University Transportation Research Center - Region 2

# Final Report

## Integrated Incident Management System (IIMS) Web Client Application Development, Deployment and Evaluation Staten Island (SI) Demonstration Project

Performing Organization: New York University (NYU)

**September 2015**

**Sponsor:**
**New York State Department of Transportation (NYSDOT)**

## University Transportation Research Center - Region 2

The Region 2 University Transportation Research Center (UTRC) is one of ten original University Transportation Centers established in 1987 by the U.S. Congress. These Centers were established with the recognition that transportation plays a key role in the nation's economy and the quality of life of its citizens. University faculty members provide a critical link in resolving our national and regional transportation problems while training the professionals who address our transportation systems and their customers on a daily basis.

The UTRC was established in order to support research, education and the transfer of technology in the field of transportation. The theme of the Center is "Planning and Managing Regional Transportation Systems in a Changing World." Presently, under the direction of Dr. Camille Kamga, the UTRC represents USDOT Region II, including New York, New Jersey, Puerto Rico and the U.S. Virgin Islands. Functioning as a consortium of twelve major Universities throughout the region, UTRC is located at the CUNY Institute for Transportation Systems at The City College of New York, the lead institution of the consortium. The Center, through its consortium, an Agency-Industry Council and its Director and Staff, supports research, education, and technology transfer under its theme. UTRC's three main goals are:

**Research**

The research program objectives are (1) to develop a theme based transportation research program that is responsive to the needs of regional transportation organizations and stakeholders, and (2) to conduct that program in cooperation with the partners. The program includes both studies that are identified with research partners of projects targeted to the theme, and targeted, short-term projects. The program develops competitive proposals, which are evaluated to insure the mostresponsive UTRC team conducts the work. The research program is responsive to the UTRC theme: "Planning and Managing Regional Transportation Systems in a Changing World." The complex transportation system of transit and infrastructure, and the rapidly changing environment impacts the nation's largest city and metropolitan area. The New York/New Jersey Metropolitan has over 19 million people, 600,000 businesses and 9 million workers. The Region's intermodal and multimodal systems must serve all customers and stakeholders within the region and globally.Under the current grant, the new research projects and the ongoing research projects concentrate the program efforts on the categories of Transportation Systems Performance and Information Infrastructure to provide needed services to the New Jersey Department of Transportation, New York City Department of Transportation, New York Metropolitan Transportation Council , New York State Department of Transportation, and the New York State Energy and Research Development Authorityand others, all while enhancing the center's theme.

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16. Abstract

This evaluation report provides background on the development and findings. The aim of the UTRC project was to develop and deploy Portable IIMS based on Smartphone web applications. Previously, traditional IIMS was deployed in the field vehicles networked to central system. The transition from the vehicle-based IIMS to portable smartphones based applications has enhanced Stakeholders' experiences and ability to increase usage, and now ready for large-scale deployment. The users and stakeholders-agencies have concluded this effort as a success.

The observations reveal field situations where IIMS can improve incident response operations. The following are some of the high level findings that led the research team to conclude that the project was the right system for the users in Region 11 and can be extended to other regions and their Traffic Management Centers (TMCs):

- Responders have opportunity to gather more detailed data and transmit in real- time to others for simultaneous decision making to improve response time and proper resources.
- Reduction in roadway damage condition assessment and repair needs and minimize lane closures and incident duration. (e.g. overturned trucks and multiple lane closures).
- Reduction in incident verification and communications times.
- The evaluation case studies have shown the potential for IIMS to further improve mobility and emergency management such as snow conditions.
- IIMS has the potential to improve traveler and responder safety
- Reduction in exposure times for responding personnel.
- IIMS has the potential to provide energy and environmental benefits.
- IIMS has improved the incident management documentation process, with 24/7 archived data availability as well as ability to update reports off-line.
- IIMS has improved the post-incident analysis process through the provision of a centralized database of incident records and through the maintenance of archived

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# Final Evaluation Report

# Integrated Incident Management system (IIMS) Web Client Application Development, Deployment and Evaluation

## Staten Island (SI) Demonstration Project

**September 27, 2015**

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Task 14 Report

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(UTRC)
City University of New York

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# EXCECUTIVE SUMMARY

## Introduction

**The Integrated Incident Management System (IIMS)** is a New York State owned real-time incident management system that enhances the incident management process through improved communications among the participating agencies. The IIMS project is under the overall direction of the New York State Department of Transportation (NYSDOT), with direct oversight through NYSDOT's Region 11 Office.

This evaluation report provides background on the development and findings. The aim of the UTRC project was to develop and deploy Portable IIMS based on Smartphone web applications. Previously, traditional IIMS was deployed in the field vehicles networked to central system

The transition from the vehicle-based IIMS to portable smartphones based applications has enhanced Stakeholders' experiences and ability to increase usage, and now ready for large-scale deployment. The users and stakeholders-agencies have concluded this effort as a success.

The observations stated in Section 5 reveals field situations where IIMS can improve incident response operations. The following are some of the high level findings that lead us to conclude that the project has indeed build a right system for the users in Region 11 and can be extended to other regions and their Traffic Management Centers (TMCs):

- Responders have opportunity to gather more detailed data and transmit in real-time to others for simultaneous decision making to improve response time and proper resources.
- Reduction in roadway damage condition assessment and repair needs and minimize lane closures and incident duration. (e.g. overturned trucks and multiple lane closures).
- Reduction in incident verification and communications times.
- The evaluation case studies have shown the potential for IIMS to further improve mobility and emergency management such as snow conditions.
- IIMS has the potential to improve traveler and responder safety
- Reduction in exposure times for responding personnel.
- IIMS has the potential to provide energy and environmental benefits.
- IIMS has improved the incident management documentation process, with 24/7 archived data availability as well as ability to update reports off-line.
- IIMS has improved the post-incident analysis process through the provision of a centralized database of incident records and through the maintenance of archived

records (under the Web-services version), which allow for individual agency and State-level report creation.

## Summary of Key Findings: IIMS Networking (Table 5 in Main Section)

| | Outcomes | Incremental Values |
|---|---|---|
| **Finding 1:** IIMS has now acquired an **universal connectivity** platform-open to all users and devices | ▪ Modified IIMS with web Client is a successful outcome from the Phase 2e development | ▪ Web connectivity with common URL<br>▪ Independent of device location, type of smartphones or desktops deployed<br>▪ 24/7 anywhere always-on web service |
| **Finding 2:** IIMS is now ***fully Integrated*** with the NYSDOT/NYC Operational IT Environments | ▪ High level commitment to collaborative efforts<br>▪ "Integrated" IMS that supports traffic incident management practice in the regions of the NYS | ▪ Operational support from DoITT and NYSOIS as IIMS now a mainstreamed operational system<br>▪ IIMS is now similar to B2B (Business to Business) web services within governments |
| **Finding 3: Web services** application has resulted in cost savings to both project and users at agencies.<br><br>Potential for wider use of IIMS is created by modified IIMS. | ▪ Reduced system hardware<br>▪ Deployments of existing and new off-the –shelf portable devices will add more users at cost savings | ▪ Central database and servers are reduced to minimum. General purpose portable devices are hand-held and user friendly, requiring minimum upkeep<br>▪ Portable units have now replaced vehicle-based mobile units, reducing initial investments drastically, and recurring vehicle maintenance costs.<br>▪ Wider use of IIMS in the field is now widely possible. |
| **Finding 4: Improved center to center communications** is enhanced with 24/7 always on Web Connectivity with JTC and other centers such as TRANSCOM, B&T, region 10 INFORM and others. | ▪ IIMS is now an "Interoperable System"- with which centers can supply and receive information on roadways and transit system and use that information to improve their operations. | ▪ Modified IIMS supports both NYCSRA and NYS ITS architecture dataflows and services packages for ATMS and EM functions.<br>▪ ITS deployments within the NYS will benefit from web-based IIMS.<br>▪ IEEE 1512 is supported and EM community is wells served for HazMat operations and evacuations in the region. |

## Table 6 Summary of Key Findings: IIMS Functionality-Development

| | Outcomes | Incremental Values |
|---|---|---|
| **Finding 5:** Portable Smartphone based IIMS helps in **gathering more data** in all formats and makes easier to communicate to central system | ▪ Builds on previous successful practice of data entries and creation of incident<br>▪ Seating in a vehicle-away from the scene is eliminated | ▪ Responders is on the scene, and not inside a vehicle anymore, leaving him/her free to secure scene as per primary task<br>▪ While observing the scene, responders can gather more data<br>▪ System now allows taking photos, text messages, and record voice message and in near-future can also add video clips to transmission. On device video can also be downloaded alter. |
| **Finding 6: Portable Smartphone based system enables direct access for managers** and supervisors with smartphones-they "See" incident and begin to react quickly and forcefully. | ▪ Higher level management assigns priority to response quickly<br>▪ Faster response, reduces overall response time | ▪ Mangers are typically equipped with smartphones, thus they are able to see and act quickly on coordination needs and scale of response<br>▪ Level of interagency and interagency communications rises due to visual images on incidents and knowledge of who is at scene in real time. |
| **Finding 7: Portable system has created an opportunity to improve** and update maps; speed of picture transmission and system upkeep exists. | ▪ Maps are old, should be updated<br>▪ Photos take time to upload-speed an issue<br>▪ System must be supported | ▪ Evaluation has found references to these functions, and development will address them.<br>▪ GDIT has a plan to support IIMS services 24/7. |
| **Finding 8:** IIMS now operates in the **Web environment** as environed by the project managers and developers.<br><br>Overarching usefulness of IIMS within the city/state agencies has been established. | ▪ Connects agencies-collaboration<br>▪ Connects responders-coordination<br>▪ Connects internal systems-Integration<br>▪ Connects center-communications<br>▪ Connects to TIM-response time reduction. | ▪ Common incident reporting format<br>▪ Inter-agency communications<br>▪ Resource coordination<br>▪ Agency culture<br>▪ Archived data for training, planning and policy making<br>▪ Regional ITS architectures and deployments<br>▪ Complying with national standards and USDOT requirements |

| | | |
|---|---|---|
| **Finding 9 : <u>System Development</u>**<br><br>The final deployment from the IIMS UTRC contract **has resulted in a state of art Portable** | ▪ IIMS Android and iOS clients exceed the stated deliverables from the smartphone research task.<br>▪ Created awareness of portable technology | ▪ Can be readily exported to other areas of the state<br>▪ Extended to other user groups<br>▪ Bridges to other systems such as SMARTS, ATIS, 511, ATMS…<br>▪ Connectivity: Field to System, Center-to Center-Interoperability |

## Synergy of IIMS with ITS Deployments in the State Regions

Like IIMS, example systems are also based on Geo-Leaner referencing system-LRS, GPS, TMC-based databases interfaces, SOPs for operational coordination among multi-agencies and shared information. The following information is derived from the evaluation team's proxy-gap analysis based on current literature, presentations and ITS standards information for C2C and C2F devices and systems.

For example, a C2C common TMDD based ATMS with XML web service application (NTCIP 2304 and IEEE 1512) can easily communicate to multiple TMCs in real-time and share IIMS gathered information and update web services on a portable platform such as now available Android Smartphones. Regional TMCs such as JTMC, INFORM and Hudson Valley TMC can make operational decisions based on common information without human-intervention and coordinate with TRANSCOM.

IIMS gateway adds another dimension to a disaster recovery mode or system fault or system failure; TMCs operation staff cans alternative use portable IIMS systems. (IIMS does NOT share servers at NYC DOITT or NYSDOT).

| | **Basis of Analysis** | **Incremental Values to ITS Efforts** |
|---|---|---|
| **Finding 10 ATMS-ATIS, SMARTS and OpenReach** | ▪ Explore if IIMS supplied data be used to support operation decisions in real-time? | ▪ Archived Information can be viewed for analysis purpose and can be used in training purposes.<br>▪ Enhances TIM operations, responders' SOPs.<br>▪ Interoperability |
| **Finding 11 511NY** | ▪ Regional-statewide information | ▪ Improves quality of information on field conditions<br>▪ Other aspects need to be researched. |
| **Finding 12 HELP** | ▪ Should HELP responders deploy IIMS portable device? | ▪ HELP responders can be easily added to Android/iOS platform and report field conditions<br>▪ Reduced response time |
| **Finding 13 ATDM/ICM** | ▪ IIMS can be integrated a as part of ICM<br>▪ During event, IIMS can be used to manage demand and support strategy | ▪ Speed management<br>▪ Demand management<br>▪ Other benefits not yet known |
| **Finding 14 Connected Vehicle Environment** | ▪ CV is a new and emerging program in the state<br>▪ Offers opportunity to participate in policy | ▪ Infrastructure standards<br>▪ Safety benefits<br>▪ Vulnerable Road Users-VRUs<br>▪ Investment and POLICY formation |

| | | |
|---|---|---|
| | formation on V2I strategy, standards and investments | ▪ Needs further research on potential benefits |

## Conclusions

Like any other investments made in ITS systems and deployments, IIMS also nurtures and enables two critical aspects of Traffic Incident Management (TIM) with respect to real-time information gathering and using it for monitoring, condition reporting and assessment of needed response and right level of resources. For example, several users indicated that IIMS produced information is authentic and provide consistent details of roadway structures and conditions nearly instantly which in turn makes easier to get "*right party*" to "*respond with right resources*". Looking from operational management aspects aspects, some operators indicated how IIMS "*complements*" investments in Variable Message Signs (VMS) and CCTV locations used during emergencies and incidents.

