

Recent Development and Deployment of Intelligent Transportation Systems in Chinese Taipei

Chinese Taipei

For The 22nd APEC Transportation Working Group Meeting

In the 15th APEC TPT-WG Meeting, Chinese Taipei submitted a status report on Intelligent Transportation Systems (ITS) entitled "The Development Directions and Deployment Strategies for ITS in Chinese Taipei". Later on Chinese Taipei has further programmed a conceptual framework for the development and deployment of ITS and the corresponding action plans, called "ITS-2000". This year this ITS master plan is under revision based on the latest development situation. Chinese Taipei has an ongoing project to review the ITS standard documents from US, Japan, and Europe. Outcomes of this project will be the information standards for ATMS, APTS, and ATIS in Chinese Taipei. Currently, data dictionary and message sets for center-to-center and data objects for center-to-field of NTCIP in US are investigated. VICS of Japan and TPEG of Europe are also reviewed. Chinese Taipei would like to participate the process of ITS standard development to meet the requirements in our economy. Besides the revision of ITS master plan and formulating the ITS standards in Chinese Taipei, several ongoing projects in the area of ATIS, APTS, and ATMS are presented as follows.

1. ATIS

Chinese Taipei has ongoing pilot projects to collect the real-time traffic information, to process the various traffic sources using the data fusion technology, and to develop a common platform for traffic information integration. In collecting the real-time traffic information, besides the traffic information directly retrieved from vehicle detectors and CCTV, the traffic accident information has been accessed from the police department and transmitted to the control center in real time. This traffic information is further integrated using WebGIS platform and is delivered to the public. Detail information can be retrieved in the report of "Challenge 2008: the e-Traffic Service" and "Using WebGIS for Real-time Urban Traveler Information."

Another research about ATIS can be referred in the report of "The series study of intelligent traffic information on collection, application, transmission and traveler's behavior - establishment of detection method and formats of traffic information in signalized area."

2. APTS

The real time bus information system has been developed in Chinese Taipei three years ago, and this system has been further enhanced not only in its functionality, but in the formulation of interface standard which covers the transmission standard among on-board unit of bus, intelligent bus stop, and the control center. Chinese Taipei is currently working on integrating the bus operating status with the management information system to further enhance the functionality of our APTS. Detailed information can be retrieved in the report of “Implementation Application of Bus Location Information System Using Integrated Services on Lease.”

3. ATMS - Traffic control

Chinese Taipei has released its latest version of urban traffic control protocol for public review, which is the communication standard between the traffic control center and the field devices. Field devices include traffic signal controllers, vehicle detectors, and changeable message signs. From our experience, the dedicated leased line communication from the field devices to the traffic control center can not serve as a timely or cost-effective solution. Therefore, wireless communication solutions, such as GPRS and wireless local area network are considered recently. Compared to the leased line communication, wireless communication has special considerations in the bandwidth, the assurance of transmission under heavy communication situation, etc. After the reviewing process, this new urban traffic control protocol will be the fundamental of urban traffic control system (UTCS). Chinese Taipei has also developed the standardized urban traffic control software (SUTCS) using the well-defined communication protocol. Each field device is required to comply this standard protocol and the functionality performed by SUTCS. Furthermore, the standard urban traffic control architecture will be deployed in two major cities in Chinese Taipei, which are Taichung and Tainan. More Detailed information can be found in “e-Traffic -Intelligent Traffic Control Systems.”

Other projects regarding the emergency vehicle management, commercial vehicle operation and fleet management are ongoing. Also, these project achievements will be exhibited in the Asia Pacific ITS Forum held on October 6-9, 2003, in Chinese Taipei. The web site for conference information is <http://ww.come2meet.com/ITSAP2003/ENG/index.htm>.

Challenge 2008: the e-Traffic Service

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ABSTRACT

The development of Advanced Traveler Information Systems (ATIS) has increased the importance of the transportation issue. ATIS provides the intelligent link between travelers, vehicles, and infrastructure. For example, ATIS collects and transmits information on traffic conditions and transit schedules for travelers before and during their trips. Alerted to hazards and delays, travelers can change their plans to minimize inconvenience and additional strain on the system. However, similar development is required in Chinese Taipei. Chinese Taipei has formulated the "Challenge 2008" comprehensive six-year development plan as the latest effort to foster the creativity and talent Taiwan needs to transform itself into the most advanced e-nation in Asia. The e-Traffic Service is a major project of ATIS.

The e-Traffic Service is user-oriented. Its goal is to provide its users with a more comfortable, safe and convenient transportation environment. This project plans to establish a Freeway and Provincial Highway Traffic Information System, Urban Arterial Real-time Traffic Information System, Traffic Information Road User Reporting System and Land-Sea-Air Passenger Transportation Information System. Meanwhile, this project will develop four demonstration centers, including an Inter-city Traffic Information Center, Urban Traffic Information Center, Sea-Land-Air Traffic Information Center and Traffic Information Integration Center. Therefore, public users could use a telephone, notebook computer, fax, internet, mobile phone, WAP and PDA to inquire about real-time traffic information via these systems.

This study will summarize the implementation strategies and contents of the e-Traffic Service, which includes 1) Establishment of Traffic Information Collection Facilities, 2) Establishment of an Intelligent Traffic Information Reporting System, 3) Establishment of a Metropolitan Area Arterial Real-Time Traffic Information System, 4) Establishment of Passenger Transportation Terminal Real-time Traffic Information and Wireless Communications Environment, 5) The Development and Operation of an Integrated Traffic Information Platform, 6) Establishment of a Real-time Traffic Information Broadcasting and Receiving Demonstration System.

Keywords: ATIS, Real-Time, Traffic Information

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1. INTRODUCTION

Among the ITS, the development of Advanced Traveler Information Systems (ATIS) has increased the importance of the transportation issue. ATIS provides the intelligent link between travelers, vehicles, and infrastructures. For example, ATIS collects and transmits information on traffic conditions and transit schedules for travelers before and during their trips. When alerted to hazards and delays, travelers can change their plans to minimize inconvenience and additional strain on the system. However, similar development is required in Chinese Taipei. Chinese Taipei has formulated the "Challenge 2008" comprehensive six-year development plan as the latest effort to foster the creativity and talent Taiwan needs to transform itself into the most advanced e-nation in Asia by 2008. The e-Traffic Service (ETS) is a major project of ATIS.

