TRANSIMS Training Course at TRACC

Transportation Research and Analysis Computing Center

Part 17

Animation of TRANSIMS Results

Dr.-Ing. Hubert Ley

Transportation Research and Analysis
Computing Center

Unit ***17***

Last Updated: December 14, 2009

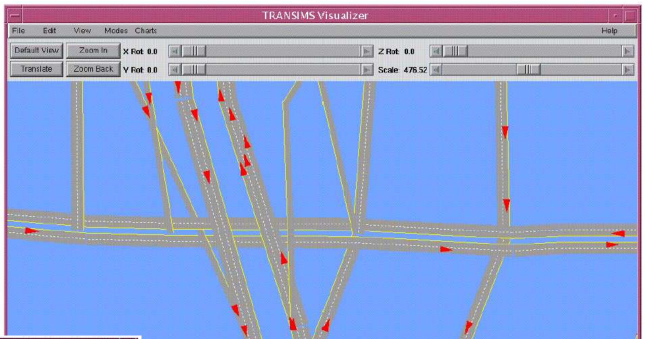
Contents

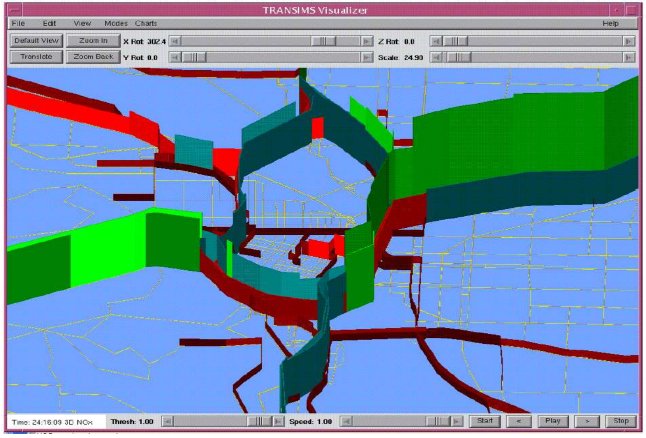
- Summary of TRANSIMS visualization
- The original TRANSIMS visualizer
- Balfour Technologies 4D-Scape
- NCSA visualizations
- Free animation techniques
- ArcSnapshot to generate second by second data
- UMN MapServer to create video frames
- ffmpeg to assemble video sequences
- NEXTA

- Interactive visualizer development at NCSA (open source)
  - NCSA is currently developing an interactive pseudo-3d visualization tool Metropolis
  - This tool will be released as open source to the TRANSIMS community
  - It will be used as a "storyboarding" tool that can define the scenery for high quality rendering using AutoDesk Maya as a service provided by NCSA

Original TRANSIMS Visualizer

- Capacity is limited to small problem sizes
- Moving vehicles represented by triangles

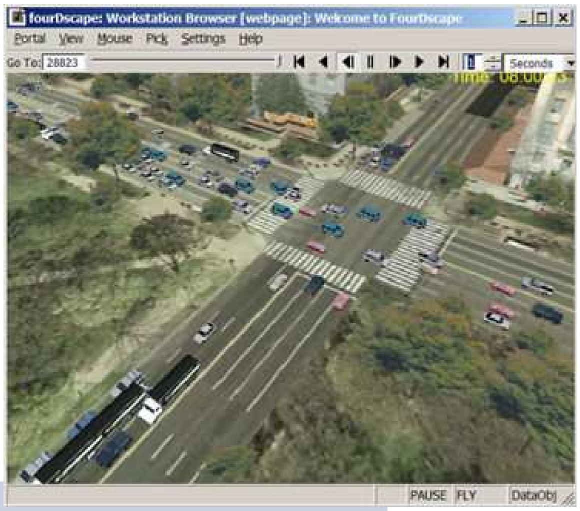




- Link delays and other aggregate information can be displayed in form of time-dependent bar graphs on top of network links

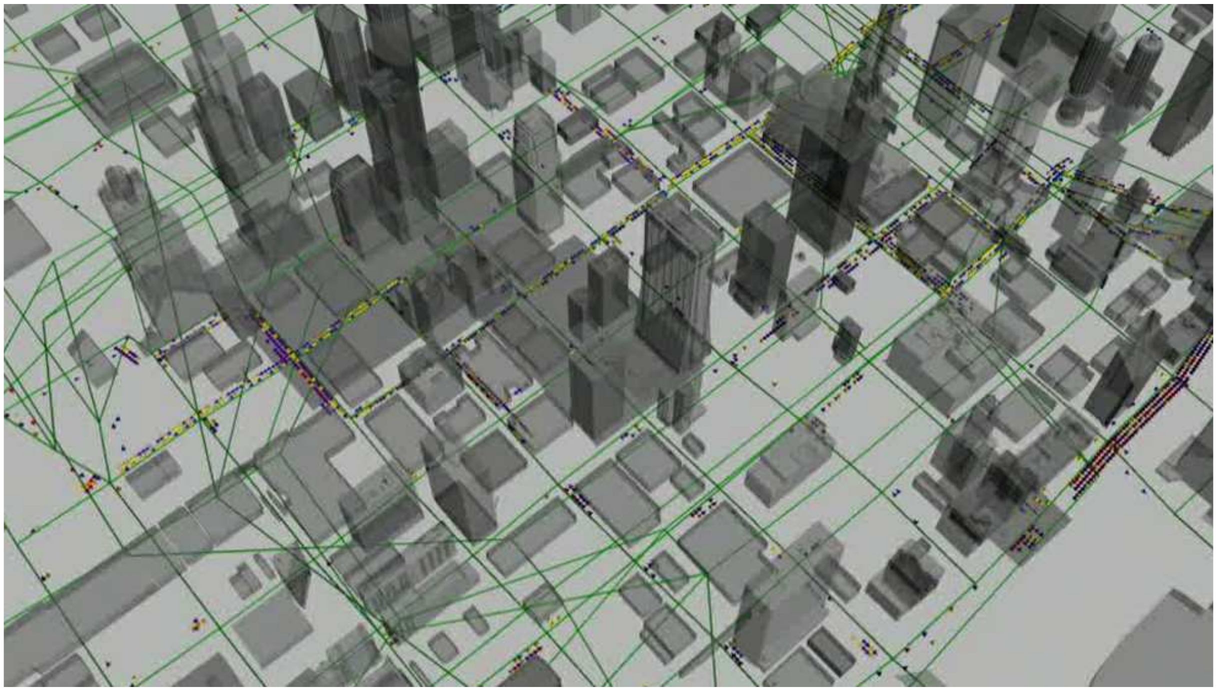
Example: fourDscape

- Three-dimensional visualization with additional time component
- Commercial application, by Balfour Technologies


fourDscape: Workstation Browser [webpage]: Welcome to FourDscape
Portal View Mouse Pick Settings Help
Go To: 28823
Seconds
Time 08:00
PAUSE
FLY
DataObj

