Open Source SSAM User Manual

New Global Systems for Intelligent Transportation Management

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Document Purpose

Surrogate Safety Assessment Model (SSAM) is a tool for safety analysis. This document provides the details to install and use the Graphical User Interface (GUI) of SSAM 3.0 (referred as SSAM in this document and the download link). SSAMAPP/SSAMAPP_MT is the Windows Executable file name, which does not require installation to run. This document is organized in terms of tabs on the SSAM.

Install SSAM

1. Download the SSAM installation package according to your system type (e.g. 32 or 64 bit).
2. Unzip the package. Then, double click "setup.exe" to start installation. The installation process will first check dependencies for SSAM GUI, so choose to install if any dependency is missing.
3. Follow the wizard to finish the installation.
4. Find SSAMAPP and SSAMAPP_MT in Start Menu >> All Programs >> NGSIM.
5. SSAMAPP_MT is the multi-threading version of SSAMAPP.

Configuration Tab

1. In "Configuration" Tab, add a .trj file for analysis.

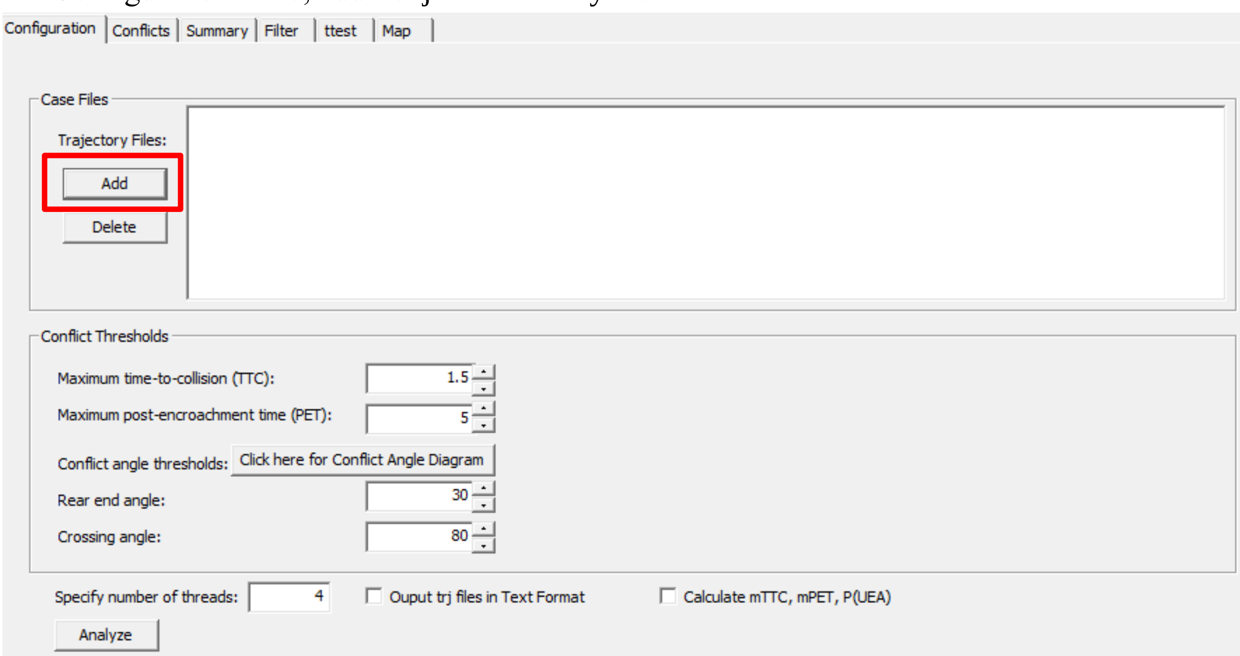


Figure 1 Add a .trj file for analysis

2. Or, open an existing SSAM file to view the previous SSAM results.

Figure 2 Open existing SSAM file

3. Configure conflict thresholds.

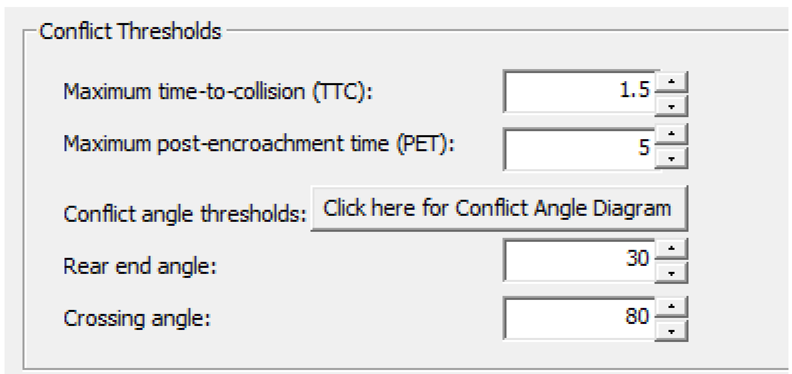


Figure 3 Configure conflict thresholds

4. Specify a number of threads. Note: this option is only available in SSAMAPP_OMPVC.exe. If the number of threads is not specified, the program will use a number that equals to the number of cores, which may not produce best performance. Usually, the performance is best when the number of threads equals to the number of cores. Users are encouraged to experiment with the number of cores.

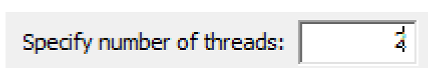


Figure 4 Specify number of threads

To find the number of cores for a system, go to Start >> All Programs >> System Tools >> System Information and find the line highlighted in Figure 5.

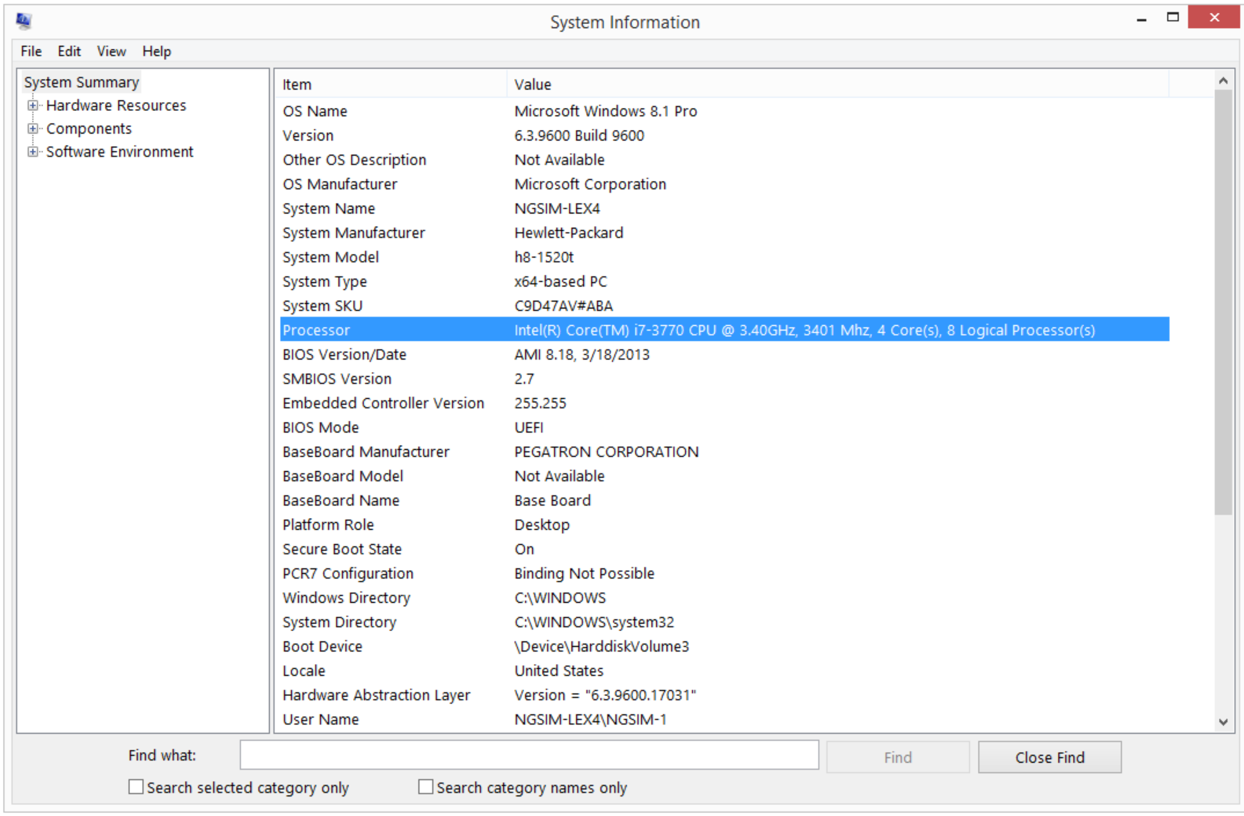


Figure 5 Number of system cores

5. Check “Output .trj files in Text Format” if necessary.

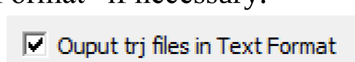


Figure 6 Output .trj files in Text Format

6. Check “Calculate mTTC, mPET, P(UEA)” if desired for analysis. Note: the calculation of these set of measures will take much longer time than the usual SSAM analysis run time as it requires the generates 100 random paths for each vehicle to detect collisions (see Appendix A for more information).

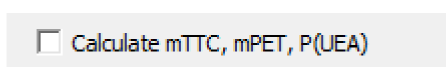


Figure 7 Calculate mTTC, mPET, P(UEA)

