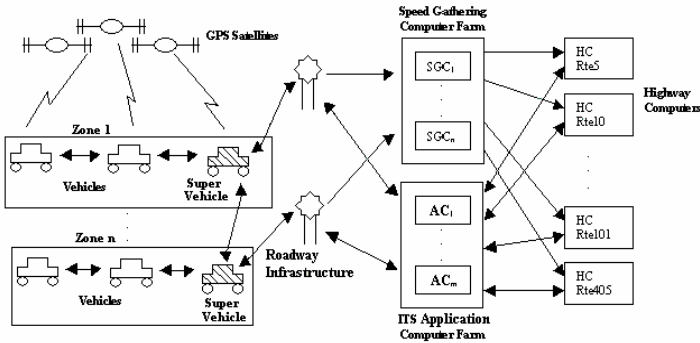


Vehicle-to-Vehicle-to-Infrastructure (V2V2I) Intelligent Transportation System Architecture

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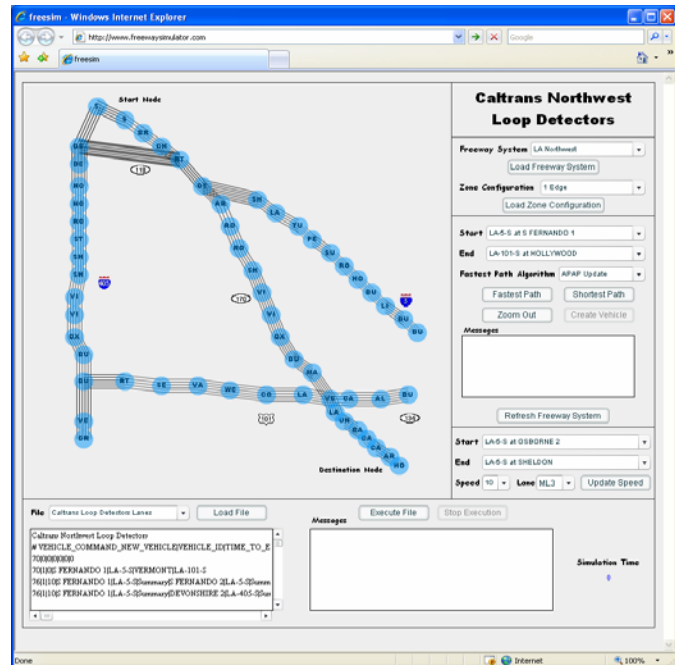
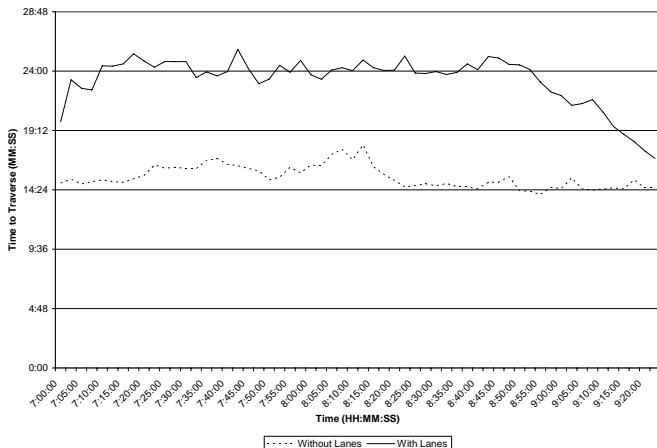


The V2V2I ITS architecture is a hybrid of the V2I and V2V architectures and breaks a transportation network into zones. A zone can be as granular as desired, as long as all vehicles within a zone are able to communicate with each other. One vehicle in the zone is designated as the Super-Vehicle and is responsible for aggregating the data from the other vehicles in the zone and transmitting it to the central server. Any queries from vehicles are transmitted through the Super-Vehicle for the zone, which is the only vehicle that will communicate with the roadway infrastructure. A Super-Vehicle can also communicate with other Super-Vehicles in adjacent zones in case the central infrastructure fails, allowing the architecture to revert to a V2V approach.

To the right is a screenshot of Freesim with lanes displayed (<http://www.freewaysimulator.com>). The simulation was executed for a three-hour period with live loop detector data gathered from the California Department of Transportation. Between 1 and 6 edges per zone were simulated, and the table below shows the number and percentage of incorrect paths out of the 361 total paths. With 1 edge per zone, the V2V2I architecture behaves as the V2I architecture does, and the 2 edges per zone and 6 edges per zone were the most accurate, enabling a significant decrease in the required bandwidth for the central server with reasonably high accuracy.

Edges per zone	# Incorrect Fastest Paths	% Incorrect Fastest Paths	# Correct Fastest Paths	% Correct Fastest Paths
1	0	0%	361	100.0%
2	49	13.6%	312	86.4%
3	53	14.7%	308	85.3%
4	65	18.0%	296	82.0%
5	118	32.7%	243	67.3%
6	48	13.3%	313	86.7%

The graph below shows the difference in the fastest path returned from the central server when using lanes and not using lanes. At any point, if vehicles are routed in the fastest lane rather than averaging all of the lanes, a vehicle can save approximately 30% of its travel time.



The graph below shows that the 4 edges per zone case has the smallest average difference with the 1 edge per zone case. This can be explained by noticing that the fastest paths obtained by the 4 edges per zone execution differ in time from the actual fastest path by the lowest amount even though the fastest path was incorrect 18.0% of the time. Further, with 6 edges per zone, the amount of time to traverse the fastest path was significantly different, though the path itself was correct 86.7% of the time, showing that the 6 edge per zone configuration is inaccurate for determining the amount of time to traverse a path though accurate for finding the fastest path.

