Genesis Evaluation Institutional Issues Test Report

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NOTE: All data reported in this DRAFT test report are preliminary and subject to modification/update, pending further review and the receipt of comments from readers. The final version of this report will contain no disclaimer.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Purpose

The objectives of *the Genesis Institutional Issues [formerly, Global]* (1995) evaluation were to:

- Document the methods used to encourage institutional cooperation during the conduct of the Genesis operational test
- Document institutional issues and lessons learned that derived from the conduct of the Genesis operational test
- Document partner goals for the operational test and perceptions of project success
- Identify future applications for and improvements to the Genesis Personal Communication Device (PCD) technology that became evident to the Genesis partners as a result of the operational test

This report, the *Genesis Evaluation Institutional Issues Test Report*, presents the results of this evaluation.

1.2 Background

Intelligent Transportation Systems (ITS) are concerned with applying advanced and emerging technologies to surface-transportation applications so that efficient use of infrastructure and energy resources, and significant improvements in safety, mobility, accessibility and productivity can be obtained. In 1991, Congress initiated the ITS program with the passage of the Inter-modal Surface Transportation Efficiency Act (ISTEA).

As part of the ISTEA initiative, the United States (U.S.) Department of Transportation (DOT) prepared a strategic plan for the implementation of a nation-wide ITS program. This document, the *ITS [formerly called Intelligent Vehicle Highway System or IVHS] Strategic Plan* was published in December 1992 and served to set forth the goals, milestones and objectives of a national ITS program. In November 1994, the Federal Highway Administration (FHWA) defined the specifics of a federal ITS program in the *National Program Plan for ITS.* This document:

- Described the national ITS program
- Stipulated that public/private “partnerships” be developed to facilitate deployment of ITS technologies

- Promoted national/state/local cooperation through the implementation of operational tests
- Provided for national program assessment

Each of these components of the *National Program Plan for ITS* (1994) as they relate to Genesis are described in the following sections.

1.2.1 Genesis System Description

Genesis is an Advanced Traveler Information System (ATIS), one of the types of ITS services defined by the *National Program Plan for ITS* (1994). As such, the system incorporated a cellular-based radio transmission system with two Personal Communications Devices (PCDs) for transmitting traffic information to travelers. The two PCDs were an alphanumeric pager (Motorola Advisor) and a Personal Digital Assistant (PDA) (Apple Newton with Motorola Newscard pager card).

Genesis is sponsored by the Guidestar office of the Minnesota Department of Transportation (MnDOT). Guidestar is responsible for implementing Mn/DOT's ITS program. The goals of the Guidestar ITS program are:

- Enhance mobility and reduce congestion
- Improve safety
- Reduce environmental impacts
- Promote new institutional relationships
- Develop public-private partnerships
- Promote a key role for academia
- Promote and strengthen ITS research and education
- Develop innovate applications of academic research
- Promote public acceptance
- Maintain ITS leadership

The goals of the Genesis project are:

- Determine technical feasibility
- Influence individual travel decisions
- Complement and integrate with other ITS projects

The complete Genesis system is shown in Figure 1 and was composed of four subsystems:

- Data Collection Subsystem (DCS)
- Traveler Information Processing Subsystem (TIPS)
- Communications Subsystem (CS)
- Personal Communication Device (PCD) Subsystem

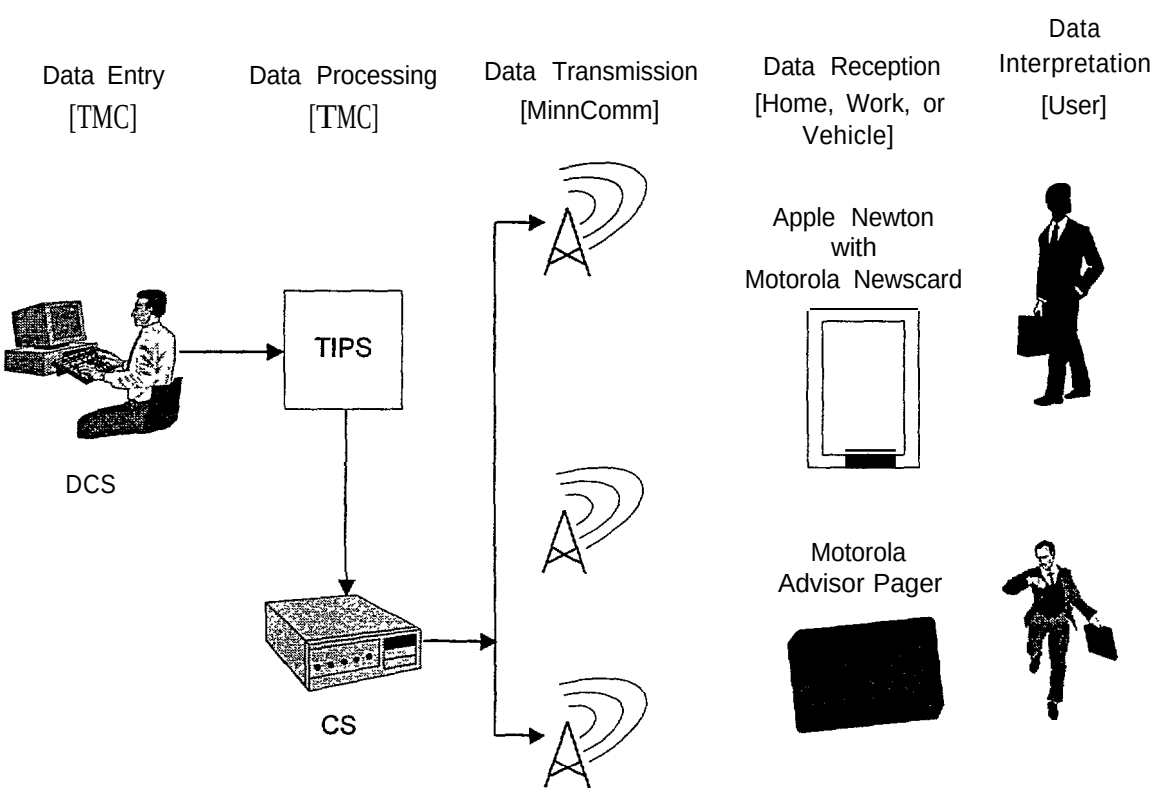

Figure 1. Genesis System Overview.

The DCS consisted of two workstations located in Mn/DOT's Traffic Management Center (TMC) that enabled operators to enter detected incidents and problems for transmission to users. These messages were constructed by opening windows on the DCS workstation for each problem and using templates to construct messages for users in one of two coverage areas, North or South. Figure 2 shows the coverage area for Genesis.

Genesis messages comprised three types:

- Congestion (e.g., slow, heavy, stop-and-go)
- Incident (e.g., accidents, disabled vehicles)
- Planned Event (e.g., stadium events, construction)

The specific format of these messages conformed to ENTERPRISE guidelines, the standard upon which ATIS messages are constructed in the United States. These standards specify that an event needs to be described, a *location* pinpointed, the *backup extent* indicated, and an *expected duration* estimated. Genesis messages conformed to this standard.

The TMC is Mn/DOT's Minneapolis-based, incident-detection center that monitors the occurrence of traffic problems primarily through video display of closed-circuit cameras placed along controlled-access highways in the Twin Cities area. Currently, the TMC disseminates traffic information to Minneapolis/St. Paul travelers via radio broadcasts and Changeable Message Signs (CMS). Radio broadcasts are transmitted over 88.5 FM (KBEM) and a number of CMSs are currently operable within the Genesis coverage area.

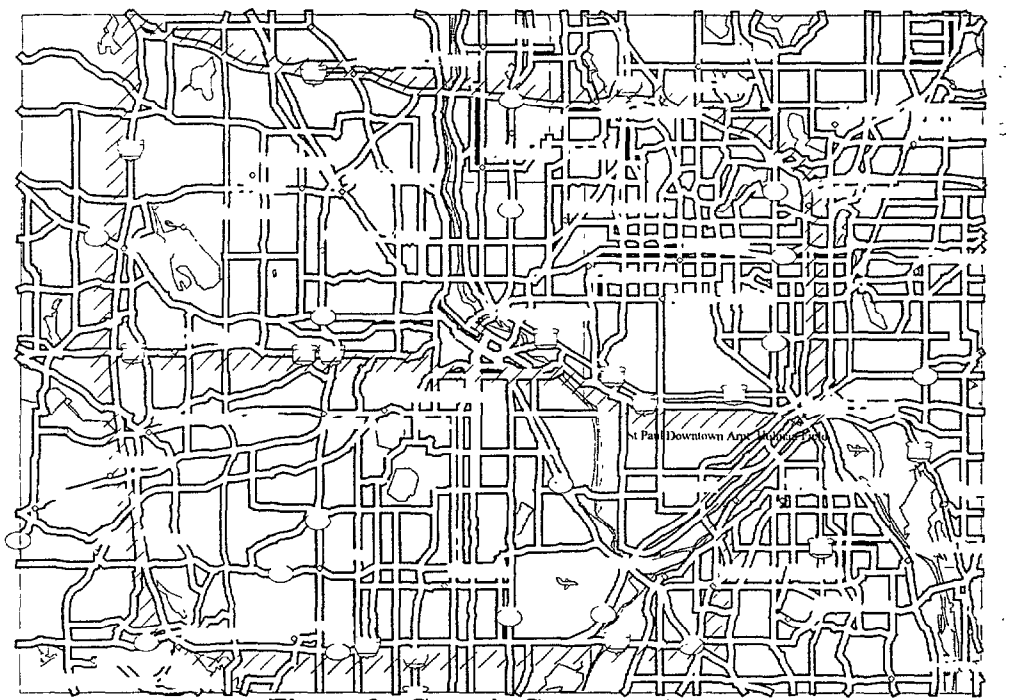

Figure 2. Genesis Coverage Area.

TIPS gathers, formats and addresses DCS information so that it may be disseminated to the Genesis user devices. Specifically, TIPS determines what location in the Genesis

coverage area, North or South, should receive the information and transfers it the CS for distribution to the user devices. In addition, TIPS logs all Genesis messages.

The CS receives incident data from TIPS and transmits it to Genesis users. This occurs by transmitting this information via telephone modem to the local cellular-communications provider selected to participate in the Genesis operational test.

The two PCD's used for Genesis were the Motorola Advisor alphanumeric pager and the Apple Newton Message Pad 110 with Motorola Newcard alphanumeric paging card. Both devices contained "mail slots" for the receipt of information. In addition to providing four, 230-character mail slots (two for the North area and two for the South) for traffic information, Genesis pagers also provided eight additional slots for numeric pages, news, current weather, forecast weather, lottery results, sports, stockmarket quotes and business news. The Genesis PDA, however, only provided three slots: one each for North and South area traffic information, and one for numeric pages.

1.2.2 Genesis Partnership Agreement

Genesis is one of the principle ITS elements of the Minnesota Guidestar program, an office of the Transportation Research and Investment Management division of Mn/DOT. Guidestar was formed in 1991 in response to the ITS initiatives resulting from ISTEA and is concerned with developing a better statewide transportation system for Minnesota citizens and businesses through leadership in technology development, testing and innovative partnerships between the public and private sectors.

At the same time that Guidestar was being formed, the University of Minnesota responded to the ITS initiative by creating the Center for Transportation Studies (CTS), an interdisciplinary entity concerned with addressing local transportation issues on a wide range of fronts. The formulation of CTS was led by a former Mn/DOT commissioner who championed Mn/DOT's initial foray into the ITS field and stimulated converging transportation studies and research which supported the ITS efforts of the State of Minnesota.

Project Genesis took shape in 1991. Initially, the idea for Genesis was developed by Mn/DOT and Motorola, and additional private-sector partners were solicited. The first meeting of interested parties was held in December, 1991, with Mn/DOT, Motorola, University of Minnesota-- Center for Transportation Studies (CTS) and the FHWA in attendance. The first order of business was to define the Genesis project and discuss the unique public-private partnership expectations inherent in the ITS initiative forwarded by ISTEA. After exploring these issues and receiving seed funding from the FHWA, Mn/DOT actively charted not only the development of Genesis, but an integrated ITS program for the State of Minnesota as well.

