System Architecture Efforts in the Gary-Chicago-Milwaukee Corridor

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The Gary-Chicago-Milwaukee (GCM) Corridor is one of four "Priority Corridors" throughout the country. These corridors were selected for special federal transportation funding based on very specific transportation and environmental criteria. One of the most significant efforts within the GCM Corridor is the Multi-Modal Traveler Information System (MMTIS). This effort is geared at providing a system for integrating Intelligent Transportation Systems (ITS) throughout the corridor. To support this effort, the MMTIS contract has produced the initial design and system architecture necessary for IDOT, and other GCM agencies, to build interoperable Advanced Traffic Management Systems (ATMS) and Advanced Traveler Information Systems throughout the GCM Corridor. In addition, there are at least six new multi-million dollar computer system projects in the GCM Corridor either currently underway, or beginning within the next two years. Parallel to these efforts, the United States Department of Transportation has recently invested millions of dollars in the development of a National ITS Architecture. This paper will discuss the work underway within the GCM Corridor and its relation to the National ITS Architecture efforts. Key words: traveler information system, Intelligent Transportation Systems, system architecture, Gary-Chicago-Milwaukee corridor.

INTRODUCTION

The Gary-Chicago-Milwaukee Corridor extends approximately 130 miles along the edge of Lake Michigan. It spans three states and 16 urbanized counties. Within the Corridor, various ITS efforts and programs have been developed over the last 40 years. This has resulted in many legacy systems that were developed before the National System Architecture was developed. The Corridor Transportation Information Center, which is discussed in further detail later in this paper, is one of these legacy systems. It grew out of *ADVANCE*, the dynamic invehicle navigation system, and was/is a prototype for a realtime traveler information system. The GCM partners are now building the successor to the C-TIC and the cornerstone of the future corridorwide efforts, the Gateway transportation information center.

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BACKGROUND

The Intermodal Surface Transportation and Efficiency Act (ISTEA) of 1991 created four corridors throughout the United States that were to receive priority attention due to their congestion problems. The GCM Corridor was one of these priority corridors. It includes all major roadways, airports, transit and rail systems, ports and intermodal transfer stations. The GCM Corridor thus offered the opportunity to support national ITS operational tests and to provide a multistate testbed for implementation and evaluation of ITS.

The GCM Coordinating Committee represents the major partners in the Corridor and is responsible for providing direction to the development of ITS. It consists of representatives from each of the three state Department of Transportation (DOTs) (Wisconsin, Indiana, and Illinois) and the Federal Highway Administration (FHWA). Under the auspices of the GCM Coordinating Committee, a Corridor Program Plan was developed which proposed the development of the Gateway. The Gateway will be a regionwide transportation information center collecting information from operating agencies and other sources within the three state area and distributing this information back to the operating agencies and other users. The remainder of this paper details the Gateway design efforts which were undertaken by De Leuw, Cather & Company with assistance from JHK & Associates and HNTB Corporation.

METHODOLOGY

Before it was possible to develop a system architecture design for the Corridor, it was necessary to inventory ITS projects that currently exist or are planned. Using a combination of interviews and questionnaires, data was collected on the 80 plus ITS projects, both public and private, throughout the Corridor and the needs of the users. Over nine different location referencing systems (latitude/longitude, street name, etc., each of which had different variations/bases) were identified in use within the Corridor which has the potential to hinder data exchange.

The next step in the definition of the system architecture design was to develop goals and objectives for ITS within the Corridor. These goals involved such items as allowing for two way data exchange; National Communications for ITS Protocol (NTCIP) compliance; conformance with the National ITS Architecture; and joint control of field devices. Each of these goals in turn were restated in performance criterion and applicable measurements. As discussed in the next section, these goals and associated criterion were used in the analysis of alternative system architectures for the Corridor.

