CORSIM User's Guide

Version 6.0

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Foreword

This User's Guide describes how to access and use CORSIM. The McTrans Center is maintaining CORSIM. Please refer to the TSIS User's Guide for information on CORSIM.

Abstract

This User's Guide describes the input, execution, and output for the CORridor-microscopic SIMulation program (CORSIM). CORSIM is the core simulation and modeling component of the Traffic Software Integrated System (TSIS) tool suite.

This document does not describe the detailed contents of each Record Type (RT) used by CORSIM. The user is referred to the CORSIM Reference Manual for that information. Additionally, this manual does not describe the TSIS environment. The reader is referred to the TSIS User's Guide, and other manuals, guides, and tutorials within the TSIS suite of traffic tools.

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1 Introduction

1.1 Overview

This User's Guide describes how to prepare the input, analyze the output, and execute the CORSIM simulation and modeling program. Detailed information concerning the input records used by CORSIM can be found in the CORSIM Record Types Reference Manual.

1.2 Simulating Traffic Systems

In traffic engineering, the concept of traffic control is giving way to the broader philosophy of Advanced Traffic Management Systems (ATMS), whose purpose is not only to move vehicles, but also to optimize the utilization of transportation resources to improve the movement of people and goods without impairing the community.

One of the most important analytical tools of traffic engineering is computer simulation. Computer simulation is more practical than a field experiment for the following reasons:

- It is less costly.

- Results are obtained quickly.

- The data generated by simulation include several measures of effectiveness that cannot be easily obtained from field studies.

- The disruption of traffic operations, which often accompanies a field experiment, is completely avoided.

- Many schemes require significant physical changes to the facility, which are not acceptable for experimental purposes.

- Evaluation of the operational impact of future traffic demand must be conducted by using simulation or an equivalent analytical tool.

- Many variables can be held constant.

If a traffic system is simulated on a computer by means of a simulation model, it is possible to predict the effect of traffic control and ATMS strategies on the system's operational performance, as expressed in terms of measures of effectiveness (MOEs), which include average vehicle speed, vehicle stops, delays, vehicle-hours of travel, vehicle-miles of travel, fuel consumption, and pollutant emissions. The MOEs provide insight into the effects of the applied strategy on the traffic stream, and they also provide the basis for optimizing that strategy.

The availability of traffic simulation models greatly expands the opportunity for the development of new and innovative ATMS concepts and designs. Planners and engineers are no longer restricted by the lack of a mechanism for testing ideas prior to field demonstration. Furthermore, because these models produce information that allows the designer to identify the weaknesses in concepts and design, they provide the basis for identifying the optimal form of the candidate approach. Finally, because the results generated by the model can form the basis for selecting the most effective candidate among competing concepts and designs, the eventual field implementation will have a high probability of success.

Many ATMS strategies affect the mode and route choice of trip-makers. To test the effect of ATMS schemes on trip patterns, it is necessary to analyze an area that contains a substantial portion of the routes that the trip-makers may follow. There is a need, therefore, for a simulation model that is capable of representing traffic flow in large urban areas containing surface street networks and freeways and that has reasonable computer usage requirements. This concept of a single integrated simulation system that can provide the user with flexibility and ease of use and that can optimize the efficiency of all computations was conceived by the Federal Highway Administration (FHWA) in the mid-1970s. FHWA has since supported a series of projects to implement this design and to develop the software for CORSIM.

1.3   CORSIM theory of operation

CORSIM consists of an integrated set of two microscopic simulation models that represent the entire traffic environment. NETSIM represents traffic on urban streets and FRESIM represents traffic on freeways. Microscopic simulation models represent movements of individual vehicles, which include the influences of driver behavior. The effects of very detailed strategies, such as relocating bus stations or changing parking restrictions, can be studied with such models.

In a multiple-model network, each of the component models of CORSIM simulates a different subnetwork The interfacing of adjoining subnetworks is accomplished by defining "interface nodes" (as shown in the following figure), which represent points at which vehicles leave one subnetwork and enter another. Nodes of this type are assigned special numbers to distinguish them from other nodes in the network. The terms "entry interface links," which receive traffic from the adjoining subnetworks, and "exit interface links," which carry traffic exiting the subnetwork to adjoining subnetworks, are used to describe links at the boundaries of the subnetworks.

The following figure illustrates a multiple-model network in which a city's central business district is bordered by a freeway. The freeway sections can be modeled with FRESIM, while the urban subnetwork can be modeled with NETSIM. Once the user identifies the appropriate subnetwork representation, all interfacing processes are handled internally by the model by the interface logic.
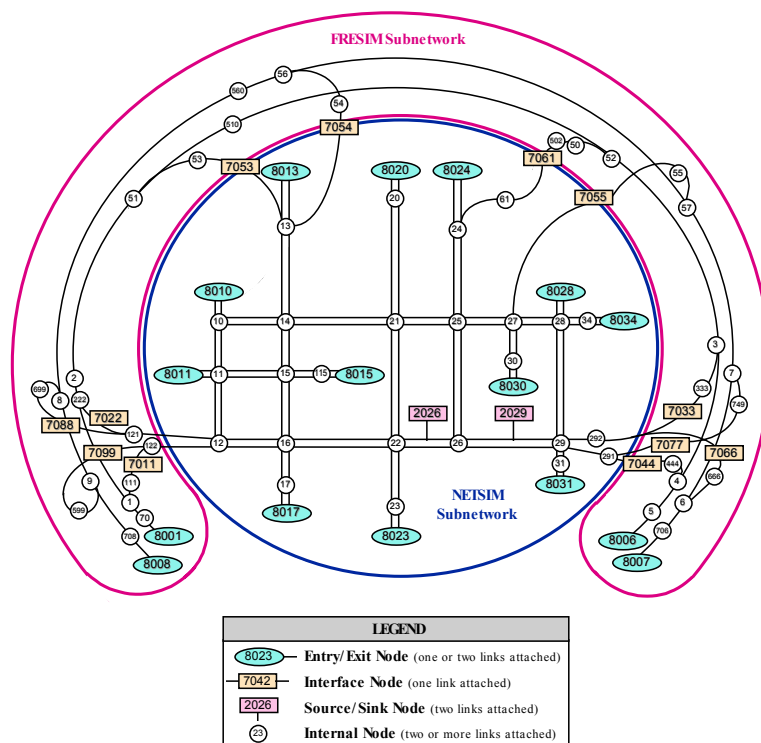
Multiple model network

CORSIM applies time step simulation to describe traffic operations. A time step is one second. Each vehicle is a distinct object that is moved every second. Each variable control device (such as traffic signals) and each event are updated every second.

CORSIM is a stochastic model, which means that random numbers are assigned to driver and vehicle characteristics and to decision making processes. The MOEs that are obtained from a simulation are the result of a specific set of random number seeds. For example, one set of random number seeds may result in three very conservative drivers driving side by side on a three-lane roadway blocking more aggressive drivers behind them. The resulting MOE would reflect a lower average speed then has been observed in the real world. Relying on the MOE generated from a single run of CORSIM may be misleading. To gain a better understanding of network performance the network should be simulated several times using different sets of random number seeds. The resulting distribution of MOEs should then be an accurate representation of the network performance.

Each vehicle is identified by fleet (auto, carpool, truck, or bus) and by type. Up to nine different types of vehicles (with different operating and performance characteristics) can be specified, thus defining the four vehicle fleets. Furthermore, a "driver behavioral characteristic" (passive or aggressive) is assigned to each vehicle. Its kinematic properties (speed and acceleration) as well as its status (queued or moving) are determined. Turn movements are assigned stochastically, as are free-flow speeds, queue discharge headways, and other behavioral attributes. As a result, each vehicle's behavior can be simulated in a manner reflecting real-world processes.

Each time a vehicle is moved, its position (both lateral and longitudinal) on the link and its relationship to other vehicles nearby are recalculated, as are its speed, acceleration, and status. Actuated signal control and interactions between cars and buses are explicitly modeled.

Vehicles are moved according to car-following logic, in response to traffic control devices, and in response to other demands. For example, buses must service passengers at bus stops (stations); therefore, their movements differ from those of private vehicles. Congestion can result in queues that extend throughout the length of a link and block the upstream intersection, thus impeding traffic flow. In addition, pedestrian traffic can delay turning vehicles at intersections.

CORSIM accumulates data every time step. At the end of each time period the accumulated data is used to produce MOEs. These MOEs can then be used in conjunction with the Highway Capacity Manual (HCM) to estimate the performance of the network.

CORSIM is capable of simulating most of the prevailing freeway geometries, including multiple-lane freeway mainlines, on/off ramps and connectors to other freeways, variations in grade, radius of curvature and super-elevation, lane additions and lane drops and auxiliary lanes, which are used by traffic to begin or end the lane-changing process or to enter or exit the freeway.

1.4 Elements of the Traffic Environment

The traffic environment, which must be specified by the user, consists of the following:

- Topology of the roadway system (in the form of a link-node diagram)
- Geometrics of each roadway component
- Lane channelizations (such as left-turn only and buses only lanes)
- Traffic volumes entering the roadway system
- Turn movements or origin-and-destination data
- Intersection Approach Geometry
- Stop and Yield Signs
- Pre-timed Signal Control
- Actuated Signal Control
- Freeway Ramp Metering Control
- Incidents and Temporary Events
- Traffic Surveillance Systems
- Fleet Components (buses, carpools, cars, and trucks)
- Load Factors (the number of passengers/vehicle)
- Turn Movement Distributions
- Bus Operations (paths, flow volumes, stations, dwell times, and routes)
- HOV Lanes (buses, carpools, or both)
- Queue Discharge Distribution on surface streets
- Lane Changing Parameters
- Variations in Driver Aggressiveness
- Reaction points for upcoming geometric changes on freeways
- Driver behavior that determines the operational performance of vehicles in the system

- Fuel consumption and pollutant emission rates

The physical environment is represented as a network comprised of nodes and unidirectional links. The links generally represent urban streets or freeway sections, and the nodes generally represent urban intersections or points at which a geometric property changes (such as a change in grade or a major midblock traffic generator).

Another important feature of CORSIM is that characteristics that change over time, such as signal timings and traffic volumes, can be represented by dividing the simulation into a sequence of user-specified time periods, during which the traffic flows, the traffic controls, and the geometry are held constant. Therefore, the morning rush hour might be simulated with one time period representing pre-rush hour, a second representing rush-hour timing, and a third representing the post-rush-hour flows. These time periods are further divided into time intervals.

CORSIM also includes a traffic assignment program, which is designed to expand the applicability of traffic simulation modeling to transportation planners. The program internally translates the origin-and-destination data - which is readily available to the planning community - into a form suitable for use by the simulation models.

The traffic assignment model interfaces with the NETSIM component of CORSIM only and uses conventional static traffic assignment techniques, along with user equilibrium and system optimization capabilities. The purpose of including a traffic assignment model in CORSIM is to extend the potential user group for this program to include planners and traffic engineers.

The planner usually has sufficient information available to produce a table of origin-and-destination volumes that represent traffic demands over an area for a specified period of time. For this information to be useful as input in the NETSIM model, it must first be transformed into link-specific turn percentages. The mechanism for performing this transformation is the traffic assignment model.

The interfacing logic is designed to perform data manipulation internally, thus freeing the user to focus attention on providing the origin-and-destination table. This logic will read and check the data and then perform the necessary data organization to provide the traffic assignment program with its data requirements. Subsequently, it will create turn percentages and entry volumes for input into the NETSIM model.

1.5   Calibration Parameters

There are several CORSIM inputs that are known as calibration parameters. These inputs allow users to fine tune CORSIM to match local real-world traffic conditions. These calibration parameters include driver behavior parameters and vehicle performance parameters. The driver behavior parameters for Netsim include queue discharge headway and start-up lost time, distribution of freeflow speed by driver type, mean duration of parking maneuvers, lane change parameters, maximum left and right turning speeds, probability of joining spillback, probability of left turn jumpers and laggers, gap acceptance at stop signs, gap acceptance for left and right turns, pedestrian delays and driver familiarity with their path. The driver behavior parameters for Fresim include mean start-up delay at ramp meters, distribution of freeflow speed by driver type, incident rubbernecking factor, car-following sensitivity factor, lane change gap acceptance parameters, and parameters that affect the number of discretionary lane changes. Vehicle performance calibration parameters for both Netsim and Fresim include speed and acceleration characteristics, fleet distribution and passenger occupancy. Fresim also includes maximum deceleration values.

1.6   Creating a Network and Calibrating CORSIM

The following steps define the basic process for using TSIS for analyzing an existing traffic network.

1. Determine the network geometry.

2. Obtain traffic and signal data.

3. Build a link-node model of the network using TRAFED, ITRAF or a Text Editor.

4. Run the simulation using CORSIM.

5. View the animation in TRAFVU to verify the inputs and confirm vehicle movement and signal operations.

6. Use the CORSIM tool's multi-run capability or use the TSIS Multi-Run Same Case script to perform multiple CORSIM simulations of the network using different random number seeds.

7. Examine the distribution of relevant MOEs and compare with field data.

8. Adjust calibration parameters as needed to match field data as closely as possible.

9. Go back to step 7 and repeat the process until CORSIM results and field data match reasonably well.

After performing these steps CORSIM should be properly calibrated for that specific network and can be used to perform other analyses with modifications of the existing network, such as determining the impact of geometry changes. The resulting set of calibration parameters should also be usable for other simulations in which driver behavior and vehicle performance characteristics would be similar.

1.7   CORSIM Capabilities and Limitations

The following tables list many elements of modern traffic systems. CORSIM can model most of those elements explicitly. Many of the other features can be approximated using the basic elements of CORSIM, along with engineering judgement and creativity. The tables are arranged into Freeway and Surface Street systems and show CORSIM capabilities and the types of input data that CORSIM uses to model those systems.

Freeway Modeling Capabilities

Modeling Capabilities	
Bottlenecks	Yes
HOV lanes, including ramp meter bypass	Yes
Barriers	Yes
Lane closures	Yes
Interchanges	Yes
Weaving sections	Yes
Toll booths / weigh stations / draw bridges	No*
Oversaturation	Yes
Time-varying demand	Yes
Trucks biased or restricted to specific lanes	Yes
Incidents	Yes
Workzones	Yes
Surveillance	Yes
Fixed-time ramp metering	Yes
Time varying fixed-time ramp metering	Yes
Traffic-responsive ramp metering	Yes
Bus operations	Yes

* These features are not modeled explicitly by CORSIM, but can be modeled using basic CORSIM elements. Some of them require using both surface street elements and freeway elements.