7. Click “Analyze”.

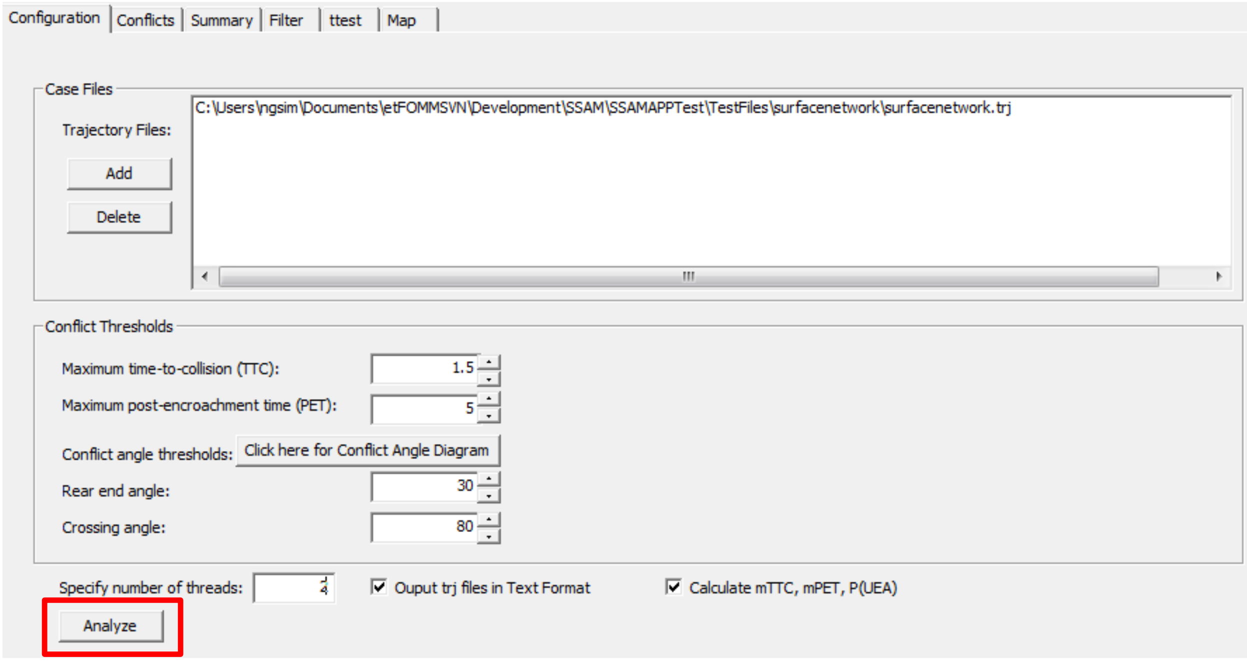


Figure 8 Start analysis

8. Wait until analysis is completed.

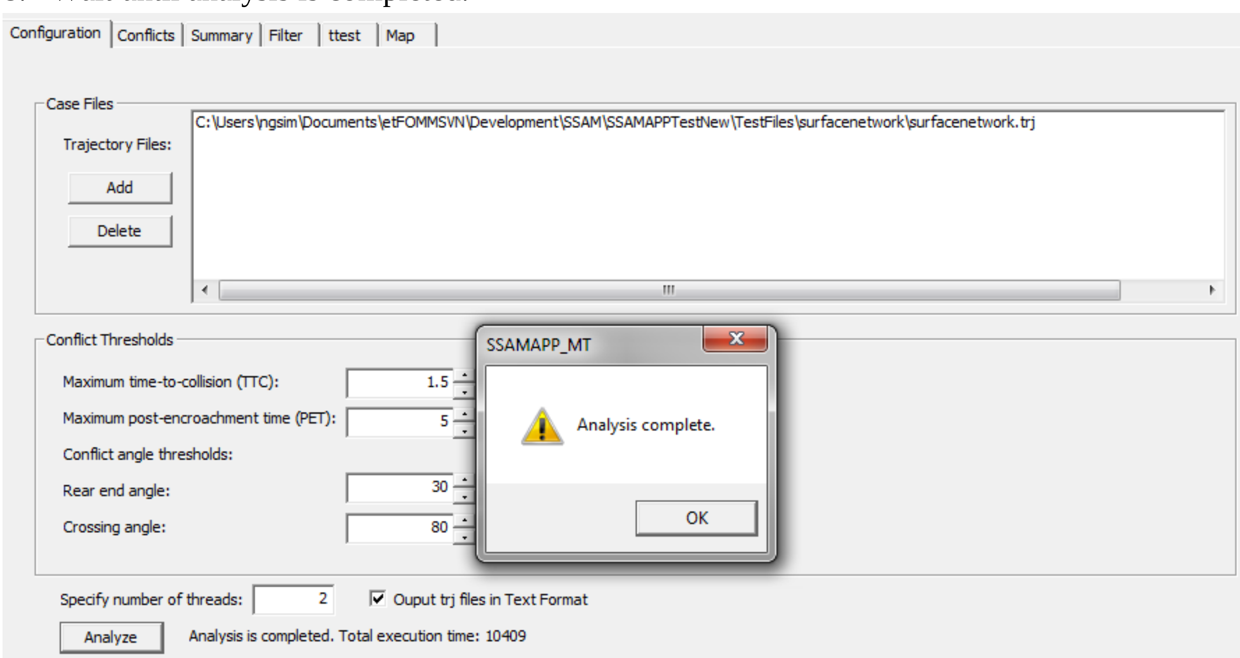


Figure 9 Analysis completion message

9. Find [networkName]_dat.csv file in the input folder if choosing to output .trj files in Text Format.

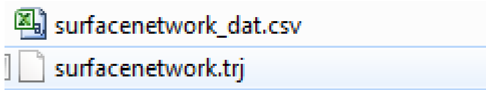


Figure 10 .trj file in .txt format

10. Save the analysis results to a SSAM file if necessary. Note: the SSAM file can be opened only in the GUI of SSAM V3.0.

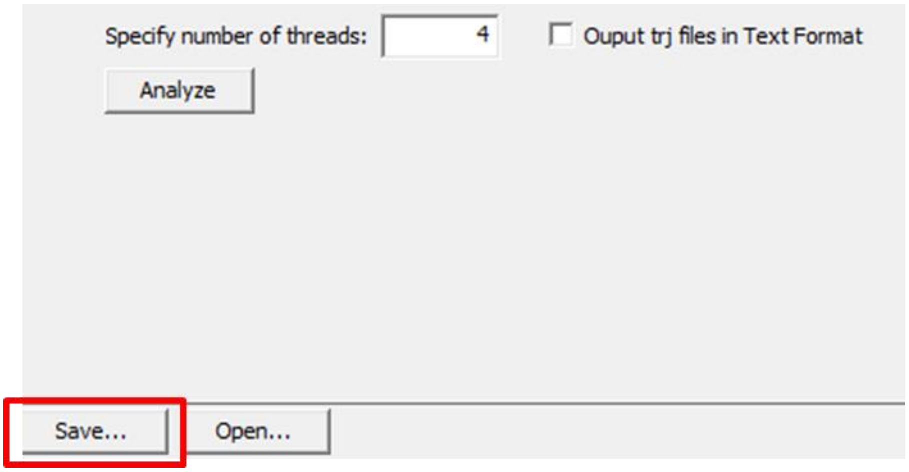
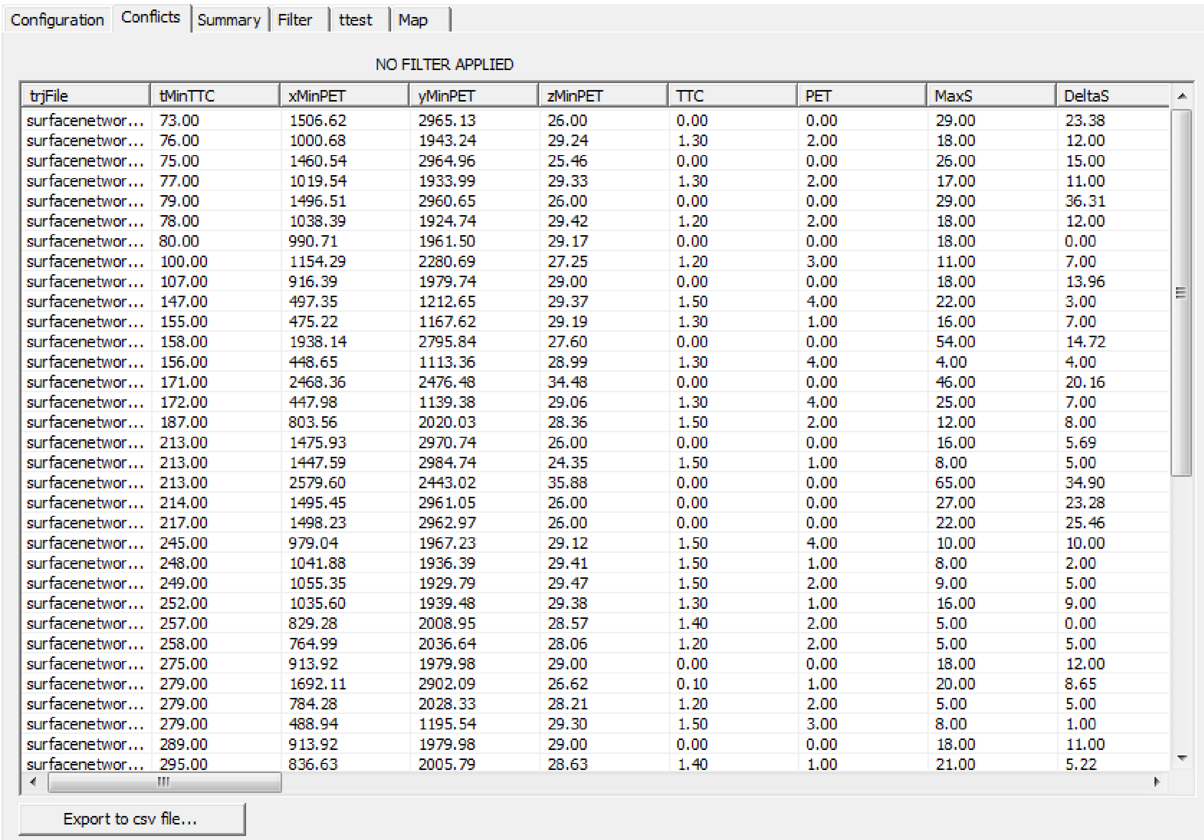


Figure 11 Save analysis to SSAM file

Conflict Tab

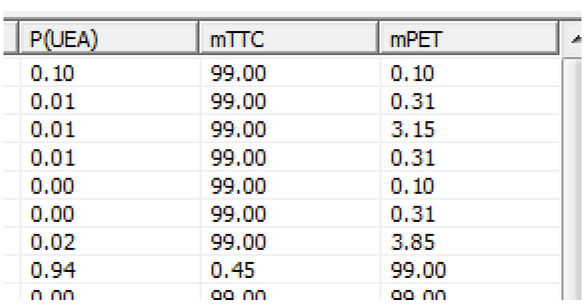
1. View conflict list in “Conflicts” Tab and click “Export to csv file…” to save conflict list to a csv file.



trjFile	tMinTTC	xMinPET	yMinPET	zMinPET	TTC	PET	MaxS	DeltaS
surfacenetwor...	73.00	1506.62	2965.13	26.00	0.00	0.00	29.00	23.38
surfacenetwor...	76.00	1000.68	1943.24	29.24	1.30	2.00	18.00	12.00
surfacenetwor...	75.00	1460.54	2964.96	25.46	0.00	0.00	26.00	15.00
surfacenetwor...	77.00	1019.54	1933.99	29.33	1.30	2.00	17.00	11.00
surfacenetwor...	79.00	1496.51	2960.65	26.00	0.00	0.00	29.00	36.31
surfacenetwor...	78.00	1038.39	1924.74	29.42	1.20	2.00	18.00	12.00
surfacenetwor...	80.00	990.71	1961.50	29.17	0.00	0.00	18.00	0.00
surfacenetwor...	100.00	1154.29	2280.69	27.25	1.20	3.00	11.00	7.00
surfacenetwor...	107.00	916.39	1979.74	29.00	0.00	0.00	18.00	13.96
surfacenetwor...	147.00	497.35	1212.65	29.37	1.50	4.00	22.00	3.00
surfacenetwor...	155.00	475.22	1167.62	29.19	1.30	1.00	16.00	7.00
surfacenetwor...	158.00	1938.14	2795.84	27.60	0.00	0.00	54.00	14.72
surfacenetwor...	156.00	448.65	1113.36	28.99	1.30	4.00	4.00	4.00
surfacenetwor...	171.00	2468.36	2476.48	34.48	0.00	0.00	46.00	20.16
surfacenetwor...	172.00	447.98	1139.38	29.06	1.30	4.00	25.00	7.00
surfacenetwor...	187.00	803.56	2020.03	28.36	1.50	2.00	12.00	8.00
surfacenetwor...	213.00	1475.93	2970.74	26.00	0.00	0.00	16.00	5.69
surfacenetwor...	213.00	1447.59	2984.74	24.35	1.50	1.00	8.00	5.00
surfacenetwor...	213.00	2579.60	2443.02	35.88	0.00	0.00	65.00	34.90
surfacenetwor...	214.00	1495.45	2961.05	26.00	0.00	0.00	27.00	23.28
surfacenetwor...	217.00	1498.23	2962.97	26.00	0.00	0.00	22.00	25.46
surfacenetwor...	245.00	979.04	1967.23	29.12	1.50	4.00	10.00	10.00
surfacenetwor...	248.00	1041.88	1936.39	29.41	1.50	1.00	8.00	2.00
surfacenetwor...	249.00	1055.35	1929.79	29.47	1.50	2.00	9.00	5.00
surfacenetwor...	252.00	1035.60	1939.48	29.38	1.30	1.00	16.00	9.00
surfacenetwor...	257.00	829.28	2008.95	28.57	1.40	2.00	5.00	0.00
surfacenetwor...	258.00	764.99	2036.64	28.06	1.20	2.00	5.00	5.00
surfacenetwor...	275.00	913.92	1979.98	29.00	0.00	0.00	18.00	12.00
surfacenetwor...	279.00	1692.11	2902.09	26.62	0.10	1.00	20.00	8.65
surfacenetwor...	279.00	784.28	2028.33	28.21	1.20	2.00	5.00	5.00
surfacenetwor...	279.00	488.94	1195.54	29.30	1.50	3.00	8.00	1.00
surfacenetwor...	289.00	913.92	1979.98	29.00	0.00	0.00	18.00	11.00
surfacenetwor...	295.00	836.63	2005.79	28.63	1.40	1.00	21.00	5.22

