VII Data Use Analysis and Processing

SYSTEM REQUIREMENTS SPECIFICATION

December 2007

Prepared By:

Mixon/Hill of Michigan, Inc.
12980 Metcalf Avenue, Suite 470
Overland Park, Kansas 66213
(913) 239-8400 Phone
(913) 239-8070 Fax

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Revision History

Revision	Issue Date	Status	Authority	Comments
01.01	09/12/2007	Draft		Draft for comment.
01.02	12/5/2007	Final		Incorporates comments on draft.

Electronic File

Saved As: **06022-rq301srs0102_DUAP_SysReq_Final.doc**

1 INTRODUCTION

This document applies to the Michigan Department of Transportation's (MDOT's) Vehicle Infrastructure Integration (VII) Data Use Analysis and Processing (DUAP) System.

1.1 Document Identification

The document control number for this document is contained in the document footer and the file name for the electronic rendition of the document is recorded in the table of contents for the document.

1.2 Document Purpose

The purpose of this requirements specification is to provide a repository for the requirements governing the design of MDOT's VII DUAP System. These requirements will form the basis for the design verification and validation of each version of the system.

A system requirements specification states what must be accomplished to fulfill the vision described in a concept of operations (ConOps). It does not state how it is to be accomplished. This document describes each requirement and the basis for inclusion of that requirement. The intended audience includes decision makers, stakeholders, designers, and testers.

This document may be updated periodically to reflect changes in the system requirements, including changes reflected in subsequent versions of the system.

1.3 System Scope

A strategy is laid out in the Michigan Department of Transportation Vehicle-Infrastructure Integration Strategic and Business Plan that focuses on partnering, developing, and deploying a VII infrastructure and test beds; increasing safety and mobility; improving asset management; developing outreach programs to better expose others to VII in Michigan; justifying the need for VII; and determining creative investment funding venues for VII activities.

Within this context, the DUAP project will investigate and evaluate the utility of VII data and its integration with other transportation agency sources in enhancing safety, increasing mobility, and improving asset management. Tasks within DUAP will identify uses for the VII data, develop algorithms to use and process the VII data, develop prototype applications and data management software, and evaluate the utility of the processed data for MDOT and its partners. Data processing will require acquisition from a variety of sources, standardization and integration, storage, synthesis for particular applications, and dissemination.

1.4 Definitions, Acronyms, and Abbreviations

This document may contain terms, acronyms and abbreviations that are unfamiliar to the reader. A dictionary of these terms, acronyms and abbreviations can be found in Appendix A.

1.5 References

Full citations for the documents referenced in this System Requirements document can be found in Appendix B, which also includes documents that have not explicitly been referenced, but contain additional information relevant to the project.

1.6 Overview

The organization and content of this document is based on the Institute of Electrical and Electronics Engineers, Inc. (IEEE) standards for System Requirements Specifications. The requirements presented in this document are intended to be a complete list of the relevant desires for MDOT's VII DUAP System.

Each requirement is identified by a unique number to allow the requirement to be referenced in future documents, providing traceability throughout the development process.

The remaining sections of the document contain the requirements for the system. The sections and their content are as follows:

Section 2 – General Description provides a general overview of the entire system and its anticipated user base. This section describes the general factors that affect the system and its requirements.

Section 3 – Specific Requirements contains the detailed requirements developed from reference documentation and stakeholder meetings. This section organizes the requirements into categories that facilitate the design and testing process. These categories are: Functional Requirements, External Interface Requirements, Performance Requirements, Design Constraints, Quality Characteristics, and Other Requirements.

2 GENERAL DESCRIPTION

This section provides a general overview of the system and describes the general factors that affect the system and its requirements. This section does not state specific requirements, but instead is intended to make the requirements easier to understand by giving them context.

2.1 Product Perspective

DUAP is a research program to determine how new VII data impacts safety, traffic operations and management, asset management, winter operations, and transportation planning. The program is focused on demonstration and assessment of data transformation and management, and DUAP system development is a means to that end. From a systems engineering functional viewpoint, the DUAP system has four high-level capabilities:

- Collecting data
- Consolidating the collected information
- Converting data into information needed by transportation agencies
- Communicating the unified information to various agencies and the public

The DUAP system itself will be a prototype—completely functional for the desired demonstrations, but not necessarily intended for operational use.

When describing a system, there are many ways to represent what the system will do and how it will be implemented. Each representation has its own strengths and limitations, but all are intended to create understanding of the system's boundaries, components, and interactions. Each representation has its own set of basic units and interactions. One or more of these representations taken together describe the system architecture.

Systems similar to the DUAP system are frequently and effectively represented as sets of interacting services. Each service has one or more interfaces by which the services interact. This representation is a very natural way of approaching a potentially complex system with a basic repeatable model.

A representation based on services and interfaces inherently leads to a flexible, scalable, and maintainable design. With well-defined interfaces, it is possible to improve the functions of the system by adding services that conform to the interfaces, but provide new operations. Services do not unnecessarily constrain the physical and computational hardware to which they might be deployed. It is possible to scale the system by adding hardware to support the processing needs of new services as they are developed and deployed. Maintainability can be preserved by being able to update both hardware and software components while the system is running.

A DUAP system based on a service-oriented architecture will then be flexible, scalable, and maintainable. It will be capable of handling large amounts of continuously streaming data. It will support current and future MDOT missions and goals.

Figure 1 is a simple (but abstract) representation of the DUAP system as a set of services. As shown in the figure, the basic services provided by DUAP are input, dynamic data, computational, persistent data, output, presentation, and administrative. These basic services are common to all information systems, but will have specific implementations for DUAP to assure that it meets the needs described earlier in the ConOps.

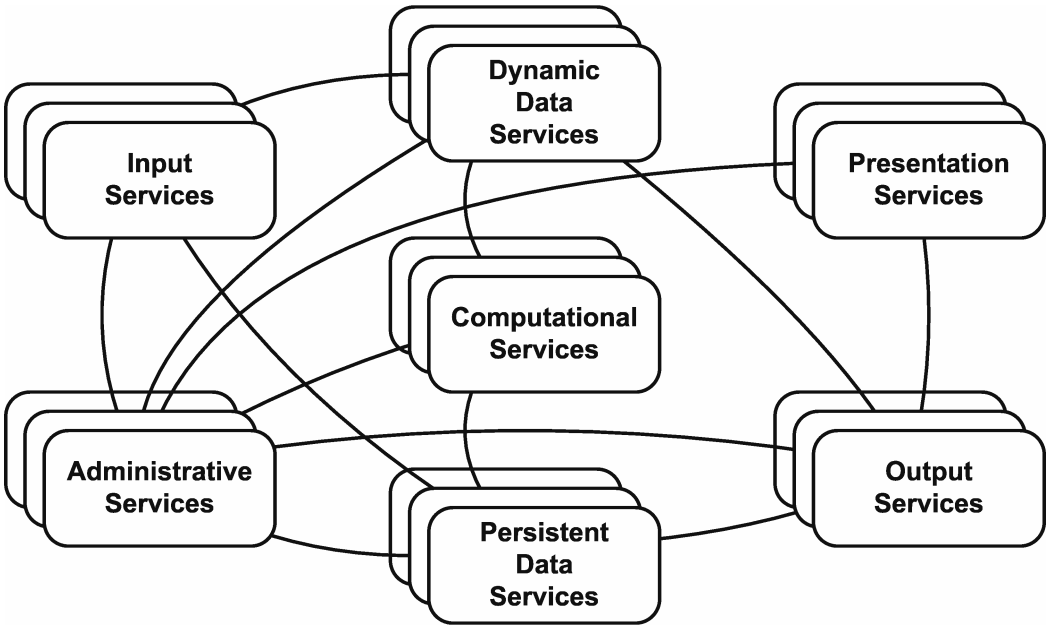

Figure 1 – DUAP System Services

2.2 Product Functions

2.2.1 Input Services

The input services of the DUAP system will

- receive probe data from individual vehicles;
- receive traffic information from Advanced Traffic Management Systems (ATMS) throughout the state;
- receive weather information from several sources; and
- receive traveler information from Advanced Traveler Information Systems (ATIS) throughout the state, as well as other governmental and commercial sources.

The VII Proof of Concept (POC) input service, for example, will use the X-031 Probe Data Service interface as described by the VII Network User to Service Delivery Node (SDN) Subsystem document. DUAP data input services will send a subscription request to the Probe Data Service, to be fulfilled within the VII network. As infrastructure data are collected from the vehicles by the network, the network feeds the data continuously to the subscribed DUAP services. (U.S. Department of Transportation, Federal Highway Administration. 2006.)

Data available to input services will vary among sources. In the case of the VII POC input service, for example, data expected to be available would include vehicle location, speed, direction of travel, acceleration, brake status, wheel angle, steering wheel position, and headlamp status. Weather-related observations that could be obtained from vehicle sensors might consist of ambient air temperature, air pressure, sun sensor, and fog light status.

Input services will also receive speed, volume, and occupancy data from ATMS throughout the state. The Michigan Intelligent Transportation Systems (MITS) Center ATMS, for example, will have its own input service for collecting speed, volume, and occupancy, and may also obtain event descriptions and messages posted on changeable message signs/dynamic message signs (CMS/DMS).

2.2.2 Dynamic Data Services

The dynamic data services are a caching service intended to store DUAP data for fast access over a relatively short duration. For example, probe vehicle data is available from the VII SDN only long enough to fulfill the registered subscription data distribution needs. The DUAP system must be able to cache the data after input such that it remains available for downstream processing.