The evaluation team has concluded that over the past many years the benefits realized from the deployments of IIMS in Region 11 are significant and supports missions and objectives of the agencies and public at large for safety and mobility improvements in the region.

As an enhanced incident management tool, modified Portable IIMS web applications has presented a significant opportunity for responders in the field, and decision makers in offices and JTMC to save time and quickly respond to the event needs with proper level of response. This contributes to overall Traffic Incident Management (TIM) practice in the state.

This is attributed to responders' enhanced ability to gather and transmit more detailed data (e.g. pavements and structural damage) simultaneously to others (managers, experts and upper management) for response, with photos, video, text and E-Mail process.

The following conclusions were reached based on evaluation team's observations and interactions with the project team and users:

- **Conclusion #1:** The current phase of the IIMS project (UTRC) has successfully achieved a technical-institutional transition from the traditional vehicle-based IIMS to *Portable IIMS* with Smartphone Web Applications. This will create an enhanced capability for field responders to gather more detailed condition data and report quickly to others as they now can walk-around the scene more freely and farther-closer to infrastructures.

- **Conclusion #2**: Current difficulties in procurement of smartphones at both NYS and NYC agencies has somewhat limited deployments of web applications. However, it is expected that agencies will very likely add more users equipped with smartphones in the future as they see benefits and current smartphone revolution in the country.

- **Conclusion #3:** IIMS is a 24/7 real-time communication system and presents a significant usage when integrated with other investments made by state in

regional TMCs and ITS field devices and subsystems. IIMS uses standards and that makes easier to bridge it to operational capabilities of ITS components.

- **Conclusion #4**: Because IIMS is already being supported by the central IT departments at both NYS and NYC in technical management, greater awareness and internal collaboration is maximized. This helps transportation departments to deal with system projects in general and for enterprise-wide applications.

- **Conclusion #5:** Engaging new users in both Region 11 context and adding new users in other parts of the state will present challenges at various levels (Why should I use IIMS? What benefits will we get? However, IIMS has evolved and proven its worth and lessons learned indicate strong appeal.

## Recommendations

### Recommendation #1: Deploy and Utilize Portable IIMS as Enterprise-wide Incident Management System Tool

From the deployment standpoint—*develop once and deploy many times*—Region 11 portable IIMS has a very strong footing and presents an opportunity to extend capabilities to gain operational benefits for other statewide regions, and their responders. As an integrated portable system (right system built with open platform standards and web services technology)—anyone with a smartphone can now access IIMS through web anywhere in the state—IIMS offers the capability to enhance other investments such as mobility-safety management deployments as part of ITS (ATMS-SMARTS-511-OpenReach etc.), and road safety improvements and emergency management initiatives.

### Recommendation #2: Expand User Class: Include Region 11 Resident Engineers Group

From the near-term stand point deployment-we recommend that Region 11 management consider including Resident Engineers-construction and Maintenance groups to deploy portable IIMS web services for situation awareness and condition reporting to improve efficiency, safety and congestion management in and around the construction areas. These groups may already have been equipped with smartphones in large number and portable IIMS applications are already available for deployments.

### Recommendation #3: Develop a Specific State-wide IIMS Training Program

Consider a low cost training plan for all stakeholders, 3 webinar modules-one to two hours each (can be developed by CYDNY-NYU team to strengthen TIM practice in the region using IIMS and coordination. Similar approach can also be

taken for Buffalo region and other parts of state. These modules can be developed for existing users as well as new users in the state.

**Recommendation # 4: Develop Statewide IIMS Portal**
Develop a separate web portal for posting IIMS information and case studies for public agencies: (www.NYSDOT/iims.com).

## Summary

### IIMS Capabilities

During the discussions with the users, the following enabling capabilities of IIMS were confirmed. Responders also recalled past incidents, examples shown here, as evidence of how multi-agencies produced responses and coordination is achieved.

- Enhances collective situational awareness
  - Crashes
  - Roadway damage
  - Routine maintenance
  - Debris/HAZMAT impact
  - Weather related road conditions
  - Disaster management
  - Snow emergencies/Roadway Closures
- Facilitates multi-agency collaboration
- Ability to share information with other systems in real-time
- Database synchronization among ITS systems

## IIMS Benefits

- More efficient operations
  - Incident response coordinated in real-time, aimed to reduce response time and overall incident duration, with minimum lane closures
  - Enhances communication between multiple agencies currently engaged and paves way to other users yet to deploy and use IIMS as a tool.
- Better On Scene Management results in:
  - Reduces congestion
  - Reduces secondary incidents
  - Enhances public and responder safety
- State of Art Web-Service enables Modular Expansion in adjutant regions and Western New York
- Portable IIMS is capable of transmission and storage of photos, video, text and E Mail in open-standards formats, avoiding proprietary solutions in the future.

# 1 INTRODUCTION

## 1.1 Introduction

Integrated Incident Management system (IIMS) is a real-time incident data collection and reporting system that provides a common operational platform to enhance multi-agency incident response. IIMS consists of mobile applications, supporting iOS, Android and BlackBerry types of smartphones, and a web application. The IIMS functionality enables responders to report on-scene incident information, including pictures and videos. This information provides agencies the ability to assess an incident without having to dispatch responders to the scene, thus reducing the time necessary to clear an incident.

## 1.2 Project Deliverable

This Final Report is a deliverable for Task 14 requirements of the UTRC contract concerned with the *Staten Island Field Test* (name of the project). The report examines and outlines how well IIMS users perform their required functions and assesses incremental benefits to users from the enhanced IIMS (web client application). The draft version of this report was circulated among project team members and their comments are addressed and additional information is incorporated in this document.

## 1.3 Report Organization

The report is organized to provide a comprehensive description of the IIMS project, project objectives, project development, milestones achieved, and user acceptance of the recently developed web client application, and makes suggestion for next steps. Together, these key elements lead us to a conclusion on the successful outcomes from the web client application development and current deployments as portable and local units based.

This report also discusses extending mobile applications (**iOS** and **Android**, and a web application) to potential construction zones user needs to enable responders to report on-scene incident information, including pictures and videos and e-mail attachments.

The report derives from the project team discussions, meeting agenda, demos-test run set ups, documents-training manuals, and face to face and telephone interviews of IIMS users, stakeholders and internal telephone conversations notes.

The Evaluation Team (Professors Prassas, Patel, and Falcocchio) has interviewed NYC OER and NYSDOT staff at JTMC, and participated with the state resident engineers-construction user group. The team had conducted a system operation walk through to

assess primarily user interface and system functionality. During and after the production stage, the team again reviewed the outcomes and user acceptance.

The following three sections collectively provide the reader with the overall project description and sequential progress made to date, and concludes with the incremental benefits resulting from the current efforts:

- **Project Background**
  - Overall Objectives of the IIMS
  - Description of the Ongoing Web Client Application Effort (Phase 2e)
  - Objectives of the SI IIMS Project (Phase 2e)

- **IIMS Development**
  - Overview of the Traditional IIMS (Mobile and Local Desktop Units)
  - Overview of the Modified IIMS (Web services with smartphones-Portable Units)

- **SI Demonstration Test**
  - Research Objectives (BlackBerry® phone experience)
  - Concept of Operations: Operational Scenarios (Incident reports)

The final two sections of this report, Evaluation Findings, and Conclusions and Recommendations provide further guidance on potential next steps.

# 2 PROJECT BACKGROUND

## 2.1 Current Project Background

Since July 2001, various phases of Field operational testing for IIMS have incrementally contributed to IIMS functionality and user experiences.

The current Phase 2e effort (as UTRC contract) that started on August 29th 2012 (and ends on September 30 2015) has focused on the development of the IIMS user interface for Smartphone (started out with BlackBerry® usage) application that provides a low cost platform to expand the IIMS deployment. At the time, NYC agencies were found to be using such devices and more users with BlackBerry® devices (from Research and Motion Corporation) were expected. At the same time the NYS agencies were deploying on other internal devices platform-Android (from Google) and iOS-iPads from Apple. These devices are collectively referred to as smartphones with ability to store data, photos, video clips and voice, and transmission speed for the Internet gateway.

The current Phase (2e) development, testing and production work supports smartphones, which also includes iPad devices. During the IIMS UTRC contract, the IIMS BlackBerry® application transitioned from an application in testing to a deployed application. System testing was completed, critical bugs were resolved, acceptance testing was completed and the application was approved for production on both the NYSDOT and NYC DoITT networks.

**Note:** Deployment of a particular type of smartphone devices (procured from a vendor) is governed by the IT management policy of the NYC and NYS; and the IIMS project has no control or influence over the agencies procurements. It is anticipated that the number of smartphone deployments in 2015 will continually to rise. The new iOS phones being procured by NYSDOT run the new iOS 8 operating system (vs original iOS 7x) installed on the portable devices. Initial testing of the IIMS iOS portable client had determined that several of the new features implemented by iOS 8 cause issues with the already **developed** IIMS iOS client. The intent was to resolve these issues so that NYSDOT users and others can use the latest iOS devices. This report addresses this issue.

Figure 1 shows how current portable IIMS Smartphone Client application has emerged. It provides the same functionality and workflow as intended by the IIMS BlackBerry® client at the beginning, but makes use of the additional screen space to provide a more complete operational picture in a single view. For example, video implementation is common on both devices, but more complete scene is captured as shown in the photo. This also reflects the usage by the responders in actual field environment, collect more relevant and usable event information to make decisions rapidly and allocate proper level of response and resources.


Figure 1 IIMS Smartphone Client Applications-NYSDOT
(Source: GDIT)

## 2.2 Overall Objectives of the IIMS

IIMS objectives linked to the operating agencies missions and goals include achieving reduction in congestion and improvement in mobility; reduction in secondary incidents and improvements in safety of travelers and responders, and reduction in emissions, energy usage and improving overall environment (See Ref.3 for details on reported beneficial outcomes).

The system objectives of the **Integrated Incident Management System (IIMS)** are to collect and communicate incident data (information) among multiple agencies providing emergency response and incident / traffic / transit / emergency management services:

- By rapidly distributing real-time usable information such as incident location, type and severity, digital images of the scene with greater details, the system aims at improving the **incident response and clearance** process.

- All participating agencies view and analyze the incident information simultaneously in real-time and make a determination on the necessary response and extent and act in a coordinated manner. This step will eventually result in quicker restoration of moving lanes; thereby restore capacity for urban mobility, after removing debris, spills and vehicles. Thus, IIMS brings safety and security of workers and road users, and enhances mobility on urban roads. These are some of the key items.

- Each agency can open an incident report, and add to and modify the existing incident report, and share details as necessary.

- The incident information is rapidly communicated throughout the incident between emergency response vehicles and emergency and traffic operation centers, and between multiple operations centers.

- Improving inter-agency collaboration, coordination and communications with the IIMS tool, agencies are able to devise proper response and rapidly dispatch correct resources are able to reduce response time and clear roadway quickly.

- Construction zone events, both of temporarily disabled moving lanes and somewhat longer lasting, reported by field responders and resident engineers group enhances responders' and motorists' safety, security, and overall response time-creating value to capacity restoration.

## 2.3 Description of the Web Client Application Effort

NYSDOT has assigned a series of sequential tasks (Task 1-18) to the University Buffalo, State University of New York, as part of the research study contract (C30506) issued by the University Transportation Research Center at the City University of New York.

The current Phase 2e IIMS project has several dimensions: Modified IIMS development, SI IIMS and Western New York State deployments of a newly modified IIMS and their evaluations.

1. GD IT is charged to develop, test and install ***Web Client Application***, including operating system interface for **Apple iOS 9 Related Upgrades to satisfy agencies' portable devices installed base and future additions.**

2. In New York City, IIMS is already operational for several years and the intent of current project is to conduct a demonstration test with the modified web client application with smartphones.

3. NYU Polytechnic School of Engineering (formerly NYU-POLY) was assigned three tasks (Task 12, 13 and 14) to evaluate the Staten Island (SI) field test based on the newly developed web applications.

4. In the Western New York coverage area, IIMS service will be imitated with the web application.

The University of Buffalo (UB) was assigned a separate tasks to evaluate deployments with a web client application for portable smartphones.

## 2.4 Objectives of the SI IIMS Project (2012-September 30, 2015)

The intent of the SI IIMS project was to act as a test-bed that uses smartphones to help in gathering and sharing incident data (perhaps on a larger scale) with all agencies operating in that corridor in order to create enhanced situational awareness. The SI corridor is also a strategic one that is highly congested and acts as an interstate mobility connector.

The specific objectives of SI Component project are:

1. To **implement** an enhanced version of the IIMS (**web client application**) along the primary transportation corridors (I-278 /440) on Staten Island.

2. **Evaluate** the system focused on the system requirements from a user perspective, including both users as well as travelers.

3. To **use results** to guide further enhancements of the IIMS in the future, and to pave the way for its deployment in areas outside the metropolitan NYC area (e.g. Upstate NY).

While the smartphone procurement efforts are ongoing at agencies and beyond the control of the IIMS project team (NYSDOT), the newly developed web client application capability has been demonstrated to operating agencies, to the evaluation team and operation centers, JTMC operators and current smartphone users. According to NYCDOT and NYSDOT, the modified IIMS application is found to be functionally satisfactorily at JTMC.

Table 1 briefly summarizes SI IIMS project technical objectives.