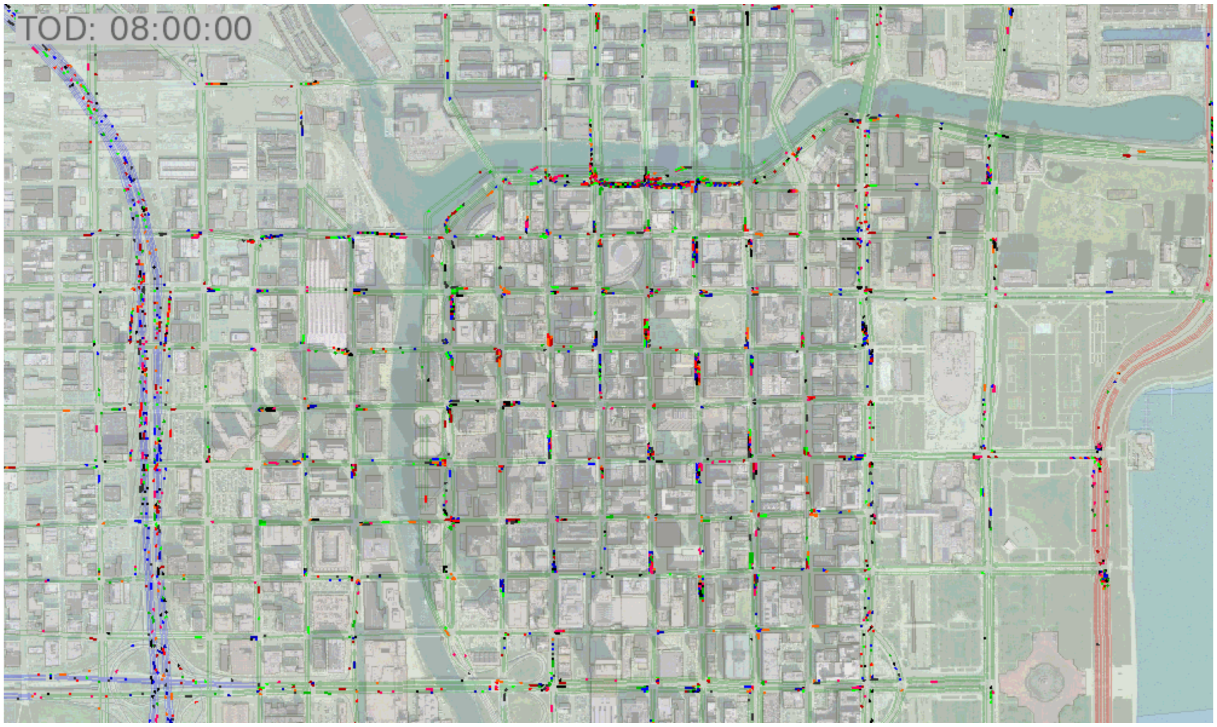
<u>**SOLUTION**</u>: A **Virtual Transportation Visualization** based on patented *fourDscape*™ technology. *fourDscape*™ creates a virtual, high-resolution four-dimensional (4D) Landscape represented in a single visual canvas that effectively provides an interactive **real-world representation of traffic patterns** over time, generated from a variety of traffic simulation software packages including **TRANSIMS**, the Federal Highway Administration's newest regional Transportation Analysis Simulation System. In *fourDscape*™, traffic flow is geo-registered on the actual roadway lanes on a high-resolution aerial photo of the region, with realistic 3D models of the buildings and features, signage, etc. of the existing or proposed environment incorporated into the interactive 4D Landscape as well. Now traffic patterns can be visually analyzed by transportation analysts, and also presented to the general public in an interactive, natural, understandable way.

Advanced Visualization (NCSA)

