1. INTRODUCTION

1.1 Purpose of This Document

A key feature of Intelligent Transportation Systems (ITS) is the use of information about transportation system conditions and travelers to improve overall system performance. ITS can generate massive amounts of data that are used primarily in real-time to effect control strategies. Examples include the adjustment of ramp meter timing based on freeway flow conditions and the use of variable message signs (VMSs) to communicate traffic incidents to travelers.

Increasing deployment of ITS throughout the Nation has brought an awareness that ITS-generated data offer great promise for uses beyond the execution of ITS control strategies. Potential applications include transportation planning, administration, operations, and research. In most cases, ITS-generated data are similar to data traditionally collected for these applications, but are much more voluminous in quantity and temporal coverage. However, up to now there has been no organized effort to identify data generated by ITS for other uses and to specify methods for their storage and analysis. This document will serve as the starting point for the process of getting a new user service -- the **Archived Data User Service (ADUS)** -- into transportation practice. Specifically, this document has four main objectives in order to bring the issue into sharper focus:

1. <u>Define the Archived Data User Service.</u> The potential of data generated by ITS for multiple uses is so great that it warrants the definition of its own ITS User Service. The creation of a new User Service requires that the National ITS Architecture (see Section 1.2.4 for a description) be amended to include it. The first step in this process is the definition of the User Service, including its stakeholders, main functions, costs and benefits, and technical and institutional issues. This document provides the information necessary to specify the Archived Data User Service.

2. <u>Serve as a Preliminary Requirements Document for the National ITS Architecture.</u> In the National ITS Architecture revision process, once a User Service is defined a detailed set of requirements is generated. These requirements are then used to formally amend the National ITS Architecture. Development of the requirements is based on detailed discussions between stakeholders and the Architecture developers. Because an ample history already exists on the needs of stakeholders, there is enough information to develop *a preliminary list of general requirements* for the Archived Data User Service. These requirements must be refined through more intense discussions with stakeholders.

3. <u>Identify Steps For Implementation Beyond Inclusion in the National ITS Architecture.</u> As presented in Chapter 3, many technical and institutional issues are associated with implementing the Archived Data User Service. In many ways, these are larger barriers to implementation than adding the User Service to the National ITS Architecture. Therefore, this document will identify these issues and will offer preliminary recommendations for dealing with them (Chapter 4). Clearly, much more remains to be done in developing effective procedures for implementing the Archived Data User Service in the field, but this

document is the first step in that direction.

4. Foster Communication Between Stakeholder Groups and the ITS Community. A need exists to bridge the communications gap between personnel who design, construct, and operate ITS and other transportation personnel. Therefore, this document will serve as an educational tool to foster communication between these diverse groups. The report is of interest to all potential stakeholders in that it identifies ITS-generated data that have application for multiple uses. It also provides a background on many of the technical chores (and their associated data needs) undertaken by the various stakeholder groups.

1.2 Background

1.2.1 Terminology

- *Multiple Uses (of ITS-Generated Data)* - Many transportation functions and applications that are not time sensitive can take advantage of ITS-generated data for use in nonreal-time. Generally, these functions are not related to the implementation of ITS control strategies, although certain types of ITS control strategies may use nonreal-time data to improve performance. *Multiple uses* refers to both the primary use for which the data were collected as well as additional uses of those data.

- *Metropolitan Planning Organization (MPO)* - The officially-designated agency in urban areas over 50,000 in population that is responsible for fulfilling the Federally-mandated transportation planning process.

- *Average Annual Daily Traffic (AADT)* - The total yearly traffic volume of a roadway divided by the number of days in the year. AADT is commonly estimated by factoring short-duration counts (1-2 days) to account for daily and seasonal variation.

- *K-factor* - the percent of daily traffic (AADT) that is present on a roadway during the peak hour of the day, both directions combined.

- *D-factor* - the percent of peak hour traffic that moves in the peak direction. Both K- and D-factors are developed from analyzing the 30th highest hour of traffic for a given year.

- *Vehicle-miles of travel (VMT).* The total number of miles traveled by vehicles over a given network and unit of time.