**Table 1 SI IIMS Project Objectives**

| | Objective | Expectations | Status |
|---|---|---|---|
| 1 | Development of Web Client Application<br><br>Operation at JTMC, OEM and OER,<br><br>Test Demos and Evaluation Team | Web client application<br><br>Installations<br><br>Evaluation Team Review | Completed/Tested-8/14 (Ref.2 ConOp Report, v1.4)<br><br>Operational at JTMC, OER, OEM Completed by GDIT (8/14) |
| 2 | Evaluate smartphone application, user experience, review incident reports | System user interface, capability, speed, user interviews, Verify access method. Field data and capabilities | Completed NYU-POLY team concurs with demo results and incidents-witnessed 9/5, 9/24-25: NYC-OER, JTMC |
| 3 | NYSDOT moves forward with Web client applications for use in other state regions-Buffalo. | Deploy Web client-Android smartphones | Underway |
| 4 | Provide Guidance on next steps | Discussed in Finding | Provided |

# 3 IIMS DEVELOPMENT

## 3.1 Introduction

This section provides descriptions for IIMS to date:

- Traditional IIMS (Deploys Mobile units)
- Modified IIMS (Portable Smartphones and tablets)

Each is described in the following sections. Section 4.1 provides details on how the original (traditional) IIMS functioned and Section 4.2 provides overview of modified new Web Client based portable Smartphone based IIMS.

## 3.2 Overview of the Traditional IIMS (Vehicle-Based)

Traditional IIMS capabilities and operational results are discussed and evaluated in the Evaluation Report (2007) [3]. In our discussions in this evaluation report mobile platform means vehicle-based roaming units in the field; portable unit means roaming with hand-held smartphone web client application accessible in the field and in the office environments-managers, and operation centers means JTMC, OEM command center, NYPD Center and other dispatching centers. Also note that SI IIMS is a name given to a phase of development project for deployment purpose, and does not mean a separate IIMS component.

### 3.2.1 Historical Background

Traditional IIMS Phase 1 provided the basic capabilities needed to create incidents and share key data elements, pictures, and location information. Phase 2 built on this foundation to offer the full range of incident management support (e.g., incident merging and splitting, messaging), expansion to other centers (e.g., New York City Department of Environmental Protection (NYC DEP), the Office of Emergency Management (OEM)), and continued technical and maintenance support for the IIMS deployment. The Phase 2c effort continued to expand IIMS capabilities by allowing users to customize new incident alerts and to filter incidents displayed on their systems, by supporting full conformance with the Extensible Markup Language (XML) version of the IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers (IEEE-1512). The Phase 2d enabled IIMS to connect to the Information

Exchange Network (IEN) thus providing important incident information to the IEN applications including 511NY.

### 3.2.2 Operational Environment in New York City

Figure 1 provides an overview of the traditional IIMS system and indicates the agencies connected, as well as those agencies that will be connected during subsequent phases.

IIMS was developed by a joint effort of the NYSDOT and United States Department of Transportation (USDOT), and in partnership with New York City; and has now grown into a real-time system that builds on agencies' incident management programs and internal protocols. The technical system is built on an open-system interface concepts and incident management standards and NTCIP Communications protocols promoted by City of New York DOT, NYSDOT and Federal Highway Administration.

IIMS is an interoperable system (IIMS) which supports a common input data format for reporting incident information and receiving real-time information to manage incident. (Ref.2). The IIMS supports coordination of incident response across NYC agencies involved in responding to roadway incidents. As shown in the figure agencies connect to the IIMS via either the NYSDOT network or the CityNet network; with these two networks being linked by the Statewide network (NYeNET). The IIMS is currently deployed at the NYSDOT Main Office in Albany and at the Department of Information Technology and Telecommunications (DoITT) in NYC. The NYSDOT Main Office server provides IIMS access for NYSDOT employees. The DoITT server provides access to non-NYSDOT agencies in New York City.

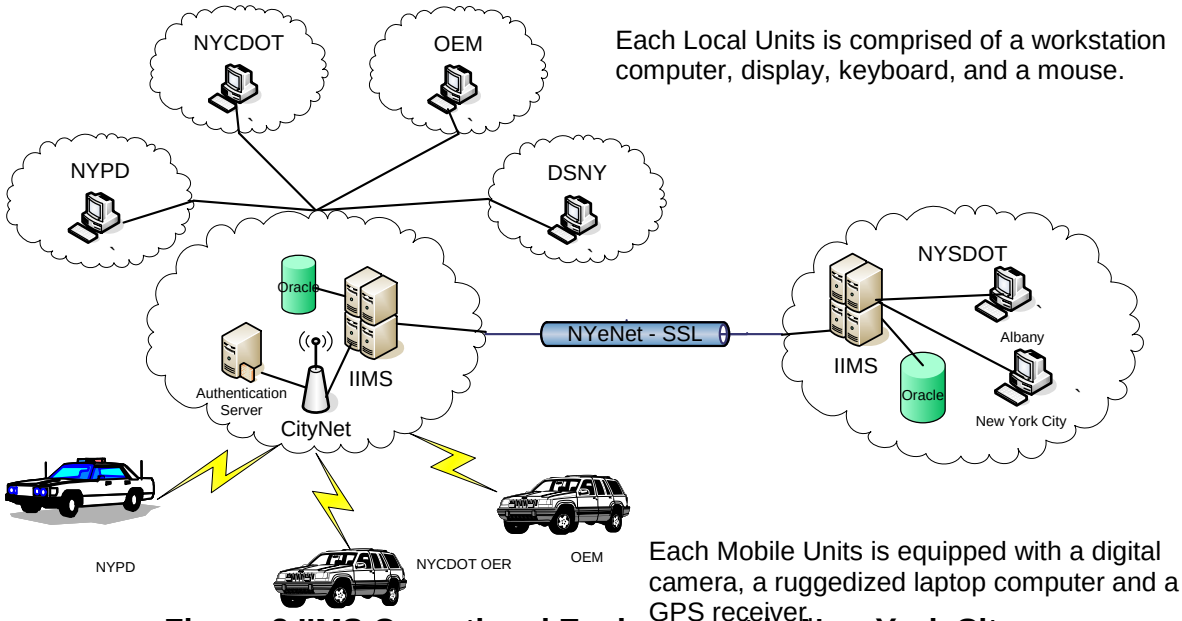



**Figure 2 IIMS Operational Environment in New York City**

(Source: GDIT, IIMS ConOps v1.3, 2013)

Figures 2 and 3 shows the traditional IIMS designed to provide vehicle-based ***Mobil Units*** equipped with

ruggedized laptops and IIMS software installed on them for capability to transmit and receive information from IIMS server.

Similarly IIMS software installed desktops called ***Local Units*** were capable of connecting to IIMS server for similar capability to transmit and receive incident information.

Figure 3 IIMS Mobile Unit

To access IIMS database services, users must have opened an account with either CityNet for NYC agencies or with NYSDOT network for state agencies. In both methods, IIMS support team will need to install IIMS software.

## 3.3 Overview of the Modified IIMS with Web Client Application

This section discusses problem definition-why change current IIMS, web services solution, web client application, modified operational environment and technical arrangement of new systems.

### 3.3.1 Problem Definition

The traditional IIMS described earlier has certain limitations:

- On-scene data collection requires responders to enter data via an **in-vehicle computer** with a limited number of IIMS equipped vehicles (Mobile Units) in operation in New York City.

- By limiting the access to road condition / incident reporting to only IIMS equipped vehicles, a limited population of IIMS mobile units can transmit critical incident reports to the JTMC located in the Borough of Queens.

- The cost requirements for the IIMS-ready mobile units are prohibitive, which limits the ability of the agencies to expand the IIMS deployment to other mobile responders in Region 11 and across New York State. The vehicle cost also spills into vehicle maintenance, and their unavailability at times and fleet management issues.

- In addition, with such constraints, the first responder must make a decision between staying in the vehicle to enter IIMS information and exiting the vehicle to secure the incident scene. Clearly the responder's first priority is to secure the incident scene. Therefore responders often enter minimal information before exiting the vehicle. Detailed information is entered later, or by a second responder.

### 3.3.2 Solution Path: Web Services

In recent years, affordable and cost-effective web services have expanded in both public and private sectors to allow business entities and agencies to make information available 24/7 on the web by simply posting documents/information at designated URL (Universal Resource Locator). This has brought expanded real-time services for wide range of users—regardless of their location, size or the text-based information, photographs, video clips or voice transmission.

System developers and NYSDOT project team realized potential benefits resulting from web-enable solutions, specifically achieving information gathering and transmission efficiency. They have further realized that as a deployed desktop application, the IIMS system limits user access to those computers that have IIMS deployed to them. In current environment, supervisors and managers need to be able to access system data remotely in order to assess the current operational status and make command decisions.

The concept for transitioning phase of IIMS is to move the system from a desktop application to a web-based application for the local units and to move the mobile units from a ruggedized laptop based system to a smart phone system. The system developers have produced a web services based Concept of Operations (Ref.2) to recreate the functionality of the successful desktop system into a web environment using any computer or smartphone device that is connected to the network (CityNet for NYC and NYSDOT IT) to access IIMS.

A **web service** is defined as a method of communication between two electronic devices over the internet. It is a software function provided at a network address (URL) over the web with the service always on.

### 3.3.3 Web Client Application

A web client is an application (software module) that communicates with a web server, using Hypertext Transfer Protocol (HTTP) that runs behind the World Wide Web.

URL for IIMS is: https://iims-test.dot.ny.gov/iims-web/ .

A web client user can be situated in any location where there is a computer and/or smartphone with access to the IIMS network (either CityNet or NYSDOT IT) as shown in Figure 4.

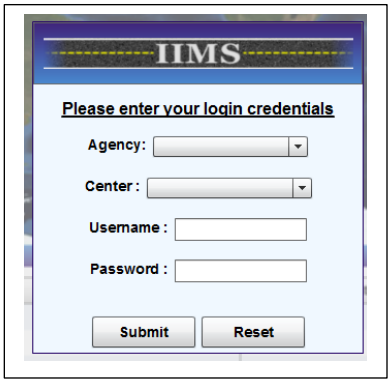



**Figure 4 IIMS Login Process**

For example, a responder arriving at the scene can create an incident report by first connecting to IIMS network either using mobile (vehicle-based laptop) or smartphone-based IIMS client. The JTMC operator could then edit the incident report to add pertinent details, which are viewed by additional agencies and dispatch the appropriate crews to clear the incident scene. Figure 4 shows database, location map and photo to indicate severity details. Multiple photos are taken and inserted into left pane.

Detailed photo of overturned vehicle sent to IIMS database is shown in Figure 5.


**Figure 5 Overview Incident Report (Archived Details are not shown)**

### 3.3.4 Web Client Application Operational Environment

Agencies connect to the IIMS via either the NYSDOT network or the CityNet network; with these two networks being linked by the Statewide network (NYeNET). These connections are through a web browser interface that enables users to create, modify, merge, split and/or delete incidents. These connections are referred to as local units.

Responders in the field connect to the system via wireless connections to the same networks. Currently, responders connect using a ruggedized laptop installed into a response vehicle. These connections are referred to as mobile units. The entire IIMS system configuration is depicted in Figure 6.

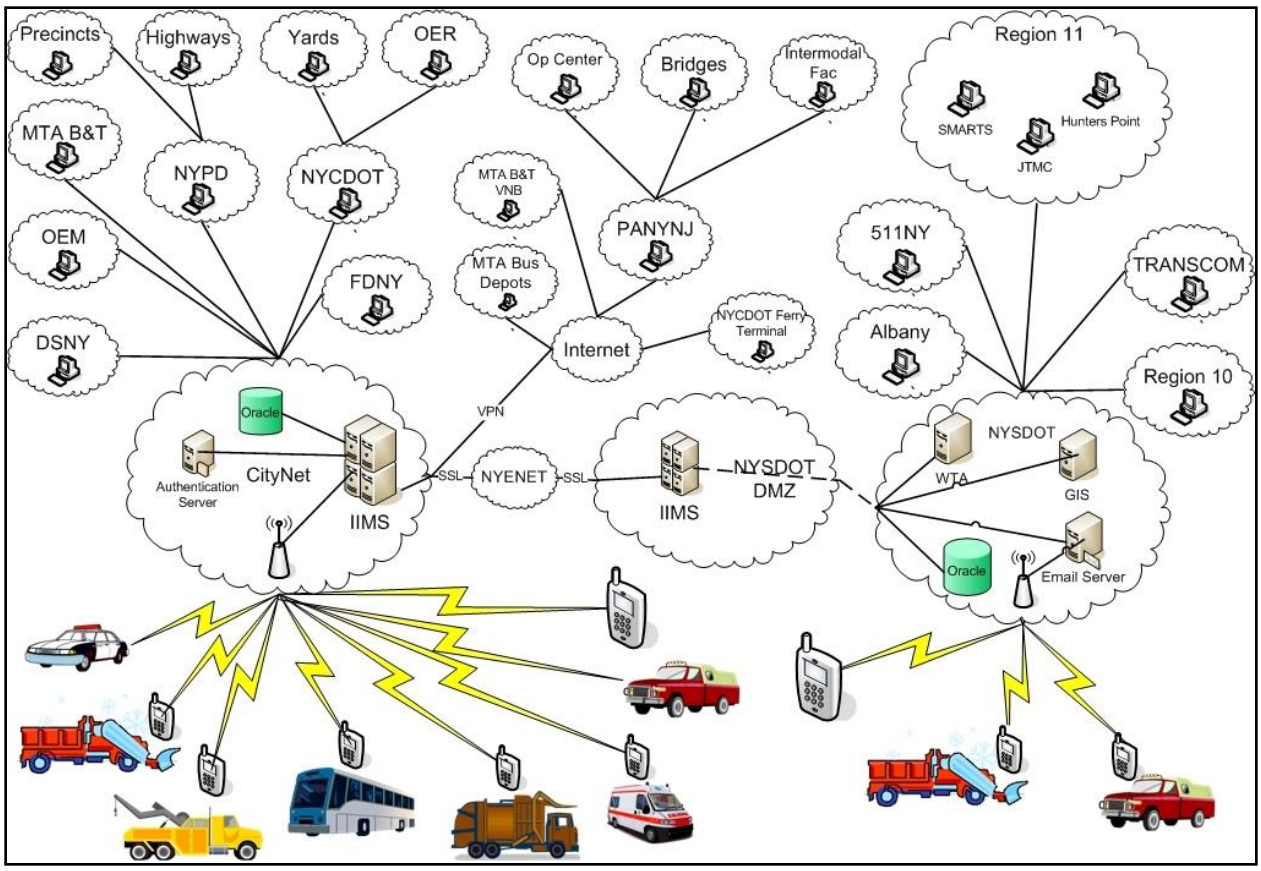



**Figure 6 Current IIMS Configuration (2014)**

(Source: GD IT, User Service Manual, v2.3, 2014

### 3.3.5 Location of the IIMS Central Equipment

As part of the transition to a web services software version, the data repository capabilities of IIMS were modified from using XML files to using Oracle relational database as per NYSDOT policy requirements.

