Trajectory Convertor Analysis-VISSIM User Manual

Version 2.1 Build 1

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Table of Contents

[1 Introduction 5](#_Toc371083769)

[2 Installation and Running the TCA 6](#_Toc371083770)

[3 Input Files 7](#_Toc371083771)

[3.1 File Requirements to Run the TCA 7](#_Toc371083772)

[3.2 Control File 7](#_Toc371083773)

[3.3 RSE Location File 9](#_Toc371083775)

[3.4 Strategy File 10](#_Toc371083776)

[4 Output Files 16](#_Toc371083778)

[4.1 TCA Input Summary File 16](#_Toc371083779)

[4.2 Transmitted PDMs File 16](#_Toc371083781)

[4.3 All PDM Snapshots File 17](#_Toc371083783)

[4.4 Transmitted BSM File 18](#_Toc371083785)

[4.5 Extended Information BSM File 19](#_Toc371083787)

List of Tables

[Table 1. Required Control file fields 7](#_Toc371083834)

[Table 2. Symbol Key 7](#_Toc371083835)

[Table 3: Control file fields 8](#_Toc371083836)

[Table 4: RSE location file fields 9](#_Toc371083837)

[Table 5. Symbol Key 10](#_Toc371083838)

[Table 6: Strategy file fields 10](#_Toc371083839)

[Table 7. TCA Input Summary file fields 16](#_Toc371083840)

[Table 8: Transmitted snapshot file fields 16](#_Toc371083841)

[Table 9: All PDM snapshots file fields 17](#_Toc371083842)

[Table 10. Transmitted BSM File Fields 19](#_Toc371083843)

[Table 11. Extended Information BSM File Fields 20](#_Toc371083844)

List of Figures

[Figure 1. Control file example with PDM and BSM vehicles 9](#_Toc371083845)

[Figure 2. RSE Locations File Example 10](#_Toc371083846)

[Figure 3. Strategy file example with gaps enabled 15](#_Toc371083847)

[Figure 4. TCA Input Summary file example excerpt 16](#_Toc371083848)

[Figure 5. Transmitted PDM snapshots file example excerpt 17](#_Toc371083849)

[Figure 6. All PDM Snapshots file example excerpt 18](#_Toc371083850)

[Figure 7. Transmitted BSM snapshots file example excerpt 19](#_Toc371083851)

[Figure 8. Extended BSM information file example excerpt 20](#_Toc371083852)

# 

# Introduction

The Trajectory Converter Analysis (TCA) Software is designed to test different strategies for producing, transmitting, and storing Connected Vehicle information. The VISSIM 5.40 add-on (TCA-V) runs with the VISSIM tool using real-time simulation vehicle information, Roadside Equipment (RSE) location information, cellular region information, and strategy information to produce a series of snapshots that the vehicle would produce. Vehicles can be equipped to generate and transmit Probe Data Messages (PDMs) or Basic Safety Messages (BSMs) which can be transmitted by either Dedicated Short Range Communication (DSRC) or via cellular. The TCA program version 2 Build 1 or 2.1 assumes perfect communication between vehicles and RSEs but future versions of the TCA 2 will include simulated communication disruptions. As soon as a vehicle equipped to transmit via DSRC is in range of a RSE, it will download all of its snapshot information directly without any loss of information. Similarly, if the vehicle is equipped to transmit via cellular, it will download all its snapshot information directly but those snapshots might be lost or delayed due to user-defined loss rate and latency. The TCA was programmed in open source Python programming language (<http://www.python.org>) and is protected under the Apache License Version 2 license agreement (<http://www.apache.org/licenses/LICENSE-2.0>).

# Installation and Running the TCA-V

The TCA-V requires the installation of VISSIM 5.40. To install the TCA-V you must have Python version 2.6.2 installed on your computer. The TCA-V will not work in any other versions of Python. Python is available at no charge from <http://www.python.org/download/releases/2.6.2/>. Python runs in Windows, Linux and Mac operating environments and does not have any prerequisites to install.

The TCA also relies on the free external Python libraries Pandas, Numpy and Dateutil. These will need to be installed as well for Python version 2.6.2. These external Python libraries can be found at the following locations:

* Pandas - <http://pandas.pydata.org/>
* Numpy - <http://www.numpy.org/>
* Dateutil - <http://labix.org/python-dateutil>

Also many Python Windows binary files for the libraries can be downloaded from the Unofficial Windows Binaries for Python Extension Packages Website (<http://www.lfd.uci.edu/~gohlke/pythonlibs/>)

Once Python and the additional libraries are installed and working, run the default input file by loading Sample\_Intersection.inp which simulates PDM and BSM equipped vehicles on a simple intersection network with four RSEs. Any additional VISSIM input files must be run from the same directory containing the c2x.ini file and code folder. To run the TCA-V, there must be C2X vehicles in the simulation. Instructions on how to equip vehicles with C2X can be found in Chapter 3 of the VISSIM C2X API guide.

