System Integration Case Study

FAST-TRAC

Preliminary IV Deliverable

#2: Systems Integration Case Study
EECS-ITS-LAB - FT99 - 001

Andrea I. Frank, M.U.P.
Thomas B. Reed. Ph.D.
Mark LeBay, B.F.A
Steven Underwood, Ph.D.

Intelligent Transportation Systems Laboratory
200 Engineering Programs Building
The University of Michigan
Ann Arbor, MI 48109-2101
Steve Underwood, Ph.D., Principal Investigator

Program Offices Telephone
(313) 764-4333
Program Offices Facsimile
(313) 763-1674

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Also, we would like to pay a special tribute to Ollie Shearer from Booz-Allen and Hamilton whose unexpected and untimely death in November 1997 left a great gap. Ollie Shearer conceived the concept of this case study on FAST-TRAC system integration, and was instrumental in the early set-up. Without him, this study would not have been conducted in this format. His candid opinion, foresight and advice are greatly missed.

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EXECUTIVE SUMMARY

This case study report is part of the FAST-TRAC (Faster and Safer Travel through Traffic Routing and Advanced Controls) Phase IV Evaluation conducted for the Road Commission of Oakland County (RCOC). The case study focuses on the systems integration aspect of the Transportation Information Management System (TIMS), which is the tool developed under the direction of RCOC to integrate various Intelligent Transportation System (ITS) technologies in Oakland County (Michigan). The TIMS is the center of a communications network that integrates advanced traffic control with traffic surveillance and traveler information systems, and solicits and distributes traffic information across jurisdictional levels of local and state traffic agencies.

The FAST-TRAC case study describes the systems integration process experienced by RCOC in terms of the problem, the institutional context, the evolution of the systems integration approach, the lessons learned, and future prospects. The main objective of the study is to document the experience of the FAST-TRAC systems integration for other agencies and parties involved in ITS systems integration projects. Special attention is paid to difficulties encountered during the integration process and the solutions developed in response. Secondary objectives include an assessment of FAST-TRAC's level of compliance with the national architecture and a review of future plans for the project in light of the development of a regional ITS architecture. The case study is structured in seven sections.

Section 1 introduces the problem of ITS systems integration and integrated ITS deployment from a national perspective. A unified approach to ITS systems integration will ensure interoperability, and is especially needed for technologies that facilitate interstate travel and transportation such as the paperless commercial vehicle. From a regional perspective, systems integration efforts should be based on the analysis and understanding of local needs and conditions so that integrated systems provide an optimal solution to existing problems.

Section 2 introduces location-specific and historical information regarding Oakland County and the FAST-TRAC program. The section puts

the ITS technology into a context of institutional arrangements and local transportation issues.

Section 3 contains a review of project goals and objectives and their evolution over the course of the project. FAST-TRAC's system integration is characterized by a willingness to experiment and try novel approaches in traffic management. This experimental approach inevitably led to adjustments and revisions during project planning and development. Based on these revisions, three phases of the project can be distinguished. Project partners, management approach, contracting and integration philosophies changed for each of those phases.

A comprehensive description of the integrated system is given in *Section 4*, including graphic representations of the conceptual linkages, software/ hardware components and data exchange protocols used.

Section 5 summarizes difficulties and obstacles encountered during the system integration in five "Lessons Learned".

The report concludes with *Section* 6 in which plans for future development and extensions of FAST-TRAC are outlined. Moreover, the implications of the federal mandate for conformance with the ITS National Architecture and standards in terms of system integration planning are highlighted.

Section 7 is an Appendix containing references, summaries from an interview and focus group session as well as a glossary of abbreviations and acronyms used frequently throughout the report.

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1. INTRODUCTION

The full potential of Intelligent Transportation Systems (ITS) will be realized only when agencies coordinate and *integrate* systems across modal, institutional and jurisdictional boundaries. Integration enables the cooperation of individual ITS components. It allows the sharing of resources and information, which promises to pay great dividends in reduced costs and improved operations for customers and agencies. As a result, the U.S. Department of Transportation's (U.S. DOT) Intelligent Transportation System (ITS) program is progressing from operational testing to system deployment with a focus on integrating various ITS technologies, as well as previously deployed systems.

The National ITS Architecture represents an existing framework for planning, implementing and deploying ITS technologies. In an effort to foster ITS system integration. Congress requires under the new Transportation Efficiency Act 21 (TEA21) that all federally funded ITS projects conform with the ITS National Architecture and related ITS standards. However, it was emphasized in a series of workshops soliciting information from concerned practitioners around the country, that compliance with the ITS Architecture in and of itself cannot ensure interoperability[1]. Systems must be integrated. Experiences of local ITS systems integration efforts, like Oakland County's FAST-TRAC program are thus important and can provide valuable insights. Lessons learned in such efforts may guide policy in developing a streamlined integration planning process, and in implementing the architecture-based integration requirements.

Oakland County's FAST-TRAC program, which is among the nation's early attempts to implement and integrate ITS, has distinguished itself as a working model for deployment and integration. The FAST-TRAC system integration with a forward-looking effort undertaken at a time of little experience with ITS system integration processes. The FAST-TRAC concept proposed the integration of advanced traffic management systems (ATMS) and traveler information systems (ATIS) through centralized collection, processing and dissemination of traffic data. The original concept called for the deployment of three systems, namely, the Autofahrer Leit- und Information system (ALI-Scout) for route guidance, the Sydney Coordinated Adaptive Traffic System (SCATS) for signal control and management, and the AUTOSCOPE™-2003 video vehicle detection system in the City of Troy. The concept of integration was later expanded thematically and geographically. The Transportation Information Management System (TIMS) became the tool that facilitates the collection, processing and dissemination of local and regional traffic information. Relationships and data exchange have been established by the Road Commission of Oakland County (RCOC) with the Michigan Department of Transportation's (MDOT) traffic operation center, the Suburban Mobility Authority for Regional Transportation (SMART) and other local government agencies. By integrating different ITS technologies not only locally but also across multiple jurisdiction (state, regional and local agencies). FAST-TRAC has fulfilled to a significant degree the national vision for ITS systems integration projects.

The purpose of this case study is to describe the FAST-TRAC system integration experience to managers and staff of similar, local system integration projects. As such, the case study addresses difficulties encountered, solutions developed, and "lessons learned" on the path to integration of many different ITS technologies.

The case study is based on the review of official documentation and interviews with project participants who had leading roles and contributed

1 National ITS Architecture Consistency Outreach Meetings Summary Findings, July 1998, U.S. Department of Transportation, p. 19.

substantialIy co the FAST-TRAC systems integration process. Documentation, such as FAST-TRAC progress reports, position papers, systems requirements documents, interface protocols, and, FAST-TRAC systems integration committee meeting minutes, provided factual information for the introduction and background sections and was used to trace the systems development. The verbal accounts from the individual interviews, group interviews and a focus group were used to collect first-hand information on the processes used in systems integration, to compile the integration process and lessons learned portion (section 5) of this report.

Systems integration occurs at two levels: organizational and technical. The case study identifies technical and organizational/institutional issues and obstacles that emerged during integration For example, at the start of the project, no appropriate national ITS data transfer standards were in place and so RCOC and its partners had to work around the lack of appropriate data exchange standards to establish information exchange and communication between specific system components. The development of a customized interface required the sharing of data structures and software architecture, which were proprietary. The need of various parties to access proprietary information for the development of customized systems interfaces caused significant delays in the project. This situation arose early on in FAST-TRAC, illustrating that institutional and technical issues in systems integration are intrinsically linked and hard to separate. The ITS data exchange standards now being developed in this area may help others to avoid some of those difficulties but may not cover all instances of data exchange.

Although this report is not proposed as a manual for system integration, the issues and lessons learned from the FAST-TRAC system integration may help other public agencies plan ITS system integration projects. Technical and institutional solutions for system integration are situation-specific and depend on many variables such as legacy systems and funding. While the federal initiative regarding a streamlined planning process for an architecture-based system integration may ensure national compatibility, it may not be able to address other issues required for system integration, such as interoperability on the technical side, or leadership and staff development on the institutional side. These issues remain relevant to ensure system integration.

2. BACKGROUND

Oakland County is located in the center of Southeast Michigan, about 15 miles north of the City of Detroit. It is part of the greater Detroit metropolitan area. The county is well connected to Detroit and ocher neighboring centers by an extensive network of interstate highways and state and local roads. The historically rural county has 37 communities and 24 townships The communities in the Southeast portion of the county have experienced an exceptionally significant influx of industry and population over the last two decades. The population growth in the county from 1980 to 1995 was 12%. Today, the county which covers 910 square miles of land area, is Michigan’s most populated county with roughly 1.1 million residents as of 1997. More significant in terms of traffic generation may be that in the same time period, two thirds of all new office development in Michigan took place in Oakland County.

Traffic operations in Oakland county are partly managed by the Road Commission of Oakland County (RCOC). RCOC (established 1913) has jurisdiction over nearly 50% of the county’s road infrastructure (ea. 2500 miles), 139 bridges and approximately 1,000 traffic signals. In addition, RCOC has a maintenance contract for 300 miles of state highway within the county. Funding comes primarily from the state fuel tax and license plate fees (nor property taxes), although some municipalities have opted to contribute additional funds from local roadmillages.

In 1987, the 61 local government units of Oakland County reported concern with traffic congestion. Increased traffic and demands on the road infrastructure threatened the quality of life in the communities. Under the guidance of Oakland County's Road Commission, a strategic planning process was initiated in order to develop approaches to address the traffic situation. Cost estimates for the road capacity increases and improvements necessary to handle the increased demand exceeded the financial capabilities of the local governments. Innovative traffic management approaches were explored as an alternative to road construction The adoption of a traffic management approach was seen as a logical extension of efforts to increase road and traffic safety, a top priority for Oakland County's Road Commission since 1977. As a consequence, the Road Commission's focus evolved from traditional road construction and maintenance toward a traffic management oriented approach to respond to increased travel demands and increase the focus on traffic safety.

I n 1988, RCOC presented a conceptual plan using an advanced traffic management system as part of a comprehensive road improvement program. Approximately $2 million of the $100 million plan was to be used for a computerized traffic signal system, which partly as a result of political realities, was proposed for deployment in the highly populated Southeast of the county (City of Troy). At that time, only the budget for the computerized traffic signal system was approved. While planning to implement the system, it quickly became apparent that the $2 million would not be sufficient to deploy all elements of a computerized traffic system. Nevertheless, this funding represented the seed for the FAST-TRAC program.

In 1992, the FAST-TRAC program gained the status of a major ITS Operational Field Test in Southeastern Michigan, integrating anATMS and an ATIS (route guidance). The City of Troy served as a testbed for a small-scale, traffic control system composed of 28 intersections under automated, adaptive signal control (SCATS) and 17 ALI-Scout beacon-equipped cars as the ATIS component. Over the years, the project evolved and grew considerably in size and geographic coverage. ITS equipment and installation was increased incrementally. For example, in June 1996, a total of 5 regional computers controlled approximately 270 intersections over southern Oakland County. By the completion of the project in August 1998, the number of controlled intersections h:1c1 been expanded to 350, including approximately 20 closed circuit television cameras to perform automated traffic surveillance and monitoring. A historical perspective of the FAST-TRAC phases and deployments are given in Table 1. As evident from the table, FAST-TRAC system integration efforts and contracts spread over two Phases: Phase IIa/IIb and Phase III. This was after the Quickphase and Phase I, which were to test the equipment and the possible coordination of SCATS and ALI-Scout.

Several inter-agency and intra-agency links for data sharing and exchange were established during FAST-TRAC. One link exists with the Michigan Department of Transportation's (MDOT) urban expressway instrumentation project in Detroit. Other links facilitate retrieval and input of pertinent traffic events from police, emergency services and traffic departments. Furthermore, integration of operations with the Suburban Mobility Authority for Regional Transportation (SMART) public transportation service was achieved. Figures 1 and 2 give an overview of the deployed systems in Oakland County and Southeast Michigan, respectively.

Component	Phase I	Phase IIa	Phase IIb	Phase III
SCATS intersections	28	250		345
ALI-Scout beacons	23	100		-
Ali-Scout vehicles	16	450		-
Autoscope detectors	100			1000
Traffic Operations center	-	1	1	1
Operational System Interfaces				
Loop detectors				450
CCTV cameras			3	23
AVL and IVU-equipped buses from SMART		111 para-transit, 25 linehaul buses		

Table 1 – Contract and Implementation Phases Overview

The system integration effort required to make FAST-TRAC a success was a concerted effort in which the Road Commission for Oakland County (RCOC), a local public agency, collaborated with consultants, systems vendors from the private industry and other public authorities. FAST-TRAC's integration of various ITS systems was accomplished through strong leadership from the implementing agency and a willingness of the involved parties and vendors to cooperate and work toward a common goal. The major FAST-TRAC partners included Siemens Automotive, Odetics ITS (previously Rockwell International), Image Sensing Systems, Inc. (ISS), AWA Traffic Systems – America, Inc. (AWATSA)[2], the Suburban Mobility Authority Regional Transportation (SMART), the Michigan Department of Transportation (MDOT), and the University of Michigan.

