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Multi-Modal Traveler Information System

Performance Criteria for Evaluating GCM Corridor Strategies & Technologies Working Paper # 18520.01

Prepared by:

De Leuw, Cather & Company

in association with:
JHK & Associates, and
HNTB Corporation

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1.0 INTRODUCTION

1.1 PURPOSE

The Gary-Chicago-Milwaukee (GCM) Multi-Modal Traveler Information System (MMTIS) is a complex project involving a wide spectrum of participants. In order to facilitate its implementation it is important to understand the direction of the MMTIS. This working paper will provide a list of the goals and objectives of the system architecture for the Corridorwide MMTIS and develop the methodology to be used to evaluate conformance to these goals and objectives. The goals and objectives will be directed at the systems and subsystems used to develop the MMTIS and the methodology will be used in a qualitative manner to ensure the goals are achieved.

1.1.1 Intended Audience

This working paper is intended to serve as a set of goals for MMTIS and criteria for evaluating different technologies and strategies that may be proposed for the GCM Corridor as well as for the system designers to ensure that the system is developed according to the vision presented herein. A future working paper will develop system requirements which will focus on achieving the goals presented herein. System developers and participants will need to conform to those requirements.

1.1.2 Working Paper Organization

Section 1 provides an introduction to the MMTIS project as a whole and to the performance criteria for the implementation of the MMTIS. Section 2 lists the GCM Corridor concept's goals and objectives. Section 3 will provide the evaluation performance criteria for these goals and objectives and Section 4 will summarize the important aspects of this working paper.

1.2 PROJECT OVERVIEW/BACKGROUND

The Gary-Chicago-Milwaukee (GCM) Corridor is one of the "ITS Priority Corridors" established by the United States Congress as part of the Intermodal Surface Transportation Efficiency Act (ISTEA). These corridors have been selected for special federal transportation funding based on very specific transportation and environmental criteria. The GCM Corridor is broadly identified by the cities of Gary, Chicago and Milwaukee and the 16 urbanized counties surrounding these cities. It includes all freeways, expressways, major arterials, airports, transit and rail systems, ports and intermodal transfer stations. The GCM Corridor offers the opportunity to support USDOT intelligent transportation system (ITS) operational tests and to provide a test bed for long-term research and evaluation of ITS. As part of the effort, a twenty-year Corridor Program Plan has been developed. This plan outlines a vision for ITS applications and the creation of a state-of-the-art test bed. It also defines the roles of the participants. For the GCM Corridor, ten program areas were established to address a common set of program objectives. This report will focus on the Multi-Modal Traveler Information System (MMTIS) program area.

The Multi-Modal Traveler Information System (MMTIS) is a comprehensive, integrated and multi-modal information system to serve the needs of travelers and operators within the GCM Corridor. The project involves a large number of ITS related tasks. It includes the ITS initiatives in the Corridor which are currently deployed or proposed. This information will be used to recommend a Corridor system architecture which best suits the characteristics of the diverse resources within the corridor. To develop this system

architecture, however, it is essential that criteria be established to assess the advisability of using current and proposed ITS strategies and technologies and their conformance with any proposed system architecture.

1.3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

Document #17100-1, MMTIS Project Glossary, contains all definitions, acronyms, and abbreviations associated with this project, as well as ITS, communications, computer programming and other related fields.

1.4 RELATED DOCUMENTS

This working paper is part of a series of documents and working papers produced to support the design of the GCM Corridor Multi-Modal Traveler Information System.

