공 학 석 사 학 위 논 문

NMEA2000 Ship Area Network Design and Test Bed using Power Line Communication

2015년 8월

부 경 대 학 교 산 업 대 학 원

컴 퓨 터 공 학 과

고 태 훈

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지도교수 서 경 룡

이 논문을 공학석사 학위논문으로 제출함

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NMEA2000 Ship Area Network Design and Test Bed using Power Line Communication

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Abstract

Under the recent changes in international agreements enforced by the International Maritime Organization (IMO), sea-going vessels are required to establish the Controller Area Network (CAN Bus) system to be connected with a backbone network referred as the Ship Area Network (SAN) by installing communication cables to control and monitor on-board electronic equipments when they are additionally mounted the ship's system. The latest SAN is comprised of the Control Area Network (CAN) and the Ethernet-based physical communications network, both of which support the National Marine Electronic Association (NMEA) 2000 standard protocol.

For existing operational ships, an extensive work will be needed for the SAN that uses unshielded twisted pair cables (UTP) depending on the location of the system to be installed. Such work could generate time, space and cost-related risks (e.g., large vessel require up to millions of won per day as an anchorage charge). Thus, in this paper, we've installed the Power Line Communication (PLC) system on an actual ship within a day utilizing the power lines which have already been laid throughout the most part of the ship. Especially, we applied the PLC technology which had employed 3-phase 4-wire type winding method (for on-land use) proposed in this paper but in this case, we designed a data coupling method for the 3-phase 3-wire type Delta winding power line without N-phase grounding system on the ship instead. Then, by using this method, the integrated network technology that meets NMEA 2000 standard was designed and the test bed was constructed accordingly. As the result, we've confirmed that the communications became efficient and consider that the technology will be a foundation technology for the ships' IoT services and for the cost-reducing purpose.

Chapter 1. Introduction

1.1 Purpose and necessity of study

Together with recent development of shipbuilding industry, marine equipment companies have been pursuing mutual growth also. Especially, the marine equipment industry continues to grow both quantitatively and qualitatively changing the industry's technical paradigm by shifting the concept of machine or electronic-based automation to the concept of IT-converged networks. It is expected that the regulations in various international agreements, which are enacted/revised by the International Maritime Organization (IMO), will be strengthened and as they've decided to fully implement e-Navigation system starting from 2018, a variety of studies and standardization plans are being proceeded actively for this task.

Meanwhile, infrastructures for core technologies such as the navigation system, geographic information system, communication network technology and its application system are required. The key technology among them is the maritime communications support technology and with this, an adequate set of data must be provided in accordance with the NMEA2000 protocol, which is a standardization plan for the serial data networking to meet increasing necessity of interfaces between an array of electronic equipments that have the direct effects on ship's navigation, when the application systems [e.g., Voyage Data Recorder (VDR) and Alarm Monitoring System (AMS)] essential for safe navigations request them to be transmitted. The ships' electronic equipments currently manufactured in Korea follow internationally agreed protocols and these equipments are operated in the form of integrated network across all levels of the ship thorough the ethernet-based Ship Area Network (SAN).

The network communication technology that plays a role of the nerve system at the ship has laid the groundwork for the next generation intelligent ship by continually developing and evolving. The ship comprised of thirty thousand or more parts is a perfect body combining mechanical engineering, electronics and information technology. Development of the ship network technology will lead to the prevention of various accidents and to the development of cutting-edge sensor monitoring technology that protects lives, not to mention replacing some of the works performed by the crew. Also, most of new-born technologies and their developments are often applied to future high-tech vessels.

Following recent trend of building larger ships like container ships, the paradigm in infrastructure construction technology for ship's network is changing. Although NMEA2000 protocol stipulates the distance of 200m and the speed of 250Kbps, the ship communication technology of the past could not overcome communication distance of 100m for it used Ethernet-based UTP/STP cables. The problem has been settled with optical cables and wireless communication method. However, for those existing ships without adequate on-board communication infrastructure would have much obstacles (i.e., spatial, temporal and costly obstacles) when the e-Navigation comes into effect following the international agreements.

Thus, in this paper, we've designed a NMEA2000-based Ship Area Network (SAN) which has been converged with Power Line Communication (PLC) technology that utilizes existing power line on the ship to expeditiously respond to the changes in International agreements and to clear away obstacles, and carried out test a bed experiment.

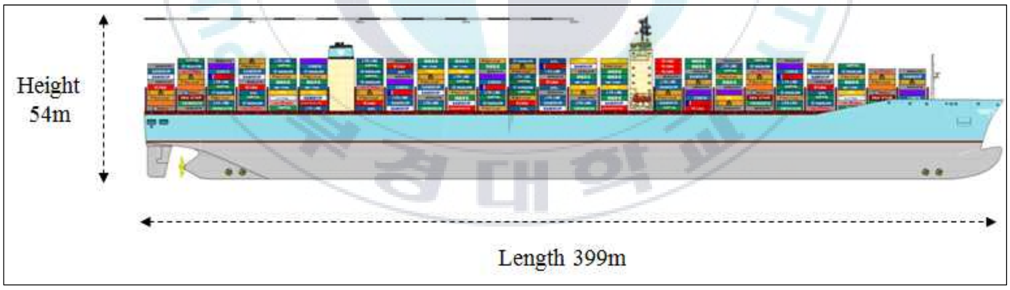
This paper is organized as follows: "Related study" is examined in chapter 2, the explanatory sections for the "NMEA2000 Ship Area Network Design and Test Bed using Power Line Communication" in chapter 3, and finally, chapter 4 outlines "Expected effects and future work" followed by the "Conclusion".

Chapter 2. Related study

The studies to understand ship's structure and its power line environment (3-phase 3-wire Delta connection), and the problem of not being able to use existing land-based power line (3-phase 4-wire Y-connection) communications, and the possible solutions have been conducted.

2.1 Structure of ship

2.1.1 Size of the ship



[Fig. 1] Container ship

The ship is a container ship with a length of approximately 399m from stem to stern reaching about 3 times of a football field. Recently, Daewoo Shipbuilding & Marine Engineering has built a mega-container ship (19,224 TEU, the size of 4-football field combined) ordered from

Swiss Mediterranean Shipping Company at Ok-po shipyard, Geoje island.