Freeway Input Data

Input Data	
Node coordinates	Yes
Link length	Yes
Grade	Yes
Number of lanes	Yes
Number and type of auxiliary lanes	Yes
Capacity	No
Freeflow speed	Yes
Turn percentages	Yes
Turn percentages by vehicle type	Yes
Time-varying turn percentages	Yes
Traffic composition	Yes
Vehicle occupancy	Yes
O-D table	Yes
Surveillance detectors	Yes
Fixed-time metering headway	Yes
Traffic-responsive metering inputs	Yes
Number of vehicles per green	Yes
User-defined driver characteristics	Yes

Surface Street Modeling Capabilities

Modeling Capabilities	
Bottlenecks	Yes
Complex intersections	Yes
HOV lanes	Yes
On-street parking	Yes
Two-way left turn lanes	No*
Oversaturation	Yes
Time-varying demand	Yes
Incidents	Yes
Pedestrians	Yes
Workzones	Yes
Unsignalized intersections	Yes
All-way stops	Yes
Roundabouts	No*
Fixed-time signals	Yes
Actuated signals	Yes

Modeling Capabilities	
Signal coordination	Yes
Surveillance	Yes
U-turns	No*
Transit signal priority	No
Bus operations	Yes
Light rail	No*

* These features are not modeled explicitly by CORSIM, but can be modeled using basic CORSIM elements. Some of them require using both surface street elements and freeway elements.

Surface Street Input Data

Input Data	
Node coordinates	Yes
Link length	Yes
Grade	Yes
Number of lanes	Yes
Lane channelization	Yes
Turn pockets	Yes
Pedestrian traffic	Yes
Freeflow speed	Yes
Turn percentages	Yes
Time-varying turn percentages	Yes
Traffic composition	Yes
Vehicle occupancy	Yes
O-D table	Yes
Signal timing plan	Yes
Surveillance detectors	Yes
Single ring actuated control	Yes
Dual ring actuated control	Yes
User-defined driver characteristics	Yes

2 Input and Output Details

2.1 Input Data

Computer simulations use a mathematical representation of the real world. Traffic simulation models are representations of the time-varying processes in traffic flow, and they require accurate descriptions of the characteristics of the vehicles, the transportation network, and the traffic control system. These characteristics vary over the physical network and over time. The structure of the input stream must also reflect the concept of network partitioning.

The characteristics that vary over time include the following:

- Traffic volumes
- Turn movements
- Traffic regulations
- Signal timing.

The characteristics that vary over space include the following:

- Traffic geometry (location of links and nodes, number of lanes, turning pockets, and auxiliary lanes)
- Types of links (such as surface streets or freeways)

Links are one-directional segments of surface streets or freeways, and nodes are usually the intersection of two or more links. Initially, the user must obtain geometric pictures of the network, such as aerial photographs or maps. A basic drawing of the geometry of a single intersection is shown in the following figure.

Intersection layout converted to a link-node diagram

The time-varying portion of the simulation analysis is expressed as a sequence of "time periods" specified by the user; that is, the input data specified by the user for a certain time period remains in force unless changed in a subsequent time period. The user can specify up to 19 time periods and must specify the conditions that have changed during each period. Therefore, the input stream consists of a sequence of "blocks" of data records, with each block defining the conditions that apply to one time period.

Each block of data records for a time period is subdivided into "sections" of data records. Some sections define conditions of one or more subnetworks, including a NETSIM subnetwork and/or a FRESIM subnetwork, while others provide inputs for the specifications that must be specified for the "global" network (such as bus routes).

The input stream of a dataset begins with a basic description of the run being made (run control data), followed by data that is divided into time periods. Each time period contains model-specific data for each subnetwork that is being simulated. Each dataset is divided into a series of 80-column records. The first time period is unique because it contains the data that does not vary from time period to time period. At the end of the model data for the first time period is global network data that is applied to all subnetwork data. This global data describes bus operations, and any other data that applies to both subnetworks. For second and subsequent time periods, only variations in data relative to the previous time periods need to be specified.
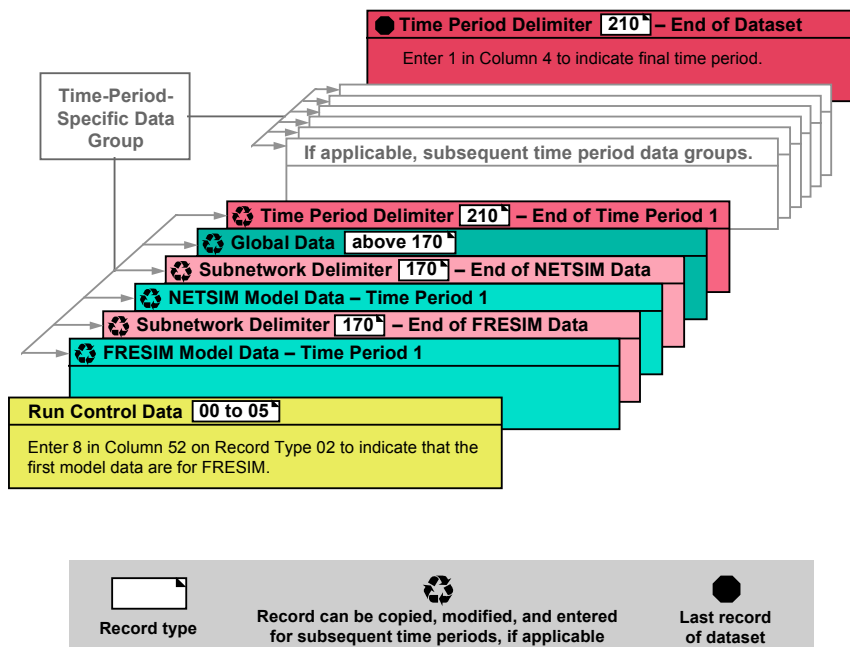
CORSIM data structure

The following tables list the record types that can be used by each model. The run control data is independent of the model that is being executed and is required for all models. Only one set of run control data records is permitted, even if more than one model and/or time period will be simulated.

Run control data required to set-up CORSIM simulation runs

RECORD TYPE	DESCRIPTION	NETSIM	FRESIM
00	Run Title	Optional	Optional
01	Run Identification	Required	Required
02	Run Control	Required	Required
03	Time Period Specification	Required	Required
04	Time Interval and Time Steps per Time Period	Required	Required
05	Reports	Required	Required

The following table indicates whether each of the remaining record types, beyond the Run Control records identified in the previous section, is required or optional. Blank boxes indicate the specified record type is not applicable to that subnetwork (FRESIM or NETSIM).

CORSIM record types

RECORD TYPE	DESCRIPTION	NETSIM		FRESIM	
		Time Period 1	**Time Periods 2 - 19**	**Time Period 1**	**Time Periods 2 - 19**
10	Link Names	Optional	Not Allowed	Optional	Not Allowed
11	NETSIM Link Description (NETSIM only)	Required	Optional		
14	Lane Alignments (NETSIM only)	Optional	Not Allowed		
19	Freeway Link Geometry (FRESIM only)			Required	Not Allowed
20	Freeway Link Operation (FRESIM only)			Required	Not Allowed
21	Surface Street Turn Movements (NETSIM only)	Optional	Optional		
22	Conditional Turn Movements (NETSIM only)	Optional	Optional		
23	Turn Movement Variations within a Time Period (NETSIM only)	Optional	Optional		
24	Vehicle Type Specific Multipliers for Freeway Turn Movements (FRESIM) or for Surface Street Turn Movements (NETSIM)	Optional	Optional	Optional	Optional
25	Freeway Turn Movements (FRESIM only)			Required	Optional
26	Turn Movement Variations within a Time Period (FRESIM only)			Optional	Optional
28	Surveillance Specification (FRESIM only)			Optional	Not Allowed
29	Freeway Incident Specification (FRESIM only)			Optional	Not Allowed
32	Freeway Lane Add and/or Drop (FRESIM only)			Optional	Not Allowed
33	HOV Specific Input (FRESIM only)			Optional	Optional
35	Sign or Pre-timed Signal Control Timing (NETSIM only)	Optional	Optional		
36	Sign or Pre-timed Signal Control Codes (NETSIM only)	Optional	Optional		
37	Freeway Metering (FRESIM only)			Optional	Optional
38	Freeway Metering Detector Specification (FRESIM only)			Optional	Not Allowed
42	Surveillance Specification (NETSIM only)	Optional	Not Allowed		
43	Approach Configuration for Actuated Controller (NETSIM only)	Optional	Not Allowed		
44	Coordination for Actuated Controller (NETSIM only)	Optional	Optional		

RECORD TYPE	DESCRIPTION	NETSIM		FRESIM	
		Time Period 1	Time Periods 2 - 19	Time Period 1	Time Periods 2 - 19
45	Traffic Movements for Actuated Controller (NETSIM only)	Optional	Optional		
46	Detectors for Actuated Controller (NETSIM only)	Optional	Optional		
47	Phase Operations for Actuated Controller (NETSIM only)	Optional	Optional		
48	Pedestrian Operations for Actuated Controller (NETSIM only)	Optional	Optional		
49	Transition Parameters for Actuated Controller (NETSIM only)	Optional	Optional		
50	Entry Link Volumes	Optional	Optional	Optional	Optional
51	Traffic Volumes on Source/Sink Links (NETSIM only)	Optional	Optional		
52	Load Factors (NETSIM only)	Optional	Not Allowed		
53	Entry Link Volume Variations within a Time Period	Optional	Optional	Optional	Optional
54	Short-term Events (NETSIM only)	Optional	Not Allowed		
55	Long-term Events (NETSIM only)	Optional	Not Allowed		
56	Parking Activity (NETSIM only)	Optional	Optional		
58	Vehicle Type Specifications (NETSIM only)	Optional	Not Allowed		
61	On-line Incident Detection Specifications (FRESIM only)			Optional	Not Allowed
62	On-line Incident Detection Algorithm Parameters (FRESIM only)			Optional	Not Allowed
63	On-line Incident Detection Detector Station Identification (FRESIM only)			Optional	Not Allowed
64	Off-line Incident Detection, Point Processing, or MOE Estimation Specification (FRESIM) or Evaluation Frequency for Surveillance Detectors (NETSIM)	Optional	Not Allowed	Optional	Not Allowed
65	Off-line Incident Detection Algorithm Parameters (FRESIM only)			Optional	Not Allowed
66	MOE Algorithm Parameters (FRESIM only)			Optional	Not Allowed
67	Off-line Incident Detection, Point Processing, or MOE Estimation Detector Station (FRESIM only)			Optional	Not Allowed
68	Car-Following Sensitivity Factor (FRESIM only)			Optional	Not Allowed
69	Pavement Friction Coefficients-Lag to Accelerate and Decelerate (FRESIM only)			Optional	Not Allowed

RECORD TYPE	DESCRIPTION	NETSIM		FRESIM	
		Time Period 1	Time Periods 2 - 19	Time Period 1	Time Periods 2 - 19
70	Lane Change Parameters, Minimum Separation for Vehicle Generation, and Maximum Non-Emergency Deceleration (FRESIM only)			Optional	Not Allowed
71	Vehicle Type Specifications (FRESIM only)			Optional	Not Allowed
74	Origin-Destination (FRESIM only)			Optional	Optional
80	Optional Link Geometric Data (NETSIM only)	Optional	Not Allowed		
81	Lane-Change Parameters (NETSIM only)	Optional	Not Allowed		
90	Link Aggregations (NETSIM only)	Optional	Not Allowed		
95	Interchange Definition Data (NETSIM only)	Optional	Not Allowed		
96	Interchange Origin Destination Data (NETSIM only)	Optional	Not Allowed		
140	Left-Turn Jump, Left- and Right-Turning Speeds (NETSIM only)	Optional	Not Allowed		
141	Spill-back Probability and Probability of Left-Turn Lagger (NETSIM only)	Optional	Not Allowed		
142	Acceptable Gap in Near-Side Cross Traffic for Vehicles at a Sign (NETSIM only	Optional	Not Allowed		
143	Additional Time for Far-Side Cross Traffic in Acceptable Gap for Vehicles at a Sign (NETSIM only)	Optional	Not Allowed		
144	Amber Interval Response (NETSIM only)	Optional	Not Allowed		
145	Gaps for Permissive Left-Turns and for Right-Turns on Red or at Signs (NETSIM only)	Optional	Not Allowed		
146	Pedestrian Delay (NETSIM only)	Optional	Not Allowed		
147	Free-Flow Speed Percentages (NETSIM only)	Optional	Not Allowed	Optional	Not Allowed
148	Short-Term-Event Duration Percentages (NETSIM only)	Optional	Not Allowed		
149	Link Type Distributions (Queue Discharge Headways and Start-Up Lost Time) (NETSIM only)	Optional	Not Allowed		
150	Dwell Time Distributions (NETSIM only)	Optional	Not Allowed		
152	Distribution of Longitudinal Distance to Start to Attempt a Lane Change (NETSIM only)	Optional	Not Allowed		
153	Driver's Familiarity with Paths Distribution (NETSIM only)	Optional	Not Allowed		

RECORD TYPE	DESCRIPTION	NETSIM		FRESIM	
		Time Period 1	Time Periods 2 - 19	Time Period 1	Time Periods 2 - 19
170	Sub-network Delimiter	Required	Required	Required	Required
172	Environmental Tables	Optional	Not Allowed	Optional	Not Allowed
173	Maximum Acceleration Tables	Optional	Not Allowed	Optional	Not Allowed
175	Traffic Assignment Parameters (NETSIM only)	Optional	Not Allowed		
176	Origin Destination Trip Table (NETSIM only)	Optional	Not Allowed		
177	Source/Sink Nodes (NETSIM only)	Optional	Not Allowed		
185	Bus Stations (NETSIM only)	Optional	Not Allowed		
186	Mean Dwell Time for Buses (NETSIM only)	Optional	Optional		
187	Bus Route Definition	Optional	Not Allowed	Optional	Not Allowed
188	Bus Route Station Stops (NETSIM only)	Optional	Not Allowed		
189	Bus Headways (Flow Rates)	Optional	Optional	Optional	Optional
195	Node Coordinate Data	Optional	Not Allowed	Optional	Not Allowed
196	Optional Link Geometric Data	Optional	Not Allowed	Optional	Not Allowed
210	Time Period Delimiter	Required	Required	Required	Required

The following table describes the required record types in FRESIM for point processing, on-line and off-line incident detection (ID), and MOE estimation.

Required record types in FRESIM for point processing, on-line and off-line incident detection, and MOE estimation

RECORD TYPE	POINT PROCESSING	ON-LINE INCIDENT DETECTION	OFF-LINE INCIDENT DETECTION	MOE ESTIMATION
02 ENTRY 2 (ID FLAG)	**ON**	**ON** FOR POINT-PROCESSING-BASED ID **OFF** FOR STANDARD ID	**ON**	**ON**
28	Required	Required	Required	Required
61		Required		
62		Required		
63		Required		
64	Required		Required	Required
65			Required	
66				Required

RECORD TYPE	POINT PROCESSING	ON-LINE INCIDENT DETECTION	OFF-LINE INCIDENT DETECTION	MOE ESTIMATION
67	Required		Required	Required

The input ("trf") file, consisting of Record Types 00 through 210 as specified in this manual, should be regarded as providing fixed format input. This means that, generally, blanks are treated as zeros. Therefore, data should be entered right justified unless otherwise directed in the specific Record Type documentation. If a data field is 2 columns wide, a 2 followed by a blank will most likely be read as 20.

