

A Study on Data Communicating Method of Real Time Based Container Tracking System

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Abstract

Transportation volume of global container is increasing as trade grows larger than before based on lifting trade barriers. At the same time, participants using logistics service require real-time based information of container location, security for preventing a robbery case, and temperature/humidity/impact. But existing system based on bar code, EDI, RFID technology is possible to communicate only part of point in all logistics network. In addition, constructing infrastructure cost high because logistics network is based on all over the world these days. Container tracking system that is suggested in this research is one of the methods for realizing Global SCM(Supply Chain Management). This would provide feature for managing container as communicating data between tracking device and information gathering server based on real-time. This research provide communicating method which has systematic communication standard and data format for diverse logistics companies when real-time based tracking device is communicating with location information gathering server.

Keywords: *Container tracking system, Data Communicating Method, SCM.*

1. Introduction

The requirements of the customers that transport their goods using containers have been changed from the cost saving aspect into the service aspect to make sure whether the cargoes are transported punctually such as the safe transport of cargoes, the state/position tracking of cargoes, prompt customs clearance. However, as the previous RFID-based container management system is difficult to provide container sealing records from shippers to consignees and has the limitation to provide real-time base passing and location tracking information, it is necessary to provide the information that users want by applying the real-time mobile communication technology. This research is to suggest the communication method having systematic communication standard and data format in communicating between real-time container tracking equipments and information collecting server for efficient communication of container tracking system built for realizing global SCM.

2. Literature Review

The advanced researches related to container tracking system and communication method for realizing container management system are as below. Yingli Wang [6] has studied on the real-time communication technology that can be applied to container transportation, and tried to suggest the possibility to apply the technology through the comparison of strengths and weaknesses between RFID technology. In Smart Container Chain Management (Smart-CM) project, Julia Carn [4] pursued the case study on tracking the state information of container

transportation in real time, but did not suggest a specific management and communication method. S.J Kim [5] proposed Intelligent Networked Containers as a method to realize global SCM, but it was based on RFID technology and has the limitation that containers were managed through the data collected only in main logistics bases, not real-time communication in all the way to the destinations. C.Y Lee [1] researched into designing and realizing the transport protocol in large tag data on the system based on RFID, and W.S Bae [3] researched into efficient authentication protocol by making use of eSeal which is container security equipment based on RFID. Besides, J.T Kim [2] made the study of light-weight protocol for tag security in RFID system. The above previous researches used RFID-based container tag and information system for the purpose of managing containers in logistics industry, but there was the limit that those researched dealt with the communication methods and protocols in RFID-based position.

3. Container Tracking System

The real-time container tracking system for global SCM introduced in this research is attached to the inside of the container carrying the real-time container tracking equipment as described in <Figure 1>, and detects the information of location and state(temperature, humidity, vibration and the opening and shutting of the door) of the container carrying the equipment in real time. In container tracking system, the communication technologies applied to the real-time container tracking device are WCDMA(Wideband Code Division Multiple Access) and GSM(Global System for Mobile communications) methods, and the location and time information of the device is acquired by using GLONASS(GLObal NAVigation Satellite System) and GPS. The information detected from the real-time container tracking device is transferred to the middleware and monitoring system through communication infrastructure such as mobile communication base station, etc., and as users can make sure the information such as the location of the container and the temperature, humidity, vibration and door opening/shutting of the inside of the container, they are able to make proper decisions for global SCM. The container tracking system consists of the real-time container tracking equipments for making sure the location and state(temperature, humidity, impact and door opening/closing) information of the container, the location information collecting server that collects the location and state information from the real-time container tracking device, the database for storing the location information, the web service server for the license management and web service, and the monitoring system for expressing the collected information.

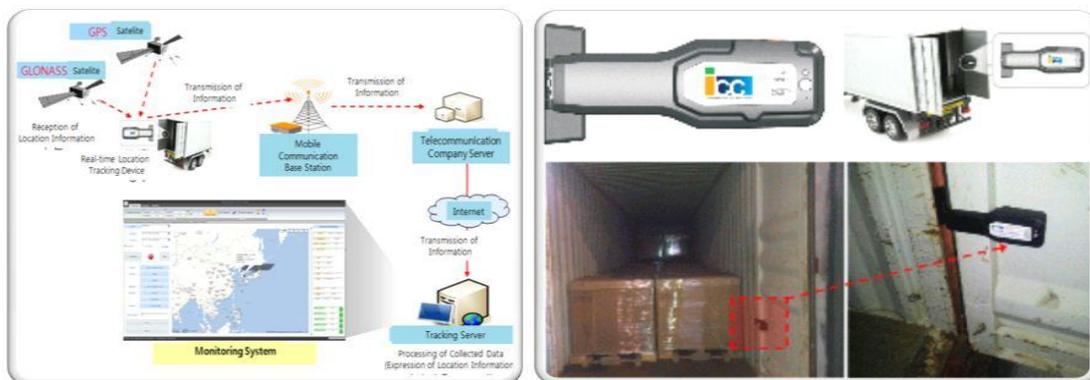


Figure 1. Outline of Real-time Container Tracking System for Global SCM

4. Information Transmission/Reception Method

The method to transmit the container information from the real-time container tracking device to the server is as follows. The real-time container tracking device transmits information according to the established cycle (basically 1 hour), and at this time, using TCP/IP socket communication, it transmits information to the server by the below payload(40 bytes). In transmitting information, SEED encryption algorithm is used for the information protection of payload 40 bytes, and in case of not transmitting the information to the server due to the surroundings (ships, steel-frame structure or no mobile communication base station), one more retransmission of the information is supposed to be tried.