2.2.3 Persistent Data Services

Persistent data services provide longer-term storage within DUAP of both data collected by input services and metadata needed by DUAP services to sustain their operations. Archive services will store data from the dynamic data services to support future data analysis and management needs. Metadata services manage data needed by other DUAP services to

- create a context for the probe vehicle, traffic, and weather data, and
- describe the operation and formatting of the input, computational, output, and presentation services.

2.2.4 Computational Services

The purpose of the DUAP system's computational services is to apply logical algorithms to incoming vehicle and traffic observations in order to transform those observations into data that is directly applicable to transportation management and operations processes. Computational services will operate on the dynamic and persistent data to perform analysis functions that derive new and useful information about what is occurring within the public infrastructure. Derived information can then be operated upon by still other services for further analysis.

Many computational services are possible. A list of immediately useful algorithms includes:

- Incident Detection and Location
- Queue Length
- Travel Time
- Segment Aggregation

- Weather Condition
- Road/Bridge Condition
- Pothole Locator
- Data Quality Checking

2.2.5 Output Services

Output services subscribe to analyzed data and format it for use by other services both within the DUAP system and external to it. For example, SAE J2354 XML formatted data can be produced as data output to be used as data input to other systems or ATIS that enhance public safety and provide access to the managed infrastructure.

Data output services also format analyzed data for use by presentation services. This could be as simple as structuring data for presentation as a report on a DUAP Web page. It could also build informative messages to be sent to VII-participating vehicles. This interaction could be achieved using the X-032 interface to the Advisory Message Distribution Service as described in the VII National System Specification.

2.2.6 Presentation Services

Presentation Services support human interpretation of DUAP data. Due to the inherent flexibility in modular service implementation, presentation services—and the data output services that support those presentation services—can be added to the system as needed.

For example, a traveler information presentation service might be expected to provide information on incidents and travel times through a Web page. Computational services—incident detection travel time calculation, and incident status monitoring, for example—would generate the data, and an output service would package the data. A presentation service, however, would create the user interface. Similarly, presentation services for maintenance support systems could be deployed to generate pavement segment maintenance priority lists, immediate maintenance alerts, and estimated segment roadway life expectancy from data created by other computational services.

2.2.7 Administrative Services

Administrative services will exist within the DUAP system to configure other services. Essentially, administrative services fulfill the role of “meta-services.” These services will be used to organize the sequence of execution for any of the other services, view logging information, and to change the operating modes of the system.

2.3 User Characteristics

2.3.1 MDOT Organizational Structure

The Director of the Michigan Department of Transportation is appointed by the Governor. The Executive Bureau also includes a Chief Deputy Director, Chief Administrative Officer, and Chief Operations Officer.

The Michigan State Transportation Commission is the policy-making body for all state transportation programs. The Commission consists of a six-member bi-partisan board appointed by the governor of Michigan with the advice and consent of the State Senate. The Office of Commission Audit reports directly to the Commission and is charged with overall responsibility to supervise and conduct auditing activities of MDOT.

MDOT operates in a decentralized organization composed of seven geographic regions, with its headquarters located in the Murray Van Wagoner Transportation Building in Lansing, Michigan, and has responsibilities for highways, aviation, and transit.

The Asset Management Council has a goal to expand the practice of asset management statewide in order to more efficiently invest in Michigan's roads and bridges. This is done through coordination and collaboration among the member agencies which include state, regional and local transportation and planning organizations.

2.3.2 Stakeholders

This section describes stakeholders who use the data gathered by the VII system. While each transportation agency has its own organizational structure and functional responsibilities, similar functions and users are present across all agencies.

The gathered information must be presented to all users in "real-time", meaning that the information is only valuable if it can be provided and acted upon quickly enough to reduce the impact of the event as it is occurring. The information also needs to be accurate.

Transportation agency (TA) Operators include local, regional, and state transportation agencies throughout Michigan, and in adjoining jurisdictions. These operators have one common objective, which is to minimize the impact of incidents and events on the normal flow of traffic.

In order to meet this objective, operators perform the following tasks:

- Review major travel impacting incidents and events
- Assess potential impact on travelers
- Determine response actions needed
- Monitor incident or event for status changes

Transportation agency maintainers include local, regional, and state employees who maintain the roadways and bridges within their particular jurisdiction. They

maintain road conditions on a daily basis as well as respond to incidents to perform cleanup and make necessary roadway repairs.

Transportation agency asset managers include local, regional, and state employees who analyze the data and information collected about the assets in their area to determine each agency's annual programs and projects. Their goal is a cost-effective use of resources within their agency.

System administrators include local, regional, and state employees who are responsible for the administration of the systems. Their goal is to have all collected data made available for use by the other stakeholders.

Transportation agency management includes the management personnel of the various local, regional, and state transportation agencies. The management personnel supervise the transportation agency staff working with both the raw and analyzed data.

Transportation agency contractors are contract employees hired by local, regional, or state transportation agencies to perform a specific job within the agency. These contractors will work with the agency staff to meet the requirements of their contract.

Travelers are all the people who use the roadways, whether driving or riding in private or commercial vehicles. They obtain their trip information from various sources and use it to prepare for their daily commute or for an extended trip. The trip information may be used by the traveler for determining possible delays along desired route(s) or choosing an alternative route or mode of transportation.

Emergency services are staffed with trained personnel who respond to emergency incidents or major disasters both on and off the roadway system. Their primary goal is to protect themselves and the public during the response to an incident. The data from the roadway system will assist them initially in getting to the incident location. After Emergency Services personnel are on-site, the data can be used to help evaluate the impact of the incident on the current traffic and help determine if additional resources are needed.

Researchers and university personnel assist the transportation agencies by analyzing the collected data based on the requirements of the particular agency for which they are working. The University of Michigan Transportation Research Institute (UMTRI) is an example of one such group. It has worked with the Michigan State Police Office of Highway Safety on crash investigation research. It is important that the data used by the researchers is accurate and complete.

The Michigan Transportation Research Board (MTRB) is led by MDOT and is a voluntary advisory body to Michigan's transportation agencies. MTRB will assist in the following:

- Identifying and prioritizing transportation research needs
- Interacting with other organizations that conduct and support research
- Advocating the value of research to improve Michigan's transportation system

- Promoting an exchange of information, ideas, and knowledge
- Helping to set the direction for annual research programs
- Evaluating annual progress

Stakeholders in DUAP-enhanced transportation system operations are almost entirely the same as those involved in the current state of operations as noted above.

The intent of adding new data sources is to provide a more complete dataset upon which the transportation agencies can base operational decisions, but there are not necessarily any new *users* of VII data within the agencies. The *providers* of VII data are, however, new stakeholders in transportation operations.

The automobile manufacturers—original equipment manufacturers (OEMs) — become stakeholders in DUAP because VII data becomes available to transportation agencies only if those OEMs provide equipment and communication systems on their vehicles for transmitting the data to the VII network. Many of the OEMs are members of the Vehicle Infrastructure Integration Consortium (VIIC), which is developing the on-board equipment (OBE) and assisting the United States Department of Transportation (USDOT) in development of applications for VII infrastructure and data. OEMs are in many cases also developing independent telematics networks from which transportation agencies might be able to obtain data similar to that provided through the USDOT/VIIC efforts.

The VII network (and any similar independent telematics networks) will also introduce a network operating entity as a stakeholder to DUAP and transportation system operations. Once the VII field infrastructure is in place, a network operating entity will be needed to operate, monitor, and maintain the flow of VII data and the infrastructure enabling it. The operating entity's responsibilities in this capacity are similar to those of a transportation agency relative to the transportation network.

2.4 General Constraints

In its prototype DUAP applications, MDOT will be evaluating a broad range of data uses and analyses. Some of these evaluations will benefit from being able to link probe vehicle data directly to information about the vehicles on which the data originates. While this ability is of tremendous value in application research, operational policies will need to be established to protect the privacy and data ownership of the data originators. While the USDOT VII program is addressing policy issues for the VII network itself, MDOT will be faced with many of the same issues as it seeks to integrate VII data into its operations.

For example, while VII probe data is "anonymized" to the extent that it is not associated directly with a particular vehicle or driver, there are inherent limitations to that anonymity. In the simplest such case, the VII-originated record of a vehicle's behavior could be uniquely correlated to a particular vehicle if it were the only such vehicle on a roadway at a particular time and corroborated by other observations. While this may not be a significant policy issue during system

development and testing, or when every vehicle on the road is VII-enabled, it could become an issue in the transition—when some, but not all vehicles are so equipped, and are therefore more identifiable.

The question of ownership of commingled data may become an issue for DUAP-based information. MDOT and its partner transportation agencies currently subscribe to selected traffic, vehicle location, and weather information services that would be blended into the DUAP data streams. While the bulk of data will be from the VII network, other sources present opportunities for data expansion and validation that might be necessary for DUAP to succeed. Limitations on the use or redistribution of data from these third-party sources could hamper the usefulness of DUAP, and will need to be considered in agreements for those services.

2.5 Assumptions and Dependencies

Data latency is the time delay experienced when data is sent from one point to another. Latency enters into the data collection process in several ways:

- The time required for vehicle systems to collect and store vehicle data
- The delay between the data collection and the data transmission from the vehicle to the roadside equipment (RSE)
- The time required for the transmission of data from the RSE to the DUAP system
- The time required for the DUAP system to process the data and publish it to other systems
- The time between the DUAP processing and the transmission to the end systems

While the VII data is much more timely and complete than data currently being processed, participants must recognize that VII data is “near real-time” data. Each system using DUAP data must be capable of evaluating the data based on the source and date/time stamps to determine the suitability of each data element for the intended purpose.

