

Use of Vehicle Probe Data in the Calibration of Traffic Microsimulation Models

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Introduction: Problem Description

- Utilize vehicle probes in conjunction with Vehicle to Roadside Communication (VRC) as a tool to help calibrate a wide-area traffic microsimulation from a travel time perspective.
- Wide-area traffic microsimulation requires a method known as Dynamic Traffic Assignment (DTA) to effectively equilibrate the route choice model, which is essential to attaining realistic paths through the network.
- The OD-based travel times of the vehicle probes output in the microsimulation are compared against travel time data obtained through potential sources such as Bluetooth, floating car studies, or third party providers.

Context: Motivation

- Calibration of the microsimulation model to link flows and queue lengths is relatively straightforward, *travel times not so easy*.
- Many transportation projects have impacts that require lane-level behavioral resolution for proper evaluation.
- Operational fidelity is necessary for meaningful traffic engineering studies, especially where user benefits requiring high resolution output are calculated.

Context: Motivation continued

- Utilize DTA in wide-area microsimulation with simulated vehicle probes to assist in calibration of route level choices against observed travel times.
- Effective deployment of DTA hinges on usability, robustness of route choices, and manageable run times.
- Develop a more compelling tool to engage stakeholders and the public at large.

Approach: Key DTA Elements

- Dynamic shortest paths based upon departure times.
- Potentially more realistic route choice and driver behavior.
- Queue build-up and dissipation.
- Short time intervals for travel time measurement.
- Dynamic User Equilibrium condition - a temporal extension of Wardrop's principle.
- Iterative computation required to achieve convergence.

Approach: Microscopic DTA

- **Microscopic in level of detail**
 - Referenced to ground truth with accurate geometry
 - Lane level and intersection area representation
 - Temporal dynamics (0.1-sec)
- **Microscopic in modeling accuracy**
 - Car following, Lane changing, Gap Acceptance
 - Employs realistic route choice models
 - Handles complex network infrastructure (signals, variable message signs, sensors, etc.)
 - Simulates multiple modes, user classes, vehicle types

