U.S. Department
of Transportation

Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY99 Results

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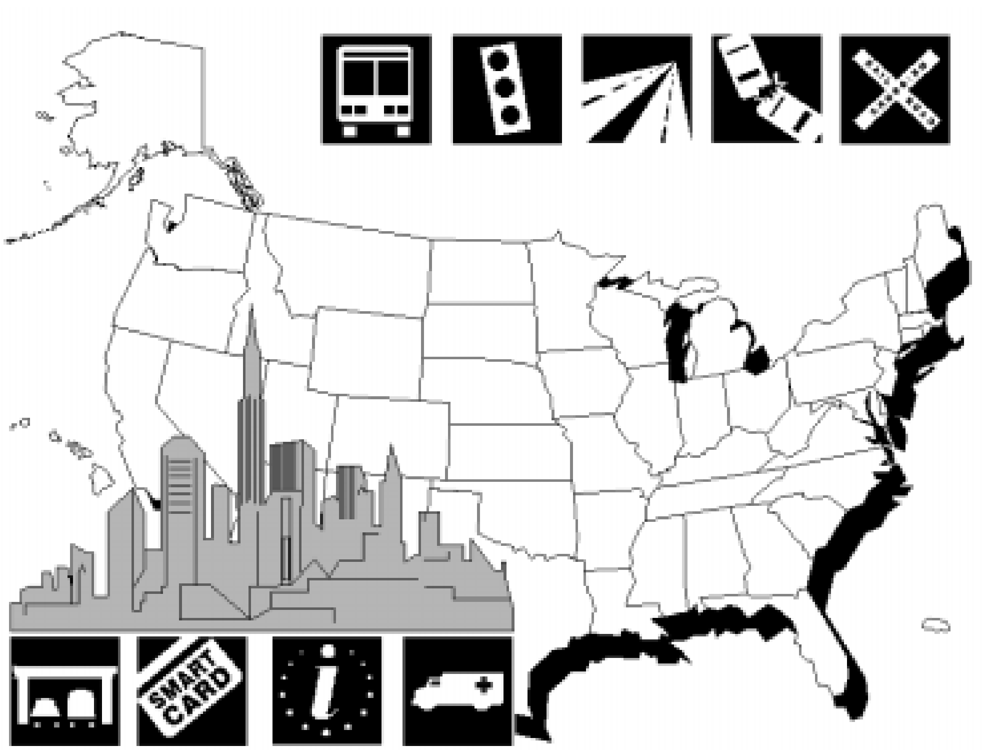

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16. Abstract

This report describes the results of a major data gathering effort aimed at tracking deployment of nine infrastructure components of the metropolitan ITS infrastructure in 78 of the largest metropolitan areas in the nation. The nine components are: Freeway Management, Incident Management, Arterial Management, Electronic Toll Collection, Electronic Fare Payment, Transit Management, Highway-Rail Intersections, Emergency Management, and Regional Multimodal Traveler Information. Deployment is tracked through the use of indicators tied to the major functions of each component. In addition, integration of components is tracked through examining the transfer of information between components and the use of that information, once transferred. The report summarizes results at a national level and includes information on the number of metropolitan areas deploying selected technologies related to the indicators.

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Preface

This report presents the results of an update of a major nationwide data gathering effort to track the deployment of the metropolitan Intelligent Transportation Systems (ITS) Infrastructure in the largest metropolitan areas of the United States. In 1997, a report documenting the results of a baseline survey was published by the U.S. Department of Transportation (DOT). This current report documents results of a survey conducted in 1999 to update the 1997 baseline data. Tracking deployment of ITS infrastructure is an important element of ITS program assessment since implementation of ITS is an indirect measure of effectiveness of the ITS program. Information regarding deployment activities provides feedback on progress of the program that can help stakeholders establish strategies for continued market growth. Understanding the rate of ITS deployment in various metropolitan areas can lead to insights regarding future program changes, redefinition of goals, or maintenance of current program direction.

The methodology followed to complete this effort is based on the development of deployment indicators designed to capture the most important functions provided by a particular ITS infrastructure component. The nine components tracked include: Freeway Management, Incident Management, Arterial Management, Transit Management, Electronic Fare Payment, Electronic Toll Collection, Highway-Rail Intersections, Emergency Management, and Regional Multimodal Traveler Information. In addition, indicators were developed to capture the level of integration of these components.

Questions or comments concerning the material presented in this report are encouraged and can be directed to:

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Acronym List

ADOT	Arizona Department of Transportation
ATMS	Advanced Traffic Management System
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
CAD	Computer-Aided Dispatch
CBD	Central Business District
CCTV	Closed Circuit Television
EFP	Electronic Fare Payment
EM	Emergency Management
ETC	Electronic Toll Collection
FHWA	Federal Highway Administration
FM	Freeway Management
FTA	Federal Transit Administration
HAR	Highway Advisory Radio
HAZMAT	Hazardous Material
HPMS	Highway Performance Monitoring System
HRI	Highway-Rail Intersections
IM	Incident Management
ISP	Information Service Provider
ITS	Intelligent Transportation Systems
IVS	In-Vehicle Signing
JPO	ITS Joint Program Office
MMDI	Metropolitan Model Deployment Initiative
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
ORNL	Oak Ridge National Laboratory
PIAS	Personal Information Access System
RMTI	Regional Multimodal Traveler Information
RTS	Remote Transfer Support
TM	Transit Management
TSC	Traffic Signal Control
USDOT	United States Department of Transportation
VMS	Variable Message Sign

EXECUTIVE SUMMARY

In January 1996, Secretary Peña set a goal of deploying the integrated metropolitan Intelligent Transportation System (ITS) infrastructure in 75[1] of the nation's largest metropolitan areas by 2006:

> *"I'm setting a national goal: to build an intelligent transportation infrastructure across the United States to save time and lives, and improve the quality of life for Americans. I believe that what we do, we must measure . . . Let us set a very tangible target that will focus our attention . . . I want 75 of our largest metropolitan areas outfitted with a complete intelligent transportation infrastructure in 10 years."*[2]
>
> -- *Secretary Peña, 1996*

In order to track progress toward fulfillment of the Secretary's goal for deployment, the U.S. Department of Transportation (DOT) Intelligent Transportation Systems (ITS) Joint Program Office (JPO) developed the metropolitan ITS deployment tracking methodology. This methodology tracks deployment of the nine components that make up the ITS infrastructure: Freeway Management; Incident Management; Arterial Management; Emergency Management; Transit Management; Electronic Toll Collection; Electronic Fare Payment; Highway-Rail Intersections; and Regional Multimodal Traveler Information. Information is gathered through a set of surveys distributed to the state and local agencies involved with these infrastructure components. The surveys gather information on the extent of deployment of the infrastructure and on the extent of integration between the agencies that operate the infrastructure. Deployment is measured using a set of indicators tied to the major functions of each component. Integration is measured by assessing the extent to which agencies share information and cooperate in operations based on a set of defined links between the infrastructure components. The details of the methodology are explained elsewhere.[3]

In FY97, the ITS JPO undertook a baseline survey of deployment in the nation's largest metropolitan areas following the metropolitan ITS deployment tracking methodology and

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[1] Since Secretary Peña's speech, the number of metropolitan areas that DOT will measure has been increased from 75 to 78. However, to maintain reporting consistency across the 10-year goal period, this report considers only the original 75 metropolitan areas.

[2] Excerpt of a speech delivered by Secretary of Transportation Peña at the Transportation Research Board in Washington, DC on January 10, 1996.

[3] Additional Resources: "Measuring ITS Deployment and Integration" http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf (also see: Electronic Document Number: 4372). U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems, 400 Seventh St., SW (HVH-1), Washington, DC 20590, Phone: 202-366-9536, Fax: 202-366-3302, Web: http://www.its.dot.gov.

published the results in a series of site reports and a nationwide summary report.[4] During the summer and fall of 1999, the ITS JPO undertook a new data collection effort for the purpose of updating the 1997 survey results. Individual site reports have been developed for each metropolitan area surveyed. This report is a national summary of the FY99 survey results.

Deployment Summary Indicators

As will be seen in section 2 of this report, the level of deployment of each of the ITS infrastructure components is described by a number of indicators. These indicators have been chosen to serve as estimators of the extent of technology deployment supporting critical functions. For each component, one of these indicators has been designated to serve as a summary for the whole component, allowing national results to be portrayed in a single graph. Figure ES.1 presents the national summary indicators. The FY99 results are compared to results from 1997, the last time the survey was conducted. In addition, responders were asked to estimate deployment levels in the year 2005 as part of the 1999 survey and these projections are included in the figure. The indicators developed for deployment tracking are surrogates that do not necessarily reflect the full breadth of deployment. Because deployment goals have not been established, these indicators should not be read as a comparison of what is deployed versus eventual deployment goals. Instead, they only reflect what is deployed compared to full market saturation (i.e., the full deployment opportunity).

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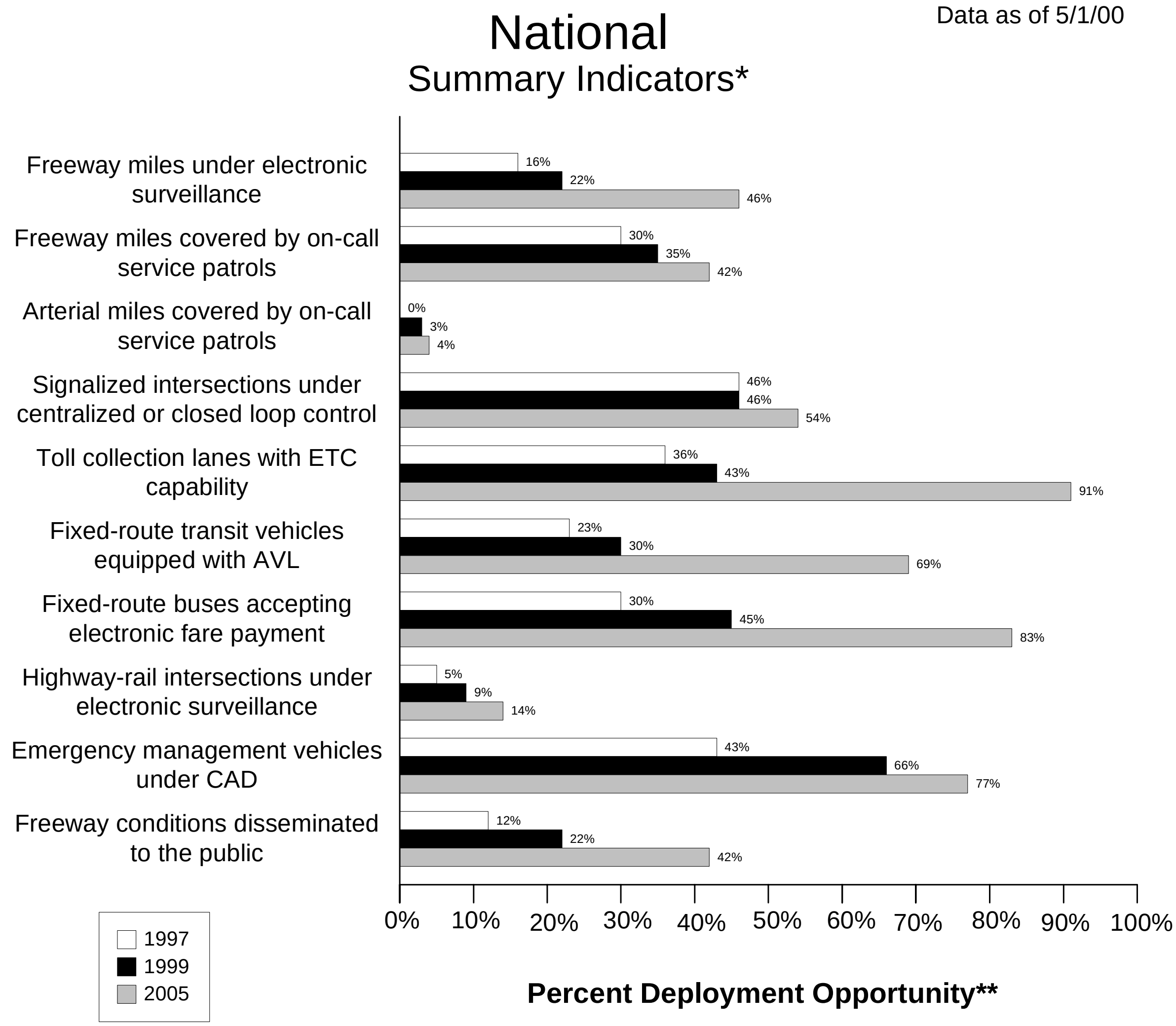
[4] "Tracking the Deployment of Integrated ITS Infrastructure in the USA: FY97 Results" http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/4jf01!.pdf . U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems, 400 Seventh St., SW (HVH-1), Washington, DC 20590, September 1998.



* Indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity
** Deployment opportunity reflects potential totals that do not necessarily reflect actual need

Figure ES.1. National Summary Indicators

Integration Indicators

ITS integration is measured using 34 links that have been defined within the ITS infrastructure. These links are both inter-component (e.g., the sharing of arterial and freeway traffic condition information between freeway and arterial management agencies) and intra-component (e.g., the sharing of traffic signal timing information between arterial management agencies). The measure of integration is the simple calculation of the number of agencies that participate in integration compared to the total number of agencies that possibly could. As with deployment, this measure does not make a distinction between those agencies that should be linked and those that should not.

Figure ES.2 presents the national summary of integration results for the FY99 survey.

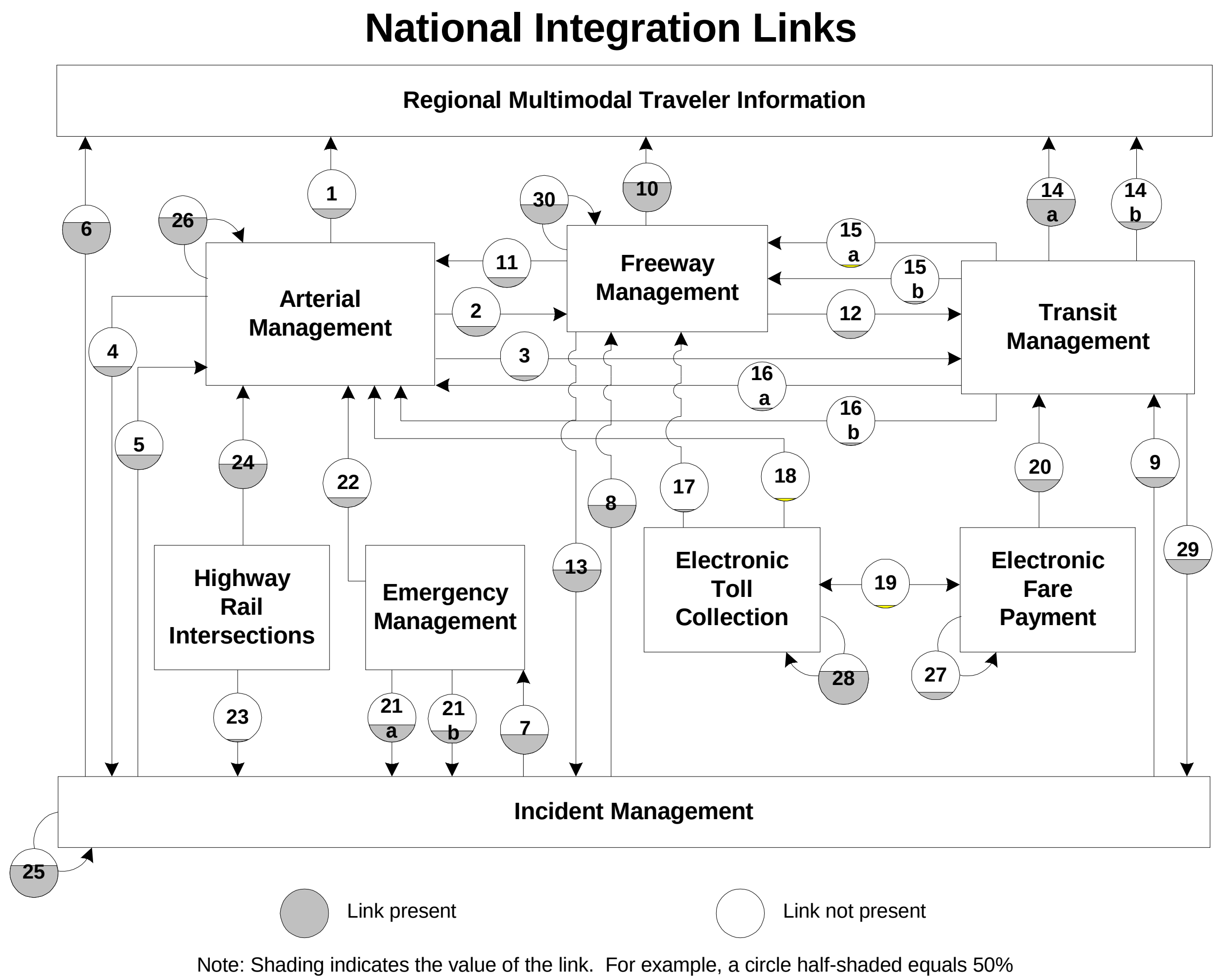


Figure ES.2. National Summary of Integration Links

Measuring Progress in Integrated Deployment

Deployment tracking data were used to develop a methodology for developing and tracking goals for integrated deployment to support monitoring of progress toward the Secretary's 10-year goal. Deployment is measured using a set of threshold values for the major infrastructure components. A metropolitan area is assigned a rating of low, medium, or high based on the number of thresholds attained. Integration is measured by evaluating the existence of integration links between a subset of the infrastructure--freeway management, arterial management, and transit management. An integration rating of low, medium, and high is assigned and combined with the deployment rating to produce a single overall rating for integrated deployment. Crossing a threshold value for either deployment or integration means that a metropolitan area has made a significant commitment to deploy and integrate the metropolitan ITS infrastructure. *However, it* *does not mean that deployment or integration is complete*. The 10-year goal will be met if all of the 75 metropolitan areas are rated medium or above for integrated deployment. This methodology is explained in detail in section 4.

Figure ES.3 summarizes the level of deployment in 75 of the nation's largest metropolitan areas for 1997 and 1999.

