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Web Information System for GPS Vehicle Tracking, Telematics, Communication and Advanced Fleet Management System

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***Abstract*: In this paper, a Web information system for fleet management and transport telematics is described a service-oriented open software platform for location-based and context-aware mobile and Web applications. A fleet management system has a communication and positioning module associated with each fleet vehicle, and a back end monitoring and control system located at a fleet data center in communication with each vehicle. The system monitors each trip automatically and generates time stamps at the start of a trip, a pick up location, a drop off location, and return of the vehicle to a garage at the end of a trip. Vehicle status information is collected and stored along with time stamps. The information is used to generate billing and payroll accounts, and also in monitoring conditions of fleet vehicles and generating alerts as needed. Turn-by-turn route instructions are provided to each vehicle. A vehicle fleet management information System identifies location and direction of movement of each vehicle in a fleet in real-time, and automatically reports Such information, as well as status of predetermined events in which the vehicle is engaged, directly to the fleet manager. Each fleet vehicle has an assigned time slot to transmit its reporting information over a communications network without interfering with transmissions from other vehicles in their own respective time slots.**

***Keywords*: Management, service and commercial**

1. Introduction

Mobility is a key in a modern world where people, goods and information move in increasing volumes and amounts worldwide. According to a study by the European Commission, freight transport within the European Union will increase by about 25% until 2010 and by almost 90% until 2030 compared to the values of 2000, and such growth will be realized almost entirely by road transport [1]. Transport and logistics companies are forced to increase the quality, punctuality, reliability, flexibility, and efficiency of transportation services, and, at the same time, have to reduce costs, empty mileage and low vehicle utilization.

Such increasing demands for mobility of people and goods raises the importance of information and communication technologies and systems to support safer and more efficient transport and fleet management. Transport Telematics applications - also known as Intelligent Transport Systems and Services (ITS) or Transport Information and Control Systems (TICS), play particularly vital roles in ensuring mobility for people and goods, and were recognized by research and development community since the mid of 90's [2]. Since then, transport telematics has been included in all EU and worldwide research and development activities, such as ERTICO-ITS Europe (http://www.ertico.com) and FP7 Challenge 6 - ICT for Intelligent Vehicles and Mobility Services [3]. Transport telematics systems are developed with aim to increase efficiency and productivity of transport, improve safety, and reduce accidents, energy use and environmental pollution. The paper focuses on the design of a service-oriented platform and development of Web fleet management information system based on it. This Web information system should provide all necessary fleet management functions, like vehicle tracking, diagnostics, mileage calculation, movement analysis, etc. fully exploiting limited capabilities of the Web and mobile client platforms.

Object of transport		Freight	People	
Vehicles		Trucks (transportation companies)	Buses	Taxis
Information provided	Vehicle position	◎ (Fleet managers) ○ (Consignors and recipients)	(Fleet managers) (Users)	◎ (Fleet managers)
	Performance records (pick-ups, drop-offs)	◎ (Fleet managers)	–	–
	Urgent instructions	○ (Drivers)	–	○ (Drivers)
	Destination and route	○ (Drivers)	–	◎ (Drivers)
	Urgent reports	(Fleet managers) ○ (Consignors and recipients)	○ (Fleet managers)	○ (Fleet managers)
	Traffic information	(Drivers) (Fleet managers)	(Fleet managers)	(Drivers) (Fleet managers)
	Arrival time prediction	(Fleet managers) (Consignors and recipients)	(Fleet managers) (Users)	(Drivers) (Users) (Fleet managers)

The overwhelming majority of the road vehicles in Japan are used privately, and mostly at weekends. On the other hand, commercial vehicles such as trucks and taxis are generally operated on a full-time basis during the week. Since the drivers of these commercial vehicles make their livings from driving, it is important for them to improve their work efficiency. By focusing on commercial vehicles—especially transportation vehicles, of which Japan has over a million—Hitachi has developed a truck fleet management ASP (application service

provider) service. We achieved this by drawing on our experience in the fields of infrastructure technology, information control technology and network/communications technology to produce a small-size telematics terminal. In this paper, we summarize the trends of telematics information services aimed at commercial vehicles, and describe the ASP service for truck fleet management. We also discuss the plans for a driver support service and traffic information provider service that Hitachi is planning to expand from the B2B (business to business) field to B2C (business to consumer) field.

2. Transport telematics and fleet management

Every transport and logistics company maintaining fleet of vehicles for transport of people and goods has the need for efficient management of these vehicles using telematics application and fleet management information systems. Such system possesses general n-tier architecture shown on Fig. 1. On the vehicle side, the GPS tracker devices is mounted on a vehicle being tracked, which contains GPS receiver, GPRS modem, a microcontroller and a local memory for storage of position/time/speed/telemetry data. Such device, periodically or on request, sends the data via wireless communication network to the Transport Control Centre's server where data are stored and processed within a database system and application components.

