USDOT Integrated Corridor Management (ICM) Initiative

ICM Surveillance and Detection Requirements for Arterial and Transit Networks

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Integrated Corridor Management (ICM) Initiative

ICMS SURVEILLANCE AND DETECTION

ICMS Surveillance and Detection Requirements For Arterial and Transit Networks

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16. Abstract

The primary objective of the ICM Initiative is to demonstrate how Intelligent Transportation System (ITS) technologies can efficiently and proactively facilitate the movement of people and goods through major transportation corridors that comprise a freeway, arterial street network, and bus and rail transit network.

This report documents the Integrated Corridor Management System (ICMS) surveillance and detection requirements for arterial streets and transit networks to support an ICMS.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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1 Introduction

The Integrated Corridor Management (ICM) Initiative is one of the ten major initiatives sponsored by the United States Department of Transportation (USDOT) Research and Innovative Technology Administration (RITA). The primary objective of the ICM Initiative is to demonstrate how Intelligent Transportation System (ITS) technologies can efficiently and proactively facilitate the movement of people and goods through major transportation corridors. A detailed description of this Initiative can be found in the *Integrated Corridor Management Initiative Program Plan Update,* available on the Web at: http://www.its.dot.gov/icms/.

The ICM Initiative consists of four phases designed to research, document, and implement ICM strategies within corridors utilizing existing ITS assets and identifying innovative approaches to reduce traffic congestion across multiple agencies and/or jurisdictions. Several of the phases will run concurrently.

Phase 1: Foundational Research

Phase 1 included research into the current state of corridor management in the United States and abroad. Initial technical guidance documents were created to assist implementers of ICM as a resource during development of concepts and requirements. During this phase, a multimodal stakeholder group was developed to support the initial and on-going efforts of the ICM Initiative. Phase 1 concluded in early 2006.

Phase 2: Corridor Tools, Strategies, and Integration

Phase 2 includes the development of analytic tools and methods that enable the implementation and evaluation of ICM strategies. The outcomes of this phase will help decision-makers identify gaps, evaluate ICM strategies, and invest in the best combination of strategies that will minimize congestion, improve safety, and help to estimate the benefit resulting from ICM across different transportation modes and traffic control systems.

Phase 3: Corridor Site Development, Analysis, and Demonstration

Phase 3 consists of three stages: concept development, modeling, and demonstration and evaluation.

Stage 1: Concept Development

Eight pioneer sites were selected to develop a Concept of Operations and System Requirements Specification documenting their specific corridor needs for an Integrated Corridor Management System (ICMS). The documents were completed in the spring of 2008.

Stage 2: Modeling

Three pioneer sites were selected to participate in the Analysis, Modeling, and Simulation (AMS) of their respective proposed ICMS. The AMS began following Stage 1.

Stage 3: Demonstration and Evaluation

Up to three pioneer sites will be selected to implement their ICMS demonstrating the institutional, operational, and technical integration approaches in the field and documenting the implementation issues and operational benefits.

Phase 4: ICM Outreach and Knowledge and Technology Transfer (KTT)

Phase 4 focuses on building an ICM KTT to furnish implementers of ICM and ICMS strategies with a comprehensive set of resources based on research and lessons learned.

Management of transportation networks in a corridor depends on the acquisition of data about current conditions in the corridor, the capability to implement various arterial traffic management strategies, and the AMS tools to support the evaluation and selection of strategies appropriate to the current conditions. During prior analysis tasks, specific arterial and transit data gaps have been identified.

The objective of this task is to derive the ICMS surveillance and detection requirements for arterial streets and transit networks to support an ICMS.

The next step will be to develop an action plan. After the action plan is developed, there is potential for coordination with a selected demonstration site.

This document is organized as follows:

- **Section 2** provides an overview of the ICM and ICMS context and a foundation for the requirements to follow.
- **Section 3** presents the requirements for surveillance and detection for the ICMS relating to arterial and transit networks.
- **Appendix A** includes a list of definitions, acronyms and abbreviations used within this document.
- **Appendix B** includes a list of documents referenced herein or pertinent to the understanding of this document.
- **Appendix C** lists the Generic Needs for an ICMS which provide the basis for the requirements.
- **Appendix D** includes tables showing the data elements required for each type of information and the preferred frequency of updates for each data element where appropriate.
- **Appendix E** provides a coverage matrix showing the requirements relating to each of the sources of surveillance and detection information for arterial and transit networks.

2 ICM and ICMS Context

This document establishes a baseline for the arterial and transit data required to support an ICMS. A basic understanding of the ICM concept and an ICMS is necessary in order to adequately analyze the arterial and transit data requirements. This section provides a description of the ICM and ICMS Context.

2.1 ICM Context

ICM is based on four concepts:

1. Corridor modes of operation
2. Strategic areas for ICM
3. Conceptual levels within the corridor
4. ICM environment

2.1.1 Corridor Modes of Operation

The corridor mode of operation refers to the manner in which the corridor ICM manager and/or the transportation network operators are operating the transportation networks that comprise a corridor. There are two major corridor modes:

- Normal mode, which constitutes all the actions taken to ensure that day-to-day transportation needs are addressed.
- Event mode, which consists of two sub-modes:
    - Planned event mode: an event that is known prior to the occurrence which will reduce the existing corridor capacity.
    - Unplanned event mode: an event which increases demand on a corridor network without foreknowledge.

A corridor can be shifted between normal mode and event mode several times during a day or can operate in a single mode for the entire day. In order to shift modes, the corridor manager has to assess the event severity, the impact on the entire corridor, and the expected duration of an event before shifting from normal mode to event mode. The ability of the existing systems to support the shift must also be analyzed.

2.1.2 Strategic Areas for ICM

In order to manage the corridor in an integrated fashion, the corridor manager is required to develop strategies in four areas and implement those strategies. The four strategic areas are:

1. Demand management: addresses the patterns of usage of the transportation networks
2. Load balancing: addresses operating each network to its maximum effectiveness
3. Event response: addresses the response to events based on their duration
4. Capital improvement: addresses the need for improvements to corridor facilities

Control strategies can be developed within the first three strategic areas, establishing actions to implement the strategy. Within the fourth strategic area, recommendations for capital expenditures for facility improvements are developed.

2.1.3 Conceptual Levels within the Corridor

There are three distinct conceptual levels within a corridor. These are:

- The physical level which includes all infrastructure components.
- The information and sharing level which provides the tools and information systems that take the data from devices and transform them into information that the transportation system operators can use to make operations decisions about the transportation networks.
- The executive or decision making level, which includes:
  - the people (who create the action plans and make the decisions),
  - the decisions (made on-the-spot),
  - the pre-planned actions (based on the action plans), and
  - the control capabilities (needed to implement the actions).

2.1.4 ICM Environment

The ICM environment consists of the four strategic areas resting upon the three conceptual levels.

2.2 ICMS Context

An ICMS is a tool to help optimize corridor operations. While it is not possible to keep corridor networks operating optimally all the time, continuous optimization is the overall goal. There are two major aspects in the discussion of an ICMS:

- Operational needs
- System architecture

2.2.1 Operational Needs

The ICMS operational needs represent a high-level statement of the capabilities required to implement and operate an ICMS. Generic ICMS needs are summarized in Appendix C.

A corridor may be comprised of several transportation modes that collectively move goods and people through the corridor. Within the ICM Initiative, a corridor is recognized if it includes at least three of the following transportation modes:

- Freeway roadway network
- Arterial roadway network
- Roadway with managed lanes
- Bus transit network
- Rail transit network
- Toll roadway network
- Ferry network

The goal of the ICMS is to optimize the use of the transportation resources across all modes of transportation within the corridor. Optimization implies a regulating process that measures performance of a system and modifies the control parameters governing operation of the system in ways that will improve or maintain the performance of the system. This is a simple feedback loop.

In a feedback driven control system, positive feedback tells the system to increase the output value. Negative feedback tells the system to reduce the output value. Optimization is achieved when feedback has driven each control parameter to a state that results in the best possible performance of the system (as described by the performance measures monitored within the system).

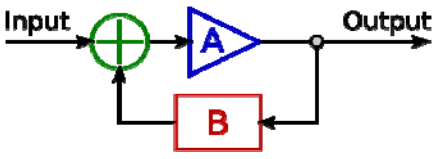

Figure 1 - Simple Feedback Optimization

Optimization therefore implies:

1. The desired performance of the system can be described based on measurable outputs of the system.
2. Performance of the system can be controlled using control measures or strategies that both positively and negatively change the performance of the system.

If a control system automatically uses performance feedback to regulate a system, the controls are considered to be a "closed loop" system. If a control system provides performance feedback information to a human, who must then take action to change the control measures, the system is considered to be an "open loop" system. Complex control systems may use a combination of open and closed loop controls for each control parameter.

Optimization of multiple transportation modes requires a control feedback loop for each transportation mode. If performance of one transportation mode can impact the performance of other transportation modes (and they almost always do), then the feedback must be based on the performance of both systems. There must be a way of describing the value of the desired performance of each system in terms that are common between the systems. Hence, it is acceptable to improve the performance of one system if the change increases the total performance value of all of the inter-related systems, but not acceptable if the total performance value is decreased. Improving the performance of one mode of transportation at the expense of performance of another mode is only acceptable if the Total Net Value of the change is positive. Improving freeway performance by one dollar at the expense of a two dollar decrease in arterial performance is not acceptable. This establishes a third constraint on optimization which applies when there are two or more performance goals that must be optimized by the same system:

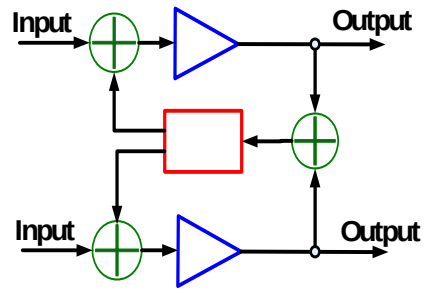

Figure 2 - Multiple Result Optimization

3. If two or more outputs are to be optimized, the governing feedback must be based on each output, the value of the results must be expressed in common terms, and the governing feedback must be applied to the inputs for all of the controlled systems.

If the system is to be stable, the control algorithm must also model the time it takes from a control change to the time a change in the output can be observed (system latency).

2.2.2 System Architecture

An ICMS typically has three distinct functions that establish how it will work:

1. Input – Information about the current situation or problem to be solved
2. Processing – The rules or algorithms that establish what the system should do given the states of the inputs
3. Output – The results of the processing based on the inputs and processing algorithms

Note that the architecture does not depend on the number or type of inputs, nor on the number of computers that might be required for processing or where the computers might be located. This means that an ICMS can be a centralized or distributed system, closed loop control, open loop control, or a hybrid of both closed and open loop controls. The figure below shows how these functions fit into the general architecture of an ICMS.

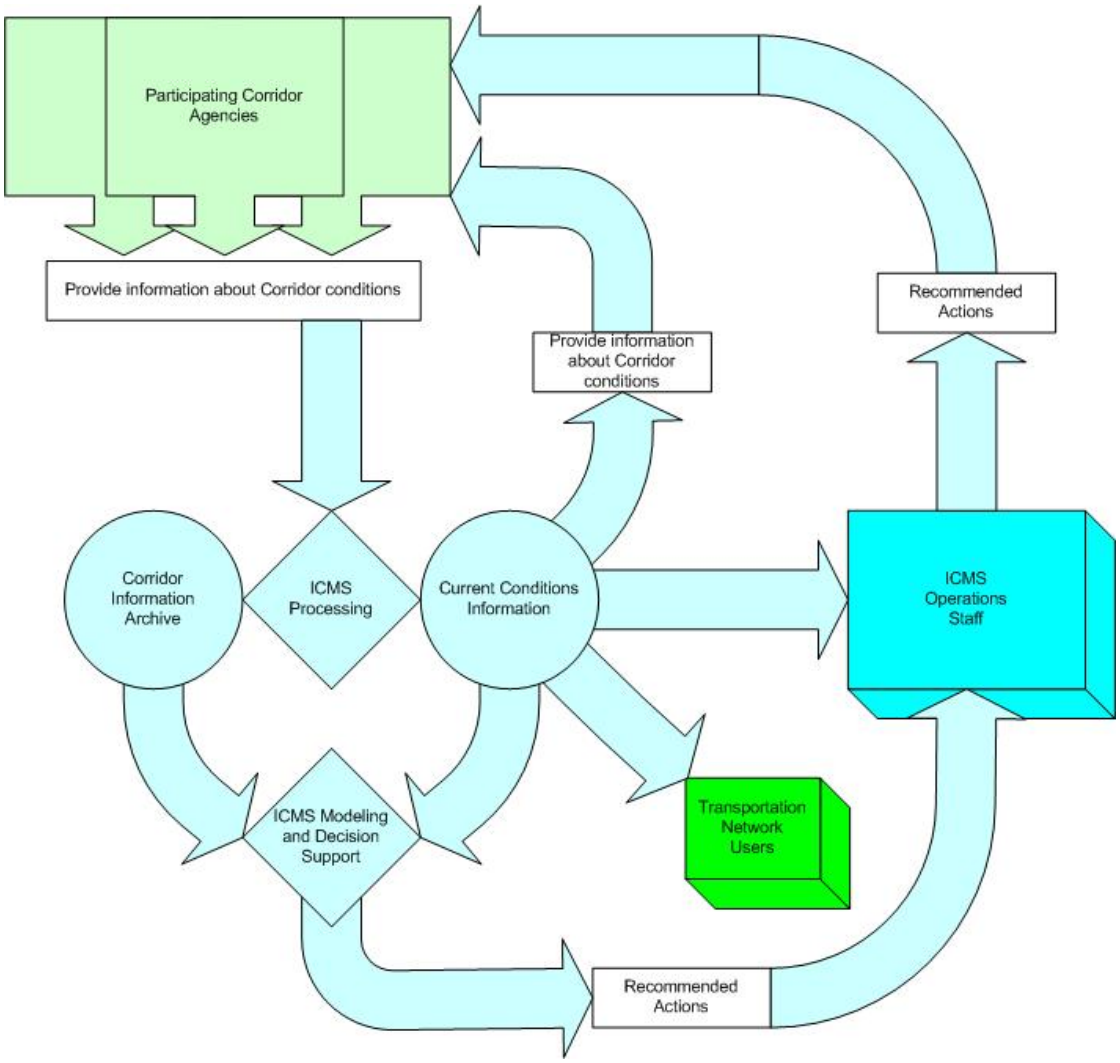

Figure 3 - Components and High-level Information Flows for ICMS

The ICMS architecture is constrained by the primary goal of optimizing the movement of goods and people through the corridor using the available transportation modes. The ICMS must receive inputs in the form of information and operational decisions from every participating transportation mode in the corridor. The ICMS processing algorithms must be capable of determining what should be done based on all of the possible states of all participating transportation modes. The ICMS outputs must be based on optimizing the value of the performance of all of the travel modes to the stated goal of moving goods and people through the corridor.

