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ASSUMPTIONS FOR THE INTELLIGENT TRANSPORTATION INFRASTRUCTURE COST ESTIMATE

APRIL 1996

The following document contains the assumptions necessary to develop representative costs to deploy an Intelligent Transportation Infrastructure (ITI) across the United States. Some elements (i.e., surveillance, communication) do not lend themselves to a one-to-one correspondence with the nine intelligent transportation infrastructure areas but are listed under the most logical areas. To obtain the cost figures, information from systems in Texas, Virginia, Massachusetts, Washington, Georgia, Minnesota, Maryland, Delaware and California was gathered and discussions with experts in the area of traffic management systems were held. In the attached spreadsheet, the cost for deploying various ITS strategies nationwide is also estimated. The costs are a "worst case scenario" (unless otherwise noted) and reflect areas that are assumed to have no existing infrastructure. In this manner, areas with an existing infrastructure may scale back their costs accordingly. The general assumptions for each size (large, medium, and small) of metropolitan system follow.

Before the assumptions are discussed, it should be mentioned that technology for traffic management strategies is in a state of continual advancement. As technological advancements are made, technologies which were once considered state-of-the-art will be considered state-of-the-practice, and competition will adjust the costs accordingly. For example, as the use of non-intrusive detection methods (i.e., video image processing, acoustic detection, infrared technology) increases, the use of pavement loop detectors will decrease. This document represents state-of-the practice technologies (and their associated costs) which could instrument an infrastructure of ITS technologies if they were procured and deployed in 1996.

DEFINITIONS

Capital costs refer to the one-time procurement cost of the elements.
Operations and Maintenance costs are annual costs associated with operating and maintaining the necessary elements. Personnel costs are listed separately and are not included under O&M. Operations and Maintenance is assumed to be 5% of the capital costs, unless otherwise recorded, and does not include personnel costs. Maintenance work for surveillance, traveler information, communication, and transportation management centers is done by the same operations and maintenance personnel.

LARGE METROPOLITAN SYSTEM

The large metropolitan area will be the size of Detroit, Michigan with 400 miles of freeway assumed. Interchanges are at l- mile spacings with all ramps metered. There are 4 lanes in each direction on the large metropolitan area's freeways. There are 12 approach lanes for each signalized intersection. There are assumed to be 2500 signalized intersections. Five additional TMCs (6 total) were included in the costs. For the purposes of this document, metropolitan statistical areas with populations, over 750,000 were assumed as large.

ITI Toolbox

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MEDIUM METROPOLITAN SYSTEM

The medium metropolitan area will be the size of Knoxville, Tennessee with 300 miles of freeway assumed. Interchanges are at l-mile spacings with all ramps metered. There are 3 lanes in each direction on the medium metropolitan area's freeways. There are 10 approaches per signalized intersection, and 1500 signalized intersections are assumed. Three additional TMCs (4 total) were included in the costs. For the purposes of this document, metropolitan statistical areas with populations between 200,000 - 750,000 were assumed as medium.

SMALL METROPOLITAN SYSTEM

The small area is the size of Cheyenne, Wyoming with 50 miles of freeway assumed. Interchanges are at 2-mile spacings with no ramps metered. There are 2 lanes in each direction on the small freeways. There are 10 approach lanes for each signalized intersection, and 50 signalized intersections are assumed. For the purposes of this document, metropolitan statistical areas with populations between 50,000 - 200,000 were assumed as small.

GENERAL ASSUMPTIONS

- Freeway mileage is given in centerline miles.
- One center each was assumed for traveler information, emergency management, and transit management. In actuality, some areas may co-locate their facilities.

Computers

The elements under computers include video switches, graphical user interfaces, high capacity storage, cable television access, audio interface, computer monitors, video monitors, video cassette recorder and workstations. The costs for the medium, and small, metropolitan areas were scaled down to 0.8 and 0.7, respectively, of the cost of a large system's computer needs.

Software for the various centers is as follows:

Transportation Management Center (Highway Advisory Radio library, traffic management, automated traffic control, HOV management, lane management, CMS library)
Traveler Information Center (route planning, traffic measurement, data fusion)
Transit Management Center (ride share, transit scheduling, dispatch and fleet management)
Emergency Management Center (emergency management, vehicle tracking)

Communications

This includes the communications equipment internal to the facility such as equipment racks, Sonet System, mulitplexers, modems, etc.