Related documents and working papers include:

- Document #17150 - Gateway Traveler Information System (TIS) System Definition Document
- Document #17200 - GCM Corridor Architecture Functional Requirements Document
- Document #17250 - Gateway TIS Functional Requirements Document
- Document #17300 - GCM Corridor Architecture Interface Control Requirements Document
- Document #17350 - Gateway TIS Interface Control Requirements Document
- Working Paper #18250 - Cellular 911 - State of the Practice
- Working Paper #18380 - GCM Corridor User Needs and Data Exchange Requirements
- Working Paper #18400 - Current and Proposed ITS Initiatives
- Working Paper #18500 - GCM Corridor Strategic Plan
- Working Paper #18550 - Alternative GCM Corridor Technologies and Strategies
- Working Paper #18555 - Proposed GCM Corridor Technologies and Strategies
- Working Paper #18600 - System Interfaces and Information Exchange
- Working Paper #18700 - Information Clearinghouse - Initial Administrative Network
- Working Paper #18790 - Information Clearinghouse - Final Network
- Working Paper #18830 - Weather Detection System Standard Message Sets
- Working Paper #19140 - Gateway TIS Phased Implementation Plan
- Working Paper #19210 - Gateway Lessons Learned
- Working Paper #19220 - Gateway TIS Design Options
- Working Paper #19840 - Variable Message Signs (VMS)/Highway Advisory Radio (HAR) State of the Practice
- Working Paper #19845 - VMS/HAR Suggested Guidelines.

Related information is also contained in the GCM Corridor Coalition's "Gary-Chicago-Milwaukee ITS Priority Corridor, *Initial Program Plan*," dated June 1995 and the "*Draft Program Plan Update*," dated April 1997.

2.0 GOALS OF THE SYSTEM ARCHITECTURE

The vision for the Corridor was introduced by the Corridor Program Plan as one of enhanced transportation productivity, mobility, efficiency and safety and corresponding reductions in energy use and negative environmental impacts through the coordinated development of ITS technologies and systems.

For the deployment phase of the GCM Priority Corridor, the vision has been detailed by the GCM Deployment Committee and the Architecture, Communications and Information (ACI) Work Group. Generally, the deployment of ITS in the Corridor will include a comprehensive, integrated and multi-modal information system that serves the needs of travelers and operators within the GCM Corridor. A major part of the ITS deployment includes the collection of transportation information from transportation management systems, the compilation and management of this information, the distribution and presentation of this information in a manner appropriate to travelers and operators and the communication systems necessary to support this information system for the Corridor. In the development of this Corridorwide information system, it is important to note that individual systems need to be supportive not only of their local needs but supportive of systems that will eventually serve the Corridor as well. It is in this light that these goals have been set forth to ensure local systems can be supportive of a Corridorwide ITS effort.

1. Provide for the two-way collection and distribution of transportation related data between the public, public agencies and private enterprise.

2. Provide an avenue for data exchange among participating agencies, including both processed and raw data.

3. Establish a framework which allows for participation in the GCM Corridor Concept with minimal restrictions.

4. Provide an avenue for joint control of field devices.

5. Provide a forum for testing new (state-of-the-art) technologies.

6. Provide an architecture that maximizes the use of existing and proposed systems in the GCM Corridor.

7. Encourage conformance with the National System Architecture.

8. Maximize use of National Transportation Communications for ITS Protocols (NTCIP) standards.

9. Allow for individual system preferences while maintaining the ability to exchange data and jointly monitor/control field devices.

10. Maximize automation of functions, particularly those related to data collection and distribution.

11. Allow for incorporation of future ITS technologies.

12. Minimize life cycle costs.

13. Provide/maintain system security/privacy.

3.0 PERFORMANCE CRITERIA

This section provides a list of performance criteria which can be used to measure compliance to the Goals and Objectives first listed in Section 2.0.

1. GOAL Provide for the two-way collection and distribution of transportation related data between the public, public agencies and private enterprise.

Better management of existing and proposed transportation systems requires that system managers have access to information such as the location of a traffic accident or a major transit delay.

This goal includes provision of a C-TIC/Gateway-type system that will provide transportation system information to public agencies to view transportation conditions of surrounding jurisdictions or complementary operations and also make information available to public and private enterprise.

