Intelligent Transportation Systems
Early Deployment Planning Study

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New York State Department of Transportation
Lower Hudson Valley, Region 8

Intelligent Transportation Systems Early Deployment Planning Study

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EXECUTIVE SUMMARY

Project Location

The Intelligent Transportation Systems Early Deployment Study of the Lower Hudson Valley area focuses on the regional transportation network including freeways, arterial routes and the local and express bus and train systems in Westchester, Rockland, Putnam, Dutchess and Orange counties.

Purpose of the Project

The purpose of this study is to provide the framework for future implementation of Intelligent Transportation Systems (ITS) in the Lower Hudson Valley area. The focus of the planning study is the regional freeway system, major arterial routes and the regional transit system. The project will identify the appropriate ITS User Services and develop the Strategic Deployment Plan necessary to implement these user services. The process will build upon existing ITS initiatives and incorporate them into an overall regional plan. The end product will be a broad conceptual plan that will guide the future development of a real time transportation information system and regional transportation management system for the Lower Hudson Valley.

Goals

The general goals of ITS are to effectively manage the transportation system, to reduce congestion, to improve mobility and increase safety on the freeway and arterial roadway network and the regional transit system. For this project, five primary goals have been developed:

- Provide efficient use of the transportation network through the implementation of an Advanced Transportation Management System (ATMS).
- Improve communications to the users and providers of the transportation network by establishing an Advanced Traveler Information System (ATIS).
- Improve safety by reducing incident response and clearance times.
- Develop a funding plan or mechanism for ITS that is in line with expected benefits.
- Promote feed back and ongoing evaluation of the process.

Benefits of ITS

The benefits of Intelligent Transportation Systems (ITS) have been outlined in a report prepared by The MITRE Corporation entitled “Intelligent Transportation Infrastructure Benefits: Expected and Experienced”. This report was prepared for the Federal Highway Administration, and published in January 1996. The use of ITS technologies has demonstrated positive effects on several Measures of Effectiveness (MOEs). Below is a sample of several ITS initiatives and the associated benefits:

Expressway Traffic Management Systems

Decreases in travel times of 20% to 48%
Increases in travel speeds of 16% to 62%
Increases in freeway capacity of 17% to 25%
Decreases in accident rates of 15% to 50%
Decreases in fuel consumption during congestion of 41%
Annual decreases in emissions of 122,000 tons of carbon monoxide (CO)
Annual decreases in emissions of 1400 tons of hydro carbons (HC)
Annual decreases in emissions of 1200 tons of nitrous oxide (NOx)

Arterial Traffic Signal Systems

Increases in travel speeds of 14% to 22%
Reductions in travel times of 8% to 15%
Reduction of vehicle stops by 0% to 35%
Reduction in delays of 17% to 37%
Reductions in fuel consumption of 6% to 12%
Annual decreases in automobile emissions of 5% to 13% of the CO
Annual decreases in emissions of 4% to 10% of the HC

Incident Management Programs

Reduced incident clearance times of approximately 8 minutes for stalled or disabled vehicles
Reduced incident clearance times of approximately 5 to 7 minute for removing damaged vehicles with a wrecker

Travel times also decrease with the reduction in time it takes to remove vehicles from the travel lanes. These decreases in travel times average 10 percent to 42 percent. The decrease in the total number of accidents is approximately 35 percent. The reduction in secondary incidents due to incident management programs was estimated at 30 percent in a before-and-after study conducted by the Texas Transportation Institute for the San Antonio TransGuide System.

Traveler Information Systems

Reduction in travel times of 20% during incident conditions
Decrease of 1900 vehicle-hours of delay per incident
Decrease of 6% to 12% in fuel consumption
Decrease of fuel emissions from the affected vehicles of volatile organic compounds (VOC) by 25%
Reduction in HC by 33%
Decrease in NOx by 1.5%

Project Advisory Group (PAG)

In order to facilitate a consensus among transportation agencies, a Project Advisory Group (PAG) was formed. This group included:

NYSDOT
FHWA
NYMTC
Mid Hudson South TCC
NYS Police
NYS Thruway Authority
TRANSCOM
NJHA
Connecticut DOT
NYS Bridge Authority
PIP Commission
Westchester County
Rockland County
Orange County
Dutchess County
Putnam County
City of White Plains
Metro North
MTA

The PAG members guided the development of this deployment plan by providing input and suggestions during the planning process.

Current ITS Initiatives

There are a number of existing and planned ITS projects in the Lower Hudson Valley. Below is a list of these projects in operation or design (Additional information on each is contained in the report):

- NYSDOT
- HELP
- NY-WINS
- EZ Pass
- Transmit Project
- Model ITI Deployment Project
- Transit AVL in Westchester County
- I-95 Corridor Coalition Information Exchange Network (IEN)
- SATIN Project
- Highway Advisory Radio (HAR)
- Regional Variable Message Signs (VMS)
- NYSTA-CCTV, VMS, HAR
- IRVN Network
- Rockland AVL System
- Closed Loop Signal Systems
- City of White Plains Signal System
- Westchester Avenue Signal System

Existing Transportation Conditions

The areas of greatest recurring congestion focus in Lower Westchester and Rockland Counties centering on the I-287/I-87 corridor. In lower Westchester County, the main recurring congestion occurs along the following north-south routes: Saw Mill River Parkway, Sprain Brook Parkway, Hutchinson River Parkway, and I-95. In the east-west direction, I-287 and the Cross County Parkway meet the criteria for recurring congestion. In Rockland County, I-87/I-287, the Palisades Interstate Parkway, as well as Route 202 show signs of recurring congestion. In Putnam County, the recurring congestion can be found along Route 6, Route 22, Route 312 and I-84. In Orange County, recurring congestion routes include Route 202 and parts of Route 17K. The focus of recurring congestion in Dutchess County centers on Poughkeepsie, with Route 9 and Route 9G, as well as a section of Route 82 in Hopewell Junction. Aerial flights were also used to verify and determine areas of recurring congestion. In addition to the recurring congestion developed from the analysis of volumes, the aerial flights found volume-related congestion, on at least one occasion, in the following areas:

- Route 6 in the Peekskill area
- Route 35 near FDR State Park
- Taconic State Parkway in the Yorktown area
- Routes 9, 9A and the Taconic State Parkway in the Ossining area
- Route 35 and I-684 in the Lewisboro area
- Saw Mill River Parkway in the Mt. Pleasant and Hastings areas
- Route 59 paralleling I-87/I-287 in Rockland County
- Route 45 in the Spring Valley area
- Route 9 in the Poughkeepsie area
- Taconic State Parkway in the Mt. Pleasant area (has since been upgraded to 6 lanes)

The greatest amount of nonrecurring congestion related to the daily accident and incidents that occur on the Region’s facilities can also be found in the Lower Westchester County area and in Rockland County. The Palisades Interstate Parkway, Sprain Brook Parkway, Hutchinson River Parkway, I-87, I-95, as well as some of the east-west routes such as I-287/I-87 and the Cross County Parkway all experience significant levels of nonrecurring congestion. In Rockland County, parts of Route 202, Route 9W, Route 17, Route 59, Route 303 and Route 45 all have some amount of nonrecurring congestion. In upper Westchester County, parts of Route 6, Route 35, Route 133, Route 117 and Route 172 experience nonrecurring congestion. In Orange County, parts of Route 202, Route 208, Route 32, Route 17, Route 9W, Route 211, Route 17M and Route 17A exhibit some amount of nonrecurring congestion. The routes that met the criteria for nonrecurring congestion in Dutchess County include Route 376, Route 44, Route 9, and Route 9G.

The public transportation services operating in the Lower Hudson Valley provide significant mobility benefits to the region. These public transportation services include local public carriers such as PART, regional public service providers such as Metro-North and private operators such as ShortLine.

According to the most recent Federal Transit Administration report, the public transportation service providers serving the Lower Hudson Valley carried almost 100,000,000 annual passenger trips. This involved the operation of over 61,000,000 annual service miles and over 2,300,000 service hours with a fleet of 700 commuter rail cars and 600 buses. Most of the trips served, 63 percent, were commuter rail trips operated by Metro-North. Local and regional, public and private bus operators provided the remaining trips in the region. Westchester Bee-Line services carried the second largest volume of passengers at over 29,000,000 annual trips, followed by Rockland Coaches (Red & Tan Lines) and Hudson Transit (ShortLine) who carried 2,100,000 annual trips and 1,610,000 annual trips, respectively.

User Services

Twenty-nine ITS user services have been identified by the Federal Highway Administration (FHWA). The 29 user services identified by the FHWA have been grouped into seven “bundles”, each of which represents the application of advanced technology to a specific transportation function. The seven bundles of user services are:

- Travel and Transportation Management
- Travel Demand Management
- Public Transportation Management
- Electronic Payment
- Commercial Vehicle Operations
- Emergency Management
- Advanced Vehicle Safety Systems

Each user service was evaluated in the context of how it would potentially enhance the efficiency or capability of the transportation system, and how it would help meet the needs identified by the various users of the transportation system. The selection of user services was based on input received from local agencies involved in this study, including departments of transportation and public works, emergency response agencies and transit operators.

A questionnaire was distributed to transportation representatives of the five counties in the study area, the major transit authority for commuter service (MTA/Metro-North Railroad), NY State Police, the NYS Thruway Authority, TRANSCOM and the NYSDOT Region 8 ITS Unit. A total of 12 surveys were distributed, completed and returned. Based on the results of the survey and an assessment of the existing transportation network, the following user services ranked the highest for this region:

- Traffic Control
- Incident Management
- En route Driver Information
- Traveler Information Service
- Pre-trip Travel Information
- Demand Management and Operations
- Public Transportation Management
- Emergency Vehicle Management
- Emergency Notification

In order to implement these user services, ITS technologies will need to be implemented that provide the following functions:

- Surveillance
- Communications
- Control Strategies
- Traveler Interface

- Data Processing

Long-Term Vision Statement

This Long-Term Vision Statement actually provides the guidance required to develop the Strategic Deployment Plan. Basically, the Intelligent Transportation System (ITS) for the Lower Hudson Valley should provide an integrated management system for the movement of people and goods on the freeway and arterial highways and the transit system. The system should create a seamless link among agencies including the New York State Department of Transportation (NYSDOT), the individual county Departments of Transportation/Departments of Public Works, New York State Thruway Authority (NYSTA), law enforcement agencies, the transit authorities and private interests.

As a summary, the NYSDOT would build, maintain and operate an ATMS on the NYSDOT roadway network in the Lower Hudson Valley. On the New York State and New England Thruways, the NYSTA would operate and maintain the ATMS. The Vision looks towards joint management of the regional network in a future Transportation Management Center (TMC)

- The ATMS would be implemented incrementally, justifying and building public support continually.
- Existing traffic control system would be upgraded, expanded and integrated with the ATMS.
- Proposed traffic signal systems would be integrated with the ATMS.
- Communications and operations links would be developed between the ATMS and other relevant agencies in the area in accordance with the Regional and National Intelligent Transportation Communications Architecture.
- Private sector participation in the ATMS would be encouraged.
- Incident management activities, including rapid response to incidents, would be implemented.
- The various transit authorities would consider upgrading their monitoring activities to include an automated vehicle location that would be interfaced with the ATMS.
- The transit authorities would collect and distribute real time information on transit service.

As the Lower Hudson Valley ITS is implemented, real benefits will accrue to three distinct sets of customers: (1) End User Customers – Automobile users, commercial vehicle operators (CVOs) and transit riders; (2) Public Agency Customers - Public agencies charged with preserving safety and mobility on the roads and transit systems; and (3) regional residents and businesses.

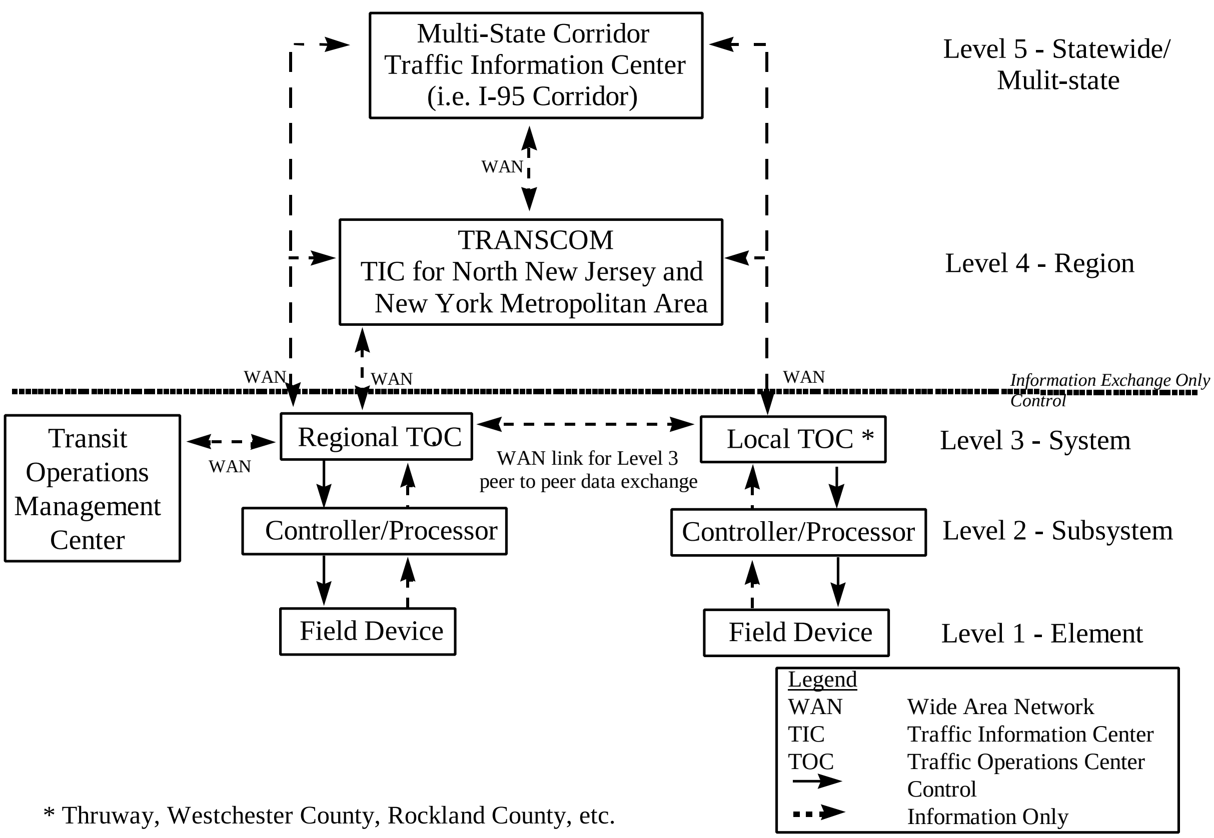
Public Outreach

An Educational Outreach Workshop was held at the Bear Mountain Inn. Over 50 people representing the various agencies and public interest groups throughout the region attended the Workshop. A number of issues and ideas were presented at the July 10, 1996 ITS Early Deployment Study, Educational Outreach Workshop that are detailed in the body of the report.

System Architecture

A system architecture concept that is dynamic and can be continually refined to produce the best possible results in an age of rapidly changing technology is critical to the future implementation of ITS in the Lower Hudson Valley. The architecture must accommodate a variety of component system architectures. Based on an assessment of each alternative's ability to meet the Lower Hudson Valley transportation objectives discussed in the User Services Plan and considering the system constraints and sensitivity issues, a Hybrid Architecture is recommended. The architecture recommended for the Lower Hudson Valley is shown in the following figure. As is easily seen, it is an architecture that is basically in line with the TRANSCOM Regional Architecture and should easily blend into the future NYC Architecture.

The Lower Hudson Valley Architecture would link Traffic Operations Centers (TOCs) and Transit Operations Facilities/Center(s) in each of the major operating jurisdictions to a Regional TOC and Traffic Information Center (TIC). These would include the other DOT Regions, the Thruway, the counties and major cities, such as White Plains, as well as the transit agencies emergency service providers and 911 centers. This architecture could also accommodate several of these agencies combining into a single TOC. A major question is precisely what information is exchanged and how will it be exchanged. Such information may include traffic image data, predicted incident data, incident response data, map display data, and incident response updates. Presently, many of these protocols are being worked out as part of the TRANSCOM and NYC architecture efforts.



Recommended Lower Hudson Valley Architecture

Figure 6 in Chapter IV, System Architecture shows the National ITS Architecture "sausage diagram" that illustrates the connection of the Lower Hudson Valley agencies.

Lower Hudson Valley Transportation Management Center

After an evaluation of the properties and buildings owned by some of the participating agencies within Westchester County and Rockland County, the site for the TMC for the Lower Hudson Valley was determined to be the NY State Police property in Hawthorne. The new facility will house the Transportation Operations Center as well as the State Police Zone 4 Headquarters. The preliminary design determined that the building would be two stories with approximately 26,000 square feet. There will be space provided in the operations room and some office space provided for the NYSTA, WC, as well as additional space for other agencies interested in locating in the TMC in the future.

Operations/Procurement Issues

This chapter describes the issues related to operating the ITS equipment and systems in the Lower Hudson Valley, such as funding, maintenance and operations, agency roles and responsibilities, etc. This chapter describes agreements and memoranda of understanding that should be developed for the Lower Hudson Valley to facilitate the implementation of Intelligent Transportation Systems.

Deployment Plan

This Early Deployment Plan is a planning study that recommends, within broad parameters, ITS equipment deployment that will address recurring and nonrecurring congestion. There are other deployment configurations that could also work, the details of which will be finalized during the future design and implementation phases. These recommendations are not exclusive solutions nor are the equipment recommendations and locations precise placements, but rather represent magnitudes of investment that would be appropriate for congested areas of this region. The maps show strategic locations of equipment placement, rather than final actual locations that will be determined during the design phases.

The deployment plan is the guide for implementing ITS equipment throughout the Lower Hudson Valley. Tables summarize the implementation schedules for the short-term, medium-term and long-term time frames. The deployment is based upon the benefit cost ratios and geographic implementation taking into account the Transportation Improvement Program for the Lower Hudson Valley.

Costs of ITS

The units costs used in estimating the cost of ITS deployment in the Lower Hudson Valley are as follows:

Highway Applications

Variable message sign with sign supports	$250,000
Closed-circuit television camera with pole and foundation	$ 25,000
Highway advisory radio transmitters with a pair of flashing beacon signs	$ 60,000
Traffic flow detection unit at half mile spacing	$ 10,000

HELP vehicle expansion cost per vehicle and operator per year	$175,000
Traffic signal system upgrades per signalized intersection	$ 4,000
Milepost, reference, landmark marker signs per mile	$ 3,000
Fiber optic communications per mile	$200,000

The total cost for the Deployment of ITS on highways throughout the Lower Hudson Valley can be summarized as follows:

Short Term (less than 5 years)	80 miles of ITS equipment	$40 million
Medium Term (5 to 10 years)	65 miles of ITS equipment	$30 million

The annual operations and maintenance would be in the range of 5 to 10 percent of the capital cost for a total of $4 million to $7 million per year.

Transit Applications

Automatic vehicle location systems per vehicle	$ 13,700
Automatic vehicle location system per transit system	$350,000
Public information monitors	$ 3,000
Variable message sign with sign support	$250,000

The cost for the transit applications of ITS is as follows:

AVL system total costs	750 buses	$10.4 million

Functional Requirements

Appendix D, Chapter XI, summarizes the User Services and the technologies that are needed to support these functions. There are examples of individual functional elements that are used for surveillance, communications, control strategies, traveler interface, and data processing and storage. A section on technology assessment summarizes the various technologies currently being used in the area for surveillance, transit ITS functions, traveler interface and system communications.

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I. TRANSPORTATION SYSTEM CHARACTERISTICS

A. PURPOSE AND NEED OF THE STUDY

The primary purpose of the Intelligent Transportation System (ITS) Early Deployment study is to identify the ITS User Services appropriate for the Lower Hudson Valley and to develop a Strategic Deployment Plan based upon these user services. The study process will identify where and how ITS technologies can be applied to improve the safety, efficiency and capacity of the regional transportation network. The study will build upon existing ITS initiatives and will incorporate them into the overall regional plan. The study will produce a framework for a conceptual plan for providing real-time traffic and traveler information within the Lower Hudson Valley region, including both the roadway and public transportation systems. An overall strategy will be outlined that is aimed at increasing the efficiency of the entire transportation system. The most beneficial applications of such a plan would be those which facilitate a greater utilization of the existing transportation system resources of the region (i.e., moving more people through the roadways, trains, buses, etc). The effort will require significant coordination and cooperation among all of the agencies providing transportation services. To this end, any ITS system developed for the Lower Hudson Valley should also be compatible with ITS initiatives being developed in the New York City area (NYSDOT Region 11), New Jersey and Connecticut. A significant portion of the commuting trips are focused on New York City and consequently, much of the commuter services are directed towards serving the New York City market. Thus, the information and data generated, via any ITS applications in the Lower Hudson Valley, ultimately should dovetail with information and data requirements of the ITS systems serving New York City.

B. LIST OF AGENCIES ON THE PROJECT ADVISORY GROUP

In order to facilitate a consensus among the transportation agencies in the area, a Project Advisory Group (PAG) was created. The role of this group was to provide input and oversight for the development of the User Services Plan and the Strategic Development Plan.

- New York State Department of Transportation
- Federal Highway Administration
- New York Metropolitan Transportation Council
- Mid-Hudson South Transportation Coordinating Committee
- New York State Police
- New York State Thruway Authority
- Westchester County
- Rockland County
- Putnam County
- Orange County
- Dutchess County
- Metro-North Railroad
- Metropolitan Transit Authority
- New York State Bridge Authority
- City of White Plains Traffic Department

- TRANSCOM
- Palisades Interstate Parkway Commission
- New Jersey Highway Authority
- Connecticut Department of Transportation

C. MAJOR FACILITIES IN THE LOWER HUDSON VALLEY AREA

The major facilities that were considered in this study include the freeways, both interstate and non-interstate facilities, as well as major arterial roadways and transit facilities and services that influence freeway operations. Intermodal facilities and facilities planned for implementation are also briefly addressed in this section.

1. LIMITED ACCESS FACILITIES

New York State Department of Transportation Jurisdiction

- I-684
- Sprain Brook Parkway
- Saw Mill River Parkway
- Taconic State Parkway
- Hutchinson River Parkway
- Route 17
- Cross County Parkway

New York State Thruway Authority Jurisdiction

- I-87
- I-95
- I-287
- I-84
- Garden State Parkway Extension

Westchester County Jurisdiction

- Bronx River Parkway (NY City Line to the Taconic State Parkway)

Palisades Interstate Park Commission Jurisdiction

- Palisades Interstate Parkway

Ideally, freeways serve as alternate routes for other, more congested freeways. In cases where the freeway network is limited in size or where major arterials parallel the freeway system, arterial roadways also serve as alternative routes to the freeway. Diversion of traffic from freeways to other freeways, from arterial roadways to freeways, and from freeways to arterial roadways, when there is an incident, can result in a reduction in overall traveler delay. However, not all arterial roadways are suitable as alternative routes for freeway traffic. An arterial used as an alternative route would preferably run approximately parallel to the freeway, would have adequate access onto and off of the freeway, and would have adequate capacity and operating speeds. In the same way, a freeway that would be used as an alternate route to an arterial would also ideally be parallel and proximate to the arterial. Arterial capacity is influenced not only by the number of lanes in each direction (a minimum of two lanes in each direction is necessary in many circumstances), but also by the signal timing along the facility. Thus, the ability to vary signal timing plans in response to a large volume of traffic diverting from the freeway significantly enhances the effectiveness of an arterial as an alternative route. This issue is discussed in greater detail in a later section entitled *System Characteristics*. Below is a list of the other arterials that have been examined as part of the regional network analyses.

2. OTHER ARTERIAL ROADWAYS (NYSDOT AND OTHER JURISDICTIONS)

ROUTE	JURISDICTION
1	State/Local
6 (includes Division St./Oregon Rd.)(County Route in Peekskill)	State/County/Local
9 (maintained by City of Yonkers within City limits)	State/Local
9A/100A (portion of 9A in Yonkers is maintained by City of Yonkers)	State/Local
9W	State
17K	State
17M	State
22 (maintained by City of Yonkers, Mt. Vernon, State)	State/Local
32	State
35/202 (maintained by Peekskill, State)	State/Local
45 (Red Schoolhouse Road to Route 202)	State
59	State
100	State
117	State
119	State
120A (State)/ Anderson Hill Road (WCDPW)	State/County
123/124	State
125/Weaver Street (City of White Plains/State/County)	State/County/Local
127 (WCDPW/State)	State/County
202 (County in Peekskill)	State
303	State
304	State
340 (Gilbert Avenue to Route 9W)	State
Westchester Avenue	County
Tuckahoe Road (State arterial; part in Yonkers)	State/County
Ashford Road/Ardsley Road/Popham Road	County/Local
Middletown/Little Tor Road (Orange Avenue to Route 202)	Local/County
New Hempstead Road (Route 202/45 to Route 9W)	Local/County
Yonkers Ave.(984E/983C)(State owns, City of Yonkers operates)	State/Local

3. TRANSIT FACILITIES

Efficient local and regional public transportation operations rely on the existence of well defined and strategically located transfer facilities. This is especially true for commuter and intermodal operations. The Lower Hudson Valley benefits from the existence of many transit facilities, most of which are located in areas with appropriate transit-related land uses. These facilities range from large downtown transit centers, such as in White Plains, to park-and-ride lots. A key transit facility, for the purpose of this project, is a point where rail and bus services meet, commuter park and ride lots, or points where several bus routes converge at a transfer center. The following list presents the key transit facilities identified in the Lower Hudson Valley. The list is presented by jurisdiction and in most cases identifies the services which operate through the facility. The transit service information was gathered during May and June 1996 and the information was current as of that date.

a) Dutchess County

Rhinecliff Amtrak Station is served only by Amtrak.

<u>Metro-North Hudson Line</u>
Poughkeepsie Station served by Poughkeepsie Transit Main Street A and Main Street B Routes, ShortLine, Leprechaun Lines, Arrow Bus, The Poughkeepsie Commuter Train Connection (Hyde Park and Apple Valley Routes), Amtrak and Metro-North.

New Hamburg Station served by Metro-North, and the New Hamburg Commuter Train Connection.

Beacon Station served by Metro-North and the LOOP Commuter Train connection. A Newburgh Beacon Shuttle Bus serving Metro-North services at Beacon will begin by Mid 1997.

<u>Metro-North Harlem Line</u>
Dover Plains Station served by Metro-North, Bonanza Bus, and Dutchess Loop Routes 2A, 2B, 7 and L.

Harlem Valley-Wingdale Station served by Metro-North, and Dutchess Loop Routes 2B, 4A, 7 and N.

Appalachian Trail Station served by Metro-North, and Dutchess Loop Routes 2B, 4A, 7 and N.

Pawling Station served by Metro-North, and Dutchess Loop Routes 2B, 4A, 7 and N.

<u>Park and Ride Lots</u>
East Fishkill Park and Ride Lot, I-84 and Lime Kiln Road, 90 spaces served by ShortLine I-84 Express.

East Fishkill Park and Ride Lot, Taconic Parkway and State Route 52, 100 spaces.

La Grange Park and Ride Lot, Taconic Parkway and Todd Hill Road, 28 spaces.

Stanford Park and Ride Lot, Taconic Parkway and Bulls Head Road, 25 spaces.

Dutchess County Intermodal Center on Route 9D in Fishkill is served by LOOP buses and Beacon Commuter Train Connection.

In addition, several other park and ride lots exist. Dutchess Mall serves as an important park and ride staging area for two of the state sponsored express routes: Poughkeepsie-White Plains Express and I-84 Express (Newburgh-Brewster-Danbury).

b) Putnam County

Metro-North Harlem Line
Patterson Station served by Metro-North

Brewster North Station served by Metro-North

Brewster Station served by Metro-North, the Bee-Line Route 84, ShortLine (to I-84 Express) and the PART Route 1 ShortLine, I-84 Express.

Metro-North Hudson Line
Cold Spring Station served by Metro-North and the PART Route 4.

Park and Ride Lots
Brewster Park and Ride Lot, I-84 and State Route 312, 75 spaces, served by ShortLine.

Carmel Park and Ride Lot, I-84 and State Route 311, 100 spaces, served by ShortLine.

c) Orange County

Metro-North Port Jervis Line
Port Jervis Station served by Metro-North and the ShortLine Honesdale Route.

Harriman Station served by Metro-North and the ShortLine Middletown Route.

Tuxedo Station served by Metro-North and the ShortLine Middletown Route.

Park and Ride Lots
Central Valley Park and Ride Lot, State Routes 6, 17 and 32, 275 spaces, served by ShortLine.

Monroe Park and Ride Lot, Museum Village, State Route 17M, 625 spaces, served by ShortLine.

Newburgh Park and Ride Lot, State Route 17K, Union Avenue, 305 spaces, served by ShortLine, Lester Lines, Newburgh-Beacon Bus and Adirondack Trailways.

Warwick Park and Ride Lot, State Route 17A, 248 spaces, served by NJ Transit.

Mathews Street Park and Ride Lot, in Goshen, 100 spaces, served by ShortLine.

d) Rockland County

Metro-North Port Jervis Line
Sloatsburg Station served by Metro-North, the ShortLine Middletown Route, and the TOR Route 56.

Suffern Station served by Metro-North, the ShortLine Middletown, West Point and White Plains Routes, and TOR Routes 56, 59 and 93.

<u>Metro-North Pascack Line</u>
Spring Valley Station served by Metro-North, the Red & Tan Lines Routes 11A, 11C and 45, the Spring Valley Jitney, and TOR Routes 57, 59, 76, 91, 92 and 94.

Nanuet Station served by Metro-North, the Red & Tan Lines Routes 11A, 11C, 20 and 47.

Pearl River Station served by Metro-North, the Red & Tan Lines Routes 11A, 11C, 20 and 47, and TOR Route 92.

<u>Park and Ride Lots</u>
Chestnut Ridge Park and Ride Lot, State Route 45, North of Pinebrook Road, 90 spaces, served by Red & Tan Lines.

Clarkstown Park and Ride Lot, Palisades (Exit 10), North Middletown Road, 94 spaces, served by Red & Tan Lines.

Mt. Ivy Park and Ride Lot, State Routes 202 and 45, 224 spaces, served by Red & Tan Lines.

New City Park and Ride Lot, Cinema 304, North of Main Street, 185 spaces, served by Red & Tan Lines.

Orangetown Park and Ride Lot, Palisades (Exit 5), Service Station, 80 spaces.

Pearl River Park and Ride Lot, Williams Street, 77 spaces, served by Red & Tan Lines.

Pomona Park and Ride Lot, Route 45, North of Sanatorium Road, 80 spaces, served by Red & Tan Lines.

Spring Valley Park and Ride Lot, Thruway (Exit 14) and State Route 59, 280 spaces. Served by TOR, Route 57 and Route 59.

Spring Valley Park and Ride Lot, Lot C, Main Street North of Railroad Tracks, 29 spaces. Served by Metro-North; the Red & Tan Lines Routes 11A, 11C and 45; the Spring Valley Jitney and TOR Routes 57, 59, 76, 91, 92 and 94.

Spring Valley Park and Ride Lot, Lot D, Municipal Plaza, 205 spaces. Served by Metro-North; the Red & Tan Lines Routes 11A, 11C and 45; the Spring Valley Jitney and TOR Routes 57, 59, 76, 91, 92 and 94.

Spring Valley Park and Ride Lot, Lot E, Main Street South of Railroad Tracks, 20 spaces. Served by Metro-North; the Red & Tan Lines Routes 11A, 11C and 45; the Spring Valley Jitney and TOR Routes 57, 59, 76, 91, 92 and 94.

Anthony Wayne State Park, Park and Ride Lot, Palisades Interstate Park and Anthony Wayne Recreational Area, 3300 spaces. This is a seasonal park and ride lot for commuter carpools for the fall and winter months. This lot is not served by any transit providers.

Stony Point, Park and Ride Lot, State Route 9W near Route 210, 50 spaces, served by TOR 94 and Red & Tan Lines.

Suffern Park and Ride Lot, Lot A, Orange Avenue North of Lafayette, 63 spaces, served by TOR 59 and 93 and ShortLine.

Suffern Park and Ride Lot, Lot B, Chestnut Street North of Lafayette, 112 spaces, served by TOR 59 and 93.

Suffern Park and Ride Lot, Lot C, Orange Avenue South of Lafayette, 15 spaces, served by TOR 59 and 93.

Suffern Park and Ride Lot, Lot E, Municipal Ball Field, 183 spaces, served by TOR 59 and 93.

Valley Cottage Park and Ride Lot, New Lake Road, Route 303 and Kings Highway, 175 spaces, served by TOR 59 and 93.

West Nyack Park and Ride Lot, Thruway (Exit 12), Route 303 and Route 59, 230 spaces, served by TOR 57, 59, 91, 92 and Red & Tan Lines.

e) Westchester County

<u>Metro-North Hudson Line</u>
Peekskill Station served by Metro-North and Bee-Line Routes 16 and 18.

Cortlandt Station served by Metro-North and Bee-Line Route 14.

Croton-Harmon Station served by Metro-North, Amtrak and Bee-Line Routes 10, 11, and 14.

Ossining Station served by Metro-North and Bee-Line Routes 11, 13, 14 and 19.

Tarrytown Station served by Metro-North and Bee-Line Route 1T, 13, TOR 57, and the Tappan Zee Express.

Dobbs Ferry Station served by Metro-North and Bee-Line Routes 1C, 1T, 1W, and 6.

Hastings Station served by Metro-North and Bee-Line Routes 1C, 1T, 1W, and 6.

Greystone Station served by Metro-North and Bee-Line Routes 1C, 1T, and 1W.

Glenwood Station served by Metro-North and Bee-Line Routes 1C, 1T, and 1W.

Yonkers Station served by Metro-North, Amtrak and Bee-Line Routes 1C, 1T, 1W, 2, 3, 4, 5, 6, 7, 8, 9, 23, 25, 30, 32 and 91 (seasonally).

Ludlow Station served by Metro-North and Bee-Line Route 32.

<u>Metro-North Harlem Line</u>
Croton Falls Station served by Metro-North and Bee-Line Route 84.

Golden’s Bridge Station served by Metro-North and Bee-Line Route 84.

Katonah Station served by Metro-North and Bee-Line Routes 19, 19G and 84.

Bedford Hills Station served by Metro-North and Bee-Line Routes 19 and 19G.

Mount Kisco Station served by Metro-North and Bee-Line Routes 12, 19 and 19G.

Chappaqua Station served by Metro-North and Bee-Line Routes 19 and 19G.

Pleasantville Station served by Metro-North and Bee-Line Routes 6, 19 and 19G.

Hawthorne Station served by Metro-North and Bee-Line Routes 6 and 19G.

Valhalla Station served by Metro-North and Bee-Line Route 6.

North White Plains Station served by Metro-North and Bee-Line Route 6.

White Plains Station served by Metro-North and Bee-Line Routes 1W, 3, 5, 6, 11, 12, 13, 14, 15, 17, 20, 20X, 21, 27, 40, 41, 60, 62, 63, 77, 84, 92 (seasonally), Shuttles A, B and C, TOR Route 57, Leprechaun Lines, ShortLine and CT Transit Route I.

Hartsdale Station served by Metro-North and Bee-Line Routes 34, 38, and 39.

Scarsdale Station served by Metro-North and Bee-Line Routes 63, 64, 65, and 66.

Tuckahoe Station served by Metro-North and Bee-Line Route 8.

Bronxville Station served by Metro-North and Bee-Line Routes 26, 30, and 52.

Fleetwood Station served by Metro-North and Bee-Line Routes 26 and 55.

Mount Vernon West Station served by Metro-North and Bee-Line Routes 7, 26 and 91.

<u>Metro-North New Haven Line</u>
Port Chester Station served by Metro-North and Bee-Line Routes 13, 61, 76, and CT Transit Route K.

Rye Station served by Metro-North and Bee-Line Routes 61 and 76.

Harrison Station served by Metro-North and Bee-Line Routes 5 and 61.

Mamaroneck Station served by Metro-North and Bee-Line Routes 60 and 61.

Larchmont Station served by Metro-North and Bee-Line Routes 60, 61, 66, 70, and 71.

New Rochelle Station served by Metro-North, Amtrak, ShortLine and Bee-Line Routes 7, 30, 42, 45, 45Q, 60, 61, 62, 66 and 91.

Pelham Station served by Metro-North and Bee-Line Route 53.

Mount Vernon Station served by Metro-North and Bee-Line Routes 7, 40, 41, 42, 52, 53, 54, 55 and 91.

Park and Ride Lots
Bedford Park and Ride Lot, State Route 172 and I-684, 60 spaces.

Eastview Park and Ride Lot, Sawmill River and Tarrytown Road, 40 spaces.

Yorktown Park and Ride Lot, State Route 6 and Taconic Parkway, 50 spaces.

Yorktown Town Hall Park and Ride Lot, 134 spaces.

The preceding list of transit facilities needs to be included in ITS deployment plans for the region. These facilities serve as the staging grounds for the public transportation infrastructure in the Lower Hudson Valley. As points of access to public transportation services, ITS applications such as real time service status information, inter-operator coordination, and regional fare media sales would all enhance public transportation services, making these services more convenient to use, more productive and more efficient. This, in turn, will make the transportation system in the Lower Hudson Valley more efficient.

4. TRANSIT SERVICE PROVIDERS AND KEY SERVICES

The following is a partial list of public transportation services in the Lower Hudson Valley region. The list is not intended to be all inclusive, but rather to identify those service providers who operate key commuter-oriented services and/or are the primary local public transport service providers in the jurisdictions within the Lower Hudson Valley region. Therefore, human service transportation services and dial-a-ride services are not included. The subsequent development of the APTS architecture, however, will be designed to allow other transit services, including human service and paratransit services, to opt into the ITS system and take advantage of the functional capabilities that will be provided. The following service information is presented by county with regional service providers noted.

a) Regional Service Providers

Metropolitan Transportation Authority - The MTA oversees regional transportation services in the greater New York Metropolitan region. This includes services provided by New York City Transit, Metro-North Railroad, Long Island Railroad, Long Island Bus, and Bridges and Tunnels.

New York City Transit - Operates the services, including buses and subways, that convey most of the Lower Hudson Valley region commuters traveling to New York City once they have reached the City. These services are the essential ingredient for distributing the huge volume of commuters each day to points throughout the City.

Metro-North Commuter Rail - Provides commuter rail service within the Lower Hudson Valley on five lines: the Hudson Line, Harlem Line, and New Haven Line east of the Hudson River and the Port Jervis and Pascack Lines west of the Hudson River. Service operated along the rail lines east of the Hudson River runs directly into Grand Central Terminal in Manhattan. The Port Jervis and Pascack lines terminate at the Hoboken Terminal where patrons may gain access to Penn Station in Manhattan via the PATH service. Metro-North services west of the Hudson River are operated by NJ Transit.

Amtrak - Amtrak operates within the region and provides services at the following four Metro-North Commuter Rail stations: Poughkeepsie, Croton-Harmon, Yonkers and New Rochelle.

ShortLine - The ShortLine is a private bus company operating charter and commuter services within all five counties in the study area in the Lower Hudson Valley to multiple destinations including New York City and Long Island. ShortLine services in the Lower Hudson Valley region include the following bus routes: West Point, Middletown, White Plains, and Honesdale. ShortLine is the primary public transportation service provider in Orange County, the primary provider of commuter services from Orange County to New York City; ShortLine also provides commuter services to Westchester County and Danbury, Connecticut through direct contracts with the NYSDOT. ShortLine provides service to Bergen County, New Jersey via the NJ Route 17 corridor. In Newburgh, there is an express bus to New York City.

Red & Tan Lines (Rockland Coaches) - A private bus company operating charter and commuter services within the Lower Hudson Valley to multiple destinations including New York City. Red & Tan Lines services in the Lower Hudson Valley region include numerous bus routes to New York City. Red & Tan Lines is the primary public transportation service provider in Rockland County for commuter services to New York City and New Jersey.

Express inter-county bus services are operated under contracts with New York State. These services provide an important level of mobility to the region. These services include the following routes: the Poughkeepsie to White Plains Express Bus, the Newburgh to Danbury Express Bus, the Middletown to White Plains Express Bus and the Newburgh-Beacon Shuttle. These services all operate at least three trips per day. Service is being operated by Hendrick Hudson Lines, a subsidiary of Leprechaun Lines of Newburgh and by ShortLine.

Other private regional service providers in the region include the following providers:

Adirondack Trailways - operates primarily in northern and western New York State with international service to Toronto and Montreal. In this region, their service consists of express bus service to New York City, Long Island and Cooperstown. They also have local service on US Route 9W between Kingston and Newburgh with stops in Poughkeepsie, northbound and southbound. Although they offer service to and from New York City during peak periods, they are not considered a commuter carrier to and from New York City. In Kingston, riders transfer from one of their services to another, as well as to Ulster County Rural Transit, Kingston Citi-Bus and ShortLine. Other major stops for Adirondack are New Paltz, Newburgh and Nanuet.

Arrow Bus - operates local bus service between New Paltz and Poughkeepsie. The service is used by students going to and from SUNY New Paltz, shoppers and some workers. This service operates six days a week with no service on Sunday. In Dutchess County the route has stops at the Main Mall and the Poughkeepsie train station.

Hudson Valley Bus Lines - is a commuter bus service operating between Putnam County and Manhattan. It primarily operates over the former Mount Kisco Bus company route.

Monroe Bus Lines - operates between the Village of Kiryas Joel and New York City with stops in Manhattan and Brooklyn. It provides commuter and off peak service.

Liberty Lines Express - operates express bus service between the City of Yonkers and Manhattan with stops in the Bronx and Manhattan. Although this service starts in Westchester County, the majority of its riders are drawn from the Bronx. Service is offered in the peak and off peak periods.

Monsey Trails - operates between the Village of New Square in Rockland County and New York City. This service also has a stop in Montvale, New Jersey.

b) Dutchess County Services

Public Transportation services are provided in Dutchess County by the County and the City of Poughkeepsie.

Dutchess County Loop - The Dutchess County Loop provides the general public fixed route and paratransit services throughout the county. Dutchess County Loop services also provides connections to Metro-North service at various train stations. The Dover Plains station on the Harlem Line is served by Dutchess County Loop routes 2A, 2B, 7, and L. The following Metro-North Stations on the Harlem Line are served by Dutchess County Loop routes 2B, 4A, 7 and N:

Harlem Valley-Wingdale Station
Appalachian Trail Station
Pawling Station

Poughkeepsie Transit - The City of Poughkeepsie operates bus services on Main Street Route A and Main Street Route B. The Poughkeepsie Station on the Metro-North Hudson Line is served by both the Main Street Route A and the Main Street Route B routes.

The *Poughkeepsie Commuter Train Connection,* operated by the Dutchess County Loop, provides transit service to the Poughkeepsie Metro-North Station on two routes: Hyde Park and Apple Valley. The *New Hamburg Commuter Train Connection* operated by the LOOP serves the Metro-North Station at New Hamburg.

The New Paltz *Arrow Bus* route also serves the Poughkeepsie Station.

c) Orange County Services

All bus service provided in the county are provided by private or non-profit providers through contracts. The principal service providers include: Newburgh-Beacon Bus Corp., Middletown Transit Corp. and ShortLine.

Newburgh-Beacon Bus Corp. - Provides fixed route services in the Newburgh area with the Northside Route and the Southside Route. In addition, the Newburgh-Beacon Shuttle provides a link to Metro-North service at the Beacon Station.

Middletown Transit Corp.- Provides fixed-route service on four routes in the Middletown/Wallkill area.

ShortLine - Provides service to stations on the Port Jervis Line. The ShortLine Honesdale Route serves the Port Jervis Station. The Middletown Route serves the Harriman, Tuxedo, and Sloatsburg Stations.

NJ Transit operates service from the Town of Warwick to Passaic and Bergen counties in New Jersey and to New York City.

d) Putnam County Services

Public transportation services are provided by Putnam County, as well as by Westchester County's Bee-Line, ShortLine and Hudson Valley Bus Lines. The County transit system is called the Putnam Area Rapid Transit (PART).

PART - Operates six fixed routes and paratransit services to serve the entire county. PART Route 1 provides service to Putnam Lake, Carmel and Brewster. This route serves the Brewster Station and provides a link to the Metro-North Harlem Line. PART Route 4 provides service through Putnam County between the Poughkeepsie Galleria in Dutchess County and the Putnam Plaza. It also serves the Westchester Mall, Jefferson Valley Mall and Baldwin Place Mall in Westchester County. The PART Route 4 provides access to the Cold Spring Station and the Garrison Station, both of which are served by the Metro-North Hudson Line.

e) Rockland County Services

Public transportation services in Rockland County are provided by the County, as Transport of Rockland (TOR), and by Red & Tan Lines, ShortLine, the Spring Valley Jitney, Monsey Trails, and the Clarkstown Mini-Trans.

Transport of Rockland (TOR) - The County bus system provides service throughout the County, to Sloatsburg in Rockland County and into White Plains in Westchester County via ten routes. The key routes are those providing commuter service and/or access to rail service. The TOR Route 56 serves Sloatsburg including the Port Jervis Line, Suffern (where access to the Port Jervis Line service is also available), Antrim, Viola and Pomona. The TOR Route 57, the Tappan Zee Express, provides express service from the Spring Valley Bus and Rail Center to downtown White Plains. This route also provides access to Metro-North service at Tarrytown (the Hudson Line) and White Plains (the Harlem Line). The TOR Route 59 serves Suffern, Monsey, Spring Valley, Nanuet, and Nyack. This route provides access to rail service on the Port Jervis Line at Suffern and on the Pascack Line at Spring Valley. TOR Routes 76, 92 and 94 also provide access to the Pascack Line at Spring Valley. The TOR Route 92 also affords access to the Pascack Line at Pearl River.

Clarkstown Mini-Trans - Provides service to Nanuet Mall from Congers, Clarkstown, New City, and Nyack via five routes.

ShortLine - Provides bus service from Suffern to the Port Authority Terminal in Manhattan.

Monsey Trails - Provides bus service from New Square/Monsey along the Garden State Parkway into Manhattan and Brooklyn.

Spring Valley Jitney - Provides local bus service in the Village of Spring Valley.

Red & Tan Lines - Provides bus service to Uptown (George Washington Bridge Bus Terminal) and Midtown Manhattan. Route 9A runs from New City to the GWB. Route 9M runs from Stony Point to the GWB. Route 11C runs from Spring Valley to the GWB. And Route 20 runs from Nanuet Mall/Pearl River to the GWB. Routes 9M, and 11AT run from Stony Point to Midtown Manhattan. Route 45, the Ramapo Flyer, runs from Mt. Ivy to Midtown Manhattan. Route 47, the Parkway Express, runs from Nanuet Mall/Pearl River to Midtown Manhattan. Route 49, the New City Comet, runs from New City to Midtown Manhattan. Routes 11A, 11C and 45 connect with rail service at Spring Valley. Routes 11A, 11C, 20 and 47 connect to rail services at Nanuet and Pearl River.

f) Westchester County Services

The County of Westchester provides local fixed-route, paratransit, express commuter bus and commuter rail feeder bus services. Services also include transit connections to commuter rail, subway and express bus services. Services are provided by the County via contracts with Liberty Lines, Hartsdale, PTLA, and Port Chester-Rye. Liberty Lines is responsible for operating the majority of the transit service provided. Service planning and analysis is conducted by the County.

Bee-Line Service - Provides a full range of local fixed-route, paratransit and commuter services. Transit services in Westchester County are distinguished by both geography and service type. Services are classified as follows: South County Local, Central County Local, North County Local, North County Express, Inter-Urban Local, Inter-Urban Express, Feeder, and Express. The North, Central and South local services provide local service in one or more of the municipalities in the County, but do not provide connecting service between major urban areas in other parts of the County.

The North County Express routes provide limited-stop service linking municipalities in the northern portion of the County with White Plains and other municipalities in the central portion of the County. The North County Express Routes include the 17, 77 and the 84. The 84 links Brewster and Carmel in Putnam County to Katonah, Mt. Kisco and White Plains. This route provides connections to the Metro-North Harlem Line at these points. Route 17 operates between the Westchester Mall and White Plains with intermediate stops in Peekskill and at the Montrose Metro-North Station (Hudson Line). The Route 77 provides express service between Yorktown and White Plains.

Inter-Urban Local routes serve several municipalities and provide connecting service between major urban areas in the southern and central portions of the County. Inter-Urban Local Routes include the 1, the 5, the 6, the 20/20X, the 40, the 60 and the 61.

Inter-Urban Express routes provide limited-stop express service linking major cities in the northern and central portions of the County. Inter-Urban Express Routes include the 3, the 21, the 41, and the 62. Route 3 provides express service between White Plains, Yonkers and the 242nd Street Subway Station in the Bronx. Route 21 provides express service between White Plains and the Bronx. Route 41 provides express service between North White Plains/White Plains and Mount Vernon. Route 62 provides express service between White Plains, Rye, New Rochelle and the Fordham Road Subway Station in the Bronx.

Feeder routes provide service to/from commuter rail stations as the primary destination. Bee-Line Feeder Routes include the: 9, 10, 18, 34, 38, 39, 64, 65, 70 and 71. Route 9 provides feeder service to the Yonkers Station (Hudson Line). Route 10 provides service to the Croton-Harmon Station (Hudson Line). Route 18 provides feeder service to the Peekskill Station (Hudson Line). Routes 34, 38, and 39 serve the Hartsdale Station (Harlem Line). Routes 64 and 65 provide feeder service to the Scarsdale Station (Harlem Line). Routes 70 and 71 serve the Larchmont Station (New Haven Line).

Express service is limited-stop service from points in Westchester County directly into Manhattan. The BXM4C/4D Route provides service from Tarrytown, Ardsley, and Tuckahoe into Manhattan.

In addition three shuttle routes exist which provide high quality service between White Plains and major employment and activity sites along the Platinum Mile Corridor.

Other operators providing service in Westchester County include ShortLine, Red & Tan Lines, CT Transit, Bonanza, Adirondack Trailways and Transport of Rockland, Peter Pan, Trailways and Leprechaun Lines.

Recent additions include new OWL bus service from Middletown to White Plains; new Leprechaun bus service from Poughkeepsie to White Plains and new bus service from Stamford, Connecticut to White Plains.

The preceding transit service providers and key services represent those public transportation services which should be considered for inclusion in a regional ITS deployment. These services form the public transportation network serving the Lower Hudson Valley and provide additional capacity to move people throughout the region, beyond the capacity afforded by the highway network.

D. CURRENT AND PLANNED ITS APPLICATIONS IN THE LOWER HUDSON VALLEY

There are a number of activities being conducted in the Lower Hudson Valley that could be classified as ITS projects; these projects are discussed below. Additional information on ITS projects in the Lower Hudson Valley can also be found in the "Local Applicability of ITS User Services" section of the "User Services" chapter.

1. TRANSPORTATION MANAGEMENT CENTER (TMC)

A TMC is the hub of all information and control of traffic management. A TMC houses the control and data manipulation hardware and software for the management of traffic and incidents, as well as the personnel to operate the controls of the traveler information and surveillance equipment. A TMC is necessary for the development of the Lower Hudson Valley Advanced Transportation Management System as a point of contact and control for traffic and transportation management. A TMC can be a very "hi-tech" center with automated computing equipment and communications equipment or it can operate in a "low-tech" mode with manual operations and surveillance of the area transportation facilities.

Currently, the NYSDOT operates a 3,800 square foot TMC from 244 Westchester Avenue in White Plains. The TMC also operates the Highway Emergency Local Patrol (HELP). In addition to this, the TMC issues the Highway Construction Bulletin (HCB), a newsletter describing the construction activities every three weeks. The TMC, in conjunction with Westchester Commuter Central (WCC) (part of the Metro Traffic Network), monitors regional traffic conditions and provides information to motorists through links to television and radio stations. Westchester County has a public-private partnership with WCC. The County receives real-time traffic information free of charge in return for providing WCC with traffic and construction-related information.

2. INFORMATION EXCHANGE NETWORK (IEN)

The Information Exchange Network (IEN) workstation of the I-95 Corridor Coalition is located at the NYSDOT TMC at 244 Westchester Avenue. The IEN provides a link between the TMC and the other Traffic Management Centers within the I-95 Corridor Coalition. The IEN is used to exchange information on incidents, accidents and construction activities between the various agencies that are on-line. To date, there are over twenty (20) IEN stations on-line along the I-95 Corridor.

3. REGIONAL ITS ARCHITECTURE

The Regional ITS Architecture is the means by which the various traffic surveillance and control systems talk to their respective TMCs and the way the various TMCs can talk to one another. It is not architecture in the sense of buildings, it is a framework for a common way of communicating and sharing data and information. This architecture is being developed for the entire metropolitan New York area under another project.

The development of a system architecture is based upon the user services and associated functions it will provide and the operating relationship of the various architecture levels. Based upon interviews with the TRANSCOM member agencies, the most important functions have been identified from a regional perspective. The focus of the regional architecture will include a clearing-house of real-time traveler information covering all critical routes and modes. A composite picture of the status of the ground transportation network will integrate the available data from the system TMCs. In the Regional Architecture, a TMC is at Level 3, the field devices (signs, cameras, traffic flow detectors, etc.) are Level 1, the controllers that these Level 1 devices are connected to are at Level 2, an entity like TRANSCOM is considered a Level 4 and the I-95 Corridor Coalition would be considered a Level 5. The regional architecture will also include regional coordination support between system-level TMCs, transportation agencies and police during “major” incidents and events which cross jurisdictional boundaries. Variable message signs (VMS), highway advisory radio (HAR) transmitters, traveler information kiosks, etc. will be used to provide information on incidents of one agency into other jurisdictions.

4. NEW YORK WIDE-AREA INFORMATION NETWORK SYSTEM (NY-WINS)

The NY-WINS will bring traveler information to motorists. The system will first be implemented along the New York State Thruway from the Tappan Zee Bridge to the Spring Valley Toll Plaza, and along the Garden State Parkway from the New York State Thruway to the Hillside Toll Plaza. The objective for the NY-WINS system development initiative is to develop and test an area-wide motorist information system that will improve travel throughout the New York region and meet the current needs of commercial vehicle operators, motorists, system operators and regional traffic managers and planners. The NY-WINS project goals are to provide real-time traveler information using existing data sources, support multi-jurisdictional cooperation and maintain a flexible and scaleable system platform to take advantage of the latest technology and traveler information systems, as the electronic toll collection and motorist information markets expand. This initiative will provide real-time travel information directly to drivers in both passenger and commercial vehicles, using a new generation of EZPass transponders, which will be capable of receiving standardized messages for motorists and presenting the data using in-vehicle voice enunciators, with the same information automatically broadcast on HAR and displayed on VMS. This demonstration project is funded by New York State Energy Research and Development Authority (NYSERDA).

5. HIGHWAY EMERGENCY LOCAL PATROL (HELP)

NYSDOT has been operating an incident management program in Region 10, Long Island, since August 1990. This program was called CATS (Commuter Assistance Teams) until August 1994. In September 1994, this program was expanded to cover more roadways in Region 10 and three roadways (I-684, Sprain Brook Parkway and a lower section of Bronx River Parkway) in Region 8. Currently, the HELP program uses 22 pick-up trucks and eight reserve pick-up trucks to serve 181 centerline miles of roadway in Regions 8 and 10.

These vehicles provide free assistance to motorists with minor problems such as no fuel or coolant, jump start, help in changing a flat tire, removal from travel lanes, providing use of a cellular phone or call the HELP dispatcher to send a tow truck. In Region 8, nine trucks, seven trucks plus two reserve trucks, patrol a total of 44 centerline miles of roadway. Three trucks patrol and one truck is in reserve to patrol the 29 centerline miles covering the entire length of I-684. Four trucks patrol and one truck is in reserve for 15 centerline miles of the Sprain Brook Parkway and the lower section of the Bronx River Parkway. The HELP vehicles patrol from 6 to 10 AM and from 3 to 7 PM, Monday through Friday, excluding NY State Holidays. The HELP technicians report and log each incident before assisting any motorist. All incidents are recorded manually in the field and input into a database developed in "Paradox". There are a set of standards and criteria in the contract with which the HELP technicians must comply. The HELP technicians must be knowledgeable in motor vehicle repair, as well as courteous to the motorist. These programs help reduce congestion by clearing the lane of traffic and the shoulder as quickly as possible, and are considered components of the Incident Management ITS user service. HELP will utilize 21 roaming vehicles in Region 8 as of February 1999.

6. AUTOMATIC VEHICLE LOCATOR SYSTEMS

Automatic vehicle locator (AVL) systems provide agencies with real-time information about vehicle location. In some cases, AVL systems also provide additional information about vehicle status (speed, vehicle diagnostic information, vehicle audio and/or video surveillance). The specific benefits of an AVL system vary, depending on the capabilities of the system and the needs of the agency implementing the system. AVL systems may be used to facilitate dispatch in the case of enforcement and emergency vehicles; they may be used to better track performance and operating conditions in the case of transit vehicles; they may be used to track equipment and/or freight in the case of commercial vehicles. Thus, AVL systems may be considered an application of the Emergency Vehicle Management, the Public Transportation Management, and Freight Mobility ITS user services, depending on the type of agency that implements the system. A more detailed explanation of the AVL System can be found in the Functional Requirements chapter.