CORSIM datasets can be coded with very few record types. Assuming that traffic assignment is not executed, the minimum records that are required to run NETSIM and FRESIM are shown in the proper sequence in the following table for a single time period dataset.

Minimum coding requirements for the CORSIM models

RECORD TYPE	DESCRIPTION	NETSIM	FRESIM
01	Run Identification	Required	Required
02	Run Control	Required	Required
03	Time Period Specification	Required	Required
04	Time Interval and Time Steps per Time Period	Required	Required
05	Reports	Required	Required
11	NETSIM Link Description (NETSIM only)	Required	
19	Freeway Link Geometry (FRESIM only)		Required
20	Freeway Link Operation (FRESIM only)		Required
21	Surface Street Turn Movements (NETSIM only)	Required	
25	Freeway Turn Movements (FRESIM only)		Required
35	Sign or Pre-timed Signal Control Timing (NETSIM only)	Required	
36	Sign or Pre-timed Signal Control Codes (NETSIM only)	Required	
50 53	Either 50 or 53, or both, can be used to define Entry Link Volumes	Required	Required
170	Sub-network Delimiter	Required	Required
210	Time Period Delimiter	Required	Required

Some of the characteristics associated with a network are limited to a maximum size, whose limits are summarized in the following table.

Size limitations of CORSIM network characteristics

CHARACTERISTIC	NETSIM	FRESIM
Actuated Controllers	Unlimited	Not Applicable
Auxiliary Lanes	Not Applicable	6
Bus Routes	500	

CHARACTERISTIC	NETSIM	FRESIM
Bus Stations	99	Not Applicable
Buses	2000	2000
Data Stations	Not Applicable	2000
Detector Stations	Not Applicable	2000
Detectors	7000	6000
Detectors for a Metering Signal	Not Applicable	10
Disjoint Freeway Segments	Not Applicable	Unlimited
Entries per Segment	Not Applicable	100
Events	200	Not Applicable
Exits per Segment	Not Applicable	100
Incidents	Not Applicable	100
Interchanges	Unlimited	Not Applicable
Lane Adds/Drops per Link	Not Applicable	3
Links	Unlimited	Unlimited
Links per Segment	Not Applicable	200
Nodes	8999	8999
Ramp Metering Signals	Not Applicable	4000
Sections of Aggregated Links	100	Not Applicable
Through Lanes	7	5
Through Lanes per Ramp Link	Not Applicable	3
Vehicles	Unlimited	Unlimited

2.2   Data Record Types

This section provides an overview of the various blocks of data records that are used to input data in CORSIM.

2.2.1   Run Control Data

Run control data consists of six record types:

1. Record Type 00 provides the title for the run.

2. Record Type 01 provides the name of the person performing the run, the date of the run, the name of the organization involved, and the run identification number.

3. Record Type 02 provides data on whether one or more models are to be run, whether traffic assignment is to be performed, the maximum initialization period to be used, and whether fuel consumption and emissions data should be output. This record also tells CORSIM which model to read input for first and what random number seeds to use.

4. Record Type 03 is the time period specification record that informs CORSIM how many time periods will be simulated as well as the duration of each time period. These time periods are used to divide the simulation into segments with similar characteristics, such as pre-rush hour, rush hour, and post-rush hour.

5. Record Type 04 specifies the time interval duration, which is used to control the frequency of the output reports provided by CORSIM.

6. Record Type 05 is the final record in the block of run control data records, and it specifies the types of output desired by the user. The frequency of both cumulative and intermediate output is specified.

2.2.2 Reports and Output Specifications

Reports and outputs are controlled with several data records. Record Type 02 specifies whether fuel consumption and emissions data should be output. Record Type 05 specifies the frequency of both cumulative and intermediate output. Record Type 90 allows aggregation of links as a group for data collection and reporting purposes for NETSIM and FRESIM. Up to 1,000 links can be contained within a maximum of 100 sections.

2.2.3 Link Names

Link names can be specified on Record Type 10 for the CORSIM model. This block of data records appears at the beginning of the data records for Time Period 1 only. Links cannot be renamed in subsequent time periods.

2.2.4 Link Description

Networks in CORSIM consist of uni-directional links. In the case of a two-way street, each roadway block would consist of two uni-directional links. Links are defined by their upstream and downstream node numbers as shown in the following figures. Entry links, exit links, interface links, and internal links have different kinds of node numbering.

The eastbound link is link (I, J) and has an upstream node number of I and a downstream node number of J. The westbound link is link (J, I) and goes from upstream node J to downstream node I.
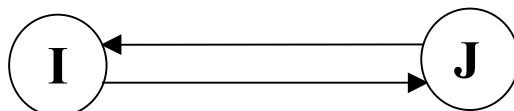

Diagram of a NETSIM link

The eastbound link is link (I, J) and has an upstream node number of I and a downstream node number of J. A corresponding westbound link for a freeway must be specified by a unique pair of upstream node and downstream node, K and L (respectively).
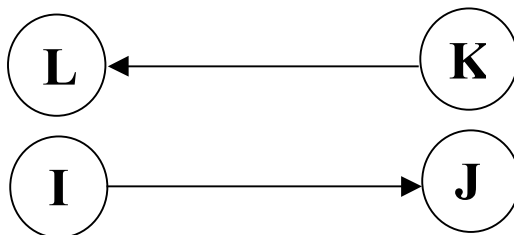

Diagram of a FRESIM link

Entry and/or exit nodes must be numbered between 8000 and 8999. Therefore, entry links have an upstream node number in the 8000's. Interface nodes which are used to join NETSIM and FRESIM sub-networks, must be numbered between 7000 and 7999 so interface links have either an upstream or downstream node in the 7000s. Internal nodes can be numbered from 1 to 6999. Internal links must have both upstream and downstream nodes numbered less than 6999.

The geometrics for each NETSIM link are coded on Record Type 11. Link records describe the number of lanes and their length, channelization (left turn only or buses only), and link-specific traffic behavior (such as free-flow speed). The link geometrics and operation data for FRESIM are coded on Record Types 19 and 20, respectively.

Turn movement descriptions describe how traffic leaves each link to approach other links. Turn movements for NETSIM are described on Record Type 21. Record Type 22 can be used to define conditional turn movements in NETSIM. Record Type 23 is used to specify time-varying turn movements within a time period for NETSIM. Record Types 25 and 26 are used to specify uniform and time-varying turn movements for FRESIM, respectively.

2.2.5 Traffic Parameters

Traffic parameters provide CORSIM with a description of how traffic behaves, and they can be specified by a variety of record types. These parameters are input into the data file in Time Period 1 only. Therefore, they remain in effect throughout the entire simulation time. Examples of traffic parameters include the response to gaps in traffic for turning vehicles, the distribution of the desired free-flow speed, and vehicle types.

For NETSIM, Record Types 140 and 141 modify the turn calibration data and spill-back, while Record Types 142 and 143 modify the acceptable gaps for turning vehicles pulling out onto a main street at stop signs. Record Type 144 describes vehicle response to yellow signals. Gaps in oncoming traffic that are acceptable for vehicles turning onto a side street across traffic are described on Record Type 145. Record Type 146 describes how pedestrian flows interact and impede traffic. Variation of free-flow speed around the user-specified free-flow speed is modified by Record Type 147. Short-term events vary according to a distribution that may be modified by Record Type 148. Start-up lost time and queue discharge headway at traffic signals vary according to distributions that may be changed by Record Type 149. The length of time that buses "dwell" at bus stops varies according to distributions that are modified by Record Type 150.

For FRESIM, Record Type 68 modifies the embedded car-following sensitivity factors, while Record Type 69 modifies the lag to accelerate and decelerate when drivers are making required maneuvers. Record Type 70 allows users to change the minimum separation for vehicle generation and lane-changing parameters, such as the time to complete a lane change, the percentage of cooperative drivers, and non-emergency deceleration. Variation of free-flow speed around the user-specified free-flow speed is modified by Record Type 147.

2.2.6 Bus Operations

Bus operations in a network are described in terms of bus routes, stations, and flow rates. Each route is assigned a "route number," which is then used to identify the flow rates, release offsets, and stations that buses may stop at along the route. The bus route is the geometric path of nodes that the bus traverses as it travels through the network. The bus flow rate is the mean headway for buses that service a particular route number. The bus stations are defined in terms of the link they are on, the distance from the downstream node, and their capacity (in numbers of buses). The average dwell time buses spend at stations is also specified.

Buses operate at a fixed headway in CORSIM. Bus stops are defined on Record Type 185. The average time each bus stops (dwells) at a station, along with the percentage of buses that do not stop, is defined on Record Type 186 (see also Record Type 150 for dwell time distributions). The route of each bus traveling through the network is defined by the series of nodes it traverses, including bus stops. The nodes are defined on Record Type 187, while the bus stops on each route are defined on Record Type 188. The routes can traverse the interface nodes between sub-networks so that a route may cover NETSIM and FRESIM streets and highways. However, bus stops cannot be specified on a FRESIM link.

CORSIM computes measures of effectiveness for buses on a route-specific basis. The delays and stops for buses are also included in the overall MOEs computed by CORSIM.

2.2.7   HOV Lane Operations

In NETSIM lanes can be channelized for buses only, carpools only, or buses and carpools only using Record Type 11. In FRESIM HOV lanes can be defined using Record Type 33.

2.2.8   Sign and Signal Control

Stop and yield signs (which are available in NETSIM) are specified on Record Types 35 and 36. Record Type 35 defines the upstream node of each approach to the intersection, while Record Type 36 defines whether the approach is controlled by a yield sign or stop sign or is uncontrolled (i.e., perpetual green).

Pre-timed signals are also specified on Record Types 35 and 36. Record Type 35 defines the upstream node of each approach to the intersection, the number of signal intervals, and the duration of each interval. Record Type 36 defines the control facing each approach during each interval, such as green ball, amber ball, red ball, green left turn arrow, etc. Signal transition from one timing plan to another is available for pre-timed signals in NETSIM. Pre-timed signals may transition over one, two, or three cycles as defined in Entry 16 on Record Type 02.

For actuated control in NETSIM, Record Type 43 defines the approaches and referenced links. Actuated coordination in NETSIM is controlled by Record Type 44, which defines the time when permissive periods begin and end and when force-offs occur. Record Type 45 defines the traffic movements that are permitted during each phase, which are defined in terms of left, through, right, and diagonal, rather than in terms of signal indications. Record Type 46 defines detector characteristics, location, and type. Phase operations are described on Record Type 47. Operational characteristics include maximum green time or maximum extension as well as vehicle extension or gap reduction time. Extensions of the phase timing for pedestrians and generation of pedestrian demand are specified on Record Type 48. Record type 49 is used to specify how a controller transitions between timing plans that are specified for different time periods.

For ramp-metering control in FRESIM, Record Type 37 defines four types of on-ramp signal control strategies, and Record Type 38 defines the location of the detectors necessary for the application of metering strategies.

2.2.9   Traffic Volumes and Vehicle Occupancy

Traffic volumes entering from outside the network are defined on Record Type 50. Traffic volumes leaving the network are not defined; they are the result of turn movements onto exit links. Traffic volumes entering or leaving the network from within the network are defined on Record Type 51. They are called source/sink volumes and occur on internal links. They are used to represent the behavior of other traffic sources or attractors, such as parking lots and office locations. Vehicle occupancy (the number of people per vehicle) can be entered on Record Type 52.

2.2.10   NETSIM Events and Parking Maneuvers

NETSIM has both short- and long-term interruptions to traffic (known as "events"). Short-term events are events with an average duration of less than 60 seconds that take place in the curb lane. Record Type 54 is used to specify short-term events. Long-term events are longer-duration interruptions to traffic for any regular (non-pocket) lane. Record Type 55 is used to specify long-term events. Interruptions to traffic by parking maneuvers can also be modeled in NETSIM and are specified on Record Type 56. Parking activity can vary from time period to another, but only on links with parking.

2.2.11   Freeway Incidents

FRESIM uses Record Type 29 to specify freeway incidents - either blockages or rubbernecking - that occur on a lane-specific basis. Each incident occurs at a specified location, extends over a user-specified length of the freeway, and lasts for any desired length of time. FRESIM also allows users to specify both on-line and off-line incident detection specifications and algorithms with Record Types 61-67. See the *Required record types*

in FRESIM for point processing, on-line and off-line incident detection, and MOE estimation table for the entries required on record types for incident detection in FRESIM.

2.2.12 Vehicle Characteristics

NETSIM and FRESIM now use the same vehicle performance characteristics Record Type 173 is used to specify the maximum acceleration tables used to define vehicle performance for both NETSIM and FRESIM.

2.2.13 Fuel consumption and pollutant emissions

Detailed vehicle characteristics for fuel consumption and pollutant emissions can be specified. NETSIM and FRESIM now use the same tables for fuel consumption and emissions. Record Type 172 is used to specify the data tables for both NETSIM and FRESIM. The fuel consumption rates can be specified for autos, trucks, and buses. Only one rate of HC emissions, CO emissions, and NOx emissions can be set for all types of vehicles.

2.2.14 Urban Interchanges

Multilevel urban interchanges can be modeled in NETSIM. In previous versions, interchanges could be modeled, but the user was required to enter turn percentages for each link within the interchange. To further assist in the coding of interchanges, an option of entering travel demand patterns (i.e., origin-destination information) through an interchange instead of turn percentages for each link has been added in this version. Information on interchanges is entered on Record Types 95 and 96.

To allow for more realistic graphical representation of interchanges the capability of having curved links and overpasses has been added. Information for these options is entered on Record Type 196. Node coordinates are entered on Record Type 195 in feet units.

2.2.15 NETSIM Traffic Assignment

Traffic assignment of O-D data is possible for the NETSIM model. Specification of the traffic assignment parameters for FHWA's (BPR's) or Davidson's functions and their related factors is entered on Record Type 175. Specification of the trip table, in the form of origin-and-destination nodes, is entered on Record Type 176. Sources and/or destinations (sinks) of traffic that are internal to the network can be specified on Record Type 177.

When traffic assignment is requested, all record types relating to entry volumes and turn movements should be left out of the dataset; the volumes and percentages will be determined by the traffic assignment results. When using traffic assignment, Record Types 22, 50, and 51 should not appear in the dataset. Entries 7-11 can be used on Record Type 21 to define prohibited turn movements, but Entries 3-6 should be left blank.

Although traffic assignment models are not categorized as simulation models, they represent an essential interface between travel demand and actual traffic flows. Assignment models can serve two purposes: to convert O-D trip tables into actual network loadings for processing by simulation models and to evaluate demand responses to operational changes.

