

# General Lighthouse Authorities The United Kingdom and Ireland

Contributing towards the  
“Marine Aids to Navigation Strategy - 2025 and beyond”

## Radio Navigation Plan

Radio  
Navigation

PLAN

SERVICE MIX

GPS

~ GALILEO

~ RADIOBEACON DGNSS

~ AIS



## Glossary of Terms

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AIS	Automatic Identification System
AtoN	Aids to Navigation
ASF	Additional Secondary Factors
CIL	Commissioners of Irish Lights
CS	Commercial Service
DfT	Department for Transport (UK)
DGNSS	Differential Global Navigation Satellite System
DGPS	Differential Global Positioning System
EC	European Commission
ECDIS	Electronic Chart Display and Information System
EGNOS	European Geostationary Navigation Overlay Service
eLoran	enhanced LOng RANge Navigation System
EMSA	European Maritime Safety Agency
ERNP	European Radio Navigation Plan
ESA	European Space Agency
EU	European Union
FOC	Full Operational Capability
GLA	General Lighthouse Authorities of the UK and Ireland
GLF	General Lighthouse Fund
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	European GNSS Agency
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IBS	Integrated Bridge System
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
INS	Integrated Navigation System
IMO	International Maritime Organization
IOC	Initial Operational Capability
ITU	International Telecommunication Union
IRCG	Irish Coast Guard
MCA	Maritime and Coastguard Agency (UK)
MSA	Merchant Shipping Act
NLB	Northern Lighthouse Board
NT	New Technology (Radar)
OS	Open Service
PNT	Position, Navigation & Timing
PRS	Public Regulated Service
RACON	RADar BeaCON
RAIM	Receiver Autonomous Integrity Monitoring
RoI	Republic of Ireland
RNAV	Radio NAVigation
SAR	Search and Rescue
SOL	Safety of Life
SOLAS	Safety of Life at Sea (IMO Convention)
THLS	Trinity House Lighthouse Service
US	United States
WWRNS	World-Wide Radio Navigation System

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## The General Lighthouse Authorities

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The General Lighthouse Authorities of the UK and Ireland are:

- The Corporation of Trinity House, known as Trinity House Lighthouse Service  
- England, Wales, Channel Islands and Gibraltar
- The Commissioners of Northern Lighthouses, known as the Northern Lighthouse Board  
- Scotland and the Isle of Man
- The Commissioners of Irish Lights, known as Irish Lights  
- All of Ireland

The costs of the GLA services are met from the General Lighthouse Fund (GLF), which derives its income mainly from light dues that are charged on commercial shipping calling at the ports of the United Kingdom and Ireland. The Irish Government contribute to the GLF, and the UK and Irish Governments have agreed that from 2015 onward CIL operations in the Republic of Ireland (RoI) will be funded from RoI sources. Charges are in direct proportion to the costs of the services provided. This cost-recovery system is regulated by the Secretary of State for Transport who has a duty to ensure the effective management of the GLF to enable the GLA to provide adequate aids to navigation at the optimum cost. An advisory body, known as the Lights Advisory Committee, which is made up of shipping and ports' representatives, is consulted by the Department for Transport on certain financial matters relating to the GLF.



Trinity House



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## Executive Summary

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This document focuses specifically upon Radio Navigation (RNAV) systems and their evolving role within the overall AtoN service provision mix. It presents the GLA plan in respect of those radio AtoN components necessary to support future e-Navigation services, including GNSS, AIS, Racons, eLoran and others.

The introduction of e-Navigation will change the way that operators react to information that is presented to them and the human factors aspect is critical. Increasing take up of GNSS technology may, over time, allow AtoN infrastructure to be rationalised. However, most importantly, if key e-Navigation components such as GNSS fail or their services are denied to users (e.g. by intentional jamming or unintentional interference) then alternatives must be in place to provide resilience.

The Plan will support and encourage deployment of GNSS systems and their recognition by IMO. These will include modernised GPS, as well as Galileo, GLONASS and Compass.

The GLA DGNSS service will be maintained until 2020 and its continuation beyond that will depend on user needs and alternatives that are available.

The Plan includes a complementary technology to GNSS in eLoran. Its performance will be proved in trials and its general adoption promoted by means of demonstrations and international negotiations.

Support will be given to the development and international harmonisation of AIS AtoNs, including synthetic and virtual.

The development of an international strategy for the future of Racons will be supported, taking account of changes in radar technology.

The implementation strategy for e-Navigation will be supported and GLA applications and services will be developed and demonstrated.

The GLA will encourage the European Commission to publish a European Radio Navigation Plan (ERNP).

The Radio Navigation Plan 2012 is a supporting document of the GLA Strategy 2025 & Beyond.



# 1. Introduction

## 1.1 General

The three General Lighthouse Authorities (GLA) - Trinity House Lighthouse Service (THLS), the Northern Lighthouse Board (NLB) and Commissioners of Irish Lights (CIL), provide marine Aids to Navigation (AtoN) to the mariner in the interests of general navigation. The GLA have a shared mission statement:

*“To deliver a reliable, efficient and cost effective AtoN service for the benefit and safety of all mariners.”*

The GLA Marine Aids to Navigation Strategy between 2010 and 2025 is:

- to continue to provide an appropriate mix of AtoN for general navigation
- to continue to provide a timely and effective response to relevant emergencies
- to continue to undertake superintendence and management of all aids to navigation in accordance with international standards, recommendations and guidelines
- to introduce e-Navigation AtoN components and services in the UK and Ireland
- to work with users, partners and stakeholders nationally and internationally, to promote the safety of marine navigation based on harmonised international standards, recommendations and guidelines
- to embrace relevant technologies as they evolve
- to improve reliability, efficiency and cost-effectiveness of the GLA service while ensuring the safety of navigation

This GLA Radio Navigation Plan (GRNP) forms the GLA response to this strategic vision and specifically addresses their responsibilities with respect to radio AtoNs. This document therefore forms an update to the first version of the GRNP issued by the GLA in 2007.

The GLA Radio Navigation Plan (GRNP) is a core component in delivering the 2025 Strategy. It has been produced by the GLA Radio Navigation Committee (IGC 7) and is under ongoing management and maintenance by the GLA Radio Navigation Committee and the Research and Radio Navigation Directorate. This document will be subject to periodic reviews.

