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National Costs of the Metropolitan ITS Infrastructure: Updated with 2004 Deployment Data

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16. Abstract

The purpose of this report, "Working Paper National Costs of the Metropolitan ITS Infrastructure: Updated with 2004 Deployment Data," is to update the estimates of the costs remaining to deploy Intelligent Transportation Systems (ITS) infrastructure elements in the 75 largest metropolitan areas in the United States.

Updates to this working paper coincide with the results from tracking the deployment of the integrated ITS infrastructure in the United States. To date, deployment tracking results are available for 1997, 1999, 2000, 2002, and 2004. The initial version of the working paper (dated September 1999) was written to update the FHWA 1995 cost estimate and to develop estimates of the investments that must still be made using the 1997 deployment tracking results. Deployment tracking results from 1999, 2000, and 2002 were incorporated into the first, second, and third revisions of this paper (dated August 2000, July 2001, and October 2003, respectively) with the majority of the updates contained within the addendum to the original document. With the 2004 deployment tracking data now available, the national deployment cost estimate can be updated again. However, for this iteration the new cost estimate is documented as a standalone report. Details on the methodology for developing estimates, and how costs and quantities were derived can be found in previous versions of the working paper.

The results show that progress is being made toward deployment of ITS infrastructure elements. Approximately 32.6% of the needed capital costs, or $192 million has been expended per large metropolitan area through 2004. This value represents an additional 17.9% increase from the 1997 expenditures of 14.7%. The total national capital cost expended for the 75 largest metropolitan areas is $14.4 billion. The total national capital cost/investment remaining is $29.8 billion.

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Working Paper National Costs of the Metropolitan ITS Infrastructure: Updated with 2004 Deployment Data

Introduction

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Updates to this working paper coincide with the results from tracking the deployment of the integrated ITS infrastructure in the United States. To date, deployment tracking results are available for 1997, 1999, 2000, 2002, and 2004. The initial version[1] of the working paper (dated September 1999) was written to update the FHWA 1995 cost estimate and to develop estimates of the investments that must still be made using the 1997 deployment tracking results. Deployment tracking results from 1999, 2000, and 2002 were incorporated into the first[2], second[3], and third[4] revisions of this paper (dated August 2000, July 2001, and October 2003, respectively) with the majority of the updates contained within the addendum to the original document. With the 2004 deployment tracking data now available, the national deployment cost estimate can be updated again. However, for this iteration the new cost estimate is documented as a standalone report. Details on the methodology for developing estimates, and how costs and quantities were derived can be found in previous versions of the working paper.

The results show that progress is being made toward deployment of ITS infrastructure elements. Approximately 32.6% of the needed capital costs, or $192 million has been expended per large metropolitan area through 2004. This value represents an additional 17.9% increase from the 1997 expenditures of 14.7% and a 5.8% increase over the last two years. The total national capital cost expended for the 75 largest metropolitan areas is $14.4 billion. The total national capital cost/investment remaining to fully deploy ITS infrastructure elements is $29.8 billion.

Background

The initial working paper was prepared to provide new estimates of the costs to fully deploy Intelligent Transportation Systems (ITS) infrastructure elements in the largest metropolitan areas in the United States. It built upon estimates that were distributed in June 1995 by Federal Highway Administration (FHWA)[5]. In building upon these 1995 cost estimates, changes were made to the cost elements, and updates were made to the unit cost values and quantities for metropolitan areas. These modifications were based on new sources of ITS cost estimates and were necessary to establish a base case for estimating the needed ITS investment. Estimates of the costs to reach full deployment were calculated and presented in detailed cost tables in the report. The base case is assumed to represent full deployment—the amount of ITS that *could be deployed*.

Three significant changes were made to the 1995 cost elements. First, cost elements were added to the existing FHWA list. Second, cost elements were disaggregated to make the physical and operational makeup of the cost elements clearer. For example, a variable message sign element was disaggregated into the sign itself and supporting structure. Third, cost elements that were no longer deemed applicable were deleted. Since 1999, no modifications have been made to the cost elements. Consequently, newer technology applications such as variable speed limit systems, road weather information systems, and pedestrian detection/safety systems are not included in the cost element list.

As part of updating the cost values, Mitretek decided to restructure the groupings of the elements. A major reason for this had to do with the way that freeway and arterial-related elements were placed in the original FHWA list. Surveillance and communications elements for both freeways and arterials were grouped together. Separating these elements makes clearer what cost elements should be introduced for a new corridor, or area-wide project.

Accounting for or addressing cost savings as a result of integration or bundling of technologies was not a major factor in how the base case estimate was developed. However, the cost associated with center-to-center design and integration is a component of the base case cost estimate. Furthermore, technologies deployed for one specific purpose may also be used in support of other applications. For example, CCTV cameras and supporting infrastructure, while primarily deployed to provide freeway surveillance and support incident detection and response, may also be used as a resource for traveler information.

The base case cost estimate is the cost of a generic metropolitan area for a given set of deployment elements and quantities at a given point in time and does not address the incremental costs of phasing in system components.

Updates to Capital Costs Expenditures (Changes to Market Penetration)

In calculating estimates of the remaining costs to deploy ITS infrastructure, it is important to recognize and account for previous ITS investments. To account for these previous investments, the amount of market penetration for the various cost elements for the current time period must be known. The 1997 deployment percentages[6] were factored into the initial working paper cost tables to produce estimates of the percentages of the needed capital investment that had already been spent and subtracted from the total needed capital to provide estimates of the investment still to be made. ITS deployment data from 1999[7], 2000[8], and 2002[9] were used to update those estimates in the first, second, and third revision of this working paper, respectively. With 2004 ITS deployment data[10] now available, those estimates can be updated again.

The same methodology used to develop the 1997 deployment estimates on future national ITS costs was used for this 2004 update with the following exceptions:

- The 2004 cost estimate is calculated for *large* metropolitan areas only, specifically 78 of the largest metropolitan areas. The initial working paper included a deployment estimate for a medium metropolitan area. Estimates of market penetration were developed using 1997 deployment percentages for medium and small size metropolitan areas. The 1997 deployment report divided the 78 largest metropolitan areas (see footnote 21 and table 2-2 in the original working paper) into three size classes. A methodology was developed to use deployment data from the three class sizes to estimate the capital cost expended through 1997 for generic medium and small size metropolitan areas. Because 1997 and 2004 deployment percentages are from different sources of measurement (extrapolated and direct, respectively), only cost estimates for large metropolitan areas will be calculated for this update.