- *Travel Demand Forecasting (TDF) Models* - models used by transportation planners to forecast future demand for transportation facilities. The output from typical TDF models includes forecasted vehicle flows on a schematic network of the area's highway system and the demand for transit ridership between origin and destination points.

- *Highway Capacity Manual (HCM)* - a documented set of procedures used by transportation analysts to determine maximum traffic flow rates and vehicle speeds and delays for a given set of traffic and highway geometric conditions.

- *Intermodal Surface Transportation Efficiency Act (ISTEA).* Federal legislation passed in 1991 that outlines surface transportation policy and programs through 1997.

- *Transformed Data.* Data that are calculated from directly-measured data using other data or assumptions based on research findings. Examples include the conversion of spot speed data to segment travel time data and the calculation of equivalent single axle loads (ESALs) from truck weight and pavement data.

1.2.2 Multiple Uses of ITS-Generated Data: A Brief History

The idea that real-time data from traffic and transit operations could be archived and used for planning purposes has been expressed many times, but institutional and technical barriers have worked against it. As ITS has grown, the potential for ITS to provide such data has been voiced in various contexts, for example, the Highway Performance Monitoring System (HPMS) Steering Committee on August 7, 1996. This was also one of the findings of a conference March 2-5, 1997, in Irvine, CA, on "Information Needs to Support State and Local Transportation Decision Making into the 21st Century." The mid-year meeting of the TRB planning committees on July 21, 1997, in Portland, ME, had a session on this topic.

Meanwhile within the USDOT, on March 27, 1997, the FHWA Office of Highway Information Management, FHWA Office of Environment and Planning, and the Joint Program Office for ITS sponsored a meeting to discuss the use of ITS for collecting data for planning, research, performance monitoring, and policy purposes. The participants discussed the potential for ITS in providing the data needed for planning, performance monitoring, and other transportation activities. They were concerned that currently there are no guidelines or specifications that cover the collection, manipulation, and retention of data generated by ITS for use in other transportation activities. One of the action items that resulted was to investigate the feasibility of establishing a new "planning" ITS user service and standards for the flow of data into the planning process. In subsequent meetings within USDOT, other modes indicated their interest and a workshop was proposed in order to assemble the stakeholders in ITS-generated data.

1.2.3 Stakeholders for ITS-Generated Data

Several stakeholder groups have been identified as having an interest in the use of data generated by ITS. Table 1.1 introduces these stakeholder groups along with their primary functions. (Chapter 2 expands the discussion of how data generated by ITS can be used to support specific stakeholder functions.) The number of stakeholder groups with an interest in archived data is much larger than for any other User Service, and is an indication of the complexity of the problem. The data needs of these stakeholders -- and how they can be met with data generated by ITS -- are the basis for the recommendations put forth in this document. It is noteworthy that significant beneficiaries of archived data are Traffic Management operators, whose systems collect the data in the first place. In addition to aiding current operations by establishing pre-determined operation plans (e.g., ramp metering rates), use of archived data will allow Traffic Management operators to move to the next level of control strategies: proactive plans that intervene prior to conditions worsening. This next level of control is sometimes referred to as modeling support for traveler information and traffic management, and it is expected to take on greater significance to the transportation profession in the near future.