FAST-TRAC represents a considerable financial investment in the future of traffic operations in Oakland County. Oakland County officials were Successful in securing federal grants under ISTEA (Intermodal Surface Transportation Efficiency Act) legislation, which included language to promote and further ITS technology testing and deployment. Since the program's inception in the early 1990's, different FAST-TRAC components, such as field tests, systems design and integration have been jointly funded by RCOC, U.S. DOT and MDOT.

2 In 1998, Transcore Inc. assumed AWATSA's contract responsibilities regarding SCATS in the US

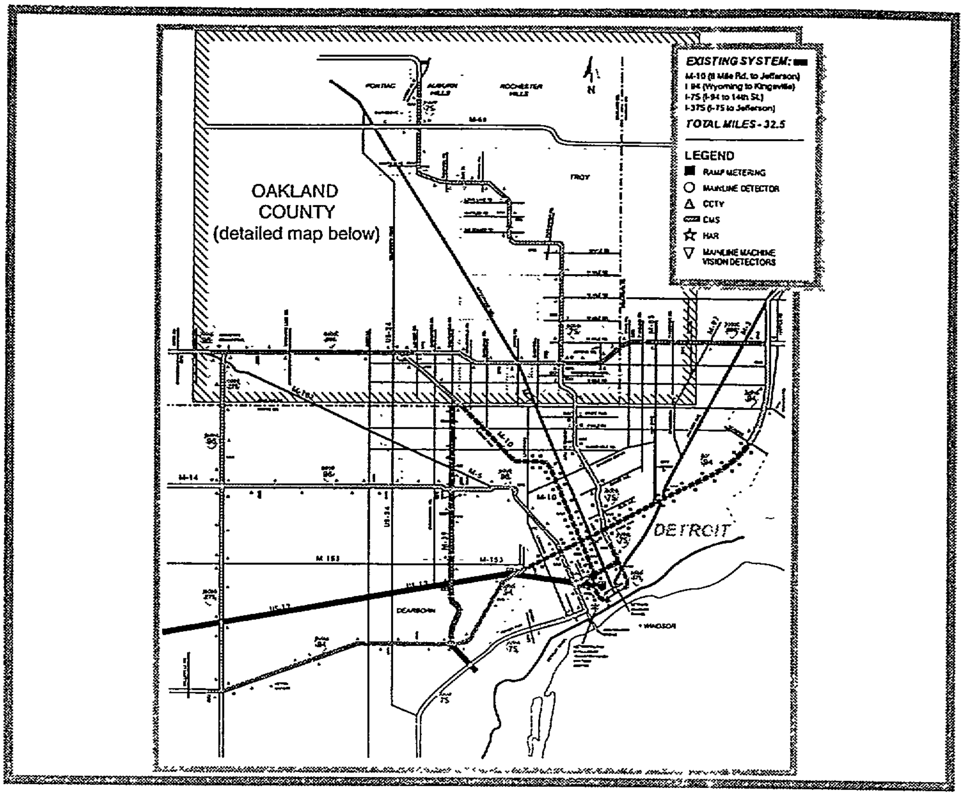


Figure 1 - Geographic Extent of Southeast Michigan ITS Deployment

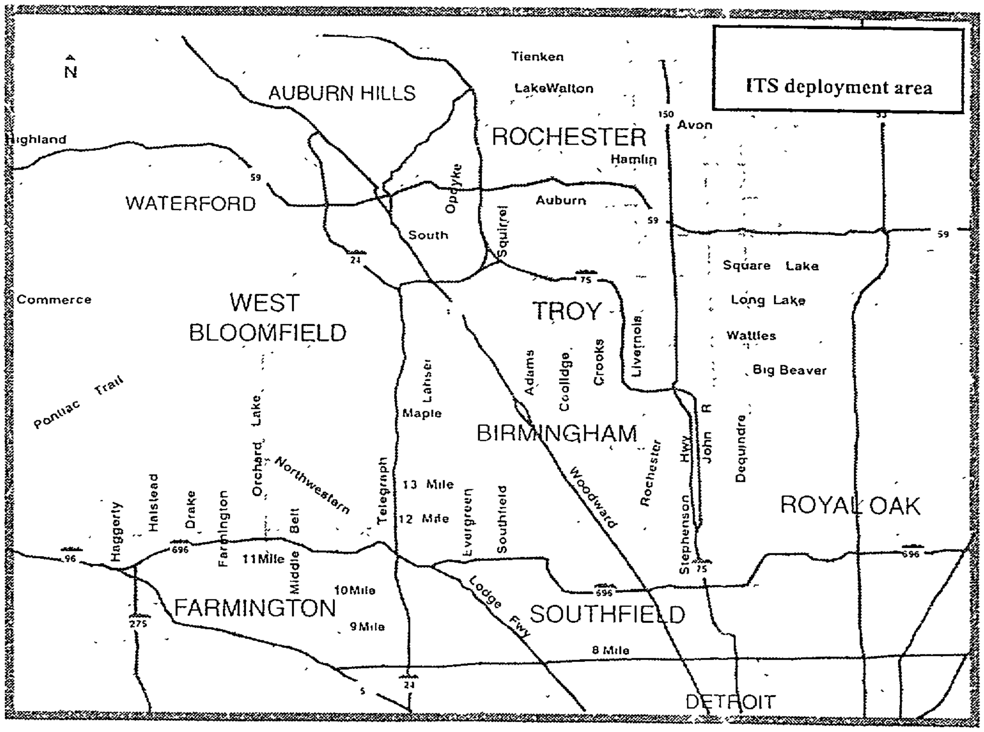


Figure 2 - Geographic Extent of FAST-TRAC Deployment Effort

3. FAST-TRAC EVOLUTION: INTEGRATION PLANNING PROCESS

FAST-TRAC represents a prime example of learning by doing. At the onset of the project, very little experience existed regarding deployment and integration of ITS technologies for traffic management and traffic information. The National ITS Architecture was undergoing initial development and could not be used to guide integration planning. The courage to experiment and the flexibility of officials and project partners in adjusting to technical advancements and shifts in political agendas proved to be a major asset of the project. As a result of the mutual learning process and changes in political climates, both the overall FAST-TRAC project goals and the objectives for the system integration changed over time. Three stages of the integration planning process can be distinguished:

1. Meeting Local Needs through High-Tech Politics
2. Meeting Federal Requirements through Aerospace Systems
3. Delivering through Systems Engineering

For each of these stages changes in the planning processes, integration approaches and concepts, participating agencies and integration partners are found. Figure 3 gives an overview of these phases and the systems integration concepts pursued. Details of the individual concepts can be viewed in the representations depicted in Figures 4-6.

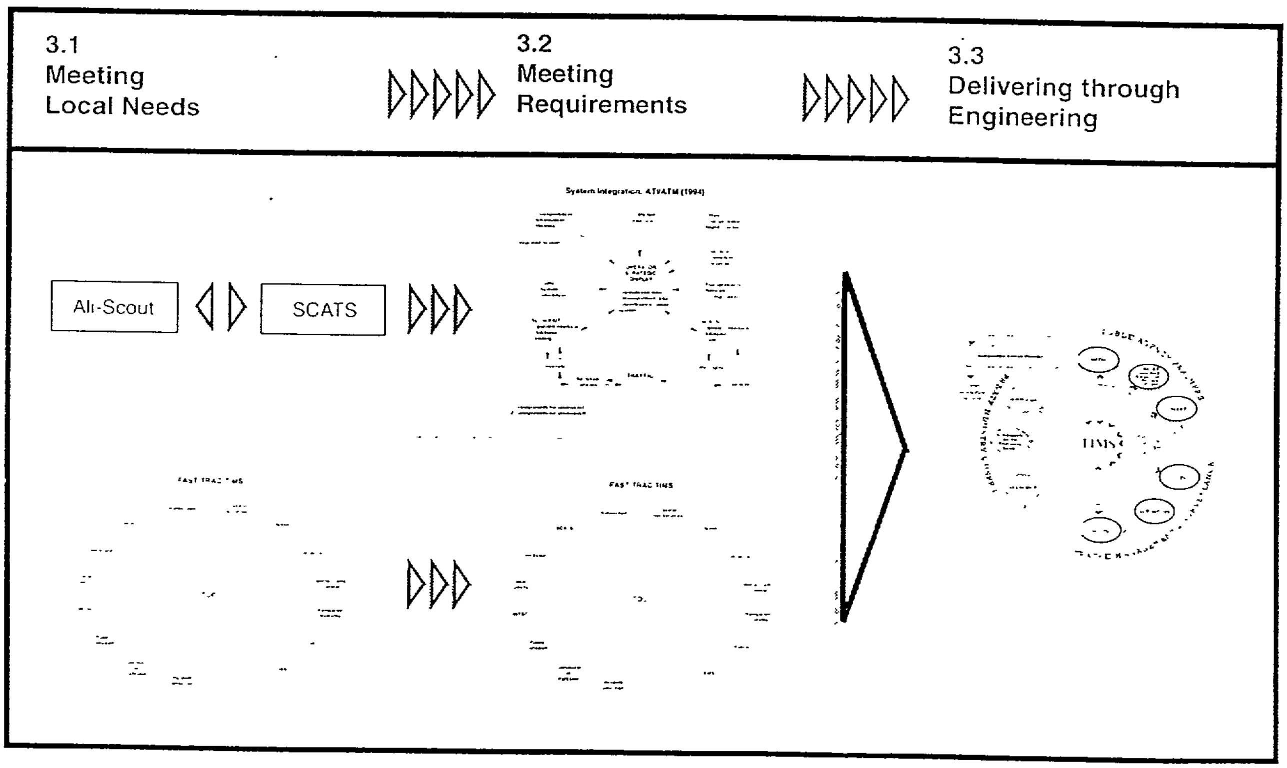


Figure 3 - Evolution of System Integration Concepts

3.1 Meeting Local Needs through High-Tech Politics

The initial stage of FAST-TRAC was driven by local traffic management needs and political earmarking strategies. Faced with declining funds and the related inability to address growing traffic capacity needs through construction, the leadership for Oakland County's Road Commission aggressively pursued ideas to improve traffic operations and management. A primary objective at that time was to extend the traffic signal system in the county to increase safety and optimize traffic flow on the existing roads rather than fund additional road construction. It soon became apparent that a high-tech system, offering real-time, areawide adaptive traffic signal control would probably fX11fill local traffic management needs, but would be too expensive for local pockets. Lobbying and earmarking for a federally funded ITS Operational Field Test seemed a feasible and appropriate approach to secure the necessary funding, given that Congressman Bob Carr could show significant investment by local governments and industry.

Ideas for FAST-TRAC and system integration were developed as early as 1988 as key individuals met at a transportation planning conference where new technologies were introduced, amongst them, video image processing as an alternative 10 inductive loops. Haugen and Associates, a consulting firm. helped to establish a fruitful contact between Siemens, ISS and county officials that ultimately led to the realization of FAST-TRAC. By the end of 1990, officials and county politicians managed to get hold of start up funding of US $3,700,000 from the County and industry to launch a test with 28 adaptive traffic signals and a beacon-based route guidance system. This quick start phase became the basis on which a target proposal for an ITS operational test was then submitted at the federal level.

In this proposal, FAST-TRAC was conceived as a field test that integrates an advanced traffic management system with an advanced traveler information system in the City of Troy. Core components of the systems integration effort were the Sydney Coordinated Adaptive Traffic System (SCATS), ALI-Scout route guidance system and AUTOSCOPE vehicle detection. FAST-TRAC goals were to:

- Improve travel times
- Reduce accidents
- Improve air quality
- Test integration of an ATMS (SCATS) with an ATIS (ALI-SCOUT)

From December 1990 to summer of 1992, planning, procurement and implementation of a "quick step" installation of 28 SCATS intersections was undertaken. In the meantime federal funding was approved to place an additional 70 intersections In Troy on the network of the adaptive signal system, to establish a traffic operation center and to install more ALI-Scout beacons and equip more vehicles with the ALI-Scout route guidance system.

In this first stage, planning had an informal character and was based on the vision and personal bonds of a few determined politicians and managers. The Interaction between the project partners was in small meetings. Agreements were often verbal and forged with a handshake. All were excited and cooperative in a spirit of invention and exploration.

However, FAST-TRAC's growth to ITS operational test status started to stretch local experience and human resources, especially since in an unusual circumstance it was decided that RCOC was to administer the federal grant locally - a responsibility typically assumed by the State transportation agency. The exception to prior practice in grant administration was a result of extensive administrative restructuring at the State level. RCOC was thrown into unknown territory.

Federal procurement regulations and requirements for ITS field tests placed a heavy administrative burden on the agency. Organization and administration of the program needed to be adjusted. This was done by establishing an internal management team which oversaw administrative aspects of the program, and by introducing procedural improvements.

3.2 Meeting Federal Requirements through Aerospace Systems

The deployment of ITS technology progressed quickly. Further ideas and opportunities in other jurisdictions emerged, such as collaboration with MDOT's ITS deployment project in Southeast Michigan. Over time it became apparent that a systematic approach to systems integration would be needed.