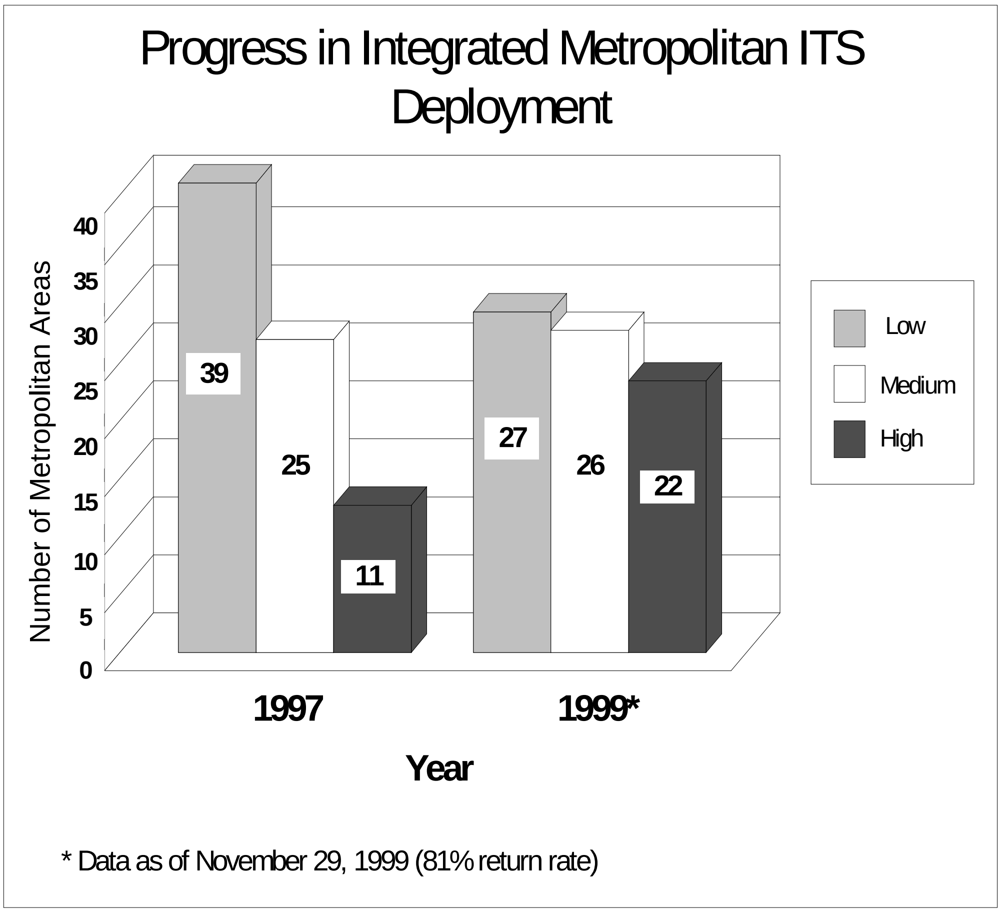


Figure ES.3. Progress in Integrated Metropolitan ITS Deployment

I - INTRODUCTION

Background

In January 1996, Secretary Peña set a goal of deploying the integrated metropolitan Intelligent Transportation System (ITS) infrastructure in 75[5] of the nation's largest metropolitan areas by 2006:

> *"I'm setting a national goal: to build an intelligent transportation infrastructure across the United States to save time and lives, and improve the quality of life for Americans. I believe that what we do, we must measure . . . Let us set a very tangible target that will focus our attention . . . I want 75 of our largest metropolitan areas outfitted with a complete intelligent transportation infrastructure in 10 years."*[6]
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> -- *Secretary Peña, 1996*

In 1997, in order to track progress toward fulfillment of the Secretary's goal for deployment, the U.S. Department of Transportation Intelligent Transportation Systems (ITS) Joint Program Office (JPO) developed the metropolitan ITS deployment tracking methodology. This methodology tracks deployment of the nine components that make up the ITS infrastructure: Freeway Management; Incident Management; Arterial Management; Emergency Management; Transit Management; Electronic Toll Collection; Electronic Fare Payment; Highway-Rail Intersections; and, Regional Multimodal Traveler Information. Through a set of indicators tied to the major functions of each component, the level of deployment is tracked for the nation's largest metropolitan areas. In addition, the integration links between agencies operating the infrastructure are also tracked. The details of the methodology are explained elsewhere.[7]

In 1997, the ITS JPO published the results of the first nationwide survey of deployment in the nation's 78 largest metropolitan areas using the metropolitan ITS deployment tracking

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[5] Since Secretary Peña's speech, the number of metropolitan areas that DOT will measure has been increased from 75 to 78. However, to maintain reporting consistency across the 10-year goal period, this report considers only the original 75 metropolitan areas.

[6] Excerpt of a speech delivered by Secretary of Transportation Peña at the Transportation Research Board in Washington, DC on January 10, 1996.

[7] Additional Resources: "Measuring ITS Deployment and Integration" http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf (also see: Electronic Document Number: 4372). U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems, 400 Seventh St., SW (HVH-1), Washington, DC 20590, Phone: 202-366-9536, Fax: 202-366-3302, Web: http://www.its.dot.gov.

methodology. The results of this effort are documented elsewhere.[8] In 1999, the ITS JPO implemented a national survey effort designed to update the information collected in the 1997 survey. This report summarizes the results of the 1999 data collection effort. Information provided in this report includes a comparison of 1997 and 1999 deployment for the metropolitan ITS infrastructure components mentioned earlier. In addition, this report compares levels of integration of these components in 1997 against those measured in 1999. In the 1999 survey, agencies were asked to estimate anticipated levels of deployment by 2005. Therefore, this report also includes a comparison of 1997, 1999, and 2005 levels of deployment from a national perspective.

Table 1.1 contains a list of the metropolitan areas that are the focus of deployment tracking efforts. The list includes the 1990 population and the 1997 and 1999 survey return rates for each metropolitan area. Approximately 2,000 survey forms were distributed in these areas with an overall response rate of 81% in 1997 and 84% in 1999.

Table 1.1 Metropolitan Areas Surveyed

Rank	Metropolitan Area	State	1990 Population	1997 Survey Return Rate	1999 Survey Return Rate
1	New York-Northern New Jersey-Southwestern Connecticut	NY	17,918,917	61%	77%
2	Los Angeles-Riverside-Orange County	CA	14,531,529	79%	84%
3	Chicago-Gary-Kenosha	IL	8,239,820	95%	90%
4	San Francisco-Oakland-San Jose	CA	6,253,311	83%	90%
5	Philadelphia-Wilmington-Atlantic City	NJ	6,218,761	62%	77%
6	Boston-Worcester-Lawrence	MA	5,455,403	71%	76%
7	Detroit-Ann Arbor-Flint	MI	5,187,171	89%	86%
8	Washington	DC	4,223,495	82%	89%
9	Dallas-Ft Worth	TX	4,037,282	91%	93%
10	Houston-Galveston-Brazoria	TX	3,731,131	87%	63%
11	Miami-Ft Lauderdale	FL	3,192,582	100%	77%
12	Seattle-Tacoma-Bremerton	WA	2,970,328	90%	89%
13	Atlanta	GA	2,959,950	82%	96%
14	Cleveland-Akron	OH	2,859,644	85%	84%

[8] "Tracking the Deployment of Integrated ITS Infrastructure in the USA: FY97 Results" http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/4jf01!.pdf. U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems, 400 Seventh St., SW (HVH-1), Washington, DC 20590, September 1998.

Rank	Metropolitan Area	State	1990 Population	1997 Survey Return Rate	1999 Survey Return Rate
15	Minneapolis-St. Paul	MN	2,538,834	73%	84%
16	San Diego	CA	2,498,016	65%	88%
17	St. Louis	MO	2,492,525	79%	83%
18	Pittsburgh	PA	2,394,811	73%	100%
19	Baltimore	MD	2,382,172	68%	89%
20	Phoenix-Mesa	AZ	2,238,480	96%	94%
21	Tampa-St. Petersburg-Clearwater	FL	2,067,959	94%	95%
22	Denver-Boulder-Greeley	CO	1,980,140	63%	92%
23	Cincinnati-Hamilton	OH	1,817,571	61%	91%
24	Portland-Salem	OR	1,793,476	78%	79%
25	Milwaukee-Racine	WI	1,607,183	96%	89%
26	Kansas City	MO	1,582,875	82%	79%
27	Sacramento	CA	1,481,102	71%	89%
28	Hampton Roads	VA	1,443,244	94%	91%
29	Indianapolis	IN	1,380,491	79%	100%
30	Columbus	OH	1,345,450	100%	100%
31	San Antonio	TX	1,324,749	100%	63%
32	New Orleans	LA	1,285,270	83%	72%
33	Orlando	FL	1,224,852	100%	94%
34	San Juan	PR	1,221,000	56%	33%
35	Buffalo-Niagara Falls	NY	1,189,288	92%	100%
36	Charlotte-Gastonia-Rock Hill	NC	1,162,093	100%	100%
37	Hartford	CT	1,157,585	92%	86%
38	Providence-Fall River-Warwick	RI	1,134,350	66%	76%
39	Salt Lake City-Ogden	UT	1,072,227	90%	86%
40	Rochester	NY	1,062,470	100%	80%
41	Greensboro-Winston Salem-High Point	NC	1,050,304	92%	97%
42	Memphis	TN	1,007,306	100%	91%
43	Nashville	TN	985,026	100%	75%
44	Oklahoma City	OK	958,839	83%	88%
45	Dayton-Springfield	OH	951,270	66%	88%
46	Louisville	KY	948,829	91%	94%
47	Grand Rapids-Muskegon-Holland	MI	937,891	90%	81%

Rank	Metropolitan Area	State	1990 Population	1997 Survey Return Rate	1999 Survey Return Rate
48	Jacksonville	FL	906,727	95%	100%
49	Richmond-Petersburg	VA	865,640	65%	75%
50	West Palm Beach-Boca Raton	FL	863,518	94%	92%
51	Albany-Schenectady-Troy	NY	861,424	94%	95%
52	Raleigh-Durham-Chapel Hill	NC	855,545	80%	82%
53	Las Vegas	NV	852,737	100%	100%
54	Austin-San Marcos	TX	846,227	100%	92%
55	Birmingham	AL	840,140	58%	70%
56	Honolulu	HI	836,231	56%	83%
57	Greenville-Spartanburg-Anderson	SC	830,563	80%	100%
58	Fresno	CA	755,580	45%	89%
59	Syracuse	NY	742,177	87%	90%
60	Tulsa	OK	708,954	95%	81%
61	Tucson	AZ	666,880	100%	100%
62	Omaha	NE	639,580	95%	86%
63	Scranton-Wilkes Barre-Hazleton	PA	638,466	81%	73%
64	Toledo	OH	614,128	88%	84%
65	Youngstown-Warren	OH	600,895	74%	81%
66	Allentown-Bethlehem-Easton	PA	595,081	60%	100%
67	El Paso	TX	591,610	86%	75%
68	Albuquerque	NM	589,131	25%	70%
69	Harrisburg-Lebanon-Carlisle	PA	587,986	60%	88%
70	Springfield	MA	587,884	67%	54%
71	Knoxville	TN	585,960	78%	92%
72	Bakersfield	CA	543,477	36%	100%
73	New Haven	CT	530,180	90%	80%
74	Baton Rouge	LA	528,264	100%	93%
75	Little Rock-North Little Rock	AR	513,117	100%	100%
76	Charleston- North Charleston	SC	506,875	68%	80%
77	Sarasota-Bradenton	FL	489,483	100%	100%
78	Wichita	KS	485,270	100%	100%

National Summary Indicators

Several deployment indicators have been developed for each component. However, a single indicator has been selected for the purpose of summarizing the level of deployment for a particular component. The summary indicators are expressed as a percentage; however, because deployment goals have yet to be established, these indicators should not be read as a comparison of what is deployed versus eventual deployment goals. Instead, they only reflect what is deployed compared to full market saturation (i.e., opportunity for deployment). The indicators are surrogates that do not necessarily reflect the full breadth of metropolitan ITS deployment

Figure 1.1 portrays the summary indicators developed from the 1997 survey and the 1999 survey. (The 1999 survey asked for estimated 2005 levels of deployment.)

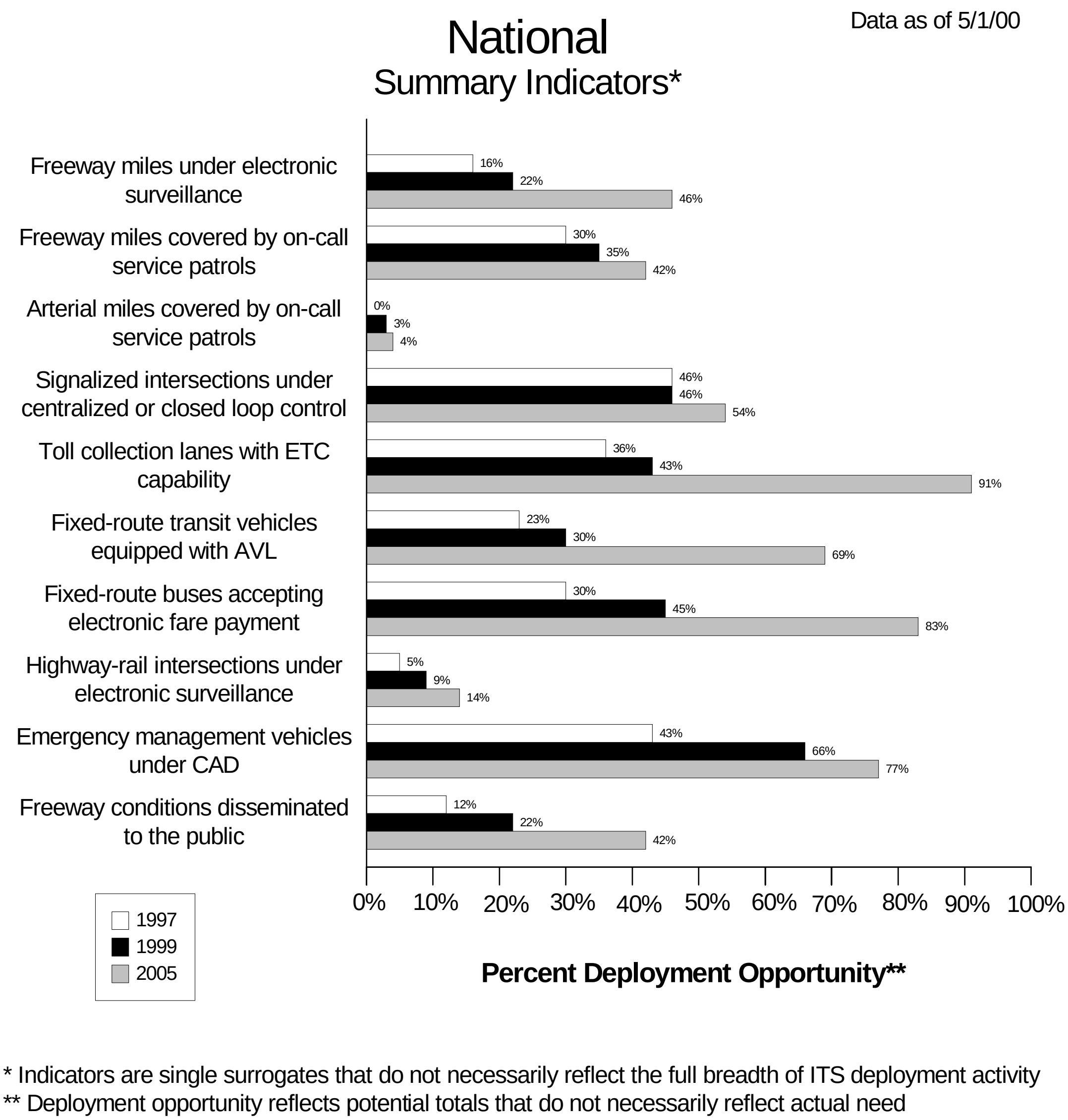


Figure 1.1 National Summary Indicators

Figure 1.2 portrays the national summary indicators for integration. As with the component indicators, definitions for inter- and intra-component integration were developed for each component. Indicators derived from these definitions were also produced for each component. A total of 34 individual integration indicators were specified and are portrayed in the third figure, which follows. Each integration indicator has been assigned a number and an origin/destination path from one ITS infrastructure component to another. For example, the integration of information from the Freeway Management component to the Regional Multimodal Traveler Information component is identified by the number "10."

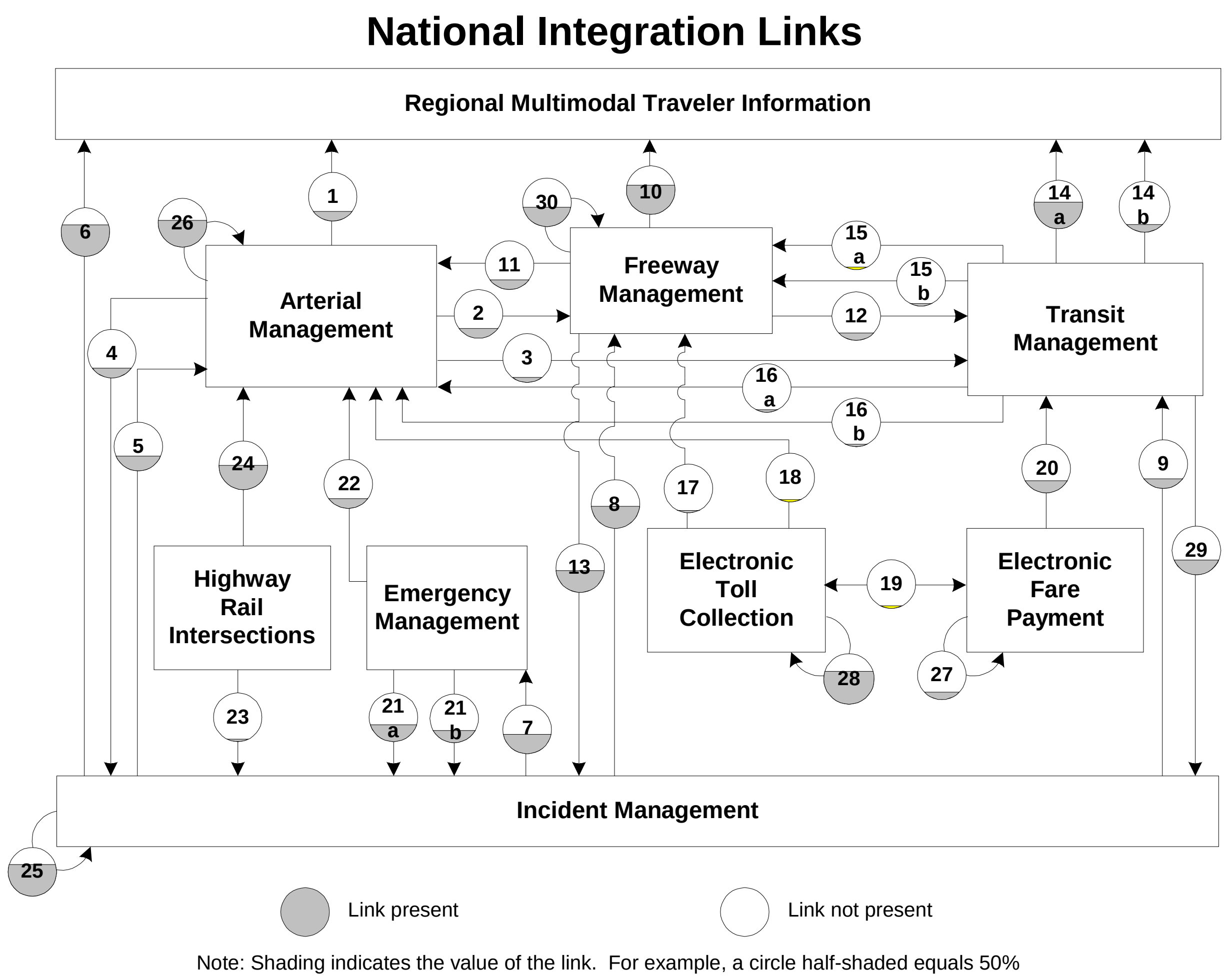


Figure 1.2 National Summary of Integration Links

Organization of Report

This report is divided into five parts: Executive Summary, Introduction, ITS Infrastructure Component Description and FY99 Survey Results, ITS Infrastructure Integration Indicator Description and FY99 Survey Results, and Deployment Goal Setting.

