MITSI Project - Final Local Evaluation Report

Executive Summary

The mission statement for the MITSI project was *facilitating National Standards Compliance migration for NaviGAtor, conducting National Architecture mapping for MARTA and E911, and evaluating CORBA as a methodology for exchanging data*. This involved assessing compliance of the GDOT NaviGAtor system with the Transportation Management Data Dictionary (TMDD), carrying out a proof of concept for exchanging ITS data between GDOT and the stakeholders using Common Object Request Broker Architecture (CORBA). The early completion of these elements permitted a second phase to develop a web based virtual Transportation Control Center (TCC) capability.

At project initiation the TMDD compliance element was considered to represent the largest financial element. A 'Blue Ribbon' Team of 'ITS experts' was assembled to advise the project team. Upon presentation of the TMDD Compliance Report, they advised that a rewrite of the NaviGAtor software was unnecessary and that data in non-compliant format could be readily accommodated by the use of translation tables, thus eliminating a costly and time-consuming process. The next element was the development and demonstration of a proof of concept of ITS data exchange using CORBA. This was successfully completed, but as CORBA technology was judged to be too complicated, process intensive, and effectively a standalone device, it was decided to explore the use of Extended Markup Language (XML) to create a Remote Event Management (REM) web based application that will permit the creation of virtual Transportation Control Centers (TCCs). End users need only to have an Internet ready PC with a web browser, and broadband access to the Internet. Password protected access and predetermined user setup provides users with as little or as much access to NaviGAtor devices as appropriate.

The MITSI team developed, to an alpha testing stage, a significant advance in cost effective ITS integration. The REM application software is jointly owned by GDOT and NET, so despite the completion of the MITSI project, continuation of the project by one or both parties to carry out beta testing and further development is assured. The MITSI project has created an application that once production hardened will offer a cost effective means of providing a ubiquitous method of ITS data sharing amongst entities be they large or small. It should prove particularly attractive for use where the startup costs for a conventional TCC cannot be justified, and for the creation of virtual TCCs for special events. Potential REM applications range from an emergency, or one-off sporting event TCC, to the Department of Transportation of a municipality setting up a permanent TCC.

A significant concern throughout the project has been the institutional issue of maintaining the stakeholders' engagement in what proved to be a foundation-building exercise. In particular MARTA took no part from early 2002 until the final project progress meeting in September 2003. Another issue that affected all parties was the large number of staff changes indicating the need for a comprehensive yet simple method of rapidly familiarizing new staff with the project to date. In the latter stages of the project this need was addressed by establishing a restricted access project website where a journal and links to key events were posted, along with all key documents.

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Introduction

The Metropolitan Intelligent Transportation System Integration (MITSI) Project was a Federal Highway Authority (FHWA) 'earmark' project and as such required the Georgia Department of Transportation to produce an interim and final evaluation report. This final report covers the entire project period from May 2000 to September 2003, and follows the Self-Evaluation Guidelines set out by Dr. Peters in *Self-Evaluation Guidelines, February 2001*. The financial details have been submitted separately to the website.

Invaluable help in the preparation of this report was received from Bill McClane and Marcus Wittich of NET who interviewed a wide cross section of staff who were involved with the MITSI Project. Hugh Colton, the author of this report, joined them for a number of the interviews, and McClane and Wittich shared their notes with Colton for the other interviews. Those interviewed were:
Carla Holmes – State Transportation Operations Engineer with GDOT;
Marion Waters – formerly State Transportation Operations Engineer with GDOT and now a consultant with Gresham Smith and Partners;
David Spinney – Head of the Office of Application Support with GDOT;
Mark Demidovich – Assistant State Transportation Operations Engineer with GDOT;
Lawson (Joe) P. Stapleton – formerly Assistant State Transportation Operations Engineer with GDOT and now a consultant with URS;
Bayne Smith - formerly Assistant State Transportation Operations Engineer with GDOT and now a consultant with URS;
David (Pete) Watford – City of Atlanta;
Jon Ringler – NET;
Ted Hancock – NET;
Paul Dugas – Independent Consultant working for GDOT.

The structure of this report consists of:

- A **Project Description** that encapsulates the entire project.

The **Evaluation** that covers:

- Impacts on mobility, safety, efficiency, productivity, energy and emissions;
- Institutional issues associated with achieving cooperation between public sector agencies.

Additional Evaluation Activities:

- Evaluating institutional issues associated with achieving cooperation among public sector agencies and documenting how they were overcome;
- Providing a brief lessons learned report on the technical and institutional issues encountered in integrating ITS components.

