State-of-the-art IVEF Service based on e-Navigation System

Bayarmaa Oyunchimeg, Jung Sik Jeong[†], and Gyei-Kark Park

Department of Maritime Electronic & Communication Engineering,
Mokpo National Maritime University, Mokpo, Jeonnam, 530-729, Korea

Abstract

In this paper, the state-of-the-art IVEF Service based on e-Navigation System was represented. The unification of the data exchange format among maritime-related systems is one of vital user-needs of e-Navigation, advantageous in bringing maritime safety and security. This paper propose the method to exchange marine information in IVEF, as recommended by the IALA, between VTS centers and Korea's GICOMS as well as the government-related agencies. To achieve this, a system data flow was designed which it acts as client and server. It enables the sending and receiving of Radar and CCTV images in accordance with the IVEF recommendation document of IALA.

Key Words : VTS, VTSO, Maritime Accident, Maritime Safety, CWA

1. Instruction

The VTS(Vessel Traffic Service) is a shore-side system which delivers all relevant safe related messages to ships, such as position of other traffic or meteorological hazard warnings, and manages vessel traffic within a port or a waterway. Following the local regulations of an authority, ships entering into the portway report to their related VTS, usually by radio, and may be tracked by the VTS control centre. Mariners must keep sharp lookout under all the navigational situations or any other warnings, while they may be directed by the VTS operator if there is a risk of incident. The VTS is regarded as the service implemented by a competent authority, and then designed to improve the safety and efficiency of navigation, safety of life at sea and the protection of the maritime environments. The VTS is governed by SOLAS(International Convention on the Safety of Life At Sea) Regulation 12 and also Guidelines for Vessel Traffic Services which was adopted by the International Maritime Organization (IMO)[1]. In

Korea, there are 15 VTS Centers to date that covers almost the whole boundaries of the state [2]. Korea government has also operated its own GICOMS(General Information Center on Maritime Safety) that enables a national VMS(Vessel Monitoring System) as well as the exchange of all the vessels information with VTS Centers including Korea Coast Guard.

The IVEF has been introduced by IALA as a recommendation in response to the e-Navigation strategy for harmonization of data exchange between shore-based stations, i.e., VTSs and all relevant shore-based systems[3]. Taking into considerations of the objectives of e-Navigation that harmonizes the data exchange format between maritime stakeholders and offers various maritime services for maritime safety, it is clear that the information exchange by the IVEF should be regarded as one of important functions of the VTS.

Regardless of importance for information exchange by the IVEF, however, there have not been any researches for VTS information exchange based on the IVEF.

This paper proposes the method of information exchange based on the IVEF among VTSs in Korea. As a client and server-based system, the IVEF client makes a connection to the server by logging-in, running the IVEF service and then receives traffic image data at a client request in the VTS. The data requested for information exchange depends upon the client's preference, such as area of interest, transmit interval, and type of data. Any IVEF service has a Basic IVEF Services (BIS). The particular characteristics of the BIS is that it is only rendered on request of another client, i.e., a VTS Center, or external agencies[4].

접수일자: 2013년 9월 1일

심사(수정)일자: 2013년 9월 7일

게재확정일자 : 2013년 11월 22일

[†] Corresponding author : jsjeong@mmu.ac.kr

본 논문은 2013년 해양수산부 재원으로 한국해양과학기술진흥원의 지원을 받아 수행된 연구임(지능형 해양사고 예방 및 구난기술 개발).

This is an Open-Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

2. The Basic IVEF services

2.1 Concept of IVEF

The IALA recommends the method to design data exchange based on IALA's format, and then to standardize data exchange and improve situation awareness by system operators in coastal areas[3]. The IVEF Service is intended to provide a common framework for exchange of vessel traffic image data between shore-based e-Navigation systems, such as VTS systems and all relevant stakeholders.

As a client/server-based system, the IVEF client makes a connection to the server by logging-in to the target server. The server will then validate the account of the requesting client. If the account is valid, the server will then run the IVEF service and return traffic images according to the requesting client's preferences - area of interest, receiving frequency and type of data. In case the requesting client has not yet configured its preferences, the IVEF system shall be allowed to input desired areas, receiving frequency and type of data.[5]

2.2 The IVEF services for VTSs and GICOMS

Since 1993, the MOF(Ministry of Oceans and Fisheries) of Korea has operated 15 VTSs, which installed along Korean coastal line. The VTS is to improve the safety and efficiency of navigation, safety of life at sea and the protection of the marine environment and/or the adjacent shore area, worksites and offshore installations from possible adverse effects of marine traffic. In addition to the VTSs, the MOF has also installed the General Information Center on the Maritime Safety and Security(GICOMS) to manage a national maritime crisis, to prevent maritime accidents, and to respond swiftly for the accidents within the jurisdiction of the state. The GICOMS also monitors and protects all Korean flagged vessels in the world.