Two optimization techniques are used in the traffic assignment model: the user equilibrium assignment and the system optimal assignment. The criterion for determining when user equilibrium has been reached is that no driver can reduce his journey time (or impedance) by choosing a new route. The criterion for the system optimization is the minimum total cost of the entire network.

A given origin-destination demand matrix is assigned over the specified network. The results of the traffic assignment are then transformed into link-specific turn percentages as required by the simulation models, which commence operation following the assignment process.

The impedance function employed by the traffic assignment model is the FHWA formula and modified Davidson's queuing functions that relate link travel time to link volume and link characteristics (capacity and free-flow travel time). Traffic assignment is performed on a transformed path network that represents the

specified turn movements in the original network. The algorithm that is used is a Frank-Wolfe decomposition variation that generates all-or-nothing traffic assignments at each iteration using the link impedances produced by the previous iteration.

For each iteration, a minimum path tree is constructed for each specified origin node to all other network nodes, using a label-correcting algorithm. The network cost function is evaluated at the end of each iteration, and a line search is conducted for the improved link flows that minimize the cost function. The iterative procedure terminates when convergence is attained or when a pre-specified upper bound on the number of iterations is reached.

2.2.16 FRESIM Traffic Assignment

The traffic volume data in FRESIM are organized into the entrance volume (Node 8XXX) (in record type 50) and the percentage of turning volume at ramp exits (in record type 25). A gravity model was implemented in FRESIM to calibrate the turning percentages to an Origin Destination (OD) table in percentages.

First of all, the destination volumes are modeled by linear systems according to the data from record type 50 and record type 25. The Jacobi Method is used to iteratively solve the linear systems. Where there are groups of freeway interchanges, in some rare cases, the sufficient condition for the convergence of the linear systems can not be satisfied. Consequently, the destination volumes **MAY** not converge. If that happens, a warning message will be given to the user.

Secondly, record type 74 is designated to specify an OD pair in percentage from an origin node to a destination node. The user is responsible for ensuring that the traffic volumes for all destination nodes agree with the traffic volume calibrated in the first step using record type 25 and record type 50. Otherwise, the OD table may not be balanced. If that happens, a warning message will indicate the unbalanced volumes at specific exit nodes. The user should make the desirable change.

If the convergence could not be achieved and/or the OD table could not be balanced, CORSIM can still run. However, CORSIM can not assign the correct volumes on all links. CORSIM will report the OD tables to assist the user in debugging the OD input data.

Please refer to record type 25, record type 50 and record type 74 discussions for details.

2.2.17 Graphics

Detailed graphical outputs are available in CORSIM. To obtain these outputs, the locations of all nodes must be specified relative to each other. Record Type 195 specifies the x and y coordinates of each node. To depict the links more realistically, their shape as well as their length must be specified. Record Type 196 provides link geometric data that describes link curvature and overpass/underpass relationships.

2.2.18 Data Delimiters

Record Type 170 and Record Type 210 are used to separate input data for sub-networks and time periods, respectively. Within a time period, data for each subnetwork is separated by a Record Type 170. Each time period ends with a Record Type 210, which indicates whether it is followed by additional time period data or is the last data record in the input stream.

2.3 Input Diagnostics

CORSIM contains a thorough set of diagnostic tests for input, which are executed in the following sequence:

- Test that the structure of the input stream is correct, that all records are in proper sequence, and that no required records have been omitted.

- Test that each data item is valid and that its value lies within a "reasonable" range.

- Test that the set of data items on a record is internally consistent, with no missing items.

- Test that all the data items on the set of records belonging to one record type are consistent and that the set is complete.

- Test that the data on all record types of a particular classification are compatible and that the classification is completely defined. A classification describes an attribute of the traffic environment, such as network geometry, traffic operations, intersection control, and traffic demand. All the record types belonging to a classification are grouped together.

- Test that the data items of all classifications are compatible and completely define the network.

Whenever an error is detected in the tests outlined above, an error message is generated. Each message contains sufficient information to allow the user to identify the cause and make any required changes.

Two categories of messages are identified: "warning messages" and "fatal error messages." Warning messages identify unusual conditions that may or may not represent an error in the input data. Conditions that lead to warning messages will not prevent the simulation from running, but they may lead to an incorrect result. The legitimacy of such conditions should always be verified by the user. Fatal error messages identify conditions that will prevent the simulation from running.

Because of data interactions and the complexity of the diagnostic tests, the presence of a single error can generate a large number of messages. An effort has been made to restrict extensive output that reports numerous inconsistencies stemming from a single error. Therefore, several diagnostic tests are not performed until entire sections of the data are error free. For example, the logic checks that the geometric and traffic control specifications provide a means to discharge all traffic that might enter each link. On an urban subnetwork, this requires consistency among several different types of data:

- Turn movement data must identify the expected discharging movements from each link (Record Type 21).

- Geometric specifications must identify a receiving link for traffic executing each of these discharge movements (Record Type 11).

- Traffic control specifications for the link must provide some opportunity (sign or signal phase) to service traffic for each of these turn movements (Record Types 35 and 36 for pretimed controllers and Record Types 43-48 for actuated controllers).

Because of similar data interactions, many tests on traffic assignment data and bus transit operations are not performed until much of the data is error free.

2.4 CORSIM Output

CORSIM include four main sections: input data echo, initialization results, intermediate results, and end of time period results. The intermediate results and end of time period results include separate output sections for NETSIM and FRESIM subnetworks. NETSIM also includes an output section that is time period specific. All other output is cumulative since the beginning of the simulation.

The input data echo consists of a copy of the input file and tables stating the complete specification of the traffic environment and run options, including all the user-supplied inputs and default values. They can be used for checking the validity and acceptability of values and parameters.

The initialization statistics show how the vehicles filled the network at different time intervals prior to the network reaching equilibrium. The initialization results are not included in the cumulative results. CORSIM starts accumulating statistics after equilibrium has been reached.

Intermediate results are optionally printed out at the end of user specified intervals. Intermediate and end of time period results include measures of effectiveness (MOE) that are used to evaluate traffic systems.

# 2.4.1 NETSIM MOEs

2.4.1.1 Netsim Link MOEs

The following are the link MOEs:

- Vehicle Trips - The number of vehicles that have been discharged from the link since the beginning of the simulation.

- Vehicle Miles - The vehicle trips times the length of link.

- Total Time (veh-min) - Total time on the link for all vehicles.

- Move Time (veh-min) - The theoretical travel time if vehicles are traveling at the free flow speed, calculated by the total travel time multiplied by the ratio of the calculated speed to the free flow speed.

- Delay Time (veh-min) - The difference between the total travel time and the moving time, represents the time that vehicles are delayed if they cannot travel at the free flow speed.

- Total Time (min per mile) - The average actual travel speed on the link, calculated by taking the total travel time and dividing it by the vehicle miles.

- Delay Time (min per mile) - The delay time in veh-min divided by the vehicle miles traveled.

- Total Time per vehicle (sec per veh) - The average travel time on a link for each vehicle, calculated by taking the total travel time and dividing it by the number of vehicle trips.

- Delay Time per vehicle (sec per veh) - The average delay on a link for each vehicle, calculated by taking the delay time in veh-min and dividing it by the number of vehicle trips.

- Queue Delay per vehicle (sec per veh) - Delay calculated by taking vehicles having acceleration rates less than 2 feet per second^2 and speed less than 9 feet per second. If a vehicle's speed is less than 3 feet per second, it will be included every second. Otherwise it will be included every two seconds.

- Control Delay per vehicle (sec per veh) -   (see Control Delay)

- Stopped Time per vehicle (sec per veh) - The time the vehicle's speed is less than 3 feet/second on the link and includes the bus dwell time.

- Stop Percentage - The ratio of the number of vehicles that have stopped at least once on a link to the total link trips.

- Average Volume (veh per hr) - Total vehicle trips divided by the simulation time.

- Average Speed (miles per hr) - Total vehicle miles divided by the total travel time.

- Average Occupancy (veh) - The summation of the vehicle content on a link every 5 seconds for the entire simulation run.

- Storage (%)- This is a value calculated by taking a constant (i.e., 6) times the adjusted vehicle length (i.e., a weighted average of all vehicle types on a link) divided by the lane length (i.e., includes the full lanes and turning pockets).

- Phase Failure - The number of times during the simulation that the queue fails to be discharged completely during a green phase.

- Average Queue Length by lane (veh) - The average queue length on a lane since the beginning of the simulation.

- Maximum Queue Length by lane (veh) - The maximum queue length that was observed on a lane since the beginning of the simulation (i.e., 100 percentile).

- Number of Lane Changes - The number of lane changes that occurred on a link during the simulation run.

- Vehicles discharged per lane

2.4.1.2 Control Delay

In the 1997 version of the HCM, intersection control delay (ICD) was defined as the delay incurred by the control facility. "Control delay includes initial deceleration delay, queue move-up time, stopped delay and final acceleration delay." The following figure illustrates the components of control delay.
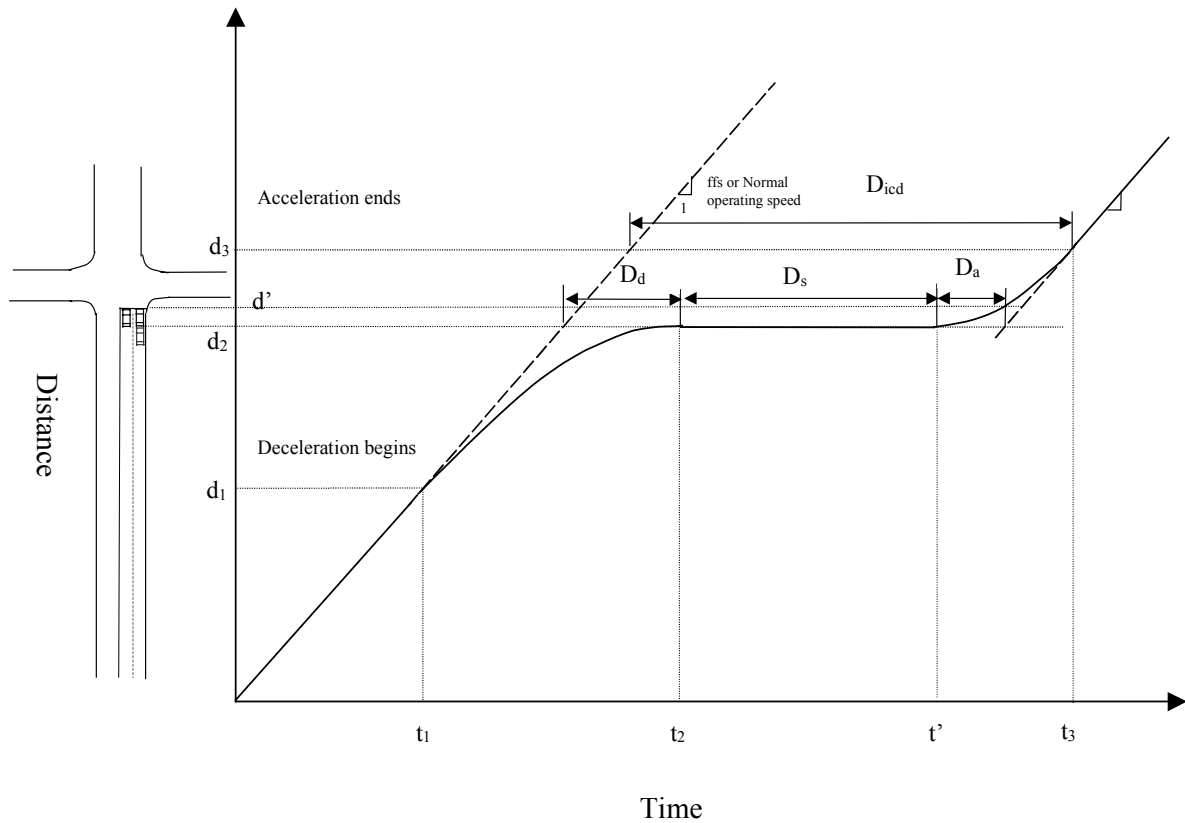
From the figure, it can be seen that

$$D_{icd} = D_d + D_s + D_a \tag{1}$$

where

D_{icd}:   Intersection control delay

D_s: Stopped delay

D_d: Delay incurred while a vehicle is decelerating in approaching the stop bar or the end of the queue

D_a: Delay incurred while a vehicle is accelerating to gain its full operating speed after the signal indication turns green

The intersection control delay D_{icd} can be calculated as follows:

$$D_{icd} = (t_3 - t_1) - \frac{d_3 - d_1}{V} \tag{2}$$

where

V: Normal operating speed of the vehicle before it slows down and responds to intersection control.

When traffic volume is light, the free flow speed (ffs) of the vehicle on the link can replace V in equation (2). However, at high demand, V can be considerably smaller than ffs. In other words, while the vehicle is delayed by intersection control, it is also delayed by high volume. The total delay from time t_1 to t_3 is calculated in equation (3).

$$D_{total} = D_{icd} + \left(\frac{d_3 - d_1}{V} - \frac{d_3 - d_1}{ffs} \right)$$

(3)

It should be pointed out that only control delay fully accounts for any slow down caused by intersection signal control. Stopped delay (D_s) only considers the time lost while a vehicle stops in the queue waiting for a green signal indication or waiting for its leader to move forward. It does not consider the time lost while a vehicle is slowing down and approaching the stop bar or the end of the queue (D_d), nor does it consider the time lost while a vehicle is in a process of regaining its normal operating speed (D_a). Approach delay may fully account for D_s and D_d, however, accumulation of D_a is terminated when a vehicle passes the stop bar of the intersection, even though it may still be in the process of regaining its full operating speed. This of course underestimates the delay incurred during the acceleration stage. In addition, the portion of D_a that is ignored may represent a significant part of D_a if the vehicle is among those first vehicles behind the stop bar. Obviously, control delay is a more accurate measurement of vehicular delay caused by intersection control.

Average ICD (AICD) can be calculated analytically by applying formulas (9-22) through (9-27) in the new Highway Capacity Manual. There are several approaches to measure intersection control delay at existing intersections:

- Test-car observing

- Path tracking

- Arrival and departure queue observing

The HCM expounds on the procedures to measure intersection control delay using the arrival departure queue observation in its Appendix III. Since CORSIM is a microscopic simulation, it is possible to track individual vehicle profiles and make accurate counts of ICD. In addition to its ability to calculate control delay for fixed time intersections, CORSIM can also calculate and accumulate control delay for intersections under sign control (stop or yield sign), and under actuated signal control.

2.4.1.3   Person MOEs

The following are the Person MOEs:

- Person Miles

- Person Trips

- Delay Person-Min

- Travel Time Person-Min

2.4.2   FRESIM MOEs

2.4.2.1   Fresim Link MOEs

The following are the Link MOEs:

- Vehicles In – Number of vehicles that have entered the link since the beginning of the simulation.

