

NEXTA: Simulation Data Visualizer for TRANSIMS

NEXTA: Network EXplorer for Traffic Analysis

Sponsored by

Federal Highway Administration

Developed and Prepared by
Dr. Xuesong Zhou, Univ. of Utah

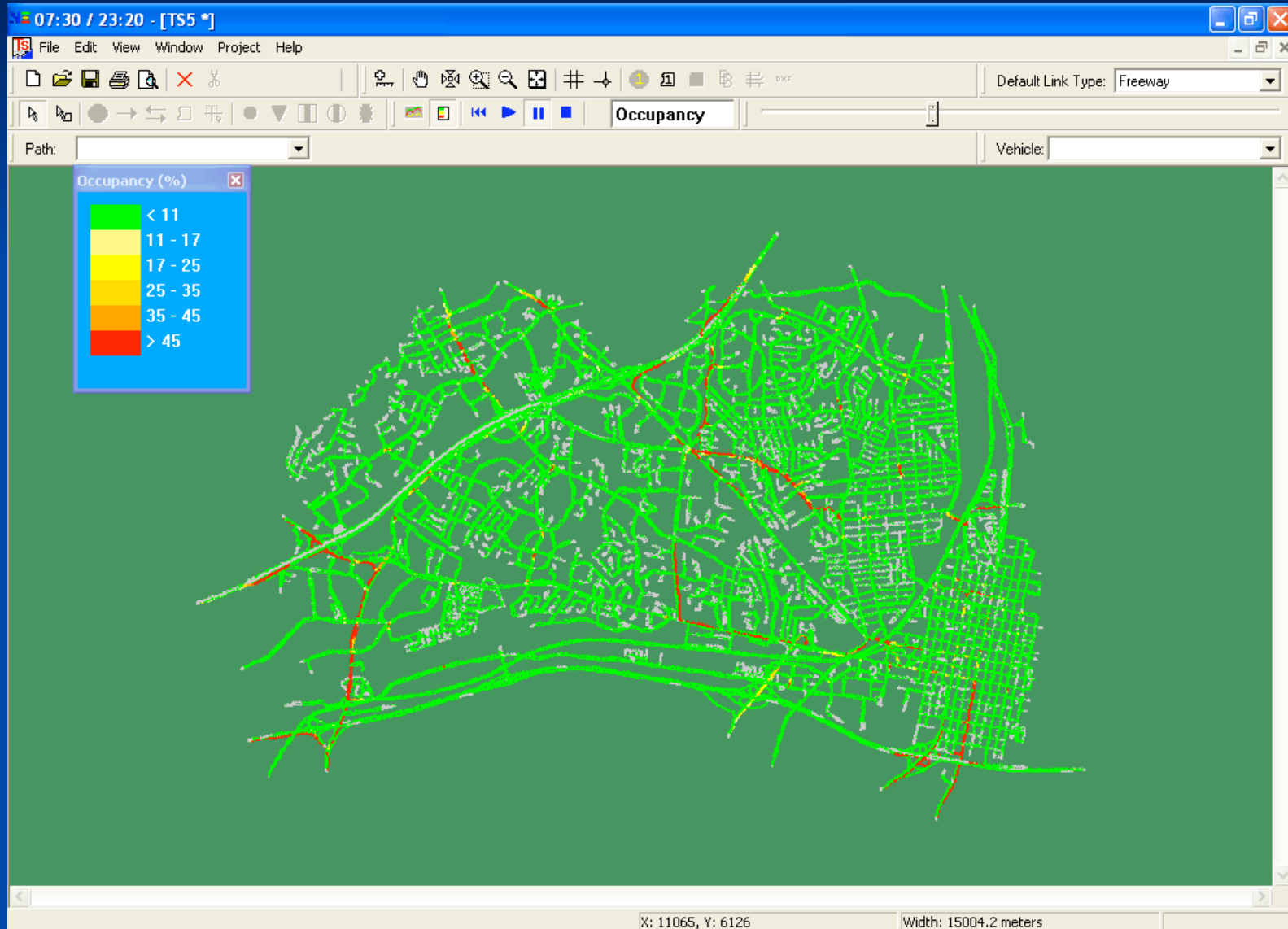
zhou@eng.utah.edu

TRANSIMS: Applications and Development
Workshop
April 8–9, 2010

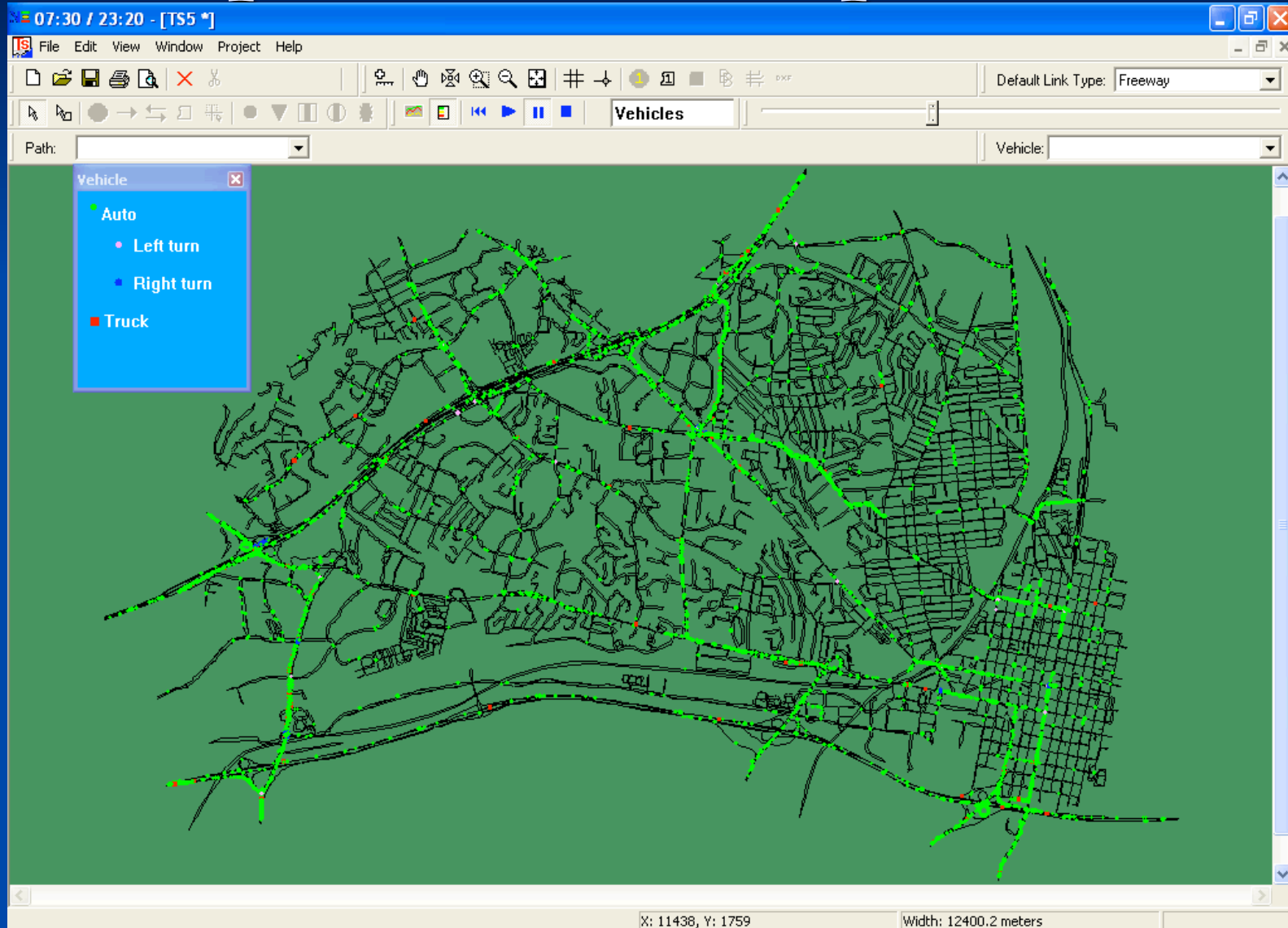
Freeware can be downloaded at

http://www.civil.utah.edu/~zhou/NEXTA_for_TRANSIMS.html

Sample Occupancy Plot



Sample Vehicle Snapshot Plot



Sample Bottleneck Snapshot Plot



Sample Travel Time Contour (Accessibility) Snapshot Plot

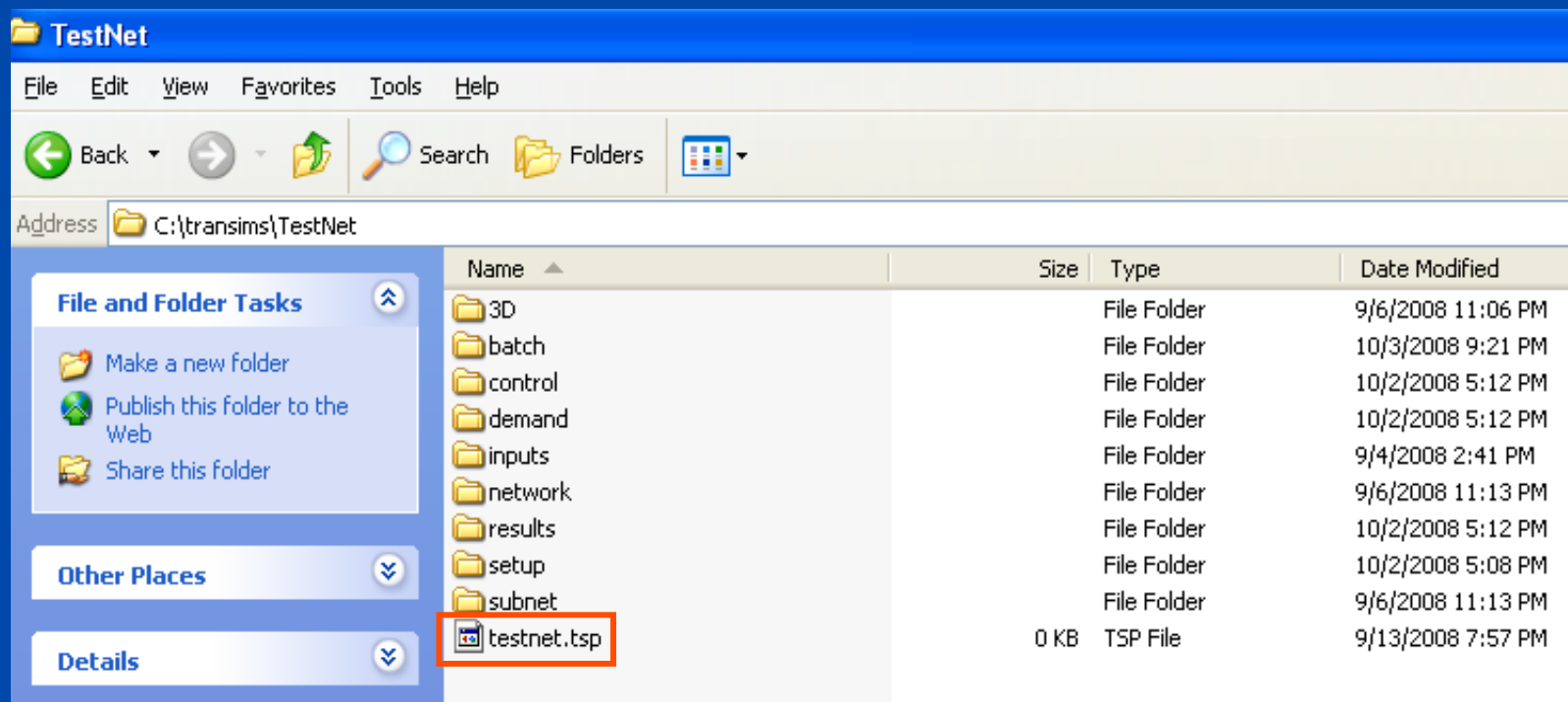


Tutorial Outline

- Network and control data visualization
 - View node and link properties, lane configuration
 - Configure dynamic project menu
- Time-dependent simulation data visualization
 - View cell occupancy, speed, queue length and vehicle locations, MOE profiles
- Other tools
 - Find multiple paths
 - Create nodes and links (in development)

Step 0: Create a Project File

- Project file (*.tsp) is used by NEXTA to locate the folder of a TRANSIMS project



Inside a *.tsp Project File

- First line should have the relative location of the microsimulation control file

```
Example: TestNet data set      setup  
      \master\Microsimulator.ctl
```

```
Example: Alexandria data set  
      setup\control  
      \Microsimulator.ctl
```


Step 1: Open a Project

The screenshot displays the TRANSIMS software interface. The 'Network Explorer' window is open, showing a file tree with 'testnet.tsp' selected under the 'subnet' folder. The 'Open' dialog box is active, showing the file name 'testnet.tsp' and the file type 'TRANSIMS Project Files (*.tsp)'. Below the 'Open' dialog, there are two smaller dialog boxes: 'Select iteration number for loading simulation results' with the value '10' selected, and 'Define Loading Time Window for Cell Occupancy and Vehicle Snapshot D...' with 'Start Time' set to '0' and 'End Time' set to '24', both in hours.

If the specified microsimulation file is not found in tsp file, the user will be provided with an option to manually load the microsimulation control file, or use the default input file locations

File Loading Status Table

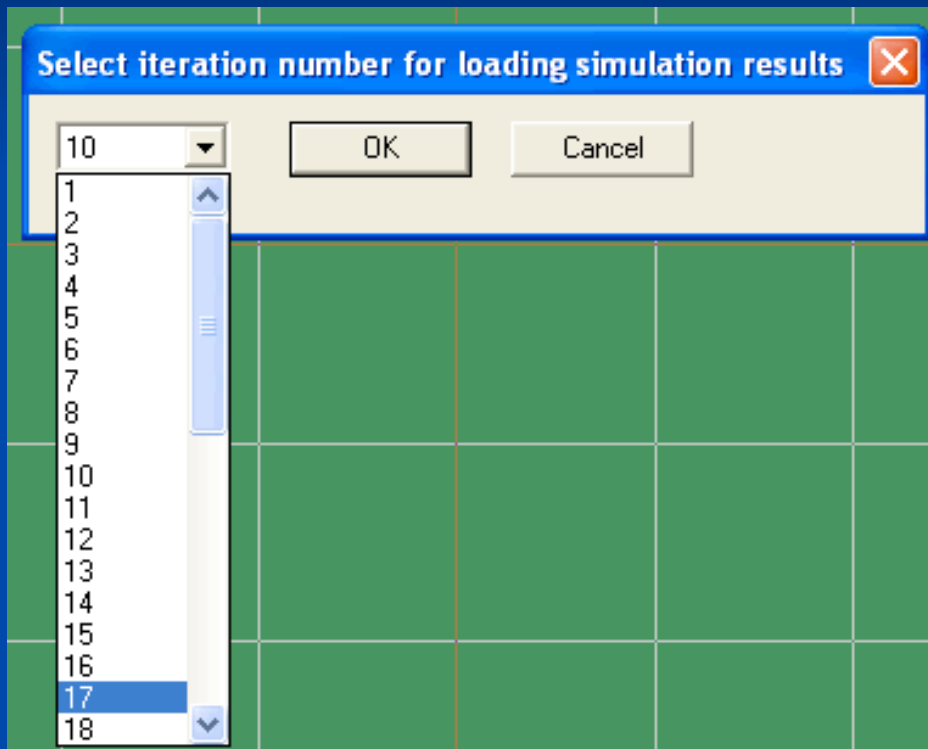


Keyword	Value	Status
--Directories--		
NET_DIRECTORY	NETWORK	
--Input File Names--		
NET_NODE_TABLE	Node.txt	Loaded
NET_LINK_TABLE	Link.txt	Loaded
NET_ACTIVITY_LOCATION_TABLE	Activity_Location_3.txt	Loaded
NET_POCKET_LANE_TABLE	Pocket_Lane.txt	Loaded
NET_LANE_CONNECTIVITY_TABLE	Lane_Connectivity.txt	Loaded
NET_SHAPE_TABLE	Shape.txt	Loaded
NET_SIGNALIZED_NODE_TABLE	Signalized_Node.txt	Loaded
NET_UN SIGNALIZED_NODE_TABLE	Unsignalized_Node.txt	Loaded
NET_TIMING_PLAN_TABLE	Timing_Plan.txt	Loaded
NET_PHASING_PLAN_TABLE	Phasing_Plan.txt	Loaded
--Simulation File Names--		
Result Directory	results (parsed from OUTPUT_SNAPSHOT_FILE_1)	
OUTPUT_SNAPSHOT_FILE_1	Snapshot.txt	Loaded
OUTPUT_OCCUPANCY_FILE_1	Occupancy_Max.txt	Loaded
OUTPUT_SUMMARY_FILE_1	Performance.txt	Loaded
--NEXTA Loading Statistics--		
# of vehicle samples	487409 between 00:01 and 23:02	

OK

Step 1: Open a Project

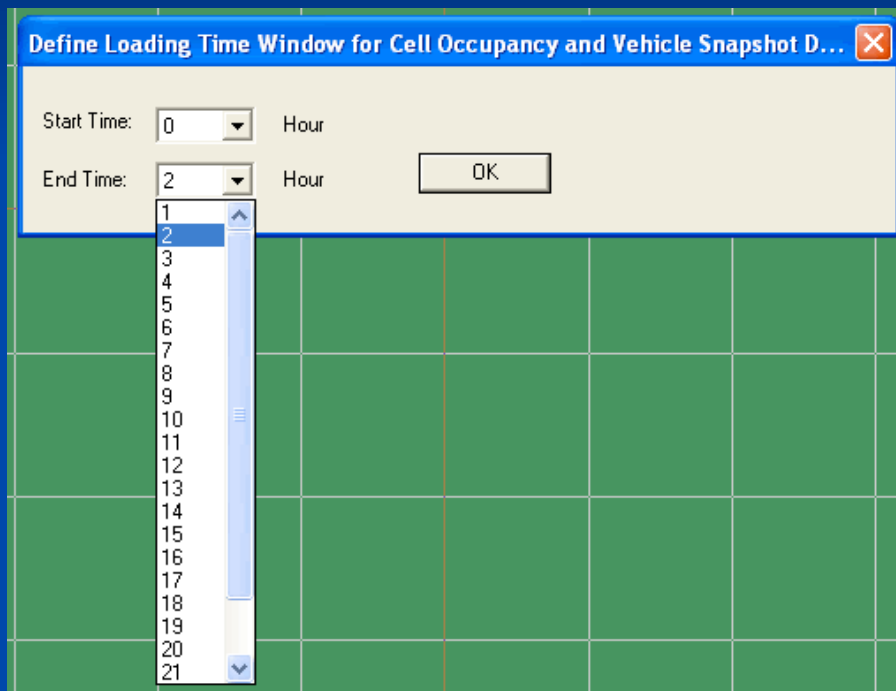
→ Select iteration number



- A user can specify an iteration number for loading average link performance, cell occupancy and vehicle snapshot data.
- By default, NEXTA automatically identifies and loads the maximum (i.e. the last) iteration number, if multiple iterations of simulation results are available from those files stored in folder "\\results".

Step 1: Open a Project

→ Define Loading Time Window



- For (memory-consuming) cell occupancy and vehicle snapshot data, a user can specify “Start Time” and “End Time” to define a data loading time window to reduce required memory for the GUI program.
- For link performance data such as density, speed and queue length, NEXTA loads 24 hours of simulation data automatically.

