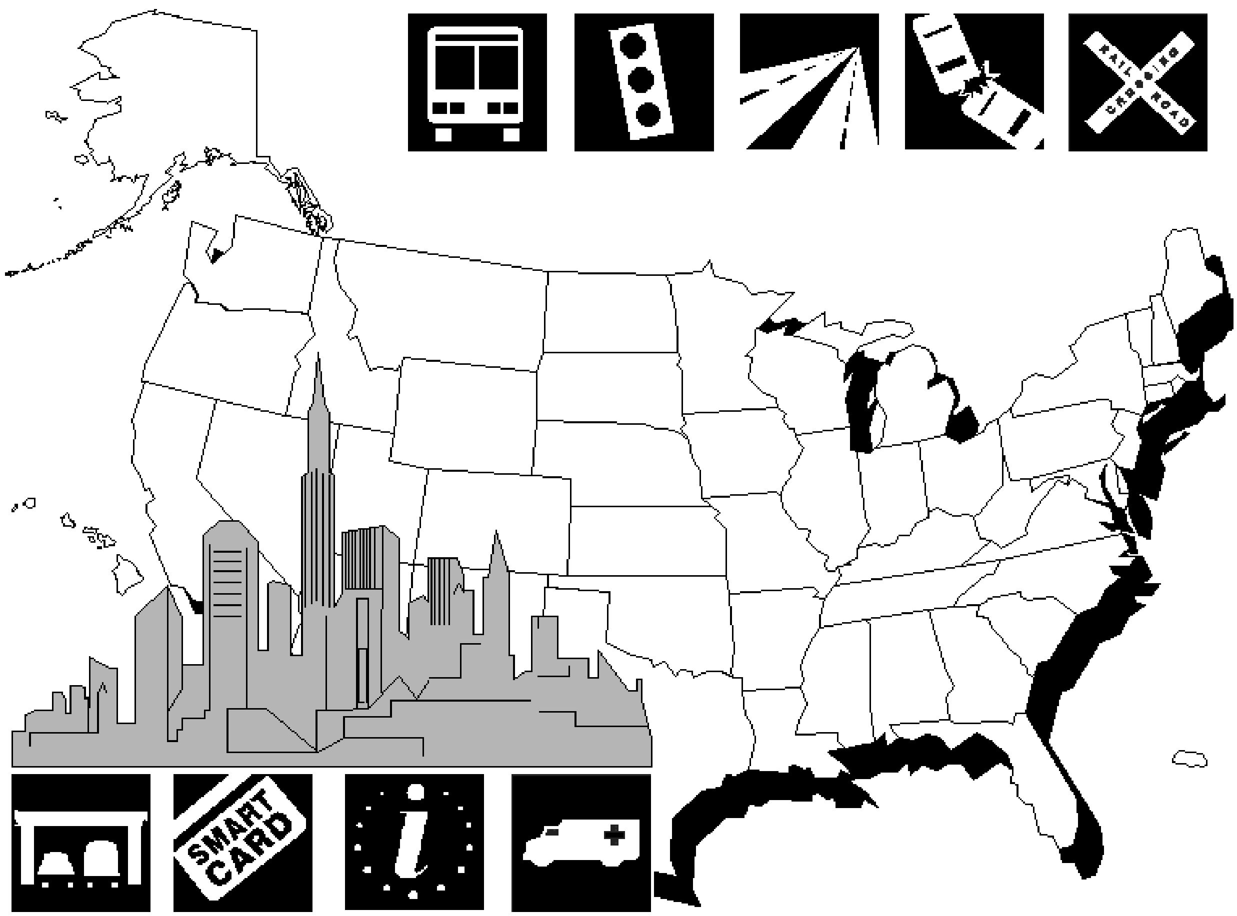
# Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY2002 Results

April 2004




Prepared for:

ITS Joint Program Office
Federal Highway Administration
Washington, DC

**Notice**

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| 4. Title and Subtitle<br><br>Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY2002 Results | | 5. Report Date<br><br>April 2004<br><br>6. Performing Organization Code |
| 7. Author(s)<br><br>Steve Gordon and Jeffrey Trombly | | 8. Performing Organization Report No. |
| 9. Performing Organization Name and Address<br><br>Oak Ridge National Laboratory<br>P.O. Box 2008, Bldg 4500N, MS 6206<br>Oak Ridge, TN 37831-6206<br><br>Science Applications International Corporation<br>301 Laboratory Road<br>Oak Ridge, TN 37831 | | 10. Work Unit No. (TRAIS)<br><br>11. Contract or Grant No.<br><br>DTFH61-00-Y-30014 |
| 12. Sponsorship Agency Name and Address<br><br>Department of Transportation<br>FHWA ITS Joint Program Office<br>400 Seventh Street, S.W. - Room 3422<br>Washington, DC 20590 | | 13. Type of Report and Period Covered<br><br>14. Sponsoring Agency Code<br><br>HOIT-1 |
| 15. Supplementary Notes<br><br>Contact person at JPO - Joseph Peters | | |

16. Abstract

This report describes the results of a major data gathering effort carried out in the spring and summer of 2002 aimed at tracking deployment of Intelligent Transportation Systems (ITS) technology in metropolitan areas in the United States. Metropolitan ITS is defined in terms of nine infrastructure components: 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, the measure being based on a comparison of the reported extent of the transfer of information between components to the maximum possible. The report summarizes results at a national level and includes information on the number of metropolitan areas deploying selected technologies related to the indicators. Three separate metropolitan surveys are included in this report: a survey of 78 major metropolitan areas, 30 medium-sized metropolitan areas, and 20 tourist sites.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Intelligent Transportation Systems, ITS, Integration, Deployment Tracking, ITS Component Indicators, Regional ITS Planning, National ITS Infrastructure | No restrictions. This document is available to the public from:<br><br>National Technical Information Service<br>Springfield, Virginia 22161 |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | | |

**Form DOT F 1700.7** **(8-72)** Reproduction of completed page authorized

**Preface**

This report presents an update of a major nationwide data gathering effort tracking the deployment of the metropolitan Intelligent Transportation Systems (ITS) technology in metropolitan areas in the United States. This report documents results of a survey conducted in 2002 conducted in three phases. The first, a survey of 78 major metropolitan areas, was an update to an on-going survey effort, last carried out in 2000. Two other surveys, targeting 30 medium-sized cities and 20 tourist sites, were new for 2002 and are included in this summary report. Tracking the deployment of ITS infrastructure is an important element of ITS program assessment, as 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:

Joseph I. Peters, Ph.D.
ITS Joint Program Office
Federal Highway Administration (HOIT-1)
400 Seventh Street, SW
Washington, DC 20590
(202) 366-2202
E-mail: joe.peters@fhwa.dot.gov

**Table of Contents**

## List of Figures

## List of Tables

## Executive Summary

In January 1996, former 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]
> *-- Former Secretary Peña, 1996*

In order to track progress toward fulfillment of the former Secretary's goal for deployment, the United States Department of Transportation (USDOT) Intelligent Transportation Systems (ITS) Joint Program Office (JPO) developed the metropolitan ITS deployment tracking methodology in 1997. 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 in a separate report. [3]

In FY97, the ITS JPO undertook a baseline survey of deployment in 78 of the nation's largest metropolitan areas following the metropolitan ITS deployment tracking methodology and published the results in a series of site reports and a nationwide summary report. 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. This process was repeated in 2000 and 2002. In 2002, the scope of the national survey was expanded to include additional metropolitan areas and to track deployments in rural areas. A total of four national surveys were conducted in 2002. The first was an update of the same 78 metropolitan areas that had been surveyed previously. The second was a survey of 30 additional metropolitan areas, smaller in population than the original 78 and reporting relatively high levels of congestion. These areas are called 'medium-sized cities' throughout this report. The third survey targeted 20 cities impacted by tourism, which are called 'tourist cities' throughout this

---

[1] Since former 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 former Secretary of Transportation Peña at the Transportation Research Board in Washington, DC on January 10, 1996.

[3] U.S. DOT (1999). *Measuring ITS Deployment and Integration* http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf, EDL# 4372.

report.   The fourth survey targeted each of the 50 states and gathered data on statewide and rural deployments.  This report is a national summary of the FY2002 results for the three metropolitan surveys.  The statewide results are documented in a separate report[4].  This report is a summary of a large amount of data.  For those interested in additional details, access to the complete data set, including results from previous surveys, is available on-line at: http://www.itsdeployment.its.dot.gov/ .

[4] U.S. DOT (2004). *Statewide/Rural Intelligent Transportation Systems (ITS) 2002 Summary Report.* http://www.itsdeployment.its.dot.gov/its2002/pdf/statewide_rural_summary_report2002.pdf.

### *Summary Deployment Indicators for Large Metropolitan Areas*

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 1 presents the 78 largest metropolitan areas summary indicators. The FY2002 results are compared to results from 1997, 1999 and 2000. In addition, responders were asked to estimate deployment levels in the year 2005 as part of the 2002 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 at the metropolitan area level, these indicators should not be read as a comparison of what is deployed versus eventual deployment goals. Instead, these indicators only reflect what is deployed in each metropolitan area compared to full market saturation (i.e., the full deployment opportunity).

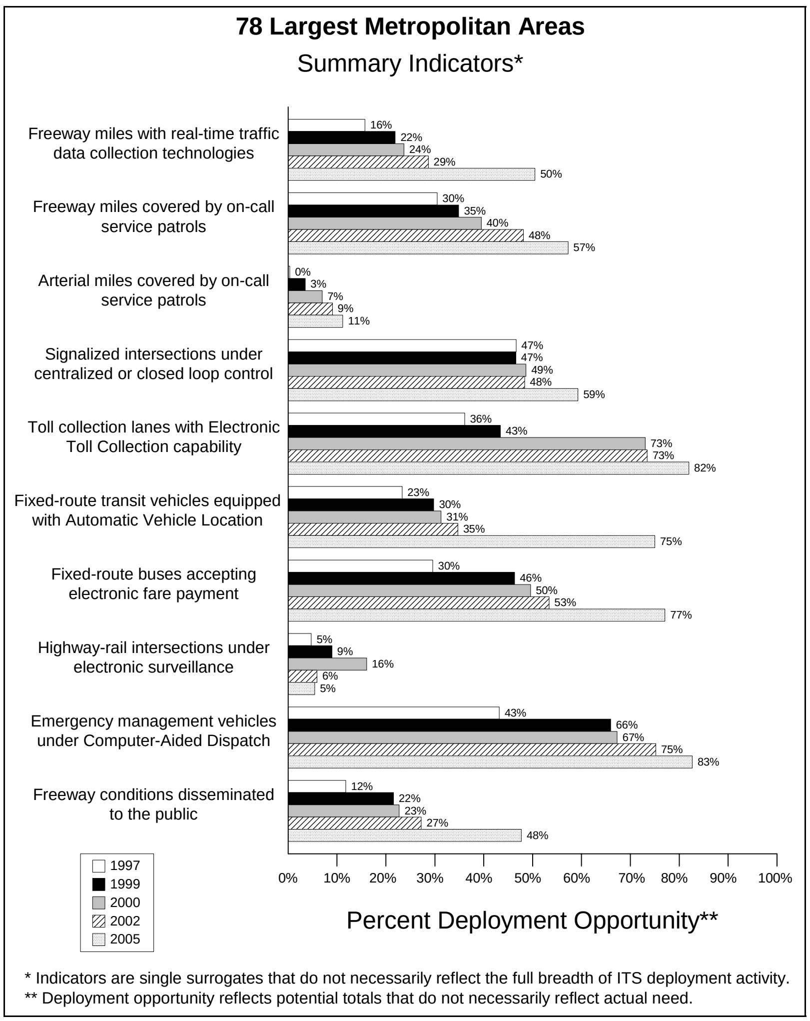



**Figure 1 78 Large Metropolitan Areas Summary Indicators**

*Integration Indicators for Large Metropolitan Areas*

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 2 presents the national summary of integration results for the FY2002 survey.

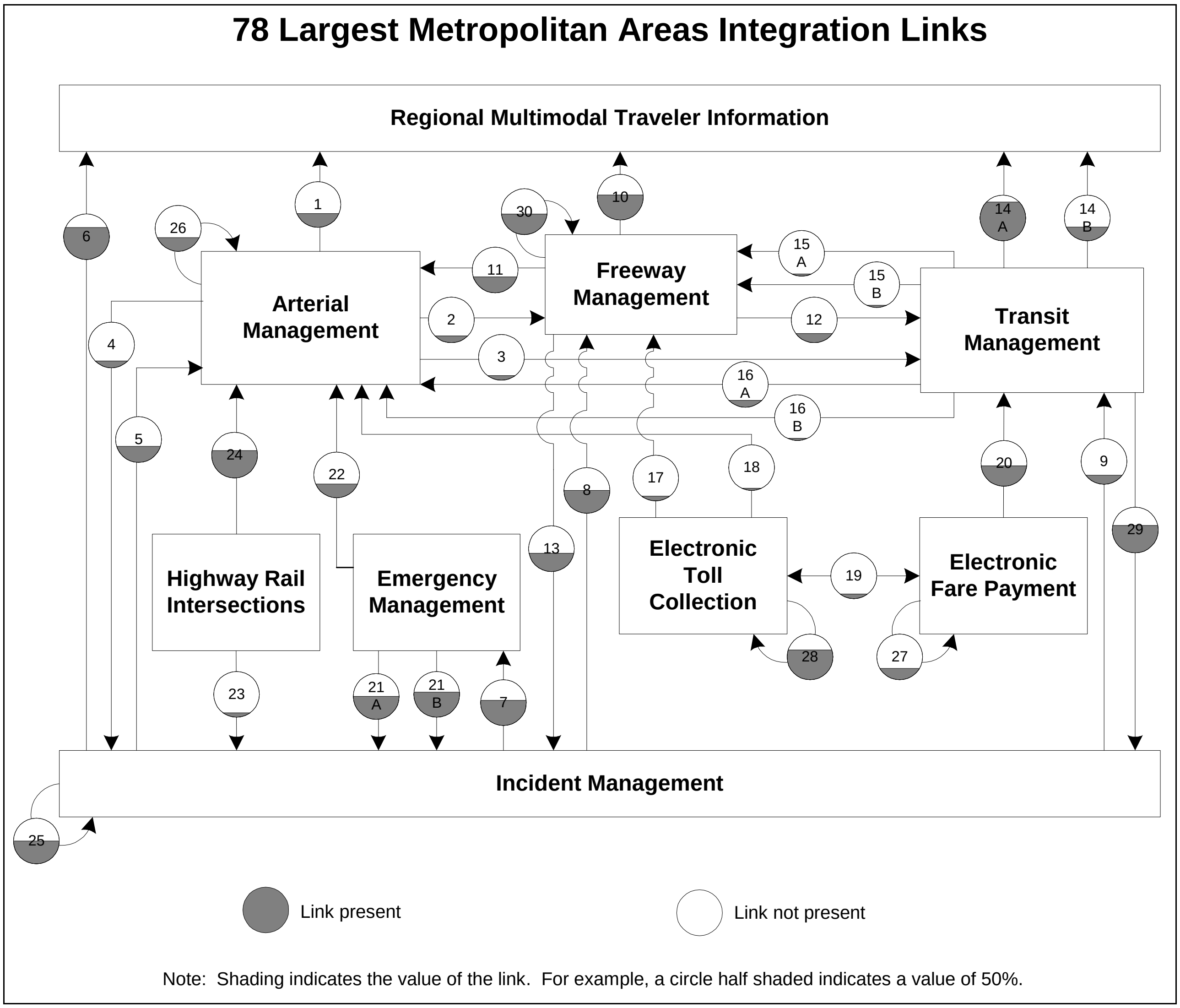



**Figure 2 78 Large Metropolitan Areas Integration Links**

### *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 former 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 high for integrated deployment. This methodology is explained in detail in section 4. Figure 3 summarizes the level of deployment in 75 of the nation's largest metropolitan areas for 1997, 1999, 2000, and 2002. A detailed description of the methodology and results for each metropolitan area is available in a separate report[5].

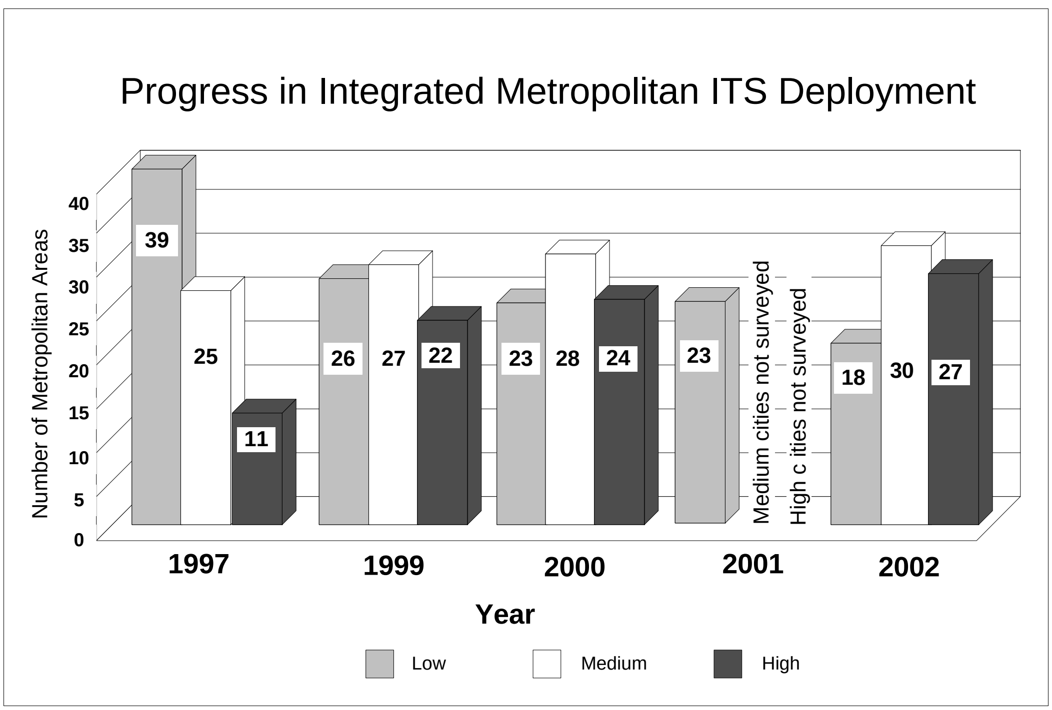



**Figure 3 Progress in Integrated Metropolitan ITS Deployment**

[5] U.S. DOT (2003). *Deploying the Integrated Metropolitan Intelligent Transportation System (ITS) Infrastructure: FY 2003 Report*. http://www.itsdeployment.its.dot.gov/its2002/pdf/goals_report2003.pdf.

### *Summary Deployment Indictors for Medium-Sized Cities*

The summary indicators for the medium-sized cities surveyed are presented in Figure 4. Compared to the same indicators shown in Figure 1, arterial, transit, and emergency management agencies in medium-sized cities have deployed ITS similarly to those in major metropolitan areas. However, freeway deployment in medium-sized cities, in the form of traffic data collection and service patrols, is substantially lower than in the larger cities.

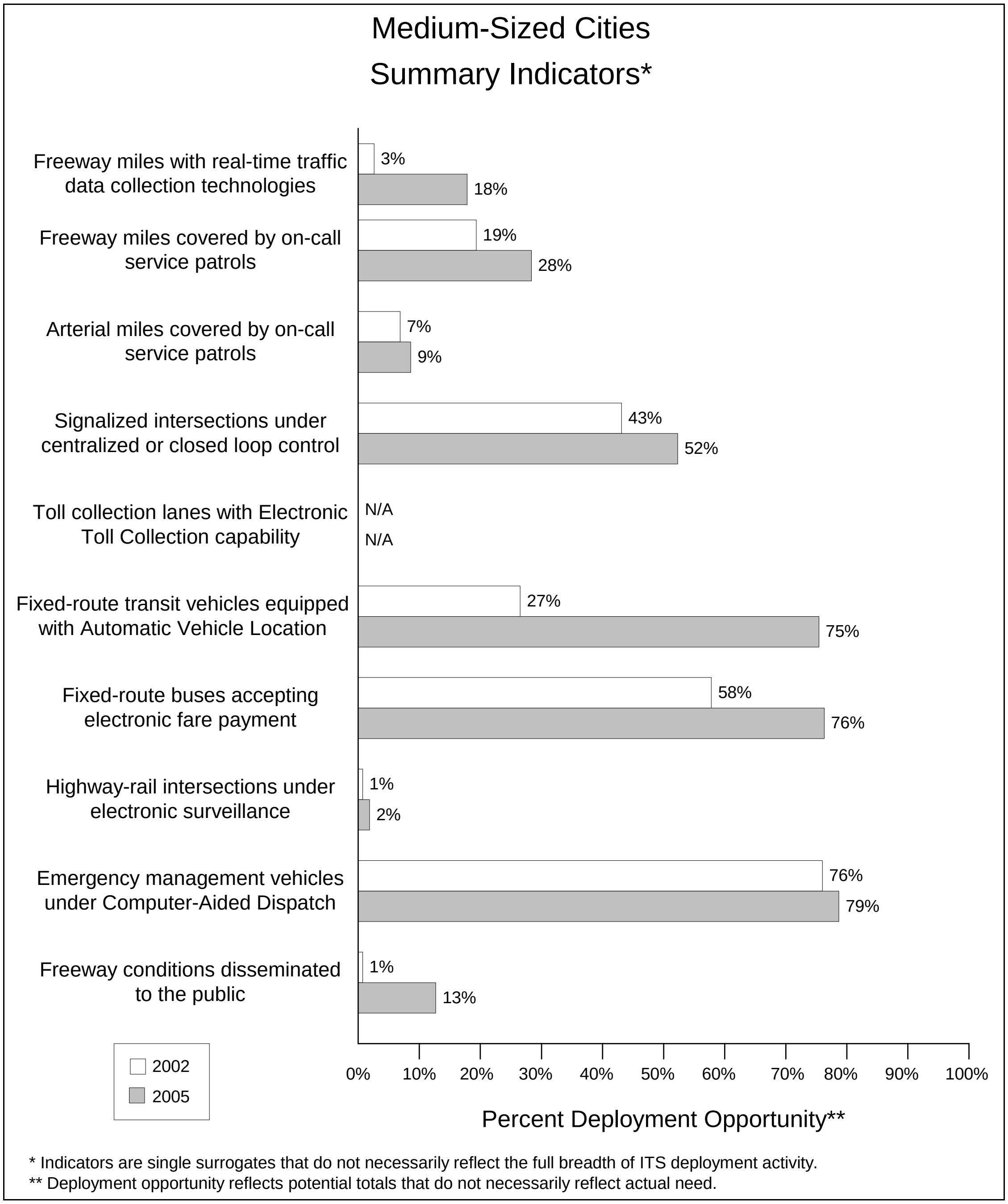



**Figure 4 Medium-Sized Cities Summary Indicators**

### *Summary Deployment Indicators for Tourist Cities*

Figure 5 contains a summary of the level of deployment in the tourist cities surveyed. The highest levels of deployment appear in Arterial Management and Emergency Management and are comparable to results for larger cities.

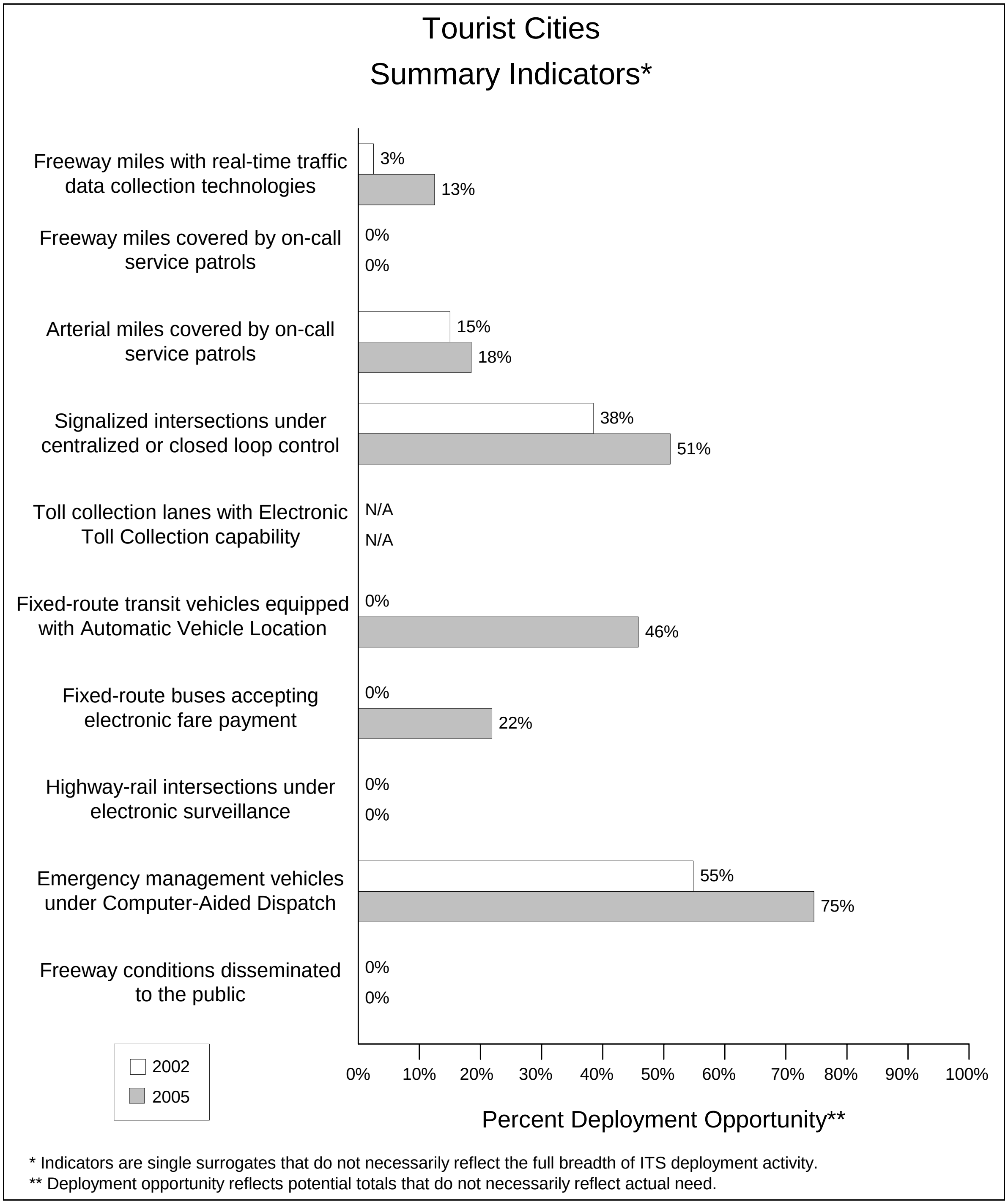



**Figure 5 Tourist Cities Summary Indicators**

# Introduction

## *Background*

This report describes the state of Intelligent Transportation System deployment in the nation's metropolitan areas. The data presented are based on the results of a nationwide survey conducted in 2002 using the tracking methodology developed by the United States Department of Transportation's ITS Joint Program Office. This methodology tracks deployment of nine components that make up the metropolitan 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 measured for the nation's largest metropolitan areas. In addition, the integration links among agencies operating the infrastructure are also tracked. The details of the methodology are explained in a separate report. [6]

In FY97, the ITS JPO undertook a baseline survey of deployment in 78 of the nation's largest metropolitan areas following the metropolitan ITS deployment tracking methodology and published the results in a series of site reports and a nationwide summary report. 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. This process was repeated in 2000 and 2002. In 2002, the scope of the national survey was expanded to include additional metropolitan areas and to track deployments in rural areas. As the result of this expansion, a total of four national surveys were conducted in 2002. The first was an update of the same 78 metropolitan areas that had been surveyed previously. The second was a survey of 30 additional metropolitan areas, smaller in population than the original 78 and reporting relatively high levels of congestions. These areas are called 'medium-sized cities' throughout this report. The third survey targeted 20 cities impacted by tourism. These areas are called 'tourist cities' throughout this report. The fourth survey targeted each of the 50 states and gathered data on statewide and rural deployments. Overall, the 2002 data gathering involved more than 2400 agencies with a 90% response rate.

