



Northern
Lighthouse
Board

Stevensons to Spoofing: Scotland's Contribution to Safe Navigation

Mike Bullock – Chief Executive



Scotland

- Coastline of approx. 10,000 KM
- 790 Islands
- West Coast deeply indented coastline with strong tidal flows, often in narrow channels
- East Coast mostly straight lines and home to large offshore Oil & Gas industry concentrated in the relatively shallow North Sea



Northern Lighthouse Board (NLB)

- Established by statute in 1786
- HQ now at 84 George Street, Edinburgh since 1832.
- Designated Non Departmental Public Body (NDPB) responsible to Department for Transport (DfT)
- Under Merchant Shipping Act 95 “*..the General Lighthouse Authorities shall have the superintendence and management of all lighthouses, buoys and beacons within their respective areas.*”



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IMO Safety of Life at Sea (SOLAS) Convention

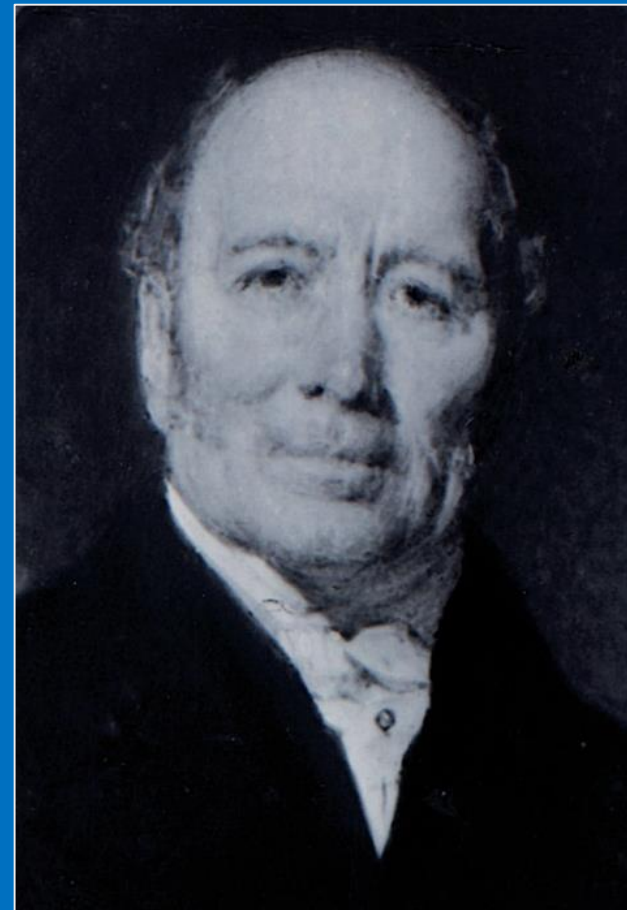
NLB Responsibilities

-provide such Aids to Navigation as the volume of traffic justifies and the degree of risk requires
-take into account the international recommendations and guidelines
-arrange for information relating to Aids to Navigation to be made available to all concerned



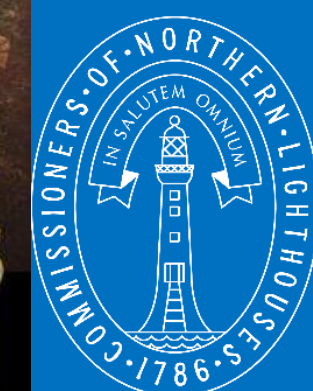
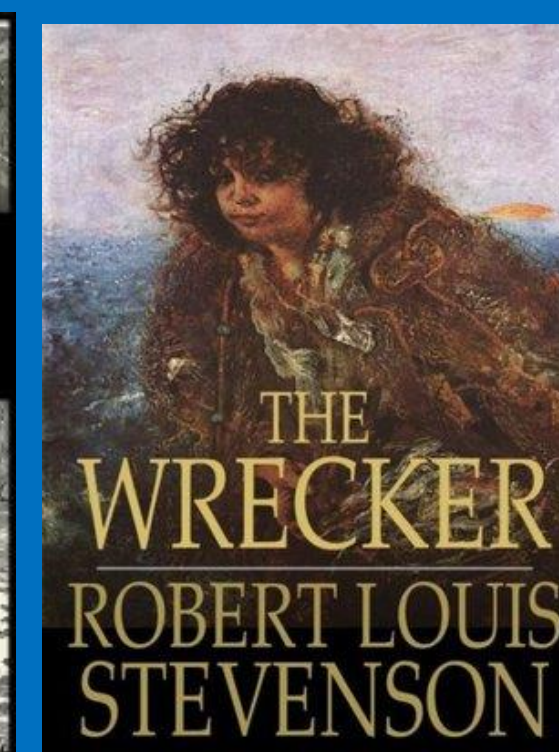
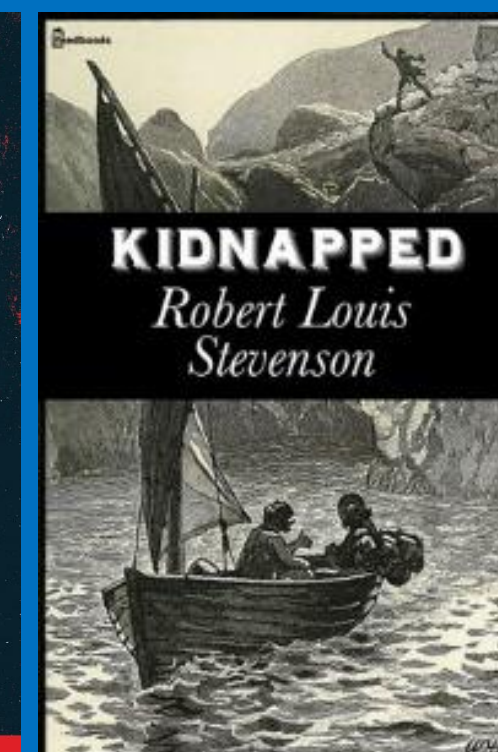
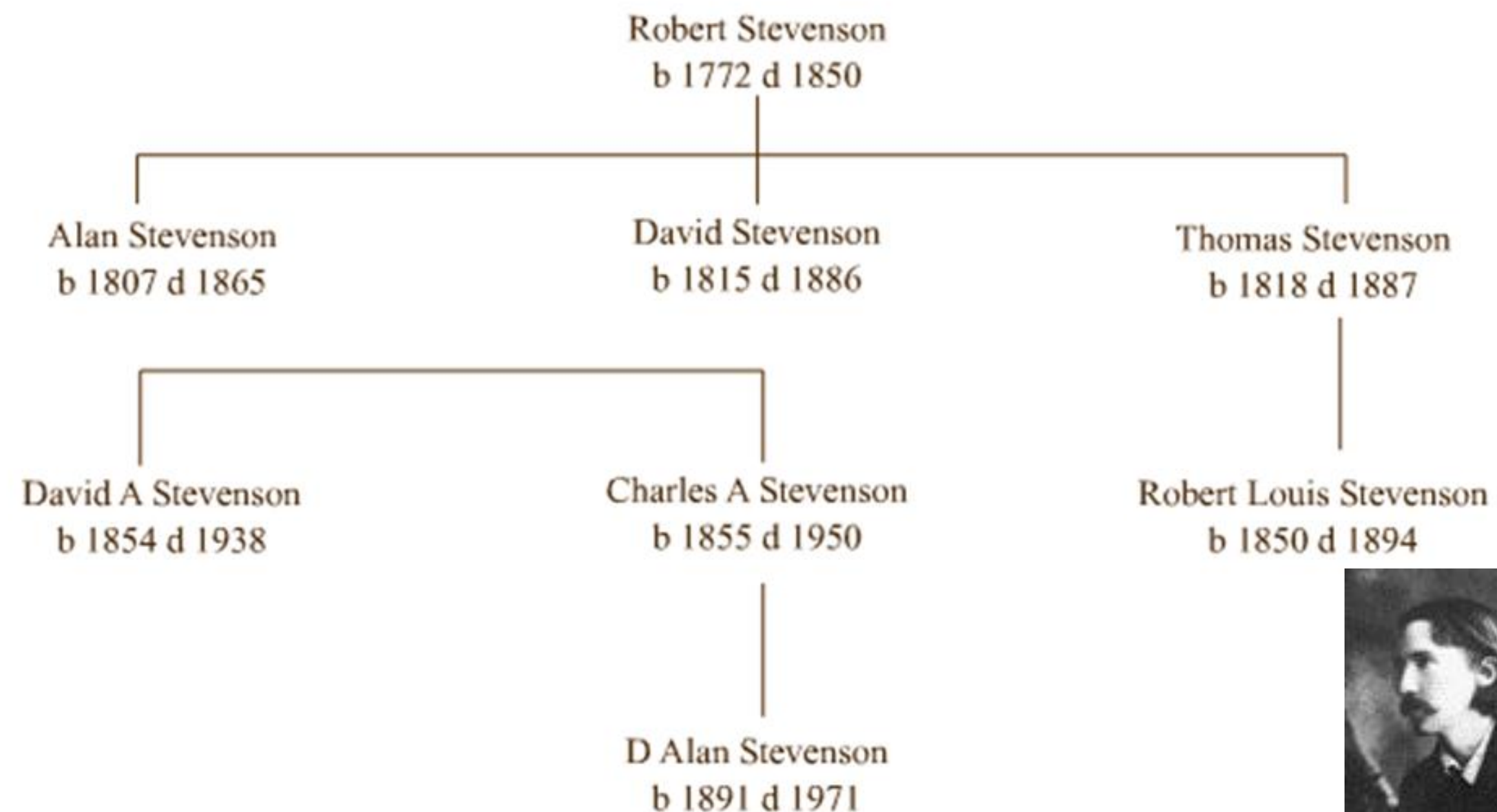
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Stevenson Dynasty of Engineers



