KAJIAN PELAN INDUK SISTEM PENGANGKUTAN PINTAR

Development of ITS System Architecture for Malaysia

Technical Note No. 5

Deployment Packages Framework

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1 INTRODUCTION CHANGE MARTEK

Deployment Packages provide an accessible, deployment oriented perspective to the Malaysian ITS Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. Deployment Packages identify the pieces of the Physical Architecture that are required to implement a particular transportation service. This chapter outlines the purpose and structure of the Deployment Packages document and describes some of the guiding principles used in developing the Deployment Packages.

1.1 Document Purpose

This Deployment Packages document provides a series of analyses centered on the Deployment Packages which illustrate how the Deployment Packages can be applied in regional and project architecture development activities. Through these definitions and analyses, the Deployment Packages document provides a comprehensive review of the Deployment Packages and how they can be used to plan and implement integrated transportation systems customized to local needs.

This document is intended to serve the transportation professional who is involved in ITS planning and/or implementation and wants to leverage the opportunities presented by the Malaysian ITS Architecture. This document, along with the other Malaysian Architecture documents, will be of particular interest to those that are developing or supporting the development of regional ITS systems. This group includes transportation planners, engineers, system integrators, and state and local implementers who are progressing towards integrated ITS implementations.

1.2 Guiding Principles

Wide spread implementation of ITS will depend on a multitude of individual deployment decisions by public agencies and the private sectors. The Malaysian ITS Architecture preserves choice for each of these implementers by limiting its scope to include only those interfaces and functional descriptions that address key system interoperability issues. This conservative scope allows each implementer to make maximum use of existing assets and provides a variety of evolutionary paths for maturing ITS capabilities based on individual priorities. This conservative scope carries over into the Deployment Packages, which bundle together the elements of the architecture that apply to representative ITS implementations.

The Architecture has benefited from participation in its development by public agencies at the national, regional, and local levels. The issues that resonate from these organizations include preservation of local autonomy, effective utilization of existing systems as well as those in development and flexibility to expand the system as local authorities deem appropriate.

These issues were echoed by the private sector with the additional recommendation that utilizing existing infrastructure enables rapid early deployment, reduces risk through utilization of known technologies and organizations, and allows more reliable cost estimation. Leveraging the existing and emerging national communications infrastructure (e.g., the Internet) was a unique idea when the architecture was originally conceived. Today, ITS, like the broader economy, is swept up in the adaptation and use of the Internet for its own business needs.

It should be noted that Deployment Packages are not a prescription for every region. They identify the key ingredients from the Architecture that support representative ITS deployments. The recipe for a particular region must be based on identified needs and available resources. As a result, tailoring a regional architecture derived from the Deployment Packages is a mandatory step to ensure that the architecture supports specific regional needs.

2 RELATING DEPLOYMENT PACKAGES TO THE ITS ARCHITECTURE

The Malaysian ITS Architecture provides a framework for designing transportation systems that implement the ITS User Services. The User Services are the key source requirements for the Architecture development effort. The Architecture defines the functions that must be performed, the Subsystems that provide these functions, and the information that must be exchanged to support these User Services. The Deployment Packages are directly traceable to both the Architecture Framework and the User Sub-Services. This section describes each of the 80 Deployment Packages and connects the Deployment Packages to the Architecture Framework and the User Sub-Services.

This section introduces the Malaysian ITS Architecture definition and relates this definition to the range of ITS services and implementation options that will be considered by implementers. This relationship between Architecture and implementation is presented using a defined set of Deployment Packages.

2.1 Relating Deployment Packages to the Physical Architecture

Deployment Packages represent particular groupings of entities defined in the Physical Architecture that correspond to specific transportation services. The Architecture Framework coordinates overall system operation by defining interfaces between equipment which may be deployed by different procuring and operating sectors. The Architecture Framework defines what each major transportation system element does and how they interact to provide all user sub-services. This Framework of Subsystems and interfaces is specified in an implementation independent fashion to preserve maximum implementation flexibility.

Figure 1 provides a high-level view of the Architecture Framework. The figure includes both the Subsystems and the major communications interconnects required to support the user services.