This report is a national summary of the FY2002 results for the three metropolitan surveys. Where possible, 2002 data are reported along with earlier data to show deployment trends. The statewide results are summarized in a separate report. For those interested in additional details, access to the complete data set, including results from previous surveys, is available on-line at: http://www.itsdeployment.its.dot.gov/ .

The first section of this report covers the results for the survey of the country's 78 largest metropolitan areas. Initially, these results are described through a set of summary indicators for deployment and integration that provide a high level view of the overall results, followed by a detailed breakout of individual deployment indicators for each infrastructure component. Trend information from earlier surveys is also included. Integration is also be covered in detail, and instead of individual components, the results are grouped according to major functions.: traffic

[6] U.S. DOT (1999).*Measuring ITS Deployment and Integration*. http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf, EDL# 4372.

management, traveler information, transit, and emergency management.  Following these results, the 2002 results for the 30 medium-sized cities and 20 tourist sites are presented.

### National Summary Indicators for 78 of the Nation's Largest Metropolitan Areas

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).  Further, it must be kept in mind that the indicators are surrogates that do not necessarily reflect the full breadth of metropolitan ITS deployment.  Figure 6 includes the summary indicators developed from the 1997, 1999, and the 2000 survey results.  The 2002 survey asked for estimated 2005 levels of deployment, therefore a projection of deployment indicators is also presented in this figure.  The information presented in this figure suggests the following:

- Summary deployment indicators have increased across all components during the period 1997 to 2002 with one exception:  Highway-Rail Intersections, which as remained fairly static.
- The highest levels of deployment are observed for Emergency Management (computer aided dispatch), and Electronic Toll Collection, which are approaching complete deployment.
- The deployment of Arterial Incident Management lags significantly behind that reported for freeways, but has shown a steady rate of increase for the period of the surveys.
- Transit agencies are deploying technology on a significant portion of their fleets, with a major increase projected for 2005.
- Freeway deployment, in the form of traffic surveillance and service patrols, has been increasing steadily and projections indicate this trend will continue in the future, to the extent that more than half of the freeway miles will be covered.

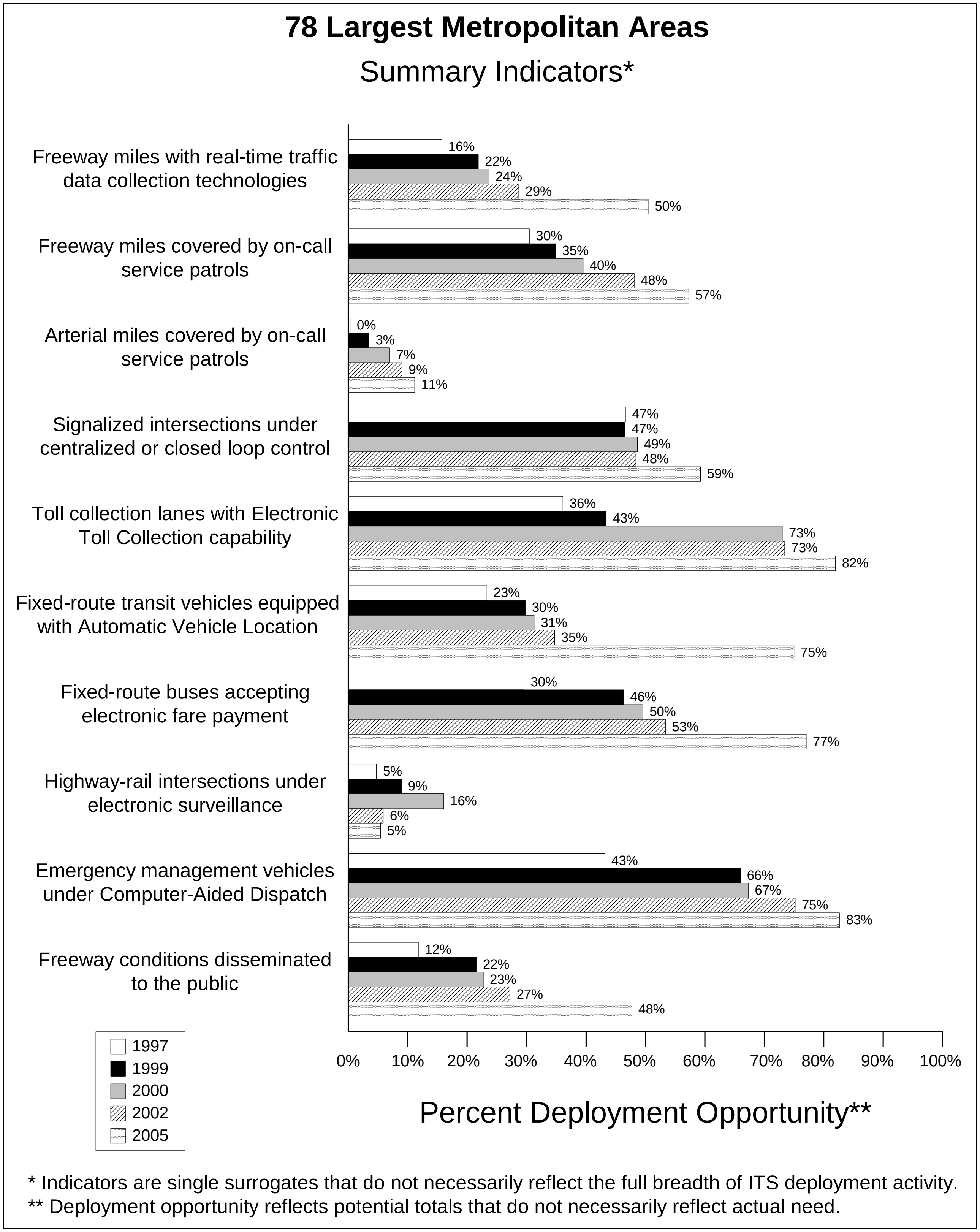



**Figure 6 78 Large Metropolitan Areas Summary Indicators**

Figure 7 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 number “10” identifies the integration of information from the Freeway Management component to the Regional Multimodal Traveler Information component. The indicators are calculated by comparing the number of agencies reporting the sharing of information on a particular link to the total number of agencies that could be doing so.

The results show that information dissemination is well established as well as certain types of interagency links, particularly between Emergency Management and Incident Management. A disturbing result is the low levels of integration between transit, arterial and freeway agencies.

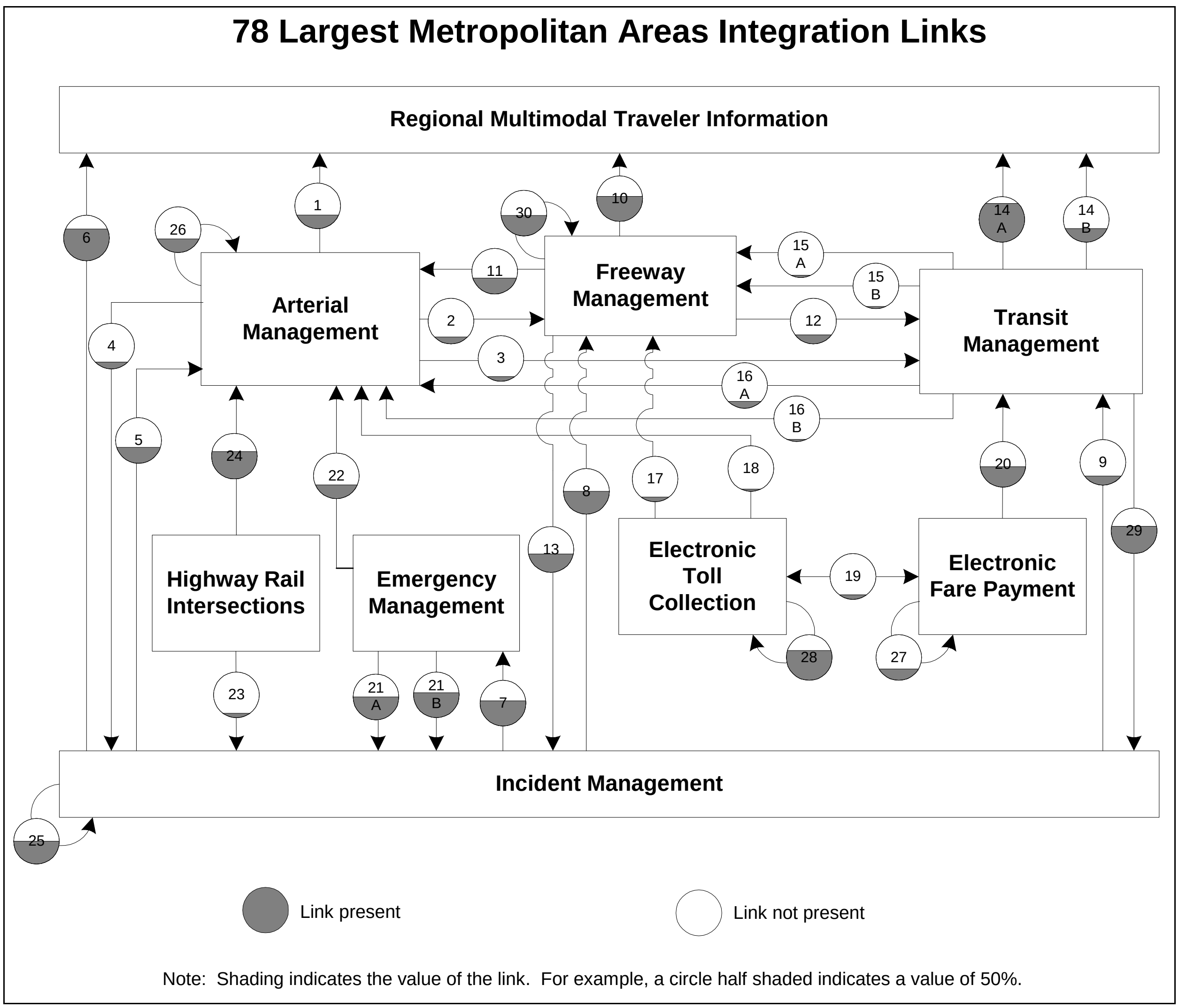



**Figure 7 78 Large Metropolitan Areas Integration Links**

**Infrastructure Component Description and Survey Results for Major Metropolitan Areas**

This section presents deployment-tracking indicators for each of the nine metropolitan ITS components for the 78 major metropolitan areas. The following information is provided for each component:

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

2. 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, FY2002 results are compared to FY1997, FY1999, FY2000, FY 2002 and estimates for FY2005. In some cases, a decrease in deployment or integration over time occurs. This reduction may be due to difference in reporting from year to year, agencies responding one year and not the other, or an actual decrease in the level of deployment

3. Additional survey results are used to evaluate the extent that individual metropolitan areas have adopted technologies. 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, FY2002 results are compared to FY1997 results, FY1999 results, FY 2000 results and 2005 estimates.

### *Freeway Management*

Freeway Management provides the following traffic management functions:

1. Surveillance: Capability to monitor traffic conditions on the freeway system in real-time
2. Control: 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.
3. Information dissemination. 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).

The Freeway Management component indicators are shown in Figure 8. Traffic surveillance has shown steady growth since 1997, a trend that is projected to continue to 2005, when over half of the freeway miles will be covered. Traveler information systems are also projected to increase markedly by 2005. On the other hand, deployment of traffic control systems, either through ramp metering or lane control is virtually static.

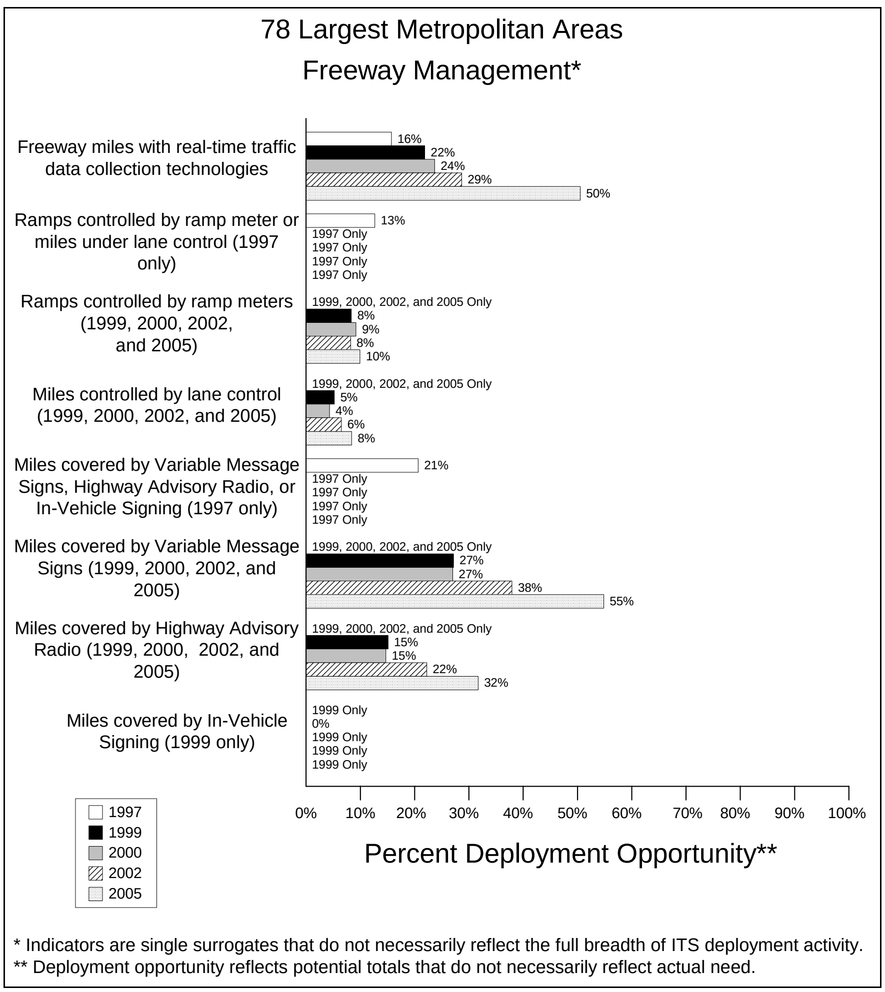



**Figure 8 Freeway Management in the Largest 78 Metropolitan Areas**

*Traffic Surveillance*

Figure 9 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, but adoption by new metropolitan areas is limited. On the other hand, although radar detectors and video image detectors are less widely deployed, both technologies show substantial growth, a trend that is projected to continue in the future.

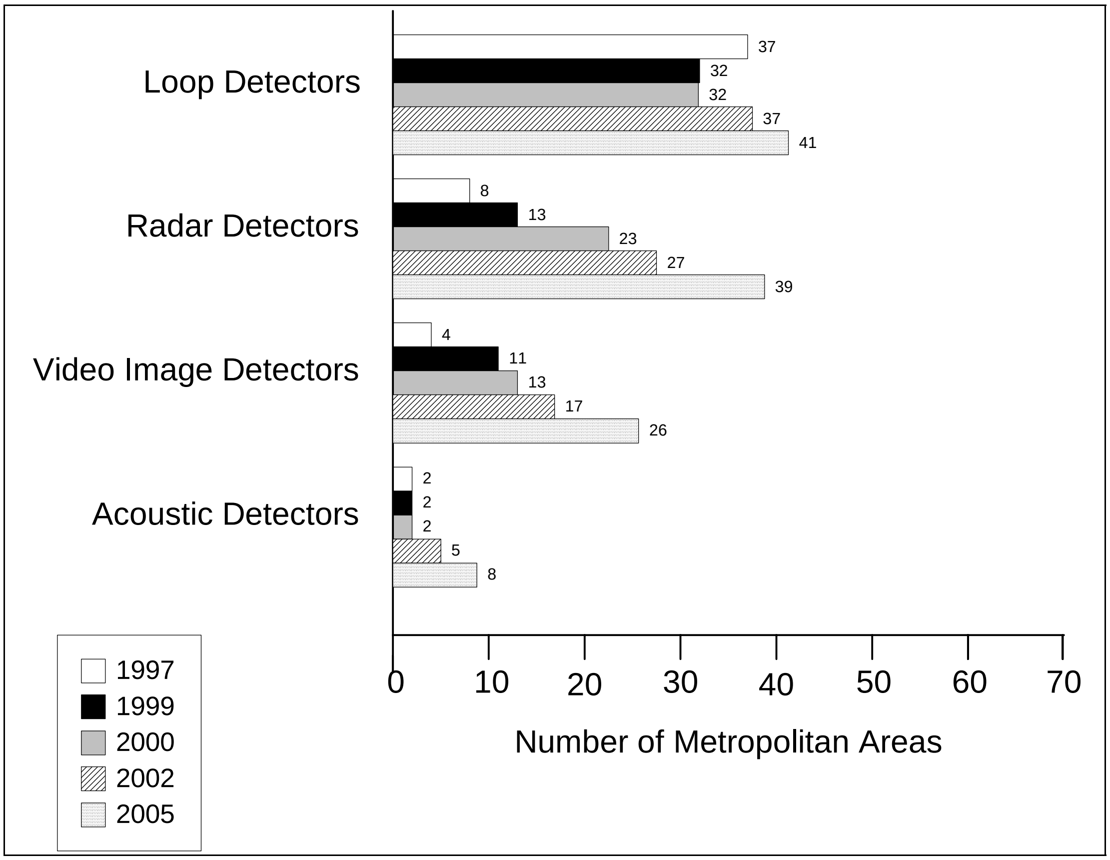



**Figure 9 Surveillance Technologies**

*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 10 shows 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. The deployment of ITS technology to control traffic on freeways, in the form of either ramp metering or lane control, is not expanding at the same rate as the surveillance and information dissemination functions of freeway management. Although the use of lane control has recently expanded, ramp metering has been basically static.

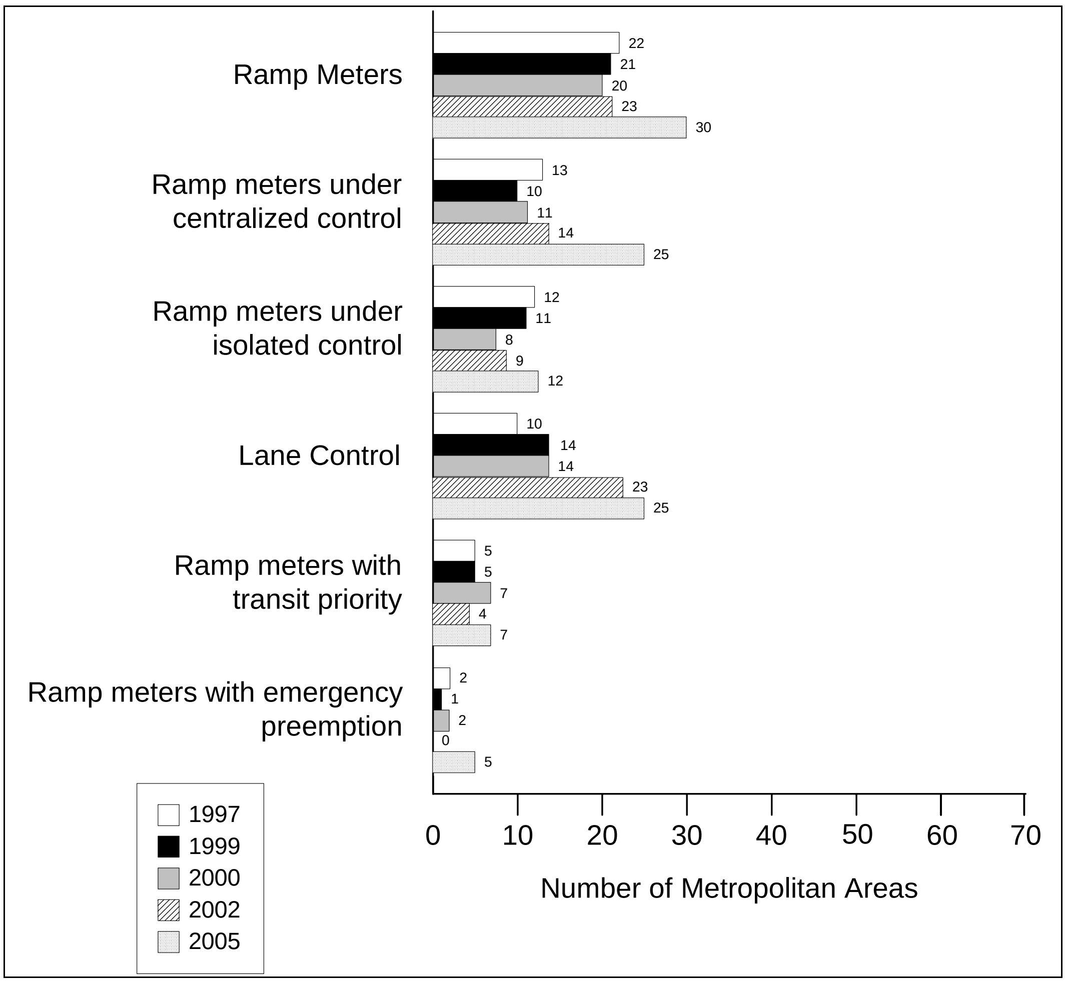



**Figure 10 Traffic Control Devices**

*Information Display*

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

Figure 11 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. The use of both technologies has shown steady growth. No metropolitan area reports using IVS.

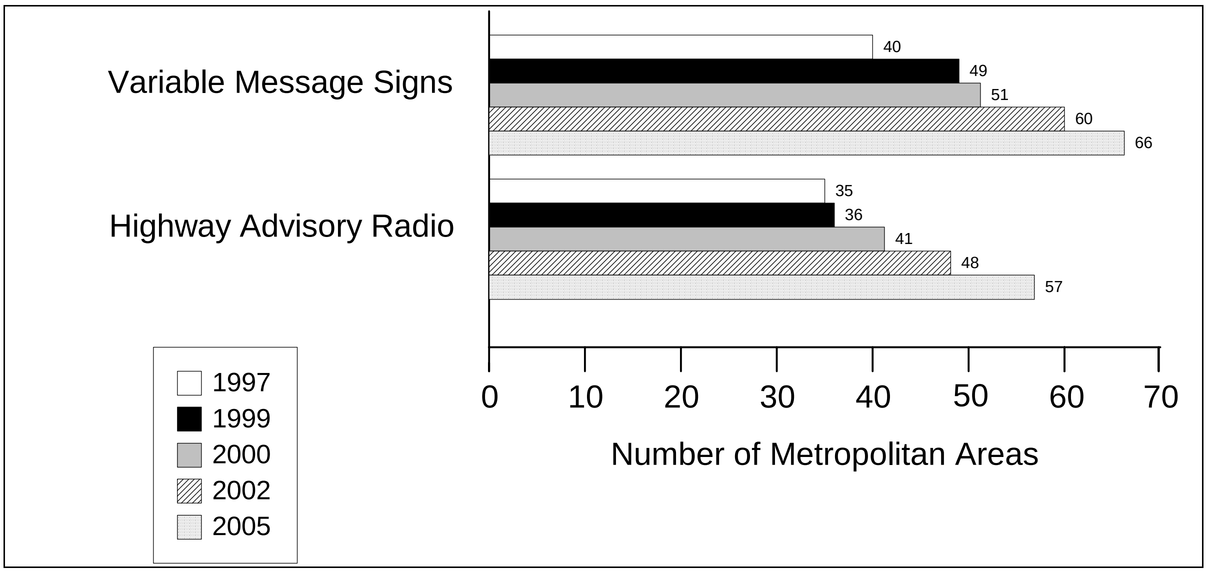



**Figure 11 Information Dissemination**

### *Incident Management*

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

1. Incident detection. Capability to detect incidents on freeways and arterial roadways.
2. Incident verification. Capability to verify incidents on freeways and arterial roadways.
3. Incident response. Capability to respond to incidents on freeways and arterial roadways.

The Freeway and Arterial Incident Management component indicators are shown in Figure 12. The use of free cellular phone call numbers is the primary means of detection of incidents. There has been steady growth in the deployment of closed circuit television to assist in incident verification. Coverage of freeway on-call service patrols to respond to incidents is expanding rapidly and is projected to encompass more than half of the freeways in major metropolitan areas by 2005. Arterial incident management is expanding, but remains much less prevalent than incident management on freeways.

