

LOGISTICS SUPPORT ITS SYSTEM USING EXISTING INFRASTRUCTURE

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SUMMARY

Universal Traffic Management Society of Japan (UTMS) has constructed experimental systems (mobile operation control systems) to support high-efficiency logistics using optical beacons that the National Police Agency has been introducing into the infrastructure of the ITS system.

This paper outlines the experimental systems, and also describes the results of demonstration tests in the fields of Tokyo, expected effects and future tasks.

BACKGROUND AND OBJECTIVES

Great economic advantages can be expected by efficiently controlling the flows of vehicles (trucks) and goods (cargos) using ITS. Another merit expected would be the prevention of a traffic jam caused by a vehicle parking for unloading etc. In these circumstances, it is required to develop and practically apply a logistics support ITS system, and the National Police Agency plans to establish the ITS system using the existing infrastructure (optical beacons). UTMS launched activities for these tasks in June 1998. The major objectives of the activities include field experiments to be performed in cooperation mainly with logistics enterprises to verify that the system is practically applicable.

SCHEME AND FEATURES OF THE SYSTEM

The configuration of the experimental system is shown in Fig. 1.

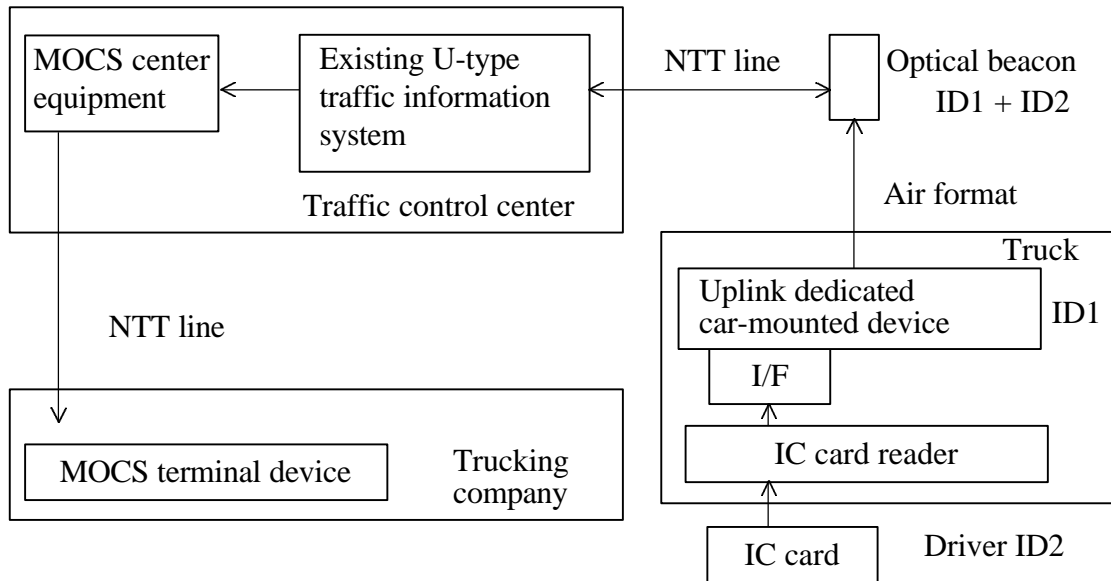


Fig. 1 Configuration of the system

Truck ID and driver ID are transmitted from the car-mounted device installed in the truck to the control center via the optical beacon. The traffic information system at the control center selects these items of information and transmits them to the MOCS center equipment. The equipment develops these items to support high-efficiency logistics. The features of the system include relatively low construction costs using the existing infrastructure, i.e., optical beacons, as communications media.

DESCRIPTION OF THE SYSTEM

The major components of the experimental system are described in the following.

Optical beacon/communications between trucks

An optical beacon uses a communications medium of near infrared rays and performs two-way communications with a car-mounted device. Communications rates for uplink and downlink are 64 and 1,024 kbit/s, respectively, with a maximum communication information traffic of 69 bytes and 10 kbytes for uplink and downlink. The experimental system has a truck uplink information unit consisting of 10 and 6 bytes in header and data areas, respectively. To identify a header area, a UTMS specification code and a sub-system key are used, and a truck ID is defined as the fixed ID, of each truck. In a data area, the sub-system key information ID number of MOCS = 41 is used, and subsequently, prefectural code, company number, driver ID and office code are specified.