There was an initiative to develop and install an AVL system in 30 HELP vehicles in Regions 8 and 10. The system was also to include a dead reckoning feature to more accurately locate the HELP vehicles when they stop for a disabled vehicle. The system was estimated to cost $1 million. The system has not been built due to budgetary constraints.

Westchester County DOT has a funded project to upgrade their Motorola signpost-based Vehicle Location System (VLS). This system has been operational for the Westchester County Bee-Line System since 1984. The $2.46 million system was considered state-of-the-art in the 1980s and was the first fleet-wide system in New York State. The system will be upgraded to a Global Positioning System (GPS)-based locating system for approximately 350 to 400 vehicles. In addition, a new communications backbone will be installed adhering to Society of Automotive Engineers SAEJ-1708 standard for a vehicle area network (VAN). Approximately $11 million has been secured for the installation of the VLS, radio system and new electronic fareboxes.

7. ELECTRONIC TOLL COLLECTION

The New York State Thruway Authority has implemented an electronic toll collection (ETC) system, EZPass. NYSTA's electronic toll collection allows vehicles to pass through toll collection areas without stopping, reducing vehicle delay, as well as increasing agency operating efficiency by reducing the personnel needed for toll collection. Vehicles using electronic toll collection are equipped with transponders, which can be read at freeway speeds, and allow payment on a monthly credit or debit system. Electronic toll collection is an application of the Electronic

Payment Services ITS user services. Other area agencies include the NYS Bridge Authority and the Port Authority of NY and NJ.

8. TRANSMIT PROJECT

TRANSMIT (TRANSCOM's System for Managing Incidents and Traffic) uses EZ Pass toll tags and roadside readers to determine travel times between known points along the NYS Thruway from the Tappan Zee Bridge to the Garden State Parkway and the Garden State Parkway from Hillsdale, New Jersey to the New York State Thruway to determine areas of congestion and locations of incidents. As part of the TRANSMIT expansion program, the following roads are proposed to be equipped with transponder readers to sample average travel times.

Cross Westchester Expressway (4 readers)
- I-87/I-287 split (MP 11.85 or MP 0.1)
- Route 100A overpass
- I-684 overpass
- Bowman Avenue overpass (MP 0.1) (or at near High Street; MP 9.8 or MP 10.1)

New England Thruway (3 readers)
- Route 1 Bridge (MP 13.75) just as I-287 merges
- Route 125 Murray Avenue overpass (MP 9.9) (or MP 9.6)
- Route 1 (New Rochelle) (MP 5.9) (or MP 5.75 or MP 5.6)

I-87 (3 readers)
- Ashford Avenue
- Midland Avenue overpass (MP 2.45)
- McClean Avenue overpass (MP 0.2) (or MP 0.4)

Bronx River Parkway (1 reader)
- Oak Street overpass (MP 1.5)

Sprain Brook Parkway (3 readers)
- Tarrytown Road overpass (or Hartsdale Road overpass)
- Ardsley Road overpass (or Underhill Road)
- Central Park Avenue overpass (or Tuckahoe Road overpass)

Hutchinson River Parkway (3 readers)
- North Street overpass
- Mamaroneck Road overpass (or Mamaroneck Avenue or south of Mamaroneck Ave.)
- Cross County Parkway split

Cross County Parkway (2 readers)
- Pedestrian overpass (or Murray Avenue overpass)
- Sign Bridge over Eastbound Cross County Parkway (provides CCP to HRP NB/SB)

9. MODEL ITI DEPLOYMENT FOR METROPOLITAN NEW YORK CITY AREA

The USDOT selected four (4) metropolitan areas (San Antonio, Seattle, Phoenix and the NY/NJ/Connecticut metropolitan area) for the demonstration of intelligent transportation infrastructure. The intent is to provide showcase demonstrations where the public and local officials can see and experience the benefits of ITS. The effort is the next step in the USDOT Operation TimeSaver initiative to promote ITS technology. In the New York City metropolitan area, the focus will be on making travel condition information more readily available to commuters and commercial vehicle operators via public/private partnerships.

Traveler information would include information about roadway and transit conditions as well as transportation services available. A regional Transportation Management System (TMS) connecting all of TRANSCOM's member agencies will gather information via a computer-based network server (a kind of "virtual" Transportation Management Center (TMC). This information can also be disseminated at traveler information kiosks, where the traveler can take printed directions or over in-vehicle terminals that audibly and visually provide directions.

10. SATIN PROJECT

In the NY/NJ/Connecticut area, the SATIN (Service Area Travelers Interactive Network) Project will provide motorists with advanced information on road conditions and give transit users current schedule and delay information (utilizing a system of traveler information kiosks at transit stations through a public/private partnership between TRANSCOM/PANYNJ and the private sector) thus enabling all travelers to choose the best route on a given day and reducing congestion. Additional benefits include increased productivity and efficiency for commercial motorists, promotion of regional tourism efforts and increased patronage of service areas and rest stops for the regional economy, and an improved public image for transportation agencies contributing information.

11. HIGHWAY ADVISORY RADIO

Highway Advisory Radio (HAR) transmitters (low powered AM radio transmitters used to broadcast local information to automobile and personal radios over a 5 to 6 mile radius) provide information regarding current traffic, roadway, and/or weather conditions to commuters. The provision of this information may be considered an application of the En Route Driver Information ITS user service.

An HAR system has been implemented by the New York State Thruway Authority. The Authority has installed five synchronized transmitters along its facility; one at the Spring Valley Toll Plaza, one at the Suffern Interchange, one at the Tappan Zee Bridge, one at the I-287/I-684 Interchange and one in Nyack. These five HAR transmitters cover I-87 from Sloatsburg to the Cross Westchester Expressway, the entire Cross Westchester Expressway and the entire section of I-95 within Region 8.

To inform motorists when to tune their radios to receive information, HAR warning signs have been installed with lights that flash only when messages pertaining to abnormal traffic conditions are being conveyed. Messages are transmitted during maintenance and construction activities, as well as during incidents. The radio messages are deployed over the telephone lines to the HAR transmitters. There is a separate telephone line to each of the HAR signs with an automatic dialer. The dynamic capability of the signs (the lights flash when there is an important message) enhances the effectiveness of the system.

Eight (8) HAR transmitters are located in the Lower Hudson Valley Area. These locations are also equipped with the flashing beacon signs. The Thruway Authority has installed three (3) transmitters; in Yonkers at the interchange of I-87 and the Cross County Parkway; in Pelham Manor at the interchange of I-95 and the Hutchinson River Parkway; and in New Rochelle along I-95/New England Thruway. There are also three (3) transmitters in Rockland County. The NYSDOT and the NYCDOT are planning to install a transmitter in the Bronx at the interchange of the Cross Bronx Expressway (I-95) and the Bronx-Whitestone Expressway (I-678).

12. VARIABLE MESSAGE SIGNS

The NYSTA uses Variable Message Signs (VMS) throughout the region. There are four permanent signs currently in use. There are two signs at the Tappan Zee Bridge. One is for traffic crossing into Westchester County and the other is for traffic crossing into Rockland County. There are also two signs along I-87. One is for southbound traffic and is located south of Tuckahoe Road in Yonkers. The other is located on I-87 for northbound traffic, south of 233rd Street in the Bronx.

The NYS Bridge Authority is using a VMS on each approach of the Newburgh-Beacon Bridge and the Mid-Hudson Bridge.

Connecticut DOT (ConnDOT) installed two VMS in the region. The first one is located on northbound Hutchinson River Parkway, two miles south of I-287. The second VMS is located on northbound I-95, south of I-287. Both VMS are controlled via telephone lines from ConnDOT's TOC in Bridgeport.

NYSDOT plans to install one VMS on southbound I-684, seventeen (17) miles north of I-287.

Portable VMS are used by the NYSDOT and the NYSTA during construction activities. Some NYSDOT maintenance residencies have portable VMS available for emergency use. An effort should be made to retain some portable VMS after construction is completed for use with long-term roadway closings due to weather and accidents.

The Mid-Hudson South Transportation Improvement Plan includes sixteen (16) VMS in Westchester County at a cost of $2.1 million.

13. FIBER OPTIC CABLE

Efforts to install fiber optic cable are underway by multiple entities in the Lower Hudson Valley. In some areas (e.g., Maryland, with the Highway and Transportation Department and Missouri, with their highway department), fiber optic cable is being installed as part of a public/private venture. In exchange for use of public right-of-way, the private entities installing the cable will allow the public entity use of a number of the fibers on the cables being installed. Fiber optics partnerships will allow public agencies to save not only on capital investments, but also on maintenance expenditures. Fiber optics provide a communications infrastructure that can be utilized for traffic control and video, voice or data transmission.

New York State Thruway Authority - A public-private partnership has been established between the NYSTA and MFS Network Technologies, Inc. to provide a fiber optic network along the NYS Thruway rights-of-way to provide high-speed voice, data and video communications. Fiber optic cable has been installed on the New York State Thruway. There are 12 fibers in this cable, dedicated for the Authority's use. This communications system covers approximately 5 miles of the Thruway from the middle of the Tappan Zee Bridge to Exit 8 of the Cross Westchester Expressway. This fiber optic cable connects all of the NYSTA's CCTV cameras with their Tarrytown Office and is installed in a fiberglass conduit on the Bridge in a multi-duct PVC conduit. MFS expects to install the fiber optic network along the entire 641-mile Thruway right-of-way, as the market demands. Inner duct and dark fiber will be available for lease through user agreements. Additional inner duct will be added if there is sufficient demand by end users. MFS will own the network during the 20 year agreement and then transfer ownership to the Authority.

New York State Department of Transportation In September 1995, the New York State Department of Transportation issued a Request for Proposal for all interested parties to install fiber optic cable within the rights-of-way of the State's limited access highways. The State developed the list of routes along which it wanted to have fiber optics installed within each region. Participation would follow standard competitive bidding practices. The current policy of the NYSDOT is that the rights-of-way of the limited access highways are open and available at all times for the installation of conduit and communications medium. The RFP was reissued in the Summer of 1998, and as of this report, two parties expressed an interest.

14. CLOSED-CIRCUIT TELEVISION CAMERAS

The NYSTA has deployed five (5) CCTV cameras along a three mile stretch of I-87 from the Cross Westchester Expressway to the Tappan Zee Bridge. An expansion of ten (10) CCTV cameras is planned along the I-87/I-287/Tappan Zee Bridge Corridor. A system of loop detectors will be tied into this project to determine traffic flow.

The Transportation Improvement Plan for Mid-Hudson South includes CCTV cameras to be installed along the Bronx River Parkway in 1998/1999 at a cost of $240,000.

15. IRVN PROJECT

TRANSCOM's IRVN (Interagency Remote Video Network) will be a digital video network where video from the agencies' Traffic Operation Centers (TOCs) will be shared with each other and TRANSCOM. The network will consist of the following thirteen locations:

Interagency Remote Video Network (IRVN)
Proposed Network Locations

Location Number	Number of Feeds *	Agency/Location
1	0	TRANSCOM, Jersey City, NJ
2	91	Connecticut Department of Transportation, Bridgeport, CT
3	4	New Jersey Turnpike Authority, New Brunswick, NJ
4	1	New Jersey Highway Authority, Woodbridge, NJ
5	3	New Jersey Department of Transportation, Mt. Arlington, NJ
6	35	New York City Department of Transportation, L.I. City, NY
7	46	New York State DOT, Hauppauge, NY
8	7	New York State Thruway Authority, Tarrytown, NY
9	23	Port Authority of New York & New Jersey, Fort Lee, NJ
10	7	Port Authority of New York & New Jersey, Weehawken, NJ
11	0	New Jersey Transit, Maplewood, NJ
12	8	MTA Bridge and Tunnels, Randall's Island, NY
13	2	Bergen County Police, Hackensack. NJ

**The number of video feeds indicates how many video feeds that agency will contribute to the network.*

The number of locations may change, if necessary, to stay within the IRVN financial budget.

16. TRAFFIC SIGNAL SYSTEMS

In Westchester County, Westchester Avenue has 15 traffic signals and over 200 loop detectors operating on a closed-loop traffic signal system in the City of White Plains and the Town of Harrison. The system is running on a PC utilizing modified Urban Traffic Control System (UTCS) software.

City of White Plains - The City operates an Urban Traffic Control System (UTCS) that currently includes 95 signalized intersections with an additional 9 signals to be added in the near future. The system has the capacity to coordinate up to 300 signalized intersections.

The Mid-Hudson South Transportation Improvement Plan includes a closed-loop traffic signal system connecting 19 traffic signals along North Avenue in New Rochelle for 1999/2000 at a cost of $1.42 million. Also, intersection improvements, as part of the White Plains traffic signal system, are scheduled for 1998/1999 at a cost of $947,000.

Westchester County
Potential Traffic Signal System Expansion

No of Signals	Locations	Status
9	Mamaroneck Avenue (5) S. Kensico Avenue (3) Lake Street (All in White Plains)	To be installed by Fall 1997
5	Old Mamaroneck Rd (W P)	In 1997 to 2002 TIP
20	Misc. White Plains	Long term capital program
4	Route 100/Central Avenue (Just south of White Plains)	No Plans
2	Route 22/Central Avenue (Just north of White Plains)	No Plans
6	Mamaroneck Avenue (Just south of White Plains)	In 1997 to 2002 TIP
3	Route 127/North Street (Just south of White Plains)	No plans
19	North Avenue, New Rochelle	Design
6	Kensico Rd./Columbus Ave Town of Mount Pleasant	
9	Bronx River Parkway (WCDPW)	
6	Mamaroneck Avenue Town of Harrison	
49	Total Potential Number of Traffic Signals	

Westchester County DPW operates a UTCS that coordinates 15 signalized intersections along five miles of Westchester Avenue between White Plains Road and Purchase Street.

The City of White Plains traffic signal system and the WCDPW system are adjacent to each other, but are not connected with a communications link.

17. TRANSPORTATION DEMAND MANAGEMENT

Region 8 has been involved in Transportation Demand Management projects since 1982. The Mid-Hudson South Transportation Improvement Plan includes approximately $3.5 million annually for TDM projects. In addition, there is over $700,000 for TDM projects related to ITS. NYSDOT, in cooperation with other agencies, has focused on implementing as many of the following early implementation actions as possible:

Region 8 TDM Early Implementation Actions

Bus/Rail Uni-Ticket (Metro North, NYSDOT, Rockland, Dutchess and Westchester)
Guaranteed Ride Home Program
MetroPool Rideshare & Van Programs.
Commuters' Register (MetroPool & NYSDOT) - circulation of 18,000 monthly
Commuter Connection (MetroPool & NYSDOT) - employer newsletter
Transit Check (tax free transit vouchers available from employers).
White Plains Intermodal Transportation Center (upgrade).
Tappan Zee Express Bus Service (Rockland-Tarrytown-White Plains)
Inter-Suburban Express Bus Services

- Orange County - Westchester Express (Middletown-White Plains)
- Taconic Express (northern Westchester Co, - White Plains)
- Poughkeepsie-White Plains Express
- Newburgh-Brewster-Danbury, CT Express
- Newburgh-NYC Express

White Plains Commuter Shuttle Bus (Metro North station to employment sites)
Subscription Bus Service (Metro Pool & NYSDOT)
EZ Pass Electronic Toll Collection
TRANSMIT-EZ PASS based traffic surveillance technology
Variable Message Signs (real time traffic information)
Highway Advisory Radio
Tappan Zee Bridge Moveable Median Barrier
Tappan Zee Bus & Carpool Toll Booths
Voluntary Employee Commute Option Program/Employer Transportation Coordinators
Telecommuting Demonstration Program
Regional TDM Unit (formed to oversee all TDM activities)
Mobility Advisory Committee (follow up to HOV/TSM Task Force)
SMART Campaign (transit & ridesharing ads on radio/in newspapers)
Park & Ride Lot Construction & Site Studies
HELP Program (Highway Emergency Local Patrol)
Haverstraw & Nyack Ferry Service
Stamford-White Plains Express Bus

In June of 1996, the NYSTA began a study of incentive pricing on the Tappan Zee Bridge to determine whether varying tolls by time of day and other traveler incentives could help to alleviate traffic congestion. Incentive pricing is designed to reduce congestion by encouraging the use of carpooling, transit and off peak period travel by varying tolls according to time of travel. The Thruway already uses the moveable center barrier and EZPass to manage demand.

18. REGIONAL TRANSIT SURVEYS

An essential part of the ITS Early Deployment Study involves identifying the public transportation ITS applications that both meet the needs of the public transit service providers in the region and are complementary to the requirements of proposed traffic control applications. The primary public transportation service providers serving the jurisdictions within the study area (Putnam County, Dutchess County, Rockland County, Orange County and Westchester County) were contacted.

Two different questionnaires were prepared. Twenty-six transit service providers identified in the Lower Hudson Valley received one of the surveys. The large service providers, such as the MTA and Metro-North, were sent a survey questionnaire dealing only with ITS issues. The remainder of the providers were sent a survey questionnaire designed to collect information about both ITS issues and basic operations. Twenty-six questionnaires were distributed. The majority of the providers not completing the questionnaire were small transit or paratransit operators for whom the questionnaire was only peripherally relevant. All the public service providers responded except for NJ Transit and Poughkeepsie Transit. Follow-up interviews were conducted as necessary and may continue to be necessary during the course of the project. The table below identifies the service providers and whether or not they submitted substantive responses to the questionnaire:

Transit Service Providers Surveyed

Service Provider	Service Area	Received Survey	Responded to Survey
Dutchess County			
Dutchess County Loop	Dutchess	Yes	Yes
Poughkeepsie Transit	Dutchess	Yes	No
Rockland County			
Rockland TOR & TRIPS	Rockland	Yes	Yes
Monsey/New Square Trails	Rockland	Yes	No
Rockland Red & Tan Lines	Rockland	Yes	No
NJ Transit	Rock/Orange	Yes	No
Orange County			
Newburgh Dial-A-Bus	Orange	Yes	Yes
ShortLine	Orange	Yes	Yes
New Windsor-Cornwall Dial-A-Bus	Orange	Yes	No
Montgomery-Crawford Dial-A-Bus	Orange	Yes	No
Monroe Bus Corp.	Orange	Yes	No
Monroe Dial-A-Bus	Orange	Yes	No
Lester Lines	Orange	Yes	No
Kiryas Joel Mini Bus	Orange	Yes	No
Highlands Dial-A-Bus	Orange	Yes	No
Adirondack Trailways	Orange	Yes	No
Newburgh-Beacon Bus Corp.	Orange	Yes	No
Goshen-Chester Dial-A-Bus	Orange	Yes	No
Warwick Dial-A-Bus	Orange	Yes	No
Wallkill Dial-A-Bus	Orange	Yes	No
Port Jervis Dial-A-Bus	Orange	Yes	No
Middletown Transit Corp.	Orange	Yes	No
PART	Putnam	Yes	Yes
Westchester Bee-Line	Westchester	Yes	Yes
Metro-North	Regional	Yes	Yes
MTA	Regional	Yes	Yes

Prior to interpreting the findings of the questionnaires as they relate to the Lower Hudson Valley, it is useful to review some of the basic terms and concepts associated with ITS public transportation applications. Intelligent Transportation Systems for transit or Advanced Public Transportation Systems (APTS) is the application of “high-tech” information systems to the direct and peripheral operations of public transportation systems. ITS for Public Transit Systems may typically include the following functions:

Automated Vehicle Location and Monitoring (AVL)
Computer Assisted Scheduling and Dispatching
Vehicle Systems Monitoring
Automated Passenger Counting and Reporting
Geographic Information System Mapping
Automated Fare Collection and Reporting
Automated Annunciation/Public Address

These functions can provide transit operators with the following types of information:

Location of transit vehicles
On-time status of transit services
Capacity status of transit vehicles
Vehicle engine/operating function status
Passenger boarding and fare data

With this information, ITS enhanced systems make the generation of the following functions and services possible:

Service status information available to the public and other transit providers
Inter-modal and inter-carrier service coordination
Trip requests can be made, booked and dispatched in real-time
A single fare media can be used on trips involving multiple carriers
Provide traveler information for an entire trip, even involving multiple carriers
Fare and passenger data collected in real-time and reported automatically
Drivers can request and receive navigational assistance on the fly
Local bus services - vehicle can go to the rider as well as the rider to go to a bus stop

19. ITS TRANSIT APPLICATIONS AND INITIATIVES

The Mid-Hudson South Transportation Improvement Plan includes $1.5 million for the Automatic Vehicle Location system for the TRIPS bus system in Rockland County, ten paratransit vehicles.

Table 1 presents a brief overview of the existing ITS initiatives being undertaken by the Metropolitan Transportation Authority and its family of transportation services that have particular relevance to the Lower Hudson Valley. The ability to electronically tie into the following systems or subsystems is important in creating an apparently seamless network of information interchange.

Table 1 Metropolitan Transportation Authority Current ITS Initiatives

Service Provider	Project Code	Project Title and Description	Project Status
MTA-NYCT	T01	***Automated Vehicle Locator & Control System*** Will track movement/location of NYCT buses, improve dispatch productivity and on-time performance. Information captured will be used for customer information display system at bus stops in the City.	System Design Complete
MTA-NYCT	T02	***Automated Train Supervision*** Will include: automated vehicle identification, real-time train tracking/schedule adherence, customer information system, automated routing, automated dispatching, and centralized traffic control.	Design Phase
MTA-NYCT	T06	***On-Line Travel Information System (OTIS)*** Computer-based system to supply customer service agents with alternative route, schedule and fare information in response to telephone inquiries.	On Line
MTA-NYCT Metro-North	T07 M02	***Customer Information System*** Interactive voice response system to provide answers to telephone inquiries regarding service and fare information.	On Line
MTA-NYCT	T10	***Bus Customer Information System*** System will provide real time bus travel information to transit customers at bus stops via video monitors, electronic variable message signs, and smart kiosks at major transfer centers.	System Design Complete
MTA-Metro-North	M05 M06	***AVIS Expansion/Grand Central Station VIS Expansion*** Integrated audio visual passenger information network at key stations. Meets ADA requirements. Interfaces train tracking and reporting system. Installation of visual information system at Grand Central Station to provide public with train arrival and departure information.	Work Scope Final
MTA-Metro-North	M07	***Interactive voice response*** Common system for interactive voice response related applications including train crew management. Will serve as a fundamental part of any future traveler information system.	Technical Work Scope Complete
MTA-Bridges & Tunnels	B03 B05	***EZ Pass & EZ Pass TRANSMIT Operational Test*** Electronic toll collection system permits automatic drive-by payment. Related system detects incidents by computing projected travel times between toll tag readers.	On Line

The preceding ITS initiatives are intended to address needs and operating issues which are very similar to those identified by transit service providers in the Lower Hudson Valley. Based on the survey responses, a great deal of information was assembled about the current status of ITS applications in the region and the stated intentions of the public transportation service providers as to whether they are planning to, or are interested in using ITS applications. Of particular note is that nearly all the respondents stated that Automated Vehicle Location technologies were being considered and/or are desirable. Of these, most were interested in using a Global Positioning Satellite (GPS) based Automatic Vehicle Location (AVL) system. Other findings included wide interest in:

A System for Coordinating Transfer Activity (Intermodal, Inter-Operator and Intra-Operator)
A System to Facilitate a Regional Fare
Real-Time AVL/Computer Aided Dispatching Capabilities
A System to Provide Real-Time Traveler Information
A System of Fare, Operating/Ridership Data Collection and Reporting

More specifically, the questionnaire elicited information about existing public transportation ITS applications and intentions in each of the jurisdictions in the Lower Hudson Valley. The current ITS initiatives in the Lower Hudson Valley are as follows:

a) Westchester County

Programmed replacement of existing radio communications system with a system of voice and data capable mobile radios, able to accommodate various ITS systems.
Participant with NYSDOT, NYSTA and MTA Metro-North in the planning and development of the Advanced Transportation Management Center for the Lower Hudson Valley.
An Automated Traveler Information System (ATIS) is currently in use. It provides the public with trip specific Bee-Line service information. This system is programmed to be upgraded to be fully automated and available 24 hours per day.
Programmed and funded replacement of sign post based AVL system with a GPS-based AVL system. This upgrade will expand coverage to all fixed route services, supervisory vehicles and paratransit services. The system will handle a 350 to 400 vehicle fleet. It will be SAE-1708 compatible.
An automated paratransit trip booking, scheduling and dispatching system (APRSDS) is in use and available to public and private operators.
Programmed upgrade of fare boxes to accommodate Smartcard technologies and acquire passenger counting and service data collection capabilities either separately or in conjunction with fare box upgrade
An additional $400,000 was budgeted to upgrade the ATIS and APRSDS systems in 1996 and 1997. About $11 million has been secured for the installation of the vehicle location system, radio system and new electronic fare boxes.

b) Putnam County

Planning to use GIS/mapping capabilities,
Planning to use automated fare/passenger counting capabilities and
Proposed acquisition of GPS-based AVL system

c.) Rockland County

Using Passenger Counting System
Using Automated Annunciation/Public Address System
Using GIS/Mapping System
Planning to Use Automated Scheduling/Dispatching System

The stated general ITS interests and projects in the Lower Hudson Valley region include the following ITS applications and capabilities:

GPS-Based AVL System Capabilities
Automated Scheduling and Dispatching Capabilities
Automated Annunciation/Public Address Capabilities
Real-Time Trip Booking and Dispatching
Inter-Modal, Inter-Operator Coordination Capabilities
Real-Time On-Time Service Information Processing Capabilities
Automated Fare and Service Data Collection & Reporting Capabilities
Signal Prioritization by Transit Buses
Vehicle System Monitoring Capabilities
Real-Time Traffic Information Capabilities
Regional/Multiple Carrier Fare Media Capabilities

d) Critical Issues for Transit

Given the information about ITS initiatives in the New York City region (NYSDOT Region 11) and the Lower Hudson Valley region (NYSDOT Region 8), several technical and institutional issues become apparent. These will require attention in the ITS Early Deployment Plan. Some of the critical issues which will need to be addressed in developing a regional ITS plan, especially one that interfaces with a system to be developed for the New York City region, will include the following:

Type of fare media to be used (magstripe, smartcard, proximity, other)
AVL technology (GPS vs. Differential GPS)
Communications compatibility/capacity (National Transportation Communication ITS Protocol (NTCIP), Location Reference Message Specifications (LRMS), Transit Communication ITS Protocol (TCIP))
General use /requirement of open standards (SAE J-1708)
System Phasing and Integration
Institutional framework and decision-making
Database formats and compatibility

The ITS infrastructure required to facilitate greater regional utilization of the current highway and transit networks can also be used for secondary purposes which have the potential to increase the productivity and efficiency of local transit and paratransit services. For example, the systems which facilitate coordinated bus-to-bus and bus-to-rail transfers, and which provide travelers with information about highway conditions and the status of the next express bus, can also be used to better coordinate local bus services and to allow for real-time transit and paratransit demand-responsive services. What is critical is that these efforts to identify the regional needs for an ITS infrastructure, while aimed primarily at improving regional throughput on the existing highway and public transportation systems, are and should also be designed to permit local transit and paratransit service providers to plug into the system when and as appropriate in the future.

20. TRANSIT ORGANIZATIONAL AND INSTITUTIONAL ISSUES RELATED TO ITS EARLY DEPLOYMENT

Local Bus and Paratransit Services - ITS applications are addressed in this study primarily as they relate to benefiting commuter services. This is a reasonable prioritization as the emphasis is to move more people more efficiently using existing resources enhanced by ITS technologies. Paratransit services and local bus services are not, however, being left out of the plan. The same basic technologies being examined for improving mobility throughout on the region's highways and commuter services can be applied to local transit and paratransit services. Once the basic ITS infrastructure is in place, so long as communications and data standards are kept open as is consistent with national ITS standards, then all technology is available for application to local and paratransit services. For example, the technology required to track the location of commuter buses is the same as that required to track local buses and paratransit service vehicles. In the functional design process, the requirements of local bus and paratransit service providers will be included. These capabilities will include the following: vehicle location monitoring, computer assisted scheduling and dispatching, real-time trip booking and dispatching, automated trip billing and electronic fare, passenger and operational data collection.

Private Operator Funding - The inclusion of the region's many and important private transit service providers in the ITS system plan is a must. The inherent difficulties in facilitating this task are recognized. The transportation planning and programming functions are set up by public agencies to serve public agencies. Although the private operators carry a large number of commuter trips each year in the region (Red & Tan and ShortLine alone carried 3.7 million passengers in 1994), the private service providers tend to get lost in the mix when it comes to regional service planning and financing. The role of the private operators in helping to provide mobility to the public is recognized. An important task in the development of the framework in which the ITS system is to be designed will need to include a means to facilitate the inclusion of the private carriers in the planning and funding processes.

21. ADVANCED TRAVELER INFORMATION SYSTEMS

Westchester County DOT's Automated Traveler Information System - The Westchester County Department of Transportation is currently using an Automated Travel Information System (ATIS) to provide the public with information about the Bee-Line System's bus schedules. This system (which was installed by Tidewater Consultants, Inc., at a cost of $800,000 (80% FTA, 20% local)), is used for trip planning based upon inquiries from the riding public. Information agents type the inquiry into the system and receive one or more trip plans. These trip plans are then given to the public over the telephone. In the near future, this system will become fully automated. Passengers will be able to interact with the computer directly over the telephone, using a voice-response system. This enhancement will enable trip planning information to be disseminated 24 hours a day, seven days a week, without requiring a live agent on the phone line.

Westchester County DOT's Para-Transit Scheduling System - The Westchester County Department of Transportation is also utilizing an Automated Paratransit Recording Scheduling and Dispatching System (APRSDS), using the Midas software created by Multisystems, Inc. This system allows telephone agents to record and schedule Bee-Line Para-Transit trip requests from Para-Transit clients, as well as interface with the private operations that provide Para Transit service for Westchester County. The APRSDS cost approximately $762,000 (80% FTA, 20% local).

22. EMERGENCY VEHICLE SIGNAL PREEMPTION

Emergency vehicle signal preemption allows emergency vehicles to get preferential treatment at traffic signals. Emergency responders in White Plains utilize traffic signal preemption to reduce response time and increase safety. Signal preemption for emergency vehicles is considered an application of the Emergency Vehicle Management ITS user service.

23. TRANSIT VEHICLE SIGNAL PRIORITIZATION

Affording transit vehicles priority treatments over single occupant vehicles (SOVs) is one means of making transit services somewhat more competitive with the automobile. It also establishes a clear signal that moving transit vehicles with many people is given a greater value than moving SOVs. There are difficulties in affording priority treatments to non-emergency vehicles. ITS can help to facilitate priority treatments for transit vehicles by integrating system decision-making. Using an established communications systems between the vehicle and the traffic signal, buses can be provided a priority treatment over other vehicles by affording the bus an early green light or an extended green light. Communications between vehicle and traffic signal can be achieved either within an AVL-based application or as a separate radio-based transponder system. In either case, with the development of the proposed TMC, signal prioritization for buses could be accommodated as part of the traffic control system. Minimal degradation to SOV traffic flow would be expected. Other priority treatments to be considered for buses include queue jumping and automated high passenger vehicles (HPV) facility monitoring.

E. SYSTEM CHARACTERISTICS

A question from the User Services survey, distributed to the area agencies, asked what their agency perceived as the transportation problems of the region today and in the future. Increases in traffic congestion and delays and the overall lack of funding for transportation maintenance and improvements topped the list of responses. Other responders thought that there is a lack of adequate or realistic alternative mass transportation; while another thought that an increase in transit/bus service on the highways would add to traffic problems. Traffic incidents and their effect on highway safety and traffic congestion, especially major incidents and the numerous accompanying secondary incidents that result, was another response to this question.

System characteristics include current and future traffic volumes and accident data, signal control systems on selected arterial roadways that may be appropriate for diversion from the freeway and transit routes for the major transit agencies in the Lower Hudson Valley.

1. CONGESTION CRITERIA

Recurring congestion is associated with roadway segments that experience the same type of congestion at the same location, usually during the peak periods. The criteria to determine areas of recurring congestion was based upon the peak period percentage of the Annual Average Daily Traffic volume (AADT) and the volume to capacity ratios for the particular roadway type. Recurring congestion occurs when the facility experiences Levels of Service E/F. Level of Service is a measurement of the quality of traffic flow along a facility. Level of Service A indicates free flow conditions, while LOS F is stopped conditions.

Nonrecurring congestion is associated with accidents and incidents and is less predictable than recurring congestion. This type of congestion can occur often enough to plan for but not so often that it can be predicted with absolute accuracy. The criteria is based upon the average number of accidents that occur along a roadway segment. The usual “Accidents per Million Vehicle Miles Traveled” data is not a criterion that provides the frequency of accidents at a location. In order to determine the amount of delay associated with nonrecurring congestion, the frequency of accidents was used. The volume criteria were lowered to include Level of Service D, because even minor incidents along the shoulder of the roadway that do not block travel lanes have an effect on traffic at Level of Service D, as well as LOS E/F. Accidents that block travel lanes can even have an effect on LOS A.

Table 2 Recurring and Nonrecurring Congestion Criteria

Recurring Congestion Minimum Criteria

Freeway/Interstate	Divided Arterial	Undivided Arterial
15,000 AADT/Lane	10,000 AADT/Lane	7,500 AADT/Lane
LOS E/F	LOS E/F	LOS E/F

Nonrecurring Congestion Minimum Criteria

Freeway/Interstate	Divided Arterial	Undivided Arterial
12,000 AADT/Lane	8,000 AADT/Lane	5,000 AADT/Lane
7 Accidents/Lane-Mile/Year	11 Accidents/Lane-Mile/Year	14 Accidents/Lane-Mile/Year
LOS D, E/F	LOS D, E/F	LOS D, E/F

2. RECURRING CONGESTION

From the existing average daily traffic volumes in the database provided in the NYSDOT Sufficiency Manual, the areas of greatest recurring congestion focus on Lower Westchester and Rockland Counties centering on the I-287/I-87 corridor. In Lower Westchester County, the main areas of recurring congestion occurs along the north-south routes; Saw Mill River Parkway, Sprain Brook Parkway, Hutchinson River Parkway, and I-95. In the east-west direction; I-287 and the Cross County Parkway also meet the criteria for recurring congestion. In Rockland County, I-87/I-287, the Palisades Interstate Parkway, as well as Route 202 show signs of recurring congestion. In Putnam County, the recurring congestion can be found along Route 6, Route 22, Route 312 and I-84. In Orange County, recurring congestion routes include Route 6/17 (since this data was gathered, this has been reconstructed as an overpass near Woodbury Commons), Route 202 and parts of Route 17K. According to the database, the focus of recurring congestion in Dutchess

County centers on Poughkeepsie, with Route 9 and Route 9G. Also, a section of Route 82 in Hopewell Junction met the recurring congestion criteria.

The Skycomp aerial flight summaries were also used to verify and determine areas of recurring congestion. In addition to the recurring congestion found in the database, Skycomp found volume-related congestion, on at least one occasion, in the following areas:

Route 6 in the Peekskill area
Route 35 near FDR State Park
Taconic State Parkway in the Yorktown area
Routes 9, 9A and the Taconic State Parkway in the Ossining area
Route 35 and I-684 in the Lewisboro area
Saw Mill River Parkway in the Mt. Pleasant and Hastings areas
Route 59 paralleling I-87/I-287 in Rockland County
Route 45 in the Spring Valley area
Route 9 in the Poughkeepsie area
Taconic State Parkway in the Mt. Pleasant area (has since been upgraded to 6 lanes)

Traffic Volumes - Traffic volumes for the routes within the study area can be found in the printouts of the database of Appendix A. Table A-1 summarizes the roadway segments that exhibit recurring congestion according to the average daily traffic volumes per lane in the database.

3. NONRECURRING CONGESTION

The analysis of nonrecurring congestion was based on accident data provided by NYSDOT. Again, as with the recurring congestion, the greatest amount of nonrecurring congestion can be found in Lower Westchester County and in Rockland County. The Palisades Interstate Parkway, Sprain Brook Parkway, Hutchinson River Parkway, I-87, I-95, as well as some of the east-west routes such as I-287/I-87 and the Cross County Parkway all have some nonrecurring congestion. In Rockland County, parts of Route 202, Route 9W, Route 17, Route 59, Route 303 and Route 45 all have some amount of nonrecurring congestion. In Upper Westchester County, parts of roads like Route 6, Route 35, Route 133, Route 117 and Route 172 met the criteria for nonrecurring congestion. In Orange County, parts of Route 202, Route 208, Route 32, Route 17, Route 9W, Route 211, Route 17M and Route 17A exhibit some amount of nonrecurring congestion. The routes that met the criteria for nonrecurring congestion in Dutchess County include Route 376, Route 44, Route 9 and Route 9G.

Accident Data - Accident data for freeway and arterial facilities are also shown in the printouts in Appendix A. Accident data are expressed in terms of the number of accidents per lane-mile per year. The accident data were provided by NYSDOT by facility for each county. Table A-2 summarizes the areas of nonrecurring congestion based upon the traffic volumes in the database and the accident data added to the database.

Arterial Traffic Signal System - Candidate arterials are those facilities having a signal spacing of no greater than one-half mile and carrying an average annual daily traffic (AADT) of more than 4,000 vehicles/lane in urban areas and 7,000 vehicles/lane in rural areas. Traffic platoons traveling along routes with a signal spacing greater than ½ mile tend to dissipate and the benefits of coordination tend to be lost. Routes carrying less than the defined level of traffic generally do not exhibit congestion; coordination of the signal system would not produce a significant benefit as contrasted with other, more heavily traveled routes.

4. ARTERIAL TRAFFIC SIGNAL SYSTEMS

Potential coordinated arterial traffic signal systems are listed in Table A-3 in Appendix A. The potential for a coordinated system was based upon an average signal spacing of less than or equal to one-half mile. Other factors that will be used to prioritize the list and determine the benefit of coordination will include travel time runs to determine the existing coordination, exact spacing of traffic signals, potential for alternative or diversion routing, as well as the amount of peak period congestion, adjacent land use type and geometrics of the roadway.

Existing systems include those under the jurisdiction of the City of White Plains as well as Westchester County Department of Public Works (DPW). Arterial signal systems are of particular interest on facilities that could potentially serve as alternative routes for diversion of traffic from the freeway.

Coordination of signals on arterial roadways that span more than one municipality is of interest not just during incidents, but also during normal operating conditions. The need for increased coordination among the various cities is important.

5. TRANSIT RIDERSHIP

The public transportation services operating in the Lower Hudson Valley provide significant mobility benefits to the region. These benefits are accrued during the peak commuting periods in the form of commuter services and throughout the day by providing general local and regional mobility. These public transportation services include local public carriers such as PART, regional public service providers such as Metro-North and private operators such as ShortLine.

According to the Federal Transit Administration, based on National Transportation Database reporting, in 1994 the public transportation service providers serving the Lower Hudson Valley carried almost 100 million annual passenger trips. This involved the operation of over 61 million annual service miles and over 2.3 million service hours with a fleet of 700 commuter rail cars and 600 buses. Most of the trips served, 63 percent, were commuter rail trips operated by Metro-North. This includes ridership from stations in Connecticut along the New Haven Line. Ridership on the inner New Haven Line, from Stamford to Grand Central Terminal, averages over 14,000 morning peak period trips which equates to an average annual ridership of over 7 million trips. The remaining trips in the region were provided by local and regional, public and private bus operators. Westchester Bee-Line services carried the second largest volume of passengers at over 29 million annual trips. Westchester was followed by Rockland Coaches (Red & Tan Lines) and Hudson Transit (ShortLine) who carried 2.1 million annual trips and 1.6 million annual trips, respectively with origins or destinations within the study area. These four carriers, Metro-North, the Bee-Line, Red & Tan Lines and ShortLine, collectively carried over 95 million annual passenger trips in the region in 1994, nearly 97 percent of all service provided.

Transit service and operating characteristics for the public transportation service providers serving the Lower Hudson Valley are presented in the table below.

Table 3 Public Transportation Services (1994)

Service Providers	Annual Trips	Fleet in Max Service	Annual Service Miles	Annual Service Hours	Trips Per Capita	Trips Per Service Hour
Dutchess LOOP	658,700	42	1,259,100	78,200	2.54	8.42
Poughkeepsie	398,000	7	256,900	20,900	13.80	19.04
Transport of Rockland (TOR)	1,396,700	30	1,129,800	57,600	5.14	24.26
Clarkstown Mini-Trans.	198,700	5	354,000	17,900	0.75	11.12
Putnam PART	137,200	11	513,100	22,000	2.98	6.22
Spring Valley Jitney	71,200	3	68,900	6,300	2.85	11.27
Rockland Coaches Within Study Area	5,222,300 2,100,000	105	4,285,300	164,200	0.96	31.81
Hudson Transit Within Study Area	2,300,000 1,610,000	107	6,376,544	281,100	0.42	8.18
Monsey New Square	462,600	17	886,900	24,800	1.70	18.63
Metro-North	62,376,200	700	37,936,800	990,200	13.86	62.76
Westchester Bee-Line	29,446,300	263	8,273,100	683,500	33.66	44.43

As the table illustrates, the amount of travel served by public transportation in the Lower Hudson Valley is remarkable. The level of service available in the region varies by jurisdiction but overall the service provided is a viable alternative to the automobile for commuting, and in many areas within the region, for local travel. Service levels in terms of trips per capita (service consumed), are highest in Westchester County, followed by the Metro-North service, Poughkeepsie Transit and Transport of Rockland (TOR). Service productivity in terms of trips carried per revenue service hour are highest for Metro-North, followed by Westchester Bee-Line, Red & Tan Lines and Transport of Rockland.

The existing public transportation services are clearly productive and providing a tremendous amount of mobility in the region. What is important to consider when assessing the requirements of an integrated transportation control system is both the amount of service available and the excess capacity available on existing services. An assessment of the excess capacity available during the peak commuting periods was conducted. This exercise provided an estimate of where and how much additional public transportation service is available for consumption in the Lower Hudson Valley. A product of this analysis is the identification of services with and without excess capacity and an estimate of how many additional trips can be served before additional service must be provided.

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II. LONG-TERM VISION STATEMENT

This Long-Term Vision Statement provides the guidance needed to develop the Strategic Deployment Plan. The Strategic Deployment Plan is based upon the statements in this Vision Statement. Specific examples of the concepts in this Vision Statement and where these concepts will be deployed are provided in the Strategic Deployment Plan.

A. BASIC ELEMENTS OF THE VISION

Based on the evaluation of the existing conditions, surveys of the involved agencies, and determination of potential user services it seems that the Intelligent Transportation System (ITS) for the Lower Hudson Valley should provide an integrated system for the movement of people and goods on the freeway and arterial highways and transit system. The system should create a seamless link among agencies including NYSDOT, the County Departments of Transportation/Departments of Public Works, New York State Thruway Authority (NYSTA), TRANSCOM, Emergency Medical Services (EMS), law enforcement agencies, the transit authorities and private interests. Through current and advanced techniques in surveillance and communication, data on real time traffic flow and weather information will be available to users. Through partnering among agencies, the use of existing resources can be maximized to improve regional transportation operations.

B. GOALS FOR THE INTELLIGENT TRANSPORTATION SYSTEMS

On a policy level, ITS goals have traditionally been structured to reduce congestion, improve mobility and improve safety. More specifically, the goals of the ITS program in the Lower Hudson Valley are:

GOAL 1:

Promote efficient use of the existing and future transportation network including mass transit to move people and goods quicker, cheaper and safer while improving air quality. This can be accomplished by reducing both recurring and nonrecurring congestion through improved efficiency of the transportation network by implementing an Advanced Transportation Management System (ATMS) for the Lower Hudson Valley region that strikes a cost-effective balance. In the balance, it will be necessary to consider:

- a comprehensive geographic coverage
- a wide range of technologies
- including expressways and arterial roadways
- establishing a multi-modal perspective
- eventual 24-hour span of coverage

as well as:

- regional benefits
- costs and cost constraints
- funding availability for capital and operational needs.

GOAL 2:

Improve communications to the general public and between transportation providers to allow intelligent decision making regarding mode, cost and trip time by establishing an Advanced Traveler Information System (ATIS). This system should:

- widely disseminate real-time information on the transportation network and general public
- provide alternate route information during incidents
- integrate a Roadway/Weather Information System (RWIS) in the regional information network and use it to provide information to key users and general public

GOAL 3:

Improve safety throughout the transportation system by continually improving emergency response time and clearance of emergencies and incidents on the transportation network. Some ways this can be accomplished include:

- providing a reference marker system on the roadway for use by highway users
- creating a Transportation Management Center (TMC) that manages traffic flow and provides regional, real-time transportation information
- providing communication links to the various county emergency management offices
- promoting regional cooperation among agencies with overlapping responsibilities

GOAL 4:

Develop a plan or mechanism for providing funding for ITS according to the benefits gained. Promote private/public partnership opportunities, such as:

- emergency service patrols
- the use of industry product demonstration/testing
- working with education facilities
- joint use of communications infrastructure along existing rights-of-way

GOAL 5:

Promote feedback and ongoing evaluation of the performance of the ATMS/ATIS components. The effort could include such things as:

- citizen advisory group meetings on a periodic basis
- a telephone line to call for suggestions and feedback
- an e-mail address for comments or questions regarding ITS

The focus of this ITS Early Deployment Study is the Lower Hudson Valley area of NYSDOT Region 8, comprising the counties of Dutchess, Orange, Putnam, Rockland and Westchester Counties. The large number of participants makes agency coordination and cooperation critical to its success. While agency coordination and cooperation are significant at all times, they become especially critical during incident management and in other situations where a large number of agencies are involved and quick response is imperative.

C.

HIGHLIGHTS OF THE VISION

The NYSDOT would build, maintain and operate an ATMS on the NYSDOT roadway network in the Lower Hudson Valley. On the New York State and New England Thruway, the NYSTA would operate and maintain the ATMS.

- The ATMS would be implemented incrementally, justifying and building public support continually.
- Existing traffic control systems would be upgraded, expanded and integrated with the ATMS.
- Proposed traffic signal systems would be integrated with the ATMS.
- Communications and operations links would be developed between the ATMS and other relevant agencies in the area, in accordance with the Regional and National Transportation Communications ITS Protocol (NTCIP).
- Private sector participation in the ATMS would be encouraged.
- Joint or partnering activities would be encouraged between participating agencies.
- Incident management activities, including rapid response to incidents, would be implemented.
- The various transit authorities would consider upgrading their monitoring activities to include automated vehicle location.
- The transit authorities would collect and distribute real-time information on transit service.
- ATMS information would be used for transportation and transportation-related activities.
- Training programs for ATMS would be prepared to educate staff of participating agencies.

D. DETAILING THE VISION

Based upon the user needs, the alternate scenarios need to be further defined and refined during the design and development process. Agreement between involved parties needs to be developed before any systems are operational and/or integrated. This is one scenario of how the vision could develop over the foreseeable future. A vision statement includes a set of indicators where policy should be developed to further the agreed-upon goals. For the Lower Hudson Valley ATMS, the following categories have been explored by the participating agencies:

- Interests and Opportunities of the Relevant Agencies
- Customers and the Benefits Received
- Roles and Responsibilities of the Relevant Agencies
- Other Issues

E. INTERESTS AND OPPORTUNITIES OF THE RELEVANT AGENCIES

Agencies which have a direct interest in the establishment of the ATMS have been identified and encouraged to participate in the establishment of the ATMS. These agencies include the following:

- New York State Department of Transportation
- New York State Police
- New York State Thruway Authority

- Westchester County
- Rockland County
- Putnam County
- Orange County
- Dutchess County
- Palisades Interstate Parkway Commission
- New York State Bridge Authority
- Various Transit Agencies
- Various Emergency Response Agencies

The needs of these agencies were derived from the User Services survey/questionnaire, along with discussions at several Project Advisory Group meetings. The survey revealed informational needs: real-time traffic conditions, incident status, weather status, transit vehicle tracking, variable message signs (VMS) for motorists and transit rider information, etc. The technical needs of the agencies include: signal system upgrade, fiber optic communications links and ITS training. There was an expressed need for one traffic management/information system to: provide strategic and long range direction, foster coordination, avoid duplication and foster a common language. The surveys revealed an outline of what the system needs: comprehensiveness in geography, technologies and modes, 24 hour access, coverage of all expressways and arterial roadways, incident management that includes all police and links to emergency preparedness system/county alerting system. Some of the open issues include: the role of the private sector, funding sources and implementation.

The surveys were used to form a basic structure for discussion among the agencies. For the Lower Hudson Valley, the following needs and goals have been identified:

1. INFORMATIONAL NEEDS

Real-time traffic conditions (traffic volumes, classifications, weigh-in-motion, speeds, densities)

- Incident status
- Weather status/roadway conditions
- Tracking transit vehicles
- Variable message signs (VMS) for motorists
- Transit rider information
- Events management
- Park & ride locations and availability
- Parking management for downtown
- Advanced Traveler Information

2. TECHNICAL NEEDS

- Signal system upgrade or expansion
- Fiber optic communications links
- Training

3. INTEGRATION OF TRAFFIC MANAGEMENT AND OTHER INFORMATION SYSTEMS NEEDS

- Provide strategic, long range direction
- Foster coordination
- Avoid duplication -- allow piggybacking
- Foster common language
- Multi-Agency Transportation Management Center

F. INSTITUTIONAL CHARACTERISTICS

In order to reap the full range of benefits of implementing ITS technologies, the individuals and organizations in the Region must work together to overcome the barriers to successful regional transportation management. The five counties of Region 8 within this study encompass a large number of jurisdictions and affected agencies, as discussed in the previous section, *Jurisdictions and Affected Agencies*. The large number of jurisdictions and agencies operating in the Lower Hudson Valley complicates institutional issues by increasing the number of agencies that must be involved in any endeavor that affects the entire area. Alternately, the jurisdictions and agencies operate independently, which results in a variety of policies in place that hinder a regional approach.

The User Services survey asked the agencies what issues were seen as having potential to derail or slow down the development of a future regionally-coordinated transportation management and information system. Funding, staffing, technology acceptance, operations and maintenance, legislation, coordination, cooperation, communications, as well as existing institutional barriers were the specific issues asked about in the questionnaire. Capital, operations and maintenance funding and technology acceptance were among the most frequent responses. Affordable communications from the field devices to the Transportation Management Center (TMC); lack of support and cooperation from the public; lack of staff allocation when compared to other critical transportation needs; legislative and political barriers; lack of the will to get the job done; and institutional barriers between all the different public agencies, as well as the public and private firms due to inherent differences in objectives were some of the other responses to this question. Cooperation, communication and coordination were also mentioned as very important issues.

Another question asked if the agencies saw a need to change the current organizational structure in their agency or in the region to support ITS initiatives. Other than responding that no changes were needed, the other responses included, closer ties between the public and private sectors; a need to find sources of funding other than county dollars; and viewing the area as one, large, seamless, integrated network for better service to the public. A continued commitment to coordinate and communicate between agencies is more important than a change in structure, said one responder. It is important to see how ITS initiatives fit within existing organizational structures. Changes to organizational structures are unlikely unless there exists clear justification for particular changes that would allow the most efficient participation in, or coordination with, the proposed regional traffic management center.

The agencies were also asked if they saw a role for the private sector. If yes, they were asked in what way, how and where. If no, why. Most responses said ‘yes’ and included traveler information, technology cooperatives, corporate sponsorships, privately sponsored service patrols, tow and recovery operations and operation of TMCs as some of the items that could include participation by the private sector. One responder said that the development of ITS policy should remain with the public sector and implementation put out to bid to the private sector. Another response included advertising and selling of information as a way for the private sector to get involved.

One of the major institutional barriers facing this region is the issue of centralization versus decentralization. Ideally, as ITS projects are developed, they should be constructed or at least operated through a central location (ultimately a regional TMC), both physically and organizationally. This becomes especially important as signalized arterials are brought into a regional management approach. Many parts of the country, as ITS technology and management have been implemented, have decided to operate principally from decentralized units relying heavily on the exchange of information. Presently New York State vehicle and traffic laws state:

- Section 1651 authorizes the County Superintendent of Highways (Commissioner of Public Works) to install traffic signals on County Roads outside of cities and villages (i.e., in towns). Specific authority over traffic signals in cities and villages rests with the local municipality (Section 1640).

- Section 1652 authorizes the County Superintendent of Highways (Commissioner of Public Works), having a functioning traffic engineering unit, when authorized by the county governing board (Board of Legislators), to have authority for the installation and maintenance of traffic signals in relation to any highway in a city, town or village not maintained by the state, providing that the governing body of the city, town or village enters into a written agreement with the county.

No agreements exist with many of the Lower Hudson Valley counties that would allow a single entity to operate the signal system in conjunction with an overall freeway management plan. In fact, in 1995, Westchester County attempted to return maintenance responsibility of all its county roads and the associated signals to the local municipalities. While this attempt was not successful, the current policy objective is still one of decentralization rather than centralization.

Another major issue facing the region is funding. Considerable TEA21 funding for ITS projects has been made available, either through the flexibility afforded States under existing programs or through demonstration projects. In question is whether Federal funds will continue to be specifically available for these purposes. If funds continue to be available, the levels of this funding is presently unknown. Equally at issue is the level of state funding which will be needed to support the maintenance and operation of these ITS projects. There is a wide variety of Federal, State, and corporate funding sources being used by states investing in ITS projects. NYSDOT's ability to form partnerships with other agencies and organizations to help this funding scenario is limited by certain legislative and/or regulatory restrictions. Early efforts will need to be instituted to determine the levels of funding commitment at the Federal, State, County and local levels, This will ultimately govern the commitment to ITS projects in the region. Decisions in ITS facilities and equipment cannot be judged solely on capital outlay. It must include cost and other considerations regarding continued operations and maintenance. Integration of the emergency services, 911, State Police and County agencies will need to be evaluate.

The cost implications and the ability to fund a regional centralized approach are important factors. Ultimately, some level of hybrid architecture that focuses on centralized information with decentralized operations will likely come out of the planning process.

G. CUSTOMERS AND THE BENEFITS RECEIVED

As the Lower Hudson Valley ITS is implemented, real benefits will accrue to three distinct sets of customers:(1) End User Customers -- Automobile users, commercial vehicle operators (CVOs) and transit riders; (2) Interim Customers -- Public agencies charged with preserving safety and mobility on the roads and transit systems; and (3) Regional Residents and Businesses. The manner in which these customers receive benefits is outlined below:

1. END USER CUSTOMERS

Automobile Users, CVOs and Transit Operators and Riders

- Improved traveler information; location guidance, incidents, delays, alternative routes and weather problems.
- Greater variety of means of receiving real-time, relevant and useful information.
- Improved travel times and travel time reliability on the roads, due to better incident management and better travel advisories.
- Safer conditions on the road, due to better incident management, delay reduction and better traffic advisories.
- Improved route guidance for transit riders and reassurance of arrival and departure status.

2. PUBLIC AGENCY CUSTOMERS

Public Agencies Charged with Preserving Safety and Mobility on the Roads and Transit Systems

- Improved quality and timeliness of information so that it directly enhances their ability to perform their work.
- More efficient use and management of personnel, physical resources and funding.
- Improved credibility of agencies -- better able to meet the needs of their customers, and better able to communicate directly with customers.
- Improved, continually evolving traffic information data base for participating agencies.
- Improved timeliness of service, including on-time transit performance.
- Improved interagency coordination.

3. REGIONAL RESIDENTS AND BUSINESSES

- The economic competitiveness of the region is improved because of improved flow of goods and services.
- Travelers experience a transportation system that is closer to being “seamless” -- among various highway network links, and between highway and transit modes, and which makes fare or toll collection easier for users.
- The quality of life for area residents will be maintained or improved, due to a reduced strain on driving conditions; people feeling that they have more control over their lives as a result of having better information; and added safety to their daily lives.

- Benefits to commercial vehicle operators and industries may be measurable in terms of reduction in delivery times and increased efficiency of just-in-time deliveries.
- In-vehicle information - both aural and visual - aids individual decision-making before and during travel.

H. ROLES AND RESPONSIBILITIES OF THE RELEVANT AGENCIES

The following is a description of the future roles and responsibilities of the agencies participating in the establishment of an ATMS for the Lower Hudson Valley. These are minimum requirements necessary for the efficient operations of the Transportation Management Center.

1. NEW YORK STATE DEPARTMENT OF TRANSPORTATION

The NYSDOT Region 8 currently operates a Transportation System Management (TSM) /Traffic Operations Center (TOC) at White Plains. This TOC should be progressed along with the ITS project in the Region. NYSDOT should build, maintain and operate an Advanced Transportation Management System (ATMS) /Advanced Traveler Information System (ATIS) on the NYSDOT owned freeways and arterial roadways network in the Lower Hudson Valley that should consist of the following:

- NYSDOT should take a leadership role in coordinating with the various agencies participating in the TMC to establish an ongoing stable funding mechanism for continuing operations.
- NYSDOT should establish an internal organizational structure to provide for accomplishment of their expanding traffic operations function. At present, the logical place for this is within the Traffic and Planning Division.
- NYSDOT will provide leadership in ensuring ITS initiatives promote multimodal objectives by integrating ITS components of its TDM, passenger transportation and traffic operations and maintenance programs.
- The NYSDOT’s Roadway/Weather Information System (RWIS) should be advanced and incorporated into the ATMS.
- Equipment, primarily covering the freeway network, which includes a variable message sign (VMS) system, a traffic flow detection system, a closed circuit television (CCTV) surveillance system, and a highway advisory radio system.
- NYSDOT should take the lead on the establishment of a regional traveler information system that will include a traveler information system in key generators in the area and to offer a highway advisory telephone (HAT) and an electronic bulletin board system to the citizens and businesses in the area. This should be coordinated with efforts in NYSDOT Regions 10 and 11 and TRANSCOM.
- The NYSDOT ATMS in the Lower Hudson Valley should be coordinated with similar systems in Regions 10 and 11 to provide seamless traffic management with Lower Hudson Valley, New York City and Long Island areas.
- Other systems may include a freeway/expressway ramp metering system and a high occupancy vehicle (HOV) network. These should be continually evaluated over time.