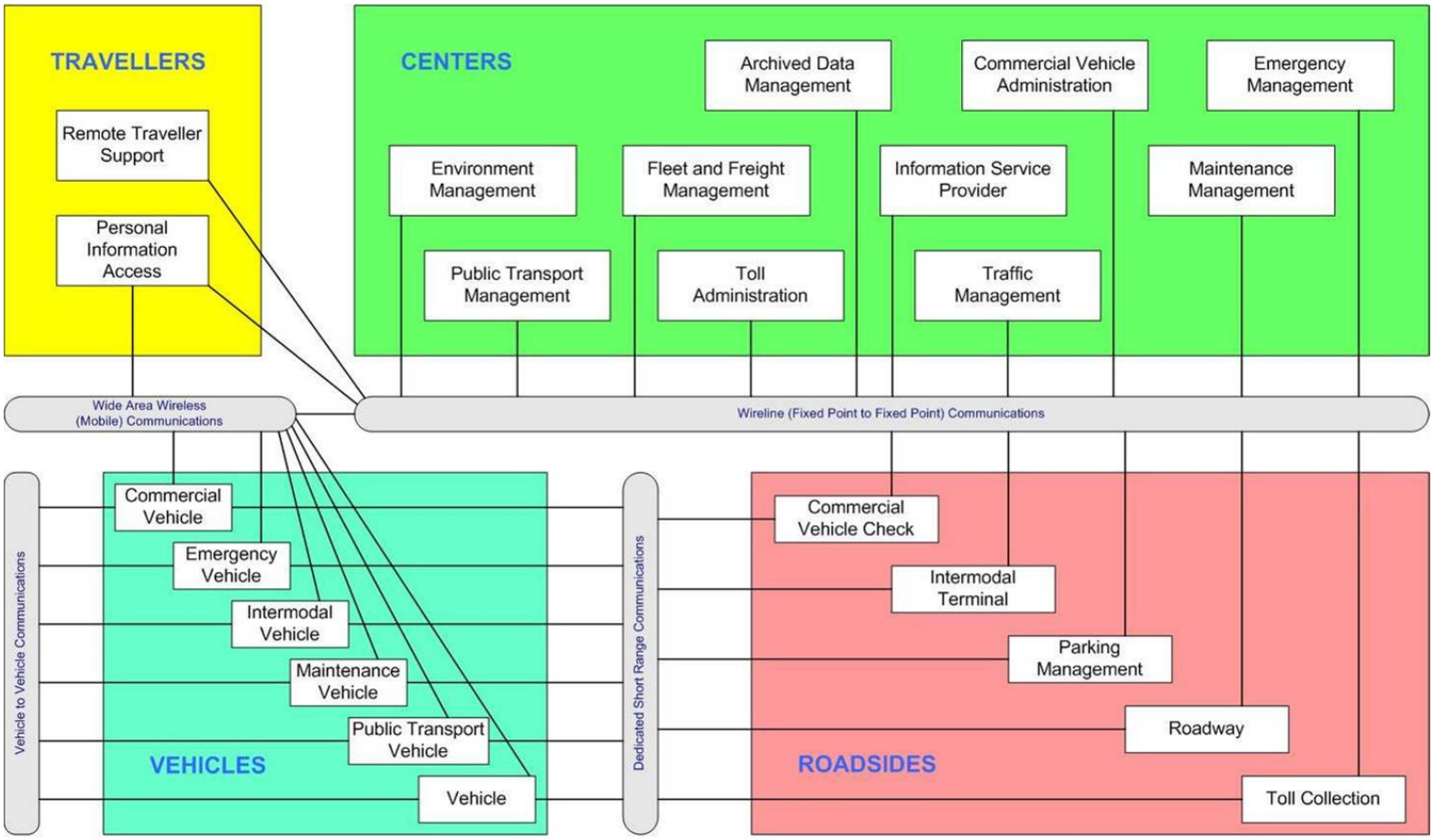

Figure 1 – Malaysian ITS Architecture Sausage Diagram

2.1.1 Deployment Packages and Subsystems

The Subsystems align closely with existing jurisdictional and physical boundaries that underscore the operation and maintenance of current transportation systems. By mirroring the current transportation environment with the identified Subsystems, the Subsystem boundaries identify the likely candidates for interface standardization. The Architecture recognizes these boundaries to minimize the impact associated with adoption of the Architecture. Maximum commonality between existing transportation system boundaries and Architecture boundaries serves to minimize the number of artificial boundaries which are imposed and constrained by the Architecture. Complete definitions of the Subsystems and other Physical Architecture entities can be found in the Physical Architecture document.

Before describing how Subsystems combined for a particular Deployment Package application, an important distinction must be made between the ”centre” Subsystems and the transportation management “centres” that are familiar to most transportation professionals.

In simplest terms, the Centre Subsystems are not “brick and mortar”. Each Subsystem is a cohesive set of functional definitions with required interfaces to other Subsystems. Subsystems are functionally, not physically defined. A regional implementation may include a single physical centre that collocates the capabilities from several of the Centre Subsystems. For instance, a single Transportation Management Centre may include Traffic Management Subsystem, Public Transport Management Subsystem, Emergency Management Subsystem, and Information Service

Provider Subsystem capabilities. Conversely, a single Subsystem may be replicated in many different physical centres in a complex metropolitan area system. For instance, Multiple Traffic Management Subsystems may be implemented in a region reflecting distinct regional highway and local arterial management centres.

A Deployment Package is implemented with a combination of interrelated equipment; this equipment often resides in several different Subsystems within the Architecture Framework and may be operated by different stakeholders. For instance, the Public Transport Vehicle Tracking Deployment Package includes vehicle location equipment in the Public Transport Vehicle Subsystem and a base station element in the Public Transport Management Subsystem. In this example, all Deployment Package elements are owned and operated by the same public transport stakeholder.

In other cases, the Deployment Package elements are owned and operated by different stakeholders. Many of the ATIS Deployment Packages require equipment in the Information Service Provider Subsystem that is owned and operated by a public or private information provider and equipment that is acquired and operated by the consumer as part of the Vehicle Subsystem or Personal Information Access Subsystem. Since equipment in different Subsystems may be purchased and operated by different end-users, these Subsystem-specific components may encounter varied deployment.

2.2 The Malaysian ITS Architecture Deployment Packages

The Architecture definition summarized in the previous section is intended to be extremely accommodating.

- It breadth supports the complete range of ITS services from basic signal control improvements to automated highway systems.
- It scalability supports implementations suitable for major metropolitan areas as well as remote rural areas.
- Its technological neutrality ensures that it will remain viable in the future and receptive to technology changes

This high degree of flexibility is necessary since the Architecture must accommodate the range of possible ITS implementations across the nation. Unfortunately, this flexibility also complicates the task of determining which pieces of the Architecture are applicable and how they can best be applied in addressing a particular community's current and future transportation needs.

To provide visibility into the service options that will be considered by ITS planners and implementers, a set of Deployment Packages have been defined. The Deployment Packages provide an accessible, deployment oriented perspective to the national Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. They address the specific service requirements of traffic managers, public transport operators, travellers, and other ITS stakeholders. The Deployment Packages were defined with enough granularities to support specific benefits analyses.

Several different Deployment Packages are defined in each major application area which provides a palette of service options at various costs. Deployment Packages are also structured to segregate services that are likely to encounter technical or non-technical challenges from lower risk services. Many of the Deployment Packages are incremental, so that more advanced packages can be efficiently implemented by building on common elements that were deployed earlier with more basic packages.

The complete set of Deployment Packages and the representing User Sub-Services are identified in Table 1. A list of the User Sub-services is provided in Table 2 for ease of reference. In order to more accurately specify Deployment Packages in tables, each is given an abbreviation as an index indicating the general class of stakeholder and an index (e.g., ATMS1 is a Deployment Package primarily of interest to transportation managers). Refer to Appendix A for the Deployment Package Context Diagrams.

Deployment Package ID	Deployment Package Name	Associated User Sub-Services
AD1	Archived Data Mart	9.2.1
AD2	Archived Data Warehouse	9.2.2
AD3	Archived Data Virtual Warehouse	9.2.3
AD4	Accident Data Management	2.1.1
APTS1	Public transport Vehicle Tracking	3.1.1
APTS2	Public transport Fixed-Route Operations	3.1.2
APTS3	Demand Responsive Public transport	3.3.1
APTS4	Passenger and Fare Management	3.1.3/5.1.3
APTS5	Public Travel Security	3.4.1
APTS6	Public Transport Maintenance	3.1.4
APTS7	Multi-Modal Co-ordination	3.1.5
APTS8	En-Route Public transport Information	3.2.1
APTS9	Multi-Modal Connection Protection	3.1.6
ATIS1	Broadcast Traveller Information	4.1.1
ATIS2	Interactive Traveller Information	4.1.2
ATIS3	Autonomous Route Guidance	4.2.1
ATIS4	Dynamic Route Guidance	4.2.2
ATIS5	ISP-Based Route Guidance	4.2.3
ATIS6	Dynamic Traffic Assignment	4.2.4/1.1.8
ATIS7	Traveller Services Payment and Reservation	4.4.1/4.4.2/5.1.4
ATIS8	Ride Matching	4.1.3/4.3.1/4.3.2
ATIS9	In-Vehicle Signing	4.2.5
ATMS01	Traffic Network Flow Monitoring	1.1.1
ATMS02	Probe-Based Flow Monitoring	1.1.7
ATMS03	Surface Street Control	1.1.2
ATMS04	Highway Control	1.1.3
ATMS05	HOV Lane Management	1.3.1
ATMS06	Traffic Information Dissemination	1.1.5
ATMS07	Regional Traffic Control	1.1.4
ATMS08	Incident Risk Prediction System	1.2.1/1.2.2
ATMS09	Predictive Demand Management	1.3.3
ATMS10	Electronic Toll Collection	5.1.1
ATMS11	Emissions Management	1.4.2
ATMS12	Virtual TMC and Vehicle-Based Sensing	1.1.6/1.4.4
ATMS13	Basic At-Grade Crossing Control	1.7.1
ATMS14	Advanced At-Grade Crossing	1.7.2
ATMS15	Modal Operations Co-ordination	1.7.3
ATMS16	Electronic Parking Payment and Parking Facility Management	4.4.3/5.1.2
ATMS17	Reversible Lane Management	1.3.2
ATMS18	Road Weather Information System	1.4.3
ATMS19	Regional Parking Management	4.4.4
ATMS20	Roadway Environmental Sensing	1.4.1
ATMS21	Roadway and Weather Data Fusion	9.1.1
ATMS22	Environmental Information Dissemination	9.1.2
ATMS23	Roadway Micro-Prediction	9.1.3
ATMS24	Maintenance Fleet Management	1.5.1
ATMS25	Smart Work Zones	1.5.2
ATMS26	Dynamic Roadway Warning	2.2.1
ATMS27	Variable Speed Limit and Enforcement	2.2.2