Communications between optical beacon and the center

Uplink information from a car-mounted device is detected by the optical beacon, and is sequentially transmitted to the center equipment using an NTT 3.4k dedicated line (2-wire, full duplex communications). The details of MOCS car information, required at present, are shown in Table 1.

Table 1 MOCS vehicle information

Item	Bytes	Description	Item	Bytes	Description
MOCS information communications number	2	Vehicle ID information communications number	Information type	1	
MOCS vehicle information			Length of effective data	1	6 bytes of effective data
Optical beacon number	2	Beacon/car lane with uplink information detected	Data area		
Car lane	1		Key information ID number	1	ID number of MOCS
Vehicle ID	5	Semi-fixed to each vehicle	Special car type information	1	Present setting 00
Vehicle type	1	Types of vehicle and car-mounted device are shown by 4 bits each.	Prefectural code	2	6 bits
Type of car-mounted device			Company number		10 bits
ID information	1		Driver ID	1	IC card number acquired
Information receiving time	4	Day, hour, minute, and second	Office code	1	Present setting 00

Restructuring the existing traffic information systems

The existing traffic information systems in the National Police Agency traffic control system are modified by adding the following functions, so that communications information sent from a car-mounted device is received via an optical beacon and transmitted to the MOCS center equipment.

- 1) From the items of uplink information transmitted from car-mounted devices, those with a MOCS key ID added in the data areas are extracted, and MOCS information is created.
- 2) The extracted MOCS information is transmitted to the MOCS center equipment at 2.5 minute intervals by RCP.

MOCS center equipment

The MOCS center equipment interfaces with existing information systems and MCOS terminal devices. The MOCS center equipment communicates with existing information systems using TCP/IP, and collects the necessary information from them. The center equipment also connects MOCS terminals through a PSTN network (high-speed digital circuits), and provides terminals with the necessary information.

The major functions of the MOCS center equipment are shown below.

(1) Constructing database

The system receives uplink information from existing information systems, and registers the information in the database.

(2) Submitting information

The system supplies MOCS terminal devices with uplink information according to the requirements of the devices.

(3) Security

The system ensures security for external connections including MOCS terminal devices.

MOCS terminal devices

MOCS terminal devices are installed at a logistics company. The company can use each function of the high-efficiency logistics support system via the screen of each MOCS terminal device. Therefore, the screen at a MOCS terminal indicates the function in the high-efficiency logistics support system. Details of each screen at a MOCS terminal are described in the following.

(1) Screen for current position information

This screen shows the current traveling conditions of vehicles. “Passing time,” “vehicle name,” and “driver name” are displayed at the location of an optical beacon on the map, where the truck has passed most recently. When a number of vehicles pass an optical beacon at the same time, indication details change periodically. Indication details are updated automatically.



Fig. 2 Screen for current position information

(2) Screen for tracing travel route

This screen displays the travel route traced by an assigned driver (vehicle name). “Pass time” is indicated at each beacon passed. The system can also give a response output by assigning ranges of object date, start time, and end time. When a truck passes a beacon several times, “pass times” are indicated on several lines.



Fig. 3 Screen for tracing travel route

- (3) Screen displaying required time in assigned section
- (4) Screen displaying required time
- (5) Screen displaying operation status of each vehicle
- (6) Screen displaying list showing operation status
- (7) Screen displaying list showing road passing status
- (8) Screen displaying summary of locations passed

Communications with car-mounted devices and card readers

This device is mounted on a commercial vehicle of a trucking company, and transmits vehicle location and uplink information such as driver ID read from an IC card R/W to an optical beacon installed by a road; when a device receives one frame or more of downlink information, it begins to transmit uplink information.

The device consists of a light projecting/detecting unit and a control unit.

- 1) Communications conditions The uplink communications range is 4.7~3.1m in the vehicle traveling direction and 2.7m in the lateral direction, with an uplink arrival optical volume of $2.0 \mu\text{w}/\text{cm}^2$.
- 2) External I/F The communications conditions for an IC card R/W are RS232C for electrical conditions, a communication rate of 9,600 bps, and a half-duplex start-stop synchronization system.