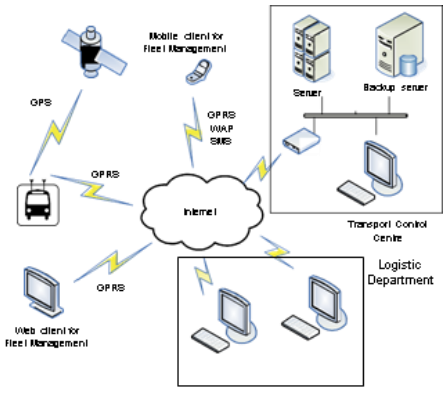

Fig. 1. Telematics application for fleet management

The server performs map matching technique to match the position received from the vehicle to the road network segment, at some distance from the start of that segment. Knowing the vehicle's speed and the time of the position update, the server determines the current position of the object till the next intersection assuming that it moves at an average speed defined for that road segment. It aims to improve the positioning of vehicles between two consecutive updates and reduce necessary communication between vehicles and the server, as well as server side update processing, since vehicle needs to send the position update only when the deviation between its actual position (as obtained from a GPS device) and the position that the server assumes exceeds the uncertainty threshold [4], [5].

A number of commercial real-time fleet management information systems are in use today, such as Fleetilla[1] and Euman LifePilot™ Fleet. Such commercial off-the-shelf fleet telematics systems can be used for vehicle tracking, information exchange between drivers and dispatchers, route guidance, visualisation of vehicle positions on digital maps, and giving important information about the actual state of the transportation system. But such solutions are mostly closed, developed on proprietary (vendor) technologies and cannot be easily integrated with management information systems and services operated in a transport and logistics company, or its business partners. Also, very limited attention has been paid to fleet management systems and transport telematics applications based on mobile and Web applications and platforms. Primary reason for this are limited features of such a thin client application, limited wireless network bandwidth and, most importantly, their limited data processing and graphics rendering performance. For the purpose of efficient data transfer between the server and the mobile/Web client more efficient data model and transfer format must be introduced. It provides considerable benefits, such as accessing fleet management functionality anytime, anywhere without the need to install and manage any software, as well as seamless integration with other IT solutions such as Payroll, Accounting, ERP, CRM, or Dispatching

3. Functions

A. *Movement management functions*

Each vehicle is provided with a telematics terminal, which uses GPS to measure its current position and reports it to an ASP center at regular intervals (usually every 15 minutes) via a mobile packet transmission network. A PC (personal computer) at the transportation company's office can be connected to the ASP center via the Internet, and can be used to display the current position and route of each vehicle superimposed on a map of Japan. Hitachi's ASP service can be linked to a freight tracking system, allowing the fleet managers to respond precisely to enquiries from consignors about their deliveries. As a result, the company can significantly improve its CS (customer satisfaction).

B. *Fleet management functions*

In Hitachi's truck fleet management service system, the telematics terminals collect three types of data (speed, time, and distance), and transmit it to Hitachi's ASP center via a mobile packet transmission network. The driving data collected in this way can be freely inspected and amended via the Internet, and can be used to print out documents such as daily driving reports and monthly statistical reports (see Fig. 2), or downloaded into accounting/payroll systems. It is also possible to identify bad driving habits such excessive acceleration or braking, speeding or prolonged idling, and this information can be used to make the drivers safer and more fuel-efficient by providing them with suitable feedback.

Fig. 2. Examples of Daily Driving Reports

The system can output daily driving reports in the form of a performance record charts (top) and graphical driving records (bottom).

C. Messaging functions

In Hitachi's ASP service, an LCD (liquid crystal display) is used to provide messaging functions. To contact one or more drivers, the fleet manager produces messages addressed to specific vehicles or to all the vehicles with a list of possible responses in the form of a set of selectable options. This allows the drivers to respond simply by selecting possible options (see Fig. 3), which is safer than would be the case if they had to respond to calls on a cell phone while driving. Also, since the text remains on the screen, there is no need to write memos. This approach not only allows people to work more effectively, but can also reduce the communication costs associated with the use of mobile networks.

D. A service platform and web information system for fleet management

Our work aims to surpass these shortcomings, by developing Web information system for transport telematics and fleet management based on open, ISO and OGC standards-compliant, service platform for mobile/Web location-based and context-aware information service development, called MOWIS [6]. Architecture of MOWIS platform includes following main components, shown in Fig. 2.

- *Geo Mobility server:* represents implementation of OGC OpenLS services for geocoding, reverse geocoding, routing, directory of points of interest (POI), presentation of information on mobile devices and gateway to location servers.
- *Moving object server:* provides data structures, database schema implementation and algorithms for representation, storage, querying and retrieval of moving objects data representing user/vehicle movement [4].
- *Traffic information server* integrates and provides dynamic multimedia data (roads condition, weather forecast, traffic accidents, road segments under construction, traffic congestions and similar) from different sources with digital geo-referenced data representing road network.
- *Context manager:* provides acquisition, storage, transformation and interpretation of context data acquired from various sensors which finally results in complete description of user's situation.
- *Services manager:* represents unified access point for MOWIS services and provides services adaptation and personalization in accordance with user's situation and context. By using context information obtained from *Context manager*, it provides service adaptation and delivery either on user's request or on notification.

4. Conclusion

In this paper, we described a Web information system for fleet management and transport telematics developed based on MOWIS platform. Thanks to the benefits of MOWIS platform, such as open architecture, standard-compliant, Web accessible services, this pilot Web information system is completed efficiently with minimal workload. A primary goal for the future is to provide scalability of Web and mobile fleet management system to enable service providers and fleet control centres to manage large fleet of vehicles in a real time, minimizing the server load and necessary wired/wireless network bandwidth, but at the same time retaining full functionality.

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