Data quality may also be an issue. Vehicle sensors may be in various states of calibration and may even function in degraded modes. Each application using the VII and DUAP data will need to have the capability of assessing the quality of data and making appropriate use of any available data quality flags.

Finally, the amount of data coming into DUAP from VII is highly dependent on the amount of data collected by each vehicle, the number of VII equipped vehicles, the number of RSE locations, and the frequency of encounters between VII equipped vehicles with RSE equipped locations. While these factors can be controlled during the evaluation phase of this project, only the number of RSE locations will be within the control of agencies during the full production roll-out of the system.

3 SPECIFIC REQUIREMENTS

This section presents the detailed requirements for the Michigan Department of Transportation's Vehicle Infrastructure Integration Data Use Analysis and Processing System and the associated institutional program necessary to achieve the needs and goals described by the VII DUAP System Concept of Operations. In this section, the requirements are divided into a number of categories as follows:

- Input Services – Input Services provide the ability for DUAP to interact with any other system that might have data needed by DUAP.
- Administrative Services – Administrative Services exist within the DUAP system to configure other services.
- Dynamic Data Services – Dynamic Data Services are the active memory of DUAP. Data obtained by the Input Services are stored here for use by other DUAP components.
- Computational Services – Computational Services apply logical algorithms to incoming vehicle and traffic observations in order to transform those observations into data that are directly applicable to transportation management and operations processes.
- Persistent Data Services – Persistent Data Services are the long-term memory of DUAP.
- Output Services – Output Services subscribe to data within DUAP Dynamic and Persistent Data Services and structure and format it for use by other services within and external to the DUAP system.
- Presentation Services – Presentation Services support human interpretation of DUAP data.
- Design Constraints – Design Constraints are imposed by existing systems, standards, regulations, or hardware limitations.
- Quality Characteristics – Quality Characteristics provide requirements which address the general quality, usability, extensibility, flexibility, and maintainability of the system.
- External Requirements – External Requirements are not part of the DUAP system, but include institutional requirements necessary to support the DUAP system. These requirements are not testable and are the responsibility of MDOT.

Table 1 shows the general layout of the requirements tables, and explains the purpose or content of each column of the requirements table. The requirements in this document are a subset of the requirements information that is tracked in the system "Requirements Matrix". While this document is intended to record the requirements that apply to a particular implementation of the product, the Requirements Matrix tracks all proposed requirements for the product. The

Matrix includes requirements that may apply to future versions of the product or which have been deferred due to cost or complexity.

Table 2 shows an explanation of the requirement identification numbering system.

Tables 3 through 15 present the requirements associated with the system services described above.

Table 1 – Explanation of the Requirements Tables

ID	Requirement	Source	Comment	Importance
A unique identifier (ID) used to trace requirements from beginning to end in a system development process.	The text of the actual requirement. Requirements formulated with "…shall…" are direct requirements; those using "…shall be able to…" are conditioned on other requirements being fulfilled or on factors outside the control of the requirement's subject.	Source(s) for the requirement; could be a reference document or a "parent" requirement.	Supporting text that may help explain the requirement, its importance, or the risks associated with implementing the requirement.	**H** – indicates that it is essential to the DUAP system **M** – indicates that it should be implemented **L** – indicates "nice to have" **D** – indicates that the requirement is deferred

Table 2 – Requirement ID Format

Requirement ID Format	Explanation of Format
High-Level Requirement AA-NNN Detailed Requirement AA-NNN-UUU	AA Represents the classification of the requirements within the requirements document. The following classifications have been used in this requirements specification: IS Input Services (Section 3.1) AS Administrative Services (Section 3.2) DD Dynamic Data Services (Section 3.3) CS Computational Services (Section 3.4) PD Persistent Data Services (Section 3.5) OS Output Services (Section 3.6) PS Presentation Services (Section 3.7) DC Design Constraints (Section 3.8) QC Quality Characteristics (Section 3.9) XR External Requirements (Section 3.10) NNN Represents the sequence number. Numbering is not necessarily sequential; gaps in the sequence leave room to add additional related requirements when they are discovered. UUU Provides unique identification.

3.1 IS – Input Services

Input Services provide the ability for DUAP to interact with other systems providing data to DUAP.

Table 3 – Input Services

ID	Function	Source	Comments	Importance
IS-010	The DUAP System shall collect probe vehicle data.	ConOps § 3.2.1 ConOps § 3.2.3 ConOps § 4.1 ConOps § 4.3.1 ConOps § 4.4 ConOps § 5.1 ConOps § 5.2 ConOps § 5.3 ConOps § 5.4 ConOps § 5.5	The ability to collect probe vehicle data is one of the primary purposes of the DUAP project.	H
IS-010-005	The DUAP data elements shall include probe vehicle data fields corresponding to the SAE J2735 format as enumerated in APPENDIX C - SAE J2735 Probe Data Elements.	ConOps § 3.2.1	See List in APPENDIX C - SAE J2735 Probe Data Elements for probe data elements to be included.	H
IS-010-010	The DUAP Input Services shall be able to collect probe vehicle data from the VII Proof of Concept (POC) Probe Data Service (PDS) using the X-031 interface.	ConOps § 4.3.1	The ability to collect probe vehicle data is one of the primary purposes of the DUAP project.	H
IS-010-015	The DUAP Input Services shall be able to collect probe vehicle data from the Chrysler Fast Feedback (telematics demonstration) fleet using the Chrysler telematics interface.	ConOps § 4.2	The specific format of the interface is to be determined in the design of the prototype.	H
IS-010-020	The DUAP Input Services shall be able to collect probe vehicle data from Southeast Michigan Snow and Ice Management (SEMSIM) using the SEMSIM interface.	ConOps § 5.2	The specific format of the interface is to be determined in the design of the prototype.	M
IS-010-030	The DUAP Input Services shall be able to collect probe vehicle data from Suburban Mobility Authority for Regional Transportation (SMART) Transit using the SMART Transit interface.	ConOps § 2.3.2.7 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	L

ID	Function	Source	Comments	Importance
IS-010-040	The DUAP Input Services shall be able to collect probe vehicle data from The Rapid Transit using the "The Rapid Transit" interface.	ConOps § 2.3.2.7 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	D
IS-010-050	The DUAP Input Services shall be able to collect probe vehicle data from Ann Arbor Transit using the Ann Arbor Transit interface.	ConOps § 2.3.2.7 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	D
IS-010-060	The DUAP Input Services shall be able to collect probe vehicle data from Detroit Department of Transportation (DDOT) Transit using the DDOT interface.	ConOps § 2.3.2.7 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	D
IS-010-070	The DUAP Input Services shall be able to collect probe vehicle data from the MDOT fleet using the MDOT probe vehicle data interface.	ConOps § 3.2.2	The specific format of the interface is to be determined in the design of the prototype.	M
IS-010-080	The DUAP Input Services shall be able to collect probe vehicle data from truck fleets using the truck fleets' interfaces.	ConOps § 3.2.2	The specific format of the interface is to be determined in the design of the prototype.	L
IS-010-090	The DUAP Input Services shall be able to collect probe vehicle data from the car rental fleets using the car rental fleets' interfaces.	ConOps § 3.2.2	The specific format of the interface is to be determined in the design of the prototype.	D
IS-030	The DUAP System shall be able to collect weather data.	ConOps § 2.3.2.1 ConOps § 3.1.1 ConOps § 3.3 ConOps § 4.3.1 ConOps § 4.4 ConOps § 5.2 ConOps § 5.4 ConOps § 7.1	Inferred to be a high level requirement since winter operations is one of the key aspects of the DUAP project.	H
IS-030-022	The DUAP Input Services shall be able to collect weather data from the Road Commission for Oakland County (RCOC) Road Weather Information Systems (RWIS) using the RCOC RWIS interface.	ConOps § 2.3.2.1 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	H

ID	Function	Source	Comments	Importance
IS-030-023	The DUAP Input Services shall be able to collect weather data from the MDOT RWIS using the MDOT RWIS interface.	ConOps § 2.3.2.6 ConOps § 4.1	The MDOT RWIS system is currently being installed and should be able to provide data in 2008. The specific format of the interface is to be determined in the design of the prototype.	L
IS-030-024	The DUAP Input Services shall be able to collect weather data from Michigan Department of Natural Resources (MDNR) weather information systems using the MDNR interface.	MHI	The specific format of the interface is to be determined in the design of the prototype.	L
IS-030-026	The DUAP Input Services shall be able to collect weather data from MDOT Aeronautics Automated Weather Observing System (AWOS) using the AWOS interface.	MHI	The specific format of the interface is to be determined in the design of the prototype.	L
IS-030-030	The DUAP Input Services shall be able to collect *Clarus* weather data as enumerated in APPENDIX D -Weather Data Elements from *Clarus*.	ConOps § 2.3.2.6 ConOps § 5.2	Inferred to be a high level requirement since winter operations is one of the key aspects of the DUAP project. See list in APPENDIX D - Weather Data Elements from *Clarus* for weather condition data elements to be included.	H
IS-030-040	The DUAP Input Services shall be able to include weather condition fields corresponding to the SAE J2354 WeatherInformation structure as enumerated in APPENDIX E -SAE J2354 Weather Information Elements.	ConOps § 3.2.1	See list in APPENDIX E - SAE J2354 Weather Information Elements for weather condition data elements to be included.	M
IS-040	The DUAP System shall be able to collect Origin/Destination (O/D) data.	ConOps § 3.2.2 ConOps § 5.3 ConOps § 5.5 ConOps § 7.1	Type of O/D data to be collected needs to be established.	L
IS-070	The DUAP System shall collect roadway traffic data.	ConOps § 2.3.2 ConOps §4.1	The ability to collect traffic data from multiple sources is one of the primary purposes of the DUAP project.	H
IS-070-003	The DUAP data elements shall include roadway event information data fields corresponding to the SAE J2354 structure as enumerated in APPENDIX F - SAE J2354 EventInformation Elements.	ConOps § 4.3.1	See List in APPENDIX F - SAE J2354 EventInformation Elements for traffic data elements to be included.	H