- The 1997 cost estimate did not account for any deployment of Traveler Information Centers; however, the 2004 and three previous cost estimates do account for deployment of these centers. Traveler Information Centers were not included in the 1997 estimate because there was no single indicator that adequately represented deployment of Traveler Information Centers. Today there are many examples of traveler information "centers" in the U.S.; to *not* account for them in the 2004 cost expenditures would present an inaccurate cost estimate. The indicator, "Freeway conditions disseminated to the public," is used to measure the deployment of these centers.

- The 2004 cost estimate separately accounts for deployment of lane control and monitoring equipment, and miles controlled by ramp meters (Freeway Management at the Roadside). Under 1997 deployment tracking, lane control or ramp metering was tracked as a single component indicator. With lane control and ramp metering tracked separately beginning with the 1999 survey, these component percentages have been incorporated into the cost estimate accordingly.

The 2004 *deployment percentages* can be factored into the cost tables to produce estimates of the *percentages of the needed capital investment that has already been spent*, and thus can be subtracted from the total needed capital to provide estimates of the investments that must still be made to reach full deployment. The effects on the detailed cost estimates of using the 2004 deployment survey data are shown in table 1. The columns in this table are defined as follows:

- ITS ELEMENTS and CAPITAL COSTS LARGE – are reproduced from the initial version of the working paper. CAPITAL COSTS LARGE represents the estimated investment needed in order to achieve full deployment for a large metropolitan area.

- % DEPLOYED BY 2004 LARGE – have been taken from the figures in reference 6.

- CAPITAL COSTS EXPENDED BY ’04 LARGE – are the product of the CAPITAL COSTS LARGE and % DEPLOYED BY 2004 LARGE. This column gives the estimated dollar expenditure on ITS metropolitan deployment through 2004.

- REMAINING CAPITAL COSTS LARGE – provides estimate of the remaining investment needed for large metropolitan areas.

The results show that progress is being made toward deployment of ITS infrastructure elements. Approximately 32.6% of the needed capital costs, or $192 million, has been expended per large metropolitan area through 2004. The national summary results are reported based on large metropolitan statistical areas (MSAs) of 75. The total national capital cost expended for the 75 largest metropolitan areas is $14.4 billion. The total national capital cost/investment remaining is $29.8 billion.

Table 2 presents detailed estimates based on 1997, 1999, 2000, 2002, and 2004 deployment tracking results. In comparing the new summary cost estimates, approximately 32.6% of the needed capital costs for ITS for large metropolitan areas was expended through 2004. This is an increase of 17.9% from the 1997 expenditures of 14.7% which represents an overall average increase of 2.5% per year. Accounting for expenditures through 1997, national capital costs remaining for the largest 75 metropolitan areas were estimated at $37.7 billion. The same estimate accounting for expenditures through 1999 is approximately $35.9 billion, through 2000 is approximately $35.3 billion, and through 2002 is approximately $32.3 billion. From 1997 to 1999, this equates to capital expenditures of approximately $1 billion per year, and approximately $0.6 billion from 1999 to 2000. Capital expenditures from 2000 to 2002 are approximately $3 billion; this equates to about $1.5 billion per year—the largest annual increase to date. Capital expenditures from 2002 to 2004 are roughly $2.6 billion—the second highest increase—approximately $1.3 billion per year.

By comparing the estimates across fiscal years, it can be determined which cost elements have the largest reduction in future costs due to taking into account the investments that have already occurred. However, since some of the estimates in each of the tables are only for the cost element groups, the "group level" will be used for this reporting. The largest increases in expenditures from 1997 to 2004 are 35% in Emergency Response Centers, 35% in Emergency Services Equipment, and 45% in Electronic Toll Collection System. These same three groupings also had the largest increases for 1997 to 2002. When comparing increases from 2002 to 2004, smaller amounts of increase are noticed. Only two are greater than or equal to 10%: the largest being Transit Management Center at 11% and Communication – Freeways at 10%.

Table 1
Effect of Factoring in 2004 Deployment Estimates on Future National ITS Metropolitan Infrastructure Costs

ITS ELEMENTS	CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2004 LARGE	CAPITAL COSTS EXPENDED BY '04 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)
SURVEILLANCE - ARTERIALS				
Loop Detectors per signal per approach lane	$33,000	34%	$11,220	
Other arterial loop detectors	$3,960	34%	$1,346	
Overhead Point Detectors [NEW]		34%	$0	
Processor (170 series), 1 per direction per half mile (Arterials) [NEW]	$62,500	34%	$21,250	
CCTV Cameras per signalized intersection	$6,250	5%	$313	
CCTV pole and foundation [NEW]	$4,500	5%	$225	
Video Image Processing/intersection	$10,000	5%	$500	
AVI equip. to identify priority veh./intersection [NEW]	$82,500			
AVL equip (to supplement GPS)/site [NEW]	$825			
SURVEILLANCE - ARTERIALS	$203,535		$34,854	$168,681
SURVEILLANCE - FREEWAYS				
Loop Detectors per fwy lane per half mile	$7,040	35%	$2,464	
Overhead Point Detectors [NEW]	$0	35%	$0	
Data Station (Fwy), 1 per half mile [NEW]	$20,000	35%	$7,000	
CCTV Cameras per freeway mile	$10,000	32%	$3,200	
CCTV pole and foundation [NEW]	$7,200	32%	$2,304	
Emissions & Environmental Sensors	$400			
SURVEILLANCE - FREEWAYS	$44,640		$14,968	$29,672
COMMUNICATION - ARTERIALS				
Twisted-pair to Signals (per intersection)	$37,500	50%	$18,750	
Wireless radio [NEW]	$0	20%	$0	
Leased line to signals [NEW]	$0	50%	$0	
Leased line to video [NEW]	$0	5%	$0	
COMMUNICATION - ARTERIALS	$37,500		$18,750	$18,750
COMMUNICATION - FREEWAYS				
Fiber-Optic Cable/ freeway mile	$106,000	32%	$33,920	
Fiber-optic hub - 1 per 5 mi. of fiber [NEW]	$0	32%	$0	
Leased line to video [NEW]	$0	32%	$0	
COMMUNICATION - FREEWAYS	$106,000		$33,920	$72,080
TRAFFIC SIGNAL CONTROL				
Central Computer System (Closed Loop) NEW	$0			
Central Computer System (Distributed) NEW	$0			
Master controllers for distributed system (1 per 25 intersections) [NEW]	$1,000			
Signal controller replacement per intersection [NEW]	$0			
Signal controller upgrade (per intersection)	$12,500			
Signal Preemption: Transit, Emergency Vehicle, RR [NEW]	$250			
TRAFFIC SIGNAL CONTROL	$13,750	50%	$6,875	$6,875
FREEWAY MANAGEMENT @ ROADSIDE				
HOV lane control & monitoring equip.	$2,500	7%	$175	
Ramp Meter Systems (per interchange)	$14,000	9%	$1,260	
FREEWAY MANAGEMENT @ ROADSIDE	$16,500		$1,435	$15,065
TRAVELER INFORMATION @ ROADSIDE/SITE				
Full Matrix VMS & Controllers (without structure)	$7,000			
Overhead Structure[Separated out]	$10,500			
Hybrid VMS with structure (Arterials)	$2,000			
Fixed HAR & Controllers	$200			
Callboxes: each direction per half-mile	$8,000			
Kiosks	$4,200			
TRAVELER INFORMATION @ ROADSIDE/SITE	$31,900	41%	$13,079	$18,821
INCIDENT MANAGEMENT EQUIPMENT				
Portable VMS	$600	45%	$270	
Portable HAR	$450	45%	$203	
Special Pickup Trucks (w. Dyn. Route Guidance)	$2,000	15%	$300	
O & M Personnel	$0	45%	$0	
INCIDENT MANAGEMENT EQUIPMENT	$3,050		$773	$2,278
TRANSP. MGMT. CTRS				
Software (various)/TMC	$600			
Computers & Hardware/TMC	$680			
Software (various)/TMC	$220			
Facilities & Communications/TMC	$4,000			
O & M Personnel/TMC	$0			
TRANSP. MGMT. CTRS	$30,000	35%	$10,500	$19,500

