

## Application of Internet of Things in Development of e-Navigation Architecture

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### Abstract.

In the face of maritime security services with the rapid development of technology, information explosion and rigorous requirements of service, e-Navigation architecture also need to constantly improve and change to match for the situation and demand. The development of internet of things architecture to guide the design of Internet of things system, realize the unified data acquisition, processing, service provide a new perspective for research on e-Navigation architecture. The purpose of this paper is to study e-navigation architecture in the perspective of the Internet of things, and how combination of the Internet of things and E navigation architecture effectively, so as to find new territory for informationization development of e-Navigation architecture research.

*Keywords: e-Navigation; Web of Things; architecture; structure*

### Introduction

E-Navigation aims to coordinate all kinds of Marine navigation system and various support shore side service, to meet the needs of users. It is a wide range strategic vision by IMO, as a global solution in future with convenience, economic, safe and efficient navigation and water activities. To become the world power in maritime, China must explore in e-Navigation areas independently and effectively which is on behalf of development trend of the future maritime. In the 12th five-year plans schemes from both transportation maritime bureau and Shanghai maritime bureau, all focus on research and exploration to e-Navigation. In recent years, the development of integrated navigation system is essentially effective exploration and practice for e-Navigation [1]. But how research and develop more in-depth to seek effective carrier and mode, we need to use new ideas and technical means to enrich and explore.

China pay close attention to development strategy of e-Navigation and the development of current situation of all countries actively, but haven't a comprehensive practice project e-Navigation like Monalisa Maritime Project of EU. Therefore China need to further strengthen in e-Navigation engineering practice, so research on chinization e-Navigation practice project is an important part of development of e-Navigation. E-Navigation architecture is the theoretical basis of e-Navigation comprehensive practice project. China has carried attempts

on the exploration in multiple applications fields, such as digital beacons, digital channel, vessel intelligent navigation, integrated navigation information release system, etc., but these are only for part of application in the field of e-Navigation application practice, not study in e-Navigation architecture level. E-Navigation architecture is a kind of people-oriented design. IALA proposed that construction of e-Navigation system architecture must be guided by the user requirements. Compose of e-Navigation system architecture include ship end system, shore system and navigation and communications infrastructure [2].

**Introduction of e-Navigation Architecture**

Entity considered by e -Navigation architecture is users and their requirements, specifications, functions and processes, as well as the technical service and systems, interaction, information and data. Overall block diagram of e-Navigation technology architecture from IALA is shown in figure 1, including the ship end systems, communication links and shore-based technology services component. Navigation security data information needed by Ship technology environment and shore-based system perception, acquire the perception data via physical link transmission technology, send the data to shore-based processing system to intelligently process data, and implement information sharing through the navigation satellite system, and the realizes all kinds of external service of navigation security information finally. In e-Navigation overall technical architecture, IMO global radio navigation system (WWRNS) including GNSS be deemed to an "outside" support system of e-Navigation system, to provide the location and time information service.

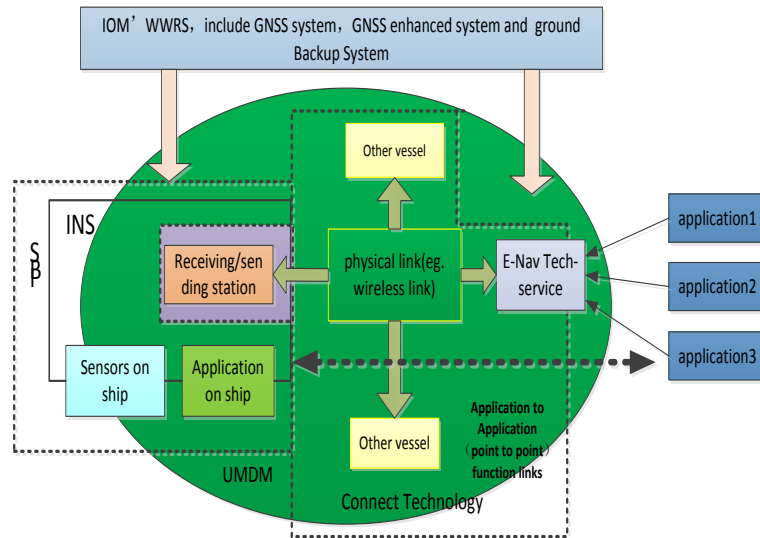


Fig.1 e-Navigation technical architecture

**Introduction for Architecture Internet of Things**

**Development situation of architecture internet of things.** Since Iot was proposed, the focus on research of Internet of things is more its applications in

industry since, but in recent years, the work gravity center of the Internet of things gradually turned to the study of its top level architecture.

