Caltrans TMS Master Plan - Calibration Methodology and Results for the I-405/I-5 Simulation Model

prepared for

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I-405 / I-5 Calibration Simulation Methodology

This technical memorandum presents the calibration methodology and results for the micro-simulation analysis for the I-405 / I-5 network in Orange County, performed by the evaluation team of the California PATH Program at University of California, Irvine (UCI).

I-405/I-5 Simulation Network Development

The whole I-405 simulation network was constructed based on the aerial photo of the target area and related geometry and infrastructure information obtained from Caltrans and the city of Irvine. Figure 1 illustrates the overall view of the network. HOV lanes, arterial signals and ramp metering have the same configurations as those in the real world. Table 1 shows the major works for the development of the I-405 / I-5 network in Paramics.

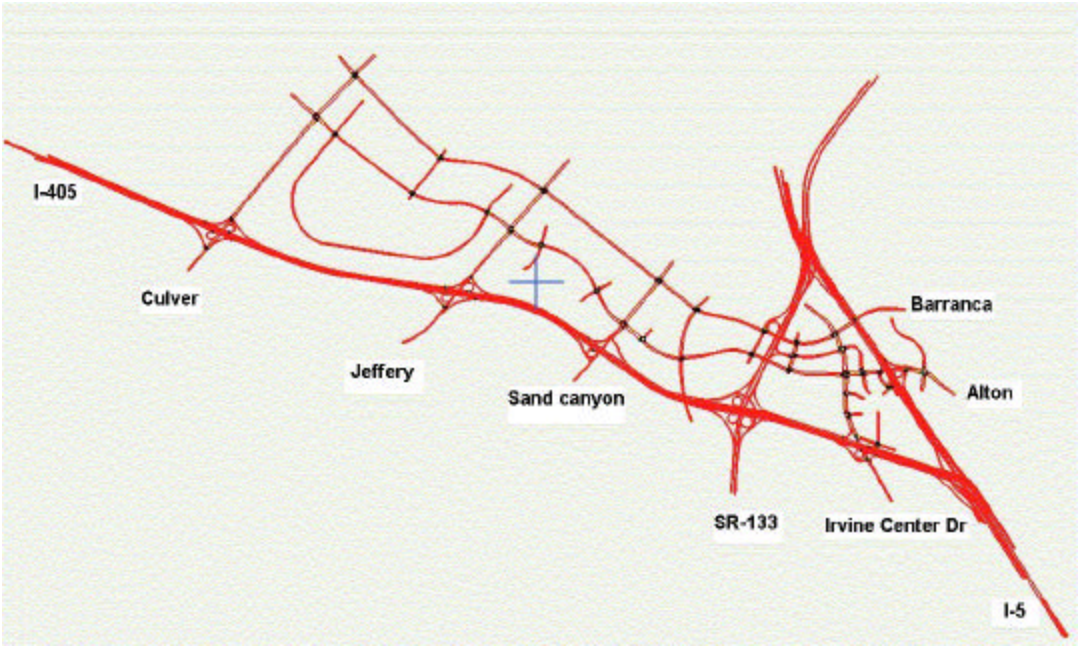

Figure 1 I-405/I-5 Study Corridor in Orange County

Table 1 - Developments for the I-405/I-5 network

Scenario	Analysis Year	Developments

"Existing"	2000	• Code network based on aerial photos, geometry maps, road information such as speed limit, detector location, etc. • Adding HOV lanes • Adding actuated signals and entrance ramp signals • Estimating OD demands of year 2000 using OCTAM model and traffic counts at cordon points • Calibrate network (using volume and travel time)
"Baseline"	2010	• Estimating OD demands of year 2010 using OCTAM model
TMS Simulations	2010	• Various TMS scenarios

Calibration Criteria

Freeway and arterial volumes at selected mainline and arterial links, as well as all on-and off-ramp volumes within the study area were calibrated against a set of available existing traffic data, including:

- Freeway loop detector data (Nov. 17, 2001, May 22, 2001 to June 5, 2001) and freeway tach run travel time data (Nov. 17, 2001) obtained from Caltrans District 12;
- 15-minute interval arterial traffic counts from the City of Irvine (most of them collected at January of 2002, and June of 2001), and
- Traffic counts at important cordon points of the network, obtained from data processing of the surveillance video data (taped between March 27, 2002 to April 19, 2002).

The following criteria were used for acceptance of the calibrated micro-simulations:

- The simulation calibration process was performed between 6 AM and 10 AM, using demand data from 5:45 AM to 10 AM. The first 1/4 hour of the micro-simulation was regarded as a "warm up" period, to fill all network links to equilibrium;

- The modeled peak period and peak hour volumes at these selected links must be within 15 percent of the observed volumes for flows greater than 700 vphpl, or within 100 vph for flows less than 700 vph. These targets must be satisfied for 85 percent of the cases;

- Total screenline flows (normally >5 links) to be within five percent for nearly all screenlines;

- The GEH statistic to be less than five for individual flows for 85 percent of the cases, and less than four for screenline totals for nearly all screenlines;

  The GEH statistic is :

$$GEH = \sqrt{\frac{(M - C)^2}{(M + C)/2}}$$

Where M is modelled flow and O is observed flow.

