The Marine Electronic Highway in the Straits of Malacca and Singapore - An Innovative Project for the Management of Highly Congested and Confined Waters

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Introduction

The bulk of world trade, in tonnage terms, is transported by ships and will remain so for many years. Economic development in many parts of the world such as in the Asia-Pacific region will exert tremendous pressures on the maritime industry, especially on future energy demands. Such pressures will have a bearing on the aging fleet of the maritime industry and the ban on single hulled tankers, burgeoning coastal populations, and the need to address marine pollution from land- and ship-based sources. Hence, a shift in policy and strategy will be required to improve shipping operations including the adoption of new technologies and management systems to enhance navigational safety and minimize pollution risk but ensure better commercial performance. It will also require a coherent monitoring and response programme within a multi-sectoral setting as marine pollution has transboundary implications in addition to social, legal and economic dimensions. This is particularly important in highly congested and confined sea lanes with high biodiversity such as the Straits of Malacca and Singapore. Thus, the sustainability of the maritime industry and the need to ensure clean seas will require coordinated and collaborative efforts among key stakeholders at the local, national and international levels. Key determinants that ensure the effectiveness of such efforts are the availability and management of up-to-date and reliable marine information.[1]

This photo collage attempts to demonstrate, in simple terms, the benefits of a marine electronic highway to navigational safety.

Source:
Strategic Ventures Corporation

Advancements in information technology have significant impacts on the shipping industry. Many of the newer commercial vessels are equipped with electronic navigational charts (ENCs) – electronic chart display and information systems (ECDIS) including an integrated bridge system.[2] However, the majority of the present world fleet still uses paper charts for navigation. The slow adoption of new technologies by the shipping industry is due to several factors such as capital

outlay requirement, training of mariners and limited sea area coverage of current ENCs. The developments of maritime safety technologies are generally industry-driven and in adherence to standards and performance criteria (*e.g.,* International Organization for Standardization [ISO], International Electrotechnical Commission [IEC], IMO and International Hydrographic Organization [IHO]). Demonstrating the benefits of electronic navigation will most likely be initially based on efforts of individual maritime companies and pilot projects in certain ports or sea areas. The realization of such benefits could hasten the adoption of electronic navigation, in particular wider coverage of ENCs and adoption of ECDIS and automatic identification systems (AIS) by all vessel types.[3]

Information technologies on environmental management and protection, especially for coastal and marine areas applications are numerous and cater to various sectors and levels. Unlike maritime safety technologies, adherence to standards and performance criteria by environmental information systems is less rigorous.

Although maritime safety and marine environmental management technologies are distinct in terms of application, systems integration is possible. This is the underpinning of the marine electronic highway.

> "A shift in policy and strategy will be required to improve shipping operations including the adoption of new technologies and management systems to enhance navigational safety and minimize pollution risk but ensure better commercial performance."

Table 1. Some examples of existing facilities and information technologies that are in place along the Straits of Malacca and Singapore for maritime safety and environment protection and management.

Facility and Information Technology	Coverage in the Straits			
	Indonesia	Singapore	Malaysia	Straits-Wide
VTS	✓	✓	✓	✓
Radar System		✓	✓	✓
ENCs	✓	✓	✓	
DGPS Broadcast Systems		✓		✓
STRAITREP	✓	✓	✓	✓
Ship Routeing System	✓	✓	✓	✓
GMDSS	✓	✓	✓	✓
GIS-based Environmental Database	✓	✓	✓	✓
Pollution Dispersion Model				✓
Oil Spill Trajectory Model	✓	✓	✓	✓

Source: PEMSEA

The Concept of a Marine Electronic Highway

Advancements in information technology and Internet connectivity are changing the way information is used by the maritime sector although a large part is still focused on local and autonomous applications. The use of information systems in more mature and expansive applications such as in a marine electronic highway that integrates maritime safety technologies and environmental management systems will result in improved performance (*e.g.*, improve situational awareness of mariners and achieve optimal underkeel clearance, enhance emergency response), new capabilities (*e.g.*, online and real time communication, enhanced monitoring system) and innovative applications (*e.g.*, integrated modelling/forecast, risk-based management).

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The Marine Electronic Highway (MEH) is envisioned to be a regional network of marine information technologies linked through the ENCs-ECDIS. The availability of differential global positioning system (DGPS)[4] with accuracy of 1 to 5 meters enhances the navigational accuracy of ENCs-ECDIS, especially in congested and confined waters.