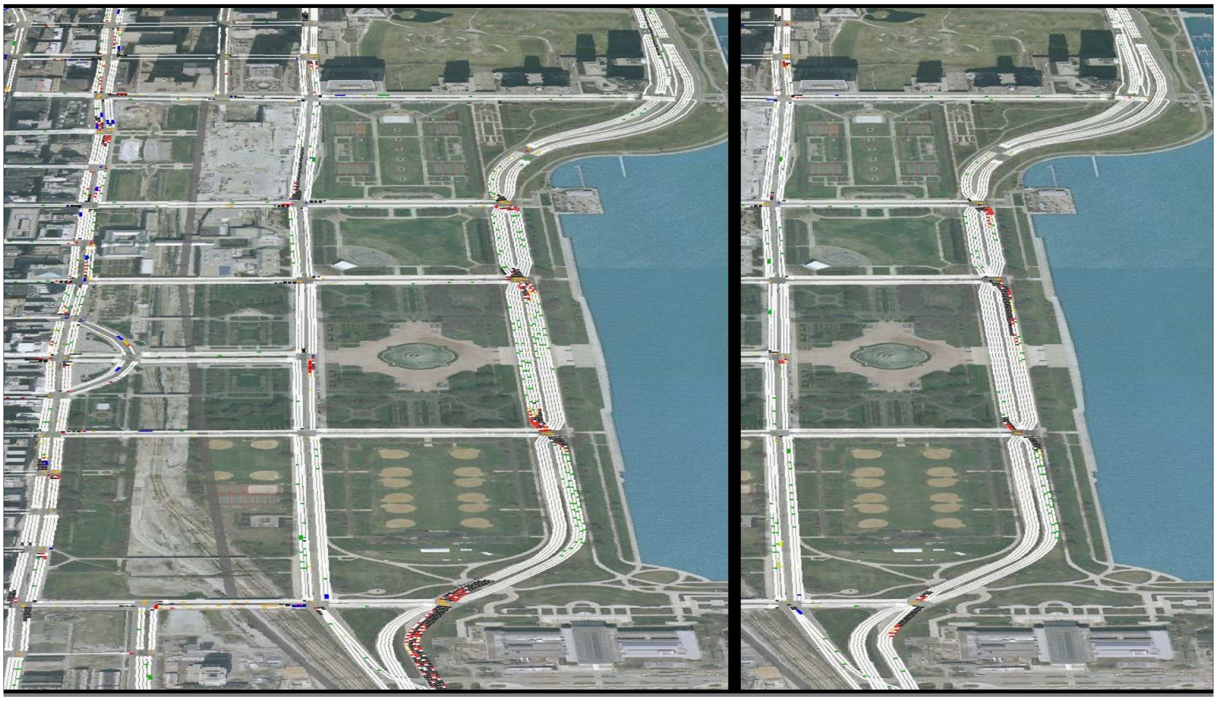


TRACC’s Visualization Technique (Free Tool)

Animation Based on Free Tools



High Quality Rendering / Interpolation / Side by Side



Animation Based on Free Tools

- Goal: Provide an animation technique that is
  - Free: Based on open source software
  - Fast: Creates animations of results within a short turnaround time
  - Portable: Works on both Windows and Linux
  - Simple: No software development needed

- General concept
  - Use available TRANSIMS GIS output only
  - Enhance with other GIS layers as appropriate
  - Use batch GIS tools deployed in web server technology
  - Use batch video processing tools to assemble video from frames

- Major tools:
  - FWTools (UMN MapServer)
  - ffmpeg

ArcSnapshot and Dynamic Data

- ArcSnapshot can be used without modification to create GIS vehicle drawings suitable for animation
- ArcSnapshot needs to be instructed to create a GIS shape file for each second during the time interval to be animated

```
TITLE                      Movie Maker
SNAPSHOT_FILE              results/snapshot_file
TRAVELER_SCALING_FACTOR 10
ARCVIEW_SNAPSHOT_FILE      ./shapes/shape.shp
NET_DIRECTORY              ../network/production
NET_NODE_TABLE             SimArea_Node
NET_LINK_TABLE             SimArea_Link
NET_SHAPE_TABLE            SimArea_Shape
VEHICLE_TYPE_FILE          ./vehicles/VehicleType
SELECT_TIME_PERIODS        08:00..08:30
SELECT_TIME_INCREMENT      1
CENTER_ONEWAY_LINKS        TRUE
LANE_WIDTH                 4.0
DRAW_VEHICLE_SHAPES        TRUE
```

ArcSnapshot (continued)

- The script generates one GIS shape file per second
  - The shape files consist of several files each
    - .shp
    - .shx
    - .dbf
    - .dbf.def
  - Naming convention (as used by ArcSnapshot):
    - The name specified in the control file, modified by inserting the time of day
    - Examples (important for proper scripting):
      - shape_802.shp (until 10am, full minutes)
      - shape_80201.shp (until 10am, seconds)
      - shape_1304.shp (after 10am)
      - shape_130401.shp

UMN MapServer

- More documentation at
  - http://mapserver.gis.umn.edu/
- Version used for TRANSIMS:
  - http://fwtools.maptools.org/
- The specific tool used for TRANSIMS animations is
  - shp2img
    - This tool is meant as a test environment for the actual web server
    - It interprets a “map” file, which defines all layers of a map
    - The output is a GIF or PNG image
    - The tool is run in a loop, once for each of the shape file generated by ArcSnapshot
    - This results in a series of images, one for each second of the day
  - Other tools can be used for reprojections, index generation, and more

The “Map” File

- Size in pixels
- Extent in UTM coordinates
- Definition of two background layers (Water, Cities)
- These are polygon layers
- The DATA entry points to the shape file (no extension)
- COLOR and OUTLINECOLOR are being used for these polygons
- STATUS ON is mandatory (this is specific to web server integration)
- Layers can also be geo-referenced raster layers (e.g. JPEG with “world” files)

```
NAME "Chicago Metropolitan Area Visualization"
STATUS ON
SIZE 1280 960
EXTENT 442131 4634273 449542 4639150
UNITS METERS
LAYER
  NAME "WATER"
  TYPE POLYGON
  STATUS ON
  DATA "background/Water"
  OPACITY 80
  CLASS
    STYLE
      COLOR 210 230 255
      OUTLINECOLOR 210 230 255
    END
  END
END
LAYER
  NAME "CITIES"
  TYPE POLYGON
  STATUS ON
  DATA "background/Cities"
  OPACITY 50
  CLASS
    STYLE
      COLOR 210 230 200
      OUTLINECOLOR 170 170 170
    END
  END
END
```

The “Map” File

- Definition of a LINK layer
- Classification is determined by the TYPE field in the GIS attribute table
- Regular expressions can be used to classify the attributes
- The TYPE of this layer is LINE
- The GIS shape file is the one produced by ArcNet
  - Either single line
  - Or one line per lane
- The Chicago project also includes a layer of building footprints (an additional polygon layer not shown)

```
LAYER
  NAME "LINKS"
  TYPE LINE
  STATUS ON
  DATA “some_directory/FullArea_Link"
  OPACITY 25
  CLASSITEM "TYPE"
  CLASS
    EXPRESSION /MAJOR|MINOR|COLLECTOR|LOCAL/
    STYLE
      COLOR 0 130 0
    END
  END
  CLASS
    EXPRESSION /FREEWAY/
    STYLE
      COLOR 0 0 255
    END
  END
  CLASS
    EXPRESSION /RAMP|BRIDGE/
    STYLE
      COLOR 100 100 100
    END
  END
  CLASS
    EXPRESSION /EXTERNAL/
    STYLE
      COLOR 255 0 0
    END
  END
END
```