### 1.2 Scope and Objectives

Since the publication of the previous GRNP, the GLA service provision environment has changed substantially. Long term economic trends in shipping coupled with the ever increasing complexity of navigating around the British Isles places extra pressure upon the GLA Radio Navigation services. New developments in technology and the planned availability of new GNSS services also provide opportunities for the GLA to deliver an improved service and greater value for money to its users.

This document focuses specifically upon Radio Navigation (RNAV) systems and their evolving role within the overall AtoN service provision mix. This document therefore presents the GLA plan in respect of those radio AtoN components necessary to support future e-Navigation services, including GNSS, AIS, Racons, eLoran and others. It also includes those radio AtoN components necessary to support future e-Navigation services. It does not include considerations around physical AtoNs such as lighthouses, beacons, major floating aids, buoys, fog signals and other audible aids.

This document is principally aimed at users - reaffirming our commitment to maintain our waters as amongst the safest to navigate in the world. We also wish to share our plans with our partners, at home and abroad, upon whom we depend for continued co-operation. These include the UK and Irish Transport Departments, the Maritime and Coastguard Agency (MCA), the Irish Coast Guard and our international partners in the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA).

This document enables the GLA to move forward with confidence in the delivery of our vision and means that we are able to plan ahead in what promises to be a varied, dynamic and challenging environment.

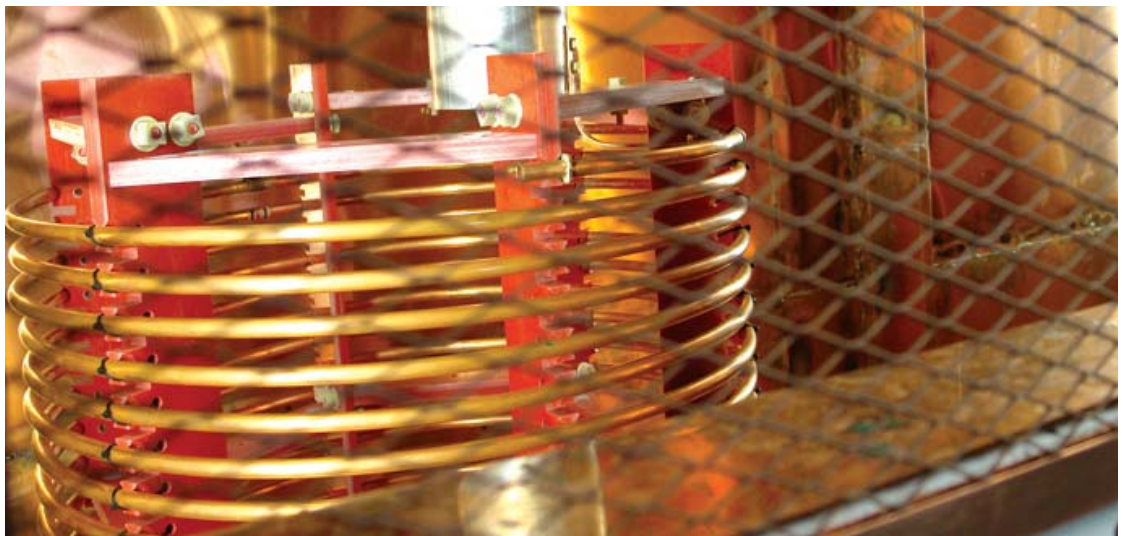


### 1.3 Structure of this Document

Section 2 describes the changing service provision environment and the external drivers that will influence the services that we provide. In response, Section 3 restates our own principles that guide our decisions and the high-level requirements that we must meet.

Section 4 states the GLA RNAV plan, including the specific actions to be undertaken by the GLA in respect of each element of our Radio Navigation system mix. Our approach towards delivering the plan is outlined in Section 5, taking into account the need for flexibility and planning for change.

Section 6 reaffirms our commitment to the user and how this plan will contribute directly towards the continued achievement of our shared mission.

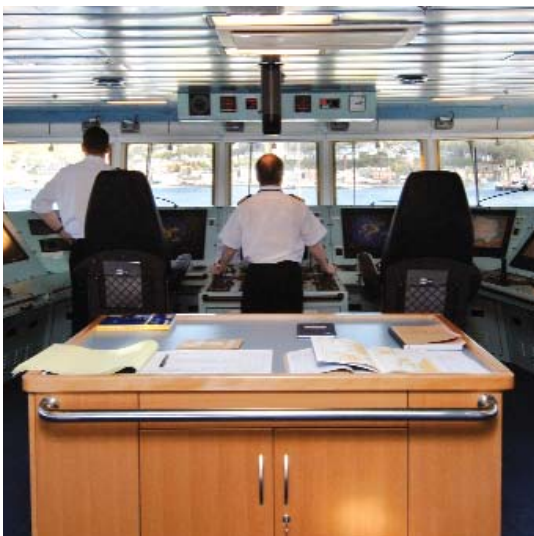




# Radio Navigation

## PLAN

*“This document focuses specifically upon Radio Navigation (RNAV) systems and their evolving role within the overall AtoN service provision mix”*



## 2.

## Our Changing Service Provision Environment

### 2.1 General

In the future, the service provided by the GLA is likely to come under increasing pressure from a variety of drivers. User requirements are becoming more demanding and complex with the increasing diversity of the marine navigation technology market, which is itself expanding in line with the proliferation of mobile and hand-held devices. This step-change in technology is taking place in the context of changing levels of worldwide shipping traffic with consequent effects on revenue for the GLA.

Through co-operation between the GLA and with their international partners, the GLA are able to influence the environment in which they operate - particularly from a technical and operational perspective. However at the same time, there are several external drivers over which the GLA have little or no influence; in these areas we will work to anticipate such change and develop a plan that is pro-active in its response. The key areas of external influence are:

- Regulatory and Institutional
- User and Societal
- Commercial
- Operational
- Technical
- Environmental



## 2.2 Regulatory and Institutional Drivers

The International Maritime Organization (IMO) SOLAS Convention Chapter V, Regulation 13 states:

- Each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.
- In order to obtain the greatest possible uniformity in aids to navigation, Contracting Governments undertake to take into account the international recommendations and guidelines when establishing such aids.

The United Kingdom and Republic of Ireland, as contracting Governments, have delegated this responsibility to the GLA through various Merchant Shipping Acts. These Merchant Shipping Acts (MSAs)<sup>1</sup> also direct the GLA to undertake the superintendence and management of all lighthouses, buoys and beacons within their respective areas.