- The status of At-Grade Railroad Crossings should be incorporated as part of the ATMS as costs, priorities and technology allow. This information will also be useful when choosing alternate routes during times of incidents.
- The New York State Thruway Authority, along with toll authorities of adjoining states in the Inter Agency Group (IAG), is advancing the use of EZPass. This electronic toll and traffic management (ETTM) system utilizes a transponder for electronic toll collection (ETC). With transponder-equipped vehicles used as probes, individual vehicle travel times are measured between instrumented reader stations. With sufficient penetration, this direct measurement will be a good indication of congestion along expressways, freeways and major arterial roadways and can provide origin and destination data. Consideration should be given to using electronic toll collection and TRANSCOM's TRANSMIT system as a backbone for both toll and non-toll freeway facilities for traffic and incident management.
- Additional traffic signals, not just those traffic signals already part of a traffic signal system, should be accommodated through closed loop signal systems, and the like, so the traffic signals and traffic signal systems can monitor traffic and be made part of the overall ATMS.
- Freeway service patrols should be incorporated into the overall traffic and incident management system to help with detection, verification and removal of disabled vehicles associated with minor incidents.
- These ATMS/ATIS systems, described above, should be operated and maintained by the NYSDOT, either directly through increased staffing and training or contracted to an outside company or agency. Opportunities exist for reducing operating costs through public/private partnerships related to traffic data available at the Traffic Management Center. These opportunities should be explored.
- NYSDOT should have joint control of the operations of the freeway/expressway systems with the NY State Thruway Authority, NY State Police, Westchester County DPW and other appropriate agencies. Interagency agreements on coordinated operations should be established.
- Efforts should be made to provide for coordination of traffic signal system operations among agencies, including NYSDOT, WCDPW and City of White Plains. This will facilitate "joint control" should there be a need for joint operations of the traffic control system in the future.
- On NYSDOT jurisdictional roadways, NYSDOT should be responsible for collecting traffic and incident data for purposes of transportation planning and modeling, air quality evaluation and congestion management. As per the TRANSCOM Regional Architecture, this data should be made available at the request of the participating agencies for their use as they see fit.

2. NEW YORK STATE POLICE / CELLULAR 911 ANSWER CENTERS

The NYS Police Cellular 911 Answer Center(s) should be located in the transportation management centers. An officer, with the authority to make decisions with regard to traffic control and safety, should be located at a traffic operations console for command and control of police operations. The State Police are the focus of incoming 911 calls from cellular callers on the highways. The State Police relay the information to the appropriate agency for response to the scene.

- The NYS Police desk should have the ability to view the CCTV camera images and should have the ability to control selection and movement of the CCTV cameras on a secondary basis.
- The NYS Police desk should be able to view the freeway and arterial status displays.

- Cellular phone calls from motorists into the State Police 911 answer points should be integrated into the incident management system for the Lower Hudson Valley. The information on location and severity should be relayed to the TMC for input into the incident management system.
- The State Police Cellular 911 Answer Points in the Lower Hudson Valley should, at a minimum, have a two-way communication link and live video feeds from the TMC, if not located in the TMC.
- The State Police Cellular 911 Answer Centers can serve as a primary detection source from cellular 911 calls. These calls can provide direction on which CCTV cameras to view or in general where an incident has occurred.

3. JURISDICTIONAL AGENCIES

Jurisdictional agencies should study the development of traffic signal systems or upgrade coordinated traffic signal systems to a system that can be traffic responsive. The system should be capable of integrating with a larger regional system on a PC-based multi-tasking platform with a geographic information system (GIS)-based computerized graphical map display (compatible with other agencies).

- Agency traffic signal systems should be interfaced with the freeway/expressway system and with the State's traffic control system using a common database and reactive to the same parameters and conditions. The system must be capable of including traffic signals at the ramp termini with end of queue detectors on the ramps for ramp metering.
- The remainder of the county and city signals, not yet included in a traffic signal system, should be incorporated into the upgraded PC based traffic signal system on an as-needed basis.
- Agencies should play a significant role in the operation of the traffic signal systems.
- The freeway management system and traffic signal system of the NYSDOT and the signal system(s) of the counties should operate under a networked, distributed operating system; ultimately housed in the same operations center.
- Agencies should implement signal prioritization, as warranted, for emergency and transit vehicles on the arterial system.
- Agencies should integrate their transit management system(s) with the TMC to receive better traffic information for their transit operators.
- Westchester Commuter Central or a similar commercial traffic reporting service should be in the TMC to receive more accurate and timely information for the roadways in the area and supply this information to commercial radio and television stations.

4. NEW YORK STATE THRUWAY AUTHORITY (NYSTA)

- The NYSTA should have dial-up remote access to the ATMS information and status display if they are not located in the TMC.
- The NYSTA should only have control of the equipment on their roadways.
- The EZPass ETTM system should be expanded in the Lower Hudson Valley and should be used as a means of detection of incidents where the percentage of vehicles equipped with the transponder is sufficient.

5. REGIONAL TRANSPORTATION OPERATORS

A communications link should be established between the TMC and the regional transit authorities (RTAs) dispatch center for direct access to the recurring and nonrecurring traffic information. The RTAs should consider locating one operations person in the traffic operations center for two purposes; 1) to be the contact at the TMC for any of the RTAs' automatic vehicle location (AVL) system information, and 2) to contact the RTAs dispatch centers with traffic flow information from the ATMS.

- The representative(s) of the RTAs should have no control of the operations system equipment, but should be able to request information.
- The AVL system displays would be included in the ATMS PC based multi-tasking environment and be used as a primary or secondary source of traffic flow information.

6. OFFICE OF DISASTER AND EMERGENCY SERVICES

- The Westchester Office of Disaster and Emergency Services (ODES) should have a two-way communications link with the TMC.

7. MAINTENANCE AGREEMENTS

- Consideration should be given to establishing central dispatching for all traffic signal maintenance to simplify complaint reporting by the public.
- Maintenance agreements between the Counties and the local jurisdictions should be formalized and written.

8. OPERATIONAL AGREEMENTS

- NYSDOT would operate any ramp metering signals on NYSDOT freeways.
- The NYSDOT's and the counties' traffic signal systems should be as compatible as possible should joint operations of the traffic control system be necessary and/or desirable in the future.

9. PRIVATE SECTOR INVOLVEMENT

- Wherever possible, the private sector should be involved in developing and expanding the ATMS.
- Private sector should include, but not be limited to, universities/colleges, manufacturing and service companies, the broadcast and print media, communications and entertainment companies, etc.
- The areas where the private sector should participate include freeway service patrols, information kiosks, new products testing, area wide communications network development, etc.
- Information should continue to be sent to traffic reporting services.

10. TRANSCOM

- Should continue to coordinate activities within the region and between the various agencies in and around the region.

I. ISSUES IN IMPLEMENTATION

1. MAINTENANCE ISSUES

Agencies participating in the ATMS should develop clear guidelines on the maintenance of the elements of the system. The following are beginning elements of assigning responsibilities for maintenance:

- A flexible agreement between NYSDOT and the counties for the maintenance of the signals should be expanded to include any additional ITS equipment. The agreement needs to be flexible to account for any changes that might occur in the jurisdiction of certain traffic signal systems.
- New traffic signals added to the Counties' traffic signal systems should be maintained as part of an agreement between NYSDOT and the counties.
- Maintenance agreements should be formalized and written, whether the work is done in-house by public agencies or by contract with private firms.
- Maintenance of other ATMS equipment should be formalized and written, whether the work is done in-house at public agencies or by contract with private firms.
- Space at the TMC should be reserved for maintaining, testing and troubleshooting; on-site or off-site storage should be provided for spare equipment.

2. OPERATIONAL ISSUES

Agencies participating in the ATMS should also develop clear guidelines on the operations of the ATMS system. These responsibilities should grow from the following initial principles of operation including:

- NYSDOT and the counties should determine which traffic signal systems will be within which jurisdiction. This could be determined on a case-by-case basis. Certain systems could become part of the state system, others could remain within the particular county system, and some individual intersections could change jurisdictions.
- Any ramp metering signals on NYSDOT freeways should be NYSDOT's responsibility; NYSTA should be responsible for any ramp meters on I-287, I-87 and I-95.

3. OPEN ISSUES

The following are several issues that will continue to be explored and which will be continually updated as new information becomes available:

- Roles for the private sector
- Funding sources: agencies, balance, availability
- Full implementation
- Policy on CCTV use -- Traffic purposes
- "Open architecture" for in-vehicle navigation systems
- Modify to incorporate new technologies

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III. USER SERVICES

A. LOCAL APPLICABILITY OF ITS USER SERVICES

Twenty-nine ITS user services have been identified by the Federal Highway Administration (FHWA). The 29 user services identified by the FHWA have been grouped into seven "bundles", each of which represents the application of advanced technology to a specific transportation function. The seven bundles of user services are:

- Travel and Transportation Management.
- Travel Demand Management.
- Public Transportation Management.
- Electronic Payment.
- Commercial Vehicle Operations.
- Emergency Management.
- Advanced Vehicle Safety Systems.

The following sections discuss the bundles of user services, and provide a brief description of each user service[1], as well as a discussion of its applicability in the Lower Hudson Valley area. Each user service is discussed in the context of how it would potentially enhance the efficiency or capability of the transportation system, and how it would help meet the needs identified by the various users of the transportation system. The discussion of each user service is based on input received from the local agencies involved in this study, including departments of transportation and Public Works, emergency response agencies and transit operators. Table 11 summarizes the ranking of the user services by participating agency as well as an overall ranking.

1. TRAVEL AND TRANSPORTATION MANAGEMENT

The Travel and Transportation Management bundle includes six user services that are designed to use advanced systems and technologies to improve the safety and efficiency of the transportation system, and to provide motorists with current information about traffic and roadway conditions, as well as traveler services. The user services in the Travel and Transportation Management bundle are shown in Table 4 and discussed in greater detail below.

En Route Driver Information - The En Route Driver Information user service provides motorists with information about traffic and roadway conditions due to both scheduled activities (i.e., construction or special events) and unscheduled activities, like accidents. En Route Driver Information is provided after the trip has begun. Driver information may be provided via radio, variable message signs, or in-vehicle messaging. Because anything that would divert the driver's eyes from the road might have a negative impact on safety, it has been suggested that in-vehicle visual displays would be limited when the vehicle is moving. Furthermore, alternatives such as "heads up" displays would be used to display the limited visual information provided when the vehicle is in motion.

[1]Descriptions of user services and user service bundles are based on the definitions provided in *National ITS Program Plan, Intelligent Transportation System*, edited by Gary W. Euler and H. Douglas Robertson, March 1995.

Table 1 Travel and Transportation Management User Services

Bundle	User Services
Travel and Transportation Management	En Route Driver Information Route Guidance Traveler Services Information Traffic Control Incident Management Emissions Testing and Mitigation

Chapter I also describes several on-going projects related to Travel and Transportation Management. A listing of the Region 8 TDM can be found in Chapter I page I-24.

Local Applicability: En Route Driver Information was identified as an appropriate user service for the Lower Hudson Valley area by some of the area agencies. En Route Driver Information meets the critical need for communication to motorists. One mechanism for En Route Driver Information is a Highway Advisory Radio (HAR) system. Currently, the New York State Thruway operates HAR transmitters in the Rockland County and Westchester County areas along the Cross Westchester Expressway and I-87 within Region 8.

Multiple agencies would expect benefits from the provision of En Route Driver Information. In addition to allowing public works and engineering agencies to communicate information about road closings and road construction, En Route Driver Information may benefit emergency response agencies because it may facilitate access to incidents, and may decrease response time. Fire departments, in particular, would benefit by being able to warn drivers that equipment would be accessing the incident site by traveling on the freeway in the "wrong" direction (fire equipment may need to access an incident on the northbound lanes by traveling southbound on the northbound lanes from the nearest interchange).

Route Guidance - The Route Guidance user service provides motorists with a suggested route to reach their destination, along with instructions for upcoming turns or other maneuvers. Ultimately, a route guidance system would provide travelers utilizing all modes with directions to their destinations based on real-time information about the transportation system, including lane closures, traffic conditions and transit information.

Local Applicability*:* This user service was highly ranked by only two of the agencies that responded to the survey. The role of route guidance during incident management can be very important. Route diversions can only be successful if the motorist can find its way back to their intended route. With route guidance, traffic control officers could be released from directing traffic on alternate routes and utilized for on site management of the incident.

Traveler Services Information - The Traveler Services Information user service provides the traveler with information regarding local services and facilities, and has been compared to a computerized version of the "yellow pages". This information would be available for pre-trip planning via a terminal in the home, office or hotel. This information would also be available en-route via either a terminal in the vehicle or at public facilities such as highway rest stops or transit terminals. Information regarding the location, services or amenities and operating hours would be available for a variety of goods and services, including food, lodging, parking, automobile repair, hospital and medical and police stations. This service would also allow the traveler to communicate with service providers interactively, which would allow travelers to reserve rooms or confirm services.

The type of information provided would vary depending on whether the information is accessed at a fixed location (i.e., a hotel lobby or transit center), or en-route (i.e., transit vehicle, private auto, or commercial vehicle). The type of information and method of presentation would also vary; information presented to drivers while the vehicle is in motion would be restricted for safety reasons. When the vehicle is parked, the driver would be free to access and utilize all available information.

Local Applicability*:* This user service was not highly ranked by the survey responders. Perhaps in the Lower Hudson Valley area, traveler service information is more appropriate in the medium to long term. Traveler information kiosks (currently only in JFK Airport) are being implemented in the three New York/New Jersey metropolitan airports by PANYNJ. These kiosks will provide travelers with information on travel options from the airport, hotels and motels, etc.

Traffic Control - The Traffic Control user service focuses on increasing the safety and efficiency of traffic flow on streets and highways. It includes adaptive signal systems on surface streets and freeway control techniques such as ramp metering on freeways.

The Traffic Control user service would gather data from the field, analyze it, and use it to assign right-of-way to users of the transportation system. The goal is to maximize the efficiency of the movement of people and goods through the roadway network, thus it may provide preferential treatment to transit and other high occupancy vehicles (HOVs), if preferential treatment is in accordance with local objectives and operating policies. The proper implementation of traffic control would help alleviate congestion problem and improve air quality. The information generated by the traffic control user service can also be disseminated to the general public, and other service providers, laying the foundation for other user services.

Traffic Control, which includes surveillance, control, and communications, provides the basis for many of the other user services. The data collected, processed and used by traffic control will be utilized by virtually all of the other services in the Travel and Transportation Management bundle, as well as some of the services in the Public Transportation Operations and Emergency Management bundles.

Local Applicability*:* Traffic control was the number one ranked user service by the survey responders. Traffic control is an important user service for implementing other user services. Advanced traffic signal systems for control of traffic flows along the arterial routes are important for diverting traffic from the freeways. Increasing the intelligence on these arterial routes by adding closed circuit television cameras and vehicle flow detection will increase the benefits of using those arterial routes as alternate routes. Routes that have the greatest potential for arterial traffic signal control will be identified and prioritized to determine the most appropriate course of action.

A significant barrier to coordinating traffic signals along certain arterial roadways is the fact that Westchester County is seeking to turn over operations and maintenance to the local jurisdictions. On freeways and interstates that experience recurring congestion, and have appropriate geometry and where adequate parallel arterial routes exist, ramp metering should be seriously considered.

Incident Management - The Incident Management user service focuses on enhancing incident detection and response. Incident detection would be enhanced by advanced sensors, data processing, and communications which would allow officials to quickly and accurately identify a variety of incidents and would allow immediate implementation of actions to minimize the effects of incidents. The service would also help officials identify and forecast hazardous weather, as well as traffic and roadway conditions, so that preventative action could be taken to minimize the possible consequences. Incident Management also involves activities that minimize the negative impacts of planned events, such as lane closures or special events. Incident Management may include coordinating the schedules of construction or other planned roadway activities.

Local Applicability*:* As the second highest ranked user service, coordinated incident management is very important and provides very high benefits by saving time and effort in responding to and clearing incidents. Determining the exact location of an incident is important for incident management. Currently, the TSM/TOC in White Plains is operating as a clearinghouse for construction activities within Region 8.

Enhancing the reference markers and including landmark signs will enable cellular telephone callers to be able to identify locations of incidents more closely, thus providing better information to the emergency dispatchers. Currently, there is no "Enhanced Cellular 911" system to automatically locate a motorist who is using their cellular phone. In addition to accidents, better information on other incidents (i.e., construction, maintenance, and pavement or weather conditions) is necessary. Coordination of the construction and maintenance schedules among the transportation agencies in the Lower Hudson Valley area is an effective way to reduce nonrecurring congestion.

The NYSDOT develops and distributes a monthly newsletter, Highway Construction Bulletin (HCB), describing the construction and maintenance schedule for Region 8. TRANSCOM provides weekly construction advisories to its member agencies.

Emissions Testing and Mitigation - Emissions Testing and Mitigation can be used to provide area-wide pollution information for use in monitoring air quality and providing data to be used to develop strategies to improve air quality. Emission information may be used to re-route traffic around sensitive air quality areas, or even, under severe conditions, to control access to such areas. Other applications include, roadside monitoring of individual vehicles to identify vehicles that exceed emission standards and diagnostic systems that provide in-vehicle monitoring of emissions levels, which would alert the driver of non-compliance so that corrective measures could be taken.

Local Applicability*:* The sections of the Lower Hudson Valley region that do not currently meet the National Ambient Air Quality Standards (NAAQS) are Westchester County, Rockland County, Orange County, Putnam County and Dutchess County. In Orange County, Blooming Grove, Chester, Highlands, Monroe, Tuxedo, Warwick and Woodbury are classified as severe ozone areas, as are all of Westchester and Rockland Counties. However, this user service was not highly ranked by the survey responders. Emissions testing is an issue for the NYSDEC's Regional Air Pollution Control Engineer. New York State is addressing the issue of air pollution generated by mobile sources (automobiles) through the use of reformulated gasoline, inspection and emissions testing and making non-polluting cars more widely available. There have been difficulties in meeting the USEPA standards. By 1998, 2% of all cars offered for sale in New York will have to be Zero Emission Vehicles, such as electric cars and others in development. Carpooling one or two days a week, walking or bicycling for short trips, utilizing public transportation and keeping engines tuned up are all ways to keep harmful emissions down. It is mandated in the Clean Air Act that the State prepare a "15 Percent Rate of Progress Plan" by November 1996 for reducing emissions of Volatile Organic Compounds by 15 percent in areas designated as being in "severe" non-attainment with the NAAQS for ozone.

Tele-Commuting one or two days per weeks is another way to reduce automobile emissions. A wide-spread plan such as an employee trip reduction program, can reduce emissions and traffic congestion.

2. TRAVEL DEMAND MANAGEMENT

The Travel Demand Management (TDM) bundle includes three user services that are designed to reduce congestion on the transportation infrastructure by encouraging commuters to use modes other than the single occupant vehicle (SOV), to alter the time and/or location of their trip, or to eliminate a trip altogether. In response to congestion and air quality concerns, many cities have already initiated travel demand management activities and others will be required to in response to the mandates of the 1990 Clean Air Amendments. The user services in the TDM bundle are shown in Table 5 and discussed in greater detail below.

Table 2 Travel Demand Management User Services

Bundle	User Services
Travel Demand Management	Demand Management and Operations Pre-Trip Travel Information Ride Matching and Reservations

Demand Management and Operations - The demand management and operations user service attempts to accomplish three primary goals: reduce SOV travel, particularly SOV commuting; effect a mode change from SOVs to HOVs, specifically in certain targeted markets; and provide a variety of mobility options. In an effort to accomplish these goals, demand management and operations may facilitate convenient alternatives to the SOV in an effort to effect a change in mode, such as transit service enhancements, the development and/or improvement of HOV facilities, and the implementation of carpool and vanpool programs.

This user service may also affect mode choice through travel incentives and disincentives, through controls on the availability, location, and price of roadways and parking. These measures are expected to improve traffic and transit operations, and increase auto occupancies. Alternative work arrangements, such as variable work hours, compressed work weeks, and telecommuting may also be implemented in an effort to manage demand.

Local Applicability*:* As the eighth highest ranked user service in the survey, demand management and operations could help to encourage high occupancy vehicle usage.

A significant amount of resources have been committed in the Lower Hudson Valley for Transportation Demand Management, as explained previously in this report under "Current and Planned ITS Applications in the Lower Hudson Valley".

Pre-Trip Travel Information - The pre-trip travel information user service provides travelers with information prior to departure, before a mode has been chosen. This information may encourage alternatives to SOV travel, including either an HOV or the elimination of a trip. Information about TDM pricing strategies may also be available to further encourage alternatives to the SOV. Coordination with electronic payment services (discussed later) would further enhance the capabilities and, presumably, the effectiveness of the pre-trip travel information.

Pre-trip information includes a range of multimodal transportation information that may be accessed at home, work, or other major sites where trips originate. Information to be provided may include transit routes, schedules, transfers, fares, intermodal connections, and ride matching services; current traffic and highway conditions, regulations and tolls; information on incidents, accidents, and road construction; current and predicted congestion and travel speeds on specific routes; parking conditions and fees; availability of park-and-ride facilities, special event information and weather information.

Local Applicability: This user service was ranked fifth in the survey. Once the travel conditions of the roadways have been collected, the next logical step is to distribute the information to the public for pre-trip planning. Some of the information that may be part of the system could include construction and maintenance schedules, special event information, information on long duration accidents, etc. In addition, this type of application can be used to advise people of alternative travel routes and to provide people with information about public transportation services. For example, the public could access information about feeder bus services which connect to the Metro-North service. Information available could include when and where to access the feeder service, the travel times, the fare and the connecting service information, including fare for Metro-North service. Another example could be service and fare information for express commuter bus services. Finally, real-time service status information could be made available to inform the public if bus or rail service is running late or if park and ride lots are full, for example.

Ride Matching and Reservations - Ride Matching and Reservations provides a strategy for reducing demand by facilitating and encouraging ridesharing as an alternative to the SOV. This service expands the market for ridesharing by providing real-time ride matching information along with reservations and vehicle assignments.

Under this service, people who wish to rideshare would provide a travel itinerary (date, time, origin and destination) and any specific restrictions or preferences (the need for wheelchair access, mode preference, etc.) to a ride matching service. The traveler would then receive ridesharing options for that itinerary, considering the preferences noted.

Local Applicability: The Lower Hudson Valley has a well established ridesharing program. Ridesharing is facilitated by the existence of a series of park and ride lots in the region and through ridematching services like MetroPool. Real-time ridematching services could enhance the existing system by informing the public when park and ride lots are full, or circumventing the need to travel to a park and ride lot at all, by matching ride requests in close geographic proximity. This could provide the added air quality benefit of mitigating cold starts.

3. PUBLIC TRANSPORTATION MANAGEMENT

The Public Transportation Management bundle includes four user services that are designed to utilize advanced vehicle electronic systems to provide data which are then used to improve transit service to the public. The user services in the Public Transportation Management bundle are shown in Table 6 and discussed in greater detail following a general discussion regarding the local applicability of this bundle of user services.

Table 3 Public Transportation Management User Services

Bundle	User Services
Public Transportation Management	Public Transportation Management En-route Transit Information Personalized Public Transit Public Travel Security

Public Transportation Management - Public Transportation Management automates the operations, planning and management functions of public transportation systems. It would provide real-time computer analysis of vehicles and facilities to improve transit operations and maintenance. The analysis would identify deviations from the schedule and offer potential solutions to dispatchers and drivers. This service would help maintain transportation schedules and assure transfer connections from vehicle to vehicle and between modes and could be coupled with traffic control services to facilitate quick response to service delays. Information regarding passenger loading, vehicle running times, accumulated miles and hours and vehicle maintenance would help improve service and provide managers with extensive information on which to base decisions. Service schedulers would have timely data to adjust trips. Personnel management would be enhanced with automatic recording and verification of driving and maintenance task performance.

Local Applicability*:* As the third highest ranked user service, public transportation management will benefit transit operators directly and the public indirectly. The ITS public transportation management capabilities allow transit operators to know where their vehicles are at any given time, be able to compare scheduled service to actual service performance in real-time and permit real-time dispatcher intervention to slow, speed or otherwise adjust services in response to conditions in the field. This increased level of control over operations will facilitate greater efficiency and effectiveness. Intermodal and inter-operator service coordination can be affected at the local and regional levels. Thus, coordination between Metro-North rail service and buses serving the rail stations can be coordinated and adjusted to respond to changing circumstances. This user service is highly applicable to transit services in the Lower Hudson Valley. Indirectly, this user service provides benefit to the public by way of providing on-time service status information to publicly accessible information systems.

En Route Transit Information - En Route Transit Information would provide information to travelers using public transportation after they begin their trips. Real-time, accurate transit service information would be available on-board the vehicle, and at transit stations and bus stops to assist travelers in making informed decisions and itinerary modifications once a trip is underway.

Local Applicability*:* Also highly ranked, En Route Transit Information provides the ability to provide up-to-date service and service status information to the public. The most direct applications would involve providing information to the public on the status of bus or rail connections at transfer centers and rail stations. As with previous user services, this application is highly applicable to services in the Lower Hudson Valley, particularly given the importance of commuter rail and associated bus feeder services in the region.

Personalized Public Transit - Personalized Public Transit would provide transit vehicles with flexible routes which offer more convenient, and often more cost effective, service to customers where traditional, fixed-route operations cannot be economically justified. Small, publicly or privately operated vehicles would provide on-demand routing to pick up passengers who have requested service and deliver them to their destinations. Route deviation schemes, where vehicles leave a fixed-route for a short distance to pick up or discharge passengers, is another possible approach. Vehicles providing this service include small buses, taxis, or other small, shared-ride vehicles. This type of service could expand transit service to lesser populated locations and neighborhoods and could potentially provide transportation at a lower cost and with greater convenience than conventional fixed route transit.

Local Applicability*:* Personalized Public Transit was ranked in the lower half of the survey. This user service has valuable potential benefit to local transit and paratransit services. The capability to deviate fixed-route buses or paratransit services in real-time or near real-time has tremendous potential for increased operating efficiency, productivity and cost savings in areas where densities are too low for efficient fixed route services and in paratransit operations. In particular, the ability to provide flex-route services in lieu of fixed route services and, therefore, mitigate the need to operate a separate ADA complementary paratransit system has tremendous potential for cost savings. In terms of paratransit services, the potential for increased service productivity and operating efficiency make this user service an alternative worth consideration by transit and paratransit service providers. Given the interest in this by the service providers and the demographics and geography of the region, this user service would have significant potential in the Lower Hudson Valley.

Public Travel Security - The Public Travel Security user service would create a more secure environment for transit patrons and operators by providing systems that monitor the environment in transit stations, parking lots, bus stops, and on transit vehicles. These systems would generate alarms, either automatically or manually, when necessary. Implementation of this user service would improve security, and the perception and acceptance of transit. This service can be integrated with other anti-crime activities.

Local Applicability*:* This user service ended up in the middle of the ranking. Transit safety tends to be an influential factor on ridership growth and retention. The ability to allay public concerns over safety (personal and vehicular) will have a positive benefit on ridership and on vehicle maintenance by reducing opportunities for vandalism.

4. ELECTRONIC PAYMENT

The Electronic Payment bundle includes one user service, electronic payment services, discussed below.

Table 4 Electronic Payment User Service

Bundle	User Service
Electronic Payment	Electronic Payment Services

Electronic Payment Services would allow travelers to pay for transportation services with electronic cards or tags. The goal is to provide travelers with a common electronic payment medium for all transportation modes and functions, including tolls, transit fares and parking. Electronic payment services would encompass the integration of payment systems of various modes to create an intermodal user service, as well as the improvement of payment systems for separate transportation modes. Payment systems for various modes would have to be perfected independently before they could be integrated.

Another goal is integration among systems in different states, especially with respect to toll payment. Electronic toll collection, transit fare payment, and parking payment would be linked through an intermodal multi-use electronic systems. A common fee payment structure could be used with all modes, possibly tying into roadway pricing options. Coordinated pricing strategies and incentives for HOV travel would be facilitated by such a system. Components of Electronic Payment Services include electronic toll collection, electronic fare collection for transit and electronic parking payment.

Local Applicability*:* This user service was ranked in the middle of the survey. Currently, the EZ Pass electronic toll collection system is in use along the NYS Thruway, I-87, I-95 and the Tappan Zee Bridge. Achieving a seamless regional fare scheme is a common desire in the Lower Hudson Valley. With the multitude of public transit service providers, this is not an easy task, however. The application of electronic payment systems would simplify public transit use in the region and may have a positive impact on ridership and service coordination. At present, commuters may need three or more different fare media to complete their trips. The ability to use one media for all modes/operators would be a true benefit.

5. COMMERCIAL VEHICLE OPERATIONS

The Commercial Vehicle Operations (CVO) bundle includes six user services that are concerned primarily with freight movement and focus on two specific areas, one to improve private sector fleet management, and the other to streamline regulatory functions. The user services in the Commercial Vehicle Operations bundle are discussed in greater detail below.

Table 5 Commercial Vehicle Operations User Services

Bundle	User Services
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance Automated Roadside Safety Inspection On-Board Safety Monitoring Commercial Vehicle Administration Processes Hazardous Material Incident Response Freight Mobility

The term Commercial Vehicle Information Systems and Networks (CVISN) refers to the ITS information system elements that support CVO. CVISN is not a new information system, but rather a way for existing systems to electronically exchange information through the use of standards and the commercially available communications infrastructure. CVISN includes information systems owned and operated by state/local governments, carriers, and other shareholders. It does not include the sensor and control elements of ITS/CVO technologies.

The goal of CVISN is to foster a crash-free environment and enhance performance-based safety management for both the public and private sectors. CVISN will enable electronic information exchange among authorized stakeholders via open standards, thus enhancing safety and increasing productivity.

The CVISN Core Infrastructure is a selected group of key CVO information systems that provide a mechanism for the exchange of safety information, registration, fuel tax, HAZMAT and commercial driver license information among states. The Core Infrastructure is also designed to provide the motor carrier industry with a methodology for obtaining the necessary credentials to operate legally, electronically. CVISN will result in the elimination of the need for numerous trips to various state agency offices—by a motor carrier operator—in order to obtain required credentials. CVISN deployment will evolve incrementally, starting with the prototype and piloting of various CVO technologies, and proceeding in practical and manageable steps with heavy end-user involvement.

The CVISN Deployment Strategy is divided into five major phases. Phase 1, which is complete, develops the architecture, management plans and technical framework necessary to coordinate the subsequent phases. Phase 2 was to prototype the technology in a live environment using two states to demonstrate the operational concepts and validate the requirements. The states involved in the prototype—Maryland and Virginia—are now field-testing the technologies connected with CVISN. The states will showcase various ITS/CVO technologies and document the “lessons learned” during the process and share those experiences with the states participating in the Pilot Phase of the effort.

Phase 3 in the deployment strategy is to Pilot the approach, in the selected states, representing the seven truckshed regions of the U.S. The States selected for this Pilot effort are: Connecticut, Michigan, Kentucky, Minnesota, Colorado, California and the combined states of Washington/Oregon. Phase 4 is to expand from the Pilot states to an equal number of partner states in the same regions. The final phase then allows for full deployment of CVISN to all interested states. By this time, the technology, concepts, cost and benefits should be well understood and documented. The end result should be deployment of the CVISN technologies in a straightforward manner with little unforeseen risk to the public or private sector.

The vision for the CVISN Program is that by the year 2005, trucking operations will become extremely efficient "paperless" due to the availability of accurate information in an electronic format. For example, carriers will have their vehicles equipped with a variety of productivity and safety improvements, such as mobile communications systems, navigation and tracking systems, on-board vehicle monitors, engine efficiency monitoring systems, collision avoidance devices, crash restraints, and vision enhancement equipment.

As a result of the implementation of CVISN, carriers will be able to participate in programs designed to enhance en-route travel by virtually eliminating weigh station delays using electronic screening to check vehicles at mainline speeds. Carriers could voluntarily adopt driver alertness management programs and equipment, and will have the ability to maintain trip logs electronically. Carriers would use electronic transactions, such as payment of taxes and fees to support intermodal interchange among trucks, railroads, ships and air freight fines, as well as using fleet management systems to optimize schedules, routing and maintenance. These same systems would be used to share information across borders with our neighbors—Canada and Mexico. Using integrated systems—containing information coordinated by Transportation, Customs, and INS agencies—motor carriers will be able to travel from one end of North America to the other with little or no stopping at the borders.

Trucking efficiency is usually measured in terms of profit, which is affected by cargo losses due to damage, transit time, cost per pound, and on-time delivery for "just-in-time" customers.

Roadway congestion, another one of the major issues identified, affects both truckers and motorists. With respect to congestion, trucking agencies noted that both access and traffic flow need to be addressed. Trucking agencies apparently try to avoid commuter peaks, which benefits both truckers and commuters. Trucking agencies' interest in avoiding congestion would also imply that additional benefits could be gained from information systems that provide truckers with real-time traffic information.

Trucking agencies also indicated interest in a number of issues related to public policy. These include, a need for better understanding of new technologies and their effects; public and private partnerships, including issues of equity; and routes for hazardous material. These issues may be construed to relate to ITS in a number of ways. The need for a better understanding of new technologies relates to ITS and the need to better communicate its capabilities and limitations, public and private partnerships relate to ITS funding issues, and, finally, routes for hazardous materials tangentially relate to the ITS user service Hazardous Material Incident Response.

Commercial Vehicle Electronic Clearance - Commercial Vehicle Electronic Clearance would allow enforcement personnel to electronically check safety, credentials, and size and weight data for transponder-equipped vehicles before they reach an inspection site, selecting only illegal or potentially unsafe vehicles for an inspection. Safe and legal carriers would be able to travel without stopping for compliance checks at weigh stations, ports-of-entry and other inspection sites.

***Local Applicability**:* Due to the fact that there is no representation from the trucking industry, this user service was ranked at the bottom of the list by the survey responders. There are some projects involving commercial vehicle operations underway within the NYSDOT Freight Services division, but no information was available at the time of this draft report.

Automated Roadside Safety Inspection - Automated Roadside Safety Inspections would use safety data provided by the electronic clearance service combined with advanced technologies to allow for more selective and rapid inspections. Through the use of sensors and diagnostics, inspectors will eventually be able to check vehicle systems and driver requirements and ultimately driver alertness and fitness for duty.

Local Applicability This type of system would be useful and applicable in the more rural and isolated areas.

On-Board Safety Monitoring - On-Board Safety Monitoring would allow non-intrusive monitoring of the driver, vehicle and cargo and notification of the driver, carrier, and possibly enforcement personnel if an unsafe situation arises. An unsafe situation might involve driver fatigue, vehicle systems, or cargo shifting. Eventually, this service would tie into the automated roadside safety inspection and electronic clearance services.

Local Applicability*:* **-** On-Board Safety Monitoring is of interest to numerous local agencies. CALSPAN and NYSDOT are involved in a MAYDAY system for passenger vehicles. The time that it takes to detect a vehicle involved in an accident in a rural area could be reduced by this system and lives could be saved. The system would send a signal to a central dispatch center to alert the center of the location and possibly the severity of the incident. The dispatcher would send out the appropriate response to the scene.

Commercial Vehicle Administrative Processes - Commercial Vehicle Administrative Processes would allow carriers to purchase credentials and collect and report fuel and mileage tax information electronically. Through automation, this service should significantly reduce the paperwork burden to both carriers and states and, furthermore, it has the potential for simplifying compliance operations.

Local Applicability*:* This type of system could save time and delay to truckers and cargo in the Lower Hudson Valley region.

Hazardous Materials Incident Response - Hazardous Materials Incident Response would provide emergency response personnel at the scene of a hazardous materials incident immediate information on the types and quantities of hazardous materials present, in order to facilitate a quick and appropriate response.

The National Academy of Sciences has determined that it is not cost effective to track all hazardous material shipments. For certain types and quantities of hazardous materials, it may only be important to locate these trucks when they are involved in a serious accident/incident and then provide specific cargo information to the appropriate emergency responders.

Local Applicability*:* Information on the type of hazardous material needs to be know by the emergency response teams when faced with a spill. The information needs to be centrally located for easy access by each of the emergency response agencies.

Freight Mobility - Freight Mobility would provide links between drivers, dispatchers and intermodal transportation providers, enabling carriers to take advantage of real-time traffic information, as well as vehicle and load location information, to increase productivity.

***Local Applicability**:* This user service would be an initiative of the trucking and shipping industries who would access the traffic and incident information on a real-time basis to better manage their fleets and move cargo more efficiently.

6. EMERGENCY MANAGEMENT

The Emergency Management bundle includes two user services that relate directly to the detection, notification, and response to emergency and non-emergency incidents which take place on or adjacent to the roadway. The focus is the improvement in the ability of roadside service providers, as well as the ability of police, fire, and rescue operations to respond appropriately, thereby saving lives and reducing property damage. The user services in the Emergency Management bundle are discussed in greater detail below.

Table 6 Emergency Management User Services

Bundle	User Services
Emergency Management	Emergency Notification and Personal Security Emergency Vehicle Management

Emergency Notification and Personal Security - Emergency Notification and Personal Security focuses on decreasing the time it takes for responding agencies to be notified of emergency and non-emergency incidents, and providing an accurate estimate of the location of the vehicle in need of assistance. This service includes both driver safety and personal security, in instances where manual notification of incidents is possible, and automated collision notification, in cases where incident severity precludes manual notification of incidents.

Local Applicability: As noted with respect to the Incident Management user service, both enforcement and emergency response personnel would benefit from rapid identification of incidents, as well as from accurate identification of incident location. Currently, incidents are often identified by motorists with cellular telephones who call the NYS Police in Poughkeepsie, or Monroe or Hawthorne depending upon the cell site. These motorists frequently provide insufficient and inaccurate information regarding the type and location of incident. The HELP program, which includes nine (9) HELP vehicles, is another source of detecting, locating and verifying incidents. The TSM/TOC is the source for tracking, notifying and logging construction site related incidents.

Emergency Vehicle Management - Emergency Vehicle Management focuses on decreasing the time it takes for agencies to respond once the incident is reported to the operator or dispatcher. This includes three sub-services: emergency vehicle fleet management, route guidance, and signal priority. Emergency vehicle fleet management would provide information regarding emergency vehicle location, and automated support to dispatchers to help determine which vehicle can most quickly reach the incident site. Route guidance would assist in the determination of the quickest route to the incident scene, and from the scene to the hospital, if needed. Signal priority would provide the ability to pre-empt traffic signals on the emergency vehicle's route, and the ability to warn drivers that an emergency vehicle is approaching and to clear the queues at the signal.

Local Applicability*:* There appear to be some opportunities for the local application of components of the Emergency Vehicle Management user service. Automatic vehicle location (AVL) systems, the basis for emergency vehicle management, could be considered for many of the enforcement and emergency response agencies. Although due to cost restraints, few agencies may be able to implement such systems in the near future. As stated previously, CALSPAN and the NYSDOT are involved in a MAYDAY system for passenger vehicles.

7. ADVANCED VEHICLE SAFETY SYSTEMS

The Advanced Vehicle Safety Systems bundle includes seven user services that are related primarily to the safety goals of ITS. These user services enhance safety by introducing technologies that would diminish the number and severity of crashes. The user services in the Advanced Vehicle Safety Systems bundle are shown in the table below. A brief definition of each user service is provided following a general discussion regarding the local applicability of this bundle of user services.

Table 7 Advanced Vehicle Safety Systems User Services

Bundle	User Services
Advanced Vehicle Safety Systems	Longitudinal Collision Avoidance
	Lateral Collision Avoidance
	Intersection Collision Avoidance
	Vision Enhancement for Collision Avoidance
	Safety Readiness
	Pre-Crash Restraint Deployment
	Automated Highway Systems

Local Applicability*:* The technologies necessary for user services in the Advanced Vehicle Safety System bundle are not appropriate for local application within the planning horizon considered in this study. Many of these technologies are currently in the research and development stages. Technologies that have been developed are perhaps more appropriate for implementation by private entities, such as car manufacturers, rather than public agencies at this time. When the technologies needed for these user services are fully developed and tested, there may be some applications in the Lower Hudson Valley area. For example, Delco is working on FOREWARN, a microwave radar detector device introduced in 1993 to alert school bus drivers to the presence of children in the driver's blind spots.[1] This kind of system could be implemented not only on school buses, but also on transit vehicles at a cost of $1,000. The system includes radar units and on-board visual and audio alarms.

Longitudinal Collision Avoidance - Longitudinal Collision Avoidance systems address vehicle collisions in which one or two vehicles are moving in essentially the same path prior to the collision, or in which one of the vehicles is stationary(i.e., a rear end collision).

Lateral Collision Avoidance - Lateral Collision Avoidance systems address one or two vehicle collisions that arise when a vehicle leaves its own lane of travel while moving forward, (i.e., merging or lane change maneuver.

Intersection Collision Avoidance - Intersection Collision Avoidance systems address collisions that arise when vehicles violate the right-of-way of other vehicles, or when right-of-way at an intersection is not clear (i.e., right angle accidents). This service would provide warnings of imminent collisions with crossing traffic, as well as warnings of control devices at upcoming intersections.

Vision Enhancement for Collision Avoidance - Vision Enhancement for Collision Avoidance would address collisions in which limited visibility is a factor. The system will enhance visually acquired information when driving visibility is low, such as at night or in fog. It will not, however, compensate for blind spots or other visual obstructions.

Safety Readiness - Safety Readiness addresses collisions caused by fatigued or impaired drivers, malfunctioning vehicle components, or degraded infrastructure conditions. Safety Readiness includes three subsystems: driver condition warning and control override, vehicle condition warning, and in-vehicle infrastructure condition warning.

Pre-Collision Restraint Deployment - Pre-Collision Restraint Deployment provides a means to anticipate an imminent collision and activate safety systems (e.g., side-impact airbags) prior to impact. The equipment is contained entirely in the vehicle.

Automated Highway Systems - The Automated Highway Systems user service focuses on improving the safety, efficiency, and comfort of the roadway system by providing fully-automated control of instrumented vehicles on instrumented highways, as well as partial vehicle control (extension of the collision avoidance systems).

B. LOCAL PERCEPTION OF USER SERVICE NEEDS

1. WESTCHESTER COUNTY AGENCIES MEETING

On May 29, 1996 a meeting was convened of the Westchester County agencies that have the most potential to participate in a Transportation Management Center (TMC) located in the Lower Westchester area of the Lower Hudson Valley Region by at least exchanging information or possibly co-locating in the TMC. Representatives from emergency services, police, fire and transportation agencies were present. The purpose of the meeting was to invite all those

[1] "Closing the Gap on Intelligent Vehicles, Traffic Technology International Talks to Gary Dickenson, Delco Electronic Corporation", *Traffic Technology International*, Spring 1995.

agencies to participate in the TMC, whether by a physical presence or with a communications link. If any of the agencies present had any plans to move their operations, this was the forum to inform others and to determine the potential for co-location. The benefit of gathering all agencies in Westchester County that have something to do with the operation of traffic and transit in a single center to manage the area facilities was explained. The efficiency of operations and communications would be the most noticeable benefit. Exchanging information on traffic and transportation conditions would occur in a more timely manner than exists today. The criteria for finding a TMC site was presented. The final site has not been located yet, but the existing TMC at 244 Westchester Avenue will be expanded to accommodate some of the interested parties. The TMC will have a link to the I-95 Corridor Coalition through the Information Exchange Network (IEN) workstation. This will provide real-time traveler information across all state jurisdictions along the I-95 Corridor. Another issue brought up was that the Federal Highway Administration will pay for on-going operations of ITS, instead of originally only the first two years of operation.

2. EDUCATIONAL OUTREACH WORKSHOP

An Educational Outreach Workshop, at the Bear Mountain Inn, was attended by over 50 people representing the various agencies and public interest groups throughout the region. The following are the issues raised at the July 10, 1996 ITS Early Deployment Study, Educational Outreach Workshop:

1. The TRANSCOM operation center in Jersey City, NJ was mentioned with regard to communications to the transit providers, emergency service providers and Departments of Transportation. Perhaps this issue was brought up with regard to the need for a multi-jurisdictional center for monitoring transportation facilities in the Lower Hudson Valley. The plan for the TMC under the Early Deployment Planning Study is to incorporate NYSDOT with State Police, local transportation and transit providers and the NYSTA, to facilitate coordination and cooperation.

2. Maintenance forces and utility work disrupts the flow of traffic. Scheduling should be looked at more closely. Incentives to complete roadway construction in a more timely manner should be considered. The Town of Clarkstown has a program in place in which the permit fees are dependent upon the number of days that the roadway is closed to traffic. This program may be something that all jurisdictions should consider to reduce construction related congestion. The existing TMC, as well as TRANSCOM, coordinate and disseminate construction information throughout the Region. This will be enhanced with real-time traffic and incident information with ITS.

3. A suggestion was made that the focus should be on the recurring and nonrecurring congestion areas for ITS deployment. Areas of nonrecurring congestion within areas of recurring congestion should be the primary focus. The Strategic Implementation Plan will address these areas first, due to high benefit/cost ratios. These roadway sections will be high on the priority list.

4. Law enforcement should have an important role and involvement in the Transportation Management Center. Currently the State Police are answering the Cellular 911 calls in three Cellular 911 Centers throughout the Region (Hawthorne, Monroe and Poughkeepsie). At a minimum, the Cellular 911 answer points should be linked with communications and video

feeds. Locating the TMC and Cellular 911 Answer points together would be the ideal situation. This project will provide support for this co-location.

5. The Cross County Parkway was moved from the “Other Arterial Routes” list to “NYSDOT Limited Access Routes” list. This has been addressed.

6. There was an expression of interest in providing some additional information on Recurring and Nonrecurring Congestion areas, as well as Truck Routes. Yonkers Avenue traveling east over the Bronx River Parkway, east over Scotts Bridge to 1st Street into northern Bronx and lower Mount Vernon and Pelham was identified as a significant truck route for local truck traffic. This route will be added to the list of major truck routes. Other congestion routes have been added to their respective lists. The Regional Engineers have provided additional areas of weather-related incidents which have been included in Appendix A, Table 2.

7. Coordination between the State and local traffic signal systems should be pursued. Close coordination of these traffic signals could provide significant benefits. Connection between the City of White Plains’ traffic signal system and the WCDPW Westchester Avenue system could provide an extension to each system and provide a wider coverage of traffic signal control. This project will outline such issues in the Strategic Implementation Plan.

8. Paratransit for the disabled; paratransit for route deviation was another issue that raised.

9. Funding for the private transit service providers to upgrade and improve their services and systems is important. If transit is to have a significant impact on the mobility of the area, then all transit operators will need to possess the technology. As part of the Strategic Implementation Plan, recommendations will be made as to which transit lines should be deployed with which technologies.

3. USER SERVICES SURVEY RESULTS

A questionnaire was distributed to transportation representatives of the five counties in the study area, the major transit authority for commuter service (MTA/Metro-North Railroad), NY State Police, the NYS Thruway Authority, TRANSCOM and the NYSDOT Region 8 ITS Unit. A total of 12 surveys were distributed, completed and returned. The following summarizes the results of the ITS questionnaire:

- What do you or your agency see as the transportation problems of the region today and in the future?

Increases in traffic congestion and delays and the overall lack of funding for transportation maintenance and improvements topped the list of responses. Other responders thought that there is a lack of adequate or realistic alternative mass transportation; while another thought that an increase in transit/bus service on the highways would add to the mix of traffic problems. Traffic incidents and their effect on highway safety and traffic congestion, especially major incidents and the numerous accompanying secondary incidents that result, was another response to this question.

- Who do you view as the transportation users (customers) that you are serving?

The responses included the general traveling public in all modes of travel; commuters, shoppers, commercial operators, truckers and mass transit riders both during the peak and non-peak hours.

- What issues do you foresee that have the potential to derail or slow down the development of a future regionally coordinated transportation management and information system? (Include funding, staffing, technology acceptance, operations and maintenance, legislation, coordination, cooperation, communications and institutional barriers.)

Capital, operations and maintenance funding and technology acceptance were among the most frequent responses. Affordable communications from the field devices to the TMC; lack of support and cooperation from the public; lack of staff allocation when compared to other critical transportation needs; legislative and political barriers; lack of the will to get the job done; and institutional barriers between the public and private firms due to inherent differences in objectives were some of the other responses to this question. Cooperation, communication and coordination were also mentioned as very important issues.

- Do you see a need to change the current organizational structure in your agency or in the region to support ITS initiatives?

Other than responding that no changes were needed, the other responses included closer ties between the public and private sectors; a need to find other sources of funding other than County dollars; viewing the area as one, large, seamless, integrated network for better service to the public. A continued commitment to coordinate and communicate between agencies is more important than a change in structure, said one responder. It is important to see how ITS initiatives fit within existing organizational structures. Changes to organizational structures are unlikely unless there were clear justification for particular changes that would allow the most efficient participation in, or coordination with, the proposed regional traffic management center.

- Do you see a role for the private sector? If, yes - what?, how?, where?. If no - why?

Most responses said ‘yes’ and included traveler information, technology cooperatives, corporate sponsorships, privately sponsored service patrols, tow and recovery operations and operation of TMCs as some of the items that could include participation by the private sector. One responder said that the development of ITS policy should remain with the public sector and implementation put out to bid to the private sector. Another response included advertising and selling of information as a way for the private sector to get involved.

Table 8 User Services Survey Results

User Services Bundles	User Services	AVERAGE RANKING	Metro North	WCDPW	Rockland County	Orange County	Dutchess County	Putnam County	MTA	WCDOT	NYSTA	NYS Police	NYSDOT	TRANSCOM
Travel & Transportation	**En Route Driver Information**	**10**	10	17	7	15	2	9	10	21	6	15	3	5
Management	**Route Guidance**	**13**	1	18	6	12	13	10	10	7	8	21	18	9
	Traveler Services Information	**12**	11	19	12	5	13	8	7	8	9	11	11	11
	Traffic Control	**1**	3	1	2	1	1	7	10	10	3	4	4	3
	Incident Management	**2**	9	2	14	8	5	1	8	9	1	1	1	1
	Emissions Testing and Mitigation	**21**	15	20	3	15	13	12	10	22	22	22	22	11
Travel Demand	**Pre-Trip Traveler Information**	**5**	2	21	9	10	13	6	3	2	7	3	2	10
Management	**Ride Matching & Reservations**	**16**	14	22	11	10	9	2	10	11	19	18	13	11
	Demand Management and Operations	**8**	4	7	1	12	10	5	10	5	11	20	7	11
Public Transportation	**Public Transportation Management**	**3**	5	6	13	5	8	13	1	1	17	6	5	4
Management	**En Route Transit Information**	**6**	6	8	8	5	13	14	2	4	13	7	8	8
	Personalized Public Transit	**17**	13	10	16	12	7	15	10	13	18	19	12	11
	Public Travel Safety	**11**	12	11	10	5	13	17	4	12	12	8	9	11
Electronic Payment	**Electronic Payment Services**	**9**	7	5	18	12	3	16	5	6	10	16	14	2
Commercial Vehicle	**CV Electronic Clearance**	**20**	22	12	22	10	13	18	10	15	14	13	19	11
Operations	**Automated Roadside Safety Monitoring**	**19**	21	13	20	10	13	19	10	16	15	12	15	11
	On-Board Safety Monitoring	**18**	19	14	19	5	12	20	10	17	16	10	21	11
	CV Administrative Processes	**22**	16	15	21	12	13	21	10	18	21	17	17	11
	Haz Mat Incident Response	**15**	18	9	15	10	4	22	10	19	2	9	20	11
	Freight Mobility	**14**	17	16	17	8	11	3	10	14	20	14	10	7
Emergency Management	**Emergency Notification and Personal Security**	**4**	20	3	4	5	13	11	6	3	4	5	6	6
	Emergency Vehicle Management	**7**	8	4	5	5	6	4	10	20	5	2	16	11

C. TECHNICAL FUNCTIONAL AREA PRIORITIES

The national ITS Program has defined seven technical functional areas that include surveillance, communications, traveler interface, control strategies, navigation/guidance, data processing, and in-vehicle sensors. ITS technologies have each been classified into one of these seven functional areas. While some technologies may be applicable in more than one functional area, each technology is categorized in the functional area in which it is most relevant. In Appendix D, Functional Requirements, Table 1 provides information regarding the technical functional areas that are utilized by the highest priority ITS user services previously defined by the survey on *"Ranking of the User Services"* and the evaluation of existing problems on the transportation network. Note that all of the user services are provided through technologies from more than one functional area.

Based upon the User Services Surveys and the feedback from the Bear Mountain Workshop, the technical functional areas that appear most important in the short and medium term are:

- Surveillance, which is needed to monitor traffic flow and detect incidents;
- Communications, which are needed to convey traffic information to the appropriate operating agencies as well as to the public;
- Control Strategies, which are needed to optimize the efficiency of freeways and arterial roadways during typical conditions and in response to incidents;
- Traveler Interface, which is need to communicate with the public; and
- Data Processing, which becomes increasingly important as the amount of data to be processed increases.

The technical functional areas that appear less important in the short and medium term are:

- Navigation/Guidance.
- In-Vehicle Sensors.

The technologies in both of these technical functional areas depend heavily on in-vehicle devices and thus may be more appropriate for implementation by vehicle manufactures, rather than local transportation providers.

D. SELECTION OF INDIVIDUAL FUNCTIONAL ELEMENTS

The importance of the elements of the technical functional areas vary, depending on the objectives and extent of the ITS system. Furthermore, it is difficult to identify the most appropriate technologies without having examined the benefit/cost ratios, and other data that will be developed in later stages of the study. However, preliminary examination of the technical function areas and specific technologies does result in expectations regarding the most important technical functional areas and technologies.

Based on local priorities and examination of the technologies that have been successfully implemented in other cities, as well as the NYC Metropolitan area, the specific technologies that appear most important in the short and medium term are:

Surveillance
- Loop detectors and/or sensors (infrared, microwave, sonar and/or radar)
- Machine vision (cameras)
- Automatic Vehicle Location (AVL)/Automatic Vehicle Identification (AVI)
- Information provided by police, emergency medical providers, motorist assistance patrol (HELP), etc.
- Weather monitors
- Electronic Toll and Traffic Management

Communications
- Local area broadcast (HAR)
- Commercial radio
- Land lines
- Satellite communications
- Cellular/wireless services

Control Strategies
- Signal control
- Ramp metering

Traveler Interface
- Variable message signs
- Kiosks
- Highway Advisory Radio
- Highway Advisory Telephone

Data Processing (data processing capabilities become increasing important as the amount of data to be processed increases
- Static and dynamic databases
- Optimal control strategies
- Incident detection and route guidance algorithms
- Coupled route selection and traffic control
- Real-time traffic prediction

It is more difficult to identify the technologies that may be appropriate in the long term, because that technology advancements would be expected to have a signification effect on the capabilities and relative costs of the options available.

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IV. SYSTEM ARCHITECTURE

There are several options for a basic architecture that will lead to the deployment of Intelligent Transportation Systems (ITS) technologies and processes in the Lower Hudson Valley Area. This architecture will provide the framework for an incremental and logical evolution of ITS in the area since it is evident that funding is not currently available for a comprehensive implementation of the entire region to the utmost degree. The development of an architecture should look to accomplish several objectives in order to become fully functional over time. Included among these are:

- Provide the overall structure to support the desired system functions and deliver the required user services to improve mobility within the region. It is recognized that the region includes many jurisdictions and includes integral linkages with other New York regions, county and local agencies, as well as linkages with New Jersey, TRANSCOM and multi-state corridor systems, such as the I-95 Corridor Coalition.

- Strike a balance between using proven, reliable technologies, and the latest "state-of-the-art" technologies. Cutting edge technologies, although offering operational advantages, are often unproven in terms of potential benefits and operations. On the other hand, there is a strong desire to harness the latest, most promising technologies in order to secure the longest useful life of the system over a reasonable period. This balance is especially critical and difficult to achieve in an environment where procurement and construction cycles may result in delays of 3 to 5 years before selected technologies are deployed.

- Provide for future regional growth and incorporate advancements in new technologies, with minimal effort. A system which requires major portions to be discarded as part of an upgrade would not be useful for very long nor economically justifiable.

- Minimize installation, operation and maintenance costs for the system, (i.e., the architecture must avoid imposing unnecessary constraints that may result in higher life cycle costs).

- Provide an "open" architecture so that multiple vendors can support the system, which will reduce life cycle costs and improve maintenance options.

A. NATIONAL ARCHITECTURE OVERVIEW

The emergence of an ITS National Architecture now provides a definitive roadmap for geographically diverse areas to implement ITS designs and deployment strategies in a consistent manner. It is a framework of interconnected subsystems which together provide the ITS User Services by allocating functions and defining necessary interfaces. While the National Architecture definition is not complete, it is sufficiently developed to provide general direction and guidance in formulating solutions to transportation issues and the provision of the core user services. Its declared mission is to be "open and flexible to prevent unnecessary restriction to implementation choice and to accommodate the varied needs of the public and private sectors."