The project planning process moved into a semi-structured mode with the formal establishment of a FAST-TRAC Systems Integration Subcommittee in November 1992. RCOC Invited representatives from Siemens, AWATSA, ISS, FHWA, MDOT, Rockwell and the University of Michigan to:

- Discuss and identify systems integration issues.
- Determine a strategic path, and
- Establish strong relationships among the project partners.

The committee met regularly and worked on conceptual issues regarding system migration (e.g., functional integration, data integration, jurisdiction, and subsystem integration). Figures 4 and 5 represent complementary concepts for the system integration that were established during this phase.

Furthermore, RCOC had put out a formal request for proposal (RFP) to hire a systems integrator to guide and support the envisioned system integration. Not surprisingly, responses to this RFP came from the Aerospace and military industries. Both aerospace and military suppliers could provide the engineering background and experience of systems integration; however, none of them had worked with local governments before. Aerospace and defense industry companies were not familiar with local government needs and operations practices. At the same time, local governments were not used to the problem-solving approaches in aerospace systems integration projects. A mutual and at times costly learning process was started as the integrators worked hard to develop a larger systems integration concept. Through this process, information flows and systems needs were mapped and hierarchies and links outlined. Several attempts were stalled and the proposal had to be revised.

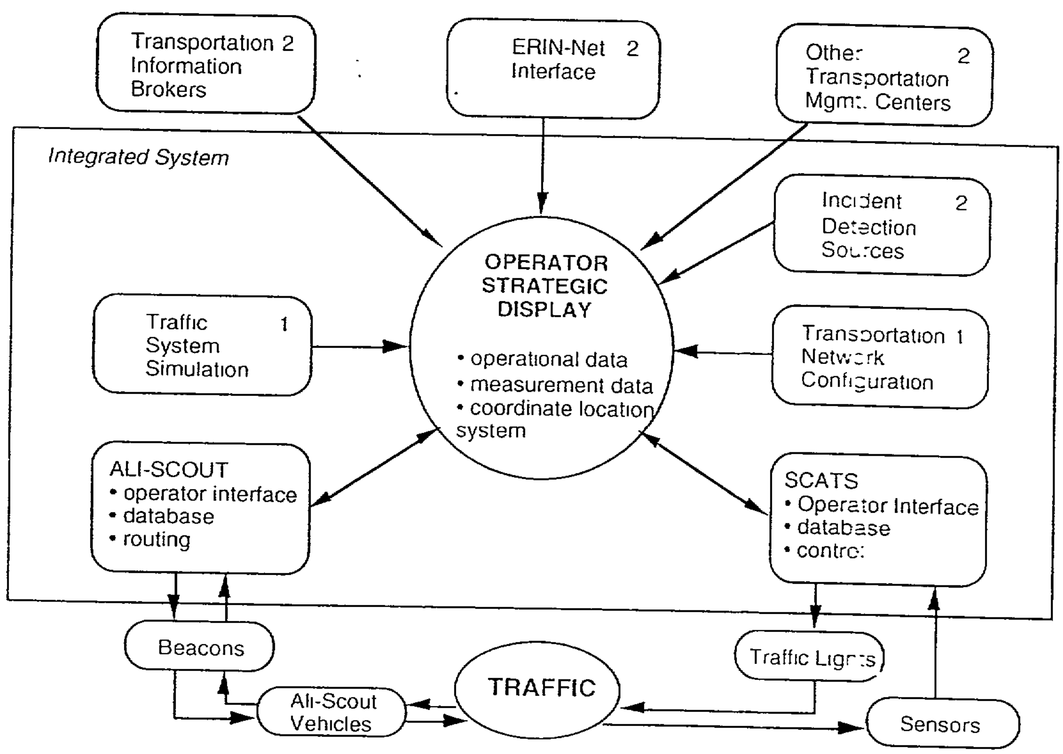
As the project progressed, RCOC broadened the conceptual and geographic scope of FAST-TRAC. As a consequence, FAST-TRAC moved away from the dualism of integrating a traffic management system and a traveler information system toward the integration of multiple intelligent transportation systems. Shortcomings of the early concept were identified. These include the inherent inefficiency of traffic management on a partial road network without information about the traffic status of adjacent arterials or highways. Likewise, the ALI-Scout system provided route guidance only to a small subset of vehicles. A set of functional systems components were able to improve upon the effectiveness of future operations. The new concept identified public transportation, emergency road services and commercial fleet operations as important elements that need to be taken into account in systems integration. In contrast to early systems design attempts in Phase I, the system architecture was now conceived, not as a hardwired system with core components, but as a loosely coupled network of interacting transportation subsystems at different jurisdictional levels and agency responsibilities.

Partners at this point included the Michigan Department of Transportation (MDOT) with its freeway operation, SMART's computer aided dispatch, and various law enforcement agencies whose services were to be linked and integrated into Oakland County's TIMS.

The intent of deploying these different technologies was to facilitate the mitigation and avoidance of traffic congestion through optimization of network trips and maximization of network capacities. These objectives were to be achieved by collecting traffic flow information, managing traffic flows through signal timing, and disseminating congestion information to travelers to encourage re-routing and trip avoidance. According to the Systems Requirement Specifications (Report Draft, Aug. 10, 95; Rockwell), goals and objectives of the FAST-TRAC project were to provide:

- Cost-effective traffic operations,
- Measurable transportation,
- Environmental improvements.

System Integration: ATI/ATM (1994)



1 - components for extension I
2 - components for extension II

Figure 4 - Original Systems Integration Concept

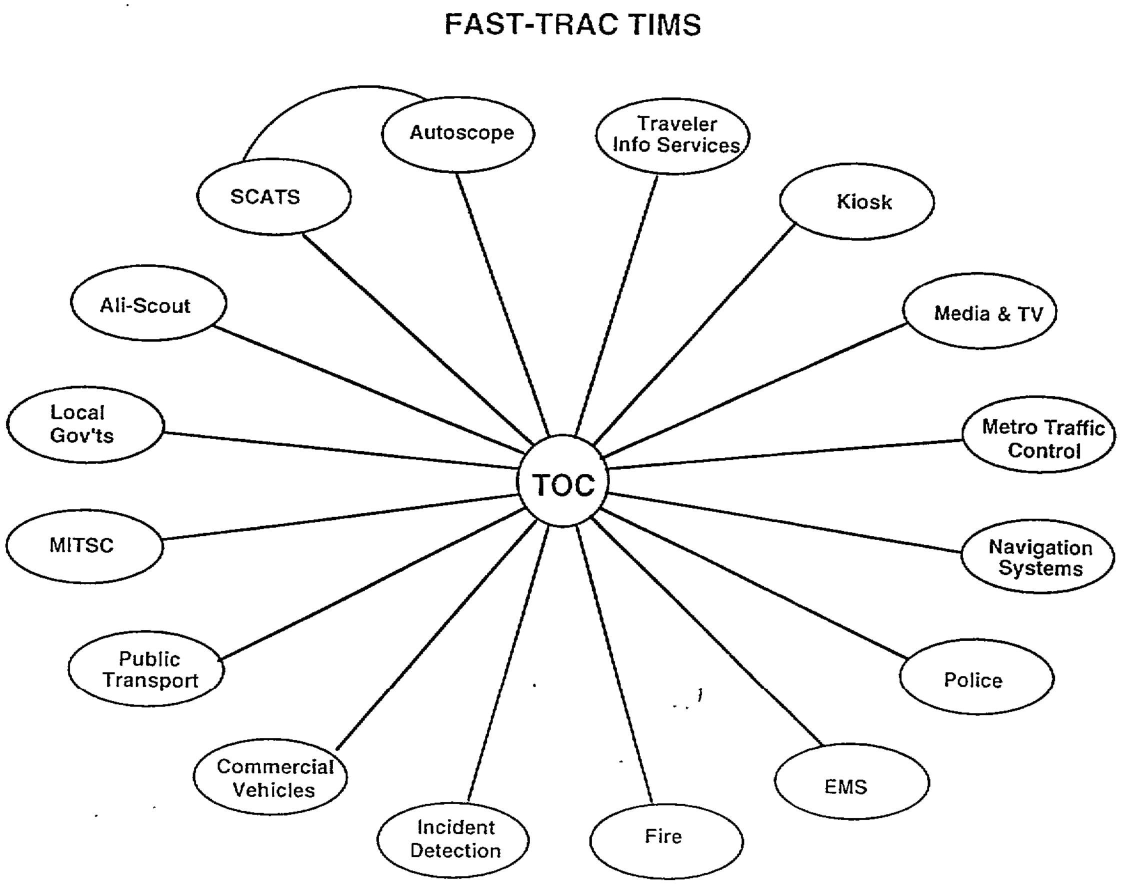


Figure 5 - TIMS Spoke Diagram

3.3 Delivering through Systems Engineering

FAST-TRAC by its very nature required a systems integration effort. Contracting and procurement for this effort was performed in a traditional manner (Design - Bid - Build). A request for proposal for systems integration work was issued. Rockwell International/Odetics was contracted as the systems integrator who was to design the integrated system and help to test and implement it. As a result of the systematic approach, the two integration concepts presented in Figures 4 and 5 were merged into a new and improved systems integration concept (Figure 6).

Separate contracts between the Road Commission and individual vendors of system components were established. Due to the way funding was allocated by the Federal Agency, contracts with vendors specified certain aspects of work to be done in the first phase. These contracts were then expanded to include more work items as monies became available in later phases.

As an aside, a majority of FAST-TRAC funding came through the Federal Highway Administration. RCOC received the authority to administer Federal funding directly - only with quarterly reporting obligations to the State Transportation authority. The obligation of timely spending of the allocated funds on the specified services and equipment were met at all times (Meeting minutes March 25, 1997).

A key factor in the success of FAST-TRAC was the establishment of a Systems Integration Committee. Over the course of the project, monthly meetings were conducted. The meetings of this committee facilitated a continuous consensus building and education process. At least one representative from each of the involved ITS systems was requested to attend at all times. In addition, the committee consisted of expert members from industry and academia who were asked to provide advice. Specific, task oriented working groups were established as needs arose. Working groups that existed at one point or another in the project include: Traffic Operations Center functions, Communications, Soccer World Cup and ATM/ATI Integration.

Through these committees, the partners developed Systems Design Specification. After adoption of the Systems Design Specification, implementation documents were developed. Rigorous adherence to a model design process kept the project on track. 7% development was conducted in 21 stepwise fashion. Losing the concept of software builds, where a build is defined as a collection of software modules that provide interim, standalone functionality The use of builds facilitates both functional level testing and overall system integration. A total of three-builds were defined for FAST-TRAC Testing for the modules within each build included at the minimum verification of the code Additional verification methods were testing the operator displays, status window notifications and viewing database tables.

Test performance was reported using detailed software trouble report (STR) logs. These functional level tests were performed as system conponents were installed and capabilities were incrementally added to each software build. It was planned that the components of each build were to be completed and installed at the same point in time, as much as possible, to facilitate integration testing. The development of interfacing systems were not all in sync with the TIMS development and so integration testing plans needed to be adjusted for testing some functional capabilities at later times.

Testing of the Transportation Information Management System (TIMS) was staged as a two-part process in which the system integrators used an integration approach and a demonstration approach. The integration approach tested functional capabilities of particular system components whereas the demonstration approach tested the capabilities of the entire system once all system elements were completed and installed. The system demonstration tests served as the acceptance test for the THUS.

Tests were performed using checklists. Both types of testing, functional integration testing and system demonstration tests, were performed on-site at the Transportation Operation Center of the Road commission of Oakland County in Waterford, Michigan. Testing procedures for each build and checklists are provided in the FAST-TRAC Transportation Information Management System Integration Plan (Rockwell Document 93-1333-0017, Oct 31, 1996).

The testing approach adopted for testing the TIMS by the systems integrator proved to be successful. “Putting it all together” and going on-line did not provide major surprises or problems since the different components were tested individually beforehand. After completion of the functional level testing and debugging, very few problems occurred at the stage of the demonstration testing. At the time of completion of this report in early 1999, most of the functions of the TIMS were tested and completed. It was expected that work on the TIMS will have been finalized by summer 1999.