The SOLAS Convention and the MSA form the basis for the GLA service provision mandate and therefore play a crucial role in driving our plan for implementation. The legal implications of the Draft Marine Navigation Bill and the Nairobi Wreck Convention for the GLA will also need to be taken into consideration.

In 2004, the European Commission published its ‘Recommendations towards the development of a European Union Radio-Navigation Plan (ERNP)<sup>2</sup>’. This document, an updated version of which is currently with the European Commission in draft form, is intended to present the EU’s policies and plans for a stable and robust radio-navigation environment in the EU. When formally adopted it will have a direct synergy with the GLA Radio Navigation Plan. In particular it will clarify the public funding available for the development of core radio navigation services, the potential for the implementation of new services such as eLoran and harmonisation of standards within international bodies such as the IMO.

At IMO NAV 57 the EU delegation stated that *“Although e-Navigation and e-Maritime were not the same, both were addressing the same strategic aims for safety and efficiency of maritime operations and progress in synergy. In essence, IMO’s e-navigation focused primarily on shipborne navigation, so on the development of electronic technology, processes and services.*

*Europe’s e-Maritime focused on shore-based facilitation and aims to develop European capabilities for seamless and effortless exchange of maritime transport information in order to facilitate the transport of goods and passengers over sea - and consequently the ships sailing to, from and around Europe.”*

In this institutional environment the regulation of radio AtoN is increasingly driven at a supranational level. The role of regional bodies such as the European Maritime Safety Agency (EMSA) is growing in prominence as increased focus is brought to bear on harmonising standards

and achieving interoperability between the multitude of different systems available to aid the navigation of the mariner. Resulting Directives will impact the equipment operated both on shore and at sea in terms of the onboard carriage requirements and the performance requirements of the shore-based equipment.

As a result the GLA recognise the importance of such bodies and the need to support their proceedings to ensure that key technologies are developed in accordance with the needs of both the user and the service provider. Of particular importance is the need to resolve spectrum issues associated with frequency congestion while making best use of the available resource through a fair, equitable and transparent management structure.

The direction likely to be taken in Europe on Regulatory and Institutional matters would be clarified by the publication of the ERNP and the GLA would support this initiative.

Major changes in technical approach, such as that required by the introduction of the e-Navigation concept, will affect how the GLA operate under the existing regulatory framework. In particular, under the SOLAS convention, the GLA have a role in providing Radio Navigation services; whether these responsibilities will increase under e-Navigation has yet to be determined.

<sup>1</sup> Merchant Shipping Act 1995 (UK), Merchant Shipping Act 1894 (Republic of Ireland).

<sup>2</sup> Recommendations towards the development of a European Union Radio-Navigation Plan (ERNP), Helios Technology Ltd, 25th October 2004.



### 2.3 User & Societal Drivers

The GLA role in fulfilling their statutory responsibility for superintendence and management of marine aids to navigation may alter significantly under an e-Navigation concept of operations. The growth in GNSS in the mass market and road transport may result in an increased risk of vulnerability due to jamming. The role of the GLA in ensuring the integrity, reliability and accuracy of its DGNSS services will become more critical in this situation. This threat, coupled with the increased dependence by marine navigators upon GNSS presents a challenge for the GLA between now and 2025 - for both regulated and non-regulated vessels.

From a societal point of view, the continued uptake of offshore power by the UK and Irish Governments is a key part of longer term aims of both executives to reduce CO<sub>2</sub> emissions dramatically by 2050<sup>3, 4, 5</sup>. The growing numbers of wind-farm installations and also wave and tidal power will increase the GLA statutory responsibility for superintendence and management of the marking of such structures. The growth in renewable energy sites will be accompanied by an increase in decommissioned offshore oil and gas installations. When left in position, these unmanned structures could remain a hazard to navigation and need to be marked appropriately using modern automated technologies.

The requirement under the UK's Port Marine Safety Code to maintain casualty response data and submit periodic availability reports to the GLA represents recognised best practice. This requirement has already been extended to other authorities responsible for the maintenance of local AtoN, such as local councils and utility providers. This practice will be further extended to those responsible for the maintenance of AtoN on renewable energy and aquaculture sites.

<sup>3</sup> Energy Act 2008, 26th November 2008.

<sup>4</sup> Climate Change Act 2008, 26th November 2008.

<sup>5</sup> Official Communication - Commission for Energy Regulation, Irish Government, December 2009.

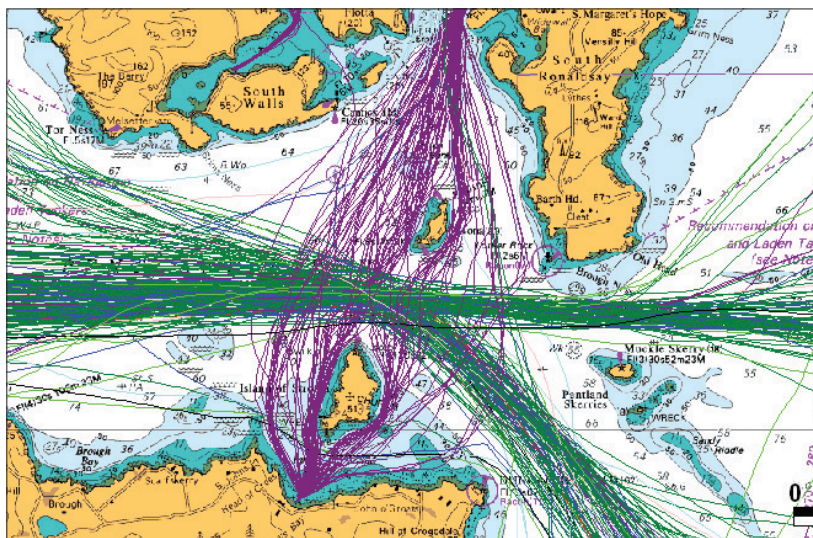
## 2.4 Commercial Drivers

There are key emergent trends in the global shipping industry which are already having, and will continue to have a significant effect on the service that the GLA deliver. Revenue generated from light dues will continue to rise and fall as shipping traffic fluctuates. Further, as central government looks to lower costs across all departments through such measures as the Comprehensive Spending Review,<sup>6</sup> downward pressure will be applied to the income provided to the GLA. The GLA Radio Navigation services must therefore be cost-effective to both the user and service provider - with the GLA adopting a flexible and user-centric approach to service provision.