II - ITS INFRASTRUCTURE COMPONENT DESCRIPTION AND FY99 SURVEY RESULTS

This section presents deployment tracking indicators for each of the nine metropolitan ITS components. The following information is provided for each component:

1. A description of the basic functions performed by each component.

2. A description of the deployment tracking indicators used to measure each function.

3. Data gathering results for each indicator displayed in a set of graphs. The horizontal bar graph that portrays results is expressed as a percent of deployment opportunity achieved for each indicator. The deployment opportunity reflects the total potential deployment and does not necessarily reflect actual need. For example, freeway management indicators are compared to a deployment opportunity consisting of the entire freeway system and are not corrected for any assessment of how local conditions might limit the scope of deployment to a portion of the freeway system. These indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity. Where possible, FY99 results are compared to FY97 and estimates for FY05. In some cases, changes to the surveys make such a direct comparison impossible.

4. Additional survey results used to evaluate the extent that related technologies have been adopted by individual metropolitan areas. This information is displayed in graphs that show the number of metropolitan areas reporting the presence of a particular technology that supports a component. In many cases, metropolitan areas have more than one of these technologies. As with the indicators, 1999 results are compared to 1997 results and 2005 estimates.

FREEWAY MANAGEMENT

Freeway Management Functions

Freeway Management provides the following traffic management functions:

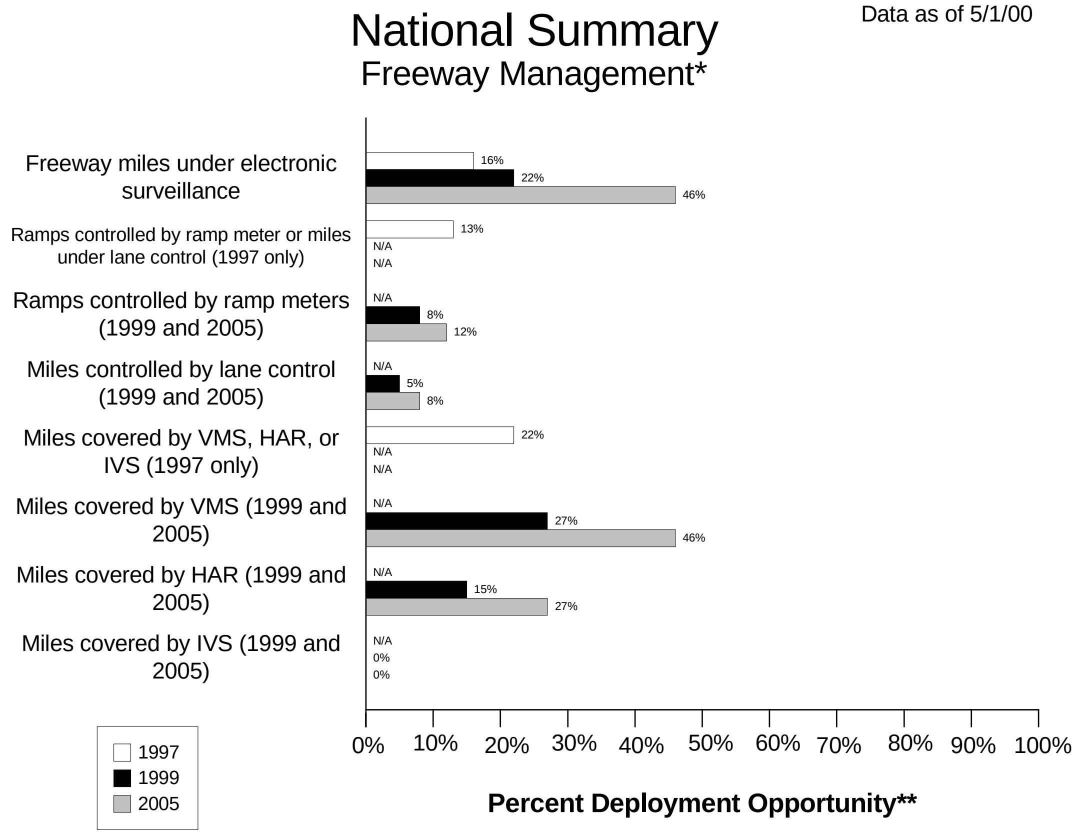
1. Capability to monitor traffic conditions on the freeway system in real-time (i.e, traffic surveillance).
2. Capability to implement appropriate traffic control and management strategies (such as ramp metering and lane control) in response to recurring or non-recurring flow impediments (i.e., traffic control).
3. Capability to provide critical information to travelers through infrastructure-based dissemination methods such as Variable Message Signs (VMS), Highway Advisory Radio (HAR), or In-Vehicle Signing (IVS) (i.e., information display).

Freeway Management Indicators

Eight indicators have been developed to measure the presence of these key functions:

1. Percentage of freeway centerline miles under electronic surveillance for monitoring traffic flow.
2. Percentage of freeway ramps covered by ramp metering or mile under lane control (1997 only).
3. Percentage of freeway centerline miles controlled by ramp metering
4. Percentage of freeway centerline miles controlled by lane control.
5. Percentage of freeway centerline miles covered by permanent VMS, HAR, or IVS (1997 only).
6. Percentage of freeway centerline miles covered by permanent VMS.
7. Percentage of freeway centerline miles covered by HAR.
8. Percentage of freeway centerline miles covered by IVS.

The Freeway Management component indicators are shown in Figure 2.1.



* Indicators are single surrogates that do not necessarily reflect the full breath of ITS deployment activity
** Deployment opportunity reflects potential totals that do not necessarily reflect actual need

Figure 2.1 Freeway Management Component Indicators
(Based on 1997 survey return of 89% and 1999 survey return of 86%)

Type of Communication

Four types of communication are commonly used by Freeway Management to transfer information among widely dispersed system elements.

Figure 2.2 contains the number of metropolitan areas that use these types of

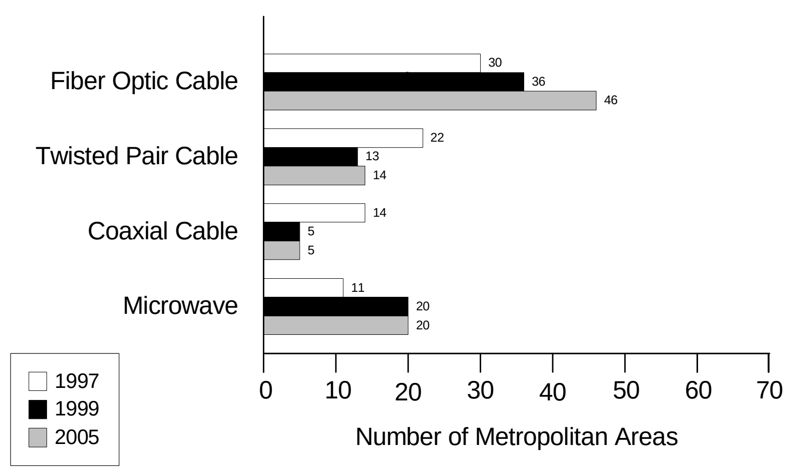


Figure 2.2. Freeway Management Types of Communication

communication. Some metropolitan areas use more than one technology. The most frequently used communication technology is fiber optic cable, followed by twisted pair cable, coaxial cable, and microwave radio.

Traffic Surveillance

Closed-circuit television (CCTV) and an array of sensors are used to electronically monitor freeway conditions in real-time.

Figure 2.3 contains the number of metropolitan areas that use various surveillance technologies. Some metropolitan areas use more than one technology. The most frequently used electronic surveillance technology is loop detectors, although radar detectors and video image detectors show the greatest projected growth.

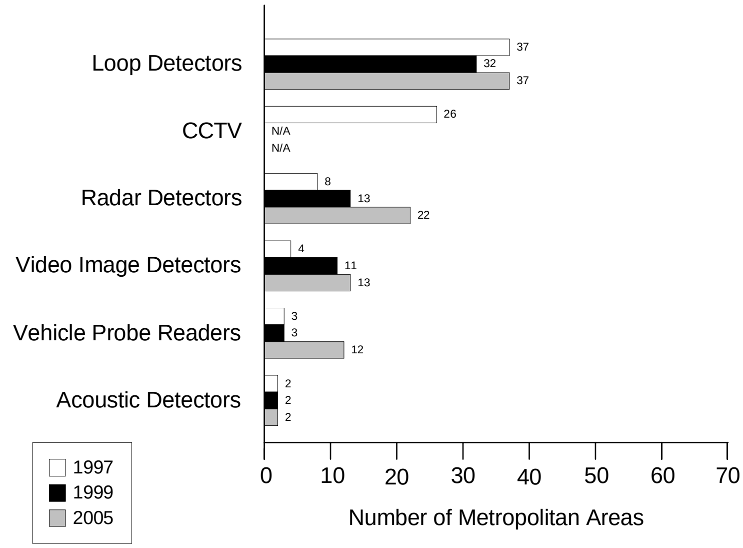


Figure 2.3. Freeway Management Surveillance

Traffic Control

Traffic condition data are analyzed to identify the cause of a flow impediment and to formulate an appropriate response in real-time. Traffic control devices, such as ramp meters or lane control devices, may be applied to provide a better balance between freeway travel demand and capacity during congested conditions.

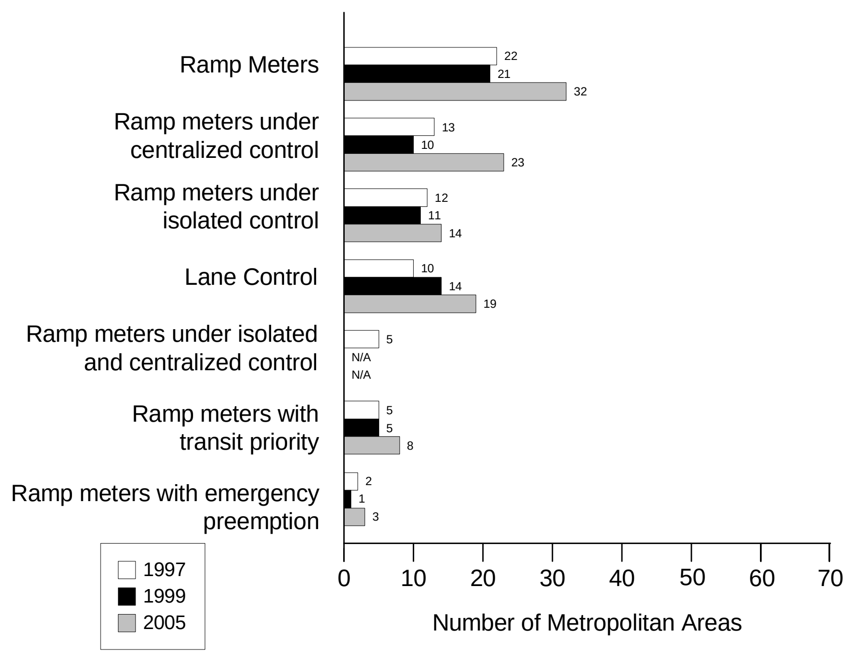


Figure 2.4. Freeway Management Traffic Control

Figure 2.4 contains the number of metropolitan areas that use lane control or ramp metering, the type of ramp meter control used, and the number of metropolitan areas that have ramp meter preemption for emergency vehicles and priority for transit vehicles.

Information Display

Information may be provided to travelers through roadside traveler information devices such as VMS, HAR, and IVS.

Figure 2.5 contains a summary of the number of metropolitan areas reporting the use of information display technologies. The most frequently used technology is VMS, followed by HAR. No metropolitan areas report using IVS.

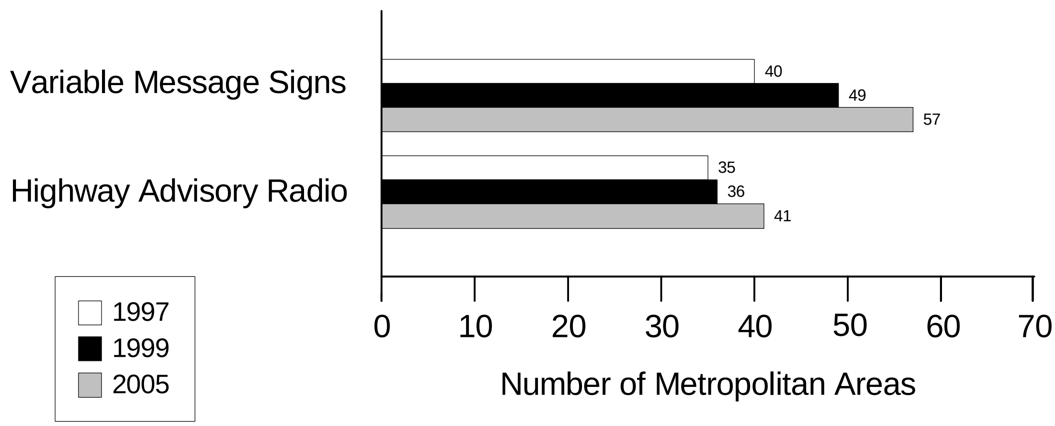


Figure 2.5. Freeway Management Information Dissemination

INCIDENT MANAGEMENT

Incident Management Functions

Incident Management provides the following traffic management functions in real-time:

1. Capability to detect incidents on the freeway and arterial roadway system (i.e., incident detection).
2. Capability to verify incidents on the freeway and arterial roadway system (i.e., incident verification).
3. Capability to respond to incidents on the freeway and arterial roadway system (i.e., incident response).

Incident Management Component Indicators

Four indicators have been developed to measure the presence of these key functions:

1. Percentage of highway miles covered by incident detection algorithms.
2. Percentage of highway miles covered by free cellular phone calls to a dedicated number.
3. Percentage of highway miles covered by surveillance cameras.
4. Percentage of highway miles covered by on-call publicly sponsored service patrols or towing services.

The Freeway and Arterial Incident Management component indicators are shown in Figure 2.6.

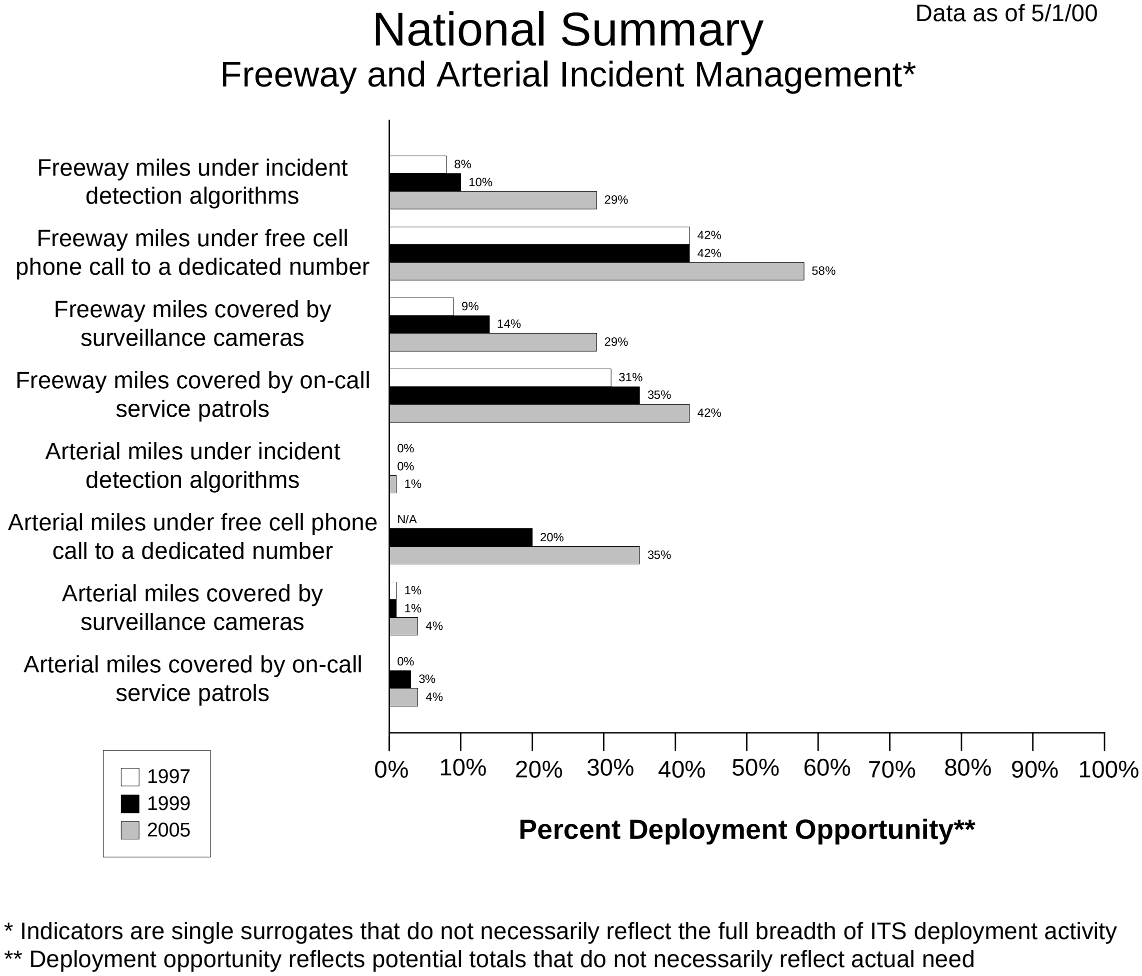


Figure 2.6 Freeway and Arterial Incident Management Component Indicators (Based on 1997 survey return of 90% and 1999 survey return of 80%)

Incident Detection

Monitoring of freeway conditions for the purpose of incident management is usually integrated with Freeway Management, with notification of the presence of an incident provided to the Incident Management component.

Figure 2.7 contains the number of metropolitan areas that use various incident detection methods. Use of free cellular phone calls to a dedicated number is the most commonly used method. Incident detection algorithms are also used in freeways and arterials.

Incident Verification

Incident verification is typically accomplished through observation by cameras.

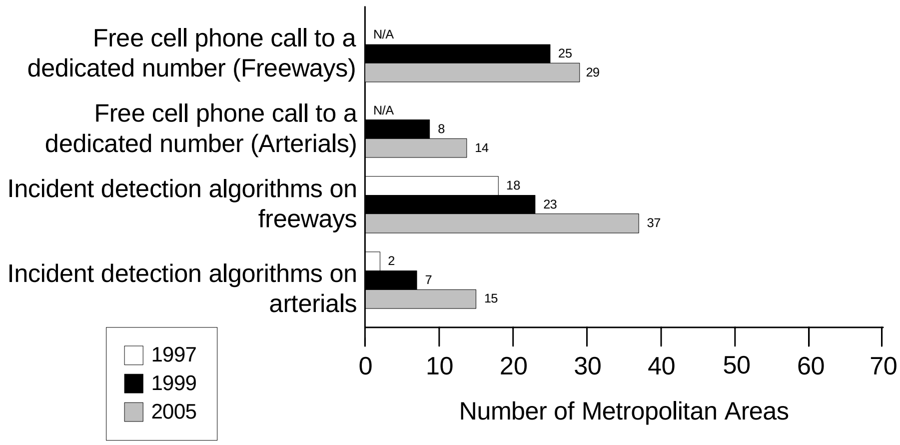


Figure2.7. Incident Management Detection

Figure 2.8 contains the number of metropolitan areas that use surveillance cameras for incident verification on arterials and freeways.

