A Network Model for the Intelligent Marine Container Tracking

ABBAS ASOSHEH, ARASH AFSHINFAR, MAHMOUD KHARRAT, NAGHMEH RAMEZANI,
Information Technology Department
Tarbiat Modares University
Jalal Ale Ahmad, PO BOX: 14115-111
Tehran-IRAN

Abstract: - Nowadays companies are putting more and more emphasis on making their supply chains, leaner and leaner. From a supply chain perspective carriers and shippers are always looking to increase their profitability and Container Tracking (CT) assists them in reducing their costs and saves their time regarding customer service improvement. On the other hand, every consignee needs to be informed of the last position and situation of his/her cargo.

In this paper different methods in cargo tracking in shipping companies based on Satellite, Radio Frequency Identifier (RFID), and Global System for Mobile communications (GSM) will be discussed. Eventually an End to End integrated and intelligent tracking method will be introduced regarding to customers’ requests and needs. The availability and cost of the different methods and customer requirements in the proposed model are key parameters. According to this model an expedite and efficient , End to End, container cargos from first stage (Release to shipper) to the last stage (Return by consignee) in destination will be considered.

Key-words: - Intelligent tracking system, GPS, RFID, Satellite tracking, Container tracking

1 Introduction

In alignment with mobile business development in various types such as cargo movements by truck, vessel, airplane and train, the market of transportation of such cargoes is going to be increased. Improving of this business probes some considerations and needs more effective and efficient information flow in worldwide scale.

According to technology explosion, nowadays, Internet is a reliable and fast infrastructure for customers, suppliers, producers and distributors. In this ways customers who are going to carry their cargo to all over the world, are looking for a reliable and on time information about the location of their cargo. In response to these requirements, cargo tracking and tracing systems with various types of managerial approaches are going to be grown. Therefore the most feature and key success for any concerned business is value added services[1].

Container movement tracking systems in shipping companies can be mentioned as one of the most important cargo exchange processes which due to its importance, need to be supported by tracking information systems. Most of the researches about container are about container bay planning and container depot simulations. There are also rare studies about CT [1].

Also special features of container movement industry in ports and vessels need to take advantage of an intelligent and integrated environment for cargo tracking and capability to select the fastest and cost effective way for tracking the cargo.

Time is a critical point in the tracking industry. Eventually the customer service aspect will become a standard so that large retailers will require shippers and carriers to provide real-time updated status. There are other facets to the demand for tracking services. Container theft is becoming more and more of an issue and companies are very keen to know as much as they can about the location of a container. So they can find it easier if it gets lost. Indeed, some insurance companies are lowering the premiums for containers with tracking services[3].

However the accurate tracking is becoming more and more important. The main goal of CT is achieving more information for supply chain management in shipping industry (mobile business). Generally shippers have made the following suggestions for an ideal cargo tracking system. None of the available
models on the market meet all these criteria exactly:

- The system must be cheap.
- The tracking system mounted on the container must be very small.
- The demands for power by tracking system on the container must be very small.
- The power supply must not take up any of the load space.

Generally a model can be regarded as smart and intelligent if three aspects to be considered in its basis: ICT Enabled, Maturity in organizational structure, Generating knowledge and value added besides learning [4].

The rest of the paper will be organized as follows: possible infrastructures and methods for container cargo tracking is discussed in section two and then in section three we will introduce an end to end container cargo tracking systems. An intelligent approached network model will be explained in forth section and the paper will be concluded in section five.

2 Container tracking Technology

CT provides some important information for shipper, consignee or other transport company about containers, the most important tracking information is the location of the container, other important information is the temperature inside it (for reefer containers) and information about whether the container door has been opened. CT systems have the following parts:

A capturing data system, an information transmitting system, software and management tools to analyze the data and present it in a usable format, are the main part of a TC.

The following is the review of the technology that is normally used:

2.1 Capturing data system

The availability and accuracy of the captured data are so important. In the following the most important type of the capturing tools will be briefly discussed.

GPS: There are two constellations of satellites which can be used for positioning, the US GPS and the Russian Global Navigation Satellite System (GLONASS).

They are based on constellations of 24 Medium Earth Orbit satellites and operated. It can be used for military purposes to determine the position of an object to an accuracy of less than 1 meter and also for commercial purposes, the accuracy of 15 to 100m can be achieved. This accuracy seems to be acceptable for marine cargo tracking[5].

RFID system: A network of tags and readers are employed to find out the location of the container. These systems are sometimes are known as Automatic Equipment Identification (AEI) or RFID. Each container is fitted with a radio tag and a network of readers is fitted at strategic points such as terminal entrances or using of mobile reader such as handhelds. When a container passes a reader the reader reads the tag on the container and identifies it. It then sends the data back to a central control system [6].

