

# INTELLIGENT TRANSPORT SYSTEM (ITS) AT PROJEK LEBUHRAYA UTARA-SELATAN (PLUS): PILOT IMPLEMENTATION

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## ABSTRACT

Projek Lebuhraya Utara-Selatan Berhad (PLUS) is the concessionaire for the longest toll expressway in Malaysia with 70 toll plazas located over 848km of both closed and open toll systems. Since 2002, PLUS has undertaken an initiative to implement an Intelligent Transport System (ITS) along the PLUS expressway addressing the following ITS needs:

- Network infrastructure upgrade;
- Control Centres upgrade;
- CCTV surveillance at mainlines;
- Variable Message Signage (VMS);
- Automatic Vehicle Detection System (AVDS); and
- basic system integration.

This paper provides an overview on the implementation of the PLUS ITS and discusses the strategy adopted and challenges encountered. The design of the system has also cater for seamless assimilation with ITS components installed at the ELITE and LINKEDUA highways following the establishment of PLUS Expressways Berhad as the common operator for all three concessions.

Other ITS-related applications currently in place include an Electronic Toll Collection (ETC) system with a choice of 2-piece tag non-stop ETC (SmartTAG) or smartcard common transportation payment system (Touch 'n Go). This ETC system has been accepted and implemented as the common ETC system providing interoperability for all toll highways in Malaysia. Also available are drive-through ETC refill lanes which allow customers to conveniently top-up their toll smartcard during entry / exit transactions.

Since 2002, PLUS has also implemented a Global Positioning System (GPS) for tracking, surveillance and monitoring of its RONDA Highway Surveillance Service comprising 91 units of patrol vehicles equipped with the GPS Tracking System. Close monitoring of the RONDA service now includes easily retrievable real-time and updated information on the exact vehicle location, vehicle speed, forward/reversing direction, start/stop of engine and even snail trail. The deployment of the GPS Tracking System under the ITS has enhanced the PLUS RONDA Surveillance Service in terms of providing faster response times especially during emergency incidents, as well as improvement of operational efficiencies and effectiveness in workforce management.

## 1.0 INTRODUCTION

Projek Lebuhraya Utara-Selatan (PLUS), a concession managed by PLUS Expressways Berhad, comprises the longest highway in Malaysia with 70 toll plazas and 848 km of both closed and open toll systems. This paper provides an update on the current implementation status of the PLUS Intelligent Transport System (ITS) and discusses the strategy adopted, problems encountered and issues regarding technical and financial matters.

Realizing the benefits of ITS in network operations of such major expressway, a pilot project was initiated in 2001 addressing the following ITS components:

- Network infrastructure upgrade,
- Control Centers upgrade,
- CCTV surveillance,
- Variable Message Signage (VMS),
- Automatic Vehicle Detection System (AVDS) and
- Basic system integration

An ITS Task Force Committee was also formed comprising representatives from various PLUS departments to facilitate the planning and development of the project.

Some of the key components of the ITS pilot implementation relates to: Co-ordination between Regional Control Centers, centralization of ITS applications/subsystems for monitoring and data dissemination, development of comprehensive system architecture as well as a master framework for ITS deployment. The ITS pilot implementation is also inline with the expected traffic growth in years to come as we further expand the PLUS network of expressways and continue to upgrade our facilities in order to generate more traffic as part of the company's business expansion plan. As the ITS deployment mainly focuses on building the capacity and expanding network facilities to accommodate growing traffic needs, the main concern of the implementation is the compatibility of the whole system for integration with other systems.

One of the key strategies in the deployment of the PLUS ITS is the development of a long-term plan to provide an extensive blueprint of phase-by-phase project implementation. ITS deployment for the PLUS expressway is to be carried out in stages beginning with the prototype between Rawang and Subang.