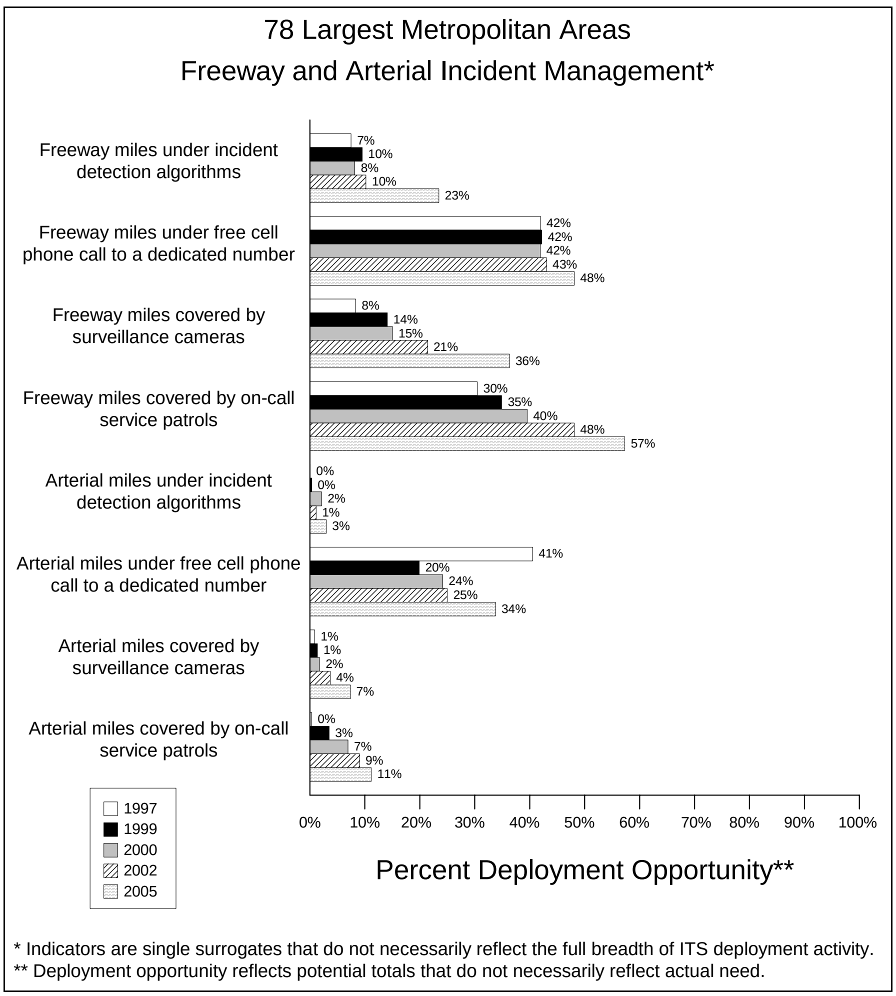



**Figure 12 Freeway and Arterial Incident Management in the Largest 78 Metropolitan Areas**

*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 13 shows 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 reported method. The use of incident detection algorithms is reported on both freeways and arterials with a significant expansion for both categories reported in 2002 and even greater growth projected for 2005.

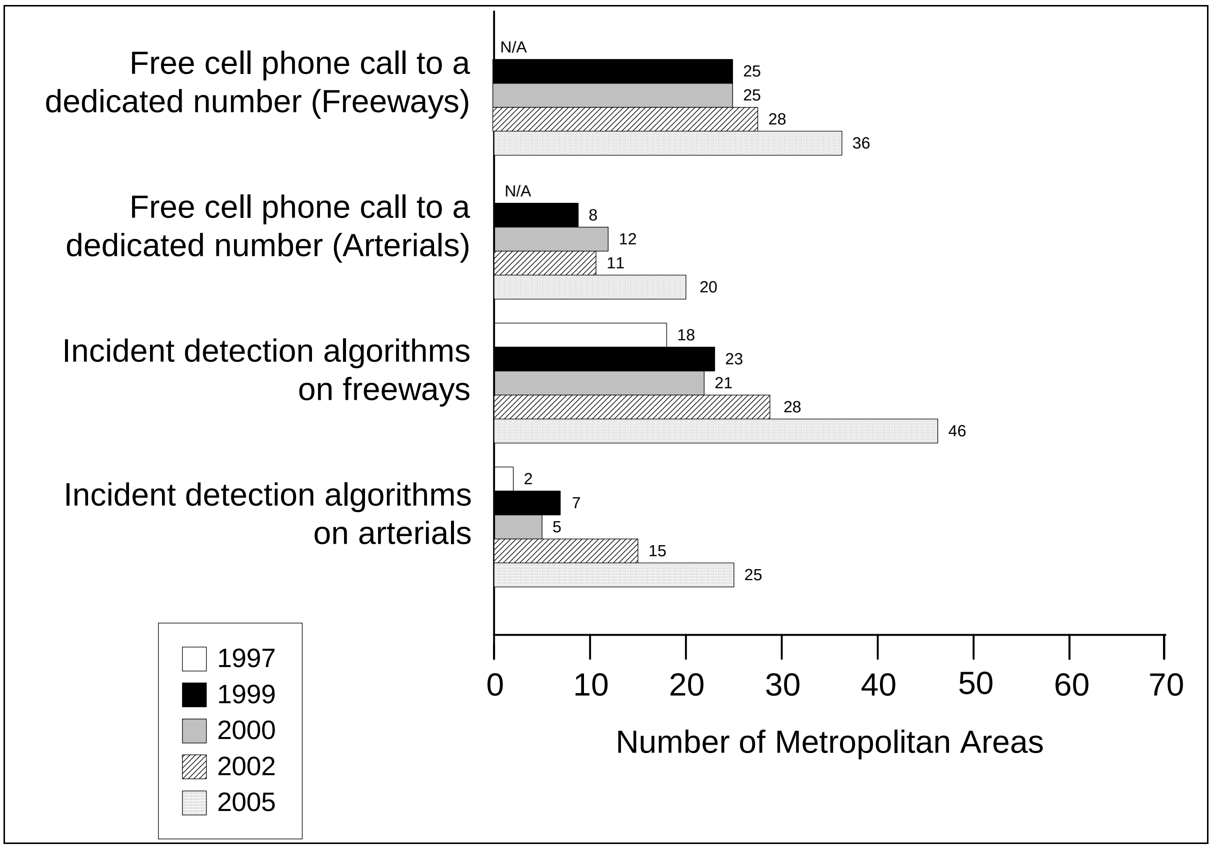



**Figure 13 Incident Detection**

*Incident Verification*

Incident verification is typically accomplished through observation by closed circuit television cameras. Figure 14 shows the number of metropolitan areas that use surveillance cameras for incident verification on arterials and freeways. This technology is widely deployed.

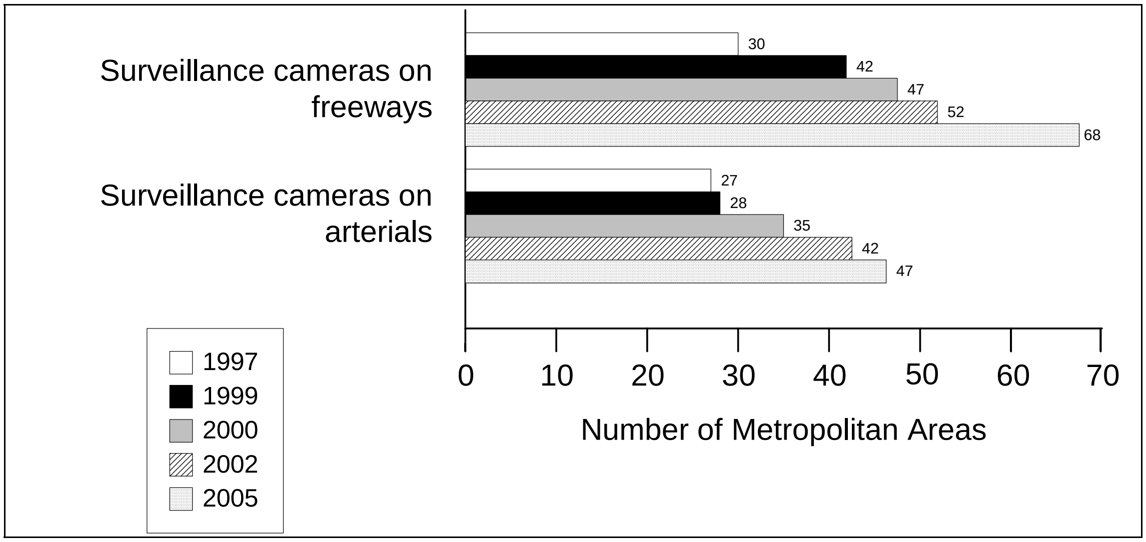



**Figure 14 Incident Verification**

*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 15 shows 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.

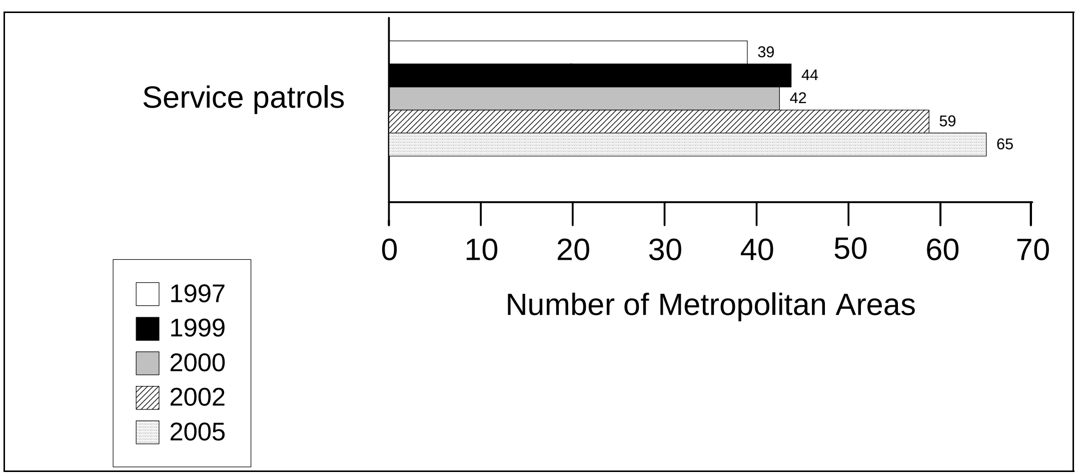



**Figure 15 Incident Response on Freeways**

Figure 16 shows the number of metropolitan areas reporting the use of publicly operated service patrols for incident response on arterials. Although the coverage of these service patrols is limited, as was shown above in Figure 12, nearly half of the metropolitan areas report some level of deployment.

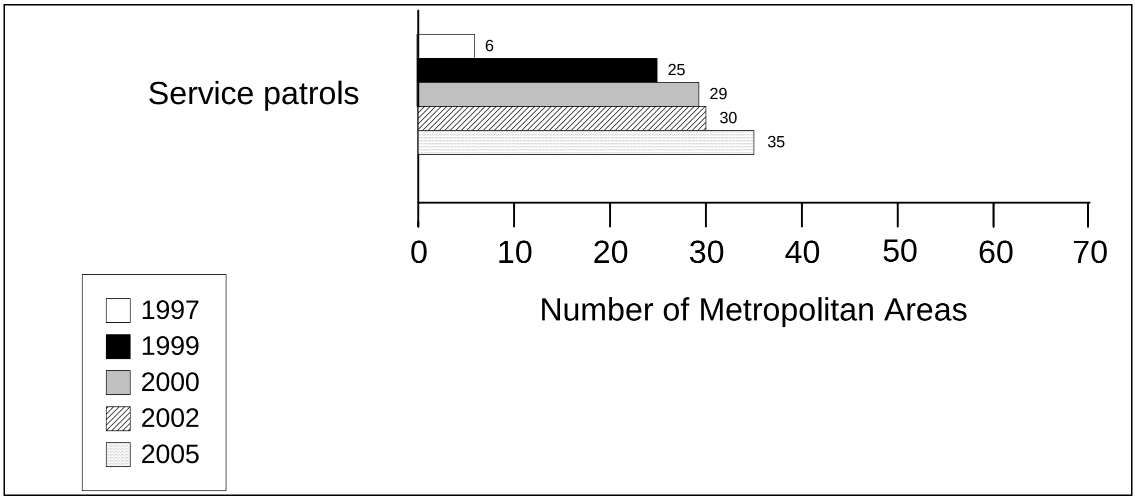



**Figure 16 Incident Response on Arterials**

### *Arterial Management*

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).

The Arterial Management component indicators are shown in Figure 17. The deployment of surveillance at signalized intersections has shown rapid growth and is projected to cover over one-third of these intersections by 2005. The use of centralized traffic signals is well established and is projected to include more than half of all signals by 2005. Traveler information systems are still only lightly deployed on arterials.

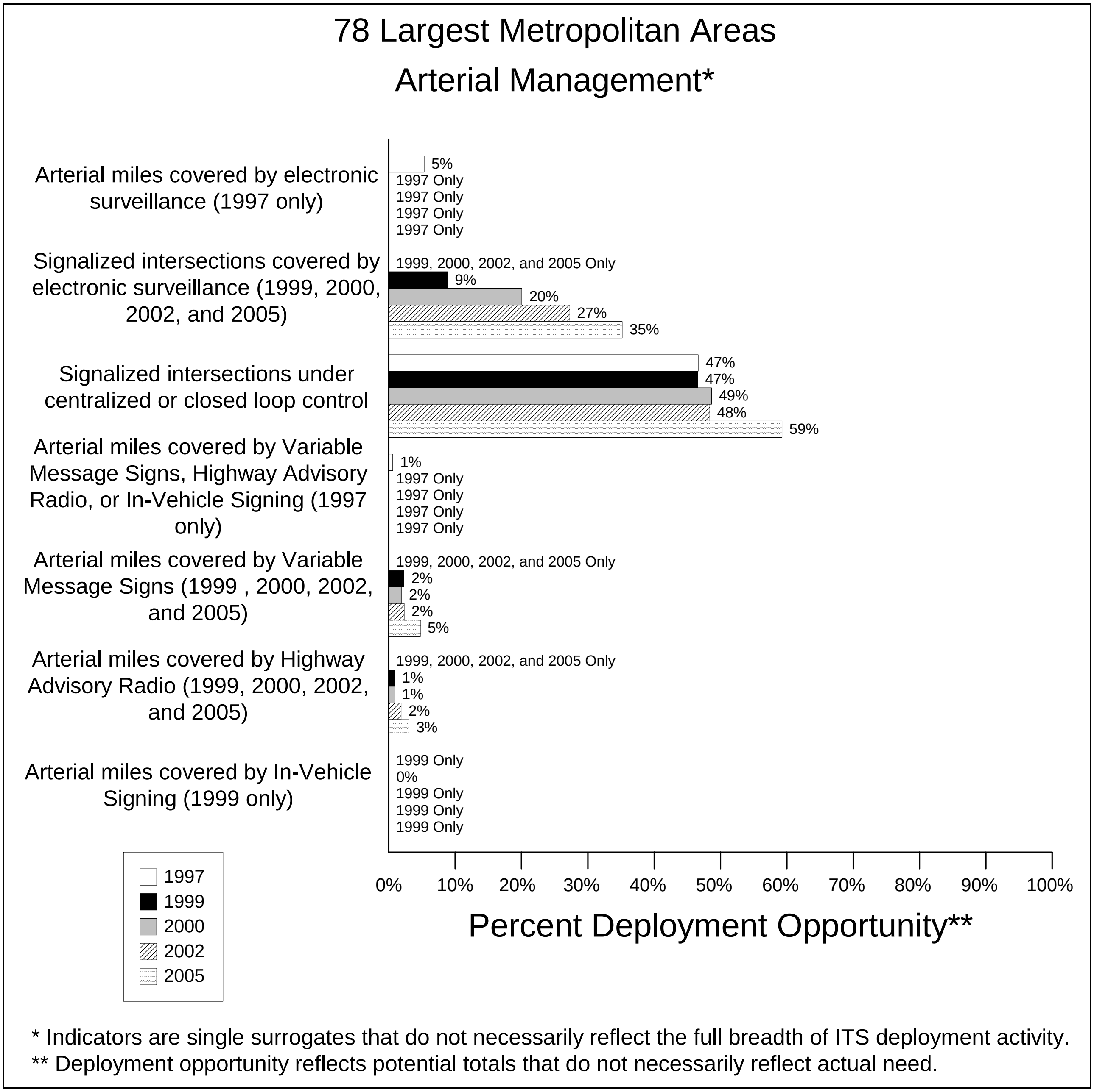



**Figure 17 Arterial Management in the Largest 78 Metropolitan Areas**

*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 closed circuit television (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 18 shows the number of metropolitan areas that use electronic surveillance on arterials. This technology is widely deployed and almost all of the major metropolitan areas report having some level of deployment.

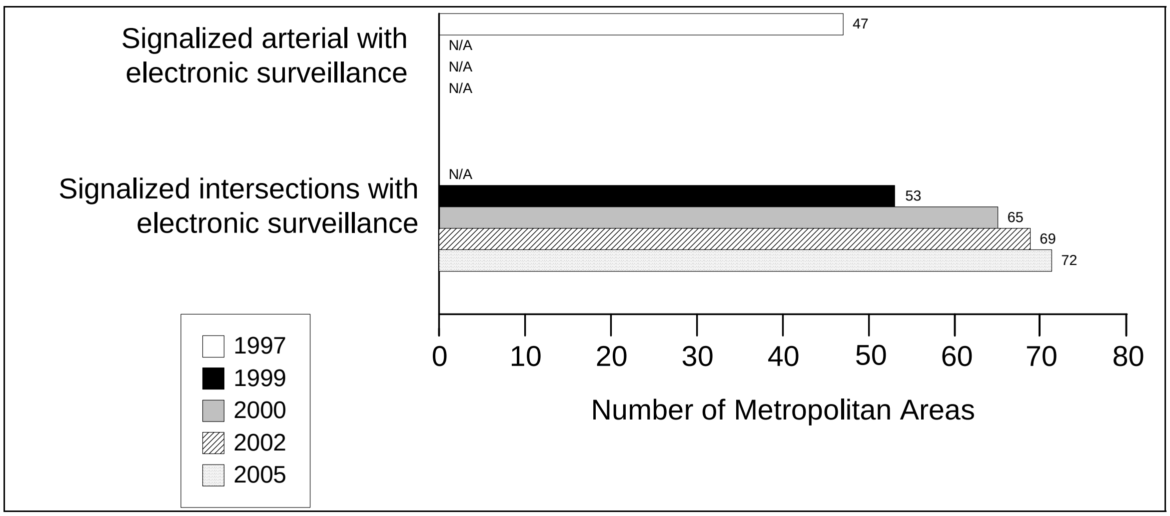



**Figure 18 Traffic Surveillance**

*Traffic Control*

Arterial Management is responsible for the coordinated control of traffic signals along urban arterials, networks, and the central business district. 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 19 contains a summary of metropolitan areas that use various control technologies. All of the metropolitan areas that have responded report signalized arterial intersections under centralized or closed loop control. The deployment of signals with emergency preemption is also widely deployed, and is reported by more than twice as many metropolitan areas as deploy signal priority for transit.

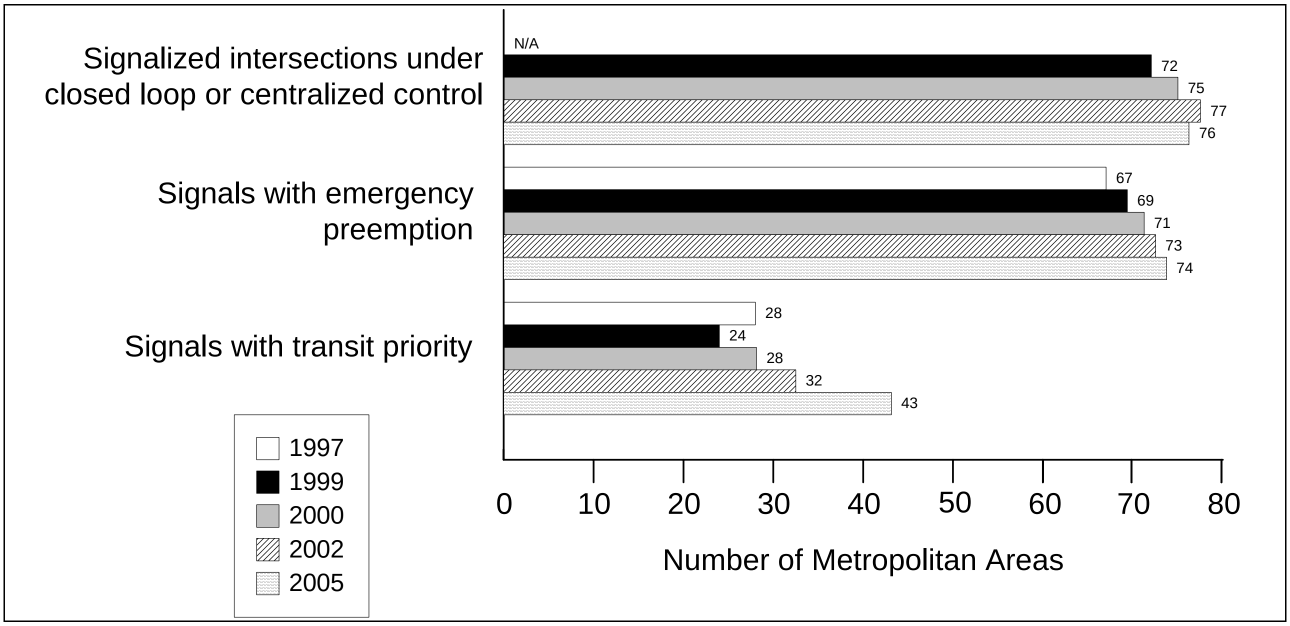



**Figure 19 Traffic Control**

*Information Display*

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

Figure 20 contains a summary of metropolitan areas that use various display technologies on arterials. Nearly half of the large metropolitan areas employ variable message signs and/or highway advisory radio. While variable message signs had the early lead in deployment, highway advisory radio is catching up.

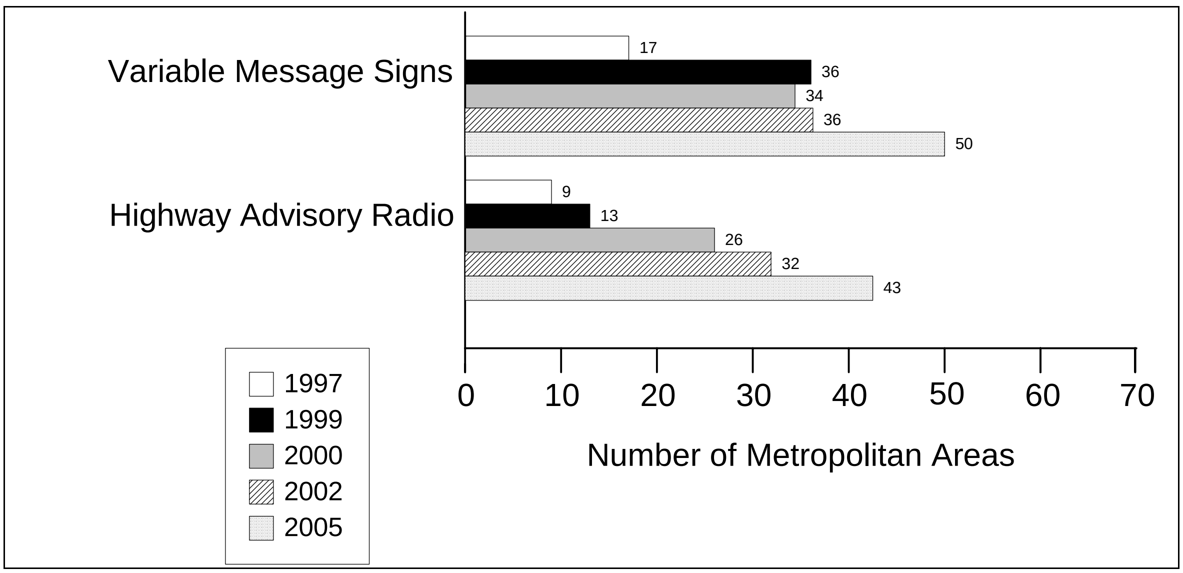



**Figure 20 Information Dissemination**

### *Electronic Toll Collection*

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

Electronically collect tolls. Automatically collect toll revenue through the application of in-vehicle, roadside, and communication technologies to process toll payment transactions.

The Electronic Toll Collection component indicators are shown in Figure 21. This technology is so widely reported that its deployment is essentially complete.

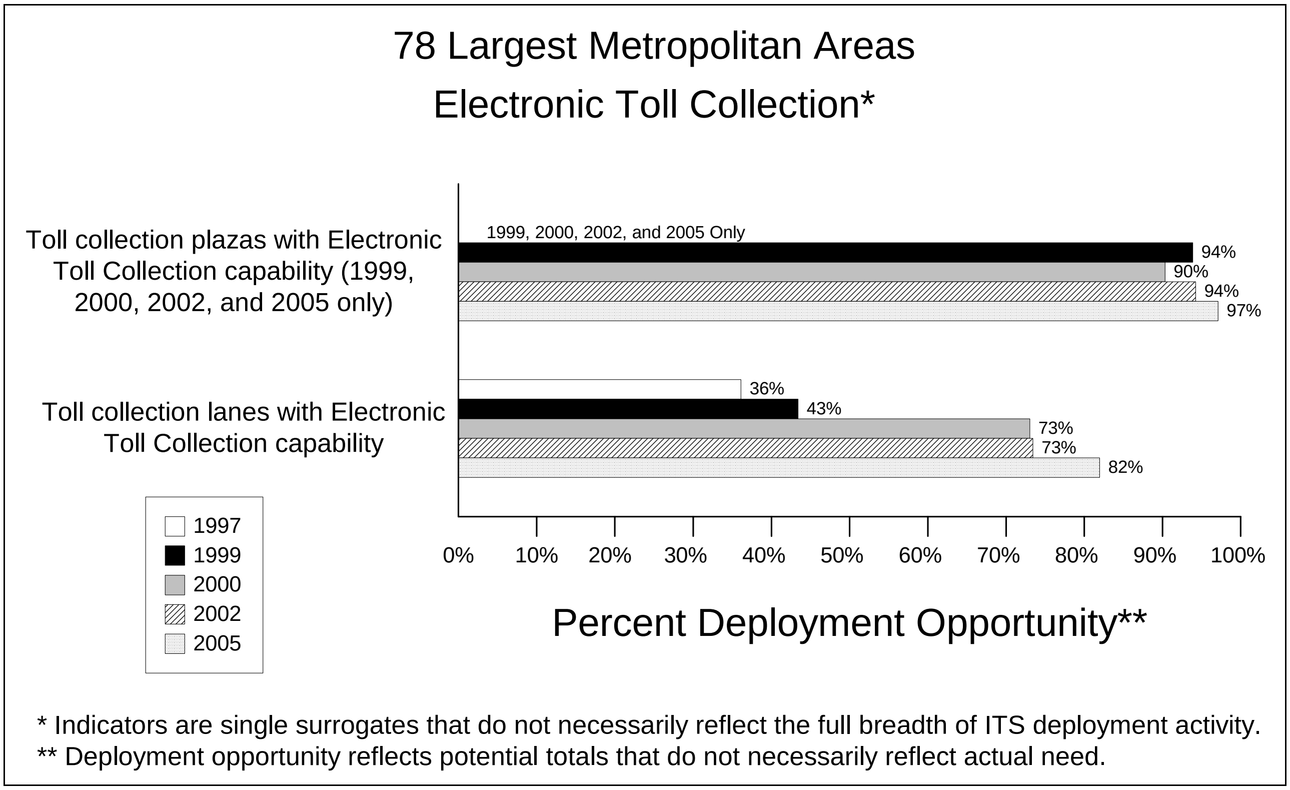



**Figure 21 Electronic Toll Collection in the 78 Largest Metropolitan Areas**

Figure 22 contains the number of metropolitan areas that have toll collection lanes with ETC capability. The deployment of this technology has not increased very much over time, reflecting the limited number of metropolitan areas collecting tolls.

