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DATA CAPTURE AND MANAGEMENT PROMGRAM: DATASETS TASK

SAFETY PILOT MODEL DEPLOYMENT – SAMPLE DATA ENVIRONMENT DATA HANDBOOK

Version 1.3

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Version History

#	Date	Author (s)	Summary of Changes
1.0	2013-07-08	D. Henclewood (BAH) B. Yelchuru (BAH)	Initial Version
1.1	2014-05-01	D. Henclewood (BAH) M. Abramovich (BAH)	Included data descriptions for data collected by Roadside Equipment. Weather data elements were also presented here along with some general direction as to how to obtain additional contextual data.
1.2	2014-06-18	D. Henclewood (BAH)	Included text to highlight subtle differences between the handbook's applicability to the Safety Pilot Model Deployment (SPMD) Sample data environment and when the full data set is available for the Complete SPMD data environment.
1.3	2015-10-28	D. Henclewood (BAH) S. Rajiwade (BAH)	Updated text to map to the "new" data files that is available via the RDE.

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1 INTRODUCTION

1.1 Background

The vision of the U.S. Department of Transportation's (USDOT) Real-Time Data Capture and Management program is to enhance current operational practices and transform future transportation systems management through the active acquisition and systematic provision of integrated data from infrastructure, vehicles, and travelers. These data will be made available to researchers, application developers, and system operators via the Research Data Exchange (RDE). The RDE is the central component of USDOT's Data Capture and Management Program. This repository aims to serve as the premier location for high-fidelity, high-resolution transportation data, which will in turn support the continued development of transportation applications, tools, and strategies to increase efficiency with which the transportation system is used and managed. To help fulfill the vision of Data Capture Management program, this data handbook will accompany the multimodal, multidimensional datasets that were collected as a part of the Safety Pilot Model Deployment (SPMD) and the Safety Pilot Contextual Data Collection effort.

The SPMD is a part of the Connected Vehicle Safety Pilot Program. This program is a research initiative that features real-world implementation of connected vehicle safety technologies, applications, and systems using everyday drivers. The effort will test performance, evaluate human factors and usability, observe policies and processes, and collect empirical data to present a more accurate, detailed understanding of the potential safety benefits of these technologies. This empirical data will support the National Highway Traffic Safety Administration's (NHTSA) decision on vehicle communications for safety. To support this initiative, the SPMD is a comprehensive data collection effort, under real-world conditions, at a test site, with multimodal traffic, hosting approximately 3,000 vehicles equipped with vehicle-to-vehicle (V2V) communication devices.

The goals of the SPMD are[1]:

- Demonstrate connected vehicle technologies in a real-world, multimodal environment
- Determine driver acceptance of vehicle-based safety systems
- Evaluate the feasibility, scalability, security, and interoperability of Dedicated Short-Range Communications (DSRC) technology
- Assess options to accelerate safety benefits

In achieving the goals of the SPMD, a number of different entities are involved in executing this field experiment. These entities include the University of Michigan Transportation Research Institute (UMTRI); the field test conductor, Battelle; Southwest Research Institute; the Crash Avoidance Metrics Partnership (CAMP), in conjunction with Virginia Tech Transportation Institute (VTTI); and Mixon Hill, Inc. The datasets that these entities will provide include basic safety messages (BSM), vehicle trajectories, and various driver-vehicle interaction data, as well

[1] Source: UMTRI Safety Pilot - www.safetypilot.us

as contextual data that describes the circumstances under which the Model Deployment data was collected.

The primary goal of the contextual data collection effort is to supplement the vehicle-based data that has been collected through the SPMD. This data collection effort will provide contextual mobility and environmental data to further describe the surroundings in which Model Deployment data was collected. These datasets will include traffic flow, signal operation, weather, and transit schedule information. In addition to being the test conductor, UMTRI will also be the main provider of not only contextual data but also of vehicle-based data.

A significant portion of the data that are collected through the SPMD will be stored in the RDE. In the RDE, data collected through this effort will be referred to as the Safety Pilot Data Environment. Figure 1 previews the datasets that are encapsulated within this environment.

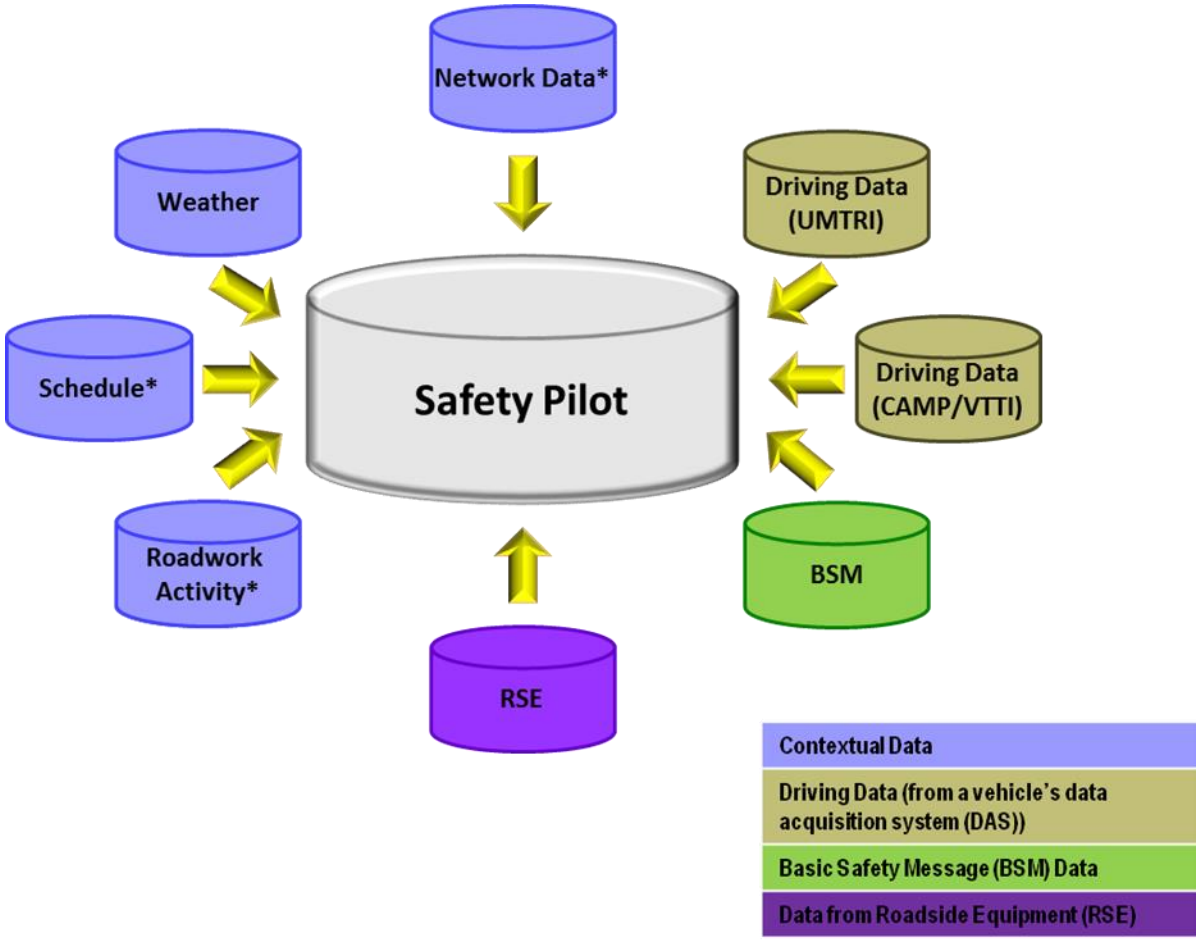

Figure 1: Potential Contents of the Research Data Exchange's Safety Pilot Data Environment
***** Datasets to be populated as soon as (additional) data becomes available

The above datasets are populated by the year and half-long SPMD exercise, which started in August 2012. The model deployment was conducted in Ann Arbor, Michigan. The field test includes 75 miles of instrumented roadway. Approximately twenty-six roadside units (roadside equipment - RSE), which are capable of communicating with appropriately equipped vehicles, and devices via DSRC, were installed throughout the network. A majority of the RSEs were placed signalized intersections while the others were strategically installed and (horizontal) curves (to provide curve speed warnings), and freeway locations. These devices and other similar devices, which are termed data acquisition systems (DAS), were installed in vehicles participating in the model deployment to facilitate vehicle-to-vehicle and vehicle-to-infrastructure communications. Figure 2 illustrates the proposed layout of the test site and the location of the roadside equipment that is capable of communicating via DSRC.

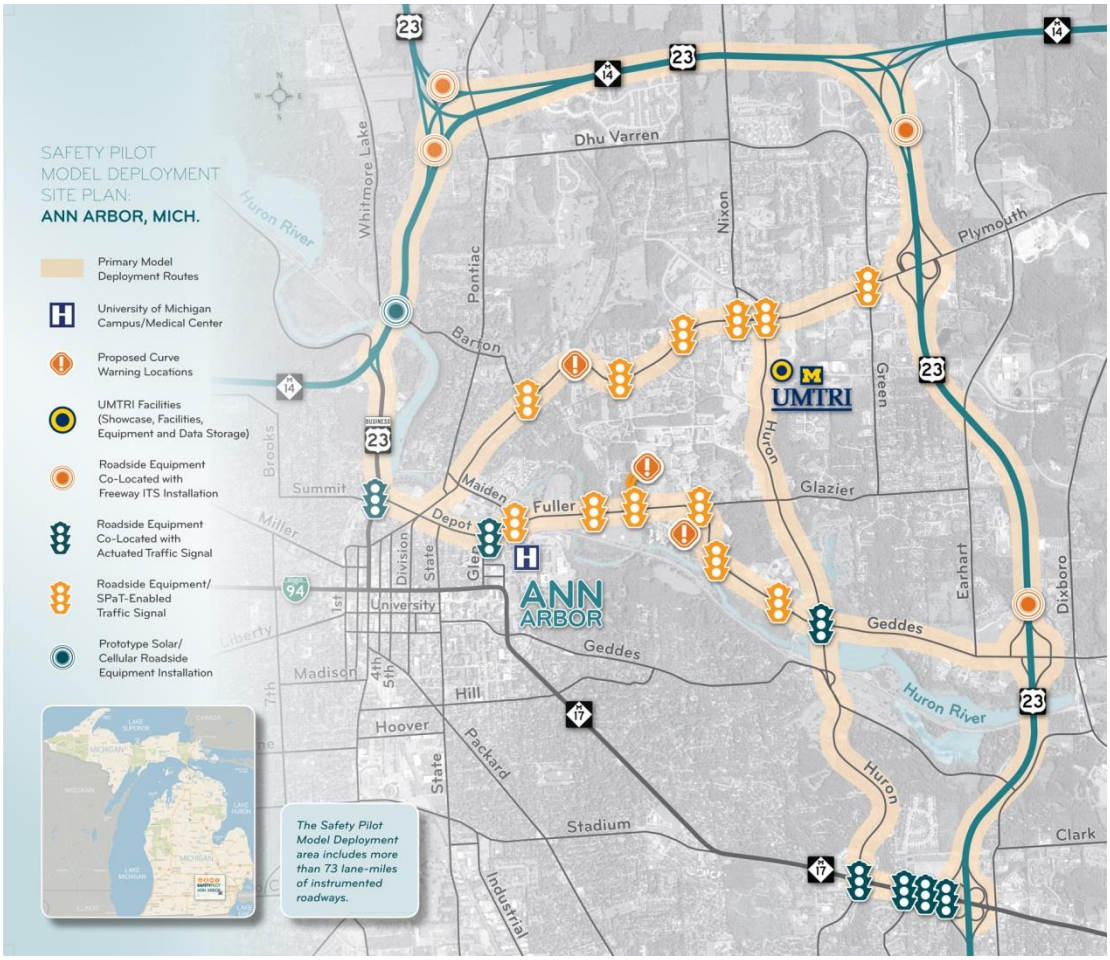

Figure 2: Safety Pilot Model Deployment Site Plan, Ann Arbor, Michigan[2]

Approximately 3,000 instrumented vehicles participated in this study. The vehicles include light (passenger) vehicles, heavy/commercial trucks, and busses—all equipped with various advanced

[2] UMTRI Safety Pilot – How it works - http://www.safetypilot.us/how-it-works.html

safety features and/or DSRC capabilities. There are four types of available device installation packages, and each vehicle is outfitted with one of the four. The device packages are referred to as Integrated Safety Device (ISD), Aftermarket Safety Device (ASD), Retrofit Safety Device (RSD) and Vehicle Awareness Device (VAD). Each of the device packages provides a series of data elements, communicating a vehicle's location and motion. The central difference amongst these devices is the amount of information collected by each and ability to receive transmitted messages. Vehicles with ISD, ASD, and RSD collect, receive, and transmit the most comprehensive set vehicle-based data. This is due in part to the advanced safety features with which these vehicles are equipped and the video data files that are also being collected to aid in the NHTSA decision regarding the impact of connected vehicles on safety.

VAD is the most basic of all the device packages. Vehicles with VAD are not able to receive transmitted messages from other vehicles; they are only able to transmit the data being generated and collected by their host vehicle. The primary function of these equipped vehicles, which make up more than 75 percent of the total equipped vehicles in this study, is to transmit "here I am" messages while increasing the probability of V2V and vehicle-to-infrastructure (V2I) interactions. For additional details regarding the test location, the vehicles, and the equipment used, please consult the test conductor's web page.[3]

1.2 Purpose of This Data Handbook

The purpose of this data handbook is to document the limited data elements that were collected during SPMD and sent to the USDOT Data Capture and Management program to support the development of mobility applications. This handbook attempts to make it easy for individuals who are unfamiliar with SPMD to become familiar with this research endeavor program, and use the data to conduct research and develop applications to further improve mobility (and transportation safety).

This data environment houses data from one of the more comprehensive data collection efforts to be undertaken in the transportation community. This environment does not only include hyper-accurate, hyper-frequent that communicates vehicle motion, but there are data that describe driver behavior, transportation infrastructure operation, namely traffic signals, and V2V and V2I interactions. Some of these high resolution data do contain and / or can potentially lead to uncovering (Sensitive) Personally Identifiable Information ([S]PII). In order to protect the privacy of SPMD participants this document along with the data that will be posted to the RDE will be void of data elements that either contain (S)PII or that may lead to the discovery of PII. Additionally, because the intent of this deployment exercise is to support NHSTA's decision regarding road user safety and V2X technologies, a number of the data elements that communicate specific safety-related information will not be available via the RDE.

Data elements that describe mobility are a majority of the elements that are included in the Safety Pilot data environment. In addition to supporting general transportation research, this data

[3] UMTRI Safety Pilot – How it works - http://www.safetypilot.us/how-it-works.html

environment is geared toward supporting the development of mobility applications, in line with the goals of programs such as the Dynamic Mobility Application (DMA), and Application for the Environment: Real-Time Information Synthesis (AERIS) programs.

1.3 Document Overview

Section 2 provides the general framework used to store, organize, and present the SPMD datasets. Section 3 and 4 details the data elements contained in the Data Acquisition System (DAS) datasets, which describe the motion of the vehicles that participated in the model deployment as collected from DAS1 and DAS2, respectively. Section 5 presents the BSM dataset, which contains BSMs that were sent and received by participating vehicles and roadside equipment. Section 6 describes the dataset corresponding to data collected by Roadside Equipment (RSE), while Section 7 details the contextual dataset, which may include information regarding weather, roadway network performance, and schedules relating to special events and transit operation. To date, the contextual dataset includes weather information and points readers to resources that they may consult to obtain information regarding the transportation network (description and performance) and transit schedules.

2 SAFETY PILOT MODEL DEPLOYMENT PROPOSED GENERAL DATA FRAMEWORK

2.1 Structuring SPMD Datasets

As illustrated in Figure 1, the Safety Pilot environment contains eight datasets:

- Driving dataset
  - DAS1
  - DAS2
- BSM dataset
- RSE dataset
- Contextual data dataset
  - Weather
  - Network
  - Schedule

The data elements that are included in these datasets were collected and are stored in a series of relational databases. Each database has a number of different tables, each pertaining to a specific set of collected data. Most of the data elements in each dataset are collected at a frequency of 10Hz. This frequency results in a number of the tables being very large, restricting the tables' ease of use. To this end, each dataset has been logically subdivided to create more manageably sized files to promote efficient data usage. The data is divided into 24-hour periods, meaning that each table in a database, which has been converted into individual flat or comma separated files (.csv) files, includes data that has been collected during a given day. Figure 3 illustrates the general framework that has been developed to organize and structure the data that has been collected during the SPMD.

The following highlights a few points regarding the aforementioned framework. The Driving Dataset is composed of data that has been collected from two different Data Acquisition Systems (DAS). DAS1 represents the data collected by the DAS developed by UMTRI, and DAS2 represents the data collected by the DAS developed by VTTI. The basic safety message (BSM) dataset includes BSMs that were transmitted and/or received by a participating vehicle, irrespective of the DAS that was installed. The Roadside Equipment (RSE) dataset contains data that was received and transmitted by roadside units that were equipped with DSRC capabilities. The Contextual datasets include data that communicate the conditions under which the Safety Pilot data were collected. They include data elements that describe network configuration and performance, weather, schedules (transit and special events), roadwork activity, and traffic incidents. Greater details for each of these datasets are provided in subsequent sections.

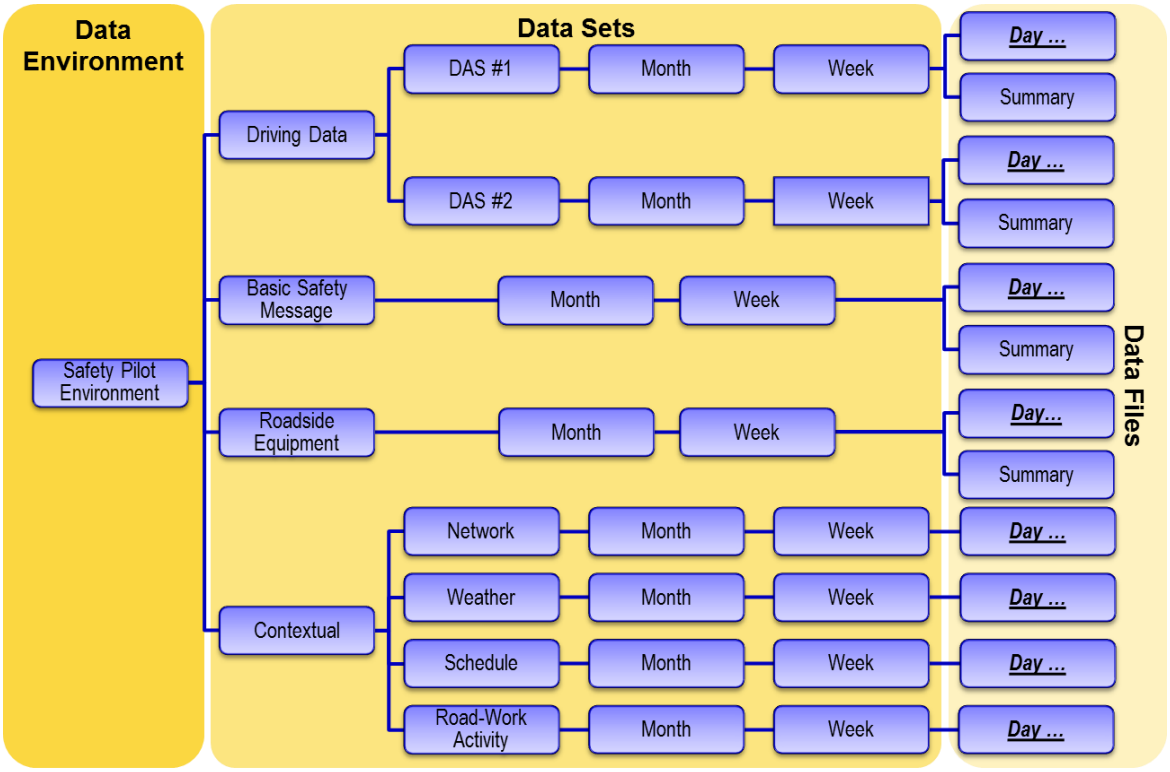

Figure 3: Generalized Data Framework the SPMD Data Environment

As previously mentioned, data were not only grouped based on their natural grouping, but also based on a 24-hour period, indicated by the rightmost field of text boxes in Figure 3. In the rightmost text boxes, the label "***Day…***" represents a number of files, belonging to a particular dataset that was collected within given 24-period. The files included under the "***Day…***" designation vary according to the dataset being explored. Table 1 presents each dataset and a list of the (potentially) accompanying files represented by the ***Day…*** designation.

Table 1: Files Included under the "Day …" Designation for Each Dataset

SPMD Environment						
Driving Data		Basic Safety Message	Roadside Equipment	Contextual		
DAS1	**DAS2**	**Basic Safety Message**	**Roadside Equipment**	**Weather***	**Network**	**Schedule**
AudioTimes	HV_Radar	BrakeByte1Events	BSM	Weather/climatic data	Pointer to Resources	Pointer to Resources
DataFrontTargets	HV_Primary	BrakeByte2Events	Geometry			
DataLane	DAS2_Trip_Summary	BsmP1	Lane			
DataWsu		ExteriorLightsEvents	LaneNode			
DAS1_Trip_Summary		PosAccurByte1Events	MAP			
		PosAccurByte2Events	Packet			
		PosAccurByte3Events	PCAPFile			
		PosAccurByte4Events	SPAT			
		SteerAngleEvents	SPATMovement			
		ThrottlePositionEvents	TIM			
		TransStateEvents	TIMRegion			
		WiperStatusFrontEvents	TIMRegionNode			
		BSM_Trip_Summary				

* Definitions for the column abbreviations are given in the corresponding section(s)

The text boxes labeled "DaySummary" represent a file that presents a few summary measures that describe the contents of the files from a particular dataset. The "DaySummary" file for the Driving, BSM and RSE dataset may contain information such as the name of each file contained in the dataset and the number of rows, fields, vehicles, and unique trip numbers, as well as the size of the file. Greater details regarding the "DaySummary" file will be presented in subsequent iterations of this handbook as the most informative set of data that summarizes a day's activity is still being determined.

2.2 SPMD File Naming Convention

The following section presents the file naming convention that is used for the various datasets and their files. Recall that each file in a dataset is broken into 24-hour periods. For each day of the SPMD, two files are immediately available to be downloaded from the RDE. One file will be that day's "Summary" file, and the other is a zip file that contains all other files belonging to the dataset. (See Table 1 for a list of files belonging to the various datasets.) The name of each "DaySummary" file will follow the following naming convention:

spmd_NameOf Dataset_ DaySummary_MM_DD_YY.csv

where:

spmd – Safety Pilot Model Deployment
NameOfDataSet – name of one of the eight datasets

DaySummary – file name/type of file
YY – two-digit year
MM – two-digit month
DD – two-digit day
csv – file extension (comma-separated file)

For example, the file *spmd_Das1_DaySummary_11_01_12.csv* represents a comma-separated file that contains a summary of the files from the DAS1 dataset that capture the activities from November 1, 2012.

The name for each zip file will follow the following naming convention, which is similar to the naming convention for the "DaySummary" file:

spmd_NameOfDataset_MM_DD_YY.zip

where:
spmd – Safety Pilot Model Deployment
NameOfDataSet – name of one of the eight datasets
YY – two-digit year
MM – two-digit month
DD – two-digit day
zip – file extension (zip file)

For example, the file *spmd_Das1_11_01_2012.zip* represents a zipped folder that contains all the files that belong to the DAS1 dataset that were populated with data that was collected on November 1, 2012.

After downloading and unzipping a dataset's zipped file for a given 24-hour period, the unzipped folder will contain a series of comma-separated files that contain the collected data elements. The naming convention for these file is as follows:

spmd_NameOf Dataset_NameOfFile_MM_DD_YY.csv

where:
spmd – Safety Pilot Model Deployment
NameOfDataSet – name of one of the eight datasets
NameOfFile – name of one of the files contained in preceding dataset
YY – two-digit year
MM – two-digit month
DD – two-digit day
csv – file extension (comma-separated file)

For example, the file *spmd_Das1_DasData_11_01_12.csv* represents the comma-separated file, DasData, which belongs to the DAS1 dataset. The DasData file contains data that was collected on November 1, 2012.

The file names for files in the Network, Weather, Schedule, and Road Work Activity datasets may differ slightly for the above naming convention. The difference in naming convention will largely be due to the fact that not all files in these datasets can be presented in a comma-separated file format. In cases where file formats differ from a comma-separated format, a special note will be made in that regard.

2.3 Detailing the Contents of Each SPMD Dataset

The details of each dataset will be presented through the use of a series of tables that communicate different aspects of the data elements contained in each dataset. To provide an overview of each dataset, the first presented table lists the files contained in the dataset and gives a brief description of each file. The next table presents a sample "Summary" file that communicates the amount of activity that occurred over a particular 24-hour period.

A series of three to four tables will be presented describing the contents of that file. The first table will present a file's data elements, along with their units and a brief description of each element. The second table will present any data elements that are enumerated, their values, and associated meaning and description. This table will not be included for each file, as not all files from the various datasets contain enumerated data elements. The third table presents a small sample of the file being described; usually it is the first ten rows of the file, populated with data from a selected 24-hour period.

The fourth table provides a few summary measures for each data element of a given file, derived from data collected over a 24-hour period. These summary values include: number of unique values, sample values, minimum and maximum values, and the number of rows contained in the file being explored. The number of unique values in this table will take on different meanings depending on whether the data element being described is discrete or continuous.

For instance, if the variable being summarized is continuous, such as a measure of time that constantly updates at a predefined frequency, the number of unique values does not communicate a significant amount of information. However, if the variable were discrete, for example, device IDs, the number of unique states will communicate the number of vehicles that participated in the Model Deployment effort during the selected 24-hour period. The sample value fields present five different values of each data element, unless the data has fewer than five unique values. In this case, all the values for that data element will be presented. The minimum and maximum values and the number of rows (in the file being explored) is just that, for each data element over the selected 24-hour period.

2.4 Data Framework Modifications due to Sanitization of the SPMD Sample

The above section detailed the framework for the entire set of data elements available from the SPMD. For the SPMD sample, some of the aforementioned structure and naming convention is

slightly different as the data will be less complex versus the complete SPMD dataset. For instance, the file name "*spmd_Das1_ DataLane_11_01_12.csv*" will be transformed to "DataLane*_11_01_12.csv*". The primary reason for this is that the month-week-day structure is not the most effective means to present the "Sample" – as it only includes data collected for a single day.

Some other changes were made to this data environment to protect participant privacy. In general, data such as audio and video data have been remove from this data environment as (S)PII may be obtain from these recordings. Additionally, making these recordings available to the public, prior to the realization of the original objectives of the study, may compromise the intent of the study that was conducted. Other files and specific data elements, within a number of files, were also deleted to protect participant privacy. These other measures were taken to prevent the identification of a participant's origin and destination for a given trip or trip segment.

3 DAS1 DATASET

The DAS1 dataset contains data that is collected by the Data Acquisition System (DAS) developed by UMTRI. This DAS collects audio and video data as well as text. However, given the presence of (S)PII in the video and audio data, only text-based data are available via the RDE. The DAS1 dataset contains 9 comma-separated files. Names and brief descriptions of each file are presented in Table 2.

Table 2: Description of the Files in the DAS1 Dataset

File Number	File	Description	Sample Rate
1	DataFrontTargets	Log of the data collected by the Mobileye sensor which is a part of the DAS; largely includes data about the (vehicle) object that is in front of the host vehicle	10Hz
2	DataLane	Logs quality of the lane markings next to the host vehicle as well as the distances between each side of the vehicle and each lane line	10Hz
3	DataWsu	Log of GPS and CAN Bus data obtained via the onboard WSU	10Hz
4	DAS1_Trip_Summary	A list of summary measures for each trip completed by a vehicle equipped with DAS1	1 per trip

By way of providing an overview of the DAS1 dataset, Table 3 presents a summary for all the files contained in this dataset. This table presents the size, number of vehicles, and number of trips in each file in the DAS1 dataset. The table below is similar to the "Summary" file that can be found on the RDE. The table below summarizes the DAS1 files that were populated with data that was collected on November 1, 2012.

Table 3: File Summary for DAS1 Dataset for November 1, 2012

File No.	File Name	No. of Rows	No. of Columns	No. of Vehicles	No. Unique Trip IDs	File Size (
1	DataFrontTargets_11_01_12.csv	884,802	11	10	47	47,884
2	DataLane_11_01_12.csv	1,401,111	8	10	51	57,470
3	DataWsu_11_01_12.csv	3,228,080	27	8	411	463,475
4	DAS1_Trip_Summary_11_01_12.csv	52	23	10	51	8

For the above table, the "No. of Unique Trip IDs" does not reflect the number of trips that contributed to a particular file. This is because different device/vehicle IDs can be assigned the same trip ID. To get a sense of number of trips that are sufficiently detailed for the data being explored, users are advised to explore the *spmd_Das1_Summary_11_01_12.csv* file, which summarizes all trips taken by equipped host vehicles for which the most comprehensive data are available. For the day being explored here, November 1, 2012, there are 51 trips for which detailed host vehicle driving data is available. This is according to the above *spmd_Das1_Summary_11_01_12.csv* file, which has 52 rows, each representing a single trip, and one representing the header row.

The details for each of the files belonging to the DAS1 dataset are presented below, and reference data collected on November 1, 2012.