ITS provides the ability to gather, organize, analyze, use and share information about transportation systems. PLUS interest in ITS arises from the growing need for better traffic management, travel information, emergency management and safety environment for the customers. In the comprehensive 5-Year ITS Master Plan (2002-2007), the overall implementation is divided into three phases. The Master Plan forms a guide and reference for initial and future ITS project implementation.

## 2.0 PILOT IMPLEMENTATION

### 2.1 *CCTV Surveillance and Network System Upgrade*

Closed Circuit Television (CCTV) system is the earliest monitoring and surveillance technology adopted by PLUS as an efficient medium in gathering traffic information as part of its ITS infrastructure. This technology has been rapidly changing due to advances in microcomputers and data communication in recent years. The data communication area is undergoing this rapid transition due to the local area networks (LAN) and the emerging availability of wide area networks (WAN) using an intranet/internet backbone.

The first generation of CCTV system concentrated at the toll plaza lanes which had been implemented throughout PLUS expressways was based on analog technology. A typical analog CCTV system comprises of video multiplexer, Video Cassettes Recorder (VCR), display monitor(s), web server and video printer. Over period of years utilizing the analog technology and with the advent of the Digital Video Recording (DVR) in second generation of CCTV system, PLUS had taken further step in upgrading its CCTV system into adopting a more competitive and effective technology. Furthermore, analog CCTV becomes obsolete when IP surveillance technology overtakes. One of the main issues arising in an analog CCTV technology is the handling of video tapes – the process of changing the tapes is labor intensive, the tape archives consume large space and the tapes degraded over time. While the poor recorded images from analogue system are always be the concerned factor, the digital recording CCTV system in contrast has the capability to provide real-time and high quality recorded images. Thus, to cope with this situation, PLUS had decided to deploy DVR enhanced CCTV system at all of its plazas and selected locations throughout PLUS expressways. Digital systems replace the time-lapse VCRs and video cassettes of analog systems with programmable digital hardware which digitizes and compresses the video signal onto a large capacity hard-disk drive. Video compression is required in digital CCTV surveillance systems because the data bandwidth and storage requirements for raw digital video are enormous. The added advantage is that it also provides a ready integration with PLUS Network for monitoring from Regional Control Center (RCC) and Traffic Monitoring Center (TMC) at PLUS HQ. By year 2004, PLUS has replaced all of its analog CCTV system to a more efficient and ultimate surveillance solution.

In addition, PLUS has also embarked on CCTV surveillance at its mainline. More than 50 cameras were installed at the mainline, interchanges and bridges. To cater to the streaming requirements, the network infrastructure has been upgraded to a higher capacity Gigabit Ethernet.

## **2.2 Variable Message Signage (VMS)**

Variable Message Signage (VMS) plays an important role in traffic management at PLUS stretches by providing en-route real-time information to the expressway users. Categorized as dynamic and effective information dissemination devices in an ITS subsystem, VMS provides various types of information including traffic info, incident notification, informative messages as well as weather condition. VMS system is one of the critical systems encapsulated within scope of PLUS ITS and its planning was included in the 5-year ITS work programme.

In ensuring the success of operations of a VMS system, a comprehensive design process and selection were carried out including fundamental criteria of site selection and placement, site design, communication, power as well as hardware requirements. The type of VMS and technology adopted by PLUS are the LED technology with full matrix criteria. Pilot implementation of VMS in PLUS started in 2002 whereby two (2) units of gantry-structured VMS were placed at strategic locations between Tanjung Malim lay-by and Ulu Bernam Rest and Service Area (RSA) and also between Kajang and Bangi interchanges. Also included in the first package of VMS installation were four (4) units of Portable Variable Message Signage (PVMS) placed at Regional Offices for purposes such as immediate response on the occasion of emergency situation e.g. accidents and landslides. In situation like emergency, PVMS is specially designed for easily detachable and refitted capability, easily transportable by PLUS Patrol unit and intervention team vehicles.

In 2003, PLUS had further expanded its VMS implementation plan with six (6) additional VMS placed between Subang and Rawang. All the eight (8) VMS are controlled from the Central Regional Control Centers (RCC).