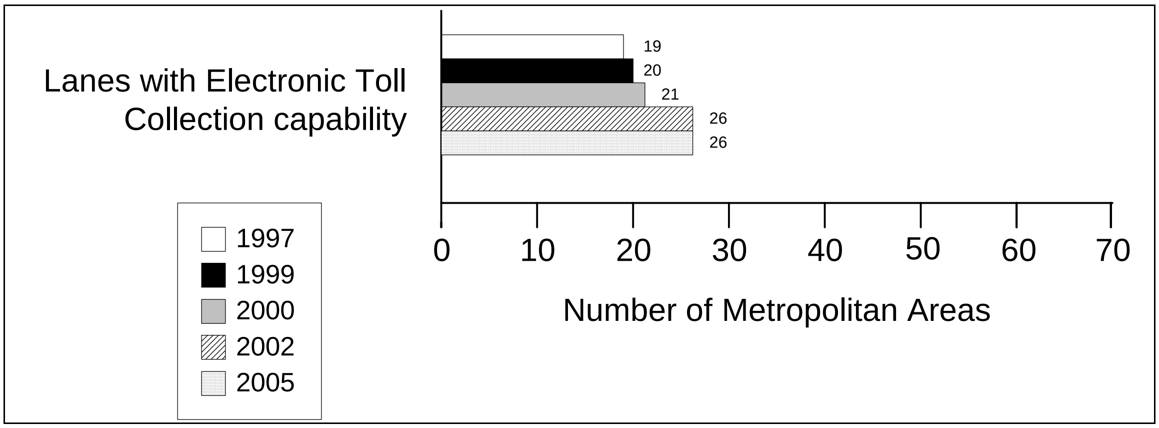



**Figure 22 Lanes with ETC Capability**

### *Electronic Fare Payment*

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

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

The Electronic Fare Payment component indicators are shown in Figure 23. This technology has shown steady growth in adoption on fixed-route buses, with more than half of them having this capability in 2002. Over half of the rail stations also accept electronic fare payment.

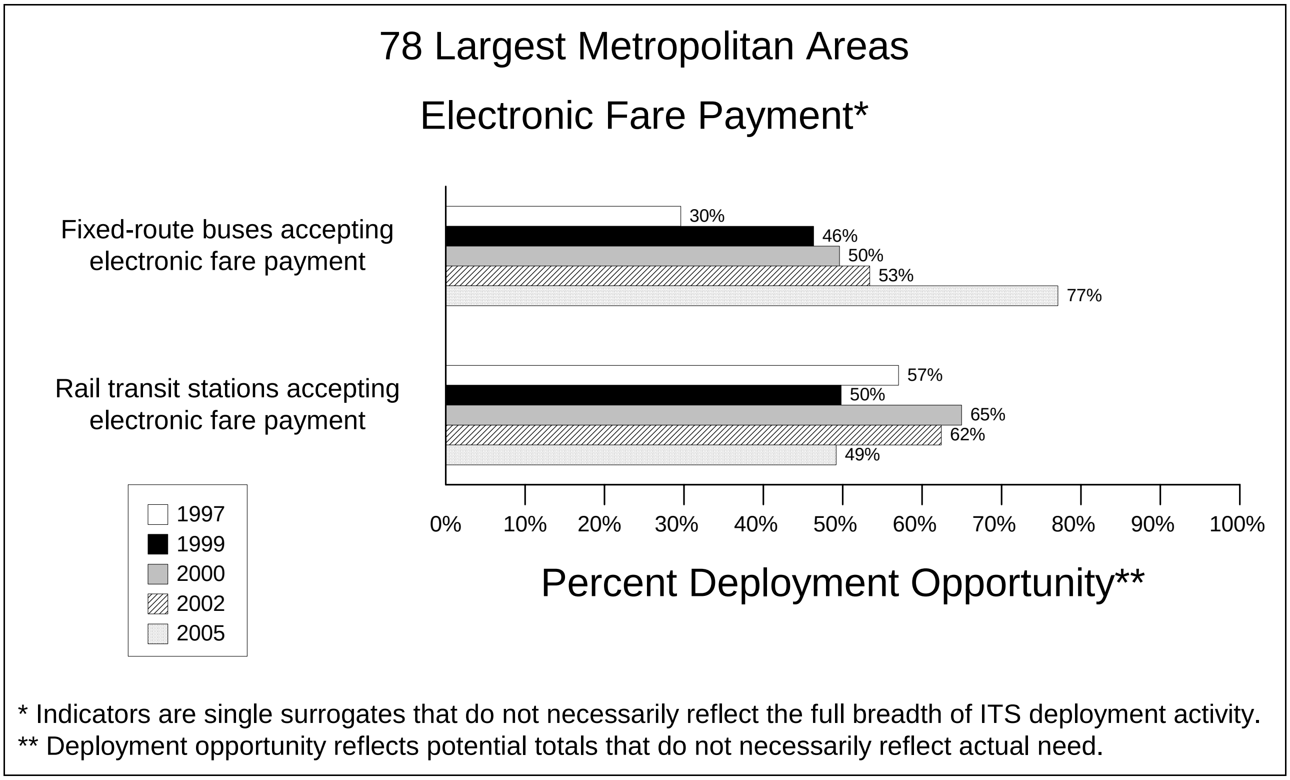



**Figure 23 Electronic Fare Payment in the Largest 78 Metropolitan Areas**

Figure 24 contains the number of metropolitan areas that use electronic fare payment media for fixed-route bus services. Magnetic stripe cards are the most widely accepted media. Only six metropolitan areas use smart cards, although this number is projected to increase markedly by 2005.

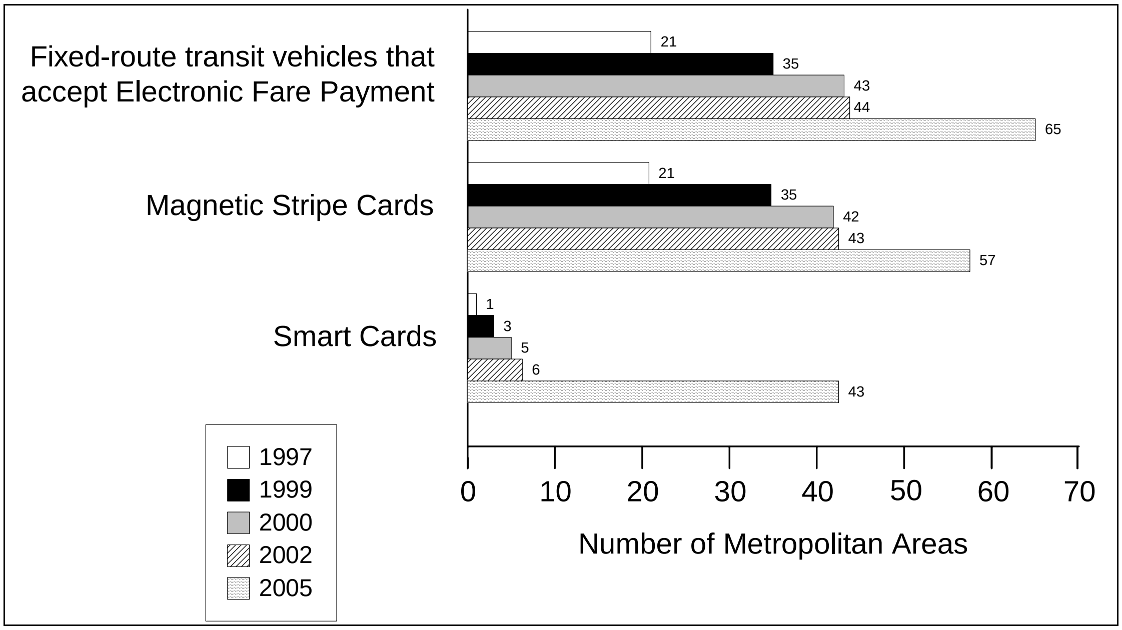



**Figure 24 Fixed Route Vehicles Accepting EFP**

Figure 25 shows the number of metropolitan areas that use electronic fare payment for heavy-rail stations. This type of deployment has shown limited growth, although it is projected to increase by 2005.

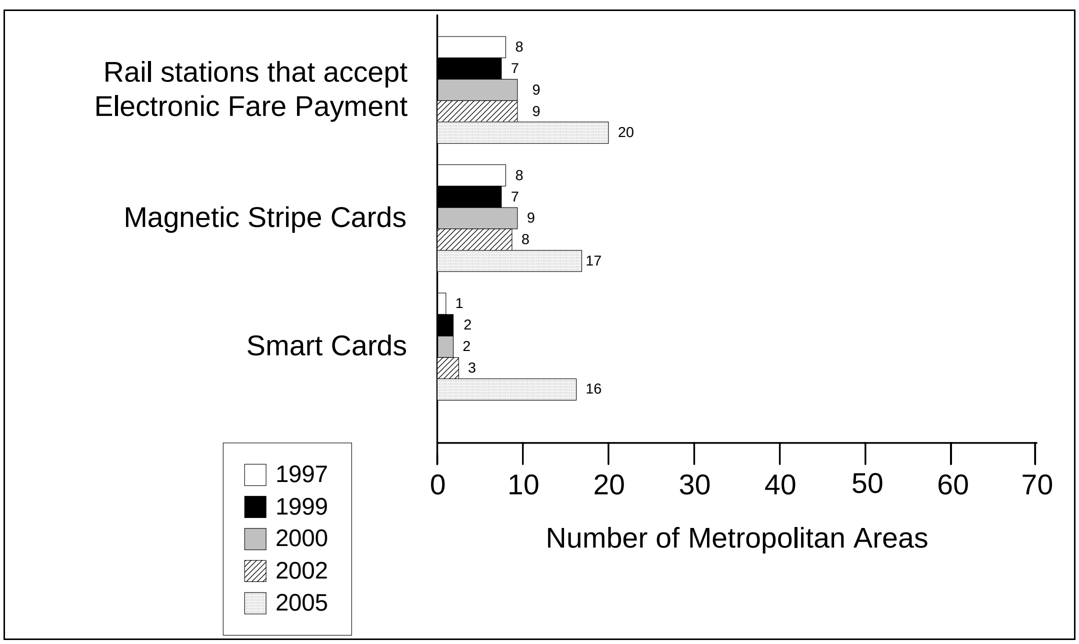



**Figure 25 Rail Stations Accepting EFP**

*Transit Management*

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.
3. Capability to provide demand responsive flexible routing and scheduling of transit vehicles.
4. Capability to provide real-time, accurate transit information to travelers.

The Transit Management component indicators are shown in Figure 26. The use of automatic vehicle location systems is well established and is reported in over one-third of the transit vehicles. Computer aided dispatch is similarly well established in the management of paratransit vehicles.

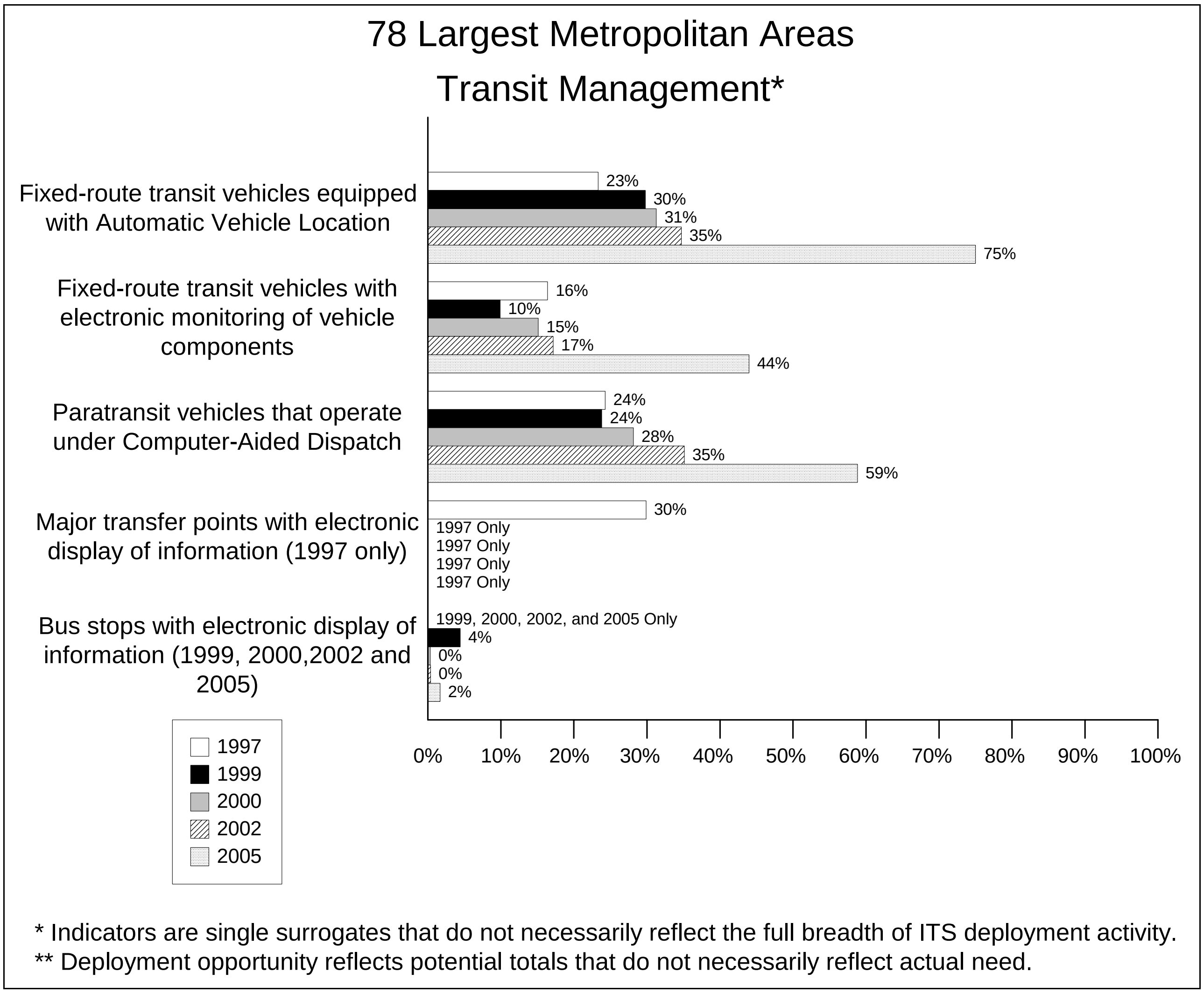



**Figure 26 Areas Transit Management in the Largest 78 Metropolitan Areas**

*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 technology 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 fuels 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 Computer Aided Dispatching (CAD) systems to provide optimal vehicle assignment and routing to meet non-recurring public transportation demand.

Figure 27 shows 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. All are well established and show strong projected growth.

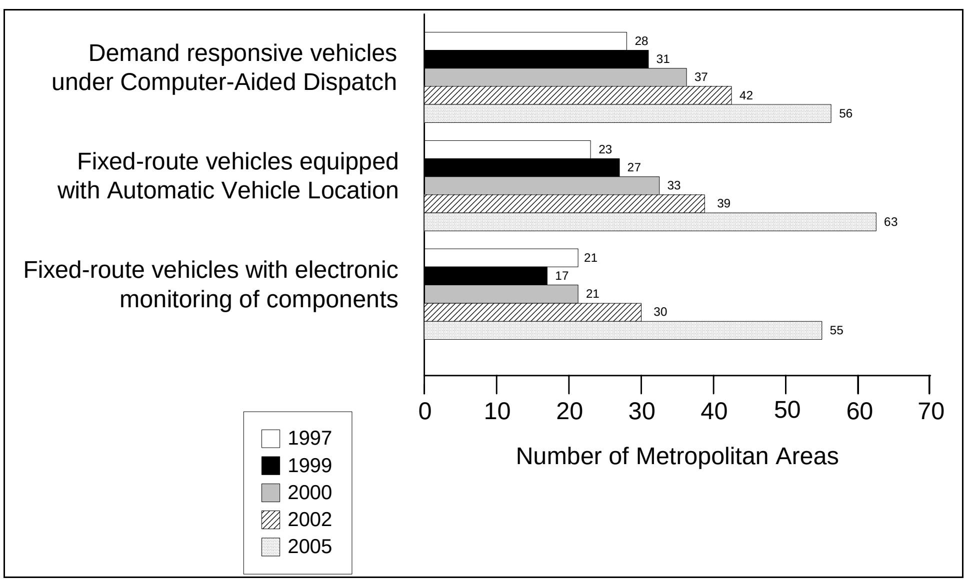



**Figure 27 Metropolitan Areas Employing Transit Management Technologies**

***Highway-Rail Intersection***

Highway-Rail Intersection provides for the following function:

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.

The Highway-Rail Intersection component indicator is shown in Figure 28. Deployment of this technology is static.

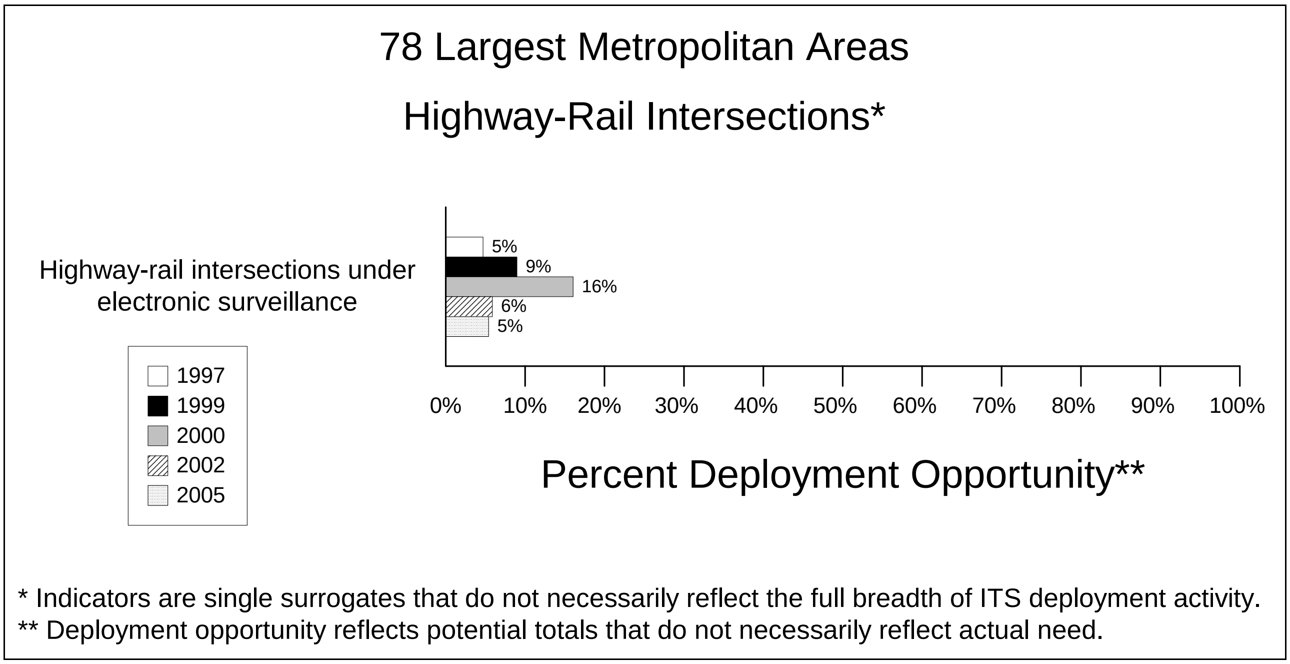



**Figure 28 Highway-Rail Intersection in the Largest 78 Metropolitan Areas**

*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 reference. 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. These systems 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 29 contains the number of metropolitan areas reporting the use of electronic surveillance at highway rail intersections, which is reported by nearly half of the major metropolitan areas, as well as intrusion detection devices.

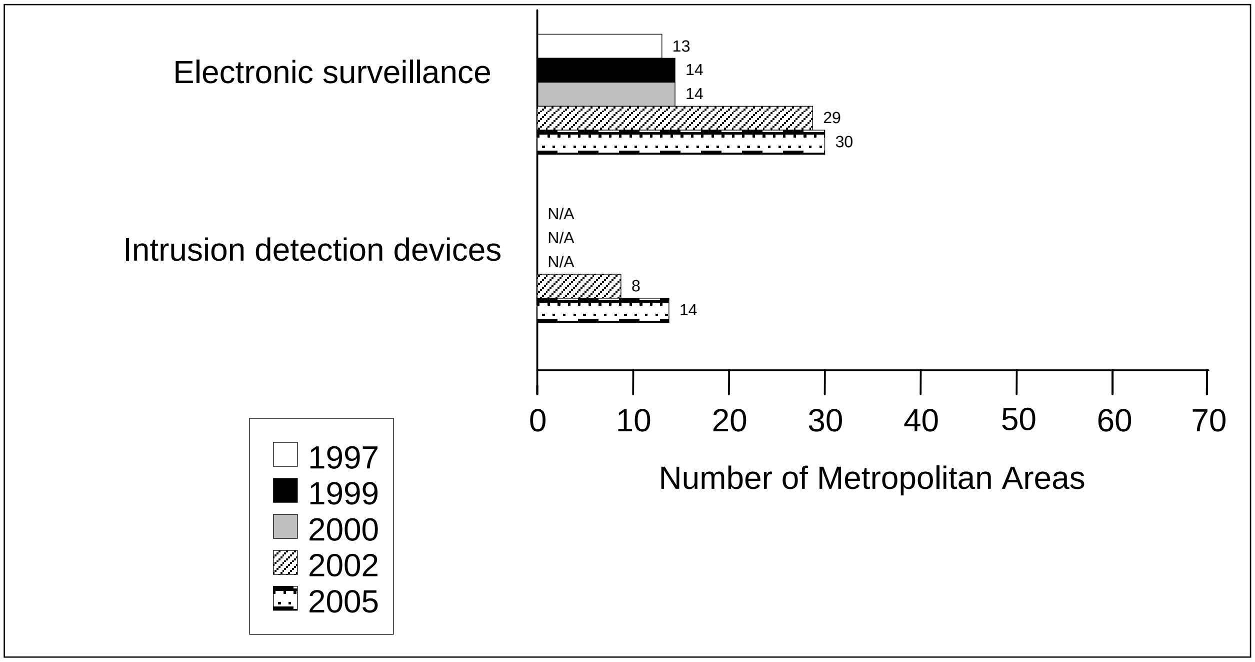



**Figure 29 HRI Surveillance**

### *Emergency Management*

Emergency Management provides the following capabilities:

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

The Emergency Management component indicators are shown in Figure 30.  The use of computer aided dispatch is widespread and is reported in three fourths of the emergency vehicles. Deployment of in-vehicle navigation systems is very limited.

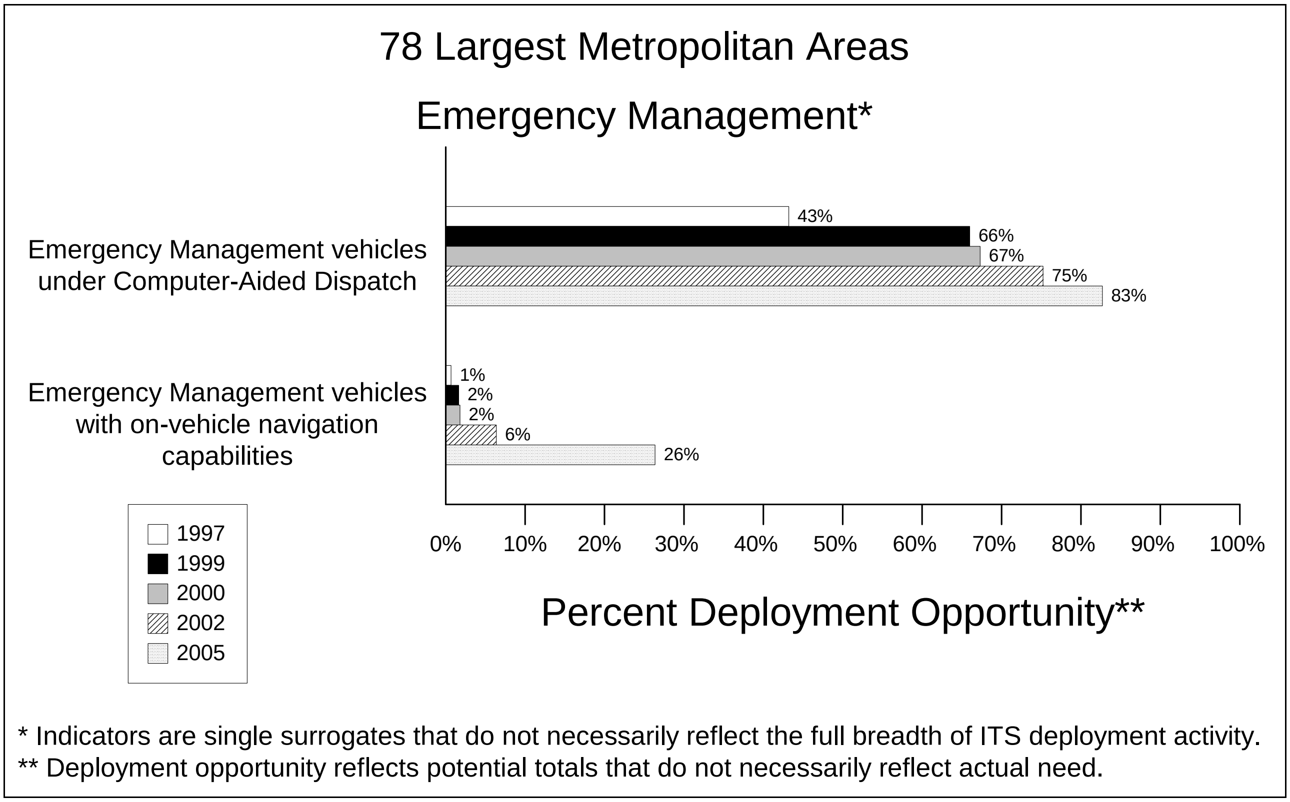



**Figure 30 Emergency Management in the Largest 78 Metropolitan Areas**

*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 31 contains the number of metropolitan areas with emergency management vehicles under computer aided dispatch and route guidance technologies.  Computer aided dispatch is universally reported.  In-vehicle route guidance, although lightly deployed as a percentage of vehicles, is reported by more than half of the metropolitan areas.