3.1 DataFrontTargets File

Elements in the *DataFrontTargets* file are populated with the aid of Mobileye's vision-based Advanced Driver Assistance Systems. This system collects information from the scene in front of the vehicle, and uses a series of algorithms to communicate measures and warnings to drivers as appropriate.[4] Table 4 briefly describes a few of the data elements collected by the Mobileye sensor, which are used to populate the *DataFrontTargets* file.

Table 4: Data Elements of the DataFrontTargets File

Field Name	Type	Units	EnumId	Description
Device	Integer	none	-	A unique, numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
Trip	Integer	none	-	Count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Time	Integer	centiseconds	-	Time in centiseconds since DAS started, which (generally) starts when the ignition is in the on position
TargetId	Integer	none	-	Numeric ID assigned by the Mobileye sensor to distinguish between the different objects being tracked; the closest obstacle is given a TargetId value of 1
ObstacleId	Integer	none	-	ID of new obstacle, as assigned by the Mobileye sensor, and its value will be the last used free ID
Range	Integer	m	-	Longitudinal position of an object, typically the closest object, relative to a reference point on the host vehicle, according to the Mobileye sensor
RangeRate	Real	m/sec	-	Longitudinal velocity of an object, typically the closest object, relative to the host vehicle, according to the Mobileye sensor
Transversal	Real	m	-	The lateral position of the obstacle, as determined by the Mobileye sensor
TargetType	Integer	none	409	Classification of an identified obstacle/target as a car, truck, pedestrian, etc.
Status	Integer	none	410	Classification of the motion (kinematic state) of an identified obstacle/target as stopped, moving, etc.
CIPV	Integer	none	1	Field communicating whether an obstacle is the closest in a vehicle's path

While Table 4 contains a number of enumerated elements whose values are associated with different meanings, Table 5 presents each of these data elements and their various enumerations.

[4] Mobileye, http://www.mobileye.com/

Table 5: Enumeration Table for DataFrontTargets File

Data Element	EnumId	Value	Name	Description
TargetType	409	0	Car	Mobileye sensor has identified an obstacle/target as a car
		1	Truck	Mobileye sensor has identified an obstacle/target as a truck
		2	Motorcycle	Mobileye sensor has identified an obstacle/target as a motorcycle
		3	Pedestrian	Mobileye sensor has identified an obstacle/target as a pedestrian
		4	Bicycle	Mobileye sensor has identified an obstacle/target as a bicycle
Status	410	0	Undefined	Mobileye sensor is unable to determine the kinematic state of the identified obstacle/target
		1	Standing	Mobileye sensor has determined that the identified obstacle/target is standing
		2	Stopped	Mobileye sensor has determined that the identified obstacle/target is stopped
		3	Moving	Mobileye sensor has determined that the identified obstacle/target is moving
		4	Oncoming	Mobileye sensor has determined that the identified obstacle/target is oncoming
		5	Parked	Mobileye sensor has determined that the identified obstacle/target is parked
		6	Unused	Value saved for future assignment
CIPV	1	0	False	Identified obstacle/target is not the closest in a vehicle's path
		1	True	Identified obstacle/target is the closest in a vehicle's path

Table 6 provides a 10-record sample from the *DataFrontTargets* file.

Table 6: Sample Records for DataFrontTargets File

Device	Trip	Time	TargetId	ObstacleId	Range	RangeRate	Transversal	TargetType	Status	CIPV
10204	510	1400	1	1	52.9125	-4.08972	-0.8	0	4	0
10204	510	1410	1	1	52.33333	-6.52678	-0.65625	0	4	0
10204	510	1420	1	1	51.60714	-8.06545	-0.51786	0	4	0
10204	510	1430	1	1	50.64844	-10.0794	-0.35938	0	4	0
10204	510	1440	1	1	49.72222	-12.4183	-0.21528	0	4	0
10204	510	1450	1	1	48.23611	-15.1649	0.0625	0	4	0
10204	510	1460	1	1	46.60417	-18.0417	0.333333	0	4	0
10204	510	1470	1	1	44.625	-19.9445	0.604167	0	4	0
10204	510	1480	1	1	42.50694	-21.4514	0.868056	0	4	0

10204	510	1490	1	1	40.3125	-22.5556	1.118056	0	4	0

Table 7 provides a few summary measures of the *DataFrontTargets* file that were obtained on November 1, 2012.

Table 7: Summary Measures for Data Elements of the DataFrontTargets File

Column Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
Device	10	10204, 10205, 10207, 13000, 13103	10204	17103	884801
Trip	47	131, 334, 162, 141, 133	2	1117	
Time	166407	715390, 905680, 1028050, 661510, 1757480	200	2871440	
TargetID	9	1, 2, 3, 5, 6	1	10	
ObstacleID	64	26, 5, 15, 62, 1	0	63	
Range	57650	71.16964, 85.65179, 101.6979, 35.97321, 110.55	0.7125	159.8	
RangeRate	197014	-2.241074, 4.055298, -,.7177575, 2.036324, 1.155552	-92.68056	111.9236	
Transversal	18589	25.03472, 10.53906, -.015625, -13.59375, -16.00893	-32	31.9375	
TargetType	5	0, 1, 2, 3, 4	0	4	
Status	6	0, 1, 2, 3, 4	0	5	
CIPV	2	0, 1	0	1	

3.2 DataLane File

The *DataLane* file is a log of lane-based information collected by the onboard Mobileye sensor. These data communicate the vehicle's position relative to the lane boundaries of its travel lane. A quality measure associated with the estimated information regarding the vehicle's lane boundaries is also presented in this table. This file contains eight fields, presented in Table 8, along with a brief description of each. While Table 8 contains a number of enumerated elements whose values are associated with different meanings, Table 9 presents these data elements and their various enumerations.

Table 8: Data Elements of the DataLane File

Field Name	Type	Units	EnumId	Description
Device	Integer	none	-	A unique numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID

Trip	Integer	none	-	Count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Time	Integer	centiseconds	-	Time in centiseconds since DAS started, which (generally) starts when the ignition is in the on position
LaneDistanceLeft	Real	m	-	Distance between the left side of the vehicle and the left boundary of the travel lane
LaneDistanceRight	Real	m	-	Distance between the right side of the vehicle and the right boundary of the travel lane
LaneHeading	Real	degrees	-	Direction in which the vehicle is traveling
LaneQualityRight	Integer	none	-	Quality of the estimated boundary measure of the travel lane's left boundary
LaneQualityLeft	Integer	none	-	Quality of the estimated boundary measure of the travel lane's right boundary

(It is intended that the following table will be populated after further conversation with UMTRI)

Table 9: Enumeration Table for DataLane File

Data Element	EnumId	Value	Name	Description
LaneQualityRight	??	0		
	??	1		
	??	2		
	??	3		
LaneQualityLeft	??	0		
	??	1		
	??	2		
	??	3		

Table 10 provides a 10-record sample from the *DataLane* file.

Table 10: Sample Records for DataLane File

Device	Trip	Time	LaneDistanceLeft	LaneDistanceRight	LaneHeading	LaneQualityRight	LaneQualityLeft
10204	512	210	-1.875	1.875	-1.024	0	0
10204	512	220	-1.875	1.875	-1.024	0	0
10204	512	230	-1.875	1.875	-1.024	0	0
10204	512	240	-1.875	1.875	-1.024	0	0
10204	512	250	-1.875	1.875	-1.024	0	0
10204	512	260	-1.875	1.875	-1.024	0	0
10204	512	270	-1.875	1.875	-1.024	0	0
10204	512	280	-1.875	1.875	-1.024	0	0
10204	512	290	-1.875	1.875	-1.024	0	0
10204	512	300	-1.875	1.875	-1.024	0	0

Table 11 provides a few summary measures of the *DataLane* file obtained from the data collected on November 1, 2012.

Table 11: Summary Measures for Data Elements of the DataLane File

Column Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
Device	10	10204, 10205, 10207, 13000, 13103	10204	17103	1401110
Trip	51	141, 162, 334, 512, 131	2	1117	
Time	288468	1833670, 737700, 763170, 2642450, 2669260	200	2884870	
LaneDistanceLeft	4248	6.59375, -8.242188, 8.566406, 2.722656, 1.253906	-9.972656	9.984375	
LaneDistanceRight	4215	-1.808594,-5.015625, 4.121094, 5.472656, -5.648438	-9.996094	9.996094	
LaneHeading	992	0, 0.09200001, 0.2, -0.019, 0.226	-1.024	0.6305	
LaneQualityLeft	4	0, 1, 2, 3	0	3	
LaneQualityRight	4	0, 1, 2, 3	0	3	

3.3 DataWsu File

Data from the onboard WSU populates the *DataWsu* file. This file primarily consists of GPS-based data elements and those that are obtained from the vehicle's Controller Area Network (CAN) Bus. In addition to GPS-based data, there are a series of data elements that present vehicle performance information and the state of a few of its components. The *DataWsu* file has the most fields, 27, of any file in the DAS1 dataset. Table 12 contains the list of fields in the *DataWsu* file, along with a brief description of each.

Table 12: Data Elements of the DataWsu File

Field Name	Type	Units	EnumId	Description
Device	Integer	none	-	A unique numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
Trip	Integer	none	-	Count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Time	Integer	centiseconds	-	Time in centiseconds since DAS started, which (generally) starts when the ignition is in the on position
GpsValidWsu	Integer	none	1	Communicates whether a GPS data point is valid or not
GpsTimeWsu	Integer	millisecond		Epoch GPS time received from the remote vehicle that has been targeted by the host vehicle's WSU
LatitudeWsu	Float	deg	-	Latitude from WSU receiver
LongitudeWsu	Float	deg	-	Longitude from WSU receiver
AltitudeWsu	Real	m	-	Altitude from WSU receiver
GpsHeadingWsu	Real	deg	-	Heading from WSU GPS receiver
GpsSpeedWsu	Real	m/sec	-	Speed from WSU GPS receiver
HdopWsu	Real	none	-	Horizontal dilution of precision
PdopWsu	Real	none	-	Position dilution of precision
FixQualityWsu	Integer	none	-	GPS Fix Quality
GpsCoastingWsu	Integer	none	-	GPS Coasted
ValidCanWsu	Integer	none	1	Valid Vehicle CAN Bus message to WSU

YawRateWsu	Real	deg/sec	-	Yaw rate from vehicle CAN Bus via WSU
SpeedWsu	Real	kph	-	Speed from vehicle CAN Bus via WSU
TurnSngRWsu	Integer	none	11	Right turn signal from vehicle CAN Bus via WSU
TurnSngLWsu	Integer	none	11	Left turn signal from vehicle CAN Bus via WSU
BrakeAbsTcsWsu	Integer	none	-	Brake, ABS, and traction control from vehicle CAN Bus via WSU
AxWsu	Real	m/sec^2	-	Longitudinal acceleration from vehicle CAN Bus via WSU
PrndlWsu	Integer	none	403	Current transmission state (Park, Reverse, Neutral, Drive, Low) from vehicle CAN Bus via WSU
VsaActiveWsu	Integer	none	-	Stability control active from vehicle CAN Bus via WSU
HeadlampWsu	Integer	none	-	Headlamp state from vehicle CAN Bus via WSU
WiperWsu	Integer	none	-	Wiper state from vehicle CAN Bus via WSU
ThrottleWsu	Real	none	-	Throttle position from vehicle CAN Bus via WSU
SteerWsu	Real	deg	-	Steering angle/position from vehicle CAN Bus via WSU

Table 12 contains a number of enumerated elements whose values are associated with different meanings. Table 13 presents each of these data elements and their various enumerations.

Table 13: Enumeration Table for DataWsu File

Data Element	EnumId	Value	Name	Description
GpsValidWsu	1	0	False	Invalid data from GPS unit
	1	1	True	Valid data from GPS unit
ValidCanWsu	1	0	False	Invalid data from vehicle CAN bus
	1	1	True	Valid data from vehicle CAN bus
TurnSngLWsu	11	0	Off	Left turn signal is off
	11	1	On	Left turn signal is on
TurnSngRWsu	11	0	Off	Right turn signal is off
	11	1	On	Right turn signal is on
PrndlWsu	403	0	Shifting	Shifting gears
	403	1	Park	Transmission is in the Park position
	403	2	Reverse	Transmission is in the Reverse position
	403	3	Neutral	Transmission is in the Neutral position
	403	4	Drive	Transmission is in the Drive position
	403	5	Drive4	Transmission is in the Drive4 position
	403	6	First	Transmission is in the first gear
	403	7	Second	Transmission is in the second gear
	403	8	Third	Transmission is in third gear
	403	9	Fourth	Transmission is in fourth gear

Table 14 provides a 10-record sample from the *DataWsu* file.

Table 14: Sample Records for DataWsu File

Device	Trip	Time	GpsValidWsu	GpsTimeWsu	LatitudeWsu	LongitudeWsu	AltitudeWsu	Gps HeadingWsu	Gps SpeedWsu	HdopWsu	PdopWsu	FixQualityWsu
10204	509	23650	1	1.35E+12	42.28868	-83.7482	203.8	106.88	6.780764	0.8	1.4	1
10204	509	23660	1	1.35E+12	42.28868	-83.7482	203.8	107.2572	6.821229	0.8	1.4	1
10204	509	23670	1	1.35E+12	42.28868	-83.7482	203.8	108.58	6.910778	0.8	1.4	1
10204	509	23680	1	1.35E+12	42.28867	-83.7482	203.8	109.0787	6.959002	0.8	1.4	1
10204	509	23690	1	1.35E+12	42.28867	-83.7482	203.7	108.64	7.036681	0.8	1.4	1
10204	509	23700	1	1.35E+12	42.28867	-83.7482	203.7	109.0606	7.090995	0.8	1.4	1
10204	509	23710	1	1.35E+12	42.28867	-83.7482	203.7	109.51	7.119417	0.8	1.4	1
10204	509	23720	1	1.35E+12	42.28866	-83.7482	203.7	109.9133	7.170913	0.8	1.4	1
10204	509	23730	1	1.35E+12	42.28866	-83.7482	203.6	111.39	7.220139	0.8	1.4	1
10204	509	23740	1	1.35E+12	42.28866	-83.7482	203.6	111.915	7.27073	0.8	1.4	1

Table continued …

Gps CoastingWsu	Valid CanWsu	Yaw RateWsu	SpeedWsu	Turn SngRWsu	Turn SngLWsu	Brake AbsTcsWsu	AxWsu	PrndlWsu	Vsa ActiveWsu	Head lampWsu	WiperWsu	ThrottleWsu	SteerWsu
0	1	3.385353	24.2392	0	0	0	0.397074	5	0	0	0	0	0
0	1	3.771652	24.41075	0	0	0	0.404651	5	0	0	0	0	0
0	1	3.771652	24.55643	0	0	0	0.404651	5	0	0	0	0	0
0	1	4.987145	24.8788	0	0	0	0.482242	5	0	0	0	0	0
0	1	4.987145	25.05241	0	0	0	0.482242	5	0	0	0	0	0
0	1	4.205868	25.33205	0	0	0	0.543147	5	0	0	0	0	0
0	1	4.205868	25.52758	0	0	0	0.543147	5	0	0	0	0	0
0	1	4.03274	25.6299	0	0	0	0.51496	5	0	0	0	0	0
0	1	4.03274	25.81528	0	0	0	0.51496	5	0	0	0	0	0
0	1	5.250378	25.9925	0	0	0	0.505906	5	0	0	0	0	0

Table 15 lists summary measures of the *DataWsu* file obtained from data collected on November 1, 2012.

Table 15: Summary Measures for Data Elements of the DataWsu File

Column Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
Device	10	10204, 10205, 10207, 13000, 13101	10204	17103	999440
Trip	51	162, 104, 513, 1113, 141	2	1117	
Time	241151	1376130, 2409830, 743900, 683800, 382610	900	2412510	
GpsValidWsu	1	1	1	1	
GpsTimeWsu	594964	1351822952900 1351827345200 1351764713500 1351808299200 1351783875200	1351737667700	1351829139600	
LatitudeWsu	748803	42.2785019210991 42.2773747970819 42.293050752057 41.7330789462533 42.2813880226503	41.7318741083832	42.4484912629007	
LongitudeWsu	760267	-83.7265748282363 -83.692588300285 -83.7233979177803 -83.7356074898158 - 83.7338702147645	-83.7879927971741	-83.4309751827293	
AltitudeWsu	2504	213.82, 224.72, 194.6, 212.75, 233	166.75	268.42	
GpsHeadingWsu	314804	260.06, 178.3642, 68.39957, 333.1638, 209.5879	0	359.9996	
GpsSpeedWsu	338569	9.114333, 11.89754, 16.85081, 5.285861, 13.21384	0	40.07752	
HdopWsu	17	0.7, 0.8, 0.9, 1, 1.1	0.7	2.5	
PdopWsu	29	1.1, 1.2, 1.3, 1.4, 1.5	1.1	4.9	
FixQualityWsu	1	1	1	1	
GpsCoastingWsu	1	0	0	0	
ValidCanWsu	2	0, 1	0	1	
YawRateWsu	314618	1.49246, 0.7796845, 0.03145057, 3.345737, 2.400542	-219.3898	638	
SpeedWsu	317743	43.9116, 33.5072, 115.7111, 72.96955, 95.49178	0	144.2791	
TurnSngRWsu	1	0	0	0	
TurnSngLWsu	1	0	0	0	
BrakeAbsTcsWsu	2	0, 64	0	64	
AxWsu	315044	-0.04029475, -.5697368, -0.3275318, 1.030152, -0.5303813	-7.655474	5.025188	
PrndlWsu	1	5	5	5	
VsaActiveWsu	1	0	0	0	

HeadlampWsu	1	0	0	0	
WiperWsu	1	0	0	0	
ThrottleWsu	1	0	0	0	
SteerWsu	1	0	0	0	

3.4 DAS1 Trip Summary File

The DAS1 Trip Summary file contains trip-level summaries, from each instrument vehicle, for each trip taken during the selected time period of the Model Deployment. The trip summaries include details such as trip start and end times, distance traveled, and the number of time a driver applied the brakes during the trip. Also captured in the trip summary file is the distance driven while the vehicle speed was greater than 25 mph. This data element is of interest not only because it further details the trip, but also because it provides a sense of the conditions under which data, for a particular trip, were collected. The Summary file contains 15 fields; below is a list of these fields and a brief description of each.

Table 16: Data Elements of the Summary Table

Field Name	Type	Units	EnumId	Description
DeviceID	Integer	None	-	This field contains the unique, numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
TripID	String	None	-	This field contains a count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Epoch Start Time	Integer	seconds	-	This field contains the epoch start time stamp, in seconds, of a trip. Epoch time, which is sometimes referred to as Unix time, is the number of seconds that has elapsed since midnight January 1, 1970
Start Date	Date	date	-	The m/d/yyyy on which the trips started
Start Time	Time	time	-	This field contains the wall clock time stamp of the start of a trip, in the form of hh:mm:sss
Epoch End Time	Integer	seconds	-	This field contains the epoch end time stamp, in seconds, of a trip. Epoch time, which is sometimes referred to as Unix time, is the number of seconds that has elapsed since midnight January 1, 1970
End Date	Date	date	-	The m/d/yyyy on which the trips ended
End Time	Time	Time	-	This field contains the wall clock time stamp of the end of a trip, in the form of hh:mm:sss
Total Trip Distance	Integer	m	-	This field contains the total distance traveled, in miles, covered in a trip
Distance Travelled w/ Speed >= 25mph	Real	m	-	This field contains the distance traveled in a trip but only when the vehicle's speed is greater than or equal to 25 mph.
Trip Duration	Real	m	-	This field contains the total time duration, in seconds, of a trip. 999999 – data unavailable
Average Speed	Real	m/s	-	This field communicates a vehicle's average speed over the entire length of the trip. 999999 – data unavailable
Maximum Speed	Real	m/s	-	This field contains the maximum speed reached during a trip
Brake Count	Integer	none	-	This field contains an indication of the number of times the driver applies the brake during a trip
Wiper Activated	String	none	-	This field indicates whether or not the wipers were activated during a trip

Table 17 provides a 10-record sample from the *Summary* file.

Table 17: Sample Records for Summary File

DeviceID	TripID	Epoch Start Time	Start Date	Start Time	Epoch End Time	End Date	End Time	Total Trip Distance	Distance Travelled w/ Speed >= 25mph
10106	297	1365680194	4/11/2013	7:27:49	1365680194	4/11/2013	7:36:33	5.124307	4.393447
10106	300	1365712962	4/11/2013	16:33:57	1365712962	4/11/2013	16:42:41	5.837012	4.617299
10116	716	1365685699	4/11/2013	8:57:23	1365685699	4/11/2013	9:08:18	12.994089	12.197617
10116	718	1365698544	4/11/2013	12:40:12	1365698544	4/11/2013	12:42:23	6.432951	6.432951
10116	719	1365703393	4/11/2013	14:01:02	1365703393	4/11/2013	14:03:13	0.647246	0.603726
10116	720	1365735768	4/11/2013	22:51:52	1365735768	4/11/2013	23:02:48	10.487535	9.914046
10118	771	1365682553	4/11/2013	8:00:35	1365682553	4/11/2013	8:15:52	7.422556	6.164827
10118	772	1365706146	4/11/2013	14:44:43	1365706146	4/11/2013	14:49:05	3.312033	2.608147
10118	773	1365714403	4/11/2013	17:00:10	1365714403	4/11/2013	17:06:43	3.980565	3.355532
10120	671	1365681111	4/11/2013	7:32:11	1365681111	4/11/2013	7:51:51	26.373104	24.054027

Table continued …

Trip Duration	Average Speed	Maximum Speed	Brake Count	Wiper Activated
524.288	35.185822	17.785469	4	No
524.288	40.079584	20.322571	11	No
655.36	71.378664	34.94302	10	No
131.072	176.686287	32.364101	0	No
131.072	17.777129	19.83666	1	No
655.36	57.609751	22.45439	4	No
917.504	29.123799	20.85228	16	No
262.144	45.483846	20.987221	13	No
393.216	36.443159	20.735519	8	No
1179.648	80.484327	35.382179	9	No

Table 18 provides a few summary measures of the *Summary* file from April 11, 2013.

Table 18: Summary Measures for Data Elements of the Summary File

Field Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
DeviceID		10204, 10205, 10207, 13000, 17101	10106	17103	278
TripID		41, 71-A, 50, 167, 87	24	2271	
Epoch Start Time	Continuous	1365711651, 1365712175, 1365679407, 1365679669, 1365680980	1365652800	1365652800	
Start Date	1	4/11/2013	4/11/2013	4/11/2013	
Start Time		6:52:52, 11:34:40, 13:04:14, 17:48:13, 18:27:32	0:02:10	23:59:59	
Epoch End Time	Continuous	1365737341, 1365684781, 1365693170, 1365703655, 1365706801	1365739199	1365739199	
End Date	1	4/11/2013	4/11/2013	4/11/2013	
End Time		12:40:12, 6:20:06, 11:19:22, 13:34:49, 16:38:19	0:02:10	23:59:59	
Total Trip Distance	Continuous	26.816043, 29.563191, 8.294983, 11.286039, 1.165109	0.014572	339.5202	
Distance Travelled w/ Speed >= 25mph	Continuous	28.814616, 22.377494, 1.025562, 8.281198, 7.480304	0	333.0411	
Trip Duration	Continuous	917.504, 786.432, 131.072, 393.216, 393.216	131.072	999999	
Average Speed	Continuous	0, 1352.01794433594, 3653.50708007812, 4117.85302734375, 4156.54296875	0.005718	999999	
Maximum Speed	Continuous	0, 3.57740211486816, 723.406127929688, 3300.6240234375, 3698.57104492188	1.538876	42.25568	
Brake Count	Continuous	0, 1104.56298828125, 2801.86206054688, 3296.44897460938, 4322.8818359375	0	345	
Wiper Activated	2	Yes, No	0	0	

4 DAS2 DATASET

The DAS2 dataset catalogs the vehicle operation data of Crash Avoidance Metrics Partnership CAMP's 64 vehicles that are equipped with integrated safety devices (ISD) and the data acquisition system developed by Virginia Tech Transportation Institute (VTTI) (DAS2). This DAS serves as the primary means by which vehicle operation data is being collected and stored. Although "DAS2" also captures text- and video-based data, only the text-based data will be available via the Research Data Exchange (RDE), as (Sensitive) Personally Identifiable Information ((S)PII) is in the video (and audio) data. As a result, the following sections will detail only text-based data. The DAS2 dataset contains four individual *.csv files. Table 19 presents the seven files and a brief description of each.

Table 19: Summary of the Files Contained in DAS2 Dataset

File Number	File	Description	Sample Rate
1	HV_Primary	Main log file for the data acquisition system that logs vehicle position and motion data	10Hz
2	HV_Radar	Registered information from the host vehicle's radar unit	10Hz
3	DAS2_Trip_Summary_File	A list of summary measures for each trip completed by a vehicle equipped with DAS2	1 per trip

By way of providing an overview of the DAS2 dataset, Table 19 presents a summary for all the files contained in this dataset. This table illustrates the contributions made that populate each file in DAS2 dataset. Table 20 is similar to the "Summary" file that can be found on the RDE; it summarizes DAS2 files populated with data collected on September 6, 2012.

Table 20: File Summary for DAS2 Dataset for September 6, 2012

File No.	File Name	No. of Rows	No. of Columns	No. of Vehicles	No. Unique Trip IDs	File Size (KB)
1	HV_Primary	2,160,912	53	51	246	576,041
2	HV_Radar	3,404,787	11	50	234	171,731
3	DAS2_Trip_Summary_File	245	15	245	53	8

For Table 20, the "No. of Unique Trip IDs" does not reflect the number of trips that contributed to a particular file. This is because the different device/vehicle IDs can be assigned the same trip ID. To get a sense of number of trips that are sufficiently detailed for the data being explored, users are advised to explore the *DAS2_Trip_Summary_File_2012_09_06.csv* file, which summarizes all the trips taken by equipped host vehicles, for which the most comprehensive data are available. For the day being explored here, September 6, 2012, there are 244 trips for which detailed host vehicle driving data is available. This is according to the above *DAS2_Trip_Summary_File_2012_09_06.csv* file, which has 245 rows, each representing a single trip, and one representing the header row.

Similar to the presentation of all the files within the DAS1 dataset, the following sections will detail the contents of each file in the DAS2 dataset. To accomplish this, three or four tables will be presented to communicate the various aspects of each file, as was the case when describing the files of the DAS1 dataset.

4.1 HV_Primary File

The *HV_Primary* file is the main file that contains the performance and operation details of vehicles with ISDs. This file contains 52 fields detailing elements such as vehicle position and speed, fidelity measures of GPS-based data elements, and vehicle operation data such as steering and throttle position. Table 21 presents the fields of the HV_Primary file as well as a few descriptors for each.

Table 21: Data Elements of the HV_Primary File

Field Name	Type	Units	EnumID	Description
DeviceID	Integer	none	-	A unique numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
Trip	Integer	none	-	Count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Time	Integer	centiseconds	-	Time in centiseconds since DAS started, which (generally) starts when the ignition is in the on position
GPS_Elevation	Float	m	-	Elevation of vehicle according to GPS
GPS_Fix_Quality	Integer	None	2	Quality of GPS information
GPS_Hdop	Float	None	-	Horizontal Dilution of Precision, used to determine position accuracy; the lower the number, the better
GPS_Heading	Float	degrees	-	Heading of vehicle according to GPS
GPS_Latitude	Float	degrees	-	Latitude of vehicle according to GPS
GPS_Longitude	Float	degrees	-	Longitude of vehicle according to GPS
GPS_Number_Satellites	Integer	satellites	-	Number of satellites used in GPS solution
GPS_Pdop	Float	none	-	Positional Dilution of Precision, used to determine position accuracy; the lower the number, the better
GPS_Speed	Float	meters/second	-	Speed of vehicle according to GPS
GPS_UTC_Time	Integer	milliseconds		UTC Time of vehicle according to GPS
GPS_Valid	Integer	None	3	Validity of GPS data
DAS_Pitch_Rate	Float	degrees/seconds	-	Vehicle angular velocity around the lateral axis
DAS_Roll_Rate	Float	degrees/seconds	-	Vehicle angular velocity around the longitudinal axis
InVehicle_ABS_State	Character	none	4	Provides ABS state of the vehicle
InVehicle_Brake_Status	Character	none	5	Provides brake status of the vehicle
InVehicle_Headlight_Status	Integer	none	6	Provides status if headlights are currently in use
InVehicle_Longitudinal_Accel	Float	meter /second^2	-	Vehicle acceleration in the longitudinal direction
InVehicle_Longitudinal_Speed	Float	meters/second	-	Vehicle speed sampled from the vehicle network (CAN bus)
InVehicle_PRNDL	Integer	None	7	Vehicle transmission state
InVehicle_Stability_Control_Status	Integer	none	8	Vehicle stability control status
InVehicle_Steering_Position	Float	degrees	-	Vehicle steering wheel position in degrees
InVehicle_Throttle_Position	Float	None	-	Vehicle throttle position

InVehicle_Traction_Control_Status	Character (10)		4	Vehicle traction control status
InVehicle_Turn_Signal_Left	Integer	None	6	Vehicle left turn signal status
InVehicle_Turn_Signal_Right	Integer	None	6	Vehicle right turn signal status
InVehicle_Wiper_Status	Integer		9	Vehicle wiper status
InVehicle_Yaw_Rate	Float	degrees/second	-	Vehicle yaw rate
LaneTrack_Crossing_Left	BIT	None	10	There is an exit on the left side of the road
LaneTrack_Crossing_Right	BIT	None	10	There is an exit on the right side of the road
LaneTrack_Distance_Left_Marker	Float	Millimeter	-	Distance from vehicle centerline to inside of left-side lane marker based on vehicle-based machine vision
LaneTrack_Distance_Right_Marker	Float	Millimeter	-	Distance from vehicle centerline to inside of right-side lane marker based on vehicle-based machine vision
LaneTrack_Lane_Width	Float	Millimeter	-	Distance between the inside edge of the innermost lane marking to the left and right of the vehicle
LaneTrack_Probability_Left_Exist	Integer	Percent	-	Probability that vehicle-based machine vision lane marking evaluation is providing correct data for the left-side lane markings; values from 0-1024, thus 100/1024 = 0.0977% per 1
LaneTrack_Probability_Right_Exists	Integer	Percent	-	Probability that vehicle-based machine vision lane marking evaluation is providing correct data for the right-side lane markings; values from 0-1024, thus 100/1024 = 0.0977% per 1
LaneTrack_Shift_Aborted	BIT	None	10	The driver aborted crossing a line; a line was crossed, then the driver crossed back over it
LaneTrack_Shift_Left	BIT	None	10	The vehicle is crossing a line on the left (cannot be STATUS_RIGHT also)
LaneTrack_Shift_Right	BIT	None	10	The vehicle is crossing a line on the right
LaneTrack_Shift_Successful	BIT	None	10	The vehicle lies in the lane between the painted lines
LaneTrack_Type_LeftLane_LeftMarker	Integer	None	11	The type of left-most marker toward the left of the vehicle
LaneTrack_Type_LeftLane_RightMarker	Integer	None	11	The type of right-most marker toward the left of the vehicle
LaneTrack_Type_RightLane_LeftMarker	Integer	None	11	The type of left-most marker toward the right of the vehicle
LaneTrack_Type_RightLane_RightMarker	Integer	None	11	The type of right-most marker toward the right of the vehicle

Table 62 contains a number of enumerated elements whose values are associated with different meanings. Table 63 presents each of these data elements and their various enumerations.