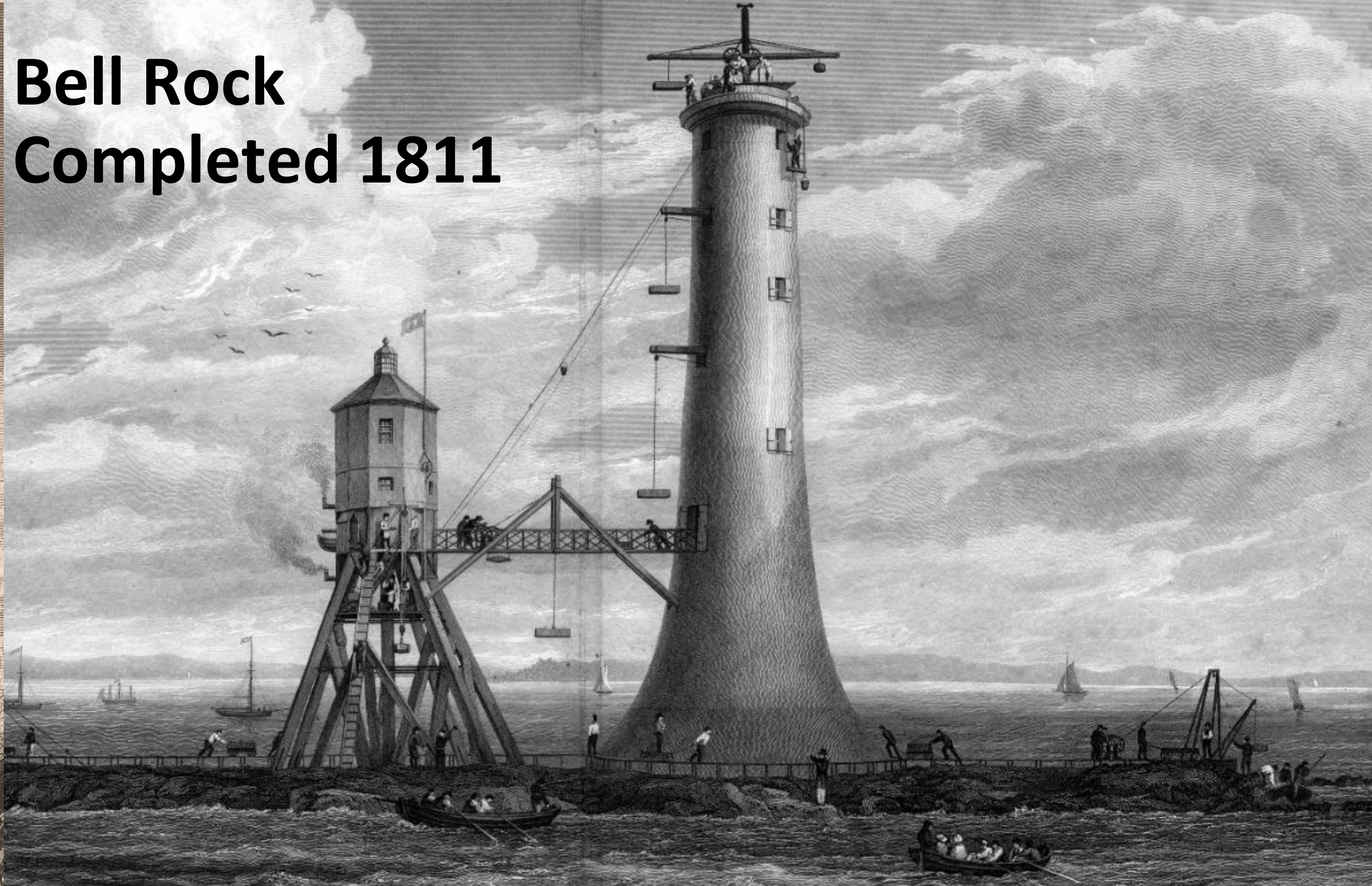
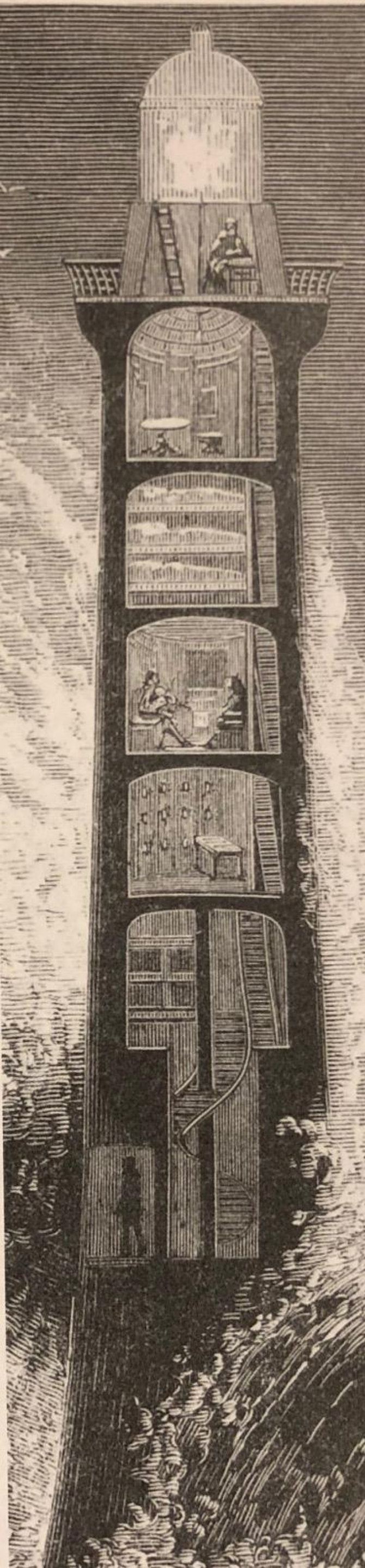
IN MEMORY OF
ROBERT STEVENSON, F. R. S. E.
CIVIL ENGINEER,
BORN AT GLASGOW, 8TH JUNE 1772;
DIED AT EDINBURGH 12TH JULY 1850, AGED 78 YEARS.
DURING THE LONG PERIOD OF HALF A CENTURY
HE WAS ENGINEER
TO THE BOARD OF NORTHERN LIGHTHOUSES
AND DESIGNED AND EXECUTED THE
BELL ROCK LIGHTHOUSE
AND OTHER PUBLIC WORKS IN THE UNITED KINGDOM.
ALSO OF
JANE SMITH HIS WIFE
WHO DIED 2^D MARCH 1846, AGED 67 YEARS.
There remaineth therefore a rest to the people of God.
HEB. IV. 9.

- Robert Stevenson and his descendants were NLB's Engineers spanning over 150 years designing most of Scotland's Lighthouses.
- Battling against the odds and elements - they constructed wonders of engineering that have withstood the test of time.