FAST-TRAC TIMS - Conceptual Overview

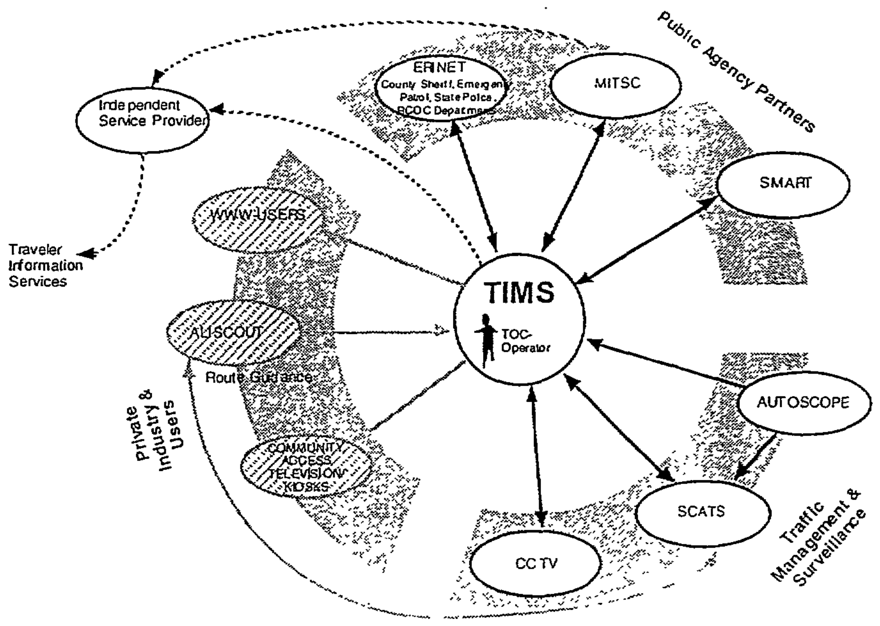


Figure 6 - TIMS Concept (1998 status)

4. THE FAST-TRAC TIMS

The transportation information management system (TIMS) integrates all aspects of FAST-TRAC ITS applications. The TIMS is not a monolithic system housed on a single, powerful computer; rather it was built piece-by-piece as a dynamic, flexible, distributed computing environment that combines multiple platforms, legacy and new systems. An open systems architecture was employed to allow for maximum flexibility, and enable expansion of the system in the future. The characteristic of the open, flexible and distributed systems architecture is reflected in the fact that parts of the TIMS are physically separated. Only about half of the systems elements are housed in Oakland County's Traffic Operation Center (TOC) in Waterford, Michigan. Five SCATS regional computers are distributed in public buildings throughout the County in Troy, Auburn Hills, Rochester Hills, Walled Lake and Southfield. Furthermore the system consists of a diverse set of platforms (Sun, IBM, et. al.) and operating systems (e.g., Solaris, DOS, etc.).

The core of the TIMS is a UNIX server which is housed at the TOC. The TIMS UNIX-server hosts a relational database and various applications which represent the interface between the various traffic management and control applications and data collection and dissemination functions. A set of PC-based workstations are linked to the TIMS server via a Local Area Network (LAN). The workstations host a graphical user interface (GUI) that aids traffic operators in accessing, managing, and disseminating traffic information as well as operating traffic management and control applications. Traffic data can be displayed graphically on the operator workstations and a Video Wall using a customized version of the the ArcView GIS application.

Figure 7 depicts a schematic overview of the TIMS and its subsystems. Traffic information (visual and numerical) is exchanged with several other agencies (SMART, MDOT, County Sheriff's Office, etc.). The TEMS links together software from traffic control management and traffic monitoring (e.g., SCATS and AUTOSCOPE). TIMS can also include information from route guidance systems (e.g., ALI-Scout). This latter feature was tested, but not implemented. These systems are provided from vendors around the world. Traffic information is a valuable commodity for the general public. Possible means for the distribution of traffic information are the World Wide Web (WWW) and cable television. The intention to distribute traffic information has been stated from the very beginning of the project, and interfaces to link *CO* the WWW and cable television were built into the TIMS. However, RCOC is currently reconsidering the responsibilities for providing traveler information services as stated earlier.

Figure 7 shows the data exchange content between the various partners and systems components of the TIMS. To establish communications, a variety of data exchange protocols and connections had to be employed. The physical connectivity and data exchange protocols and standards employed are also depicted.

Conceptually, the TIMS was conceived to consist of four subsystems, each of which serves a specific function. These four subsystems are:

1. Collection and Dissemination Subsystem.

2. Operator Control Subsystem.

3. Video Subsystem.

4. ERINet/WWW Subsystem.

Subsystems and their component interfaces are described in more detail below.

4.1 Collection and Dissemination Subsystem

The Collection and Dissemination Sub-system manages the collection, correlation, and distribution of data to and from other TIMS subsystems and external sources. The subsystem serves as the repository for all TIMS data. It consists of a powerful UNIX-platform (TIMS server) which holds a relational database management system and various applications to interface with the other subsystems and external systems. There are three different links:

- Interfaces to RCOC's traffic control and management applications and systems,

- Interfaces to external partners (SMART, MDOT),

- Links to TIMS subsystems (Operator subsystem. ERINet subsystem).

The first two links require the connection of heterogeneous systems which are in part owned by other agencies or located in spatially separate sites. Detailed descriptions of these interfaces and linkages follow, starting with the interface descriptions of RCOC's traffic control and management system components (SCATS, AUTOSCOPE and the ALI-Scout route guidance system). Interfaces to the partnering agencies of MDOT and SMART are specified as well. Linkages to the other TIMS subsystems need n detailed description. They are established via a Local Area Network and are based on TCP/IP controlled dialogue.

Figure 7 - Overview of the TlMS

OAKLAND COUNTY SYSTEM INTEGRATION
DATA EXCHANGE WITH TIMS
Exchange Protocols And Conceptual Overview

University of Michigan, Ann Arbor, MI 48109
ITS Research Laboratory (September 24, 1998)

NOTES

(1) ALI-Scout Dynamic Route Guidance System was disconnected in Feb 29, 1997 after extensive system tests. It was concluded that ALI-SCOUT could not provide travel link times for SCATS in the desired manner. Furthermore, the link is not in conformance with the National ITS Architecture.

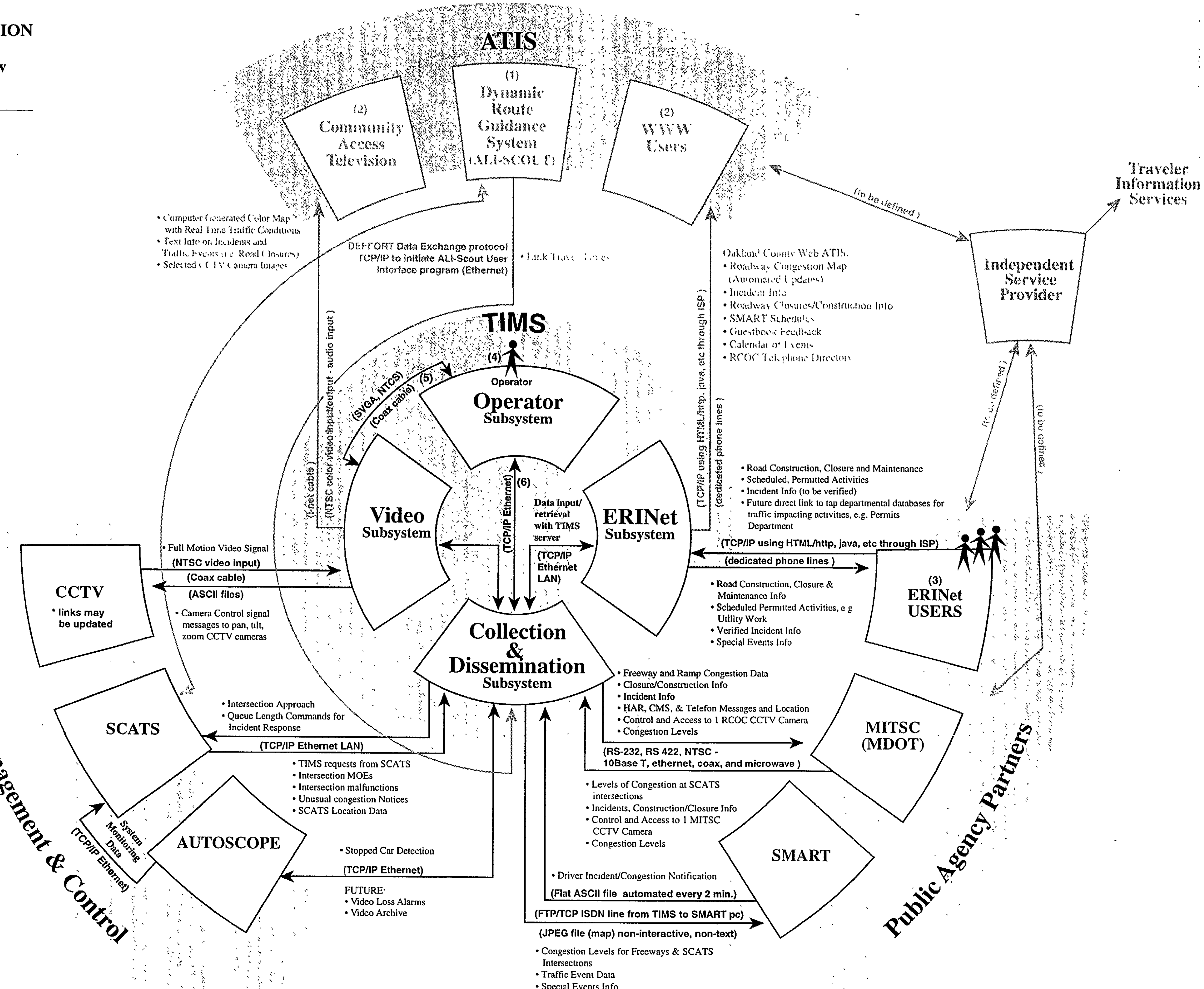
(2) Plans to distribute traffic info directly to the Public were halted in 1997. This affected the WWW and CATV broadcasts. Instead, it was planned to make traffic information data available to an Independent Service Provider who is charged with providing Traffic Information Services to the public. Responsibility of partial ATIS services (www) may be resumed by RCOC

(3) The list of authorized ERINet Users includes:
- Oakland County Sheriff
- Michigan Emergency Patrol
- Michigan State Police
- RCOC Departments: Permits, Construction, Maintenance, Engineering, Traffic Safety, and Dispatch

4) The Operator is responsible for:
- Monitoring, Control and Display of Traffic Information when the system is not running in automated mode.

5) The SVGA, NTCS, Coax Cable is used for:
- Control CCTV
- Control Cameras
- Control Videowall
- Receive Video to Display on Monitors

6) The TCP/IP Ethernet interface between the Operator Subsystem and Collection & Dissemination Subsystem is used to:
- Retrieve Data & Invoke Interface Programs to Control SCATS, ALI-Scout and Autoscope



↔ Currently deployed Data Exchange Systems

↔ Tentatively Planned Deployment of Data Exchange Systems

Interfaces to traffic control and management applications and systems

Traffic management series on the availability of traffic flow information. RCOC's traffic management operation relies on AUTOSCOPE intersection traffic sensors and loop detectors to monitor traffic flow. Based on traffic flow information, SCATS modifies the traffic light phases. Additional traffic flow and link travel time information is gathered from SMART transit vehicles. Plans also called for including link travel time information from private passenger vehicles via ALI-Scout, although this feature was not implemented in the final system. These latter links are described in more detail in the section on "Interfaces to external partners."

AUTOSCOPE - TIMS Interface

The TIMS communicates with the Scope-server and Supervisor programs, which reside on the AUTOSCOPE System Server, via the TIMS LAN. The Scopeserver program provides station detector data consisting of:

Volume Count

Average Speed.

Average Rate

Vehicle Class Count,

Average Time Headway,

Average Time Occupancy,

Vehicle Density per Lane,

Detector Status Data,

From each of the 1000 AUTOSCOPE sensors. These data provide a measure of effectiveness (MOE) for traffic flow. The data is polled by the TIMS server every 120 seconds using an automated routine. Traffic operators can access AUTOSCOPE data directly through the supervisor user interface program. Access is via the TIMS LAN and a login interface residing on the TIMS server. Communication in both cases uses TCP/IP protocol.

SCATS - TIMS Interface

There is a two-way data exchange between the TIMS and the Sydney Coordinated Adaptive Traffic System (SCATS). SCATS coordinates and adapts the times of traffic light phases and intervals to current traffic flow in a dynamic feedback mode. The SCATS system implemented in FAST-TRAC itself consists of a Central Management System (CMS) and 5 regional computers. The SCATS CMS communicates with the regional computers, which in turn communicate and control the various intersection controllers. The TIMS is connected to the SCATS CMS via a LAN Ethernet connection. Data flows are from:

SCATS to TIMS

- Intersection Measures of Effectiveness
- Unusual congestion notification
- Equipment malfunction status indication; and

TIMS to SCATS

- Intersection approach queue lengths (as received from AUTOSCOPE).
- Issue Preprogrammed commands for incident responses, event programs.

ALI-Scout – TIMS Interface

The ALI-Scout's central office computer was to provide directional Link Travel Times obtained from the ALI-Scout equipped vehicles in the field to the Oakland County TIMS database. For purposes of this interface, a link is a road section between two intersections as defined in the digital map database (NavTech). Link travel time information was to be transmitted every 5 minutes. In addition, Standard Profile information was to be made available to the

TIMS database on a request basis. Standard Profiles are generated by the ALI-Scout central computer. They are comprised of the compiled and averaged link travel times. Profiles represent historical values of link travel times for various road segments as a weighted average. They consist of 5 minute slots for each day covering the time period from 5 AM to 11 PM. A single time slot is provided for the night phase from 11 PM to 5 AM.

Unlike individual link travel times, which are transmitted automatically, Standard Profile data transfer must be initiated manually by a TIMS operator. To facilitate this transfer, the ALI-Scout operating computer's user interface program allows remote login by the TIMS operator. The TIMS operator work stations were connected to the ALI-Scout operating computer via the TIMS LAN. Platforms are HP UNIX for ALI-Scout and Sun-Unix for the TIMS. The computers are physically co-located in the Oakland TOC.

