# TRANSPORTATION ANALYSIS SIMULATION SYSTEM (TRANSIMS)

**Version: TRANSIMS-2.0**

# VOLUME FOUR – CALIBRATIONS, SCENARIOS, AND TUTORIALS

**1 June 2001**

**LA-UR-00-1766**

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# VOLUME FOUR – CALIBRATIONS, SCENARIOS, AND TUTORIALS

**1 June 2001**

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# Acknowledgments

This work was supported by the U. S. Department of Transportation (Assistant Secretary for Transportation Policy, Federal Highway Administration, Federal Transit Administration), the U. S. Environmental Protection Agency, and the U. S. Department of Energy as part of the Travel Model Improvement Program.

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# 1. CALIBRATION

## 1.1 Introduction

The TRANSIMS calibration suite is used to understand fundamental traffic flow characteristics of the TRANSIMS microsimulation. In order to determine the effects of driving rules, the calibration suite provides controlled tests of traffic flow behavior. The test networks are simplified situations where elements of the microsimulation can be tested in isolation.

## 1.2 Calibration Networks

The calibration networks provide the following test cases for evaluation of driving logic:

- One-lane freeway traffic to test if car-following behavior generates reasonable fundamental diagrams.
- Three-lane freeway traffic to test if passing-lane-changing behavior generates reasonable fundamental diagrams. Lane usage can also be evaluated.
- Merging at stop and yield signs and left turns against opposing traffic to test for acceptable flow rates at non-signalized intersections.
- Signalized intersection to evaluate flow rates and to test lane-changing behavior for plan following.

The freeway network (one and three lanes) is a 1000-cell (75 km) circle where vehicles enter on one side of the circle (cell 1), and flow and density measurements are taken on the opposite side of the circle (cells 491 – 495). The vehicle density is continuously increased from 0 to 0.5 (0 veh/km/lane to 66 veh/km/lane) during the simulation run.

To test merge behavior at stop signs and yield signs at an unsignalized intersection, an incoming link with one lane is added to the circle at cell 500. The incoming vehicles are removed at site 750.

To test left turns against opposing traffic, two links are added to the circle. An opposing link that ends at cell 500 on the circle provides vehicles that will make a left turn across the traffic on the circle. The vehicles turn across the circle onto a link that begins at cell 500 where they eventually exit from the simulation.

The signalized intersection includes a three-lane approach link. Three one-lane links exit from the intersection: one left, one straight, and one right. Incoming vehicles attempt lane changes on the approach link in order to follow their intended movement at the intersection. The intersection has a signal with a 60-second green phase and a 60-second red phase.

Note: For more information, refer to *TRANSIMS traffic flow characteristics*, by K. Nagel, P. Stretz, M. Pieck, S. Leckey, R. Donnelly, and C. L. Barrett. The paper was presented to the Transportation Research Board in Washington, D.C., in January 1998.]

## 1.3 Circle Network

### 1.3.1 Overview

The Circle Network, with merge and turn lanes, is used to calibrate and test the microsimulation. There are two circle networks—a one-lane and a three-lane circle. Multiple calibrations are run on these basic networks. First, freeway traffic is calibrated by looking at traffic—uninterrupted by turns or merges—around the one- and three-lane circles. The one-lane circle demonstrates car following behavior, while the dynamics of lane changing is apparent using the three-lane circle. The speed limit on the circle is 37.5 meters per second (five cells per second) for the Freeway calibrations and 22.5 meters per second (three cells per second) for both the merge and left-turn calibration networks.

Both the one- and three-lane circles have intersections (or nodes) where vehicles can merge into the traffic moving around the circle or cross the traffic on the circle. These intersections are used to measure (and calibrate) the effects of gap acceptance parameters for left turns and merging.

### 1.3.2 Description

Both the one- and three-lane circle calibration networks have thirteen unidirectional links. Links 1 through 7 form the circle. These links and the order of their connections are shown in Fig. 1. The link numbers are given in the rectangles surrounding the diagram. Traffic on the circle moves from link 1 to 2 to 3 etc., before returning to link 1 from link 7. As shown in Fig. 1, the actual roadway is laid out as a square, but traffic behaves as if it were a circle. All nodes on this portion of the network act as *seamless* nodes. Vehicles do not pause or slow down at the corners of the box. The maximum speed on these seven links is 37.5 meters per second (five cells per second).

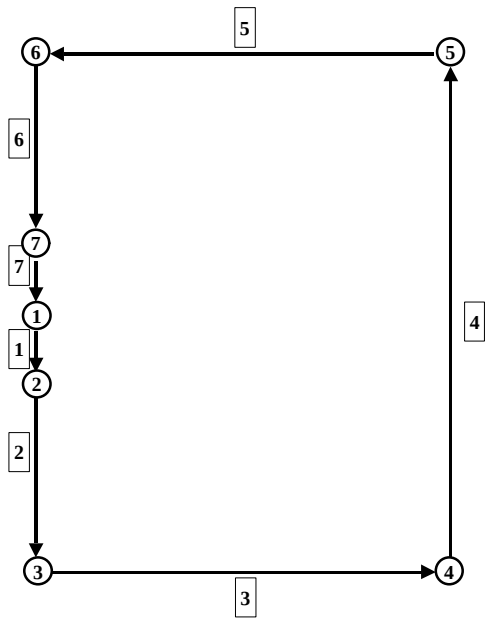



*Fig. 1. The structure and connections of the seven links and nodes making up the one- and three-lane circles.*

Links 3, 4 and 5 are 1875 meters long. The shorter links 2 and 6 are 750 meters long, while the shortest links 1 and 7 are but 187.5 meters. Links 8 through 12 allow for traffic to merge into the traffic on link 1 or cross the traffic at the node joining links 1 and 7, node 1. Fig. 2 shows these links.

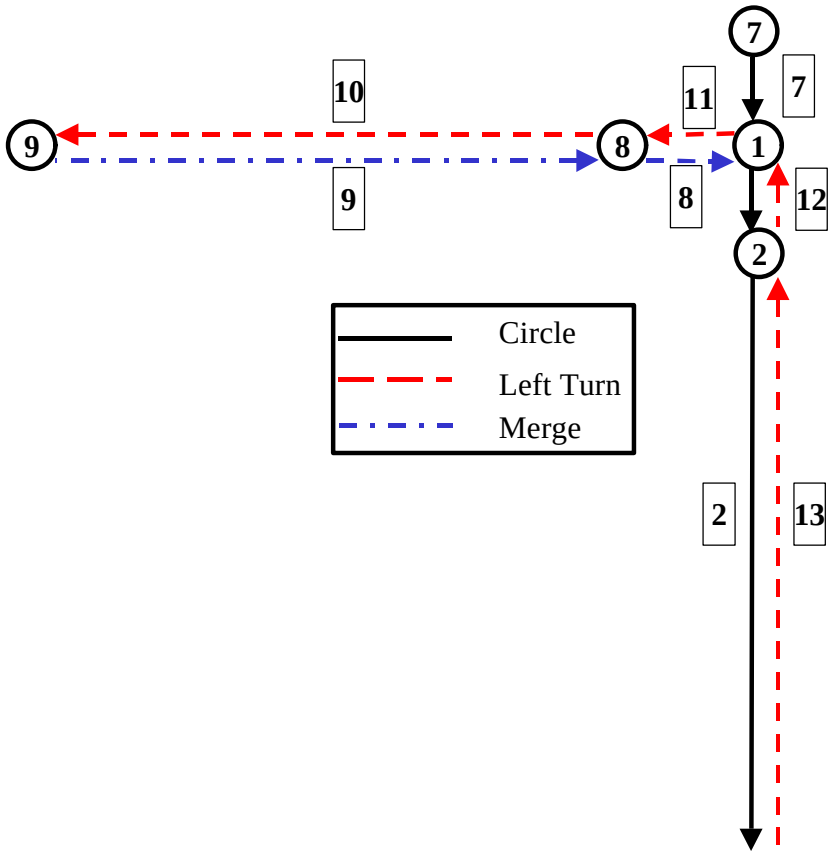



*Fig. 2. Links of the circles, left turn, and merge networks are shown. Links 1, 2, and 7 are on the circle. Link 12 allows for left turns across the traffic at node 1. Link 8 permits merges into the traffic below link 7 on link 1.*

For right-turn or merge calibrations, traffic originates on link 9, moves to link 8, and merges into the circle traffic on link 1. Stop, yield, or no controls may be placed at the node to control traffic moving from link 8 to link 1.

To calibrate gap acceptance for left turns across traffic, traffic starts on link 13, moves to link 12, crosses the circle traffic at the node, and continues on to links 11 and 10. Vehicles turning left must yield to the circle traffic. The circle traffic is not affected by the turning movements of the other vehicles.

### 1.3.3 Usage

The Circle Networks are used to calibrate the Traffic Microsimulator. Each is invoked using a preset plan file, and the output is filtered to produce an analysis file containing the statistics of interest.

#### 1.3.3.1 Calibration Filters

The filters on the freeway, merge, and left-turn calibration runs collect summary data on five-cell sample blocks placed at specified locations on the calibration networks (Table 1). The data are summarized over three-minute intervals. The sample blocks cut across all lanes of the link, but data are reported on a lane-by-lane basis, as well as the link totals.

**Table 1. Calibration Network – Sampling Locations**

| Network | Sample Block Location | Sampled Type |
|---|---|---|
| Freeway | Sites 491 – 495 on the circle | Circle vehicles |
| Merge | Sites 491 – 495 (Link 7) on the circle<br>Sites 501 – 505 (Link 1) on the circle | Circle vehicles<br>Merging vehicles |
| Left Turn | Sites 491 – 495 (Link 7) on the circle<br>Sites 1 – 5 (Link 11) on exiting link | Circle vehicles<br>Left-turn vehicles |

#### 1.3.3.2 Freeway Calibrations

One- and three-lane freeway traffic is calibrated by moving traffic around the circle on links 1 to 7. Configuration files for these two calibrations are in files *$TRANSIMS_HOME/scenarios/calibration/freeway1/freeway1.cfg* and *$TRANSIMS_HOME/scenarios/calibration/freeway3/freeway3.cfg*. The plan files contain vehicle plans that start vehicles on one of the seven links and move the vehicles around the circle. The density of vehicles is continuously increased by adding more vehicles to the network. The vehicles continue around the circle and are not removed. A small snippet of one vehicle's plans is given below. In this plan, vehicle and individual number 1 start at parking location 4 on link 4 then pass through nodes 5, 6, 7, 1, 2, 3 and 4 in order.

```
1 0 1 1 1 1
2 4 2 1 2
3360358 3360360 1
1 0 1
3361
1 0
5 6 7 1 2 3 4
5 6 7 1 2 3 4
5 6 7 1 2 3 4
5 6 7 1 2 3 4
```

The microsimulation for the two freeway calibrations is carried out using the following commands:

```
% cd $TRANSIMS_HOME/scenarios/calibration/freeway1
% csh $TRANSIMS_HOME/scenarios/calibration/freeway1/scripts/run_calib.csh
% cd $TRANSIMS_HOME/scenarios/calibration/freeway3
% csh $TRANSIMS_HOME/scenarios/calibration/freeway3/scripts/run_calib.csh
```

Snapshot output is collected on link 7. This output is filtered using the program *$TRANSIMS_HOME/bin/FreewayFilter***.** This filter is invoked by the shell scripts above using the following command (where <> denotes input data):

```
% $TRANSIMS_HOME/bin/FreewayFilter <# lanes> <snapshot filename> <output file>
```

This produces output files with the format in Table 2.

**Table 2. Freeway filter format.**

| Field | Description |
|---|---|
| `Simulation Time` | The seconds since simulation start. |
| `Lane` | The lane number. |
| `Density` | The vehicles/km/lane at the sample block on the circle. |
| `Flow` | The vehicles/hour/lane at the sample block on the circle. |

The columns contain the vehicle flows and roadway densities on the lanes on link 7. These can be plotted to produce a diagram showing the relationship between the flows and the densities.

#### 1.3.3.3 Merge Calibrations

The configuration file for the merge calibration simulation is *$TRANSIMS_HOME/scenarios/calibration/merge2/merge2.cfg***.** The plan file for this simulation contains plans for vehicles traveling around the circle as in the freeway calibrations. Additional vehicles are given plans that start at parking location 13 on link 8 and merge into the traffic on link 1 at node 1. These vehicles proceed through nodes 2 and 3. They are removed from the network at the parking location 3 on link 3. A sample of these plans is given below.

```
1000001 0 1 1 1 1
0 13 2 3 2
8753 8753 1
1 0 1
5
1000001 0
1 2 3
```

The microsimulation for the merge calibration is carried out using the following command lines:

```
% cd $TRANSIMS_HOME/scenarios/calibration/merge2
% csh $TRANSIMS_HOME/scenarios/calibration/merge2/scripts/run_calib.csh
```

Output is collected on links 1 and 7 and is filtered for analysis using the program *$TRANSIMS_HOME/bin/MergeFilter* **.** The file produced by this filter contains the vehicle flow and density on link 7 and the flow of the merging vehicles on link 1. These data may be plotted to assess the merge rate as a function of the flow of oncoming traffic. The format of this file is shown in Table 3.

**Table 3. Merge filter format.**

| Field | Description |
|---|---|
| `Simulation Time` | The seconds since simulation start. |
| `Lane` | The lane number. |
| `Flow-7` | The flow of circle traffic in vehicles/hour/lane (link 7). |
| `Density-7` | The density of circle traffic in vehicles/km/lane (link 7). |
| `Flow-1` | Flow of merging vehicles in vehicles/hour/lane (link 1). |

This filter is invoked by the script using the following command line:

```
% $TRANSIMS_HOME/bin/MergeFilter <# lanes> <snapshot filename> <output file>
```

#### 1.3.3.4 Left-Turn Calibrations

The number of vehicles making a left-hand turn across traffic is calibrated using the left-turn plan set. The configuration file for this simulation is found in *$TRANSIMS_HOME/scenarios/calibration/left2/left2.cfg***.** Here, a baseline set of vehicles traverses the circle as in the freeway or circle calibration studies. Meanwhile, vehicles turning left start at parking location 16 on link 12, cross oncoming traffic at node 1, and move onto link 11. They proceed through node 8 to link 10 and are removed from the simulation at parking location 9. The plan of *left-turn* vehicle number 1000001 is given below.

```
1000001 0 1 1 1 1
0 16 2 9 2
8628 8628 1
1 0 1
4
1000001 0
1 8
```

This microsimulation calibration is invoked with the following commands:

```
% cd $TRANSIMS_HOME/scenarios/calibration/left2
% csh $TRANSIMS_HOME/scenarios/calibration/left2/scripts/run_calib.csh
```

An output file is produced by filtering the vehicle snapshot data from links 7 and 11. The filtering code is in *$TRANSIMS_HOME/bin/LeftturnFilter*. It is invoked by the script using the following command:

```
% $TRANSIMS_HOME/bin/LeftturnFilter <# lanes> <snapshot filename> <output file>
```

This filter computes the flow of the vehicles that make the left turn to link 11 and the flow and density of the vehicles on link 7. The format of this file is shown in Table 4.

**Table 4. Left-turn filter format.**

| Field | Description |
|---|---|
| `Simulation Time` | The seconds since simulation start. |
| `Lane` | The lane number. |
| `Flow-7` | The flow of circle traffic in vehicles/hour/lane (link 7). |
| `Density-7` | The density of circle traffic in vehicles/km/lane (link 7). |
| `Flow-11` | The flow of left-turn vehicles in vehicles/hour/lane (link 11). |

## 1.4 Tee Network

### 1.4.1 Overview

Lane changing behavior and plan following are studied using a network in the form of a "T." Vehicles start at the bottom of the "T" in three lanes and try to move to the correct lane to continue straight ahead, turn right, or make a left turn. As with the circle networks, this network is designed to test the dynamics of the Traffic Microsimulator rather than the complete TRANSIMS Framework. Vehicle plan sets for traffic on this network are produced *offline*—not using the Route Planner.

The intersection at the top of the "T" is controlled by a traffic signal. Therefore, this network is also used to evaluate vehicle behavior at the signal.

### 1.4.2 Description

The Tee Network has five links and is shown in Fig. 3. Links 1 and 2 are three-lane freeway type links with maximum speeds of 30 meters per second (four cells per second).

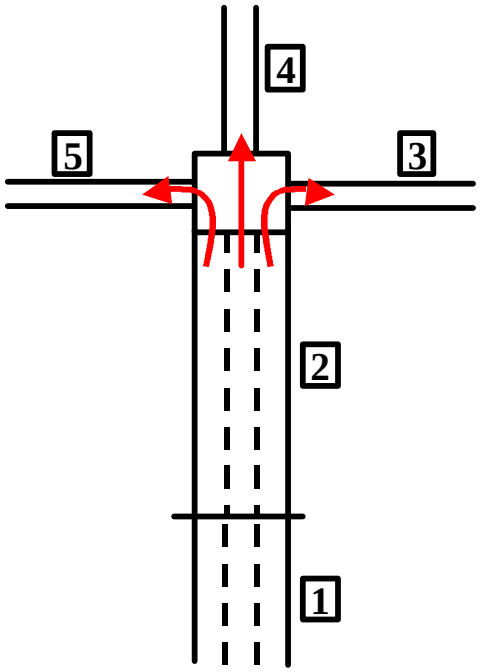



*Fig. 3. The five links of the Tee Network are shown. Vehicles enter on link one and exit on one of the links 3, 4, or 5.*

In this network, the left lane of link 2 is connected to the single lane of link 5. The middle lane is connected to link 4, and the right lane to link 3. The intersection connecting links 2 through 5 is controlled by a signal operating under various phasing cycles. The set of plans for this network has vehicles starting midway up link 1 and exiting on one of the links 3 through 5.

### 1.4.3 Usage

The tee calibration tests the weaving behavior of vehicles as they approach the intersection at node 2. A script to exercise this network is found in *$TRANSIMS_HOME/scenarios/calibration/tee/scripts/run_calib.csh.* All vehicles in this plan file start at parking location 1 on link 1 and proceed through node 1 to link 2. At node 2, one-third of the vehicles, those numbered 1 to 3600, turn right to link 3; one-third, numbered 3601 to 7200, move straight ahead to link 4; and the one-third with vehicle numbers greater than 7200 turn left to link 5. The vehicles are placed on link 1 in a random lane and attempt to enter the correct lane on link 2. Three of these plans, one for each of the turning movements, follow:

```
1 0 1 1 1 1
1 1 2 3 2
1 1 1
1 0 1
4
1 0
1 2
```

```
3601 0 1 1 1 1
1 1 2 4 2
1 1 1
1 0 1
4
3601 0
1 2

7201 0 1 1 1 1
1 1 2 5 2
1 1 1
1 0 1
4
7201 0
1 2
```

The Traffic Microsimulator is invoked using the configuration file *TRANSIMS_HOME/scenarios/calibration/tee/tee.cfg*. The following commands are used to run the simulation:

```
% $TRANSIMS_HOME/scenarios/calibration/tee
% csh $TRANSIMS_HOME/scenarios/calibration/tee/scripts/run_calib.csh
```

Correct microsimulation behavior is determined by assessing the vehicle snapshot data for link 2. Additionally, event data will indicate any vehicle that is unable to move to the correct lane for movement through the intersection. This information is obtained by filtering the raw data. The filtering code is in *$TRANSIMS_HOME/bin/TeeFilter*. It is invoked with the following command:

```
% $TRANSIMS_HOME/bin/TeeFilter <light cycle> <snapshot filename> <signal evolution file>
```

The light cycle time for all calibration networks given here is 60 seconds. The output from the filters is in two files: *tee.lane_state.60* and *tee.vehicle_turns.60*. The format of these files is shown in Table 5 and Table 6.

**Table 5. Signalized intersection filter – vehicle lane state.**

| Field | Description |
|---|---|
| `Time` | The seconds since simulation start. |
| `Box Distance From Node 2` | The starting distance of box in meters measured from the node from which the vehicles are traveling away . |
| `Light Color` | The state of traffic control (`g`=green, `r`=red). |
| `Light Cycle` | The length of traffic control cycle in seconds. |
| `#in-1-to-1` | The number of vehicles in the sample box during the 30-second interval that were in lane 1 and planned to turn left at the intersection. |
| `#in-1-to-2` | The number of vehicles in the sample box during the 30-second interval that were in lane 1 and planned to go straight at the intersection. |

| Field | Description |
|---|---|
| `#in-1-to-3` | The number of vehicles in the sample box during the 30-second interval that were in lane 1 and planned to turn right at the intersection. |
| `#in-2-to-1` | The number of vehicles in the sample box during the 30-second interval that were in lane 2 and planned to turn left at the intersection. |
| `#in-2-to-2` | The number of vehicles in the sample box during the 30-second interval that were in lane 2 and planned to go straight at the intersection. |
| `#in-2-to-3` | The number of vehicles in the sample box during the 30-second interval that were in lane 2 and planned to turn right at the intersection. |
| `#in-3-to-1` | The number of vehicles in the sample box during the 30-second interval that were in lane 3 and planned to turn left at the intersection. |
| `#in-3-to-2` | The number of vehicles in the sample box during the 30-second interval that were in lane 3 and planned to go straight at the intersection. |
| `#in-3-to-3` | The number of vehicles in the sample box during the 30-second interval that were in lane 3 and planned to turn right at the intersection. |

**Table 6. Signalized intersection filter – vehicle turn data.**

| Field | Description |
|---|---|
| `Time` | The seconds since simulation start. |
| `Light Cycle` | The length of the traffic control cycle in seconds. |
| `#left turns` | The number of vehicles that turned left during the 30-second interval. |
| `#ahead` | The number of vehicles that went straight during the 30-second interval. |
| `#right turns` | The number of vehicles that turned right during the 30-second interval. |
| `#total lost` | The number of vehicles that were off-plan during the 30-second interval. |
| `#lost with plan to turn left` | The number of vehicles that were off-plan and planned to turn left during the 30-second interval. |
| `#lost with plan to go straight` | The number of vehicles that were off-plan and planned to go straight during the 30-second interval. |
| `#lost with plan to turn right` | The number of vehicles that were off-plan and planned to turn right during the 30-second interval. |

# 2. SCENARIOS

## 2.1 Bignet Network

The Bignet (sample) Network and associated scenario have been designed to demonstrate TRANSIMS' principal components:

- Population Synthesizer,
- Activity Generator,
- Route Planner,
- Traffic Microsimulator (particularly cellular automata), and
- Emissions Estimators.

Although other programs will come into play during the course of the run, the modules noted above will be the principal players. The Bignet Network has been designed to demonstrate the computational resources required for a complete run of TRANSIMS using a small community (25,000 households).

Running Bignet is a computer-intensive effort. One-processor machines can run Bignet, but obtaining results can take a day. Multicomputer systems with a slow network (less than 100 Mbps) or systems with slow read/write to storage media may take even longer to yield results. Memory requirements on a one-CPU machine are approximately 600 megabytes and even more for a multiprocessor machine. The final output will be approximately 1 gigabyte on your hard drive.

After installing TRANSIMS, you can use this standalone tutorial to get started. A working knowledge of Unix-based systems is beneficial but not mandatory.

### 2.1.1 Network Description

The Bignet Network consists of 3,853 nodes, 7,441 links with 1,7458 kilometers of roadway, and one parking location and two activity locations on almost every link. The Bignet Network is approximately one-tenth the size of Portland, Oregon, with 25,000 households containing 57,000 people, approximately 3,000 additional vehicles (itinerant travelers—those vehicles merely passing through the city), and another 3,000 freight vehicles.

Bignet exercises much of the code within the TRANSIMS modules; it has the normal population, trip-table activities, bus and rail transit, bicycles, bridges, a freeway, and restricted access roads. This version of Bignet does not incorporate feedback.

Bignet consists of an 8x8 grid of block groups, in which each block group consists of an 8x8 grid of local streets with secondary arterials on the edges. The following three sections

1) describe how land is used on the Bignet Network,

2) provide a detailed description of the Bignet Network, and

3) described the Bignet Network's connectivity.

Appendix A provides a detailed explanation of the naming convention used for Bignet's links and nodes.

#### 2.1.1.1 Land Use in Bignet

The most basic way to view the Bignet Network is to look at its land use. Fig. 4 shows the Network's land use, zone divisions, and block groups. Fig. 5 in the next section shows how the streets are laid out within each block.

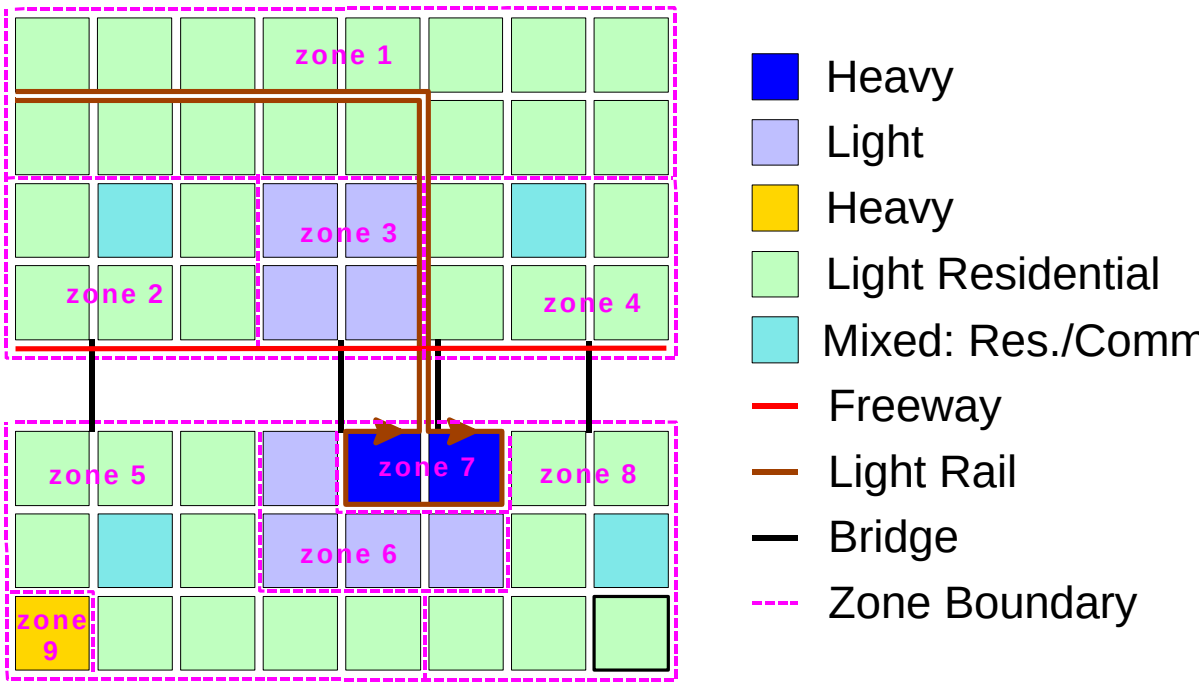



*Fig. 4. In this schematic, the unlabeled white space across the middle of the network represents a river (the four black lines represent bridges). On the north side of town, just south of the local streets, is an east-to-west freeway. A single rail line runs from the northwest corner of the Network to the downtown area, around which it makes a loop and returns to the northwest station. Pink, dashed lines indicate zone boundaries, which are labeled with pink text.*

Of the 15 zones in Bignet, nine are shown in Fig. 1. The remaining six consist of boundary zones. All activities of the basic grid shown in this figure are as follows:

- west is zone 10,
- north is zone 11,
- east is zone 12, and
- south is zone 13.

The freeways also have two zones: zone 14 west of the network, and zone 15 east of the network.

Colors denote how land is used. For example, yellow shows that zone 9 is a heavy industrial area. This area has no homes but is the workplace for a significant fraction of the population. Because of its heavy industrial use, this zone is also a major freight location. Freight trips constitute the travel of approximately 5% of the population; these trips are made between both ends of the freeway and this industrial zone. There are also freight trips that never leave the freeway.

Colored dark blue, the "downtown" zone—like the heavy industrial zone—has no home locations but does serve as the workplace for much of the population. This area serves as the shopping and recreational destination for this community. Surrounding this downtown area and again on the north side of the river are two light commercial zones (light blue). These zones have the same features as the downtown area, except that the activities performed in these zones are far fewer than those in the downtown zone.

Most of the grid is colored light green, which represents residential zones. These block groups have nothing but home locations in varying densities. All travelers (except transit drivers, itinerant travelers, and freight) begin the simulation at time zero at a home location.

There are block groups in four of the primarily residential zones with both home locations and commercial activity locations. These zones (colored cyan) represent neighborhood stores, parks, strip malls, etc.

#### 2.1.1.2 Detailed Description of the Network

Bignet consists of an 8x8 grid of block groups. Each block group has secondary arterials on its borders and local streets in between. The centermost local street in each direction is classified as a collector street.

On the left half of Fig. 2 is a diagram that shows only the links with a speed limit greater than two cells per second (15 m/s). The following color codes and their corresponding meanings are as follows:

Green = secondary arterials

Red = primary arterials

Black = freeway-endlinks

The freeway along the river and the rail-only links are not shown, although they both have a maximum speed of five cells per second (37.5 m/s).

The right half of Fig. 5 provides the detail of one block group with the following color codes and their corresponding meanings:

Green = secondary arterials

Dark blue = local streets

Light blue = collector streets

This diagram also shows all of the traffic signals in that local block group. Note that yield signs exist only on the outer edges of the network.

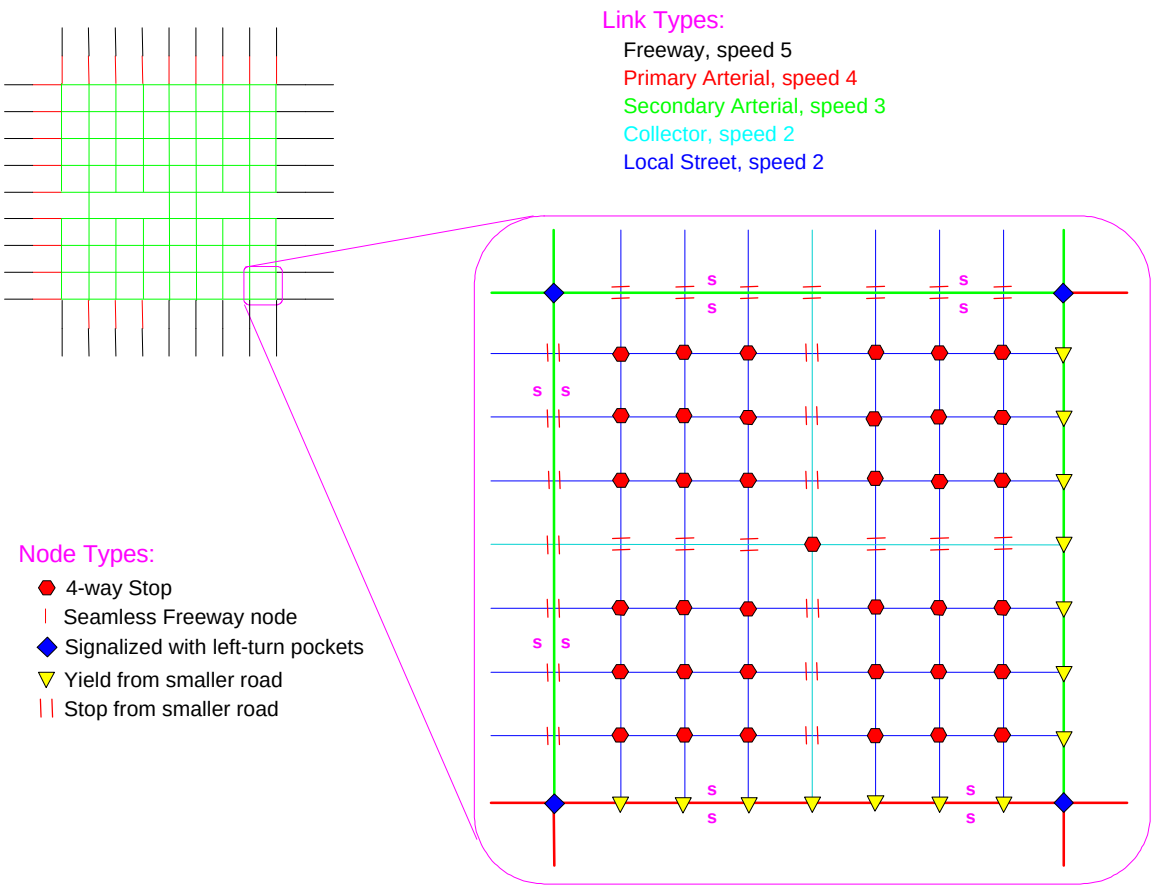



*Fig. 5. The Bignet Network (S = transit stop).*

Projecting out of the 8x8 grid of local streets (where the secondary arterials would have continued) are primary arterials (red) with two lanes in each direction and a speed of 30 m/s (four cells per second). Connected to these are freeways (black) with two lanes in each direction and a speed of 37.5 m/s (five cells per second).

