Guidance on Including ITS Elements in Transportation Projects

Federal Highway Administration
Office of Travel Management

January 2001

Guidance on Including ITS Elements in Transportation Projects

Purpose

The purpose of this document is to provide guidance for including ITS equipment/technologies as part of traditional transportation construction or maintenance projects.

Scope

This document is not intended to simplify the planning process, rather it is intended to help with a specific part of the planning process.

Intended Audience

The intended audience includes state and local transportation implementers and project developers as well as U.S. DOT field offices. Although planners are not the primary audience, close coordination between planners and transportation engineers is essential to the application of this guidance.

Incorporating ITS into Traditional Transportation Projects

An initial thought may be, "Why would I want to incorporate ITS into traditional transportation projects?" Although the traditional planning process is focused more on capacity expansion and capital improvement projects, ITS implementations across the country have provided many positive benefits such as system efficiency, safety improvements, and time and costs savings. One way for ITS deployments to maintain momentum and financial support is to incorporate ITS infrastructure within the scope of more traditional transportation projects. Incorporating ITS elements into other capital projects just makes good engineering, financial, and political sense. To do otherwise could later entail re-work of previous projects, resulting in lost time and money. More often than not, a lack of coordination in the construction schedules will lead to situations like the digging up of ITS communication cable for a lane widening project or digging up the pavement to lay the cable.

> *"Part of the I-15 Reconstruction project included the field devices and communications equipment of the ATMS. This helped to avoid conflicts in construction, as $72 million in ATMS equipment would never have competed well against the $1.59 billion in highway construction for priority."*
>
> *Excerpted from ITS America's Summer 2000 ITS Quarterly question and answer piece with Martin Knopp of the Utah Department of Transportation.*

One approach for installing ITS equipment/technologies during traditional transportation projects is to conduct a site-specific ITS assessment. A site-specific ITS assessment is a 3-step process. The assessment can be applied to a particular region, metropolitan planning area, or state, and should be conducted by state or local transportation engineers. The assessment requires some up-front "planning" with transportation staff followed by coordinating with project managers and contractors. Up-front planning for ITS is necessary so that ITS elements can be effectively programmed to be included in other transportation projects

(instead of being added at the last minute or overlooked altogether). Deploying ITS alongside and as an integral part of other transportation projects can result in saving time and money, minimization of re-work, and facilitating modernization and increased benefits such as improved safety and efficiency.

Conducting a Site-specific ITS Assessment

The 3 steps of a site-specific ITS assessment (see figure 1) are described in this section. Working through the steps of the assessment is an iterative process and should *not* be viewed as prescriptive, rather it is intended to provide a basis on which each region or state DOT can build an approach for incorporating ITS infrastructure into traditional transportation projects. Because a site-specific ITS assessment is intended to help with a specific part of the planning process, an overview of the transportation planning process is provided in appendix A. Helpful hints for using this approach are presented at the end of this document.

The **first step** of the site-specific assessment consists of taking an inventory of existing, planned, and future ITS infrastructure. The inventory should be as site- or location-specific as possible. Identify particular corridors, intersections, freeway sections, etc. where ITS elements would improve congestion, safety, and incident management. This initial step should be done independent of any particular project and should be taken across the region or metropolitan area.

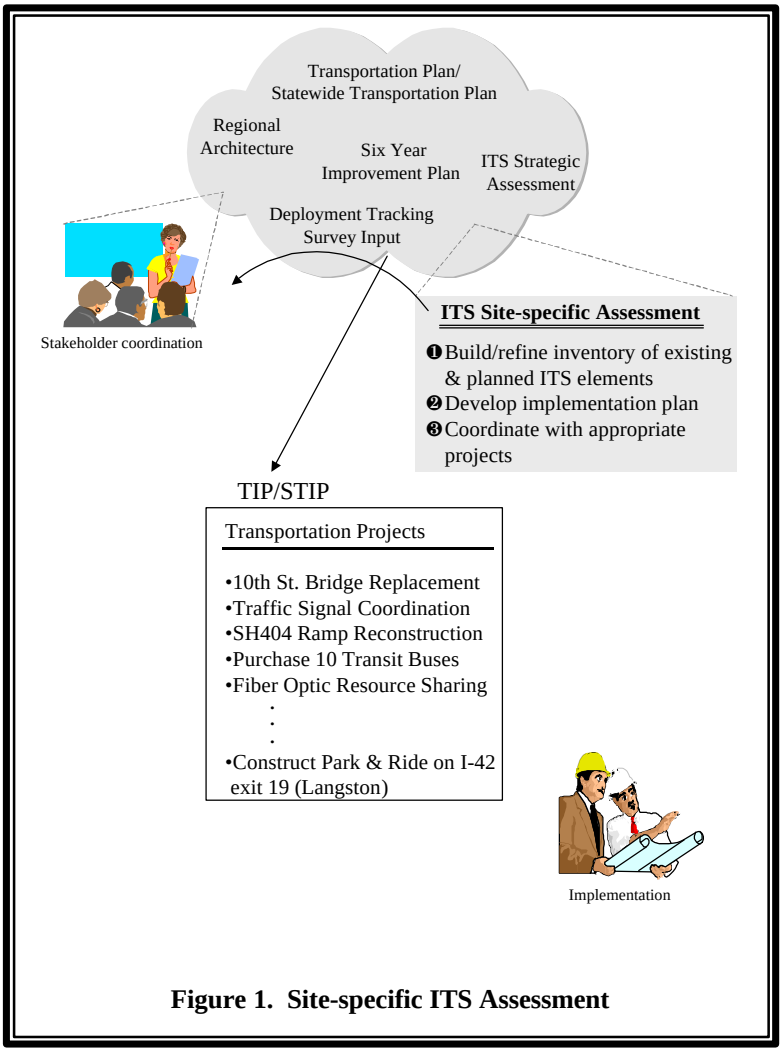


Figure 1. Site-specific ITS Assessment

In order to complete an effective ITS inventory, preliminary planning for ITS in your region should be completed or at least started. A great place to start is with your organization's input to the most recent metropolitan deployment tracking surveys and regional architecture if they exist for your area. The ITS inventory can be built from the inventory done in conjunction with the regional architecture. Other sources include agency-specific plans, ITS Early Deployment Plans, Statewide ITS Strategic Plans, and state or local DOT inventory lists. From this information you can build an inventory of ITS infrastructure elements that would best meet

the transportation issues and problems of your region. In building the ITS inventory keep in mind the functional requirements that need to be met by deploying ITS. Consider the technologies and equipment that are currently available and those available in the near term.

The ITS inventory can serve as a tool to ensure that ITS technology solutions are incorporated into capital improvement plans and that ITS projects are included in the TIP. The sample ITS inventory in figure 2 includes ITS elements that have been either deployed (**existing**), have been identified in the TIP or other plan (**planned**), or are identified as part of the future transportation needs of a region (**future**). This first step is an "up-front" exercise that will prepare your organization to partner with non-ITS projects planned for your region.