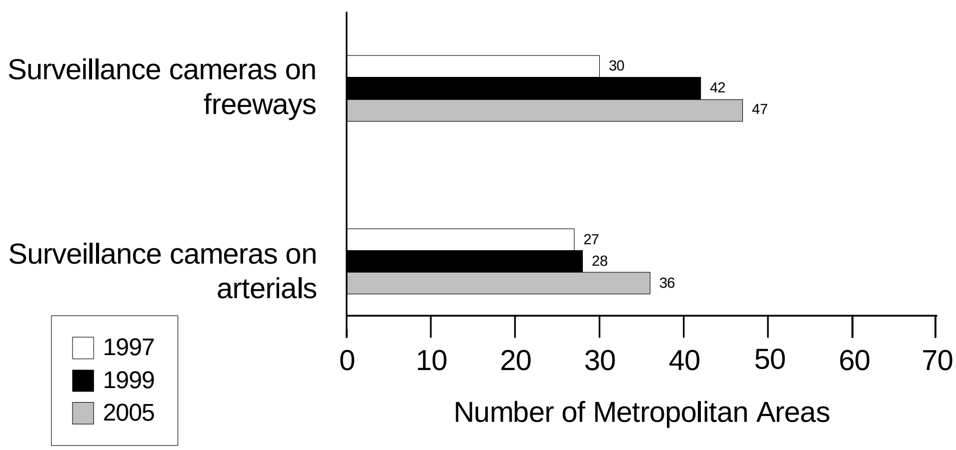


Figure 2.8. Incident Management Verification

Incident Response

Roadways are cleared and flow restored as rapidly as possible, minimizing frustration and delay to travelers while at the same time meeting the requirements and responsibilities of the agencies involved.

Figure 2.9 contains the number of metropolitan areas that use various incident response methods in freeways. More than half of the metropolitan areas reporting use publicly operated service patrols.

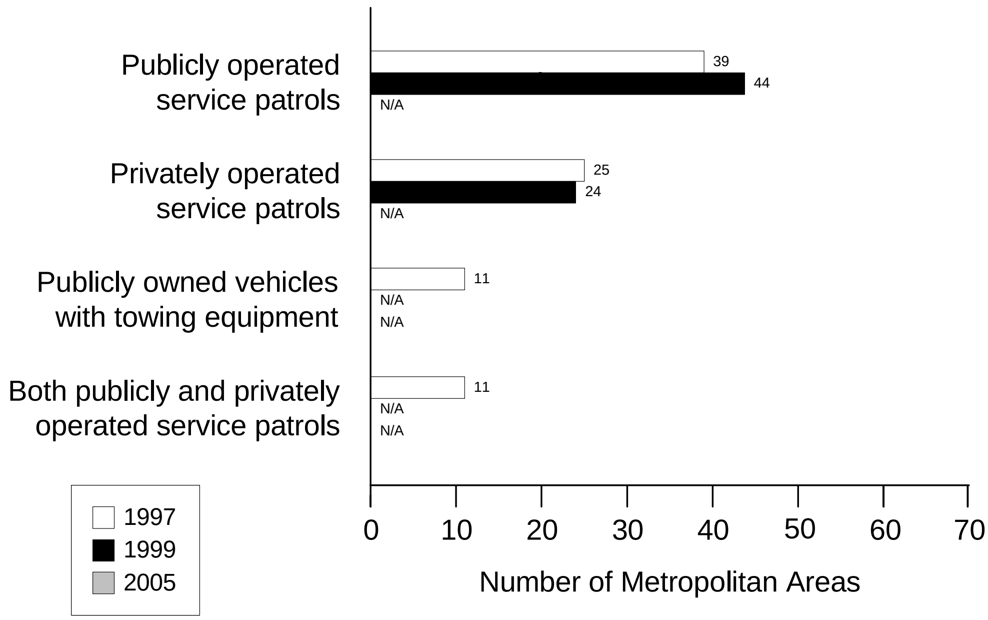


Figure 2.9. Freeway Incident Management Response

Figure 2.10 contains the number of metropolitan areas that use various incident response methods in arterials. Although not widely deployed, the most commonly used method is the use of publicly operated service patrols.

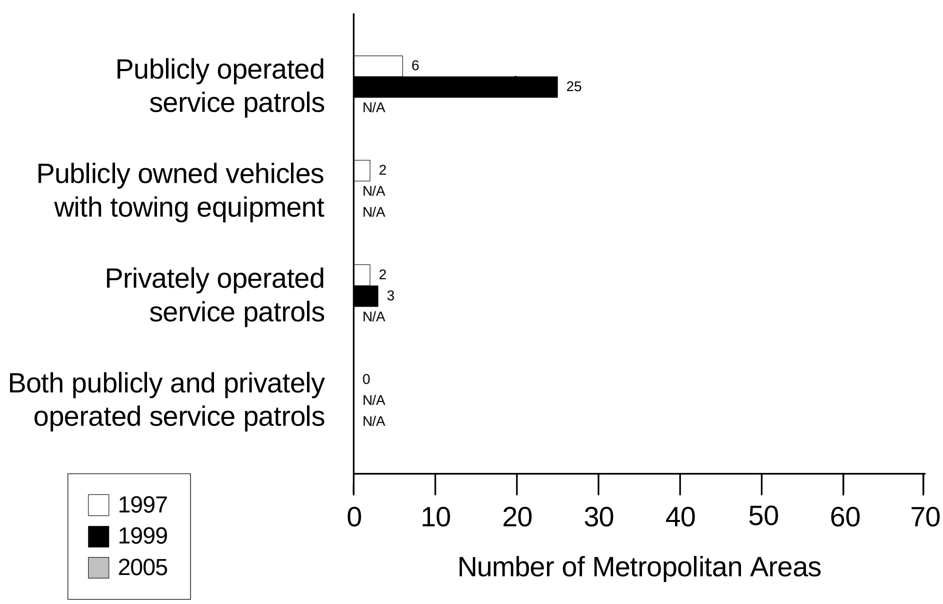


Figure 2.10. Arterial Incident Management Response

Arterial Management

Arterial Management Functions

Arterial Management provides for the following traffic management functions:

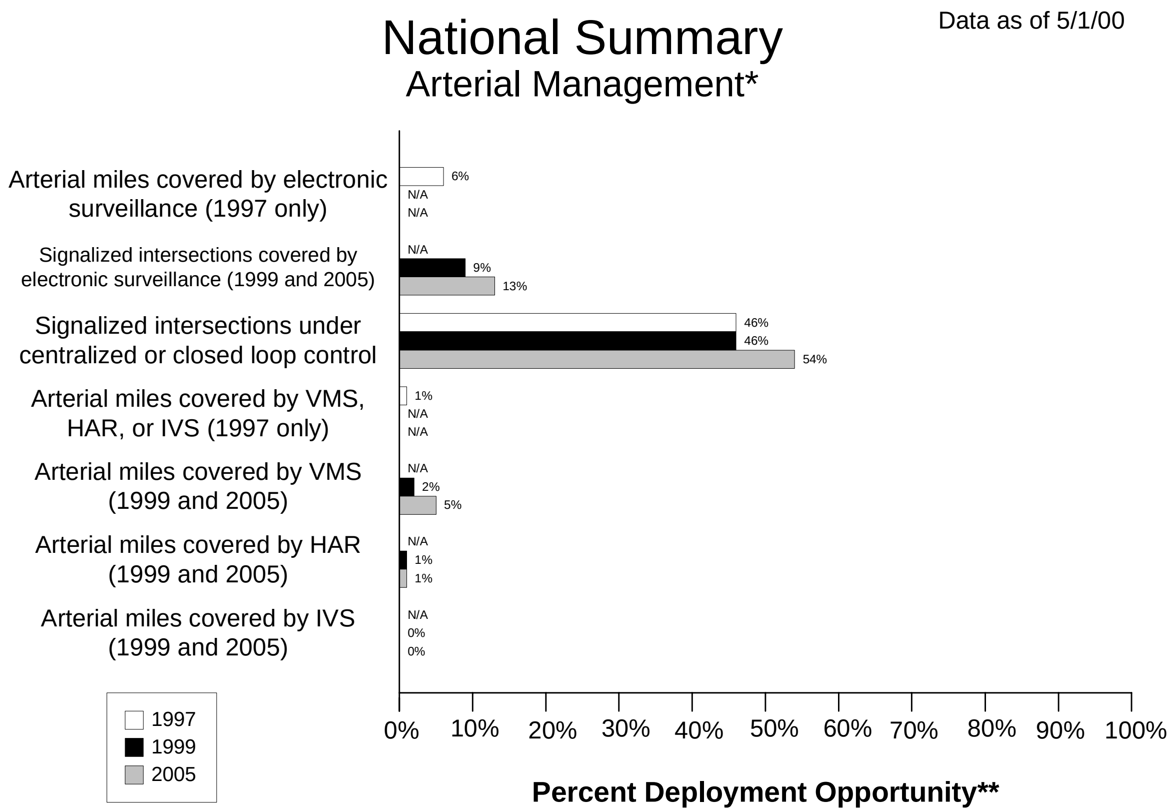
1. Capability to monitor traffic flow conditions on arterials in real-time (i.e., traffic surveillance).
2. Capability to implement traffic signal timing patterns that are responsive to traffic flow conditions (i.e., traffic control).
3. Capability to provide critical information to travelers through infrastructure-based dissemination methods such as VMS, HAR, or IVS (i.e., information display).

Arterial Management Component Indicators

Seven indicators have been developed to measure the presence of these key functions:

1. Percentage of signalized arterial and Central Business District (CBD) centerline miles covered by electronic surveillance for monitoring traffic flow (1997 only).
2. Percentage of signalized intersections covered by electronic surveillance.
3. Percentage of arterial and CBD signalized intersections under closed loop or centralized control.
4. Percentage of signalized arterial and CBD miles covered by VMS, HAR, or IVS (1997 only).
5. Percentage of arterial miles covered by VMS.
6. Percentage of arterial miles covered by HAR.
7. Percentage of arterial miles covered by IVS.

The Arterial Management component indicators are shown in Figure 2.11.



* Indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity
** Deployment opportunity reflects potential totals that do not necessarily reflect actual need

Figure 2.11. Arterial Management Component Indicators
(Based on 1997 survey return of 70% and 1999 survey return of 78%)

Traffic Surveillance

Traffic signal control may incorporate peripheral elements that are not essential to the task of traffic control per se, but which may enhance overall traffic management capabilities in an area. These elements could include CCTV surveillance, motorist information and/or traveler information components, a database management system to support analysis and development of management strategies, and data exchange with other traffic management systems including freeway management and incident management.

Figure 2.12 contains the number of metropolitan areas that use electronic surveillance on arterials. More than half of the metropolitan areas reporting have signalized arterial miles with electronic surveillance for monitoring traffic flow.

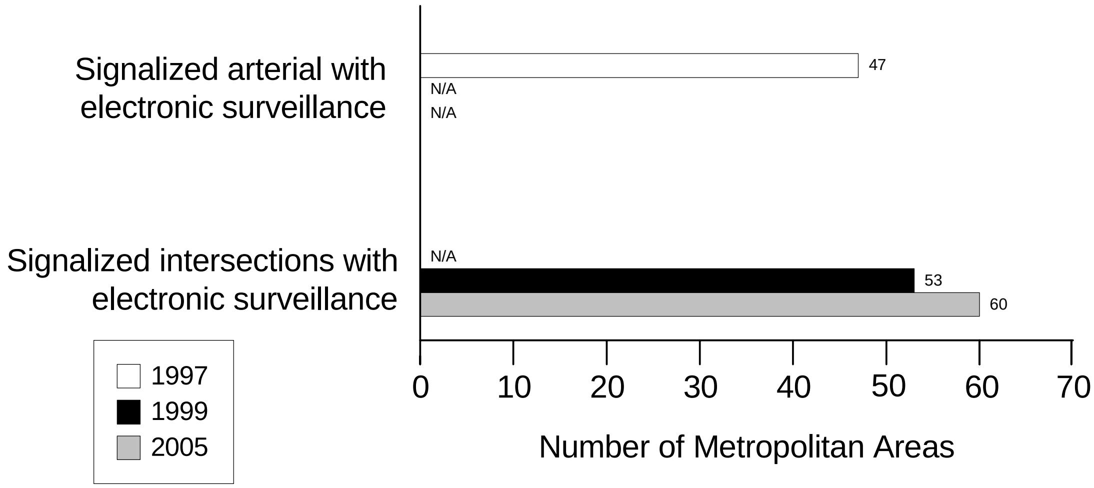


Figure 2.12. Traffic Signal Surveillance

Traffic Control

Arterial Management is responsible for the coordinated control of traffic signals along urban arterials, networks, and the CBD. Arterial Management provides the capability to adjust the amount of green time for each street and coordinate operation between each signal in response to changes in demand patterns. Traffic signal timing patterns may be executed in response to pre-established “time of day” or “special event” plans, based on historical traffic conditions, or may be executed in response to real-time traffic conditions using “traffic-adaptive” algorithms. Coordination can be implemented through a number of techniques including time-based and hard-wired interconnection methods. Coordination of traffic signals across agencies requires development of data sharing and traffic signal control agreements. Therefore, a critical institutional component of Arterial Management is the establishment of formal or informal arrangements to share traffic control information as well as actual control of traffic signal operation across jurisdictions.

Figure 2.13 contains a summary of metropolitan areas that use various control technologies. All of the metropolitan areas that responded, report having signalized arterial miles under centralized or closed loop control. Most of the metropolitan areas reporting use closed loop control. More metropolitan areas report having signals with preemption for emergency vehicles than priority for transit vehicles.

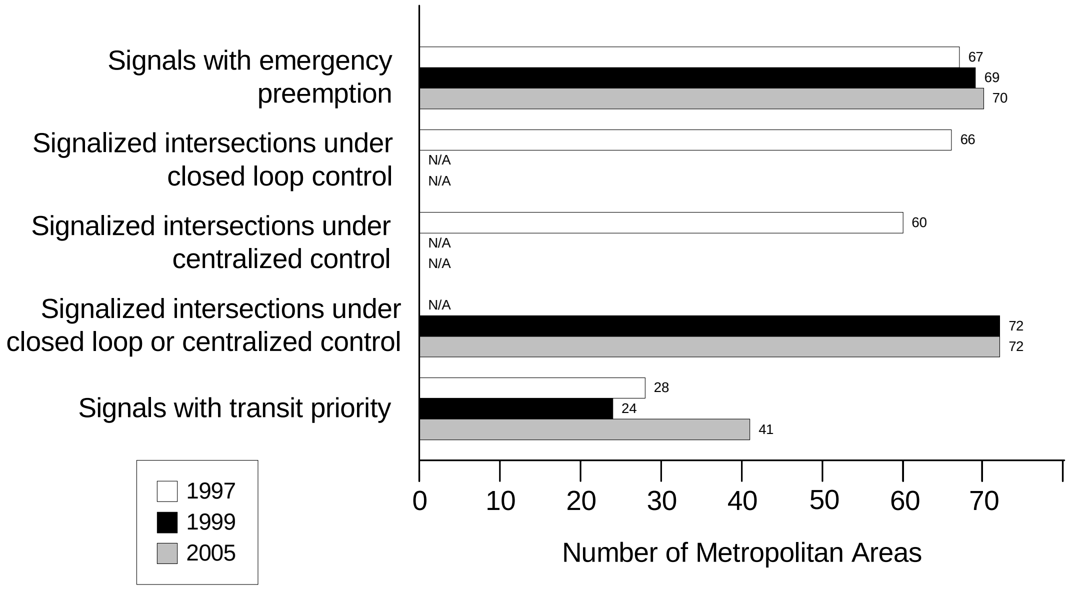


Figure 2.13. Traffic Signal Control

Information Display

Information may be provided to travelers through roadside traveler information devices such as VMS, HAR, and IVS.

Figure 2.14 contains a summary of metropolitan areas that use various display technologies. VMS is the method used most often.

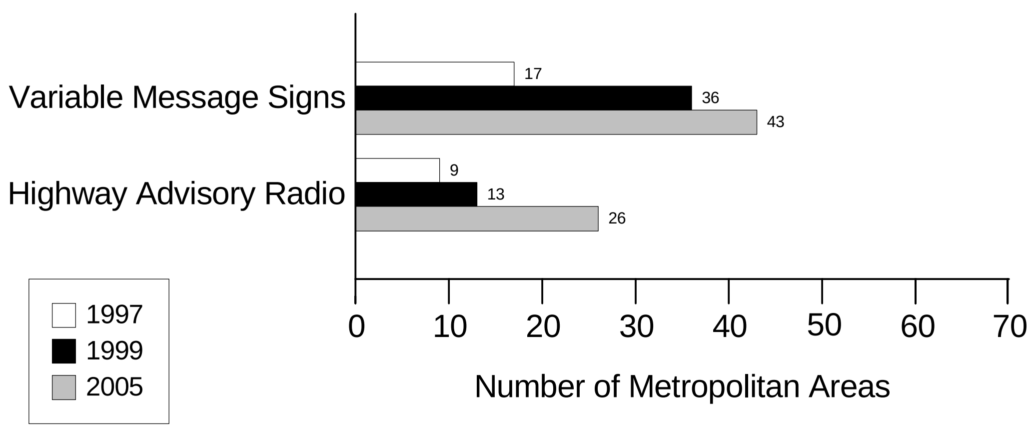


Figure 2.14. Methods of Information Dissemination

ELECTRONIC TOLL COLLECTION

Electronic Toll Collection Functions

Electronic Toll Collection (ETC) provides for the following traffic management function:

1. Automatically collect toll revenue through the application of in-vehicle, roadside, and communication technologies to process toll payment transactions (i.e., electronically collect tolls).

Electronic Toll Collection Indicators

Two indicators have been developed to measure the presence of this capability:

1. Percentage of toll collection lanes with ETC capability.
2. Percentage of toll collection plazas with ETC capability (1999 and 2005 only).

The Electronic Toll Collection component indicators are shown in Figure 2.15.