Since 2012, achievements of research on Internet of things architecture spring up. In china, as. Beijing University of Posts and Telecommunications as a representative, Web of things architecture becomes the new hotspot to internet of things architecture. In paper of Promote the development of an open Internet of things [3], this stage of development is defined as "chimney" stage of development, mainly used as industry application and the closed loop application, in some extent belongs to the Intranet or private networks. One view of this paper is that this pattern construction is high cost, difficult object/information sharing and connectivity between application systems. So this pattern construction neither can adapt with the requirements of development large-scale and collaborative nor can guide and push more potential development for Internet of things. Open Internet of things (also Web of things) is the important ways to solve "chimney" development bottleneck. Web of things builds an open and flexible Internet of things architecture, provides open common service and universal run support, to realize the convenient sharing of networking equipment data information and control functions, to fuse cognitive network peripheral node into information space.

The European Union, the United States, Japan, South Korea, France, have done a lot of work on research of open Internet top-level architecture. The basic idea of Internet of things general architecture is compatible, open and flexible. Typical application of Internet of open architecture is the application in intelligent city. Through the analysis of the above internet of things architecture, consider that introduce the concepts of architecture design into e-Navigation architecture study, forming a new open Internet architecture.

**Technology of the Internet of things & the application in e-Navigation.**From the point of communication objects and processes, the core of the Internet of things is information interaction between people and things. The basic characteristics of the Internet of things can be summed up as comprehensive perception, reliable transmission and intelligent processing [4].

From the system architecture, the Internet of things can be divided into information acquisition, communication network, and information processing application three levels. The information acquisition layer collects entity information with the aid of various sensors equipment; the communication network layer accomplish the transmission of information; Information processing application layer is combined with industry demand, data processing, integration, excavating, to implement the widespread intelligent application.

the key technology to supports network are mainly concentrated in fields of perception, control, network communications, microelectronics, computer, software, embedded system, micro-electro-mechanical technology. According to compose, Internet of things can be divided into generic technology, sensing and recognition technology, network communication and intelligent processing and service. The Internet of things industry covers sensing perception, transmission channel, arithmetic processing and application in the fields of industry, involving technology including RFID radio frequency identification, sensors, wireless

network transmission, high performance computing, intelligent control, etc. the development of e-Navigation can't do without communication, intelligent control, and the important component of the Internet of things – “Internet”. The technical development foundation of The Internet of things is consistent with e-Navigation, with many of the same technology dependence.

Although the Internet of things has been widely used in various fields, this paper focuses on its application in e navigation to study. Currently, as we well known, the VTS, AIS system of maritime bureau, ship networking, the telemetry buoy remote control system, hydrologic meteorological service system, including the sailors certificate of recognition system research and development and pushed in recent years, all have the application of concept and technology of Internet of things. AIS system, the telemetry buoy remote control system, hydrologic meteorological service system and the sailors certificate of recognition system important application achievements in the field of Maritime Security after the implementation of e-Navigation strategy.

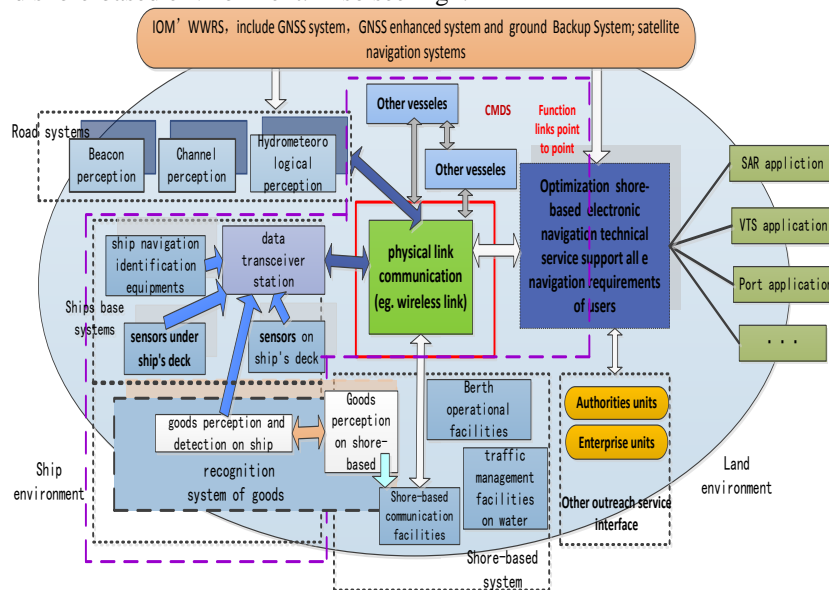
The core concept of Internet of things is to build the world's perception network, real-time control, precise manage and scientific decision-making the physical world. E-Navigation target is used to coordinate all kinds of Marine communication and navigation systems and support variety shore-based services of user demand driven, in order to ensure ship navigation safety, protect the Marine environment and improve the efficiency of transportation. So it is emphasizing that overall considerate various e-Navigation system infrastructure, vessels and communication mode, to the application of the internet of things in e-Navigation area, to build the comprehensive integrity top level architecture which covers the shore, ship, communication.

