Trajectory Convertor Analysis User Manual

Version 2.1 Build 1

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Table of Contents

[1 Introduction 5](#_Toc371082823)

[2 Installation and Running the TCA 6](#_Toc371082824)

[3 Input Files 7](#_Toc371082825)

[3.1 File Requirements to Run the TCA 7](#_Toc371082826)

[3.2 Control File 7](#_Toc371082827)

[3.3 Vehicle Trajectory File 10](#_Toc371082828)

[3.4 VISSIM File 11](#_Toc371082830)

[3.5 RSE Location File 12](#_Toc371082832)

[3.6 Strategy File 13](#_Toc371082833)

[4 Output Files 19](#_Toc371082835)

[4.1 TCA Input Summary File 19](#_Toc371082836)

[4.2 Transmitted PDMs File 19](#_Toc371082838)

[4.3 All PDM Snapshots File 20](#_Toc371082840)

[4.4 Transmitted BSM File 22](#_Toc371082842)

[4.5 Extended Information BSM File 23](#_Toc371082844)

List of Tables

[Table 1. Required Control file fields 7](#_Toc371082800)

[Table 2. Symbol Key 8](#_Toc371082801)

[Table 3: Control file fields 8](#_Toc371082802)

[Table 4: Required Vehicle Trajectory file fields 11](#_Toc371082803)

[Table 5. Required VISSIM file fields 11](#_Toc371082804)

[Table 6: RSE location file fields 12](#_Toc371082805)

[Table 7. Symbol Key 13](#_Toc371082806)

[Table 8: Strategy file fields 13](#_Toc371082807)

[Table 9. TCA Input Summary file fields 19](#_Toc371082808)

[Table 10: Transmitted snapshot file fields 19](#_Toc371082809)

[Table 11: All PDM snapshots file fields 20](#_Toc371082810)

[Table 12. Transmitted BSM File Fields 22](#_Toc371082811)

[Table 13. Extended Information BSM File Fields 23](#_Toc371082812)

List of Figures

[Figure 1. Example Control file 10](#_Toc371082813)

[Figure 2. Trajectory file example 11](#_Toc371082814)

[Figure 3. VISSIM (.fzp) file example excerpt 12](#_Toc371082815)

[Figure 4. RSE Locations File Example 13](#_Toc371082816)

[Figure 5. Strategy file example with gaps enabled 18](#_Toc371082817)

[Figure 6. TCA Input Summary file example excerpt 19](#_Toc371082818)

[Figure 7. Transmitted PDM snapshots file example excerpt 20](#_Toc371082819)

[Figure 8. All PDM Snapshots file example excerpt 22](#_Toc371082820)

[Figure 9. Transmitted BSM snapshots file example excerpt 23](#_Toc371082821)

[Figure 10. Extended BSM information file example excerpt 24](#_Toc371082822)

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# Introduction

The Trajectory Converter Analysis (TCA) Software is designed to test different strategies for producing, transmitting, and storing Connected Vehicle information. The TCA reads in and uses vehicle trajectory information in CSV format or VISSIM output, 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

To install the TCA you must have Python version 2.7.5 or later installed on your computer but will not work with Python 3. Python is available at no charge from <http://www.python.org/download/releases/2.7.5>. 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. 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, run the TCA using the provided default input files or by placing all input files into the same directory as the TCA program python files. To run the TCA, type at the command prompt the Python executable name (include the path if the Python path is not included in the system PATH variable) and the TCA program file, followed by the name of the control file. Below shows the order of the items on the command prompt:

C:\>*<python directory>*python TCA2.py *<your control file>*

Example:

C:\>C:\python27\python TCA2.py myinput.xml

The TCA may also run without specifying a control file on the command line. If no control file is given, the software will default to TCAinput.xml as the control file in the same directory as the TCA2.py file. To run the TCA without specifying a control file, edit TCAinput.xml to contain the desired control parameters, and then type:

C:\>*<python directory>*python TCA2.py

Example

C:\>C:\python27\python TCA2.py

# Input Files

## File Requirements to Run the TCA

The first requirement to run the TCA is a comma-delimited file containing vehicle trajectory information (See Section 3.3). In order for the TCA to read the trajectory file, a XML file Control file must contain the elements in Table 1.