The primary arterials are 1,000 meters long; the freeway links connected to them are 450 meters long. The node in between them has no control because the only change is in the speed limit. There are no link features (parking, activity locations, transit stops, etc.) on the primary arterials, but at the outside end of each of the freeways are one parking location and two activity locations (one on either side). All of these features are 50 meters from the outside end of the links.

The secondary arterials (green) have two lanes in each direction and a speed limit of 22.5 meters per second (three cells per second). They are all 225 meters long. (Note that a single green line on the left half of Fig. 5 has eight links per block, as shown on the right half of the figure.)

In cases in which secondary arterials intersect with local or collector streets, the secondary arterial takes precedence, whereas the smaller street must always stop or yield (yielding takes place on outside edges only).

When two secondary arterials intersect, there is a signalized intersection with left-turn pockets for each incoming link. The timing and phasing of the signals is fixed and the same for all signals throughout the network (see Fig. 6).

As shown in Fig. 6, the signal functions break down into four distinct phases:

- During phase 1, the east-west links have a protected left turn from the left-turn pocket. All links may make a right turn after an initial stop.
- During phase 2, the east-west links have a green light (protected) for the straight-through path and may make right turns without stopping (protected). The north-south links may still make a right turn after stopping. The east-west links may make a left turn, but only if there is no oncoming traffic—the links are not protected during this phase.
- Phases 3 and 4 duplicate phases 1 and 2, with the east-west directions switched with north-south.

The center of every secondary arterial has

1) one parking location accessible from both directions, and
2) one activity location on each side of the street.

At the point at which the secondary arterial forms the boundary of two zones, one activity location resides in each zone. Also in the center of the link is one transit stop in each direction, although not every secondary arterial link has a transit-stop pair.

Buses stop twice in each block group in each direction: they stop once on the third link from the west or south and once on the seventh link from the west or south. Bus routes run straight paths along all east-west secondary arterials and along all north-south secondary arterials that have bridges.

Bridges are a special case of secondary arterials. There are only two links from one side of the river to the other: a 1,575-meter link to the South, and a 225-meter link to the

north. There are no stops, parking, or activity locations on the bridges. Left-turn pockets are available where the bridges intersect the secondary arterials on either side of the river. The signal timing and phasing at the locations are the same as for all other signals.

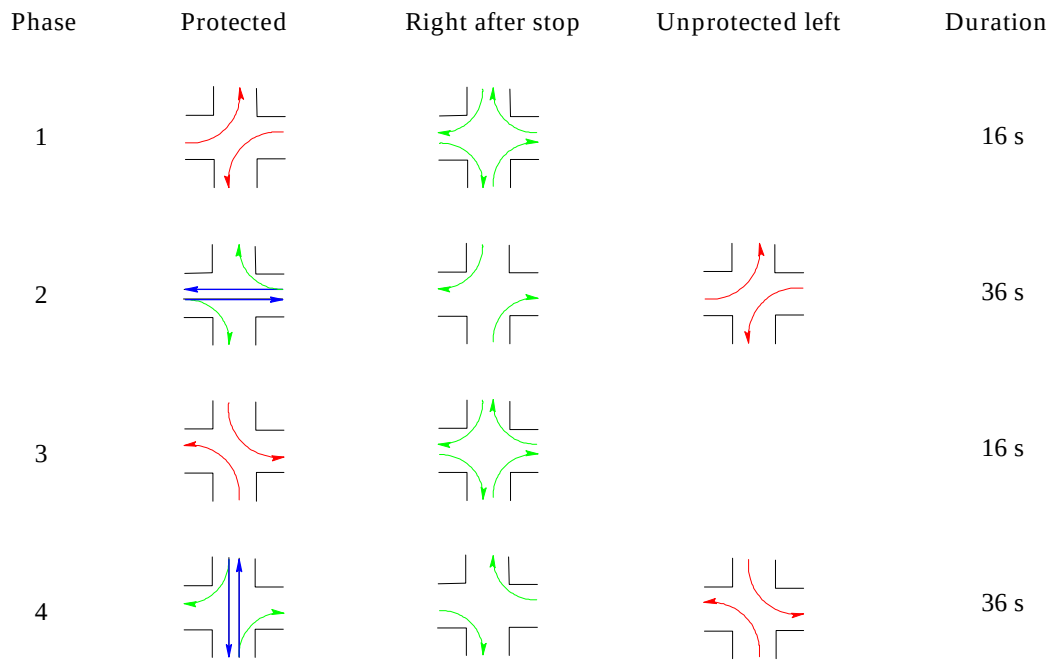



*Fig. 6. Signal timing and phasing in Bignet.*

Although all end-links sticking out of the network are classified as freeways, when we refer to “the freeway” in this document, we refer to the single east-west road just south of the north bank of the river. This freeway has three lanes in each direction and a maximum speed of five cells per second (37.5 m/s). There are only three places to enter the freeway: at either end of the local street grid, or on the second bridge from the west. At all three locations, there are two 75-meter merge lanes to enter the freeway in both directions, as well as two 75-meter turn lanes for exiting the freeway. The freeway has no transit stops. There also are no activity or parking areas, except at the east and west ends of the freeway (and these are outside of local streets).

Local and collector streets are considered the same except that the latter have precedence over the former where they intersect (see the right half of Fig. 2). Both streets (each 225-meters long) have one lane in each direction and a speed limit of 15 meters per second (2 cells per second). At the center of each street is one parking location accessible from both locations and one activity location on each side of the street.

Land use determines the use of activity locations, such as home, work, and shopping. A four-way stop is in place where two local or collector streets intersect. Where collector and local streets intersect, the collector has precedence and travelers on the local street must stop before continuing. Travelers advance when there is an opening in the traffic along the collector street.

Bignet's light rail line has its own rail-only links on the north side of the river, as well as crossing the river. However, the rail travels on the secondary arterials on the south side of the river. The rail circles the downtown area then returns to the rail-only links and its origin. Both ends of the route have a parking location that functions as a yard for the trains; there also are stops distributed along the route.

On the east-west portion of the north-of-the-river part of the route, there are two stops in each direction. On the north-south portion of this part, there are five stops in each direction, increasing in frequency closer to the river. There are no stops on the bridges.

On the secondary arterial portion of the trip, the rail line stops twice in every block group in each direction: once on the third link from the west or south, and once on the seventh link from the west or south—the same as busses. In this portion of the route, the rail line uses the same stops as the busses (which run on the same links).

Throughout the network, vehicles can travel anywhere except for the rail-only links north of the river. Conversely, the light rail can only use the rightmost lane while traveling on the secondary arterials around the downtown area (vehicles can use any lane). Travelers walk anywhere on the network except for the following:

- rail-only links,
- bridges, and
- freeway.

All transit vehicles may use only the links on their routes. These vehicles are scheduled to arrive at a stop every ten minutes, although the actual arrival time depends on network congestion and the number of people using the route.

#### 2.1.1.3 Lane Connectivity

Much like the link-to-link connectivity through nodes, TRANSIMS also requires lane-to-lane connectivity. On the local street grid, the lane connectivity follows a common sense approach. From a local or collector street, travelers may turn left or right or go straight from the only lane that exists. At signalized intersections, left turns only can be made from the left turn lane and right turns only from the right lane. All of the connectivity is shown in Fig. 7.

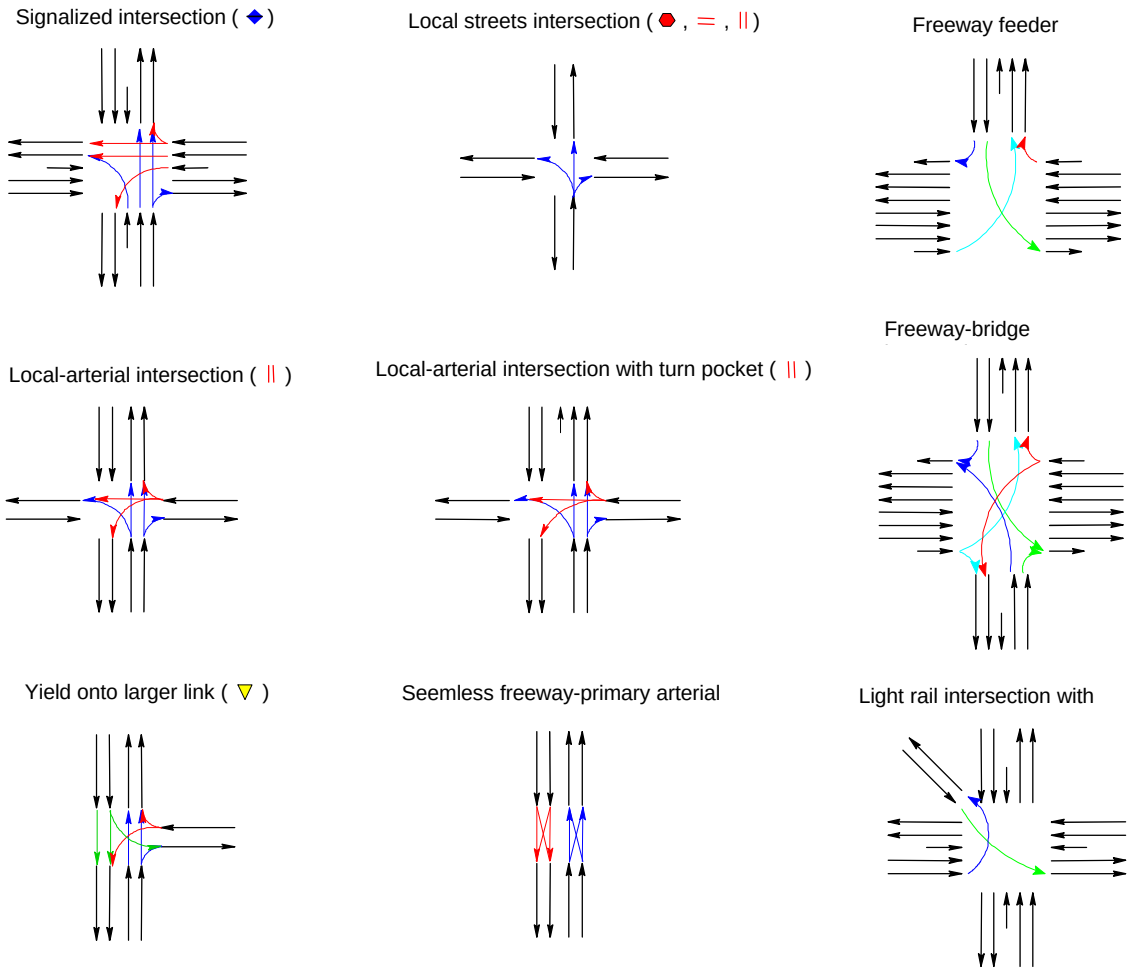



*Fig. 7. Lane connectivity in Bignet.*

The only part that is possibly confusing is the connectivity with the freeway in the third column. The freeway has merge lanes for entering and turn lanes for exiting. The center six lanes are accessible only from these two lanes, not from connecting links.

### 2.1.2 File and Directory Descriptions

The Bignet directory is located relative to the main TRANSIMS release directory, which is created during the installation process.

```
$TRANSIMS_HOME/scenarios/bignet
```

This folder contains the subdirectories *config_files*, *data*, *network*, and *scripts*. These directories contain the scenario input data, specialized configuration files, and scripts to run the TRANSIMS modules. The master configuration file *bignet.cfg* is also in this folder.

The subdirectories *activity*, *itinerants*, *log*, *plans*, *population*, *output*, *router*, *trucks*, and *vehicle* will contain the output of the TRANSIMS modules.

#### 2.1.2.1 Data Directory

The *data* directory contains all of the source data for Bignet. Source data does not change during the course of the run, nor is any output from any module written to the directory. Files are broken down as follows:

- *data/actgen* – survey data, network zone information, and weighting factors used by the Activity Generator.
- *data/pop* – census data for the Population Generator.
- *data/transit* – plans, routes, schedules, and vehicle files for all of the transit on Bignet.

The *data* directory contains the following files:

- zone tables and time table for the trip-table activity generator,
- vehicle prototype file listing data for the vehicle types to be used in the simulation,
- list of allowed modes (walking, auto, etc.), and
- files listing the links and nodes to be included in the output files from the Traffic Microsimulator.

#### 2.1.2.2 Network Directory

The *network* directory contains the 18 tables necessary to describe the network to the TRANSIMS modules, every one of which uses these files. A description of the contents of these files can be found in Volume Two (*Networks and Vehicles*).

#### 2.1.2.3 *config_files* Directory

The *config_files* directory contains specialized configuration files for some of the TRANSIMS modules. These specialized configuration files use the keys in the master configuration file and then modify selected keys for specialized use.

#### 2.1.2.4 Output Directories

During a simulation run, the TRANSIMS modules place generated data files in the output directories. Some of the resultant data from one module are then used as input for another module, but the unifying feature is that the data have been generated (as output) by some TRANSIMS module at some point in the run.

After completing a run, the output directories will contain several files, including population files (*population*), activities (*activity*), route plans (*plan*), vehicles (*vehicle*), log files from the TRANSIMS modules (*log*), itinerant travelers (*itinerants*), freight trips (*trucks*), problems encountered during routing (*router*), and data from the traffic microsimulation (*output*). In addition, many of these files have an index created so that

the data in them can be accessed efficiently by TRANSIMS modules. These directories may contain approximately one gigabyte of data at the end of a simulation run.

### 2.1.3 Before Running the Bignet Scenario

The following sections describe the environment variables and the disk space required to run the Bignet scenario.

#### 2.1.3.1 Environment Variables

The TRANSIMS executables should be in *$TRANSIMS_HOME/bin/,* with *$PVM_ROOT* serving as the base of the parallel virtual machine (PVM) tree. The respective environment variables must be set, which in C-shell (Bourne shell instructions below) might look like the following, depending on the location of the TRANSIMS package:

```
% setenv TRANSIMS_HOME /usr/local/transims-1.1
% setenv PVM_ROOT $TRANSIMS_HOME/pvm/pvm3
```

Note that these paths reflect the location of where the TRANSIMS package was installed (see Volume Six (*Installation*)). Several other PVM environment variables also must be set:

```
% set path=($path $PVM_ROOT $PVM_ROOT/lib $PVM_ROOT/bin)
% setenv PVM_ARCH `pvmgetarch`
```

Note: Make sure that you use the left single quote in the second line above, then `PVM_ARCH` automatically will be set for Linux, Solaris, or any other architecture. This line makes sure that the path of PVM is correct.

The above instructions are for *csh* or *tcsh* command interpreters. For *sh* or *bash* interpreters (type "`echo $SHELL`" to find out), then do the following:

```
% export TRANSIMS_HOME=/usr/local/transims-1.1
% export PVM_ROOT=$TRANSIMS_HOME/pvm/pvm3
% set path=($path $PVM_ROOT $PVM_ROOT/lib $PVM_ROOT/bin)
% export PVM_ARCH=`pvmgetarch`
```

#### 2.1.3.2 Disk Space

Bignet may require more than one gigabyte of storage. You may elect to soft link the local output directories in the Bitnet scenario directory to other hard drives.

#### 2.1.3.3 Modifying the Configuration File

The following steps are designed to ensure that the configuration file reflects your computer's particular configuration:

**Step One** While still in the Bignet directory, use an editor to open the configuration file *bignet.cfg*.

- The first line has the configuration file key `TRANSIMS_ROOT` on it.
- Make sure the value of this key reflects the location on your system of the TRANSIMS package (it should already be correct from the installation process).

**Step Two** Search for the string `PAR_HOST_0`.

- This string specifies the name of the machine on which you will be running the microsimulation.
- Edit its value to have the fully qualified host name.
  Note: only the PVM version of the microsimulation needs this key set.

**Step Three** On the next line, (`PAR_SLAVES`) is the number of CPUs the microsimulation will use.

- Enter an integer less than or equal to the total number of CPUs in the machine, but greater than or equal to one.

**Step Four** Search for `ROUTER_NUMBER_THREADS` and set this equal to the same number used in `PAR_SLAVES`.

- This will be the number of CPUs used by the Route Planner.

For both the Route Planner and the Traffic Microsimulator, note that you can "lie" to the programs and tell them to use as many or as few slaves and threads as you want. The above instructions will produce the optimal run.

Once you have completed this process, you are ready to run TRANSIMS on the Bignet Network.

### 2.1.4 Running the Bignet Scenario

Scripts to run the TRANSIMS modules on the Bignet scenario are in the *$TRANSIMS_HOME/scenarios/bignet/scripts* directory. These scripts control the TRANSIMS modules to

- generate a synthetic test population;
- locate the population on the Bignet Network;
- generate vehicles for the households in the population;
- generate itinerant travelers and trucks that will pass through the Bignet Network;
- route the travelers, itinerants, and trucks;
- run the Traffic Microsimulator to show the movements of the travelers through the transportation network; and
- generate an emissions estimate for the Bignet simulation.

The file *RunAll* contains the ordering that should be used to run the scripts. You must have the `TRANSIMS_HOME` environment variable set correctly in order to use the scripts. A complete run on the Bignet scenario will take several hours.

#### 2.1.4.1 Keeping Track of the Run's Progress

To check the progress of the simulation, use the log files that the TRANSIMS modules create in the log directory. Each TRANSIMS module will produce a log file. If a log file has any error messages in it or has an exit code that is not "Success Exit", the run probably failed and you will need to learn more about TRANSIMS to troubleshoot the problem.

Some of the data found in the log files requires a thorough understanding of TRANSIMS. Note: The *BlockGroupLoc.log* will be filled with error messages from households that we never intended to place on this network. These messages should be ignored unless you are using real census data on a real network.

The Activity Generator and Route Planner create problem files that list information about households or travelers that had problems during activity list creation or routing.

Looking at the end of the Traffic Microsimulator log (*output/logfile*) will tell you how far the microsimulation has progressed. The total time being simulated is defined in the configuration file *bignet.cfg* by the `CA_SIM_START_*` and `CA_SIM_STEPS` configuration file keys.

Note that many *log/problem* files, particularly *act.problems*, *router.problems*, and the Traffic Microsimulator logfile, will be filled with errors that normally would be fixed using feedback, which we are not using in these examples.

### 2.1.5 Using Scripts to Run the Bignet Scenario

First, set the appropriate environment variables, then change directory to *$TRANSIMS_HOME/scenarios/bignet*. Scripts to run the TRANSIMS modules are located in the scripts directory. The file *scripts/RunAll* documents the order in which the scripts are run; this is explained in detail in the sections below.

#### 2.1.5.1 Making a Population

Creating a population involves four steps:

1) creating the households from census data,
2) locating the households in appropriate block groups on the transportation network,
3) assigning vehicles to the households, and
4) preparing a population with demographics that are needed by the TRANSIMS Activity Generator.

Run the script *MakeBasePopulation* to create the baseline population from census data. Next, run the script *PreparePop* to locate the households, assign vehicles, and convert the population demographics to those needed by the Activity Generator. Log files from the TRANSIMS modules used during the generation will be in the log directory. *BlockGroupLoc.log* will report errors that can be ignored. The errors are the result of locating only certain block groups from PUMA 01300.

The results of the population generation will be in the population and vehicle subdirectories. The baseline population from census data is *population/pop_base*. The located population is *population/pop_located*, and the population that will be used by the Activity Generator is *population/pop_converted*. A TRANSIMS vehicle file that contains the vehicles assigned to the households is *vehicle/vehicles.pop*.

#### 2.1.5.2 Creating Activities for the Population

The Activity Generator will create a 24-hour activity list for each person in the population. Run the script *script/RunActivityGenerator* to generate the activities. The generated activities will be in *activity/activities*. The Activity Generator problem file (*activity/act.problems*) will contain some households where shared ride activities could not be assigned. The log file will also contain messages about these households. These problems are corrected using feedback to rematch the problematic households to obtain a different activity pattern. Since we are not using feedback in this example, these problems are ignored.

#### 2.1.5.3 Creating Itinerant Travelers and Freight Using Trip Tables

Not all travelers in a municipality reside in the city. TRANSIMS simulates these non-resident individuals by using origin/destination trip tables. Freight activities are also generated using origin/destination trip tables.

The *ActTripGen* program creates the population, vehicle, and activity files for travelers generated from trip tables. The trip tables are in the data subdirectory *trip.zonetable1* for itinerants, and *trip.zonetable2* for freight. The same time of day is used for both, *trip.timetable*.

Run the scripts *scripts/GenerateItinerants* and *scripts/GenerateTrucks* to create the itinerant traveler and freight trips. The population, vehicle, and activity files for itinerant travelers will be in the *itinerants* subdirectory. Results for freight will be in the *trucks* subdirectory.

#### 2.1.5.4 Routing All Travelers

The TRANSIMS Route Planner is run separately on the population, itinerant travelers, and freight trips. The separate route plans and vehicles files are combined later for use by the Traffic microsimulator.

After the route plans are generated, the run scripts create

- an iteration database that contains information about each trip that was routed, and
- a text file that contains statistics about the route plans.

Run the script *scripts/RouteTrucks* to generate route plans for the freight trips. The results are the route plans (*trucks/plans.trucks*), the iteration database (*itdb.trucks.000.it*), and the plan statistics (*trucks/planstat_trucks.txt*).

Run the script *scripts/RouteItinerants* to generate route plans for the itinerant travelers. The results are the route plans (*itinerants/plans.itinerants*), the iteration database (*itinerants/itdb.itinerants.000.it*), and the plan statistics (*itinerants/planstat_itinerants.txt*).

Run the script *scripts/RoutePop* to generate route plans for the resident population. The results are the route plans (*plans/plans*).

After the Route Planner runs are completed, the route plans for all travelers must be combined and sorted by departure time in preparation for the Traffic Microsimulation. The vehicle files for all travelers, including the transit vehicles in *data/transit*, must be combined into a single vehicle file.

Run the script *scripts/FinishRouter* to prepare the plans and combine the vehicle files. In addition, the script also generates an iteration database (*itdb.000.it*), and plan statistics on the population (*log/plan_stat.txt*).

#### 2.1.5.5 Running the Traffic Microsimulator

The Traffic Microsimulator is the final step in simulating the Bignet community. For details regarding how to run the Traffic Microsimulator, see Volume Three (*Modules*), Chapter Five (*Traffic Microsimulator*).

The script *script/RunMsim* is used to run the Traffic Microsimulator. The script uses the PVM communication mechanism in the microsimulator. The following environment

variables must be set to execute the script: `TRANSIMS_HOME`, `PVM_ROOT`, `PVM_ARCH`, and `PVM_EXPORT`. In addition, *$PVM_ROOT/lib* and *$PVM_ROOT/bin* must be in the user's path.

Run the script *script/RunMsim* to execute the Traffic Microsimulator on the travelers' route plans. Depending on the number of processors and the processor speed, this run may take a few hours or much longer (days). Check on the run's progress by looking at the end of the log file (*output/logfile*). Data files generated by the run will be in the *output* subdirectory.

A series of one-hour snapshots of all vehicles on the transportation network is in the file *output/snapshot.veh*. The Output Visualizer can be used to view the snapshots. Convert the snapshot data into a binary indexed vehicle file for use with the Output Visualizer using the following command:

```
% cd output
% $TRANSIMS_HOME/bin/indexvehtovin snapshot.veh snapshot.veh.bin
```

See Volume Three (*Modules*), Chapter Eight (*Output Visualizer*) for instructions on how to use the Output Visualizer to view snapshot data.

The event output files from the Traffic Microsimulator record all major events in the simulation. In this example, these events have been filtered into several files in the output subdirectory.

- *anomaly.offplan.trv* – records every occurrence of a traveler who is off plan.
- *anomaly.other.trv* – records all other anomalies.
- *endtrips.trv* – contains a record of the beginning and end of every trip in the simulation.
- *endsim.trv* – records any travelers present in the simulation at the simulation stop time.
- *event.trv* – records vehicle events for emissions calculations.

#### 2.1.5.6 Postprocessing

Postprocessing the resultant data from the Traffic Microsimulator enables the user to make it easier (and sometimes possible) to visualize the results. The first step in postprocessing is to convert the ASCII vehicle snapshot output into a binary file. Such a conversion enables the Output Visualizer to read it much faster. To execute this conversion, use the following command line:

```
$TRANSIMS_HOME/bin/indexvehtobin output/snapshot.veh output/snapshot.veh.bin >&! indexvehtobin.log
```

The next step is to perform the emission estimation for the Bignet simulation. Run the script *scripts/GenerateEmissions* to produce emission estimates from the Traffic Microsimulator output.

See Section 3.8 of this volume for information about how to use the Output Visualizer to display the data produced form the Tailpipe Emissions Estimator.

There are other data files that would need some postprocessing before they can be visualized, but we stop our example at these. To see how to convert all the other forms of data for visualization, see Volume Three (*Modules*), Chapter Eight (*Output Visualizer*).

# 3. TUTORIALS

## 3.1 Population Synthesizer

### 3.1.1 Running the Population Synthesizer

Before running the Population Synthesizer, the environmental `TRANSIMS_HOME` variable must be set (see Troubleshooting). Once this is done, perform the following four steps.

**Step One** Create a working directory in which the Population Synthesizer's output files will be generated.

**Step Two** Change directory (`cd`) into the working directory.

**Step Three** Copy the following configuration file into the working directory.

```
$TRANSIMS_HOME/data/synpop/sample/example.cfg
```

You may want to edit the configuration file to change the output filename prefixes for the base of forecast populations. To do this, use the following configuration file keys:

`SYNPOP_BASE_PREFIX` and `SYNPOP_FORECAST_PREFIX`

You may want to change the output filename prefixes for the household or person demographics as well. To do this, use the following configuration file keys:

`SYNPOP_HOUSEHOLD_DEMOGRAPHICS` and
`SYNPOP_PERSON_DEMOGRAPHICS`

Appendix B lists the valid person and household demographic field names.

The Activity Generator requires the following household demographics:

- `R18UNDR`,
- `RWRKR89`, and
- `RHHINC`

The Activity Generator also requires the following person demographics:

- `AGE`,

- `RELAT1`,
- `SEX`, and
- `WORK89`.

To suppress the generation of a base- or forecast-year population, remove the following configuration file key:

`SYNPOP_BASE_PREFIX` or `SYNPOP_FORECAST_PREFIX`

**Step Four** Once steps 1 through 3 are completed, type the executable name followed by the configuration file key `Syn example.cfg.` Note that the directory in which `Syn` is installed must be in the user's path (`$TRANSIMS_HOME/bin/Syn`).

Various information messages will be printed on the console. The Population Synthesizer takes approximately one-half hour to run this example on typical computing platforms.

### 3.1.2 Files

After the Synthetic Population Generator has run, four new files will be present in the working directory:

1) *user_supplied_base_prefix_Family_Synthetic_HHRecs.out*

2) *user_supplied_base_prefix_Non_Family_Synthetic_HHRecs.out*

3) *user_supplied_base_prefix_Group_Synthetic_HHRecs.out*

4) *user_supplied_forecast_prefix_Synthetic_HHRecs.out*

The first three files contain the base-year (1990) populations for the demographic types; the last file contains the forecast-year (1994) population.

#### 3.1.2.1 File Format

The file format consists of two lines containing the names of the household and the demographic data, followed by the synthetic household data.

The first line of data consists of the following:

- tract ID,
- block group ID,
- an "H" to indicate that it is a household record,

- household ID (always –1),
- `PERSONS` field,
- `AUTOS` field,
- home location (always –1), and
- demographic data in the order listed in line one of the file (`PUMSHH, R18UNDR, RWRK89, RHHINC` in this example).

See Volume Three (*Modules*) for more information on file formats. This household record is followed by person records (one per person in the household files; group quarter records have one person per household). A person consists of the following:

- household ID (always –1),
- a `P` to indicate that it is a person record,
- person ID (always –1), and
- demographic data in the order listed in line two of the file (`AGE, RELAT1, SEX, WORK89` in this example).

### 3.1.3 Troubleshooting

#### 3.1.3.1 Environment Variables

Before running the Population Synthesizer, make sure that the environment variables are set appropriately.

*TRANSIMS_HOME* – root directory of the TRANSIMS distribution. The following directory must be present and have read permission by the user:

*$TRANSIMS_HOME/data/synpop*

#### 3.1.3.2 Configuration File Keys

Before running the Population Synthesizer, make sure that the following four configuration file keys are set appropriately.

1) Set `SYNPOP_STF_INFO_DIR` to *$TRANSIMS_HOME/data/synpop/Parep2/stf*. This directory must be present and have read permission by the user.

2) Set `SYNPOP_STF_DATA_DIR` to the directory in which STF3A data resides. Sample STF3A data is in *$TRANSIMS_HOME/data/synpop/sample/stf*. If using Oregon PUMA 01300, the following should be set to this directory: `SYNPOP_STF_DATA_DIR`. If using data from a mounted CD-ROM, set `SYNPOP_STF_DATA_DIR` to the CDROM directory (Example: */mnt/cdrom*). The directory must be available and have read permission by the user.

3) Set `SYNPOP_PUMS_DATA_DIR` to the directory in which the PUMS data resides. Sample PUMS data for Oregon is in *$TRANSIMS_HOME/data/synpop/sample/pums*. If using Oregon PUMA 01300, `SYNPOP_PUMS_DATA_DIR` should be set to this directory. If using data from a mounted CD-ROM, set `SYNPOP_PUMS_DATA_DIR` to the CDROM directory (example: */mnt/cdrom*). The directory must be available and have read permission by the user.

4) Set `SYNPOP_MABLE_FILE` to where the downloaded MABLE/Geocorr data resides. Sample MABLE data for Oregon is in the following directory:

   *$TRANSIMS_HOME/data/synpop/sample/mable/geocorr.csv*

   If using Oregon PUMS 01300, `SYNPOP_MABLE_FILE` should be set to this directory.

The following directory must also be available and have read permission by the user: *$TRANSIMS_HOME/data/synpop/doc*

Each PUMA should be processed separately. The PUMA ID that is entered must match exactly the PUMA number in the MABLE/GEOCORR file and the PUMS data (i.e., 01300, not 1300).

### 3.1.4 Locating a Population on a Transportation Network

#### *3.1.4.1 BlockGroupLoc* Utility

The *BlockGroupLoc* utility generates home locations for populations on a transportation network by correlating census tract and block-group user data values specified in the network activity location file with tract and block group data in the baseline population. Candidate home locations must have the same census tract and block group as the household; they also must have residential land-use values greater than zero.

*BlockGroupLoc* also generates household and person IDs and assigns them to the located population. The user data in the activity location table in the TRANSIMS transportation network must contain tract, block group, and residential and commercial land-use values.

Alternative tract and block groups may be specified for households in block groups that do not have activity locations associated with the household's tract/block group. The alternative tract/block group pairs are specified in a Tract/Block Group Substitution file. If a household does not have at least one activity location with a matching tract/block group in either network activity location table, the Tract/Block Group Substitution file is omitted from the located population produced by *BlockGroupLoc*.

Usage:

```
% BlockGroupLoc <configuration file>
```

Table 7 lists the configuration file keys from the TRANSIMS configuration file used by *BlockGroupLoc*. Some keys have default values that may be used if the key is not specified in the configuration file.

