Vision of the decision support model on board of the vessel with use of the shore based IT tools

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ABSTRACT: The Maritime Safety Committee (MSC) at its 81st session decided to include, in the work programmes of the NAV and COMSAR Sub-Committees, a high priority item on "Development of an e-navigation strategy". E-navigation is meant to integrate existing and new electronic navigational tools (ship and shore based) into one comprehensive system that will contribute to enhanced navigational safety and security while reducing the workload of the mariner (navigator). This paper describes present IT created to support navigational and administrative activities related to vessel movement and cargo transhipment. Direction of development of existing systems is drafted with reference to E-Navigation concept. Information sets available for the vessel in Polish Sea Areas are grouped.

1 MARITIME SAFETY AND SECURITY INFORMATION EXCHANGE SYSTEM (MARSSIES) APPLICATION

Poland is currently implementing its National SafeSeaNet System compliant with Vessel Traffic Monitoring and Information System (VTMIS) Directive 2002/59/EC. The system consist of two main software components i.e. MarSSIES (Maritime Safety and Security Information Exchange System) and PHICS (Polish Harbour Information and Control System).

PHICS is an administrative system designed to facilitate specific duties of maritime administration like: supervision over training centres or seafarers certificates, exchange of FAL forms. It is also a basic system for electronic exchange of documents connected to vessel arrival and transhipment of cargoes.

MarSSIES is a basic operational platform for maritime administration and allied services. It presents integrated navigational and operational data from different sources on ECDIS background. It is also a National system for data exchange with European SafeSeaNet, presenting data of all vessels and their cargoes within EU waters.

MarSSIES is a comprehensive IT tool used for the purpose of information exchange between shore based authorities which duties involve activities at Sea. Model of the system was based on the existing procedures of information exchange. Core of the system consist of Event Model which enables simultaneous notification of logged users.

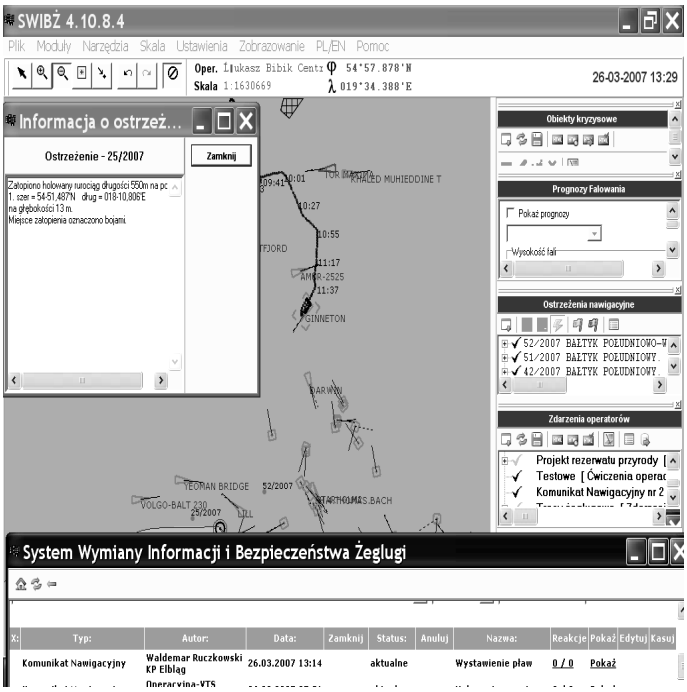

Fig. 1. MarSSIES Display at VTS Centre

Event is a pre-defined set of information or data. Every authorised user defines types of events and describes procedures for each of them (event support mechanism). New events can be initiated by operators or automatically as a result of readings received from other sensors, databases. When new event occurs, it is being processed by the system in accordance with procedure, e.g. system notifies specified receivers, waits for registration of appropriate decisions, etc.

