INTELLIGENT TRANSPORTATION SYSTEM ARCHITECTURE
for the
BINGHAMTON METROPOLITAN REGION

BACKGROUND

The Federal Highway Administration issued a Final Rule on Intelligent Transportation System Architecture and Standards in January 2001; the Federal Transit Administration issued a National ITS Architecture Policy on Transit Projects concurrently (see Appendix A for the full text). This action was taken to implement §5206(e) of the Transportation Equity Act for the 21st Century.

The rule required that any region that was implementing ITS projects at the time of the issuance of the rule shall have a regional ITS architecture by February 7, 2005; other regions were required to have an architecture in place within four years of its first ITS project being advanced to final design.

The rule further specifies what an ITS Regional Architecture must include, and that it must follow the framework of the ITS National Architecture. The required components are:

a. A description of the region, timeframe, and service scope;

b. Identification of participating agencies and other stakeholders;

c. An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture;

d. Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture;

e. System functional requirements;

f. Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture);

g. Identification of ITS standards supporting regional and national interoperability; and

h. The sequence of projects required for implementation

The Binghamton Metropolitan Regional ITS Architecture complies with all of these requirements.

INTRODUCTION

The term Intelligent Transportation Systems, or ITS, is generally used to describe the application of advanced technology to the operation of transportation systems. The goal of ITS deployment is to improve the efficiency, reliability, and safety of travel.

ITS often involves:

- **Detection technology**, to provide real time information on how the system is operating. This may include sensors in the pavement or above the roadway that measure vehicle speed, sensors at traffic signals that measure vehicle presence, sensors in vehicles like buses or snowplows that report location, closed-circuit television cameras to provide visual detection/verification of highway incidents, or sensors that provide information on weather conditions.
- **Control technology**, to allow for real time response to traffic conditions. This may include control of traffic signals, either individually or in systems, to respond to changing traffic volumes, preemption by emergency vehicles, or priority for transit vehicles; control of ramp meter signals to manage the flow of vehicles entering a freeway; or control of variable message signs or emergency highway advisory radio to communicate to travelers.
- **Communications technology**, to allow everything to work together. This may include communications from detection devices to traffic management centers, which then communicate to control systems; communications to emergency dispatch centers when incidents are detected; communications to highway maintenance centers in response to weather conditions; and direct communications to travelers via everything from internet sites, to radio traffic report services, to in-vehicle devices, to signs at bus stops and kiosks at employment sites or visitor centers.

ITS encompasses a set of technology-based tools that help us actively manage our transportation system from minute to minute in response to changing conditions. Instead of traffic signals operating on a pre-set timing plan, a central computer may control an entire regional signal system that responds to demand. When a bus is running behind schedule on a busy arterial street, a green signal can be held long enough for the bus to get through. When a crash occurs on the Interstate, travelers can be quickly diverted to a pre-planned detour rather than become part of an inevitable traffic jam. A commuter may look at an Internet site before leaving for work and choose an alternate route or mode based on the information. Trucks can be weighed without stopping and have their credentials checked electronically, increasing the productivity of both drivers and inspectors.

ITS ARCHITECTURE

As described above, deployment of ITS to improve traffic operations can involve numerous types of devices and many agencies. Making sure that all these ITS elements work together as a system can be a significant challenge from both a technical and institutional perspective. While technical standards continue to be developed, interoperability remains an issue when system elements are purchased at different times. Institutional cooperation can be even more of a challenge. Development of an ITS Regional Architecture is a systematic method

for making sure not only that everything works when a project is deployed, but also anticipates future needs so systems can grow without resulting in expensive retrofits. Having defined the geographic area that will constitute an ITS region, and identified stakeholders, the exercise begins in earnest by determining what the needs are that we may best address with ITS tools (for example, in the Binghamton area we may identify better management of incidents on Interstate 81 as important to reduce congestion and improve safety by avoiding secondary crashes in the traffic queue, but have no need to improve toll collection since we have no toll facilities). Next, the appropriate ITS services are identified that can meet those needs, and operational concepts are constructed and functional requirements enumerated. This in turns leads to what may be seen as the key value of creating the ITS architecture: identifying the required interconnections and the information that flows through them.

Continuing the example of incident management on Interstate 81, we would need a way to:

- detect the incident as soon as possible after it occurs;
- determine its exact location;
- verify its specific nature;
- communicate with and dispatch the appropriate law enforcement and emergency service response, as well as highway maintenance and possibly other specialized resources;
- inform travelers about the incident via variable message signs, highway advisory radio, 511 traveler information telephone service, and/or the news media; and
- activate a pre-planned detour if necessary, communicating with local law enforcement and public works personnel involved in the detour route, and turning on a modified traffic signal timing plan to accommodate the volume of detoured traffic.

In order to accomplish all of this, we would establish which of these steps could be automated using ITS technology, what organizations would need to exchange information, and what information they need to exchange to accomplish the desired outcome.