Happy Valley Regional ITS Inventory

ITS Inventory Item	**Status**
Upgraded signals and interconnect for centralized management (from a Transportation Management Center (TMC)) along the Rt.34A and Main Street corridors	Planned
Vehicle detection capability (e.g., radar, video imaging, and loops) along selected I-40 ramps and the Rt.34A and Main Street corridors	Future
Upgraded highway advisory radio (HAR) along major freeways	Existing
Color closed-circuit television (CCTV) cameras for traffic management, vehicle detection, and incident management along major freeways, bridges (15th Street & Dog River), and corridors	Future
Communication backbone to support ITS technologies along major freeways – Fiber optic cable along I-5 between exits 35 and 57 – Lay cable along I-16, I-29, & I-40 in Langston city limits	 Existing Planned
LED variable message signs (VMS) for traffic and incident information dissemination along I-16, I-29, & I-40 in Langston city limits	Future
Electronic toll collection (ETC) for I-16	Future
Traveler information kiosks at I-5 rest areas	Future
Lane control signals for I-16 toll road and major arterials	Future
Trapped vehicle detection and pedestrian gate and warning system at high volume rail/roadway intersections	Future
Automated vehicle location capability on transit buses	Future
Electronic fare payment system on new transit buses	Future
Weigh-in-Motion (WIM) at I-5 weigh stations	Future
Handheld safety inspection devices for commercial vehicle inspections	Existing

Figure 2. Sample ITS Inventory

The **second step** of the site-specific assessment is the development of an implementation plan. This step helps flesh out ITS priorities, needs, budgets, and timing/scheduling. Furthermore, it facilitates "mapping" ITS technologies to related traditional transportation projects. The ITS implementation plan is based on the contents of the ITS inventory. A first step in the implementation plan process is to begin bundling inventory items into candidate improvements, develop timing and phasing schedules, and set priorities and budgets. Each of the inventory

items should be assessed to factor in technologies, location, public/private stakeholders, costs, and priorities (see figure 3). Regional ITS decisions related to system wide or common infrastructure items such as communication backbone, toll tag technology, and NTCIP standards, although not reflected in figure 3, need to be considered and decided on. Information from the implementation plan can be used to coordinate deployment with capital projects. The implementation plan will probably go through several iterations and should be revised over time.

Once ITS equipment items (e.g., variable message signs, color CCTV camera, ramp meters) and quantities are known, a preliminary cost estimate, including capital costs and O&M costs, can be developed. ITS unit cost information is available from the Federal Highway Administration (FHWA) ITS Joint Program Office web site at http://www.its.dot.gov/eval/itsbenefits.htm. Other tools and resources available to assist in the development of ITS plans and projects can be found at the end of this document. A copy of the cost information is attached as appendix B.

The **third step** of a site-specific ITS assessment consists of matching up related ITS improvements and traditional projects identified in the Transportation Improvement Plan (TIP) or other planning documents. This includes coordinating any remaining planning, design, development, and deployment of these projects. Consider working ITS projects into private partnership projects such as installing CCTV cameras on cellular towers constructed by telecommunication companies via right-of-way agreements. Such private partnership projects may not be covered in transportation planning documents; however, knowledge of special agreements and projects can be identified through local ITS stakeholders.

Figure 4 highlights possible relationships between sample planned capital projects and sample ITS technologies. The objective is to identify which capital projects present good opportunities to implement items identified through the ITS site-specific assessment process. For example, highway construction and lane-widening projects are usually excellent opportunities to install telecommunication lines or conduits (for later use) to interconnect vehicle detection devices, variable message signs (VMSs), and other roadside ITS devices to a transportation management center (TMC). Likewise, the purchase of new transit buses and light-rail cars provides an opportunity to include ITS technologies such as automatic vehicle location (AVL) devices and other vehicle communication components. Note that the ITS infrastructure elements in figure 4 are not site-specific; however, that information is available in the ITS inventory and ITS implementation plan and does need to be considered when deciding on whether or not there is a good match.

Potential transportation projects identified in the mapping process can be added to the original ITS inventory list (see figure 5). For example, the I-40 lane construction project (063429) could be linked with the inventory entry for planned vehicle detection deployments along I-40. By continuing to add information to the ITS inventory, you can use it as a database for keeping track of your ITS needs and near-term projects. Appendix C contains a generic version of figure 4 demonstrating the connection between traditional capital projects and ITS infrastructure elements.

Happy Valley Regional ITS Implementation Plan

ITS inventory item	Status	Implementation Factors
Upgraded signals and interconnect for centralized management (from a Transportation Management Center (TMC)) along Rt.34A and Main Street corridors	Planned	Need comm infrastructure. Coordinate w/ vehicle count/detection project
Vehicle detection capability (e.g., radar, video imaging, and loops) along selected I-40 ramps and Rt.34A & Main Street corridors	Future	Radar technology good for I-40. Develop cost estimate for radar & video imaging.
Upgraded highway advisory radio (HAR) along major freeways	Existing	
Color closed-circuit television (CCTV) cameras for traffic management, vehicle detection, and incident management along major freeways, bridges (15th Street & Dog River), and corridors	Future	Need comm infrastructure. Cost estimate per camera ~$45K. Investigate mounting on existing structures.
Communication backbone to support ITS technologies along major freeways – Fiber optic cable along I-5 between exits 35 and 57 – Lay cable along I-16, I-29, & I-40 in Langston city limits	 Existing Planned	Near term priority. Research possibility of no cost installation in exchange for use of roadway right-of-way.
LED variable message signs (VMS) for traffic and incident information dissemination along I-16, I-29, & I-40 in Langston city limits	Future	Need comm infrastructure. Investigate sign technologies and costs – capital and O&M.
Electronic toll collection (ETC) for I-16	Future	Need comm infrastructure.
Traveler information kiosks at I-5 rest areas	Future	Low priority.
Lane control signals for I-16 toll road and major arterials	Future	Need comm infrastructure.
Trapped vehicle detection and pedestrian gate and warning system at high volume rail/roadway intersections	Future	Research incidents at Farmer Rd. and 8th Street.
Automated vehicle location capability on transit buses	Future	Develop cost estimates for AVL system.
Electronic fare payment system on new transit buses	Future	Develop cost estimates for card readers.
Weigh-in-Motion (WIM) at I-5 weigh stations	Future	Scope installation.
Handheld safety inspection devices for commercial vehicle inspections	Existing	