The ETS project is user-oriented with its goal to provide users with a more comfortable, safe and convenient transportation environment. Reviewing the relative projects implemented by the MOTC, the starting of the Real-time Traffic Information System (RTIS) was the earliest and now has been applied practically to provide information to the public. The Institute of Transportation (IOT) initiated the RTIS July 1996. The RTIS contains real-time road traffic information and airport flight information. The real-time road traffic information incorporates freeway traffic detection data, real-time broadcasting traffic data and real-time freeway bus monitoring data. The flight information includes the flight arrivals and departures of Taipei, Kaohsiung and CKS international airports. For more comprehensive applications, the MOTC has endeavored to develop uniform data formats and open structures to facilitate the private corporations performing value-adding services.

2. MOTIVATIONs

The real-time road traffic information provided by the RTIS only focused on freeway. It remains still deficient in providing real-time traffic information on provincial highways and in urban areas. Moreover, because the government lacks comprehensive planning and financial support to create the fundamental infrastructure of ITS , the development of related industries in the private sector is apparently impeded.

The MOTC has supported the local government is building up some advanced standard traffic management systems for demonstration. For example, the Bus Location Information System (BLIS) containing 250 buses in Kaohsiung and Taichung was established in 2001. Using the speed data transmitting from the bus on the road, the control center could figure out the real-time traffic situation on the arterial. Furthermore, when including the traffic data collected by the detectors, we can build an adequate database for constructing an urban traffic information demonstration center. Although the flight arrival and departure information in some airports is released, the providing of air passenger transportation information could still get better. This is also the case with marine passenger transportation information.

The purpose of the ETS is to expand the application scope of the ITS. It preferentially focuses on the offering of daily traffic information to improve the convenience of the transportation environment. Therefore, the ETS is planning to build up the intercity and urban real-time traffic information system and the marine and air passenger transportation information system. With the establishment of these

demonstration systems, the public will easily be able to attain real-time traffic information for land, marine and air transportation. And it is hoped that future ITS projects will be implemented successfully along with the completing of the ETS project.

3. OBJECTIVE, GOALS AND STRATEGIES

3.1 Objective

The objective of ETS is to set up the standards of traffic information generating, processing and releasing. These standards will be the rules of data expansion and will provide for the future development of ATIS. These standards are regarded as the general information service environment for the public and the eternal development structure for private corporations.

3.2 Goals and strategies

- (1) Build up the Inter-city Traffic Information Center (ITIC) to integrate the national freeway and provincial highway traffic data.
- (2) Build up the Urban Traffic Information Center (UTIC) to integrate the various traffic data in the urban areas.
- (3) Build up the Sea-Land-Air Traffic Information Center (SLATIC) to integrate the terminal information of passenger transportation for the public users.
- (4) Build up the union contact point and identical data format. Also, facilitate the public and the corporations sharing of that traffic information for the provision of more ITS services.

The structure of the ETS project is depicted in figure 1. It comprises the settlement of four centers: ITIC, UTIC, SLATIC and Traffic Information Integration Center (TIIC). The ETS project will endeavour incorporate the other e-traffic projects like the urban traffic control system project, the BLIS project, the real-time intercity passenger transportation information system and the e-taxicab project instead of rebuilding new infrastructures.

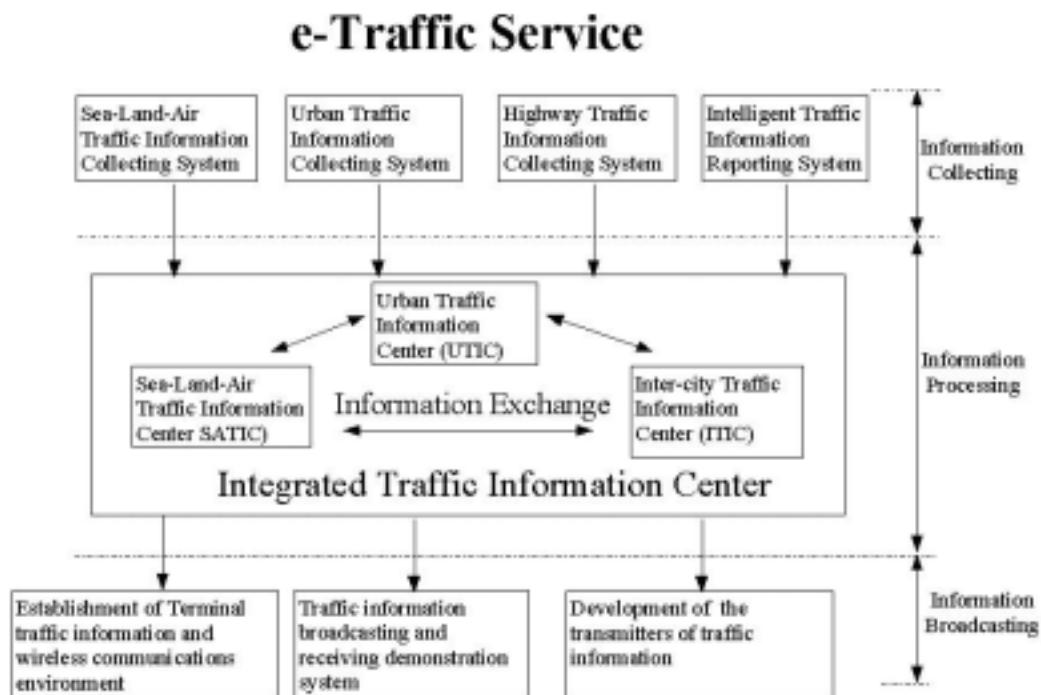


Figure 1. The Structure of the e-Traffic Service

The strategies of the ETS project are described as follows:

- (1) Establish the traffic information collection facilities, which includes
 - A) locating detectors on the national freeways and provincial highways,
 - B) locating detectors on the urban arterials,
 - C) developing a wireless information collecting and dispatching environment.
- (2) Establish an intelligent traffic information reporting system, which includes
 - A) improving the real-time traffic data delivery system in the broadcasting station,
 - B) combining the traffic information data and geographic information data,
 - C) developing an intelligent traffic information delivery system.
- (3) Establish a metropolitan area arterial real-time traffic information system, which includes
 - A) employing the real-time bus location information data,

- B) employing the urban traffic control system,
 - C) applying and integrating the parking information data.
- (4) Establish a passenger transportation terminal real-time traffic information and wireless communications environment, which includes
- A) displaying the arrival and departure information of flights in the airports,
 - B) displaying the schedule information of shipping lines in the harbors,
 - C) displaying the traffic information in the other transportation terminals,
 - D) developing the wireless communication environment in the transportation terminals.
- (5) Develop and Operate an integrated traffic information platform, which includes
- A) planning the integrated information platform containing the intercity, urban, sea-land-air transportation information data,
 - B) drawing up the mechanisms of database expansion and maintenance,
 - C) developing the transmitters of traffic information generated by the integrated platform,
 - D) providing the real-time traffic information by a simple telephone number,
 - E) developing a bi-lingual traffic information service system.
- (6) Establish a real-time traffic information broadcasting and receiving demonstration system, which includes
- A) analyzing and planning the development of wireless broadcast technology,
 - B) analyzing and planning the development of an onboard unit,
 - C) implementing the demonstration projects.

