GCM

Gary - Chicago - Milwaukee ITS Priority Corridor

Corridor Transportation Information Center

Requirements Specification
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PROPRIETARY AND CONFIDENTIAL

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GARY-CHICAGO-MILWAUKEE CORRIDOR
CORRIDOR TRANSPORTATION INFORMATION CENTER
REQUIREMENTS SPECIFICATION DOCUMENT

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1 INTRODUCTION

1.1 PURPOSE

The **System Definition Document** identifies the top level processes, data flows, and system controls for the Gary-Chicago-Milwaukee (GCM) Corridor Transportation Information Center (C-TIC.) This **Requirements Specification** establishes the requirements on the system defined in the System Definition Document. These requirements are testable statements of system and subsystem functions. This document is intended to be used in conjunction with the **Interface Control Specification** to obtain a more complete understanding of the system.

1.1.1 Goals of this Document

The C-TIC Requirements Specification has the following goals:

- Reduce the development effort by minimizing omissions, misunderstandings, and inconsistencies early in the cycle.
- Provide a basis for estimating costs and schedules.
- Provide the baseline for system integration testing, validation, and verification.
- Provide a well documented GCM C-TIC system so that it may serve as a test bed for future ITS technology evolution and system architecture.

This document will be periodically revised to reflect the expanding capabilities of the Gary, Chicago, and Milwaukee Traffic Management Centers.

1.1.2 Intended Audience

The GCM C-TIC Requirements Specification is intended for:

- The GCM Architecture Committee in that it establishes functional requirements and the performance requirements/goals that are to be met in the delivery of hardware and software.
- Members of the various design groups that have development responsibility in that it characterizes the software and hardware processes.
- Other interested parties who may be contemplating the design of a similar traffic information clearinghouse system.

1.1.3 Document Organization

This document is organized as a requirements specification overview followed by specific requirements for each of the C-TIC functional areas. Section 2 provides the overall C-TIC requirements in terms of hardware, software, and user interface. Section 3 provides the data and information flow requirements. Each section is sufficiently

complete so that the requirements for that functional area can be completely determined from the overall requirements and the requirements for that particular functional area.

1.2 SCOPE

This document includes requirements for the major functional areas of the C-TIC. Some requirements for manual components are specified where they directly impact the functional area. This includes the handling of anecdotal data (non-numeric data from human sources.) This document does not cover management or operations requirements. Throughout this document are items in *italics* which are to be read as an initial estimation and are subject to further investigation and review.

1.2.1 C-TIC PROJECT OVERVIEW

The Gary-Chicago-Milwaukee Corridor is one of the corridors selected by the USDOT to receive priority attention under the ISTEA legislation. The corridor is broadly identified by the 16 urbanized counties in the states of Wisconsin, Illinois, and Indiana. It includes all major freeways, airports, transit, and rail systems, ports and intermodal transfer stations. The GCM corridor extends 130 miles and covers more than 2,500 square miles. It is home to more than ten million people and employs more than four million persons.

The GCM Corridor offers the opportunity to support USDOT ITS operational tests and to provide a testbed for longterm 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 testbed. It also defines the roles of the participants.

One of the recommendations in the Plan was the implementation of a Corridor Transportation Information Center (C-TIC.) The C-TIC is to be designed to act as a pass through between various information sources in Illinois, Indiana, and Wisconsin. It is not designed to control and monitor traffic control devices but rather to facilitate the sharing of information between various agencies, control centers, and private firms. This information will include travel times on selected routes, weather information, incident locations, construction information, etcetera. Minimal processing of the data will occur in the C-TIC.

1.2.1.1 Subcomponents

The C-TIC will be subdivided into separate functional areas. The four main subcomponents that comprise the C-TIC are the following:

- Communications Interface
- Archiving and Data Services
- C-TIC Operator Interface
- Web Server Interface.

1.2.1.2 Information Flows

The major priority of the C-TIC is to facilitate the flow of information between the three states. The C-TIC is involved in three types of information flows:

- Inbound to the C-TIC
- Within the C-TIC
- Outbound from the C-TIC.

1.2.2 Project Requirements

This document specifies the requirements and/or goals for:

- System processes
- Performance levels
- Reliability levels
- Interdependencies with external systems.

1.3 DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

The System Glossary Document, Document #9936, contains all definitions, acronyms, and abbreviations associated with this project. It also contains information relating to ITS, communications, and other related standards.

1.4 STANDARDS

All UIC-EECS products including, but not limited to, documentation and source code, shall, throughout the project life, meet and conform to the standards set forth in these Specifications and, in general, to a suitable subset to those issued by the American National Standards Institute (ANSI) with respect to software.

2 C-TIC REQUIREMENTS

2.1 C-TIC INTRODUCTION

This section will provide a system-level overview of the Gary-Chicago-Milwaukee Corridor Transportation Information Center (C-TIC) tasks as well as the functional requirements to be achieved within the project. This overview of the C-TIC concept is given to establish a framework for the development of the necessary processes, operational procedures, data streams and control flows.

In addition, this section will provide the functional requirements that support the C-TIC system's features and components. This section is not intended to provide design specifications for any of the C-TIC system's identified activities. However, in addition to the detailed functional requirements, important design or implementation statements will be made where appropriate.

2.2 OBJECTIVES

2.2.1 Introduction

The C-TIC is designed to serve several purposes in the GCM Priority Corridor. Its primary responsibility is to collect, organize, and redistribute travel time, incident, and weather information that has been received from various sources in the three states. The information provided to the contributing agencies is as per their request (i.e., Indiana incident information is not extremely useful to the Wisconsin MONITOR system.) Congestion and incident information will be provided to the public through a map on the Internet. Eventually, transit information will also be available on the Internet.