In fact, the VTS could have a two-way send/receive capability provided that each has an IVEF system composed of user client, network-enabled workstation and database storage. Currently, the GICOMS does not provide data back to VTS, rather relays data to the other stakeholders, such as the other related ministry, navy, coast guard, fisheries, ship owners, etc.[6]

Fig. 1. The IVEF Services in operation

Fig. 1 shows a conceptual configuration for information exchange among VTS Centers and other stakeholders. The VTS centers locally and regionally may share the information regarding ship movements in the area of interest. The data to be exchanged among VTS centers, and between the VTS and the GICOMS center, should be synchronized through interface router by which is inter-connected to both. The TCP/IP protocol is used for data exchange. The GICOMS center has its integrated database, wherein all ship track information is being stored. This integrated database is accessible by authorized agencies and/or users through a common type of gateway, e.g, coast guard, navy, fisheries so on. Fig. 2 shows the GICOMS data exchange structure.

Fig. 2. GICOMS data exchange structure

However, the data to be exchanged between the VTS center and the GICOMS center is obtained from AIS and Radar. It means that all the IVEF data for the VTS center can be transmitted to the GICOMS center. GICOMS basically provides information to its users through web access. The information received and transmitted by GICOMS Center is acquired through its coastal base stations that are installed the Korean coastal line, as shown in Fig. 2.

The information includes all the data from AIS, Radar, and CCTV. Radar and CCTV images are very useful information for government agencies. It should be noted that it is possible of system operators to be able to acquire from AIS, Radar, and also CCTV which are installed the VTS centers, in term of maritime domain awareness in Korean coast. The VTS system consists of AIS data processor or router device which filters duplicate and invalid data from AIS base station. The AIS data router in GICOMS then receives the data based on TCP/IP from VTS Centers, filtering duplicate and invalid data acquired from the VTS. All the data for vessels can be exchanged among VTSs and be-

tween the VTS and the GICOMS by the basic IVEF services. Fig. 3 shows the configuration for the IVEF services.[7]

Fig. 3. Configuration for IVEF services

3. Design of IVEF for VTS System

3.1 Characteristics of IVEF data

Among the maritime surveillance systems, AIS is primarily utilized for vessel-tracking and monitoring. However, it is already been known that using this tool alone is limited to tracking only those vessels that are cooperative; that is why various projects aim to improve surveillance systems by integrating more sensors that enables the operating centers to track their coastlines more accurately. In addition, maritime surveillance could also be improved by enhancing interface communication protocol among its sub-systems. The AIS data is mostly based on the IEC 61993-2[4], while the IVEF protocol is based on the IALA Recommendation V-104[5].

Table 1. Characteristics of IVEF and AIS data

	IVEF	AIS
Extensibility	Data parameters could be extended with the use of Tagged Item element indicated in the IALA Recommendation	AIS messages could be extended through binary messages
Service	Using IVEF protocol enables two-way data transmission between VTS, and multi-agencies by logging-in to the target VTS to receive data according to individual preferences.	Data reception preference on area of interests, time interval and data types can not be varied on individual requesting clients in real-time.
Memory usage	Data are transmitted as XML files through the network thus consuming greater memory.	Data is transmitted directly as encrypted messages, thus reducing memory consumption.

As described in Table 1, the IVEF and AIS can be extended when it comes to data parameters. In terms of memory usage, the IEC protocol conserves more memory than IVEF protocol, since the latter transmits data through XML files. However, the IVEF protocol has significant advantage with regards to providing information, as more agencies could utilize and customize their received data in terms of area of interest, time interval and type of data preferences.

3.2 Comparison of GICOMS data exchange protocol with IVEF

In Table. 2, The IVEF protocol has been compared with its GICOMS which uses a data exchange format, e.g., the extended NMEA0183.

Table 2. Comparison of extended NMEA0183 with IVEF

	IVEF	Extended NMEA0183
Network Protocol	TCP/IP	TCP/IP
Image transfer	Possible	Not currently possible
Network transfer	XML file	Direct message
Network message protocol	Message Identifier (Header) + Control Information (XML filename)/Image data (seeSection3.5)	Message ID, etc. (Header) + Data (IEC 61993-2) + Footer (checksum)

The IVEF and NMEA0183 are transferred through the network using TCP/IP. With regards to network transfer approach, the IVEF transmits data with XML file, while the extended NMEA0183 transmits data as message sentences. The significant advantage of using the IVEF is that it is possible to transmit images while it is not currently possible in the extended NMEA0183 standard. A sample message of such protocol is illustrated below:

```

$SND6,VTS1006,4403305,
P,0,20110518114952|!AIVDM,1,1,,B,16SWNe?00093OSv
EG=mP00w<2HFa,0*76'$SND6,VTS1006,4403305,P,0,2
0110518114952' is the header part of the message,
while the remaining parts on such message is based
on NMEA0183, by which it includes IEC 61993-2 part
('16SWNe?00093OSvEG=mP00w<2HFa').