- Trip travel times will be within 15 percent of observed travel times for 85 percent of the routes. Trips include from the northern to the southern end of the corridors, and from the mid-point of the corridors to each of the two ends.

Calibration Methodology

The I-405 / I-5 network is calibrated according to the following procedure:

1. Defining the mean target headway and driver reaction time based on previous experiences on the calibration study. These two parameters are key user specified parameters in PARAMICS's car-following and lane-changing models. They were originally set to 0.9 and 0.6 respectively, which may be modified further during the calibration process.

2. Obtaining the background OD table from OCTA travel demand model (OCTAM). The O-D matrix derived from the OCTAM model was only for the whole morning peak hour, i.e from 6-9 AM. The OD demand matrix was further expanded to 4 hours, i.e. from 6-10 AM.

3. Modifying route choice behaviors of the simulation network, which are determined by the traffic assignment method of PARAMICS, through adding tolls to entrance ramps and changing the speed definition of arterial links.

4. Estimating the OD table of Year 2000 by matching loop counts at measurement points and cordon points of the network. The FURNESS model was used for balancing the OD table.

5. Loading the time-dependent OD demand through the use of "matrix" and "profile" files in order to match the peak-hour traffic counts at measurement points and the tach run travel time data between upstream and downstream ends of both northbound and southbound of freeway I-405. Due to the high traffic demands during the peak hour, some network coding problems will show up and need to be corrected. If there is an obvious unreasonable bottleneck existed in the network, fine-tuning the signposting setting of some related links and modifying the values of the mean target headway and driver reaction time are major methods to increase the freeway throughput. The values of the mean target headway and driver reaction time are 0.79 and 0.66 in the final calibrated network.

Calibration Results

Based on the calibration acceptance criteria, the "Existing" simulation network was calibrated and approved by Caltrans in May 2002. The traffic volume calibration results are presented in Tables 2, showing respectively the results of the peak hour and peak period network calibration. Likewise, travel time comparisons were conducted for the "Existing" simulation network, and all of the routes selected for calibration satisfy the calibration acceptance criteria, as presented in Table 3.

"Baseline" Simulation Network Development

Once the "Existing" micro-simulation network was calibrated, the existing traffic volumes were scaled up using OCTA's traffic growth rates, to represent Year 2010 volumes. The resulting "Baseline" network will be used to estimate the impacts of each TMS business process. The following actions were taken in developing the "Baseline" network of Year 2010:

- The network of 2010 is regarded as the same as that of 2000.

- Based on the OD table of 2000 and 2025, obtained from OCTAM model, the growth rates of each zone in the network were calculated. The growth rates of 2010 were estimated through interpolation. The growth factor of an origin zone was applied to the demand from this origin zone to any destination zone. After applying this method to the whole OD table of Year 2000, the OD table of Year 2010 was generated. The total number of vehicles of the morning peak hour (from 6 to 10 AM) increases about 12% compared with that of Year 2000.

- The signal control was kept the same as that of 2000 because of the even growth of arterial traffic. The ramp metering control was extended as from 6 to 10 AM (instead of from 6 to 9 AM) due to the effect of "peak spreading", which assumes that some people would adjust their departure times to avoid the really congested peak hour.

- The demand profiles for all OD pair were kept the same as that of Year 2000.