The 2010 report by Atkins entitled “*Assessing the Provision of Marine Aids to Navigation around the United Kingdom and Ireland*”, provided various recommendations<sup>7</sup>. This included a review of how light dues are levied in the UK and Ireland and a thorough assessment of the scope for cost reductions across a range of operational and support functions over the short and long term. At a managerial level, the report recommends efficiency savings that could be made in the administration of the GLA in their functions as AtoN providers, quasi-regulators and system specifiers. Implementation of the Atkins recommendations is ongoing and significant changes and savings have already been achieved.

The report assessed additional measures the GLA could take to reduce support costs, including:

- Building new business models based around Service Level Agreements
- Outsourcing non-core business areas
- Working more closely with other bodies that monitor, manage and operate GNSS services



Despite the current economic downturn however, the GLA must be prepared for shipping movements to return to growth over the long/mid-term. The GLA must therefore consider scenarios and develop contingency plans that will enable them to meet their service commitments if 'business as usual' growth resumes.

Trends in global growth and shipping are inevitably reflected in the age of the world fleet. Over the last ten years, the average ages of container ships and tankers have significantly decreased, prompted by demand in Asia. While the average age of the world fleet is decreasing, more than 30% of the fleet is more than 20 years old.

The pressures on service provision will increase as a result of these changes. The size, age and ability of the international fleet is becoming more varied and this has a significant effect upon our plans for introducing new onboard equipment. Essentially, the GLA must meet the demands of 30 year old cargo ships with basic bridge and navigation equipment as well as brand-new container ships with fully integrated bridge systems.

<sup>6</sup> Spending Review 2010, [www.hm-treasury.gov.uk](http://www.hm-treasury.gov.uk).

<sup>7</sup> ATKINS, Assessment of the Provision of Marine Aids to Navigation around the UK and Ireland, Final Report, March 2010.

## 2.5 Operational Drivers

With the current economic downturn there is a distinct need for flexibility from both the users and the service providers. The extra capacity generated in the industry during the world-wide growth in shipping movement has produced excess shipping capacity during the downturn. In this situation ship operators will utilise the most cost-efficient vessel for the task at hand.

However from an operational perspective, reliability of service provision is the key and comprehensive risk management processes will still need to be followed to ensure that adequate resilience is built into the system. For the GLA, this means providing a guaranteed seamless, high integrity, 'always-on' positioning system to seafarers.

e-Navigation is defined as:

**“The harmonized collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment”.**

The introduction of e-Navigation will change the way that operators react to information that is presented to them and getting the human factors part of this right is critical. Increasing take up of this technology may, over time, allow the AtoN infrastructure to be rationalised. However, perhaps most importantly, we need to understand what happens when key e-Navigation components (e.g. GNSS) fail or their services are denied to users (e.g. by intentional jamming or unintentional interference).

In addition to e-Navigation there are many evolving elements in the operational environment that present new challenges to service provision in terms of cost, risk and service level, including:

- The widespread and growing reliance upon GNSS as the primary means of position fixing
- The increasing deployment of Traffic Routing Schemes to cope with increasing traffic levels
- The balance between traditional navigation skills and the role of technological advances such as ECDIS and INS/IBS



## 2.6 Technical Drivers

Through co-operation between the GLA and with their international partners, the GLA are able to influence and determine the technical service provision environment. However, there are several external drivers which the GLA need to anticipate and respond to. Those that will directly influence the AtoN system mix until 2025 include:

- Introduction of new GNSS services: Galileo and EGNOS; modernised GPS, the restoration and modernisation of GLONASS; Compass and others
- Prospect of European-wide provision of eLoran services
- Introduction of NT radars
- Availability of broadband communications and their potential role as an e-Navigation component

The GLA will need to monitor and assess a number of emerging on-vessel capabilities to ensure that the AtoN service is tailored to the needs of the user. These include:

- Growing deployment of ECDIS and INS/IBS
- Inclusion of RAIM and possibly inertial navigation systems in future GNSS receiver standards
- Development of new receiver based techniques for detecting and mitigating the potential effects of GNSS interference (intentional and unintentional)
- Availability of consumer-grade multi-constellation GNSS receivers and their proliferation amongst non-regulated vessels and smaller craft

In addition to these specific technologies the GLA will also need to take account of new system engineering best practice including:

- Certification and standardisation of more involved systems
- Forthcoming availability of software defined receivers
- Remote diagnostics and through-life service management

These new systems and services provide an ever-increasing array of options through which to optimise cost, risk and service level. At the same time, the need for co-ordination with partners in IALA and key stakeholders such as MCA and ICG has never been more important in order to ensure consistent levels of service provision on an international basis.

## 2.7 Environmental Drivers

As environmental drivers gain prominence in the UK and Ireland the GLA act not only to preserve the marine environment within which the ships operate but also with a wider economic and climate conscious mindset. Shipping will need to adapt both to operating in a changing climate as well as navigating the marine-based renewables put in place to avoid these changes (such as wind-farms, tidal and wave power systems).

The impacts of regulations on other sectors will also affect the GLA as their implementation leads to the proliferation of off-shore equipment and a subsequent requirement for a safe navigation service in their vicinity. An example is the UK Department of Energy and Climate Change's Energy Act 2011 which binds the UK to fulfil its commitment by the construction of multiple off-shore wind farms<sup>8</sup>.

At an institutional level it is likely that shipping will, in future, be incorporated into the European Emissions Trading Scheme - which, in turn, will increase the drive towards more efficient operations (e.g. through slow steaming)<sup>9</sup>.

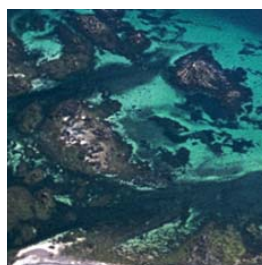
Climate change is forecast to give rise to an increase in frequency and severity of the winter storms in UK and Irish waters and ice free summers in higher latitudes opening up previously un-navigable and more efficient shipping channels around the globe. In the longer term rising sea levels could render some ports unusable and change the navigable approaches to others.