Input Files

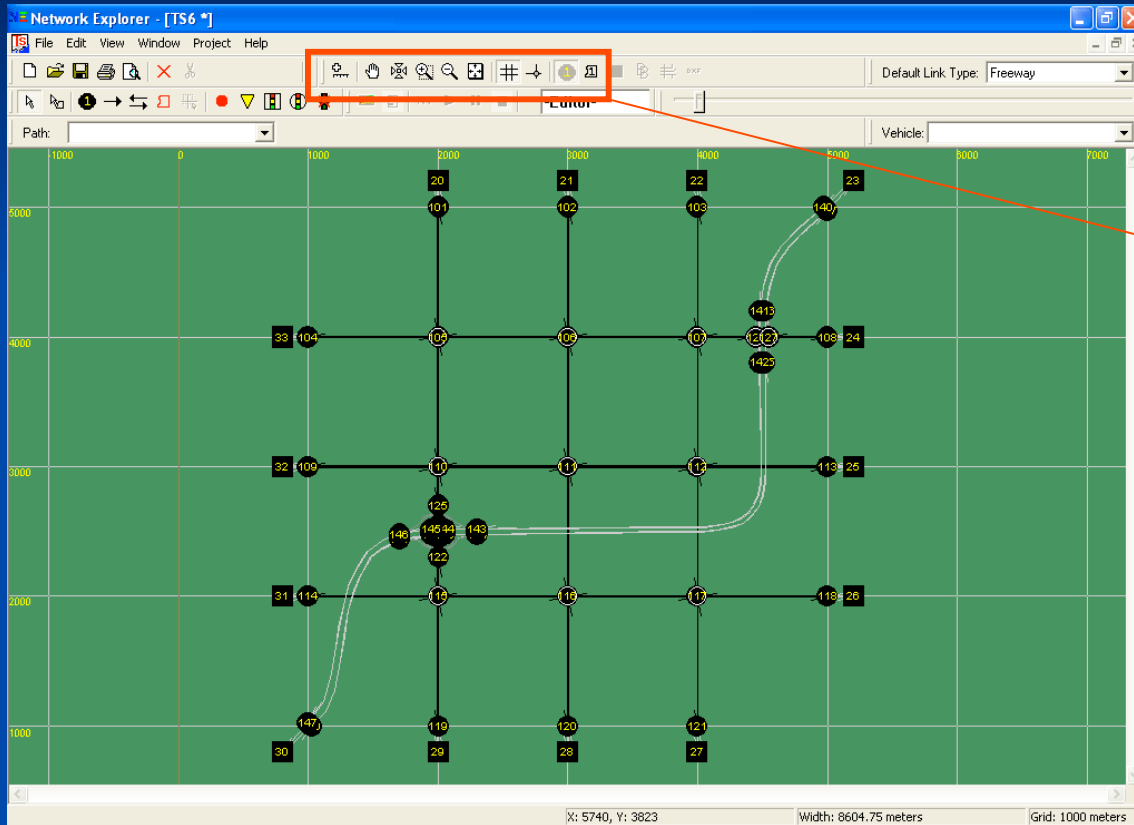
- Folder Network
 - Node.txt, Link.txt, Pocket_Lane.txt, Shape.txt, Zone.txt
 - Signalized_Node.txt, Timing_Plan.txt, Phasing_Plan.txt
- Folder Results
 - Performance.txt (density, speed, queue)
 - Occupancy_Avg.txt (cell occupancy)
 - Snapshot.txt (vehicle locations)

Remarks: A test data set with the above files can be downloaded at

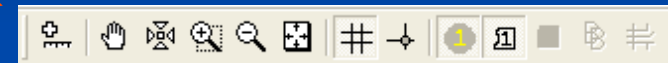
<http://www.civil.utah.edu/~zhou/TestNet.zip>










A user can execute `/setup/runall.bat` to generate those files

First Look

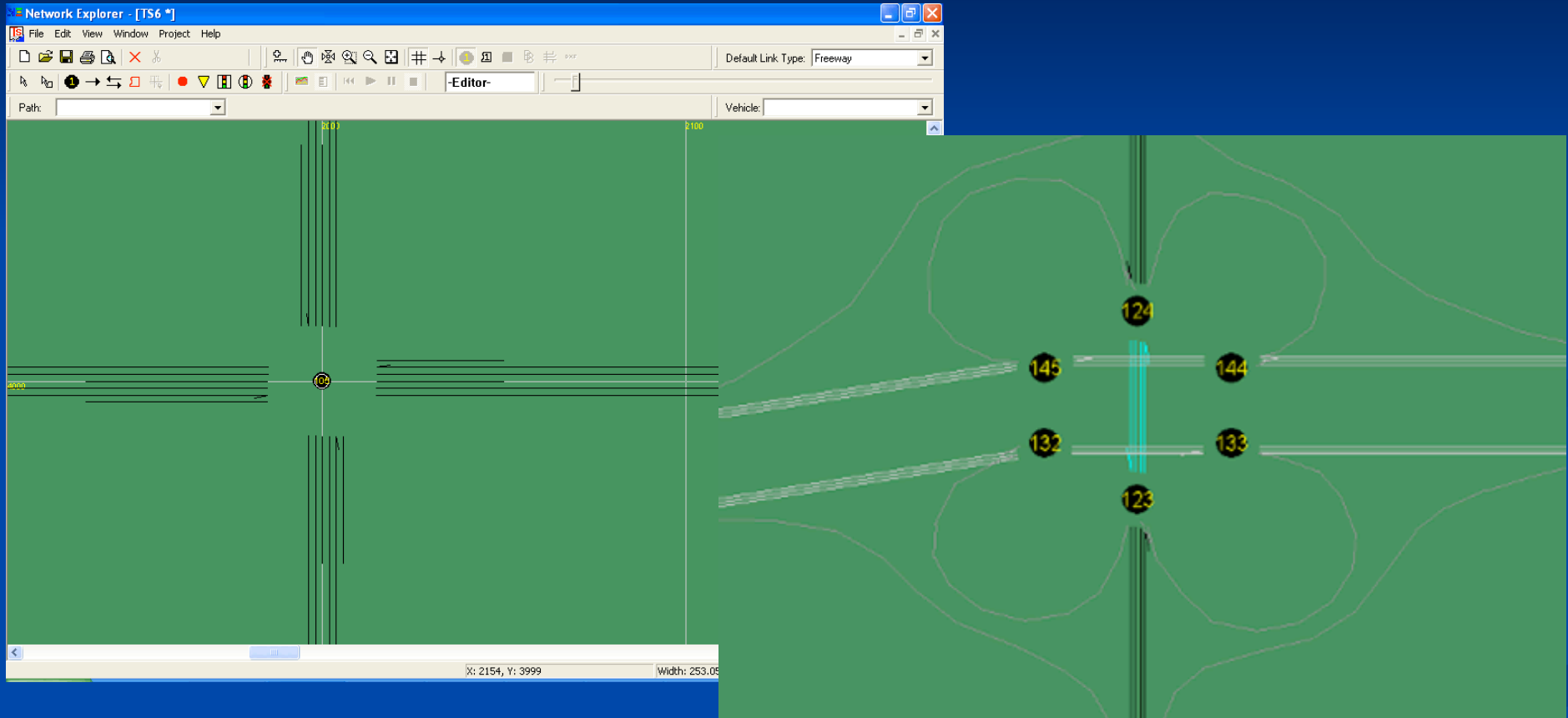


View Tools



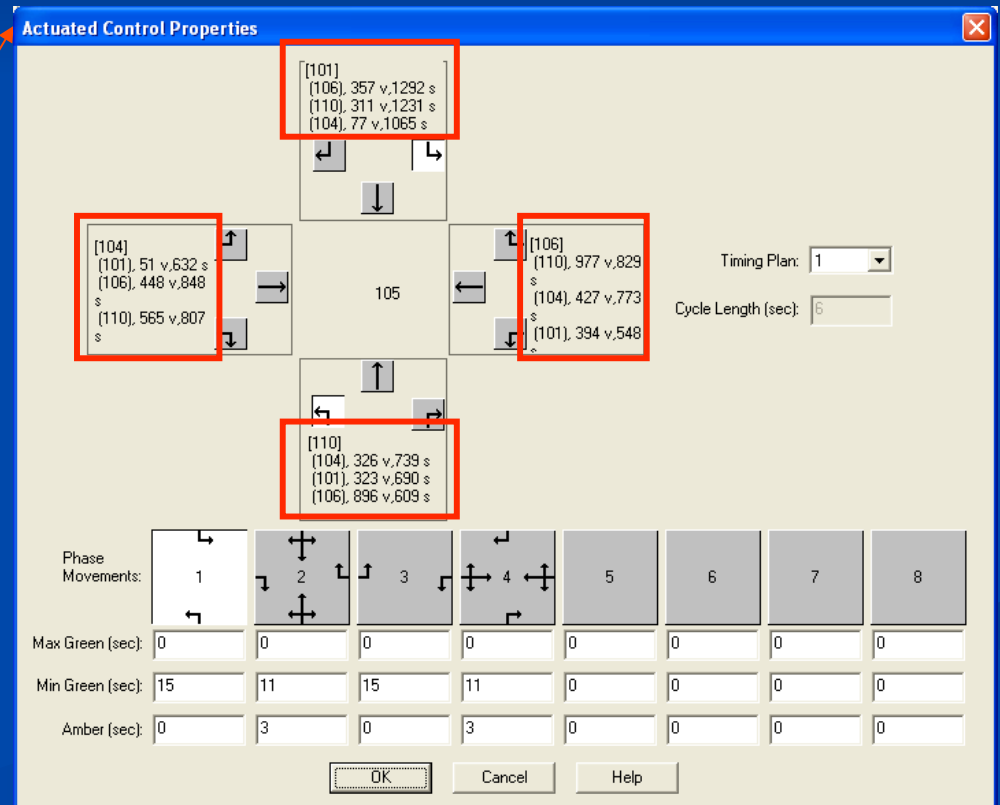
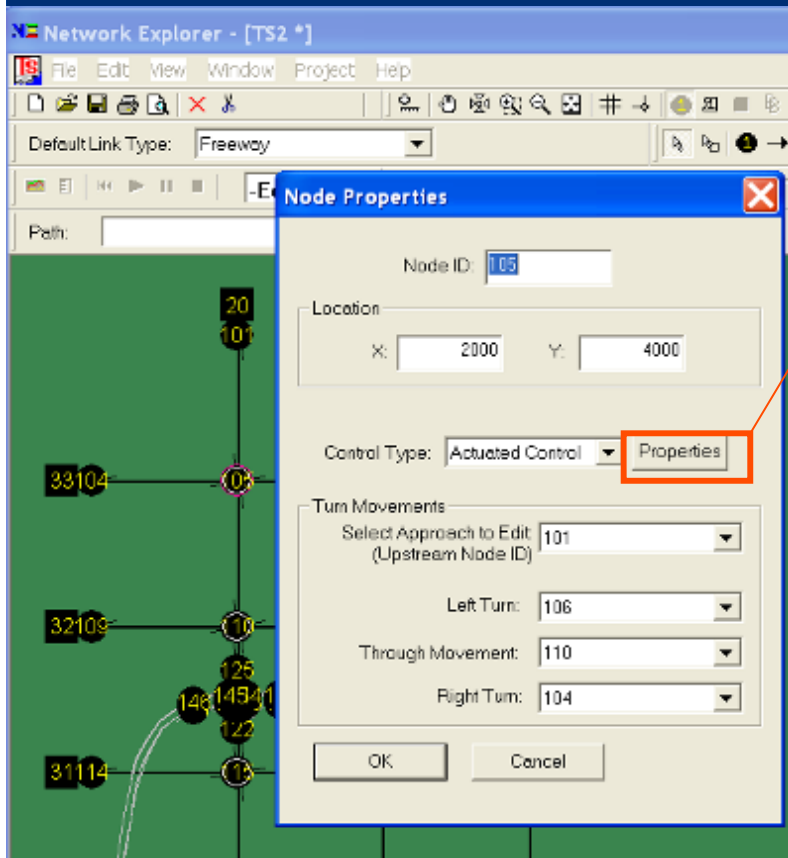
-  Distance
-  Move Network
-  Pan
-  Zoom In
-  Zoom Out
-  Show Entire Network
-  Show/Hide Grid
-  Show/Hide Node
-  Show/Hide Zone

Step 2: Zoom In -> View Lane Configuration

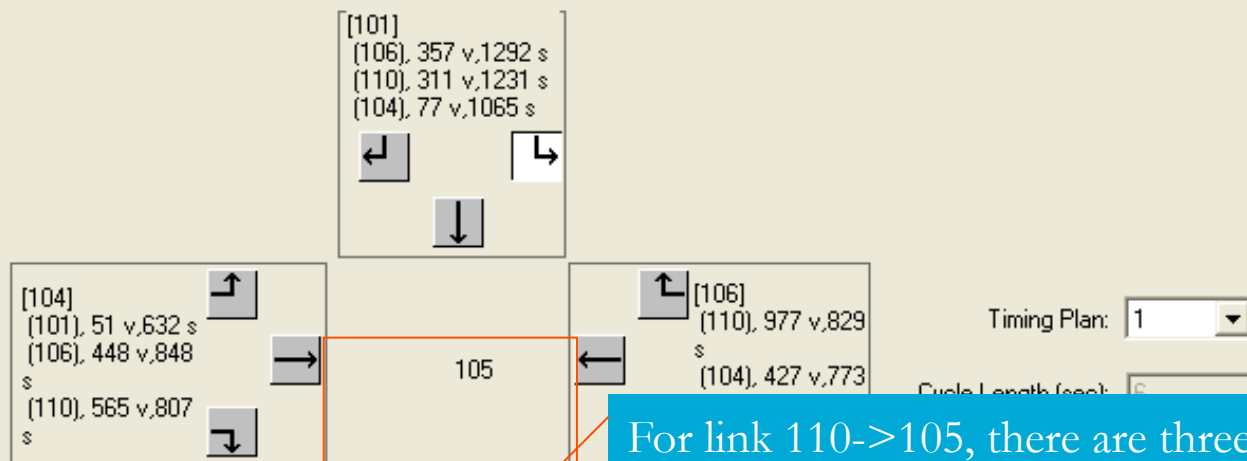


Zooming can also be accomplished with the **Page Up / Page Down** keys, the **+ / -** keys or the **mouse wheel**.

Step 3: Double-Click a Node to Show Node and Control Properties



Actuated Control Properties

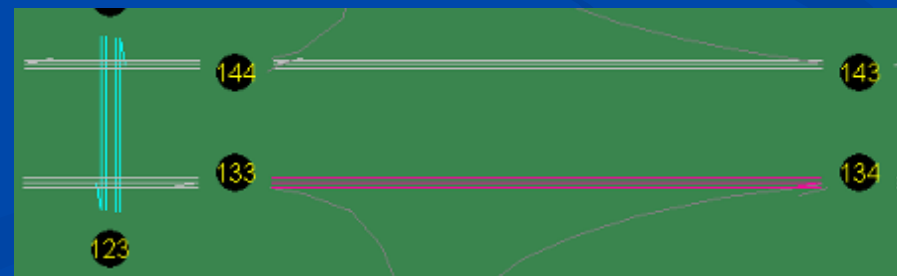
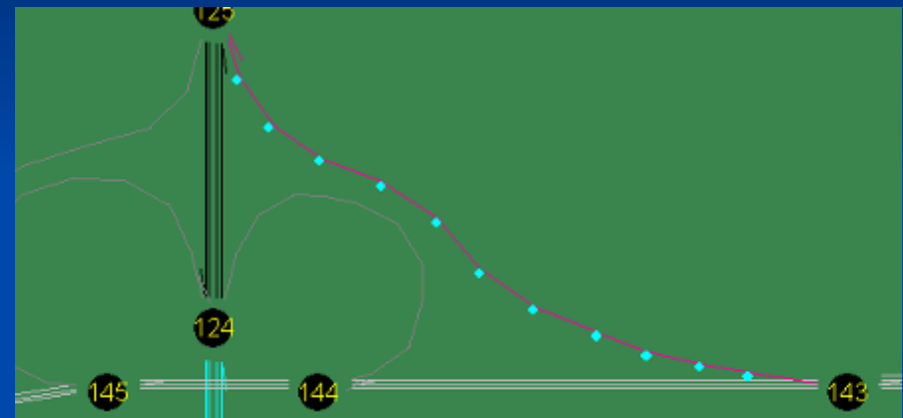
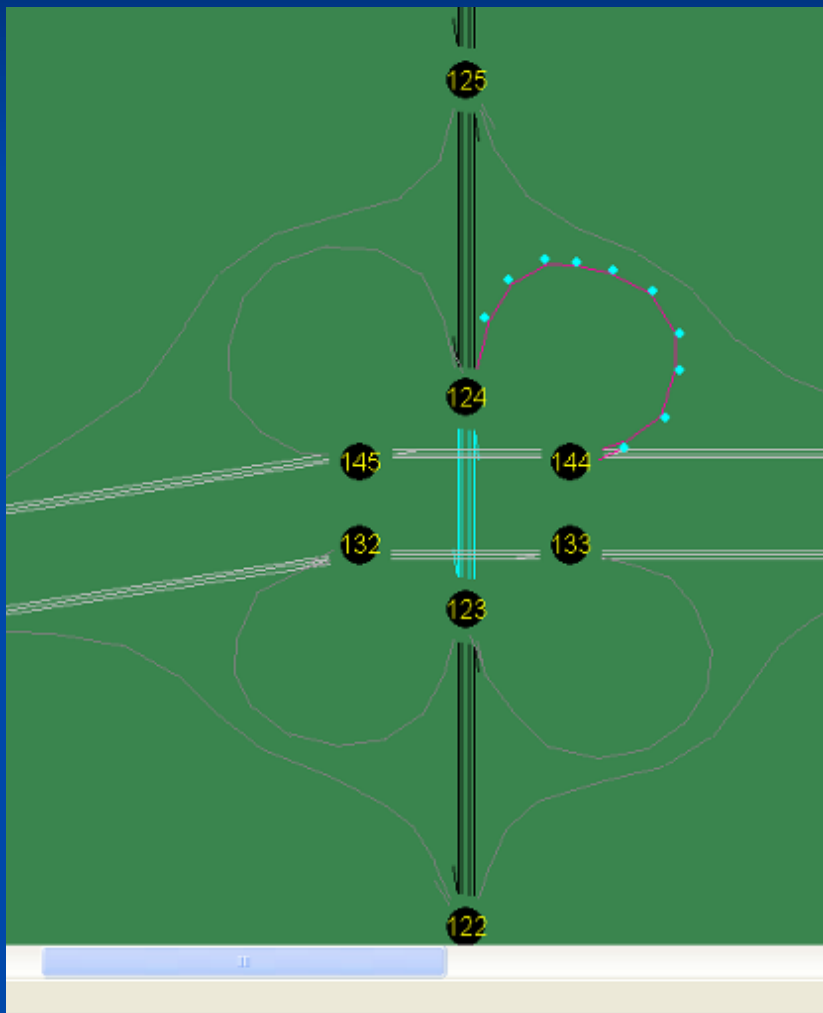


For link 110->105, there are three movements with traffic volume: movement 110->105->104 has 326 vehicles with 729 seconds of average delay, movement 110->105->101 has 323 vehicles with 690 seconds of average delay, and movement 110->105->106 has 896 vehicles with 609 seconds of average delay

