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# Research Results

# Modeling and Control of HOT lane Phase II

Toolbox development for efficient quantitative assessment of operational scenarios on freeways with managed lanes

Transportation Safety and Mobility

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**Project Title:**
Modeling and Control of HOT lane Phase II

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## WHAT WAS THE NEED?

High-Occupancy Vehicle (HOV) lanes are intended to reward carpoolers by providing a shorter travel time. However, it is often the case that HOV 2+ lanes get as congested as the General Purpose (GP) lanes, whereas HOV 3+ lanes remain underutilized. This led to the concept of High-Occupancy Toll (HOT) lanes. Available to HOVs without charge, HOT lanes admit other, Low-Occupancy Vehicles (LOVs) if they pay a fee, dynamically adjustable based on the traffic demand. A common two-prong operational goal for dynamically-tolled HOT lanes is high utilization while keeping traffic speed above 45 mph. However, in reality, HOT facility along the I-10 freeway, the demand-management ability of dynamic pricing in peak hours can be smaller than expected due to large numbers of self-declared HOVs accessing the lane for free.

Need exists to extend the, already developed, driver behavior model by incorporating HOT policy violations. Development of a parameterization of the willingness of low-occupancy vehicle drivers to violate and misrepresent themselves as HOVs in required. The developed model describes the apparent HOVs as either (a) honest HOVs, or (b) violating non- HOVs. The split between the two types is a tunable parameter, which can be adjusted based on outside estimates of the portion of actual violation among self-reported HOVs. This extended driver behavior model was used alongside our traffic model and the amount of toll evasion and other costs that are attributable to violators was estimated through simulation.

## WHAT WAS OUR GOAL?

The goal for this project was to develop the toolbox for efficient quantitative assessment of operational scenarios on freeways with

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managed lanes in terms of vehicle miles traveled (VMT), vehicle hours traveled (VHT), delay, travel time, and toll revenue. This toolbox includes data analysis and modeling components. In addition, work under this project also explored the impact of HOT policy violations on the operation of the GP and the HOT lanes.

## WHAT DID WE DO?

This project extended the driver behavior model with a second, alternative parameterization of HOT violation. To accompany ready-to-pay model, this project developed a concept of a willing-to-violate model. This model describes the portion of non-HOV drivers that are willing to misrepresent themselves as HOVs to gain free access as a function of several variables, including e.g. the toll cost saved by violation, probability of being caught and the difference of traffic density in the general purpose and the HOT lanes. This parameterization allowed for study of effects on the HOT lane system as a function of estimated probability of catching violators from increased enforcement.

## WHAT WAS THE OUTCOME?

Based on the data from Performance Measurement System (PeMS) and FasTrak , two simulations were run. The first simulation covered type I and type II violators. Type I violations occur only on HOT lanes with limited access when vehicles switch between the GP and the HOT lanes at undesignated locations. Type II violations occur on both full- and limited-access HOV lanes – this is the type of cheating when the FasTrak transponder is set to HOV when the vehicle has fewer occupants than required. Type I violations can be estimated from FasTrak data: we can count vehicles that entered the HOT lane but never exited or vice versa – exited without ever entering. Type II violations can only be estimated using the simulation model as their number is derived from the risk-benefit ratio of the cheaters, which depends on the difference of the traffic congestion between the general purpose and the HOT lanes as well as the probability of being caught. These simulations were run on Berkeley Advanced Traffic Simulator (using models of I-10WB (https://github.com/akurzhan/L0-planning). Performance measures were computed based on the simulation results.

## WHAT IS THE BENEFIT?

The benefit to state is that it will become easier and accurate to put a price on the LOV HOT lane user. The developed model also introduces the concept of a ready-to-pay curve, which describes the portion of low occupancy vehicles that are willing to pay the HOT toll. The ready-to-pay curve uses a logistic regression model (sometimes called a logit model) and models the portion of vehicles that are ready to pay as a function of two values: the toll price and the difference in speed between the general purpose and HOT lanes.

## IMAGES

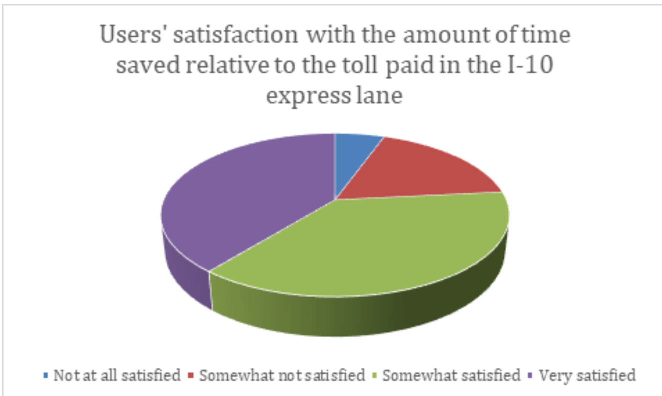


Image 1

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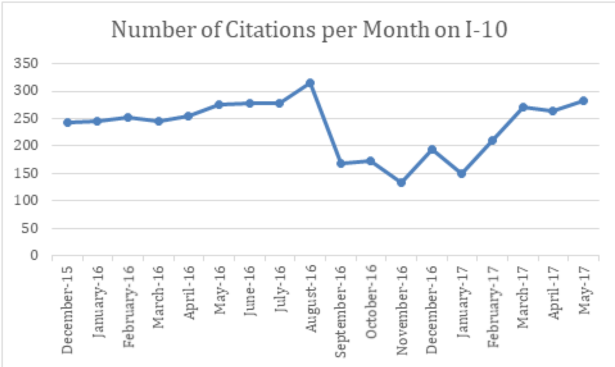


Image 2

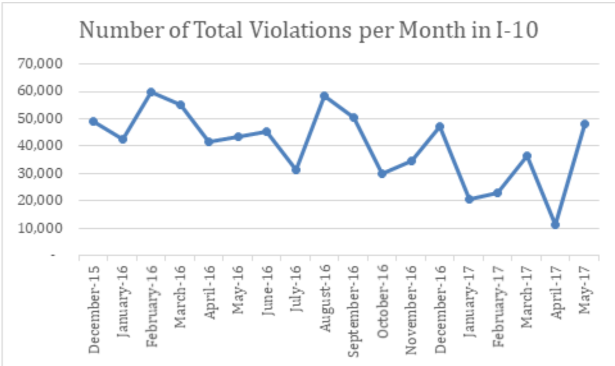


Image 3

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