

7 Transit Networks

The transit network represents major fixed-route transit services. In the SACSIM model, the transit network is essentially an overlay on the road network, primarily by designation of bus transit lines on the road network. Separate transit-only links are coded for light rail transit lines, which generally operate on exclusive right-of-way. The SACSIM model can represent the impacts of increased road congestion on bus travel times as well as time savings for buses traveling in HOV or managed lanes.

7.1 Working with the Transit Network

7.1.1 Fixed-Route Regular Bus Services

1. Open the transit line file (tranline.txt) in Cube to edit fixed-route, normal bus service attributes:
 - o Line geometry (which streets bus routes use)
 - o [Line attributes](#), discussed below
2. Use the Cube interface to add new lines or delete lines.

7.1.2 Rail Transit Services

1. Edit the geometry (i.e., where the rail line goes):
 - a. Open the transit.txt line file in Cube
 - b. Add nodes to the SACSIM highway network at each stop location and significant vertex (e.g. where the line makes a significant turn).
 - c. Update the [CSVs of rail links and station links](#) in Excel.
2. Update the node list and other [transit line attributes](#) in Cube.

7.1.3 Bus Rapid Transit (BRT)

There is no established, single way to represent BRT in SACSIM, but below are some general guidelines to follow depending on the flavor of BRT you intend to represent.

- For BRT that acts more like rail, with total or near-total separation from mixed-flow vehicular traffic, it may be best to code as a rail transit service.
- For bus services that have some of the operational features of BRT that speed up service (e.g. off-board fare payment, queue-jump lanes, etc.) but operate with some mixed-flow vehicular traffic, SACOG convention has been to code it as a [normal bus service](#), but to adjust the [time factor](#) attribute to have the bus speed be closer to that of non-transit vehicular traffic.

7.1.4 Park-and-Ride Lots

To edit or update park-and-ride facilities in SACSIM, refer to the [section on Park-and-Rides](#).

7.1.5 Coding Future or Forecasted Transit Service

How you code in future transit service into the model network entails essentially the same procedures and file types as coding in or editing existing transit service, described above. However, *what* you code in (e.g., where you put future service, how frequent you make it, what times of day it

runs, which stops have park-and-ride facilities, etc.) depends on the application or scenario you are modeling transit for. Some examples include:

- Modeling future services explicitly planned by a transit agency, such as a planned rail line extension, service reorganization, or new bus route.
- Aligning future transit service with expected population in job growth, even if it is not based on explicit transit agency plans, which rarely forecast transit service more than five years out. SACOG's 2020 MTP-SCS applied this approach in developing its future-year transit services, providing new service or increased service levels to areas in which it forecasted significant job or population growth.

7.2 Transit Lines

The major fixed route transit services in the SACOG region are explicitly represented in the transit networks as “lines”, or series of stops served by a transit vehicle at a specified service frequency. Table 7-1 provides a listing of the operators included. Each line operating on a fixed (or largely fixed) route, and with a published schedule, is coded into the SACSIM transit networks.

7.2.1 Transit Service Periods

SACSIM fixed-route transit considers five different service periods:

- Period 1, spanning from 5:00am until 9:00am
- Period 2, from 9:00am until 3:00pm
- Period 3, from 3:00pm until 6:00pm
- Period 4, from 6:00pm until 8:00pm
- Period 5, from 8:00pm until 11:00pm

By breaking up transit service into these periods, SACSIM aims to accurately represent how transit service varies throughout the day, e.g.:

- Transit availability and frequency differences throughout the day
- How transit is affected by changes in highway traffic congestion throughout the day

7.2.2 Transit Line Attributes

Table 7-2 provides a listing of the key variables coded for each transit line.