Deployment Package ID	Deployment Package Name	Associated User Sub-Services
ATMS28	Signal Enforcement	2.2.3
ATMS29	Mixed Use Warning Systems	1.6.1
ATMS30	Automated Non-Vehicular Road User Protection	1.6.2
AVSS01	Vehicle Safety Monitoring	7.4.1
AVSS02	Driver Safety Monitoring	7.4.2
AVSS03	Longitudinal Warning Systems	7.1.3
AVSS04	Lateral Warning Systems	7.1.1
AVSS05	Intersection Collision Warning	7.2.1
AVSS06	Pre-Collision Restraint Deployment	7.5.1
AVSS07	Sensor-Based Driving Safety Enhancement	7.3.1
AVSS08	Longitudinal Collision Avoidance	7.1.4
AVSS09	Lateral Collision Avoidance	7.1.2
AVSS10	Intersection Collision Avoidance	7.2.2
AVSS11	Automated Vehicle Operation	7.6.1
CVO01	Fleet Administration	6.1.1
CVO02	Freight Administration	6.1.2
CVO03	Electronic Clearance	6.3.1
CVO04	Commercial Vehicle Administrative Processes	6.6.1
CVO05	International Border Crossing Clearance	6.3.2
CVO06	Weigh-In-Motion (WIM)	6.3.3
CVO07	Roadside CVO Safety	6.4.1/6.4.2
CVO08	On-Board Safety Monitoring	6.5.1
CVO09	CVO Fleet Maintenance	6.1.3
CVO10	Hazardous Material Incident Response	8.2.1
CVO11	Freight In-Public transport Monitoring	6.2.1
CVO12	Freight Terminal Management	6.2.2
EM1	Emergency Response Management	8.4.1
EM2	Emergency Vehicle Routing	8.4.2
EM3	Personal Security and MAYDAY Support	8.1.1/8.1.2
EM4	Disaster Command and Control	8.3.1
EM5	Disaster Information Dissemination	8.3.2

Table 1 – Summary of Deployment Packages and User Sub-Services

Sector No. 1: Advanced Traffic Management Systems			
1.1	**Urban Traffic Control**	*1.1.1*	*Traffic Network Flow Monitoring*
		1.1.2	*Surface Street Control*
		1.1.3	*Highway Control*
		1.1.4	*Regional Traffic Control*
		1.1.5	*Traffic Information Dissemination*
		1.1.6	*Virtual TMC*
		1.1.7	*Probe-Based Flow Monitoring*
		1.1.8	*Traffic Estimation and Prediction*
1.2	**Incident Detection and Management**	*1.2.1*	*Incident Management Co-ordination*
		1.2.2	*Incident Prediction System*
1.3	**Travel Demand Management**	*1.3.1*	*High Occupancy Vehicle Lane Management*
		1.3.2	*Reversible Lane Management*
		1.3.3	*Predictive Demand Management*
1.4	**Environment Conditions Management**	*1.4.1*	*Roadway Environmental Sensing*
		1.4.2	*Emissions Management*
		1.4.3	*Road Weather Information System*
		1.4.4	*Vehicle-Based Sensing*
1.5	**Operations and Maintenance**	*1.5.1*	*Infrastructure Maintenance Management*
		1.5.2	*Smart Work Zone*
1.6	**Non-Vehicle Road User Safety**	*1.6.1*	*Mixed Use Warning Systems*
		1.6.2	*Automated Non-Vehicular Road User Protection*
1.7	**Multi-Modal Junction Safety and Control**	*1.7.1*	*Basic At-Grade Crossing Control*
		1.7.2	*Advanced At-Grade Crossing*
		1.7.3	*Modal Operations Co-ordination*
Sector No. 2: Safety Systems			
2.1	**Improved Accident Data Collection**	*2.1.1*	*Accident Data Management*
2.2	**Automated Dynamic Warning and Enforcement**	*2.2.1*	*Dynamic Roadway Warning*
		2.2.2	*Variable Speed Limit and Enforcement*
		2.2.3	*Signal Enforcement*
Sector No. 3: Advanced Public Transport Systems			
3.1	**Public Transport Operations Management**	*3.1.1*	*Public Transport Vehicle Tracking*
		3.1.2	*Public Transport Fixed-Route Operations*
		3.1.3	*Passenger and Fare Management*
		3.1.4	*Public Transport Maintenance*
		3.1.5	*Multi-Modal Co-ordination*
		3.1.6	*Multi-Modal Connection Protection*
3.2	**En-Route Public Transport Information**	*3.2.1*	*En-Route Public Transport Information*
3.3	**Demand Responsive Public Transport**	*3.3.1*	*Demand Responsive Public Transport*
3.4	**Public Travel Security**	*3.4.1*	*Public Travel Security*
Sector No. 4: Advanced Traveller Information Systems			
4.1	**Pre-Trip Traveller Information**	*4.1.1*	*Broadcast Traveller Information*
		4.1.2	*Interactive Traveller Information*
		4.1.3	*Real-Time Ridesharing information*
4.2	**Route Guidance and Navigation**	*4.2.1*	*Autonomous Route Guidance*
		4.2.2	*Dynamic Route Guidance*
		4.2.3	*ISP-Based Route Guidance*
		4.2.4	*Traffic Estimation and Prediction*