The *Genesis Concept Definition and Preliminary System Design* was prepared in 1992. This document was prepared by BRW, Inc., Battelle Memorial Institute, JHK and Associates, and Barrientos and Associates, and specified a five-phase Genesis project. The phases were:

- Pilot pager test in Minneapolis
- Pager test in Minneapolis
- PDA test in Minneapolis
- Pager test in St. Paul
- PDA test in St. Paul

By February 1994, a series of Genesis detailed system design documents were completed by IBM [now LFS], JHK and BRW. In addition to providing details about the Genesis system design, these document added a third Genesis PCD, the notebook computer, and information about the Genesis operational test and evaluation plans. A summary of this information is provided in *Genesis.. A Summary of the Detailed System Design* (March, 1994).

At the same time that Genesis was taking shape, other Mn/DOT ITS systems were also being configured. These included Trilogy and Travlink, two other ATIS projects. Travlink focused on providing transit riders with up-to-the-minute bus information, while Trilogy was concerned with providing in-vehicle traveler information. Throughout, Mn/DOT's Guidestar office served to coordinate ITS development within Mn/DOT. In addition, the Metro division of Mn/DOT, one of eight operating field divisions within the State of Minnesota and the one representing the Twin Cities area of Minneapolis and St. Paul, also extended its interest in ITS applications for solving traffic problems within their jurisdiction by becoming a leading proponent of these applications within Mn/DOT, especially for the Trilogy project.

In March 1994, LFS was selected to be the private partner for Genesis. As part of its team, LFS retained JHK, MinnComm Paging, Inc. and BRW as subcontractors. JHK was responsible for the development of DCS, MinnComm was the communications service provider and BRW served as local liaison for the project and staffed the Genesis HELP desk during the conduct of the operational test. The Genesis public partners throughout the project, of course, were Mn/DOT and the FHWA.

1.2.3 Genesis Operational Test

The Genesis operational test was conducted in the Twin Cities area of Minneapolis and St. Paul from July 25, 1995 through January 24, 1996. According the FHWA document, *Generic ITS Operational Test Guidelines* (1993), an ITS operational test is a "joint public/private venture, conducted in the real world under live transportation conditions.. ." that "serve[s] as [a] transition between research and development (R&D)

and the full-scale deployment of [ITS] technologies." In the grand scheme of the ITS initiative, Genesis was one of the first ITS operational tests to be completed in the United States.

Genesis operational test participants were 492 individuals divided into pager (449) and PDA user (43) categories. These individuals were recruited from the public at large and from those who indicated that they drove a lot on the Genesis travel network, either for commuting to/from work/school or for work-related travel. The use of pagers for receiving traffic information was evaluated throughout the six-month operational test, while PDAs were only evaluated during the final two months of the test.

Staging of the Genesis operational test took almost four-years to occur. Starting from a draft Mn/DOT Request For Proposal (RFP) in August, 1991 which specified, in actuality, a smart-vehicle probe system rather than an ATIS, through the start of the live test in July, 1995. Fielding of the Genesis operational test involved a number of significant events, including approximately five "delay" periods that could be identified. Table 1 provides a summary of the significant events in the conduct of the Genesis operational test.

The first phase of the Genesis operational test was originally scheduled to occur from April through September, 1993. Due to various problems, however, the actual test did not start until over two years later. The Genesis operational test delays and the primary reason for them were:

- Winter, 1992/93-System definition
- Summer, 1993-Search for partners
- Spring/Summer, 1994--Development-contract negotiation
- Spring, 1995-System-requirements re-definition
- Fall, 1995-PDA development

Each of the above are discussed in the following sections.

System-Definition Delay

Genesis system-definition problems occurred toward the end of the first year of the project when the technical team failed to bring closure on the scope of the system to be developed. In particular, at the time, Mn/DOT was actively considering fielding the radio communications infrastructure required to host Genesis, in direct opposition to Motorola's interests. In addition, the PDA proposed for the project was not a commercial system and was considerably more "enhanced," and costly than the one that was eventually used. Resolving of such broad-scale issues did not occur, however, until the ***Genesis Concept and Preliminary System Design*** document was produced in March, 1993 at the urging of the FHWA.

Search-for-Partners Delay

Due in part to the determination that Genesis would best be hosted on a communications system that currently provided services (e.g., paging) to customers, Motorola discontinued its involvement in the project in the Spring of 1993. This occurrence resulted in an expanded search by Mn/DOT for new private-sector partners to assist with detailed system design. Negotiations with potential partners requires time, however, so Genesis was delayed again. Ultimately, after discussions occurred with a number of companies, IBM Federal Systems [now Loral Federal Systems], BRW, Inc., and JHK and Associates were selected to assist with Genesis detailed system design.

Development-Contract Negotiation Delay

After the Genesis detailed system design was completed in early 1994, Mn/DOT entered contract negotiations for developing the Genesis system with Loral Federal Systems Company [formerly IBM Federal Systems Company]. These activities represented a second-round of contract negotiations for all parties involved, but this time the negotiations were protracted due to the level of specificity required. Issues for Mn/DOT were the level of private-sector in-kind contributions, state auditing requirements, and state non-indemnification requirements, while LFS was primarily concerned with negotiating software rights and the appropriate contract vehicle (i.e., firm-fixed fee).

System Requirements Re-Definition Delay

After the Genesis development contract was signed, unexpected problems were encountered that resulted in additional delays to fielding of Genesis. These primarily involved the resolution of problems that were encountered due to a lack of specification regarding the nature of the Genesis system. For example, integration with the Trilogy project required that the algorithms used to calculate Genesis links or way-points be changed to accommodate the method used to calculate Trilogy nodes, with the result being that the size of the Genesis network was expanded. Also, further Mn/DOT database specification resulted in a Database Management System (DBMS) switch from DB2 to Oracle. Finally, an apparent expansion (i.e., requirements creep) in the amount of traffic incidents that should be handled by Genesis resulted in unexpected processing difficulties for DCS processors.

PDA-Development Delay

Original specifications stipulated that Genesis traffic messages were to be provided as personal pages to users. When it was discovered in December of 1994 that a mail-slot architecture was used for the Motorola Advisor pagers, this architecture was specified for the Genesis PDA. Unfortunately, the Motorola Newscard only provided one mail slot and software patches written for the Apple Newton to provide an emulation of the multiple pager mail-slots proved difficult to code and implement.

Table 1. Genesis Event List.

Date(s)	Event
August 1991	Initial Genesis concept developed
December 1991	First Genesis meeting
December 1991 through May 1993	Genesis technical team meets to define the scope of Genesis project and suggest partnership guidelines
December 1992	Genesis selected as FHWA operational test
Winter 1992/93	System-definition delay
March 1993	***Genesis Concept Definition and Preliminary System Design*** document produced
Summer 1993	Search-for-partners delay
July 1993 through November 1994	Genesis evaluation test plans developed
March 1994	Detailed Genesis system design documents completed
Spring/Summer 1994	Development-contract negotiation delay
July 1994	Minnesota Guidestar request for Genesis partners solicited
August 1994	Loral Federal Systems selected as Genesis private-sector partner
September 1994 through March 1996	Genesis working committee meets to discuss technical issues related to system development, deployment, conduct of the operational test, and evaluation.
October 1994	***Project Genesis Master Plan*** completed
November 1994	Genesis evaluation test plans completed
December 1994	***Genesis System Specification*** completed and independent evaluator selected
January 1995	Genesis operational test participant recruitment initiated
Spring 1995	System-requirements re-definition delay
May 1995 through July 1995	Genesis integration and field testing conducted
July 1995 through January 1996	Genesis operational test conducted
Fall 1995	PDA development delay
December 1995	Genesis PDAs distributed
June 1996	Final Genesis evaluation reports delivered

1.2.4 Genesis Evaluation

The Genesis evaluation was conducted by two independent evaluators, Science Applications International Corporation (SAIC) and the University of Minnesota Human Factors Research Laboratory (UMHFRL), through the implementation of five test plans.

These test plans, which were drafted in the Fall of 1994 and completed in the Spring of 1995, addressed five (5) Genesis evaluation topics:

- ***System Effectiveness Test--*** determine the impact of Genesis use upon driving behavior
- ***User Perception Test--*** determine user perceptions of Genesis utility
- ***Modeling Test--*** based upon System Effectiveness Test results, make projections for greater levels of market penetration
- ***Institutional Issues Test--*** assess the major institutional issues that impacted the development of Genesis or may impact deployment of the system
- ***Human Factors Test--*** conduct an independent assessment of the usability of the Genesis PCD devices

The first four of these Genesis evaluation tests were conducted by SAIC, while UMHFRL, conducted the human factors test. Both organizations conducted their respective portions of the Genesis evaluation while under contract with the Minnesota Guidestar office of Mn/DOT.

2. Methods

2.1 Overview

Data collection for the ***Genesis Institutional Issues Test*** evaluation was conducted during November and December, 1995. Predominant data-collection procedures consisted of checklists and semi-structured interviews. Specific hypotheses, measures of effectiveness, measures of performance, data sources and methods of analysis for the ***Genesis Institutional*** Issues ***Test*** are shown in Table 2.

Table 2. Methods Used to Address the Objectives of the Genesis *Institutional* Issues *Test.*

Objective	Hypothesis	Measure of Effectiveness	Measure(s) of Performance	Data Source	Method of Analysis
Document the methods used to encourage institutional cooperation during the conduct of the Genesis operational test	Genesis methodology led to effective institutional cooperation.	Partner relationships may be documented. Project was on schedule and under budget.	Perceptions of system development and deployment adequacy. Perceptions of operational test completeness.	Partner interviews. Strategic/Program plans. System documentation. Meeting minutes.	Description
Document institutional issues and lessons learned that derived from the conduct of the Genesis operational test.	Genesis Institutional issues and lessons learned can be documented.	Completeness	Perceptions of legal and institutional impediments to: • Partnerships • Deployment	Checklist of Volpe Center (1994) findings. Partner interviews.	Description Quotation Cross Tabulation
Document Partner goals for the Genesis operational test and perceptions of project success.	Participation in Genesis Partnership results project success	Identified: • Goals • Perceptions of project success	Attribution statements.	Partner interviews.	Description
Identify future applications for and improvements to the Genesis PCD technology that became evident to the Genesis Partners as a result of the operational test.	Genesis results may be effectively applied to future ITS PCD efforts.	Identified: • Applications • Improvements	Documented suggestions.	Partner interviews.	Description Quotation

All data collected for the ***Genesis Institutional Issues Test*** evaluation were gathered by the author of this report, or the Genesis evaluation principal investigator. The data ***sources*** for ***the Genesis Institutional*** Issues ***Test*** evaluation are shown in Table 3. Specific data-collection methods for each objective are described in the following sections.

Table *3. Genesis Institutional Issues Test* Data Sources.

Objective	*Data Source*
Document methods used to promote institutional cooperation	Partner verbal reports, program plans, system documentation and meeting minutes
Document institutional issues and lessons learned	Volpe Center (1994) checklist and Partner interviews
Assess Partner goals and perceptions of project success	Partner interviews
Identify future applications for and improvements to PCD technology	Partner interviews

2.2 Method for Documenting Methods Used to Promote Institutional Cooperation

Genesis institutional cooperation was documented by obtaining verbal reports from Genesis partner representatives, reviewing ITS strategic and program plans, and reviewing Genesis system documentation, and reading Genesis meeting minutes. The primary sources of information in each of these categories are listed below.

2.1.1 Genesis Partner Representatives

Ray Starr, as Mn/DOT Genesis program manager, served as the primary source of Genesis information provided by the partners. He provided historical, technical and organizational information regarding the Genesis project. In addition, Gary Hallgren, Mn/DOT Trilogy program manager, and Marilyn Remer, Mn/DOT Travlink program manager, provided related-project and systems-integration information. Finally, Melanie Braun, Guidestar Assistant Marketing Director, provided general information on Guidestar activities that provided a context for understanding Genesis.