There are several performance criteria that can be measured against this goal. These performance criteria will establish how readable the messages are, whether the computers are interchangeable or not, the stability of the communications infrastructure, the expandability of the system itself and whether source or headend computers can be easily upgraded. Other criteria rate the data for its usefulness, accuracy and reliability. Each of these criteria is described below.

CRITERION Readability/Interchangeability

The National Transportation Communications for ITS Protocols (NTCIP) have been chosen as the Corridor standard for data transmission between Intelligent Transportation Systems (ITS). NTCIP provides transmission rules as well as message format (standard message). The NTCIP standardizes readability and interchangeability between computers or centers.

Initially, many systems will not be NTCIP compliant. For the short term, third party hardware or software may need to be created to translate data from existing sources into an acceptable format. Once the NTCIP Center-to-Center protocols are established, however, future data sources should comply.

In addition, the participants in the GCM Corridor have decided to conform to the requirements of the National Location Referencing Message Specification (LRMS). By conforming to this standard, the need for location translation will be minimized and compliance will be maintained with nationwide ITS efforts.

MEASURE NTCIP compliant.
National LRMS compliant.

CRITERION Expandability

The number of data sources should be expandable. In the short term, the number of data sources will be limited to large public agencies providing data on the major transportation modes, major highways and arterials. As participation in the system

increases, local data sources need to be incorporated to provide a complete picture of the transportation network in real time.

Similarly, the number of public data access points should be expandable. As well, as the amount of data being provided on the Internet expands, map access and updates should not slow down considerably.

In addition, a given source should be able to add individual source inputs (e.g. the TSC adding more detection capabilities).

MEASURES Ability to add individual source inputs.
Ability of changing map displays as data sources increase.
Ability of incorporating data sources.
Ability of adding public access providers/sites.
Speed of map access and map/data updates on Internet.

CRITERION Scalability/Enhanceability

The Gateway must have the ability to be easily reused on other hardware platforms with minimal impact on other systems with which it is connected. The Gateway should also have the ability to add enhancements with minimal impact on the individual systems.

As well, the Gateway should be configured in such a manner that adding or taking away (subsystem failure) individual data sources will not affect the operation of the MMTIS. Downed systems will not affect the rest of the MMTIS. This will become more important as data fusion and verification are incorporated into the MMTIS.

MEASURES Equipment and time necessary to rehost or add enhancements.
Ability to isolate individual systems.

CRITERION Validity/Usability

The data provided within the system must be valid and useable to the traveler and/or the participating agencies. To the maximum extent possible, all data should be validated at the source.

MEASURES Number of Internet hits as tracked over time.
Number of data requests as tracked over time.
Feedback from users on data validity.
Comparison of data to actual known conditions.

CRITERION Accuracy

Accuracy is the responsibility of the data source. To the extent possible, the data source must provide a description of their data validation and verification procedures. The overall system will be unable to perform data checking and

verification to a level acceptable to the other participants. If the data source is unable to do so, their data will be used only as a secondary source for confirmation only; or noted as unconfirmed.

Similarly, the calculations which are used at an individual data source to process their raw data need to be provided to the Gateway if any data fusion needs to be performed at the Gateway. For example, if two agencies are calculating speed or travel times differently, the Gateway needs to be aware of this before data is fused for display to the public.

MEASURES Validation and Verification procedures provided.
Calculations and data processing procedures provided.

CRITERION Reliability/Accountability

The data sources need to establish a data provision rate. Clients using the system will become dependent on particular data being available. Credibility is risked whenever data is unavailable or out of date. There are two aspects to this criterion. Not only does the data source need to be reliable, the MMTIS also needs to be accessed reliably. This means that connections to the public access sites need to be reliable.

Transmission rates could vary from real time to monthly updates.

MEASURES Mean time between failures.
Mean time to repair.
Percent availability per month.

2. GOAL Provide an avenue for data exchange among participating agencies, including both processed and raw data.

Criteria for the communications infrastructure include reliability, security and affordability as well as scaleability/enhanceability.