Figure 3. Sample ITS Implementation Plan

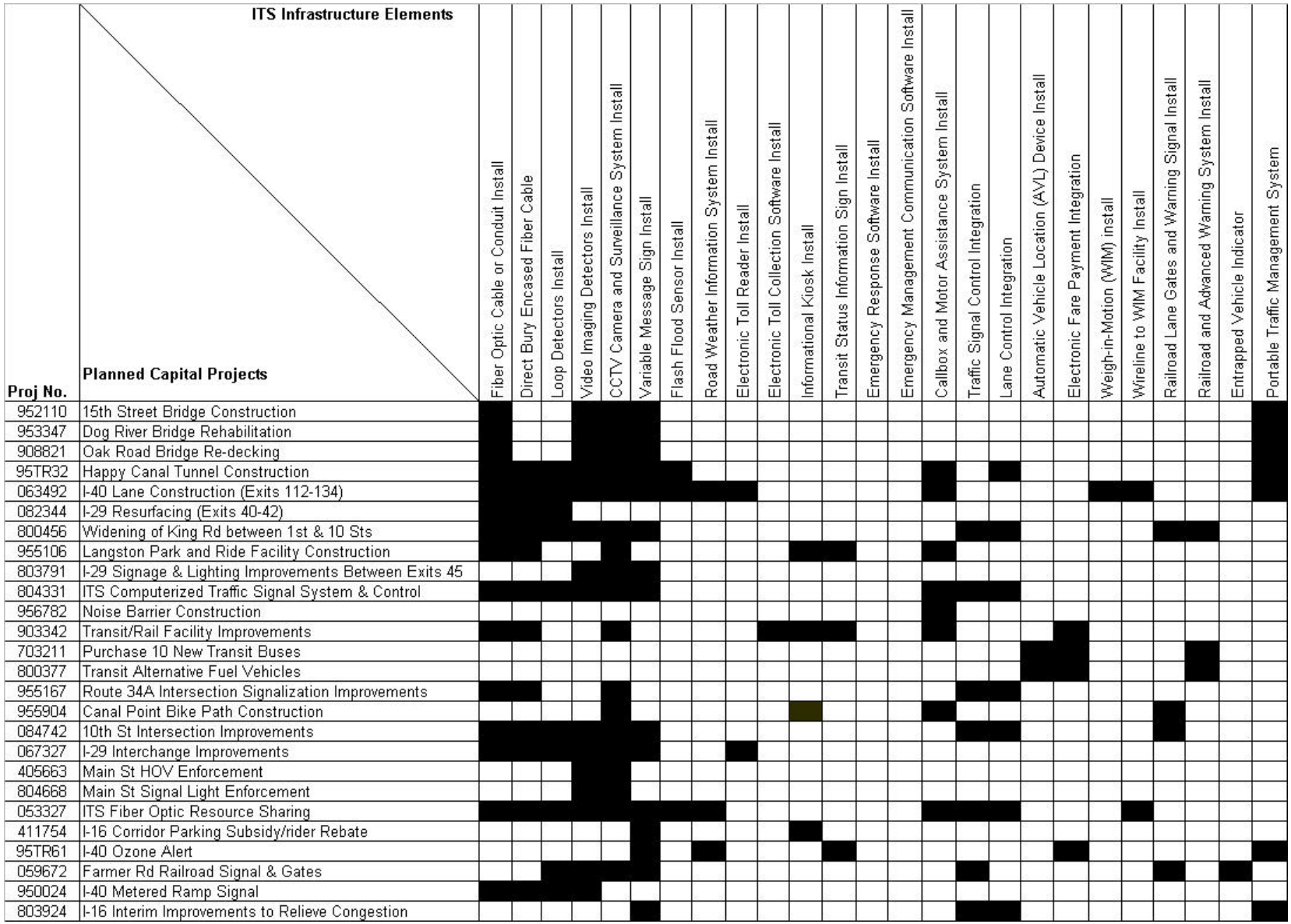


Figure 4. Sample Matrix Matching ITS Infrastructure to Related Site-specific Capital Projects (Happy Valley)

Happy Valley Regional ITS Inventory – *Revised*

ITS inventory item	Status	Implementation Factors	Projects
Upgraded signals and interconnect for centralized management (from a Transportation Management Center (TMC)) along Rt.34A and Main Street corridors	Planned	Need comm infrastructure. Coordinate w/ vehicle count/detection project	955167 804331
Vehicle detection capability (e.g., radar, video imaging, and loops) along selected I-40 ramps and Rt.34A & Main Street corridors	Future	Radar technology good for I-40. Develop cost estimate for radar & video imaging.	063492 405663 053327
Upgraded highway advisory radio (HAR) along major freeways	Existing		
Color closed-circuit television (CCTV) cameras for traffic management, vehicle detection, and incident management along major freeways, bridges (15th Street & Dog River), and corridors	Future	Need comm infrastructure. Cost estimate per camera ~$45K. Investigate mounting on existing structures.	952110 953347 908821 053327
Communication backbone to support ITS technologies along major freeways – Fiber optic cable along I-5 between exits 35 and 57 – Lay cable along I-16, I-29, & I-40 in Langston city limits	 Existing Planned	Near term priority. Research possibility of no cost installation in exchange for use of roadway right-of-way.	082344 067327 950024 053327
LED variable message signs (VMS) for traffic and incident information dissemination along I-16, I-29, & I-40 in Langston city limits	Future	Need comm infrastructure. Investigate sign technologies and costs – capital and O&M.	803791 95TR61 067327 053327
Electronic toll collection (ETC) for I-16	Future	Need comm infrastructure.	
Traveler information kiosks at I-5 rest areas	Future	Low priority.	
Lane control signals for I-16 toll road and major arterials	Future	Need comm infrastructure.	803924
Trapped vehicle detection and pedestrian gate and warning system at high volume rail/roadway intersections	Future	Research incidents at Farmer Rd. and 8th Street.	059672
Automated vehicle location capability on transit buses	Future	Develop cost estimates for AVL system.	703211
Electronic fare payment system on new transit buses	Future	Develop cost estimates for card readers.	703211
Weigh-in-Motion (WIM) at I-5 weigh stations	Future	Scope installation.	
Handheld safety inspection devices for commercial vehicle inspections	Existing		

Figure 5. Sample Revised ITS Inventory – Mapped to Capital Projects

There may be instances where there is no opportunity to work ITS projects into traditional highway projects. For example, a region may plan to install toll tag readers and related software to enable electronic toll collection, but there are no construction or maintenance projects planned for the existing toll plazas. In this case, and others similar to it, a separate ITS project must be undertaken. In some cases, it may even be desirable to plan for a separate ITS project (because of the nature and scope of the project, or because of schedule considerations). The ITS fiber optic resource sharing project (053327) listed in figure 4 is one example.

It is good engineering practice to communicate/coordinate with transportation planners and appropriate toll agency members to determine if, during the near term, any road construction or maintenance is likely to be scheduled. Coordination and communication between project owners and planners is critical in order to ensure ITS components are appropriately considered.

It is important to note that **close coordination** between project managers must occur as soon as a traditional transportation project has been identified as a potential match for an ITS project. Note that the mapping of ITS project to non-ITS project is not a one-to-one relationship. More than one non-ITS project could be matched with more than one ITS project, and vice versa. Also, note that the managing/contracting for the ITS elements of a bigger, highway construction project can be done separately as long as coordination occurs. Depending on the projects involved, separate contracts may be put in place, or some type of sub-contract let for the ITS elements. For example, when deploying VMS signs in conjunction with highway construction, the same contractor who will be constructing new lanes might also be under contract to lay the telecommunications conduit, and construct the VMS tower and controller cabinet foundations. An ITS contractor would then be responsible for selecting, purchasing, and integrating the actual VMSs. Regardless of the type of contracting arrangement chosen, coordinating the design, schedules, phasing, and cost control are all aspects that must be considered and worked to ensure that the projects are completed on-time, and with minimal interference.

Additional Resources and Tools:

- **ITS JPO Costs Database** – provides cost data that are useful in developing project cost estimates during the planning process (see appendix B). Cost data and background information are available for download or on-line at http://www.its.dot.gov/eval/itsbenefits.htm.
- **ITS Deployment Analysis System (IDAS)** – is a cost/benefit analysis tool for use in the planning of proposed ITS improvements. IDAS (http://idas.camsys.com) is available for purchase through McTrans Center at the University of Florida, mctrans@ce.ufl.edu.
- **Turbo Architecture** – assists transportation planners and system integrators in the development of regional and project architectures using the National ITS Architecture as a starting point. Turbo Architecture is available for purchase through McTrans Center at the University of Florida, mctrans@ce.ufl.edu.

- **ITS Mainstreaming at Maricopa County DOT (MCDOT)** – the process used by MCDOT for incorporating ITS into regional planning, design, procurement, and system operations is available at http://www.aztech.org/its.asp**.**

Helpful Hints:

- Communicate and coordinate with planners and project managers within your organization and from other agencies in your region
- Consider ITS solutions as part of TIP projects
- Review deployment tracking survey input from your region
- Determine if an ITS plan or strategy or regional architecture exists at the metropolitan, statewide, corridor, or multi-state level
- Check if the ITS plan is coordinated with the state, other Metropolitan Planning Organizations (MPOs), regional operations, other agencies (e.g., police, fire, incident management)
- Determine if the ITS plan is part of your twenty year Transportation Plan
- Look at Early Deployment Plans (EDPs) as a source for documentation of a regional architecture
- Determine if an ITS inventory has been performed for your area. If not, refer to your area's TIP and transportation plan, or input to the metropolitan surveys (e.g., MPO Survey, Freeway Survey)
- Use figures 2 and 3 as templates as starting points for building your inventory and site-specific ITS assessment
- Review your region's TIP for possible capital projects related to your ITS needs
- Look for opportunities to *piggyback* on capital projects identified in the TIP
- A good time to begin a site-specific ITS assessment is as a follow-on to development of a regional architecture
- Focus initially on ITS improvements needed in the near-to-mid term time frame, but don't overlook your future needs if they dovetail with other projects being implemented in your area
- Match ITS projects with traditional projects in the transportation plan adoption stage
- Talk with project managers about the possibilities of incorporating ITS elements into their capital projects 2-3 years out in order to get the "biggest bang for the buck." Depending upon the project, you may still be able to influence a project that is only 1 year out from implementation
- While going through regional transportation plans and other project/planning documents, identify projects for which ITS should be considered for later discussion with state/local transportation stakeholders (such as potential re-construction projects, or major widening being considered in long range plans)
- Don't forget about ITS during various construction projects
- Bring together the right group of stakeholders in developing an ITS implementation plan (step 2), as this will ensure that opportunities to coordinate with the planned projects of all affected agencies are considered
- Be sure to revisit your ITS implementation plan on a periodic basis to ensure that it maintains relevance and becomes an integral part of the local decision making process
- Develop initial cost estimates for the ITS projects using planning tools such as IDAS or the JPO ITS unit costs database (see Appendix A) as a starting point
- Look for opportunities to make planning for ITS a normal part of the regional planning process