The GLA will therefore need to ensure that they are able to:

- maintain a full SOLAS service, even under extreme weather conditions
- mark the most direct route possible between origin and destination (including supporting international initiatives with such aims)
- mark high density sea-lanes with high levels of safety and efficiency

<sup>8</sup> Green Energy, (Definition and Promotion) Bill, Bill 15 of 2008-2009, 12th May 2009 UK Parliament, [www.parliament.uk/](http://www.parliament.uk/)

<sup>9</sup> EU Plans for shipping Emissions Cap, 29th June 2007, [www.euractiv.com](http://www.euractiv.com)



### 3. Our Guiding Principles

The GLA share a fundamental set of principles in regard to AtoN service provision:

- The GLA must provide such aids to navigation as deemed practicable, necessary and justified by the volume of traffic and the degree of risk
- Each GLA shall take into account appropriate international directives, requirements, recommendations and guidelines, including those of IALA
- The GLA co-operate closely with each other to minimise overlap in the provision of AtoN and to ensure consistent levels of service provision
- Integration and collaboration is likely to extend to other neighbouring administrations in the short to medium term

These high level shared principles guide our internally driven requirements in response to the external influences in the service provision environment described in Section 2. Our Radio AtoN services must adhere to the following requirements:

- Services should meet the needs of all users, from tankers, cargo, passenger and container ships through to small leisure and fishing vessels
- Services should meet the needs of users and not just be driven by emerging technological solutions
- Services should offer good value for money and evolve in a manner that seeks to reduce the cost of service provision whilst maintaining safety obligations
- Standardisation and global interoperability should enable the earliest possible uptake of new services and technology
- An integrated approach to radio AtoN services should ensure high levels of safety, integrity, reliability and flexibility
- Diversity across the infrastructure should minimise single points of failure to service provision
- Collaboration with other transport sectors and industries should identify opportunities for sharing infrastructure and utilising common technologies
- An optimised radio AtoN system mix must maintain the ability to respond effectively and quickly in the event of an emergency

## 4. The GLA Radio Navigation Plan

### 4.1 Optimising the Radio Navigation Service Mix

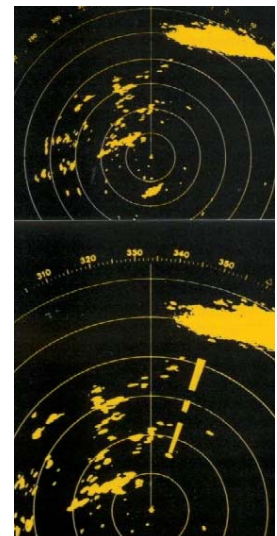
In order to meet the varied user requirements, Radio AtoN provision must be considered in the context of an overall system of AtoN in any particular area. The mix of AtoNs provided within the system must meet user needs in differing weather and other environmental conditions, taking into account the type and density of traffic as well as technological developments in surface navigation.

**An optimised service provision mix is one that is flexible in the way that it can be cost-effectively deployed to meet the needs of different groups of users.**

It is accepted that the need for visual AtoN to provide position fixing has decreased markedly in recent years due to widespread use of the Global Navigation Satellite System (GNSS). Conversely, the need for AtoN to provide hazard marking and warning has increased in order to assist the mariner in spatial and situational awareness.

There is a perception that the disparity between onboard equipment fit and competence amongst users is increasingly evident and that this has been further exacerbated by global economic pressures upon the shipping business. The mariner navigating only by compass and paper chart will have totally different needs to that of a watchkeeper on the bridge of a modern cruise ship. Importantly, the variety of navigation equipment and skills in non-SOLAS vessels requires the GLA to ensure that the risk control measures provided by AtoN are comprehensive.

It is recognised that the widespread reliance on GNSS as the primary means of position fixing has encouraged mariners to navigate in areas where, and under conditions in which, they had not previously ventured - for example, close inshore, at night and in reduced visibility. The recognised vulnerabilities of GNSS to interference and jamming must be taken into consideration when determining future AtoN provision.



# Radio Navigation

## PLAN

To deliver a reliable, efficient and cost effective AtoN service, the GLA must therefore take account of the vessel-borne navigation aids deployed by each type of user. This includes the anticipated roll-out of e-Navigation services and concepts aimed at delivering (amongst other benefits) safer berth-to-berth navigation. This plan therefore also includes activities aimed at influencing the introduction of e-Navigation components and services that manage potential uncertainties.

Support and encouragement will be offered to the European Commission in bringing forward the ERNP for publication. The GLA Plan is consistent with the 2004 draft ERNP.

This plan is based upon the GLA supporting the full range of Radio Navigation systems available to deliver a flexible service that meets the needs of all users. This approach is the only way that we can maintain service levels in the context of a rapidly changing and unpredictable service provision environment. GLA systems will be deployed in particular areas in a way that balances cost, risk and service levels.

An increase in the number of available GNSS systems will not of itself mitigate the risk of jamming or interference.

Our Radio Navigation plan envisages an overall AtoN system mix comprising:

- GNSS (GPS, Galileo, DGNSS, GLONASS, Compass)
- Automatic Identification System (AIS)
- Racons
- Enhanced (e)Loran
- Other e-Navigation AtoN components



## 4.2 GPS

GPS is a dual-use radio-navigation system that is operated for the Government of the United States by the US Air Force and managed by the Interagency GPS Executive Board. It is defined nationally by the US to meet military and civil requirements with a global user-base.

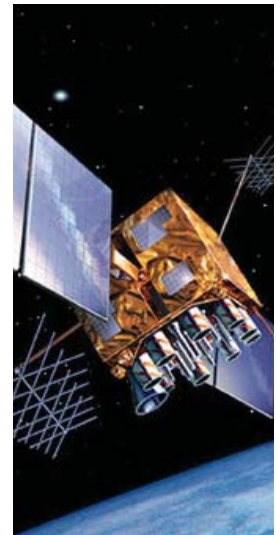
The US has programmes underway to modernise the GPS system and introduce new GNSS services. These will be provided via diverse carrier frequencies and offer the maritime user many benefits in terms of service level performance. Some of these new services have already been launched and others are planned to be rolled out between now and 2020.

