Innovative Geospatial Solutions towards a Sustainable Maritime Trade

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Key words: Cartography, GNSS/GPS, hydrography, positioning, risk management, standards, environment protection, eNavigation, cooperation

SUMMARY

The maritime traffic volume has increased substantially in the last years and the growth rate is expected to ascend even further in the years to come. The amount of gas emissions from the global maritime trade and the ship accidents risk is intensifying proportionally. These two elements have a significant global impact on the marine environment and the climate change. We will explain how innovative geospatial solutions, such as vessel and voyage planning or the eNavigation International Maritime Organization concept can help reduce the maritime trade environmental footprint as long as a good cooperation is maintained between the private and public sectors.

Vessel and voyage planning solutions integrate several geospatial data types to provide the navigator with an optimized ship route. When planning the voyage, parameters like the vessel's structure, the weather prediction and of course the hydrography and cartography, are taken into account automatically by the optimization algorithm. It is then possible to ensure an efficient and safe voyage, while minimizing the gas emission of a ship. Such an analysis can be made before the voyage using predicted parameters and the available nautical charts database, or also real time at sea with updated information received directly on board.

The eNavigation concept also works towards enhancing safety of navigation and environmental protection globally. We will briefly present the eNavigation framework, together with existing intelligent geo-information integrated systems capable of providing critical navigational and operational information to the mariner. This information needs to be delivered in a timely manner by combining real-time geospatial data streams with marine vector cartography. Automatic routing, weather limitation zones definition and checks for high risk features at sea, are just a few of the geospatial solutions now made available to the ship's captain. Adequate display of such information on the bridge of a vessel brings improved situational awareness to the navigator, and the risk of accidents at sea, like grounding or collision, can therefore be significantly diminished.

We will finally underline the importance of private-public cooperation in furthering the sustainability and safety of the maritime trade. Public bodies produce reliable geospatial information which is a necessary data input for the above mentioned innovative maritime solutions. Private and public sector need to cooperate even more closely to provide the mariner with the best of both worlds: reliable quality hydrographic data combined with innovative and efficient geospatial solutions.

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1. INTRODUCTION

Oceans represent an invaluable economic resource for many stakeholders, like the fishing or the mining industry; this also includes the international maritime trade. The Secretary General of the International Maritime Organization (IMO) recently warned that "establishing a sustainable maritime transportation sector is essential to the development and growth of the world's economy" (Sekimizu, 2012). We will present in this paper how innovative geospatial solutions can help reduce the environmental footprint of the growing maritime trade, especially when private and public sectors cooperate closely.

2. VESSEL AND VOYAGE PLANNING SOLUTIONS

Vessel and voyage planning solutions integrate several geospatial data types in order to provide the navigator with an optimized ship route. When planning the voyage, parameters like the vessel's structure, the weather prediction and of course the marine cartography, are taken into account automatically by the algorithm. It is then possible to ensure an efficient and safe voyage, by minimizing the fuel consumption for the desired arrival times, thus reducing the Green House Gas (GHG) emission of the ship. Such an analysis can be made before the voyage using predicted parameters and the available marine charts database, and also real time at sea, via satellite communication with updated data streams such as wind, waves, currents as well as chart updates received directly on board.

In Jeppesen VVOS©, a ship-specific model of the ship's motion, engine and propeller characteristics is used to recommend speed and heading changes to manage ship motions according to the waves and wind forecasts (see Figure 1). This helps the master make en route informed decisions to minimize heavy weather damage. The mariner can also download the latest ocean area forecasts and recalculate the passage plans as new forecasts become available or operational requirements change.

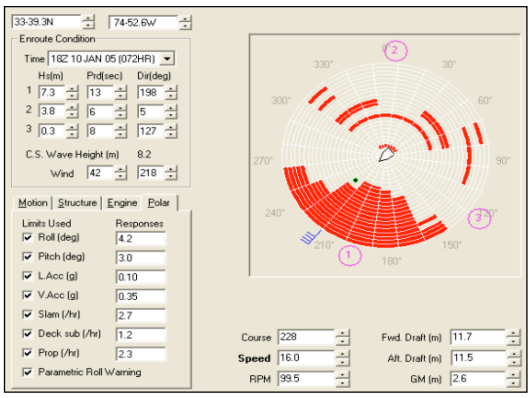

Figure 1. Polar diagram shows safe speed and heading.

The route optimization is performed on a user defined grid using weather assembly process and taking into account safe operating limits imposed by the mariner and ship responses (Chen, 2011). A histogram is then produced, which can be used to minimize fuel consumption for a range of arrival times, as presented in Figure 2.