While many larger metropolitan areas have been using ITS for a number of years to address traffic congestion through freeway management, it is relatively new to the Binghamton area. The New York State Department of Transportation has installed overhead variable message signs on Interstate 81 and Route 17, and operates a system of automated road weather information stations. There are some elements of advanced traffic signal systems, including emergency vehicle signal pre-emption.

Being early in the process makes the development of an ITS Regional Architecture all the more beneficial. By defining all of the steps and elements described above, we can be more certain that when we design a project that uses ITS technology, we will get it right the first time. And getting the Architecture right requires that all of the primary stakeholders participate from the beginning so everyone understands each other's needs, constraints, and requirements.

The need for an ITS Regional Architecture is further established in the BMTS long-range regional transportation plan, *TRANSPORTATION TOMORROW:2025*, as noted in this excerpt:

> **SYSTEM MANAGEMENT AND OPERATIONS**
> A key element of providing safe and efficient mobility for both persons and freight is managing the operation of the transportation system. System management often

involves the realtime communication of information between system users and system operators. This may rely on what has become known as “intelligent transportation system” technology, ranging from advanced traffic signal control systems to traveler information systems to advanced transit operations with automatic vehicle locators. System management requires a different perspective than capital construction because of ongoing operational costs.

GOAL: It is the goal of the BMTS to provide for the effective management and operation of the metropolitan transportation system.

OBJECTIVES:

- To ensure proper consideration of “intelligent transportation system” (ITS) technology to enhance personal mobility.
- To develop partnerships among the agencies responsible for operating various elements of the transportation system to facilitate a unified operating strategy.
- To set aside necessary resources for ongoing operational functions.

STEP 1(A): DEFINE THE REGION, TIMEFRAME, AND SCOPE

This ITS Regional Architecture will apply to the Binghamton Metropolitan Region. That has generally been defined as all of Broome County, and the Town of Owego in Tioga County. While the Binghamton urbanized area, as defined by the U.S. Census Bureau, has been extended into Susquehanna County, Pennsylvania along the I-81 corridor, that area will not be included in the regional architecture because of the difference in the institutional structure. As noted in the stakeholders discussion, there will be close coordination with Pennsylvania DOT regarding ITS applications in the I-81 corridor, but they are working to define their own regional architecture for northeast Pennsylvania.

A ten year horizon has been selected for this iteration of the ITS Regional Architecture. This will facilitate the identification of most of the anticipated opportunities for ITS deployment and integration. While a twenty year timeframe would match the BMTS long range transportation plan, it is difficult to forecast ITS needs and opportunities over such a long period.

The scope of this architecture will be generally inclusive of ITS opportunities. There are, however, some systems that are being developed on a statewide level. These will be acknowledged in the Binghamton architecture, but not addressed independently. These systems include commercial vehicle operations applications, the 511 traveler information system, and a proposed statewide electronic information network.

STEP 1(B): IDENTIFY PARTICIPATING AGENCIES and OTHER STAKEHOLDERS

An ITS Regional Architecture will of necessity involve numerous agencies and stakeholders who will play a role in implementation and ongoing operations. It is therefore critical that these participants are identified early so they can be involved in the development of the architecture. This leads to agency buy-in and subsequently to more successful operations.

The following agencies and stakeholders were identified as key participants in the development of the Binghamton ITS Regional Architecture. Those in bold are considered core stakeholders with primary responsibility for development and/or implementation of the architecture; the role of the others will be input and review.

Transportation Agencies:

- Federal Highway Administration
- Federal Transit Administration
- New York State Dept of Transportation
    - Main Office ITS
    - **Region 9 Planning**
    - **Region 9 Traffic Engineering & Safety**
    - **Region 9 Maintenance**
    - **Broome County Resident Engineer**
    - Region 6 Planning
    - Region 6 Traffic Engineering & Safety
    - Region 6 Maintenance

- Tioga County Resident Engineer
- Pennsylvania Department of Transportation
- **Binghamton Metropolitan Transportation Study**
- Broome County
  - **Department of Public Transportation**
  - Department of Public Works/Highways
  - Department of Aviation
  - Information Technology
- Tioga County Department of Public Works/Highways
- Transit Agencies
  - Tioga County Public Transportation
  - Greyhound Bus Lines
  - Shortline/Coach USA

Public Safety Agencies

- **Broome County Office of Emergency Services**
- **New York State Police**
- **Broome County Sheriff**
- Tioga County Sheriff
- Local Police Agencies
  - City of Binghamton
  - Village of Johnson City
  - Village of Endicott
  - Village of Owego
  - Village of Port Dickinson
  - Town of Vestal
- Local Fire Departments
  - City of Binghamton
  - Village of Johnson City
  - Village of Endicott
  - Village of Owego
  - Vestal FD
  - Dickinson – Prospect Terrace FD
  - Endwell FD
- Local EMS Agencies
  - City of Binghamton
  - Union Volunteer Emergency Squad
  - Vestal FD EMS
  - Broome Volunteer Emergency Squad

Other Stakeholders

- AAA of Southern New York
- Broome County Chamber of Commerce
- Tioga County Chamber of Commerce
- Binghamton University
- Local broadcast news media
- Visitor Center representatives (I-81 Gateway Center, Roberson Museum, Endicott)
- Special events organizers (Spiedie Fest, First Night, BC Open, for example)

These stakeholders were engaged at two levels. First, they were invited to participate in a general session that focused on introducing them to a broad understanding of ITS and to the concept of an ITS architecture. Next, they were assigned to one of the following working groups. The groups were developed based on a review by the core group of which market packages would be applicable in the region.