The IIMS is a NYSDOT sponsored system. Therefore NYSDOT requires the use of the NYSDOT network to host the IIMS servers, which are located in Albany. The ability to access the NYSDOT network requires an active NYSDOT user account. However, the IIMS Region 11 deployment utilizes non-NYSDOT agencies and therefore personnel that do not have NYSDOT accounts. Instead, these agencies utilize the CityNet network, with the IIMS servers hosted by DoITT. Since the IIMS system is, by design, a centralized system, the server at NYSDOT and the server at DoITT need to be able to communicate in order to remain synchronized. The servers utilized by both state and city agencies require Windows operating systems.

As shown in Figure 6, the NYSDOT and DoITT servers each host an IIMS web server with an Oracle database. The databases are synchronized by Each NYSDOT and NYC IIMS agency can consist of one or more web clients, mobile units or smartphone clients.

A web client is defined as an authorized IIMS user. A mobile unit is a ruggedized laptop deployed into a responding vehicle. A smartphone client is an IIMS smartphone application deployed to an approved IIMS smart phone (i.e. a smart phone where the user can authenticate to the IIMS network-Figure 7).

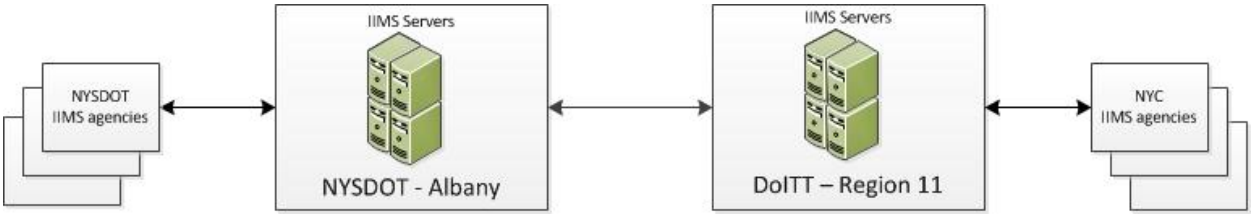



**Figure 7 IIMS Physical Server Layout**

(Source: GD IT, Ref.2)

# 4 DEMONSTRATION TEST RESEARCH METHODOLOGY

## 4.1 Conceptual Representation

Figure 9 provides a conceptual representation of the field test to assess effectiveness of the handheld smartphones equipped with the IIMS Smartphone application within the overall IIMS functions.

Note that SI does not have separate requirements for IIMS the other parts of the City and agencies use IIMS as city-wide system. As a result, it is reasonable that incidents in SI are reported within the protocol in effect. SI is by nature is within the additional users operational environment (PANYNJ and MTA-B&T) and their eventual participation will only enhance IIMS value in the corridor. At this stage both agencies are aware of the IIMS but not actively engaged in procurement process.

It is anticipated that this new application may result in an efficient, cost-effective, and bring to agencies a portable means to manage incidents. As shown in the figure, field aims to investigate how well the portable interface is working (or could work) to open an incident and conduct incident information reporting, communications aspects and improving overall response time.

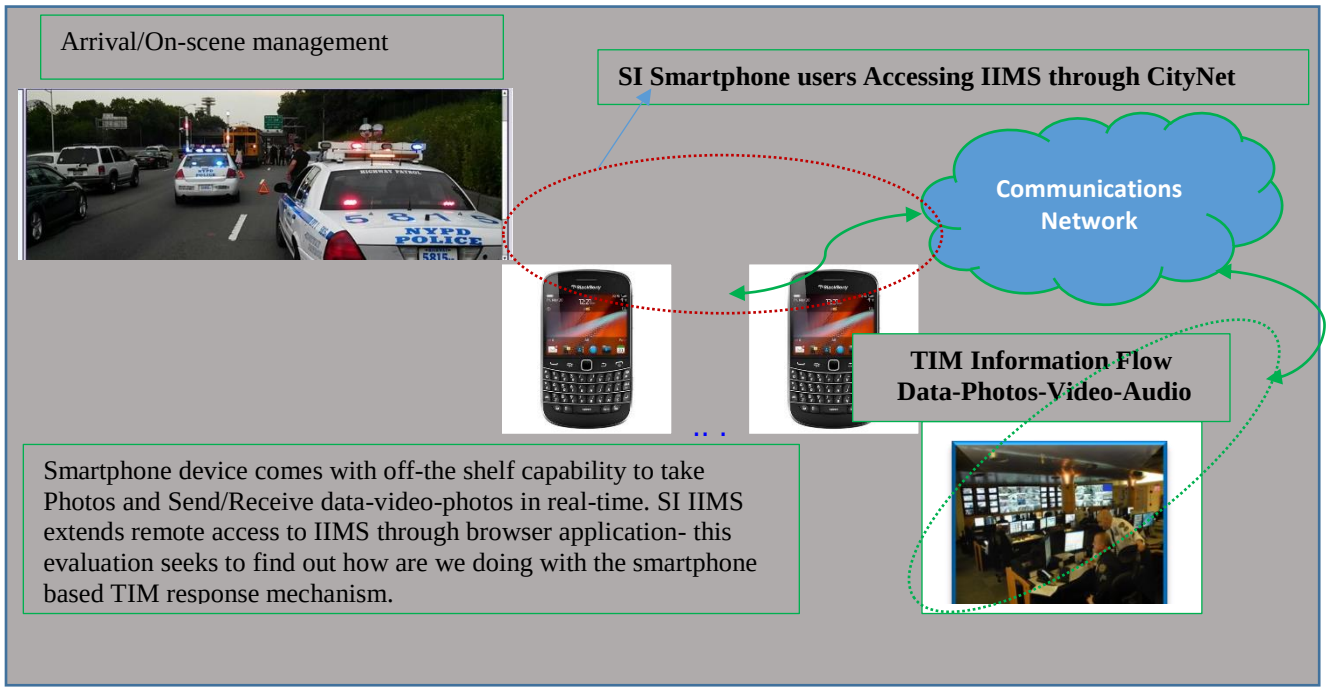



**Figure 9 Conceptual Representation of SI Test Environment**

## 4.2 Research Methodology

Table 2 outlines the methodology used to conduct evaluation of the SI IIMS field test.

This methodology covers only the current stakeholders who are operating Smartphone technology interface and JTMC operation center:

- It is anticipated that the current users will perceive this new approach-portable capability-as more attractive way of doing current tasks and improving information gathering and transmission.

- At some later stage the new stakeholders-namely PANYNJ and MTA-will draw from the experiences of the current users in managing incidents that involve their facilities, bridges and tunnels and linking access routes in the SI Corridor. Thus, IIMS testimonials will be shared among all operators within the City, a higher level goal.

### 4.2.1 Methodology

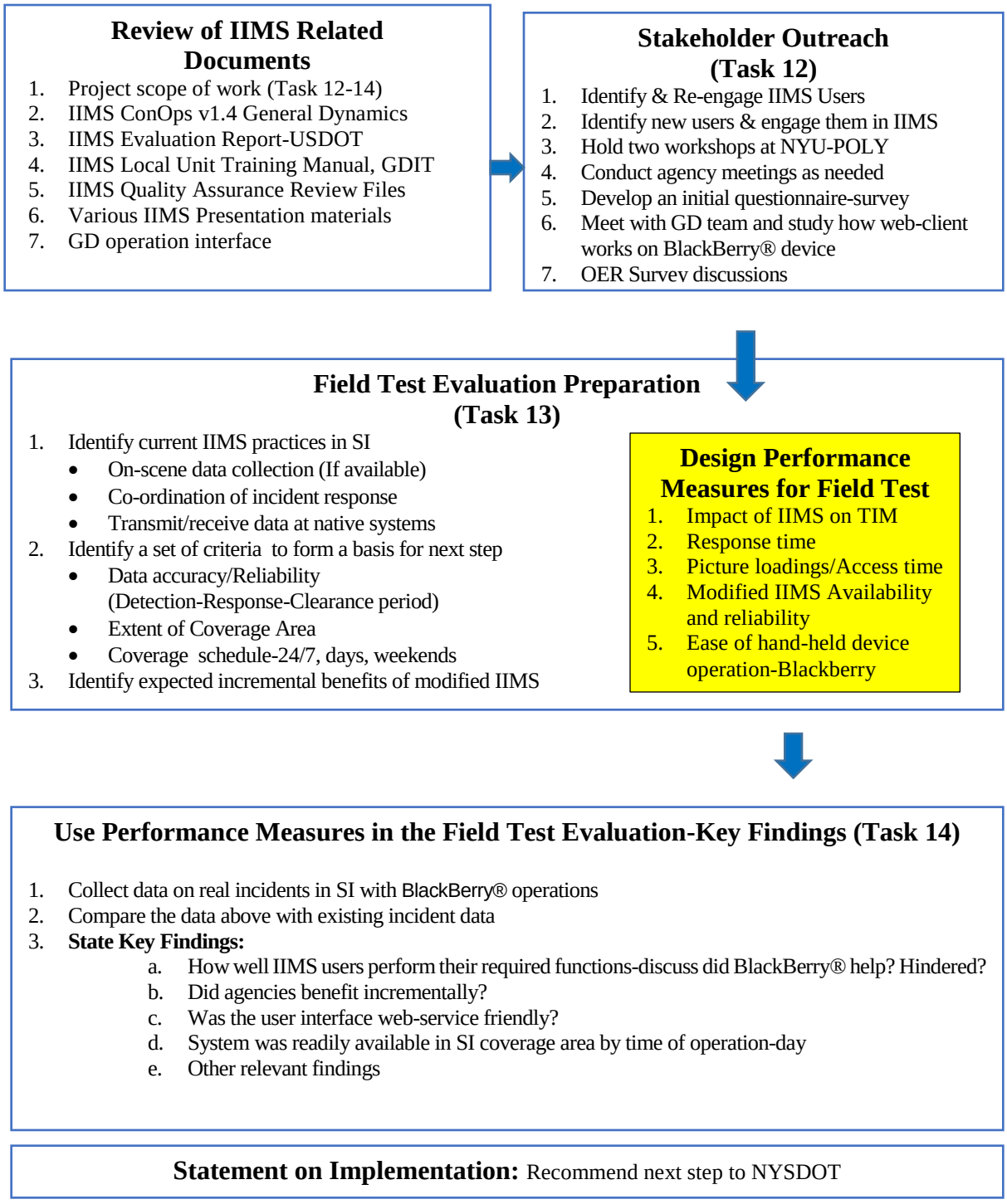
Table 2 outlines the methodology used in the evaluation and assessment process. The team has accessed the relevant documentation and information on IIMS, and derived input from the software development team and NYSDOT to create knowledgebase on issues facing system and agencies users. Using this as a basis, the team re-engaged current stakeholders and used various means as stated in the top right box to bring new stakeholders to the table. The middle box shows field test evaluation preparation steps and performance measures. The last box presents key findings and conclusions.

### 4.2.2 Lack of IIMS Data Availability for SI Region

At present the SI coverage area is routinely handled by NYC agencies without additional focus on web client application (Interview, OER 9/5/14). SI incidents observed are of low profile type such as disabled vehicles. Observations at JTMC have not revealed serious reported incidents. Search of IIMS database from January 2 2014 to date has not come up with any serious incident or events. However, OER indicated that disabled vehicles are routinely called in by the NYPD and DOT when they occur outside of IIMS.

However, qualitatively the user interface for modified web client-based IIMS capability is equally valid and workable in SI region. One exception is the web connectivity in parts of the SI area. Evaluation team feels that it may or may not be an issue of concern at the moment.

## Table 2 SI IIMS Proposed Evaluation Methodology



# 5 EVALUATION OF SYSTEM INTERFACE AND FIELD OBSERVATIONS

## 5.1 Completed Portable Platform Demonstration (February 3 2014, and March 14)

The evaluation team also met with the OER and discussed issues of concern and tasks. On 9/5/14 OER walk though was conducted by the evaluation team and both NYCDOT and NYU-POLY accepted the operational capability of the IIMS as satisfactory.

