

PARAMICS Plugin Document – Freeway MOE

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Table of Contents

Table of Contents	2
1. Introduction	3
2 Plugin implementation	4
2.1 Algorithm description	4
2.2 Pseudo codes	4
3 Step-by-step user manual	5
3.1 Preparation of the “moe_freeway_control” file	5
3.2 Loading plugin	7
3.3 Output file	7
3.4 Error checking	8
3.5 Application: collecting data for HICOMP	8
4 Technical supports	11
4.1 Limitations	11
4.2 Contact information	11

1. Introduction

This API plug-in can be used to collect the following two types of data:

- Point-to-point travel time between two loop detectors along freeway
- On-ramp delay

2 Plugin implementation

2.1 Algorithm description

2.2 Pseudo codes

3 Step-by-step user manual

3.1 Preparation of the “moe_freeway_control” file

The name of the input file of this API plug-in is “moe_freeway_control”, which should be placed to the network directory. The format of this input file can be demonstrated through an example of the file shown below.

number of sections	7
report cycle	30
collection start time	06:00:00
collection end time	10:00:00
delay calculation	35
upstream detector	405n0.93ml
downstream detector	405n2.99ml
upstream lanes	0
downstream lanes	0
vehicle types	0
sample rate	50
link type	ML
upstream detector	405n2.99orspill
downstream detector	405n2.99orb
upstream lanes	0
downstream lanes	0
vehicle types	0
sample rate	100
link type	RAMP
upstream detector	405n0.93ml
downstream detector	405n2.99ml
upstream lanes	1 5
downstream lanes	1 5
vehicle types	1 2
sample rate	10
link type	HOV
...	

There are two parts in “moe_freeway_control”. The first part is the global options that need to be specified for the API plug-in. “number of sections” is the number of sections that needs to perform a travel time related data collection. The data collection interval is

specified as “report cycle”. Its unit is second. For example, if the report cycle is 300 seconds, it means all collected data will be output once every 300 seconds. “collection start time” and “collection end time” are the time period that data are collected.

The second parts are used to input the information of each section.

- (1) “upstream detector” and “downstream detector” are two boundaries of the section. It is recommended that the length of a section is not too long. 3-5 miles will be good.
- (2) “upstream lanes” and “downstream lanes” can be specified. If users want to collect data for vehicles on all lanes, please write as “upstream lanes 0”; if users want to collect data on some specific lanes, such as lane 1 and 2, please write as “upstream lanes 2 1 2”. Here the first 2 means there are two lanes and 1 and 2 are actually lane numbers.
- (3) “vehicle types” uses the same rule as “upstream lanes” So, users can specify the types of vehicles for travel time collection. “vehicle type 0” means all types. “vehicle type 4 7 8 9 10” means that there are totally four types of vehicles for data collection and they are type 7, 8, 9 and 10.
- (4) “sample rate” is used to determine the percentage of vehicles to be tracked. If sampling rate is 10%, it means when 10% of vehicles passing upstream detectors will be tracked for their trips. When these vehicles hit the downstream detector, their travel time and speed will be obtained. So, it may happen that all 10% vehicles selected won't arrive the downstream detector because they may exit freeway before the downstream detector.
- (5) “link type” could be RAMP, ML, or RAMP, depending on where the section is located.

There are three sections in the example. The first section is an example of the point-to-point travel time collection on mainline. The second one is an example of the on-ramp data collection (which can be used to collect ramp delay data). The loop detectors specified here should be located on the entrance ramp. Usually, the first detector can be the queue detector and the second detector can be a detector located at the link beyond the on-ramp signal. Please have a look at the below figure that shows that typical loop detector configuration at an on-ramp. The third section is a HOV section. Only vehicles on lane 5 may be traced for travel time collection.

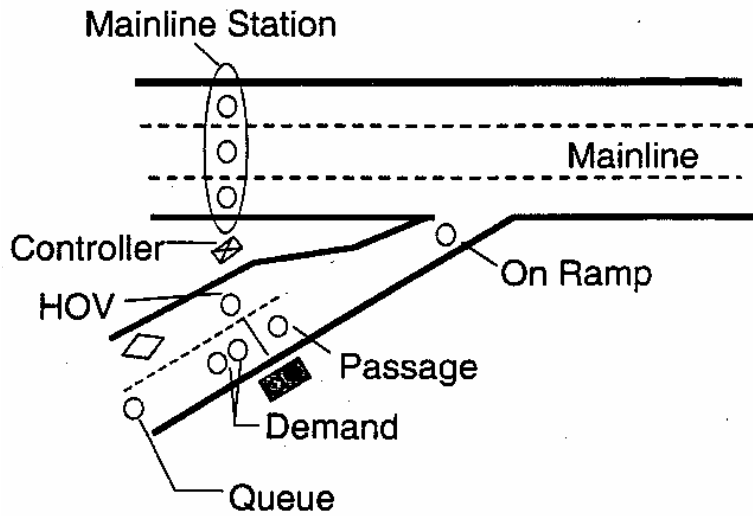


Figure 1 Typical ramp metering configuration

3.2 Loading plugin

After the completion of the “moe_freeway_control” file, you can load the simulation network together with this plugin. The names of this plugin files is freeway_moe.dll. It can be used under Modeller or Processor (batch mode). Run simulation and then you will see that this plugin generates output files continuously.

