Marine information overlays

The what, why and how of MIOs

Dr Lee Alexander
Centre for Coastal and Ocean Mapping, Joint Hydrographic Centre, University of New Hampshire, USA

Chair, Harmonisation Group on Marine Information Overlays (HGMIO)

The advent of ECDIS and other types of electronic charting systems provides the mariner with a new navigation tool capable of displaying a wide variety of information. As an automated decision aid, capable of continuously determining a vessel's position in relation to land, charted objects, aids-to-navigation and unseen hazards, electronic charting is an entirely new approach to maritime navigation. However, to fully realise its potential, ECDIS (electronic chart display and information system) and other electronic charting systems should provide information beyond that which is contained on a paper nautical chart.

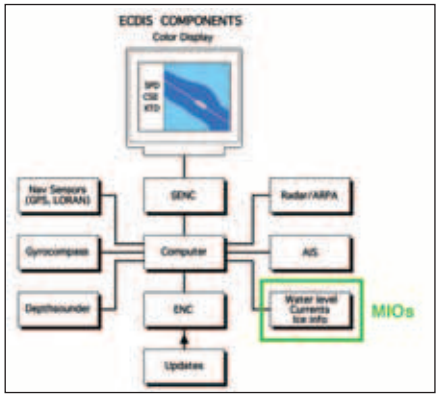
Marine information overlays (MIOs) is a generic term used to describe chart and navigation-related information that supplements the minimum information mandated by the IMO performance standards for ECDIS. The basic concept is to provide a supplemental layer of information (in the form of points, lines or areas) that can be displayed by an ECDIS in conjunction with existing chart and navigation-related information.

This article explains the what, why how of MIOs – and the potential for the mariner.

The first point to make is that MIOs are not part of the ENC (electronic navigational chart). Rather, an MIO is additional information that is displayed in conjunction with the overall system ENC (SENC): the data held in the ECDIS system resulting from the transformation of the ENC for appropriate use. This is similar in concept to adding radar or AIS (automatic identification system) information to an ECDIS display. As additional non-mandatory information not already covered by existing IMO, IHO (International Hydrographic Office), or IEC (International Electrotechnical Commission) standards, MIOs can include items such as ice coverage, tide/water level, current flow, meteorological and oceanographic information, and details of marine protected areas.

MIOs are provided in various formats, including IHO S-57 data (such as objects/attributes), as an AIS binary message, or in a proprietary format.

For certain operations, MIOs provide time-critical information and can be a key factor for decision-support, for example under-keel clearance, or 'go/no-go'). In this context, some electronic navigation equipment (including GPS chart plotters, ECS and ECDIS) have been programmed to provide an indication/alarm where there is something contained in the MIO that requires immediate attention.



▲ Figure 1: ECDIS components

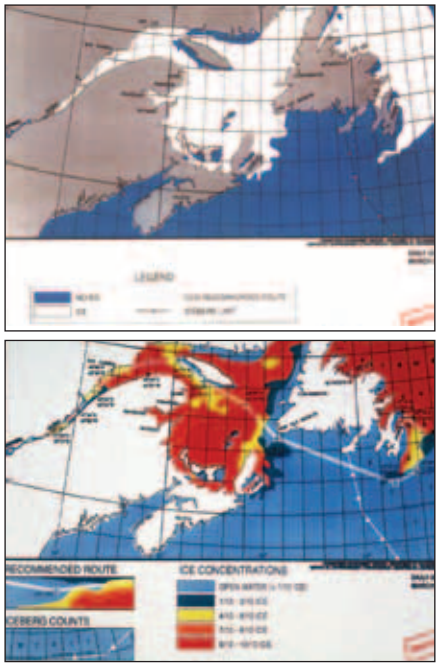
There are two basic categories of MIOs: static and dynamic. A static MIO consists of relatively fixed or constant information that is not subject to continual change. This includes information on marine habitats, seafloor geology, or regulated marine protected areas. Dynamic MIOs are more temporal and deal with real-time data that have instantaneous value or are constantly changing. Examples of dynamic MIOs include tide/water level, current flow, and weather information that are continually being updated. However, these two categories are not mutually exclusive and there can be a combination of predicted forecast, and so-called 'now-cast' (a forecast that is continually being updated) information. At present, most static MIOs are provided in IHO S-57 format, while dynamic MIOs will be broadcast as AIS binary messages.

To date, MIOs have been developed for sea ice coverage, tide/water level, current flow, and marine protected areas. Some examples:

Ice coverage

For some shipping regions, (such as the Baltic Sea, Great Lakes and Canadian maritimes), knowing where ice is (or is not) can be a crucial factor in voyage planning during the winter season. In most cases, this information is currently provided to mariners via fax, text messages and the internet. However, there is a new initiative in Canada to begin providing sea ice information as IHO S-57 based MIOs to be used with existing electronic chart equipment onboard vessels and ashore.