4. STRATEGIES AND TIME SCHEDULES

The ETS project includes data collection, system integration and information distribution. There are six main strategies enclosed in the ETS project and the implementation timetable spans from 2003 to 2007. The main strategies and schedules are as follows.

- (1) Establish the traffic information collection facilities. The timetable is
- A) To complete the projects planning and recognition, in 2003,
 - B) To complete the evaluation of traffic information resources and building strategies, in 2004,
 - C) To establish the traffic information collecting facilities, from 2005 to 2007.
- (2) Establish the intelligent traffic information reporting system. The timetable is
- A) To improve the real-time traffic data delivery system in the broadcasting station, in 2003,
 - B) To develop the intelligent traffic information delivery system, in 2004.
- (3) Establish the metropolitan area arterial real-time traffic information system. The

timetable is

- A) To plan the metropolitan area arterial real-time traffic information system and select the target city, in 2003,
 - B) To establish the metropolitan area arterial real-time traffic information system, from 2004 to 2007.
- (4) Establish the passenger transportation terminal real-time traffic information and wireless communications environment. The timetable is
- A) To plan and build the real-time traffic information service system in the transportation terminals, in 2003,
 - B) To plan and build the wireless communication environment in the transportation terminals, from 2004 to 2007.
- (5) Develop and operate the integrated traffic information platform. The timetable is
- A) To plan and build the integrated information platform, in 2003,
 - B) To build and expand the real-time traffic information provider, in 2004,
 - C) To maintain and support the integrated traffic information center and develop the bi-lingual traffic information service system, from 2005 to 2007.
- (6) Establish the real-time traffic information broadcasting and receiving demonstration system. The timetable is
- A) To complete projects planning and recognition, in 2003,
 - B) To plan the real-time traffic information broadcasting and receiving demonstration system, in 2004,
 - C) To build the real-time traffic information broadcasting and receiving demonstration system, from 2005 to 2006,
 - D) To maintain and operate the real-time traffic information broadcasting and receiving demonstration system, In 2007.

5. BUDGET

Table 1. The Budget of the e-Traffic Service

Strategies	Budget (Unit : NT\$ in Thousand)					
	2003	2004	2005	2006	2007	Total
(1) Establish the traffic information collection facilities		5,000	14,000	14,000	14,000	47,000
(2) Establish the intelligent traffic information reporting system.	6,000	6,000				12,000
(3) Establish the metropolitan area arterial real-time traffic information system		4,000	4,000	4,000	4,000	16,000
(4) Establish the passenger transportation terminal real-time traffic information and wireless communications environment	5,000	4,000	4,000	4,000	4,000	21,000
(5) Develop and Operate the integrated traffic information platform	5,000	5,000	3,000	3,000	3,000	19,000
(6) Establish the real-time traffic information broadcasting and receiving demonstration system		3,000	5,000	5,000	2,000	15,000
Total	16,000	27,000	30,000	30,000	27,000	130,000

6. EXPECTED EFFECTIVENESS

The expected effectiveness and influences are as follows.

- (1) Build an integrated traffic information center to provide various kinds of real-time information services to the public .
- (2) Set up a stable and diverse traffic information database as the data basis for developing ITS technologies.
- (3) Demonstrate the achievement and share successful experience of ITS development with the other countries.
- (4) Cultivate the national ITS human resources for the sustainable development of ITS technologies .
- (5) Formulate the union contact point and standard to integrate the whole real-time traffic information for the future development and research basis of ITS technologies.

Using WebGIS for Real-Time Urban Traveler Information

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ABSTRACT

This research adopts the technology of WebGIS to investigate the feasibility of integrating traffic data from various sources, and then to provide the integrated traffic information to the public. Data Sources include vehicle detectors from the urban traffic control system of Advanced Transportation Management System (ATMS) and real time bus information from Advanced public transportation system (APTS). Real time traffic data from APTS and ATMS were processed, bus location and traffic data such as volume, speed, and occupancy of each vehicle type for each lane, were stored into database. Detector data was further propagated to the database used by WebGIS. Thereafter thematic maps using traffic data, such as occupancy and volume, were created in the WebGIS server and refreshed every 5 minutes. Through this demonstrated Internet traffic information gateway, the public can retrieve not only the real-time traffic condition of each road segment, but the bus location, which will fulfill the needs of the public for better route or transport mode choice.

Keywords: Geographic information system, ATMS, ATIS, APTS

INTRODUCTION

This research adopts the technology of WebGIS to illustrate the urban traffic condition by using traffic data from various sources, and then provide to the public over the Internet. Data Sources include vehicle detectors from the urban traffic control system (UTCS) of Advanced Transportation Management System (ATMS) and real time bus information from Advanced public transportation system (APTS). Data was collected, processed, and incorporated under the environment of Internet GIS in real-time situation. Real-time bus information was gathered from the bus control center of Kao-Hsiung city, where the system has been successfully operated since 2000. Bus location and speed data captured from the GPS receiver are transmitted via wireless communication to the control center. Once the center received the latitude and longitude (in the WGS84 coordinate) of each bus, a dynamic GIS geo-coding

process was performed to read the latitude and longitude, and then “geo-code” bus location into the city map. Data was updated based as the event-driven situation. This paper starts with travel time data collection methods in urban area, followed by introduction of real time bus location information system in Taiwan and the standardized urban traffic control software (SUTCS). Finally description of this proposed system is introduced.

TRAVEL TIME DATA COLLECTION IN URBAN AREA

There are a couple of ways to perform traffic data collection tasks, such as using various kinds of detecting devices, such as inductance loop detectors, video cameras, by microwave to collect or estimate travel times, or by non-traditional approaches. Non-traditional approaches include test vehicle, license plate matching, ITS probe vehicle, extrapolation method, vehicle signature matching, platoon matching, and aerial surveys. This research will only review the use of inductance loop detectors and probe vehicles to measure link travel time for their availability under current situation.