Simple integration of communications and computing infrastructure will not be sufficient for an ICMS architecture. Sharing information and ITS equipment controls will not constitute an ICMS. The ICMS architecture will require AMS components capable of evaluating multiple travel modes, and decision support or closed loop control components capable of using feedback from the AMS components to make changes in how all of the transportation modes operate. An ICMS requires a common understanding and agreement across all corridor participants as to how "good for the corridor" will be measured. A system where participants will only make changes that benefit the operation of their particular transportation mode is not truly integrated, nor can it be considered an "Integrated Corridor Management" system.

For the purposes of this document, the architecture is based on participation of the following systems:

- **Arterial Traffic Management System** – Arterial traffic management may take many forms. In some corridors this may be a central traffic signal management system that has been modified to provide real-time arterial traffic surveillance and detection information. These requirements will also treat this system as a source of surveillance video and information about the arterial roadside equipment whenever such information is available.
- ***Clarus*** – The *Clarus* system collects weather data from multiple sources. If the agencies in the corridor provide RWIS information to *Clarus*, it may be easier to collect weather information in and around the corridor from *Clarus* rather than interface with multiple RWIS systems. Some *Clarus* requirements are included as an example of how to acquire weather surveillance data from this source.
- **Construction/Maintenance Management System** – Construction and maintenance management systems often contain valuable information about events that will have transportation impacts. Examples include information about activities that may close or limit access to transit stops or parking facilities, or the lane closures and detours associated with arterial maintenance activities.
- **Parking Management System** – There may be multiple parking management systems in a corridor, and in some cases, parking information may come from transit management systems.
- **Public Safety CAD System** – Computer Aided Dispatch (CAD) systems usually don't have surveillance data about the arterial network, but they are often a source of information about incidents and special events.
- **Road Weather Information System** – Some corridors may have Road Weather Information Systems (RWIS) that can provide information about road conditions and general information about weather conditions that could help assess the

weather's impact on the transportation networks in the corridor. The RWIS may also be the source of information about the status of the ESS equipment.

- **Roadside Equipment** – In most corridors, the roadside equipment will be connected to one of the systems previously mentioned in this list. Roadside equipment would include the Vehicle Detection Station (VDS), Closed Circuit Television (CCTV) camera, Dynamic Message Sign (DMS), Highway Advisory Radio and Traffic Advisory Radio (HAR/TAR), Environmental Sensor Station (ESS), and parking facility equipment in the field.
- **Transit Management System** – The transit management system may serve as the focal point for all of the surveillance and detection information about the transit network, including Automatic Vehicle Location (AVL) and Automated Passenger Counting (APC) data.

In a typical corridor, the number of participating agencies and systems could be substantially larger. Within the scope of this document it is not possible to provide examples for every potential data source within a corridor. These example systems will be used to provide example requirements for most situations that would be found in a corridor.

2.2.3 Data Flow

For the purposes of this document, the ICMS requirements will be based on a simplified set of data flows. Figure 4 shows the information flows based on the type of information, without regard to the system or agency that may provide the information. Each system that provides information to the ICMS will be associated with interface requirements that define the physical, functional, performance, and protocol requirements for the interface. These are usually defined in a separate Interface Control Document (ICD). The ICMS will have functional requirements associated with each data flow from each source system. The functional requirements will have complementary data requirements describing what data are included in the flow and performance requirements establishing how frequently the data will be acquired and how long it will be retained.

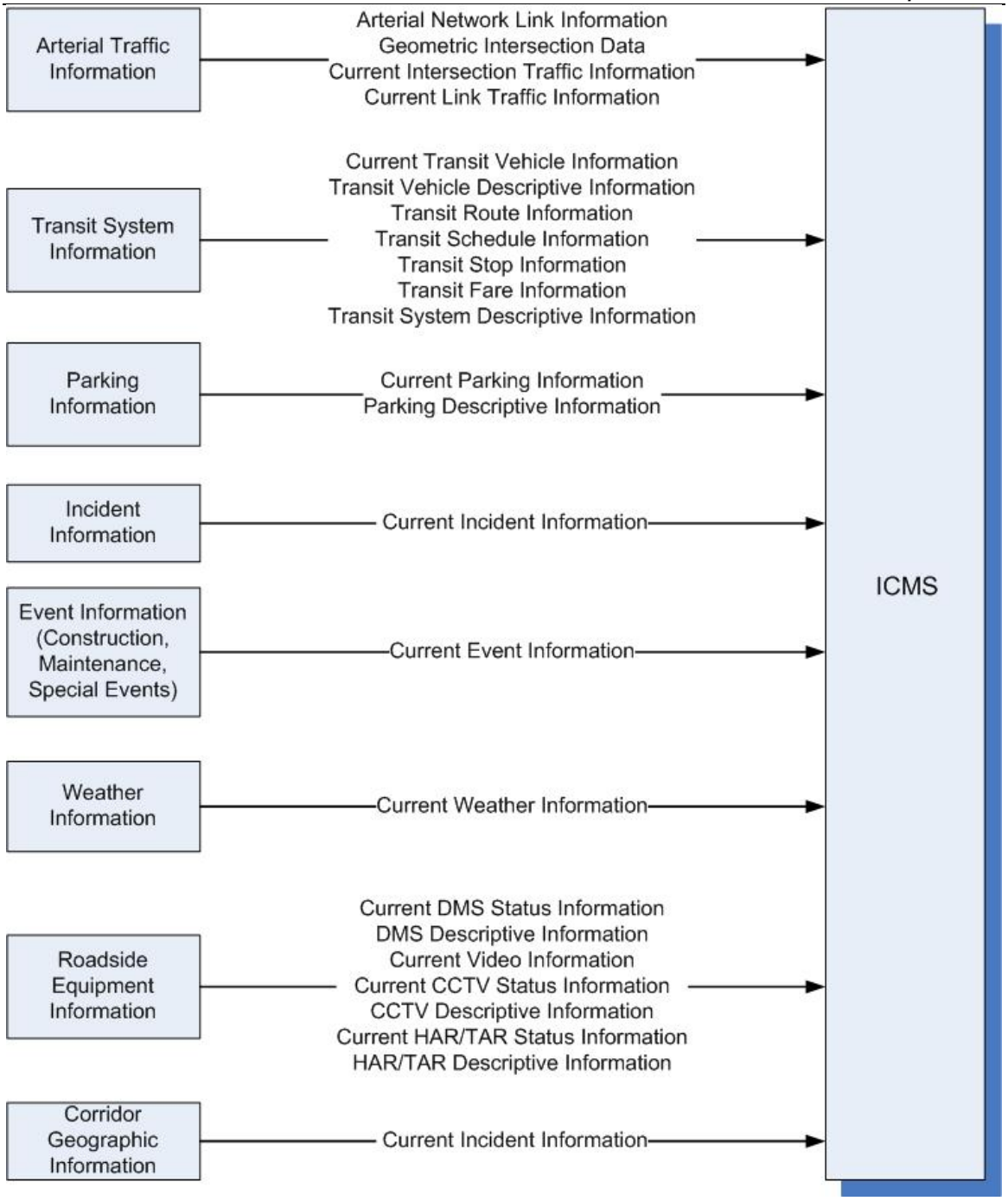

Figure 4 - Basic Data Flows for Arterial and Transit Surveillance Information

Another way to look at the ICMS data is in terms of the data stores for the information in these data flows. With the exception of the video information from cameras, the information flows represent "live" information that will go into a current data store in the ICMS, or relatively static information describing the corridor. This later descriptive information is often referred to as metadata. The metadata provides the required context for the observational data. In most cases, both the current observations and the metadata are archived in a historical database. The historical archive provides information for

reporting, analysis, and modeling. Figure 5 shows the context for the ICMS data associated with arterial and transit surveillance and detections.

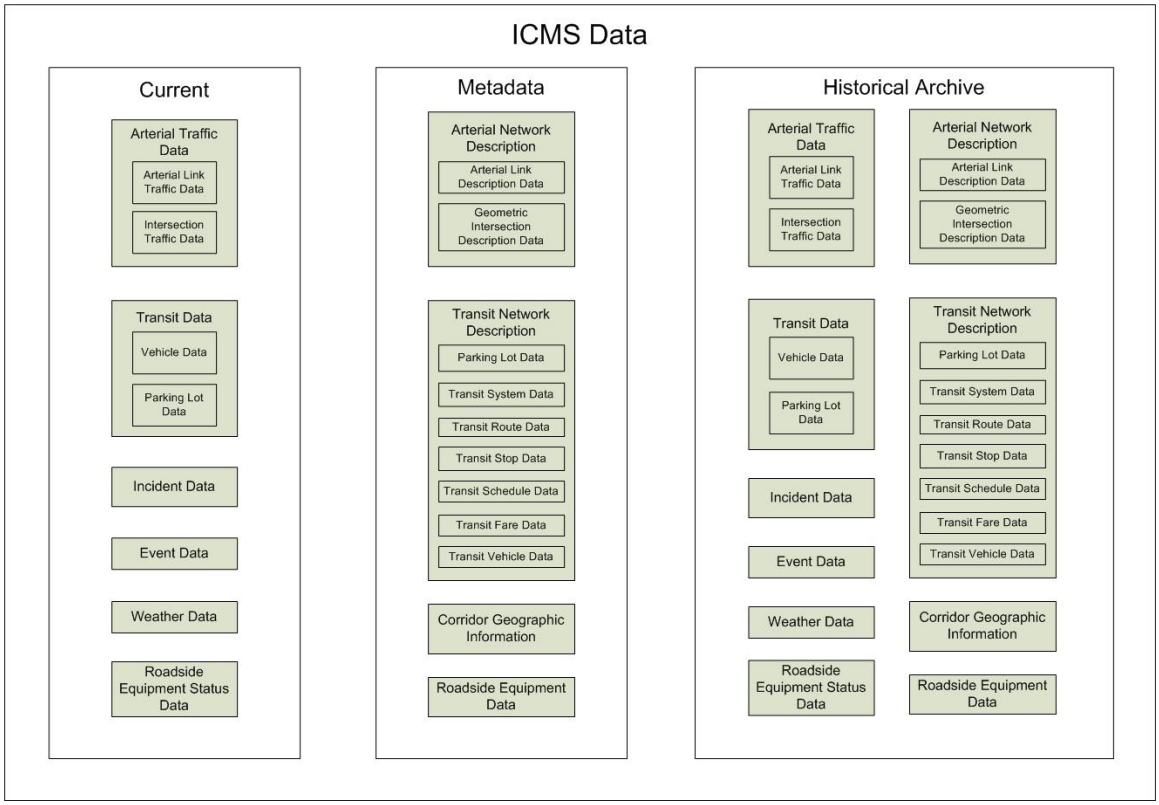

Figure 5 - ICMS Data for Arterial and Transit Surveillance Information

2.3 Surveillance and Detection Concepts

Surveillance and detection requirements for ICMS are driven by the purposes for which the information will be used, the limitation on the capabilities required to collect the information, and the ability to deliver the information to the ICMS.

The purpose will often dictate what information is needed (data types), where the data should be collected (location), how often the data should be sampled (sampling rate), and how often the data should be reported to the ICMS (reporting rate). The purpose may also dictate the accuracy and precision requirements for each data type. The time between acquiring a data sample and when it can be displayed to an ICMS operator (latency) may also be of concern for certain time sensitive data types. Latency may also be a critical issue in closed loop control functions.

Data acquisition can be expensive and this cost often places limitations on the number of values that can be sampled and the number of locations where data sampling can take place. Since the materials, equipment, installation, and maintenance costs for sensors are a factor, past designs often favor implementing a small number of sensors and calculating much of the required data from the samples collected from the sensors. For example, vehicle presence detector data are often used to calculate speed, volume, and occupancy data. Using data from existing detection sensors can help close data gaps, provided the design, location, and accuracy of the resulting data meet the requirements set by the ICMS purpose for the data.