Project Description

The original genesis for the FHWA funded MITSI project was identified jointly by Lawson (Joe) P. Stapleton, the then Georgia Department of Transportation (GDOT) Assistant State Traffic Operations Engineer, and David Spinney, the then NaviGAtor IT Manager, in 1998. Readers should note that Stapleton led the GDOT team that originally conceived the Georgia NaviGAtor traffic management system in the early 1990s, the construction & commissioning of the Transportation Management Center (TMC) in Atlanta, and the associated city and county operated Transportation Control Centers (TCC) in early 1996, and he continued in that position until 2000. The GDOT Automated Transportation Management System (ATMS), better known locally as Georgia NaviGAtor is based on in-house developed software used to integrate and share traffic data gathered from the machine vision detectors (VDS cameras) deployed along the freeways in the Atlanta metropolitan area as part of the traffic management system implemented for the 1996 Olympic Games. Stapleton's MITSI vision was supported by the then State Traffic Operations Engineer, Marion G. Waters, and by the then Commissioner of GDOT, Wayne Shakelford. Two stakeholders, the City of Atlanta, and the Metropolitan Atlanta Rapid Transit Authority (MARTA) were recruited to the project team. MARTA contributed $400,000, and the City of Atlanta contributed manpower in lieu of cash. A consultant contract to implement the MITSI project was placed with National Engineering Technology Inc (NET) on May 26, 2000.

The primary objective of the MITSI project was to assess compliance of the GDOT NaviGAtor, MARTA SmartTrack and the City of Atlanta 911 Computer Aided Dispatch (CAD) systems with the then recently created Transportation Management Data Dictionary (TMDD), and subsequently to investigate methods to bring the NaviGAtor system into compliance. At the time of the project initiation the TMDD compliance element was considered to represent the largest financial element of the project effort, although specific values were never defined. Views of the interviewees differed as to their expectations regarding software recoding. Stapleton was very clear that it was never his intention to rewrite NaviGAtor, hence reinforcing the MITSI mission statement: *facilitating National Standards Compliance migration for NaviGAtor, conducting National Architecture mapping for MARTA and E911.*

The secondary element was, to quote the latter part of the mission statement: *evaluating CORBA as a methodology for exchanging data.* CORBA being the Common Object Request Broker Architecture.

A 'Blue Ribbon' Team of ITS experts was invited to join the project team as technical advisors. The members of the 'Blue Ribbon Team were:

Ed Seymour, Texas Transportation Institute
Steve Dellenback, Southwest Research
Joel Markowitz, Metropolitan Transportation Commission
Ken Vaughn, Trevilon
Dan McCreery, NEMA
Eva Lerner-Lam, Palisades Consulting Group, Inc.
Warren Tighe, Gardner Transportation Systems.

The Blue Ribbon team studied the TMDD Compliance Report produced by NET and subsequently advised the MITSI Project Team that a rewrite of the various software elements used by NaviGAtor, SmartTrack and the 911 CAD was unnecessary, and that data in a non-compliant format could be readily accommodated by the use of translation tables. Recoding NaviGAtor so as to be TMDD compliant would be a costly and time consuming process, providing no cost benefit. Furthermore, the cost of rewriting NaviGAtor software would far exceed the available MITSI budget, thus the decision was made to eliminate any software re-engineering. Attention then turned to the development and demonstration of a proof of concept of ITS data exchange using CORBA.

The "Discovery Zone" was proposed by NET as a means of leveraging the lessons learned from the California DOT (Caltrans) implementation of CORBA and identifying data of interest for GDOT and its partners. It was decided to use a different CORBA implementation for the MITSI Project as compared to Caltrans, so as to benefit from additional capabilities. It is worth noting that at the inception of the MITSI Project, CORBA was an open standard with a number of independent implementations. Since that time the various implementers of CORBA have been purchased by a single entity that has changed CORBA from an open standard into a proprietary standard with a consequent high price tag to maintain currency.

Once the details of the ITS data to be collected had been established, some practical problems arose. In the case of MARTA, the MITSI team was informed that a new build of the MARTA SmartTrack software, termed 'Build 51' would be purchased. 'Build 51' would offer the capability of interfacing with the CORBA data factory process to extract live data from the SmartTrack system. Unfortunately budgetary constraints at MARTA precluded them from purchasing that upgrade until early 2003, by which time it was too late to be of use to the MITSI project.

The first formal demonstration of the CORBA proof-of-concept took place on February 6, 2002 and was attended by GDOT, the stakeholders, and the Blue Ribbon Team. Unfortunately the CORBA system did not function satisfactorily. Subsequently NET carried out a thorough review of their code, and the computer system. A further demonstration of the CORBA system took place on June 5, 2002. This proved successful, nevertheless, it was concluded that the CORBA application for sharing center to center ITS data had a number of significant drawbacks, and a production hardened system was not developed. It should be noted that the proof of concept system continued to be used until the end of the project.