Table 1
Effect of Factoring in 2004 Deployment Estimates on Future National ITS Metropolitan Infrastructure Costs

ITS ELEMENTS	CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2004 LARGE	CAPITAL COSTS EXPENDED BY '04 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)
TRAVELER INFORMATION CENTER				
Computers and Hardware	$102			
Software (various)	$300			
Facilities & Communication (stand-alone)	$4,000			
O & M Personnel	$0			
TRAVELER INFORMATION CENTER	$4,402	28%	$1,233	$3,169
EMERGENCY RESPONSE CENTER				
Computers & Hardware	$400			
Software (various)	$70			
Facilities & Communications (stand-alone)	$4,000			
O & M Personnel	$0			
EMERGENCY RESPONSE CENTER	$4,470	78%	$3,487	$983
EMERGENCY SERVICES EQUIPMENT				
Cellular radio, comm. services per vehicle	$990			
EMERGENCY SERVICES EQUIPMENT	$990	78%	$772	$218
TRANSIT MANAGEMENT CENTER				
Computers & Hardware	$340			
Software (various)	$120			
Facilities & Communication (stand-alone)	$4,000			
O & M Personnel	$0			
TRANSIT MANAGEMENT CENTER	$4,460	47%	$2,096	$2,364
TRANSIT VEHICLE INTERFACES				
Cellular radio, display, etc per vehicle	$12,600	30%	$3,780	
AVI Transponder (on Signal Priority routes) [NEW]	$0		$0	
In-vehicle AVL equip. per vehicle [NEW]	$0	47%	$0	
TRANSIT VEHICLE INTERFACES	$12,600		$3,780	$8,820
ELECTRONIC FARE PAYMENT SYSTEM				
In Transit Mgmt Center				
Central Computer System	$3,000	63%	$1,890	
Training & Documentation	$80	63%	$50	
At ticketing site				
Station Controller [DELETE]	$0			
Ticket Office Machine & Validator	$2,440	63%	$1,537	
Ticket Vending Machines	$30,000	63%	$18,900	
Turnstile [DELETE]	$0			
On Transit Vehicles				
Bus Farebox	$14,000	63%	$8,820	
Smart Card	$6,000	18%	$1,080	
Sys Engineering. Etc. [MOVED]				
ELECTRONIC FARE PAYMENT SYSTEM	$55,520		$32,278	$23,242
ELECTRONIC TOLL COLLECTION SYSTEM				
AVI Plaza Computer equipment	$2,600			
Manual AVI (per lane)	$2,190			
Automatic AVI (per lane)	$1,050			
Manual Automatic AVI (per lane)	$1,875			
AVI Dedicated (per lane)	$480			
Express AVI (per lane)	$480			
ELECTRONIC TOLL COLLECTION SYSTEM	$8,675	81%	$7,027	$1,648
SYS DESIGN & INTEGRATION				
TMC, TIC, EMC, Transit MC	$5,400	47%	$2,538	
Electronic Fare Payment Sys	$5,400	63%	$3,402	
SYS DESIGN & INTEGRATION	$10,800		$5,940	$4,860
TOTAL PER LARGE METRO AREA	**$588,792**		**$191,765**	**$397,027**
Percent Capital Cost Expended Through 2004:			**32.6%**	
NUMBER OF LARGE METRO AREAS:	**75**			
				($B)
TOTAL NATIONAL CAPITAL COST FOR ALL LARGE METRO AREAS				**$44.2**
TOTAL NATIONAL COST EXPENDED BY 2004 FOR ALL LARGE METRO AREAS				**$14.4**
TOTAL NATIONAL CAPITAL COST REMAINING FOR ALL LARGE METRO AREAS				**$29.8**

Table 2
Effect of Factoring in 1997, 1999, 2000, 2002 and 2004 Deployment Estimates on Future National ITS Metropolitan Infrastructure Costs