MarSSIES presents information compliant with following standards:
- IHO S57
- IHO S52
- IALA V-128 Recommendations

2 SOURCES OF DATA FOR NAVIGATOR

Navigator on board nowadays may use various sources of navigational data to support his decision making process during "deep sea" vessel passage. Radar, ECDIS, AIS, meteorological are among those sources of data.
Officer of the Watch (OOW) is not always able to obtain detailed picture of the navigational situation on the approach to its destination though. Local vessel activities, safety and security measures, cargo operation at the berth may cause delays in time of arrival and extend the time of vessel presence in restricted waters.
Data form National SafeSeaNet is generally available for mariners thanks to the services provided by VTS or harbour masters or via the internet for authorised users. Current model is far from general idea of Vessel Traffic Management or E-Navigation. This is mainly because of communication restrictions in range or excessive costs of internet at sea. Some of the information processed also have to be limited only to authorised users because of its commercial or security nature.
Because of all above mentioned conditions information from shore based sources (VTS, AIS, Radar, Cargo Management Systems, administrative or operational databases) should be brake down into categories with priorities for ship in restricted waters.
Categorisation may facilitate future communication means when referring to cost-benefit analysis and it may also facilitate decision making process on board of the vessel as the OOW will only use limited set of the most important and valuable data.
Table No.1 illustrates information available for the vessel on the MarSSIES platform. The information presented are generally available on board, though idea of the MarSSIEs is that the vessel itself would be a data source as well.

Table 1. Information available – MarSSIES

Type of data	Source	Possible Communication
Navigational Warninig	Hydrographic Office	VHF, Navtex
ENC	Hydrographic Office	Sattelite
Radar VTS	VTS – virtual AIS targets	via AIS
AIS, VTS tracking data	VTS	MarSSIES
Vessel Radar (NMEA), local Radar	Network	MarSSIES
Cargo data	Local databases/vessel	MarSSIES
SafeSeaNet		
Local database	SafeSeaNet	MarSSIES
Safety Navigational data	MarSSIES users	MarSSIES

3 DECISION SUPPORT MODEL – DATA TO BE DISPLAYED

As it was presented different data is available on board. Even with present state-of-the-art communication and positioning technologies on board it is always a navigator (man) who is to make a decision. Decision making process is not only related to information available but also to perceptiveness and analytical skills. That is why proper tools are designed to support decision making process. Those tools are aimed to present to the navigator the most important data in a very clear an unambiguous manner.
With present state of data that may be transferred from ship to shore (Table 1) problem of validity and importance become one of he most important. For example information on dredging operations outside the ship safety domain may not be as important as information on pilot boarding time change.
Because of the range of information available ashore and required for the vessel to enhance its safety and security data priorities should be defined.
Next step and problem to be solved is to find a mathematical formula which will choose from theo-reticaly infinite set (A) – representing data available ashore with relation to the set (B) of priorities given to transfer particular element of set (A) for the ves-sel.

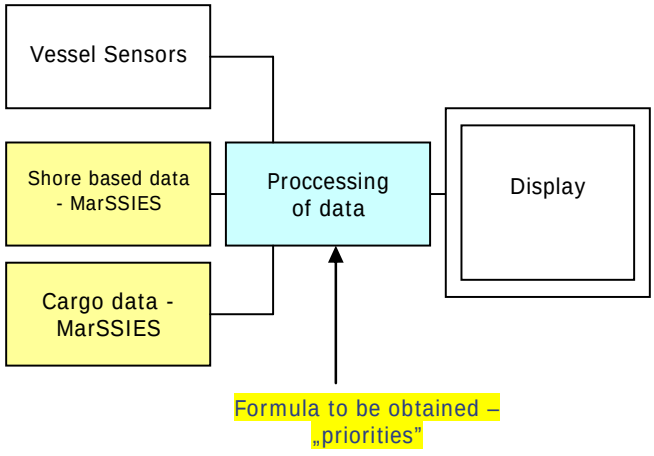

Fig. 2. Processing of data to be displayed

It is assumed that safety of vessel is a function of a few parameters [2][3]:

$$P_i = \int(A_i, S_i, N_i, H_i, M_i, I_i, R_i)$$

where:

P – is a navigational safety factor

A – defines dimensions of the area
S – defines parameters of the vessel
N – defines parameters of positioning systems
H – defines hydrometeorological conditions
M – indicates maneuvering parameters in relation to human factor
I – defines traffic density
R – defines parameters of traffic measures

When searching for the mathematical evaluation of priorities of data to be displayed authors are focusing on positioning systems parameters (N) as well as on traffic density and traffic measures (I, R). Traffic measures will not only relate to availability of separation schemes with efficient depth and width but also to navigational aids and services provided by shore based authorities.
Intention is to check in the future weather general decision function (Robust Sequence Estimation) may be applied to process data and to give priorities for each type of data mentioned.

