



Improving Intersection Behavior through Delay-Based Left Turn Phase Initiation

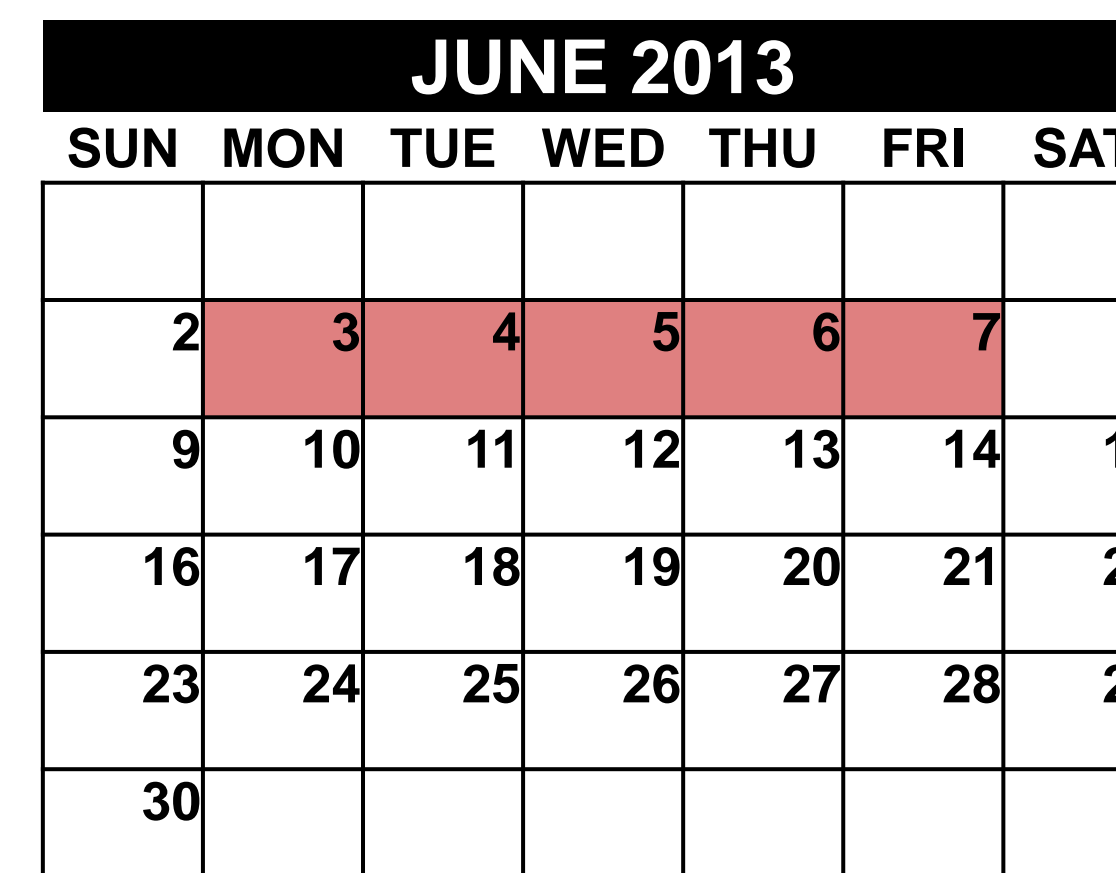
Steven M. Lavrenz¹, Alexander M. Hainen¹, Amanda Stevens², Christopher M. Day¹, Howell Li¹, Richard Freije¹, W. Benjamin