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Research on International E-Navigation Practical Project and Its Inspiration

Z. X. Du[†*], P.F. Huang[†], & M. Becker[‡]

[†]Navigation College, Jimei University, Xiamen 361021, China, *Email: duzhixiu_0219@126.com
[‡]Deptment Civil, Environmental, & Architectural Engineering, University of Colorado Boulder, Boulder, CO, USA

ABSTRACT: E-Navigation as the global solution for safeguarding safety and security at sea and protection of the marine environment, has promote the construction of many practical projects with international influence. The paper analyzed the representative MONALISA , EfficenSea and ARIADNA Maritime projects and learned their new ideas and techniques, then combined with the actual needs of the development of China's navigation support to establish China marine traffic management system(STM) based on vessel supervision and maritime service. The system gathered maritime participants, actors and navigation systems (including AtoN, AIS base station, Beidou CORS station, etc.) to create a maritime chain, and shared region maritime information by maritime cloud, helped ship to achieve safety-environmental protection-efficient transportation from berth to berth at sea.

KEYWORDS: e-Navigation; e-Navigation Testbeds; Navigation support.

INTRODUCTION

The rapid development of the global economy and trade drives the world shipping economy expanding rapidly, which encourages continued to high-speed and large-scale development of the ship. The busy sea transportation brings a great challenge to the safety and security of sea and marine environmental protection. To address the challenge, improve navigation safety, reduce the risk of marine pollution, improve water transportation efficiency, create maritime highways, IMO (International Maritime Organization) developed and dominated the e-Navigation strategy [1]. Since the e-Navigation strategy proposed, countries have vigorously promoted the construction of e-Navigation and actively built the e-Navigation practice engineering. Such as the EU's EfficenSea, MONALISA, ACCSEAS, ARIADNA. Some Asian countries are also active in the research of e-Navigation practical project, such as South Korea's Smart-Navigation project, Japan's electronic navigational support systems (ENSS), along the regional information providing system (MICS), smart ship application platform project (SSAP) and so on [2]. China as an important part of the global economic entity and one of the world's largest marine countries, especially since the implement of China's "maritime power" strategy and "one belt and one road" strategy, which makes the rapidly growing of maritime traffic flow, and thus brings huge "burden" to safety and security of marine traffic, marine environment. IMO member states put forward the concept of e-Navigation in 2005, according to the definition of e-Navigation determined by IMO, e-Navigation refers to the collection, integration and display of marine 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 [3]. E-Navigation is regarded as the new direction of global maritime security development in the future [4]. Studying on e-Navigation shipping engineering practice in developed countries and the background and key technologies of the project, then analyzing the test results, to provide reference for the construction of our country's e-Navigation practical project.

INTERNATIONAL E-NAVIGATION PRACTICE PROJECT

In order to facilitate the effective sharing and comparisons of the test result of international e-Navigation practice project, it proposed that IALA would coordinate various practical engineering testing results and formed the specific format templates of practical engineering implementation considerations and sharing results at the 58th meeting of IMO's navigation safety board. I [5]. In addition, IALA has developed a common platform to effectively share the world e-Navigation practice project [2]. This article specifically describes two typical projects.

MONALISA

EU Maritime Electronic Highway Project (Motorways & Electronic Navigation by Intelligence at Sea, abbreviated MONALISA) is an e-Navigation practice project implemented by EU for the Baltic region, which is to create an

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electronic motorways project for Baltic region by intelligent navigation. This project is led by European Commission / TEN-T executive, participants include the Swedish Maritime Administration, the Danish Maritime Administration, the Finnish Transport Agency, SAAB company, SSPA company, GATEHOUSE company ,Chalmers University and so on [6]. This project is divided into two phase, detailed introduction is as follows:

(1) MONALISA 1.0

MONALISA 1.0 project started in September 2010, which took three years to complete, with a total investment of 22.4 million euros. This project is a comprehensive marine engineering, based on e-Navigation technical architecture proposed by the International Maritime Organization (IMO) and the International Association of Lighthouse Authorities (IALA) [7], using AIS technology, GIS technology and ECDIS to achieve the broadcasting sharing of the regional ship's dynamic plan routes, the automatic certification and supervision of seafarer ' s competency certificates, quality assurance and regionalization share of maritime information of high-dynamic master channel depth data, so as to carry out the dynamic supervision of the ship and the automatic verification of seafarer's competency certificates on duty, and ultimately create the highway for the Baltic region [6].