The default configuration is the TCAinput.xml file which enables PDM vehilces (Type 1) to transmit via Cellular and BSM vehicles (Type 2) to transmit via DSRC. Any changes to this configuration must be made by either editing TCAinput.xml or by specifying the new control file in the c2x.ini file. See the comment on line 1of c2x.ini for an example of how to specify a different control file.

# Input Files

## File Requirements to Run the TCA-V

In order for the TCA-V to work in real-time with C2X-enabled vehicles in VISSIM, a XML Control file must contain the elements in Table 1.

Table 1. Required Control file fields

| Required | Control File Element(s) | Description |
| --- | --- | --- |
| Market Penetration | PDMVehicleTypes  And/or  BSMVehicleTypes | The control file must define which vehicles are equipped to generate and transmit either PDM or BSM snapshots. This is defined by selecting specific vehicle types (these are the C2X vehicles in VISSIM). Vehicles currently cannot be equipped to generate/transmit **both** PDMs and BSMs. Therefore, the user must have two or more types of C2X vehicles in VISSIM to generate both PDM and BSM output. |
| RSE Location File is required if PDMs and/or BSMs will be transmitted via DSRC | RSELocationFile | Name of the file containing the names and coordinates of the RSEs. See Table 4 for more information. |

## Control File

The Control file is an XML format input file that contains all information about the names of all other input and output files for the TCA. Some elements in the Control file have default values and do not need to be included in the Control file unless the user wants to change the value. Required elements are marked with a symbol (see Table 2) depending on the model type. The Control file has the structure outlined in Table 3 and an example is shown in Figure 1.

Table 2. Symbol Key

| Symbol | Description |
| --- | --- |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900441505[1].png | Required for DSRC communication |
| No Symbol | Optional element |

Table 3: Control file fields

| Sym. | Enclosing Element | Element | Description | Values |
| --- | --- | --- | --- | --- |
|  | ControlFile | OutputLevel | Integer value determining how much information is output by the TCA:  0=None  1=Just major events  2=All Snapshot activities  3=Maximum output | Integer |
|  | ControlFile | Title | Title for the scenario | Character String |
|  | ControlFile | Seed | Number used to initialize the random number generator | Integer |
|  | EquippedVehicles | PDMVehicleTypes | List of vehicle types separated by a comma that are equipped to generate and transmit PDMs (TypeColumn in the CSVTrajectoryFileFields must be specified). | Character String |
|  | EquippedVehicles | BSMVehicleTypes | List of vehicle types separated by a comma that are equipped to generate and transmit BSMs (TypeColumn in the CSVTrajectoryFileFields must be specified) | Character String |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900441505[1].png | InputFiles | RSELocationFile | Name of the RSE location file that has all RSE information in it | Character String |
|  | InputFiles | StrategyFile | Name of the XML based strategy file that the TCA will use | Character String |
|  | OutputFiles | PDMAllFile | Name of the output file that will contain all of the PDMs generated by the TCA | Character String |
|  | OutputFiles | PDMTransFile | Name of the output file that will contain all of the transmitted PDM information. | Character String |
|  | OutputFiles | BSMTransFile | Name of the output file that will contain all of the transmitted BSM information | Character String |
|  | OutputFiles | BSMExtendedFile | Name of the output file that will contain additional information on transmitted BSMs | Character String |
|  | OutputFiles | BSMExtendedFlag | Option (0 or 1) to produce a transmitted BSM file that contains extra information for debugging purposes | Integer |
|  | ControlFile | ColorDisplayDuration | Duration to display color on the car:  Blue: BSM equipped vehicles  Black: PDM transmission Purple: PDM Periodic generation  Orange: PDM Stop generation  Green: PDM Start generation | Integer (seconds) |

## 

Figure 1. Control file example with PDM and BSM vehicles

## RSE Location File

The RSE Location file is a comma-delimited file that contains geographical location information for the RSEs. This file is only required if PDM and/or BSM vehicles will transmit via DSRC.

This file must have a header line and only the fields from Table 4 in the exact order listed are required. An example of an RSE Location File is shown in Figure 2.