### **2.3 Control Centers Upgrade**

As PLUS Expressways stretches from the north to south of Peninsular Malaysia, PLUS highway management infrastructure is divided into three regional areas – northern, central and southern. Each region is further divided into a few sections depending on the distribution of toll plazas.

The increase in traffic volume utilizing the expressway has increased the need to a more manageable traffic monitoring and surveillance. The main focus of upgrading the facilities including the control room operation of PLUS Regional Control Center (RCC) and Traffic Monitoring Center (TMC) was to better manage the traffic control system as well as to enhance PLUS's services to the expressway users. With growing traffic, PLUS has upgraded its TMC and RCC Central with video wall displays since 2001 for better traffic management. RCC upgrade for northern and southern region took place in 2002, amongst which the transformation works were the relocation of telecommunication equipments, video wall display and audio system as well as new layout design of both control centers. The Menora-Meru Tunnel Control Room was also part of the upgrading plan whereby video cubes had been allocated especially for tunnel operational monitoring purposes.

#### **2.4 Automatic Vehicle Detection System (AVDS)**

In addition to CCTV and VMS, PLUS had further enhanced its traffic monitoring means to another form of traffic information data collection; which is the AVDS technology that uses digital-based image processing in determining potential incident situation and traffic data collection. Automatic Vehicle Detection System (AVDS) is another subcomponent of ITS in monitoring and surveillance mean as it exploits sensing technology in determining the quality of traffic flow in a highway. The most typical traffic information that could be retrieved through an AVDS data is traffic volume, occupancy, speed, delay, count, vehicle classification etc.

Traffic detection by video was chosen over traditional traffic counting by in pavement-loops to avoid trenching which is both costly and disruptive as well as to mitigate potentially costly maintenance. The AVDS system implemented throughout PLUS is based-on video image processing as traffic detection system. The AVDS system is controlled at the Regional Control Centers (RCC) via the integrated central computer software..

The implementation plan of AVDS System is part of PLUS Central Computer System (CCS) project. As for the initial AVDS deployment, two (2) units of camera per location for better detection accuracy and minimizing false alarms are installed at strategic locations.

## **2.5 INTEGRATION AND CENTRAL COMPUTER SYSTEM (CCS)**

The most important factor of an ITS implementation is coordinating seamless integration between subsystems. PLUS ITS integration under the Central Computer System (CCS) started in 2004 combined with the AVDS implementation between Subang and Rawang and integration of these systems with CCTV and VMS systems. PLUS CCS is currently operating at the Central Regional Control Center which will eventually be relocated to the new PLUS Headquarters in Subang currently under construction.

As the core component of ITS, CCS features an integrated software solution based on the latest open system technologies and an innovative Real Time Data Engine that specifically designed and developed to integrate ITS subsystems. One of the potential features is comprehensive incident management system that allows operators with the appropriate response plans for any scenarios, in line with the main purpose of embarking upon the ITS implementation plan which is to configure PLUS Traffic Response Management System for overall operational requirements and to enhance the operation by applying fully automatic traffic management plan for immediate response of emergency situations.

The initial implementation of CCS will also include the network link-up with Traffic Monitoring Center (TMC) of Malaysian Highway Association (MHA) and the ELITE highway network. PLUS CCS is scheduled to start its operation by August 2006. For future development, PLUS plans to further expand the connectivity and integration of its ITS network link-ups with Penang Bridge and LINKEDUA expressways.



## **2.6 Global Positioning System (GPS) Implementation on PLUS RONDA Vehicle**

Global Positioning System (GPS) plays a major role as part of integrated solution in every implementation of Intelligence Transport System (ITS) worldwide for tracking, surveillance and monitoring means. As part of the concession, PLUS had established a special unit to patrol the expressways called PLUSRONDA since initial operations and subsequently in 2002, PLUS RONDA Highway Surveillance Services had been equipped and installed with GPS Tracking System. Pilot implementation of GPS involved 32 nos of PLUS RONDA vehicles. TM Malaysia as the main service provider of telecommunication services in Malaysia has offered an Automatic Vehicle Location (AVL) service to tracking and monitoring of PLUS RONDA vehicles with minimal infrastructure cost.