Table 22: Enumeration Table for HV_Primary File

Data Element	EnumId	Value	Name	Description
GPS_Fix_Quality	2	0	invalid	Quality of GPS information
		1	GPS fix	Quality of GPS information
		2	dgps fix	Quality of GPS information
GPS_Valid	3	0	Valid	Validity of GPS data
		1	invalid	Validity of GPS data
InVehicle_ABS_State	4	0	Unavailable	Provides ABS state of the vehicle
		1	Off	Provides ABS state of the vehicle
		2	on (but not engaged)	Provides ABS state of the vehicle
		3	engaged	Provides ABS state of the vehicle
InVehicle_Brake_Status	5	0	Not active	Provides brake status of the vehicle
		15	Active	Provides brake status of the vehicle
InVehicle_Headlight_Status	6	0	Not active	Provides status if headlights are currently in use
		1	Active	Provides status if headlights are currently in use
InVehicle_PRNDL	7	0	Neutral	Vehicle Transmission State
		1	Park	Vehicle Transmission State
		2	Drive	Vehicle Transmission State
		3	Reverse	Vehicle Transmission State
		4	Reserved1	Vehicle Transmission State
		5	Reserved2	Vehicle Transmission State
		6	Reserved3	Vehicle Transmission State
		7	Unavailable	Vehicle Transmission State
InVehicle_Stability_Control_Status	8	0	Unavailable	Vehicle stability control status
		1	off	Vehicle stability control status
		2	on or active (engaged)	Vehicle stability control status
InVehicle_Wiper_Status	9	0	off	On or off
		5	on	On or off
LaneTrack_Crossing_Left/Right LaneTrack_Shift_Aborted/Successful LaneTrack_Shift_Left/Right	10	1	LANE	
		2	RIGHT	
		4	LEFT	
		8	ABORT	
		10	SHIFT	
		20	CROSS_SOLID	
		40	CALIBRATE	
		80	LOW_SUN	
		100	NIGHTTIME	
		200	EXIT_RIGHT	
		400	EXIT_LEFT	

		800	SCAN_TILT	
		1000	CAM_TILT	
		2000	NO_VIDEO	
		4000	CAM_SKEW	
		8000	CALIBRATE_SKEW	
LaneTrack_Type_LeftLane_Left/RightMarker LaneTrack_Type_RightLane_Left/RightMarker	11	0	SOLID	Type of marker
		1	DASH	Type of marker
		2	UNSURE	Type of marker
		3	DARK_SOLID	Type of marker

Table 64 provides a 10-record sample from the HV_Primary File.

Table 23: Sample Records for HV_Primary File

DeviceID	Trip	Time	GPS_ Elevation	GPS_ Fix_Quality	GPS_ Hdop	GPS_ Heading	GPS_ Latitude	GPS_ Longitude	GPS_Number_ Satellites	GPS_ Pdop	GPS_ Speed	GPS_ UTC_Time	GPS_ Valid	DAS_ Roll_Rate
11	61062	477818	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	477918	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478018	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478118	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478218	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478318	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478418	201.993	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478518	202.093	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478618	202.093	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0
11	61062	478718	202.093	2	1.03	231.85	42.28913	-83.7394	9	2.06	0	1.35E+12	1	0

Table continued …

DAS_ Pitch_Rate	InVehicle_ ABS_State	InVehicle_ Brake_Status	InVehicle_ Headlight_Status	InVehicle_ Longitudinal_Accel	InVehicle_ Longitudinal_Speed	InVehicle_ PRNDL	InVehicle_ Stability_Control_Status	InVehicle_ Steering_Position	InVehicle_ Throttle_Position
0	2	15	0	-0.4522	0	2	1	-1.28125	0
0	2	15	0	-0.4522	0	2	1	-1.28125	0
0	2	15	0	-0.4522	0	2	1	-1.28125	0
0	2	15	0	-0.3746	0	2	1	-1.28125	0
0	2	15	0	-0.4522	0	2	1	-1.28125	0
0	2	15	0	-0.3746	0	2	1	-1.28125	0
0	2	15	0	-0.4522	0	2	1	-1.28125	0
0	2	15	0	-0.3746	0	2	1	-1.28125	0
0	2	15	0	-0.3746	0	2	1	-1.28125	0
0	2	15	0	-0.3746	0	2	1	-1.28125	0

Table continued …

InVehicle_ Traction_Control_Status	InVehicle_ Turn_Signal_Left	InVehicle_ Turn_Signal_Right	InVehicle_ Wiper_Status	InVehicle_ Yaw_Rate	LaneTrack_ Crossing_Left	LaneTrack_ Crossing_Right	LaneTrack_Distance _Left_Marker	LaneTrack_Distance _Right_Marker	LaneTrack_ Lane_Width
2	0	0	0	0.011659	0	0	-4414	2169	6583.675
2	0	0	0	0.011659	0	0	-4414	2169	6583.675
2	0	0	0	0.111659	0	0	-4414	2169	6583.675
2	0	0	0	0.311659	0	0	-4414	2169	6583.675
2	0	0	0	-0.18834	0	0	-4414	2169	6583.675
2	0	0	0	0.011659	0	0	-4414	2169	6583.675
2	0	0	0	0.111659	0	0	-4414	2169	6583.675
2	0	0	0	-0.08834	0	0	-4414	2169	6583.675

2	0	0	0	0.311659	0	0	-4414	2169	6583.675
2	0	0	0	0.011659	0	0	-4414	2169	6583.675

Table continued …

LaneTrack_ Probability_Left_Exist	LaneTrack_ Probability_Right_Exists	LaneTrack_ Shift_Aborted	LaneTrack_ Shift_Left	LaneTrack_ Shift_Right	LaneTrack_ Shift_Successful	LaneTrack_Type_ LeftLane_LeftMarker	LaneTrack_Type_ LeftLane_RightMarker	LaneTrack_Type_ RightLane_LeftMarker
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1
336	212	0	0	0	0	1	0	1

Table continued …

LaneTrack_Type_RightLane_RightMarker
0
0
0
0
0
0
0
0
0
0

Table 24 provides a few summary measures of the *HV_Primary* file that are based on data collected on September 6, 2012.

Table 24: Summary Measures for Data Element of the HV_Primary File

Field Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
Device	51	0, 11, 13, 14, 15	0	87	2,160,912
Trip	246	52672, 52762, 53327, 53472, 54464	52672	211231	
Time	587812	2967, 2992, 2994, 2998, 3000	2967	5292093	
GPS_Elevation	6157	0, 22.1000003814697, 23.2999992370605, 24.3999996185303, 26	0	315.2000122	
GPS_Fix_Quality	2	1, 2 ,	1	2	
GPS_Hdop	434	0.639999985694885, 0.649999976158142, 0.660000026226044, 0.670000016689301, 0.680000007152557	0.639999986	12.93000031	
GPS_Heading	58253	0, 0.00100000004749745, 0.00300000002607703, 0.00700000021606684, 0.00999999977648258	0	359.9899902	
GPS_Latitude	184390	0, 41.8953475952148, 41.8953514099121, 41.8953552246094, 41.8953590393066	0	43.17897415	
GPS_Longitude	125898	-84.5110397338867, -84.5110321044922, -84.5110244750977, -84.5110168457031, -84.5110092163086	-84.51103973	0	
GPS_Number_Satellites	10	3, 4, 5, 6, 7	3	12	
GPS_Pdop	767	1.10000002384186, 1.11000001430511, 1.12000000476837, 1.12999999523163, 1.13999998569489	1.100000024	21.98999977	
GPS_Speed	14880	0, 0.00833300035446882, 0.0166669990867376, 0.025000000372529, 0.0333329997956753	0	121.3200073	
GPS_UTC_Time	1	2147483647	2147483647	2147483647	
GPS_Valid	2	1	1	1	
DAS_Roll_Rate	110	-0.325195, -0.650391, -0.975586, -1.300781, -1.625977	-0.325195	9.755859	
DAS_Pitch_Rate	147	-0.325195,	-0.325195	9.755859	

		-0.650391, -0.975586, -1.300781, -1.625977		
InVehicle_ABS_State	4	0, 1, 2, 3,	0	3
InVehicle_Brake_Status	3	0, 1, 15	0	15
InVehicle_Headlight_Status	2	0, 1 ,	0	1
InVehicle_Longitudinal_Accel	72471	-9.89999961853027, -9.88059997558594, -9.8612003326416, -9.84179973602295, -9.70600032806396	-9.899999619	4.863399982
InVehicle_Longitudinal_Speed	15236	0, 0.00833300035446882, 0.0166669990867376, 0.025000000372529, 0.0333329997956753	0	436.7520142
InVehicle_PRNDL	5	0, 1, 2, 3, 7	0	7
InVehicle_Stability_Control_Status	2	0, 1 ,	0	1
InVehicle_Steering_Position	10643	-539.5, -538.375, -536.1875, -531.375, -531.28125	-539.5	536.59375
InVehicle_Throttle_Position	100	0, 1, 2, 3, 4	0	100
InVehicle_Traction_Control_Status	3	0, 1, 2	0	2
InVehicle_Turn_Signal_Left	2	0, 1 ,	0	1
InVehicle_Turn_Signal_Right	2	0, 1 ,	0	1
InVehicle_Wiper_Status	3	0, 5, 6	0	6
InVehicle_Yaw_Rate	94419	-327.670013427734, -52.4900016784668, -51.8400001525879, -51.8300018310547, -51.2999992370605	-327.6700134	47.65000153
LaneTrack_Crossing_Left	2	0, 1 ,	0	1
LaneTrack_Crossing_Right	2	0, 1 ,	0	1
LaneTrack_Distance_Left_Marker	10454	-1, -10, -100, -1000, -10002	-1	999
LaneTrack_Distance_Right_Marker	10081	-1, -10, -100, -1000, -10012	-1	9997
LaneTrack_Lane_Width	121898	-1015.992981, -10165.075195, -1041.39917, -10551694, -10647.668945	-1015.992981	9998.285156
LaneTrack_Probability_Left_Exist	1027	0, 1, 10, 100, 1000	0	999
LaneTrack_Probability_Right_Exists	1026	0, 1, 10, 100, 1000	0	999
LaneTrack_Shift_Aborted	2	0, 1 ,	0	1
LaneTrack_Shift_Left	2	0, 1 ,	0	1
LaneTrack_Shift_Right	2	0, 1 ,	0	1
LaneTrack_Shift_Successful	2	0, 1 ,	0	1
LaneTrack_Type_LeftLane_LeftMarker	4	0, 1, 2, NULL,	0	2
LaneTrack_Type_LeftLane_RightMarker	4	0, 1, 2, NULL,	0	2
LaneTrack_Type_RightLane_LeftMarker	4	0, 1, 2, NULL,	0	2
LaneTrack_Type_RightLane_RightMarker	4	0, 1, 2, NULL,	0	2

4.2 HV_Radar File

The *HV_Radar* file is populated with data collected from a radar unit that is part of a vehicle's integrated safety device unit. The radar unit performs a number of functions, including estimating the type of object that is in front of the host vehicle, as well as that object's speed and distance location relative to the host vehicle. Table 25 presents the fields of the HV_Radar file as well as the associated descriptions.

Table 25: Data Elements of the HV_Radar File

Field Name	Type	Units	EnumId	Description
DeviceID	Integer	None	-	A unique numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
Trip	Integer	None	-	Count of ignition cycles – each ignition cycle commences when the ignition is in the on position and end when it is in the off position
Time	Integer	None	-	Time in centiseconds since DAS started, which (generally) starts when the ignition is in the on position
Object_Type	Enumerated	None	14	Estimate of the object type, based on the size of the raw RADAR cluster of returns. Evolution of Object_Length_TX.
Range_X	Float	meters	-	Range to forward radar target measured longitudinally from the radar.
Range_Y	Float	meters	-	Range to forward radar target measured laterally from the radar.
Speed_X	Float	meters/second	-	Range rate to forward radar target measured longitudinally from radar.
Speed_Y	Float	meters/second	-	Range rate to forward radar target measured laterally from radar.
Target_InPath	ENUM	None	15	Compute from Object_ID - verify ID=1 is in path
Target_Moving	ENUM	None	16	Whether the object detected is moving or not. It is moving if it's Relative Speed - RADAR speed is equal to zero.
TargetID	Integer	none	-	Numeric value used to differentiate one radar target from others

Table 25 contains three enumerated elements whose values are associated with different meanings. Table 26 presents each of these data elements and their various enumerations.

Table 26: Enumeration Table for HV_Radar File

Data Element	EnumId	Value	Name	Description
Object_Type	14	0	Unclassified	The radar unit estimates that there is an unclassified object detected in front of the host vehicle
		1	Pedestrian	The radar unit estimates that there is a pedestrian object detected in front of the host vehicle
		2	Bike	The radar unit estimates that there is a bike object detected in front of the host vehicle
		3	Light_Vehicle	The radar unit estimates that there is an light vehicle object detected in front of the host vehicle
		4	Heavy_Vehicle	The radar unit estimates that there is an heavy vehicle object detected in front of the host vehicle
		5	Tractor_Trailor	The radar unit estimates that there is a tractor trailer object detected in front of the host vehicle
Target_In_Path	15	1	Lead_Vehicle	Computed from Object_ID - verify ID=1 is in path
Target_Moving	16	0	Stationary	The object detected in front of the host vehicle is not moving
		1	Moving	The object detected in front of the host vehicle is moving

Table 27 provides a 10-record sample from the *HV_Radar* file.

Table 27: Sample Records for the HV_Radar File

DeviceID	Trip	Time	TargetID	Object_ Type	Range_X	Range_Y	Speed_X	Speed_Y	Target_ InPath	Target_ Moving
20	209423	7798	0	3	8.928	-2.528	1.7	-0.9	1	1
20	209423	7898	0	3	8.992001	-2.784	1.8	-0.8	1	1
20	209423	7998	0	3	9.184	-3.232	1.9	-0.6	1	1
20	209423	8098	0	3	9.280001	-3.424	1.9	-0.6	1	1
20	209423	8198	0	3	9.408	-3.552	1.9	-0.5	1	1
20	209423	8298	0	3	9.632001	-3.84	2	-0.4	1	1
20	209423	8398	0	3	9.76	-3.936	2	-0.4	1	1
20	209423	8498	0	3	9.856001	-4.064	2	-0.3	1	1
20	209423	8598	0	3	10.144	-4.192	2	-0.2	1	1
20	209423	8698	0	3	10.272	-4.224	2	-0.2	1	1

Table 28 provides a few summary measures of the HV_Primary file that were obtained from data collected on 09/06/2012

Table 28: Summary Measure for the HV_Radar File

Field Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
					3,404,787
Device	50	0, 11, 13, 14, 15	0	87	
Trip	234	52672, 52762, 53327, 53472, 54464	52672	211231	
Time	487352	3353, 3392, 3398, 3399, 3453	3353	5292093	
TargetID	256	0, 1, 2, 3, 4	0	255	
Object_Type	5	0, 1, 3, 4, 5	0	5	
Range_X	6394	-7.3600001335144, -6.6560001373291, -5.9520001411438, -5.76000022888184, -5.21600008010864	-7.36	199.9680023	
Range_Y	2673	-46.7519989013672, -44.992000579834, -44.9599990844727, -44.9280014038086, -44.8959999084473	-46.8	45.85599899	
Speed_X	967	-72, -71.9000015258789, -71.8000030517578, -70.8000030517578, -70.6999969482422	-72	31.60000038	
Speed_Y	441	-33.5999984741211, -33.0999984741211, -32.5999984741211, -32.0999984741211, -31.6000003814697	-33.6	18.20000076	
Target_InPath	2	0, 1 ,	0	1	
Target_Moving	2	0, 1 ,	0	1	

4.3 DAS2 Trip Summary File

The DAS2 Trip Summary file is similar to the DAS1 Trip Summary File. As a result of this similarity, the tables below are the same as the files presented in the section detailing the contents of the DAS1 Trip Summary file. The DAS2 Trip Summary file contains trip-level summaries, from each instrument vehicle, for each trip taken during the selected time period of

the Model Deployment. The trip summaries include details such as trip start and end times, distance traveled, and the number of time a driver applied the brakes during the trip. Also captured in the trip summary file is the distance driven while the vehicle speed was greater than 25 mph. This data element is of interest not only because it further details the trip, but also because it provides a sense of the conditions under which data, for a particular trip, were collected. The Summary file contains 15 fields; below is a list of these fields and a brief description of each.

Table 29: Data Elements of the DAS2 Trip Summary file

Field Name	Type	Units	EnumId	Description
DeviceID	Integer	None	-	This field contains the unique, numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
TripID	String	None	-	This field contains a count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Epoch Start Time	Integer	seconds	-	This field contains the epoch start time stamp, in seconds, of a trip. Epoch time, which is sometimes referred to as Unix time, is the number of seconds that has elapsed since midnight January 1, 1970
Start Date	Date	date	-	The m/d/yyyy on which the trips started
Start Time	Time	time	-	This field contains the wall clock time stamp of the start of a trip, in the form of hh:mm:sss
Epoch End Time	Integer	seconds	-	This field contains the epoch end time stamp, in seconds, of a trip. Epoch time, which is sometimes referred to as Unix time, is the number of seconds that has elapsed since midnight January 1, 1970
End Date	Date	date	-	The m/d/yyyy on which the trips ended
End Time	Time	Time	-	This field contains the wall clock time stamp of the end of a trip, in the form of hh:mm:sss
Total Trip Distance	Integer	m	-	This field contains the total distance traveled, in miles, covered in a trip
Distance Travelled w/ Speed >= 25mph	Real	m	-	This field contains the distance traveled in a trip but only when the vehicle's speed is greater than or equal to 25 mph.
Trip Duration	Real	m	-	This field contains the total time duration, in seconds, of a trip. 999999 – data unavailable
Average Speed	Real	m/s	-	This field communicates a vehicle's average speed over the entire length of the trip. 999999 – data unavailable
Maximum Speed	Real	m/s	-	This field contains the maximum speed reached during a trip
Brake Count	Integer	none	-	This field contains an indication of the number of times the driver applies the brake during a trip
Wiper Activated	String	none	-	This field indicates whether or not the wipers were activated during a trip

Table 30 provides a 10-record sample from the *Summary* file.

Table 30: Sample Records for Summary File

DeviceID	TripID	Epoch Start Time	Start Date	Start Time	Epoch End Time	End Date	End Time	Total Trip Distance	Distance Travelled w/ Speed >= 25mph
10106	297	1365680194	4/11/2013	7:27:49	1365680194	4/11/2013	7:36:33	5.124307	4.393447
10106	300	1365712962	4/11/2013	16:33:57	1365712962	4/11/2013	16:42:41	5.837012	4.617299
10116	716	1365685699	4/11/2013	8:57:23	1365685699	4/11/2013	9:08:18	12.994089	12.197617
10116	718	1365698544	4/11/2013	12:40:12	1365698544	4/11/2013	12:42:23	6.432951	6.432951
10116	719	1365703393	4/11/2013	14:01:02	1365703393	4/11/2013	14:03:13	0.647246	0.603726
10116	720	1365735768	4/11/2013	22:51:52	1365735768	4/11/2013	23:02:48	10.487535	9.914046
10118	771	1365682553	4/11/2013	8:00:35	1365682553	4/11/2013	8:15:52	7.422556	6.164827
10118	772	1365706146	4/11/2013	14:44:43	1365706146	4/11/2013	14:49:05	3.312033	2.608147
10118	773	1365714403	4/11/2013	17:00:10	1365714403	4/11/2013	17:06:43	3.980565	3.355532
10120	671	1365681111	4/11/2013	7:32:11	1365681111	4/11/2013	7:51:51	26.373104	24.054027

Table continued …

Trip Duration	Average Speed	Maximum Speed	Brake Count	Wiper Activated
524.288	35.185822	17.785469	4	No
524.288	40.079584	20.322571	11	No
655.36	71.378664	34.94302	10	No
131.072	176.686287	32.364101	0	No
131.072	17.777129	19.83666	1	No
655.36	57.609751	22.45439	4	No
917.504	29.123799	20.85228	16	No
262.144	45.483846	20.987221	13	No
393.216	36.443159	20.735519	8	No
1179.648	80.484327	35.382179	9	No

Table 31 provides a few summary measures of the *Summary* file from April 11, 2013.

Table 31: Summary Measures for Data Elements of the Summary File

Field Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
DeviceID		10204, 10205, 10207, 13000, 17101	10106	17103	278
TripID		41, 71-A, 50, 167, 87	24	2271	
Epoch Start Time	Continuous	1365711651, 1365712175, 1365679407, 1365679669, 1365680980	1365652800	1365652800	
Start Date	1	4/11/2013	4/11/2013	4/11/2013	
Start Time		6:52:52, 11:34:40, 13:04:14, 17:48:13, 18:27:32	0:02:10	23:59:59	
Epoch End Time	Continuous	1365737341, 1365684781, 1365693170, 1365703655, 1365706801	1365739199	1365739199	
End Date	1	4/11/2013	4/11/2013	4/11/2013	
End Time		12:40:12, 6:20:06, 11:19:22, 13:34:49, 16:38:19	0:02:10	23:59:59	
Total Trip Distance	Continuous	26.816043, 29.563191, 8.294983, 11.286039, 1.165109	0.014572	339.5202	
Distance Travelled w/ Speed >= 25mph	Continuous	28.814616, 22.377494, 1.025562, 8.281198, 7.480304	0	333.0411	
Trip Duration	Continuous	917.504, 786.432, 131.072, 393.216, 393.216	131.072	999999	
Average Speed	Continuous	0, 1352.01794433594, 3653.50708007812, 4117.85302734375, 4156.54296875	0.005718	999999	
Maximum Speed	Continuous	0, 3.57740211486816, 723.406127929688, 3300.6240234375, 3698.57104492188	1.538876	42.25568	
Brake Count	Continuous	0, 1104.56298828125, 2801.86206054688, 3296.44897460938, 4322.8818359375	0	345	
Wiper Activated	2	Yes, No	0	0	

5 BASIC SAFETY MESSAGE (BSM) DATASET

A BSM is one of the messages belonging to the Society of Automotive Engineers (SAE) J2735 Standard. This standard is geared toward supporting the interoperability of DSRC applications through the use of a standardized message set and its data frames and data elements. A BSM, which is at times referred to as a "heartbeat" message, is a frequently transmitted message (usually at approximately 10Hz) that is meant to increase a vehicle's situational awareness. These messages are intended to be used for a variety of applications to exchange safety data regarding a vehicle's state. As such, they are an integral part of the SPMD and will be instrumental in the evaluation in the various safety applications being examined during model deployment.

A BSM contains up to two parts. Part I, the binary large object (blob), is included in every BSM. It contains the fundamental data elements that describe a vehicle's position (latitude, longitude, elevation) and motion (heading, speed, acceleration). Part II of a BSM contains optional data that is transmitted when required or in response to an event. Typically Part II contains data that serves as an extension of vehicle safety information (path history, path prediction, event flags) and data pertaining to the status of a vehicle's components, such as lights, wipers, and brakes.

The BSM data are collected by WSUs that were installed on all the vehicles that participated in the model deployment. Several different brands of WSUs were employed through the deployment effort, but all data were stored in a single dataset. This highlights the interoperability goal set forth by the SAE J2735 Standard. This is unlike the case with the "driving" data, which were stored in two separate datasets: one for data collected by DAS1 and another for DAS2.

The BSM dataset includes 22 files, which are listed and briefly described in Table 32.

Table 32: Description of the File Contained in the Basic Safety Message Dataset

File Number	File	Description	Sample Rate
1	BrakeByte1Events	Status of the vehicle's primary brake system	On Event
2	BrakeByte2Events	Status of the vehicle's system control/advance breaking features (e.g., antilock brake system, stability control)	On Event
3	BsmP1	Part I of the BSM, primarily vehicle position and motion data	10 Hz
4	ExteriorLightsEvents	Provides the status of all exterior lights on the vehicle	On Event
5	PosAccurByte1Events	Accuracy of the positional determination with respect to each given Axis – semi-major	On Event
6	PosAccurByte2Events	Accuracy of the positional determination with respect to each given Axis – semi-minor	On Event
7	PosAccurByte3Events	Accuracy of the positional determination with respect to each given Axis – orientation of semi-major axis	On Event
8	PosAccurByte4Events	Accuracy of the positional determination with respect to each given Axis – orientation of semi-minor axis	On Event
9	SteerAngleEvents	The angle of the steering wheel (signed value)	On Event
10	ThrottlePositionEvents	Throttle position, expressed in units of 0.5 percent of range of travel	On Event
11	TransStateEvents	Current state of a vehicle's transmission	On Event
12	WiperStatusFrontEvents	Current state of the wiper system at the front of the vehicle	On Event
13	BSM_Trip_Summary_File	A list of summary measures for each trip per transmitted BSMs	Per trip

5.1 BSM Dataset Timestamps

Each file in the BSM dataset contains a time field, either a "Gentime" or a "StartTime", and "EndTime" field. Entries in the "GenTime" field mark the time stamp at which an event was recorded, while "StartTime" and "EndTime" are the minimum and maximum "GenTime" for a given event. The values for each time entry are informed by the 1609.2 Security Services for Applications and Management Messages layer, a member of the IEEE 1609 family standards for the management and security of networks—vehicle network, specifically. The secured time stamp is an Epoch-based time measurement, measuring the number of milliseconds (or microseconds) elapsed since midnight, January 1, 2004 (2004-01-01-00:00:00). In addition, these timestamps were supposed to be relative to UTC, but due to some inaccuracies in the 1609.2 documentation there is a 35-second offset with respect to UTC (which also includes the recent addition of another leap second during the summer). Timestamps in the BSM dataset also include a factor of 1,000,000 that needs to be accounted for in order to use these time stamps.

To convert these timestamps to a more standard format, facilitating their usage with other datasets, the following formula can be used to convert the timestamps to the number of seconds elapsed since January 1, 2004 at 00:00:00.

# of seconds since 2004-01-01 00:00:00 = (Gen/Start/End Time)/1,000,000 - 35

The results from the above formula can then be used to further convert BSM timestamps into Epoch timestamps by adding it to 1072933200 (seconds).

5.2 Mapping BSM Dataset Files to SAE J2735 Data Frame

The files, and their names, contained in the BSM dataset are based on the data frame dictated by the SAE J2735 Standard. Therefore for additional details for some of the above files, please consult the SAE J2735 Standard.[5] However, to make use of the documentation, Table 33 maps files names to data frame names that are used by the J2735 Standard.

Table 33: J2735 Mapping of Data Frames to File in the BSM Dataset

Model Deployment Name	J2735 Standard (Data Frame) Terminology
BrakeByte1Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-BrakeAppliedStatus
BrakeByte1Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-WheelBrakesUnavailable
BrakeByte1Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-SpareBit
BrakeByte1Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-TractionControlState
BrakeByte2Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-AntiLockBrakeStatus
BrakeByte2Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-StabilityControlStatus
BrakeByte2Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-BrakeBoostApplied
BrakeByte2Events	MSG_BasicSafetyMessage-BSMblob-BrakeSystemStatus-AuxiliaryBrakeStatus
ExteriorLightsEvents	MSG_BasicSafetyMessage-VehicleStatus-ExteriorLights
PosAccurByte1Events	MSG_BasicSafetyMessage-BSMblob-PositionalAccuracy-MajorAccuracy
PosAccurByte2Events	MSG_BasicSafetyMessage-BSMblob-PositionalAccuracy-MinorAccuracy
PosAccurByte3Events	MSG_BasicSafetyMessage-BSMblob-PositionalAccuracy-HeadingPA
PosAccurByte4Events	MSG_BasicSafetyMessage-BSMblob-PositionalAccuracy-HeadingPA
SteerAngleEvents	MSG_BasicSafetyMessage-VehicleStatus-Steering-SteeringWheelAngle
TransStateEvents	MSG_BasicSafetyMessage-BSMblob-TransmissionAndSpeed-TransmissionState
WiperStatusFrontEvents	MSG_BasicSafetyMessage-VehicleStatus-Wipers-WiperStatusFront

The following sections will detail each of the aforementioned files while providing samples of each to equip users with the requisite knowledge to extract insights from the BSM dataset.