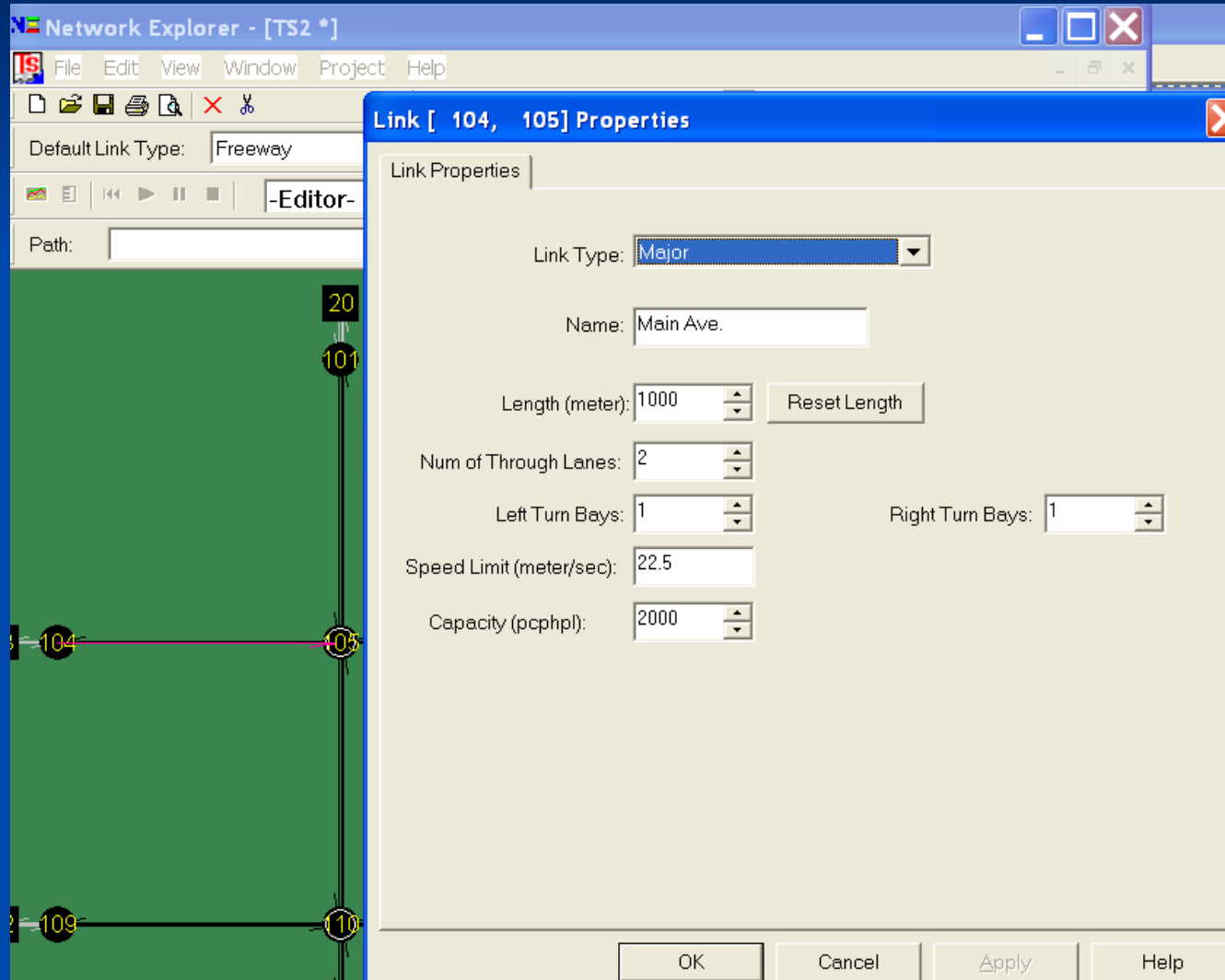
Phase Movements:	1	2	3	4	5	6	7	8
Max Green (sec):	0	0	0	0	0	0	0	0
Min Green (sec):	15	11	15	11	0	0	0	0
Amber (sec):	0	3	0	3	0	0	0	0

OK Cancel Help

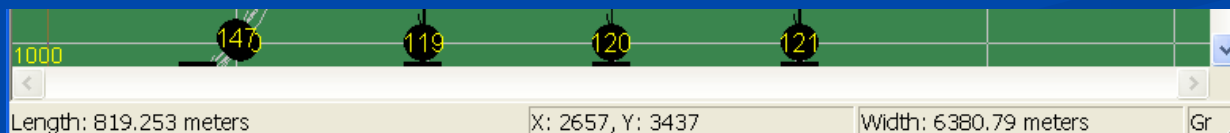
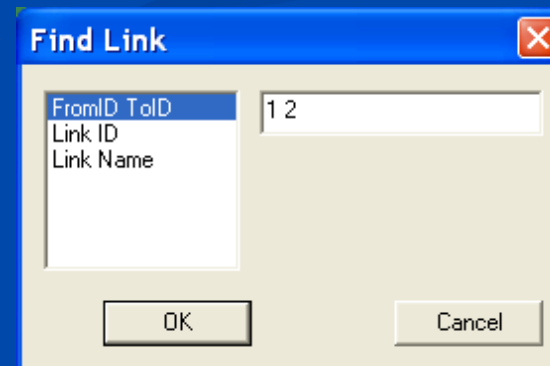
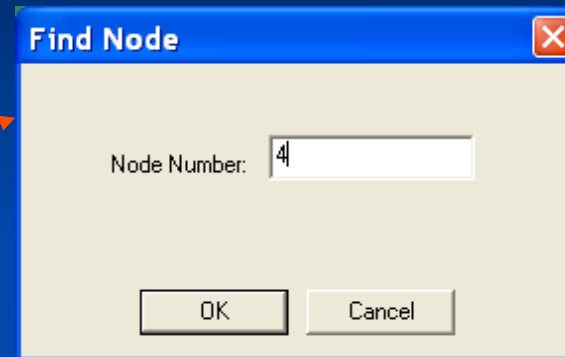
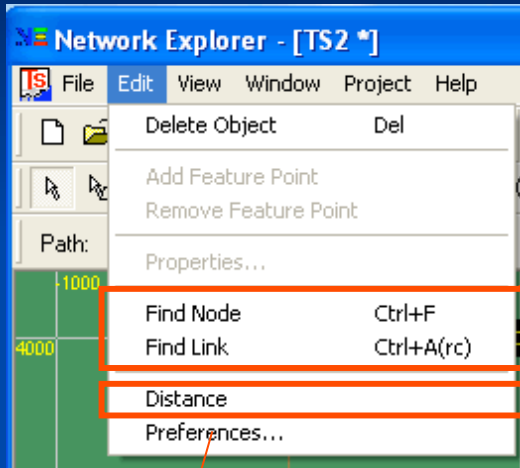
Step 4: Single-Click a Link to Show Shape Points



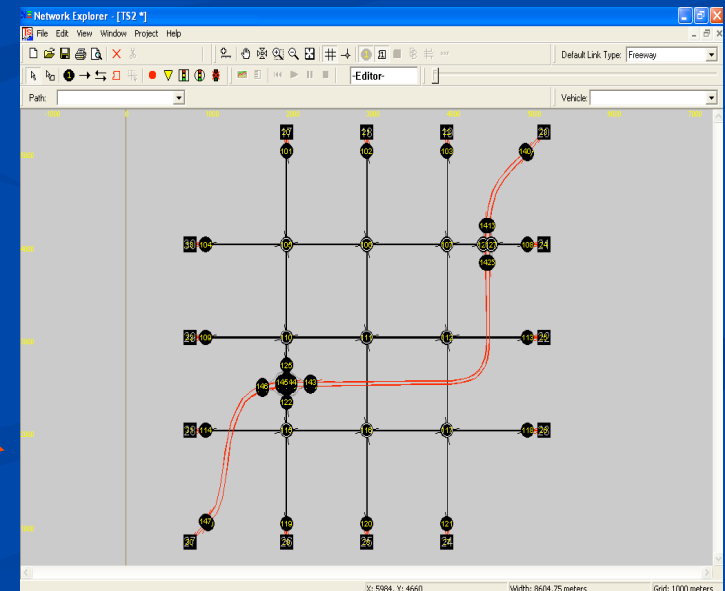
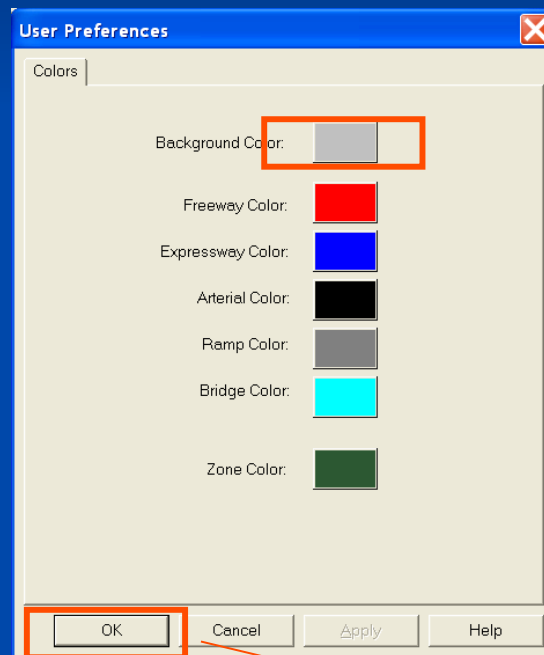
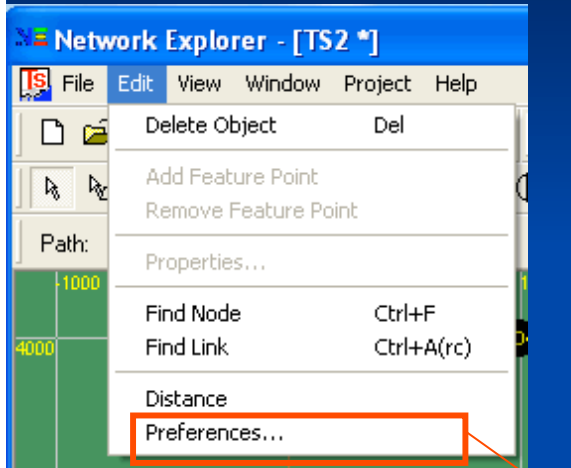
Step 5: Double-Click a Link to Show Link Property



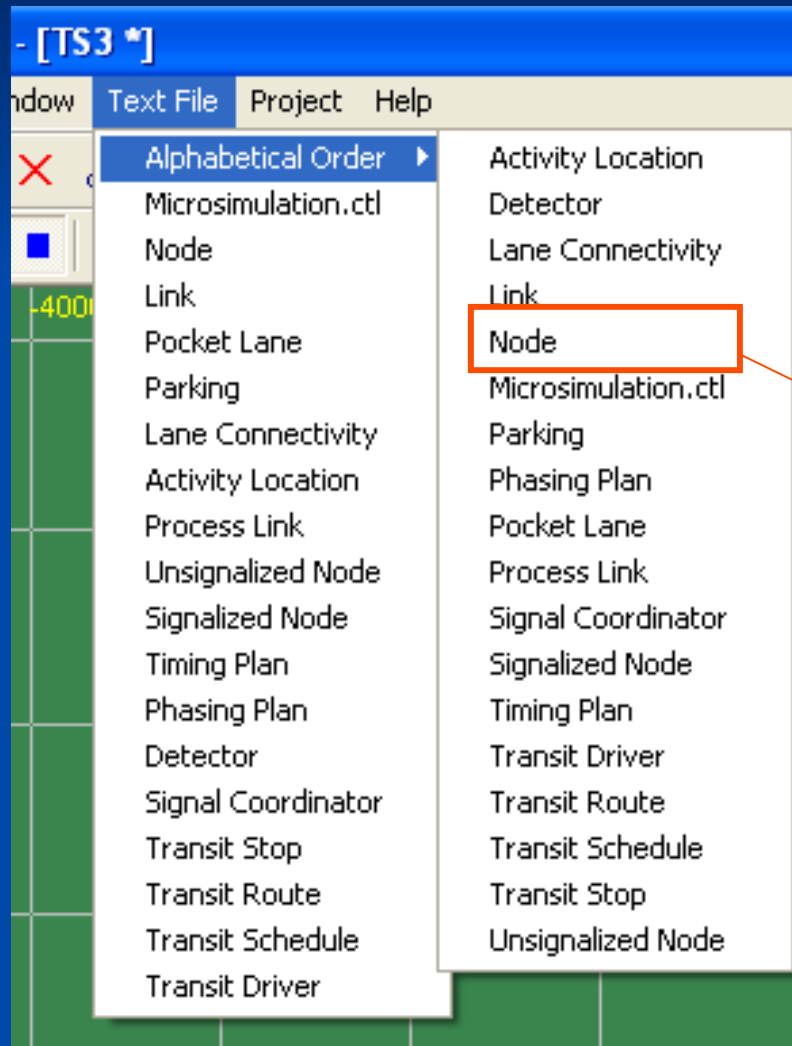
Step 6: Find Node / Find Link / Measure Distance



Step 7: Change Color Preferences for Background and Link Types



Step 8: View Text File



NEXTA fetches input file names directly from the microsimulator control file.

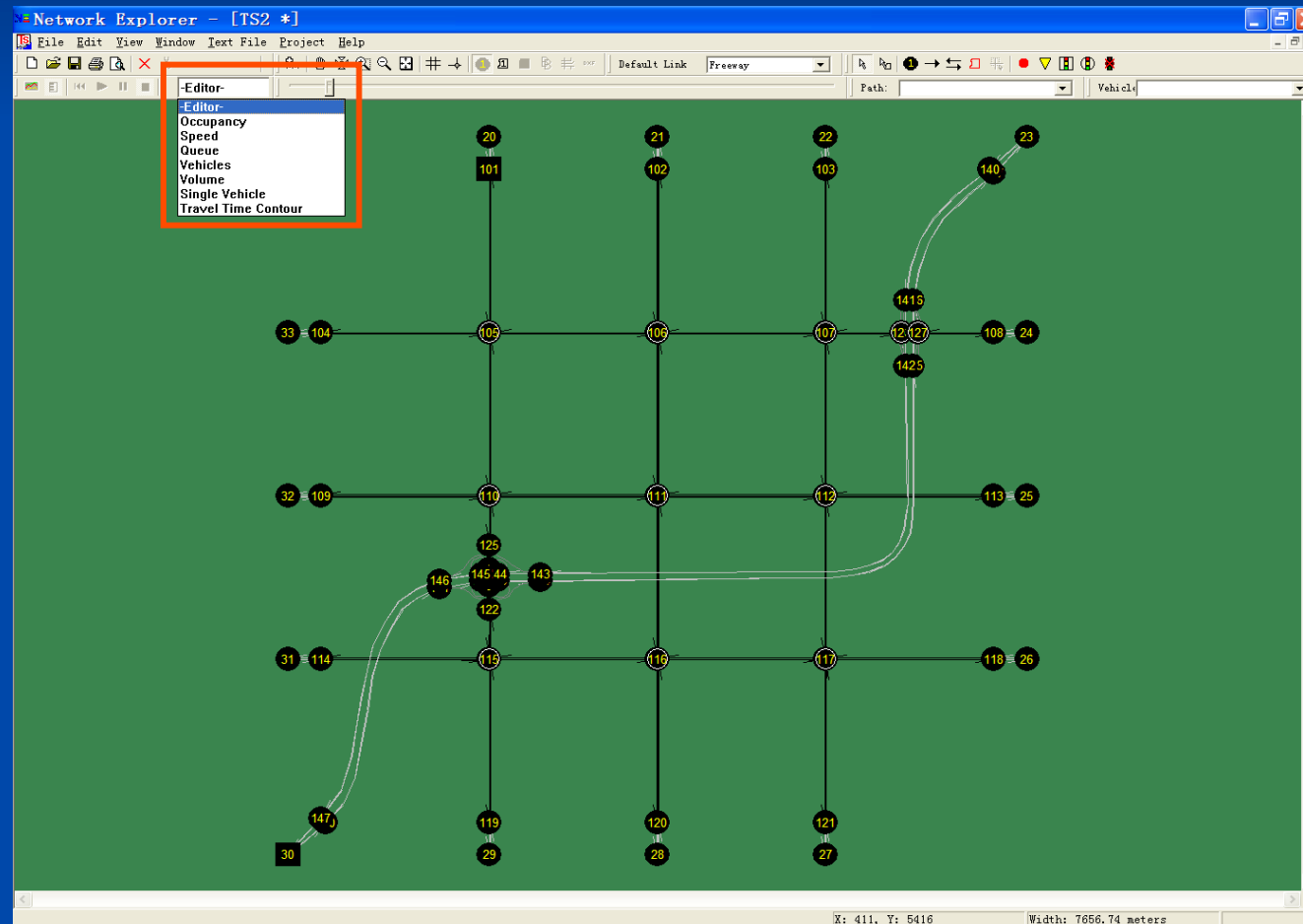
A screenshot of a WordPad window titled "Node.txt - WordPad". The window displays a text file with the following content:

NODE	X_COORD	Y_COORD	Z_COORD	NOTES
20	2000.00	5200.00	0	External Station
21	3000.00	5200.00	0	External Station
22	4000.00	5200.00	0	External Station
23	5200.00	5200.00	0	External Station
24	5200.00	4000.00	0	External Station
25	5200.00	3000.00	0	External Station
26	5200.00	2000.00	0	External Station
27	4000.00	800.00	0	External Station
28	3000.00	800.00	0	External Station
29	2000.00	800.00	0	External Station
30	800.00	800.00	0	External Station
31	800.00	2000.00	0	External Station
32	800.00	3000.00	0	External Station
33	800.00	4000.00	0	External Station
101	2000.00	5000.00	0	Network Node
102	3000.00	5000.00	0	Network Node