The reporting rate, volume of information required, and latency restrictions figure heavily into the ability to deliver information to the ICMS. The freeway, tollway, arterial, and transit networks in a corridor can easily cover hundreds of square miles. The costs associated with providing power and communications to each sensor location can therefore place a constraint on the number of locations, and may even make some locations prohibitively expensive to monitor.

A distinction may need to be made between the data used for operational purposes, and the data archived in the historical data. Depending on the requirements for reporting, analysis, modeling, and decision support uses of the historical data, some data reduction processing may take place before data is placed in the archive. Data reduction techniques include sampling (record only every nth value), averaging (calculating the average value of samples over a specified time range), min/max (record only the highest and lowest values within a specified time range), or combinations of these techniques. These techniques should be used with caution. While data reduction may save money, the methods can place severe restrictions on how the processed data can be used in the future.

Corridors with modern Advanced Traffic Management Systems (ATMS) will usually have most, if not all, of the surveillance and detection capabilities required to support an ICMS implementation. The remainder of this section will focus on a discussion of the arterial and transit surveillance requirements that are detailed in Section 3.

2.3.1 Arterial Traffic Data

Several research projects have focused, in part, on whether the vehicle detectors associated with traffic signal systems can be used to gather the desired traffic data for ICMS and for other modeling, analysis, and simulation purposes. This is due in large part to the anticipated cost associated with adding any other arterial traffic sensors. This possibility raises several questions about where the sensors should be located and what information the sensors should be capable of collecting.

A signal system usually needs to know that there is a vehicle in one or more of the approach lanes to the intersection. In some cases, but not always, it may be important to know whether the vehicle is in a turn lane or a through lane. Sensors in adjacent lanes might be connected so that a vehicle in either lane would yield presence detection. Alternatively, several sensors along the queue might be connected so that a vehicle anywhere along the approach would yield presence detection. Either of these configurations would make it difficult, if not impossible, to use the sensors to collect speed, volume, and occupancy data.

The best modeling and analysis tools use speed, volume, and occupancy data for each approach lane in the intersection. Analysis and performance modeling for the signal system will also require corresponding signal phase information for the turn and through signal heads and require that the traffic data and signal data be time-stamped and collected at higher sampling rates than most signal controllers can handle without modification.

Signal systems may provide the necessary information about traffic in the intersections, but the very nature of a signalized intersection makes it a troublesome place to collect information about traffic flow in the arterial links – the roadways between the intersections. Modeling and performance measures for the arterial links are more focused

on the speed and volume of traffic (though not necessarily on a lane-by-lane basis). Without additional sensors on the exit roadways leaving the intersection, it is difficult to measure the volume of traffic on each link. Since link travel time is a preferred performance measure, the problem arises of where and how to measure speed for the travel time calculation.

Since it would be less expensive to install link sensors at intersections, some research is looking at whether sensors on exit lanes at or near the crosswalks can collect information that can be used to accurately calculate link volumes, link speeds, and link travel times.

Other research has focused on sensors about 400 ft from the intersection. The idea here is that sensors would be close enough to the intersection that it would still be possible to connect them to controllers or other data acquisition devices in the intersection. This would allow the existing communication and power infrastructure of the intersection to be used. The 400 ft distance from the intersection would usually be enough to dampen the effects of the intersection traffic and would more nearly represent free flow conditions on the link.

Still other projects have settled on mid-block sensors, installing the required communications and power infrastructure for the sensors when necessary. Of course, as distance between intersections decreases, the 400 ft and mid-block solutions converge to the mid-block solution.

Figure 6 shows the potential locations for traffic sensors to collect the intersection and link data for an ICMS. There is no clear consensus at this time as to which of the potential sensor locations are best suited for collecting ICMS data.

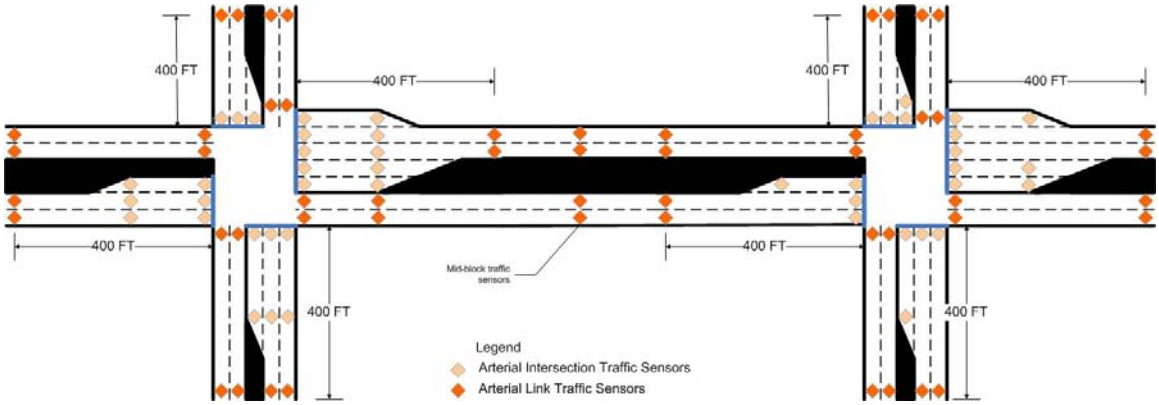

Figure 6 - Potential Sensor Locations for Collecting Arterial Traffic Data

2.3.2 Transit Data

The surveillance and detection data for transit systems falls into two categories:

- Vehicle data (location, speed, passenger counts)
- Parking facility data (current utilization)

Most of the data issues for transit systems revolve around communications with the vehicles. The key information all centers on data that is only available in the vehicle: vehicle location, time to arrival at next stop (derived from vehicle location and speed),

and the remaining capacity to carry additional passengers (derived from the current passenger count).

There are substantial differences between how bus and rail transit systems acquire vehicle location and speed data. AVL systems are the only practical way for bus systems to acquire the vehicle and speed data. The location of rail transit vehicles (heavy rail, light rail, and commuter rail) is typically tracked via the train control system, which uses blocks. For heavy rail (subways), these blocks are short and the location of trains can be determined with fairly high precision. For light rail, the blocks are typically longer (300 – 500 feet in length). However, sometimes light rail operators use GPS-AVL to track the location of their trains if their system is above ground. For commuter rail, which typically operates on the general railroad system (using freight train tracks), the blocks are even longer (300 – 1,000 feet in length). Speed is estimated based on the distance a train travels per unit of time.

AVL systems can provide the desired location and speed data, but communications limitations can limit how often the data is reported. Most APC systems are designed to collect passenger counts and download the data at the end of the day. Even if real-time counts are available, data communications limitations may prevent the system from sending the data from the bus to the transit management system on a real-time basis.

Even though parking facilities may not be operated by the transit agency, or even associated with the transit system, parking information can have a heavy impact on corridor transportation usage patterns. Absence of destination parking can make transit travel more attractive, and absence of parking and transit stops near the trip origin can make transit travel less attractive. The key information is basically how many parking spaces are remaining at each facility at any given time. Most parking management systems arrive at this information by counting vehicles as they enter and leave the facility, but it may be possible to monitor the presence/absence of vehicles in each parking space as well.

The requirements in this document assume that mode shifts to transit systems are a corridor management strategy, and that the nature of the planned shifts will require current information about both the location and capacity of the transit vehicles. For this reason, the requirements are specifying collection of the AVL and APC data while the vehicles are in operation.

Lower priority decisions for integration of transit infrastructure revolve around whether the message signs at transit stops need to be integrated with the ICMS, and whether video from transit vehicles or transit stops should be included with the surveillance video feeds for monitoring traffic. The requirements in this document will generally not include DMS and CCTV systems associated with the transit network. If these surveillance and detection sources are needed in a corridor, the requirements for arterial DMS and CCTV systems could be easily adapted for the equivalent transit system components.

3 System Requirements

This section presents the basic requirements for the surveillance and detection of arterial and transit networks for a typical ICMS. The requirements are intended to be detailed enough to establish an understanding of the requirements as they apply to all corridors and to provide guidance for tailoring requirements to specific corridors.

The requirements do not cover every type of data that might be needed in a corridor. The requirements represent a basic core for surveillance and detection requirements in a corridor. Additional surveillance and detection data may be required depending on the nature of a specific corridor or the architecture of a specific ICMS implementation. For example, some requirements have been included for acquiring surveillance video data, but no requirements have been included for managing or archiving video data.

In this section, the requirements are divided into a number of categories as follows:

- System Performance - the requirements that define the critical performance conditions of the system and the associated capabilities. These requirements will include functional capabilities and performance characteristics such as speed of execution, frequency of execution, and planned utilization rates.
- Information Management - the requirements that relate to data types, data structures, data management, data retention, and data backup and restoration requirements.
- System Interfaces - the requirements that relate to interfaces among different components and their external capabilities, including all of the system users and external systems that participate in the function of the system.

These requirements are inter-related. Each system that communicates with the ICMS will need requirements to specify the interface. Each interface may define one or more data flows and a functional requirement will be associated with each data flow. The functional requirements for data flows will have associated data requirements to define what data elements are part of the flow, and performance requirements that define how often the data transfer occurs and how long the data will be retained in the historical archive.

Metadata is usually static, unchanging over long periods of time and as a result, many systems are not capable of exchanging metadata on an active basis. The requirements in these specifications assume that metadata will be exchanged using data exports and data imports that are managed manually by the system administrator.

Table 1 shows the general layout of the requirements tables, and explains the purpose or content of each column of the requirements table.

Table 1 - Explanation of the Requirements Tables Attributes

ID	Requirement	Source	Comment	Allocation	Criticality
A unique identifier used to trace requirements from beginning to end in a system development process. An example ID format is shown in Table 2.	The text of the actual requirement. Requirements formulated with "… shall…" are direct requirements; those using "… will…" are conditioned on other requirements being fulfilled or on factors outside the control of the requirement's subject.	Need or needs which are the root source of the requirement. N1 would indicate Need 1 as listed in Appendix C.	Supporting text that may help explain the requirement, its priority, or any risks that could hinder successful implementation of the requirement.	The system, sub-system, or other allocation unit to which the requirement has been assigned. (if known)	H = High (required to accomplish mission) M = Medium (will improve ability to accomplish mission) L = Low (nice to have, but will not affect ability to accomplish mission)

Table 2 shows an explanation of the requirement identification numbering system. The identification scheme in this document uses a parent-child relationship to group related requirements. Stripping the last three digits of a child requirement ID will yield the ID for the parent (e.g. D-012 is the parent of the child requirement D-012-017). Child requirements are used to provide a breakdown or refinement of the parent requirement.

Table 2 - Requirement ID Format

Requirement ID Format	Explanation of Format
High-Level Requirement X-NNN Detailed Requirement X-NNN-UUU-UUU	**X – Represents the classification of the requirements within the requirements document. The following classifications have been used in this requirements specification:** F – **Functional Requirements** P – **Performance Requirements** D – **Data Requirements** I – **Interface Requirements** NNN **Represents the High-Level requirement sequence number. Numbering is not necessarily sequential; gaps in the sequence leave room to add additional related requirements when they are discovered.** UUU-UUU **Provides unique identification for detailed requirements.**

Table 3 provides a glossary of the action verbs used in the requirements and the intended meaning of each action verb for the purposes of this specification. This glossary is provided as an illustration of one way to reduce ambiguity. Organizations may choose different terms and establish alternate definitions that are specific to the requirements that will be written.

Table 3 - Glossary of Requirements Terms

Acquire	Acquire is used when the system will receive data from an external source when there is no design constraint on whether the data exchange is a "push" or a "pull".
Calculate	Calculate is used when the system must use an algorithm to mathematically or logically evaluate data to arrive at a specified result. If a specific algorithm is required, the algorithm will be specified. Otherwise the algorithm is left to the designer.
Control	Requirements formulated with "…shall control…" indicate that the system must include the components necessary for the system to effect direct control of the specified object. Requirements formulated with "…shall provide controls…" indicate that the system must provide a user interface that includes the capabilities required for the user to control the specified object through the system interface.
Data Store	A data store is a physical device capable of storing data used by the system. Use of the term data store also implies that there is a file structure or data structure that provides organization to the information contained in the data store. Data store is used in place of "database" to avoid mandating a database as the design solution for the requirement.
Determine	Requirements formulated with "…shall determine…" indicate that the system must perform a calculation or logical operation to calculate or select the specified result. In the absence of additional detailed requirements for the algorithm, the designer is expected to determine the required methods for making the determination.
Display	Requirements formulated with "…shall display…" indicate that the system must present the specified information using the specified visual user interface.
Forecast	Requirements formulated with "…shall forecast…" indicate that the system must perform a calculation or logical operation to calculate or select the specified result where the result represents a predicted future value or condition. In the absence of additional detailed requirements for the algorithm, the designer is expected to determine the required methods for making the forecast.
Get	Requirements formulated with "…shall get…" imply a design constraint that mandates that the system initiate the data transfer. The system must "pull" or poll the external system for the information as opposed to a "push" where the external system initiates the data transfer.
May	Requirements formulated with "… may…" are permissive and describe a permissible/optional feature or behavior. To avoid ambiguity, the opposite of may is expressed as "need not", instead of "may not".
Include	Include is used to indicate that the specified functionality, hardware, or other component must be provided as a part of the system.
Print	Requirements formulated with "…shall print…" indicate that the system must present the specified information in hard copy form using a printing device.
Process	Requirements formulated with "…shall process…" indicate that the system must perform a calculation or logical operation to achieve the specified result. In the absence of additional detailed requirements for the algorithm, the designer is expected to determine the required methods for the processing.
Provide	Requirements formulated with "…shall provide…" indicate that the system will make data available to an external system. The term is used when there is not a design constraint on whether the method is "push" or "pull".