At present, GPS is the principal means of position fixing used by all classes of mariner in ocean and coastal navigation. The GLA believe that this will remain true until at least 2020 and that our Radio Navigation Plan should reflect this reality. However, as stated many times within this document, general reliance on GPS leads to a single point of failure and this is reflected in our strategy to:

- Support/encourage deployment of other baseline GNSS systems such as Galileo - see Section 4.3
- Provide augmentation services for integrity and accuracy through Radiobeacon DGNSS - see Section 4.4
- Promote complementary technologies to GNSS

In support of this plan, the GLA will:

- Encourage the EU to work with US GPS authorities to ensure the continued availability of GPS services in Europe
- Monitor the development of new GPS service components to ensure that the services provided meet the needs of the mariner
- Encourage and support the WWRNS recognition (via IMO) of new GPS services due to be available before 2020
- Co-operate with other UK critical infrastructure stakeholders to examine the feasibility of a common GNSS performance monitoring network by 2015



### 4.3 Galileo

In the future, the single GPS constellation that provides today's GNSS will be supplemented by Galileo and other global systems such as GLONASS and Compass. GNSS will therefore provide a wide range of signals and services with performance above and beyond that available today - fulfilled by, potentially, over 100 satellites by 2025.

Galileo is the European GNSS programme currently being implemented by the European Commission (EC), with assistance from the European Space Agency (ESA). Previous initiatives to fund the design and build of the system using private investment have failed and therefore the initial phase of the system roll-out is being funded by European Member States. The European GNSS Agency (GSA) is responsible for the commercialisation of the system and for its security management aspects.

Galileo is expected to offer a range of new GNSS services comprising:

- An Open Service (OS) - free at the point of use and interoperable with the free-to-air GPS service
- A Safety of Life (SOL) service - providing pseudo real-time integrity messages to the user, and certified for specific applications
- A Commercial Service (CS) - providing commercial specific data services to users with more stringent requirements
- A Public Regulated Service (PRS) - aimed at government users with more stringent security requirements
- A Search and Rescue (SAR) service - compatible with today's COSPAS/SARSAT services

Galileo is expected to provide an Initial Operational Capability (IOC) in 2015, offering 18 satellites supporting the OS, PRS and SAR, with a possible increase to 24 satellites in 2016. The date for achieving Full Operational Capability (FOC), including a certified SOL service, is now quoted as 2020.

There are clear benefits to the maritime community of the Galileo OS - allowing users to achieve a higher level of service performance from two constellations. The Galileo OS will offer a high degree of interoperability with the future open GPS signal and at the same time will provide a

certain degree of redundancy at a system level. This increased level of performance in terms of reliability and integrity may allow the GLA to consider a degree of rationalisation in its DGNSS infrastructure from 2020 onwards - see Section 4.4.

In response to the opportunity offered by Galileo and other emerging global GNSS components, the GLA will:

- Support and contribute towards the WWRNS recognition of the Galileo Open Service (OS)
- Test and demonstrate the Galileo OS when available to confirm that its performance is in line with expectations
- Monitor the development and specification of the other Galileo (and other GNSS) services in order to ensure that the services meet the needs of the mariner
- Continue to promote the immediate development of GNSS onboard equipment standards through IMO, IALA, IEC and ITU. These should include generic software GNSS receivers that will enable an accelerated and more cost-effective uptake amongst users

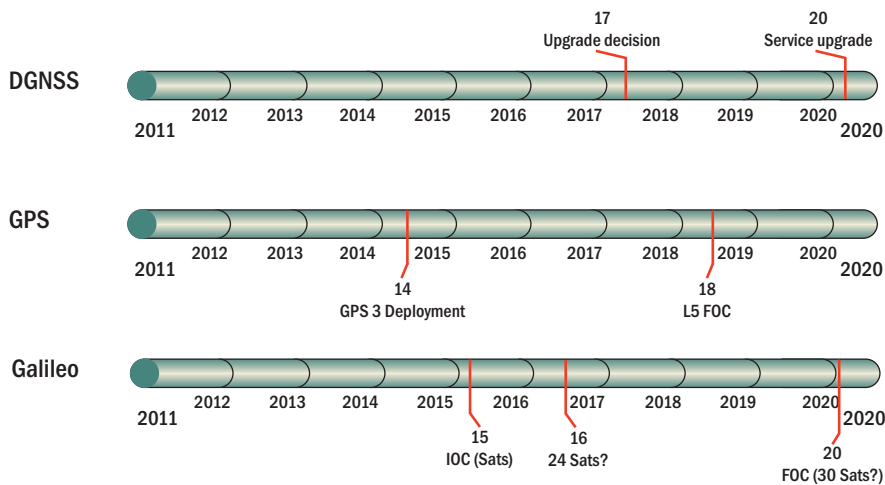




### 4.4 Radiobeacon DGNSS

Radiobeacon DGNSS remains the internationally accepted means of providing DGNSS (DGPS at present) corrections to maritime users. It is defined internationally with global standards and regional harmonisation of frequencies through IALA and ITU. This service today represents an important means by which each State's obligations are met - to ensure a safe and efficient marine navigation infrastructure, as required under the IMO SOLAS Convention.

The GLA will continue to provide their differential GNSS service. This service will be developed in line with GPS, Galileo, GLONASS and Compass to provide not only comprehensive but cost effective augmentation in terms of accuracy and integrity. The service will monitor the performance of GPS and eventually Galileo, GLONASS and Compass, to provide timely integrity warnings of service degradation.



In the context of external commercial drivers, the GLA will carefully examine whether the availability of multiple GNSS constellations provides an opportunity for partial rationalisation of the DGNSS network after 2020. This could be in conjunction with more advanced GNSS receiver functionality such as RAIM and/or alternative integrity monitoring infrastructure. Such a decision will need to be taken by 2017 based upon all available information concerning service performance and, in particular, integrity.

Future developments of the DGNSS service must also take account of the introduction of other differential GNSS augmentation services such as EGNOS (European Geo-stationary Navigation Overlay Service). EGNOS has been certified for use by aviation users and declared operational

in 2011. The integration of EGNOS into the existing DGNSS infrastructure and the transmission of multiple corrections to users could potentially offer increased service level at little additional overall cost to the maritime industry.

In support of this plan, the GLA will:

- Continue their long term programme of system development and upgrade, taking into account the availability of new GNSS signals and services
- Seek opportunities for potential system rationalisations from 2020 onwards whilst keeping pace with the evolving user requirements for reliability and integrity
- Continue to work towards the WWRNS recognition through IMO of Radiobeacon DGNSS, with support from our international partners
- Determine the technical feasibility, policy implications and commercial business case supporting the integration of DGNSS radiobeacons and EGNOS
- Work within IALA and IMO to ensure that the ERNP is harmonised with IMO resolutions and standards and IALA's recommendations and guidelines



### 4.5 eLoran

eLoran (enhanced Loran) is a low frequency terrestrial navigation system based on a number of transmission stations, which emit precisely timed and shaped radio pulses centred at the 100 kHz radio frequency. eLoran represents a move away from the hyperbolic Loran of old; it works in much the same way as GNSS, and is an independent and complementary system with no failure modes in common with GNSS.