Loop Detectors

Malik and Skarbardonis (2001) have conducted researches in developing the infrastructure and algorithms to “generate a large, accurate database of vehicle trajectories and identifying features through the integration of loop and video data.” And this database is further used to validate the algorithms developed in their previous research on travel time estimation, etc. Hellinga and Gudapati (2000) estimate link travel time from different data sources for use in ATMS and ATIS. Their proposed traffic data fusion mechanism consists of four main elements, which are three input data sources, such as loop detector, probe vehicle, driver report, and one data fusion sub-model. Each data source will generate an estimate of average link travel time, and then input to the data fusion sub-model to estimate a fused average link travel time. And this information can be used for the traffic management purpose and for traveler information.

For the urban arterial, network links are controlled by a traffic signal and result in the various behaviors of queues, which is caused by the detector location relative to the intersection stop line. Gipps (1977), Gault (1981), and Hellinga and Gudapati (2000) developed regression model as an estimator of link travel time based on detector occupancy, or the detector location. Hellinga and Gudapati proposed estimated link travel time by using the following formula.

$$t_d = e^{\alpha_1 + \alpha_2 K^2} K^{\alpha_3 + \alpha_4 x + \alpha_5 x^2} X^{\alpha_6}$$

Where t_d is link delay time (sec) defined as the difference between travel time on link and the free speed travel time on link, K is the detector occupancy (%), x is detector location measured from the stop line (m), and α_i is regression coefficient. And the estimated link travel time is t_d plus the free speed link travel time.

Probe Vehicles

According to the Travel Time Data Collection Handbook (1998), ITS probe vehicle systems for travel time data collection have the following advantages: low cost per unit of data, continuous data collection, automated data collection, electronic format data, and no disruption of traffic. However, it also has the following disadvantages: higher implementation cost, fixed infrastructure constraints, requiring skilled software designers, privacy issues, and not recommended for small scale data collection efforts. Handbook also presents five types of ITS probe vehicle data collection systems, which are signpost-based automatic vehicle location (AVL), automatic vehicle identification (AVI), ground-based radio navigation, cellular geo-location, and global positioning system (GPS).

Probe vehicles, such as buses used in this research, equipped with GPS receivers and two-way communication receive position and speed information and are then transmitted to a control center for travel time information. A significant amount of research has been conducted to evaluate the accuracy of population estimates made on the basis of a sample of observation as obtained from probe vehicle reports. This literature describes efforts to quantify the level of market penetration required to achieve desired level of reliability in population origin-destination traffic demands and link travel times. Some of this research has demonstrated that under certain conditions, probe travel times provide a biased estimate of the population travel times.

REAL TIME BUS LOCATION INFORMATION SYSTEM IN TAIWAN

A real time bus location information system (BLIS) was proposed by using existing communication facilities, such as GSM, Data TAC, etc. Buses are treated as the probing vehicle, and used to collect traffic condition. This system was developed and further operated in Kao-Hsiung city since 2001 and Tai-Chung city since 2002, respectively. Several standard communication protocols within this system were defined, such as interface among system operators and the control center, interface

among various kinds of on-board unit in bus, and standard data format for third-parties system integrators. Architecture of BLIS is shown as figure 1, different communication operators transmit bus location information using standard data format to the control center. The control center integrates bus data from various communication operators and then broadcasts in two ways; one is through wireless communication to the bus stop to provide the expected bus arrival situation, and the other is by Internet for several purposes, such as for the management issues of bus operators, the public, the third-party value-added applications, etc. And this research is one of these third-party value-added applications. The format of bus data is “Command,Cmp,LLI,X,Y,V,D”. The command “01” means the bus is in correct operating schedule, Cmp stands for the communication provider identification, LLI is the wireless modem identification for each bus, X is the longitude, Y is the latitude, V is the speed of bus, and D is the azimuth of bus. Sample of this data string is “01, 33,02, 120.46533,25.026423,183”.



Figure 1. Architecture and presentation of the bus location information system

THE STANDARDIZED URBAN TRAFFIC CONTROL SOFTWARE (SUTCS)

As introduced by Wu (2002), SUTCS is developed by the Minister of Transportation and Communications (MOTC), Chinese Taipei. It adopts the ideas of object-oriented and distributed computing design. Unified modeling language (UML) is used during the design phase, and an object-oriented case tool, Rational Rose, was used to accomplish this task. There are five modules and four interfaces in SUTCS, which are for device control, data collection, database, traffic control, and communication. Four interfaces are for data, communication, control strategy, and user interface. Traffic data is collected through vehicle detectors, then transmitted to SUTCS via leased-line or wireless communication, and finally stored in vehicle detector data table. Figure 2 shows architecture of SUTCS, relationship between vehicle detector and SUTCS. Statistical traffic data retrieved by vector detectors is analyzed and shown as figure 3.

Table 1 is the data schema for vehicle detector, both travel speed and traffic volume are accumulated with three types of vehicle, lane occupancy is also included.

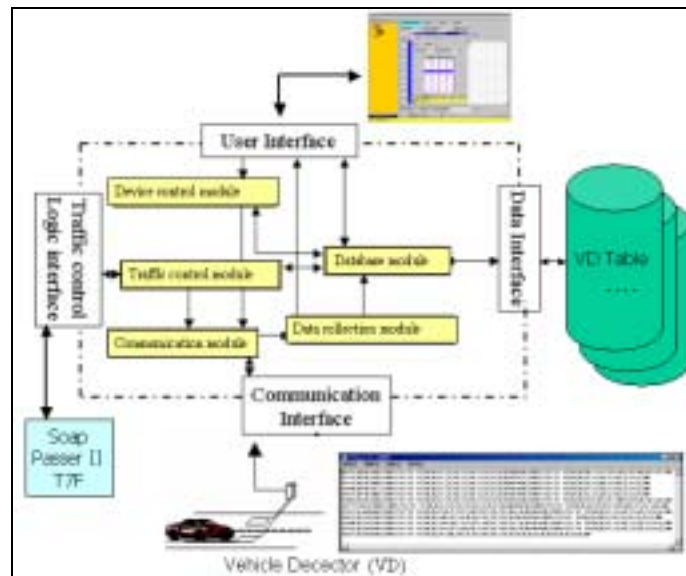


Figure 2. Architecture of SUTCS



Figure 3. Traffic data statistics

Field name	Description	Data type	Key	Value
DeviceID	Vehicle detector ID	Varchar(7)	PK1	
DataTime	Data time	Varchar(16)	PK2	
LaneOrder	Lane ID	Small(1)	PK3	0-6
BigVolume	Traffic volume for large vehicle	Small(5)		0-255
BigSpeed	Travel speed for large vehicle (km/hr)	Small(5)		0-120
CarVolume	Traffic volume for passenger car	Small(5)		0-255
CarSpeed	Travel speed for passenger car (km/hr)	Small(5)		0-120
MotorVolume	Traffic volume for motorcycle	Small(5)		0-255
MotorSpeed	Travel speed for motorcycle (km/hr)	Small(5)		0-120
AvgSpeed	Average speed for vehicle (km/hr)	Small(5)		0-120
LaneOccupancy	Lane occupancy (%)	Small(5)		0-100
DataValid	Data validation	Varchar(2)		