Electronic seals: They are radio tags incorporated into a container seal. They can be read using a handheld to find out if the container’s door was open and can transmit this information to the central control system [7].

Sensing devices: They can be used to detect what is happening on the container itself. Typical sensors include the following items.

- Temperature sensors
- Pressure sensors
- Door opening sensors
- Motion detectors
- Air in/Air out detectors on refrigeration units.

2.2 Data transmission systems

In this section two important wireless transmission systems will be reviewed. Data can be transmitted from a mobile object to a base station using a number of different satellite networks. The satellite networks which commonly used for CT are INMARSAT, ORBOCOMM and ARGOS [2].

Data can be transmitted through mobile telephone networks (GSM protocol) in a region with a good coverage. There are four generation for GSM which from Generation 2, data stream can be transmitted on GSM infrastructure digitally.
2.3. Software and management tools
Four types of well known systems are:

Container terminal operating system: It manages the containers in a terminal. The systems are updated every time a container is brought into or out of the terminal.

Shipping Line lashing systems: These systems determine which containers are on which vessel. What the estimated arrival time is and (possibly) the exact co-ordinates of a vessel in motion.

Integrator software system: These systems are being developed which compile tracking data from a number of disparate sources and put it together in a format suitable for customers.

Web GIS: All the tracking units generate raw data which in most of cases they are not clear for the user, but with using vector maps and special software (preferably Web based) every authorized user will be able to view the position and other information about his/her cargo graphically.

3 Container tracking system (CTS)
There are so many companies that offer marine CTS via satellite (E.g. GeoNspace, and INMARSAT), RFID and GSM networks.

CTS via satellite: On the oceans which any type of telecommunication infrastructure is not available, satellite is the most reliable and more practical solution. This type of tracking that is used for vessel and CT will be done by Low Earth Orbit (LEO) satellites and GPS. There are 2 main components for satellite tracking method:

- Satellite transceiver module: This module is used for sending (TX) and receiving (RX) of messages to/from satellite.
- Battery: The major issue with CT system is battery power. Batteries are required to run the tracking unit on the container and tracking data. The life span of a battery varies with the application and battery size.

The process of satellite tracking model (Fig.1) includes nine stages.
1. Location requested by user through internet.
2. Request forwarding to communication server.
3. Request transmission to the concerned satellite.
4. Request sent to the container unit.
5. Position recovery by GPS mounted on the container.
6. Transmission the position to the satellite.
7. Information received by communication server from the satellite.
8. Transferring the information to the web server.
9. Reply to the customer about the request.

Fig.1 Satellite Based Tracking

CTS via RFID: Regarding to the limited range of RFID technology for (3 to 25 feet), this technology is mostly used in harbors and container depots. The most important parts of RFID tracking unit are Tag (Passive or Active), Tag Reader, Tag Writer, Antenna, Amplifier and Battery[8].

In passive tags the reader emits radio frequency energy in the air continuously. As the tag on the container approaches the reader, it starts to store the energy generated by the reader. And active tags are connected to a power supply normally a battery. The power supply can be used to run sensors which monitor the operating status of the container. The data from the sensors can then be transmitted over the tag system[9].

There are two types of services in CT by RFID technology:

- Cargo gateway control: The reader will fetch the information and in case of permission for entering or exiting the cargo, the entrance or exit gate will be opened. If there is any tag on the container or there is not any permission for that container, the port security guards will inspect the container.
- Position tracking services: By this type of service, with taking advantage of GPS and RFID technology, the position of container during its trip, will be logged in the memory.
of RFID unit and after passing the gateway, all information will be fetched by RFID reader and afterward the received information will be entered into software. The information in the software can be analyzed in four aspects:

- Container was not allowed to pass from some zones.
- Container was not allowed to pass from some zones in some times.
- The zones which have been passed by container during trip.
- The duration of container stop[10].

CTS via GSM can be mentioned as third model of marine CTS. Three main components of this system are GSM Modem, SIM card, Antenna, Amplifier and Battery.

The process of GSM satellite tracking model (Fig. 2) includes nine stages the same as discussed in the satellite part except the position of the information which is BTS or GSM satellite.

Other type of using GSM is so that in case of taking place any special event, the GSM Modem will dial the center and sends the alert [11].

There are two main limitations for this technology for marine containers tracking, the range of applicability and the expensive cost [12].

4 Proposed intelligent tracking model

All of the major shipping lines try to offer electronic tracking data to their customers[13].

