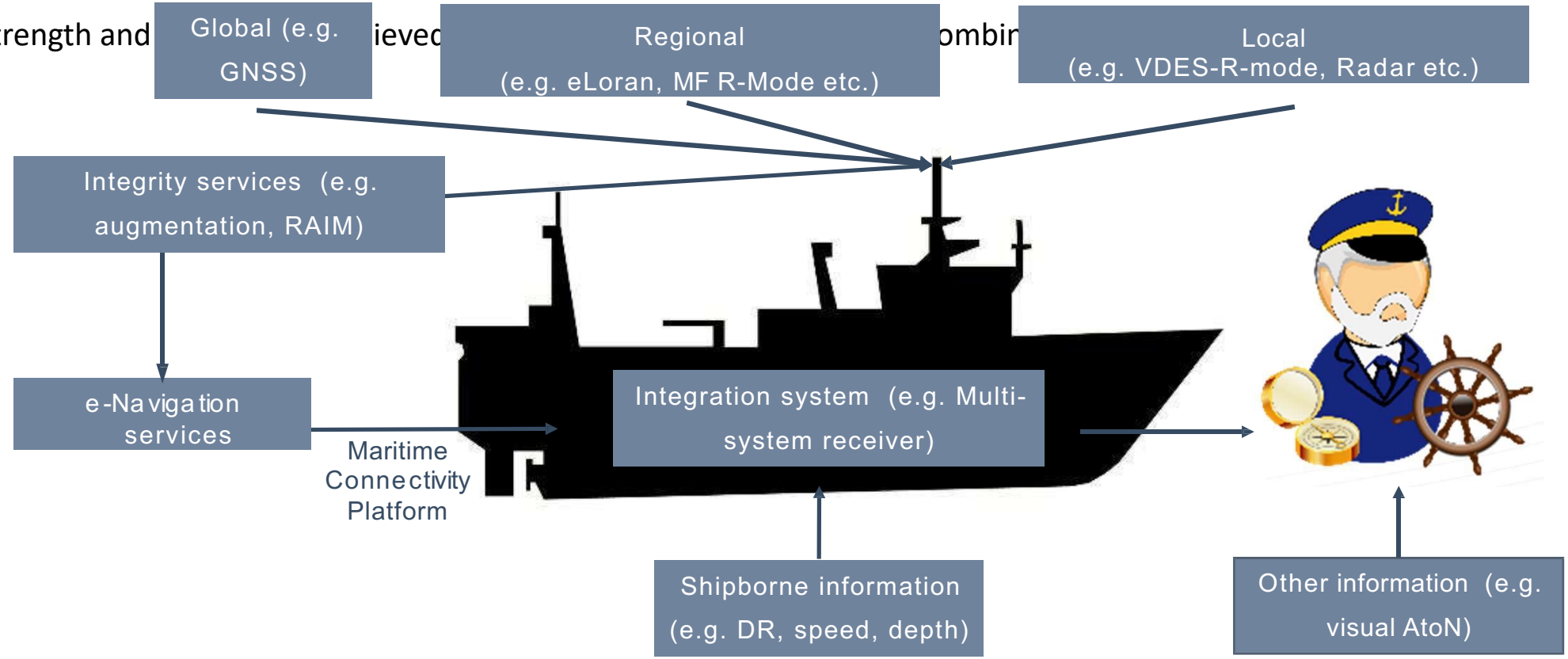
Ship's radar

Multi constellation GNSS (GPS, Galileo +) + terrestrial systems
Integrity from SBAS/EGNOS + Vessel RAIM