ID	Function	Source	Comments	Importance
IS-070-005	The DUAP Input Services shall include roadway traffic data fields corresponding to the SAE J2354 structure as enumerated in APPENDIX G - SAE J2354 LinkTrafficInformation Elements.	ConOps § 4.3.1	See List in APPENDIX G - SAE J2354 LinkTrafficInformation Elements for traffic data elements to be included.	H
IS-070-010	The DUAP Input Services shall be able to collect roadway traffic data from the MITS Center using the MITS traffic data interface.	ConOps § 4.3.1	The specific format of the interface is to be determined in the design of the prototype.	H
IS-070-020	The DUAP Input Services shall be able to collect roadway traffic data from the Western Michigan Traffic Management System (WMTMS) using the WMTMS interface.	ConOps § 2.3.2.1	The specific format of the interface is to be determined in the design of the prototype.	D
IS-070-030	The DUAP Input Services shall be able to collect roadway traffic data from the RCOC system using the RCOC system interface.	ConOps § 2.3.2.1 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	H
IS-070-040	The DUAP Input Services shall be able to collect roadway traffic data from the Road Commission of Macomb County (RCMC) system using the RCMC system interface.	ConOps § 2.3.2.1 ConOps § 4.1	The specific format of the interface is to be determined in the design of the prototype.	L
IS-070-050	The DUAP Input Services shall be able to collect roadway traffic data from NAVTEQ Corporation's Traffic.com using the Traffic.com interface.	ConOps § 2.3.2.8	Data sharing agreements may prevent commingling of data with other MDOT data sources. The specific format of the interface is to be determined in the design of the prototype.	L
IS-070-060	The DUAP Input Services shall be able to collect roadway traffic data from the Traffic Monitoring System for Highways (TMS/H) using the TMS/H interface.	ConOps § 2.3.2.2	The specific format of the interface is to be determined in the design of the prototype.	L
IS-070-070	The DUAP Input Services shall be able to collect traffic data from the Ann Arbor Traffic Management Center (TMC) system using the Ann Arbor TMC interface.	ConOps § 2.3.2.6	The specific format of the interface is to be determined in the design of the prototype.	D
IS-070-080	The DUAP Input Services shall be able to collect traffic data from the Detroit TMC system using the Detroit TMC interface.	ConOps § 2.3.2.6	The specific format of the interface is to be determined in the design of the prototype.	D
IS-070-090	The DUAP Input Services shall be able to collect traffic data from the Superior and Traverse City North Regions TMC system using the Superior and Traverse City North Regions TMC interface.	ConOps § 2.3.2.6	The specific format of the interface is to be determined in the design of the prototype.	D

ID	Function	Source	Comments	Importance
IS-070-100	The DUAP Input Services shall be able to collect traffic data from the Statewide TMC system using the Statewide TMC interface.	ConOps § 2.3.2.6	The specific format of the interface is to be determined in the design of the prototype.	D
IS-110	The DUAP System shall be able to collect traveler information.	ConOps § 2.3.2.6 ConOps § 4.3.1		L
IS-130	The DUAP System shall be able to collect road condition data.	ConOps § 5.4	The ability to collect road condition data is one of the primary purposes of the DUAP project.	H
IS-130-010	The DUAP Input Services shall be able to collect road condition data from Traffic Management Systems (TMS) using the TMS interface.	ConOps § 5.4 ConOps § 7.1	The specific format of the interface is to be determined in the design of the prototype.	H
IS-140	The DUAP System shall be able to collect work zone (lane closure) data.			H
IS-905	The DUAP System shall log Input Services data transactions.	MHI		M

3.2 AS – Administrative Services

Administrative Services exist within the DUAP system to configure other services and manage interfaces with users and other systems.

Table 4 – Administrative Services

ID	Function	Source	Comments	Importance
AS-020	The DUAP System shall be able to organize the sequence of execution of computational modules.	ConOps § 4.3.7		H
AS-030	The DUAP System shall allow the system administrator to add, modify, and delete Input Services.	MHI		H
AS-040	The DUAP System shall allow the system administrator to add, modify, and delete Computational Services.	MHI		H
AS-050	The DUAP System shall allow the system administrator to add, modify, and delete Output Services.	MHI		H
AS-060	The DUAP System shall allow the system administrator to add, modify, and delete Presentation Services.	MHI		H
AS-200	The DUAP System shall restrict access to authorized users.	MDOT		H
AS-210	The DUAP System shall keep records of user access.	MDOT		H
AS-220	The DUAP System shall allow a system administrator to add, modify and delete user access rights.	MDOT		H
AS-905	The DUAP System shall be able to log system operations.	MHI		H
AS-906	The DUAP System shall log Administrative Services data transactions.	MHI		H

3.3 DD – Dynamic Data Services

Dynamic Data Services are the active memory of DUAP. Data obtained by the Input Services are stored here for use by other DUAP components.

Table 5 – Dynamic Data Services

ID	Function	Source	Comments	Importance
DD-010	The DUAP System shall cache (both raw and derived) probe vehicle data.	MHI	See List in APPENDIX C - SAE J2735 Probe Data Elements for probe data elements to be included.	H
DD-070	The DUAP System shall cache (both raw and derived) traffic data.	MHI	See List in APPENDIX G - SAE J2354 LinkTrafficInformation Elements for traffic data elements to be included.	H
DD-030	The DUAP System shall cache (both raw and derived) road weather data.	MHI	See List in APPENDIX E - SAE J2354 Weather Information Elements for road weather data elements to be included.	H
DD-130	The DUAP System shall cache (both raw and derived) road condition data.	MHI		H
DD-100	The DUAP System shall cache data only if the data record associates the data with its source, a geo-referenced location, and a timestamp.	MHI		H
DD-050	The DUAP System shall cache data for 1 week.	ConOps § 4.3.2	One week allows sufficient time for both immediate operational needs and archiving processes.	H
DD-040	The DUAP System shall allow data to be accessed as soon as it is cached.	ConOps § 4.3.2		H
DD-905	The DUAP System shall log Dynamic Data Services data transactions.	MHI		H

3.4 CS – Computational Services

Computational Services apply logical algorithms to incoming vehicle, traffic, weather, and roadway condition observations in order to transform those observations into data that are directly applicable to transportation management and operations processes.

Requirements for specific computational services may be added as they are identified in future system analyses. The research orientation of the project and prototypical nature of the systems development make it very likely that new computational needs will be discovered as the project progresses.

Table 6 – Computational Services

ID	Function	Source	Comments	Importance
CS-010	The DUAP System shall derive traffic data from probe vehicle data.	ConOps § 3.2.3 ConOps § 4.3.4 ConOps § 5.1 ConOps § 5.2 ConOps § 5.3	The ability to collect and process traffic data is one of the primary purposes of the DUAP project.	H
CS-010-010	The DUAP Computational Services shall be able to derive speed from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		H
CS-010-020	The DUAP Computational Services shall be able to derive congestion level based on volume to capacity from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		H
CS-010-030	The DUAP Computational Services shall be able to derive traffic counts from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		L
CS-010-040	The DUAP Computational Services shall be able to derive traffic distribution (occupancy) from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		L
CS-010-050	The DUAP Computational Services shall be able to derive freeway queue length from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		H
CS-010-055	The DUAP Computational Services shall be able to derive arterial queue length from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		L
CS-010-060	The DUAP Computational Services shall be able to derive travel time from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		H
CS-010-070	The DUAP Computational Services shall be able to derive turning movements from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		M
CS-020	The DUAP System shall be able to infer incidents from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.1 ConOps § 5.3		H

ID	Function	Source	Comments	Importance
CS-020-010	The DUAP Computational Services shall be able to infer incident occurrences from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.1 ConOps § 5.3		H
CS-020-020	The DUAP Computational Services shall be able to infer incident locations from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.1 ConOps § 5.3		H
CS-020-030	The DUAP Computational Services shall be able to infer incident type from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.1 ConOps § 5.3		M
CS-020-040	The DUAP Computational Services shall be able to infer incident severity from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.1 ConOps § 5.3		M
CS-040	The DUAP System shall be able to derive road surface weather observations from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.2		H
CS-070	The DUAP System shall be able to derive travel demand from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.3		L
CS-100	The DUAP System shall be able to derive roadway surface conditions from probe vehicle data.	ConOps § 4.3.4		L
CS-100-010	The DUAP Computational Services shall be able to derive pavement surface conditions from probe vehicle data.	ConOps § 4.3.4		L
CS-100-020	The DUAP Computational Services shall be able to derive bridge surface conditions from probe vehicle data.	ConOps § 4.3.4		L
CS-100-030	The DUAP Computational Services shall be able to derive pothole location from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.4		H
CS-100-040	The DUAP Computational Services shall be able to derive pothole severity from probe vehicle data.	ConOps § 4.3.4 ConOps § 5.4		L
CS-120	The DUAP System shall be able to identify high risk locations.	ConOps § 4.3.4 ConOps § 5.2		M
CS-130	The DUAP System shall be able to calculate measures of effectiveness.	ConOps § 3.1.3		H
CS-140	The DUAP System shall be able to perform data quality checking.	ConOps § 4.3.4		M
CS-905	The DUAP System shall log Computational Services data transactions.	MHI		H

3.5 PD – Persistent Data Services

Persistent Data Services are the long-term memory of DUAP.