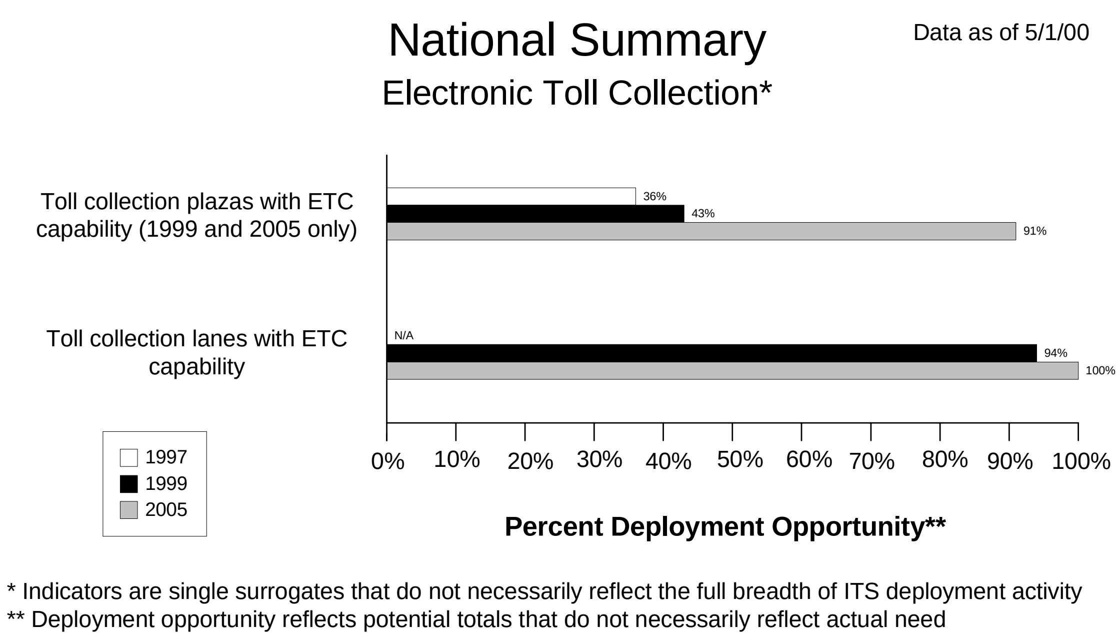


Figure 2.15. Electronic Toll Collection Component Indicators
(Based on 1997 survey return of 89% and 1999 survey return of 92%)

Figure 2.16 contains the number of metropolitan areas that use various toll collection control and technologies. A total of 20 metropolitan areas have toll collection lanes with ETC capability. Most areas use a distributed overhead antenna with tag-based, in-vehicle equipment.

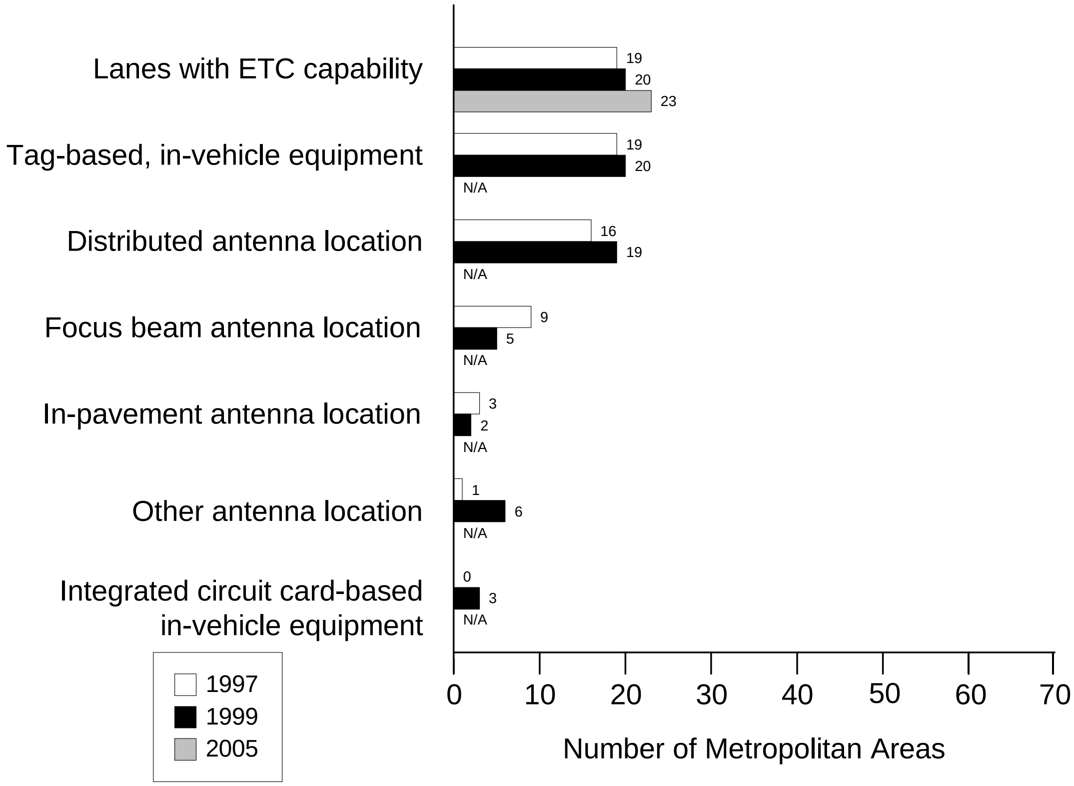


Figure 2.16. Electronic Toll Collection Control and Technologies

ELECTRONIC FARE PAYMENT

Electronic Fare Payment Functions

Electronic Fare Payment (EFP) provides for the following fare payment functions:

1. Capability to pay public transit fares on fixed-route bus and light-rail transit vehicles using EFP media.
2. Capability to pay public transit fares at heavy-rail transit stations using EFP media.

Electronic Fare Payment Component Indicators

Two indicators have been developed to measure the presence of these key functions:

1. Percentage of fixed-route bus and light-rail transit vehicles that accept electronic payment of fares.
2. Percentage of heavy-rail transit stations that accept electronic payment of fares.

The Electronic Fare Payment component indicators are shown in Figure 2.17.

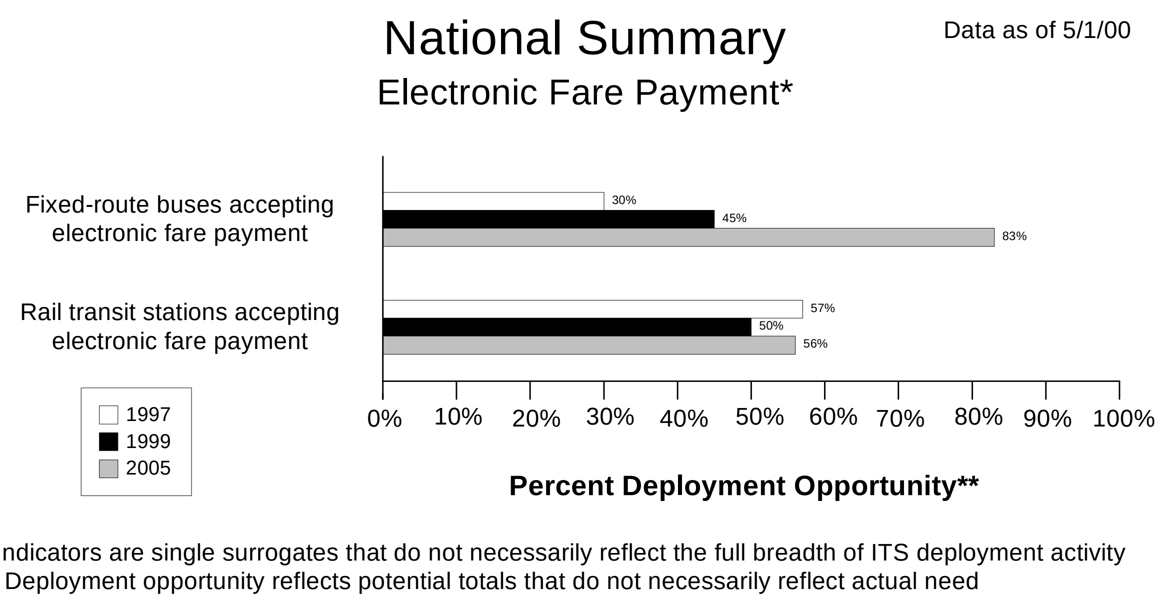


Figure 2.17. Electronic Fare Payment Component Indicators
(Based on 1997 survey return of 81% and 1999 survey return of 95%)

Figure 2.18 contains the number of metropolitan areas that use EFP media for fixed-route bus services. Only three metropolitan areas use smart cards.

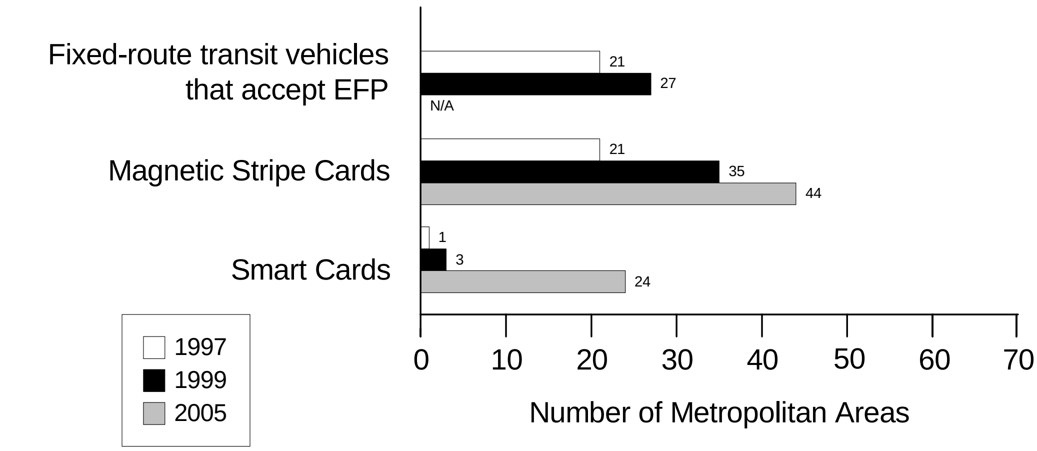


Figure 2.18. Electronic Fare Payment Fixed Route Bus

Figure 2.19 contains the number of metropolitan areas that use EFP for heavy-rail.

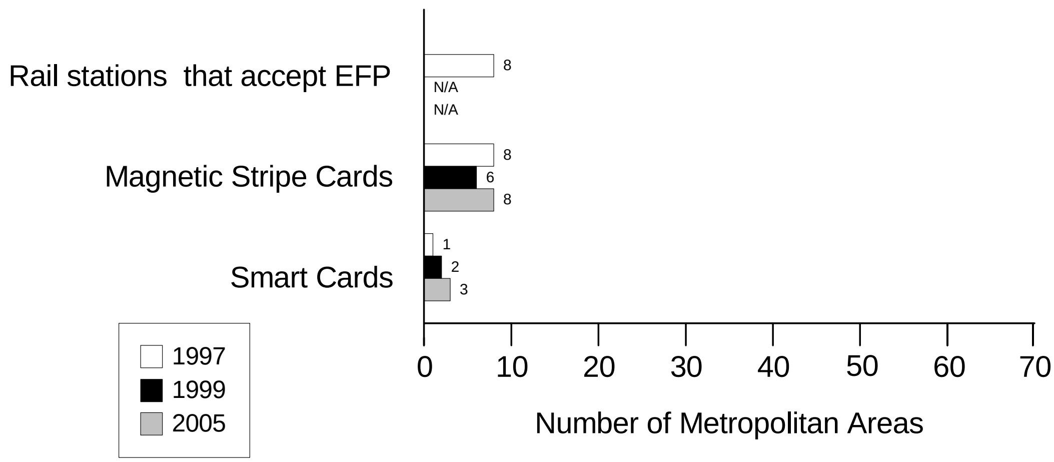


Figure 2.19. Electronic Fare Payment Heavy Rail

TRANSIT MANAGEMENT

Transit Management Functions

Transit Management provides for the following functions:

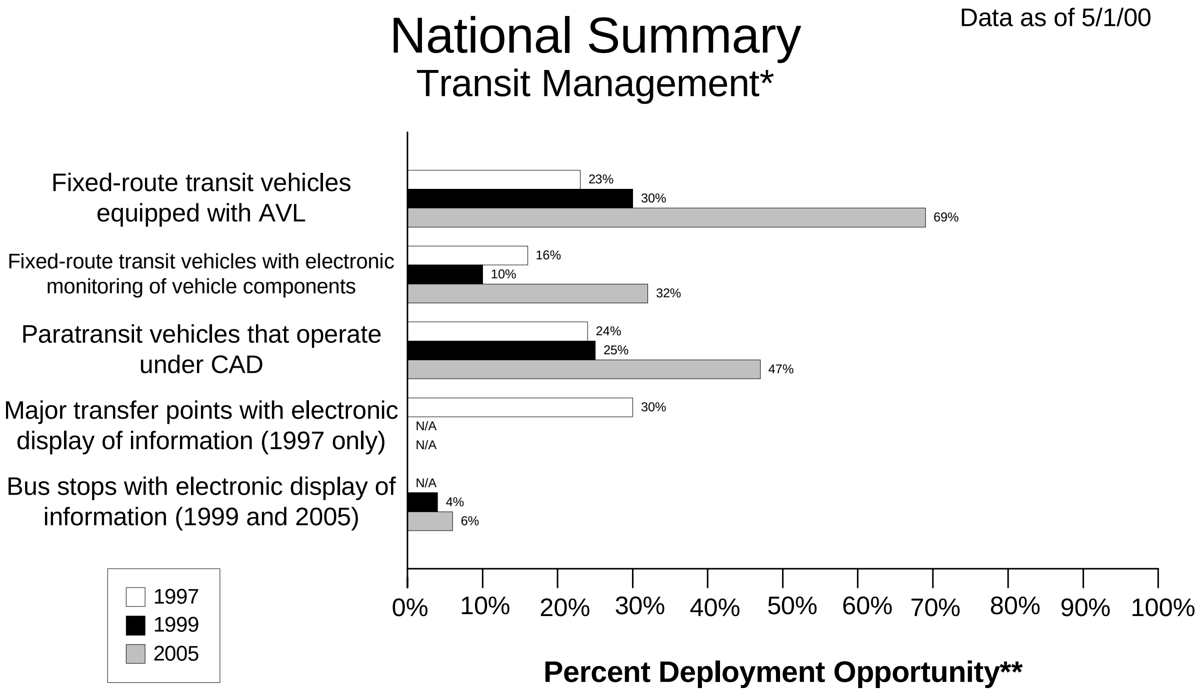
1. Capability to monitor the location of transit vehicles to support schedule management and emergency response (i.e., Automatic Vehicle Location [AVL]).
2. Capability to monitor maintenance status of the transit vehicle fleet (i.e., vehicle maintenance monitoring).
3. Capability to provide demand responsive flexible routing and scheduling of transit vehicles (i.e., paratransit management).
4. Capability to provide real-time, accurate transit information to travelers (i.e., information display).

Transit Management Indicators

A total of five indicators have been developed to measure the presence of these key functions:

1. Percentage of fixed-route transit vehicles equipped with AVL.
2. Percentage of fixed-route transit vehicles equipped with electronic monitoring of vehicle components.
3. Percentage of paratransit vehicles under Computer-Aided Dispatch (CAD).
4. Percentage of fixed-route transit locations with electronic display of transit information (1997 only).
5. Percentage of bus stops with electronic display of information (1999 and 2005 only).

The Transit Management component indicators are shown in Figure 2.20.



* Indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity
** Deployment opportunity reflects potential totals that do not necessarily reflect actual need

Figure 2.20. Transit Management Component Indicators
(Based on 1997 survey return of 81% and 1999 survey return of 95%)

Automatic Vehicle Location

Transit Management supports management of the transit fleet by electronically monitoring vehicle locations in real-time. Transit vehicles equipped with AVL technology provide the basis for vehicle tracking. Information on the current location of a transit vehicle is transmitted to a centralized dispatcher who then compares the actual location with the scheduled location. Depending on the variance between the actual and scheduled locations, actions may be taken to improve schedule adherence and to transfer information to travelers. This also supports emergency response by providing real-time information on vehicle locations in emergency situations.

Vehicle Maintenance Monitoring

Transit management includes electronic monitoring of vehicle performance parameters using in-vehicle sensors. This involves monitoring of usage statistics such as mileage and status of routine scheduled maintenance. In addition, this permits automatic monitoring of vehicle conditions including key parameters such as oil and fuel levels and tire pressure.

Paratransit Vehicle Dispatching

The use of AVL also supports advanced demand-responsive computer-aided routing and scheduling. Transit dispatchers can combine real-time information on vehicle location and status with advanced CAD systems to provide optimal vehicle assignment and routing to meet non-recurring public transportation demand.

Figure 2.21 contains the number of metropolitan areas reporting the use of AVL on fixed-route services, the use of electronic vehicle maintenance monitoring systems, and the use of a CAD system for demand-responsive vehicle dispatching.

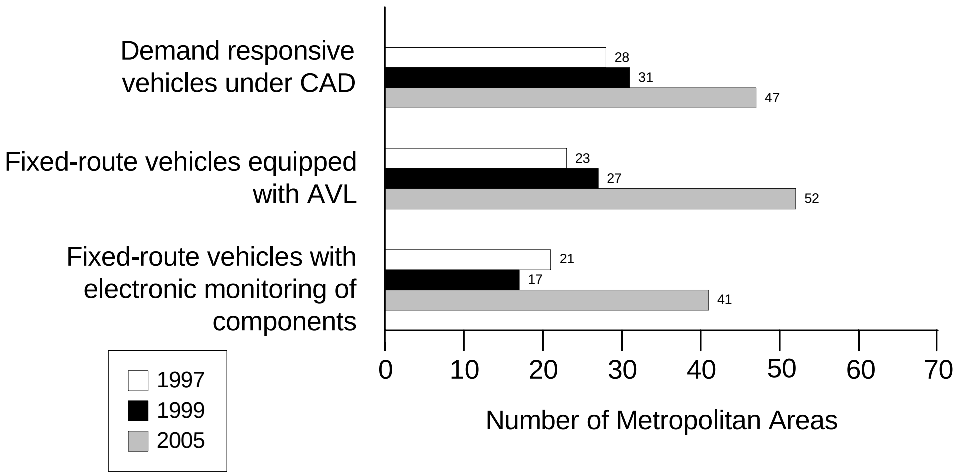


Figure 2.21. Transit Management, AVL, Maintenance, and Paratransit

HIGHWAY-RAIL INTERSECTION

Highway-Rail Intersection Functions

Highway-Rail Intersection provides for the following function:

1. Electronically monitor highway-rail intersections to: (a) coordinate rail movements with the traffic control signal systems, (b) provide travelers with advanced warning of crossing closures, and (c) improve and automate warnings at highway-rail intersections.