The operational field test of integration between ALI-Scout and SCATS was discontinued in February 1997. The test revealed both technical and institutional problems. Miscommunication was frequent and hampered by the fact thatdocumentation from Siemens to RCOC and AWA Traffic Systems America (now Transcore) was provided in German rather than English. At the beginning of the test, there was no data transfer format for link travel time information from ALI-Scout to TIMS. Proprietary issues hindered the cooperation between SCATS and ALI-Scout representatives. Siemens and AWA Traffic Systems America (AWATSA) eventually settled on using the Data Exchange Format for Transport (DEFFORT) developed by the European Comrnunity. Further, the link travel times that ALI-Scout provided were not sufficiently current (25 minute turnaround) to work dynamically with SCATS.

Interfaces to external Partners [SMART, MDOT]

Interfaces to external partners generally cross traffic modal boundaries and jurisdictions. They were especially difficult to establish and represent a great achievement.

MDOT/TIMS Interface

MDOT's Southeast Michigan highway instrumentation project presents a major ITSeffort. 180 miles of freeway in the greater Detroit Metropolitan Area are monitored and managed using Changeable Message Signs (CMS), loop detectors and CCTV cameras. Parts of the instrumented highways pass through Oakland County, where many intersections of arterials are monitored and managed by RCOC's ITS technology. The collaboration and data exchange between RCOC .and IMDOT is manifest in the data exchange between MDOT's Michigan Intelligent Transportation Systems Center (MITSC) in downtown Detroit and the FAST-TRAC TIMS. This data exchange and sharing enables both agencies to enhance traffic operations and coordinate management and control at the Interface of freeways and arterials. The TIMS, through an Interface, can issue periodic data requests. Data flow from MITSC to TIMS includes:

- Freeway & Arterial network status,
- Roadway/Freeway information; closures, construction, permitted activities,
- Traveler information; Test of changeable Message signs and status; Highway advisory radio messages (HAR) text, Interactive Voice Response (IVR) text and status.
- Incident information, location and alternate routing information.

The TIMS can periodically provide MITSC with traffic information on roads and intersections under RCOC's jurisdiction and control. Furthermore, RCOC and MITSC have permission and capacity to control one of the other respective agency's CCTV cameras.

This is probably one of the more integrated interfaces. While the connection and data exchange seems favorable and working well, issues of control and access need to be clearly defined. At the beginning of operation, several inequities threatened the open access and control policies. For example, since for integration reasons, RCOC's operator workstations were coded as cameras - MDOT MITSC operators were able to view not only cameras but also computer screens in the other agency's TOC. As traffic operations in Oakland County are currently run in an automated mode, privacy invasion is not an issue and redesign of the interface to accommodate access barriers were not a prime concern raised by the agency in this case.

SMART/TIMS Interface

The data exchange between the Suburban Mobility Authority for Regional Transportation (SMART) and FAST-TRAC's TIMS is a mutually rewarding cooperation - since both RCOC and SMART can benefit from the traffic information collected by the respective agencies. SMART started to employ an Automated Vehicle Location (AVL) system to truck their linehaul vehicles Mobile Data Terminals (MDTs) in buses aid in the collection of traffic related information. Five different incidents are recorded in SMART's database:

- Congestion - slow traffic on either direction of bus travel,
- Off Schedule - violated late alert threshold,
- Any accident - passenger, property damage and vehicle stuck etc.,
- Dispatcher created recordings, which include details in incident description,
- Back on Route/Schedule - for RSA off route and/or off schedule buses.

SMART shares some of the collected traffic data, such as link travel times, congestion and incident information with the TIMS. In return, TIMS provides SMART with traffic and travel related incident dam, traffic events, special event information as well as levels of congestion of intersections and freeways from the TIMS database.

The interface allows for a two-way data exchange between the TIMS database and server and a SMART interface PC via a Wide Area Network (WAN) using FTP and TCP/IP transfer protocols. SMART data is transmitted to the TIMS for recording every 2 minutes.TIMS data is transmitted every 5 minutes to the SMART Interface PC. The file format is token delimited ASCII (TIMS to SMART) and flat ASCII (SMART to TIMS) respectively. In addition, SMART plans to disseminate a map of bus routes via the RCOC webpage in the future.

4.2 Operator Control Subsystem

The Operator Control Subsystem is co-located with the TOC. It has connections to the Collection and Dissemination Subsystem as well as the Video Subsystem. Its purpose is to facilitate the display of the traffic network status and provide a graphic user interface (GUI) to interact with and manage the TIMS subsysterns and all integrated internal applications from a single-user PC-based workstation. Display of the traffic network status is possible by either displaying full motion video from one of the CCTV cameras or a network status map using GIS as a geo-referenced mapping platform. A GUI aids in the manipulation of the displays, i.e. zooming, saving, selection of displayable features (roads, highways, landmarks), icons (incidents, congestion levels, camera status, etc.), legend, and themes. Basic spatial analysis (i.e., the selection of intersections within a defined distance from a traffic incident) will be supported as well. The management of TIMS subsystems is also guided by a GUI. It facilitates basic system management tasks like the configuration of systems parameters, user access and data archival and back up. Finally, traffic operators can actively manage traffic, for example, by changing SCATS timing plans.

4.3 Video Subsystem

The Video Subsystem is co-located with the TOC and is directly connected to the Operator Subsystem of the TIMS. The subsystem's physical components include a Video Wall, auxiliary monitors and various video control and switching equipment. The Video Subsystem supports the display of full motion video, as well as computer screen displays from the operator work stations, onto the Video Wall. The Video Subsystem provides access to video monitoring cameras (CCTV). It also has capability to output to Community Access TV (CATV).

CCTV Interface

The two-way interface between the TIMS Video Subsystem and the RCOC's Closed Circuit Television (CCTV) cameras facilitates the reception of full motion video and the transmission of camera control signals to remotely adjust the view area of any particular camera. Camera control signals, i.e. pan, tilt, zoom and focus, are sent through the Operator Control Subsystem to the PTZ-receiver of the camera. The signals consist of multiple character encoded ASCII-messages which are transmitted via a 4800 baud data line. Twenty-three Closed-Circuit Television Cameras were installed at critical intersections within Oakland County. The system supports the reception, selection for display and control of full motion video signals from up to 50 Closed Circuit Television Cameras. In addition, the system can control and select for display one of the CCTV cameras of MDOT's Southeast Michigan highway instrumentation project (see also TIMS/MDOT interface description).

Community Access TV Interface

Community Access TV (CATV) was envisioned as one means (besides the WWW pages, see ERINet Subsystem) to disseminate traffic information to the public. The TIMS Video Subsystem has the capability to output NTSC formatted video to a CATV service provider. RCOC will not provide audio signal – however the CATV provider would have the option of adding audio to the TIMS generated video before public dissemination. Three different outputs were planned:

- Computer generated color map depicting real time traffic conditions,
- Textual information on incidents and traffic events, such as road closures,
- Operator selected CCTV camera images.

Although functional, the CATV component has not been exploited, since it fell under the umbrella of ATIS components that RCOC originally decided to outsource. However, this outsourcing did nor take plate and the status of the video capability is under reconsideration.

4.4 ERINet Subsystem

The ERINet (Emergency Response Information Network) Subsystem exploits the accessibility of the World-Wide Web (WWW) for purposes of disseminating traffic information to the general public as well as for use by local agencies. The subsystem is to facilitate two types of services: public access web pages and ERINet access pages. Public access pages on the RCOC's webpage display color-coded congestion maps of regional arterials and freeways, incident locations, construction work zones and roadway closures. Maps and information are periodically updated based on the traffic data from loop detectors, AUTOSCOPE, etc. Restricted access pages provide a uniform means for various agencies to enter relevant traffic data into the TIMS database or likewise to retrieve data from it. This two-way exchange of data is restricted to local law enforcement agencies, the Michigan Emergency Patrol, Michigan State Police and other Oakland County Departments. Depending on the data source (submitting agency or agent), data will be classified as "trusted" or "un-trusted". Un-trusted entries are subject to TOC operator verification before the data can be redistributed. Data collected and disseminated through ERINet include:

Road Construction, closure and maintenance activities,

Scheduled permitted activities, including utility work,

Verified incident information,

Special-events (sports meetings, Concerts etc.).

A digital map database to facilitate the display of traffic information was obtained from the Southeastern Michigan Council of Governments (SEMCOG). The map displays highways and arterial roads. After testing, there was considerable dissatisfaction with the map data quality - especially attribute data such as road names, which were found to be incomplete. As the agency that developed the map did not see a need to change the map database to RCOC's specifications, a consu1tant was hired to make the changes. At this point, procedures for further development and upgrading of this digital map database are not in place, which is potentially problematic, since costs, effort and expertise needed to maintain digital databases are often underestimated.

The ERINet Subsystem web page design was completed by 1997. The restricted ERINert access for data input and retrieval was activated about a year later after the TIMS/SCATS interface was completed. This interface is necessary to establish the dynamic data flow to update the traffic congestion map on the web page. As of the writing of this report, the public portion of the web site had not been completed. Although RCOC's original intent was to provide this information, during system development RCOC entered negotiations with an Independent Service Provider for a contract that would award exclusive rights to traffic data and its public dissemination. Negotiations over this contract halted development efforts aimed to provide public access to traffic information. The contract negotiations were later discontinued and the status of the public access is being reconsidered.

5. LESSONS LEARNED

The "lessons learned" were gleaned from the comments of project participants during a series of interviews and a focus group session. Comments were generalized to a certain extent, so the lessons represent a summary of issues that might be useful to future system integration projects. For the purposes of this report the lessons are categorized as:

- Identify and empower a project champion,
- Get the right parties involved,
- Secure long and short-term funding,
- Establish appropriate project control mechanisms, and
- Follow standard systems integration practices.

One key idea that came across throughout the investigation is that, in the words of one respondent, "It is easy to integrate systems, but it is difficult to integrate companies." Institutional integration is key to successful system integration in a multi-organization project such as FAST-TRAC.

Lesson #1: IDENTIFY AND EMPOWER A PROJECT CHAMPION

Interviewees agreed and emphasized that project success is contingent upon identifying and empowering a project champion within the public agency and possibly in the participating partner firms and agencies of the planned system integration. Some interviewees pointed out, that the lack of having a champion in one of the partnering agencies slowed the progress of integration.

Interviewees defined a champion as a knowledgeable and capable person in a position of authority who embraces the project vision, has time to manage and lead the project, and is dedicated to seeing the project succeed. In short, a champion is one who has the ability and motivation to take “ownership” of the project. The champion must network, both to stay on top of changes that may affect the project, such AS advances in technology, and to communicate with project partners and other organizations that might affect the project outcome. For this, it is very helpfu1 if the champion has technical interest and understanding or at least a “technology champion” who can provide assistance in that respect. Furthermore, the responsibility for ensuring interorganizational communication lies with the agency champion. As pointed out later, communication and cooperation are crucial to successful system integration. In fact, one party noted that the difficulties in systems integration were not issues of technical integration but rather issues of institutional integration, i.e., issues of enabling diverse organizations to work together toward a common goal. The project champion is clearly key to the requisite institutional integration and thus essential to project success. In addition to facilitating interorganizational communication and cooperation, the project champion is often instrumental in securing financial and moral support. Novel and ground-breaking projects often move from the drawing board to reality due primarily to the charisma of such champions.

As inferred in the above; to be effective, the identified champion must be empowered through freedom to allocate his/her time more or less exclusively to the project and through being given the authority, within the agency, needed to accomplish project objectives. The agency needs to back up their commitment to the project and to the champion through allocating sufficient money, competent staff, and other resources for the project. Specifically, the agency needs to provide for in-house technical expertise to develop requests for proposals and enable the qualified review of consultant work. This expertise may be hard to come by as systems integration is a new task for most public agencies and public agency staff may not be familiar with the technologies and systems engineering process. As a result, interviewees recommended considerable investment In terms of salary and training of staff involved in the system integration. It was felt that a highly motivated staff would be more willing and able to work through the problems inevitably encountered in a systems integration project. Another reason to pay sufficiently high salaries to technically knowledgeable staff is to ensure their long-term commitment and so avoid employee turnover and the associated disruptive loss of historical project knowledge. Conversely, several interviewees recommended that knowledgeable staff can often be recruited from other agencies that had successfully embarked on system integration and ITS projects.

FAST-TRAC was blessed early in the project when several dynamic individuals established leadership. In addition to RCOC’s leaders who established links to political representatives that later were instrumental in earmarking funds, there were also champions in the partnering organizations, like Siemens Automotive and ISS (AUTOSCOPE). The professionals’ interests converged and the partners put a lot of energy toward realizing first an operational field test and then moving on to systems integration. FAST-TRAC had several interesting situations where individuals involved in the project changed positions and employers. but managed to remain working on the project. One of the initial agency champions moved from public agency to become project manager for the systems integrator of FAST-TRAC, for example. Fortunately, the successor at the public agency continued to pursue FAST-TRAC system integration. While RCOC managed to keep several long term employees with good technical knowledge working continuously on the project, partner companies experienced relatively high employee turnover, which brought about disruptions in the project progress in terms of rehashing agreements and interpretation of agreements with new project leaders.