5.3 BsmMD File

The *BsmMD* File is the BSM metadata file for the transmitted BSMs from a single vehicle. All transmitted BSMs are embedded in a frame with security and communication layers. The basic function of this file is to be a pointer into the file that contains all the BSMs transmitted by each

[5] Dedicated Short-Range Communications (DSRC) Message Set Dictionary, http://standards.sae.org/j2735_200911/

participating vehicle. The file contains device IDs, certification IDs, and offsets; these elements are a part of the security and communication layer that is required for the V2V/V2I network. As a part of the security layer, the *BsmMD* file contains a set of randomly generated device IDs that mask the true ID of a transmitting antenna ("TxRandom"). These randomly generated device IDs are also accompanied by the unmasked ID of transmitting antenna and the ID receiving antenna. An additional security layer is attached to a transmitted BSM by way of a certificate ID. The certificate ID (CertID) protects transmitted BSMs throughout the connected vehicle environment and enables connected vehicles (and roadside equipment) to accept only messages of entities with valid certificate IDs. For additional information regarding security measures incorporated into the connect vehicle network, review the Certificate Management Entities for a Connected Vehicle Environment document produced by RITA/USDOT.[6]

In addition to the various security details, the *BsmMD* file also contains time offset values for the various parts of a BSM as well as the frame offsets to allow BSMs to be synced with associated video recordings. These frame offsets will be of limited value to RDE users as the RDE will not host such recordings. Including the aforementioned data elements of the BSM metadata file, there are a total of 13 fields. Table 34 provides a brief overview of each of these fields.

Table 34: Data Elements of the BsmMD File

Field Name	Type	Units	EnumId	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
Gentime	Integer	milliseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
CertId	Integer	None		Numeric value attached to BSMs to verify that the source of the message is valid
TxRandom	Integer	None		Randomly assigned ID to mask the device ID of the transmitting device for security purposes
FrameOffset	Integer			(to be filled in pending input from Safety Pilot Test Conductor)
FrameSize	Integer			(to be filled in pending input from Safety Pilot Test Conductor)
BsmPIRelOffset	Integer	sec/msec		(to be filled in pending input from Safety Pilot Test Conductor)
BsmPIIRelOffset	Integer	sec/msec		(to be filled in pending input from Safety Pilot Test Conductor)
BsmPIIIRelOffset	Integer	sec/msec		(to be filled in pending input from Safety Pilot Test Conductor)
GenTimeRelOffset	Integer	sec/msec		(to be filled in pending input from Safety Pilot Test Conductor)
PsIdByte	Integer	None		(to be filled in pending input from Safety Pilot Test Conductor)

Table 35 provides a 10-record sample of the contents of the *BsmMD* file.

Table 35: Sample Records for BsmMD File

RxDevice	FileId	TxDevice	Gentime	CertId	TxRandom	FrameOffset	FrameSize

[6] Certificate Management Entities for a Connected Vehicle Environment: http://www.its.dot.gov/connected_vehicle/cm_connected_ vehicle.htm

10	13963	10	278802340808876	-4449541671506560000	0	40	292
10	13963	10	278802340908860	4846661789333420000	0	348	363
10	13963	10	278802341008885	-4449541671506560000	0	727	292
10	13963	10	278802341108882	-4449541671506560000	0	1035	292
10	13963	10	278802341208958	-4449541671506560000	0	1343	292
10	13963	10	278802341309002	-4449541671506560000	0	1651	292
10	13963	10	278802341408935	4846661789333420000	0	1959	363
10	13963	10	278802341508966	-4449541671506560000	0	2338	292
10	13963	10	278802341608941	-4449541671506560000	0	2646	292
10	13963	10	278802341708937	-4449541671506560000	0	2954	292

Table continued …

BsmPIRelOffset	BsmPIIRelOffset	BsmPIIIRelOffset	GenTimeRelOffset	PsIdByte
69	109	109	218	32
140	180	180	289	32
69	109	109	218	32
69	109	109	218	32
69	109	109	218	32
69	109	109	218	32
140	180	180	289	32
69	109	109	218	32
69	109	109	218	32
69	109	109	218	32

Table 36 provides a few summary measures of the *BsmMD* file that was populated with data collected on November 1, 2012.

Table 36: Summary Measures for Data Elements of the BsmMD File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	90	10	2896	52, 83, 62, 11, 2133	4402115
FileId	531	13965	83928	45247, 22166, 21648, 48238, 24906	
TxDevice	312	-32438	32364	-31579, -15567, 9757, -30470, -18888	
GenTime	69010	278809095	278895493	278833433 278873173 278814106 278860048 278812391	
CertID	2133	-9220360569067272308	9211289221355773666	795103942098043545 4603058481584197546 -1749524897943679860 7304383493594146308 -232168673156436312	

TxRandom	783	-32659	32703	-9031, 30935, 12994, -11635, 26668	
FrameOffset	3034419	40	26784154	4661438, 1976180, 1993160, 897190	
FrameSize	266	193	505	230, 298, 366, 434, 481	
BsmPIRelOffset	16	50	141	50, 51, 52, 53, 67	
BsmPIIRelOffset	16	90	181	90, 91, 92, 93, 107	
BsmPIIIRelOffset	16	90	181	90, 91, 92, 93, 107	
GenTimeRelOffset	266	119	431	162, 251, 319, 387, 141	
PsIdByte	1	32	32	32	

5.4 BsmP1 File

The *BsmP1* file can be considered as the main BSM file. It contains BSM measures that change frequently, approximately 10 Hz. These measures mainly include motion (speed and acceleration) and location (longitude and latitude) elements. The *BsmP1* file contains both Part I and Part II elements of the BSM. The majority of the data elements in this file are defined in Part I of the BSM structure; however, elements such as PathCount, RadiusOfCurvature, and Confidence are defined in Part II of the BSM.

The *BsmP1* file primarily gets populated with data that is obtained through the vehicle's CAN bus and then transmitted via an onboard WSU. This file contains a field that communicates elapsed time, "Gentime"; it is important to note that the above discussion regarding BSM timestamps does apply to this measure.

In total there are 19 fields in the *BsmP1* file. A brief description of each is given in Table 37.

Table 37: Data Elements of the BsmP1 File

Field Name	Type	Units	EnumId	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
Gentime	Integer	milliseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
TxRandom	Integer	None		Randomly assigned ID to mask the device ID of the transmitting device for security purposes
MsgCount	Integer	None		Message ID that gets incremented by one with each BSM
DSecond	Integer	Deciseconds		Time in deciseconds since ignition started
Latitude	Float	Degrees		Current latitude of the vehicle
Longitude	Float	Degrees		Current longitude of the vehicle
Elevation	Float	Meters		Current elevation of vehicle according to GPS
Speed	Real	m/sec		Vehicle speed

Heading	Real	Degrees		Vehicle heading/direction
Ax	Real	m/sec^2		Longitudinal acceleration
Ay	Real	m/sec^2		Lateral acceleration
Az	Real	m/sec^2		"Vertical" acceleration
Yawrate	Real	Deg/sec		Vehicle yaw rate
PathCount	Integer	None		Number, between 1 and 23, representing a group of points that communicate a vehicle's position and motion. Each group of points is of non-uniform size.
RadiusOfCurve	Float	Centimeter		Estimate of the radius of a curve being negotiated, which is derived from a number of systems and sensors. Positive and negative values reflect right and left turns, respectively, and +/- 32767 for straight paths.
Confidence	Integer	Percent		Signals the accuracy and non-steady state and steady state of curvature estimate. In steady state (straight roadways or curves with constant radius of curvature), a high confidence value is reported.

Seeing that the *BsmP1* file does not contain any enumerated values, no such table will be presented here. Table 38 presents a 10-record sample of the contents of the *BsmP1* file.

Table 38: Sample Records for BsmP1 File

FileId	TxDevice	Gentime	TxRandom	MsgCount	DSecond	Latitude	Longitude	Elevation	Speed
13963	10	278802340808876	0	76	14700	42.29717	-83.7013	239.4	0.86
13963	10	278802340908860	0	77	14800	42.29717	-83.7013	239.4	0.72
13963	10	278802341008885	0	78	14900	42.29717	-83.7013	239.4	0.66
13963	10	278802341108882	0	79	15000	42.29717	-83.7013	239.4	0.52
13963	10	278802341208958	0	80	15100	42.29717	-83.7013	239.4	0.46
13963	10	278802341309002	0	81	15200	42.29718	-83.7013	239.3	0.38
13963	10	278802341408935	0	82	15300	42.29718	-83.7013	239.3	0.3
13963	10	278802341508966	0	83	15400	42.29718	-83.7013	239.3	0
13963	10	278802341608941	0	84	15500	42.29718	-83.7013	239.3	0.14
13963	10	278802341708937	0	85	15600	42.29718	-83.7013	239.3	0

Table continued …

Heading	Ax	Ay	Az	Yawrate	PathCount	RadiusOfCurve	Confidence
9.9375	-1.07	0.01	-10	-0.6	11	3276.7	100
9.9375	-1.15	0.01	-10	-1.1	11	3276.7	100
9.9375	-1.07	0.01	-10	-0.5	11	3276.7	100
9.9375	-1.07	0.01	-10	-0.5	11	3276.7	100
9.9375	-0.91	0.01	-10	-0.69	11	3276.7	100
9.9375	-0.68	0.01	-10	-0.3	11	3276.7	100
9.9375	-0.52	0.01	-10	-0.1	11	3276.7	100
9.9375	-0.45	0.01	-10	-0.3	11	3276.7	100
9.9375	-0.29	0.01	-10	0	11	3276.7	100
9.9375	-0.45	0.01	-10	-0.1	11	3276.7	100

Table 39 provides a few summary measures of the *BsmP1* file that was populated with data collected on November 1, 2012.

Table 39: Summary Measures for Data Elements of the BsmP1 File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	100	10	17103	47, 2170, 2740, 10, 2175	6208811
FileId	607	1	83928	14573, 38271, 53362, 30700, 52526	
TxDevice	322	-32438	32364	-14396, -12341, 47, 2170, 2740	
GenTime	77258	278809095	278895493	278867928 278826637 278889886 278821991 278814712	
TxRandom	1058	-32659	32703	0, 20252, 8722, 10709, -14715	
MsgCount	128	0	127	31, 26, 94, 99, 5	
DSecond	3256	0	65535	29999, 35526, 50800, 13700, 25230	
Latitude	381503	39.22074	90	42.3905, 41.22485, 42.29181, 42.60708, 42.20224	
Longitude	154894	-84.55163	180	-83.70036, -83.78992, -83.52829, -83.87242, -83.61079	
Elevation	2586	120.7	6144.1	256.5, 156.6, 328.8, 138.8, 228.9	
Speed	2245	0	163.82	1.14, 19.72, 24.68, 25.16, 32.88	
Heading	28801	0	360	351.225, 62.5, 179, 297.1625, 171.775	
Ax	1489	-20	20.01	0, -13.15, 4.66, 6.19, 1.45	
Ay	547	-9.89	20.01	-9.88, 1.11, -1.3, -3.22, 1.08	
Az	152	-10	1.54	-1.64, -1.9, -1.44, -2.32, -1.78	
Yawrate	23015	-327.67	327.67	0, 192.99, -30.07, -41.28, -22.99	
PathCount	24	0	23	0, 1, 2, 3, 4	
RadiusOfCurve	49872	-2499.9	3276.7	-1912.3, -1305, -33.8, 1521.3, 517.3	
Confidence	101	0	100	31, 52, 10, 89, 0	

5.5 BrakeByte1Events File

The *BrakeByte1Events* file is one of 19 files in the BSM data that has the same structure. These files log only the change of a particular data element. This is unlike the aforementioned files that are populated in a time history format. These 19 files end with "events" in their file names (see

Table 32 above). Some of these files contain BSM data elements that do not change frequently, such as a vehicle's front bumper height or length, while others are empty as they were not populated with their corresponding data element as they change even less frequently (e.g. vehicle type).

The *BrakeByte1Events* file communicates the states of half of the BSM's data elements that describe the overall brake system status of a vehicle. The brake system elements being presented in this file include the brake applied status, the availability of the wheel brakes, and the state of the traction control system. The *BrakeByte1Events* contain six fields, each of which is briefly described in Table 40.

Table 40: Data Elements of the BrakeByte1Events File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Details the current state of specific components of the brake system

Note, as mentioned in the BSM Dataset Timestamp section, StartTime and EndTime are, respectively, minimum and maximum values of Gentime—the time at which a vehicle measure changes.

To determine the meaning of the entries in the "Value" field of the *BrakeByte1Events* file, the entries have to first be converted into an 8-bitstring (00000000). This string will then be partitioned in accordance with the J2735 Standard to communicate the relevant information regarding the state of a vehicle's brake system.

From the J2735 Standard, the first 4 bits in the 8-bitstring (**0000**0000) indicate the brake being applied to a particular wheel of a vehicle. The first four bits communicate the *BrakeAppliedStatus*, the terminology used by the J2735 Standard. The bits are assigned wheels Left Front, Right Front, Left Rear, and Right Rear, respectively. If the brakes are applied on a particular wheel, the designated bit will change from 0 to 1. For vehicles with fewer than two front or rear wheels and those with more than two front or rear wheels, the following J2735 excerpt details how the *BrakeAppliedStatus* is communicated in the first four bits.

On a vehicle with only one front wheel, the brake-applied status is represented by the Left Front wheel indicator and the Right Front indicator is always set to zero. Similarly, on a vehicle with only one rear wheel the brake-applied status is represented by the Left Rear wheel indicator and the Right Rear indicator is always set to zero. If a vehicle has more than two front wheels (respectively more than two rear wheels) with independent braking, the collective brake-applied status of these wheels is mapped to the Left Front and Right Front (respectively Left Rear and Right Rear) indicators in a locally defined manner.

—Society of Automotive Engineers J2735 Standard, 2009

The fifth bit (0000**0**000) communicates the availability of brake information. When this bit is set to 1, it represents that data regarding the brake system is currently unavailable. The sixth bit (00000**0**00) is a reserved bit and is set to zero. The last two remaining bits (000000**00**) communicate the state of the traction control system (TCS). This information in turn informs others if one or more of a vehicle's drive wheels are slipping during acceleration and whether a vehicle is equipped with a traction control system. The four permutations of these two bits are as follows:

- 00 – TCS is unavailable – a vehicle is not equipped with TCS/TCS is unavailable
- 01 – TCS is off – TCS is available but in the off position
- 10 – TCS is on – TCS is on but not engaged
- 11 – TCS is engaged – TCS is on and engaged

As an example, if the entry in the "Value" field of the *BrakeByte1Events* file is 2, its 8-bitstring is 00000010. This means that brake is not being applied to any of the wheels of the vehicle (**0000**0010), data regarding the brake system is available (0000**0**010), and the TCS is on but not engaged (000000**10**). However, if the entry were 242, its 8-bitstring is 11110010. This string means that brake is being applied to all four wheels of the vehicle, data is available, and the TCS is on but not engaged.

Table 41 provides a 10-record sample from the *BrakeByte1Events* file.

Table 41: Sample Records for the BrakeByte1Events File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13963	10	278802340808876	278802342808914	242
10	13963	10	278802342908861	278802345408999	2
10	13963	10	278802345508924	278802346908867	242
10	13963	10	278802347008853	278802393409013	2
10	13963	10	278802393508969	278802408009037	242
10	13963	10	278802408109073	278802408109073	2
10	13963	10	278802408208995	278802408208995	242
10	13963	10	278802408308994	278802409908997	2
10	13963	10	278802410009005	278802445409010	242
10	13963	10	278802340808876	278802342808914	242

Table 42 provides a few summary measures of the *BrakeBytes1Events* file that was populated with data collected from November 1, 2012.

Table 42: Summary Measures for Data Elements of the BrakeByte1Events File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	100	10	17103	46, 17101, 1111, 2196, 2030	39321
FileId	607	1	83928	64600, 37756, 46, 47125, 24904	
TxDevice	322	-32438	32364	-3237, 46, 32014, 4460, -2479	
StartTime	23343	278809095	278895493	278878856 278850469 278864532 278819165 278822082	
Endtime	23411	278809103	278895650	278871938 278867610 278813232 278820892 278874855	
Value	10	0	243	0, 3, 241, 1, 242	

5.6 BrakeByte2Events File

The *BrakeByte2Events* file is another of 19 files in the BSM data that has the same structure. This file is similar to the *BrakeByte1Events* file as it too communicates the state of some of the component of the vehicle's brake system. The brake system components described in this file include the state of the antilock brakes, the state of the stability control system, the application of the brake boost, and the state of the auxiliary brake system. The six fields of the *BrakeByte2Events* file are briefly described in Table 43.

Table 43: Data Elements of the BrakeByte2Events Events File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Details the current state of specific components of the brake system

Similar to the *BrakeByte1Events* file, the meaning of an entry in the "Value" field is also based on the conversion of that entry into an 8-bit string. However, this 8-bit string communicates the state of four brake-related components of a vehicle—each using two bits to present the status of the each component. The first two bits in this string (**00**000000) pertain to the state of the vehicle's antilock brake system (ABS), and their permutation is as follows:

00 – ABS is unavailable – a vehicle is not equipped with ABS/ABS is unavailable

01	– ABS is off	–	ABS is available but in the off position
10	– ABS is on	–	ABS is on but not engaged
11	– ABS is engaged	–	ABS is on and engaged

The next two bits (00**<u>00</u>**0000) pertain to state of the vehicle's stability control unit (SCU), with the following permutations:

00	– SCU is unavailable	–	a vehicle is not equipped with a SCU/SCU is unavailable
01	– SCU is off	–	ABS is in the off position
10	– SCU is on	–	ABS is on or engaged

Bits five and six (0000**<u>00</u>**00) communicates whether *BrakeBoost* in being applied. *BrakeBoost* is a part of a system that detects the potential of a situation in which maximum brake power will be required and pre-charges the brake system even before the driver depresses the brake pedal. The application of the *BrakeBoost* indicates a situation that warrants emergency braking. Note, not all vehicles are equipped with *BrakeBoost* capability. The meaning associated with the permutations of the fifth and sixth bits are as follows:

00	– BB is unavailable	–	a vehicle is not equipped with a BB/BB is unavailable
01	– BB is off	–	BB is in the off position
10	– BB is on	–	BB is on/is being applied

The last two bits of the 8-bit string (000000**<u>00</u>**) for the *BrakeByteEvents* file present the state of the auxiliary brake system. The auxiliary brake system is often called the *parking brake*. The permutations of these two bits are presented below:

00	– AuxB is unavailable	–	vehicle is not equipped with AuxB/AuxB is unavailable
01	– AuxB is off	–	AuxB is in the off position
10	– AusB is on	–	AuxB is on/active
11	– BB is reserved		

As an example, if the entry in the "Value" field of the BrakeByte2Events file is 144, its 8-bit string is 10010000. This means that the vehicle's ABS is on but not engaged, the SCU is in the off position, and both the vehicle's brake boost and auxiliary brake are either not available and/or the vehicle is not equipped with these features.

Table 44 provides a 10-record sample from the *BrakeByte2Events* file.

Table 44: Sample Records for the BrakeByte2Events File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13963	10	278802340808876	278802520009075	144
10	13964	10	278803558516008	278804514215589	144
10	13965	10	278854062239425	278855117939037	144
10	13966	10	278870906321203	278871005121203	144
10	13967	10	278872010004714	278872100404846	144
11	14568	11	278799446199882	278800288900170	144
11	14569	11	278800952575137	278801225474269	144
11	14570	11	278870852228655	278871965128293	144
11	14571	11	278873307709346	278873906309349	144

Table 45 provides a few summary measures of the *BrakeBytes2Events* file that was populated with data collected on November 1, 2012.

Table 45: Summary Measures for Data Elements of the BrakeByte2Events File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	99	10	17103	46, 17101, 1111, 2196, 2030	783
FileId	598	1	83928	1, 3, 4, 32, 33	
TxDevice	321	-32438	32364	-1048,40,42,43,44	
StartTime	720	278809127	278895473	278809127 278809531 278809565 278809713 278809737	
Endtime	726	278809286	280509908	278809286 278809938 278809992 278810498 278810519	
Value	9	0	224	0, 192, 32, 144, 224	

5.7 ExteriorLightEvents File

The *ExteriorLightEvents* file communicates the state of all the vehicle's exterior lights. The structure of this file is similar to that of the 19 files in the BSM dataset whose titles end with "events." This file has six fields; each is presented with a brief description in Table 46.

Table 46: Data Elements of the ExteriorLightEvents File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Details the current state of specific components of the brake system

The "Value" field in this file relates the states of the nine exterior lights via an 8-bit string (converted into an integer). Table 101 presents these nine exterior light events and their 8-bit string representation.

Table 47: 8-Bit String Represent for the ExteriorLightEvents File

J2735 Exterior Light Terminology	Meaning	8-Bit String Representation	Decimal Representation
allLightsOff	All exterior lights are off	00000000	0
lowBeamHeadLightsOn	Low beam headlights are on	00000001	1
highBeamHeadLightsOn	High beam headlights are on	00000010	2
leftTurnSiganlOn	Left turn signal is on	00000100	4
righTurnSignalOn	Right turn signal is on	00001000	8
hazardSignalOn	Hazard signal is on	00001100	12
automaticLightControlOn	Lights are on due to automatic light control	00010000	16
daytimeRunningLightsOn	Day time running lights are on	00100000	32
fogLightOn	Fog lights are on	01000000	64
parkingLightsOn	Parking lights are on	10000000	128

If an entry in the "Value" field is not listed in the above table's "Decimal Representation," convert the entry to an 8-bit string and use Table 101 to decode the 8-bit string. For example, if 5 is an observed entry in the *ExteriorLightEvents* file, its 8-bit string representation is 00000101. Using Table 101, the observed entry means the low-beam headlights are on in addition to the left turn signal.

Table 48 provides a nine-record sample from the *ExteriorLightEvents* file.

Table 48: Sample Records for the ExteriorLightEvents File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
40	29940	40	278857974767108	278857974767108	0
40	29940	40	278858005867415	278858005867415	8
40	29942	40	278859611925347	278860354738625	1
42	30702	42	278879388463735	278879520336919	0
43	31324	43	278803586567422	278804702215551	0
43	31325	43	278854793993369	278854793993369	1
44	31777	44	278800446845062	278800446845062	8
44	31780	44	278851760521604	278851761021581	1

Table 49 provides a few summary measures of the *ExteriorLightEvents* file that was populated with data collected from November 1, 2012.

Table 49: Summary Measures for Data Elements of the ExteriorLightEvents File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	67	40	17103	46, 17101, 1111, 2196, 2030	1515
FileId	388	1	83928	64600, 37756, 46, 47125, 24904	
TxDevice	289	-32438	32364	-3237, 46, 32014, 4460, -2479	
StartTime	1413	278809127	278895389	278809127 278809164 278809187 278809269 278809277	
Endtime	1421	278809164	280509908	278809164 278809187 278809269 278809277 278809286	
Value	8	0	11	0, 11, 3, 5, 9	

5.8 PosAccurByte1Events File

The PosAccurByte1Events is one of four files that consist of various parameters of quality used to model the accuracy of the positional determination with respect to each given axis. The *PosAccurByte1Events* file communicates a quality measure, reflecting the accuracy of a vehicle's estimated position with respect to the semi-major axis. This accuracy measure aims to reflect the error of a vehicle's position within one standard deviation, 0–12.7m, of the vehicle's true position, and with the least significant bit being equivalent to 0.05m. The structure of this file is also similar to that of the 19 files in the BSM dataset whose titles end with "events." This file has six fields; each is presented in Table 50 with a brief description.

Table 50: Data Elements of the PosAccurByte1Events File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Quality measure, reflecting the positional accuracy with respect to the semi-major axis

The "Value" field in this file relates the aforementioned quality measure of a vehicle position relative to the semi-major axis. The maximum value that entries in the "Value" field can take on is 255. This value represents the unavailability of a measure for the semi-major axis, and therefore an accuracy measure is not able to be obtained for that entry. A value of 254 reflects

that the associated accuracy of the estimate of a vehicle's position is equal to or greater than 12.70m. All other values less than 254 represent the accuracy/proximity, between 0m and 12.65m. The vehicle's estimated position is with respect to its actual position.

Table 51 provides a 10-record sample from the *PosAccurByte1Events* file.

Table 51: Sample Records for the PosAccurByte1Events File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13963	10	278802340808876	278802520009075	255
10	13964	10	278803558516008	278804514215589	255
10	13965	10	278854062239425	278855117939037	255
10	13966	10	278870906321203	278871005121203	255
10	13967	10	278872010004714	278872100404846	255
11	14568	11	278799446199882	278800288900170	255
11	14569	11	278800952575137	278801225474269	255
11	14570	11	278870852228655	278871965128293	255
11	14571	11	278873307709346	278873906309349	255
11	14572	11	278877489317501	278878647117698	255

Table 52 provides a few summary measures of the *PosAccurByte1Events* file that was populated with data collected from November 1, 2012.

Table 52: Summary Measures for Data Element of the PosAccurByte1Events File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	99	10	17103	46, 17101, 1111, 75, 2196	763
FileId	598	1	83928	1, 3, 4, 32, 33	
TxDevice	321	-32438	32364	-1408, 10, 11, 12, 13	
StartTime	708	278809127	278895473	278809127, 278809731, 278809565, 278809713, 278809737	
Endtime	710	278809286	280509908	278809286, 278809938, 278809992, 278810498, 278810519	
Value	1	255	255	255	

5.9 PosAccurByte2Events File

The PosAccurByte2Events is one of four files that consist of various parameters of quality used to model the accuracy of the positional determination with respect to each given axis. The *PosAccurByte2Events* file is very similar to *PosAccurByte1Events*. The difference between these two files is that the former communicates a quality measure, reflecting the accuracy of a vehicle's estimated position with respect to the semi-minor axis, rather than the semi-major axis. As with the *PosAccurByte1Events* file, this accuracy measure aims to reflect the error of a vehicle's position within one standard deviation, 0m–12.7m, of the vehicle's true position. This file consists of six fields, and their names and descriptions are presented in Table 53.

Table 53: Data Elements of the PosAccurByte2Events File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Quality measure, reflecting the positional accuracy with respect to the semi-minor axis

The "Value" field in this file relates the aforementioned quality measure of a vehicle position relative to the semi-minor axis. The maximum value that entries in the "Value" field can take on is 255. This value represents the unavailability of a measure for the semi-minor axis, and therefore an accuracy measure is not able to be obtained for that entry. A value of 254 reflects that the associated accuracy of the estimate of a vehicle's position is equal to or greater than 12.70m. All other values less than 254 represent the accuracy/proximity, between 0m and 12.65m. The vehicle's estimated position is with respect to its actual position.

Table 54 provides a 10-record sample from the *PosAccurByte2Events* file.

Table 54: Sample Records for the PosAccurByte2Events File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13963	10	278802340808876	278802520009075	255
10	13964	10	278803558516008	278804514215589	255
10	13965	10	278854062239425	278855117939037	255
10	13966	10	278870906321203	278871005121203	255
10	13967	10	278872010004714	278872100404846	255
11	14568	11	278799446199882	278800288900170	255
11	14569	11	278800952575137	278801225474269	255
11	14570	11	278870852228655	278871965128293	255
11	14571	11	278873307709346	278873906309349	255

11	14572	11	278877489317501	278878647117698	255

Table 55 provides a few summary measures of the *PosAccurByte2Events* file that was populated with data collected on November 1, 2012.

Table 55: Summary Measures for Data Elements of the PosAccurByte2Events File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	99	10	17103	46, 17101, 1111, 75, 2196	763
FileId	598	1	83928	1, 3, 4, 32, 33	
TxDevice	321	-32438	32364	-1408, 10, 11, 12, 13	
StartTime	708	278809127	278895473	278809127, 278809731, 278809565, 278809713, 278809737	
Endtime	710	278809286	280509908	278809286, 278809938, 278809992, 278810498, 278810519	
Value	1	255	255	255	

5.10 PosAccurByte3Events File

The PosAccurByte3Events is one of four files that consist of various parameters of quality used to model the accuracy of the positional determination with respect to each given axis. The *PosAccurByte3Events* file communicates the orientation of semi-major axis relative to true north (0~359.9945078786 degrees). To get a sense of the orientation of the semi-major axis, an entry from this file's "Value" Column is combined with a similar entry from the "Value" column from the *PosAccurByte4Events* file. The values from these two files are combined using the formula below to give axis orientation:

*AxisOrientation = ((...Byte3Value*256) + ...Byte4Value)*0.0054932479*

The structure of this file is also similar to that of the 19 files in the BSM dataset whose title end with "events." This has six fields; each is presented in Table 56with a brief description.

Table 56: Data Elements of the PosAccurByte3Events File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Orientation measure of semi-major axis relative to true north

The "Value" field in this file relates the aforementioned values to be used to determine semi-major axis orientation.

Note: Least significant bit (LSB) units = 0. 0054932479 and
0 = 0 degrees
1 = 0. 0054932479 degrees
65534 = 359.9945078786 degrees
65535 = orientation unavailable

Therefore, the maximum value that entries in the "Value" field can take on is 65535. This value represents the unavailability of a measure for the orientation of the semi-major axis.

Table 57 provides a 10-record sample from the *PosAccurByte1Events* file.