Table 7 – Persistent Data Services

ID	Function	Source	Comments	Importance
PD-020	The DUAP System shall store geo-references for Michigan roadways.	ConOps § 2.3.2.4		H
PD-030	The DUAP System shall store DUAP system configuration data.	MHI		H
PD-040	The DUAP System shall archive cached data.	ConOps § 4.3.3 ConOps § 5.1 ConOps § 5.2 ConOps § 5.3 ConOps § 5.4		H
PD-040-010	The DUAP Persistent Data Services shall be able to archive cached (raw and derived) probe vehicle data.	ConOps § 4.3.3		H
PD-040-020	The DUAP Persistent Data Services shall be able to archive cached (raw and derived) traffic data.	ConOps § 4.3.3		H
PD-040-030	The DUAP Persistent Data Services shall be able to archive cached (raw and derived) roadway weather data.	ConOps § 4.3.3		H
PD-040-040	The DUAP Persistent Data Services shall be able to archive cached (raw and derived) road condition data.	ConOps § 4.3.3		H
PD-905	The DUAP System shall log Persistent Data Services data transactions.	MHI		H

3.6 OS – Output Services

Output Services subscribe to data within DUAP Dynamic and Persistent Data Services and structure and format it for use by other services within and external to the DUAP system.

Table 8 – Output Services

ID	Function	Source	Comments	Importance
OS-010	The DUAP System shall publish data.	ConOps § 4.3.5 ConOps § 5.1 ConOps § 5.2		H
OS-010-010	The DUAP Output Services shall be able to publish traveler data in SAE J2354 format as enumerated in Appendix E.	ConOps § 4.3.5 ConOps § 5.1	See APPENDIX E - for listing of traveler data using the SAE J2354 format.	H
OS-010-025	The DUAP Output Services shall be able to publish roadway traffic information in Traffic Management Data Dictionary (TMDD) format.	ConOps § 5.3 MHI		L
OS-010-030	The DUAP Output Services shall be able to publish traffic data to TMS using the TMS interface format.	ConOps § 4.1 ConOps § 5.1	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	M
OS-010-020	The DUAP Output Services shall be able to publish data to SEMSIM using the SEMSIM interface format.	ConOps § 4.1 ConOps § 5.2	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	L
OS-010-050	The DUAP Output Services shall be able to publish traffic data in the VISSIM traffic analysis tool VISSIM interface format.	ConOps § 4.1 ConOps § 2.3.2 MHI	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	D
OS-010-060	The DUAP Output Services shall be able to publish traffic data in the Synchro traffic analysis tool Synchro interface format.	ConOps § 4.1 ConOps § 2.3.2 MHI	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	D

ID	Function	Source	Comments	Importance
OS-010-070	The DUAP Output Services shall be able to publish traffic data in the Paramics traffic analysis tool Paramics interface format.	ConOps § 4.1 ConOps § 2.3.2 MHI	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	D
OS-010-075	The DUAP Output Services shall be able to publish traffic data in the SimTraffic traffic analysis tool SimTraffic interface format.	ConOps § 4.1 ConOps § 2.3.2 MHI	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	D
OS-010-080	The DUAP Output Services shall be able to publish traffic management data in TMS/H interface format.	ConOps § 4.1 ConOps § 5.3	Integrate new capabilities with existing applications. The specific format of the interface is to be determined in the design of the prototype.	M
OS-010-090	The DUAP Output Services shall be able to publish weather data elements as enumerated in APPENDIX D - Weather Data Elements from *Clarus* output format.	ConOps § 2.3.2.6	See APPENDIX D -Weather Data Elements from *Clarus* for listing of weather data elements.	H
OS-010-100	The DUAP Output Services shall be able to publish asset condition data using the asset condition data interface format.	ConOps § 3.1 ConOps § 3.1.3 ConOps § 4.1 ConOps § 7.1	The specific format of the interface is to be determined in the design of the prototype.	L
OS-020	The DUAP System shall publish alerts.	ConOps §4.3.6 ConOps § 5.1		
OS-020-010	The DUAP Output Services shall be able to publish traffic condition alerts using the traffic condition alert interface format.	ConOps § 5.1	The specific format of the interface is to be determined in the design of the prototype.	M
OS-020-020	The DUAP Output Services shall be able to publish weather condition alerts using the weather condition alert interface format.	ConOps § 5.2	The specific format of the interface is to be determined in the design of the prototype.	M
OS-020-030	The DUAP Output Services shall be able to publish asset condition alerts using the asset condition alert interface format.	ConOps § 5.4	The specific format of the interface is to be determined in the design of the prototype.	L
OS-020-040	The DUAP Output Services shall be able to publish alerts using the threshold exceeded alert interface format when thresholds have been exceeded.	ConOps § 4.3.6 ConOps § 5.1 ConOps § 6.1	The specific format of the interface is to be determined in the design of the prototype.	H
OS-030	The DUAP System shall publish information for the MDOT *MI Drive* presentation.			

ID	Function	Source	Comments	Importance
OS-905	The DUAP System shall log Output Services data transactions.	MHI		H

3.7 PS – Presentation Services

Presentation Services support human interpretation of DUAP data.

Table 9 – Presentation Services

ID	Function	Source	Comments	Importance
PS-010	The DUAP Presentation Services shall present data published by Output Services.	ConOps § 4.3.5 ConOps § 4.3.6		H
PS-020	The DUAP Presentation Services shall include a user interface for browsing traffic information.	ConOps § 4.3.6		H
PS-020-010	The traffic information browser shall allow a user to query traffic-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	H
PS-020-020	The traffic information browser shall allow a user to view traffic-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	H
PS-020-030	The information browsers shall provide a means for users to select between Metric and English units of measurement for display.	ConOps § 4.3.6 MHI	Not currently a stakeholder-requested function.	D
PS-020-040	The information browsers shall provide a map display which uses icons to identify the locations with associated data.	ConOps § 4.3.6 MHI		H
PS-020-050	The system map display shall provide a means to select which data layers are displayed.	ConOps § 4.3.6 MHI		L
PS-020-060	The system map display shall support each type of traffic item to be displayed in its own layer.	ConOps § 4.3.6 MHI		M
PS-020-070	The system map display shall support pan and zoom capabilities to allow a user to select the area to be displayed.	ConOps § 4.3.6 MHI		M
PS-020-080	The system map display shall support de-cluttering to reduce the number of icons displayed when large areas are displayed.	ConOps § 4.3.6 MHI		L
PS-020-090	The information browsers shall provide tabular information identifying locations with associated data.	ConOps § 4.3.6 MHI		H
PS-020-100	The tabular information display shall provide a means to select the data to be displayed.	ConOps § 4.3.6 MHI		L

ID	Function	Source	Comments	Importance
PS-020-110	The tabular information display shall provide a means to select the area to be displayed.	ConOps § 4.3.6 MHI		M
PS-030	The DUAP Presentation Services shall include a user interface for browsing incident information.	ConOps § 4.3.6 ConOps § 5.1		H
PS-030-010	The incident information browser shall allow a user to query incident-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 5.1	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	H
PS-030-020	The incident information browser shall allow a user to view incident-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 5.1	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	H
PS-040	The DUAP Presentation Services shall include a user interface for browsing traveler information.	ConOps § 4.3.6 ConOps § 5.1		M
PS-040-010	The traveler information browser shall allow a user to query traveler-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 5.1	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	M
PS-040-020	The traveler information browser shall allow a user to view traveler-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 5.1	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	M
PS-050	The DUAP Presentation Services shall include a user interface for browsing asset condition information.	ConOps § 4.3.6 ConOps § 5.4 ConOps § 7.1		M
PS-050-010	The asset condition information browser shall allow a user to query asset condition-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 7.1	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	M
PS-050-020	The asset condition information browser shall allow a user to view asset condition-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 7.1	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	M
PS-080	The DUAP Presentation Services shall include a user interface for browsing weather information.	ConOps § 4.3.6 ConOps § 5.2		H
PS-080-010	The weather information browser shall allow a user to query weather-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 5.2	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	H

ID	Function	Source	Comments	Importance
PS-080-020	The weather information browser shall allow a user to view weather-related information using a web browser capable of supporting HTML 4.01, JavaScript (ECMA-262 edition 3), and XML 1.0.	ConOps § 4.3.6 ConOps § 5.2	Web browsers such as Microsoft Internet Explorer 6.0 (and later) and Mozilla Firefox 2.0 (and later) support these capabilities.	H
PS-200	The DUAP System shall require users to log in for system access.	MDOT		
PS-200-010	The DUAP Presentation Services shall require users to uniquely identify themselves.	MHI	Could be implemented, for example, through a username.	
PS-200-020	The DUAP Presentation Services shall require users to confirm their identity.	MHI	Could be implemented, for example, through a password associated with that username.	
PS-905	The DUAP System shall log Presentation Services data transactions.	MHI		H

3.8 DC – Design Constraints

This section identifies design constraints imposed by existing systems, standards, regulations, or hardware limitations.

