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Carrier Tracking and Tracing System using Low Earth Orbit

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ABSTRACT

The purpose of carrier tracking and tracing is to achieve more information over shipments via carrying in mobile business. At multimodes, especially consignor wants to be aware of the exact situation and position of goods. As an innovative business model, we present CGPS(Carrier Global Positioning System) scheme using LEO(Low Earth Orbital) satellite. The LEO collects the data periodically and sends to the web server, and eventually customer's PC or PDA. This provides shipping company or freight forwarder with more robust information such as door status, container inside condition, etc.

1. Introduction

With the advent of e-business, web-based connectivity and supply chains based on new technologies are becoming essential in the logistics industry. In external logistics and transportation, it is important to maintain the relation between the information system and physical goods. Thus, customers are driving the implementation of systems to ensure timely, thorough and accuracy information, often with immediate access, in response tracking and tracing systems are proliferating with the Internet. A tracking and tracing system links up an information system with a physical distribution system.

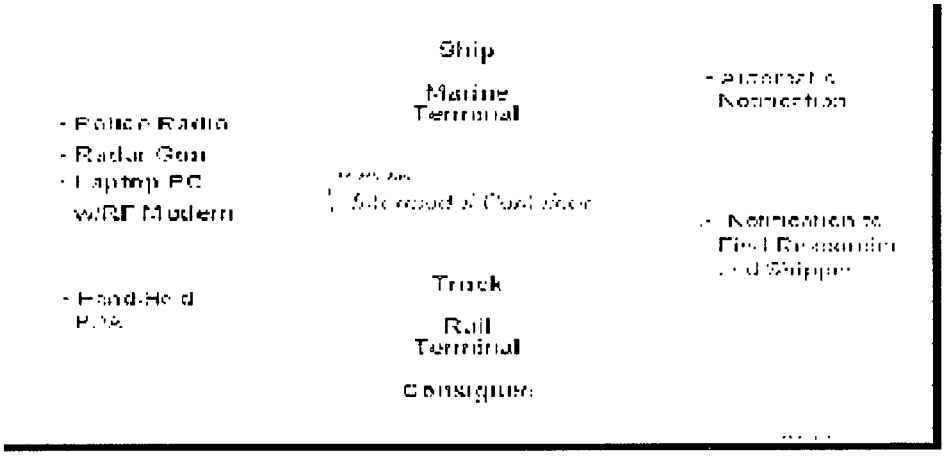
The concept of Intelligent Transportation Systems (ITS), which deals with the application of advanced technologies to transportation, became popular in the 1990s. Commercial Vehicle Operations (CVO) were introduced as a subsystem of ITS in the United States with the application of ITS technologies to the movement of freight. ITS/CVO (Commercial Vehicle Operations) have been the prominent services in logistics and freight transportation. They include electronic screening, credentials administration, weigh-in-motion, border-crossing and automatic equipment identification. Recently, global SCM (Supply Chain Management) expands ITS/CVO services to intermodal transportation and logistics information systems in diverse areas: warehousing, ports, airports, rail stations, etc.

Tracking and tracing of trucks and dispatching services are very popular in the private field and the EDI services are most distinctive in logistics. CVO now has a broader meaning, including intermodal terminal operation and coordination among modes. Global visibility (tracking and tracing of freights and commodities) emerged as a necessity in various logistics fields, especially for services provided by the integrators such as DHL, UPS, and Fed-Ex. This paper covers recent trends of tracking and tracing services in CVO and Logisvally's container tracking services using low-orbit satellites.

2. Tracking and Tracing Services for Commercial Vehicles and Containers

In Korea, tracking services are provided by several types of companies such as telecommunication companies, S.I. companies, trucking companies, which are the followings: KTlogis, Zimtruck, SDS (Samsung Data System, Inc.), OK-Net by Daesin, SK Netruck. In 2002, about 15,000 truck drivers use tracking and dispatching services, which is about 1% of the total trucks in Korea. Current market of CVO reaches approximately 11 million dollars where 1.1 billion dollars in the world. In five years, it is expected that the market will grow up to more than 30 times in Korea: CVO services include border-crossing, credentials administration, logistics e-Marketplace, electronic screening services including dispatching, tracking and tracing services.