AVL is a combination of GPS, communication and geo-spatial system technology as it features computer-based vehicle tracking system that functions by measuring the real-time position of each vehicle and relaying back to a central location. By using the AVL System Solution provided by TM, closed monitoring of the RONDA with real time and updated information including exact vehicle locations, vehicle speed, forward/reversing direction, start/stop of engine and also snail trail could be retrieved easily. With seamless access to the Web's Network Maps Application featuring Digital Map with GIS Features (nationwide), PLUS operations personnel could view the detailed network map and associated information, and at the same time perform network analysis to support operational or management decision making. The deployment of such tracking system has benefited PLUS RONDA Surveillance Services in terms of faster response time especially during emergency incidents, improvement of operational efficiency as well as effectiveness in workforce management. By year 2005, all 91 PLUS RONDA vehicles have been installed with GPS tracking system as the PLUS Ronda services have now been extended to ELITE, LINKEDUA and Penang Bridge.

## **2.7 Electronic Toll Collection (ETC) System**

Electronic Toll Collection (ETC), in general, has been one of the most widely adopted and economically successful application of ITS among the highway operators. The deployment of ETC in PLUS started in 1998 as part of PLUS effort to increase user convenience, facilitate speedier transactions, increase throughput at toll plazas and in reducing manpower costs. A stand alone ETC basic system contains ETC Lane, ETC Plaza on PC based and Basic ETC point-of-sale module which runs on an ETC Plaza PC. The 2-piece ETC system incorporates the infra-red technology.

Toll collection on all PLUS Expressway operates on two systems, namely the closed and open toll system. All toll fares are based on the pre-established rates agreed between the concessionaire and the government and also the distance traveled by the users. Touch 'n Go and SmartTAG are two systems of ETC that have been implemented at almost all of PLUS Toll Plazas. With infrared-technology featured system, users could conveniently pay toll fares within just a few seconds of their time. In determining the deployment of ETC in a toll plaza, among a few criteria that need to be considered are the ETC penetration as well as comprehensive traffic projection. By year 2006, all PLUS toll plazas have been deployed with the Touch 'n Go system while SmartTAG system is available at 43 toll plazas throughout PLUS highways.

For smoother traffic flow, several expansion and channelisation projects for ETC Lanes at selected toll plazas were implemented during year 2004 in order to increase the ETC penetration at toll plazas besides offering convenience to the users.

### 3.0 CONCLUSION

As ITS plays an important role in enhancing the operational reliability and business efficiency, the most practical and suitable approach for developing country such as Malaysia in embracing the ITS technology is by implementing “*Step-by-Step*” architecture. The implementation of PLUS ITS could be categorized as the concept of affordable and structural development of ITS subsystem before the integration of into a complete and comprehensive manageable system. This is to ensure future upgradeability, interoperability and compatibility of system expansion and addition.

This paper has provided a general updated information on the ITS implementation at PLUS Expressways. The overall implementation in details involved series of projects that are being deployed by-stages based on the manifestation of the earlier ITS blueprint prepared by PLUS ITS committee. The development of PLUS ITS will continuously expands and undergoes a comprehensive performance monitoring in order to further upgrade the system implementation in future.

In the near years to come, PLUS plans to further expand its network connectivity from North to South; which will also include the integration with ELITE, LINKEDUA and Penang Bridge network infrastructures. One of the biggest challenges in the ITS implementation agenda is in sustaining the stability and fidelity of the network operation as well as the coordination and interoperability amongst ITS subsystems. In line with PLUS motto as the leading highway operator in Malaysia, PLUS will always be concern about the needs of the expressways users in order to increase the quality of services as well as the comfort ability of its expressways.