Figure 12 Conflict tab

2. View values of original safety measures and new added measures such as P(UEA), mTTC, mPET.

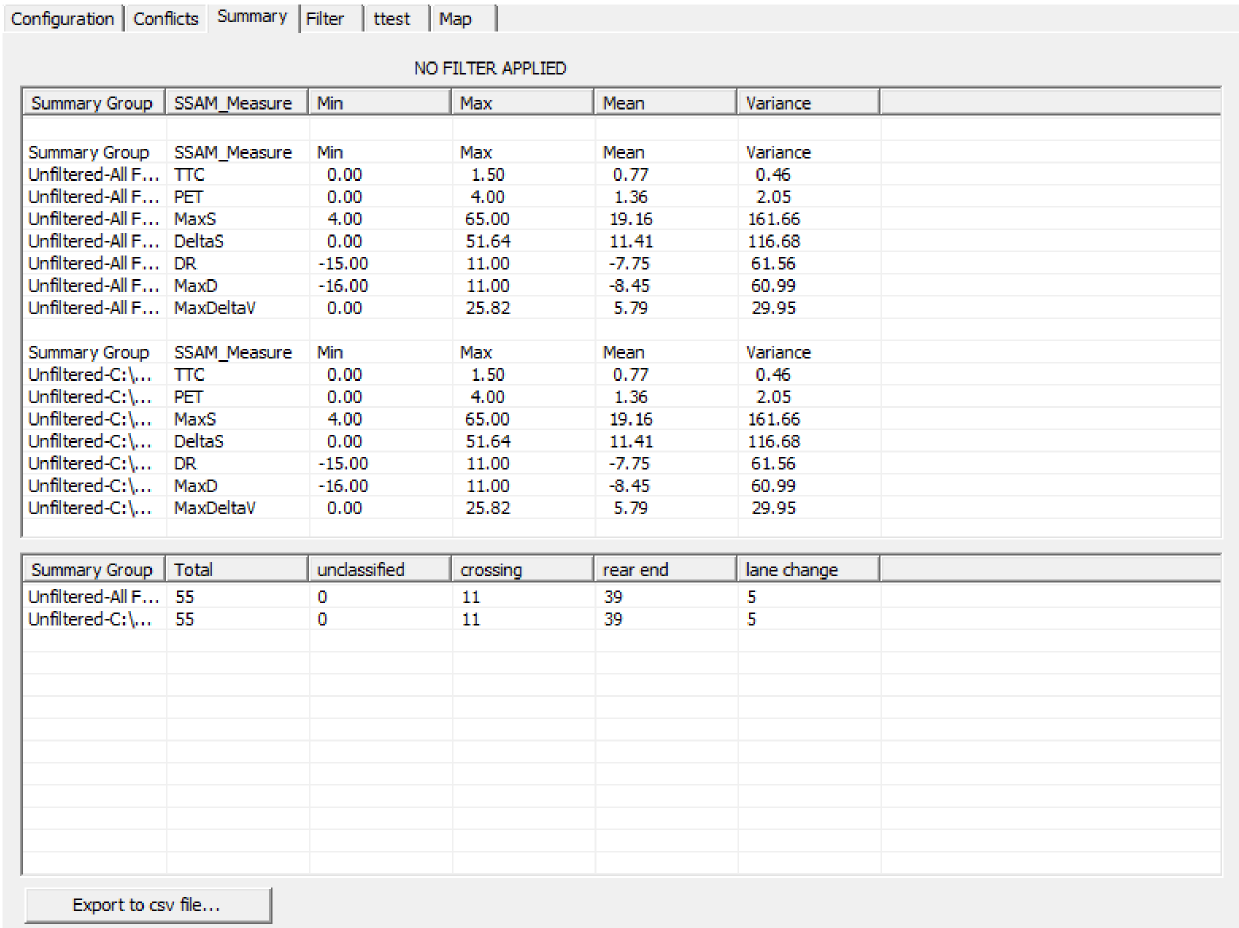


P(UEA)	mTTC	mPET
0.10	99.00	0.10
0.01	99.00	0.31
0.01	99.00	3.15
0.01	99.00	0.31
0.00	99.00	0.10
0.00	99.00	0.31
0.02	99.00	3.85
0.94	0.45	99.00
0.00	99.00	99.00

Figure 13 View safety measures

Summary Tab

1. View conflict summary in “Summary” Tab and click “Export to csv file…” to save conflict summary to a csv file.



Summary Group	SSAM_Measure	Min	Max	Mean	Variance
Summary Group	SSAM_Measure	Min	Max	Mean	Variance
Unfiltered-All F…	TTC	0.00	1.50	0.77	0.46
Unfiltered-All F…	PET	0.00	4.00	1.36	2.05
Unfiltered-All F…	MaxS	4.00	65.00	19.16	161.66
Unfiltered-All F…	DeltaS	0.00	51.64	11.41	116.68
Unfiltered-All F…	DR	-15.00	11.00	-7.75	61.56
Unfiltered-All F…	MaxD	-16.00	11.00	-8.45	60.99
Unfiltered-All F…	MaxDeltaV	0.00	25.82	5.79	29.95
Summary Group	SSAM_Measure	Min	Max	Mean	Variance
Unfiltered-C:\…	TTC	0.00	1.50	0.77	0.46
Unfiltered-C:\…	PET	0.00	4.00	1.36	2.05
Unfiltered-C:\…	MaxS	4.00	65.00	19.16	161.66
Unfiltered-C:\…	DeltaS	0.00	51.64	11.41	116.68
Unfiltered-C:\…	DR	-15.00	11.00	-7.75	61.56
Unfiltered-C:\…	MaxD	-16.00	11.00	-8.45	60.99
Unfiltered-C:\…	MaxDeltaV	0.00	25.82	5.79	29.95

Summary Group	Total	unclassified	crossing	rear end	lane change
Unfiltered-All F…	55	0	11	39	5
Unfiltered-C:\…	55	0	11	39	5

Figure 14 Summary tab

Map Tab

1. View conflict map in “Map” Tab. Note: links and intersections are drawn if Intersection Model compatible network description files are provided in the same folder as the .trj file; otherwise, only conflict points are drawn[1]. Use “Map Switch” button to show or hide the links and intersections if they are drawn.

   Control on map:

   1.1.1. Use the mouse scroll wheel to zoom in or out.

   1.1.2. Hold scroll wheel down as you move the mouse to pan left/right or up/down.

   1.1.3. Hold the mouse left key as you move the mouse to change the view point.

   1.1.4. Click the mouse left key to stop the view continuous rolling.

   1.1.5. Click “Reset” button to recover the view to the initial status.

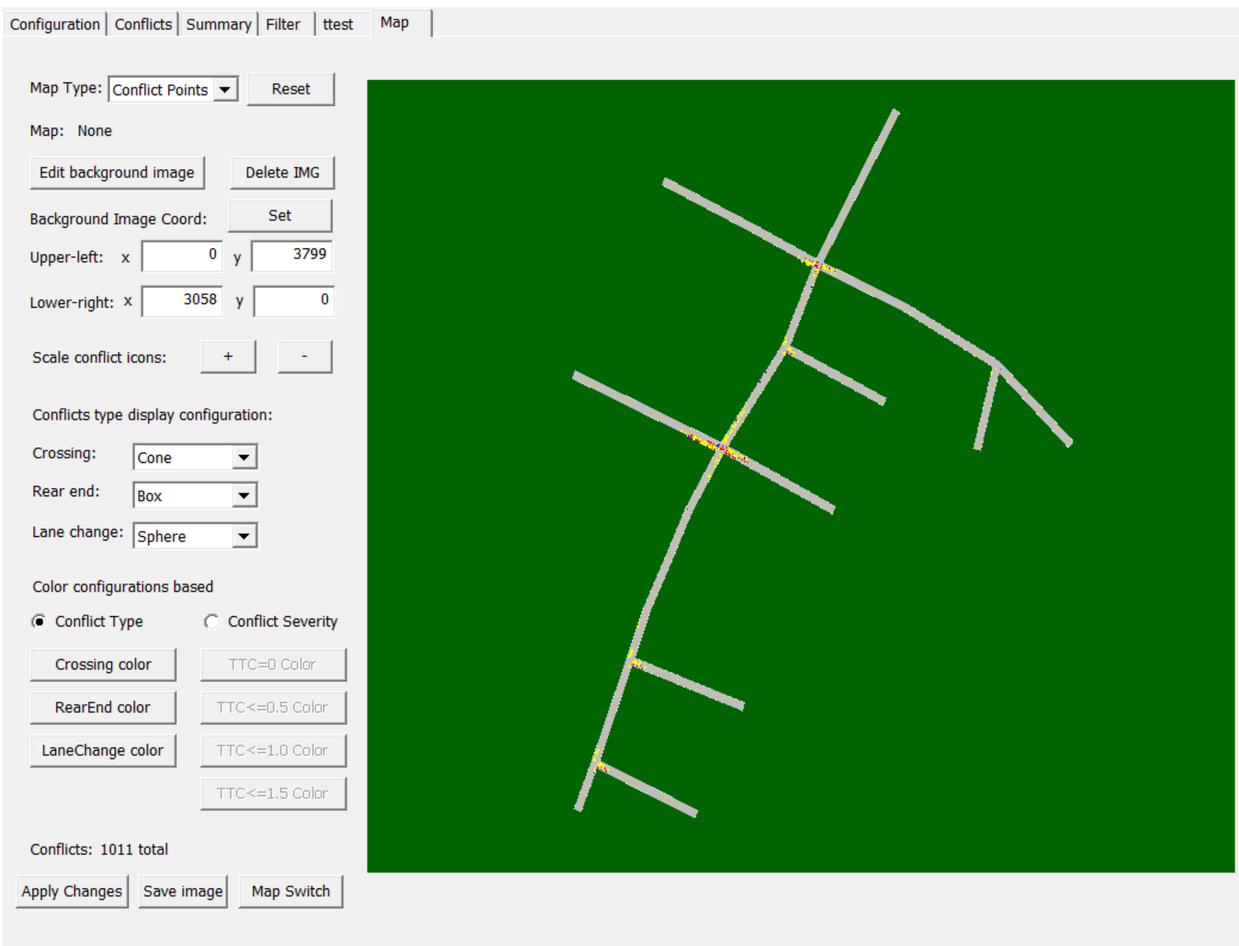
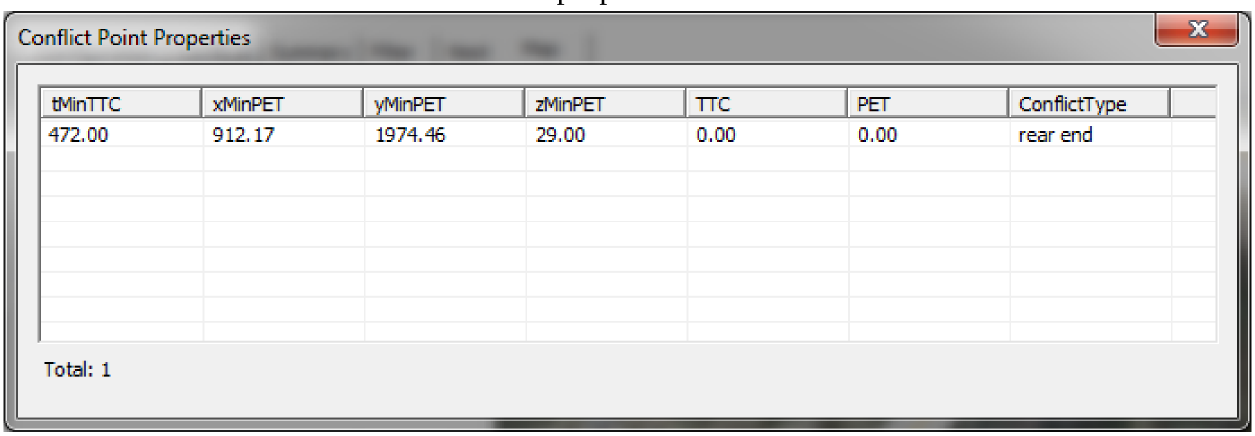


Figure 15 View conflict map

[1] 3D Map roadway background discussed in Map Tab is created by utilizing some of proprietary source code and will not available for Open Source SSAM 3.0. However, New Global System may provide the 3D Map roadway background function with/without charges. Please contact ngsim@ngsim.com or (662)-341-5724 for details.

Note: Intersection Model is a program developed by New Global Systems Corp. to calculate the details in the link and lane shapes, intersection shapes, and vehicle moving paths. The Intersection Model compatible files can be generated by running ETFOMM simulation. The Enhanced Transportation Flow Open source Microscopic Model (ETFOMM) is a software product sponsored by USDOT under the "Microscopic Traffic Simulation Models and Software—An Open Source Approach" research project. As an open source software, ETFOMM inherits 40 years of FHWA development of traffic simulation algorithms and flow theories, while overcoming CORSIM's limitations in supporting research. ETFOMM takes a CORSIM TRF file as input and outputs a set of text files in the format compatible with Intersection Model. ETFOMM download information can be found in http://www.etfomm.org. Besides ETFOMM, any set of network description files in the Intersection Model compatible format can be used in SSAM to draw network layout[1]. The Intersection Model compatible format can be found in Appendix B.

2. Left-click on icons to view the conflict properties.



tMinTTC	xMinPET	yMinPET	zMinPET	TTC	PET	ConflictType
472.00	912.17	1974.46	29.00	0.00	0.00	rear end

Figure 16 View conflict point properties

3. Right-click on two diagonal points to filter conflict points. The selected area is zoomed in and the data is updated in "Conflict" and "Summary" tabs. For example, right-click on the two positions indicated by the red points will change to view to that area. Note: red points in the screenshot are for the purpose of demonstrating the positions to click and they are not actually displayed in the map.

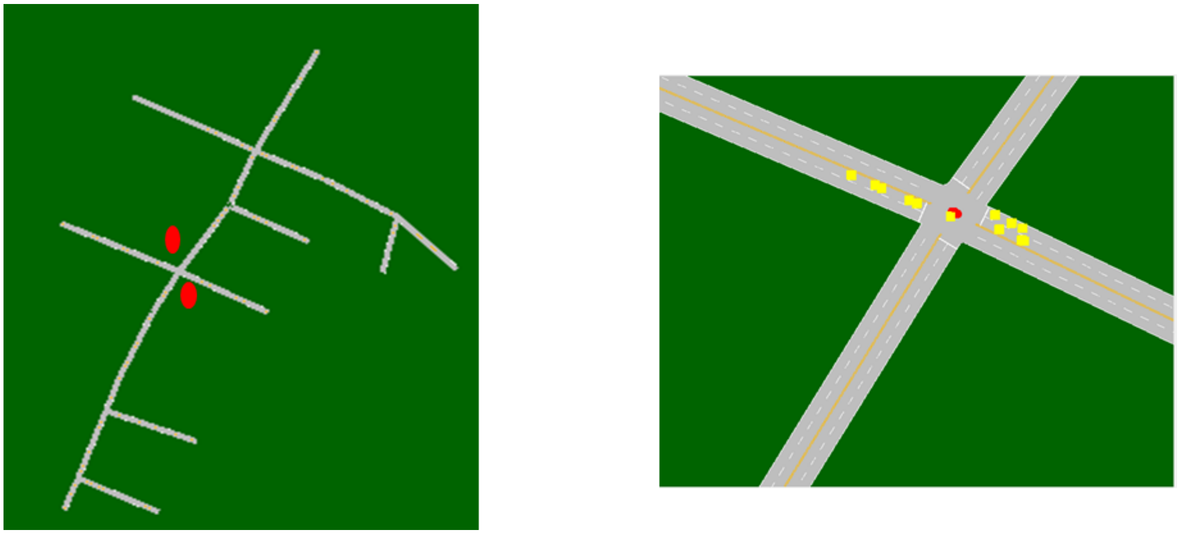


Figure 17 Filter by selecting map area

4. Click “Edit background image” to add background image (.jpg format); click “Delete IMG” to remove the background image from the map.