3.3 Output file

There are two output file of this plugin, which are “moe-freeway.txt” and “moe-freeway_bak.txt”. They can be found in the subdirectory:

network/Log/run-xxx

where network is the name of the current working directory, and xxx is a three-digit sequence number. The two output files have the same contents but their formats are different. “moe-freeway_bak.txt” is a so-called flat file.

The format for the output files is as follows.

405n0.93ml-405n5.55ml							
time	vol	mean-tt	tt-std	spd	spd-std	delay	tot-delay
06:05:00	9	248.0	17.9	68.9	5.0	0.0	0.0
06:10:00	75	249.0	18.1	68.7	4.9	0.0	0.0
06:15:00	72	250.6	16.4	68.2	4.4	0.0	0.0
06:20:00	76	254.8	20.7	67.2	5.5	0.0	0.0
...							

“time” is the report time, which is the end time of a collection period. “vol” is the number of vehicles having been traced in last collection period. “mean-tt” and “tt-std” are the average travel time and its standard deviation of all traced vehicles in a time period. Accordingly, “spd” and “spd_std” are the travel speed and its standard deviation of all traced vehicles. “delay” is defined as the difference between actual travel time and ideal travel time calculated based on the speed limit of freeway sections. If the actual travel time is higher than the ideal travel time, “delay” will be a value larger than 0; otherwise, “delay” is 0. “tot_delay” will be calculated if “delay” is higher than 0. “tot_delay” represents the total delay experienced by all traced vehicles.

“delay and ”“tot_delay” are estimated based on “mean_tt” and the ideal travel time. They may be larger than 0 although “spd” (average speed) is higher than the speed limit of the corresponding section. The reason is that “spd” is equal to the average speed of all traced vehicles while “mean_tt” is equal to the average travel time of all traced vehicles. The value of “spd” times “mean_tt” is not exactly equal to the length of two measurement points.

3.4 Error checking

If any mistakes happened in the “moe_freeway_control” file or the other two supporting plugins, i.e. loop data aggregator and ramp metering control, this plugin will be disabled. The report window of PARAMICS will show whether this plugin is working.

Through enabling the option: “checking control file” in the “moe_freeway_control” file, you can check if there is any error in the “moe_freeway_control” file.

3.5 Application: collecting data for HICOMP

3.5.1 Background

Caltrans has a congestion monitoring program called HICOMP that defines freeway delay based on 35 mph. The total delay associated with each segment is obtained by using the following formula:

$$\text{Vehicle-hours of delay} = V \times D \times T \quad (1)$$

Where,

V - Volume in vehicles per hour = number lanes x Vehicles per hour per lane¹

D - Duration of congestion in hours

¹ V is the design capacity of a road segment. Most districts use a value of 2000 vphpl, although District 4 (Oakland) has been using a value of 2,200 vphpl since 1995.

T - Travel time in hours under congested conditions minus the travel time at 35 mph to go the same distance

Caltrans' tach run vehicles (i.e. floating cars equipped with GPS devices) are used to collect the travel data with time intervals 15 to 30 minutes. Loop detectors are also being used in some district routes.

In order to use Freeway MOE plugin to collect data for HICOMP, we need to assume that a segment is defined as the section of freeway between two loop detector stations. The following two types of input data can be collected for the total delay equation:

- (1) Duration of congestion in hours;
- (2) Travel time in hours under congested conditions minus the travel time at 35 mph to go the same distance. The assumption

3.5.2 Method and an example

For a simulation network, the Freeway MOE plugin is used to collect data for HICOMP. The "freeway_moe_control" is shown as follows:

```

number of sections      1
checking control file  yes
report cycle           300
collection start time  06:00:00
collection end time    10:00:00

loop detectors          405n2.99ml 405n3.86ml
links                  8:9 10:108
sample rate            100
destination zone       2
entrance ramp          no

```

In this control file, 100% vehicles heading for destination zone 2 are traced between two loop detector stations (i.e. 405n2.99ml and 405n3.86ml) in order to get the travel time data. The time interval for the travel time data collection is 5 minutes (300 seconds). "vol" is the number of probe vehicles used to be traced. For the period from 6:35:00 to 6:40:00, the number of traced vehicles is 626. The reason for so many vehicles to be traced is that 100% vehicles heading for are traced according to the control file of the plugin. A lower sampling rate can be applied.