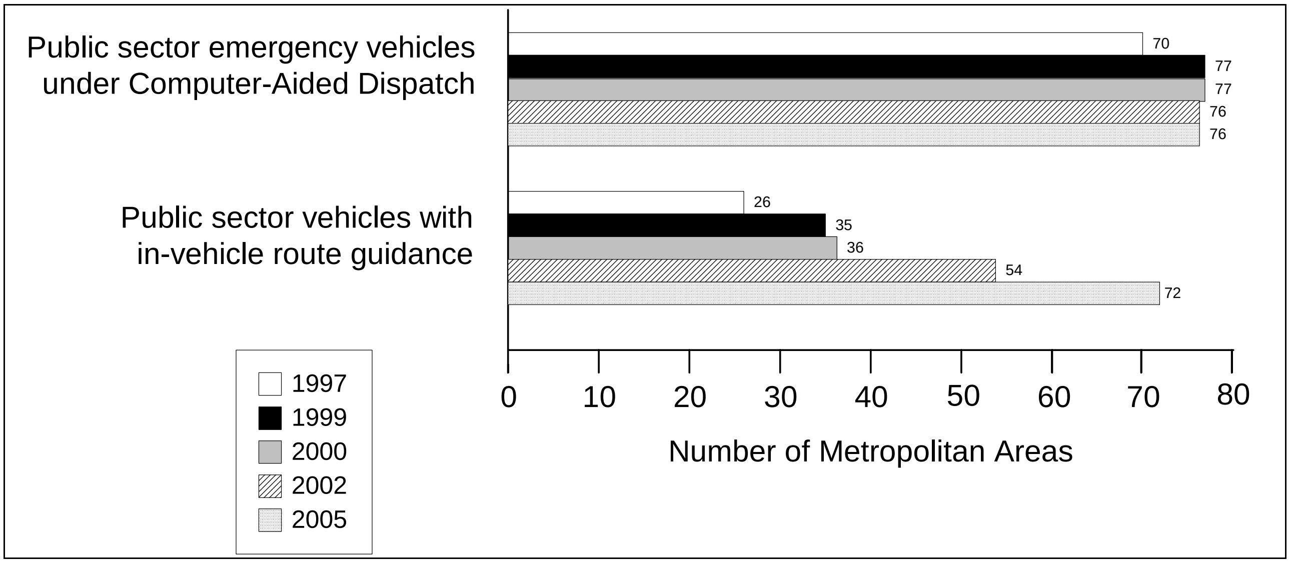



**Figure 31 EMS Vehicles Technologies**

*Regional Multimodal Traveler Information*

Regional Multimodal Traveler Information provides for the following capabilities:

1. Collection of data. Collect current, comprehensive, and accurate roadway and transit performance data for the metropolitan area.
2. Data dissemination. 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. Multimodal support. Provide multimodal information to the traveler to support mode decision-making.

The Regional Multimodal Traveler Information component indicators are shown in Figure 32. Traveler information capability covered nearly one third of freeway miles in 2002. The use of a variety of media to disseminate information is growing steadily. Traveler information is becoming multi-modal, with more than one third of the traveler information systems incorporating two or more modes.

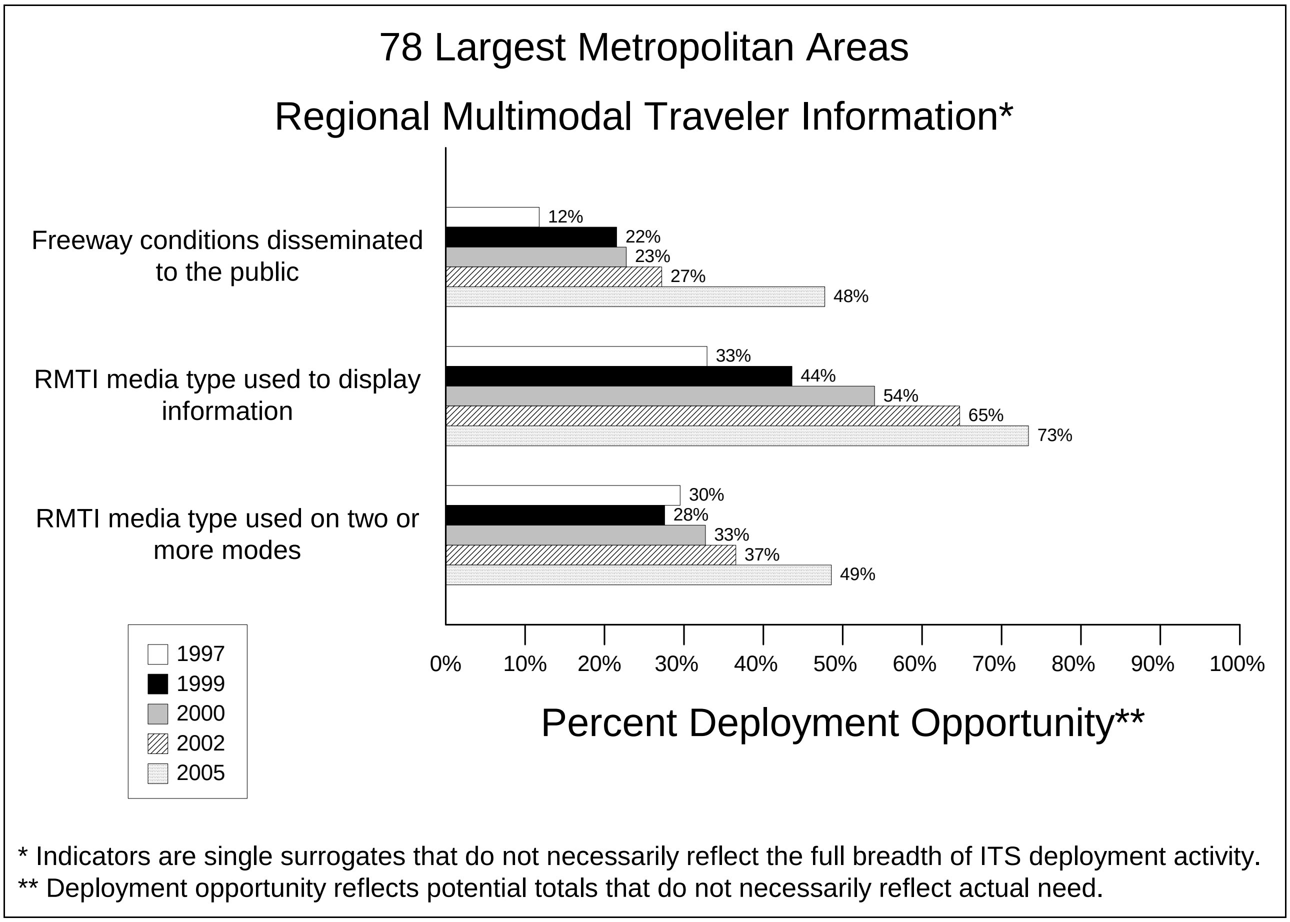



**Figure 32 Regional Multimodal Traveler Information in the Largest 78 Metropolitan Areas**

*Freeway Conditions Disseminated to the Public*

The Regional Multimodal Traveler Information component of the metropolitan ITS infrastructure involves information dissemination by a number of agencies. The indicator tracks the percentage of freeway miles in each metropolitan area for which data are gathered through surveillance systems and traffic information made available to the public.

*Media Employed to Disseminate Traveler Information*

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. The indicator assigns a percentage for each metropolitan area based on the number of these eight media employed to distribute traveler information.

*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. This indictor tracks the percentage of the eight possible media for which information on more than one mode is disseminated.

## Integration in Large Metropolitan Areas

A critical aspect of the deployment of ITS technology 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 33. 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 number "10" identifies the integration of information from the Freeway Management component to the Regional Multimodal Traveler Information component. 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.)

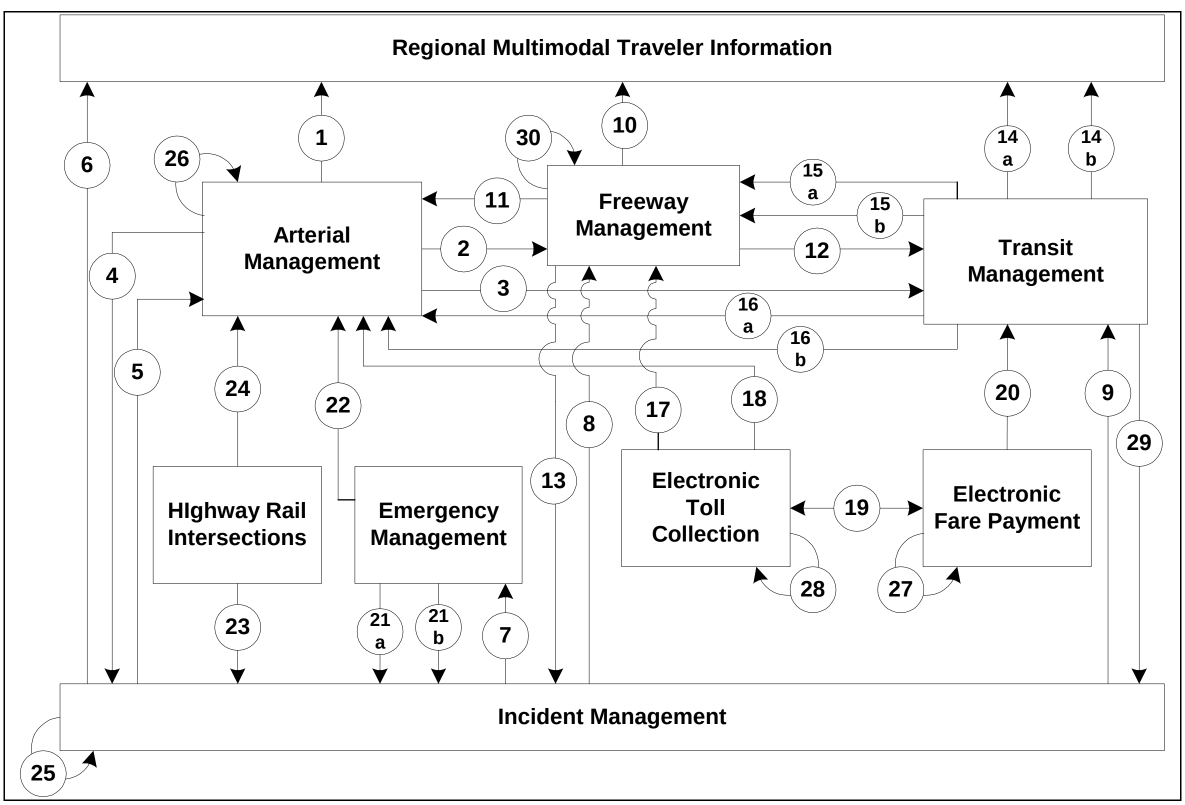



**Figure 33 Integration Links**

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. The integration rating is indicated by the shading in the circles associated with each link in Figures 34 to 37.

### *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 34 presents an overview of the integration links that define Traffic Management Integration. Freeway management and incident management are well integrated. Other interagency integration is more limited, however. In particular, integration between freeway, arterial, and transit management is quite limited.

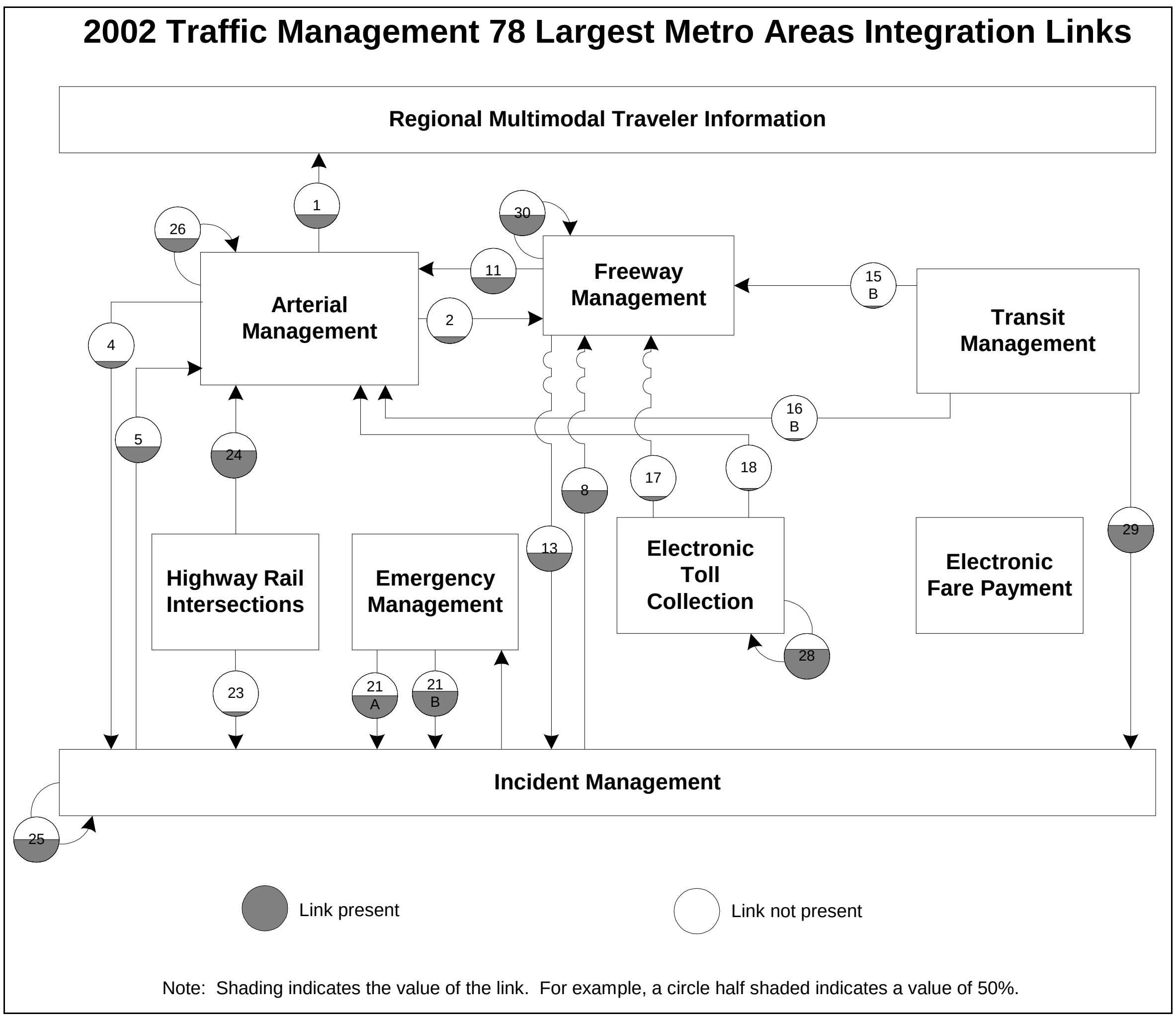



**Figure 34 Traffic Management Integration Links**

Table 1 presents a description of each of these links along with a summary of the survey results for each link.

**Table 1 Traffic Management Integration Links**

| 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 63 of the 445 (14%) Arterial Management 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 66 of the 345 (15%) Arterial Management 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 41 of the 121 (34%) Incident Management agencies to an Arterial Management agency. |

| 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 60 of the 121 (50%) 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 39 of the 121 (32%) Freeway Management agencies to a Arterial Management 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 48 of the 121 (40%) 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 3 of the 205 (1%) Transit Management agencies to a Freeway Management agency. |
| 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 8 of the 205 (4%) Transit Management agencies to an Arterial Management agency. |

| Link | From/To | Description | Survey Response |
|---|---|---|---|
| 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 9 of the 121 (7%) Freeway Management agencies. |
| 18 | Electronic Toll Collection to Arterial Management (ETC equipped vehicles as probes) | Vehicles equipped with ETC tags are monitored by Arterial Management to determine arterial travel speeds or travel times. | ETC equipped vehicles are used as probes by 5 of the 445 (1%) Arterial Management 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 60 of the 121 (50%) 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 64 of the 121 (53%) Incident Management agencies. |
| 23 | Highway-Rail Intersections 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 25 of the 445 (6%) Arterial Incident Management agencies (Arterial Management 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. | 248 of the 445 (56%) Arterial Management Agencies have signals that adjust timing in response to train crossing. |

| Link | From/To | Description | Survey Response |
|---|---|---|---|
| 25 | Incident Management intra-component | Agencies participating in formal working agreements or Incident Management plans coordinate incident detection, verification, and response. | 422 of the 878 (48%) 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. | 131 of the 445 (29%) Arterial Management agencies share data with another Arterial Management agency. |
| 28 | Electronic Toll Collection intra-component | ETC agencies share a common toll tag for the purpose of facilitating “seamless” toll transactions. | 44 of the 71 (62%) Toll Collection agencies use a common toll tag. |
| 29 | Transit Management to Incident Management | Transit agencies notify Incident Management agencies of incident locations, severity, and type. | Incident information is provided by 113 of the 205 (55%) 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. | 54 of the 121 (45%) 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 by-product 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 35 presents an overview of the integration links that define Traveler Information Integration. Arterial management information is only rarely made available to travelers. On the other hand, transit information, particularly schedule information, is widely available. Information on incidents is also widely disseminated.

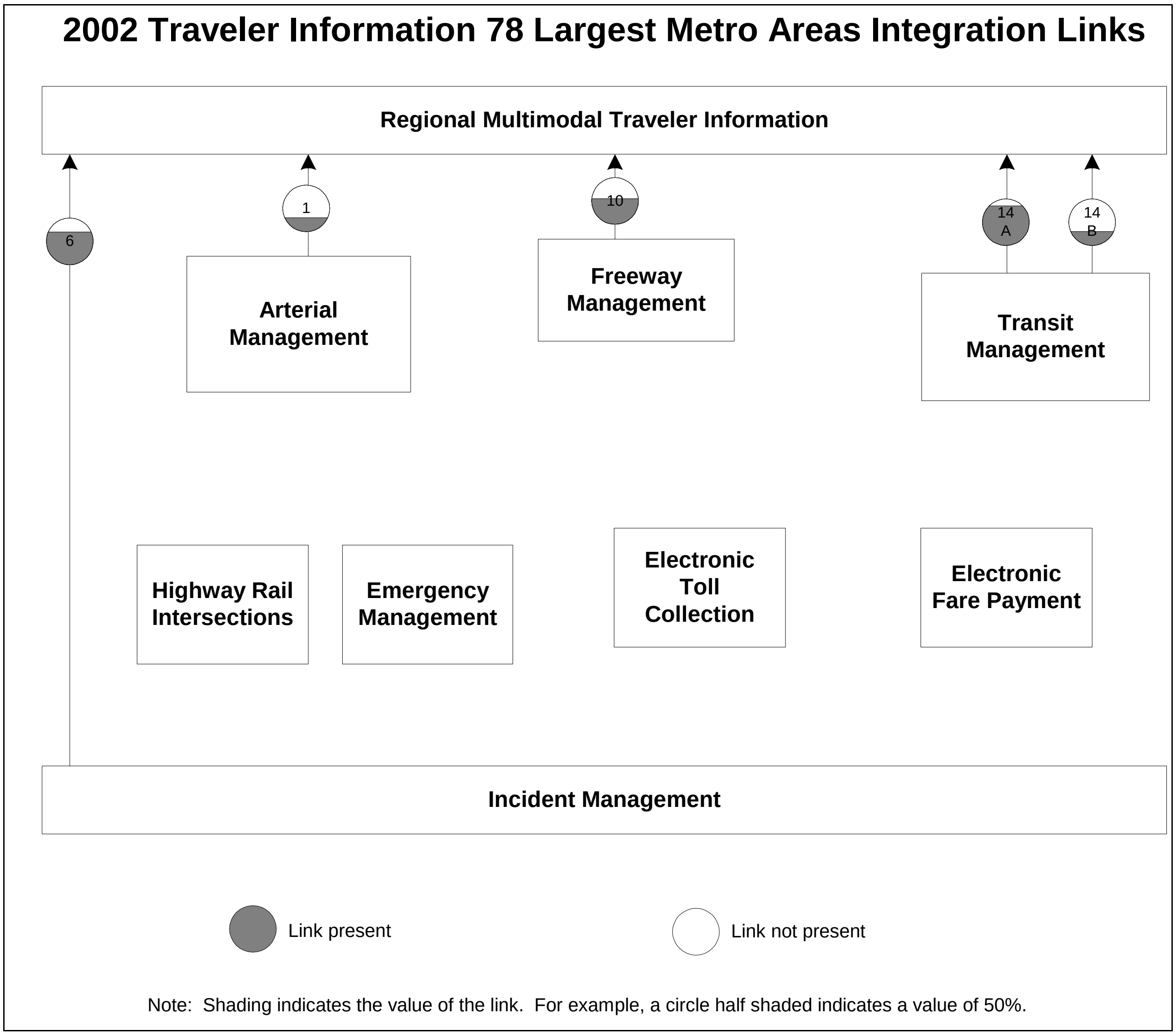



**Figure 35 Traveler Information Integration Links**

Table 2 presents a description of each of these links along with a summary of the survey results for each link.

**Table 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 112 of the 445 (25%) of the Arterial Management 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 for 85 of the 121 (70%) 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 65 of the 121 (54%) 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 167 of the 205 (81%) 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 60 of the 205 (29%) 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 36 presents an overview of the integration links that define Transit Management Integration. Overall, transit agencies are not well integrated into the ITS information infrastructure.

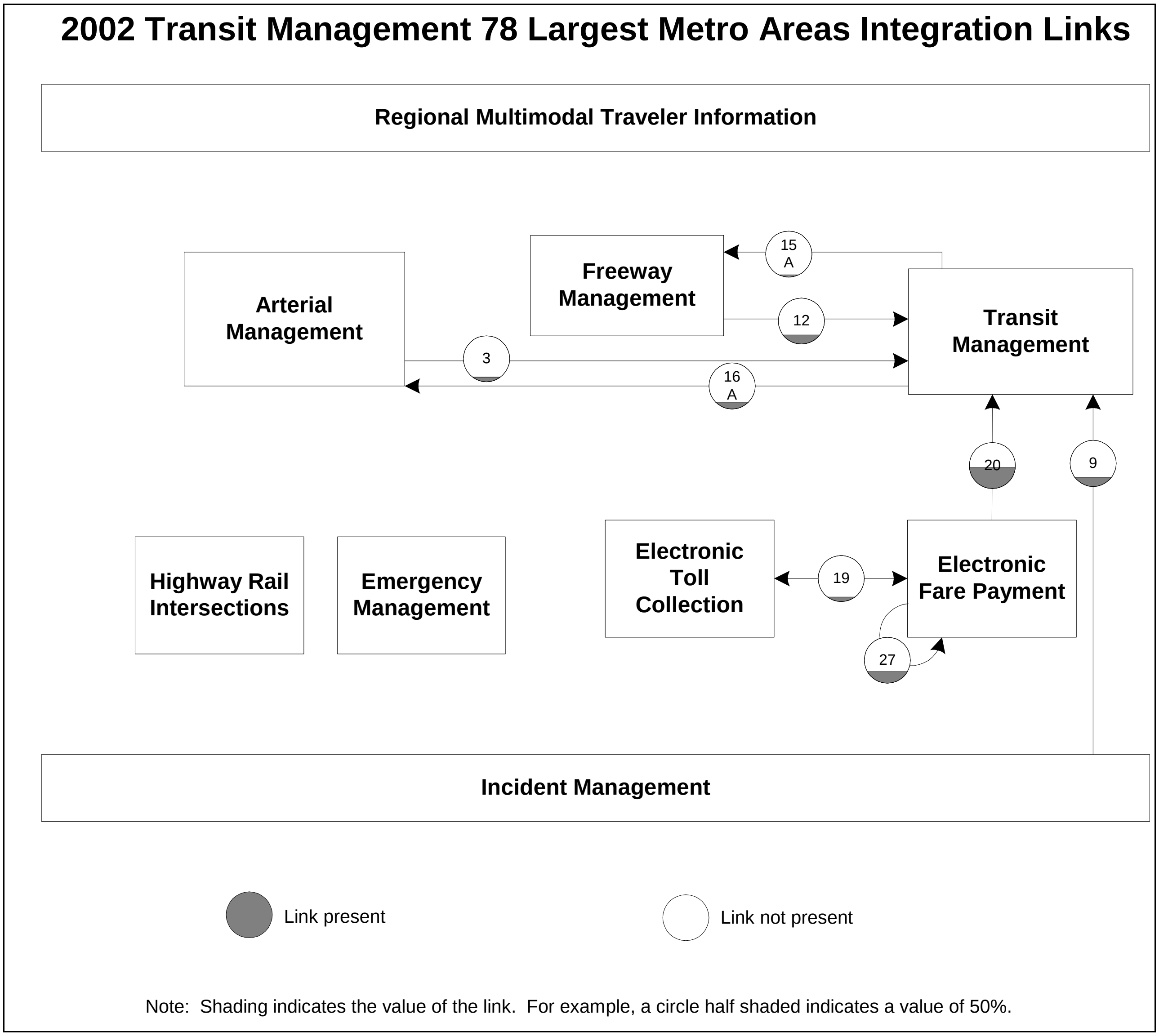



**Figure 36 Transit Management Integration Links**

Table 3 presents a description of each of these links along with a summary of the survey results for each link.