Approach: Microscopic DTA



Weaving and Interchange Analysis

Local Streets with Centroids



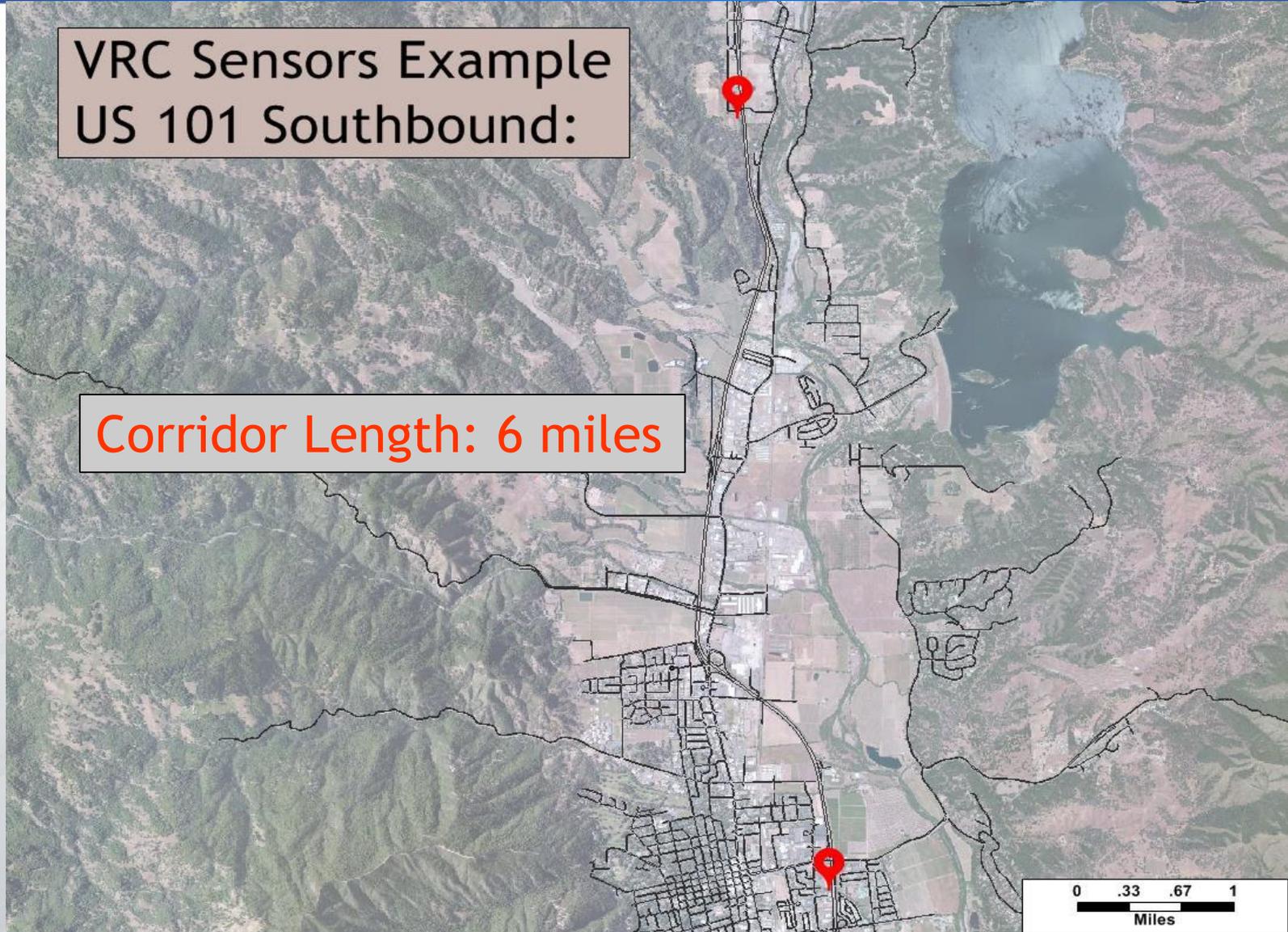
Implementation: Framework

- **Temporal Origin-Destination Matrix**
 - Estimated regionally for Ukiah, CA.
 - 15 minute time intervals using link and turn movement counts.
 - Provides excellent conformity with observed count data.
- **Simulation Elements**
 - Sensors to support Vehicle to Roadside Communication (VRC) to calibrate route choices and travel times.
 - Reporting capabilities to efficiently process simulation output from VRC.
 - Included all traffic control and management infrastructure.
 - Implemented in TransModeler by Caliper Corporation.

Implementation: Framework

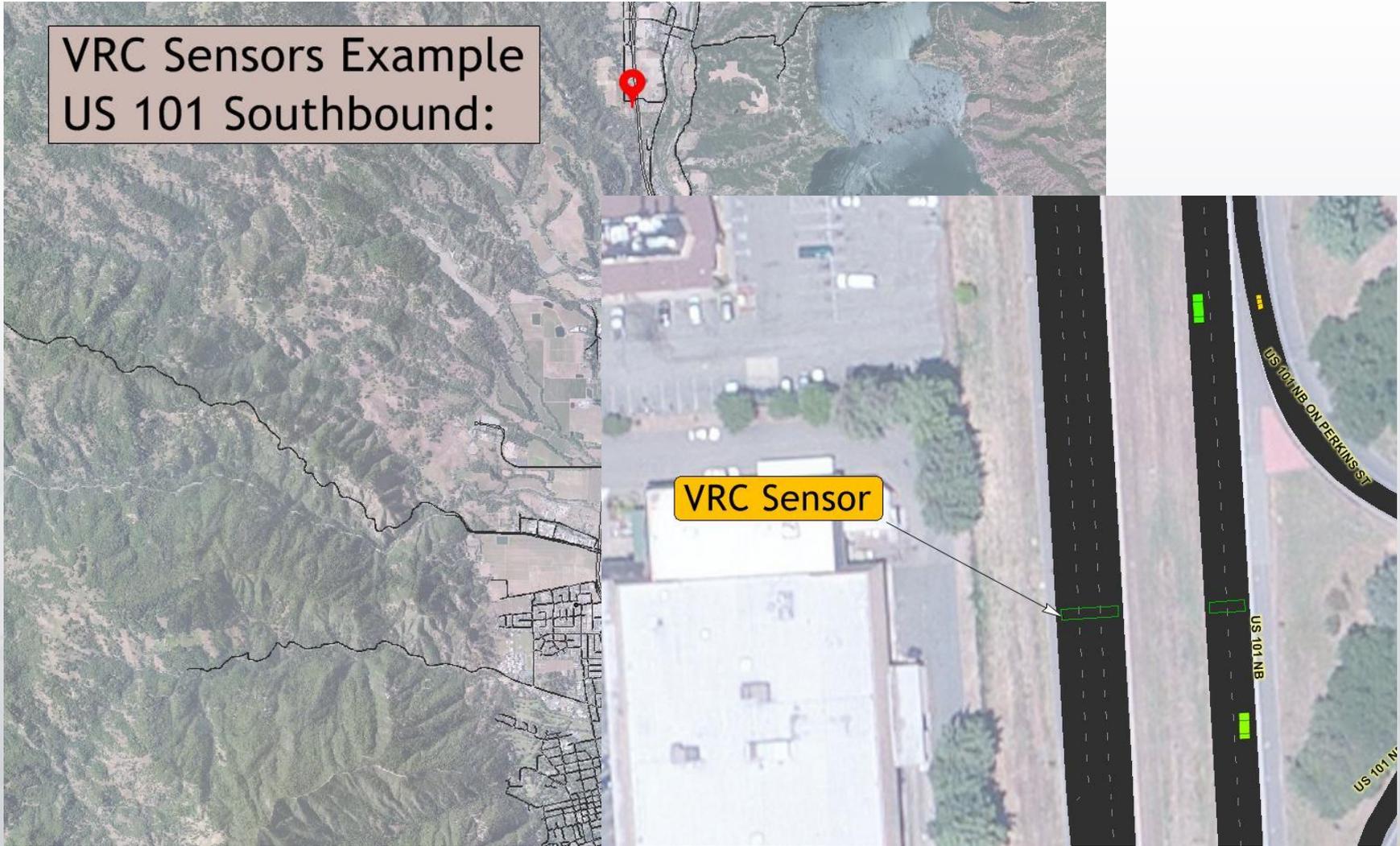
VRC Sensors Example
US 101 Southbound:

Corridor Length: 6 miles



Implementation: Framework

VRC Sensors Example
US 101 Southbound:



Implementation: Features

- Assign estimated OD matrix in 15 minute intervals.
- Dense street network.
- Realistic accessibility, connectivity.
- Time of day based signal control plans.
- Simulate multiple travel modes.
- Practical running times (30x real time for Ukiah).
- VRC sensor infrastructure to support probe vehicle interaction and reporting.

Implementation: Reporting

Matrix6 - VRC Sensor Matrix (Average Travel Time (min.))

	283	284	285	286	287	288	289	290	291	292	293	294
283	—	—	—	5.17	—	—	—	—	—	—	—	3.93
284	1.78	—	—	—	3.24	—	3.83	3.00	2.78	3.40	—	—
285	—	5.20	0.00	—	—	—	—	—	—	8.64	—	5.05
286	—	—	—	0.00	—	—	—	—	—	—	—	—
287	3.85	—	—	—	—	—	3.20	—	—	—	—	—
288	—	—	—	—	2.17	—	—	—	—	—	—	—
289	3.00	—	—	—	—	—	—	—	0.52	—	—	—
290	3.93	—	—	—	—	3.17	2.19	—	—	—	—	—
291	3.04	—	—	—	—	—	—	—	—	—	—	—
292	3.29	—	—	—	—	—	—	—	—	—	—	—
293	—	3.01	—	5.85	—	—	—	—	—	—	—	—
294	—	—	—	—	—	—	—	—	—	—	—	—

PM Base Year

08/18/15 08:41:39 (5 of 5)

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Vehicle-to-Roadside Communication Sensor Report 4:30:00PM - 5:30:00PM

Date & Time of Run: 08/18/15 08:47:21

Selection: Selection:2

Dataview7 - VRC Sensor Matrix Statistics

Matrix	Count
Total Vehicles	142
Transit Vehicles	142
Truck Vehicles	142
VMT	142
VHT	142
StdDev Travel Distance (mi.)	29
StdDev Travel Speed (mph)	29
StdDev Travel Time (min.)	29
Average Travel Distance (mi.)	29
Average Travel Speed (mph)	29
Average Travel Time (min.)	29

Sensor 284

Detection Time	Vehicle ID	Origin ID	Destination ID	Speed (mph)
4:30:03PM	19466	Centroid 63	Centroid 5263	69.20
4:30:05PM	21855	Centroid 232	Centroid 764	65.60
4:30:08PM	22458	Centroid 2931	Centroid 224	59.20
4:30:09PM	18912	Centroid 3	Centroid 766	50.60
4:30:10PM	22477	Centroid 2931	Centroid 163	69.20
4:30:10PM	22024	Centroid 252	Centroid 222	45.20
4:30:17PM	19528	Centroid 64	Centroid 5263	65.60
4:30:19PM	22390	Centroid 2931	Centroid 5263	69.20
4:30:19PM	19525	Centroid 64	Centroid 5263	64.40
4:30:26PM	21427	Centroid 196	Centroid 133	75.70
4:30:30PM	22020	Centroid 252	Centroid 2910	65.60
4:30:31PM	21405	Centroid 196	Centroid 225	65.50
4:30:38PM	22389	Centroid 2931	Centroid 5263	69.20
4:30:41PM	22789	Centroid 6139	Centroid 153	58.50
4:30:43PM	19028	Centroid 6	Centroid 5263	30.70
4:30:45PM	22801	Centroid 6139	Centroid 157	69.20
4:30:47PM	21531	Centroid 202	Centroid 2910	64.30



Implementation: Sample Results (PM)

US101 Southbound:

Trip Number	Start Time	Time at First Sensor (s)	Travel Time (s)	Simulated Time (s)
11	15:40:13	Start +79	286.0	309.0
13	15:53:19	Start +91	285.0	310.8
15	16:06:31	Start +79	284.0	309.0
17	16:19:25	Start +81	295.0	310.8
19	16:32:43	Start +79	289.0	310.8

US101 Northbound:

Trip Number	Start Time	Time at First Sensor (s)	Travel Time (s)	Simulated Time (s)
12	15:46:48	Start +61	304.0	310.2
14	16:00:06	Start +62	294.0	309.0
16	16:13:05	Start +61	292.0	311.4
18	16:26:11	Start +64	302.0	311.4
20	16:39:21	Start +65	297.0	310.2

Conclusions

- **Implementation of VRC infrastructure in conjunction with probe vehicles in microsimulation is a helpful tool that makes travel time calibration more manageable.**
- **Future work might involve feedback of probe data to route choice model to simulate dynamic response to incidents or other network disruption.**
- **Significant calibration effort is necessary to replicate link-level queue lengths and travel times at the regional level, however it is not insurmountable.**

Thank you

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