Summary

Tollways form an important part of the transportation network in many countries. Each day, millions of people pay tolls while traveling to and from their daily activities. Therefore, optimizing the performance of tolled highways is clearly in the interest of a large section of the worldwide driving public. Two factors contribute to poor performance of toll plazas:

- If there are too few toll booths to handle the traffic demand, long lines form, causing drivers to spend exorbitant amounts of time **queuing** in line.
- If there are too many toll booths compared to the number of lanes on the road, automobiles will back up in the process of **merging** as the extra lanes out of the toll plaza end.

In this paper we will address the question of determining the number of tollbooths which minimizes the performance reduction due to both of these factors. We conclude that the correct approach to optimizing performance is to minimize waiting time. Then we develop a model of toll plazas and their users with the following features:

1. Vehicles enter the plaza with inter-arrival times distributed exponentially.
2. Entering vehicles are distributed evenly among the available tollbooths, which function as queues with exponentially distributed service time.
3. Vehicles leaving the tollbooths enter another queue with a differently distributed service time, which simulates the effect of merging.

Under these assumptions, the average delay for a particular toll plaza configuration can be derived using results from queuing theory, giving us the tools to compute the optimal number of toll booths for several different configurations, results displayed at the end of our paper.