Table 1. Schema of vehicle detector

WEB GIS AND OPEN GIS

Web GIS is the emerging technology to integrate mapping and GIS (Geographic Information Systems) functionality to the Internet. The integration of GIS and the WWW leads to an increase of the usage and accessibility of spatial data. Originally, GIS software was only accessed by certain trained experts and by making GIS applications available through the Internet could make this technology accessible for more people. According to the description of Rinner (1998), the functionality of the Web GIS is to provide the accessibility of geo-reference data to the client through the Internet. A GIS map server, such as Autodesk MapGuide, ESRI ArcIMS, Intergraph WebMap, etc., delivers maps through the WWW in either the vector or raster format.

Mapping functions normally include zooming, pan, distance or area calculation, etc. Some advanced spatial analysis functions, such as networking, buffering, and overlaying are also embedded in certain map servers.

In 1994, the Open GIS Consortium, Inc. (OGC) was founded to promote the idea of interoperable geo-processing. The web map server (WMS) interface specification was directly related to the map publishing over the Internet. Four protocols between the client side and the map servers were “GetCapabilities”, “GetMap”, “GetFeatureInfo”, and “DescribeLayr”. Currently, OGC has several research projects ongoing to validate the architecture of interoperability and specification developed, such as Geospatial One-Stop-Transportation Pilot (GOS-TP), Geographic Objects (GO-1), Testing and Evaluation of Conformance and Interoperability (CITE), Critical Infrastructure Protection (CIPI), Geospatial Information for Sustainable Development Initial Capability Pilot (GISD-ICP), Open Location Services (OLS). Specifications adopted include Web Map Server (WMS), Web Feature Server (WFS), Web Coverage Server (WCS), and Catalog Server (CS).

PROPOSED WEBGIS FOR REAL-TIME TRAVELER INFORMATION

This demonstrated system adopts GeoMedia Web Enterprise (Windows 2000 version), which uses IIS to deliver maps in the ActiveCGM or JPEG formats over the Internet. The latest version of digital map released by Institute of Transportation (IOT) was used as a base map. Layers of map include road, landmark, bridge, tunnel, river, and railway. Microsoft ACCESS database was used to store spatial and attribute data of the study area. There are two major data components, which are traffic data and bus location data. A cross-reference table was defined to relate each vehicle detector to a dedicated road segment. Every-time when the developed program reads vehicle detector data from SUTCS, the attribute data fields, which record traffic data, was updated. For bus location information, data was connected through the ODBC. Every bus location in the WGS 84 format was dynamically “geo-code” to the map. Figure 5 shows the overview of the process of the system. In order to dispatch the real-time vehicle detector and bus location data to the WebGIS system, an event-driven mechanism, instead of the polling mechanism, has been established. Under this mechanism, server will automatically send the latest data to the WebGIS if there is any change. The WebGIS refreshes in every 5 minutes.

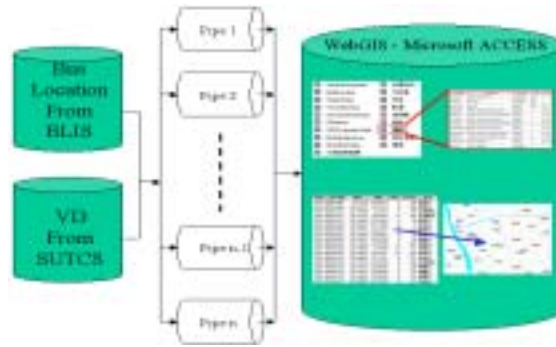


Figure 5. Overview of the proposed processes

Figure 6 shows the final Web output and data flow of this proposed system. In the Web output area, located in the lower-right part of figure 6, the upper-left section is for legend control where users can change the style of each geographic object or layer. The lower-left section is for the definition of measuring units, screen resolution, and traffic data queries. The lower-right section is for the query input and displaying results. And the main area is for map display. Users can query detailed traffic data. Each road segment is color-theme, high-occupancy roads are red, and low-occupancy roads are green, while the rest are in gray. Users can also zoom in/out, pan, and refresh the resulted map. The Web map is automatically refreshed in every 5 minutes.

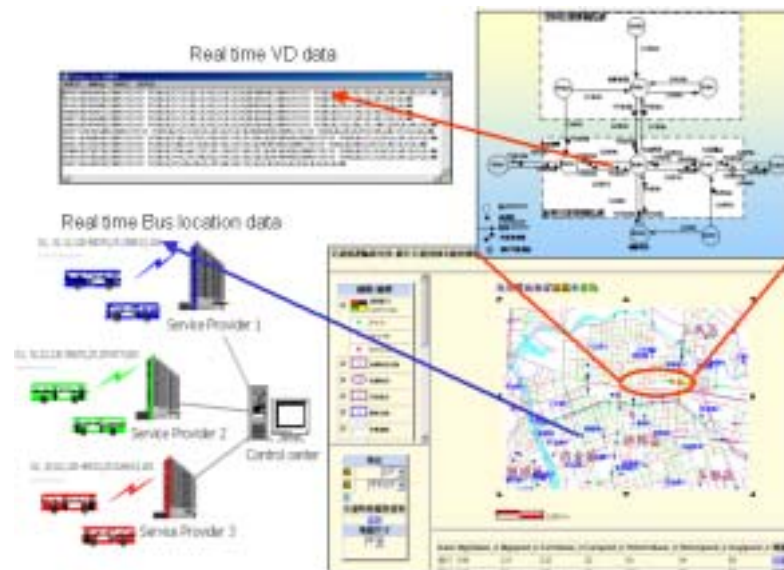


Figure 6. The output and data flow of proposed WebGIS traveler information

Besides the Web output area, figure 6 also shows the vehicle detector data from the SUTCS, which is collected from the field devices, and the bus location is transmitted through different communication service providers. The upper-right part is the study area of SUTCS used in this research. Figure 7 shows in the zoom-in area of the SUTCS and the query result of a particular road in details.