Coincidently the desire for the exchange of ITS data between interested parties in the Atlanta region blossomed to the extent that a formal group calling themselves TIME (Traffic Incident Management Enhancement) was established. TIME created a formal grouping of potential stakeholders all of whom have the same desire to access and share ITS data. Hence it was decided by the MITSI Team to embrace TIME as their goals and objectives were clearly the same as the existing stakeholders. The MITSI Team decided to cease further development of the CORBA element of the project beyond the proof-of-oncept stage, and to investigate alternative center-to-center ITS data sharing methods. With a substantial portion of the funds remaining unspent, a time only extension of the NET contract was agreed by FHWA. The new contract completion date was set for September 30, 2003. NET was tasked to examine the feasibility of utilizing a web services application to provide a ubiquitous yet efficient means of exchanging ITS data between diverse users. This element of the

MITSI Project was named the Remote Event Management (REM) application. REM was required by the MITSI mandate and the stakeholders to meet the following criteria:

- Utilize a web services framework to provide NaviGAtor functionality in a national standards compliant XML based format;
- Create a browser-based application using this framework to provide access to a subset of NaviGAtor functionality to satisfy the needs of TIME members;
- Extend portions of the application to explore the viability of NaviGAtor proliferation through an Application Services Provider (ASP) model.

It was recognized at this juncture that this task was a possible quantum leap forward in capability, but with the time, and to a lesser degree, funding constraint it would almost certainly not provide a production hardened application by the end of the MITSI contract. Nevertheless it was felt the MITSI Team should proceed.

It was agreed that the REM application should provide remote access to the following NaviGAtor functions:

- Create, update, confirm and terminate an incident (unplanned event);
- View an incident (unplanned event);
- View the streamed video from traffic cameras (CCTV);
- Control CCTV camera functions;
- View the NaviGAtor map showing incidents, planned lane closures (PLC), cameras and Changeable Message Signs (CMSs);
- View accepted response plans;
- View contact information;
- Create, update, confirm, and terminate planned events (e.g. PLCs);
- Provide Internet Protocol (IP) addressable camera support;
- Demonstrate adding an IP addressable camera to the system;
- Support jurisdictional events;
- View color-coded congestion on a map.

By virtue of the use of the Internet as the communication medium, users need not be physically connected to the GDOT fiber network as with CORBA, but merely connected via the Internet. The intensity of data exchange is such that realistically the Internet access had to be a broadband connection. Security was assured by using a secure sockets system requiring users to have a logon and password. Further security was provided by assigning privileges to users on a case by case basis to meet their individual needs, thus limiting users to their area of interest and preventing intentional or unintentional misuse of the NaviGAtor system. This was considered an important aspect to prevent disruption to the existing the NaviGAtor production system.

On reaching the end of the NET project contract on September 30, 2003, all the key features had been tested and demonstrated with the exception of certain CMS activities. In general terms the REM application met all the objectives providing the capability to provide virtual TCC capability limited only by the availability of broadband Internet access. The MITSI Team was convinced of the viability of the REM application. By virtue of the fact that the REM application software is jointly owned by GDOT and NET, the continued development by one or both parties is certain.

GDOT plans to continue the work of production hardening as part of the Georgia NaviGAtor ongoing development process.

Evaluation

Impacts on mobility, safety, efficiency, productivity, energy and emissions.
The purpose of the MITSI Project involved a review of the various ITS systems employed by GDOT, MARTA, and the City of Atlanta 911 CAD Center, to assess their conformity with TMDD. The MITSI project was to lay the foundation for management center operational improvements that impact mobility. Phase I of the MITSI project resulted in no new operational changes being introduced. However, GDOT gained access to 911 incident data and was able to informally test the benefits of such a data exchange for day-to-day operations. The proof of concept of center-to-center communications using CORBA has had no particular impact on the NaviGAtor system, but the experience of GDOT accessing 911 traffic incident data has value in that by using the proof of concept system, the GDOT operations staff have been exposed to the concept and reality of ITS data exchange.

As a result of what the MITSI Team learnt in the first phase, particularly with regard to sharing ITS data, the team was able to focus in on an expanded range of requirements for center-to-centre communication. Using CORBA as a proof of concept highlighted a major shortcoming. It neither provided a low cost method of sharing ITS data, nor did it provide a viable tool to expand the sharing of ITS data beyond those organizations that were already on the GDOT fiber network. It is estimated the equipment cost of a new TCC with its Unix server, fiber network connection and associated equipment is upwards of $100,000. There are a number of towns in the Atlanta metropolitan area that want to have a TCC capability, but this level of expenditure is outside their budget limits, and if provided by GDOT, would cause a consequential reduction in monies for expansion of the NaviGAtor system. Thus there was a unanimous desire to create a simple system that would provide as much capability as possible but within the budget of typical office equipment. The result was the creation of the concept of using a broadband Internet connection in lieu of a dedicated fiber connection to the GDOT backbone, and a personal computer instead of a dedicated NaviGAtor terminal and associated Unix server. The result of the second phase of the MITSI Project was the development of what, to all intents and purposes, is a virtual TCC. Restrained only by accessibility to a high speed Internet connection, any modern PC can be used as the virtual TCC terminal.