During the months of January/February, the NYC metropolitan area faced a severe snow fall and a series of continuous storms that occupied the entire IIMS related workforces at agencies. However, the development team met with both OEM and OER staff and discussed portable platform and demonstrated their work to date. OEM continues to use IIMS for coordination activities.

On February 3, the development team met with the NYU evaluation team at NYU and demonstrated new applications using portable devices and a step through of functionality was carried out.

The demo was carried out to check process and response of inputting an incident into system and adding photos and text-voice in real-time. The Evaluation team discussed user interface issues with the development team and concluded satisfactorily the real opportunity to see performance. The evaluation team witnessed positive and acceptable outcomes.

Another demo meeting was held with GD team on March 14 2014 when further discussions and demo was presented. Both demos were carried out for an expected functionality and results were noted. Subsequently the evaluation team became aware of the steps leading to the IIMS software migration to the production network and the test devices were updated to connect to the production network. The acceptance test was run against the production network on August 19th, 2014 and passed. The results were found to be acceptable to the users.

The Evaluation team had also discussed potential period of two months of deployments once both OER and OEM teams were able to purchase their portable devices internally. This period could stretch to well past summer months. However, it was found that such activity may or may not materialize in the timeframe of this project soon enough to gather data and assess large-scale outcomes. The team relied on whatever was available.

## 5.2 Incremental Benefits of IIMS Mobile Applications and Expectations

*The Integrated* Incident Management System (IIMS) core applications continue to evolve around new technology. The most recent transition is the use of mobile devices (*iOS, Android and BlackBerry*, all trade names or trademarks) to replace the old laptop platform (IIMS Mobile Unit (MU)) that was tethered to the responder's vehicle. That fixed vehicle-based platform is now being modernized with smartphones-based portable platform.

It is anticipated that the user-friendly portable smartphone-based IIMS applications will not only enhance information-input process but also significantly expand users' base and types of events reported. Thus, the greater use of IIMS system as a whole is an expectation from this field test.

The deployment of IIMS on mobile devices provides many benefits to the responder. The IIMS mobile applications have been designed with a simple user interface that allows responders' to quickly be able to utilize the application. The use of mobile devices allows the responder to continue collecting incident data while performing their duties at the incident scene.

### *5.2.1 Reliability Factor*

The IIMS mobile device applications are also more reliable, as the entire IIMS application resides in one piece of equipment with no external connections that could cause a system failure, such as the GPS being disconnected or the inability to access pictures from a digital camera.

The IIMS mobile device applications (*iOS, Android and BlackBerry*) utilize the frameworks / application programming interface (API) to access the mobile device's file system, on-board devices (camera and GPS), mapping capabilities, and a set of libraries that support user interface development.

Use of the framework has simplified the overall design of the IIMS mobile device applications and has increased the reliability of the application as compared to the IIMS MU.

### *5.2.2 Improved Support Strategy for Web Client Application*

Availability of support service and system upkeep of IIMS are two concerns that operationally detrimental and both have identified by users in the New York City

Evaluation team has discussed this issue with NYC agencies and feedback indicates that the current incremental benefit is at high level and must continue in the future arrangements.

This is consistent with the aim of the GDIT to provide for IIMS support strategy consists of 24-hour phone support, on-site GDIT representation and periodic user group meetings.

### *5.2.3 Value to Users*

- All system users are provided with access to a 24-hour toll free number to report system issues. This number is monitored by a GDIT trained technician, capable of diagnosing and repairing software and hardware issues.

- GDIT staffed a NYC area representative that periodically visited stakeholder facilities to, among other things, discuss system issues, train personnel on new features, install new system versions and troubleshoot reported issues.

- GDIT conducted periodic user group meetings. Key personnel from each IIMS agency were invited to these meetings. The agenda for these meetings varied somewhat, but generally included discussion on new features being implemented, resolution of existing issues, features desired by users and system feedback from users.

- All reported issues to GDIT are recorded in a problem report database and included in GDIT final report. Resolution of issues was discussed during user group meetings.

### *5.2.4 Improved User Interface with Web Client Application*

Figure 10 provides an example of the opening user interface page. The overall simplicity achieved was greatly appreciated by the system operators. This incident overview screen provides a map and incident list to summarize the current active IIMS incidents and two task/information bars. The user is directed to adjust and edit as necessary with ease.

The previous IIMS responder user interface, the Mobile Unit (MU), was a much more complex application. The IIMS MU was comprised of a presentation layer (developed in .NET) and an application layer (developed in Java) which provided the communications interface to the IIMS server application. This was a very complex design that presented potential maintenance and reliability issues. The application layer was also responsible for communicating with external devices such as the GPS, digital camera and video camera.

The external interfaces were not directly controlled by the host computer or the IIMS software, and occasional issues were reported by responders that external devices could not be accessed. This has now been resolved.

## 5.3 Assessing Project Expectations

Table 3 outlines the desired outcomes from the field test.

**Table 3 Summary of Expectations and Outcomes**

| | Expectation | Anticipated Outcomes | Outcomes |
|---|---|---|---|
| 1 | Application Enhancements-Smartphones | Ease of Access<br>On-scene management, Overall ease of operation | Excellent<br>JTMC/OER expressed high level of satisfaction on ease of operations |
| 2 | Deployment Expansion: Current Clients | Increased IIMS Usage | Potential exists |
| 3 | Deployment Expansion: MTA Family | Use of IIMS | Future deployment |
| 4 | Deployment Expansion: PANYNJ Family | Use of IIMS | Future deployment |
| 5 | Operation & Maintenance | Help Desk-system support-Training, reduction in O&M costs | Excellent, support is key as per NYC expressed |
| 6 | User Requirements-Validation | Have we met their needs? Requirements? | Meet |

### *5.3.1 User Interface for Handling IIMS System Errors*

Agencies had expressed concern about IIMS system errors. The web client design provides the user with an error message whenever an unexpected event occurs. Typically, the error message will be a dialog box, as shown below, with a title that describes the type of error, and a system generated error message and the IIMS Help Desk phone number (Figure 11).

The user is expected to use their discretion in deciding whether or not to contact the IIMS Help Desk. Should the use decide to call the Help Desk, the user should be prepared to provide the error title ("Login Failed" in the above figure) and the system generated message ("HTTP request error" shown in Figure 11).


**Figure 11 IIMS Web Client Error**

If the system generates an unexpected error, the user should contact the IIMS Help Desk and report the error. The error message is likely to appear as above, with additional system generated information, instead of the succinct system message and IIMS Help Desk message. The user is advised to remember the steps that lead to cause the error, if possible.

Table 4 provides a summary of Smartphone Applications System Interface Observations.

**Table 4 Summary of Smartphone Applications System Interface Observations**

| | Issue | Examination | Performance Measure |
|---|---|---|---|
| 1 | User Interface: General | Ease of operation-market-based device, no device development cost: *Can we use hand-held device smoothly?* | Accessibility met |
| 2 | Network Availability | 24/7, Corridor, On-scene coverage area, periodic-centimes: *Does the device work?* | System Availability met |
| 3 | Network Reliability | System data transmission-accuracy-speed End to End Information Transmission Improvements: *Was the information received? Should I retransmit? Do I have to wait for network to come-on line?* Although Network reliability in this aspect is not an IIMS issue and we know it won't transmit immediately if the network is down and have built IIMS to address this. | Efficiency, no issue was reported |
| 4 | Uploading Errors | Device produced errors-can't get through. System asked me to wait-ACK, resend- no-reply. Better understanding of situation-Smartphone clients setup to automatically retry uploads. Photos saved on device for manual upload if uploads fail. | Reliability-normal |
| 5 | On-scene management | Mobility, time-savings, better quality of data. *I was able to do my on-scene tasks and also collect/transmit information at the same time. All went very well, before I had to do all this in the vehicle parked away from the scene, now I am on the scene.* | **Qualitative**: Assess change in data accuracy, more accurate information on location, details and efficient lane management. Reported-well |
| 6 | Hand-Held Device-Screen Size | Small screen makes it difficult to operate, key-board, holding: Portability at the cost of clarity on screen? Photo size, *Did the small screen make it difficult-hinder to upload information?* | Acquiring off-the-shelf portable devices-market-driven process and driven by concerned agency policy (Both NYSDOT and NYCDOT agencies may have different devices in use. Ease of Operation |
| 7 | User Acceptance | Rise in IIMS reporting using hand-held devices? *Did more users joined-in and more events logged in? Did the SI corridor under test experienced wider use of IIMS? Response time reduction?* | User satisfaction with the specific devices. Rise in % of users with higher level of use Relative comparison with in-vehicle IIMS vs Portable IIMS reporting |
| 8 | Cost Factors | Portable devices-based IIMS leads to lower system development-support and installation-maintenance cost, training even with additional users. *Can we expect deployment of portable IIMS platform to lower operational costs to NYSDOT and agencies?* | System upkeep costs: Qualitative assessment<br><br>Indicative of efficiency due to web services and web connectivity is highly cost effective, mobile units are replaced with non-recurring upkeep costs. |
| 9 | Migration to Future IIMS | *Can we deploy portable IIMS in other parts of the state? Add more features based on field test results? Do we re-configure current set up?* | General guidance is to migrate deployments to state regions. |

# 6. ILLUSTATIONS OF PORTABLE IIMS FIELD USAGE

## 6.1 Illustration of NYCDOT OER Created Incident Report (Figure 8)

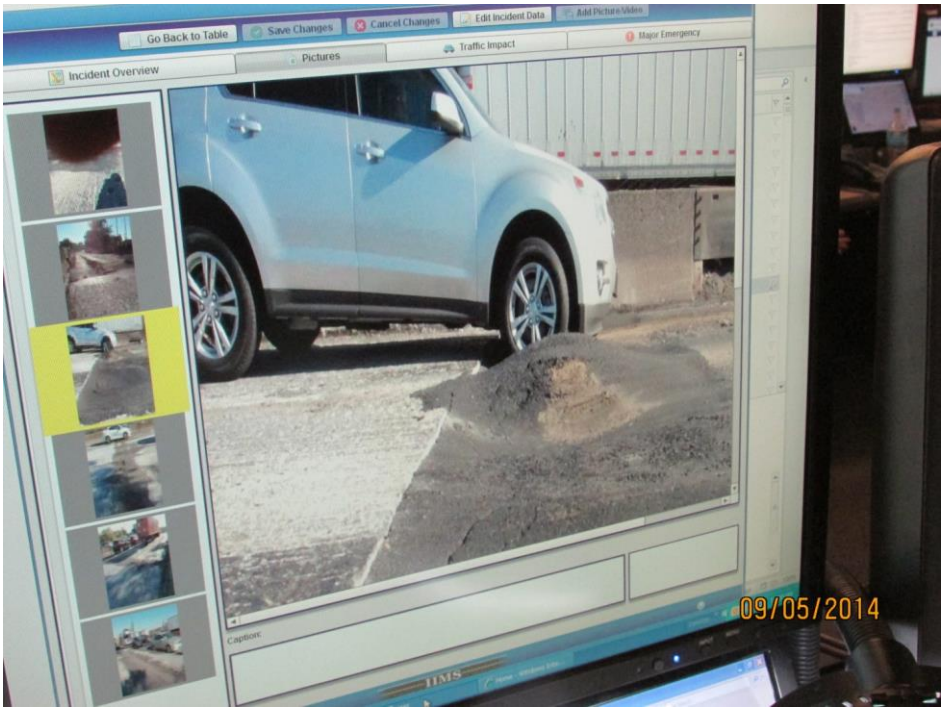
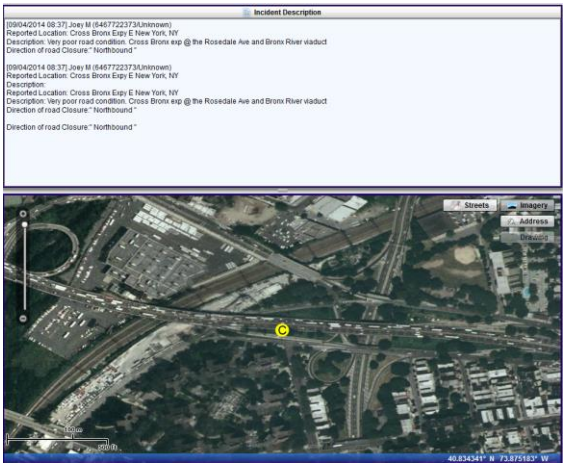



**Figure 8 Incident Report using Modified IIMS-On-Scene Details**

Is the scene-detail shown in photos indicative of a “rough roadway” or a potential “structural damage”? Two agencies viewing this may differ. The incident was opened on 9/4/2104 by OER. The damage to roadway by NYSDOT contractor was communicated to JTMC operators, and lane closure to avert serious damage was need. The initial reporting was viewed as a rough roadway, but closer details indicated a potential caving-in underway.




Responder collects details. Cross Bronx ExP at Rosedale Av, The Bronx

## 6.2 Illustration of On-Site Opportunity for Detailed Data Gathering for Responders and Assessment at JTMC (Figure 9)

Portable smartphones can transmit photos and video clips to users and centers. Note, how an initially observed small crack can be treated to avoid a roadway buckling situation later. Scattered debris also presents a challenge in lane restoration.