		4.2.5	*In-Vehicle Signing*
4.3	**Ride Matching and Reservation**	*4.3.1*	*Ride Matching*
		4.3.2	*Real-Time Ride Matching*
4.4	**Traveller Services and Reservations**	*4.4.1*	*Traveller Yellow Pages*
		4.4.2	*Services Purchases and Reservations*
		4.4.3	*Parking Facility Management*
		4.4.4	*Regional Parking Management*
Sector No. 5: Electronic Payment Systems			
5.1	**Electronic Payment Services**	*5.1.1*	*Electronic Toll Collection*
		5.1.2	*Electronic Parking Payment*
		5.1.3	*Public Transport Services Payment*
		5.1.4	*Traveller Services Payment*
Sector No. 6: Commercial Vehicle Operations Systems			
6.1	**Commercial Fleet Management**	*6.1.1*	*Fleet Administration*
		6.1.2	*Freight Administration*
		6.1.3	*CVO Fleet Maintenance*
6.2	**Commercial Freight Management**	*6.2.1*	*Freight In-Public Transport Monitoring*
		6.2.2	*Intermodal Interface Management*
6.3	**Commercial Vehicle Electronic Clearance**	*6.3.1*	*Electronic Clearance*
		6.3.2	*International Border Crossing Clearance*
		6.3.3	*Weigh-In-Motion (WIM)*
6.4	**Automated Roadside Safety Inspection**	*6.4.1*	*Inspection Support Systems*
		6.4.2	*Automated Vehicle Safety Read Out*
6.5	**On-board Safety Monitoring**	*6.5.1*	*On-board Safety Monitoring*
6.6	**Commercial Vehicle Administrative Processes**	*6.6.1*	*Commercial Vehicle Administrative Processes*
Sector No. 7: Advanced Vehicle Control Systems			
7.1	**Vehicle-Based Collision Avoidance**	*7.1.1*	*Lateral Warning Systems*
		7.1.2	*Lateral Collision Avoidance*
		7.1.3	*Longitude Warning Systems*
		7.1.4	*Longitude Collision Avoidance*
7.2	**Infrastructure-Based Collision Avoidance**	*7.2.1*	*Intersection Collision Warning*
		7.2.2	*Intersection Collision Avoidance*
7.3	**Sensor-Based Driving Safety Enhancement**	*7.3.1*	*Sensor-Based Driving Safety Enhancement*
7.4	**Safety Readiness**	*7.4.1*	*Vehicle Safety Monitoring*
		7.4.2	*Driver Safety Monitoring*
7.5	**Pre-Collision Restraint Deployment**	*7.5.1*	*Pre-Collision Restraint Development*
7.6	**Automated Vehicle Operation**	*7.6.1*	*Automated Vehicle Operation*
Sector No. 8: Emergency Management Systems			
8.1	**Emergency Notification and Personal Security**	*8.1.1*	*Personal Security*
		8.1.2	*MAYDAY Support*
8.2	**Hazardous Material Planning and Incident Response**	*8.2.1*	*Hazardous Material Planning and Incident Response*
8.3	**Disaster Response and Management**	*8.3.1*	*Disaster Command and Control*
		8.3.2	*Disaster Information Dissemination*
8.4	**Emergency Vehicle Management**	*8.4.1*	*Emergency Response Management*
		8.4.2	*Emergency Vehicle Routing*

Sector No. 9: Information Warehousing Systems			
9.1	**Weather and Environment Data Management**	*9.1.1*	*Roadway and Weather Data Fusion*
		9.1.2	*Environmental Information Dissemination*
		9.1.3	*Roadway Meso and Micro Prediction*
9.2	**Archived Data Management**	*9.2.1*	*Archived Data Mart*
		9.2.2	*Archived Data Warehouse*
		9.2.3	*Archived Data Virtual Warehouse*

Table 2 – Summary of User Services and User Sub-Services

It is important to note that the Deployment Packages are illustrative rather than prescriptive. The actual implementation variations that are possible across the nation are myriad and cannot be enumerated through a finite set of packages. The Deployment Packages are tools that allow this Implementation Strategy.

2.2.1 Description of Deployment Packages

Archived Data Mart (AD1)

This deployment package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.

Archived Data Warehouse (AD2)

This deployment package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources

spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this deployment package in addition to the basic query and reporting user access features offered by the ITS Data Mart.

Archived Data Virtual Warehouse (AD3)

This deployment package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse Deployment Package, but provides this access using enhanced interoperability between physically distributed ITS archives that are each locally managed. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse Deployment Package are parsed by the local archive and dynamically translated to requests to remote archives which relay the data necessary to satisfy the request.

Accident Data Management (AD4)

This deployment package provides traffic detectors, road condition sensors, environment sensors and other supporting field equipment that support the collection of data on the accident-prone locations. The collected data are then used for accurate analysis of these locations and causes of accidents.

Public Transport Vehicle Tracking (APTS1)

This deployment package provides for an Automated Vehicle Location System to track the public transport vehicle's real time schedule adherence and updates the public transport system's

schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A 2-way wireless communication link with the Public Transport Management Subsystem is used for relaying vehicle position and control measures. Fixed route public transport systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Public Transport Management Subsystem processes this information, updates the public transport schedule and makes real-time schedule information available to the Information Service Provider Subsystem via a wireline link.

Public Transport Fixed-Route Operations (APTS2)

This deployment package performs automatic driver assignment and monitoring, as well as vehicle routing and scheduling for fixed-route services. This service uses the existing AVL database as a source for current schedule performance data, and is implemented through data processing and information display at the Public Transport Management Subsystem. This data is exchanged using the existing wireline link to the information service provider where it is integrated with that from other transportation modes (e.g. rail, ferry, air) to provide the public with integrated and personalized dynamic schedules.

Demand Responsive Public Transport (APTS3)

This deployment package performs automatic driver assignment and monitoring as well as vehicle routing and scheduling for demand response public transport services. This package uses the existing AVL database to monitor current status of the public transport fleet and supports allocation of these fleet resources to service incoming requests for public transport service while also

considering traffic conditions. The Public Transport Management Subsystem provides the necessary data processing and information display to assist the public transport operator in making optimal use of the public transport fleet. The Information Service Provider Subsystem may either be operated by public transport management centre or be independently owned and operated by a separate service provider. In the first scenario, the traveller makes a direct request to a specific paratransit service. In the second scenario, a third party service provider determines the paratransit service is a viable means of satisfying a traveller request and uses wireline communications to make a reservation for the traveller.

Passenger and Fare Management (APTS4)

This deployment package allows for the management of passenger loading and fare payments on-board vehicles using electronic means. The payment instrument may be either a stored value or credit card specific to the application, or as supported by a broader banking network. This package is implemented with sensors mounted on the vehicle to permit the driver and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the public transport vehicle to allow fare payment. Data is processed, stored, and displayed on the public transport vehicle and communicated as needed to the Public Transport Management Subsystem using existing wireless infrastructure.

Public Travel Security (APTS5)

This deployment package provides for the physical security of public transport passengers. An on-board security system is deployed to perform surveillance and warn of potentially hazardous situations. Public areas (e.g. stops, park and ride lots, stations) are also monitored. Information is communicated

to the Public Transport Management Subsystem using the existing or emerging wireless (vehicle to centre) or wireline (area to centre) infrastructure. Security related information is also transmitted to the Emergency Management Subsystem when an emergency is identified that requires an external response. Incident information is communicated to the Information Service Provider.

Public Transport Maintenance (APTS6)

This deployment package supports automatic maintenance scheduling and monitoring. On-board condition sensors monitor critical system status and transmit critical status information to the Public Transport Management Subsystem. Hardware and software in the Public Transport Management Subsystem processes this data and schedules maintenance activities.

Multi-Modal Co-ordination (APTS7)

This deployment package establishes 2-way communications between multiple public transport and traffic agencies to improve service co-ordination. Intermodal co-ordination between public transport agencies can increase traveller convenience at transfer points and also improve operating efficiency. Co-ordination between traffic and public transport management is intended to improve on-time performance of the public transport system to the extent that this can be accommodated without degrading overall performance of the traffic network. More limited local co-ordination between the public transport vehicle and the individual intersection for signal priority is also supported by this package.

En-Route Public Transport Information (APTS8)

This deployment package provides commuters at public transport stops and on-board public transport vehicles with ready access to public transport information. The information services include public transport stop annunciation, imminent arrival signs, and real-time public transport schedule displays that are of general interest to commuters. Systems that provide custom public transport trip itineraries and other tailored public transport information services are also represented by this deployment package.