The MITSI project has demonstrated that not only was a proof of concept system developed, but a working alpha system was assembled that used most of the current NaviGAtor capabilities to view ITS data, log incidents, view traffic data maps, and view any video source on the NaviGAtor system, and the capability to easily add IP addressable cameras.

In effect the MITSI Project has far exceeded its original remit. The MITSI team has developed the basis for a nationally integrated ITS system with all the ‘back office’ data application functions being provided by an Application Service Provider (ASP).

Limiting the evaluation to the Metropolitan Atlanta area the MITSI project has provided the stimulus to develop and no doubt deploy by the Summer of 2004 a ubiquitous system whereby TIME members will be able to have any number virtual TCCs permanently or temporarily connected to NaviGAtor, and the capability to bring on line, at very short notice, additional TCCs for special

events. The consequential free flow of ITS data will address many of the elements of this section of the evaluation as follows:

- **Mobility** will be improved as local jurisdictions hitherto unserved or underserved by NaviGAtor data will have the opportunity to fully access all ITS data that affects them. Thus they will be better able to control and organize their response to incidents. Additionally each jurisdiction will be able to add their data to the NaviGAtor database, and have a map providing graphical information of their jurisdiction. The overall result will be an improvement in mobility;
- **Safety** will be enhanced by the speedup in data transfer between disparate branches of the response community. The availability of streamed CCTV images will help managers make better assessments of the staff and equipment that need to be deployed;
- **Efficiency** will likewise improve as data passes more efficiently between those that need to know;
- **Productivity** will be enhanced as there will be a reduced need for telephone calls to be made as data will be available to the parties that need to know;
- **Energy** consumption will be reduced as incidents should be cleared faster due to ITS data sharing. Fewer drivers will be delayed, and less drivers will seek alternate and possibly longer routes to their destinations resulting in reduced fuel consumption. Better access to CMSs will also improve information being disseminated to drivers and a consequential reduction in travel times as alternates can be planned;
- **Emissions** will improve, as traffic will flow at speeds at which fuel burns more efficiently.

Institutional issues associated with achieving cooperation among public sector agencies.
An important element of the MITSI project was the proof of concept of center-to-center integration of data using CORBA. The progress of this element in part relied upon the willingness of the stakeholders to become involved in the project and to be prepared to share data. The stakeholders, MARTA and the City of Atlanta 911 CAD Center, have not changed in name or function, but in the case of MARTA the members of the MITSI Project team were eliminated. However in the case of City of Atlanta 911 CAD organization, Pete Watford remained with the city, although his role has changed several times, and he continued to provide a vital link to the City 911 CAD, and data kept flowing to the CORBA proof of concept system. Recently with the appointment of a new Police Chief there is a new interest in developing ITS data exchange using REM.

MARTA has experienced a critical financial challenge in the last two years. This led to a delay in purchasing the software (Build 51) upgrade to the MARTA ITS system, which in turn prevented integration of data into the CORBA system. Furthermore there has been the loss of all the staff that was involved with the MITSI project. The possibility of re-engagement, which appeared to be imminent in September 2002, faded with the announcement of further staff reductions. Notwithstanding these challenges MARTA sent the newly appointed ITS Manager to the final MITSI project meeting in September 2003.

GDOT had a number of personnel changes since the MITSI contract was signed. Of most significance was the fact that the person most responsible for the vision of MITSI was not involved once the project had been funded. The new project manager, who had had no involvement up to that time, was provided with a minimal transfer of information, and that which was provided focused on reviewing documentation of the project.

At a recent ITS Georgia conference the REM application was demonstrated to the audience. A number of TIME members were present and they commented favorably at what they saw. Time members in general have indicated that they wish to avail themselves of access to NaviGAtor using the REM application just as soon as the production-hardened version is available.

The institutional issues presented a number of challenges, many of which were only recognized upon reflection when the interim evaluation was being conducted. The MITSI project data in a digestible form was not easily accessed, although the MITSI project from a technical and contractual aspect was well documented. McClane (NET) had been collaborating closely with Colton (GDOT) on the evaluation of this project and it was mutually concluded that a single up-to-date readily accessible source of information was long overdue. At the April 2003 MITSI meeting it was agreed to populate the limited access website, http://mitsi.intranets.com and a one sheet chronology of events, and a journal of recent activities was posted along with other significant documents. Each MITSI member was issued with a username and password to access the website contents at any time. The benefits of the website included:

- A readily available source of briefing information for new personnel to rapidly acquaint themselves with the project;
- A living document that could was used to present an executive summary of the project to date;
- An aide memoir to participating staff so that they could quickly check on significant facts, and dates;

- A digest that enabled higher management to stay in touch with the project;
- A one paragraph ‘elevator story’ of what was the MITSI project, what had been achieved and would be achieved by its conclusion.