APPENDIX A

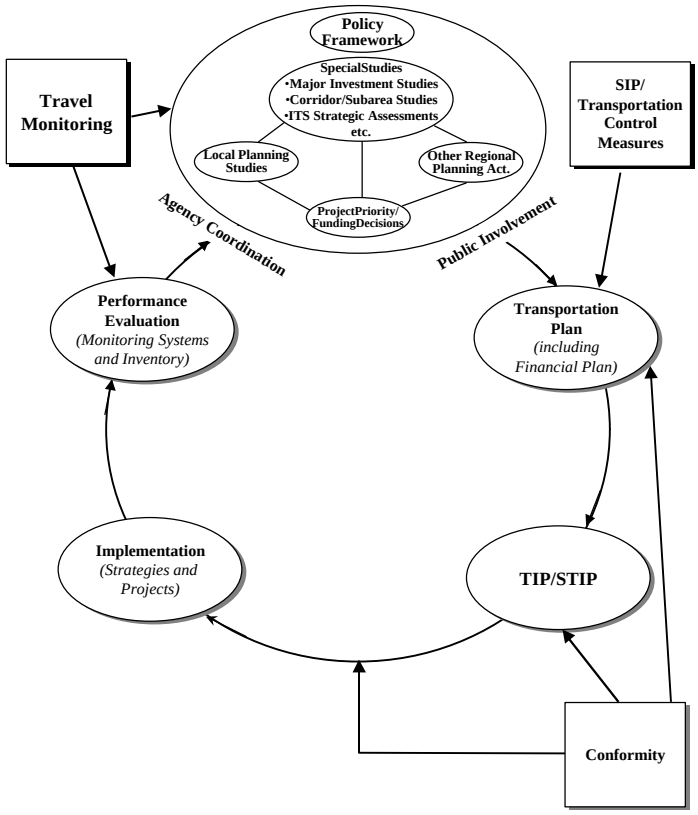
Transportation Planning Process/Project Cycle Overview

Transportation Planning Process/Project Cycle Overview

Although the focus of this document is a site-specific ITS assessment, an overview of the transportation planning process is provided as background information and to set the context for where the site-specific ITS assessment fits into the planning process. Figure 1 shows a sample overview of the transportation planning process. It is important to note that planning for ITS infrastructure deployment should not be a separate process from the regular transportation planning process nor require a change in the transportation planning process itself. Rather, it should be an integral part of the process.

The transportation planning process is an iterative process and has two primary products: the transportation plan and the Transportation Improvement Plan (TIP). Although not part of the planning process, implementation and evaluation are included to reflect the complete project cycle.

The items at the top of figure 1 represent a broad range of transportation planning activities necessary to develop long range transportation plans and identify specific near-term projects. Examples of these activities include establishing goals and policy, identifying project funding/programming, and conducting corridor/subarea studies and ITS strategic assessments. The corridor/subarea studies and ITS strategic assessments are used to consider different transportation strategies, including ITS, as possible solutions to the transportation problems of a geographical area. Products of the ITS strategic assessment include a regional ITS framework and regional architecture which lay out a regional approach or framework for implementing ITS. It is within the context of these planning activities that the ITS site-specific assessment would be conducted.



Source: "Integrating ITS within the Transportation Process: An Interim Handbook," January 1998.

Figure A-1. Overview of the Transportation Planning Process

Each state DOT and metropolitan area are required to periodically prepare a transportation plan and TIP. The transportation plan contains long range transportation plans for a region. The overall policy direction for a region is stated here along with projects and programs to be implemented over a 20-year period. ITS projects and strategies need to be included in the transportation plan. The TIP describes specific projects that will be implemented in the near-term (e.g., 3-5 years). In order to receive federal funding, ITS projects must be included in this plan.

> *"[An ITS strategic assessment] provides a mechanism for communicating potential ITS initiatives to other parts of the planning process. Other (non-ITS) projects may be able to integrate ITS elements more cost-effectively (e.g., along with a highway construction project) than if the ITS elements were implemented alone."*
>
> *Excerpted from "Integrating ITS Within the Transportation Process: An Interim Handbook," January 1998*

For more information on integrating ITS into the transportation planning process, refer to the resources provided below. Many of the documents are available from the Department of Transportation, Federal Highway Administration, ITS Joint Program Office Electronic Document Library (EDL) at http://www.its.dot.gov/welcome.htm.

Additional ITS Planning Resources

- "Incorporating ITS into Transportation Planning: Phase I Final Report," Revised, September 1997 (EDL #7548)
- "Integrating Intelligent Transportation Systems with the Planning Process: An Interim Handbook," January 1998 (EDL #3903)
- "Transportation Planning and ITS: Putting the Pieces Together," April 1998 (EDL #3683)
- "Incorporating ITS Solutions into the Metropolitan Transportation Planning Process, Overcoming Institutional Barriers, November 2000 (EDL # 13177)
- "Florida's ITS Planning Guidelines: Integration of ITS into the Transportation Planning Process," June 2000 (http://www.dot.state.fl.us/planning/)

APPENDIX B

JPO ITS Unit Costs Database

(See website http://www.its.dot.gov/eval/itsbenefits.htm for more information about this database)

ITS UNIT COST DATABASE (as of September 30, 2000)