Table 4: RSE location file fields

| Column | Name | Description | Value |
| --- | --- | --- | --- |
| 1 | Name | String based name for RSE. This name is output in the TCA snapshots | Character String |
| 2 | X | X location of the RSE in feet | Integer (feet) |
| 3 | Y | Y location of the RSE in feet | Integer (feet) |



Figure 2. RSE Locations File Example

## Strategy File

The Strategy file is an XML based file that stores all information for controlling how the TCA handles snapshot generation, RSE interaction, buffer management, and Probe Segment Number (PSN) generation. The Strategy file can be set to run the J2735 standard or several variations of the standard. Every element has a default value so a Strategy file is only necessary if the user wants to change the value of an element. For example, PSN gaps are turned off by default and a Strategy file must be used to turn them on and change the gap parameters if desired (see Figure 3).

Elements that are required for different TCA model variations are noted with their respective symbol. (see Figure 5). The Strategy file has the fields in Table 6 and an example is shown in Figure 3.

Table 5. Symbol Key

| Symbol | Description |
| --- | --- |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Required element for a Cellular model |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Required element for a DSRC model |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\OZ4HO43N\MC900441494[1].png | Required element when PSN Gaps are enabled |
| No Symbol | Always Optional |

Table 6: Strategy file fields

| Sym. | Root Element(s) | Element | Description | Value |
| --- | --- | --- | --- | --- |
|  | Strategy | Title | Title of the strategy | Character String |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PSNStrategy | TimeBetweenPSNSwitches | Time between PSN changes | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PSNStrategy | DistanceBetweenPSNSwitches | Distance between PSN changes | Integer (feet) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PSNStrategy | RSEFlag | Include last RSE location with each snapshot (0-false, 1-true) | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PSNStrategy | Gap | Gap Setting for TCA:  0-No gaps  1-Gaps on | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  StopStartStrategy | Strategy | Stop/Start Strategy can be:  1 - Max time and speed (both time and speed trigger start/ stop snapshot)  2 - Max Distance or time (either distance traveled or time motionless triggers start/stop) | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  StopStartStrategy | StopThreshold | Vehicle must be stopped at least this long to create a stop snapshot | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  StopStartStrategy | StopLag | Time in seconds that must pass before a 2nd stop snapshot can be taken | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  StopStartStrategy | StartThreshold | Speed in mph that a vehicle must have after a stop before a start snapshot can be taken | Integer (mph) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  StopStartStrategy | MultipleStops | Can more than one stop SS in a row be taken, 0-false 1-true | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PeriodicStrategy | Strategy | Periodic Strategy can be:  1 - Speed interpolation (Periodic SS taken based on speed value) | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PeriodicStrategy | LowSpeedThreshold | The time to the next periodic snapshot uses these values. If the vehicle’s speed is below the LowSpeedThreshold, the ShortSpeedinterval is used as the time to the next periodic. If the vehicle’s speed is above the HighSpeedThreshold, the LongSpeedinterval is used. If the speed is between the thresholds, the time is interpolated. | Integer(mph) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PeriodicStrategy | ShortSpeedinterval | See LowSpeedThreshold | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/DSRC/ PeriodicStrategy | HighSpeedThreshold | See LowSpeedThreshold | Integer (mph) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PeriodicStrategy | LongSpeedInterval | See LowSpeedThreshold | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  PeriodicStrategy | MaxDeltaSpeed | Percentage change in speed, periodic strategy 2 only | Float (%) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].pngC:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  DSRC/  BufferStrategy | TotalCapacity | Snapshot capacity for the buffer | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  BufferStrategy | SSRetention | Buffer Retention Strategy can be:  1 – FIFO  2 – Every other snapshot  3 – Every other plus keep the first and the last IDs  4 – Every other plus save the oldest SS | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  RSEInformation | MinRSERange | Minimum range in feet that vehicles can communicate to RSEs | Integer (feet) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  RSEInformation | MaxRSERange | Maximum range in feet that vehicles can communicate to RSEs | Integer (feet) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  RSEInformation | TimeoutRSE | Time in seconds that must pass before a vehicle can communicate with an RSE after just communicating with one | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  RSEInformation | MinNumberofSStoTransmit | Minimum number of snapshots to transmit | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900433804[1].png | Inputs/  DSRC/  RSEInformation | RSEReports | Number of times a vehicle may transmit snapshots to a given RSE before going out of range | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\OZ4HO43N\MC900441494[1].png | Inputs/  DSRC/  GapInformation | MinTime | Min time in seconds for random generation of gap | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\OZ4HO43N\MC900441494[1].png | Inputs/  DSRC/  GapInformation | MaxTime | Max time in seconds for random generation of gap | Integer (seconds) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\OZ4HO43N\MC900441494[1].png | Inputs/  DSRC/  GapInformation | MinDistance | Min distance in feet for random generation of gap | Integer (feet) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\OZ4HO43N\MC900441494[1].png | Inputs/  DSRC/  GapInformation | MaxDistance | Max distance in feet for random generation of gap | Integer (feet) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular | PDMCellularFlag | PDMs can be transmitted via cellular:  0: Off  1: On | Integer (0 or 1) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular | BSMCellularFlag | BSMs can be transmitted via cellular:  0: Off  1: On | Integer (0 or 1) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular | MinNumberofSStoTransmitViaCellular | Minimum number of snapshots to transmit via cellular | Integer |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular | DefaultLossPercent | Default loss percentage of snapshots transmitted via cellular | Integer (%) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular | DefaultLatency | Default lag of snapshot transmission via cellular | Integer (ms) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular/  Regions/  Region# (where # is replaced by an integer in the range 1-7) | Point1 | Coordinates separated by a comma of the top left point of the rectangular cellular region | Character String |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular/  Regions/  Region# (where # is replaced by an integer in the range 1-7) | Point2 | Coordinates separated by a comma of the bottom right point of the rectangular cellular region | Character String |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular/  Regions/  Region# (where # is replaced by an integer in the range 1-7) | LossPercent | Loss percentage of snapshots transmitted via cellular | Integer (%) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular/  Regions/  Region# (where # is replaced by an integer in the range 1-7) | Latency | Lag of snapshot transmission via cellular | Integer (ms) |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900442135[1].png | Inputs/  Cellular/  Regions/  Region# (where # is replaced by an integer in the range 1-7) | Name | Name of the cellular region | Character String |