2.1.2 ITS Strategic and Program Plans

U. S. DOT, FHWA and Guidestar ITS strategic and program plans that provided a background for understanding Genesis were:

U. S. Department of Transportation (December, 1992), ***ITS [formerly called Intelligent Vehicle Highway Systems] Strategic Plan.***

Federal Highway Administration (November, ***1994), National Program Plan for Intelligent Transportation Systems (ITS).***

Minnesota Department of Transportation (June, ***1994), Minnesota Guidestar Strategic Plan.***

2.1.3 Genesis System Documentation

Various pieces of Genesis system documentation provided specifics about system development, deployment and operation:

BRW, Inc., Battelle Corporation, JHK and Associates, and Barrientos and Associates (March, 1993), ***Genesis Concept Definition and Preliminary Design.***

BRW, Inc. (March, 1994), ***Genesis: A Summary of the Detailed System Design.***

Loral Federal Systems-- Owego (October, 1994), ***Minnesota Guidestar Project Genesis -- Phase I Master Plan.***

Loral Federal Systems-- Owego (December, ***1994), Genesis System Specification for Phase I.***

2.1.4 Genesis Meeting Minutes

Genesis operational test activities were documented by two sets of Genesis meeting minutes: technical team and working committee. The Genesis technical team was composed of representatives of public, private and non-profit entities concerned with defining the Genesis operational concept; defining the Genesis partnership agreement; and providing the initial system design work. This group met over a seventeen-month period from December, 199 1 to May, 1993. The meetings of the Genesis technical team are shown in Table 4.

The Genesis working committee was comprised of representatives of the FHWA, Genesis public- and private-sector partners, partner subcontractors and the independent evaluator. This group met from September, 1995 to March, 1996 to review and discuss the status of the project's development, deployment, testing and evaluation status. The meetings of the Genesis working committee are shown in Table 5.

Table 4. Genesis Technical Team Meetings

DATE	PRIMARY TOPIC(S)
December 13, 1991	Meeting #l: Genesis concept, partnership expectations, critical issues, and roles and responsibilities
February 7,1992	Meeting #2: Project definition and refinement
March 6,1992	Meeting #3: Project definition and refinement (continued)
March 19,1992	Meeting #4: Market research and shared infrastructure issues
April 10, 1992	Meeting #5: Project status, memorandum of understanding, and data infrastructure
May 7,1992	Meeting #.6: Project status and future course of action
June 22,1992	Interim team meeting
July 8, 1992	Interim team meeting
July 9, 1992	Interim team meeting
July 31, 1992	Meeting #7: Task order agreement, project scope
August 21,1992	Meeting #8: Consultant presentation
September 22, 1992	Meeting #9: Consultant kickoff
September 23, 1992	Interim team meeting
September 24, 1992	Meeting #10: Vision recap
October 15, 1992	Meeting #l1: Vision, roles and risks
October 29, 1992	Meeting # 12: Sensors, software and messages
November 19, 1992	Meeting #13: Messages, data collection and computers
December 4, 1992	Meeting #14: Data flow results

Table 4. Genesis Technical Team Meetings (Continued).

DATE	PRIMARY TOPIC(S)
December 17, 1992	Meeting #15: Data flows, risk assessment, family of devices, and communication technologies
January 7, 1993	Meeting #16: Project schedule update, messages and data collection
January 22, 1993	Meeting #17: PCD requirements, evaluation and operational test area
February 8, 1993	Meeting #18: Schedule, evaluation and communications
February 24, 1993	Meeting #19: Project phasing and costs
May 6, 1993	Meeting #20: Project status and direction

2.2 Method for Documenting Institutional Issues and Lessons Learned

Documentation of Genesis institutional issues and lessons learned was accomplished through the use of semi-structured interviews in which a checklist was used to ensure all topics of interest were covered. Genesis partner representatives were asked to complete the checklist in advance of interview sessions. Specifics of checklist and semi-structured interview data collection procedures are discussed in the following sections.

2.2.1 Volpe Center Checklist

The checklist, or Genesis Institutional Issues Survey as it was called, was constructed from a document produced by the Volpe National Transportation Systems Center (Volpe Center) in 1994. This paper, entitled ***Review of the Travlink and Genesis Operational Tests,*** identified "existing (i.e., currently present)" and "possible (i.e., could potentially occur in the future)" institutional issues that applied to both the Genesis and Travlink operational tests as they were being developed by Mn/DOT at the time. The institutional issues identified in the Volpe Center document were listed and topically grouped in the Genesis Institutional Issues Survey in the same fashion that they were identified in the Volpe Center document. The checklist was then distributed to each of the partner representatives to be interviewed. Usually, completion of the Genesis Institutional Issues Survey required 10- 15 minutes and occurred just prior to the conduct of the interview session.

Table 5. Genesis Working Committee Meetings.

DATE	PRIMARY TOPICS
September 14, 1994	Meeting #l : Team instructions, project schedule, TMC operations, and system specification
October 25, 1994	Meeting #2: Travel zones, pager functionality, data collection subsystem (DCS), and traveler information processing subsystem (TIPS)
December 12, 1994	Meeting #3: Project schedule, program risk, system architecture, and pager design
January 18, 1995	Meeting #4: Travlink and Trilogy integration, mapping issues, personal digital assistant (PDA), integration testing, and training
March 28, 1995	Meeting #5: User recruitment, plans for integration and testing
June 8, 1995	Meeting #6: Integration- and field-testing status, training plans, user recruitment and evaluation status, and test support
August 22, 1995	Meeting #7: Operational test status
October 24, 1995	Meeting #8: Evaluation and operational test status
March 19, 1996	Meeting #9: Preliminary evaluation findings, operator feedback

Existing and possible Genesis institutional issues identified in the Volpe Center (1994) report were grouped into ten categories:

1. New Business Relationships-how to establish and conduct ITS business relationships

2. Contracting and Auditing-how to establish public-private ITS partnerships

3. Organizational Coordination-intra- and inter-agency coordination within Mn/DOT required for successful deployment of ITS programs

4. Funding-what it takes to obtain public and private funding for ITS projects

5. Human Resources-how to attract qualified staff to work in ITS and develop appropriate work habits

6. Intellectual Property and Royalty Rights-how to sort out proprietary and ownership rights for ITS partnerships

7. User Perception and Acceptance-how end users of ITS services perceive the usefulness of the product

8. Project Evaluation-how to determine ITS benefits

9. Implementation and Deployment-how to develop economies-of-scale to implement ITS programs most efficiently

10. Standards and Regulation-how to develop appropriate standards and regulations for ITS without restricting development and deployment

2.2.2 Semi-Structured Interviews

The semi-structured interviews were conducted over a five-week period. Interviews were generally conducted in the office of the Genesis partner representative, with one interview conducted over the telephone. A written record of interviewee responses was kept and meetings were not tape recorded.

Interviewees were identified in advance through consultation with Ray Starr, Genesis program manager. The eleven (11) Genesis partner representatives who participated in these interviews are identified in Table 6.

The primary focus of the Genesis institutional issues interviews was to document important Genesis problem areas and any lessons learned that may be derived from them. To do this, each interviewee was asked to discuss the 3-5 most significant, or important, institutional issues that impacted the conduct of the Genesis operational test. As previously indicated, an institutional issue was one that negatively impacted the deployment of the Genesis system and conduct of the operational test. To facilitate continuity with the work conducted by the Volpe Center (1994), each interviewee was told that they were free to discuss any issue previously identified by the Volpe Center or to identify new issues.

Table 6. Partner Representatives Interviewed as Part of the Genesis *Institutional Issues Test.*

NAME	ORGANIZATION	ROLE
Matt Burt	BRW, Inc.	*Senior Transportation Planner* responsible for supporting LFS by serving as meeting coordinator, supervisor of the Genesis HELP desk, and liaison to the Genesis evaluator.
Ron Dahl	Mn/DOT, Metro Division	*Information Systems Manager* responsible for maintenance of TMC computer systems and integration of ITS programs.
Abby Falak	Mn/DOT, Guidestar Division	*Genesis System Administrator* responsible for maintenance of DCS and TIPS, installing Genesis upgrades, and trouble-shooting.
Gary Hallgen	Mn/DOT Metro Division	*Trilogy Project Manager* responsible for that project's development, overseeing DCS operator activities, and Trilogy integration with Genesis.
Ed Heller	JHK and Associates	*Genesis Software Development Manager* responsible for design, development and testing of the DCS.
Dan Huchinson	LFS	*Lead Systems Engineer* responsible for all Genesis hardware and software development.
Chris Kolb	MinnComm Paging, Inc.	*Sales Representative* responsible for coordinating Genesis pager/PDA distribution to users and Genesis distribution via communications provider facilities.
Judy Marks	LFS	*Business Area Manager* responsible for planning, scheduling, and managing her company's involvement in Guidestar ITS initiatives.
Marilyn Remer	Mu/DOT, Guidestar Division	*Travlink Project Manager* responsible for that project's development and Travlink integration with Genesis.

Table 6. Partner Representatives Interviewed as Part of the Genesis *Institutional* Issues *Test* (Continued).

NAME	ORGANIZATION	ROLE
Ray Starr	Mn/DOT, Guidestar Division	*Genesis Project Manager* responsible for planning, scheduling, and managing his organization's involvement in Genesis.
Jim Wright	Mn/DOT, Guidestar Division	*Minnesota Guidestar Director* responsible for guiding Mn/DOT's technical initiatives in the ITS area.

Conduct of Genesis institutional issues interviews was guided by use of a protocol. This protocol consisted of 19 questions divided into four areas:

- Partner-Representative Background
- Organizational Perspective
- Identification of Institutional Issues and Lessons Learned
- Future Solutions

The nineteen (19) questions asked and the reasons for asking them were:

Partner-Renresentative Background

I. What is your position?

Partner representatives were asked to provide their job titles and description of their job responsibilities in order to secure an understanding of their organization perspectives regarding the Genesis project.

2. What is your experience/history with the Genesis project?

Partner representatives were asked to provide their background and history with the Genesis project in order to obtain their perspective regarding the development and deployment of the project.

3. What stage was Genesis in when you first became involved?

Plan
____*Design/Develop*
____*Implement/Test*
____*Evaluate*
____*Commercial Deployment*

Genesis partner representatives were asked to provide this information to supplement the information requested in the previous question.

Organizational Perspective

4. In your own words, what are your organization 's project goals?

Partner representatives were asked to list their organization's Genesis goals in order to determine the degree of overlap with those provided by the other partner representatives.

5. What were the brnefits and risks ofparticipating in this operational test for your organization?

Partner representatives were also asked to provide the perceived benefits and risks of Genesis participation in order to gauge their commitment to the project.

6. Who would you say were the initiators of the project?

This question was asked in order to gain a perspective on what organizations were most responsible for starting Genesis.

7. Who would you consider to be the champions of the project, i.e., who is really pushing for it to succeed?

This question was asked in order to determine what individual(s) were primarily pushing for Genesis to succeed.

8. What do you consider to be the most important measures of success of this project, i.e., how will you know that it has succeeded or met its goals?

Partner representatives were asked to provide their estimates of what it would take for Genesis to be considered a success, or a project that has met its goals and obligations.

9. In your opinion, is the program a success.? If so, what are its positive contributions?

Partner representatives were asked to relate whether, considering the factors discussed by the previous question, they thought that the Genesis project was successful.

Identification of Institutional Issues and Lessons Learned

10. What were the three (3) to five (5) most important institutional and legal impediments that project participants encountered while establishing the Genesis partnership and while deploying its services and products? These issues may or may not

have been previously identified by the Volpe Center (1994) as either existing or potential institutional issues. Please list in order ofpriority.

This question was considered to be the primary question asked by the *Genesis Institutional Issues Test* evaluation. The objective here was to get the partner representative to list, in order of priority, the institutional issues, or problems, that most affected the development, deployment and conduct of the Genesis operational test. The evaluator wrote these issues down and determined the parameters surrounding these issues before the Genesis partner representatives were asked to elaborate on each issue. Most partner representatives had little difficulty in providing the topics to be included on this list and responding to the following questions for each issue that they identified.

10-1. Was this issue previously identified by Volpe Center (1994) as either an existing or potential Genesis institutional issue?

____*Yes*
____*No*

This question was asked in order to determine the degree of overlap with the set of Genesis institutional issues previously identified by Volpe Center (1994).

10-2. What, specifically is the issue?

Partner representatives were asked to state as succinctly as possible the nature of the problems or issues they identified. These issues were addressed in the order that they were originally identified by Question 10.

10-3. When in the project ltfe-cycle did this issue occur?

____*Plan* ____*Design/Develop* ____*Implement/Test* ____*Evaluate* ____*Commercial Deployment*

This question was asked in order to determine the point in the Genesis program where the problem was first encountered.

10-4. How did this issue affect the overallproject?

Partner representatives were asked to describe in as much detail as they felt appropriate how the issues they identified in Question 10 affected the overall project.