The “Map” File

- This is the layer that draws the vehicle shapes
- This assumes that ArcSnapshot created vehicle polygons rather than points
- The DATA is undefined and is inserted dynamically once per second
- Regular expressions can be used to assign 10 different colors depending on the last digit of the Vehicle ID
- Some CLASS blocks have been removed for legibility

```
LAYER
  NAME "VEHICLES"
  TYPE POLYGON
  STATUS ON
  DATA "this is dynamically set from the script"
  OPACITY 100
  CLASSITEM "VEHICLE"
  CLASS
    EXPRESSION /.*0$/
    STYLE COLOR 255 0 0 OUTLINECOLOR  255 0 0 END
  END
  CLASS
    EXPRESSION /.*1$/
    STYLE COLOR 0 255 0 OUTLINECOLOR  0 255 0 END
  END
  CLASS
    EXPRESSION /.*2$/
    STYLE COLOR 0 0 255 OUTLINECOLOR  0 0 255 END
  END
  CLASS
    EXPRESSION /.*3$/
    STYLE COLOR 50 50 50 OUTLINECOLOR  50 50 50 END
  END
  CLASS
    EXPRESSION /.*4$/
    STYLE COLOR 0 0 0 OUTLINECOLOR  0 0 0 END
  END
  …
END
```

Executing SHP2IMG

- The shp2img utility needs to be called once per second of animation
- Calling syntax is:
  - shp2img -m mapfile -d VEHICLES shapes/shape_800 -o frames/frame_0001.gif
- The “mapfile” is the layer definition file shown previously
- The VEHICLES argument dynamically replaces the DATA string in the VEHICLES layer with this string, which should evaluate to a shape file excluding the ending .shp (in a “shapes” directory)
- The number 800 (for 8am) needs to be changed to 80001, 80002, …, 80059, 801, 80101, 80102 … for every iteration
- The frame number should be increased by one for each iteration
- The frame number must be a four digit number with leading zeros starting at 0001 for later concatenation into a video sequence (see ffmpeg)
- The result is a set of as many GIF images as there are seconds in the animation, all in the “frames” directory

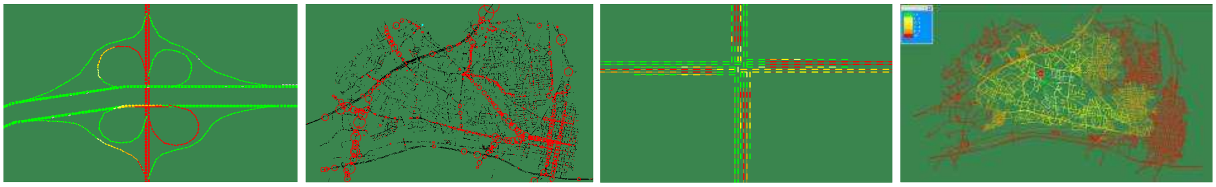
ffmpeg

- Can be found at:
  - http://ffmpeg.mplayerhq.hu/
- Wikipedia documentation:
  - http://en.wikipedia.org/wiki/FFmpeg
- Use Google to find Windows binaries (no official release by the authors)
- For Linux, build ffmpeg from the latest source
- RPM packages may be available

- Syntax to create a QuickTime MPEG4 video:
  - ffmpeg -b 10MB -r 5 -i frames/frame_%4d.gif -vcodec mpeg4 movie.mov
  - -b is the bit rate, e.g. 10 Megabits per second
  - -r is the frame rate for playback, e.g. 5 per second
  - -i specified the series of input frames to be assembled (from shp2img)
  - -vcodec specifies MPEG4 compression into final output movie.mov
- Use QuickTime to play the resulting movie

NEXTA (Free Tool)
University of Utah

NEXTA



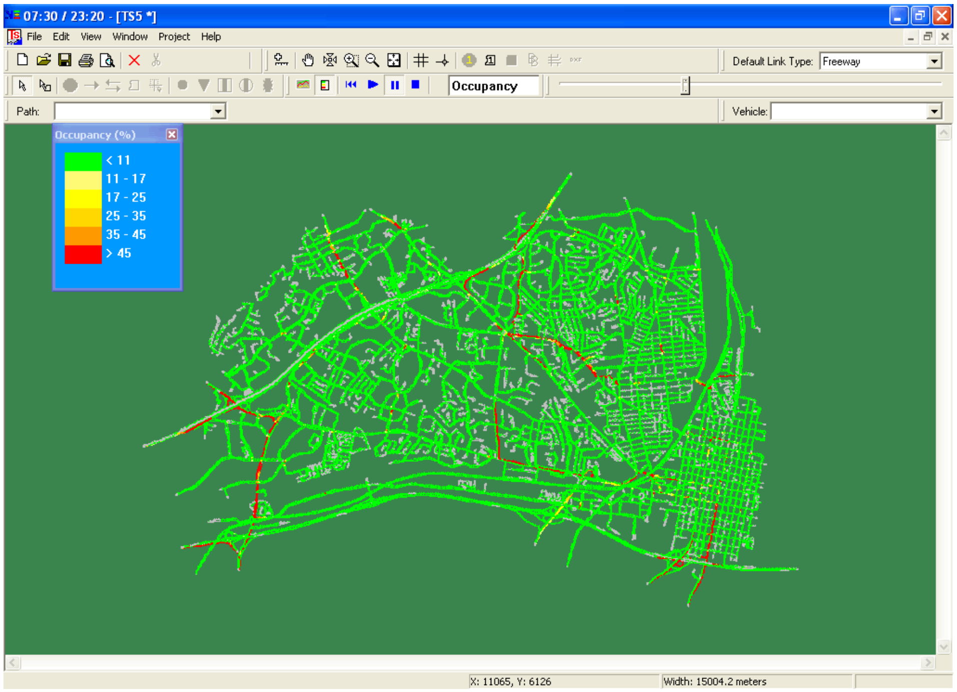
Quick Introduction to
NEXTA: Simulation Data Visualizer for TRANSIMS

NEXTA: **N**etwork **EX**plorer for **T**raffic **A**nalysis
Sponsored by
Federal Highway Administration

Developed and Prepared by
Dr. Xuesong Zhou, Univ. of Utah
zhou@eng.utah.edu

Freeware can be downloaded at
http://www.civil.utah.edu/~zhou/NEXTA_for_TRANSIMS.html

Sample Occupancy Plot



07:30 / 23:20 - [TS5 *]