Table 1.1. Stakeholders for Data Generated by ITS

Stakeholder Group	Primary Transportation-Related Functions	Example Applications
MPO and state transportation planners	Identifying multimodal passenger transportation improvements (long- and short-range); congestion management; air quality planning; develop and maintain forecasting and simulation models	! congestion monitoring ! link speeds for TDF and air quality models ! AADT, K- and D-factor estimation ! temporal traffic distributions ! truck travel estimation by time of day ! macroscopic traffic simulation ! parking utilization and facility planning ! HOV, paratransit, and multimodal demand estimation ! congestion pricing policy
Traffic management operators	Day-to-day operations of deployed ITS (e.g., Traffic Management Centers, Incident Management Programs)	! pre-planned control strategies (ramp metering and signal timing) ! highway capacity analysis ! saturation flow rate determination ! microscopic traffic simulation -- historical -- short-term prediction of traffic conditions ! dynamic traffic assignment ! incident management ! congestion pricing operations
Transit operators	Day-to-day transit operations: scheduling, route delineation, fare pricing, vehicle maintenance; transit management systems; evaluation and planning	! capital planning and budgeting ! corridor analysis planning ! financial planning ! maintenance planning ! market research ! operations/service planning ! performance analysis planning ! strategic/business planning
Air quality analysts	Regional air quality monitoring; transportation plan conformity with air quality standards and goals	! emission rate modeling ! urban airshed modeling
MPO/state freight and intermodal planners	Planning for intermodal freight transfer and port facilities	! truck flow patterns (demand by origins and destinations) ! HazMat and other commodity flow patterns
Safety planners and administrators	Identifying countermeasures for general safety problems or hotspots	! safety reviews of proposed projects ! high crash location analysis ! generalized safety relationships for vehicle and highway design ! countermeasure effectiveness (specific geometric and vehicle strategies) ! safety policy effectiveness
Maintenance personnel	Planning for the rehabilitation and replacement of pavements, bridges, and roadside appurtenances; scheduling of maintenance activities	! pavement design (loadings based on ESALs) ! bridge design (loadings from the "bridge formula") ! pavement and bridge performance models
Commercial vehicle enforcement personnel	Accident investigations; enforcement of commercial vehicle regulations	! HazMat response and enforcement ! congestion management ! intermodal access ! truck route designation and maintenance ! truck safety mitigation ! economic development
Emergency management services (local police, fire, and emergency medical)	Response to transportation incidents; accident investigations	! labor and patrol planning ! route planning for emergency response ! emergency response time planning ! crash data collection

Stakeholder Group	Primary Transportation-Related Functions	Example Applications
Transportation researchers	Development of forecasting and simulation models and other analytic methods; improvements in data collection practices	! car-following and traffic flow theory development ! urban travel activity analysis
Private sector users	Provision of traffic condition data and route guidance (Information Service Providers); commercial trip planning to avoid congestion (carriers)	

1.2.4 Overview of ITS Data Flows

The foundation for identifying ITS-generated data relevant for multiple purposes is the National ITS Architecture prepared for FHWA by several contractors. It has been produced as a series of documents totaling more than 5,000 pages. As stated in the Executive Summary Document:

> ITS technologies have been encapsulated in a collection of interrelated user services for application to the nation's surface transportation problems. To date, 30 user services have been identified, the most recent being the Highway Rail Intersection. This list of user services is neither exhaustive nor final. The user services have been bundled into six categories as shown (...in Table 1.2).
>
> ITS presents stakeholders with a variety of options to address their transportation needs. Left without adequate guidance, stakeholders could easily develop systems solutions to their needs which were incompatible with their regional neighbors. Put another way, if City A chooses to implement User Services one way, and a neighboring City B another, then it is a real possibility that a motorist/traveler would find that none of the ITS equipment or services purchased for use in City A would work in City B. To fully maximize the potential of ITS technologies, system design solutions must be compatible at the system interface level in order to share data, provide coordinated, area-wide integrated operations, and support interoperable equipment and services where appropriate. The National ITS Architecture provides overall this guidance to ensure system, product, and service compatibility and interoperability, without limiting the design options of the stakeholder.
>
> The National ITS Architecture provides a common structure for the design of intelligent transportation systems. It is not a system design nor is it a design concept. What it does is define the framework around which multiple design approaches can be developed, each one specifically tailored to meet the individual needs of the user, while maintaining the benefits of a common architecture noted above. The architecture defines the functions (e.g., gather traffic information or request a route) that must be performed to implement a given user service, the physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle), the interfaces/information flows between the physical subsystems, and the communication requirements for the information flows (e.g., wireline or wireless). In addition, it identifies and specifies the requirements for the standards needed to support national and regional interoperability, as well as product standards needed to support economy of scale considerations in deployment.