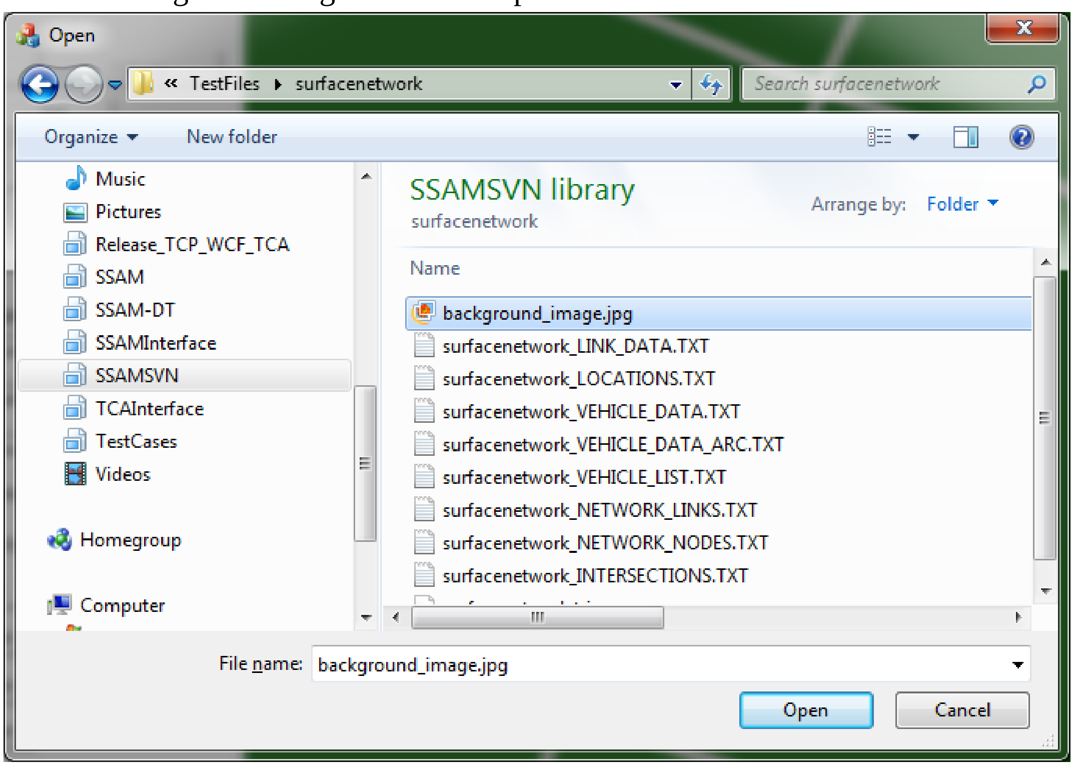


Figure 18 Select background image

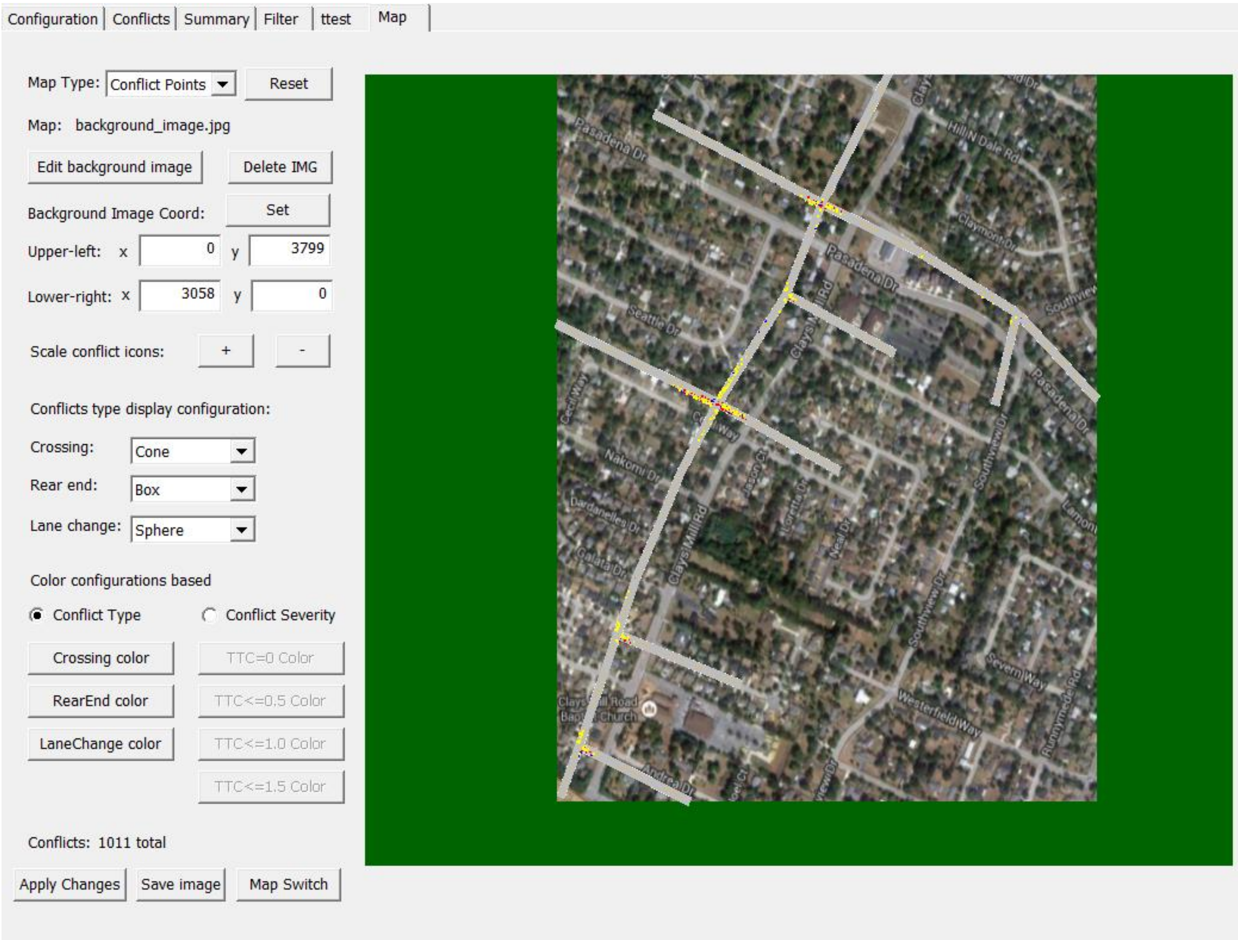


Figure 19 Map with background image

5. Set “Background Image Coord:” to adjust background image to match the network as close as possible: in this example, set the following values: upper-left (-29, 4200), lower-right (2829, 0).

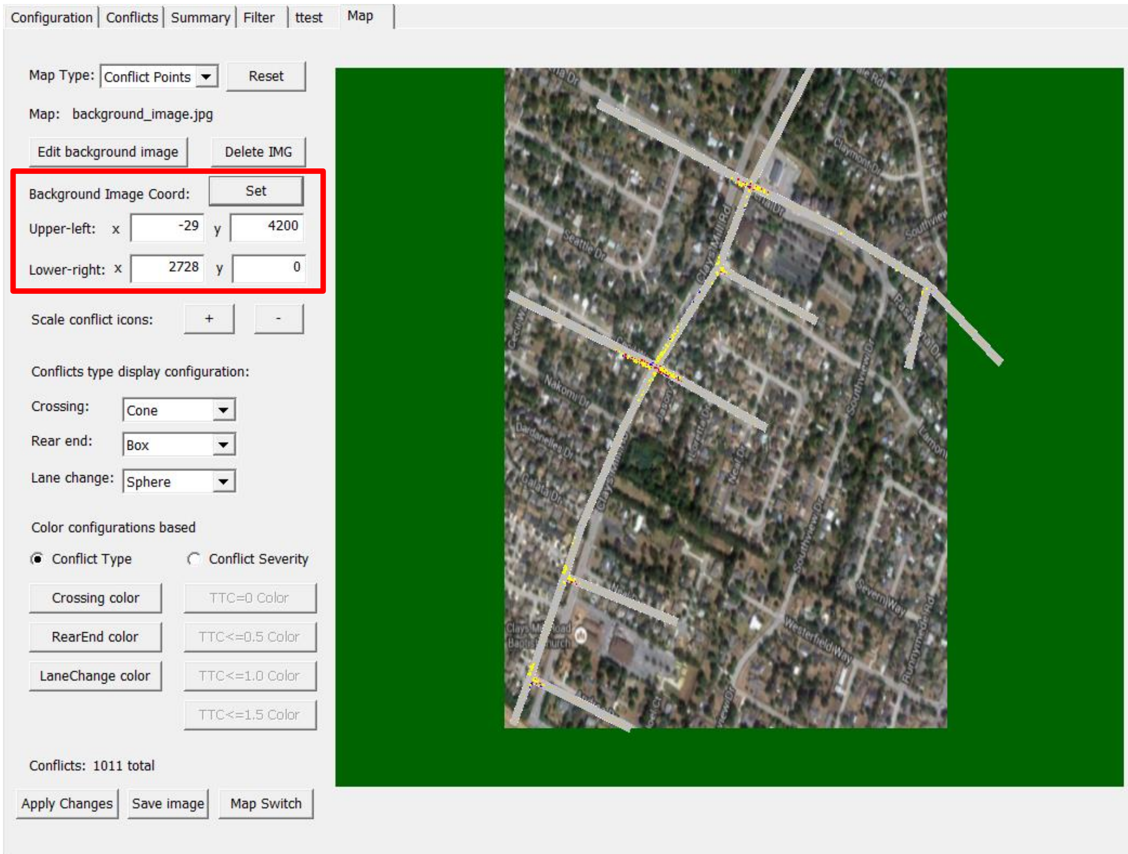


Figure 20 Set map coord

6. Adjust scale of conflict points.

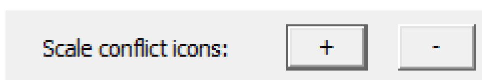


Figure 21 Adjust scale of conflict points

7. Adjust other properties of conflict points:

7.1. Set shapes for conflict points.

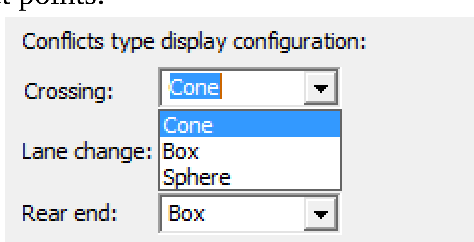


Figure 22 Set shapes for conflict points

7.2. Set color of conflict points.

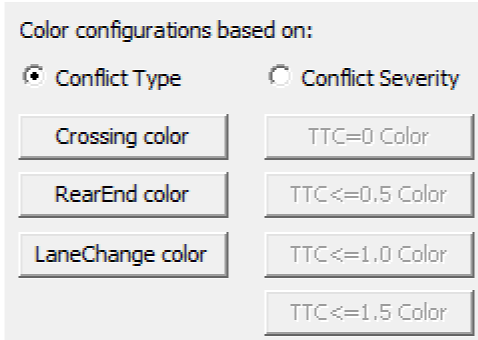


Figure 23 Set color of conflict points

7.3. Click “Apply changes” to update the map view.

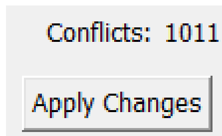


Figure 24 Show conflicts

8. Select “Bar Chart” map type to view bar charts in user-defined grids. The bar chart functionality displays the comparison of conflict counts of different types occurring in each user-defined grid.