**Table 7. *BlockGroupLoc* configuration file keys.**

| Configuration File Key | Description |
|---|---|
| ACT_BLOCKGROUP_HEADER | The user data column header in the network activity location file used to specify the block group. Default = BG |
| ACT_HOME_HEADER | The user data column header in the network activity location file used to specify single-family home locations. Default = HOME |
| ACT_MULTI_FAMILY_HEADER | The user data column header in the network activity location file used to specify multifamily-home locations. If not specified, multifamily user data from the activity location file is ignored. |
| ACT_TRACT_HEADER | The user data column header in the network activity location file used to specify the census tract. Default = TRACT |
| NET_ACTIVITY_LOCATION_TABLE* | The name of the network activity location table. |
| NET_DIRECTORY* | The directory in which the network files reside. |
| NET_LINK_TABLE* | The name of the network link table. |
| NET_NODE_TABLE* | The name of the network node table. |
| POP_BASELINE_FILE* | The name of the file containing the baseline population. |
| POP_LOCATED_FILE* | The name of the file in which the located population will be written. |
| POP_NEAREST_BG_FILE | The name of the Tract/Block Group Substitution file that contains information about the nearest tract/block group for block groups that have no activity locations on the transportation network. |
| POP_STARTING_HH_ID | The number from which the generated households will be sequentially numbered. Default = 1 |
| POP_STARTING_PERSON_ID | The number from which the generated persons will be sequentially numbered. Default = 101 |

* Configuration file keys that are required for *BlockGroupLoc*. All others are optional and will use default values.

☛ The current version of *BlockGroupLoc* must be executed once for each of the three types of synthetic household files produced by running the Population Synthesizer. Specify distinct values for the following configuration file keys: POP_BASELINE_FILE and POP_LOCATED_FILE in each run. In addition, specify different values for POP_STARTING_HH_ID and POP_STARTING_PERSON_ID in each run so that IDs in the output files do not overlap.

It may be necessary to examine the successive output files to determine the last value of each ID used thus far. To do this, specify the values `Sfr-area` for `ACT_HOME_HEADER`, `Mfr-area` for `ACT_MULTI_FAMILY_HEADER`, and `BLOCKGR` for `ACT_BLOCKGROUP_HEADER`.

☛ Once *BlockGroupLoc* produces the three output files, they must be concatenated into a single file. To do this, use a text editor to remove the two header lines from the second and third files, then append each file to the first file. The resulting concatenated file will be used as an input file for the *Vehgen* program (which is described in the following section) and for the Activity Generator. There will be fewer records in the located population than were in the household files because of the network's limited size.

### 3.1.5 Generating a TRANSIMS Vehicle File for Located Synthetic Populations

#### *3.1.5.1 Vehgen* Utility

A TRANSIMS vehicle file contains information about the initial locations of a household's vehicles. For most households, the vehicle's starting location will be the parking location near the household's home location.

The *Vehgen* utility creates a TRANSIMS vehicle file that contains information about the household's vehicles and their starting locations.

To find each vehicle's starting parking location, iterate through the process links connected to the home activity location. Every home activity location must have at least one parking location that is accessible via the activity location's process links.

Usage:

```
% Vehgen <configuration file>
```

Table 8 lists the configuration file keys from the TRANSIMS configuration file used by *Vehgen*. Some keys have default values that may be used if the key is not specified in the configuration file.

**Table 8. *Vehgen* configuration file keys.**

| Configuration File Key | Description |
|---|---|
| `NET_ACTIVITY_LOCATION_TABLE` | The name of the network activity location table. |
| `NET_DIRECTORY` | The directory in which the network files reside. |
| `NET_LINK_TABLE` | The name of the link table. |
| `NET_NODE_TABLE` | The name of the network node table. |
| `NET_PARKING_TABLE` | The name of the network parking table. |
| `NET_PROCESS_LINK_TABLE` | The name of the network process-link table. |
| `NET_TRANSIT_STOP_TABLE` | The name of the network transit-stop table. |

| Configuration File Key | Description |
|---|---|
| POP_LOCATED_FILE | The name of the file containing the located population. |
| POP_STARTING_VEHICLE_ID | The number from which the vehicle IDs will be sequentially numbered. Default = 100 |
| VEHICLE_FILE | The name of the TRANSIMS vehicle file that will be written. |

## 3.2 Activity Generator

### 3.2.1 Usage

The name of the Trip Table Activity Generator program is *ActTripGen*. Several TRANSIMS configuration file keys are provided to control the numbering of households, persons, and vehicles.

By controlling the initial numbering, users can run the Activity Generator multiple times using different trip tables and produce consistently numbered population and vehicle files. The user also can control the random number seed.

The Activity Location Table in the TRANSIMS Network must contain a column of user data that specifies the zone number associated with each activity location.

Table 9 contains configuration file keys for the Trip Table Activity Generator.

**Table 9. Trip Table Activity Generator configuration file keys.**

| Configuration File Key | Description |
|---|---|
| ACT_TAZ_HEADER | The column header in the network activity location file that contains the zone information. Default = TAZ |
| ACT_TRIP_TABLE_OUTPUT* | The name of the activity file that will be output from the Trip Table Activity Generator. |
| ACT_TRIPTABLE_FILE* | The name of the file containing the trip table matrix. |
| ACT_TRIPTABLE_STARTING_HH_ID | The starting household ID for households generated from trip table matrices. Default = 1 |
| ACT_TRIPTABLE_STARTING_PERSON_ID | The starting person ID for travelers generated from trip table matrices. Default = 1 |
| ACT_TRIPTABLE_STARTING_VEHICLE_ID | The starting vehicle ID for vehicles generated from trip table matrices. Default = 1 |
| ACT_TRIPTABLE_VEHICLE_FILE* | The name of the vehicle file that will be output from the Trip Table Activity Generator. |
| ACT_TRIPTIME_FILE* | The name of the file containing the time of day trip table data. |

| Configuration File Key | Description |
|---|---|
| MODE_MAP_FILE* | The name of the TRANSIMS mode file containing mapping between mode strings and integer values. The string wcw must be in this file. |
| NET_ACTIVITY_LOCATION_TABLE* | The network activity location table, which must contain a column that has the zone number for the activity locations. |
| NET_DIRECTORY* | The directory where the network tables reside. |
| NET_LINK_TABLE* | The network link table. |
| NET_NODE_TABLE* | The network node table. |
| NET_PARKING_TABLE* | The network parking table. |
| NET_PROCESS_LINK_TABLE* | The network process link table. |
| NET_TRANSIT_STOP_TABLE* | The network transit stop table (may be an empty table). |
| POP_TRIPTABLE_FILE* | The name of the population file that will be output from the Trip Table Activity Generator. |
| VEH_VEHICLE_SUBTYPE | The subtype of the vehicle fleet will be generated. Default = 0 |
| VEH_VEHICLE_TYPE | The type of vehicles that will be generated. Default value is assigned from a type enumeration in the TRANSIMS Network = 1 (kAuto) |

* Required configuration file keys. All others are optional and will use default values.

The Trip Table Activity Generator is invoked with a single command line argument, the name of the TRANSIMS configuration file.

Example:

```
% $TRANSIMS_HOME/bin/ActTripGen <configuration filename>
```

### 3.2.2 Activity Generator Usage

#### 3.2.2.1 Overview

The Activity Generator uses data files that are specified in a TRANSIMS configuration file. Some data files are specific to a network and use activity patterns derived from the Portland activity survey. Data files in the TRANSIMS distribution are for the Bignet Network only.

Found in the *TRANSIMS_HOME/data/bignet/data/actgen* directory, the data files are specified in the Activity Generator configuration file, *TRANSIMS_HOME/data/bignet/bignet.cfg*. Refer to Appendix B in Volume Three (*Modules*), Chapter Three (*Activity Generator*) for a description of the configuration file keys used by the Activity Generator.

The Activity Generator requires a synthetic population that has demographics that exactly match the demographic variables in the regression tree. The Population Converter program, *PopConverter*, will create this population from the synthetic population produced by the TRANSIMS Population Synthesizer and located on the Bignet Network using the Block Group Locator program. The Population Converter program uses a TRANSIMS configuration file to specify the input population and the output file for the converted population. The configuration file *TRANSIMS_HOME/data/bignet/bignet.cfg* contains the appropriate keys to run the population converter on the test population for the Bignet Network. The test population that is located on the Bignet Network is in *TRANSIMS_HOME/data/bignet/output/population.located*. The Activity Generator uses a TRANSIMS vehicle file to specify the vehicle IDs that are used in a household's activities. The vehicle file is created from the located population using the Vehicle Generator program. The vehicle file is *TRANSIMS_HOME/data/bignet/output/vehicles*.

#### 3.2.2.2 Running the Activity Generator

The environment variable `TRANSIMS_HOME` must be set to the directory where the TRANSIMS distribution is installed. The instructions below assume that a TRANSIMS population has been created using the TRANSIMS Population Synthesizer and located on the Bignet Network and that a TRANSIMS vehicle file has been generated from the located population.

- Change directory to *TRANSIMS_HOME/data/bignet*
  ```
  % cd $TRANSIMS_HOME/data/bignet
  ```
- Run the Population Converter.
  ```
  % $TRANSIMS_HOME/bin/PopConverter $TRANSIMS_HOME/data/bignet/bignet.cfg
  ```
- Run the Activity Generator and redirect the messages into the logfile.
  ```
  % $TRANSIMS_HOME/bin/ActivityGenerator $TRANSIMS_HOME/data/bignet/bignet.cfg  > output/ag.log
  ```

Activities for the population are produced in the *$TRANSIMS_HOME/data/bignet/output* directory. Messages from the Activity Generator will be in the file *$TRANSIMS_HOME/data/bignet/output/ag.log*.

## 3.3 Route Planner

### 3.3.1 Before Running the Route Planner

In order to run the Route Planner, ensure that all of the files specified in the configuration file keys exist (with the exception of the created output files, which are listed below). A description of all Route Planner configuration file keys is given Table 10.

**Table 10. Route Planner configuration file keys.**

| Configuration File Key | Description |
|---|---|
| ACTIVITY_FILE* | The path to a TRANSIMS activity file.. |
| LOG_ROUTING | Turns on Route Planner logging. This produces information about the status and progress of the Route Planner. Default = 0 |
| LOG_ROUTING_DETAIL | Turns on detailed Route Planner logging. Produces many messages. Default = 0 |
| MODE_MAP_FILE* | The path to a mode file.. |
| PLAN_FILE* | The name of the file where plans should be written. (Overwrites an existing file.). |
| ROUTER_BIKING_SPEED | The speed to use when computing delays for walk links traversed by bicycle (meters/second). Default = 4.0 |
| ROUTER_CORR | The Route Planner will change the reported length of a link to be equal to its Euclidean length whenever the ratio of the two is less than this value. This is done in order to avoid problems when the Sedgewick-Vitter heuristic is used. Floating-point number between 0 and 1. Default = 0.0 |
| ROUTER_DELAY_NOISE | The percentage of noise to add to link delays. Default = 0 |
| ROUTER_FILTER_EXCLUDE_MODE | The plan modes not to include in the plan file. Default it to include no modes. Only one of INCLUDE_MODE and EXCLUDE_MODE may be specified. |
| ROUTER_FILTER_EXCLUDE_VEHICLE | The plan vehicle types not to include in the plan file. Default is to include no vehicle types. Only one of INCLUDE_VEHICLE and EXCLUDE_VEHICLE can be specified. |
| ROUTER_FILTER_INCLUDE_MODE | The plan modes to include in the plan file. Default is to include all modes. |
| ROUTER_FILTER_INCLUDE_VEHICLE | The plan vehicle types to include in plan file. Default is to include all vehicle types. |
| ROUTER_GET_OFF_TRANSIT_DELAY | The delay encountered when exiting a transit vehicle. Default = 4 seconds |
| ROUTER_GET_ON_TRANSIT_DELAY | The delay encountered when boarding a transit vehicle. Default = 3 seconds |

| Configuration File Key | Description |
|---|---|
| ROUTER_HOUSEHOLD_FILE | The path to a file containing a list of integer IDs for householders to be planned. |
| ROUTER_INTERNAL_PLAN_SIZE | Positive integer. Should be enough to accommodate the length (in number of nodes) of the shortest path between any two nodes in the network (and may need to be quite large when multimodal plans are used). Default = 400 |
| ROUTER_LINK_DELAY_FILE | The feedback file from which to read link delays. If the configuration file key is not present or the file does not exist, the free speed delays are used. |
| ROUTER_MESSAGE_LEVEL | The level of warning messages to produce:<br>-2 (ERROR)<br>-1 (PRINT)<br>0 (SEVERE WARNING)<br>1 (WARNING).<br>Produces information about possible anomalies the Route Planner has encountered. Default = 1 |
| ROUTER_NUMBER_THREADS | The number of worker threads to be used. A value of 0 means no threads will be used. Positive integer. Default = 0 |
| ROUTER_OVERDO | Non-negative floating-point number. If set to 0, no adjustment is made to the distance estimates. If positive, the search for the shortest path to the origin will be biased in the direction of a straight line to the destination. This will produce non-optimal paths. The paths will still be reasonable, but the heuristic may cause relatively small congestion on links to be ignored, and this can break the iterative relaxation mechanism. Default = 0.0 |
| ROUTER_PROBLEM_FILE* | The path name to a file in which activities with anomalies identified by the Route Planner are written.. |
| ROUTER_SEED | The seed to use for the random number generator. If the configuration file key is set to 0, use process ID. Default = 0 |
| ROUTER_WALKING_SPEED | The speed to use when computing delays for walk links (meters/second). Default = 1.0 |
| ROUTER_ZERO_BACKD | Integer, 0 or 1. Default = 0 |
| TRANSIT_ROUTE_FILE | The file containing route of transit vehicles. |
| TRANSIT_SCHEDULE_FILE | The file containing schedules of transit vehicles. |
| VEHICLE_FILE* | The path to a TRANSIMS vehicle file.. |

* Required configuration file keys. All others are optional and will use default values.

### 3.3.2 Required Input Files

The required input files for the Route Planner are listed in Table 11.

**Table 11. Required input files for the Route Planner.**

| Input File | Description |
|---|---|
| ROUTER_ACTIVITY_FILE | Contains the activities for the travelers to be routed. |
| MODE_MAP_FILE | Contains the travel modes to be used for routing. |
| VEHICLE_FILE | Contains the starting locations of available vehicles. |

If the transportation network contains transit, the configuration file keys TRANSIT_ROUTE_FILE and TRANSIT_SCHEDULE_FILE are also required.

### 3.3.3 Created Output Files

The created output files for the Route Planner are listed in Table 12.

**Table 12. Created output files.**

| Input File | Description |
|---|---|
| PLAN_FILE | Contains the plans for all successfully routed travelers. |
| ROUTER_PROBLEM_FILE | Contains information about unsuccessfully routed travelers. |

### 3.3.4 Setting the Number of CPUs

On a multiprocessor machine, the configuration file key ROUTER_NUMBER_THREADS should be set to the number of CPUs available.

On a single processor machine, ROUTER_NUMBER_THREADS should be set to 0.

### 3.3.5 Running the Route Planner

Run the Route Planner by keying

```
% <Router> <config>
```

where <Router> is the name of the Route Planner executable (usually Router), and <config> is the name of the configuration file to be used.

## 3.4 Traffic Microsimulator

### 3.4.1 Parallel Configuration and Communication Setup

Running the Traffic Microsimulator requires that the user's environment be properly set up. Because it uses the Parallel Virtual Machine (PVM) or Message Passing Interface (MPI) protocols to run in a distributed environment, the user must ensure that these are correctly configured before using the Traffic Microsimulator. This section gives some tips on setting up the environment.

The Traffic Microsimulator uses a master/slave paradigm to run in distributed mode. That is, there will be several copies of the executable running during a simulation run. One of these will be the “master,” responsible for providing a synchronization heartbeat to the slaves and for other chores such as collecting, sorting, and writing output. These notes are written in the expectation that the master and slaves will all be running on the same "machine". In other words, they will be distributed over the processors of a multiprocessor computer. It is also possible to run the simulator distributed over several different machines on a network.

Communication among the master and slaves is accomplished by passing messages using one of two message passing protocols: MPI or PVM. Both are widely available with no license fee. Traffic Microsimulator performance is similar with either. Each communication scheme requires the user to specify the architecture used for communication, and MPI further requires the user to choose the “device” to be used for communication.

For example, on Solaris under PVM, an appropriate architecture is SUN4SOL2; for MPI under Linux, an appropriate architecture is LINUX and device is ch_p4. See the documentation supplied with PVM and MPI for further description of allowed architectures and devices.

The choice of architecture and device is made by the user at compile time, by supplying the `PVM_ARCH` or `MPI_ARCH` and `MPI_DEVICE` command line arguments to `make`. The Makefile system creates different versions of the "CA" executable that are placed in communication environment, architecture, and device-dependent directories under the *bin* directory.

For example, compiling with the command

```
% make APP=CA COMMUNICATION=PVM PVM_ARCH=SUN4SOL2
```

creates the executable *bin/ARCH.PVM.SUN4SOL2/CA*.

Similarly,

```
% make APP=CA COMMUNICATION=MPI MPI_ARCH=LINUX MPI_DEVICE=ch_p4
```

creates *bin/ARCH.MPI.LINUX.ch_p4/CA*. See the installation manual for more details.

Both PVM and MPI require that the user gain access to the machine on which processes are to be run without typing a password. The exact mechanism for spawning processes depends on the implementation and installation of these packages. One scheme that should work for all installations uses a file named *.rhosts* in the user's home directory. This file should list the name of the machine to be used and the user's login name on that machine.

The *.rhosts* file's permissions should be set to deny access to others. You should be able to remote shell (*rsh*) to the desired machine without being prompted for a password. Because of potential security risks, some networks automatically remove *.rhosts* files on a daily basis, so it may be necessary to recreate it. Contact your system administrator for details on the most appropriate setup for your system.

How the CA is invoked depends on the communication protocol in use.

#### 3.4.1.1 PVM

The PVM daemon must be running before the Traffic Microsimulator is invoked. The daemon can be started by typing `pvm`. At the PVM prompt, the user can type

- `ps` to see a list of all the user's processes currently running under PVM;
- `quit`, to exit the console, leaving the daemon running; or
- `halt` to kill the daemon and all the user's processes currently running under PVM.

PVM must be restarted each time the machine is rebooted.

It is important to make sure that the version of PVM running is the same as the one the CA was linked with. It is recommended to set the environment variable `PVM_ROOT` to *$TRANSIMS_HOME/pvm/pvm3*. In addition, make sure *$PVM_ROOT/bin* and *$PVM_ROOT/lib* are both in your path.

The PVM version of the executable requires that the configuration file key `PAR_HOST_0` be defined in the configuration file. It should be set to the name of the machine on which the executable is invoked.

When PVM is running, invoke the Traffic Microsimulator using the full pathname to the executable and to a configuration file on the command line. Assuming the configuration file is named *test.cfg* in the current working directory, and that the communication architecture is SUN4SOL2, the simulator could be started with the following command line:

```
% $TRANSIMS_HOME/bin/ARCH.PVM.SUN4SOL2/CA  test.cfg
```

An optional additional argument is the name of a file the Traffic Microsimulator will use for its logging output in the directory specified by the configuration file key `OUT_DIRECTORY`. The default value is `logfile`. To send logging information to the file *Microsim.log*, the example above command line would become:

```
% $TRANSIMS_HOME/bin/ARCH.PVM.SUN4SOL2/CA  test.cfg Microsim.log
```

#### 3.4.1.2 MPI

MPI jobs are usually started with a command called `mpirun`, which determines information about your machine configuration and starts all of the processes. This script is distributed with MPI and can vary from one implementation to another. It usually requires the argument `-np <integer>`, which specifies the number of processes to spawn. This should be set to one more than the number of slaves specified by the configuration file key `PAR_SLAVES`. The other arguments to `mpirun` are the full pathname of the executable and the arguments for the executable.

Compiling the MPI executable requires the environment variable `MPI_ROOT` to be set correctly. If you wish to use the MPI distributed with TRANSIMS, set `MPI_ROOT` to *$TRANSIMS_HOME/mpich-1.2.0*. Make sure that *$MPI_ROOT/bin* is in your path.

Currently, the MPI implementation requires that the full path name to the configuration file be passed in on the command line. Assuming that the configuration file is named *test.cfg* in the current working directory, that you are running with only one slave, and that you are using the communication architecture LINUX and device ch_p4, the Traffic Microsimulator could be started with the following command line:

```
% mpirun -np 2 $TRANSIMS_HOME/bin/ARCH.MPI.LINUX.ch_p4/CA `pwd`/test.cfg
```

As above, you may specify the name of a log file in the *`OUT_DIRECTORY`* by adding one more argument to this command line.

The message “Permission denied” usually means that `mpirun` cannot start up slaves. Often this happens because there is no *.rhosts* file. This file should be in your home directory, should contain the name of the machine you will run on and your user name, and should be accessible only to you.

### 3.4.2 Msim.csh Script

In addition to invoking the executable directly, it may be invoked using the script *Msim.csh* located in *$TRANSIMS_HOME/scripts*. Because it tries to handle many different configurations and user environments, using the script is not as robust as invoking the executable directly. Nonetheless, it should work in the majority of cases as long as the following conditions are met:

- `csh` is in */bin*.
- `awk` is in your path.
- `SetEnv` is in *$TRANSIMS_HOME/bin*.
- Your *cshrc* file does not contain any `echo` commands.
- The environment variable `TRANSIMS_HOME` is set.

In addition, the environment variable `PAR_COMMUNICATION` should be set to either `PVM` or `MPI`, and the environment variable `PAR_DEVICE` should be set to an appropriate architecture or architecture/device combination for MPI, such as `LINUX.ch_p4`. If they are not set, the default values `MPI` and `solaris.ch_p4` will be used. If PVM is used, the script tries to ensure that `PAR_HOST_0` is set correctly.

The *Msim.csh* script takes one optional argument—the name of a configuration file to use. If this is not provided, the script attempts to derive it from the name of the current working directory. For example, if you run *Msim.csh* from the directory *$TRANSIMS_HOME/data/bignet*, it will assume the configuration file is *$TRANSIMS_HOME/data/bignet/bignet.cfg*. The script runs the Traffic Microsimulator with the log filename set to *Microsim.log*.

### 3.4.3 Configuration File Keys

Configuration file keys control how drivers and vehicles behave in traffic. Variations in behavior among drivers are accomplished by allowing certain behaviors to vary randomly within limits. Table 13 lists and describes configuration file keys

**Table 13. Configuration file keys.**

| Configuration File Key | Description |
|---|---|
| `CA_BROADCAST_ACC_CPN_MAP`<br>`CA_BROADCAST_TRAVELERS` | If `Broadcast Travelers` is set, migrating travelers are broadcast to every CPU. Because only one CPU will eventually make use of the traveler, this is inefficient. If `Broadcast Acc CPN Map` is set, each CPU knows which CPU is associated with every accessory, so traveler migration messages can be targeted to only the single CPU that needs them. If the CPN Map is not broadcast, travelers must be broadcast. |
| `CA_DECELERATION_PROBABILITY` | To enhance traffic variation, each automobile driver randomly decides whether to decelerate for no apparent reason at each timestep. The probability of decelerating is a value in the range 0.0 to 1.0. Default = 0.2 |
| `CA_ENTER_TRANSIT_DELAY`<br>`CA_EXIT_TRANSIT_DELAY` | The mean number of timesteps it takes for a single traveler to enter or exit a transit vehicle. |
| `CA_GAP_VELOCITY_FACTOR` | At unsignalized intersections and during protected movements at signalized intersections, drivers wait for a suitable gap in cross traffic before proceeding through the intersection. The number of empty cells in a suitable gap is based on the speed of the cross traffic and the gap velocity factor. The suitable gap is calculated for each lane of the cross traffic.<br><br>`Gap = Speed of Oncoming Vehicle * Gap Velocity Factor`<br><br>The gap velocity factor must be greater than 0.0. The default value is 3.0. Note that vehicles with a speed of 0 result in a suitable gap size of 0, which improves traffic flow in congested conditions. |

| Configuration File Key | Description |
|---|---|
| CA_IGNORE_GAP_PROBABILITY | Drivers at unsignalized intersections wait for a suitable gap in cross traffic before proceeding through the intersection. Allowing each driver to ignore the gap constraint with some probability prevents the deadlock that would take place when vehicles are waiting for each other at multiway stop/yield signs. The probability that the drivers at multiway stop/yield signs will ignore the constraint is a value in the range of 0.0 to 1.0. Default = 0.66 |
| CA_INTERSECTION_CAPACITY | The number of vehicles that can be held by each intersection's buffers. |
| CA_INTERSECTION_WAIT_TIME | The number of seconds that a vehicle requires to pass through a signalized intersection. A vehicle resides in an intersection-queued buffer for this amount of time and is then placed on the next link if the first cell on that link is unoccupied. It will remain in the intersection for a longer time if entry to the next link is blocked by another vehicle. Valid values are positive. Default = 1 second |
| CA_LANE_CHANGE_PROBABILITY | Variation in traffic is reduced by not allowing every driver who would change lanes based on vehicle speed and gaps in the traffic to do so at each timestep. This is done to prevent *lane hopping*. The probability that a driver will change lanes when speed and gaps permit is a value in the range of 0.0 to 1.0. Default = 0.99 |
| CA_LATE_BOUNDARY_RECEPTION | If `Late Boundary Reception` is set, the simulation will try to overlap computation and communication. |
| CA_LOOK_AHEAD_CELLS | The preferred lane for a vehicle to be in as it approaches an intersection depends on the connectivity from the current link to the next link in the plan. In some situations, it is advantageous for the driver to look beyond the next link to subsequent links in the plan when deciding the preferred lane. `Look Ahead Cells` controls how far ahead the driver will look. A value of 0 indicates that the driver will not look beyond the next link. A positive value indicates that the driver will look at least one additional step beyond the next step in the plan. The number of additional links considered is determined by the lengths of the subsequent links, with link lengths being summed until the accumulated distance is greater than or equal to `Look Ahead Cells`. Valid values are positive or zero. Default = 35 cells |
| CA_MAX_WAITING_SECONDS | `Max Waiting Seconds` determines the number of seconds that a vehicle will try to enter an intersection. If the vehicle has not moved from the link into or through the intersection in `Max Waiting Seconds`, the vehicle abandons its plan and tries an alternative movement through the intersection (if one exists). `Max Waiting Seconds` must be > 0 and should be greater than the longest red phase of the traffic controls in the simulation. Default = 600 seconds |
| CA_NO_TRANSIT | If set, travelers whose plans originate or end at a transit stop are removed from the simulation. None of their remaining legs are used. (The transit driver plans do not fall into this category, thus transit vehicles can still be present in the simulation, but no passengers will use them.) |

| Configuration File Key | Description |
|---|---|
| CA_OFF_PLAN_EXIT_TIME | The number of seconds a vehicle is allowed to deviate from its plan before being removed from the simulation. This prevents off-plan vehicles from wandering on the transportation network. Valid values are positive. Default = 1 second |
| CA_PLAN_FOLLOWING_CELLS | A count of the number of cells preceding the intersection within which a vehicle will make lane changes to get in an appropriate lane and thus transition to the next link in its plan. Beyond this distance, lane-changing decisions are based only on vehicle speed and gaps in the traffic. Within this distance, the lane required by the vehicle's plan is also taken into account. As the vehicle nears the intersection, the bias to be in the lane required to stay on plan is increased. Valid values are positive or zero. Default = 70 cells |
| CA_RANDOM_SEED1<br>CA_RANDOM_SEED2<br>CA_RANDOM_SEED3 | These three values are combined to initialize the random number generator. Note that the actual sequence of random numbers generated on a slave also depends on the number of slaves and the partitioning in general. |
| CA_SEQUENCE_LENGTH | The slaves are implicitly synchronized among themselves by the actions of passing boundaries and migrating vehicles. They are also explicitly synchronized by the master every `Sequence Length` timestep. It may be more efficient to allow the implicit synchronization to control the simulation. |
| CA_SIM_START_HOUR<br>CA_SIM_START_MINUTE<br>CA_SIM_START_SECOND | These values are combined to calculate the simulation's starting time. Plans whose estimated arrival time is before the start time are not executed. |
| CA_SIM_STEPS | The simulation executes `Sim Steps` timesteps before exiting. |
| CA_SLAVE_MESSAGE_LEVEL<br>CA_MASTER_MESSAGE_LEVEL | Only warning messages whose severity is at least as high as `Message Level` will be written to the master or slave log file. |
| CA_SLAVE_PRINT_MASK<br>CA_MASTER_PRINT_MASK | Controls which logging messages to ignore. They are code set within the code based on the values of the `LOG_` configuration file keys and should not be set directly. |
| CA_TRANSIT_INITIAL_WAIT | The number of timesteps a transit vehicle must be present at a transit stop before any passengers get on or off. |
| CA_USE_NETWORK_CACHE | If set, use a cached binary representation of the network. This representation would have been created by a prior run of the simulation. |
| CA_USE_PARTITIONED_ROUTE_FILES | It is more efficient for slaves to read only those plans that start in the part of the network for which they are responsible. If the partitioning to be used by the simulation is available (for example, from a prior run of the simulation), the *DistributePlans* utility will create a separate pair of indexes for each slave into one common plan file. If `Use Partitioned Route Files` is set, the slaves will look for these slave-specific indexes. If they do not exist, the simulation will fall back to using a single global pair of indexes. |
| CA_USE_ROMIO_FOR_OUTPUT | If set, and the executable was compiled with the `USE_ROMIO` and `USE_MPI` flags defined, the parallel output system will use ROMIO files instead of Unix files. |
| PAR_HOST_COUNT | The number of distinct machines that make up the parallel machine environment. |

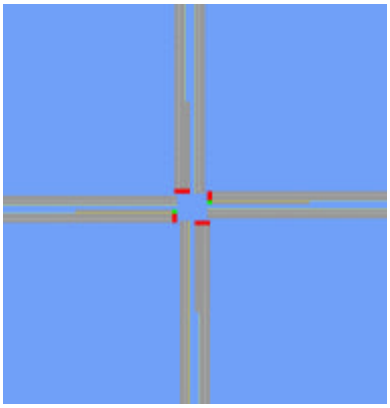
| Configuration File Key | Description |
|---|---|
| PAR_HOST_I<br>PAR_HOST_CPUS_I<br>PAR_HOST_SPEED_I | The parallel machine environment to the simulation. There should be one set of these three variables, with `I` replaced by an integer from 0 to the value of `PAR_HOST_COUNT – 1`, for each host. Host should be a string containing the name of the machine. `Host CPUS` should give the number of CPUs available for use on the machine. `Host Speed` should give the relative speeds of the different machines in arbitrary units. The sum of all the values of `Host CPUS` must be at least one larger than the number of slaves requested. |
| PAR_RTM_INPUT_FILE<br>RTM_FEEDBACK_FILE<br>RTM_SAMPLE_INTERVAL<br>PAR_RTM_PENALTY_FACTOR | The partitioning algorithms try to find the partition that spreads the computation associated with nodes and links evenly while simultaneously trying to minimize the communication costs associated with split links. The costs for each node and link can be estimated using run time costs from prior runs. These costs are sampled at the interval defined by `RTM Sampling Interval` and written out to the file named by RTM File. They are read in from the file found in the directory named by `OUTPUT_DIRECTORY`. |
| PAR_SLAVES | The number of slave processes to spawn. It must be smaller than the number of host CPUs available (to allow one process for the master). |
| PLAN_FILE | The name of the file in which plans reside or a string to which *.tim.idx* and *.trv.idx* can be appended to find the time-sorted and traveler-id-sorted indexes into a plan file. The plans should include all travelers; for example, plans created by the Route Planner, transit driver plans, freight plans, etc. The name should be given as an absolute path name because the slave executables are not always run from the current working directory. |
| VEHICLE_FILE | The name in which vehicles reside or a string to which *.veh.idx* can be appended to find the vehicle-id-sorted index into a vehicle file(s). The vehicle file must include all vehicles to be used in the simulation. |
| VEHICLE_PROTOTYPE_FILE | The vehicle prototype file must include information about every vehicle type used in the simulation. |

## 3.5 Generic Signal Tutorial

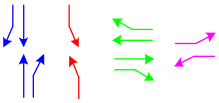
This tutorial outlines how to create generic signals for calibration and testing, and how to run the TRANSIMS Traffic Microsimulator to measure their performance. The files for the tutorial reside in the directory *$TRANSIMS_HOME/scenarios/gensig*.

