The Cargo Container Tracking System

Executive Summary-Users Point of View

Group 6

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I pledge my honor that
I have abided by the
Stevens Honor System

Reliable and accurate global and domestic transportation of goods is a vital aspect in maintaining a sound and robust economic state. Everything from wheat to luxury automobiles are transported through cargo containers. A 1997 Commodity Flow Survey estimated that over $7 Trillion dollars worth of goods traveled via intermodal cargo containers. In this dependence by industry and government on this method of transportation, there is often little ability to accurately track location and status of various containers. Companies in the transport sector try to find ways of increasing their efficiency while reducing costs; customers often demand a tracking service, because they want to know where their shipments are and when to expect them. Current systems that are in use are limited by the high cost of equipping mobile units or containers, or the limited ability of present systems to meet the needs of the shipping/transport/leasing organizations.

What has been proposed, and is the goal of this project, is to develop a system in which the problems of current supply chain management system can be addressed. Geared primarily towards container leasing companies and multi-scaled shipping companies, we are planning to develop a system for intermodal container chassis in which the chassis will be outfitted with a wireless device which, will be read by a receiver node installed in locations such as weight stations, tollbooths, and loading docks. Essentially these locations would be those with an established network infrastructure and a position that is strategically useful for tracking purposes. Additionally vital tracking, customs, inventory, and contents information will be transmitted via the wireless link into online databases for purposes of security verification and tracking status. Our team will be developing one or more prototype systems based on either a high-speed system approach and (or) a low-speed system approach by the Spring 2002.

As stated before current present day systems do not meet the functional requirements for a fully automatic tracking and management system, or simply depend on technology which is too costly to widely implement. In developing a finalized design for our system we evaluated these alternatives in order to establish a foundation by examining the various system's strengths and limitations.

The first alternative systems we examined were based on GPS (Global Positioning Systems) technology. This system provides a real-time means of interactively tracking individual containers over a world-wide domain. However, the system lacks the ability to exchange data between remote node and base station, a key component in delivering tracking and other information services. Additionally the system depends on a clear LOS (line of sight) to the orbiting satellites, this essentially negates the usefulness of the system in closed environments such as warehouses and container ship holds. Finally the system is expensive to implement and operate. Qualcomm Inc. manufactures and markets such a system. Their proprietary system provides the above functionality at a staggering cost per unit tracked.

The second alternative system involves video image tracking. By setting up stop motion digital video cameras, each individual containers serial number can be scanned and processed into an online database. The advantages of this system are that it is a quick and accurate way in which resources can be identified and tracked. However, the implementation is costly and would require a significant network infrastructure in to accommodate an intensive imaged based system.

Our design incorporates the positive aspects of both these alternative while minimizing the negative factors which diminish the overall functionality of the design. In order to accomplish this successfully our design is broken up into two independent systems, a low-speed and a high-speed system.

The low-speed system is primarily geared to applications in which the container is "backed up into the gate". This operating environment allows for maximum level of secure and reliable exchange of data between remote and base station. The net effect is the minimization human involvement in inspecting and verifying cargo, as well as the ability to instantly and automatically update container locations and inventory contents. The result is an overall improvement in efficiently in the loading and unloading process which will results in overall savings to the user.

In utilizing a Bluetooth based wireless interface vital tracking, security and inventory data can be transmitted to a bases station and processed into a centralized database. Inventory movement and security seals can also be monitored and controlled from this point as well. Bluetooth provides the ideal foundation to develop a system on for several reasons. First, Bluetooth provides the necessary bandwidth need to accomplish the transfer of data between remote and base stations. Second, Bluetooth based systems can interface with other hardware necessary to perform the operating functions and information storage requirements. Finally Bluetooth is widely available and relatively inexpensive to acquire and develop for, thereby minimizing potential development costs. Presently there are many commercially available Bluetooth based components which meet the budgetary and performance requirements needed for this design.

The low-speed system, as mentioned before, is broken up into two separate parts, a base station and a remote station. The base station essentially acts as the control center for the operation of the system. Equipped with a Bluetooth based access point, a WAN connection, and a user interface, information and control functions can be exchanged with the remote unit on the intermodal container. This portion of the design provides a means to remove manual intervention and functions presently necessary for verifying the containers inventory, security, and customs information. Additionally it provides an automatic means of updating location and status to the end-user or party which an interest in the whereabouts or status of the container. The remote station is essentially a Bluetooth transponder interfaced with some means data storage. Container and security information is stored on this transponder. When a network connection is detected the information on the container is synchronized with the base station and simultaneously updated. As the contents of the container change this information is also updated on the remote station as well. Additional implementations of this system most likely will include expansion of control functions (the opening and closing of door seals for example), as well as the addition of process monitoring of environmental, security, and other vital variables within the container.

The high-speed system confronts a different set of operational requirements. First it has to operate at highway speeds reliably and also be able to incorporate within existing network infrastructures easily. This system is primarily directed more for updating the location of particular assets while in transit. Due to inherent limitations of the system and environment certain capabilities present in the low-speed system are not available at high speeds. The net effect to the user is a system is a limitation functionality of the system but a maximization of system robustness by providing a means to introduce more accountability into the system.

In implementing this system we are confronted with a tradeoff. Because we are operating at highway speeds (greater than 45 MPH) the Bluetooth based approach will not accommodate the rapid decrease in network connection negotiation time between the remote and base station. Because of this we are forced to rely on another means of information exchange. Our design encompasses an RF based solution. In doing so we are limited by two factors. First FCC regulations limit the use of RF based systems to three bandwidths along interstate highways (913 Mhz ISM, 2.4Ghz ISM, and 5.8 Ghz ISM). Additionally present transponder based system have limited internal storage capacity of 256 bits and provide no method of two-way information exchange. Because of this our design essentially weighs operational speed versus data bandwidth. Therefore it becomes necessary to limit the functionality of the high-speed system as compared to that of the low-speed system. Essentially the high-speed system will be used primarily for intermediate tracking purposes between destinations. This system will serve as a waypoint to update container location only. The basic operation of the system is similar to that of the low-speed system with the exception that system operation occurs at an elevated speed and less data is exchanged.

Overall the culmination of both systems provides an environment in which accountability and reliability in the overall process of supply chain management is emphasized. The automation and improvement of the tracking and tracing process presented in this system is a vital component towards ensuring success and profitability of entities within the shipping and tracking industry.