Subsystem/Unit Cost Element	IDAS No.^	Lifetime* (years)	Capital Cost ($K)		O&M Cost ($K/yr)		Notes
			Low	High	Low	High	
Roadside Telecommunications (RS-TC)							
DS0 Communication Line	TC001	20	0.5	1	0.6	1.2	56Kbps capacity. Leased with typical distance from terminus to terminus is 8-15 miles, but most of the cost is not distance sensitive.
DS1 Communication Line	TC002	20	0.5	1	4.8	8.4	1.544Mbps capacity (T1 line). Leased with typical distance from terminus to terminus is 8-15 miles, but most of the cost is not distance sensitive.
DS3 Communication Line	TC003	20	3	5	24	72	44.736 Mbps capacity (T3 line). Leased with typical distance from terminus to terminus is 8-15 miles, but most of the cost is not distance sensitive.
ISP Service Fee	TC007				0.12	0.18	Monthly service fee ($10 to $15 per month).
Direct Bury Armor Encased Fiber Cable				60		0.02	Cost is per km.
Conduit Design and Installation - Corridor				65		0.02	Cost is per km.
Twisted Pair Intallation				12		0.02	Cost is per km.
Fiber optic Cable Installation				20		0.02	Cost is per km.
Telephone Drop			1	3	0.2	0.3	Cost is per drop.
Cellular Communication				0.5	0.3	0.4	Cost is for one unit.
900 MHz Spread Spectrum Radio				9	0.15	0.4	Cost is per link.
Microwave Communication				15	0.3	0.7	Cost is per link.
Wireless Communications, Low Usage	TC004				0.18	0.2	125 Kbytes/month available usage.
Wireless Communications, Medium Usage	TC005				0.6	0.7	1,000 Kbytes/month available usage.
Wireless Communications, High Usage	TC006	20	0.5	1	1.2	1.8	3,000 Kbytes/month available usage.
Roadside Detection (RS-D)							
Inductive Loop Surveillance on Corridor		5	3	8	0.5	0.8	Double set (4 loops) with controller, power, etc.
Inductive Loop Surveillance at Intersection		5	9	16	1	1.6	Four legs, 2 lanes/approach.
Machine Vision Sensor on Corridor			21.7	29	0.2	0.4	One sensor both directions of travel.
Machine Vision Sensor at Intersection			25.7	34	0.2	0.4	Four sensors, 4 leg intersection.
Passive Accoustic Sensor on Corridor			4.4	10	0.2	0.4	Two sensors both directions of travel.
Passive Accoustic Sensor at Intersection				15	0.2	0.4	Four sensors, 4 leg intersection.
Remote Traffic Microwave Sensor on Corridor				6	0.2	0.4	One sensor both directions of travel.
Remote Traffic Microwave Sensor at Intersection				18	0.2	0.4	Four sensors, 4 leg intersection.
CCTV Video Camera	RS007	10	10	50	0.2	1	Color video cameras. The low end of the range is specific to CCTV for arterial roads.
CCTV Video Camera Tower	RS008	20	18	50		0.9	Per camera location.
Flash Flood Sensors				30	0.3	0.6	Cost is per unit.
Blowing Dust/Visibility Sensors				20	0.3	0.6	Cost is per unit.
Roadside Control (RS-C)							
Linked Signal System LAN	RS002	20	40	70	0.4	0.8	Linked signal system LAN.
Signal Controller Upgrade for Signal Control	RS003	20	2.5	10	0.2	0.5	Per intersection.
Signal Controller			11	17.5	0.2	0.9	Includes installation of traffic signal controller per intersection.
Traffic Signal			95	115	2.4	3	Includes installation for one signal (four leg intersection). Costs range from traffic signal with inductive loop detection to non-intrusive detection.
Signal Preemption Receiver	RS004	5	2	8	0.05	0.2	Two per intersection.
Signal Controller Upgrade for Signal Preemption	RS005	10	2	5			Add-on to base capability (per intersection).
Ramp Meter	RS006	5	30	50	1.5	3.5	Per location. Includes controller, power, etc.
Software for Lane Control	RS011	20	25	50	2.5	5	Software and hardware at site. Software is off-the-shelf technology and unit price does not reflect product development.
Lane Control Gates	RS012	20	100	150	2	3	Per location.
Fixed Lane Signal	RS009	20	6	8	0.6	0.8	Cost per signal.
Roadside Information (RS-I)							
Roadside Message Sign	RS010	20	50	75	2.5	3.75	Fixed message board for HOV and HOT lanes.
Wireline to Roadside Message Sign	RS013	20	6	9			Wireline to CMS (0.5 mile upstation).
Variable Message Sign - Full Matric and Controller	RS015	20	48	120	2.4	6	Includes cost for small and large VMS.
Variable Message Sign Tower	RS016	20	100	150		5	Tower structures for VMS.
Variable Message Sign - Portable		14	21.5	25.5	1.2	2	Trailer mounted VMS (3-line, 8" character display); includes trailer, solar or diesel powered
Highway Advisory Radio	RS017	20	16	32	0.6	1	HAR
Roadside Weather Information System (RWIS)				75	1.4	2.4	Cost of Roadside Weather Information System (RWIS) does not include upgrade to detect blowing dust or flash flood.
Roadside Probe Beacon	RS020	5	5	8	0.5	0.8	Radio beacons (per location).
Roadside Rail Crossing (R-RC)							
Rail Crossing 4-Quad Gate, Signals	RS021	20	115	130	4.25	4.85	Gates and signals.
Rail Crossing Train Detector	RS022	20	16	21.5	0.77	1.03	Train detector circuitry and communication line from intelligent interface controller (IIC) to wayside interface equipment (WIE). Assume two track crossing with two 0.5 mile communication lines.
Rail Crossing Controller	RS023	10	8	10	0.4	0.5	Intelligent interface controller (IIC).
Rail Crossing Pedestrian Warning Signal, Gates	RS024	20	10	15	0.2	0.3	Pedestrian warning signal and gates.
Rail Crossing Trapped Vehicle Detector	RS025	10	25	30	1.25	1.5	Entrapped vehicle detection camera, with poles and controller.
Toll Plaza (TP)							
Electronic Toll Reader	TP001	10	2	5	0.2	0.5	Readers (per lane).
High-Speed Camera	TP002	10	5	10	0.5	1	Cost includes 1 camera/2 lanes.
Electronic Toll Collection Software	TP003	10	5	10			Includes COTS software and database.
Electronic Toll Collection Structure	TP004	20	10	15			Mainline structure.
Parking Management (PM)							
Entrance/Exit Ramp Meters		10	2	5	0.2	0.5	Ramp meters are used to detect and count vehicles entering/existing the parking facility. O&M costs based on annual service contract.
Tag Readers		10	2	5	0.2	0.5	Readers support electronic payment scheme. O&M costs based on annual service contract.
Database and Software for Billing & Pricing		10	10	15	1	2	Database system contains parking pricing structure and availability. O&M costs based on annual service contract.
Parking Monitoring System		10	14	46			Includes installation, detectors, and controllers.
Hardware		5	2	11.5	0.2	1.15	Hardware is the central computer system. O&M costs based on annual service contract.
Remote Location (RM)							
CCTV Camera	RM001	10	4	5	0.08	0.1	Interior fixed mount camera for security.
Integration of Camera with Existing Systems	RM002	10	2	2.5			Per location.
Informational Kiosk	RM003	7	9.55	50	0.955	5	Includes hardware, enclosure, installation, modem server, and map software for indoor and outdoor.
Integration of Kiosk with Existing Systems	RM004	7	2.2	27.4			Software costs are for COTS (low) and developed/outdoor (high).
Kiosk Upgrade for Interactive Usage	RM005	5	5	8	0.5	0.8	Interactive information display interface (upgrade from existing interface).
Kiosk Software Upgrade for Interactive Usage	RM006	5	10	12			Software is COTS.
Transit Status Information Sign		10		5.5			A LED display installed at transit terminal that provides status information on transit arrival.
Smart Card Vending Machine	RM007	5	37	40	1.85	2	Ticket vending machine for smart card.
Software, Integration for Smart Card Vending	RM008	20	3	5			Software is COTS.
Emergency Response Center (ER)							
Basic Facilities, Comm for Large Area	EM006		4000	4000	400	600	For population >750,000.
Basic Facilities, Comm for Medium Area	EM007		3200	3200	400	480	For population <750,000 and >250,000.
Basic Facilities, Comm for Small Area	EM008		2800	2800	400	420	For population <250,000.

ITS UNIT COST DATABASE (as of September 30, 2000)