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Bell Rock Completed 1811

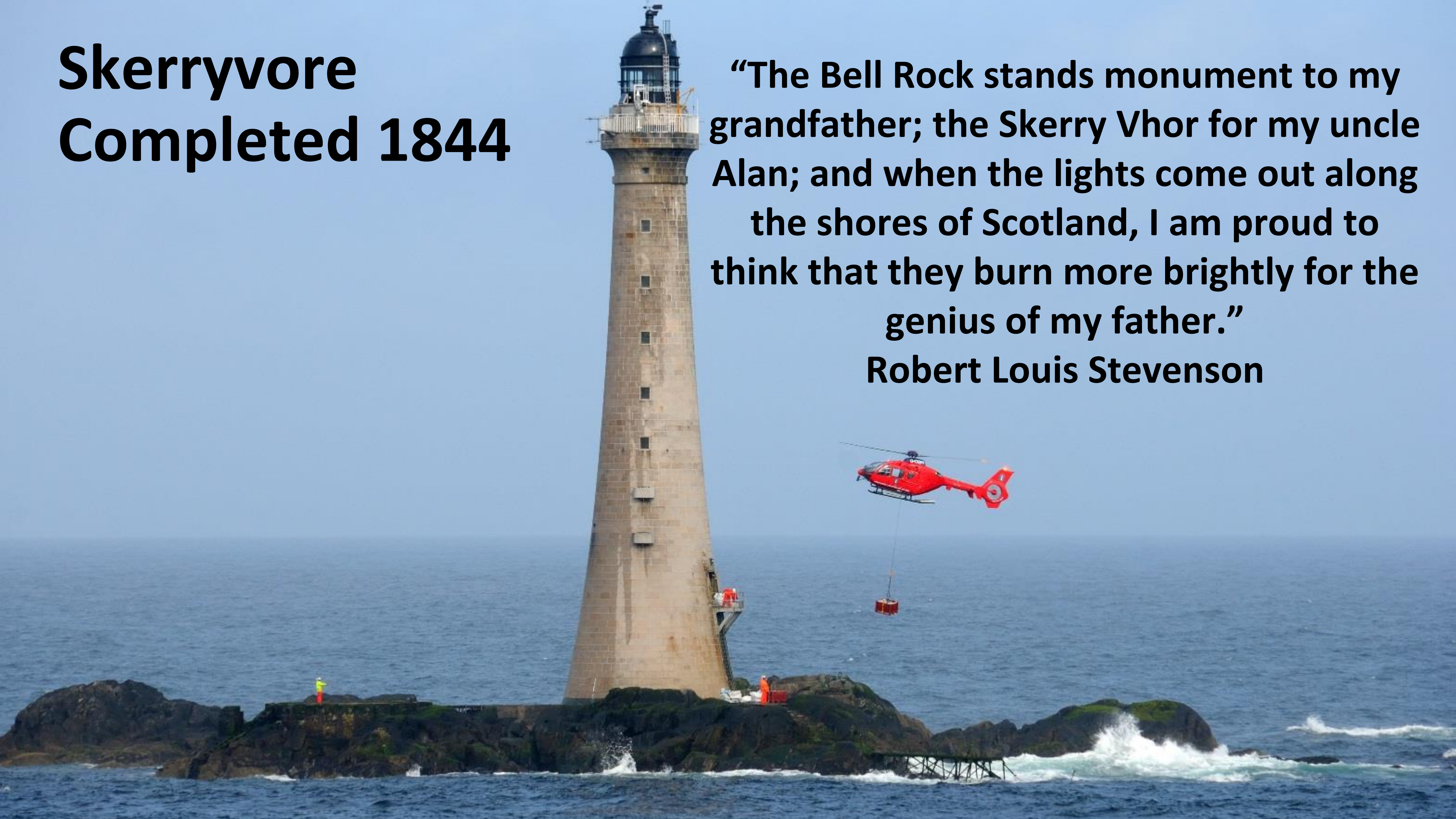


Bell Rock

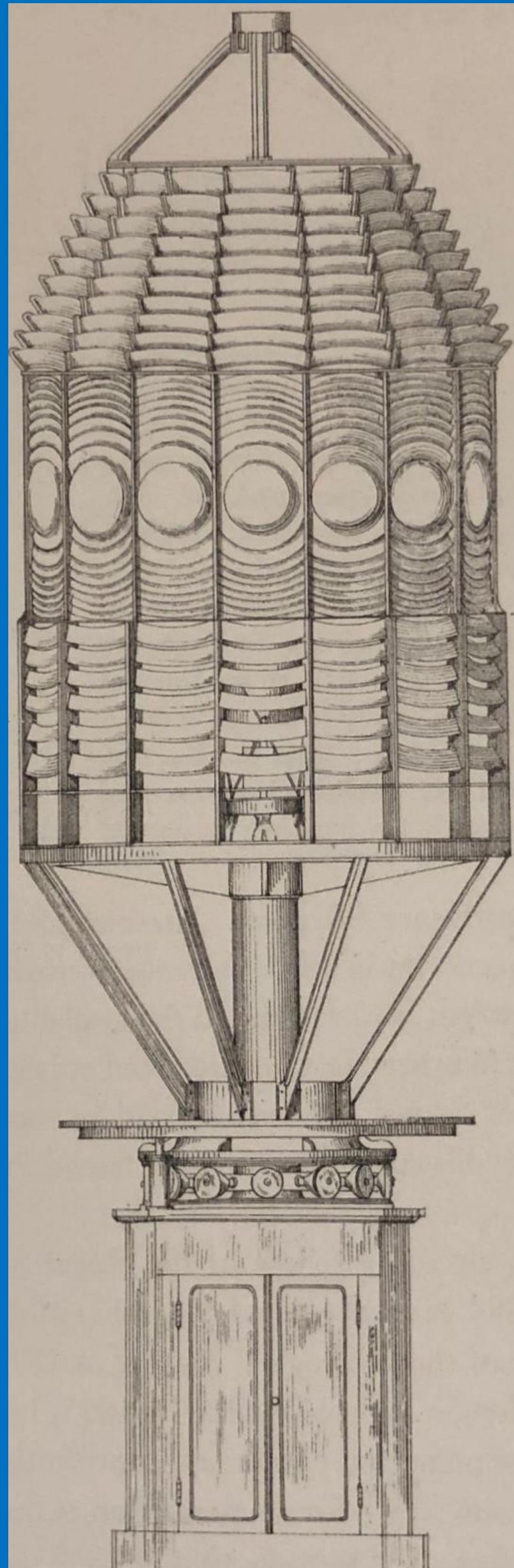


Skerryvore Completed 1844

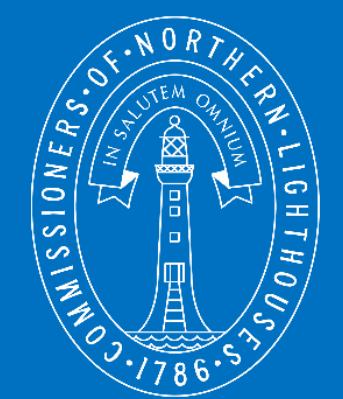
**“The Bell Rock stands monument to my grandfather; the Skerry Vhor for my uncle Alan; and when the lights come out along the shores of Scotland, I am proud to think that they burn more brightly for the genius of my father.”
Robert Louis Stevenson**



Fesnel



- 1834 Thomas Stevenson travelled to Paris to visit the Fresnel brothers
- 1835 Thomas published Report “On Illumination of Lighthouses Using Lenses”
- 1835 Britain’s first Dioptric Lens installed at Inchkeith in the Forth



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A History of Innovation

- VHF radio lighthouse (1979)



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A History of Innovation

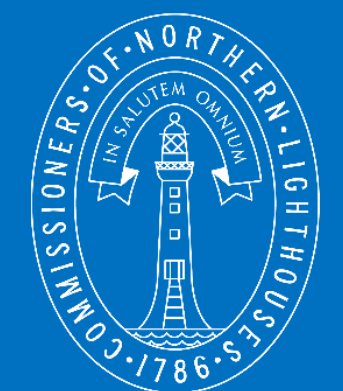
- VHF radio lighthouse (1979)
- “Talking Lighthouse” Distance measuring technology (1929)



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A History of Innovation

- VHF radio lighthouse (1979)
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- Radio-controlled fog signal (1914)



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A History of Innovation

- VHF radio lighthouse (1979)
- “Talking Lighthouse” Distance measuring technology (1929)
- Radio-controlled fog signal (1914)
- Lighthouse automation (1894)
- Flashing light buoy (1880)
- Virtual AtoN (1851)

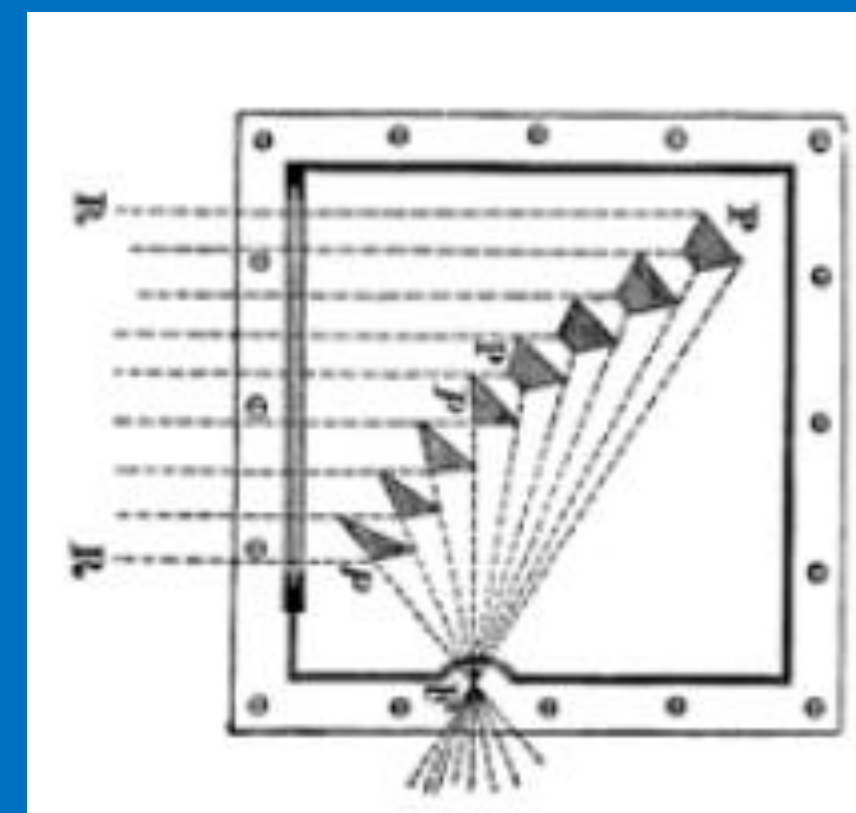
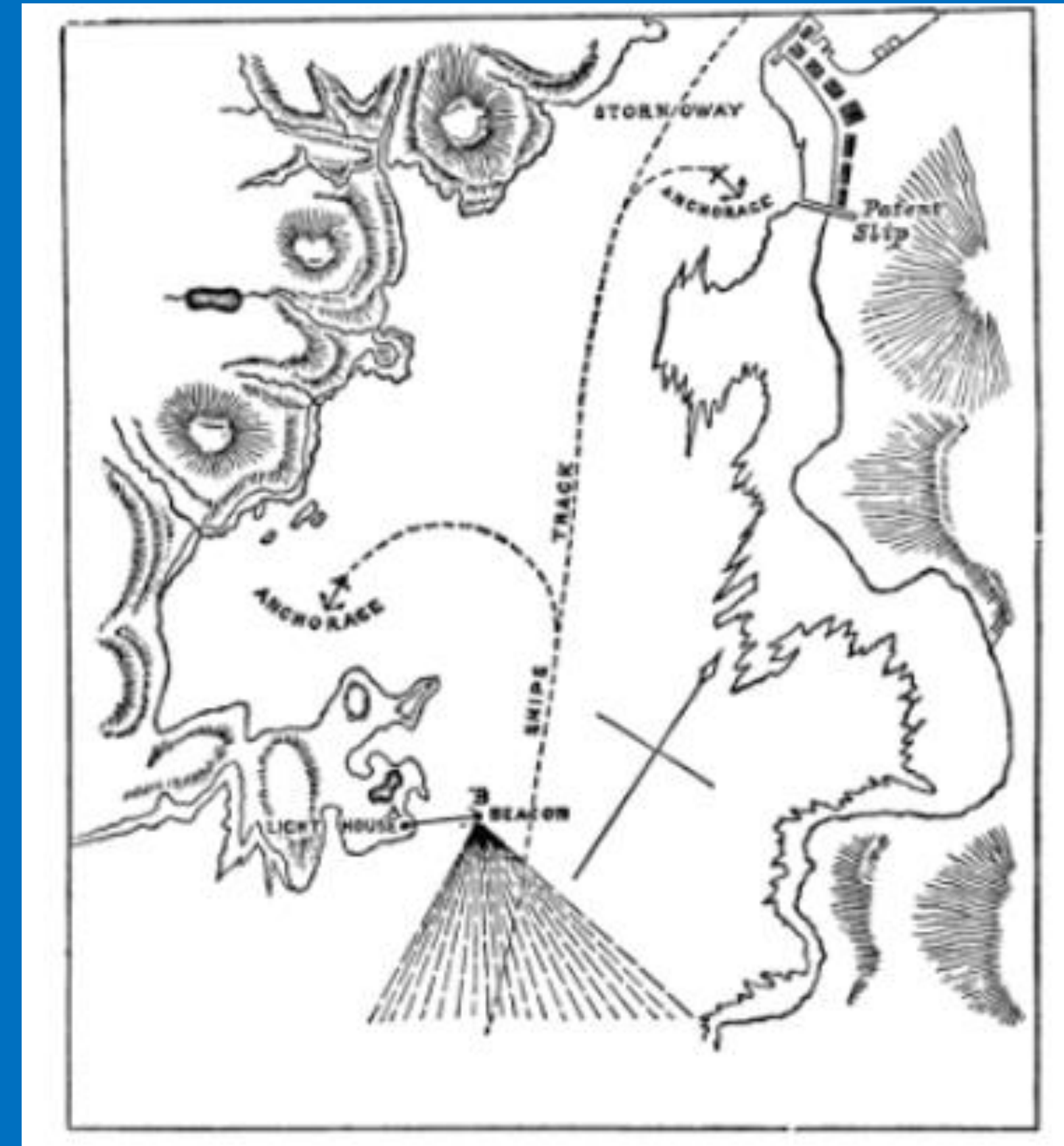


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“The Apparent Lighthouse” 1851



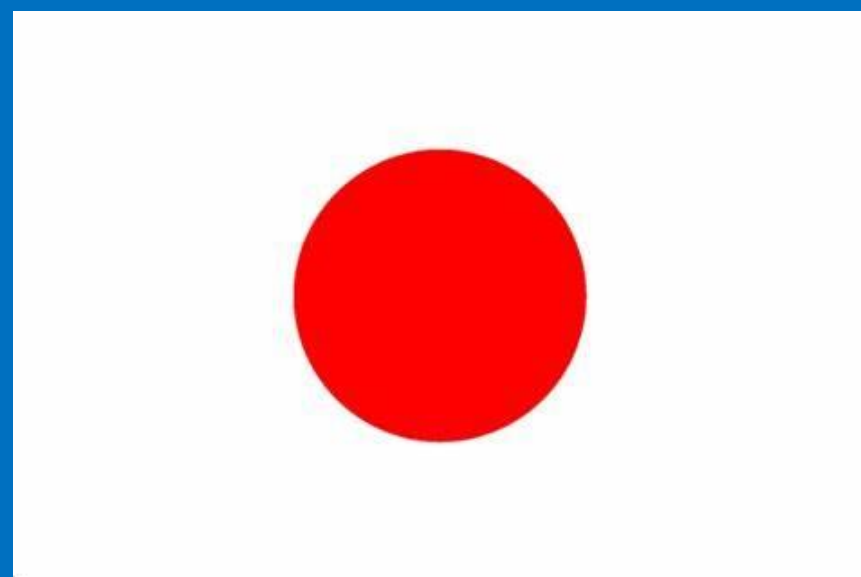
A LAMPLESS LIGHTHOUSE—This strange but ingenious **beacon** is located at **Arnish** Rock, Stornoway Bay, in the Hebrides, Scotland. It is a cone of cast iron plates, surmounted by an arrangement of prisms and a mirror, which reflect the light from the lighthouse on Lewis Island, 500 ft. distant across the channel.