10-5. What were the major causes of this issue and how were they overcome?

Partner representatives were asked to identify the cause(s) of each issue identified in Question 10 in order to determine the reason(s) these issues were encountered. As part of this identification process, each partner representative was also asked to state whether these problems were overcome.

Future Solutions

16. What overall lessons were learned in dealing with this issue that can be applied to other deployments of ITS products and services?

After identifying each Genesis institutional issues and the reason(s) for its occurrence, each Genesis partner representative was asked to provide the lessons that could be learned from the situation. To increase the potential significance of these answers, each interviewee was asked to provide the lessons learned in a fashion that could assist other ITS professionals to avoid these types of problems with their projects.

17. Knowing what you know now, if you were assigned to be the project manager in charge of all resources, how would you have done the project manager's job differently if you had to do it from the beginning?

The purpose of this question was to obtain a succinct summary statement from each partner representative as to what were the most important management issues that should have been addressed in the Genesis project and, by extrapolation, to other ITS projects.

18. What do you feel are some of the future applications of Genesis PCD Technology?

Each partner representative was asked to provide some suggestions regarding how he/she felt the Genesis technology could be extended to solve related types of ITS problems.

19. What do you feel are some of the improvements that could be made to Genesis PCD Technology?

Each partner representative was asked to provide some suggestions for how Genesis, as it was implemented, could be improved.

2.3 Method for Documenting Partner Goals and Perceptions of Project Success

Documentation of Genesis partner goals and perceptions of project success occurred as part of the semi-structured interviews conducted with the Genesis partner representatives. Specifically, Questions #5 and #9 addressed these topics.

2.4 Method for Identifying Future Applications for and Improvements fo PCD Technology

Identification of future applications for and improvements to PCD technology occurred as part of the semi-structured interviews conducted with the Genesis partner representatives. Specifically, Questions #18 and #19 addressed these topics.

3. Results

3.1 Methods Used to Promote Institutional Cooperation

Five (5) activities are highlighted as methods used to promote institutional cooperation for the Genesis project. Identification of these methods occurred primarily through review of documentation and discussion with partner representatives, in particular the Genesis Project Manager. Descriptions of these activities are contained in the following sections:

- Mn/DOT Fund Encumbrance Process
- Guidestar Committees
- Genesis Working Committee
- Shared Equipment
- Shared Personnel

3.1.1 Mn/DOT Fund-Encumbrance Process

The organization of Mn/DOT for implementing ITS projects is shown in Figure 3. Understanding of this organizational structure is important because Mn/DOT ITS projects are implemented administratively through two different branches of the department, and procedures for obtaining funds for individual projects involve organizational coordination through the Commissioner's office.

As indicated, Genesis and Travlink are two ITS projects managed by Minnesota Guidestar office, which is a component of the Transportation Research and Investment Management division of Mn/DOT. Transportation Research and Investment Management, in turn is a part of the Modal and Resource Management branch of Mn/DOT. Effectively, Guidestar is the organization within Mn/DOT responsible for ITS research.

The Trilogy project, among other ITS projects, is managed by Mn/DOT's Operations offke. The Operations office is contained in the Metro division of Mn/DOT, the latter of which is a part of the Engineering and Operations branch of the department. The significant aspect of this organizational structure is that Metro's Operations office is actually a line organization, i.e., one responsible for providing transportation-related services to the general public. Mn/DOT's TMC, for instance, disseminates traffic information via radio and CMS broadcasts under the auspices of the Operations office. As a result, this organization considers itself to be a service-provider as opposed to a research branch of Mn/DOT, although Metro's Operations office does research to determine the effectiveness of its programs.

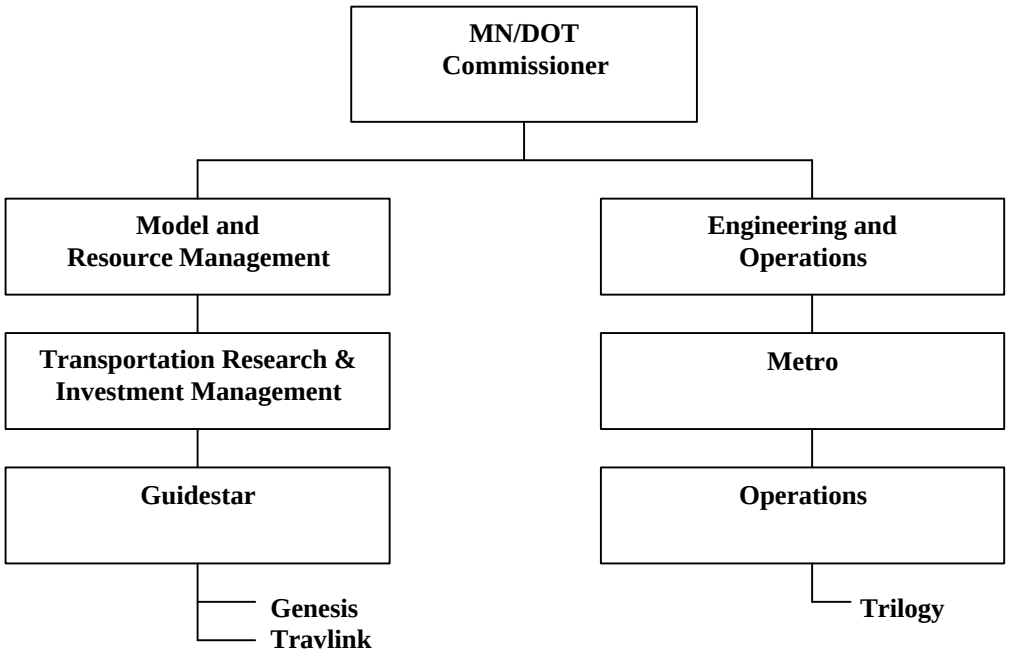

Figure 3. Mn/DOT Organization.

Mn/DOT funds for implementing ITS projects, including those received in block grants from the FHWA, are administered through the Commissioner's office. ITS funds are kept in an account where organizations designated as being responsible for ITS projects may "encumber" the funds for their project, i.e., earmark it for spending. After proper approval is obtained from the Commissioner for actually spending money on an ITS project, Mn/DOT organizations may withdraw the money for this purpose.

3.1.2 Guidestar Committees

The organization of the Guidestar office of Mn/DOT is shown in Figure 4. This organizational structure promotes Genesis institutional cooperation because the Guidestar charter provides for a set of hierarchical committees to manage and coordinate all ITS activities, including the Genesis project, to ensure the overall success of Mn/DOT's objectives in this area.

The *planning and program management committee,* meets once a year to make recommendations to the Commissioner regarding the allocation of ITS funds received from the FHWA. These funds may be encumbered for use, pending Commissioner approval, by any organization within Mn/DOT that the committee has determined is qualified to perform this work

The *executive committee* is composed of Guidestar senior managers and chief administrative officers. Its purpose is to ensure that the Guidestar program stays focused on its goals and objectives, supports the program's overall success, and makes appropriate strategic policy decisions. It meets four times a year.

The *steering committee* of Guidestar is responsible for directing Guidestar's day-to-day management activities, developing and maintaining the program's strategic plan, specifying project funding requirements, and for assisting with the coordination of specific projects, such as Genesis. This committee is comprised of representatives from federal, state and local government agencies and meets twice a month.

Guidestar *working committees* are responsible to the Guidestar steering committee for the coordination, implementation and management of individual projects. Specifically, working committees prepare project work plans, coordinate and manage project implementation activities, report on the status of individual projects, and prepare appropriate recommendations. For Genesis, the working committee met about every six weeks and was comprised of representatives of the FHWA, the partners, partner subcontractors, and the independent evaluator.

3.1.3 Genesis Working Committee

Organization of the Genesis working committee is shown in Figure 5. Understanding the structure of this committee is important because the relationships among the entities shown in the figure were major factors that contributed to the dynamics of the Genesis operational test.

The Guidestar office of Mn/DOT served as the Genesis project manager and received funding and input from the FHWA while it simultaneously received in-kind contributions from and paid LFS to be the primary developer of the project, the latter of which LFS accomplished with the assistance of three subcontractors. All three organizations-- FHWA, Mn/DOT and LFS-- were the "partners" in the Genesis operational test.

Two other organizations, SAIC and UMHFRL, were the "independent evaluators" of the Genesis project. These organizations worked for Mn/DOT and received their tasking directly from the Guidestar office. They had an independent relationship between each other, but retained an overall responsibility to each other to provide a fair and impartial, yet coordinated, evaluation of the Genesis system.

These two broad classes of Genesis participants, partners and evaluators, were tied together primarily through the Genesis working committee. This was the coordinating body of Genesis and it was composed of representatives of the Genesis partners and independent evaluators. The Genesis working committee met about every six weeks and monitored the development and deployment of Genesis, as well as the conduct of the independent evaluation. The Genesis working committee was also responsible for

addressing any problems that may arise during the development and deployment of Genesis, and for providing suggested solutions to the Genesis project manager for consideration.

Responsibilities of all Genesis working committee participants, including subcontractors, are shown in Table 7.

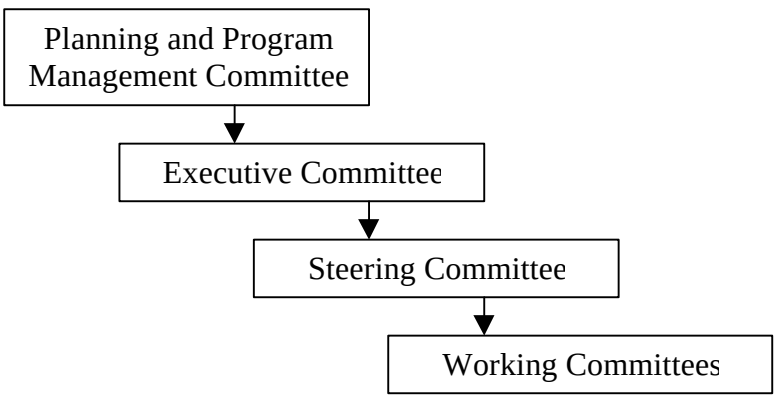

Figure 4. Guidestar Committees.

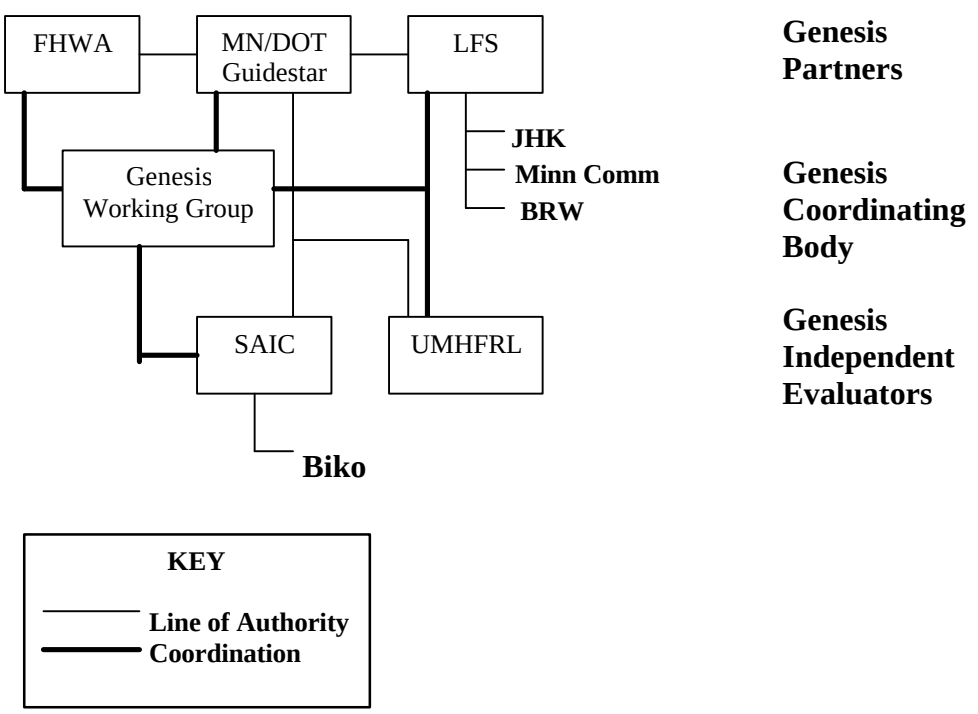

Figure 5. Genesis Working Committee Structure.