Working Groups:

- Traffic Management (ATMS)
- Emergency Management (EM)
- Traveler Information (ATIS)
- Maintenance and Construction (MC)
- Public Transportation ((APTS)

A listing of stakeholders and working group membership is included in Appendix B.

STEP 2(A): INVENTORY SYSTEMS

An important starting point for the ITS Regional Architecture is enumerating all ITS elements that have already been deployed, who owns and operates them, and what function they serve. As noted in the introduction, there have been few ITS deployments in the Binghamton region.

The ITS Architecture Guidance proposes beginning the inventory by focusing on the centers.

EXISTING		
ITS CENTER	OWNER	DESCRIPTION
Emergency dispatch/911 PSAP	Broome County	Operational. Receives emergency calls, dispatches public safety resources, controls freeway VMS
Maintenance & construction operations	NYSDOT	Most ITS functions not enabled. Receives RWIS input, dispatches highway maintenance resources (weather, incident), can control freeway VMS
Transit operations	Broome County	No ITS functions enabled. Radio dispatch of transit and paratransit buses.
Traffic management	NYSDOT Region 6	Serves primarily maintenance and incident function. No existing interface with NYSDOT Region 9
PLANNED		
Traffic management	NYSDOT Region 9	NYSDOT's plans indicate the establishment of a "24/7" traffic management center in the Binghamton Metropolitan region. Stated functions to include freeway management, incident management, traveler information, arterial signal management

The next portion of the inventory is an enumeration of specific elements, including roadside systems, vehicle systems, and traveler systems.

EXISTING			
ITS ELEMENT	OWNER	DESCRIPTION	FUNCTION
Permanent VMS	NYSDOT Region 9 (may also be operated by Broome County 911 dispatch center)	6 overhead VMS on I-81 and NY Route 17.	Traveler information
Road Weather Information Station	NYSDOT	RWIS stations located along NY 17, I-81, I-88. Detect and report weather and pavement conditions	Roadway winter maintenance decision support
Permanent Continuous Traffic Count Stations	NYSDOT	Various locations on freeway system	Archived data; potential for freeway management
NY 434 Signal System	NYSDOT Region 9	Time based coordination using Time-Warner cable TV infrastructure	Arterial traffic management
Emergency Vehicle Traffic Signal Pre-emption	Municipal govts, NYSDOT	3M Opticom™ system at over 180 intersections	Emergency management
BC Transit Electronic Fare Collection System	Broome County – Dept of Public Transportation	Electronic fareboxes on all BC Transit buses	Passenger and fare management
PLANNED			
NYSDOT Signal Systems	NYSDOT Region 9	Closed loop signal systems on NY 434, US 11 (Front Street) and US 11 (Court St)	Arterial traffic management
Freeway Incident Management	NYSDOT Region 9	Deployment planned for I-81, I-86, I-88 in metropolitan region. May include loop detection, CCTV, additional permanent VMS, HAR	Incident management

Because there are few ITS elements deployed in the Binghamton Metropolitan Region, there is much less concern about “legacy” systems that may not be compatible with future installations.

STEP 2(B): DETERMINE NEEDS AND SERVICES

The deployment of ITS elements must respond to identified needs if the investment in the purchase and operation is effective. Therefore, the ITS Regional Architecture must define regional transportation system needs that can be addressed through ITS. The USDOT guidance document suggests that needs be documented with a sufficient level of detail to provide an understanding of the affected jurisdiction, agency, or location.

For the Binghamton ITS Regional Architecture, stakeholders were engaged in a series of working group meetings to identify needs, using the working groups enumerated in Step 1(B). Since stakeholders have the most direct involvement in providing transportation, public safety, and information services to the travelers, it was felt that they would have the clearest picture of needs.