Table 57: Sample Records for the PosAccurByte3Events File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13965	10	278854062239425	278855117939037	255
10	13966	10	278870906321203	278871005121203	255
10	13967	10	278872010004714	278872100404846	255
10	13968	10	278892652834177	278893745083482	255
10	13969	10	278894110846835	278894294046104	255
11	14570	11	278870852228655	278871965128293	255
11	14571	11	278873307709346	278873906309349	255
11	14572	11	278877489317501	278878647117698	255
11	14573	11	278894637641410	278895427341752	255
12	19024	12	278809748617439	278810027316786	255

Table 58 provides a few summary measures of the *PosAccurByte1Events* file that was populated with data collected on November 1, 2012.

Table 58: Summary Measures for Data Elements of the PosAccurByte3Events File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	99	10	17103	46, 17101, 1111, 75, 2196	763
FileId	598	1	83928	1, 3, 4, 32, 33	
TxDevice	321	-32438	32364	-1408, 10, 11, 12, 13	
StartTime	708	278809127	278895473	278809127, 278809731, 278809565, 278809713, 278809737	
Endtime	710	278809286	280509908	278809286, 278809938, 278809992, 278810498, 278810519	
Value	1	255	255	255	

5.11 PosAccurByte4Events File

The PosAccurByte4Events is one of four files that consist of various parameters of quality used to model the accuracy of the positional determination with respect to each given axis. The *PosAccurByte3Events* file communicates the orientation of semi-major axis relative to true north (0~359.9945078786 degrees). To get a sense of the orientation of the semi-major axis, an entry from this file's "Value" Column is combined with a similar entry from the "Value" column from the *PosAccurByte3Events* file. The values from these two files are combined using the formula below to give axis orientation:

*AxisOrientation = ((...Byte3Value*256) + ...Byte4Value)*0.0054932479*

The structure of this file is also similar to that of the 19 files in the BSM dataset whose title end with "events." This file has six fields; each is presented in Table 59 with a brief description.

Table 59: Data Elements of the PosAccurByte4Events File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Orientation measure of semi-major axis relative to true north

The "Value" field in this file relates the aforementioned values to be used to determine semi-major axis orientation.

Note: Least significant bit (LSB) units = 0. 0054932479 and
0 = 0 degrees
1 = 0. 0054932479 degrees
65534 = 359.9945078786 degrees
65535 = orientation unavailable

Therefore, the maximum value that entries in the "Value" field can take on is 65535. This value represents the unavailability of a measure for the orientation of the semi-major axis.

Table 60 provides a 10-record sample from the *PosAccurByte4Events* file.

Table 60: Sample Records for the PosAccurByte4Events File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13965	10	278854062239425	278855117939037	255
10	13966	10	278870906321203	278871005121203	255
10	13967	10	278872010004714	278872100404846	255
10	13968	10	278892652834177	278893745083482	255
10	13969	10	278894110846835	278894294046104	255
11	14570	11	278870852228655	278871965128293	255
11	14571	11	278873307709346	278873906309349	255
11	14572	11	278877489317501	278878647117698	255
11	14573	11	278894637641410	278895427341752	255
12	19024	12	278809748617439	278810027316786	255

Table 61 provides a few summary measures of the *PosAccurByte1Events* file that was populated with data collected on November 1, 2012.

Table 61: Summary Measures for Data Elements of the PosAccurByte4Events File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	99	10	17103	46, 17101, 1111, 75, 2196	763
FileId	598	1	83928	1, 3, 4, 32, 33	
TxDevice	321	-32438	32364	-1408, 10, 11, 12, 13	
StartTime	708	278809127	278895473	278809127, 278809731, 278809565, 278809713, 278809737	
Endtime	710	278809286	280509908	278809286, 278809938, 278809992, 278810498, 278810519	
Value	1	255	255	255	

5.12 SteerAngleEvents File

The *SteerAngleEvents* is another of 19 files in the BSM data that has the same structure. The file however communicates the angle of the steering wheel, expressed in a signed (to the right being positive) value with units of 1.5. This file consists of six fields; their names and descriptions are presented in Table 62.

Table 62: Data Elements of the SteerAngleEvents File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	Microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Value to be converted to degrees to communicate steer angle

The "Value" field in this file captures a vehicle's steering wheel angle. However these values have to be converted before the steering wheel angle can be determined. The LSB units = 1.5 degrees and entries in this field have a range of -126 to +127, which facilitates steering angles between -/+189 degrees and a value signifying that the steering angle is unavailable. For example:

0 = +1.5 degrees
-126 = -189 degrees and beyond
+126 = +189 degrees and beyond
+127 = unavailable steering angle

More generally, for values between 0 and 126 you simply multiply by 1.5 degrees. However for value between 129 and 255, maskoff the highest bit (which is being used as a sign bit) by doing a bitwise AND with a value of 127. Then swap the remaining bit values by doing a bitwise exclusive OR with a value of 127 and then multiply by -1.5. Table 63 provides a 10-record sample from the *SteerAngleEvents* file.

Table 63: Sample Records for the SteerAngleEvents File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13969	10	278894114346925	278894114546893	2
10	13969	10	278894114646943	278894114746870	3
10	13969	10	278894114846848	278894114846848	4
10	13969	10	278894114946836	278894115746864	5
10	13969	10	278894115846910	278894115846910	3
10	13969	10	278894115946834	278894115946834	0
10	13969	10	278894116046815	278894116046815	251
10	13969	10	278894116146874	278894116146874	243
10	13969	10	278894116246976	278894116246976	234
10	13969	10	278894116346968	278894116346968	225

Table 64 provides a few summary measures of the *SteerAngleEvents* file that was populated with data collected from November 1, 2012.

Table 64: Summary Measures for Data Elements of the SteerAngleEvents File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	100	10	17103	46, 17101, 1111, 75, 2196	398026
FileId	600	1	83928	64600, 32678, 37756, 46, 21649	
TxDevice	322	-32438	32364	-3237, 46, 32014, 4460, -2479	
StartTime	52712	278809099	278895493	278821468 278879330 278828607 278889958 278819115	
Endtime	52772	278809100	280509908	278816509 278884429 278869725 278875916 278812974	
Value	254	0	255	0, 238, 23, 215, 46	

5.13 ThrottlePositionEvents File

The *ThrottlePositionEvents* file presents the relative position of the throttle over a given trip. Throttle position is measured in percent, communicating the displacement of the throttle from its default position to it maximum displacement during a particular trip. This file has six fields; their names and meaning are presented in Table 65.

Table 65: Data Elements of the ThrottlePositionEvents File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None		Details the relative position of the throttle over a given trip

The LSB units = 0.5, therefore the entries for the "Value" ought to range from 0 to 200, and to get the relative throttle position, multiple each entry by 0.5. However, in exploring of the data, the values only range for 0 to 100. This signifies that the devices that capture the measure, already took into account the 0.5 factor. Table 66 provides a 10-record sample from the *ThrottlePositionEvents* file.

Table 66: Sample Records for the ThrottlePositionEvents File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
60	37756	60	278820631933209	278820632033193	24
60	37756	60	278820632133238	278820632133238	23
60	37756	60	278820632233308	278820633133245	22
60	37756	60	278820633233312	278820633533266	20
60	37756	60	278820633633260	278820633633260	19
60	37756	60	278820633733234	278820633733234	17
60	37756	60	278820633833217	278820635233306	16
60	37756	60	278820635333289	278820635333289	14
60	37756	60	278820635433285	278820635433285	10
60	37756	60	278820635533258	278820635533258	2

Table 67 provides a few summary measures of the *ThrottlePositionEvents* file that was populated with data collected from November 1, 2012.

Table 67: Summary Measures for Data Elements of the ThrottlePositionEvents File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	67	40	17103	46, 17101, 1111, 2030, 2196	64845
FileId	389	1	83928	64600, 47125, 37756, 46, 161	
TxDevice	289	-32438	32364	-3237, 46, 32014, 4460, -2479	
StartTime	18465	278809115	278895425	278884429, 278810675, 278864532, 278872256, 278850469	
Endtime	18456	278809115	280509908	278884429 278810675 278858959 278864532 278878856	
Value	91	0	100	0,23, 46, 69, 29	

5.14 TransStateEvents File

The *TransStateEvents* file provides the current state of the vehicle's transmission. Similar to the previously presented files ending with "…events," this file has the same structure with the same six fields. The only difference occurs as the meaning of the entries in the "Value" field. Table 68presents the names and meaning of each of the fields.

Table 68: Data Elements of the TransStateEvents File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None	2	Details the current state of specific components of the transmission

Currently, there are eight values assigned to communicate the state of a vehicle's transmission. However, three of these values are reserved for future assignments. Table 69 presents these values and their associated meaning.

Table 69: Enumeration Table for TransStateEvents File

Data Element	EnumId	Value	Name	Description
TransState	2	0	Neutral	Transmission is in the neutral position
		1	Park	Transmission is in the park position
		2	Forward	Transmission has engaged one of its forward gears
		3	Reverse	Transmission has engaged one of its reverse gears
		4	Reserved1	Reserved for future use
		5	Reserved1	Reserved for future use
		6	Reserved1	Reserved for future use
		7	Unavailable	Unavailable value or not equipped with a transmission

Table 70 presents a 10-record sample of the *TransStateEvents* file.

Table 70: Sample Records for TransStateEvents File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
10	13965	10	278854062239425	278854144339437	1
10	13965	10	278854144439436	278854144439436	2
10	13965	10	278854144539436	278854153039506	3
10	13965	10	278854153139456	278855104639016	2
10	13965	10	278855104739046	278855104739046	3
10	13965	10	278855104839016	278855104839016	2
10	13965	10	278855104939016	278855108939022	3
10	13965	10	278855109039022	278855109039022	2
10	13965	10	278855109139022	278855109139022	0
10	13965	10	278855109239058	278855113739063	2

Table 71 provides a few summary measures of the *TransStateEvents* file that was populated with data collected from November 1, 2012.

Table 71: Summary Measures for Data Element of the TransStateEvents File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	100	10	17103	46, 17101, 1111, 75, 2196	2405
FileId	600	1	83928	64600, 32678, 37756, 46, 21649	
TxDevice	322	-32438	32364	-3237, 46, 32014, 4460, -2479	
StartTime	1576	278809127	278895473	278809127, 278809271, 278809272, 278809274, 278809281	
Endtime	1561	278809271	280509908	278809271, 278809272, 278809992, 278809274, 278809281	
Value	5	0	7	0, 3, 7, 1, 2	

5.15 WiperStatusFrontEvents File

The contents of the *WiperStatusFrontEvents* file is intended to communicate whether it is raining or snowing at the vehicle's current location and how hard it is raining it is raining or snowing. If the wipers are in the "On" position, it serves as a proxy for whether or not it is raining or snowing. The wipers' "swipes per minute" also serves as a proxy for how hard it is raining or snowing. Similar to the previously presented files, ending with "…events," this file has the same structure with the same six fields and the only difference being the meaning of the entries in the "Value" field. Table 72 presents the names and meaning of each of the fields.

Table 72: Data Elements of the WiperStatusFrontEvents File

Field Name	Type	Units	EnumID	Description
RxDevice	Integer	None		ID (number) of the device that logs a BSM
FileID	Integer	None		Reference number to locate the source of the data in its original file
TxDevice	Integer	None		ID (number) of the device that transmits a BSM
StatTime	Integer	Microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
EndTime	Integer	Microseconds		A more secure form of Epoch time, which is influenced by 1609.2 of the IEEE 1609 family of standards-related network management and security
Value	Integer	None	3	Details the current state of vehicle's front wipers

Currently, there are seven values assigned to communicate the state of a vehicle's front wipers. Table 73 presents these values and their associated meaning.

Table 73: Enumeration Table for WiperStatusFrontEvents File

Data Element	EnumId	StyleName	Value	Name	Description
WiperStatusFront	3		0	Unavailable	The status of the vehicle wiper is unavailable or the vehicle is not equipped with the wiper sensor status.
			1	Off	Front wipers are not activated
			2	Intermittent	Front wipers are operated at an intermittent frequency
			3	Low	Front wipers are operated at a low frequency
			4	High	Front wipers are operated at a high frequency
			126	Washer in use	Wipers are active due to the use of the washer fluid
			127	AutomaticPresent	The wipers have the ability to be automatically turned on

Table 74 presents a 10-record sample of the *WiperStatusFrontEvents* file.

Table 74: Sample Records for WiperStatusFrontEvents File

RxDevice	FileId	TxDevice	StartTime	Endtime	Value
40	29940	40	278857974767108	278858005867415	1
40	29942	40	278859611925347	278860354738625	1
42	30702	42	278879388463735	278879520336919	1
43	31325	43	278854793993369	278854793993369	1
44	31780	44	278851760521604	278851761021581	1
44	31782	44	278891818788784	278891818987946	1
46	32676	46	278853353372476	278853367472437	1
60	37756	60	278820631933209	278821026336242	1
60	37757	60	278821840332029	278822201434111	1
60	37758	60	278855422332110	278856316838843	1

Table 75 provides a few summary measures of the *WiperStatusFrontEvents* file that was populated with data collected on November 1, 2012.

Table 75: Summary Measures for Data Elements of the WiperStatusFrontEvents File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
RxDevice	67	40	17103	40, 42, 43, 44, 46	566
FileId	388	1	83928	1, 3, 4, 32, 33	
TxDevice	289	-32438	32364	-1048,40,42,43,44	
StartTime	512	278809127	278895366	278809127, 278809737, 278809966, 278810233, 278810236	
Endtime	513	278809286	280509908	278809286, 278809938, 278810458, 278810498, 278810519	
Value	4	0	3	0, 1, 2, 3	

5.16 BSM Trip Summary File

The BSM Trip Summary is similar to both summary files for the DAS1 and DAS2 datasets. As a result of this similarity the tables below are the same as those presented in the section detailing the DAS1 Trip Summary File. The BSM Trip Summary file contains trip-level summaries, from each instrument vehicle, for each trip taken during the selected time period of the Model Deployment. The trip summaries include details such as trip start and end times, and total trip distance. Also captured in the trip summary file is the distance driven while the vehicle speed was greater than 25 mph. This data element is of interest not only because it further details the trip, but also because it provides a sense of the conditions under which data, for a particular trip, were collected. The Summary file contains 13 fields; below is a list of these fields and a brief description of each.

Table 76: Data Elements of the Summary Table

Field Name	Type	Units	EnumId	Description
DeviceID	Integer	None	-	This field contains the unique, numeric ID assigned to each DAS. This ID also doubles as a vehicle's ID
TripID	String	None	-	This field contains a count of ignition cycles—each ignition cycle commences when the ignition is in the on position and ends when it is in the off position
Epoch Start Time	Integer	seconds	-	This field contains the epoch start time stamp, in seconds, of a trip. Epoch time, which is sometimes referred to as Unix time, is the number of seconds that has elapsed since midnight January 1, 1970
Start Date	Date	date	-	The m/d/yyyy on which the trips started
Start Time	Time	time	-	This field contains the wall clock time stamp of the start of a trip, in the form of hh:mm:sss
Epoch End Time	Integer	seconds	-	This field contains the epoch end time stamp, in seconds, of a trip. Epoch time, which is sometimes referred to as Unix time, is the number of seconds that has elapsed since midnight January 1, 1970
End Date	Date	date	-	The m/d/yyyy on which the trips ended
End Time	Time	Time	-	This field contains the wall clock time stamp of the end of a trip, in the form of hh:mm:sss
Total Trip Distance	Integer	m	-	This field contains the total distance traveled, in miles, covered in a trip
Distance Travelled w/ Speed >= 25mph	Real	m	-	This field contains the distance traveled in a trip but only when the vehicle's speed is greater than or equal to 25 mph.
Trip Duration	Real	m	-	This field contains the total time duration, in seconds, of a trip. 999999 – data unavailable
Average Speed	Real	m/s	-	This field communicates a vehicle's average speed over the entire length of the trip. 999999 – data unavailable
Maximum Speed	Real	m/s	-	This field contains the maximum speed reached during a trip

Table 77 provides a 10-record sample from the *Summary* file.

Table 77: Sample Records for Summary File

DeviceID	TripID	Epoch Start Time	Start Date	Start Time	Epoch End Time	End Date	End Time	Total Trip Distance	Distance Travelled w/ Speed >= 25mph
10106	297	1365680194	4/11/2013	7:27:49	1365680194	4/11/2013	7:36:33	5.124307	4.393447
10106	300	1365712962	4/11/2013	16:33:57	1365712962	4/11/2013	16:42:41	5.837012	4.617299
10116	716	1365685699	4/11/2013	8:57:23	1365685699	4/11/2013	9:08:18	12.994089	12.197617
10116	718	1365698544	4/11/2013	12:40:12	1365698544	4/11/2013	12:42:23	6.432951	6.432951
10116	719	1365703393	4/11/2013	14:01:02	1365703393	4/11/2013	14:03:13	0.647246	0.603726
10116	720	1365735768	4/11/2013	22:51:52	1365735768	4/11/2013	23:02:48	10.487535	9.914046
10118	771	1365682553	4/11/2013	8:00:35	1365682553	4/11/2013	8:15:52	7.422556	6.164827
10118	772	1365706146	4/11/2013	14:44:43	1365706146	4/11/2013	14:49:05	3.312033	2.608147
10118	773	1365714403	4/11/2013	17:00:10	1365714403	4/11/2013	17:06:43	3.980565	3.355532
10120	671	1365681111	4/11/2013	7:32:11	1365681111	4/11/2013	7:51:51	26.373104	24.054027

Table continued …

Trip Duration	Average Speed	Maximum Speed
524.288	35.185822	17.785469
524.288	40.079584	20.322571
655.36	71.378664	34.94302
131.072	176.686287	32.364101
131.072	17.777129	19.83666
655.36	57.609751	22.45439
917.504	29.123799	20.85228
262.144	45.483846	20.987221
393.216	36.443159	20.735519
1179.648	80.484327	35.382179

Table 78 provides a few summary measures of the *Summary* file from April 11, 2013.

Table 78: Summary Measures for Data Elements of the Summary File

Field Name	No. of Unique Values	Sample Values	Min. Value	Max. Value	No. of Rows
DeviceID		10204, 10205, 10207, 13000, 17101	10106	17103	278
TripID		41, 71-A, 50, 167, 87	24	2271	
Epoch Start Time	Continuous	1365711651, 1365712175, 1365679407, 1365679669, 1365680980	1365652800	1365652800	
Start Date	1	4/11/2013	4/11/2013	4/11/2013	
Start Time		6:52:52, 11:34:40, 13:04:14, 17:48:13, 18:27:32	0:02:10	23:59:59	
Epoch End Time	Continuous	1365737341, 1365684781, 1365693170, 1365703655, 1365706801	1365739199	1365739199	
End Date	1	4/11/2013	4/11/2013	4/11/2013	
End Time		12:40:12, 6:20:06, 11:19:22, 13:34:49, 16:38:19	0:02:10	23:59:59	
Total Trip Distance	Continuous	26.816043, 29.563191, 8.294983, 11.286039, 1.165109	0.014572	339.5202	
Distance Travelled w/ Speed >= 25mph	Continuous	28.814616, 22.377494, 1.025562, 8.281198, 7.480304	0	333.0411	
Trip Duration	Continuous	917.504, 786.432, 131.072, 393.216, 393.216	131.072	999999	
Average Speed	Continuous	0, 1352.01794433594, 3653.50708007812, 4117.85302734375, 4156.54296875	0.005718	999999	
Maximum Speed	Continuous	0, 3.57740211486816, 723.406127929688, 3300.6240234375, 3698.57104492188	1.538876	42.25568	

6 ROADSIDE EQUIPMENT DATASET

The RSE dataset includes 13 files, which are listed and briefly described in Table 79.

Table 79: Description of the File Contained in the Roadside Equipment Dataset

File Number	File	Description	Sample Rate
1	BSM	BSM data including motion and location elements	10 Hz
2	Geometry	Describes intersection detail at locations where RSE were placed	N/A
3	Lane	Describes lane attributes in the vicinity of the RSE, which is often located at an intersection with multiple (lane) approaches	N/A
4	LaneNode	Describes lane descriptors as they relate to nodes (ground reference points), usually near an intersection	N/A
5	Map	Wrapper object for map data. Includes complex intersection descriptions, high speed curve outlines, and segments of roadway. Sometimes referred to as the GID layer	N/A
6	Packet	Provides details for every packet transmission. Packet includes fileIDs, sources, and time stamps	10 Hz
7	PCAP	Describes packet capture header information and specifies listening setup used to capture all vehicle to vehicle communications	10 Hz
8	SPAT	Contains basics of a SPAT message including intersection details	10 Hz
9	SPATMovement	Describes signal and timing information for movements at intersections	10 Hz
10	TIM	Contains Traveler Information Message information which transmits advisory and road sign messages to vehicles	10 Hz
11	TIMRegion	Specifies types of regions to which TIMs apply	N/A
12	TIMRegionNode	Specifies types of regions to which TIMs apply in terms of offsets from a give node	N/A
13	TIMRegionXRef	Maps TIMs to the regions in which messages are applicable	N/A
14	WeatherData	Specifies surface weather data at stations of interest	Varies

6.1 BSM File

The BSM file is populated with basic safety messages received from equipped vehicle within the communication range of an RSE. These basic safety messages do not only contain both Part I and Part II elements. These BSMs also contains elements that communicate additional details about the vehicle that is used for vehicle safety applications, and elements that communicate specific items of a vehicle‘s status that are used in data event snapshots which are gathered and periodically reported to an RSEs or as part of the BSM Part II content.

These BSMs are transmitted at a rate of 10 Hz. Some of the more pertinent data contained in these BSMs include motion (speed and acceleration) and location (longitude and latitude)

elements. The RSEs BSM file primarily gets populated with data that is obtained through the vehicle's CAN bus and then transmitted via an onboard WSU.

In total there are 28 fields in the RSE's BSM file. A brief description of each is given below. For a more detailed description of each field / attribute consult the J2735 Standard.

Table 80: Data Elements of the BSM File

Field Name	Type	Units	EnumId	Description
BSMID	Integer	None		ID (number) of message transmitted from equipped vehicle
DSRCMsgId	Integer	None	1	Details the type of message that follows
MsgCount	Integer	None		Sequence number within stream of messages with the same DSRCMsgId and from the same sender
TemporaryID	Integer	None		4 byte random device identifier. Changes periodically to ensure anonymity of vehicle
DSeconds	Integer	Milliseconds		Time in milliseconds (up to a minute). Range is 0 – 60999
Latitude	Integer	1/10th integer microdegrees		32 bit value of current latitude of the vehicle with reference to horizontal datum in use. 90000001 is used when unavailable
Longitude	Integer	1/10th integer microdegrees		32 bit value of current longitude of the vehicle with reference to horizontal datum in use. 180000001 is used when unavailable
Elevation	Integer	1/10th integer meters		Current elevation of vehicle above or below reference ellipsoid (typically WSG-84). Range is 0 to 61439 (6143.9 m) and -4095 to -1
PositionalAccuracy	Hexadecimal	None		Data indicating accuracy of positional determination of vehicle with respect to each given axis. Full explanation follows table
TransmissionState	Integer	None	2	Vehicle transmission state
Speed	Integer	0.02 m/sec		Vehicle speed in 0.02 m/sec unsigned units. 8191 indicates speed is unavailable
Heading	Integer	0.0125 degree units		Vehicle heading/direction in 0.0125 degree units from North (e.g 28799 units = 359.9875 deg). North is defined as the axis from WSG-84 coordinate system and its reference ellipsoid. Headings east are positive. 28800 used when unavailable. Heading data sent by a vehicle indicates the orientation of the front of the vehicle
SteeringWheelAngle	Integer	1.5 degree units		Steering wheel angle in 1.5 degree units. Right is positive.
LongitudinalAcceleration	Integer	0.01 m/sec^2		Longitudinal acceleration (along x axis or parallel to the vehicle's direction of travel with a front to rear centerline) in 0.01 m/sec^2 units. Negative values indicate braking. Permitted range is over 2Gs.
LateralAcceleration	Integer	0.01 m/sec^2		Lateral acceleration (along y axis or perpendicular to the vehicle's direction of travel with a left to right centerline) in 0.01 m/sec^2 units. Negative values indicate braking. Permitted range is over 2Gs
VerticalAcceleration	Integer	0.02 G		Vertical acceleration (along vertical axis) in 0.02 G units. Permitted range is -3.4 – 1.54 G
YawRate	Integer	0.01 deg/sec		Vehicle yaw rate in 0.01 deg/sec units. Yaw to the right is positive.
BrakeAppliedStatus	Hexadecimal	None		Indicates whether brakes are being applied to any of the four wheels. Full explanation follows table
wheelBrakesUnavailable	Integer	None	3	Communicates availability of brake system data
TractionControlState	Hexadecimal	None	4	Indicates whether or not vehicle has a traction control system and whether or not one or more wheels are slipping during acceleration. Hex string is converted to binary bits to extract values
AntilockBrakeStatus	Hexadecimal	None	5	Communicates state of vehicle's anti-lock braking system. Hex string is converted to binary bits to extract values
StabilityControlStatus	Hexadecimal	None	6	Communicates state of vehicle's stability control status. Hex string is converted to binary bits to extract values
BreakBoostApplied	Hexadecimal	None	7	Emergency braking indicator communicating state of vehicle's brake boost system (which may pre-charge the brake system before driver presses brake pedal). Hex string is converted to binary bits to extract values
AuxiliaryBrakeStatus	Hexadecimal	None	8	Communicates state of vehicle's auxiliary brake system (i.e. parking brake). Hex string is converted to binary bits to extract values

To extract the data from the PositionalAccuracy field in Table 80, the hexadecimal string may be divided into four octets (0xB4 0xB3 0xB2 0xB1). Each octet should be converted to decimal to obtain its value. Byte 1, converted to decimal denotes the semi-major accuracy at one standard deviation in 0.05 m units. For example, 0xA1 is 161 in decimal and denotes an accuracy of 8.05 m. The permitted range is 0-12.7 meters. A hex value of 0xFE = 254 denotes any value equal to or greater than 12.7 m while a hex value of 0xFF = 255 indicates an unavailable semi-major value. Byte 2 denotes the semi-minor accuracy at one standard deviation and is mapped in the same way as byte 1. Bytes 3 and 4 are read together and, converted to decimal, represent the orientation of the semi-major axis relative to true north in 360/65535 deg = 0.0054932479 deg units. For example, a hex string of 0xC57A is 50554 in decimal and denotes an orientation of 277.7057 deg. The maximum orientation permitted is 0xFFFE = 65534. A hex value of 0xFFFF = 65535 is used for unavailable orientations.

Table 80 contains a number of enumerated elements whose values are associated with different meanings. Table 81 presents each of these data elements and their various enumerations.

Table 81: Enumeration Table for BSM File

Data Element	EnumId	Value	Name	Description
DSRCMsgId	1	0	Reserved	Reserved for future use
		1	A La Carte Message (ACM)	
		2	Basic Safety Message (BSM)	Heartbeat message
		3	Basic Safety Message Verbose	Message used only for testing
		4	Common Safety Request (CSR)	
		5	Emergency Vehicle Alert (EVA)	
		6	Intersection Collision Alert (ICA)	
		7	Map Data (MAP)	For GID and intersections
		8	nmea Corrections (NMEA)	
		9	probe Data Management (PDM)	
		10	probe Vehicle Data (PVD)	
		11	Roadside Alert (RSA)	
		12	rtcm Corrections (RTCM)	
		13	Signal Phase and Timing Message (SPAT)	
		14	Signal Request Message (SRM)	
		15	Signal Status Message (SSM)	
		16	Traveler Information (TIM)	
TransmissionState	2	1	Neutral	Vehicle transmission state
		2	Park	Vehicle transmission state

		3	Forward gears	Vehicle transmission state
		4	Reserve gears	Vehicle transmission state
		5	Reserved1	Vehicle transmission state
		6	Reserved2	Vehicle transmission state
		7	Reserved3	Vehicle transmission state
wheelBrakesUnavailable	3	0	Available	Communicates availability of brake system data
		1	Not available	Communicates availability of brake system data
TractionControlState	4	00	Unavailable	Vehicle not equipped with traction control or unavailable
		01	Off	Vehicle equipped with traction control, not active
		10	On	Vehicle equipped with traction control, active
		11	Engaged	Vehicle equipped with traction control, engaged
AntilockBrakeStatus	5	00	No antilock system	Vehicle not equipped with antilock brakes
		01	Off	Vehicle equipped with antilock brakes, not active
		10	On	Vehicle equipped with antilock brakes, active
		11	Engaged	Vehicle equipped with antilock brakes, engaged
StabilityControlStatus	6	00	Unavailable	Vehicle not equipped with stability control system or unavailable
		01	Off	Vehicle equipped with stability control system, not active
		10	On or engaged	Vehicle equipped with stability control system, active or engaged
BrakeBoostApplied	7	00	Unavailable	Vehicle not equipped with brake boost or unavailable
		01	Off	Vehicle equipped with brake boost, not active
		10	On	Vehicle equipped with brake boost, active
AuxiliaryBrakeStatus	8	00	No auxiliary braking system	Vehicle not equipped with auxiliary braking system
		01	Not applied	Vehicle equipped with auxiliary braking system, not applied
		10	Applied	Vehicle equipped with auxiliary braking system, applied
		11	Reserved	

A 10-record sample for the *BSM* file is given in Table 82.