This document was not intended to be a substitute for detailed meeting minutes and reports on studies that formed part of the project, but a digest of key expectations and events.

Additional Evaluation Activities

Peters' evaluation guidelines called for at least two evaluations in addition to the Local Evaluation Report. The two evaluations carried out were:

- A brief lessons learned report on the technical and institutional issues encountered in integrating ITS components;
- A lessons learned report on the experiences, challenges, and approaches used in achieving consistency with the National ITS Architecture and/or implementation of ITS standards.

A Brief Lessons Learned Report on the Technical and Institutional Issues Encountered in Integrating ITS Components.

Peters poses a number of questions and what follows is an attempt to address those questions based on the responses from the wide range of the persons interviewed and the practical results of the project to date.

What institutional impediments did the project participants encounter while working with different agencies to achieve integration?
Each of the institutions involved in MITSI are separate and distinct. They are parts of the pieces of a jigsaw puzzle that fit together, somewhat imperfectly, with overlaps and a few holes to form a transportation infrastructure. As independent entities they have their own agenda, and this was made clear when, from their point of view, the stakeholders' attention was diverted to challenges of far greater importance.

MITSI was a non-core activity with little immediately identifiable benefits to the stakeholders in the short term, other than to GDOT. It is believed that this factor caused the project to be positioned low down on the stakeholders' order of priority. Thus, when financial challenges arose, stakeholder senior management concentrated on issues more important to their entity. GDOT too let MITSI slip as when there were software development problems with NaviGAtor, work on MITSI by NET, who was also the sub-contractor responsible for NaviGAtor development, was shelved until the NaviGAtor issues had been resolved.

The signs of disengagement by the stakeholders that were identified were:

Failure to attend scheduled progress meetings;
Failure to attend major presentations;
Failure to respond to telephone calls, voicemail and e-mail;
Failure to execute previously agreed project steps.

Towards the end of the project there were clearly benefits to be shared and it was at this time that greater interest from both stakeholders and TIME members began to emerge. This leads to the conclusion that unless the stakeholders can see potential benefits it will be harder to maintain their attention. Clearly when financial constraints preclude continued active involvement then the project team needs to at least maintain contact. This the MITSI Project Manager did, and finally MARTA was re-engaged. The earlier availability of a website where the proceedings could be easily accessed may have made the Project Manager's task less onerous.

Where in the life cycle of the project did the impediments occur? What were the causes of the impediments and how were they overcome?
The primary impediments to this project did not appear to have been driven by the project life-cycle (e.g. transition between phases), but were caused primarily by changes in the institutions supporting this project resulting in the following impediments:

- Initially there was the loss of the GDOT visionaries at the commencement of the project. It took a period of time for the Project Manager, who came from outside the visionary group, to be fully conversant with the overall aims and goals of the MITSI project. On reflection the

requisite cohesion between GDOT and the stakeholders may not have been fully consummated, added to this the lack of continuity on the part of GDOT, which in the absence of a journal clearly setting out what had been achieved to date, made picking up the project a much greater challenge. The loss of the visionaries coincided with the reorganization of the GDOT Information Technology (IT) section. IT services were for some time uninvolved in the MITSI Project so an internal discontinuity was created. After a period this was addressed by GDOT IT with the creation of IT project engineers, and one was assigned to the MITSI project. Nevertheless in the interim there was a lack of continuity by GDOT IT. Later when IT provided a project engineer there was a further continuity issue when the incumbent project engineer resigned. A supervisor stepped into the breech, but a replacement was some months in materializing. The project website was in place by that time and it provided a faster transition for the new incumbent.

- An impediment occurred after the first Blue Ribbon team meeting in 2001, when the TMDD work finished and the project shifted to the CORBA implementation, the focus of the project shifted to a proof of concept of center-to-center ITS data exchange. As this element of the project was getting underway GDOT experienced a period when their continually developing NaviGAtor ITS software became unstable resulting in GDOT instructing their System Integrator, TransCore for whom NET was the software subcontractor, to cease work on the MITSI project and concentrate on NaviGAtor software issues.

- In 2001, MARTA began to experience a rapidly growing financial crisis that prevented them from upgrading their system so that it would have been accessible by the CORBA system. MARTA's software Build 51 did not materialize until late Spring 2003, too late to be used for the data integration. A further impediment occurred when in Spring 2002 the MARTA staff that had been involved with MITSI left its employ. A MARTA contractor continued to attend meetings for a further 4 months before that person left MARTA. It was not until the summer of 2002 that MARTA hired a new ITS Manager, and the process of re-engagement began. This process was barely underway when the senior member of MARTA management to whom the ITS Manager reported left MARTA. With no replacement the MARTA ITS Manager's time was devoted to more pressing operational matters.

