The butterfly effect- imbalances in lane change accommodation time and lasting disturbances.

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Classic highway traffic flow theory can explain the evolution of signals and waves once they form. Given sufficient boundary conditions the theory captures the evolution of the traffic state over space and time. But one rarely finds such ideal boundaries on real highways. Often disturbances arise within a region that classic theory would tell us should be homogeneous. These disturbances often grow and give rise to unstable traffic upstream, e.g., resulting in stop-and-go conditions during congestion which in turn can result in an increased frequency of accidents.

This talk will examine one potential source of these disturbances, namely how lane change maneuvers perturb car-following relations and the resulting macroscopic impacts on the traffic state. It will be shown that the impacts of lane change maneuvers are not balanced, the response time to an exiting vehicle is longer than the response time to an entering vehicle. This accommodation imbalance is likely due to the difference between mandatory need to make way for an entering vehicle verses discretionary nature of closing a gap. After illustrating this imbalance on two facilities, the talk will explain how it can give rise to lasting disturbances that propagate upstream and as will be discussed, it appears to be a source of speed and flow fluctuations within a queue.

Reference:

Wang, C. and Coifman, B., "The Effect of Lane Change Maneuvers on a Simplified Car-following Theory," IEEE Transactions on Intelligent Transportation Systems, Vol 9, No 3, 2008, pp 523-535.