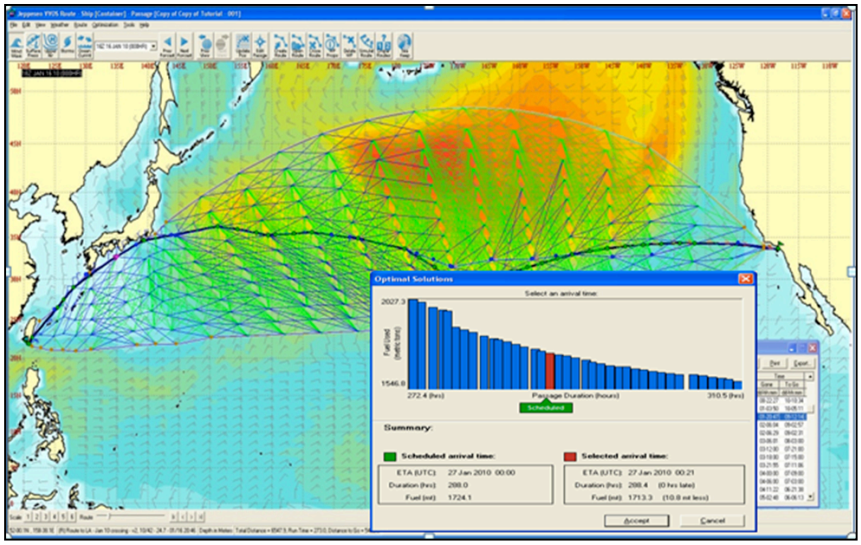

Figure 2. Histogram of fuel consumption trade-off
with arrival times and corresponding optimum route

Many other geospatial tools including automatic routing, under keel clearance, tide current optimization, are now fully operational and available to the mariner. Such vessel and voyage optimization solutions allow for safer and more economical passage, by minimizing accidents like groundings and collisions as well as reducing fuel consumption and GHG emissions.

Recent technology developments, in particular the availability of communication means at sea, have increased the capacity of the mariner to access near real time information even further away from the coast. Various data originators produce data streams containing information like weather predictions, wave heights or nautical chart updates which can be transmitted to a ship via radio broadcasts or satellite links. For the vessel and voyage optimization process to be possible, these data streams need to be harmonized. Then in order to bring situational awareness to the mariner, the resulting information will need to be rendered intelligently as a non-cluttered visual display for the mariner. The homogeneous data streams and coordinated implementation of such new maritime capabilities is managed by the IMO, via the e-navigation framework.

3. E-NAVIGATION

E-navigation is defined as “the harmonized collection, integration, exchange, presentation and analysis of maritime information on board 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” (IMO, 2009). As such, it aims at enhancing global safety of navigation and environmental protection by ensuring the implementation of intelligent information

integrated solutions, which will provide critical navigational and operational information to the mariner. This information also needs to be delivered in a timely manner by combining real-time geospatial data streams from various data originators with the marine vector cartography. All the data streams, whether static or dynamic, require merging and appropriate rendering by the final visualization system.

The data fusion process is made more complex as various parties and means of transmission are involved in the production and distribution of maritime safety information: Hydrographic Offices produce the cartographic base layer available on board the vessel as a core database and issue additional updates as necessary; in trafficked areas, Maritime Safety Administrations broadcast traffic information to all ships using their Automatic Identification Systems (AIS), together with aids to navigation status updates for instance.

So as to ensure a harmonization of existing and future data streams on board a vessel and allow for a safe passage, the International Hydrographic Organization (IHO) started working in 2001 on the S-100 data model. As the IHO director underlines, "S-100 has been developed to provide a contemporary hydrographic geospatial data standard that can support a wide variety of hydrographic related digital data sources, thereby enabling the easier integration of hydrographic data and applications into geospatial solutions" (Bessero, 2013). This data model is compliant with ISO 19100 series of geographic standards. This will ensure the compatibility as well as the merging capacity of data streams produced by various data originators (IHO, 2010), emitted by different means and received by the multiple systems on board the vessel.

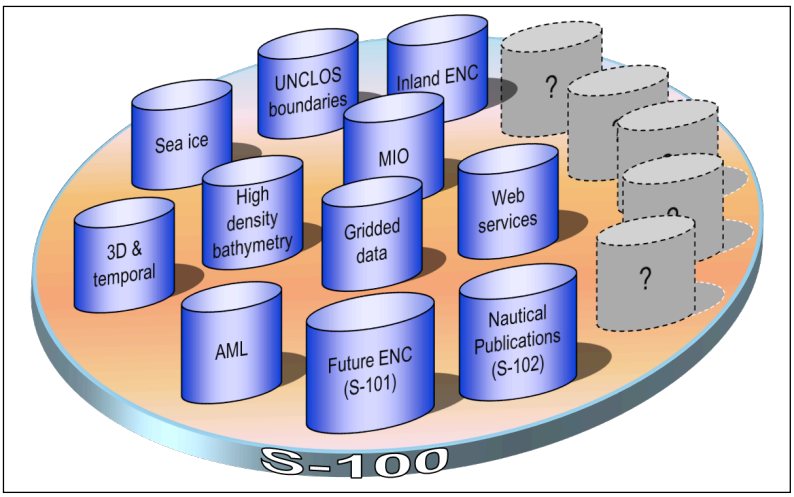

Figure 3. S-100 supports a greater variety of data sources, products and services (Bessero, 2013).