Table 1.2. User Services in the National ITS Architecture

User Services Bundle	User Services
Travel and Transportation Management	! En-Route Driver Information ! Route Guidance ! Traveler Services Information ! Traffic Control ! Incident Management ! Emissions Testing and Mitigation ! Demand Management and Operations ! Pre-trip Travel Information ! Ride Matching and Reservation ! Highway Rail Intersection
Public Transportation Operations	! Public Transportation Management ! En-Route Transit Information ! Personalized Public Transit ! Public Travel Security
Electronic Payment	! Electronic Payment Services
Commercial Vehicle Operations	! Commercial Vehicle Electronic Clearance ! Automated Roadside Safety Inspection ! On-board Safety Monitoring ! Commercial Vehicle Administration Processes ! Hazardous Materials Incident Response ! Freight Mobility
Emergency Management	! Emergency Notification and Personal Security ! Emergency Vehicle Management
Advanced Vehicle Control and Safety Systems	! Longitudinal Collision Avoidance ! Lateral Collision Avoidance ! Intersection Collision Avoidance ! Vision Enhancement for Crash Avoidance ! Safety Readiness ! Pre-Crash Restraint Deployment ! Automated Highway System

Specification of User Services is the method by which stakeholder needs are addressed by the National ITS Architecture. To develop functions that meet these needs, the National ITS Architecture converts the User Services into a large series of **subsystems** that are connected by real-time **data flows**. Each subsystem performs a unique set of functions. Data are collected by the subsystems and then shared through the data flows with other subsystems. Thus, each data flow in the National ITS Architecture has been created to assist the control functions of the ITS subsystems. An example of a data flow diagram is given as Figure 1.1 for Emergency Management. It shows the various subsystems that are involved with Emergency Management as well as the flow of data between the subsystems. Note that the data flows in this diagram represent general types of data; these are further broken down into specific data elements elsewhere in the National ITS Architecture. The general nature of the data flows and their associated data dictionary maintains the purpose of the National ITS Architecture, namely, that it serve as a blueprint for guidance in developing ITS; it is not meant to imply any specific system design.