2.2.2 Purpose

2.2.2.1 Goals of the C-TIC Requirements Specification

The goal of the C-TIC Requirements Specification is to state and clarify the definition of the C-TIC within the GCM Priority Corridor context. Clarification of the C-TIC functions will reduce omissions and misunderstandings, as well as provide a basis for estimating costs and schedules. Specific hardware and software needs and objectives will be stated.

2.2.2.2 Intended Audience

This specification is primarily intended for use by the developers of the C-TIC system. It can also be useful to the developers and system engineers working on the MONITOR and Borman systems. Developers of related ITS systems can also derive benefit from this specification.

2.2.3 Scope

This document is an extension and refinement of the C-TIC System Definition Document (#9932.) It is concerned with the specification of hardware and software requirements for the C-TIC.

2.2.3.1 C-TIC Process Identification

The C-TIC is primarily concerned with incoming and outgoing data communications, archiving and operator input of anecdotal information. The C-TIC acts as the information clearinghouse for the three states' traffic management operations. The C-TIC provides outputs that are to enhance each state's understanding of the traffic

conditions in the others' domain so that this information can be available to travelers through other means such as variable message signs or HAR. The major subcomponents that comprise the C-TIC are the following:

- C-TIC.1 Communications Interface
- C-TIC.2 Archiving and Data Services
- C-TIC.3 C-TIC Operator Interface
- C-TIC.4 Web Server Interface.

Figure 2-1 shows the relationships between the C-TIC subcomponents and external entities with Release 3 features shown as future.

2.3 APPROACH

2.3.1 Configuration

The GCM C-TIC will be implemented over three (3) releases. Release 1 will be the prototype system and will only incorporate a subset of the possible connections in order to prove the C-TIC concept. The C-TIC will continually grow with additional connections to external sources and provide additional output to the contributing agencies and to the public via the Internet. Specific details on the functionality provided with each release are presented in Table 2-1.

Table 2-1 C-TIC Features vs. Release Table

	March 31, 1996	August 31, 1996	March 31, 1997
Features	Release 1	Release 2	Release 3
External Sources	TSC Illinois Tollway Manual Fax Capability	SSI (All States) MONITOR NWCD *999	Borman Dundee Rd. CLSS
Operator Interface (GUI)	Map Display Process Monitoring Data Monitoring Backup Capability Log Files Standard Reports	Anecdotal Inputs Weather Data (All States)	Configurable Reports Archiving Multiple Privilege Levels Activity Scheduler
Internet	Ill. Congestion (Map) Ill. Travel Times (Map)	Wisc. Congestion (Map) Wisc. Travel Times (Map) Incident Data (Password Controlled)	Ind. Congestion (Map) Ind. Travel Times (Map) Weather Data

2.4 SCOPE OF WORK

This scope of work identifies system-level requirements for the C-TIC as it applies to the GCM Priority Corridor initiative. The C-TIC shall provide central computing resources, console functions, communications interfaces, data archiving and services and the web server interface.

2.5 GENERAL C-TIC REQUIREMENTS

2.5-1 To the maximum extent possible, all operations are to be fully automatic, including restarts. The software shall include an automatic loading and automatic startup procedure. Automatic startup shall require no operator intervention for the powerfail restart. System programs shall automatically take all actions necessary to initialize the system, start the applications software and provide the connection to external sources and receivers in such a way as to provide a smooth transition to automatic, full operation of the C-TIC. The C-TIC shall be fully operational within 30 minutes (max) after the time a total system restart was begun.

2.5-2 Planned (scheduled) and unplanned (emergency) shutdown procedures shall be provided in detail. Unplanned shutdowns shall occur automatically due to a failed system test. Planned and unplanned shutdowns shall provide a smooth transition. In the case of an unplanned shutdown, advanced shutdown notification, to the extent possible, for an orderly shutdown of the system shall be provided so that any volatile memory is protected against loss or damage in an emergency shutdown situation.

2.5-3 The system shall automatically support daylight savings time and standard time, the number of days in a month, century changes and leap years.

2.5-4 Automatic procedures to the extent possible shall be provided to monitor and test the operation of all peripheral equipment, including modems. Monitoring and testing procedures shall be conducted at least on a per request basis. The output from the procedures shall include corrective actions when a fault is found, identification of failed units and reports of hardware failures.

2.5-5 Multitasking capability shall be provided. Multitasking shall mean that more than one program may be memory resident and executed concurrently within the machine under the management of the operating system.