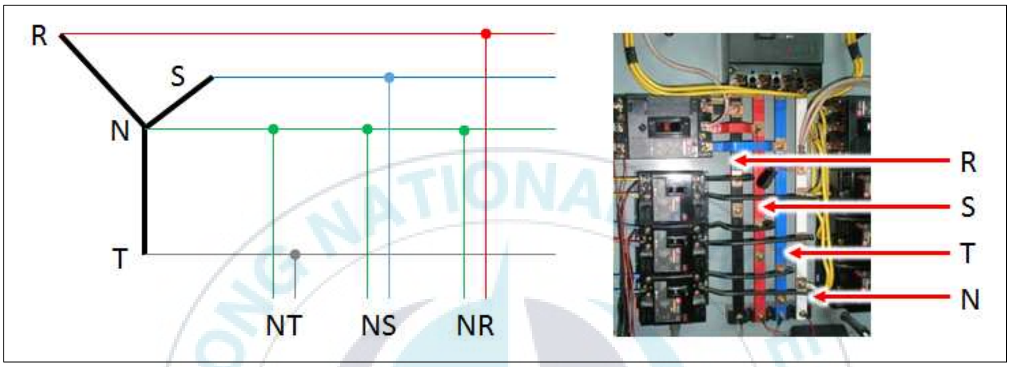
2.1.2 Interior structure of the ship

[Fig. 2] Ship's steel structure

As shown in [Fig. 2], many processes are required to route communication cables when new or additional electronic equipments are to be installed to establish a connection with the integrated SAN. Ship's bulkhead structures are made of steel plates so that it has an unfavorable environment. Due to recent demands of mobile device use within the ship, WiFi AP units have been installed but the problem is that because of the shielding function of steel bulkheads, they need to be installed at several places.

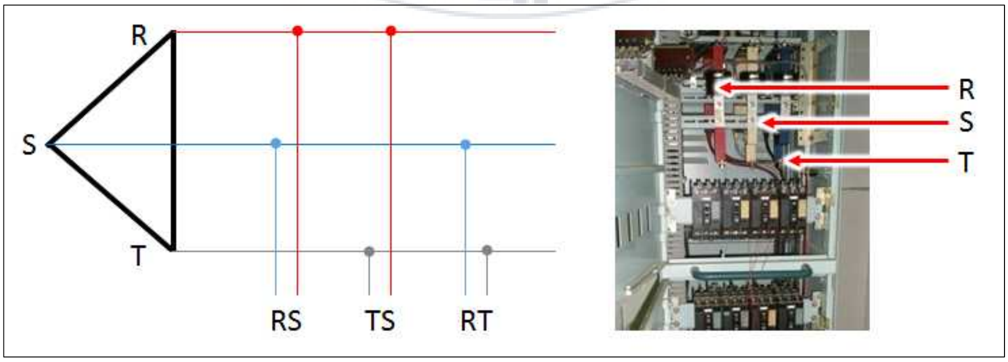
2.2 Power Line Communication

2.2.1 Outline of PLC (Power Line Communication)



[Fig. 3] 3-phase 4-wire Y-connection (land-use power line structure)

The PLC technology was developed in US in 1924 and mostly used for the power-usage readings and home networks on land. As shown in the picture, it is comprised of 4 phases (R, S, T and N).



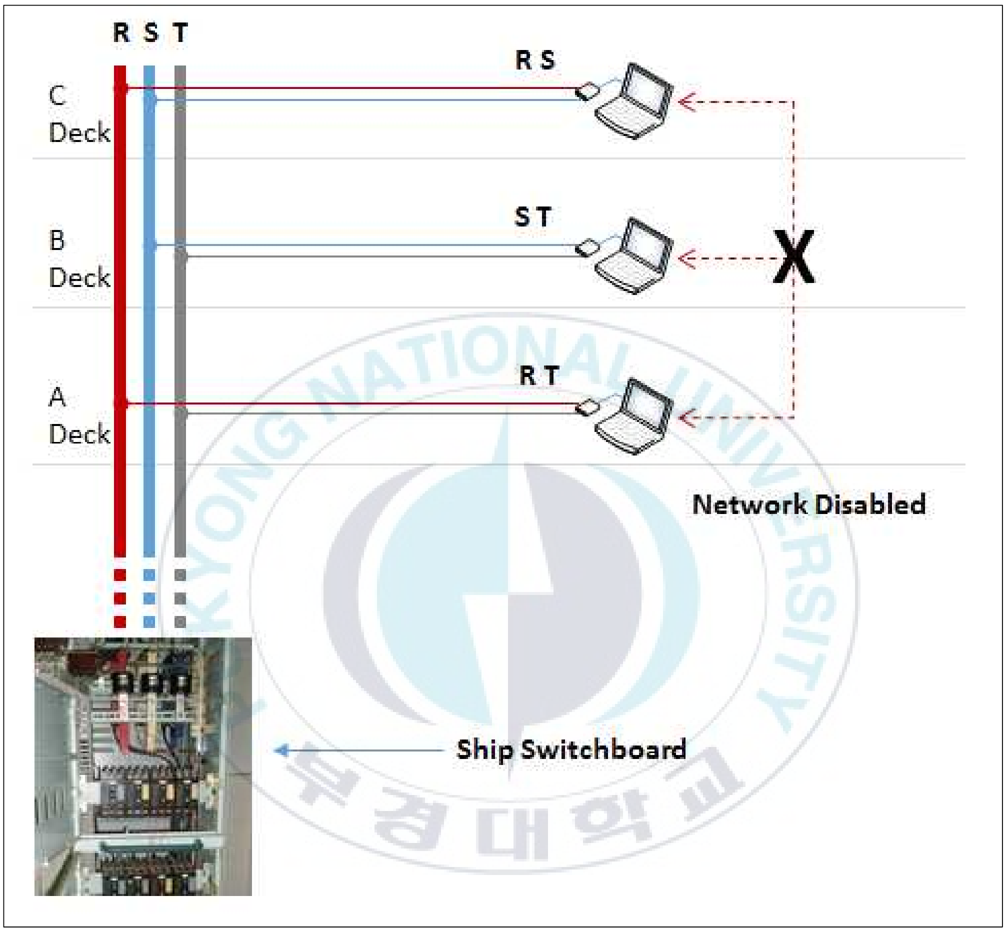
[Fig. 4] 3-phase 3-wire Delta connection (shipboard power line structure)

[Fig. 4] is the power line structure used on a ship and unlike the land-use type, it is comprised with just 3 phases (R, S, and T), missing the N-phase.