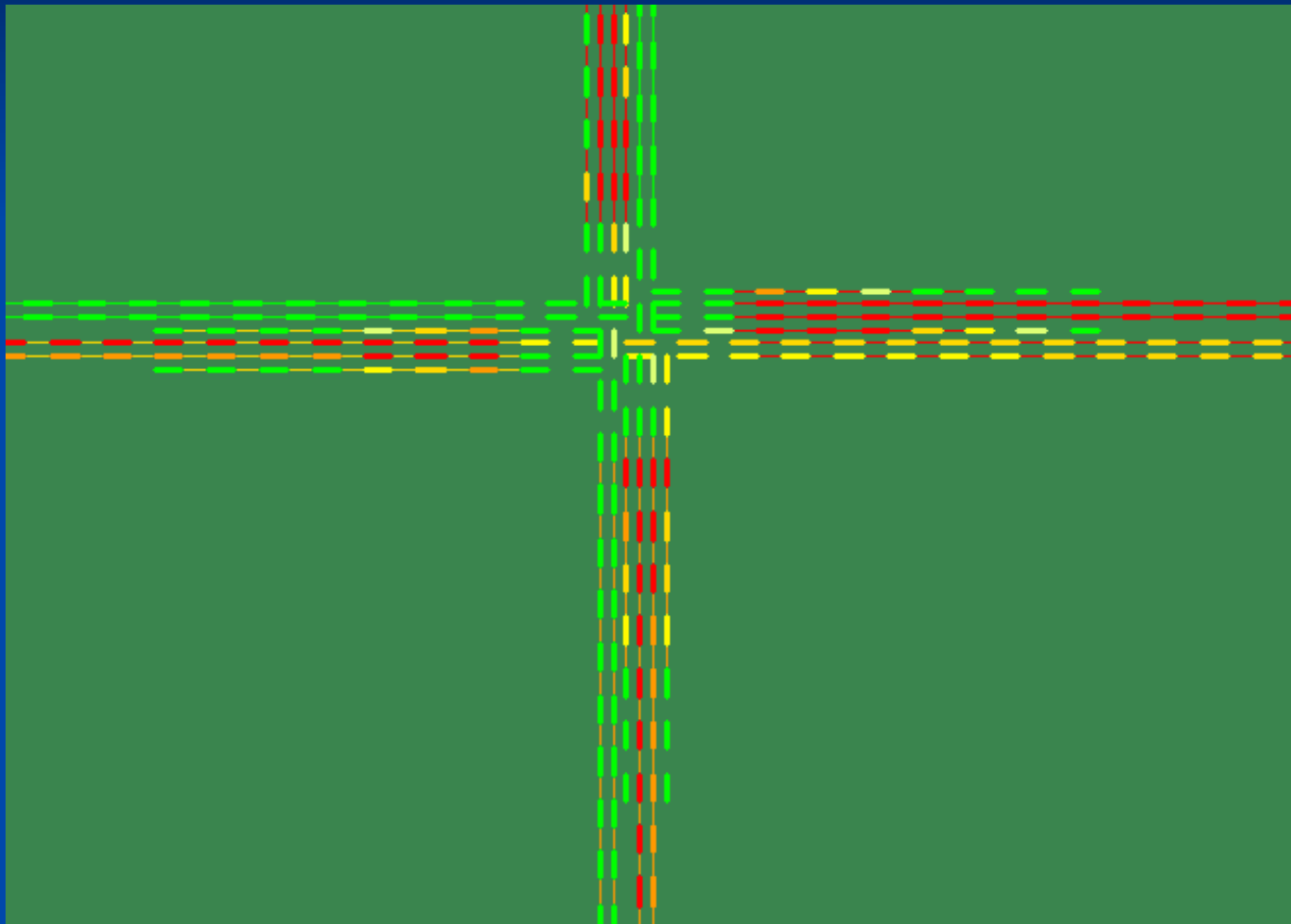
For Help, press F1

Step 9: Select Display Mode to View Simulation Results

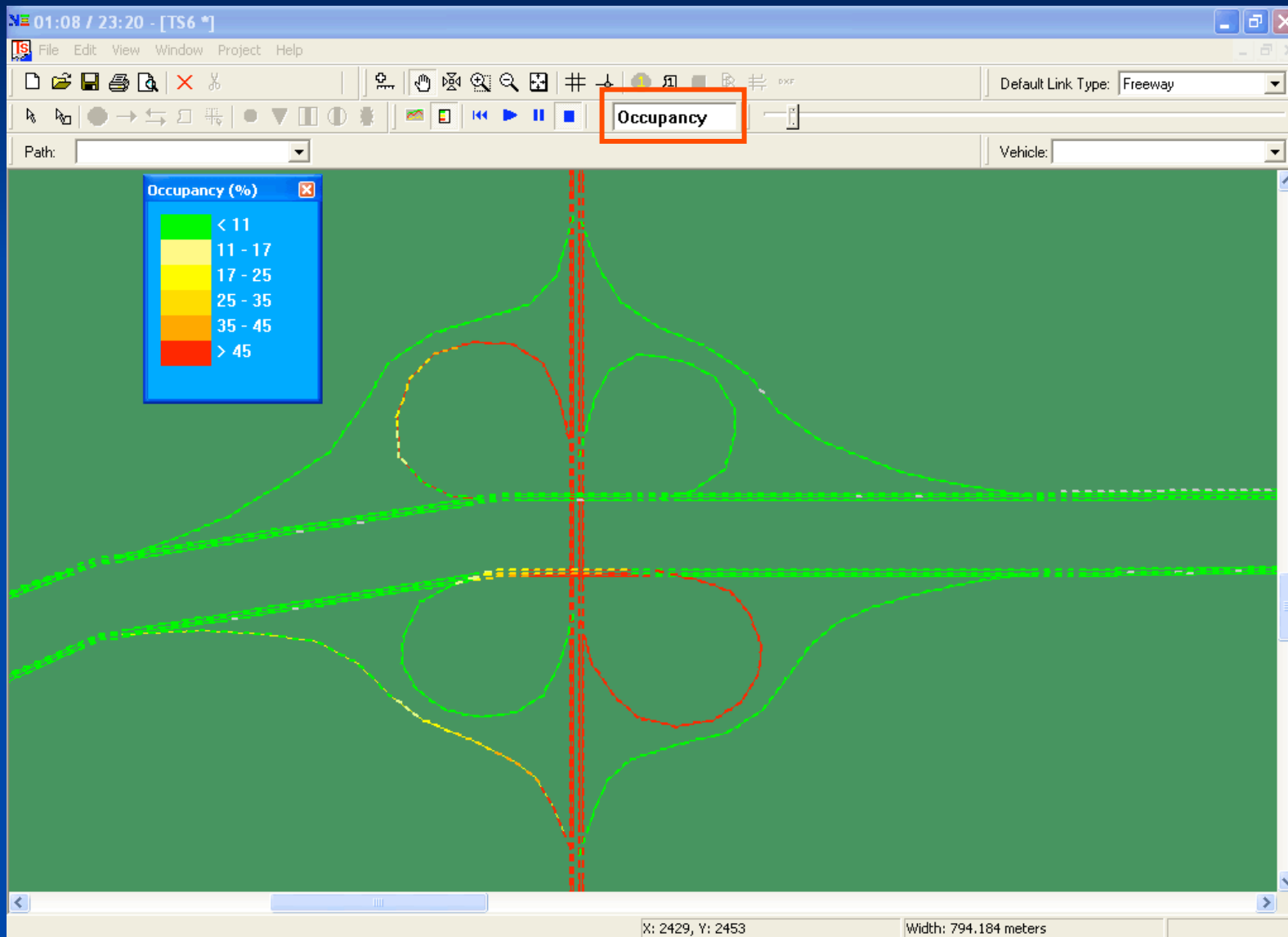
- Occupancy, Speed, Queue, Vehicles, Volume, Single Vehicle, Travel Time Contour



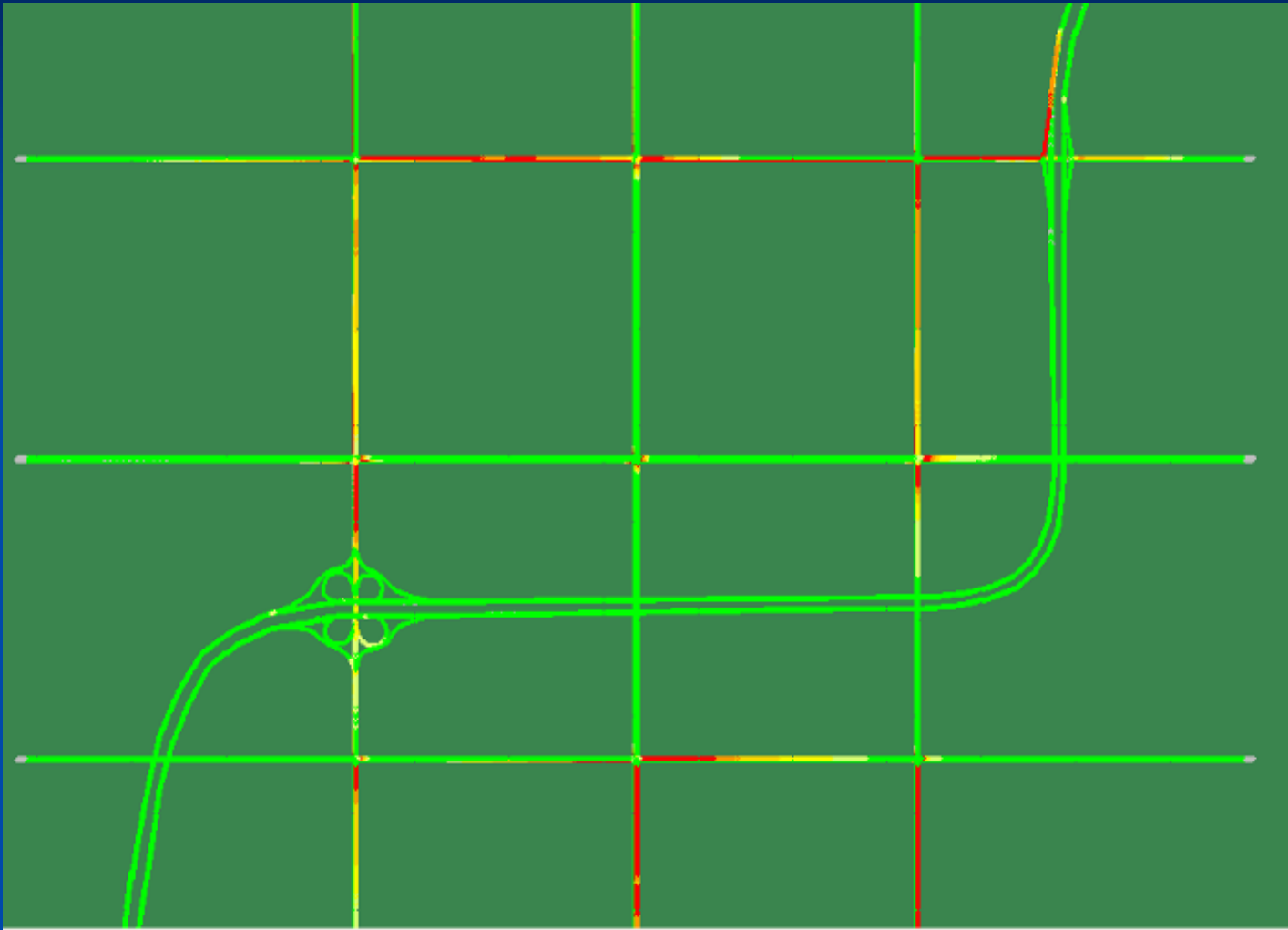
Cell-based Occupancy (I)



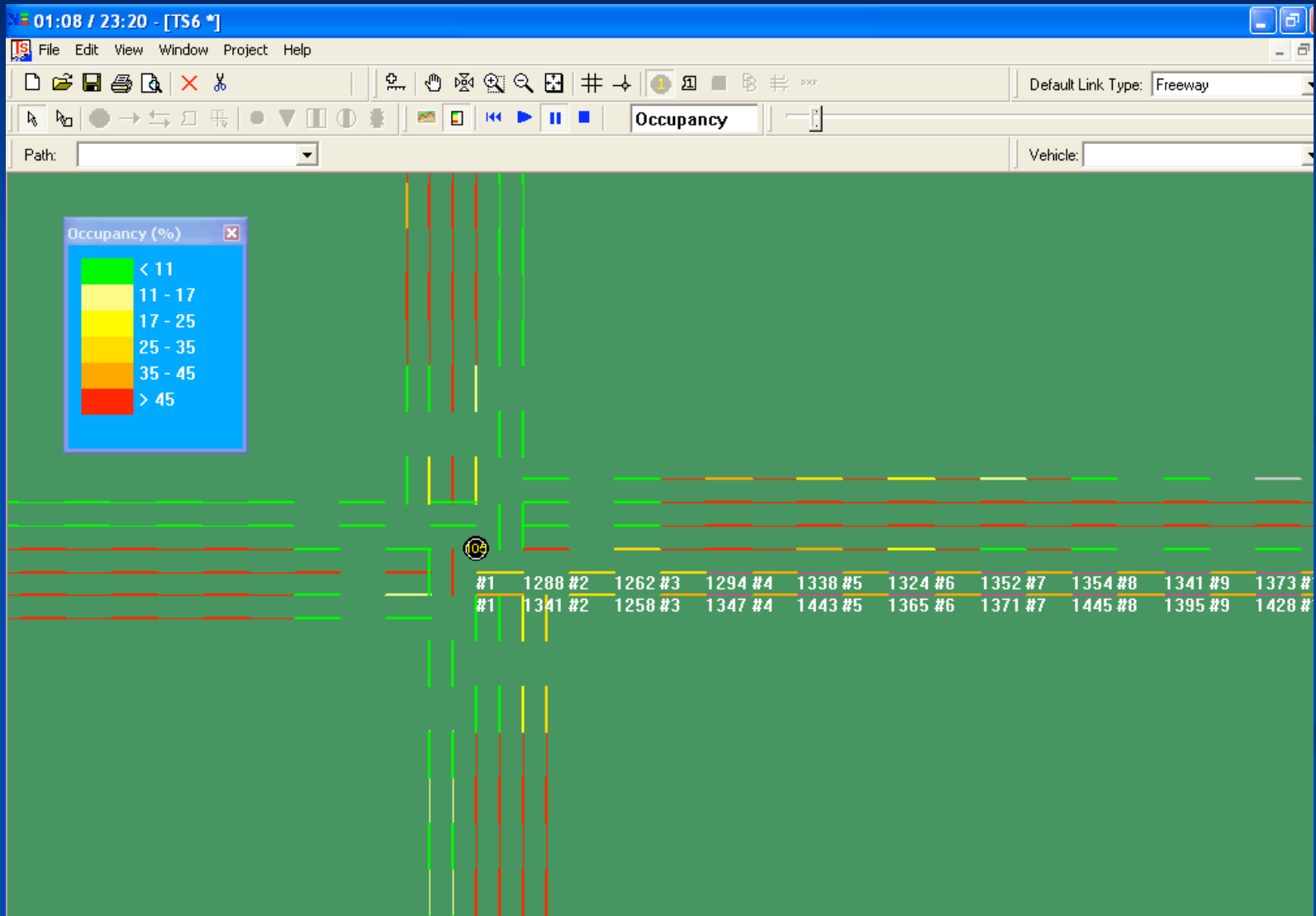
Cell-based Occupancy (II)



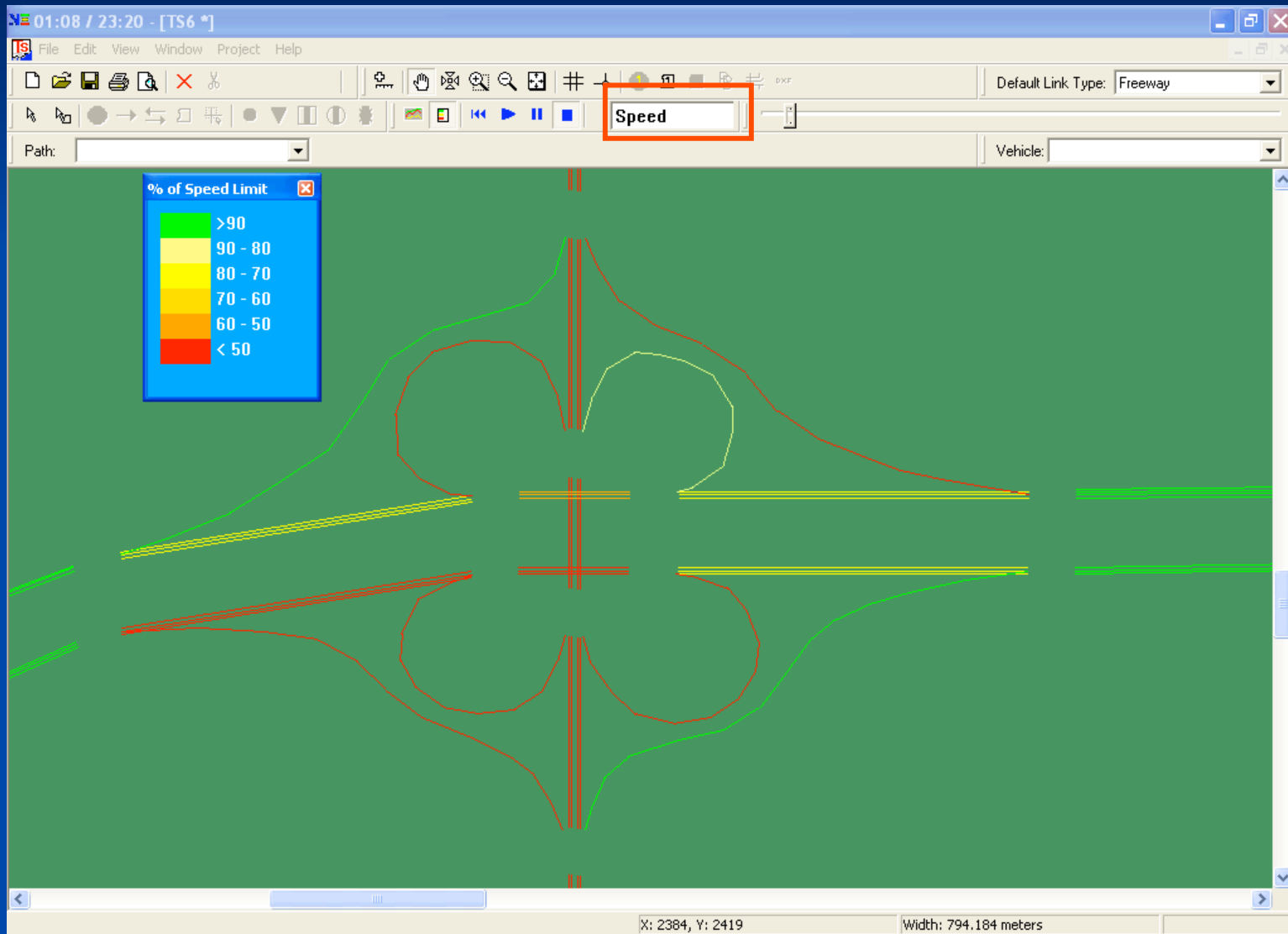
Cell-based Occupancy (III)



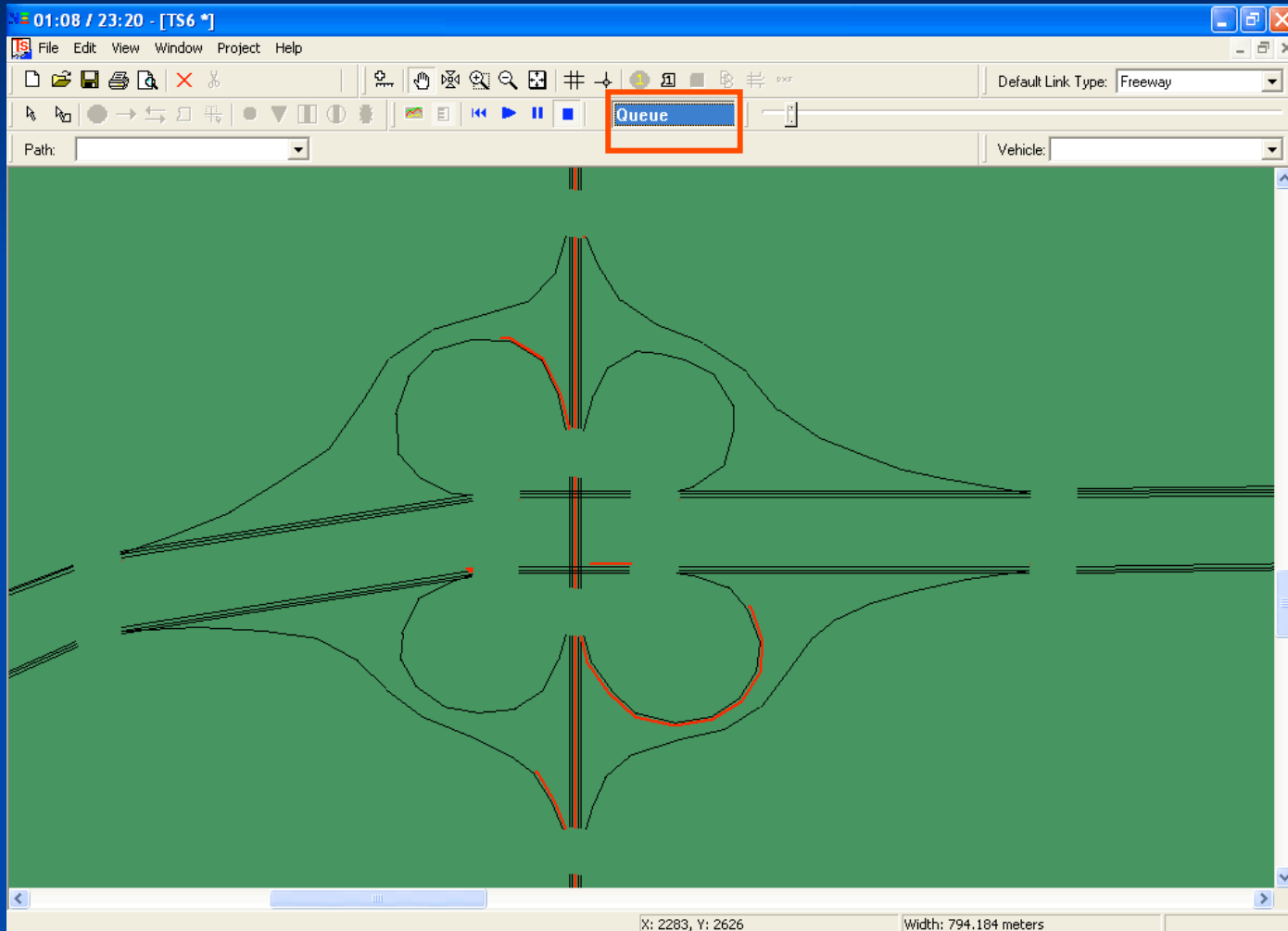
Cell-based Occupancy (IV)