This goal implies provision of the datapipe or communications infrastructure necessary to facilitate data exchange among participating agencies.

CRITERION Maintainability of Connection/Reliability

The links between the public, private enterprise and public agencies should be reliable and maintainable. These connections should be able to automatically reestablish themselves if problems occur. As well, system links should not be costly. The link should not require constant supervision of either the transmitter or the receiver.

MEASURES Hours to maintain per month.
Cost to maintain per month.
Automatic reconnection ability.

Mean time to repair.
Mean time between failures.

CRITERION System Security

Data exchange among participating agencies shall occur along secure means. System integrity shall not be comprised by allowing intruders to change or modify data. Additionally, the systems of individual participating agencies must be secure against intrusion.

MEASURES Level of protection against intruders (high, medium, low).
Ensure that data is not corrupted.
Ensure verification of command origination.
Ensure verification of passwords and operator identifiers.

CRITERION Affordability

Communications costs should not prohibit provision of data.

MEASURES Cost of communications per month.

3. GOAL Establish a framework which allows for participation in the GCM Corridor concept with minimal restrictions.

This goal refers to the ability of agencies, public entities and private entities to participate in the GCM Corridor concept without undue costs or effort.

CRITERION Interconnectivity

Use of national or widely accepted standards should be encouraged. These include the ITS communications protocols and message structures for location referencing. The NTCIP has been chosen as the Corridor standard for data transmission between ITS. NTCIP provides transmission rules as well as the message format. The National Location Referencing Message Specification (LRMS) provides a standard format for communicating positions within a transportation system. The LRMS ensures that different agencies can relate the exact location of an event or infrastructure element. Other standardized interface protocols should be considered for data exchange such as the TCP/IP interface standard.

MEASURES NTCIP compliant.
National LRMS compliant.
Compliance with standard data exchange (i.e. TCP/IP).

CRITERION Enhanceability

Minimize use of custom hardware and software. Allow for variability of interfaces.

MEASURES Use of off-the-shelf hardware and software.

Use of open systems standards for any custom software.

CRITERION Readability/Interchangeability

Encourage readability between devices. Ensure that equipment is in compliance with standard interchange protocols like NTCIP.

MEASURES NTCIP compliant.

4. GOAL Provide an avenue for limited joint control of field devices.

As improved transportation system efficiency is key to the MMTIS Corridor concept, information on the system is no good unless managers can react and respond by making appropriate system adjustments. Limited joint control of field devices would encourage system efficiency by enabling one jurisdiction to warn travelers of a problem before they encounter the problem. In terms of VMS, those devices closest to jurisdictional boundaries may prove most helpful to adjoining agencies. With joint control comes the necessity of providing system security and accuracy as well as a means of providing the joint control (interchangeability).

CRITERION System Security

Control of a particular field device should be restricted to an agreed upon list of agencies and likely a similarly restricted set of messages. Individual system integrity shall be maintained by allowing limited access to an agency's system.

MEASURES Level of system security (high, medium, low).
Selective access to specific devices only.

CRITERION Accuracy

Provide system monitoring to indicate status of field devices. This would be helpful when the owning agency has changed the status of a field device at the request of a secondary agency. This process would allow the secondary agency to confirm that the field device was changed to the desired status.

MEASURES Field device monitoring to confirm status and location.

CRITERION Readability/Interchangeability

The National Transportation Communications for ITS Protocols (NTCIP) has been chosen as the Corridor standard for data transmission between Intelligent Transportation Systems (ITS). NTCIP provides transmission rules as well as message format (standard message). The NTCIP standardizes readability and interchangeability between a master controller or computer and such field devices as traffic signal controllers, environmental sensor stations, variable message signs, highway advisory radio, closed circuit television cameras and freeway ramp meters.