Highway-Rail Intersection Indicator

A single component indicator has been developed to measure the presence of this capability:

1. Percentage of highway-rail intersections under electronic surveillance.

The Highway-Rail Intersection component indicator is shown in Figure 2.22

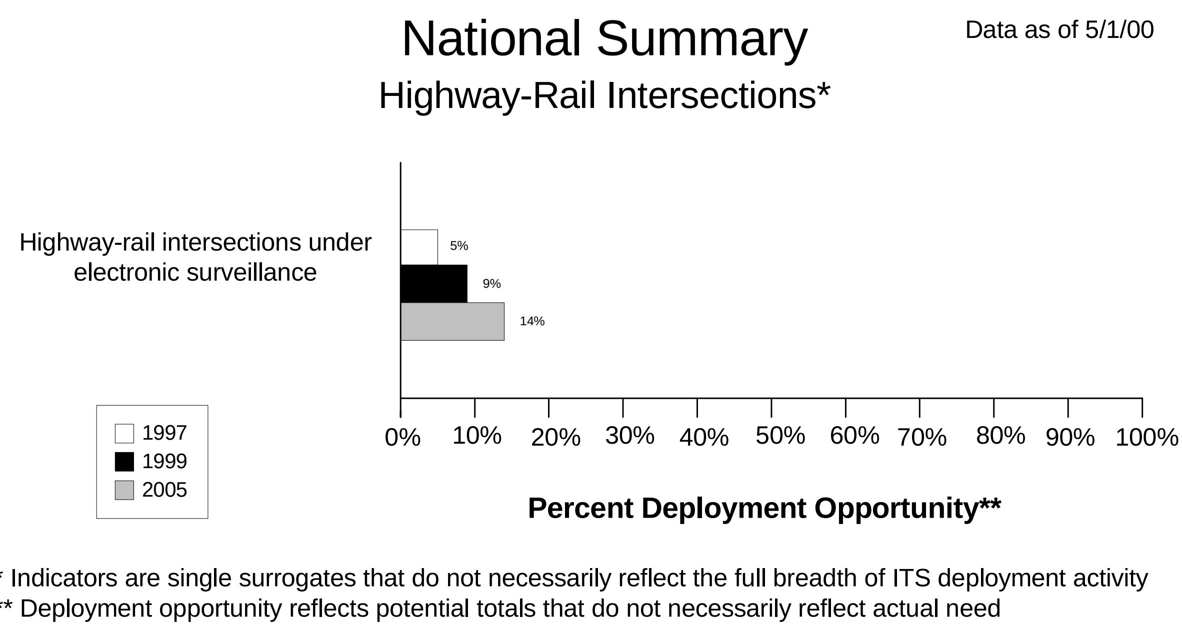


Figure 2.22. Highway-Rail Intersections Component Indicator (Based on 1997 survey return of 64% and 1999 survey return of 78%)

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Electronic Surveillance

The at-grade highway-rail intersection is a special form of roadway intersection where a roadway and one or more railroad tracks intersect. At a highway-rail intersection, the right-of-way is shared between railroad vehicles and roadway vehicles, with railroad vehicles typically being given preference. Railroad trains, which travel at high speeds and can take up to a mile or more to stop, pose special challenges. As a result, automated systems are now becoming available that allow the deployment of safety systems to adequately warn drivers of crossing hazards.

The Highway-Rail Intersection component involves electronic surveillance of grade crossings to detect vehicles within the crossing area, either through video or other means such as loop detectors. This may eventually support real-time information on train position and estimated time of arrival at a crossing and interactive coordination between roadway traffic control centers and train control centers.

Figure 2.23 contains the number of metropolitan areas reporting the use of video and other than video surveillance as well as electronic traffic violator devices. The purpose of the latter is to enforce crossing restrictions by identifying violators.

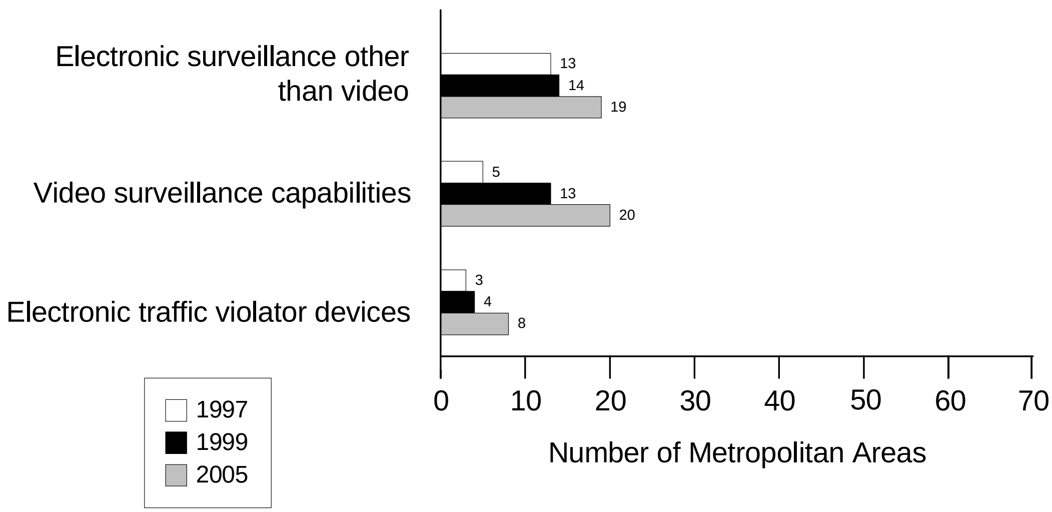


Figure 2.23. Highway-Rail Intersections Surveillance

EMERGENCY MANAGEMENT

Emergency Management Functions

Emergency Management provides the following capabilities:

1. Capability to operate public sector emergency vehicles under CAD.
2. Capability to provide public sector emergency vehicles with in-vehicle route guidance capability.

Emergency Management Indicators

Two indicators have been developed to measure the presence of these capabilities:

1. Percentage of public sector emergency vehicles operating under CAD.
2. Percentage of public sector emergency vehicles with in-vehicle route guidance capability.

The Emergency Management component indicators are shown in Figure 2.24.

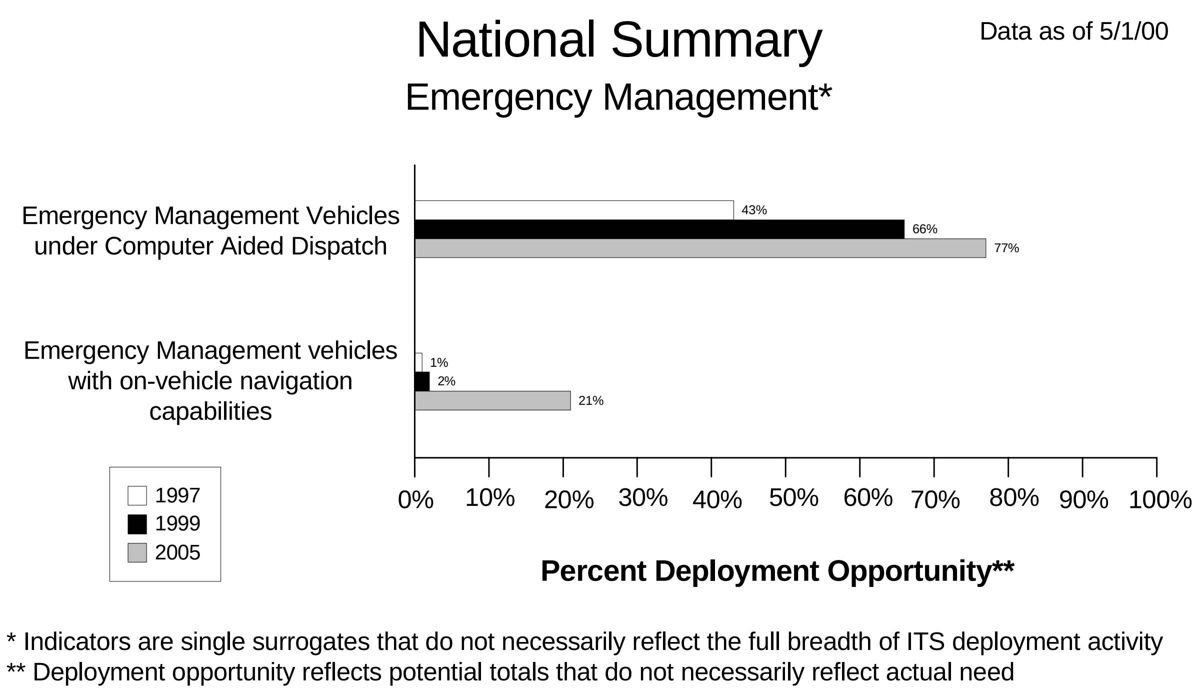


Figure 2.24. Emergency Management Component Indicator
(Based on 1997 survey return of 94% and 1999 survey return of 85%)

Computer-Aided Dispatch

Emergency vehicle fleet management utilizes AVL equipment to provide CAD of vehicles. Through the use of real-time information on vehicle location and status, emergency service dispatchers can make optimal assignment of vehicles to incidents.

Route Guidance

The installation of route guidance equipment in emergency service vehicles provides improved directional information for drivers and improves responsiveness of emergency services.

Figure 2.25 contains the number of metropolitan areas with emergency management vehicles dispatch and guidance technologies.

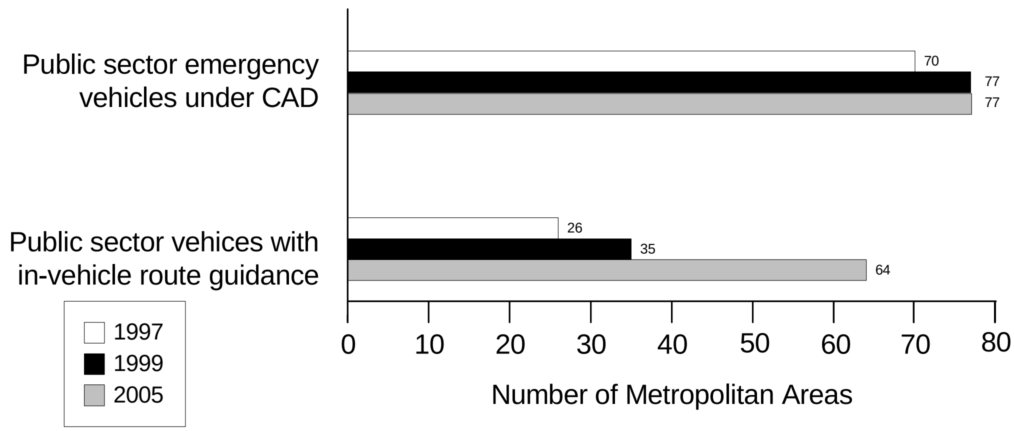


Figure 2.25. Emergency Management Dispatch and Guidance

REGIONAL MULTIMODAL TRAVELER INFORMATION

Regional Multimodal Traveler Information Functions

Regional Multimodal Traveler Information provides for the following capabilities:

1. Collect current, comprehensive, and accurate roadway and transit performance data for the metropolitan area.
2. Provide traveler information to the public via a range of communication techniques (broadcast radio, FM subcarrier, the Internet, cable TV) for presentation on a range of devices (home/office computers, television, pagers, personal digital assistants, kiosks, radio) (i.e., media).
3. Provide multimodal information to the traveler to support mode decision-making.

Regional Multimodal Traveler Information Indicators

Three component indicators have been developed to measure the presence of the above capabilities:

1. Percentage of geographic coverage of surveillance data provided from Freeway Management.
2. Percentage of total possible media types used to display information to travelers.
3. Percentage of total possible media types that display information of two or more modes to travelers.

The Regional Multimodal Traveler Information component indicators are shown in Figure 2.26.

Geographic Coverage of Traveler Information

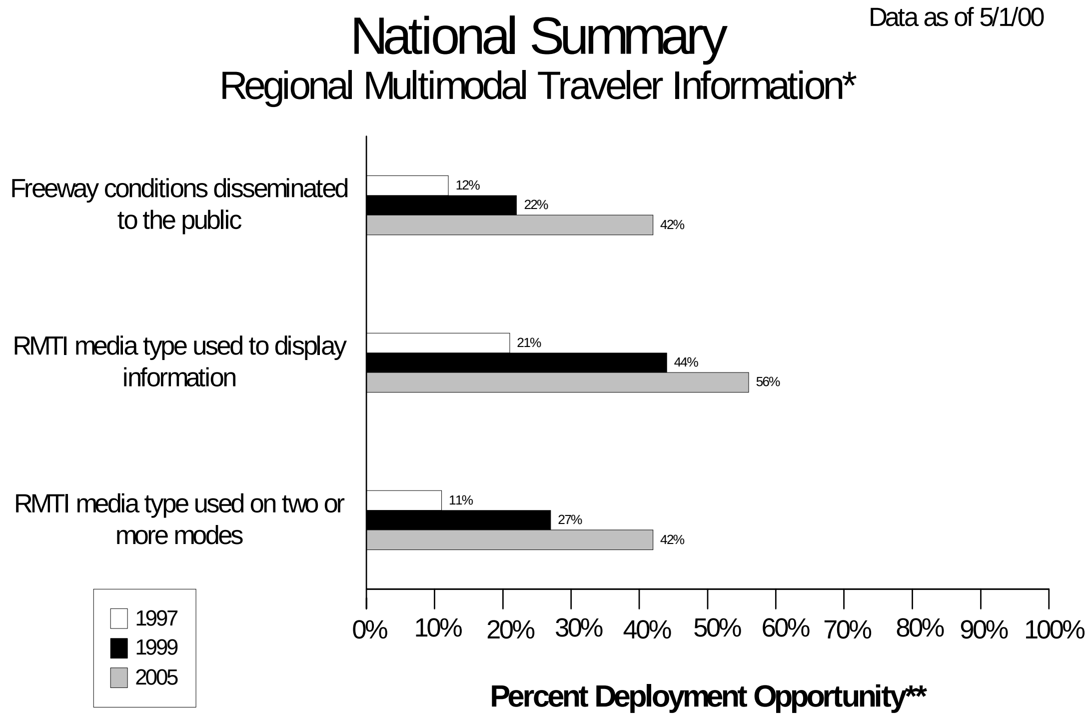
The Regional Multimodal Traveler Information component of the metropolitan ITS infrastructure receives roadway and transit system surveillance and detection data from a variety of sources provided by both public and private sector entities. It has the capability to combine data from different sources, package the data into various formats, and provide the information to a variety of distribution channels.

Media Employed

Agencies or organizations use many methods to disseminate traveler information to the public. Indicator calculations are based on a deployment opportunity of eight media: dedicated cable TV, telephone systems, web sites, pagers, interactive TV, kiosks, e-mail, and in-vehicle navigation.

Media Displaying Information on More Than One Transportation Mode

Traveler information on more than one transportation mode may be displayed on a single medium. For example: Transit schedules and fares as well as freeway travel times, speeds, or conditions may be displayed on a Web site.



* Indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity

** Deployment opportunity reflects potential totals that do not necessarily reflect actual need

Figure 2.26. Regional Multimodal Traveler Information Component Indicators (Based on 1997 survey return of 92% and 1999 survey return of 86%)

III - ITS INFRASTRUCTURE INTEGRATION INDICATOR DESCRIPTION AND FY99 SURVEY RESULTS

A critical aspect of ITS that provides much of its capability is the integration of individual components to form a unified regional traffic control system. Individual ITS components routinely collect information that is used for purposes internal to that component. For example, the Arterial Management component monitors arterial conditions to revise signal timing and to convey these conditions to travelers through such technologies as VMS and HAR. Agencies operating other ITS components can make use of this information in formulating control strategies. For example, Transit Management agencies may alter routes and schedules based on real-time information on arterial traffic conditions, and Freeway Management agencies may alter ramp metering or diversion recommendations based on the same information.

As with the component indicators, definitions for inter- and intra-component integration were developed for each component, and indicators, derived from these definitions, were produced for each. A total of 34 individual integration links were specified and are portrayed in Figure 3.1. Each integration link has been assigned a number and an origin/destination path from one ITS infrastructure component to another. Both inter- and intra-agency links are considered. For example, the integration of information from the Freeway Management component to the Regional Multimodal Traveler Information component is identified by the number “10.” The transfer of information between traffic signal agencies is identified by link “26" that has Arterial Management as both the origin and the destination. This labeling convention is used throughout the main body of this report (Note: Four of the 32 numbered indicators have “a” and “b” indicators, making the total 34.)

The measurement of integration associated with each of the links is agency-based. The calculation is simple and is an expression of the number of agencies that share data divided by the total number of agencies that possibly could. Therefore, for each of the integration links, a percentage integration score, ranging from zero to one hundred, is assigned. As with the deployment indicators, this rating system is based on the maximum possible integration without consideration of whether it is needed in every case.

In order to make the discussion of individual links clearer, links have been grouped into four broad categories: (1) Traffic Management Integration, (2) Traveler Information Integration, (3) Transit Management Integration, and (4) Emergency Management Integration. In Figures 3.2 to 3.5, the integration rating is indicated by the shading in the circles associated with each link (e.g.,  100%,  50%,  25%).

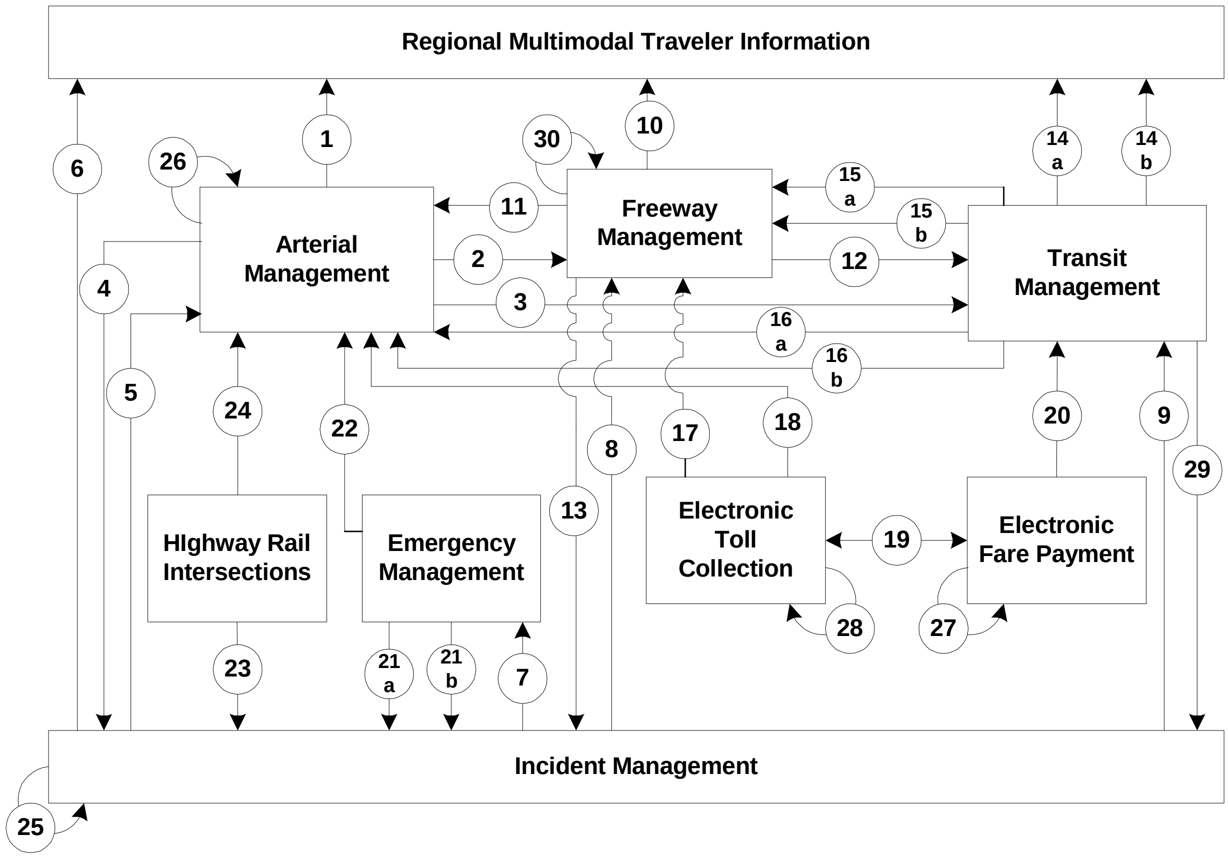


Figure 3.1. Integration of ITS Components

Traffic Management Integration

Traffic Management Integration enables the implementation of coordinated traffic management strategies among operating agencies responsible for Freeway Management, Incident Management, and Arterial Management within a metropolitan area. Key characteristics of traffic management integration include the following:

1. Collection of real-time traffic and incident data on the freeway and arterial street network.
2. Coordination of management actions in response to changes in traffic flow.
3. Collaboration among operating agencies to optimize the strategies available to improve traffic flow.