Table 10 – Design Constraints

ID	Requirement	Source	Comments	Importance
DC-010	The DUAP System shall conform to IT standards established by the Michigan Department of Information Technology (MDIT).	ConOps § 2.5 ConOps § 4.6.4	The software for this project will meet MDIT standards provided at the start of this project. Any exceptions will be documented and approved by MDIT before implementation. MDIT will be consulted throughout this project to ensure compliance with these standards.	H
DC-010-010	The DUAP System shall use a Java software foundation.	ConOps § 4.6.4		M
DC-010-015	The DUAP system shall use Java Database Connectivity (JDBC) components to interact with databases.			M
DC-010-020	The DUAP System shall be able to use Oracle 10G as the relational database.	ConOps § 4.6.4		M
DC-010-030	The DUAP System shall handle database data requests through standard Structured Query Language (SQL). Commands.	ConOps § 4.6.4		H
DC-040	The DUAP System shall use Michigan Geographic Framework geo-references.	ConOps § 2.3.2.4 ConOps § 4.1	Section 2 of the ConOps provides a description of the existing systems and interfaces. This standard is listed as a part of that description.	H

3.9 QC – Quality Characteristics

Quality Characteristics provide requirements which address the general quality, usability, extensibility, flexibility, and maintainability of the system.

Table 11 – Quality Characteristics

ID	Requirement	Source	Comments	Importance
QC-020	The DUAP System shall be capable of adding new data sources.	ConOps § 3.2.3	Access could only be provided when new data sources are established and available.	L
QC-030	The DUAP System shall be capable of adding new computational algorithms.	ConOps § 3.2.3	Access could only be provided when new algorithms are established and available.	L
QC-040	The DUAP System shall be capable of adding new output formats of published data.	ConOps § 3.2.3	Access could only be provided when new communication formats are established and available.	L
QC-050	The DUAP System shall be capable of adding new presentations of published data.	ConOps § 3.2.3	Access could only be provided when new user interface needs are established and available.	L

3.10 XR – External Requirements

External Requirements are not part of the DUAP system, but include institutional requirements necessary to support the DUAP system. These requirements are not testable and are the responsibility of MDOT.

Table 12 – External Requirements

ID	Requirement	Source	Comments	Importance
XR-100	Access to the DUAP system shall be limited to users authorized by MDOT.	ConOps § 4.4		H

APPENDIX A - DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

The following table provides the definitions of all terms, acronyms, and abbreviations required to properly interpret this Concept of Operations.

Term	Definition
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AWOS	Automated Weather Observing System
CGI	Center for Geographic Information
Clarus	The *Clarus* (which is Latin for "clear") System is an integrated surface transportation weather observing, forecasting, and data management system.
CMS	Changeable Message Sign
ConOps	Concept of Operations
DDOT	Detroit Department of Transportation
DMS	Dynamic Message Sign
MDNR	Michigan Department of Natural Resources
DUAP	Data Use Analysis and Processing
ESS	Environmental Sensor Station
FHWA	Federal Highway Administration
HTML	Hyper Text Markup Language
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers, Inc.
ITS	Intelligent Transportation Systems
JDBC	Java Database Connectivity
MDIT	Michigan Department of Information Technology
MDOT	Michigan Department of Transportation
MGF	Michigan Geographic Framework
MHI	Mixon/Hill of Michigan, Inc.
MITS	Michigan Intelligent Transportation Systems
MTRB	Michigan Transportation Research Board
NCAR	National Center for Atmospheric Research
O/D	Origin / Destination

Term	Definition
OBE	On-Board Equipment
OEM	Original Equipment Manufacturer
PDS	Probe Data Service
POC	Proof of Concept
RCMC	Road Commission of Macomb County
RCOC	Road Commission for Oakland County
RSE	Roadside Equipment
RWIS	Road Weather Information Systems
SAE	An organization formerly known as Society of Automotive Engineers, now known as SAE International
SDN	Service Delivery Node
SEMCOG	Southeast Michigan Council of Governments
SEMSIM	Southeast Michigan Snow and Ice Management
SMART	Suburban Mobility Authority for Regional Transportation
SQL	Structured Query Language
TA	Transportation Agency
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TMS	Transportation Management System
TMS/H	Traffic Monitoring System for Highways
UMTRI	University of Michigan Transportation Research Institute
USDOT	United States Department of Transportation
VII	Vehicle Infrastructure Integration
VIIC	Vehicle Infrastructure Integration Consortium
WMTMS	Western Michigan Traffic Management System
XML	eXtensible Markup Language

APPENDIX B - REFERENCED DOCUMENTS

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

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APPENDIX C - SAE J2735 PROBE DATA ELEMENTS

The DUAP system shall be capable of storing the following data elements:

ID	Element	Description
IS-010-500	Probe Segment Number	Identifier of related probe data snapshots
IS-010-510	Time	Local time
IS-010-520	Date	Local date
IS-010-530	Time Confidence	95% confidence level for the currently reported value of time
IS-010-540	Latitude	Latitude of the center of the vehicle
IS-010-550	Longitude	Longitude of the center of the vehicle
IS-010-560	Elevation	Elevation of the center of the vehicle
IS-010-570	Positioning Confidence	95% confidence level for the currently reported value of positioning entries
IS-010-580	Heading	Current heading of the vehicle
IS-010-590	Speed	Current vehicle speed
IS-010-600	Speed & Heading Confidence	95% confidence level for the currently reported values of Speed and Heading.
IS-010-610	Air Temperature	Ambient air temperature
IS-010-620	Wiper Status	Indication of wiper status. Settings could be: not equipped, off, intermittent, low, high, or automatic
IS-010-630	Wipers Rate	Number of wiper sweeps per minute
IS-010-640	Vehicle Exterior Lights	Status of exterior lights. Settings could be: parking lights, headlights (low and high beam, automatic light control), fog lights, daytime running lights, turn signals (right/left), and hazard signals
IS-010-650	Rain Sensor	Rain/snow intensity. The value of the Rain Sensor data element ranges from 0-7, with 0 indicating "No Rain/Snow", 1 indicating "Light Mist", and 7 indicating "Heavy Downpour"
IS-010-660	Sun Sensor	Level of sunlight. The value of the Sun Sensor data element ranges from 0-7, with 0 indicating "Complete Darkness", 1 indicating "Minimal Sun Light", and 7 indicating "Maximum Sun Light"
IS-010-670	Traction Control	Indication of whether one or more of the vehicle's drive wheels was slipping during an acceleration. Values could indicate no traction control system, or whether the system is off, on, or engaged

ID	Element	Description
IS-010-680	Stability Control	Indication of whether the vehicle's stability control system is activated because of the vehicle being too far off-axis during a turn. Values could indicate no stability control, or whether the system is off or active
IS-010-690	Anti-Lock Brakes	Indication of whether the vehicle's anti-lock brake system is on due to an extreme braking condition or a slippery roadway condition. Values could be not equipped, off, on, or engaged
IS-010-700	Wheel that Exceeded Vertical Acceleration threshold	Indication of which wheel exceeded a threshold of percent change in vertical G acceleration per second. Values could be All Off (or not equipped), or which wheel triggered the event
IS-010-710	Vertical Acceleration	Vehicle's vertical G acceleration per second
IS-010-720	Brake Applied	Wheel braking status. Values could indicate whether all brakes are off, which wheel brakes are applied, or whether all brakes are applied
IS-010-730	Steering Wheel Angle	Angle relative to straight that the steering wheel is turned
IS-010-740	Steering Wheel Angle Rate of Change	Rate of change of the steering wheel angle
IS-010-750	Longitudinal Acceleration	Acceleration along the X axis or the vehicle's direction of travel in parallel with a front to rear centerline. Negative values indicate braking action
IS-010-760	Lateral Acceleration	Acceleration along the Y axis or perpendicular to the vehicle's direction of travel in parallel with a left-to-right centerline. Negative values indicate left turning action and positive values indicate right turning action
IS-010-770	Obstacle Distance	Indicates the presence of an obstacle and its measured distance from the vehicle detecting and reporting the obstacle
IS-010-780	Obstacle Direction	Indicates the obstacle direction from the vehicle to an obstacle. The data is expressed in degrees as azimuth relative to forward direction of vehicle
IS-010-790	Yaw Rate	Amount of rotation about vehicle's longitudinal axis within a certain time period

ID	Element	Description
IS-010-800	100% Brake Boost Applied	Indication of emergency braking. This data element is an on/off value which indicates engagement of the vehicle's brake boost assist function
IS-010-810	Barometric (Ambient) Pressure	Barometric pressure: ranging from 580 hPa to 1,090 hPa with a resolution of 2 hPa
IS-010-820	Tire Pressure	Provides Tire Pressure for up to 4 Tires each with a range of 1 to 255 PSI
IS-010-830	Tire Pressure Monitoring System	Indication of whether the vehicle's tire pressure monitoring system is activated. Values could indicate no monitoring system, or whether the system is off or active

APPENDIX D - WEATHER DATA ELEMENTS FROM CLARUS

The DUAP system shall be capable of storing the following weather data elements from *Clarus*:

ID	Element	Description	Units
IS-030-200	essLatitude	Latitude of the Environmental Sensor Station (ESS) [observation] per WGS-84 datum	10^-6 degrees
IS-030-210	essLongitude	East longitude from the Prime Meridian of the ESS [observation]	10^-6 degrees
IS-030-220	essVehicleSpeed	Current speed being reported by the vehicle	km/hr
IS-030-230	essVehicleBearing	Current bearing of the vehicle	degrees clockwise from true North
IS-030-240	essVehicleOdometer	Current odometer reading of the vehicle	meters
IS-030-250	essReferenceHeight	Reference elevation of the ESS; height to base of station for permanent ESS height to the ground surface upon which the ESS resides for transportable ESS, or height to surface under vehicle for mobile ESS	meters above mean sea level
IS-030-260	essAtmosphericPressure	Force per unit area exerted by the atmosphere	10^-1 millibars, or 10^-1 hectopascals
IS-030-270	windSensorAvgSpeed	Two-min. average of the wind speed	10^-1 meters per second
IS-030-280	windSensorAvgDirection	Two-min. average of wind direction (CW from North)	degrees clockwise from true North
IS-030-290	windSensorSpotSpeed	Instantaneous wind speed	10^-1 meters per second
IS-030-300	windSensorSpotDirection	Instantaneous wind direction (CW from North)	degrees clockwise from true North