Traffic Management needs:

- Improve operation of State signalized arterials to reduce congestion and improve safety
  - NY 434, City of Binghamton and Town of Vestal
  - US 11 (Front Street), Towns of Dickinson and Chenango
  - US 11 (Court Street), City of Binghamton, Town of Kirkwood
  - NY17C (segments) City of Binghamton, Village of Johnson City, Village of Endicott, Town of Union
  - Automated pedestrian detection on NY 434
- Improve freeway incident management on NY 17, I-81, I-88 throughout region
  - Continuous speed/volume monitoring
  - Visual verification of incidents on high volume segments
  - Motorist notification of lane and/or road closure
  - Automated detour notification and implementation
- Improve active work zone management
  - NYSDOT principle arterials, throughout region
- Ability to manage traffic from special events
- Reduce truck speeds at critical freeway locations through automated speed monitoring and notification
  - NYSDOT principle arterials, throughout region

Emergency Management needs:

- Improve incident verification in locations where cell-911 calls produce unreliable information
- Daily information to public safety agencies on highway construction and maintenance activities
- Realtime information to public safety agencies on road weather conditions
- Realtime information to public safety dispatchers on location of police and EMS vehicles
- Ability to operate signals during power outages without police manpower
- Improve signal operation on detour routes
- Improve interagency/inter-sector communication
- Ability to accurately inform motorists regarding complex detour routes
- Ability to provide accurate information to drivers of oversize trucks regarding detour routes
- Automated mayday notification from vehicle crashes in rural portion of county

Traveler Information needs:

- Up to date weather/road condition to travelers who are outside the Binghamton region, but are traveling to or through the area
- Website and kiosks to provide traveler information
- List of regional special events with associated realtime traffic and weather information
- Commercial radio traffic information that is accessible in vehicle throughout the region
  - Dedicated radio station for school bus closures, traffic and transit information, and weather conditions

Maintenance and Construction needs:

- Realtime information on location of NYSDOT maintenance vehicles for safety issues
- Improved management of NYSDOT maintenance work zones on high volume/high speed facilities
- Additional Road Weather Information Stations (RWIS)
- Automated ice control treatment on structures in critical locations on high volume/high speed facilities
- Prompt, reliable notification when maintenance forces are needed to assist in incident management
- A NYSDOT web page with work zone info and weather info
- Work zone location information available to emergency services groups.
- Interstate and inter-region work zone information availability.

Public Transportation needs:

- Realtime information to transit dispatcher on location of BC Transit and paratransit vehicles
- Daily information to transit agencies on highway construction and maintenance activities
- Realtime information to transit supervisor on congestion on State arterial streets that are bus routes
- Realtime information to transit supervisor on implementation of pre-planned detour that involves a bus route
- Ability to inform riders of fixed route system schedule problems
- Automated route planning service

The next step is to identify the ITS services that can be used to meet the enumerated needs. For the purposes of the Binghamton ITS Regional Architecture, the menu of services is drawn from the National ITS Architecture “Market Packages”.

Traffic Management Services:

- Network Surveillance (ATMS 1). Includes traffic detectors, supporting field equipment, and communications. Enables traffic managers to monitor traffic and road conditions, identify and verify incidents, and notify information services.
- Surface Street Control (ATMS 3). Traffic signal control equipment, central control and monitoring, and communications links. May range from pre-timed control systems to fully traffic responsive systems.
- Traffic Information Dissemination (ATMS 6). Includes roadside devices to disseminate traffic information to travelers, including variable message signs (VMS) and highway

advisory radio (HAR). Also provides for direct links to media and center-to-center communications.

- Incident Management System (ATMS 8) Includes elements to collect incident information from various sources to detect and verify the incident and provide for the appropriate response. Provides for coordination of incident response with emergency management and other necessary responders.
- Speed Monitoring (ATMS 19). Provides for the monitoring of vehicle speed on a roadway segment, and can provide feedback message on appropriate speed. Can be adjusted by environmental/roadway conditions.

Emergency Management Services:

- Emergency Management (EM 1). Provides for dispatch and tracking of emergency vehicles and related resources.
- Emergency Routing (EM 2). Provides for dynamic routing of emergency vehicles to maximize response efficiency.
- Mayday Support (EM 3). Provides for automated or manual initiation of a request for emergency response; and enables emergency management to locate the user.

Traveler Information Services:

- Broadcast Traveler Information (ATIS 1). Provides for the collection of a wide variety of information on traffic, transit, incidents, weather, and more; and near realtime dissemination via existing infrastructure including broadcast media.
- Interactive Traveler Information (ATIS 2). Provides similar information as in ATIS 1, but via interactive devices including Internet, telephone, kiosks and the like. Includes 511 Traveler Information telephone systems.

Maintenance and Construction Services:

- Maintenance and Construction Vehicle Tracking (MCO 1). Uses automated vehicle location technology (AVL) to track location of vehicles.
- Road Weather Data Collection (MCO 3). Uses fixed roadside sensors and/or vehicle-mounted sensors to collect current road and weather conditions.
- Weather Information Processing and Distribution (MCO 4). Provides for processing and communication of road weather data.
- Roadway Automated Treatment (MCO 5). Uses environmental sensors and automated treatment systems to respond to adverse conditions like roadway icing, and systems to inform drivers when treatment is activated.
- Winter Maintenance (MCO 6). Supports winter road maintenance based on information received from other sources.
- Roadway Maintenance and Construction (MCO 7). Supports services for scheduled and unscheduled maintenance and construction.
- Work Zone Management (MCO 8). Provides for traffic management through work zones as well as communication to other groups on work zone activity.
- Work Zone Safety Monitoring (MCO 9). Systems to improve the safety of work crews and the traveling public.