  By Spring 2003 the financial crisis at MARTA continued, culminating in a substantial reorganization of senior management that resulted in a flattening of the hierarchical pyramid as senior managers were let go. No doubt this in turn created substantial additional duties for the remaining managers, thus burying MITSI below numerous internal issues that demanded immediate attention. The end result was disengagement of MARTA for more than a year. Finally in September 2003 a new ITS Manager was in post and attended the final MITSI Project meeting.

- GDOT Operations experienced a number of personnel changes during the course of the MITSI project, including 3 MITSI Project Managers, and a number of other key position changes including at least two resignations and two new hires.

- The City of Atlanta experienced some challenges with the election of a new Mayor, and the appointment of a new Police Chief, and the hiatus that preceded this event as the remaining

senior police officers left in post were anxious not to permit access to time sensitive data, so access to the City 911 CAD data was limited.

The CORBA proof of concept element of the project was completed before 'Build 51' was finally implemented some 3 years late. This effectively excluded MARTA from the proof-of-concept element of the project and required that for testing simulated data had to be used.

The process of maintaining engagement has proved to be a challenge to all concerned. The representative from the city of Atlanta continued attending MITSI meetings, despite being moved between various city departments. He should be recognized for his dogged determination to remain engaged.

The addressing of impediments not connected to the project life cycle was beyond the control of this project. The Project Manager could not plan for these impediments to occur at any particular phase of the project. Nevertheless these issues demanded attention, and to their credit, the project managers at GDOT and NET worked hard to remain in contact with the stakeholders, despite the lack of reciprocation. It can be argued that the MITSI Project team overcame the City 911 CAD data restriction, and successfully demonstrated the feasibility of integrating ITS data. The only goal that was not achieved was access to MARTA data. CORBA feasibility was proven and therefore access to the MARTA data, although desirable, was not an insurmountable impediment, and did not prevent the successful demonstration of the proof of concept.

How were the different missions of each of the partnering organizations merged?
The successful cohesion established between so many diverse governmental organizations during the period leading up to the 1996 Summer Olympics was the key factor that was exploited to bring the MITSI partners together to execute the MITSI Project. Missions "merged" at a personal level during the Olympics, however, subsequent financial crises at the city of Atlanta and MARTA overshadowed stakeholder involvement demonstrating a failure to institutionalize this coupling. In the closing days of the project MARTA was re-engaged which demonstrates that the common elements of the missions of each partner had not been completely submerged. By the very end of the project a high level of interest was being shown by the stakeholders.

How was ITS facilitated within each of the partnering organizations?
By the very nature of the MITSI project, all the work conducted in Phase I took place outside of the legacy systems of the stakeholders and has thus posed no risks to their operations, i.e. the TMDD review and CORBA proof of concept. It was not the purpose of the first phase of the MITSI project to improve the exchange of ITS information between the constituent members. Phase II of the MITSI Project produced the REM application and this has created serious interest by the stakeholders.

How does each of the partners assess the risks and benefits of the project?
By virtue of the nature of the two primary activities, the risk to the stakeholders was limited in that no day-to-day activities were affected. The TMDD compliance element was scaled back as a result of the wise advice from the Blue Ribbon Team who provided peer review and advised that the use of translation tables is an acceptable and cost effective method of dealing with legacy ITS. Thus any

TMDD translation would take place outside the City of Atlanta 911 CAD system and the MARTA SmartTrack system, thus eliminating any risk to the respective systems.

The representative from the City of Atlanta has expressed his satisfaction with what MITSI has achieved.

When the REM application was being finally tested it did impact the NaviGAtor production system, and on one occasion the early intervention of a member of GDOT senior management prevented a potentially disastrous situation. Incorrect messages were being displayed on the CMSs and visual indication of the health of each CMS was inadvertently removed.

Despite the testing problem and the inherent risk of testing an unproven application on a production system, the GDOT MITSI team was well pleased with the outcome of the project and look forward to the implementation of the REM application.

What technical issues were encountered while integrating different components?
Initially simulated data had to be used in place of live data from both stakeholders. At the first formal demonstration the CORBA system was choking, but an in depth review of the code addressed this shortcoming. Data from the City of Atlanta 911 CAD system was used later by the CORBA system. Without Build 51 the MARTA SmartTrack system was unable to share data with the CORBA system.

The REM application by its very nature used a different data integration approach. However this capability did not include utilizing stakeholder data in the testing due to shortage of time.

By the very nature and size of an ITS system such as NaviGAtor it has proved impossible to create a test environment that completely reflects the production system. Hence the alpha testing had to be carried out on the production system. The production system was designed to operate as a stand-alone system accessed by other Unix servers. Adding a Windows based browser access provided challenges. Whereas the NaviGAtor code is well known, a Java enabled Windows Internet Explorer (IE) browser proved to have some latent characteristics that made certain activities unreliable. Control of the CMSs was unreliable. The cache feature of IE seemed to prevent the latest data displayed on a CMS from being displayed to the operator of a virtual TCC. This problem remained unsolved at the end of the MITSI project. It will be dealt with before beta testing commences.