ID	Element	Description	Units
IS-030-310	windSensorGustSpeed	Maximum wind gust recorded during preceding 10 min.	10^-1 meters per second
IS-030-320	windSensorGustDirection	Direction of max. wind gust during preceding 10 min.	degrees clockwise from true North
IS-030-330	windSensorSituation	Describes the weather and travel situation in terms of wind from staffed stations only. Specific ranges for these values are defined in the Glossary of Meteorology	integer
IS-030-340	essAirTemperature	Instantaneous dry-bulb temperature	10^-1 degrees Celsius
IS-030-350	essWetBulbTemp	Instantaneous wet-bulb temperature	10^-1 degrees Celsius
IS-030-360	essDewpointTemp	Instantaneous dewpoint temperature	10^-1 degrees Celsius
IS-030-370	essMaxTemp	Maximum air temperature during preceding 24 hours	10^-1 degrees Celsius
IS-030-380	essMinTemp	Minimum air temperature during preceding 24 hours	10^-1 degrees Celsius
IS-030-390	essRelativeHumidity	Relative humidity	percent
IS-030-400	essAdjacentSnowDepth	Depth of undrifted & unplowed snow off roadways	centimeters
IS-030-410	essRoadwaySnowDepth	Depth of unpacked snow on roadway surface	centimeters
IS-030-420	essRoadwaySnowpackDepth	Depth of packed snow on roadway surface	centimeters
IS-030-430	essPrecipYesNo	Indicates whether or not precip is detected: (1) precip; (2) noPrecip; (3) error	integer
IS-030-440	essPrecipRate	Rate of rainfall or water equivalent of snow	10^-1 grams per sq. meter per second
IS-030-450	essSnowfallAccumRate	Rate of snowfall accumulation	10^-7 meters per second

ID	Element	Description	Units
IS-030-460	essPrecipSituation	Description of precipitation type & intensity; see NTCIP 1204 for validation rules and text mapping	integer
IS-030-470	essIceThickness	Thickness of the ice	millimeters
IS-030-480	essPrecipitationStartTime	Time when most recent precipitation event began	seconds since 00:00:00 Jan 1, 1970 UTC
IS-030-490	essPrecipitationEndTime	Time when most recent precipitation event ended	seconds since 00:00:00 Jan 1, 1970 UTC
IS-030-500	essPrecipitationOneHour	Total water equivalent precipitation over preceding 1 hr	10^-1 kg per sq meter
IS-030-510	essPrecipitationThreeHours	Total water equivalent precipitation over preceding 3 hrs	10^-1 kg per sq meter
IS-030-520	essPrecipitationSixHours	Total water equivalent precipitation over preceding 6 hrs	10^-1 kg per sq meter
IS-030-530	essPrecipitationTwelveHours	Total water equivalent precipitation over preceding 12 hrs	10^-1 kg per sq meter
IS-030-540	essPrecipitation24Hours	Total water equivalent precipitation over preceding 24 hrs	10^-1 kg per sq meter
IS-030-550	waterLevelSensorReading	Depth of the water from a user-defined point	centimeters
IS-030-560	essTotalSun	Total amount of sunshine during preceding 24 hrs	minutes
IS-030-570	essCloudSituation	Description of amount of cloud cover; see NTCIP 1204 for validation rules and text mapping	integer
IS-030-580	essTotalRadiation	Average total radiation during the radiation period	joules per sq meter
IS-030-590	essTotalRadiationPeriod	Length of time essTotalRadiation is averaged [i.e., accumulated]	seconds
IS-030-600	essVisibility	Surface visibility	10^-1 meters

ID	Element	Description	Units
IS-030-610	essVisibilitySituation	Describes visibility of travel environment; see NTCIP 1204 for validation rules and text mapping	integer
IS-030-620	essSurfaceStatus	Describes pavement surface status; see NTCIP 1204 for validation rules and text mapping	integer
IS-030-630	essSurfaceTemperature	Current pavement surface temperature	10^-1 degrees Celsius
IS-030-640	essPavementTemperature	Current pavement temp. 2-10 cm below surface, specifically at pavementSensorTemperatureDepth	10^-1 degrees Celsius
IS-030-650	essSurfaceSalinity	Pavement [surface] salinity	parts per one hundred thousand by weight
IS-030-660	essSurfaceFreezePoint	Solution freeze point temperature	10^-1 degrees Celsius
IS-030-670	essSurfaceBlackIceSignal	Indicates whether or not black ice is detected; see NTCIP 1204 for data validation and mapping	integer
IS-030-680	essPavementSensorError	Type of pavement sensor error; see NTCIP 1204 for data validation and mapping	integer
IS-030-690	essSurfaceIceOrWaterDepth	Current ice thickness or water depth on roadway surface	10^-1 millimeters
IS-030-700	essSurfaceConductivityV2	Conductivity of the ice/liquid mixture on the pavement as detected by the sensor	10^-1 millimhos/cm
IS-030-710	pavementSensorTemperatureDepth	Depth at which the pavement temperature is detected	centimeters
IS-030-720	essSubSurfaceTemperature	Current sub-surface temperature	10^-1 degrees Celsius
IS-030-730	essSubSurfaceMoisture	Sub-surface moisture expressed as a percentage (e.g., 0 indicates dry, 100 indicates saturated)	percent

ID	Element	Description	Units
IS-030-740	essSubSurfaceSensorError	Type of sensor error; see NTCIP 1204 for data validation and mapping	integer
IS-030-750	essMobileFriction	Measured coefficient of friction	percent
IS-030-760	essMobileObservationGroundState	Prevailing observed ground state of the surrounding environment as determined by the observer; an indicator of past weather conditions; see NTCIP 1204 for data validation and mapping	integer
IS-030-770	essMobileObservationPavement	Prevailing observed conditions on the driving surface as determined by the observer; see NTCIP 1204 for data validation and mapping	integer
IS-030-780	essPaveTreatProductType	Type of treatment being applied to the road; see NTCIP 1204 for data validation and mapping	integer
IS-030-790	essPaveTreatProductForm	Condition of the treatment being applied to the road; see NTCIP 1204 for data validation and mapping	integer
IS-030-800	essPercentProductMix	Percentage of the total application mix by weight that is of the type specified in essPaveTreatProductType	percent
IS-030-810	essPaveTreatmentAmount	Quantity of the treatment being applied	kg per lane km
IS-030-820	essPaveTreatmentWidth	Width of the spread of treatment	meters
IS-030-830	essCO	Concentration of carbon monoxide in the air	ppm
IS-030-840	essCO2	Concentration of carbon dioxide in the air	ppb
IS-030-845	essNO	Concentration of nitrous oxide in the air	ppm
IS-030-850	essNO2	Concentration of nitrous dioxide in the air	ppb
IS-030-855	essSO2	Concentration of sulfur dioxide in the air	ppb

ID	Element	Description	Units
IS-030-860	essO3	Concentration of ozone in the air	parts per one hundred billion
IS-030-865	icePercent	Percent of ice cover on roadway	percent
IS-030-870	precip10min	Total water equivalent precipitation over preceding 10 min	tenths of kilograms per square meter
IS-030-875	precipIntensity	Description of precipitation intensity	
IS-030-880	precipType	Description of precipitation type	
IS-030-885	essInstantaneousSolarRadiation	The instantaneous ultraviolet, visible, and near-infrared (wavelength of less than 3.0 micrometers) radiation hitting the earth's surface in watts per square meter	watts per square meter

APPENDIX E - SAE J2354 WEATHER INFORMATION ELEMENTS

The DUAP system shall be capable of storing the following data elements for each weather condition item received from SAE J2354 providers:

ID	Element	Description
IS-030-901	id	Unique identifier
IS-030-902	reference	Reference identifier
IS-030-903	issuingAgency	Name of reporting agency
IS-030-904	updateTime	Date/timestamp indicating when the item was updated by the issuing agency
IS-030-905	location	Geographic location description
IS-030-906	altLocType	Alternate location data
IS-030-907	elevationsAbove	Indicate whether the information reported applies to elevations above the given elevation
IS-030-908	elevationsBelow	Indicate whether the information reported applies to elevations below the given elevation
IS-030-909	isForecast	Indicate whether the date/timestamps are forecasted or absolute
IS-030-910	coverageTime	Date/timestamp indicating the coverage time
IS-030-911	forecastExpires	Date/timestamp indicating the forecasted expiration time
IS-030-912	tempSummary	Temperature summary
IS-030-913	tempQualifiers	Temperature qualifier
IS-030-914	highTemp	High temperature in tenths of degree Celsius
IS-030-915	lowTemp	Low temperature in tenths of degree Celsius
IS-030-916	currTemp	Current temperature in tenths of degree Celsius
IS-030-917	conditions	Weather conditions
IS-030-918	sunriseTime	Sunrise time
IS-030-919	sunsetTime	Sunset time
IS-030-920	skyConditions	Sky conditions
IS-030-921	cloudPercent	Amount of cloud cover
IS-030-922	visibilityLevel	Visibility level
IS-030-923	visibilityQualifier	Visibility qualifier
IS-030-924	visibility	Surface visibility in tenths of a meter
IS-030-925	windsType	Type of winds
IS-030-926	windDirection	Wind direction
IS-030-927	windAngle	Wind angle in degrees
IS-030-928	windSpeed	Wind speed in tenths of meters per second
IS-030-929	windGustSpeed	Wind gust speed in tenths of meters per second
IS-030-930	precipitationProbability	Precipitation probability
IS-030-931	precipitation	Precipitation type
IS-030-932	humidity	Relative humidity in percent
IS-030-933	snowDepth	Current depth of unpacked snow in centimeters
IS-030-934	snowPack	Current depth of packed snow in centimeters
IS-030-935	snowFall	Snowfall accumulation rate in 10^{-7} meters per second
IS-030-936	snowOffRoad	Depth of snow in centimeters on representative areas other than the highway pavement
IS-030-937	iceThickness	Thickness of ice in millimeters