2.2.1.1 Acknowledgement

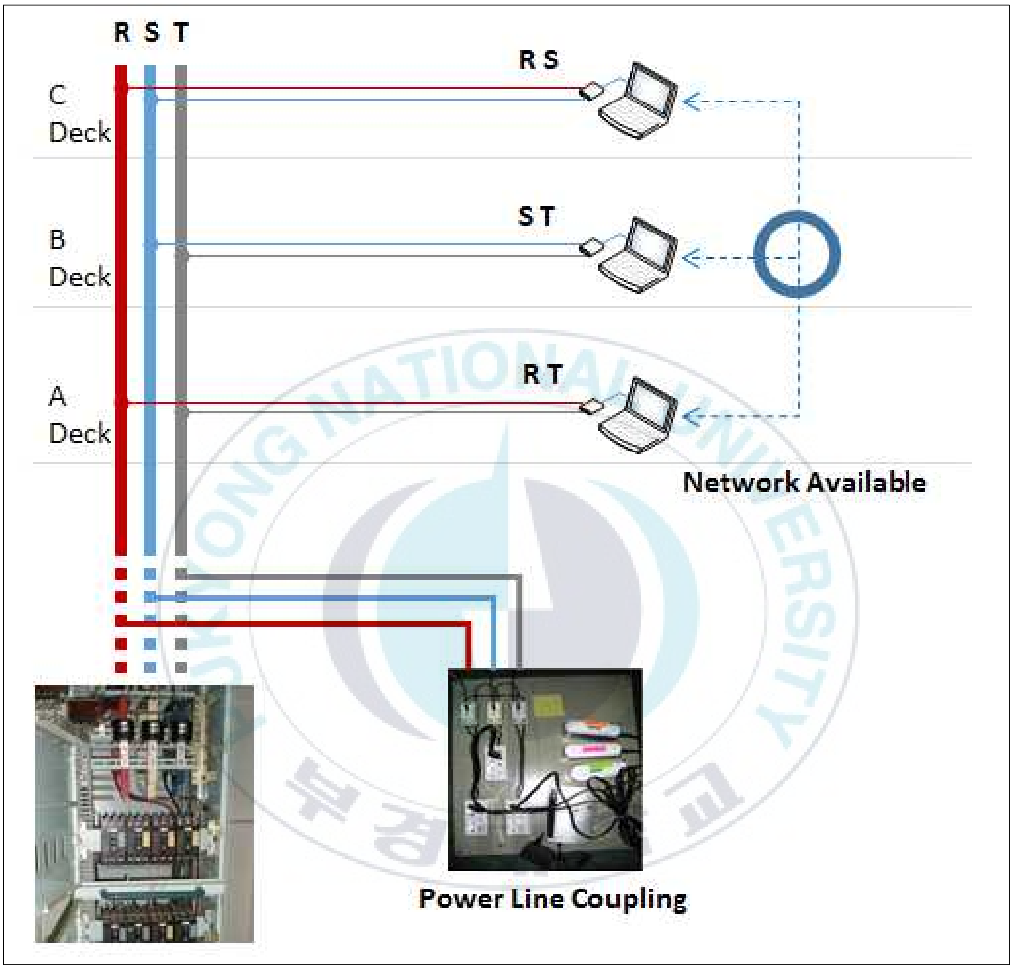
A part of the fundamental technology in this paper contains the Republic of Korea 'Patent No. 10-0942020' registered on Feb. 2010 after being submitted on April of 2008 related to the theory concerning 'The Ship-PLC Master Coupler Under the 3-Phase 3-Line Delta Connection Environment' by the author of this paper, SUNCOM Co., Ltd.

2.2.2 Delta connection data coupling



[Fig. 5] Problem associated with PLC

Network configuration with the Y-connection type can be possible regardless of phase changes in the same power line structure as all the connections are made with the same N-phase. However, the configuration with the Delta connection type will not be possible since there's no common phase like N such that the network cannot be comprised with the PCs on A, B and C decks.



[Fig. 6] A solution for the problem of network configuration with Delta connection

To solve above mentioned problem, we successfully established connections using the Delta connection by coupling R, S and T phases behind the switchboard where the power is supplied initially, as shown in [Fig. 6].

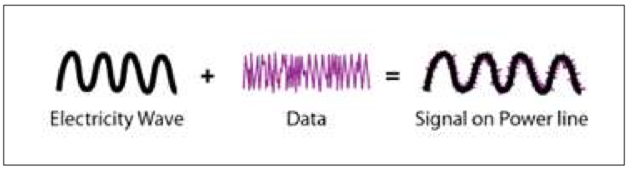
2.2.3 Scalability of PLC

Since the PLC supports various communication methods like Ethernet- and Serial (RS-232/422/485)-based ones, its use can be extended to a variety of activities on the ship such as acquisition and analysis of all sorts of sensor information, signaling of dangers, status information monitoring through the connections with different types of electronic equipments on the ship.

Thus, with this scalability in mind, we've verified the feasibility of the PLC-applied SAN by performing a test bed experiment using shipboard CAN BUS-type electronic equipments that adapts the NMEA 2000 standard.

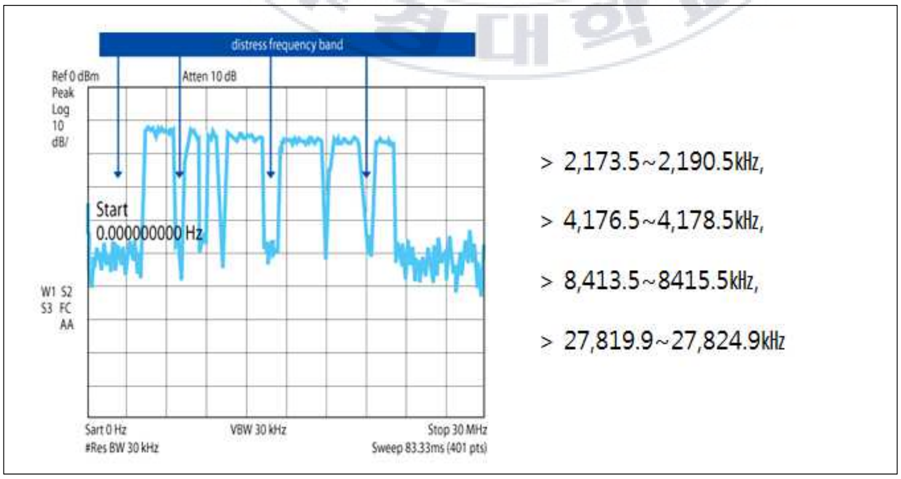
2.2.4 Features Ship-PLC

As in [Fig. 7], the Ship-PLC transmits data using the carrier frequency on the high-frequency power line.