In the real-time container tracking device, information is periodically transmitted to the server by using TCP/IP socket communication, and in the server, the packet that is encrypted through SEED encrypt is decoded and ACK(ACKnowledge) is identified. At that time, the length of the encrypted packet is 32byte, and if it is normally decoded, it is arranged into 19byte, and the detailed explanation of the received payload is as follows.

Table 1. Payload of Information Transmission in Real-time Container Tracking Device

Section	Definition	Length
Index	Log index stored in the real-time location tracking device	2byte
Protocol ID	ID of the relevant protocol. The ID of this protocol is 0x01.	1byte
TSR Tag ID	Unique number identifying TSR tag	8byte
Date & Time	Indicating the time of the event occurrence and information transmission of the device	6byte
Location Data	Indicating the current location of the container on the basis of GPRMC data of GPS	11byte
Temp	Temperature value measured in the real-time location tracking device	2byte
Humid	Humidity value measured in the real-time location tracking device	2byte
Impact	Expressing the vector sum of the acceleration value of X, Y and Z axes of the 3-axis acceleration sensor.	2byte
Container Door Status	Indicating the status of container door (shutting/opening)	1byte
Battery Capacity	Indicating the percentage(%) of battery residual capacity	1byte
On/Off Status	Indicating the status of initial On, In Progress and Off	1byte
Transmission Cycle	Indicating the cycle of the device's transmitting information to the server	1byte
RSSI	Indicating the signal receiving sensitivity between the device and the base station	1byte
Error Status	Storing the error code concerning the error and malfunction of transmitted information	1byte

Table 2. Payload in Information Reception from the Server

Section	Definition	Length
Packet Length	Length of Payload received from the real-time location tracking device	1byte
Protocol ID	ID of the relevant protocol. The ID of this protocol is 0x01	1byte
TSR Tag ID	Unique number identifying TSR tag	8byte
Setting Change Flag	Making sure whether the setting is changed or not by the server during the operation	1byte
Optional Data	The information for changing equipment information(server IP & Port, TR cycle, checksum)	8byte

5. Case Study

5.1. Outline

As explained below, the container tracking system with the real-time container tracking device and the communication method between servers was applied to actual work-site operations. Container tracking system was applied to the combined district that marine transportation and land transportation (TSR: Trans Siberia Railway) from Korea to Moscow, Russia. Especially, TSR is the longest railway in the world connected the distance of 9,300km between Moscow and Vladivostok, and has harsh transportation environments.

Table 3. Application Environments of Global Container Tracking System

Section		Information Transmission Cycle
Objects		LCL Freight. 3 40ft containers
Operational Period		Dec. 16, 2011 (Fri.) ~ Jan. 10, 2012 (Tue.), for 26 days
Test Method (Routes and devices)		Yangsan ICD in Korea ~ Busan New Port in Korea ~ Vostochny Port in Russia ~ Moscow, Russia (Among 100 devices, 3 devices were selected randomly)
Used Device ID	11110008	Information Transmission Cycle : 1 hour in the country, 10 hours in other countries (Used USIM: Vodafone)
	11110227	Information Transmission Cycle : 1 hour in the country, 1 hours in other countries (Used USIM: Megafon)
	11110233	Information Transmission Cycle : 1 hour in the country, 10 hours in other countries (Used USIM: Vodafone)

5.2. Operational Result

As a result of operating the information transmission/reception method of the container tracking system(communication standard and data format), the result value can be acquired as the following <Table 4>, <Table 5> and <Table 6>, and the information for global container transportation management which is the aim of the container tracking system can be collected. Especially, as shown in the operational result, the shadow zone occurred from Kazan, Russia and the surrounding area(approx. 1,000km), and though the information could not be collected in the shadow zone in real time, the transportation information could be collected by analyzing the logs stored in the internal memory of the real-time container tracking device. At present, it is assumed that in this part, the real-time communication is not possible due to the infrastructure shortage problem, and it is necessary to expand communication infrastructure, or to seek for the solution to solve the problem through the support on business processes