4 MARSSIES AS AN ELEMENT OF E-NAVIGATION

During the first session of the E-NAV committee working definition of the E-Navigation was drafted. It states that: "e-Navigation is the collection, integration and display of maritime information onboard and ashore by electronic means to enhance berth-to-berth navigation and related services, safety and security at sea and protection of the marine environment."
It is expected that E-Navigation will enhance safety, security, protection of the environment, national interests, and SAR activities.
Following objectives were drafted by the committee members in relation to E-Navigation.

- Provide a holistic or systems approach to shore and onboard navigation activity.
- Improve the 'man machine interface' and provide clear information to a mariner so that he may make informed decisions, correctly interpret his situational display, and safely navigate his vessel to reduce collisions and groundings.
- Harmonise and standardise information and information transfer (ship-to-ship, ship-to-shore), equipment interfaces (i.e., 'plug and play' approach), and functionality whilst maintaining transparency and being receptive to advances in technology.
- Make recommendations on emergency management and fallback techniques, including the use of traditional navigation techniques, lights, beacons, radar plotting, etc. in case of failures.
- Prioritise information on the e-navigation display and adapt to changing situations.
- Allow simple, efficient communication ship/ship, ship/shore, shore/ship and shore/shore, making for effective teamwork (e.g., sharing tactical display, simplifying & co-ordinating reporting procedures).
- Improve traffic efficiency and port risk management.
- Contribute to an optimum mix of AtoNs.
- Improve situational awareness to both the vessel and shore.
- Expand VTS capabilities, including coastal and oceanic.
- Mitigate information overload, do not create additional tasks, but recognize OOW will need to change.

The components of e-navigation were defined in the following way:

- Ship and shore data: E-Ship + E-VTS = E-NAV.
- Navigation-related services, systems, and equipment.
- Communications.
- Networks / data exchange.
- Consolidated reports.
- Procedures.
- Training / Human elements.
- Interfaces (ECDIS/GIS, Radar, INS/IBS, VTS, AIS, DGNSS).
- Displays and technical protocols.
- Navigational messages.
- Services.
- Systems Components.
  - AIS,
  - Radar,
  - VHF/HF/MF,
  - GMDSS,
  - GNSS and terrestrial navigation systems/RNAV,
  - LRIT,
  - MSI,
  - Navtex,
  - INMARSAT and other satellite communications systems,
  - ECS/ENC/ECDIS,
  - Visual (ECS),
  - Voice recognition,
  - CCTV,
  - Portable Pilot Units,
  - Assisted docking,
  - Virtual AtoN,
  - Hazards,
  - Met/Hydro sensors (e.g., ice, fog, tidal),
  - Shore initiated info.
- Three-dimensional control (automatic, shipborne, and shore-based.)

Practically MarSSIES may provide its users most of the data listed in the E-Navigation concept and additionally can provide an effective and cost limited voice communication using VOIP communication technology.

Additionally its interface and event mechanism allow it user to add as many additional information (in text or layer form as possible). Overall content may be sometime ambiguous or may be outside perception of the VTS operator that is why authors will seek for possible solution in further publications.

Bearing in mind that only vessels of maritime administration and allied services may use this Web- based system there are no comments from commercial mariners concerning data content. Maritime administration is interested in the most effective thus most environmental friendly shipping while commercial users are usually limited by time and costs.

5 CONCLUSIONS

Mechanism of display and control of data priorities will certainly meet the needs of increasing number of data sources to be presented onboard and ashore in the E-Navigation systems. It may also reduce future costs of the data transmission between shore and ship.

When referring to the limitations of the E-Navigation concept one of the issues raised was a existing man/machine interface limitations and technical constraints.

In case of the MarSSIES software Maritime Administration together with allied services are trying to find a consensus between the scope of data and possible communication means, network bandwidth as well as the content of the displayed data.

That is why further work to elaborate a solution for prioritising data will not only benefit coastal administrations but also mariners equipped with E-Navigation software.

Parallel to ongoing process of defining E-Navigation, international bodies should seek for a solution of E-Navigation tools on board of vessels. Software components of those tools would be able to process data with use of developed “prioritising solution”.

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