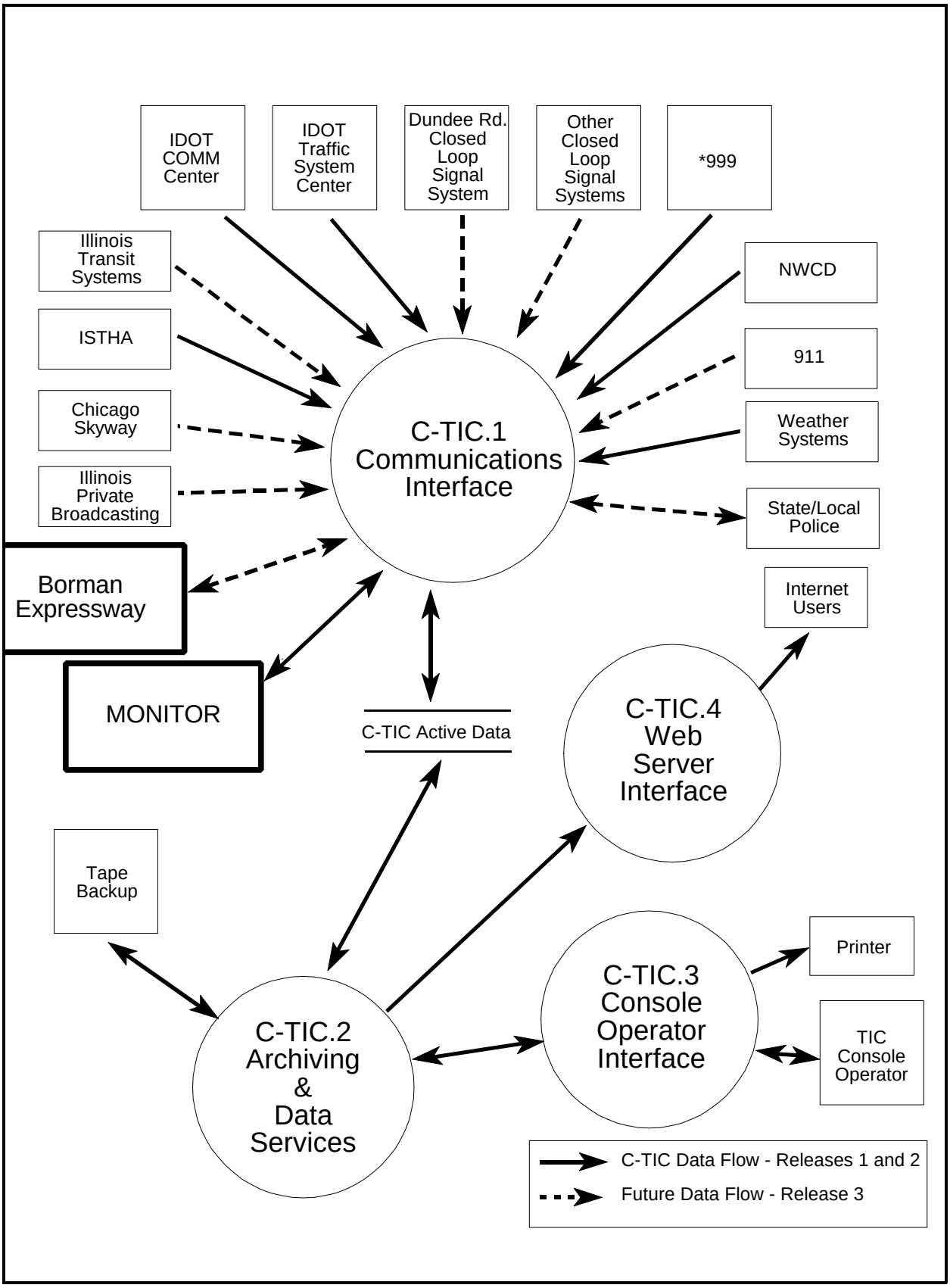

Figure 2-1 C-TIC Dataflow Diagram

2.6 C-TIC HARDWARE REQUIREMENTS

2.6.1 Data Storage

2.6.1.1 On-Line

2.6.1.1-1 The system shall contain at least 13.6 GB of disk storage. The C-TIC server shall allocate its disk space among its client data/executables.

2.6.1.1-2 The system shall be capable of storing data online at the following rates:

2.6.1.1-2a • Detector data 360 Mbytes/week
2.6.1.1-2b • ETTM data 40 Mbytes/week
2.6.1.1-2c • Transit System data 45 Mbytes/week
2.6.1.1-2d • Incident data 400 Mbytes/week
2.6.1.1-2e • Anecdotal data 200 Mbytes/week.

2.6.1.2 Off-Line

2.6.1.2-1 The C-TIC shall provide off-line storage capacity of at least 5.0 GB on magnetic tape. This tape will be used primarily for off-line storage of archived/historical information.

2.6.2 Memory

2.6.2-1 The C-TIC server shall contain between 256 MB and 512 MB RAM to avoid excessive swapping of program or data to disk. The C-TIC server memory shall provide transparent error detection and correction for single bit errors.

2.6.2-2 The C-TIC shall utilize existing memory up to the point where additional memory is essential to the operation of the C-TIC.

2.6.3 Components

2.6.3-1 The C-TIC system shall contain components that are scalable and capable of handling a heavy processing load. The C-TIC components shall be capable of handling multiple users simultaneously along with the processing of incoming data and outgoing information.

2.6.3-2 The C-TIC shall be portable to other similar hardware platforms and scalable in terms of number of I/O connections, processes, user interface features, etc.

2.6.3-3 The C-TIC shall utilize existing hardware components up to the point where additional components are essential to the operation of the C-TIC.

2.6.4 Performance

2.6.4-1 The system shall be designed to provide for safe, reliable and efficient control and monitoring operations under the full range of working conditions, continuously 24 hours per day for the design life of the system (10 years), subject to having reasonable regular scheduled maintenance. The hardware acceptance test for the system will consist of a thirty (30) day test where the system shall satisfy the following:

2.6.4-1a • not require maintenance more than once

2.6.4-1b • be available for operation 99% of the total available runtime.

2.6.4-2 *The system design shall take into account the impact of major problems with a low probability of occurrence.*

2.6.4-3 The system supplied shall:

2.6.4-3a • identify component or sub-system failure and erratic operation

2.6.4-3b • localize the effect of the foregoing conditions

2.6.4-3c • provide reasonable system operation without the full complement of system equipment (e.g., be able to perform its functions with the loss of some or several external interfaces to the extent practical)

2.6.4-3d • provide for a mean time to repair (MTTR) for the system as a whole of not more than eight (8) hours

2.6.4-3e • provide for minimum shutdown time during periods of maintenance or repair

2.6.4-3f • provide safe and orderly automatic shutdown and restart of the installation and its subsystems when sporadic problems no longer exist.

2.6.4-4 Unusual system or equipment conditions such as CPU failure, unexpected CPU halt, memory failure, and disk failure shall be considered unrecoverable faults. Under these or similar conditions, operation shall be automatically and safely terminated in an orderly manner, to the extent possible and shall not be automatically restarted unless all system boot conditions are met.

2.6.4-5 Equipment conditions such as failure of individual modems shall be considered performance degrading faults. Under these conditions, the system shall, where practical, disregard the failed element and continue operation in a degraded but otherwise unaffected manner.