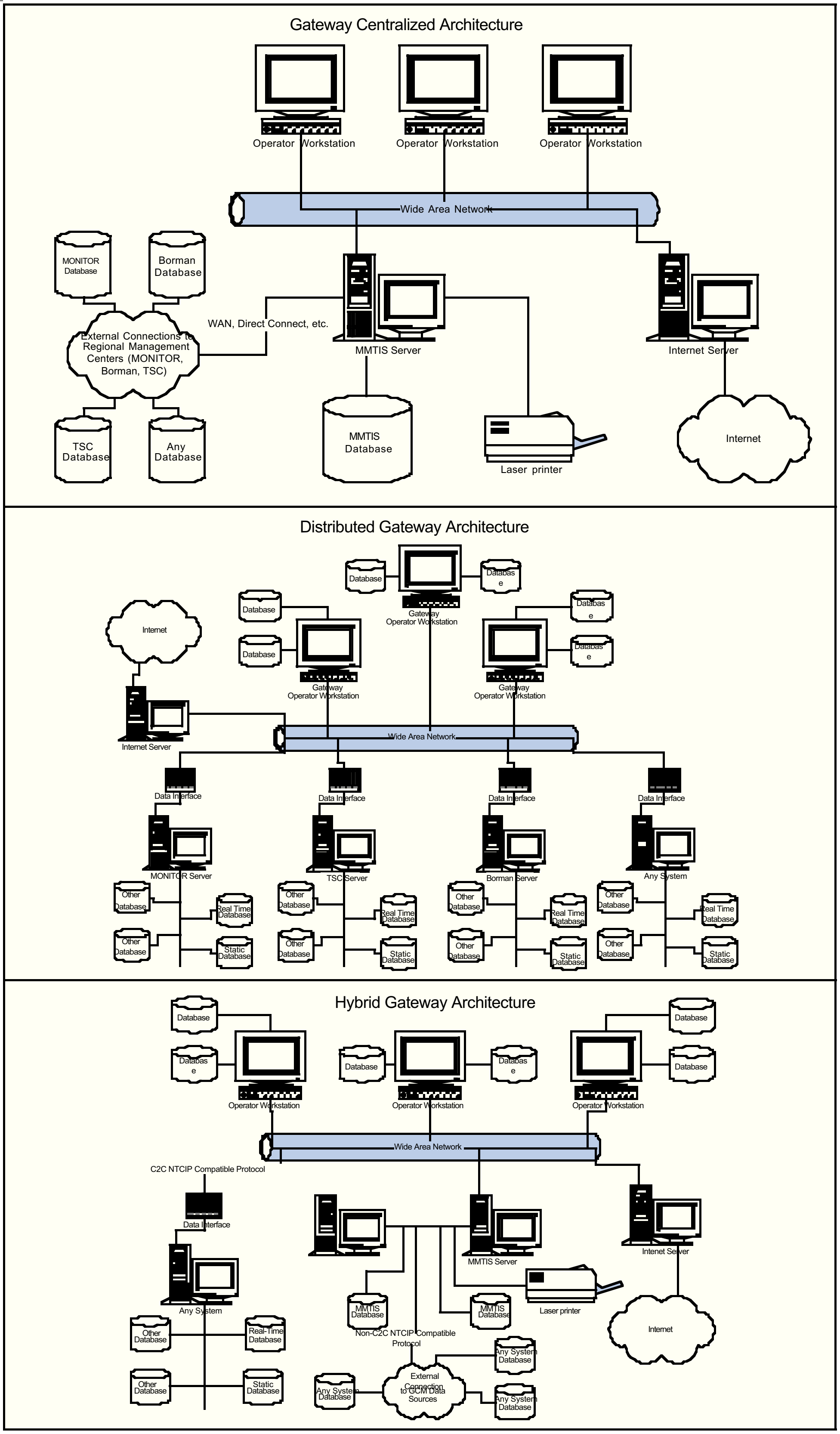

FIGURE 1 Gateway potential architectures.