Multi-Modal Connection Protection (APTS9)

This Malaysian Deployment Package supports the co-ordination of multimodal services to optimize the travel time of travellers as they move from mode to mode (or to different routes within a single mode). A near term function supported by this Malaysian Deployment Package would be for a single public transport agency to co-ordinate crossing routes so that passengers on one route would have the opportunity to transfer with minimum wait time to another route within the same public transport system. The next level of complexity of this Malaysian Deployment Package would be for this co-ordination to occur across public transport agencies, or between public transport agencies and other modes of transportation. The most advanced functions of this Malaysian Deployment Package would be to track the route of an individual traveller and ensure that connections are properly scheduled on an individual basis. This final capability represents a very long-term functionality, which could be managed either through an Information Serviced Provider or through a Public Transport Management subsystem.

Broadcast Traveller Information (ATIS1)

This deployment package provides the user with a basic set of ATIS services; its objective is early notification. It involves the collection of traffic conditions, road conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather information, and the near real time dissemination of this information over a wide area through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). Different from the deployment package ATMS6 - Traffic Information Dissemination - which provides the more basic HAR and DMS information capabilities, ATIS1 provides the more sophisticated digital broadcast service. Successful deployment of this deployment package relies on availability of real-time traveller information from roadway instrumentation, probe vehicles or other sources.

Interactive Traveller Information (ATIS2)

This deployment package provides tailored information in response to a traveller request. Both real-time interactive request/response systems and information systems that .push a tailored stream of information to the traveller, based on a submitted profile are supported. The traveller can obtain current information regarding traffic conditions, road conditions, public transport services, ride share/ride match, parking management, and pricing information. A range of two-way wide-area wireless and wireline communications systems may be used to support the required digital communications between traveller and the information service provider. A variety of interactive devices may be used by the traveller to access information prior to a trip or en-route, including phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. Successful deployment of this deployment package relies on

availability of real-time transportation data from roadway instrumentation, probe vehicles or other means.

Autonomous Route Guidance (ATIS3)

This deployment package relies on in-vehicle sensory, location determination, computational, map database, and interactive driver interface equipment to enable route planning and detailed route guidance based on static, stored information. No communication with the infrastructure is assumed or required. Identical capabilities are available to the traveller outside the vehicle by integrating a similar suite of equipment into portable devices.

Dynamic Route Guidance (ATIS4)

This deployment package offers the user advanced route planning and guidance which is responsive to current conditions. The package combines the autonomous route guidance user equipment with a digital receiver capable of receiving real-time traffic, public transport, and road condition information which is considered by the user equipment in provision of route guidance.

ISP-Based Route Guidance (ATIS5)

This deployment package offers the user advanced route planning and guidance which is responsive to current conditions. Different than the Dynamic Route Guidance Deployment Package, this deployment package moves the route planning function from the user device to the information service provider. This approach simplifies the user equipment requirements and can provide the infrastructure better information on which to predict future traffic and appropriate control strategies to support basic route planning with minimal user equipment. The package includes both turn by turn route guidance as might be used in a vehicle as well as pre-trip routes. The package includes two

way data communications and optionally also equips the vehicle with the databases, location determination capability, and display technology to support turn by turn route guidance.

Dynamic Traffic Assignment (ATIS6)

This deployment package allows a traffic management centre to continuously optimize the traffic control strategy based on near-real time information on intended routes for a proportion of the vehicles within their network while offering the user advanced route planning and guidance which is responsive to current conditions. It would utilize the individual and ISP route planning information to optimize signal timing while at the same time providing updated signal timing information to allow optimized route plans. The use of predictive link times for this deployment package is possible through utilizing the deployment package ATMS9 - Traffic forecast and Demand Management--at the traffic management centre.

Traveller Services Payment and Reservation (ATIS7)

This deployment package enhances the Interactive Traveller Information package by making infrastructure provided yellow pages and reservation services available to the user. The same basic user equipment is included. This deployment package provides multiple ways for accessing information either while en-route in a vehicle using wide-area wireless communications or pre-trip via wireline connections.

Ride Matching (ATIS8)

This deployment package enhances the Interactive Traveller Information package by adding an infrastructure provided dynamic ridesharing/ride matching capability. In terms of equipment requirements, ATIS8 is similar to ATIS7.

In-Vehicle Signing (ATIS9)

This deployment package supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short-range communications between roadside equipment and the vehicle and wireline connections to the Traffic Management Subsystem for co-ordination and control.

Traffic Network Flow Monitoring (ATMS01)

This deployment package includes traffic detectors, road condition sensors, environmental sensors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the centre which uses the data (traffic management, maintenance management, or archive data management). The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this deployment package enables the operators of the centres to monitor traffic environmental and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.

Probe-Based Flow Monitoring (ATMS02)

This deployment package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this deployment package: 1) wide-area wireless communications between the vehicle and Information Service Provider is used to communicate current vehicle location and status, and 2)

dedicated short range communications between the vehicle and roadside is used to provide equivalent information back to the Traffic Management Subsystem. The first approach leverages wide area communications equipment that may already be in the vehicle to support personal safety and advanced traveller information services. The second approach utilizes vehicle equipment that supports toll collection, in-vehicle signing, and other short-range communications applications identified within the architecture. The deployment package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, roadside beacons and wireline communications for the short range communications option, data reduction software, and utilizes wireline links between the Traffic Management Subsystem and Information Service Provider Subsystem to share the collected information. Both “Opt out” and ”Opt in” strategies are available to ensure the user has the ability to turn off the probe functions to ensure individual privacy. Due to the large volume of data collected by probes, data reduction techniques are required in this deployment package which include the ability to identify and filter out-of-bounds or extreme data reports.

Surface Street Control (ATMS03)

This deployment package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this deployment package ranging from static pre-timed control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests.

Additionally, general advisory and traffic control information can be provided to the driver while en-route. This deployment package is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal co-ordination. Systems that achieve co-ordination across jurisdictions by using a common time base or other strategies that do not require real time co-ordination would be represented by this package. This deployment package is consistent with typical urban traffic signal control systems.

Highway Control (ATMS04)

This deployment package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. Co-ordination and integration of ramp meters are included as part of this deployment package. This package is consistent with typical urban traffic freeway control systems. This package incorporates the instrumentation included in the Network Surveillance Deployment Package to support freeway monitoring and adaptive strategies as an option. This deployment package also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management centre; however, developments might allow for point detection with roadway equipment. For example, a CCTV might include the capability to detect an incident based upon image changes. Additionally, this deployment package allows general advisory and traffic control information to be provided to the driver while en-route.

HOV Lane Management (ATMS05)

This deployment package manages HOV lanes by co-ordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.

Traffic Information Dissemination (ATMS06)

This deployment package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management centre to the media (for instance via a direct tie-in between a traffic management centre and radio or television station computer systems), public transport management centre, emergency management centre, and information service provider.

Regional Traffic Control (ATMS07)

This deployment package advances the Surface Street Control and Freeway Control Deployment Packages by adding the communications links and integrated control strategies that enable integrated Inter-jurisdictional traffic control. This deployment package provides for the sharing of traffic information and control among traffic management centres to support a regional control strategy. The nature of optimization

and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Deployment Packages and adds hardware, software, and wireline communications capabilities to implement traffic management strategies which are co-ordinated between allied traffic management centres. Several levels of co-ordination are supported from sharing of information through sharing of control between traffic management centres.