There are four basic elements of the architecture:

- Users: The class of people who interface with architecture implementation as travelers or operators. The capabilities and services of ITS would be utilized for improved travel, enhanced service, streamlined operations, and increased profits.

- External Systems: The computer systems outside of ITS that interface with the architecture.

- System Environment: The physical world of roadway, rail, etc.

- Internal Subsystems: The key elements of the Architecture that interact to provide ITS services and functionality.

These four basic elements provide a top level architecture for the nineteen (19) subsystems that are defined in the National Architecture.

Remote Access:
1. Personal Information Access
2. Remote Traveler Support

Centers:
3. Information Service Provider
4. Traffic Management
5. Emission Management
6. Emergency Management
7. Transit Management
8. Toll Administration
9. Fleet and Freight Management
10. Commercial Vehicle Administration
11. Planning

Vehicles:
12. Emergency Vehicle
13. Personal Vehicle
14. Transit Vehicle
15. Commercial Vehicle

Roadside:
16. Commercial Vehicle Inspection
17. Toll Collection
18. Parking Management
19. Roadway

The Transportation Layer of the National ITS Architecture consists of these 19 interconnected subsystems as shown in Figure 1. This diagram shows both the subsystems (Transportation Layer) and the communications interconnects (Communications Layer) required to support the User services.

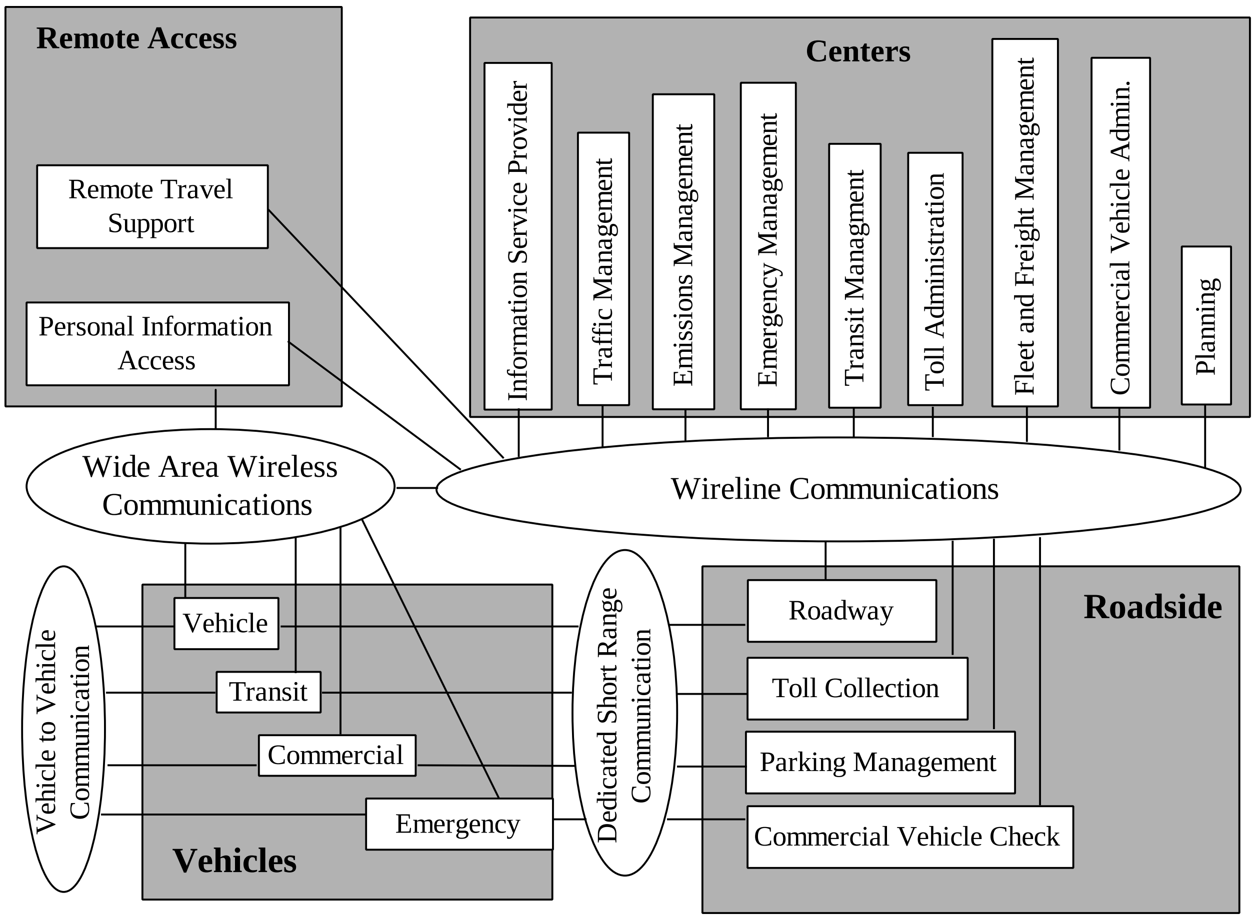


Figure 1 - Physical Architecture

These subsystems align closely with existing jurisdictional and physical boundaries that underscore the operation and maintenance of current transportation systems. By mirroring the current transportation environment with the identified subsystems, the subsystems identify the likely candidates for interface standardization.

The Lower Hudson Valley Architecture will likely contain the following subsystems:

- Information Service Provider Subsystem
- Traffic Management Subsystem
- Emergency Management Subsystem
- Transit Management Subsystem
- Toll Administration Subsystem
- Planning Subsystem
- Roadway Subsystem
- Toll Collection Subsystem
- Transit Vehicle Subsystem
- Emergency Vehicle Subsystem
- Personal Information Access Subsystem
- Remote Traveler Support Subsystem

Furthermore, as part of the National Architecture effort, there are three standards under development: the Advanced Traffic Controller (ATC) specifications; the National Transportation Communication for ITS Protocol (NTCIP); and the Transit Communications Interface Profiles (TCIP). The ATC is a standard to establish common interfaces for traffic control devices. The NTCIP, on the other hand, will establish a standard communications protocol. The NTCIP is intended to allow computers, master controllers, and field devices to talk to each other, regardless of the type of device or manufacturer. The TCIP is intended as a communications protocol for interfacing with transit vehicle devices.

B. TCIP (Transit Communications Interface Profiles)

The purpose of Transit Communications Interface Profiles (TCIP) is to define interface standards for communications between the many and varied transit ITS devices available and under development and, more importantly, to define protocols for the exchange of transit data between transit agencies. The goal is to achieve optimum safety, efficiency and economy in the application of ITS systems and to assure successful communicate between one another, an essential for the success of any ITS application and attempts at inter-operator coordination.

Currently, no TCIP standards have been adopted. But, as of November 14, 1997, the initial comment period on draft ITE TCIP standards came to a close. Comments received are being incorporated into final draft specifications. Following this, the public review process will begin on the draft TCIP standards and by the end of 1998 official Transit Communications Interface Profiles may be in place.

The draft TCIP standards were designed to facilitate and assure the reliable interface and exchange of information between different transit agencies. The draft specification comprises data definitions and message sets for primary transit functional areas. These include: fare collection, incident management, scheduling and runcutting, spatial representation, and traffic management. The profiles are intended to standardize interfaces and thus mitigate the costly and often hit-or-miss track record of customizing interfaces for each agency.

The Lower Hudson Valley has not been directly represented in efforts at establishing these standards. Representatives from NYCTA, NJ Transit, NYCDOT and PATH have been involved. The region will need to monitor the development of the TCIP standards and be cognizant of them as the region moves forward in the development and implementation of the ITS plan.

C. OTHER REGIONAL ARCHITECTURE INITIATIVES

As discussed in the User Services Plan, there are also several regional initiatives that will impact the selection of an architecture for the Lower Hudson Valley. Included among these are:

- Regional ITS Architecture
- IEN
- Model Deployment
- NYC Early Deployment

1. Regional ITS Architecture

The Regional Intelligent Transportation System Architecture is the means by which the various traffic surveillance and control systems will talk to their respective Transportation Management Centers and the way the various TMCs can talk to one another. It is a framework for a common way of communicating and sharing data and information. This architecture was developed for the entire metropolitan New York area under another project.

The development of a system architecture, under the direction of TRANSCOM and its member agencies, is based upon the user services and associated functions it will provide and the operating relationship of the various architecture levels. Based upon interviews with the TRANSCOM member agencies, the most important functions have been identified from a regional perspective. The focus of the regional architecture will include a clearing house of real-time traveler information covering all critical routes and modes. A composite picture of the status of the ground transportation network will integrate the available data from the system Traffic Management Centers (TMCs). In the Regional Architecture, a TMC is at Level 3, the field devices (signs, cameras, traffic flow detectors, etc.) are Level 1, the controllers that these Level 1 devices are connected to are at Level 2; an entity like TRANSCOM is considered a Level 4 and the I-95 Corridor Coalition would be considered a Level 5. The regional architecture will also include regional coordination support between system-level TMCs, transportation agencies and police during “major” incidents and events which cross jurisdictional boundaries. Variable message signs (VMS), highway advisory radio (HAR) transmitters, traveler information kiosks, etc. will be used to provide information on incidents of one agency into other jurisdictions.

2. Information Exchange Network (IEN)

The Information Exchange Network (IEN) workstation of the I-95 Corridor Coalition is located at the NYSDOT TMC White Plains. The IEN provides a link between the TMC and the other Traffic Management Centers within the I-95 Corridor Coalition. The IEN is used to exchange information on incidents, accidents and construction activities between the various agencies that are on-line. To date there are over a dozen IEN stations on-line at various agencies along the I-95 Corridor.

3. Model ITI Deployment For Metropolitan New York City Area

The USDOT selected four (4) metropolitan areas (San Antonio, Seattle, Phoenix and the NY/NJ/Connecticut metropolitan area) for the demonstration of intelligent transportation infrastructure. The intent was to provide showcase demonstrations where the public and local officials can see and experience the benefits of ITS. The effort is the next step in the USDOT Operation TimeSaver initiative to promote ITS technology. In the New York City metropolitan area, the focus will be on making travel condition information more readily available to the traveling public and commercial vehicle operators via public/private partnerships. Traveler information would include information about roadway and transit conditions, as well as transportation services available. A regional Transportation Information System connecting all of TRANSCOM’s member agencies will gather information via a computer-based network server (a kind of “virtual” Transportation Management Center). This information will ultimately be disseminated via telephone, computers, pagers, sold to information providers and found at traveler information kiosks, where the traveler can take printed directions; or via in-vehicle terminals that audibly and visually provide directions.

4. NYC Early Deployment

As part of the early deployment efforts for NYC, a local architecture is being developed. This architecture will provide an interface for multiple agencies in NYC to exchange information. As part of this effort, the architecture is also developing interface protocols so that Regions 8, 10 and 11 of the NYSDOT will directly exchange traffic and transit information. As of the completion of this report, the NY City Region 11 ITS Architecture has not yet been finalized. However, the Lower Hudson Valley ITS Architecture and the NYC Early Deployment ITS Architecture will conform to the National ITS Architecture.

D. ARCHITECTURE ALTERNATIVES

The operation and procurement of a system for automated vehicle location and schedule on-time service monitoring needs to be examined. These functions can either be centralized at the TMC and support remote access from the bus dispatch centers or be decentralized with separate systems installed by each bus system and allowing remote access of each by the TMC. A centralized system may prove to be more cost-effective regionally, but will require a digital radio communication system sufficient to provide reliable radio coverage throughout the region. The decentralized approach may prove to be easier to define at the local level, will likely require upgraded radio systems, may prove more expensive regionally, will introduce problems of system compatibility at the regional level. The AVL, communications and service monitoring system functions will need to be carefully defined and designed. For a regional system, agreements will need to be developed for operations and funding. For a decentralized system, regional system integration plans will need to be developed and regional radio channels established.

Given the range of appropriate user services and the architecture considerations discussed previously, a range of architectural formats was considered. Each of the component subsystems that are to be deployed within the Lower Hudson Valley architecture has its own system architecture. Given that the area includes a collection of existing, developing and future systems, there are several different system architectures, each with its own advantages and drawbacks that must be defined. The three basic types of architectures that exist in transportation management systems today are:

- Centralized System Architecture
- Distributed (Decentralized) System Architecture
- Hybrid System Architecture

Each of these formats, together with its advantages and disadvantages, are discussed below.

Centralized System Architecture

This system architecture format treats the Lower Hudson Valley area as though it were a single agency, as shown in Figure 2. It has the advantage of an economy of scale and the avoidance of delays or miscommunications due to lack of coordination. There is a central Traffic Operations Center (TOC) that collects data, analyzes it, and controls all aspects, including signs, ramp meters, and surface street signals. The arrows represent the flow of data, while involved agencies are represented by a rectangle around a general description. advantage of

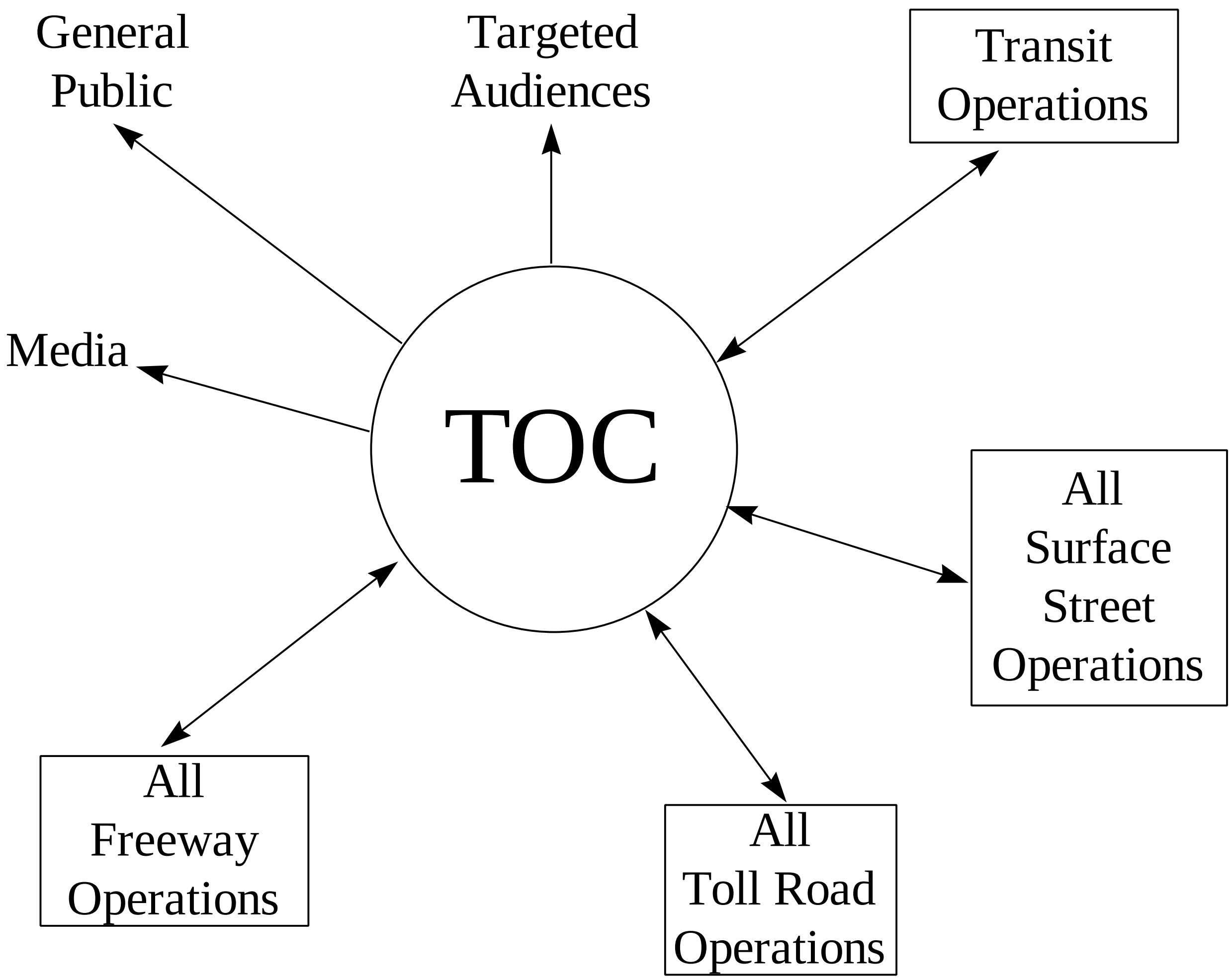


Figure 2 - Centralized System Architecture

The advantages of a Centralized Architecture:

- Straight-forward design
- Isolates the majority of the software and, with dedicated communications, links hardware requirements to the central computer

Disadvantages include:

- Heavy inter-dependency
- Heavy processing requirements due to high computer communications loads
- High life-cycle cost
- Single point of failure (i.e., if the central system or communications fails, all or most functionality is lost).
- Less responsive to local needs

- Lesser compatibility with organizational structures
- Difficulty of transition to Decentralized System Architecture

1. DISTRIBUTED (DECENTRALIZED) SYSTEM ARCHITECTURE

As illustrated in Figure 3, multiple agency TMCs monitor and control ITS features along roadway and transit systems under their jurisdiction with a Traffic Operations Center (TOC) handling freeways. These centers are fairly autonomous. Communications between them are generally ad hoc, relying on voice telephone, with a handful of agency connections for graphical traffic information. This has the advantages of flexibility, responsiveness to local needs, compatibility with organizational structures, and ease of transition.

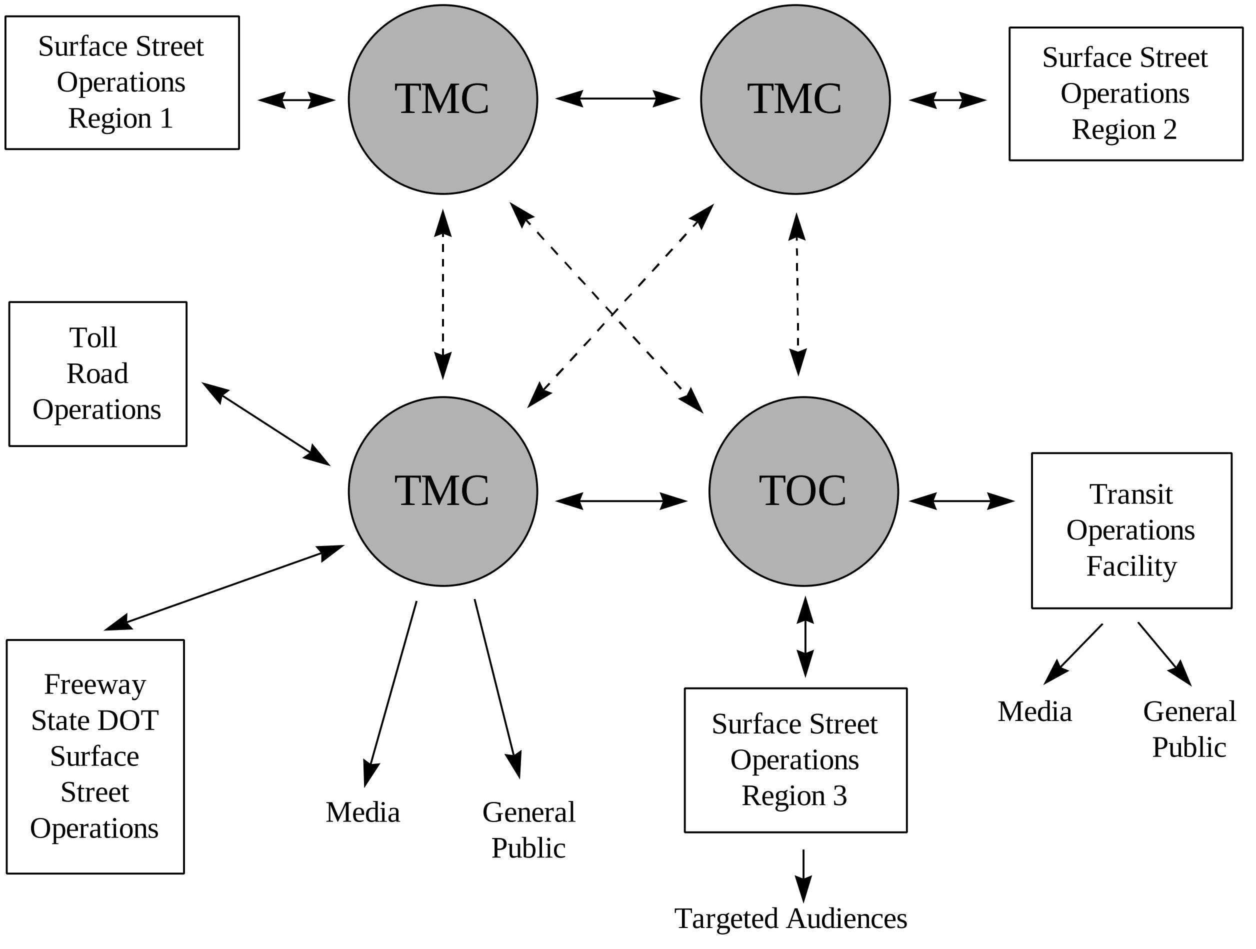


Figure 3 - Distributed System Architecture

Closed Loop Signal Systems are a good example of this architecture. These field distributed systems feature a central microcomputer that communicates with local area masters using either dedicated or dial-up communications facilities. The local area masters are connected to the intersection controllers using dedicated communications facilities. There are already closed loop signal systems deployed in the region.

Advantages of the Distributed Architecture include:

- Interaction between subsystems
- Voice communications requirements between agencies, TMCs, etc. are minimal because agencies are already connected through existing phone networks
- Provides for jurisdictions to have independent or coordinated control options
- Responsiveness to local needs
- Compatibility with organizational structures
- Multiple points of failure must occur for system to fail
- Modularity in building a system from subsystems
- Incremental financing of system development

Disadvantages for Distributed Architecture include:

- Requires a more complex communication network system to link data and video, not just voice over telephone lines.
- Could pose challenges in effecting economies of scale and the avoidance of delays or miscommunications due to lack of centralized coordination
- No direct coordination and interfaces among the agencies operating in the area

2. HYBRID ARCHITECTURE

The hybrid architecture format is an assembly of selected features of the centralized and distributed architectures. This structure has both the local Traffic Management Center (TMC), for local monitoring and control, a freeway Traffic Operations Center (TOC) and an area-wide multi-agency Traveler Information Center (TIC). These structures enable fusion of status data, major incident management, and control at an area-wide level, as appropriate. The information is tied together using automated data sharing. Certain forms of this architecture can have the advantage of global information sharing without sacrificing the current local capabilities. Figure 4 shows how this architecture would interface.

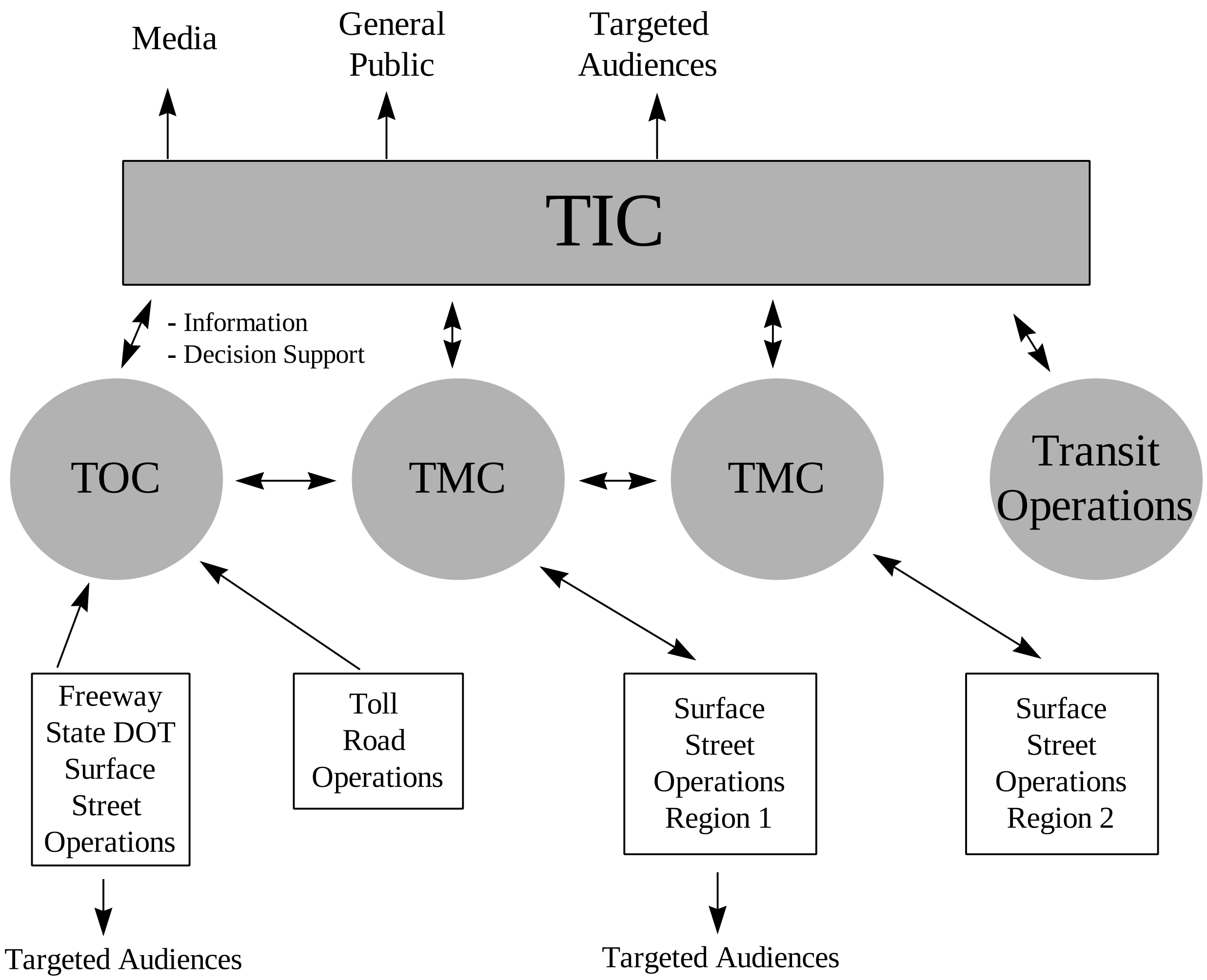


Figure 4 - Hybrid Architecture

The advantages of a hybrid architecture include:

- The communications requirements are more flexible, since there is no real-time data exchange between the local controllers and central.
- The individual operators retain control of their systems, but can now work in a more informed and coordinated manner.
- Provides a great degree of flexibility in operation.
- Accepts the integration of existing systems with minimal costs.
- There is a transparent interface to the traveling public.
- Promotes co-existence of multiple agencies in certain Centers.
- Easily allows staged deployment.
- Eases the process of expanding in the future.

The disadvantages include:

- Need to develop clear memoranda of understanding.
- Requires distinct communications protocols to be developed.

- Requires a champion to promote cooperation and overcome institutional profiles.
- Less costly than a distributed architecture but more costly than a centralized architecture.

3. SYSTEM ARCHITECTURE RECOMMENDATIONS

A system architecture concept that is dynamic and can be continually refined to produce the best possible results in an age of rapidly changing technology is critical to the future implementation of ITS in the Lower Hudson Valley. The architecture must accommodate a variety of component system architectures. Based on an assessment of each alternative's ability to meet the Lower Hudson Valley transportation objectives discussed in the User Services Plan and considering the system constraints and sensitivity issues, a Hybrid Architecture is recommended. The architecture recommended for the Lower Hudson Valley is shown in Figure 5. As is easily seen, it is an architecture that is basically in line with the TRANSCOM Regional Architecture and should easily blend into the future NYC Architecture.

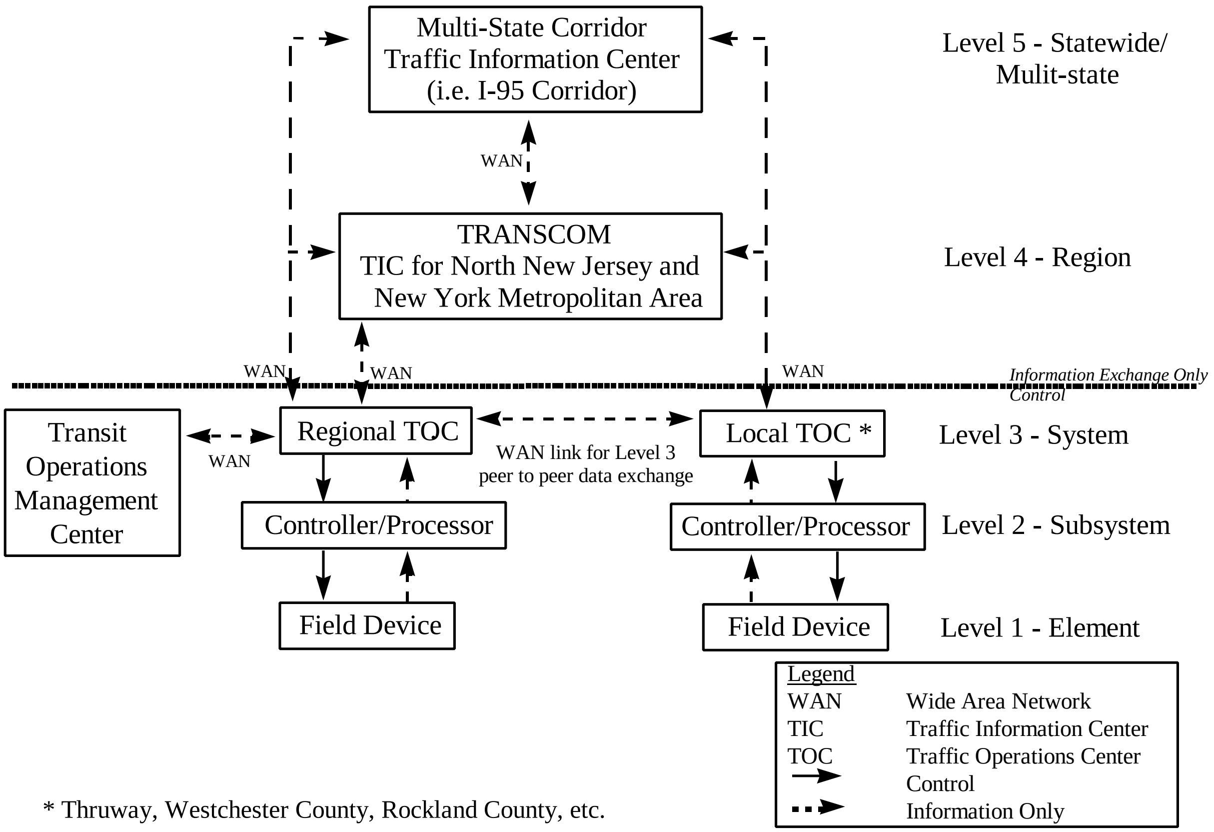


Figure 5 - Recommended Lower Hudson Valley Architecture

The Lower Hudson Valley Architecture would link Traffic Operations Centers (TOCs) and Transit Operations Facilities/Center(s) in each of the major operating jurisdictions to a Regional TOC and Traffic Information Center (TIC). These could include the other DOT Regions, the Thruway, the counties and major cities, such as White Plains, as well as the transit agencies emergency service providers and 911 centers. This architecture could also accommodate several of these agencies combining into a single TOC. A major question is: precisely what information is exchanged and how will it be exchanged. Such information may include: traffic image data, predicted incident data, incident response data, map display data, and incident response updates. Presently, many of these protocols are being worked out as part of the TRANSCOM and NYC architecture efforts.

As shown above, this architecture describes the framework for this system. It consists of multiple levels and system components. These levels and system components are defined below:

- Elements (Level 1) - Elements include devices that perform specific system functions and tasks, usually in the field and typically comprising either the collection or presentation of data. Examples of devices that collect data include vehicle detectors, ice sensors, CCTV cameras and automatic vehicle identification tag readers. Example of data presentation devices include signal heads, variable message signs, highway advisory radio transmitters and in-vehicle message displays.

- Subsystem (Level 2) - Subsystems typically control or collect data from multiple elements. Functions at this level may include preprocessing of element device data, local control of element devices, data storage and data conversion. Examples of Level 2 subsystems include signal controllers, ETC field processors and VMS controllers. Subsystems as they are described here are not the same as the subsystems identified in the National ITS Architecture.

- System (Level 3) - The system functions by combining input from subsystems and elements in a manner that supports monitoring and management of the functions being carried out. Systems provide a centralized interface to multiple subsystems and elements, and also provide processing of subsystem and element data into management information for a particular agency. The Transit Operations Facilities are Level 3 Systems.

- Geographical Region (Level 4) - Level 4 comprises a network of systems in a geographical region that supports exchange of data between agencies within the geographical region. TRANSCOM would serve as the Level 4 regional network. TRANSCOM collects and distributes data among various transportation and enforcement agencies in the metropolitan area comprising New York, northern New Jersey and Connecticut. Level 4 systems support the exchange of critical traveler information (such as the Traffic Information Center (TIC)) and are not directly involved in command and control functions.

- State-wide / Multi-state (Level 5) - Level 5 comprises a class of multi-state wide area systems that support the exchange of critical traveler information among transportation and enforcement entities throughout a multi-state travel corridor. Specifically, the I-95 Corridor Coalition is a Level 5 entity that includes states along the east coast from Maine to Virginia.

Each of the centers (TOCs) will be connected to the TRANSCOM regional wide-area network (WAN). This WAN will provide for the complete integration of all of the Lower Hudson Valley's traffic systems into a decentralized format. Individual TOCs within the Lower Hudson Valley such as Westchester County and the regional 911 centers, should also be directly connected to exchange certain levels of information. It should be emphasized that **each agency will still have ultimate control over all of its own signals, field devices, and operations.** However, to facilitate mutual aid and cooperative operations, only with the approval of the controlling agency, the system will allow:

- An agency to monitor system operation of other systems in the geographical region.

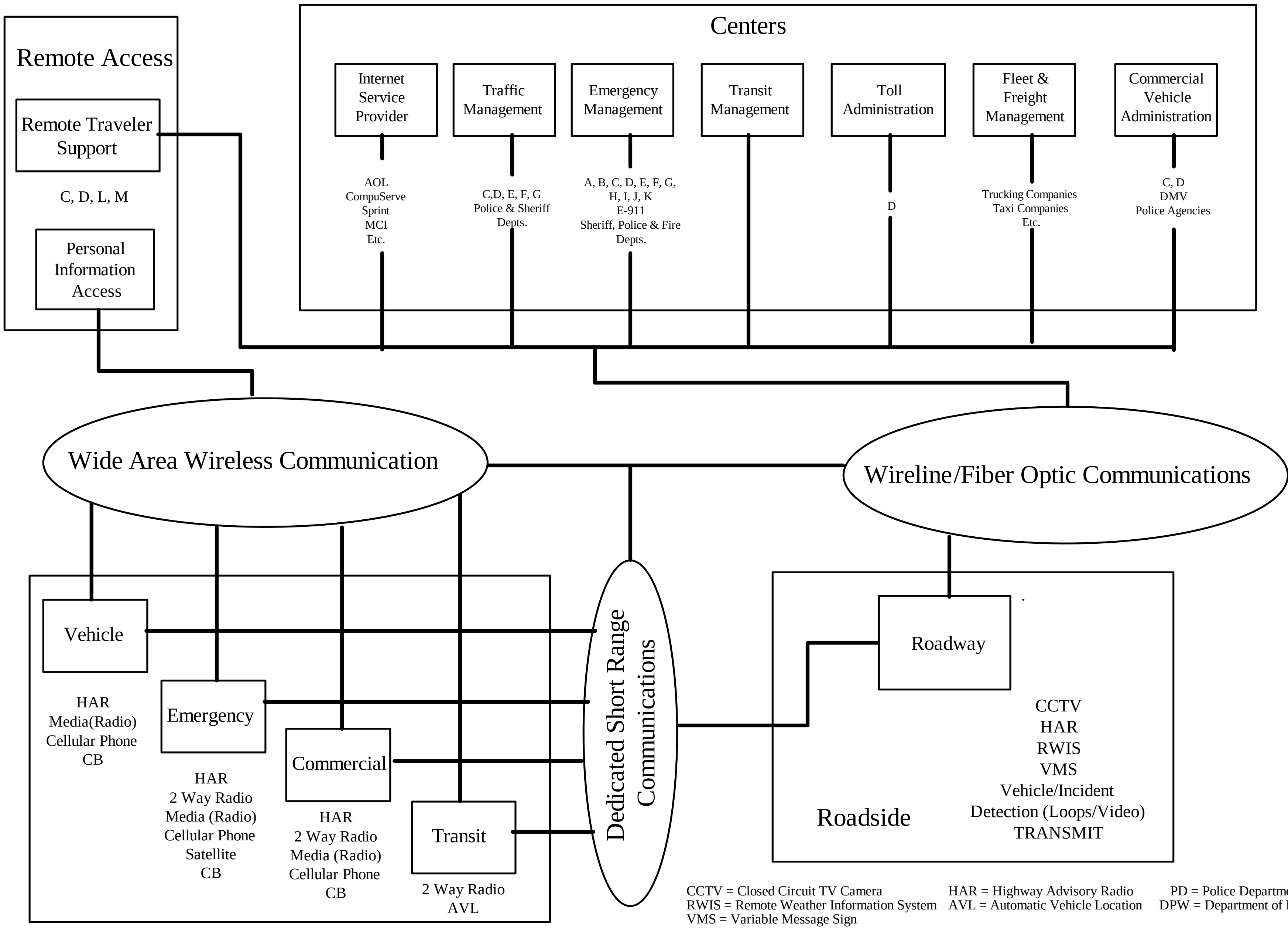
- Messages, data, and video to be passed back and forth between operators, and other personnel of the connected agencies.

If response plans have been developed and a major incident occurs, an individual agency would be contacted through TRANSCOM or directly within Level 4 and would respond according to a pre-defined response plan and bring resources as required and implement the pre-defined actions. If response plans have not been established, then TRANSCOM's TIC would simply notify all agencies of the incident. Each of the individual TOCs would perform the basic device data acquisition and control functions for all of its resources (i.e., communications, failure monitoring, system detector processing, etc.). The TIC would have the capability for extracting relevant data from the Level 3 systems that monitor the regional system.

Agency/Organization	Key
FHWA	A
NY State	B
NYSDOT	C
NYSTA	D
NY State PD	E
WCDPW	F
City of White Plains	G
Rockland County	H
Putnam County	I
Orange County	J
Dutchess County	K
Westchester Commuter Central	L
Media	M

Figure 6 - Architecture Interfaces of the Lower Hudson Valley

FIGURE 6
ARCHITECTURAL INTERFACES OF THE LOWER HUDSON VALLEY



CCTV = Closed Circuit TV Camera
RWIS = Remote Weather Information System
VMS = Variable Message Sign
HAR = Highway Advisory Radio
AVL = Automatic Vehicle Location
PD = Police Department
DPW = Department of Public Works

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V. TRANSPORTATION MANAGEMENT CENTER

A. INTRODUCTION

The New York State Department of Transportation is in the process of developing plans to relocate and expand the Lower Hudson Valley Transportation Management Center (TMC) from its current temporary location at 244 Westchester Avenue in White Plains to a new Lower Hudson Valley TMC that is intended to manage the future Intelligent Transportation System (ITS) in the five county area; Westchester, Rockland, Putnam, Dutchess and Orange. The new TMC will become the nerve center and focal point for the management of the Lower Hudson Valley transportation network. It will also become the command center for future incident response to traffic conditions that impact traffic flow in the Lower Hudson Valley. A central hub of an extensive communications network will ultimately link the TMC to a regional transportation information network to monitor and control transportation flow. As part of the ITS Early Deployment Plan, numerous candidate buildings and properties for this TMC were evaluated throughout the Rockland County and Westchester County areas. These sites were evaluated based upon factors such as their location, size, ownership, utilities and security.

Upon completion of design and construction, the Traffic Management Center will ultimately serve as the centerpiece for the Lower Hudson Valley Intelligent Transportation Systems. In addition, the functions performed in the TMC may include transit management and coordination with the transit providers. Most Advanced Transportation Management System (ATMS) functions and Advanced Traveler Information functions will be performed at this TMC. Both technically and visually, the TMC will play a major role in defining the success and public image of the Lower Hudson Valley Intelligent Transportation Network.

The internal functions of this TMC will include items such as incident management, systems operations, freeway and arterial roadway monitoring, congestion management as well as other Intelligent Transportation System (ITS) activities that may include the regional transit system. Perhaps one of the most important issues to the success of the internal operations of the TMC are the facilities (i.e. building, grounds, utilities, etc.) and location. Also, of great importance to the success of the internal operations of the TMC is the experience of the operators and the degree to which automated responses to conditions can be implemented with confidence. Adequate floor space, highway access, communication linkages, site security, building construction and alternate route access will all contribute to a successful TMC.

This report describes the process by which the most suitable location for the TMC was determined. The following sections of this report describe the criteria and potential sites and review the process by which the final TMC location was chosen. The conceptual plans for the TMC building will also be presented in this report.

B. FUNCTIONS OF THE TRANSPORTATION MANAGEMENT CENTER

A TMC serves as the main facility from which ITS activities, such as incident management information dissemination and VMS control, are operated and coordinated. The TMC should ultimately house the following functions:

1. ADMINISTRATION

Personnel management
Facility operations
Office space
Record Storage
Telephone Equipment
Reception area
Agency coordination - State Police, Fire and Emergency Management, Public Transportation

2. INCIDENT MANAGEMENT

Operator workplace(s) - workstation with monitor, modem, report and graphic printers, scanner
State Police Sergeant or Command Post
Transit operator dispatch center(s)
Communications server
Tape backup unit
Telephone equipment
Radio equipment

3. SYSTEMS OPERATIONS, SYSTEM ENGINEERING, COMMAND AND CONTROL, INTERAGENCY COORDINATION

Engineers workplace(s) - workstation with monitor, modem, report and graphic printers, scanner, laptop PC
Transit workstation(s) with monitors to display GIS based AVL information
Communications server
Offices with guest chairs and table

Storage for computer service needs (toner, ribbons, boxes of paper)
Tape backup unit
Large Video Monitor wall
VMS operating console
Roadway/Weather Information System work station
VMS controls
Conference room for Interagency coordination meetings

4. COMMUNICATIONS AND DISPATCH, DATA COLLECTION AND DISSEMINATION, ELECTRICAL/ COMMUNICATIONS ACCESS

Communication transmitter room
Communications hardware room
Modems for remote tie-in to regional AVL system from each transit dispatch center
Public transportation AVL system base station equipment (AVL radio base, GPS antenna, AVL tracking system server, transit master schedule server, on-time tracking system processor)
Satellite antenna
HAR taping room
Maintenance dispatch/communications
Media room/podium/sound system

5. MAINTENANCE, FIELD SUPPORT

Maintenance workplace(s)
Mechanical and electrical supply and equipment rooms
Garages for vehicles
Power room
HVAC
Freeway service patrol program/vehicles

6. PUBLIC RELATIONS

Conference room
Speaker system
Podium

7. SECURITY

Interior and Exterior CCTV Surveillance System
Access Cards/Security Codes

8. GENERAL

Kitchen
Lunchroom/Lounge
Showers
Lockers
Restrooms
Parking

All of these functions joined together in the TMC will ultimately allow NYSDOT and other agency personnel to:

- Supervise operation of the system
- Perform administrative duties and maintain records
- Modify system functions
- Respond to calls from local agencies and the public
- Coordinate with the State and local Police
- Monitor equipment
- Observe computer outputs on map display terminals and printers
- Monitor field equipment
- Observe CCTV
- Monitor public transportation services
- Facilitate coordination between public transportation services
- Provide real-time information to public transit dispatch centers
- Provide real-time public transportation service information for public dissemination

C. SIZING CONCEPT

To adequately assess the existing and future space needs for a TMC, it is necessary to understand several underlying concepts of the systems design. These concepts require clear definition and include the following:

- The space requirements must consider the communications equipment. Most likely NYSDOT will implement a SONET "ring" network topology for wide area network communications throughout the region. The TMC will need to communicate to field devices via this network. The TMC will function as one of the SONET hubs, and will contain equipment that communicates to the field site hubs. The TMC communications equipment should allow traffic operations personnel to communicate with the field devices via the SONET ring network. The communications equipment will allow transit dispatch centers to access AVL information and assess on-time performance in real-time via the SONET ring network. Therefore, the capacity of the network must be great enough to handle multiple users simultaneously. In addition, communications between the AVL tracking system server, the master schedule server and the on-time tracking system processor should remain separate from the SONET ring network. The user requests and system processed responses will be communicated via the SONET ring network, the system processing will be on line to maintain the processing speeds required to assess public transportation on-time status.

- The video image display requirements will be a major determining factor in the equipment quantification process for the operations of the TMC. A display wall layout will include several monitors that can continually scan operations of multiple CCTV surveillance areas. Large display monitors are required for displaying GIS based AVL information on public transportation services in the region.

- The individual operators will require PC-based work stations. Operations of the various field devices will be able to be controlled from these workstation areas. The public transportation workstation(s) will consist f a fast PC-based computer with maximum RAM and large graphical monitors. This workstation(s) will have direct connection to the on-time tracking system processor. The AVL tracking system server and the transit master schedule server should be comprised of the fastest PC-based or minicomputer technology with large volume storage and maximum RAM.

- The number and type of field devices will determine the communications needs. This equipment will need to be placed into a special room dedicated to housing this communications equipment.

- The operations philosophy of the TMC will be essential in the determination of the space requirements. The degree of control, integration and/or separation by function, workstation, and operator will likely be based on time of day operations. The system will need to be designed to allow all functions to be managed from a single workstation. Individual elements or sub-areas may be split-off during peak hours or major incidents and managed by separate operators as required.

All of these factors will need to be considered in the sizing of the future TMC facility.

D. TMC FUNCTIONAL AREAS

A TMC needs to be fully functional and contain many types of rooms to meet the needs. Included among these functional spaces are the following:

1. PUBLIC SUPPORT SPACES

The public will visit the site to learn about their highway system and traffic control and the operation of the other control and management systems occurring at the center. The larger tour groups will likely be school children. Single classes of 26 students with 4 to 6 adult escorts could be the norm. The planning size for tour groups for this facility is proposed to be about 32 people. Public transportation service information will be maintained and available to the public at the TMC.

- **Reception Room** - Groups will gather in the reception room. There should be seating for approximately 12 people and ample room for standees. There should also be displays, exhibitions and handouts available to provide self orientation on the operation of the facility. The facility receptionist will staff the room to screen visitors who have come on business from those who have come to tour. Small groups and individuals may be able to visit the facility without a reservation or a guide.

- **Conference Room** - After the visitors have all assembled they will move to the conference room. The room will provide a view for any group to observe the activities in the operations room. The room should be sized at roughly fifteen square feet per person. A table system that can be assembled into a combination of table sizes is proposed for the conference room. The size should range from one large table to accommodate 32 visitors to multiple tables for various types of presentations. The space will have film viewing capability or large screen video. The room will also function as a crisis control room.

- **Public Rest Rooms** - Public rest rooms are to be provided near the reception and conference rooms. The entry to these rooms will accessible from the reception area. The rooms will be designed to meet the current Americans with Disabilities Act (ADA) requirements.

2. TMC SUPPORT SPACES

- **Internal Conference Room** - The Incident Management Support Space should have a conference room located near the office area. There should be space for up to 20 people to have meetings. The space will have film viewing capability or large screen video. The room could also double as a training room and a crisis room when the larger conference room is not required. This room should also have windows from which to view the operations room.

- **Staff Rest Rooms** - Staff rest rooms will be provided on each floor. One rest room could be combined with a locker and shower room on one floor if that space is conveniently located. The rooms will be designed to meet the current Americans with Disabilities Act (ADA) requirements.

- **Locker/Shower Rooms** - A separate men's and women's locker and shower room should also be provided. About ten to twenty lockers for each sex could be provided. Two shower stalls in each locker room should also be provided. The locker room should have a bench with space for drying and dressing. The rooms will be designed to meet the current disabled accessibility requirements.

- **Break Room** - A break room with seating for about 12 people needs to be provided. A counter with a sink, space for a microwave and a dishwasher is proposed. There should be a cabinet space for storage of food, dishes and other supplies. A large refrigerator should also be provided. In some state facilities vending machines are provided. Currently space for vending machines has not been identified. The break room should be located near the staff restrooms.

3. TMC OPERATIONS AREAS

- **Operations Room** - The operations room will be the focal point of the facility. A conceptual plan should allocate between 10 and 12 workstations in the operations room. This will allow for future expansion and multiple agencies to have a work station in the operations room. The open area on the upper floor will be surrounded by glass walls from floor to ceiling to keep out noise. Views will be provided from the large conference room as well as the break room, viewing room and the hallway adjacent to the locker rooms.

- **Maintenance Room** - The maintenance room provides space for the technicians who will be maintaining the System. Storage for the necessary tools and spare equipment should also be provided in this area. Maintenance of the Highway Emergency Local Patrol (HELP) vehicles and space for related equipment needs to also be included somewhere in the TMC. The need for dispatch and coordination makes placement of the HELP function within the Center a more efficient operation from a management perspective.

- **Electronics Room** - The uninterruptible power supply and HVAC functions are located in this space. The racks which hold such electronic devices as the video switches, central processing units (CPU), PC network equipment and SONET equipment for the TMC should also be located in this room.

- **Electrical/Telephone Room** - The building's phone, voice messaging, and electronic alarm system should be contained in one room separate from the operations center communications area. This minimizes the potential for disruption of TMC operations during maintenance activities. Access to the TMC communications areas should be restricted to qualified staff.

- **Offices** - Three offices; one for the System Manager, one for the Assistant System Manager and one for the Maintenance Supervisor should be included in the facility. These 3 offices should be located on the operations room level. Each shift supervisor will also have their own room to minimize disruption from shift and work overlaps. About nine to ten offices and roughly ten cubicle spaces also need to be provided for agencies and other NYSDOT staff personnel.

- **State Police 911 Communications Center** - This room needs to be integrated into the operations room, so that any incident reported to the dispatching team can immediately be handled by the operators in the operations room. The 911 operator(s) can view the activities in the operations room. The dispatching facility will handle all of the dispatching functions of the State Police. A booth surrounded by sound-proof glass walls with a sliding door to the operations room will need to be provided to accommodate coordination of emergency activities.

- **Communications Room** - The communications room has been designed to accommodate maintenance and expansion. The area should be large enough to ultimately house the equipment for control of approximately 600 video cameras. This area needs to be on an outside wall to facilitate receiving the incoming fiber optic, telephone or dedicated communications lines.

Space will be required to house the public transportation support systems including: base radio communications system to support AVL communications between vehicles and base (TMC); communications banks for modems to support communications between the transit dispatch centers and the master scheduling server and the on-time tracking system processor; and space for the AVL tracking system server.

- **HAR Taping Room** - The HAR taping should occur in a booth-like room adjacent to the operations room. It has been located for ease of access and to facilitate message updating. The recording technician will be looking at the operations room CCTV monitors while developing a message which will act as a reminder to update the HAR messages when conditions change**.**

E. HOW THE LOWER HUDSON VALLEY TMC FUNCTIONS

The Operations Room is the central focus of the transportation management activities in the TMC. The daily operational functions of the TMC personnel will include monitoring the highway detection system, which includes speed, volume and traffic density. The operator will view the CCTV monitors, which are programmed to display a particular view of the highway that has been preset in conjunction with a certain speed or density threshold at an adjacent detector station. The operator might change messages on several of the VMSs approaching a congested area to reflect congested conditions related to recurring congestion, or change the highway advisory radio broadcast message. The operator might also spot a disabled vehicle via the CCTV monitor and dispatch a service patrol vehicle to help a stranded motorist whose vehicle appears to be disabled. The operators might also be in frequent contact with the City of White Plains Traffic Control Center (TCC) operators, several of the fire and emergency service providers or any of the regional transit agencies. A State Police Communications Center will also be located in the TMC. Facilities will be established within the TMC to monitor public transportation services in the region and permit transit operations centers to anticipate and react to conditions to maintain services on schedule, alter operations when and where needed and facilitate service coordination between transit systems.

For a typical nonrecurring incident, the scenario might play out as follows:

The area map is displayed on the large screen monitor at the front of the operations room. One section of the status map showing the detection system flashes "red" indicating an average speed for that half-mile section of less than 15 miles per hour. The adjacent sections denote slow speeds in both directions approaching the area. This indicates the strong possibility that there is an incident at this location. By this time the speed threshold; set to pan, tilt and zoom the adjacent CCTV camera to a preset position; has projected the image of this area onto one of the large monitors. The CCTV image is used to verify the occurrence of the incident, identify the type of incident, number of vehicles involved and the precise location.

Meanwhile, the State Police Communications Center's display terminal, located in the TMC, indicates that the State Police Communications Center has received several calls from cellular phone users about an accident in this area, but the direction and milepost are conflicting. In the TMC the TMC Operator has visual verification and can determine the precise location of the incident. The State Police Communications Specialist contacts the appropriate State Police vehicle who arrives on the scene momentarily.

To mitigate the delays and backups due to any lane closings, a TMC operator might request a special timing plan from the City of White Plains or from a Westchester County Traffic Control Center operator to be implemented on the parallel arterials and at the detour off-ramps. At the same time, another TMC operator can pull up the VMS menu on the workstation. There may be messages in the message library that are appropriate for this incident. The operator sends the message to the appropriate signs adjacent to the scene. In this case, the group of VMSs have been predetermined for this particular incident. Incident Management Plans were developed to determine a grouping for each segment of the highway between interchanges. The typical message frames might include "ACCIDENT AHEAD-PREPARE TO STOP" and "SEEK ALTERNATE ROUTE-TUNE TO 530 AM". Also at this time, the first operator is uploading a highway advisory radio broadcast message indicating that a particular segment or lanes of the highway have been closed due to the accident. The message recommends two alternative off-ramps. These messages are prerecorded, stored in a digital format and in some cases are edited together to form more comprehensive messages.

With the direct view of the CCTV image, the State Police Communications Specialist is able to tell the emergency service personnel to approach the scene by coming down the opposite way on the off-ramp due to the configuration of the accident.

The TMC operators monitor the incident until it is cleared. As traffic conditions return to normal the VMSs are turned off and the HAR broadcasts are changed to indicate traffic conditions have returned to normal. The traffic signal timings are changed back to their proper time of day plans.

This type of scenario could be developed for any type of incident. The severity and duration would dictate the intensity of traffic management needed. For instance if the mainline of a section of the expressway was completely blocked by a burning tanker truck, a greater number of VMSs and HAR transmitters would be activated, and a greater number of alternative routes would be implemented with special timing plans. In cases where the incident had impacts of a regional nature, the information would be forwarded to TRANSCOM and the I-95 Corridor Coalition via the regional architecture and the I-95 IEN server to disseminate beyond the Lower Hudson Valley. For more localized minor incidents, the information exchange and agency coordination would occur through local interfaces which might be manual or automated.

The Transportation Management Center would act as a detection and verification arm for the State Police Communications Center for roadway incidents. The use of the detection systems and the CCTV camera system will reduce the amount of time to detect, locate, verify and assess an incident. Cellular phone users, enhanced milepost markers and landmark signing, Highway Emergency Local Patrols (HELP), county and state DOT maintenance personnel, police patrols, CB users and commercial vehicle operators would also act as “detectors” by calling into the Cellular 911 number.

In the scenario presented, the TMC would have notified (via fax, phone or on-line communications) the transit dispatch centers whose services are affected by the incident. Transit operations dispatchers would then be in a position to monitor the operations of the vehicles via the AVL tracking system and observe when and where service is likely to fall behind schedule. In response, the dispatch centers can take corrective actions for specific vehicles to minimize delays and coordinate inter-operator connections to avoid missed trips. The public will be notified of the service conditions and operational changes via automated public information systems and through information dissemination channels such as

TRANSCOM and local news. As a matter of course, the current on-time operational status of public transportation services will be monitored and exceptional information accessible by the public via telephone, fax and on-line channels. The information provided will be route and time specific for each operator.

F. SPACE PROGRAMMING FOR THE TMC

1. ADJACENCY RELATIONSHIPS

Spaces within a building often share a functional relationship with one another. These relationships and their hierarchy of importance can be recorded in an Adjacency Matrix. The matrix indicates two levels of adjacency: people and information. Each type implies a different kind of design response. Two or more spaces may need to be physically adjacent or located very close to one another when people need face to face contact or when people move from one area to another as part of their activities. With some relationships two spaces may simply need to be accessible to one another, but this can be accomplished with a corridor or through another intervening space rather than with direct adjacency.

Finally, there may be a requirement that people in different spaces only exchange information. The adjacency may then be entirely electronic.

For this facility the operators must be able to see the console monitors comfortably and the public or visitors should be able to view the operations from the conference room. The layout should reflect the function of the operations center, with operational consideration as the primary focus. Each operator's station will be used by a number of different people. This is due to the shift nature of the work and the operational nature of dealing with various types of events.

The building layout will depend upon the desirable spatial relationships between various functional areas. For example, the functional spaces which include the operations room (which houses operator workstations and a large display wall with closed circuit television monitors and graphic displays), the communications room (where the associated communications equipment for 911 and the TMC are located), the State Police Communications Center (which houses the State Police Communications Specialists), equipment maintenance room and the equipment room (which includes the computer, peripherals and communications hardware) should be adjacent to one another. The public spaces will include the reception lobby (which serves as the place for visitor gathering and orientation), conference room (which provides space for holding large meetings and public viewing of the operations room) and the public support rooms which include the rest rooms, elevators to meet accessibility requirements and a break room to provide refreshments.