## 

Figure 3. Strategy file example with gaps enabled

# Output Files

## TCA Input Summary File

The TCA Input Summary File is a comma-delimited file that is always produced and lists every Control and Strategy element and their values. This file also includes an error message if an element is incorrectly defined. The file contains the items from Table 7 for each element of the Control and Strategy files. An excerpt of an example TCA Input Summary file is shown in Figure 4.

Table 7. TCA Input Summary file fields

|  |  |
| --- | --- |
| Column | Description |
| FILE | The name of the file, either the name of the Control or Strategy file, from which the element is located |
| NAME | Name of the element |
| VALUE | Value of the element |
| XML\_TAG | The XML tag of the element |
| TYPE | Can be either Default or User-Defined |
| ERRORS | Error message, if any |

## 

Figure 4. TCA Input Summary file example excerpt

## Transmitted PDMs File

The Transmitted PDM file is a comma delimited file that stores all PDM snapshot information that is transmitted to RSEs or via cellular, based on the RSE or cellular region locations and the strategy implemented in the TCA. The first line of the Transmitted Snapshot file is a header line describing all of the fields. The Transmitted Snapshot file contains the data elements from Table 8 on each line. An excerpt from an example Transmitted PDM file is shown in Figure 5.

Table 8: Transmitted snapshot file fields

| Column | Name | Description | Value |
| --- | --- | --- | --- |
| 1 | Time Taken | Time that the snapshot was taken | Integer |
| 2 | PSN | The PSN number for the snapshot | Integer |
| 3 | Speed | Speed in mph that the vehicles were going then the snapshot was taken | Float (mph) |
| 4 | X | X value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 5 | Y | Y value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 6 | Transmit To | RSE or cellular region the snapshot was transmitted to | Character String |
| 7 | Transmit Time | The time the snapshot was transmitted | Integer |
| 8 | Message number | The order of the message within a transmission. Snapshots are transmitted in messages containing up to 4 snapshots | Integer |
| 9 | Snapshot number | Position of the snapshot within the message | Integer |

## 

Figure 5. Transmitted PDM snapshots file example excerpt

## All PDM Snapshots File

The All PDM Snapshots file is a debugging comma delimited file that stores all PDM snapshot information including PDM snapshots that were deleted and not transmitted to an RSE. This file includes: type of snapshot taken, vehicle ID, whether the snapshot was deleted and why. The first line of the All Snapshots file is a header with all the field titles. The All PDM Snapshots file has the fields listed in Table 9. An excerpt of an example All PDM Snapshots file is shown in Figure 6.