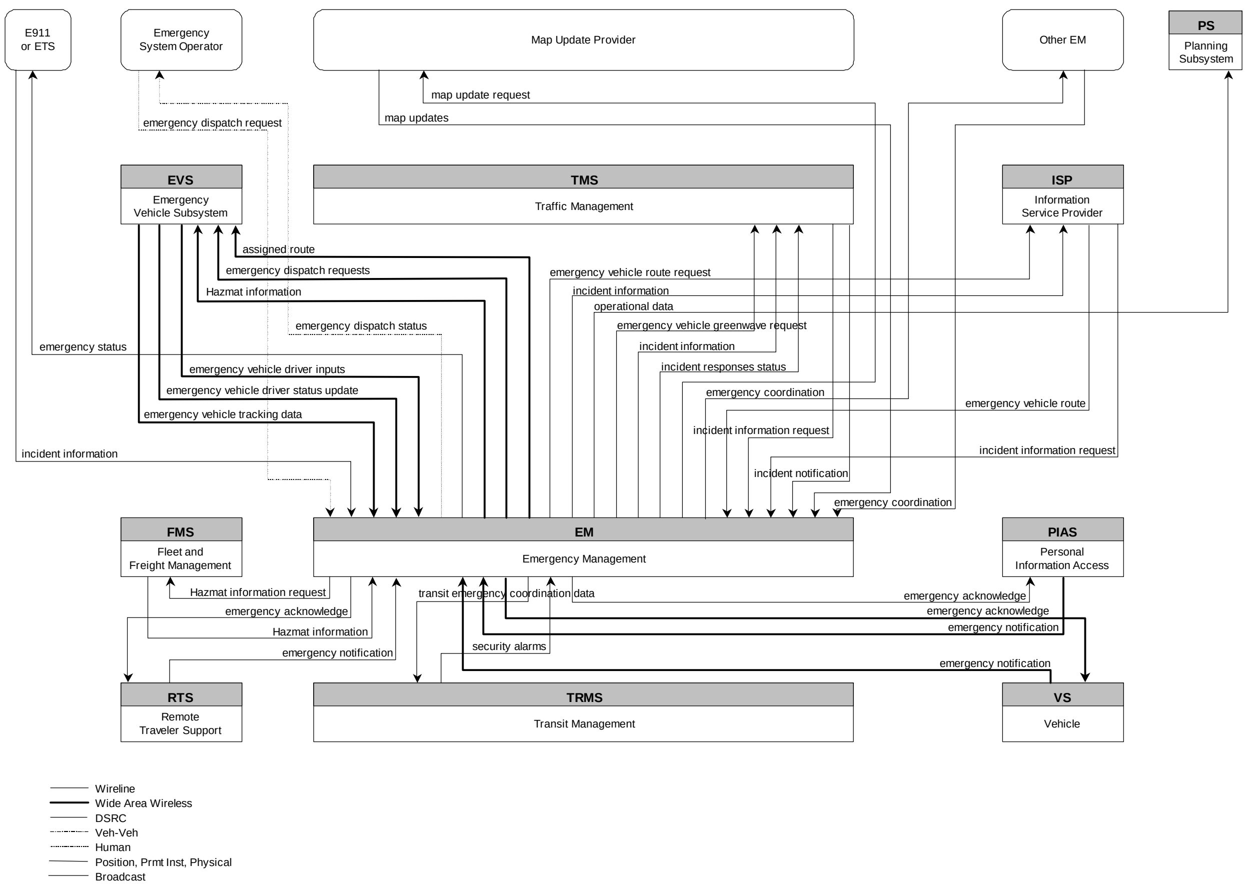

Figure 1.1. Architecture Flow Diagram for Emergency Management

A Planning Subsystem has also been defined in the National ITS Architecture (Figure 1.2). In its present form, the Planning Subsystem focuses on data for evaluating the performance of ITS and planning for future ITS. It is clear that the current Planning Subsystem is not as robust as required to meet the myriad needs of transportation planners. In addition, other stakeholders (see above) could benefit from use of the data and their needs should be considered. Therefore, it is anticipated that the formal Archived Data User Service for the National ITS Architecture being specified here would be used to modify or replace the current Planning Subsystem to account for the needs of other stakeholders.

The data flow diagrams in the National ITS Architecture serve as the initial basis for identifying ITS-generated data for multiple uses. For the most part, the data flows are based in real-time (or very close to real-time) and are used by the subsystems very shortly after they are collected. Multiple uses of the data for many forms of transportation planning, operations, and research will likely not need the data in any form approaching real-time and may not need the level of temporal detail represented in the raw data flows. Therefore, a key component of the Archived Data User Service is the structure for processing and storing data, both of which are discussed in detail in Chapter 4.

Table 1.3 presents a brief description of the selected data sources and representative data flows (i.e., data elements). In constructing Table 1.3, an attempt was made to match data generated by ITS with the needs of stakeholder groups. Thus, it is neither an exhaustive list of available data generated by ITS nor stakeholder needs. (For a complete discussion of data generated by ITS, the reader is referred to the National ITS Architecture documents. Appendix A provides recent efforts to document stakeholder needs.) The data sources correspond to subsystems in the National ITS Architecture but could be expanded to account for data sources not previously identified by that effort. (Some ITS deployments preceded the release of the National ITS Architecture.) The data elements shown in Table 1.3 roughly correspond to the those in the National ITS Architecture's data dictionary and can be used as a starting point for verifying that the National ITS Architecture accounts for all relevant data flows. These data elements are the basis for specific recommendations on the User Service structure presented in Chapter 4.