Table 82: Sample Records for BSM File

BSMID	DSRCMsgId	MsgCount	TemporaryId	DSeconds	Latitude	Longitude	Elevation	Positional Accuracy	TransmissionState
1738218409	2	36	-1275975333	59800	423091009	-836928071	2510	0xFFFFFFFF	7
1738218417	2	126	738663065	0	423051742	-836925983	2436	0xFFFFFFFF	7
1738218423	2	109	-1157424605	59900	423072124	-836847010	2401	0xFFFFFFFF	7
1738218430	2	127	738663065	100	423051743	-836925983	2436	0xFFFFFFFF	7
1738218439	2	110	-1157424605	0	423072179	-836846806	2401	0xFFFFFFFF	7
1738218447	2	38	-1275975333	0	423091256	-836928078	2510	0xFFFFFFFF	7
1738218455	2	0	738663065	200	423051741	-836925983	2436	0xFFFFFFFF	7
1738218464	2	1	738663065	300	423051741	-836925983	2436	0xFFFFFFFF	7
1738218474	2	2	738663065	400	423051741	-836925982	2436	0xFFFFFFFF	7
1738218483	2	41	-1275975333	300	423091626	-836928087	2511	0xFFFFFFFF	7

Table continued …

Speed	Heading	Steering WheelAngle	Longitudinal Acceleration	Lateral Acceleration	Vertical Acceleration	YawRate	Break AppliedStatus	wheelBrakes Unavailable	Traction ControlState
176	28708	127	16	11	45	46	0x00	0	0x00
0	19316	127	-1	-1	43	0	0x00	0	0x00
381	5586	127	30	1	42	9	0x00	0	0x00
0	19316	127	-1	-1	43	0	0x00	0	0x00
383	5586	127	30	1	42	9	0x00	0	0x00
174	28702	127	-15	7	45	33	0x00	0	0x00
0	19316	127	-3	-1	43	0	0x00	0	0x00
0	19316	127	-3	-1	43	0	0x00	0	0x00
0	19316	127	-1	-1	43	0	0x00	0	0x00
173	28704	127	-9	7	45	30	0x00	0	0x00

Table continued…

Antilock BrakeStatus	Stability ControlStatus	Brake BoostApplied	Auxiliary BrakeStatus
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00

Table 83 provides a few summary measures of the *BSM* file that was populated with data collected on April 11, 2013.

Table 83: Summary Measures for Data Elements of the BSM File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
BSMID	16095310			1738218409, 1801843621, 1801843622, 1920703252, 1920703253	16095310
DSRCMsgId	1			2	
MsgCount	128			108,42, 0, 1, 2	
TemporaryID	11587			-1275975333, 738663065, -1157424605, 738663065, -1157424605	
DSeconds	2194	0	65535	0, 100, 200, 400, 59900	
Latitude	456480	0	900000001	423091009, 423051742, 423072124, 423051743, 423072179	
Longitude	640092	-840921953	180000001	-836928071, -836925983, -836847010, -836925983, -836846806	
Elevation	1775	-12773	7315	2510, 2436, 2401, 2436, 2511	
PositionalAccuracy	5			0xE4FFFFFF, 0xFFFFFFFF, 0xE5FFFFFF, 0xFE000000, 0xFFFFFF2F	
TransmissionState	5			0,1,2,3,7	
Speed	512	0	511	398, 177, 0, 381, 471	
Heading	28805	-34	28805	13870, 28708, 28704, 5586, 28702	
SteeringWheelAngle	254	0	255	78, 144, 41, 47, 67	
LongitudinalAcceleration	1385	-2000	2001	-707, 1368, 282, -194, 289	
LateralAcceleration	667	-16769	2001	480, 509, 451, 472, -686	
VerticalAcceleration	123	0	255	12, 15, 75, 209, 78	
YawRate	36164	0	32767	-11718, 14858, 7649, -10037, 13826	
BrakeAppliedStatus	3			0x0F, 0x00, 0x01	
wheelBrakesUnavailable	2			0,1	
TractionControlState	3			0x00, 0x01, 0x03	
AntilockBrakeStatus	3			0x00, 0x01, 0x03	
StabilityControlStatus	1			0x00	
BreakBoostApplied	1			0x00	
AuxiliaryBrakeStatus	2			0x00, 0x02	

6.2 Geometry File

The Geometry captures a few descriptive fundamentals of the intersections that were accompanied by RSEs, during the Safety Pilot Model Deployment. This file contains descriptors such as intersection and geometry direction IDs, as well as longitude, latitude, and elevation of the intersection.

Table 84: Data Elements of the Geometry File

Field Name	Type	Units	EnumId	Description
GeometryId	Integer	None		Unique ID (number) of the geometry element
IntersectionId	Integer	None		Global ID number of intersection within country or region. Assignment of IDs is done by regional schema. Follows SAE J2735 Standard
GeometryDirectionId	Integer	None		Unique ID (number) used to relate one or more motor vehicle lanes for an intersection approach or egress description with any associated pedestrian or special purpose lanes. Also may be used to describe one or more barriers at an intersection
Longitude	Integer	1/10th integer microdegrees		Geographic longitude of the intersection with reference to horizontal datum in use. 180000001 is used when unavailable
Latitude	Integer	1/10th integer microdegrees		Geographic latitude of the intersection with reference to horizontal datum in use. 900000001 is used when unavailable
Elevation	Integer	1/10th integer meters		Geographic elevation of the intersection above or below reference ellipsoid (typically WSG-84). Resolution is to 1 decimeter.). Range is 0 to 61439 (6143.9 m) and -4095 to -1. Elevations above 61439 are represented by the hex string 0xEFFF and those lower than -4095 are represented by the hex string 0xF000

No enumerations are present in the *Geometry* file.

A 10-record sample for Geometry file is given in Table 85.

Table 85: Records for Geometry File

GeometryId	IntersectionId	GeometryDirectionId	Longitude	Latitude	Elevation
1	126	1	-2005985330	422864680	0
2	126	1	-2005985330	422864680	0
3	126	1	-2005985330	422864680	0
4	126	1	-2005985330	422864680	0
5	126	1	-2005985330	422864680	0
6	126	1	-2005985330	422864680	0
7	126	1	-2005985330	422864680	0
8	126	1	-2005985330	422864680	0
9	126	1	-2005985330	422864680	0
10	126	1	-2005985330	422864680	0

Table 86 provides a few summary measures of the *Geometry* file.

Table 86: Summary Measures for Data Elements of the Geometry File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
GeometryId	46309				46309
IntersectionId	6			173, 175, 170, 172, 126	
GeometryDirectionId	1			1	
Longitude	6	-2005985330	1416436686	-2005985330, 1354701006, 75045326, 3476090806, 1416436686	
Latitude	6	422808140	422873350	422873350, 422871420, 422864680, 422808140, 422872330	
Elevation	4	-13816	24585	-13816, 0, -1016, 24585	

6.3 Lane File

The "Lane" file details the attributes of lanes in the vicinity of the RSE, which is often located at an intersection with multiple (lane) approaches. The primary information that the Lane file communicates are the intersection to which that lane belongs, the numbers of lane and allowable vehicle maneuvers.

Table 87: Data Elements of the Lane File

Field Name	Type	Units	EnumId	Description
LaneId	Integer	None		Unique ID (number) of the lane element
GeometryId	Integer	None		Unique ID (number) of the geometry element
LaneNumber	Integer	None		Unique index value which specifies a lane or other characteristic at an intersection. Barrier and other specialty lanes may be included. The IntersectionId and LaneNumber together specify a regionally unique way to address a specific lane at a specific intersection
LaneTypeId	Integer	None	1	Specifies type of lane being traveled along. Includes motorized vehicle, pedestrian, and dedicated train and transit lanes
LaneAttributes	Hexadecimal	None	2	Specifies possible movements from a motorized vehicle lane. Full explanation follows table
Width	Integer	Centimeters		Specifies width of a lane. Maximum width is 32767 cm
ReferenceLaneNumber	Integer	None		A reference lane is a lane drivable by motorized vehicle traffic which contains detailed geometric information (center line path and width) and basic lane attributes (permitted maneuvers). Data may be shared with a nearby "computed" lane in the same intersection. ReferenceLaneNumber indicates which lane the computed lane parallels
LateralOffset	Integer	None		Specified by Cartesian coordinates as offsets from an intersection with a northern orientation: eastern and northern offsets are therefore positive
NodeAttributes	Integer	None		Specifies the attribute of the node that the lane is associated with
ManeuverCode	Integer	None	3	Defines specific use of a single lane. Use of values within a set of lanes need not be exclusive. Each lane may be of only one type (have one ManeuverCode) at a time.

To extract the data from the LaneAttributes field in Table 87, the hexadecimal string is converted to binary. Each logical bit of the binary string specifies a characteristic of the lane (which may be cumulative) if it is logically true. LaneTypeId enumerations are provided in Table 88 by specifying the relevant bit from least significant (bit 0) to most significant (bit 15). For example, a LaneAttributes of 0x4000 has a binary representation of 0100000000000000 (bit 14 logically true) and specifies a two way left turn lane. A bit string of 0010000010000000 (bits 13 and 7 true) specifies a maneuverHOVLane and a maneuverNoStop.

Table 87 contains a number of enumerated elements whose values are associated with different meanings. Table 88 presents each of these data elements and their various enumerations.

Table 88: Enumeration Table for Lane File

Data Element	EnumId	Value	Name	Description
LaneTypeId	1	1	Vehicle	Motorized vehicle lane
		2	Computed	Computed lane
		3	Pedestrian	Pedestrian lane
		4	Special	Special purpose lane
LaneAttributes	2	0	noLaneData VehicleLaneAttributes	(No bits in logical true position)
		Bit 0	egressPath	Two-way path or outbound path described
		Bit 1	maneuverStraightAllowed	
		Bit 2	maneuverLeftAllowed	
		Bit 3	maneuverRightAllowed	
		Bit 4	Yield	
		Bit 5	maneuverNoUTurn	
		Bit 6	maneuverNoTurnOnRed	
		Bit 7	maneuverNoStop	
		Bit 8	noStop	
		Bit 9	noTurnOnRed	
		Bit 10	hovLane	
		Bit 11	busOnly	
		Bit 12	busAndTaxiOnly	
		Bit 13	maneuverHOVLane	
		Bit 14	maneuverSharedLane	TWLTL - Two way left turn lane
		Bit 15	maneuverBikeLane	
ManeuverCode	3	0	Unknown	
		1	uTurn	
		2	leftTurn	
		3	rightTurn	
		4	straightAhead	
		5	softLeftTurn	
		6	softRightTurn	
		7-127	Reserved	Reserved for standard use
		128-255	Reserved	Reserved for local use

A 10-record sample for the *Lane* file is given in Table 89.

Table 89: Sample Records for Lane File

LaneId	GeometryId	LaneNumber	LaneTypeId	LaneAttributes	Width	Reference LaneNumber	Lateral Offset	Node Attributes	ManeuverCode
1	13	1	1	0x00E2	335	0	0	0	NULL
2	4	1	1	0x00E2	335	0	0	0	NULL
3	12	1	1	0x00E2	335	0	0	0	NULL
4	16	1	1	0x00E2	335	0	0	0	NULL
5	1	1	1	0x00E2	335	0	0	0	NULL
6	6	1	1	0x00E2	335	0	0	0	NULL
7	14	1	1	0x00E2	335	0	0	0	NULL
8	15	1	1	0x00E2	335	0	0	0	NULL
9	5	1	1	0x00E2	335	0	0	0	NULL
10	11	1	1	0x00E2	335	0	0	0	NULL

Table 90 provides a few summary measures of the *Lane* file.

Table 90: Summary Measures for Data Elements of the Lane File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
LaneId	694595			67453, 217273, 504266, 149916, 511389	694595
GeometryId	46309			7569, 3444, 12166, 22538, 21970	
LaneNumber	15			3,1, 14, 4, 11	
LaneTypeId	3			1, 2, 3	
LaneAttributes	12			0x00E2, 0x00EA, 0x00E6, 0x00A2, 0x00AA	
Width	11	227	671	260, 268, 305, 318, 396	
ReferenceLaneNumber	5	0	4	0, 1, 2, 3, 4	
LateralOffset	11	-731	366	-518, -366, -335, 0, 366	
NodeAttributes	2	0	2	0, 2	
ManeuverCode	1			NULL	

6.4 LaneNode File

The LaneNode file captures lane descriptors as it relates to a node (a reference point on the ground) which is often times at or near an intersection. The point may also be referring to the location of an RSE or data collection / sensor point. This file contains data elements, whose values describe various positions within / along a lane.

Table 91: Data Elements of the LaneNode File

Field Name	Type	Units	EnumId	Description
LaneNodeId	Integer	None		Unique ID (number) representing the point on the ground which is associated with the lane being described. Usually specified at an intersection
LaneId	Integer	None		Unique ID (number) used to specify a lane at a given location
EasternOffset	Integer	None		Specified by Cartesian coordinates as offsets from an intersection with a northern orientation: eastern and northern offsets are therefore positive
NorthernOffset	Integer	None		Specified by Cartesian coordinates as offsets from an intersection with a northern orientation: eastern and northern offsets are therefore positive
ElevationOffset	Integer	None		Positive ElevationOffsets indicate rises in elevation (while negative values indicate a drop). Specified relative to the intersection's reference point
Width	Integer	Centimeters		Specifies width of a lane. Maximum width is 32767 cm

No enumerations are present in the *LaneNode* file.

A 10-record sample for *LaneNode* file is given in Table 92.

Table 92: Sample Records for LaneNode File

LaneNodeId	LaneId	EasternOffset	NorthernOffset	ElevationOffset	Width
409896	159642	-245	-3	0	0
1506452	586810	-1498	-855	0	0
936856	364942	301	40	0	0
1440598	561159	44	-228	0	0
668001	260189	191	139	0	0
1657136	645507	606	194	0	0
1267606	493791	71	-159	0	0
1536030	598319	-211	-155	0	0
1644877	640733	191	139	0	0
963924	375495	-162	151	0	0

Table 93 provides a few summary measures of the *LaneNode* file.

Table 93: Summary Measures for Data Elements of the LaneNode File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
LaneNodeId	1000000			802778, 672499, 1542964, 220088, 749685	1000000
LaneId	382157			646786, 185509, 523316, 154556, 108784	
EasternOffset	143	-2090	1200	59, -199, -245, -203, 202	
NorthernOffset	152	-855	1169	50, 280, -236, 88, -343	
ElevationOffset	41	-28	103	-22, 58, 10, -4, -7	
Width	1	0	0	0	

6.5 Map File

The intersections map message provides the geometric intersection description (GID) data that defines a digital map of an intersection down to the lane level. The extent of the map in each direction depends on factors such as topology, signal reception, and other intersections in the area. The MAP message provides local geo-referenced coordinates of the intersection, vehicle, pedestrian, and special lane geometry, and permitted navigation maneuvers.

Table 94: Data Elements of the Map File

Field Name	Type	Units	EnumId	Description
MAPID	Integer	None		Unique ID (number) of the map element
IntersectionId	Integer	None		Global ID number of intersection within country or region. Assignment of IDs is done by regional schema. Follows SAE J2735 Standard
ContentVersion	Integer	None		Indicates change in message content. Has meaning relative to last message broadcast. Applications must only read a message if ContentVersion has changed from the previous message. Takes on values from 0 to 255
MessageAttributes	Hexadecimal	None	1	Specifies format and content of the rest of the MAP message. Full explanation follows table
SignalScheme	Hexadecimal	None	2	Specifies signal scheme element used to select which preempt or priority controller sequence is to be activated to provide service to one or more intersection lanes. Full explanation follows table
PreemptLaneNumbers	Integer	None		Relates intersection approach lanes with a number system used by an approaching vehicle to assert a priority or preempt service request

To extract the data from the MessageAttributes field in Table 94, the hexadecimal string is converted to binary. Each logical bit of the binary string specifies a characteristic of the MAP message if it is logically true. MessageAttributes enumerations are provided in Table 95 by specifying the relevant bit from least significant (bit 0) to most significant (bit 7). For example, a MessageAttributes of 0x03 has a binary representation of 0100 (bit 2 logically true) and specifies that the MAP message contains the intersection's geometric data. Note bit 1 specifies the node offset resolution and, unlike other bits, is not interpreted on a logically true/logically false basis.

Similarly, the SignalScheme data is obtained by converting the 8 character hexadecimal string binary bits 76543210. Bits are then read in groups and converted to decimal. Bits 0-3 are grouped, as are bits 4-6 and bit 7. For example, a bit string of 11110101 has a decimal value 1 for bit 7, a decimal value of 7 for bits 4-6, and a decimal value of 5 for bits 0-3. These decimal values are interpreted according to their enumerations in Table 95.

Table 95: Enumeration Table for Map File

Data Element	EnumId	Value	Name	Description
MessageAttributes	1	Bit 0		Elevation data is included
		Bit 1	Node offset resolution	Logical 0 indicates centimeter resolution, while logical 1 indicates decimeter resolution
		Bit 2		Message contains intersection's geometric data
		Bit 3		Message contains navigational movement data
		Bit 4	Reserved	
		Bit 5	Reserved	
		Bit 6	Reserved	
		Bit 7	Reserved	
SignalScheme	2	Bits 0-3		
		0		No defined strategy
		1-7		Desired strategy if available
		Bits 4-6		
		0	Reserved	
		1-6		Desired strategy if available
		7	Cabinet flash	
		Bit 7		
		0	Priority	
		1	Preempt	

A 10-record sample for *Map* file is given in Table 96.

Table 96: Sample Records for Map File

MAPID	IntersectionId	ContentVersion	MessageAttributes	SignalScheme	PreemptLaneNumbers
1267877462	172	0	0x0F	0x00	NULL
1338659683	172	0	0x0F	0x00	NULL
1055736053	171	0	0x0E	0x00	NULL
2797092098	172	0	0x0F	0x00	NULL
2006429938	173	0	0x0F	0x00	NULL
2139414204	172	0	0x0F	0x00	NULL
1250085587	171	0	0x0E	0x00	NULL
1224574257	172	0	0x0F	0x00	NULL
2884960490	172	0	0x0F	0x00	NULL
1033606944	126	0	0x0E	0x00	NULL

Table 97 contains a few summary measures of the *Map* file.

Table 97: Summary Measures for Data Elements of the Map File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
MAPID	1000000			2707235687, 2097016008, 2406120781, 2629156953, 2145552940	1000000
IntersectionId	5			172, 126, 173, 171, 175	
ContentVersion	1			0	
MessageAttributes	2			0x0F, 0x0E	
SignalScheme	1			0x00	
PreemptLaneNumbers	1			NULL	

6.6 Packet File

This file provides the associated details for each packet. Details captured in this file include the PCAP fileID in which the transmitted packet is stored, along with the source and time stamp of the transmitted packet.

Table 98: Data Elements of the Packet File

Field Name	Type	Units	EnumId	Description
PacketId	Integer	None		Unique ID (number) for every captured packet
PCAPFileId	Integer	None		Contains the file ID in which the transmitted packet is stored
PacketNumber	Integer	None		Specifies the packet number of the packet contained in the *PCAP* file
PacketLocation	Integer	None		Specifies the location of a packet within the *PCAP* file (or within a blob within the *PCAP* file)
PacketDataLength	Integer	None		Number of bytes of packet data captured and saved in the file.
PacketTimestamp	String	None		Year-month-day-hour-minute-second timestamp when packet was captured. GMT is used
TimestampMicroseconds	Integer	Microseconds		Microsecond offset from PacketTimestamp. Further details when packet was captured. Given PacketTimestamp has a resolution to seconds, TimestampMicroseconds should not exceed 1 second (1000000 ms)
IncludedLength	Integer	None		Number of bytes of packet data captured and saved to file. IncludedLength should not exceed OriginalLength or SnapLen (from *PCAP* file)
OriginalLength	Integer	None		Number of bytes of packet data on the network when data was captured. If SnapLen (from *PCAP* file) is less than OriginalLength, IncludedLength saved to file will be smaller than OriginalLength
SourceIPAddress	Integer	None		Specifies the (non-constant) IP address of the on-board vehicle unit that transmitted a packet to the RSE
EtherType	Integer	None		Specifies the transmission protocol used in the payload (of an Ethernet Frame)
WSMPVersion	Integer	None		Communicates the Wave Short Message Protocol that is being employed within the transmitted packet
Channel	Integer	None		Specifies the channel on which a packet is transmitted
DataRate	Integer	MB/s		Specifies the transfer rate (amount of data transmitted per second) with respect to a given channel
PowerUsed	Integer	dBm		Specifies the amount of power required to transmit a packet. Units are specified in dBms, where a dBm is the power ratio in decibels of the measured power referenced to one milliwatt (mW)
PSID	Hexadecimal	None		Specifies the type of message sent. For example, a PSID of 0x20 (32 in decimal) indicates a Basic Safety Message. 0x8003 (32771) specifies a Traveler Information Message (TIM), 0xBFE0 (49120) and 0x8002 (32770) specify Signal Phase and Timing (SPAT) messages, 0xBFF0 (49136) and 0x8002 (32770) specify MAP messages (or GIDs), 0x23 (35) specifies a Security Credential Management message, and 0xBFE1 (49121) specifies a General IP Data Exchange message

No enumerations are present in the *Packet* file.

A 10-record sample for *Packet* file is given in Table 99.

Table 99: Sample Records for Packet File

PacketId	PCAPFileId	Packet Number	Packet Location	Packet DataLength	Packet Timestamp	Timestamp Microseconds	Included Length	Original Length	Source IPAddress
3038534630	899948	1	24	364	5/1/2013 12:02:24 AM	257510	364	364	0x9DA58E226EF3
3038534631	899948	2	404	364	5/1/2013 12:02:24 AM	356483	364	364	0x9DA58E226EF3
3038534632	899948	3	784	364	5/1/2013 12:02:24 AM	557771	364	364	0x9DA58E226EF3
3038534633	899948	4	1164	435	5/1/2013 12:02:24 AM	658162	435	435	0x9DA58E226EF3
3038534634	899948	5	1615	364	5/1/2013 12:02:24 AM	756790	364	364	0x9DA58E226EF3
3038534635	899948	6	1995	364	5/1/2013 12:02:24 AM	858257	364	364	0x9DA58E226EF3
3038534636	899948	7	2375	364	5/1/2013 12:02:25 AM	358629	364	364	0x9DA58E226EF3
3038534637	899948	8	2755	364	5/1/2013 12:02:25 AM	455012	364	364	0x9DA58E226EF3
3038534639	899950	1	24	263	5/1/2013 1:55:19 AM	92435	263	263	0x6E85F92816F4
3038534640	899951	1	24	230	5/1/2013 2:50:39 AM	438348	230	230	0x3ED0C57C42F0

Table continued …

EtherType	WSMPVersion	Channel	DataRate	PowerUsed	PSID
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	22	32
35036	2	172	12	20	32
35036	2	172	12	20	32

Table 100provides a few summary measures of the *Packet* file that was populated with data collected between April 30 and May 1, 2013.

Table 100: Summary Measures for Data Elements of the Packet File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
PacketId	1000000			3038979454, 3039377400, 3040420746, 3039667714, 3039297609	1000000
PCAPFileId	82			900506, 900683, 899953, 900172, 900287	
PacketNumber	689508			4170, 59623, 2089, 61515, 36044	
PacketLocation	952145	24	19999427	9515526, 1075885, 432416, 390378, 1830106	
PacketDataLength	270	171	505	210, 383, 252, 465, 372	
PacketTimestamp	26558			2013-05-01 11:09:00.000, 2013-05-01 05:54:52.000, 2013-05-01 12:47:59.000, 2013-05-01 12:34:16.000, 2013-05-01 10:51:27.000	
TimestampMicroseconds	572393	15	999991	720184, 515681, 125539, 188156, 253930	
IncludedLength	270	171	505	306, 214, 268, 375, 471	
OriginalLength	270	171	505	225, 450, 296, 395, 210	
SourceIPAddress	1642			0x822FED0D7991, 0x9A7D939A0A20, 0xC697D337B20D, 0x4283192A994A, 0x31822D2E2D63	
EtherType	1			35036	
WSMPVersion	1			2	
Channel	1			172	
DataRate	1			12	
PowerUsed	6	10	32	18, 22, 32, 21, 10	
PSID	1			32	

6.7 PCAP File

The PCAP file is populated with packet capture header information, specifying the listening setup used to capture all vehicle to vehicle communications.

Table 101: Data Elements of the PCAP File

Field Name	Type	Units	EnumId	Description
PCAPFileID	Integer	None		Unique ID (number) for every packet header
Filename	String	None		Specifies the name of the PCAP file. Filename contains the name of the RSE manufacturer, the RSE's location ID and name, and the data and timestamp.
FileTimeStampDate	String	None		Specifies the month-day-year on which the packet header was created
FileTimeStampTime	String	None		Specifies the hour-minute-second time when the packet header was created
VersionMajor	Integer	None		Major version number of the *PCAP* release
VersionMinor	Integer	None		Minor version number of the *PCAP* release
ThisZone	Integer	Seconds		Correction time between GMT and local time zone. Timestamps usually in GMT such that ThisZone is usually 0
SigFigs	Integer	None		Number of significant figures in the timestamp capture. However, usually set by capture tools to 0
SnapLen	Integer	None		Maximum (snapshot) length of captured packets in octets – usually 65535
Network	Integer	None		Specifies link-layer header type used in the packet. A complete enumeration is not provided as many types are possible. For example, Network is 1 for Ethernet or 255 for Bluetooth

No enumerations are present in the *PCAP* file.

A 10-record sample for the *PCAP* file is given in Table 102.

Table 102: Sample Records for PCAP File

PCAP FileID	Filename	FileTime StampDate	FileTime StampTime	Version Major	Version Minor	This Zone	Sig Figs	Snap Len	Network
588302	Savari-LocID0172-B_dsrc1_in_2013_04_11_00_21_34.pcap	4/11/2013	0:21:34	2	4	0	0	65535	1
588319	Savari-LocID0194_dsrc1_in_2013_04_11_00_19_34.pcap	4/11/2013	0:19:34	2	4	0	0	65535	1
588343	Savari-LocID0137_dsrc0_out_2013_04_11_00_07_34.pcap	4/11/2013	0:07:34	2	4	0	0	65535	1
588362	Savari-LocID0038_dsrc1_out_2013_04_11_00_03_41.pcap	4/11/2013	0:03:41	2	4	0	0	65535	1
588366	Savari-LocID0038_dsrc1_in_2013_04_11_00_03_41.pcap	4/11/2013	0:03:41	2	4	0	0	65535	1
588371	Savari-LocID0038_dsrc0_out_2013_04_11_00_03_41.pcap	4/11/2013	0:03:41	2	4	0	0	65535	1
588374	Savari-LocID0170_dsrc1_in_2013_04_11_00_28_42.pcap	4/11/2013	0:28:42	2	4	0	0	65535	1
588378	Savari-LocID0076_dsrc0_out_2013_04_11_00_09_18.pcap	4/11/2013	0:09:18	2	4	0	0	65535	1
588391	Savari-LocID0076_dsrc1_out_2013_04_11_00_09_18.pcap	4/11/2013	0:09:18	2	4	0	0	65535	1
588398	Savari-LocID0081_dsrc1_in_2013_04_11_00_12_21.pcap	4/11/2013	0:12:21	2	4	0	0	65535	1

Table 103 provides a few summary measures of the *PCAP* file that was populated with data collected on April 11, 2013.

Table 103: Summary Measures for Data Elements of the PCAP File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
PCAPFileID	2503			590575, 592026, 590454, 592039, 591835	2503
Filename	2503			Not included for brevity	
FileTimeStampDate	1			4/11/2013	
FileTimeStampTime	1045			13:17:53, 13:31:50, 5:54:15, 2:08:30, 20:07:39	
VersionMajor	1			2	
VersionMinor	1			4	
ThisZone	1			0	
SigFigs	1			0	
SnapLen	1	65535	65535	65535	
Network	1			1	

6.8 SPAT File

The SPAT (Signal Phasing and Timing) file contains the basics of a SPAT message. This file includes SPAT message and intersection IDs, and the timestamp of the SPAT message.

Table 104: Data Elements of the SPAT File

Field Name	Type	Units	EnumId	Description
SPATID	Integer	None		Unique ID (number) for every SPAT message
CurrentVersion	Integer	None		Indicates change in message content. Has meaning relative to last message broadcast. Applications must only read a SPAT message if CurrentVersion has changed from the previous message
IntersectionId	Integer	None		Global ID number of intersection within country or region. Assignment of IDs is done by regional schema. Follows SAE J2735 Standard
IntersectionStatus	Hexadecimal	None	1	Specifies Advance Traffic Controller status on the intersection. Full explanation follows table
MsgTimestamp	String	None		Year-month-day-hour-minute-second-tenth of second timestamp when message was generated. GMT is used

To extract the data from the IntersectionStatus field in Table 104, the hexadecimal string is converted to binary. Each logical bit of the binary string specifies a characteristic of the intersection (which may be cumulative). IntersectionStatus enumerations are provided in Table 106 by specifying the relevant bit from least significant (bit 0) to most significant (bit 15). For example, an IntersectionStatus of 0x03 has a binary representation of 00000011 (bits 0 and 1 logically true) and specifies that manual control is enabled and Stop Time is activated and all counting/timing has stopped. A 0x00 hex value (or 00000000 bit string) indicates the intersection is operating normally.

Table 105: Enumeration Table for SPAT File

Data Element	EnumId	Value	Name	Description
IntersectionStatus	1	0	Normal	Intersection operating normally
		Bit 0	Manual	Manual control enabled
		Bit 1	Stop Time activated	All counting/timing has stopped
		Bit 2	Conflict flash	Intersection in conflict flash state
		Bit 3	Preempt active	
		Bit 4	Priority active	
		Bit 5	Reserved	
		Bit 6	Reserved	
		Bit 7	Reserved	

A 10-record sample for *SPAT* file is given in Table 106.