Speed

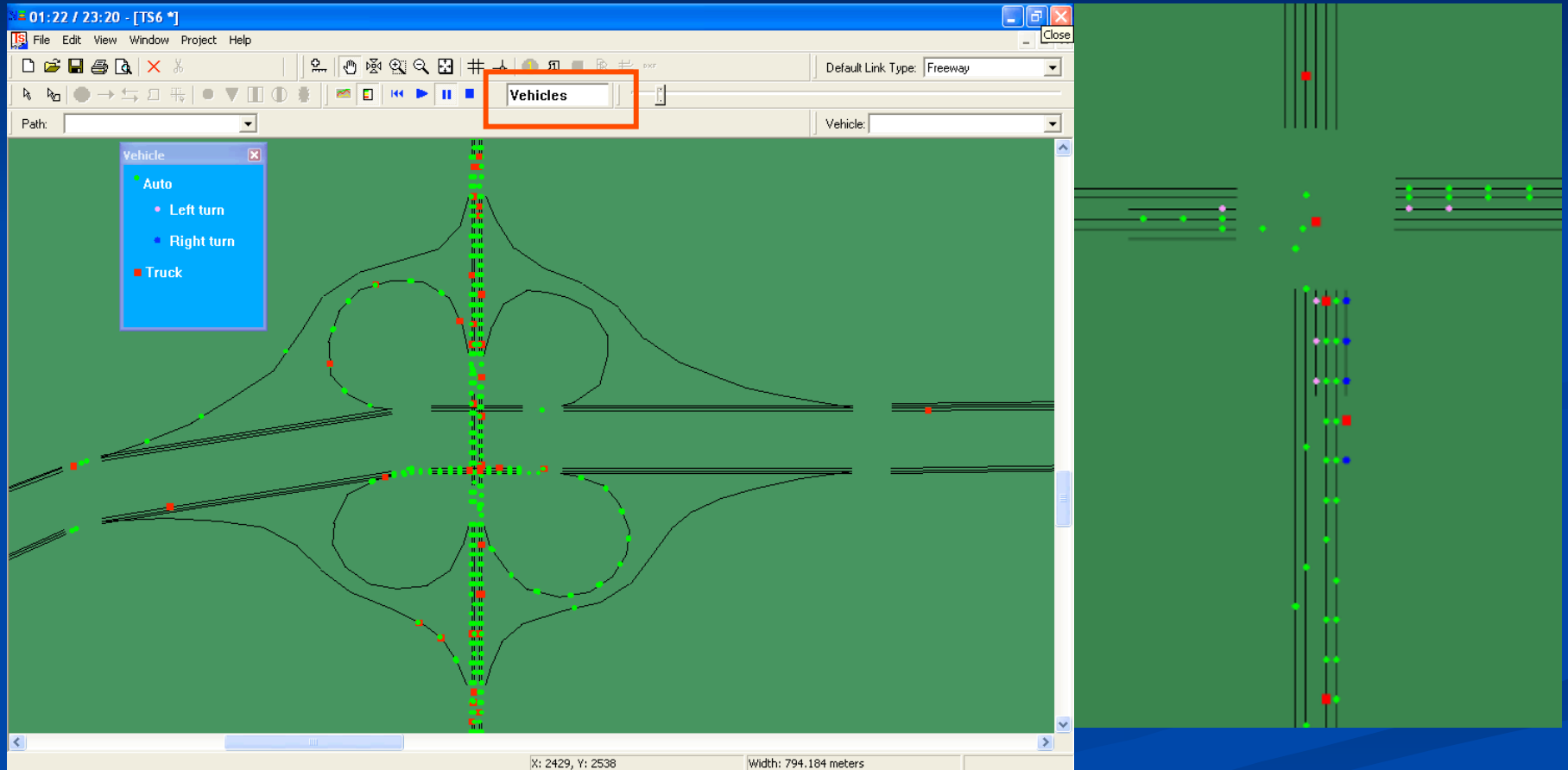


Queue Length



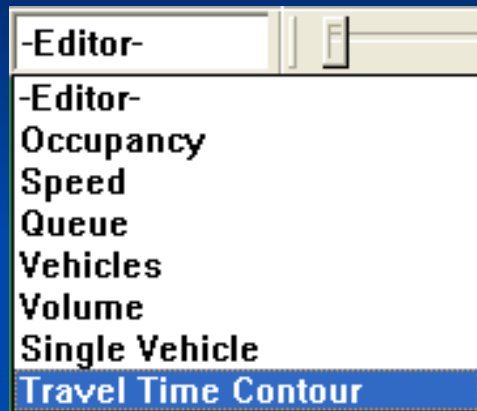
Queue length = average number of stopped vehicles per lane * 7.5 meters

Vehicle

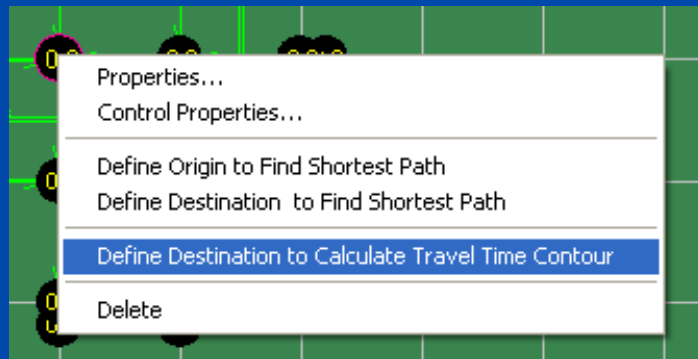


Vehicle locations are imported from snapshot file

Travel Time Contour

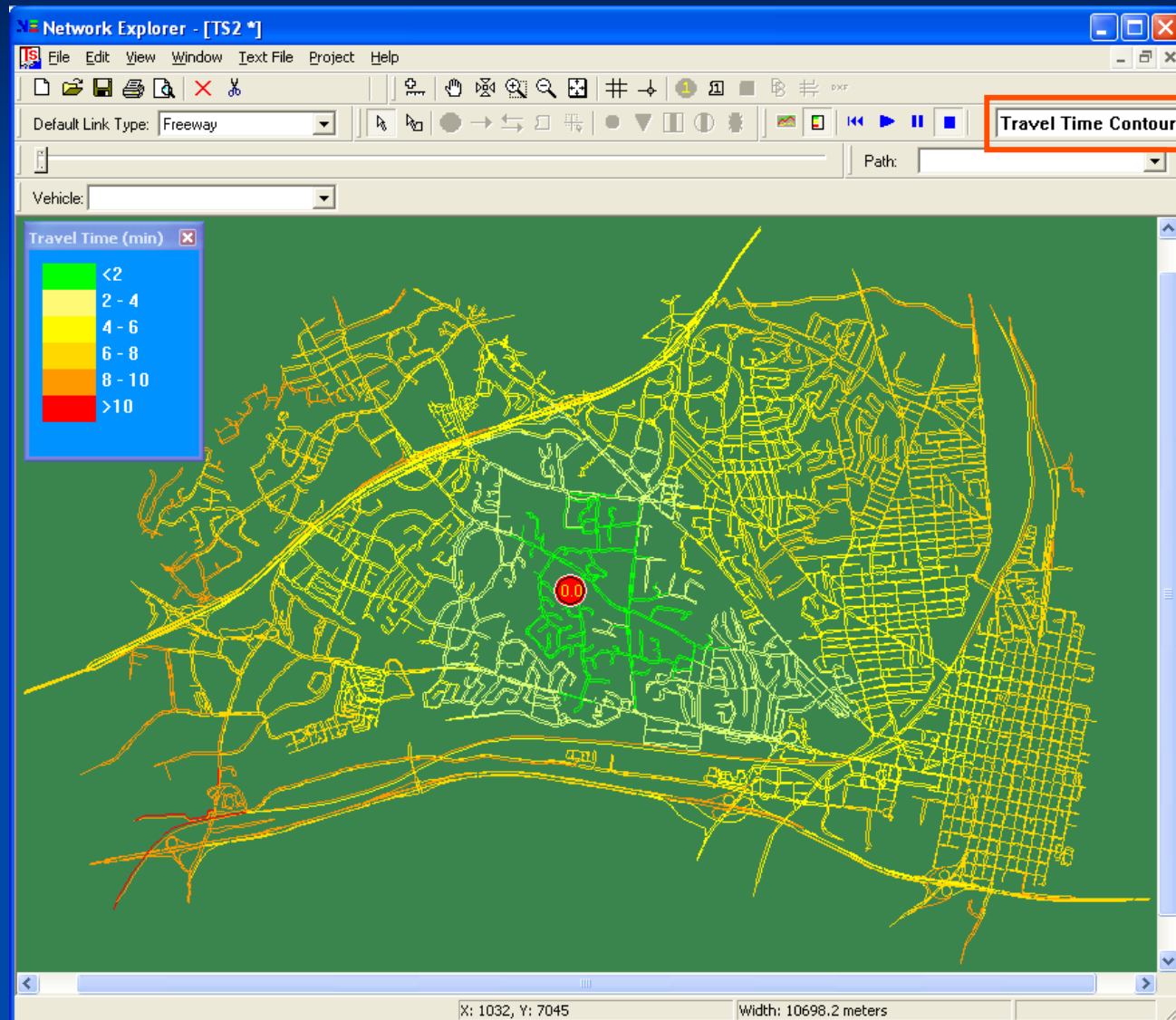


When the display mode is set to Travel Time Contour Display Mode, the minimum path travel times between a designated destination and other nodes can be plotted on the network window.



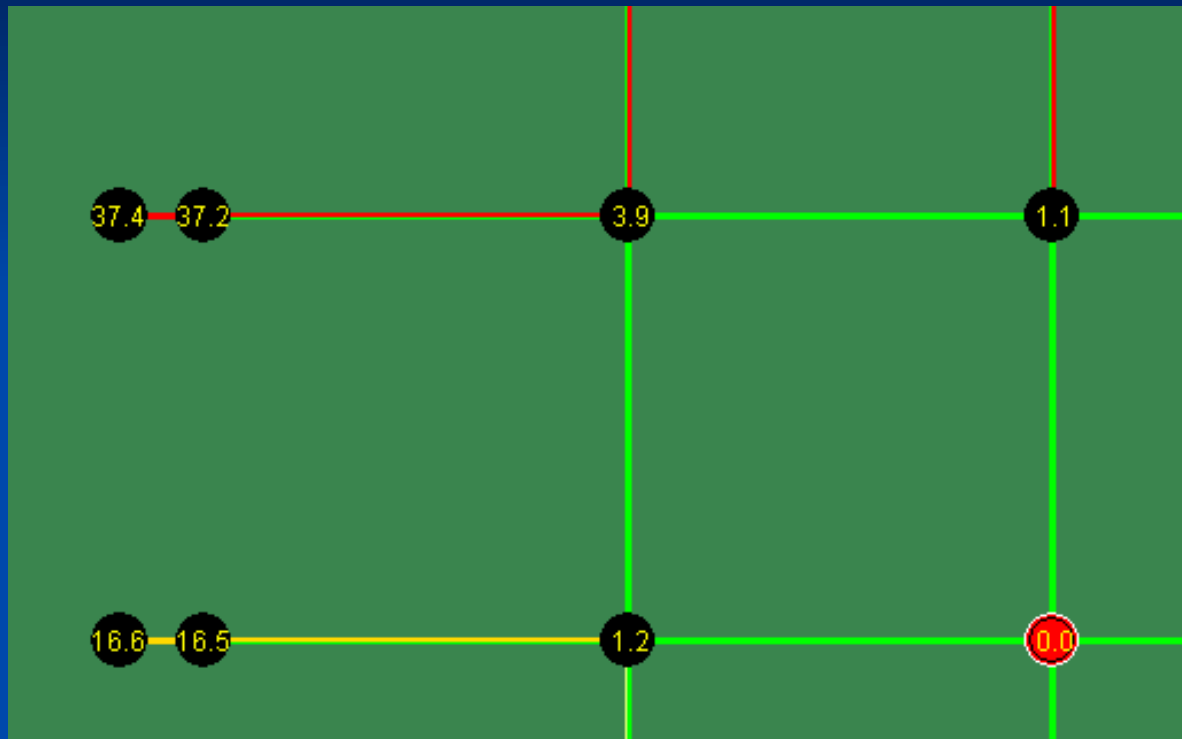
A user can right-click a node to select menu “Define Destination to Calculate Travel Time Contour”.

Travel Time Contour



The minimum path travel times between a designated destination and other nodes are plotted on the network window.

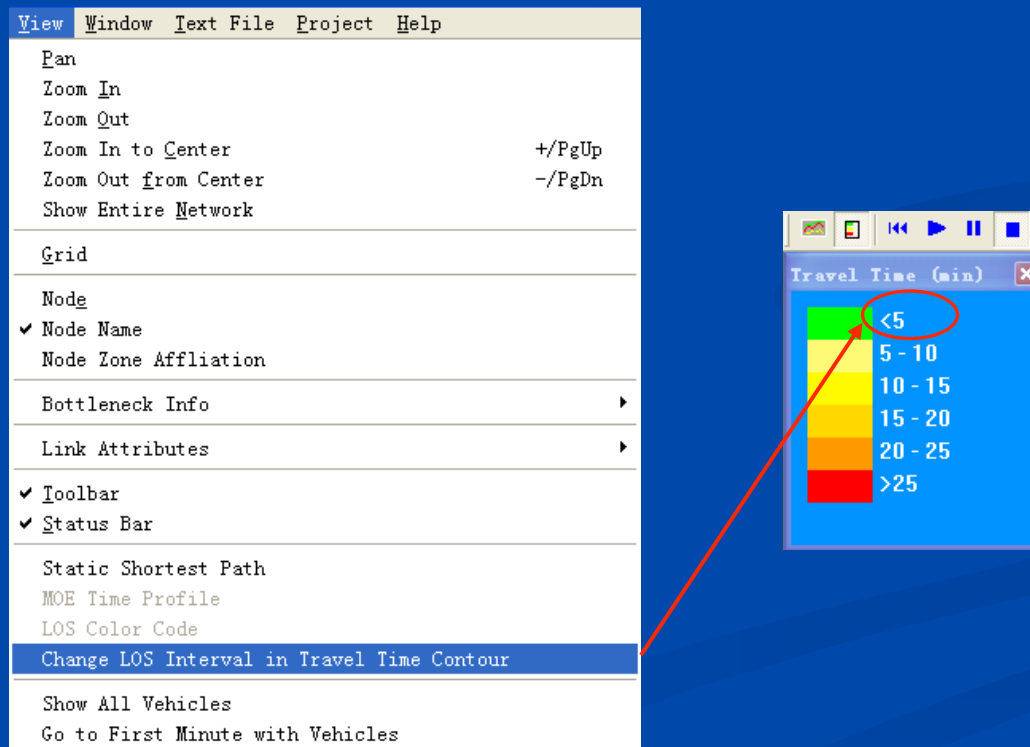
Travel Time Contour



The numbers on a node indicates the calculated minimum path travel time (in minutes) between the current node to the designated destination.

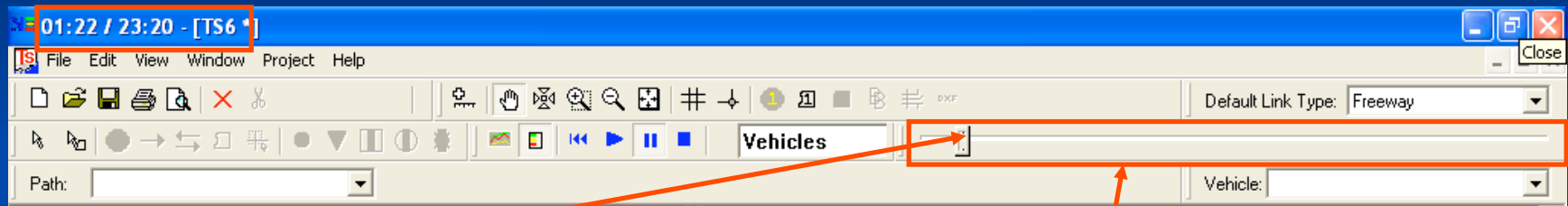
Travel Time Contour

A user can also customize the thresholds of travel time categories displayed in travel time contour by selecting menu -> View -> Change LOS Interval in Travel Time Contour.



Step 10: Show Simulation Results at a Given Time

Simulation Time Clock: 1 hour: 33 min

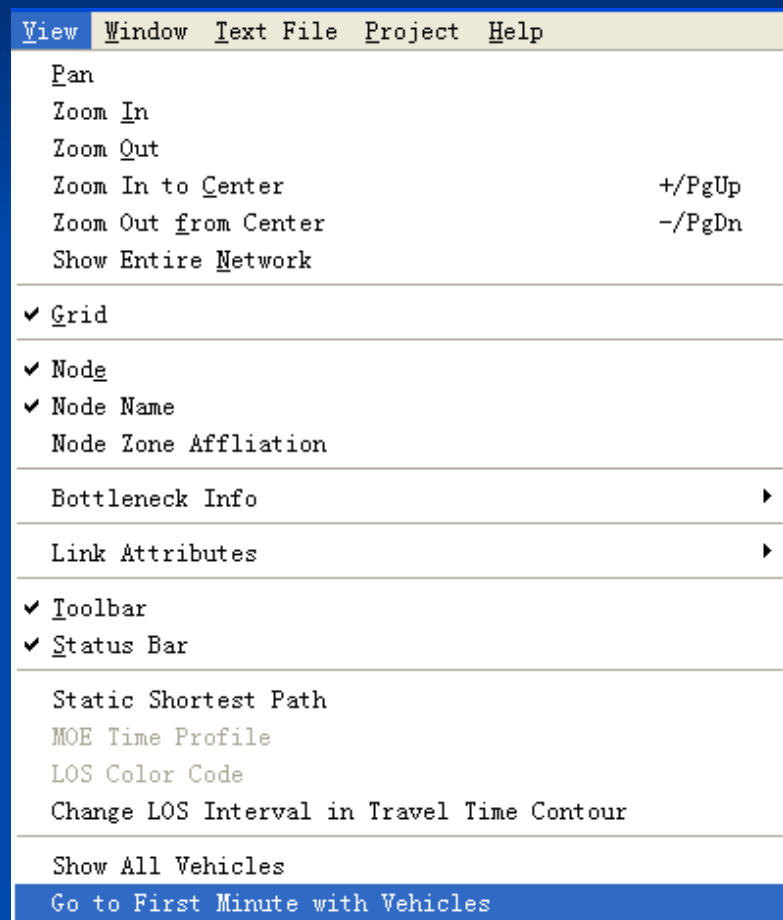


Clock Bar

Slider

Drag the slider of the clock bar to view simulation results at a given time of simulation horizon

Go to First Minute with Vehicles

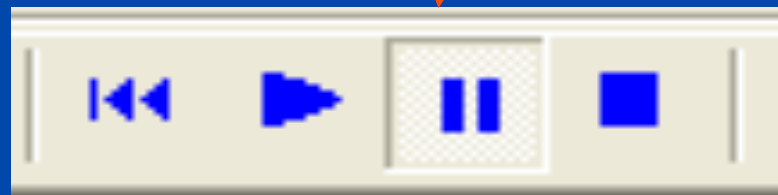
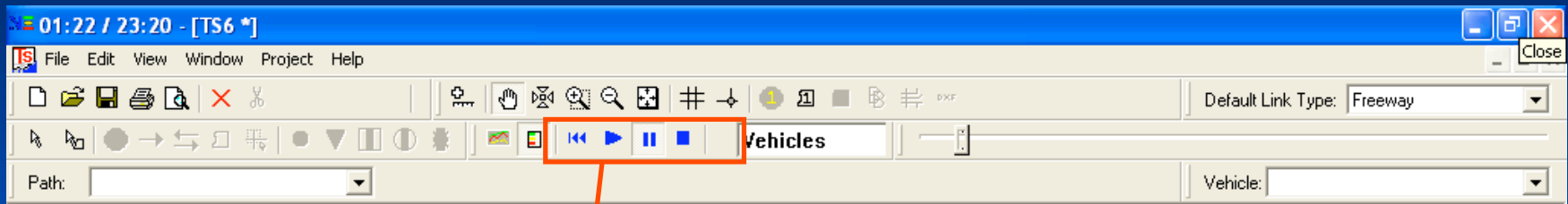


A user can set the slider of the clock bar at the first minute with vehicles.