ID	Element	Description
IS-030-938	blackIce	Indication of the amount of black ice on the roadway
IS-030-939	freezePoint	Temperature at which the existing solution on the roadway will freeze, in tenths of degrees Celsius
IS-030-940	rain24hrs	Total water equivalent precipitation over the 24 hours preceding the observation in tenths of kilograms per square meter
IS-030-941	rain1Hr	Total water equivalent precipitation over the hour preceding the observation in tenths of kilograms per square meter
IS-030-942	rainRate	Rainfall, or water equivalent of snow, rate in tenths of grams per square meter per second
IS-030-943	precipSituation	Weather situation in terms of precipitation
IS-030-944	precipYesNo	Indication that moisture has been detected by the sensor
IS-030-945	waterDepth	Depth of the water in centimeters
IS-030-946	surfaceWaterDepth	Current depth of water on the surface of the roadway measured in millimeters
IS-030-947	precipStart	Date/timestamp at which the precipitation started
IS-030-948	precipEnd	Date/timestamp at which the precipitation ended
IS-030-949	smogAlert	Smog alert indicator
IS-030-950	airQualityIndex	Air quality index
IS-030-951	carbonMonoxide	Concentration of carbon monoxide in the air, measured in parts per million
IS-030-952	carbonDioxide	Concentration of carbon dioxide in the air, measured in parts per billion
IS-030-953	hydroCarbon	Concentration of hydrocarbon in the air, measured in parts per million
IS-030-954	sulfurDioxide	Concentration of sulfur dioxide in the air, measured in parts per billion
IS-030-955	nitricOxide	Concentration of nitrous oxide in the air, measured in parts per million
IS-030-956	nitrousDioxide	Concentration of nitrogen dioxide in the air, measured in parts per billion
IS-030-957	particulate	Concentration of small particulate matter of 10 micrograms per cubic meter micrometers or less in diameter in the air, measured in parts per million micrograms per cubic meter
IS-030-958	ozone	Concentration of ozone in the air, measured in parts per one hundred billion
IS-030-959	uvLevel	Ultraviolet index
IS-030-960	airQuality	Air quality
IS-030-961	airQualifier	Air quality qualifier
IS-030-962	levelOfService	Qualitative measure describing operational conditions within a traffic stream
IS-030-963	status	Weather-related road closure status
IS-030-964	drivingRestrictions	Weather-related driving restrictions
IS-030-965	drivingIndex	Weather-related driving conditions
IS-030-966	medianType	Type of median
IS-030-967	mobileFriction	Measured coefficient of friction in percent
IS-030-968	pavementConditions	Pavement conditions

ID	Element	Description
IS-030-969	pavementTemperature	Current pavement temperature 2-10 centimeters below the pavement surface in tenths of degrees Celsius
IS-030-970	surfaceTemperature	Current pavement surface temperature in tenths of degrees Celsius
IS-030-971	surfaceSalinity	Pavement salinity in parts per one hundred thousand
IS-030-972	pavementType	Pavement type
IS-030-973	treatmentForm	Condition of the treatment being applied to the road
IS-030-974	treatmentType	Type of treatment being applied to the road
IS-030-975	treatmentAmount	Quantity of the treatment being applied in kilograms per lane kilometer
IS-030-976	treatmentWidth	Width of the spread of treatment in meters
IS-030-977	pressure	Force per unit area exerted by the atmosphere in tenths of millibars (a.k.a. tenths of hectopascals)
IS-030-978	solarRate	Direct solar radiation integrated over the 24 hours preceding the observation in joules, per square meter
IS-030-979	dewPoint	Dewpoint temperature in tenths of degrees Celsius

APPENDIX F - SAE J2354 EVENTINFORMATION ELEMENTS

The DUAP system shall be capable of storing and publishing the following data elements for each traffic event or incident item:

ID	Element	Description
IS-070-301	id	Unique identifier
IS-070-302	reference	Reference identifier
IS-070-303	issuingAgency	Name of reporting agency
IS-070-304	updateTime	Date/timestamp indicating when the item was updated by the issuing agency
IS-070-305	location	Geographic location description
IS-070-306	isForecast	Indicate whether the date/timestamps are forecasted or absolute
IS-070-307	coverageTime	Date/timestamp indicating the coverage time
IS-070-308	forecastExpires	Date/timestamp indicating the forecasted expiration time
IS-070-309	typeEvent	Type of traffic event
IS-070-310	severity	Severity
IS-070-311	status	Status
IS-070-312	cause	Cause
IS-070-313	description	Description
IS-070-314	advice	Advice
IS-070-315	affectedLane	Lanes affected and direction(s) of travel impacted
IS-070-316	vehiclesInvolvedCount	Number of vehicles involved
IS-070-317	types	Types of vehicles involved
IS-070-318	injuries	Number of injuries
IS-070-319	startTime	Date/timestamp indicating the start time
IS-070-320	clearTime	Date/timestamp indicating the ending time
IS-070-321	repeatTimes	Repeating times for traffic events which recur over a period of days
IS-070-322	furtherData	URL for further information

APPENDIX G - SAE J2354 LINKTRAFFICINFORMATION ELEMENTS

The DUAP system shall be capable of storing and publishing the following data elements for each traffic condition item:

ID	Element	Description
IS-070-501	id	Unique identifier
IS-070-502	reference	Reference identifier
IS-070-503	issuingAgency	Name of reporting agency
IS-070-504	updateTime	Date/timestamp indicating when the item was updated by the issuing agency
IS-070-505	location	Geographic location description
IS-070-506	isForecast	Indicate whether the date/timestamps are forecasted or absolute
IS-070-507	coverageTime	Date/timestamp indicating the coverage time
IS-070-508	forecastExpires	Date/timestamp indicating the forecasted expiration time
IS-070-509	capacity	Link capacity expressed as the maximum capacity in vehicles per hour for each referenced link
IS-070-510	delay	Calculated delay in seconds (additional time it will take above that recorded during free flow conditions) for vehicles driving along each referenced link
IS-070-511	density	Link density expressed as the vehicle concentration per kilometer of the link for each referenced link
IS-070-512	lanesMinimumNumber	Minimum number of lanes for each referenced link
IS-070-513	lanesNumberOpen	Minimum number of open lanes for each referenced link
IS-070-514	length	Link length for each referenced link from beginning node to ending node in meters
IS-070-515	levelOfService	Link level of service for each referenced link
IS-070-516	medianType	Link median type for each referenced link
IS-070-517	name	Link name for each referenced link
IS-070-518	occupancy	Percent occupancy measured for each referenced link
IS-070-519	pavementType	Pavement type for each referenced link.
IS-070-520	restrictionAxleCount	Maximum axle count per vehicle for each referenced link
IS-070-521	restrictionAxleWeight	Maximum axle weight for each referenced link
IS-070-522	restrictionClass	Restriction classification for each referenced link
IS-070-523	restrictionHeight	Maximum vehicle height in centimeters for each referenced link
IS-070-524	restrictionLength	Maximum vehicle length in centimeters for each referenced link
IS-070-525	restrictionWeight	Maximum vehicle weight in kilograms for each referenced link
IS-070-526	restrictionWidth	Maximum vehicle width in centimeters for each referenced link
IS-070-527	roadNumber	County, State, or Federal route numbers with any associated alphabetic designators for each referenced link

ID	Element	Description
IS-070-528	shoulderWidthLeft	Left shoulder width in centimeters for each referenced link
IS-070-529	shoulderWidthRight	Right shoulder width in centimeters for each referenced link
IS-070-530	speed	Average vehicular speed in kilometers per hour for each referenced link
IS-070-531	speedLimit	Posted or legal speed limit for automobiles in kilometers per hour for each referenced link
IS-070-532	linkStatus	Link status for each referenced link
IS-070-533	surfaceConditions	Surface conditions for each referenced link
IS-070-534	travelTime	Travel time in seconds for each referenced link
IS-070-535	truckSpeedLimit	Posted or legal speed limit for trucks in kilometers per hour for each referenced link
IS-070-536	nodeDelay	Travel delays in seconds
IS-070-537	nodeLinksNum	Number of roadway links beginning or ending at each link node
IS-070-538	nodeName	Name of the roadway intersection as used for identification of a link node
IS-070-539	nodeStatus	Status of each roadway intersection
IS-070-540	owner	Ownership for each referenced link
IS-070-541	jurisdiction	Name of the law enforcement agency with authority over the referenced link
IS-070-542	affectedLanes	Lanes affected and direction(s) of travel impacted for each referenced traffic condition reported