ITS ELEMENTS	CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 1997 LARGE	CAPITAL COST EXPENDED BY '97 LARGE ($K)	UPDATED CAP COST LARGE ($K)	% DEPLOYED BY 1999 LARGE	CAPITAL COSTS EXPENDED BY '99 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2000 LARGE	CAPITAL COSTS EXPENDED BY '00 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2002 LARGE	CAPITAL COSTS EXPENDED BY '02 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2004 LARGE	CAPITAL COSTS EXPENDED BY '04 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)
SURVEILLANCE - ARTERIALS																
Loop Detectors per signal per approach lane	$33,000	5%	$1,650		9%	$2,970		16%	$5,280		27%	$8,910		34%	$11,220	
Other arterial loop detectors	$3,960	5%	$198		9%	$356		16%	$634		27%	$1,069		34%	$1,346	
Overhead Point Detectors [NEW]		5%			9%			16%			27%			34%		
Processor (170 series), 1 per direction per half mile (Arterials) [NEW]	$62,500	5%	$3,125		9%	$5,625		16%	$10,000		27%	$16,875		34%	$21,250	
CCTV Cameras per signalized intersection	$6,250	1%	$63		1%	$63		1%	$63		4%	$250		5%	$313	
CCTV pole and foundation [NEW]	$4,500	1%	$45		1%	$45		1%	$45		4%	$180		5%	$225	
Video Image Processing/intersection	$10,000	1%	$100		1%	$100		1%	$100		4%	$400		5%	$500	
AVI equip. to identify priority veh./intersection [NEW]	$82,500		$0			$0			$0			$0			$0	
AVL equip (to supplement GPS)/site [NEW]	$825		$0			$0			$0			$0			$0	
SURVEILLANCE - ARTERIALS	$203,535		$5,181	$198,355		$9,159	$194,376		$16,121	$187,414		$27,684	$175,851		$34,854	$168,681
SURVEILLANCE - FREEWAYS																
Loop Detectors per fwy lane per half mile	$7,040	17%	$1,197		22%	$1,549		22%	$1,549		30%	$2,112		35%	$2,464	
Overhead Point Detectors [NEW]	$0	17%	$0		22%	$0		22%	$0		30%	$0		35%	$0	
Data Station (Fwy), 1 per half mile [NEW]	$20,000	17%	$3,400		22%	$4,400		22%	$4,400		30%	$6,000		35%	$7,000	
CCTV Cameras per freeway mile	$10,000	9%	$900		14%	$1,400		12%	$1,200		22%	$2,200		32%	$3,200	
CCTV pole and foundation [NEW]	$7,200	9%	$648		14%	$1,008		12%	$864		22%	$1,584		32%	$2,304	
Emissions & Environmental Sensors	$400		$0			$0			$0			$0			$0	
SURVEILLANCE - FREEWAYS	$44,640		$6,145	$38,495		$8,357	$36,283		$8,013	$36,627		$11,896	$32,744		$14,968	$29,672
COMMUNICATION - ARTERIALS																
Twisted-pair to Signals (per intersection)	$37,500	46%	$17,250		46%	$17,250		49%	$18,375		48%	$18,000		50%	$18,750	
Wireless radio [NEW]	$0	43%	$0		20%	$0		90%	$0		16%	$0		20%	$0	
Leased line to signals [NEW]	$0	46%	$0		46%	$0		49%	$0		48%	$0		50%	$0	
Leased line to video [NEW]	$0	1%	$0		1%	$0		1%	$0		4%	$0		5%	$0	
COMMUNICATION - ARTERIALS	$37,500		$17,250	$20,250		$17,250	$20,250		$18,375	$19,125		$18,000	$19,500		$18,750	$18,750
COMMUNICATION - FREEWAYS																
Fiber-Optic Cable/ freeway mile	$106,000	9%	$9,540		14%	$14,840		12%	$12,720		22%	$23,320		32%	$33,920	
Fiber-optic hub - 1 per 5 mi. of fiber [NEW]	$0	9%	$0		14%	$0		12%	$0		22%	$0		32%	$0	
Leased line to video [NEW]	$0	9%	$0		14%	$0		12%	$0		22%	$0		32%	$0	
COMMUNICATION - FREEWAYS	$106,000		$9,540	$96,460		$14,840	$91,160		$12,720	$93,280		$23,320	$82,680		$33,920	$72,080
TRAFFIC SIGNAL CONTROL																
Central Computer System (Closed Loop) NEW	$0															
Central Computer System (Distributed) NEW	$0															
Master controllers for distributed system (1 per 25 intersections) [NEW]	$1,000															
Signal controller replacement per intersection [NEW]	$0															
Signal controller upgrade (per intersection)	$12,500															
Signal Preemption: Transit, Emergency Vehicle, RR [NEW]	$250															
TRAFFIC SIGNAL CONTROL	$13,750	46%	$6,325	$7,425	46%	$6,325	$7,425	49%	$6,738	$7,013	48%	$6,600	$7,150	50%	$6,875	$6,875
FREEWAY MANAGEMENT @ ROADSIDE																
HOV lane control & monitoring equip.	$2,500		$0		5%	$125		4%	$100		7%	$175		7%	$175	
Ramp Meter Systems (per interchange)	$14,000	13%	$1,820		8%	$1,120		8%	$1,120		8%	$1,120		9%	$1,260	
FREEWAY MANAGEMENT @ ROADSIDE	$16,500	13%	$1,820	$14,680		$1,245	$15,255		$1,220	$15,280		$1,295	$15,205		$1,435	$15,065
TRAVELER INFORMATION @ ROADSIDE/SITE																
Full Matrix VMS & Controllers (without structure)	$7,000															
Overhead Structure[Separated out]	$10,500															
Hybrid VMS with structure (Arterials)	$2,000															
Fixed HAR & Controllers	$200															
Callboxes: each direction per half-mile	$8,000															
Kiosks	$4,200															
TRAVELER INFORMATION @ ROADSIDE/SITE	$31,900	22%	$7,018	$24,882	27%	$8,613	$23,287	27%	$8,613	$23,287	39%	$12,441	$19,459	41%	$13,079	$18,821

Table 2
Effect of Factoring in 1997, 1999, 2000, 2002 and 2004 Deployment Estimates on Future National ITS Metropolitan Infrastructure Costs