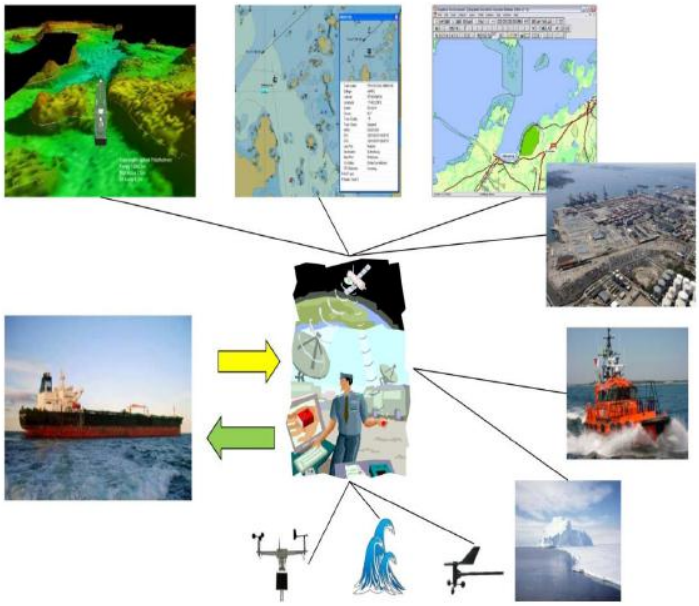

Figure 1. Master layout plan of ship courses planning.

(2) MONALISA 2.0

MONALISA 2.0 project started in September 2013, expected to be completed in December 2015, with a total investment of 24.3 million euros, based on e-Navigation Strategy Implementation Plan (SIP) (NCSR1/9) proposed by International Maritime Organization (IMO)[8], focusing on the use of marine cloud technology and information communication technology (ICT) to achieve a more secure - efficient – environmental STM (Sea Traffic Management). The STM will be a collection of all maritime players, actors and systems (including infrastructure) to build a maritime chain, and use marine information belongs to marine cloud sharing region to make maritime transport more efficient, more flexible, predictable, safe and environmental, reduce the administrative burden in the maritime sector at the same time.

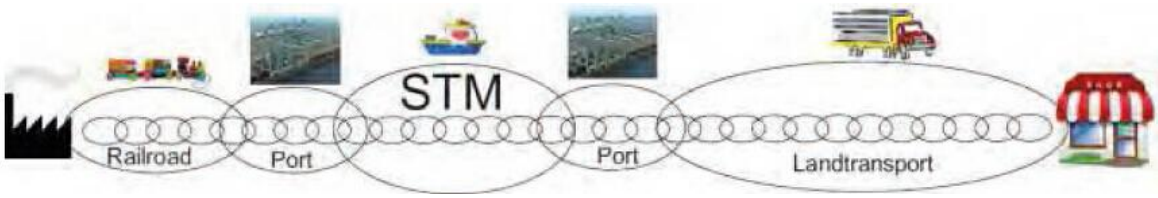

Figure 2. Maritime chain of STM.

STM includes five sub-concepts, namely: traffic flow management, strategic voyage management, dynamic voyage management, port integrated decision support and system-wide information management [9].

EfficenSea

EU efficient, safe and sustainable traffic at sea (Efficient, Safe and Sustainable Traffic at Sea, abbreviated EfficenSea) is one of the more successful e-Navigation practical project, divided into two phase, detailed introduction is as follows:

(1) EfficenSea1.0

EfficenSea 1.0 project started in February 2009, which lasted three years, with a total investment of 8 million euros. 16 partners in Denmark, Sweden and other four countries participate in the construction. Utilizing AIS, VTS, NAVTEX and radar technology, this project has achieved real-time sharing of hydro meteorological information in the area of shipping routes, including wind, current, waves, water level and sea water density, real-time route information exchange service of vessels, maritime safety information service, search and rescue service, and thus creating an efficient, secure and sustainable transport at sea for the Baltic region [10]. The project was known as "strategic project" for the Baltic region in 2007-2013, and also known as the Baltic region "flagship projects" based on the EU strategy [11].