Utilising improved Additional Secondary Factor (ASF) provision and a differential service, eLoran can offer increased accuracy and integrity to provide backup and integrity for GNSS. A prototype service, in continuous operation at Harwich since 2008, is providing an accuracy of around 10m (95%). Better accuracy could be expected in the context of a more comprehensive European service.

eLoran allows users to retain GNSS levels of navigational safety even when satellite services are disrupted. The GLA have undertaken studies and trials to understand the effect of GPS jamming on safe navigation at sea. These trials have clearly demonstrated the potential failure modes of all GPS-fed onboard navigation systems and the potential for hazardously misleading information.

The GLA consider the provision of a complementary, internationally standardised, back-up system to be essential to e-Navigation.

In support of this plan the GLA will:

- Continue the operation of our trial eLoran service and aim to achieve eLoran initial operational capability (IOC) in a limited region of GLA waters by 2013
- On achievement of IOC, review European support with a view to advancing to FOC
- Make the eLoran business case and results of GLA trials available to regional and international stakeholders
- Monitor the development of other potential complementary and internationally standardised back-up systems that will enable the GLA to maintain their existing service levels until 2025



## 4.6 Automatic Identification System

AIS technology can significantly enhance and complement existing Aids to Navigation. In particular, AIS technology can be used in the following ways:

- To provide AtoN identity and AtoN status confirmation to the mariner
- As Real or Synthetic AIS transmitted on behalf of an existing AtoN
- As Virtual AIS AtoN, where no physical AtoN exists, for example for use in wreck marking prior to deploying buoys, mitigating further the risk to mariners
- To broadcast AtoN monitoring for the service provider
- To facilitate traffic analysis by AtoN providers to assist in the provision of the appropriate level of service and mix of AtoN

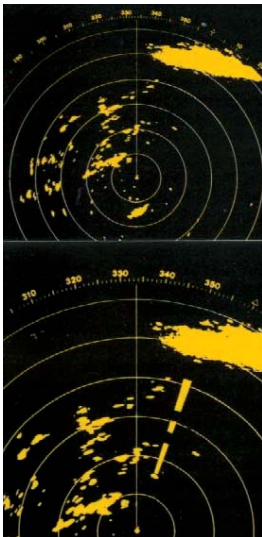
Under SOLAS, all ships of 300 gross tonnes and upwards engaged on international voyages, cargo ships of 500 gross tonnes and upwards not engaged on international voyages and passenger ships irrespective of size are already required to be fitted with an Automatic Identification System (AIS). In addition, ships not engaged on international voyages and constructed before 1 July 2002 have also been required to be equipped with AIS since 1 July 2008. Over and above these rules, there are now some international authorities that require all vessels transiting their area of jurisdiction to be fitted with AIS.

As AIS develops, the GLA will seek to exploit all these benefits to enhance their service delivery to the mariner by applying AIS technology to selected AtoNs. The use of AIS as an AtoN will have a direct and positive financial impact on our service provision. Under certain circumstances AIS may provide an appropriate alternative to permanent or temporary physical AtoNs. However, this is not seen as a means of reducing the cost of service provision.

In order to maximise the opportunities presented by AIS, the GLA will:

- Enable an operational AIS virtual AtoN service
- Work closely alongside the MCA and IRCG to establish the necessary inter-agency service level agreements
- Continue our involvement in the development of relevant standards through IMO, IALA, IEC and ITU
- Monitor the development of new and evolving AIS technologies and assess their ability to support new value added AtoN services to the user

### 4.7 Racons



Users continue to place a high importance on Racons as an integral part of any AtoN system particularly at night, in reduced visibility and adverse weather conditions. In response, the GLA recognise the importance of Racons in the overall service provision mix and their role in satisfying the needs of specific users.

The GLA consider Racons a very important element of the AtoN system mix since they provide an independent means of identifying and locating marks in poor visibility and without reliance on GNSS. S-Band (2.9 - 3.1 GHz) radar is particularly useful in heavy rain clutter conditions. It is generally recognised that S-band radar is preferred as the ARPA/collision avoidance radar due to its detection and display properties.

IMO MSC79 approved new radar performance standards in Resolution 192(79) that removed the requirement for S-Band Radars to trigger Racons. This was intended to facilitate the introduction of "new technology" (NT) to improve detection of small targets, performance in clutter and to enable future radars to meet the more stringent limits being imposed on spurious and out of band emissions.

Racons that are compatible with the new radar technologies could be developed, but there are currently no industry standards or recommendations for these "new technologies".

In support of this plan, the GLA will:

- When providing new or replacement Racons, normally use those most compatible with NT Radar
- Continue to monitor developments in radar technology and support specific studies or trials as required
- Continue to liaise with appropriate national and international bodies and Racon manufacturers, as required, to investigate solutions and ensure that the mariners' requirements are met
- Explore potential for absolute positioning using enhanced radar AtoNs and additional processing facilities on radars
- Encourage development of an international strategy for the future of Racons



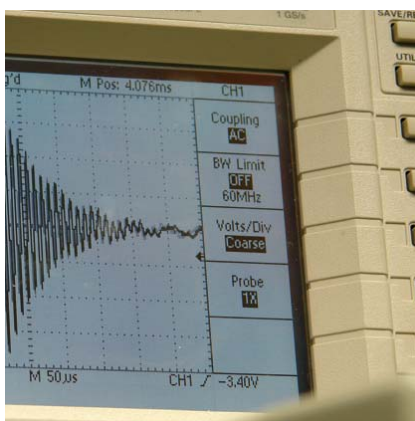
## 4.8 e-Navigation Components

The IMO's e-Navigation concept is defined as *“the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment”*.