- The NAME of the line.
 - For lines existing in the base year, the first 4 characters refer to the operator name:
 - AMTR – Amtrak Capitol Corridor service
 - AUBT – Auburn Transit
 - CSUS – California State University Sacramento Hornet Shuttle
 - ELDO – El Dorado Transit
 - ETRN – E-Tran, in Elk Grove
 - FOLS – Folsom Stage Line
 - PLAC – Placer County Transit
 - RSVL – Roseville Transit
 - SCTL – South County Link (serving south Sacramento County)
 - SRTD – Sacramento Regional Transit District
 - UTRN - Unitrans
 - YOLO – Yolo County Transportation District (Yolobus)
 - YUSU – Yuba-Sutter Transit
 - The next characters up until the underscore (_) refer to the line number
 - The A/B indicator after the underscore refers to the direction
 - Example: SRTD1_ A = Sacramento Regional Transit route 1, direction A
 - Not all routes are split out by direction
- TIMEFACs are factors applied multiplicatively to the time on the transit supply link (for transit only links like LRT or BRT) or the congested time from the highway network for the appropriate [service period](#) (for lines operating in mixed traffic on the road network) to factor

in stops and dwell time into overall transit travel times. Table 7-3 shows the typical transit time factors used in SACSIM.

- ONEWAY is an indicator for a one-way direction route. An example of a true one-way route is one of the many commuter buses into Downtown Sacramento, which operate inbound-only in the morning, and outbound-only in the afternoon. ONEWAY is also used on many two-way routes that are broken out into two separate, one-way routes to account for routing or scheduling differences between the two directions.
- CIRCULAR is an indicator of routes operating as a loop, with the last station or stop on one trip being the first station or stop on the next trip. Riders of CIRCULAR routes do not incur any wait time penalty if their trip takes them through the route's last/first stop.
- OPERATOR is a variable which serves both as an identifier for the operating entity for each line, and as a lookup reference for fares.
- MODE is an indicator of the transit "submode" for each line. Submodes include: rail; commuter bus; and all other bus.
 - Note - links added to the lines through the Cube PT "autogenerate" functions (MODE =12, 13) are used for controlling access to and from stations or stops
- COLOR indicates more general service types, listed below. Important to note is that COLOR value does not in any way affect a line's attractiveness, travel speed, etc. It is primarily used to visually denote different service types when mapping transit lines, or for getting ridership or other tallies grouped by service type.
 - *1 = Light Rail.* Lines are generally longer, linear, run in their own dedicated right of way, and outside of downtown centers usually have stops spaced more than 0.5 miles apart.
 - *3 = Commuter Bus.* These bus services usually serve only during the AM and PM peak periods and serve major employment centers such as downtown Sacramento and UC Davis. These services generally have several stops at the "home end" where users live and at the "work end" where users work, with few if any stops in between.
 - *4 = Bus Rapid Transit (low).* As discussed under [Working with the Transit Network](#), bus rapid transit, or BRT, usually has routes that are similar to fixed-route local buses, but with varying levels enhancements like dedicated lanes, queue-jump lanes, off-board fare payment, etc. to improve operations and provide an experience closer to rail service.
 - *5 = Fixed Route Local Bus.* Local fixed-route buses typically travel longer, linear routes that cross large parts of the operator's service area. Stops are generally less than 0.25mi apart.
 - *6 = Regional/Commuter (Heavy) Rail* includes service such as Amtrak's Capitol Corridor service to the Bay Area. Regional rail has generally infrequent service, but has higher speeds and long distances (10+ miles) between stops.
 - *7 = Neighborhood shuttle.* Like a local fixed-route bus but serves a smaller area and is more likely to be a circular or loop-shaped route rather than a longer linear route. Most of UC Davis's Unitrans routes are considered neighborhood shuttles.
 - *8 = Streetcar.* Like light rail, but generally has more frequent stops and serves a smaller area.

As with capacity class designations for the highway network, some of the distinctions between service type COLORS are not black-or-white. Examples are: so-called "hybrid" streetcar systems that operate

more like light rail; or certain types of lower end bus rapid transit (BRT) that operate more like a normal fixed-route local bus. The model user must use his/her professional judgement in such situations to decide which COLOR to assign a specific line.

- HEADWAY(#) is the average headway, or time spacing between scheduled buses or trains, in minutes. The # in parentheses indicates the [service period](#). HEADWAY is computed as follows:
 - Total minutes in service period / Total trips made by the route in service period
 - E.g. if the service period is AM peak, the total minutes is 240. For a route with 4 trips during this period, that route’s AM peak headway is 240/4 = 60 minute headway between arrivals.
 - HEADWAY values of 0 denote times during which there is no service. E.g., if the HEADWAY for midday is 0, it means that route makes no trips during the midday period.