Table 9: All PDM snapshots file fields

| Column | Name | Description | Value |
| --- | --- | --- | --- |
| 1 | Vehicle ID | ID of the vehicles as stated in the vehicle trajectory file | Character String |
| 2 | SS Number | The number of the snapshot. Snapshot numbers start at 1 for each vehicle | Integer |
| 3 | Time Taken | Time that the snapshot was taken | Integer |
| 4 | PSN | The PSN number for the snapshot | Integer |
| 5 | Speed | Speed in mph that the vehicles were going then the snapshot was taken | Float (mph) |
| 6 | X | X value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 7 | Y | Y value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 8 | Last Transmitted To | The name of the last RSE or cellular region that the vehicle transmitted to (only included if RSEFlag option is turned on in the Strategy file) | Character String |
| 9 | Type | Snapshot type (1-stop, 2-start, 3- periodic) | Integer |
| 10 | Transmit Time | The time the snapshot was transmitted to an RSE (-1 if not transmitted) | Integer |
| 11 | Transmit To | RSE or cellular region the snapshot was transmitted to (-1 if not transmitted) | Character String |
| 12 | Delete Time | Time the snapshot was deleted from the buffer. This value is 0 if the snapshot was not deleted | Integer |
| 13 | Delete Reason | Reason the snapshot was deleted (0-Not deleted, 1- Buffer overload, 2-Left in the buffer after the vehicle trajectory stopped, 3-PSN rollover gap, 4- RSE interaction, 5- Snapshot lost during cellular transmission) | Integer |

## 

Figure 6. All PDM Snapshots file example excerpt

## Transmitted BSM File

The Transmitted BSM file is a comma delimited file that stores all BSM snapshot information that is transmitted via DSRC or cellular, based on the RSE or cellular region locations and the strategy implemented in the TCA. The first line of the Transmitted Snapshot file is a header line describing all of the fields. The Transmitted Snapshot file contains the data elements from Table 10 on each line. An excerpt from an example file of transmitted BSMs is shown in Figure 7.

Table 10. Transmitted BSM File Fields

| Column | Name | Description | Value |
| --- | --- | --- | --- |
| 1 | Vehicle ID | ID of the vehicles as stated in the vehicle trajectory file | Character String |
| 2 | Message number | The order of the message within a transmission. Snapshots are transmitted in messages containing up to 4 snapshots | Integer |
| 3 | Snapshot number | Position of the snapshot within the message | Integer |
| 4 | Time Taken | Time that the snapshot was taken | Integer |
| 5 | X | X value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 6 | Y | Y value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 7 | Speed | Speed in mph that the vehicle was going when the snapshot was taken | Float (mph) |
| 8 | Average Acceleration | Average acceleration that the vehicle was going between the previous snapshot and the current snapshot | Float (?) |

## 

Figure 7. Transmitted BSM snapshots file example excerpt

## Extended Information BSM File

The Extended Information BSM file is a debugging comma delimited file that stores extra information on top of what was included in the Transmitted BSM file. This file is optional to the user and can be included by using the BSMExtendedFlag option in the Control file. The first line of the Extended Information BSM file is a header line describing all of the fields. The file contains the data elements from Table 11 on each line. And excerpt from an example Extended Information BSM file is shown in Figure 8.

Table 11. Extended Information BSM File Fields

| Column | Name | Description | Value |
| --- | --- | --- | --- |
| 1 | Vehicle ID | ID of the vehicles as stated in the vehicle trajectory file | Character String |
| 2 | Message number | The order of the message within a transmission. Snapshots are transmitted in messages containing up to 4 snapshots. | Integer |
| 3 | Snapshot number | Position of the snapshot within the message | Integer |
| 4 | Time Taken | Time that the snapshot was taken | Integer |
| 5 | X | X value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 6 | Y | Y value in feet for the location of the vehicle when the snapshot was taken | Integer (feet) |
| 7 | Speed | Speed in mph that the vehicle was going when the snapshot was taken | Float (mph) |
| 8 | Average Acceleration | Average acceleration that the vehicle was going between the previous snapshot and the current snapshot | Float (?) |
| 9 | Last Transmitted To | The name of the last RSE or cellular region that the vehicle transmitted to | Character String |
| 10 | Type | Snapshot type (4-BSM snapshot) | Integer |
| 11 | Transmit Time | The time the snapshot was transmitted to an RSE (-1 if not transmitted) | Integer |
| 12 | Transmit To | RSE or cellular region the snapshot was transmitted to (-1 if not transmitted) | Character String |

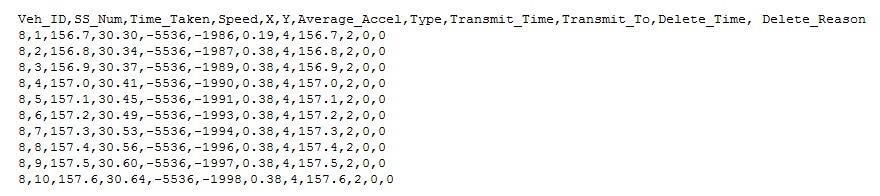


Figure 8. Extended BSM information file example excerpt

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