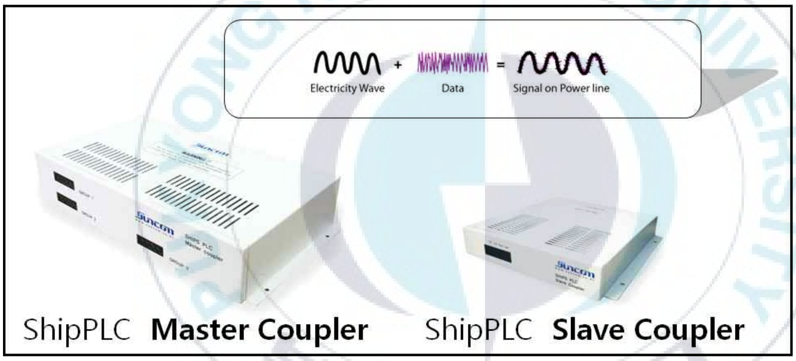
[Fig. 7] Principle of PLC

However, ship operators are very conservative as long as frequency interference – which may influence ship's navigation safety – is concerned so that the frequency violations are strictly controlled (e.g., for maritime signaling bandwidth) by making notification of relevant laws. The Ship-PLC product used in the experiment has eliminated such problem in advance.



[Fig. 8] Avoiding maritime distress signaling bandwidth

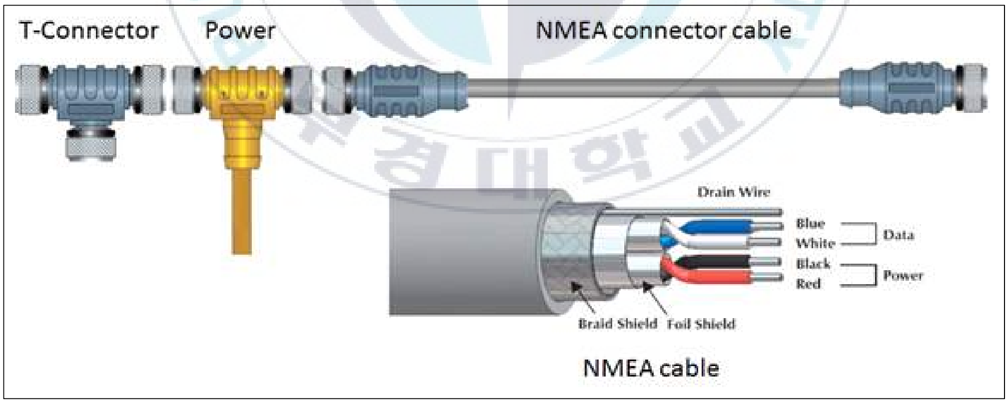
Ship-PLC is networking technology enabling the transfer of data through existing power lines at the ship [1 - 5]. It provides high-speed transfer and needs no extra cables [6 - 9]. [Fig. 1] shows Ship-PLC. For the vessel which has been already wired entirely, the PLC can save costs and time. Our PLC unit provides up to 200Mbps for data transfer. The PLC promises fast and efficient network on vessel deck. Definition of PLC The communication technology that transfers data on the high frequency signal, using carrier frequency on power lines as a medium.



[Fig. 9] Ship-PLC

2.2.5 NMEA 2000 Standard

The NMEA 2000 standard is one that applies to the real-time data communications between various electronic equipments used on the ships and prevents Bus conflicts using the ISO 11898 CAN on the physical layer. For the purpose of e-Navigation implementation, the IMO agreement stipulates that the communication equipments standards on the ships must follow the NMEA 2000 standard to standardize the communications between dissimilar on-board electronic equipments installed on all sorts of ships. This standard is the ships' network standard which uses CAN Bus to avoid collisions, enabling the reasonable processing speed of 250kbps and the transmission range of 200m, and real-time bi-directional N:N access.



[Fig. 10] NMEA 2000 Standard

2.2.6. Example of NMEA 2000 standard application for a ship

[Fig. 11] represents the NMEA 2000 standard CAN BUS. All the shipboard electronic equipments are built with the NMEA 0183/2000 standard CAN BUS in accordance with international specifications.

[Fig. 11] NMEA standard CAN BUS

Chapter 3. NMEA2000 Ship Area Network Design and Test Bed using Power Line Communication

3.1. NMEA 2000 integrated network using PLC

Using the container ship with a full length of 304m and a height of 49m (i.e., M/Y Hyundai Colombo owned by Hyundai Merchant Marine, Korea) - which can load 6,800 TEU + 20-feet containers - as a test bed, we've installed a PLC Master Coupler to the Emergency Breaker located in the Emergency Room positioned in the section between the Bridge and the Bow Room (a straight-line distance of 180m) on the upper deck. Using the power line of the same section as a backbone, we connected a NMEA 2000 equipment to the serial port of a notebook and performed data transmission experiments for the CAN + SAN integrated network using a PLC modem and a PLC repeater.

[Fig. 12] Test bed using a 6,800 TEU-class container ship

3.1.1. Tests for PLC and NMEA communication

[Fig. 13] Ship-PLC+NMEA test bed and communication testing section

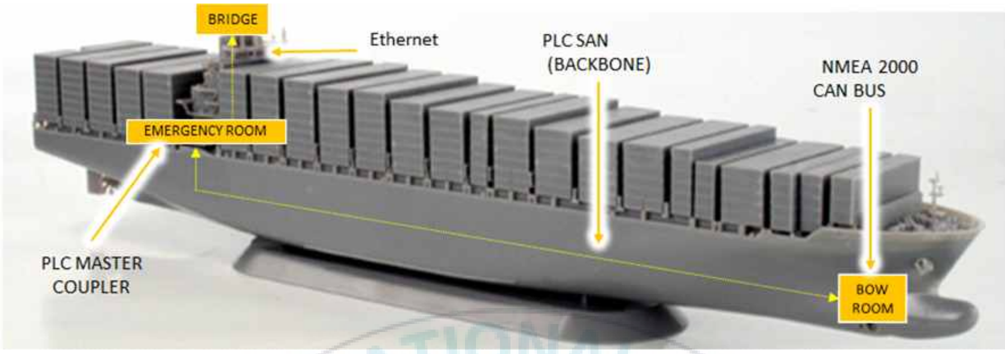
As shown in [Fig. 13], the section between the Bridge and the Bow Room where data collection and monitoring are carried out was chosen as the test bed and both the furthest distance and poor environment where additional cable installments are most difficult were considered. The test was conducted with existing power line without installing separate communication cables at the section.