Public Transportation Services

- Transit Vehicle Tracking (APTS 1). Provides for automated vehicle location system (AVL) to track a transit vehicle's location in realtime, and for fixed-route systems match that information to the schedule.
- Demand Response Transit Operations (APTS 3). Performs automatic driver assignment and monitoring, vehicle routing and scheduling for demand responsive paratransit service.
- Transit Passenger and Fare Management (APTS 4). Allows for on-board management of passenger fare payment and data collection on passenger utilization and loading.
- Transit Security (APTS 5). Provides for physical security of transit passengers on vehicles and at stops/stations.
- Transit Traveler Information (APTS 8). Provides transit information to riders on vehicles and at stops, including such items as realtime schedule, and bus stop annunciation.

STEP 2(C): DEVELOP OPERATIONAL CONCEPT

The next step in the architecture is to match the needs and services, understand how the services can be built into operational systems, and develop an operational concept for each. The ITS Final Rule states that an operational concept "identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture". The role relates to the transportation function; for example, "manages traffic on arterial streets". The responsibility relates to delivery of a specific identified service; for example, "initiates signal timing plan for special events".

In developing the operational concepts for the Binghamton Regional Architecture, there is a focus on a set of centers that will provide the services:

- **Regional Traffic Management Center (TMC).** This center will be operated by NYSDOT. Efficiencies in staffing will be gained if it is co-located with an Emergency Management Center. The TMC may be placed administratively within the structure of the NYSDOT Regions (9 and 6), or it may operate outside of that structure. It may have responsibilities for a larger geographic region than the Binghamton Metropolitan Region, but for the purpose of this regional architecture, the focus will be on the metropolitan area.
  - **Roles of the TMC:**
    - Freeway incident management on I-81, I-88, and NY 17 (future I-86)
    - Arterial street traffic management on US 11 (Front Street), US 11 (Court Street), NY 17C, and NY 434
    - Active work zone management on principal arterials
    - Traveler information dissemination
  - **Responsibilities of the TMC:**
    - Freeway incident management:
      - Incident detection through traffic speed detection devices
      - Incident verification through CCTV
      - Coordination with Emergency Management Center
      - Dispatch of NYSDOT maintenance vehicles/resources
      - Dissemination of traveler information through activation of VMS and HAR
    - Arterial street traffic management

- Initiation of traffic signal timing plans to accommodate detours of special events
- Notification of local law enforcement agencies of detour activation and suspension

- Active work zone management
  - Oversee the operation of work zone travel time/speed detection and traveler information dissemination
- Traveler information dissemination (in addition to freeway incident management)
  - Real time traffic information
  - Road weather information
  - Special event traffic and parking information
  - Emergency notifications (AMBER Alert, for example)

- **Regional Maintenance and Construction Operations Center (MCO).** This center will also be operated by NYSDOT, and may be incorporated in the TMC but perform as a separate functional center. As with the TMC, its responsibilities are likely to cover all of NYSDOT Region 9.
  - **Roles of the MCO:**
    - NYSDOT maintenance and construction vehicle tracking
    - Road weather information collection and dissemination
    - State highway maintenance and construction management
    - State highway winter maintenance management
  - **Responsibilities of the MCO**
    - Dispatch NYSDOT maintenance vehicles
      - Dispatch resources to incidents when requested by TMC or EMC
    - Maintain daily list of NYSDOT construction and maintenance work zones; transmit to TMC and EMC.
    - Receive road weather information and transmit to State and local maintenance forces, and to the TMC and EMC

- **Broome County Emergency Management Center (EMC).** This center is operated by the Broome County Department of Emergency Services, and is presently located at the Broome County Public Safety facility. It acts as the 911 public safety answering point (PSAP), and dispatches most of the law enforcement, fire service, and EMS assets in the county.
  - **Roles of the EMC:**
    - Emergency management, including incident verification and dispatch of assets.
    - Emergency vehicle routing support
  - **Responsibilities of the EMC:**
    - Receive notification of emergencies and incidents via 911 calls, from TMC, or from Mayday services
    - Dispatch emergency services resources, including police, fire, and EMS
    - Activate roadside traveler information devices when TMC is unavailable
    - Advise emergency vehicle operators of road conditions or work zones that may interfere with travel
    - Using AVL and information from TMC and MCO, provide routing support to emergency vehicles for most efficient response

- **Broome County Transit Management Center (TranMC).** This center will be operated by the Broome County Department of Public Transportation, and will likely be located at their facility on Old Mill Road in the Town of Vestal, pending the construction of the Binghamton Intermodal Transit Terminal.
  - **Roles of the TranMC:**
    - BC Transit vehicle tracking and schedule management
    - BC Lift and BC Country paratransit dispatch, vehicle tracking, and schedule management
    - Transit traveler information management and dissemination
  - **Responsibilities of the TranMC:**
    - Track location of BC Transit (fixed route) buses in comparison to schedule; determine root cause if late
    - Dispatch BC Lift and BC Country paratransit vehicles; using AVL, track location and determine root cause off schedule
- Update transit traveler information devices: website, kiosks, VMS at transit stops

