IALA GUIDELINE

G1057
THE USE OF GEOGRAPHIC INFORMATION SYSTEMS BY AIDS TO NAVIGATION AUTHORITIES

Edition 1.1

December 2007

urn:mrn:iala:pub:g1057:ed1.1

10, rue des Gaudines – 78100 Saint Germain en Laye, France
Tél. +33 (0)1 34 51 70 01 – contact@iala-aism.org

www.iala-aism.org

International Association of Marine Aids to Navigation and Lighthouse Authorities
Association Internationale de Signalisation Maritime

DOCUMENT REVISION

Revisions to this document are to be noted in the table prior to the issue of a revised document.

Date	Details	Approval
December 2007	First issue.	Council 42
July 2022	Edition 1.1 Editorial corrections.	

CONTENTS

List of Figures

1. INTRODUCTION

Although there are unique circumstances surrounding the work that Marine Aids to Navigation (AtoN) authorities undertake, in many ways, their overall objectives are the same:

> "To provide aids to navigation networks and systems in the most efficient and effective way possible with the aim to assist the mariner in making safe and expeditious passage."

AtoN authorities need to identify best practices in service delivery to make optimum use of management and staff. In particular, the use of geographic information systems (GIS) may assist in effective AtoN planning, including evaluation and validation; ensuring that funds are invested wisely in new technology.

Coastal waterways are becoming increasingly congested with vessel traffic and developments such as offshore wind farms, tidal turbines and aquaculture sites, which require to be marked. In addition, light pollution through coastal development, the advent of larger and faster ships, and the continued growth in small craft usage means that designing suitable AtoN systems becomes ever more complex. Using GIS, accurate design and provision of AtoN systems as well as suitable simulation, can prove very useful and may reduce the chance of costly mistakes being made.

Chapter V of the 1974 *SOLAS Convention* (as amended) describes the approach taken by Contracting Governments to establish and operate AtoN.

SOLAS Chapter V, Regulation 13, states:

> "1. Each Contracting Government undertakes to provide, as it deems practical and necessary, whether 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.
>
> 2. 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.
>
> 3. Contracting Governments undertake to arrange for information relating to aids to navigation to be made available to all concerned. Changes in the transmissions of Position-fixing systems which could adversely affect the performance of receivers fitted in ships shall be avoided as far as possible and only be effected after timely and adequate notice has been promulgated."
>
> * Refer to the appropriate recommendations and guidelines of IALA and to *SN/Circ.107*.

This Guideline is one of those referred to in section 2 above and provides information about the use of GIS to help AtoN authorities meet the requirements of section 1.

2. SCOPE

In many fields of work, the management of information that has a spatial component (i.e., information with a link to a physical location) can be enhanced using GIS technology. AtoN are distinctly linked to physical locations, and their use by mariners invariably involves the use of more than one AtoN at a time, that is, AtoN networks or systems. These single and interdependent linkages between AtoN and their physical locations mean that GIS technology can provide AtoN authorities with enhancements in many areas of their business, which may ultimately lead to benefits for mariners.

This document provides guidance for the implementation and use of GIS to assist authorities in the planning and evaluation of the suitability and effectiveness of the provision of AtoN networks or systems depending on user needs and expectations, traffic volume and identified risks.

This document provides a generic overview of GIS and its potential applications within AtoN authorities, and should be read in conjunction with the IALA Recommendation *R0138 (O-138) The use of GIS and Simulation by Aids to Navigation Authorities.*

The process for implementation and using GIS applications and tools may vary across the IALA membership.

3. THE USE OF GIS BY AtoN AUTHORITIES

A GIS captures, displays, stores, analyses, and manages spatially referenced data. A key feature of GIS is its analytical functionality, which allows a user to interact with spatial data to determine relationships between different types of data and to produce qualitative (diagrammatic/graphical) and quantitative (numeric/tabular) results.

GIS technology can be integrated with other information technologies and is generally considered an important component of a wider information management solution for any authority that has an interest in or a responsibility for spatially related information.

GIS can provide a powerful information management and visualization platform, with tools for AtoN management such as planning, layout, maintenance, evaluation and so on. GIS can also provide an open and integrated environment for the collection, display and analysis of data from various information sources such AIS networks, VTS and other ship reporting systems. The following diagram details an example of how GIS can be incorporated into the activities of an AtoN authority.