### 3.5.1 Generic Signal Builder

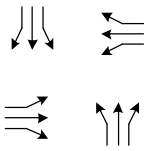
The generic signal builder is a software application for constructing an intersection and vehicular demand for testing the performance of an actuated signal in the Traffic Microsimulator. It generates the following:



- One intersection with an actuated signal and a specified timing plan.
- Four links in the cardinal directions with a specified length, number of lanes, and speed limit in the north-south and east-west directions.
- Four pocket lanes (one per link) of a specified length for left turns.
- Eight vehicle detectors (two per phase) of a specified length and placement.
- Four phases at the signal: “north-south through,” “north-south left,” “east-west through,” and “east-west left.”



- Plans for vehicles with specified headways for the twelve possible movements at the intersection: “southbound left,” “southbound through,” “southbound right,” “westbound left,” “westbound through,” “westbound right,” “northbound left,” “northbound through,” “northbound right,” “eastbound left,” “eastbound through,” and “eastbound right.”



The TRANSIMS configuration file keys controlling the details of the intersection and demand are given in Table 14. The values in the table reflect those used in this tutorial.

**Table 14. Generic Signal Builder configuration file keys used in example.**

| Configuration File Key | Value in Example | Description |
|---|---|---|
| CALIB_PLUS_DETECTOR_LENGTH | 37.5 | The length [meters] of the detectors. Default = six cells |
| CALIB_PLUS_DETECTOR_OFFSET | <default> | The offset [meters] of the detectors, measured from the point of the detector closest to the node to the node. Default = the intersection setback |
| CALIB_PLUS_GREEN_EXTENSION | 0.60 | The green extension in terms of the fraction of the initial green. Default = 0.50 |
| CALIB_PLUS_GREEN_LEFT_EW | 8 | The number of seconds for greens of the “east-west left” phase. The phase does not exist if this is zero. |
| CALIB_PLUS_GREEN_LEFT_NS | 8 | The number of seconds for greens of the “north-south left” phase. The phase does not exist if this is zero. |
| CALIB_PLUS_GREEN_THRU_EW | 20 | The number of seconds for greens of the “east-west through” phase. The phase does not exist if this is zero. |
| CALIB_PLUS_GREEN_THRU_NS | 20 | The number of seconds for greens of the “north-south through” phase. The phase does not exist if this is zero. |
| CALIB_PLUS_LANES_EW | 2 | The number of lanes in the east-west direction. |
| CALIB_PLUS_LANES_NS | 2 | The number of lanes in the north-south direction. |
| CALIB_PLUS_LINK_LENGTH | <default> | The length [meters] of the links. Default = thirty cells plus the intersection setback |
| CALIB_PLUS_PARKING_OFFSET | <default> | The offset [meters] of the parking from the edges of the network. |
| CALIB_PLUS_POCKET_LENGTH | <default> | The length [meters] of pocket lanes. Default = eight cells |
| CALIB_PLUS_SETBACK | <default> | The setback [meters] at the intersection. This defaults to an optimal value for the Output Visualizer. |
| CALIB_PLUS_SPACING_EAST_LEFT | 18 | The spacing [seconds] for vehicles leaving parking and planing to make a left turn movement approaching the intersection from the east. |

| Configuration File Key | Value in Example | Description |
|---|---|---|
| CALIB_PLUS_SPACING_EAST_RIGHT | 18 | The spacing [seconds] for vehicles leaving parking and planing to make a right turn movement approaching the intersection from the east. |
| CALIB_PLUS_SPACING_EAST_THRU | 4 | The spacing [seconds] for vehicles leaving parking and planing to make a through movement approaching the intersection from the east. |
| CALIB_PLUS_SPACING_NORTH_LEFT | 0 | The spacing [seconds] for vehicles leaving parking and planing to make a left turn movement approaching the intersection from the north. |
| CALIB_PLUS_SPACING_NORTH_RIGHT | 0 | The spacing [seconds] for vehicles leaving parking and planing to make a right turn movement approaching the intersection from the north. |
| CALIB_PLUS_SPACING_NORTH_THRU | 3 | The spacing [seconds] for vehicles leaving parking and planing to make a through movement approaching the intersection from the north. |
| CALIB_PLUS_SPACING_SOUTH_LEFT | 24 | The spacing [seconds] for vehicles leaving parking and planing to make a left turn movement approaching the intersection from the south. |
| CALIB_PLUS_SPACING_SOUTH_RIGHT | 21 | The spacing [seconds] for vehicles leaving parking and planing to make a right turn movement approaching the intersection from the south. |
| CALIB_PLUS_SPACING_SOUTH_THRU | 7 | The spacing [seconds] for vehicles leaving parking and planing to make a through movement approaching the intersection from the south. |
| CALIB_PLUS_SPACING_WEST_LEFT | 30 | The spacing [seconds] for vehicles leaving parking and planing to make a left turn movement approaching the intersection from the west. |
| CALIB_PLUS_SPACING_WEST_RIGHT | 27 | The spacing [seconds] for vehicles leaving parking and planing to make a right turn movement approaching the intersection from the west. |
| CALIB_PLUS_SPACING_WEST_THRU | 24 | The spacing [seconds] for vehicles leaving parking and planing to make a through movement approaching the intersection from the west. |
| CALIB_PLUS_SPEED_EW | <default> | The speed limit [meters per second] in the east-west direction.<br>Default = five cells per second |

| Configuration File Key | Value in Example | Description |
|---|---|---|
| `CALIB_PLUS_SPEED_NS` | <default> | The speed limit [meters per second] in the north-south direction.<br>Default = five cells per second. |
| `CALIB_PLUS_TIME_LIMIT` | 3600 | The number of seconds for which to generate plans. |

The generic signal builder also uses the additional TRANSIMS keys in Table 15—not all of these are required, however.

**Table 15. Additional Generic Signal Builder configuration file keys.**

| Configuration File Key | Required ? |
|---|---|
| CA_CELL_LENGTH | no |
| NET_ACTIVITY_LOCATION_TABLE | yes |
| NET_BARRIER_TABLE | yes |
| NET_DETECTOR_TABLE | yes |
| NET_DIRECTORY | yes |
| NET_LANE_CONNECTIVITY_TABLE | yes |
| NET_LANE_USE_TABLE | yes |
| NET_LANE_WIDTH | no |
| NET_LINK_MEDIAN_HALFWIDTH | no |
| NET_LINK_TABLE | yes |
| NET_NODE_TABLE | yes |
| NET_PARKING_TABLE | yes |
| NET_PHASING_PLAN_TABLE | yes |
| NET_POCKET_LANE_TABLE | yes |
| NET_PROCESS_LINK_TABLE | yes |
| NET_SIGNAL_COORDINATOR_TABLE | yes |
| NET_SIGNALIZED_NODE_TABLE | yes |
| NET_SPEED_TABLE | yes |
| NET_STUDY_AREA_LINKS_TABLE | yes |
| NET_TIMING_PLAN_TABLE | yes |
| NET_TRANSIT_STOP_TABLE | yes |
| NET_TURN_PROHIBITION_TABLE | yes |
| NET_UNSIGNALIZED_NODE_TABLE | yes |
| OUT_SNAPSHOT_LINKS_1 | yes |
| OUT_SNAPSHOT_NODES_1 | yes |
| PLAN_FILE | yes |
| VEHICLE_FILE | yes |
| VEHICLE_PROTOTYPE_FILE | yes |

The generic signal builder is invoked with a single argument:

```
% BuildTestSignal <config-file>
```

where `<config-file>` is the name of the configuration file containing the keys listed in the two tables above. The directory *$TRANSIMS_HOME/scenarios/gensig* contains the configuration file *signal.cfg* with the keys used in this tutorial. Running *BuildTestSignal* with this configuration file results in the network files stored in the *network* subdirectory and in the vehicle and plan files stored in the *data* subdirectory.

### 3.5.2 Assessing Generic Signal Response

In order to assess the response of the generic signal created by the builder, we run the Traffic Microsimulator and analyze the output. The script *signal.csh* in the directory *$TRANSIMS_HOME/scenarios/gensig/scripts* does this. After running the Traffic Microsimulator, the *output* subdirectory contains several files of interest:

- *snapshot.veh* – the vehicle snapshot data for the travelers; suitable for viewing in the Output Visualizer
- *snapshot.sig* – the signal snapshot data for the actuated signal; suitable for viewing in the Output Visualizer
- *times.trv* – the travel time and inconvenience measure statistics for the travelers; suitable for analysis with the *scripts/counts.awk* script
- *lost.trv* – traveler event data for any travelers that became lost in the simulation; there should be few or none

The script will also produce console output summarizing the response of the signal. Four performance measures are tabulated for each movement at the intersection:

- *flow [veh/hr]* – the flow of vehicles making the movement
- *travel time [s/veh]* – the observed mean and standard deviation for the travel times measured from when a vehicle leaves its parking location on the incoming link to when it enters its parking location on the outgoing link
- *time stopped [s/veh]* – the observed mean and standard deviation for the number of seconds that a vehicle is stopped while it waits to pass through the intersection
- *accelerations from stop [#/veh]* – the observed mean and standard deviation for the number of times a vehicle has to accelerate after being stopped on the roadway

For the example in this tutorial, the summary should look similar to the following:

```
Movement:                    southbound, left
  Flow [veh/hr]:             0

Movement:                    southbound, thru
  Flow [veh/hr]:             1177
  Travel Time [s/veh]:       35.3696 (mean), 15.3534 (s.d.)
  Time stopped [s/veh]:      3.19031 (mean), 9.24733 (s.d.)
  Accels. from stop [#/veh]: 2.13594 (mean), 0.859248 (s.d.)

Movement:                    southbound, right
  Flow [veh/hr]:             0

Movement:                    westbound, left
  Flow [veh/hr]:             197
  Travel Time [s/veh]:       86.4162 (mean), 43.3299 (s.d.)
```

```
  Time stopped [s/veh]:      11.1015 (mean), 25.0976 (s.d.)
  Accels. from stop [#/veh]: 3.30457 (mean), 1.48758 (s.d.)

Movement:                    westbound, thru
  Flow [veh/hr]:             894
  Travel Time [s/veh]:       52.4586 (mean), 26.8092 (s.d.)
  Time stopped [s/veh]:      2.84228 (mean), 9.19959 (s.d.)
  Accels. from stop [#/veh]: 2.9396 (mean), 1.5013 (s.d.)

Movement:                    westbound, right
  Flow [veh/hr]:             199
  Travel Time [s/veh]:       54.5578 (mean), 28.1368 (s.d.)
  Time stopped [s/veh]:      5.09045 (mean), 13.0257 (s.d.)
  Accels. from stop [#/veh]: 2.59799 (mean), 1.32543 (s.d.)

Movement:                    northbound, left
  Flow [veh/hr]:             139
  Travel Time [s/veh]:       150.367 (mean), 87.6663 (s.d.)
  Time stopped [s/veh]:      17.3813 (mean), 43.9112 (s.d.)
  Accels. from stop [#/veh]: 3.54676 (mean), 2.14078 (s.d.)

Movement:                    northbound, thru
  Flow [veh/hr]:             499
  Travel Time [s/veh]:       67.6212 (mean), 55.6657 (s.d.)
  Time stopped [s/veh]:      4.11222 (mean), 10.2163 (s.d.)
  Accels. from stop [#/veh]: 3.11824 (mean), 2.12748 (s.d.)

Movement:                    northbound, right
  Flow [veh/hr]:             167
  Travel Time [s/veh]:       66.9701 (mean), 57.4042 (s.d.)
  Time stopped [s/veh]:      3.07784 (mean), 8.74332 (s.d.)
  Accels. from stop [#/veh]: 2.8024 (mean), 1.66552 (s.d.)

Movement:                    eastbound, left
  Flow [veh/hr]:             119
  Travel Time [s/veh]:       61.8739 (mean), 36.7648 (s.d.)
  Time stopped [s/veh]:      18.1008 (mean), 30.0298 (s.d.)
  Accels. from stop [#/veh]: 1.72269 (mean), 0.649959 (s.d.)

Movement:                    eastbound, thru
  Flow [veh/hr]:             149
  Travel Time [s/veh]:       33.2886 (mean), 19.4514 (s.d.)
  Time stopped [s/veh]:      10.0067 (mean), 15.5748 (s.d.)
  Accels. from stop [#/veh]: 1.39597 (mean), 0.555304 (s.d.)

Movement:                    eastbound, right
  Flow [veh/hr]:             133
  Travel Time [s/veh]:       33.0752 (mean), 19.1769 (s.d.)
  Time stopped [s/veh]:      10.1955 (mean), 15.1164 (s.d.)
  Accels. from stop [#/veh]: 1.43609 (mean), 0.655436 (s.d.)
```

For reference, the demand in this example is given in Table 16.

**Table 16. Movement demand.**

| Movement | Demand [veh/hr] |
|---|---|
| Southbound, left | 0 |
| Southbound, through | 1200 |
| Southbound, right | 0 |
| Westbound, left | 200 |
| Westbound, through | 900 |
| Westbound, right | 200 |
| Northbound, left | 150 |
| Northbound, through | 514 |
| Northbound, right | 171 |
| Eastbound, left | 120 |
| Eastbound, through | 150 |
| Eastbound, right | 133 |

We can see that nearly all of the vehicles make it through the intersection with the actuated signal.

By editing the `CALIB_PLUS_SPACING` parameters in the configuration file and then rerunning *BuildTestSignal*, one can evaluate additional demands for the signal under consideration. One can change the actuation algorithm's parameters by editing its configuration file keys:

```
NET_DETECTOR_PRESENCE_SAMPLE_TIME
NET_ACTUATED_ALGORITHM_B_BETA
NET_ACTUATED_ALGORITHM_B_DENSITY_CONST
NET_ACTUATED_ALGORITHM_B_FLOW_CONST
```

The signal timing and detector layout may be altered with other `CALIB_PLUS` configuration file keys.

### 3.5.3 Troubleshooting

The following are possible problems that might arise:

- The *$TRANSIMS_HOME* environment variable has not been set.
- You tried to run the Traffic Microsimulator, but do not have write permission to the output directory *$TRANSIMS_HOME/scenarios/gensig/output*.
- You tried to run *BuildTestSignal*, but do not have write permissions for the network, plan, vehicle, or output files specified in the configuration file.
- You have edited the configuration file *$TRANSIMS_HOME/scenarios/gensig/signal.cfg* to change some of the filenames or locations, but have not made the corresponding changes in the script *$TRANSIMS_HOME/scenarios/gensig/scripts/signal.csh*.

- You changed the specification for the travel time output in the configuration file *$TRANSIMS_HOME/scenarios/gensig/signal.cfg*–this prevents the script *$TRANSIMS_HOME/scenarios/gensig/scripts/counts.awk* from running because it depends on the details of the output specification.
- The C shell executable is not in */bin/csh*, or the `NAWK` executable is not in */bin/nawk* on your system.
- The `NAWK` executable on your system is a variant of the standard GNU/Linux version.

## 3.6 Selector/Iteration Database

The Selector/Iteration Database takes a single command-line argument: the TRANSIMS configuration file.

## 3.7 Tailpipe Emissions Estimators

Before running the Tailpipe Emissions Estimators, the Traffic Microsimulator must be run to collect velocity and energy summary data.

Run *ConvertVELfile* in order to convert the Traffic Microsimulator velocity summary data file(s) into a format that can be read into the Tailpipe Emissions Estimator.

```
% ConvertVELfile <configFilename>
```

The configuration file keys `EMISSIONS_LDV_VELOCITY_FILE` and `EMISSIONS_HDV_VELOCITY_FILE` can be used to specify the output files. If not used, the filenames default to *velocity.ldv.out* and *velocity.hdv.out* in the current working directory.

The configuration file keys `EMISSIONS_MICROSIM_LDV_VELOCITY_FILE` and `EMISSIONS_MICROSIM_HDV_VELOCITY_FILE` can be used in the configuration file to define the velocity summary output files to be used as input. If not used, the filenames default to *summary.ldv.vel* and *summary.hdv.vel* in the current working directory. These filenames are created by adding *.vel* to the `OUT_SUMMARY_NAME_n` file specification, where `VELOCITY` was specified by `OUT_SUMMARY_TYPE_n`.

Run *ConvertENRfile* in order to convert the four Traffic Microsimulator energy summary data files into fractions across the energies and soaks.

```
% ConvertENRfile <configFilename>
```

The configuration file keys `EMISSIONS_ENR_NO_SOAK_FILE`, `EMISSIONS_ENR_SHORT_SOAK_FILE`, `EMISSIONS_ENR_MEDIUM_SOAK_FILE`, and `EMISSIONS_ENR_LONG_SOAK_FILE` can be used to specify the output files. If not used, the filenames default to *energy.no.out*, *energy.short.out*, *energy.medium.out*, and *energy.long.out* in the current working directory.

The configuration file keys `EMISSIONS_MICROSIM_ENR_NO_SOAK_FILE`, `EMISSIONS_MICROSIM_ENR_SHORT_SOAK_FILE`, `EMISSIONS_MICROSIM_ENR_MEDIUM_SOAK_FILE`, and `EMISSIONS_MICROSIM_ENR_LONG_SOAK_FILE` can be used in the configuration file to define the energy summary output files to be used as input. If not used, the filenames default to *summary.no.enr*, *summary.short.enr*, *summary.medium.enr*, and *summary.long.enr* in the current working directory. These filenames are created by adding *.enr* to the `OUT_SUMMARY_NAME_n` file specification, where `ENERGY` was specified by `OUT_SUMMARY_TYPE_n`. The configuration file key `OUT_SUMMARY_ENERGY_SOAK_n` is used for each of these files to specify the soak time collected. The possible values for this key are `NEGLIGIBLE`, `SHORT`, `MEDIUM`, or `LONG`. The configuration file keys `CA_SHORT_SOAK_TIME`, `CA_MEDIUM_SOAK_TIME`, and `CA_LONG_SOAK_TIME` are used to set the break points of soak times that are collected in the four energy soak files.

Run the LDV Tailpipe Emissions Estimator to produce a file of emissions on autos and light trucks that can be read into the Output Visualizer. The configuration file used to run the Traffic Microsimulator to collect velocity data must be specified on the command line. Before running this program, verify that all of the necessary input files are present in the directory you will be running from or that all the Tailpipe Emissions Estimator configuration file keys are set properly. These include *ARRAYP.INP*, the eight *arrayp*.out*, three static soak ratios files, the *velocity.ldv.out* and *energy*.out* files produced above. Refer to Volume Three (*Modules*), Chapter Seven (*Emissions Estimators*) for detailed explanations of the various input and output files and their configuration keys.

```
% EmissionsEstimator <configFilename>
```

The file *emissions.ldv.out* will be produced, or the file specified by the `EMISSIONS_LDV_OUTPUT_FILE` configuration file key. If the configuration file key `EMISSIONS_WRITE_DEGBUG_OUTPUT` is defined and set to 1, the debugging files will be written also.

Run the HDV Tailpipe Emissions Estimator to produce a file of emissions on heavy trucks or buses that can be read into the Output Visualizer.

```
% EmissionsEstimatorHDV <configFilename>
```

The *EmissionsEstimatorHDV* program is run similar to the LDV Emissions Estimator but uses different configuration file keys. Refer to Volume Three (*Modules*), Chapter Seven (*Emissions Estimators*) for detailed explanations of the various input and output files needed. The file *emissions.hdv.out* will be produced.

Run the Output Visualizer to display the emissions. The Output Visualizer needs the configuration file used to run the microsimulation in order to know which network to bring up.

```
% Vis <configFilename>
```

Within the Output Visualizer,

- select File→Open Variable Size Box Data
- choose the *emissions.ldv.out* file produced by the Tailpipe Emissions Estimator or the *emissions.hdv.out* file produced by the *EmissionsEstimatorHDV* program

To cycle through the different emissions columns (VTT, NOX, CO, HC, FE, and FLUX), select View→Increment Column. The type of data being display is labeled in the lower window next to the time. To animate the emissions data through different timestep, use the animation tools at the bottom of the Output Visualizer's window. To view the legend of bar colors and values, select View→Legend.

If the `VIS_COLORMAPS` configuration file key is not defined, the minimum and maximum values for each column of data in the emissions is determined and saved. Appropriate scale factors are calculated for each column. When the emissions file is

opened, these value ranges and scale factors will be used and updated when displaying the default columns. If the `VIS_SLIDER_XROT` configuration file key is not defined, the display is rotated about the x-axis to 303.8 and about the z-axis by 44.6. The display will automatically be in the 3D mode and rotated for optimal viewing of bar height. Otherwise, use the instructions below to achieve the same effect.

To display three-dimensional emissions where not only the color of the summary box but also the height depends on the emissions value:

- rotate the network so the Z is at about 45 and the X at about 300,
- select Modes→Lights On/Off to get better shading,
- select View→Variable Size Boxes, then
- click [OK].

Just start cycling through the emissions data fields (View→Increment Column) to view the different data columns. The three-dimensional emissions can also be animated through the timesteps.

### 3.7.1 Troubleshooting

Listed here are warnings and error messages for the Tailpipe Emissions modules. If a warning is output, the program will continue processing. If an error is outputted, the program will exit at that time.

#### 3.7.1.1 Messages and ERRORs from *ConvertVELfile*

ERROR in [ENV]: Usage: ConvertVELfile <configFilename>

Occurs when the configuration file is not specified when running the *ConvertVELfile* program. To run *ConvertVELfile*, you must specify the configuration file on the command line.

WARNING in [ENV]: ConvertVELfile: Unable to open input file: <velocityFilename>

Occurs when the *ConvertVELfile* program is either unable to locate or unable to open one of the input files specified either in the configuration file or the default files. Make sure that you have the correct location for your input file and that it has proper read permissions set.

ERROR in [ENV]: ConvertVELfile: Unable to open either velocity input file

Occurs when the *ConvertVELfile* program was unable to convert either velocity input file because of the inability to open either input file (LDV and HDV). This is usually a sign of a bigger problem such as a read-protected directory, or the configuration file keys are missing from the configuration file.

WARNING in [ENV]: ConvertVELfile: Unable to open output file: <outputFilename>

Occurs when the *ConvertVELfile* program is unable to open the output files specified in the configuration file or the default files. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *ConvertVELfile* or the directory specified by the configuration file keys for the output file.

ERROR in [ENV]: ConvertVELfile: Unable to open either velocity output file

Occurs when the *ConvertVELfile* program was unable to convert either velocity input file because of the inability to open either output file (LDV or HDV). This is usually a sign of a bigger problem such as a write-protected directory, or the configuration file keys are missing from the configuration file.

WARNING in [ENV]: ConvertVELfile: Problem reading metadata for file <velocityFilename>

Occurs if a velocity file appears to have metadata in it but an error occurred while trying to read the metadata. Check to make sure that the metadata is all on one line. This line can be removed from the file, but the integrity of the data cannot be checked then.

ERROR in [ENV]: ConvertVELfile: Problem reading metadata in both velocity files

Occurs when the *ConvertVELfile* program was unable to convert either velocity input file because of problems reading the metadata in both input files (LDV and HDV).

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> does not have the assumed timestep: 3600

Occurs when the *ConvertVELfile* program is verifying the metadata and finds the timestep to be other than 3600 seconds.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> does not have the assumed sample time: 1

Occurs when the *ConvertVELfile* program is verifying the metadata and finds the sample time to be other than 1 second. This will cause the current velocity file to not be converted to a format the Tailpipe Emissions Estimator needs.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> does not have the assumed cell length: 7.5

Occurs when the *ConvertVELfile* program is verifying the metadata and finds the cell length to be other than 7.5 meters. This will cause the current velocity file to not be converted to a format the Tailpipe Emissions Estimator needs.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> does not have the assumed box length: 30.0

Occurs when the *ConvertVELfile* program is verifying the metadata and finds the box length to be other than 30.0 meters. This will cause the current velocity file to not be converted to a format the Tailpipe Emissions Estimator needs.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> vehicle type (<velocityFileVehType>) does not match assumed vehicle type: AUTO

Occurs when the *ConvertVELfile* program is verifying the metadata of the input file defined by `EMISSIONS_MICROSIM_LDV_VELOCITY_FILE` (or the default *velocity.ldv.out*) and finds the vehicle type to be other than `AUTO`.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> vehicle type (<velocityFileVehType>) does not match assumed vehicle type: TRUCK

Occurs when the *ConvertVELfile* program is verifying the metadata of the input file defined by `EMISSIONS_MICROSIM_HDV_VELOCITY_FILE` (or the default *velocity.hdv.out*) and finds the vehicle type to be other than `TRUCK`. This is okay if the vehicle type is `BUS` but should be checked otherwise.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> does not have the assumed max velocity: 37.5

Occurs when the *ConvertVELfile* program is verifying the metadata and finds the maximum velocity to be other than 37.5 meters per second. This will cause the current velocity file to not be converted to a format the Tailpipe Emissions Estimator needs.

WARNING in [ENV]: ConvertVELfile: velocity file: <velocityFilename> does not have the assumed number of bins: 6

Occurs when the *ConvertVELfile* program is verifying the metadata and finds the number of velocity bins to be other than six bins. This will cause the current velocity file to not be converted to a format the Tailpipe Emissions Estimator needs.

ERROR in [ENV]: ConvertVELfile: MetaData incorrect in both velocity files

Occurs when the *ConvertVELfile* program was unable to convert either velocity input file caused by metadata not matching assumed values. Check the configuration file keys to verify the correct settings for those keys that were reported as having problems.

WARNING in [ENV]: ConvertVELfile: Bad header for velocity file: <velocityFilename>

Occurs when the *ConvertVELfile* program was unable to read the header to the velocity file. This is usually a sign that the velocity summary input file was empty.

ERROR in [ENV]: ConvertVELfile: Bad header for both velocity files

Occurs when the *ConvertVELfile* program was unable to convert either velocity input file because of problems reading file header lines in both input files.

WARNING in [ENV]: ConvertVELfile. Bad header in velocity file. Field "<field name>" is missing

Occurs when there is a missing necessary field in the velocity file. The fields needed are `TIME`, `LINK`, `NODE`, `DISTANCE`, `COUNT0`, `COUNT1`, `COUNT2`, `COUNT3`, `COUNT4`, and `COUNT5`. If any of these fields are missing, the simulation must be rerun with the configuration modified to allow collection of all of these fields.

ERROR in [ENV]: ConvertVELfile: Fields missing in both velocity files

Occurs when the *ConvertVELfile* program was unable to convert either velocity input file because of finding fields missing in both input files (LDV and HDV).

WARNING in [ENV]: ConvertVELfile: Empty interior box(es) for time:link:node <time>:<link>:<node>

Occurs when the *ConvertVELfile* program finds a link with no counts in a box in between boxes with counts. This message will occur only once per time:link:node and will be displayed only if the configuration file key `EMISSIONS_WRITE_DEBUG_OUTPUT` is set to 1 in the configuration file. At this point, the remaining boxes on the link are not converted.

WARNING in [ENV]: ConvertVELfile: Data in 1st velocity bin ONLY for time:link:node <time>:<link>:<node>

Occurs when the *ConvertVELfile* program finds a link with counts in the first velocity bin only. This message will occur only once per time:link:node and will be displayed only if the configuration file key `EMISSIONS_WRITE_DEBUG_OUTPUT` is set to 1 in the configuration file. If this box occurs before a valid box is found, it is skipped. If valid box data have been found, the remaining boxes on the link are skipped.

WARNING in [ENV]: ConvertVELfile: No data in input data file: <velocityFilename>

Occurs when the *ConvertVELfile* program finds no data in one of the velocity input files (LDV or HDV).

ERROR in [ENV]: ConvertVELfile: No data in either velocity input file

Occurs when the *ConvertVELfile* program finds no data in either of the velocity input files (LDV or HDV).

ERROR in [ENV]: ConvertVELfile: Calloc failure

Occurs when the *ConvertVELfile* program attempts to allocate some memory and is unable to.

#### 3.7.1.2 Messages and ERRORs from *ConvertENRfile*

ERROR in [ENV]: Usage: ConvertENRfile <configFilename>

Occurs when the configuration file is not specified when running the *ConvertENRfile* program. To run *ConvertENRfile*, you must specify the configuration file on the command line.

ERROR in [ENV]: ConvertENRfile: Unable to open input file: <energyFilename>

Occurs when the *ConvertENRfile* program is either unable to locate or unable to open one of the four energy input files specified either in the configuration file or the default files. Make sure that you have the correct location for your input files and that they have proper read permissions set.

ERROR in [ENV]: ConvertENRfile: Unable to open output file: <outputFilename>

Occurs when the *ConvertENRfile* program is unable to open one of the four output files specified in the configuration file or the default files. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *ConvertENRfile* or the directory specified by the configuration file keys for the output files.

WARNING in [ENV]: ConvertENRfile: problem reading metadata for file: <energyFilename>

Occurs when the *ConvertENRfile* program finds metadata in at least one of the four energy files but an error occurred while trying to read the metadata. Check to make sure the metadata is all on one line. This line can be removed from the file but the integrity of the data can not be checked then.

ERROR in [ENV]: ConvertENRfile: Bad header for energy file: <energyFilename>

Occurs when the *ConvertENRfile* program had problems reading the header line in one of the four energy input files. The energy input file may be empty.

ERROR in [ENV]: ConvertENRfile: Bad header in energy file. Field "<fieldName>" is missing

Occurs in the *ConvertENRfile* program when there is a missing necessary field in one of the four energy input files. The fields needed in the short, medium, and long energy files are `TIME`, `LINK`, `NODE`, `ENERGY0`, `ENERGY1`, `ENERGY2`, `ENERGY3`, `ENERGY4`, `ENERGY5`, `ENERGY6`, and `ENERGY7`. The fields needed in the negligible energy input file are `TIME`, `LINK`, `NODE`, and `ENERGY0`. If any of these fields are missing, the simulation must be rerun with the configuration modified to allow collection of all of these fields.

WARNING in [ENV]: ConvertENRfile: energy files do not have the assumed TimeStep: 3600

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files have metadata, and they all have the same timestep and that timestep is other than 3600 seconds.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same TimeStep

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files have metadata, and the timesteps to all four energy files are not the same. Check that the four files are all from the same microsimulation run and that the configuration file contains the correct values for data collection.

ERROR in [ENV]: ConvertENRfile: incorrect soak (<fileSoak>) for file: <energyFilename> Soak should be: <soak>

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata, and at least one of the energy input files does not contain the correct soak.
The file defined by `EMISSIONS_MICROSIM_ENR_NO_SOAK_FILE` (or default *summary.no.enr*) should contain the soak `NEGLIGIBLE`.
The file defined by `EMISSIONS_MICROSIM_ENR_SHORT_SOAK_FILE` (or default *summary.short.enr*) should contain the soak `SHORT`.
The file defined by `EMISSIONS_MICROSIM_ENR_MEDIUM_SOAK_FILE` (or default *summary.medium.enr*) should contain the soak `MEDIUM`.
The file defined by `EMISSIONS_MICROSIM_ENR_LONG_SOAK_FILE` (or default *summary.long.enr*) should contain the soak `LONG`.

ERROR in [ENV]: ConvertENRfile: energy files do not have the assumed maxEnergy: 105.0

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and either all four energy files maximum energy is the same and is not set to 105.0, or that the `NEGLIGIBLE` energy file is set to 0.0 and the other three are the same but not 105.0. Check the configuration file keys for the `OUT_SUMMARY_ENERGY_MAX_DEFAULT` or `OUT_SUMMARY_ENERGY_MAX_n` value.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same MaxEnergy

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and that they have different maximum energies. Check the configuration file keys for the `OUT_SUMMARY_ENERGY_MAX_DEFAULT` or `OUT_SUMMARY_ENERGY_MAX_n` value.

ERROR in [ENV]: ConvertENRfile: energy files do not have the assumed Number of Bins: 8

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and either all four energy files have the same number of energy bins and the number of bins is not 8 bins, or the `NEGLIGIBLE` energy file has one bin and the other three have the same number of energy bins but not 8 bins. Check the configuration file key `OUT_SUMMARY_ENERGY_BINS_DEFAULT` or `OUT_SUMMARY_ENERGY_BINS_n` value.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same Number of Bins

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and that they have different numbers of energy bins. Check that the four files are all from the same microsimulation run and that the configuration file key `OUT_SUMMARY_ENERGY_BINS_DEFAULT` or `OUT_SUMMARY_ENERGY_BINS_n` value is correct.