Table 106: Sample Records for SPAT File

SPATID	CurrentVersion	IntersectionId	IntersectionStatus	MsgTimeStamp
3040841724	33	126	0x00	2013-04-30 20:41:57.800
3040841732	34	126	0x00	2013-04-30 20:41:57.900
3040841739	35	126	0x00	2013-04-30 20:41:58.000
3040841756	36	126	0x00	2013-04-30 20:41:58.100
3040841763	37	126	0x00	2013-04-30 20:41:58.200
3040841771	38	126	0x00	2013-04-30 20:41:58.300
3040841781	39	126	0x00	2013-04-30 20:41:58.400
3040841790	40	126	0x00	2013-04-30 20:41:58.500
3040841795	41	126	0x00	2013-04-30 20:41:58.600
3040841805	42	126	0x00	2013-04-30 20:41:58.700

Table 107 provides a few summary measures of the *PCAP* file that was populated with data collected between April 30 and May 1, 2013.

Table 107: Summary Measures for Data Elements of the SPAT File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
SPATID	1000000			3042889811, 3043234510, 3043103347, 3043183081, 3042991778	1000000
CurrentVersion	256			195, 139, 62, 16, 87	
IntersectionId	1			126	
IntersectionStatus	1			0x00	
MsgTimestamp	429117			2013-04-30 22:04:48.000, 2013-04-30 23:23:35.200, 2013-05-01 01:39:53.000, 2013-04-30 23:06:42.800, 2013-05-01 08:48:35.900	

6.9 SPATMovement File

The SPATMovement file provides the signal phase and timing information for one or more movements at an intersection.

Table 108: Data Elements of the SPATMovement File

Field Name	Type	Units	EnumId	Description
MovementId	Integer	None		Unique ID (number) for every movement
SPATID	String	None		Unique ID (number) for every SPAT message
CurrentState	Hxadecimal	None	1	Defines the current state of a particular known movement and depends on the type of lane that the CurrentState applies to. Full explanation follows table
MinTimeremaining	Integer	0.1 second units		Specifies minimum guaranteed time remaining before signal change to next phase. Maximum value is 1200 (2 minutes). Enumerations of 1201 and 1202 indicate an indefinite time remaining (greater than 2 minutes) and an unknown amount of time remaining, respectively
MaxTimeremaining	Integer	0.1 second units		Specifies anticipated maximum time remaining before signal is expected to change to next phase. Anticipated time subject to change. Times are provided relative to *SPAT* MsgTimestamp. Maximum value and bounds are identical to MinTimeremaining
YellowState	Hexadecimal	None	2	Specifies next (yellow-only) state of all possible lights pertaining to a movement. Interpretation of YellowState depends on the type of lane that the movement is applied to.
YellowTime	Integer	0.1 second units		Specifies duration of a yellow signal phase
PedestrianDetect	Integer	None	3	Indicates possible presence of pedestrians in the movement's walk area
VehiclePedestrianCount	Integer	None		Indicates estimated count of vehicles (for vehicle lanes) or pedestrians (for pedestrian lanes) within a predefined time period
LaneSet	Hexadecimal	None	4	Specifies movement within lanes at an intersection. Full explanation follows table

Data from the CurrentState field in Table 108 is interpreted differently for vehicle, pedestrian, and special lanes. For vehicle lanes, the hexadecimal string is read as character pairs that map to lighting combinations. For example, a vehicle CurrentState of 0x04080200 is read as 0x04000000, indicating a red U-Turn arrow, 0x00080000, indicating a flashing soft left arrow, and 0x00000200, indicating a yellow right arrow. All three of these lighting arrangements are present, such that the CurrentState hexadecimal characters apply cumulatively. Similarly, a vehicle CurrentState of 0x01 is read as 0x00000001 and indicates a solid green ball.

For pedestrian lanes, CurrentState defines the current signal state of crosswalk indicators for a particular known pedestrian movement. For pedestrian lanes, the CurrentState is always a 2 character hexadecimal string with a leading 0 which may be enumerated directly.

Finally, for special lanes, CurrentState defines the current signal state of a special movement, such as a train crossing. For special lanes, the CurrentState is always a 2 character hexadecimal string which may also be enumerated directly.

For vehicle lanes, YellowState also maps in the same fashion as CurrentState, although only yellow lightings may apply. As with CurrentState, YellowState is always a 2 character hexadecimal string with a leading 0 which may be enumerated directly for pedestrian lanes. YellowState does not apply to special lanes.

Data from the LaneSet field in Table 108 is provided as a sequence of movement/lane pairs. Each movement/lane pair is provided as a double-octet (four-character) hex string. The first two characters represent the movement, while the last two characters represent the lane. The movement is obtained by converting the hexadecimal value to an 8 bit binary string with bits 76543210. A movement is present with a logical 1 for any given bit. For example, a LaneSet string of 0x0703 has the movement characters 07, which are written as 00000111 in binary. Bits 0, 1, and 2 are in the logical 1 position, indicating straight, left, and right movement. The string has lane characters 03 which directly indicate lane 3. Therefore, a LaneSet of 0x0703 indicates straight/left/right movement on lane 3. There is no limit to the number of movement lane/pairs possible. For example, a LaneSet of 0x08040302 indicates a U-Turn on lane 4 (with movement string 00001000 in binary) and straight/left on lane 2 (with movement string 00000011 in binary).

Table 108 contains a number of enumerated elements whose values are associated with different meanings. Table 109 presents each of these data elements and their various enumerations.

Table 109: Enumeration Table for SPATMovement File

Data Element	EnumId	Value	Name	Description
CurrentState	1	Vehicle Lanes		
		0x00000001	Green ball	
		0x00000010	Green left arrow	
		0x00000100	Green right arrow	
		0x00001000	Green straight arrow	
		0x00010000	Green soft left arrow	
		0x00100000	Green soft right arrow	
		0x01000000	Green U-Turn arrow	
		0x00000002	Yellow ball	
		0x00000020	Yellow left arrow	
		0x00000200	Yellow right arrow	
		0x00002000	Yellow straight arrow	
		0x00020000	Yellow soft left arrow	
		0x00200000	Yellow soft right arrow	
		0x02000000	Yellow U-Turn arrow	
		0x00000004	Red ball	
		0x00000040	Red left arrow	
		0x00000400	Red right arrow	
		0x00004000	Red straight arrow	
		0x00040000	Red soft left arrow	
		0x00400000	Red soft right arrow	
		0x04000000	Red U-Turn arrow	
		0x00000008	Flashing ball	

		0x00000080	Flashing left arrow	
		0x00000800	Flashing right arrow	
		0x00008000	Flashing straight arrow	
		0x00080000	Flashing soft left arrow	
		0x00800000	Flashing soft right arrow	
		0x08000000	Flashing U-Turn arrow	
		Pedestrian Lanes		
		0x00	Unavailable	Current state unavailable or not equipped
		0x01	"Do not walk"	
		0x02	"Flashing, do not walk"	
		0x03	"Walk"	
		Special Lanes		
		0x01	Unavailable	Current state empty or not in use
		0x02	Being Occupied	Special lane about to be occupied
		0x03	Occupied	Special lane is occupied
		0x04	Emptying	Special lane about to be empty
YellowState	2	Vehicle Lanes		
		0x00000002	Yellow ball	
		0x00000020	Yellow left arrow	
		0x00000200	Yellow right arrow	
		0x00002000	Yellow straight arrow	
		0x00020000	Yellow soft left arrow	
		0x00200000	Yellow soft right arrow	
		0x02000000	Yellow U-Turn arrow	
		Pedestrian Lanes		
		0x00	Unavailable	YellowState unavailable or not equipped
		0x01	"Do not walk" next	Next YellowState is "do not walk"
		0x02	"Flashing, do not walk" next	Next YellowState will be "flashing, do not walk"
		0x03	"Walk" is next	Next YellowState will be "walk"
PedestrianDetect	3	0	Unavailable	Detection unavailable
		1	None	No pedestrians detected
		2	One or more	One or more possible pedestrians detected
LaneSet	4	Movement characters (mapped to bits)		
		Bit 0	Straight motion	
		Bit 1	Left turn	
		Bit 2	Right turn	
		Bit 3	U-Turn	
		Bits 4-7	Not used	
		Lane characters directly indicate lanes		

A 10-record sample for the *SPATMovement* file is given in Table 110.

Table 110: Sample Records for SPATMovement File

MovementId	SPATID	Current State	Min Timeremaining	Max Timeremaining	YellowState	YellowTime	Pedestrian Detect	Vehicle Pedestrian Count	LaneSet
3680586804	3040841724	0x04	362	1018	NULL	0	0	0	0x01010504
3680586824	3040841724	0x04	67	293	NULL	0	0	0	0x02010701
3680586845	3040841724	0x04	208	948	NULL	0	0	0	0x03010904
3680586848	3040841732	0x04	361	1017	NULL	0	0	0	0x01010504
3680586869	3040841724	0x01	147	643	0x02	36	0	0	0x04010B01
3680586872	3040841732	0x04	66	292	NULL	0	0	0	0x02010701
3680586890	3040841724	0x40	208	704	NULL	0	0	0	0x06020A02
3680586894	3040841732	0x04	207	947	NULL	0	0	0	0x03010904
3680586917	3040841724	0x40	656	1201	NULL	0	0	0	0x0802
3680586918	3040841732	0x01	146	642	0x02	36	0	0	0x04010B01

Table 111**Error! Reference source not found.** provides a few summary measures of the *SPATMovement* file that was populated with data collected between April 30 and May 1, 2013.

Table 111: Summary Measures for Data Elements of the SPATMovement File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
MovementId	1000000			3681632666, 3682128383, 3682180361, 3682320967, 3682175869	1000000
SPATID	109247			3040970421, 3041042888, 3040896184, 3040892366, 3040875722	
CurrentState	9			0x11, 0x20, 0x10, 0x02, 0x01	
MinTimeremaining	1058	0	1057	185, 563, 968, 28, 955	
MaxTimeremaining	1202	0	1201	1109, 1193, 229, 994, 23	
YellowState	3			NULL, 0x02, 0x20	
YellowTime	6	0	36	19, 31, 0, 14, 17	
PedestrianDetect	3	0	2	0, 1, 2	
VehiclePedestrianCount	1	0	0	0	
LaneSet	102			0x01010504, 0x04010B01, 0x0802, 0x06020A02, 0x03010904	

6.10 TIM File

The TIM file is populated with details pertaining to Traveler Information Message (TIM). This message is used to send various types of messages (advisory and road sign types) over the WSM stack to vehicles. It makes heavy use of the ITIS encoding system to send well known phrases, but allows limited text for local place names. The supported message types specify several sub-dialects of ITIS phrase patterns to further reduce the number of bytes to be sent. The expressed messages are active at a precise start and duration period, which can be specified to a resolution of a minute. The affected local area can be expressed using either a radius system or a system of short defined regions which is similar to the way roadway geometry is defined in the map fragment messages.

Table 112: Data Elements of the TIM File

Field Name	Type	Units	EnumId	Description
TIMID	Integer	None		ID (number) of TIM message. May be either “advisory” or “road sign” type. If advisory, TIMID is a two byte Advisory Number which connects to additional message content transmitted in ATIS message format over the IP stack, if available. Advisory Numbers are always present and unique, even if no information is available. If road sign, TIMID is a combination of 3D position, direction, and a MutCDCode
TIMPacketID	String	None		Unique ID (number) for every packet of messages sent by roadside equipment
URLBase	Integer	None		Internet-style URI/URL string which links to a designated resource when combined with URLShort. Protocol to be used should be given in the string. Last letter of the string may be used to differentiate multiple URLBase values in a single system. 26+10=36 base addresses may exist. The last letter then matches up with the first letter of the URLShort value. These letters are stripped from both the base and short elements before being combined to obtain the final URL/URI value
MessageIdData	Hexadecimal	None		Communicates several attributes of the transmitted TIM. Using a tag/type-length-value/data structure, MessageIdData provides information pertaining to the 3D position of the object, which has latitude, longitude, elevation, heading (slice) and mutcdcode components. See corresponding metadata document for additional information.
FurtherInfold	String	None		Provides a link number to other messages which relate to the same event according to the DSRC SAE J2735 Standard. 0 is used when FurtherInfold is unknown or not present
Latitude	Integer	1/10th integer microdegrees		32 bit value of current latitude of the vehicle with reference to horizontal datum in use. 90000001 is used when unavailable
Longitude	Integer	1/10th integer microdegrees		32 bit value of current longitude of the vehicle with reference to horizontal datum in use. 180000001 is used when unavailable
Elevation	Integer	Decimeters		Current elevation of vehicle above or below reference ellipsoid (typically WSG-84) in decimeters when converted to decimal from hex. Range is 0 to 61439 (6143.9 m) and -4095 to -1. An elevation above 6143.9 m is coded 0xEFFF and an elevation below -409.5 m is coded 0xF001. A missing elevation is specified by 0xF000.
ViewAngle	Hexadecimal	None	1	Specifies permitted travel or motion in a direction specified as an angle of a circular arc. Usually used to indicate a gross direction of travel to which the enclosed message or data frame applies. Full explanation follows table
MutCDCode	Integer	None	2	Defines basic MUTCD type

MsgIdCRC	String	None		Defines a two byte data element calculated over the payload bytes of the message. Generated according to CRC-CCITT polynomial $x^{16} + x^{12} + x^5 + 1$. An initial seed value of 0 is used. Note that no framing errors may occur because the first byte of every DSRC message is never zero (but 0x30). The most significant bit is always transmitted first in the typical ASN bytes order. A well-formed DSRC message, when decoded and input to the CRC process, should always result in a CRC value of 0.
StartTime	String	None		Specifies time that the TIM message will become valid. Time is specified in a minute of the year format. A year attribute is optional. StartTime is found in the data frame header of a TIM message
Duration	Integer	Minutes		Specifies the length of time that the TIM message will be valid after the StartTime. Duration is found in the data frame header of a TIM message
SignPriority	Integer	None		Indicates the relative importance of a sign on a scale from 0 (least important) to 7 (most important)
AnchorLatitude	Integer	1/10th integer microdegrees		Specifies latitude of a location from which offsets may be used to create additional data using a flat-early projection centered at this location. The WSG-84 coordinate system is used. AnchorLatitude is typically used in descriptions of maps, intersections, signs, and traveler data. The AnchorLatitude is specified with reference to the horizontal datum in use. All of the AchorLatitude (4 bytes), AnchorLongitude (4 bytes), and AnchorElevation (2 bytes) data may be used to build a complete10-byte 3D position. 90000001 is used when unavailable
AnchorLongitude	Integer	1/10th integer microdegrees		Specifies longitude of a location from which offsets may be used to create additional data using a flat-early projection centered at this location. The WSG-84 coordinate system is used. AnchorLongitude is typically used in descriptions of maps, intersections, signs, and traveler data. The AnchorLongitude is specified with reference to the horizontal datum in use. All of the AnchorLatitude (4 bytes), AnchorLongitude (4 bytes), and AnchorElevation (2 bytes) data may be used to build a complete10-byte 3D position. 180000001 is used when unavailable
AnchorElevation	Integer	1/10th integer microdegrees		Specifies elevation of a location from which offsets may be used to create additional data using a flat-early projection centered at this location. The WSG-84 coordinate system is used. AnchorElevation is typically used in descriptions of maps, intersections, signs, and traveler data. The AnchorElevation is specified with reference to the horizontal datum in use. All of the AnchorLatitude (4 bytes), AnchorLongitude (4 bytes), and AnchorElevation (2 bytes) data may be used to build a complete10-byte 3D position.
CommonLaneWidth	Integer	Centimeters		Specifies width of a lane. Maximum width is 32767 cm
DirectionOfUse	Integer	None	3	Specifies allowed direction of travel on a street lane or path described by shape points. Default direction is outward, away from an initial set of points.
URLShort	String	None		Internet-style URI/URL string which links to a designated resource when combined with URLBase. The first letter of the string may be used to differentiate multiple URLBase values in a single system. 26+10=36 base addresses may exist. The first letter then matches up with the last letter of the URLBase value. These letters are stripped from both the base and short elements before being combined to obtain the final URL/URI value
TIMContentTypeId	Hexadecimal	None		Specifies the type of content in the TIM
ITISCodesAndText	Integer	None		Specifies the ITIS code(s) associated with the TIM. A code indicates an event or lists an ITS-related item. See Volume 2 of the J2450 Standard for a complete set of ITIS codes

To extract the data from the ViewAngle field in Table 112, the hexadecimal string is read character by character and mapped to degree ranges specified in Table 113. For example, a

ViewAngle string of 0x8181 corresponds to enumerated values 8000, 0100, 0080, and 0001 and therefore identifies that permitted travel is in directions of 0 to 22.5 degrees, 157.5 to 180 degrees, 180 to 202.5 degrees, and 337.5 to 360 degrees. 0 degrees is due east, so a ViewAngle of 0x8181 specifies permitted travel in the east and west directions. Any number of four-character groups may be specified within ViewAngle to permit travel in additional degree ranges.

Table 112 contains a number of enumerated elements whose values are associated with different meanings. Table 113 presents each of these data elements and their various enumerations.

Table 113: Enumeration Table for TIM File

Data Element	EnumId	Value	Name	Description
ViewAngle	1	0001	0 to 22.5 degrees	
		0002	22.5 to 45 degrees	
		0004	45 to 67.5 degrees	
		0008	67.5 to 90 degrees	
		0010	90 to 112.5 degrees	
		0020	112.5 to 135 degrees	
		0040	135 to 157.5 degrees	
		0080	157.5 to 180 degrees	
		0100	180 to 202.5 degrees	
		0200	202.5 to 225 degrees	
		0400	225 to 247.5 degrees	
		0800	247.5 to 270 degrees	
		1000	270 to 292.5 degrees	
		2000	292.5 to 315 degrees	
		4000	315 to 337.5 degrees	
		8000	337.5 to 360 degrees	
		0000	No ViewAngle	
		FFFF	All ViewAngles	
MutCDCode	2	0	Reserved	Reserved for future use
		1	A La Carte Message (ACM)	
		2	Basic Safety Message (BSM)	Heartbeat message
		3	Basic Safety Message Verbose	Message used only for testing
		4	Common Safety Request (CSR)	
		5	Emergency Vehicle Alert (EVA)	
		6	Intersection Collision Alert (ICA)	
		7	Map Data (MAP)	For GID and intersections
		8	nmea Corrections (NMEA)	
		9	Probe Data Management (PDM)	
		10	probe Vehicle Data (PVD)	
		11	Roadside Alert (RSA)	
		12	rtcm Corrections (RTCM)	
		13	Signal Phase and Timing Message (SPAT)	

		14	Signal Request Message (SRM)	
		15	Signal Status Message (SSM)	
		16	Traveler Information (TIM)	
DirectionOfUse	3	0	Forward	Direction of travel follows node ordering
		1	Reverse	Direction of travel is the reverse of node ordering
		2	Both directions	Direction of travel allowed in both directions.

A 10-record sample for the *TIM* file is given in Table 114.

Table 114: Sample Records for TIM File

TIMID	TIMPacketID	URLBase	Message IdData	Further InFold	Latitude	Longitude	Elevation	View Angle	MutCDCode
1097789045	0x000000000000001500	NULL	Lengthy hexadecimal string	0x00	422982950	-837274060	2545	0x0006	2
1097789049	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789052	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789056	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789060	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789064	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789068	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789072	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789077	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2
1097789081	0x000000000000001500	NULL		0x00	422982950	-837274060	2545	0x0006	2

Table continued …

MsgIdCRC	StartTime	Duration	SignPriority	Anchor Latitude	Anchor Longitude	Anchor Elevation	Common LaneWidth	Direction OfUse	URLShort
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL
0x00000000	10/5/2011 12:01:00 AM	32000	2	422986840	-837268780	2551	351	0	NULL

Table continued …

TIMContentTypeId	ITISCodesAndText

1	13609
1	13609
1	13609
1	13609
1	13609
1	13609
1	13609
…	…

Table 115 provides a few summary measures of the *TIM* file that was populated with data collected on April 11, 2013.

Table 115: Summary Measures for Data Elements of the TIM File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
TIMID	6878065			1458173277, 2766900943, 1182074471, 1127471206, 2819481532	6878065
TIMPacketID	4			0x00000000000001100, 0x00000000000001600, 0x00000000000001200, 0x00000000000001500	
URLBase	0			NULL	
MessageIdData	4			0xA010800419348ECE 8104CE1A320E820209 A681020018820102, and other long hex strings	
FurtherInfold	1			0x00	
Latitude	4	422874830	422983370	422874830, 422983370, 422982950, 422879440	
Longitude	4	-837274060	-837144050	-837189730, -837144050, -837274060, -837223200	
Elevation	4	2444	2671	2545, 2671, 2444, 2470	
ViewAngle	4			0x0018, 0x8001, 0x0006, 0x6000	
MutCDCode	1			2	
MsgIdCRC	1			0x00000000	
StartTime	1			10/5/2011 12:01:00 AM	
Duration	1	32000	32000	32000	
SignPriority	1			2	
AnchorLatitude	4	422874830	422987809	422887080, 422874830, 422987809, 422986840	
AnchorLongitude	4	-837268780	-837131366	-837131366, -837268780, -837191798, -837229965	
AnchorElevation	4	2471	2644	2644, 2473, 2551, 2471	
CommonLaneWidth	3	335	366	335, 351, 366	
DirectionOfUse	1			0	

URLShort	1			NULL	
TIMContentTypeId	1			1	
ITISCodesAndText	2			13609, 13610	

6.11 TIMRegion File

This file outlines the region for which the TIM is applicable. Thus far, there are 6 regions presented.

Table 116: Data Elements of the TIMRegion File

Field Name	Type	Units	EnumId	Description
TIMRegion	Integer	None		Specifies a given region for which a TIM message is valid. Up to 16 valid regions may be used to geographically define where each message is useful to the driver. Multiple regions are used to describe precise segments of roadway to which a message applies, such as east- and west-bound lanes approaching an intersection or interchange
Direction	Hexadecimal	None	1	Specifies the direction of travel for which a message is valid. Unless a region is defined as omnidirectional, the vehicle must be traveling in a designated direction – vehicle physically being within the area described by AreaType is not enough to make a message valid for display. Mapping follows that of the ViewAngle field within the *TIM* file
Extent	Integer	None	2	Specifies spatial distance over which the TIM applies and is presented to the driver. Under certain conditions, some messages may never be sown to the driver of a vehicle if they are short in duration and other conflicting needs supersede the display for long enough that the Extent message is no longer relevant
TIMAreaTypeId	Integer	None	3	Provides a description of the region in which the message broadcast is valid.
Latitude	Integer	Centimeters		32 bit value of current latitude of the vehicle with reference to horizontal datum in use. 90000001 is used when unavailable
Longitude	Integer	1/10th integer microdegrees		32 bit value of current longitude of the vehicle with reference to horizontal datum in use. 180000001 is used when unavailable
Elevation	Integer	Decimeters		Current elevation of vehicle above or below reference ellipsoid (typically WSG-84) in decimeters when converted to decimal from hex. Range is 0 to 61439 (6143.9 m) and -4095 to -1. An elevation above 6143.9 m is coded 0xEFFF and an elevation below -409.5 m is coded 0xF001. A missing elevation is specified by 0xF000.
LaneWidth	Integer	Centimeters		Specifies width of a lane. Maximum width is 32767 cm
DirectionOfUse	Integer	None	4	Specifies allowed direction of travel on a street lane or path described by shape points. Default direction is outward, away from an initial set of points.
RadiusSteps	Integer	2.5 centimeter units		Defines one of three possible measures of the radius of the circular area for which the TIM is valid. Range is 0 to 32767 units
Miles	Integer	Miles		Defines one of three possible measures of the radius of the circular area for which the TIM is valid. Range is 1 to 2000 miles
Kilometers	Integer	Kilometers		Defines one of three possible measures of the radius of the circular area for which the TIM is valid. Range is 1 to 5000 kilometers

Table 116 contains a number of enumerated elements whose values are associated with different meanings. Table 117 presents each of these data elements and their various enumerations.

Table 117: Enumeration Table for TIMRegion File

Data Element	EnumId	Value	Name	Description
Direction	1	0001	0 to 22.5 degrees	
		0002	22.5 to 45 degrees	
		0004	45 to 67.5 degrees	
		0008	67.5 to 90 degrees	
		0010	90 to 112.5 degrees	
		0020	112.5 to 135 degrees	
		0040	135 to 157.5 degrees	
		0080	157.5 to 180 degrees	
		0100	180 to 202.5 degrees	
		0200	202.5 to 225 degrees	
		0400	225 to 247.5 degrees	
		0800	247.5 to 270 degrees	
		1000	270 to 292.5 degrees	
		2000	292.5 to 315 degrees	
		4000	315 to 337.5 degrees	
		8000	337.5 to 360 degrees	
		0000	No Direction	
		FFFF	All Directions	
Extent	2	0	Use message for…	an instant only
		1		3 meters only
		2		10 meters only
		3		50 meters only
		4		100 meters only
		5		500 meters only
		6		1000 meters only
		7		5000 meters only
		8		10,000 meters only
		9		50,000 meters only
		10		100,000 meters only
		127		ever
TIMAreaTypeId	3	1	Circular region	Simplest region and is effective in covering a large area that is not restricted to one specific road segment.
			Polygon region	Used to describe complex regions, such as an agency's jurisdictional coverage
			Shape point set	Allows a spline-like representation of a road segment using the same concepts developed for DSCR map fragments and is intended to tightly bind the region to the contour of a particular road. Described segments use a node list to efficiently describe the contour of the roadway center line as well as any changes in width and elevation
DirectionOfUse	4	0	Forward	Direction of travel follows node ordering
		1	Reverse	Direction of travel is the reverse of node ordering
		2	Both directions	Direction of travel allowed in both directions.

A 10-record sample for the *TIMRegion* file is given in Table 118.

Table 118: Sample Records for TIMRegion File

TIMRegionId	Direction	Extent	TIMAreaTypeId	Latitude	Longitude	Elevation	LaneWidth	DirectionOfUse	RadiusSteps
1	0x0006	0	1	0	0	0	0	NULL	0
2	0x6000	0	1	0	0	0	0	NULL	0
3	0x1800	0	1	0	0	0	0	NULL	0
4	0x8001	0	1	0	0	0	0	NULL	0
5	0x0070	0	1	0	0	0	0	NULL	0
6	0x8001	0	1	0	0	0	0	NULL	0

Table continued …

Miles	Kilometers
0	0
0	0
0	0
0	0
0	0
0	0

Table 119 provides a few summary measures of the *TIMRegion* file.

Table 119: Summary Measures for Data Elements of the TIMRegion File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
TIMRegion	6			1, 2, 3, 4, 5, 6	6
Direction	5			0x0006, 0x8001, 0x6000, 0x1800, 0x0070	
Extent	1			0	
TIMAreaTypeId	1			1	
Latitude	1	0	0	0	
Longitude	1	0	0	0	
Elevation	1	0	0	0	
LaneWidth	1			0	
DirectionOfUse	1			NULL	
RadiusSteps	1	0	0	0	
Miles	1	0	0	0	
Kilometers	1	0	0	0	

6.12 TIMRegionNode File

The TIMRegionNode file defines the applicable region of a TIM in terms of offsets from a given node, which may be at an intersection or a point on the ground near an RSE.

Table 120: Data Elements of the TIMRegionNode File

Field Name	Type	Units	EnumId	Description
TIMRegionNodeId	Integer	None		Unique ID (number) used to demarcate the point of a region for which a TIM is applicable
TIMRegionId	Integer	None		Specifies a given region for which a TIM message is valid. Up to 16 valid regions may be used to geographically define where each message is useful to the driver. Multiple regions are used to describe precise segments of roadway to which a message applies, such as east- and west-bound lanes approaching an intersection or interchange
XOffset	Integer	Centimeters		Specifies the latitudinal offset from an anchor point of a given node within a shape point set that defines the valid region for a message. Ranges from -32767 to 32767 cm
YOffset	Integer	Centimeters		Specifies the longitudinal offset from an anchor point of a given node within a shape point set that defines the valid region for a message. Ranges from -32767 to 32767 cm
ZOffset	Integer	Centimeters		Specifies the elevation offset from an anchor point of a given node within a shape point set that defines the valid region for a message. Ranges from -32767 to 32767 cm
Width	Integer	Centimeters		Specifies width of a lane. Maximum width is 32767 cm

No enumerations are present in the *TIMRegionNode* file.

A 10-record sample for the *TIMRegionNode* file is given in Table 121.

Table 121: Sample Records for TIMRegionNode File

TIMRegionNodeId	TIMRegionId	XOffset	YOffset	ZOffset	Width
1	1	3388	3547	0	0
2	1	3563	2524	0	0
3	1	3542	1450	0	0
4	1	3536	650	0	0
5	1	3540	-65	0	0
6	1	3539	-785	0	0
7	1	3537	-1608	0	0
8	1	3400	-2607	0	0
9	1	3643	-3420	0	0
10	2	-3497	3267	0	0

Table 122 provides a few summary measures of the *TIMRegionNode* file.

Table 122: Summary Measures for Data Elements of the TIMRegionNode File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
TIMRegionNodeId	46			5, 10, 11, 18, 20	46
TIMRegionId	6			1, 2, 4, 5, 6	
XOffset	46	-9688	5010	-3461, -3400, 3536, 3537,- 3391	
YOffset	46	-13310	15817	3016, -195, 2420, 1486, -150	
ZOffset	1	0	0	0	
Width	1	0	0	0	

6.13 TIMRegionXRef File

The TIMRegionXRef file maps each traveler information message, via its ID, to the region in which the message is applicable.