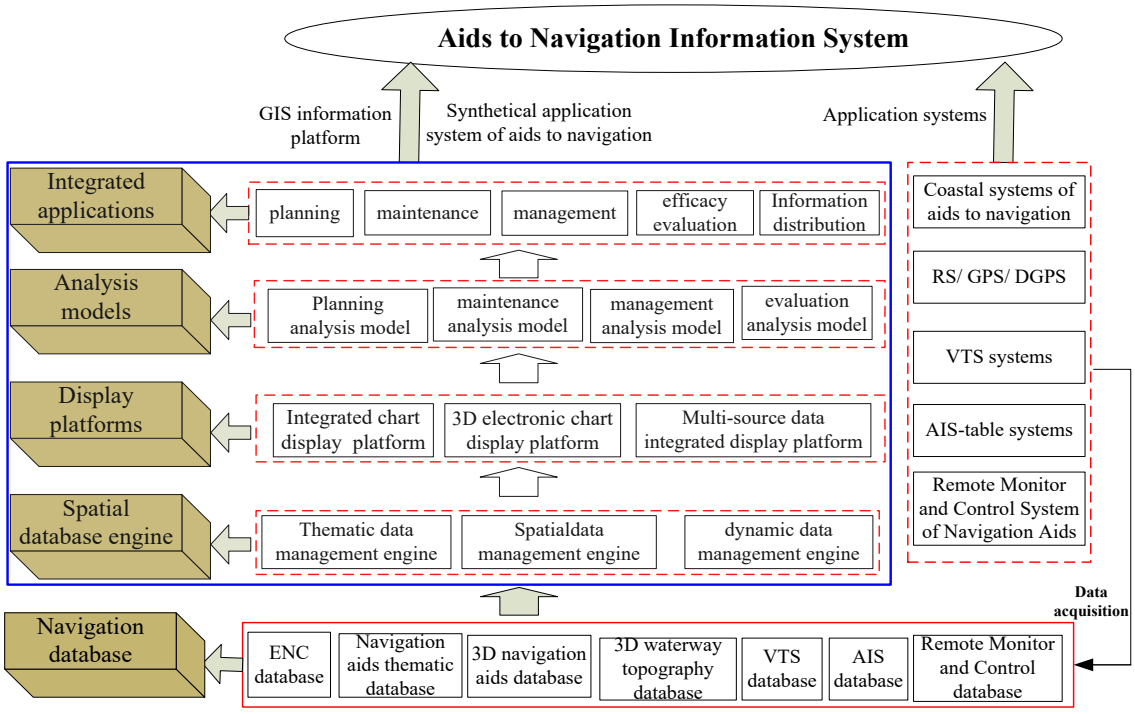

Figure 1 AtoN information system, incorporating GIS

Note: Diagram provided, courtesy of China Maritime Safety Administration

4. APPLICATIONS OF GIS

GIS can be used to display information on AtoN activities, facilitate the review and evaluation of AtoN and contribute to channel design and planning of waterways.

4.1. INFORMATION DISPLAY

The primary types of geographic information generally included in a GIS are in a vector or raster format. GIS can be used to display various types of information, such as:

- Spatial information on AtoN (e.g., characteristic, maintenance, placement, service providers) and other related matters such as environmental information (e.g., building, background lighting))
- Vessel traffic and tracking (e.g., AIS and VTS) and, where possible, including non-SOLAS vessels
- Hydrographic information
- Go/no-go areas, design or restricted areas (i.e., marine parks, protected wildlife areas, particularly sensitive sea areas, aquaculture sites, fish farms, wind farms)
- Meteorological-oceanographic information
- Oil and gas exploitation information (e.g., pipelines, cables, future facilities)
- Historical information (e.g., maintenance and service records, data log about previous locations of an AtoN)
- Charts, photographs, transportation images, satellite images

4.2. REVIEW AND EVALUATION OF ATON SERVICES

GIS can be used to perform review and evaluation of AtoN networks and systems, analyse availability and reliability, optimize maintenance activities, planning site visits (ships, road access, service contractors) and new constructions. It can also be used to evaluate AIS shore station networks, VHF radio coverage, or any other types of coverage of AtoN services.

4.3. WATERWAY DESIGN AND PLANNING

Similarly, GIS can be a useful tool for the design of AtoN systems or networks for the following:

- Optimizing port approaches, waterway evaluation and planning.
- Analysing potential risk areas and identifying problem areas (groundings, collision, incidents, etc.).
- Analysing the impact of new structures off-shore and on-shore.

Detailed hydrographic information needed for the design and optimisation of AtoN structures, or the placement of floating AtoN, may not be available within published nautical/hydrographic information. AtoN authorities may need to request additional and more detailed hydrographic survey information from hydrographic authorities. If such information is not available, AtoN authorities may need to commission surveys to meet their needs.

5. IMPLEMENTING / ACQUIRING A GIS

5.1. ASSESSMENT FRAMEWORK

An assessment framework is needed to evaluate potential GIS solutions. Such a framework could include the following considerations:

- Initial cost involves more than the actual purchase price of hardware and software. It needs to include the cost of building databases and training users.

- Functionality should refer to the depth and breadth of capabilities of a GIS.