### **E-Navigation architecture based on Internet of things**

The items in the open Internet of things can connect with all forms of communication links, starting from the application, according to the need for selective worldwide network. The open Internet of things system architecture [5] is applied to the study of e-Navigation architecture. Various shore-based communication technology systems, communication links, ship end systems, route systems; identification and management system of goods concatenate together to be a large network, and each system it the network can exchange and share information.

By studying the maritime internet of things [6], e-Navigation technology architecture, and the of concept and technology architecture of Internet of things, Iot perspective of e-Navigation technical architecture can be studied from shore-based, ship side, communication link combined with Internet of things intelligent disposal technology and ideas. E-navigation technology architecture based on the technology of Internet of things through various means of communication connect, shore-based system, ship end systems and communication link in e-Navigation system architecture together, and form a kind of intelligent integrated navigation system. In addition, the sensor identification system is an important part of the Internet of things. Add the goods perception system, channel perception system, AIDS to navigation system

perception and any other perception system to e-Navigation architecture, to make the data acquisition exponentially. Finally, realize the information sharing between ships and shore-based control systems and all the relevant systems from ship end systems to shore-based systems. It is important to import IoT for enriching e-Navigation architecture. As the result, it form a new comprehensive stronger, bigger volume, informationization level higher, integrated navigation architecture system, is the upgrades for e navigation architecture. E - Navigation architecture can be divided into five blocks: physical link, WWRS, CMDS, ship and shore-based environment. Also see Fig2.



FiFig.2 E-navigation architecture based on IoT perspective

E - navigation architecture based on Internet of things based on e - navigation architecture, introduce the part of the Internet of things which is in conformity with development of e - Navigation into e-Navigation architecture, to make e-Navigation more efficient, reliable and convenient for the user service, and to realize information sharing and intelligent disposal of data in all the all related systems. Greatly improve the service quality and efficiency of e - navigation service. Comparing figure 1 and figure 2, the new architecture based on e - navigation architecture, absorb the comprehensive data acquisition perception network system (route system, ship-base systems, goods identification system and shore-based goods identification, etc.) of Internet of things to achieve comprehensive collection of related data. Besides, physical link communication, general maritime data in terrestrial environments are ascend on the basis of the original, data more rich, transport more secure.

All data processed can be transmitted safely between subsystems in the whole structure, according to the need for data sharing. Under the support of huge amounts of data acquisition, data security transmission and intelligent disposal, e-Navigation will provides more comprehensive content, higher

reliability, emergency response more quickly services for all users including shore-based user, with high intelligent features.

The e-navigation architecture based on Internet of things in accordance with e-Navigation architecture, but different with e-Navigation architecture, it enriches the part of the collection of information on the basis of e-Navigation architecture. Compared with e-Navigation architecture, in the information acquisition layer, add sensor network, route system and other information collection technology, not only make the source of the information collection greatly increases, data acquisition frequency of the same information source also has greatly increased, the density of the amount of data information based database parameters increase for the data processing to obtain effective information for the higher accuracy and real-time performance.

### **Design of maritime security platform based on the architecture**

Designing the maritime security platform, implement application verification of e - Navigation architecture in the view of the Internet of things. This platform can be researched from AIDS to navigation, electronic chart, hydrology and meteorology and traffic police radio, etc. According to the flow of information, it can be overall designed from information collection, information security transmission and intelligent disposal. At the same time the three portions correspond to information collection, information processing and external service navigation security platform.