Table 2 - I-405/I-5 Traffic Volume Calibration Results

	Peak Hour (7-8 AM)				AM Peak Period (6-10 AM)			
Mainline Detectors	**Raw**	**Original**	**% diff**	**GEH**	**Raw**	**Original**	**% diff**	**GEH**
405n0.93ml	6803	6808	0%	0.06	24505	24428	0%	0.49
405n3.31ml	9127	9006	-1%	1.27	33274	32646	-2%	3.46
495n3.86ml	8322	8248	-1%	0.81	30589	29890	-2%	4.02
405n5.74ml	9545	9377	-2%	1.73	34277	33475	-2%	4.36
405s6.21ml	7960	8135	2%	1.95	28255	27904	-1%	2.09
405s3.31ml	8098	8010	-1%	0.98	28501	27795	-2%	4.21
405s0.77ml	5583	5514	-1%	0.93	20057	19638	-2%	2.97
5n22.2ml	7533	7686	2%	1.75	26830	26614	-1%	1.32
5s22.14ml	6499	6974	7%	5.79	24464	24025	-2%	2.82
133n9.37ml	510	471	-8%	1.76	1496	1498	0%	0.05
133n10.05ml	804	817	2%	0.46	2534	2607	3%	1.44
133s10.05ml	2752	2674	-3%	1.50	8557	8557	0%	0.00
133s9.37ml	1760	1652	-6%	2.61	5233	5429	4%	2.68
Ramp Detectors								
405n0.93fr	160	162	1%	0.16	546	564	3%	0.76
405n0.93orb	512	507	-1%	0.22	1815	1760	-3%	1.30
405n1.11orb	110	149	35%	3.43	447	445	0%	0.09
405n1.73ff	56	54	-4%	0.27	213	197	-8%	1.12
405n1.93ff	2227	2166	-3%	1.30	6887	6987	1%	1.20
405n2.99fr	165	196	19%	2.31	726	705	-3%	0.79
405n2.99orb	436	442	1%	0.29	1418	1358	-4%	1.61
405n3.86fr	709	731	3%	0.82	2737	2704	-1%	0.63
405n3.86orb	307	320	4%	0.73	931	963	3%	1.04
405n4.03orb	816	809	-1%	0.25	2889	2686	-7%	3.84
405n5.55fr	460	426	-7%	1.62	1626	1659	2%	0.81
405n5.55orb	682	670	-2%	0.46	2161	2134	-1%	0.58
405n5.74orb	1026	1075	5%	1.51	3567	3576	0%	0.15
405s5.69fr	853	959	12%	3.52	3182	3139	-1%	0.76
405s5.69orb	316	276	-13%	2.32	983	921	-6%	2.01
405s5.5orb	241	281	17%	2.48	940	914	-3%	0.85
405s4.03fr	409	392	-4%	0.85	1602	1554	-3%	1.21
405s4.03orb	183	212	16%	2.06	647	664	3%	0.66
405s3.84orb	624	567	-9%	2.34	2112	1904	-10%	4.64
405s2.88fr	864	817	-5%	1.62	2937	2743	-7%	3.64
405s2.88orb	152	159	5%	0.56	468	505	8%	1.68
405s1.58ff	592	573	-3%	0.79	1881	1953	4%	1.64
405s1.57ff	70	117	67%	4.86	315	319	1%	0.22
405s0.96fr	1546	1496	-3%	1.28	4906	4907	0%	0.01
405s0.96orb	20	33	65%	2.53	58	123	112%	6.83
405s0.77orb	9	11	22%	0.63	43	43	0%	0.00
5n22.1fr	742	802	8%	2.16	2443	2600	6%	3.13
5n22.1orb	84	94	12%	1.06	289	339	17%	2.82
5n22.2orb	199	232	17%	2.25	752	735	-2%	0.62
Arterial Detectors								
Jeffery 405-Alton	2119	1963	-7%	3.45	6563	6317	-4%	3.07
	882	1057	20%	5.62	3520	3505	0%	0.25
Alton E of Jeffery	758	604	-20%	5.90	1987	2038	3%	1.14

	439	446	2%	0.33	1470	1386	-6%	2.22
Alton E of Sand	624	443	-29%	7.84	1675	1480	-12%	4.91
	729	777	7%	1.75	2443	2469	1%	0.52
Alton E of Laguna	804	619	-23%	6.94	2102	2382	13%	5.91
	491	606	23%	4.91	1714	1921	12%	4.86
Barranca SR133-ICD	428	420	-2%	0.39	1287	1240	-4%	1.32
	959	962	0%	0.10	3235	3161	-2%	1.31

Table 3 - I-405/I-5 Travel Time Calibration Results

Travel time							
Mainline Trip Analysis	**start**	**arrival**	**Raw**	**start**	**arrival**	**Original**	**% diff**
southbound I405 from Culver to ICD	6:00:22	6:04:38	256	6:00:00	6:15:00	264.5	3%
	6:25:14	6:29:36	262	6:25:00	6:30:00	257.8	-2%
	6:47:01	6:51:17	256	6:45:00	6:50:00	255.7	0%
	7:06:34	7:10:56	262	7:05:00	7:10:00	259.6	-1%
	7:24:45	7:28:54	249	7:25:00	7:30:00	263.1	6%
	7:46:23	7:50:48	265	7:45:00	7:50:00	278.9	5%
	8:05:14	8:09:41	267	8:05:00	8:10:00	326.8	22%
	8:24:23	8:28:44	261	8:25:00	8:30:00	262.6	1%
	8:43:42	8:47:47	245	8:45:00	8:50:00	259.5	6%
	9:04:27	9:08:34	247	9:05:00	9:10:00	246.4	0%
Northbound I405 from ICD to Culver	6:00:58	6:04:45	227	6:00:00	6:05:00	238.5	5%
	6:19:32	6:23:40	248	6:20:00	6:25:00	247.1	0%
	6:40:51	6:44:50	239	6:40:00	6:45:00	250.9	5%
	7:00:58	7:05:05	247	7:00:00	7:05:00	258.3	5%
	7:23:06	7:27:57	291	7:25:00	7:30:00	324.7	12%
	7:40:53	7:49:29	514	7:45:00	7:50:00	543.2	6%
	7:57:57	8:05:58	481	8:00:00	8:05:00	498.9	4%
	8:22:06	8:27:59	353	8:25:00	8:30:00	441.4	25%
	8:40:27	8:44:25	238	8:40:00	8:45:00	427.4	80%
	8:59:57	9:04:03	246	9:00:00	9:05:00	257.8	5%