  Issues involved in evaluating functionality can include the appropriateness of raster versus vector, processing and the ability to add customized software modules.

- Ease of use is important, but there can be a trade-off with functionality.
- The degree of complexity and functionality affects costs, the GIS user interface and the requirements for training.
- GIS is rapidly evolving, and as a result, it is important to select a GIS with potential for future development.
- There are many companies offering GIS. It is important to select one that will continue to offer ongoing support in the form of technical help, advice, and possibly even skilled employees.

5.2. AUTHORITIES' NEEDS

In addition to the above framework, there are some key questions AtoN authorities will need to evaluate when selecting and then implementing a GIS:

- What chart / map / survey feature datasets does your authority have available in digital format, and what file formats are they in (e.g., ESRI Shape files, MapInfo TAB files, AutoCAD dwg/dxf files, IHO vector chart formats, etc.)?
- What attribute datasets does your authority have available in a digital format, and what format are they in (e.g., Microsoft Access, Excel, text files, etc.)?
- What attribute/map feature datasets do your authority have available in a hardcopy format (e.g., paper maps/charts, paper lists etc.)?

  The answer to this question will determine the amount of digitising that will be required.

- Will your authority need to purchase or acquire datasets from external sources?
- Is the proposed GIS to be networked on a local area network and/or wide area network?

  Or, is it to be available as a stand-alone application on individual computers?

- Are the attribute/map databases to be centralized on a server that will be accessed by remote GIS users?
- What level of GIS functionality is required:
  - Analysis functions (e.g., point density analysis, network analysis, overlay/Boolean analysis, etc.)?
  - Projections/datum (e.g., coordinate conversions and datum transformations)?
  - Managing different vertical datums?
  - Data modelling (e.g., digital terrain modelling, surface modelling)?
  - Importing/exporting a wide range of data formats?
  - Handling of raster/vector layers?
  - WMS/WFS internet based information sources?
- Does the proposed GIS need to interface with other systems (e.g., asset management system, image management system, or records management system)?
- How many users are anticipated for the proposed GIS?

This will impact the cost of the system. Also, what will be the level of user expertise (e.g., system administrators, power users, casual users)?

- What will be the main purpose of the proposed GIS:
  - Display of graphical information?
  - Data analysis/modelling?
  - Map and plan creation/preparation?
  - Generate information to support incident investigations?
  - Manage information to support operation and maintenance?
- Will the GIS need to interface with an incident and/or environmental management system?

  If so, then the GIS tools will need to be readily accessible, reliable and easy to use.
- Once a GIS has been developed and implemented, how would the authority provide for the continual improvement and updating of the GIS?

  Continual improvement is a process of increasing the effectiveness of the authority to fulfil its responsibilities.
- Will the GIS facilitate:
  - Two and three-dimensional nautical and AtoN symbols?
  - Adequate display and/or conversion of hydrographic vector data (e.g., IHO S57 data)?
  - The creation of nautical chart like borders and grids?
  - The use of degrees, minutes and decimal minutes (e.g., dd mm.mmm) for geographic coordinate notation.

5.3. TRAINING AND AWARENESS

The AtoN authority needs to have assigned process ownership to facilitate and encourage staff buy-in to the use of GIS. The owner needs to be responsible for the process, its management and its improvement.

The training for staff needs to be aligned to the competency requirements determined for the process.

Mechanisms to enable staff to reach and sustain the required level of competence could include:

- Ensuring staff induction training incorporates GIS
- Access for staff to GIS documents, e.g., web-based applications
- Feedback loop including comments, suggestions and statistical information

6. DEFINITIONS

The definitions of terms used in this Guideline can be found in the *International Dictionary of Marine Aids to Navigation* (IALA Dictionary) at http://www.iala-aism.org/wiki/dictionary and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered the authoritative source of definitions used in IALA documents.

7. ABBREVIATIONS

AGI	Association for Geographic Information
AIS	Automatic Identification System
AtoN	Aid(s) to Navigation
CAD	Computer-Aided Design
DGPS	Differential Global Positioning System
ENC	Electronic navigation chart
GIS	Geographic information system
GPS	Global Positioning System. Operated by the Government of the United States
IHO	International Hydrographic Organization
IMO	International Maritime Organization
RS	Remote sensing
SN/Circ.	Safety of Navigation Circular (IMO
SOLAS	International Convention for the Safety of Life at Sea (IMO 1974 as amended)
S57	IHO Transfer Standard for Digital Hydrographic Data
VTS	Vessel traffic services
WFS	Web Feature Services
WMS	Web Map Service
3-D	Three dimensional

8. REFERENCES

[1] Association for Geographic Information (AGI) and the University of Edinburgh Department of Geography online GIS dictionary (http://www.geo.ed.ac.uk/agidict/welcome.html).