A snapshot file might only cover a short time period of the entire simulation horizon.

After a TRANSIMS project has been loaded, a user can click on menu->View ->Go to First Minute with Vehicles to jump to the first time stamp with snapshot data.

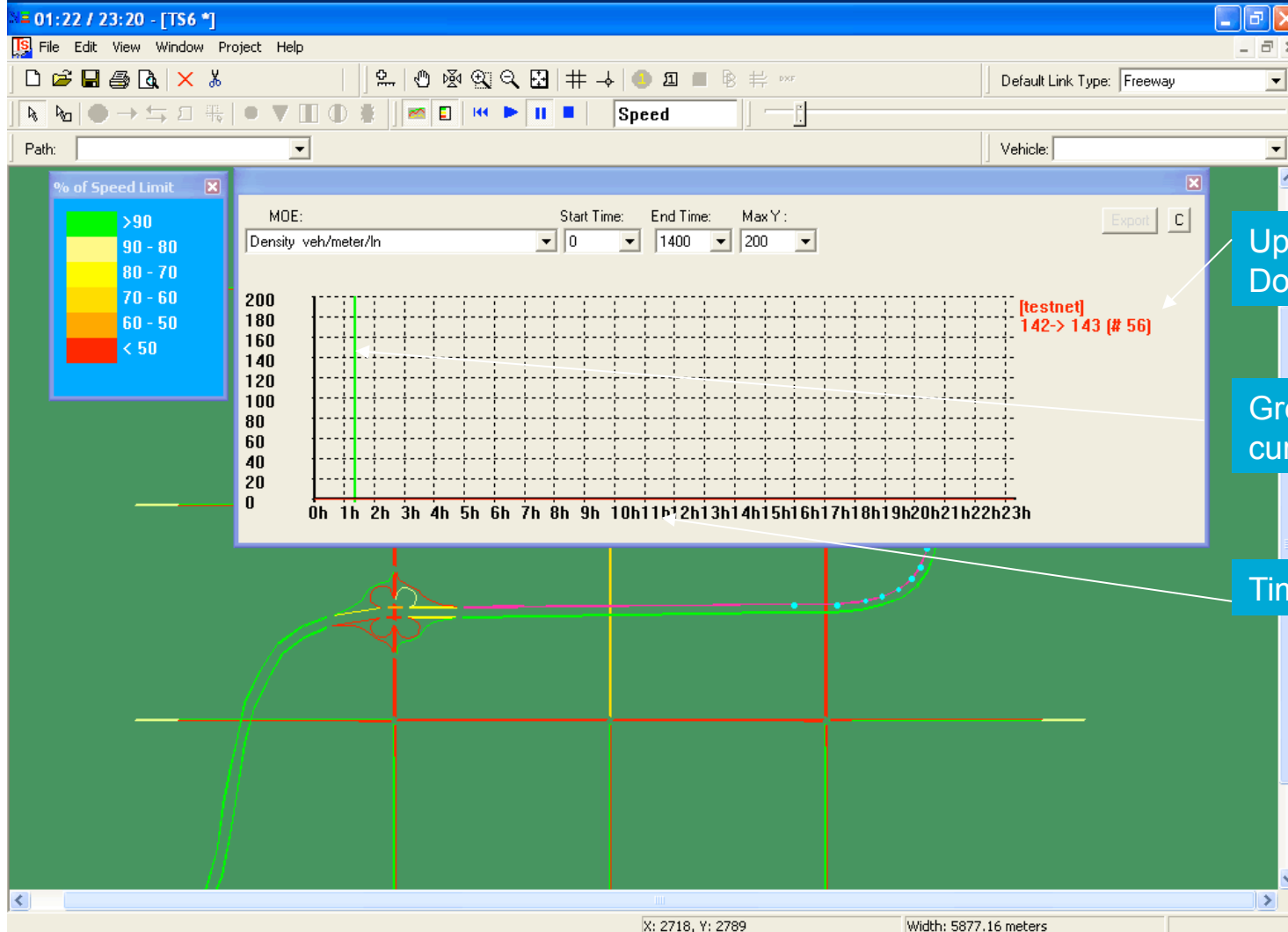
Step 11: Play Animation



Rewind, play, pause, stop

Remarks: Simulation clock is advanced at 1-min interval

Step 12: Double-Click a Link to Show MOE Profile



Upstream node ->
Downstream node (# link ID)

Green line indicates the
current simulation time

Time axis (unit: min)

Step 13: Configure MOE Display Dialog

- MOE: Density, Speed, Queue Length, Volume
- Start Time, End Time, Max Y
- Background color

The image shows a software interface for configuring an MOE (Mean of Error) display. The main dialog has the following fields:

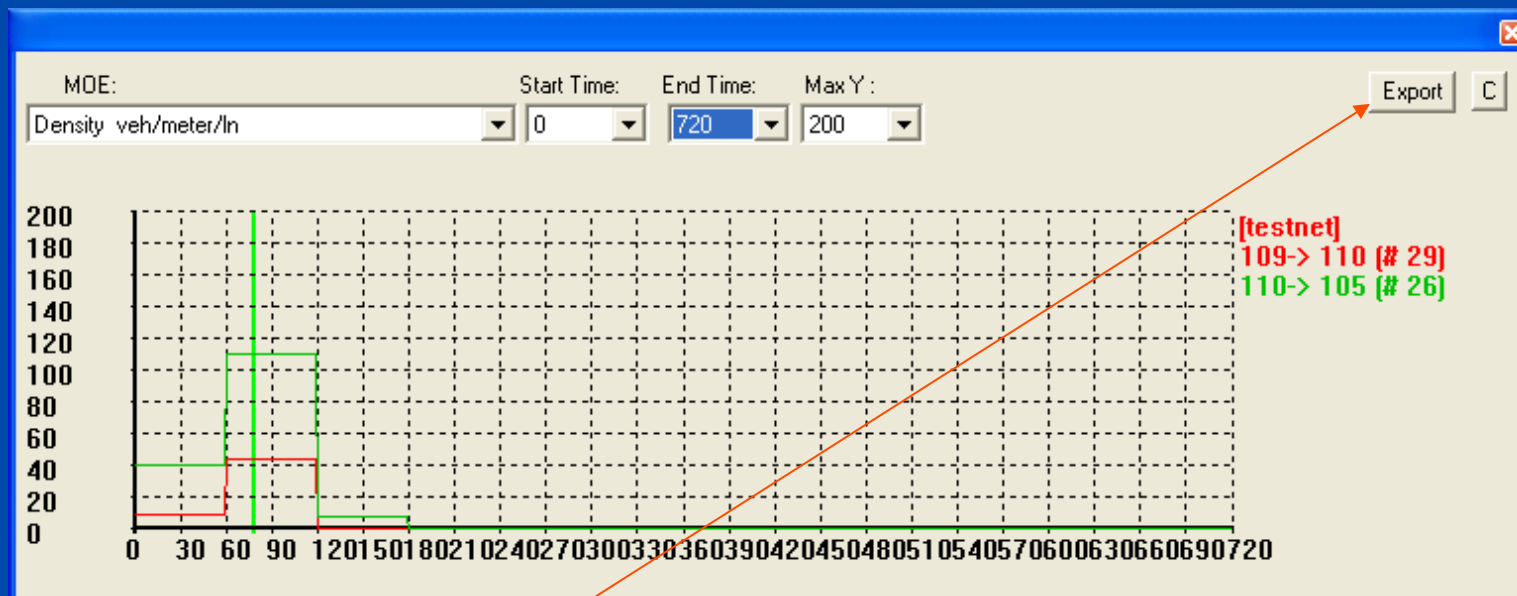
- MOE: Density veh/meter/ln
- Start Time: 0
- End Time: 1400
- Max Y: 200

Below these fields is a grid plot with a vertical green line at 1h. The y-axis ranges from 0 to 200, and the x-axis ranges from 0h to 23h. A red label "[testnet] 142-> 143 (# 56)" is positioned near the top right of the grid.

A "Color" dialog box is open in the foreground, showing a color palette with "Basic colors" and "Custom colors" sections. The "Basic colors" section contains a grid of 48 color swatches. The "Custom colors" section contains a grid of 12 empty color swatches. The "Color" dialog has "OK" and "Cancel" buttons at the bottom.

Step 14: Multi-link Comparison

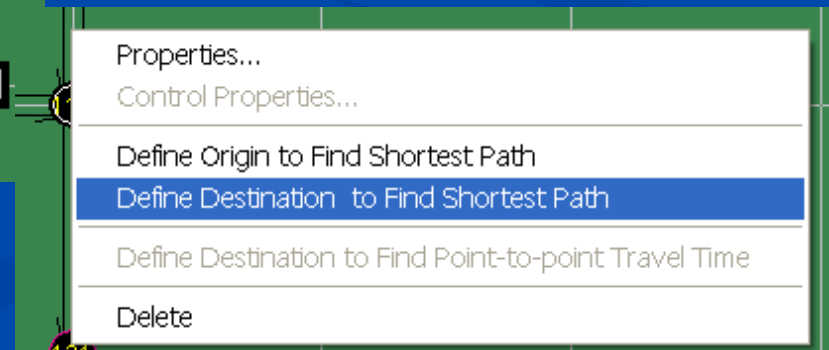
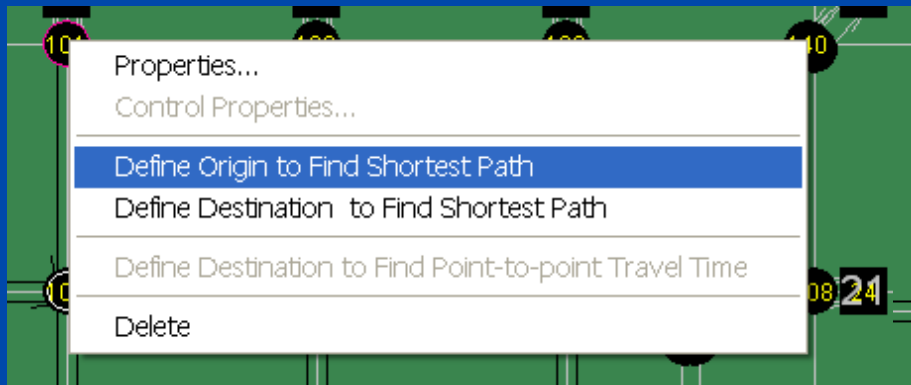
- Select multiple links (by using Ctrl+ mouse click) to display MOE time profiles simultaneously for multiple selected links, in the same or different projects.



- Data can be exported to a CSV file

Step 15: Find Paths

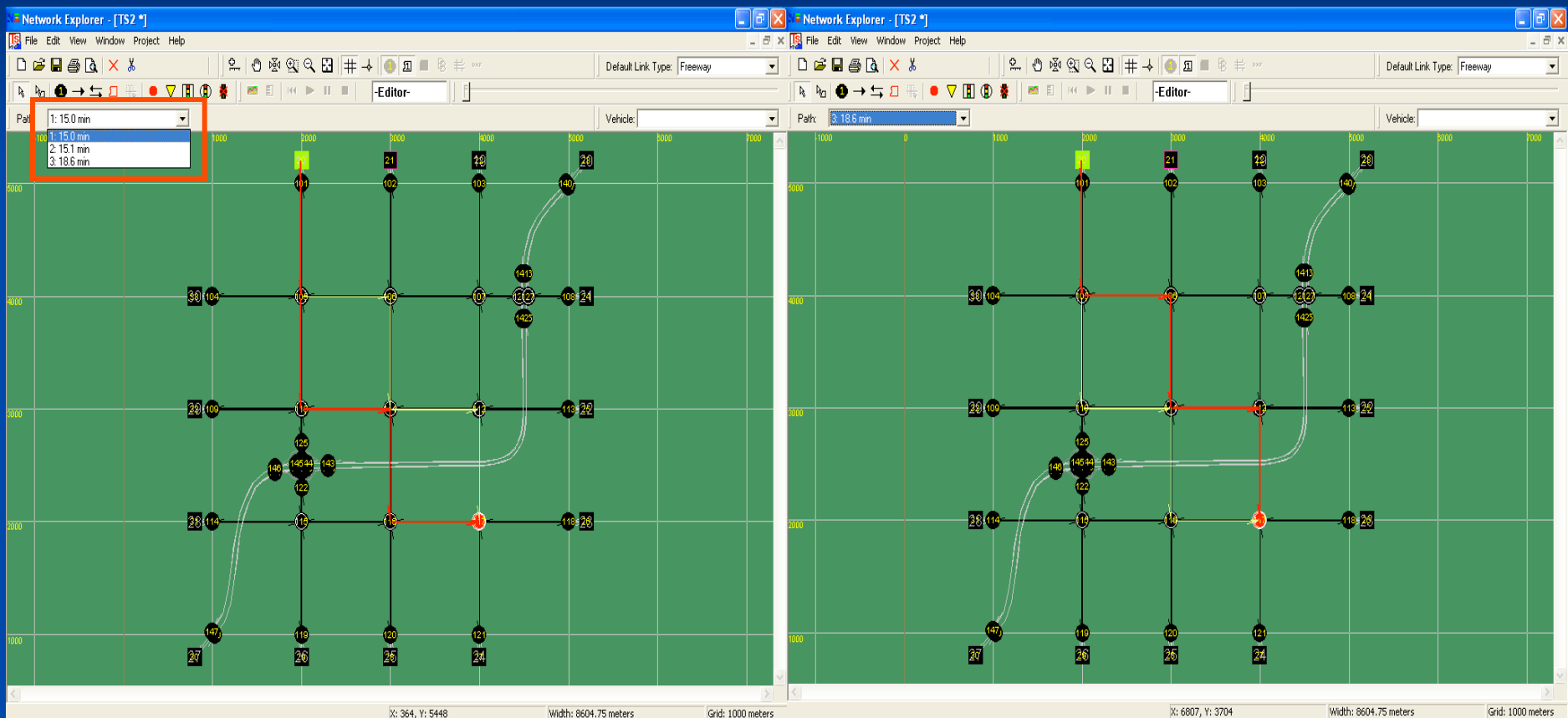
- Select an origin node,
- Right-click to select menu “Define Origin to Find Shortest Path”,
- Select a destination node,
- Right-click to select menu “Define Destination to Find Shortest Path”.



Step 16: Show Multiple Paths

■ Path 1: 15 min


Path 3: 18.6 min



The path finding algorithm uses dynamic travel time calculated from simulated link speed at a given time.

Step 17: Create Nodes/Links



 Insert node (in the middle of a link)

 Add one-way link

 Add two-way link

 Add zone

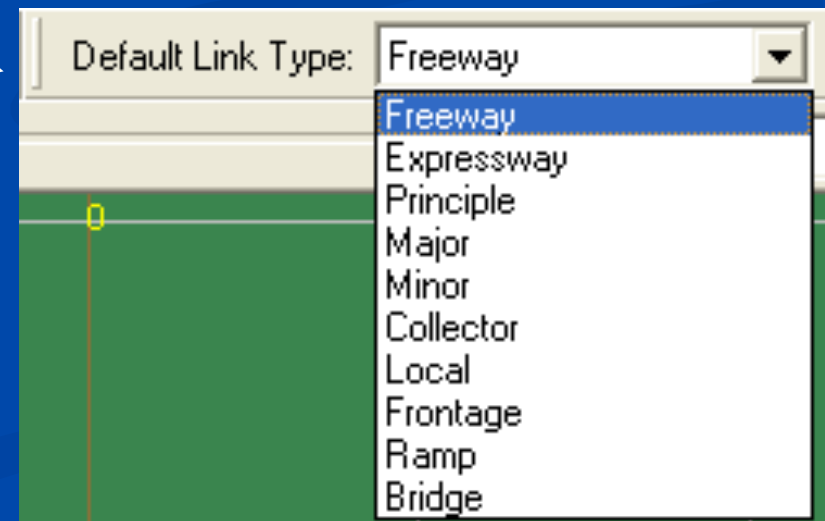
 Add stop sign

 Add yield sign

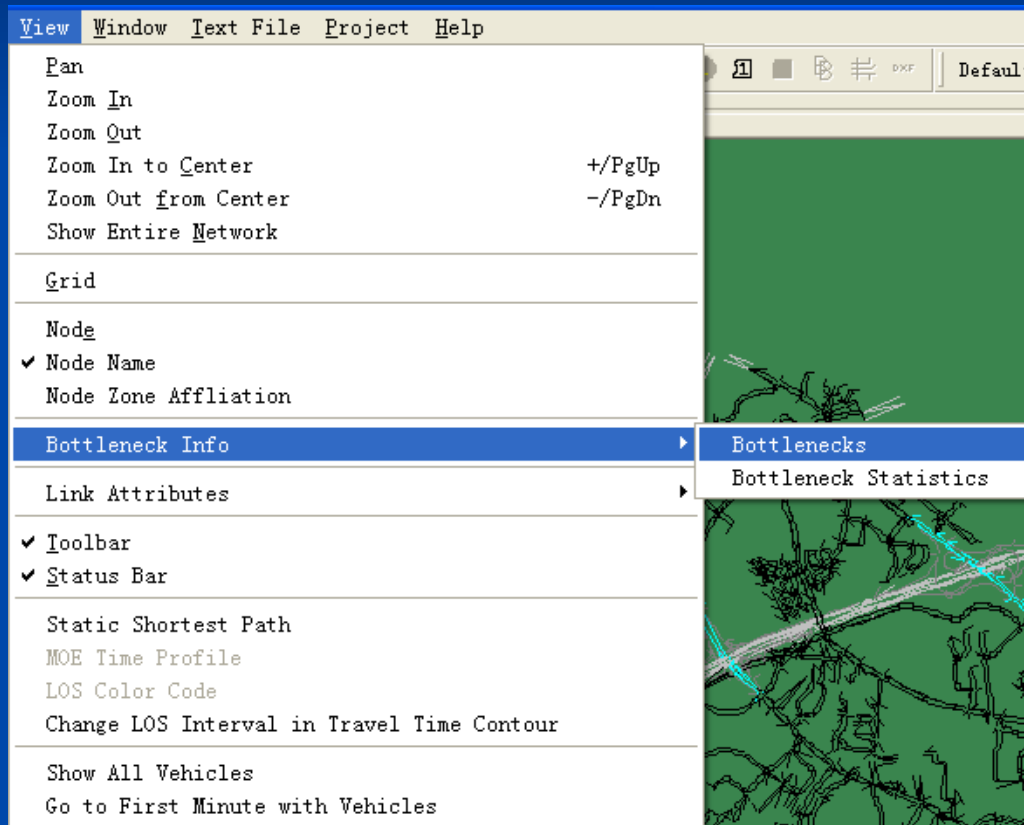
 Add pre-timed controller

 Add actuated controller

Select link type



Step 18: Show Bottleneck Information



A user can click on menu View->Bottleneck Info-> Bottlenecks to display bottleneck information on different links.