Publish	Requirements formulated with "…shall publish…" indicate that the system will make data available to an external system and that there is a design constraint mandating that the system receiving the data must "pull" or poll for the data. This is the opposite of "send".
Quality Check	Requirements formulated with "…shall quality check…" indicate that the system must perform a calculation or logical operation to validate that data meets specified quality measures. In the absence of additional detailed requirements for the algorithm, the designer is expected to determine the required methods for the processing.
Receive	Requirements formulated with "…shall receive…" indicate that the system will acquire data and that there is a design constraint mandating that the external system providing the data must "push" the data.
Send	Requirements formulated with "…shall send…" indicate that the system will make data available to an external system and that there is a design constraint mandating that the system "push" the data. This is the opposite of "publish".
Store	Requirements formulated with "…shall store…" indicate that the system must place the information in a non-volatile memory device.
Switch	Requirements formulated with "…shall switch…" indicate that the system must take the necessary actions to route information from a source to a specified destination.
Update	Requirements formulated with "…shall update…" indicate that the system must replace existing information with newer information. This implies deleting or overwriting the previous information.
Validate	Requirements formulated with "…shall validate…" indicate that the system must perform a calculation or logical operation to validate that data meets specified quality measures. In the absence of additional detailed requirements for the algorithm, the designer is expected to determine the required methods for the processing.
Shall	Requirements formulated with "… shall…" describe a feature or behavior that is mandatory for an implementation that conforms to this document. Such requirements will be validated by test or inspection.
Will	Requirements formulated using "… will…" are conditioned on other requirements being fulfilled or on factors outside the control of the requirement's subject.
Should	Requirements formulated using "… should…" describe a goal, feature, or behavior that is recommended but not mandatory.

3.1 System Performance Requirements

This section covers the requirements that define the critical performance conditions of the system and the associated capabilities. These requirements will include functional capabilities and performance characteristics such as speed of execution, frequency of execution, and planned utilization rates.

The performance values (speeds, frequencies, etc.) in these requirements are recommended values. These values may need to be modified to meet the needs of each corridor and the capabilities of supporting systems in the corridor.

3.1.1 Functional Requirements

These requirements address what functions the system must perform, including special functions relating to specific operational phases and modes. These requirements may include specific methods, calculations, or algorithms where constraints on the methods exist.

The F-001 series of requirements identify each type of information that the system will acquire, and the sources from which the system will acquire the information.

3.1.1.1 Functional Requirements for Arterial Information

ID	Requirement	Source	Comment	Allocation	Criticality
F-001-010	The ICMS shall acquire Current Arterial Traffic Information from data sources monitoring the arterial network.	N1, N2, N3, N4.5		ICMS	H
F-001-010-010	The ICMS shall acquire Current Roadside Equipment Status Data from Vehicle Detection Stations.	N4.5	This requirement applies to corridors where the ICMS will monitor the status of roadside equipment.	ICMS	L
F-001-010-020	The ICMS shall acquire Current Arterial Traffic surveillance video from Closed Circuit Television.	N2, N3	This requirement applies to corridors where the ICMS will need to acquire traffic surveillance information from CCTV cameras in the arterial network.	ICMS	L
F-001-010-050	The ICMS shall acquire Current Arterial Link Traffic Data from the Arterial Traffic Management System.	N1, N2, N3, N4.5	A similar requirement should be generated for each system that will provide Arterial Link Traffic Data.	ICMS	H
F-001-010-055	The ICMS shall acquire Current Arterial Intersection Traffic Data from the Arterial Traffic Management System.	N1, N2, N3, N4.5	A similar requirement should be generated for each system that will provide Arterial Intersection Traffic Data.	ICMS	H

3.1.1.2 Functional Requirements for Transit Information

ID	Requirement	Source	Comment	Allocation	Criticality
F-001-020	The ICMS shall acquire Current Transit Vehicle Data from data sources monitoring the transit network.	N1, N3, N4.5		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
F-001-020-010	The ICMS shall acquire Current Transit Vehicle Data from the Transit Management System.	N1, N3, N4.5	This requirement applies to corridors where the ICMS will need to acquire transit vehicle data from transit management systems. A similar requirement should be generated for each system that will provide Current Transit Vehicle Data.	ICMS	H
F-001-030	The ICMS shall acquire Current Parking Facility Data from data sources monitoring parking facilities in the corridor.	N1, N3, N4.5		ICMS	H
F-001-030-020	The ICMS shall acquire Current Parking Facility Data from the Parking Management System.	N1, N3, N4.5	This requirement applies to corridors where the ICMS will need to acquire parking facility data from parking management systems. A similar requirement should be generated for each system that will provide Current Parking Facility Data.	ICMS	H

3.1.1.3 Functional Requirement for Related Observational Information

ID	Requirement	Source	Comment	Allocation	Criticality
F-001-040	The ICMS shall acquire Current Weather Data from data sources monitoring weather information that will affect the corridor.	N1, N2, N3, N4.5		ICMS	M
F-001-040-010	The ICMS shall acquire Current Weather Data from the RWIS system.	N1, N2, N3, N4.5	This requirement applies to corridors where the ICMS will need to acquire weather data from road weather systems. If there are multiple RWIS systems, a similar requirement should be generated for each system that will provide Current Weather Data.	ICMS	M

ID	Requirement	Source	Comment	Allocation	Criticality
F-001-040-040	The ICMS shall acquire Current Weather Data from the *Clarus* System.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to acquire weather data from the *Clarus* System for the corridor.	ICMS	M
F-001-050	The ICMS shall acquire Current Event Data from sources in the corridor.	N1, N2, N3, N4.5		ICMS	H
F-001-050-030	The ICMS shall acquire Current Event Data from the Construction/Maintenance Management System.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to acquire current information about planned events from a Construction/Maintenance Management System in the corridor. A similar requirement should be generated for each system that will provide Current Event Data.	ICMS	H
F-001-050-050	The ICMS shall acquire Current Event Data from authorized ICMS Operators via manual entry.	N1.2.3, N2, N3		ICMS	H
F-001-080	The ICMS shall acquire Current Incident Data from data sources in the corridor.	N1, N2, N3		ICMS	H
F-001-080-010	The ICMS shall acquire Current Incident Data from the Public Safety CAD System.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to acquire Incident Information from a Public Safety CAD System in the corridor. A similar requirement should be generated for each system that will provide Current Incident Data.	ICMS	H
F-001-080-020	The ICMS shall acquire Current Incident Data from the Arterial Traffic Management System.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to acquire Incident Information from a Traffic Management System in the corridor.	ICMS	H
F-001-080-040	The ICMS shall acquire manually entered Current Incident Data from authorized ICMS Operators via manual entry.	N1, N2, N3		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
F-001-080-060	The ICMS shall acquire Current Incident Data from the Transit Management System.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to acquire Incident Information from the Transit Management System.	ICMS	M

3.1.2 Performance Requirements

These requirements will include performance characteristics such as speed of execution, frequency of execution, and planned utilization rates for functionality where these requirements have not already been stated in the functional requirements.

ID	Requirement	Source	Comment	Allocation	Criticality
P-002-002	Unless otherwise specified in the governing Interface Control Documents, the ICMS shall update Current Arterial Link Traffic Data at least once every 60 seconds.	N1, N2, N3		ICMS	H
P-002-004	Unless otherwise specified in the governing Interface Control Documents, the ICMS shall update Current Arterial Intersection Traffic Data at least once every 60 seconds.	N1, N2, N3		ICMS	H
P-002-006	Unless otherwise specified in the governing Interface Control Documents, the ICMS shall update Current Transit Vehicle Data at least once every 30 seconds.	N1, N2, N3		ICMS	H
P-002-008	Unless otherwise specified in the governing Interface Control Documents, the ICMS shall update Current Parking Facility Data at least once every 60 seconds.	N1, N2, N3		ICMS	H
P-002-010	Unless otherwise specified in the governing Interface Control Documents, the ICMS shall update Current Weather Data at least once every 20 minutes.	N1, N2, N3		ICMS	H
P-002-012	Unless otherwise specified in the governing Interface Control Documents, the ICMS shall update Current Roadside Equipment Status Data at least once every 5 minutes.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to directly acquire data from roadside equipment.	ICMS	L

ID	Requirement	Source	Comment	Allocation	Criticality
P-004-002	The ICMS shall perform data quality checks and store Current Arterial Link Traffic Data in the Current Arterial Link Traffic Data Store within 5 seconds of receiving the data.	N1, N2, N3	If 5 seconds is not enough time, the requirements engineer may increase the time. Before increasing the time, consider the value trade-off between increased latency and extensive quality checks.	ICMS	H
P-004-004	The ICMS shall perform data quality checks and store Current Arterial Intersection Traffic Data in the Current Arterial Intersection Traffic Data Store within 5 seconds of receiving the data.	N1, N2, N3	If 5 seconds is not enough time, the requirements engineer may increase the time. Before increasing the time, consider the value trade	ICMS	H
P-004-006	The ICMS shall perform data quality checks and store Current Transit Vehicle Data in the Current Transit Vehicle Data Store within 5 seconds of receiving the data.	N1, N2, N3	If 5 seconds is not enough time, the requirements engineer may increase the time. Before increasing the time, consider the value trade	ICMS	H
P-004-008	The ICMS shall perform data quality checks and store Current Parking Facility Data in the Current Parking Facility Data Store within 5 seconds of receiving the data.	N1, N2, N3	If 5 seconds is not enough time, the requirements engineer may increase the time. Before increasing the time, consider the value trade	ICMS	H
P-004-010	The ICMS shall perform data quality checks and store Current Weather Data in the Current Weather Data Store within 5 seconds of receiving the data.	N1, N2, N3	If 5 seconds is not enough time, the requirements engineer may increase the time. Before increasing the time, consider the value trade	ICMS	L
P-004-012	The ICMS shall perform data quality checks and store Current Roadside Equipment Status Data in the Current Roadside Equipment Status Data Store within 5 seconds of receiving the data.	N1, N2, N3	This requirement applies to corridors where the ICMS will need to directly acquire data from roadside equipment.	ICMS	L

3.2 System Information Management Requirements

This section covers the requirements that relate to data types, data structures, data management, data retention, and data backup and restoration requirements. Data storage capacity should be sized to meet current and future demands of the corridor.

The sizing values in the following requirements are provided for illustration purposes. Each corridor must establish sizing criteria appropriate for the amounts of data anticipated for the corridor, and the data retention times appropriate for the corridor.

NOTE: The tables referenced in the following requirements can be found in APPENDIX D – ICMS DATA**.**