Subsystem/Unit Cost Element	IDAS No.^	Lifetime* (years)	Capital Cost ($K)		O&M Cost ($K/yr)		Notes
			Low	High	Low	High	
Emergency Response Hardware	EM001	10	15	30	0.3	0.6	Includes 3 workstations.
Emergency Response Software	EM002	10	70	150	0.5	3.5	Includes emergency response plans database, vehicle tracking software, and real traffic coordination.
Emergency Response Labor	EM003				50	165	Two people. Salary costs are fully loaded including salary, overtime, overhead, benefits, etc.
Emergency Management Communications Software	EM004	20	5	10	2.5	5	Shared database between 4 sites. Cost is per site; software is COTS.
Hardware, Software Upgrade for E-911 and Mayday	EM005	10	105	180	1.7	2.5	Data communications translation software, E911 interface software, processor, and 3 workstations.
800 MHz. 2-way Radio		5		1.7		0.09	Cost is per radio.
Emergency Vehicle On-Board (EV)							
Communications Interface	EV001	10	0.3	2		0.02	Emergency vehicle communications. Cost is per vehicle.
Information Service Provider (ISP)							
Basic Facilities, Comm for Large Area	IS019		4000	4000	400	600	For population >750,000. (stand-alone)
Basic Facilities, Comm for Medium Area	IS020		3200	3200	400	480	For population <750,000 and >250,000. (stand-alone)
Basic Facilities, Comm for Small Area	IS021		2800	2800	400	420	For population <250,000. (stand-alone)
Information Service Provider Hardware	IS001	5	40.5	49.5	0.81	0.99	Includes 2 servers and 5 workstations.
Systems Integration	IS017	20	90	110			Integration with other systems.
Information Service Provider Software	IS002	20	275	550	13.75	27.5	Includes database software (COTS) and traffic analysis software.
Map Database Software	IS003	2	15	30			Software is COTS.
Information Service Provider Labor	IS004				175	250	2 Staff @ 50K to 75K and 1 staff @ 75K to 100K. Salary cost are fully loaded prices and include base salary, overtime, overhead, benefits, etc.
FM Subcarrier Lease	IS005				120	240	Cost is per year.
Hardware Upgrade for Interactive Information	IS006	5	18.9	23.1	0.378	0.462	Includes 1 server and 2 workstations.
Software Upgrade for Interactive Information	IS007	20	250	500	12.5	25	Trip planning software (includes some development costs).
Added Labor for Interactive Information	IS008				100	150	1 Staff @ 50K to 75K. Salary cost are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Software Upgrade for Route Guidance	IS009	20	250	500	12.5	25	Route selection software. Software is COTS.
Map Database Upgrade for Route Guidance	IS010	2	100	200			Map database software upgrade.
Hardware Upgrade for Emergency Route Planning	IS011	5	13.5	16.5	0.27	0.33	Includes 1 server.
Software Upgrade for Emergency Route Planning	IS012	20	50	100	2.5	5	Route guidance software. Software is COTS.
Hardware Upgrade for Dynamic Ridesharing	IS013	5	5.4	6.6	0.108	0.132	Includes 2 workstations.
Software Upgrade for Dynamic Ridesharing	IS014	20	100	200	5	10	Software includes some development cost.
Added Labor for Dynamic Ridesharing	IS015				100	150	1 Staff @ 50K to 75K for 2 shifts. Salary cost are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Liability Insurance for Dynamic Ridesharing	IS016				50	100	50K to 100K per year.
Software Upgrade for Probe Information Collection	IS018	20	250	500	12.5	25	Software includes COTS and some development cost.
Cable TV Traffic Channel Hardware		5		19			Includes hyperconverter, Pentium PC, TV, converter card, video mux, and demux.
Cable Channel Airtime						78	Cost is per year.
Transportation Management Center (TM)							
Basic Facilities, Comm for Large Area	TM040		4000	4000	400	600	For population >750,000.
Basic Facilities, Comm for Medium Area	TM041		3200	3200	400	480	For population <750,000 and >250,000.
Basic Facilities, Comm for Small Area	TM042		2800	2800	400	420	For population <250,000.
Hardware for Signal Control	TM001	5	15	30			Includes 3 workstations.
Software, Integration for Signal Control	TM006	5	180	220			Software and integration, installation and 1 year maintenance. Software is COTS.
Labor for Signal Control	TM002				486	594	Costs include labor for operations (2 @ 50% of the time, at 100K), transportation engineer (1 at 50% of the time, at 100K), update timing plans (2K per system per month for every 10 systems), and signal maintenance technician (2 @ 75K). Salary cost are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Hardware, Software for Traffic Surveillance	TM003	20	135	165	6.75	8.25	Processor and software.
Integration for Traffic Surveillance	TM032	20	225	275	11.25	13.75	Integration with other systems.
Hardware for Freeway Control	TM004	5	15	30			Includes 3 workstations.
Software, Integration for Freeway Control	TM007	5	180	220			Software and integration, installation and 1 year maintenance. Software is off-the-shelf technology and unit price does not reflect product development.
Labor for Freeway Control	TM005				225	275	Labor for operations (2 @ 50% of 100K) and maintenance technicians (2 @ 75K). Salary cost are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Hardware for Lane Control	TM008	5	5.4	6.6	0.27	0.33	Includes 1 workstation and 19" monitor.
Software, Integration for Lane Control	TM009	10	225	275	11.25	13.75	Software development and integration and software upgrade for controllers. Software development is fine tune adjustments for local installations. Otherwise, software is COTS.
Labor for Lane Control	TM010				90	110	Labor for 2 operators @ 50% of 100K.
Software, Integration for Regional Control	TM011	10	300	440			Software and integration, installation and 1 year maintenance. Integration with other TMC's. Software is COTS.
Labor for Regional Control	TM012				180	220	Labor for operators (2 @ 50% of 100K), transportation engineer (1 @ 50% of 100K), and maintenance contract. Salary costs are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Video Monitors, Wall for Incident Detection	TM013	5	40.5	49.5	2.025	2.475	Includes 5 19" video monitors and video wall monitors (3x3=9 monitors w/switch).
Hardware for Incident Detection	TM014	5	81.7	119.3	4.085	5.965	Includes 4 servers, 5 workstations, and 2 laser printers.
Integration for Incident Detection	TM025	20	90	110	4.5	5.5	Integration with other systems.
Software for Incident Detection	TM015	5	90	110	4.5	5.5	Software is COTS and includes development cost
Labor for Incident Detection	TM016				630	770	Labor for operators (4 @ 100K and 1 manager @ 150K) and 2 maintenace techs @ 75K.
Video Monitor for Incident Response	TM017	5	2.7	3.3	0.135	0.165	Includes 1 19" monitor.
Hardware for Incident Response	TM018	5	2.7	3.3	0.135	0.165	Includes 1 workstation.
Integration for Incident Response	TM026	20	180	220			Integration with other systems.
Software for Incident Response	TM019	2	13.5	16.5	0.675	0.825	Software is COTS.
Labor for Incident Response	TM020				90	110	Labor for incident management coordinator (1 @ 100K).
Automated Incident Investigation System		5		15			Includes workstation, tripod, monopole antenna, Auto Integration, and AutoCAD software.
Hardware for Traffic Information Dissemination	TM021	5	5	10	0.25	0.5	Includes 1 workstation.
Software for Traffic Information Dissemination	TM022	5	18	22	0.9	1.1	Software is COTS.
Integration for Traffic Information Dissemination	TM023	20	90	110	4.5	5.5	Integration with other systems.
Labor for Traffic Information Dissemination	TM024				90	110	Labor for 1 operator @ 100K. Salary costs are fully loaded and include base salary, overtime, overhead, benefits, etc.
Software for Dynamic Electronic Tolls	TM027	5	22.5	27.5	1.125	1.375	Includes software installation and 1 year maintenance. Software is COTS.
Integration for Dynamic Electronic Tolls	TM028	20	90	110	4.5	5.5	Integration with other systems.
Hardware for Probe Information Collection	TM033	3	5	10	0.5	1	Includes 1 workstation.
Software for Probe Information Collection	TM034	5	18	22	1.8	2.2	Includes software installation and 1 year maintenance. Software is COTS.
Integration for Probe Information Collection	TM035	20	135	165	13.5	16.5	Integration with other systems.
Labor for Probe Information Collection	TM036				45	55	Labor for 1 operator (4 hours per day @ 100K/year). Salary costs are fully loaded prices and include base salary, overtime, overhead, benefits, etc.
Software for Rail Crossing Monitor	TM037	5	18	22	1.8	2.2	Includes software installation and 1 year maintenance. Software is COTS.
Integration for Rail Crossing Monitor	TM038	20	90	110			Integration with other systems.
Labor for Rail Crossing Monitor	TM039				45	55	Operators (1 @ 50% of 100K). Salary costs are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Transit Management Center (TR)							
Basic Facilities, Comm for Large Area	TR014		4000	4000	400	600	For population >750,000.
Basic Facilities, Comm for Medium Area	TR015		3200	3200	400	480	For population <750,000 and >250,000.