Incident Risk Prediction System (ATMS08)

This deployment package manages both predicted and unexpected incidents so that the impact to the transportation network and traveller safety is minimized. Requisite incident detection capabilities are included in the freeway control deployment package and through the regional co-ordination with other traffic management and emergency management centres, weather service entities, and event organiser supported by this deployment package. Information from these diverse sources are collected and correlated by this deployment package to detect and verify incidents and implement an appropriate response. This deployment package provides Traffic Management Subsystem and Maintenance Management Subsystem equipment that supports traffic operations/maintenance personnel in developing an appropriate response in co-ordination with emergency management and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications and presentation of information to affected travellers using the Traffic Information Dissemination Deployment Package. The same equipment assists the operator by monitoring incident status as the response unfolds. The co-ordination with emergency

management might be through a CAD system or through other communication with emergency field personnel. Co-ordination between traffic and maintenance operations, as well as assets such as tow trucks are also included.

Predictive Demand Management (ATMS09)

This deployment package includes advanced algorithms, processing, and mass storage capabilities that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better link travel time forecasts. The source data would come from the Traffic Management Subsystem itself as well as other traffic management centres and forecasted traffic loads derived from route plans supplied by the Information Service Provider Subsystem. In addition to short-term forecasts, this deployment package provides longer-range forecasts that can be used in transportation planning. This deployment package provides data that supports the implementation of TDM programs, and policies managing both traffic and the environment. Information on vehicle pollution levels, parking availability, usage levels, and vehicle occupancy are collected by monitoring sensors to support these functions. Demand management requests can also be made to Toll Administration, Public Transport Management, and Parking Management Subsystems.

Electronic Toll Collection (ATMS10)

This deployment package provides toll operators with the ability to collect tolls electronically and detect and process violators. Variations in the fees that are collected enables implementation of demand management strategies. Dedicated short-range communication between the roadway equipment and the vehicle is required as well as wireline interfaces between the toll

collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle tags of toll violators are read and electronically posted to vehicle owners. Standards, inter-agency co-ordination, and financial clearinghouse capabilities enable regional and ultimately national interoperability for these services. The population of toll tags and roadside readers that these systems utilize can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.

Emissions Management (ATMS11)

This deployment package monitors individual vehicle emissions and provides general air quality monitoring using distributed sensors to collect the data. The collected information is transmitted to the environment management subsystem for processing. Both individual detection and identification of vehicles that exceed emissions standards and general area-wide monitoring of air quality are supported by this deployment package. For area wide monitoring, this deployment package measures air quality, identifies sectors that are non-compliant with air quality standards, and collects, stores and reports supporting statistical data. For point emissions monitoring, this deployment package measures tail pipe emissions and identifies vehicles that exceed emissions standards. The gathered information can be used to implement environmentally sensitive TDM programs, policies, and regulations.

Virtual TMC and Vehicle-Based Sensing (ATMS12)

This deployment package provides for special requirements of rural road systems. Instead of a central TMC, the traffic management is distributed over a very wide area (e.g. a whole

region or collection of regions). Each locality has the capability of accessing available information for assessment of road conditions. The package uses vehicles as smart probes that are capable of measuring road conditions and providing this information to the roadway for relay to the Traffic Management Subsystem and potentially direct relay to following vehicles (i.e., the automated road signing equipment is capable of autonomous operation). In vehicle signing is used to inform drivers of detected road conditions.

Basic At-Grade Crossing Control (ATMS13)

This deployment package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the roadway subsystem and the driver in the architecture definition.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed, detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the traffic management subsystem. Similar interfaces and services are provided for other types of multimodal crossings (e.g. drawbridges).

Advanced At-Grade Crossing (ATMS14)

This deployment package manages highway traffic at highway-rail intersections (HRIs) where operational requirements demand advanced features (e.g., where rail operational speeds are greater than 80 miles per hour). This deployment package includes all capabilities from Basic At-Grade Crossing Deployment Package and augments these with additional safety features to mitigate the risks associated with higher rail speeds. The active warning systems supported by this deployment package include positive barrier systems which preclude entrance into the intersection when the barriers are activated. Like the Standard Package, the HRI equipment is activated on notification by wayside interface equipment which detects, or communicates with the approaching train. In this deployment package, additional information about the arriving train is also provided by the wayside interface equipment so that the train's direction of travel, its estimated time of arrival, and the estimated duration of closure may be derived. This enhanced information may be conveyed to the driver prior to, or in context with, warning system activation. This deployment package also includes additional detection capabilities which enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to highway and railroad officials.

Modal Operations Co-ordination (ATMS15)

This deployment package provides an additional level of strategic co-ordination between rail operations and traffic management centres. Rail operations provide train schedules, maintenance schedules, and any other forecast events which will result in highway-rail intersection (HRI) closures. This information is used to develop forecast HRI closure times and

durations which may be used in advanced traffic control strategies or to enhance the quality of traveller information.

Electronic Parking Payment and Parking Facility Management (ATMS16)

This deployment package provides enhanced monitoring and management of parking facilities. The included equipment assists in the management of parking operations, co-ordinates with transportation authorities, and supports electronic collection of parking fees. This is performed by sensing and collecting current parking facilities status, sharing the data with information service providers and traffic operations, and automatic fee collection using short range communications with the same in-vehicle equipment utilized for electronic toll collection.

Reversible Lane Management (ATMS17)

This deployment package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this deployment package includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This deployment package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.

Road Weather Information System (ATMS18)

This deployment package monitors current and forecast road and weather conditions using a combination of weather service information and data collected from environmental sensors deployed on and about the roadway. The collected road

weather information is monitored and analyzed to detect and forecast environmental hazards such as icy road conditions, dense fog, and approaching severe weather fronts. This information can be used to more effectively deploy road maintenance resources, issue general traveller advisories, and support location specific warnings to drivers using the Traffic Information Dissemination Deployment Package.

Regional Parking Management (ATMS19)

This deployment package supports co-ordination between parking facilities to enable regional parking management strategies.

Roadway Environmental Sensing (ATMS20)

This Malaysian Deployment Package monitors current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. In addition to fixed sensor stations at the roadside, sensing of the roadway environment can also occur from sensor systems located on the Maintenance Vehicle Subsystem. The collected environmental data is analyzed by the Traffic Management Subsystem to detect and forecast environmental hazards such as icy road conditions, dense fog, and approaching severe weather fronts. This information can be used to more effectively deploy road maintenance resources, issue general traveller advisories, and support location specific warnings to drivers using the Traffic Information Dissemination Deployment Package or the Environmental Information Dissemination Deployment Package.

Roadway and Weather Data Fusion (ATMS21)

This Malaysian Deployment Package supports the fusion of roadway environmental data with general weather forecasts and observations. The roadway environmental data comes from

roadside sensor systems, or sensor systems mounted on maintenance vehicles. The weather data comes from the Malaysian Meteorological Service.

Environmental Information Dissemination (ATMS22)

This Malaysian Deployment Package supports the dissemination of roadway and weather data to centres which can utilize it as part of their operations, or to the Information Service Providers who can provide the information to travellers.