Figure 3.2 presents an overview of the integration links that define Traffic Management Integration.

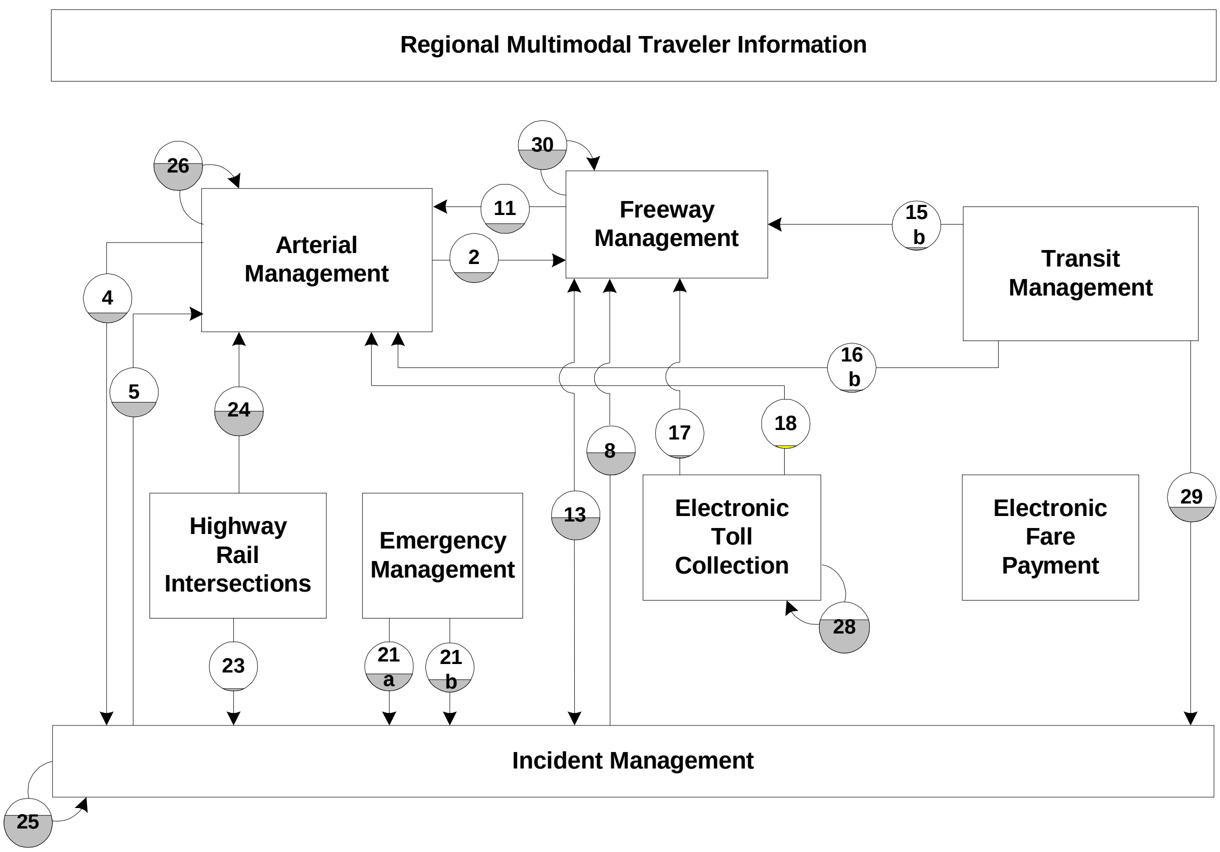


Figure 3.2. Traffic Management Integration Links

Table 3.1 presents a description of each of these links along with a summary of the survey results for each link.

Table 3.1 Traffic Management Integration

Link	From/To	Description	Survey Response
2	Arterial Management to Freeway Management	Freeway Management Center monitors arterial travel times, speeds, and conditions using data provided from Arterial Management to adjust ramp meter timing, lane control or HAR in response to changes in real-time conditions on a parallel arterial.	Traffic condition information is sent from 75 of the 380 (20%) Traffic Signal Control agencies to a Freeway Management agency.
4	Arterial Management to Incident Management	Incident Management monitors real-time arterial travel times, speeds, and conditions using data provided from Arterial Management to detect arterial incidents and manage incident response activities.	Traffic condition information is sent from 69 of the 380 (18%) Traffic Signal Control agencies to an Incident Management agency.
5	Incident Management to Arterial Management	Arterial Management monitors incident severity, location, and type information collected by Incident Management to adjust traffic signal timing or provide information to travelers in response to incident management activities.	Incident severity, location, and type data are sent from 31 of the 106 (29%) Incident Management agencies to a Traffic Signal Control agency.

Table 3.1 Traffic Management Integration (continued)

Link	From/To	Description	Survey Response
8	Incident Management to Freeway Management	Incident severity, location, and type data collected by Incident Management are monitored by Freeway Management for the purpose of adjusting ramp meter timing, lane control or HAR messages in response to freeway or arterial incidents.	Incident severity, location, and type data are sent from 43 of the 106 (41%) Incident Management agencies to a Freeway Management agency.
11	Freeway Management to Arterial Management	Freeway travel time, speeds, and conditions data collected by Freeway Management are used by Arterial Management to adjust arterial traffic signal timing or arterial VMS messages in response to changing freeway conditions.	Freeway travel time, speeds, and condition data are sent from 20 of the 106 (19%) Freeway Management agencies to a Traffic Signal Control agency.
13	Freeway Management to Incident Management	Incident Management monitors freeway travel time, speed, and condition data collected by Freeway Management to detect incidents or manage incident response.	Freeway travel time, speeds, and condition data are sent from 47 of the 106 (44%) Freeway Management agencies to an Incident Management agency.
15b	Transit Management to Freeway Management (transit vehicles equipped as probes)	Transit vehicles equipped as probes are monitored by Freeway Management to determine freeway travel speeds or travel times.	Transit vehicle probe data is sent from 1 of the 199 (1%) Transit Management agencies to a Freeway Management agency.

Table 3.1 Traffic Management Integration (continued)

Link	From/To	Description	Survey Response
16b	Transit Management to Arterial Management (transit vehicles equipped as probes)	Transit vehicles equipped as probes are monitored by Arterial Management to determine arterial speeds or travel times.	Transit vehicle probe data is sent from 1 of the 199 (1%) Transit Management agencies to a Traffic Signal Control agency.
17	Electronic Toll Collection to Freeway Management (ETC-equipped vehicles as probes)	Vehicles equipped with ETC tags are monitored by Freeway Management to determine freeway travel speeds or travel times.	ETC-equipped vehicles are used as probes by 8 of the 106 (8%) Freeway Management agencies.
18	Electronic Toll Collection to Arterial Management (ETC equipped vehicles as probes)	Vehicles equipped with electronic toll collection (ETC) tags are monitored by Arterial Management to determine arterial travel speeds or travel times.	ETC equipped vehicles are used as probes by 3 of the 380 (1%) Traffic Signal Control agencies.
21a	Emergency Management to Incident Management (Incident location, severity and type)	Incident Management is notified of incident location, severity, and type by Emergency Management to identify incidents on freeways or arterials.	Emergency Management agencies provide notification of incident location, severity, and type to 34 of the 106 (31%) Incident Management agencies.
21b	Emergency Management to Incident Management (Incident clearance activities)	Incident Management is notified of incident clearance activities by Emergency Management to manage incident response on freeways or arterials.	Emergency Management agencies provide notification of incident clearance to 24 of the 106 (23%) Incident Management agencies.

Table 3.1 Traffic Management Integration (continued)

Link	From/To	Description	Survey Response
23	Highway-Rail intersection to Incident Management	Incident Management is notified of crossing blockages by Highway-Rail intersection to manage incident response.	Highway-Rail crossing blockage data are provided to 14 of the 380 (4%) Arterial Incident Management agencies (Traffic Signal agencies).
24	Highway-Rail intersections to Arterial Management	Highway-Rail intersection and Arterial Management are interconnected for the purpose of adjusting traffic signal timing in response to train crossing.	Highway-Rail crossing blockage data are provided to 188 of the 380 (49%) Traffic Signal agencies.
25	Incident Management intra-component	Agencies participating in formal working agreements or Incident Management plans coordinate incident detection, verification, and response.	593 of the 895 (66%) Emergency Management agencies participate in a formal Incident Management program.
26	Arterial Management intra-component	Agencies operating traffic signals along common corridors sharing information and possibly control of traffic signals to maintain progression on arterial routes.	211 of the 380 (56%) Traffic Signal Control agencies share data with another Traffic Signal Control agency.
28	ETC intra-component	ETC agencies share a common toll tag for the purpose of facilitating "seamless" toll transactions.	46 of the 70 (65%) Toll Collection agencies use a common toll tag.

Table 3.1 Traffic Management Integration (continued)

Link	From/To	Description	Survey Response
29	Transit Management to Incident Management	Transit agencies notify Incident Management agencies of incident locations, severity, and type	Incident information is provided by 51 of the 199 (26%) Transit Management agencies to an Incident Management agency.
30	Freeway Management intra-component	Agencies operating freeways within the same region share freeway travel time, speeds, and condition data.	43 of the 106 (41%) Freeway Management agencies send data to another Freeway Management agency.

Traveler Information Integration

The collection, processing, and distribution of timely information related to the performance of the transportation system is a byproduct of integrating selected metropolitan ITS components. Information gathered by Freeway Management, Incident Management, Arterial Management, and Transit Management components is fused to create a region-wide traveler information database. Information in the database is then transferred to various media for display to travelers. Travelers receiving this information can make better informed decisions regarding if, when, where, and how to travel, which may lead to an increase in travel efficiency and a reduction in travel congestion and delay. Figure 3.3 presents an overview of the integration links that define traveler information integration.

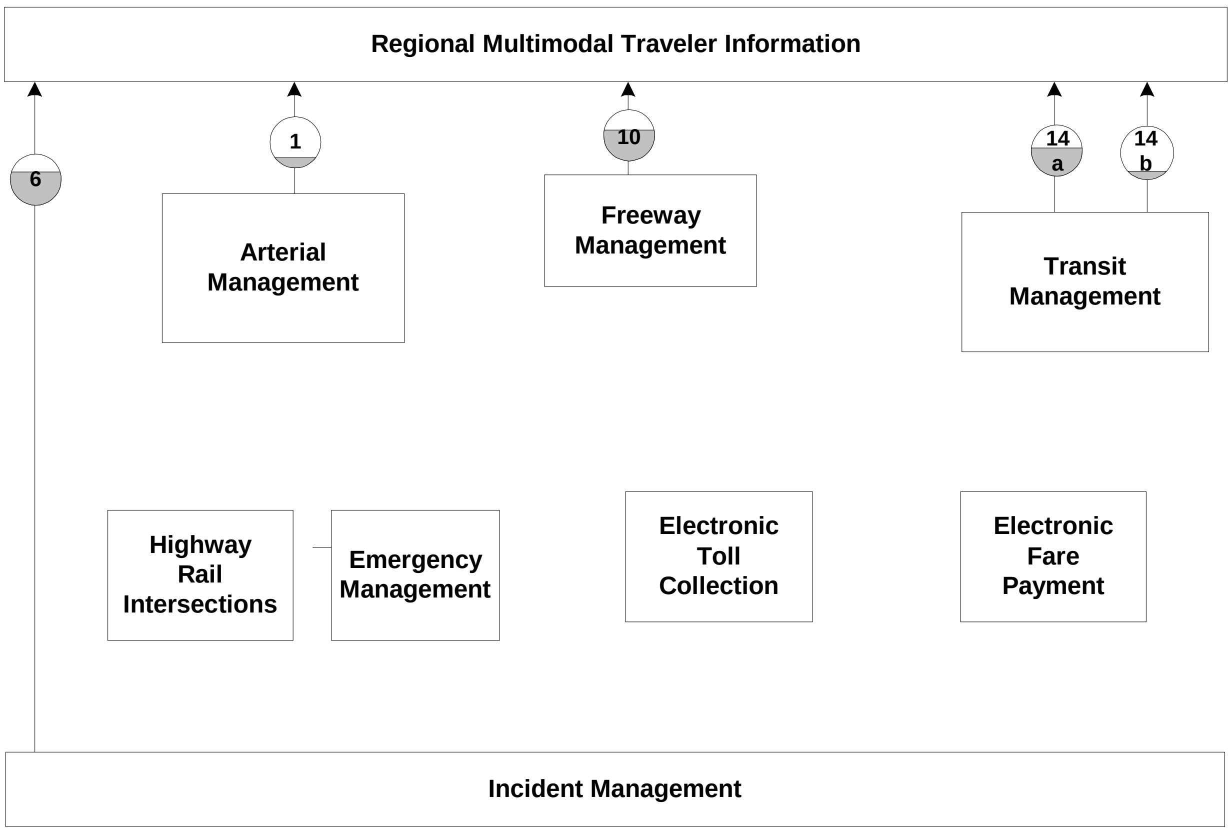


Figure 3.3. Traveler Information Integration

Table 3.2 presents a description of each of these links along with a summary of the survey results for each link.

Table 3.2 Traveler Information Integration Links

Link	From/To	Description	Survey Response
1	Arterial Management to Regional Multimodal Traveler Information	Arterial travel time, speed, and condition information are displayed by Regional Multimodal Traveler Information media.	Arterial travel time, speed, and condition information are displayed by Regional Multimodal Traveler Information media for 73 of the 380 (19%) of the Traffic Signal agencies.
6	Incident Management to Regional Multimodal Traveler Information	Incident location, severity and type information are displayed by Regional Multimodal Traveler Information media.	Incident location, severity and type information are displayed by Regional Multimodal Traveler Information media fro 64 of the 106 (60%) Incident Management agencies.
10	Freeway Management to Regional Multimodal Traveler Information	Freeway travel time, speed and condition information are displayed by Regional Multimodal Traveler Information media.	Freeway travel time, speed and condition information are displayed by Regional Multimodal Traveler Information media for 60 of the 106 (57%) Freeway Management agencies
14a	Transit Management to Regional Multimodal Traveler Information (transit routes, schedules, and fares)	Transit routes, schedules, and fare information are displayed on Regional Multimodal Traveler Information media.	Transit routes, schedules, and fare information are displayed on Regional Multimodal Traveler Information media for 110 of the 199 (55%) Transit Management agencies.
14b	Transit Management to Regional Multimodal Traveler Information (schedule adherence)	Transit schedule adherence information is displayed on Regional Multimodal Traveler Information media.	Transit schedule adherence information is displayed on Regional Multimodal Traveler Information media for 33 of the 199 (17%) Transit Management agencies.

Transit Management Integration

Transit management integration provides public transit operators with information and control capabilities to better manage transit system on-time performance. Transit management integration also exploits the use of EFP media to improve the efficiency of route planning and financial management. Figure 3.4 presents an overview of the integration links that define transit management integration.

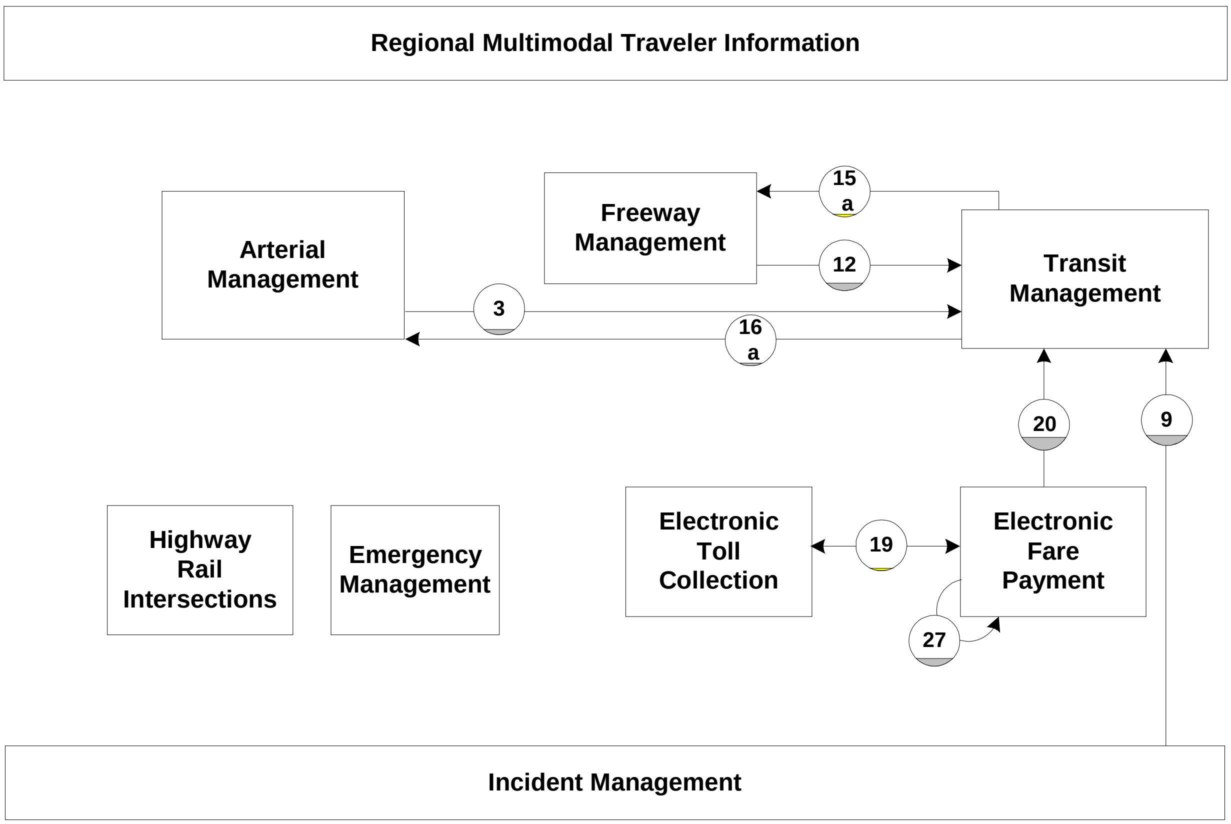


Figure 3.4. Transit Management Integration Links

Table 3.3 presents a description of each of these links along with a summary of the survey results for each link.

Table 3.3 Transit Management Integration Links

Link	From/To	Description	Survey Response
3	Arterial Management to Transit Management	Transit Management adjusts transit routes and schedules in response to arterial travel times, speeds, and conditions information collected as part of Arterial Management.	Traffic condition information is sent from 39 of the 380 (10%) Traffic Signal Control agencies to a Transit Management agency.
9	Incident Management to Transit Management	Transit Management adjusts transit routes and schedules in response to incident severity, location, and type data collected as part of Incident Management.	Incident severity, location, and type data are sent from 19 of the 106 (18%) Incident Management agencies to a Transit Management agency.
12	Freeway Management to Transit Management	Transit Management adjusts transit routes and schedules in response to freeway travel times, speeds, and conditions information collected as part of Freeway Management.	Freeway travel time, speeds, and condition data are sent from 14 of the 106 (13%) Freeway Management agencies to a Transit Management agency.
15a	Transit Management to Freeway Management (ramp meter priority)	Freeway ramp meters are adjusted in response to receipt of transit vehicle priority signal.	Transit vehicle receives ramp meter priority for 1 of the 199 (1%) Transit Management agencies.
16a	Transit Management to Arterial Management (traffic signal priority)	Traffic signals are adjusted in response to receipt of transit vehicle priority signal.	Transit vehicle receives traffic signal priority for 1 of the 199 (1%) Transit Management agencies.
19	Electronic Toll Collection to Electronic Fare Payment	Transit operators accept ETC-issued tags to pay for transit fares.	2 of the 199 (1%) Transit Management agencies accept ETC tags for payment of transit fares
20	Electronic Fare Payment to Transit Management	Rider ship details collected as part of EFP are used in transit service planning by Transit Management.	EFP data are used by 55 of the 199 (28%) Transit Management agencies.