[Fig. 14] Installation point of PLC modem

Since the power lines furcate in each section to supply power, we applied the PLC repeater for each section (i.e., passage #1, #2, and #3), and by using the PLC we constructed a network between the Bridge and the Bow Room, followed by the test. Our goal was to apply the network to the cargo hall.

We first installed a PLC Master Coupler in the 200V Emergency Breaker Panel of the Emergency Room located on the upper deck. Second, the PLC modem was installed in the Bow Room and third, a PLC Repeater Modem was installed at 100m on the Passageway. Fourth, the PLC Repeater Modems were installed at 2/5 and 4/5 points of the Passageway. Fifth, the Passageway 220V Emergency Breaker PLC Repeater was installed and finally, we confirmed the network establishment after installing the PLC Repeater on the Rotary Switch located at the entrance of Bow Room.

3.1.2. Goal of final test



[Fig. 15] PLC + NMEA-converged network

We chose a spot furthest from the Bridge, where data collection and data transmission are carried out toward the land. The spot had the poorest environment for additional data cable installments and our premise was that the network had to overcome an extreme environment assuming that the NMEA 2000 standard CAN BUS-type electronic equipments will be installed at all levels of the ship.

3.2. Performance evaluation

Performance evaluation was repeated three times. In order to avoid 'speed down' problem due to introduction of noises, which is the most vulnerable factor for the PLC, we've conducted the test by minimizing the noise by installing the PLC Repeaters in respective sections. Our final goal was to reduce installment costs and maximize efficiency by using the least number of the PLC Repeaters.

3.2.1 First test

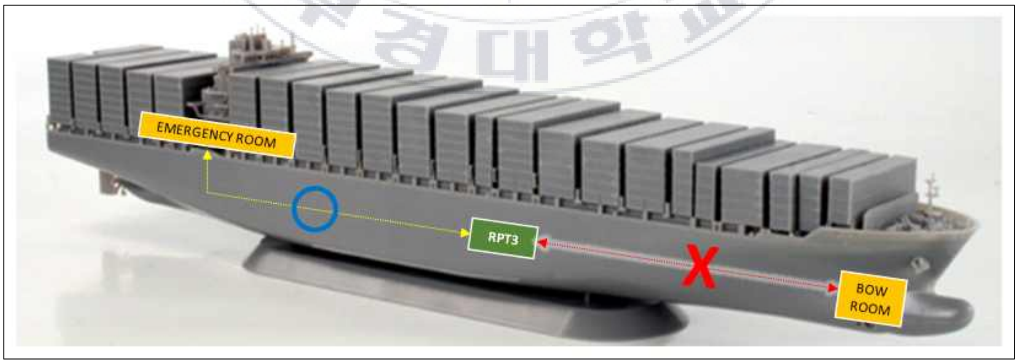
In the first test, we selected a breaker, whose power line had been linked to the Bow room and therefore controllable, among the 220V Emergency Breakers in the Emergency Room located on the upper deck. Then, the PLC Master Coupler was installed as described in [Fig. 16].

[Fig. 16] Emergency Room

[Fig. 17] shows that the network between the Emergency Breaker and the Bow Room was not established when the network test was conducted by installing the PLC Modem after moving to the Bow Room

[Fig. 17] BOW Room

[Fig. 18] shows installing process of the PLC repeaters After installing a PLC Repeater at 100m point on Passageway from the Emergency Room, we performed the transmission test for this section. The connection was satisfactory showing the speed of approximately 0.75Mbps for 1.08MB data size transmission but the connection between the Emergency Room and the Bow Room was still unsuccessful.



[Fig. 18] Installation of PLC Repeater

For this reason, the Repeater Modems were installed at 3/5 and 4/5 points as described in [Fig. 19] after removing the Repeater Modem installed on a halfway point of the Passageway.

[Fig. 19] Installation status on the Passageway

As described in [Fig. 20], the connections between the Emergency room and both Repeaters at 2/5 (RPT 1) and 4/5 (RPT 2) have been confirmed contrary to the connection between the Emergency Room and the Bow Room.

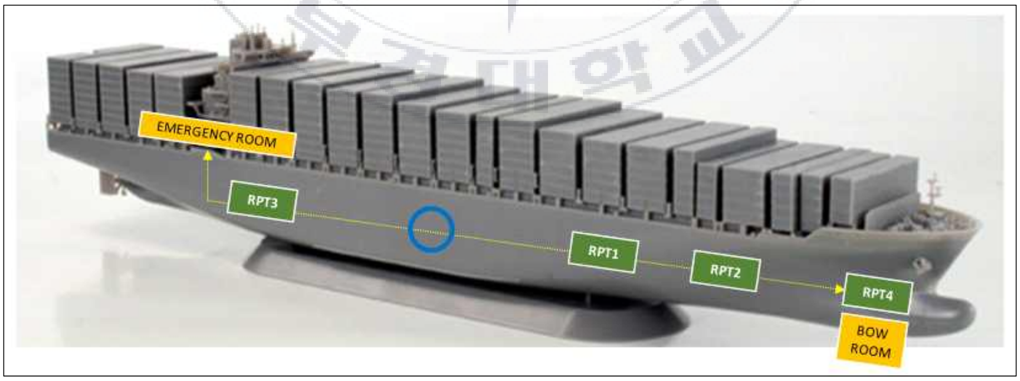
[Fig. 20] Additional installation of PLC Repeater

3.2.2. Second test

By connecting a PLC Repeater to a breaker, which can be linked to the rotary Switch in the Bow Room, among the single-phase breakers in the Feed Panel of the Emergency Room, we solved the problem.