ERROR in [ENV]: ConvertENRfile: energy files do not have the assumed CA short soak time: 600

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata, all have the same short soak time, and the short soak time that is not 600 seconds. Check that the configuration file key `CA_SHORT_SOAK_TIME` is set to 600.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same CA short soak time

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and that they have different short soak times. Check that the four files are all from the same microsimulation run and that the configuration file key `CA_SHORT_SOAK_TIME` is set to 600.

ERROR in [ENV]: ConvertENRfile: energy files do not have the assumed CA medium soak time: 1800

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata, all have the same medium soak time, and the medium soak time is not 1800 seconds. Check that the configuration file key `CA_MEDIUM_SOAK_TIME` is set to 1800.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same CA medium soak time

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and that they have different medium soak times. Check that the four files are all from the same microsimulation run and that the configuration file key `CA_MEDIUM_SOAK_TIME` is set to 1800.

ERROR in [ENV]: ConvertENRfile: energy files do not have the assumed CA long soak time

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata, all have the same long soak time, and the long soak time is not 9000 seconds. Check that the configuration file key `CA_LONG_SOAK_TIME` is set to 9000.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same CA long soak time

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and that they have different long soak times. Check that the four files are all from the same microsimulation fun and the configuration file key `CA_LONG_SOAK_TIME` is set to 9000.

ERROR in [ENV]: ConvertENRfile: not all energy files have the same date/time stamp

Occurs when the *ConvertENRfile* program is verifying the metadata and finds that all four energy files contain metadata and that the date stamp does not match in all four energy files. This means that the four energy files were collected from different microsimulation runs.

ERROR in [ENV]: ConvertENRfile: not all energy files have metadata

Occurs when the *ConvertENRfile* program has determined that some, but not all, of the energy files have metadata. This means that the four energy files were collected from different microsimulation runs from different versions of the TRANSIMS software or that the files have been altered.

WARNING in [ENV]: ConvertENRfile: No data in input data file: <energyFilename>

Occurs when the *ConvertENRfile* program finds no data in at least one of the energy input files.

ERROR in [ENV]: ConvertENRfile: Not all energy files have time:link:node <time>:<link>:<node>

Occurs when the *ConvertENRfile* program is in the process of writing out the fractions and has found an instance where there was not a row of data in all four energy files for a particular time, link, and node.

ERROR in [ENV]: *ConvertVELfile*: Calloc failure

Occurs when the *ConvertENRfile* program attempts to allocate some memory and is unable to.

#### 3.7.1.3 Messages and ERRORs from *EmissionsEstimator*

ERROR in [ENV] Usage: EmissionsEstimator <configFilename>

Occurs when the *EmissionsEstimator* program is run without a configuration file as an argument on the command line. Specify the configuration file used to run the Traffic Microsimulator to produce the velocity and energy data for the Tailpipe Emissions Estimator.

ERROR in [ENV]: Unable to open the velocity input file: <velocityFilename>

Occurs when the *EmissionsEstimator* program is unable to locate or open the postprocessed velocity input file. Make sure that the file is present in the directory in which you are attempting to run *EmissionsEstimator* or that the configuration file key `EMISSIONS_LDV_VELOCITY_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: Unable to open the composite array input file: <arrayFilename>

Occurs when the *EmissionsEstimator* program is unable to locate or open one of the four composite array input files. Make sure that the files are present in the directory in which you are attempting to run *EmissionsEstimator* or that the configuration file keys `EMISSIONS_COMPOSITE_INPUT_FILE`, `EMISSIONS_COMPOSITE2P_INPUT_FILE`, `EMISSIONS_COMPOSITE4P_INPUT_FILE`, and `EMISSIONS_COMPOSITE6P_INPUT_FILE` contain the correct filenames and that the files have read permissions.

ERROR in [ENV]: Unable to open the composite differences array input file: <arrayFilename>

Occurs when the *EmissionsEstimator* program is unable to locate or open one of the four composite difference array input files. Make sure that the files are present in the directory in which you are attempting to run *EmissionsEstimator* or that the configuration file keys `EMISSIONS_COMPOSITE_DIFF_INPUT_FILE`, `EMISSIONS_COMPOSITE2P_DIFF_INPUT_FILE`, `EMISSIONS_COMPOSITE4P_DIFF_INPUT_FILE`, and `EMISSIONS_COMPOSITE6P_DIFF_INPUT_FILE` contain the correct filenames and that the files have read permissions.

ERROR in [ENV]: Unable to open the composite array parameter input file: <paramFilename>

Occurs when the *EmissionsEstimator* program is unable to locate or open the composite array parameter input file. Make sure that the file is present in the directory in which you are attempting to run *EmissionsEstimator* or that the configuration file key `EMISSIONS_ARRAY_PARAMETERS_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: Unable to open the energy distribution input file: <distFilename>

Occurs when the *EmissionsEstimator* program is unable to locate or open one of the four energy distribution input files created by *ConvertENRfile*. Make sure that the files are present in the directory in which you are attempting to run *EmissionsEstimator* or that the configuration file keys `EMISSIONS_ENR_NO_SOAK_FILE`, `EMISSIONS_ENR_SHORT_SOAK_FILE`, `EMISSIONS_ENR_MEDIUM_SOAK_FILE`, and `EMISSIONS_ENR_LONG_SOAK_FILE` contain the correct filenames and that the files have read permissions.

ERROR in [ENV]: Unable to open the soak time ratio input file: <ratioFilename>

Occurs when the *EmissionsEstimator* program is unable to locate or open one of the three static soak ratios files. Make sure that the files are present in the directory in which you are attempting to run *EmissionsEstimator* or that the configuration file keys `EMISSIONS_RATIO_SHORT_SOAK_FILE`, `EMISSIONS_RATIOS_MEDIUM_SOAK_FILE`, and `EMISSIONS_RATIOS_LONG_SOAK_FILE` contain the correct filenames and the files have read permissions.

ERROR in [ENV]: Unable to open the output file: <outputFilename>

Occurs when the *EmissionsEstimator* program is unable to open the output file. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EmissionsEstimator*. If you are not using the default output filename *emissions.ldv.out*, make sure that the configuration file key `EMISSIONS_LDV_OUTPUT_FILE` contains the correct filename.

ERROR in [ENV]: Unable to open the debugging output file: <debugFilename>

Occurs when the *EmissionsEstimator* program is unable to open one of the debugging files. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EmissionsEstimator*. If you are not using the default debug filenames (*debug.ldv.out* and *calcsum.ldv*), make sure the configuration file keys `EMISSIONS_DEBUG1_FILE` and `EMISSIONS_DEBUG2_FILE` contain the correct filenames. This message is printed only if the configuration file key `EMISSIONS_WRITE_DEBUG_OUTPUT` is set to 1.

ERROR in [ENV]: Input file ARRAYP.INP does not have enough data

Occurs when ten data elements are not present in the *ARRAYP.INP* file or the in file specified by the `EMISSIONS_ARRAY_PARAMETERS_FILE` configuration file key.

ERROR in [ENV]: Missing a header line from input file: <arrayFilename>

Occurs when the *EmissionsEstimator* program has problems reading the two header lines in one of the array composite or array composite difference files.

ERROR in [ENV]: Not enough input data in file: <arrayFilename>

Occurs when there is not enough data in one of the array composite or array composite difference files. Each file must contain six columns of data. The number of rows of data must be the maximum number of acceleration bins multiplied by the maximum number of velocity bins. These two values are read in from the *ARRAYP.INP* file. In this release of the emissions modules, these values are 20 speed bins and 34 power bins. There should be 680 rows of data in these files.

ERROR in [ENV]: Input file <ratiosFilename> does not have enough ratios

Occurs when there is not enough data in one of the three ratios input files. Each file must contain enough data for four levels of soaks (`NEGLIGIBLE`, `SHORT`, `MEDIUM`, and `LONG`) and eight soak power bins; this is 32 values.

ERROR in [ENV]: Network configuration keys NET_DIRECTORY, NET_NODE_TABLE, or NET_LINK_TABLE are not defined

This version of the environmental model uses road network tables. These three configuration file keys must be set in the configuration file.

ERROR in [ENV]: Missing header line from input file: <distFilename>

Occurs when the *EmissionsEstimator* program has problems reading one of the four energy distribution file headers. These files were created by *ConvertENRfile*.

ERROR in [ENV]: EmissionsEstimator : Calloc failure

Occurs when the *EmissionsEstimator* program was unable to allocate enough storage to do its calculations on a specific area of the network.

ERROR in [ENV]: EmissionsEstimator: There was no data (or incorrect data format) in input file: <velocityFilename>

Occurs when the *velocity.ldv.out* file is missing data (or the file specified by the `EMISSIONS_LDV_VELOCITY_FILE` configuration file key). The value after *nv* = should be the number of lines of data following for that particular time, link, and node. Errors in the *velocity.ldv.out* file may have been introduced by the *ConvertVELfile* program.

ERROR in [ENV]: Missing data from input file: <velocityFilename>

Occurs when the *velocity.ldv.out* file is missing data (or the file specified by the `EMISSIONS_LDV_VELOCITY_FILE` configuration file key). The value after *nv* = should be the number of lines of data following for that particular time, link, and node. Errors in the *velocity.ldv.out* file may have been introduced by the *ConvertVELfile* program.

ERROR in [ENV]: Input file <distFilename> does not have enough data

Occurs when at least one of the four energy distribution files is missing data. Errors in these files may have been introduced by the *ConvertENRfile* program.

WARNING in [ENV]: Input file <distFilename> does not match velocity file (time,link,node) Velocity (<time>,<link>,<node>) Energy (<time>,<link>,<node>) skipping velocity record

Occurs when a row in the velocity data and a row in the energy data does not match time, link, or node, and the energy link ID is smaller than the velocity ID or the link IDs are the same but the energy node ID is smaller. This is a normal occurrence for vehicles that have entered a link right before energy collection has begun. This message is printed only when the configuration file key `EMISSIONS_WRITE_DEBUG_OUTPUT` is set to 1.

WARNING in [ENV]: Input file <distFilename> does not match velocity file (time,link,node) Velocity (<time>,<link>,<node>) Energy (<time>,<link>,<node>) skipping energy record

Occurs when a row in the velocity data and a row in the energy data does not match time, link, or node and the energy link ID is larger than the velocity link ID or the link IDs are the same but the energy node ID is larger. This message is printed only when the configuration file key `EMISSIONS_WRITE_DEBUG_OUTPUT` is set to 1.

WARNING in [ENV]: Unable to find link <link> in network

Occurs when searching for a particular link ID read in from velocity data and unable to find it in the network link table. This link data will be skipped.

WARNING in [ENV]: Invalid street type: <type> for link:node <link>:<node>

Occurs when processing a link from the velocity input and the link is not travelable by autos.

WARNING in [ENV]: Data set contains a link with empty interior boxes for the time:link:node (<time>:<link>:<node>)

There must be vehicles present in a consecutive set of boxes on any particular link. Links may contain boxes that are empty at the beginning and the end of the link. In order to calculate emissions correctly, boxes that contain vehicles must all be consecutive. There may not be empty boxes in the middle of a set of boxes with vehicles. One way to check if a box contains vehicles is to look across a particular row of data in the *velocity.ldv.out* file. If all values are zero, there were no vehicles in that box. Links that contain empty interior boxes will be discarded, and emissions will not be calculated on them. These links should have been filtered out in the *ConvertVELfile* program. This message is printed only if the `EMISSIONS_WRITE_DEBUG_OUTPUT` configuration file key is set to 1.

WARNING in [ENV]: Data set contains a link with velocity data in 1st speed bin ONLY for time:link:node (<time>:<link>:<node>)

Occurs when there is a non-zero value in the first column of velocity counts and all other counts in that row are zero. The *EmissionsEstimator* program is unable to calculate emissions for this situation and, therefore, that link will be discarded from the output data. These links should have been filtered out in the *ConvertVELfile* program. This message is printed only if the `EMISSIONS_WRITE_DEBUG_OUTPUT` configuration file key is set to 1.

#### 3.7.1.4 Messages and ERRORs from *EmissionsEstimatorHDV*

ERROR in [ENV]: Usage: EmissionsEstimatorHDV <configFilename>

Occurs when the *EmissionsEstimator* program is run without a configuration file as an argument on the command line. Specify the configuration file used to run the Traffic Microsimulator to produce the velocity data for the Evaporative Emissions Estimator.

ERROR in [ENV]: Unable to open the velocity input file: <velocityFilename

Occurs when the *EmissionsEstimatorHDV* program is unable to locate or open the postprocessed velocity input file. Make sure that the file is present in the directory in which you are attempting to run *EmissionsEstimatorHDV* or that the configuration file key `EMISSIONS_HDV_VELOCITY_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: Unable to open the composite array input file: <arrayFilename>

Occurs when the *EmissionsEstimatorHDV* program is unable to locate or open the composite array input file. Make sure that the file is present in the directory in which you are attempting to run *EmissionsEstimatorHDV* or that the configuration file keys `EMISSIONS_COMPOSITE_HDV_INPUT_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: Unable to open the composite array parameter input file: <paramFilename>

Occurs when the *EmissionsEstimatorHDV* program is unable to locate or open the composite array parameter input file. Make sure that the file is present in the directory in which you are attempting to run *EmissionsEstimatorHDV* or that the configuration file key `EMISSIONS_HDV_ARRAY_PARAMETERS_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: Unable to open the output file: <outputFilename

Occurs when the *EmissionsEstimatorHDV* program is unable to open the output file. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EmissionsEstimatorHDV*. If you are not using the default output filename *emissions.hdv.out*, make sure the configuration file key `EMISSIONS_HDV_OUTPUT_FILE` contains the correct filename.

ERROR in [ENV]: Unable to open the debugging output file: <debugFilename>

Occurs when the *EmissionsEstimatorHDV* program is unable to open one of the debugging files. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EmissionsEstimatorHDV*. If you are not using the default debug filenames (*debug.hdv.out* and *calcsum.hdv*), make sure that the configuration file keys `EMISSIONS_DEBUG1_HDV_FILE` and `EMISSIONS_DEBUG2_HDV_FILE` contain the correct filenames. This message is printed only if the configuration file key `EMISSIONS_WRITE_DEBUG_OUTPUT` is set to 1.

ERROR in [ENV]: Input file ARRAYP_HDV.INP does not have enough data

Occurs when ten data elements are not present in the *ARRAYP_HDV.INP* file or the file specified by the `EMISSIONS_HDV_ARRAY_PARAMETERS_FILE` configuration file key.

ERROR in [ENV]: Not enough input data in file: <arrayFilename>

Occurs when there is not enough data in the array composite file. The first portion of this file contains 20 lines of data (the number of speed bins), followed by two header lines, followed by rows of data for the maximum number of acceleration bins multiplied by the maximum number of velocity bins. These two values are read in from the *ARRAYP_HDV.INP* file. In this release of the emissions modules, these values are 20 speed bins and 4 power bins. There should be 80 rows of seven columns of the second portion of data in this file.

ERROR in [ENV]: Missing a header line from input file: <arrayFilename>

Occurs when the *EmissionsEstimatorHDV* program has problems reading the two header lines found in the middle of the array composite file.

ERROR in [ENV]: EmissionsEstimatorHDV: Calloc failure

Occurs when the *EmissionsEstimatorHDV* program was unable to allocate enough storage to do its calculations on a specific area of the network.

ERROR in [ENV]: Not enough input data in file: <velocityFilename>

Occurs when the *velocity.hdv.out* file is missing data (or the file specified by the `EMISSIONS_HDV_VELOCITY_FILE` configuration file key). The value after *nv* = should be the number of lines of data following for that particular time, link, and node. Errors in the *velocity.hdv.out* file would have been introduced by the *ConvertVELfile* program.

ERROR in [ENV]: Network Configuration keys NET_DIRECTORY, NET_NODE_TABLE, or NET_LINK_TABLE are not defined

This version of the environmental model uses road network tables. These three configuration file keys must be set in the configuration file.

WARNING in [ENV]: invalid street type: <type>

Occurs when processing a link from the velocity input and the link is not travelable by autos.

WARNING in [ENV]: Data set contains a link with empty interior boxes for time:link:node (<time>:<link>:<node>)

There must be vehicles present in a consecutive set of boxes on any particular link. Links may contain boxes that are empty at the beginning and the end of the link. In order to calculate emissions correctly, boxes that contain vehicles must all be consecutive. There may not be empty boxes in the middle of a set of boxes with vehicles. One way to check if a box contains vehicles is to look across a particular row of data in the *velocity.hdv.out* file. If all values are zero, there were no vehicles in that box. Links that contain empty interior boxes will be discarded and emissions will not be calculated on them. These links should have been filtered out in the *ConvertVELfile* program. This message is printed only if the `EMISSIONS_WRITE_DEBUG_OUTPUT` configuration file key is set to 1.

WARNING in [ENV]: Data set contains a link with velocity data in lst speed bin ONLY for time:link:node (<time>:<link>:<node>)

Occurs when there is a non-zero value in the first column of velocity counts and all other counts in that row are zero. The *EmissionsEstimatorHDV* program is unable to calculate emissions for this situation and, therefore, that link will be discarded from the output data. These links should have been filtered out in the *ConvertVELfile* program. This message is printed only if the `EMISSIONS_WRITE_DEBUG_OUTPUT` configuration file key is set to 1.

## 3.8 Evaporative Emissions Estimator

Before running the Evaporative Emissions Estimator, the Traffic Microsimulator must be run to collect traveler event and velocity summary data.

Run *ConvertTRVfile* in order to convert the Traffic Microsimulator traveler event data into a format that can be read into the Evaporative Emissions Estimator.

```
% ConvertTRVfile <configFilename>
```

The configuration file key `EMISSIONS_MICROSIM_TRAVELER_FILE` can be used in the configuration file to specify the traveler event file to be used as input. If not used, the filename defaults to *event.trv* in the current working directory. The filename is created by adding *.trv* to the end of the `OUT_EVENT_NAME_n` file specification.

The configuration file key `EMISSIONS_PA_OUTPUT_FILE` can be used to specify the output file created by the *ConvertTRVfile* program. If not used, the filename defaults to *pa.out* in the current working directory.

Run the Evaporative Emissions Estimator to produce a file of light-duty vehicle emissions that can be read into the Output Visualizer. The configuration file used to run the Traffic Microsimulator to collect traveler event and velocity summary data must be specified on the command line. Before running this program, verify that all necessary input files are present in the directory you will be running from or that all Evaporative Emissions Estimator configuration file keys are set properly. These include the *EMISSIONS_MATRICLES.dat* file, the *pa.out* file, the *summary.ldv.vel* file, and the city-specific data file. Refer to Volume Three (*Modules*), Chapter Seven (*Emissions Estimators*) for detailed explanations of the various input and output files and their configuration keys.

```
% EvaporativeEstimator <configFilename>
```

The files *StationaryEvapEmis.dat* and *OperatingEvapEmis.dat* will be produced, or the files specified by the `EMISSIONS_EVAP_STATIONARY_OUTFILENAME` and `EMISSIONS_EVAP_OPERATING_OUTFILENAME` configuration file keys. If the configuration file key `EMISSIONS_WRITE_DEGBUG_OUTPUT` is defined and set to 1, the debugging files specified by `EMISSIONS_EVAP_DEBUG_FILENAME` (or default *debug.dat*) will be written also.

Run the Output Visualizer to display the emissions. The Output Visualizer needs the configuration file used to run the microsimulation in order to know which network to bring up.

```
% Vis <configFilename>
```

Within the Output Visualizer,

- select File→Open Variable Size Box Data

- choose the *StationaryEvapEmis.dat* or *OperatingEvapEmis.dat* file produced by the *EvaporativeEstimation* program

To animate the emissions data through different timestep, use the animation tools at the bottom of the Output Visualizer's window. To view the legend of bar colors and values, select View→Legend.

If the `VIS_COLORMAPS` configuration file key is not defined, the minimum and maximum value for the HC column of data in emissions is determined and saved. The appropriate scale factor is calculated. When the emissions file is opened, the value ranges and scale factor will be used. If the `VIS_SLIDER_XROT` configuration file key is not defined, the display is rotated about the x-axis to 303.8 and about the z-axis by 44.6. The display will automatically be in the 3D mode and rotated for optimal viewing of bar height. Otherwise, use the instructions below to achieve the same effect.

To display three-dimensional emissions where not only the color of the summary box but also the height depends on the emissions value:

- rotate the network so the Z is at about 45 and the X at about 300,
- select Modes→Lights On/Off to get better shading,
- select View→Variable Size Boxes, then
- click [OK].

The three-dimensional emissions can also be animated through the timesteps.

### 3.8.1 Troubleshooting

Listed here are warnings and error messages for the Evaporative Emissions modules. If a warning is output, the program will continue processing. If an error is outputted, the program will exit at that time.

#### 3.8.1.1 Messages and ERRORs from *ConvertTRVfile*

ERROR in [ENV]: Usage: ConvertTRVfile <configFilename>

Occurs when the configuration file is not specified when running the *ConvertTRVfile* program. To run *ConvertTRVfile*, you must specify the configuration file on the command line.

ERROR in [ENV]: ConvertTRVfile: Unable to open the traveler event input file: <eventFilename>

Occurs when the *ConvertTRVfile* program is either unable to locate or unable to open the event input file specified either in the configuration file or the default file. Make sure that you have the correct location for your input file and that it has proper read permissions set.

ERROR in [ENV]: ConvertTRVfile: Bad header for traveler event file: <eventFilename>

Occurs when the *ConvertTRVfile* program had problems reading the header line in the event input file. The event input file may be empty.

ERROR in [ENV]: ConvertTRVfile: Bad header in traveler event file. Field "<fileldName>" is missing

Occurs in the *ConvertTRVfile* program when there is a missing necessary field in the event input files. The fields needed are `TIME`, `VEHICLE`, `LOCATION`, `STATUS`, and `VEHTYPE`. If any of these fields are missing, the simulation must be rerun with the configuration modified to allow collection of all of these fields.

ERROR in [ENV]: ConvertTRVfile: Calloc failure

Occurs when the *ConvertTRVfile* program attempts to allocate some memory and is unable to.

ERROR in [ENV]: ConvertTRVfile: Unable to open the output file: <ouputFilename>

Occurs when the *ConvertTRVfile* program is unable to open the event output file specified in the configuration file or the default files. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *ConvertTRVfile* or the directory specified by the configuration file keys for the output files.

#### *3.8.1.2* Messages and ERRORs from *EvaporativeEstimator*

ERROR in [ENV]: Usage: EvaporativeEstimator <configFilename>

Occurs when the configuration file is not specified when running the *EvaporativeEstimator* program. To run *EvaporativeEstimator*, you must specify the configuration file on the command line.

ERROR in [ENV]: EvaporativeEstimator: Unable to open vehicle activity input file: <PAFilename>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the vehicle activity input file. Make sure that the file is present in the directory in which you are attempting to run *EvaporativeEstimator* or that the configuration file key `EMISSIONS_PA_OUTPUT_FILE` contains the correct filename and that the file has read permissions. This file is produced by the *ConvertTRVfile* program.

ERROR in [ENV]: EvaporativeEstimator: Missing a header line from vehicle activity input file: <PAFilename>

Occurs when either the vehicle activity file is empty or the first line in the file is not the header line that should begin with the characters `VEHICLE`.

ERROR in [ENV]: EvaporativeEstimator: Unable to open velocity input file: <velFileName>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the velocity summary input file. Make sure that the file is present in the directory in which you are attempting to run *EvaporativeEstimator* or that the configuration file key

`EMISSIONS_MICROSIM_LDV_VELOCITY_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: EvaporativeEstimator(SimInfo::readHeader): problem reading metadata for file: <velFileName>

Occurs when it has been determined that there is metadata in the velocity summary file but an error occurs while trying to read the metadata. Check to make sure the metadata is all on one line. This line can be removed from the file, but the integrity of the data cannot be checked then.

ERROR in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> does not have the assumed time step: 3600

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the timestep to be other than 3600 seconds.

ERROR in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> does not have the assumed sample time: 1

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the sample time to be other than 1 second.

ERROR in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> does not have the assumed cell length: 7.5

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the cell length to be other than 7.5 meters.

ERROR in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> does not have the assumed box length: 30.0

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the box length to be other than 30 meters.

WARNING in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> vehicle type (<vehType>) does not match assumed vehicle type (AUTO)

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the vehicle type to be other than `AUTO`. The input file defined by `EMISSIONS_MICROSIM_LDV_VELOCITY_FILE` (or the default *velocity.ldv.vel*) must be of vehicle type `AUTO`.

WARNING in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> does not have the assumed max velocity: 37.5

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the maximum velocity to be other than 37.5 meters per second.

ERROR in [ENV]: EvaporativeEstimator(VerifyMetadata): velocity file: <velFileName> does not have the assumed number of bins: 6

Occurs when the *EvaporativeEstimator* program is verifying the metadata and finds the number of velocity bins to be other than 6.

ERROR in [ENV]: EvaporativeEstimator(SimInfo::readHeader): Bad header for velocity file: <velFileName>

Occurs when the *EvaporativeEstimator* program was unable to read the header to the velocity file. This is usually a sign that the velocity summary input file was empty.

ERROR in [ENV]: EvaporativeEstimator(SimInfo::readHeader): Bad header in velocity file. Field "<field>" is missing

Occurs when there is a missing necessary field in the velocity file. The fields needed are `TIME`, `LINK`, `NODE`, `DISTANCE`, `COUNT0`, `COUNT1`, `COUNT2`, `COUNT3`, `COUNT4`, and `COUNT5`. If any of these fields are missing, the simulation must be rerun with the configuration modified to allow collection of all of these fields.

ERROR in [ENV]: EvaporativeEstimator: Unable to open city input file: <CityFilename>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the city-specific input file. Make sure that the file is present in the directory in which you are attempting to run *EvaporativeEstimator* or that the configuration file key `EMISSIONS_EVAP_CITY_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: EvaporativeEstimator: Unable to open stationary output file: <StationaryFilename>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the stationary emissions output file. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EvaporativeEstimator*. If you are not using the default output filename *StationaryEvapEmis.dat*, make sure that the configuration file key `EMISSIONS_EVAP_STATIONARY_OUTFILENAME` contains the correct filename.

ERROR in [ENV]: EvaporativeEstimator: Unable to open operative output file: <OperatingFilename>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the operating emissions output file. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EvaporativeEstimator*. If you are not using the default output filename *OperatingEvapEmis.dat* , make sure that the configuration file key `EMISSIONS_EVAP_OPERATING_OUTFILENAME` contains the correct filename.

ERROR in [ENV]: EvaporativeEstimator: Unable to open debug output file: <DebugFilename>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the debugging output file. This may occur because of lack of disk space or lack of write privileges in the directory in which you are attempting to run *EvaporativeEstimator*. If you are not using the default output filename *debug.dat* , make sure that the configuration file key `EMISSIONS_EVAP_DEBUG_FILENAME` contains the correct filename.

ERROR in [ENV]: EvaporativeEstimator(readCityData): Missing a header line from city input file: <CityFilename>

Occurs when attempting to read one of the eight header lines in the city-specific data file. The file could either be empty or not contain enough lines of data in it.

ERROR in [ENV]: EvaporativeEstimator(readCityData): Not enough input data in city file: <CityFilename>

Occurs when attempting to read data from the city-specific data file and an error occurs. This probably means there were not enough lines of data in the input file or an incorrect number of lines for a particular type of data. Number of years of vehicle models is the first value read in from the file. There must be that number of lines of data for the six sections of percentage data. There must be 24 lines of temperature data at the end.

ERROR in [ENV]: EvaporativeEstimator(readCityData): Number of vehicle model years (<numYears>) > maximum (50) in file: <CityFilename>

Occurs when the first number read in from the city-specific data file is greater than 50. To allow for more than 50 model years, the variable `MAX_NUM_YRS_AGE_DISTR` in the *evaporative.h* file must be increased.

WARNING in [ENV]: EvaporativeEstimator(UserDefined::Initialize): Cumulative Model Year Distribution adds up to greater than 100%

Occurs when `UserDefined::Initialize` is summing up the cumulative distributions, and the sum is greater than 100%. Check the city data file to verify the correct values for the "Percent of vehicles for a particular model year".

ERROR in [ENV]: EvaporativeEstimator(CreateNetwork): One or more network configuration keys is not defined: NET_DIRECTORY, NET_NODE_TABLE, NET_LINK_TABLE, NET_PARKING_TABLE, NET_ACTIVITY_LOCATION_TABLE, NET_TRANSIT_STOP_TABLE, NET_PROCESS_LINK_TABLE

This version of the environmental model uses road network tables. These seven configuration file keys must be set in the configuration file.

WARNING in [ENV]: EvaporativeEstimator(GetParkingInfo): ParkingId <PAId> NOT found

Occurs when attempting to convert a parking location ID into a link, node, and distance, and the parking location is not found in the network link table. This Parking Location's emissions are not output.

WARNING in [ENV]: EvaporativeEstimator(GetParkingInfo): Invalid offset <offset> for PA <PAId>

Occurs when checking parking location offset against the link length, and the offset is at a point beyond the end of the link. This error is caused by an invalid offset entered into the parking location table. This parking location's emissions are not output.

WARNING in [ENV]: EvaporativeEstimator(readPAfile): No data in vehicle activity input data file: <PAFilename>

Occurs when attempting to read vehicle activity data from the postprocessed traveler event file and there is no data in the file.

WARNING in [ENV]: EvaporativeEstimator(readPAfile): EvaporativeEstimator(readPAfile): Time (<readTime>) is out of range <simStart> - <simEnd> for file: <PAFilename>

Occurs when a read-in time from the vehicle activity file is out of range of the

simulation start and end times, which are determined from the configuration file keys `CA_SIM_START_SECOND`, `CA_SIM_START_MINUTE`, `CA_SIM_START_HOUR`, and `CA_SIM_STEPS`.

WARNING in [ENV]: EvaporativeEstimator(askLeaker): Invalid Evaporative Emission Type

Occurs when the function **`askLeaker`** does not recognize the inputted emission type. The current vehicle's type is not changed.

WARNING in [ENV]: EvaporativeEstimator(getTemperature): hour out of bounds <hour>

Occurs when the function **`getTemperature`** is attempting to return the temperature for a given time of day and the time of day is not within the normal ranges 0 - 23 or accepted values -1, 24, 25. Temperature is set to -99.

WARNING in [ENV]: EvaporativeEstimator(getPartialDiurnal): Unknown vehicle type

Occurs when the function **`getPartialDiurnal`** does not recognize the inputted vehicle type. The partial diurnal ratio is set to 0.

WARNING in [ENV]: EvaporativeEstimator(getHotSoak): Unknown vehicle type

Occurs when the value of the variable `description` is not recognized. Hot soak is set to 0.0.

ERROR in [ENV]: EvaporativeEstimator(RunningLossCoef::Initialize): Unable to open coef input file: <CoefFilename>

Occurs when the *EvaporativeEstimator* program is unable to locate or open the emissions coefficient input file. Make sure that the file is present in the directory in which you are attempting to run *EvaporativeEstimator* or that the configuration file key `EMISSIONS_EVAP_COEF_FILE` contains the correct filename and that the file has read permissions.

ERROR in [ENV]: EvaporativeEstimator(RunningLossCoef::Initialize): Not enough input data in coef file: <CoefFilename>

Occurs when attempting to read the emissions coefficient file and there is not enough data in the file. There should be 112 lines of six columns of data.

WARNING in [ENV]: EvaporativeEstimator(RunningLoss::getTotalRunningLoss): Time (<readTime>) is out of range <simStart> - <simEnd> for file: <VELFilename>

Occurs when the timestep read in from the velocity summary file is not within the range of the simulation start and end times, which are determined from the configuration file keys `CA_SIM_START_SECOND`, `CA_SIM_START_MINUTE`, `CA_SIM_START_HOUR`, and `CA_SIM_STEPS`.

## 3.9 Output Visualizer

### 3.9.1 Running the Output Visualizer

To run the Output Visualizer, type the following command line:

```
% <Vis> <configfile>
```

where <`Vis`> is the executable file, and <`configfile`> is the name of the configuration file upon which you would like to view the data.