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Japan: Richard Henry Brunton 1841-1901

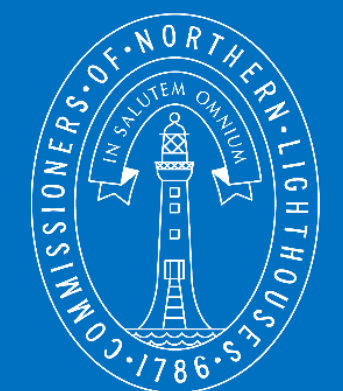
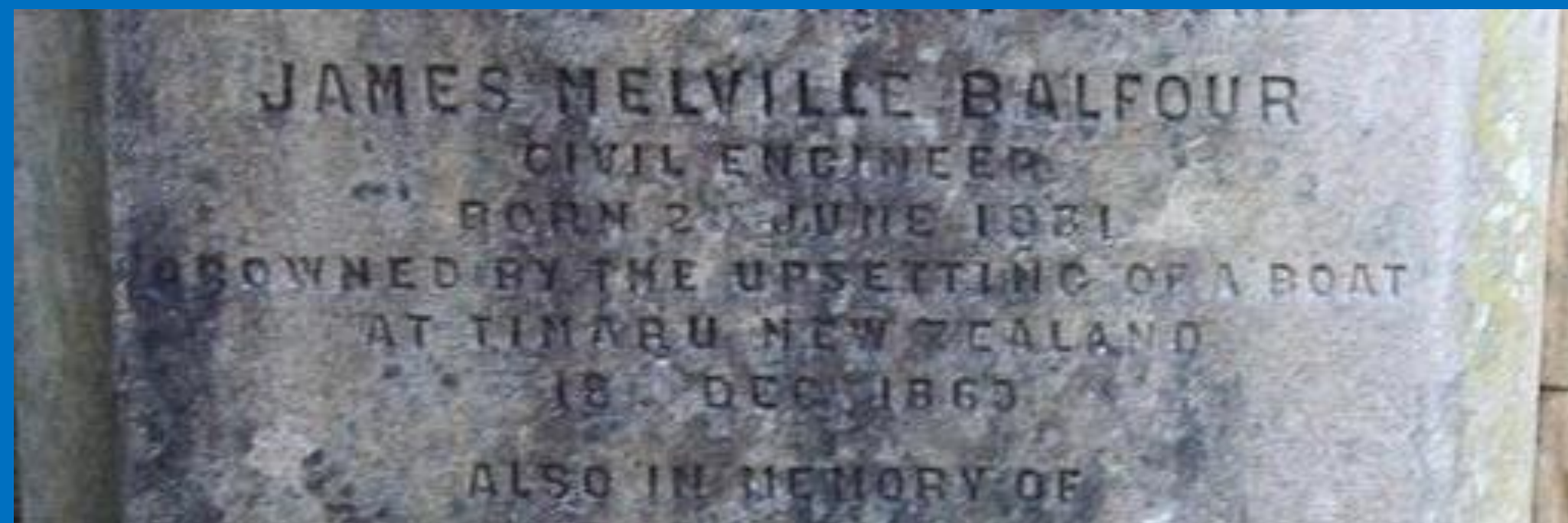
- The increasing trade between and Japan necessitated action to improve navigational safety around Japan's coast
- Following a request for assistance from the Japanese Government David and Thomas Stevenson selected and trained Brunton
- Surveyed the Japanese coast building 26 Lighthouses between 1868-1876
- The “Father” of Japanese Lighthouses



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New Zealand: James Melville Balfour 1831-1869

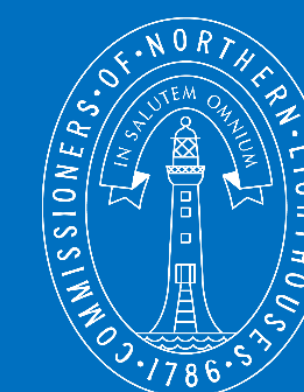
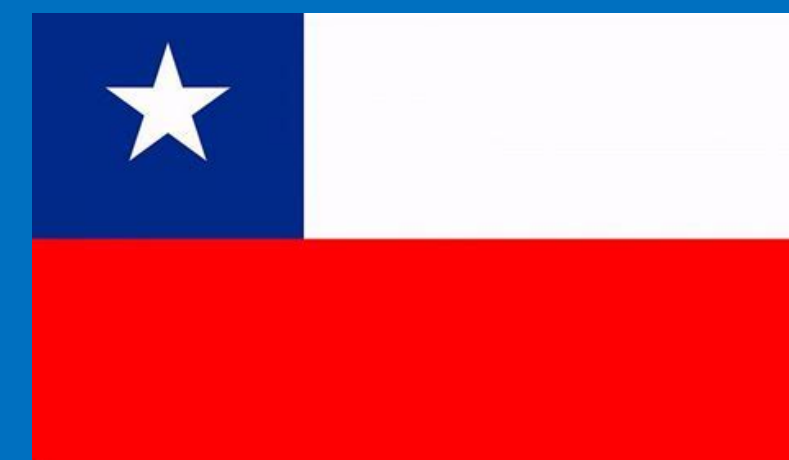
- Completed his Apprenticeship with Thomas and David Stevenson (the latter was married to Balfour's sister).
- 1863 arrived in New Zealand
- 1866 appointed Colonial Marine Engineer
- Set in train the building of New Zealand's network of lighthouses.
- 1869 Tragically drowned



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Chile: 21st Century

- Annual experience & training



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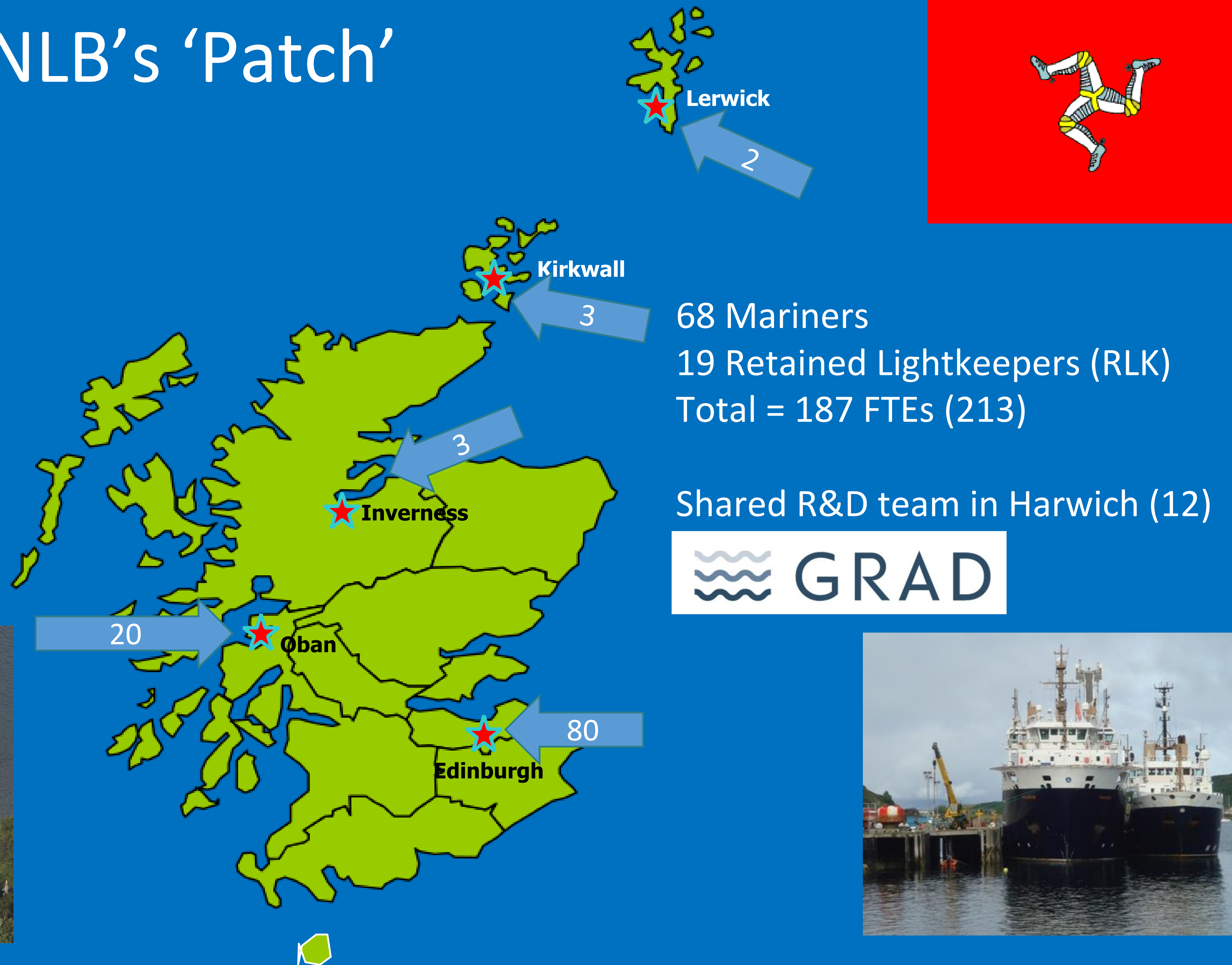
International Association of Marine Aids to Navigation and Lighthouse Authorities

- NGO of national authorities (80+), industry & academic institutes.
- Aim: harmonise Marine AtoN across the globe.
- Sets guidelines and performance standards.