The employee spaces will include work areas or offices separate from the functional operation rooms. The operators and the technicians will have work areas in which to plan their work and to provide a personal work space. The offices will provide work places for the management personnel. In addition, offices must be provided for agency personnel who perform part-time supervisory and crisis responsibilities. Control centers cannot be viewed in the same light as a normal office with normal working hours. People are often expected to work under very hectic and strenuous conditions and atypical working schedules. Consequently, provisions must be made for the operators and engineers to function for long periods of time, possibly days at a time. Employee service rooms will include rest rooms, elevators, kitchen facilities, locker rooms with shower facilities and a quiet room for resting over extended shifts.

G. BUILDING / SITE SELECTION TARGET CRITERIA

1. CRITERIA

Pursuant to discussions with the Department and other agencies and based on the information provided in the previous sections, as well as, a review of similar facilities constructed around the country, the Transportation Management Center (TMC) space requirements were initially determined to be approximately 16,000 SF to 18,000 SF. This size was intended to accommodate the functions listed in the Section “Functions of the Transportation Management Center” and to allow for inclusion of other interested agencies during major incidents as well as on a more permanent basis. The inclusion of a 911 Answer Center in the TMC and the State Police Troop K Zone 4 Headquarters, for example, was also considered important for efficient incident management. After discussions with key State Police personnel it was decided to evaluate an option to combine the State Police and the TMC into one single facility. With the addition of the State Police to the facility the size of the facility would need to be increased to roughly 23,000 to 28,000 SF. With all of these factors in place, the following is an initial list of criteria used to evaluate potential TMC sites:

a) Access

- Proximity to roadway system

- Emergency access alternatives
- Proximity to police/maintenance facilities
- Travel/time factors to incidents
- Ease of communication linkage

b) Location

- Physical environment condition
- Existing adjacent properties
- Availability of site services - power/water/sewer/communications

c) Costs

- Initial vs. long term
- Lease vs. own

d) Building Structure

- Physical condition of structure/services
- Code/regulatory compliance
- NY State code, ADA, NFPA
- Volumetric capacity
- Expansion/flexibility
- Availability of site
- Utilities

After some further discussions with NYSDOT personnel, the following is a list of the minimum criteria that was used to evaluate and select potential locations for the TMC:

A. Site Area:	Minimum of 2 acres (87,120 SF ±)	
B. Available Parking:	45 to 60 parking spaces	
	TMC:	15-20 spaces
	State Police:	5 - 10 spaces
	Other Agencies:	5 - 10 spaces
	Visitor spaces:	5 spaces
	Additional spaces (future):	15 spaces
C. Building Area:	23,000 sq. ft. - 28,000 sq. ft.	

Potential Breakdown

Operations:	16,000 - 18,000 SF.
State Police:	6,000 - 8,000 SF
Unassigned:	1,000 - 2,000 SF
Total Space:	23,000 - 28,000 SF

D. Operations Room Height/Volume: Ability to have 12' - 0" clear (min.) within control center (approximately 1,000 sq. ft. area). 8'-0" to 9'-0" acceptable elsewhere.

E. Construction Type:

Non-combustible/fire protected steel framing:	O.K.
Masonry construction:	O.K.
Wood construction:	Not desired

F. Exterior Windows: Acceptable for office use, not desired for operation center.

G. Floor Loading: 50 PSF (minimum)

H. Elevator: Required if two or more floors; building must be ADA compliant.

I. Proximity to I-287 corridor: Critical - located proximate to the I-287 corridor for initial system

J. Proximity to alternative access and emergency routes: Important - especially for emergency vehicles

K. Proximity to police/county/ DOT maintenance facilities: Preferred

L. Expansion capability: Preferred

M. Ease of Communication linkage: Adjacent to fiber optic network and I-287/I-87; 911 capabilities

N. Security: Convenient access, but ability to limit access needed; secure facilities

O. Utilities: Available gas, water, electricity, sewer and storm drainage

P. Ownership: Ability of the State to lease or purchase the property in a timely manner and act within a time frame that meets the market conditions

H. EVALUATION OF PROPERTIES / BUILDINGS

Early results of the traffic congestion and incident data information from the Early Deployment Study in the Lower Hudson Valley are that the roadway network in Westchester and Rockland County would form the backbone of a regional ITS system. Therefore, it was determined that the appropriate location of the TMC would be somewhere in Westchester and Rockland counties within the vicinity of the parkway system in Westchester County, I-287 and other primary corridors. Initially, various properties and buildings owned by NYSDOT, New York State Thruway Authority and Westchester County were evaluated. These properties and buildings were inspected by engineers and architects to begin the evaluation process. In addition, the private real estate market was contacted to determine if privately owned buildings were available for purchase, lease or partial lease by NYSDOT. The following are a list of the sites that were evaluated as a potential locations for the Lower Hudson Valley TMC. The locations of these properties can be found on the accompanying map. The numbers in parentheses refer to the numbers shown on the site location maps, Figure 1-A and 1-B.

1. WESTCHESTER COUNTY

Mazur's Furniture (1)

This property is located at the Lake Street overpass of the Cross Westchester Expressway. This property will likely be taken as part of the Cross Westchester Expressway reconstruction. The location of this property is acceptable, but the size of the building is inadequate and the parking lot and site is inadequate for the feasible expansion of the building and parking to meet the desirable criteria.

Commercial Building - Pepe Motors, Inc. (2)

This property is located at Brockway Place at the Cross Westchester Expressway. This property consists of three attached buildings, with a total of 38,000 square feet, situated on three acres of lands. Floor plans of the building were acquired from the owner. The buildings had too much space and the owner was not willing to subdivide the property. None of the three buildings was adequate alone for the housing the TMC.

Land adjacent to Texaco, Inc. (5)

This site consists of a frame building on 2 acres at the corner of Purchase Street and Kenilworth Road near the Hutchinson River Parkway.

Surplus Property (6)

This two story house came from the Department's surplus property list. It is located at 126 Purchase Street in the vicinity of the Hutchinson Parkway, northbound, in Harrison.

Central Park Avenue (7)

This 1.17 acre site is located at Healy Avenue and Central Park Avenue in Greenburgh. This site, initially thought to be available, was no longer vacant.

Saw Mill River Road (Route 9A) (8)

The site consists of several wood frame construction houses that have been converted to offices just south of the Cross Westchester Expressway in Elmsford.

Armory - Route 9A (17)

This one story brick building is located at Saw Mill River Road (Route 9A) at the Grasslands Complex. It is currently owned by the Division of Military and Naval Affairs while the land is owned by Westchester County. The building is currently being used by both the Westchester County Police Academy and the military. This site initially met all of the criteria to serve as the TMC; however, this building was not pursued due to the ownership situation which precluded any opportunity for the Department in the foreseeable future. The building will not revert back to the County so that they obtain full ownership of the property until well after the year 2000. This precludes any opportunity to negotiate for joint use of the site.

Cross Westchester Executive Park (18)

Two buildings of 45,000 square feet and 85,000 square feet were for sale at the Executive Park located at Saw Mill River Road and Grasslands Road. These buildings are generally too large for the needs of the TMC and were not going to be sold in parts.

Fairview Office Complex (19)

A 9,200 square foot building is located at the Fairview Office Complex on the Saw Mill River Road at Fairview Park Drive. The office space totals 2,000 square feet and the warehouse totals 7,200 square feet. The floor plans were reviewed; however, the space was found to be too small for the long term functions of the TMC.

Office Building (20)

This vacant, 200,000 square foot building is located at the Hutchinson River Parkway Interchange with King Street. This building is considered too large for the TMC.

Office Building (21)

Two buildings located at 222 Westchester Avenue, one at 7,100 square feet and one at 95,000 square feet, were available for a 15 year lease. These buildings were not for sale. Both of the sizes did not fit into the TMC profile.

Commercial Building (22)

This building is located on the corner of Hillside Avenue, Route 100 and Old Tarrytown Road, one block north of the Cross Westchester Expressway. This building is owned by Beth Abraham Hospital and contains 15,125 square feet of office and warehouse space formerly NCR property. The asking price for the building was in the $2.5 to $3 million range. Additional cost would be incurred for renovation of this building.

NYS Police Troop K, Zone 4 Headquarters, Hawthorne (24)

Located at the intersection of the Sprain Brook Parkway and Taconic State Parkway in Hawthorne, this site has access from the Sprain Brook Parkway, as well as Route 100A. The proximity of the State Police Troop K, Zone 4 Headquarters lends itself to locating the TMC at this site. The existing building is too small to accommodate the functions of the TMC; however, the site lends itself to new construction. This site is approximately 4 miles from the Cross Westchester Expressway.

100 Grasslands Road (25)

This vacant office building of 48,211 square feet is located along Grasslands Road in Greenburgh. In order to rent this space the State must act in a timely manner. The State's Office of General Services (OGS) may not be able to sign a lease agreement in the amount of time that the office rental market will bear.

2. ROCKLAND COUNTY

Clarkstown NYSDOT Surplus Properties (11) and (12)

(11) This 5.2 acre site is located at the intersection of West Clarkstown Road and Eckerson Road. The access to this site from major highways is poor.

(12) This 16.3 acre site is located at the intersection of West Clarkstown Road and Mallory Road. The access to this site from major highways is poor.

Spring Valley (13)

This 11 acre site is located near Interchange 14 of I-87.

Letchwood Psychiatric Center (14)

Several large stone buildings are located on this property at Exit 14 of the Palisades Interstate Parkway, north of I-87. These buildings could probably be renovated to suit the TMC needs; however, this site is not centrally located among the major roadways and long term ownership is uncertain.

NYS Armory, Rockland County (15)

The New York State Armory is located off of Exit 6 of the Palisades Interstate Parkway, south of I-87. This site is not in close proximity of the I-87/I-287 corridor. This building is located on the Rockland County side of the Hudson River.

Rockland Psychiatric Center (16)

Located off Exit 6 of the Palisades Interstate Parkway, south of I-87, this site houses a few very large concrete buildings, which generally are too large for the TMC, which will need only 25,000 SF to 30,000 SF.

3. NEW YORK STATE DEPARTMENT OF TRANSPORTATION

NYSDOT Maintenance Sites (3), (9), (10)

There are several maintenance facilities in Westchester County and Rockland County. According to the maintenance/residence engineers, these sites are already utilized to their capacity. Expansion of these sites does not seem feasible due to inadequate acreage, disturbance of existing operations and limitations on the ability to directly modify the existing buildings.

(3) 51 Purdey Avenue in White Plains
(9) 228 Town Line Road in Nanuet
(10) 2A Ridge Road in New City

Kentucky Riding Stables (4)

This 3.6 acre site located at the confluence of Mamaroneck Avenue, Union Avenue and the Hutchinson River Parkway, was a possible candidate for the TMC. The location and size of this property was adequate for the TMC function, but the existing tenant would need to be evicted. The eviction process might be a long a drawn process.

Parkway Group Building (23)

This building is located in Pleasantville. The existing building is too small and is in need of renovation and expansion to accommodate the TMC needs.

4. NEW YORK STATE THRUWAY AUTHORITY

Tarrytown Facility (26)

This site is located off Route 9 in Tarrytown and presently houses the operations center for the Tappan Zee Bridge corridor as well as the downstate headquarters of the NYSTA.

NYSTA Maintenance Facility (27)

This maintenance facility is located below the interchange of I-684 and I-287 in the Town of Harrison.

NYSTA Property, Rye (28)

Located at the intersection of I-95 and Route 1 (Boston Post Road) in Rye, this 8 acre site is the result of the reconfiguration of the interchange ramps. The location of this property is not central to the congestion in the Westchester County/Rockland County area. The access to this site is poor with respect to traffic along Boston Post Road.

I. SITE SELECTION ANALYSIS

Each of the above sites was carefully evaluated based upon the site criteria listed previously. A site was eliminated if a criteria, critical to the success of the TMC was found for that site. The criteria included such things as inadequate property size, building size, parking area, type of frame construction, location and property ownership. If any of these criteria were not met at any site, then that site was eliminated from further contention. The following table lists the sites and the major negative factor that eliminated the site from further investigation.

Table 1 Potential TMC Sites

No.	Site Name	Major Negative Factor
(1)	Mazur's Furniture	Inadequate property size
(2)	Commercial Building - Pepe Motors, Inc.	Inadequate building sizes, 3 small buildings total 38,000 SF
(3)	51 Purdey Ave in White Plains, Maintenance	Space is at Capacity
(4)	Kentucky Riding Stables	Existing tenant needs to be evicted
(5)	Land adjacent to Texaco, Inc.	Wood construction of existing building
(6)	126 Purchase Street, Harrison	Wood construction of existing building
(7)	Central Park Avenue	Less than 2 acres
(8)	Saw Mill River Road (Route 9A)	Wood construction of existing building
(9)	228 Town Line Rd in Nanuet, Maintenance	Space is at capacity
(10)	2A Ridge Road in New City, Maintenance	Space is at capacity
(11)	Clarkstown Surplus Property	Poor site access
(12)	Clarkstown Surplus Property	Poor site access
(13)	Spring Valley Property	Poor site access
(14)	Letchwood Psychiatric Center	Poor location; ownership dispute
(15)	NYS Armory, Rockland County	Not in primary corridor
(16)	Rockland Psychiatric Center	Too large, not able to subdivide
(17)	Armory - Route 9A	Ownership conflicts
(18)	Cross Westchester Exec. Park	Too large, not able to subdivide
(19)	Fairview Office Complex	Less than minimum space criteria
(20)	200,000 SF Office Building	Too large, not able to subdivide
(21)	222 Westchester Ave Office Bldgs	Not for sale
(22)	Commercial Building	Too costly to buy
(23)	Parkway Group Building	Less than minimum space criteria
(24)	NYS Police Troop K, Zone 4 Headquarters	Existing building is at capacity; need to construct new building
(25)	100 Grasslands Road	Time frame inadequate
(26)	Tarrytown Facility	Building space is at capacity, inadequate parking
(27)	NYSTA Maintenance Facility	Building space is at capacity, inadequate site to accommodate both operations
(28)	NYSTA Property, Rye	Poor access
(29)	Westchester County Airport - Joint News Center	Inadequate excess space; existing space needs to be maintained
(30)	Armory Building, New Rochelle	Not readily available

J. CONCEPTUAL PLANS

The process of developing a TMC reached a critical point. There was a need to move ahead before the Congressionally designated funding was lost. There is a need in the Lower Hudson Valley for a permanent TMC to be established before any other discrete ITS projects are implemented. The space at 244 Westchester Avenue is being outgrown and a more permanent situation needs to be established. A formal invitation was sent to the New York State Police, Westchester County and the New York State Thruway Authority requesting their commitment and participation in the Lower Hudson Valley TMC. The New York State Police responded favorably. In Albany, the NYSDOT 's experiences with a joint TMC with the State Police have been favorable.

As a result of the evaluation process, ultimately the State Police Troop K, Zone 4 Headquarters property in Hawthorne, New York was chosen as the location for the new Lower Hudson Valley Transportation Management Center. Preliminary conceptual plans for a new TMC facility at the Hawthorne Troop K, Zone 4 Headquarters of the New York State Police were then developed. Each of the elements that need to be part of a TMC and their relationship to one another were included in this TMC conceptual design. The inclusion of the State Police Communications Center into the TMC was considered extremely important for reliable and efficient incident reporting and response. By having a State Police person in the TMC it will make incident management a much more efficient process. Additionally, the State Police Troop K, Zone 4 Headquarters facilities can be incorporated directly into the new TMC space. By incorporating the State Police within the daily operations of the TMC, improved incident detection, verification and response can be facilitated. Having the State Police personnel within the daily operation of the TMC promotes a sense of cohesion and unity in the incident management process. A law enforcement decision maker would thus be available to resolve any issues involving the vehicle and traffic laws.

Space requirements are largely based upon the staffing requirements. It is the intent of this conceptual plan to provide additional space for other transportation agencies operating within the Lower Hudson Valley, in particular the Westchester County and Rockland County areas to join in the TMC. These include Transportation Agencies, Transit Operators, Police Departments and other emergency response agencies. The commitment of the New York State Police to be co-located within the TMC has already been accommodated in the plan. In addition some additional workstations in the operations room will be included to allow other transportation agencies in the Lower Hudson Valley to join in the operations in the future. The following table shows the space requirements for each room:

Table 2 Space Allocation

Lower Level	**Square Footage**
Transportation Management Center Wing	
Operations Room	1,800
Electronics Room	1,650
Communications Room	790
Highway Advisory Radio Recording Room	100
State Police Communications Center	900
Storage Room	990
Electrical/Telephone Room	330
Maintenance Room/Receiving	1,025
Elevator/Elevator Machine Room	200
System Manager's Office	225
Assistant System Manager's Office	150
Maintenance Supervisor's Office	150
Restrooms	280
Stairways	350
Corridors/Entryways	1,260
State Police Wing	
Locker Rooms/Restroom	1,215
Conference Room	525
Storage Room	385
Garage	700
Utility Room	165
Lobby/Entryway	315
Stairways	240
Elevator/Elevator Machine Room	90
Corridors	190
Lower Level Total	**14,025**

Table 3 Space Allocation

Upper Level	**Square Footage**
Transportation Management Center Wing	
Offices (8)	1,200
Offices (8)	200
Cubicles (10)	1,500
Viewing Room	500
Conference Rooms (2)	1,000
Break/Coffee Room	450
Mechanical Room	300
Restrooms/Lockers/Showers	860
Copy Room	230
Storage Room	300
Elevator	100
Stairways	350
Corridors/Entryways	1,410
State Police Wing	
Station Commander's Office	345
Captain's Office	235
Sergeant's Office	235
Squad Room	640
B.C.I. Room	490
Adult Interrogation	130
Juvenile Interrogation	130
Identification Room	130
Zone Secretary	325
Senior Investigator	130
Break/Coffee Room	150
Restrooms	110
Stairway	240
Elevator	140
Corridors/Entryways	395
Upper Level Total	**12,225**
Building Total Square Footage	**26,250**

1. EXISTING CONDITIONS

The Troop K property is owned by the New York State Police. The site is located between the Sprain Brook Parkway and Bradhurst Avenue (Route 100A), approximately 2 miles north of Route 100C in the Town of Mt. Pleasant, New York. Access to the 7.7 acre site is through Chateau Lane, a narrow tree lined street, which also serves as the main driveway for a multi-unit condominium complex. State Police and other authorized vehicles can also enter the site directly from the Sprain Brook Parkway.

The existing State Police facility building is housed in a one story masonry structure, approximately 6,000 square feet, near the south edge of the property. Two small parking lots are adjacent to the north and west faces of the building, while a fenced impound lot and larger overflow parking area are further north of the building. A grassed and vegetated field separates the building from the Sprain Brook Parkway right-of-way.

The surrounding property is developed on the east and north sides of the site. Those properties were once owned by the State and were subsequently sold. The property on the east is a condominium complex that is centered around an old state police barracks. The old barracks have been converted into a condominium. The exterior wall of the converted old barracks building is about 15 feet from the property line. Vacant land that exists around the existing condominium, but not directly adjacent to the site is being developed with more housing. The State Home for the Mentally and Physically Challenged is north of the site, about 350 feet north of the State Police driveway gate. There is a paved parking area between the driveway gate and the State facility.

The State Police building is presently a one story masonry building. With a building area of approximately 5,900 square feet, based upon building as-built drawings, dated 1974. The facility has a vehicle fueling station with an above ground fuel storage tank located on the west end of the building 's north parking area.

2. ZONING CODE

The property is within the zoning jurisdiction of the Town of Mount Pleasant. The property is currently zoned as R-20 - One Family Residential District. It was determined that New York State is exempt from the zoning code to redevelop this site as a TMC.

3. SITE DEVELOPMENT

Chateau Lane is approximately 18 feet wide and has a crest vertical curve which does not allow for adequate sight distance. As part of the TMC building construction, the existing roadway would be widened to 22 feet and the entire length resurfaced. The existing south curbline will remain intact and all widening will occur to the north side of the road. The existing granite curb will be reset and adjacent driveway aprons reconstructed to meet the new roadway edge elevations. The non-standard vertical curve will also be reconstructed to provide stopping sight distance for a 20 mph design speed.

The proposed TMC and State Police Facility is much larger than the existing building. The new structure will be located to the north of the existing building's footprint, in the existing impound area and overflow parking lot. A new parking lot and maintenance area will be to the south of the proposed building and will extend into the existing vegetated area. A retaining wall, approximately 15 feet west of the new building, will limit the amount of slope grading and keep all construction activities within the existing right-of-way.

The main entrance to the TMC will be on the north face of the building. The sidewalk areas and TMC employee parking area will be at the second floor level to allow direct access into the facility's viewing/receptionist area. The remaining doors and garages are for TMC maintenance and State Police personnel and lead to the first floor. The adjacent sidewalks and parking areas will also be set at the first floor level to provide barrier free access at all pedestrian entrances.

By placing the new facility north of the existing structure, construction of the TMC and State Police wing can proceed without interrupting existing police activities. Temporary parking facilities may be required, since the existing main parking area will be used as a construction staging area. In addition, temporary utility connections to the existing building are necessary to avoid conflicts with construction. Relocation of the existing vehicle fueling station, located to the northwest of the existing structure, will also be part of this construction. A permit from NYSDEC is required for moving above ground fuel storage tanks. This fueling station will be moved just east of the new main parking area. This secured location allows State Police and authorized vehicles easy access to the fuel pumps as they exit or enter the TMC facility. Demolition of the existing building and construction of the new parking lot and maintenance area can proceed once personnel are in the new building.

4. ENVIRONMENTAL PROJECT CLASSIFICATION

As part of the conceptual site design, a National Environmental Policy Act (NEPA) Checklist was completed. This checklist should be completed during the project's scoping phase and is used to determine if a specific action can be categorized as a Categorical Exclusion. Based on the checklist assessment, the proposed project qualifies for a Programmatic Categorical Exclusion. The completed checklist can be found in the back of this report.

A field inspection on October 21, 1997 revealed no wetland areas within the proposed construction limits. A monitoring well was observed in the existing parking lot area, which suggested the presence of an underground storage tank (UST). The New York State Department of Environmental Conservation determined that a 3,000-gallon UST existed at this facility. The tank was closed in October 1994, and has been removed from the site.

One environmental issues that needs consideration during Final Design is the existence of an aboveground storage tank.

On the west end of the existing State Police building is an operational vehicle fueling station. This vehicle fueling station consists of a 4,000-gallon, aboveground, fuel storage tank. In order for this tank to be relocated and reused, the existing NYSDEC permit must be removed. Following the removal of this permit, an application for a new permit, describing it's new location, will be submitted to NYSDEC for approval.

5. LOCATING THE BUILDING ON THE PROPERTY

The width of the site is constrained by the hill on the west and the need to maintain the access drive from the Sprain Brook Parkway to the existing entrance to the property at the driveway to Bradhurst Avenue (Route 100A). In addition, a setback needs to be provided between the east property line and the new building face. A setback of twenty feet would provide for a fifteen foot driveway and a narrow planting strip. Setback considerations are not an issue on the west side where the property line is over 100 feet from the proposed building's west wall. The toe of the hill and existing site drainage determine the building location on the west. The resultant available building width (in the east - west direction) is about 120 feet. The resultant available building length (in the north - south direction) between the existing State Police building and the gated driveway is about 225 feet. Therefore, a one story building of 28,000 square feet would not fit on the site.

The operations room, communications room, State Police Communications Center, equipment room and maintenance room have a mandatory adjacency requirement. These spaces constitute about 25 percent of the total building area and could be characterized as the incident management area. These spaces also require a higher floor to ceiling space than the other public and employee support spaces. The operations room is the hub around which the communications room, State Police Communications Center, equipment room and maintenance room are centered around. This does not leave much space to provide for the public viewing of the operations room, under a single story concept.

A two story building, 100 feet wide, would be about 100 feet long. The public entry could be located at the upper floor at the north end near the driveway gate. This is closer to the public vehicular access from Bradhurst Avenue (Route 100A). Loading access would be at the lower floor in the area currently occupied by the State Police north parking area. The operations and incident management area is best suited for the higher ceiling to optimize screen viewing and to minimize distractions. In addition to the higher ceiling height previously mentioned, this space needs to be cut off from natural light. Putting the operations and incident management area on the lower level works well on the sloped site since most of the lower level is almost completely below grade on three sides. The employee offices and work stations and the public reception and conference rooms would have windows and natural light. The operations and incident management area is more secure being segregated on one floor separate from those activities that require interface with the public.

There are two options for designing the TMC building at the Hawthorne site. One is to design a building that houses the operations, communications and 911 spaces and the various support spaces and the other option is to develop a building footprint that would include the functions and spaces already in the existing Hawthorne State Police barracks. These two concept options are both included at the end of this report and illustrate the adjacency issues as well as the functional issues of the TMC. Figures 2-A and 2-B represent the option with the State Police Headquarters remaining in a separate building on the site. Figures 2-A and 2-B also show the floor plan of the first option with the furniture in place. The placement of the furniture gives a relative scale of each room. All of the rooms have been defined in Figures 3-A and 3-B. Figures 4-A and 4-B show the second option with a new State Police Headquarters attached to the new TMC building. For security reasons, the TMC and State Police Headquarters would need to be separated by a security door on the upper floor, where the offices of the State Police officers are located. Figures 6-A, 6-B and 6-C illustrate the cross sectional view of the operations room and the cross sectional view of the relationship of the operations room on the lower floor to the viewing room on the upper floor. Figure 7 illustrates the orientation of the proposed building on the property.

Several other factors need to be included and considered in the final design of this TMC. The factors include the following:

6. SECURITY

Access to the operations room should be convenient to the staff while limiting access to unauthorized persons. Most agencies prefer a viewing window into the operations room for the public to watch the workings of the transportation management center from outside of the operations room itself. Access to the operations room should be limited to prevent unauthorized persons from tampering with the highly technical equipment contained within the operations room and from interfering or distracting from the operators' work. Access may be limited by means of coded security locks or keycard locks.

Another factor which needs to be considered is the employees' security at night. Restrooms or any locations within the building that may be accessed during the off hours must be well lighted and secure. Building access and parking facilities need to be in well lit and secure areas, with possibly a video surveillance image of the parking lot being returned to the center.

The security systems design elements requiring coordination are the high security authorized access by the use of interior and exterior site closed circuit television (CCTV) cameras; adjacent electronic card reader access system and/or key pad verification of personal identification number (PIN); remote controlled heavy duty electronic locking devices; door position switches; optional metal detection system.

7. ENVIRONMENTAL

The environmental aspects of the Transportation Management Center design include HVAC and lighting. These items are directly related not only to operator comfort, but also to the efficient operation of the TMC. Air conditioning vents should be placed in locations that do not blow directly on the operators or other personnel. The air in the operations room and equipment room should be cool; but for most of the mini-computers in use today, it does not need to be "computer room" conditioned. If a video equipment room is used, the air in this room should also be cool and the room should be well ventilated.

The lighting in a transportation center has a variety of functions to serve. High light levels are needed for performing maintenance. Fairly high light levels are needed for reading books, maps, and plans. A relatively low ambient light level is needed to control glare and surface reflections on a CRT display, especially if it is in color display. The light level must be controlled to prevent eye strain and fatigue that occurs if the eye constantly has to shift between bright and dim lighting. Therefore, the site should be conducive to controlled lighting. Light colored or reflective surfaces should be avoided in the immediate vicinity of projection screens and video monitors. These surfaces reflect light and "wash out" the screened image. Florescent lights cause the same problems. One solution to these problems is to use recessed light that can be controlled with a dimmer. Window shades or drapes should be used to control external light.

8. UNINTERRUPTIBLE POWER SUPPLY

An uninterruptible power supply (UPS) will provide the TMC with continuous and reliable power from which to operate the equipment in the TMC. A UPS falls into one of two basic categories, standby and line-interactive. A standby system provides power when the outside power supply is disrupted. A line-interactive system uses the outside power supply to continually charge a battery and the TMC equipment runs off the battery. The advantages of a line-interactive system are that it removes power spikes from the incoming source and there is no disruption in service if the outside power supply is interrupted. This will protect the TMC from disruption of service in the event of a power outage or a brown-out.

9. DISPLAY EQUIPMENT

Large screen projection systems allow the projection of data, graphics or video directly onto a large screen. Most of the newer video projectors on the market today are equipped with auto coverage. Automatic convergence is a hardware/software system that automatically and accurately aligns the projected color image from a data/graphics projector when initialed by the user through a command from the projector’s keyboard or remote.

Rear screen projection typically requires the construction of a dedicated projection room. The image can be projected directly at the screen, or if limited by space, the image can be “folded” in one or two first surface mirrors to reduce the amount of space required. Rear screens are most resistant to ambient light and are available in rigid or flexible membrane material. Lenticular rigid screens are also available and offer a brighter image. An alternative to the rear projection room is the projection enclosure. Examples of rear projection enclosures are the “Trooper” and the “Retro” projection enclosures. These units combine a high grain lenticular screen (typically 67 inch diagonal) installed on casters. This provides a rear projection screen room without costly construction and offers portability.

Computer terminals, PCs, VCRs or other video signals are connected to the projection system via straight cable or through an electronic interface. Depending upon the equipment used, different video display standards and scan rates are used. These include NTSC, RGB, PGA, VGA, Super VGA and others. Use of the different standards with a video projector requires that separate electronic video interfaces be used to convert information to the proper video input for display on the projection system.

The video equipment is a collection of individual elements that have independent functions and specifications that, when placed onto a system, will provide video from roadway surveillance cameras to be displayed in the TMC. The individual elements are:

- Racks and cabinets
- Microprocessor camera control system
- Video concentrator
- Fiber optic termination equipment
- Video switches

- Video transmission equipment
- SONET element

These items are intended to be housed in the electronics room.

10. CONSOLE WORKSTATIONS

The design of the control console should be carefully planned. The control console is the interface between the operator and the system. Equipment may be mounted in the console to provide instant feedback to the operator regarding the status of the system and provide control functions necessary for the operation of the system. The console typically includes such equipment at telephones and radios as well as microcomputers and computer terminals. Control functions such as closed circuit television cameral controls and projection display controls may also be housed in the console. These items may be housed inside of the console leaving only the control surfaces exposed to the operators. All equipment housed within the console should receive adequate ventilation.

The microcomputer workstations housed in the console are used to turn data into graphic information, thereby speeding important decisions about signal operations. This graphic information is normally displayed on high resolution color monitors. The terminals are used to communicate with the central computer and to obtain data directly from the intersections.

The console shell should be ergonomically designed with operator comfort the highest priority. The length of desk top space is determined by the number of positions desired at the console allowing approximately 40 inches per station. This dimension is ultimately defined by the type and amount of equipment to be installed at each position. The writing surface between the operator and the equipment should be about 18 to 24 inches deep to allow comfortable access to panel controls and an optimal distance from the CRTs to the eye. The depth need to be short enough to allow operator comfortable access to all controls on the console without stretching to reach those controls at the top of the fence of the console, but wide enough to accommodate keyboards, allow an adequate writing surface, and space to spread out technical manuals. The CRTs should be mounted into the console at about eye level or slightly below. Additional storage areas such as drawers and storage cabinets may be designed into the console depending upon availability of space.

K. CONSTRUCTION COSTS

The cost estimate assumes adequate soil for standard concrete footings and foundations that support insulated exterior concrete block bearing walls and interior steel columns that support a steel floor joists and deck with concrete topping, and a steel roof deck with rigid insulation and built-up roofing. The site work assumes trenching, excavation, backfill, storm drainage, pavement, driveways and parking costs. The site survey will quantify these site conditions and associated costs. The windows are metal framed with insulated glass, the doors are insulated steel and the clear glass block walls define the major entrances. Hydraulic elevators and steel pan with concrete tread stairs connect the two floors. Standard office interior construction and finishes are assumed throughout except that the Electronics, Operations, Communications and 911 Rooms have a raised computer floor for wiring flexibility. The electronic equipment and office furniture are not included in this cost estimate. The building is sprinklered and the air is conditioned with multi-zone variable air volume (VAV) units. Locker rooms, toilet rooms and kitchen specialties and fixtures are included. The total costs include a 25 percent contingency which will be reduced in subsequent phases when variables become defined.

Lower Hudson Valley
Transportation Management Center

Table 4 Total Capital Construction Costs

Foundations / Substructures			$ 120,706	
Exterior Closures/ Roofing/ Superstructure			$ 495,658	
Interior Construction/Specialties			$ 293,821	
Mechanical/Electrical Systems			$ 642,378	
Contractors Overhead and Profit (15%)			$ 232,884	
Contingency (25%)			$ 388,140	
Total Building Cost				**$ 2,173,586**
ITS Equipment				$ 913,550
Site Work				$ 392,757
Total Construction Costs				**$ 3,479,894**

Includes the State Police Wing				
Construction Component			**Subtotal Cost**	**Total Cost**
Foundations / Substructures			$ 180,616	
Exterior Closures/ Roofing/ Superstructure			$ 946,549	
Interior Construction/Specialties			$ 478,209	
Mechanical/Electrical Systems			$ 995,908	
Contractors Overhead and Profit (15%)			$ 390,192	
Contingency (25%)			$ 650,320	
Total Building Cost				**$ 3,641,794**
ITS Equipment				$913,550
Site Work				$ 392,757
Total Construction Costs				**$ 4,948,101**

L. STAFFING / PERSONNEL REQUIREMENTS

In the initial phase of operations in the Lower Hudson Valley, 15 to 16 hours of TMC coverage by NYSDOT personnel is recommended for Monday through Friday. The hours of operations during weekdays could be 5:30 AM to 8:30 PM to provide adequate coverage for both AM and PM peaks, with allowances for "late clearing" of PM congestion and some overlap of shifts. On special high demand weekends, such as holidays and high recreational travel times, expanded operations is recommended. The weekday operations would entail two 8 hour shifts with a one hour overlap. During the off-hours the State Police could take over operations at the TMC, since the State Police are already a 24 hour per day, 7 day per week operation.

Adequate performance of the equipment tasks for routine, daily operations will generally require personnel in administrative, operations, and maintenance classifications. Of paramount importance in considering overall staff requirements, is the attainment of a certain level of redundancy in personnel in the operations and maintenance classifications to insure that the random occurrence of simultaneous, multiple events and/or incidents will not adversely affect overall system performance and personnel response.

In order to facilitate a more efficient incident management system, it is imperative that a State Police Officer is located in the State Police Communications Center. In other areas around the country, such as Texas and California, police officers are stationed in the TMC. This provides the best linkage between the transportation operators/managers and the law enforcement personnel for immediate decision making. The law enforcement officer can view the scene of an incident via the closed circuit television camera monitors and then make decisions as to the type of response by the law enforcement personnel and in turn start the process of calling emergency medical and wrecker services.

Staff Assignments and schedules are shown in the following table:

Table 5 Transportation Management Center Staffing and Schedule

Staff	Number		Schedule
	Short/Medium-Term	Long-Term	
Operations			
Systems Manager	1	1	8:00AM - 5:00PM
Assistant. Systems Manager / Shift Supervisor	1	1	6:00AM - 3:00PM
Control Room Supervisor	0	1	11:30AM-8:30PM
Control Room Operators	2	3	6:00AM - 3:00PM
Control Room Operators	2	3	1:00PM - 9:00PM
Communication Specialist	1	2	7:00AM - 3:00PM
Communication Specialist	1	2	3:00PM - 11:00PM
Communication Specialist	1	2	11:00PM - 7:00AM
State Police Lieutenant	1	1	9:00AM - 5:00PM
State Police Sergeant	1	1	7:00AM - 3:00PM
State Police Sergeant	1	1	3:00PM - 11:00PM
State Police Sergeant	1	1	11:00PM - 7:00AM
Maintenance			
Maintenance Supervisor	1	1	8:00AM - 5:00PM
Assistant Maintenance Supervisor	0	1	9:00AM - 6:00PM
Electronics Technician	2	4	6:30AM - 3:30PM / 9:30AM - 6:30PM

1) DETAILED ROOM DESIGN DATA

ADMINISTRATIVE OFFICES

Area (net):	150 SF
Quantity:	7 Offices
Function:	Individual administrative offices for agency personnel, part-time supervisory and crisis management personnel.
Key Dimensions:	Accommodate small meeting for three to four people.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: Acoustical ceiling tile (ACT)
Electrical:	Provide 120 volt, 20 amp, duplex receptacle on each wall for office equipment from panelboard with transient voltage surge protection.
HVAC:	Provide individual temperature control as needed from the HVAC system servicing all Administration areas.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting with parabolic louvered fixtures to limit glare.
Acoustic:	Maximum background sound level: NC 35. Provide ceiling having minimum NRC 0.65+.
Telecommunications:	Two admin communications boxes (4-port outlets) positioned on adjacent walls. The four RJ45 jacks shall provide connectivity for telephone service, PC LAN connection and peripherals.
Audio Visual:	None, paging may be audible from corridor if room door is in open position.
Security:	Each office shall be secured by a solid core door, lock and key. No dedicated CCTV cameras in this area, however, the interior hallway serving the administration office suite shall have camera(s) as required to ensure coverage.
Notes:	

OPEN OFFICE

Area (net):	1200 SF - open office area sub divided with furniture system partitions to provide individual office workstation cubicles
Quantity:	10 cubicles
Function:	Office for maintenance tech nicians and control room operators.
Key Dimensions:	Accommodate small meetings for up to 4 people per cubicle.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp quadruplex receptacles, one per cubicle, along fixed wall for power to panel system and office equipment from panelboard with transient voltage surge protection. Provide duplex convenience receptacles for cleaning and maintenance to all areas with a maximum 25' extension cord.
HVAC:	Provide a single zone temperature control as needed for this area from the HVAC system servicing all Administration areas.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting with parabolic louvered fixtures to limit glare . Provide occupancy sensor control for two zones of equal size within this area. Provide task lighting on furniture partition system.
Acoustic:	Maximum background sound level: NC 35. Provide ceiling having minimum NRC 0.65+.
Telecommunications:	10 admin communication boxes (4-port outlets) positioned at each cubical adjacent to electrical box on serviced walls. The four RJ45 jacks shall provide connectivity for telephone service, PC LAN connection and peripherals.
Audio Visual:	Provide paging in two equal sized zones within this area.
Security:	Open office areas shall be secured by a solid core door , lock and key. No dedicated CCTV cameras in this area, however, the interior hallway serving the administration office suite shall have camera(s) as required to ensure coverage.
Notes:	

RECEPTION AND WAITING

Area (net):	350 SF Total - subdivided as follows: 150 SF Reception 200 SF Waiting
Quantity:	1 reception, 1 waiting
Function:	Reception and waiting area for administrative suite.
Key Dimensions:	
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp, Duplex receptacle on each wall for office equipment from panelboard with transient voltage surge protection.
HVAC:	Provide individual temperature control from the independent HVAC system servicing all Administration areas.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting with parabolic louvered fixtures to limit glare.
Acoustic:	Maximum background sound level: NC 35. Provide NRC 0.65+ ceiling.
Telecommunications:	Two admin communication boxes (4-port outlets) for each workstation . The four RJ45 Jacks shall provide conn ectivity for telephone service, PC LAN connection and peripherals.
Audio Visual:	Provide paging loudspeakers in waiting area only.
Security:	Administrative offices suite shall be secured by solid core doors , lock and key. No dedicated CCTV cameras in reception and waiting areas , however, the interior hallway serving the administration office area shall have camera(s) located as required to ensure coverage.
Notes:	Provide seating for 10 in waiting room.

REPRODUCTION

Area (net):	150 SF
Quantity:	1
Function:	Copying and production duplication.
Key Dimensions:	Min. 6 foot clear area in front of copier and work counter.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide dedicated outlet for copy machine and 3 - 120 volt, 20 amp, duplex outlets at work center height for automated mailing equipment. Provide duplex convenience outlets on two opposing walls.
HVAC:	Provide temperature control as needed from HVAC system servicing all Administrative areas. Maintain 68°F to 78°F.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting using lensed fixtures.
Acoustic:	Maximum background sound level: NC 40 Provide sound absorptive ceiling (minimum NRC 0.65+) .
Telecommunications:	One admin communications box (4-port) in the room at work center height for automated mailing equipment . The four RJ45 jacks shall provide connectivity for telephone service, PC LAN and peripherals.
Audio Visual:	Provide paging loudspeakers.
Security:	No dedicated CCTV. General coverage of entrance will be part of the interior hallway CCTV camera coverage.
Notes:	1 copier 1 express mail computer 1 mail postage meter

STORAGE

Area (net):	150 SF
Quantity:	1
Function:	General office storage.
Key Dimensions:	
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Sealed concrete Walls: Painted GWB, Ceiling: ACT Provide fire treated tempered hardboard wainscot protection to 4 foot height at GWB walls.
Electrical:	Provide 120 volt, 20 amp duplex receptacles for convenience power on two opposing walls. Locate one outlet adjacent to admin. communication box.
HVAC:	Provide ventilation, heat and/or HVAC from system servicing all administration areas to maintain room temperature range 68 °F to 78°F.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 30 maintained footcandles at floor level of fluorescent lighting using lensed fixtures arranged to coordinate with storage equipment for best illumination and visibility.
Acoustic:	Maximim background sound level: NC 45.
Telecommunications:	Provide one admin. communications box (four port outlets) positioned near entrance for telephone and inventory control computer.
Audio Visual:	Provide paging loudspeakers.
Security:	Secured with a solid core door; lock and key. No dedicated CCTV. General coverage of entrance will be part of the interior hallway CCTV camera coverage.
Notes:	

STAFF CONFERENCE

Area (net):	400 SF
Quantity:	1
Function:	Meeting room for administrative staff and visitors to serve up to 25 people.
Key Dimensions:	Provide a rectangular room configuration having length to width proportions between 1:1 and 1:2.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp, duplex receptacles served from a panel powered with transient surge protection. Locate receptacles on all walls at 10 feet on center and at each communications box location under conference table.
HVAC:	Provide individual temperature control from the independent HVAC system servicing all Administration areas.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at table level of fluorescent lighting with parabolic louvered fixtures and incandescent wall washers with local dimmer control. Provide two 8 foot sections of track for spot lighting with independent dimmer control for each section. Locate track to highlight the head end of the room and one sidewall for presentations. Provide switching and dimming control to facilitate switching and dimming illumination levels at the head end of the room separately for projection, and to allow separate dimming control of wall washers and track mounted spotlighting for each wall.
Acoustic:	Maximum background sound level: NC 35. Reverberation time should be 0.5 to 0.6 seconds at 500 Hz. Provide sound absorption on ceiling (minimum NRC 0.65+) and at least 2 adjacent walls. Sound panels on wall shall provide tack surface and shall be mounted above a chair rail.
Telecommunications:	There shall be four admin communications boxes (four port outlets) each containing 4 RJ45 jacks, plus one 75 ohm coaxial cable jack at each comm box location . Two shall be placed in floor to best serve central conference table arrangements. Additionally, there shall be at least one dedicated digital line for teleconferencing. Provide control of feeds to communications and teleconferencing lines from Operations and 911 control consoles.
Audio Visual:	Provide paging loudspeakers.
Security:	No CCTV cameras in rooms. Access hallways shall be covered by CCTV cameras.
Notes:	Provide chair rail at 32 inches above finish floor under acoustic wall panel with ledge to hold tack pins.

**LARGE CONFERENCE
AND VISITOR VIEWING**

Area (net):	1100 SF - subdivide as follows: Conference 600 SF Visitor Viewing Area 500 SF
Quantity:	1
Function:	Meeting room. May be set up in full size or subdivided to provide separate meeting room and waiting room for visitors to serve groups of up to 32 people.
Key Dimensions:	Provide a rectangular room configuration having length to width proportions between 1:1 and 1:2.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp, duplex receptacles served from a panel powered with transient surge protection. Locate re ceptacles on all walls at 10' on center and at each communications box location under conference table.
HVAC:	Provide individual temperature control from the independent HVAC system servicing all Administration areas.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	For each space subdivision, provide 50 maintained footcandles at table level of fluorescent lighting with parabolic louvered fixtures and incandescent wall washers with local dimmer control. Provide two 8 foot sections of track for spot lighting with independent dimmer control for each section. Locate track to highlight the head end of the room and one sidewall for presentations. Locate lighting controls to facilitate convenient operation in either combined or subdivided configuration. Provide switching and dimming control to facilitate switching and dimming illumination levels at the head end of the room separately for projection, and to allow separate dimming control of wall washers and track mounted spotlighting for each wall.
Acoustic:	Maximum background sound level: NC 35. Reverberation time should be 0.5 to 0.6 seconds at 500 Hz. Provide sound absorption on ceiling (minimum NRC 0.65+) and at least 2 adjacent walls.
Telecommunications:	Within each sub division, there shall be four standard communications boxes (each containing 4 RJ45 jacks served by 4-

**LARGE CONFERENCE
AND VISITOR VIEWING**

	pair Cat. 5 UTP; one 75 ohm coaxial cable jack. Two shall be placed to serve a single central conference table in such position as to permit cables to be fed onto the table surface. Coordinate communications box locations with electrical. Additionally, there shall be at least one dedicated digital line for teleconferencing. Provide control of feeds to communications and teleconferencing lines from Operations and 911 control consoles.
Audio Visual:	Provide paging loudspeakers.
Security:	Provide CCTV cameras in rooms. Access hallways shall be covered by CCTV cameras.
Notes:	Operable sliding glass partition between large conference and viewing area to allow spaces to be opened to each other as much as possible.

RESTROOMS (M/F)

Area (net):	432 SF total 108 SF each
Quantity:	4
Function:	Toilets for visitor and employee use.
Key Dimensions:	ADA compliant
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable and Cleanable Finishes: Floors: Ceramic tile, integral base. Walls: Ceramic tile at wet walls, non-absorbent paint finished GWB. Ceiling: Painted GWB.
Electrical:	Provide 120 volt, 20 amp , GFI protected receptacle for cleaning.
HVAC:	Provide exhaust of 12 air changes minimum.
Plumbing/Fire Protection:	Provide hot and cold water and drainage to plumbing fixtures. Provide sprinkler protection.
Lighting:	Provide 20 maintained footcandles at lavatory level with lensed fluorescent fixture. Over counter and compact fluorescent downlights in remainder of room.
Acoustic:	Maximum background sound level due to mechanical systems shall be NC 40. Surrounding wall STC 52+.
Telecommunications:	None.
Audio Visual:	Provide water-resistant paging loudspeakers.
Security:	None.
Notes:	Provide one recessed flip down baby changing station, one soap dispenser, one towel dispenser and one mirror at each lav and one paper waste receptacle in each public restroom. Provide toilet partitions, double roll toilet paper roll holder w/ shelf, one seat cover dispenser in each toilet cubicle. Provide napkin disposal in women’s restroom.

STAIRS

Area (net):	300 SF total 150 SF each
Quantity:	2
Function:	Public access, staff circulation, emergency exits.
Key Dimensions:	Size for exit requirements based on occupancy and applicable building code.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Floors: Rubber treads. Walls: GWB. Ceiling: GWB.
Electrical:	Provide 1-120 volt, 20 amp, duplex receptacle. Locate to facilitate cleaning and maintenance with 25 foot cord.
HVAC:	Provide HVAC to maintain temp. range of 68 °F to 78°F.
Plumbing/Fire Protection:	Comply with applicable building code.
Lighting:	30 footcandles at floor level with recess fluorescent fixture.
Acoustic:	N/A
Telecommunications:	N/A
Audio Visual:	N/A
Security:	N/A
Notes:	N/A

ELEVATOR

Area (net):	100 SF
Quantity:	1
Function:	Two stops passenger elevator for visitor, staff & freight.
Key Dimensions:	Size for exit requirements based on occupancy and applicable building code.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Standard cab finishes.
Electrical:	Mfg. Std. code
HVAC:	Mfg. Std. code
Plumbing/Fire Protection:	Mfg. Std. code
Lighting:	Mfg. Std. code
Acoustic:	N/A
Telecommunications:	Emergency phone in cab.
Audio Visual:	N/A
Security:	Provide ability to lock out.
Notes:	Provide protector pads for freight.

SYSTEM MANAGER

Area (net):	225 SF
Quantity:	1
Function:	Executive office
Key Dimensions:	Accommodate small meetings for up to four people within office.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp, duplex receptacle on each wall for office equipment from panelboard with transient voltage surge protection.
HVAC:	Provide individual temperature control.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting with parabolic louvered fixtures.
Acoustic:	Maximum background sound level: NC 35. Room surround wall: STC 52 Provide ceiling with minimum NRC 0.65+.
Telecommunications:	Two admin communications boxes (4-port outlets) located in office on opposing walls. This will provide telephone, PC LAN and peripheral support.
Audio Visual:	None, paging may be audible from corridor.
Security:	Secured solid core door, lock and key.
Notes:	

ASSISTANT SYSTEM MANAGER

Area (net):	150 SF
Quantity:	1
Function:	Technical manager office
Key Dimensions:	Accommodate small meetings for up to four people within office.
Adjacency Requirements:	See adjacency matrix. .
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB or CMU Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp , duplex receptacle on each wall for office equipment from panelboard with transient voltage surge protection.
HVAC:	Provide temperature control from chief engineer's office
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting with parabolic louvered fixtures to limit glare.
Acoustic:	Maximum background sound level: NC 35. Room surround wall STC 52+. Provide ceiling having minimum NRC 0.65+.
Telecommunications:	Two admin communications boxes (4-port outlets) located in office on opposing walls. This will provide telephone, PC LAN and peripheral support.
Audio Visual:	None, paging may be audible from corridor if door is open.
Security:	Secured solid core door, lock and key.
Notes:	

MAINTENANCE SUPERVISOR

Area (net):	150 SF
Quantity:	1
Function:	Manager office
Key Dimensions:	Accommodate small meetings for seven people within office.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Carpet Walls: Painted GWB or CMU Ceiling: ACT
Electrical:	Provide 120 volt, 20 amp , duplex receptacles on each wall served from panelboard with transient voltage surge protection.
HVAC:	Provide individual temperature control from same HVAC system as security.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 50 maintained footcandles at desk level of fluorescent lighting with parabolic louvered fixture to limit glare.
Acoustic:	Maximum background sound level: NC 35. Room surround wall STC 52+. Provide ceiling having minimum NRC 0.65+.
Telecommunications:	Provide two wall-mounted ADMIN/COM boxes (4-port outlets) located on opposing walls. This will provide telephone PC LAN and peripheral support.
Audio Visual:	None, paging may be audible from corridor if door is open.
Security:	Secured solid core door, lock and key.
Notes:	7 linear feet of work surface, plan racks and files for handling and storage of large documents.

OPERATIONS

Area (net):	738 SF
Quantity:	1
Function:	Operations control room
Key Dimensions:	Two-story control room, electronic equipment racks and service access way, Operations and security control console and video monitor array.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Raised, non-static carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide power for operations and controls systems from panelboard with transient voltage surge protection. Provide UPS power. Provide convenience receptacles located to provide power for cleaning and maintenance to all parts of the room with a maximum 25 foot extension cord.
HVAC:	Provide individual temperature control supplied from the same HVAC system as 911, Communication, System Manager, Assistant System Manager and System Maintenance Supervisor.
Plumbing/Fire Protection:	An air pressurized pre-action fire sprinkler system with smoke alarm controlled water flow as an alternative to wet fire sprinkler protection in this area.
Lighting:	Provide 50 maintained footcandles at desk level using parabolic louvered fluorescent fixtures and incandescent task lights with individual dimming control. Provide a minimum uniform desk level illumination of 20 maintained footcandles without task lighting.
Acoustic:	Maximum background sound level due to mechanical systems shall be NC 35. Room surround wall STC 52+. Reverberation time should be 0.5 to 0.7 seconds at 500 Hz. Provide ceiling having minimum NRC 0.65+. Provide fabric covered sound absorption panels at wall areas having a minimum NRC 0.75.
Telecommunications:	An array of Operations and Control equipment within a secure, acoustically controlled area which allows minimum staffing to have maximum information and reaction capabilities. The following systems will be controlled and/or monitored from the Console which

OPERATIONS

	shall be designed for 11 operators at one time.
Audio Visual:	Video monitor array.
Security:	Access shall be through steel secured doors with door position switches, electronic locking devices and proximity card reader with supplemental key pad verification for insertion of PIN. The Operations area shall be located within the Security suite and have hardwall construction except for the laminated security glazed acoustical viewing windows from the designated public viewing and conference areas. A CCTV camera surveying the console operators position shall be installed, which, through the building LAN, can convey a password accessible image to any other networked workstation.
Notes:	Electronic equipment racks Operations console Video monitor array

911

Area (net):	738 SF
Quantity:	1
Function:	911 Communications control room
Key Dimensions:	Control room, electronic equipment racks and service access way, 911 Communications control console and video monitor array.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Raised, non-static carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide power for 911 Communications and controls systems from panelboard with transient voltage surge protection. Provide UPS power. Provide convenience receptacles located to provide power for cleaning and maintenance to all parts of the room with a maximum 25 foot extension cord.
HVAC:	Provide individual temperature control supplied from the same HVAC system as Operations, Communication, System Manager, Assistant System Manager and System Maintenance Supervisor..
Plumbing/Fire Protection:	An air pressurized pre-action fire sprinkler system with smoke alarm controlled water flow as an alternative to wet fire sprinkler protection in this area..
Lighting:	Provide 50 maintained footcandles at desk level using parabolic louvered fluorescent fixtures and incandescent task lights with individual dimming control. Provide a minimum uniform desk level illumination of 20 maintained footcandles without task lighting.
Acoustic:	Maximum background sound level due to mechanical systems shall be NC 35. Room surround wall STC 52+. Reverberation time should be 0.5 to 0.7 seconds at 500 Hz. Provide ceiling having minimum NRC 0.65+. Provide fabric covered sound absorption panels at wall areas having a minimum NRC 0.75.
Telecommunications:	An array of 911 Communications and Control equipment within a secure, acoustically controlled area which allows minimum staffing to have maximum information and reaction capabilities. The following systems will be controlled and/or monitored from the

911

	Console which shall be designed for 5 operators at one time.
Audio Visual:	Video monitor array.
Security:	Access shall be through steel secured doors with door position switches, electronic locking devices and proximity card reader with supplemental key pad verification for insertion of PIN. The 911 area shall be located within the Security suite and have hardwall construction except for the laminated security glazed acoustical viewing window to the Operations Room. A CCTV camera surveying the console operators position shall be installed, which, through the building LAN, will convey a password accessible image to any other networked workstation.
Notes:	Electronic equipment racks Operations console Video monitor array

HIGHWAY ADVISORY RECORDING ROOM

Area (net):	100 SF
Quantity:	1
Function:	Record travel advisories to provide information for telephone information and radio broadcast.
Key Dimensions:	Control room, electronic equipment racks and service access way, recording control console and equipment.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Raised, non-static carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide power for recording systems from panelboard with transient voltage surge protection. Provide UPS power. Provide convenience receptacles located to provide power for cleaning and maintenance to all parts of the room with a maximum 25 foot extension cord.
HVAC:	Provide individual temperature control supplied from the same HVAC system as Operations, 911, Communications.
Plumbing/Fire Protection:	An air pressurized pre-action fire sprinkler system with smoke alarm controlled water flow as an alternative to wet fire sprinkler protection in this area..
Lighting:	Provide 50 maintained footcandles at desk level using parabolic louvered fluorescent fixtures and incandescent task lights with individual dimming control. Provide a minimum uniform desk level illumination of 20 maintained footcandles without task lighting.
Acoustic:	Maximum background sound level due to mechanical systems shall be NC 35. Room surround wall STC 52+. Reverberation time should be 0.5 to 0.7 seconds at 500 Hz. Provide ceiling having minimum NRC 0.65+. Provide fabric covered sound absorption panels at wall areas having a minimum NRC 0.75.
Telecommunications:	An array of recording equipment within a secure, acoustically controlled area which allows minimum staffing to have maximum information and reaction capabilities. The following systems will be controlled and/or monitored from the Console which shall be

HIGHWAY ADVISORY RECORDING ROOM

	designed for 1 operator at one time.
Audio Visual:	Video monitor array.
Security:	Access shall be through the Operations and Communications rooms. The Communications area shall be located within the Security suite and have hardwall construction except for the laminated security glazed acoustical viewing window to the Operations Room.
Notes:	Electronic equipment racks Recording console

COMMUNICATIONS

Area (net):	738 SF
Quantity:	1
Function:	Communications control room
Key Dimensions:	Control room, electronic equipment racks and service access way, Communications control console and video monitor array.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Raised, non-static carpet Walls: Painted GWB Ceiling: ACT
Electrical:	Provide power for Communications controls systems from panelboard with transient voltage surge protection. Provide UPS power. Provide convenience receptacles located to provide power for cleaning and maintenance to all parts of the room with a maximum 25 foot extension cord.
HVAC:	Provide individual temperature control supplied from the same HVAC system as Operations, 911, System Manager, Assistant System Manager and System Maintenance Supervisor.
Plumbing/Fire Protection:	An air pressurized pre-action fire sprinkler system with smoke alarm controlled water flow as an alternative to wet fire sprinkler protection in this area.
Lighting:	Provide 50 maintained footcandles at desk level using parabolic louvered fluorescent fixtures and incandescent task lights with individual dimming control. Provide a minimum uniform desk level illumination of 20 maintained footcandles without task lighting.
Acoustic:	Maximum background sound level due to mechanical systems shall be NC 35. Room surround wall STC 52+. Reverberation time should be 0.5 to 0.7 seconds at 500 Hz. Provide ceiling having minimum NRC 0.65+. Provide fabric covered sound absorption panels at wall areas having a minimum NRC 0.75.
Telecommunications:	An array of 911 Communications and Control equipment within a secure, acoustically controlled area which allows minimum staffing to have maximum information and reaction capabilities. The

COMMUNICATIONS

	following systems will be controlled and/or monitored from the Console which shall be designed for 4 operators at one time.
Audio Visual:	Video monitor array.
Security:	Access shall be through steel secured doors with door position switches, electronic locking devices and proximity card reader with supplemental key pad verification for insertion of PIN. The Communications area shall be located within the Security suite and have hardwall construction except for the laminated security glazed acoustical viewing window to the Operations Room.
	A CCTV camera surveying the console operators position shall be installed, which, through the building LAN, will convey a password accessible image to any other networked workstation.
Notes:	Electronic equipment racks Operations console Video monitor array

ELECTRONICS

Area (net):	1766 SF total
Quantity:	1
Function:	Area to house electronic equipment for telephone operations, 911 and communications.
Key Dimensions:	Minimum vertical clearance 12'-0
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Raised floor Walls: CMU Fire-retardant-treated ¾-inch 4 x 8 plywood backboards shall be installed on two walls. Ceiling: None
Electrical:	Provide dedicated phase panel board with transient voltage surge protection for rack mounted equipment. Provide emergency power backup. Provide convenience receptacles located to provide power for cleaning and maintenance to all parts of the room with a maximum 25 foot extension cord.
HVAC:	Provide independent, dedicated HVAC system for computer room type environmental control.
Plumbing/Fire Protection:	An air pressurized pre-action fire sprinkler system with smoke alarm controlled water flow as an alternative to wet fire sprinkler protection in this area.
Lighting:	Provide 50 maintained footcandles at floor level of fluorescent lighting using industrial lensed fixtures. Arrange lighting in relation to equipment racking aisles for best illumination and equipment visibility.
Acoustic:	Maximum background sound level from mech. systems - NC 45.
Telecommunications:	Powered 19-inch communications ranks shall be installed; the exact number to be determined by the final design of the systems to be supported within the room. Systems anticipated to be included in the room include: • *Telephone equipment* • *Data network support electronics; routers, hubs, file servers, CD-ROM towers, modems, UPS* • *Television/radio equipment* • *Alarm status dot matrix printers* • *PCs with CRTs & laser printers* In addition, space for 2 persons to work: desks, document and software storage and other amenities.
Audio Visual:	N/A
Security:	Access to the Electronics Room shall be through a steel secured door with door position switch, electronic locking device and proximity card reader with supplemental key pad verification for insertion of PIN. The Electronics area shall be located within the Security suite and have hardwall construction . A CCTV surveillance camera shall be positioned in the corridor with a view of the exterior door to the room.
Notes:	

MAINTENANCE SHOP

Area (net):	1,175 SF
Quantity:	1
Function:	Maintenance assembly/repair shop for building electronic equipment
Key Dimensions:	Minimum vertical clearance 12 '-0". Accommodate receiving and crate breakdown for large freight items.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Sealed concrete Walls: Painted GWB or CMU; Provide fire-treated tempered hardboard wainscot protection to 8 foot height at GWB walls. Ceiling: no finish
Electrical:	Provide individual 120 volt, 20 amp circuits with multi-outlet surface wireways at work benches.
HVAC:	Provide individual temperature controlled heat, ventilation or HVAC and supply from separate system to maintain temperature within the range of 68°F to 78°F.
Plumbing/Fire Protection:	Provide shop type sink with hot and cold water and drain. Provide sprinkler protection. Provide eyewash station.
Lighting:	Provide 50 maintained footcandles at bench level of fluorescent lighting using industrial fixtures.
Acoustic:	Maximum background sound level: NC 45. Room surround wall STC 52+ Provide ceiling with minimum NRC 0.65. These shops should be preferably separated from noise sensitive rooms vertically and horizontally.
Telecommunications:	Three (3) wall-mounted admin communication boxes (4-port outlets). They shall be distributed based upon the final configuration of the shop.
Audio Visual:	Provide paging loudspeakers.
Security:	Exterior surveillance coverage of the door areas shall be provided by the loading area CCTV cameras contained in weather tight enclosures and mounted on pan/tilt supports. All shop doors shall be secured steel; door position switches, electronic locking devices, and proximity card readers.
Notes:	Assistant Maintenance Supervisor work station. 2 shared technician work benches. 50 linear feet industrial shelving. Provide fume extraction system at work benches for general exhaust at work area, not intended for hazardous materials.