Champions are likely to apply different management styles. For example, one of the early project champions worked very informally in one-on-one meetings with the project parties. Project work was performed based on oral agreements, whereas later champions adopted a more formalized management style with structured meetings and stronger contractual binding. There is no clear evidence that one management style proved superior to another. However, it can be speculated that in the early project stages an informal approach might help to get the desired project partners excited and involved whereas later stages require more tedious and documented interaction to ensure that the project stays on track.

Lesson # 2: GET THE RIGHT PARTIES INVOLVED

Interviewees agreed that systems integration is a team effort. Having suitable partners in the project was mentioned multiple times as a key to success. The agency that initiates the systems integration generally has to select a number of experts and companies that are involved in the systems integration effort. In the transportation doamin, it may be necessary to coordinate systems integration activities with other agencies at the state level or with neighboring areas, since road networks in general do not stop at jurisdictional boundaries. The agency in charge needs to select the partners of the systems integration effort carefully. Thus, in parallel with raising a champion and Staffing up the public agency, the public agency is faced with the task of getting the right parties involved, i.e., a funding agency, possibly other public agencies, a systems integrator, and possibly vendors/ providers of ITS systems components.

The basic message that interviewees communicated was that the public agency must develop a strategy for public/private partnerships. Specifically, they must partner and/or contract with competent organizations 1) with whom they can work and 2) that are committed to the project. Or in short, “Partner with Winners.” Herein lies what may be one of the biggest obstacles in the set-up process. Traditional procedures for hiring contractors are based on competitive bidding with the lowest bidder being selected. But in systems integration, lowest bids may not lead to a contract with the most suitable or competent contractor. It may also lead to matching up organizations in a team that provide competitive products. To avoid team conflicts, a different approach aiming at a total team concept was recommended in which an effort is made to avoid involving organizations that have inherently competitive products/services. Vendors, as well as a systems integrator, are to be selected on the basis of criteria such as expertise and experience with similar projects. In addition, the systems integrator and involved vendors should have offices in close geographic proximity with the area where the systems integration will happen.

In addition, working with other public agencies may pose problems. Public agencies governing road and transit, in many instances, have little or no history of working together and may also have little mutual understanding. These agencies may also have a history of competing for the same funding dollars.

To establish a team, the agency must thus recognize the motivations and capabilities of organizations that could potentially participate in the project. All parties must share the same view of the finished product, and motivations toward reaching that goal must be compatible, if not fully understood or appreciated. The agency must also understand any internal or external constraints that might be placed on the relationship. A common constraint that must be recognized and resolved as early as possible is that of proprietary issues. Another issue is cost share requirements for both government agencies and contractors. Great differences in procurement procedures are likely between private and public organizations. Moreover, participants should also display willingness and ability to coordinate and communicate and to share data and systems. Compatibility of organizational “personalities” and communication and working style is crucial to the selection process as is the availability of resources that the organization can apply to the project, especially qualified and committed personnel, including a champion.

The agency must lead potential participants to “buy-in” and then integrate the disparate organizations into a team. This involves reorganizing the capabilities, constraints, and goals of each party and accommodating all in a win-win arrangement where each organization clearly understands and accepts its responsibilities. Teamwork also calls for forgoing personal ties of good communication and cooperation, and since incompatible personalities can be detrimental to project success, the project champion and managers need to consider staff personalities as well as expertise when staffing the project.

Two issues in particular were repeatedly mentioned as major setbacks for FAST-TRAC system integration. One was that of communication with foreign partners and language difficulties. For example, the systems integrator and RCOC were given non-Enlgish language Documentation of interface and software manuals at several points in the project. This caused some mischief and delay. The second issue involved proprietary concerns. The collaboration between two of the FAST-TRAC partners (Siemens and AWATSA) was hindered by their mutua1 proprietary concern. While the integration of a route guidance system (ALI-Scout) with SCATS was tested thoroughly during the operational field test phase of the project, the difficulties in communication and collaboration may have prevented a more successful approach to overcoming technical difficulties that, according to the final reports, prevented the further application of the technologies beyond the test.

As a consequence of this experience, several interviewees cautioned against working across international barriers. International vendors may have special espzrtise and economically favorable services and products that mar entice agencies to buy into their rjroducts and services. However these competitive advantages ought to be balanced against other issues such as work ethics, style, cooperation and the general difficulty of cross-cultural and multilingual communication complicated by time zone differences. The latter two issues can put extraordinary strain on a project. At the very least, agencies need to be aware of potential difficulties and the need to spend extra time and funds to ensure effective communication with foreign-based partners. The same holds for proprietary issues. One way to counteract these difficulties at the outset are contractual agreements specifying working language and collaboration requirements.

Lesson #3: SECURE LONG- AND SHORT-TERM FUNDING

A project such as the FAST-TRAC integration of multiple ITS is long-term and costly. Running out of funds mid-way through a project would obviously jeopardize the completion of the project and may also leave heritage systems in ;I nonfunctional state. Recognizing this, a number of parties involved in FAST-TRAC stressed the importance of developing a business plan to secure and to allocate funding early in the project. Such a funding plan should include mechanisms to cultivate a close relationship with each actual and potential funding agency, and also address both project development in the short and intermediate term and maintenance and operation funding in the long term.

Several project participants specifically noted that reliance on a single source of funding should be avoided. Similarly, creativity should be applied in seeking out and developing funding mechanisms. Several interviewees stressed that phasing of project funding is risky since advanced phases of the project may never be completed if the available pool of funding "dries up". This is in contrast to technical and institutional aspects of the project where phasing may prove beneficial.

In the case of FAST-TRAC, significant funds were secured from the budget allocated by the Federal Government for ITS. Earmarked funds were secured for an Operational Field Test of ALI-Scout and SCATS that allowed the purchase and deployment of traffic signals and SCATS. However, a long-term business plan for funding, or a lack thereof, is one of the weaker points of the FAST-TRAC project. Since federal funds provided under ISTEA were designated for the operational field test only, but used to deploy a system that it to stay. It has been difficult to allocate the significant amounts of funds needed for operating, maintaining and updating this system. In addition, it is unclear if TEA21 funds may be located that allow systems updates, possibly to assure compliance with national ITS standards.

As a consequence of these funding shortages, FAST-TRAC's systems integration design features high levels of automation, reducing the need for human intervention and surveillance. Human intervention is currently necessary only to verily incident data from local agencies submitted through ERINet and adjustment of SCATS plans. Systems integrators are working on the institution of rule-based incident management plans to further automate some of these tasks. Most other day-to-day operations such as data exchanges with SMART and MDOT are performed in automated modes. An operator, who was originally planned to be monitoring the system during day time hours (i.e., 7 am to 6 p.m.) has not been hired and so the system currently runs without an operator. Meanwhile, RCOC is exploring possible ways to recover some expenditures by sharing traffic data or providing ATIS services.

Lesson #4: ESTABLISH APPROPRIATE PROJECT CONTROL MECHANISMS

A number of interviewees related that a key to successful project completion is the early establishment of appropriate project control mechanisms as a framework to foster inter-organization cooperation and communication. Project control mechanisms also provide a struture of accountability and so avoid conflicts of responsibility, and handle differences in contracting procedures and project expectations. One interviewee emphasized this lesson by stating that the project will suffer, perhaps seriously, if project control mechanisms are not in place early on and used consistently. Essential control mechanisms can be divided into four stages: set up, timing and coordination of schedules, rewards and punishments, and documentation. These control mechanisms must have enough bite to truly control the scope and progress of the project. At the same time, however, the control mechanisms must have enough flexibility to accommodate changing needs and, perhaps, changing technologies.

Set up. As stated before, institutional integration is key to success. This integration can be facilitated with contractual language outlining relationships and responsibilities.

The first step in the set up process is for the public agency to select a model of institutional integration. Specifically, the agency mustestablish a management process, i.e., decide who has management authority to coordinate the activity between organizations. Participants discussed two models. The public agency can either a) hire a competent integrator who will be responsible for subcontracting all other needed parties; or, b) act as a general contractor, establishing a separate contract with each systems vendor and the systems integrator, recognizing that the system integrator will then have little leverage over the other contracted parties.

Regardless of the path chosen, the public agency must at this point ensure that the project contracts and agreements address, the goals and concerns of all project participants. These documents must lay out mutually beneficial objectives, define payments and sharing of costs and benefits, and clarify and codify lines of responsibility (including deliverables), general project timing, and penalties and means of redress for non-compliance. The contracts and agreements must also establish a mechanism to promote open communication among the multiple participating organizations, especially to handle the sharing and protection of proprietary information, and also include specific deliverables and “gates” to promote and control forward motion of the project. A project structure that facilitatesinformal contacts will significantly enhance thelikelihood of project success.

In FAST-TRAC, RCOC followed a traditional scheme, choice “b” in the description above, by which the agency takes on the responsibility of procurement and contracting. Procurement and contracts are based on bids from companies for certain ITS parts. Contracts are between the public agency and system vendors or the systems integrator. This set up imposed severe constraints on the work of the systems integrator, which had no lc\.er-age in requiring other parties to deliver software and interfaces on time. Through the setup of multiple, independent contracts, it was difficult to coordinate the contract deadlines and deliverables of individual contractors with the requirements for systems integration procedures. This led to significant frustration on the part of the systems integrator. On the other hand, systems integration between RCOC’s FAST-TRAC and MDOT’s instrumented highway project was enhanced by the fact that the same systems integrator (Rockwell/ Odetics) was hired by both agencies. Nevertheless, companies in the private sector are often unwilling to cooperate to the extent desired by the pubic agencies out of fear that participation in the project will give away trade secrets to their competition. Institutional integration can be facilitated by having compatible goals, choosing compatible partners, and charismatic leadership that can promote a team effort.

Timing and Coordination of Schedules.

It seems obvious that timing and coordination of various schedules is crucial within a team where members work on different elements of the project, and advancement from one project phase to the next depends on the availability of intermittent products. Yet, coordination is oftendifficult and so the systems integration team structure must enforce synchronization of schedules among all partners and contrators. The public agency is responsible for keeping the project to the stated goals and for creating, or overseeing creation of a coordinated timeline for development and deployment of the integrated system and its components. Again, as pointed out in the preceding section, some contracting arrangements may make this task easier than other arrangements. Interviewees found it important to have a representative of each affected organization at every meeting.

In FAST-TRAC, regularly held System Integration Subcommittee meetings facilitated the formal contact between the involved project parties. The meetings were held at varying locations and generally all partners were represented by at least one person. The meetings were used to monitor the progress of development of parts of the integrated system. They also represented an opportunity to discuss upcoming technical and institutional issues in a broader forum with input from all, not just from the parties directly involved.

Delays in completing certain parts of the project occurred for various reasons. For example, a delay in the completion of one of the crucial interfaces led to lags in going on-line for other TIMS components. This happened because the one systems component was to supply data which serves as input for other components. Several interviewees expressed their frustration about the inability to get parties to comply and cooperate In a more timely fashion.

Rewards and Punishments. Mechanisms of accountability must be established and administered by the public agency. Without appropriate rewards and punishments it may be difficult to ensure cooperation among the various project participants. In the case of FAST-TRAC no explicit schemes were set up, which may explain some of the significant delays the project experienced over the course of the implementation.

Documentation. An essential project control mechanism is complete and clear documentation to guide and evaluate the integration process. At the start of the project, agreements in the request for a systems integration proposal must detail work processes, goals, and objectives as well as deliverables. Once the project is underway, well defined working documents are essential, e.g., systems requirements documents and interface control documents (one for each direction of each data flow is necessary, i.e., two for each interface). A rigorous procedural advancement is recommended in which system requirements and interfaces are set out in a logical and clear fashion. Documentation at the end of each major step needs to be reviewed and "signed off" by the implementing agency before further advancement of the project. Similarly, deliverable documents should have clear goals and elements that are traceable over time. All agreements (informal decisions, letters of agreement, contracts, etc.) must be clearly and consistently documented and communicated to all pertinent parties.

In FAST-TRAC, the lion's share of documentation was produced by the systems integrator. Documents were reviewed by members of the Systems Integration Subcommittee. Since the implementing agency, at least at the onset of the project, had not required the parties to adhere to a preset format, deliverables are somewhat inconsistent in format and derail. Therefore, the concept and 1ntcma1 logic are at times hard to follow from document to document.

Lesson #5: FOLLOW STANDARD SYSTEMS INTEGRATION PRACTICES

All interviewees agreed that a large project should adhere to a structured systems integration approach, and be thoroughly reviewed at each stage of the process. This process must have early, frequent, and continuing involvement from all organizations, e.g., meetings of participants should be held on a regular basis, and all should understand the operational requirements implied by project goals. The process can be described by four sets of actions: set realistic but visionary goals, agree on a philosophy and approach, plan with a view to deployment, and emphasize interoperability.

Set Realistic but Visionary Goals. A systems integration project is no different than any other project in that it needs clearly stated goals that are both realistic and visionary. The lead agency must work with the different business partners to set goals, which must be compatible with the goals of the participants selected for the project. Finding the right mix of realism and vision is a challenge.