Table 123: Data Elements of the TIMRegionXRef File

Field Name	Type	Units	EnumId	Description
TIMID	Integer	None		ID (number) of TIM message. May be either “advisory” or “road sign” type. If advisory, TIMID is a two byte Advisory Number which connects to additional message content transmitted in ATIS message format over the IP stack, if available. Advisory Numbers are always present and unique, even if no information is available. If road sign, TIMID is a combination of 3D position, direction, and a MutCDCode
TIMRegionID	Integer	None		Specifies a given region for which a TIM message is valid. Up to 16 valid regions may be used to geographically define where each message is useful to the driver. Multiple regions are used to describe precise segments of roadway to which a message applies, such as east- and west-bound lanes approaching an intersection or interchange

No enumerations are present in the *TIMRegionXRef* file.

A 10-record sample for the *TIMRegionXRef* file is given in Table 124.

Table 124: Sample Records for TIMRegionXRef File

TIMID	TIMRegionId
3085023	1
1545102108	1
1687513910	4
2320093427	1
1544638550	2
2203708619	5
2325473736	5
290377092	2
341192918	5
1308996291	5

Table 125 provides a few summary measures of the *TIMRegionXRef* file.

Table 125: Summary Measures for Data Elements of the TIMRegionXRef File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
TIMID	28950989			2036947172, 615289040, 755910678, 399394297, 3009958123	57901980
TIMRegionId	6			1, 2, 4, 5, 6	

7 CONTEXTUAL DATA

Contextual data is intended to communicate the state of surrounding systems and elements that may impact transportation performance and operation. The goal of providing these data is to give data users a complete as possible picture state of the transportation system during the collection of vehicle-based and RSE-based data. The contextual data is also meant to provide insights into how various components of the system interact with, and impact vehicle operations.

The contextual data may include network descriptors and network performance, weather, incident and road-work activity, and scheduling data. The RDE will provide weather data and a thorough description of the elements provided. As for other contextual data, readers are directed to other portals. See section following after the description of the weather data elements below.

7.1 Weather Data

Given the significant impact that weather events have on transportation system performance and operation, an integral component of the contextual dataset are data elements that describe the weather condition under which vehicles are operating. These data element include temperature, precipitation, wind speed, cloud coverage, and when available road surface temperature and precipitation readings. Data provided via the RDE was obtained from the National Climatic Data Center. The following will detail the weather data elements that is include in the Safety Pilot Model Deployment data environment.

Table 126 contains a number of enumerated elements whose values are associated with different meanings. Table 127 presents each of these data elements and their various enumerations.

Table 126: Data Elements of the WeatherData File

Field Name	Type	Units	EnumId	Description
USAF	Integer	None		Air Force Catalog station number
WBAN	Integer	None		National Climate Data center WBAN number
YR-MODAHRMN	Integer	None		Specifies year-month-day-hour-minute of the weather observation in Greenwich Mean Time.
DIR	Integer	Compass Degrees		Specifies wind direction. 990 is used to report variable wind, while *** is used to report calm air (with wind speed 0)
SPD	Integer	Mph		Wind speed
GUS	Integer	Mph		Wind gust
CLG	Integer	Hundreds of feet		Specifies cloud ceiling given by the lowest opaque layer with 5/8 or greater coverage. A CLG value of 722 is used to indicate an unlimited ceiling
SKC	String	None	1	Specifies sky cover
L	Integer	None	2	Specifies low cloud type
M	Integer	None	3	Specifies middle cloud type
H	Integer	None	4	Specifies high cloud type
VSB	Real	Statute miles		Specifies the visibility, rounded to the nearest tenth of a statute mile. For some weather stations, visibility is reported to a maximum of 7 to 10 miles in metar observations, but to higher values in synoptic observations, which causes the visibility value to fluctuate from one data record to the next. Also, VSB values of 10 may be reported as 10.1 due to being archived in metric units and then reconverted to English units.
MW (4 columns)	Integer	None		Specify manually observed present weather according to a digit code. A table of weather codes follows the enumeration table
AW (4 columns)	Integer	None		Specify auto-observed present weather according to a digit code. A table of weather codes follows the enumeration table
W	Integer	None	5	Past weather indicator.
TEMP	Integer	Degrees Fahrenheit		Temperature
DEWP	Integer	Degrees Fahrenheit		Dew point
SLP	Real	Millibars		Sea level pressure, rounded to the nearest tenth of a millibar
ALT	Real	Inches		Altimeter setting, rounded to nearest hundredth of an inch
STP	Real	Millibars		Station pressure, rounded to the nearest tenth of a millibar
MAX	Integer	Degrees Fahrenheit		Maximum temperature over a defined time period
MIN	Integer	Degrees Fahrenheit		Minimum temperature over a defined time period
PCP01	Real	Inches		Specifies the amount of liquid precipitation occurring over the last hour, rounded to the nearest hundredth of an inch
PCP06	Real	Inches		Specifies the amount of liquid precipitation occurring over the last six hours, rounded to the nearest hundredth of an inch
PCP24	Real	Inches		Specifies the amount of liquid precipitation occurring over the last 24 hours, rounded to the nearest hundredth of an inch
PCPXX	Real	Inches		Specifies the amount of liquid precipitation occurring for a period other than the last 1, 6, or 24 hours. Usually a 12 period for stations outside of the US and a 3 hour period for stations within the US. 0.00T is recorded as the PCPXX value if only trace amounts of precipitation were recorded
SD	Integer	Inches		Specifies the snow depth

Table 127: Enumeration Table for WeatherData File

Data Element	EnumId	Value	Name	Description
SKC	1	CLR	Clear	Clear sky
		SCT	Scattered	1/8 – 4/8 coverage
		BKN	Broken	5/8 – 7/8 coverage
		OVC	Overcast	Overcast sky
		OBC	Obscured	Obscured sky
		POB	Partial obscuration	
L	2	0	No low clouds	
		1		Cumulis humulis or Cumulus fractus other than of bad weather
		2		Cumulus mediocris or congestus, with or without Cumulus of species fractus or humulis or Stratocumulus, all having bases at the same level
		3		Cumulonimbus calvus, with or without Cumulus, Stratocumulus or Stratus
		4		Stratocumulus cumulogenitus
		5		Stratocumulus other than Stratocumulus cumulogenitus
		6		Stratus nebulosus or Stratus fractus other than of bad weather, or both
		7		Stratus fractus or Cumulus fractus of bad weather, or both (pannus) usually below Altostratus or Nimbostratus
		8		Cumulus and Stratocumulus other than Stratocumulus cumulogenitus, with bases at different levels
		9		Cumulonimbus capillatus (often with an anvil), with or without Cumulonimbus calvus, Cumulus, Stratocumulus, Stratus or pannus
M	3	0	No middle clouds	
		1		Altostratus translucidus
		2		Altostratus opacus or Nimbostratus
		3		Altocumulus translucidus at a single level
		4		Patches (often lenticular) of Altocumulus translucidus, continually changing and occurring at one or more levels
		5		Altocumulus translucidus in bands, or one or more layers of Altocumulus translucidus or opacus, progressively invading the sky – these Altocumulus clouds generally thicken as a whole
		6		Altocumulus cumulogentis (or cumulonimbogentus)
		7		Altocumulus translucidus or opacus in two or more layers, or Altocumulus opacus in a single layer, not progressively invading the sky, or Altocumulus with Altostratus or Nimbostratus
		8		Altocumulus castellanus or floccus
		9		Altocumulus of a chaotic sky – generally at several levels
H	4	0	No high clouds	
		1		Cirrus fibratus, sometimes uncinus, not progressively invading the sky
		2		Cirrus spissatus, in patches or entangled sheaves, which usually do not increase and sometimes seem to be the remains of the upper part of a Cumulonimbus; or Cirrus castellanus or floccus
		3		Cirrus spissatus cumulonimbogenitus

		4		Cirrus unicinus or fibratus, or both, progressively invading the sky; they generally thicken as a whole
		5		indicates Cirrus (often in bands) and Cirrostratus, or Cirrostratus alone, progressively invading the sky – they generally thicken as a whole, but the continuous veil does not reach 45 degrees above the horizon
		6		Cirrus (often in bands) and Cirrostratus, or Cirrostratus alone, progressively invading the sky; they generally thicken as a whole; the continuous veil extends more than 45 degrees above the horizon, without the sky being totally covered
		7		Cirrostratus covering the whole sky
		8		Cirrostratus not progressively invading the sky and not entirely covering it
		9		Cirrocumulus alone, or Cirrocumulus predominant among the high clouds
W	5	0		Clouds covering 1/2 or less of the sky throughout the appropriate period
		1		Clouds covering more than 1/2 of the sky during part of the appropriate period and covering 1/2 or less during part of the period
		2		clouds covering more than 1/2 of the sky throughout the appropriate period
		3	Sandstorm, Duststorm or blowing snow	
		4	Fog, ice fog, or thick haze	
		5	Drizzle	
		6	Rain	
		7	Snow, or rain and snow mixed	
		8	Shower	Shower or showers
		9	Thunderstorms	Thunderstorm or thunderstorms with or without precipitation

The list of weather codes for the *MW* and *AW* fields within the weather data file are given in Table 128.

Table 128: Weather codes for MW and AW fields

00-49 No precipitation at the station at the time of observation	20-29 Precipitation, fog, ice fog or thunderstorm at the station during the preceding hour, but not at the time of observation	40-49 Fog or ice fog at the time of observation	60-69 Rain	80-99 Showery precipitation, or precipitation with current or recent thunderstorm
00-19 No precipitation, ice fog (except for 11 and 12), duststorm, sandstorm, drifting or blowing snow at the station at the time of observation or, except for 09 and 17, during the preceding hour	20: Drizzle (not freezing) or snow grains not falling as shower(s)	40: Fog or ice fog at a distance at the time of observation, but not at the station during the preceding hour, the fog or ice fog extending to a level above that of the observer	60: Rain, not freezing, intermittent, slight at time of observation	80: Rain shower(s), slight
00: Cloud development not observed or not observable	21: Rain (not freezing) not falling as shower(s)	41: Fog or ice fog in patches	61: Rain, not freezing, continuous, slight at time of observation	81: Rain shower(s), moderate or heavy

01: Clouds generally dissolving or becoming less developed	22: Snow not falling as shower(s)	42: Fog or ice fog, sky visible, has become thinner during the preceding hour	62: Rain, not freezing, intermittent, moderate at time of observation	82: Rain shower(s), violent
02: State of sky on the whole unchanged	23: Rain and snow or ice pellets not falling as shower(s)	43: Fog or ice fog, sky invisible, has become thinner during the preceding hour	63: Rain, not freezing, continuous, moderate at time of observation	83: Shower(s) of rain and snow mixed, slight
03: Clouds generally forming or developing	24: Freezing drizzle or freezing rain not falling as shower(s)	44: Fog or ice fog, sky visible, no appreciable change during the preceding hour	64: Rain, not freezing, intermittent, heavy at time of observation	84: Shower(s) of rain and snow mixed, moderate or heavy
04: Visibility reduced by smoke, e.g. veldt or forest fires, industrial smoke or volcanic ashes	25: Shower(s) of rain	45: Fog or ice fog, sky invisible, no appreciable change during the preceding hour	65: Rain, not freezing, continuous, heavy at time of observation	85: Show shower(s), slight
05: Haze	26: Shower(s) of snow or of rain and snow	46: Fog or ice fog, sky invisible, has begun or has become thicker during the preceding hour	66: Rain, freezing, slight	86: Snow shower(s), moderate or heavy
06: Widespread dust in suspension in the air, not raised by wind at or near the station at the time of observation	27: Shower(s) of hail (Hail, small hail, snow pellets), or rain and hail	47: Fog or ice fog, sky invisible, has begun or has become thicker during the preceding hour	67: Rain, freezing, moderate or heavy	87: Shower(s) of snow pellets or small hail, with or without rain or rain and snow mixed, slight
07: Dust or sand raised by wind at or near the station at the time of observation, but no well-developed dust whirl(s) or sand whirl(s), and no duststorm or sandstorm seen or, in the case of ships, blowing spray at the station	28: Fog or ice fog	48: Fog, depositing rime, sky visible	68: Rain or drizzle and snow, slight	88: Shower(s) of snow pellets or small hail, with or without rain or rain and snow mixed, moderate or heavy
08: Well developed dust whirl(s) or sand whirl(s) seen at or near the station during the preceding hour or at the time of observation, but no duststorm or sandstorm	29: Thunderstorm (with or without precipitation)	49: Fog, depositing rime, sky invisible	69: Rain or drizzle and snow, moderate or heavy	89: Shower(s) of hail (hail, small hail, snow pellets), with or without rain or rain and snow mixed, not associated with thunder, slight
09: Duststorm or sandstorm within sight at the time of observation, or at the station during the preceding hour	30-39 Duststorm, sandstorm, or blowing snow	50-99 Precipitation at the station at the time of observation	70-79 Solid precipitation not in showers	90: Shower(s) of hail (hail, small hail, snow pellets), with or without rain or rain and snow mixed, not associated with thunder, moderate or heavy
10: Mist	30: Slight or moderate duststorm or sandstorm has decreased during the preceding hour	50-59 Drizzle	70: Intermittent fall of snowflakes, slight at time of observation	91: Slight rain at time of observation, thunderstorm during the preceding hour but not at time of observation
11: Patches of shallow fog or ice fog at the station, whether on land or sea, not deeper than	31: Slight or moderate duststorm or sandstorm no appreciable change during the preceding hour	50: Drizzle, not freezing, intermittent, slight at time of observation	71: Continuous fall of snowflakes, slight at time of observation	92: Moderate or heavy rain at time of observation, thunderstorm during the

about 2 meters on land or 10 meters at sea				preceding hour but not at time of observation
12: More or less continuous shallow fog or ice fog at the station, whether on land or sea, not deeper than about 2 meters on land or 10 meters at sea	32: Slight or moderate duststorm or sandstorm has begun or has increased during the preceding hour	51: Drizzle, not freezing, continuous, slight at time of observation	72: Intermittent fall of snowflakes, moderate at time of observation	93: Slight snow, or rain and snow mixed or hail (hail, small hail, snow pellets), at time of observation, thunderstorm during the preceding hour but not at time of observation
13: Lightning visible, no thunder heard	33: Severe duststorm or sandstorm has decreased during the preceding hour	52: Drizzle, not freezing, intermittent, moderate at time of observation	73: Continuous fall of snowflakes, moderate at time of observation	94: Moderate or heavy snow, or rain and snow mixed or hail (hail, small hail, snow pellets) at time of observation, thunderstorm during the preceding hour but not at time of observation
14: Precipitation within sight, not reaching the ground or the surface of the sea	34: Severe duststorm or sandstorm no appreciable change during the preceding hour	53: Drizzle, not freezing, continuous, moderate at time of observation	74: Intermittent fall of snowflakes, heavy at time of observation	95: Thunderstorm, slight or moderate, without hail (hail, small hail, snow pellets), but with rain and/or snow at time of observation, thunderstorm at time of observation
15: Precipitation within sight, reaching the ground or the surface of the sea, but distant, i.e., estimated to be more than 5 km from the station	35: Severe duststorm or sandstorm has begun or has increased during the preceding hour	54: Drizzle, not freezing, intermittent, heavy (dense) at time of observation	75: Continuous fall of snowflakes, heavy at time of observation	96: Thunderstorm, slight or moderate, with hail (hail, small hail, snow pellets) at time of observation, thunderstorm at time of observation
16: Precipitation within sight, reaching the ground or the surface of the sea, near to, but not at the station	36: Slight or moderate drifting snow generally low (below eye level)	55: Drizzle, not freezing, continuous, heavy (dense) at time of observation	76: Diamond dust (with or without fog)	97: Thunderstorm, heavy, without hail (Hail, small hail, snow pellets), but with rain and/or snow at time of observation, thunderstorm at time of observation
17: Thunderstorm, but no precipitation at the time of observation	37: Heavy drifting snow generally low (below eye level)	56: Drizzle, freezing, slight	77: Snow grains (with or without fog)	98: Thunderstorm combined with duststorm or sandstorm at time of observation, thunderstorm at time of observation
18: Squalls at or within sight of the station during the preceding hour or at the time of observation	38: Slight or moderate blowing snow generally high (above eye level)	57: Drizzle, freezing, moderate or heavy (dense)	78: Isolated star-like snow crystals (with or without fog)	99: Thunderstorm, heavy, with hail (hail, small hail, snow pellets) at time of observation, thunderstorm at time of observation
19: Funnel cloud(s) (Tornado cloud or waterspout) at or within sight of the station during the preceding hour or at the time of observation	39: Heavy blowing snow generally high (above eye level)	58: Drizzle and rain, slight	79: Ice pellets	
		59: Drizzle and rain, moderate or heavy		

A 10-record sample for the *WeatherData* file is given in Table 129.

Table 129: Sample Records for WeatherData File

USAF	WBAN	YR-MODAHRMN	DIR	SPD	GUS	CLG	SKC	L	M
725374	94889	201304110053	60	7	***	6	OVC	*	*
725374	94889	201304110140	***	***	***	6	OVC	*	*
725374	94889	201304110153	***	***	***	6	OVC	*	*
725374	94889	201304110244	70	10	***	4	OVC	*	*
725374	94889	201304110253	80	9	***	4	OVC	*	*
725374	94889	201304110313	40	14	***	4	OVC	*	*
725374	94889	201304110322	50	8	***	4	OVC	*	*
725374	94889	201304110353	40	10	18	4	OVC	*	*
725374	94889	201304110446	70	10	***	4	OVC	*	*
725374	94889	201304110453	70	13	21	4	OVC	*	*

Table continued …

H	VSB	MW (1)	MW (2)	MW (3)	MW (4)	AW (1)	AW (2)	AW (3)	AW (4)
*	8	**	**	**	**	**	**	**	**
*	10	**	**	**	**	**	**	**	**
*	10	**	**	**	**	**	**	**	**
*	2.5	**	**	**	**	10	**	**	**
*	2.5	**	**	**	**	10	**	**	**
*	1.8	**	**	**	**	10	**	**	**
*	2	**	**	**	**	10	**	**	**
*	2	**	**	**	**	10	**	**	**
*	3	**	**	**	**	10	**	**	**
*	3	**	**	**	**	10	**	**	**

Table continued…

W	TEMP	DEWP	SLP	ALT	STP	MAX	MIN	PCP01	PCP06
*	41	39	1014.9	29.96	984.1	***	***	0	*****
*	41	39	******	29.94	983.5	***	***	*****	*****
*	41	39	1013.9	29.93	983.1	***	***	0	*****
*	39	39	******	29.95	983.8	***	***	*****	*****
*	40	39	1014.9	29.95	983.8	***	***	0	*****
*	39	37	******	29.95	983.8	***	***	*****	*****
*	39	37	******	29.96	984.1	***	***	*****	*****
*	40	38	1014.8	29.95	983.8	***	***	0	*****
*	39	37	******	29.92	982.8	***	***	*****	*****

*	39	38	1013.3	29.91	982.5	***	***	0	*****

Table continued…

PCP24	PCPXX	SD
*****	*****	**
*****	*****	**
*****	*****	**
*****	*****	**
*****	*****	**
…	…	…

Table 130 provides a few summary measures of the *WeatherData* file.

Table 130: Summary Measures for Data Element of the WeatherData File

Field Name	No. of Unique Values	Min. Value	Max. Value	Sample Values	No. of Rows
USAF	1			725374	44
WBAN	1			94889	
YR-MODAHRMN	18			201304110322, 201304000000, 201304110446, 201304110313, 201304110653	
DIR	9	40	990	990, 90, ***, 60, 80	
SPD	13	7	20	7, 10, 15, 16, 20	
GUS	10	18	28	20, 21, 25, 28, ***	
CLG	4	4	8	***, 4, 6, 8	
SKC	2			***, OVC	
L	1			*	
M	1			*	
H	1			*	
VSB	12	2	10	1.8, 2.5, 3, 7, 9.1	
MW (4 columns)	2			***, 10	
AW (4 columns)	5			10, 61, 62, 63, ***	
W	1			*	
TEMP	6	37	41	37, 38, 39, 40, ***	
DEWP	6	35	39	35, 36, 37, 38, ***	
SLP	21	1006.8	1014.9	1013.9, 1010, 1012.2, 1012.4, 1009.6	
ALT	18	29.72	29.96	29.76, 29.72, 29.93, 29.81, ***	
STP	18	976.2	984.1	983.3, 982.2, 976.5, 981.8, 978.8	
MAX	6	38	48	38, 39, 40, 42, ***	
MIN	3	37	39	37, 39, ***	
PCP01	15	0	0.46	0.11, 0.24, 0.37, 0.00T, ***	
PCP06	3	1.04	1.04	0.00T, 1.04, ***	

PCP24	3	0.36	1.33	0.36, 1.33, ***	
PCPXX	3	0.64	0.64	0.00T, 0.64, ***	
SD	1			**	

Additional weather data may be obtained from Weather Underground (http://www.wunderground.com/). This data repository provides weather data from specific weather stations, which one may use to learn of weather in a more localized area.

7.2 Other Contextual Data

7.2.1 Network Data

Network data references in terms both a description of the physical network from which the data was collected and additional performance measures detailing the efficiency with which people and goods are transported throughout the system. One of the more detailed repositories of network data in which the Safety Pilot Model Deployment was executed is the website of the Michigan Department of Transportation (MDOT) (http://www.michigan.gov/mdot/). From MDOT's website a detailed functional classification (road) map is available at http://www.miwats.org/s/Appendix-B-Washtenaw-County-NFC-map.pdf. In terms of network performance, MDOT provides a web based, geospatial tool that provides a layer of average daily traffic counts at http://www.mcgi.state.mi.us/ntfa/. Other network performance supplemental data can be obtained from MDOT's main page as well as the Federal Highway Administration - Highway Statistics Series (http://www.fhwa.dot.gov/policyinformation/statistics.cfm).

The Network data set contains two data files. One of these files presents Annual Average Daily Traffic (AADT) along select roadways in Washtenaw County, Michigan. The data in this file were obtained from the Traffic Count Database System (TCDS). The TCDS is a tool for the traffic engineer or planner to organize an agency's traffic count data. This tool also allows user to upload data from a traffic counter; view graphs, lists and reports of historic traffic count data; search for count data using either the database or the Google map; and print or export data to your desktop. The database can be accessed via http://washtenaw.ms2soft.com/tcds/tsearch.asp?loc=Washtenaw&mod=. The data range for these data is 01/01/1999 – 01/01/2015.

The second data file in the data set presents traffic count samples collected throughout Washtenaw County over a 24 or 48 hour period. This data was obtained from the Washtenaw Area Transportation Study (http://www.miwats.org/traffic-counts/). These count data are collected by road agencies and used in monitoring the performance and needs of the transportation system. The data range for these data is 08/08/1985 – 06/06/2013.

The data in these files spans 1985 – 2015. Data beyond the years of the Safety Pilot Model Deployment were included to support researchers in having a comprehensive view of the road network in the Ann Arbor / Washtenaw County area. While traffic count data is collected rather infrequently, across the network, having data the spans multiple years, and are collected along different roadways, these data are intended to provide supplemental data to communicate network-wide flow estimates.

7.2.2 NetworkAADTCount File

The NetworkAADTCount file presents traffic counts from Washtenaw County in Michigan. This data in this file was obtained from The Traffic Count Database System (TCDS). The following sections presents a brief description of each data element in the network file.

Table 131: Data Elements of the NetworkAADTCount File

Field Name	Type	Units	EnumId	Description
Loc ID	String	None		This field contains the location's ID number for a given count value.
County	String	None		The county where the record resides
Community	String	None		The community where the record resides.
On	String	None		The street where the record is located.
From	String	None		One of the endpoints of the record's link.
To	String	None		The other endpoint of the record's link.
Approach	String	None		Direction from street, in Column H, that the record resides.
At	String	None		Name of the nearest cross street to the record.
Dir	String	None		The flow direction of this record (for example, EB, WB, NB, SB).
Latitude	Float	None		Latitude of the record(er)
Longitude	Float	None		Longitude of the record(er).
Latest	Integer	None		The most recent count data.
Latest Date	Date	None		The most recent count data date.

A 10-record sample for the *NetworkTrafficCount* file is given in ***Table 132***

Table 132: Sample Records for NetworkTrafficCount File

Loc ID	County	Comm	On	Fr.	To	Approach	At	Dir	Lat.	Lon.	Latest	Latest Date
0010210001	Washtenaw	Salem Twp	Currie Rd			NORTH OF	Eight Mile Rd	2-WAY			1040	1/1/2008
0010210001_NB	Washtenaw	Salem Twp	Currie Rd			NORTH OF	Eight Mile Rd	NB				
0010210001_SB	Washtenaw	Salem Twp	Currie Rd			NORTH OF	Eight Mile Rd	SB				
0010220002	Washtenaw	Salem Twp	Currie Rd			SOUTH OF	Eight Mile Rd	2-WAY			3875	1/1/2014
0010220002_NB	Washtenaw	Salem Twp	Currie Rd			SOUTH OF	Eight Mile Rd	NB			2093	1/1/2014
0010220002_SB	Washtenaw	Salem Twp	Currie Rd			SOUTH OF	Eight Mile Rd	SB			1782	1/1/2014
0010230003	Washtenaw	Salem Twp	Eight Mile Rd			EAST OF	Currie Rd	2-WAY			6690	1/1/2014
0010230003_EB	Washtenaw	Salem Twp	Eight Mile Rd			EAST OF	Currie Rd	EB			3454	1/1/2014

0010230003_WB	Washtenaw	Salem Twp	Eight Mile Rd			EAST OF	Currie Rd	WB			3236	1/1/2014

7.2.3 NetworkTrafficCount File

The NetworkTrafficCount file presents traffic count samples collected throughout Washtenaw County over a 24 or 48 hour period. This data was obtained from the Washtenaw Area Transportation Study (http://www.miwats.org/traffic-counts/). These count data are collected by road agencies and used in monitoring the performance and needs of the transportation system. The data range for these data is 08/08/1985 – 06/06/2013.

Note to readers and users of the data and the definitions below: At the time of publication of this document the Research Data Exchange team did not receive the official definitions for the attributes in this file. The definitions below represents the team's attempt at defining these attributes based on context and experience in the field.

Table 133: Data Elements of the NetworkTrafficCount File

Field Name	Type	Units	EnumId	Description
TrafficCountDataID	Integer	None		This field contains a unique ID for each traffic count record.
CountID	Integer	None		This field contains an assigned ID for each set of traffic count records collected at the same location on the same date.
Count Date	Date	None		Date on which the traffic count data was collected
StreetName	String	None		The name of the street on which the traffic count was collected.
DirectionFromCross	String	None		The direction of the data collection (street) location from the reference / closest cross street.
CrossStreet	String	None		Closet or reference cross street to the street on which traffic count data is being collected.
TravelDirection	String	None		Corresponding travel direction to traffic count value; for the street that the traffic count data is being collected.
24HourCount	Integer	None		Number of vehicles detected over a 24-hour period at the data collection location.
PeakHourCount	Integer	None		Highest number of vehicles is detected in an hour during the data collection period.
PeakHourTime	Integer	None		The specific hour, of the day, during which the highest number of vehicles is detected during the data collection period
5PMCount	Integer	None		The specific hour, of the day, during which the highest number of vehicles is detected during the data collection period
Source Agency	String	None		The agency that collected the corresponding count data
48HourAverage	Integer	None		Indicator as to whether or not an average over a 48 hour period was used to derive the corresponding traffic count value.
CityTwp	String	None		City / Township in which the data is being collected.

A 10-record sample for the *NetworkTrafficCount* file is given in ***Table 134***

Table 134: Sample Records for NetworkTrafficCount File

TrafficCountDataID	CountID	Count Date	StreetName	DirectionFromCross	CrossStreet	TravelDirection	…
13854	26871	6/6/2013	CLARK	W	HEWITT	2way	…
13855	26871	6/6/2013	CLARK	W	HEWITT	EB	…

13856	26871	6/6/2013	CLARK	W	HEWITT	WB	…
13846	26868	6/5/2013	BURNS	E	EDISON	EB	…
13845	26868	6/5/2013	BURNS	E	EDISON	2way	…
13847	26868	6/5/2013	BURNS	E	EDISON	WB	…
13848	26869	6/5/2013	BURNS	E	EDISON	2way	…
13849	26869	6/5/2013	BURNS	E	EDISON	EB	…
13850	26869	6/5/2013	BURNS	E	EDISON	WB	…
13851	26870	6/5/2013	BURNS	W	EDISON	2way	…

…

24HourCount	PeakHourCount	PeakHourTime	5PMCount	Source Agency	48HourAverage	CityTwp
13623	1082	1700	1082	WCRC	FALSE	Superior Twp
6452	571	1700	571	WCRC	FALSE	Superior Twp
7171	552	800	511	WCRC	FALSE	Superior Twp
177	20	1600	14	WCRC	FALSE	Ypsilanti Twp
316	40	1600	28	WCRC	FALSE	Ypsilanti Twp
139	20	1600	14	WCRC	FALSE	Ypsilanti Twp
316	40	1600	28	WCRC	FALSE	Ypsilanti Twp
177	20	1600	14	WCRC	FALSE	Ypsilanti Twp
139	20	1600	14	WCRC	FALSE	Ypsilanti Twp
342	35	1600	24	WCRC	FALSE	Ypsilanti Twp

7.2.4 Transit Schedule Data

The SPMD data includes data that were obtained from transit vehicles and they traverse Ann Arbor. More specifically, a significant portion of these data were collected while transit vehicles were servicing the University of Michigan. If transit schedule data is required for a research task, the transit mobility data that is included in the SPMD data environment maybe complimented by the transit schedule information that is found at http://pts.umich.edu/taking_the_bus/routes/.