Table 7. Responsibilities of Genesis Working Committee Participants.

PARTICIPANT	DESCRIPTION OF RESPONSIBILITY
Biko Associates	Subcontractor to SAIC. Responsible for providing transportation planning expertise to the Genesis evaluation, hiring all research technicians, and for coordinating focus group activities.
BRW, Inc.	Sub-contractor to LFS. Responsible for providing Genesis Help Desk services to Genesis users and support services (meeting space, minutes) to the Genesis working committee.
FHWA	Federal Highway Administration, specifically, FHWA division, region and national personnel who guide ITS operational tests. Responsible for providing technical oversight to the Genesis project.
JHK and Associates	Sub-contractor to LFS. Responsible for developing DCS user interface and database capabilities.
LFS	Loral Federal Systems-- Owego, the Genesis private-sector partner. Responsible for developing the Genesis system, which primarily included the TIPS, DCS and PCD components. Also responsible for overseeing the performance of three subcontractors: MinnComm Paging, JHK and Associates and BRW, Inc.
MinnComm Paging	Sub-contractor to LFS. Responsible for providing the Genesis CS and all pagers and PDAs for use in the Genesis operational test.
Mn/DOT	Minnesota Department of Transportation, the Genesis public-sector partner. Responsible for overseeing the design, development, deployment of the Genesis system; conduct of the Genesis operational test; and monitoring the Genesis independent evaluation.

Table 7. Responsibilities of Genesis Working Committee Participants (Continued).

PARTICIPANT	DESCRIPTION OF RESPONSIBILITY‘
Operational Test Staff	Personnel responsible for operating and/or maintaining the Genesis system. This included TMC staff (e.g., System Administrator and DCS Operators), communications-provider staff, other Mn/DOT staff and ccntractor personnel, but not evaluator personnel or partner representatives.
SAIC	Science Applications International Corporation, the primary Genesis independent evaluator. Responsible for the design and production of all Genesis evaluation test plans, recruitment of Genesis users, and conduct of the Genesis independent evaluation.
UMHFRL	University of Minnesota Human Factors Research Laboratory, Genesis independent evaluator. Responsible for conducting the human-factors portion of the Genesis independent evaluation.

3.1.4 Shared Equipment

The Genesis project promoted institutional cooperation by sharing equipment resources with other ITS projects whenever possible. In particular, both the Genesis and Trilogy projects used the same DCS workstation to compose traffic messages for its users to reduce space requirements within the TMC and provide for more efficient data dissemination.

Common use of the DCS workstation for Trilogy and Genesis required considerable coordination between project management. In particular, software algorithms for determining incident locations were discovered to be different for the two projects. This occurrence stipulated in the Spring of 1995 that members of the two development teams work closely together to determine how incident locations needed to be differentially formatted so as to best facilitate message transmission for each project.

One result of Genesis/Trilogy coordination regarding equipment usage was a better understanding of the information-processing requirements of the two projects. This knowledge will be helpful in the future as Guidestar moves toward a broader-scale, traffic- information dissemination project for full-scale deployment. Another outcome of Genesis/Trilogy equipment coordination was a better understanding of the integration testing requirements of each system. Finally, this coordination required the managers of the two projects to communicate with each other regarding the development status of

each other's projects, an activity which helped both to better understand the overall context in which to place his project.

3.1.5 Shared Personnel

The Genesis project promoted institutional cooperation by sharing personnel resources. In particular, the project agreed to share the expenses of a System Administrator and DCS Operators with the Trilogy project to save money by coordinating spending. Specifically, Genesis paid for the Genesis/Trilogy System Administrator, while Trilogy paid for the DCS Operators.

One outcome of Genesis and Trilogy sharing personnel resources was saved expenses. Another was improved technical understanding of how each other's projects operated which contributed to more effective coordination when problems in either project developed needed to be resolved. A third outcome was improved communication between the two project managers.

3.2 Institutional Issues and Lessons Learned

The documentation of Genesis institutional issues and lessons learned was the main focus of the Genesis *Institutional Issues Test* evaluation. A checklist and semi-structured interviews were used to determine the existence of institutional issues, while semi-structured interviews were used to derive Genesis lessons learned.

3.2.1 Genesis Institutional Issues

Genesis institutional issues were identified by asking partner representatives to engage in two activities:

- Score existing and potential Genesis institutional issues that were identified in the Volpe Center (1994) report for their actual impact upon Genesis. The list of these institutional issues included those applicable to both Travlink and Genesis since the integration of both of these systems was done together.
- Discuss the three to five most important Genesis institutional issues, either previously identified by Volpe Center (1994), or new.

The results of these two activities are discussed in the following sections:

- Impact of Volpe Center-Identified Institutional Issues
- Discussion of Most Important Institutional Issues

Impact of Volpe Center-Identified Institutional Issues

Genesis and Travlink institutional issues that were previously identified by Volpe Center (1994) can be divided into existing and possible categories. *Existing* institutional issues were those that were deemed by Volpe Center as currently impacting either the Genesis or Travlink operational tests, while *possible* issues were those that could possibly impact the two operational tests. Genesis partner representatives were asked to score these two sets of issues as part of the *Genesis Institutional Issues Test* in order to relate the current evaluation to this previous work and to stimulate awareness of the types of issues that could be discussed in the discussion portion of the semi-structured interview.

The top ten (10) Volpe Center (1994)-identified *existing* institutional issues that impacted the Genesis operational test are shown in Table 8.

Table 8. Top Ten Vople-Identified Existing Genesis Institutional Issues.

ISSUE	TOPICAL CATEGORY
1. Funding limitations can negatively impact the scope and level of functionality of an operational test.	FUNDING
2. Two divisions within Mn/DOT were pursuing ITS activities simultaneously.	ORGANIZATIONAL COORDINATION
3. The ITS program lacks standards.	STANDARDS AND REGULATION
4. Public-private partnerships require management styles and organizational structures not found in traditional government-contractor relationships.	NEW BUSINESS RELATIONSHIPS
5. Operations personnel within Mn/DOT view ITS activities as add-on functions.	ORGANIZATIONAL COORDINATION
6. Judging the success of ITS operational tests is difficult because benefits are hard to quantify.	PROJECT EVALUATION
7. Projects with multiple partners are difficult to manage.	NEW BUSINESS RELATIONSHIPS
8. Implementation of operational tests on a small-scale complicates standardization.	IMPLEMENTATION AND DEPLOYMENT
9. Participation in operational tests places a strain on the staffs of the public-sector partners.	HUMAN RESOURCES
10. Private partners were unwilling to share proprietary information.	INTELLECTUAL PROPERTY AND ROYALTY RIGHTS

The top ten Volpe Center (1994)-identified *existing* institutional issues that were rated as impacting the Genesis operational test by representatives of the partners were distributed widely across topical categories: two each were from the organizational coordination and new business relationships categories, while six other categories provided one top-ten issue. The categorization of the top ten existing Volpe Center (1994)-identified institutional issues that impacted the Genesis operational test is shown below:

CATEGORY	NUMBER
Organizational Coordination	2
New Business Relationships	2
Funding	1
Standards and Regulation	1
Project Evaluation	1
Implementation and Deployment	1
Human Resources	1
Intellectual and Property Rights	1
Total:	10

The top ten (10) Volpe Center (1994)-identified *possible* issues that impacted the Genesis operational test are shown in Table 9.

The top ten Volpe Center (1994)-identified *possible* institutional issues that were rated as impacting the Genesis operational test by representatives of the partners were not as widely distributed across topical categories as were the existing institutional issues: the funding and user perception and acceptance categories garnered three (3) top-ten positions each, while the implementation and deployment category provided two top-ten issues. Only two other categories provided one topic each. The categorization of the top ten possible Volpe Center (1994)-identified possible institutional issues is shown below:

CATEGORY	NUMBER
Funding	3
User Perception and Acceptance	3
Implementation and Deployment	2
Organization Coordination	1
Contracting and auditing	1
Total:	10

Table 9. Top Ten Volpe Center-Identified *Possible* Genesis Institutional Issues.

ISSUE	TOPICAL CATEGORY
1. Funds have not been committed for implementation of products and services after the test is complete.	FUNDING
2, ITS success may be limited because the infrastructure required for deployment of ITS technologies and services is not in place.	IMPLEMENTATION AND DEPLOYMENT
3. Funding for ITS operational tests is limited and not guaranteed.	FUNDING
4. The ability to update technology as projects proceed is especially difficult.	IMPLEMENTATION AND DEPLOYMENT
5. Public perception diminishes the ability of government agencies to take risks.	USER PERCEPTION AND ACCEPTANCE
6. Changes in Mn/DOT executives could affect the ITS program.	ORGANIZATIONAL COORDINATION
7. Partners may not make a commitment if continued and adequate funding of the project is not guaranteed.	FUNDING
8. Potential users may not accept and participate in ITS activities.	USER PERCEPTION AND ACCEPTANCE
8. Partners may forget to make customer satisfaction a high priority.	USER PERCEPTION AND ACCEPTANCE
10. Contracts that lack explicit dispute-resolution terms could be a problem in the event that a partner is non-compliant.	CONTRACTING AND AUDITING

Table 10 shows the top twenty (20) Volpe Center (1994)-identified institutional issues, either existing or possible, that were rated by the Genesis partner representatives as having impacted the Genesis operational test. This list was integrated from the lists for existing and possible Genesis institutional issues.

Table 10. Integrated List of Top-Twenty Volpe Center-Identified Genesis Institutional Issues.

ISSUE	TOPICAL CATEGORY
1. Funds have not been committed for implementation of products and services after the test is complete.	FUNDING (Possible)
2. Funding limitations can negatively impact the scope and level of functionality of an operational test.	FUNDING (Existing)
3. ITS success may be limited because the infrastructure required for deployment of ITS technologies and services is not in place.	IMPLEMENTATION AND DEPLOYMENT (Possible)
4. Two divisions within Mn/DOT were pursuing ITS activities simultaneously.	ORGANIZATIONAL COORDINATION (Existing)
5. Funding for ITS operational tests is limited and not guaranteed.	FUNDING (Possible)
6. The ITS program lacks standards.	STANDARDS AND REGULATIONS (Existing)
7. Public-private partnerships require management styles and organizational structures not found in traditional government-contractor relationships.	NEW BUSINESS RELATIONSHIPS (Existing)
7 (8). Operations personnel within Mn/DOT view ITS activities as add-on functions.	ORGANIZATIONAL COORDINATION (Existing)
7 (9). Judging the success of ITS operational tests is difficult because benefits are hard to quantify.	PROJECT EVALUATION (Existing)
7 (10). The ability to update technology as projects proceed is especially difficult.	IMPLEMENTATION AND DEPLOYMENT (Possible)

Table 10. Integrated List of Top-Twenty Volpe Center-Identified Genesis Institutional Issues (Continued).

ISSUE	TOPICAL CATEGORY
11. Projects with multiple partners are difficult to manage.	NEW BUSINESS RELATIONSHIPS (Existing)
12. Implementation of operational tests on a small-scale complicates standardization.	IMPLEMENTATION AND DEPLOYMENT (Existing)
13. Participation in operational tests places a strain on the staffs of the public-sector partners.	HUMAN RESOURCES (Existing)
13 (14). Public perception diminishes the ability of government agencies to take risks.	USER PERCEPTION AND ACCEPTANCE (Possible)
15. Private partners were unwilling to share proprietary information.	INTELLECTUAL PROPERTY AND ROYALTY RIGHTS (Existing)
16. Coordination and communication between the Federal Transit Administration and other partners needs improvement.	ORGANIZATIONAL COORDINATION (Existing)
16 (17). Transit agencies and Mn/DOT have different priorities.	ORGANIZATIONAL COORDINATION (Existing)
16 (18). Changes in Mn/DOT executives could affect the ITS program.	ORGANIZATIONAL COORDINATION (Possible)
16. (19). Federal funds for [ITS] projects are not released as quickly as expected.	FUNDING (Existing)
16 (20). Partners may not make a commitment if continued and adequate funding of the project is not guaranteed.	FUNDING (Possible)

When integrated, the top ten *existing* and *possible* Volpe Center (1994)-identified institutional issues that were rated as impacting the Genesis operational test by representatives of the Genesis partners congregated in two major categories: funding and organizational coordination. Both of these categories provided live institutional issues

that were rated among the top twenty (20), or most significant, institutional issues that affected the Genesis operational test. After this, the implementation and deployment category provided three topics and new business relationships category provided two top-twenty issues, while five categories provided one each. The categorization of the top twenty existing and possible Volpe Center (1994)-identified institutional issues that impacted the Genesis operational test is shown below:

CATEGORY	NUMBER
Funding	5
Organizational Coordination	5
Implementation and Deployment	3
New Business Relationships	2
Standards and Regulations	1
Project Evaluation	1
Human Resources	1
User Perception and Acceptance	1
Intellectual Property and Royalty Rights	1
Total:	**20**

Discussion of Most Important Institutional Issues

Genesis partner representatives were asked to describe the three to five most important, or significant, institutional issues that impacted the Genesis operational test. This was done by asking the six questions in the Genesis Institutional Issues Interview Protocol that addressed the parameters surrounding each institutional issue and taking written notes that reflected as accurately as possible each respondent's answer.