ID	Requirement	Source	Comment	Allocation	Criticality
D-002	The ICMS shall include a data store for current information about the transportation network.	N1, N2, N3, N4.5		ICMS	H
D-002-001	The ICMS shall include a data store for Current Incident Data.	N1, N2, N3		ICMS	H
D-002-001-002	The ICMS Current Incident Data shall include the data elements listed in Table D-002-001-002.	N1, N2, N3		ICMS	H
D-002-001-004	The ICMS shall include data storage capacity for Current Incident Data for 1000 incidents.	N1, N2, N3		ICMS	H
D-002-002	The ICMS shall include a data store for Current Event Data.	N1, N2, N3		ICMS	H
D-002-002-002	The ICMS Current Event Data shall include the data elements listed in Table D-002-002-002.	N1, N2, N3	Current event information may include events that are scheduled for future times but are not yet in effect. In this context “current” refers to the information, not the event.	ICMS	H
D-002-002-004	The ICMS shall include data storage capacity for Current Event Data for 10,000 events.	N1, N2, N3		ICMS	H
D-002-006	The ICMS shall include a data store for Current Arterial Traffic Data.	N1, N2, N3, N4.5		ICMS	H
D-002-006-002	The ICMS Current Arterial Link Traffic Data shall include the data elements listed in Table D-002-006-002.	N1, N2, N3, N4.5		ICMS	H
D-002-006-004	The ICMS shall include data storage capacity for Current Arterial Traffic Data for 1000 links.	N1, N2, N3, N4.5		ICMS	H
D-002-006-006	The ICMS Current Arterial Intersection Traffic Data shall include the data elements listed in Table D-002-006-006.	N1, N2, N3, N4.5		ICMS	H
D-002-006-008	The ICMS shall include data storage capacity for Current Arterial Intersection Traffic Data for 1000 intersections.	N1, N2, N3, N4.5		ICMS	H
D-002-008	The ICMS shall include a data store for Current Transit Vehicle Data.	N1, N2, N3, 4.5		ICMS	H
D-002-008-002	The ICMS Current Transit Vehicle Data shall include the data elements listed in Table D-002-008-002.	N1, N2, N3, N4.5		ICMS	H
D-002-008-004	The ICMS shall include data storage capacity for Current Transit Vehicle Data for 1000 vehicles.	N1, N2, N3, N4.5		ICMS	H
D-002-009	The ICMS shall include a data store for Current Parking Facility Data.	N1, N2, N3, N4.5		ICMS	H
D-002-009-002	The ICMS Current Parking Facility Data shall include the data elements listed in Table D-002-009-002.	N1, N2, N3, N4.5		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
D-002-009-004	The ICMS shall include data storage capacity for Current Parking Facility Data for 100 parking lots.	N1, N2, N3, N4.5		ICMS	H
D-002-010	The ICMS shall include a data store for Current Weather Data.	N1, N2, N3		ICMS	M
D-002-010-002	The ICMS Current Weather Data shall include the data elements listed in Table D-002-010-002.	N1, N2, N3, N4.5		ICMS	M
D-002-010-004	The ICMS shall include data storage capacity for Current Weather Data for 1000 locations.	N1, N2, N3, N4.5		ICMS	M
D-002-016	The ICMS shall include a data store for Current Roadside Equipment Status Data.	N1, N4.5		ICMS	L
D-002-016-002	The ICMS Current Roadside Equipment Status Data shall include the data elements listed in Table D-002-016-002.	N1, N4.5		ICMS	L
D-002-016-004	The ICMS shall include data storage capacity for Equipment Status Data for 10,000 locations.	N1, N4.5		ICMS	L
D-004	The ICMS shall include a data store for Descriptive Information about the transportation network.	N1, N2, N3, N4		ICMS	H
D-004-002	The ICMS Descriptive Information Data Store shall include storage for Roadside Equipment Data.	N1, N4		ICMS	H
D-004-002-002	The ICMS Roadside Equipment Data shall include the data elements listed in Table D-004-002-002.	N1, N4		ICMS	H
D-004-002-004	The ICMS shall include data storage capacity for Roadside Equipment Data for 15,000 locations.	N1, N4		ICMS	H
D-004-004	The ICMS shall include a data store for Corridor Geographic Information.	N1, N3, N4		ICMS	H
D-004-004-002	The ICMS Corridor Geographic Information shall include the data elements listed in Table D-004-004-002.	N1, N3, N4		ICMS	H
D-004-005	The ICMS shall include a data store for Arterial Link Data.	N1, N4		ICMS	H
D-004-005-002	The ICMS Arterial Link Data shall include the data elements listed in Table D-004-005-002.	N1, N3, N4		ICMS	H
D-004-004-004	The ICMS shall include data storage capacity for Arterial Link Data for 1000 Arterial Links.	N1, N3, N4		ICMS	H
D-004-006	The ICMS shall include a data store for arterial Geometric Intersection Description data.	N1, N4		ICMS	H
D-004-006-002	The ICMS Geometric Intersection Description data shall include the data elements listed in Table D-004-006-002.	N1, N4		ICMS	H
D-004-006-004	The ICMS shall include data storage capacity for Geometric Intersection Description information for 1000 intersections.	N1, N4		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
D-004-008	The ICMS shall include a data store for Arterial Network Descriptive Data.	N1, N2, N3, N4.3		ICMS	H
D-004-008-002	The ICMS Arterial Network Descriptive Data shall include the data elements listed in Table D-004-008-002.	N1, N2, N3, N4.3		ICMS	H
D-004-008-004	The ICMS shall include data storage capacity for descriptive information for 10 Jurisdictions.	N1, N2, N3, N4.3		ICMS	H
D-004-016	The ICMS shall include a data store for Parking Facility Descriptive Data.	N1, N3, N4		ICMS	H
D-004-016-002	The ICMS Parking Facility Descriptive Data shall include the data elements listed in Table D-004-016-002.	N1, N3, N4		ICMS	H
D-004-016-004	The ICMS shall include data storage capacity for Parking Facility Descriptive Data for 200 parking lots.	N1, N3, N4		ICMS	H
D-004-018	The ICMS shall include a data store for Transit System Descriptive Data.	N1, N3, N4		ICMS	H
D-004-018-002	The ICMS Transit System Descriptive Data shall include the data elements listed in Table D-004-018-002.	N1, N3, N4		ICMS	H
D-004-018-004	The ICMS shall include data storage capacity for Transit System Descriptive Data for 3 transit systems.	N1, N3, N4	The metadata for a “transit system” includes the agency name, address, and other contact information.	ICMS	H
D-004-018-006	The ICMS Transit Route Descriptive Data shall include the data elements listed in Table D-004-018-006.	N1, N3, N4		ICMS	H
D-004-018-008	The ICMS shall include data storage capacity for Transit Route Descriptive Data for 600 Transit Routes.	N1, N3, N4		ICMS	H
D-004-018-010	The ICMS Transit Stop Descriptive Data shall include the data elements listed in Table D-004-018-010.	N1, N3, N4		ICMS	H
D-004-018-012	The ICMS shall include data storage capacity for Transit Stop Descriptive Data for 6000 Transit Stops.	N1, N3, N4		ICMS	H
D-004-018-014	The ICMS Transit Schedule Descriptive Data shall include the data elements listed in Table D-004-018-014.	N1, N3, N4		ICMS	H
D-004-018-016	The ICMS shall include data storage capacity for Transit Schedule Descriptive Data for 600 Transit System schedules.	N1, N3, N4		ICMS	H
D-004-018-018	The ICMS Transit Fare Descriptive Data shall include the data elements listed in Table D-004-018-018.	N1, N3, N4		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
D-004-018-020	The ICMS shall include data storage capacity for Transit Fare Descriptive Data for 100 Transit System Fares.	N1, N3, N4	The structure and content of the Transit Fare Descriptive Data will vary depending on how an agency determines the fare structure: by fare types such as off-peak, student, senior, monthly pass; or by distance traveled, time of travel, or other fare structure.	ICMS	H
D-004-018-022	The ICMS Transit Vehicle Descriptive Data shall include the data elements listed in Table D-004-018-022.	N1, N3, N4		ICMS	H
D-004-018-024	The ICMS shall include data storage capacity for Transit Vehicle Descriptive Data for 200 Transit System Vehicles.	N1, N3, N4		ICMS	H
D-006	The ICMS shall include a data store for Archived Information about the transportation network.	N1, N2, N3, N4		ICMS	H
D-006-006	The ICMS Archive Information Data Store shall include storage for Arterial Traffic data.	N1.2		ICMS	H
D-006-006-002	The ICMS Arterial Link Traffic Archive Data shall include the data elements listed in Table D-006-006-002.	N1.2		ICMS	H
D-006-006-003	The ICMS shall include data storage capacity for 60 months of Arterial Link Traffic Archive Data.	N1.2		ICMS	H
D-006-006-004	The ICMS Arterial Intersection Traffic Archive Data shall include the data elements listed in Table D-006-006-004.	N1.2		ICMS	H
D-006-006-006	The ICMS shall include data storage capacity for 60 months of Arterial Intersection Traffic Archive Data.	N1.2		ICMS	H
D-006-006-008	The ICMS Roadside Equipment Status Archive Data shall include the data elements listed in Table D-006-006-008.	N4		ICMS	L
D-006-006-010	The ICMS shall include data storage capacity for 60 months of Roadside Equipment Status Archive Data.	N4		ICMS	L
D-006-008	The ICMS shall include a data store for Transit System Archive Data.	N1.2		ICMS	H
D-006-008-002	The ICMS Transit Route Archive Data shall include the data elements listed in Table D-006-008-002.	N1.2		ICMS	H
D-006-008-004	The ICMS shall include data storage capacity for 10,000 Transit System Routes.	N1.2		ICMS	H
D-006-008-006	The ICMS Transit Schedule Archive data shall include the data elements listed in Table D-006-008-006.	N1.2		ICMS	H
D-006-008-008	The ICMS shall include data storage capacity for 10,000 Transit System Schedules.	N1.2		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
D-006-008-010	The ICMS Transit Fare Archive Data shall include the Transit System Fare data listed in Table D-006-008-010.	N1.2		ICMS	H
D-006-008-012	The ICMS shall include data storage capacity for 1000 Transit System Fares.	N1.2		ICMS	H
D-006-008-014	The ICMS Transit Vehicle Archive Data shall include the data elements listed in Table D-006-008-014.	N1.2		ICMS	H
D-006-008-016	The ICMS shall include data storage capacity for 5000 transit vehicles.	N1.2		ICMS	H
D-006-008-018	The ICMS Transit Stop Archive Data shall include the data elements listed in Table D-006-008-018.	N1.2		ICMS	H
D-006-008-020	The ICMS shall include data storage capacity for 5000 Transit Stops.	N1.2		ICMS	H
D-006-010	The ICMS shall include a data store for Weather Archive Data.	N1.2		ICMS	H
D-006-010-002	The ICMS Weather Archive Data shall include the data elements listed in Table D-006-010-002.	N1.2		ICMS	L
D-006-010-004	The ICMS shall include data storage capacity for 60 months of Weather Archive Data.	N1.2		ICMS	L
D-006-014	The ICMS shall include a data store for Parking Facility Archive Data.	N1.2		ICMS	H
D-006-014-002	The ICMS Parking Facility Archive Data shall include the data elements listed in Table D-006-014-002.	N1.2		ICMS	H
D-006-014-004	The ICMS shall include data storage capacity for 60 months of Parking Facility Archive Data.	N1.2		ICMS	H
D-006-016	The ICMS shall include a data store for Event Archive Data.	N1.2		ICMS	H
D-006-016-002	The ICMS Event Archive Data shall include the data elements listed in Table D-006-016-002.	N1.2		ICMS	H
D-006-016-004	The ICMS shall include Event Archive Data storage capacity for 10,000 Events.	N1.2		ICMS	H
D-006-017	The ICMS shall include a data store for Incident Archive Data.	N1.2		ICMS	H
D-006-017-002	The ICMS Incident Archive Data shall include the data elements listed in Table D-006-017-002.	N1.2		ICMS	H
D-006-017-004	The ICMS shall include Incident Archive Data storage capacity for 10,000 Incidents.	N1.2		ICMS	H

3.3 System Interface Requirements

This section covers the requirements that relate to interfaces among different components and their external capabilities, including all of the system users and external systems that participate in the function of the system. The characteristics of interfaces to systems under development, or future systems, may also be included. The requirements may address any interdependencies or constraints associated with the interfaces (e.g. communication protocols, special devices, standards, fixed formats, or existing Interface Control Documents).

Interface Control Documents (ICDs) are a good way to manage interface requirements where numerous systems and interfaces are involved. An ICD will typically document one interface. The ICD should include all of the information and requirements that a designer would need to design and build a working interface for any system that is required to use the interface. The ICD becomes a configuration management tool to help keep changes in one system from rippling into interfaced systems. For example, an ICD for the interfaces between a CAD system and the ICMS can be used initially to create the ICMS interface to an existing CAD system. Later, if the CAD system is replaced, the ICD can be used to create an interface on the new CAD system that will work with the existing ICMS interface.

3.3.1 External System Interface Requirements

As a system requirements specification, the requirements may include functionality that is not part of the ICMS itself. These requirements are allocated to the external systems that will provide the functionality. In a software requirements specification for the ICMS these external requirements would be omitted, or listed as external requirements if they provide information that is needed to support design activities.

If an ICD only defines one data flow, then a simple requirement statement (like I-200-001-004) may be enough to define the information exchange. If the ICD defines multiple information flows, multiple requirements (or a complex requirement like I-200-016-004) may be necessary to identify which information flows must be supported.

3.3.1.1 Transit Management System Interfaces

The following interface requirements define the necessary interfaces between Transit Agency systems and the ICMS.

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-001	The ICMS shall include an interface with the Transit Management System.	N1, N2, N3, N4		ICMS	H
I-200-001-002	The ICMS shall acquire Current Transit Vehicle information from the Transit Management System in accordance with the requirements stated in the Transit Management System Interface Control Document.	N1, N2, N3, N4		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-001-004	The Transit Management System shall provide Current Transit Vehicle information to the ICMS in accordance with the requirements stated in the Transit Management System Interface Control Document	N1, N2, N3, N4		Transit Management System	H

3.3.1.2 Parking Management System Interface

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-004	The ICMS shall include an interface with the Parking Management System.	N1, N2, N3, N4		ICMS	H
I-200-004-002	The ICMS shall acquire Current Parking Facility information from the Parking Management System in accordance with the requirements stated in the Parking Management System Interface Control Document.	N1, N2, N3, N4		ICMS	H
I-200-004-004	The Parking Management System shall provide Current Parking Facility information to the ICMS in accordance with the requirements stated in the Parking Management System Interface Control Document.	N1, N2, N3, N4		Parking Management System	H

3.3.1.3 Arterial Traffic Management System Interface

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-016	The ICMS shall include an interface with the Arterial Traffic Management System.	N1, N2, N3		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-016-002	The ICMS shall acquire the following information from the Arterial Traffic Management System in accordance with the requirements stated in the Arterial Traffic Management System Interface Control Document: • Current Arterial Link Traffic Information • Current Arterial Intersection Traffic Information • Current Incident Information • Current Event Information • Current DMS Status Information • Current HAR/TAR Status Information • Current RWIS Status Information • Current VDS Status Information • Current CCTV Status Information • Current Video Information	N1, N2, N3		ICMS	H
I-200-016-004	The Arterial Traffic Management System shall provide the following information to the ICMS in accordance with the requirements stated in the Arterial Traffic Management System Interface Control Document: • Current Arterial Link Traffic Information • Current Arterial Intersection Traffic Information • Current Incident Information • Current Event Information • Current DMS Status Information • Current HAR/TAR Status Information • Current RWIS Status Information • Current VDS Status Information • Current CCTV Status Information • Current Video Information	N1, N2, N3		Arterial Traffic Management System	H
I-200-016-006	The ICMS shall provide the following information to the Arterial Traffic Management System in accordance with the requirements stated in the Arterial Traffic Management System Interface Control Document: • Current Incident Information • Current Event Information • Current Transit Vehicle Information	N1, N2, N3		ICMS	H