Although the MEH is still being defined, some of the basic components can be outlined. From a technical standpoint, the MEH has two components, namely maritime safety, and environmental protection and management. Within maritime safety, three categories are recognized, namely, navigational safety, precision navigation and emergency response. Precision navigation shall be the backbone of the MEH upon which all the technological platforms would be integrated commencing with the ENCs-ECDIS (Figure 1). Precision navigation consists of onshore, sea-based and ship-based facilities from which information and data flow into the network. Such facilities include transponders[5] such as an AIS and onboard access to the Internet.

With AIS, real time information can be automatically provided to and/or received from appropriately equipped shore facilities or other ships. With enhanced AIS, hydrographical and oceanographic data including weather conditions can be transmitted and/or received, thereby facilitating ship movement, particularly in restricted or congested waterways as well as during inclement conditions. Currently, AIS is mainly for basic ship information exchange. However, future developments may include other relevant information such as weather data. With AIS or similar facility, information flow could be real time, forecast, archived data, and monitoring/time lag data. The presence of a network of meteorological centers such as the South East Asian Centre for Atmospheric and Marine Prediction (SEACAMP) could provide higher resolution local weather conditions or forecasts that could be transmitted through the AIS allowing mariners to evaluate the weather conditions along their route.

For environmental protection and management, four categories are identified that have a bearing on the marine and coastal environments: environmental monitoring, protection and management, emergency response and risk/damage

Figure 1. The Marine Electronic Highway is the integration of maritime safety technologies and marine environment management and protection with precision navigation as its backbone.

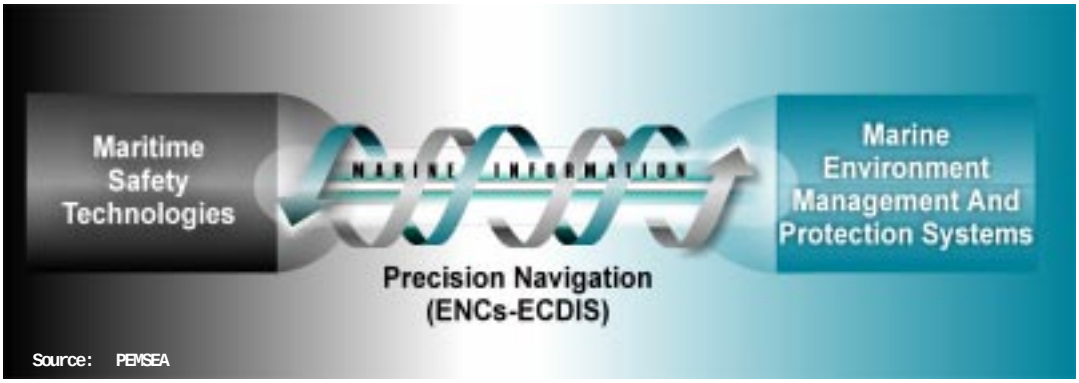
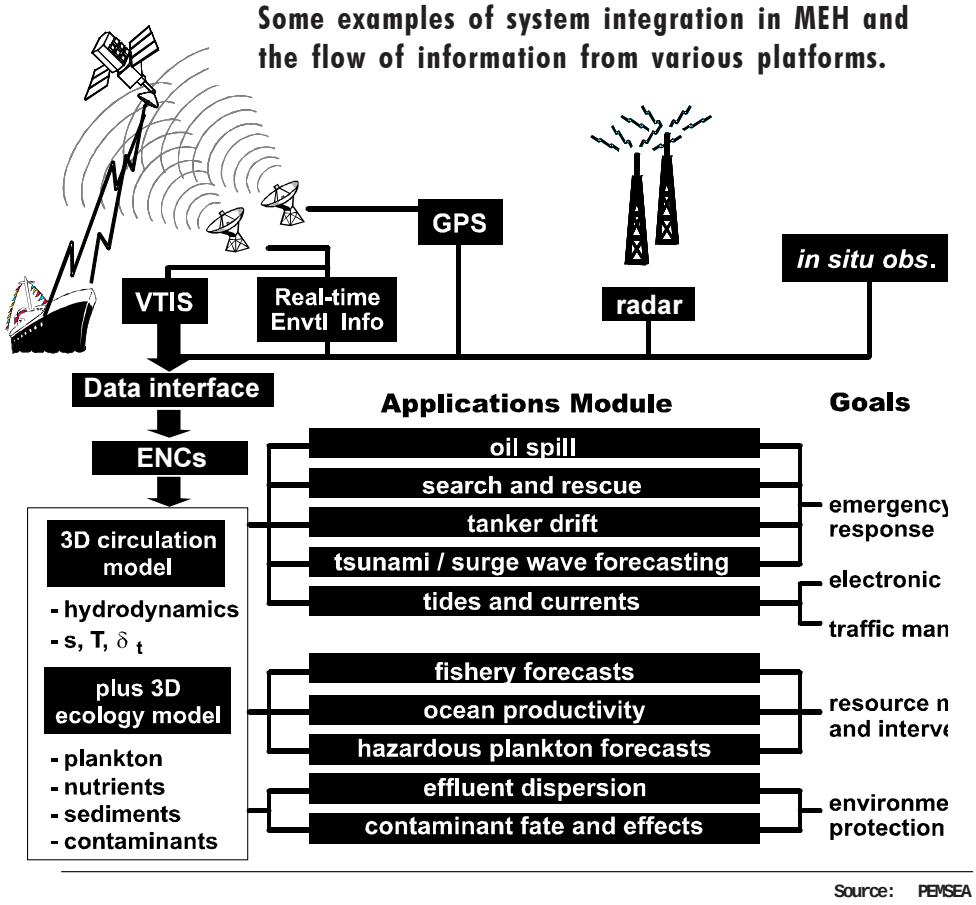