A Genesis institutional issue was one that either negatively affected the development of the Genesis system or implementation of the operational test, or had the potential to negatively affect the test if it were not controlled. Interviewees were instructed that the issues they discussed could be taken from the Volpe Center (1994) list or, if they wished, newly identified. Finally, each Genesis institutional issue was discussed in the order in which it was presented by the interviewees.

Table 11 shows the 42 topics [minimum possible = 33, maximum possible = 55, mean = 3.8] that the eleven (11) Institutional Issues Test interviewees stated as being the most important Genesis institutional issues. Type shows whether the issue was an existing or possible institutional issue previously identified by the Volpe Center (1994), or whether the issue was newly identified by the interviewees. Number shows how many of the interviewees identified this same topic as being important.

Table 11. Genesis Institutional Issues That Were Discussed.

ISSUE	TYPE	NUMBER
NEW BUSINESS RELATIONSHIPS --- None ---	---	---
CONTRACTING AND AUDITING		
1. Viability of Genesis partners needs to be determined in advance	**New**	1
2. Strategic negotiation process for ITS projects is difficult	**New**	1
3. Current contracting procedures are not suited to the requirements of ITS projects	Existing	1
4. Developing memoranda of understanding with partners has been difficult	Existing	
5. Projects with multiple partners are difficult to manage	Existing	1
ORGANIZATIONAL COORDINATION		
1. Metro and Guidestar divisions of Mn/DOT need to work more effectively together	**New**	3
2. A gap in expectations for ITS projects exists between regional and national FHWA offices	**New**	1
3. Operations personnel with Mn/DOT view ITS activities as add-on functions	Existing	4
4. Changes in Mn/DOT executives could affect the ITS program	Possible	1
FUNDING		
1. Genesis funding was excessive for amount of demonstrated return	**New**	1
2. Federal funds for [ITS] projects are not released as quickly as possible	Existing	1
3. Funding limitations can negatively impact the scope and level of functionality of an operational test	Existing	5
4. Funds have not been committed for implementation of products and services after the test is complete	Possible	2
HUMAN RESOURCES		
1. Staffing continuity is not a big concern among partners	**New**	1
INTELLECTUAL PROPERTY AND ROYALTY RIGHTS		
1. Software rights and ownership not clear	**New**	1

Table 11. Genesis Institutional Issues That Were Discussed (Continued)

ISSUE	TYPE	NUMBER
USER PERCEPTION AND ACCEPTANCE		
1. Pager turn-on problems for existing users affected acceptability	**New**	1
2. Partners may forget to make customer satisfaction a high priority	Possible	2
PROJECT EVALUATION		
1. Judging the success of ITS operational tests is difficult because benefits are hard to quantify	Existing	1
IMPLEMENTATION AND DEPLOYMENT		
1. Software changes caused development delays	**New**	1
2. Feasibility of PDA operation should have been determined in advance	**New**	2
3. performance requirements not specified	**New**	1
4. Integration of related projects not a high priority	**New**	2
5. Sustainability of Genesis is questionable	**New**	1
6. Better technical support needed from development contractor	**New**	2
7. Development process not clearly specified	**New**	2
8. Implementation of operational tests on a small-scale complicates standardization	Existing	1
9. ITS success may be limited because the infrastructure required for deployment of ITS technologies and services is not in place	Possible	1
STANDARDS AND REGULATION		
--- None ---	---	---
	New = 15 Existing = 8 Possible = 4 **Total = 27**	42

Twenty-seven Genesis institutional issues were discussed by partner representatives. Twelve, or 44%, of the 27 issues discussed were identified as being one of the existing or possible Genesis institutional issues identified by the Volpe Center (1994). Fifteen, or 56%, were newly identified issues. Thus, of the 62 (44 existing, 18 possible) issues previously identified by Volpe Center (1994), only 19% (8 existing, 4 possible) were selected to be discussed by the Genesis partner representatives.

The first thing noticeable about the list of most important Genesis institutional issues is that the majority (i.e., 15) were newly identified. This means that development and deployment of the Genesis system and conduct of the corresponding operational test

resulted in making apparent a number of institutional issues that were previously un-identified. Perhaps this is to be expected due to the extent of the experience acquired since the Volpe Center (1994) interviews.

Nine Genesis institutional issues were discussed by two or more partner representatives. A synopsis of the comments made for each of these issues is provided in the following sections.

FUNDING LIMITATIONS CAN NEGATIVELY IMPACT THE SCOPE AND LEVEL OF FUNCTIONALITY OF AN OPERATIONAL TEST [Category: FUNDING]

Five (5) Genesis partner representatives indicated that funding limitations impacted the scope and functionality of the Genesis operational test. In particular, planned Genesis phases 2 and 3, that would have added an interactive (i.e., two-way) communications capability, were dropped when the expected amount of FHWA funding for Guidestar ITS programs was not forthcoming. This caused the Guidestar executive committee to cancel phases 2 and 3 of the Genesis operational test and change the conceptual scope of the Genesis operational test in mid-stream. Phase 1 of the test now included 50 one-way PDAs along with 400 pagers. In addition, cancellation of phases 2 and 3 hindered deployment of phase 1 by requiring software-development resources to be used for the PDA and causing emphasis in phase 1 to be switched from a pilot test to that of a full-blown evaluation. Finally, it was feared that the rushed PDA development process may have backfired in that user perceptions of the (incomplete) PDA functionality might not have been as positive as it might have been if a fully-functional PDA had been fielded.

Reasons given for causing this problem were that: (1) the FHWA was "micro-managing" the project and withdrew funding because of what the FHWA perceived to be technological limitations (e.g., PDA usability, travel-time algorithms) of the phase 2 and 3 technologies, (2) the FHWA did not want to fund the additional sensors that were proposed for phases 2 and 3, and (3) that competing program objectives within Mn/DOT's Guidestar division drew funding away from Genesis.

OPERATIONS PERSONNEL WITHIN MN/DOT VIEW ITS ACTIVITIES AS ADD-ON FUNCTIONS [Category: ORGANIZATIONAL COORDINATION]

Four (4) Genesis partner representatives remarked that it appeared Mn/DOT personnel working at the Traffic Management Center (TMC) viewed Genesis as excess, or extra, workload rather than view it as part of their service mission. The impact of this view, it was said, caused delays during integration testing, affected staff moral in that workers for the Genesis private and public partners felt that they were causing extra workload for TMC operations personnel and were not appreciated for doing so, and affected the perceptions of Genesis' usefulness among TMC workers.

The reasons given for causing this problem were that: (1) a better "buy in" from TMC personnel, especially management, should have been obtained from the start; (2) TMC

management was more interested in supporting another project (i.e., Trilogy) over Genesis; (3) there was inadequate planning for the obvious integration problems that would have to be addressed among Genesis, Trilogy and Travlinlc; and (4) there was no study of the impact that Genesis would have upon the daily operations of the TMC,

METRO AND GUIDESTAR DIVISIONS OF MN/DOT NEED TO WORK MORE EFFECTIVELY TOGETHER [Caregory: ORGANIZATIONAL COORDINATION]

Three (3) Genesis partner representatives suggested that Mn/DOT's Metro and Guidestar divisions needed to learn how to work more effectively together in deploying ITS projects. The primary concern in this area was communication; in particular, different lines of reporting authority affecting key project personnel made if difficult for everyone to work together as a team. In addition, perceptions of Mn/DOT's Guidestar division as being an "ivory tower" research division appeared to influence responsiveness on Metro's part. Finally, different perspectives regarding Genesis' development process (e.g., should separate or integrated workstations be built) were not adequately understood or appreciated by either party until delays in the development process appeared.

The reported causes of Metro's and Guidestar's difficulties in working together were many: (1) organizational (e.g., Genesis and Trilogy were in different reporting hierarchies), (2) technical (e.g., which project, Genesis or Trilogy, was going to drive the technological scheme for disseminating traffic information?), (3) Guidestar and Metro personnel working the project were separated (i.e., they worked in different rooms), (4) different perceptions of problems among affected personnel (e.g., the priority of user interface issues with the DCS workstation versus database query problems), and (5) different responses to crises among personnel (e.g., over-reaction to system crashes and other problems).

FUNDS HAVE NOT BEEN COMMITTED FOR IMPLEMENTATION OF PRODUCTS AND SERVICES AFTER THE TEST IS COMPLETE [Category: FUNDING]

Two (2) Genesis partner representatives indicated that they were very concerned about the ITS funding situation beyond the current operational tests around the country. That is, if funding stops or slows precipitously, the ITS momentum might grind to a halt. Related to this issue, these two individuals were concerned about whether there will be sufficient funds to pay for operators, software maintenance/improvement personnel, and support personnel beyond the end of the test; if not, then there is even less of a chance that ITS will become institutionalized within Mn/DOT's operations sector.

There were two primary causes for the above problem. First, the current Federal political climate calling for a balanced budget makes it hard for the FHWA to commit to long-term operating budgets for ITS projects anywhere in the country, let alone Mn/DOT's projects. Secondly, it was suggested that because the Guidestar office did not select an overall systems integrator from the start, Mn/DOT effectively hamstrung its ITS program

by allowing each program to fend for itself in the operations-budget area. Although Guidestar's current Polaris project is now seeking a unified architecture for all of Mn/DOT's ITS programs, it remains to be seen whether an integrated system would have been a better initial sell to Mn/DOT's operating divisions and, thus, more effective in garnering additional ITS funds.

PARTNERS MAY FORGET TO MAKE CUSTOMER SATISFACTION A HIGH PRIORITY [Category: USER PERCEPTION AND ACCEPTANCE]

Two (2) Genesis partner representatives, both from the public sector, indicated that they believed that private partner personnel put a low priority on customer satisfaction. In particular, both were concerned about the usability and performance of the DCS software that was placed in the TMC, and the lack of responsiveness that was exhibited in solving some of the system problems. In particular, slow query or system response times affected the operator's capability to put timely messages out to users, and attempts to update Genesis software often caused system crashes that affected other projects (e.g., Trilogy), sometimes for days. In addition, complaints about the usability of the DCS user interface were common, and often it was difficult to get a timely response to fixing the problems. The upshot, for one partner representative, was that these performance problems with DCS affected the institutional relationships among the two primary Mn/DOT organizations involved, Guidestar and Operations.

Reasons provided for these problems were that: (1) TMC operations personnel, or the users of DCS, were not consulted from the beginning regarding the adequacy of the user interface; (2) DCS software was unstable (i.e., not fully tested) before it was installed in the TMC; (3) troubleshooting methods for solving DCS problems were cumbersome and slow due to the fact that too many people were involved in the problem-solving chain; and (4) the distant locations of some of the critical technical people required to solve DCS problems sometimes resulted in troubleshooting requests going unmet.

FEASIBILITY OF PDA OPERATION SHOULD HAVE BEEN DETERMINED IN ADVANCE [Category: IMPLEMENTATION AND DEPLOYMENT]

Two (2) Genesis partner representatives, both from the private sector, were critical of the decision to proceed with PDA deployment during the Genesis operational test because of what they felt was an inadequate technical understanding of the feasibility of combining the Apple Newton with the Motorola Newscard. Basically, as it turned out, interface problems between the two devices slowed development and resulted in a system that was not well accepted by users, primarily due to some basic incompatibilities between the two devices.