Roadway Micro-Prediction (ATMS23)

This Malaysian Deployment Package supports advanced systems which use the data from the Roadway and Weather Data Fusion Deployment Package, along with advanced algorithms, to create micro-predictions of roadway conditions which can support improved maintenance planning and dispatch.

Maintenance Fleet Management (ATMS24)

This Malaysian Deployment Package supports automated management of fleets of maintenance, construction, or special service vehicles. This Malaysian Deployment Package includes the infrastructure-based systems that monitor vehicle location, vehicle status, and the output of sensors (such as environmental or road surface sensors) which are mounted on the vehicles. Also included are the systems within the maintenance vehicles that create this information and send it to the control centre or control system. The infrastructure systems perform vehicle dispatch, routing, and asset management.

Smart Work Zones (ATMS25)

This Malaysian Deployment Package includes systems that gather, store, and disseminate information relating to work zones. The roadside elements of the deployment package can monitor and control traffic in the vicinity of the work zone. The centre element of this deployment package can participate in incident management by initiating incident notification, or by participating in incident response. It can advise drivers of work zone status (either directly at the roadside or through an interface with the Information Service Provider or Traffic Management Subsystems.). The centre systems can manage and track construction and maintenance activities, co-ordinating with other Subsystems (such as Traffic Management). It can schedule and manage the location and usage of maintenance assets (such as portable DMS). These information systems are used by roadway maintenance personnel, roadway construction personnel, or other work crew personnel assigned to highway construction and maintenance. Co-ordination with these systems allows the ITS Architecture to rapidly correct deficiencies that are noted through its advanced surveillance capabilities and also improves the quality and accuracy of information available to travellers regarding closures and other roadway construction and maintenance activities.

Dynamic Roadway Warning (ATMS26)

This Malaysian Deployment Package supports the dynamic presentation of warning information to drivers. Warnings may be generated in response to roadway weather conditions, road surface conditions, traffic conditions, obstacles or animals in the roadway, and any other transient events that can be sensed. Warnings may also be generated that recognize the limitations of a given vehicle for the geometry of the roadway, e.g. rollover risk for tall vehicles. This Malaysian Deployment Package

differs from “Traffic Information Dissemination” in that it is possible for all processing to occur remotely at the roadside, making this capability autonomous for remote application. It also expands the capabilities of Traffic Information Dissemination by focusing on non-traffic roadway issues.

Variable Speed Limit and Enforcement (ATMS27)

This Malaysian Deployment Package supports the ability to dynamically vary speed limits in response to roadway conditions. This could include lowering speed limits due to weather or traffic conditions, to reduce the risk of accidents. This Malaysian Deployment Package also relates to the Smart Work Zones Deployment Package when it is used to aid in traffic calming around roadwork areas. A key capability of this Malaysian Deployment Package is the ability to provide automated enforcement of the variable speed limit, by detecting and conveying violation information to law enforcement. This Malaysian Deployment Package can be used to build on the capability of Dynamic Roadway Warning, to create an enforceable lowering of the speed limit in response to transient, localized roadway conditions.

Signal Enforcement (ATMS28)

This Malaysian Deployment Package supports the detection and enforcement of roadway control signals. A common implementation of this capability is “red light enforcement” for signalized intersections. Information documenting a vehicle disobeying a traffic signal is captured and conveyed to law enforcement. This Malaysian Deployment Package is a logical predecessor to “Intersection Safety Warning” and “Intersection Collision Avoidance”, where the signal violation detection is also used to reduce the likelihood of a traffic accident. This same relationship also exists to “Mixed Use Warning Systems” and

"Automated Non-Vehicular Road User Protection'" since pedestrians, bicyclists, and other non-vehicle traffic may be threatened by signal violations.

Mixed Use Warning Systems (ATMS29)

This Malaysian Deployment Package supports the near term sensing and warning systems used to interact with pedestrians, bicyclists, and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways.

Automated Non-Vehicular Road User Protection (ATMS30)

This Malaysian Deployment Package supports more advanced systems of sensing and warning for pedestrians, bicyclists and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways. Specifically, advanced imaging sensors are anticipated to provide improved sensing and recognition capabilities, which would allow automated warning or active protection systems for this class of users.

Vehicle Safety Monitoring (AVSS01)

This deployment package diagnoses critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition and performance, determine on-board safety data and display information.

Driver Safety Monitoring (AVSS02)

This deployment package determines the driver's condition, and warns the driver of potential dangers. On-board sensors will determine the driver's condition and performance, determine on-board safety data and display information.

Longitudinal Warning Systems (AVSS03)

This deployment package allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.

Lateral Warning Systems (AVSS04)

This deployment package allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

Intersection Collision Warning (AVSS05)

This deployment package determines the probability of a collision in an equipped intersection (either highway-highway or highway-rail) and provides timely warnings to drivers in response to hazardous conditions. Monitors in the roadway infrastructure assess vehicle locations and speeds near an intersection. Using this information, a warning is determined and communicated to the approaching vehicle using a short-range communications system. Information can be provided to the driver through the deployment package ATIS9 - In-Vehicle Signing.

Pre-Collision Restraint Deployment (AVSS06)

This deployment package provides in-vehicle sensors to monitor the vehicle's local environment, determine collision probability and deploy a pre-collision safety system. It will include on-board sensors to measure lateral and longitudinal gaps and together with weather and roadway conditions will determine lateral and longitudinal collision probability. It will have the mechanism to deploy a pre-collision safety system.

Sensor-Based Driving Safety Enhancement (AVSS07)

This deployment package enhances driver visibility using an enhanced vision system. On-board sensing and display hardware is needed to provide detection and imaging of obstacles under low visibility driving conditions.

Longitudinal Collision Avoidance (AVSS08)

This deployment package automates the speed and headway control functions on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the throttle and brakes. It requires on-board sensors to measure longitudinal gaps and a processor for controlling the vehicle speed.

Lateral Collision Avoidance (AVSS09)

This deployment package automates the steering control on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the steering. It requires on-board sensors to measure lane position and lateral deviations and a processor for controlling the vehicle steering.

Intersection Collision Avoidance (AVSS10)

This deployment package determines the probability of an intersection collision and provides timely warnings to approaching vehicles so that avoidance actions can be taken. This deployment package builds on the Intersection Collision Warning infrastructure and in-vehicle equipment and adds equipment in the vehicle that can take control of the vehicle in emergency situations. The same monitors in the roadway infrastructure are needed to assess vehicle locations and speeds near an intersection. This information is determined and communicated to the approaching vehicle using a short-range

communications system. The vehicle uses this information to develop control actions which alter the vehicle's speed and steering control and potentially activate its pre-collision safety system.

Automated Vehicle Operation (AVSS11)

This deployment package enables "hands-off" operation of the vehicle on the automated portion of the highway system. Implementation requires lateral lane holding, vehicle speed and steering control, and Automated Highway System check-in and checkout. This deployment package currently supports a balance in intelligence allocation between infrastructure and the vehicle pending selection of a single operational concept by the AHS consortium.