In this way they need an intelligent internet system which provide details of where the shipments are when the container No or bill of lading No is input. Shipment tracking with shipping lines is largely a matter of data entry and retrieval from a central computer system. The shipping lines have a central computer system which monitors in real time which containers are on board of which ships, where the ships are and the estimated time of arrival. It also has data of which containers are booked to go on which ships. Data can be entered and retrieved from this system remotely using electronic data interchange and the internet.

Regarding to the above mentioned technologies, every technology has some advantages, disadvantages, and need special telecommunication infrastructure and cost. Selecting the best method according to value, route, activity of a marine container as an end to end network, will be cost effective and causes to increases the satisfactory of customers.

On the other hands there are two groups of customer for CT. Some customers need to know the location of their cargo real-time or in specific time intervals and the others want to be alerted if there is a problem with the shipment. If there is a problem, then they would like all possible available information in order to resolve it. In order to establish an intelligent network, creating an integrated information system from all available technologies are required (Fig.3).

![Fig.2 GSM Based Tracking](image1)

![Fig.3 Technology deployment in the proposed intelligent tracking network](image2)

One of the most important features of this intelligent network (Fig.3) is capability of automatically conceiving the situation of container in response to tracking request. Recognition of current situation of container, choosing the optimum route for tracking from database tables with consideration of marine container movement processes.
Customer interface with this system is via short message service (SMS) or a portal with Web GIS interface so that the system receives request with an indicator such as container No or Bill of lading Number (B/L No).

Nowadays, all the researches about marine CT are only based on one aspect and dimension of any mentioned models in this paper. Therefore an intelligent end-to-end network which has been introduced in this paper, offers faster and most cost effective route for tracking the container. According to disadvantages and limitations of every model, it is not possible to apply one single tracking method for any type of cargo situation. The single method will not be cost effective and generally it causes increasing cost and duration of services for customers.

In the new hybrid solution the basis is an integrator software which stores all container activities and regarding to the different standard, main activities (ACTs) of a container are Release to Shipper (RTS), Return by Shipper (RBS), Load on board (LOB), Discharge (DIS), Deliver to Consignee (DTC) and Return by Consignee (RBC) which have certain time durations. All these activities will be registered and analyzed in the integrator software.

Therefore according to the request of consignee, the intelligent system will determine the last activity of the container and finds the fastest and most cost effective solution for tracking a specified container.

As you can see in fig. 4, the idea is using a data warehouse system. All agents or port operators in all over the world will enter the features of a container such as container No, Voyage No, Last Act, location, vessel name (For LOB and DIS), Date and time of the act.

According to International Safety Marine Standard (ISMS), all vessels have been obliged to send their last geographical position to a database by a device named sailor every 30 minutes. Therefore the central host can have the last ACT of every container.

Now suppose that a user sends a request to a server (by either web interface or SMS). The entity for this request is container No, the central data base (Fig. 4) will be asked about the last ACT. If the last ACT is RTS, RBS, DIS, DTC or RBC, it will return to the user last ACT, Location and date/time.

If the last Act was LOB, it sends a query to the vessels position database about the last location and eventually returns to the user, last Act, Vessel No, Latitude, Longitude, and Date/Time.

There are three key components for this software:

- Intelligent Software for registering ACT information about containers.
- Interface for receiving user requests
- GSM Modem + SIM card (optional on the server for receiving user requests via SMS)
However there are three considerations for this method:

- The possibility of forgetting any ACT registration of a container that is all concerned people in port or principal must enter every movement of container in the commercial software.
- This method is approximately offline (only in LOB mode, it is online) and the user will be only informed from last ACT of a container not from last moment location.
- As you can see in fig. 5, because this model is dedicated for marine CT, the tracking will be started from RTS which the empty container is delivered to the customer and will be finished RBC mode which empty container will be returned to haulier (Forwarder, shipping line, Port operator and so on).

According to the intelligence aspects which discussed in introduction, in the represented model all three aspects can be seen. This model is based on Network infrastructure and database interaction which indicates its ICT enabled feature.

For using this service the organization should be able to apply its concerned culture and all organizational resources and structures should be trained and prepare for this service.

5 Conclusion

As amount of container shipments get larger and IT systems get more complex, the demand on shipping lines to develop intelligent tracking and IT systems grow. Shipment tracking with shipping lines is largely a matter of data entry and retrieval from a central computer system.

A conceptual network model for an intelligent marine CT has been introduced which included the GPS, Satellite, RFID and GSM technologies. It based on the last ACT of the container and could be a proper response to the customer request. All containers’ activities would be registered and analyzed in the integrator software and according to the request of consignee; the intelligent system will determine the last activity of the container and finds the fastest and most cost effective solution for tracking a specified container.

References:

[3] AHN, "Container Tracking and Tracing System to enhance value added," in Conference of Container Management South Korea, 2005