The reason given for this problem was that Mn/DOT was too aggressive in trying to use new technology, especially without having done feasibility studies regarding the compatibility of the Apple Newton with the Motorola Newscard in advance. Compounding this situation, one interviewee indicated, was Mn/DOT's decision to push

for *full* deployment of the PDAs in the Genesis operational test after it was determined that phases 2 and 3 of the project were canceled.

INTEGRATION OF RELATED PROJECTS NOT A HIGH PRIORITY [Category: IMPLEMENATION AND DEPLOYMENT]

Two (2) Genesis partner representatives indicated that Genesis integration testing should have proceeded more smoothly. In particular, one thought that the development schedules for the different projects that needed to be integrated with Genesis (i.e., Travlink and Trilogy) were not in sync with Genesis' development schedule. This caused delays for the other projects because their people either needed to assist with integration testing on the Genesis' schedule, or were required to solve problems that occurred due to the integration of Genesis with their system. In addition, the other partner representative felt that the procedures used for Genesis integration testing were inadequate, especially for real-time updates to the system. For example, the Genesis system crashed at least twice due to software updates that were supposed to occur with little or no system impact. This caused problems for Genesis' users (e.g., public), it was stated, in addition to making life difficult for system operators.

The reasons provided for this problem were: (1) inadequate project scheduling; (2) poor communications among some of the participants; (3) development delays which caused delays for other projects; (4) changes in system requirements; and (5) incomplete, or unclear, software update and integration testing procedures. One major reason for the software update problems, it was argued, was that new software patches were inadequately tested by the developer before they were sent to Mn/DOT to be installed in the TMC. Further, this problem was exacerbated because the developer was not able to test on a "live" system like the one operating in the TMC. This caused the developer to miss, or simply not understand, many of the problems encountered by the Genesis system administrative staff.

BETTER TECHNICAL SUPPORT IS NEEDED FROM DEVELOPMENT CONTRACTOR [Category: IMPLEMENTATION AND DEPLOYMENT]

Two (2) Genesis partner representatives, one private and one public, agreed that better technical support for Genesis was needed from the development contractor. Basically, the problem appeared to be delays in getting technical assistance for system problems (e.g., crashes, performance degradation) that occurred during some software upgrades, during peak operating conditions, or during evening operations. Because the people available for solving these problems were often unavailable because of difficulties in reaching them (e.g., responsible person, time-zone differences), it was felt that recovery time from these problems was severely delayed. For example, a crash which occurred one evening would not get solved until the middle of the next day, after an opportunity to serve the public during an AM rush hour had passed. As a result, these delays in service caused much anxiety among TMC operations and Genesis system administrator

personnel, and hindered working relations among the partners by causing the public sector partner to balk at installing upgrades due to fear of lack of technical support.

The reasons provided for this difficulty were: (1) contractor personnel responsible for solving problems were hard to reach because they were subcontractors and protocol required that prime contractor personnel needed to be included in discussions of all problems; (2) contractor personnel were often unavailable because of time-zone differences or extended communications channels; (3) a technical-support "hot-line" was not provided; and (4) corporate decision-making processes were often slow because of the need to determine whether the company was responsible for correcting a technical-support request or whether the request was beyond scope of the contract and required additional funding to solve.

DEVELOPMENT PROCESS NOT CLEARLY SPECIFIED [Category: IMPLEMENTATION AND DEPLOYMENT]

Two (2) Genesis partner representatives, one each from the private and public sectors, indicated that the Genesis development process was unclear. In particular, it was felt that Mn/DOT's entry into the ITS computer-systems development was handicapped by a lack of previous management experience in this area. This included such things as knowing what types of engineering was best needed to solve specific problems, how to write system requirements, how validation testing was conducted, how equipment procurements were best handled, and how the evaluation process fit into the whole picture. In essence, it was suggested that it was unclear whether Genesis was a research and development contract, which would make provisions for handling system requirements changes, or a development contract which simply specified that the system needed to be built to documented specifications. For example, Mn/DOT's request to change Genesis's database software from DBII to Oracle severely impacted development, as did numerous requests to change the DCS user interface. Evidently, an underlying distinction that appeared to be missing was what was the difference between a software repair and a software enhancement or upgrade. This lack of understanding, unfortunately, was deemed the primary cause of Genesis' system development delays and operational problems.

The reasons, or causes, provided for the lack of clarity regarding Genesis' development process were primarily attributed to Mn/DOT. This included: (1) a lack of previous system development experience; and (2) a basic misunderstanding about the-- sometimes severe-- impacts of changing system requirements once development has started. Nonetheless, both interviewees felt that a lot was learned during Genesis' implementation that should enable the development of future projects to proceed more smoothly.

3.2.2 Genesis Lessons Learned

Lessons learned for each of the top-ten most important Genesis institutional issues identified by the *Genesis Institutional Issues Test* evaluation are presented in the following sections.

Funding Limitations Can Negatively Impact The Scone and Level Of Functionality Of An Operational Test

- Adequate feasibility scoping of ITS projects is needed.
- There is a need to continually "sell" an ITS project until all funding is received.
- There is a need to get as much funding for a project in advance as possible.
- There is a need to educate more people on the overall development process for a project.

Operations Personnel Within Mn/DOT View ITS Activities As Add-On Functions

- Commitment, or buy-in, for the project should have been obtained from the TMC's management and operations personnel from the start.
- Better planning, especially for the overall systems architecture and integration testing (the latter of which occurs on-site), should have been conducted in advance of the project.
- TMC operations personnel should have been consulted throughout the systems development process for their inputs rather than when problems (e.g., excessive time required for integration testing) occurred.

Metro And Guidestar Divisions Of Mn/Dot Need To Work More Effectively Together

- Shared vision of project needed.
- Better communications channels needed:
- --Who determines extent of problem?
- --Who calls who when a problem occurs?
- --Who makes the final decision regarding system-integration problems?
- Schedule coordination needed.
- Shared commitment needed.

Federal Funds For [ITS] Projects Are Not Released As Quickly As Possible

- State agencies can't assume FHWA funding will always be there and, as a result, state directors of ITS projects should probably seek increased monetary contributions from their private partners.
- Expectations regarding the results of ITS projects should probably be reduced; development schedules should be more realistic, and more careful review of projects is probably needed.

Funds Have Not Been Committed For Implementation Of Products And Services After The Test Is Complete

- Private sector should be expected to pick up more of the cost of building traveler information systems.
- Mn/DOT should hire one company to do the overall system architecture instead of developing multiple projects independently, with multiple companies.

Partners May Forget To Make Customer Satisfaction A High Priority

- Operations personnel, especially those expected to use and maintain an ITS system, should be involved from the start regarding the usability of the system.
- ITS software specifications should include quality statements (e.g., availability requirements, query response times) to avoid a broad class of usability problems (e.g., downed systems, slow query response times) that can hamper operations.

Feasibility Of PDA Operation Should Have Been Determined In Advance

- Feasibility of combining new technology needs to be determined in advance of a project, e.g., PDA and pager card compatibility.
- Analyses which more clearly specified the operational requirements of Genesis should have been conducted before the system requirements were written.

Integration Of Related Projects Not A High Priority

- Integration-testing schedules for different ITS systems should be coordinated.
- Integration testing procedures should minimize impact upon more mature system.

- Live-trial integration-testing procedures should be written to facilitate field personnel effectiveness.
- Development contractor needs to thoroughly test all integration testing procedures before they are delivered to the customer.

Better Technical Support Is Needed From Development Contractor

- Lines of communication with who's best to solve particular types of problems are needed.
- All-hours technical support "hot line" is needed.
- Technical support requirements (e.g., after-hours support) needs to be better specified in ITS contracts.
- Need to better understand each partners organizational culture so that the 'process" of getting to the proper sources of information is recognized.

Development Process Not Clearly Specified

- Project's development process should be documented and understood by all participants before development is initiated.
- One contractor should be given the job of overseeing complete ITS system design and development instead of just being given one small part to build.
- Perhaps all operational tests should be viewed as research and development efforts and funded accordingly (i.e., money should be set aside for system changes/upgrades that are discovered during the construction of the system).

3.3 Partner Goals and Perceptions of Project Success

All partner representatives were asked to provide their organization's goals for participating in the Genesis operational test. A summary of their responses is provided in Table 12.

Table 12. Reasons for Participating in Genesis Operational Test.

PRIVATE PARTNERS	PUBLIC PARTNERS
Develop market-driven solution for traffic problems in the Twin Cities	Provide traffic information so people can make better decisions
Build and grow ITS business	Opportunity to integrate different ATIS programs
Develop a replicable ITS technology	Provide timely traffic information to the general public
Establish or strengthen relationship with Guidestar partners	Offer options to drivers
Exposure in ITS area	Improve traffic flow
See traffic information become available to general public	Test ATIS concept
Develop incident data-collection subsystem and data interfaces to enhance the technology	Interested in two-way communications technology
	Provide an opportunity to measure travel times-never done before
	Test different delivery methods
	Provide a significant ATIS for users
	Equipment will become core of future incident-dissemination system
	Test the value of using PCDs for providing traffic information
	Learn about technology issues in ITS area

All Genesis partner representatives were asked to list the perceived benefits and risks of participating in the Genesis operational test for their organization. A summary of their responses is provided in Table 13.

Table 13. Perceived Benefits and Risks of Participating in Genesis Operational Test.

BENEFITS	RISKS
Private-Partner Responses	
Exposure to ITS technologies	Technical risks
Reference-can say we've done this	Requirements changes from Mn/DOT
Experience working with state contracts	Performance challenges
Technology integration	User acceptance-not sure whether people will want to pay for traffic information
Chance to put a useful product in front of users	Program failure
Establish relationship with Mn/DOT	Negative image if project a failure
Develop ITS workbase	Being a sub-contractor
Establish relationships with Guidestar partners	Requirements/enhancement risk
Increased pager sales/rental	Cost overrun
Exposure	
Learn about technology	
Consolidate database technology	
Work with Mn/DOT on ITS project	

Table 13. Perceived Benefits and Risks of Participating in Genesis Operational Test (Continued).

BENEFITS	RISKS
Public-Partner Responses	
Project exposed to a larger audience	[Contractor] does not know about project requirements, needs and architecture
Sharing of traffic information	Too much work is done through contractor instead of in-house
Experience of working with other operational tests during integration	Not having information due to technical problems
Fusing data and data distribution	Additional time required for integration and testing
Partnership with MinnComm	Public concern over cost
Good for public	Throw-away technology
Good project for learning about DBMS issues	Monetary
Work with TMC	Won't work
Good user product	People won't use it
Experience dealing with private sector	Risk relationship with TMC if system doesn't work well (e.g., DCS)
Software development/specification experience	No processes for implementation
Real ITS project with success potential	Opportunity to develop partnerships
Learn about technology	

Genesis partner representatives were also asked to provide their perceptions regarding whether Genesis was a successful project. Their responses are provided in Table 14.

Table 14. Perceived Genesis Success.

PRIVATE PARTNERS	PUBLIC PARTNERS
Lukewarm at this point-interface with Trilogy was difficult and we're still learning about pagers/wireless communications systems.	Can't determine-current problems (e.g., Trilogy interface) make me very frustrated at this point. I guess I'll have to wait until I see the evaluation results.
Yes, we've helped facilitate Guidestar's impact in the TMC and have shown the value of ITS technology. There appears to be genuine interest in this program.	Yes, the project provides traffic information to users and helps them make informed decisions.
Yes, because it shows the public what ITS is all about and because we've learned a lot about TIPS/DCS integration.	No, because the Genesis system as it currently exists won't be retained. This primarily has to do with the fact that the system is unstable and the Trilogy interface doesn't work right.
Yes, because I think this project has a lot of benefits for the public.	Yes, because the system is providing useful traffic information to people.
Too early to tell-- will depend upon whether system is retained or applied to future uses.	Partial success-we've had some successes (e.g., good user product, system development experience), but we've also learned some lessons (e.g., need for integrated system architecture, negative impact upon TMC).
	Too early to tell, but we've learned a lot about contracts, software development and project management.

3.4 Future Applications for and improvements to PCD Technology

All Genesis partner representatives were asked for their inputs regarding future applications for and improvements to the Genesis PCD technology. Their responses are provided in the following sections.