ITS UNIT COST DATABASE (as of September 30, 2000)

Subsystem/Unit Cost Element	IDAS No.^	Lifetime* (years)	Capital Cost ($K)		O&M Cost ($K/yr)		Notes
			Low	High	Low	High	
Basic Facilities, Comm for Small Area	TR016		2800	2800	400	420	For population <250,000.
Transit Center Hardware	TR001	10	15	30			Includes 3 workstations.
Transit Center Software, Integration	TR002	20	815	1720	6	12	Includes vehicle tracking & scheduling, database & information storage, schedule adjustment software, real time travel information software, and integration. Software is COTS.
Transit Center Additional Building Space	TR003				6	9	Additional space required for ITS technology - $12-$18 / sq.ft., 500 sq.ft.
Transit Center Labor	TR004				50	250	Labor for 3 staff @ 75K. Salary cost are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Upgrade for Auto. Scheduling, Run Cutting, or Fare Payment	TR005	20	20	40	0.4	0.8	Processor/software upgrade, installation and 1 yr. maintenance (for processor). Software is COTS.
Integration for Auto. Scheduling, Run Cutting, or Fare Payment	TR012	20	225	500			Integration with other systems.
Further Software Upgrade for E-Fare Payment	TR013	20	40	60	0.8	1.2	Software upgrade. Software is COTS.
Vehicle Location Interface	TR007	20	10	15			Vehicle location interface.
Vehicle Location Equipment				275		16.5	
Video Monitors for Security System	TR008	10	15	20	0.75	1	Five per site.
Hardware for Security System	TR009	10	55	90	1.1	1.8	Includes 1 server and 3 workstations.
Integration of Security System with Existing Systems	TR010	20	250	500			Integration with other systems.
Labor for Security System	TR011				202	247	Labor for 3 staff @ 75K each. Salary cost are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Toll Administration (TA)							
Toll Administration Hardware	TA001	5	10	15	1	1.5	Includes Pentium PC with 1G hard drive, 2 workstations, printer, and modem.
Toll Administration Software	TA002	10	40	80	4	8	Includes local database and national database coordination. Software is COTS.
Transit Vehicle On-Board (TV)							
Driver Interface and Schedule Processor	TV001	10	0.3	0.5	0.006	0.01	On-board schedule processor and database.
Cell Based Communication Equipment	TV002	10	0.15	0.25	0.0075	0.0125	Cell-based radio with data capacity.
GPS/DGPS for Vehicle Location	TV003	10	0.5	0.8	0.01	0.016	AVL GPS/DGPS.
Signal Preemption Processor	TV004	10	0.3	0.6	0.006	0.01	On-board schedule processor and database.
Trip Computer and Processor	TV005	10	0.1	0.15	0.002	0.003	On-board processor for trip reporting and data storage.
Security Package	TV006	10	4.2	5.3	0.21	0.265	On-board CCTV surveillance camera and hot button.
Electronic Farebox	TV007	10	0.8	1.5	0.04	0.075	On-board flex fare system DBX processor, on-board farebox, and smart card reader.
Commercial Vehicle Administration (CA)							
Commercial Vehicle Admin Hardware	CA001	10	15	30	0.3	0.6	Includes 3 workstations.
Commercial Vehicle Admin Software, Integration	CA002	20	200	220	4	4.4	Includes processor and integration. Software is COTS .
Commercial Vehicle Admin Labor	CA003				270	330	Labor for 4 staff @ 75K (average). Salary costs are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Software Upgrade for Electronic Credential Purchasing, Mgt	CA004	20	60	140	1.2	2.8	Electronic credentials purchase software, database and management for post-trip processing & E-credentials.
Software Upgrade for Inter-Agency Info Exchange	CA005	20	20	40	0.4	0.8	Processor and integration add-on. Software is COTS.
Added Labor for Inter-Agency Info Exchange	CA006				67	82	Labor for 1 staff @ 75K (average). Salary cost are fully loaded prices including base salary, overtime, benefits, etc.
Software Upgrade for Safety Administration	CA007	20	40	80	0.8	1.6	Database add-on, software, and integration. Software is COTS.
Commercial Vehicle Check Station (CC)							
Check Station Structure	CC001	20	50	75			Roadside structure - mainline w/ lane indicator signals.
Signal Board	CC002	10	10	15	1	1.5	Roadside signal board.
Signal Indicator	CC003	20	5	10	0.25	0.5	Signal indicator system.
Roadside Beacon	CC004	10	5	8	0.5	0.8	Roadside beacon used for electronic screening (not included in roadside subsystem). Beacon repair/replacement maintenance.
Wireline to Roadside Beacon	CC005	20	10	20			Dedicated wireline communication from beacon to roadside (1 mile upstream).
Check Station Software, Integration	CC006	20	180	215			Software, processor and integration.
Check Station Hardware	CC007	10	0.3	0.5	0.006	0.01	Includes 1 workstation.
Detection System	CC008	10	50	75	2.5	3.75	Commercial vehicle communication interface and communication device (cell based radio).
Software Upgrade for Safety Inspection	CC009	20	40	80	0.8	1.6	Safety-database add-on, and result writing to vehicle tag processor add-on. Software is COTS.
Handheld Safety Devices	CC010	5	3	5	0.3	0.5	For commercial vehicle inspection. The devices either measure data themselves or read data from the vehicle. Three per location.
Software Upgrade for Citation and Accident Recording	CC011	20	20	40	1	2	Software add-on for recording of citation and accident information to the commercial vehicle.
Weigh-In-Motion Facility	CC012	10	14	21	1.4	2.1	Includes WIM fixed load cell and interface to roadside facility. Software is COTS.
Wireline to Weigh-In-Motion Facility	CC013	10	1	2	0.1	0.2	Wireline communication (local line).
Commercial Vehicle On-Board (CV)							
Electronic ID Tag	CV001	10	0.65	1.1	0.013	0.022	Includes ID tag, additional software & processing, and database storage. Software is COTS.
Communication Equipment	CV002	10	1.15	2.25	0.0075	0.0125	Commercial vehicle communication interface and communication device (cell-based radio).
Central Processor and Storage	CV003	10	0.3	0.5	0.006	0.01	Equipment on board for the processing and storage of cargo material.
GPS/DGPS	CV004	10	0.3	0.5	0.006	0.01	GPS for vehicle location.
Driver and Vehicle Safety Sensors, Software	CV005	10	1.1	2.2	0.04	0.08	Additional software and processor for warning indicator and audio system interface, and onboard sensors for engine/vehicle and driver. Software is COTS.
Cargo Monitoring Sensors and Gauges	CV006	10	0.17	0.35	0.017	0.035	Optional on-board sensors for measuring temperature, pressure, and load leveling.
Fleet Management Center (FM)							
Fleet Center Hardware	FM001	10	15	30	0.3	0.6	Costs include 3 workstations.
Fleet Center Software, Integration	FM002	20	215	500			Includes processor and integration. Software is COTS.
Fleet Center Labor	FM003				337	412	Labor for 5 staff @ 75K. Salary costs are fully loaded prices including base salary, overtime, overhead, benefits, etc.
Software for Electronic Credentialing, Clearance	FM004	20	80	180			Includes electronic credential purchase software, database and management for trip reports, and database management for preclearance. Software is COTS.
Software for Tracking and Scheduling	FM005	20	40	100	4	10	Vehicle tracking and scheduling. Software is COTS.
Vehicle Location Interface	FM006	20	10	15			Vehicle location interface from FMS to TMS.
Software Upgrade for Fleet Maintenance	FM007	20	20	40	0.4	0.8	Processor/software upgrade to add capability to automatically generate preventative maintenance schedules from vehicle mileage data. Software is COTS.
Integration for Fleet Maintenance	FM008	20	100	200	2	4	Integration with other systems.
Software Upgrade for HAZMAT Management	FM009	20	20	40	0.4	0.8	Vehicle tracking & scheduling enhancement. Software is COTS.
Hardware Upgrade for HAZMAT Management	FM010	10	5	10	0.1	0.2	Includes 1 workstation.
Vehicle On-Board (VS)							
Communication Equipment	VS001	7	0.2	0.4	0.004	0.008	Wireless data transceiver.
In-Vehicle Display	VS002	7	0.05	0.1	0.001	0.002	In-vehicle display/warning interface. Software is COTS.
In-Vehicle Signing System	VS003	7	0.16	0.4	0.0032	0.008	Interface to active tag reader, processor for active tag decode, and display device for messages.
GPS/DGPS	VS004	7	0.25	0.5	0.005	0.01	Global Positioning System/Differential Global Positioning Systems.
GIS Software	VS005	7	0.2	0.3			Geographical Information System (GIS) software for performing route planning.
Route Guidance Processor	VS006	7	0.1	0.15	0.002	0.003	Limited processor for route guidance functionality.
Sensors for Lateral Control	VS007	7	0.8	1.1	0.016	0.022	Includes lane sensors in vehicle and lateral sensors MMW radar.
Electronic Toll Equipment	VS008	7	0.04	0.1			Active tag interface and debit/credit card interface.
Mayday Sensor and Processor	VS009	7	0.15	0.65	0.003	0.013	Collision detector sensor and interface for Mayday processor. Software is COTS.
Sensors for Longitudinal Control	VS010	7	0.3	0.5	0.006	0.01	Longitudinal sensors MMW radar.
Advanced Steering Control	VS011	7	0.5	0.6	0.01	0.012	Advanced steering control ("hands off" driving). Software is COTS.
Advanced Cruise Control	VS012	7	0.15	0.3	0.003	0.006	Adaptive cruise control (automatic breaking and accelerating)