#### **(a) perception and acquisition of information:**

Information acquisition terminal collect and integrate relevant information need for maritime security services. Information sources come from AIDS to navigation, surveying and mapping, communication, related to maritime authorities and port authorities, hydrology and meteorology, AIS, GNSS and other relevant departments. Collection information include navigation mark dynamic/static information, surveying and mapping information, marine communication, navigation warning, VTS, channel anchorage, berths, water depth, AIS, GNSS, and other related data, the data including dynamic information of AIDS to navigation, hydrometeorological information, AIS information and radar information in periodic return.

The complexity of the data determines the difficulty during the process of collecting. Platform research and develop all kinds of technology and terminals to acquire maritime security information. After processing, integration, statistical, the data be sent. Now, the data is much and disorderly, and need to unify planning port, design a common standard to send data through a variety of access methods. To retain extensible interface, for the more other maritime security information hadn't taken into account reserving access port, research on extensible interface will be done.

#### **(b) data transmission & information sharing**

Complexity and multi-source heterogeneity of data lead to the complexity of the data fusion and storage. And if you want to obtain valid data, the data must be filtered, screened, and fused in depth, finally package sent to the data processing part. Technologies and systems as follows to realize this link:

- (1) *based on AIS binary message security information release and ship sailing at sea intelligent early warning;*
- (2) *the AIS system;*
- (3) *NAVDAT transmission technology;*
- (4) *The WEB, the Internet, network transmission;*
- (5) *Integrated application of computer technology, network technology, modern communication technology and GNSS, AIS and ECDIS and Web key technologies, such as using a variety of information sources to maritime security, safety related timely release of information to the related departments or the user.*

**(c) intelligent disposal & external services**

Be research multi-source heterogeneous fusion methods of navigation data and storage model to improve the comprehensive utilization efficiency of existing data, create more value and ensure the safety of navigation.

Because of the complexity of the large amount of data storage, cloud storage technology need the help of virtualization cluster application, network technology and other technology to achieve reasonable storage, integration, and management for data. Cluster technology can make the platform has characteristics of high availability, load balancing, scalability, fault recovery, and the maintainability. Virtualization application can improve the utilization rate, reliability, maintainability, safety of the system hardware. Through use of control program and hide specific physical characteristics of computing platform, we can provide users with the virtual environment in abstract, unified, simulation.

Information intelligent disposal involves technology and research:

- (1) *in the data management using modern data processing technology, cloud computing, cloud computing is a typical distributed computing is handling a growing number of maritime security information is the most effective solution;*
- (2) *Research on data mining technology, in the huge amounts of data to find useful information;*
- (3) *Related algorithm model, etc.;*
- (4) *Other information processing technology research.*
- (5) *Through the following systems and r&d information intelligent disposal and foreign services:*
- (6) *navigation information release platform;*
- (7) *The sailors certificate remote identification system based on AIS;*
- (8) *Passenger routes meteorological decision system of research and development of the technology for realizing the foreign service methods, such as research and development;*
- (9) *Routes Shared services, users can see around the ship plan route, navigable conditions of ships with a more detailed understanding, ship users can adjust plan route, decrease caused by the factors such as traffic density of collision problem;*
- (10) *Other foreign services and technological research.*

In the end, realize the internal information service by following ways:

- (1) *form the product specification and data;*

- (2) *The use of AIS base station for navigation safety and warning information broadcast;*
  - (3) *Provide data support for NAVIDATA, become NAVIDATA data center;*
  - (4) *Use the Internet to release to maritime security related information;*
  - (5) *Using sea communication technology broadcast maritime security information;*
  - (6) *Timing on regional send navigational information (including beacon real-time dynamic information, hydrometeorological information, and the berth dynamic information, navigational information, AIS, etc.), the means of information can be AIS, Internet, mobile phone short message, etc., in order to reduce the user for bobble navigational information navigation accidents;*
- (1) *Other related methods and techniques.*

### **Conclusions**

The achievement of open Internet of things provides a new perspective to the research of e-Navigation architecture. This paper plan to build e-Navigation open Internet of things architecture by analyzing the basic characteristics of open internet of things architecture, base support of technology and the purpose both for e-Navigation and IoT, and finding out its complements to and something may be incompatible with e-Navigation. This architecture based on e-Navigation infrastructure (i.e. shore, boats, communication system), data acquisition, intelligent processing and storage technology in the Internet of things provide complementary technology support and smart ideas. Provide research on e-Navigation intelligent architecture with theoretical support. End up with instance analysis in the paper, designing a kind of maritime security platform to verify the usability of this architecture.

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