Facilities

The facility costs were based on purchasing as opposed to leasing space. A building of 23,000 square feet was assumed in the costs for a large system. The costs were scaled accordingly to 0.8 for medium and 0.7 for small. Some of the centers may be co-located.

Field Hardware

- CCTV is at every mile of freeway and at l/l0th of the signalized intersections (trouble spots).
- Environmental Sensors detect road conditions (ice, fog, precipitation, pumping stations, tunnel ventilation, etc.)
- HOV Lane Monitoring and control include the gates and hardware.
- Loop detectors are placed at half-mile spacings on the freeways across all lanes. They are also placed at every approach fane of signalized intersections and at intermediate locations.
- Call boxes are spaced at half-mile intervals in each direction.
- Video image processing (VIPS) is used at l/l0th of the signalized intersections for the large and medium metropolitan areas.
- Fiber-Optic cable costs include trenching, conduit, installation, and cable.
- Kiosk costs widely vary, depending on the level of integration with various transportation modes, the level of security required, and the type of installation (wall-mounted, free-standing, indoor, outdoor). A mid-range system was assumed. Capital costs include procurement of the kiosks, alarms, software adjustments, technical assistance. Annual costs include kiosk and software maintenance, training, leased dedicated phone lines, supplies, and software license fees.

Incident Management Equipment

The vehicles mentioned in this section are pickup trucks which have the materials necessary to change tires, direct traffic, make minor repairs, provide nominal amounts of fuel, push vehicles from the road, radio for help, and clean up minor accidents from the roads. They are not heavy-duty towing trucks.

System Design & Integration

The costs for system design and integration were based on a large system. The costs for the medium and small areas were scaled accordingly to 0.8 for medium and 0.7 for a small system.

Other

Under "Road Communication," costs are listed as per intersection. These costs include codecs, leased lines, video switches, and interconnection of signal.

Electronic Toll Collection Systems

For large metropolitan areas, 15 lanes are assumed per toll plaza. For medium and small areas, 10 and 6 lanes are assumed, respectively. Large areas have 20 toll plazas and medium and small have 10 and 2, respectively. It is assumed that 40 percent of the lanes in the large and medium toll plazas use AVI technologies. The small metropolitan areas are assumed not to use AVI technology.

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Electronic Fare Payment Systems

The cost of proximity (smart) cards and related detection/communication equipment is not high, relatively speaking. Implementing a system, however, requires an extensive equipment base, communications infrastructure, and data processing center. These cost figures assume that the electronic fare payment system is installed on an existing transit infrastructure.

Software allows the smart cards to be used as a conventional stored value card, an employee pass, a discount value card (student or handicapped), a bus transfer, a bus farecard, and a parking lot farecard. As the use of the smart cards expands, additional software will be required to allow account reconciliation between different transportation providers accepting the same card, expanded control measures for a larger card population base, and specific operational requirements for both new and existing users.