Fleet Administration (CVO01)

This deployment package keeps track of vehicle location, itineraries, and fuel usage at the Fleet and Freight Management Subsystem using a cell based or satellite data link and the pre-existing wireless infrastructure. The vehicle has a processor to interface to its sensor (e.g., fuel gauge) and to the cellular data link. The Fleet and Freight Management Subsystem can provide the vehicle with dispatch instructions, and can process and respond to requests for assistance and general information from the vehicle via the cellular data link. The deployment package also provides the Fleet Manager with connectivity to intermodal transportation providers using the existing wireline infrastructure.

Freight Administration (CVO02)

This deployment package tracks cargo and the cargo condition. This information is communicated with the Fleet and Freight Management Subsystem via the existing wireless infrastructure. Interconnections are provided to intermodal shippers and

intermodal freight depots for tracking the cargo from source to destination.

Electronic Clearance (CVO03)

This deployment package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem over wireline to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This package allows a compliant driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short-range communications to the roadside. The roadside check facility may be equipped with AVI, weighing sensors, transponder read/write devices, computer workstation processing hardware, software, and databases.

Commercial Vehicle Administrative Processes (CVO04)

This deployment package provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in the electronic clearance program provided by a separate deployment package which allows commercial vehicles to be screened at mainline speeds at commercial vehicle check points. Through this enrolment process, current profile databases are maintained in the Commercial Vehicle Administration Subsystem and snapshots of this database are made available to the commercial vehicle check facilities at the roadside to support the electronic clearance process.

International Border Crossing Clearance (CVO05)

This deployment package provides for automated clearance specific to international border crossings for both commercial

and private vehicles. This package augments the electronic clearance package by allowing interface with customs-related functions.

Weigh-In-Motion (WIM) (CVO06)

This deployment package provides for high speed weigh-in-motion with or without AVI attachment. Primarily this deployment package provides the roadside with additional equipment, either fixed or removable. If the equipment is fixed, then it is thought to be an addition to the electronic clearance and would work in conjunction with the AVI and AVC equipment in place.

Roadside CVO Safety (CVO07)

This deployment package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the Commercial Vehicle Check roadside element. The capabilities for performing the safety inspection are shared between this deployment package and the On-Board CVO Safety Deployment Package which enables a variety of implementation options. The basic option, directly supported by this deployment package, facilitates safety inspection of vehicles that have been pulled in, perhaps as a result of the automated screening process provided by the Electronic Clearance Deployment Package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-Board CVO Safety deployment package, utilize additional vehicle safety monitoring

and reporting capabilities in the commercial vehicle to augment the roadside safety check.

On-Board Safety Monitoring (CVO08)

This deployment package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety Deployment Package and includes roadside support for reading on-board safety data via tags. This deployment package uses the same communication links as the Roadside CVO Safety Deployment Package, and provides the commercial vehicle with a wireless link (data and possibly voice) to the Fleet and Freight Management and the Emergency Management Subsystems. Safety warnings are provided to the driver as a priority with secondary requirements to notify the Fleet and Freight Management and Commercial Vehicle Check roadside elements.

CVO Fleet Maintenance (CVO09)

This deployment package supports maintenance of CVO fleet vehicles through close interface with on-board monitoring equipment and AVLS capabilities with in the Fleet and Freight Management Subsystem. Records of vehicle mileage, repairs, and safety violations are maintained to assure safe vehicles on the highway.

Hazardous Material Incident Response (CVO10)

This deployment package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and co-ordinates the response. The response is tailored based on information that is

provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.

Freight In-Public Transport Monitoring (CVO11)

This Malaysian Deployment Package covers the ability to track and monitor intermodal containers and intermodal freight shipments. This includes determining the location of a container while it is on a railway car and, if appropriate, monitoring measured parameters of the container contents (temperature, shock and vibration, etc.). This information is provided to freight customers, fleet managers, and logistics service providers. In general, a truck will pick up a container from a customer, a container freight station, or an intermodal terminal, and then deliver the container to the appropriate one of these for intermodal mode change or final delivery. This Malaysian Deployment Package supports the monitoring of the container during this pickup-transport-drop-off period.

Freight Terminal Management (CVO12)

This Malaysian Deployment Package supports the operation of the roadway aspects of an intermodal terminal. The “terminal” may represent the transfer point between roadway and one or more other modes of container transport (rail, air or water), and may be an actual port facility or a private intermodal transfer facility. The key capabilities include the ability to identify and control vehicle traffic entering and departing the facility, guide vehicles to loading and unloading points, maintain site security and monitor container integrity, provide an interface to Customs as appropriate, and acknowledge container pickup and drop-off.

Other capabilities include the ability to track container locations within the facility and to manage any other required assets, like truck chassis. This Malaysian Deployment Package may be deployed in conjunction with Weigh-in-Motion and Roadside CVO Safety to provide truck weight and safety assessments for vehicles prior to departing the facility.

Emergency Response Management (EM1)

This deployment package provides the computer-aided dispatch systems, emergency vehicle equipment, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Co-ordination between Emergency Management Subsystems supports emergency notification and co-ordinated response between agencies. Existing wide area wireless communications would be utilized between the Emergency Management Subsystem and an Emergency Vehicle to enable an incident command system to be established and supported at the emergency location. The Emergency Management Subsystem would include hardware and software for tracking the emergency vehicles. Public safety, traffic management, maintenance management and many other allied agencies may each participate in the co-ordinated response managed by this package.

Emergency Vehicle Routing (EM2)

This deployment package supports dynamic routing of emergency vehicles and co-ordination with the Traffic Management Subsystem for special priority on the selected route(s). The Information Service Provider Subsystem supports routing for the emergency fleet based on real-time traffic conditions and the emergency routes assigned to other responding vehicles. In this deployment package, the Information Service Provider Subsystem would typically be

integrated with the Emergency Management Subsystem in a public safety communications centre. The Emergency Vehicle would also optionally be equipped with dedicated short-range communications for local signal pre-emption.

Personal Security and MAYDAY Support (EM3)

This package allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Subsystem to locate the user and determine the appropriate response. The Emergency Management Subsystem may be operated by the public sector or by a private sector provider. The request from the traveller needing assistance may be manually initiated or automated and linked to vehicle sensors. The data is sent to the Emergency Management subsystem using wide area wireless communications with voice as an option. Providing user location implies either a location technology within the user device or location determination within the communications infrastructure.

Disaster Command and Control (EM4)

This Malaysian Deployment Package supports the co-ordinated response to large-scale disasters. Examples can include natural disasters like blizzards, earthquakes, and floods or man-made disasters like chemical spills, terrorism, or air crashes. The Malaysian Deployment Package supports co-ordination of the roadway transportation management centres with the overall command authority that is leading the disaster response. This includes co-ordination of emergency management and maintenance management fleets and activities, the use of public transport assets to support evacuation and the exchange of information with traffic management to control roadway usage.

Disaster Information Dissemination (EM5)

This Malaysian Deployment Package supports the dissemination from a central co-ordinating point of disaster-related information. Disasters are considered to be large-scale events that affect regions and may require regional-level or even national-level response. The information that is disseminated can include evacuation guidance to travellers via traffic management and information service providers. Information can also include specific disaster response status for the operational needs of various transportation and emergency management agencies. The Malaysian Deployment Package also supports the capability for the disaster-co-ordinating agency to collect information from the transportation agencies, to help maintain a complete picture of the disaster and the status of the response.