ITS ELEMENTS	CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 1997 LARGE	CAPITAL COST EXPENDED BY '97 LARGE ($K)	UPDATED CAP COST LARGE ($K)	% DEPLOYED BY 1999 LARGE	CAPITAL COSTS EXPENDED BY '99 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2000 LARGE	CAPITAL COSTS EXPENDED BY '00 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2002 LARGE	CAPITAL COSTS EXPENDED BY '02 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2004 LARGE	CAPITAL COSTS EXPENDED BY '04 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)
INCIDENT MANAGEMENT EQUIPMENT																
Portable VMS	$600	31%	$186		38%	$228		39%	$234		51%	$306		45%	$270	
Portable HAR	$450	31%	$140		38%	$171		39%	$176		51%	$230		45%	$203	
Special Pickup Trucks (w. Dyn. Route Guidance)	$2,000	1%	$20		2%	$40		2%	$40		6%	$120		15%	$300	
O & M Personnel	$0	31%	$0		38%	$0		39%	$0		51%	$0		45%	$0	
INCIDENT MANAGEMENT EQUIPMENT	$3,050		$346	$2,705		$439	$2,611		$450	$2,601		$656	$2,395		$773	$2,278
TRANSP. MGMT. CTRS																
Software (various)/TMC	$600															
Computers & Hardware/TMC	$680															
Software (various)/TMC	$220															
Facilities & Communications/TMC	$4,000															
O & M Personnel/TMC	$0															
TRANSP. MGMT. CTRS	$30,000	17%	$5,100	$24,900	22%	$6,600	$23,400	22%	$6,600	$23,400	30%	$9,000	$21,000	35%	$10,500	$19,500
TRAVELER INFORMATION CENTER																
Computers and Hardware	$102															
Software (various)	$300															
Facilities & Communication (stand-alone)	$4,000															
O & M Personnel	$0															
TRAVELER INFORMATION CENTER	$4,402	0%	$0	$4,402	22%	$968	$3,434	21%	$924	$3,478	28%	$1,233	$3,169	28%	$1,233	$3,169
EMERGENCY RESPONSE CENTER																
Computers & Hardware	$400															
Software (various)	$70															
Facilities & Communications (stand-alone)	$4,000															
O & M Personnel	$0															
EMERGENCY RESPONSE CENTER	$4,470	43%	$1,922	$2,548	66%	$2,950	$1,520	67%	$2,995	$1,475	75%	$3,353	$1,118	78%	$3,487	$983
EMERGENCY SERVICES EQUIPMENT																
Cellular radio, comm. services per vehicle	$990															
EMERGENCY SERVICES EQUIPMENT	$990	43%	$426	$564	66%	$653	$337	67%	$663	$327	75%	$743	$248	78%	$772	$218
TRANSIT MANAGEMENT CENTER																
Computers & Hardware	$340															
Software (various)	$120															
Facilities & Communication (stand-alone)	$4,000															
O & M Personnel	$0															
TRANSIT MANAGEMENT CENTER	$4,460	23%	$1,026	$3,434	30%	$1,338	$3,122	31%	$1,383	$3,077	36%	$1,606	$2,854	47%	$2,096	$2,364
TRANSIT VEHICLE INTERFACES																
Cellular radio, display, etc per vehicle	$12,600	16%	$2,016		10%	$1,260		15%	$1,890		18%	$2,268		30%	$3,780	
AVI Transponder (on Signal Priority routes) [NEW]	$0		$0			$0			$0			$0			$0	
In-vehicle AVL equip. per vehicle [NEW]	$0	23%	$0		30%	$0		31%	$0		36%	$0		47%	$0	
TRANSIT VEHICLE INTERFACES	$12,600		$2,016	$10,584		$1,260	$11,340		$1,890	$10,710		$2,268	$10,332		$3,780	$8,820
ELECTRONIC FARE PAYMENT SYSTEM																
In Transit Mgmt Center																
Central Computer System	$3,000	30%	$900		45%	$1,350		42%	$1,260		52%	$1,560		63%	$1,890	
Training & Documentation	$80	30%	$24		45%	$36		42%	$34		52%	$42		63%	$50	
At ticketing site																
Station Controller [DELETE]	$0															
Ticket Office Machine & Validator	$2,440	30%	$732		45%	$1,098		42%	$1,025		52%	$1,269		63%	$1,537	
Ticket Vending Machines	$30,000	30%	$9,000		45%	$13,500		42%	$12,600		52%	$15,600		63%	$18,900	
Turnstile [DELETE]	$0															
On Transit Vehicles																
Bus Farebox	$14,000	30%	$4,200		45%	$6,300		42%	$5,880		52%	$7,280		63%	$8,820	
Smart Card	$6,000	1%	$60		4%	$240		6%	$360		8%	$480		18%	$1,080	
Sys Engineering. Etc. [MOVED]																
ELECTRONIC FARE PAYMENT SYSTEM	$55,520		$14,916	$40,604		$22,524	$32,996		$21,158	$34,362		$26,230	$29,290		$32,278	$23,242

Table 2
Effect of Factoring in 1997, 1999, 2000, 2002 and 2004 Deployment Estimates on Future National ITS Metropolitan Infrastructure Costs

ITS ELEMENTS	CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 1997 LARGE	CAPITAL COST EXPENDED BY '97 LARGE ($K)	UPDATED CAP COST LARGE ($K)	% DEPLOYED BY 1999 LARGE	CAPITAL COSTS EXPENDED BY '99 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2000 LARGE	CAPITAL COSTS EXPENDED BY '00 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2002 LARGE	CAPITAL COSTS EXPENDED BY '02 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)	% DEPLOYED BY 2004 LARGE	CAPITAL COSTS EXPENDED BY '04 LARGE ($K)	REMAINING CAPITAL COSTS LARGE ($K)
ELECTRONIC TOLL COLLECTION SYSTEM																
AVI Plaza Computer equipment	$2,600															
Manual AVI (per lane)	$2,190															
Automatic AVI (per lane)	$1,050															
Manual Automatic AVI (per lane)	$1,875															
AVI Dedicated (per lane)	$480															
Express AVI (per lane)	$480															
ELECTRONIC TOLL COLLECTION SYSTEM	$8,675	36%	$3,123	$5,552	43%	$3,730	$4,945	73%	$6,333	$2,342	73%	$6,333	$2,342	81%	$7,027	$1,648
SYS DESIGN & INTEGRATION																
TMC, TIC, EMC, Transit MC	$5,400	20%	$1,080		35%	$1,890		35%	$1,890		42%	$2,268		47%	$2,538	
Electronic Fare Payment Sys	$5,400	30%	$3,240		45%	$2,430		42%	$2,268		52%	$2,808		63%	$3,402	
SYS DESIGN & INTEGRATION	$10,800		$4,320	$6,480		$4,320	$6,480		$4,158	$6,642		$5,076	$5,724		$5,940	$4,860
TOTAL PER LARGE METRO AREA	**$588,792**		**$86,472**	**$502,320**		**$110,572**	**$478,220**		**$118,353**	**$470,439**		**$157,732**	**$431,060**		**$191,765**	**$397,027**
Percent Capital Cost Expended:			**14.7%**			**18.8%**			**20.1%**			**26.8%**			**32.6%**	
NUMBER OF LARGE METRO AREAS:	**75**															
				($B)			**($B)**			**($B)**			**($B)**			**($B)**
TOTAL NATIONAL CAPITAL COST FOR ALL LARGE METRO AREAS				**$44.2**			**$44.2**			**$44.2**			**$44.2**			**$44.2**
TOTAL NATIONAL COST EXPENDED FOR ALL LARGE METRO AREAS				**$6.5**			**$8.3**			**$8.9**			**$11.8**			**$14.4**
TOTAL NATIONAL CAPITAL COST REMAINING FOR ALL LARGE METRO AREAS				**$37.7**			**$35.9**			**$35.3**			**$32.3**			**$29.8**