IIMS' capability to enable assessment quickly; result: inject urgent cold patch roadway drainage repairs to restore right lane operational (archived photos). See also Figure 8 photos taken by portable smartphones.

Figure 9 IIMS On-Site Data Gathering and Assessment Capabilities

## 6.3 Illustration of Evaluation of Field Condition Reporting and Repairs to Keep Moving Lanes Open and Keep Roadway Safe (Figure 10)

In recent months, portable IIMS smartphone devices have taken photos that not only document and report field conditions, but also reduced response time for both repairs and aiding responders in keeping accountability trail for construction defects, lane closures and maintenance work (Figure 13).

On-site responders send these pictures and e- mails to supervisors and managers concurrently, thus minimizing assessment and response time by multiple partners. In some cases, OER commissioner is able to authorize remedial work or step based on high fidelity information gathered by portable devices in the field.

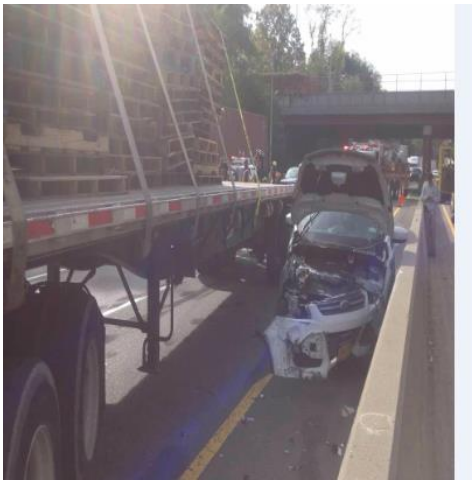


Figure 10 Examples of Events: how OER On-site Assessment and Documented Information Supports Decision Making and Helps to Keep Roadway Safe and Open

## 6.4 Illustration of the Assessment of Infrastructure Damage and Needed Repairs Simultaneously at On-site and Off-site (JTMC and office locations) (Figure 11)

Figure 11 shows photos taken by a portable IIMS smartphone web client application that forms a big part of simultaneous assessment (at site and away from the site) and repair activities needs additional details on an overpass condition about to be affected adversely-detail information is necessary in increments. On the other end, the detailed photo taken by portable smartphone on Rt.440 in SI outline areas shows previously un-noticed or non-reported assets such as broken street light pole ready for pick up repairs, and a call box pole; both items require no field visit and verification beyond initial observation. This allows us to conclude how nature of portable IIMS has altered the way from traditional IIMS; how responders and managers make quick decisions based on detailed information from the start.

**Figure 11 Even Situation Photos that May be Requiring Close-up Details**

## On Incident Coordination Using IIMS

In a casual way the evaluation team revisited part of expectations on incident coordination. In that context the Evaluation Team noticed while reviewing archived records that the system does not track which agencies are responsible for particular incident management activities. For example, while the record creation usually has an agency identified, the “all lanes clear” entry does not. This would help in reviewing how the agencies work together during an incident: for example, if NYCDOT OER is the first agency on scene, does the agency also typically work the scene until all lanes clear or does NYPD assume traffic management responsibilities and declare “all lanes clear?” The system could better indicate **which agency is assuming particular incident management activities**, especially if the agencies decide to use archived IIMS data to review their incident management. (Ref.3)

Here is a response on the topic from a major responder that relies on IIMS for Response.

_____

*“There are several factors (phases) in the overall responsibility for an incident which is dependent on the incident type, location, and the agreements and understanding that have been worked out over the years.*

*For example: in an infrastructure damage such as a hole through the deck of an arterial roadway that is within city limits, but owned by the State, the City and State DOTs have an understanding that the city will take the immediate action of making it safe (usually by plating or closing the lane) until the State can respond and make a permanent repair unless it is so severe that it requires immediate attention with State resources.*

*With respect to incident management, for lane closures, NYPD would handle the closing of traffic lanes and diversion of traffic.*

*Once the infrastructure defect is determined by the DOT(s) to be safe to open for traffic, - (there would be an on scene inter agency coordination and concurrence of course) - for the NYPD's purpose the incident is made safe, lanes are reopened and the incident is closed, but for the DOTs responsibility the incident is not FULLY closed until the permanent repair has been scheduled at a convenient time and completed.*

*In summation-*
*The IIMS would facilitate real time communication (images, mapping, and text) with on scene response personnel as well inter agency elements.*

*Each agency would "close" an incident respective to their area of responsibility for the incident, but in coordination with the other responsible agencies. “*

*Deputy Commission Nelson Castillo*
*September 27, 2015*
*Office of Emergency Response (OER)*
*New York City Department of Transportation*

# 7. EVALUATION FINDINGS

## 7.1 Evaluation Findings

This section presents key findings from the evaluation effort in three summary tables with assessment criteria (as required by Task 14): *How well IIMS users perform their required functions and incremental benefits to users from modified (enhanced) IIMS;* Table 5 outlines Findings 1 thru 4 as networked system benefits. Table 6 outlines Findings 6-9 as enhanced Incident Management functions with the modified IIMS. Additionally, Table 7 summarizes IIMS as a Gateway to other example systems.

**Table 5 Summary of Key Findings: IIMS Networking**

| | Outcomes | Incremental Values |
|---|---|---|
| **Finding 1:** IIMS has now acquired an **universal connectivity** platform-open to all users and devices | ▪ Modified IIMS with web Client is a successful outcome from the Phase 2e development | ▪ Web connectivity with common URL<br>▪ Independent of device location, type of smartphones or desktops deployed<br>▪ 24/7 anywhere always-on web service |
| **Finding 2:** IIMS is now ***fully Integrated*** with the NYSDOT/NYC Operational IT Environments | ▪ High level commitment to collaborative efforts<br>▪ "Integrated" IMS that supports traffic incident management practice in the regions of the NYS | ▪ Operational support from DoITT and NYSOIS as IIMS now a mainstreamed operational system<br>▪ IIMS is now similar to B2B (Business to Business) web services within governments |
| **Finding 3: Web services** application has resulted in cost savings to both project and users at agencies.<br><br>Potential for wider use of IIMS is created by modified IIMS. | ▪ Reduced system hardware<br>▪ Deployments of existing and new off-the –shelf portable devices will add more users at cost savings | ▪ Central database and servers are reduced to minimum. General purpose portable devices are hand-held and user friendly, requiring minimum upkeep<br>▪ Portable units have now replaced vehicle-based mobile units, reducing initial investments drastically, and recurring vehicle maintenance costs.<br>▪ Wider use of IIMS in the field is now widely possible. |
| **Finding 4: Improved center to center communications** is enhanced with 24/7 always on Web Connectivity with JTC and other centers such as TRANSCOM, B&T, region 10 INFORM and others. | ▪ IIMS is now an "Interoperable System"-with which centers can supply and receive information on roadways and transit system and use that information to improve their operations. | ▪ Modified IIMS supports both NYCSRA and NYS ITS architecture dataflows and services packages for ATMS and EM functions.<br>▪ ITS deployments within the NYS will benefit from web-based IIMS.<br>▪ IEEE 1512 is supported and EM community is wells served for HazMat operations and evacuations in the region. |

**Table 6 Summary of Key Findings: IIMS Functionality-Development**

| | Outcomes | Incremental Values |
|---|---|---|
| **Finding 5:** Portable Smartphone based IIMS helps in **gathering more data** in all formats and makes easier to communicate to central system | ▪ Builds on previous successful practice of data entries and creation of incident<br>▪ Seating in a vehicle-away from the scene is eliminated | ▪ Responders is on the scene, and not inside a vehicle anymore, leaving him/her free to secure scene as per primary task<br>▪ While observing the scene, responders can gather more data<br>▪ System now allows taking photos, text messages, and record voice message and in near-future can also add video clips to transmission. On device video can also be downloaded alter. |
| **Finding 6: Portable Smartphone based system enables direct access for managers** and supervisors with smartphones-they "See" incident and begin to react quickly and forcefully. | ▪ Higher level management assigns priority to response quickly<br>▪ Faster response, reduces overall response time | ▪ Mangers are typically equipped with smartphones, thus they are able to see and act quickly on coordination needs and scale of response<br>▪ Level of interagency and interagency communications rises due to visual images on incidents and knowledge of who is at scene in real time. |
| **Finding 7: Portable system has created an opportunity to improve** and update maps; speed of picture transmission and system upkeep exists. | ▪ Maps are old, should be updated<br>▪ Photos take time to upload-speed an issue<br>▪ System must be supported | ▪ Evaluation has found references to these functions, and development will address them.<br>▪ GDIT has a plan to support IIMS services 24/7. |
| **Finding 8:** IIMS now operates in the **Web environment** as environed by the project managers and developers.<br><br>Overarching usefulness of IIMS within the city/state agencies has been established. | ▪ Connects agencies-collaboration<br>▪ Connects responders-coordination<br>▪ Connects internal systems-Integration<br>▪ Connects center-communications<br>▪ Connects to TIM-response time reduction. | ▪ Common incident reporting format<br>▪ Inter-agency communications<br>▪ Resource coordination<br>▪ Agency culture<br>▪ Archived data for training, planning and policy making<br>▪ Regional ITS architectures and deployments<br>▪ Complying with national standards and USDOT requirements |
| **Finding 9 : System Development**<br><br>The final deployment from the IIMS UTRC contract **has resulted in a state of art Portable Platform** | ▪ IIMS Android and iOS clients exceed the stated deliverables from the smartphone research task.<br>▪ Created awareness of portable technology and web services among partners and users | ▪ Can be readily exported to other areas of the state<br>▪ Extended to other user groups<br>▪ Bridges to other systems such as SMARTS, ATIS, 511, ATMS…<br>▪ Connectivity: Field to System, Center-to Center<br>▪ Interoperability |

## Table 7 Examples of Value Added by IIMS to Other ITS Systems

Like IIMS, example systems are also based on Geo-Leaner referencing system-LRS, GPS, TMC-based databases interfaces, SOPs for operational coordination among multi-agencies and shared information. The following information is derived from the evaluation team's proxy-gap analysis based on current literature, presentations and ITS standards information for C2C and C2F devices and systems.

For example, a C2C common TMDD based ATMS with XML web service application (NTCIP 2304 and IEEE 1512) can easily communicate to multiple TMCs in real-time and share IIMS gathered information and update web services on a portable platform such as now available Android Smartphones. Regional TMCs such as JTMC, INFORM and Hudson Valley TMC can make operational decisions based on common information without human-intervention and coordinate with TRANSCOM.

IIMS gateway adds another dimension to a disaster recovery mode or system fault or system failure; TMCs operation staff cans alternative use portable IIMS systems. (IIMS does NOT share servers at NYC DOITT or NYSDOT).

| | **Basis of Analysis** | **Incremental Values to ITS Efforts** |
|---|---|---|
| **Finding 10 ATMS-ATIS, SMARTS and OpenReach** | ▪ Explore if IIMS supplied data be used to support operation decisions in real-time? | ▪ Archived Information can be viewed for analysis purpose and can be used in training purposes.<br>▪ Enhances TIM operations, responders' SOPs.<br>▪ Interoperability |
| **Finding 11 511NY** | ▪ Regional-statewide information | ▪ Improves quality of information on field conditions<br>▪ Other aspects need to be researched. |
| **Finding 12 HELP** | ▪ Should HELP responders deploy IIMS portable device? | ▪ HELP responders can be easily added to Android/iOS platform and report field conditions<br>▪ Reduced response time |
| **Finding 13 ATDM/ICM** | ▪ IIMS can be integrated a as part of ICM<br>▪ During event, IIMS can be used to manage demand and support strategy | ▪ Speed management<br>▪ Demand management<br>▪ Other benefits not yet known |
| **Finding 14 Connected Vehicle Environment** | ▪ CV is a new and emerging program in the state<br>▪ Offers opportunity to participate in policy formation on V2I strategy, standards and investments | ▪ Infrastructure standards<br>▪ Safety benefits<br>▪ Vulnerable Road Users-VRUs<br>▪ Investment and POLICY formation<br>▪ Needs further research on potential benefits |

## 7.2 Extending Portable IIMS Web Client Applications to Construction Work Condition Reporting

The evaluation team feels that there is immediate opportunity to deploy smartphone based web applications to a fairly large group of users yet not connected to IIMS platform. Since the application is already done and smartphones are deployable, with minimal effort, this opportunity can be turn into a reality in short term. This step could also lead the state to IIMS's ability-flexibility to extend to new user groups in other regions and TMCs.

This is based on the evaluation findings and the initial assessment of the user group needs, the current IIMS work effort has created an excellent opportunity to take advantage to extend IIMS capabilities to support Resident Engineers and Construction Deployments (user needs and requirements are yet to be elicited to support *mission needs*. This will aid in safety improvements, congestion management overall efficiency of lane management and maintenance of traffic in the work zone and in vicinity.