Manual data transmission methods (e.g., faxes which would necessitate an operator keying the data into the system) are unacceptable on a long term basis due to the demands on the operator. For the short term, third party black boxes may need to be created for existing data sources to translate data into an acceptable format. The NTCIP protocols should allow easy interchangeability amongst agencies and a variety of equipment. In the interim, joint control over existing field devices may need to be provided through requests and/or by providing limited joint agency access to the existing communications equipment. Written agreements will be required between the involved agencies.

MEASURES NTCIP Compliant or accessibility to existing protocol.

CRITERION Accountability

An agreed upon responsibility level should be established for changing equipment status and ensuring appropriate usage.

MEASURES Signed agreements with responsibility levels.

5. GOAL Provide a forum for testing new (state-of-the-art) technologies.

CRITERION Accuracy

Any new technology should be tested for its accuracy and ability to provide the desired capabilities within the required ranges.

MEASURES Compare performance to state-of-the-practice equipment.
Compare performance to required ranges.

CRITERION Reliability

Any new technology should be performance tested for an extended duration of time to ensure reliable results prior to implementation into the MMTIS.

MEASURES Mean time between failures.
Mean time to repair.
System statistics.

CRITERION Readability/Interchangeability

Control and monitoring of field devices should be facilitated on a Corridorwide basis. Although each system may still have their own protocols, there should be a provision for a third party black box or compliance to the NTCIP. The NTCIP family of protocols has been chosen as the Corridor standard for data transmission between Intelligent Transportation Systems (ITS). NTCIP provides transmission rules as well as message format (standard message). The NTCIP standardizes readability and interchangeability between a master controller or computer and such field devices as traffic signal controllers, environmental sensor stations, dynamic

message signs, highway advisory radio, closed circuit television cameras and freeway ramp meters.

Additionally, the Corridor has agreed to comply with the LRMS specifications. This enables a single location to be defined and understood by all agencies. It is not necessary that a single location referencing methodology be adopted Corridorwide, only that the system be capable of conversion between the LRMS and the various location referencing methods.

MEASURES NTCIP compliant or conversion with third party black box.
National LRMS compliant.

CRITERION Interoperability

The National Transportation Communications for ITS Protocols (NTCIP) has been chosen as the Corridor standard for data transmission between Intelligent Transportation Systems (ITS). NTCIP provides transmission rules as well as message format (standard message). The NTCIP standardizes readability and interchangeability between a master controller or computer and such field devices as traffic signal controllers, environmental sensor stations, dynamic message signs, highway advisory radio, closed circuit television cameras and freeway ramp meters. The NTCIP protocols should allow easy interoperability amongst agencies and a variety of equipment.

MEASURES NTCIP Compliant.

CRITERION Affordability

An engineering assessment of benefits and costs shall be performed.

MEASURES Cost of procuring, installing and maintaining new technology.
Benefits of using new technology.

6. GOAL Provide an architecture that maximizes the use of existing systems in the GCM Corridor concept.

This architecture should provide an inclusive setting which accommodates as much of the existing ITS infrastructure as possible.

CRITERION Interconnectivity

The system architecture should easily allow interconnectivity between existing systems by allowing for a variety of media and protocols.

MEASURES Number of system types to be interconnected and the percent capable of being interfaced with.

CRITERION Scalability

The system architecture should easily allow expansion and growth, including the addition of participants and public access.

MEASURES Ability of expansion.

CRITERION Enhanceability

The system architecture should enable enhancements by easily incorporating additional capabilities. A data source may not currently provide variable message sign status information. If they upgrade their field components to allow this capability, the Gateway should be able to accommodate the new data.

MEASURES Equipment and time necessary to add enhancements.

CRITERION Readability/Exchangeability

The system architecture should encourage eventual conformance to national standards including the NTCIP while allowing third party black boxes to be used in the interim.

MEASURES Conformance to national standards.
Conformance to the NTCIP.

CRITERION Information Exchange/Limited Interoperability

The system architecture should encourage conformance to the NTCIP for communications between centers and eventually to/from field devices. In the interim, existing field devices will use third party black boxes or various interface protocols.