Smith¹, Hayley Summers¹, James R. Sturdevant², and Darcy M. Bullock¹
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Paper No. 14-0302

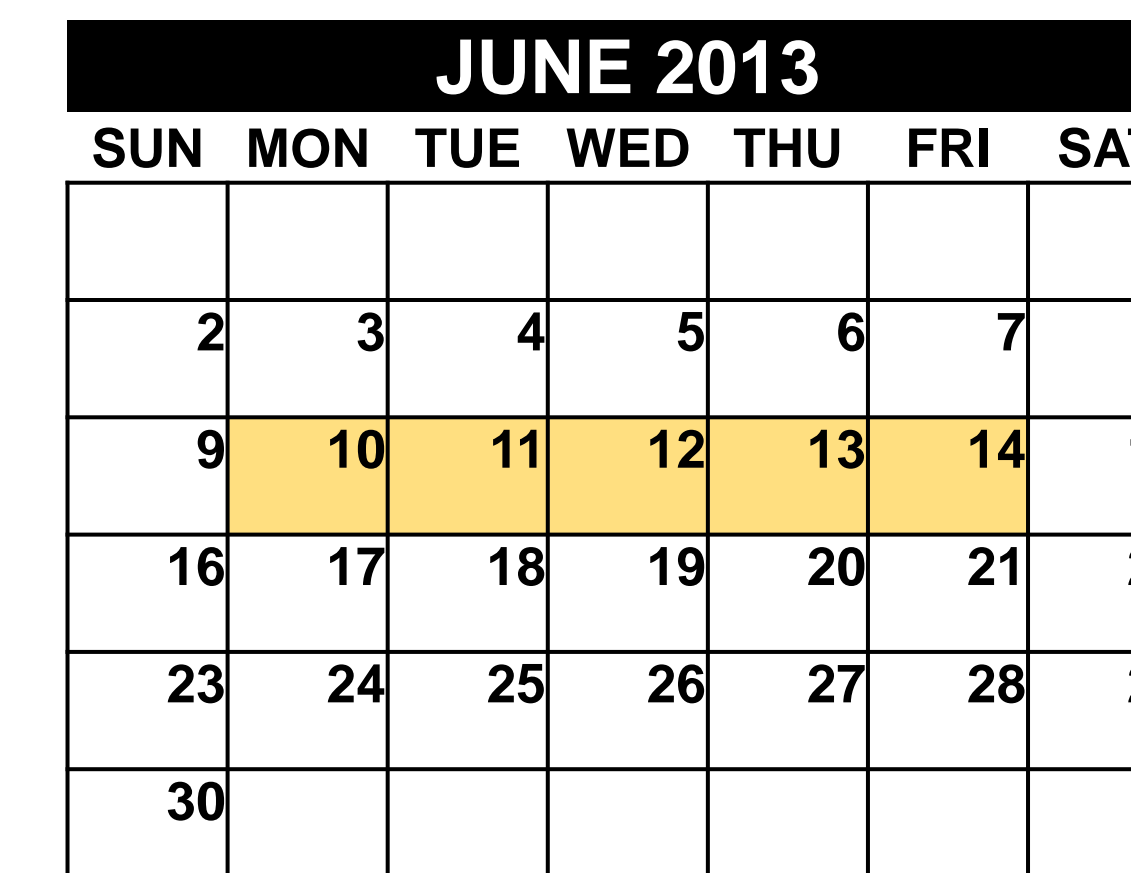


Abstract

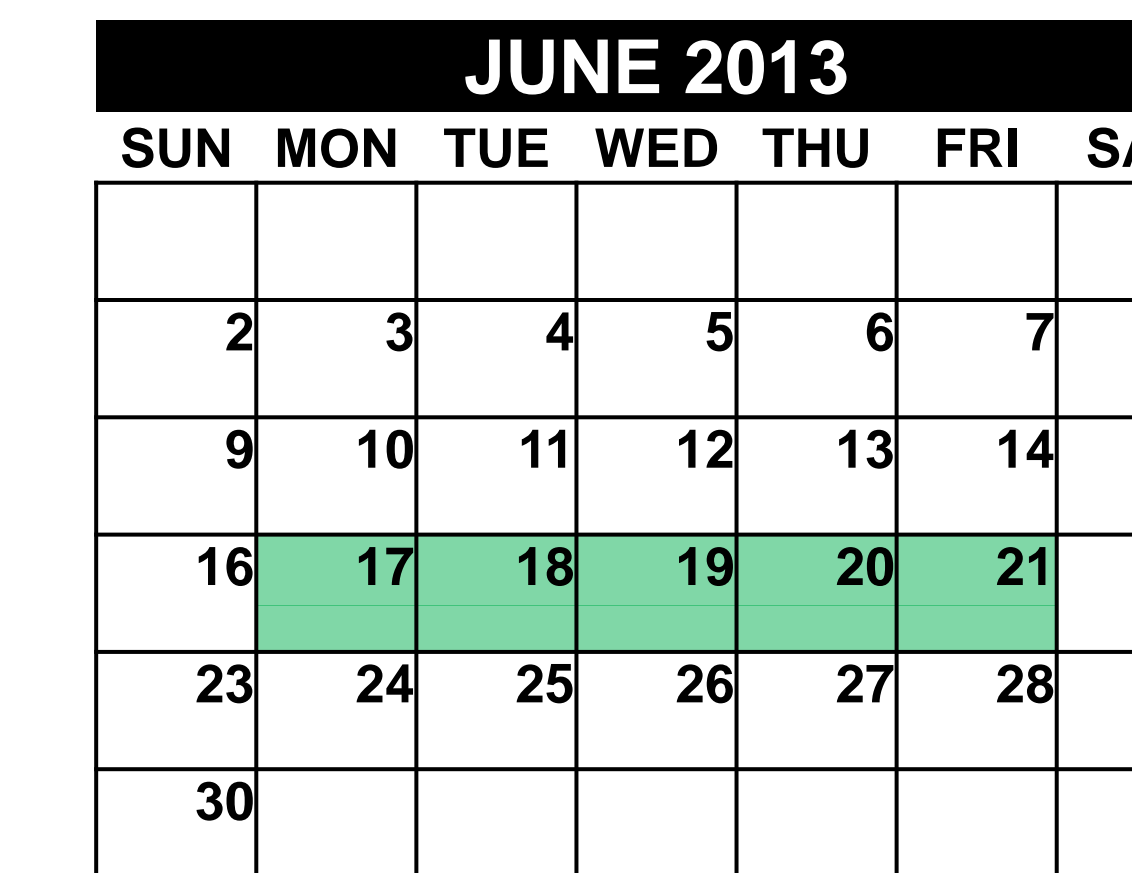