Table 3.3 Transit Management Integration Links (continued)

Link	From/To	Description	Survey Response
27	EFP intra-component	Operators of different public transit services share common EFP media.	42 of the 199 (21%) Transit Management agencies have a common fare media that can be used on more than one transit service (within that transit operator or with another transit operator).

Emergency Response Integration

Emergency Management integration increases emergency response capabilities through improved incident notification from Incident Management and traffic signal preemption provided by Arterial Management. Figure 3.5 presents an overview of the integration links that define emergency response integration.

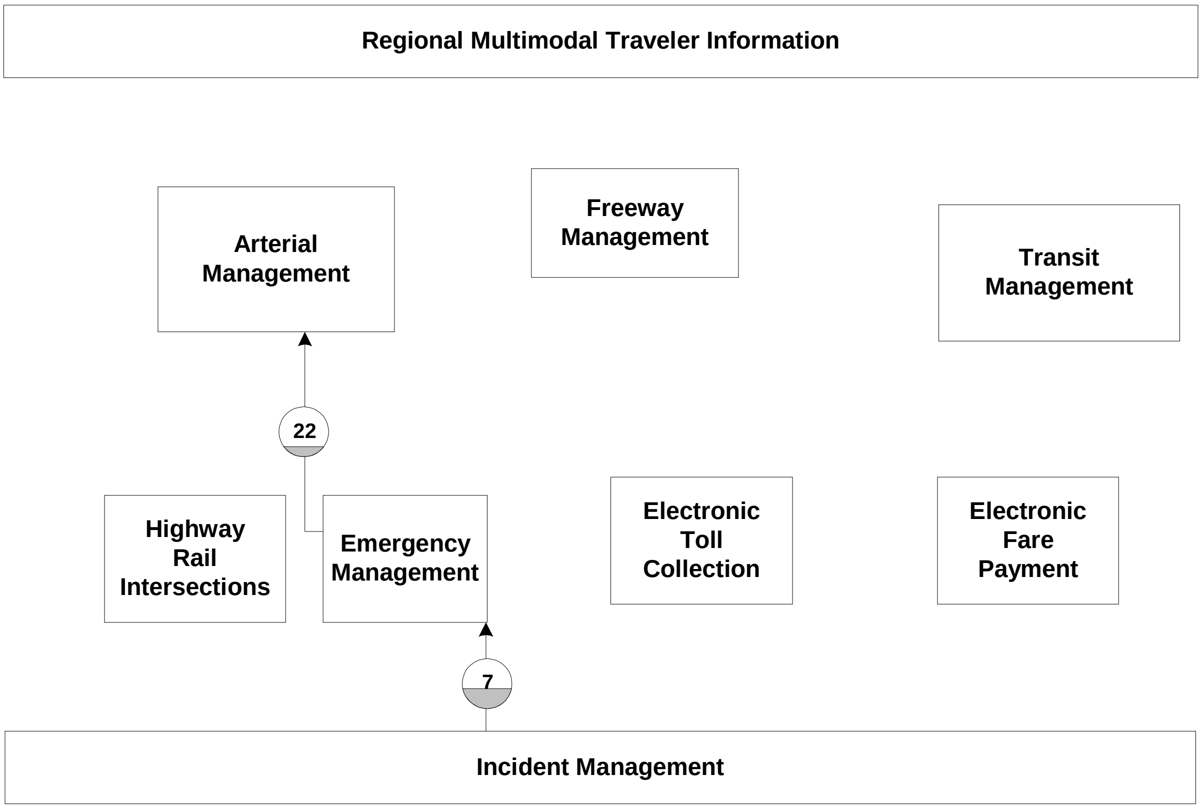


Figure 3.5. Emergency Management Integration

Table 3.4 presents a description of each of these links along with a summary of the survey results for each link.

Table 3.4 Emergency Management Integration Links

Link	From/To	Description	Survey Response
7	Incident Management to Emergency Management	Incident severity, location, and type data collected as part of Incident Management are used to notify Emergency Management for incident response.	Incident severity, location, and type data are sent from 37 of the 106 (35%) Incident Management agencies to an Emergency Management agency.
22	Emergency Management to Arterial Management	Emergency Management vehicles are equipped with traffic signal priority capability.	Emergency response vehicles receive traffic signal priority for 193 of the 895 (22%) Emergency Management agencies.

IV - DEPLOYMENT GOAL SETTING

Background

A set of deployment threshold values was identified and applied across all metropolitan areas in order to categorize each metropolitan area into one of three levels of deployment: High, Medium, or Low. These threshold values were established in a way that allowed demarcation of meaningful progress toward an achievable 10-year goal, while still maintaining some requirement for "stretching" to reach the goal.

The assignment of a single integrated deployment rating for each metropolitan area was accomplished using a three-step process. First, the current level of deployment of the ITS infrastructure components at each metropolitan area was determined. These data were compared to an established threshold level for each component to determine a deployment rating. Next, an integration rating was assigned to each area based on the degree to which infrastructure components are integrated. Finally, the resulting ratings for deployment and integration were combined into a single overall integrated deployment rating.

Crossing a threshold value for either deployment or integration means that a metropolitan area has made a significant commitment to deploy and integrate the metropolitan ITS infrastructure. *However, it does not mean that deployment or integration is complete*. Figure 4.1 shows that, even in the high level of deployment, a metropolitan area may still have "miles to go" in completing full deployment. A significant level of investment of time and money is needed to organize and perform initial planning for metropolitan areas categorized as low, in order to build deployment momentum. Metropolitan areas in the medium stage are moving rapidly toward full

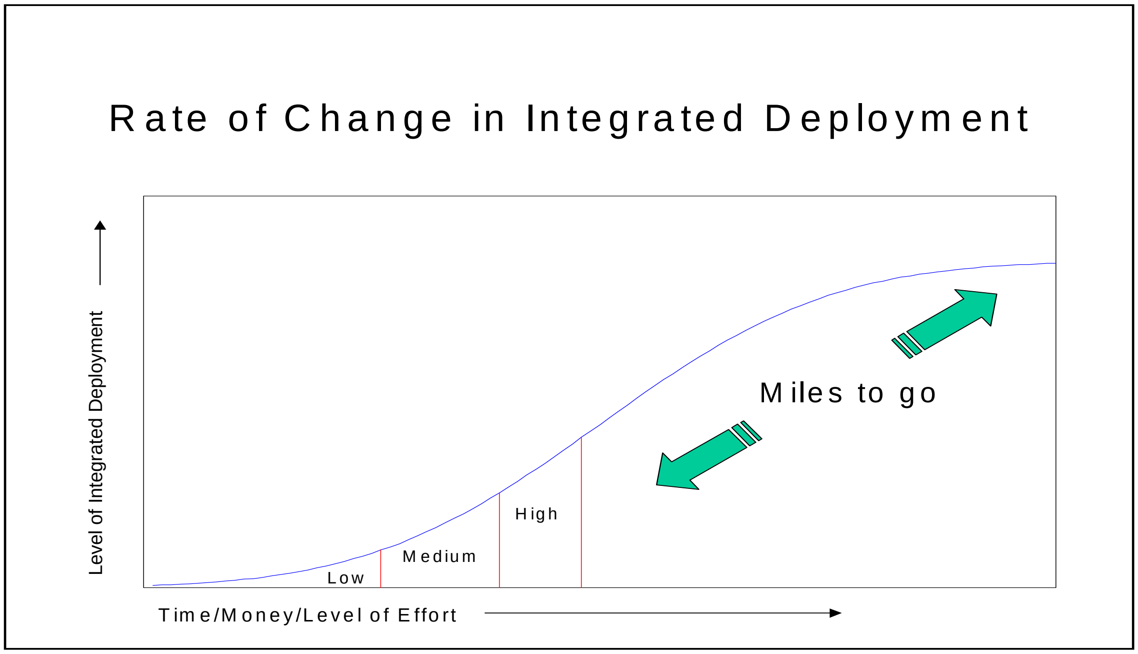


Figure 4.1 Rate of change in Integrated Deployment

deployment through leveraging the important initial investments in ITS infrastructure. Metropolitan areas in the high category are beginning to experience still higher rates of return on investment in ITS; however, they still need continued investment to bring them up to complete deployment. New systems are being added to an already robust infrastructure, and integration is multiplying the impact of deployments, producing more "bang for the buck". All this adds up to a solid and expanding base for deploying the integrated infrastructure, but only with a sustained commitment of time and resources.

1999 Status of Integrated Deployment

As shown in Figure 4.2, a total of 27 metropolitan areas are categorized as low, 26 as medium, and 22 as high in 1999. This can be contrasted with the 1997 deployment baseline in which 39 areas were characterized as low, 25 as medium, and 11 as high. The information suggests that considerable progress has been made in the deployment of integrated ITS over the past two years.

Table 4.1 lists the 75 metropolitan areas and their respective level of integrated deployment for 1997 and 1999. Areas with a high level of integrated deployment in 1999 are listed at the top of the table, followed by areas with a medium level of integrated deployment, and finally areas with

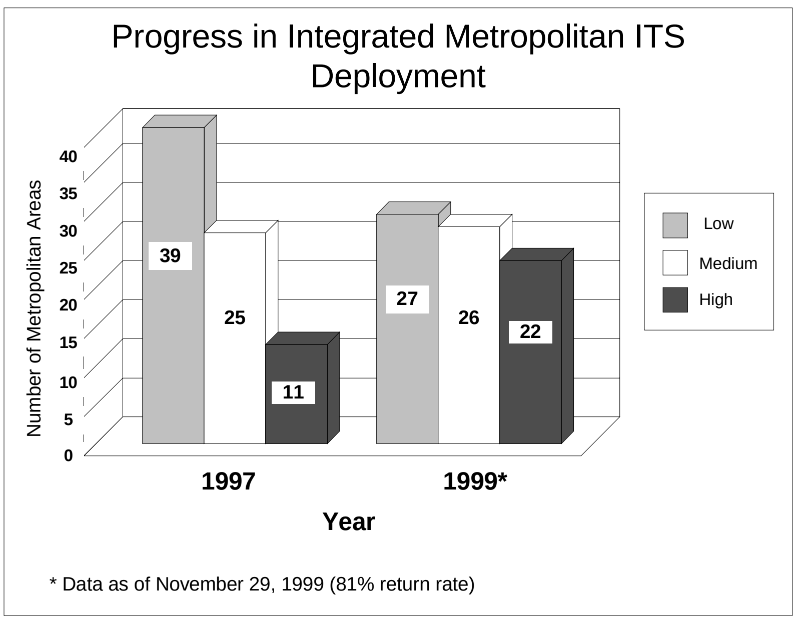


Figure 4.2 Progress in Integrated Metropolitan ITS Deployment

a low level of integrated deployment. A total of 11 areas moved from a low to medium level of integrated deployment from 1997 to 1999, one area moved from low to high, and 10 areas moved from a medium to a high level of deployment. The methodology used to prepare these ratings combines information concerning deployment and integration into a single integrated deployment measure.

Table 4.1 Metropolitan Areas and Their Respective Level of Integrated Deployment

Metropolitan Area	1997 Integrated-Deployment Level	1999[3] Integrated-Deployment Level
Atlanta	High	High
Baltimore	Med	High
Charlotte, Gastonia, Rock Hill	Med	High
Chicago, Gary, Lake County	Med	High
Cincinnati, Hamilton	High	High
Dallas, Fort Worth	Med	High
Detroit, Ann Arbor	Med	High
Greensboro, Winston-Salem, High Point	Low	High
Houston, Galveston, Brazoria	High	High
Los Angeles, Anaheim, Riverside	High	High
Milwaukee, Racine	Med	High
Minneapolis, St. Paul	High	High
New York, Northern New Jersey, Southwestern Connecticut	High	High
Orlando	Med	High
Philadelphia, Wilmington, Trenton	Med	High
Phoenix	High	High
Portland, Vancouver	High	High
San Antonio	Med	High
San Diego	High	High
San Francisco, Oakland, San Jose	Med	High
Seattle, Tacoma	High	High
Washington	High	High
Albany, Schenectady, Troy	Low	Med
Allentown, Bethlehem, Easton	Med	Med
Austin	Med	Med
Boston, Lawrence, Salem	Med	Med
Buffalo, Niagara Falls	Med	Med
Cleveland, Akron, Lorain	Med	Med
Denver, Boulder	Med	Med
Hampton Roads	Med	Med
Harrisburg, Lebanon, Carlisle	Low	Med
Hartford, New Britain, Middletown	Low	Med
Jacksonville	Med	Med
Memphis	Med	Med
Miami, Fort Lauderdale	Med	Med
New Haven, Meriden	Med	Med

Metropolitan Area	**1997 Integrated-Deployment Level**	**1999[3] Integrated-Deployment Level**
New Orleans	Low	Med
Pittsburgh, Beaver Valley	Med	Med
Raleigh-Durham	Med	Med
Richmond, Petersburg	Low	Med
Rochester	Med	Med
Sacramento	Med	Med
Salt Lake City, Ogden	Low	Med
Scranton, Wilkes-Barre	Low	Med
St. Louis	Low	Med
Tampa, St. Petersburg, Clearwater	Low	Med
Tucson	Low	Med
West Palm Beach, Boca Raton, Delray	Low	Med
Bakersfield	Low	Low
Baton Rouge	Low	Low
Birmingham	Low	Low
Charleston	Low	Low
Columbus	Low	Low
Dayton, Springfield	Low	Low
El Paso	Low	Low
Fresno	Low	Low
Grand Rapids	Low	Low
Greenville, Spartanburg	Low	Low
Honolulu	Low	Low
Indianapolis	Low	Low
Kansas City	Low	Low
Knoxville	Low	Low
Las Vegas	Low	Low
Little Rock, North Little Rock	Low	Low
Louisville	Low	Low
Nashville	Low	Low
Oklahoma City	Low	Low
Omaha	Low	Low
Providence, Pawtucket, Fall River	Low	Low
Springfield	Low	Low
Syracuse	Low	Low
Toledo	Low	Low
Tulsa	Low	Low

Metropolitan Area	1997 Integrated-Deployment Level	1999[3] Integrated-Deployment Level
Wichita	Low	Low
Youngstown, Warren	Low	Low

Tracking Integrated Deployment Progress

The measurement of progress for 1999 can be set in a context of yearly goals leading to successful achievement of the Secretary's 2006 integrated deployment goal. Figure 4.3 portrays the level of integrated deployment measured in 1997 and 1999 along with goals for deployment for each year through 2005. No data were collected in 1998; therefore, only the goal levels of integrated deployment are shown for 1998. This figure shows that as of 1999, nationwide integrated deployment is advancing at a rate compatible with the achievement of the Secretary's year 2005 goal. The data contained in this figure indicate that all 75 metropolitan areas should be moved out of the low category into either a high or medium level of deployment by 2006.

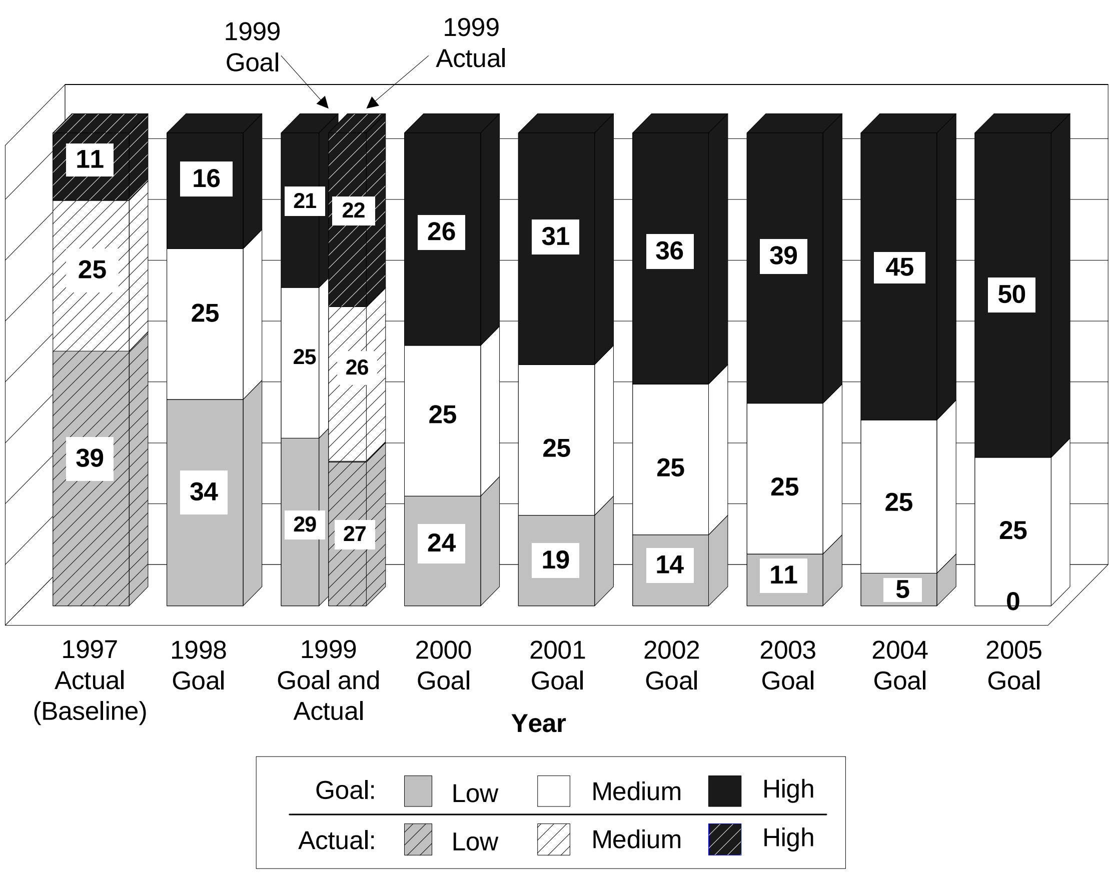


Figure 4.3 Deployment Goals and Actual Deployment Levels for 75 Metropolitan Areas.

Appendix A

References

"Building the ITI: Putting the National Architecture into Action," Federal Highway Administration, FHWA-JPO-96-011, April 1996 (ITS Electronic Document Library document number 415).

Highway Performance Monitor Guide Field Manual," United States Department of Transportation. Federal Highway Administration, August 1993.

"Intelligent Transportation Systems: The National Architecture, A Framework for Integrated Transportation into the 21st Century" (Publication Number: FHWA-JPO-96-012) (ITS Electronic Document Library document number 4847).

"Measuring ITS Deployment and Integration," Oak Ridge National Laboratory, August 1998 (ITS Electronic Document Library document number 4372).

"National Transit Database," U.S. DOT/Federal Transit Administration(FTA). Federal Transit Administration, Washington, 1995.

"1990 Census of Population and Housing," U.S. Department of Commerce, U.S. Bureau of The Census, 1993.