Default Link Type: Freeway

Occupancy

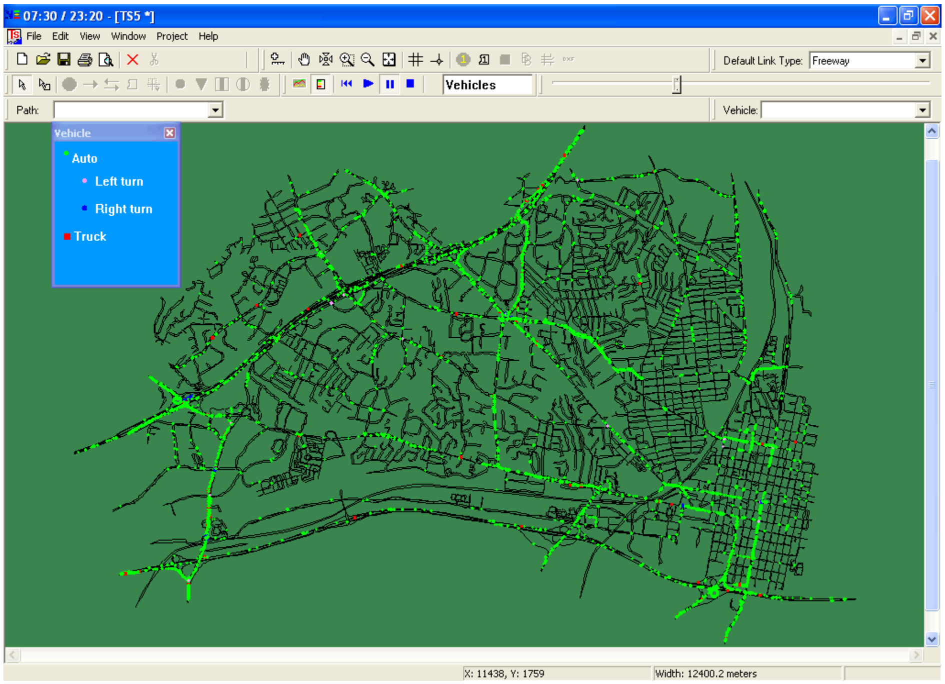
Occupancy (%)

🟩	< 11
🟨	11 - 17
🟨	17 - 25
🟨	25 - 35
🟧	35 - 45
🟥	> 45

X: 11065, Y: 6126

Width: 15004.2 meters

Sample Vehicle Snapshot Plot



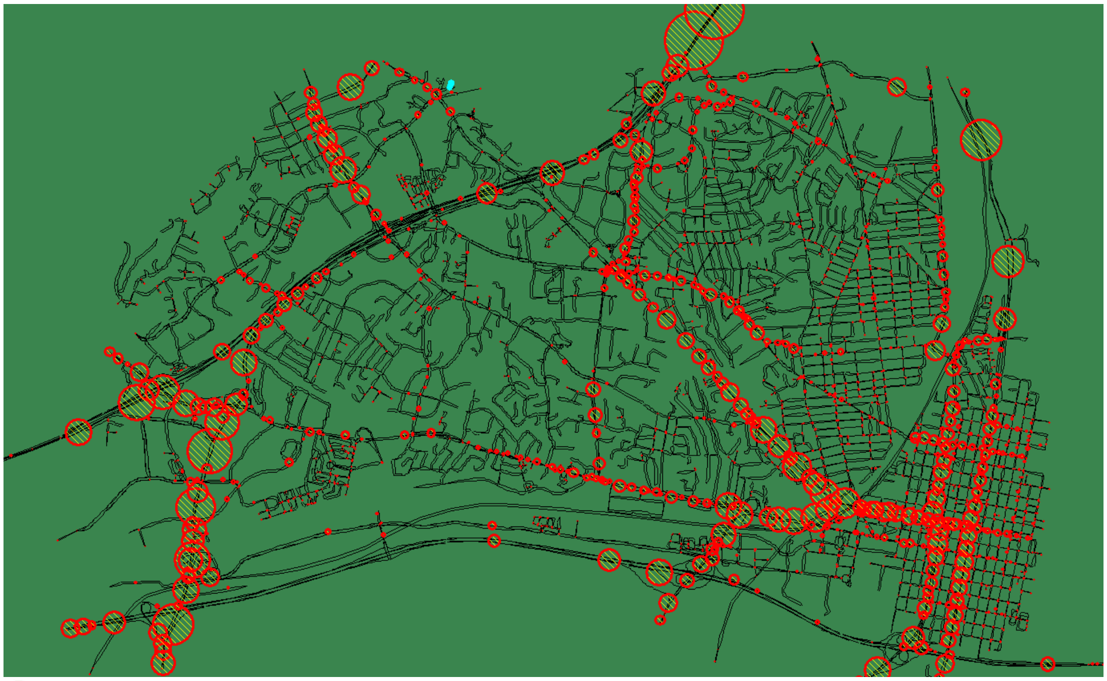
Default Link Type: Freeway

Vehicle:

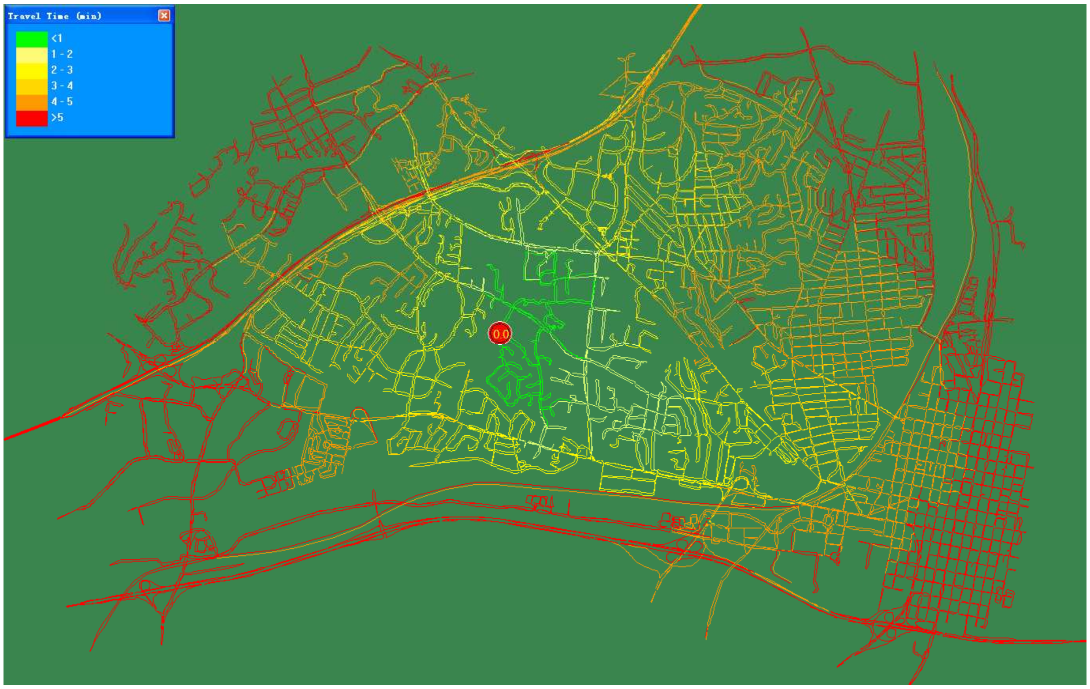
X: 11438, Y: 1759

Width: 12400.2 meters

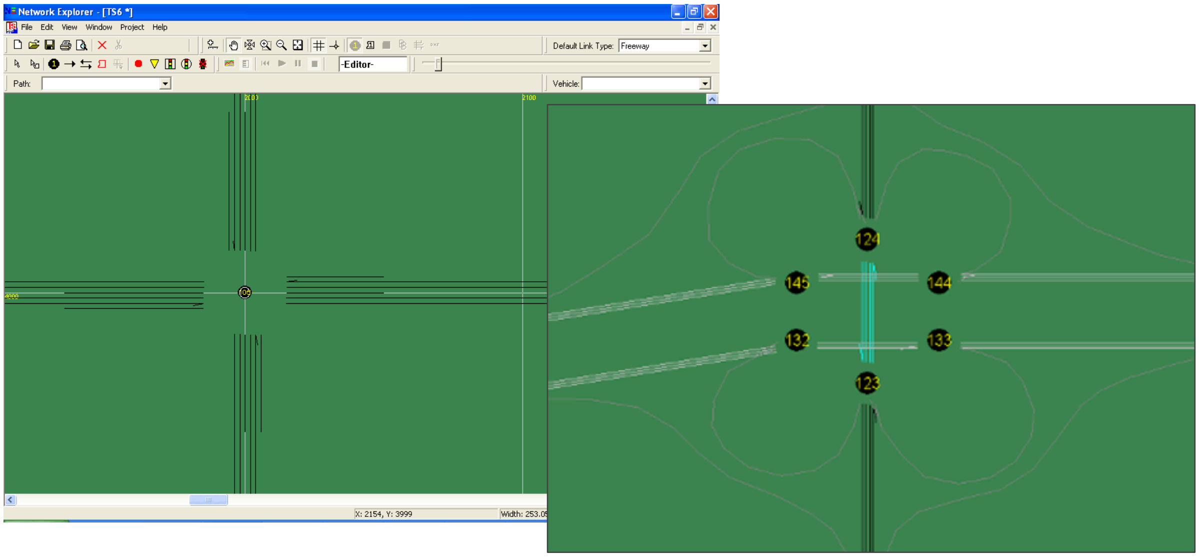
Sample Bottleneck Snapshot Plot



Sample Travel Time Contour (Accessibility) Snapshot Plot

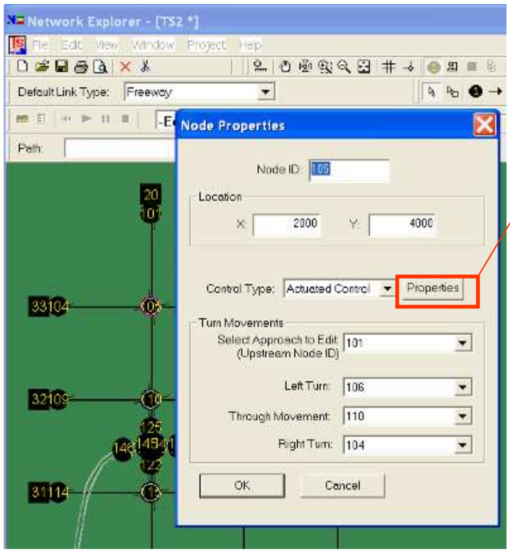


Lane Configuration


Network Explorer - [TS6 *]
File Edit View Window Project Help
Default Link Type: Freeway
-Editor-
Path:
Vehicle:
X: 2154, Y: 3999
Width: 253.0
124
145
144
132
133
123

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

Node and Control Properties


Network Explorer - [TS2 *]
File Edit View Window Project Help
Path:
20
101
33104
105
32109
110
125
146
145
122
31114
115
OK
Cancel