[Fig. 21] Linking PLC Modem to a single-phase Breaker in Emergency Room

As described in [Fig. 21] the connection was quite satisfactory when 1.2MB size data was transmitted for the test. The result was 1.07MB.

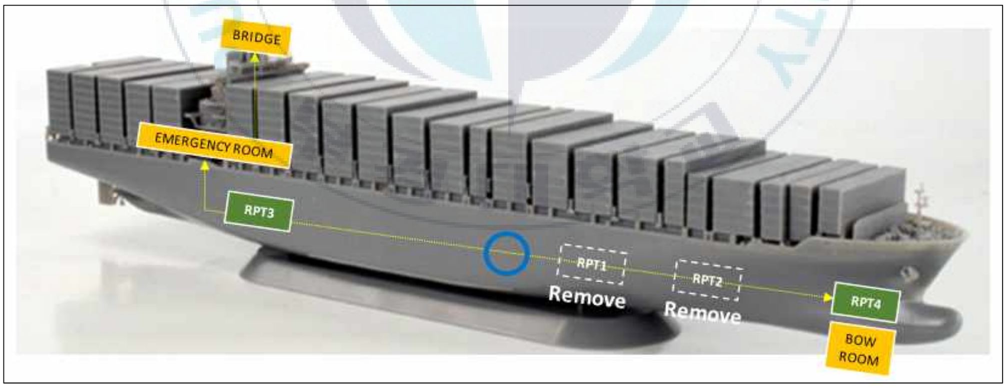


[Fig. 22] Completion of network set up between Emergency Room and Bow Room

As shown in [Fig. 22], by connecting the PLC Repeater to the Emergency Rotary Switch located at the entrance of Bow Room while maintaining the PLC modem, the network for entire section has been established.

3.2.3. Third test

As for the third test, a network test was conducted after removing the PLC Repeaters installed on the Passageway and the connection between the Emergency Room and the Bow Room had been confirmed eventually. After converting the network as an Ethernet-type network by connecting (serial connection) the NMEA Data Converter to a notebook in the Bow Room, final test was carried out performing Ping Test with the PC located in the Bridge. Lastly, basic precautions for arranging the wires installed in each section and for equipment handling after the notebook mounting process were given. The quality measurement log values are indicated in [Table. 1].



[Fig. 23] Network completion in the final section

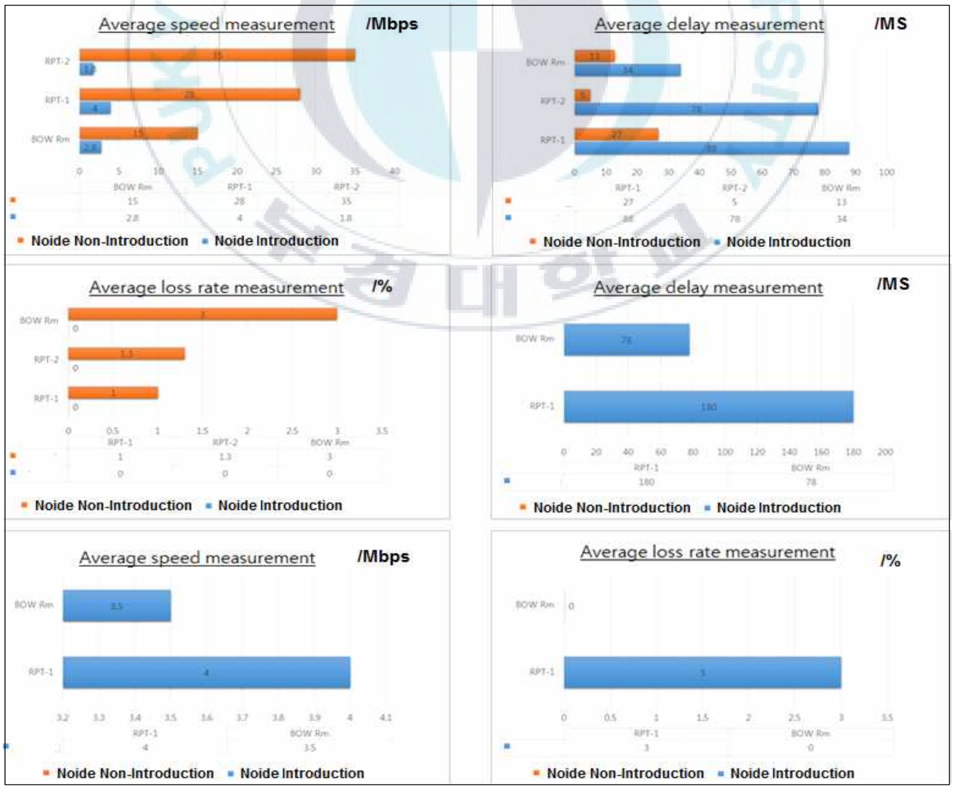
[Table. 1] Quality measurement log values using JPERF

```
[1912]  0.0- 1.0 sec  1160 KBytes  9503 Kbits/sec
[1912]  1.0- 2.0 sec  1520 KBytes  12452 Kbits/sec
[1912]  2.0- 3.0 sec  1272 KBytes  10420 Kbits/sec
[1912]  3.0- 4.0 sec   768 KBytes  6291 Kbits/sec
[1912]  4.0- 5.0 sec   848 KBytes  6947 Kbits/sec
[1912]  5.0- 6.0 sec  1016 KBytes  8323 Kbits/sec
```

3.3 PLC transmission test following introduction of noise

[Table. 2] shows Measurements of PLC tests due to noise introduction. The most vulnerable part of the PLC is the introduction of noise so that countermeasures must be studied to avoid any future communication disruptions. In this paper, we've artificially introduced noises to see how the communication quality would deteriorate due to noises.