On one hand, realism in goal setting is necessary for many reasons. Goals that are too ambitious can often not be achieved, which leads to frustration and disappointment at various levels for all of the involved parties. Unrealistic goals may lead efforts in multiple directions and dead ends; these are costly effects, both in terms of time to completion and wasted funding. If goals are not clearly stated, the procurement process will lead an agency astray - ending up with different products. On the other hand, the visionary aspect in goal setting is important to solve unique or tough problems. Visionary thinking is often needed to secure federal/state money for a project. Special funding opportunities are found in the field of innovations and non-traditional approaches that cannot be exploited otherwise.

Projects often set goals that require new technical innovations. This is a risky undertaking that nonetheless can probably not be totally avoided. However, risks in terms of building on novel technica1 solutions should be kept to a minimum. The public agency should seek advice from systems integrators and consultants regarding technical feasibility of goals and alternative options whenever possible. Extensive risk assessment and development of alternative strategies at the onset of a project may be useful.

As noted, compatibility of goals among the project participants is essential for success. This is not to say that all groups are after the same thing, rather they agree on a single definition of the end product, i.e., they agree on what they would call a success in terms of the final integrated system. This implies that project goals should be compatible with the strategic goals of each organization. Along with this is the need to establish an environment of trust and a "win-win" team mentality. Once each organization has the opportunity to state and discuss their goals and concerns, effective ground rules can be established and the project has a fair chance of running smoothly.

When establishing a vision and goals, the public agency, in collaboration with project partners, should specifically determine regional needs and inventory legacy systems and then determine what kind of ITS should be put in place and how these ITS can be integrated into existing local and regional goals. This process will likely involve focus groups with local stakeholders and other forms of public outreach, both to come to a shared understanding of what ITS is and how it relates to traffic planning and to achieve buy-in of these groups. The process will also involve an "environmental scan" to see what agencies in comparable situations are doing.

While FAST-TRAC had set out goals in terms of the project, these goals changed over time. Furthermore, objectives for subsystems were not clearly documented which led to a series of surprise discoveries during the operartional field test. For example, ALI-Scout was marketed as a dynamic route guidance system by Siemens. It was inferred that the system could provide real-time link travel times back to SCATS and so initiate dynamic changes in the signal phasing. However, processing of ALI-Scout data transmitted from vehicles in the field via beacons to the main computer created a lag of about 25 minutes. This turnaround time rendered real-time responses impossible and ultimately contributed to the discontinuation of the integration effort.

Agree On A Philosophy And Approach. It was felt, at least by some interviewees, that a solid conceptual plan and clear decision on the philosophical approach toward systems integration was necessary to steer successfully and efficiently through the system integration process. In this context, the philosophy and approach should cover the overall program strategy including whether to address transportation problems with technology or policy, whether to use emerging or traditional technology, centralized or decentralized systems, manual, semi-automated, or fully automated operations, etc. Part of the philosophy and approach selection process may be to develop a regional concept or architecture, as a subset of the National ITS Architecture, to meet regional needs. This architecture would include desired functional capabilities and performance criteria and also put forth potential deployment scenarios. Questions regarding the design process and implementation strategy, such as whether to prove a concept through developing a prototype and/or field testing or to instead buy a proven system, must also be addressed at this point.

In FAST-TRAC, it was decided early on to use technology to increase the capacity of the road system in Oakland county. As a consequence, many cutting edge and new technologies were incorporated into the system.

Plan With A View To Deployment. Although it seems self-evident, interviewees articulated the need for a clear plan as part of a successful systems integration process. Specifically, they noted the need to plan the project in a disciplined way, proceeding through a series of stages ending in a deployment, in contrast to experimentation with various options and approaches. Special intervieweees emphasized that a public agency embarking on a long-term project is well advised to produce intermediate results in relatively short time segments so as to avoid loss of public support and funding. In response to this, other interviewees commented that the agency should not stretch the project out too long or else staff turnover, and the associated loss of historical perspective on the project, could jeopardize successful completion of the project.

One of the project participants emphasized that design activities should not be rushed, because doing so adds large costs in the long run. In a similar vein, the advice for future integration projects was to not oversell the value or capabilities of technologies. The words of wisdom were to not underestimate the costs and time to complete the project, be wary of pitfalls in the procurement process, and do not spread yourself too thin, i.e., focus on a few specific goals and stay within soft resources. A means to help stay focused on goals is to begin with a concise definition of requirements. These requirements should be used to carefully scope the system up front and, yet, leave room for expansion, both in system size and capabilities. The group also advised staff of future integration efforts to keep abreast of technologies and approaches inside and outside the nation and "to not reinvent the wheel," but rather improve on it.

These were interesting statements, especially in light of the fact that FAST-TRAC adopted a different approach. Many new and novel things were explored. ATMS with ATIS integration as in SCATS and ALI-Scout was a completely new approach. Also, the AUTOSCOPE video vision system broke new grounds in replacing the traditional loop detectors.

Emphasize Interoperability. A major issue of the systems integration process is interoperability, which includes cross-platform compatibility, data exchange and access between different systems, and many other issues. From a technical point of view, interoperability is greatly helped by some kind of commonality between the different systems, to be integrated for example, the integration could develop a universal data model to facilitate data conversion. The integrator could also use standardized physical interfaces and data exchange formats, or a common spatial database, for example. As a last resort, the integrator could develop customized interfaces between different systems components to ensure interoperability. System development and later integration is also added by modularity of design with well defined interface specifications. Compatibility with any national architecture was also advised.

In FAST-TRAC, Rockwell/Odetics was in charge of overcoming the multiple barriers for data exchange and transfer, and the integration process was carried out in a well-defined manner. A major issue that did arise was understanding ALI-Scout system capabilities, especially in terms of definition of dynamic route guidance and timeliness of guidance updates and the data upon which those updates are made. Other significant issues included modeling of SCATS operation, integration of SCATS and ALI-Scout, and multiplexing of data from AUTOSCOPE and SCATS. The project phasing and slow evolution of the project (with test periods and trials to integrate technologies which then got dismantled again) made it difficult to develop a universal data model. Planning of data flows and exchange was attempted but the effort was greatly hampered by the lack of cooperation of different vendors especially regarding disclosure of proprietary systems architectures.

Traffic management is inherently based on spatial representation of traffic flow and incidents. Congestion levels and traffic events are displayed on a digital map database for the region. Data integration is facilitated by the fact that different partners agree on the use of the same geographical map database provided by the regional planning agency, SEMCOG. However, this database's primary purpose is not transportation and traffic management, and links representing roads do not contain all the necessary lane information, turn-restrictions and so forth, that navigation applications such as ALI-Scout rely on. Data transfer and reference to and between different databases are somewhat problematic and a switch to a different database may be necessary in the future to facilitate the integration of further systems into FAST-TRAC.

ADDITIONAL COMMENTS

Although not raised during the fact-finding portion of this study, and taken as a "given" in most work, the most basic of all lessons is: the need to recognize the true nature of the problem. Public outreach is needed, if not to promote the project, then at least to avoid public confusion about the goals and methods of the project. The latter point hit home early on in FAST-TRAC when the public attributed an unpopular change in the left turn regulation at traffic lights (from permissive to protected) to the FAST-TRAC effort. Note also that many of the institutional issues recorded here resemble issues raised in an earlier report on institutional issues in the *implementation* of ITS technologies (Institutional Issues Report, EECS - ITS Lab-FT 97 - 018).

A summary observation is that the existence of a general concept of systems integration, although essential for implementing a project such as FAST-TRAC, does not guarantee successful implementation. In FAST-TRAC, three main ingredients supported the progress of the systems integration. First, a relatively independent local agency with decision power and the capability to act quickly. Second, a structured and rigorously administered systems engineering process. Third, an administrative setup that aided in the resolution of technical and institutional problems.

6. FUTURE PLANS AND RECOMMENDATIONS

FAST-TRAC's goals and objectives evolved over time, both in scope and geographic extent, as a deeper understanding of the possibilities and impacts of ITS technologies was developed, and partnerships with vendors and other agencies emerged. The evolution of goals and objectives reflected not only the gradual learning process of the individuals and institutions involved in the project, but also technological progress and changes in political climate and institutional arrangements.

Traffic management using ITS, as opposed to road construction, is a novel concept for local transportation authorities. Several issues became pertinent for the future progress of the project. These were the integration of advanced traffic management and traveler information, the integration of ITS technologies for freeways and arterial streets. and the integration of different traffic information data sources into a central traffic operation center. An additional issue was communication costs. The system integration topics were given to working groups for further discussion and solution development. However, at the time the project started in the early 1990's, there were few opportunities to develop an understanding of the duties, liabilities and responsibilities that the FAST-TRAC system integration would entail for RCOC. This had a number of implications, which are described below.

Working on systems integration meant that RCOC had to partner with organizations that had no prior working relationship with local authorities. RCOC also had to develop staff expertise and hire staff with knowledge in systems integration and ITS. Moreover, traditional procurement procedures are not necessarily well suited for the procurement of ITS products and technology and so RCOC had to adapt to new procedures in conducting business. For example, classic design-bid-build contracting separates design work from actual construction work. If components need to be constructed to work together in an integrated system, project component time lines from different bidders may be hard to coordinate. A combined design-build contract may be a better choice (Booz-Allen & Hamilton, 1997). Further, relationships between agencies and vendors grew, and goals and objectives were adapted and modified. Hence, institutional arrangements *and* systems integration goals and objectives had to be adapted to changing conditions making FAST-TRAC an evolving project.

FAST-TRAC's system integration efforts are just being completed. Hence it is too early to give an overview of the benefits and evaluate the implications of the systems integration. Instead, this section will be used to look at future planning for ITS in Oakland County. The approach is twofold. First, a brief summary of the existing integrated system and near-term improvements and extension planned by RCOC will be described. Second, a broader perspective will be taken to outline long-term goals for maintenance, upgrading and further development of the FAST-TRAC TIMS.

6.1 Today's Situation and Planned Systems Improvements

At the time of completion of this report, FAST-TRAC Phases IIa and IIb neared completion. From an RCOC standpoint, all systems elements were deployed and integration work was completed except debugging some interfaces. While the systems integration effort of linking RCOC administered subsystems such as AUTOSCOPE and SCATS was successful, systems integration fell short in terms of the data that is exchanged with partnering agencies. For example, the systems of partnering agencies, like the transit agency SMART, did not develop as quickly as anticipated thus leading to delays in providing the data to be exchanged with RCOC. However, in this example, future advancement of SMART's systems operation will allow the desired and planned for data exchange. A second reason for less than originally planned integration was that data flows and needs were not always completely understood at the beginning of the integration planning and that proprietary issues impeded unrestricted data exchange. These problems emphasize that creating a truly multi-modal and interjurisdictional integrated system is very difficult.

Several extensions to the current system are planned under contracts with ISS. Odetics and Transcore (formerly AWATSA). Remaining work items for FAST-TRAC can be summarized as follows:

- Pursue improvements and extensions of the existing system;
- Develop dissemination strategies for traffic information;
- Continue research and experimentation (as permitted by financial resources)

Examples of this are given below.

Improvements and extension of the existing system

A variety of improvements and extensions of the existing system are being undertaken. These are described below.

A contract with ISS seeks to improve the AUTOSCOPE capabilities to provide automated feedback on malfunctioning of the image sensing system to avoid costly and time consuming field checks, as well as multiplexing communication lines with SCATS.

The latest contract with Transcore provides for SCATS systems upgrades. Furthermore, the system integrator (Odetics) has been commissioned to develop a rule based traffic incident management plan in conjunction with SCATS that would allow for further automation of operations at the traffic management center. Another avenue to improve the benefits from the existing system is to provide for automated switching of the school flashing light warning for the 60 school zones in Oakland county. Phases for flashing lights at schools must be adjusted from daylight saving time to regular time and back as well as from the time periods schools are in session to vacation periods. The procedure could be automated by placing a SCATS controller with the flashing light. Feasibility of this automated switching approach as part of a SCATS event management plan will be tested at one site.

The ERINet Subsystem of the TIMS accepts data input on traffic events, construction zones, road closures etc. into the TIMS database for display on the traffic status map. While this method is feasible and works - it requires human interaction and thus is subject to failure due to understaffing or staff failure to send in the information. Furthermore, the method of manually updating the system with traffic events inherently lags significantly in terms of time. RCOC has indicated interest in enhancing the reliability of traffic related information flows by connecting directly to databases that record anticipated traffic disturbances. Currently Oakland County's permit department for example has been targeted for a test in connecting the TIMS with the permit departments database for sharing data on permits that will lead to road related disturbances. Permit related road works could, then be posted on the traffic congestion map together with other traffic information.

Develop dissemination strategies for traffic information

The data collected by ITS technologies such as AUTOSCOPE sensors or loop detectors provide traffic flow information at temporal and spatial scales not available before. These data could be potentially valuable for city planners, as well as for delivery services and the like. In recognition of this, the possibility of exploiting FAST-TRAC traffic data, in an entrepreneurial way, as a source of revenue was debated.