- Vehicles Out – Number of vehicles that have been discharged from the link since the beginning of the simulation.

- Lane Changes – Number of lane changes that have occurred on the link since the beginning of the simulation.

- Current Content – Number of vehicles currently on the link.

- Average Content – Total number of vehicle seconds accumulated on the link since the beginning of the simulation divided by the number of seconds since the beginning of the simulation.

- Vehicle Miles – Total distance traveled on the link by all vehicles on the link since the beginning of the simulation.

- Vehicle Minutes – Total time on the link for all vehicles on the link since the beginning of the simulation.

- Total Time (seconds per vehicle) – Link length divide by the average speed (in feet/second) of all vehicles on the link since the beginning of the simulation.

- Move Time (seconds per vehicle) – Total Time per vehicle multiplied by the Ratio of Move Time to Total Time.

- Delay Time (seconds per vehicle) – Total Time per vehicle minus Move Time per vehicle.

- Ratio of Move Time to Total Time – Total Vehicle Minutes minus the total accumulated number of vehicle delay (in seconds), divided by Total Vehicle Minutes. Delay is the difference between the time it would take a vehicle to travel the length of the link if it traveled at the link freeflow speed and the actual time that it takes the vehicle to travel that distance.

- Total Vehicle Minutes per Vehicle Mile – Vehicle Minutes divided by Vehicle Miles.

- Delay Vehicle Minutes per Vehicle Mile – Vehicle Minutes divided by Vehicle Miles multiplied by (1 minus Ratio of Move Time to Total Time).

- Volume – Density multiplied by Speed.

- Density – Average Content divided by the link length divided by the average number of lanes on the link.

- Speed – Vehicle Miles divided by (Vehicle Minutes divided by 60).

- Link Type – Ramp or Mainline

2.4.2.2 HOV Link Statistics

Most of these statistics are the same as the link statistics, except broken down by lane, and some MOEs are converted to units per person. That conversion is accomplished by dividing the MOE by the total number of occupants transported by all of the vehicles on the link since the beginning of the simulation. This table also indicates that a lane is an HOV lane or an SOV lane and reports the volume of violators that used the HOV lanes. A violator is a vehicle that does not qualify to use the HOV lane but uses it anyway

3 Configuring and Running CORSIM

3.1   Overview

The CORSIM simulation program is the primary simulation tool in the TSIS package of traffic tools. It is implemented as a Dynamically Linked Library (DLL). DLLs cannot be executed directly. They require a separate program to start and control their execution. There are three different ways to execute CORSIM using tools provided with TSIS; running CORSIM from TShell with the provided CORSIM Driver tool, running CORSIM from a user-configurable script in TShell, or running CORSIM external to TSIS with the provided command line executable. This chapter describes how to configure and run the CORSIM simulation.

3.2   CORSIM as a TSIS Tool

3.2.1   CORSIM Driver Tool Overview

The CORSIM Driver tool is an Active X control that operates within the TSIS graphical user interface, known as TShell. As such, TShell supports the CORSIM Driver by supplying menus, toolbars, and a status bar. In this document, we will describe only those elements of the TShell interface that have a unique operation with regard to the CORSIM Driver. For example, the File, Options, Tools, Window, and Help menus operate in a common fashion as they do for all TShell components, and will not be described here. Please refer to the TShell User's Guide for information regarding the operation of these common elements.

The CORSIM Driver tool provides a clean and functional interface to CORSIM. It is consistent with the other tools within TSIS, which should reduce the learning curve for new users. It also provides the capability to run multiple CORSIM simulations simultaneously. In addition, multiple versions of CORSIM can be supported within a single TSIS installation by adding a new CORSIM Driver using a different CORSIM DLL.

The user interface for the CORSIM Driver tool is a window that displays the text messages output by the CORSIM simulation. It has many of the same characteristics of a text editor except that it is read only. You cannot type into the window. It also has a toolbar used to control the execution of the CORSIM simulation.
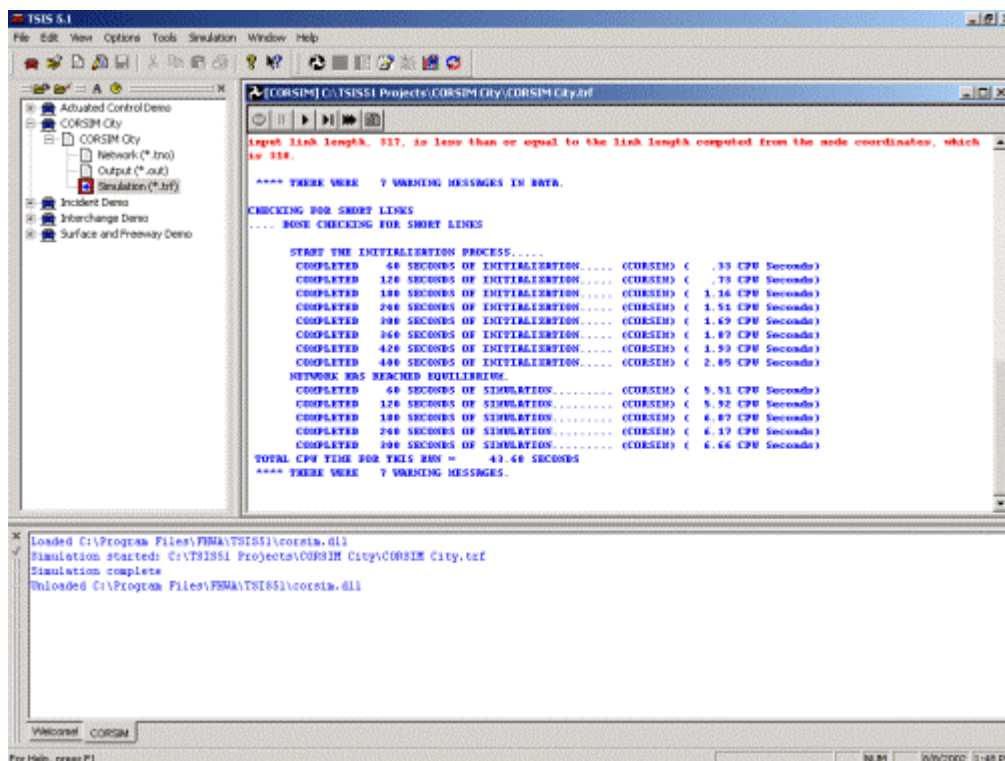
3.2.2 Multi-run Processing Description

Due to the stochastic nature of CORSIM, it is necessary to run CORSIM multiple times varying the random number seeds to gain an accurate reflection of the performance of the testcase. The CORSIM Driver Tool has a built-in multiple-run capability and a built-in output processor. The multi-run capability runs a testcase multiple times changing the random number seeds for each run. The Output Processor collects user-selected MOE data for selected links from CORSIM over multiple runs, organizing it in one place. When Output Processing is selected, a statistics file (or files, depending on how many formats are selected) is created. These files are overwritten if they already exist, and are created if they do not exist.

The positive aspects of this approach are:

1. Data from multiple runs are summarized based on user-selected statistics.

2. The user specifies which MOE to collect.

3. Use of the tool encourages users to account for the stochastic nature of CORSIM.

The negative aspects of this approach are:

1. Only the selected data is collected. If it is determined that additional MOE, links, or statistics are desired the simulation must be rerun to collect the new data.

2. Only raw MOE are collected. Some additional calculations may be necessary to obtain the desired data.

3. Not every MOE found in the CORSIM generated output file can be collected by this tool.

Under certain circumstances, the CORSIM simulation may encounter exceptional conditions and be unable to complete a run. Should this happen, statistical data for that run will be discarded and will not factor into the analysis functions (Mean, Standard Deviation, etc.). The analysis functions will be applied as if that run had not occurred.

3.2.3   Setting up the CORSIM Driver Tool for a new Configuration

1.   Select "Tool Configuration" from the TShell Tools menu. The Tool Configuration dialog will appear.
2.   Click the "Add" button. The Tool Configuration wizard will appear.
3.   Click the "…" button to the right of the "Path" edit box. Use the Windows® File dialog to select "CorsimDriver.dll" in the TSIS install directory.
4.   Type a unique name in the "Name" edit box.
5.   Select "Simulation" in the Category group.
6.   Type an appropriate string in the "Tool Tip String" edit box.
7.   Type "trf" in the "File Extensions" edit box.
8.   Click the "…" button to the right of the "Bitmap Path" edit box. Use the Windows® File dialog to select the bitmap of choice.
9.   Click the "Next" button. The COM Object wizard will appear.
10. Select the Output Pane behavior of choice.
11. Select "HTML" for help category.
12. Click the "…" button and use the Windows® File dialog to select <help file name>.
13. Click the "Next" button. The CORSIM Properties wizard will appear.
14. Select the desired CORSIM options (reference the CORSIM Properties description).
15. Click the "Next" button. The Message Text wizard will appear.
16. Select the desired Message Text options (reference Message Text description).
17. Click the "Next" button. The Multiple Run wizard will appear.
18. Select the desired Multiple Run options (reference the Multiple Run Properties description).
19. Click the "Next" button. The Run Time Extension wizard will appear.
20. Select the desired Run-Time Extensions (reference the Run-Time Extensions description).
21. Click the "Next" button. The Version Information wizard will appear.
22. Click the "Finish" button. The Version Information wizard will disappear.
23. Click the "OK" button. The new CORSIM tool is now ready for use.

3.2.4   CORSIM Properties

The CORSIM Properties apply any time the tool is used. Access the properties dialog by opening the Tool Configuration dialog from the Tools menu and Editing the tool. Alternatively, right click on the tool's icon in the Traffic Tool Toolbar. The following dialog will be displayed. The Tool Configuration page is common to all TSIS tools. The COM Object page is common to all TSIS tools that are COM implementations. The rest of the pages on this dialog are common only to CORSIM tools.
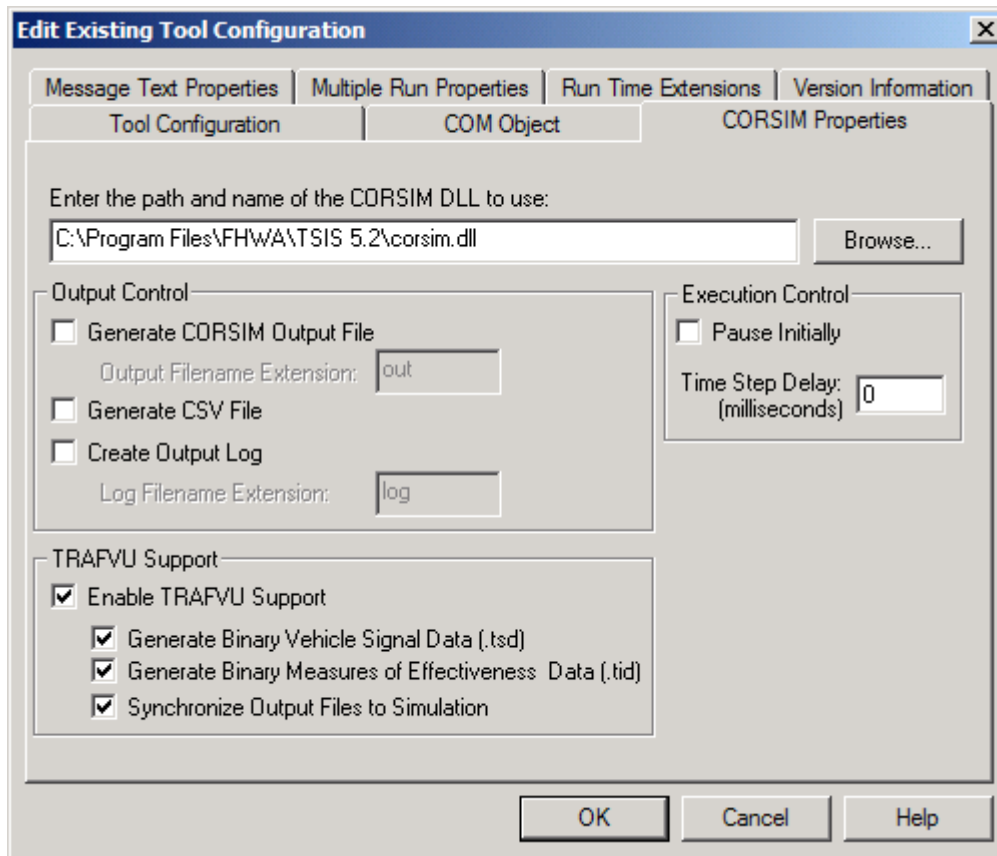
Open the CORSIM Properties page.

"Enter the path and name of the CORSIM DLL to use:" The full path to the CORSIM DLL must appear in the edit box. Clicking the "Browse…" button will bring up a Windows® File dialog to select the file.

Output Control

"Generate Output File" File will be casename.ext, where casename is the input file (without the extension) and ext is the Output File Extension (see below). (Reference CORSIM output description)

"Output File Extension:" See above. Extension should be specified without the leading dot.

"Generate CSV File" If checked the output MOE will be saved as a Comma Separated Value (CSV) file by CORSIM.

"Create Output Log" Output that appears in the message text window will be echoed to the log file. Its name will be casename.ext, where casename is the input file (without the extension) and ext is the Log File Extension (see below).

"Log File Extension:" See above. Extension should be specified without the leading dot.

TRAFVU Support

"Enable TRAFVU Support" Turns on or off the following functionality at one time.

"Generate Binary Vehicle Signal Data (.tsd)" Generates the Time Step Data files used by TRAFVU to animate the simulated vehicles and signals. [Reference TRAFVU documentation on TSD file]

"Generate Binary Measures of Effectiveness Data (.tid)" Generates the Time Interval Data files used by TRAFVU to display Measures Of Effectiveness (MOE) data. [Reference TRAFVU documentation on TID file]

"Synchronize Output Files to Simulation" TSD and TID files will be written as the simulation progresses, allowing simultaneous running of TRAFVU and CORSIM. If this is not checked, the files will be written when the operating system file buffer becomes full. The buffer may contain many seconds worth of data. Allowing the buffer to fill is slightly more efficient.

Execution Control

"Pause Initially" CORSIM will run to equilibrium and then pause before the first time step. A similar behavior can be achieved by starting the simulation with Step rather Start/Resume. Step will pause after the first time step.

"Time Step Delay" This is the milliseconds between time steps. As CORSIM uses a 1-second time step, a value of 1000 milliseconds will make CORSIM run more or less in real time if possible. This can be used in conjunction with "Sync Output Files with Simulation" to animate in real time.