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-016-008	The Arterial Traffic Management System shall acquire the following information from the ICMS in accordance with the requirements stated in the Arterial Traffic Management System Interface Control Document: • Current Incident Information • Current Event Information • Current Transit Vehicle Information	N1, N2, N3		Arterial Traffic Management System	H

3.3.1.4 CAD System Interface

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-013	The ICMS shall include an interface with the Public Safety CAD System.	N1, N2, N3		ICMS	H
I-200-013-002	The ICMS shall acquire Current Incident information from the Public Safety CAD System in accordance with the requirements stated in the Public Safety CAD System Interface Control Document.	N1, N2, N3		ICMS	H
I-200-013-004	The Public Safety CAD System shall provide Current Incident information to the ICMS in accordance with the requirements stated in the Public Safety CAD System Interface Control Document.	N1, N2, N3		Public Safety CAD System	H
I-200-013-006	The ICMS shall provide the following information to the Public Safety CAD System in accordance with the requirements stated in the Public Safety CAD System Interface Control Document: • Current Incident Information • Current Event Information • Current Arterial Link Traffic Information	N1, N2, N3		ICMS	H
I-200-013-008	The Public Safety CAD System shall acquire the following information from the ICMS in accordance with the requirements stated in the Public Safety CAD System Interface Control Document: • Current Incident Information • Current Event Information • Current Arterial Link Traffic Information	N1, N2, N3		Public Safety CAD System	H

3.3.1.5 Road Weather Information System Interface

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-023	The ICMS shall include an interface with the RWIS System.	N1, N2, N3		ICMS	L
I-200-023-002	The ICMS shall acquire Weather information from the RWIS System in accordance with the requirements stated in the RWIS System Interface Control Document.	N1, N2, N3		ICMS	L
I-200-023-004	The RWIS System shall provide Current Weather information to the ICMS in accordance with the requirements stated in the RWIS System Interface Control Document	N1, N2, N3		RWIS System	L

3.3.1.6 *Clarus* Weather System Interface

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-024	The ICMS shall include an interface with the *Clarus* System.	N1, N2, N3		ICMS	L
I-200-024-002	The ICMS shall get Current Weather information from the *Clarus* System in accordance with the requirements stated in the *Clarus* System Interface Control Document.	N1, N2, N3	Note that in this case there are design constraints dictated by an existing system, and "get" is used to indicate that a particular method is required.	ICMS	L
I-200-024-004	The *Clarus* System shall publish Current Weather information to the ICMS in accordance with the requirements stated in the *Clarus* System Interface Control Document	N1, N2, N3	Note that in this case there are design constraints dictated by an existing system, and "publish" is used to indicate that a particular method is required.	*Clarus* System	L

3.3.1.7 Construction/Maintenance Management System Interface

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-034	The ICMS shall include an interface with the Construction/Maintenance Management System.	N1, N2, N3		ICMS	L

ID	Requirement	Source	Comment	Allocation	Criticality
I-200-034-002	The ICMS shall acquire Current Event information from the Construction/Maintenance Management System in accordance with the requirements stated in the Construction/Maintenance Management System Interface Control Document.	N1, N2, N3		ICMS	L
I-200-034-004	The Construction/Maintenance Management System shall provide Current Event information to the ICMS in accordance with the requirements stated in the Construction/Maintenance Management System Interface Control Document.	N1, N2, N3		Construction/ Maintenance Management System	L

APPENDIX A – Definitions, Acronyms, And Abbreviations

The following table provides the definitions of all terms, acronyms, and abbreviations required to properly interpret this System Requirements Specification.

AMS	Analysis, Modeling, and Simulation
APC	Automated Passenger Counter
ATMS	Advanced Traffic Management System
AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CCTV	Closed-circuit Television
DMS	Dynamic Message Sign
ESS	Environmental Sensor Station
ft	Foot, feet – a unit of measurement
HAR	Highway Advisory Radio
ICD	Interface Control Document
ICM	Integrated Corridor Management
ICMS	Integrated Corridor Management System
ID	Identifier
ITS	Intelligent Transportation System
KTT	Knowledge and Technology Transfer
NTCIP	National Transportation Communication ITS Protocol
RITA	Research and Innovative Technology Administration
RWIS	Road Weather Information System
TAR	Traffic Advisory Radio
USDOT	United States Department of Transportation
VDS	Vehicle Detection Sensor

APPENDIX B – Reference Documents

The following documents contain additional information pertaining to this project or have been referenced within this document:

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APPENDIX C – Generic ICMS Needs

N1 – Need to optimize the supply and demand for transportation services within the corridor. Operations need to manage the supply of services to match demand. Assessing the availability of service during periods of varying demand involves knowing about either permanent or non-permanent changes to service availability and methods to make additional services available on either a permanent or temporary basis. These services include mass transit services and motorist assist services.

N1.1 – Need to share control of devices within a corridor – Operators within a corridor need to be able to share information from, and control of, ITS devices within a corridor in order to manage supply and demand for transportation services. Devices may include HOV/HOT lane controls, DMS, HAR, CCTV, VDS, and RWIS roadside equipment, and video switches in operations centers. Control sharing rules should be established through institutional agreements among the equipment owners in the corridor.

N1.2 – Need to understand demand for transportation services – This includes evaluation of alternatives for responding to changes in demand whether temporary or long-term. This requires collection of information about the volume of people who are demanding their services and the origin and destination of their trips. This also requires collection of information about willingness of travelers to shift from one network or mode to another based on conditions or incentives.

N1.2.1 – Need for corridor performance measures – Measures are needed to evaluate how well a corridor is operating.

N1.2.2 – Need for impact assessment tools – Maintenance and operation departments need to assess the potential impact of actions under consideration. This can be an assessment of long-term or short-term changes. The tools need to consider both intra-network and cross-network effects to deliver the net effect on corridor operations.

N1.2.2.1 – Need to collect information about performance and response of the transportation network. – Data needs to be stored in an accessible data structure so that it can be used by analytical and/or predictive processes that support other needs. The analytical tools will need both current and historical information for analysis.

N1.2.2.1.1 – Need to collect and archive information from permanent data collection installations in the corridor – As current information is collected in the corridor, it should be archived in a location and format that is useable by the analysis, modeling, and simulation tools.

N1.2.2.1.2 – Need to collect and archive information from temporary data collection installations in the corridor – It may be too expensive to collect all information needed on a regular, current basis. Some information may need to be collected for a period of time and stored as "typical" or historical reference information. "Typical" information can be used in place of continuous instrumented information, and historical information can be used as a basis for comparison between past and current conditions.

N1.2.2.1.3 – Need for current information – The ICMS and system operators need current information about conditions within the corridor. This information includes travel volumes on networks within the corridor, travel times on networks, location and effect of events that impact capacity, and a measure of unused capacity on each network within the corridor.

N1.2.2.1.4 – Need to have quality physical infrastructure – The ITS components need to be reliable, available, maintainable (and well maintained), extensible, and interoperable.

N1.2.2.2 – Need to have descriptive information about corridor infrastructure - Certain static information is needed by operators and systems in order to perform required tasks. This information may include geographic, geometric, descriptive, or restrictive information about the transportation infrastructure and the ITS infrastructure.

N1.2.2.3 – Need to monitor the physical status of the ITS and transportation infrastructure – Operations and maintenance staff need to have information about the operational status of the infrastructure in order to plan maintenance and make decisions about which resources can be used in response to new conditions that may arise.

N1.2.3 – Need to collect and process information in a timely manner – Information needs to be collected and processed within time frames consistent with the need for timely information. Processed information needs to be current enough for the system and operators to use as a basis for decisions and actions required to regulate and manage the transportation networks. Information must be current enough for transportation network users to make timely and appropriate decisions about time, route, and modes of travel.

N1.2.3.1 – Need to have a quality information processing infrastructure – The ICMS sub-systems and components need to be reliable, available, maintainable (and well maintained), extensible, and interoperable.

N1.2.3.2– Need to present understandable information – System operators and public users need information to be presented in formats that are easy to understand and relevant to the decisions that need to be made. This applies to visual and audio information presentation, use of appropriate contexts (map displays for geographic information, visual clues such as color, shape, blink) to convey states, and use of tabular and graph presentations to show relationships between parameters.

N1.2.4 Need to provide methods to modify supply and demand – Operations need to manage the supply of services to match demand or modify the demand to match available network capabilities. Assessing the availability of service during periods of varying demand involves knowing about either permanent or non-permanent changes to service availability and methods to make additional services available on either a permanent or temporary basis. These services include mass transit services and motorist assist services.

N2 – Need for coordination with other corridor participants – To convey planned changes in operational status and to convey current near-real-time conditions.

N2.1 – Need for transportation system operators and public safety organizations to coordinate – There is a need for coordination on a real-time basis for incidents requiring response by two or more organizations.

N2.2 – Need for standard definition of customary actions – This identifies a set of pre-planned actions and the circumstances that would trigger those actions. This also implies shared access to the information required to identify the circumstances to the level necessary to establish which actions are required, and associated response information such as location.

N2.3 – Need to have competent and well-trained staff – This applies to the proper operation and maintenance of systems, and training in interpreting the information provided and determining the most effective actions to take when circumstances require non-customary action.

N3 - Need for communication with transportation network users. Operators need to communicate with users to let them know the existing conditions in the transportation network and what alternative travel modes are available. Active communication sends information to users: HAR, DMS, text messaging, email, etc. Passive communication makes information available but users must seek out the information: media outlets, traffic web sites, travel web sites, 511 systems.

N3.1 – Need to coordinate and control information sources within the corridor - Operators should have access to the information they need to perform their jobs, and the information should come from reliable sources.

N3.2 – Need to present information that is timely, correct, consistent across sources, and understandable to the network users - Operators, agency staff, and the public should have access to timely information. Information should represent the current situation and be reliably correct. Everyone should receive the same (as opposed to conflicting) information regardless of the method or source they choose for obtaining information about the corridor.

N4 – Need to provide ITS infrastructure, operations, and management capabilities to manage the corridor – Implementing integrated corridor management will require staff, ICMS computing and communication infrastructure, working space for the staff, and the training and infrastructure to support the staff.

N4.1 – Need to have competent and well-trained staff to operate the ITS systems and coordinate the transportation services in the corridor – In addition to staffing the operations positions for an ICMS, the staff will need documentation and training to operate the system. The staff will also need training on procedures and pre-planned responses to situations in the corridor.

N4.2 – Need to have competent and well-trained staff to maintain the ITS systems in the corridor – In addition to staffing maintenance positions or contracting maintenance for the system, the maintainers will need documentation and training on how to maintain the system.

N4.3 – Need to have quality, affordable corridor ITS infrastructure

N4.3.1 – Need to share existing information and infrastructure wherever possible – Duplication of effort to collect and disseminate information can be unnecessarily costly and can result in errors or inconsistencies between the resulting sets of information. Shared access to information and infrastructure is necessary for cost containment and can greatly facilitate information consistency and coordination of effort.

N4.3.2 – Need to improve existing infrastructure where needed – Existing systems and field infrastructure may need to be modified to provide additional functionality to support interfaces or informational requirements for the ICMS.

N4.3.3 – Need to build new infrastructure where necessary – New ITS infrastructure may be necessary to fill surveillance and detection gaps or to create the infrastructure necessary to implement one or more of the corridor management strategies.

N4.4 – Need to have a quality information processing infrastructure for the corridor – An ICMS will require computers for servers and workstations, communications equipment to interconnect the computers and agency staff, and field devices to collect data, provide information the public, or implement corridor control strategies. These systems need appropriate hardware, security, and environmental support to function.

N4.5 – Need to monitor the current status of the ITS systems in the corridor – Monitoring provides the information necessary to establish performance measures for the ICMS and related ITS systems in the corridor. Monitoring is also an essential function for determining when maintenance may be needed to restore a component to working order.

APPENDIX D – ICMS DATA

The following tables represent one way of conveying information about system data requirements. This method was used for this document to facilitate discussions about what data elements should be included in the requirements for transit and arterial data.

There is a noticeable disparity between the completeness of the tables. In some cases the data needs are well understood and well documented. In some cases there is no clear consensus about what should be included. In some cases the appropriate standards may not be finalized.

The tables for metadata and archive data will only include suggestions for the types of data that might be needed. Tailoring for specifics of the corridor needs and the resulting corridor ICMS architecture is more extensive than the scope of this document can cover.

Table D-002-001-002 describes the data elements for current incidents in the network.