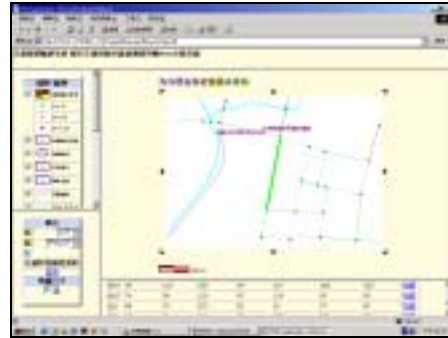


Figure 7. Detailed information of a particular road and its attributes

CONCLUSIONS

This research has demonstrated the WebGIS technology to integrate data from the bus location and vehicle detector, which are from APTS and ATMS, respectively. An event-driven data updating mechanism has been developed to forward the real time traffic to the WebGIS. Bus location was dynamically “geo-code”, and the occupancy of road was used as an indicator of traffic condition for thematic mapping. Finally the merged traveler information is delivered to the public using Web maps through the Internet. However there are further issues that need to be investigated, such as the frequent stop-and-go behavior of buses, the proper model to convert vehicle detector’s data, which is originally designed for traffic signal control, to the usage of ATIS.

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The Series Study of Intelligent Traffic Information on Collection, Application, Transmission and Traveler's Behavior – Establishment of Detection Method and Formats of Traffic Information in Signalized Area

Chinese Taipei

That the increased number of private vehicles and limited spaces in Taiwan made traffic worse becomes the most concerned traffic problem. Therefore, how to offer the real-time, correct and low cost traffic information becomes the important issue. In order to solve this problem, Chinese Taipei has been actively developing Advanced Traveler Information System (ATIS) and has already successfully completed lots of timely and convenient systems for road users, such as real-time national highway traffic information system, Taipei real-time traffic information system, bus location information system. Because of the actively participation of private business sectors, many demonstration projects of ATIS have been set up. Since the initial part is focused on technical development of individual system, it is necessary for government authorities at the time when initiates have been built, to discuss a series of problems on traffic information collection, application, transmission and traveler's behavior etc. A series of researches will be continued for 4 years during which studies will be carried on step by step in order to prospectively popularize the results to all traffic information centers around Taiwan to let all travelers get the real-time, correct and needful traffic information wherever or whenever they are, or whatever system they are using. Through these processes, the domestic traffic system in Taiwan will become more intelligent.

So far, road users could hardly obtain any real-time traffic information except they are in highways, arterial roads in Taipei and some specific roads. Therefore, the public authorities face the awkward situation of insufficient information while popularizing ATIS. In 2003, relevant issues on enlarging current road information will first be explored in the research. Also, the information items, contents, formats as well as corresponding transfer programs will be designed according to traveler's needs.

Current domestic road information sources include road detectors, police information and bus information. In order to enhance current resources, the government authorities would not only continuously set up road detectors and get relevant information from private business sectors but also necessarily study the feasibility of fusing other information into road information. In recent years, the Ministry of Transportation and Communications of Chinese Taipei has vigorously promoted the city traffic control systems with software standardization and popularized this policy to other counties and cities in Taiwan since 2003. As a result, more and more detectors have been installed to important signalized intersection in urban areas. The information collected is used not only for traffic control but also for

users' route choice reference. Due to signal impact, the information collected cannot directly feedback the actual road situation. Therefore, it should be studied how to transfer the detector information in signalized intersection into the crowded degree model and some practical application methods. Moreover, this project will study how to install more extra detectors in order to increase the accuracy of ATIS information and fulfill the development objective of intelligent traveler's information.

Implementation Application of Bus Location Information System Using Integrated Services on Lease

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ABSTRACT

In order to implement the policy of intelligent public transportation, and to assist the local bus businesses in improving their service quality, the Institute of Transportation, Ministry of Transportation and Communications of Chinese Taipei has enabled Kaohsiung and Taichung to establish a Bus Location Information System (BLIS) using integrated services on lease. The fleet operation scale in these two projects is not only the largest Advanced Public Transportation Systems (APTS) project in Taiwan, but it is also the first project successfully implemented using integrated services on lease. Due to the success of these BLIS projects, the Ministry of Transportation and Communications plans to provide follow-up budgets in the six-year development plan, and to subsidize local governments to establish BLIS beginning in 2003.

1. Introduction

In Taiwan, because government finances have gradually worsened recently, attracting private funds to investing in ITS and improving the public service is an important issue. Therefore, the Institute of Transportation (IOT) has introduced a new concept : “the key point is to serve, not to own”, indicating that the duty of the government is to provide the services, but not to own the equipment. Just like some public projects with BOT (Build-Operate-Transfer) or BOO (Build-Operate-Own), they were established and operated by the industry, not the government. Because the projects using BOT or BOO must have a higher self-liquidating rate, we provide a traditional trade method – “Lease”.

In the Integrated Services On Lease (ISOL) approach, the public rents the equipment and the service from the private information service providers (ISP), and the ISP must operate the system and maintain the service. In the bus location information system used by Kaohsiung and Taichung cities, the leasing objects include communication (i.e. wireless and wire), equipment (i.e. OBU in buses and bus stops) and integrated services (i.e. provide information, system operation and maintenance). The functions and leasing objects of the BLIS are shown in Figure 1.

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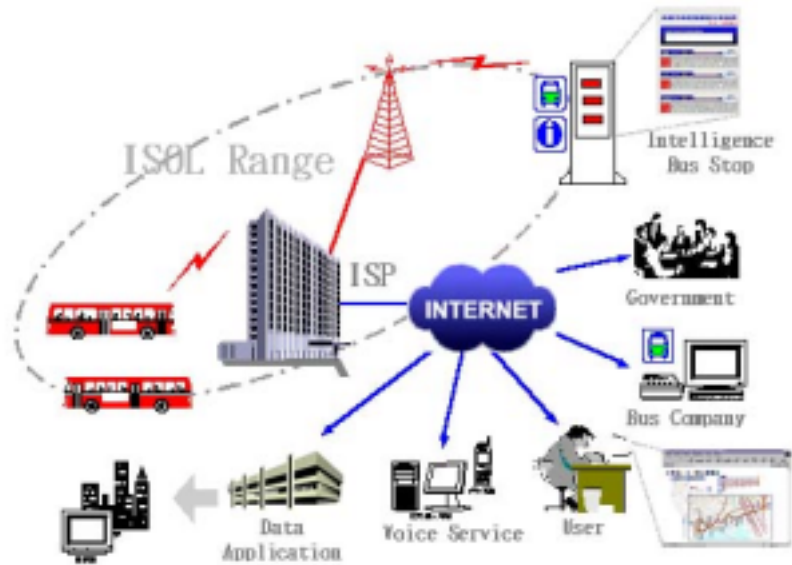


Figure 1. The function and leasing objects of BLIS

2. BLIS in Kaohsiung and Taichung City

The ISOL concept was first introduced by IOT in 1999. This new concept was discussed and revised at many public conferences, and the first ISOL project in Taiwan was executed in 2000. After intensive competition, Kaohsiung and Taichung City were chosen as the demonstration area and provided bus location information service formally in 2001 and 2002. The function of the system is as follows.