3.2.5   Message Text Properties

The CORSIM Driver has a set of predefined message types. The Message Text Properties dialog page controls the color and style of text messages written to the view.   Messages of the appropriate type will have these colors. Clicking the "Change…" button on the "Message Text Font" will bring up a standard Windows Font dialog to select the font style. Clicking the "Change…" button on the color message types will bring up a standard Windows® color dialog to select the new color.
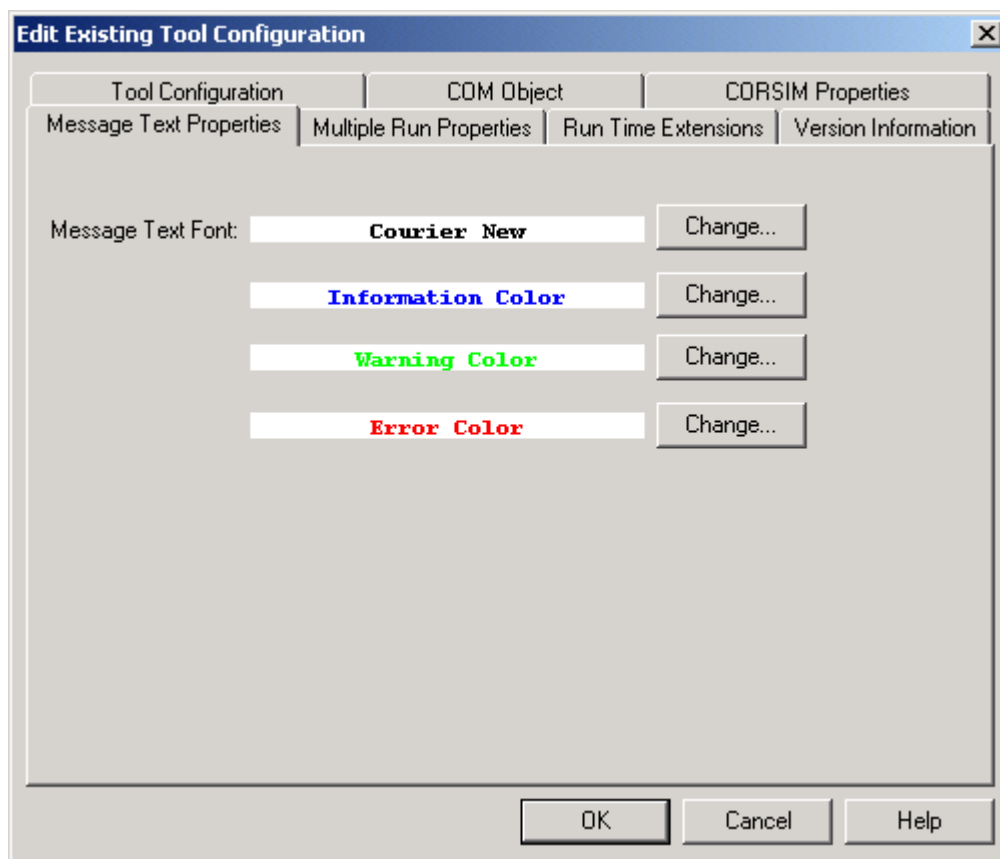
 "Message Text Font" Text that appears in the message window will use this font.

"Information Color" Messages of the Information Type will use this color

"Warning Color" Messages of the Warning Type will use this color

"Error Color" Messages of the Error Type will use this color

3.2.6   Multiple Run Properties

When multiple run properties are edited from the Traffic Tool Toolbar Properties dialog, changes are global, and affect all cases except those that have explicitly saved properties (see below).

Alternatively, to edit multiple run properties for a single open instance, use the "Simulation | Run Multiple Properties…" menu item or ▣ Run Multiple Properties toolbar button. Properties changed will only persist until the case is closed, unless the "Save Configuration for Case" button is checked, in which case the properties will persist for that case only (see below).
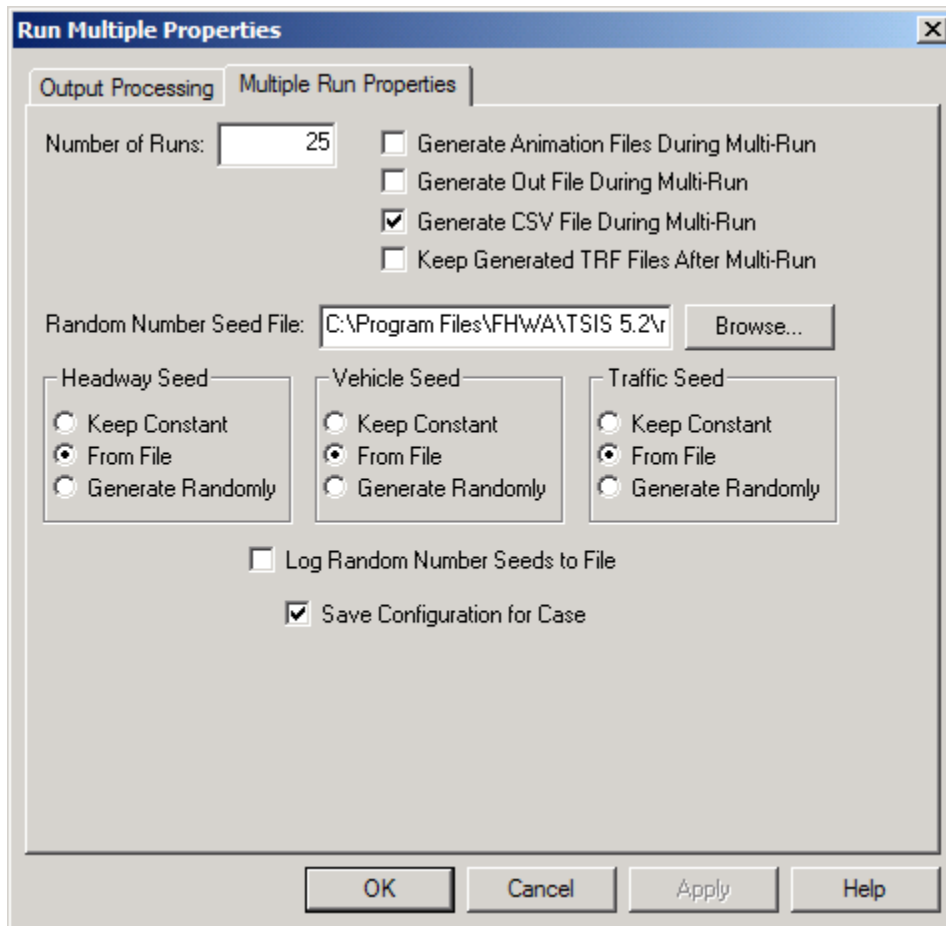
"Number of Runs:" The number of times CORSIM will run.

"Generate Animation Files During Multi-Run" If checked, TSD and TID files will be generated for each run.

"Generate Out File During Multi-Run" If checked, CORSIM will create output files for each run.

"Generate CSV File During Multi-Run" If checked, CORSIM will create the output file in CSV format for each run.

"Keep Generated TRF Files After Multi-Run" If checked, the TRF file that is generated for each run will be saved. If not checked, the TRF file for the individual run will be deleted after CORSIM has finished running. The original TRF file will not be affected. This prevents a large number of files from being stored on the computer.

"Random Number Seed File:" The full path must be specified. This is an ordinary text file containing random number seeds. The first line must have the number of seed groups in the file. Each line thereafter has three random number seeds (one each for Vehicle Headway, Vehicle Generation, and Traffic Decisions, respectively). Clicking the "Browse…" button will bring up a Windows® File dialog to select the random number seed file. A random number seed file with 30 sets of seeds is provided with CORSIM (random.rns). However, users are free to create their own random number seed file(s).

Random Number Seed Options

"Keep Constant" The random number seed will not change. It will be the same as in the original input file. You may want to hold one or two random number seeds constant while varying the other random number seed or seeds. Holding all three random number seeds the same will produce the exact same results for each run and therefore waste resources.

"From File" The random number seed will be read from the file specified in the "Random Number Seed File" edit box. If there are fewer entries in the file than there are runs, the remaining seeds will be generated randomly.

"Generate Randomly" The random number seed will be generated randomly. Every time the multi-run function is used, different results will be produced. This increases variability but decreases repeatability.

"Log Random Number Seeds" If checked, a file will be created with all the random number seeds used. It will be a text file laid out as described above, titled casename.rns, where casename is the input file (without the extension). This may be useful if the "Generate Randomly" option is selected above. The file generated could then be used as the source of the random numbers used with the "From File" option for subsequent simulation runs.

"Save Configuration for Case" This option is only enabled if editing options from an open case. If checked, the properties on this page will be saved for future use. When this case is next opened, the saved options will be used instead of the global tool options.

3.2.7 Run Time Extensions

Run Time Extensions are used to modify CORSIM's default behavior.
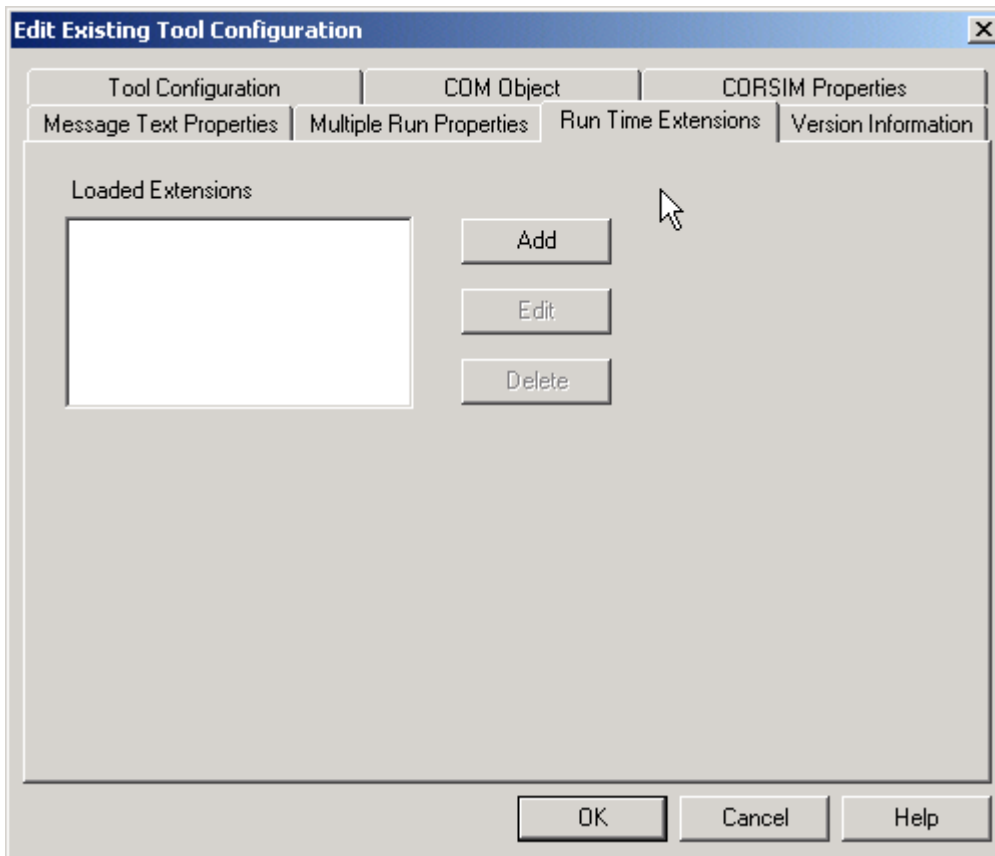
"Loaded Extensions" List of run-time extension path names that will be used.

Click the "Add" button to add another run-time extension to the list.

Click the "Edit" button to change the properties of the selected extension.

Click the "Delete" button to remove the selected run-time extension from the list.

3.2.7.1   Run Time Extension Properties Dialog

This dialog is reached by clicking either the "Add" or "Edit" button on the Run Time Extensions property page.
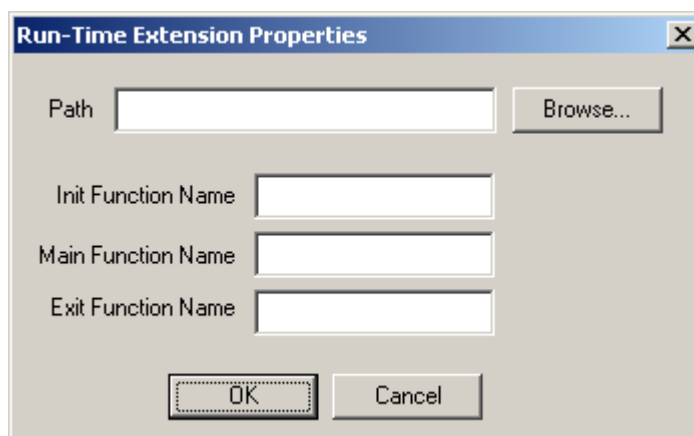
The full path name of the extension must be specified. Click the "Browse…" button to bring up a Windows® File dialog to select the file.

"Init Function Name" The name of the initialization function. The initialization function will be called during CORSIM initialization after the input file has been validated.

"Main Function Name" The name of the main function. This function will be called every time step.

"Exit Function Name" The name of the cleanup/exit function. This function will be called right before the DLL is unloaded.

3.2.8　　Output Processing Properties

This property page is accessed through the "Simulation | Multi-Run Properties…" menu item or CORSIM Driver toolbar button.
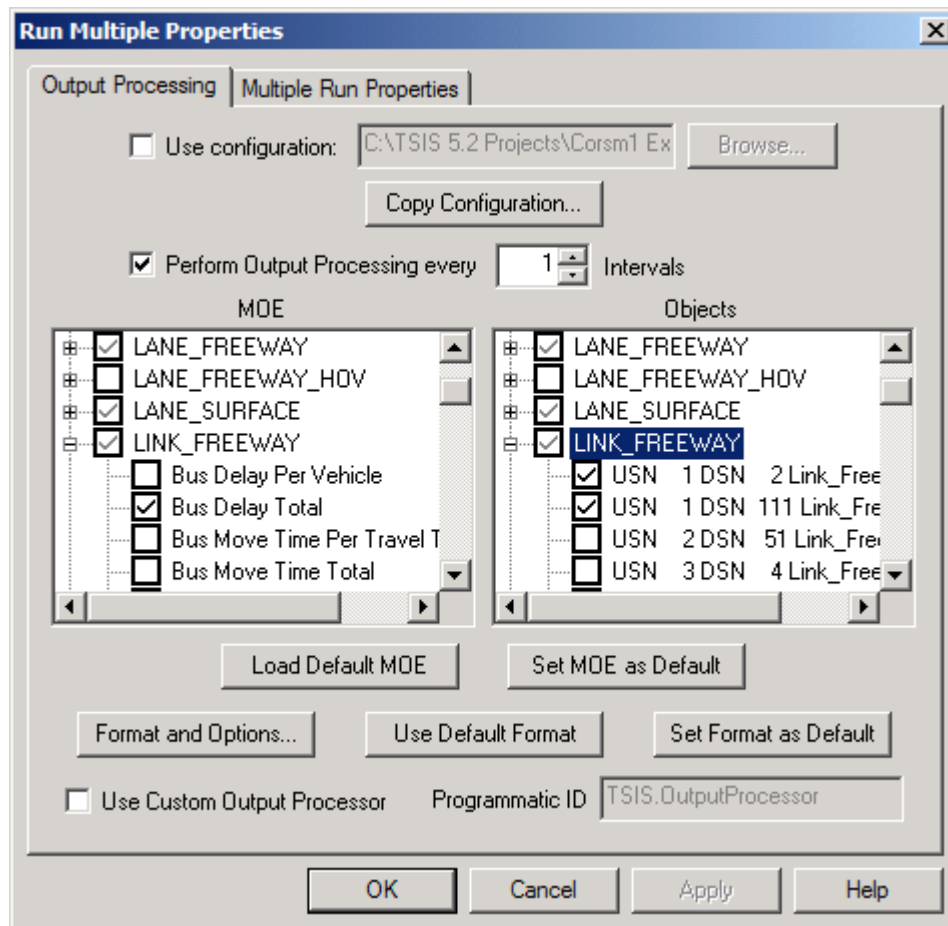
"Use Configuration" When this box is checked, configuration parameters are read from and saved to the file specified in the edit box. This allows a single file to provide configuration parameters for an entire set of similar test cases. The "Browse…" button brings up a Windows® File Dialog to select the file. If this box is not checked, the configuration parameters are read from and saved to a file named casename.cfg where casename is the name of the current testcase.