Do not run this application in the background because you will need a text output window to retrieve various information types.

### 3.9.2 Manipulating the View

#### 3.9.2.1 Translating

To translate, perform the following four steps:

1) Click on [Translate].

2) Use the left mouse button to click a point in the viewing area.

3) Hold the button down and drag to another point in the viewing area.

4) Release the left mouse button.

The Output Visualizer redraws the network, which is translated by the distance between the two points.

To undo a translation, click [Default View], which resets the viewing transformations to their original values and redraws the network.

#### 3.9.2.2 Zooming

##### 3.9.2.2.1 Zoom-in

To zoom-in, perform the following steps:

1) Click on [Zoom In].

2) Use the left mouse button to click a point in the viewing area.

3) Hold the button down and drag to another point in the viewing area.

4) Release the left-mouse button.

The Output Visualizer displays the selected area with the maximum magnification allowable in the monitor's window.

To undo a zoom operation, click [Default View], which resets the viewing transformations to their originals values and redraws the network. It also can be undone by clicking [Zoom Back].

#### 3.9.2.2.2 Zoom-back

Zoom-back reverses the last zoom-in operation. Up to 50 zoom-in operations can be undone.

Note that when selecting an area to zoom into, any diagonal in any direction will work. For example, the same results can be produced by clicking on the upper left then dragging to the lower right of an area, as when clicking on the lower right and dragging to the upper left.

Fig. 8 provides a sample zoomed-in view of the network. Note that, in this figure, the lane dividers are displayed as white dashed lines and that the yellow lines are drawn on the left side of the links, thereby indicating the direction of traffic.

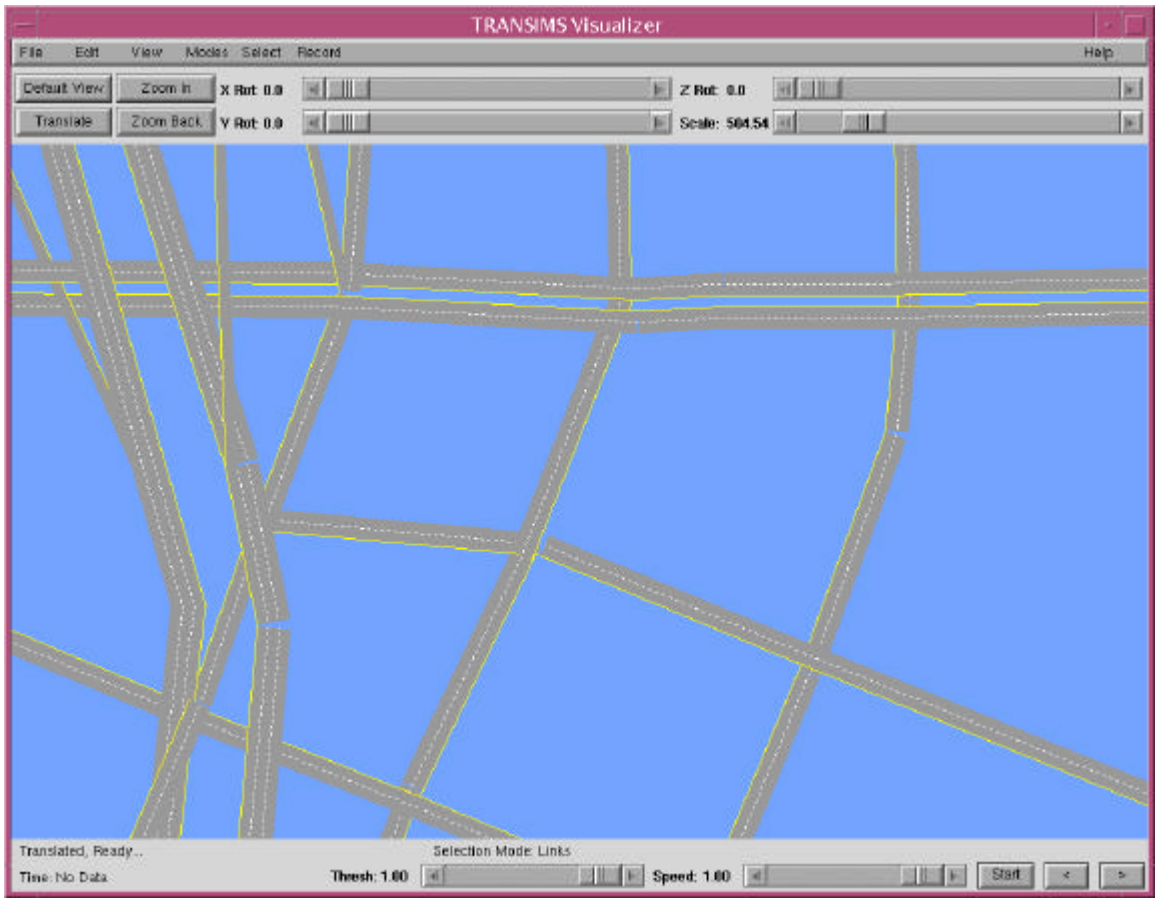



*Fig. 8. The Output Visualizer displaying a zoomed-in view of the Portland EMME/2 Network.*

#### 3.9.2.3 Rotating

To rotate an object, drag the thumb button to the right of the "Z Rot" label. The entire network will rotate about the Z-axis by the amount shown on the slider. You can also click on the arrows at the ends of the slider to increase or decrease the rotation.

#### 3.9.2.4 Scaling

To scale, drag the thumb button to the right of the "Scale Label." The entire network will be magnified about the current center of the window by the amount shown by the slider. You may also click on the arrows at the ends of the slider to increase or decrease the scale.

#### 3.9.2.5 Displaying Vehicle Evolution Files

To create an Indexed Vehicle Evolution File, use the *indexvehtobin* utility to convert a vehicle-snapshot file into a binary format (see Chapter 6 for a description of this utility). Once this is done, read in a Vehicle Evolution File by selecting File→Open Indexed Vehicles.

The text in the status bar changes to *Reading in Vehicles…* while the vehicle evolution file is being read and will return to *Ready…* once completed.

The Output Visualizer displays the vehicles as points when zoomed out and transitions to displaying vehicles as triangles when zoomed in. The display should now look similar to that shown in Fig. 9.

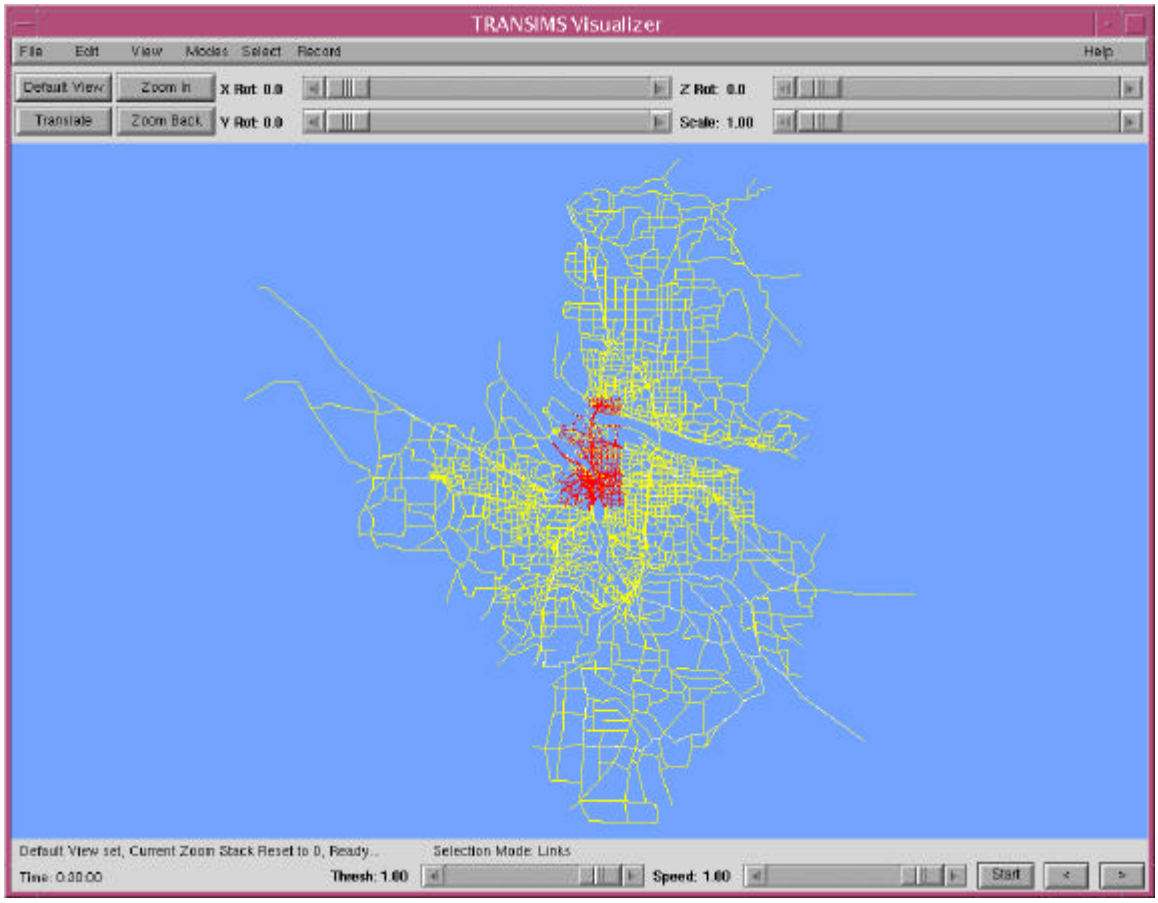



*Fig. 9. The Output Visualizer displaying vehicles on the Portland EMME/2 Network.*

### 3.9.2.6 Looking for High Vehicle Densities

The leftmost slider at the bottom of the window is labeled "Thresh." This slider controls the transparency of the vehicles when vehicles are shown as points. When Thresh is 1.00, the vehicles are not transparent; as thresh declines, they become more transparent.

Thus, because in very zoomed-out views vehicles are smaller than pixels, pixels with multiple transparent vehicles will appear darker. The highest densities of vehicles will appear as the darkest pixels as the Thresh slider goes towards zero (see Fig. 10).

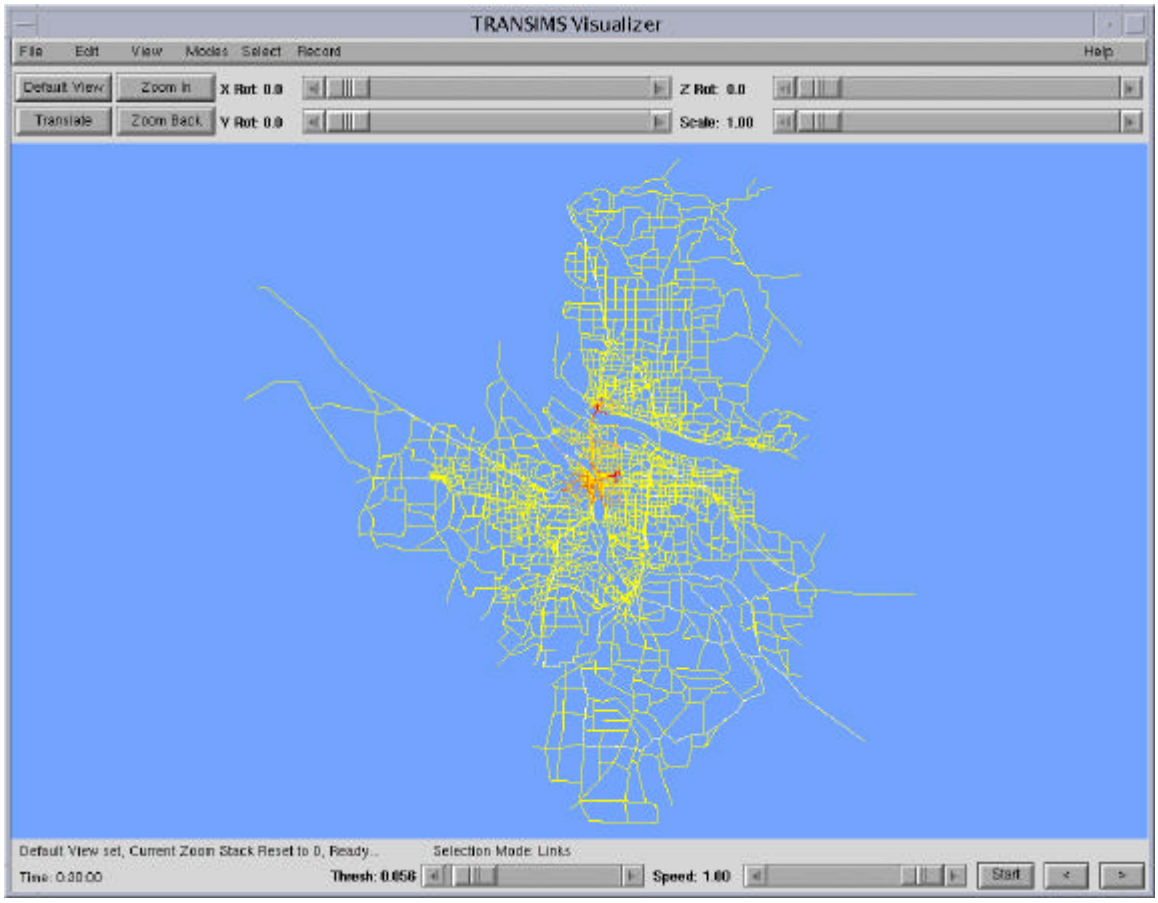



*Fig. 10. The Output Visualizer displaying high vehicle densities on the Portland EMME/2 Network.*

If you zoom in, the vehicles will be displayed as triangles (see Fig. 11). The point of the triangle in the middle of the lane represents the front of the vehicle.

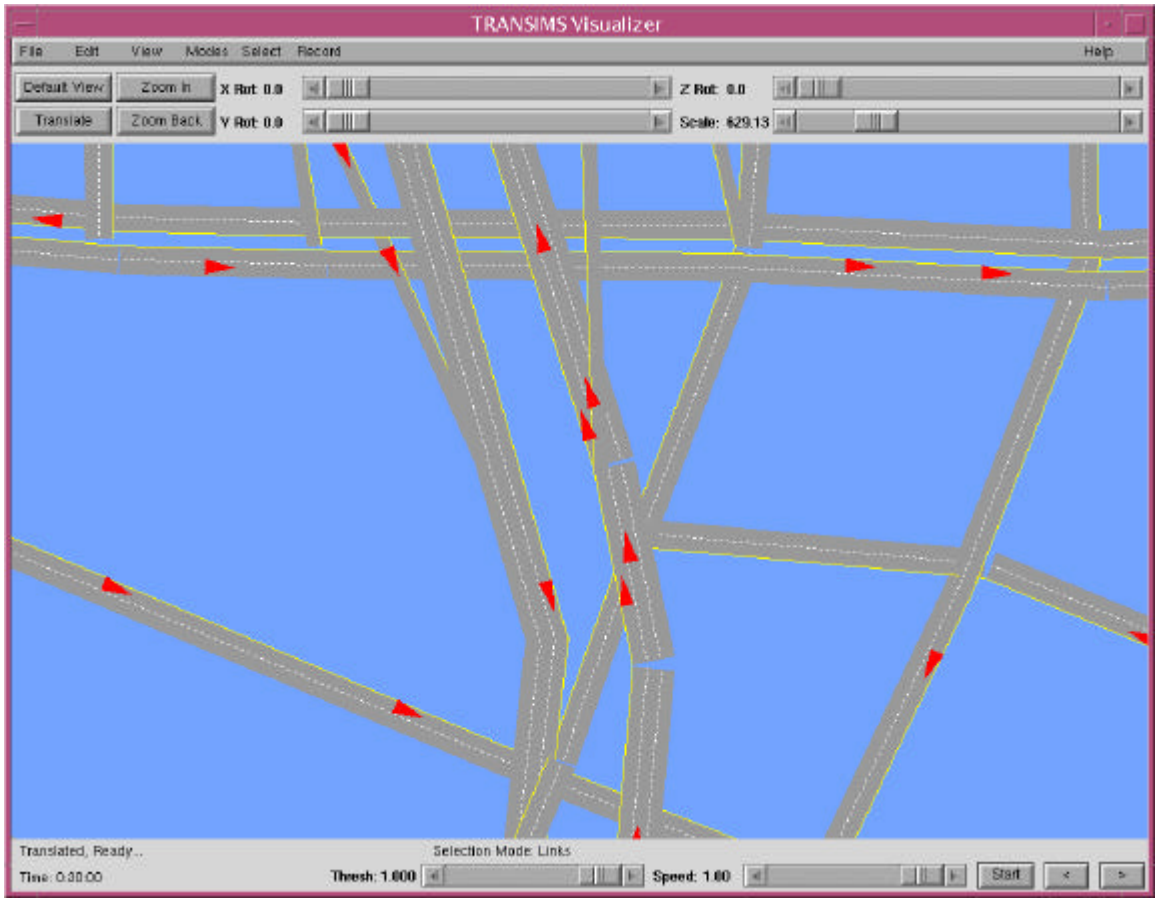



*Fig. 11. The Output Visualizer displaying vehicles on the Portland EMME/2 Network by using a zoomed-in view.*

### 3.9.2.7 Coloring the Vehicles by Different Schemes

By selecting View→Vehicles, you will call up the Select and Vehicle Viewing Parameters dialog box. This dialog box enables you to select a scheme by which to color the vehicles. You may

- have the vehicles all appear in one color,
- color the vehicles by type,
- color by number of passengers,
- color by velocity,
- color by user field, or
- color the vehicles with random colors.

Coloring the cars randomly proves useful when watching the flow of large numbers of vehicles and yet retaining the focus on a particular vehicle. Different vehicle types can be distinguished by coloring by Type.

Vehicles can also be drawn in 3-D in any mode by selecting the 3-D Vehicles checkbox at the bottom of the Vehicle Viewing Parameters dialog box. To accomplish this, select Modes→Color by Velocity, then click [OK]. The vehicles are colored according to velocity: dark red (being the slowest), then bright red, then blue, then bright green, followed by dark green (for the fastest vehicles).

#### 3.9.2.8 Animating the Vehicles

Perform the following steps to animate the vehicles:

1) To start the animation, click the left mouse button on the viewing area. As each animation frame is drawn, the timestep is written in the status bar.

2) To stop the animation, click the right mouse button.

3) To slow the animation speed, drag the Speed slider toward “0” (left).

4) To display the starting timestep, click [Start].

5) To advance the timestep, click [>]. To decrease it, click [<].

##### 3.9.2.8.1 Animating Faster

Because the entire network is redrawn for each frame, the animation may appear quite slow, particularly for networks with large numbers of links. The animation speed can be greatly increased by switching on the Overlay mode. This is done by selecting Modes→Overlay.

Once this mode is on, restart the animation. The animation frame rate now should be much faster because the network is drawn only once and is copied from memory into the viewing area for each subsequent timestep. Note that the Overlay mode is useful only for larger size networks (more than 3,000 links), as smaller networks often can be drawn faster than the pixel transfer can take place.

#### 3.9.2.9 Retrieving Information about a Vehicle

To retrieve information about a certain vehicle, click on the front middle of it (when it is large enough to be represented as a triangle) with the middle mouse button. If the vehicles are represented by points, click on a point within five meters of the middle front of the vehicle. This in turn will bring up information in the text window from which you started the Output Visualizer and on the selection status line. A typical output is as follows:

*Found Vehicle: ID 336565 Type 16 Passengers 0*
*Velocity 24.59 Link ID 16155 User: 0*

Because the first vehicle whose point is within the five-meter tolerance is selected for output, try to select a point in which it is not likely that the point will be within the tolerances of another vehicle. If a vehicle cannot be found at the point where you have clicked, the following message is displayed:

*Vehicle NOT FOUND at xcoordinate ycoordinate*

#### 3.9.2.10 Ride-in-Vehicle Mode

Sometimes it is convenient to have the viewpoint set as if you were riding in a given vehicle. To accomplish this, use the Modes→Ride in Vehicle Mode menu option.

To use this mode, perform the following steps:

1) Select a vehicle ID and enter it into the dialog box that is displayed when Edit→Find Vehicle is selected.

2) Select the Modes→Ride in Vehicle Mode menu item, and the entire data set will be searched for the chosen vehicle ID and processed into a new data set.

3) Check to make sure there are no warnings (there is at least one record for the chosen vehicle ID); the viewpoint will be set as if you were riding in that vehicle.

Notice that the text labeling on the sliders has changed to Roll, Pitch, Yaw, and Height. These sliders can be used to manipulate the direction in which you are looking (much like the controls of an airplane). Fig. 12 provides a sample view created in this mode.

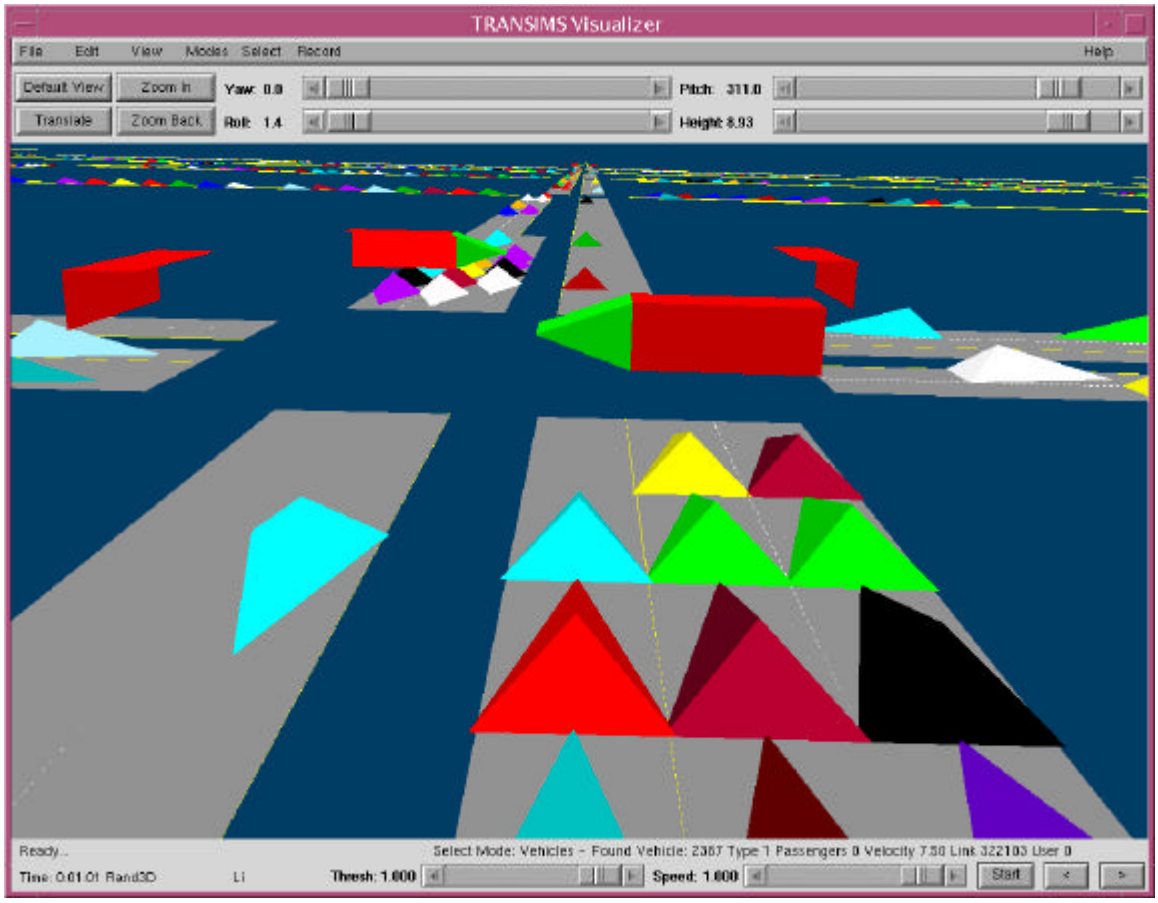



*Fig. 12. The Output Visualizer displaying a view in the Ride-In Vehicle mode.*

To toggle back to the default viewpoint, select the menu item again. When you are ready to go on to viewing another type of data, stop the animation and free the memory used for the vehicle evolution data by selecting File→Close Indexed Vehicles.

#### 3.9.2.11 Viewing Variable-Size Box Data

To read in a Variable-Size Box data file, select File→Open Variable Size Box. The text in the status bar will change to *Reading in Variable Size Boxes…* while the file is being read and will return to *Ready…* once completed.

The Output Visualizer displays the first column of data in the file by default. Links are colored according to the user-selectable colormap.

Other columns can be displayed by selecting View→Increment Data Column, which increments the data column being displayed. Data animation can be displayed by clicking the left mouse button in the viewing area; stopping the animation is done by clicking the right mouse button.

Variable-Size Box data files can be produced from plans by using the *Plan2BoxSummary* utility. The emissions package also produces files of this type.

#### 3.9.2.12 Viewing the Data in 3-D

Because it can be very difficult to identify outlying values with colormapped data, the Output Visualizer provides 3-D capabilities. It is much easier to identify outlying data when viewing tall bar graphs than by coloring the data values with a given colormap.

To view data in 3-D, perform the following steps:

1) Select View→Variable Size Boxes. A dialog box is displayed that allows you to enter a scale factor for multiplying the data values into 3-D bar heights.

2) Enter an appropriate scale factor, then click [OK].
   The display is rendered with 3-D bars on the boxes.

3) Rotate the display to approximately 290 degrees with the X Rot slider.

4) Left-click to animate the data.

5) Right-click to stop the animation.

The display may look confusing at this point because all faces of the 3-D bar boxes are colored exactly the same. You will not be able to distinguish the tops of the boxes from the sides.

The lighting model fixes this problem. Switch on the lighting model by selecting Modes→Lights On/Off. Fig. 13 provides a sample view of 3-D Variable-Size Box data.

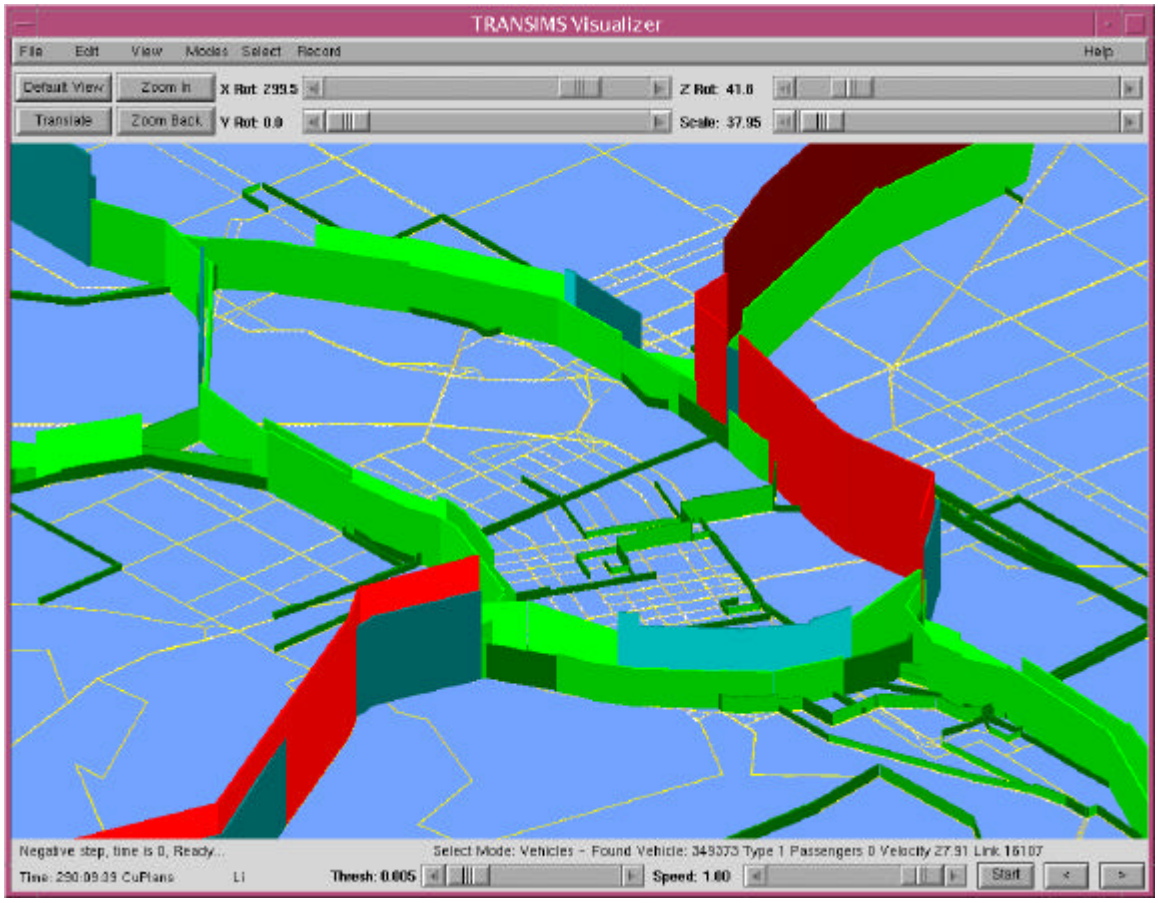



*Fig. 13. The Output Visualizer displaying cumulative plan data.*

### 3.9.2.13 Varying the Colormap Thresholds

In some cases, it may be desirable to determine whether the data value of one link is higher than another. Because of the colormap, however, the two links will have the same color.

Changing the colormap into a more finely grained colormap with more colors can alleviate this problem, but there is an alternative and more convenient way. By cycling the colormap (that is, by increasing the minimum value color), the links on the display change colors.

The link with the higher data value associated with it will change colors before the other link of the same initial color. This cycling of colormaps is accomplished by using the Thresh slider.

Free the memory used for the Variable-Size Box data by selecting File→Close Variable Size Box Data.

# Appendix A: Bignet Systematic Number System

## Systematic Numbering of IDs

Because there are so many links in the Bignet Network, it is very difficult to diagnose problems and find exactly where a certain error took place. To alleviate this problem, we have systematically numbered all objects (e.g., links, nodes, parking, and activity locations) so that the user can find an object's type and location by using its unique ID.

This numbering scheme is used for all of Bignet except for the numbering of freeway, bridge, and rail-only links. This numbering scheme is an independent system. Thus, we have divided the remainder of this discussion into two sections:

1) the first addresses the majority of the Bignet numbering scheme, and

2) the second discusses the numbering scheme for freeway, bridge, and rail-only links.

## Numbering Scheme for the Majority of Bignet

Every ID consists of five to seven digits, each of which has a special meaning. Of these digits, all but the last four depend on the object type. The last four digits give the object's location. In this four-digit sequence, the first two specify the block group location and the last two specify the location within that block group (this is shown in Fig. 14).

As shown in Fig. 14, the southwest-most local block group has a block ID of 11 (this is not "eleven," but rather "one-one"—remember, every digit means something). The next block to the north is block 21 (two-one), and the next block group to the east of 11 (one-one) has ID 12. Note that the first digit is the y-block and the second is the x-block. Every object in Bignet has these two digits as fourth and third from last. For example, a node in the west half of the downtown area will have an ID of x35nn.

The last two digits of every ID denote the location within the block, again numbered from the southwest corner. Each node has a unique location. As shown in Fig. 14, the southwest-most node had local ID of 01 (zero-one). Thus, if these nodes were in the aforementioned downtown block group, they would have IDs x3500, x3510, and x3501. The "x" denotes the node type.