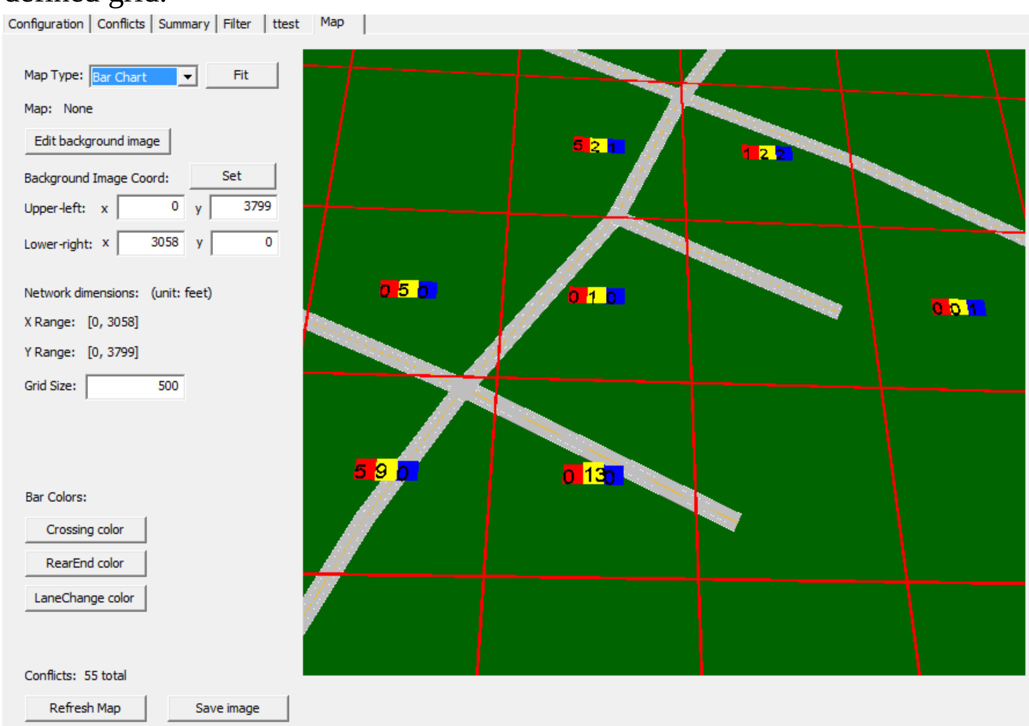
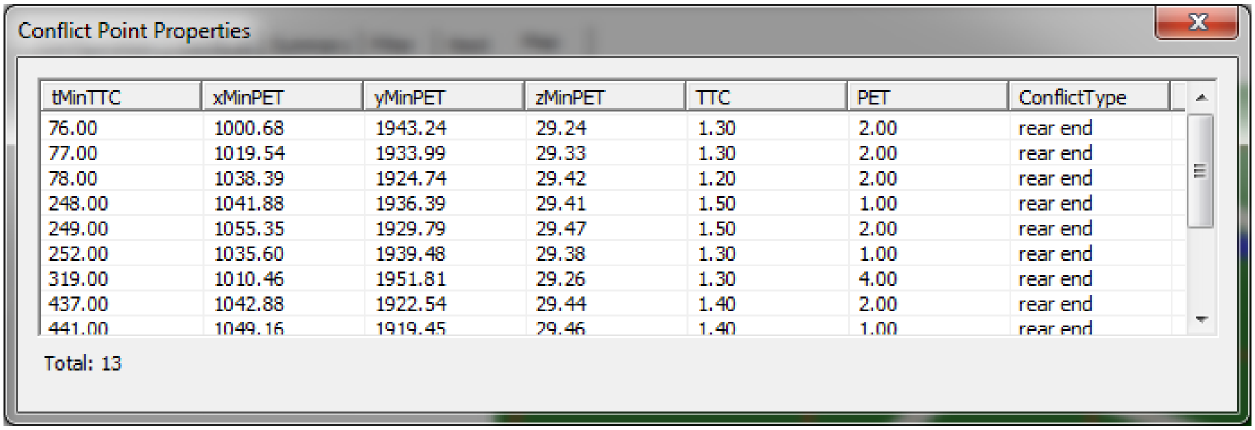


Figure 25 View bar charts

9. Left-click bar to view conflict points with the selected conflict type in that grid.



tMinTTC	xMinPET	yMinPET	zMinPET	TTC	PET	ConflictType
76.00	1000.68	1943.24	29.24	1.30	2.00	rear end
77.00	1019.54	1933.99	29.33	1.30	2.00	rear end
78.00	1038.39	1924.74	29.42	1.20	2.00	rear end
248.00	1041.88	1936.39	29.41	1.50	1.00	rear end
249.00	1055.35	1929.79	29.47	1.50	2.00	rear end
252.00	1035.60	1939.48	29.38	1.30	1.00	rear end
319.00	1010.46	1951.81	29.26	1.30	4.00	rear end
437.00	1042.88	1922.54	29.44	1.40	2.00	rear end
441.00	1049.16	1919.45	29.46	1.40	1.00	rear end

Figure 26 View conflict points in grid

10. Adjust configuration of bar chart map type:
    10.1. The grid size can be user defined by the analyst. Note: the number of conflict points in each grid will change accordingly.

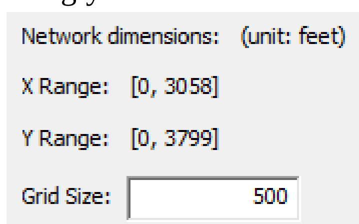


Figure 27 Change grid size

    10.2. The bar colors can be user defined by the analyst.

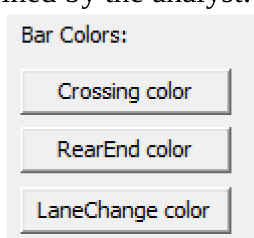


Figure 28 Set bar colors

    10.3. Click “Apply changes” to update the map view.

11. Select “Contour” map type to view contour map. The contour map is drawn using the numbers of conflict points in the user-defined grids as values; it shows the change of values across the network. In the contour map, each contour line is a level, which connects points of the same

level value, and the level values are calculated by dividing the difference between the maximum and minimum values by the number of levels defined by users. Every pair of successive contour lines form a contour interval.

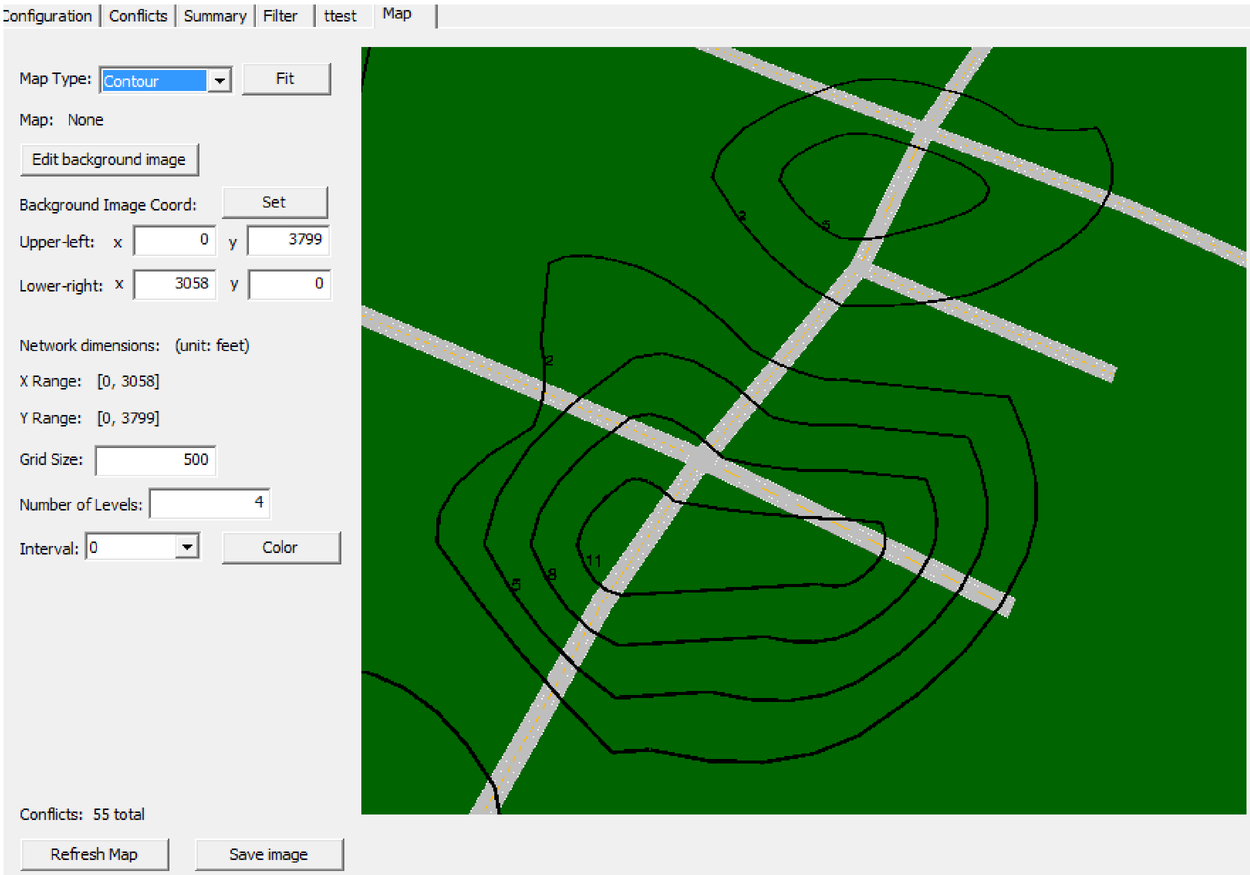


Figure 29 View contour map

12. Adjust configuration of contour map:
    12.1. The grid size can be user defined by the analyst: Note: the number of conflict points in each grid will change accordingly.

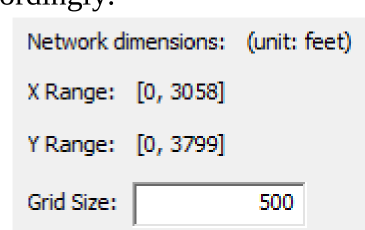


Figure 30 Change grid size

12.2. The number of levels can be user defined by the analyst.

Figure 31 Change number of levels

12.3. Click "Apply changes" to update the map view.

13. Select "Heat Map" map type. The heat map is generated by filling contour intervals with user-defined colors, and it also shows hotspots of conflict occurrences.

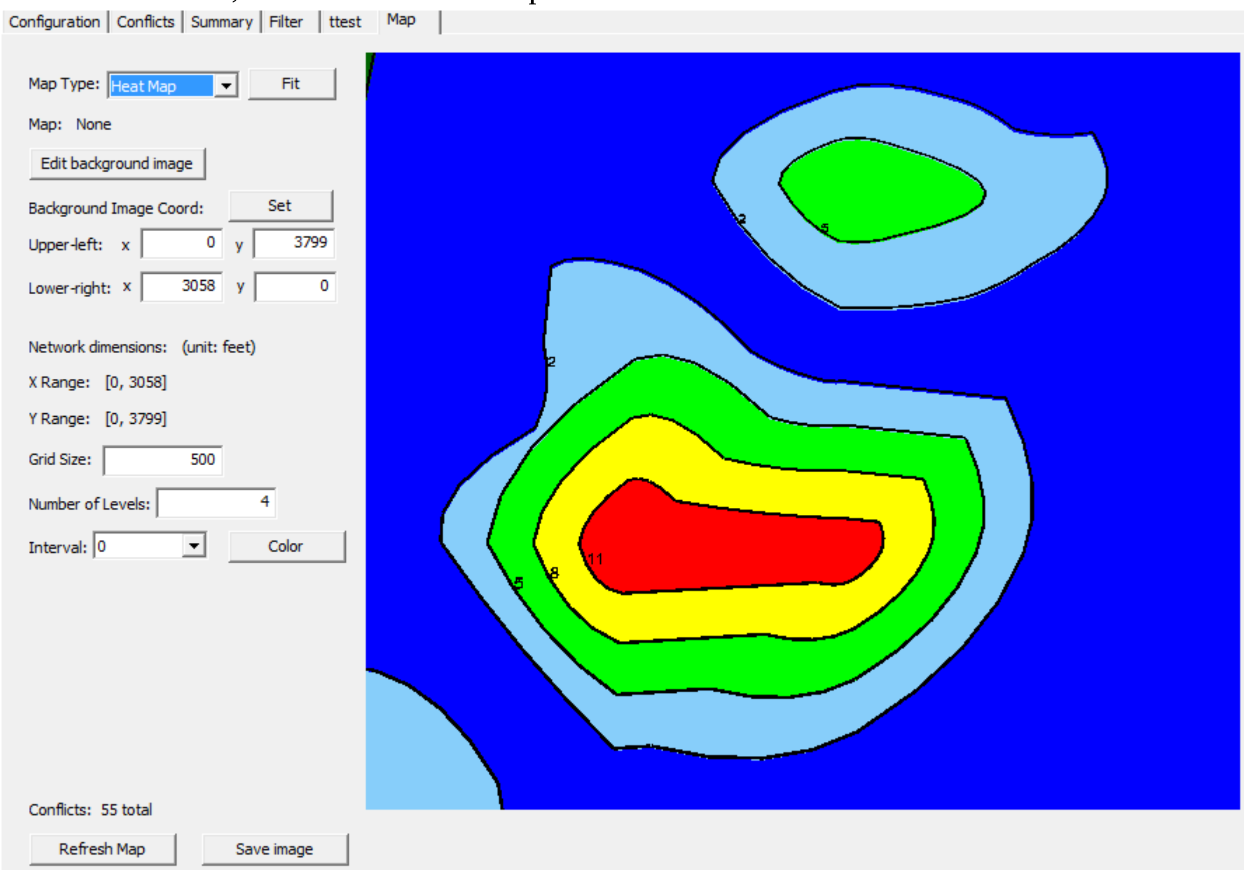


Figure 32 View heat map

14. Adjust configuration of heat map:

14.1. The grid size can be user defined by the analyst. Note: the number of conflict points in each grid will change accordingly.