BREAK AREA

Area (net):	450 SF
Quantity:	1
Function:	Employee break area.
Key Dimensions:	8'-0" ceiling
Adjacency Requirements:	See adjacency matrix.
Finishes:	Floor: Resilient flooring and base. Walls: Painted GWB Ceiling: ACT
Electrical:	Provide power receptacles for vending machines , coffee service and microwave. Provide one duplex convenience outlet on each wall.
HVAC:	Provide HVAC from same system serving administrative areas to maintain temp. in range 68 °F to 78°F.
Plumbing/Fire Protection:	Provide stainless steel self rimming sink with hot and cold water, drain and connection for coffee machine and refrigerator ice maker . Provide sprinkler protection.
Lighting:	Provide 30 footcandles at table level of fluorescent lighting using compact fluorescent downlights.
Acoustic:	Maximum background sound level: NC 40 ceiling material with minimum NRC 0.65+.
Telecommunications:	Provide one RJ45 recessed jack for wall-mounted telephone and one 750 ohm coaxial cable jack for television.
Audio Visual:	Provide paging loudspeakers. Provide Cable TV outlet.
Security:	No door security is required.
Notes:	Provide 12 linear feet of base and wall cabinets with counter and sink, 2 vending machines , refrigerator, coffee machine and microwave..

STAFF/ADMIN MENS' RESTROOMS

Area (net):	312 SF
Quantity:	1
Function:	Administrative staff toilets w/showers
Key Dimensions:	2 lav. 1 toilet 1 urinal 1 shower
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, and cleanable finishes: Floor: Vitreous ceramic tile floor and base Walls: Ceramic tile at wet wall, non-absorbent paint finished GWB elsewhere Ceiling: Non-absorbent paint finished GWB
Electrical:	Provide 120 volts, 20A GFI protected receptacle at each lavatory.
HVAC:	Provide exhaust of 12 air changes minimum.
Plumbing/Fire Protection:	Provide hot and cold water and drain for connections to all plumbing fixtures. Provide accessible fixtures. Provide electric water cooler in the corridor in vicinity of the toilet rooms. Provide sprinkler protection.
Lighting:	Provide 20 maintained footcandles at lavatory level with lensed fluorescent fixture over counter and compact fluorescent downlights in remainder of room.
Acoustic:	Maximum background sound level: NC 45. Room surround wall: STC 52+.
Telecommunications:	None.
Audio Visual:	Provide water resistant paging loudspeakers.
Security:	CCTV cameras are forbidden. However, entrance to men's toilets should be within the range of hallway camera.
Notes:	Final fixture count to be determined. Provide one recessed flip down baby changing station, one soap dispenser, one towel dispenser and one mirror at each lav and one paper waste receptacle in each public restroom. Provide toilet partitions, double roll toilet paper roll holder w/ shelf, one seat cover dispenser in each toilet cubicle.

STAFF/ADMIN WOMEN'S' RESTROOMS

Area (net):	312 SF
Quantity:	1
Function:	Administrative staff toilets w/ shower
Key Dimensions:	2 lav 2 toilets 1 shower
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, and cleanable finishes: Floor: Vitreous ceramic tile floor and base Walls: Ceramic tile at wet wall, non-absorbent paint finished GWB elsewhere Ceiling: Non-absorbent paint finished GWB
Electrical:	Provide 120 volts, 20 amp GFI protected receptacle at each lavatory.
HVAC:	Provide exhaust of 12 air changes minimum.
Plumbing/Fire Protection:	Provide hot and cold water and drain for connections to all plumbing fixtures. Provide accessible fixtures. Provide sprinkler protection.
Lighting:	Provide 20 maintained footcandles at lavatory level with lensed fluorescent fixture over counter and compact fluorescent downlights in remainder of room.
Acoustic:	Maximum background sound level: NC 45. Room surround wall STC 52+.
Telecommunications:	None.
Audio Visual:	Provide water resistant paging loudspeakers.
Security:	CCTV cameras are forbidden. However, entrance to women's toilets should be within the range of hallway cameras .
Notes:	Final fixture count to be determined. Provide one recessed flip down baby changing station, one soap dispenser, one towel dispenser and one mirror at each lav and one paper waste receptacle in each public restroom. Provide toilet partitions, double roll toilet paper roll holder w/ shelf, one seat cover dispenser in each toilet cubicle. Provide napkin disposal.

MECHANICAL ROOM

Area (net):	770 SF
Quantity:	1
Function:	Central boiler room housing boiler, pumps and mechanical equipment.
Key Dimensions:	For entire facility. Min. vertical clearance 10 foot, 12 foot optimum
Adjacency Requirements:	See adjacency matrix.
Finishes:	Floor: Sealed concrete Walls: CMU, grouted cores Ceiling: No finish
Electrical:	Provide 480 volt, 3 phase power to central heating/air conditioner and air handling equipment from panel in this area. Provide duplex convenience power outlets at admin communications box location and at locations to provide power for cleaning and maintenance to all areas with a 25 foot cord.
HVAC:	
Plumbing/Fire Protection:	Provide water supply for make-up and floor drains w/ trap priming. Provide shop sink w/ hot and cold water and drain. Provide natural gas for gas fired equipment. Provide sprinkler protection.
Lighting:	Provide 30 maintained footcandles at floor level with open industrial fluorescent fixtures chain hung.
Acoustic:	Surround wall STC 52+. Transformers and all rotating mechanical equipment and acoustical piping shall be properly isolated from the building structure to prevent structure-borne noise transmissions. Surround wall and slabs shall be substantial enough and/or isolated to maintain any transmitted noise with acceptable limits. Provide acoustical door and seals.
Telecommunications:	Provide one admin communications (4-port outlet) to provide for telephone, PC LAN and peripherals.
Audio Visual:	Provide paging by phone.
Security:	Secured steel acoustical doors, lock and key.
Notes:	Rooftop equipment includes redundant and cooled chillers and fan equipment.

MAIN ELECTRICAL ROOM

Area (net):	372 SF
Quantity:	1
Function:	Area to main electrical and house emergency power system for distribution throughout the building. Transformers shall be mounted on resilient isolators.
Key Dimensions:	Minimum vertical clearance of 12 feet.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Sealed concrete Walls: Concrete, CMU or GMB Ceiling: No finish
Electrical:	
HVAC:	Provide positive ventilation system heat and HVAC to maintain temperature with the range 68 °F and 90°F.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 30 maintained footcandles at floor level with open industrial fluorescent fixtures chain hung.
Acoustic:	NC 40-45 Room surround wall: STC 47 Transformers shall be properly acoustically isolated from building structure and partitions to prevent structure borne noise transmission. Provide acoustical seals and door.
Telecommunications:	Wall telephone.
Audio Visual:	Provide paging loudspeakers.
Security:	Secured steel doors with door position switches, electronic locking devices and proximity card reader
Notes:	

ELEVATOR MACHINE ROOMS

Area (net):	100 SF
Quantity:	1
Function:	Area to house elevator hydraulics and control equipment.
Key Dimensions:	10'x10' proximate to elevator shaft.
Adjacency Requirements:	See adjacency matrix .
Finishes:	Durable, low maintenance finishes: Floor: Sealed concrete Walls: CMU Ceiling: No finish
Electrical:	Provide 480 volt, 3 phase power to elevator machine with shunt trip from sprinkler system and 120 volt power to convenience outlets located 10 feet on center and to machine room, cab, shaft and pit.
HVAC:	Provide ventilation, heater, HVAC system to maintain temperature between 50°F and 90°F.
Plumbing/Fire Protection:	Provide sprinkler protection. Provide shut off valve with tamper switch and flow switch on a separate sprinkler branch to the elevator machine room. Pit sump - no pump.
Lighting:	Provide 30 maintained footcandles at floor level with open industrial fluorescent fixtures.
Acoustic:	
Telecommunications:	Provide wall-mounted telephone.
Audio Visual:	Provide paging loudspeakers.
Security:	Secured; steel doors, lock and key.
Notes:	

EMERGENCY GENERATOR

Area (net):	600 SF Outdoors Pad mounted
Quantity:	1
Function:	Area to house diesel driven emergency generator.
Key Dimensions:	Minimum vertical clearance of 12 feet.
Adjacency Requirements:	See adjacency matrix.
Finishes:	N/A
Electrical:	
HVAC:	N/A
Plumbing/Fire Protection:	
Lighting:	
Acoustic:	All rotating mechanical equipment and associated piping shall be properly isolated from the building structure to prevent structure-borne noise transmission. Provide substantial window and wall constructions to withstand the mechanical noise transmission to adjacent spaces.
Telecommunications:	N/A
Audio Visual:	N/A
Security:	This equipment shall be secured with 8 foot high chain link fence enclosure around and over. CCTV surveillance of emergency generator area.
Notes:	

ELECTRICAL/TELEPHONE CLOSETS

Area (net):	40 SF each
Quantity:	*(to be determined)*
Function:	To house electric and telephone sub-area equipment distribution .
Key Dimensions:	Minimum width of 5 feet.
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable low maintenance finishes: Floor: Sealed concrete Walls: Painted GWB, CMU Ceiling: No finish
Electrical:	Refer to systems narrative.
HVAC:	Provide ventilation or cooling to maintain 90° F maximum space temperature.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 30 maintained footcandles at floor level with fluorescent open industrial fixtures.
Acoustic:	See partition matrix for partition STC ratings. Maximum background sound level due to mechanical systems shall be NC 45.
Telecommunications:	None.
Audio Visual:	
Security:	Secured steel or solid core wood door; door position switch, electrified door strike or latch, proximity card reader access.
Notes:	

HOT WATER HEATER CLOSETS

Area (net):	35 SF
Quantity:	To be determine (where possible at stacked fixture locations combine DHW supply from a common water heater closet at one level.)
Function:	Generation of hot water for public toilets.
Key Dimensions:	As required.
Adjacency Requirements:	Locate hot water closets in the vicinity of each bank of public toilets.
Finishes:	Durable, low maintenance finishes: Floor: Sealed concrete Walls: Painted GWB, CMU Ceiling: No finish
Electrical:	Provide 120/240 volt, power to each hot water heater location.
HVAC:	Provide vent, heat or HVAC to maintain temp. in range: 50 °F to 90°F.
Plumbing/Fire Protection:	Provide floor drain, pressure release drain and cold water supply to the heater. Heater shall supply point-of-use demand to lavatories served. (Provide sprinkler system).
Lighting:	Provide 30 maintained footcandles at floor level with open industrial fixtures. Provide for positive shut off of lighting when not occupied.
Acoustic:	N/A
Telecommunications:	None.
Audio Visual:	None.
Security:	Secured steel or solid core wood door, lock and key.
Notes:	Closets may be required or heaters installed in mechanical rooms.

GENERAL STORAGE

Area (net):	975 SF total
Quantity:	2 spaces, 725 SF and 250 SF
Function:	Storage of building maintenance supplies , materials and equipment
Key Dimensions:	
Adjacency Requirements:	See adjacency matrix.
Finishes:	Durable, low maintenance finishes: Floor: Sealed concrete Walls: Painted GWB or CMU Provide fire treated tempered hardboard wainscot protection to 8 ft height at GWB walls. Ceiling: no finish
Electrical:	Provide convenience receptacles located at admin communications box location to provide power for inventory control systems and for cleaning and as required for maintenance to all parts of the room with a maximum 25 foot extension cord.
HVAC:	Provide positive ventilation system, heat or HVAC to maintain temperature in the range of 68 °F.
Plumbing/Fire Protection:	Provide sprinkler protection.
Lighting:	Provide 30 maintained footcandles at floor level with open industrial fluorescent fixtures chain hung coordinated with storage unit spacing.
Acoustic:	Maximum background sound level: NC 45.
Telecommunications:	One admin communications box (4 port outlet) to provide telephone PC LAN and peripheral support for inventory control systems..
Audio Visual:	Provide paging loudspeakers.
Security:	Secured steel or solid core wood doors; lock and key.
Notes:	

GARAGE

Area (net):	600 SF
Quantity:	2 vehicle bays
Function:	Storage and loading of standard size vans and small trucks
Key Dimensions:	Vehicle clearance, 20 feet
Adjacency Requirements:	See adjacency matrix.
Finishes:	Floor: Sealed concrete Walls: CMU Ceiling: GWB
Electrical:	Provide 1-120 volt, 20 amp, duplex convenience outlet at each bay.
HVAC:	Provide ventilation, heat or HVAC to maintain temperature in the range: 50°F to 90°F.
Plumbing/Fire Protection:	Provide sprinkler protection and occupancy separation per code.
Lighting:	Provide 30 footcandles at floor level with lensed industrial fluorescent fixtures.
Acoustic:	Room surround wall STC 52+: NC 40-45.
Telecommunications:	Provide wall phone intercom to reception.
Audio Visual:	N/A
Security:	CCTV coverage at loading doors.
Notes:	Lift point over truck bay capacity: 500lb.

JANITOR

Area (net):	20 SF
Quantity:	2
Function:	Chemical/utility/cleaning supply storage.
Key Dimensions:	Minimum 8’-0” ceiling
Adjacency Requirements:	See adjacency matrix.
Finishes:	Floors: Sealed concrete, resilient base. Walls: Epoxy painted GWB or CMU; protect GWB walls with fire treated tempered hardboard wainscoting to 8 f eet above finished floor. Ceiling: No finish.
Electrical:	Provide 120 volt, 20 amp duplex receptacle for convenience power at 42 inch AFF.
HVAC:	Provide exhaust of 12 air changes minimum.
Plumbing/Fire Protection:	Provide mop basin with hot and cold water, hose bibb. Provide sprinkler protection.
Lighting:	Provide 20 maintained footcandles with open industrial fluorescent fixture.
Acoustic:	Maximum background sound level: NC 40.
Telecommunications:	None
Audio Visual:	
Security:	Secured steel or solid core wood door, lock with key.
Notes:	Shelf and mop rack.

2) SITE PLAN, GRADING, DRAINAGE AND UTILITY PLAN, TYPICAL SECTIONS

3) COST ESTIMATES

LOWER HUDSON VALLEY - NYSDOT - TRAFFIC MANAGEMENT CENTER - 26,250 S.F.

CONSTRUCTION COMPONENTS	QTY. UNITS	UNIT TYPE	UNIT COST	TOTAL COST	NOTES
A 1 FOUNDATIONS					
Spread Footings	15	Ea.	$141.52	$ 2,123	At cols.
Strip Footings	650	L.F.	$35.38	$ 22,997	650 l.f.: perim., 340 l.f.:pits
C.I.P. Fnd. Walls	350	L.F.	$48.80	$ 17,080	4' high
Dampproofing Walls	322	L.F.	$14.12	$ 4,545	to 12' high
Bldg. Exc. & Backfill	10,000	S.F.	$4.27	$ 42,700	
A 2 SUBSTRUCTURE					
Slab on grade	14,100	S.F.	$6.47	$ 91,171	4" industrial reinforced
A 3 SUPERSTRUCTURE					
Structured floor w/ cols.	12,270	S.F.	$10.04	$ 123,198	Slab, deck, jst, bm, col
Fireproof columns 2 flrs.	400	L.F.	$18.30	$ 7,320	GWB (if reqd.)
Roof structure	14,070	S.F.	$4.44	$ 62,482	Deck, joist,beam,
w/ cols. to roof	14,070	S.F.	$1.27	$ 17,852	
Stairways	6	Flt.	$4,672.60	$ 28,036	Conc. / stl. pan
A 4 EXTERIOR CLOSURE					
8" c.m.u. / mtl.stud / insul.	17,670	S.F.	$30.50	$ 538,935	
Glass block	300	S.F.	$25.68	$ 7,704	
Exterior doors / frames	2	single	$1,239.52	$ 2,479	
Exterior doors / frames	6	dbl.	$2,379.00	$ 14,274	
Alum. wdw. frames	1,500	S.F.	$24.10	$ 36,143	
Insulated glazing - clr.	1,500	S.F.	$21.90	$ 32,849	
A 5 ROOFING					
Built - up w/ballast	14,070	S.F.	$2.16	$ 30,383	
Galv. sht. mtl	600	L.F.	$16.84	$ 10,102	
Flashing	600	S.F.	$3.34	$ 2,006	
Insulation	14,070	S.F.	$2.28	$ 32,099	Polyisocyanurate
Roof hatch	1	Ea.	$688.08	$ 688	
A 6 INTERIOR CONST.					

LOWER HUDSON VALLEY - NYSDOT - TRAFFIC MANAGEMENT CENTER - 26,250 S.F.

CONSTRUCTION COMPONENTS	QTY. UNITS	UNIT TYPE	UNIT COST		TOTAL COST	NOTES
Drywall partitions 3 5/8" mtl.	23,540	S.F	$3.45	$	81,274	5/8"gwb both sides
5/8" g.w.b. - ext. wall	17,670	S.F	$0.66	$	11,641	5/8" gwb one side ext. wall
3 1/2" sound insulation	10,000	S.F.	$0.60	$	5,978	Some walls
6" sound insulation	12,270	S.F.	$0.70	$	8,533	Some ceilings
Gwb tape & finish	64,750	S.F	$0.52	$	33,968	All gwb walls
Toilet partitions	12	Ea.	$793.00	$	9,516	
Solid wd. doors	34	Ea.	$486.78	$	16,551	
Solid wd. doors dbl.	5	Ea.	$689.30	$	3,447	
O/h door w/ motor	4	Ea.	$3,794.20	$	15,177	
Paint on gwb	64,750	S.F	$0.61	$	39,498	
Ceramic tile	360	S.F	$6.04	$	2,174	Wall tile
Ceramic tile	1,410	S.F	$8.04	$	11,336	Floor tile
Carpet tile	10,515	S.F	$4.04	$	42,462	
Vinyl comp. tile	4,175	S.F	$2.44	$	10,187	
Concrete finish	4,800	S.F	$1.32	$	6,324	
Suspended ceiling	26,250	S.F	$2.51	$	65,972	
A 7 CONVEYING SYSTEM						
3500 lb.hydro. elevator	2	Ea.	$55,754.00	$	111,508	
A 8 MECHANICAL						
2" c.i. waste	150	L.F.	$19.07	$	2,860	
4" c.i. waste	500	L.F.	$25.68	$	12,841	
3/4" copper	500	L.F.	$9.97	$	4,984	
50 gal. water htr.	2	Ea.	$1,830.00	$	3,660	
4"dia. roof drain	6	Ea.	$873.52	$	5,241	
additional leaders	100	L.F.	$23.30	$	2,330	
Kitchen sink	2	Ea.	$1,238.30	$	2,477	
Bath lavatory	19	Ea.	$828.38	$	15,739	
Service sink	2	Ea.	$1,701.90	$	3,404	
Urinals	4	Ea.	$1,262.70	$	5,051	
Water cooler	4	Ea.	$1,933.70	$	7,735	
Toilet	16	Ea.	$1,299.30	$	20,789	
Sprinkler (lower)	14,070	S.F.	$1.95	$	27,465	
Sprinkler (upper)	12,270	S.F.	$1.55	$	19,011	
Boiler heating & reheat	26,250	S.F.	$6.25	$	163,968	All areas
VAV DX 30 Ton 12 zone	12,270	S.F.	$14.91	$	182,926	Upper floors
VAV DX 6 Ton 4 zone	2,000	S.F.	$21.35	$	42,700	Operation & Communicatio
Electronics 20 ton DX	2	Ea.	$48,800.00	$	97,600	Computer room units
A 9 ELECTRICAL						
Fluorescent fixtures	26,250	S.F.	$3.94	$	103,441	2 watts / s.f.

LOWER HUDSON VALLEY - NYSDOT - TRAFFIC MANAGEMENT CENTER - 26,250 S.F.

CONSTRUCTION COMPONENTS	QTY. UNITS	UNIT TYPE	UNIT COST		TOTAL COST	NOTES
Light pole	3	Ea.	$2,793.80	$	8,381	30' h.- 2 brackets ea.
Receptacle	26,250	S.F.	$1.70	$	44,515	5 / 1,000 s.f.
Wall switch	26,250	S.F.	$0.38	$	9,928	2.5 / 1,000 s.f.
Electric service	1	Ea.	$26,108.00	$	26,108	2,000 a. 3 ph. 4 w.120/208
Feeder installation	200	L.F.	$356.24	$	71,248	2,000 a. 3 ph. 4 w.120/208

A 11 SPECIALTIES

Curtain rod	4	Ea.	$65.88	$	264	
Towell dispenser	12	Ea.	$76.25	$	915	
Grab bar	10	Ea.	$61.24	$	612	
Mirror	23	Ea.	$140.85	$	3,240	
Lockers	60	Ea.	$162.87	$	9,772	
Refrigerator	2	Ea.	$366.00	$	732	
Window blinds	1,500	S.F.	$10.19	$	15,281	
Pedestal access floor	5,440	S.F.	$15.32	$	83,358	
SUB-TOTAL - ARCHITECTURAL				$	2,601,282	

SITE WORK

Clearing and grubbing	$	7,150
Earthwork	$	83,307
Pavement Existing	$	27,219
Pavement New	$	135,084
Drainage	$	48,083
Curb and sidewalk	$	42,084
Landscaping	$	2,463
Lighting	$	16,312
Pavement markings	$	1,122
Retaining wall	$	29,932
SITE WORK TOTAL	$	392,757

Appendix C

ITSEquipmentCostswithTransit

Quantity	Item	Unit	Subtotal
5	Servers (CCTV, Sign, HAR, Traffic control...)	$5,000	$25,000
3	Servers (AVL tracking system server, master scheduler, on-time tracking system processor	$5,000	$15,000
1	Server Networking	$1,500	$1,500
10	Workstations	$7,000	$70,000
3	Electronics racks	$1,000	$3,000
1	Video switch (48 camera, 32 out)	$60,000	$60,000
6	Communications Nodes	$30,000	$180,000
8	Modems for remote access	$500	$4,000
1	Digital Radio Base Station/AVL	$50,000	$50,000
5	Video/Data Multiplexer (Sonet/DS-1)	$40,000	$200,000
1	UPS (20 kW)	$20,000	$20,000
20	Monitors	$4,000	$80,000
2	Projection Monitor	$40,000	$80,000
3	Printers	$3,000	$9,000
2	**Radio Scanners**	$2,000	$4,000
1000	Fiberoptic runs (in feet)	$15	$15,000
1000	**Coaxial runs (in feet)**	$1	$1,000
13	LAN Hubs	$1,000	$13,000
	Contingency	10%	$83,050
	Estimated Total ITS Equipment Cost		$913,550

Notes:

Communication node ranges from $10,000 to $50,000
Workstations range from $5,000 to $7,000
Video switch price depends upon number of inputs/outputs
Fiberoptic runs are within the building
Coaxial cable runs are within the building
Cost does not include 911 hardware
On-time status processing software for transit operators ranges from $500,0000 to $1 million, depending on the number of vehicles
Additional equipment will be necessary to link to SONET ring network

4) NATIONAL ENVIRONMENTAL PROTECTION ACT (NEPA) CHECKLIST

NEPA ASSESSMENT CHECKLIST

Answer the following questions by checking YES or NO.

I. THRESHOLD QUESTION	YES	NO
1. Does the project involve unusual circumstances as described in 23 CFR §771.117(b)?	___	✓

● If YES, the project does not qualify as a Categorical Exclusion and an EA or EIS is required. You may STOP COMPLETING THE CHECKLIST.

● If NO, go on.

II. AUTOMATIC CATEGORICAL EXCLUSION	YES	NO
2. Is the project an action listed as an Automatic Categorical Exclusion in 23 CFR §771.117(c) (C List) and/or is the project an element-specific project classified by FHWA as a Categorical Exclusion on July 22, 1996?	___	✓

● If YES to question 2, the project qualifies for a C List Categorical Exclusion. You may STOP COMPLETING THE CHECKLIST. The checklist should be included in the appendix of the Final Design Report (or Scope Summary Memorandum/Final Design Report). The CATEGORICAL EXCLUSION DETERMINATION memo is to be sent to the appropriate Main Office Design liaison unit with a copy of the Final Design Report (or Scope Summary Memorandum/Final Design Report). A copy of the CATEGORICAL EXCLUSION DETERMINATION memo must also be sent to the Office of Budget and Finance, Project and Letting Management, and others (see sample DETERMINATION memo attached).

(Note - Even if YES to question 2, there may be specific environmental issues that still require an action such as an EO 11990 Wetland Finding or a determination of effect on cultural resources. The project is still an Automatic Categorical Exclusion but the necessary action must be taken, such as obtaining FHWA's signature on the wetland finding. Refer to the appropriate section of the Environmental Procedures Manual for guidance.)

● If NO to question 2, go on.

III. PROGRAMMATIC CATEGORICAL EXCLUSION	YES	NO
3. Is the project on new location or does it involve a change in the functional classification or added mainline capacity (add through-traffic lanes)?	___	✓

	YES	NO
4. Is this a Type I project under 23 CFR 772, "Procedures for Abatement of Highway Traffic Noise and Construction"?	___	✓
5. If the project is located within the limits of a designated sole source aquifer area or the associated stream flow source area, is the drainage pattern altered?	___	✓
6. Does the project involve changes in travel patterns?	___	✓
7. Does the project involve the acquisition of more than minor amounts of temporary or permanent right-of-way (a minor amount of right-of-way is defined as not more than 10 percent of a parcel for parcels under 4 ha (10 acres) in size, 0.4 ha (1 acre) of a parcel 4 ha to 40.5 ha (10 to 100 acres) in size and 1 percent of a parcel for parcels greater than 40.5 ha (100 acres) in size?	___	✓
8. Does the project require a Section 4(f) evaluation and determination in accordance with the FHWA guidance?	___	✓
9. Does the project involve commercial or residential displacement?	___	✓
10. If Section 106 applies, does FHWA's determination indicate an opinion of adverse effect?	___	✓
11. Does the project involve any work in wetlands requiring a Nationwide Wetland Permit #23?	___	✓
12. Does the project involve any work in wetlands requiring an individual Executive Order 11990 Wetland Finding?	___	✓

	YES	NO
13. Has it been determined that the project will significantly encroach upon a flood plain based on preliminary hydraulic analysis and consideration of EO 11988 criteria as appropriate?	___	√
14. Does the project involve construction in, across or adjacent to a river designated as a component proposed for or included in the National System of Wild and Scenic Rivers?	___	√
15. Does the project involve any change in access control?	___	√
16. Does the project involve any known hazardous materials sites or previous land uses with potential for hazardous material remains within the right-of-way?	___	√
7. Does the project occur in an area where there are Federally listed endangered or threatened species or critical habitat?	___	√
18. Is the project, pursuant to EPM Chapter 1A and Table 2 and Table 3 of 40 CFR Parts 51 and 93, non-exempt or does it exceed any ambient air quality standard?	___	√
19. Does the project lack consistency with the New York State Coastal Zone Management Plan and policies of the Department of State, Office of Coastal Zone Management?	___	√
20. Does the project impact or acquire any Prime or Unique Farmland as defined in 7 CFR Part 657 of the Federal Farmland Protection Policy Act <u>and</u> are there outstanding compliance activities necessary? (<u>Note:</u> Interpret compliance activity to mean completion of Form AD 1006.)	___	√

If NO for questions, 3-20, go on to answer question 21.

● If YES to any question 3-20, project will not qualify as a Programmatic Categorical Exclusion. Answer questions 21 and 22 for documentation only and go on to question 23.

	YES	NO
21. Does the project involve the use of a temporary road, detour or ramp closure?	___	✓

● If NO to questions 3-20 and NO to question 21, the project qualifies as a Programmatic Categorical Exclusion. You may STOP COMPLETING THE CHECKLIST. The checklist should be included in the appendix of the Final Design Report (or Scope Summary Memorandum/Final Design Report). The CATEGORICAL EXCLUSION DETERMINATION memo is to be sent to the appropriate Main Office Design liaison unit with a copy of the Final Design Report (or Scope Summary Memorandum/Final Design Report). A copy of the Categorical Exclusion memo must also be sent to the Office of Budget and Finance, Project and Letting Management, and others (see sample DETERMINATION memo attached).

● If YES to question 21, preparer should complete question 22 (i-v). If questions 3-20 are NO and 21 is YES, the project will still qualify as a Programmatic Categorical Exclusion if questions 22 (i-v) are YES.

	YES	NO
22. Since the project involves the use of temporary road, detour or ramp closure, will all of the following conditions be met:		
i. Provisions will be made for pedestrian access, where warranted, and access by local traffic and so posted.	___	___
ii. Through-traffic dependent business will not be adversely affected.	___	___
iii. The detour or ramp closure, to the extent possible, will not interfere with any local special event or festival.	___	___
iv. The temporary road, detour or ramp closure does not substantially change the environmental consequences of the action.	___	___
v. There is no substantial controversy associated with the temporary road, detour or ramp closure.	___	___

● If questions 3-20 are NO, 21 is YES and 22 (i-v) are YES, the project qualifies for a Programmatic Categorical Exclusion. You may STOP COMPLETING THE CHECKLIST. The checklist should be included in the appendix of the Final Design Report (or Scope Summary Memorandum/Final Design Report). The CATEGORICAL EXCLUSION DETERMINATION memo should be sent to the appropriate Main Office Design liaison unit with a copy of the Final Design Report (or Scope Summary Memorandum/Final Design Report.) A copy of the CATEGORICAL EXCLUSION DETERMINATION memo must also be sent to the Office of Budget and Finance, Project and Letting Management, and others (see sample DETERMINATION memo attached).

● If questions 3-20 are NO, 21 is YES and any part of 22 is NO, go on to question 23.

	YES	NO
23. Is the project section listed in 23 CFR §771.117(d) (D List) or is the project an action similar to those listed in 23 CFR §771.117(d)?	____	____

For those questions which precluded a Programmatic Categorical Exclusion, documentation should be provided for any YES response to questions 3-20 or for a NO response to any part of questions 22 (i-v). This documentation, as well as the checklist, should be included in the Design Approval Document, i.e., Final Design Report, etc., to be submitted to the Main Office/FHWA Design liaison unit for submission to the FHWA Division for classification of the project as a D List Categorical Exclusion.

APPENDIX E

ABOVE GROUND AND UNDER GROUND STORAGE TANKS

Figure 8

Operations Room
Workstations and Video Monitor Wall

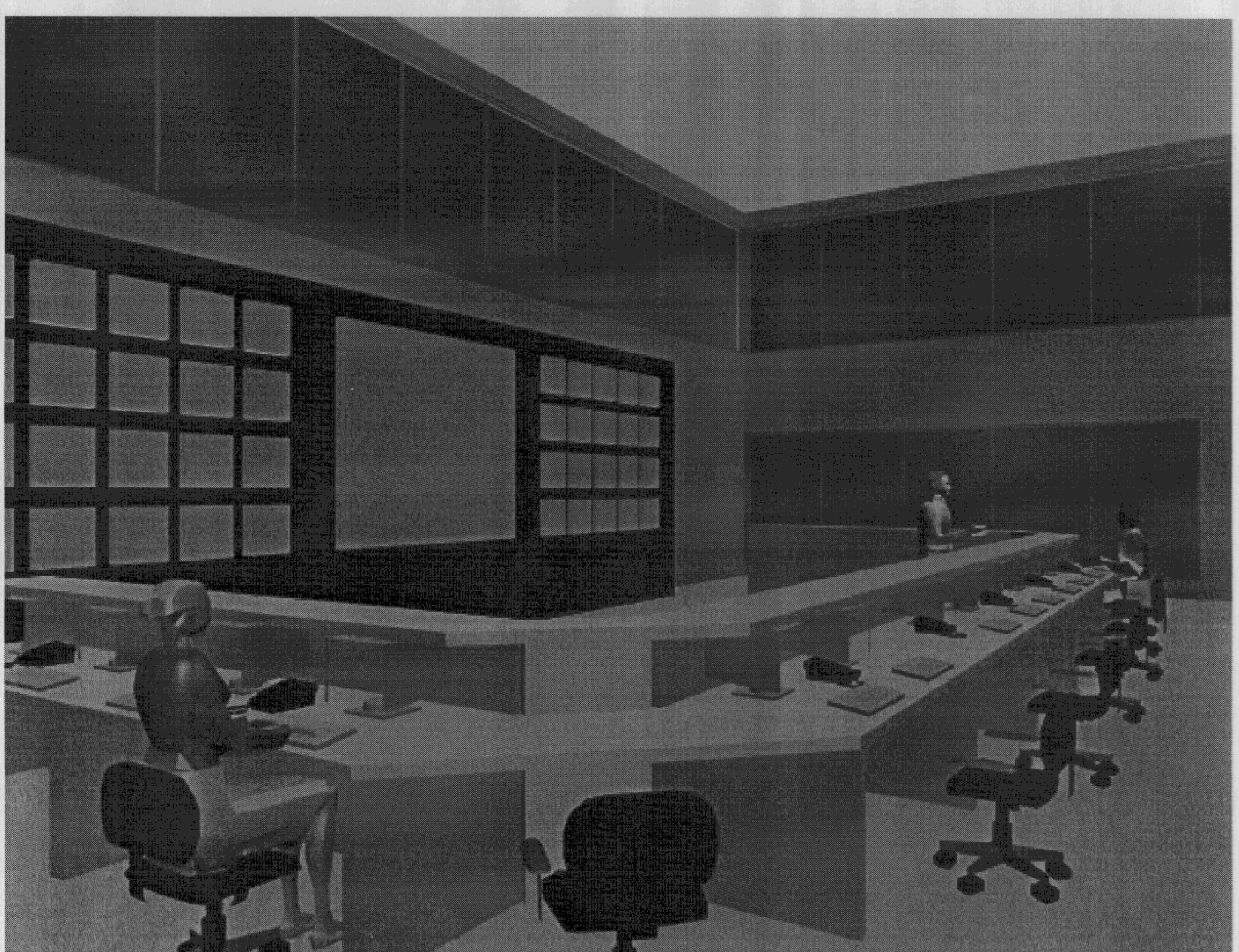
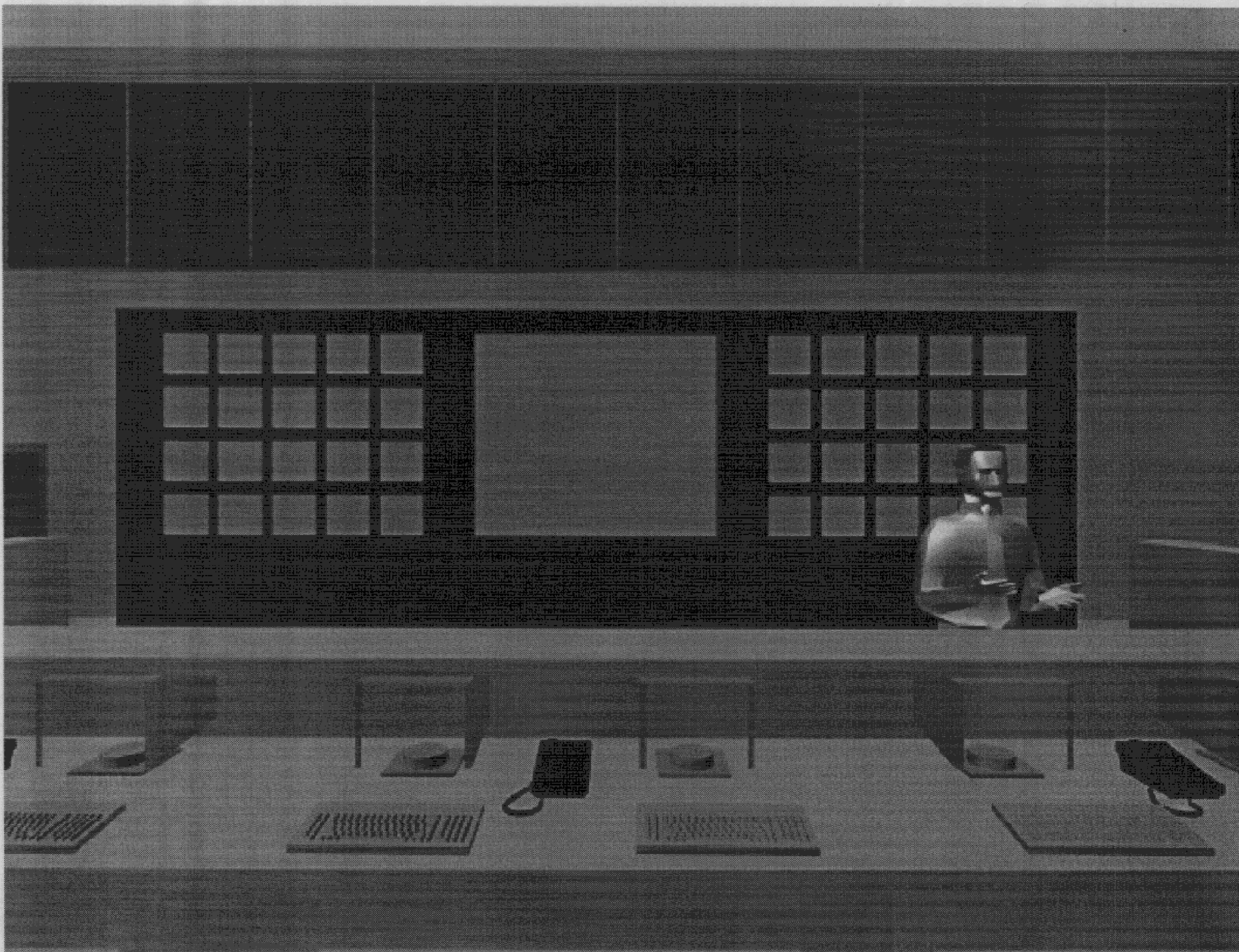


Figure 9

Operations Room
Video Monitor Wall



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Memorandum

To: Bernie Kalus/HNTB

From: Jill Lu

Project: Cross Westchester Expressway

Project No.: 89837

Date: 4/23/98

Re: UST at the Transportation Management Center in Hawthorne

As requested, We have contacted the New York State Department of Environmental Conservation (NYSDEC) for information regarding a possible underground storage tank located at the Transportation Management Center (currently New York State Police Highway Patrol) in the town of Hawthorne. According to the information provided by Mr. Mike Murthy of NYSDEC region 3 office, there used to be a 3,000-gallon UST at the facility. The tank was closed in October 1994, and has been removed from the site. All the tank records are available with NYSDEC. Mr. Murthy will provide more detailed information in mail.

Copies To: ☐ Below ☐ Staff ☐ File Page of

S. Dalzell

5) ABOVE GROUND AND UNDER GROUND STORAGE TANKS

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VI. OPERATIONS/PROCUREMENT ISSUES

The key to the success of the Lower Hudson Valley ITS will be an effective program of operations and maintenance. This will require personnel located at the TMC, individuals responsible for field maintenance, and a management structure to coordinate and administer the overall operation. Training of staff, both initially and on a continuing basis, as new equipment and functions are added, is critical to ensure that the staff can provide maximum effectiveness. Complete and thorough system documentation is also necessary for effective operation. Certain actions and issues related to the operations and implementation of the future system include agreements, procurement methods and staffing.

A. TRANSIT OPERATIONS/PROCUREMENT ISSUES

The operation and procurement of a system for automated vehicle location and schedule on-time service monitoring needs to be examined. These functions can either be centralized at the TMC and support remote access from the bus dispatch centers or be decentralized with separate systems installed by each bus system and allowing remote access of each by the TMC. A centralized system may prove to be more cost-effective regionally, but will require a digital radio communication system sufficient to provide reliable radio coverage throughout the region. The decentralized approach may prove to be easier to define at the local level, will likely require upgraded radio systems, may prove more expensive regionally, and will introduce problems of system compatibility at the regional level. The AVL, communications and service monitoring system functions will need to be carefully defined and designed. For a regional system, agreements would need to be developed for operations and funding. For a decentralized system, regional system integration plans would need to be developed and regional radio channels established.

B. AGREEMENTS/MEMORANDA OF UNDERSTANDING

In order to be effective, the proposed ITS system must be conceived and operated in a cooperative effort by multiple State and local agencies. Generally, its purpose is to be responsive to traffic and incident conditions without regard to jurisdictional boundaries. The system should be developed as a unit, but it must operate in the context of decentralized functions and responsibilities. Since it will support and enhance current functions, the cooperative relationships established for its operation would extend beyond its functions of incident detection, incident response and motorist information. The system would serve as an effective catalyst for communications among agencies involved in incident response.

A series of agreements and memoranda of understanding would be necessary to establish and support the Intelligent Transportation System. This would need to be developed over a period of time as an ordinary part of system design and development. Multiple agreements or memoranda are advisable, in lieu of a single document, to provide flexibility for responding to future needs.

Potential needs for cooperative agreements or memoranda of understanding would likely include four categories:

- Agency Support
- System Construction, Operations and Maintenance
- Emergency Response
- Specialized Control Plans

C. AGENCY SUPPORT

One of the first documents to be executed should be a joint statement of support for improved operations within the Lower Hudson Valley area. This should be a statement of policy, with specific roles and responsibilities to be identified in follow-up documents. This agreement should provide a statement of goals and objectives in support of a cooperative policy. The agency support statement should include State, County and City authorities. This document can serve to inform the public of intent and commitment to the system, and would provide general guidance (through goals, objectives, and policies) for further system development.

To best serve its intended purpose, execution of the agency support agreement should be well publicized. This could include formal signing ceremonies and perhaps even include media coverage. In addition to indicating support and cooperation of involved jurisdictions, this would provide an early opportunity for public education regarding the character and intent of the ITS system.

D. SYSTEM DESIGN, CONSTRUCTION, MAINTENANCE AND OPERATIONS

Agreements would also be necessary among participating jurisdictions and agencies to establish and operate the system. These would be within the categories of: funding, system operation and maintenance, and functional roles and responsibilities. Among the topics which may need to be addressed are the following:

- Funding

  - engineering
  - construction
  - start-up
  - operations

- System Operation and Maintenance

  - control center roles
  - field equipment
  - administration and management
  - staffing

- Functional Roles and Responsibilities

  - communication responsibilities of the TMC

- on site coordination (incident manager, call for tow trucks, etc.)
- roles and limitations of service patrols
- identification and management of diversion route systems
- operation of variable message signs and motorist information systems
- data links (CCTV, traffic counts, operating speeds, etc.)

E. EMERGENCY RESPONSE

Agreements, and cooperative understandings are already in place for the coordination of incident response, as part of the existing regional 911 center operations. Changes may occur as emergency response personnel interact and as the system design evolves, but the system will not supplant or modify most established relationships. Emergency response will be conducted utilizing the "Incident Command System". Some potential new emergency response policies may require enabling legislation, including:

- Vehicle removal policies
- Lane closure policies
- Tow truck notification policies

F. SPECIALIZED CONTROL PLANS

In addition to agreements and/or memoranda of understanding for day-to-day system operations and emergency response, it may be useful to establish formalized roles, responsibilities, and relationships for special conditions. These include the following, as a minimum:

- Recurring special events
- Unique special events
- Maintenance of traffic during construction
- Special incidents, such as HAZMAT spills

G. PROCUREMENT METHODS

An important element in the implementation of the Lower Hudson Valley ITS is the method to be used for procurement. Several procurement techniques have been used throughout the country on related projects. They are outlined below:

1. SOLE-SOURCE

The basis for a sole-source procurement is the documented existence of only one technical or cost-effective solution to the requirements of a particular project. The most common basis for sole-source procurements is the requirement for compatibility with existing equipment, so that system-wide interoperability can be maintained. For an initial system-wide procurement, compatibility with existing equipment is not a factor, and sole-source procurement is not advisable or practical.

For later project phases, sole-source procurements will probably be necessary to maintain equipment compatibility for specific devices, such as CCTV camera controllers. Operation and maintenance problems caused by incompatible equipment are design and procurement issues for the initial system. Conversion or replacement of non-interoperable devices before the end of their useful life is an expensive penalty to be paid for lack of foresight.

2. ENGINEER/CONTRACTOR

This procurement method is the one typically used for highway projects. It is based on the concept that all critical system parameters can be fully specified and documented in a single set of contract documents (i.e., Plans, Specifications, and Estimates - PS & E package), that a single contractor is best suited to implement the project, and that the only criteria of significance for selecting the contractor is the initial bid price. The extensive experience with this process for highway construction has resulted in a very rigid set of procedures and rules within most highway agencies, severely restricting the flexibility of system designers and implementers.

3. TWO-STEP APPROACH

This method modifies the engineer/contractor technique by separating the technical evaluation step from the financial step. This approach provides an opportunity to reject proposals that do not meet the technical criteria for the project. This minimizes the risk of selecting a contractor whose bid is low, but who is not technically capable of performing the work. It also insures that the technical merits of each proposal are fully considered prior to award of a contract, instead of during the “material submittal” stage of a traditional highway construction contract.

4. DESIGN/BUILD

In this approach, a single entity is selected to handle all the work associated with implementing the system. The designer/builder is responsible for detail system design, procurement of all equipment, construction of all system elements, integration of the various sub-systems, and final system turn-on and operational cut-over. The fully functional system is then turned over to the operating agency. A design/build concept simplifies the number of contracts and the steps associated with taking a system from concept to operations. This can be beneficial if the designer/builder fully understands the project concept, and has the experience to successfully handle the full scope. Often the design/builder can use streamlined equipment purchase procedures, thereby speeding up the project schedule.

However, this approach limits the agency's role to that of limited oversight and monitoring activities of the design/builder. This can be detrimental since the agency personnel with direct operational experience and needs are typically not involved with the detail design and thus cannot provide input and feedback during design and implementation.

5. SYSTEM MANAGER/SYSTEM INTEGRATOR

This procurement method divides the project into several sub-projects for each of the various sub-systems, with the work overseen by a system manager who administers each contract and is responsible for integrating several sub-systems into an overall, operating system. The most effective structure for this approach is to use a moderate sized "design team" consisting of agency and system manager personnel. The system manager converts the project plan into preliminary designs and defines sub-systems, develops PS&E packages for sub-systems, oversees bidding and awarding, supervises construction, selects and procures computer and communications hardware components, develops system software, integrates and tests sub-systems, and supervises operator training.

By assigning responsibility for total system success to the system manager, a single source of accountability and responsibility is defined. The involvement of agency personnel as part of the design team results in improved coordination and tighter cost controls. The agreement between the agency and the system manager is a negotiated contract, which can be easily adapted as project needs are refined. This provides increased flexibility to meet the specific project requirements, when compared to the typical fixed-price, turnkey or design/build contracts.

H. RECOMMENDATIONS

Presently, the only process used in New York State is the engineer/contractor with low bids governing the selection. Over time NYS should consider migrating to other options, such as System Manager or a modified Design/Build approach which may give the designer more flexibility and result in better quality systems. This migration should include operations as well, so that the builder takes responsibility for the functioning of the systems.

I. STAFFING

As these systems are built and become more technologically sophisticated and a TMC comes on-line, new positions will have to be created within NYSDOT Region 8's Transportation Operations Department. These positions include system operators, specialized maintenance personnel and a systems manager.

1. OPERATOR

The specific functions that the operator will need to perform include:

- Utilizing the computer displays and CCTV screens to monitor and verify the traffic conditions and incidents on the freeways;
- Operating the computer systems, through a keyboard or mouse or joystick, to select different displays and to control field devices, such as Variable Message Signs and CCTV cameras;

- Responding to status and alarm messages from the computer systems, again with a keyboard and mouse, that are generated when incidents are detected or equipment malfunctions are detected;
- Utilizing telephone and radio equipment to communicate with police, incident response personnel, fire personnel, etc. who are responding to an incident;
- Utilizing telephone or facsimile equipment to communicate with media and the public regarding the status of an incident or current traffic conditions;
- Troubleshooting and performing simple replacements for malfunctioning equipment in the TMC;
- Maintaining logs and other required records of activities.

Several different strategies have been utilized by other TMCs for hiring operators. These include college students working part-time, disabled individuals on either a part-time or full-time basis, or full-time agency technical or support staff and hiring consultants to provide operation personnel.

2. EQUIPMENT MAINTAINERS

The maintenance and repair of all equipment must be accomplished in a timely fashion in order to achieve effective system operation. The typical goal for these systems is a four-hour response from the time a failure is reported until the equipment is returned to service. This requires a maintenance technician with adequate spares, appropriate tools and equipment, and up-to-date training.

It is likely that for the scope of the initial ATMS project, one to two maintenance technicians will be adequate. While it is possible to share this individual with other maintenance and support activities, it is important that the technician's first priority should be the support of the field equipment, and not other equipment. This individual should be available prior to the start of any construction for the project so that familiarity with the system design can be obtained. The technician's input to the design process, to insure that maintainability is designed into the system, will yield long-term benefits. The technician could also be involved during construction work so that details are retained by an agency employee. Also, since the technician will have to live with or correct any problems created by the construction, there will be a strong incentive to get the system built correctly.

Another important role of the maintenance technician is to coordinate with other roadway maintenance or construction activities to minimize the disruption of field equipment. Because contractors and other organizations do not recognize the importance of the field equipment and the associated power and communications circuits, their actions can create problems. The maintenance technician, by being available or on-site during these potential disruptions, can minimize or eliminate equipment down-time.

The maintenance technician needs to be well experienced in a wide range of skills, including electronics, communications, power distribution, cable installation and repair, portable generators, and general small scale mechanical repairs. Since the maintenance technician will be faced with a diversity of equipment and failure conditions, a broad set of general repair capabilities is required. Effective troubleshooting and problem isolation techniques, supported by a systematic and logical approach, is needed to quickly identify and correct problems. Preventive maintenance, locating and repairing small problems before they become major, and conscientious record keeping and documentation are also regular components of the equipment maintenance program.

3. SYSTEM MANAGER

A manager of the operators and maintenance technician will also be required. It is desirable that this individual also have some level of engineering background so that broader system support and long-range upgrades can be handled. The role of the manager will be to provide day-to-day supervision and scheduling of operations and maintenance activities, to coordinate with other agencies and organizations, to develop plans and policies for incident management and freeway monitoring, and to financially manage the operation by developing budgets and being responsible for operating within these budgets.

The manager will also be available to support the operator during a major incident, to provide higher level liaison with other agencies and the media, and to serve as a back-up person if regular operations personnel are not available. The manager will be responsible for training new operations personnel, and insuring that current staff are trained on new equipment and that refresher training is conducted for all personnel.

The manager will be responsible for supervision of maintenance activities, insuring that adequate spares are available and that the maintenance technician has all the tools, equipment, and testing devices needed to perform effectively. The manager must make certain that the technician's training is current and up-to-date. When a crisis occurs, the manager must serve as an expediter for factory support and repair services, and provide a buffer between the maintenance technician and other individuals, so that the technician can work without being disturbed. When the maintenance technician is on vacation, sick-leave, at training, etc., the manager must be able to fill-in and provide basic levels of equipment support and repair.

Operations and Maintenance Costs

Adequate performance of the equipment tasks for routine, daily operations will generally require personnel in administrative, operations, and maintenance classifications. Of paramount importance in considering overall staff requirements, is the obtainment of a certain level of redundancy in personnel in the operations and maintenance classifications to insure that the random occurrence of simultaneous, multiple events and/or incidents will not adversely affect overall system performance and personnel response.

The staff requirements and costs to achieve this goal are presented as a general basis of defining overall space needs. Daily weekday operations consisting of approximately 15 to 16 hours per day. Approximate hours of operation are anticipated to be 5:30 AM to 8:30 PM to provide adequate coverage for both AM and PM peaks, with allowances for "late clearing" of PM congestion and some overlap of shifts.

Staff Assignments and schedules are shown in the following table.

Table 1 Traffic Operations Center Staffing and Schedule

Primary Routes

Staff	Number: Short/Medium-Term	Number: Long-Term	Schedule
Operations			
Systems Manager	1	1	8:00AM - 5:00PM
Asst. Systems Mngr. /Shift Supervisor	1	1	6:00AM - 3:00PM
Control Room Supervisor	0	1	11:30AM-8:30PM
Control Room Operators	2	3	6:00AM - 3:00PM
Control Room Operators	2	3	1:00PM - 9:00PM
Maintenance			
Maintenance Supervisor	1	1	8:00AM - 5:00PM
Asst.Maintenance Supervisor	0	1	9:00AM - 6:00PM
Electronics Tech.	2	4	6:30AM - 3:30PM / 9:30AM - 6:30PM

The following table summarizes the subtotal annual operations and maintenance costs in 1998 dollars for the implementation of each phase.

The annual operations, maintenance and equipment parts/physical plant in the following table represents the total annual costs at the end of each of the phases. For example, the costs of Operations Staff at the Short-Term phase also includes the cost of Operations Staff of the Near-Term. The costs of Operations Staff at the Medium-Term phase includes the Near, Short and Medium-Term Operation Staff costs.

