ECDIS for Naval Applications

An electronic chart system, whether an Electronic Chart Display and Information System (ECDIS) or an Electronic Chart System (ECS), is primarily designed for safe navigation. But its ability to display information selectively and relate it spatially is considered a real-time GIS application in the marine environment, to be used as a basis in survey operations and for presenting the analysed results, as well as in naval operations. This article describes the potential for naval warfare applications.

Since time immemorial the evolution of mankind has progressed and brought with it constantly increasing knowledge. The learning process is continual and creativity is the hallmark of change.

Information technology has significantly changed the concept of war, the induction of the latest computers and communication capabilities facilitating communication with troops on the battlefield. Networking battlefield commanders, command headquarters, field units, and individual soldiers in the battlefield is carried out with the latest state-of-the-art technology in computers and efficient communication network systems.

ECDIS-ECS: Real-time Marine GIS

The most important aspect of any operation in a marine environment is linked primarily to safe navigation. The ability of a naval vessel to navigate safely needs detailed information on subsurface hazards and depth information. This is integrated with shipboard systems providing information on direction, speed and the geographic position. Until the last decade of the twentieth century navigation at sea was performed by a combination of paper chart and shipboard systems. An electronic chart system, either an Electronic Chart Display and Information System (ECDIS) or an Electronic Chart System (ECS) capable of displaying vectorised data, on board a naval vessel is primarily designed for safe navigation. But its ability to display information selectively and relate it spatially is considered a real-time GIS application in the marine environment.

The potential of ECDIS/ECS for other GIS applications is recognised and it may become a potent tool in naval operations. A brief overview of potential applications of ECDIS/ECS is presented here. An electronic chart system used by naval vessels must be capable of using a variety of geospatial data from both civilian and military sources. Such a system is required to be able to present information for use in operations such as mine warfare, amphibious operations, submarine and anti-submarine operations. These details cannot be supported by the existing International Maritime Organisation (IMO) type approved ECDIS system. Each country has to design or identify its own requirements and develop databases and should be able to integrate these with a shipboard system for effective use of both ECDIS/ECS and ENC database.

An Additional Military Layers (AML) concept is the ideal way to achieve this goal. Geospatial data of various parameters necessary for naval operations may be added as AML. All this information can be provided either in stand-alone format or integrated with ship-borne warfare systems to assist naval personnel in safe navigation and warfare capability. Developed countries are seriously looking into the use of ECDIS/ECS for such purposes and most NATO navies are planning to integrate WECDIS (term used for Naval version of ECDIS) data and functionality with ship-borne Command, Control, Communicate and Information (C3I) systems.

Additional Military Layers

Warships operating in unfamiliar waters need to have up-to-date information on various parameters in order to perform their tasks successfully and ensure the safety of men and material. ECDIS/ECS with AMLs and any other information required in the operations, when overlaid on the ENC database, may be viewed and queried by the user. Current research is aimed at providing Marine Information Objects (MIO) which are time variant and needed by the mariner in wartime or peacetime for more effective performance of electronic chart systems as a real-time GIS application in the marine environment.

All naval operations need information pertaining to the marine environment in respect of geology, bottom topography, oceanography and meteorology, in addition to information regarding navigation, weapon capabilities, shipboard systems and manpower. These operations can be supported by thematic information in layered form. AML applications may be categorised for use in the following naval operations.

Submarine Operations

Both offensive and defensive sub-marine operations require information on bottom characteristics such as type of sediments and topography. This information is extracted from marine geological parameters, including type of rocks, sediments and geological formations on the seabed. In addition, the acoustic characteristics of the water medium from the surface to the bottom of the sea play a significant role in successful sub-marine operations.

Mine Countermeasures

Mine countermeasures include minesweeping, tracking, hunting and clearing. Effective mine clearing is a demanding task, as it requires sophisticated sonar and communication facilities. It also requires a database covering route surveys, mine tracking and hunting. This database must also include data on sonar imageries, oceanographic data and environmental data. Electronic chart systems, with their integrated navigation sensors and digital chart, make it easy to provide for positioning the mines while laying them, whether these are to be laid from a ship or small vessels.

Naval Control of Shipping

In time of war the navy controls all sea traffic, both commercial and military. In such situations, the ability of naval forces to control this traffic largely depends on the information available to them concerning the movement of various vessels and sea routes that require control for preventing enemy vessels entering the area. An electronic chart system with radar overlay, Automatic Identification System (AIS) and ARPA would provide the means for a naval fleet to control the movement of ships in coastal waters at harbours and ports.

Amphibious Operations
Amphibious operations play a significant role in allowing occupational forces to actually land army contingents for land-based offensive operations and to occupy enemy territory. The essential parameters for successive operations are information on coastal installations, environment, beach gradients, seabed, wave conditions, bathymetry, near-shore hazards, near-surface currents, visibility, wind and sea state. All such data can be embedded as additional layers in the electronic chart systems for use by amphibious vessels.
Similarly, all other operations envisaged above can utilise ECDIS/ECS with operation-specific data as an additional layer in the ECDIS/ECS. Most of these operations need more or less similar input data for successful operations.

AML Layer Themes
The layers below are only illustrative and not exhaustive; they may be added as per requirement:

- Operation areas and boundaries
  Sensitive areas for operational purposes may be defined and delineated in a separate layer so as to identify enemy areas or national maritime limits for policing and protecting installations offshore
- High resolution sounding data or seabed scans
  Delineation of seabed topography for accurate assessment of surface undulations, required for submarine operations, may be placed in separate layers using high-resolution bathy-metry or sonar images
- Bottom objects, large or small
  A number of objects small or large, which may be deterrent or advantageous for submarine operations, can be placed in a layer
- Sediment type provinces
  The acoustic signature of the seabed is very important in sonar operations. This will provide great impetus in submarine and antisubmarine oper-ations. The delineation of seabed provinces by the nature of surface and subsurface seabed characteristics can be added as an additional layer
- Q routes, mine danger areas
  Specific routes in the sea-lanes marked for safety of convoys sup-ported by escort vessels, and areas where mines are laid, are delineated and these overlaid as additional layers
- Transit lanes and operation areas for underwater warfare
  Transit lanes are identified as underwater areas for submarine operations. Analysing prevalent oceanographic conditions conducive to submarine operations delineates these lanes
- Meteorological conditions
  Meteorological conditions in near-shore areas and water characteristics in terms of transparency and subsurface hazards are identified and placed in separate layers for use in amphibious operations. This includes information on beach gradients, bottom sediment characteristics and weather conditions

The limitations are dependent on display capabilities and the ability of the system to store and display data as and when required. It is expected that technological innovations in computer processing, display capabilities and integration of different sensors for the collection of real-time data will certainly soon achieve the objective of utilisation by naval personnel.

Conclusion
Data is complex in a marine environment; as seen from above and bringing the data into relationship with various multidimensional parameters is a complex process. The most important aspect of the entire exercise would be to evaluate the fourth dimension in the marine environment, which is time. The time factor plays a very significant role, as the ocean is a dynamic environment with several natural forces contributing to constant change, both on and below the surface.
A multidimensional approach is expected to meet the various requirements of naval warfare. In this approach, each object is treated as an additional dimension for a given data point. Temporal variability is treated as another dimension. In other words, there will be a minimum of four dimensions: x, y, z and time. A multidimensional approach, with dynamic representation of variables, will make ECDIS/ECS a versatile tool in the future.

This brief overview of potential applications of ECDIS/ECS in naval operations, and future developments in ECDIS/ECS, is compiled from various sources in the published technical literature.

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