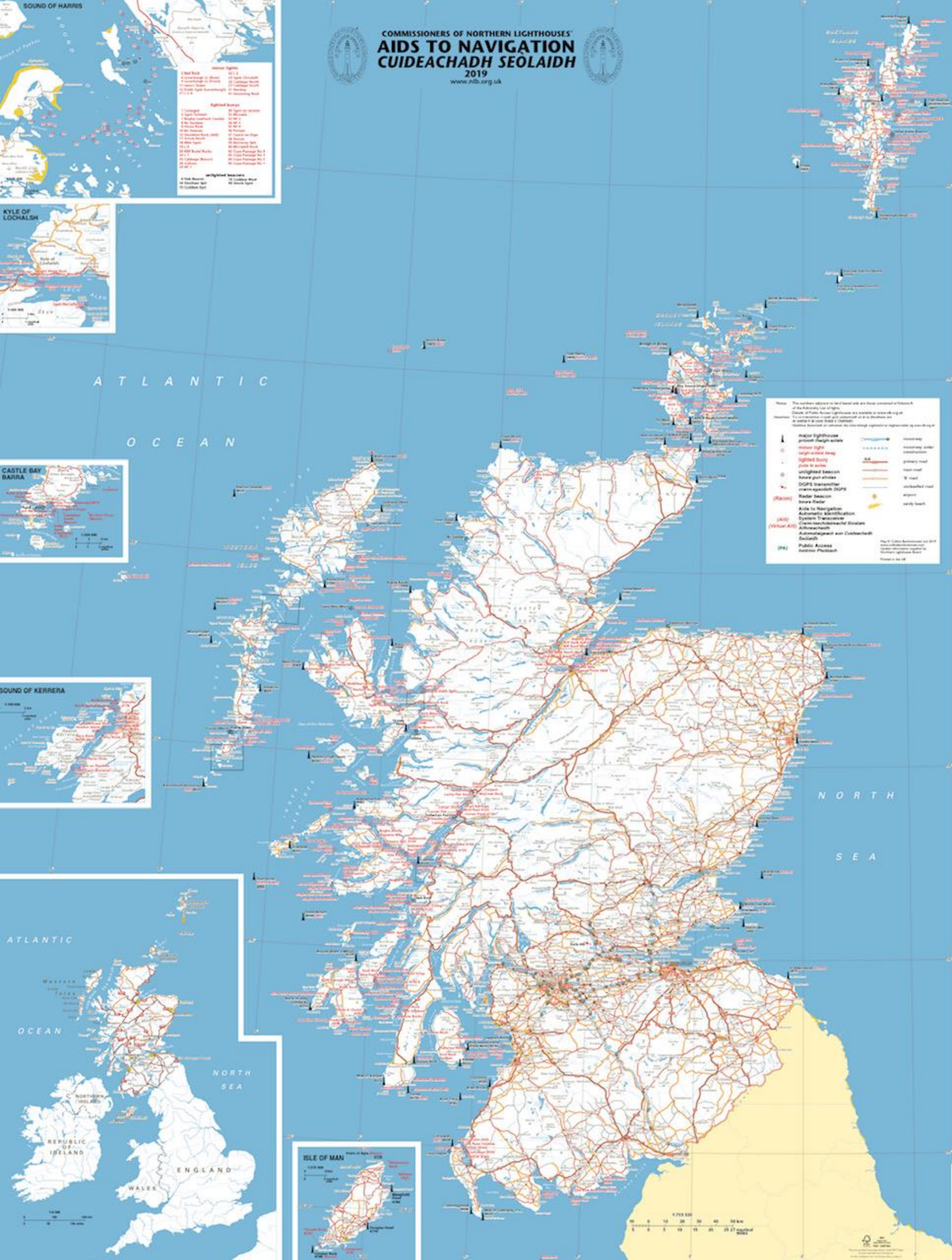




NLB's 'Patch'







- 206 Lighthouses
- 170 Statutory buoys
- 23 Beacons
- Radio Navigation Aids
- 104 Commercial Buoys
- Superintendence of:
 - over 2,000 Local Aids to Navigation (AtoN)
 - 130 Oil & Gas Platforms
 - 500+ Aquaculture sites

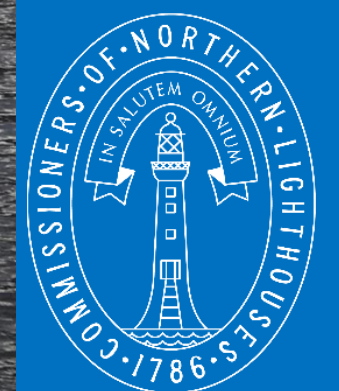


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Innovation: LED Precision Directional Light