Alternative Values of Full Market Penetration

Just as it was important in the previous section to use the current market penetration estimates to reduce the estimate of still-needed investments, it is also important to determine the actual amount of needed infrastructure investment—what *should be deployed*. It is believed that cost estimates presented thus far reflect the maximum amount of deployment or what *could be deployed* (based on the current definitions of the metropolitan ITS infrastructure). To show how the level of full deployment might affect the estimate of investment needs, a simple *parametric analysis* of the values for full market penetration was performed for the initial working paper. A similar parametric analysis has been performed for this report. This analysis was carried out for the generic large metropolitan area using four different constant values for all cost elements for the percent that the "should" deployment levels might be of the "could" level. The four values are 33%, 50%, 67%, and 80%. The lower parametric value of 33% was added to the 1999, 2000, and 2002 analyses to broaden the range of possible "should" levels.

The approach for calculating the results for these various levels is to start with information in table 1, and then add the appropriate constant value for the "should" level.

It can be shown algebraically that as long as the percent for the "should" level is larger than the largest value for the 2004 percent deployment shown in table 1 (this value is 81%), then the calculations for estimating the remaining costs for alternative values of full market penetration can be carried out at the aggregate level. For the four "should" levels, none can be carried out at the aggregate level because at these deployment levels we need to account for instances where ITS expenditures to date are greater than the "should" level capital cost. To not account for these "over expenditures" would misrepresent the investment needed to reach the "should" level.

Simplified versions of this calculation have been carried out using only the group level or major ITS cost elements with the "should" case set to 80%, 67%, 50%, and 33% of the could case. The results are shown in tables 3, 4, 5, and 6, respectively. The expenditures through 2004 are the cost element group level values from table 1. By carrying out the calculations and summing the columns, it can be seen that the total investment needed is $471 million at 80%, $394 million at 67%, $294 million at 50% and $194 million at 33% for the generic large area instead of $589 million. Furthermore, taking into account that $192 million has already been deployed through 2004, only $279 million, $205 million, $112 million, and $38 million is remaining, respectively. The results of the parametric analysis are summarized in table 7 and figure 1.

Table 3
Effect of Setting Full Deployment at 80% of "Could" Case for Generic Large Areas

GENERIC LARGE METRO AREA

Major ITS Cost Elements	Capital Cost for Could Case ($K)	Capital Cost Expended Through 2004 ($K)	Should Case at 80% of Could Case ($K)	Should Case - 2004 Expenditure ($K)
SURVEILLANCE - ARTERIALS	$203,535	$34,854	$162,828	$127,974
SURVEILLANCE - FREEWAYS	$44,640	$14,968	$35,712	$20,744
COMMUNICATION - ARTERIALS	$37,500	$18,750	$30,000	$11,250
COMMUNICATION - FREEWAYS	$106,000	$33,920	$84,800	$50,880
TRAFFIC SIGNAL CONTROL	$13,750	$6,875	$11,000	$4,125
Freeway Management @ Roadside	$16,500	$1,435	$13,200	$11,765
Traveler Information @ Roadside	$31,900	$13,079	$25,520	$12,441
INCIDENT MANAGEMENT EQUIPMENT	$3,050	$773	$2,440	$1,667
TRANSPORTATION MGMT CENTERS	$30,000	$10,500	$24,000	$13,500
TRAVELER INFORMATION CENTER	$4,402	$1,233	$3,522	$2,289
EMERGENCY RESPONSE CENTER	$4,470	$3,487	$3,576	$89
EMERGENCY SERVICES EQUIPMENT	$990	$772	$792	$20
TRANSIT MANAGEMENT CENTER	$4,460	$2,096	$3,568	$1,472
TRANSIT VEHICLE INTERFACES	$12,600	$3,780	$10,080	$6,300
ELECTRONIC FARE PAYMENT SYS	$55,520	$32,278	$44,416	$12,138
ELECTRONIC TOLL COLLECTION SYS	$8,675	$7,027	$6,940	
SYS DESIGN & INTEGRATION	$10,800	$5,940	$8,640	$2,700
TOTAL PER METRO AREA	**$588,792**	**$191,767**	**$471,034**	**$279,354**

Derived Percentage of Full Deployment
Capital Cost Expended Through 2004 **32.6%**

Table 4
Effect of Setting Full Deployment at 67% of "Could" Case for Generic Large Areas

GENERIC LARGE METRO AREA

Major ITS Cost Elements	Capital Cost for Could Case ($K)	Capital Cost Expended Through 2004 ($K)	Should Case at 67% of Could Case ($K)	Should Case - 2004 Expenditure ($K)
SURVEILLANCE - ARTERIALS	$203,535	$34,854	$136,368	$101,514
SURVEILLANCE - FREEWAYS	$44,640	$14,968	$29,909	$14,941
COMMUNICATION - ARTERIALS	$37,500	$18,750	$25,125	$6,375
COMMUNICATION - FREEWAYS	$106,000	$33,920	$71,020	$37,100
TRAFFIC SIGNAL CONTROL	$13,750	$6,875	$9,213	$2,338
Freeway Management @ Roadside	$16,500	$1,435	$11,055	$9,620
Traveler Information @ Roadside	$31,900	$13,079	$21,373	$8,294
INCIDENT MANAGEMENT EQUIPMENT	$3,050	$773	$2,044	$1,271
TRANSPORTATION MGMT CENTERS	$30,000	$10,500	$20,100	$9,600
TRAVELER INFORMATION CENTER	$4,402	$1,233	$2,949	$1,716
EMERGENCY RESPONSE CENTER	$4,470	$3,487	$2,995	
EMERGENCY SERVICES EQUIPMENT	$990	$772	$663	
TRANSIT MANAGEMENT CENTER	$4,460	$2,096	$2,988	$892
TRANSIT VEHICLE INTERFACES	$12,600	$3,780	$8,442	$4,662
ELECTRONIC FARE PAYMENT SYS	$55,520	$32,278	$37,198	$4,920
ELECTRONIC TOLL COLLECTION SYS	$8,675	$7,027	$5,812	
SYS DESIGN & INTEGRATION	$10,800	$5,940	$7,236	$1,296
TOTAL PER METRO AREA	**$588,792**	**$191,767**	**$394,491**	**$204,539**