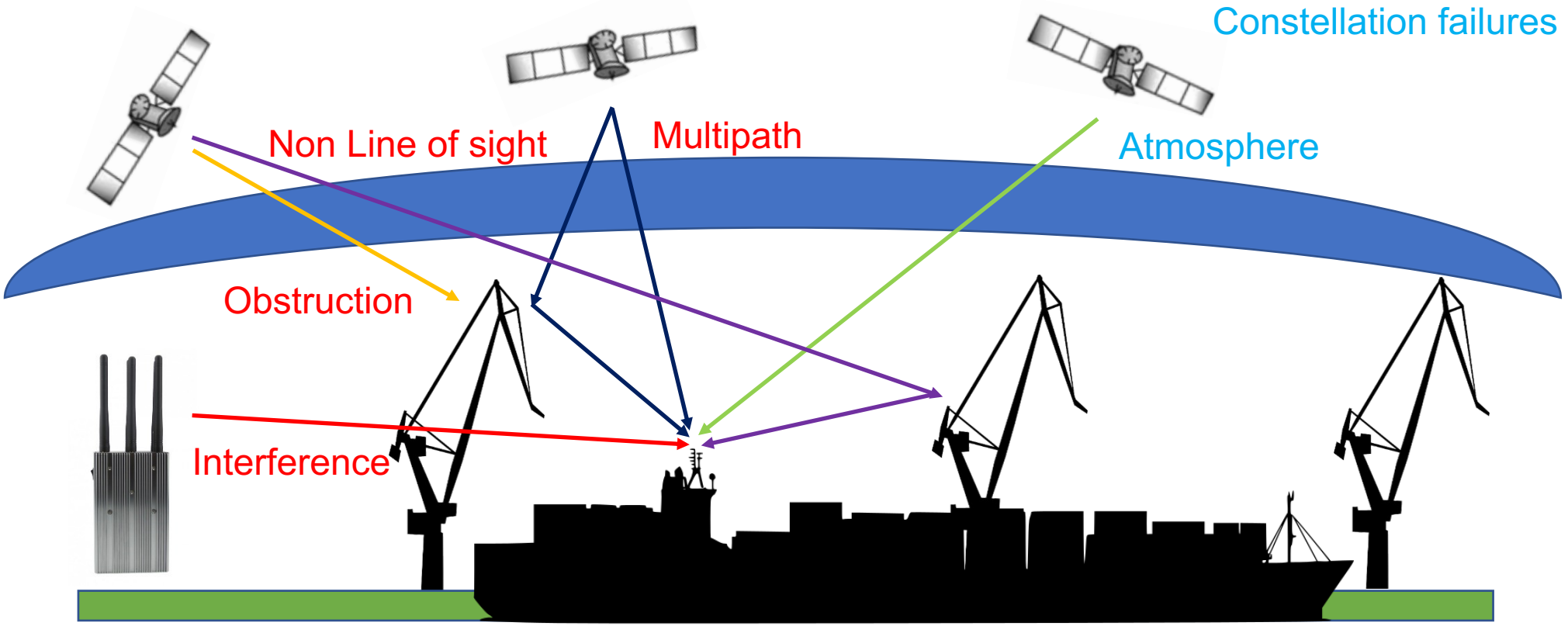
- DR – traditional, inertial or supported by radar image processing (RaDR)
- Port operations supported by local radio navigation signals (e.g. Locata™)

A system of systems approach

- Recognising that one solution does not fit all requirements
- Strength and ieved ombin



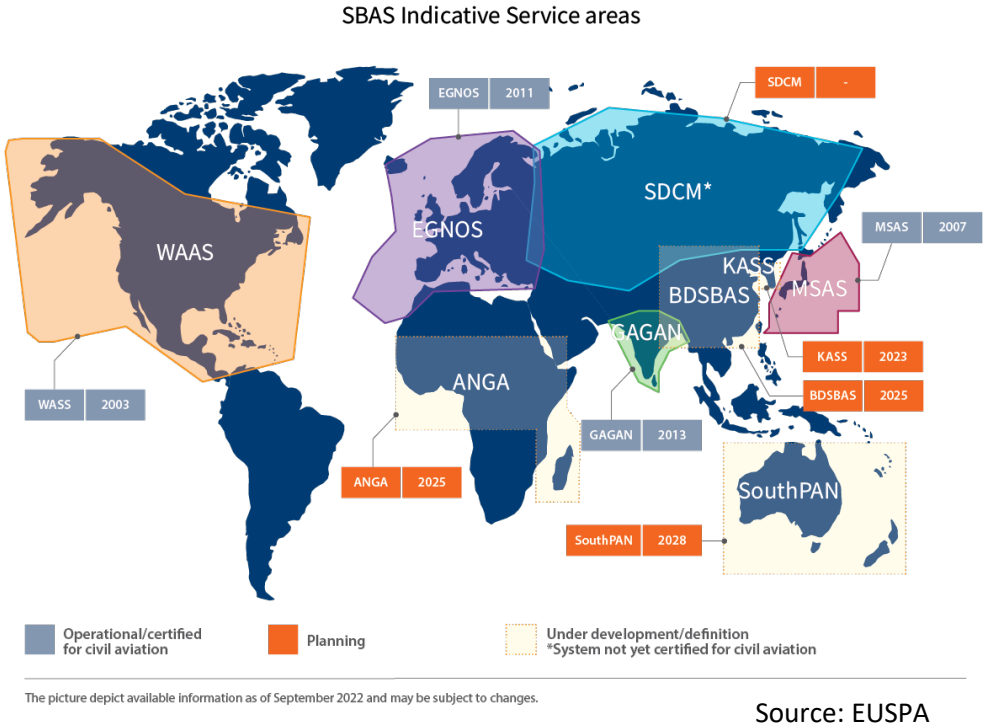
System and user level integrity



System level integrity – considers failures external to the vessel.
User level integrity – considers system level components, plus the local environment and receiver.