**Table 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 43 of the 445 (10%) Arterial Management 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 24 of the 121 (20%) 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 24 of the 121 (20%) 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 4 of the 205 (2%) 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 27 of the 205 (13%) Transit Management agencies. |
| 19 | Electronic Toll Collection to Electronic Fare Payment | Transit operators accept ETC-issued tags to pay for transit fares. | 11 of the 205 (5%) 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 85 of the 205 (41%) Transit Management agencies. |

| Link | From/To | Description | Survey Response |
|---|---|---|---|
| 27 | Electronic Fare Payment intra-component | Operators of different public transit services share common EFP media. | 42 of the 205 (20%) 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 Response Integration increases emergency response capabilities through improved incident notification from Incident Management and traffic signal preemption provided by Arterial Management.  Figure 37 presents an overview of the integration links that define Emergency Response Integration.

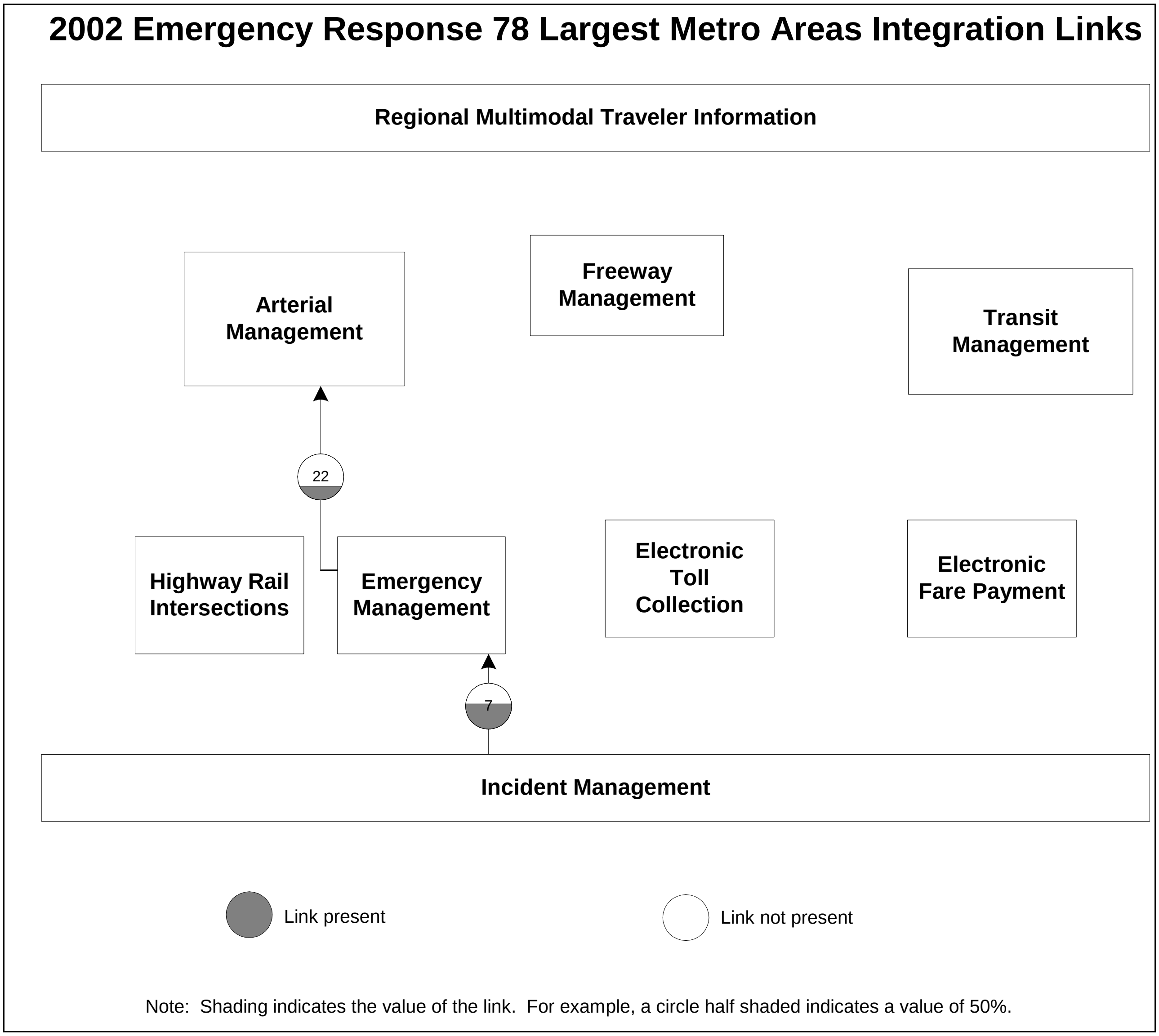



**Figure 37 Emergency Response Integration Links**

Table 4 presents a description of each of these links along with a summary of the survey results for each link.

**Table 4 Emergency Response 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 62 of the 121 (51%) 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 226 of the 878 (26%) Emergency Management agencies. |

**Summary Deployment Indicators for Medium-Sized Cities**

The summary indicators for the medium-sized cities surveyed are presented in Figure 38. The highest rate of deployment is for Emergency Management, followed by Transit Management, and Arterial Management. Freeway Management is lightly deployed in medium-sized cities, but substantial growth is projected.

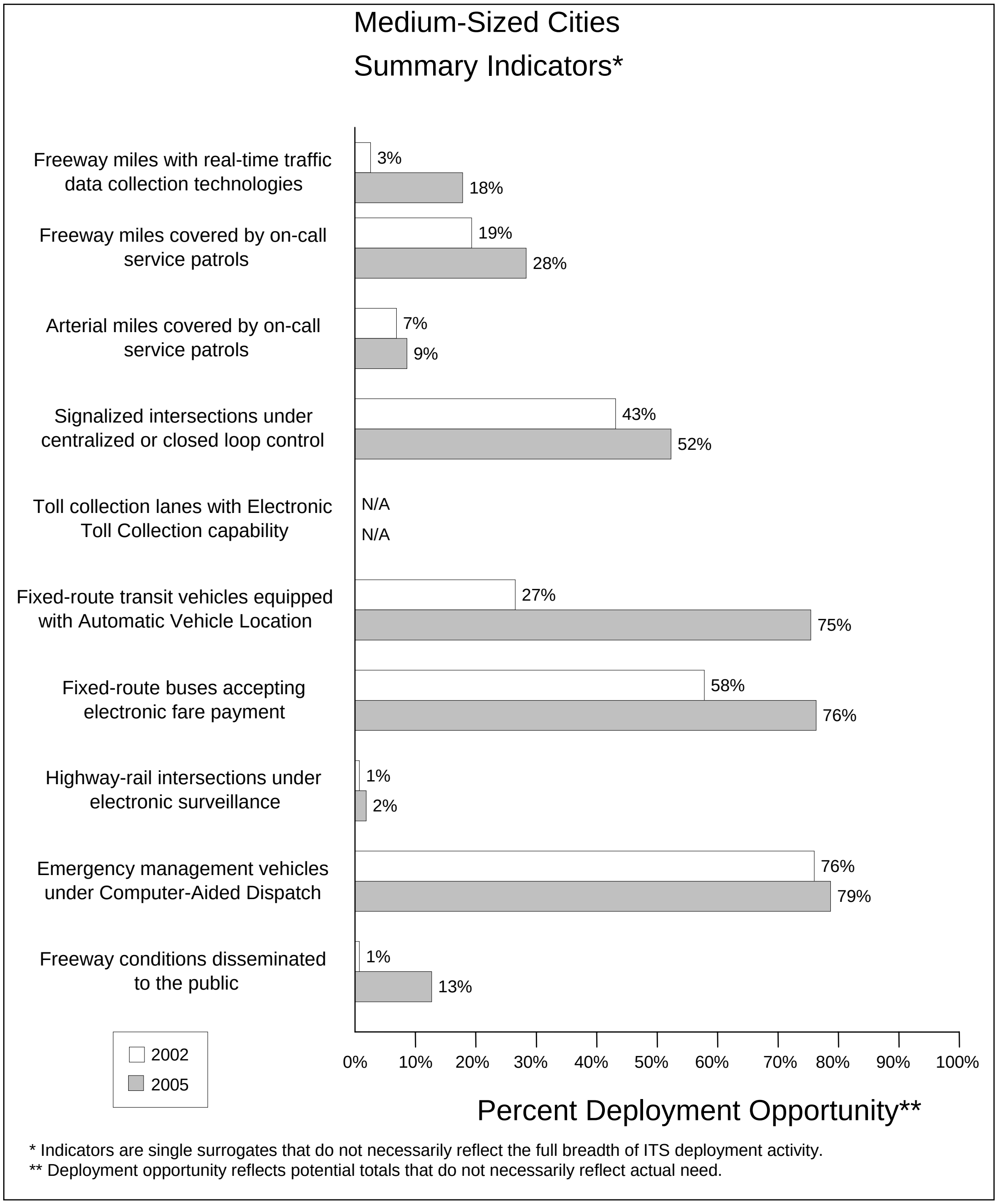



**Figure 38 Medium-Sized Cities Summary Indicators**

*Freeway Management*

Figure 39 summarizes the level of Freeway Management in the medium-sized cities surveyed. The results indicate that only a limited level of freeway deployment is present in these areas. The most widely deployed technology is Highway Advisory Radio, followed by Variable Message Signs.

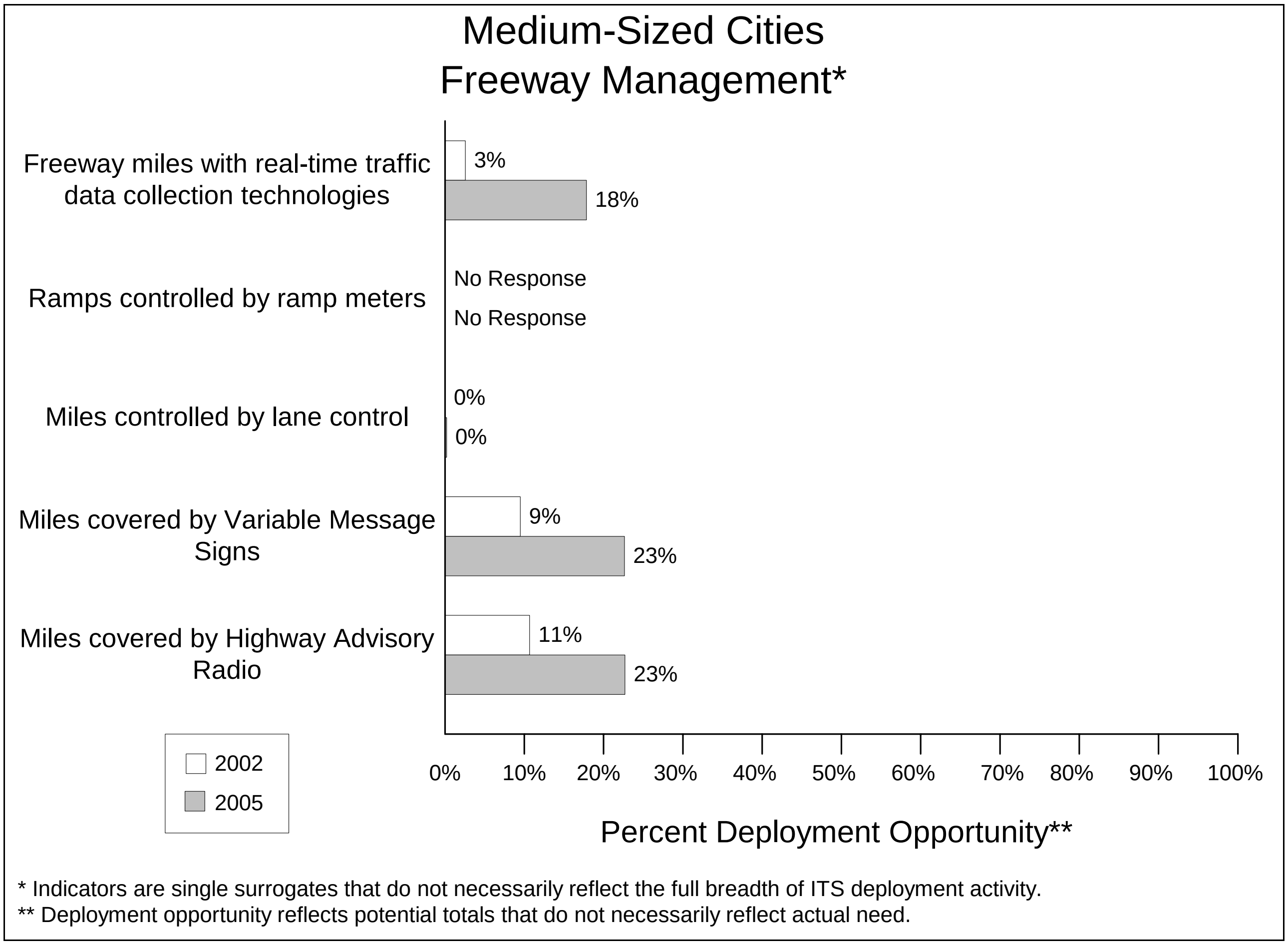



**Figure 39 Medium-Sized Cities Freeway Management Indicators**

*Incident Management*

Figure 40 summarizes the level of incident management in the medium-sized cities surveyed. Freeway Survey Patrols are deployed on nearly 20% of the freeway miles in these areas. Arterial incident management is lightly deployed in these areas, a result that is similar to that observed in the larger areas. The deployment of ITS on freeways in general is projected to increase markedly by 2005 in the medium-sized cities.

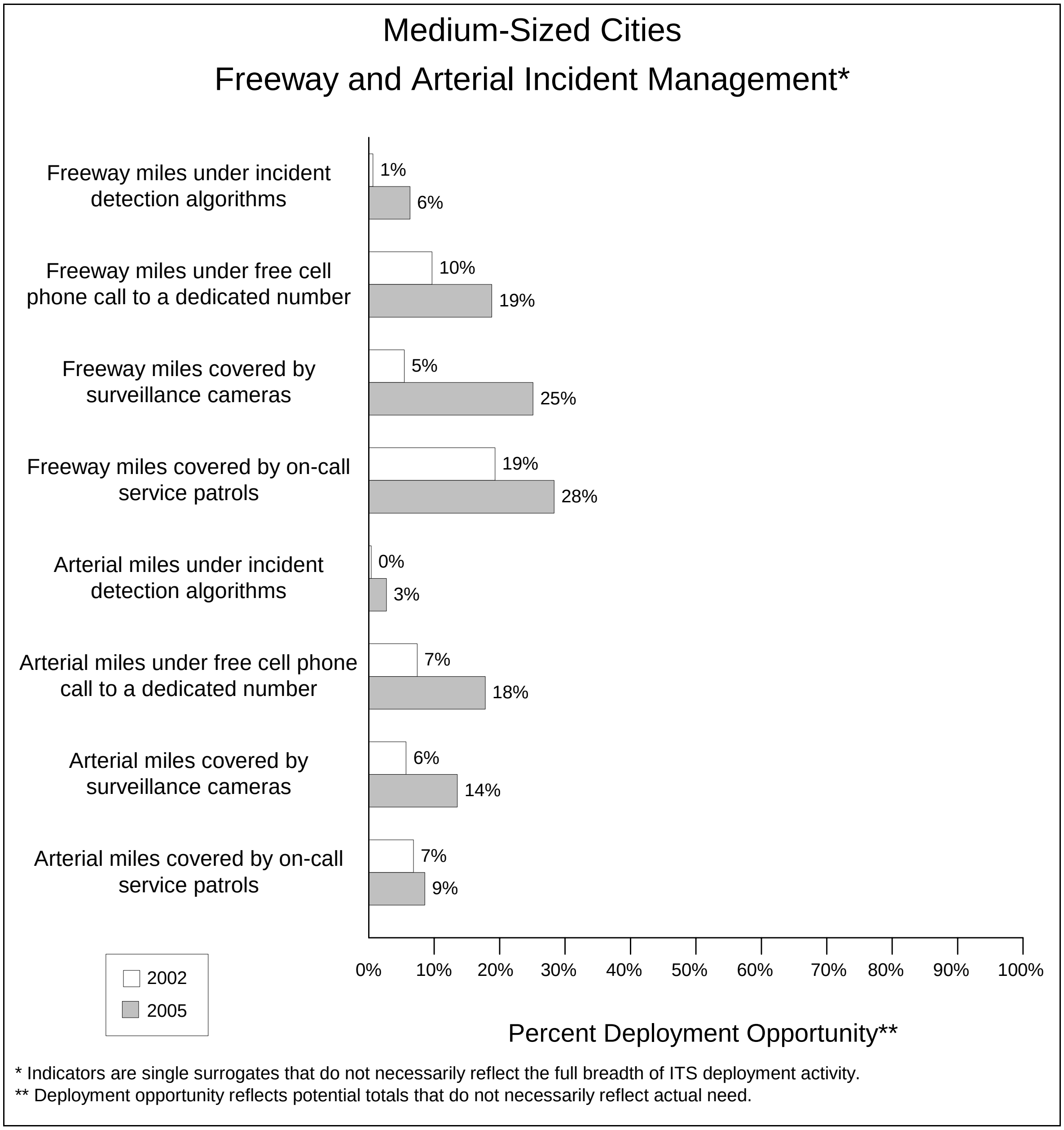



**Figure 40 Medium-Sized Cities Freeway and Arterial Incident Management Indicators**

### *Arterial Management*

Figure 41 indicates that Arterial Management is widely deployed in the medium-sized cities surveyed. A significant proportion of traffic signals are under centralized or closed loop control and a high proportion of intersections are covered by electronic surveillance.

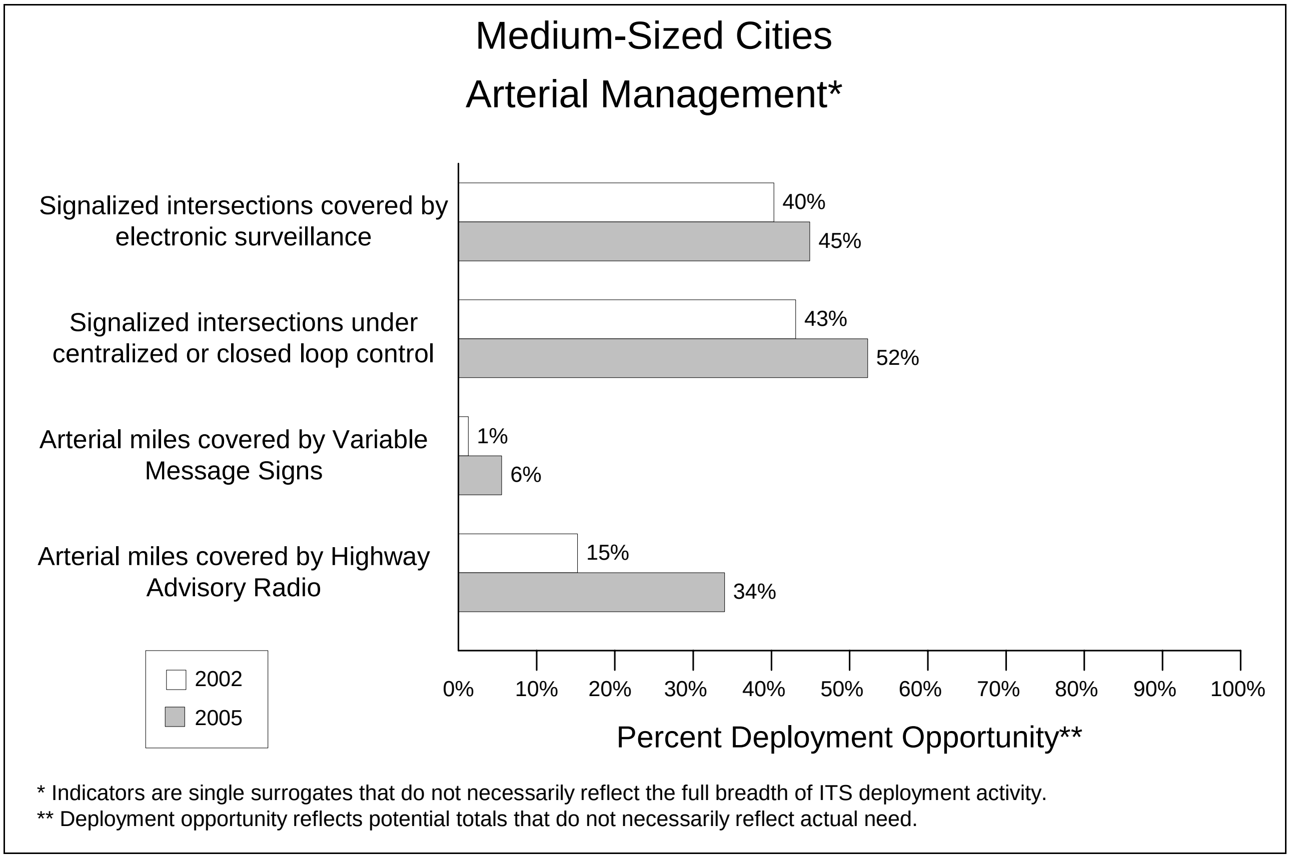



**Figure 41 Medium-Sized Cities Arterial Management Indicators**

### *Transit Management*

Figure 42 summarizes the level of Transit Management in the medium-sized areas. Nearly one-third of the paratransit vehicles operate under Computer-Aided Dispatch. Slightly over one-fourth of the vehicles are equipped with Automatic Vehicle Location. There is a large increase in deployment of ITS for transit projected for 2005 in medium sized cities.

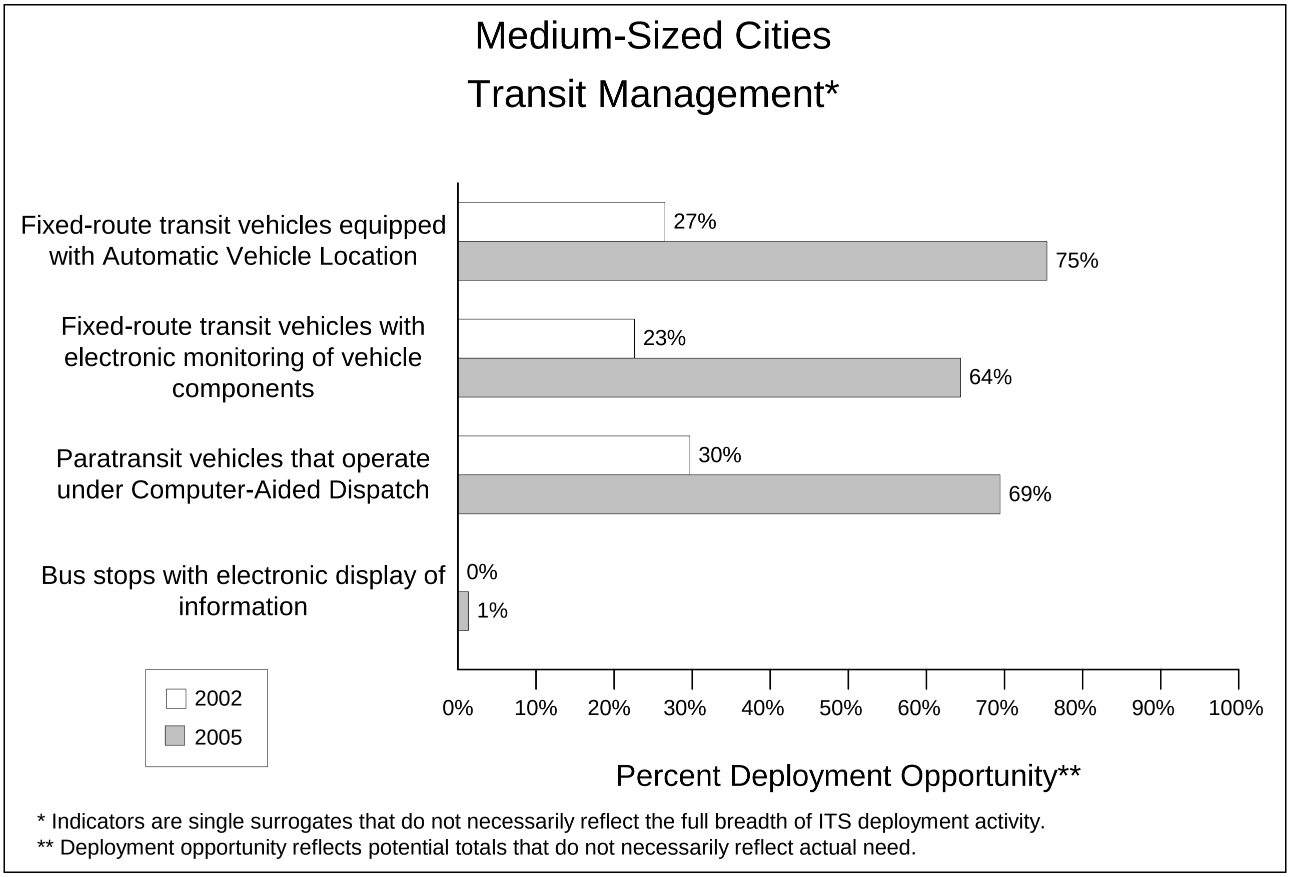



**Figure 42 Medium-Sized Cities Transit Management Indicators**

### *Electronic Fare Payment*

Figure 43 indicates that a significant proportion of vehicles are equipped with electronic fare payment capability in the medium-sized cities.