Additional capability added in the last leg of the project included modification of the current IIMS e-mail feature to enable users to select the information included in the e-mail message:

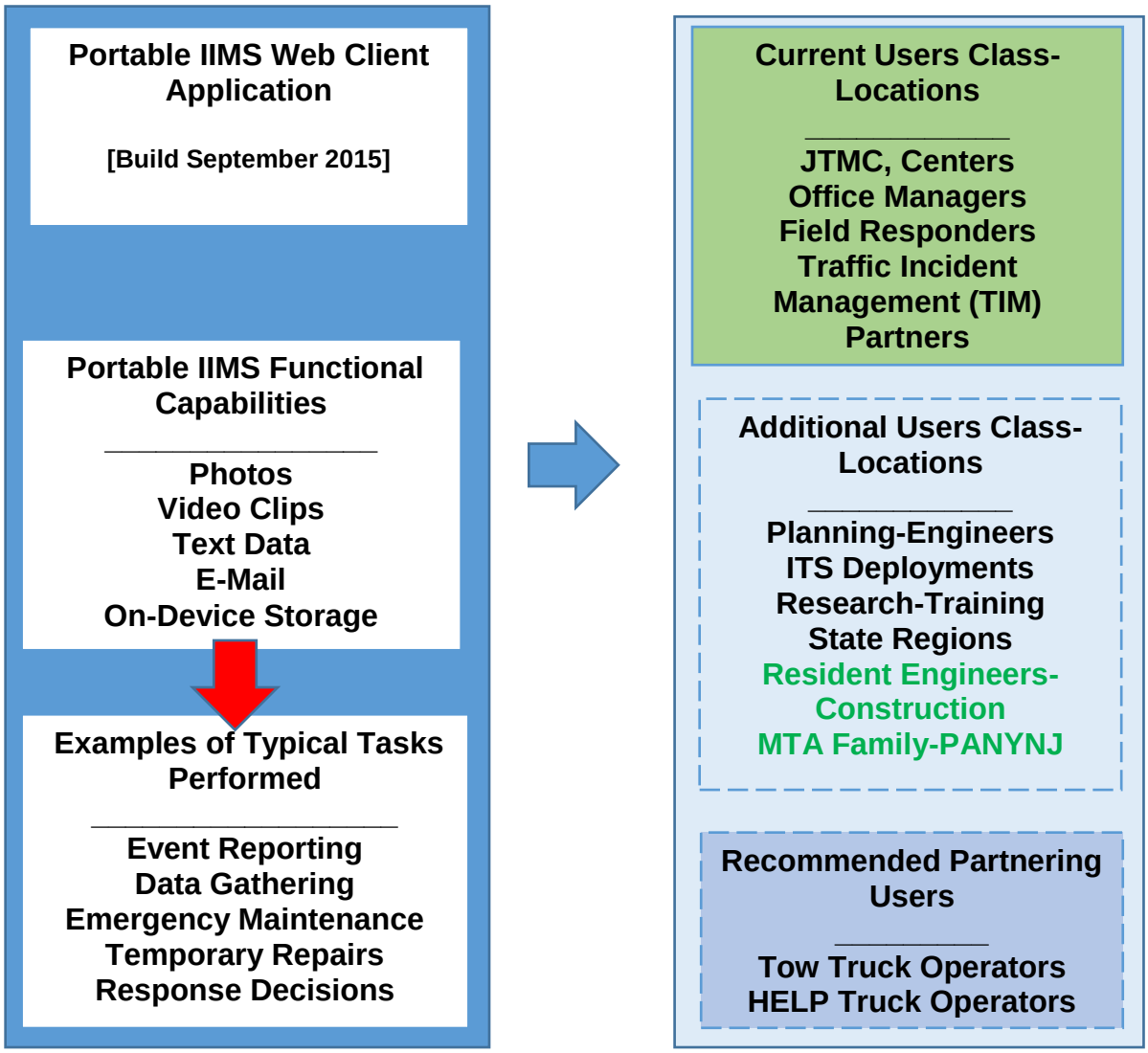
- Current e-mail capability only allows the user to select only one message content per e-mail. If more incident information is to be sent to IIMS server, another e mail message is to be created-thus a cumbersome process to send successive e-mails.

- Newly modified capability allows the device to send multiple attachments (pictures, videos or map) as part of a single message. This will impact on how a device is used by the users and their willingness to provide details on incidents.

- Evaluation team has concluded that the current IIMS has adopted the emerging technology to align with the agencies' current practices (such as use of Android smartphones) and developed a path to future additions. As the technology evolves and agencies prepare for a better future for asset utilization and mobility management, IIMS development project has transitioned from the fixed platform to a more fully and engaged Portable Platform.

Figure 12 depicts the relationship between current portable IIMS capabilities and various tasks performed, and types of user classes- both current users and potential new users that can be added in the future in regions of the state.

It should be also noted that hired tow truck operators are often the earliest first responders reaching the event site and they are also equipped with portable smartphones; thereby allowing to send initial information to other responders in the vicinity etc. Similar expectations can also be from the HELP responders who are also typically equipped with portable devices, including radio communications. Similar programs also exist in other parts of the state.




**Note**: All of the capabilities are readily available to other state regions and their intended user class stakeholders-including emergency law enforcement, responders and agencies involved in the roadway incident management, including local cities.

**Figure 13 IIMS Capabilities and Various User Classes**

## 7.3 Potential Benefits for the Expanded User Class and Deployments

To illustrate the lessons learned and potential benefits for the expanded user class and potential usage in other regions (Figure 12) the following examples shown in Figure 13 are drawn from current portable IIMS. Photos show complex-time-critical relevant task performed by the first and transportation responders at crashes scenes and construction condition reporting and detailed data gathering needs related to damage roadway infrastructure. Critical lane management-closers (loss of lanes and how many) is always dependent on greater details for impact analysis at scene and in offices. Portable IIMS makes such tasks easier and efficient with capabilities for photos, video clips, text-location information and send-receive functions for decision makers at all levels.


Figure 13 Examples of Task Performed by Responders Drawn from Portable IIMS

## 7.4 Evaluation of Feedback Received from System Operators and Users

Towards the very end of the project, the Evaluation team carried out a production level interface discussion with the operators and system users to ascertain interface issues, bugs, and potential enhancements during late September 2015. This following is a summary list that serves as a starting point in remedying underlying issues. The list is not based on any one order of priority, and is reviewed also by the system developers.

1. **Picture Annotation** – The current system just allows a user to take a picture and send it back to the IIMS servers. Users have expressed a desire to be able to annotate a picture prior to sending it to the server

Figure 14 Hazardous Hanging Sign


The IIMS archived picture in Figure 14 illustrates an overhanging sign that was discovered and reported by a NYPD HP officer, which followed a temporary traffic management set up by him in the right lane as a safety measure. This event was simultaneously seen and reviewed by OER responder present nearby, and dispatched a repair crew without traveling to the scene. In this situation, if the photo had an annotation-say direction of the roadway, it would further help mangers located in the office or JTMC to determine impacts; a simple enhancement could be highly effective in lane management.

2. **Impact Areas** – Impact area drawing was added to the web client in one of the last releases of IIMS software. There have been several minor bugs detected by users/testing that should be corrected. These include issues with drawing linepoint shapes and restoring the screen when closing an unsaved drawing.

3. **Camera Zoom Level for Android** – The camera zoom level for Android zooms in very small increments, requiring users to zoom multiple times to get the picture they want. The camera operation should be modified to zoom in larger increments (This comment also reflected in Figure 11 details).

4. **Estimated Duration Setting** – The estimated duration is an important data item for an incident. A user can easily include this in the incident text, but IIMS should provide a specific field that would allow the user to set this value-revise/update and thus automatically populate the duration field on the web client.

5. **Clear Description in iOS Mobile Client when Pictures are Sent** – When a user sends a picture with the iOS mobile client, the incident description is included, but

not cleared. Therefore, the incident description gets sent repeatedly if the user sends more than one picture. Once the description has been sent it should be cleared.

6. **Increase Web Client filtering options** – The web client provides the ability to filter incidents on a number of criteria, but additional ones such as who created the incident or what agency created the incident, might be useful. The filtering options should be reviewed to determine what other possibilities could be added and how useful they would be. Also the option should filter who receives the incident. Only agencies that can't assist should receive the incident.

7. **Enhance reverse geocode processing** – The current reverse geocoding selects the 1st returned address and assigns it the incident location. In the case where an incident is located in an area with an overpass, it is possible that the reverse geocoding returns multiple addresses and the user could select the appropriate one.

8. **Merge incident upgrade** – When users merge two incidents together, it is difficult to determine that IIMS id of the newly created incident. There should be some feedback to the user to indicate where the new incident is in the incident list. The system should show who generated the incident and what agency (user) did the merge.

9. **Email capability** – report generation – The Email capability currently auto-populates the e-mail that is sent. Instead, the user should be provided with options to allow them to pick and choose the pictures/videos/maps that are included with the e-mail. Also the user should be able to email the incident (information/pictures) to none IIMS users.

10. **Incident classification** – The USDOT provides guidelines for classifying incidents based on incident duration. Add this classification to the web client. This step will also allow sharing information across ITS applications and agencies.

11. **Confirmation of center-to-center picture sending** – When one IIMS server requests a picture from another IIMS server (i.e. Albany requests a picture from DoITT), the IIMS only makes one attempt to satisfy that request. IIMS should implement a more fail/safe process to enable retrying of picture sending.

12. **Correct participating center panel** – The participating center panel currently references users by multiple user id's. The panel should be updated so that the user references are consistent. Different user should have different rights. A manager should have more rights than an operator.

13. **Additional incident detail screens** – The design of the IIMS mobile clients is to be simple and efficient. However, we can still add additional, and optional, data

entry screens that would enable a user to enter additional information. These screens would match with the web client enabling data to be auto populated.

14. **Disable "Cancel Changes" button in Impact Areas** – When drawing an impact area, there is a cancel changes option that enables the user to cancel their drawing changes and a cancel changes button that cancels any changes that have been made to the incident. The button that cancels any changes made to the incident should be disabled when an impact area is being drawn so that a user must cancel the drawing mode using the drawing mode cancel changes button.

15. **System busy notification** – The web client should provide additional feedback, possibly through cursor changes, that indicates when the system is busy performing a potentially time consuming task. The system should indicate the duration of the current task it's performing.

16. **Login failure processing** – There appears to be a bug in the login failure processing that will occasionally lock a user out of the system, requiring them to contact GDIT to have their account unlocked. We need to determine what is causing the locking of accounts.

17. **Authorize Tow** – Authorize Tow should have access to IIMS so they can receive and take pictures of incidents.

18. **Map**- Location should be shown.

19. **After Action / Incident Review** – IIMS system could be used as a learning tool for all agencies. We should conduct table top studies (mock incidents) using the IIMS system.

# 8. CONCLUSIONS AND RECOMMENDATIONS

## 8.1 Conclusions

The evaluation team has concluded that over the past many years the benefits realized from the deployments of IIMS in Region 11 are significant and supports missions and objectives of the agencies and public at large for safety and mobility improvements in the region.

As an enhanced incident management tool, modified Portable IIMS web applications has presented a significant opportunity for responders in the field, and decision makers in offices and JTMC to save time and quickly respond to the event needs with proper level of response. This contributes to overall Traffic Incident Management (TIM) practice in the state.

This is attributed to responders' enhanced ability to gather and transmit more detailed data (e.g. pavements and structural damage) simultaneously to others (managers, experts and upper management) for response, with photos, video, text and E-Mail process.

The following conclusions were reached based on evaluation team's observations and interactions with the project team and users:

- Conclusion #1: The current phase of the IIMS project (UTRC) has successfully achieved a technical-institutional transition from the traditional vehicle-based IIMS to *Portable IIMS* with Smartphone Web Applications. This will create an enhanced capability for field responders to gather more detailed condition data and report quickly to others as they now can walk-around the scene more freely and farther-closer to infrastructures. (With traditional IIMS, they had to remain in vehicle to enter data for incident report).

- Conclusion #2: Current difficulties in procurement of smartphones at both NYS and NYC agencies has somewhat limited deployments of web applications. However, it is expected that agencies will very likely add more users equipped with smartphones in the future as they see benefits and current smartphone revolution in the country.

- Conclusion #3: IIMS is a 24/7 real-time communication system and presents a significant usage when integrated with other investments made by state in regional TMCs and ITS field devices and subsystems. IIMS uses standards and that makes easier to bridge it to operational capabilities of ITS components.

- Conclusion #4: Because IIMS is already being supported by the central IT departments at both NYS and NYC in technical management, greater awareness and internal collaboration is maximized. This helps transportation

departments to deal with system projects in general and for enterprise-wide applications.

- **Conclusion #5:** Engaging new users in both Region 11 context and adding new users in other parts of the state will present challenges at various levels (Why should I use IIMS? What benefits will we get? Cost etc.). However, IIMS has evolved and proven its worth and lessons learned will guide state and cities and law enforcement jurisdictions once the initial steps are taken.

## 8.2. Recommendations

**Recommendation #1: Deploy and Utilize Portable IIMS as Enterprise-wide Incident Management System Tool**

From the deployment standpoint—*develop once and deploy many times*—Region 11 portable IIMS has a very strong footing and presents an opportunity to extend capabilities to gain operational benefits for other statewide regions, and their responders. As an integrated portable system—anyone with a smartphone can now access IIMS through web anywhere in the state—IIMS offers the capability to enhance other investments such as mobility-safety management deployments as part of ITS (ATMS-SMARTS-511-OpenReach etc.), and road safety improvements and emergency management initiatives.

Therefore, the evaluation team strongly recommends that the state consider this web client application as readily available enterprise-wide enabling web service for state agencies and partners engaged in road safety, congestion-mobility management, construction and maintenance, and repairs and emergency-disaster management. With this approach, cumulative investments already made and experiences gained in the TIM practice will translate in a workforce that is prepared and supported by a proven tool to improve response time for all types of events and weather emergencies.