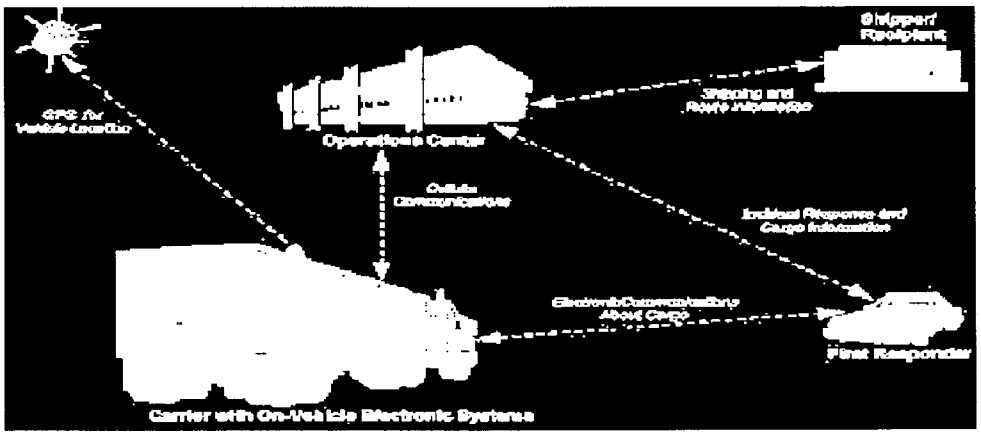
In Korea, tracking services depended on GPS and MDT transponders in the beginning; however, most companies provide services using cell-tracking because of high costs currently. Still, GPS and MDT transponders are applied to parcel services



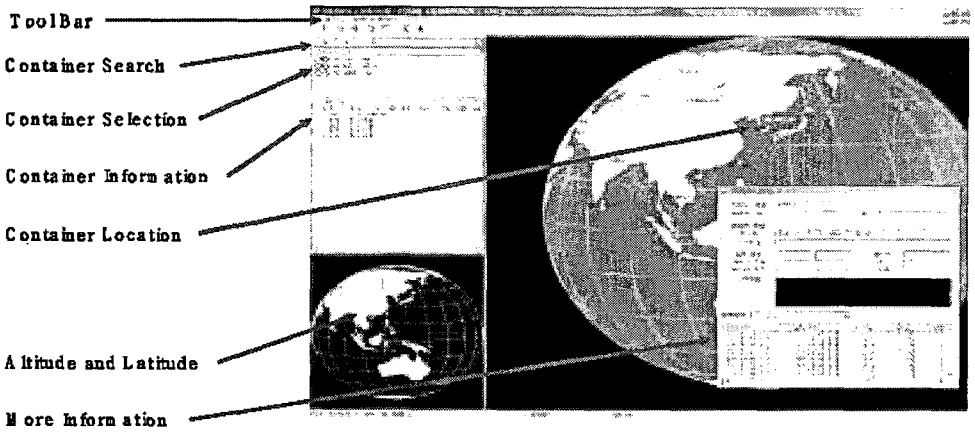
<Figure 1> Tranzit Xpress Ⅱ: Hazardous Transportation Incident Response

and high-value products. Although currently not applied to CVO, beacon and DSRC (Dedicated Short Range Communication) offer traffic information and ETCS (Electronic Toll Collection System) services, which can extend their service areas to CVO market. GPS satellites give the information of an exact spot and automatic vehicle location (AVL) services can be provided, but this method cannot be self-satisfied. Wireless telecommunications such as cellular, GSM, DSRC need to send the data from GPS satellites to the operation center. DSRC has limitations in wide-area communications as it is oriented for short-range and it requires devices along the roads. Cell tracking services have wide range of errors, approximately one kilometer. To acquire exact information, GPS sensors are needed and connected to cellular and GSM phones. Beacon and Infra-Red can also be applied to tracking services of trucks.