[Table. 2] Measurements of PLC tests due to noise introduction



3.4 List of ships on which the PLC system has been installed and additional information

[Table. 3] List of ships on which the PLC system has been installed and additional information

NO	Shipping company	Name of ship	Installation date	Installed section	Number of supplied modems(EA)	
					Master coupler	Client model
1	STX Pan Ocean	GOOD FRIEND	2007	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR, CO, 2O, 3O	1	8
2	STX Pan ocean	ORIENTAL FRONTIER	2007	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
3	STX Pan Ocean	OCEAN HOST	2007	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
4	STX Pan Ocean	OCEAN ROYAL	2007	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
5	STX Pan Ocean	SILVER CARRIER	2007	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
6	STX Pan Ocean	AUTO ATLAS	2008	ECR	1	2
7	STX Pan Ocean	AUTO BANNER	2008	ECR	1	2
8	STX Pan Ocean	EASTERN CARRIER	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
9	STX Pan Ocean	HARMONY CARRIER	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
10	STX Pan Ocean	HS PIONEER	2008	BRIDGE, SHIP'S OFFICE, ECR	1	3
11	STX Pan Ocean	CUPID FEATHER	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
12	STX Pan Ocean	MAGIC FORTIS	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
13	STX Pan Ocean	MAGIC ORIENT	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
14	STX Pan Ocean	NEW DIAMOND	2008	ECR	1	2
15	STX Pan Ocean	ORIENTAL HOPE	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
16	STX Pan Ocean	OCEAN MASTER	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5

17	STX Pan Ocean	OCEAN UNIVERSE	2008	BRIDGE	1	2
18	STX Pan Ocean	ORIENTAL FRONTIER	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
19	STX Pan Ocean	PAN AMBITION	2008	ECR	1	2
20	STX Pan Ocean	STX SINGAPORE	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
21	STX Pan Ocean	VISION	2008	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
22	STX Pan Ocean	FRONTIER CARRIER	2009	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
23	STX Pan Ocean	HS ACASIA	2009	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
24	STX Pan Ocean	LADY KADOORIE	2009	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
25	STX Pan Ocean	ORIENTAL TREASURE	2009	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
26	STX Pan Ocean	ATLANTIC ADVENTURE	2011.11	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
27	STX Pan Ocean	SEA OF FUTURE	2012	SHIP'S OFFICE, ECR	1	3
28	STX Pan Ocean	SEA OF GRACIA	2012	ECR	1	2
29	STX Pan Ocean	SEA OF HARVEST	2012	SHIP'S OFFICE, ECR	1	3
30	STX Pan Ocean	STX AZAREA	2010. 06	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
31	STX Pan Ocean	SINOKOR HONGKONG	2010. 12	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	6
32	STX Pan Ocean	STX FREESIA	2010. 12	ECR	1	2
33	STX Pan Ocean	HANJIN PIONEER	2011. 02	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
34	MSC	MSC LONDON	2014. 07	BRIDGE, G DECK, F DECK	1	3
35	STX Pan Ocean	DK IMAN	2014. 10	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
36	STX Pan Ocean	DK ITONIA	2014. 10	BRIDGE, CAPTAIN, CENG, SHIP'S OFFICE, ECR	1	5
37	MSC	MSC NEWYORK	2014. 10	BRIDGE, G DECK, F DECK	1	3
38	MSC	MSC ISTANBUL	2015. 01	A DECK, B DECK, C DECK, D DECK, E DECK, F DECK	1	7
39	MSC	MSC AMSTERDAM	2015. 04	A DECK, B DECK, C DECK, D DECK, E DECK, F DECK	1	6

[Table. 3] is the list of ships on which the PLC system has been installed and shows shipping companies, ship's names, installed sections and the number of modems supplied (EA). The total number of ships SUNCOM Co., Ltd. installed the PLC system from 2007 to 2015 was 39 and the average cost involved in the system construction was approx. USD 8,000 per ship. For the 39 ships, the distances for the system construction ranged from a minimum of 170m to 200m maximum, showing total average distance of roughly 185m. As of July of 2015, installing the PLC system will lead to about 50% cost reduction when compared to setting up internet network using UTP cables on a ship.

Chapter 4. Expected effects and future work

The ship network communication technology designed in this paper is very effective for the old ships that have been built a decade or more ago, still being operated in a poor environment, and need some sort of safety measures so that we expect that the proposed technology will advance realization of e-Navigation through international standardization.

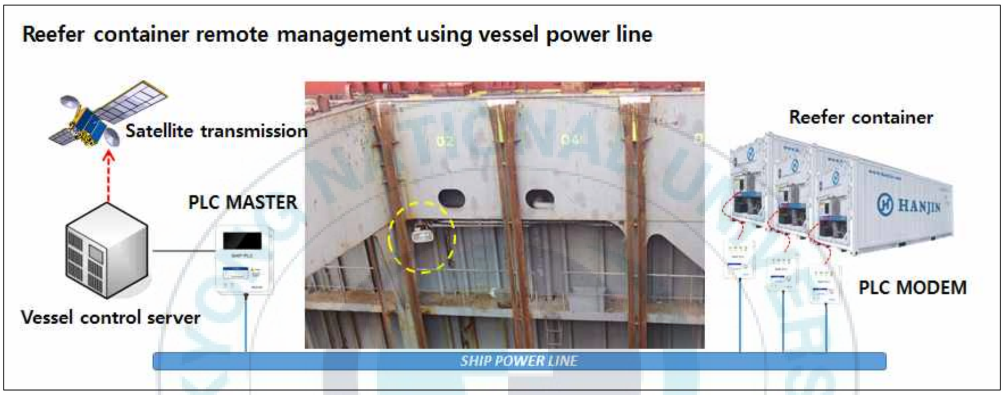
With the early realization of e-navigation, the technology for the maritime SAN data communication infrastructure, which is the key technology of e-navigation, is expected to be responsible for providing basic data for analysis/prevention of maritime accidents, reduction of navigation costs, and pollution control by reducing CO_2 emission.

4.1 Utilization of reefer container monitoring system

When a cargo is to be transported to US or Europe starting from Korea, it will take about 7 days to 45 days. Different from general cargo containers, the reefer containers need to maintain consistent temperature/humidity and to be inspected daily to prevent spoilage of refrigerated goods during sailing period. However, cargos in the reefer container could be scattered throughout the decks depending on a port of call while unloading or uploading them such that they cannot be controlled perfectly with limited personnel. Therefore, we can expect the possibility of monitoring the reefer containers during the sailing period using the PLC-backbone system without laying separate communication cables to obtain the data from various NMEA 2000 CAN BUS-based controllers including temperature and humidity sensors.