IC card and card reader

A card reader installed in a truck is connected to the car-mounted device, and uploads the information from the IC card of the driver to an optical beacon.

The driver sets the IC card in the card reader when he gets into the vehicle, and removes the card when getting out.

In the present experimental system, the information in an IC card consists only of a driver ID, with the main aim of evaluating the communications status of the IC card when it is mounted on a vehicle. In the future, however, information on logistics etc. will be added to the IC card, with the goal of operating and controlling logistic vehicles comprehensively.

FIELD EXPERIMENT

Demonstration tests in fields were carried out in a period of March 8 to 19, 1999, to verify that the system could function effectively and apply practically. Test fields included the 3 wards of Adachi, Katsushika and Edogawa, Tokyo, where 20 trucks were pursued by means by 185 heads of optical beacons. There were 2,751 uplinks from the trucks during the period of experiment, and the system was confirmed to work normally. The measured intervals for the trucks to pass the optical beacons were 5 minutes or less, for 60% of all trips.

Table 2

Optical beacon passing intervals (minutes)	Ratio (%)
~ 5	60
6 ~ 20	15
21 ~ 60	12
61 ~ 120	9
121 ~	4

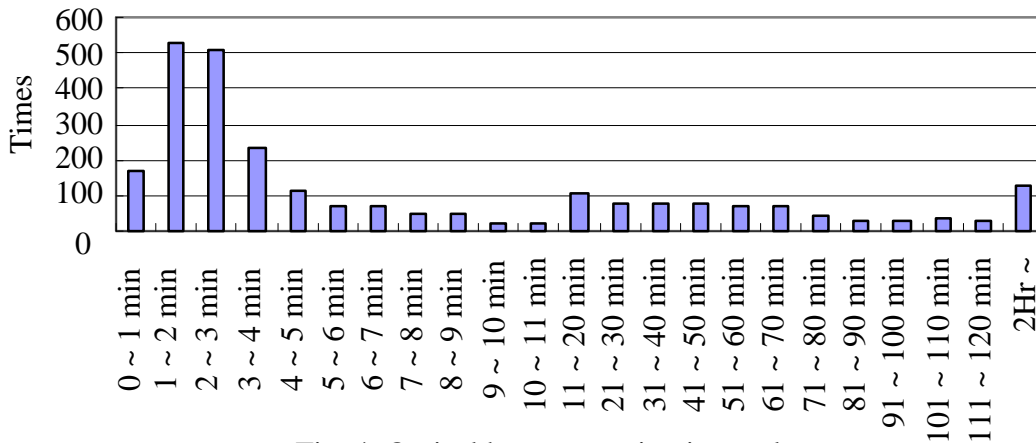


Fig. 4 Optical beacon passing intervals

The accurate time for a truck to have passed an optical beacon was confirmed on the MOCS monitor, at an average delay time of 3 minutes, as vehicle position information. Regarding information on travel routes, most of 4-ton trucks could be traced.

As a result of a questionnaire survey with truck dispatchers, it was confirmed that the information provided, including vehicle position information and travel route information, was practically effective.

EXPECTED RESULTS

The present system can be realized at relatively low cost using the communications media of optical beacons incorporated in the existing infrastructure, and even a small or medium-sized logistics company can introduce the system. The company can grasp in real-time information on the current locations of trucks and can trace travel routes, which supports planning the distribution and operation of vehicles every day. In addition, the company can also use statistical data on required times in distribution routes (for each truck and driver), so the system may support implementation of truck operating plans. Furthermore, these statistical data can also be utilized as basic data for administration and management. As such, various items of information provided by MOCS terminal devices can be used effectively to support high-efficiency logistics.

CONCLUSIONS AND FUTURE TASKS

Tests have just begun on the ITS high-efficiency logistics support system using the existing infrastructure as an initial trial. One of the indispensable conditions for future tasks is to increase the installation density of optical beacons, because this is closely related to improving the functions of the system. In addition, it is also required to extract the logistics activities to which the system can be applied with the current arrangement of optical beacons. In other words, one of the key conditions if the system is to be operated effectively is the number of logistic routes that can be covered by the optical beacons installed. The effectiveness of the system will be raised in the future by increasing the sophistication of the functions of car-mounted devices and IC cards, individually controlling travel times and loading/unloading times of cargos, and controlling information on collecting and distributing loads.