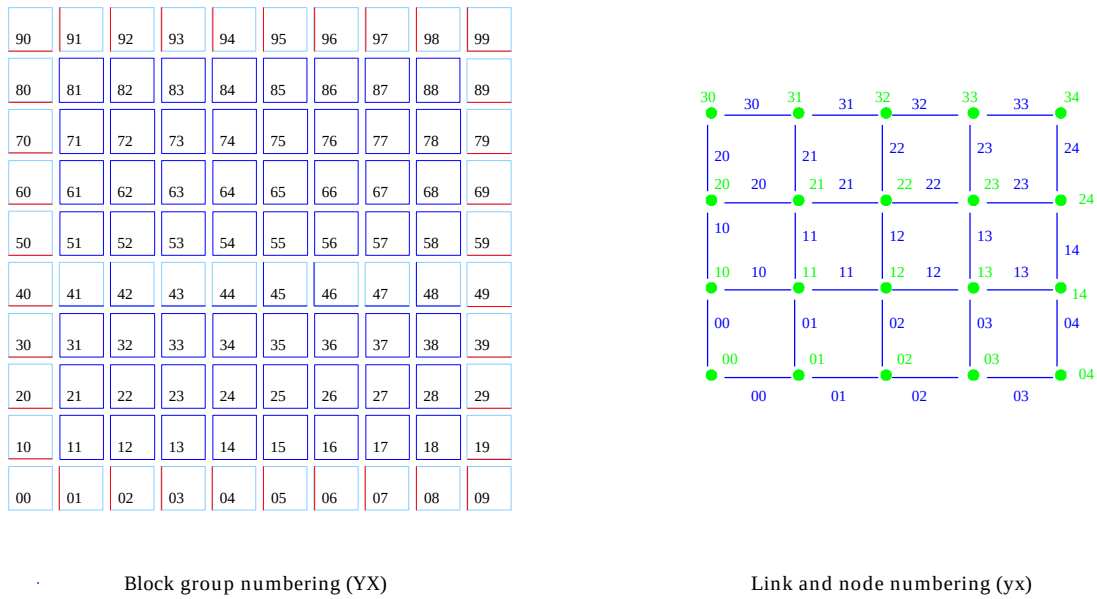



*Fig. 14. ID numbering in Bignet.*

Because each node can be specified by only the last four digits, adding another digit is not expressly necessary, but it does help the user diagnose problems. The different node types are detailed in Table 17. Links are numbered relative to the nodes to which they are connected. A link ID's last four digits match those of the node to the south or the west-end of the link. (All links are either north-south or east-west.)

**Table 17. Node control types.**

| Node type | ID | Description |
|---|---|---|
| Seamless | 1 | Freeway-Primary Arterial connection |
| Signalized | 2 | Signalized intersection with left turn pockets |
| 4-Way stop | 3 | Both NS and EW roads must stop. |
| NS Stop | 4 | NS road must stop, EW road has no control |
| EW Stop | 5 | EW road must stop, NS road has no control |
| NS Yield | 6 | NS road must yield, EW road has no control |
| EW Yield | 7 | EW road must yield, NS road has no control |
| Endnote | 8 | End of network (no more links) |

Unlike nodes, a link location does not uniquely specify the link, because two links will have the same four location digits. Therefore, the fifth digit from the right specifies the orientation of the link relative to the node with the same four location digits (see Table 18).

**Table 18. Link orientation from given node.**

| ID | Description |
|---|---|
| 1 | Link is north of node having same location |
| 2 | Link is east of node having same location |

As with nodes, each link ID includes one more piece of information beyond that required for unique specification: the link type. Listed in Table 19, these types have been discussed in previous sections. To summarize link IDs, this information is organized as "`tdYXyx`," where

- `t` denotes the link type in Table 19,
- `d` corresponds to the direction in Table 18,
- `Y` represents the north-south block in which the link is located,
- `X` is the east-west block,
- `y` is the north-south local location within that block, and
- `x` is the east-west local location within that block.

Again, note that `YXyx` corresponds uniquely to the node east or south of the link.

**Table 19. Link types.**

| Link type | ID | Description |
|---|---|---|
| Freeway | 5 | two lanes in each direction, 5 cells per second |
| Primary Arterial | 4 | two lanes in each direction, 4 cells per second |
| Secondary Arterial | 3 | two lanes in each direction, 3 sells per second |
| Collector | 2 | one lane in each direction, 2 cells per second |
| Local | 1 | one lane in each direction, 2 cells per second |

As discussed earlier, most links have parking locations and activity locations, both of which have transit stops on some secondary arterials. These are all classified as features on the link. Although physically part of a link, pocket lanes are also considered to be a link feature in TRANSIMS. Moreover, all activity locations must be connected to other link features using process links. All of these objects share the link's four location digits. Like links, they all have six digits, the first of which is the feature type (listed in Table 20), and the second of which lists a direction or orientation.

**Table 20. Link feature designations.**

| Feature type | ID | Description |
|---|---|---|
| Pocket | 6 | for left turns at signalized intersections |
| Parking | 7 | one on each side of link |
| Activity | 8 | only one per link |
| Transit Stop | 4 | one on each side of link |
| Parking-Process | 9 | transfer between Parking and Activity Location |
| Stop-Process | 5 | transfer between Transit Stop and Activity Location |

The orientation digit will be different for distinct types of features. Pocket lanes, parking locations, and transit stops all have the orientation digit filled to identify the direction of the lane to which they are attached. Because they can be on either side of the link and in Bignet links are bidirectional, this includes all four compass directions listed in Table 21.

**Table 21. Pocket, parking, and transit stop orientations.**

| Direction | ID |
|---|---|
| North | 3 |
| South | 4 |
| East | 5 |
| West | 6 |

Although parking lots are considered to be on one side of the link, they can be accessed from traffic in either direction on the link. Transit stops can be accessed only from traffic moving on the same side of the road. We need this information so we know the end of the link the left-turn lane occupies on pocket lanes.

Process links require a little more information encoded in the digit because each activity location must be connected to parking and transit stops in both directions. Furthermore, process links are unidirectional (and thus there are twice as many possible values). Table 22 lists the possible values of this digit. We do not need to distinguish whether it is a parking lot or transit stop connected to the activity because that has already been done in the ID's first digit (see Table 21).

**Table 22. Process link direction s(X = parking location or transit stop).**

| ID | Description |
|---|---|
| 1 | from X to Activity on northbound part of link |
| 2 | from X to Activity on southbound part of link |
| 3 | from X to Activity on eastbound part of link |
| 4 | from X to Activity on westbound part of link |
| 5 | to X from Activity on northbound part of link |
| 6 | to X from Activity on southbound part of link |
| 7 | to X from Activity on eastbound part of link |
| 8 | to X from Activity on westbound part of link |

Each link that has activity locations has exactly two—one on each side of the road. In Bignet, there is at most one parking lot on each link; the lot is connected to both activity locations with "from" and "to" process links.

If a Bignet link has transit stops, it has exactly two—one on each side of the road. Each transit stop is connected only to the activity location on its own side of the road. If an individual gets off transit on the northbound side, that individual must walk to the intersection and cross to get to the southbound-side activity location.

## Bridge, Freeway, and Rail-only Links

Bridges are labeled in a way that is similar to the rest of the network, except that

- the links at the beginning and the end of the block have been stretched to connect, and
- all of the links in between these two have been deleted.

The numbering of freeway and rail-only links is in no way systematic, except that all objects associated with them have ID values less than 100.

Fig. 15 shows a subset of the links and nodes on both sides of the river. The figure includes the bridges, the freeway, and two of the three rail-only links. Colors are defined as follows:

- nodes are red,
- links are black,
- freeway links are green, and
- rail-only links are in blue.

Note that the freeway has connections to nodes only at the merge and turn lanes (nodes 2, 4 and 7).

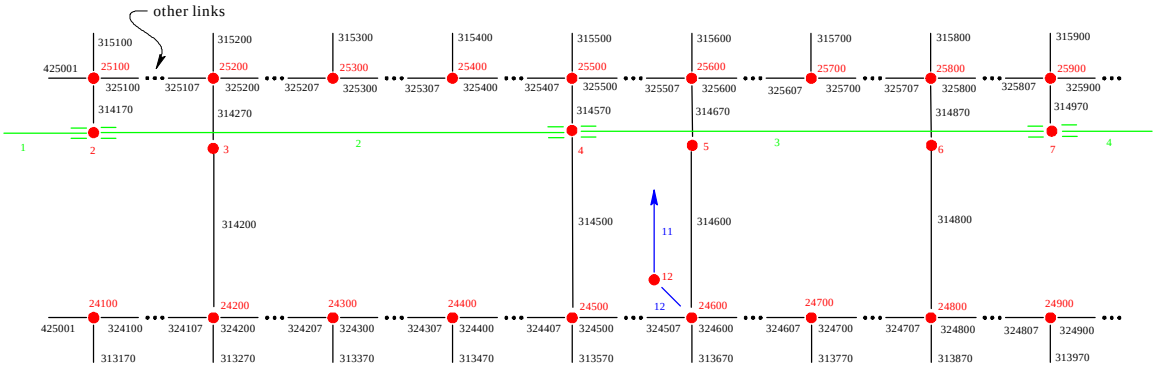



*Fig. 15. Link and node numbering around the river in Bignet (not to scale).*

The rail line consists of three rail-only links:

- At 9,185 meters in length, the first link extends from just outside the local black groups to the northeast corner of block 86.

- At 7,200 meters in length, the second link runs from block 86 to just northwest of the intersection at node 24600.
- At 60 meters in length, the third links connect the second link to that node, and thus it connects to local streets.

All three links have one lane in each direction and a maximum speed of five cells per second (37.5 m/s). Because there are no signals or competing traffic, the rail lines tend to run at this speed when on the rail-only links. On the local streets, they must obey the slower speed limit and compete with other vehicles. The rail-only links are depicted in Fig. 16. This figure shows only the secondary arterials for reference.

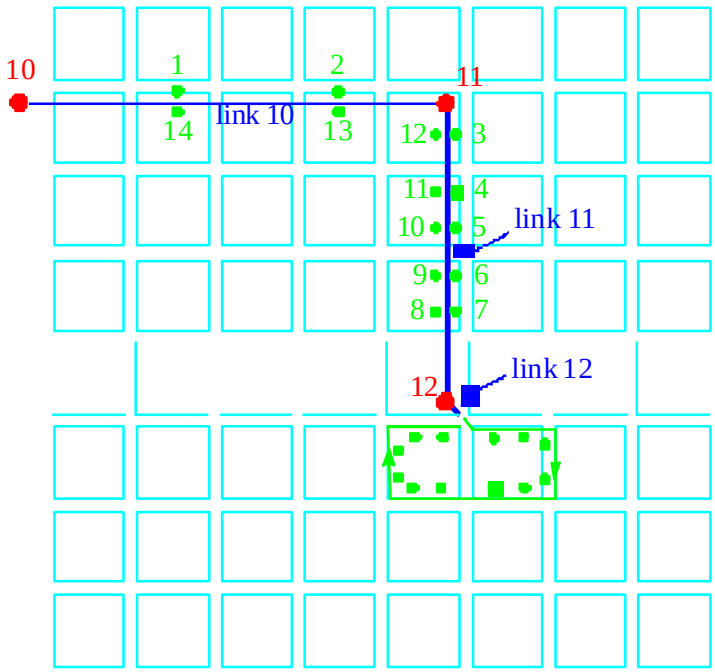



*Fig. 16. Numbering on the rail-only links (nodes in red, links in blue, and stops in green).*

There are two stops in each direction on link 10, which are numbered 1, 2, 13, and 14. These are the first two and last two stops of the rail line, respectively. Stops 1 and 14 are connected to activity location 858202, and stops 2 and 13 are connected to activity location 858402 through process links. On link 11, there are five more stops in each direction, also connected to the nearest activity location in each case. For all stops, the activity location to which they are connected also happens to be connected to a bus stop.

## Appendix B: Valid Person and Household Demographic Field Names

Following is a list of the demographic options that are available for households and the allowed values for each demographic item.

```
DATA          SIZE         BEGIN

D  RECTYPE          1            1
        Record Type
V         H  .Housing Record

D  SERIALNO         7            2
V 0000000..
    9999999  .Housing unit/GQ person serial number unique
             .identifier assigned within state or state group

D  SAMPLE           1             9
        Sample Identifier
V         1  .5% sample
V         2  .1% sample
V         3  .Elderly

D  DIVISION         1            10
        Division code
V         0  .Region/division not identifiable
V            .(Selected MSA/PMSAs on 1% sample)
V         1  .New England (Northeast region)
V         2  .Middle Atlantic (Northeast region)
V         3  .East North Central (Midwest region)
V         4  .West North Central (Midwest region)
V         5  .South Atlantic (South region)
V         6  .East South Central (South region)
V         7  .West South Central (South Region)
V         8  .Mountain (West region)
V         9  .Pacific (West region)

D  STATE            2            11
        State Code
V    01..56  .FIPS state code (See appendix I-59)
V        99  .PUMA boundaries cross state lines – 1% file

D  PUMA              5           13
        Public use microdata area (state dependent)
V   00100..
V     99999  .PUMA code (Includes tract groups) 1st 3
V            .Digits = main PUMA – generally county place
V            .Last 2 digits = groups of tracts, BNA, etc.

D  AREATYPE         2            18
        Area type revised for PUMS equivalency file
         (See Appendix C-1)
V        10  .Central city
V        11  .Central city part
V        20  .MSA/PMSA – Outside central city
V        21  .MSA/PMSA – Outside central city (part)
V        22  .Central City (part) & outside central city
V            .(part)
V        30  .Entire MSA
V        31  .2 or more MSAs/PMSAs
```

```
V        40  .Mixed MSA/PMSA/NON-MSA/PMSA area
V        50  .Outside MSA/PMSA
V        60  .Place
V        61  .Place – part
V        70  .MCDs/Towns (New England only)
V        80  .Counties/independent Cities (2 or more)
V        81  .County/independent city – part
V        82  .County/independent city

D  MSAPMSA          4            20
        MSA/PMSA
V    0040..
V      9360  .FIPS/MSA/PMSA code, selected MSA/PMSA
V            .(See appendix G)
V      9997  .Mixed MSA/PMSA NONMSA/PMSA area
V      9998  .2 or more MSAs
V      9999  .Not in MA

D  PSA              3            24
        Planning service area (elderly sample only –
         state dependent)
V       000  .N/A (Elderly PUMS only)
V  1..18B  .Planning service area codes (See appendix G)

D  SUBSAMPL         2            27
        Subsample number (Use to pull extracts – 1/1000/etc.)
V    00..99  .See text. pp 4-45.

D  HOUSWGT          4            29
        Housing Weight
V    0000..
V      1152  .Integer weight of housing unit

D  PERSONS          2            33
        Number of person records following this housing
         record
V        00  .Vacant unit
V        01  .One person record (one person in household
V            .or any person in group quarters)
V    02..29  .Number of person records (number of persons
V            .in household)

D  GQINST           1            35
        Group quarters institution
V         0  .N/A (housing unit)
V         1  .Institutionalized
V         2  .Not institutionalized

D  HFILLER          3            36
        Filler

D  UNITS1           2            39
        Units in structure
V        00  .N/A (GQ)
V        01  .Mobile home or trailer
V        02  .One-family house detached
V        03  .One-family house attached
V        04  .2 Apartments
V        05  .3-4 Apartments
V        06  .5-9 Apartments
V        07  .10-19 Apartments
V        08  .20-49 Apartments
V        09  .50 or more apartments
```

```
V        10  .Other

D  HUSFLAG          1            41
        All 100% housing unit data substituted
V         0  .No
V         1  .Yes

D  PDSFLAG          1            42
        All 100% person data substituted
V         0  .No
V         1  .Yes

D  ROOMS            1            43
        Rooms
V         0  .N/A (GQ)
V         1  .1 Room
V         2  .2 Rooms
V         3  .3 Rooms
V         4  .4 Rooms
V         5  .5 Rooms
V         6  .6 Rooms
V         7  .7 Rooms
V         8  .8 Rooms
V         9  .9 or more rooms

D  TENURE           1            44
        Tenure
V             0  .N/A (GQ/vacant)
V         1  .Owned with mortgage or loan
V         2  .Owned free and clear
V         3  .Rented for cash rent
V         4  .No cash rent

D  ACRE10           1            45
        On ten acres or more
V         0  .N/A (GQ/not a one-family house or mobile home)
V         1  .House on ten or more acres
V         2  .House on less than ten acres

D  COMMUSE          1            46
        Business or medical office on property
V         0  .N/A (GQ/not a one-family house or mobile home)
          1  .Yes
V         2  .No

D  VALUE            2            47
        Property value
V        00  .N/A (GQ/rental unit/vacant, not for sale only)
V        01  .Less than $ 10000
V        02  .$ 10000 - $ 14999
V        03  .$ 15000 - $ 19999
V        04  .$ 20000 - $ 24999
V        05  .$ 25000 - $ 29999
V        06  .$ 30000 - $ 34999
V        07  .$ 35000 - $ 39999
V        08  .$ 40000 - $ 44999
V        09  .$ 45000 - $ 49999
V        10  .$ 50000 - $ 54999
V        11  .$ 55000 - $ 59999
V        12  .$ 60000 - $ 64999
V        13  .$ 65000 - $ 69999
V        14  .$ 70000 - $ 74999
V        15  .$ 75000 - $ 79999
```

```
V        16  .$ 80000 - $ 89999
V        17  .$ 90000 - $ 99999
V        18  .$100000 - $124999
V        19  .$125000 - $149999
V        20  .$150000 - $174999
V        21  .$175000 - $199999
V        22  .$200000 - $249999
V        23  .$250000 - $299999
V        24  .$300000 - $399999
V        25  .$400000 or more

D  RENT1            2            49
        Monthly rent
V        00  .N/A (GQ/not a rental unit)
V        01  .Less than $ 80
V        02  .$  80 - $ 99
V        03  .$ 100 - $124
V        04  .$ 125 - $149
V        05  .$ 150 - $174
V        06  .$ 175 - $199
V        07  .$ 200 - $224
V        08  .$ 225 - $249
V        09  .$ 250 - $274
V        10  .$ 275 - $299
V        11  .$ 300 - $324
V        12  .$ 325 - $349
V        13  .$ 350 - $374
V        14  .$ 375 - $399
V        15  .$ 400 - $424
V        16  .$ 425 - $449
V        17  .$ 450 - $474
V        18  .$ 475 - $499
V        19  .$ 500 - $524
V        20  .$ 525 - $549
V        21  .$ 550 - $599
V        22  .$ 600 - $649
V        23  .$ 650 - $699
V        24  .$ 700 - $749
V        25  .$ 750 - $999
V        26  .$1000 or more
V        27  .No cash rent (NCR)

D  MEALS            1            51
        Meals included in rent
V         0  .N/A (GQ/not a rental unit/rental-NCR)
V         1  .Yes
V         2  .No

D  VACANCY1         1            52
        Vacant usual home elsewhere (UHE)
V         0  .N/A (occupied or regular vacant/GQ)
V         1  .Vacant UHE-owner
V         2  .Vacant UHE-renter
V         3  .Vacant UHE-undetermined

D  VACANCY2         1            53
        Vacancy status
V         0  .N/A (occupied/GQ)
V         1  .For rent
V         2  .For sale only
V         3  .Rented or sold, not occupied
V         4  .For seasonal/recreational/occasional use
V         5  .For migratory workers
```

```
V         6  .Other vacant

D  VACANCY3         1            54
         Boarded up status
V         0  .N/A (occupied/GQ)
V         1  .Yes
V         2  .No

D  VACANCY4         1            55
         Months vacant
V         0  .N/A (occupied/GQ)
V         1  .Less than 1 month
V         2  .1 up to 2 months
V         3  .2 up to 6 months
V         4  .6 up to 12 months
V         5  .12 up to 24 months
V         6  .24 or more months

D  YRMOVED          1            56
         When moved into this house or apartment
V         0  .N/A (GQ/vacant)
V         1  .1989 or 1990
V         2  .1985 to 1988
V         3  .1980 to 1984
V         4  .1970 to 1979
V         5  .1960 to 1969
V         6  .1959 or earlier

D  BEDROOMS         1            57
         Bedrooms
V         0  .N/A (GQ)
V         1  .No bedrooms
V         2  .1 Bedroom
V         3  .2 Bedrooms
V         4  .3 Bedrooms
V         5  .4 Bedrooms
V         6  .5 or more bedrooms

D  PLUMBING         1            58
         Complete plumbing facilities
V         0  .N/A (GQ)
V         1  .Yes, all three facilities
V         2  .No

D  KITCHEN          1            59
            Complete kitchen facilities
V         0  .N/A (GQ)
V         1  .Yes
V         2  .No

D  TELEPHON         1            60
         Telephone in Unit
V         0  .N/A (GQ/vacant)
V         1  .Yes
V         2  .No

D  AUTOS            1            61
         Vehicles (1 ton or less) available
V         0  .N/A (GQ/vacant)
V         1  .No vehicles
V         2  .1 vehicle
V         3  .2 vehicles
V         4  .3 vehicles
```

```
V         5  .4 Vehicles
V         6  .5 Vehicles
V         7  .6 Vehicles
V         8  .7 or more vehicles

D  FUELHEAT         1            62
        House heating fuel
V         0  .N/A (GQ/vacant)
V         1  .Gas:  Underground pipes
V         2  .Gas:  Bottled, tank, or LP
V         3  .Electricity
V         4  .Fuel oil, kerosene, etc.
V         5  .Coal or coke
V         6  .Wood
V         7  .Solar energy
V         8  .Other fuel
V         9  .No fuel used

D  WATER            1            63
        Source of water
V         0  .N/A (GQ)
V         1  .Public system or private company
V         2  .Individual drilled well
V         3  .Individual dug well
V         4  .Other source such as a spring, creek, etc.

D  SEWAGE           1            64
        Sewage disposal
V         0  .N/A (GQ)
V         1  .Public sewer
V         2  .Septic tank or cesspool
V         3  .Other means

D  YRBUILT          1            65
        When structure first built
V         0  .N/A (GQ)
V         1  .1989 or 1990
V         2  .1985 to 1988
V         3  .1980 to 1984
V         4  .1970 to 1979
V         5  .1960 to 1969
V         6  .1950 to 1959
V         7  .1940 to 1949
V         8  .1939 or earlier

D  CONDO            1            66
        House or apartment part of condominium
V         0  .N/A (GQ)
V         1  .Yes
V         2  .No

D  ONEACRE          1            67
        House on less than 1 acre
V         0  .N/A (GQ, two or more units in structure)
V             1  .Yes
V         2  .No

D AGSALES           1            68
        1989 Sales of Agriculture Products
V         0  .N/A (less than 1 acre/GQ/vacant/
V            .2  or more units in structure)
V         1  .None
V         2  .$1 to $999
```

```
V         3  .$1,000 to $2,499
V         4  .$2,500 to $4,999
V         5  .$5,000 to $9,999
V         6  .$10,000 or more

D  ELECCOST         4            69
        Electricity (yearly cost)*
V      0000  .N/A (GQ/vacant)
V      0001  .Included in rent or in condo fee
V      0002  .No charge or electricity not used
V    0003..
       3099  .$3 to $3,099
V      3100  .Topcode
V     3101+  .$3101 or more = state median of topcoded
             .values

D  GASCOST          4            73
        Gas (yearly cost)*
V      0000  .N/A (GQ/vacant)
V      0001  .Included in rent or in condo fee
V      0002  .No charge or gas not used
V    0003..
       2099  .$3 to $2,099
V      2100  .Topcode
V     2101+  .$2101 or more = state median of topcoded
             .values

D  WATRCOST         4            77
        Water (yearly cost)
V       000  .N/A (GQ/vacant)
V       001  .Included in rent or in condo fee
V       002  .No charge
V  003..999  .$3 to $999
V      1000  .Topcode
V     1000+  .$1001+ or more = state median of topcoded
             .values

D  FUELCOST         4            81
        House heating fuel (yearly cost)
V      0000  .N/A (GQ/vacant)
V      0001  .Included in rent or in condo fee
V      0002  .No charge or these fuels not used
V    0003..
       1899  .$3 to $1,899
V      1900  .Topcode
V    1,901+  .$1,901 or more = state median of topcoded
             .value

D  RTAXAMT          2            85
        Property taxes (yearly amount)
V        00  .N/A (GQ/vacant/not owned or being bought/not a
             .one-family house, mobile home or trailer or
             .condo)
V        01  .None
V        02  .$   2 - $  49
V        03  .$  50 - $  99
V        04  .$ 100 - $ 149
V        05  .$ 150 - $ 199
V        06  .$ 200 - $ 249
V        07  .$ 250 - $ 299
V        08  .$ 300 - $ 349
V        09  .$ 350 - $ 399
V        10  .$ 400 - $ 449
```

```
V        11  .$ 450 - $ 499
V        12  .$ 500 - $ 549
V        13  .$ 550 - $ 599
V        14  .$ 600 - $ 649
V        15  .$ 650 - $ 699
V        16  .$ 700 - $ 749
V        17  .$ 750 - $ 799
V        18  .$ 800 - $ 849
V        19  .$ 850 - $ 899
V        20  .$ 900 - $ 949
V        21  .$ 950 - $ 999
V        22  .$1000 - $1099
V        23  .$1100 - $1199
V        24  .$1200 - $1299
V        25  .$1300 - $1399
V        26  .$1400 - $1499
V        27  .$1500 - $1599
V        28  .$1600 - $1699
V        29  .$1700 - $1799
V        30  .$1800 - $1899
V        31  .$1900 - $1999
V        32  .$2000 - $2099
V        33  .$2100 - $2199
V        34  .$2200 - $2299
V        35  .$2300 - $2399
V        36  .$2400 - $2499
V        37  .$2500 - $2599
V        38  .$2600 - $2699
V        39  .$2700 - $2799
V        40  .$2800 - $2899
V        41  .$2900 - $2999
V        42  .$3000 - $3099
V        43  .$3100 - $3199
V        44  .$3200 - $3299
V        45  .$3300 - $3399
V        46  .$3400 - $3499
V        47  .$3500 - $3599
V        48  .$3600 - $3699
V        49  .$3700 - $3799
V        50  .$3800 - $3899
V        51  .$3900 - $3999
V        52  .$4000 - $4099
V        53  .$4100 - $4199
V        54  .$4200 - $4299
V        55  .$4300 - $4399
V        56  .$4400 - $4499
V        57  .$4500 = Topcode
V        58  .$4501 - $54992Ä¿RANGE
V        59  .$5500 - $7499  ³ FOR
V        60  .$7500 or more2ÄÙ  MEDIAN

D  HFILLER2         3            87

D  INSAMT           4            90
         Fire/hazard/flood insurance (yearly amount)
V      0000  .N/A (not owned or being bought/not a one
V            .family house, mobile home, or condo/GQ/vacant)
V      0001  .None
V    0002..
       1299  .$2 to $1,299
V      1300  .Topcode
V     1301+  .$1,301 or more=state median of topcoded values
```

```
D  MORTGAG          1            94
        Mortgage status
V         O  .N/A (not owned or being bought/not a one family
             .house, mobile home, or condo/GQ/vacant)
V         1  .Mortgage deed of trust, or similar debt
V         2  .Contract to purchase
V         3  .None

D  MORTGAG3         5            95
           Mortgage payment (monthly amount)
V     00000  .N/A (not owned or being bought/not a one
             .family house, mobile home, or condo/GQ/vacant)
V     00001  .No regular payment required
V   00002..
      01999  .$2 to $1,999
V     02000  .Topcode
V     02001+ . $2,001 or more = state median of topcoded
             .values

D  TAXINCL          1            100
        Payment include real estate taxes
V         0  .N/A (GQ/vacant/not owned or being bought/
             .not a one family house or condo/not mortgaged/
             .No regular mortgage payment)
V         1  .Yes, taxes included in payment
V         2  .No, taxes paid separately or taxes not required

D  INSINCL          1            101
        Payment include fire/hazard/flood insurance
V         0  .N/A (GQ/vacant/not owned or being bought/
             .Not a one family house, MHT or condo/not
             .mortgaged/no regular mortgage payment)
V         1  .Yes, insurance included in payment
V         2  .No, insurance paid separately or no insurance

D  MORTGAG2         1            102
        Second mortgage or home equity loan status
V         0  .N/A (GQ/vacant/not owned or being bought/
             .not a one family house, mobile home, trailer or
             .condo/not mortgaged/no second mortgage)
V         1  .Yes
V         2  .No

D  MORTAMT2         5            103
        Second mortgage payment (monthly amount)
V      00000 .N/A (GQ/vacant/condo/not owned or being
             .bought/not a one family house/not mortgaged/
             .no second mortgage)
V      00001 .No regular payment required
V    00002..
       00999 .$2 to $999
V      01000 .Topcode
V     01001+ .$1001 or more = state median of topcoded
      .values

D  CONDOFEE         4            108
        Condo fee (monthly amount)
V      0000  .N/A (not owned or being bought/not
V            .condo/GQ/vacant/no condo fee)
V    0001..
       0599  .$1 - $599
V      0600  .Topcode
V     0601+  .$601 or more = state median of topcoded values
```

```
D  MOBLHOME         4            112
        Mobile home costs (yearly amount)
V      0000  .N/A (GQ/vacant/not owned or being bought/
V            .not mobile home/no costs)
V    0001..
V      3399  .$1 - $3,399 (cost in dollars)
V      3400  .Topcode
V     3401+  .$3401 or more = state median of topcoded
V            .values

D  RFARM            1            116
        Farm/nonfarm status
V         0  .N/A (GQ/urban)
V         1  .Rural farm
V             2  .Rural nonfarm

D  RGRENT           4            117
        Gross rent
V      0000  .N/A (GQ/vacant, not rented for cash rent)
V    0001..
       1499  .Gross rent (dollars)
V      1500  .Topcode
V     1501+  .1501 or more = state median of topcoded values

D  RGRAPI           2            121
        Gross rent as a percentage of household income in
         1989
V        00  .N/A (GQ/vacant/not rented for cash rent/owner
             .occupied/no household income)
V        01  . 1% to  9%
V        02  .10% to 14%
V        03  .15% to 19%
V        04  .20% to 24%
V        05  .25% to 29%
V        06  .30% to 34%
V        07  .35% to 39%
V        08  .40% to 49%
V        09  .50% to 59%
V        10  .60% to 69%
V        11  .70% to 79%
V        12  .80% to 89%
V        13  .90% to 99%
V        14  .100% or more

D  HFILLER3         1            123
        Filler

D       ROWNRCST    5            124
        Selected monthly owner costs
V      00000 .N/A (not owned or being bought/not a one
V            .family house, mobile home, or
V            .condo/GQ/vacant/no costs )
V   00001..
      20299  .Monthly owner costs in dollars
V     20300  .Topcode

D  RNSMOCPI         3            129
        Selected monthly owner costs as a percentage of
         household income in 1989
V       000  .N/A (not owned or being bought/not a one family
             .house, mobile home, or condo/GQ/vacant/no HH
             .income)
```

```
V  001..100  .1% to 100%
V       101  .101% or more

D  RRENTUNT         1            132
        Specified rent unit
V         0  .Not specified rent unit
V         1  .Specified rent unit

D  RVALUNT          1            133
        Specified value unit
V         0  .Not specified value unit
V         1  .Specified value unit

D  RFAMINC          7            134
        Family income
V   0000000  .N/A(GQ/vacant/no income)
V -999999..
V   9999999  .Total family income in dollars (See user notes
             .for state maximum and minimum values
             .Includes single person households.)

D  RHHINC           7            141
        Household income
V   0000000  .N/A(GQ/vacant/no income)
V -999999..
    9999999  .Total household income in dollars (See user notes
             .for state maximum and minimum values)

D  RWRKR89          1            148
        Workers in family in 1989
V         0  .N/A (GQ/vacant/non-family household)
V         1  .No workers
V         2  .1 worker
V         3  .2 workers
V         4  .3 or more workers in family

D  RHHLANG          1            149
        Household language
V         0  .N/A (GQ/vacant)
V         1  .English only
V         2  .Spanish
V         3  .Other Indo-European language
V         4  .Asian or Pacific Island language
V         5  .Other language

D  RLINGISO         1            150
        Linguistic isolation
V         0  .N/A (GQ/vacant)
V         1  .Not linguistically isolated
V         2  .Linguistically isolated

D  RHHFAMTP         2            151
        Household/family type
V        00  .N/A (GQ/vacant)
V        01  .Married-couple family household
V             Other family household:
V        02  .Male householder
V        03  .Female householder
V             Nonfamily household:
V             Male householder:
V        11  .Living alone
V        12  .Not living alone
V             Female householder:
```

```
V        21  .Living alone
V        22  .Not living alone

D  RNATADPT         2            153
        Number of own natural born/adopted children in
         household (unweighted)
V        00  .N/A(GQ/vacant/no own natural born/adopted
V            .children)
V    01..28  .Number of own children natural born/adopted
             .children in household

D  RSTPCHLD         2            155
        Number of own stepchildren in household (unweighted)
V        00  .N/A(GQ/vacant/no own stepchildren)
V    01..28  .Number of own stepchildren in household

D  RFAMPERS         2            157
        Number of persons in family (unweighted)
V        00  .N/A (GQ/vacant/non-family household)
V    01..29  .Number of persons in family

D  RNRLCHLD*        2            159
        Number of related children in household (unweighted)
V        00  .N/A (GQ/vacant/no related children)
V    01..28  .Number of related children in household

D  RNONREL          1            161
            Presence of nonrelatives in household
V         0  .N/A (No nonrelatives in household/GQ/vacant)
V         1  .1 or more nonrelatives in household

D  R18UNDR          1            162
        Presence of person under 18 years in household
V         0  .N/A (No person under 18 in household/GQ/vacant)
V         1  .1 or more person under 18 in household

D  R60OVER          1            163
        Presence of persons 60 years and over in household
V         0  .N/A (No person 60 and over/GQ/vacant)
V         1  .1 person 60 and over (unweighted)
V         2  .2 or more person 60 and over (unweighted)

D  R65OVER          1            164
        Presence of person 65 years and over in household
V         0  .N/A (No person 65 and over/GQ/vacant)
V         1  .1 person 65 and over (unweighted)
V         2  .2 or more person 65 and over (unweighted)

D  RSUBFAM          1            165
        Presence of subfamilies in Household
V         0  .N/A (No subfamilies or not
V            .applicable/GQ/vacant)
V         1  .1 or more subfamilies

D  AUNITS1          1            166
        Units in structure allocation
V         0  .No
V         1  .Yes

D  AROOMS           1            167
        Rooms allocation
V         0  .No
V         1  .Yes
```

```
D  ATENURE          1            168
        Tenure allocation
V         0  .No
V         1  .Yes

D  AACRES10         1            169
        On ten acres or more allocation
V         0  .No
V         1  .Yes

D  ACOMMUSE         1            170
        Business or medical office on property allocation
V         0  .No
V         1  .Yes

D  AVALUE           1            171
        Value allocation
V         0  .No
V         1  .Yes

D  ARENT1           1            172
        Monthly rent allocation
V         0  .No
V         1  .Yes

D  AMEALS           1            173
        Meals included in rent allocation
V         0  .No
V         1  .Yes

D  AVACNCY2         1            174
        Vacancy status allocation
V             0  .No
V         1  .Yes

D  AVACNCY3         1            175
        Boarded up status allocation
V         0  .No
V         1  .Yes

D  AVACNCY4         1            176
        Months vacant allocation
V         0  .No
V         1  .Yes

D  AYRMOVED         1            177
        When moved into this house or apartment allocation
V         0  .No
V         1  .Yes

D  ABEDROOM         1            178
        Number of bedrooms allocation
V         0  .No
V         1  .Yes

D  APLUMBNG         1            179
        Complete plumbing facilities allocation
V         0  .No
V         1  .Yes

D  AKITCHEN         1            180
        Complete kitchen facilities allocation
```

```
V         0  .No
V         1  .Yes

D  APHONE           1            181
        Telephones in house allocation
V         0  .No
V         1  .Yes

D  AVEHICLE         1            182
        Vehicles available by household allocation
V         0  .No
V         1  .Yes

D  AFUEL            1            183
        House heating fuel allocation
V         0  .No
V         1  .Yes

D  AWATER           1            184
        Source of water allocation
V         0  .No
V         1  .Yes

D  ASEWER           1            185
        Sewage disposal allocation
V         0  .No
V         1  .Yes

D  AYRBUILT         1            186
        When structure first built allocation
V         0  .No
V         1  .Yes from not answered
V         2  .Yes “don’t know”

D  ACONDO           1            187
        House or apartment part of condominium allocation
V         0  .No
V         1  .Yes

D  AONEACRE         1            188
        House on less than 1 acre allocation
V         0  .No
V         1  .Yes

D  AAGSALES         1            189
        1989 Sales of Agricultural Products allocation
V         0  .No
V         1  .Yes

D  AELECCST         1            190
        Electricity (yearly cost) allocation
V         0  .No
V         1  .Yes


D  AGASCST          1            191
        Gas (yearly cost) allocation
V         0  .No
V         1  .Yes

D  AWATRCST         1            192
        Water (yearly cost) allocation
V         0  .No
```

```
V         1  .Yes

D  AFUELCST*        1            193
         House heating fuel (yearly cost) allocation
V         0  .No
V         1  .Yes

D  ATAXAMT          1            194
         Taxes on property allocation
V         0  .No
V         1  .Yes

D  AINSAMT          1            195
         Fire, hazard, flood insurance allocation
V         0  .No
V         1  .Yes

D  AMORTG           1            196
         Mortgage status allocation
V       0 .No
V       1 .Yes no answer
V       2 .Yes from junior mortgage

D  AMORTG3          1            197
         Regular mortgage payment allocation
V       0 .No
V       1 .Yes

D  ATAXINCL         1            198
         Payment include real estate taxes allocation
V       0 .No
V       1 .Yes

D  AINSINCL         1            199
         Payment include fire, hazard, flood insurance
          allocation
V       0 .No
V       1 .Yes

D  AMORTG2          1            200
         Second mortgage status allocation
V       0 .No
V       1 .Yes

D  AMRTAMT2         1            201
             Second mortgage payment allocation
V       0 .NO
V       1 .Yes

D  ACNDOFEE         1            202
         Condominium fee allocation
V       0 .No
V       1 .Yes

D  AMOBLHME         1            203
         Mobile home costs allocation
V       0 .No
V       1 .Yes

D  FILLER           28           204
```