"Copy Configuration" This button brings up a Windows® File dialog to select a configuration file from another case. The configuration parameters are copied from another case and then saved to a file named casename.cfg where casename is the name of the current testcase.   This may be useful when there are several nearly identical case files representing alternative configurations for which the same statistics are to be collected. The options only need to be set once, and can then be copied for the other cases.

 "Perform Output Processing" Output processing will only be performed if the box is checked. The configuration parameters will be saved in either case.

"Intervals" The number of intervals between statistics collections. A value of 1 collects statistics every interval, while a value of 5 will cause statistics to only be collected every fifth interval. The interval duration is specified in the TRF file on Record Type 4, Entry 2, and in TRAFED on the Network Properties Dialog, Time Periods Page.

"MOE" There are many "Classes" of Measures of Effectiveness in CORSIM. Each Class has different MOE that are specific to that Class. For example, the Bus Station class has a set of MOE and Freeway Link has a different set of MOE. Open a Class by clicking the '+' sign to the left of the Class name. A list of MOEs for each class that are available in this version of CORSIM will be shown. Click the desired MOE in the tree view to select or unselect them. Selected items will be checked. Statistics for the selected MOE will be collected and output for objects selected in the "Objects" tree view for the selected Class. Link aggregations are selected using the Section Class. Link Aggregations for NETSIM are entered on Record Type 90 or on the Network | Link Aggregation dialog in TRAFED. If there are no objects in the TRF file that correspond to a certain class, that class will not be shown. For example, if a network does not have any Bus Stations, the Bus Station class will not be displayed in the MOE selection area. Right clicking on the class title in the MOE selection area will allow the user to select all MOE of that class or deselect all MOE of that class. NOTE: MOEs and Objects for a class must both be chosen for data to be collected.

"Objects" There are many "Classes" of Objects in CORSIM. Each Class has different objects that are specific to that Class for the current TRF file. For example, the Bus Station class will have a list of bus stations and the Freeway Link class will have a list of freeway links. Open a Class by clicking the '+' sign to the left of the Class name. A list of objects for this class that are available in the TRF file will be shown. Click the desired object in the tree view to select or unselect them. Selected items will be checked. Statistics for the selected object will be collected and output for MOEs selected in the "MOE" tree view for the selected Class. If there are no objects in the TRF file that correspond to a certain class, that class will not be shown. For example, if a network does not have any Bus Stations, the Bus Station class will not be displayed in the Object selection area. Right clicking on the class title in the Object selection area will allow the user to select all objects of that class or deselect all objects of that class. NOTE: MOEs and Objects for a class must both be chosen for data to be collected.

"Load Default MOE" Push this button to load the default MOE. Each individual network can have its own configuration file. It has no MOE selected when it is first opened in the Run Multiple Properties dialog. Applying a default set of MOE can save time when a similar set of MOE are always selected. Set the default MOEs with the "Set MOE as Default" button.

"Set MOE as Default" Push this button to save the current set of MOE as the default set of MOE. This only applies to the MOE selection area. The Objects selection area is specific to a network and is not affected by this button. The objects must be selected individually for each network.

"Format and Options…" This button brings up the Format Type and Options properties dialog for the output processor. (See below)

"Use Default Format" Push this button to load the default set of format type and options to the Format Type and Options dialog. Applying a default set of format and options can save time when a similar set of options are always selected. Set the default format with the "Set Format as Default" button.

"Set Format as Default" Push this button to save the current set of formats as the default set of formats from the Format Type and Options dialog. Applying a default set of format and options can save time when a similar set of options are always selected.

 "Use Custom Processor and Programmatic ID" Check the box and fill in the Programmatic ID to use your own output processor. This option is provided for software developers. The box should be left unchecked in most cases.

Format and Options
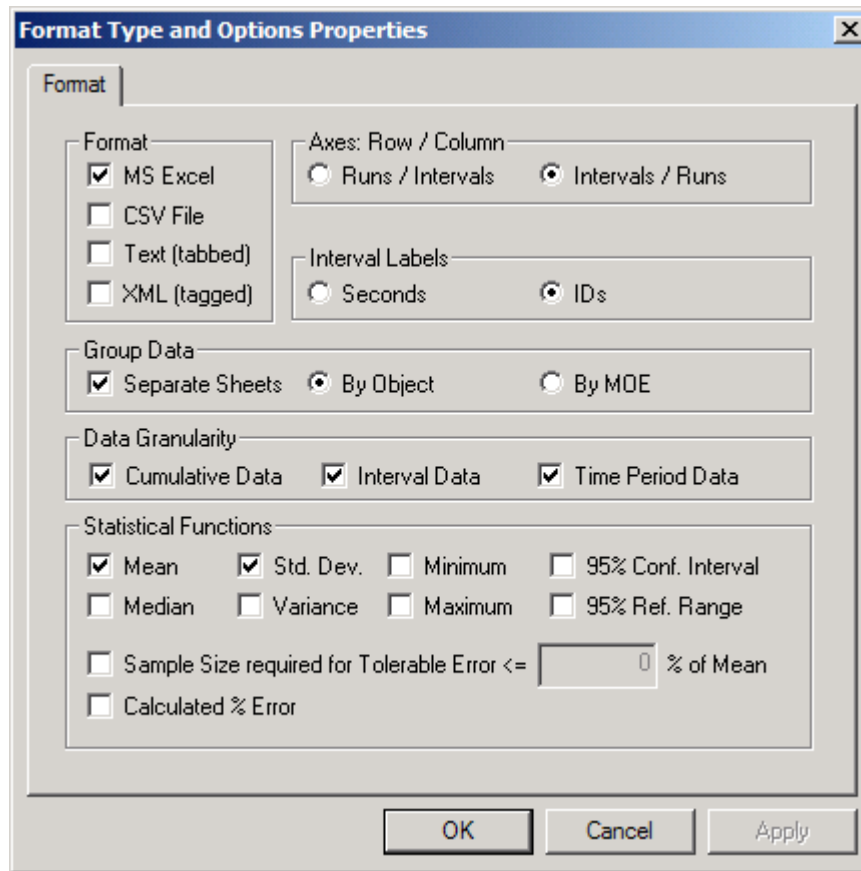
"Format" The TSIS Output Processor supports three file formats: Microsoft Excel®, Comma-Separated-Value (CSV), Tabbed Text, and XML tagged format. An automation-capable version of Microsoft Excel® must be installed on your machine to use the EXCEL format. CSV, tabbed text, and XML formats may be used on any machine. Most spreadsheet programs (including Excel®) can import these files. Spreadsheet programs, including Excel®, may be added to TSIS as tools. Refer to the TSIS User's Guide for details.

"Axes: Row/Column" Selecting the "Runs/Intervals" radio button will organize the data such that each run (and summary statistic) is in a horizontal row down, with intervals in columns across. Selecting the "Intervals/Runs" radio button will organize the data such that each interval is in a horizontal row down, with runs (and summary statistics) in columns across. The summary statistics are calculated for each interval and summarized over the number of runs. For example, if the testcase being simulated has 60 intervals and it is run 20 times, each interval will have a value for the selected statistic(s) over those 20 runs. If Standard Deviation is selected, each interval will have a value for standard deviation over the 20 runs.

"Interval Labels" Selecting the "Seconds" radio button will label the intervals (rows or columns, depending on the axis setting, above) in seconds. Selecting the "IDs" radio button will label the intervals with their CORSIM interval IDs.

"Group Data" "Separate Sheets" only applies to Excel® format. If checked, each combination of link and MOE will be on a separate worksheet in the workbook. If not checked, there will be a worksheet for each link (for "By Link" grouping) or each MOE (for "By MOE" grouping). For CSV and Tabbed Text formats, statistics are either sorted by link or MOE, depending on which option is chosen.

"Data Granularity" The MOE values can be gathered, analyzed, and presented in different granularities. "Cumulative Data" are data that have accumulated since the end of the initialization period. "Interval Data" are data accumulated over each interval. (The interval duration is specified in the TRF file on Record Type 4, Entry 2, and in TRAFED on the Network Properties Dialog, Time Periods Page.) "Time Period Data" are accumulated over each time period. (The time periods and duration are specified in the TRF file on Record Type 3, and in TRAFED on the Network Properties Dialog, Time Periods Page.)

"Statistical Functions" The Output Processor supports many typical statistical functions. The Minimum, Maximum, Mean, Median, Standard Deviation, and Variance use well-known equations.

"95% Conf. Interval" If this box is checked, a 95% confidence interval is computed for each MOE selected by the user. The 95% confidence interval defines, with a 95% certainty, the range in which the true or "population" mean of the *overall simulation analysis* should fall. The calculation for the 95% confidence interval term is

$$1.96 \bullet \left(\frac{\sigma}{\sqrt{n}} \right),$$

where $\begin{cases} 1.96 \text{ is the Z - value for the Standard Normal Curve for 95\% confidence} \\ \sigma \text{ is the sample standard deviation computed from the simulation results} \\ n \text{ is the sample size (e.g., number of simulation runs).} \end{cases}$

The sample mean plus-or-minus (+/-) the value computed from the above calculation represents the 95% confidence interval for the mean of the given simulation MOE. The value computed (e.g., the +/- term) is displayed by the output processor.

"95% Ref. Range" If this box is checked, a 95% reference range is computed for each of the MOE selected by the user. The 95% reference range defines, with a 95% certainty, the range in which sample means or "observations" from *individual simulation runs* should fall. The calculation for the 95% reference range term is

$$1.96 \bullet \sigma,$$

where $\begin{cases} 1.96 \text{ is the Z - value for the Standard Normal Curve for 95\% confidence} \\ \sigma \text{ is the sample standard deviation computed from the simulation results.} \end{cases}$

The sample mean plus-or-minus (+/-) the value computed from the above calculation represents the 95% reference (or "normal") range for the observations of the given simulation MOE. The value computed (e.g., the +/- term) is displayed by the output processor.

"Sample Size required for Tolerable Error" If this box is checked, the user must also enter a tolerable error in terms of a percent of the mean. The sample size required for tolerable error calculates the minimum number of simulation runs (i.e., the sample size) required to produce results with a "sampling error" less than or equal to the tolerable error entered by the user. The formula for the sample size calculation is:

$$n = \frac{(1.96)^2 \bullet \sigma^2}{E^2},$$

where $\begin{cases} n \text{ is the required sample size (e.g., number of simulation runs)} \\ 1.96 \text{ is the Z - value for the Standard Normal Curve for 95\% confidence} \\ \sigma^2 \text{ is the sample variance computed from the simulation results} \\ E \text{ is the tolerable error for the sample mean (in same units as the mean).} \end{cases}$

The output processor calculates the tolerable error term by multiplying the sample mean of each selected MOE by the user input value for percent tolerable error (i.e., "% of Mean"). The required sample size for a 95% confidence interval on the mean is then computed for each MOE and displayed by the output processor. Therefore, when determining the number of simulation runs to perform, the user should use the sample size result from their MOE of key interest.

If the calculated sample size is less than the number of simulation runs made by the user, then the user does not need to perform additional runs. If, however, the calculated sample size is greater than the number of runs made by the user, the user should run the simulation again with at least as many runs as the calculated sample size. Determining the sample size is an iterative process since running the simulation for a different number of runs will produce a different sample variance. The user should repeat the process until the number of runs made is greater than or equal to the value calculated for the required sample size. As seen in the equation, the smaller the tolerable error term, the larger the required sample size.

"Calculated % Error" If this box is checked, the output processor will display the calculated percent error term for each MOE. The calculated % error is the current percent error term from the simulation results. This value is the 95% confidence interval (e.g., the +/- term) as a percentage of the sample mean. This term gives the user an indication of how close they are to the tolerable error term (e.g., "% of Mean") that they entered for the previous function.

"Nearest Neighbor" The output processor also displays a "Nearest Neighbor" value for each simulation run that is calculated as the sum of the absolute values of the difference between the sample value at each interval and the sample mean for that interval. The formula to compute the "Nearest Neighbor" value for "run number j" is:

$$NearestNeighborValue_{run\,j} = \sum_{i=1}^{number\ of\ intervals} \left| mean_i - value_{ij} \right|$$

Therefore, the simulation run with the lowest value for "Nearest Neighbor" can be thought of as the run closest to the mean. This is useful if the user wants to re-run one simulation and generate animation files that are characteristic of the average results.