STEP 2(D): DEFINE FUNCTIONAL REQUIREMENTS

This step provides more detail about how each piece of the ITS system will function. As noted in the guidance document, this is a high-level description rather than a detailed system design. "A region can choose to develop their systems using object-oriented analysis, functional analysis, or whatever methodology they choose. The real objective of a regional ITS architecture is to clearly define interfaces and the responsibilities on both sides of the interface, and keep the implementation details used by any particular system as transparent as possible."

For the Binghamton ITS Regional Architecture, functional requirements are enumerated in terms of the "Equipment Packages" defined in the National ITS Architecture. These Equipment Packages derive from the Market Packages referenced as services in Step 2(B).

- **Regional TMC: Functional Requirements**
  - The TMC shall provide the capability to detect and verify incidents on NY 17, I-81, and I-88 by collecting and analyzing data from traffic surveillance equipment.
    - Market Package ATMS 01 - Equipment Packages:
    - Roadway Basic Surveillance This equipment package monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
    - Collect Traffic Surveillance: This equipment package collects, stores, and provides electronic access to the traffic surveillance data.
    - Traffic Maintenance: This equipment package provides monitoring and remote diagnostics of field equipment to detect field equipment failures, issues problem reports, and tracks the repair or replacement of the failed equipment.
  - The TMC shall provide the capability for controlling traffic signal operations on State signalized arterial streets (NY 434, US 11/Court Street, US 11/Front Street, NY 17C)
    - Market Package ATMS 03 – Equipment Packages:
    - TMC Signal Control: This equipment package provides the capability for traffic managers to monitor and manage the traffic flow at signalized intersections. This capability includes analyzing and reducing the collected data from traffic surveillance equipment and developing and implementing control plans for

signalized intersections. Control plans may be developed and implemented that coordinate signals at many intersections under the domain of a single traffic management subsystem. In advanced implementations, this package collects route planning information and integrates and uses this information in predicting future traffic conditions and optimizing the traffic control strategy for these conditions. These capabilities are achieved through real-time communication of logged routes from an Information Service Provider. The planned control strategies can be passed back to the Information Service Provider so that the intended strategies can be reflected in future route planning.

- The TMC shall provide the capability for incident management and response, including detection, verification, and coordination with emergency management.
  - Market Package ATMS 08 – Equipment Packages
  - TMC Incident Detection: This equipment package provides the capability to traffic managers to detect and verify incidents. This capability includes analyzing and reducing the collected data from traffic surveillance equipment, monitoring external alerting and advisory and incident reporting systems, collecting special event information, and monitoring for incidents and hazardous conditions through available sensor and surveillance systems.
  - TMC Incident Dispatch Coordination/Communication: This equipment package provides the capability for an incident response formulation function minimizing the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.
  - Emergency Response Management: This equipment package provides the strategic emergency response capabilities and broad inter-agency interfaces that are implemented for extraordinary incidents and disasters that require response from outside the local community. It provides the functional capabilities and interfaces commonly associated with Emergency Operations Centers. This equipment package develops and stores emergency response plans and manages overall coordinated response to emergencies. It tracks the availability of resources and assists in the appropriate allocation of these resources for a particular emergency response. This equipment package provides coordination between multiple allied agencies before and during emergencies to implement emergency response plans and track progress through the incident. It provides vital communications linkages that provide real-time information to emergency response personnel in the field.
- The TMC shall provide the capability for disseminating traffic information to travelers.
  - Market Package ATMS 06 – Equipment Packages
  - TMC Traffic Information Dissemination: This equipment package provides the capability to disseminate traffic and road conditions information to travelers. Information is provided to drivers using DMS, HAR, and in-vehicle signing equipment. Information is provided to other travelers by making current road network conditions information available to information service providers and the media.

- Roadway Traffic Information Dissemination: This equipment package provides the roadside elements of traffic information dissemination including DMS, HAR, and talking pedestrian signs.

· The TMC shall provide the capability for monitoring vehicle speeds in critical locations
  - Roadway Speed Monitoring: This equipment package monitors vehicle speeds. If the speed is determine to be excessive, then roadside equipment can suggest a safe driving speed. Environmental conditions may be monitored and factored into the safe speed advisories that are provided to the motorist. This equipment package can also provide an enforcement function, reporting speed violations to an enforcement agency.

È **Regional MCO: Functional Requirements**

· The MCO shall provide the capability for automated tracking of NYSDOT maintenance vehicles.
  - Market Package MCO 01 – Equipment Packages:
  - MCV Vehicle Location Tracking: This equipment package tracks vehicle location and reports this location to a dispatch center.