(1) Internet Web Service

The BLIS provides the public real-time bus location, bus lines and bus transfer service information in internet which is shown in Figure 2.



Figure 2. Internet Service

(2) Bus Operation Supervision

The bus operator can supervise the state of all lines and buses with GIS(which is shown in Figure 3) at the system control center. In addition, the operator can obtain and search the system's historical data.



Figure 3. Operating Supervision

(3) System Raw Data Supply

BLIS can supply the system's raw data to persons who have permission from the government, so that they can provide bus information to the public with mobile phones, PDA, and so on.

(4) Telephone Voice Service

In Taiwan, mobile phones are very popular recently. To make the system's service

more movable, the BLIS could provide telephone voice function automatically too. This function is not only to provide the public more convenient services, but also extends the service to anywhere at any time.

(5) Bus Stop

By now, Kaohsiung and Taichung City have 110 and 120 bus stops to provide bus information. The new style bus stop in Kaohsiung is shown in Figure 4.



Figure 4. Bus Stop in Kaohsiung City

3.The Planning of ISOL Project

Just like other projects, the comprehensive planning is a necessary requirement for an ISOL project. So at the initial stage, we offered the following three important operation elements: (1) Standard level of service and measure method, (2) Standard communication protocols and (3) ISP's operation and substitution strategy.

(1) Standard level of service and measure method

The service level of the system is a very critical issue for the ISOL procedures, not only related to the rent payments, but also includes important criteria for ISP substitution procedures. We define of these three criteria as follows.

- The error allowable range of bus information is within 30 M or 6 Sec.

When the bus nears the bus stop area, the BLIS system will change the bus location information on intelligence bus stop. The allowable range of error between bus stop area is 30 M or 6 sec, as shown in Figure 5.

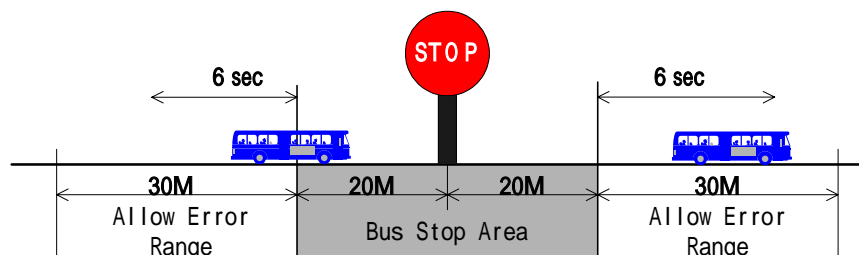


Figure 5. Allowable Range of System Error.

■ Wireless coverage rate : 97%

For each data point at control center, data is received from the probe bus and the bus location is mapped with GIS. In Figure 6, every point indicates that the probe bus location and the wireless communication system are working. The minimum requirement for wireless coverage of the BLIS system in Kaohsiung and Taichung is 97%.



Figure 6. Testing Output of Wireless Coverage In Kaohsiung

(2) Standard Communication Protocols.

For data exchange among the ITS centers and the future substitution of ISP, IOT has defined five standard communication protocols in the BLIS data flow, as shown in Figure 7.

A : System center incoming data.

B : System center to other application center.

C : Data receiver to process unit. (Bus stop)

D : OBU(On Board Unit) to other unit.

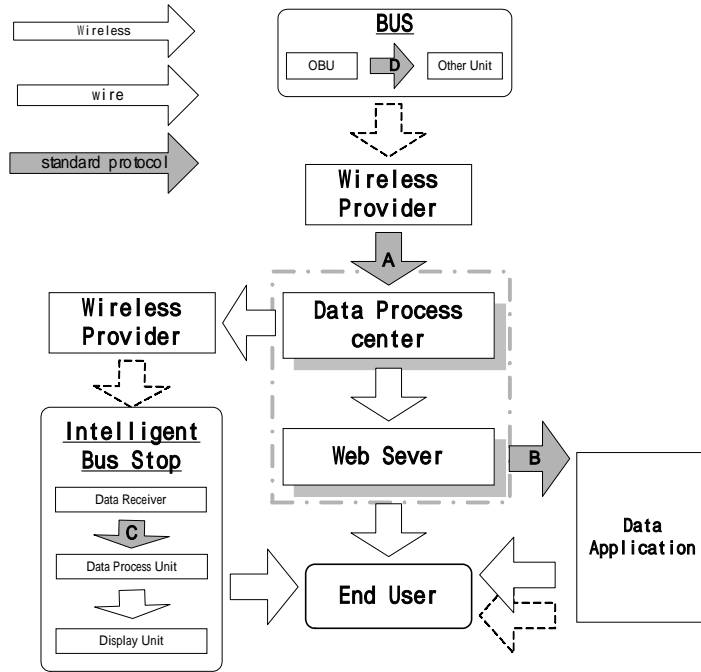


Figure 7. Standard Communication Protocols in BLIS Data Flow.

(3) ISP's Operation and Substitute Strategy

The operation procedure and substitute strategy are very important for the ISOL project. Based on the BLIS experience in Kaohsiung and Taichung, IOT provides two step performance tests and ISP replacement procedure, as shown in Figure 8. To maintain the BLIS service level, the Kaohsiung and Taichung municipal governments evaluate the system performance monthly.

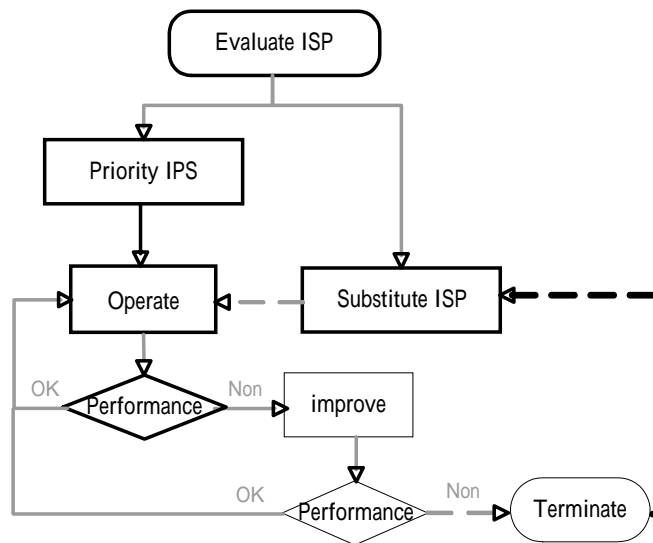


Figure 8. ISOL Operation and ISP Replacement Procedure.