Table 4. Data collected in Real-time Container Tracking Device ID 11110227

Index	Device ID	Date	Time(UTC)	Latitude	Longitude	Temp.	Humidity	Impact	Door Status	Battery	Power	TR Cycle	Error Code
1	11110227	11:12:16	1:52:48	35.236771 [N]	129.04519 [E]	8.83 °C	19.54%	0.0 G	None	94	0n	5 mins	0x0
2	11110227	11:12:16	1:57:49	35.236751 [N]	129.04514 [E]	13.10 °C	19.97%	0.0 G	None	94	0n	5 mins	0x0
3	11110227	11:12:16	1:59:08	35.237092 [N]	129.04588 [E]	13.64 °C	18.50%	3.0 G	None	93	0n	5 mins	0x20
...
597	11110227	12:01:08	19:57:04	56.399698 [N]	57.515049 [E]	-11.33 °C	31.42%	1.41 G	Close	53	0n	60 mins	0x0
598	11110227	12:01:08	20:57:05	56.35891 [N]	57.449578 [E]	-11.89 °C	32.20%	1.41 G	Close	53	0n	60 mins	0x0
599	11110227	12:01:08	21:57:06	56.287239 [N]	57.22646 [E]	-10.29 °C	32.28%	1.41 G	Close	52	0n	60 mins	0x1
...

Table 5. Monitoring Result of Device ID: 11110008

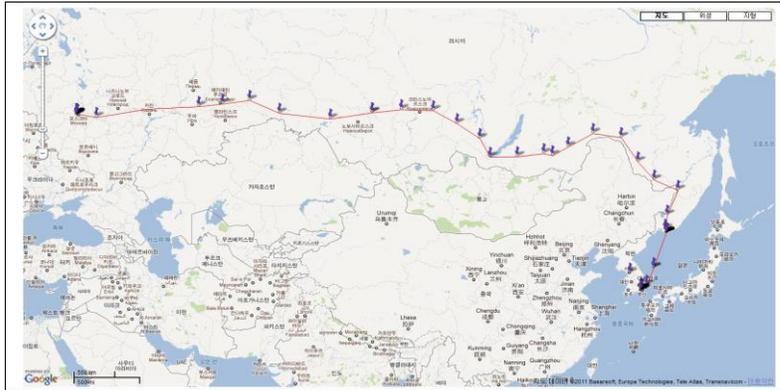
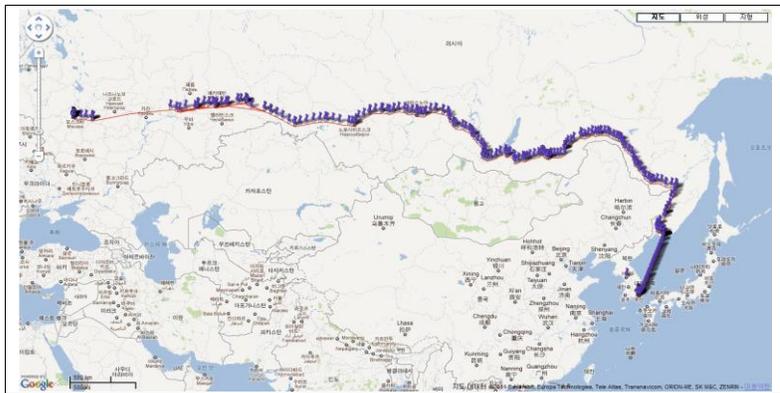
	Max. Temp	10.14°C
	Min. Temp.	-29.80°C
	Max. Humidity	32.66%
	Min. Humidity	16.18%
Information is normally transmitted at 10-hour intervals. (Occurrence of shadow zone : Kazan~Moscow area)		

Table 6. Monitoring Result of Device ID: 11110227

	Max. Temp	10.70°C
	Min. Temp.	-31.79°C
	Max. Humidity	33.28%
	Min. Humidity	17.8%
Information is normally transmitted at 1-hour intervals.(Occurrence of shadow zone : Kazan~Moscow route)		

6. Conclusion

This research can provide the container management system for global SCM by proposing the communication method having systematic communication standard and data format in the communication between the real-time container tracking device and the server collecting information. As the system and communication method suggested in this research includes the steps of information transmission/reception and re-transmission, container sealing records, real-time base transit information and location tracking information can be provided effectively, and after transmitting information or in case of not transmitting information normally, the information is stored in the internal memory and the event log is transmitted to manager program, so effective information management is possible in the future. In addition, as the information is transmitted in the method of GSM, and the information of location and time is identified by using GPS and GLONASS, the existing mobile communication infrastructure can be fully utilized, and it can be applied to not only containers but the equipments and systems that track locations in real time by using M2M-based mobile communication module.

The case study of the container management system proposed in this research has the limitation that it was applied to only the route of the container transportation between Korea and Russia. In our future study, the system would be applied to various transportation routes, and it would be suggested that it is generally applicable when the proposed communication standard and data format are applied to various logistics industry.

Acknowledgments

This work was supported by the grant No. B0009720 from the Regional Technology Innovation Program of the Ministry of Knowledge Economy(MKE)

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