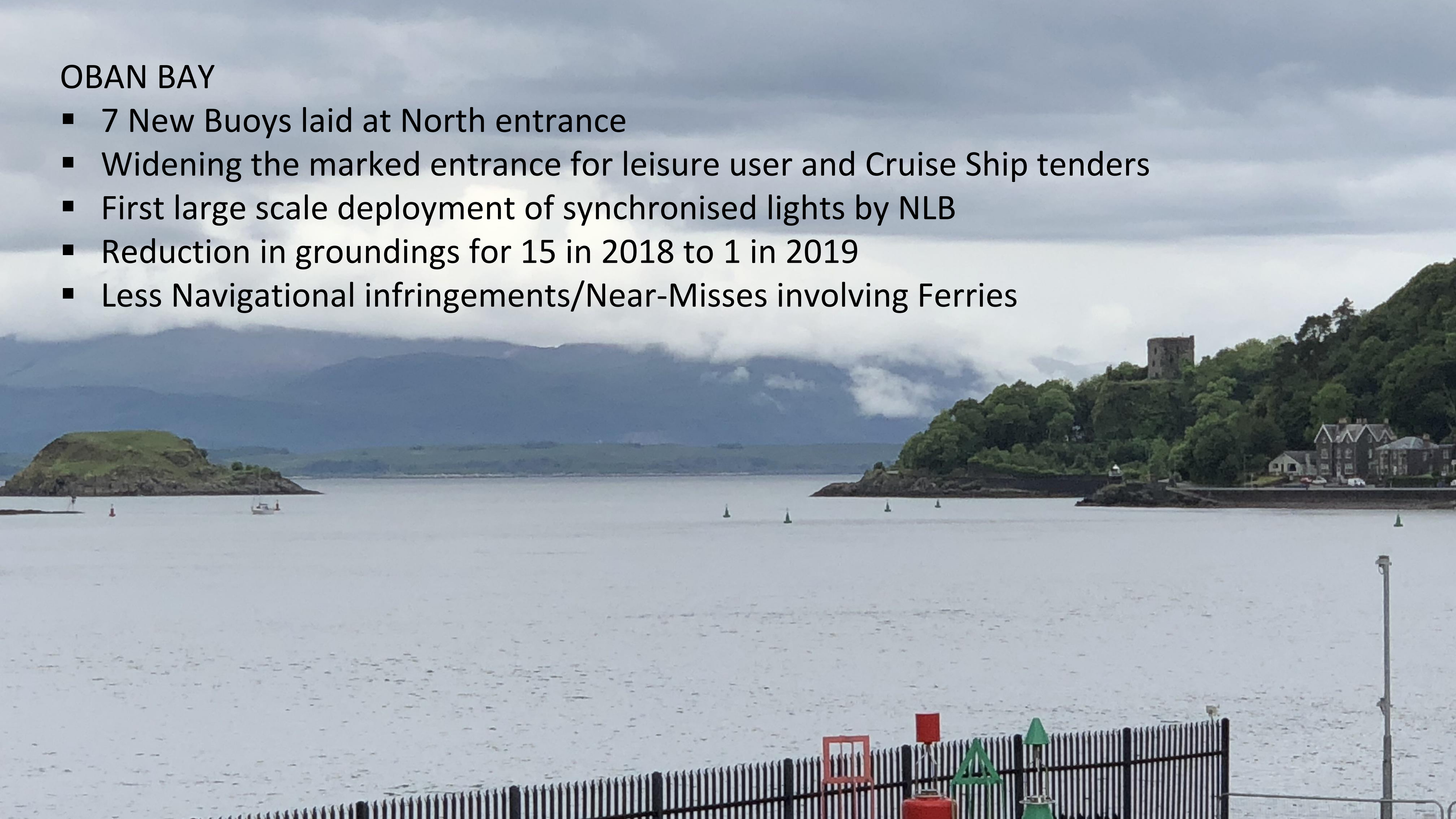
MV BOUDICCA 28,300 t 206m 900 pax



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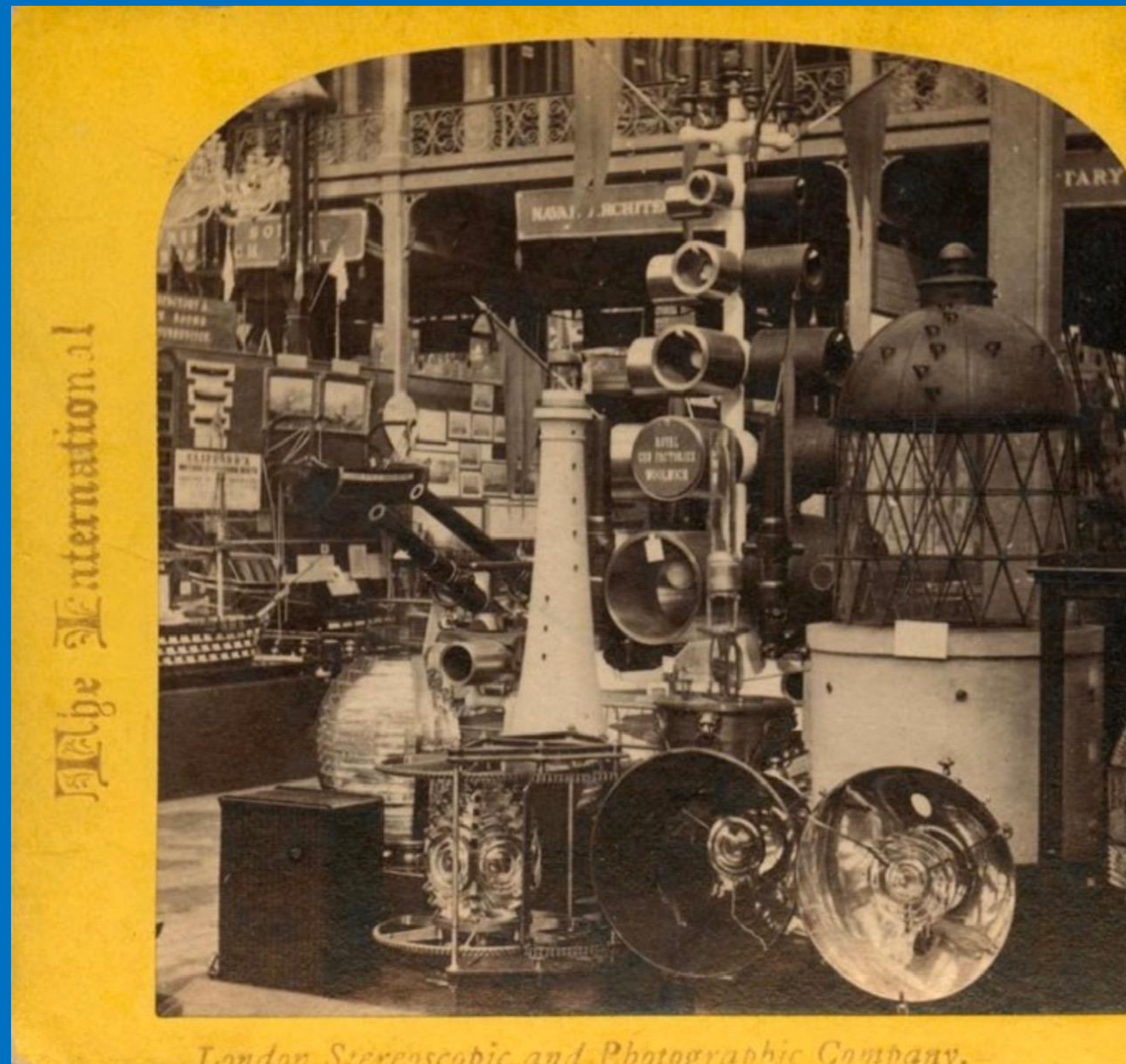
OBAN BAY

- 7 New Buoys laid at North entrance
- Widening the marked entrance for leisure user and Cruise Ship tenders
- First large scale deployment of synchronised lights by NLB
- Reduction in groundings for 15 in 2018 to 1 in 2019
- Less Navigational infringements/Near-Misses involving Ferries





Innovation Continues.....



1862 NLB display at the International Exhibition, London



Commissioners of
IRISH LIGHTS

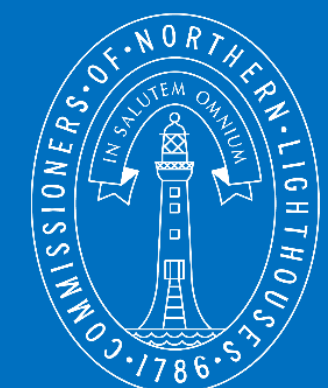


TRINITY HOUSE



GRAD

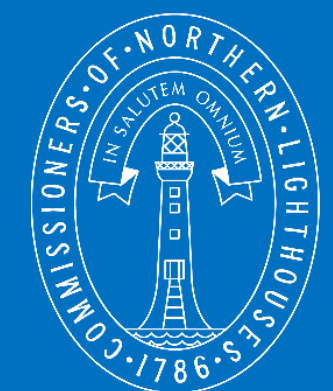
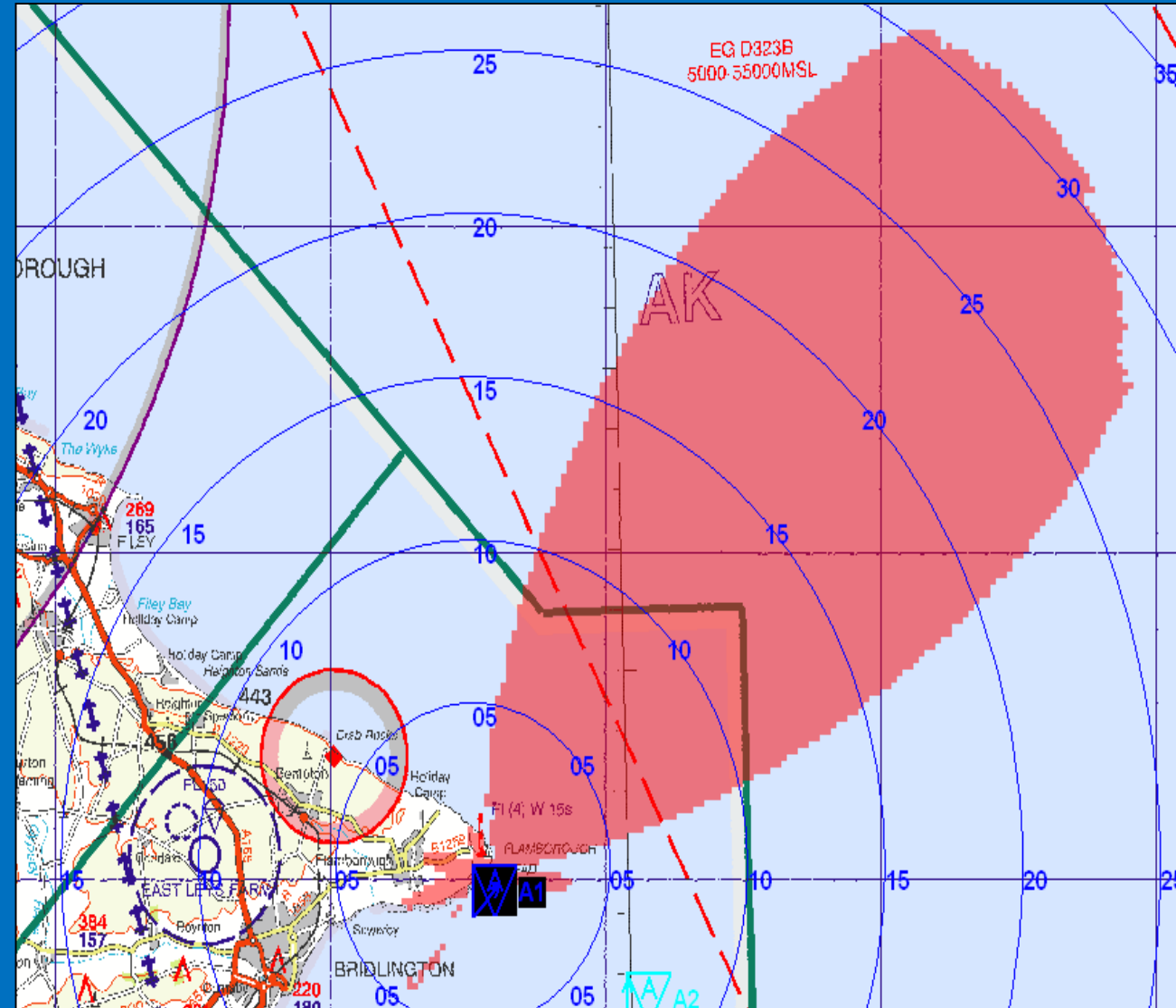
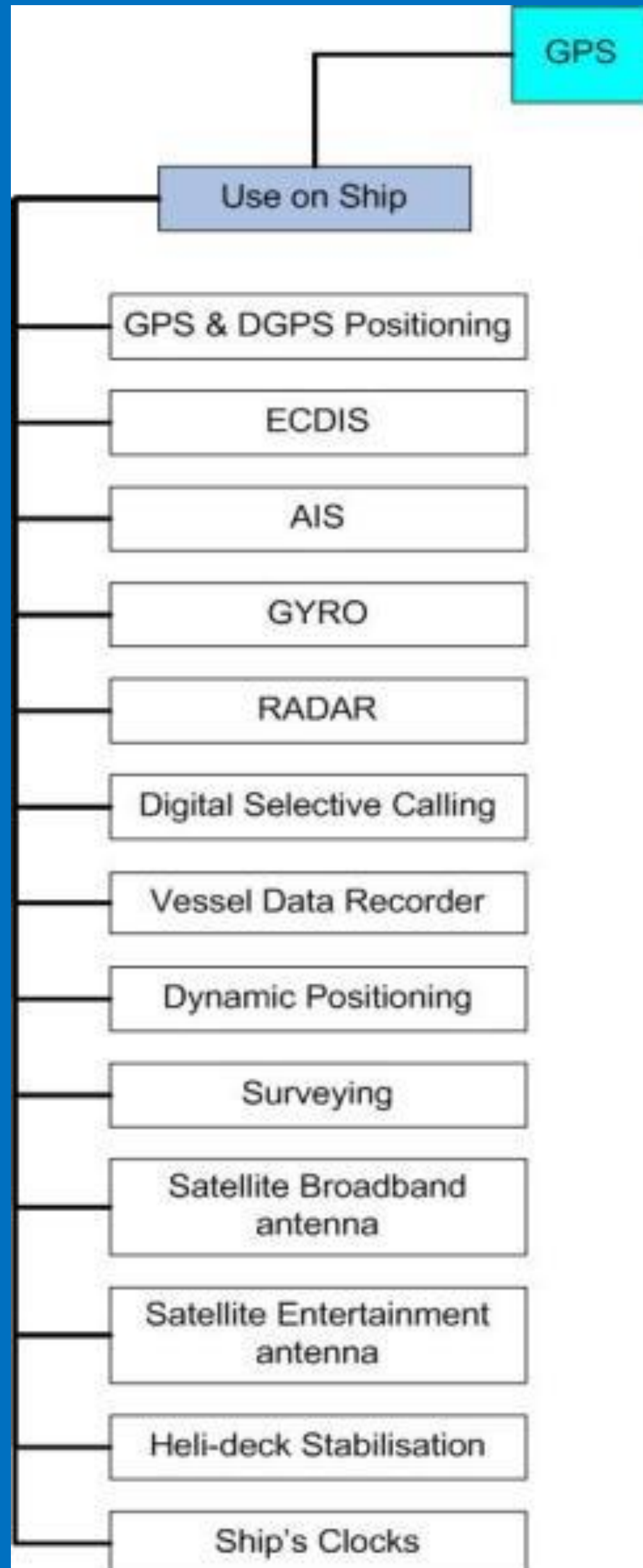
Driving Innovation for
Safer Maritime Navigation