· The MCO shall provide the capability for the collection and dissemination of road weather information.
  - Market Packages MCO 03 and MCO 04 – Equipment Packages:
  - Roadway Environmental Monitoring: This equipment package measures environmental conditions and communicates the collected information back to a center where it can be monitored and analyzed. A broad array of general weather and road surface information may be collected. Weather conditions that may be measured include temperature, wind, humidity, precipitation, and visibility. Surface and sub-surface sensors can measure road surface temperature, moisture, icing, salinity, and other measures.
  - TMC Environmental Monitoring: This equipment package assimilates current and forecast road conditions and surface weather information using a combination of weather service provider information and an array of environmental sensors deployed on and about the roadway. The collected environmental information is monitored and presented to the operator. This information can be used to more effectively deploy road maintenance resources, issue general traveler advisories, and support location specific warnings to drivers. Other equipment packages process the collected information and provide decision support.
  - Emergency Environmental Monitoring: This equipment package assimilates current and forecast road conditions and surface weather information from a variety of sources, including both weather service providers and vehicle probes. The collected environmental information is monitored and presented to the operator. This information can be used to more effectively manage incidents.

· The MCO shall provide the capability for support of NYSDOT winter maintenance activities.
  - Market Package MCO 06 – Equipment Packages:
  - MCM Winter Maintenance Management: This equipment package manages winter road maintenance, tracking and controlling snow plow operations, roadway treatment (e.g., salt spraying and other material applications) based on weather information.

- The MCO shall provide the capability for support of NYSDOT scheduled and unscheduled maintenance activities.
  - Market Package MCO 07 – Equipment Packages
  - MCM Roadway Maintenance and Construction: This equipment package provides overall management and support for routine maintenance on a roadway system or right-of-way. Services managed are landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling routine maintenance activities.
- The MCO shall provide the capability for management of work zones and traffic through work zones.
  - Market Package MCO 08 – Equipment Packages
  - MCM Work Zone Management: This equipment package remotely monitors and supports work zone activities, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zones.

È **Broome County EMC: Functional Requirements**

- The EMC shall provide the capability for the dispatch and tracking of emergency vehicles and related resources.
  - Market Package EM 01 – Equipment Packages
  - Emergency Call-Taking: This equipment package supports the emergency call-taker, collecting available information about the caller and the reported emergency, and forwarding this information to other equipment packages that formulate and manage the emergency response. This equipment package receives 9-1-1, 7-digit local access, and motorist call-box calls and interfaces to other agencies to assist in the verification and assessment of the emergency and to forward the emergency information to the appropriate response agency.
  - Emergency Dispatch: This equipment package supports safe and efficient dispatch of emergency vehicles. It tracks the location and status of emergency vehicles and dispatches these vehicles to incidents. Pertinent incident information is gathered from the public and other public safety agencies (see the Emergency Call-Taking equipment package) and relayed to the responding units. Incident status and the status of the responding units is tracked so that additional units can be dispatched and/or unit status can be returned to available when the incident is cleared and closed.
- The EMC shall provide the capability for dynamic routing of emergency vehicles to maximize response efficiency.
  - Market Package EM 02 – Equipment Packages
  - Emergency Routing: This equipment package supports routing of emergency vehicles and enlists support from the Traffic Management Subsystem to facilitate travel along these routes. Routes may be determined by this equipment package

based on real-time traffic information and road conditions or routes may be provided by the Traffic Management Subsystem on request.
    - Vehicle Location Determination: This equipment package determines current location information and provides this information to other equipment packages that use the location information to provide various ITS services.
- The EMC shall provide the capability for acquisition of and response to automated emergency calls (Mayday services).
    - Market Package EM 03 – Equipment Packages:
    - Mayday Support: This equipment package receives Mayday messages and security alarms, determines an appropriate response, and either uses internal resources or contacts a local agency to provide that response. The nature of the emergency is determined based on the information in the mayday or alarm message as well as other inputs. This package effectively serves as an interface between automated mobile mayday systems and alarm systems and the local public safety answering point for messages which require a public safety response. This equipment package represents the general security services provided by telematics service providers as well as more specific services that focus on commercial vehicle safety and security.

Broome County Transit Management Center: Functional Requirements

- The TranMC shall provide the capability for realtime tracking of BC Transit fixed-route buses, and BC Lift and BC Country paratransit vehicles.
    - Market Package APTS 01 – Equipment Packages:
    - Transit Center Tracking and Dispatch: This equipment package provides the capabilities for monitoring transit vehicle locations and determining vehicle schedule adherence. The equipment package shall also furnish users with real-time travel related information, continuously updated with real-time information from each transit system within the local area of jurisdiction, inclusive of all transportation modes, from all providers of transportation services, and provide users with the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents conditions, weather conditions, and special events. This equipment package also supports the capability for two-way voice communication between the transit vehicle operator and a facility, two-way data communication between the transit vehicles and a facility.
    - On-board Transit Trip Monitoring: This equipment package provides the capabilities to support fleet management with automatic vehicle location and automated mileage and fuel reporting and auditing. This package may also record other special events resulting from communication with roadside equipment. This includes only the equipment on board the vehicle to support this function including the vehicle location devices such as GPS equipment, communication interfaces, a processor to record trip length, and the sensors/actuators/interfaces necessary to record mileage and fuel usage.
- The TranMC shall provide the capability for the support of demand responsive transit operations: BC Lift and BC Country.
    - Market Package APTS 03 – Equipment Packages
    - Transit Center Paratransit Operations: This equipment package provides the capability to automate planning and scheduling, allowing paratransit and flexible-