SYSTEM OPTION DEVELOPMENT AND ANALYSIS

Following a systems inventory, design options were next developed. These included a review of centralized versus distributed systems and hybrids. The three potential architectures are as shown in Figure 1. Mapping of the alternate architectures to the National System Architecture was also performed. Data flows were identified and a list of potentially applicable interface standards was developed. Based upon feedback from these participants through meetings and workshops, an architecture was developed for the Corridor that was agreeable to the participants. This architecture is presented in the next section.

RECOMMENDED SYSTEM ARCHITECTURE

Overall System Architecture

The architecture proposed is based upon the MultiModal Traveler Information System (MMTIS) which is the name applied to the overall ITS scheme in the Corridor. MMTIS will be implemented using staged implementation. It is an information based system which will also facilitate joint monitoring and control of field devices such as variable message signs. The Gateway is the central element of the Corridor and will be the transportation information hub. The Gateway collects dynamic and static transportation data from the distributed transportation management systems throughout the corridor. This information will be presented directly to travelers, to transportation system operators and to information service providers. The Gateway will also serve as a “go-between” for various users who will eventually share control and monitoring of field devices such as Closed Circuit Television (CCTV). The Gateway has been designed as a distributed system as shown in Figure 2. Regional hubs in each state are responsible for collecting data within their respective states and providing it to the Gateway server. This server then distributes corridor wide data back to the regional hubs for their own distribution and use. Regional hubs also have the ability to distribute data they collect. Minimal data fusion will occur at the Gateway server as it is intended that the regional hubs will perform any necessary data fusion prior to transmission to the server.

Conformance With National Architecture

The developers of the National ITS Architecture envisioned that ITS systems would be deployed in an ad-hoc manner with a variety of combinations of subsystems and functionality. To ensure national