Figure 2. **Marine Electronic Highway Functional Diagram. Some examples of system integration in MEH and the flow of information from various platforms.**



Source: PEMSEA

assessment. Currently, the technologies being utilized for environmental protection and management are numerous with varying data formats. However, integrated systems are already in the market, such as GIS linked to other systems, providing a wide range of applications.

The integration of the maritime safety component with the environmental protection and management technologies will be the foundation of the marine electronic highway. This technical integration will be built from the perspective of end-users and their requirements and is one aspect of the MEH system. It will include new technologies, applications and management approaches. For the MEH to work effectively, system integration between maritime safety technologies and environmental information systems must never interfere with precision navigation. Other issues include security of online transactions, communication traffic, access costs, and protection against cyber crimes. Some of the possible systems within the MEH are illustrated in Figure 2.

Sustainable financing mechanisms, obligations associated with accession or ratification of international conventions, protocols, agreements and treaties, legal, institutional and administrative arrangements and political considerations are the non-technical aspects of the MEH that will have to be identified, assessed and integrated into the system.

The Marine Electronic Highway Project

The Global Environment Facility (GEF)/United Nations Development Programme (UNDP)/ IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas (MPP-EAS) initiated

> "The use of information systems in more mature and expansive applications such as in a marine electronic highway that integrates maritime safety technologies and environmental management systems will result in improved performance..., new capabilities... and innovative applications..."

discussions on the need for an enhanced information technology system in the Straits of Malacca and Singapore to address navigational safety and transboundary marine pollution issues in 1996.

In 1997, the Strategic Ventures Corporation (SVC), a private company based in Canada, completed a pre-feasibility study for the World Bank on the Southeast Asia MEH focusing primarily on the public sector. The following year, the International Finance Corporation (IFC) commissioned a feasibility analysis of the MEH, this time giving emphasis on the private sector. Using the inputs of both studies, the MPP-EAS prepared the Project Preparation and Development Facility (PDF) Block B Application (for grants up to US $350,000), which was reviewed and endorsed by the Governments of Malaysia and Indonesia, and submitted to the GEF.

While the general outline of the MEH had been discussed in various fora and by the major users (*e.g.*, shipping companies, oil spill responders, environmental agencies), there are other aspects that need to be considered:

- Who will the other users of the highway be and what are their needs?
- What technologies and services currently available among the three littoral States will meet the needs of identified users?
- What new technologies and services will be required and how will they be packaged as part of the MEH?
- Who will provide these new technologies and services?
- What mechanisms will allow these technologies and services to operate efficiently and profitably within the MEH network?
- What are the financial implications of such technologies and services?

Essentially, the Malacca Straits MEH will consist of physical infrastructure, hardware and software, processes and resources focusing on both navigational safety and transboundary marine pollution prevention. The system will also include economic, legal and institutional mechanisms that will allow it to be fully functional, efficient and sustainable, without compromising public welfare.

Project Objectives

The Regional MEH Project will have three phases:

Phase 1 – Setting up a prototype system in the Straits of Malacca and Singapore;
Phase 2 – Network construction in priority waters from the Straits to Sea of Japan/East Sea; and
Phase 3 – Completion of the entire network with emphasis on oil and gas transportation routes.