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GNSS Jamming Demonstration

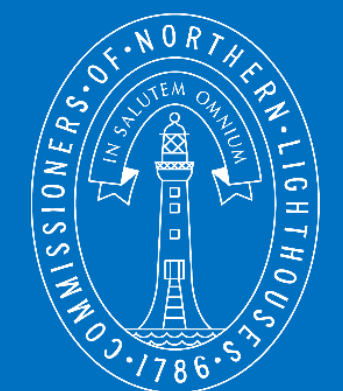
- **Dynamic tests onboard NLV POLE STAR demonstrated the dependency of numerous systems on GNSS**



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MARUSE Project

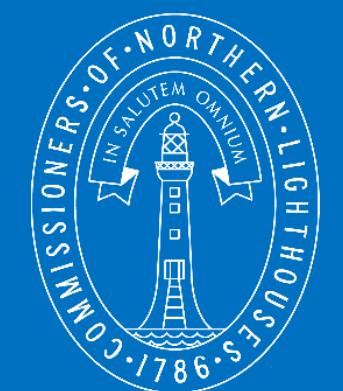
- Demonstration of Pseudolites for positioning



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eLoran Demonstration

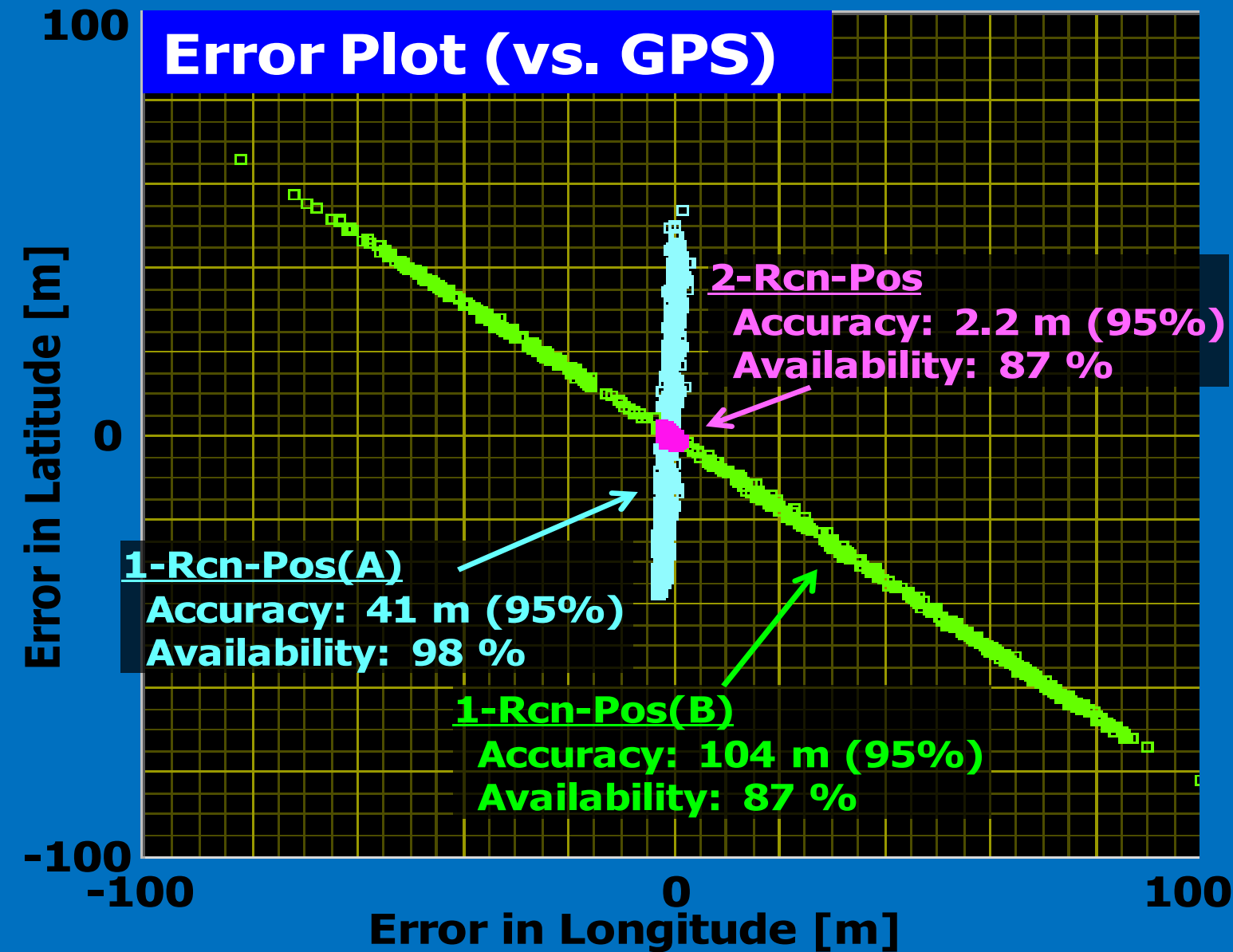
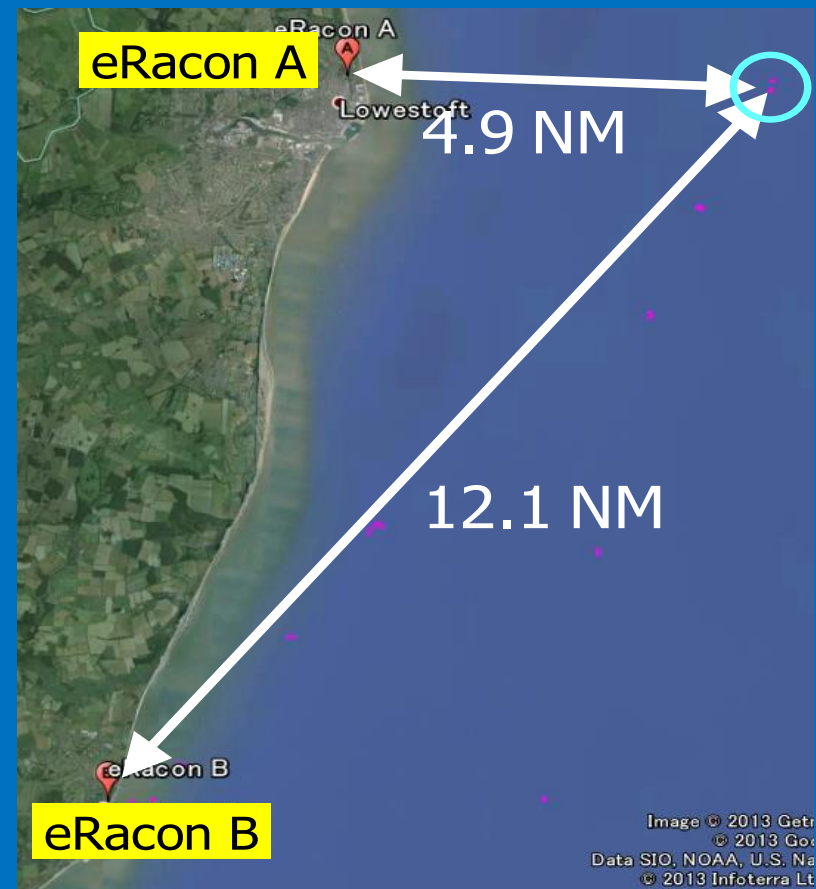
- Transmitter at Anthorn
- Reference stations at various ports
- Shipborne receivers



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Smart Radar & Radar Beacon trials

Distance: **4.9 NM** to eRacon A, **12.1 NM** to eRacon B
Measuring Time: **23 min** (558 radar antenna rotations)



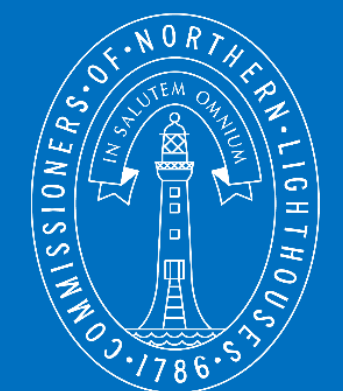
- BulletsRadar-map-matching
- Modified radar beacons (racons) transmitting an encoded message including transceiver location within morse pulse
- Shipborne radar modified to interpret pulse