Table 1. Required Control file fields

| Required | Control File Element(s) | Description |
| --- | --- | --- |
| Type of trajectory file | FileType | The control file must correctly label the type of trajectory file: either ‘vissim’ or ‘csv’ |
| Name of the trajectory file | TrajectoryFileName | File name of the trajectory file including its extension |
| Column heading names of required trajectory information | XColumn, YColumn, TimeColumn, IDColumn, SpdColumn | For each of the five variables, specify the column header name from the Vehicle Trajectory file where it is found. These fields are **not** required with VISSIM file (.fzp) input. |
| Market Penetration | PDMMarketPenetration, PDMVehicleIDs, or PDMVehicleTypes,  And/or  BSMMarketPenetration, BSMVehicleIDs, or BSMVehicleTypes | The control file must define which vehicles are equipped to generate and transmit either PDM or BSM snapshots. This is defined by either selecting a percentage of all vehicles, specific vehicle IDs, or specific vehicle types. In order to select vehicle types, the control file must specify the column name from the Vehicle Trajectory file where vehicle type is found. Vehicles currently cannot be equipped to generate/transmit **both** PDMs and BSMs. Therefore, if the user defines a separate market penetration for both PDMs and BSMs, the TCA first assigns vehicles to be equipped for PDMs, then assigns BSM equipage out of the remaining vehicles. |
| 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 6 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\315YD8PJ\MC900441511[1].png | Required for CSV trajectory input files |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\TZ13Q51I\MC900441505[1].png | Required for DSRC communication |
| All | Required for every model |
| 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 |
| All | InputFiles/  TrajectoryFile | FileType | Type of file to read into the TCA:  ‘vissim’=VISSIM output file  ‘csv’=Trajectory file | Character String |
| All | InputFiles/  TrajectoryFile | TrajectoryFileName | Name of the trajectory or VISSIM file that has all vehicle trajectory information | Character String |
| C:\Users\M29565\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\315YD8PJ\MC900441511[1].png | InputFiles/  TrajectoryFile/  CSVTrajectoryFileFields | XColumn, YColumn, TimeColumn, IDColumn, SpdColumn | For each of the five variables, specify the column name in the Vehicle Trajectory file where it is found. These fields are not required with VISSIM file input. | Character String |
|  | InputFiles/  TrajectoryFile/  CSVTrajectoryFileFields | TypeColumn | Optional variable to specify the column name in the Vehicle Trajectory file where vehicle type is found | 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 |
|  | EquippedVehicles | PDMMarketPenetration | Percentage of vehicles (0-100) that are equipped to generate and transmit PDMs | Integer |
|  | EquippedVehicles | PDMVehicleIDs | List of Vehicle IDs separated by a comma that are equipped to generate and transmit PDMs | Character String |
|  | 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 | BSMMarketPenetration | Percentage of vehicles (0-100) that are equipped to generate and transmit BSMs | Integer |
|  | EquippedVehicles | BSMVehicleIDs | List of Vehicle IDs separated by a comma that are equipped to generate and transmit BSMs | 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 |
|  | 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 |

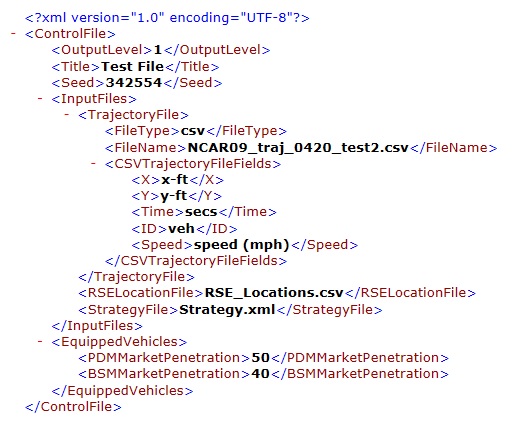


Figure 1. Example Control file

## Vehicle Trajectory File

The Vehicle Trajectory file is a comma-delimited file that stores all trajectory information for a number of vehicles. The trajectory points for each vehicle must be in order by time, although trajectories for different vehicles may be intermingled. The trajectory information should be provided every second, but the TCA will accept files that have shorter or longer time steps or time gaps.