*COST ANALYSIS FOR INTELLIGENT TRANSPORTATION INFRASTRUCTURE: LARGE, MEDIUM, AND SMALL METRO AREAS

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ELEMENTS	QUAN LARGE	QUAN MEDIUM	QUAN SMALL	UNT COST O&M ($K)	UNT COST CAPITAL ($K)	O&M COST LARGE ($K)	CAPITAL COST LARGE ($K)	O&M COST MEDIUM ($K)	CAPITAL COST MEDIUM ($K)	O&M COST SMALL ($K)	CAPITAL COST SMALL ($K)
SURVEILLANCE											
Point Detection (loops)	40,000	25,000	1,500	0.04	0.80	1,600	32,000	1,000	20,000	60	1,200
CCTV Cameras	650	450	110	1.00	20.00	650	13,000	450	9,000	110	2,200
Video Image Proc'g\intx	250	150	0	2.00	40.00	500	10,000	300	6,000	0	0
Environ'l Sensors\area	100	70	40	0.20	4.00	20	400	14	280	8	160
HOV lane control &	10	8	0	12.50	250.00	125	2,500	100	2,000	0	0
monitoring equ't\ area											
SUBTOTAL ($K)						2,895	57,900	1,864	37,280	178	3,560
TRAVELER INFORMATION											
Fixed CMS & Contrlrs	100	75	25	10.00	200.00	1,000	20,000	750	15,000	250	5,000
Fixed HAR & Contrlrs	10	7	2	1.00	20.00	10	200	7	140	2	40
Hybrid CMS (arterials)	100	80	0	1.00	20.00	100	2,000	80	1,600	0	0
Ramp Meter sys (per interchange)	400	300	0	2.00	40.00	800	16,000	600	12,000	0	0
Signal Upgrades	2,500	1,500	50	0.25	5.00	625	12,500	375	7,500	13	250
SUBTOTAL ($K)						2,535	50,700	1,812	36,240	265	5,290
COMMUNICATION											
Callboxes	1,600	1,200	0	0.50	5.00	800	8,000	600	6,000	0	0
Fiber-Optic Cable\mi	400	300	50	12.00	240.00	4,800	96,000	3,600	72,000	600	12,000
Signal Communication	2,500	1,500	50	0.50	10.00	1,250	25,000	750	15,000	25	500
per intersection											
SUBTOTAL ($K)						6,850	129,000	4,950	93,000	625	12,500
TRANSP'N MGT CTRS											
Computers & Hardware	1	1	1	34.00	680.00	34	680	27	544	24	476
Software (various)	1	1	1	11.00	220.00	11	220	11	220	11	220
Facilities and Communication	1	1	1	200.00	4,000.00	200	4,000	160	3,200	140	2,800
O&M Personnel	36	24	15	50.00	0.00	1,800	0	1,200	0	750	0
ADDITIONAL TMCs	5	3	0	2,045.00	4,900.00	10,225	24,500	4,908	11,760	0	0
SUBTOTAL ($K)						12,270	29,400	6,306	15,724	925	3,496
TRAVELER INFO CTR											
Computers and Hardware	1	1	1	5 10	102.00	5	102	4	82	4	71
Software (various)	1	1	1	15.00	300 00	15	300	15	300	15	300
Facilities and Communication	1	1	1	200 00	4,000 00	200	4,000	160	3,200	140	2,800
Kiosks	200	150	50	10.00	30.00	2,000	6,000	1,500	4,500	500	1,500
O&M Personnel	30	25	10	50.00	0.00	1,500	0	1,250	0	500	0
SUBTOTAL ($K)						3,720	10,402	2,929	8,082	1,159	4,671
TRANSIT MGT CTR											
Computers and Hardware	1	1	1	17 00	340.00	17	340	14	272	12	238
Software (various)	1	1	1	4 50	90.00	5	90	5	90	5	90
Facilities and Communication	1	1	1	200 00	4,000.00	200	4,000	160	3,200	140	2,800
O&M Personnel	3	2	1	50.00	0.00	150	0	100	0	50	0
SUBTOTAL ($K)						372	4,430	278	3,562	206	3,128

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* MUST USE THE DETAILED ASSUMPTIONS DOCUMENT TO INTERPRET THIS TABLE

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*COST ANALYSIS FOR INTELLIGENT TRANSPORTATION INFRASTRUCTURE: LARGE, MEDIUM, AND SMALL METRO AREAS