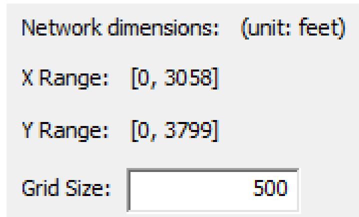


Figure 33 Change grid size

14.2. The number of levels can be user defined by the analyst.

Figure 34 Change number of levels

14.3. The colors of the interval can be user defined by the analyst. Select an interval from the drop list, click “Color”, select the color for the current interval, and click “OK”. Repeat the same operation to select color for any interval. If the number of intervals exceeds the number of user-defined colors, the default colors for new intervals are dark blue.

Figure 35 Change color of intervals

14.4. Click “Apply changes” to update the map view.

15. Click “Save image” to save the current conflict map to an image file (.bmp format):

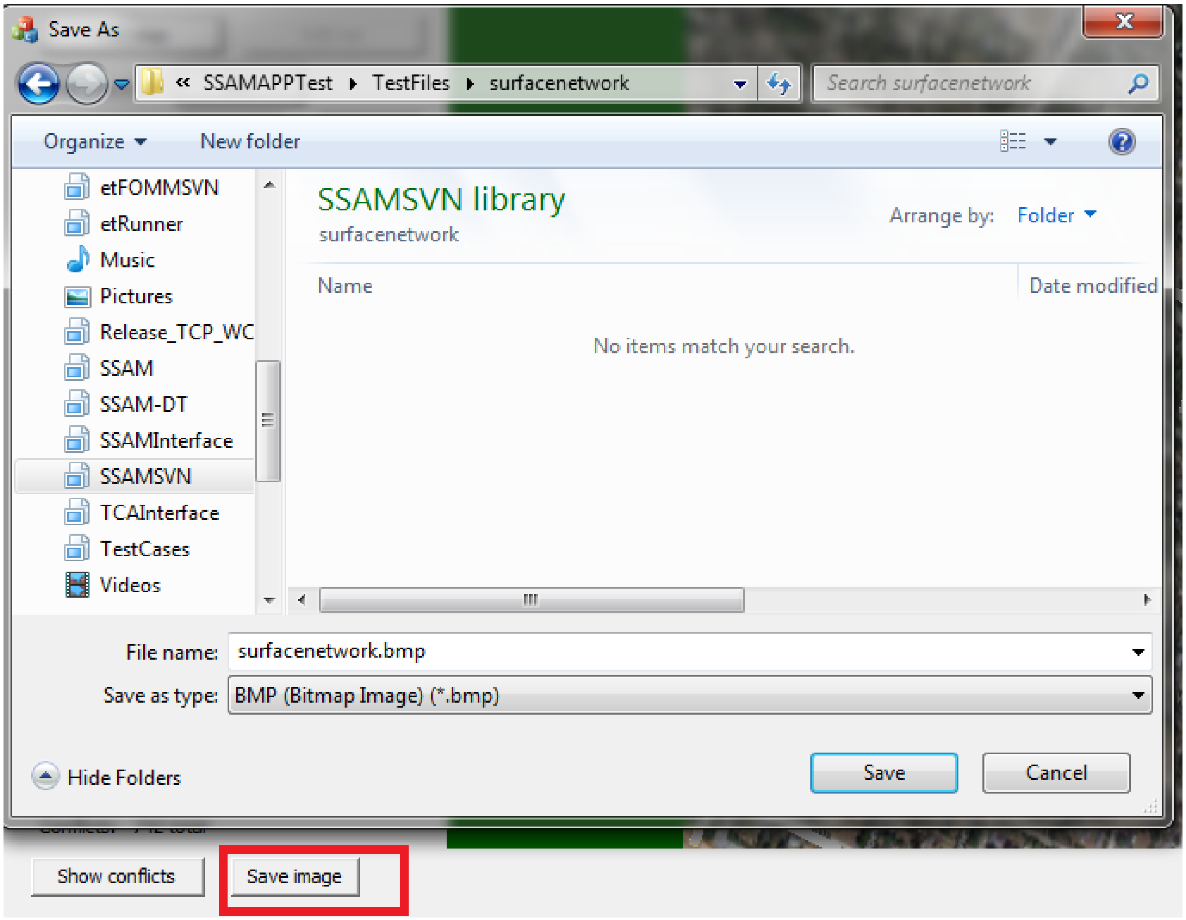


Figure 36 Save the current conflict map

Filter Tab

1. In Filter Tab, set filter parameters as necessary.

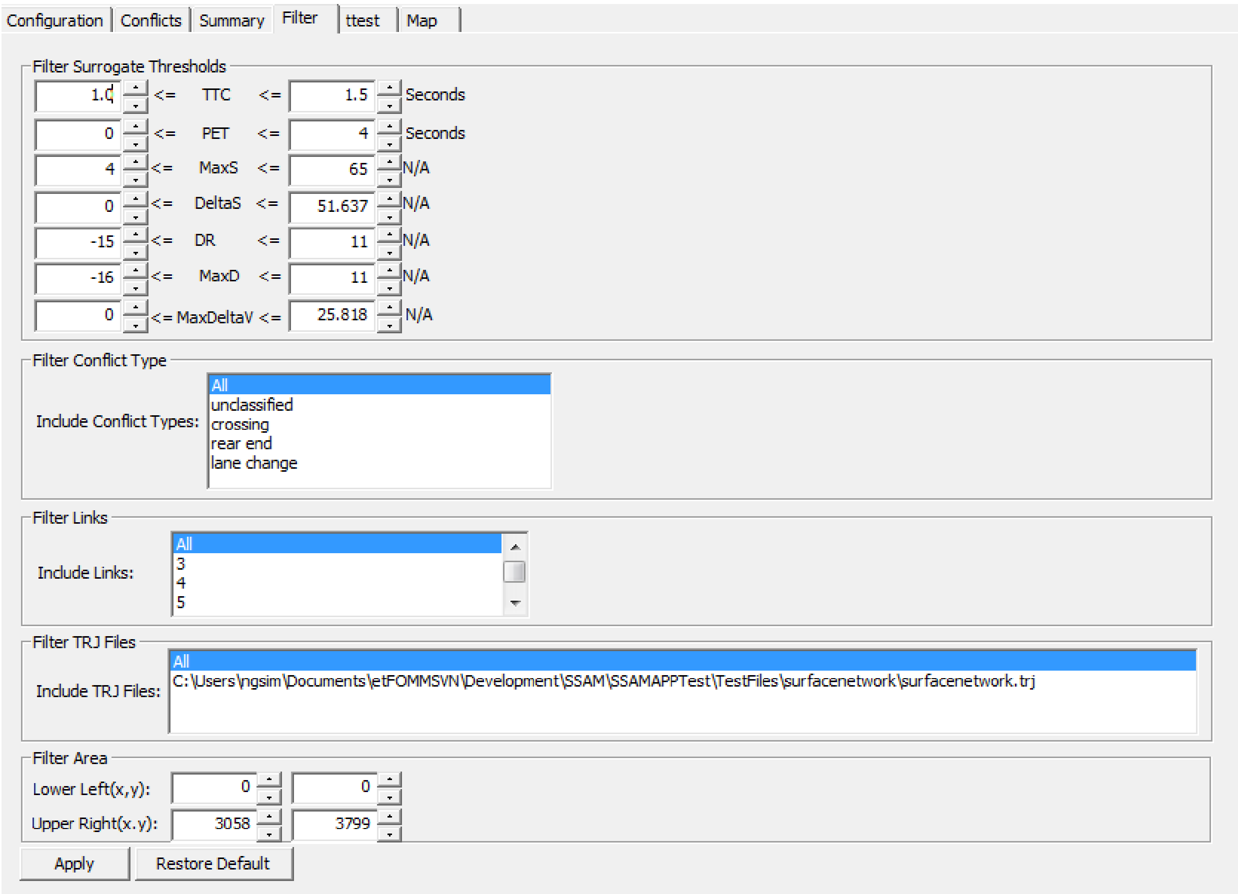


Figure 37 Set filter parameters

2. Click “Apply” to filter analysis results.

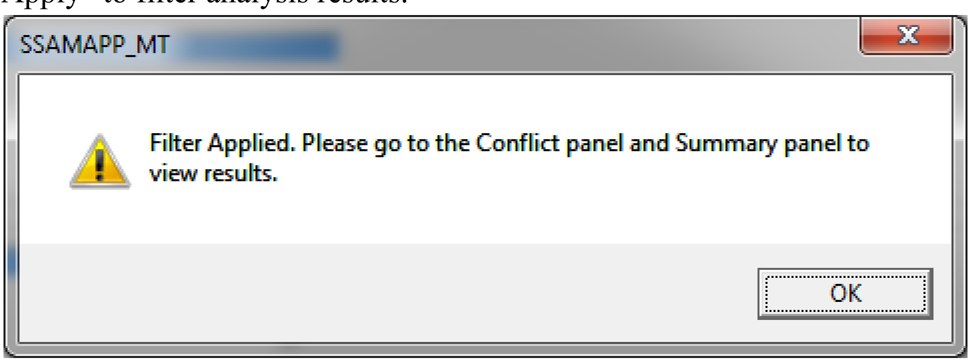


Figure 38 Filter being applied message

3. View filtered conflict points in "Conflict" Tab.

Configuration | Conflicts | Summary | Filter | ttest | Map |

FILTER APPLIED

trjFile	tMinTTC	xMinPET	yMinPET	zMinPET	TTC	PET	MaxS	DeltaS
surfacenetwor...	76.00	1000.68	1943.24	29.24	1.30	2.00	18.00	12.00
surfacenetwor...	77.00	1019.54	1933.99	29.33	1.30	2.00	17.00	11.00
surfacenetwor...	78.00	1038.39	1924.74	29.42	1.20	2.00	18.00	12.00
surfacenetwor...	100.00	1154.29	2280.69	27.25	1.20	3.00	11.00	7.00
surfacenetwor...	147.00	497.35	1212.65	29.37	1.50	4.00	22.00	3.00
surfacenetwor...	155.00	475.22	1167.62	29.19	1.30	1.00	16.00	7.00
surfacenetwor...	156.00	448.65	1113.36	28.99	1.30	4.00	4.00	4.00
surfacenetwor...	172.00	447.98	1139.38	29.06	1.30	4.00	25.00	7.00
surfacenetwor...	187.00	803.56	2020.03	28.36	1.50	2.00	12.00	8.00
surfacenetwor...	213.00	1447.59	2984.74	24.35	1.50	1.00	8.00	5.00
surfacenetwor...	245.00	979.04	1967.23	29.12	1.50	4.00	10.00	10.00
surfacenetwor...	248.00	1041.88	1936.39	29.41	1.50	1.00	8.00	2.00
surfacenetwor...	249.00	1055.35	1929.79	29.47	1.50	2.00	9.00	5.00
surfacenetwor...	252.00	1035.60	1939.48	29.38	1.30	1.00	16.00	9.00
surfacenetwor...	257.00	829.28	2008.95	28.57	1.40	2.00	5.00	0.00
surfacenetwor...	258.00	764.99	2036.64	28.06	1.20	2.00	5.00	5.00
surfacenetwor...	279.00	784.28	2028.33	28.21	1.20	2.00	5.00	5.00
surfacenetwor...	279.00	488.94	1195.54	29.30	1.50	3.00	8.00	1.00
surfacenetwor...	295.00	836.63	2005.79	28.63	1.40	1.00	21.00	5.22
surfacenetwor...	311.00	875.20	1989.17	28.93	1.40	2.00	20.00	20.00
surfacenetwor...	313.00	1500.01	2997.71	26.00	1.20	4.00	15.00	15.00
surfacenetwor...	319.00	1010.46	1951.81	29.26	1.30	4.00	15.00	4.00
surfacenetwor...	437.00	1042.88	1922.54	29.44	1.40	2.00	8.00	6.00
surfacenetwor...	441.00	1049.16	1919.45	29.46	1.40	1.00	16.00	3.00
surfacenetwor...	442.00	1017.74	1934.87	29.32	1.40	2.00	5.00	3.00
surfacenetwor...	441.00	992.60	1947.20	29.21	1.50	4.00	12.00	12.00
surfacenetwor...	462.00	1067.12	1910.64	29.55	1.50	1.00	15.00	7.00
surfacenetwor...	468.00	965.67	1960.42	29.08	1.20	1.00	13.00	6.06
surfacenetwor...	478.00	1773.81	2866.81	26.95	1.20	3.00	6.00	0.00
surfacenetwor...	497.00	599.17	1450.02	28.47	1.30	4.00	18.00	7.00
surfacenetwor...	586.00	1134.45	1877.61	29.85	1.50	2.00	13.00	9.00

Export to csv file...