2.6.4-6 The system shall be housed in a room with sufficient environmental regulation to maintain temperature (70 - 80 ºF) and humidity (20 - 70% RH non-condensing) control.

2.6.4-7 The system shall be powered by an Uninterruptible Power Supply (UPS) to ensure smooth operation during any power disruptions from the commercial power source.

2.6.4-8 Power failure at the C-TIC shall cause the system to automatically shut down in a recoverable fashion. Equipment shall be connected to the UPS and will continue to operate up to the limit of the UPS and thereafter shall shut down in a recoverable fashion. Upon return of power, the system shall automatically restart, perform necessary conditioning operations and recommence automatic operation. The recovery procedure shall also automatically restart any C-TIC devices which are necessary for reliable system operation. The restart shall be performed consistent with each device's recommended startup procedure.

2.7 EXTERNAL DATA INTERFACE REQUIREMENTS

2.7.1 General

2.7.1-1 The external interfaces shall be able to support text based data transmission (fax or teletype), interactive text-based workstations, interactive graphical workstations and distributed video.

2.7.2 Capacity

2.7.2-1 The system shall be capable of handling up to sixty (60) external data interfaces. These can be a combination of telephone lines/modems, leased lines, Internet connections, etc.

2.7.2-2 Each line and associated hardware shall be capable of handling information at a rate of at least 14.4 kbps, but the modems shall also be capable of adjusting to accommodate modems with slower transfer rates.

2.7.3 Performance

2.7.3-1 The system shall be capable of receiving information from all external data interfaces with no frequent, continual, noticeable loss of system performance (speed, reliability.)

2.7.3-2 The system shall be capable of transmitting all text and graphical information to all external agencies with no frequent, continual, noticeable loss of system performance (speed, reliability.)

2.7.4 Internet Connection

2.7.4-1 The system shall provide a GCM Corridor Homepage on the World Wide Web. The homepage shall be accessible by any Internet user using at least an IBM/IBM compatible 386 with 4 MB RAM and a 2400 bps modem. However, it is recommended that the user has a 9600 bps modem to decrease the download time for the congestion map.

2.7.4-2 The homepage shall be available 24 hours per day, 7 days a week, 99% of the time, for the life of the project.

2.7.4-3 The homepage shall provide a map for the corridor. The Internet map shall have a different display for the three different states of the corridor:

2.7.4-3a • Illinois
2.7.4-3b • Wisconsin
2.7.4-3c • Indiana

For example, there shall be an Internet map for that portion of the corridor in Wisconsin, as well as an Internet map for that portion of the corridor in Illinois, as well as one for Indiana. Each of these individual state Internet maps shall show some overlap of the state borders within the corridor.

2.7.4-4 On the Internet map, highways shall be identified by their interstate route number. In addition, this number, when clicked on, shall reveal the common highway name (e.g., Eisenhower, Skyway, Borman.)

2.7.4-5 The Internet maps shall provide congestion data in the form of color coded segments, where each color denotes a different level of congestion for all instrumented/detectorized roadways of strategic importance or national significance.

2.7.4-6 On the Internet map, incidents will be geographically identified by icons. Icon symbols shall denote incident type.

2.7.4-7 Detailed detector information shall be available by clicking on the appropriate icon on the Internet map.

2.7.4-8 Travel times between major interchanges shall be provided on the Internet map.

2.7.4-9 Schedules and other information for corridor public transportation systems shall be provided through a link to the homepage of the individual system. The GCM homepage shall provide a link to the following homepages when they are available:

2.7.4-9a • Amtrack train system
2.7.4-9b • Greyhound bus system
2.7.4-9c • Milwaukee County Transit District Bus System
2.7.4-9d • Metra train system
2.7.4-9e • Pace Bus System
2.7.4-9f • CTA Bus System.

And the following Indiana Transit Districts:

2.7.4-9g • Gary Public Transportation Corporation
2.7.4-9h • East Chicago Transit District
2.7.4-9i • Hammond Transportation System
2.7.4-9j • Michigan City Municipal Coach
2.7.4-9k • Laporte Transport
2.7.4-9l • Chicago South Shore & South Bend Commuter Railroad (Northern Indiana Commuter Transportation District.)

2.7.4-10 The GCM homepage shall also allow privileged users access to additional features. The following features will be password protected:

2.7.4-10a • weather conditions for the corridor
2.7.4-10b • details on each incident.

2.7.4-11 All data provided to the homepage from the C-TIC shall be automatically updated every minute.

2.8 ARCHIVAL SYSTEM AND DATA SERVICE REQUIREMENTS

2.8.1 Database

2.8.1.1 General

2.8.1.1-1 The system shall use a standard off-the-shelf database software package.

2.8.1.1-2 The system shall use a mutually acceptable version of the Versant object oriented database.

2.8.1.1-3 Not used.

2.8.1.1-4 As part of the database, the system shall be able to perform simple queries on the database. This includes operator generated queries and standard reports.

2.8.1.2 Distributed Computing

2.8.1.2-1 The database shall support platform heterogeneity in that it shall perform transparent management of data across different computing platforms.

2.8.1.2-2 The database shall incorporate location independent access to data - data items shall automatically be assigned unique identifiers which are independent of the data's physical location.

2.8.1.2-3 The database shall support data migration - ability to store and transparently migrate data across computers.

2.8.1.3 Performance

2.8.1.3-1 The database shall have the capability to store up to 281 tera-objects with each object of unlimited size.

2.8.1.3-2 The server shall support queries and forward responses to the client.

2.8.1.3-3 The database shall have the ability to group operations such as data reads and writes to minimize communication overhead.

2.8.1.3-4 The database shall have the ability to update objects and fail at the end of the transaction if a conflict occurs.