The immediate objective is to reach consensus among interested stakeholders on the development and implementation of a regional MEH. This period will also be used to collect additional information necessary to effectively plan the second phase, and conduct an early analysis of a potential third phase. It will be followed by the refinement of the Project Brief and the development of a project document

that will be the basis for the implementation of the first phase.

The developmental objective of Phase 2 is to implement, through an "appropriate institution" a regional MEH, commencing in the Straits of Malacca and Singapore. GEF has allocated a Project Development Facility (PDF) Block B grant to develop a Project Brief on Phase 1. The World Bank is the implementing agency with the IMO as the executing agency of the PDF Block B Grant.

Strategies and Approach

The MEH Project consists of three components, namely, maritime safety, environmental protection and management, and sustainable financing. Four key issues are fundamental to advance MEH technology in the Straits of Malacca and Singapore, namely:

1. Information technology, specifically integrating existing technologies and capacities with new and innovative ones while focusing on the specific needs of users within the three countries as well as other users;

2. Socio-economic benefit to the governments, industry/private sectors, and civil society as a consequence of the proposed MEH technology;

3. Financing mechanisms/ investment potential, including the establishment of interagency, intergovernmental and inter-sectoral partnerships as vehicles for successfully developing, financing, constructing and operating the MEH as a self-sustaining, revenue-generating enterprise; and

4. Institutional arrangements, with agreements among participating parties on the administrative, legal, financial and operational aspects of a "managing tool," which will be responsible for implementing the first phase MEH project.

To achieve the objective of the PDF Block B and pave the way for the implementation of the first phase MEH in the Straits of Malacca and Singapore, several strategies and approaches are envisaged.

Stakeholder Participation and Partnership

The MEH Project entails building consensus among relevant and interested stakeholders at the local, national and regional levels. One of the mechanisms to involve stakeholders is the establishment of national and regional steering committees.

Each country shall define the MEH technology and the existing/ available systems and capacities. In doing so, they shall contribute to MEH development including potential uses/users, benefits and obligations. The establishment of an inter-sectoral and inter-ministerial body to be called a National Steering Committee shall galvanize and coordinate such efforts. Additional institutional arrangements shall be undertaken such as assigning a lead agency and a National Focal Point.

> "The integration of the maritime safety component with the environmental protection and management technologies will be the foundation of the marine electronic highway."

At the regional level, the Project Steering Committee shall be composed of the National Focal Points, the GEF/World Bank and IMO. Potential members are from the private sector (*i.e.*, technology providers and users), shipping industry and special bodies like the Tripartite Technical Experts Group and user States. Observers from interested institutions and organizations are invited to participate in technical sessions. Over time, certain private sector groups will be members of the Project Steering Committee where a "managing tool" shall emerge.

> "...the sustainability of the maritime industry and the need to ensure clean seas will require coordinated and collaborative efforts among key stakeholders at the local, national and international levels."

Aside from providing a technical description, the Action Plan for a regional MEH shall also include an estimate of investments and operating costs, assessment of the economic impact potential and market sector analysis (*i.e.*, users, their needs and willingness to pay), among others. Apart from the design of the "managing tool," proposals shall be prepared to include an implementation plan, an operational plan, evaluation of incremental cost and identification of co-financing. The participation of user States in the development of the MEH, particularly as regards sustainable financing, shall take into account the provisions of Article 43 of the United Nations Convention on the Law of the Sea (UNCLOS) since part of the Straits of Malacca and Singapore is an international sea lane.[6]

Refinement of the MEH Concept

The PDF Block B Grant will define the technical specifications of a regional MEH for the Straits of Malacca and Singapore including other components.

Action Plans, GEF Project Brief and Workshops

The development of the technical description of the MEH and its financial components as well as the legal and institutional arrangements will be dealt with at several levels. At the national level, each littoral State shall identify and describe all mechanisms already in place in the Straits of Malacca and Singapore that are within their territorial jurisdiction. This shall include technologies/infrastructure, regulating instruments, capacity, budgetary allocation, management systems, operation and maintenance modalities, *etc.* relating to maritime safety and environmental protection/management.

In addition, gaps, constraints and benefits derived from these mechanisms will also be quantified. The level of interagency coordination and cooperation as well as system integration shall be critically assessed to determine the technical, legal, institutional, financial and management barriers and how to overcome them.

Potential technologies and mechanisms to enhance maritime safety and environmental protection/management shall also be identified and assessed including gaps and constraints to system integration, operation, management, maintenance and sustainability.