ELEMENTS	QUAN LARGE	QUAN MEDIUM	QUAN SMALL	UNT COST O&M ($K)	UNT COST CAPITAL ($K)	O&M COST LARGE ($K)	CAPITAL COST LARGE ($K)	O&M COST MEDIUM ($K)	CAPITAL COST MEDIUM ($K)	O&M COST SMALL ($K)	CAPITAL COST SMALL ($K)
TRANSIT VEHICLE INTERFACES											
Kiosk, cellular radio etc\ per veh	2,000	1,200	100	0.32	6 30	630	12,600	378	7,560	32	630
SUBTOTAL ($K)						630	12,600	378	7,560	32	630
EMERGENCY MGT CTRS											
Computers & Hardware	1	1	1	17.00	340.00	17	340	14	272	12	238
Software (various)	1	1	1	3.00	60.00	3	60	3	60	3	60
Facilities and Communication	1	1	1	200.00	4,000 00	200	4,000	160	3,200	140	2,800
O&M Personnel	3	2	1	50.00	0.00	150	0	100	0	50	0
SUBTOTAL ($K)						370	4,400	277	3,532	205	3,098
EMERGENCY VEHICLE SERVICES											
Cellular radio, Comm service/veh	3,300	2,500	500	0.02	0.30	50	990	38	750	8	150
SUBTOTAL ($K)						50	990	38	750	8	150
INCIDENT MGT EQUIPMENT											
Vehicles	40	25	0	2.50	50 00	200	2,000	125	1,250	0	0
Portable HAR	10	5	3	2.50	50.00	50	500	25	250	15	150
Portable CMS	15	10	10	1.50	30.00	45	450	30	300	30	300
O&M Personnel	40	30	5	50.00	0.00	2,000	0	1,500	0	250	0
SUBTOTAL ($K)						2,295	2,950	1,680	1,800	295	450
SYS DESIGN & INTEGRATION											
TMC, TIC, EMC, TRANSIT MC	1	1	1	0.00	5,400.00	0	5,400	0	4,320	0	3,780
SUBTOTAL ($K)						0	5,400	0	4,320	0	3,780
ELECTRONIC TOLL COLLEC'N SYS											
Manual/AVI (per lane)	30	10	0	147.00	73 00	4,410	2,190	1,470	730	0	0
Automatic/AVI (per lane)	15	5	0	48 00	70.00	720	1,050	240	350	0	0
Manual/Automatic/AVI (per lane)	15	5	0	116 00	125.00	1,740	1,875	580	625	0	0
AVI Dedicated (per lane)	30	10	0	5 00	16.00	150	480	50	160	0	0
Express AVI (per lane)	30	10	0	5.00	16.00	150	480	50	160	0	0
AVI Plaza Computer equ't	20	10	0	7.00	130 00	140	2,600	70	1,300	0	0
SUBTOTAL ($K)						7,310	8,675	2,460	3,325	0	0
ELECTRONIC FARE PAYMENT SYS											
Central Computer System	1	1	0	150.00	3,000.00	150	3,000	150	3,000	0	0
Ticket Vending Machines	500	300	0	3.00	60.00	1,500	30,000	900	18,000	0	0
Sys Engr, Prog Mgt, Installation	1	1	0	0.00	16,000.00	0	16,000	0	9,600	0	0
Training & Documentation	1	1	0	4.00	80.00	4	80	4	80	0	0
Bus Farebox	2,000	1,200	0	0.35	7.00	700	14,000	420	8,400	0	0
Station Controller	65	35	0	1.00	20.00	65	1,300	35	700	0	0
Turnstile	600	400	0	1.38	27.50	825	16,500	550	11,000	0	0
Ticket Office Machine & Validator	100	80	0	1.22	24.40	122	2,440	98	1,952	0	0
Smart Card	2,000,000	1,000,000	0	0 00	0.01	1,000	20,000	500	10,000	0	0
SUBTOTAL ($K)						4,366	103,320	2,657	62,732	0	0

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ELEMENTS	QUAN LARGE	QUAN MEDIUM	QUAN SMALL	UNT COST O&M ($K)	UNT COST CAPITAL ($K)	O&M COST LARGE ($K)	CAPITAL COST LARGE ($K)	O&M COST MEDIUM ($K)	CAPITAL COST MEDIUM ($K)	O&M COST SMALL ($K)	CAPITAL COST SMALL ($K)
TOTAL PER METRO AREA ($K)						43,662 O&M LARGE	420,167 CAPITAL LARGE	25,628 O&M MEDIUM	277,907 CAPITAL MEDIUM	3,896 O&M SMALL	40,753 CAPITAL SMALL
NATIONWIDE TOTALS ($K)											
LARGE METRO AREAS (#)	75			43,662	420,167	3,274,658	31,512,525				
MEDIUM METRO AREAS (#)		125		25,628	277,907			3,203,510	34,738,325		
SMALL METRO AREAS (#)			200	3,896	40,753					779,234	8,150,680
TOTAL ($K)						3,274,658	31,512,525	3,203,510	34,738,325	779,234	8,150,680

TOTAL NATIONAL CAP COST	74.4 BILLION
TOTAL NATIONAL O&M COST	7.3 BILLION

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