2.8.1.4 Data Integrity

2.8.1.4-1 The database shall maintain concurrency control - ability to lock data to prevent inconsistent views of the data.

2.8.1.4-2 The database shall be capable of supporting serialized transactions - the result of concurrent operations shall be consistent with a serialized sequence of those same operations.

2.8.1.4-3 Database transactions shall not be allowed to partially commit.

2.8.1.4-4 The database shall have the ability to mirror a database and automatically switch to the backup database, if necessary. Failover shall be transparent and allow transactions to continue uninterrupted.

2.8.1.5 Storage Space Management

2.8.1.5-1 The system shall provide for online space reclamation and reuse - data which is no longer needed shall automatically be reclaimed by the database and its memory location reused for subsequent data storage.

2.8.1.5-2 The system shall provide for the online addition of data volumes - ability to add storage to the database without interruption of transactions.

2.8.1.5-3 The active system shall have the capacity to store all data items for a period of at least sixteen (16) days. Data items include: inbound data streams, operator logs and system logs.

2.8.1.6 Standardization

2.8.1.6-1 The database shall be ODBC compliant.

2.8.1.6-2 The database shall support SQL based queries.

2.8.1.7 Interfaces

2.8.1.7-1 The database shall be capable of interfacing with C and C++ applications.

2.8.2 Archival System

2.8.2-1 Archive system shall store data on a computer readable removable media. Sequential or random access media may be used.

2.8.2-2 The archive system shall have the ability to perform automated or operator initiated migration of data from active system to archive system.

2.8.2-3 The archive system shall prompt the operator to insert additional media during data migration, if necessary.

2.8.2-4 The archive system shall have the ability to perform operator initiated retrieval of data from archive system to active system.

2.8.2-5 The archive system shall prompt the operator to insert additional media during data retrieval, as necessary.

2.8.2-6 Not used.

2.8.2-7 The active system shall be capable of storing at least fourteen (14) days worth of data retrieved from archive system concurrently with two (2) days of active data.

2.8.2-8 The system shall have the capability to perform daily purging of data from the database.

2.8.3 Backup System

2.8.3-1 The system shall be capable of performing a backup on the database.

2.8.3-2 The system shall be capable of performing a backup on each disk drive independently.

2.8.3-3 The backup utility shall have a tape verification process which checks the contents of the file on disk against the contents of the file on the tape. A warning screen shall be presented to the operator if the backup was performed manually, otherwise a log file shall contain this information.

2.8.3-4 The backup utility shall have the following capabilities:

2.8.3-4a
- formatting/reformatting tapes

2.8.3-4b • listing contents of tape to user-selected destination (printer at C-TIC, printer at UIC-EECS, file, terminal)

2.8.3-4c • displaying total space available on tape as part of tape contents inquiry

2.8.3-4d • displaying remaining space available on tape as part of tape contents inquiry

2.8.3-4e • prompting for additional media, as necessary

2.8.3-4f • perform its operations while the system is online

2.8.3-4g • performing backups in an automatic mode (scheduled activity: daily, weekly, monthly, etc.)

2.8.3-5 The backup system shall store data on a computer readable removable media. Sequential or random access media may be used.

2.8.3-6 The system shall have the ability to perform automated or operator initiated backup of data from active system to backup system.

2.8.3-7 The system shall have the ability to perform operator initiated restoration of data from backup system to active system.

2.8.3-8 The backup system shall prompt the operator to insert additional media during data restoration, as necessary.

2.8.3-9 The system shall have the ability to backup and restore individual files.

2.8.4 Performance

2.8.4-1 When the system is in full operating mode, the backup utility shall have no significant, sustained impact on the operation of the C-TIC.

2.8.4-2 A full database backup shall take no longer than sixty (60) minutes when the system is online.

2.8.4-3 A daily incremental database backup shall take no longer than thirty (30) minutes when the system is online.

2.9 OPERATOR INTERFACE REQUIREMENTS

2.9.1 GUI Environment

2.9.1-1 Software and hardware shall be provided to accommodate control and operation of the system, online operator interaction with the software and databases, report generation from the system and system support activities.

2.9.1-2 Attended operation with a high level of user interaction will generally occur during normal weekday working hours. The system shall automatically operate unattended, monitoring subsystems and providing event and status logging, at all other times.

2.9.1-3 User commands and responses shall be in accepted traffic engineering or other non-specialist terms that can be readily comprehended by a trained operator and shall not be cryptic.

2.9.1-4 Not Used.

2.9.1-5 Not Used.

2.9.1-6 The system shall provide for multi-user capability whereby different users can interact with the system by means of the GUI simultaneously from the two terminals. Both terminals shall have full and complete access to the application software and the operating system software dependent only on the access level of the user logged on.

2.9.1-7 There are two (2) means by which the operator can request actions to be taken by the system:

2.9.1-7a • Operator request. Operator requests shall take place immediately and shall have priority over the activity scheduler. Operator requests include standard reports, map displays and data inputs.

2.9.1-7b • Activity scheduler. The activity scheduler shall be used to schedule all operator generated requests including reports, tape backups, etc., by time of day and day of week.

2.9.1-8 The activity scheduler shall be structured to permit the use of any request at any time in a twenty-four hour day, to a one minute resolution. It shall be possible to execute up to five requests in a one minute period. All requests in the activity scheduler shall become effective during the minute in which they are scheduled. It shall be possible to execute 2000 requests in a 24 hour period. It shall be possible to copy the contents of a one day activity schedule to another. The operator shall be able to develop at least 10 individual daily schedules.

2.9.1-9 All requests which affect system operation (e.g., changing a parameter, stopping a process, etc.) shall be adequately protected from operator errors.

2.9.1-10 The following requirements exist for the user interface:

2.9.1-10a • ability to store all data received online for 14 days as previously noted.