4. Advantages of ISOL

From the experience of Kaohsiung and Taichung with BLIS using ISOL, we found that ISOL can not only reduce the financial demands, but also can expand the scope of the system and the market demand. At the same system scale, ISOL can decrease the initial payments. For example, at the 250 OBU scale in Kaohsiung and Taichung, it only required 600 million NT dollars in the first year, whereas for the same scale, the traditional procurement method may have required about 1000 million. Figure 9 shows the yearly payment difference between ISOL and procurement, indicating that the total payment will be equal after three years. In other words, the project's break-even point is three years. Therefore, if the ISP using the ISOL method provides the service for more than three years, the ISP will be more beneficial than using the procurement method.

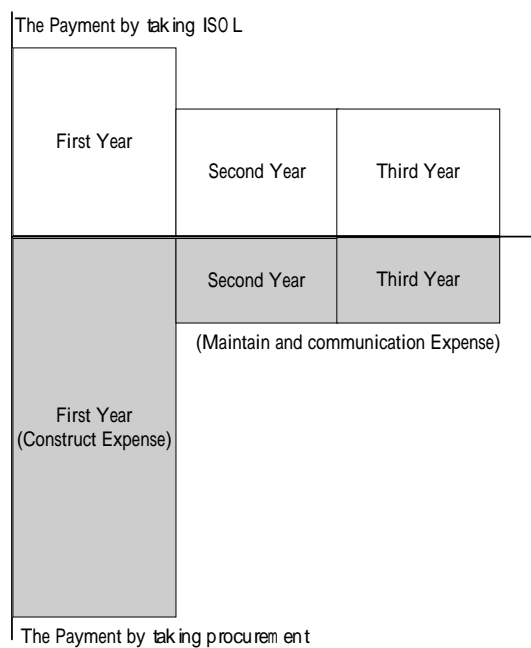


Figure 9. Payment Comparison between ISOL and Procurement.

Furthermore, in the same condition of payment, ISOL not only can expand the scope of the system and supply more services, but also can increase the market demand. As shown in Figure 10, the ISOL can provide more OBUs at the system initial stage.

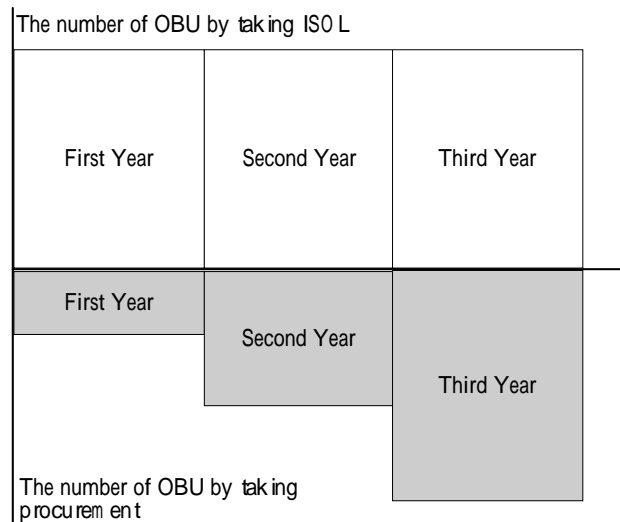


Figure 10. Number of OBU compared between ISOL and Procurement Method

5. Conclusions

This paper introduces the new concept of integrated services on lease, and summarizes the findings from planning and implementation in Kaohsiung and Taichung, which established a Bus Location Information System by using integrated services on lease. Based on the discussions above, we find that:

1. Because finances have worsened in recent years, the use of integrated services on lease could draw private funds into public projects which do not have higher self-liquidating rates.
2. The integrated services on lease project have three important operation elements: (1) Standard level of service and measurement methods, (2) Standard communication protocols and (3) ISP operation and substitution strategy.

e-Traffic – Intelligent Traffic Control Systems

1. Project Description

The Ministry of Transportation and Communications (MOTC) has implemented the “e-Traffic – Intelligent Traffic Control Systems Project” in order to: (1) develop the standardized software and communication protocol for urban traffic control systems, (2) establish an intelligent and advanced transportation management system in urban areas, (3) employ a traffic control center utilizing both wired and wireless transmission networks to monitor road traffic conditions and regulate vehicular flow by propagating traffic information. In addition, it is hoped that the transportation information exchange mechanism built from this project will form the backbone of the future Intelligent Transportation System (ITS) of Taiwan and create a common-use environment for information sharing with the public. The main objectives of the project are as follows:

- Provide a dynamic urban traffic signaling mechanism in real time to manage traffic according to the changing traffic flow capacities and furthermore to provide smooth driving conditions.
- Allow the public to access the urban traffic information in real time.
- Establish a traffic information exchange mechanism among various transportation systems for the purpose of traffic management and information sharing with the public.

2. Implementation Plan

The MOTC has compiled a budget to subsidize county and municipal governments to establish an intelligent and advanced transportation management system for improving signaling control methods, strengthening the functions of roadway traffic surveillance, and integrating mass transit, parking and transportation information systems. In addition, a transportation information announcement system will be established in order to allow the public to obtain related transportation information from changeable message signs, through on-board unit, on the Internet or on their mobile phones.

3. Project Execution Status

This year (2003), the MOTC will complete the field-testing of the standardized traffic control software for urban traffic control systems. After a careful assessment, the cities of Taichung and Tainan were selected by the MOTC to begin the planning and design of intelligent urban traffic control systems, and both urban areas have already appointed separate consulting firms to carry out the master planning, design and establishment of their advanced transportation management systems. Besides the main task of establishing the urban traffic signal control system, the system will integrate all information of public transit, parking, and real-time traffic information to become an advanced traveler information system. The planning and design of the Taichung and Tainan systems are scheduled to be completed by the end of this year (2003), and next year the traffic control center and its related facilities for integrated operations is expected to be firmly established. Afterwards, the public will be able to greatly benefit from the transportation improvements brought about by the new age hi-tech system.

4. Expected Benefits and Impact of the System

- (1) The establishment of the urban area advanced transportation system and traffic information exchange center will help alleviate traffic congestion problems.
- (2) The public can access traffic information in real time to fulfill their needs.
- (3) The functions of the traffic control system for all municipal governments will be improved considerably.
- (4) The system will promote the development of Taiwan's traffic control, information and communication industry.
- (5) The system will formulate standardized traffic control software, and economize the procurement, upgrading and maintenance costs of equipment.
- (6) The system will effectively uplift Taiwan's overall transportation services.