Were you able to apply lessons learned from similar deployments to your project's deployment?
The MITSI project benefited from the CORBA work that NET had already carried out in California. This provided a solid base from which to work, however the nature of the beast in Georgia was somewhat different. Nevertheless a familiarity with CORBA no doubt helped a great deal with the numerous technical challenges that the project posed.

According to Peters the following issues have been identified in previous deployments and are addressed below:

- **Organizational Issues** – Changes in stakeholders' organizations were to be expected, but changes to the degree that were experienced were undoubtedly beyond anything that could have been anticipated when this project was being proposed. The respective project managers addressed these problems by devising ways to get on with the job despite the hindrances. An example was the direct appeal to City 911 made by Marion Waters of GDOT to release data as promised, this proved to be a watershed event;

- **Human Resource Issues** – These have manifested themselves in the form of staff changes to the extent that little or no continuity has been maintained, and no tool was put in place to ease the transition until the latter stage of the project when the website was created. In the later stages of the project the MITSI team recognized the importance of this factor;

- **Public Acceptance Issues** – By its very nature this project has not raised any public acceptance issues;

- **Regulatory/Legal Issues** – Similarly no public acceptance issues were raised;

- **Financial Issues** – Diligence by the GDOT Project Managers ensured that the project funds have been spent frugally. This in turn has permitted a great deal of ground to be covered by the web services REM element of this project, an activity not originally envisaged as part of the project;

- **Other Issues** – For a project of such length, more than three years, several of the above issues could have been addressed by utilizing the project plan to aggressively communicate and monitor progress. This in turn would have provided all the participants with a comprehensive sanity check on progress. Instead the project relied upon monthly meetings that were occasionally missed due to holidays or other important operational demands, and thus created opportunities for the project to slow down. With earlier implementation of the issues log that was later adopted this tool would have focused attention and created better communication by using the project plan to identify actions and monitor progress.

A lessons learned report on the experiences, challenges, and approaches used in achieving consistency with the National ITS Architecture and/or implementation of ITS standards.

For the MITSI Team the challenge of how to make a legacy ITS software package TMDD compliant thus achieving consistency with the National ITS Architecture must at first have seemed daunting. For those intimately involved with ITS development, implementation and operation there was an implicit understanding that changes and updates to software code are not undertaken lightly. Unlike Commercial Off-The-Shelf Software (COTS) that is created and tested on one or more dedicated systems, with extensive testing by selected users, ITS software such as GDOT's NaviGAtor, is developed for a very special purpose, using limited testing facilities, and as such should be considered a 'one-off'. An ITS system involves monitoring hundreds, if not thousands, of external/peripheral input/output devices. The result is that it is difficult to simulate a complete complex system for development and testing purposes. Hence a development system has limited capabilities when it comes to testing a new implementation of software. It is quite typical to have a diverse range of input types, of which a number may be faulty or missing at any one time, but nevertheless the ITS system must tolerate these conditions and function normally, or as near to normal as possible. Even when a major ITS system is developed using a modular approach, a major overhaul, such as that contemplated to make NaviGAtor TMDD compliant would be an undertaking involving considerable expense, and undoubtedly an unacceptable disruption to the existing production system as the new software would have to be mounted and demounted countless times in order to be tested in parallel with normal operations.

The three ITS systems that were the subject of the MITSI Project, namely – GDOT's NaviGAtor, the City of Atlanta's 911 CAD, and MARTA's SmartTrack are legacy systems developed and commissioned prior to the development of TMDD. The initial wave of enthusiasm to create a ubiquitous TMDD compliant ITS infrastructure spawned the MITSI Project. The in depth analysis of NaviGAtor presumed initially that the software should be rewritten, at least in part, so that it would be TMDD compliant, and to this end a study was carried out. A Blue Ribbon team of ITS luminaries had been assembled as part of the MITSI Project team and they reviewed the TMDD report. Their unanimous recommendation was that legacy ITS software need not be rewritten to make it TMDD compliant, but that it was both feasible and acceptable to implement a translation strategy that would take the terms from the legacy software and translate them into TMDD compliant terms. Hence there was no justification to rewrite legacy ITS software with the sole aim of becoming TMDD compliant. The importance of this conclusion cannot be overstressed. It saved GDOT a huge expense and disruption. This validated conclusion will save other Departments of Transportation considerable operational disruption and expense.