2.9.1-10b • ability to perform tape backups of data and logs with no significant affect on online operation. The operator shall be cabable of scheduling backups on a daily basis through the activity scheduler. Full backups shall take no longer than one hour as previously noted.

2.9.1-10c • graphical user interface with pull down menus.

2.9.1-10d • ability to display data in real time including the ability to display color coded congestion maps and tabular reports.

2.9.1-10e • ability to manually enter data and to modify anecdotal and incident data received electronically from other sources where needed.

2.9.1-10f • Not Used.

2.9.1-10g • ability to monitor accuracy and efficiency of all processes in the C-TIC including the receipt and transmittal of data.

2.9.1-10h • provide a secure logon through the use of passwords and security levels. Be able to support at least 10 users, each with a different password and up to 5 levels of command security.

2.9.1-10i • all system users in the C-TIC shall have the capability to list and/or print all system database and system monitoring information.

2.9.1-10j • maintain a record of actions by the operator. All operator intervention activities shall be recorded and output on a time sequential log by the system. As a minimum, it shall indicate details of the data or commands input and the time initiated.

2.9.1-10k • provide statistical information on C-TIC operations and run simple queries.

2.9.1-10l • Not Used.

2.9.1-10m • provide for operator configurable reports.

2.9.1-10n • allow for reports to be printed at scheduled times.

2.9.1-10o • Not Used.

2.9.1-10p • Not Used.

2.9.1-10q • perform administrative functions such as opening/closing accounts, viewing version numbers and performing diagnostics.

2.9.1-10r • be seamless to the operator when accessing the various menus, reports and statuses.

2.9.1-10s • inform the operator if a particular area of the user interface is in use (e.g., if two operators attempt to change the same parameter in the system.) It shall be possible, however, to perform simultaneous "reads" of identical items.

2.9.1-10t • display a visual alarm and an audible alarm when a process has failed or has experienced an unusual condition.

2.9.1-10u • display a bank of process indication lights which provide a means to identify times when processing error conditions are occurring and also when a process has failed. This shall include both the operation of the process itself and the data flows into and out of the process.

2.9.1-11 It shall be possible to display multiple concurrent displays on the operator terminals. At least eight windows shall be capable of being open at the same time with minimal degradation in system performance.

2.9.1-12 It shall not be possible for persons to log into the C-TIC remotely, except for system developers.

2.9.1-13 The graphical displays shall use color to the maximum extent possible.

2.9.1-14 Not used.

2.9.1-15 Not used.

2.9.1-16 There shall be six (6) standard types of reports produced by the system:

2.9.1-16a • Summary of C-TIC Operations

1. This report shall contain a listing of each of the processes and associated with each process shall be:

- number of times the status indicator changed from green to yellow and the duration
- number of times the status indicator changed from yellow to red and the duration
- number of times the status indicator changed from red to maroon and the duration
- number of times the process was shut down and the duration

2. This report shall be automatically run and directed to the appropriate output location each day shortly after midnight and reflect the last 24 hours of operation.

3. There shall be the capability to provide these statistics for specific weeks and/or months as chosen by the operator.

2.9.1-16b • Summary of Operator Input Incidents

1. This report shall provide a summary for each operator

- number of incident entries for each incident type
- daily and monthly results
- number of startups and shutdowns

2. This report shall be automatically run and directed to the appropriate output location each day at a user specified time and reflect the last 24 hours of operation and the last month.

2.9.1-16c • Summary of Automatically Input Incidents

1. This report shall provide a summary for each data source:

- number of incident entries for each incident type
- daily and monthly results

2. This report shall provide a summary of the percentage of incidents where the location was automatically resolved. All non-resolved locations shall be listed on the report with the data source.

3. This report shall be automatically run an printed each day at a user specified time and reflect the last 24 hours of operation and the last month.

4. There shall be the capability to provide these statistics for specific weeks and/or months as chosen by the operator.

2.9.1-16d • Summary of C-TIC Performance

1. This report shall contain the following statistics which reflect the last 24 hours of operation in a graphical format. The required statistics are:

- CPU utilization percentage
- number of processors used
- disk pages per second
- disk swaps per second
- interrupts per second
- disk transactions per second
- disk errors per second
- packets per second

2.9.1-16e • Summary of Time Stamps

1. This report shall provide information for each data source:

- associated with each data source shall be the average time from data receipt to data being available for other uses and the number of reports received from each data source

2. This report shall be automatically run and printed each day at a user specified tima and reflect the last 24 hours of operation.

2.9.1-16f • Summary of Incoming Loop Detector Data

1. This report shall provide information from each of the loop detector reporting stations:

- number of detector reports received

2. This report shall be automatically run and directed to the appropriate output location each day shortly after midnight and reflect the last 24 hours, the last seven (7) days and the last thirty (30) days of operation.

2.9.1-17 Not used.

2.9.1-18 It shall be possible to retrieve any and all user specified input parameters and print them on all output devices. All parameters shall be displayed in an appropriate format using decimal and/or alphanumeric characters with English language headings for each column or row as appropriate.

2.9.1-19 Not used.

2.9.1-20 Not used.

2.9.1-21 It shall be possible to select the output device(s) upon which the report will be presented. If a device is busy at the time of a report, the report shall be queued such that it can be presented at the earliest opportunity the device is free. Output devices include the terminal screen, disk file and printer.

2.9.1-22 Using Versant utilities, the user shall be able to display and print the following reports:

2.9.1-22a
- a tabular or graphical presentation (user selectable) of all data from a specified source over a specified time period (within the last seven days) in increments of 5 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours.

2.9.1-22b
- a time sequential log of all events over a user selectable period (up to sixteen (16) days.) The operator shall be able to request the log at any time during the day, in which case it shall provide a record of changes thus far in the current day.

2.9.1-22c
- in general, access any field in the database and generate a report.