Satellite Based Augmentation Systems (SBAS)

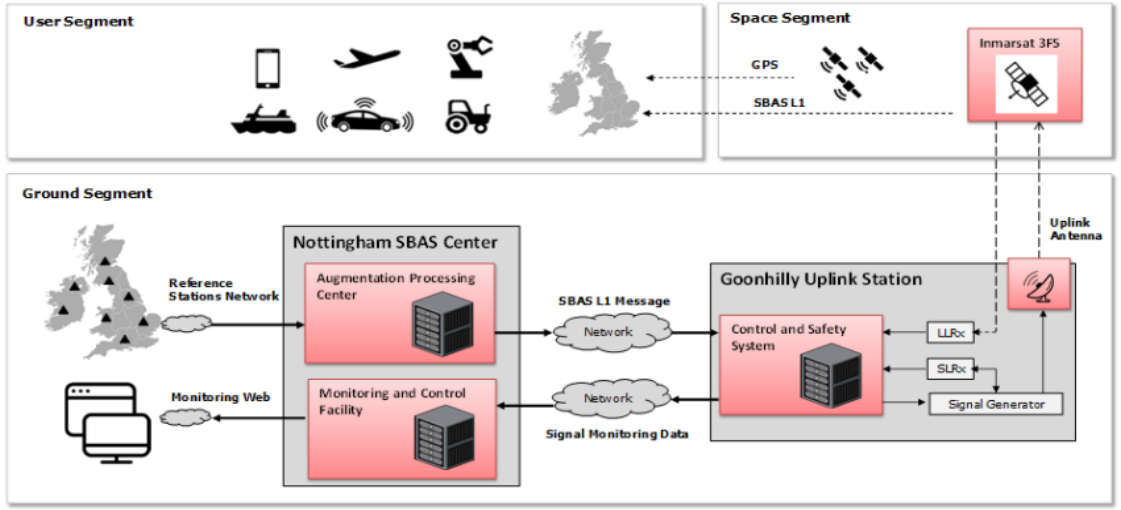
- Many different services established around the world with new systems coming online.
- Developed originally to serve aviation requirements, but SBAS can support maritime integrity.
- Technical and regulatory challenges to overcome.
- EGNOS provides:
  - Open Service
  - Safety of Life service (aviation)
- Proposed EGNOS maritime safety of life service due to be launched in approximately 2024.



Source: EUSPA

UK SBAS

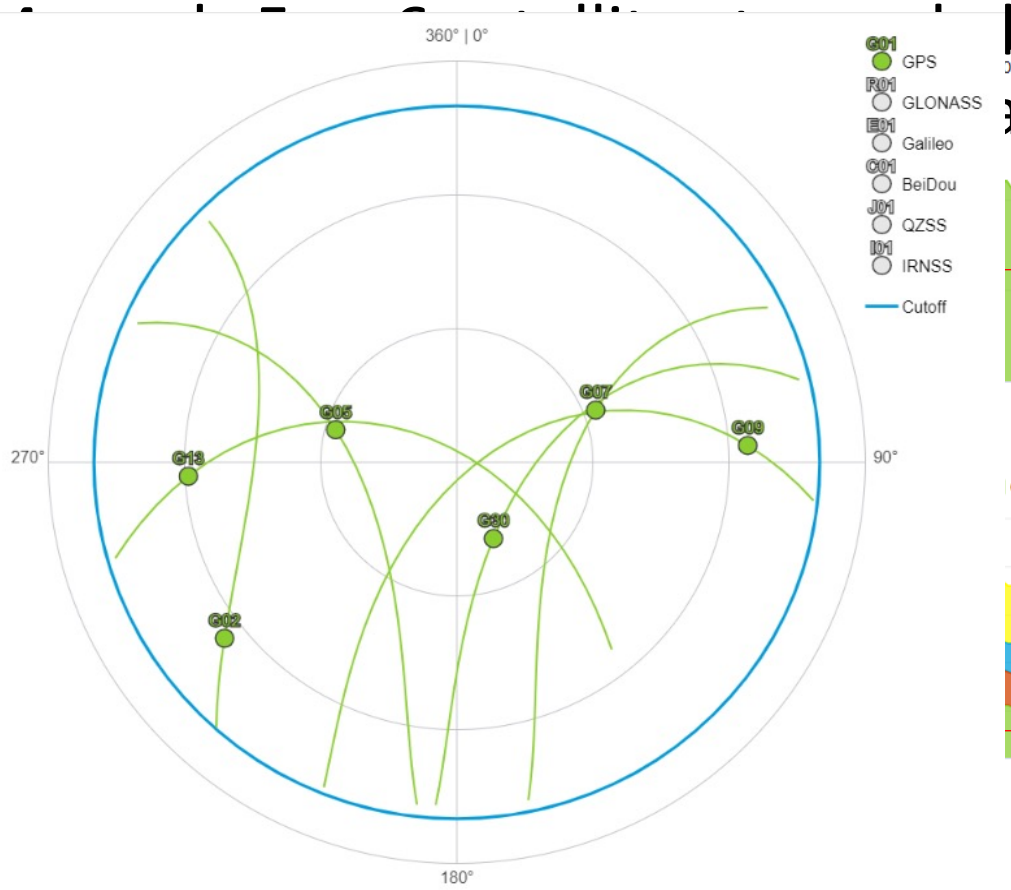
- Post Brexit, UK is not able to use the EGNOS Safety of Life service. This would be the same for the maritime service.
- Recent work in the UK has seen the development and trials of a UK SBAS signal.
- INSPIRe will work alongside the UK SBAS trial to ensure the approach considered is suitable for all SBAS solutions.