```

3.3 Design of network message protocol

As shown in Table 3, the packet messages transmitted through TCP/IP are divided into three main components, i.e., (1) message identifier; (2) control information messages; and (3) image data.

Table 3. Packet messages to be transmitted by TCP/IP

Seq.	Parameter	Details
1	Message Identifier	Message type identifier for (a) control information messages; and (b) image data
2	Control information	XML-formatted messages based on Interface Control Document for IVEF by the International Association of Lighthouse and Aids-to-Navigation Authorities (IALA)
3	Image data	Filename format for sent/received CCTV and Radar image data

Message identifiers serves as the header for the entire packet message and are used to enable the program to identify the type of message which is either control information or image data. The proponent has formatted the message identifiers as follows:

```
MSGTYP_CTRLINFO_IVEF_LoginRequest (Log-in Request)
MSGTYP_CTRLINFO_IVEF_LoginResponse(Log-in Response)
MSGTYP_CTRLINFO_IVEF_ServiceRequest (Service Request)
MSGTYP_CTRLINFO_IVEF_ServiceResponse (Service Response)
MSGTYP_IMGDATAAC (CCTV image data)
MSGTYP_IMGDATAR (Radar image data)
```

The data sent to and from a VTS Center are formatted in XML which is based on the interface control document in the IVEF recommended by IALA. The message contents of these data are divided into two types - image and control information messages. The image messages contain an image data in binary form.

Fig. 4. Illustration of sending control information through TCP/IP

Fig. 4 illustrates the process of sending control information through TCP/IP. The control information messages are client/server transactions which are transmitted and/or received to enable services such as log-in/log-out and service request/response for Radar and CCTV images. According to Interface Control Document in the IVEF by IALA, The XML messages that were sent and received by an IVEF client/server shall have the following layout - XML version tag, main node, header node, body node, and message-specific node(s). Below is a format for XML messages:

```
<?xml version="1.0" ?>
<IVEF_element_name
xmlns="urn:http://www.iala.org/XMLSchema/IVEF/1.0">
<Header Version="0.1.6" MsgRefId="Universally Unique Identifier"/>
<Body>
<Message-specific nodes />
</Body>
</IVEF_element_name>
```

The XML format for control information messages 'Element name' is an identifier of the type of message to be transmitted. The element names to be used for the IVEF system are LoginRequest, LoginResponse, ServiceRequest, ServiceResponse and TaggedItem. As described in Table 4, 'MsgRefId' is a Universally Unique Identifier (UUID) for each message, which consists of 32 hexadecimal digits displayed in 5 groups and separated by hyphens.

Table 4. Data format for UUID

Seq.	Parameter	Description	Format
1	Message Type	Message Types	'CTRLINFO': Control Information message 'IMGDATAAC': Image data (CCTV) 'IMGDATAR': Image data (Radar)
2	Pre-set parameter 1	Pre-set parameter	0000
3	Pre-set parameter 2	Pre-set parameter	0000
4	Area Code	Pre-defined code of an area wherein	'OBSN': Busan 'OICN':

		certain data will be transmitted/received	Incheon
5	Curent Date	Current date of transmission / reception	Year + Month + Day (yymmdd)
6	Current Time	Current Time of transmission /reception	hours + minutes + seconds (hhmmss)

The proponent designed a format for generating this UUID as shown in Table 5. An example of generated UUID is: CTRLINFO-0000-0000-0BSN-110819120022. Message-specific nodes are based on Interface Control Document for IVEF by IALA. The proponent formatted these XML lines as follows:

Table 5. XML attribute description for control information messages

X M L Element	XML-formatted message
L o g - i n Request	<LoginRequest Name=" " Password=" " /> Attributes: Name: username Password: user password
L o g - i n Response	<LoginResponse MsgId=" " Result=" " Reason=" " /> Attributes: MsgId: shall be based on the value of MsgRefId Result: '1': Accepted; or '2': Declined Reason: String that describes the reason for declining; only used when result is declined
S e r v i c e Request	<ServiceRequest Area=" " Transmission=" " Type=" " /> Attributes: Area: Area-of-Interest set by user; (for demonstration program, the proponent use Busan or Incheon for options) Transmission: Interval or the receiving frequency that can be set by the user on receiving the preferred images Type: Type of image data to be received: 'C': CCTV; 'R': Radar
S e r v i c e response	<ServiceResponse Result=" " /> Attribute: Result: '1': OK; '2': NOT OK
T a g g e d Item	<TaggedItem Key=" " Value=" " /> Attributes:

Key: (fixed) 'DateTime'
Value: Current date and time (yymmddhhmmss)

5. Conclusions

Recently, the maritime safety management has been widely recognized as the modern essential services to prevent maritime accidents in active way as well as in proactive way. In this paper, we proposed the method of designing the IVEF Service among VTSs and then between the VTS and GICOMS in the era of e-Navigation. The network message protocol was defined and designed by considering the characteristics of the IVEF data. As a client and server-based system, the IVEF client makes a connection to the server by logging-in, running the IVEF service and then receives traffic image data at a client request in the VTS.

The future improvements can include allowing a user to retrieve traffic images within a more specific position, such as latitude and longitude coordinates.

References

- [1] IMO, *Guidelines for Vessel Traffic Services, Resolution A.857(20)*, Nov. 1997, IMO.
- [2] Korea MOF, "Vessel Traffic Services Center", Available: <http://www.vtskorea.info>, 2013. [Accessed : September 30, 2013]
- [3] IALA, *The e-Navigation Architecture - the initial Shore-based Perspective*, IALA Recommendation e-Nav-101, Dec. 2009, IALA.
- [4] IEC, *Maritime navigation and radiocommunication equipment and systems - Automatic identification systems(AIS)-Part 2: Class A shipborne equipment of the universal automatic identification system(AIS-Operational and performance requirements, methods of test and required test results*, IEC 61993-2 1st Ed., 2001, IEC.
- [5] IALA, *IALA Recommendation V-145 on the Inter-VTS Exchange Format(IVEF) Service*, Ed.1 June 2011, IALA.
- [6] ISO, *Open Systems Interconnection Reference Model*, International Standards Organization Standard 7498-1, 1994, ISO.
- [7] Manipis, Lory Anne P., Dr. Gyei-Kark Park, Dong-Gyun Kim, "A Study on the Enhancement of Maritime Surveillance in Korea Using Inter-VTS Exchange Format (IVEF)", *Proceedings of KIIS Spring Conference*, pp. 19-21, 2011.

저 자 소 개

Bayarmaa Oyunchimeg

2009 Exchange Student, Dept. of
Electronic and Computer science,
Handong Global University,
Korea
2010 Graduated from Dept. of
Information and Communication,

Huree ICT University, Mongolia

2013 Graduated from Department of Maritime Electronic
and Communication, Mokpo National Maritime
University, Korea

2013-Present Student in Doctoral Course, Department of
Marine Electronic and Communication, Graduate School,
Mokpo National Maritime University

Research Interest:

Maritime traffic protocol, Maritime Information and
Communication Network

Phone : +82-10-8209-8484

E-mail : bayarmaa@mmu.ac.kr

정중식(Jung Sik Jeong)†

1987 Graduated from Dept. of
Nautical Science, Korea
Maritime University

1993 Received Master Degree in
Communication and Electronic
Engineering from Korea
Maritime University

2001. Received the degree of Doctor in Electrical and
Electronic Engineering from Tokyo Institute of
Technology

1993-96 Senior Researcher, Korea Telecom. R&D
Center.

2002-Untill now Professor, Faculty of International
Maritime Transportation Sciences, Mokpo
National Maritime University

Research Interest:

Maritime Traffic Engineering, Ship Collision Avoidance,
Maritime Information and Communication Network

Phone : +82-61-240-7173

E-mail : jsjeong@mmu.ac.kr

박계각(Gyei-Kark Park)

1982 Graduated from Dept. of
Nautical Science, Korea
Maritime University

1993 Received the degree of Doctor
of Engineering from Tokyo
Institute of Technology

1993-94 Senior Researcher, LIFE(Laboratory for
International Fuzzy Engineering), Japan

1995-Untill now Professor, Faculty of International
Maritime Transportation Sciences, Mokpo
National Maritime University

2011 President of Korea Institute of Intelligent
Systems(KIIS)

2011-Untill now Vice President of Korean
Association of Shipping and Logistics

Research Interest:

Intelligent system in marine industry, Intelligent
navigation control system, Machine Learning based
on linguistic instruction, Port Economics,
Transportation and Logistics System

Phone : +82-61-240-7128

E-mail : gkpark@mmu.ac.kr