2.9.1-23 Database file maintenance functions shall be provided to allow files to be created and updated on disk, to allow files to be transferred from disk to tape and to restore files back onto disk from tape. Capabilities shall be provided to allow the operator to create a duplicate copy of the database on tape or on another disk cartridge, and restore the same, by request through one of the two operator terminals.

2.9.1-24 Not used.

2.9.1-25 There shall be the capability to display the last five (5) incidents received from NWCD in a window on the user interface. This display shall be in text format and shall be able to combine identical incidents as responded to by Fire, Police, etc. Part of the display shall show the current number of vehicles that have been dispatched to each incident.

2.9.1.1 Corridor Map

2.9.1.1-1 The operator shall be able to display a corridor map showing at least all roadways involved in the C-TIC data collection. In general, these roads include all National Highway System roads in the sixteen counties of the GCM Corridor.

2.9.1.1-2 Not used.

2.9.1.1-3 The corridor map shall display icons which represent incidents, road closures and lane closures which are either manually or automatically entered.

2.9.1.1-4 The corridor map shall allow for zooming (10 levels) and scrolling.

2.9.1.1-5 The corridor map shall be able to display the entire corridor area on one screen and selectively show information.

2.9.1.1-6 The corridor map shall be able to display with user settable parameters including road levels, road colors and road names.

2.9.1.1-7 The corridor map shall be able to display state and jurisdictional boundaries.

2.9.1.1-8 The corridor map shall be able to perform segment identifications by control-clicking on a section of the map display. The resulting display should then show the segment name, city and segment identification number.

2.9.1.1-9 Through the corridor map, the operator shall be able to manually input incident data using the map display and a pulldown menu, including the ability, where needed, to modify data received electronically or previously entered.

2.9.1.1-10 The corridor map shall provide a static display showing the location of all detectors and sources of information, appropriately labelled with their names.

2.9.1.1-11 The corridor map shall provide details by clicking on the appropriate icon.

2.9.1.2 Data Monitoring

2.9.1.2-1 The system shall be capable of displaying data in real-time as it arrives at the C-TIC. Monitoring of events and graphical displays shall be updated automatically at the data receipt rate when being viewed by the operator.

2.9.1.2-2 The operator shall be capable of displaying plots for a selected segment which present the travel time vs. time of day.

2.9.1.3 Data Entry

2.9.1.3-1 The operator interface shall incorporate error checking into all data entry fields. Limits shall be instituted for minimum and maximum values for numerical entries as well as recognition of alphabetic characters. For text entries, error checking shall also be used to the extent possible. An error message shall be displayed to the operator which will allow for correction of the improper entry.

2.9.1.3-2 The operator interface shall incorporate consistency checks into the data entry process. This would check for interrelationships between entry fields and limit entries based on programmed instructions (limitations.)

2.9.1.3-3 The operator shall be able to select incidents, lane/road closures, segments, etc. by boxing the area or icon that is needed. This process shall also work in reverse; a DESELECT function for improperly selected areas shall be implemented.

2.9.1.3-4 Data entry shall be constructed so that it minimizes the operator's use of keystrokes, mouse clicks and time. The user interface shall ensure that the operator can enter a minimum number of keystrokes in order to access a function. The operator shall not be required to memorize any commands. Online help shall be available for all features. The primary input device shall be the mouse. A secondary input device shall be hot keys.

2.9.1.4 Performance

2.9.1.4-1 The operator interface shall meet the following performance requirements:

2.9.1.4-1a
- ability to present the desired screen, window or process no later than 10 seconds after the request is made at least 95% of the time.

2.9.1.4-1b
- ability to begin printing the desired standard report no later than 30 seconds after the request is made assuming an empty queue.

2.9.1.4-1c
- ability to scroll the map screen in a smooth manner.

2.10 SOFTWARE REQUIREMENTS

2.10-1 The application software shall be based on high level state-of-the-art programming languages (C or C++.) The operating system software shall include a high level language compiler capable of handling the proposed source code used in the preparation of the application software. Where portions of the proposed application software package have been written in assembler code, an assembler shall be provided.

2.10-2 The system shall be designed to provide safe, reliable and efficient control and monitoring operations under the full range of working conditions, continuously 24 hours per day for the design life of the system (10 years), subject to having reasonable regular scheduled maintenance. The software acceptance test for the system will consist of a thirty (30) day test where the system shall satisfy the following:

- 2.10-2a not require maintenance more than once
- 2.10-2b be available for operation 99% of the total available runtime, excluding backups
- 2.10-2c the requirements noted herein.

2.10.1 Operating System

2.10.1-1 The system shall utilize UNIX as the operating system. Maintenance and diagnostic software shall be provided to support the hardware. *The software shall provide the capability of identifying the existence, location and type of malfunctions, and shall check all phases of system operation. As a minimum, these tests shall include individual tests of the following:*

- 2.10.1-1a *memory access, tested by reading and writing entire memory*
- 2.10.1-1b *individual registers*
- 2.10.1-1c *instruction execution*
- 2.10.1-1d *interrupt and trap response*
- 2.10.1-1e *I/O transfers, including all peripheral equipment*
- 2.10.1-1f *all digital input/output equipment furnished.*

2.10.2 Utilities

2.10.2-1 The maintenance and diagnostic software will permit an operator to test processor and memory functions and the peripheral equipment supplied.

2.10.2-2 UIC-EECS shall recommend third party off-the-shelf software or provide all necessary utility software to perform functions such as:

- 2.10.2-2a display and make modifications to any field in the database.
- 2.10.2-2b rename disk files and assign named files and devices for input/output during program execution from a file manager.
- 2.10.2-2c save, restore and otherwise manipulate programs from devices or files.
- 2.10.2-2d selectively transfer any user designated information between any two applicable devices in the system (e.g., tape to disk and vice versa.)

2.10.2-2e
- provide disk file functions including creation and deletion of files, copying of files and a directory of all fields including size and location of each.