The data could also support Advanced Traveler Information Services (ATIS). Early in the debate, tightening ITS funds and the difficulty of securing sufficient human resources for traffic management operations and maintenance raised a discussion about public agency involvement in ATIS provision. ATIS service provision puts a high burden on the public agency in terms of personnel commitment and cost, while at the same time, it is problematic and controversial for a public agency to charge for such service. According to one Road Commission official, it seemed like travel services were not really within the scope of the RCOC mission; and the agency was in danger of "spreading itself too thin." As a result, RCOC along with MDOT considered outsourcing the ATIS portion of the FAST-TRAC project. Contract negotiations with Independent Service Providers (BPS) were undertaken. The plan was that an ISP would take over the dissemination of traveler information. The ISP would process traffic data obtained at no cost from public agencies (e.g. MDOT and RCOC), and disseminate it in the form of various service packages. A revenue sharing agreement with the public agencies was to partially pay for the collection of the data. At completion, of this report, MDOT had signed a contract with Smart-Route Systems for operation of the Michigan Intelligent Transportation Systems Center (MITSC) in exchange for exclusive access to MDOT traffic data, which could then be sold at a profit. Prior to conclusion of contract negotiations, RCOC was excluded from the contract.

At this point, RCOC also intends to shift some resources to the provision of the ATIS components of the system. In the near future, two mobile changeable message signs will provide travelers with pertinent information on detours and traffic incidents. Part of the traveler information system to be tested is the Road Weather Information System (RWIS). For RWIS, temperature, road surface conditions, wind and precipitation will be measured at strategically dangerous locations (e.g., bridges). This information will then be conveyed to the traveler as a warning. Further ATIS strategies are being explored. The FAST-TRAC Systems Integration Committee may be restructured to help in developing feasible, low-cost ATIS strategies. One issue is the consistency and reliability of traffic data. Cable TV and Internet dissemination of information are certainly possible options. More elaborate strategies such as revenue sharing approaches with Independent Service Providers are being considered and are desirable as this income could pay to hire a traffic operator, provide operating funds or pay for future research.

Continue Research and Experimentation

Another concern in RCOC's further planning is legacy equipment. Approximately 100 beacons are still deployed around the City of Troy from the SCATS - ALI-Scout operational field test. The removal of the beacons poses a significant financial burden while the unused equipment poses liability issues. Alternative uses of the beacons are thus being explored. One idea is to use the beacons as a means to transmit radio signals for detour traffic routing.

6.2 Recommendations

Planning Process

FAST-TRAC's system integration efforts were all in all successful. The integration planning process can be characterized as a long and winding road. It probably can be stated that this rough experience was a result of the lack of previous experience. The expenditure of extra funds on the search for suitable solutions was practically unavoidable. However, now, given the experience of FAST-TRAC and similar projects around the nation, and the emergence of ITS as a mature approach to traffic management, future efforts to plan for ITS deployment should be more structured. Outreach sessions of the FHWA and FTA suggest a planning approach for ITS that:

- Incorporates ITS into the state, regional and local transportation planning processes (STIP/TIP):

- Uses procedures for a5suring consistency with the ITS National Architecture;
- Uses RFP, proposal and contracting procedures suitable for ITS design, procurement and deployment;
- Applies methods for assuring that new integration and/or deployment dovetails with existing infrastructure and is open to new expansion; and
- Involves citizens in planning and tradeoffs with other public initiatives.

While the Federal Government is likely to request that ITS elements be identified in the regional and local transportation plans - there is little or no incentive for doing so in respect to monetary rewards to the transportation planning agencies. The pay-off of being aware of ITS elements within a local or regional transportation plan are probably long-term in that documentation of ITS elements and deployment may help to bring all players together, create awareness and thus help in shaping a tru1y integrated transportation management system.

Oakland County Vision

Throughout the course of the FAST-TRAC project, RCOC was transformed. Staff expertise grew significantly. RCOC worked with universities, consulting firms and industry on research and evaluation of their ITS deployment. This increased RCOC's understanding of the impact and implications of ITS technology on the various users. Moreover, integrated traffic management requires a specialized work environment, i.e., the traffic operation center with appropriate displays and infrastructure, e.g., wiring, heating and ventilation, and lighting. In response to this, RCOC moved into a new building where a state of the arc traffic operation center, complete with local area networkethernet wiring, was built and incorporated into the agency's office structure. Oakland County thus currently has a functional and integrated ITS system with the TIMS collecting, analyzing, responding and disseminating traffic information from various sensors and other transportation agencies such as MDOT and SMART.

It is anticipated that growing success in traffic management and positive feedback from road users will ensure that traffic management will be incorporated as a standard component in the Road Commission's task list, and that it will be staffed appropriately in the future. Nevertheless, there is room for improvement and increasing benefit from the system. Transportation management systems must be flexible and grow with the demands and changes in the physical andinstitutional environment. Systems integration needs to be viewed as a continuous effort rather than a one-time event. Issues and opportunities for future work for Oakland County derive from the following efforts:

- SEMSIM commercial vehicle operation (snow plow route optimization) project integration.
- Spatial database upgrades.
- Formation of a common database for exploiting traffic related information for planning and research.
- Issues of limited geographic data and traveler information gaps and distributor liability.

RCOC is currently making plans regarding these opportunities.

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B. Interview and Focus Group Summary

An interview was conducted on Monday October 27, 1997 at 9:30-11:30 am. This interview was followed by a focus group session on Wednesday October 30. 1997 at 10:45 - 1:45 pm. The focussgroup session was held at the Information Technology Building, 1200 N Telegraph, Waterford, Ml. The interview and focus group session were conducted by researchers from the University of Michigan (Dr. Thomas Reed. Andrea Frank and Mark LeBay)
Results of those sessions are summarized below.

The interview was conducted as an informal conversation with questions and answers. For ease of later analysis the interview was taped with the permission of the interviewees. Results of the interview are summarized below under the headings "Objectives and Goals of FAST-TRAC", "FAST-TRAC Relationship to ITS Architecture", "Technical Integration Issues", "Process", and "Lessons Learned."

Objectives and Goats of FAST-TRAC

- The original goals and objectives matured and evolved over time. The core of FAST-TRAC was to be the ATIS and ATMS integration of SCATS and ALL-SCOUT. There is currently no intention to continue with the ATIS integration using beacons to distribute traffic information. There may be an alternative ATIS component through TIMS or with SmartRoute Systems.
- Goal development for FAST-TRAC came from a strategic planning process of 61 communities in Oakland county. The planning effort was triggered by unprecedented rapid urbanization and growth which induced heavy traffic on tow grade roads. Since there was no or little money to widen roads a technology approach to congestion reduction and traffic management was adopted.
- Initially FAST-TRAC was linked to an entrepreneurial spirit. There existed plans to sell data and traffic information collected at the central data repository to other interested parties to recover some of the investment and maintenance cost.
- Further. there was the idea that a traffic control and management system could be used for automated toll collection.

FAST-TRAC Relationship to ITS Architecture

- The current status of the ITS Architecture does not provide sufficient detail to be of much help
- Standards for message exchange and data transfer are not finished or not advanced enough to be useful for FAST-TRAC.

Technical Integration Issues

- Legacy systems are problematic to integrate; it is best if people who designed them are still around (need to be included in contracts).
- Platform study.
- The more data the better. Data redundancy, i.e. data information from multiple sources makes data verifiable and automation of procedures becomes possible.
- Data security is not of highest concern

Process

- No real decision-making in committees
- Committees do not get work done, just delay decisions ("do not vote"))
- Use workgroups to get things worked out
- Contracts and responsibilities are an issue. For example time lines and work items need to be in synch. The arrangement in the FAST-TRAC case is found sub-optimal by the interviewers They agree that it would be better that an agency contracts a system-integrator who then subcontracts to the various companies involved In FAST-TRAC's case. RCOC has contracts with many different companies: responsibility of coordination lies in the agencies hands and puts tremendous administrative burden on the public agency. Depending on contractual language. the system integration has little leverage to coordinate time lines and schedule to guarantee that the project progresses in a timely fashion

Lessons Learned

- *Have clearly stated goals and objectives*
"know what you want" as an agency

2. Use an experienced systems integrator.
(how to measure this? what are criteria to evaluate systems integrators?)
- previous projects
- communication skills
- disciplined process and approach

3. Documentation of System Integration Engineering Process
Documentation of the process is essential. Deliverables, documents should have traceable elements over time and document goals, system requirements, interfaces controls in a logical and clear fashion.

4. Institutional Integration
" It is easy to integrate systems, but it is difficult to integrate companies"
Institutional integration is key. The institutional integration could be facilitated with contractual language and contractual determination of relationships and responsibilities.

5. Process
An integration management process is needed.

6. Leadership and Champions
Personal interest from a person of each involved agency (agencies) is very helpful. It is important that the agency take "ownership" and develops pride in the project in order to make it successful. It is very helpful if someone in the agency has technical interest and understanding. There also need to be the resources (in terms of time, money and personnel) to investigate the employment of ITS and its technologies.

7. *Having something in common helps*
the data exchange.
In the case of Oakland County's FAST-TRAC project, several agencies use a common geographic base map as reference. This supported the ease of data transfer (an x, y coordinate is the same in all systems).

The focus group session was led by Thomas Reed led through a structured interview process The sequence of activities was as follows:

I. introduction and Session Objectives

II. ISSUES

IIa. Quick Response (Issues)
Participants were handed white 6x5 index cards and marker pens. They were asked to write down in key words issues: "anything that determines the success of the system integration anything that did or could impact the systems integration process".

IIb. Sorting of Issue Cards
Participants were ask to evaluate their issues according to a scale of 1 to 5 with 1 being essential and 5 being not essential to indicate the importance of the issues in regards to the project. Then participants put up cards on the front wall (with the help of the facilitators) along the scale. In the first round one by one issues that were deemed very essential (1) were put up; then other essential issues (2) were put up in a third round the remaining issues were sorted into categories 3-5.
During IIa and IIb. participants were encouraged to write additional issue cards it comments from others triggered thoughts and ideas.

IIc. Selection of Top Issues
Participants were invited to come to the board and review the issues. They were again to rank the issues. This time they were allowed to mark issue cards with crosses to indicate the most essential ones. Each person was allowed to select 3 issues.

IId. Classification of Issues
Under the guidance of the facilitator, the cards were taken off the board and sorted by content
The panicipants were asked to assign categories for the different issues.

III. RECOMMENDATIONS

IIIa. Quick Response (Recommendations)

IIIb. Sorting of Recommendations

Participants were ask to evaluate their recommendations according to a scale of 1 to 5 with 1 being easy to implement and 5 being difficult to implement. Participants were also asked to indicate if they had used this particular activity in FAST-TRAC and if it was important to do soThen participants put up cards on the front wall (with the help of the facilitators) along the scale of easy to difficult. In the first round recommendations that were deemed most important were put up; then all others of lesser importance were collected and posted on the board by levels of difficulty.

During IIIa and IIIb, participants were encouraged to write additional recommendation cards if comments from others triggered thoughts and ideas.

IIIc. Selection of Top Recommendations

Participants were invited to come to the board and review the recommendations. They were again asked to rank the recommendations. This time they were asked to mark the cards with crosses to indicate the most essential ones. Each person was allowed to select 3 recommendations.

IIId. Classification of Recommendations

Under the guidance of the facilitator, the cards were taken of the board and sorted by content. The participants were asked to assign categories for the different recommendations.

IV. Summary and Final Remarks

Summary Results of the Focus Group Session

Issue Table

1	Communication between Organizations	Coordination of schedules	Timing	Proprietary Information
2	Goal setting	Compatibility of Goals	Public-Private Partnership	
3	Program Strategy	Implementation Strategy	Design Process	
4	Staffing			
5	Interoperability	Proof of Concept	Prototyping	
6	Business plan for funds	Funding		

Focus Group Recommendations

The project needs:

- Champion (clear leadership and decision making)
- Project Authority (management and contracting)
- Total Team Concept
- Network (frequent and personal contacts)
- Put it in the Contract and RFP
- Staffing (appropriately skilled)
  how to select an systems integrator (criteria list)
- Have a Plan and know what you want (be specific)
- Don't rush design; use system approach

C. Acronyms and Abbreviations

ALI-Scout	- Autofahrer Leit- und Informationssystem (driver guidance and information system)
ATIS	- Advanced Traveler Information System
ATMS	- Advanced Traffic Management System
AUTOSCOPE	- AUTOSCOPE 2003 Video Vehicle Detection System
AWATSA	- AWA Traffic Systems America, Inc. (Transcore, since 1998)
CCTV	- Closed Circuit Television
DOT	- Department of Transportation
ERINet	- Emergency Road Information Network
FAST-TRAC	- Faster and Safer Travel through Traffic Routing and Advanced Controls
FHWA	- Federal Highway Administration
FTA	- Federal Transit Administration
ISS	- Image Sensing Systems, Inc.
ISTEA	- Intermodal Surface Transportation Efficiency Act of 1991
ITS	- Intelligent Transportation Systems
LAN	- Local Area Network
MDOT	- Michigan Department of Transportation
MITSC	- MDOT's Michigan Intelligent Transportation Systems Center in Detroit
RCOC	- Road Commission for Oakland County
SCATS	- Sydney Coordinated Adaptive Traffic System
SMART	- Suburban Mobility Authority for Regional Transportation
STI P	- State Transportation Improvement Plan
TIP	- Transportation Improvement Plan
TIMS	- Traffic Information Management System
TOC	- Traffic Operation Center
WWW	- World Wide Web