Table 4 - D-002-001-002 - Current Incident Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
LRMS: Location Reference	References a logical or physical link by an identifier or by one or more location referencing profiles.	SAE J2266			Current Incident Information	60 seconds	On change
Is Forecast	T/F flag indicating whether the start time is actual or forecast.	SAE J2354	Boolean		Current Incident Information	60 seconds	On change
Coverage Time		SAE J2354	Complex time		Current Incident Information	60 seconds	On change
Forecast Expires	Expiration time for forecast of when incident will end	SAE J2354	Date Time Pair		Current Incident Information	60 seconds	On change
Type Event		SAE J2354 TMDD			Current Incident Information	60 seconds	On change

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
severity		SAE J2354 TMDD			Current Incident Information	60 seconds	On change
status		SAE J2354 ITIS			Current Incident Information	60 seconds	On change
cause		SAE J2354 ITIS	Sequence		Current Incident Information	60 seconds	On change
description		SAE J2354 ITIS	Sequence		Current Incident Information	60 seconds	On change
advice		SAE J2354 ITIS	Sequence		Current Incident Information	60 seconds	On change
Affected Lanes	Lanes affected by event	SAE J2354	Sequence		Current Incident Information	60 seconds	On change
Vehicles Involved Count		SAE J2354 TMDD			Current Incident Information	60 seconds	On change
types		SAE J2354	Sequence		Current Incident Information	60 seconds	On change
injuries		SAE J2354	Sequence		Current Incident Information	60 seconds	On change
Start Time	Actual start time for incident	SAE J2354	Complex time		Current Incident Information	60 seconds	On change
Clear Time		SAE J2354	Complex time		Current Incident Information	60 seconds	On change

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Further Data		SAE J2354			Current Incident Information	60 seconds	On change
status		SAE J2354 ITIS			Current Incident Information	60 seconds	On change

Table D-002-002-002 describes the data elements for current events in the network. Current event information may include events that are scheduled for future times but are not yet in effect. In this context "current" refers to the information, not the event.

Table 5 - D-002-002-002 - Current Event Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
LRMS: Location Reference	References a logical or physical link by an identifier or by one or more location referencing profiles.	SAE J2266	Complex		Current Event Information	60 seconds	On change
Is Forecast	T/F flag indicating whether the start time is actual or forecast.	SAE J2354	Boolean		Current Event Information	60 seconds	On change
Coverage Time		SAE J2354	Complex time		Current Event Information	60 seconds	On change
Forecast Expires	Expected end time for event	SAE J2354	Date Time Pair		Current Event Information	60 seconds	On change
Type Event	Type of event	SAE J2354 TMDD			Current Event Information	60 seconds	On change
severity	Code describes severity of event.	SAE J2354 TMDD			Current Event Information	60 seconds	On change

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
status		SAE J2354 ITIS			Current Event Information	60 seconds	On change
cause		SAE J2354 ITIS	Sequence		Current Event Information	60 seconds	On change
description		SAE J2354 ITIS	Sequence		Current Event Information	60 seconds	On change
advice		SAE J2354 ITIS	Sequence		Current Event Information	60 seconds	On change
Affected Lanes	Lanes affected by event	SAE J2354	Sequence		Current Event Information	60 seconds	On change
Start Time		SAE J2354			Current Event Information	60 seconds	On change
Clear Time		SAE J2354			Current Event Information	60 seconds	On change
Repeat Times		SAE J2354			Current Event Information	60 seconds	On change
Further Data		SAE J2354			Current Event Information	60 seconds	On change

Table D-002-006-002 describes the data elements for current arterial traffic information for Arterial Links in the network.

Table 6 - D-002-006-002 - Current Arterial Link Traffic Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Complex Time	Date/Time stamp for when the data was sampled.	SAE J2354	Time		Link Traffic Information	N/A	Each message
LRMS: Location Reference	References a logical or physical link by an identifier or by one or more location referencing profiles.				Link Traffic Information	N/A	Each message
ITIS: Restriction Class_ Code	Class of traffic restrictions applied to a Link. This is used to characterize traffic restrictive conditions currently in effect.	SAE J2354 SAE J2540	Integer	2560-2815	Link Traffic Information	N/A	On change
ITIS: Link_ Surface Conditions	Abnormal surface conditions currently found on the Link (e.g. dry, wet, ice, snow, etc.). Taken from a sub range of IT IS codes called "Pavement Conditions."	SAE J2354 SAE J2540	Integer	588-6143	Link Traffic Information	N/A	On change

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
TMDD: Link _Level Of Service _code	A qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers as defined in the Highway Capacity Manual.	SAE J2354 ITE TM 1.03	Integer	0-6	Link Traffic Information	N/A	On change
TMDD: Link_ Delay_ quantity	Delay time for travel along a particular link. This is the additional time it will take above the free-flow travel time from one end of the link to the other	SAE J2354 ITE TM 1.03	Integer	0-605000	Link Traffic Information	30 sec	2 minute
TMDD: Link_ Density_ rate	Vehicle concentration per kilometer of the link.	SAE J2354 ITE TM 1.03	Integer	0-2000	Link Traffic Information	30 sec	1 minute
TMDD: Link _Lanes Number Open	The lowest number of lanes currently open in the link at any point.	SAE J2354 ITE TM 1.03	Integer	0-50	Link Traffic Information	N/A	On change
TMDD: Link_ Travel Time _quantity	The current average travel time of the vehicles using the link (in seconds).	SAE J2354 ITE TM 1.03	Integer	0-65535	Link Traffic Information	30 sec	2 minute
TMDD: Link_ Speed Average _rate	The current average speed of the vehicles using the link in KPH.	SAE J2354 ITE TM 1.03	Integer	0-255	Link Traffic Information	.01 sec	1 minute

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
TMDD: Link_ Occupancy _percent	The current average percent occupancy of the vehicles determined by detectors on the link.	SAE J2354 ITE TM 1.03	Integer	0-100	Link Traffic Information	.01 sec	1 minute
TMDD: Link_ Status	The current Link status providing an indication of standard or non-standard Link operations using the IT IS codes.	SAE J2354 ITE TM 1.03	Integer	768-1023	Link Traffic Information	N/A	On change

Table D-002-006-006 describes the data elements for current arterial intersection traffic information for each approach lane in the intersection**.**

Table 7 - D-002-006-006 - Current Arterial Intersection Traffic Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Complex Time	Time stamp for when the data was sampled.	SAE J2354	time		Intersection Traffic Information	N/A	Each message
Intersection_ ID	A unique identification designation for the intersection. Used to link intersection information between data sets.	SAE J2735	Integer	32 bit	Intersection Traffic Information	N/A	Each message
Approach_ ID	A unique identification for each approach within the intersection.	SAE J2735	Integer	8 bit	Intersection Traffic Information	N/A	Each message

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Lane_ Number	A unique identification for each approach Lane within the intersection.	SAE J2735	Integer	8 bit	Intersection Traffic Information	N/A	Each message
TMDD: Detector_ Vehicle Speed_ rate	The current average speed of the vehicles using the Lane in KPH.	ITE TM 1.03	Integer	0-255	Intersection Traffic Information	.01 sec	1 minute
TMDD: Detector _Vehicle Count_ quantity	The number of vehicles detected by a detector during a specific reporting period.	ITE TM 1.03	Integer	0-100000	Intersection Traffic Information	.01 sec	1 minute
TMDD: Detector_ Status_ code	A code which indicates whether a detector is failed or operating.	ITE TM 1.03	Integer	0-Failed 1-Operational 2-Off 3-Unknown	Intersection Traffic Information	N/A	1 minute

Table D-002-008-002 describes the data elements for Current Transit Vehicle Data.

Table 8 - D-002-008-002 - Current Transit Vehicle Data

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Complex Time	Time stamp for when the data was sampled.	SAE J2354	Time		ICurrent Transit Vehicle Information	N/A	Each message
Vehicle ID	Identification number of vehicle	TCIP			Current Transit Vehicle Information	N/A	Each message
Route ID	Identification number of route	TCIP			Current Transit Vehicle Information	N/A	Each message
Run ID	Identification number of run	TCIP			Current Transit Vehicle Information	N/A	Each message
Stop ID	Identification number of next stop	TCIP			Current Transit Vehicle Information	N/A	Each message
Passenger Count	Number of passengers on vehicle	TCIP			Current Transit Vehicle Information	Each Stop	Each pull-out
Route Adherence	Vehicle on scheduled route	TCIP			Current Transit Vehicle Information	30 sec	30 sec
Schedule Adherence	Offset from schedule	TCIP			Current Transit Vehicle Information	30 sec	30 sec

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Alarm	Vehicle Alarm condition	TCIP			Current Transit Vehicle Information	30 sec	30 sec
LRMS: Location Reference	References a logical or physical link by an identifier or by one or more location referencing profiles.	SAE J2266	Complex		Current Transit Vehicle Information	30 sec	30 sec
Next Stop Location	Next stop location				Current Transit Vehicle Information	30 sec	30 sec
Next Stop Time	Next stop time countdown	TCIP			Current Transit Vehicle Information	30 sec	30 sec
Speed	Average Speed	TCIP			Current Transit Vehicle Information	30 sec	30 sec
Incident type	Type of incident	TCIP			Current Transit Vehicle Information	30 sec	30 sec

Table D-002-009-002 describes the data elements for Current Parking Facility Data in the network.

Table 9 - D-002-009-002 - Current Parking Facility Data

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Lot_ident	Unique ID to tie parking facility observational data to parking facility metadata		Complex		Current Parking Information	N/A	Each message
Complex Time	Time stamp for when the data was sampled.	SAE J2354	Time		Current Parking Information	N/A	Each message
Percent Full	Percentage of parking facility spaces that are occupied and/or reserved.	SAE J2354		0-100	Current Parking Information		60 seconds
General Status	Codes and text describing the general status of the facility.	SAE J2354 ITIS			Current Parking Information		60 seconds
Prices	Current price schedule information	SAE J2354 TCIP			Current Parking Information		60 seconds

Table D-002-010-002 describes the data elements for Current Weather Data for the corridor. Table 10 is not inclusive of all weather elements in NTCIP 1204. The weather elements should be tailored to meet the corridor needs.

Table 10 - D-002-010-002 - Current Weather Data

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
Complex Time	Date/Time stamp for when the data was sampled.	SAE J2354	Time		Weather Information	N/A	Each message
LRMS: Location Reference	References a logical or physical link by an identifier or by one or more location referencing profiles.	SAE J2266			Weather Information	N/A	Each message
ESS Air Temperature	Current temperature in tenths of degrees C	NTCIP-1204			Weather Information	20 minutes	20 minutes
ESS Pavement Temperature	Current pavement temperature in tenths of degrees C	NTCIP-1204			Weather Information	20 minutes	20 minutes
ITIS: Weather Conditions	Gross condition	ITIS			Weather Information	20 minutes	20 minutes
ESS Avg Wind Direction	Wind direction expressed in degrees	NTCIP-1204		0-360	Weather Information	1 minute	20 minutes
ESS Avg Wind Speed	Average wind speed expressed in tenths of meters per second	NTCIP-1204			Weather Information	1 minute	20 minutes
ESS Relative Humidity	Relative humidity expressed as a percent	NTCIP-1204			Weather Information	20 minutes	20 minutes
ESS Roadway Snow Depth	Depth of snow on roadway expressed in centimeters	NTCIP-1204			Weather Information	20 minutes	20 minutes
ESS Roadway Snow Pack Depth	Depth of snow pack on roadway expressed in centimeters	NTCIP-1204			Weather Information	20 minutes	20 minutes
ESS Snowfall Accum Rate	Rate of accumulation of snow expressed in centimeters	NTCIP-1204			Weather Information	5 minutes	20 minutes

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
ESSIceThickness	Thickness of ice on roadway in millimeters	NTCIP-1204			Weather Information	20 minutes	20 minutes
ESSSurfaceBlackIceSignal	Thickness of black ice on roadway in millimeters	NTCIP-1204			Weather Information	20 minutes	20 minutes
ESSPrecipitationOneHour	The rain accumulation over the last hour measured in tenths of kilograms per square meter.	NTCIP-1204			Weather Information	5 minutes	20 minutes
ESSPrecipRate	The current rate of precipitation measured in tenths of grams per square meter per second.	NTCIP-1204			Weather Information	1 minute	20 minutes

Table D-002-016-002 describes the data elements for Current Roadside Equipment Status Information in the network.

Table 11 - D-002-016-002 - Current Roadside Equipment Status Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow	Sampling Frequency	Reporting Frequency
	Equipment ID						
	Time/Date stamp						
	Equipment operational status						
	Equipment error messages						
	Current message (for DMS, HAR/TAR)						
	Display message author (for DMS, HAR/TAR)						
	Owning System ID						

Table D-004-002-002 describes the data elements that provide descriptive information about the roadside equipment.

Table 12 - D-004-002-002 – Roadside Equipment Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Roadside Equipment Metadata would typically include the following: • Equipment ID • Equipment name • Equipment type • Owning agency ID • Owning agency name • Owning system name • Owning system ID • Maintenance contact information • Equipment location (latitude, longitude, elevation, roadway, cross street, mile marker, address) • Sign # rows • Sign # characters per row • Sign # phases • Date/Time last updated				

Table D-004-004-002 describes the data elements that provide geographic information about the corridor.

Table 13 - D-004-004-002 – Corridor Geographic Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Corridor Geographic Metadata would typically include the following data: • Corridor roadway map data • Corridor rail map data • Corridor geographic features map data • Street names • Jurisdictional boundary map data • Jurisdiction names • Date/Time last updated				

Table D-004-005-002 describes the data elements that provide descriptive information about the arterial links in the network.