The output file "moe-freeway.txt" is shown in Table 1. "mean-tt" (unit: second) is the average travel time of all traced vehicles and "spd" (unit: mph) is the average travel speed of all traced vehicles. The current plugin does not output the distance between two loop detector stations in the output file. But, the distance (unit: mile) between two loop stations can be estimated by:

$$\text{Distance} = (\text{mean_tt} / 3600) * \text{spd} \quad (2)$$

The first one line of “spd” and “mean-tt” can be used to estimate the distance of two loop stations. So, Distance = (45.8 / 3600) * 65.8 = 0.837 miles. The travel time (in hour) at speed 35 mph is:

$$tt_0 = \text{Distance} / 35 \quad (3)$$

So, $tt_0 = 0.837 / 35 = 0.0239$ hour (or 86.1 seconds).

The highlighted lines in Table 1 correspond to the time periods having delays (mean_tt > 86.1). “T” in the Equation 1 can be obtained:

$$T = \text{mean_tt} / 3600 - tt_0 \quad (4)$$

For the time period from 7:40 to 7:45,

$$T = 87.4 / 3600 - 0.0239 = 0.0243 - 0.0239 = 0.0004 \text{ hour}$$

“D” in Equation 1 is 5 minutes or 1/12 hour in this example.

$$D = 5 / 60 = 1/12 \text{ hour}$$

The corresponding freeway has four lanes and thus its capacity is:

$$V = 4 * 2000 = 8000 \text{ vehicles}$$

The vehicle-hours of delay for the period from 7:40 to 7:45 can be calculated:

$$\text{Vehicle-hours of delay} = 8000 * 1/12 * 0.0004 = 0.267 \text{ hours}$$

Table 1 An example of the output file

Time	405n2.99ml-405n3.86ml vol	mean-tt	tt-std	Spd	spd-std	delay	tot-delay
6:35:00	239	45.8	5.3	65.8	7.3	0	8.3
6:40:00	626	47.2	5.8	63.9	7.6	1.5	915.5
6:45:00	641	48.6	7.2	62.4	8.6	2.9	1828.3
6:50:00	571	47.2	6.3	64.2	8.3	1.4	800.9
6:55:00	590	50.3	6.6	60.1	8	4.6	2704.5
7:00:00	628	53.1	9.1	57.7	10	7.3	4603.5
7:05:00	627	50.5	7.4	60.2	8.9	4.7	2970.7
7:10:00	643	50.2	9.1	60.9	9.7	4.5	2876.8
7:15:00	679	54.2	8.8	56.3	8.8	8.5	5749.3
7:20:00	667	51.6	7.3	58.8	8.5	5.8	3896.3
7:25:00	621	59.1	9.6	51.7	8.5	13.3	8285.7
7:30:00	633	59.9	11.5	51.7	10.5	14.1	8931.8

7:35:00	683	60.1	8.7	50.5	7.2	14.3	9769.6
7:40:00	614	60.2	13.5	51.6	10.1	14.4	8871.5
7:45:00	538	87.4	12.3	34.7	5.2	41.7	22408.1
7:50:00	601	97.1	22.8	33	10.6	51.4	30864
7:55:00	512	80.9	13.8	38.1	7.7	35.1	17974.6
8:00:00	537	79.6	10.7	38	4.9	33.9	18187.4
8:05:00	511	107.4	11.4	28	2.8	61.6	31485.1
8:10:00	519	123.4	17.1	24.6	3.7	77.6	40284.6
8:15:00	549	91.4	23.3	34.9	9.6	45.6	25038.9
8:20:00	623	88.4	19.7	35.5	8.5	42.7	26599.7
8:25:00	508	76.9	17.8	40.8	9.6	31.1	15813.6
8:30:00	589	79.1	14.8	39	7.5	33.3	19639.2
8:35:00	549	85.9	13	35.5	5.9	40.2	22062.9
8:40:00	545	73.8	12.8	41.6	7.9	28.1	15291.9
8:45:00	586	86.3	14.6	35.6	7	40.6	23766.4
8:50:00	598	69	10.4	44.1	7	23.2	13901.2
8:55:00	597	66.7	15.3	47.1	11.6	21	12518.7
9:00:00	563	50.6	8.8	60.5	10	4.8	2710.4
SUMMARY:	17387	68.8	23.2	47.8	14.4	23	400759.5
TOTAL	on-ramp	delay:	0	(0	on-ramps)		

4 Technical supports

4.1 Limitations

If there are more than one route between the first detector and the second detector, this API plug-in will have problems to be used.

4.2 Contact information

Any comments and suggestions are welcome. Please contact us at the email address: lchu@translab.its.uci.edu.