The trajectory file must have a column for each of the following variables in any order: vehicle ID, time in seconds from the beginning of the trajectory, speed of the vehicle, and finally the x and y values for the vehicle location. Fields in the input control file specify the column where each of these variables may be found in the vehicle trajectory file. Other columns in the trajectory file will be ignored.

The first line of the vehicle trajectory file contains all header information for the file. The vehicle trajectory file can have the columns located in any order from Table 4. An example of a trajectory file is shown in Figure 2. Also, the sample control file in Figure 1 shows how to correctly specify, for the TCA, where to locate each column of this particular file of trajectory data.

Table 4: Required Vehicle Trajectory file fields

| Name | Description | Values |
| --- | --- | --- |
| Vehicle ID | Vehicle ID describing the vehicle | Character String |
| Time | Seconds from the beginning of the vehicle trajectory | Integer (seconds) |
| Speed | Speed of the vehicle in mph | Float (mph) |
| x value | X location of the vehicle. These values may be based on longitude | Integer (feet) |
| y value | Y location of the vehicle. These values may be based on latitude | Integer (feet) |

## 

Figure 2. Trajectory file example

## VISSIM File

Instead of a comma-delimited trajectory data file, the TCA can also read in a standard VISSIM (version 5.40) output file (.fzp file) which is created by VISSIM after running a simulation. This file can be obtained by choosing the option in VISSIM to produce the Vehicle Record Evaluation with the required VISSIM fields from Table 5. For additional information about this file please read the VISSIM user guide. An excerpt from an example VISSIM file is shown in Figure 3.

Table 5. Required VISSIM file fields

| Parameter Name | Description | Values |
| --- | --- | --- |
| Vehicle Number (VehNr) | Number (ID) of the vehicle | Integer |
| Speed [mph] (v) | Speed [mph] at the end of the simulation step | Float (mph) |
| Vehicle Type (Type) | Number of the vehicle type | Integer |
| Simulation Time (t) | Seconds from the beginning of the simulation | Float (seconds) |
| World Coordinate Front X (WorldX) | World coordinate x (vehicle front end at the end of the simulation step) | Float (feet) |
| World Coordinate Front Y (WorldY) | World coordinate y (vehicle front end at the end of the simulation step) | Float (feet) |

## 

Figure 3. VISSIM (.fzp) file example excerpt

## 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 6 in the exact order listed are requied. An example of an RSE Location File is shown in Figure 4.

Table 6: 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 4. 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 5).

Elements that are required for different TCA model variations are noted with their respective symbol. (see Figure 7). The Strategy file has the fields in Table 8 and an example is shown in Figure 5.

Table 7. 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 8: 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 5. 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 9 for each element of the Control and Strategy files. An excerpt of an example TCA Input Summary file is shown in Figure 6.

Table 9. 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 6. 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 10 on each line. An excerpt from an example Transmitted PDM file is shown in Figure 7.

Table 10: 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 7. Transmitted PDM snapshots file example excerpt

## All PDM Snapshots File

The All PDM Snapshots file is a comma delimited file that stores all PDM snapshot information including PDM snapshots that were deleted and not transmitted. 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 11. An excerpt of an example All PDM Snapshots file is shown in Figure 8.

Table 11: 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 8. 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 12 on each line. An excerpt from an example file of transmitted BSMs is shown in Figure 9.

Table 12. 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 9. 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 13 on each line. And excerpt from an example Extended Information BSM file is shown in Figure 10.

Table 13. 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) | 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 |

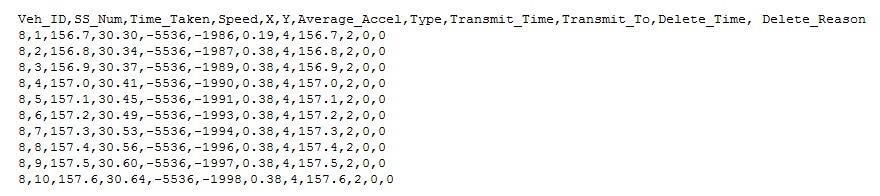


Figure 10. Extended BSM information file example excerpt

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