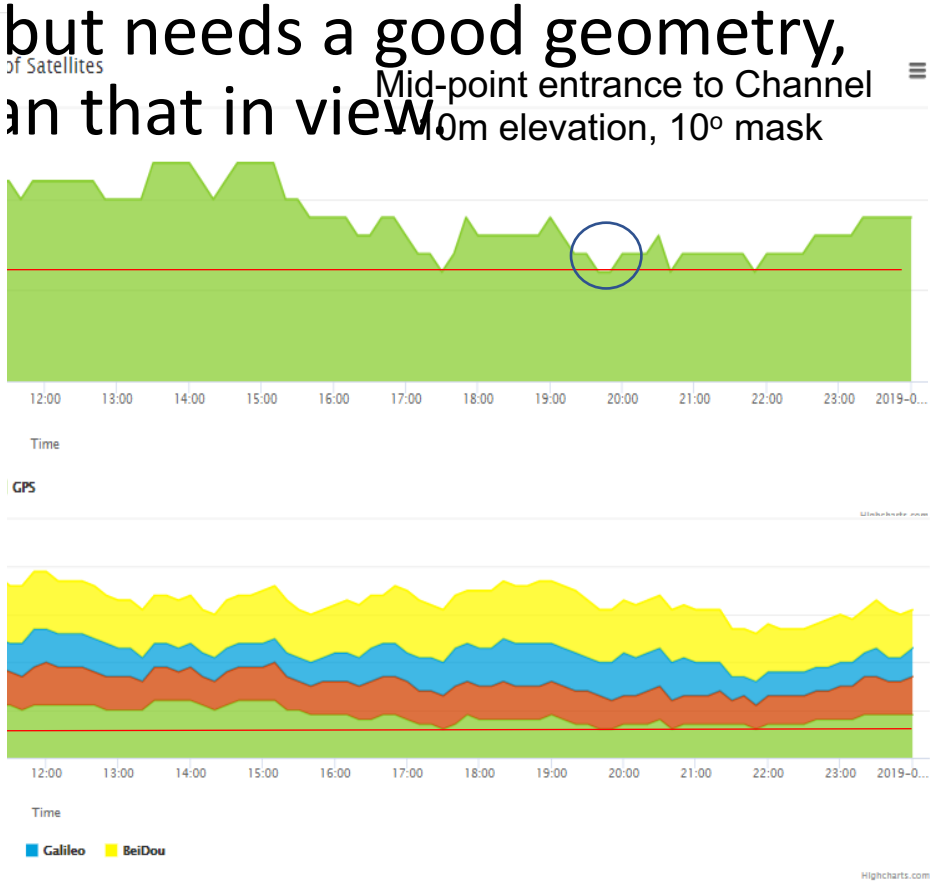


Source: GMV

RAIM

- RAI[illegible] but needs a good geometry, me[illegible] an that in view.





Integrity in today's standards

Regulated vessels (sometimes call SOLAS)

- Equipment governed by IMO receiver performance standards and IEC test specifications.
- Integrity is often expressed as a time to alarm in which to notify the user of an unsafe state.
- Terrestrial augmentation and RAIM provided as example sources of integrity and IEC tests cover both with simple tests.
- SBAS is only considered in the multi-system receiver performance standard.
- Slow to change and therefore often lags technology

Unregulated vessels (sometimes call non-SOLAS)

- Free to use whatever systems they wish.
- Range of options and performance levels.
- Rapid evolution process – often first to adopt new technology/approaches

Requirements timeline

Crewed vessel

Mariner guided by integrity information

Simple definition of integrity

INSPIRe

Fully autonomous vessel

No mariner /or remote operator to interpret integrity information

Fully detailed HPL and VPL (possibly driven by liability requirements)