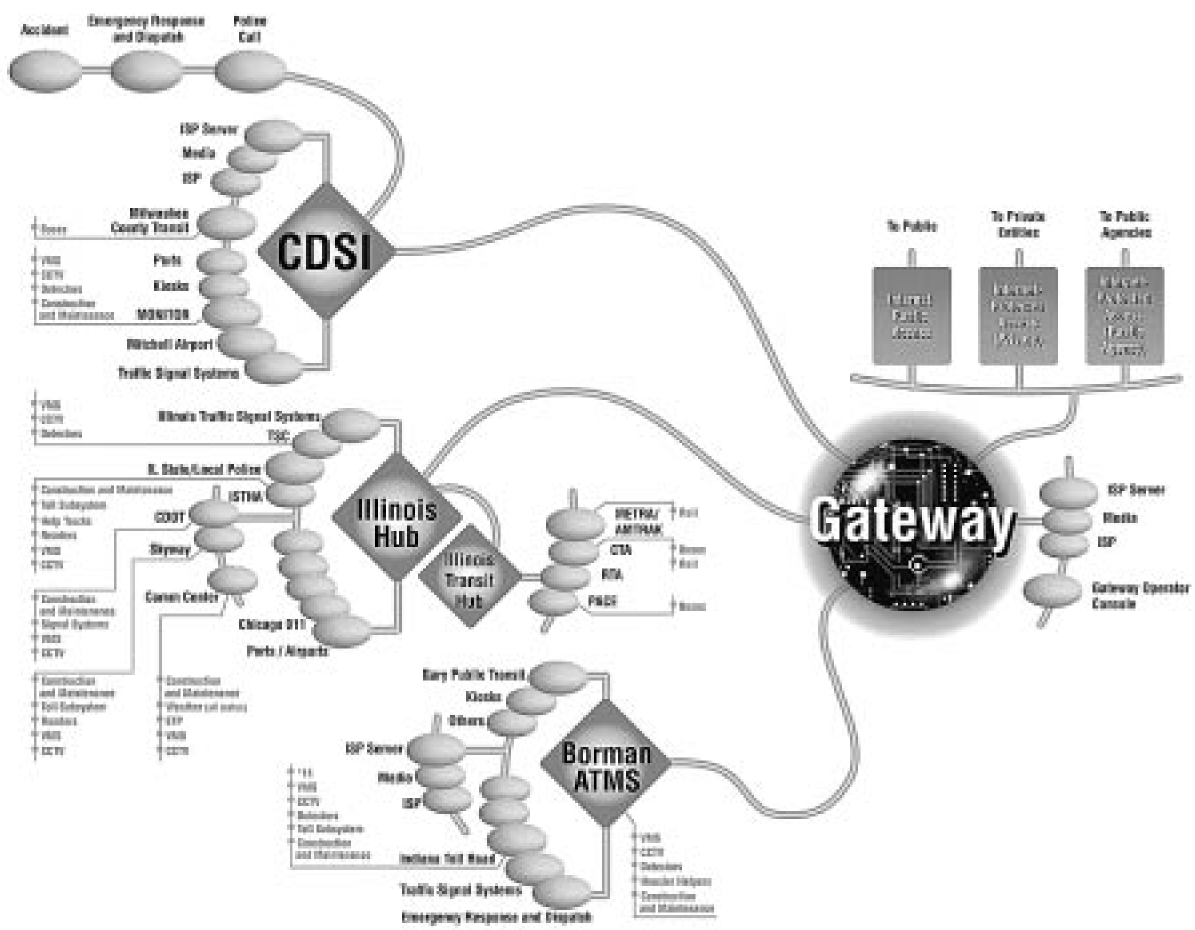

FIGURE 2 Gateway ultimate phase.

and regional system compatibility however, standards for the architecture's interfaces and data flows are necessary. Thus, the degree of compatibility of an architecture or a system with the National ITS Architecture can be measured by its use of national interface standards. National interoperability is specified for all interfaces to mobile subsystems:

- Information Service Providers (ISP) to Personal Information Access Subsystems
- Toll Collection Subsystems to Vehicle Subsystems
- Commercial Vehicle Subsystems to Traffic Management Subsystems.

Regional interoperability is specified when the coordination issues are regional rather than national in scope:

- Traffic Management Subsystems to Transit Management Subsystems
- Traffic Management Subsystems to Information Service Providers
- Traffic Management Subsystems to Traffic Management Subsystems.

As the Gateway and the MMTIS are regional in nature, they should conform to regional standards. However, there is nothing to prevent them from following a national standard (e.g. NTCIP) and there are very valid reasons for so doing. For example, by following a national standard for Traffic Management Subsystems to Information Service Providers, much wider distribution of transportation data will be obtained as it will be more attractive to national providers.

The principal national standard is the NTCIP. The primary objective of the NTCIP is to provide a communications standard that ensures the interoperability and interchangeability of traffic control and ITS devices. The NTCIP is actually a family of standard communications protocols used for data transmission within and between ITS. Work is under way on additional protocols for applications such as computer to computer or traffic management center (TMC) to TMC data exchange, which are directly applicable to the Gateway. Other efforts are involved in communications within transit management systems and communications with and between moving vehicles which are applicable to MMTIS.

Another other aspect dealing with the Gateway and MMTIS obtaining compliance with the National ITS Architecture involves the use of a modular approach. Software will be developed in modules that can be modified or removed as more details emerge on NTCIP and the National ITS Architecture.

Lastly, compliance with the National ITS Architecture will be obtained thru the use of the LRMS which is being developed under the auspices of the Federal Highway Administration. As previously noted, the agencies in the Corridor use a number of methods for referencing and tracking of geographic information. However, in order to be able to exchange data between agencies and also to allow for the interoperability required nationally, a point in space must be able to be identified by all parties which will be possible thru LRMS.

Thus, in summary, compliance with the National ITS Architecture will be obtained through the use of standard, nationally recognized interfaces (NTCIP); through the use of modular software to accommodate changes on the national scene; and through the use of a common referencing system (LRMS).

National ITS Architecture Implications and Gateway Current Status

The National ITS Architecture has been under development for several years. However, there remain many details/standards yet to be finalized. Efforts are underway in several committees such as those of SAE and ITE to develop these standards. As very little has been formally adoped, all current ITS activities are somewhat at risk since they may have to undergo change to meet future standards. This issue has been of great concern to the GCM partners and is an issue we have made great pains to address. The following paragraphs review the degree of compliance and status of various elements in the Corridor.