Project outcome based on measures of effectiveness
Addressing the nine basic ITS components and the benefits:

Freeway management – The CORBA proof of concept demonstrated the capability to disseminate center-to-center data within the limitations of the stakeholders' respective systems. The REM application provides a different approach to sharing freeware management data freeing potential TCCs from the need to be on the GDOT network. REM demonstrated the capability to share NaviGAtor ITS freeway management data with any virtual TCC and enable the rapid creation of a virtual TCC. The only requirement is a network ready PC with access to a high

speed Internet connection. The production hardened virtual TCC will be capable of the functions that a NaviGAtor TMC currently enjoys;

- **Incident management –** Whereas the CORBA proof of concept demonstrated the possibility to enhance incident management, the REM application took this concept to a whole new level with its capability to provide a complete virtual TCC. The REM application meets a broad spectrum of requirements. For an emergency situation a virtual TCC could be setup anywhere that a broadband Internet connection could be established. As mobile satellite Internet access becomes available the virtual TCC could be in a vehicle just waiting to be activated. For the smaller city or less populous county the REM application offers the capability to access the power of the NaviGAtor ITS at minimal cost. For a large city with facilities spread around the conurbation the REM application offers the capability to provide a virtual TCC at every DOT, police office, 911 center and firehouse. There is no geographical limitation on the REM application other than broadband access to the Internet.

  The end result is that in a relatively short time incident management capabilities utilizing NaviGAtor will be available throughout Georgia. The logged data will be accessible to all who need to know potentially offering a quantum leap in capability as compared to what exists today.

  The effectiveness of incident management will be greatly enhanced to the benefit of the operators and the public at large;
- **Traffic signal control –** This aspect was not a part of the MITSI Project, nevertheless using the REM application as a baseline there may be opportunities to integrate and centrally control hitherto standalone systems;
- **Transit management –** This aspect was not a part of the MITSI Project. However, by use of the REM application Transit Authorities will have access to the NaviGAtor system and the CMSs. Timely posting of information could assist in times of Transit incidents;
- **Electronic toll collection –** This aspect was not a part of the MITSI Project;
- **Electronic fare payment –** This aspect was not a part of the MITSI Project;
- **Highway-rail intersections –** This aspect was not a part of the MITSI Project;
- **Emergency management services –** The REM application offers numerous possibilities for the emergency services as mentioned above concerning incident management;
- **Regional multimodal –** This aspect was not a part of the MITSI Project.

Evaluation Conclusions

Navigating the institutional changes: careers, management, and budget issues.
The MITSI project established a foundation for center-to-center interchange of ITS data. Initially the general perception was that there would be no immediate benefits accruing to the project participants, hence, it proved difficult to maintain the engagement of the stakeholders at all levels. This factor was exacerbated by a lack of continuity of personnel involved in the project. Thus for a project of this size and duration it was essential to establish a mechanism to deal with staff changes and provide project management continuity. These shortcomings were addressed by the creation of an on-line journal. Future projects should pay close attention to maintaining the engagement of the stakeholders from day one, by creating at the outset a specific task to maintain stakeholder engagement at all levels with a particular emphasis on upper management. Nevertheless it must be recognized that when a stakeholder has a financial crisis it may be impossible to successfully maintain engagement.

TMDD
Despite the stakeholder engagement issue there was general agreement that the TMDD compliance review, and the wise advice of the blue ribbon team, showed how standards should be applied to legacy systems without simply rewriting the software code.

CORBA
Utilizing CORBA as a center-to-center approach proved that data could be moved between disparate systems. However it was concluded that CORBA would not be a satisfactory tool for GDOT due to the cost of ownership of CORBA, and the complexity of operation. It was decided to stop the CORBA work after the successful proof of concept and explore an alternative cost effective means of sharing ITS data and devices between any government jurisdictions and services.

Remote Event Management
The CORBA "proof-of-concept" convinced the MITSI Team of the value of sharing center-to-center incident data. However it was everyone's desire to see an application that could be simply invoked and that had value to the MITSI stakeholders, and all other potential users of the data. Here the vision of a few members of the team became paramount in enumerating the requirements and defining what was practical using the best tools available. XML and Java, two freely available programming tools, were selected for the REM application. In less than six months, the project, that some contended was merely an academic exercise, was transformed into a ground breaking landmark in ITS integration. The final phase of the MITSI Project has effectively globalized the NaviGAtor system, metamorphosing it from a high cost, high level system, into a system available to the smallest entity at an acceptable cost. The writer is unaware of any other system that has created such a ubiquitous system.

From humble beginnings has sprouted a milestone in ITS data sharing.

Glossary of Abbreviations

ASP	Application Service Provider
CAD	Computer Aided Dispatch
Caltrans	California Department of Transportation
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off-The-Shelf Software
CMS	Changeable Message Sign
CCTV	Closed Circuit TeleVision
FHWA	Federal HighWay Authority
GDOT	Georgia Department of Transportation
IE	Internet Explorer
IP	Internet Protocol
ITS	Intelligent Transportation System
MARTA	Metropolitan Atlanta Regional Transport Authority
MITSI	Metropolitan
NET	National Engineering Technology Inc
PLC	Planned Lane Closure
REM	Remote Event Management
TCC	Transportation Control Center
TIME	Traffic Incident Management Enhancement
TMC	Transportation Management Center
TMDD	Transportation Management Data Dictionary
XML	Extended Markup Language