Step 18: Show Bottleneck Information



Step 19: Sort Link Performance Data

A user can click on menu Project->Sort Link Performance Data to sort, display and export the link performance data in a designated time window.

Link Performance

Select an MOE

Switch Time Window

Index	Density	Speed	Queue	Volume	Bottleneck	LinkID	From ID -> To ID, Type, #
[0.0]	0.0	vmpl,	11.2 mps,	0.0 %	2.0 v,	0.07 h	[6 v, 0.7 min], (6491,
[0.0]	0.0	vmpl,	11.7 mps,	0.0 %	2.0 v,	0.26 h	[110 v, 0.1 min], (3410,
[0.0]	0.0	vmpl,	11.9 mps,	0.0 %	4.0 v,	0.11 h	[70 v, 0.1 min], (3054,
[0.0]	0.0	vmpl,	12.1 mps,	0.0 %	2.0 v,	0.00 h	[0 v, 0.0 min], (3663,
[0.0]	0.0	vmpl,	12.3 mps,	0.0 %	2.0 v,	0.00 h	[1 v,
[0.0]	0.0	vmpl,	12.4 mps,	0.0 %	3.0 v,	0.00 h	[1 v,
[0.0]	0.0	vmpl,	12.4 mps,	0.0 %	4.0 v,	0.06 h	[113 v,
[0.0]	0.0	vmpl,	12.6 mps,	0.0 %	2.0 v,	0.34 h	[31 v,
[0.0]	0.0	vmpl,	12.8 mps,	0.0 %	1.0 v,	0.00 h	[1 v,
[0.0]	0.0	vmpl,	12.9 mps,	0.0 %	1.0 v,	0.00 h	[0 v,
[0.0]	0.0	vmpl,	12.9 mps,	0.0 %	3.0 v,	0.00 h	[0 v,
[0.0]	0.0	vmpl,	12.9 mps,	0.0 %	3.0 v,	0.00 h	[0 v,
[0.0]	0.0	vmpl,	12.9 mps,	0.0 %	3.0 v,	1.20 h	[68 v,
[0.0]	0.0	vmpl,	13.0 mps,	0.0 %	1.0 v,	0.00 h	[2 v,
[0.0]	0.0	vmpl,	13.0 mps,	0.0 %	1.0 v,	1.24 h	[485 v,
[0.0]	0.0	vmpl,	13.0 mps,	0.0 %	2.0 v,	0.00 h	[0 v,

Statistics Exporting Interval: 60 min

Export

Microsoft Excel - data.csv

Link ID	Start Time	End Time	Density (v)	Speed (me)	Queue Le	Volume (v)	From Node	To Node	Link Type	# of Lanes
1	0	1400	0.17	21.08	0	22.11	20	101	0	2
2	0	1400	0.05	21.69	0	7.97	101	20	0	2
3	0	1400	0.16	21.12	0	22.16	21	102	0	2
4	0	1400	0.06	21.68	0	9.86	102	21	0	2
5	0	1400	0.16	21.21	0	22.07	22	103	0	2
6	0	1400	0.05	21.69	0	8.53	103	22	0	2
7	0	1400	1.79	20.52	1.14	22.07	24	108	0	2
8	0	1400	0.06	21.65	0	9.86	108	24	0	2
9	0	1400	0.16	21.45	0	22.11	25	113	0	2
10	0	1400	0.07	21.48	0	10.11	113	25	0	2
11	0	1400	0.16	21.24	0	22.03	26	118	0	2
12	0	1400	0.06	21.68	0	9.56	118	26	0	2
13	0	1400	0.78	20.25	0.43	22.07	27	121	0	2
14	0	1400	0.07	21.66	0	11.44	121	27	0	2
15	0	1400	0.83	20.81	0.47	21.69	28	120	0	2
16	0	1400	0.07	21.48	0	10.71	120	28	0	2
17	0	1400	0.17	21.17	0	23.19	29	119	0	2
18	0	1400	0.06	21.63	0	9.77	119	29	0	2

Step 20: Sort Movement Performance Data

A user can click on menu Project->Sort Movement Performance Data to sort, display and export the intersection movement performance data in a designated time window.

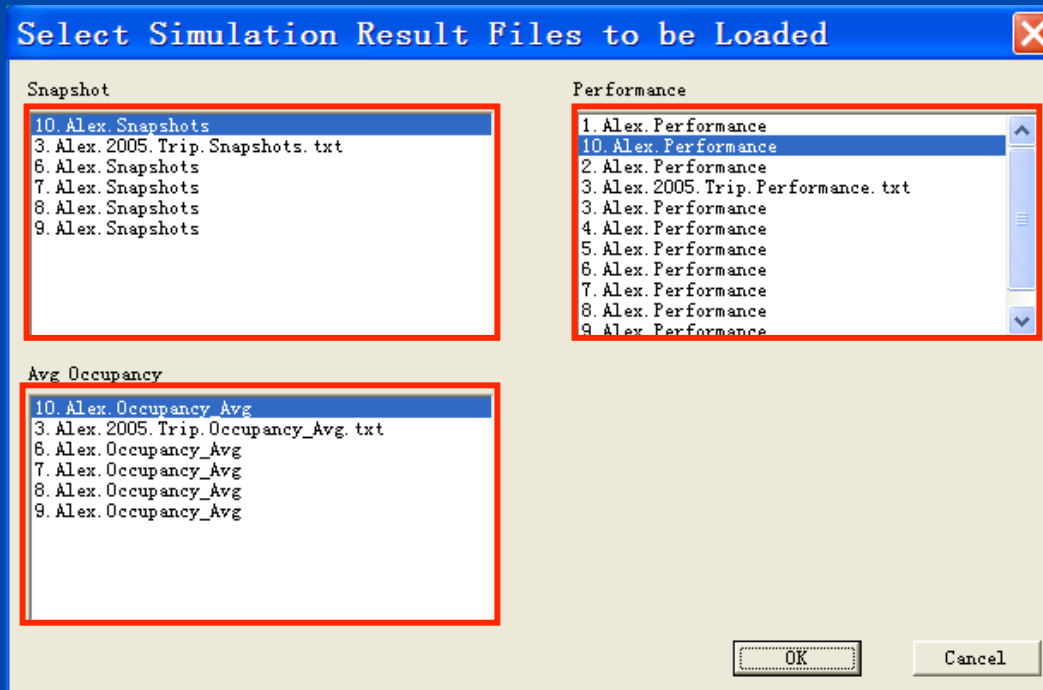
The image shows a software interface for 'Turning Movement Delay' and an Excel spreadsheet. The dialog box has a title bar with a close button. Below the title bar, there is a section labeled 'Select a Field' with a red box around it and an arrow pointing to it. This section contains several buttons: 'From Node', 'To Node', 'Control Type', 'Movement', 'Node 3', 'Volume', and 'Delay (s)'. Below these buttons is a table with columns corresponding to these fields. The table has 19 rows of data. At the bottom of the dialog box, there is a 'Statistics Exporting Interval' field with the value '600' and a 'min' unit, and an 'Export' button. The Excel spreadsheet in the background shows a table with columns: 'FromNode', 'ToNode', 'ToNodeCc', 'MovementNode3', 'volume', and 'delay (sec)'. The data in the spreadsheet matches the data in the dialog box table.

Index:	From Node	To Node	Control Type	Movement	Node 3	Volume	Delay (s)
[108]III(25)	108,	127	A,	T,	126,	62	
[109]III(29)	109,	110	A,	L,	105,	36	
[109]III(29)	109,	110	A,	R,	125,	71	
[109]III(29)	109,	110	A,	T,	111,	17	
[110]III(26)	110,	105	A,	L,	104,	32	
[110]III(26)	110,	105	A,	R,	106,	89	
[110]III(26)	110,	105	A,	T,	101,	32	
[110]III(29)	110,	109	N,	T,	32,	21	
[110]III(30)	110,	111	A,	L,	106,	96	
[110]III(30)	110,	111	A,	R,	116,	14	
[110]III(30)	110,	111	A,	T,	112,	55	
[110]III(33)	110,	125	N,	R,	146,	12	

	FromNode	ToNode	ToNodeCc	MovementNode3	volume	delay (sec)
1						
2	20	101	1	T	105	516
3	21	102	1	T	106	516
4	22	103	1	T	107	515
5	24	108	1	T	127	514
6	25	113	1	T	112	517
7	26	118	1	T	117	515
8	27	121	1	T	117	513
9	28	120	1	T	116	498
10	29	119	1	T	115	540
11	31	114	1	T	115	540
12	32	109	1	T	110	516
13	33	104	1	T	105	515
14	30	130	1	T	131	1207
15	23	140	1	T	141	1107
16	101	105	5	L	106	357
17	101	105	5	T	110	311
18	101	105	5	R	104	77
19	105	101	1	T	20	185

Step 21: Reload Simulation Data with Selected Files

As there might be multiple snapshot files for the same simulation run, a user can click on menu ->File->Reload Simulation Data with Selected Files to reselect the simulation files to be loaded.



A user can select the snapshot, performance, and average occupancy files of a designated simulation run individually.

Future Development

- Save network data
- Run simulation directly
- Configure simulation scenarios
- Use vehicle trajectory information
 - Enable travel time reliability analysis
 - Enable impacted vehicle analysis
 - Identify traffic bottlenecks through vehicle trajectory file

Vehicle Trajectory-based Traffic Analysis and Visualization

Potential GUI enhancement for TRANSIMS

1. Gap Analysis for Quantifying Traffic User Equilibrium

- Step 1: Read vehicle trajectory file
- Step 2: Group vehicles by
 - OD pair od , departure time τ , path p
- Step 3: Output experienced mean travel time and least travel time
- Step 4: Calculate the gap function

$c_{odp}^{\tau}(r)$

π_{od}^{τ}

$$Gap(r, \pi) = \sum_{o \in O} \sum_{d \in D} \sum_{\tau \in T} \sum_{p \in P(o, d, \tau)} r_{odp}^{\tau} [c_{odp}^{\tau}(r) - \pi_{od}^{\tau}]$$

Interface

✖
Vehicle Path Analysis

1: Critical OD Pair Filter

At least vhc(s) Travel time >= min Origin Destination

Pass Through Incident/Work Zone/Toll Only

1 -> 2: 14102 vhc(s), 12.12 min	▲
1 -> 6: 10 vhc(s), 6.20 min	▢
1 -> 8: 10 vhc(s), 5.02 min	▼

2: User Attributes Filter

Information Class: Vehicle Type: Departure time: Time Interval:

3: Path List

Path #, of vhc(s), avg travel time, toll

All paths	▲
#1: 1949 vhc(s), 12.89 min	▢
#2: 4 vhc(s), 10.15 min	▢
#3: 188 vhc(s), 13.63 min	▢
#4: 78 vhc(s), 13.98 min	▢
#5: 61 vhc(s), 11.72 min	▢
#6: 25 vhc(s), 13.32 min	▼

4: Vehicle List

ID, departure time, travel time, toll

17023, 60.0 min, 10.46 min	▲	17023
17024, 60.0 min, 10.46 min	▢	
17025, 60.1 min, 10.64 min	▼	
17026, 60.0 min, 10.64 min	▢	

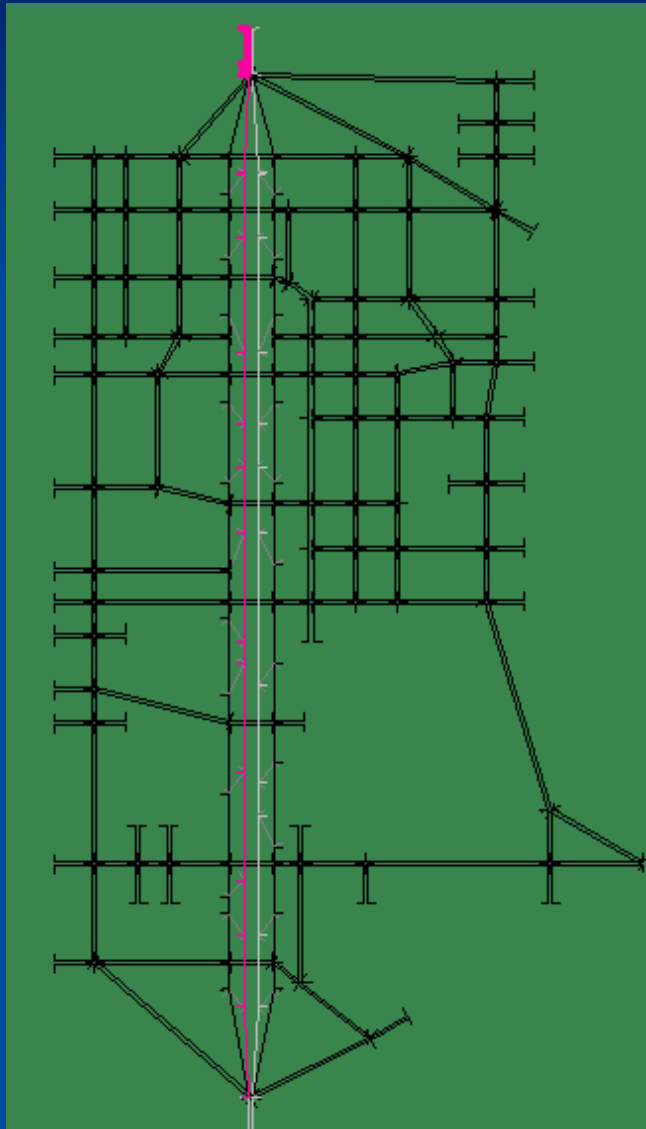
2504 vhc(s), avg travel time=13.08min std[2.01]

5: Link List

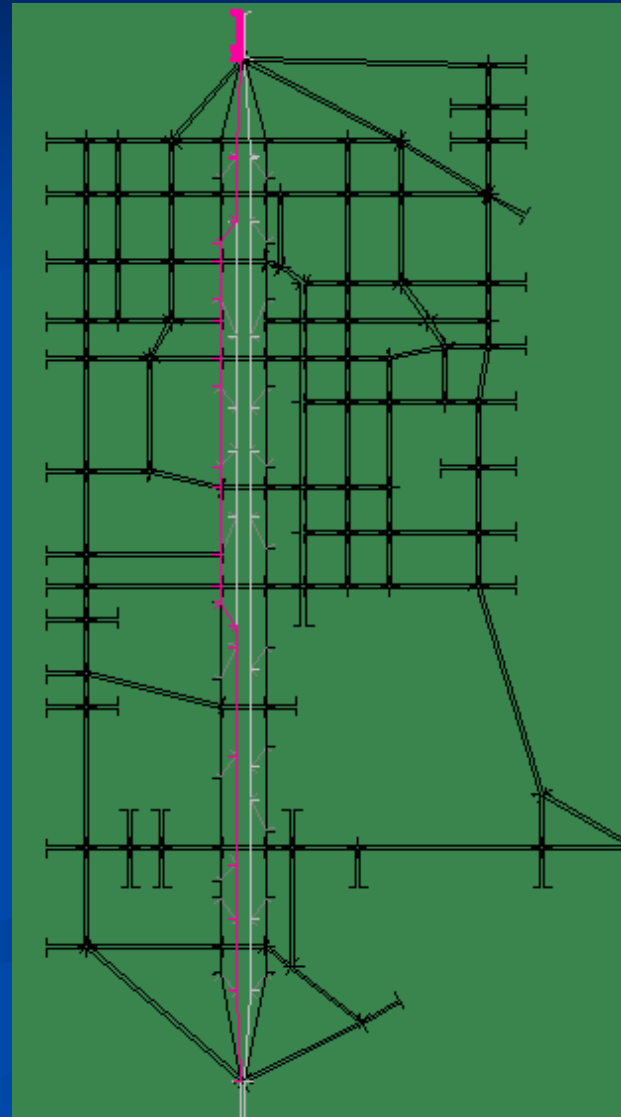
From Node -> To Node, length, arrival time, speed, stop time

199-> 116, 1.52 ml, @60.0 min, -, 0.0 min	▲
116-> 19, 0.38 ml, @ 60.6 min, 56.8 ml/h, 0.0 min	▢
19-> 23, 0.19 ml, @ 61.0 min, 56.8 ml/h, 0.0 min	▼