MEASURES Conformance to the NTCIP.

7. GOAL Encourage conformance with the National System Architecture.

The National System Architecture provides a methodology for incorporating subsystems, their interfaces and their data streams into one system. The National System Architecture provides for interoperability and compatibility by developing national standards for products from competing vendors.

CRITERION Interconnectivity

The system architecture should encourage eventual compliance with the NTCIP communications protocol. As well, published network standards should be met (i.e. TCP/IP).

MEASURES Compliance of NTCIP.
Compliance with published network standards (TCP/IP).

CRITERION Scalability

Ability to run on larger or smaller models of a similar platform. Similarly, the addition of new device types to the system should minimize the need to recompile the system components.

MEASURES Ability to add new devices (easy, medium, difficult).

CRITERION Enhanceability

Allow for future enhancements in conformance with National System Architecture. The impact of changing components should be minimized by using a modular approach in design. Adding features or data to one part of the system should not require recompilation of other parts of the system.

MEASURES Ease in incorporating new functionality (easy, medium, difficult).

CRITERION Readability/Exchangeability

A standard over-the-wire protocol for data should be used that hides platform-specific details such as word size and byte ordering. Compliance with NTCIP should be encouraged.

MEASURES Compliance with NTCIP and other standard protocols.

CRITERION Interoperability

Ability to access data on different platforms (hardware and software) per National System Architecture.

MEASURES The system should be seamless.
Ease of access (easy, medium, difficult).

8. GOAL Maximize use of NTCIP standards.

CRITERION Interconnectivity

The participating agencies should consider NTCIP compliance when equipment purchases are being evaluated.

MEASURES Compliance with NTCIP.

CRITERION Readability/Exchangeability

The participating agencies should consider NTCIP compliance when equipment purchases, including computers and head end control equipment are being evaluated.

MEASURES Conformance to national standards.
Conformance to the NTCIP.

CRITERION Interoperability

Interoperability not only requires a communication link which reliably delivers data, but also a common data format that allows cross platform communications to be understandable. New system deployment should conform to the NTCIP for communications between field devices and controllers/computers and center to center communications to allow interoperability of field devices. Other standards like TCP/IP should be encouraged for various transactions.

MEASURES Conformance to the NTCIP.
Conformance with TCP/IP and other protocols.
Mean time between failures for communications link.

9. GOAL Allow for individual system preferences while maintaining the ability to exchange data and jointly monitor/control field devices.

CRITERION Interconnectivity

Allow for individuality, but maintain the ability to exchange information and provide for the ability to jointly control/monitor devices. Use of national or widely accepted standards should be encouraged. These include the ITS communications protocols and message structures for location referencing. The NTCIP has been chosen as the Corridor standard for data transmission between ITS. NTCIP provides transmission rules as well as the message format. The National Location Referencing Message Specification (LRMS) provides a standard format for communicating positions within a transportation system. The LRMS ensures that different agencies can relate the exact location of an event or infrastructure element. The system architecture should encourage eventual compliance with the NTCIP. As well, published network standards should be met (i.e. TCP/IP).

MEASURES Conformance with published network standards (TCP/IP).
Conformance with NTCIP.

CRITERION Expandability

Ability to add more field devices, etc. Although this is a local issue, it impacts the value of information that is distributed.

MEASURES Ease in access (easy, medium, difficult).

CRITERION Accuracy

Any new technology should be tested for its accuracy and ability to provide the desired capabilities within the required ranges.

MEASURES Compare performance to state-of-the-practice equipment.
Compare performance to required ranges.

10. GOAL Maximize automation of functions, particularly those related to data collection and distribution.

CRITERION Validity/Accuracy

The data provided within the system must be accurate and valid to the traveler and/or the participating agencies. To the maximum extent possible, all data should be validated and its accuracy proven at the source. This will improve the automation of the data distribution to other sources. Provide system monitoring to indicate status of field devices. This would be helpful when the owning agency has changed the status of a field device at the request of a secondary agency. This process would allow the secondary agency to confirm that the field device was changed to the desired status without necessitating a field trip.