The Corridor Transportation Information Center (C-TIC) is being used as the prototype for both the operational test of the initial communications network and for the Gateway. At the time of this writing, it has been in operation for over 30 months. Linked color coded congestion maps of major roadways in the corridor between Milwaukee and Gary have been placed on the Internet. The addresses on the Internet are http://www.ai.eecs.uic.edu/GCM/GCM.html and http://www.GCM.travelinfo.org (after June 1, 1998).

The C-TIC is not in compliance with the National ITS Architecture and will be replaced by the Gateway. Current real time data inputs to the C-TIC include: *999, NorthWest Central Dispatch, the Illinois State Police, the IDOT Traffic System Center, and MONITOR. These links as described in the following sections will be retained during the Gateway implementation. Anecdotal data is also input manually to the C-TIC on a daily basis that relates to construction/maintenance operations undertaken by the three state DOTs, Chicago DOT and the Illinois State Toll Highway Authority. These manual inputs will be converted to electronic inputs during the Gateway implementation as the sources are automated.

*999 is the cellular phone based motorist aid system. Operators are able to answer a call, locate the incident on a NavTech electronic map database (with automatic assignment of a NavTech link ID), input the incident into a retrievable database and alert the primary response agency. Real time data from *999 is then electronically input into the C-TIC for broader distribution. The *999 system currently processes up to 300,000 reports annually for the Chicagoland area. This system is currently not in conformance with the National Architecture Standards and changes will need to be made to the referencing system.

Inputs to the C-TIC from NorthWest Central Dispatch (NWCD), an emergency dispatch operation for seven suburban communities in the outlying Chicago area, have also been automated, as has the connection to District 15 of the Illinois State Police. For these two systems, filtering occurs on a personal computer at the source to delete confidential/proprietary information as well as incidents that will not affect traffic flow. Upon arrival at the C-TIC, the location data within the incident message is deciphered via table lookup for use in the C-TIC database. To make this connection compliant with the National ITS Architecture, changes will need to be made to convert location data to the LRMS format.

Inputs from the Traffic Systems Center TSC), IDOT's freeway management system in the Chicago area, include speed, volume and occupancy data at five minute intervals for each of over 1500 loop detectors. The C-TIC converts this data to travel times and color coded congestion displays. The TSC is currently undergoing an upgrade and will use the LRMS format and NTCIP standards for TMC to TMC protocols.

The C-TIC also includes a connection to MONITOR, the freeway management system in Milwaukee. This system provides travel times from loop detectors on the Milwaukee freeway system as well as message displays from the Variable Message Signs (VMS) and Highway Advisory Radio (HAR) systems. CCTV images can also be viewed as snapshots. WisDOT is currently developing a regional hub for the Gateway which will convert the data from MONITOR to LRMS format and make it NTCIP TMC to TMC compatibile.

The Illinois Toll Highway Authority has an electronic toll system (I-Pass) and a prototype traffic management system has been successfully demonstrated that involves reading the toll cards in the vehicles at selected locations and developing travel times for links. As the traffic management center is developed, processed travel times and congestion levels will be sent to the C-TIC using LRMS format.

A connection is also under development to the Advanced Transportation Management System (ATMS) on the Borman Expressway in Indiana which will serve as the regional hub for Indiana. Data on travel times, incidents, HAR and VMS will be sent to the Gateway using the LRMS.

CONCLUSION

Multiple agencies in the three state area are continuing to cooperate under the GCM banner. The region has already created a regional architecture compatible with the National ITS Architecture. As the Gateway is created and the region integrated through this one system, the National ITS Architecture will be implemented and the existing legacy systems brought into conformance.

REFERENCES

Technical reference documents are on-line at http:www//gcmpic.ai.uic.edu/piclib.html