route transit services to develop, print and disseminate schedules, and automatically update customer service operator systems with the most current schedule. In addition, this equipment package provides the capability to assign vehicle operators to routes in a fair manner while minimizing labor and overtime services, including operator preferences and qualifications, and automatically tracking and validating the number of work hours performed by each individual operator. These capabilities shall be provided through the utilization of dispatch and fleet management software running on a workstation type processor.

- o On-board Paratransit Operations: This equipment package forwards paratransit and flexible-route dispatch requests to the operator and forwards acknowledgements to the center. It coordinates with, and assists the operator in managing multi-stop runs associated with demand responsive, flexibly routed transit services.

· The TranMC shall provide the capability for disseminating realtime transit information to riders on vehicles and at stops.

- o Market Package APTS 08 – Equipment Packages:
- o Remote Transit Information Services: The equipment package furnishes transit users with real-time travel-related information at transit stops, multi-modal transfer points, and other public transportation areas. It provides transit users with the latest available information on transit routes, schedules, transfer options, bicycle accessibility, fares, real-time schedule adherence, current incidents, weather conditions, and special events. In addition to tailored information for individual transit users, this equipment package supports general annunciation and/or display of imminent arrival information and other information of general interest to transit users.
- o Transit Center Information Services: This equipment package collects the latest available information for a transit service and makes it available to transit customers and to Information Service Providers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are enroute. Information provided can include the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, and special events. In addition to general service information, tailored information (e.g, itineraries) is provided to individual transit users.
- o On-board Transit Information Services: The equipment package furnishes enroute transit users with real-time travel-related information. Current information that can be provided to transit users includes transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, non-motorized transportation services, and special events are provided. In addition to tailored information for individual transit users, this equipment package also supports general annunciation and/or display of general schedule information, imminent arrival information, and other information of general interest to transit users.

STEP 3: DEFINE INTERFACES and INFORMATION FLOWS

In order to carry out the roles and responsibilities outlined in the previous step, it is necessary to specify how information flows among the various centers and elements that comprise the ITS architecture. For example, the TMC may be notified of an incident on I-81 through information from a speed/volume detector (roadside element), verify the incident using input from a CCTV (roadside element), notify the TMC (center-to-center), notify the MCO if maintenance resources will be required (center-to-center), and put up a message on the VMS (roadside element).

The following table shows all of the information flows recognized in the Regional Architecture.

The details of the architecture have been developed using TurboArchitecture 2.0. This is software developed for the Federal Highway Administration for the purpose of creating and maintaining a regional ITS architecture in a framework that is compatible with the National ITS Architecture. The graphic output from TurboArchitecture cannot be conveniently displayed in this report. It is available on the BMTS website at www.bmtsonline.org

STEP 4: IMPLEMENTATION

Once the ITS architecture is adopted, it can serve its purpose of being the blueprint for ITS deployment in the Binghamton metropolitan region. Through defining operational concepts and functional requirements, project developers can make sure that the design of ITS elements accommodate not only the specific needs of the project, but also planned expansion for identified future functions. This will also require a discussion of how ITS standards are used in procurements to ensure future interoperability. The National Transportation Communications for ITS Protocol (NTCIP) sets the basis for standards, many of which are still in development.

Because ITS architecture recognizes both technical and institutional linkages, the architecture will also be useful in identifying which agencies and organizations will need to cooperate to achieve the desired functions. The interagency agreements may cover very specific items, like how images from CCTV cameras will be used, to much broader concerns like shared staffing of a TMC.

There has been general agreement that the highest priority be assigned to establish the Regional TMC. An opportunity exists in the context of a planned construction project at the NY 17/Interstate 81 junction/overlap at Prospect Mountain. A primary outcome of the project is the designation of that segment of NY 17 as Interstate 86. Because many of the ITS applications, particularly in the incident management arena, focus on the principal arterial freeway system, and in particular on that location, it may prove imperative to put them in place as part of the project. A project architecture is being developed separately as part of the project design, but will necessarily conform to the Regional Architecture. Most of the roles and responsibilities related to managing traffic and incidents in this location are assigned to the TMC, which leads in turn to giving it a high priority.

It is envisioned that an ITS Strategic Plan will be developed as a follow on activity to the Regional Architecture. The Plan will provide a detailed map of project sequencing, standards, and interagency agreements.