(2) EfficenSea 2.0

EfficenSea 2.0 project started on May 1, 2015, which lasted three years, with a total investment of 85 million Danish kroner, 32 partners from 12 countries of the European Union to participate in the construction, is an innovative project developed by European Union, led by the Danish. A breakthrough in the development of this project is to propose using the "Marine cloud" to achieve system communication, improve information exchange between the maritime sectors. Meanwhile, the project will also develop new and more extensive digital services in the navigation field and automatically generate shipping emissions reports and monitor, improve operational efficiency. This project uses modern communications, navigation and management system to better meet the business needs for efficiency, increase safety and improve system availability [12].

ARIADNA

ARIADNA project was launched in 2010, which lasted three years, the project jointly carried out by Isdefe, INTA, more than 10 companies, the project is proposed on the basis of the Volumetric Navigation System (VNS), using three-dimensional surveillance technology, information monitoring stereoscopic technology, combining real-time navigation data, GNSS location information, time information, ship performance data and sea conditions, weather and other data to calculate and predict the dynamic changes of navigation position information in the boat, other ship surrounding it, thereby effectively avoiding ship collision and grounding, guarantying the safety of navigation. Moreover, in order to avoid a ship's human error in the harbor, inland waterways and other transportation-intensive sailing waters, ARIADNA also designed early warning and collision avoidance system in the ship terminal [13-14].

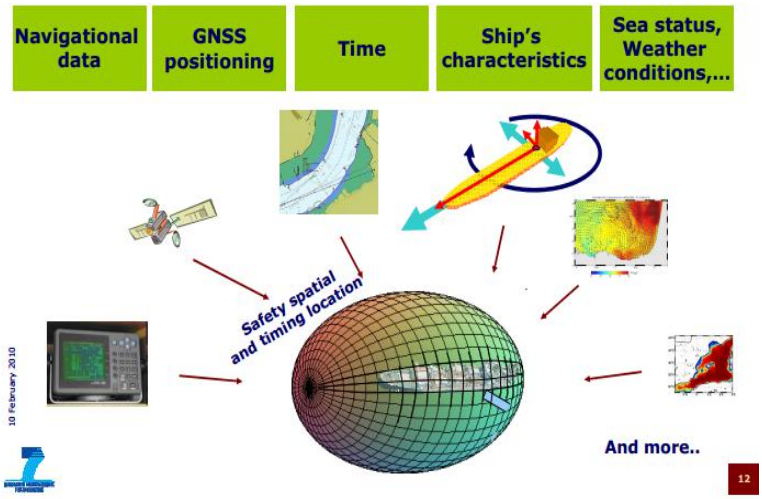

Figure 3. Three-dimensional envelope of massive parameter calculation in ARIADNA project

THE INSPIRATION TO OUR COUNTRY'S E-NAVIGATION

e-Navigation in China

China as one of largest marine countries in the world, as IMO Class A member, attaches great importance to the construction of navigation support, is also active in e-Navigation-related research. Up to now, China has built AIS and radar network covering the country's major inland waters and coastal waters inshore, VHF communications has basically continuous coverage coastal waters inshore. Self-developed Beidou satellite navigation system has gone to the stage of history, IMO MSC94 considered and adopted the circular of the Beidou satellite navigation system officially classified as a global radio navigation system component [15], Beidou CORS (Continuously Operating Reference Stations) Stations covering the country has also been established one by one, to implement the dynamic monitoring and service for the ship in the major coastal ports and waterways. In addition, China also started the construction of e-Navigation practice projects, such as "Yangshan Port e-Navigation" of the East China Sea maritime security center, and NAVDAT (NAVIGATION DATA) system which was independent researched broadcasts maritime safety and security information; "Comprehensive Maritime security system " of North Sea maritime security center and "efficient ship reporting service out or in of Shenzhen port" of the South China Sea maritime security center which is studying, these practices for e-Navigation has greatly promoted the development of China's e-Navigation, and made great achievements. However, because of a late start and other reasons, there are some disadvantages compared with foreign countries, specific performance are as follows:

Our country's e-Navigation practice projects mainly were constructed by integrating the existing system and equipment, lack of innovation in technology;

Our e-Navigation project is a regional practice, and was developed independently for a specific area, it does not have the generality required by international e-Navigation;

Our maritime security systems have the phenomenon of multi-standard, multi-system, and data resources were scattered, there was also "information island" phenomenon[16], these phenomenon resulted in the difficult in data sharing, providing consistent, reliable and real-time information to business users.

The inspiration to our e-Navigation

According to standards and regulatory requirements of international e-Navigation strategy to the status quo e-Navigation Development of China and needs a starting point, foreign successful in e-Navigation practice engineering of advanced concepts and technology, establish a set of ship monitoring and marine services as a whole the Chinese maritime traffic management system (STM), this system is the set of all maritime players, actors and systems (including infrastructure beacon, AIS base stations, Compass CORS stations, etc.) to create a maritime chain, and the use of maritime cloud regional maritime information sharing, assist ship from berth to secure between berth - Eco - efficient maritime transportation.

Integrate Maritime e-Navigation Vessel Supervision

(1) Ships regulatory approach based on routes sharing

Ships regulatory based on routes sharing refers to report the planned route to the monitoring centers (VTS centers)in the region when the ship enters into our jurisdiction, VTS center t-hen initiatively broadcast the route planning to other ships in the same area by the 27th message. At the same time, VTS center establish a new model which can regulate the current sail situation and forecast the future traffic condition by deduction and analysis of ship rout planning, when there is a risk with the forecasted ship , VTS center sent planned routes and recommended routes point to point by the 28th message[17], at the same time, the ship's ECDIS platform displayed recommended routes, the ship can choose to receive or reject recommendations, in order to achieve regional traffic analysis, traffic organization, early navigation warning. This mode is the main consideration of the exchange of report line design, route information.

(2) Ship supervision mode based on volume navigation

Shipping regulation based on the volume of navigation refers to the integrated ship navigation data, GNSS data, ship performance, sea state , weather conditions to calculate shipping volume, and then combining with three dimensional security technology and information monitoring technology to set up multiple different levels of three dimensional volume envelope for the ship. VTS center and the ECDIS platform of the ship are both able to see the ship and the three dimensional shape of the other ship which surrounding around the ship, and real-time

understanding of dynamic changes. If the distance between two ships or the distance between ship 3D outer perimeters and sea bottom was equal to or less than the alarm limit, the alert would be triggered. Thus, to avoid the ship collision and grounding and then to ensure the safety of navigation. Fulling considering the influencing factors of ship parameters to design a 2D ship safety protection line which will be the foundation of the late 3D design concept, detailed below.

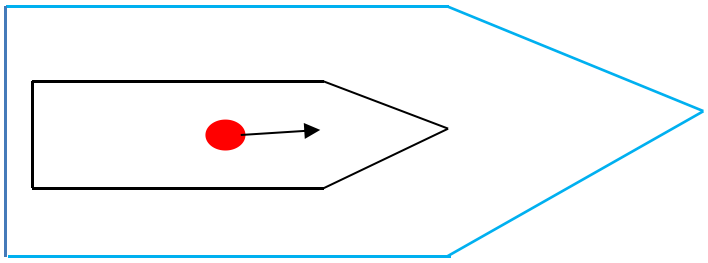

Figure 4. Vessel volume navigation elementary model Scheme of envelope calculation.

RED: Reference point of the vessel

BLACK: True dimension of the vessel

BULE: 2D safety envelope of the vessel

Based on system of volume navigation, when ship out of the garage, it is able to calculate the distance with high accuracy between ship and the wharf, ship heading, pilotage un-berthing ships with high efficiency. In addition, the concept can also be used to ship intelligent collision avoidance, unmanned ship, and other fields, has the very good application prospect.