Default Link Type: Freeway

Node Properties

Node ID: 105

Location

X: 2000 Y: 4000

Control Type: Actuated Control Properties

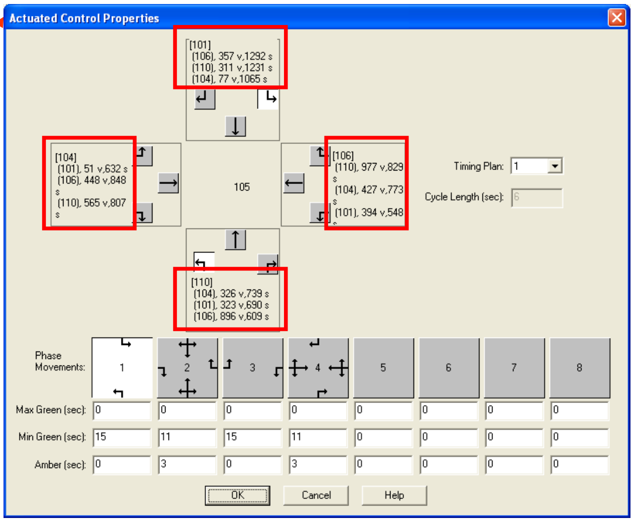
Turn Movements

Select Approach to Edit (Upstream Node ID): 101

Left Turn: 106

Through Movement: 110

Right Turn: 104



Actuated Control Properties

[101]
(106), 357 v,1292 s
(110), 311 v,1231 s
(104), 77 v,1065 s

[104]
(101), 51 v,632 s
(106), 448 v,848 s
(110), 565 v,807 s

[106]
(110), 977 v,829 s
(104), 427 v,773 s
(101), 394 v,548 s

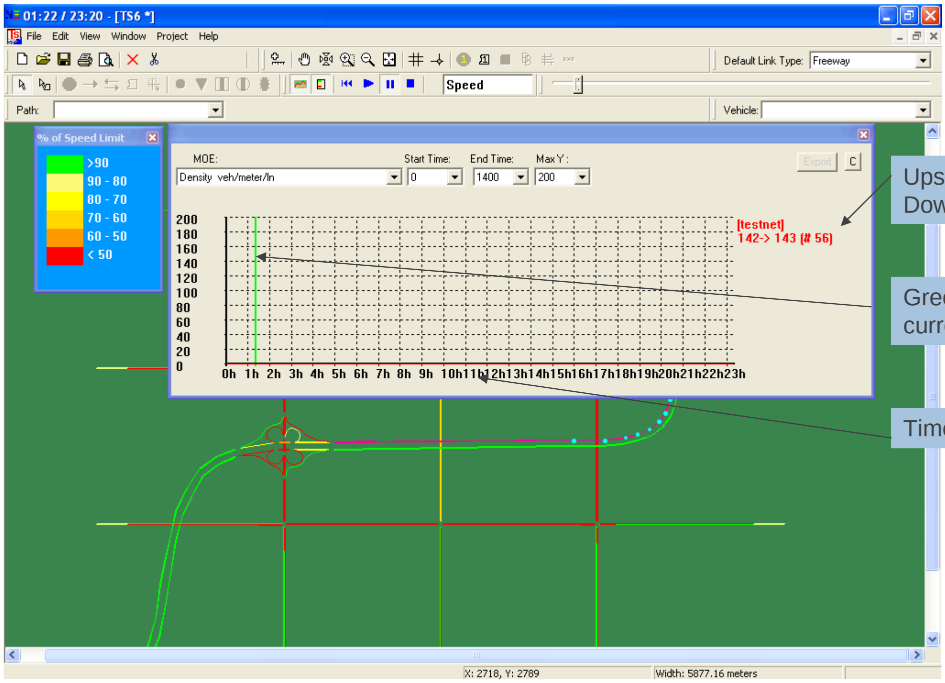
[110]
(104), 326 v,739 s
(101), 323 v,690 s
(106), 896 v,609 s

Timing Plan: 1

Cycle Length (sec): 6

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

Link MOE Profile


01:22 / 23:20 - [TS6 *]
File Edit View Window Project Help
Speed
Path:
Vehicle:
% of Speed Limit
Export
C
200
180
160
140
120
100
80
60
40
20
0
0h 1h 2h 3h 4h 5h 6h 7h 8h 9h 10h11h12h13h14h15h16h17h18h19h20h21h22h23h

Default Link Type: Freeway

% of Speed Limit	
🟩	>90
🟨	90 - 80
🟨	80 - 70
🟨	70 - 60
🟧	60 - 50
🟥	< 50

MOE: Density veh/meter/ln

Start Time: 0

End Time: 1400

Max Y : 200

[testnet]
142-> 143 (# 56)

X: 2718, Y: 2789

Width: 5877.16 meters

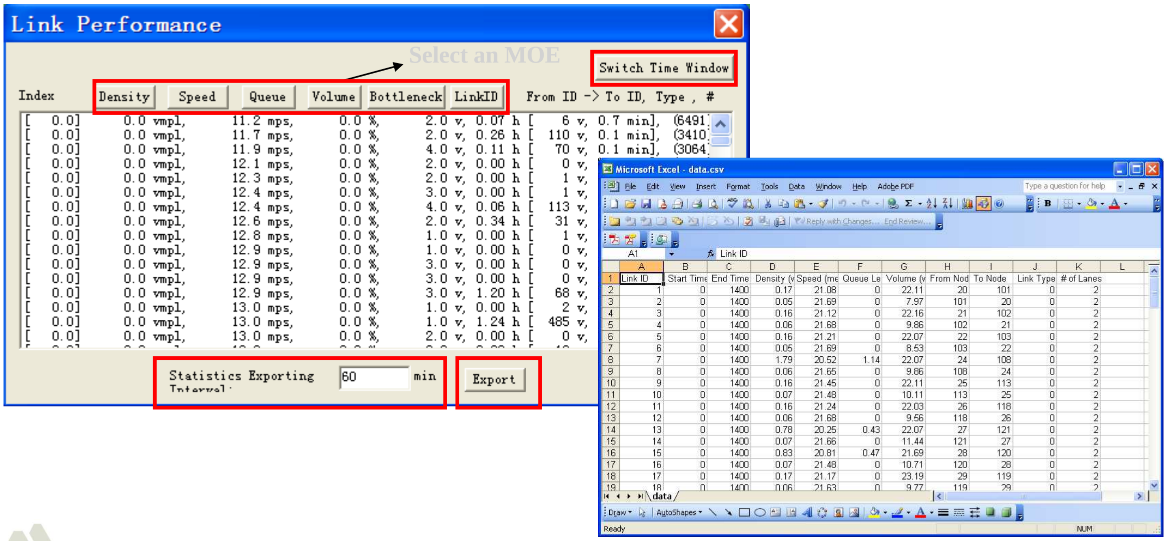
Upstream node -> Downstream node (# link ID)

Green line indicates the current simulation time

Time axis (unit: min)