In Taiwan, the GSM-USSD (Unstructured Supplemented Service Data) was launched in August 2001 by Telecommunication Enterprise. GSM-USSD send information of a vehicle such as gas mileage, speed, payload status and a route to the center. In freight and fleet management, applications to hazardous materials are distinctive for containers. In the U.S., Tranzit Xpress, Operation Respond, Truckdesk are adopted for hazardous-materials management systems. Tranzit Xpress I was developed by State of Pennsylvania and Tranzit Xpress II was developed by State of California. Figure 1 describes the function of DSRC tag and concepts. Tranzit Xpress monitors vehicle location, status of hazardous materials to respond emergencies and incidents. Tranzit Xpress system is composed of the Information Dispatching/ Operations Center, the On-Vehicle Electronics systems, and a battery of off vehicle



<Figure 2> Basic Structure of Transit Xpress



<Figure 3 > Example of web GIS

devices.

3. KEY COMPONENTS OF CGPS

The CGPS consists of 3 main elements such as antenna, receiver, and battery. These were also problem makers while we setup the system. We explain the structure of each element and finally overall scheme of it.

3.1 Antenna

Since GPS is broadcasting system, the container should be well detected and located by satellite. The main constraint is that the antenna should be always exposed by outside, the receiving error can be expected into shade region. Also container can be stacked with multi layers, and it takes risk of breakage. Among these restrictions, we selected LEO(Low Earth Orbit) as Korea ORBCOMM. The system represents a new era in remote messaging and data communication. Using a constellation of LEO satellites, ORBCOMM provides cost-effective monitoring, tracking and messaging capabilities. The system increases the productivity and efficiency of remote operations by making location coordinates and other critical information readily available-often from areas that are beyond the geographic and economic reach of traditional systems.

The satellite relays these messages to an ORBCOMM Gateway Earth Station(GES). The message is sent through a Gateway Control Center(GCC) to its destination, through the Internet or other terrestrial networks, to a personal computer, or to a subscriber communicator pager. Messages and data sent to a remote Subscriber Communicator(SC) can be initiated from any computer using common e-mail systems, including the Internet mail and X.400. The NCC or GCC then transmits the information using ORBCOMM's global telecommunications network. The system uses 137~138MHz and 400MHz frequencies for transmissions down to mobile or fixed data communications devices and 148~150MHz frequencies for transmissions up to the satellites.

3.2 Receiver Module

The system receives the signal from GPS via satellite, and it can monitor the status of container. We set the power below the 10mW and the channel upto 21 differences. Possible interference can be occurred but, the antenna was manufactured according to the minimum allowance. Figure 3 displays the assembly of antenna and the module.

3.3 Battery

As one of main problems, we had to solve the battery functions. Since it takes more than 3 months for the container to be reclaimed, the life of battery should be more than the same period without recharging. Solar battery could be a solution, but weather does not allow the container to be exposed to Sun at all times. Therefore, we designed the battery minimizing the necessary power such as total of 20Ah. We also assumed 4,320 as the average number of message transmission for 3 months.

The initial input is AC 460Volts, and transformer works for 220Volts. The final system output is set to 12Volts. following is outline of the battery installation.

4. PROVISION OF WEB GIS

As an application of CGPS, the system can

track and trace the container and it provides web GIS. With simple globular map, the system can visualize the exact location of the container. User can easily select the container and search data. More information also can be withdrawn including exact altitude and latitude.

5. CONTRIBUTIONS AND FUTURE WORKS

The proposed CGPS generates many areas for mobile business. Tracking and tracing the container is one of main issues among shipping companies and freight forwarders. In terms of managing the container, they can save at least multi million dollars against loss or damage.

This work really opens new paradigm of location based systems and possibility of global tracking system over worldwide. Solution retained company such as Logisvalley keeps the application more searching. Since the system is limited to special container along with power supply currently, we should investigate the way to apply for regular containers.

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