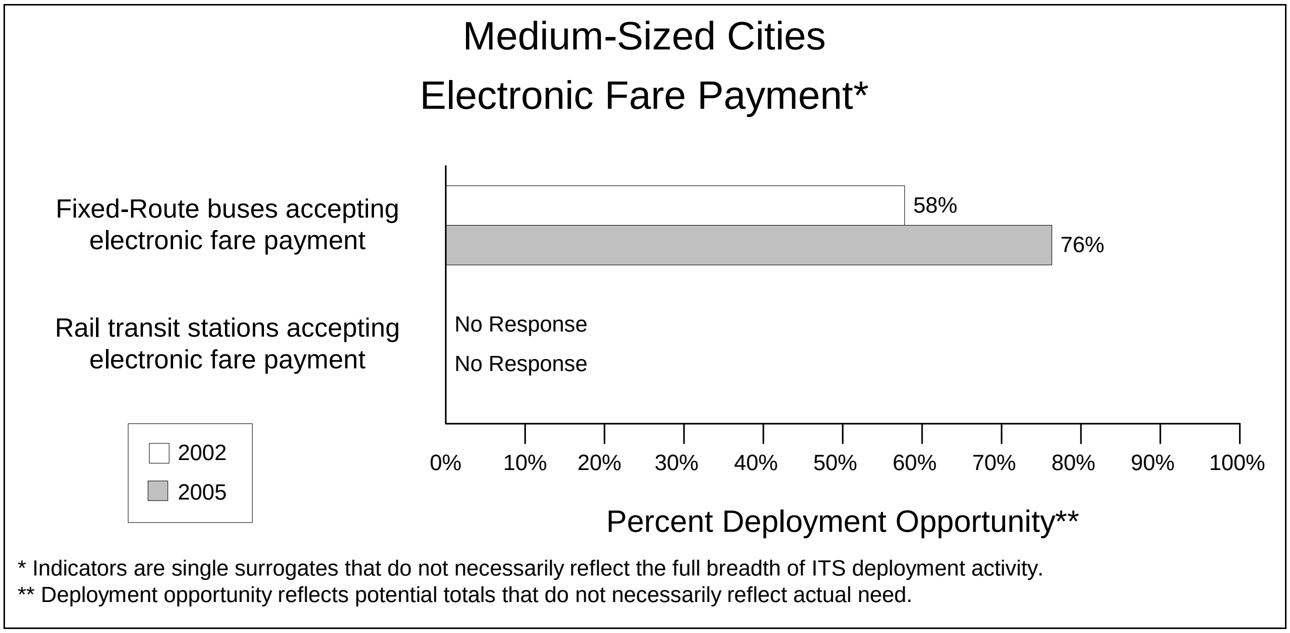



**Figure 43 Medium-Sized Cities Electronic Fare Payment Indicators**

### *Highway-Rail Intersections*

As presented in Figure 44, very few highway-rail intersections are under electronic surveillance in the medium-sized cities surveyed.

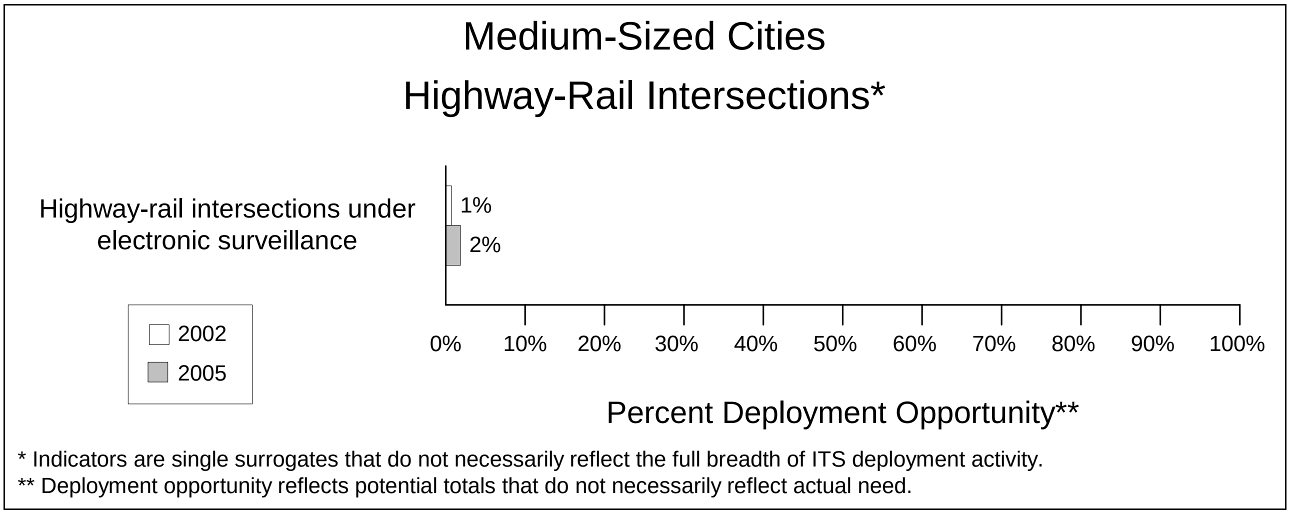



**Figure 44 Medium-Sized Cities Highway-Rail Intersections Indicators**

*Emergency Management*

Figure 45 shows that a large proportion of emergency management vehicles are equipped with Computer Aided Dispatch in the medium-sized areas.

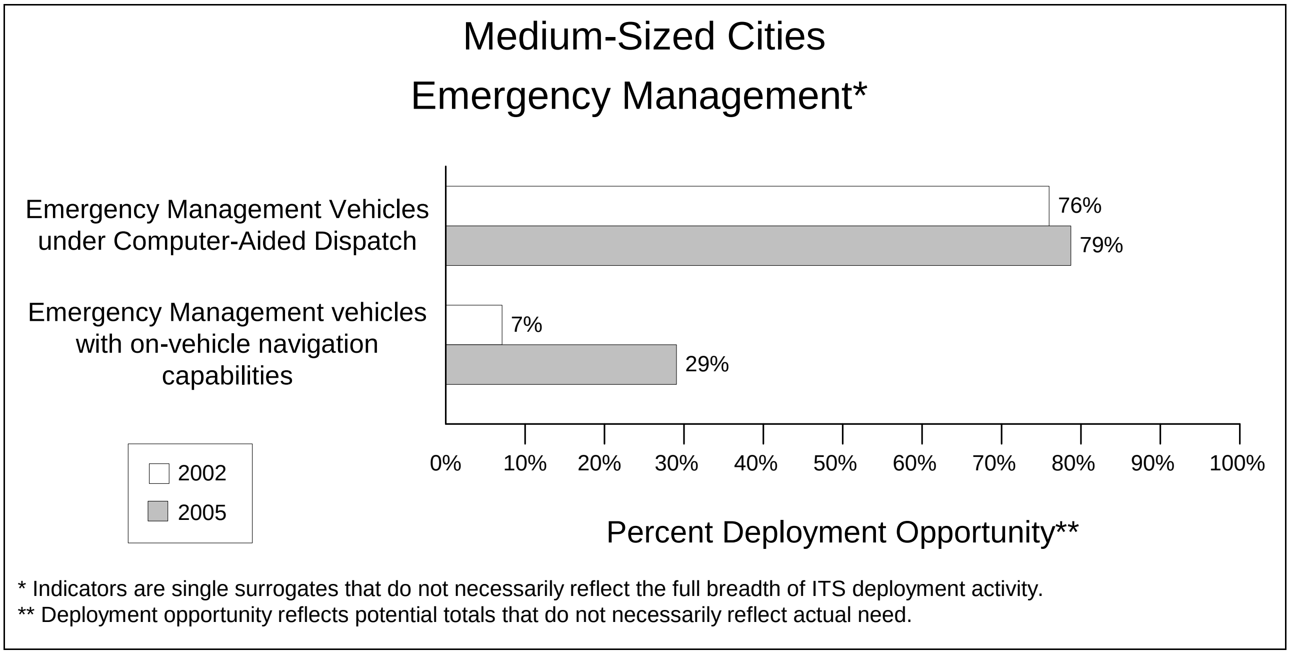



**Figure 45 Medium-Sized Cities Emergency Management Indicators**

### *Regional Multimodal Traveler Information*

Figure 46 summarizes the level of Regional Multimodal Traveler Information in medium-sized areas surveyed. The results indicate that several media are used to distribute traveler information in these areas.

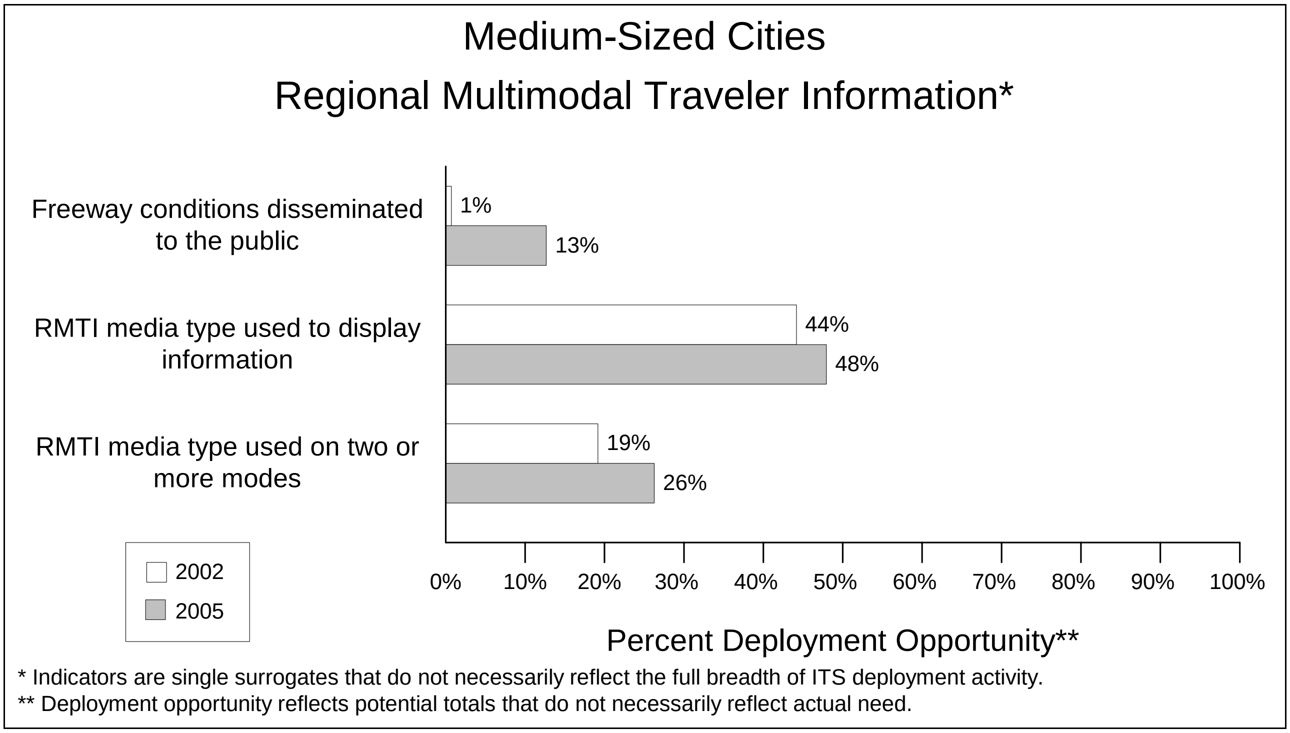



**Figure 46 Medium-Sized Cities Regional Multimodal Traveler Information Indicators**

### *Electronic Toll Collection*

No toll collection agencies operate in the medium-sized areas surveyed.

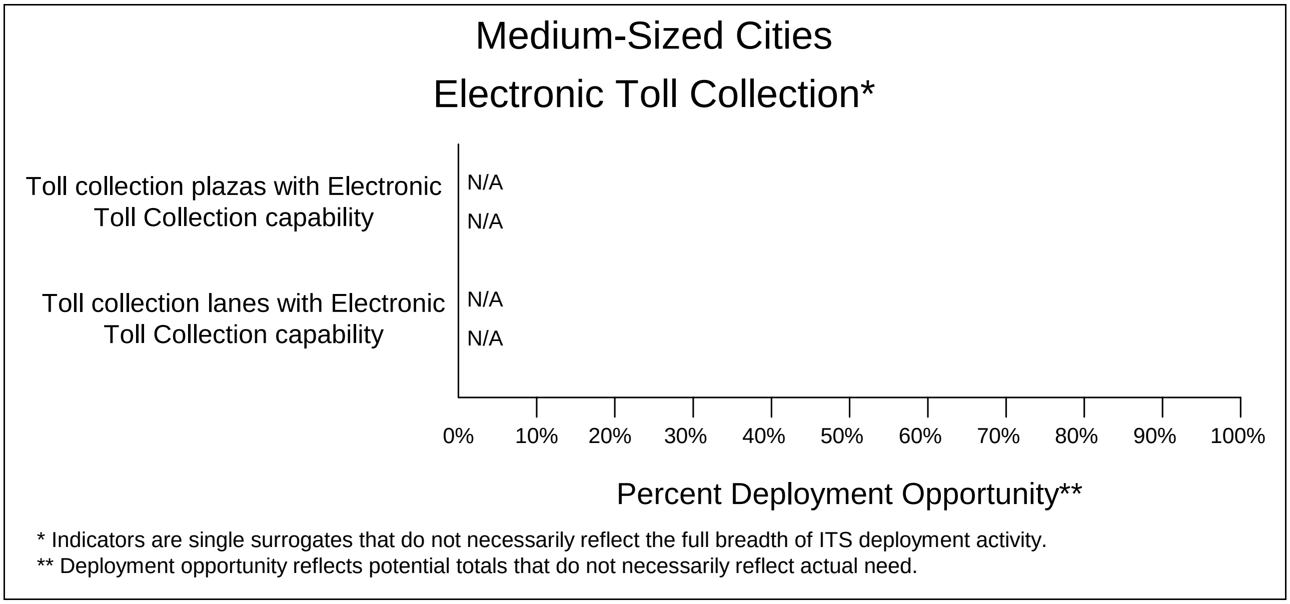



**Figure 47 Medium-Sized Cities Electronic Toll Collection Indicators**

## Integration Indicators for Medium-Sized Cities

Figure 48 summarizes the level of integration in the medium-sized areas surveyed. The highest levels of integration appear between Incident Management and Emergency Management. The results are comparable to those seen for the major metropolitan areas, including the poor integration between transit, arterial, and freeway agencies.

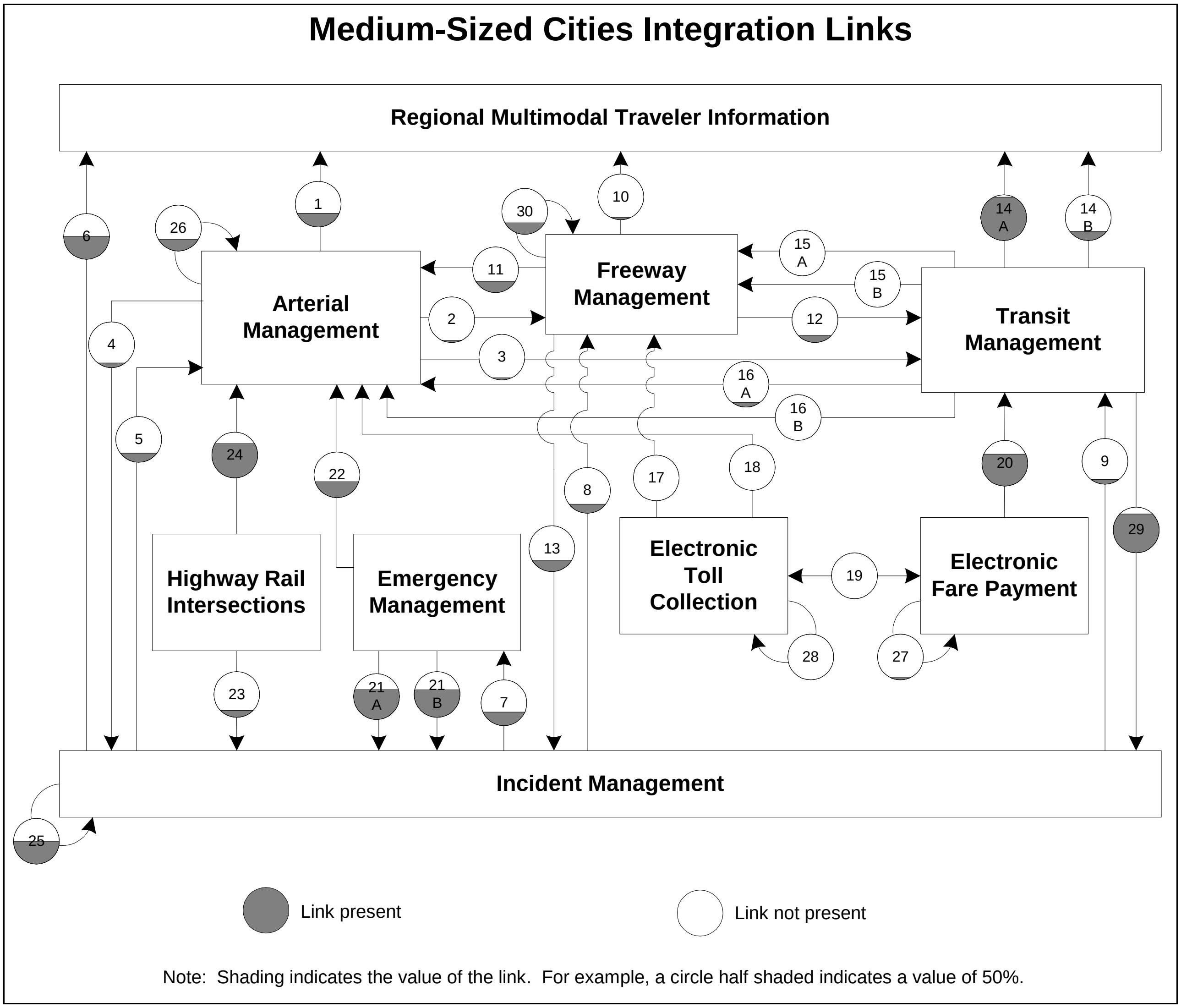



**Figure 48 Medium-Sized Cities Integration Indicators**

## Comparison of Medium-Sized and Major Metropolitan areas

Overall, how do these results compare to those for major metropolitan areas? Table 5 shows a comparison of the deployment summary indicators for the 78 major metropolitan areas and the 30 medium-sized areas for 2002. These results show that agencies involved with emergency management, arterial management, and transit in medium-sized cities deploy similarly to those in larger cities. There is a marked difference, however, in the level of deployment of technologies on freeways. This is clear for both electronic surveillance as well as service patrols on freeways.

**Table 5 Comparison of Large and Medium-Sized Metropolitan Areas**

| System/ Component | Large | Medium | Similar? |
|---|---|---|---|
| | % Deployed | | |
| EMS vehicles under CAD | 73% | 76% | YES |
| Buses equipped with Electronic Fare Payment | 51% | 51% | YES |
| Freeway miles covered by service patrols | 50% | 19% | NO |
| Number of signalized intersections under computer control | 49% | 43% | YES |
| Buses equipped with Automatic Vehicle Location | 35% | 28% | YES |
| Freeway miles under electronic surveillance | 30% | 3% | NO |
| Freeway conditions disseminated to the public | 30% | 1% | NO |
| Arterial miles covered by service patrols | 9% | 7% | YES |
| HRI under electronic surveillance | 11% | 1% | NO |

## Summary Deployment Indicators for Tourist Cities

Figure 49 contains a summary of the level of deployment in the tourist cities surveyed. The highest levels of deployment appear in Arterial Management and Emergency Management, which are comparable to those seen in the larger cities surveyed.

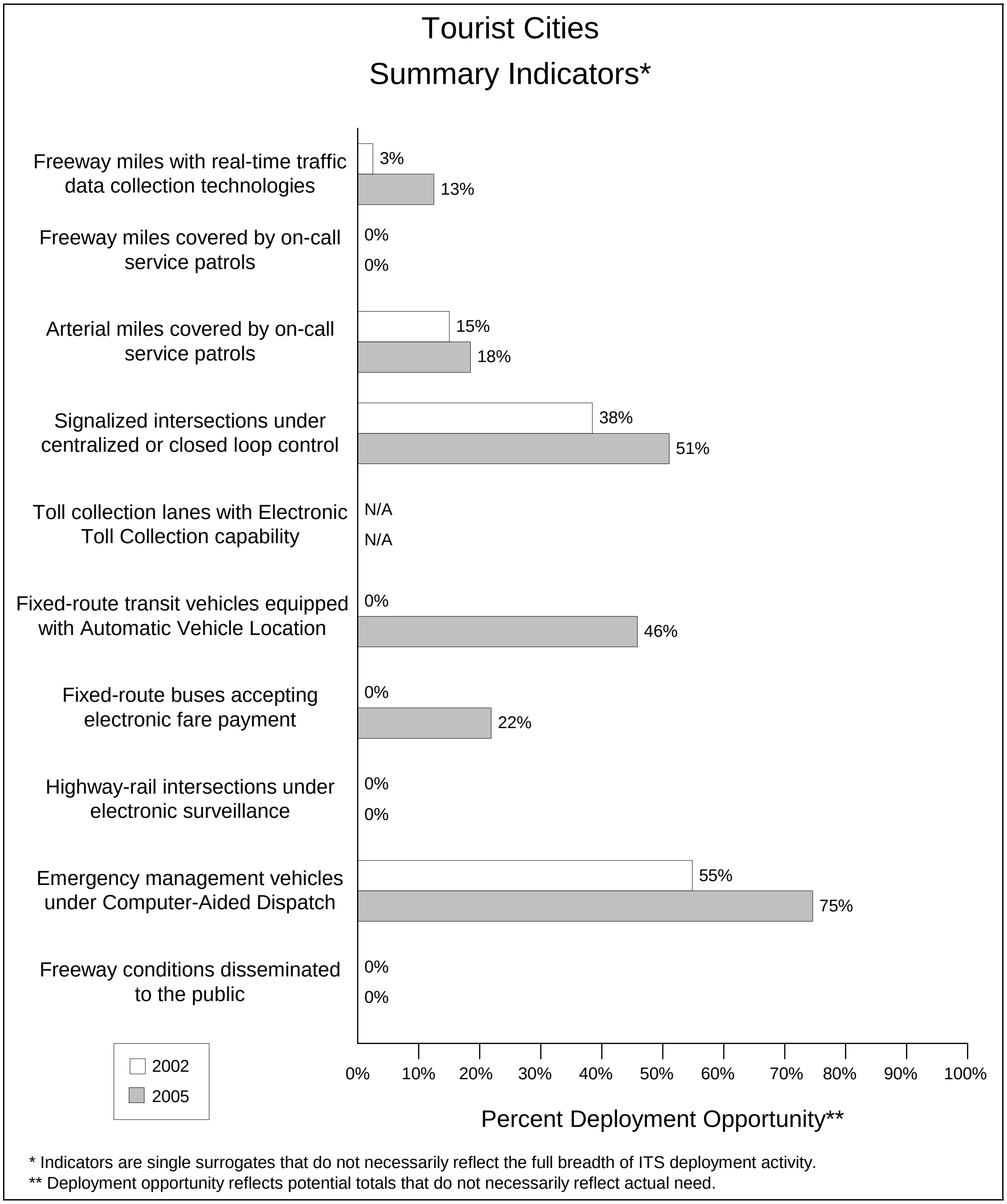



**Figure 49 Tourist Cities Summary Indicators**

### *Freeway Management*

As shown in Figure 50, Highway Advisory Radio covers one-half of all the freeway miles in the tourist cities surveyed. Little other deployment is evident in this area.

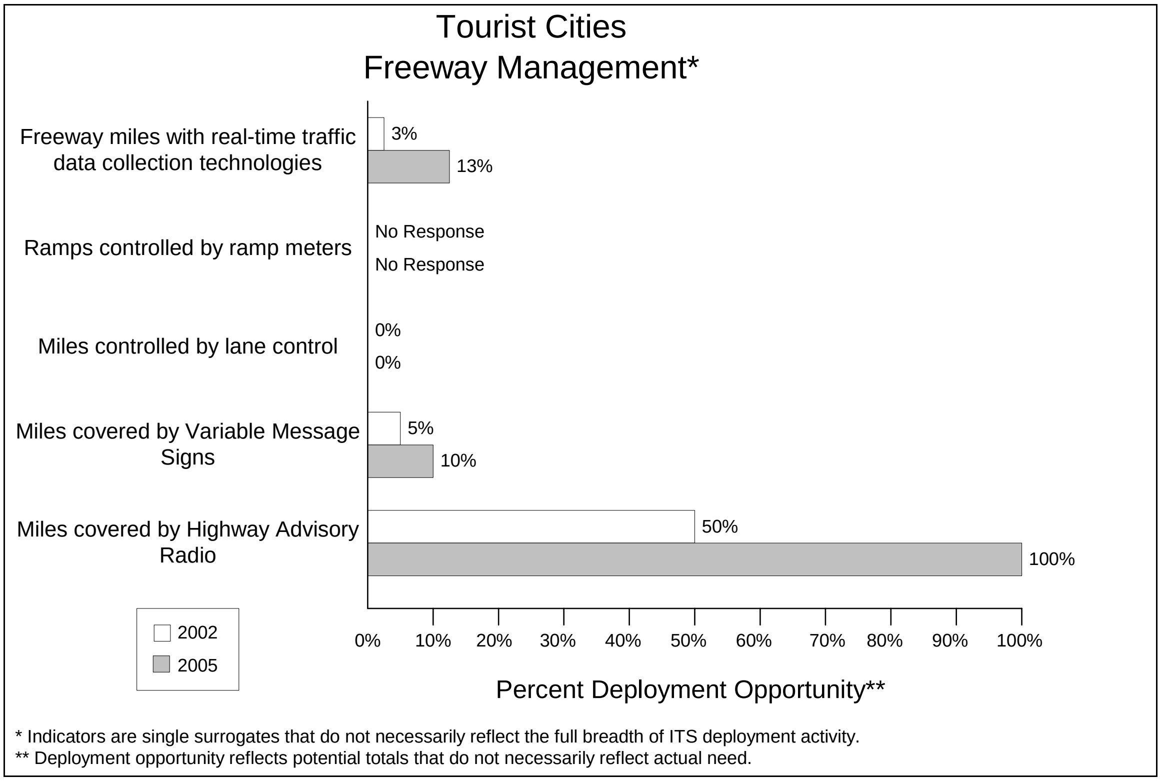



**Figure 50 Tourist Cities Freeway Management Summary Indicators**

*Incident Management*

Figure 51 summarizes the level of freeway and arterial incident management in the tourist cities. Deployment of service patrols on arterials is unexpectedly high and is higher than both major metropolitan and medium-sized cities surveyed. Freeway Incident Management is low when compared to Arterial Incident Management.