Table 2 Annual O & M Cost Summary

Primary Route System

Phase	Operations Staff	Maintenance Staff	Equipment Parts/ Physical Plant	Total Annual O&M
Near-Term	$60,000	$50,000	$40,000	$150,000
Short-Term	$415,000	$109,000	$523,000	$1,047,000
Medium-Term	$415,000	$190,000	$1,103,000	$1,708,000
Long-Term	$645,000	$365,000	$1,198,000	$2,208,000

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VII. DEPLOYMENT PLAN

A. PURPOSE

The purpose of the Early Deployment Plan (EDP) is to recommend and prioritize Advanced Transportation Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Advanced Public Transportation Systems (APTS), Emergency Vehicle Management Systems and Commercial Vehicle Operations (CVO) applications for the Lower Hudson Valley in order to better manage the existing roadway and transit networks. Improvements to the roadway network will allow for more efficient, effective and reliable traffic flow that will benefit the motorists, commercial vehicle operators, emergency vehicle operators and transit service providers. Increasing the availability of transit service and roadway information will allow for better service coordination among transit operators, as well as promoting improved flow and response for commercial vehicle operators, emergency response agencies and the traveling public. The result will be a more effective and efficient transportation system for the Lower Hudson Valley.

For the EDP to be effective in increasing the throughput and operational efficiency of the existing roadway and transit networks, its development and application requires an overall Strategic Deployment Plan which targets key transportation facilities and services within the critical corridors of the Lower Hudson Valley. This Plan will outline those facilities that are critical to the flow of people and goods throughout the Lower Hudson Valley and will prioritize those routes based upon several factors including their relative benefit/cost ratios.

B. ROADWAY AREAS OF COVERAGE

The freeway and major arterial systems within the Lower Hudson Valley have been given the primary considerations in developing the Strategic Deployment Plan for an areawide ATMS. Based on the evaluation of user services, as well as recurring and nonrecurring congestion, as well as a list provided by the NYSDOT, certain limited access routes have been designated for initial study. These regional roadways are shown below:

1. LIMITED ACCESS FACILITIES

New York State Department of Transportation Jurisdiction

- I-684
- Sprain Brook Parkway
- Saw Mill River Parkway
- Taconic State Parkway
- Hutchinson River Parkway
- Route 17
- Cross County Parkway

New York State Thruway Authority Jurisdiction

- I-87
- I-95
- I-287
- I-84
- Garden State Parkway Extension

Westchester County Jurisdiction

- Bronx River Parkway (NY City Line to the Taconic State Parkway)

Palisades Interstate Park Commission Jurisdiction

- Palisades Interstate Parkway

2. OTHER ARTERIAL ROADWAYS

Ideally, freeways serve as alternate routes for other, more congested freeways. In cases where the freeway network is limited in size or where major arterials parallel the freeway system, arterial roadways also serve as alternative routes to the freeway. Diversion of traffic from freeways to other freeways, from arterial roadways to freeways, and from freeways to arterial roadways, when there is an incident, can result in a reduction in overall traveler delay. However, not all arterial roadways are suitable as alternative routes for freeway traffic. An arterial used as an alternative route would preferably run approximately parallel to the freeway, would have adequate access onto and off of the freeway, and would have adequate capacity and operating speeds. In the same way, a freeway that would be used as an alternate route to an arterial would also ideally be parallel and proximate to the arterial. Arterial capacity is influenced not only by the number of lanes in each direction (a minimum of two lanes in each direction is necessary in many circumstances), but also by the signal timing along the facility. Thus, the ability to vary signal timing plans in response to a large volume of traffic diverting from the freeway significantly enhances the effectiveness of an arterial as an alternative route. This issue is discussed in greater detail in a later section entitled *System Characteristics*. Below is a list of the other arterials that have been examined as part of the regional network analyses.

NYSDOT and Other Jurisdictions

ROUTE	JURISDICTION
1	State/Local
6 (includes Division St./Oregon Rd.)(County Route in Peekskill)	State/County/Local
9 (maintained by City of Yonkers within City limits)	State/Local
9A/100A (portion of 9A in Yonkers is maintained by City of Yonkers)	State/Local
9W	State
17K	State
17M	State
22 (maintained by City of Yonkers, Mt. Vernon, State)	State/Local
32	State
35/202 (maintained by Peekskill, State)	State/Local
45 (Red Schoolhouse Road to Route 202)	State

59	State
100	State
117	State
119	State
120A (State)/ Anderson Hill Road (WCDPW)	State/County
123/124	State
125/Weaver Street (City of White Plains/State/County)	State/County/Local
127 (WCDPW/State)	State/County
202 (County in Peekskill)	State
303	State
304	State
340 (Gilbert Avenue to Route 9W)	State
Westchester Avenue	County
Tuckahoe Road (State arterial; part in Yonkers)	State/County
Ashford Road/Ardsley Road/Popham Road	County/Local
Middletown/Little Tor Road (Orange Avenue to Route 202)	Local/County
New Hempstead Road (Route 202/45 to Route 9W)	Local/County
Yonkers Ave.(984E/983C)(State owns, City of Yonkers operates)	State/Local

C. TRANSIT COVERAGE

The bus and rail systems within the Lower Hudson Valley have been given the primary considerations in developing the Strategic Deployment Plan for an areawide APTS. Based on the evaluation of user services; available technologies, peak transit volumes, critical transit facilities and services and the proximity and impact of these transit facilities and services in relation to corridors with recurring and nonrecurring congestion, certain transit facilities and services have been designated for the implementation of various ITS applications. The transit facilities and services include, transit and transfer centers, commuter services and key park and ride lots. The facilities and services recommended to be targeted for ITS treatments and a suggested phasing plan are presented in the transit section of this report.

Benefit/cost ratios have been developed to prioritize transit ITS applications. The benefits considered in this analysis primarily reflect the volume of people moved by a service or facility where such information was available. In addition, the strategic operational importance of a facility or service was considered based on the input from representatives from the counties and/or operators.

D. ADVANCED PUBLIC TRANSPORTATION SYSTEMS APPLICATIONS

1. BACKGROUND

There are many reasons for examining potential ITS applications to transit services in the Lower Hudson Valley. The primary purpose is to develop APTS applications for the Lower Hudson Valley to provide the information needed to better manage existing regional roadway and transit networks. Improvement to the roadway network to allow for more efficient, effective and reliable traffic flow will benefit the transit services operating on these roadways. Increasing the availability of transit service information will allow for better service coordination among transit operators. The expected result being a more effective and efficient transportation system for the Lower Hudson Valley and, thus, the ability to move more people through existing services and infrastructure.

The target audience of the public transportation-related aspects of the Early Deployment Plan are comprised of those persons and organizations that will benefit from and provide inputs to the APTS applications identified as part of this effort. The target audience includes the residents and workers within the Lower Hudson Valley, in general, and, more specifically, those who currently or will potentially use the public transportation services provided within the Lower Hudson Valley. The target audience also includes public transportation service operators within the Lower Hudson Valley. These include commuter rail, commuter bus, local bus service operators and regional bus companies, both private and public. In addition, the proposed Transportation Management Center and the agencies and organizations associated with it, are included in the target audience.

2. ITS APPLICATION TARGETING STRATEGIES

For the EDP to be effective in increasing the throughput and operational efficiency of the existing roadway and transit networks, its development and application requires an overall strategic deployment plan which targets key transportation facilities and services within the critical corridors of the Lower Hudson Valley.

Targeting key services and facilities involved an iterative process. Key transportation facilities were targeted by identifying and prioritizing Metro-North stations by average daily inbound boardings and those stations designated by Metro-North as operationally significant. Bus operations serving key Metro-North stations were also targeted, as were large park and ride lots which serve as staging points for commuter bus services. Key commuter bus operations, both publicly and privately operated, were targeted. The resulting list of transit facilities and services was then prioritized in terms of the ability of each to move the most people and to serve as a conduit to which roadway demand might be diverted to transit and, thus, mitigated.

Through examination of service schedules and interviews with transit service operators, an inventory of transit services in the Lower Hudson Valley was compiled. These included: commuter rail, commuter bus, and local bus services provided by public and private operators. This information was reported in the User Services report.

The resulting initial inventory of transit services and facilities under consideration for potential transit ITS applications is presented in Table 1 - Inventory of Primary Services and Facilities. For each service or facility, information on each of the four primary determinant factors is presented. These include:

- Places where intra-operator or inter-operator service coordination occurs;
- Facilities or services with high volume ridership or are of operational importance;
- Park and Ride lots served by transit; and
- Proximity to and potential impact on highly congested corridors.

Ridership activity was examined by stop or facility, where such information was available from transit operators. Where such information was not available, input from the operators was used to identify priority bus stops and transfer centers. For Metro-North service, an initial set of stations was selected where average daily inbound ridership exceeds 1,000 passengers or was designated by Metro-North as operationally significant. The operationally significant stations were identified by Metro-North as Poughkeepsie, Beacon and Tarrytown. In addition, key transfer or transit centers for each jurisdiction were identified.

Park and Ride lots served by transit were identified in each jurisdiction. Park and Ride facilities served by transit with 200 or more parking spaces were identified. Park and Ride lots that are in close proximity to train stations or transit centers were also identified.

This set of transit services and facilities were then examined with respect to their proximity to congested corridors in the Lower Hudson Valley. The critical determining factor reviewed was whether or not the facility could be used to reduce congestion on critical road segments downstream.

Table 1 presents facilities and identifies services that have been identified as candidates for consideration for transit ITS applications based on the determinants sited above. The inventory below represents a refined set of facilities and services by county.

Table 1 Inventory of Primary Transit Services and Facilities

Transit Facility/Service	M-N Daily Inbound Trips	P&R Lot Spaces	Connecting Transit Services	Benefits Congested Corridor
Westchester County	5697		BL1,3,5,6,11,12,13,14,15,17, 20/20x, 21,	Yes
White Plains Transit Center			27,40,41,60,62,63,77,84, A,B,C; TZE1; SL	
Croton-Harmon Station	4074		BL10,11,14	Yes
Scarsdale Station	3931		BL63,64,65,66	Yes
Larchmont Station	3338		BL60,61,66,70,71	Yes
Hartsdale Station	2728		BL34,38,39	Yes
Bronxville Station	2724		BL26,30,52	Yes
New Rochelle Transit Center	2651		BL7,30,42,45/45q,60,61,62,66; SL	Yes
Rye Station	2469		BL61,76	Yes
Pelham Station	2267		BL53	Yes
Tarrytown Station	2237		BL1T, 13; TZE1	Yes
Fleetwood Station	2188		BL26, 55	Yes
N. White Plains Station	2109		BL6	Yes
Chappaqua Station	2054		BL19,9g	Yes
Mamaroneck Station	1999		BL60,61	Yes
Harrison Station	1938		BL5,61	Yes
Port Chester Station	1884		BL13,61,76; CT K	Yes
Crestwood Station	1648			Yes
Mount Vernon Transit Center	1307		BL7,40,41,42,52,53,54,55	Yes
Ossining Station	1302		BL11,13,14,19	Yes
Mt. Kisco Station	1267		BL12,19,19G	Yes
Tuckahoe Station	1264		BL8	Yes
Peekskill Station	1170		BL16,18	Yes
Dobbs Ferry Station	1148		BL1C,1T,1W,6	Yes
Hastings Station	1098		BL1C,1T,1W,6	Yes
Katonah Station	1037		BL19,19G,84	Yes
Mt. Vernon West Station	1033		BL7,26	Yes
Yonkers Transit Center	674		BL1C,1T,1W,2,3,4,5,6,7,8,9,23,25,30,32,90,91	Yes
Dutchess County				
Poughkeepsie Station/Main & Mkt	1316		PT A,B; Arrow; CTC	Yes
Beacon Station	1266		CTC	Yes
New Hamburg Train Station	821		CTC	Yes
Dutchess Mall			P-WP, LOOP 3B, 4	Yes
Dutchess Transportation Center		90	LOOP; CTC	Yes
Rockland County				
Spring Valley Transit Terminal	51	254	M-N,RT 11A,11C,45;SVJ;TOR 57,59,91,92,94	Yes
Spring Valley P&R Lot (Exit 14)		280	TOR 57,59	Yes
Nanuet Mall and Nanuet Station	486		M-N; CMT D; RT 11A,11C,20,47	Yes
Suffern Transit Center		373	TOR 59, 93, M-N	Yes
Pearl River Station	255	77	RT	Yes
West Nyack P&R Lot (Exit 12)		230	TOR 57, 59, 91, 92, RT	Yes
Mt Ivy P&R Lot		224	RT	Yes
Putnam County				
Brewster Station, P&R Lot	1116	75	Bee-Line 84; PART 1, SL	Yes
Putnam Plaza			PART Routes	
Orange County				
Monroe P&R Lot		625	SL	Yes
Newburgh P&R Lot		305	SL, LL, N-B, ADR	Yes
Central Valley P&R Lot		275	SL	Yes
Warwick P&R Lot		248	NJT	Yes
Regional Services			Multiple, Carries over 54 million annual trips	Yes
Metro-North Commuter Rail			Multiple, Carries over 2.1 million annual trips	Yes
Red and Tan Lines			Multiple, Carries over 1.6 million annual trips	Yes
ShortLine				

BL - BeeLine	RT - Red and Tan	LL - Leprechaun Lines
NJT - NJ Transit	SL - ShortLine	ADR - Adirondack
TOR - Transport of Rockland	M-N - Metro North	CMT - Clarkstown Mini-Trans
PART - Putnam County	LOOP - Dutchess Co	TZE - Tappan Zee Express
SVJ - Spring Valley Jitney	CT - Conn Transit	P-WP - Poughkeepsie - White Plains Express
N-B - Newburgh-Beacon		CTC - Commuter Connection

3. PRIORITY SERVICES AND FACILITIES

Recognizing that resources are not infinite, a prioritized set of transit services and facilities by county and will need to be identified for potential ITS applications. A proposed sub-set was compiled based on the determinant factors cited above and is presented below. The primary objective was to identify those services and facilities which have the greatest potential to move the greatest volume of passengers via transit. Consideration was given to existing transit ridership volumes, number of lines or routes served, large Park and Ride facilities served by transit, and geographical distribution within the Lower Hudson Valley. It is recognized, however, that the actual projects selected for ITS applications may not necessarily be addressed in the order presented due to numerous considerations, not the least of which is funding. The proposed priority set of transit services and facilities recommended for consideration for ITS applications, by jurisdiction, include:

Table 2 Suggested Prioritized Transit Services and Facilities by County

Transit Facility/Service	M-N Daily Inbound Trips		Connecting Transit Services	
Westchester County **White Plains Transit Center**	5697		BL1,3,5,6,11,12,13,14,15,17, 20/20x, 21, 27,40,41,60,62,63,77,84, A,B,C; TZE1; SL	Yes
Croton-Harmon Station	4074		BL10,11,14	Yes
Scarsdale Station	3931		BL63,64,65,66	Yes
Larchmont Station	3338		BL60,61,66,70,71	Yes
Hartsdale Station	2728		BL34,38,39	Yes
Bronxville Station	2724		BL26,30,52	Yes
New Rochelle Transit Center	2651		BL7,30,42,45/45q,60,61,62,66; SL	Yes
Rye Station	2469		BL61,76	Yes
Tarrytown Station	2237		BL1T, 13; TZE1	Yes
Port Chester Station	1884		BL13,61,76; CT K	Yes
Mount Vernon Transit Center	1307		BL7,40,41,42,52,53,54,55	Yes
Yonkers Transit Center	674		BL1C,1T,1W,2,3,4,5,6,7,8,9,23,25,30,32,90,91	Yes
Dutchess County				
Poughkeepsie Station/Main & Mkt	1316		PT A,B; Arrow; CTC	Yes
Beacon Station	1266		CTC	Yes
Rockland County				
Spring Valley Transit Terminal	51	254	M-N,RT 11A,11C,45;SVJ;TOR 57,59,91,92,94	Yes
Spring Valley P&R Lot (Exit 14)		280	TOR 57,59	Yes
Nanuet Mall and Nanuet Station	486		M-N; CMT D; RT 11A,11C,20,47	Yes
Putnam County				
Brewster Station, P&R Lot	1116	75	Bee-Line 84; PART 1, SL	Yes
Putnam Plaza			PART Routes	
Orange County				
Monroe P&R Lot		625	SL	Yes
Newburgh P&R Lot		305	SL, LL, N-B, ADR	Yes
Regional Services **Metro-North Commuter Rail** **Red and Tan Lines** **ShortLine**			Multiple, Carries over 54 million annual trips Multiple, Carries over 2.1 million annual trips Multiple, Carries over 1.6 million annual trips	Yes Yes Yes

Benefit/cost ratios have also been developed to prioritize transit ITS applications. The benefits considered in this analysis primarily reflect the volume of people moved by a service or facility where information would be available. In addition, the strategic operational importance of a facility or service was considered, based on the input from representatives from the counties and/or operators. Estimates of time and cost savings were prepared for key services and facilities. ITS cost estimates were based on the general functional specifications of ITS systems required. Benefit/cost ratios are presented later in this chapter.

E. POTENTIAL BENEFITS OF ITS FOR HIGHWAYS

The benefits of Intelligent Transportation Systems (ITS) have been outlined in a report prepared by The MITRE Corporation entitled “Intelligent Transportation Infrastructure Benefits: Expected and Experienced”. This report was prepared for the Federal Highway Administration, and published in January, 1996. The use of ITS technologies has demonstrated positive effects on several Measures of Effectiveness (MOEs). Below is a sample of several ITS initiatives and the associated benefits:

<u>Expressway Traffic Management Systems</u>

Decreases in travel times of 20% to 48%
Increases in travel speeds of 16% to 62%
Increases in freeway capacity of 17% to 25%
Decreases in accident rates of 15% to 50%
Decreases in fuel consumption during congestion of 41%
Annual decreases in emissions of 122,000 tons of carbon monoxide (CO)
Annual decreases in emissions of 1400 tons of hydro carbons (HC)
Annual decreases in emissions of 1200 tons of nitrous oxide (NOx)

<u>Arterial Traffic Signal Systems</u>

Increases in travel speeds of 14% to 22%
Reductions in travel times of 8% to 15%
Reduction of vehicle stops by 0% to 35%
Reduction in delays of 17% to 37%
Reductions in fuel consumption of 6% to 12%
Annual decreases in automobile emissions of 5% to 13% of the CO
Annual decreases in emissions of 4% to 10% of the HC

<u>Incident Management Programs</u>

Reduced incident clearance times of approximately 8 minutes for stalled or disabled vehicles
Reduced incident clearance times of approximately 5 to 7 minute for removing damaged vehicles with a wrecker

Travel times also decrease with the reduction in time it takes to remove vehicles from the travel lanes. These decreases in travel times average 10 percent to 42 percent. The decrease in the total number of accidents is approximately 35 percent. The reduction in secondary incidents due to incident management programs was estimated at 30 percent in a before-and-after study conducted by the Texas Transportation Institute for the San Antonio TransGuide System.

Traveler Information Systems

Reduction in travel times of 20% during incident conditions
Decrease of 1900 vehicle-hours of delay per incident
Decrease of 6% to 12% in fuel consumption
Decrease of fuel emissions from the affected vehicles of volatile organic compounds (VOC) by 25%
Reduction in HC by 33%
Decrease in NOx by 1.5%

F. ITS COSTS

To calculate the cost of the segments, the ITS equipment was placed on the selected routes following the criteria described below:

Variable Message Signs (VMSs)

On Interstates and other Limited Access Highways:
VMSs should be placed prior to interchanges with Interstate and other Limited Access Highways for alternate route diversion. VMSs should be placed approximately ¾ of a mile prior to the alternative route decision point; the sight distance necessary to read a message of three panels of three lines each at the prevailing speed of the roadway should be considered. Special attention should be given to vertical and horizontal curves.

On Major Arterial Roadways; at least two (2) lanes per direction:
VMSs should be placed prior to interchanges with Interstate and other Limited Access Highways as well as Major Arterial Roadways. VMSs should be placed approximately one-half mile prior to the decision point; keeping in mind the sight distance necessary to read a three-panel message at the prevailing speed of the facility. Special attention should be given to vertical and horizontal curves.

Closed Circuit Television Cameras (CCTV)

CCTV cameras should be deployed along roadways that meet the criterion for high accident locations. CCTV cameras should be placed at intervals to maintain coverage of the entire segment of roadway that meets this criterion. Generally, this would consist of 1.5 to 2-mile spacing of cameras.

For all other roadway segments, CCTV cameras should be considered at interchanges with other Interstate and Limited Access Highways, and interchanges with Major Arterial Roadways. More than one CCTV camera may be needed, depending upon the site conditions. These CCTV cameras would be used to verify the traffic conditions of interchanges with diversion routes before, during and after a diversion plan. In many cases, capacity constraints of the interchange preclude the accommodation of additional traffic volume, especially at peak travel periods. The CCTV images could be used to determine whether diversions should be used and/or continued or be discontinued.

Traffic Volume, Travel Speed and Traffic Density Detection Systems

Detection systems provide information on speed, traffic volume and excess capacity on the diversion routes. Detection equipment should be deployed along roadways that meet the criterion for high incident roadways. Deployment of detection equipment along segments of roadways that act as links between alternative routes should also be considered. These detection systems could provide valuable information with regard to travel speeds and traffic volumes to determine the usefulness of a link for diversion purposes.

Detection Systems should also be deployed on roadways that meet the high accident criterion and should be placed at intervals along the roadway that provide the most cost-effective use of such systems (i.e., 1/2 mile spacing or between interchanges). Whenever possible, detection equipment should be employed that is non-intrusive to the flow of traffic. This provides detection equipment that can be installed, operated and maintained with minimal disruption to traffic flow.

Highway Advisory Radio (HAR)

It is recommended that a system of individual HAR transmitters be deployed to cover the entire area. The transmission ranges should be set and the transmitters should be located so that their coverages do not overlap or interfere with one another. An area wide initiative should be deployed. This initiative should coordinate with the HAR of the airport and the toll authorities. Some degree of cooperation, coordination and shared use of the messages on HAR between the airport, the toll authorities and the State in the area should be developed based upon location, severity and impact of an incident on the adjacent agencies roadway.

Communications

Generally, a fiber optic backbone system should be considered for communications. Other less costly techniques should be used for remote camera, HAR and VMS locations. Some of these communications options may include pain old telephone service (POTS) and leased line options such as T1 and ISDN. Also, spread spectrum radio and FM subcarrier may also be feasible options in some isolated areas.

Tenth of a mile markers and landmark signs may be valuable tools for motorists to better locate stranded vehicles, especially on rural roadways. “Emergency Call 911” signs may also be deployed to remind motorists to call the State Police 911 center to report incidents.

After locating the equipment, the total capital costs were developed for each segment. The annualized capital cost of the equipment was calculated using a factor of 0.1295 which is based upon a 5 percent annual rate of interest over a 10-year period. Ten years is the expected life of much of this equipment. The total annualized capital cost was divided into the total annualized benefit for each segment. This became the annual benefit/cost ratio for each segment of roadway.

Spreadsheets were developed which present these total capital costs and the annualized costs for the routes in the Lower Hudson Valley. These spreadsheets are included in Appendix A, Chapter VIII - Data and Summary Tables. Phasing of the implementation was based on the relative benefit/cost ratios, as well as the continuity of phasing for roadway segments. The cost of a regional TMC was not included in any system costs because the regional TMC is being developed and implemented as a separate project.

G. BENEFIT/COST CALCULATIONS

Average annual daily traffic (AADT) volumes and the two year average accident frequency data were provided by NYSDOT and Westchester County. These data were summarized by roadway segment into tables for the primary freeway routes, as well as the arterial routes. A typical roadway segment on the freeways is between interchanges and between intersections on the arterial routes. The peak hour traffic volumes were calculated by multiplying the AADT by a factor of 14 percent. The two year average accident frequency data were multiplied by a factor of six (6) to arrive at the number of incidents. The number of incidents was then multiplied by a factor of 10 percent to arrive at the number of peak hour incidents. These factors are nationally accepted statistics; for the ratio of incidents to accidents and for the percentage of incidents during the peak hour. To calculate the benefits of implementing the advanced transportation management system (ATMS) and advanced transportation information systems (ATIS), an amount of time saved per vehicle per incident was determined. A value for time was used for truckers as well as passenger vehicles. National statistics suggest using a value of $25 per hour per truck and $10 per hour per passenger vehicle. In order to calculate the reduction of vehicle-hours of delay for an incident, five (5) minutes of time savings was utilized. This is the total time saved in detecting an incident, responding to the incident and clearing the incident. This is also a nationally accepted statistic for reduction in delay with transportation management equipment installed. The amount of traffic that passes the total number of accidents during the peak hour multiplied by the five (5) minutes of savings is the total amount of vehicle hours of delay saved on that segment of roadway, or:

Peak Hour Benefit	=	Peak Hour Traffic Volume	x	Peak Hour Accident Frequency	x	Time Saved Per Vehicle Per Accident	x	Dollar Value of Time Per Vehicle	x	Number of Peak Hours Per Day

H. AGENCY INVOLVEMENT

In order to facilitate consensus among the transportation agencies in the area, a Project Advisory Group (PAG) was created. The role of this group was to provide input and oversight for the development of the User Services Plan and the Strategic Development Plan. The group included:

- New York State Department of Transportation
- Federal Highway Administration
- New York Metropolitan Transportation Council
- Mid-Hudson South Transportation Coordinating Committee
- New York State Police
- New York State Thruway Authority
- Westchester County
- Rockland County
- Putnam County

- Orange County
- Dutchess County
- Metro-North Railroad
- Metropolitan Transit Authority
- New York State Bridge Authority
- City of White Plains Traffic Department
- TRANSCOM
- Palisades Interstate Parkway Commission
- New Jersey Highway Authority
- Connecticut Department of Transportation

This group should continue to meet on a periodic basis to discuss the outcome of major incidents, to plan construction and maintenance activities, as well as to guide the planning and design process of the Advanced Transportation Management System, to help deploy early action ATMS strategies set forth in this plan and to promote improved communications between emergency response and management agencies. It is likely that sufficient funds may not be available to implement all of the recommendations set forth in this plan. This group or the Region's Mobility (MAC) group should reach consensus on which projects should be included in the Region's TIP.

I. DEPLOYMENT SCHEDULE

1. PRIORITIZATION AND SELECTION OF ITS STRATEGIES

Many factors affect the priorities of ITS deployment. ITS systems are usually constructed in stages, often in conjunction with major construction projects. For example, the installation of fiber optic communications conduit and loop detectors can be included in or scheduled at the same time as contracts that involve the reconstruction of roadway pavements. Variable message signs can be installed prior to or during construction projects to provide traveler information during the construction period. Several factors that that need to be considered in scheduling the deployment of ITS projects include:

- *High Probability of Success and Significant Benefits*
  Projects or locations with high levels of traffic congestion and high accident rates should get a higher rating.

- *Action Orientation*
  Rapid deployment of the ITS should be promoted while larger-scale projects are being planned. Staged deployment of systems and subsystems provides near-term benefits, allows incorporation of evolving technologies and enables adaptable changes in budgetary climates.

- *A Focus on Problem Solving*
  Systems and programs must meet an identifiable need, most often an informational need, and must not be pursued for the sake of technology.

- *Connectivity in System Development*

Some segments of roadways may not qualify individually but, taken as a whole, they may contribute to a system such that their inclusion to the project is vital to a successful deployment.

- *Geographical Deployment Balance*
  To maintain the interest and support of the Lower Hudson Valley, the evaluation process must consider the equity of deployment in areas that do not have the highest rankings.

- *Maintaining Operational Roles*
  ITS providers should retain operational responsibilities that are within their purview but coordinated actions should be the focus of ITS projects.

Ultimately, the program should strive to achieve the following:

- a capability to distribute multi-modal traveler information to the general traveling public;
- surveillance and detection capabilities resulting in current, comprehensive, and accurate traffic and transit system performance information;
- infrastructure-based communications systems linking field equipment with central software/database systems;
- communications among jurisdictions, between traffic and transit agencies, and between the public and the private sectors, without relinquishing control responsibility;
- information sharing/coordination with emergency medical services, hazardous materials programs, and other appropriate participants;
- proactive management of roadway and transit resources to achieve regional transportation objectives.

Figures B-8 through B-14 in Appendix B, Chapter IX - Highway Figures, illustrate the segmentation or phasing of the ITS implementation described below. The segmentation is based upon logically manageable routes; the segments would eventually become one cohesive and comprehensive system to be managed.

The implementation of the APTS applications should also follow a strategic, logical, cost-effective and productive course. The deployment should examine alternative means to improve transit services and service coordination at key facilities and among key service operators in areas that benefit the most congested corridors.

Short-Term (First Phase) - Initial projects and/or actions which can be implemented within two years from the decision to proceed as well as projects and/or actions planned to be implemented in a time frame of two to five years from the decision to proceed.

Medium-Term (Second Phase) - Projects and/or actions to be implemented in a five to ten year time frame from the decision to proceed.

Long-Term (Final Phase) - Projects and/or actions to be implemented more than ten years into the future.

In Appendix B, Figures B-1 through B-7 also depict the congestion within the Lower Hudson Valley. Figures B-8 through B-14 depict the implementation phasing for the Lower Hudson Valley study area. Figures B-15 through B-21 show the roadways that warrant traffic flow detection systems. Figures B-22 through B-28 illustrate the routes that should be covered by closed-circuit television camera surveillance. Figures B-29 through B-35 show the potential traffic signal coordination routes within the Lower Hudson Valley. Figures B-36 through B-42 display the potential locations for variable message signs and highway advisory radio transmitters within the study area.

2. HIGHWAY APPLICATIONS

a) Early Action Projects

The following are some projects that should be implemented within the first two years. These are projects that involve interagency cooperation, have potentially high benefits and demonstrate a need to implement.

Region 8 Hudson River Bridge Crossings

Agencies: NYS Bridge Authority, NYS Thruway Authority, NYSDOT, NYS Police, TRANSCOM

Locations: Rip Van Winkle Bridge, Kingston-Rhinecliff Bridge; Mid-Hudson Bridge, Newburgh-Beacon Bridge, Bear Mountain Bridge
NYS Thruway/I-87, Taconic State Parkway, Route 9 and Route 9W

Hardware: Variable Message Signs, Highway Advisory Radio, HAR Flashing beacon signs, Roadway/Weather Information Sensors, TRANSMIT Readers, Traffic flow sensors, CCTV cameras

Strategies: A system of diverting traffic between the Hudson River Crossings in cases of incidents, inclement weather, etc.

- Strategically locate VMS at key decision points along the NYS Thruway/I-87, I-84 and the Taconic State Parkway.
- Install HAR transmitters at each bridge facility.
- Install CCTV cameras at the bridge facility for visual verification of incidents and traffic flow across the bridge.
- Link video feeds to NYSBA facilities and others as required.
- Coordinate between the NYS Thruway Authority, NYS Bridge Authority, NYS Police, TRANSCOM and the NYSDOT using fax, telephone, email, radio, etc.
- Install flashing beacon HAR warning signs prior to key decision locations along Routes 9 and 9W.
- Install Roadway/Weather Information System (RWIS) sensors on each bridge. Link RWIS information to the NYSBA and any other appropriate agency.
- Establish communications links with NYSTA, NYS Police and NYSDOT.
- Install traffic flow sensors (possibly TRANSMIT readers) along I-87, Taconic State Parkway and Routes 9 and 9W.
- Develop an incident management plan for each bridge and its alternate(s) with the operating agencies and the State Police, as well as with TRANSCOM.

Specific locations of hardware:

Route/Location	Direction	Device	Information on
I-87, S of Int 16	NB	VMS	All NYSBA Bridges
I-87, N of Int 20	SB	VMS	All NYSBA Bridges
I-84, W of I-87	EB	VMS	Newburgh-Beacon Br
I-84, E of I-87	WB	VMS	Newburgh-Beacon Br

Location	Device	Information on
Bear Mtn Bridge	HAR	Weather and incidents
Newburgh-Beacon Bridge	HAR	Weather and incidents
Mid-Hudson Bridge	HAR	Weather and incidents
Kingston-Rhinecliff Bridge	HAR	Weather and incidents
Rip Van Winkle Bridge	HAR	Weather and incidents

Location	Device	Information on
Bear Mtn Bridge	CCTV	Weather and incidents
Newburgh-Beacon Bridge	CCTV	Weather and incidents
Mid-Hudson Bridge	CCTV	Weather and incidents
Kingston-Rhinecliff Bridge	CCTV	Weather and incidents
Rip Van Winkle Bridge	CCTV	Weather and incidents

Costs: $1.5 million for 4 VMS signs, 5 HAR transmitters, 5 CCTV cameras and the associated software. Communications is not included until the options are researched.

Traffic Management of the Cross Westchester Expressway Reconstruction

Agencies: NYSDOT, WCDPW, NYSTA

Location: I-287 corridor with remote devices along the feeding routes and parkways

Hardware: CCTV cameras, VMS signs, HAR transmitters, HELP vehicle expansion, contracted tow trucks, leased telephone lines, wireless communications

Strategies: To implement temporary and permanent ATMS and ATIS equipment to manage and mitigate traffic during the reconstruction of the Cross Westchester Expressway.

Specific Location of Hardware: Portable VMS signs along the Parkways and feeder routes at the approaches to I-287, as well as along the I-287 corridor at major decision points. Implement the permanent CCTV cameras at key interchanges along the CWE and at major decision points for checking diversion routes for congestion and incidents. Cooperation between the NYSDOT and the NYSTA and Westchester Commuter Central to provide up to date information on the road construction schedules. Increase the HELP coverage along the CWE and implement an on-call tow truck system to remove disabled vehicles from the corridor during peak hours or when the roadway is restricted due to lane closings.

Costs: Approximately $2.0 million to implement approximately 10 VMS signs, 10 CCTV cameras, 2 HAR transmitters and develop 2 or 3 tow truck contracts.

Communications Assessment Study

There is a need to gather information on the existing communications infrastructure for the various agencies in the Lower Hudson Valley, such as the NYSDOT, NYSTA, WCDPW/DOT, and the NYS Police. This study should recommend expansion, upgrade or abandonment of existing systems as well as construction of new systems and system components.

Cost: Approximately $100,000 to research the available communications links, assess their viability and develop a plan that will recommend the cost effective means to communicate between the various field devices and the appropriate agencies.

b) Short-Term Implementation Plan

Short-Term deployment elements will be focused on the highest priority projects. The timing of this implementation will obviously be influenced by funding availability, the interface and compatibility with on-going regional projects and the strategies on which the Region is focusing. The Short-Term Plan will focus on the development of the backbone ITS infrastructure, the construction of a Lower Hudson Valley TMC and the development of the procedure and processes to manage the Lower Hudson Valley transportation infrastructure.

It is necessary to implement such devices as the milepost/kilometerpost markers, landmark signs and route/direction designation signs and “Accidents/Incidents - Call 911” signs prior to or in concert with developing the electronic deployment. The static signing provides the location designations for the existing operations of incident management. These static signs provide information to the motorist in locating incidents, as well as providing information to the traffic incident responders. Training is essential to familiarize the incident response personnel with the more automated methods of detecting, locating and verifying incidents. Cellular phone users must be educated in the use of the milepost/kilometerpost markers when reporting incidents to the 911 operators.

Proposed actions under consideration for implementation as part of the deployment plan in the Short-Term are presented below. These actions include efforts aimed at improving “operator to operator” and “operator to TMC” communications, initially relying on low-tech systems. In addition, the Short-Term should be used as a time for defining and developing plans for the implementation of the Automated Vehicle Location (AVL) system and Geographic Information System (GIS) most appropriate for the Lower Hudson Valley given the operational and management informational requirements, participating transit services, the state of technology, communications requirements and constraints and fiscal resources.

The following recommendations are designed to deliver the maximum benefit for the least amount of initial investment and to build a sound foundation for the future regional Advanced Transportation Management System.

Incident Reporting and Response (All major routes within the study area)

- Deploy milepost/kilometerpost markers, landmark signs, and route/direction designation signs for freeways only (arterial roadways have cross streets and other reference markers).

- Deploy "Accidents/Incidents - Call 911" signs for a low-tech, low-cost incident detection system for freeways and arterials within the study area.

- Educate cellular phone users on what information is necessary to report an incident(i.e., develop insert for cellular phone bills with the roadside markers and how to read them).

- Continue to collect and disseminate construction and maintenance information on a weekly basis to the participating agencies and to the public via print media.

- Expand the temporary ITS Center which is responsible for the coordination of construction and maintenance among agencies, coordination of traffic for special events management by utilizing portable, cellular-controlled variable message signs (VMSs) and permanent highway advisory radio (HAR) transmitters. This step should be implemented to further the development of the traffic and incident management process until the permanent TMC is constructed.

- The HELP program should be expanded to cover the roadways with the highest number of incidents. The existing routes include the following:

Route	Limits	Centerline Miles	Trucks
Sprain Brook Pkwy/ Bronx River Pkwy	Hawthorne to NYC	15	4
I-684	Brewster to I-287	29	3
I-287	Tarrytown to Port Chester	12	2

The ITS deployment can supplement the HELP program by locating incidents and verifying the type of incident. This could have the potential to make better use of the HELP vehicle time by dispatching the vehicle to the scene of an incident rather than have the HELP vehicles roam, thus increasing the coverage of each HELP vehicle. Strategic locations for the HELP vehicles to be stationed would need to be determined. However, until the ITS equipment is in place, the expansion of the HELP program should include the following limited access routes with the highest number of incidents:

Route	Limits	County
Saw Mill River Pkwy	Bronx County Line to I-287	Westchester
I-84	Penn State Line to Dutchess Cnty Line	Orange
I-87	Wstcr Cnty Line to Orange Cnty Line	Rockland
I-95	Bronx Cnty Line to Conn State Line	Westchester
Hutchinson River Pkwy	Bronx County Line to I-287	Westchester
Taconic State Pkwy	Valhalla Circle to Dutchess Cnty Line	Wstcr/Putnam
Palisades Int Pkwy	NJ State Line to Orange Cnty Line	Rockland
Cross County Pkwy	Saw Mill Pkwy to Hutchinson River Pkwy	Westchester

- Expand the Thruway's network of permanent HAR transmitters to cover more of the area to aid in the management of traffic during pre-planned incidents (i.e., construction, maintenance, special events, weather-related incidents, major incidents involving lane closures or entire roadway closures of long duration that allow sufficient time to set up portable VMSs and record HAR broadcast messages).

- Develop guidelines and standards for construction projects to include ITS elements (i.e. fiber optic conduit and pull boxes while the roadway/shoulders are excavated). This is a critical step for reducing the expense of developing a fiber optic network and a communications plant to support the ITS equipment.

- Continue to develop partnerships with the private sector and other public sector agencies in communications infrastructure, technology testing, traveler information systems, freeway service patrols, CCTV cameras, etc.

- Finalize the work necessary to develop the permanent ITS Center (TMC) and possible joint center, complete design and construction of the facility. The initial operations will focus on gathering regional information, creating databases for planning and operations and disseminating the information to all of the participating agencies.

- Begin developing direct communication links between the TMC and other agencies. This is critical for developing a "seamless" system of traffic and incident management for the Lower Hudson Valley Area.

- The congestion data and the benefit/cost ratios, when screened for continuity and logical phasing of implementation, indicate that the ATMS should be constructed for the route segments shown below for an initial system of approximately 80 miles, which is estimated to cost approximately $40 million. The tables in Appendix A summarize the cost and the benefit/cost ratios.

Route	Limits	County
I-287	I-87 to I-95	Westchester
Cross County Pkwy	Saw Mill to Hutch River Pkwy	Westchester
I-95	Bronx County Line to Conn. State Line	Westchester
Taconic State Pkwy	I-287 to Hawthorne	Westchester
Sprain Brook Pkwy	I-287 to Hawthorne	Westchester
Saw Mill River Pkwy	I-287 to Hawthorne	Westchester
Hutchinson River Pkwy	I-287 to Bronx County Line	Westchester
I-684	I-287 Interchanges	Westchester
I-87	I-287 to Orange County Line	Rockland
Route 119	Route 9 to Route 22	Westchester

NOTE:
I-684 in Westchester County and Putnam County is scheduled for major reconstruction projects.
I-87 has CCTV and VMS equipment, as well as fiber optic communications

- Begin to develop the regional communications network and transition communications and control connections of field equipment. Study the possible alternatives to a completely fiber system, a completely telephone company solution and the hybrid solution.

- Develop traffic signal systems throughout the Lower Hudson Valley. The table, Potential Traffic Signal Coordination Systems, in the Appendix lists the traffic signals that have the potential to be coordinated into a system, in route number order.

- Look at the potential to expand the City of White Plains traffic signal system to cover more roadways around the City of White Plains

- Promote agreements between the State, Counties, Cities and Villages to allow for one single operator of a computerized signal system. Ownership and maintenance of the signals will not change.

- Evaluate the potential of expanding the TRANSCOM TRANSMIT Project for traffic flow and incident detection on each of the roadways designated for ITS implementation prior to finalizing the design of the traffic flow and incident detection system.

- Evaluate the success of TRANSCOM's SATIN (kiosk) project to determine how the ATIS network should be expanded to cover more locations with kiosks.

- Expansion of the I-287 Incident Management Plan should be considered for other corridors throughout the Lower Hudson Valley, such as the following routes ranked highly for total incidents:

Route	Limits
SMRP	Bronx County Line to I-684
I-84	Penn state Line to Dutchess County Line
I-87	In Rockland County
I-95	In Westchester County
100	CCP to Route 202
59	Route 17 to Route 9W
9	In Dutchess County
119	In Westchester County

- Evaluate the need for Roadway/Weather Information System sensors within the Lower Hudson Valley areas of recurring flooding, fogging and icing at the following locations at a minimum, as reported by the resident engineer:

Route	Location	Problem
6	At I-87	Weather related incidents
9W	West Point to Cornwall	Snow/Ice
17A	Warwick to Greenwood Lake	Snow/Ice
218	West Point to Cronwall	Floods
HRP	Mount Vernon Area	Floods
SMRP	Pleasantville Area	Floods

c) Medium Term Implementation Plan

The next set of Intelligent Transportation Systems should be developed including the following routes that total approximately 65 miles with a capital cost of approximately $30 million:

Route	Limits	County
I-87	Bronx Cnty Line to I-287	Westchester
Sprain Brook Parkway	Bronx River Pkwy to I-287	Westchester
Hutchinson River Pkwy	Route 120 to Conn. State Line	Westchester
Bronx River Pkwy	Bronx Cnty Line to I-287	Westchester
Route 9	I-84 to Route 41	Dutchess
Route 17/6	I-87 to Route 51	Orange
Route 17M	I-87 to Route 51	Orange

- Expand the TMC agencies involved to additional agencies as the communications network is expanded and connections to other traffic and emergency centers are provided.

- Expand the regional database for operations

- Begin to integrate the signalized arterials into the management system

- Integrate the new transit AVL systems into the traffic flow monitoring system to expand the regional network.

The Medium-Term phase of the deployment is defined as the period between five and ten years. This phase should involve the continued automation of the communication links between transit service operation centers, the TMC and public information dissemination channels; refinement of ITS applications from phase one; expansion of applications to cover additional local transit and paratransit services; and upgrading systems to take advantage of technological improvements. The Medium-Term phase should see the wide application of systems to collect and disseminate real-time operational information for the regionally significant transit facilities and services.

d) Long Term Implementation Plan

The third set of roadways should be deployed with ITS equipment and they are as follows:

Route	Limits	County
Route 59	Route 17 to Route 9W	Rockland
Route 100	Cross County Pkwy to Route 202	Westchester
Saw Mill River Pkwy	Bronx Cnty Line to I-287	Westchester
Palisades Int. Pkwy	NJ State Line to Orange Cnty Line	Rockland
I-684	I-287 Interchanges to Putnam Cnty Line	Westchester
Route 202/9W	PIP to I-287/I-87	Rockland
Taconic State Pkwy	Various interchanges, Conn Line to Rte 6	Westchester (Upper A)
Bear Mtn Pkwy	Peekskill Area	Westchester (Upper A)
Route 202	Peekskill Area	Westchester (Upper A)
Route 6	Peekskill Area	Westchester (Upper A)
Route 9	Peekskill Area	Westchester (Upper A)
I-684	Saw Mill Pkwy to I-84	Westchester (Upper B)
I-84	Conn Line to Route 312	Westchester (Upper B)
Route 9G	Poughkeepsie Area	Dutchess
Route 77	Poughkeepsie Area	Dutchess
I-84	Route 9 to Route 208	Putnam
Route 9W	Ulster County to Newburgh	Putnam
Route 32	Ulster County to Newburgh	Putnam
Route 17K	Newburgh to Route 208	Putnam
Route 52	Route 300 to Newburgh	Putnam
Route 6/17	I-84 to Route 51	Orange
Route 17M	I-84 to Route 51	Orange
Route 17A	Route 94 to Goshen	Orange

Long-Term plans should include reviewing and updating the traffic volume and accident data to find additional roadways that meet the criteria for recurring and nonrecurring congestion. Also, the TIP should be reviewed to cross reference any potential ITS deployment roadways with the construction plans for those roadways.

3. POTENTIAL TRANSIT ITS APPLICATIONS

Informational Requirements and Dissemination

Informational and dissemination requirements are critical to the success of the systems developed for the Lower Hudson Valley. The operational, management and public information required by each of the users and beneficiaries of the system must be identified. Systems must be developed to assure that the information required is received by users and beneficiaries. At the highest level, the following informational requirements have been identified for the Lower Hudson Valley:

MTA/Metro-North on-time service information needs to be provided to the Transportation Management Center and to transit dispatch centers for services which interface with Metro-North to facilitate coordinated train-bus operations and to provide informational links to public information systems;

Other transit operators need to provide scheduled service and on-time service status information (where it exists) to the TMC and to transit dispatch centers to facilitate coordinated bus-to-bus and bus-to-train operations and to provide informational links to public information systems;

Identify operational and management interface and data sharing requirements, the least of which should include: a trip or run identifier, the scheduled time at the interface point, the expected or real time at the interface point;

Identify institutional relationships to be established to facilitate data sharing. The tables presented in the preceding section identify existing service coordination opportunities. Additionally, continuing and regular communications channels should be established to inform the key private carriers of conditions on the road network;

Identify technical means of sharing data among operators and institutions, Current means include phone, fax, the internet, and system-to-system communications; and

TRANSCOM, news bureaus, and the Model Deployment Initiative should be considered as means to broadcast information to the public.

The implementation of transit ITS applications will define these informational and dissemination requirements in greater detail based on the actual operations that are to be coordinated and the APTS applications implemented.

The implementation of the APTS applications should follow a strategic, logical, cost-effective and productive course. The deployment should examine alternative means to improve transit services and service coordination at key facilities and among key service operators in areas that benefit the most congested corridors.

The deployment should include the development of Short-Term *(First Phase)* functional design plans for key facilities and bus operators initially using existing and largely manual-based processes and then followed by the implementation of systems to automate many of these processes at priority facilities and services. These could include buses acting as probes on the road network and radioing accidents and incidents to their dispatch center; the center would then call the TMC to convey the report. Likewise, train-to-bus and bus-to-bus service coordination should be facilitated via inter-operator communication between dispatch centers and to the TMC. This phase involves actions to be conducted in the first two to five years from the decision to proceed.

a) Transit Early Action Deployment Efforts

The underlying assumption is that ITS can facilitate better inter-operator and intra-operator service coordination and thus, a more reliable and coordinated system of transit services can be provided to the public. This, in turn, would generate more satisfied customers and increase ridership.

The full scale recommendation is to facilitate communications between the Metro-North operations center and the bus operations centers of operators that provide services to/from the Metro-North stations. The purpose of this communications link is to let each operations center know about service delays and on-time status so that operating adjustments can be made accordingly to better facilitate transfers and decrease passenger wait times. In addition, service status information can be sent to the public via message boards at stations, via a telephone information system, and via TV, radio, and the internet. The full scale deployment would transmit this information via computers and high speed lines and use alarm functions to alert dispatchers of events requiring action. Likewise, service status information would be sent via computer to the various systems which would be used for public dissemination.

The scaled down demonstration version of this project is to establish the communications linkages between the Metro-North operations center and the bus operations centers in Westchester County (Bee-Line; Liberty Lines) and Rockland County (TZX services; Rockland Coaches and ShortLine). This communications link may take the form of an automated fax feature on the Metro-North service monitoring system on the one hand and human initiated fax or phone messages from the bus operations centers to Metro-North. The services to be targeted would be the Tarrytown Station (TZX and Bee-Line services) and the White Plains Transcenter (TZX and Bee-Line services). The goal would be for service delay information to be shared with each operations center so that appropriate operational actions may be taken.

For example, the TZX1 bus from Rockland County to the Tarrytown Station typically carries close to a full load (45-50 people). If one of these buses is running late by a matter of say two minutes or less, it would be in the best interests of all involved to hold the train. Likewise, if an afternoon Metro-North train is delayed coming into Tarrytown, it would be beneficial for the bus operators to know how delayed the train will be so that they can hold the buses at the station or release them as the case may be.

The first step in this demonstration plan is to get the key agencies to agree on the plan and agree on rules of operations and operational thresholds for holding trains and buses. The key agencies/operators are: Metro-North, Rockland County; Westchester County, Liberty Lines, Rockland Coaches, and ShortLine.

The second step is to identify means to completed the communications linkages between the operations centers. This includes identifying needed systems programming as in the case of the automated fax functions on the Metro-North monitoring system, identifying any needed hardware and additional phone lines, exchanging fax phone numbers and establishing operational points of contact and communications protocols in each operations center.

The third step is to establish operating procedures and operating thresholds for when to hold trains and buses. These thresholds will need to be sensitive to existing schedules, passenger loads and delay times.

The fourth step is to establish a timeline and start date for implementing the communications linkages and SOPs.

An additional phase of this demonstration project would be to make the service status information and coordination actions available to the public at the stations via variable message boards and via an information broker such as TRANSCOM or the TMC.

Further, this demonstration system could be expanded to feed the service status information to a regionally accessible telephone information system.

b) Transit Short-Term Deployment Efforts

Proposed actions for consideration to be implemented as part of the deployment plan in the Short-Term are presented below. These actions include efforts aimed at improving inter-operator and operator-to-TMC communications relying initially on low tech systems. In addition, the Short-Term should be used as a time for defining and developing plans for the implementation of the Automated Vehicle Location (AVL) system and Geographic Information System (GIS) most appropriate for the Lower Hudson Valley given operational and management informational requirements, participating transit services, the state of technology, communications requirements and constraints, and fiscal resources. Towards the end of the Short-Term, the first set of ITS applications should be implemented at priority facilities and services. The Short-Term actions recommended are as follows:

Sharing of Scheduled and Real-Time Transit Service Information

Metro-North establish automated fax dial-up links from train control center to the TMC and to bus dispatch centers of operators serving stations along each train line (involves creating a link from an existing Metro-North system).

Metro-North communications with public at stations via message/audio board (current Metro-North program).

Metro-North communications with TRANSCOM and other information outlets, continue information sharing.

Establish inter-operator communications links between bus dispatch centers to facilitate service coordination where service interface occurs, communications could be made by phone, fax, pager.

Sharing of Real-Time Roadway Network Information

The TMC should establish communications with bus operations (public and private) dispatch centers via phone, pager, fax.

Buses used as probes to monitor roadway conditions and report accidents and incidents to bus dispatch via radio or cell phone; bus dispatch will convey report to the TMC via phone, pager, fax.

Establish regular and continuing communications between TRANSCOM and key private carriers to inform them of conditions on the road network via phone, fax, pager, email.

Bus service and status information and parking availability information should be conveyed to the public via variable message signs near key park-and-ride lots served by transit.

Bus Service Disruption/Interruption Information

Intra-operator service coordination information should be conveyed via radio to bus dispatch center(s) to affect better service coordination at key transfer centers.

Inter-operator service coordination information should be conveyed from the bus to the bus dispatch center via radio and from bus dispatch center to bus dispatch center via phone, pager, fax to facilitate service coordination at key transfer centers.

Bus on-time status and service disruption information should be conveyed to the public at key transit centers via message signs.

Standard operating procedures and on-time service deviation thresholds should be established and are required to trigger public notification at transit centers.

Incident Reporting and Response

Standard procedures, including informational requirements need to be developed for incident and accident reporting from bus to dispatch and from dispatch to 911.

Bus Prioritization at Signalized Intersections

Standards and thresholds need to be adopted for major intersections.

Standards and thresholds need to be adopted for high bus traffic areas.

Means of bus prioritization should be based on site specific conditions.

Automated Vehicle Location Planning

The geographic coverage for the AVL system(s) must be defined. Coverage may include the entire Lower Hudson Valley, be specific to each or all transit operator(s), cover key corridors and areas or some combination. Westchester County is in the process of acquiring a GPS-based AVL system. Rockland and Putnam Counties are planning to acquire such systems too. The implementation of AVL systems should be done in a coordinated manner so that data can be shared. At one end, it may be useful for a regional system AVL system to be developed through the TMC with individual operators monitoring their vehicles from remote hook-ups. Given the size, topography and the potential number of vehicles that potentially may be monitored at any given time, this may be a large undertaking. A decentralized approach, one that allows the TMC to have a remote hook-up to AVL systems maintained by individual operators, has its own set of technological and operating constraints. The question of regional or decentralized AVL systems should certainly be addressed in the short term before implementation of AVL systems by individual operators gets much closer to actualization. A technical study is required to define communications, processing, hardware and software requirements for an AVL system to simply track vehicles. These requirements should also be defined if the AVL system is to monitor vehicle location with respect to scheduled location and if a determination is to be made as to the impact of variances on service coordination. The former approach may be relatively straightforward, the latter will require more computing power.

AVL information sharing must be defined between the needs of the TMC and the needs of the transit operators. The table presented above identifies existing coordination requirements.

The AVL uses and data requirements for the TMC must be defined.

Bus operator AVL uses and data requirements must be defined. Most intended applications, based on discussions with the operators, involve monitoring scheduled to actual on-time performance with the desire to make operational decisions and to inform the public.

Coordinate APTS applications, informational requirements and efforts with the MDI program and other ITS initiatives in Lower Hudson Valley. To date, the proposed efforts herein are consistent with the intent of the Region 11 EDP and with the MDI.

The following table identifies recommended ITS applications for key transit services and facilities in the Lower Hudson Valley by county. The table documents proposed ITS applications and required communications and ITS capabilities.

Table 3 Proposed ITS Applications for Priority Transit Facilities and Services

Services & Facilities by County	Avg Daily Inbound Trips	Parking Spaces	Coordinating Services	Recommended ITS Applications	Required Communications	Required ITS Capabilities
Westchester County			M-N,BL1,3,5,6,11,12,13,14,15,17, 20/20x,21,27,40,41,60,62,63, 77,84, A,B,C; TZE1; SL, CT I			
White Plains Transit Center	5,697			RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Croton-Harmon Station	4,074		M-N,BL10,11,14	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Scarsdale Station	3,931		M-N,BL63,64,65,66	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Larchmont Station	3,338		M-N,BL60,61,66,70,71	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Hartsdale Station	2,728		M-N,BL34,38,39	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
\Bronxville Station	2,724		M-N,BL26,30,52	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
New Rochelle Transit Center	2,651		M-N,BL7,30,42,45/45q,60,61,62,66; SL	RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Rye Station	2,469		M-N,BL61,76	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Tarrytown Station	2,237		M-N,BL1T, 13; TZE1	RM, CO1, CO2, PI	A, B, C, D, E, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Port Chester Station	1,884		M-N,BL13,61,76; CT K	RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Mount Vernon Transit Center	1,307		M-N,BL7,40,41,42,52,53,54,55	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Yonkers Transit Center	674		M-N,BL1C,1T,1W,2,3,4,5,6,7,8,9, 23,25,30,32,90,91	RM, CO1, PI	A, B, D, F, G	1, 2, 3, 4, 5, 6, 7, 8,
Dutchess County						
Poughkeepsie Station/Main & Mkt	1,316		M-N,PT A,B; Arrow; CTC	RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Beacon Station	1,266		M-N,CTC	RM, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Rockland County						
Spring Valley Transit Terminal	51	254	M-N,RT 11A,11C,45;SVJ; TOR 59,91,92,94,TZE1	RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Spring Valley P&R Lot (Exit 14)		280	TOR 59, TZE1	RM, CO1, PI	C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Nanuet Mall and Nanuet Station	486		M-N; CMT D; RT 11A,11C,20,47	RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Putnam County						
Brewster Station, P&R Lot	1,116	75	M-N,BL84; PART 1, SL	RM, CO1, CO2, PI	A, B, C, D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Putnam Plaza			PART Routes	RM, CO1, PI	D, F, G	1, 2, 3, 4, 5, 6, 7, 8, 9
Orange County						
Monroe P&R Lot		625	SL	PI	D	3, 4, 9
Newburgh P&R Lot		305	SL, LL, N-B, ADR	PI	D	3, 4, 9
Regional Services						
Metro-North Commuter Rail	105,882			RM, CO1, CO2, PI	A, B, C	3, 4, 9
Red and Tan Lines	4,118			PI	D, F, G	1, 3, 5, 6, 7, 8, 9
ShortLine	3,137			PI	D, F, G	1, 3, 5, 6, 7, 8, 9

Suggested ITS Applications
- RM Real Time Service Monitoring
- CO1 Intra-Operator Service Coord
- CO2 Inter-Operator Service Coord
- PI Passenger Information Messaging

Required Communications
- A Train Control Center to Public Address/Message Board
- B Train Control Center to Bus Dispatch Center(s)
- C Between Bus Dispatch Center(s)
- D Bus Dispatch Center to Public Address/Message Board
- E Bus Dispatch Center to Train Control Center
- F From TRANSCOM re: Road Network Conditions
- G Between TMC and Dispatch Centers

ITS Capabilities Required
1. AVL, Automated Vehicle Location
2. CAD, Computer Aided Dispatch
3. ATIS, Advanced Traveler Info Sys
4. VMS, Variable Messaging Boards
5. GIS, Geographic Information Sys
6. Mobile Digital Communications
7. MDT, Vehicle Mobile Data Term
8. GPS antenna
9. Hardware, Software, Comm

The specific actions identified in the table above are presented in detail in the following paragraphs. These are proposed ITS applications for various operators and facilities.