Derived Percentage of Full Deployment
Capital Cost Expended Through 2004 **32.6%**

Table 5
Effect of Setting Full Deployment at 50% of "Could" Case for Generic Large Areas

GENERIC LARGE METRO AREA

Major ITS Cost Elements	Capital Cost for Could Case ($K)	Capital Cost Expended Through 2004 ($K)	Should Case at 50% of Could Case ($K)	Should Case - 2004 Expenditure ($K)
SURVEILLANCE - ARTERIALS	$203,535	$34,854	$101,768	$66,914
SURVEILLANCE - FREEWAYS	$44,640	$14,968	$22,320	$7,352
COMMUNICATION - ARTERIALS	$37,500	$18,750	$18,750	$0
COMMUNICATION - FREEWAYS	$106,000	$33,920	$53,000	$19,080
TRAFFIC SIGNAL CONTROL	$13,750	$6,875	$6,875	$0
Freeway Management @ Roadside	$16,500	$1,435	$8,250	$6,815
Traveler Information @ Roadside	$31,900	$13,079	$15,950	$2,871
INCIDENT MANAGEMENT EQUIPMENT	$3,050	$773	$1,525	$752
TRANSPORTATION MGMT CENTERS	$30,000	$10,500	$15,000	$4,500
TRAVELER INFORMATION CENTER	$4,402	$1,233	$2,201	$968
EMERGENCY RESPONSE CENTER	$4,470	$3,487	$2,235	
EMERGENCY SERVICES EQUIPMENT	$990	$772	$495	
TRANSIT MANAGEMENT CENTER	$4,460	$2,096	$2,230	$134
TRANSIT VEHICLE INTERFACES	$12,600	$3,780	$6,300	$2,520
ELECTRONIC FARE PAYMENT SYS	$55,520	$32,278	$27,760	
ELECTRONIC TOLL COLLECTION SYS	$8,675	$7,027	$4,338	
SYS DESIGN & INTEGRATION	$10,800	$5,940	$5,400	
TOTAL PER METRO AREA	**$588,792**	**$191,767**	**$294,396**	**$111,906**

Derived Percentage of Full Deployment
Capital Cost Expended Through 2004 **32.6%**

Table 6
Effect of Setting Full Deployment at 33% of "Could" Case for Generic Large Areas

GENERIC LARGE METRO AREA

Major ITS Cost Elements	Capital Cost for Could Case ($K)	Capital Cost Expended Through 2004 ($K)	Should Case at 33% of Could Case ($K)	Should Case - 2004 Expenditure ($K)
SURVEILLANCE - ARTERIALS	$203,535	$34,854	$67,167	$32,313
SURVEILLANCE - FREEWAYS	$44,640	$14,968	$14,731	
COMMUNICATION - ARTERIALS	$37,500	$18,750	$12,375	
COMMUNICATION - FREEWAYS	$106,000	$33,920	$34,980	$1,060
TRAFFIC SIGNAL CONTROL	$13,750	$6,875	$4,538	
Freeway Management @ Roadside	$16,500	$1,435	$5,445	$4,010
Traveler Information @ Roadside	$31,900	$13,079	$10,527	
INCIDENT MANAGEMENT EQUIPMENT	$3,050	$773	$1,007	$234
TRANSPORTATION MGMT CENTERS	$30,000	$10,500	$9,900	
TRAVELER INFORMATION CENTER	$4,402	$1,233	$1,453	$220
EMERGENCY RESPONSE CENTER	$4,470	$3,487	$1,475	
EMERGENCY SERVICES EQUIPMENT	$990	$772	$327	
TRANSIT MANAGEMENT CENTER	$4,460	$2,096	$1,472	
TRANSIT VEHICLE INTERFACES	$12,600	$3,780	$4,158	$378
ELECTRONIC FARE PAYMENT SYS	$55,520	$32,278	$18,322	
ELECTRONIC TOLL COLLECTION SYS	$8,675	$7,027	$2,863	
SYS DESIGN & INTEGRATION	$10,800	$5,940	$3,564	
TOTAL PER METRO AREA	**$588,792**	**$191,767**	**$194,301**	**$38,214**

Derived Percentage of Full Deployment
Capital Cost Expended Through 2004 **32.6%**

Table 7
Parametric Analysis of Changing From the "Could" Case Full Deployment Level to Various "Should" Cases
For the Generic Large Areas