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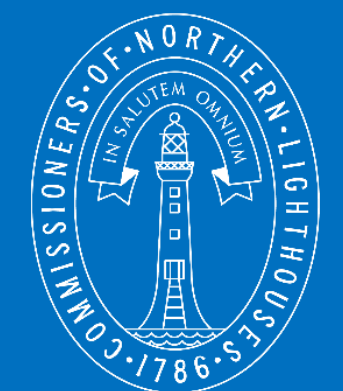
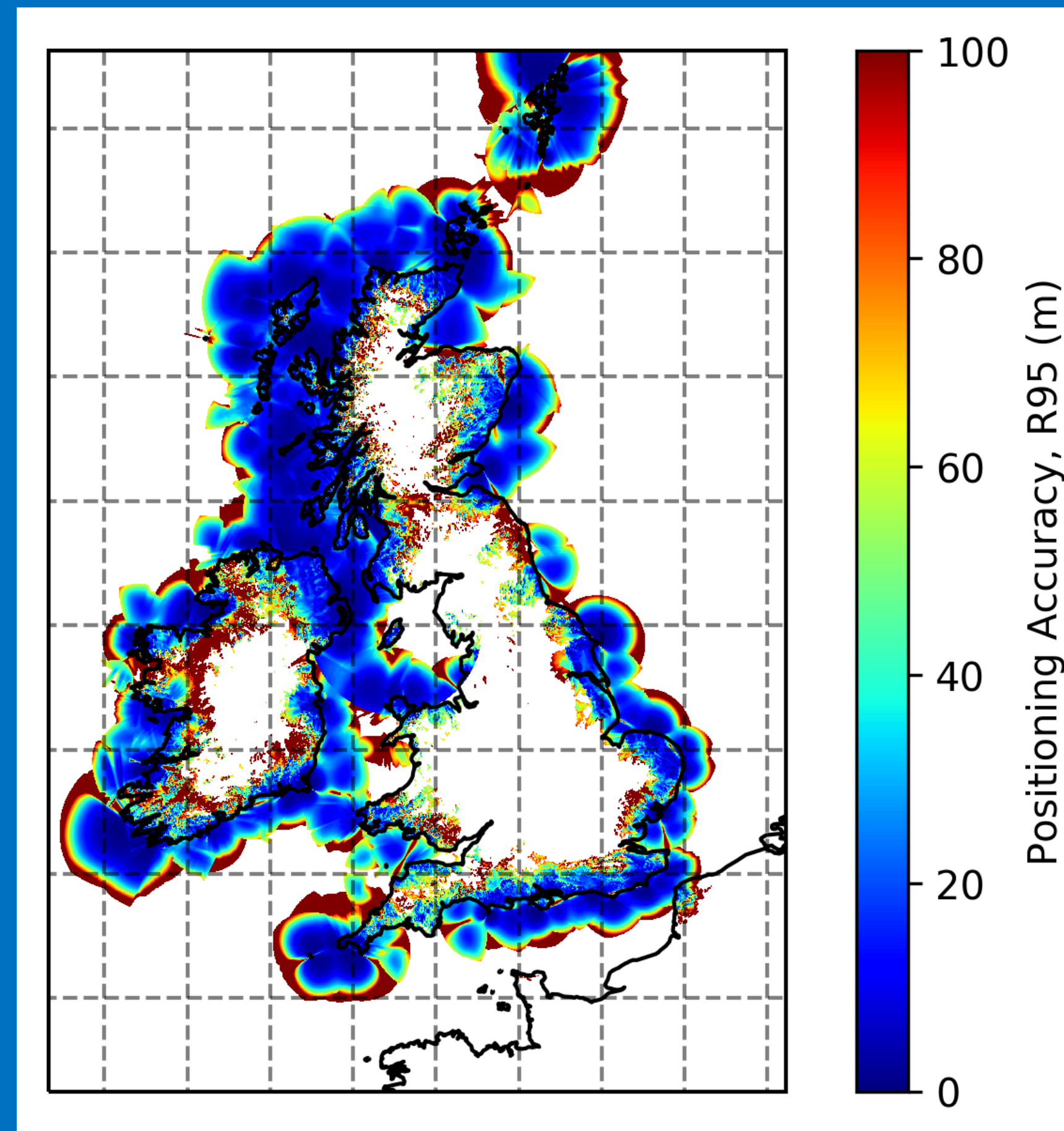
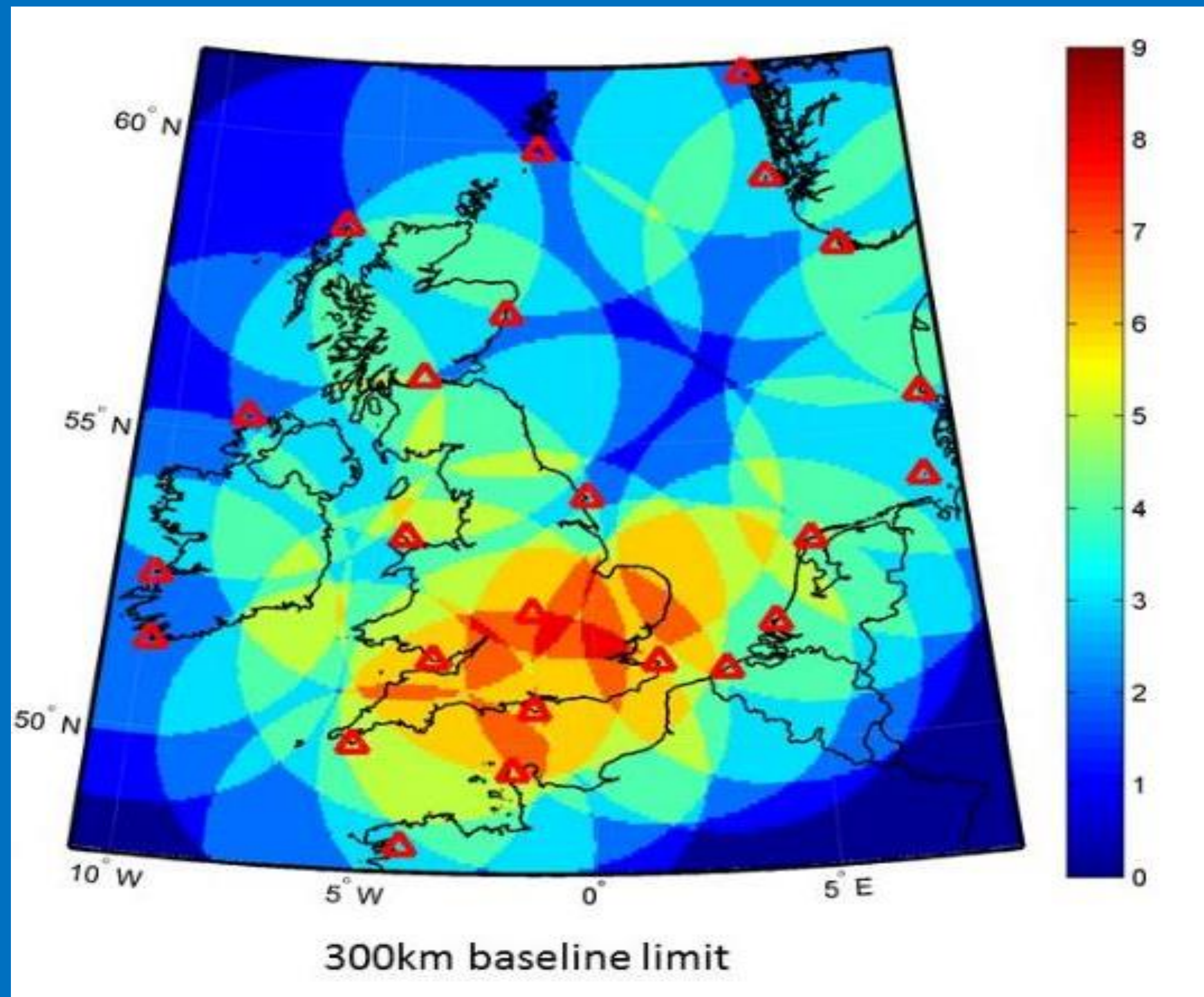


- Electronic Pelorus
- Takes relative bearings to Charted objects
- Draws a bearing line on eChart



R-Mode trials

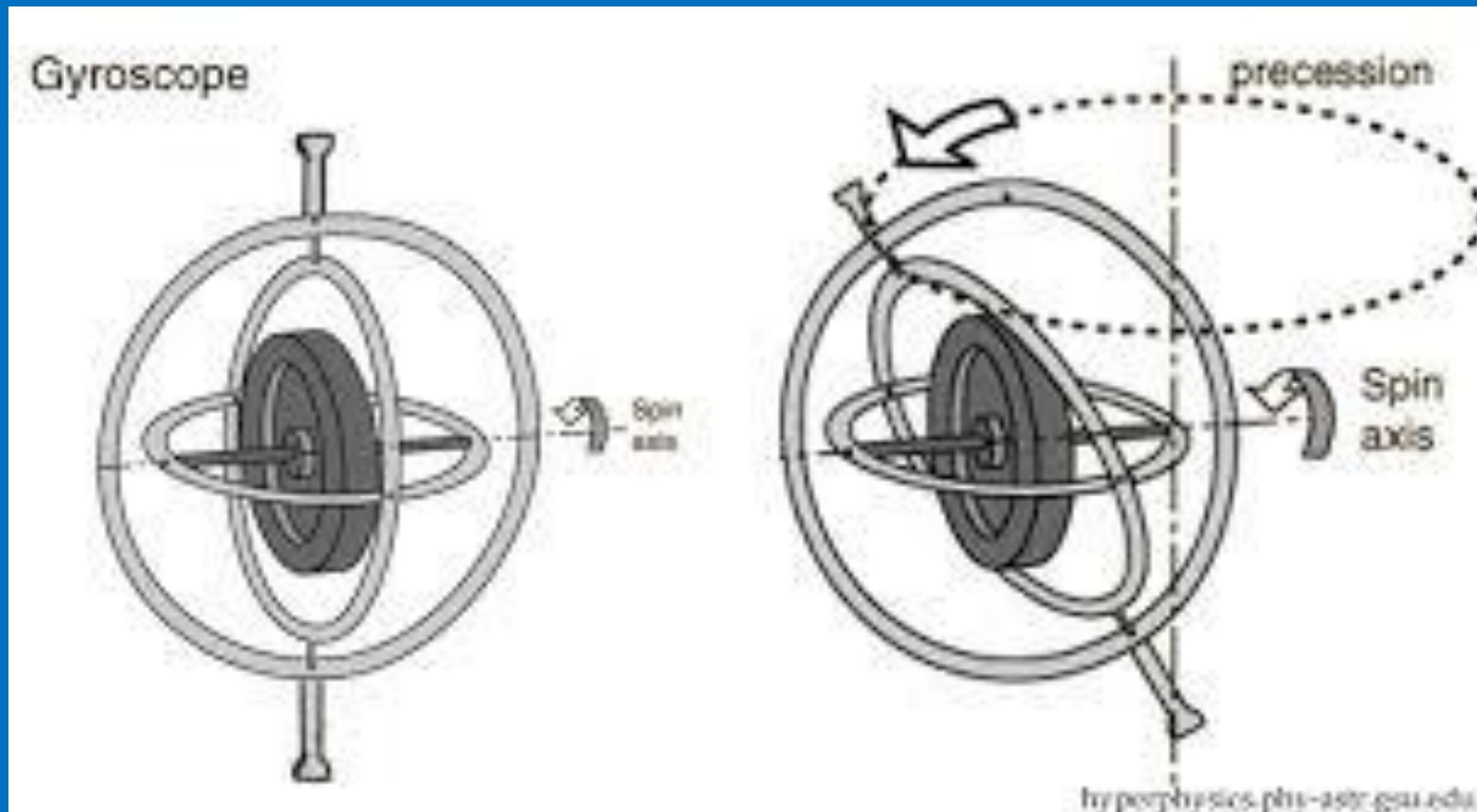
- Transmission of PNT signals using existing MF and VHF maritime networks



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Inertial navigation systems

- Trials of different grades of gyrocompass, assessing accuracy, standalone duration and cost-benefit of each



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Contribution towards awareness of GNSS issues

FINAL

The economic impact on the UK of a
disruption to GNSS

Full Report

Public

June 2017



LE
London
Economics

Commissioned by

Innovate UK

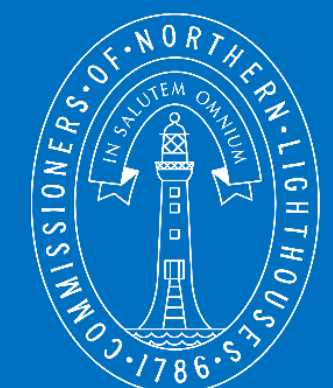


**Satellite-derived
Time and Position:
A Study of Critical
Dependencies**




Government
Office for Science

- LSE Report
- Blakett Report
- Cross-governmental PNT Group



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In Salutem Omnium
For the Safety of All