3.4.1 Future Applications for Genesis PCD Technology

Genesis-partner-representative suggestions regarding future applications for Genesis PCD technology are provided below:

- PCD acceptance critical-- FHWA will get cold feet otherwise.
- Some type of device, developed in the consumer market area, needs to be developed-- should not be driven by ITS, however.
- Wonderful idea, but not sure what people are going to do with it-- pagers will be here for awhile, however.
- Alternative modes (e.g., intemet) for distributing traffic information are necessary.
- Phase 2 and 3 applications (e.g., driver profile, two-way communications) were good ideas, but they appeared to get ahead of technology.
- Mn/DOT needs to make traffic information available on a wider scale-- private sector will then develop/determine delivery system.
- Sees hope for in-vehicle and in-home applications.
- Genesis needs to be expanded by gaining more service providers.
- Transit information needs to be added.
- Graphic, map-based, interface would be an improvement.
- Two way capabilities would be nice, but may be too expensive.
- PCD acceptability by public needs to be improved.
- Latter phases of Genesis (e.g., driver profile, two-way communications) would be good-- depends upon PCD technology improvement.
- Real time, comparative traffic information is needed.
- Different ways to disseminate traffic information are needed .
- Automated route planning is needed.
- PDA usage needs to be improved, perhaps by adding route planning capabilities.
- Route-planning capability based upon travel-time information is needed.
- Fax and telephone servers for distributing information are needed.
- Filtering information by route should be attempted.

3.4.2 Improvements to Genesis PCD Technology

Genesis-partner-representatives suggestions for improvements to Genesis PCD technology are provided below:

- Need to focus more on the type of information that is being disseminated-- not the technology itself.
- Need user inputs along the way, not just engineering perspective.
- Genesis is more timely and accurate than current commercial activities (e.g., radio, TV)-- needs to stay this way to get wide acceptance.
- Real-time systems are needed that are unobtrusive-- Genesis PCDs may be too obtrusive.
- Need to integrate with CMS system.
- Message formatting needs to be improved.
- Motorola's "mail-slot" idea is good-- needs to be expanded to PDA.
- GPS for PDA.
- Pager readability needs to be improved.
- Information should be distributed by road, not zone.
- Map displays on PDAs are needed.
- Scrolling of information needs to be controlled better.
- Too many messages being sent.
- Message usefulness needs to be improved.

4. Discussion

The major findings of the Genesis *Institutional Issues Test* evaluation are highlighted by identifying (1) the most significant existing/possible issues that were identified by the Volpe Center (1994 - and (2) newly-identified issues that actually impacted the conduct of the Genesis operational test. This discussion is provided in the following sections:

- Significant Volpe Center-Identified Issues
- Significant New Issues

4.1 Significant Voipe Center-identified issues

The most significant Genesis institutional issues can be derived by looking at the overlap between top twenty issues identified in the Genesis Institutional Issues Survey and those the Genesis partner representatives wished to discuss during the evaluation interviews. Eight (8) topics were included in both lists. Of these topics, two subject categories-- **funding** and **organizational coordination**-- contained two or more topics that were identified in both lists. These topics are discussed below.

4.1.1 Funding

Three topics were identified as significant *funding* issues:

- Funding limitations can negatively impact the scope and level of functionality of an operational test (discussed by 5 people, #2 checklist rank).
- Funds have not been committed for implementation of products and services after the test is complete (discussed by 2 people, #l checklist rank).
- Federal funds for [ITS] projects are not released as quickly as possible (discussed by 1 person, #18 checklist rank).

The major concerns expressed were that the lack of expected FHWA funding for phases 2 and 3 of Genesis (1) severely impacted the evaluation of the Genesis operational test, and (2) impaired the ability of Mn/DOT to deploy Genesis after the operational test was complete. In particular, concern was expressed regarding how well Genesis PCD functionality (both pager and PDA) would be evaluated since the functionality that was provided did not benefit from additional refinement from feedback and technological advancement that would have occurred if the original, phased deployment schedule for Genesis was kept. In addition, the lack of committed funds (both federal and state) beyond the end of the operational test led some to question the long-term commitment that is being provided to the ITS area. Regardless of these concerns, however, the Genesis operational test was conducted pretty much on schedule, with feedback that was

fairly encouraging regarding the need to continue the dissemination of traffic information to Twin Cities area travelers.

4.1.2 Organizational Coordination

Two (2) topics were identified as significant *organizational coordination* issues:

- Operations personnel within Mn/DOT view ITS activities as add-on functions (discussed by 4 people, #7 checklist rank).
- Changes in Mn/DOT executives could affect the ITS program (discussed by 1 person, # 15 checklist rank).

The first of these topics is particularly significant because it was the second most frequently discussed Genesis institutional issue and indicates that Mn/DOT could do a better job coordinating the development and deployment of ITS projects. For example, it was widely held was that Mn/DOT personnel working in the TMC viewed their activities related to Genesis as extra, or beyond, their current job responsibilities. Given the fact that other ITS projects (e.g., Trilogy, Travlink) were also conducted through the TMC, this points to the need for a more thorough analysis of the operational impacts of ITS, especially upon operations personnel.

Regarding potential changes in Mn/DOT executives, the concern expressed here was that interest within the department for ITS applications might wane if those individuals who advocated for Minnesota's current entry into this field would ever leave. Although an earlier example of such an occurrence resulted in the formation of the CTS at the University of Minnesota, this fear appears to be aimed at keeping a critical mass of ITS technological expertise in residence within Mn/DOT.

4.2 Significant New Issues

Of the 15 issues newly identified by the Genesis partner representatives, the majority, or seven, of these issues were related to implementation and deployment. This makes sense since these issues were not obvious or anticipated before the start of the test, They became apparent, however, once the development process was initiated. Two other categories, contracting and auditing, and organizational coordination, also had newly identified issues. The significance of the new issues identified for each of these areas is discussed below.

4.2.1 Implementation and Deployment

The seven topics newly identified as *implementation and deployment* issues were:

- Feasibility of PDA operations should have been determined in advance (discussed by 2 people).

- Integration of related projects not a high priority (discussed by 2 people).
- Better technical support needed from development contractor (discussed by 2 people).
- Development process not clearly specified (discussed by 2 people).
- Software changes caused development delays (discussed by 1 person).
- Performance requirements not specified (discussed by 1 person).
- Sustainability of Genesis is questionable (discussed by 1 person).

These topics addressed the need to clearly delineate the general system development process for ITS projects. In particular, the importance of: (1) doing proper operations and feasibility analyses with all proposed equipment; (2) planning integration-testing efforts that minimize impacts upon the development schedules of other projects; (3) receiving timely technical support during live-trial operations; and (4) clearly identifying the system development process for all involved parties was highlighted. Regarding the latter, in particular, procedures clearly delineating the difference between software-trouble reports (i.e., problems that must be fixed to meet contractual obligations) and software-enhancement reports (i.e., software changes outside the scope of the current contract and, perhaps, requiring additional funding) were needed for Genesis.

Other Genesis implementation and deployment issues raised included: (5) the need to minimize software changes (i.e., requirements) during development because of the possibility that unforeseen impacts (e.g., time, money) may be encountered; (6) the need to clearly specify performance requirements (e.g., system availability) in ITS software requirements; and (7) the need to design a sustainable (i.e., usable) system architecture that will provide greater returns for the money spent. All three of these issues imply the need for improved requirement tracking efforts within Mn/DOT. If system requirements could be easily identified, for instance, confusion over what needed to be built would be reduced.

4.2.2 Contracting and Auditing

Two topics were newly identified as *contracting and auditing* issues:

- Viability of Genesis partners needs to be determined in advance (discussed by 1 person).
- Strategic negotiation process for ITS projects is difficult (discussed by 1 person).

These issues identified the need to determine-- in advance-- the financial viability of all partners and companies providing hardware and software to an ITS project. For example, a supplier of one of the early PDAs proposed for Genesis became insolvent. Consequently, this caused problems for the development contractor because a new,

compatible PDA needed to be found very quickly. As a result, the operational impacts of this new device were not fully understood before the beginning of the Genesis operational test. The insolvency also contributed to some software difficulties because interface software developed for use with the Motorola Newscard was lost by the company that purchased the original PDA supplier.

Another contracting and auditing issue that was deemed significant was the need to provide some structure to the strategic negotiation process for ITS projects. It was felt, for example, that the free-form negotiations that initially took place between the public- and private-sector Genesis partners could have proceeded more smoothly if both parties had a better understanding of each other's contracting history, contracting preferences, and what each party wanted to derive from the Genesis contract. Factors to be considered here are the different contracting requirements/perspectives of federal and state contracts, the fact that ITS partners may not share a common framework for negotiation, and the parameters surrounding the new and special contracting requirements imposed by the ITS partnership agreements promoted by the FHWA.

4.2.3 Organizational Coordination

Two topics were newly identified as *organizational coordination* issues:

- Metro and Guidestar divisions of Mn/DOT need to work more effectively together (discussed by 3 people).
- A gap in expectations for ITS projects exists between regional and national FHWA offices (discussed by 1 person).

The need to better coordinate the installation, testing, and updating procedures for any future ITS software placed in the TMC was highlighted. In addition, the need to better coordinate ITS expectations between national and regional FHWA personnel was also discussed. An example cited in this regard was the differing perspectives forwarded by FHWA personnel regarding the significance of Genesis phases 2 and 3 and the need, in particular, to fund these latter phases.

5. Summary and Conclusions

A summary of the major findings and the conclusions derived from the *Genesis Institutional Issues Test* are presented in the following sections.

5.1 Summary

As was stated in the Introduction, the goals of the Genesis project were to:

- Determine technical feasibility.
- Influence individual travel decisions.
- Complement and integrate with other ITS projects.

The results of the Genesis Evaluation have shown that the above goals have been met. PCDs were shown to be viable for providing travelers with up-to-date traffic information. Users of the Genesis PCDs responded to the information provided and altered route choices. Finally, Genesis was integrated with other ITS projects (e.g., Travlink) under the Guidestar.

The Genesis operational test was completed, as scheduled, on January 24, 1996. Findings indicated that the Genesis traffic information was used on a daily basis by 65% of the operational test participants, and that this information was used to significantly alter their travel strategies. Other results indicated that there was great interest and satisfaction with the traffic-information dissemination concept, but that improvements to Genesis messages and the PCDs themselves were needed, particularly for the PDA.

System development impacts upon Genesis included (1) a three-month delay in the start of the operational test; (2) initiation problems for existing pager users; and (3) delayed deployment of the PDA. Other problems included: (4) coordination of integration testing; and (5) adequate and timely receipt of technical support for system updates after the Genesis operational was initiated.

The three (3) categories of institutional issues that had the most impact upon the conduct of the Genesis operational test were:

- Funding
- Newly-Identified Implementation and Deployment Concerns
- Organizational Coordination

Cutbacks in funding were felt to be the major problem for Genesis because they resulted in a reduced scope of services. In particular, a poorer user interface for both users and system operators occurred because improvements to these systems were supposed to be

identified in the first phase of Genesis and implemented before the start of phases *2 and 3*. In addition, functions that were planned for Genesis phases 2 and 3 (e.g., the providing of route-specific information, two-way communications capabilities) and that had the potential of significantly improving user satisfaction were not implemented. Finally, the lack of continuation funds served to provide a damper on the purported significance of the Genesis operational test.

Newly-identified implementation and deployment issues were considered to have significant impacts upon the Genesis operational test because they served to hinder the deployment of this system. Among the issues identified here were the needs to conduct feasibility analyses in advance of system development, make system integration a high priority, provide timely technical support, clearly delineate an overall development process, minimize software changes, delineate system performance requirements, and build a sustainable system.

Organizational coordination was one of the top three Genesis institutional because it highlighted the need for improved coordination between Mn/DOT operating units. In short, the concerns expressed here primarily appear to simply be one of communication--better communication regarding the planned ITS activities of the Guidestar office of Mn/DOT is needed because these projects may have very real impacts upon the activities of other offices (e.g., Operations) within Mn/DOT. In addition, coordination of integration testing activities of the various ITS projects that were being fielded in the TMC could have been better planned.

5.2 Conclusions

Overall, the results of the *Genesis Institutional Issues Test* emphasized:

- The importance of proper financial planning for ITS projects to ensure that project goals are realized.
- The significance of understanding the myriad of factors involved with system development and deployment, especially as they relate to integration testing.
- The need to communicate the operational impacts of newly-fielded ITS systems upon the activities of other operating units.

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