While several demonstration projects have shown that providing additional information as MIOs is technically feasible there are no government agencies or organisations in North America or Europe that, as yet, provide this type of service. However, the goal is still achievable. Using



▲ Figure 2: Two examples of sea ice coverage information

existing telecommunications infrastructure, government agencies can warn marine operators of hazardous ice conditions by the timely provision of digital data that is easily displayed as an overlay on an electronic chart (above). The challenge is not really technical; rather, it is how to establish the necessary operational infrastructure, that is, inter- and intra-governmental agency cooperation.

Tides/water levels

Several electronic chart system manufacturers provide tidal information as an additional functional capability. This information can be displayed as alphanumeric text, in the form of tide tables, or as graphs showing the height of tide for a selected geographical area. Some of the selected parameters include date, time, and number of days to be calculated. While highly useful, this information is usually displayed separately from the electronic chart.

In 2001, SevenCs developed a simulation model for a 'tide-adjusted' ENC. Prototype ENC data sets were produced for two ports: Singapore and Schelde/Vlissingen in The Netherlands. Using one-metre contour depth areas, a simulated 10 m tidal range was then applied, and the display of 'safe water' continuously adjusted based on time and ship's safety depth contour (see Figure 3). Further enhancements included the establishment of designated tidal zones within the overall area. When coupled with either forecast or real-time tidal information, the main benefit to the mariner would be decision support for voyage planning. With a tide-adjusted ENC, two types of information are particularly useful:

- time/duration for vessel transit (high v low tide);
- amount of vessel draft (and/or under-keel clearance) that would occur.

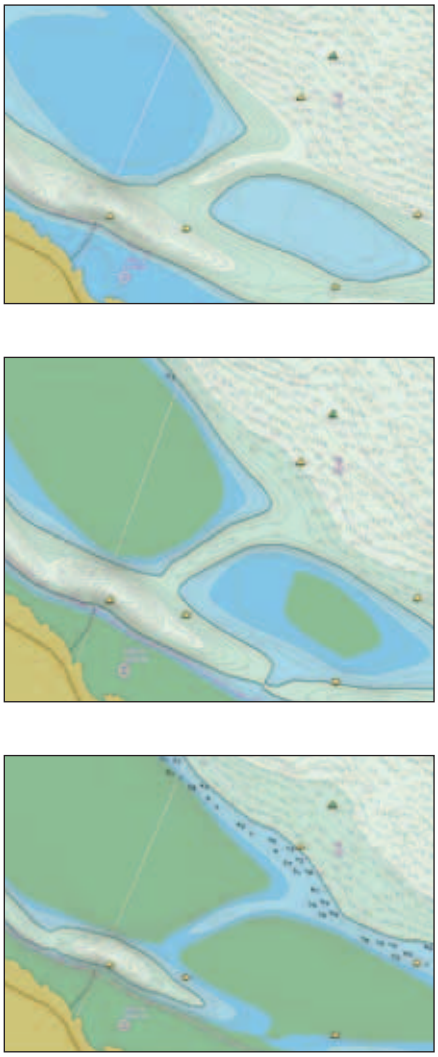
While the benefits of this functional capability are clear to most mariners – particularly those operating deep draught vessels – the operational implementation of this functional capability with ENCs and ECDIS has yet to occur. This is due in part to the fact that the current IHO S-57 data standard does not allow for ENC depth information to be 'adjusted' based on tides or water levels. Another factor is that most ENCs do not contain the necessary depth contour intervals needed to support such a function. However, it is expected that the future IHO Geospatial Data Standard (IHO S-100) and 'next-generation' ENCs, especially for port areas and confined waterways, will address this.

Current flow

As with tidal/water level information, several electronic chart system manufacturers provide information on tidal streams and current flow as a functional capability. Since most of the flow that a vessel encounters is caused by tidal changes, this information is most often provided in a similar format to tide tables, such as alphanumeric text. However, like tides, some electronic chart systems provide graphics or charts showing current flow vectors (icons) that indicate current flow velocity and direction within a selected geographical area. Similar to tidal heights, selected parameters include date, time, and number of days to be calculated. Again like tides, it may have limited capability for route planning/monitoring in this format since it is not integrated with the ENC.

Weather/oceanographic

Several electronic chart systems have a capability to receive and display a variety of weather and oceanographic-related information. Information parameters include:



▲ Figure 3: SevenCs example of a time sequence of 'tide-adjusted ENC' showing changes that occur for depth areas

- temperature;
- wind speed and direction;
- height, direction and period of wind caused waves and/or swell;
- atmospheric pressure;
- type of precipitation (eg rain, snow);
- likelihood of freezing spray.

Depending on the installed electronic chart system and shipboard communication systems, some users can subscribe to weather forecast information provided by organisations such as the UK Meteorological Office or the National Ocean Service, NOAA (USA).

For type-approved ECDIS equipment, there are ongoing efforts by the IHO-IEC Harmonisation Group (HGMIO) to develop appropriate S-57 objects/attributes and

● Continued on p11

S-52 colours and symbols for weather-related information. Liaison has also been established between IHO and the World Meteorological Organisation (WMO) to develop future standards for data and display.

In addition to being an important factor for route/voyage planning, weather/oceanographic information can be critical for search and rescue (SAR) and recovery operations. Figure 4 shows an SAR pattern (expanding square) in which current set is a calculated factor within the search area. Wind set/drift is another factor that can also be used.