Comprehensive maritime e-Navigation maritime service

(1) Maritime service mode based on maritime cloud information sharing

At present, China's maritime services have basically achieved informationization and have accumulated a lot of data information. However, the limits of technical level and historical conditions in china at that time, several standards of data and multiple system, dispreading of data resources, all above factors contribute to "Data Island" and difficulty of data sharing. Therefore, it is hard to provide reliable, consistent and up-to-date information for users. Based on information sharing maritime cloud refers to introducing cloud computing technology to the construction of maritime information, making use of cloud computing technology to build a unified data center as a maritime could platform, through the internet, virtualization, automation management technology and by means of scale, intensive, specialization, to achieve centralized management of information resources and provide users with they requiring information in the form of sharing. Maritime cloud platform is in a unified interface encapsulation, and forming a flexible, simple and diverse application development and operation ability, which provides a distributed parallel computing ability. The establishment of maritime cloud platform makes the maritime information in data processing, resource sharing, collaborative office and intelligence analysis to be improved, and improving the maritime supervision, service and emergency response capabilities in full range.

(2) Maritime service mode based on maritime efficient transportation chain

For cargo owners, to ensure the safety of goods from the starting point to the destination is their ultimate goal. Therefore, this paper puts forward the construction of maritime service model based on the maritime chain, as a function of the STM of the ship traffic management system. According to information carried by cargo, use of networking, GPS/BeiDou, AIS, ECDIS and other technology, combining with the ship, ports and ground transportation scheduling stakeholders to establish a maritime logistics chain. Thus, to realize the safety, environmental protection and efficient maritime transportation.

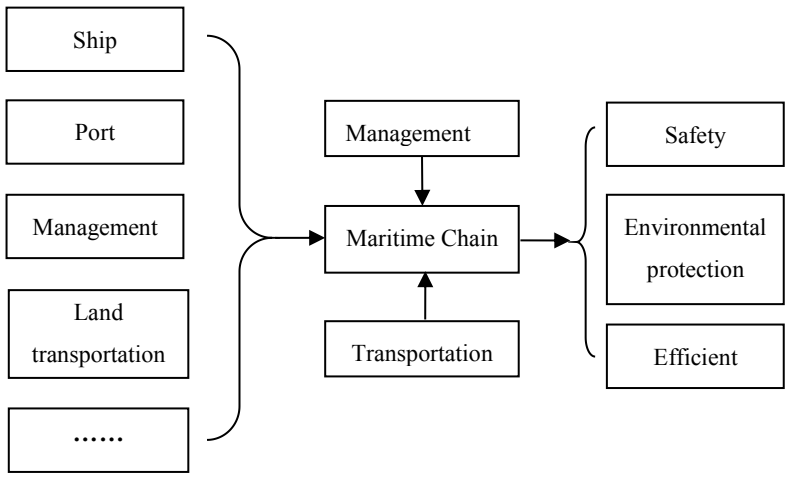

Figure 5. Maritime chain structure diagram.

CONCLUSION

In the international MONALISA EfficienSea engineering and ARIADNA engineering inspired, we propose a set of regulation and marine services for the integration of China's maritime Traffic Management system STM(Sea Traffic Management) in this paper. This system uses a shipping route sharing, shipping volume navigation maritime and maritime chain, such as technology innovation. It is not only achieve the regulatory digitalization and ship intelligent collision avoidance, but also will join the maritime chain land transportation. Besides, it is the first time to guarantee the safety of ship navigation and protection of the marine environment. Thus, it improve the efficiency of transportation. However, the system still remains some difficulties to be solved. For example route sharing may leak trade secrets, which is necessary to form a set of corresponding laws and regulations. Or how volume navigation to use the real time data of ship itself and the surrounding environment, how to calculate the volume range of ship navigation, the network safety of maritime cloud. Such problems should be solved by means of cooperation of government, monitor department and research institutions.

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