Table 7-1 SACSIM Transit Operators

Operator/Fare Group Number	Description
1	RT light rail lines
2	RT fixed-route bus lines
3	Yolobus commuter/express lines
4	Yolobus local fixed route bus lines
5	Roseville commuter bus lines
6	Roseville local fixed route bus lines
7	Yuba-Sutter Transit commuter lines
8	Yuba-Sutter local fixed route bus lines
9	El Dorado Transit commuter bus lines
10	El Dorado Transit local fixed route bus lines
11	Placer County Transit commuter lines
12	Placer County Transit local fixed route bus lines
13	Unitrans local fixed route bus lines; CSUS Hornet shuttle lines
14	Heavy rail (currently Sacramento region stops for Capitol Corridor)
15	South County Transit (SCT Link)
16	E-Tran commuter lines
17	E-Tran local bus lines
18	Future Neighborhood Shuttle
19	Future Streetcar
20	Folsom Stage Line

Source: SACOG 2020.

Table 7-2 Transit Line File Variables

Variable	Description
NAME	Name of Line
TIMEFAC	Highway to transit running time factor
ONEWAY	1 = line only goes 1 direction; 0 = line runs both directions
CIRCULAR	1= circular, 0 = not circular
OPERATOR	Operator of line and fare group (1-20)
MODE	Transit submode (1-3)
COLOR	Service type
HEADWAY[1]	Morning service period (5:00 AM to 9:00 AM), in minutes
HEADWAY[2]	Midday service period (9:00 AM to 3:00PM), in minutes
HEADWAY[3]	Afternoon peak service period (3:00 PM to 6:00 PM)
HEADWAY[4]	Evening service period (6:00 PM to end of 8:00 PM)
HEADWAY[5]	Evening service period (8:00 PM to 11:00 PM)

Source: SACOG 2020.

7.2.3 Demand-Responsive Transit Services

Dial-a-ride, paratransit, private transit operations, and individual bus routes that operate within a travel analysis zone (TAZ) or that operate very infrequently were not included in the transit network. Such routes are excluded in standard transit modeling practice for several reasons. They cannot be modeled reliably using macro-level measures. Additionally, these services usually carry very small volumes, and are not addressed explicitly in regional planning or corridor studies.

SACSIM19 currently excludes “microtransit” services, such as Sacramento Regional Transit’s SmaRT Ride and West Sacramento’s Via shuttle, which essentially provide on-demand transit service within a defined area and to select light rail stations. Future versions of SACSIM may incorporate microtransit services if they rise as a significant transit mode.

7.3 Transit Access Coding and Network Additions

Transit access coding refers to the use of links explicitly coded in the highway network, links manually added to the highway network in order to provide access to transit stations or stops, and links which are “auto-generated” by Cube to provide access to transit stations or stops, and to provide transfers from one line to another line. These three sets of links, in combination, are included in a “transit background network” which is subsequently used in transit path-building, skimming and assignment.

7.3.1 Links Explicitly Coded in Highway Network

Transit access links include all highway links, except for freeway mainline and freeway ramp links. Walk paths from traffic analysis zones to the first-boarding transit station or stop include centroid connectors, all surface streets, and explicitly coded pedestrian/bike-only links. Additionally, walk paths can include “contra-flow” direction on one-way surface streets.

7.3.2 Transit Access Links Manually Added to Highway Network

One major subset of these links are links representing exclusive transit links. The biggest categories of these links are rail lines, such as the Sacramento Regional Transit light rail lines, or the portions of the Capital Corridor train service within the SACOG region. However, in the future these links could include bus-only roadway segments. These links are not actually “access links”, but are alignments for transit lines to operate on. These links are included in the “transit_links.csv” file.

A second subset of these links are access links which connect between the highway network and the rail stations in the above-described rail transit links. These links allow for paths to be built from the highway network to stations or stops on exclusive guideway transit links, and for transfers between transit lines operating on exclusive guideways, and transit lines operating in mixed traffic. These links are included in the “station_links.csv” file.