MEASURES Field device monitoring.
Accuracy of the received data.

CRITERION Reliability

Data exchange among participating agencies shall occur on a reliable and consistent basis. The communications media chosen for two-way data exchange must be reliable. If the communications media requires frequent manual resetting and monitoring, then automation is hampered.

MEASURES Mean time between failures.
Mean time to repair.

CRITERION Maintainability of Connection

The links between the public, private enterprise and public agencies should be reliable and maintainable. These connections should be able to automatically reestablish themselves if problems occur. As well, system links should not be costly. The link should not require constant supervision of either the transmitter or the receiver.

MEASURES Hours to maintain per month.
Cost to maintain per month.
Automatic reconnection exist?

11. GOAL Allow for incorporation of future ITS technologies.

CRITERION Expandability

The number of data sources should be expandable, not only in the short term, but in the long term, where the technologies may have been improved. Future ITS technologies should comply to national standards and allowance for these in the Corridor System Architecture will enable incorporation of future ITS technologies.

MEASURES Conformance with national standards (NTCIP, TCP/IP, etc.).

CRITERION Scalability/Enhanceability

Individual systems must have the ability to be rehosted with minimal impact on other systems with which they are connected.

MEASURES Equipment and time necessary to rehost and/or provide enhancements.

CRITERION Interconnectivity/Interoperability

Because it is likely that future ITS technologies will conform to national standards such as the NTCIP, the Corridor system architecture should be developed to encourage eventual compliance with all of the NTCIP family of protocols. As well, published network standards should be met (i.e. TCP/IP) as future ITS technologies are most likely to be in conformance with these.

MEASURES Conformance with national standards - NTCIP, TCP/IP.

12. GOAL Minimize life cycle costs.

CRITERION Affordability

An engineering assessment of benefits and costs shall be performed.

MEASURES Cost of procuring, installing and maintaining new technology.
Benefits of using new technology.

13. GOAL Provide/maintain system security/privacy.

CRITERION Security

Data exchange among participating agencies shall occur along secure means. System integrity shall not be comprised by allowing intruders access to the data. Additionally, the systems of individual participating agencies should be secure against intrusion.

In addition, certain data such as the driver license numbers of those involved in incidents, may need to be deleted from data provided to others to ensure privacy.

MEASURES Level of protection against intruders (high, medium, low).
Verify that data is not corrupted.
Verify command origination.
Verify passwords and operator identifiers.
Deletion of private, non-essential data items.

4.0 SUMMARY

This working paper provided a set of criteria and measures that can be used to evaluate the Corridor system architecture. Throughout these criteria, the importance of compliance with the National System Architecture as well as national standards and protocols which focus on center-to-center and center-to-field exchange of information was clearly cited. One of these national standards, the National Transportation Communications for ITS Protocols (NTCIP) will enable many aspects of the Corridorwide concept to be established. Without compliance to the NTCIP, systems will need to provide third party black boxes and other conversion algorithms in order to provide monitoring and control functions.

It is not the intention of the MMTIS to require that the same hardware/software components be purchased throughout the Corridor. These decisions need to be made on a local agency by agency basis. The MMTIS is only concerned with the types of data, the form of the data and the degree to which data can be translated among agencies. It is only a requirement that a communications path between these devices and the Gateway be established in the case of monitoring and control functions and that data can be exchanged easily among agencies no matter what communications protocol is being used.

The measures applied to the criteria presented herein are primarily non-quantifiable. That is, most are not measurable in terms of meeting a five or ten percent change in system performance or other measurable event. Much of the functionality of the MMTIS is measured with "Yes" or "No" requirements. For example, " Yes," a field device is NTCIP compliant or provision has been made for some translational protocol to be used in place of the NTCIP.