3.3   Running CORSIM as a TSIS Tool

3.3.1   Basic Operation

In order to run the CORSIM simulation from the TShell interface you must select a testcase from the Project

View. Then select the "Simulation | CORSIM" tool from the Tools menu or on the Tools toolbar. The CORSIM Driver interface window will be displayed in the TShell Workspace. The name of the selected file will be in the title bar.
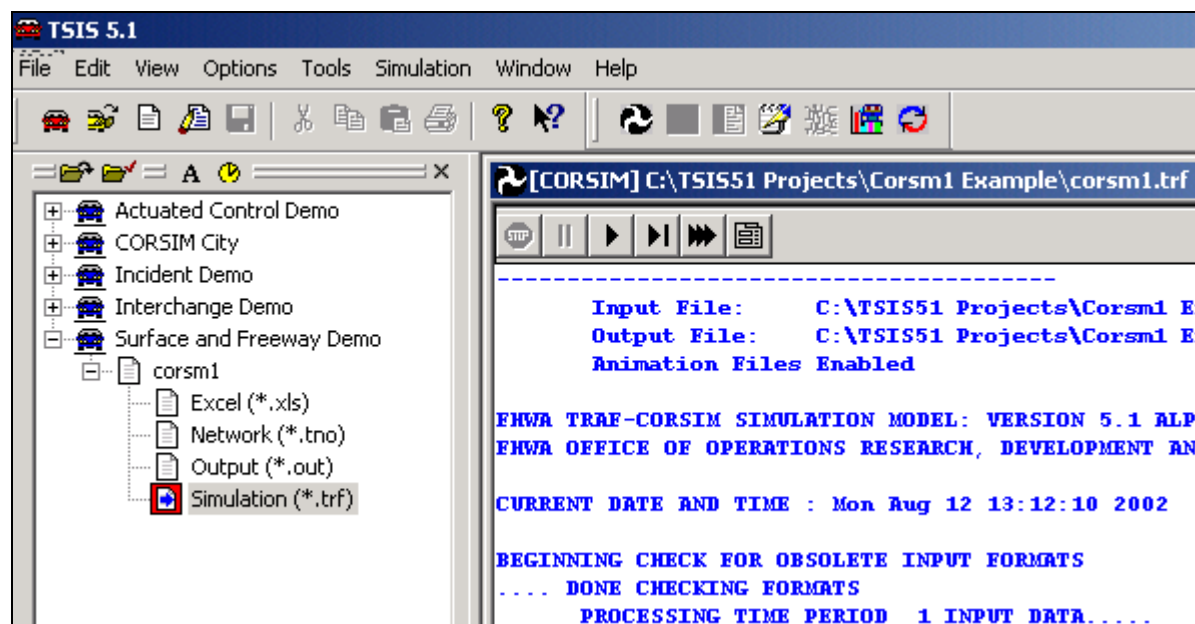
Text Window

When a simulation is running, text is continuously added to the window. If the cursor is at the end of the text, it will remain there, and the window will scroll automatically to keep the cursor in view. If the cursor is anywhere else, the window will not scroll.

Arrow keys, Page Up/Down, Home, End: The keys all move the cursor as normal for Windows® applications. Text can be selected, copied, and printed. Entire window contents can be saved and printed by opening the context menu by right clicking in the window. The menu contains "Save Text…" and "Print Text…" items that open standard Windows dialogs to complete the action.

Simulation Toolbar

Stop: Stops a simulation in progress

Pause: Pauses a simulation in progress

Play: Starts a simulation, or resumes a paused simulation

Step: Starts a simulation (will pause after executing first time step), or executes a single time step of a paused simulation

Multi-Run: Runs a simulation multiple times with different random number seeds and executes the output processor if it has been selected.

Properties: Brings up a dialog for editing output processing and multi-run properties

Simulation Menu
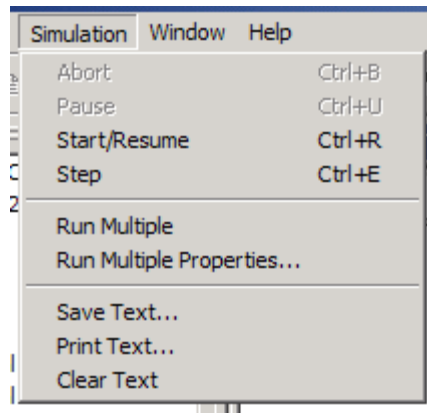
The Simulation Menu is displayed in the TShell menu bar by the CORSIM Driver. It contains many items that apply to running the CORSIM simulation.

Abort: Stops the simulation.

Pause: Pauses the simulation. It may be continued with either Resume or Step.

Start/Resume: Starts the simulation or resumes a simulation that has been paused.

Step: Runs the simulation for a single time step. If used to start the simulation, it will run to equilibrium and then pause after the first time step.

Run Multiple: Runs the simulation multiple times and performs output processing if selected.

Run Multiple Properties…: Brings up the Output Processing/Multiple Run Properties dialog.

Save Text…: Saves the text in the message window to a file in either txt format or rtf format. The default format is plain text. To change the format, select "Rich Text Files" in the "Save as type:" dropdown of the Windows® File dialog.

Print Text…: Prints the text in the message window.

Clear Text: Clears the CORSIM Driver text window.

Edit Menu

The Edit Menu has items enabled while the CORSIM Driver interface has user focus.

Copy: Copies text selected in the message window to the clipboard.

Select All: Selects all the text in the message window.

Find: Find text in the message window.

Running CORSIM (Single Run)

Select a testcase from the TShell Project View. Start the CORSIM tool. Then select "Start/Resume" from the Simulation menu or ▶ on the CORSIM toolbar. The testcase will be opened by CORSIM and the simulation will begin. Any error or warning messages that CORSIM simulation generates will be displayed in the text area of the CORSIM Driver interface. Any messages that the CORSIM Driver generates will be displayed in the TShell Output View at the bottom of the application. While CORSIM is running the Start button and Multi-Run button and the Properties button will be disabled and the Stop button and the Pause button will be enabled. Output Processing is not performed during a "Single Run" of CORSIM. Output Processing is only performed during "Multiple Run" and when output processing is checked in the output processor properties.

The CORSIM DLL is running in memory space assigned to a CORSIM Server, which is started by each CORSIM Driver Tool. Each CORSIM tool that is started can run independent of any other CORSIM tool. It is possible to run two or more CORSIM tools at the same time. This may be useful when you want to run different testcases unattended. Much of the time used during a simulation run is writing to the storage device. During that time the processor is under utilized. Depending on the computer configuration of processors, memory, and storage, it may be slightly faster to run two testcases simultaneously instead of sequentially. The computer may be able to take advantage of the wasted processor time by simulating a different testcase while waiting for the disk Input/Output.

Running CORSIM (Multiple Run)

Select a testcase from the Project View in TShell. Start the CORSIM tool. Setup the multi-run capability of the CORSIM Driver select "Run Multiple Properties" from the Simulation menu or ▣ to set processing options (reference the Multi-run / Output Processing description) and/or case-specific run parameters. By default, output processing will not be done unless it is checked and some MOE and links are selected.

Select "Run Multiple" from the Simulation menu or ▶▶ on the CORSIM toolbar. The testcase will be copied and renamed with an underscore and run number appended to the casename. The random numbers will be changed to the next set of random numbers. Then CORSIM will run on the new case and start collecting statistics if the output processing was selected. When finished with the new case, the process starts again. This continues until the number of runs has been completed. When the number of runs has been completed the statistics will be collated and statistical values calculated and written to the selected summary files. Depending on the number of runs, number of selected MOE, number of selected links, and the number of intervals, summarizing the data can take some time after the last simulation run has completed.

3.4   Running CORSIM from the Command Line

In the TSIS install directory there is an executable file named RunCORSIM.exe. This program can be used to run CORSIM from the command line using a Command Prompt. There are many arguments that can be set to configure the CORSIM run. If no arguments are provided, the possible argument list will be displayed and the program will terminate. Using this capability allows repeatability by documenting all the arguments that are passed to the RunCORSIM program. The command and the arguments can be stored in a batch file to be run at a later time.

```
Command Prompt                                                    _|□|×|

C:\>"c:\program files\fhwa\tsis 5.2\RunCORSIM.exe"
usage:
        RunCORSIM "c:\full path to\input.trf" [options]

Recognized Options:
tsd        - generate TSD file
tid        - generate TID file
out        - generate OUT file
csv        - generate CSV file
trf        - keep intermediate TRF files
step=n     - set step delay to n milliseconds
runs=n     - run n times
logrns     - log random number seeds
corsim="c:\full path to\corsim.dll"
rnsfile="c:\full path to\random.rns"

headway=n
vehicle=n
traffic=n
        set random number seed code to n, where
        0 is Keep Constant, 1 is From File, and 2 is Generate Randomly

rte="c:\full path to\rte.dll"
init=rte_init_function_name
main=rte_main_function_name
shutdown=rte_shutdown_function_name
        Multiple run-time extensions can be specified at
        one time.  The path option must come first.  All
        of one run-time extension's functions must be
        specified before the next run-time extension's
        path.  The function name parameters are optional,
        and may be specified in any order.
```

The basic command line is as follows:

```
        RunCORSIM "C:\Full path to\input.trf" [options]
```

The path and filename of the testcase must be the first argument passed to RunCORSIM.exe. Include the quotes in the testcase path and filename. Other options that follow may be specified in any order. Options should be separated by a space; however, options cannot contain spaces except in quoted file names.

Generate the TSD, TID, OUT, CSV files during the simulation. These files will not be generated unless specified as options. The TRF option keeps the TRF files generated during multi-run processing. Otherwise the TRF files are deleted after processing is complete.

```
        tsd

        tid

        out

        csv

        trf
```

Set the step delay to 'n' milliseconds. If this option is omitted, step delay will be 0 milliseconds.

```
        step=n
```

Set the number of runs. If this option is omitted, the simulation will be run once with no output processing. If this entry is present the testcase will be run 'n' runs using the output processor configuration file that is present in the directory with the testcase.

```
        runs=n
```

Use the logrns option to keep a log of the random number seeds used during the run.

```
        logrns
```

Set the CORSIM DLL to use. Include the quotes. If this option is omitted, "corsim.dll" in the TSIS install directory will be used.

```
        corsim="C:\Full path to\corsim.dll"
```

Set the name and path to the random number seed file to use. If this option is omitted, "random.rns" in the TSIS install directory will be used.

```
rnsfile="C:\Full path to\random.rns"
```

Set random number seed code for each type of random number to n, where 0 is keep constant, 1 is read from file, and 2 is generate randomly. Any that are omitted will be set to read from file.

```
headway=n

vehicle=n

traffic=n
```

Multiple run-time extensions can be specified at one time. The path option must come first. All of one run-time extension's functions must be specified before the next run-time extension's path. The function name parameters are optional, and may be specified in any order.

```
rte="c:\full path to\rte.dll"

init=rte_init_function_name

main=rte_main_function_name

shutdown=rte_shutdown_function_name
```

An example command line execution of CORSIM looks like the following:

```
RunCORSIM "C:\Full path\input.trf" tsd tid out rnsfile="C:\Full
path\random.rns" runs=30 headway=0
```

3.5   Running CORSIM from a Script

The TSIS package is delivered with a very powerful script tool. It uses the Visual Basic Script language and uses the interfaces to other tools to execute tasks. A script can be used to complete repetitive tasks or to improve the repeatability of tasks. One of the most useful tasks a script can perform is running many different testcases multiple times. For example, a project may have many different alternative scenario testcases that represent different geometry alternatives or different signal timing plans. In order to compare the alternatives, each testcase should be run multiple times to generate average statistics. A script can be set up to read a list of testcases and run each testcase multiple times. Using a script also reduces user interaction. A long list of testcases can be started in a script and run over night without having to start each testcase individually.

The TSIS package supplies many scripts that perform various tasks. These scripts should perform most of the common tasks a traffic engineer would need. With some modification by the user, the provided scripts can be customized to run CORSIM exactly as the user desires. The Script Tool User's Guide contains a detailed description of how to set up and run scripts.

4 Appendix A

4.1   Architecture

The architecture of the CORSIM simulation running in TSIS is shown in the following figure.
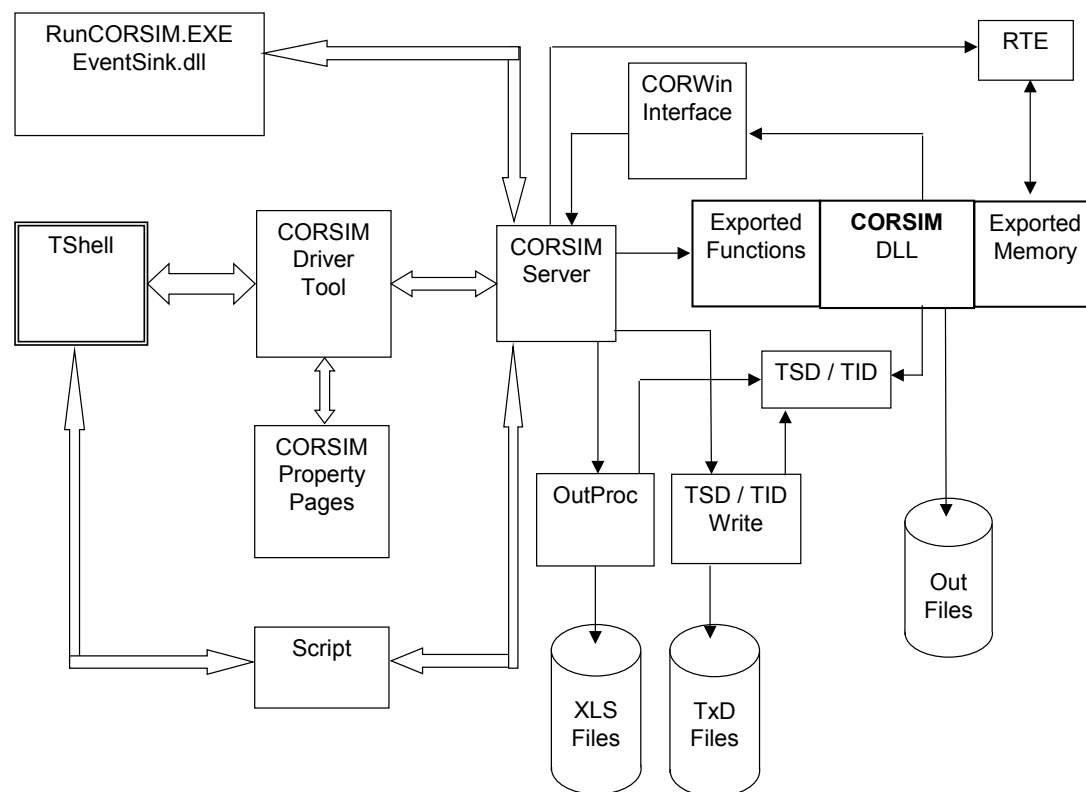
4.2   Component Overview

There are many components required to run the CORSIM DLL.

TSIS.exe (TShell): Provides the framework for the architecture.

CORSIMDriver.dll: This is the TSIS tool. It provides the user interface and property persistence.

CORSIMServer.exe: Hosts the CORSIM DLL. Provides the capability of running multiple simultaneous CORSIM simulations.

CORSIM.dll, Metering.dll: These two DLLs are the actual CORSIM simulation. The Metering.dll is linked to CORSIM.dll.

CORWin.dll: Provides a mechanism for CORSIM and Run-Time Extensions (RTE) to pass messages.

OutProc.dll: Provides output processing. During the run it collects statistics generated by CORSIM and writes output files containing this data along with additional summary data. [Reference OutputProcessor documentation for details.]

TXD500.dll: Contains the shared data structures required for creating TSD and TID files. CORSIM fills these data structures and other processes read these structures. The output processor uses this data in its statistics processing. The TXDWrite module uses this data to create the TSD and TID files.

TXDWrite500.dll: Performs the actual writing of TSD and TID data. Reads the data structures from the TXD module and formats the data. It then writes it to the TSD and TID files.

RunCORSIM.exe (EventSink.dll): Provides a command-line interface to CORSIM.

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