The structural components of e-Navigation - many of which already exist on some vessels-include:

- Integrated Navigation Systems and Integrated Bridge Systems
- Integrated displays using Electronic Chart Display and Information Systems (ECDIS)
- Electronic Navigation Charts (ENCs)
- Electronic Positioning Fixing Systems (EPFS)
- Vessel route and status information
- Transmission of positional and navigational information using AIS
- Information prioritisation, alarm management and decision support
- Appropriate and reliable communications channels

The GLA are working with their international partners to investigate how e-Navigation may develop and to provide a road map to development and certification. This will help to match services to user requirements and identify the progression path and potential system design. The



GLA are also investigating the use of additional sensors on AtoNs to determine what information will need to be made available to the mariner to enable e-Navigation and how this can be best achieved.

In support of this plan, the GLA will:

- Support Government and IMO in e-Navigation development and standardisation for the benefit of all users
- Ensure that resilient PNT is recognised as an essential element of e-Navigation and that its provision is addressed as part of the implementation strategy
- Investigate what AtoN information is required for e-Navigation to work correctly and determine the necessary role of the GLA
- Support the initial implementation of e-Navigation and the securing of necessary spectrum to support the GLA necessary role
- Monitor the development of new communications technologies in the mass market and assess their suitability to meet the GLA requirements in respect of e-Navigation
- Investigate additional benefits of e-Navigation for the GLA, including the provision of value added services to specific groups of maritime users



## 5. Delivering the Plan

### 5.1 Implementation

This plan will be delivered through:

- **Co-operation between the three GLA** - at all stages of the business lifecycle (covering concept, requirements, design, development, test, operation, disposal, etc) to ensure the provision of the required level of service
- **Strategic Participation in IALA** - to ensure continuous representation of national interests whilst working alongside our international partners
- **Continuous Aids to Navigation Review** - to ensure that the Aids to Navigation system effectively supports user needs, taking into account all potential changes in the service provision environment. This includes trends, types, volume and mix of traffic, local hazards, areas of traffic convergence/separation, environmental considerations and changes to other risk mitigation measures
- **Consultation with User Groups** - to ensure the level of service continues to meet their requirements, taking into account the balance between radio navigation, other AtoNs and onboard systems
- **International agreement on IMO e-Navigation** - the GLA will work through IALA and IMO to give their input and support to the e-Navigation initiative





- **Participation in European Projects** - in order to ensure that we actively influence and monitor those activities that directly impact upon our strategy. In particular, we will work to bring about the implementation of the ERNP. Moreover we will examine various European development programmes with the aim of securing external funding to maximise leverage in the GLA ongoing investment in R&D. For example, the GLA are participating in the ACCSEAS project under the INTERREG IVB programme in the North Sea Region. This will lead to the development and implementation of e-Navigation test-beds, meeting many of the objectives of this Plan. ACCSEAS will enable the provision of radio navigation services in coordination with neighbouring countries and encourage harmonisation of levels of service and adoption of common standards
- **Continuing Contribution to Developments in Marine Technology** - to ensure future and current Radio Navigation service provision remains relevant and supported by international standards where appropriate
- **Application of the Risk Assessment principles** - as laid down in the IALA Guidelines, to better understand the vulnerabilities of our system mix and the redundancy required in our systems and operations
- **Continued and closer co-operation with the MCA and IRCG** - who have the national lead in providing the AIS network
- **Providing input to future revisions of Merchant Shipping Acts** - to ensure that our GRNP is well aligned with our regulated responsibilities
- **Promotion and communication of this plan** - to ensure that our users, national stakeholders and international partners are fully aware of how we intend to continue providing our service up until 2025

## 5.2 Planning for Change

This plan reflects the level of service the GLA will provide to all users, taking advantage of technological and operational improvements that we forecast in radio AtoN service provision. However, there are other developments in the external environment, many of which have been discussed in Section 2, that will directly impact our level of service in the future. In particular, the GLA must plan for slow annual growth in maritime traffic in the short term, whilst preparing for a return to more rapid growth over the longer term.

As outlined in our Marine Aids to Navigation Strategy, we believe our overall plan will evolve to reflect progress made at international and national level in any or all of the following areas:

- Inter-body agreements between IMO, IHO, MCA, IALA and Administrations on e-Navigation and any subsequent changes to mandatory carriage requirements
- Anticipated timescales for the implementation and operation of new GNSS services
- The realisation of the European Radio Navigation Plan (ERNP) and the implementation of all recommendations
- The adoption of eLoran as the terrestrial back up to GNSS in Europe and establishment of an Initial Operational Capability (IOC)
- Automatic Identification System (AIS) data that facilitates the use of synthetic and virtual aids to navigation
- A network of AIS stations around our coast facilitates implementation of AIS as an AtoN, and as an emergency wreck marking system by stakeholders such as the GLA; as well as providing the all-important traffic data to inform the risk management process that determines the deployment of AtoNs
- Measures are considered that direct traffic in high density and high risk areas, potentially leading to some degree of sea-traffic control and changes in the provision of AtoN and Vessel Traffic Services accordingly
- The carriage of integrated navigation receivers by non-SOLAS Vessels to ensure that all mariners have a position-fixing capability with or without the availability of radar or visual AtoNs

### 6.

## Our Commitment to the User

The GLA will:

- Work closely together to maximise their benefit and impact
- Consult regularly with users through the Joint User Consultative Group, individual consultative committees and local user groups, to understand their needs, inform them about developments and consider their views to improve the service we provide for all classes of mariner
- Engage with other maritime service providers in the UK and Ireland to ensure a co-ordinated approach to safety of navigation in our areas of responsibility
- Work with local lighthouse authorities and our neighbouring littoral states to ensure that users receive an effective and seamless service
- Provide a stable and resilient AtoN service for general navigation that meets international standards, recommendations and guidelines
- Respond to wrecks, new dangers and AtoN casualties in a timely fashion to minimise the risk to users
- Engage with international organisations, government and other bodies to promote the harmonisation and standardisation of AtoN services
- Ensure that through constant review the AtoN mix is relevant, reliable and cost effective
- Conduct their activities in a way that minimises their impact on the environment

This plan describes how the GLA will adapt in the face of a rapidly changing service environment, thereby optimising service provision in terms of cost, risk and service level.

When delivered, this plan will mitigate risk in providing for the safety of navigation, the protection of life, property and the marine environment.

If the plan, as described in this document, is not implemented, the GLA will not be able to provide services as cost-effectively, maintain their track record of success or deliver their shared mission statement:

**“To deliver a reliable, efficient and cost effective Aids to Navigation Service for the benefit and safety of all mariners”.**

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# Radio Navigation

## PLAN



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