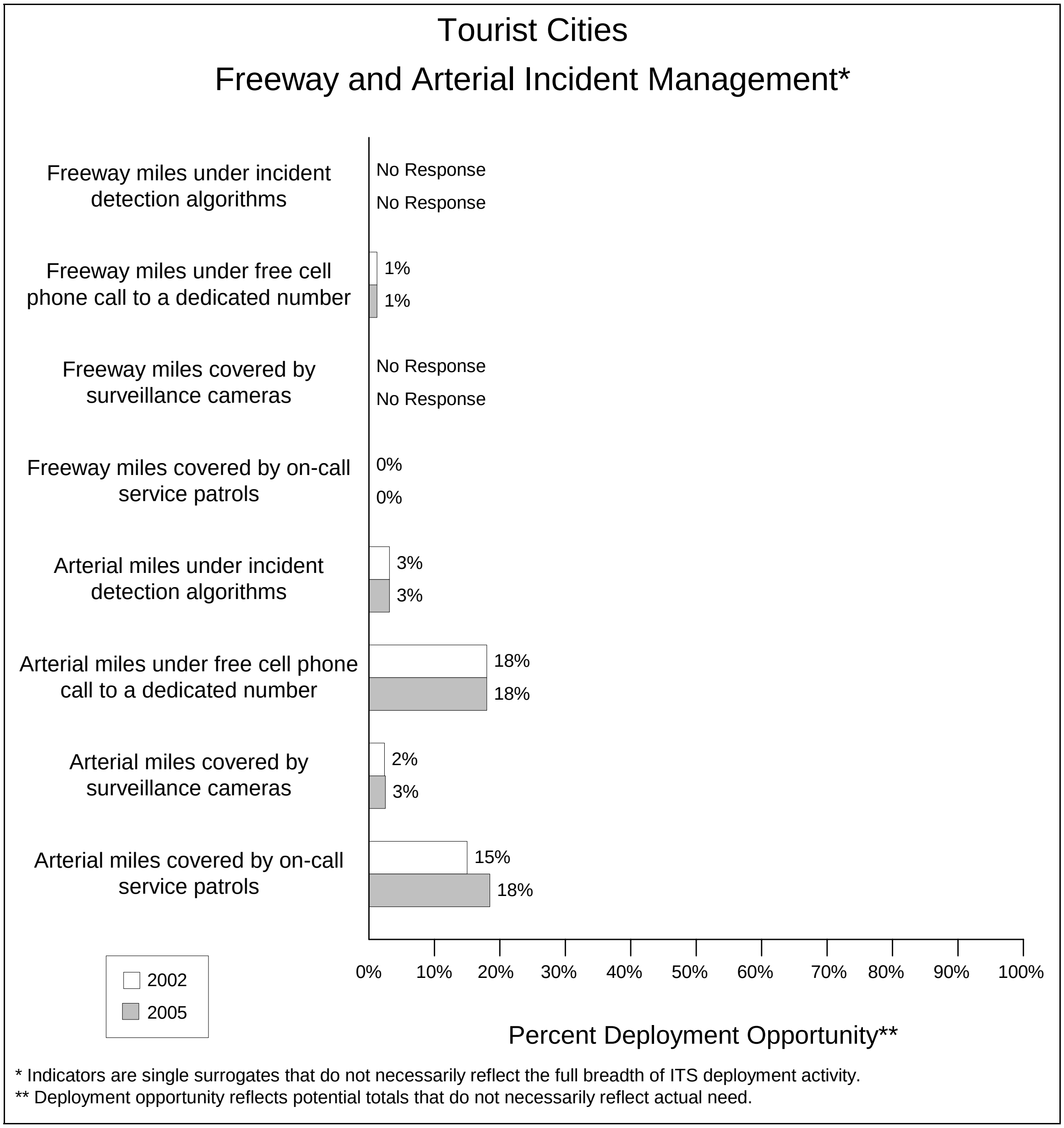



**Figure 51 Tourist Cities Freeway and Arterial Incident Management Summary Indicators**

### *Arterial Management*

Figure 52 shows that deployment of ITS technology on arterials is well established in the tourist areas surveyed. Half of the signalized intersections are under electronic surveillance and more than one-third of the signalized intersections are under centralized or closed loop control.

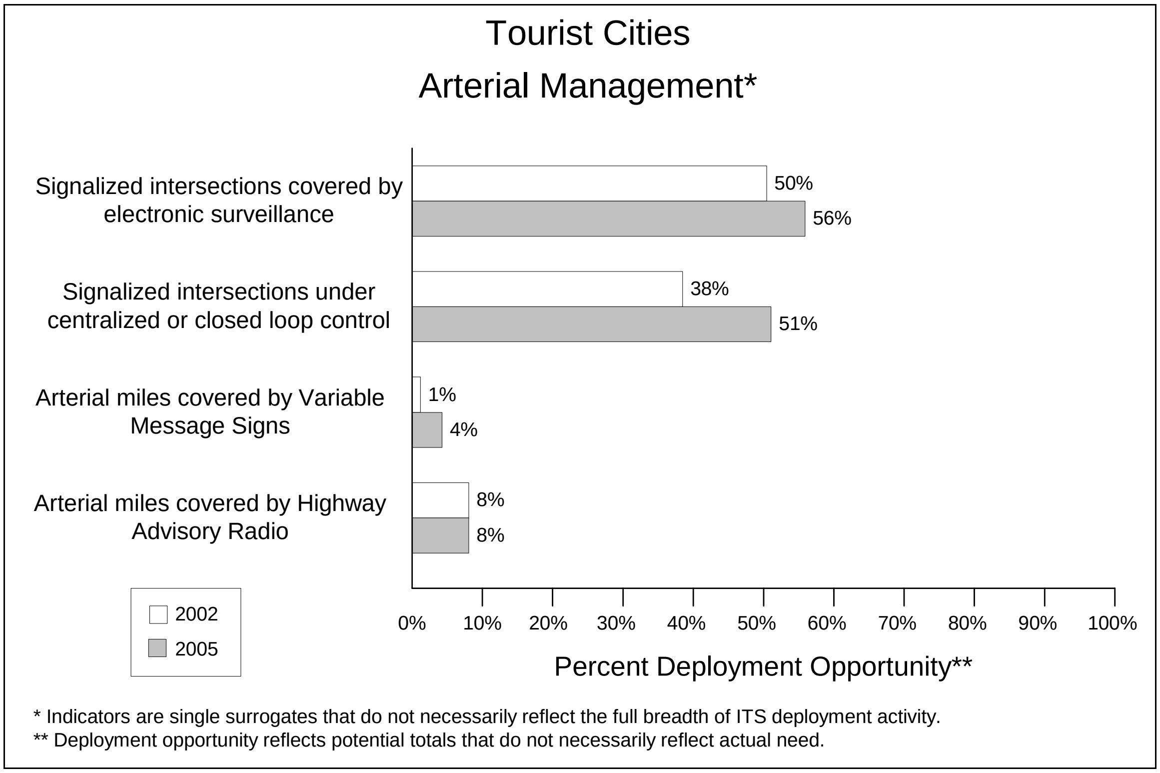



**Figure 52 Tourist Cities Arterial Management Summary Indicators**

### *Transit Management*

Figure 53 shows that slightly over one-fourth of paratransit vehicles are equipped with Computer Aided Dispatch. A large increase in deployment of ITS technology for transit is projected for 2005.

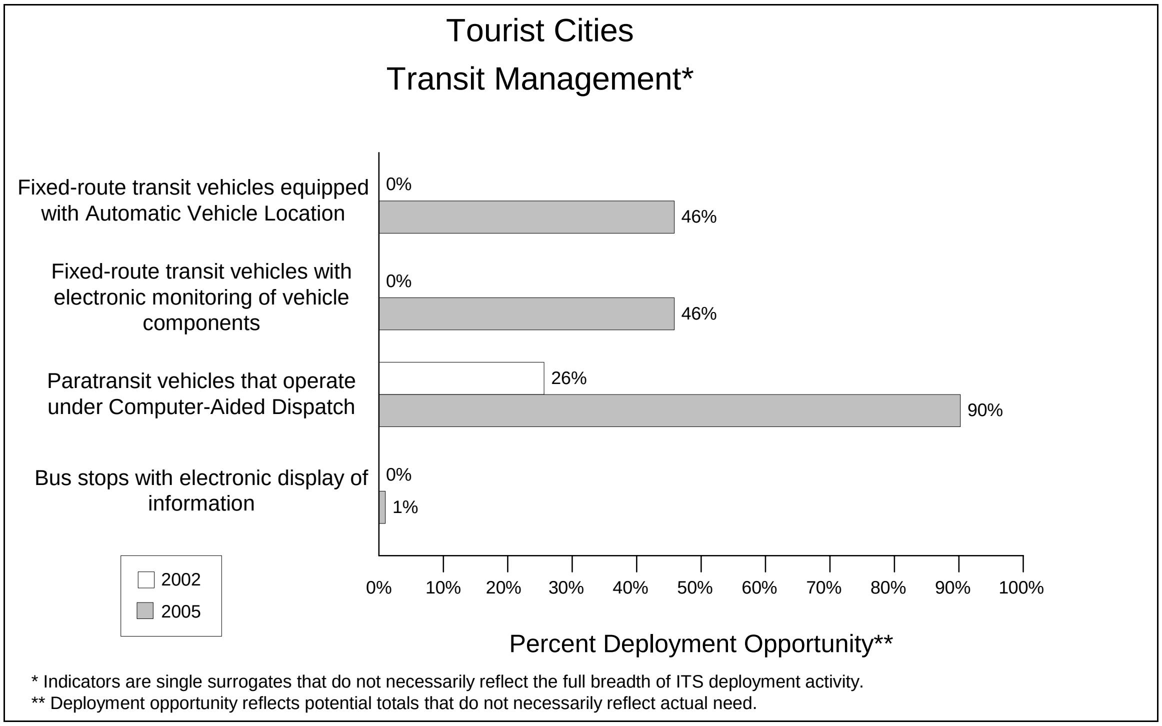



**Figure 53 Tourist Cities Transit Summary Indicators**

### *Electronic Fare Payment*

As presented in Figure 54, no Electronic Fare Payment capabilities are deployed in the tourist cities surveyed, although this technology is projected to be deployed significantly by 2005.

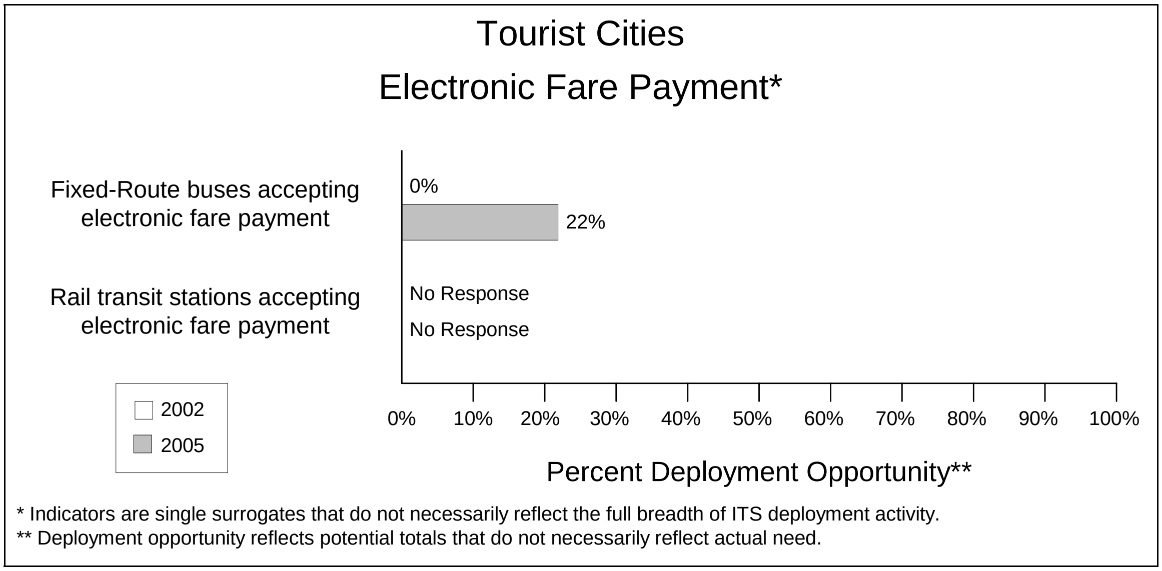



**Figure 54 Tourist Cities Electronic Fare Payment Summary Indicators**

### *Highway Rail Intersections*

As presented in Figure 55, no Highway Rail electronic surveillance capabilities are deployed in the Tourist cities surveyed.

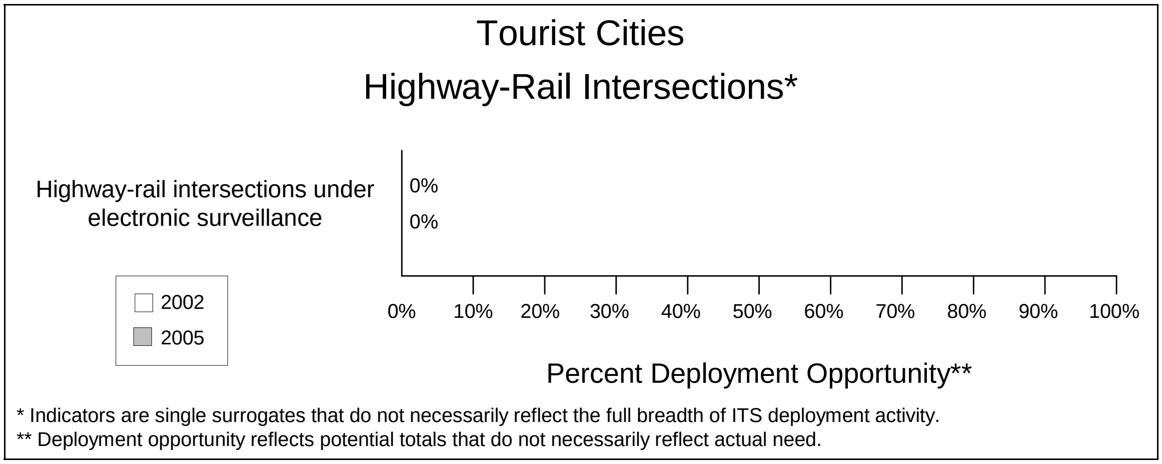



**Figure 55 Tourist Cities Highway-Rail Intersections Summary Indicators**

### *Emergency Management*

Figure 56 shows a high level of deployment of emergency vehicles equipped with Computer Aided Dispatch.

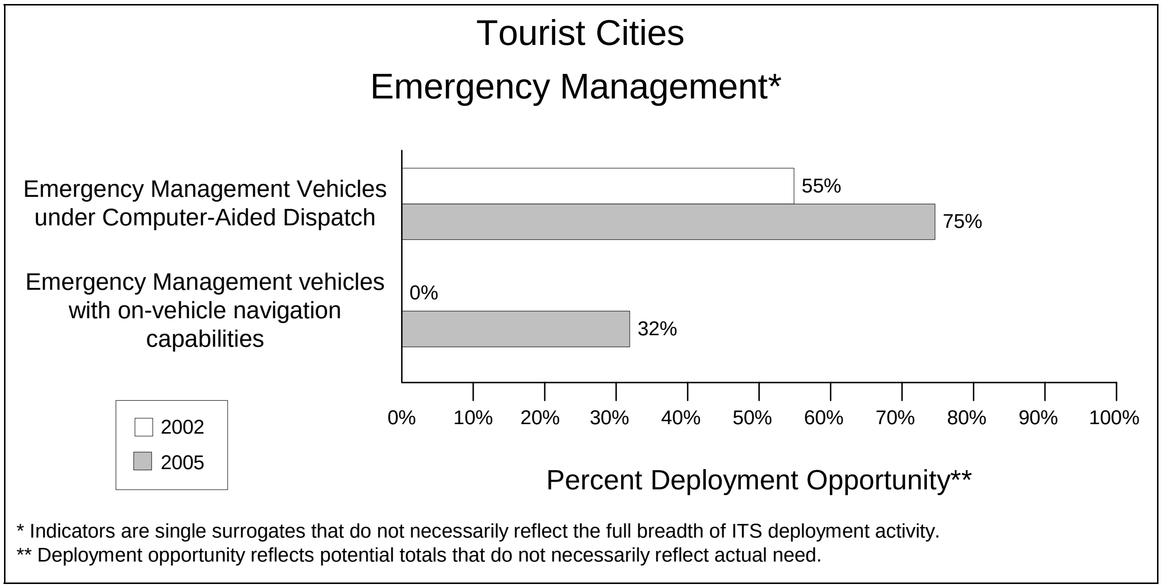



**Figure 56 Tourist Cities Emergency Management Summary Indicators**

### *Regional Multimodal Traveler Information*

Several types of media are used to distribute traveler information in tourist cities as summarized in Figure 57. No freeway information is distributed, however.

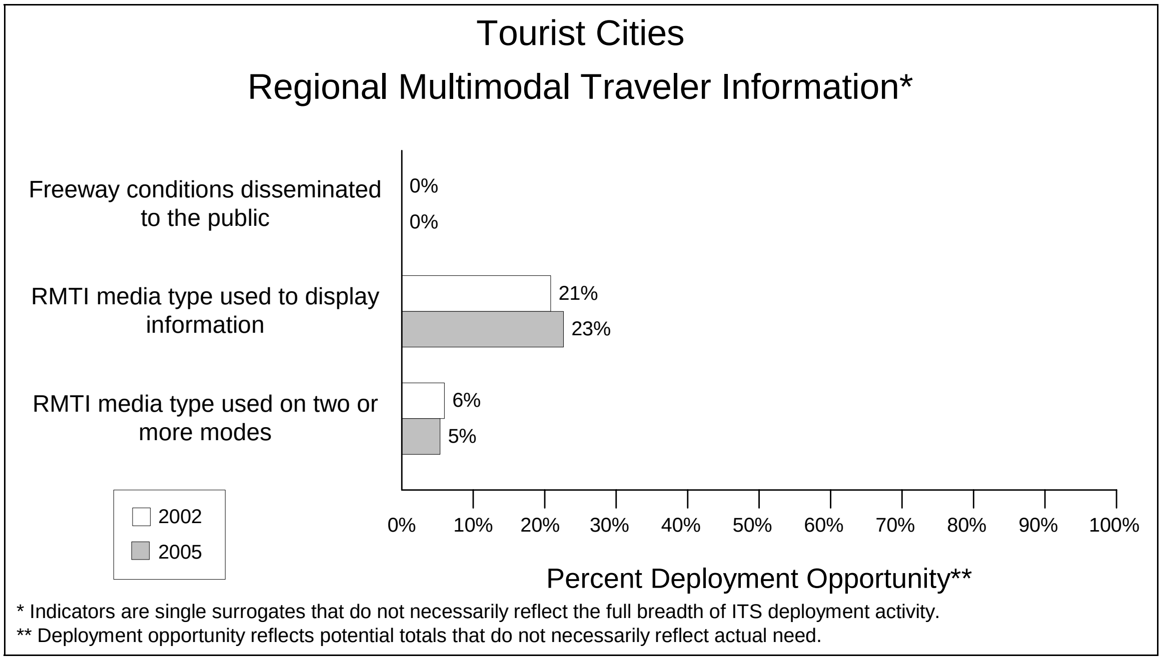



**Figure 57 Tourist Cities Regional Multimodal Traveler Information Summary Indicators**

### *Electronic Toll Collection*

As shown in Figure 58, no Electronic Toll Collection capabilities are deployed in the tourist cities surveyed.

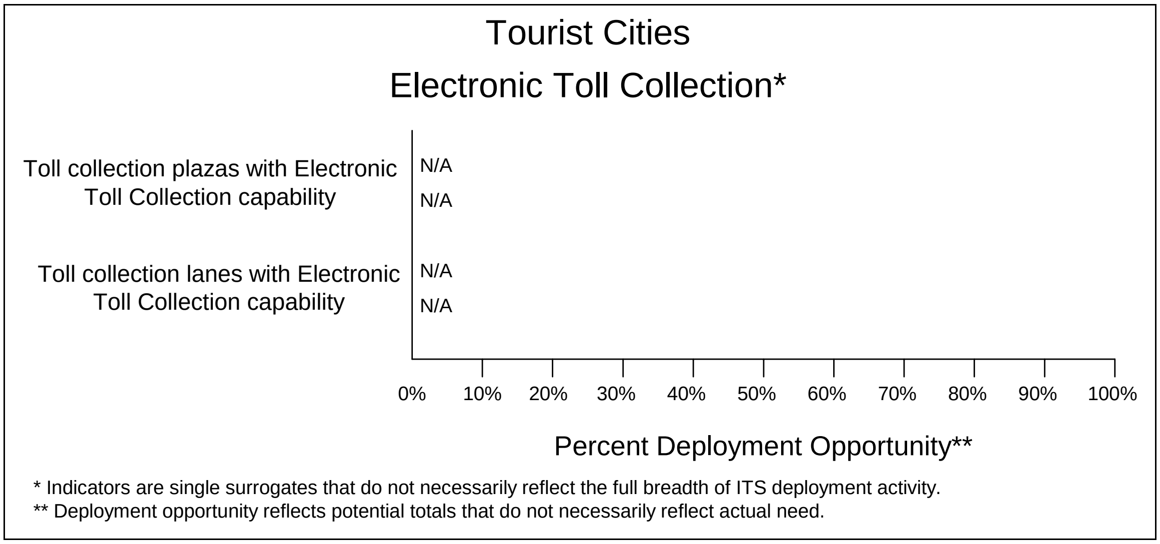



**Figure 58 Tourist Cities Electronic Toll Collection Summary Indicators**

## Integration Indicators for Tourist Cities

Figure 59 shows that integration among components within the tourist cities surveyed is quite limited, and mainly focused on information dissemination.

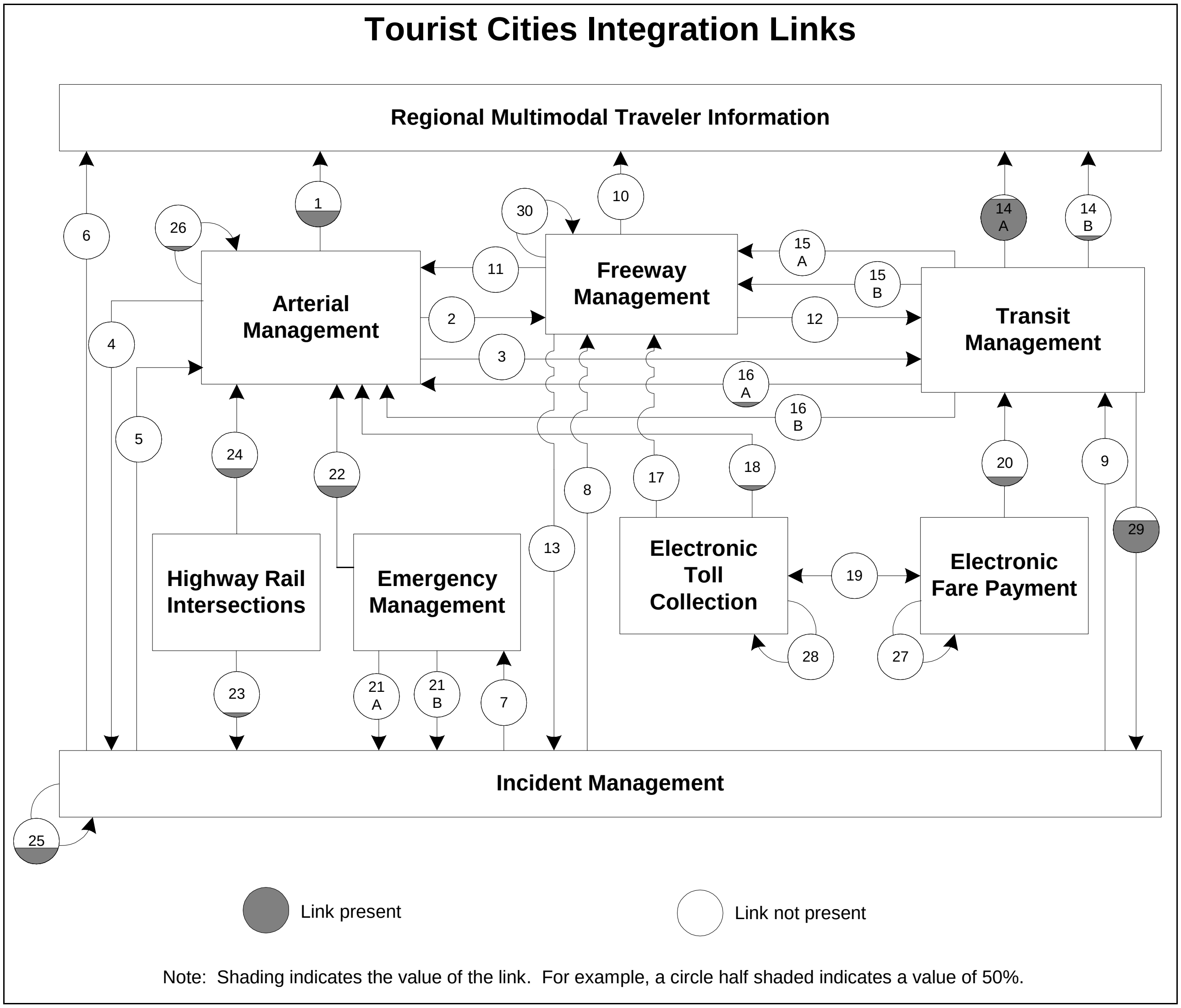



**Figure 59 Tourist Cities Integration Indicators**

## Conclusions

The 2002 survey results indicate that the adoption and deployment of key ITS technologies continue to advance in major cities. Deployment of freeway surveillance and closed circuit television cameras is advancing rapidly. The use of technology to support transit, public safety, arterial traffic management, and toll collection is also advancing apace. However, this good news is balanced by the lack of integration between key metropolitan agencies, which is the continuation of a long standing and disturbing trend. These results indicate that ITS technology is being deployed to improve efficiency and effectiveness of individual agencies, with less emphasis on using the real-time data and flexible control capabilities from ITS to create a regionally integrated transportation management system. The addition of medium and tourist cites to the survey makes it possible to draw additional conclusions. One of these conclusions is that deployment on freeways is closely tied to city size, with a marked difference shown between large and medium-sized metropolitan areas. The second conclusion is that with the exception of freeway management, agencies generally deploy similarly, regardless of the size of the metropolitan area in which they are located.

## Appendix A References


U.S. DOT (1996). *Building the ITI: Putting the National Architecture into Action.* http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/3qn01!.pdf, EDL# 4847.

U.S. DOT (1993). *Highway Performance Monitor Guide Field Manual*.

U.S. DOT (1996). *Intelligent Transportation Systems: The National Architecture, A Framework for Integrated Transportation into the 21st Century*. http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/3qn01!.pdf, EDL# 4847.

U.S. DOT (1995). *National Transit Database*. http://www.fta.dot.gov/transit_data_info_national_transit_db/614_ENG_HTML.html.

U.S. Department of Commerce (1993). *1990 Census of Population and Housing*.

To access an electronic version of this publication visit
the ITS Deployment Tracking Web Site at:
http://www.itsdeployment.its.dot.gov

Visit the
ITS Joint Program Office web site at:
http://www.its.dot.gov