Figure 39 Filtered conflict points

4. View filtered summary in "Summary" Tab.

Configuration | Conflicts | Summary | Filter | ttest | Map |

FILTER APPLIED

Summary Group	SSAM_Measure	Min	Max	Mean	Variance
Summary Group	SSAM_Measure	Min	Max	Mean	Variance
Unfiltered-All F...	TTC	0.00	1.50	0.77	0.46
Unfiltered-All F...	PET	0.00	4.00	1.36	2.05
Unfiltered-All F...	MaxS	4.00	65.00	19.16	161.66
Unfiltered-All F...	DeltaS	0.00	51.64	11.41	116.68
Unfiltered-All F...	DR	-15.00	11.00	-7.75	61.56
Unfiltered-All F...	MaxD	-16.00	11.00	-8.45	60.99
Unfiltered-All F...	MaxDeltaV	0.00	25.82	5.79	29.95
Summary Group	SSAM_Measure	Min	Max	Mean	Variance
Filtered-All Files	TTC	1.20	1.50	1.36	0.01
Filtered-All Files	PET	1.00	4.00	2.35	1.30
Filtered-All Files	MaxS	4.00	25.00	12.71	32.75
Filtered-All Files	DeltaS	0.00	20.00	6.78	19.55
Filtered-All Files	DR	-15.00	0.00	-10.68	18.96
Filtered-All Files	MaxD	-16.00	0.00	-11.23	16.45
Filtered-All Files	MaxDeltaV	0.00	10.00	3.42	4.91

Summary Group	Total	unclassified	crossing	rear end	lane change
Unfiltered-All F...	55	0	11	39	5
Filtered-All Files	31	0	0	31	0
Filtered-C:\Us...	31	0	0	31	0

Export to csv file...

Figure 40 Filtered summary

T-Test Tab

1. Use T-Test Tab to perform two-sample t-tests to find significant difference between the two population means. To start the t-test, open another SSAM file to compare with the SSAM results from current .trj file. Note: There should be more than one conflicts in each SSAM file, and each SSAM file should contain more than one iteration.

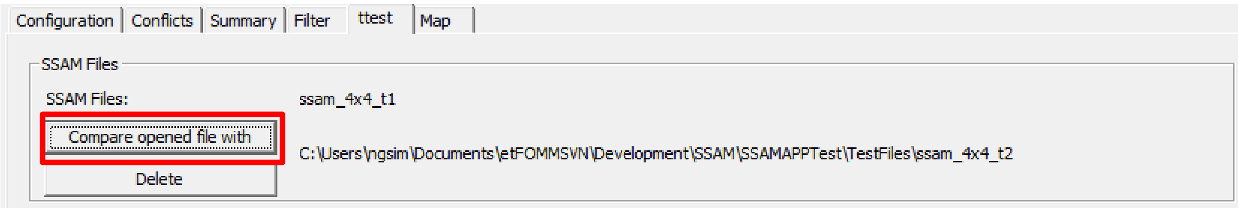


Figure 41 Open SSAM File for t-test

2. Set T-Test configuration and click “Analyze” to run t-test.

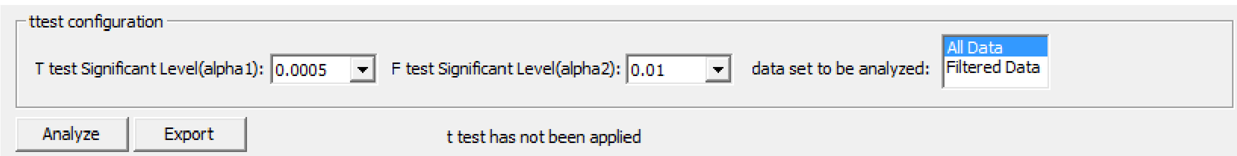
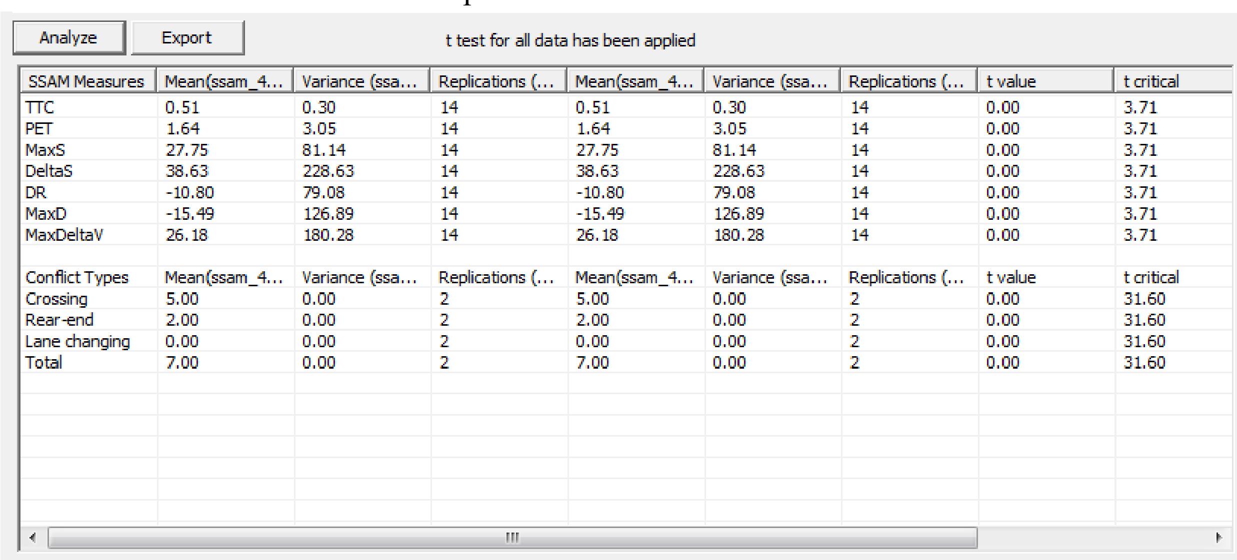


Figure 42 Set t-test configuration

3. View t-test results and click “Export” to save the results to a csv file:


Analyze Export t test for all data has been applied

SSAM Measures	Mean(ssam_4...	Variance (ssa...	Replications (...	Mean(ssam_4...	Variance (ssa...	Replications (...	t value	t critical
TTC	0.51	0.30	14	0.51	0.30	14	0.00	3.71
PET	1.64	3.05	14	1.64	3.05	14	0.00	3.71
MaxS	27.75	81.14	14	27.75	81.14	14	0.00	3.71
DeltaS	38.63	228.63	14	38.63	228.63	14	0.00	3.71
DR	-10.80	79.08	14	-10.80	79.08	14	0.00	3.71
MaxD	-15.49	126.89	14	-15.49	126.89	14	0.00	3.71
MaxDeltaV	26.18	180.28	14	26.18	180.28	14	0.00	3.71
Conflict Types	Mean(ssam_4...	Variance (ssa...	Replications (...	Mean(ssam_4...	Variance (ssa...	Replications (...	t value	t critical
Crossing	5.00	0.00	2	5.00	0.00	2	0.00	31.60
Rear-end	2.00	0.00	2	2.00	0.00	2	0.00	31.60
Lane changing	0.00	0.00	2	0.00	0.00	2	0.00	31.60
Total	7.00	0.00	2	7.00	0.00	2	0.00	31.60

Figure 43 View t-test results

Appendix A. Terms & Definitions

This appendix serves as a glossary, defining several surrogate safety measures and other terms used within SSAM.

Case document is a file which contains the required information for analyzing trajectory data. It also contains the result set of the analysis. The required information for creating a case document is as follows:

- A list of trajectory files to be analyzed.
- Threshold values (TTC and PET).

All of the above are configured via the **Configuration** tab in the SSAM software. The result set obtained after analyzing a single or a group of trajectory files in the case document comprises of the following information:

- List of conflicts.
- List of summary data.

A case document can be overwritten and saved.

The following surrogate safety measures are ordered according to their column-wise appearance (from left-to-right) in the conflicts table on the **Conflicts** tab.

trjFile is the name of the trajectory file (i.e.,.trj file) where this conflict was identified.

tMinTTC is the simulation time where the minimum TTC (time-to-collision) value for this conflict was observed. At the beginning of each simulation, the time is (generally) 0 and advances in increments of 0.1 to 1.0 seconds per time step depending on the resolution of the simulation software.

xMinPET is the x-coordinate specifying the approximate location of the conflict at the time when the minimum PET (post encroachment time) was observed. More specifically, this location corresponds to the center of the (first) vehicle, where the subsequent arrival of the second vehicle to the same location was the shortest encroachment observed.

yMinPET is the y-coordinate specifying the approximate location of the conflict at the time when the minimum PET (post encroachment time) was observed. More specifically, this location corresponds to the center of the (first) vehicle, where the subsequent arrival of the second vehicle to the same location was the shortest encroachment observed.

zMinPET is the z-coordinate specifying the approximate location of the conflict at the time when the minimum PET (post encroachment time) was observed. More specifically, this location corresponds to the center of the (first) vehicle, where the subsequent arrival of the second vehicle to the same location was the shortest encroachment observed.

TTC is the minimum time-to-collision value observed during the conflict. This estimate is based on the current location, speed, and trajectory of two vehicles at a given instant.

PET is the minimum post encroachment time observed during the conflict. Post encroachment time is the time between when the first vehicle last occupied a position and the second vehicle subsequently arrived at the same position. A value of 0 indicates an actual collision.

MaxS is the maximum speed of either vehicle throughout the conflict (i.e., while the TTC is less than the specified threshold). This value is expressed in feet per second or meters per second, depending on the units specified in the corresponding trajectory file.

DeltaS is the difference in vehicle speeds as observed at **tMinTTC**. More precisely, this value is mathematically defined as the magnitude of the difference in vehicle velocities (or trajectories), such that if ***v1*** and ***v2*** are the velocity vectors of the first and second vehicles respectively, then **DeltaS = || *v1* - *v2* ||**. Consider an example where both vehicles are traveling at the same speed, ***v***. If they are traveling in the same direction, **DeltaS** = 0. If they have a perpendicular crossing path, **DeltaS** = **(√*2*)*v***. If they are approaching each other head on, **DeltaS** = ***2v***.

DR is the initial deceleration rate of the second vehicle. Note that in actuality, this value is recorded as the instantaneous acceleration rate. If the vehicle brakes (i.e., reacts), this is the first negative acceleration value observed during the conflict. If the vehicle does not brake, this is the lowest acceleration value observed during the conflict. This value is expressed in feet per second or meters per second, depending on the units specified in the corresponding trajectory file.

MaxD is the maximum deceleration of the second vehicle. Note that in actuality, this value is recorded as the minimum instantaneous acceleration rate observed during the conflict. A negative value indicates deceleration (braking or release of gas pedal). A positive value indicates that the vehicle did not decelerate during the conflict. This value is expressed in feet per second or meters per second, depending on the units specified in the corresponding trajectory file.

MaxDeltaV is the maximum **DeltaV** value of either vehicle in the conflict (see **FirstDeltaV** or **SecondDeltaV** for more information).

ConflictAngle is an approximate angle of hypothetical collision between conflicting vehicles, based on the estimated heading of the each vehicle (see explanation of **FirstHeading**). The angle, expressed in the perspective of the first vehicle to arrive at the conflict point, conveys the direction from which the second vehicle is approaching the first vehicle, as shown in figure 96. The angle ranges from -180 ° to +180 °, where a negative angle indicates approach from the left and a positive angle indicates approach from the right. An angle of 180 ° (or -180 °) indicates a direct head-on approach, and an angle of 0 ° (or -0 °) indicates a direct rear approach.

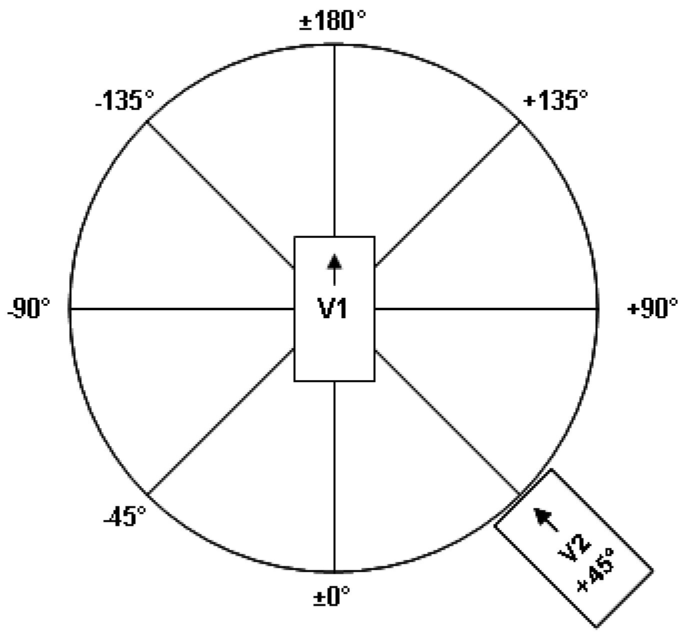


Figure 44 Conflict Angle

ClockAngle is an alternative expression of the conflict angle in terms of a more familiar clock hand positions. Again, the angle is expressed in the perspective of the first vehicle, with the clock time indicating the angle from which the second vehicle is approaching, as shown in figure 97. The 12:00 position is direct ahead of the first vehicle, 3:00 is to the right, 6:00 is directly behind, and 9:00 is to the left.