Serving protected left turn phases for one or two vehicles can often be an inefficient use of cycle green time when the opposing through movements are over capacity. This paper assesses the performance of an intersection based on the application of controller logic that delays the call for a protected left turn phase based on vehicle wait times. Four weeks of evaluation were carried out where the delay on left turn phase calls was varied in 25 second increments, from 0 to 75 seconds. The results indicate that delaying left turn phase initiation substantially increases the amount of green time for saturated through movements, while minimally increasing the travel delay for left-turning drivers. The paper concludes by recommending agencies consider using a delay in the range of 25 to 50 seconds for calling protected phases at intersections where the opposing through movement is oversaturated and could benefit from additional green time.



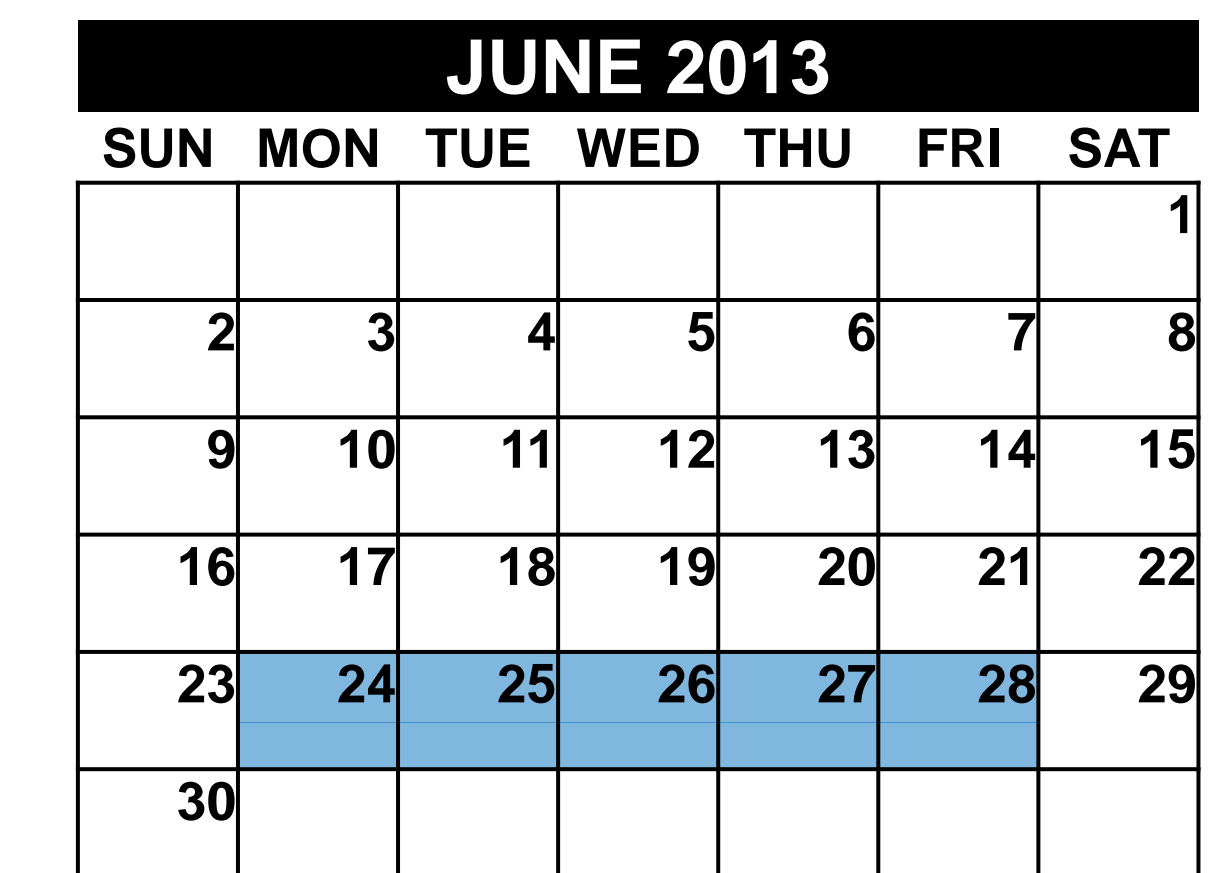
0s Delay Parameter



25s Delay Parameter



50s Delay Parameter

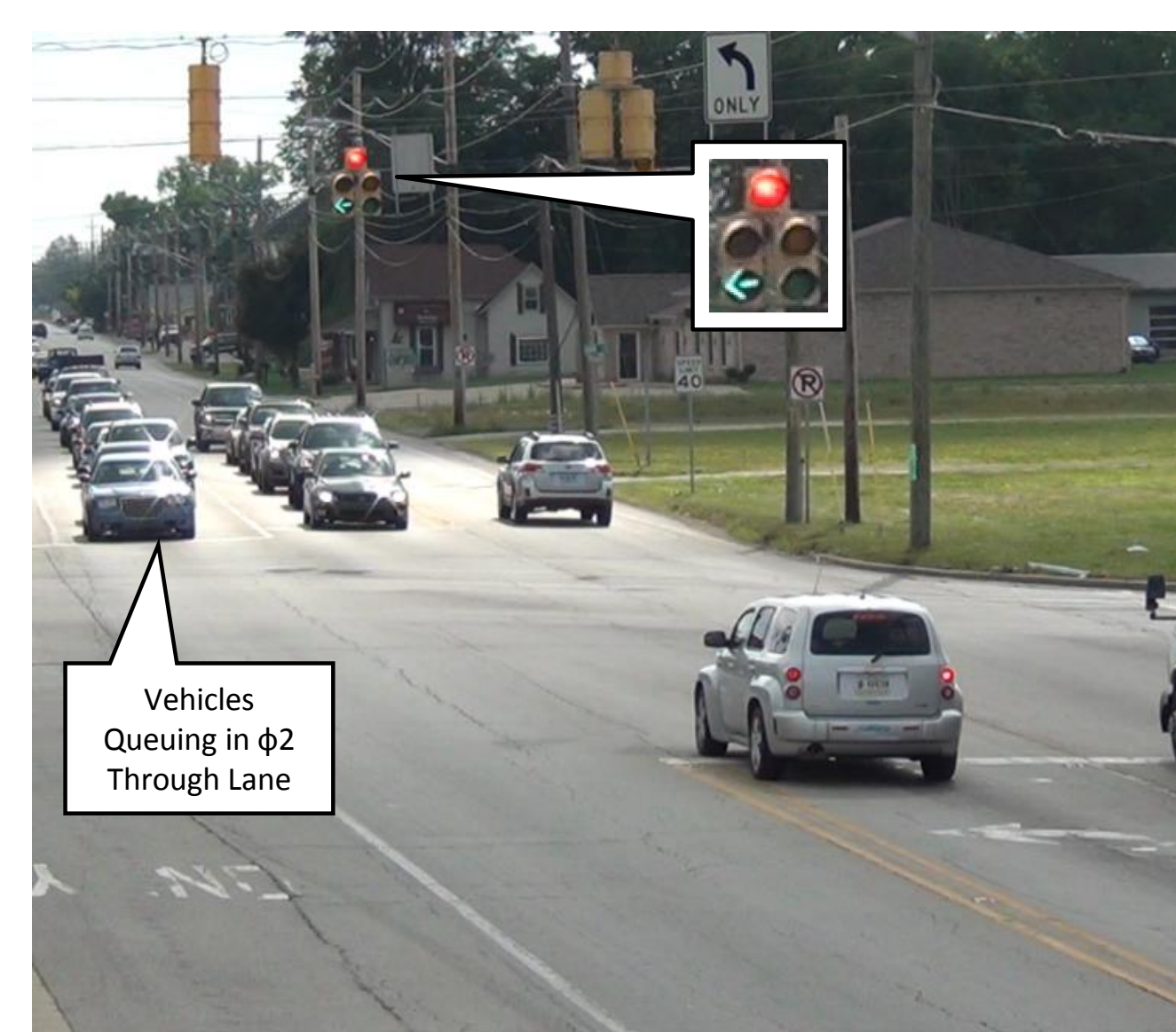


75s Delay Parameter

Can Eliminating the Protected Left Improve the Saturated Through Movement?