For the regional MEH, a similar approach shall be adopted. However, additional considerations include the existing/available regional infrastructure and mechanisms, contributions of user States and international bodies including obligations, constraints and gaps arising from Article 43 of the UNCLOS and other international instruments.

Multisectoral Team of Experts

Three national action plans (Indonesia, Malaysia and Singapore) and a regional action plan shall be developed based on the abovementioned processes. A multisectoral team of experts recruited for the Project together with a Project Manager shall develop the action plans in close consultation with the governments and the Project Steering Committee. The regional Action Plan shall also include an implementation and operational plan for the first phase and an initial implementation plan for the second phase.

Review, validation and refinement will be carried out for each action plan at the national and regional levels through workshops. Two national workshops will be undertaken by the Project while a third one will be organized by Singapore.

The regional workshop aims to develop consensus on the first phase of the regional MEH and formulate an implementation plan that will assist the

stakeholders in addressing and overcoming any gaps and barriers associated with the construction and operation of a full-scale MEH system.

Status of the MEH Project

On 7 November 2000, the World Bank approved, in principle, the PDF Block B Grant. IMO initiated start up activities such as the holding of consultative meetings with relevant government agencies in the three littoral States, establishing country organizational framework, preparing for the first Project Steering Committee Meeting and recruiting project personnel. A Letter of Agreement was signed on 12 March 2001 between the World Bank and IMO to implement the PDF Block B Grant.

In 19 to 20 March 2001, the first Project Steering Committee Meeting was held in Putrajaya, Malaysia. The meeting achieved the following:

- Establishment of the Project Steering Committee;
- Assurance of firm commitments from the governments of Indonesia, Malaysia and Singapore to the MEH Project;
- Approval of Terms of Reference of the Project Manager and three Technical Consultants ;
- Initial review of the curriculum vitae of candidates for the Project Manager and the three Technical Consultants ; and
- Agreement on the work plan.

The recruitment of the Project Manager and Technical Consultants has been accomplished.[7] The implementation of the remaining five project activities, meanwhile, is underway.

Conclusion

MEH provides a host of potential opportunities and benefits not only for the shipping industry, but also to a variety of users. Its application may be extended to environmental management programs, search-and-rescue operations, anti-piracy programme, environmental impact assessment, and fisheries/aquaculture management, among others. The implementation of the MEH Project and the lessons to be learned will thus be much anticipated.

> "Sustainable financing mechanisms, obligations associated with accession or ratification of international conventions, protocols, agreements and treaties, legal, institutional and administrative arrangements and political considerations are the non-technical aspects of the MEH that will have to be identified, assessed and integrated into the system."

Endnotes:

[1] In the context of this article, marine information is a broad collection of diverse types of information associated with activities in the coastal and marine environments such as shipping, fishing, coastal and marine management, marine conservation, maritime crime prevention, marine pollution response and prevention, *etc.*

[2] Such a system involves the automated collection, processing and display of the ship's navigation and other sensor data in order to maximize watch bridge efficiency and navigational safety. Electrotech Australia. 2001. Avail from: http://www.electrotech.net.au/navigation/.

[3] Regulation 19 of Chapter V of the International Convention for the Safety of Life at Sea (SOLAS) requires AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged in international voyages and passenger ships irrespective of size built on or after 1 July 2002. Similar ships constructed before 1 July 2002 will also be required but at varying dates (beginning 1 July 2003 but not later than 1 July 2008).

[4] DGPS is a radio navigation system that receives satellite generated positioning information. This system calculates real-time corrections to that information based on its known positioning and then transmits those corrections over select marine radio beacon transmitters to users located in the transmitter's coverage area. U.S. Coast Guard. Understanding DGPS. Avail from: http://www.uscg.mil/reserve/magazine/mag1996/.

[5] These are electronic circuits that are attached to an item whose position or presence was to be determined. Transponders News. Avail from: http://rapidttp.com/transponder/.

[6] Please see Prof. Robert C. Beckman's related article entitled "Using Article 43 of UNCLOS to Improve Navigational Safety and Prevent Pollution in International Straits," which is found on pages 18 to 23 of this issue. *Ed.*

[7] For more details, refer to the news brief on the personnel hired for the MEH project found on page 61 of this issue. *Ed.*

Reference for Photo on Page 24 :

Strategic Ventures Corporation. The South East Asia Marine Electronic Highway. A report to the World Bank (June 1997).