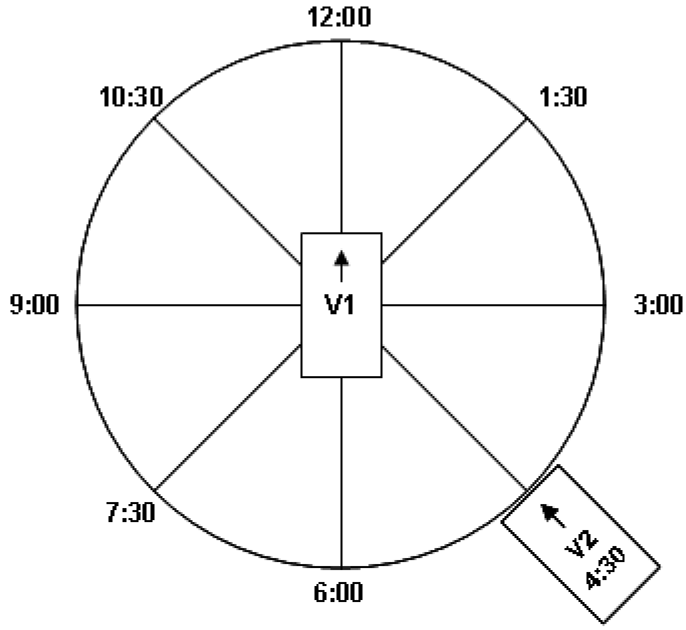


Figure 45 Clock Angle

ConflictType describes whether the conflict is the result of a rear end, lane change, or crossing movement. If link and lane information is not available for both vehicles, then the event type is classified based solely on the absolute value of the **ConflictAngle** as follows. The type is classified as a rear-end conflict if **||ConflictAngle||** < 30 °, a crossing conflict if **||ConflictAngle||** > 85 °, or otherwise a lane-changing conflict. However, the simulation model that produced the vehicle trajectory data can generally provide link and lane information for both vehicles—though the coding of these values may vary significantly from one simulation vendor to the next. If link and lane information is available, that information is utilized for classification in the case that the vehicles both occupy the same lane (of the same link) at either the start or end of the conflict event. If the vehicles both occupy the same lane at the start *and* end of the event, then it is classified as a rear-end event. If either vehicle ends the conflict event in a different lane than it started (while having not changed links), then the event is classified as a lane-change. If either of the vehicles changes links over the course of the event, then the conflict angle determines the classification as previously described, with the following possible exception). For two vehicles that begin the conflict event in the same lane, but change links over the course of the event, the classification logic considers only rear-end or lane-change types, based on the conflict angle (using the threshold value previously mentioned). Note that vehicle maneuvers such as changing lanes into an adjacent turn bay lane or entering into an intersection area may be consider changing links, depending on the underlying simulation model. In some cases, vehicles which appear to be traveling in the same lane may actually be considered by the simulation model as traveling on different links that happen to overlap.

PostCrashV is an estimate of the post collision velocity of both vehicles. This estimate assumes that the vehicles did crash, at the estimated **ConflictAngle**, at velocities observed at the

tMinTTC, and assuming an inelastic collision between the center of mass of both vehicles, where both vehicles subsequently deflect in the same direction and at the same velocity.

PostCrashHeading is the estimated heading of both vehicles following a hypothetical collision (as discussed in **PostCrashV**). This heading is expressed as the angle measured counterclockwise from the x-axis (which is assumed to point right), such that 0 ° is right, 90 ° is up, 180 ° is left, and 270 ° is down. The angle ranges from 0 ° to 360 °.

FirstVID (SecondVID) is the vehicle identification number of the first (second) vehicle. The first vehicle is the vehicle that arrives to the conflict point first. The second vehicle subsequently arrives to the same location. In rare cases (actually collisions) both vehicles may arrive to a location simultaneously, in which case the tie between first and second vehicle in broken arbitrarily.

FirstLink (SecondLink) is a number indicating which link the first (second) vehicle is traveling on at **tMinTTC**.

FirstLane (SecondLane) is a number indicating in which lane the first (second) vehicle is traveling on at **tMinTTC**.

FirstLength (SecondLength) is the length of the first (second) vehicle in feet or meters.

FirstWidth (SecondWidth) is the width of the first (second) vehicle in feet or meters.

FirstHeading (SecondHeading) is the heading of the first (second) vehicle during the conflict. This heading is approximated by the change in position from the start of the conflict to the end of the conflict. Note that in most non-rear-end conflicts, at least one vehicle is turning throughout the conflict. Its actual heading would vary accordingly throughout the conflict. If the vehicle does not move during the conflict, then the direction in which it is facing is taken as the heading. This heading is expressed as the angle measured counterclockwise from the x-axis (which is assumed to point right), such that 0 ° is right, 90 ° is up, 180 ° is left, and 270 ° is down. The angle ranges from 0 ° to 360 °.

FirstVMinTTC (SecondVMinTTC) is the velocity (speed) of the first (second) vehicle at **tMinTTC**.

FirstDeltaV (SecondDeltaV) is the change between conflict velocity (given by speed **FirstVMinTTC** and heading **FirstHeading**) and the post-collision velocity (given by speed **PostCrashV** and heading **PostCrashHeading**). This is a surrogate for the severity of the conflict, calculated assuming a *hypothetical* collision of the two vehicles in the conflict.

xFirstCSP (xSecondCSP) is the x-coordinate of the first (second) vehicle at the conflict starting point (CSP). The CSP is the location of the vehicle at **tMinTTC**.
yFirstCSP (ySecondCSP) is the y-coordinate of the first (second) vehicle at the conflict starting point (CSP). The CSP is the location of the vehicle at **tMinTTC**.

xFirstCEP (xSecondCEP) is the x-coordinate of the first (second) vehicle at the conflict ending point (CEP). The CEP is the location of the vehicle at either the last time step where the TTC value is below the specified threshold or where the last post- encroachment value was observed, whichever occurs later in the conflict timeline.

yFirstCEP (ySecondCEP) is the y-coordinate of the first (second) vehicle at the conflict ending point (CEP). The CEP is the location of the vehicle at either the last time step where the TTC value is below the specified threshold or where the last post- encroachment value was observed, whichever occurs later in the conflict timeline.

P(UEA) is the probability of unsuccessful evasive action added in SSAM-3.0. From the initial positions and velocities of the pair of vehicles, the program (i) generates 100 paths for each vehicle using combinations of acceleration and orientation that are independently generated from two triangular distribution functions and (ii) detects all collision points between every pair of projected paths. P(UEA) is the percentage resulting from dividing the number of collision points by the total number of combinations of paths.

mTTC is multiple TTC and was added in SSAM-3.0. From the initial positions and velocities of the pair of vehicles, the program (i) generates 100 paths for each vehicle using combinations of acceleration and orientation that are independently generated from two triangular distribution functions and (ii) detects all collision points between every pair of projected paths. Total TTC of the set of collision points is mTTC for the pair of vehicles.

mPET is multiple PET and was added in SSAM-3.0. From the initial positions and velocities of the pair of vehicles, the program (i) generates 100 paths for each vehicle using combinations of acceleration and orientation that are independently generated from two triangular distribution functions (ii) and detects all collision points between every pair of projected paths. Total PET of the set of collision points is mPET for the pair of vehicles.

Appendix B. Intersection Model Network Description File Format

Note: All fields are delimited by comma.

1. (TRJ_file_name)_NETWORK_LINKS.TXT

    1.1. Line 1: [NUMBER_OF_FREEWAY_LINKS] FREEWAY LINKS
    1.2. Starting from Line 2, list one freeway link at each line:
        1.2.1. usn
        1.2.2. dsn
        1.2.3. length
        1.2.4. number of full lanes
        1.2.5. dsn of thru receiving link
        1.2.6. dsn of off-ramp receiving link
        1.2.7. link type: 0=mainline, anything else=ramp.
        1.2.8. thru alignment lane
        1.2.9. offramp alignment lane
        1.2.10. mainline sending lane
        1.2.11. offramp receiving lane
        1.2.12. aux_lane_id(1): ID for first auxiliary lane.
        1.2.13. aux_lane_code(1): code for first auxiliary lane:
            1.2.13.1. code 1: Right acceleration Lane.
            1.2.13.2. code 2: Right deceleration Lane.
            1.2.13.3. code 3: Right full auxiliary Lane.
            1.2.13.4. code 4: Left acceleration Lane.
            1.2.13.5. code 5: Left deceleration Lane.
            1.2.13.6. code 6: Left full auxiliary Lane.
        1.2.14. aux_lane_length(1): length for first auxiliary lane.
        1.2.15. aux_lane_id(2)
        1.2.16. aux_lane_code(2)
        1.2.17. aux_lane_length(2)
        1.2.18. aux_lane_id(3)
        1.2.19. aux_lane_code(3)
        1.2.20. aux_lane_length(3)
        1.2.21. aux_lane_id(4)
        1.2.22. aux_lane_code(4)
        1.2.23. aux_lane_length(4)
        1.2.24. aux_lane_id(5)
        1.2.25. aux_lane_code(5)
        1.2.26. aux_lane_length(5)
        1.2.27. aux_lane_id(6)
        1.2.28. aux_lane_code(6)

1.2.29. aux_lane_length(6)
1.2.30. adddrop_code(1): code for first add/drop lane, 1 for adding and -1 for dropping.
1.2.31. adddrop_lane(1): lane ID for first add/drop lane.
1.2.32. adddrop_dist(1): starting distance from usn for first add/drop lane.
1.2.33. adddrop_code(2)
1.2.34. adddrop_lane(2)
1.2.35. adddrop_dist(2)
1.2.36. adddrop_code(3)
1.2.37. adddrop_lane(3)
1.2.38. adddrop_dist(3)

1.3. First line after freeway links: [NUMBER_OF_STREET_LINKS] STREET LINKS

1.3.1. usn
1.3.2. dsn
1.3.3. number of full lanes
1.3.4. alignment lane
1.3.5. thru alignment lane
1.3.6. number of left pockets
1.3.7. number of right pockets
1.3.8. left dsn
1.3.9. thru dsn
1.3.10. right dsn
1.3.11. left diagonal dsn
1.3.12. right diagonal dsn
1.3.13. number of lanes
1.3.14. lane lengths for all lanes, delimited by comma.

2. (TRJ_file_name)_NETWORK_NODES.TXT

2.1. Node ID
2.2. x
2.3. y
2.4. network code: 1=freeway, 2=surface street.
2.5. altitude

3. (TRJ_file_name)_INTERSECTIONS.TXT

3.1. Line 1: field names
3.2. Sending Usn
3.3. Sending Dsn
3.4. Receiving Usn
3.5. Receiving Dsn
3.6. CONNDirection, the connection's turning direction:

3.6.1. “0”, straight
3.6.2. “1”, U-turn
3.6.3. “2”, left-hand U-turn, ignored.
3.6.4. “3”, left-turn
3.6.5. “4”, right-turn
3.6.6. “5”, partial left-turn, used as left diagonal.
3.6.7. “6”, partial right-turn, used as right diagonal.
3.6.8. “7”, no direction (dead end)
3.7. CONNEDGE_up_int_width: the intersection width of the upstream node.
3.8. Stop Bar Distance
3.9. pAx – not in use, left as 0.
3.10. pAy– not in use, left as 0.
3.11. pBx– not in use, left as 0.
3.12. pBy– not in use, left as 0.
3.13. Sending Lane ID
3.14. Receiving Lane ID
3.15. Lane center: the distance to from the middle point to the left boundary of the intersection.
3.16. Turningway Length
3.17. Turningway entry point, presented as distance to the dsn.
3.18. Turningway exit point, presented as distance from the usn.
3.19. IMLaneLength-not in use, left as 0.
3.20. Lane Length
3.21. Lane Width
3.22. Lane Channelization
3.23. Lane Shape Size: number of points to describe lane center line.
3.24. Lane shape points: list all shape points for lane center line, with each point represented as a pair of x and y. All values should be delimited by comma. For example, x1, y1, x2, y2,…
3.25. CW Boundary Lane Shape Size: number of points to describe lane right edge.
3.26. CW Boundary Lane Shape: list all shape points for lane right edge, with each point represented as a pair of x and y. All values should be delimited by comma. For example, x1, y1, x2, y2,…
3.27. CCW Boundary Lane Shape Size: number of points to describe lane left edge.
3.28. CCW Boundary Lane Shape: list all shape points for lane left edge, with each point represented as a pair of x and y. All values should be delimited by comma. For example, x1, y1, x2, y2,…
3.29. Conn Length: path length.
3.30. Conn Shape Size: number of points to describe path center line.

3.31. Conn Shape: list all shape points for lane center line, with each point represented as a pair of x and y. All values should be delimited by comma. For example, x1, y1, x2, y2,…

3.32. CW Boundary Conn Shape Size: number of points to describe path right edge.
3.33. CW Boundary Conn Shape: list all shape points for path right edge, with each point represented as a pair of x and y. All values should be delimited by comma. For example, x1, y1, x2, y2,…
3.34. CCW Boundary Conn Shape Size: number of points to describe path left edge.
3.35. CCW Boundary Conn Shape: list all shape points for path left edge, with each point represented as a pair of x and y. All values should be delimited by comma. For example, x1, y1, x2, y2,…