An E-navigation test bed included schemes following the S-100 data model, which were developed and implemented by Jeppesen for maritime safety information, meteorological and hydrodynamic data, as well as notice to mariners (Olsen, 2012). This information can either be broadcasted by AIS or via email, for early notice to the bridge crew and displayed directly on the Electronic Chart Display and Information System (ECDIS) as showed in Figure 4.

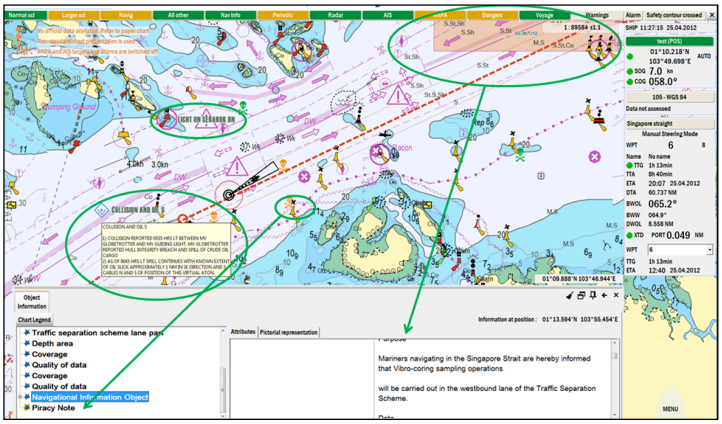

Figure 4. ECDIS screen shot during e-navigation test bed.

With the guidance from IMO and IHO, intelligent and timely information is made available to the mariner on the bridge of a vessel. This improves the maritime situational awareness of navigators and significantly diminishes the risk of accidents at sea. With a reduced number of groundings and collisions, comes less oil spills and subsurface drifting containers. So by improving navigation safety with the implementation of e-navigation and other innovative geospatial solutions, the environment protection is also enhanced. But at the core of this successful implementation lies the need for well-established and efficient private-public cooperation.

4. PRIVATE-PUBLIC COOPERATION

The importance of private-public cooperation in furthering the sustainability and safety of the maritime trade also needs to be stressed. Public bodies produce reliable and quality geospatial information which is a necessary input to the above mentioned innovative maritime solutions. For example, official marine vector cartography constitutes the base layer of e-navigation and geospatial optimization algorithms. Unfortunately, its availability to the private sector is still critical in some areas. On the contrary, the cooperation can sometimes go further than simple data access when the private sector provide tools and services to data originators to help them improve their data gathering and information consolidation.

While the public sector organizations manage public interest, create and maintain regulations, the private sector organizations are well equipped to develop innovative products and manage product lifecycles. Public-Private Cooperation (PPC) allows both partners to focus on their core competences and perfect the delivery in these areas (Bergmann, 2012). Roles and responsibilities should be clearly defined for instance within contractual agreements and the Private sector must respect the authority of the data originator. Both parties should acknowledge their respective competences and communicate regularly to build a strong relationship. Such PPC allows for full concentration on the common goal and an innovative future.

Private and public sectors are required to cooperate even closer to provide the mariner with the best of both worlds: reliable quality data combined with innovative geospatial solutions.

With efficient PPC, state of the art geospatial solutions can minimize the risk of accidents at sea and the environmental impact of the growing maritime trade.

5. CONCLUSION

The ever increasing maritime traffic and recent technology developments have boosted the mariners' need for readily available higher quality navigational information. Under the guidance of international bodies, together with reinforced Private-Public Cooperation, innovative geospatial maritime solutions can significantly improve safety of navigation and enhance environmental protection. Combining the effort of all stakeholders, we can speed up our journey towards a sustainable maritime trade and global "blue economy".

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BIOGRAPHICAL NOTES

Since joining the Jeppesen Maritime Industry Affair's team, Celine Roux has made a positive impact on the company's business and reputation in the maritime arena. Roux is responsible for supporting the Maritime Industry Affairs team's strategic activities in Southeast Asia – a high-priority area for Jeppesen and a key region for the world's shipping industry. Roux's base of operations is in the Sydney area, Gladesville, Australia.

Roux has directed successful initiatives to strengthen Jeppesen's relationships with Hydrographic Offices, data providers, coastal administrators and other key maritime organizations throughout Southeast Asia. Her extensive experience in marine survey and hydrography has already been of inestimable benefit to Jeppesen.

Roux's credentials include a Master's degree in complex systems engineering and recognition as a Category A surveyor by both the International Hydrographic Organization and the International Federation of Surveyors. Prior to joining Jeppesen, Roux worked with the French Naval Hydrographic Service (SHOM), where she led the External Relations division. Roux will continue to play an important role as Jeppesen establishes key strategic relationships around the world and cements its position as a leader in electronic navigation.

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