Following is a list of the demographic options that are available for persons and the allowed values for each demographic item.

```
DATA                    SIZE     BEGIN

D  RECTYPE          1            1
        Record Type
V          P .Person Record

D  SERIALNO         7            2
V  0000000..
V    9999999 .Housing unit/GQ person serial number unique
V            .identifier assigned within state or state group

D  RELAT1           2            9
        Relationship
V         00 .Householder
V         01 .Husband/wife
V         02 .Son/daughter
V         03 .Stepson/stepdaughter
V         04 .Brother/sister
V         05 .Father/mother
V         06 .Grandchild
V         07 .Other relative
              Not related
V         08 .Roomer/boarder/foster child
V         09 .Housemate/roommate
V         10 .Unmarried partner
V         11 .Other nonrelative
              Group quarters
V         12 .Institutionalized person
V         13 .Other persons in group quarters

D  SEX              1           11
        Sex
V          0 .Male
V          1 .Female

D  RACE             3           12
        Recoded detailed race code (Appendix C)
V    001-037 .(See appendix C)
V    301-327 .American Indian Tribes

D  AGE              2           15
        Age
V         00 .Less than 1 year
V     01..89 .Age in years
V         90 .90 or more years old

D  MARITAL          1           17
        Marital status
V          0 .Now married, except separated
V          1 .Widowed
V          2 .Divorced
V          3 .Separated
V          4 .Never married or under 15 years old

D  PWGT1            4            18
        Person’s weight
V     0001..
V       1152 .Person’s weight

D  PFILLER1         4            22
        Filler
```

```
D  REMPLPAR         3            26
        Employment status of parents
V        000 .N/A (not own child of householder, and not
             .child in subfamily)
V           Living with two parents:
V             Both parents in labor force:
V       111     .Both parents at work 35 or more hours
V       112     .Father only at work 35 or more hours
V       113     .Mother only at work 35 or more hours
V       114     .Neither parent at work 35 or more hours
V             Father only in labor force:
V       121     .Father at work 35 or more hours
V       122     .Father not at work 35 or more hours
V             Mother only in labor force:
V       133     .Mother at work 35 or more hours
V       134     .Mother not at work 35 or more hours
V       141   Neither parent in labor force
V           Living with one parent:
V             Living with father:
V       211     .Father at work 35 or more hours
V       212     .Father not at work 35 or more hours
V       213     .Father not in labor force
V             Living with mother:
V       221     .Mother at work 35 or more hours
V       222     .Mother not at work 35 or more hours
V       223     .Mother not in labor force

D  RPOB             2           29
        Place of birth (Recode)
V       10   .Born in State of residence
V           Born in other State in the U.S.:
V       21   .Northeast
V       22   .Midwest
V       23   .South
V       24   .West
V           U.S. outlying areas:
V       31   .Puerto Rico
V       32   .American Samoa
V       33   .Guam
V       34   .Northern Marianas
V       35   .US Virgin Islands
V       36   .Elsewhere
V       40   .Born abroad of American parents
V           Foreign born:
V       51   .Naturalized citizen
V       52   .Not a citizen

D  RSPOUSE          1            31
        Married, spouse present/spouse absent
V        0   .N/A (less than 15 years old)
V        1   .Now married, spouse present
V        2   .Now married, spouse absent
V        3   .Widowed
V        4   .Divorced
V        5   .Separated
V        6   .Never married

D  ROWNCHLD         1            32
            *Own child (see Appendix B, page 14)
V       * 1   .Own child
V       * 0   .Not own child

D  RAGECHLD         1            33
```

```
        Presence and age of own children
V        * 0 .N/A (male)
V          1 .With own children under 6 years only
V          2 .With own children 6 to 17 years only
V          3 .With own children under 6 years and 6 to 17
             .years
V        *  4 .No own children (.incl. females under 16 years)
D  RRELCHLD         1            34

            *Related child (see Appendix B, Page 14)
V         * 1 .Related child
V         * 0 .Not related child

D  RELAT2           1            35
        Detailed relationship (other relative)
V          0 .N/A (GQ/not other relative)
V          1 .Son-in-law/daughter-in-law
V          2 .Father-in-law/mother-in-law
V          3 .Brother-in-law/sister-in-law
V          4 .Nephew/niece
V          5 .Grandparent
V          6 .Uncle/aunt
V          7 .Cousin
V          8 .Other related by blood or marriage
V          9 .Other relative

D  SUBFAM2          1            36
        Subfamily number
V          0 .N/A (GQ/not in a subfamily)
V          1 .In subfamily 1
V          2 .In subfamily 2
V          3 .In subfamily 3

D  SUBFAM1          1            37
        Subfamily relationship
V          0 .N/A (GQ/not in a subfamily)
V          1 .Husband/wife
V          2 .Parent in a parent/child subfamily
V          3 .Child in subfamily

D  HISPANIC         3            38
        Detailed Hispanic origin code (See appendix I)
V  000,006.. .
         199 . Not hispanic
V  001,210..
         220 .Mexican, mex-am
V  002,261..
         270 .Puerto Rican
V  003,271..
         274 .Cuban
V   221..230 .Central American
V   231..249 .South American
V   275..289 .Dominican
V  004,200..
   209,250..
         260
V   290..401 .Other Hispanic

D  POVERTY          3            41
        Person poverty status recode (See appendix B)
V        000 .N/A
V   001..500 .% Below or above poverty status value
V        501 .501% or more of poverty value
```

```
D  POB              3            44
        Place of birth (Appendix I)
V 001..056   .FIPS State code (U.S. States and D.C.)
V 060..099   .Puerto Rico (072) or U.S. outlying area
V 100..553   .Foreign country
V      554   .At sea
V      555   .Abroad, not specified

D  CITIZEN          1            47
        Citizenship
V        0   .Born in the U.S.
V        1   .Born in Puerto Rico, Guam, and outlying areas
V        2   .Born abroad of American parents
V        3   .U.S. citizen by naturalization
V        4   .Not a citizen of the U.S.

D  IMMIGR           2            48
        Year of entry
V       00   .Born in the U.S.
V       01   .1987 to 1990
V       02   .1985 to 1986
V       03   .1982 to 1984
V       04   .1980 or 1981
V       05   .1975 to 1979
V       06   .1970 to 1974
V       07   .1965 to 1969
V       08   .1960 to 1964
V       09   .1950 to 1959
V       10   .Before 1950

D  SCHOOL           1            50
        School enrollment
V        0   .N/A (less than 3 years old)
V        1   .Not attending school
V        2   .Yes, public school, public college
V        3   .Yes, private school, private college

D  YEARSCH          2            51
        Educational attainment
V       00 .N/A (less than 3 years old)
V       01 .No school completed
V       02 .Nursery school
V       03 .Kindergarten
V       04 .1st, 2nd, 3rd, or 4th grade
V       05 .5th, 6th, 7th, or 8th grade
V       06 .9th grade
V       07 .10th grade
V       08 .11th grade
V       09 .12th grade, no diploma
V       10 .High school graduate, diploma or GED
V       11 .Some college, but no degree
V       12 .Associate degree in college, occupational program
V       13 .Associate degree in college, academic program
V       14 .Bachelor's degree
V       15 .Master's degree
V       16 .Professional degree
V       17 .Doctorate degree

D  ANCSTRY1         3            53
        Ancestry – first entry (See appendix I)
V 001..998   .Ancestry codes – first entry
V      999   .Not reported
```

```
D  ANCSTRY2         3            56
        Ancestry – second entry (See appendix I)
V        000 .No secondary ancestry
V   001..998 .Ancestry codes
V        999 .Not reported

D  MOBILITY         1            59
        Mobility status (lived here on April 1, 1985)
V          0 .N/A(less than 5 years old)
V          1 .Yes same house (nonmovers)
V          2 .No, different house (movers)

D  MIGSTATE         2            60
        Migration – State or foreign country code
         (Appendix I)
V         00 .N/A (person less than 5 years old/lived
V             .in same house in 1985)
V     01..56 .FIPS state code (U.S. States and D.C.)
V         72 .Puerto Rico
V         98 .Other abroad in 1985
V         99 .State not identified (B sample)

D  MIGPUMA          5            62
        Migration PUMA (state dependent)
V      00000 .N/A (person less than 5 years old/lived in
             .same house in 1985)
V    00100..
       99800 .Migration PUMA  (Not coded to tract level)
V      99900 .Abroad

D  LANG1            1            67
        Language other than English at home
V          0 .N/A (less than 5 years old)
V          1 .Yes, speaks another language
V          2 .No, speaks only English

D  LANG2            3            68
        Language spoken at home (See appendix I)
V   000..600 .N/A (less than 5 years old/speaks only
             .English)
V   601..999 .Specific language codes

D  ENGLISH          1            71
        Ability to speak English
V          0 .N/A (less than 5 years old/speaks only English)
V          1 .Very well
V          2 .Well
V          3 .Not well
V          4 .Not at all

D  MILITARY         1            72
        Military service
V          0 .N/A (less than 16 years old)
V          1 .Yes, now on active duty
V          2 .Yes, on active duty in past, but not now
V          3 .Yes, service in reserves or national guard only
V          4 .No service

D  RVETSERV         2            73
        Veteran period of service
V       00   .N/A (less than 16 years old, no active duty)
V       01   .September 1980 or later only
```

```
V       02   .May 1975 to August 1980 only
V       03   .May 1975 to August 1980 and September 1980
V            .or later only
V       04   .Vietnam era, no Korean conflict, no WWII
V       05   .Vietnam era and Korean conflict, no WWII
V       06   .Vietnam era and Korean conflict and WWII
V       07   .February 1955 to July 1964 only
V       08   .Korean conflict, no Vietnam era, no WWII
V       09   .Korean conflict and WWII, no Vietnam era
V       10   .WWII, no Korean conflict, no Vietnam era
V       11   .Other service

D  SEPT80           1            75
             Served September 1980 or later
V        0   .(Did not serve this period/less than 16 years
V            .old)
V        1   .Served this period

D  MAY75880         1            76
        Served May 1975 to August 1980
V        0   .(Did not serve this period/less than 16 years
V            .old)
V        1   .Served this period

D  VIETNAM          1            77
        Served Vietnam era (August 1964 – April 1975)
V        0   .(Did not serve this period/less than 16 years
V            . old)
V        1   .Served this period

D  FEB55            1            78
        Served February 1955 – July 1964
V        0   .(Did not serve this period/less than 16 years
V            .old)
V        1   .Served this period

D  KOREAN           1            79
        Served Korean conflict (June 1950 – January 1955)
V        0   .(Did not serve this period/less than 16 years
V            .old)
V        1   .Served this period

D  WWII             1            80
        Served World War II (September 1940 – July 1947)
V        0   .(Did not serve this period/less than 16 years
V            .old)
V        1   .Served this period

D  PFILLER2         1            81
        Filler

D  OTHRSERV         1            82
        Served any other time
V        0   .(Did not serve this period/less than 16 years
V            .old)
V        1   .Served this period

D  YRSSERV          2            83
        Years of active duty military service
V       00   .N/A (less than 16 years/no active duty military
V            .service)
V       01   .1 Year or less of service
V   02..49   .2 to 49 years of service
```

```
V       50   .50 or more years of service

D  DISABL1          1            85
        Work limitation status
V          0 .N/A (less than 16 years, and selected persons in
V            .GQs – See appendix C)
V          1 .Yes, limited in kind or amount of work
V          2 .No, not limited

D  DISABL2          1            86
        Work prevented status
V          0 .N/A(less than 16 years, and selected persons in
V            .GQs – See appendix C)
V          1 .Yes, prevented from working
V          2 .No, not prevented from working

D  MOBILLIM         1            87
        Mobility limitation
V          0 .N/A (less than 15 years/institutionalized
V                .person, and selected persons in GQs –
V            .See appendix C)
V          1 .Yes, has a mobility limitation
V          2 .No, does not have a mobility limitation

D  PERSCARE         1            88
        Personal care limitation
V          0 .N/A (less than 15 years/institutionalized
V            .person, and selected persons in GQs –
V            .See appendix C)
V          1 .Yes, has a personal care limitation
V          2 .No, does not have a personal care limitation

D  FERTIL           2            89
        Number of children ever born
V         00 .N/A (less than 15 years/male)
V         01 .No children
V         02 .1 Child
V         03 .2 Children
V         04 .3 Children
V         05 .4 Children
V         06 .5 Children
V         07 .6 Children
V         08 .7 Children
V         09 .8 Children
V         10 .9 Children
V         11 .10 Children
V         12 .11 Children
V         13 .12 or more children

D  RLABOR           1            91
        Employment status recode
V          0 .N/A (less than 16 years old)
V          1 .Civilian employed, at work
V          2 .Civilian employed, with a job but not at work
V          3 .Unemployed
V          4 .Armed forces, at work
V          5 .Armed forces, with a job but not at work
V          6 .Not in labor force

D  WORKLWK          1            92
        Worked last week
V          0 .N/A (less than 16 years old/not at work/
V            .unemployed/NILF/Q21A not reported)
```

```
V          1 .Worked
V          2 .Did not work

D  HOURS            2            93
        Hours worked last week
V       00   .N/A (less than 16 years old/not at
V            .work/unemployed/NILF)
V   01..98   .1 to 98 hours worked last week
V       99   .99 or more hours worked last week

D  POWSTATE         2            95
        Place of work – state – (Appendix I)
V       00   .N/A (not a worker—not in the labor force,
V            .including persons under 16 years; unemployed;
V            .employed, with a job not at work; Armed Forces,
             .With a job but not at work)
V    01-56   .FIPS state code (U.S. States and D.C.)
V       98   .Abroad
V       99   .State not identified

D  POWPUMA          5            97
        Place of work PUMA (State dependent)
V    00000   .N/A (not a worker—not in the labor force,
V            .including persons under 16 years;
V            .unemployed; employed, with a job but not at
V            .work; Armed Forces, with a job but not at
V            .work)
V  00100..
     99800   .PUMA of work (Not coded to tract level)
V    99900   .Abroad

D  MEANS            2            102
        Means of transportation to work
V       00   .N/A (not a worker—not in the labor force,
V            .including persons under 16 years;  unemployed;
V            .employed, with a job but not at work;  Armed
V            .Forces, with a job but not at work)
V       01   .Car, truck, or van
V       02   .Bus or trolley bus
V       03   .Streetcar or trolley car
V       04   .Subway or elevated
V       05   .Railroad
V       06   .Ferryboat
V       07   .Taxicab
V       08   .Motorcycle
V       09   .Bicycle
V       10   .Walked
V       11   .Worked at home
V       12   .Other method

D  RIDERS           1            104
        Vehicle occupancy
V        0   .N/A (not a worker or worker whose means of
V            .transportation to work was not car, truck,
V            .or van)
V        1   .Drove alone
V        2   .2 People
V        3   .3 People
V        4   .4 People
V        5   .5 People
V        6   .6 People
V        7   .7 to 9 people
V        8   .10 or more people
```

```
D  DEPART           4            105
        Time of departure for work – hour and minute
V       0000 .N/A (not a worker or worker who worked at
             .home)
V     0001..
        2400 .Time (hour and minute of departure for
             .work) (2400 midnight)

D  TRAVTIME         2            109
        Travel time to work
V         00 .N/A (not a worker or worker who worked at home)
V     01..98 .1 to 98 minutes to get to work
V         99 .99 Minutes or more to get to work

D  TMPABSNT         1            111
        Temporary absence from work
V          0 .N/A (less than 16 years old/at work/did not
             .report Q25)
V          1 .Yes, on layoff
V          2 .Yes, on vacation, temporary illness, labor
             .dispute
V          3 .No

D  LOOKING          1            112
        Looking for work
V          0 .N/A (less than 16 years old/at work/did not
             .report Q26A)
V          1 .Yes
V          2 .No

D  AVAIL            1            113
        Available for work
V          0 .N/A (less than 16 years/at work/not looking/
             .Q26A = 0/did not report Q26B)
V          1 .No, already has a job
V          2 .No, temporarily ill
V          3 .No, other reasons (in school, etc.)
V          4 .Yes, could have taken a job

D  YEARWRK          1            114
        Year last worked
V          0 .N/A (less than 16 years old)
V          1 .1990
V          2 .1989
V          3 .1988
V          4 .1985 to 1987
V          5 .1980 to 1984
V          6 .1979 or earlier
V          7  .Never worked

D  INDUSTRY         3            115
        Industry
V        000 .N/A (less than 16 years old/unemployed who
             .never worked/nilf who last worked prior to
             .1985)
V 010..992   .specific industry codes (see appendix I)

D  OCCUP            3            118
        Occupation
V      000   .N/A (less than 16 years old/unemployed who
             .never worked/nilf who last worked prior to
             .1985)
```

```
V 003..909   .specific occupation codes (see appendix I)

D  CLASS            1            121
        Class of worker
V        0   .N/A (less than 16 years old/unemployed who
V            .never worked/NILF who last worked prior to
V            .1985)
V        1   .employee of a private for profit company or
V            .business or of an individual, for wages,
V            .salary, or commissions
V        2   .Employee of a private not-for-profit,
V            .tax-exempt, or charitable organization
V        3   .Local government employee (city, county, etc.)
V        4   .State government employee
V        5   .Federal government employee
V        6   .Self-employed in own not incorporated
V            .business, professional practice, or farm
V        7   .Self-employed in own incorporated
V            .business, professional practice or farm
V        8   .Working without pay in family business or farm
V        9   .Unemployed, last worked in 1984 or earlier

D  WORK89           1            122
        Worked last year (1989)
V        0   .N/A (less than 16 years old)
V        1   .Worked last year
V        2   .Did not work last year

D  WEEK89           2            123
        Weeks worked last year (1989)
V       00   .N/A (less than 16 years old/did not work in
             .1989)
V   01..52   .1 to 52 weeks worked last year

D  HOUR89           2            125
        Usual hours worked per week last year (1989)
V       00   .N/A (less than 16 years old/did not work in
                 .1989)
V   01..98   .1 To 98 usual hours
V       99   .99 Or more usual hours

D  REARNING         6            127
        Total person's earnings
V     000000 .N/A (no earnings)
V     -19996 .Loss of $19996 or more
V   -19995..
      283999 .Total person's earnings in dollars
V     284000 .$284000 = Topcode
V    284001+ .State medians included

D  RPINCOME         6            133
        Total person's income (signed)
V    000000   .N/A (no income)
V    -29997   .Loss of $29997 or more
V  -29996..
     400999  .Total person's income in dollars
V    401000  .Topcode of total person's income
V   401001+  .State medians included

D  INCOME1          6            139
        Wages or salary income in 1989
V    000000  .N/A (less than 16 years old/none)
V  000001..
```

```
V    139999  .$1 – 139,999
V    140000  .Topcode
V   140001+  .140001 or more = state median of topcoded
V            .values

D  INCOME2          6            145
           Nonfarm self-employment income in 1989 (signed)
V   000000   .N/A (less than 16 years/none)
V   -09999   .Loss of $9,999 or more
V   -00001..
V     -09998 .Loss $1 to $9,998
V     000001 .Break even or $1
V   000002..
      089999 .$2 To $89999
V     090000 .Topcode
V    090001+ .$90,001 or more = state median of topcoded
             .values

D  INCOME3          6            151
        Farm self-employment income in 1989 (signed)
V     000000 .N/A (less than 16 years/none)
V     -09999 .Loss of $9,999 or more
V  -00001 to
      -09998 .Loss $1 to $9,998
V          1 .Break even or $1
V   000002..
      053999 .$2 To $53999
V     054000 .Topcode
V    054001+ .$54001 or more = state median of
             .topcoded values

D  INCOME4          6            157
        Interest, dividends, and net rental income in 1989 (signed)
V     000000 .N/A (less than 15 years/none)
V     -09999 .Loss of $9,999 or more
V  -00001 to
      -09998 .Loss $1 to $9,998
V          1 .Break even or $1
V   000002..
      039999 .$2 To $39999
V     040000 .Topcode
V    040001+ .$40001 or more = state median of
             .topcoded values
D  INCOME5          5            163
        Social security income in 1989
V      00000 .N/A (less than 15 years/none)
V    00001..
       16999 .$1 to $16999
V      17000 .Topcode
V     17001+ .17001 or more = state median of topcoded
             .values

D  INCOME6          5            168
        Public assistance income in 1989
V      00000 .N/A (less than 15 years/none)
V    00001..
        9999 .$1 To $9999
V      10000 .Topcode
V     10001+ .$10001 or more = state median

D  INCOME7          5            173
        Retirement income in 1989
V    00000   .N/A (less than 15 years/none)
```

```
V    00001..
       29999 .$1 to $29999
V      30000 .Topcode
V     30001+ .$30001 or more = state median of topcoded
             .values

D  INCOME8          5            178
        All other income in 1989
V    00000   .N/A (less than 15 years/none)
V  00001..
     19999   .$1 to $19999
V    20000   .Topcode
V   20001+   .$20,001 or more = state median of topcoded
             .values

D  AAUGMENT         1            183
        Augmented person (see text pp. C-5)
V        0   .No
V        1   .Yes

D  ARELAT1          1            184
        Relationship allocation flag
V        0   .No
V        1   .Yes

D  ASEX             1            185
        Sex allocation flag
V        0   .No
V        1   .Yes

D  ARACE            1            186
        Detailed race allocation flag
V        0   .No
V        1   .Yes

D  AAGE              1           187
        Age allocation flag
V        0   .No
V        1   .Yes

D  AMARITAL         1            188
        Marital status allocation flag
V        0   .No
V        1   .Yes

D  AHISPAN          1            189
        Detailed Hispanic origin allocation flag
V        0   .No
V        1   .Yes
D  ABIRTHPL         1            190
        Place of birth
V        0   .No
V        1   .Yes

D  ACITIZEN         1            191
        Citizenship allocation flag
V        0   .No
V        1   .Yes

D  AIMMIGR          1            192
        Year of entry allocation flag
V       0 .No
V       1 .Yes
```

```
D  ASCHOOL          1            193
        School enrollment allocation flag
V       0 .No
V       1 .Yes

D  AYEARSCH         1            194
        Highest education allocation flag
V          0 .No
V          1 .Yes

D  AANCSTR1         1            195
        First ancestry allocation flag
V          0 .No
V          1 .Yes

D  AANCSTR2         1            196
        Second ancestry allocation flag
V          0 .No
V          1 .Yes

D  AMOBLTY          1            197
        Mobility status allocation flag
V          0 .No
V          1 .Yes

D  AMIGSTATE        1            198
        Migration state allocation flag
V          0 .No
V          1 .Yes

D  ALANG1           1            199
        Language other than English allocation flag
V          0 .No
V          1 .Yes

D  ALANG2           1            200
        Language spoken at home allocation flag
V          0 .No
V          1 .Yes

D  AENGLISH         1            201
        Ability to speak English allocation flag
V          0 .No
V          1 .Yes

D  AVETS1           1            202
        Military service allocation flag
V          0 .No
V          1 .Yes

D  ASERVPER         1            203
        Military periods of service allocation flag
V          0 .No
V          1 .Yes
D  AYRSSERV         1            204
        Years of military service allocation flag
V          0 .No
V          1 .Yes

D  ADISABL1         1            205
        Work limitation status allocation flag
V        0   .No
```

```
V        1   .Yes

D  ADISABL2         1            206
        Work prevention status allocation flag
V        0   .No
V        1   .Yes

D  AMOBLLIM         1            207
        Mobility limitation status allocation flag
V        0   .No
V        1   .Yes

D  APERCARE         1            208
        Personal care limitation status allocation flag
V        0   .No
V        1   .Yes

D  AFERTIL          1            209
        Children ever born allocation flag
V        0   .No
V        1   .Yes

D  ALABOR           1            210
        Employment status recode allocation flag
V        0   .No
V        1   .Yes

D  AHOURS           1            211
        Hours worked last week allocation flag
V        0   .No
V        1   .Yes

D  APOWST           1            212
        Place of work state allocation flag
V        0   .No
V        1   .Yes

D  AMEANS           1            213
        Means of transportation to work allocation flag
V        0   .No
V        1   .Yes

D  ARIDERS          1            214
        Vehicle occupancy allocation flag
V        0   .No
V        1   .Yes

D  ADEPART          1            215
        Time of departure to work allocation flag
V        0   .No
V        1   .Yes

D  ATRAVTME         1            216
        Travel time to work allocation flag
V        0   .No
V        1   .Yes

D  ALSTWRK          1            217
        Year last worked allocation flag
V        0   .No
V        1   .Yes

D  AINDUSTR         1            218
```

```
        Industry allocation flag
V       0 .No
V       1 .Yes

D  AOCCUP           1            219
        Occupation allocation flag
V       0 .No
V       1 .Yes

D  ACLASS           1            220
        Class of worker allocation flag
V          0 .No
V          1 .Yes

D  AWORK89          1            221
        Worked last year allocation flag
V          0 .No
V          1 .Yes

D  AWKS89           1            222
        Weeks worked in 1989 allocation flag
V          0 .No
V          1 .Yes

D  AHOUR89          1            223
        Usual hours worked per week in 1989 allocation flag
V          0 .No
V          1 .Yes

D  AINCOME1          1           224
        Wages and salary income allocation flag
V          0 .No
V          1 .No (derived)
V          2 .Yes

D  AINCOME2         1            225
        Nonfarm self-employment income allocation flag
V          0 .No
V          1 .No (derived)
V          2 .Yes

D  AINCOME3         1            226
        Farm self-employment income allocation flag
V          0 .No
V          1 .No (derived)
V          2 .Yes

D  AINCOME4         1            227
        Interest, dividend, and net rental income allocation flag
V          0 .No
V          1 .No (derived)
V          2 .Yes

D  AINCOME5         1            228
        Social security income allocation flag
V          0 .No
V          1 .No (derived)
V          2 .Yes
D  AINCOME6         1            229
        Public assistance allocation flag
V        0   .No
V        1   .No (derived)
V        2   .Yes
```

```
D  AINCOME7         1            230
        Retirement income allocation flag
V        0   .No
V            1   .No (derived)
V        2   .Yes

D  AINCOME8         1            231
        All other income allocation flag
V        0   .No
V        1   .No (derived)
V        2   .Yes
```

# Appendix C: Calibration Error Codes

Error codes Calibration are in the range 14000 – 14999.

**Table 23. Calibration error codes.**

| Code | Description |
|---|---|
| 14001 | Caught signal. |
| 14002 | Assertion failed. |
| 14003 | Invalid program usage. |
| 14004 | Failed to open file for reading. |
| 14005 | Failed to open file for writing. |
| 14006 | Required column missing in microsimulation output. |
| 14007 | Signal time not matched with vehicle snapshot time. |

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