- For example, if the portable IIMS is adopted for statewide usage, it can serve coordination during snow emergency across regions (remember IIMS is LR database and GPS-based 24/7 tool), including local jurisdictions and improve response times for responders at all levels.

- It can also act as a uniform and consistent utility for monitoring and condition reporting and assessment.

Sample Examples of Deployments Preparation Steps:

- Engage local law enforcement agencies and emergency management community (911 included upstate), early on and demonstrate to them the benefits of the IIMS functionality.

- Hold at least two tabletop workshops to assess user needs prior to deployments to secure buy-in from the stakeholders from the law enforcement community.

- Prior to the future deployment effort, conduct regional tabletop exercises for deriving local inputs (Region 8, 6 for example) from the concerned stakeholders (Agencies, Police-Fire and other responders).

**Recommendation #2: Expand User Class: Include Region 11 Resident Engineers Group**

From the near-term stand point-3 to 6 months deployment-we recommend that Region 11 management consider including Resident Engineers-construction and Maintenance groups to deploy portable IIMS web services for situation awareness and condition reporting to improve efficiency, safety and congestion management in and around the work zone areas. We believe that group may already have been equipped with smartphones in large number and portable IIMS applications are already available for deployments.

**Recommendation #3: Develop a Specific State-wide IIMS Training Program**

Consider a low cost training plan for all stakeholders, 3 webinar modules-one to two hours each (can be developed by CYDNY-NYU team to strengthen TIM practice in the region using IIMS and coordination. Similar approach can also be taken for Buffalo region and other parts of state. These modules can be developed for existing users as well as new users in the state.

**Recommendation # 4: Develop Statewide IIMS Portal**

Develop a separate web portal for posting IIMS information and case studies for public agencies: (www.NYSDOT/iims.com).

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[7] Edward Mark, *Integrated Incident Management system (IIMS) in New York City Area*, NYSDOT, 2004, 11 pages.

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# APPENDIX: Theory of Operation for the IIMS Development

Transportation planners and operating agencies in the NYC region had identified a need for system tool with which multiple agencies can manage incidents and quickly restore capacity. This was considered a necessary for both mobility management and safety standpoints.

The operational needs, specific user needs and requirements identified by the Systems Engineering Process (SEP), and ongoing deployment requirements of the service packages of the New York City Sub-regional Architecture and New York State Statewide ITS Architecture have formed the baseline for the development and deployments of a centralized incident data sharing system. IIMS is that system.

IIMS is described as an **integrated system** for the following reasons:

- Serves a wide region of the New York City and can be extended to other parts of the state.
- Meets incident information needs of the multiple agencies having responsibilities to manage roadway networks, transits facilities and emergency responses. Agencies from NYC and NYS are the clients-users.
- The IIMS functionality/capability is available to users 24/7 both in the field operational environment and at operation centers.
- System functions and development is based on the open system platform and national ITS standards such as NTCIP, IEEE 1512 etc. IIMS is an interoperable system.
- Data flows identified by the NYC Sub-regional and NYS ITS architectures are supported in information exchange format for centers.
- Coordination aspects among operating agencies is achieved while allowing for each agency to invoke its own local response protocol.
- Finally, IIMS supports NYSDOT and NYC technology objectives by providing transportation information with web services platform; a new development in public sector usage of web capability.

Thus, IIMS integrates user needs, standards, functions, web technology and institutional arrangements to achieve reduction in incident response time and enhancing on-scene safety of motorists and responders. The overall goal of reducing congestion on road networks and generally improve mobility is also achieved by the IIMS presence in the practice.

**Support for the Traffic Incident Management (TIM) Process**

Traffic incident management (TIM) is the process of coordinating the resources of a number of different partner agencies and private sector companies to detect, respond to, and clear traffic incidents as quickly as possible to reduce the impacts of incidents on safety and congestion, while protecting the safety of on-scene responders and the traveling public. When a crash occurs congestion quickly builds up and chances of a secondary incident increases. The sooner incidents are detected, the sooner safety personnel can respond to the incident and clear it from the roads thereby allowing traffic lanes to re-open and traffic to return to normal conditions. TIM assists with creating a safe work zone with proper signage and equipment for emergency crews responding to an incident.

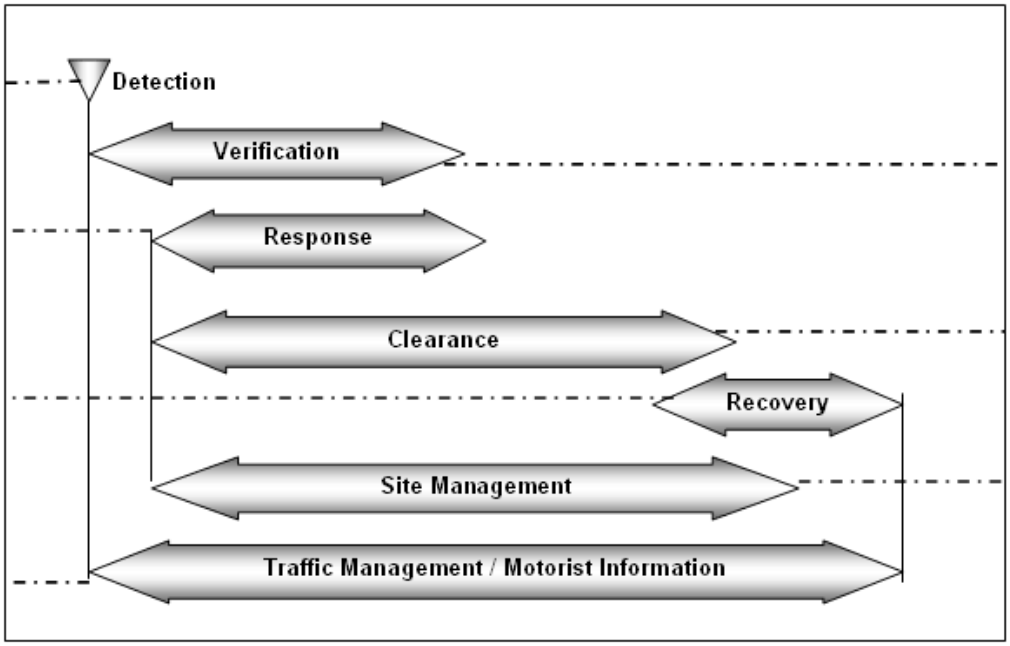



**Figure 2 Timeline of Stages in the Traffic Incident Management Process**
(Source: FHWA Freeway Operations and Management Handbook, 2006)

Figure 2 activity diagram shows stages of TIM practice where public agencies are striving to coordinate their response and keep roadways open and safe for public users and responders. Response is the activation, coordination, and management of the appropriate personnel, equipment, and communication links and motorist information media as soon as it is reasonably certain that a traffic incident has occurred. Timely and effective response reduces the incident's duration, and therefore, the time of roadway operation at reduced capacity.

At each stage, agencies make efforts using Intelligent Transportation Systems (ITS) resources and other means to reduce ***time duration*** so that the overall time of clearing lanes and restoring normal operations is achieved. For example, at the beginning stages, the joint traffic management center (JTMC), an operator can quickly verify reported incident using CCTV cameras and coordinate response among concerned agencies, and update messages on dynamic message signs (DMSs) to inform motorists.

A wide variety of techniques and approaches can be applied to each of these stages to achieve efficiency, primarily in the form or time-duration management and on-scene safety of the personnel and traveling public.

**Role of IIMS in Improving TIM Process by Reduction Response Time**

IIMS, as its name implies, is a traffic incident management system, integrated within a multi-agencies operational environments. Thus, IIMS is both a technology response and an institutional collaboration in NYS regions.

IIMS development is aimed at achieve reduction in ***response time***. The theory of operation behind the IIMS is that if all agencies receive current information on an event (incident) simultaneously, analyze it in real-time and provide response in a coordinated manner, incident

will cleared and managed faster and result in reduced response time. Better on-scene management made possible by faster and coordinated and measured response will also contribute to improved safety of responders and road users and reduction in secondary incidents.

Since road network and transit system operational environment in the City falls under multi-jurisdictions and resources are located in multiple operating agencies, need for a common protocol and information sharing system play a significant role in reducing response time.

Thus, IIMS can be viewed both as a technical system developed by NYSDOT and used by multiple agencies within the City of New York and the State regions; and a common reporting format for traffic incident management (TIM). Any responder or user can provide input into IIMS database in real-time in a pre-determined format of data, photos, video clips and voice messaging. The outputs from system is available to all users in the form of usable data (text), voice, and both photographs and video clips on a 24/7 basis.

Keeping in mind the specific user needs and requirements (note that IIMS is not a general purpose IT database tool), IIMS is intentionally developed *as a* ***data gathering and data sharing tool*** to provide agencies with a more effective, efficient, and coordinated multi-agency response mechanism within the individual agency operational set up to manage ongoing incident or a situation. This forms the business case for IIMS.

Traffic Incident Management (TIM) coordination among multi-agencies is a key outcome of this effort. As a technical system, IIMS incorporates GIS and GPS features, and real-time database with video, data and voice transmission capability for use by agencies personnel equipped with portable devices and by the fixed locations operation such as Joint TMC (JTMC) and provides coverage over wide area 24/7.

**Summary of the IIMS Development Objectives**

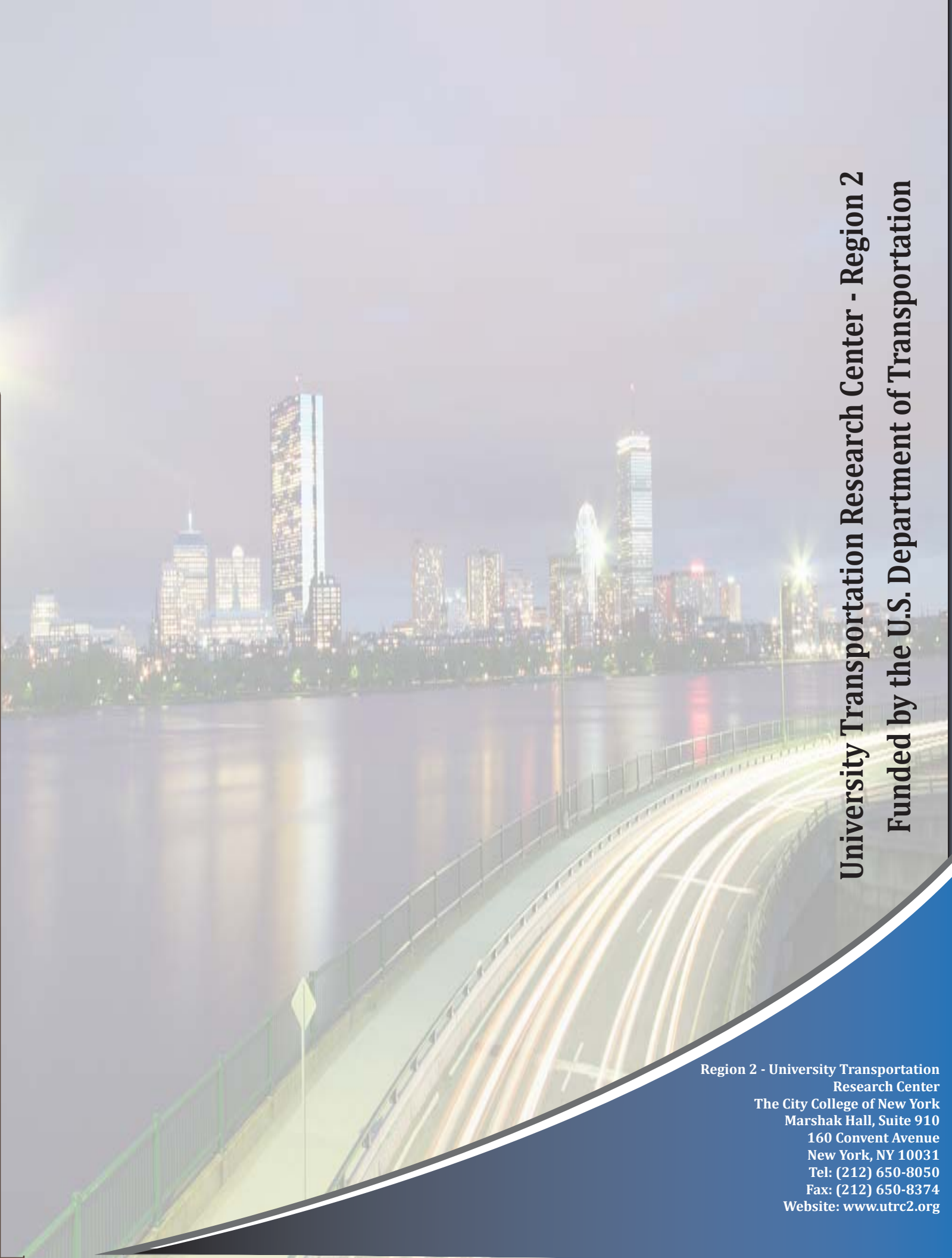
Key IIMS development objectives can be summarized as follows:

- Development of a common information exchange interface protocol for input-output means for incidents.

- Development of an Interoperable System (*ability of agencies and devices to exchange information and use that information to better manage roadway and transit networks).*

- Develop and implement Web Services-platform for both desktop and portable devices environments, and connect both NYC and NYS native IT systems.

- Achieve reduction in ***Response Time*** with integration of coordinated approach and making real-time incident information available to all operation and management levels users at multiple agencies. Facilitate extension of this capability to all parts of the State regions.



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