Table 14 - D-004-005-002 - Arterial Link Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
Complex Time	Time/date stamp for when the data was last changed	SAE J2354	Time		Link Traffic Information
LRMS: Location Reference	References a logical or physical link by an identifier or by one or more location referencing profiles.	SAE J2266			Link Traffic Information
TMDD: Link_ Capacity_ rate	Link maximum capacity in vehicles per hour	ITE TM 1.03	Integer	0-300000	Link Traffic Information
TMDD: Link_ Jurisdiction _Text	The name of the law enforcement agency with authority over this link.	ITE TM 1.03	String	0-128 Characters	Link Traffic Information
TMDD: Link_ Lanes Number_ quantity	The lowest number of lanes in the link at any point.	ITE TM 1.03	Integer	0-50	Link Traffic Information
TMDD: Link_ Ownership_ text	The name of the designated owner of the Link.	ITE TM 1.03	String	0-256 Characters	Link Traffic Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
TMDD: Link_ Length_ quantity	The length of the Link from beginning Node to ending Node, in meters.	ITE TM 1.03	Integer	0-160000	Link Traffic Information
TMDD: Link_ Median Type	The Link-median-type of the median for the separation of opposing or parallel traffic links.	ITE TM 1.03	Integer	0-10	Link Traffic Information
TMDD: Link_ Shoulder Width Left_ quantity	The width of the left shoulder of the Link in centimeters	ITE TM 1.03	Integer	0-999	Link Traffic Information
TMDD: Link_ Shoulder Width Left_ quantity	The width of the left shoulder of the Link in centimeters	ITE TM 1.03	Integer	0-999	Link Traffic Information
TMDD: Link_ Name	The name of the Link for user identification	ITE TM 1.03	String	0-128 Characters	Link Traffic Information
TMDD: Link_ Other_ text	Used to provide additional information when “Other” is the designated type.	ITE TM 1.03	String	0-256 Characters	Link Traffic Information
TMDD: Link_ Road Number	County, State, or Federal route numbers with any associated alphabetic designators	ITE TM 1.03	String	0-64 Characters	Link Traffic Information
TMDD: Link_ Pavement_ type	The type of material from which the roadway pavement is constructed.	ITE TM 1.03	Integer	0-11	Link Traffic Information
TMDD: Link_ Restriction Axle Count_ quantity	Maximum axle count for a vehicle allowed on the Link.	ITE TM 1.03	Integer	0-20	Link Traffic Information
TMDD: Link_ Restriction Height_ quantity	Minimum vertical clearance on a Link in centimeters.	ITE TM 1.03	Integer	0-2000	Link Traffic Information
TMDD: Link_ Restriction Axle Weight _quantity	Maximum axle weight for a vehicle allowed on the Link.	ITE TM 1.03	Integer	0-20000	Link Traffic Information
TMDD: Link_ Restriction Weight Vehicle _quantity	Maximum Vehicle Weight allowable on a Link in kilograms	ITE TM 1.03	Integer	0-20000	Link Traffic Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
TMDD: Link_ Restriction Length_ quantity	Maximum Vehicle Length allowable on a link in centimeters	ITE TM 1.03	Integer	0-80000	Link Traffic Information
TMDD: Link_ Restriction Width_ quantity	Maximum allowable vehicle width on a Link in centimeters.	ITE TM 1.03	Integer	0-2000	Link Traffic Information
TMDD: Link_ Truck Speed Limit	The posted or legal speed limit on the Link for trucks in kilometers per hour.	ITE TM 1.03	Integer	0-255	Link Traffic Information

Table D-004-006-002 describes the data elements that provide descriptive information about the arterial intersections.

Table 15 - D-004-006-002 – Geometric Intersection Description Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
Complex Time	Time/date stamp for when the data was last changed	SAE J2354	Time		Geometric Intersection Description
Intersection_ ID	A unique identification designation for the intersection. Used to link intersection information between data sets.	SAE J2735	Integer	32 bit	Geometric Intersection Description
GID_ Content_ Version		SAE J2735	Integer	8 bit	Geometric Intersection Description
Reference_ Point		SAE J2735	Integer	8 bit	Geometric Intersection Description
Reference_ Point_ ID		SAE J2735	Integer	8 bit	Geometric Intersection Description
Approach_ ID	A unique identification for each approach within the intersection.	SAE J2735	Integer	8 bit	Geometric Intersection Description
Intersection_ Attributes		SAE J2735	Binary	8 bit	Geometric Intersection Description
Latitude		SAE J2735	Integer	32 bit (signed)	Geometric Intersection Description

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
Longitude		SAE J2735	Integer	32 bit (signed)	Geometric Intersection Description
Altitude		SAE J2735	Integer	16 bit (signed)	Geometric Intersection Description
Label (optional)		SAE J2735	String	255 Characters	Geometric Intersection Description
Lane_ Number	A unique identification for each approach lane within the intersection.	SAE J2735	Integer	8 bit	Geometric Intersection Description
Lane_ Width	The width of the approach lane.	SAE J2735	Integer	16 bit	Geometric Intersection Description
Lane_ Attributes		SAE J2735	Binary	16 bit	Geometric Intersection Description

Table D-004-008-002 describes the data elements that provide descriptive information about the Arterial Network.

Table 16 - D-004-008-002 – Arterial Network Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Arterial Network Descriptive Information would typically include the following data: • Street map data • Link-Intersection interconnection data • Street names • Jurisdiction names • Jurisdiction contact information				

Table D-004-016-002 describes the data elements that provide descriptive information about parking facilities in the corridor.

Table 17 - D-004-016-002 – Parking Facility Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Parking Facility Descriptive Information would typically include the following data: • Parking Facility ID • Parking Facility type • Facility name • Facility capacity • Facility amenities (covered parking, valet service, reserved parking, etc.) • Associated Transit Stops (list) • Facility Owner name • Contact information • Location map data				

Table D-004-018-002 describes the data elements that provide descriptive information about transit systems in the corridor.

Table 18 - D-004-018-002 – Transit System Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Transit System Descriptive Information would typically include the following data: • Transit System ID • Transit System name • Contact information • Service area map data				

Table D-004-018-006 describes the data elements that provide descriptive information about transit system routes in the corridor.

Table 19 - D-004-018-006 – Transit Route Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Transit Route Descriptive Information would typically include the following data: • Transit System ID • Transit Schedule ID • Effective date • Transit Stop ID (list) • Route map data				

Table D-004-018-010 describes the data elements that provide descriptive information about transit system stops in the corridor.

Table 20 - D-004-018-010 – Transit Stop Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Stop Descriptive Information would typically include the following data: • Transit System ID • Transit Stop ID • Effective date • Transit Route ID (list) • Associated Parking Lots (list) • Amenities (handicap access, shelter, DMS, kiosk, etc.) • Stop map data				

Table D-004-018-014 describes the data elements that provide descriptive information about transit system schedules in the corridor.

Table 21 - D-004-018-014 – Transit Schedule Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Schedule Descriptive Information would typically include the following data: • Transit System ID • Transit Schedule ID • Effective date for schedule • Transit Route ID • Stop ID • Pull-in time • Pull-out time • Days of week schedule effective				

Table D-004-018-018 describes the data elements that provide descriptive information about transit system fares in the corridor.

Table 22 - D-004-018-018 – Transit Fare Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Fare Descriptive Information would typically include the following data: • Transit System ID • Transit Fare ID • Effective date for Fare • Fare type • Fare • Associated Route ID				

Table D-004-018-022 describes the data elements that provide descriptive information about transit system vehicles in the corridor.

Table 23 - D-004-018-022 – Transit Vehicle Metadata

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	Transit Vehicle Descriptive Information would typically include the following data: • Vehicle ID • Transit System ID • # of passenger seats • # of passenger standing room • # of handicap seats • Manufacturer and model of vehicle • Amenities (lift, bicycle racks, etc.)				

Table D-006-006-002 describes the data elements that provide archived information about arterial link traffic in the corridor.

Table 24 - D-006-006-002 – Arterial Link Traffic Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Arterial Link Traffic Archive information will typically have the same data fields as the Current Arterial Link Traffic data (table D-002-006-002.)				Current Link Traffic Information

Table D-006-006-004 describes the data elements that provide archived information about arterial intersection traffic in the corridor.

Table 25 - D-006-006-004 – Arterial Intersection Traffic Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Arterial Intersection Traffic Archive information will typically have the same data fields as the Current Arterial Intersection Traffic data (table D-002-006-006.)				Current Intersection Traffic Information

Table D-006-008-002 describes the data elements that provide archived information about transit routes in the corridor.

Table 26 - D-006-008-002 – Transit Route Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Route Archive information will typically have the same data fields as the Transit Route metadata (table D-004-018-006.)				

Table D-006-008-006 describes the data elements that provide archived information about transit schedules in the corridor.

Table 27 - D-006-008-006 – Transit Schedule Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Schedule Archive information will typically have the same data fields as the Transit Schedule metadata (table D-004-018-014.)				

Table D-006-008-010 describes the data elements that provide archived information about transit fares in the corridor.

Table 28 - D-006-008-010 – Transit Fare Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Fare Archive information will typically have the same data fields as the Transit Fare metadata (table D-004-018-018.)				

Table D-006-008-014 describes the data elements that provide archived information about transit vehicles in the corridor.

Table 29 - D-006-008-014 – Transit Vehicle Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Vehicle Archive information will typically have the same data fields as the Current Transit Vehicle data (table D-002-008-002.)				

Table D-006-008-018 describes the data elements that provide archived information about transit system stops in the corridor.

Table 30 - D-006-008-018 – Transit Stop Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Transit Stop Archive information will typically have the same data fields as the Transit Stop metadata (table D-004-018-010.)				

Table D-006-010-002 describes the data elements that provide archived information about weather in the corridor.

Table 31 - D-006-010-002 – Weather Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Weather Archive information will typically have the same data fields as the Current Weather data (table D-002-010-002.)				

Table D-006-014-002 describes the data elements that provide archived information about parking facilities in the corridor.

Table 32 - D-006-014-002 – Parking Facility Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Parking Facility Archive information will typically have the same data fields as the Current Parking Facility data (table D-002-009-002.)				

Table D-006-016-002 describes the data elements that provide archived information about events in the corridor.

Table 33 - D-006-016-002 – Event Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Event Archive information will typically have the same data fields as the Current Event data (table D-002-002-002.)				

Table D-006-017-002 describes the data elements that provide archived information about incidents in the corridor.

Table 34 - D-006-017-002 – Incident Archive Information

Data Dictionary Name	Description	Reference Standard	Data Type	Value Constraints	Associated Data Flow
	The Incident Archive information will typically have the same data fields as the Current Incident data (table D-002-001-002.)				

APPENDIX E – Requirements Coverage Matrix

	Performance F-001	Performance P-002	Performance P-004	Current Data D-002			Metadata D-004			Archive Data D-006			Interface I-200		
	Function	**Frequency**	**Processing**	**Store**	**Elements**	**Capacity**	**Store**	**Elements**	**Capacity**	**Store**	**Elements**	**Capacity**	**System**	**Specification**	**Data Flows**
Arterial Traffic Network	F-001-010			D-002-006			D-004-008	D-004-008-002	D-004-008-004	D-006-006			I-200-016-002	I-200-016-004	I-200-016-006
Link Traffic	F-001-010-050	P-002-002	P-004-002		D-002-006-002	D-002-006-004	D-004-005	D-004-005-002	D-004-005-004		D-006-006-002	D-006-006-003			
Intersection Traffic	F-001-010-055	P-002-004	P-004-004		D-002-006-006	D-002-006-008	D-004-006	D-004-006-002	D-004-006-004		D-006-006-004	D-006-006-006			
Roadside Equipment	F-001-010-010	P-002-012	P-004-012	D-002-016	D-002-016-002	D-002-016-004	D-004-002	D-004-002-002	D-004-002-004		D-006-006-008	D-006-006-010			
Video	F-001-010-020														
Transit Network	F-001-020						D-004-018	D-004-018-002	D-004-018-004	D-006-008			I-200-001	I-200-001-002	I-200-001-004
Vehicle Data	F-001-020-010	P-002-006	P-004-006	D-002-008	D-002-008-002	D-002-008-004		D-004-018-022	D-004-018-024		D-006-008-014	D-006-008-016			
Route Data								D-004-018-006	D-004-018-008		D-006-008-002	D-006-008-004			
Stop Data								D-004-018-010	D-004-018-012		D-006-008-018	D-006-008-020			
Schedule Data								D-004-018-014	D-004-018-016		D-006-008-006	D-006-008-008			
Fare Data								D-004-018-018	D-004-018-020		D-006-008-010	D-006-008-012			
Parking Network	F-001-030														
Parking Facility Data	F-001-030-020	P-002-008	P-004-008	D-002-009	D-002-009-002	D-002-009-004	D-004-016	D-004-016-002	D-004-016-004	D-006-014	D-006-014-002	D-006-014-004	I-200-004	I-200-004-002	I-200-004-004
Weather	F-001-040	P-002-010	P-004-010	D-002-010	D-002-010-002	D-002-010-004				D-006-010	D-006-010-002	D-006-010-004			
RWIS Data	F-001-040-010												I-200-023	I-200-023-002	I-200-023-004
Clarus Data	F-001-040-040												I-200-024	I-200-024-002	I-200-024-004
Events	F-001-050			D-002-002	D-002-002-002	D-002-002-004				D-006-016	D-006-016-002	D-006-016-004			
Construction	F-001-050-030												I-200-034	I-200-034-002	I-200-034-004
Manual Data Entry	F-001-050-050														
Incidents	F-001-080			D-002-001	D-002-001-002	D-002-001-004				D-006-017	D-006-017-002	D-006-017-004			
CAD Incident Data	F-001-080-010												I-200-013-002	I-200-013-004	I-200-013-006
Arterial Incident Data	F-001-080-020												I-200-016-002	I-200-016-004	I-200-016-006
Transit Incident Data	F-001-080-060												I-200-001-002	I-200-001-004	I-200-001-006
Manual Data Entry	F-001-080-040														
Geographic Metadata							D-004-004	D-004-004-002	D-004-004-004						

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