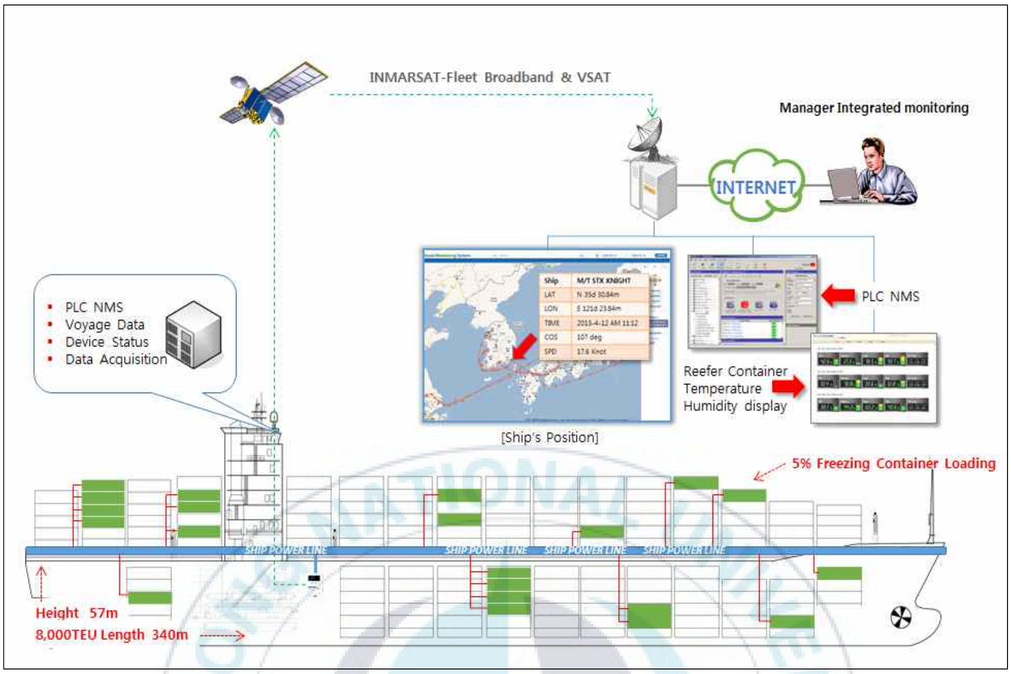
[Fig. 24] Problem of reefer container management during sailing period

In [Fig. 24], we can observe a direct manual operation by the crew to check temperature and humidity data for the reefer container management. However, since the weather condition during the sailing period will not be always favorable, crew are consistently exposed to dangers. Application of the wireless communication technology has been attempted but its commercialization was impossible due to the nature of each port of call. In other words, the wireless communication technology was limited depending on the cargo locations.



[Fig. 25] Reefer container status data transmission using power line

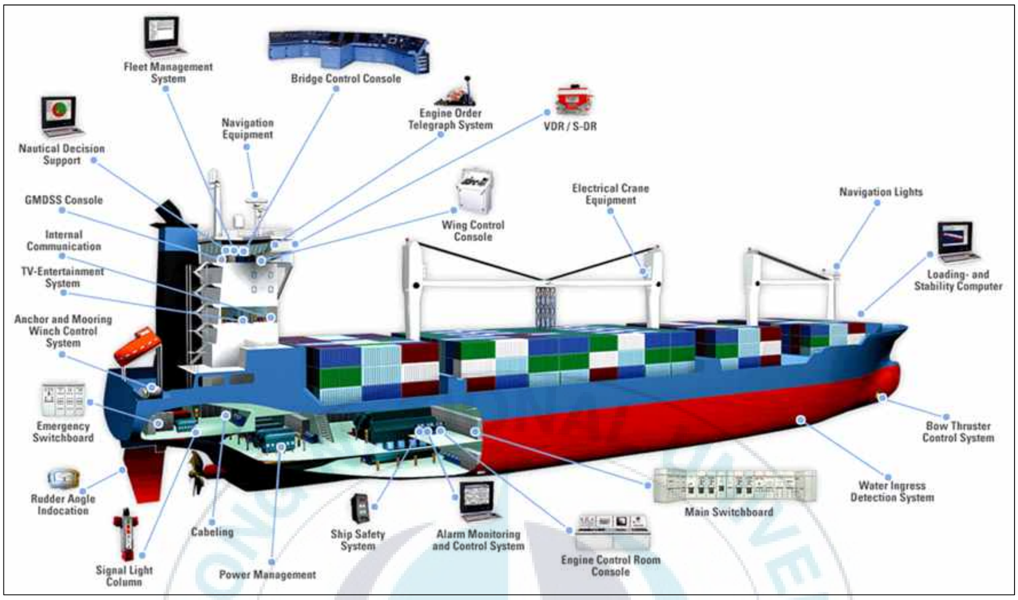
As shown in [Fig. 25], one can find the light and power line within the cargo hold easily so that separate cable installation is not needed.



[Fig. 26] Real-time monitoring of reefer container during navigation

[Fig. 26] shows how the temperature and humidity data of reefer containers loaded on and off the decks separately during the sailing period are collected at the Bridge through the PLC. Then, collected data will be send to the land via satellites together with the ship's location information so that land-based administrators can monitor containers' overall statuses though the web. Such technology can be used when a shipping company deals with cargo owners for it will provide higher credibility in service they would like to offer.

4.2 Utilization of e-Navigation



[Fig. 27] Ship with e-Navigation system

[Fig. 27] show the major electronic equipments installed all over the ship and these become the monitoring and controlling targets. Since it will be very costly and time consuming to lay additional communication cables every time new electronic equipment is mounted, NMEA 2000 + PLC integrated technology will be able to reduce such risks.

Chapter 5. Conclusion

Purpose of carrying forward the policies (e.g., IMO, IEC, ISO and IALA, etc.) related to the e-Navigation and its standardization is to secure navigation and maritime safety through convergence of shipbuilding technology with Information technology. The technology enables collection of sensor data with various electronic equipments and machines and analysis of the data by sending them to the land side efficiently, during entire process of departure and entry.

Should the e-Navigation policy become obligatory, existing ships will suffer overwhelming damages in costs following temporary suspension of ship operation, extra equipment purchase or replacement, and network cable installments to be certified.

In this paper, we've performed an actual test bed experiment on a ship to enable easy adaptation of NMEA 2000 protocol between the relevant parties using the PLC technology with 3-phase 3-wire Delta connection method applied within the ship without installing separate network cables. This technology can be applied to the old ships under the direct influence of changes made in international agreements or to the existing ships which are impossible to install additional network cables due to their features or types.

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