A third subset of these links connect from park-and-ride lots to the nearest traffic analysis zone. The drive portion of park-and-ride transit trips are skimmed and assigned in the vehicle assignment process, and the transit portion of these trips are assigned from the park-and-ride lot node to the final destination, via the transit access links and transit lines. The connection between the park-and-ride lot TAZ, through the park-and-ride lot node and to the transit station, is built through links included in the “pnr.dbf” file.

7.3.3 Auto-Generated Transit Access Links

Links for two access modes are generated through Cube PT path-building software. One mode is walk access and egress links, which consolidate the more complicated paths built on the actual network components described above into single links connecting from TAZ to a range transit stations or stops (coded as MODE = 13). Another mode is transfer links which connect between one or more transit lines, and other transit lines, where the lines do not have stations or stops in common (MODE =12). Examples include: rail-to-bus station connections; and rail-to-rail station connections, if the rail lines do not share a common station.

7.4 Transit Travel Speeds and Stop Times

Travel speeds of buses operating in mixed flow are determined by means of a time factor relating bus speed (including stops) to auto speed. Time factors were determined separately for peak and off-peak local bus service by comparing the scheduled transit travel times with the model’s respective highway travel times.

For buses, delays from stopping, deceleration, and acceleration are implicitly represented in the time factors (TIMEFAC) discussed in the [line attributes](#). Portions of the highway network are not detailed enough to explicitly represent each bus stop, so the time factor gives a reasonable estimate unbiased by the relative fineness or coarseness of the highway network. Table 7-3 provides the default time factors for a variety of typical operating contexts.

Table 7-3 Highway to Bus Transit Time Factors

Service Type	Time Factor
Urban Fixed Route (most RT bus routes)	2.01
Urban Fixed Route w/in Sac. CBD	2.25
Urban BRT w/ Signal Priority	1.78
Rural Fixed Route	1.62
Commuter Bus (Freeway Segments)	1.18

Source: SACOG 2020.

For most of the LRT system, light rail vehicles operate on exclusive right-of-way, with pre-emption of traffic signals at crossings of surface streets. For this reason, travel times are less subject to road conditions, and more stable and predictable. LRT travel times are influenced by the characteristics of the track they operate on, performance of the LRV’s, and the spacing of stations. Table 7-4 provides the performance characteristics of LRVs used for estimation of travel times. Although for base year (in this case, 2016) it is not necessary to have a method of estimating LRV travel times, since they can be observed directly, for future lines an estimation method is required.

Table 7-4 Light Rail Vehicle Operating Assumptions

Variable	Performance
Acceleration Rate	2.5 mph/sec
Deceleration Rate	-2.5 mph/sec
Maximum Running Speed	55 mph
Station Dwell Time	0.5 minutes

Source: SACOG 2020.

7.5 Park-and-Ride Locations

Park-and-ride (PNR) locations with transit service are included in the transit network. Where they are coded in the network, enable transit trips in which the traveler drives to the PNR, parks in it, then transfers to its corresponding transit stop to continue his/her journey. SACSIM does not include PNR locations that are not served by transit. Table 7-5 lists the attributes for the PNR DBF table.

Table 7-5 Park-and-Ride Table Fields

Field	Description
PNR_NODE	Node ID from highway network representing PNR location
STA_NODE	Node ID of the bus or rail stop served by the PNR lot
ZONE	Node ID of the TAZ centroid tagged to the PNR lot
PNRCAP	Number of parking spaces (enter zero if KNR)
PRKCOST	Daily parking cost, in cents
DESC_	Location description. Include station name and indicate if KNR or PNR
X/Y	Latitude/longitude

Source: SACOG 2020.

7.5.1 Transit Drop-Off Locations (KNR)

Transit drop-off zones, also known as “kiss-and-ride”, or KNR locations, enable trips in which a traveler rides as a passenger in a private auto and gets dropped off at a transit stop. KNR locations are coded using the same process as PNRs and are stored in the same “pnr.dbf” table.

7.5.2 Adding PNR or KNR locations

To code in a park-and-ride or kiss-and-ride location:

1. Add a node to the SACSIM highway network at the PNR location.
2. Include it in the “pnr.dbf” table of PNR nodes and attributes.
3. Include it in the [station links CSV](#).
4. Ensure it is connected to the rest of the highway network with a link of CAPCLASS 62.