Path 1: 1,949 vehicles
12.89 min



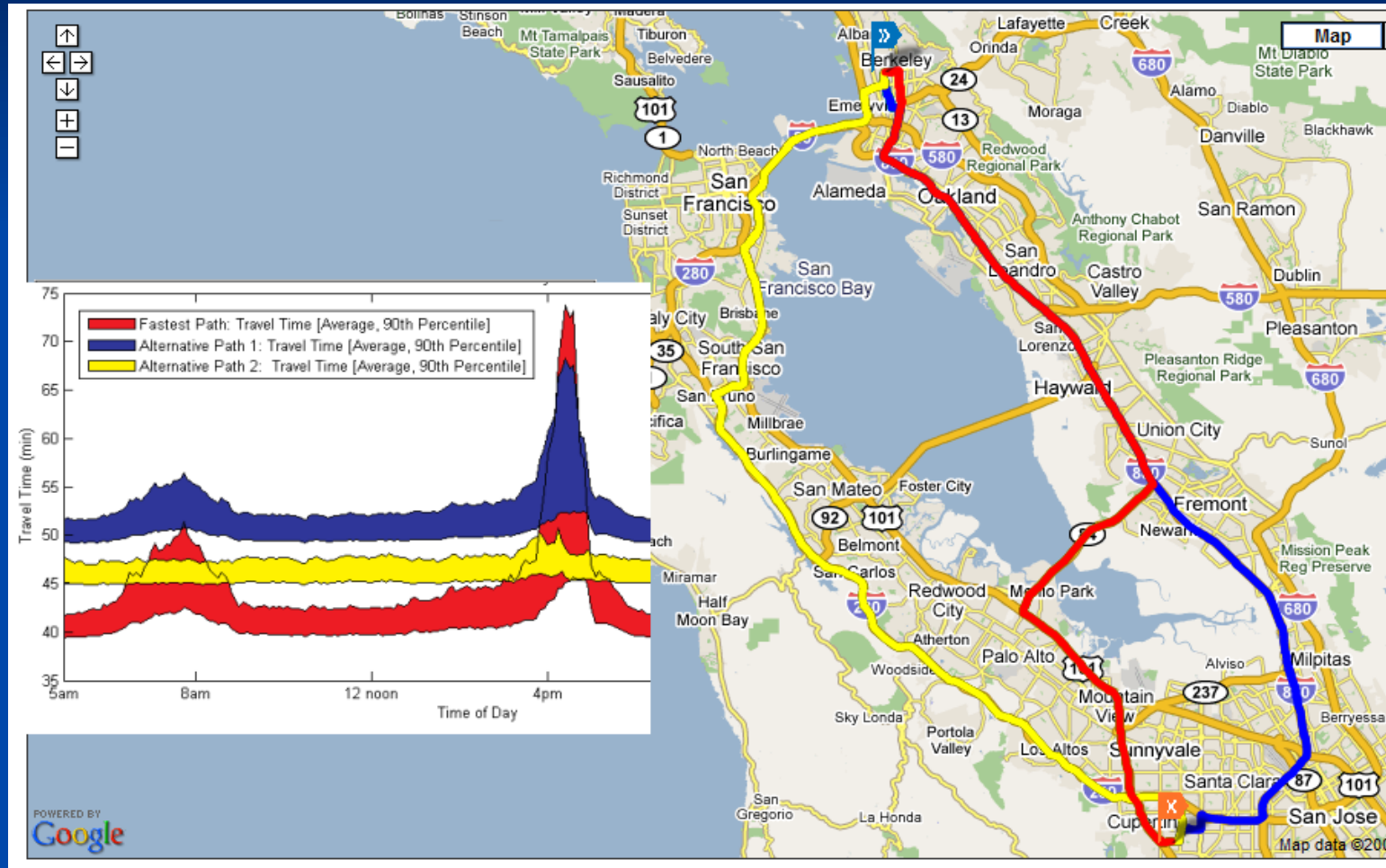
Path 5: 61 vehicles
11.72 min



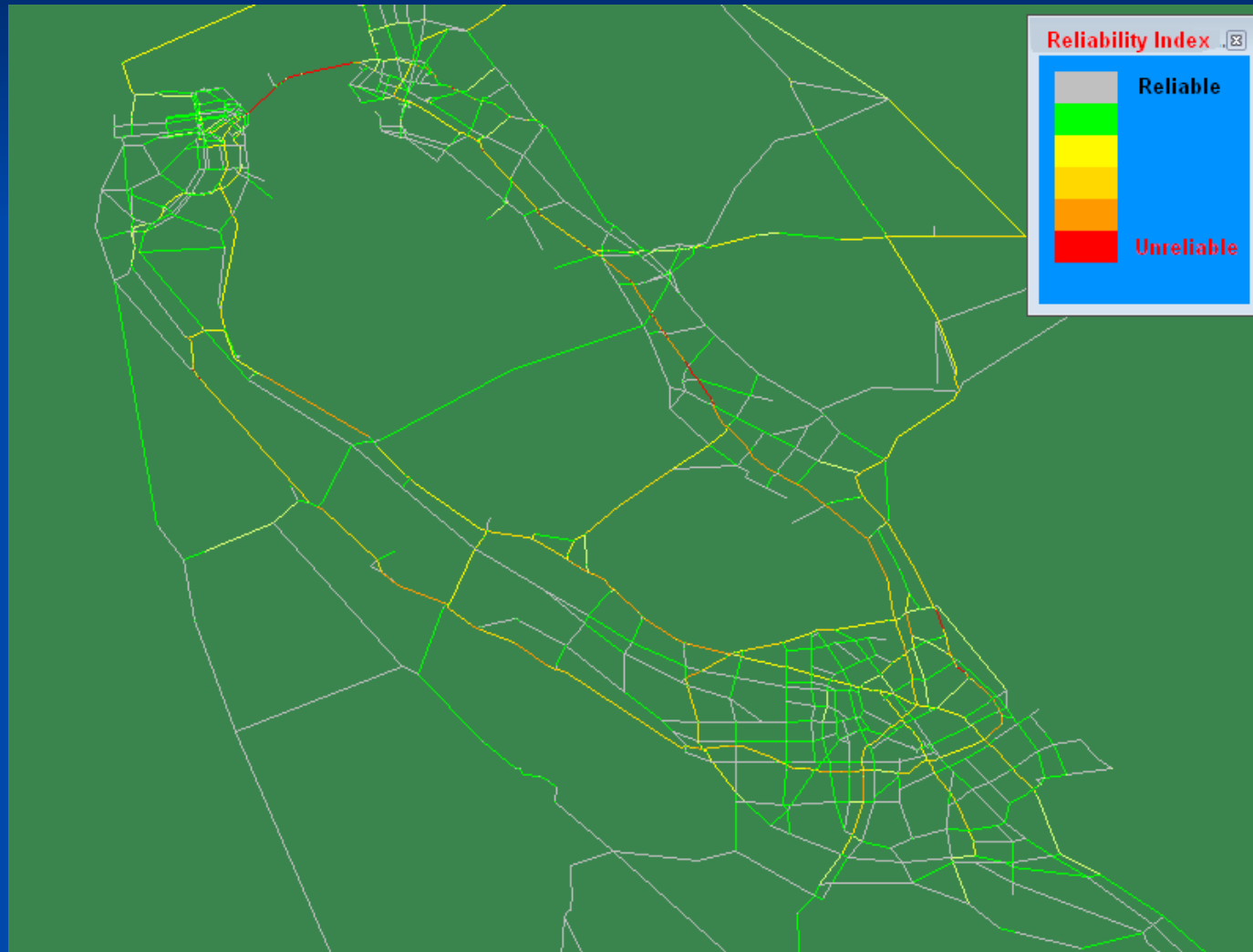
2. Travel Time Reliability Analysis

- Step 1: Read vehicle trajectory file
- Step 2: Group vehicles by
 - OD pair od , departure time τ , path p
- Step 3: Reliability Statistics Output:
 - Mean, median, variance, standard deviation, range, skewness, percentiles, buffer time and index

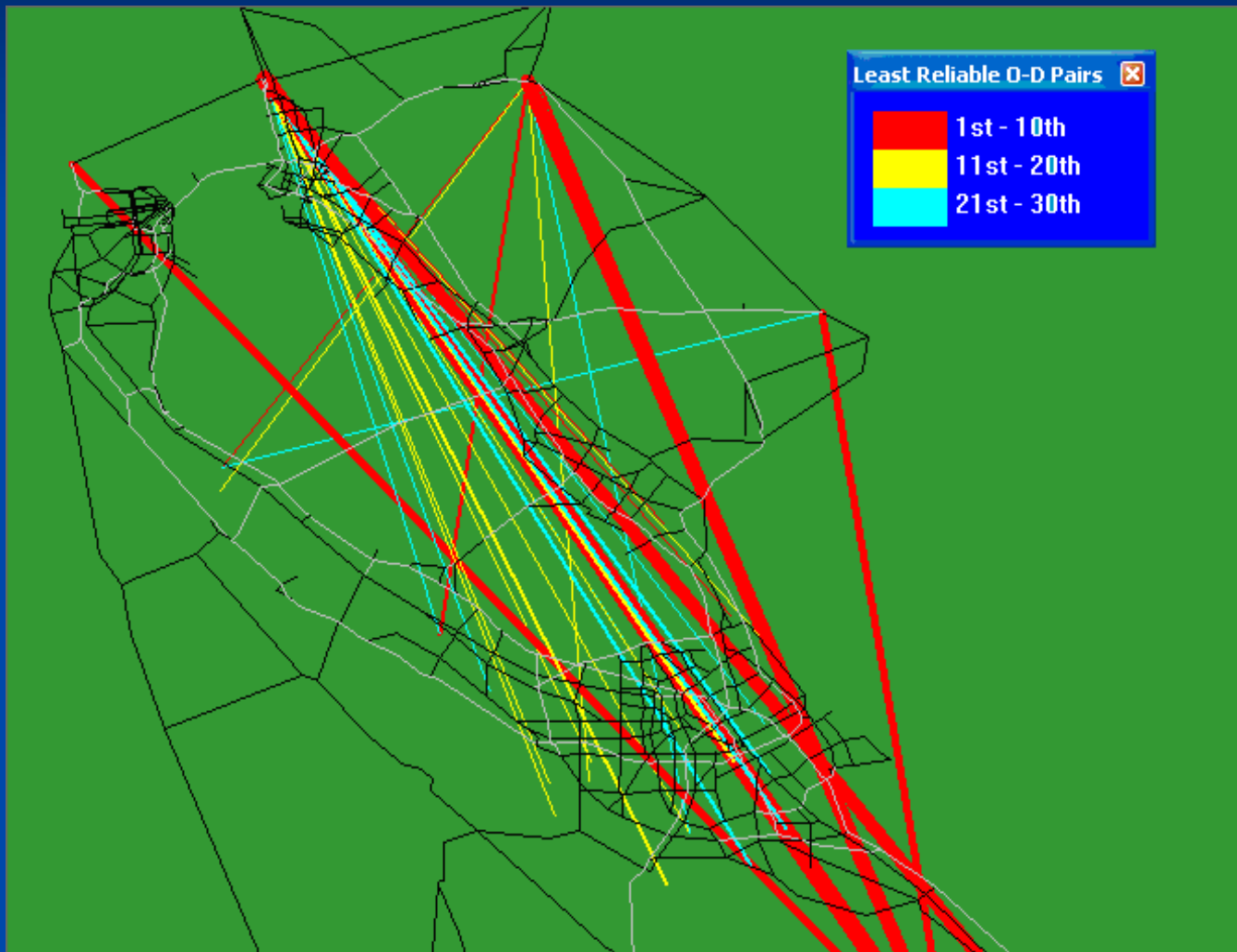
Path-level Travel Time Reliability Visualization



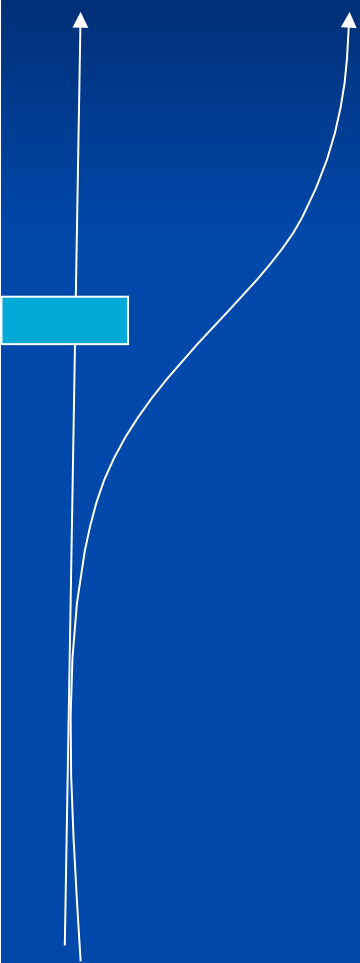
Link-level Traffic Reliability Visualization



Network-level Traffic Reliability Visualization



3. Impacted Vehicle Analysis

- 
- Fully utilize vehicle trajectory data at different cases to evaluate the system-wide impacts of incident, work zone, toll link, and/or VMS
 - **Do nothing** vs. **alternative** cases
 - **Impacted vehicles** are vehicles passing through the link of interest in the base case
 - **Diverted** vs. **non-diverted** vehicles in alternative case

Impacted Vehicle Analysis

Base Case:

Alternative Case:

		Travel Time (min)			
OD pair, # of vhc, diversion rate,		(base case, non-diverted, diverted)			
All OD pairs: 208 vhc(s), 3%,		5.03,	5.73 (\$0.00),	5.73]	
2 -> 1: 208 vhc(s), 3%,		5.03,	5.73(\$0.00),	5.73]	

Impacted Type:

- All impacted vehicles
- Non-diverted vehicles
- Diverted vehicles

Information Class:

- User Equilibrium
- All Classes
- En-route Info
- System Optimum
- Unresponsive (hist info)
- User Equilibrium
- VMS Responsive (pretrip info)

Vehicle List:

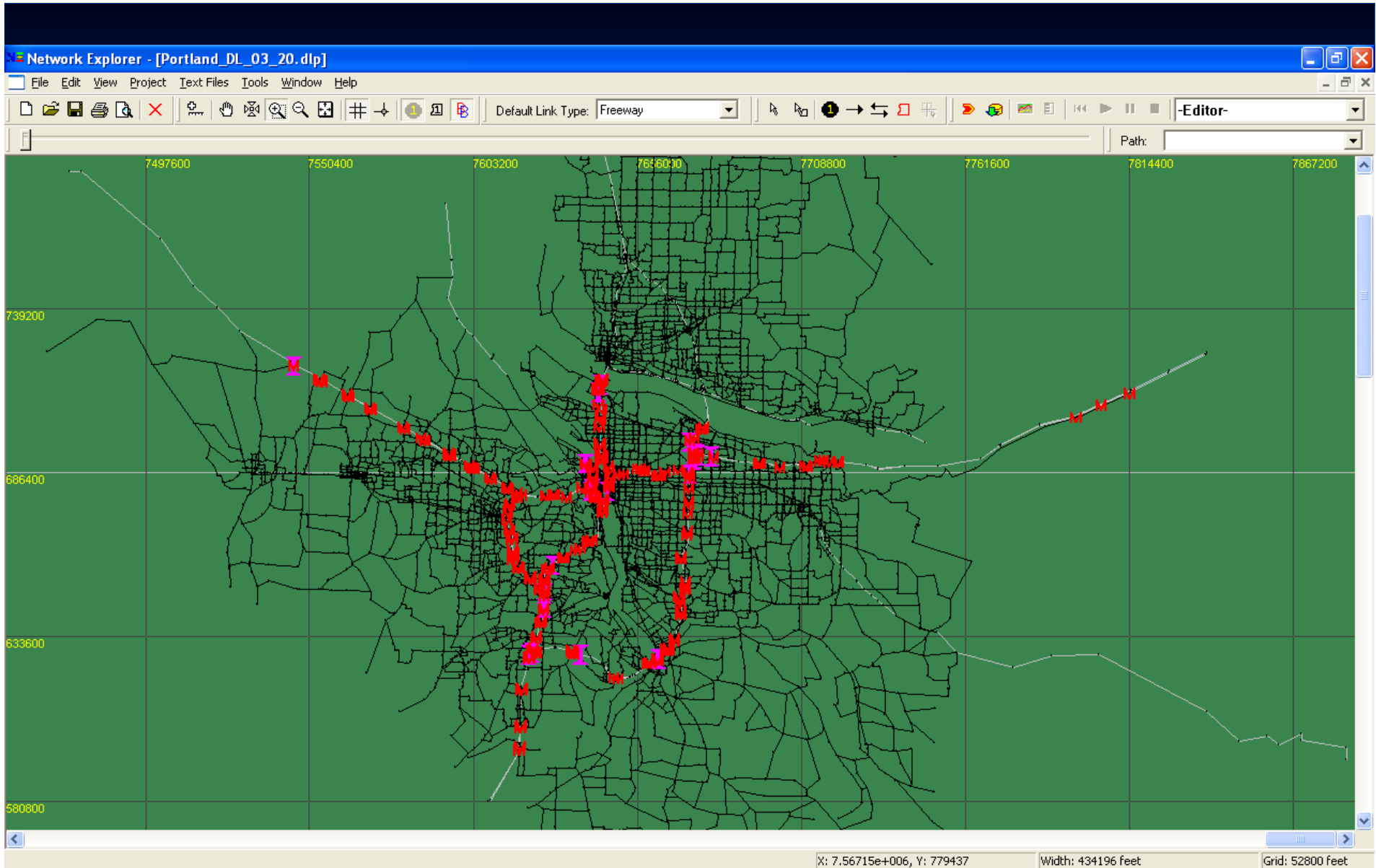
Id, departure time, travel time

0 impacted vehicles, avg travel time = 0.00 min

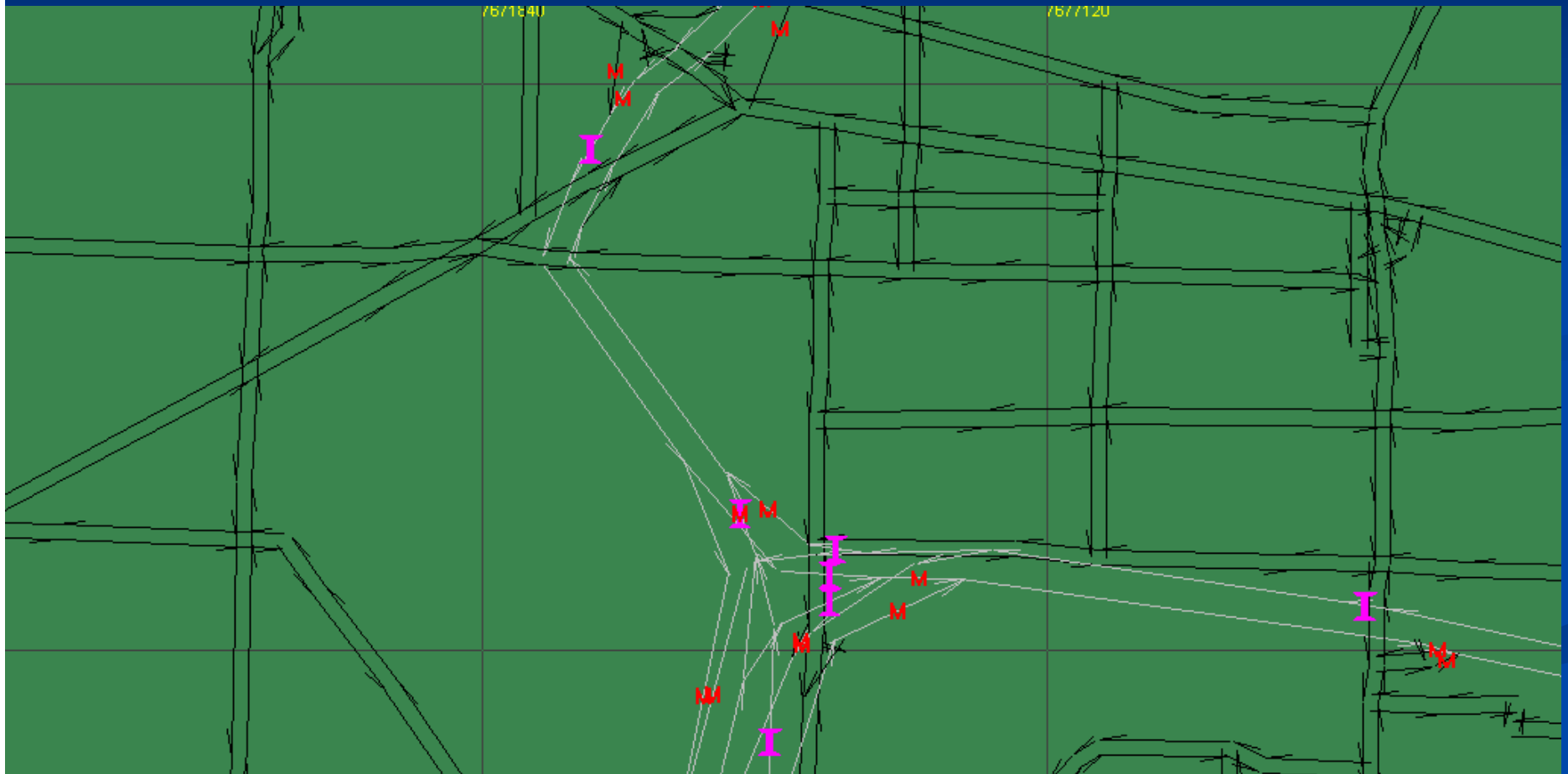
OK

4. Bottleneck Identification

- Geometric Bottleneck
 - Lane drop
 - Weaving
 - Merge
- Use vehicle trajectory to detect **speed transition points** along vehicle paths
- Identify the head and tail of congestion/bottleneck
- Use multi-day vehicle samples to distinguish **recurring and non-recurring** bottlenecks (under stochastic capacity)



Merge/Lane Drop Bottleneck



I see congestion everywhere, but
where is the active bottleneck?