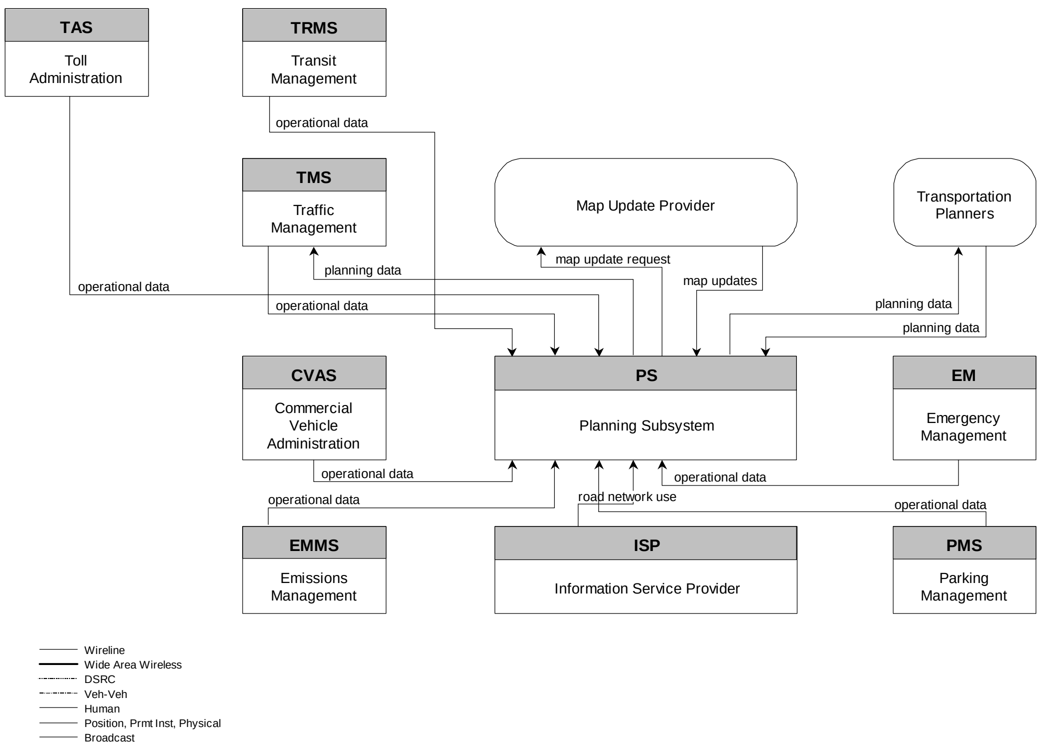

Figure 1.2. Architecture Flow Diagram for the Planning Subsystem

Table 1.3. ITS Data Relevant for Multiple (Nonreal-Time) Uses

Ref. No.	ITS data source	Primary data elements	Features of the Data Source: Typical collection equipment	Features of the Data Source: Spatial coverage	Features of the Data Source: Temporal coverage	Real-time uses	Possible multiple uses of ITS-generated data
FREEWAY AND TOLL COLLECTION							
1	Freeway traffic flow surveillance data	! volume ! speed ! occupancy	! loop detectors ! video imaging ! acoustic ! radar/ microwave	Usually spaced at <= 1 mile; by lane	Sensors report at 20-60 second intervals	! ramp meter timing ! incident detection ! congestion/queue identification	! Congestion monitoring ! Link speeds for TDF and air quality models ! AADT, K- and D-factors ! Saturation flow rates ! Pre-planned TMC operations
		! vehicle classification ! vehicle weight	! loop detectors ! WIM equipment ! video imaging ! acoustic	Usually 50-100 per state; by lane	Usually hourly	Pre-screening for weight enforcement	! Truck percents by time of day for TDF and air quality models ! Truck flow patterns ! Pavement loadings
2	Ramp meter and traffic signal preemptions	! time of preemption ! location	Field controllers	At traffic control devices only	Usually full-time	Priority to transit, HOV, and EMS vehicles	Network details for microscopic traffic simulation models (e.g., TRAF, TRANSIMS)
3	Ramp meter and traffic signal cycle lengths	! begin time ! end time ! location ! cycle length	Field controllers	At traffic control devices only	Usually full-time	Adapt traffic control response to actual traffic conditions	! Network details for microscopic traffic simulation models (e.g., TRAF,TRANSIMS) ! Pre-planned TMC operations
4	Visual and video surveillance data	! time ! location ! queue length ! vehicle trajectories ! vehicle classification ! vehicle occupancy	! CCTV ! aerial videos ! image processing technology	Selected locations	Usually full-time	! coordinate traffic control response ! congestion/queue identification ! incident verification	! Congestion monitoring ! Car-following and traffic flow theory
5	Vehicle counts from electronic toll collection	! time ! location ! vehicle counts	Electronic toll collections equipment	At instrumented toll lanes	Usually full-time	Automatic toll collection	Traffic counts by time of day
6	TMC generated traffic flow metrics (forecasted or transformed data)	! link congestion indices ! stops/delay estimates	TMC software	Selected roadway segments	Hours of TMC operation	! incident detection ! traveler information ! preemptive control strategies	! congestion monitoring ! effectiveness of prediction methods
ARTERIAL AND PARKING MANAGEMENT							
7	Arterial traffic flow surveillance data	! volume ! speed ! occupancy	! loop detectors ! video imaging ! acoustic ! radar/ microwave	Usually midblock at selected locations only ("system detectors")	Sensors report at 20-60 second intervals	! progression setting ! congestion/queue identification	! congestion monitoring ! link speeds for travel forecasting models (free flow only) ! AADT, K- and D-factors