Westchester County - In Westchester County, plans are in development for several high priority ITS-related projects. The primary transit ITS related initiatives of Westchester County include: the upgrading of the radio communication system to a digital system, the implementation of a GPS-based automated vehicle location system, the implementation of a computer-assisted dispatch system and the development of a system for automated annunciation, electronic fare collection and automated passenger counting. The ITS projects recommended below are consistent with the above priority ITS projects.

White Plains Transit Center - This transit center is the busiest in the Lower Hudson Valley, the average daily inbound Metro-North traffic exceeds 5,700 trips and over 25 routes and operators use this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the relevant operations centers.

Metro-North should establish an automated fax dial-out routine within their train control and passenger/platform information systems. In the event of a service disruption, this system would send a fax to the dispatch centers of Bee-Line, ShortLine, Tappan Zee Express, and Connecticut Transit. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

In addition, a public address/messaging system, in the form of kiosks or monitors, should be established and messaging boards with audible announcements located at this facility. This system should be used to post delay information and on-time service status information by Metro-North and by Bee-Line, Tappan Zee Express, Connecticut Transit and ShortLine. Communications between the public message boards and the operator dispatch centers must be established.

Further, for bus-to-bus connections (intra-operator and inter-operator), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services, as well as transfer connection information such as bus bay location, departure time, and on-time status. This system will require the use of a GPS based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 1, 3, 5, 6, 11, 12, 13, 14, 15, 17, 20/20x, 21, 27, 40, 41, 60, 62, 63, 77, 84, A, B, C; Tappan Zee Express 1; ShortLine, and Connecticut Transit 1.

Finally, the TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Croton-Harmon Station - At this station, the average daily inbound Metro-North traffic exceeds 4,000 trips and three Bee-Line routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, this system would send a fax to the dispatch center of Bee-Line in the event of a service disruption. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by

Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services, as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 10, 11, 14.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Scarsdale Station - At this station, the average daily inbound Metro-North traffic exceeds 3,900 trips and four Bee-Line routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a BPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 63, 64, 65, 66.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Larchmont Station - At this station, the average daily inbound Metro-North traffic exceeds 3,300 trips and five Bee-Line routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will required the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 60, 61, 66, 70, 71.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Hartsdale Station - At this station, the average daily inbound Metro-North traffic exceeds 2,700 trips and three Bee-Line routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 34, 38, 39.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Bronxville Station - At this station, the average daily inbound Metro-North traffic exceeds 2,700 trips and three Bee-Line routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will required the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 26, 30, 52.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

New Rochelle Transit Center - At this station, the average daily inbound Metro-North traffic exceeds 2,600 trips and two bus operators with a total of ten routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North, ShortLine and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line and ShortLine services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 7, 30, 42, 45/45q, 60, 61, 62, 66; ShortLine.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Rye Station - At this station, the average daily inbound Metro-North traffic exceeds 2,500 trips and two Bee-Line routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 61, 76.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Tarrytown Station - At this station, the average daily inbound Metro-North traffic exceeds 2,200 trips and two bus operators with three bus routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North, Tappan Zee Express and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch centers of Bee-Line and Tappan Zee Express. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed. Communications between Tappan Zee Express and Metro-North is recommended to effect service coordination between these two operators where and when operationally feasible and warranted. In cases where Tappan Zee Express is slightly late it may be beneficial for Metro-North to hold the train for the incoming feeder bus.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North, Tappan Zee Express and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line and Tappan Zee Express services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 1T, 13; Tappan Zee Express 1.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Port Chester Station - At this station the average daily inbound Metro-North traffic exceeds 1,900 trips and two bus operators and four bus routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North, Connecticut Transit and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line and Connecticut Transit. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North, Connecticut Transit and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line and Connecticut Transit services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 13, 61, 76; Connecticut Transit K.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Mount Vernon Transit Center - At this station, the average daily inbound Metro-North traffic exceeds 1,300 trips and eight Bee-Line bus routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 7, 40, 41, 42, 52, 53, 54, 55.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Yonkers Transit Center - This station serves a relatively low number of Metro-North riders but is a significant bus transfer center. The average daily inbound Metro-North traffic is about 700 trips, but over fifteen Bee-Line bus routes serve this facility. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and Bee-Line.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch center of Bee-Line. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by Bee-Line. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (Bee-Line services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Bee-Line 1C, 1T, 1W, 2, 3, 4, 5, 6, 7, 8, 9, 23, 25, 30, 32, 90, 91.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Dutchess County - Two primary transit facilities are located in Dutchess County. These are the Poughkeepsie Station and LOOP transfer center at Main and Market, and the Beacon Station. Dutchess County is interested in acquiring a computer-assisted dispatch system.

Poughkeepsie Train Station and LOOP Transfer Center - The Poughkeepsie train station and the Dutchess County LOOP transfer center are located at separate facilities. For ITS applications to be effective, it is recommended that the LOOP transfer center at Main and Market be relocated to the train station. Metro-North serves about 1,300 daily inbound trips at the Poughkeepsie station. The LOOP transfer center is used by LOOP routes, Poughkeepsie Transit Routes, Arrow Bus and CTC. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, intra-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and LOOP, Poughkeepsie Transit and CTC.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch centers of LOOP, Poughkeepsie Transit and CTC. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and by LOOP, Poughkeepsie Transit and CTC. Communications between the public message boards and the operator dispatch centers must be established.

For bus-to-bus connections (LOOP, Poughkeepsie Transit, Arrow Bus and CTC services), service status information should be posted on the passenger messaging system to notify passengers of the on-time status of regularly scheduled services as well as transfer connection information. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: LOOP, Poughkeepsie Transit, Arrow Bus and CTC.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Beacon Station - The Beacon train station serves about 1,300 daily inbound Metro-North trips and is served by the Beacon CTC service. ITS applications that should be implemented include: real-time service monitoring, inter-operator service coordination, and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and CTC.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch centers of CTC. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and CTC. Communications between the public message boards and the operator dispatch centers must be established. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: Beacon CTC.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Rockland County - Rockland County is pursuing the development of a kiosk-based traveler information system to be posted at key transit centers, as well as the application of a GPS-based automated vehicle location system.

Spring Valley Transit Center - The Spring Valley train station, transfer center and park and ride lots are loosely co-located and will need to be tied together with some physical design improvements and ITS system technologies. The Spring Valley train station serves about 100 daily inbound Metro-North trips. The park and ride lots have a combined capacity of about 250 spaces. The area is served by Red and Tan Lines, TOR, Spring Valley Jitney and the Tappan Zee Express services. ITS applications that should be implemented include: real-time service monitoring, intra-operator service coordination, inter-operator service coordination and real-time en-route passenger information systems. To accomplish these, communications must be established between the operations centers at Metro-North and TOR, Spring Valley Jitney and the Tappan Zee Express.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch centers of TOR, Spring Valley Jitney and the Tappan Zee Express. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility and should be compatible with the transit kiosk Rockland County is interested in acquiring. This system would be used to post delay information and on-time service status information by Metro-North and TOR, Spring Valley Jitney and the Tappan Zee Express. Communications between the public message boards and the operator dispatch centers must be established. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: TOR 59, 91, 92, 94; Spring Valley Jitney; Red and Tan Lines 11A, 11C, 45; and the Tappan Zee Express 1.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Spring Valley Lot (Exit 14) - The Spring Valley Lot has a capacity of about 280 spaces and is served by TOR and the Tappan Zee Express services. ITS applications that should be implemented include: real-time service monitoring and real-time en-route passenger information systems.

The public address/messaging system discussed above should be located at this facility and should be compatible with the transit kiosk system Rockland County is interested in acquiring. This system could also take the form of a variable messaging sign visible from the highway would be used to post service and parking availability information and on-time service status information by TOR and the Tappan Zee Express. Parking status must be tracked and posted. Communications between the public message boards and the operator dispatch centers and the parking lot must be established. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: TOR 59 and the Tappan Zee Express.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Nanuet Mall and Station - The Nanuet train station and the transfer center at the Mall may need to be tied together with some physical design improvements and ITS system technologies to create an integrated center. As the current operations tend to be separate, serving commuter rail and commuter bus patrons, these two functional areas can be treated as such. The train station serves about 500 daily inbound Metro-North trips. The area is served by TOR, Red and Tan Lines and Clarkstown Mini Trans services. ITS applications that should be implemented include: real-time service monitoring and real-time en-route passenger information systems. Inter-operator and intra-operator communications may also be appropriate. To accomplish these, communications must be established between the operations centers at Metro-North and TOR and the Clarkstown Mini Trans.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch centers of TOR,. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility and should be compatible with the transit kiosk Rockland County is interested in acquiring. This system would be used to post delay information and on-time service status information by Metro-North and TOR and Clarkstown Mini Trans. Communications between the public message boards and the operator dispatch centers must be established. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: TOR routes; Clarkstown Mini Trans; and Red and Tan Lines 11A, 11C, 20, and 47.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Putnam County - In Putnam County interest in ITS applications includes the proposed acquisition of an automated vehicle location system. The following recommended projects are consistent with the plans of the County.

Brewster Station and Park and Ride Lot - The Brewster train station and the park and ride lot, located close by, may need to be tied together with some physical design improvements and ITS system technologies to create an integrated center. The train station serves about 1,100 daily inbound Metro-North trips and the park and ride lot has a capacity of 75 spaces. The area is served by Bee-Line, PART and ShortLine services. ITS applications that should be implemented include: real-time service monitoring and real-time en-route passenger information systems. Inter-operator and intra-operator communications may also be appropriate. In addition, variable messaging signs may be appropriate to notify the public of commuter services and parking availability. To accomplish these, communications must be established between the operations centers at Metro-North and PART.

From the proposed Metro-North automated fax dial-out routine discussed above, in the event of a service disruption, this system would send a fax to the dispatch centers of TOR. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

The public address/messaging system discussed above should be located at this facility. This system would be used to post delay information and on-time service status information by Metro-North and PART. Communications between the public message boards and the operator dispatch centers must be established. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include: PART Route 1; Bee-Line 84; and ShortLine.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Putnam Plaza - The Putnam Plaza serves as a major PART transfer center. The area is served by PART routes. ITS applications that should be implemented include: real-time service monitoring, real-time en-route passenger information systems and intra-operator communications may also be appropriate. To accomplish these, communications must be established at the operations center of PART.

The public address/messaging system discussed above should be located at Putnam Plaza. This system would be used to post delay information and on-time service status information by PART. Communications between the public message boards and the operator dispatch center must be established. This system will require the use of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Routes affected include all PART routes.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Orange County - Orange County has not expressed interest or displayed an immediate need for transit ITS applications for their various transit and paratransit services. In future however, the County may wish to acquire AVL and dispatching systems to achieve more efficient and cost effective operations and service delivery through coordinated service delivery. The following recommended ITS applications in Orange County are consistent with current programs in the County.

Monroe Park and Ride Lot - The Monroe Lot has a capacity of about 625 spaces and is served by ShortLine. ITS applications that should be implemented include: real-time service monitoring, variable messaging signs and real-time en-route passenger information systems.

The ITS system should take the form of a service status message board and a variable messaging sign visible from the highway would be used to post service and parking availability information and on-time service status information for ShortLine. Parking status must be tracked and posted. Communications between the public message board and the operator dispatch center and the parking lot must be established. This system will require the use by ShortLine of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Alternatively, the bus service dispatchers could post service status updates to the variable messaging system. ShortLine commuter routes are affected.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Newburgh Park and Ride Lot - The Newburgh Lot has a capacity of about 305 spaces and is served by ShortLine; Leprechaun Lines; Newburgh-Beacon Express; and Adirondack Trailways. ITS applications that should be implemented include: real-time service monitoring, variable messaging signs and real-time en-route passenger information systems.

The ITS system should take the form of a service status message board and a variable messaging sign visible from the highway would be used to post service and parking availability information and on-time service status information for ShortLine; Leprechaun Lines; Newburgh-Beacon Express; and Adirondack Trailways. Parking status must be tracked and posted. Communications between the public message board and the operator dispatch center and the parking lot must be established. This system will require either the use by the bus operators of a GPS-based automated vehicle location system capable of comparing actual and scheduled on-time performance and should also track ridership activity and passengers on board. Mobile data terminals will be required in vehicles and a GIS-based computer-assisted dispatching system will be necessary to track vehicles on screen. Digital data communications between dispatch and vehicles is recommended. Alternatively, the bus service dispatchers could post service status updates to the variable messaging system. ShortLine; Leprechaun Lines; Newburgh-Beacon Express; and Adirondack Trailways commuter routes are affected.

The TMC should be established as a remote site for automatic receipt of the service information sent by the operators to the passenger messaging boards. The TMC can thus be notified of service delays and disruptions.

Regional Transit Service Providers are active in the Lower Hudson Valley. The three key commuter service providers that should be included in regional transit ITS deployment are Metro-North Commuter Rail, Red and Tan Lines and ShortLine.

Metro-North carries, on average, over 106,000 daily inbound trips in the Lower Hudson Valley. Metro-North has a program of ITS developments which have been identified in this study. The proposed ITS applications identified herein are consistent and compatible with existing and proposed Metro-North ITS applications.

Proposed ITS applications to be developed by Metro-North include the addition of an automated routine in the train control and passenger information systems to generate dial-out faxes of service disruptions to the relevant dispatch centers of bus operators serving Metro-North stations in the event of a service disruptions. The fax should identify the nature of the disruption, the estimated delay time for each station along the affected line. If the disruption exceeds the estimated delay, updated information should be faxed.

Red and Tan Lines carries over 4,100 daily trips in the Lower Hudson Valley. ITS applications recommended for Red and Tan Lines include the use of a vehicle location system, access to real-time road network conditions (highway ITS applications) and tie in to variable messaging signs to inform the public of service status and parking capacity information at park and ride lots. On-time service status information should be provided to the TMC.

ShortLine carries over 3,100 daily trips in the Lower Hudson Valley. ITS applications recommended for ShortLine include the use of a vehicle location system, access to real-time road network conditions (highway ITS applications) and tie in to variable messaging signs to inform the public of service status and parking capacity information at park and ride lots. On-time service status information should be provided to the TMC.

c) Transit Medium Term Deployment Efforts

The Medium-Term *(Second Phase)* of the deployment plan would involve the continued automation of the communication links between transit service operation centers, the TMC and public information dissemination channels. The Medium-Term phase would also include the implementation of appropriate APTS applications to collect and disseminate real-time operational information for the secondary set of transit facilities and services and the upgrading of systems to take advantage of improvements in technologies. These activities might be conducted in the time frame of five to ten years from the decision to proceed.

d) Transit Long-Term Deployment Efforts

The long term phase of the deployment should involve the refinement and expansion of APTS applications throughout the Lower Hudson Valley. These efforts would include expanding APTS applications to interested local transit operators and paratransit service providers to facilitate greater service coordination (inter-modal and intra-modal) at the local and regional levels. Efforts should also include upgrading systems to speed processing by taking advantage of improved technologies.

J. TRANSIT ITS COST ESTIMATES

Based on a review of current literature on transit ITS applications, cost estimates have been prepared for the ITS applications proposed for the Lower Hudson Valley. A review of these cost estimates is presented in the table, **Proposed ITS Applications, Estimated Costs** and discussed in the text below.

In total, it is estimated that the transit ITS applications proposed for the Lower Hudson Valley will amount to a cost of about $11.4 million This includes estimates of operations center costs, in-vehicle costs, as well as costs for equipment at transit centers and park and ride facilities. Not included in these costs are the cost of a central system for a regional electronic fare system and costs associated with “push” type systems to provide continually updated transit service information via monitors to the public at transit centers and facilities.

Regarding the electronic fare system, costs were included in the in-vehicle estimates for card readers. Currently, Westchester County is actively investigating options for an electronic fare system. As the system adopted by Westchester County will need to be compatible with Region 11 systems, it is recommended that the regional system be the system that is adopted by Westchester County. The central operations center costs of this system will be established as the system is further defined.

The information to be provided to the public by phone, computer, cable and monitors (or kiosks) at transit facilities was assumed to be “pushed” to these various end user interface devices by the MDI system. Costs for the central information system were, therefore, not included in these estimates. Costs for the purchase, wiring and installation of monitors to be used at transit facilities to provide on-time service information and service coordination information (transfer coordination) were included. In addition, the costs (central operating center and in-vehicle) to collect and process the real-time transit service information have been included and are reflected in the “bundled” AVL costs presented below.

In developing cost estimates, several operational factors were important. First, it was assumed for operational effectiveness that the entire fleet of each operator would be outfitted for AVL, where AVL was required. Second, for consistency, the 1994 National Transit Database fleet information was used for each operator. Third, the AVL application recommended is what we have termed a “bundled” AVL system. This “bundled” system includes the required hardware, software and communications to deliver vehicle monitoring, computer-aided dispatch, GIS mapping, schedule adherence monitoring and electronic fare acceptance. This assumes each vehicle would be equipped with a mobile data terminal (MDT), a digital radio, a GPS receiver and an electronic card reader. Each operating center (or a regional operating center with remote work stations) would be equipped with hardware, software and communications to facilitate real-time processing of vehicle monitoring, schedule adherence monitoring, computer-aided dispatch, and the informational requirements to support real-time service information sources for operators and the public. Service monitoring and informational support systems for Metro-North services were assumed to be part of on-going efforts by that agency and efforts in Region 11.

The cost estimates for the “bundled” AVL system are based on the TCRP Synthesis 24 report, “AVL Systems for Bus Transit, 1997”. Based on this report, the total allocated costs of the “bundled” AVL system, in-vehicle and central operations center costs included, averages $13,700 per vehicle and no less than $350,000 per transit system. The estimated regional cost for the “bundled’ AVL system is just over $10.4 million and would equip 750 buses.

Table 4 Proposed ITS Applications, Estimated Costs

Services & Facilities by County	Recommended ITS Applications	(1) Vehicle Fleet	(2) AVL System Costs	(3) Pub Info Monitors	Variable Message Signs	Estimated APTS Costs
Westchester County						
White Plains Transit Center	RM, CO1, CO2, PI		--	8	--	$24,000
Croton-Harmon Station	RM, CO1, PI		--	4	--	$12,000
Scarsdale Station	RM, CO1, PI		--	4	--	$12,000
Larchmont Station	RM, CO1, PI		--	4	--	$12,000
Hartsdale Station	RM, CO1, PI		--	4	--	$12,000
Bronxville Station	RM, CO1, PI		--	4	--	$12,000
New Rochelle Transit Center	RM, CO1, CO2, PI		--	6	--	$18,000
Rye Station	RM, CO1, PI		--	4	--	$12,000
Tarrytown Station	RM, CO1, CO2, PI		--	4	--	$12,000
Port Chester Station	RM, CO1, CO2, PI		--	4	--	$12,000
Mount Vernon Transit Center	RM, CO1, PI		--	6	--	$18,000
Yonkers Transit Center	RM, CO1, PI		--	6	--	$18,000
County Sub-Total:		380	$5,206,000	$174,000	--	$5,380,000
Dutchess County						
Poughkeepsie Station/Main & Mkt	RM, CO1, CO2, PI		--	2	--	$6,000
Beacon Station	RM, CO2, PI		--	2	--	$6,000
County Sub-Total:		50	$685,000	$12,000	--	$697,000
Rockland County						
Spring Valley Transit Terminal	RM, CO1, CO2, PI		--	4	--	$12,000
Spring Valley P&R Lot (Exit 14)	RM, CO1, PI		--	--	$250,000	$250,000
Nanuet Mall and Nanuet Station	RM, CO1, CO2, PI		--	4	--	$12,000
County Sub-Total:		38	$520,600	$24,000	$250,000	$794,600
Putnam County						
Brewster Station, P&R Lot	RM, CO1, CO2, PI		--	2	--	$6,000
Putnam Plaza	RM, CO1, PI		--	2	--	$6,000
County Sub-Total:		14	$350,000	$12,000	--	$362,000
Orange County						
Monroe P&R Lot	PI		--	--	$250,000	$250,000
Newburgh P&R Lot	PI		--	--	$250,000	$250,000
County Sub-Total:		--	--	--	$500,000	$500,000
Regional Services						
Metro-North Commuter Rail (4)	RM, CO1, CO2, PI	--	--	--	--	--
Red and Tan Lines	PI	143	$1,959,100	--	--	$1,959,100
ShortLine	PI	125	$1,712,500	--	--	$1,712,500
Regional Total:		750	$10,043,320	$222,000	$750,000	$11,405,200

Suggested ITS Applications	Transit Operators	Notes:
RM Real Time Service Monitoring	Bee-Line	(1) Source: 1994 Section 15 Report.
CO1 Intra-Operator Service Coordination	Spring Valley Jitney	(2) TCRP Synthesis 24: AVL Systems for Bus Transit, 1997. Avg fully allocated cost of $13,700 / veh for AVL system, CAD, radio, public info, schedule adherence. Includes Operating center & in-vehicle costs
CO2 Inter-Operator Service Coordination	Clarkstown Mini-Trans	(3 $3000 per monitored installed.
PI Passenger Information Messaging	Transport of Rockland	(4) Metro-North costs excluded.
User Services Supported	Red & Tan Lines	
Advanced Traveler Information	ShortLine	
En-Route Traveler Information	Putnam PART	
Transit Management/Service Coordination	Poughkeepsie Transit	
Computer Aided Dispatch	Dutchess LOOP	

AVL system cost estimates by County/operator were developed based on the information presented in the TCRP Synthesis 24 report. Accordingly, the cost estimates are provided below:

Table 5 Proposed Automatic Vehicle Location System Cost Summary

County/Operator	Fleet	Capital AVL Costs	Estimated O&M Costs
Westchester	380	$5,206,000	$ 180,900
Dutchess County LOOP & Poughkeepsie Transit	50	$ 685,000	$ 25,100
Rockland County TOR, SV Jitney, Clarkstown MT	38	$ 520,600	$ 19,400
Putnam County	14	$ 350,000	$ 8,100
Red & Tan Lines	143	$1,959,100	$ 69,000
ShortLine	125	$1,712,500	$ 60,500
Regional Total	**750**	**$10,433,200**	**$ 363,000**

The “bundled” AVL system will facilitate the following functions:

- real-time service monitoring, including schedule adherence monitoring;
- real-time service coordination (inter-operator and intra-operator);
- the provision of real-time service status information for pre-trip and en-route purposes to end user interface devices (public and private) including kiosks, monitors, and information dissemination organizations such as TRANSCOM, news bureaus, etc.; and
- real-time computer aided dispatching of services.

To provide information about the status of transit services and transfer connection information to the public at transit centers, service displays or monitors will be required. These monitors are much the same as those used in airports to display arrival and departure information. Estimates were made of the number of monitors required at each of the key transit facilities in the region. Large transit centers, like the White Plains Transit Center, were estimated to require eight monitors each while the smaller stations were estimated to require two monitors each. The cost of the monitors, including wiring and installation was estimated at $3000 each, according to A/E guidelines used in airport design. It was assumed that the systems used to supply the service information to these monitors would come from the AVL systems of the service operators via an interface with the TMC and the regional MDI system. The number of monitors and related costs estimated for each transit facility in the region is presented in the table, **Proposed ITS Applications, Estimated Costs**. In total, it is estimated that the cost for transit service monitors at key transit facilities in the region will be about $225,000.

At key park and ride lots in the region, it was recommended that variable message signs be used to inform the public as to the availability and status of transit service and parking. Variable message signs were recommended for three park and ride lots based on parking capacity and the availability of transit service at these lots. The three lots include: Spring Valley (Exit 14) in Rockland County, and the Monroe and Newburgh Lots in Orange County. The estimated costs for installed variable message signs, based in A/E design guidelines, is $250,000 for each lot. The combined estimated cost for variable message signs for park and ride lots in the region is $750,000.

In total, the estimated capital cost of providing the recommended ITS applications in the Lower Hudson Valley region amounts to about $11.4 million.

In addition, estimates of annual operating and maintenance costs were prepared. The table on the following page presents estimated capital, operating and maintenance costs, as well as benefit/cost analyses for the proposed ITS applications. Operating and maintenance costs are based on the following assumptions:

- maintenance costs of $472 per vehicle annually as per TCRP Synthesis Report 24
- communication costs of $24 per month for a "clean" analog line (NYNEX)
- hardware and software service contract of $100 per month per device.

Estimated ITS benefits are based on improvements in operating efficiency, improved ridership and reduced SOV use. These assumptions are defined below:

- reduced operating costs of 5% of non-revenue miles (USDOT Benefits Assessment of APTS, 1996)
- increased transit ridership of 2% based on TCRP Synthesis Report 24
- average fare revenue applied to increased ridership defined as $3.25 per trip for Metro-North and commuter buses and $1.00 per trip for local services.
- reduced SOV travel estimated from assumed average vehicle occupancy of 1.1 and an average trip length of 5 miles at a cost of $0.30 per mile.

In total, the region is estimated to recoup the costs of the ITS applications in less than three years and see benefits of $16.5 million over the seven-year life of the systems, $38.8 million if one considers benefits accrued as a result of increased Metro-North ridership at stations within the Lower Hudson Valley not programmed for ITS applications. The greatest benefits accrue to the larger systems and to stations with the greatest volume of ridership. Not all counties will benefit however. Putnam County is not expected to see a benefit over the estimated seven year life of the proposed systems. The first year and seven year benefit/cost estimates are summarized below by County/operator.

Table 6 Benefits and Costs by County/Operator

County/Operator	Year 1 ITS Costs Less Benefits	Ratio of Benefits to Costs	7 Year Years to Payoff	Costs Less Benefits
Westchester	$2,382,700	0.58	1.79	($15,601,100)
Dutchess	$ 542,200	0.26	4.50	($ 386,600)
Rockland	$ 448,300	0.22	5.66	($ 129,300)
Putnam	$ 314,500	0.17	7.62	$ 29,300
Red & Tan	$1,441,800	0.29	3.79	($ 1,662,300)
ShortLine	$1,440,600	0.19	6.30	($ 191,100)
Regional Total	**$6,767,700**	**0.39**	**2.74**	**($16,557,000)**

The cost of providing the variable message signs for the park and ride lots is estimated to cost a total of $750,000 or about $1.84 per space. The attached table also presents these estimates.

The analysis supports the investment in the ITS system for the region over the assumed seven-year life of the system. It is expected that the costs for upgrading and replacing components after seven years will be significantly less than the initial investment due to falling costs of technologies. In fact, the costs assumed are largely based on developmental costs and thus may be significantly overstated.

It is hereby noted and should be recognized that the direct operating cost savings and increased revenue due to ridership increases identified will accrue to the transit operators but these constitute only two components of the benefits identified. Included in these, are benefits accruing to Metro-North, an operator that may not directly share in the cost of these investments. The remaining benefits will not be accrued directly to the counties or the operators expected to bear the cost of these investments. The remaining benefits estimated are societal benefits and not necessarily tangible.

Proposed ITS Applications, Estimated Costs

Services & Facilities by County	Recommended ITS Applications	(1) Vehicle Fleet	(2) AVL System Costs	(3) Pub Info Monitors	Vehicle Message Signs	Estimated APTS Costs
Westchester County						
White Plains Transit Center	RM, CO1, CO2, PI		--	8	--	$24,000
Croton-Harmon Station	RM, CO1, PI		--	4	--	$12,000
Scarsdale Station	RM, CO1, PI		--	4	--	$12,000
Larchmont Station	RM, CO1, PI		--	4	--	$12,000
Hartsdale Station	RM, CO1, PI		--	4	--	$12,000
Bronxville Station	RM, CO1, PI		--	4	--	$12,000
New Rochelle Transit Center	RM, CO1, CO2, PI		--	6	--	$18,000
Rye Station	RM, CO1, PI		--	4	--	$12,000
Tarrytown Station	RM, CO1, CO2, PI		--	4	--	$12,000
Port Chester Station	RM, CO1, CO2, PI		--	4	--	$12,000
Mount Vernon Transit Center	RM, CO1, PI		--	6	--	$18,000
Yonkers Transit Center	RM, CO1, PI		--	6	--	$18,000
County Sub-Total:		380	$5,206,000	$174,000	--	$5,380,000
Dutchess County						
Poughkeepsie Station/Main & Mkt	RM, CO1, CO2, PI		--	2	--	$6,000
Beacon Station	RM, CO2, PI		--	2	--	$6,000
County Sub-Total:		50	$685,000	$12,000	--	$697,000
Rockland County						
Spring Valley Transit Terminal	RM, CO1, CO2, PI		--	4	--	$12,000
Spring Valley P&R Lot (Exit 14)	RM, CO1, PI		--	--	$250,000	$250,000
Nanuet Mall and Nanuet Station	RM, CO1, CO2, PI		--	4	--	$12,000
County Sub-Total:		38	$520,600	$24,000	$250,000	$794,600
Putnam County						
Brewster Station, P&R Lot	RM, CO1, CO2, PI		--	2	--	$6,000
Putnam Plaza	RM, CO1, PI		--	2	--	$6,000
County Sub-Total:		14	$350,000	$12,000	--	$362,000
Orange County						
Monroe P&R Lot	PI		--	--	$250,000	$250,000
Newburgh P&R Lot	PI		--	--	$250,000	$250,000
County Sub-Total:		--	--	--	$500,000	$500,000
Regional Services						
Metro-North Commuter Rail (4)	RM, CO1, CO2, PI	--	--	--	--	--
Red and Tan Lines	PI	143	$1,959,100	--	--	$1,959,100
ShortLine	PI	125	$1,712,500	--	--	$1,712,500
Regional Total:		750	$10,433,200	$222,000	$750,000	$11,405,200

Suggested ITS Applications
- RM Real Time Service Monitoring
- CO1 Intra-Operator Service Coordination
- CO2 Inter-Operator Service Coordination
- PI Passenger Information Messaging

User Services Supported
- Advanced Traveler Information
- En-Route Traveler Information
- Transit Management/Service Coordination
- Computer Aided Dispatch

Transit Service Providers
- Bee-Line
- Spring Valley Jitney
- Clarkstown Mini-Trans
- Transport of Rockland
- Rockland Coaches
- Putnam PART
- Poughkeepsie Transit
- LOOP

Notes:
(1) Source: 1994 Section 15 Report.
(2) TCRP Synthesis 24: AVL Systems for Bus Transit, 1997. Avg fully allocated cost of $13,700 / veh for AVL system, CAD, radio, public info, schedule adherence. Includes Operating center & in-vehicle costs
(3) HNTB Corp A/E guidelines. $3000 per monitored installed.
(4) Metro-North costs excluded.

ITS Capabilities Required
1. AVL, Automated Vehicle Location System
2. CAD, Computer Aided Dispatch
3. ATIS, Advanced Traveler Information System
4. VMS, Variable Messaging Boards
5. GIS, Geographic Information System
6. Mobile Digital Communications System
7. MDT, Vehicle Mobile Data Terminals
8. GPS antenna
9. Hardware, Software, Communications

Table 7 Annual ITS Costs for Highways (Ranked by Benefit/Cost)

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XI. FUNCTIONAL REQUIREMENTS

The National ITS Program has defined seven technical functional areas pertinent to the successful application of the required user services in an area like the Lower Hudson Valley. These include surveillance, communications, traveler interface, control strategies, navigation/guidance, data processing and in-vehicle sensors. Furthermore, ITS technologies have each been classified into one of these seven functional areas. While some technologies may be applicable in more than one functional area, each technology is categorized in the functional area in which it is most relevant. Table 1 provides a relationship between the technical functional areas that are utilized by the highest priority ITS user services previously defined by the survey in "Ranking of the User Services" and the evaluation of existing problems on the Lower Hudson Valley transportation network. Note that all of the user services are provided through technologies from more than one functional area. User services in Table 1 include all of the user services identified as appropriate for implementation in the short and medium time frame. In the following sections the functional areas and related user services are discussed.

A. SURVEILLANCE

Surveillance is the mechanism that permits the collection of a range of transportation data including speed, volume, density, travel time, queue length, and in some cases, vehicle positions for buses and transit. Control strategies that may need to be implemented, incident management plans, responses and procedures, and motorist information are selected on the basis of this collected data. The data is used for making transportation management decisions and stored to provide a historical record of transportation conditions. Surveillance can also be used to obtain information on vehicle classification, width, speed, acceleration characteristics, and hazardous materials. Specific technologies in the surveillance technical functional area are shown in Table 2.

1. USER SERVICES THAT UTILIZE SURVEILLANCE TECHNOLOGIES

Surveillance is one of the most important technical functional areas, because it provides the data necessary for many of the user services to work properly and be integrated together. Without surveillance capabilities, however primitive or sophisticated, there is no knowledge of the current operating conditions, there is no information for operational decisions and, ultimately, there is no information to provide to the users. In the proposed plan, all of the user services except the Emergency Notification and Personal Security user service would be expected to utilize technologies in the surveillance technical functional area. The Emergency Notification and Personal Security user service provides notification to the Traffic Management Center (TMC) or emergency responder, and thus does not require surveillance.

Table 1 Technical Functional Area for Selected User Services

User Service	Surveillance	Communications	Traveler Interface	Control Strategies	Navigation/ Guidance	Data Processing	In-Vehicle Sensors
Traffic Control	X	X		X		X	
Incident Management	X	X	X	X	X	X	X
En Route Drive Information	X	X	X		X	X	X
Travel Information Services	X	X	X		X	X	X
Pre-Trip Travel Information	X	X	X		X	X	
Demand Management and Operations	X	X	X		X	X	X
Public Transportation Management	X	X		X	X	X	X
Emergency Vehicle Management	X	X			X	X	
Emergency Notification and Personal Security		X					X

Table 2 Surveillance Technologies

Technology	Explanation, Examples or Characteristics
Vehicle probes	Examples include Transit, fleet and HELP vehicles equipped with an on-board computer, two-way communications link, or AVI transponder.
Loop detectors	Detect vehicle through a change in the magnetic field (embedded in the pavement).
Infrared sensors	Detect vehicles when infrared beam is broken (located above the pavement).
Microwave and radar sensors	Detect vehicle motion through Doppler phase shift (located above the pavement).
Machine vision	Examples include video cameras, which may or may not include a microprocessor for image interpretation.
Aerial surveillance	Uses helicopter or light airplanes to monitor traffic flow, detect incidents, and identify alternate routes.
Automatic vehicle identification (AVI)	Uses vehicle-based transponders and readers at fixed locations
Weigh-in-motion	Uses road-mounted sensors and processors to determine vehicle weight.
Automatic vehicle classification	Uses vehicle sensors, detectors (which receive information from sensors), data processing, and a recorder (to store data).
Automatic vehicle location (AVL)	Uses transmitters, dead-reckoning, global positioning systems (GPS), or LORAN, and map matching to identify location of HELP and/or Transit vehicles.
Police/emergency medical/other traveler information	Information based on human observation and transmitted via two-way information link. Examples may include monitoring police scanners in the TMC.
Weather and other environmental information	Includes information based on weather monitors (roadway monitors, National Weather Service Monitoring, etc.), as well as pollution and emissions monitors. Examples include installing pavement and atmospheric sensors at foul weather areas and monitoring the results in the TMC.

Many of the user services would utilize surveillance technologies that provide general information about traffic flow, such as detectors, vehicle probes, and video surveillance. This information may be augmented by information provided by AVI and AVL systems that work with buses, commercial vehicles and emergency response vehicles. This information would be utilized for routing purposes for Emergency Vehicle Management, Public Transportation Management, En Route Driver Information, and as general information to be provided to the public and operating agencies. The user services focusing on transit, namely Public Transportation Management would also utilize surveillance technologies that provide more specific information, such as an AVL system for transit vehicles, and audio or video surveillance of transit vehicles and facilities.

B. COMMUNICATIONS

Communications include all transmissions (including voice, video, and data transmissions) between the elements of the transportation system, both the vehicles and the infrastructure. Communications technologies provide the TMC with information about traffic and roadway conditions; transit vehicle locations and schedule adherence and allow system users to be better informed about network conditions which in turn allows for more efficient utilization of the roadway system. Communications services include:

- Communications between traffic management infrastructure and vehicles,
- Communications between elements of the infrastructure and supporting organizations and agencies; and
- Communications between vehicles.

Specific technologies in the communications technical functional area are shown in Tables 3 and 4.

1. USER SERVICES THAT UTILIZE COMMUNICATIONS TECHNOLOGIES

Communications is another one of the most important technical functional areas, because it is necessary to transmit data for surveillance, and to transmit information to operating agencies and transportation consumers. Without communications capabilities, there is no mechanism to transmit roadway data to the TMC, and there is no mechanism to communicate conditions to either incident responders or roadway users. The importance of communications is exemplified by the fact that all of the user services shown in Table 1 would be expected to utilize technologies from the communications technical functional area.

Table 3 Technologies for Communications Between Vehicles and Infrastructure

Technology	Explanation, Examples or Characteristics
Local-area broadcasts	Examples include highway advisory radio (HAR) and automatic HAR (AHAR), which will automatically tune to the AHAR frequency for the duration of the message. The NYSTA currently operates several throughout the Region.
FM sub-carrier (one-way)	Utilities spare bandwidth in the guard bands of conventional FM radio stations (vehicles must be equipped to receive and decode the date).
Infrared and microwave beacons (two-way)	Transfer data at high rates, but coverage range is limited (less than 100 ft.)
Wide-area radio system (two-way)	Transmits common information to all vehicles, to be sorted by a device in the vehicle.
Cellular radio services (two-way)	Can selectively access vehicles within specific cells of the system (message could vary depending on driver's location).
Satellite communications (two-way)	Provide nationwide coverage of voice or data transmission.
AVI/ETTM tags (two-way)	Used on advanced roadways with communication and reader

	capabilities.

Table 4 Technologies for Communications Between Elements of the Traffic Management System[1]

Technology	Explanation, Examples or Characteristics
Landlines	Examples include twisted pair wire (for data from detectors), and coaxial or fiber optic cable (for unprocessed video). Lines needed depend on transmission rates required.
Microwave	Transmits images and data from roadside video cameras, or controls variable message signs; used where landlines are not cost effective (such as in rural and mountainous areas).
Wide-area radio, FM subcarrier	Connects variable message signs to the TMC where land lines are not cost effective.
Satellite communications (two-way)	Used where land lines are not appropriate due to cost or other factors.
Spread-spectrum radio	Transmits video, voice and data when land lines are not cost effective.

1Technologies that facilitate communications between the elements of the traffic management system address: communications between traffic sensors, signals, signs and ramp meters and the traffic management center (TMC); communications between the TMC and vehicles (for examples, via communications base stations or beacons); and communications between the TMC and other TMCs, organizations, and/or agencies (for example, emergency response or enforcement agencies).

C. TRAVELER INTERFACE

Traveler interface allows the traveler to interact with the ITS system to obtain traffic management center updates or information from the database. The traveler may interact with the system:

- At home or work via telephone, computer, television, or radio;
- At bus stops or transit kiosks; and
- In-vehicle through a computer, car radio, cellular telephone, roadside variable message sign, personal digital assistant or specially equipped automated vehicle identification tag.

This functional area includes all the technologies with which the traveler interfaces. Traveler interface technologies must be easy to understand, without ambiguity, and designed to provide a level of detail appropriate to the needs of the user and the task at hand. Specific technologies in the traveler interface technical functional area are shown in Table 5.

1. USER SERVICES THAT UTILIZE TRAVELER INTERFACE TECHNOLOGIES

Technologies in the traveler interface technical functional area are utilized by five of the user services shown in Table 1. With applications for the Incident Management, En Route Driver Information, Traveler Information Services, Pre-Trip Travel Information and Demand Management and Operations user services, traveler interface technologies are needed for communication with transportation consumers. In general, the traveler interface technologies vary from the communications technologies in that they can allow interaction with the user. For example, traveler interface technologies allow motorists to query about conditions on specific routes and provide preference information for input into route selection algorithms.

Note that other user services, such as Public Transportation Management and Emergency Vehicle Management, might utilize some of the technologies included in the traveler interface technical functional area (such as a keyboard). However, the use of the traveler interface technologies in these cases would not be for "traveler interface", or communications with transportation consumers.

The kind of technology used for traveler interface varies, depending on the user service. While a kiosk at a transit station might utilize a touch screen to provide En Route Transit Information, a variable message sign might be used to provide information regarding alternate routes for Incident Management.

Table 5 Traveler Interface Technologies

Technology	Explanation, Examples or Characteristics
Touch Screen	When a user points to an item on the display screen, an infrared light grid overlaying the display screen is broken.
Key pad or key board	Used to input destination or reference data, or request traveler services information (when vehicle not in motion).
Variable message sign	Displays information regarding current traffic or roadway conditions, or alternate routes.
Voice recognition	Allows user to give voice commands to on-board computer without looking away from the roadway.
Voice output	Computerized voice may provide audio warning and advisory information (including route guidance) to augment graphic information
Visual display	Displays route guidance information (via simplified street diagrams and turn arrows), traveler services information, and safety and incident advisories. More detailed graphics are displayed when vehicle is stopped.
Heads up display	Projects route guidance visual display information onto a two-dimensional laser holograph that the motorist can view without looking away from the roadway.

D. CONTROL STRATEGIES

Control strategies include those strategies that the TMC can implement to help control demand for the infrastructure, smooth traffic flow or improve traveler safety. Control strategies may focus on either the freeway or the surface streets, or they may manage traffic on the entire system. On freeways and interstates that experience recurring congestion and have appropriate geometry, ramp metering should be seriously considered.

The control function involves the operation of traffic control measures such as signals, freeway ramp meters and HOV lane restrictions. Control strategies allow the TMC to respond to incidents and other special events by changing signal control to accommodate additional traffic loads on specific links of facilities. Control strategies attempt to increase the efficiency in the roadway network, and generally involve demand reduction techniques. Specific technologies in the control strategies technical functional area are shown in Table 6.

1. USER SERVICES THAT UTILIZE CONTROL STRATEGIES TECHNOLOGIES

As shown in Table 17, technologies in the control strategies technical functional area may be utilized in conjunction with the Traffic Control, Incident Management and Public Transportation Management user services. Signal control and ramp metering technologies may be used to directly influence vehicle volumes on certain links, which may be important for the Incident Management and the Traffic Control user services. Signal prioritization may be provided for transit vehicles, contributing to the Public Transportation Management user services.

Table 6 Control Strategies Technologies

Technology	Explanation, Examples or Characteristics
Ramp metering	Traffic signals at freeway entrance ramps help maintain an acceptable level of service (LOS) on the freeway. Traffic flow improves because vehicles merge onto freeway one at a time rather than in platoons or randomly.
HOV restrictions	Limit use of a lane to certain kinds of vehicles (such as buses and/or registered vanpools) or vehicles that meet the minimum occupancy requirement (such as two or three person carpools).
Signal control	Allows for orderly and efficient movement of vehicles on arterial roadways and through networks. May improve traffic flow and reduce vehicle delay and incidents.
Parking restrictions	Include limits on on-street parking (especially near intersections). May increase capacity.
Ramp/lane closures	Closure of the freeway entrance ramp or freeway lane segment prior to entrance point may help maintain LOS on the freeway.
Road use pricing	Also called congestion pricing, this demand management technique allows variable pricing for peak and off-peak periods.
Reversible lanes	Lane capacity is assigned based on directional distribution of traffic. Examples include reversible HOV lanes.

E. NAVIGATION/GUIDANCE

On-board navigation systems assist the traveler in route planning and route following. Information may be provided via a video display terminal in the vehicle, a heads-up display, voice output, or dash board signals. While this functional area does not necessarily include information on real-time conditions, more advanced systems will integrate this information. Specific technologies in the navigation/guidance technical functional area are shown in Table 7.

1. USER SERVICES THAT UTILIZE NAVIGATION/GUIDANCE TECHNOLOGIES

Technologies in the Navigation/Guidance technical functional area may be used in conjunction with the provision of the Incident Management Emergency Vehicle Management, Public Transportation Management, En Route Driver Information, Pre-Trip Travel Information, and Demand Management user services. For the Pre-Trip Travel Information and Incident Management user services, the navigation/guidance technologies provide information about the local transportation infrastructure, including a map and possible routes. In all other cases, the technologies in the Navigation/Guidance technical functional area would also provide information regarding current vehicle location, and its relationship to the final destination. For the transit user services, this information would not only be of interest to the patrons on-board (as well as the drivers and managers), but it would also be of interest to patrons waiting for the next bus.

Table 7 Navigation/Guidance Technologies

Technology	Explanation, Examples or Characteristics
Position display	Indicates current vehicle position on road network.
Guidance display	Simplified street diagrams and turn arrows guide vehicle while it is I motion. Include information on lane changes, turns, freeway exits, etc.
Map database	Includes road network, and parking facilities; may include speed limits and traffic control information (such as turn restrictions that vary depending on the time of day).
Dead reckoning	Determines vehicle location and orientation based on distance and direction traveled.
LORAN (long range radio navigation system)	Identified vehicle location using multiple transmitters. System initially developed for maritime use, thus most transmitters are located along the coast.
Global positioning system (GPS)	Provides vehicle location based on satellite-based radio tri-lateration system.
Map matching	Provides vehicle location using dead reckoning and map database, requires extensive database for high accuracy.

F. DATA PROCESSING

Data processing includes the management and quality control of all data pertaining to ITS. The data processing function includes all in-vehicle, roadside, and central computer processing. This functional area also includes the algorithms that are used for navigation and for making traffic management decisions. Specific technologies in the data processing technical functional are shown in Table 8.

1. USER SERVICES THAT UTILIZE DATA PROCESSING TECHNOLOGIES

Many of the technologies in the data processing technical functional area provide the "intelligence" in the ITS systems. These technologies are often algorithms that sort through extensive data regarding current and historical conditions, and identify not only the current operation characteristics (and identify them as typical or unusual), but also may provide an optimal management strategy, if action needs to be taken. The recommended action might be a suggested route for a specific emergency vehicle, or a traffic management plan for implementation. Data processing becomes increasingly critical as the volume of data (provided by the surveillance technologies) increases.

Table 8 Data Processing Technologies

Technology	Explanation, Examples or Characteristics
Coupled route selection and traffic control	Algorithms that adjust route guidance recommendations and signal settings based on demand levels.
Database -- static	Contains historical time of day and day of week traffic data. Useful for predicting traffic conditions and identifying unusual conditions.
Database -- dynamic	Contains real-time data describing current traffic conditions. Useful for traffic management decisions.
Route selection algorithms	Estimates optimal routing for individual vehicles based on destinations and route preferences.
Driver, vehicle, and cargo scheduling	Matches available drivers and vehicles to cargo delivery needs, facilitates just-in-time delivery.
Real-time traffic prediction	Calculates current traffic flows, queue lengths, and delays based on volume and speed information indicated by detectors.
Traffic assignment algorithms	Predict traffic loads and link times on network based on current traffic data. Estimate routes that individual vehicles will take based on trip and network characteristics.
Route guidance algorithms	Translate route information into simple directions displayed in the vehicle.
Data fusion techniques	Integrate historical and current data from a variety of sources to provide estimates of traffic characteristics.
Optimal control strategies	Uses algorithms to optimize settings of traffic control devices at central or sub-area TMCs.
Incident detection	Uses algorithms (such as pattern recognition and time series) to

algorithms	detect anomalies or disruptions in traffic flow due to an incident.

G. IN-VEHICLE SENSORS

In-Vehicle sensors include all in-vehicle devices that monitor the individual vehicle and driver. In-vehicle sensors also include sensors that monitor elements of the driving environment that pertain to individual vehicle operation. Specific technologies in the in-vehicle sensors technical functional area are shown in Table 9.

1. USER SERVICES THAT UTILIZE IN-VEHICLE SENSOR TECHNOLOGIES

Technologies in the in-vehicle sensors technical functional area may address a variety of user services, including Emergency Notification and Personal Security, En Route Driver Information, Public Transportation Management, Traveler Information Services and Demand Management and Operation. For the Emergency Notification and Personal Security user service, in-vehicle sensors would check the status of vehicle operating systems and provide notification of malfunction, collision, or other dangerous situation. For the En Route Driver Information, Demand Management and Public Transportation user services, in-vehicle sensors would be used for identification of vehicle location.

Table 9 In-Vehicle Sensor Technologies

Technology	Explanation, Examples or Characteristics
Equipment status sensors	In-vehicle systems programmed to store and/or display engine diagnostics; may also record operating information (speed, acceleration, fuel consumption, etc.).
Vehicle headway sensors	Monitor front and rear headway, as well as side distances and lane position indicators (may use gap radar or other technology).
Odometers	Electronic odometers used in navigation can measure distance traveled in increments of less than one inch.
Electronic compasses	Superimposition of the earth's magnetic field produces a phase shift in the induced voltages of the electronic compass when orientation of compass changes due to a change in vehicle orientation.
Driver fatigue and performance monitoring	Sensors monitor driver conditions, which may include drowsiness, and slow or excessive reactions (sensors may also include breathalyzer, etc.)

H. TECHNICAL FUNCTIONAL AREA PRIORITIES

Based upon the User Services Surveys, the feedback from the Bear Mountain Workshop, and the assessment of existing transportation conditions, the technical functional areas that appear most important in the short and medium term are:

- Surveillance, which is needed to monitor traffic flow, bus flow, emergency vehicle operations, weather and to detect incidents;
- Communications, which are needed to convey traffic and transit information to the appropriate operating agencies as well as to the public;
- Control Strategies, which are needed to optimize the efficiency of freeways and arterial roadways, during typical conditions and in response to incidents;
- Traveler Interface, which is needed to communicate with the public; and
- Data Processing, which becomes increasingly important as the amount of data to be processed increases.

The technical functional that appear less important in the short and medium term are:

- Navigation/Guidance.
- In-Vehicles Sensors.

The technologies in both of these technical functional areas depend heavily on in-vehicle devices and thus may be more appropriate for implementation by vehicle manufacturers, rather than local transportation providers. They are best thought of as long range options as technology matures and diversifies.

I. SELECTION OF INDIVIDUAL FUNCTIONAL ELEMENTS

The importance of the elements of the technical functional areas vary, depending on the objectives and extent of the ITS system. Preliminary examination of the technical functional areas and specific strategies results in expectations regarding the most important technical functional areas and related technologies.

Based on local priorities and examination of the technologies that have been successfully implemented in other cities, as well as the NYC Metropolitan area, the specific strategies and technologies that appear most important in the short and medium term are:

Surveillance
- Loop detectors and/or sensors (infrared, microwave, sonar and/or radar)
- Machine vision (cameras)
- Automatic Vehicle Location (AVL)/Automatic Vehicle Identification (AVI)
- Information provided by police, emergency medical providers, motorist assistance patrol, (HELP), etc.
- Roadway/weather monitors
- Electronic toll tags/probes (TRANSMIT)

Communications
- Local area broadcast (HAR)
- Commercial traffic information companies (Shadow Traffic, Meeting Traffic, etc.)
- Land lines

- Satellite communications
- Cellular/wireless services

Control Strategies
- Signal control
- Ramp metering

Traveler Interface
- Variable message signs
- Kiosks
- Highway Advisory Radio
- Highway Advisory Telephone

Data Processing / Storage (data processing capabilities become increasingly more important as the amount of data to be processed increases
- Static and dynamic databases
- Optimal control strategies
- Incident detection and route guidance algorithms
- Coupled route selection and traffic control
- Real-time traffic prediction

It is more difficult to identify the technologies that may be appropriate in the long term, due to the fact that technology advancements would be expected to have a significant effect on the capabilities and relative costs of the options available.

J. TECHNOLOGY ASSESSMENT

There are three main technology components of an Intelligent Transportation System; Surveillance, Traveler Interface and System Communications. Control Strategies and Data Processing deal more with the system and software aspects. Surveillance technology includes the pavement intrusive and non-intrusive technologies that are used to determine the conditions of traffic and transit flow, as well as the use of closed-circuit television (CCTV) cameras to confirm the exact location and impact of an incident. Traveler Interface involves the use of variable message signs, highway advisory radio, highway advisory telephone, kiosks and electronic bulletin boards to provide outlets for travelers to access information on travel conditions. The System Communications section includes the media currently available for transmission of data, voice and video for Intelligent Transportation Systems. The following is a detailed description of the technologies available in today's market for Surveillance, Traveler Interface and System Communications.

Surveillance

Advanced Traffic Management Systems (ATMS) typically provide two different sub-systems for roadway surveillance: vehicle/traffic flow detectors, and closed circuit television (CCTV) cameras. These two subsystems provide different functions but operate together to provide the transportation management center (TMC) with real-time status of traffic conditions. The vehicle detection sub-system electronically monitors the flow of traffic on the roadways and transmits this information in "real-time" to the TMC for analysis and status displays. The operators utilize the results of the analysis and the status information to make decisions regarding management of the traffic. The CCTV sub-system provides the operators with visual means for verification of the conditions reported by the vehicle detection sub-system. The CCTV images also provide the operator with an independent evaluation of traffic conditions.

Each of these two sub-systems can be deployed and utilized jointly, as well as separately. However, the complementary interaction of the two sub-systems improves the overall system operation in a manner that neither system can provide alone. The vehicle detection system, since it is automated and can function with minimal human intervention, provides continuous surveillance and up-to-the-minute data. The CCTV system allows the human observer to view and interpret an incident, or other traffic conditions, and determine an appropriate response. As more progress is made in the technologies of image processing, artificial intelligence and expert systems, it is inevitable that computer systems will augment the capabilities of the human observer.

Transit ITS Functional Requirements

A limited number of integrated ITS applications are recommended for transit services in the Lower Hudson Valley. The ITS functional requirements recommended include:

- Global Positioning Satellite Based Automated Vehicle Location System,
- computer assisted scheduling and dispatching system,
- en-route traveler information system,
- pre-trip traveler information system,
- intra- and inter-operator service coordination,
- variable messaging systems,
- region-wide digital radio communications system,
- mobile data terminals,
- electronic fare collection and passenger counting, and
- geographic information system.

Some of the basic terms and concepts associated with ITS public transportation applications are presented below. ITS is the application of high tech information systems to the direct and peripheral operations of transportation systems. ITS Systems may typically include the following functions:

- Automated Vehicle Location and Monitoring (AVL),
- Computer Assisted Scheduling and Dispatching,
- Vehicle Systems Monitoring,
- Automated Passenger Counting and Reporting,
- Geographic Information System Mapping,
- Automated Fare Collection and Reporting, and
- Automated Annunciation/Public Address.

These functions can provide service providers with the following types of information:

- The location of transit vehicles,

- The on-time status of transit services,
- The capacity status of transit vehicles,
- Vehicle engine/operating function status, and
- Passenger boarding and fare data.

With this information, ITS enhanced systems make the generation of the following functions and services possible:

- En-route Service status information for the public and transit providers,
- Inter-modal and inter-operator service coordination,
- Trip requests can be made, booked and dispatched in real-time,
- A single fare media can be used on trips involving multiple carriers,
- Provide traveler information for an entire trip, even involving multiple carriers,
- Fare and passenger data collected in real-time and reported automatically,
- Drivers can request and receive navigational assistance on the fly, and
- flexible bus service can be scheduled for better operating efficiency.

The most beneficial applications of such a system are those which facilitate a greater utilization of the existing transportation system resources of the region. That is, moving more people along the highways, trains, buses, etc. To this end, any ITS system developed for the Lower Hudson Valley should be compatible with ITS initiatives being developed in the New York City area (NYSDOT Region 11).

Coordinating ITS initiatives in the New York City region (NYSDOT Region 11) with those in the Lower Hudson Valley region (NYSDOT Region8) will involve several technical and institutional issues. Some of the critical issues which need to be addressed in developing a regional ITS plan, especially one that interfaces with a system to be developed for the New York City region, will include the following:

- Type of fare media to be used (magstripe, smartcard, proximity, other),
- AVL technology application development,
- Radio communications compatibility/capacity,
- General use /requirement of open standards (SAE J-1708),
- System phasing and system integration,
- Communications linkages (operator to operator),
- Institutional framework and decision-making, and
- Database formats and compatibility.

The ITS infrastructure required to facilitate greater regional utilization of the current highway and transit networks can also be used for secondary purposes which have the potential to increase the productivity and efficiency of local transit and paratransit services. For example, the systems which facilitate coordinated bus-to-bus and bus-to-rail transfers, and provides travelers with information about highway conditions and the status of the next express bus, can also be used to better coordinate local bus service and to allow for real-time transit and paratransit demand-responsive services.

Traveler Interface

Traveler interface technologies are typically the mechanisms used to bring information back to the traveling public. They include such devices as VMS, HAR, HAT, computers with electronic bulletin boards, information kiosks, on-board signs and mechanisms such as visual displays in vehicles or advance notification systems for transit stations.

System Communications

Commercial circuits and agency-owner circuits are the two primary alternatives available for system communications. Typical ITS use both of these alternatives, with the chosen mix of types being driven by cost constraints and other technical and system-specific requirements. However, irrespective of the choices to use private or publicly-owned systems, it is of utmost importance that the communications system architecture be designed around common and commercially supported standards so that it has sufficient flexibility to respond to the rapid changes in communications technology. This will enable agencies to utilize emerging lower-cost, faster, and higher capacity circuits, in addition to many of the new wireless communications options that are being spurred by growth in both portable computers and personal communications.