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 , #
Export
Microsoft Excel - data.csv
File Edit View Insert Format Tools Data Window Help Adobe PDF
Type a question for help
Reply with Changes... End Review...
data
Draw AutoShapes
Ready
NUM

```
[   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],  (3064
[   0.0]    0.0 vmpl,    12.1 mps,    0.0 %,    2.0 v, 0.00 h [   0 v,
[   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

A1 Link ID

	A	B	C	D	E	F	G	H	I	J	K	L
1	Link ID	Start Time	End Time	Density (v	Speed (me	Queue Le	Volume (v	From Nod	To Node	Link Type	# of Lanes	
2	1	0	1400	0.17	21.08	0	22.11	20	101	0	2	
3	2	0	1400	0.05	21.69	0	7.97	101	20	0	2	
4	3	0	1400	0.16	21.12	0	22.16	21	102	0	2	
5	4	0	1400	0.06	21.68	0	9.86	102	21	0	2	
6	5	0	1400	0.16	21.21	0	22.07	22	103	0	2	
7	6	0	1400	0.05	21.69	0	8.53	103	22	0	2	
8	7	0	1400	1.79	20.52	1.14	22.07	24	108	0	2	
9	8	0	1400	0.06	21.65	0	9.86	108	24	0	2	
10	9	0	1400	0.16	21.45	0	22.11	25	113	0	2	
11	10	0	1400	0.07	21.48	0	10.11	113	25	0	2	
12	11	0	1400	0.16	21.24	0	22.03	26	118	0	2	
13	12	0	1400	0.06	21.68	0	9.56	118	26	0	2	
14	13	0	1400	0.78	20.25	0.43	22.07	27	121	0	2	
15	14	0	1400	0.07	21.66	0	11.44	121	27	0	2	
16	15	0	1400	0.83	20.81	0.47	21.69	28	120	0	2	
17	16	0	1400	0.07	21.48	0	10.71	120	28	0	2	
18	17	0	1400	0.17	21.17	0	23.19	29	119	0	2	
19	18	0	1400	0.06	21.63	0	9.77	119	29	0	2	

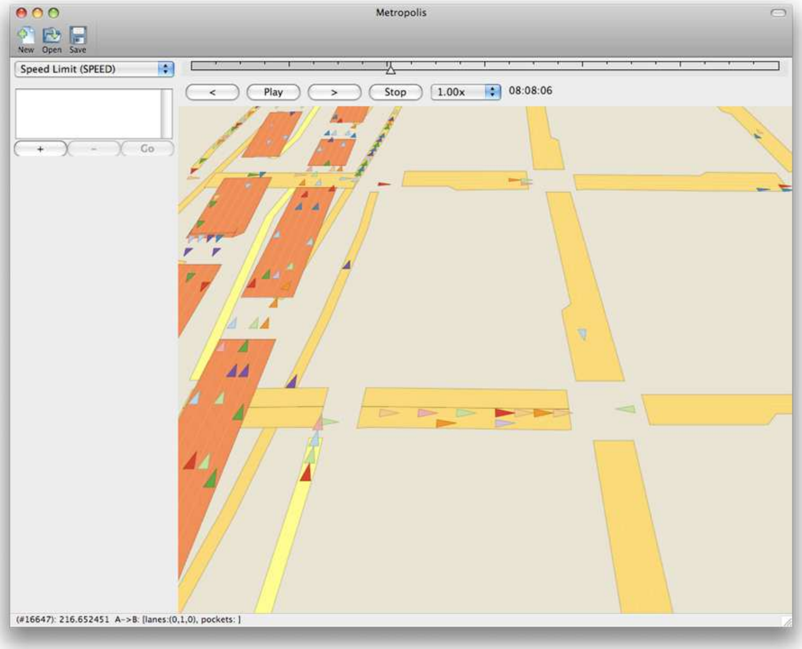
Metropolis
University of Illinois / NCSA

Interactive 3-D Visualization Tool for TRANSIMS

- Open Source on SourceForge
- Written in Python
  - Compatible with Linux, Windows, Mac
- Can deal with large metropolitan areas
- Interactive selection of areas and links of interest
- Three-dimensional navigation, plus navigation in time
- Replay functionality

- Metropolis will become available in the spring of 2010

Metropolis Design Examples

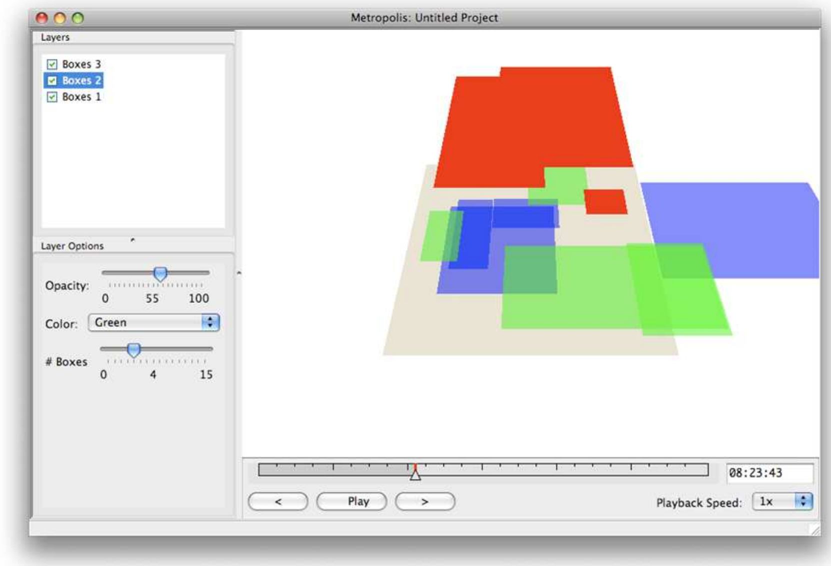


08:08:06

(#16647): 216.652451 A->B: [lanes:(0,1,0), pockets:]

Figure 3.3.2: The user interface of Metropolis is still under development. This view show the rendering of individual lanes, including pocket lanes such as turn and merge lanes, and a refined rendering of individual vehicles, which are now shown as triangles to indicate the direction of their movements.

Metropolis Design Examples



☑ Boxes 3
☑ Boxes 2
☑ Boxes 1

Opacity: 55 (0–100)
Color: Green
Boxes: 4 (0–15)
08:23:43
Playback Speed: 1x

Figure 3.3.1: A screenshot of the preliminary version of Metropolis with a "dummy" layer type that simply renders colored rectangles. The various layers are listed in the upper left panel; the user can rearrange the order of the layers by dragging and dropping in order to specify which layer is drawn on top. Each layer can also be hidden or shown by toggling the checkbox next to its name. The settings for the currently highlighted layer are shown in the lower left panel. Any changes to a layer's settings, along with insertion, removal, or rearrangement of layers, can be undone by choosing "Undo" from the Edit menu. The navigation and time controls are identical to those used in the prototype.

Credits and Acknowledgements

- USDOT provided the funding for the development of these training materials
- USDOT provided the funding for the TRACC computing center and the resources necessary to perform these training session
- NCSA developed some of the imagery used in this presentation
- University of Utah provided the slides describing NEXTA (Prof. Xuesong Zhou)