Table 1.3. ITS Data Relevant for Multiple (Nonreal-Time) Uses

Ref. No.	ITS data source	Primary data elements	Features of the Data Source: Typical collection equipment	Features of the Data Source: Spatial coverage	Features of the Data Source: Temporal coverage	Real-time uses	Possible multiple uses of ITS-generated data
8	Traffic signal phasing and offsets	! begin time ! end time ! location ! up/down-stream offsets	Field controllers	At traffic control devices only	Usually full-time	Adapt traffic control response to actual traffic conditions	Network details for microscopic traffic simulation models (e.g., TRAF, TRANSIMS)
9	Parking management	! time ! lot location ! available spaces	Field controllers	Selected parking facilities	Usually day time or special events	Real-time information to travelers on parking availability	Parking utilization and needs studies
TRANSIT AND RIDESHARING							
10	Transit usage	! vehicle boardings (by time and location) ! station origin and destination (O/D) ! paratransit O/D	Electronic fare payment systems	Transit routes	Usually full-time	Used for electronic payment of transit fares	! route planning/ run-cutting ! ridership reporting (e.g., Section 15)
11	Transit route deviations and advisories	! route number ! time of advisory ! route segments taken	TMC software	Transit routes	Usually full-time	Transit route revisions	Transit route and schedule planning
12	Rideshare requests	! time of day ! O/D	CAD	Usually areawide	Day time, usually peak periods	Dynamic rideshare matching	! travel demand estimation ! transit route and service planning
INCIDENT MANAGEMENT AND SAFETY							
13	Incident logs	! location ! begin, notification, dispatch, arrive, clear, depart times ! type ! extent (blockage) ! HazMat ! Police accident rpt. reference ! cause	! CAD ! computer-driven logs	Extent of Incident Manage-ment Program	Extent of Incident Management Program	Incident response and clearance	! incident response evaluations (program effectiveness) ! congestion monitoring (e.g., % recurring vs nonrecurring) ! safety reviews (change in incident rates
14	Train arrivals at Highway Rail Intersections	! location ! begin time ! end time	Field controllers	At instru-mented HRIs	Usually full-time	! coordination with nearby traffic signals ! notification to travelers	Grade crossing safety and operational studies
15	Emergency vehicle dispatch records	! time ! O/D ! route ! notification, arrive, scene, leave times	CAD	Usually areawide	Usually full-time	Coordination of Emergency Management response	! Emergency management labor and patrol studies ! Emergency management route planning