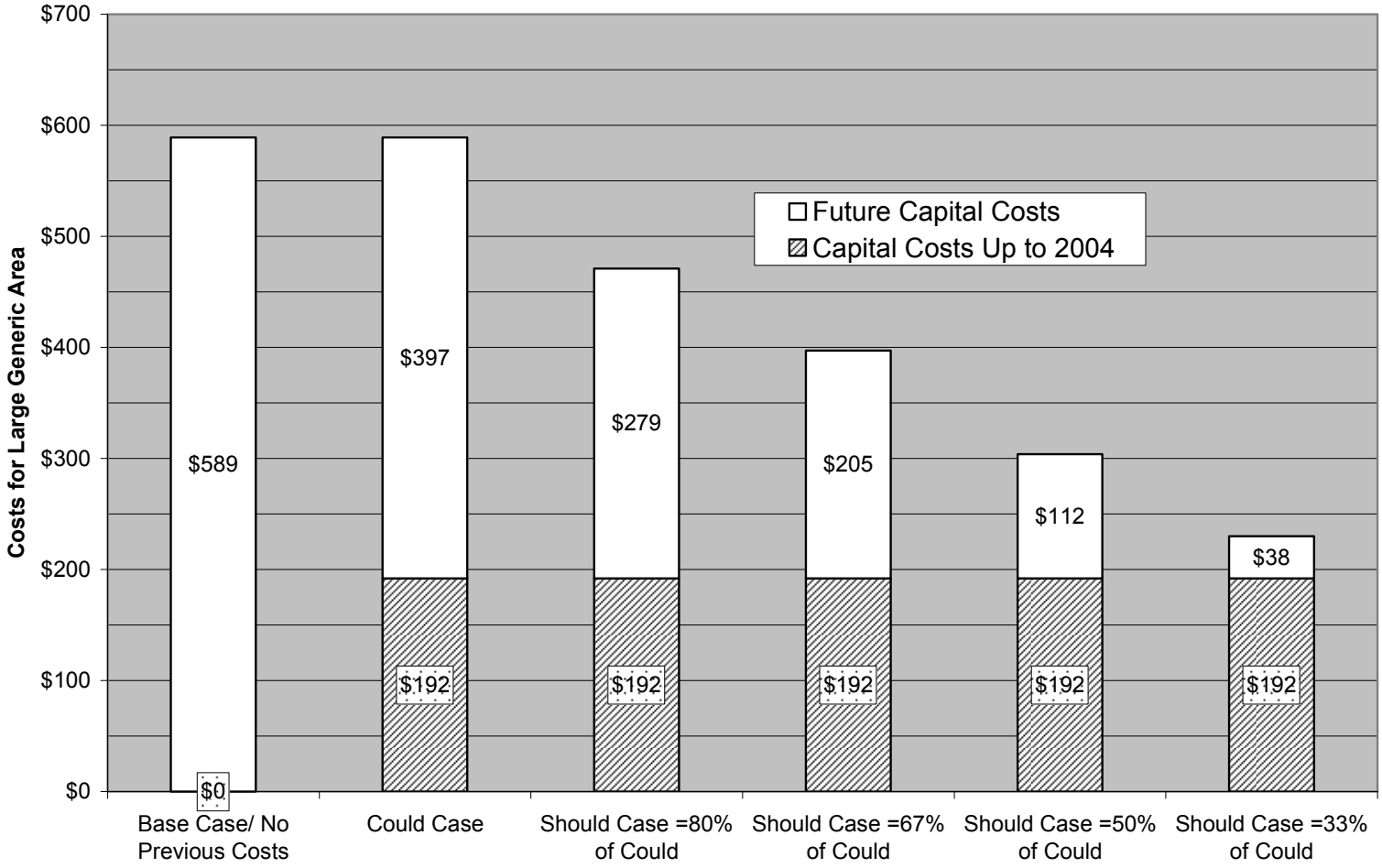
GENERIC LARGE METRO AREA

Capital Cost for "Could" Case Full Deployment ($M)	% Deployed Through 2004	Capital Costs Through 2004 ($M)	Parametrically Selected "Should" Case Capital Costs as % of "Could" Case	Capital Costs for "Should" Case Deployment ($M)	**Should Case Capital Costs - 2004 Capital Costs ($M)**
$589	32.6%	$192	*100%*	$589	**$397**
$589	32.6%	$192	*80%*	$471	**$279***
$589	32.6%	$192	*67%*	$394	**$205***
$589	32.6%	$192	*50%*	$294	**$112***
$589	32.6%	$192	33%	$194	**$38***

Note: The overall 2004 Deployment Percentage is derived in Table 1.

* Values are from tables 3, 4, 5, and 6, respectively.

Figure 1: Results of Parametric Analysis of Different Levels of Full Deployment Along With Previous Costs ($Millions)



Summary and Conclusions

Applying the 2004 deployment data provides a fifth set of data points with which to gauge the trend in ITS infrastructure deployment expenditures and to estimate the investment still to be made. The results show that progress is being made toward deployment of ITS infrastructure elements; hence, a reduction in the still-needed investment.

Table 8 shows ITS infrastructure trends from 1997 through 2004. Approximately 32.6% of the needed capital costs, or $192 million has been expended per large metropolitan area through 2004. This value represents an additional 17.9% increase from the 1997 expenditures of 14.7%. Accounting for expenditures through 1997, national capital costs remaining for the largest 75 metropolitan areas were estimated at $37.7 billion. The same estimate accounting for expenditures through 1999 is approximately $35.9 billion, through 2000 is approximately $35.3 billion, and through 2002 is approximately $32.3 billion. From 1997 to 1999, this equates to capital expenditures of approximately $1 billion per year, and approximately $0.6 billion from 1999 to 2000. Capital expenditures from 2000 to 2002 are approximately $3 billion; this equates to about $1.5 billion per year—the largest annual increase to date. Capital expenditures from 2002 to 2004 are roughly $2.6 billion—the second highest increase—approximately $1.3 billion per year. The estimate for annual O&M costs (see table C-4 of the initial working paper - reference 1) remains unchanged when the market penetration for the current time period is factored in.

Table 8
ITS Infrastructure Needed to Reach Full Deployment Factoring ITS Deployment Tracking Data from 1997 through 2004

	Generic Large Area	75 Largest Metropolitan Areas	% Difference
Capital Costs without Considering Deployment Levels	$589M	$44.2B	N/A
Capital Costs with 1997 Deployment Levels	$502M	$37.7B	-14.7%
Capital Costs with 1999 Deployment Levels	$478M	$35.9B	-18.8%
Capital Costs with 2000 Deployment Levels	$470M	$35.3B	-20.1%
Capital Costs with 2002 Deployment Levels	$431M	$32.3B	-26.8%
Capital Costs with 2004 Deployment Levels	$397M	$29.8B	-32.6%
Annual O&M Costs Unchanged by 2004 Deployment Levels	$58M	$4.3B	N/A

Note: Numbers are rounded

To investigate how the level of deployment might affect the estimate of investment needs, a parametric analysis similar to that performed in the initial working paper was performed for the generic large metropolitan area. This analysis was performed for four different constant values—33%, 50%, 67%, and 80%—with the constant values each representing the percent that the "should" deployment levels might be of the "could" (full deployment) level. The 100% level was defined as the "could" case, while the lower levels were defined as possible "should" cases. The lower value of 33% was included in this analysis to broaden the range of possible "should" cases.

Using a "should" case of 67% of the "could" case, the generic large area would need only $394 million, instead of $589 million for ITS infrastructure deployment. Furthermore, taking into account that $192 million has already been deployed through 2004, only $205 million remains for the still-needed investment. Making estimates of the investment needed at the national level depends quite heavily on the values estimated for the "should" case and base year deployment levels. These values will vary, not only by cost element, but by the specific transportation needs and network characteristics associated with each metropolitan area.

Next Steps

As additional deployment tracking data become available, ITS infrastructure deployment expenditures and trends can continue to be tracked and analyzed, and the estimates of the still-needed investment can be updated. Current plans are to update this working paper after the results of the 2005 deployment tracking activity are made available in calendar year 2006.

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