Marine protection areas

Because the current IHO ENC Product Specification (IHO S-57 Edition 3.1) cannot easily be upgraded, MIOs can serve to provide important supplemental information not easily accommodated in an ENC. A good example of this is a designated marine protected area (MPA). While the basic area and limitations can be included in an ENC, additional details such as critical habitats and regulated/permitted activities are not included.

In the United States, there is a pilot project in the Florida Keys National Marine Sanctuary to convert existing coral reef habitat and MPA/zones into MIOs that can be used with ECS equipment (see figure 5 A and B). The project goal is to strengthen marine resource conservation by bringing critical coral, (MPA) marine protected areas, and other environmental protection-related information to the mariners operating within the sanctuary. This testbed can also be useful in determining what new S-57 object classes are needed and how they should be portrayed.

In the Straits of Malacca/Singapore, a marine electronic highway (MEH) project is being planned by IMO that has an MIO component. In order to reduce the environmental impact of shipping and coastal activities, MIOs will be produced from existing geo-spatial information that has been produced by environmental agencies and natural resource managers. This includes sensitive habitats (spawning areas and migratory areas), MPAs, endangered species habitats, and social-economic factors. In this regard, it is expected that the MEH project will include the development/implementation of both static and dynamic MIOs. In addition to participation by the cognisant government agencies of the three littoral states (Malaysia, Indonesia, and Singapore), it is expected that there will also be involvement by IHO, IALA and the International Chamber of Shipping (ICS).

Another MIO initiative involves the protection of whales. The North Atlantic right whale (Eubalaena glacialis) is among the world's most endangered whale with a population of less than 300 individuals – and declining. The decline is due primarily to high mortality from human activities, most notably fishing gear entanglements and vessel collisions. Currently, there is a project being conducted in the NOAA Stellwagen Bank National Marine Sanctuary (east of Boston, USA) where the presence/location of right whales is determined by acoustic sonobouys. With rapid conversion of a right whale location into an AIS binary message and disseminating it via the Internet and AIS base station, mariners can plan and/or modify their voyage plan to avoid transiting through an area where right whales have been reported (Figure 6).

Looking ahead

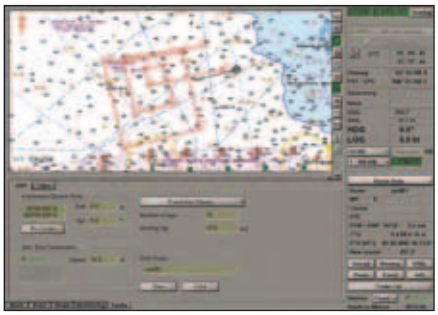
While there is increased interest by the maritime community in supplemental information from a variety of sources, practical consideration dictates that MIOs must be capable of being used by existing shipboard equipment and systems such as ECDIS and AIS. This, in turn, raises challenges related to developing appropriate data formats capable of dealing with time-varying information (x, y, z and time). There is also a concern about the simultaneous display of MIOs with other chart and navigation-related information, and the potential impact in terms of an overly-cluttered display. With the recent adoption by IMO of performance standards for the presentation of navigation-related information on shipborne displays, IMO Resolution MSC 191(79), 6 December 2004, and the recent advent of the e-Navigation concept, MIOs will continue to evolve with regard to data formats, portrayal, and precedence.

In this respect, the IALA e-Navigation Committee will be reviewing the role of MIOs in the broader concept of operation for e-Navigation. This effort will include MIO data content/format, presentation/display, and user functionality for both shore-based and shipborne electronic charting equipment.

In the near future, the realisation will occur that the real benefit of MIOs lies in decision support ('what if'). This is a far more important consideration than what the information looks like when displayed. This varies, and should be both subjective and flexible. What, how and when an MIO will be displayed depends on three major factors:

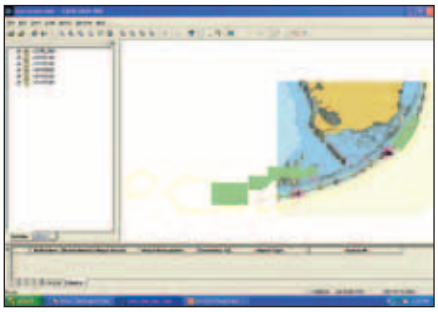
- **1.** the current situation (eg route planning or route monitoring)
- **2.** the task-at-hand (eg grounding avoidance or collision avoidance -- or both)
- **3.** the preference of the user (eg minimum or maximum amount of information).

In the final analysis, the type of supplemental information or enhanced functionality needed on electronic charting systems is best decided by the mariner. In this regard, it is the opinions and advice of practising mariners (pilots, masters, and mates) that must be the deciding factor.



▲ Figure 4: A search and rescue (SAR) pattern displayed on an electronic chart that factors in current drift.

▲ Figure 5A: Marine protection area (Florida Keys National Marine Sanctuary)



▲ Figure 5B: Selected coral reef and regulatory information displayed on an ENC.

▲ Figure 6: Right whale location MIO