ITS UNIT COST DATABASE (as of September 30, 2000)

Subsystem/Unit Cost Element	IDAS No.^	Lifetime* (years)	Capital Cost ($K)		O&M Cost ($K/yr)		Notes
			Low	High	Low	High	
Intersection Collision Avoidance Processor, Software	VS013	7	0.28	0.55	0.0056	0.011	Software/processor for infrastructure transmitted information, interface to in-vehicle signing and audio system, software and processor to link to longitudinal and lateral vehicle control modules based on input signal from vehicle intersection collision warning equipment package. Software is COTS.
Vision Enhancement System	VS014	7	1.2	2.2	0.06	0.11	In-vehicle camera, software & processor, heads-up display, and infra-red sensors (local sensor system). Software is COTS.
Driver and Vehicle Safety Monitoring System	VS015	7	0.66	1.25	0.033	0.0625	Safety collection processor and software, driver condition sensors, six vehicle condition sensors (@ $50 each), and vehicle data storage. Software is COTS.
Pre-Crash Safety System	VS016	7	1.1	2.15	0.037	0.067	Vehicle condition sensors, vehicle performance sensors, software/processor, interface, pre-crash safety systems deployment actuators. Software is COTS.
Software, Processor for Probe Vehicle	VS020	7	0.05	0.15	0.001	0.003	Software and processor for communication to roadside infrastructure, signal generator, message generator. Software is COTS.
Active Tag		7	0.02	0.05	0.002	0.005	Read-only vehicle tag.
Passive Tag		5		0.015			Vehicle tag that can be updated (writable).
In-Vehicle Navigation System		7		2.8			COTS product that includes in-vehicle display amd supporting software.
Personal Devices (PD)							
Basic PDA	PD001	7	0.25	0.4	0.005	0.008	Personal digital assistant.
Advanced PDA for Route Guidance, Interactive Information	PD002	7	0.5	0.75	0.01	0.015	Personal digital assistant with advanced capabilities (route guidance, interactive).
Modem Interface, Antenna for PDA	PD003	7	0.18	0.25	0.0036	0.005	Modem interface and separate antenna for wireless capability.
PDA with Wireless Modem		5		1.33			Personal digital assistant with wireless modem.
Software Upgrade for Interactive Information		7	0.1	0.2	0.002	0.004	Software is COTS.
GPS/DGPS	PD005	7	0.5	0.8	0.025	0.04	GPS/DGPS.
GIS Software	PD006	7	0.1	0.15	0.005	0.0075	Additional GIS/GUI capability.

^ Applicable only to unit cost elements used in IDAS
* Not available for several equipment or subsystems
COTS - Commercial off-the-shelf

APPENDIX C

Generic Sample Matrix Mapping ITS Infrastructure to Related Traditional Capital Projects

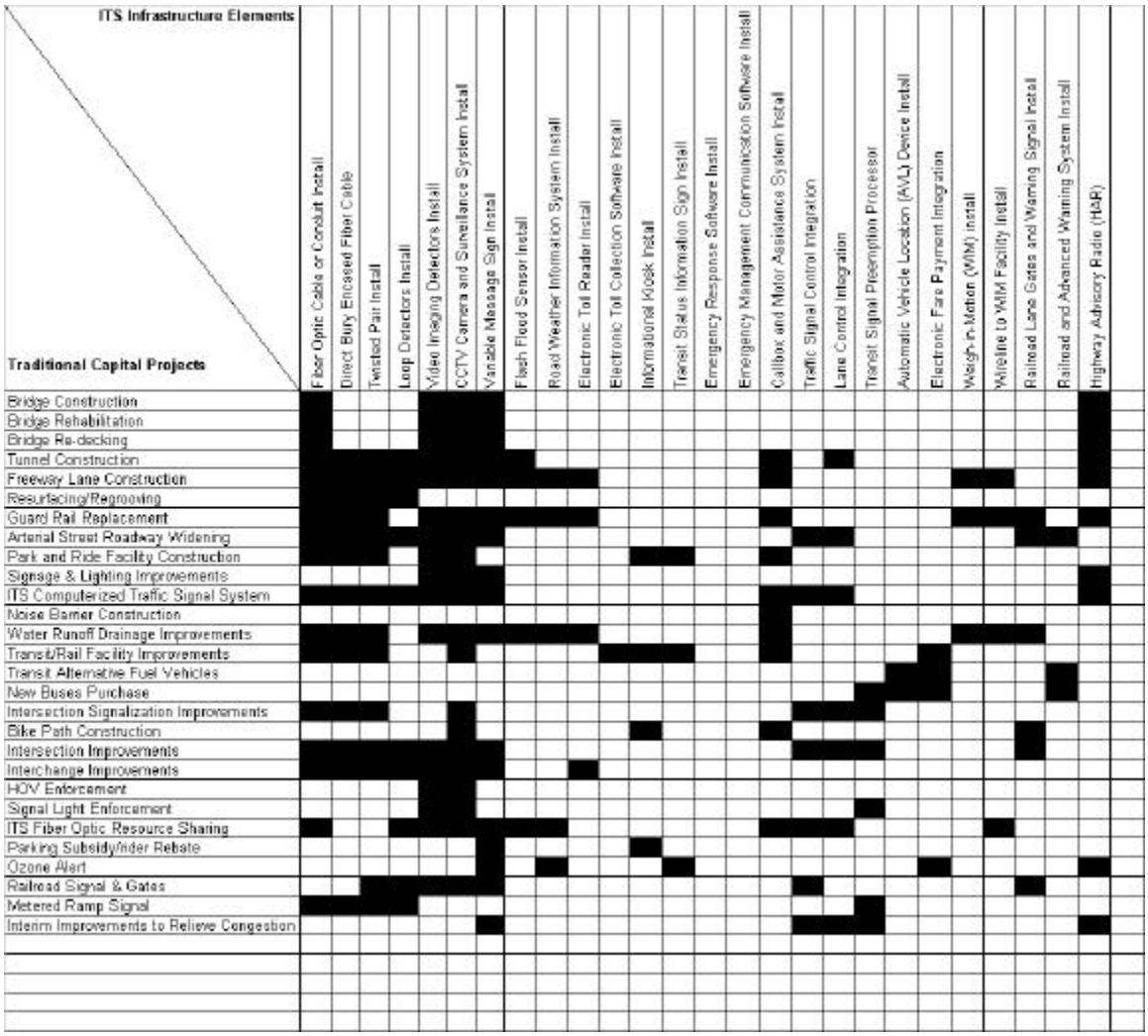


Figure C-1. Sample Matrix Matching ITS Infrastructure to Related Traditional Capital Projects