2.10.2-2f
- provide a firewall machine to prevent outside access by other entities (e.g., only a write access should exist for data dumps from authorized sources. It shall not be possible for an outside entity to access the C-TIC and change data, read data, etc.)

2.10.2-3 UIC-EECS shall provide editor software to adequately support the input, modification, display, listing and storage onto disk and tape files, of assembly language source code, C/C++ source codes and data for eventual use by programs written in any of the proposed language(s.)

2.11 C-TIC Requirements by Release

The designers must be aware of the timeline for each of the C-TIC Requirements. The GCM C-TIC will be implemented over three (3) releases. Table 2-2 provides a breakdown by release for each of the C-TIC Requirements. System designers shall incorporate the requirements in this specification by the appropriate release for compliance and acceptance.

Table 2-2 C-TIC Requirements vs. Release Table

C-TIC REQUIREMENTS VS. RELEASE TABLE			
Requirement Category	Initial Requirements **Release 1**	Additional Requirements **Release 2**	Additional Requirements **Release 3**
General	2.5-1 2.5-2 2.5-3 2.5-4 2.5-5		
On-Line Data Storage	2.6.1.1-1 2.6.1.1-2 (a, b)	2.6.1.1-2 (d, e)	2.6.1.1-2 (c)
Off-Line Data Storage	2.6.1.2-1		
Memory	2.6.2-1 2.6.2-2		
Components	2.6.3-1 2.6.3-2 2.6.3-3		
Performance	2.6.4-1 (a, b) 2.6.4-2 2.6.4-3 (a, b, c, d, e, f) 2.6.4-4 2.6.4-5 2.6.4-6 2.6.4-7 2.6.4-8		
General External Data Interface	2.7.1-1	2.7.1-1 (anecdotal)	2.7.1-1 (distributed video)
External Interface Capacity	2.7.2-1 2.7.2-2		
External Interface Performance	2.7.3-1 2.7.3-2		
Internet Interface	2.7.4-1 2.7.4-2 2.7.4-3 (Illinois) 2.7.4-4 (Illinois) 2.7.4-5 (Illinois) 2.7.4-7 (Illinois) 2.7.4-8 (Illinois) 2.7.4-11 (Illinois)	2.7.4-3 (Wisconsin) 2.7.4-4 (Wisconsin) 2.7.4-5 (Wisconsin) 2.7.4-6 2.7.4-7 (Wisconsin) 2.7.4-8 (Wisconsin) 2.7.4-10 (b) 2.7.4-11 (Wisconsin)	2.7.4-3 (Indiana) 2.7.4-4 (Indiana) 2.7.4-5 (Indiana) 2.7.4-7 (Indiana) 2.7.4-8 (Indiana) 2.7.4-9 2.7.4-10 (a) 2.7.4-11 (Indiana)
General Database System	2.8.1.1-1 2.8.1.1-2 2.8.1.1-3 2.8.1.1-4		2.8.1.1-4 (configurable reports)
Distributed Computing	2.8.1.2-1 2.8.1.2-2 2.8.1.2-3		

C-TIC REQUIREMENTS VS. RELEASE TABLE			
Requirement Category	Initial Requirements **Release 1**	Additional Requirements **Release 2**	Additional Requirements **Release 3**
Database Performance	2.8.1.3-1 2.8.1.3-2 2.8.1.3-3 2.8.1.3-4		
Database Data Integrity	2.8.1.4-1 2.8.1.4-2 2.8.1.4-3 2.8.1.4-4		
Database Storage Space Management	2.8.1.5-1 2.8.1.5-2 2.8.1.5-3		
Database Standardization/ Interfaces	2.8.1.6-1 2.8.1.6-2 2.8.1.7-1		
Archival System	2.8.2-8		2.8.2-1 2.8.2-2 2.8.2-3 2.8.2-4 2.8.2-5 2.8.2-7
Backup System	2.8.3-1 2.8.3-2 2.8.3-3 2.8.3-4 (a, b, c, d, e, f) 2.8.3-5 2.8.3-6 2.8.3-7 2.8.3-8 2.8.3-9		2.8.3-4 (g) 2.8.3-6 (automatic, scheduled activity)
Backup System Performance	2.8.4-1 2.8.4-2 2.8.4-3		
GUI Environment	2.9.1-1 2.9.1-2 2.9.1-3 2.9.1-6 2.9.1-7 (a) 2.9.1-9 2.9.1-10 (a, b, c, d, g, i, j, k, q, r, s, t, u) 2.9.1-11 2.9.1-12 2.9.1-13 2.9.1-16 (a, d, f) 2.9.1-18 2.9.1-21 2.9.1-22 (c) 2.9.1-23	2.9.1-10 (e) 2.9.1-16 (b, c, e) 2.9.1-25	2.9.1-7 (b) 2.9.1-8 2.9.1-10 (h, m, n) 2.9.1-22 (a, b)

C-TIC REQUIREMENTS VS. RELEASE TABLE			
Requirement Category	Initial Requirements **Release 1**	Additional Requirements **Release 2**	Additional Requirements **Release 3**
Corridor Map	2.9.1.1-1 2.9.1.1-4 2.9.1.1-5 2.9.1.1-6 2.9.1.1-8 2.9.1.1-10	2.9.1.1-3 2.9.1.1-7 2.9.1.1-9 2.9.1.1-11	
Data Monitoring	2.9.1.2-1		2.9.1.2-2
Data Entry		2.9.1.3-1 2.9.1.3-2 2.9.1.3-3 2.9.1.3-4	
GUI Performance	2.9.1.4-1 (a, b, c)		
Software	2.10-1 2.10-2 (a, b, c)		
Operating System	2.10.1-1		
Software Utilities	2.10.2-1 2.10.2-2 (a, b, c, d, e) 2.10.2-3		2.10.2-2 (f)