Table 1.3. ITS Data Relevant for Multiple (Nonreal-Time) Uses

Ref. No.	ITS data source	Primary data elements	Features of the Data Source: Typical collection equipment	Features of the Data Source: Spatial coverage	Features of the Data Source: Temporal coverage	Real-time uses	Possible multiple uses of ITS-generated data
16	Emergency vehicle locations	! vehicle type ! time ! location ! response type	Automatic Vehicle Identification (AVI) or GPS equipment	Usually areawide	Usually full-time	! tracking vehicle progress ! green wave and signal preemption initiation	! Emergency management route planning ! Emergency management response time studies
17	Construction and work zone identification	! location ! date ! time ! lanes/ shoulders blocked	TMC software			Traveler information	Congestion monitoring
COMMERCIAL VEHICLE OPERATIONS							
18	HazMat cargo identifiers	! type ! container/ package ! route ! time	CVO systems	At reader and sensor locations	Usually full-time	! Identifying HazMat in specific incidents ! routes for specific shipments	! HazMat flows ! HazMat incident studies
19	Fleet Activity Reports	! carrier ! citations ! accidents ! inspection results	CVO inspections	N/A	Usually summarized annually	May overlap with SAFETYNET functions	
20	Cargo identification	! cargo type ! O/D	CVO systems	At reader and sensor locations	Usually full-time	Clearance activities	Freight movement patterns
21	Border crossings	! counts by vehicle type ! cargo type ! O/D	CVO systems	At reader and sensor locations	Usually full-time	Enforcement	Freight movement patterns
22	On-board safety data	! vehicle type ! cumulative mileage ! driver log (hrs. of service) ! subsystem status (e.g., brakes)	CVO systems	At reader and sensor locations	Usually full-time	Enforcement and inspection	Special safety studies (e.g., driver fatigue, vehicle components)
ENVIRONMENTAL AND WEATHER							
23	Emissions Management System	! time ! location ! pollutant concentrations ! wind conditions	Specialized sensors	Sensor locations	Usually full-time	Identification of hotspots and subsequent control strategies	! trends in emissions ! special Air Quality studies
24	Weather data	! location ! time ! precipitation ! temperature ! wind conditions	Environmental sensors	At sensor locations	Usually full-time	Traveler information	! congestion monitoring (capacity reductions) ! freeze/thaw cycles for pavement models
VEHICLE AND PASSENGER INFORMATION							

Table 1.3. ITS Data Relevant for Multiple (Nonreal-Time) Uses

Ref. No.	ITS data source	Primary data elements	Features of the Data Source: Typical collection equipment	Features of the Data Source: Spatial coverage	Features of the Data Source: Temporal coverage	Real-time uses	Possible multiple uses of ITS-generated data
25	Location referencing data	Special case; pertains to all location references in ITS and planning					Need conversion from lat/long to highway distance and location (e.g., milepost references for queue lengths)
26	Probe data	! vehicle ID ! segment location ! travel time	! probe readers and vehicle tags ! GPS on vehicles	GPS is areawide; readers restricted to highway locations	Usually full-time	! coordinate traffic control response ! congestion/queue identification ! incident detection ! real-time transit vehicle schedule adherence ! electronic toll collection	! congestion monitoring ! link speeds for travel forecasting models ! historic transit schedule adherence ! traveler response to incidents or traveler information ! O/D patterns
27	VMS messages	! VMS location ! time of msg ! msg content	TMC software	VMS locations	Hours of TMC operation	Traveler information	Effects of VMS message content on traveler response
28	Vehicle trajectories	! location (route) ! time ! speed ! acceleration ! headway	! AVI or GPS equipment ! advanced video image processing	AVI restricted to reader locations; GPS is areawide	1-10 second intervals	Collected as part of surveillance function	! Traffic simulation model calibration for local conditions (driver type distributions) ! Modal emission model calibration ! Traffic flow research
29	TMC and Information Service Provider generated route guidance	! time/date ! O/D ! route segments ! estimated travel time	TMC/Information Service Provider software	Usually areawide	Hours of TMC operation	Traveler information	! O/Ds for travel demand forecasting model inputs ! Interzonal travel times for travel demand forecasting model calibration
30	Parking and roadway (congestion) pricing changes	! time/date ! rte. segment/ lot ID ! new price	TMC software	Facilities subject to variable pricing	Hours of TMC operation	Demand management	! Special studies of traveler response to pricing ! Establishment of pricing policies