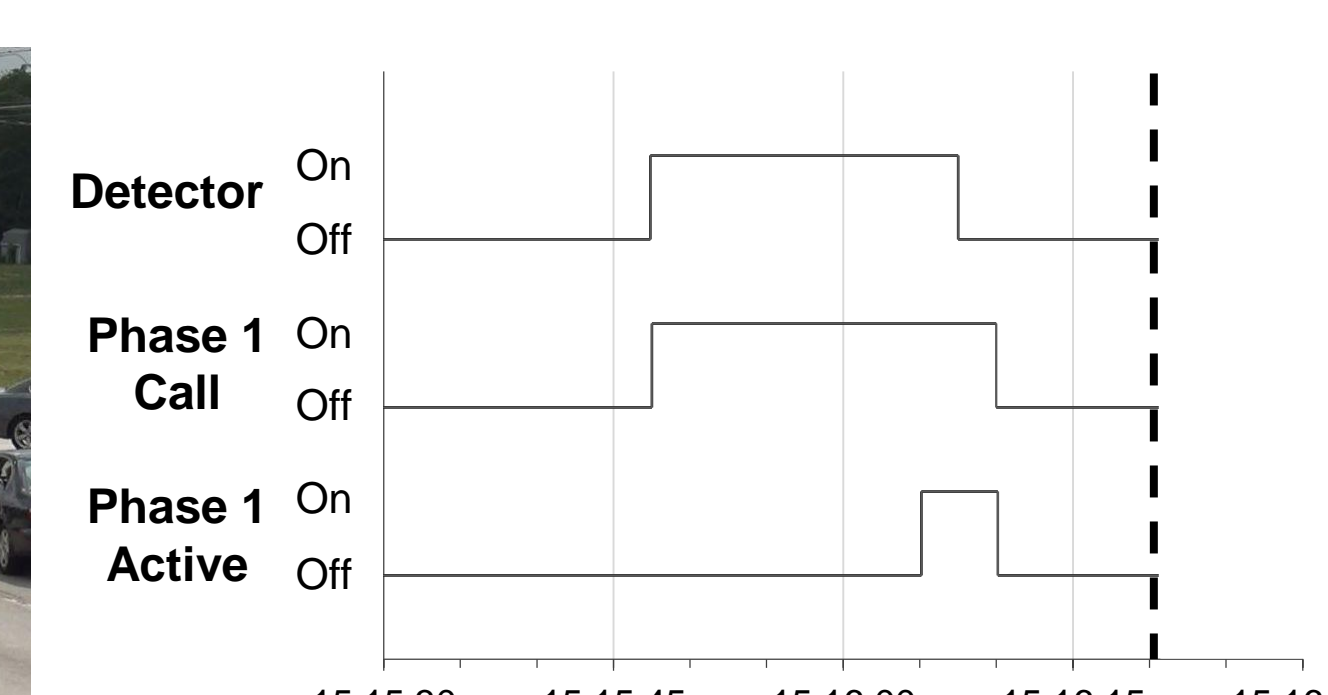
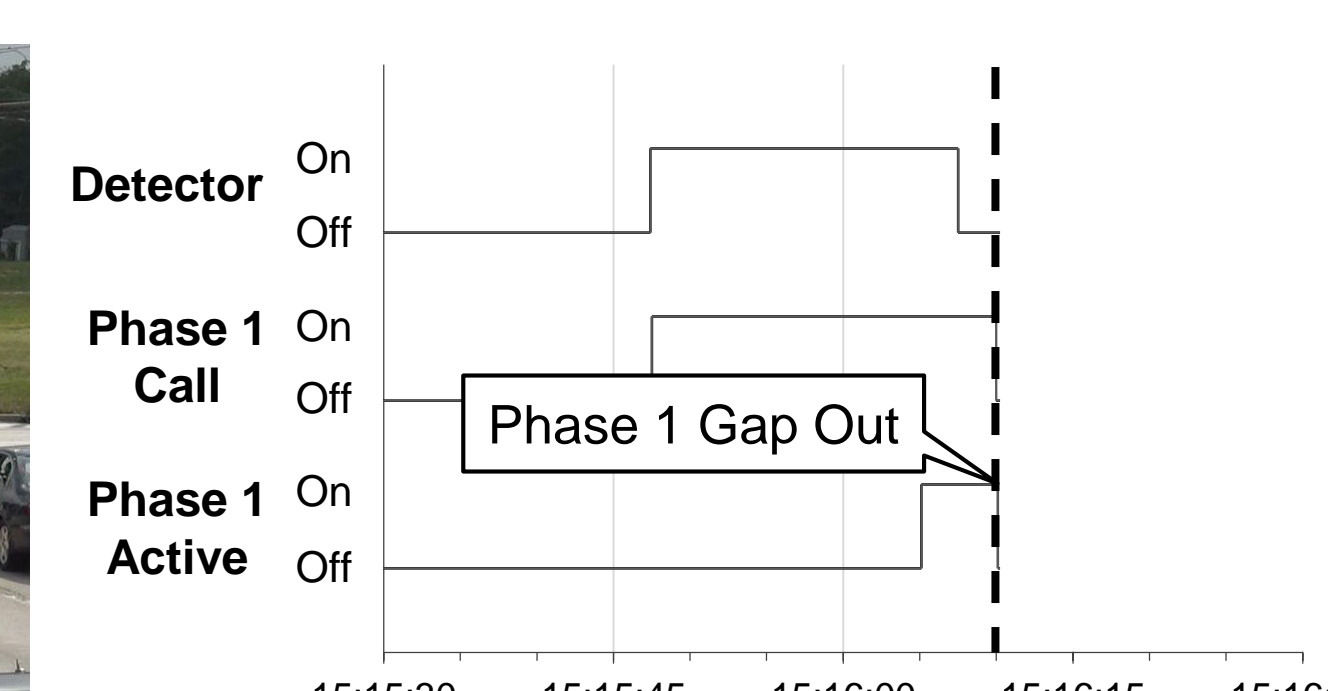
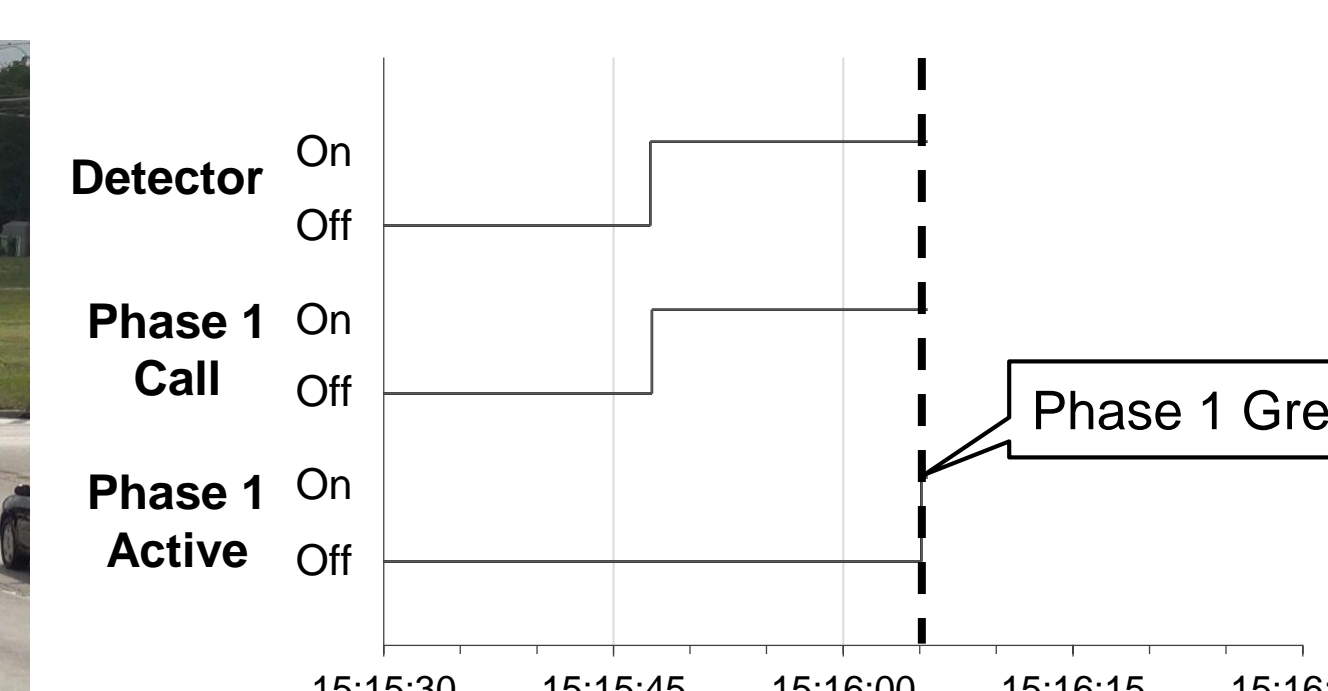
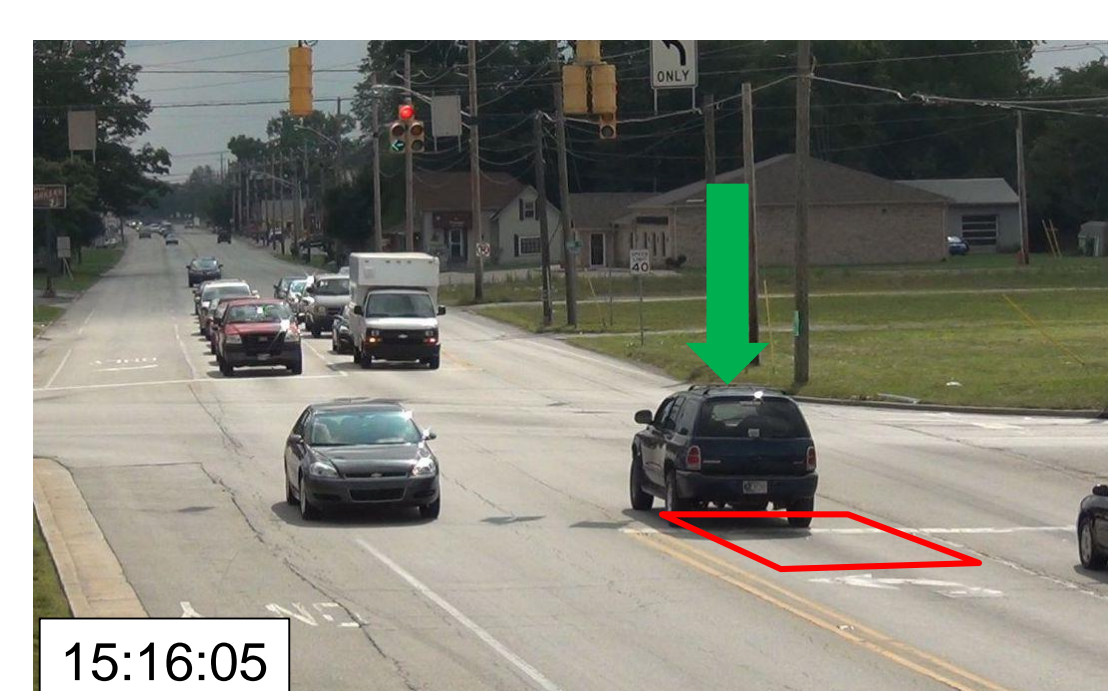
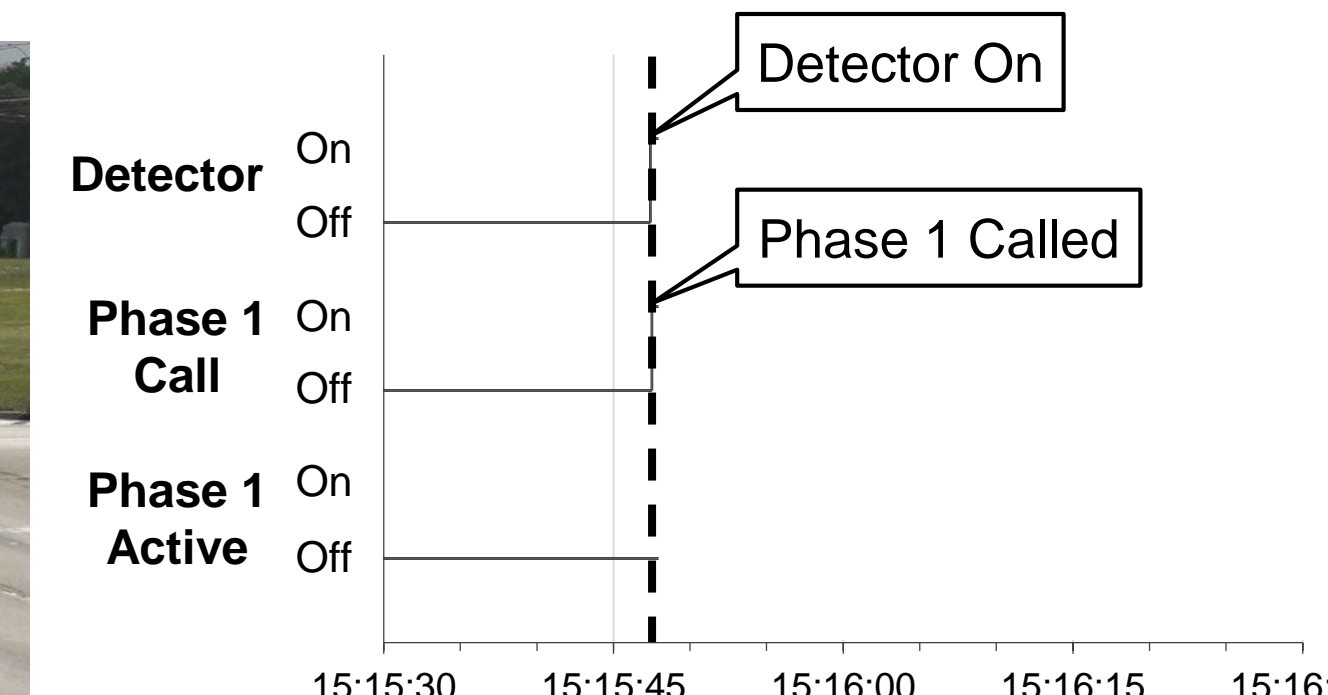
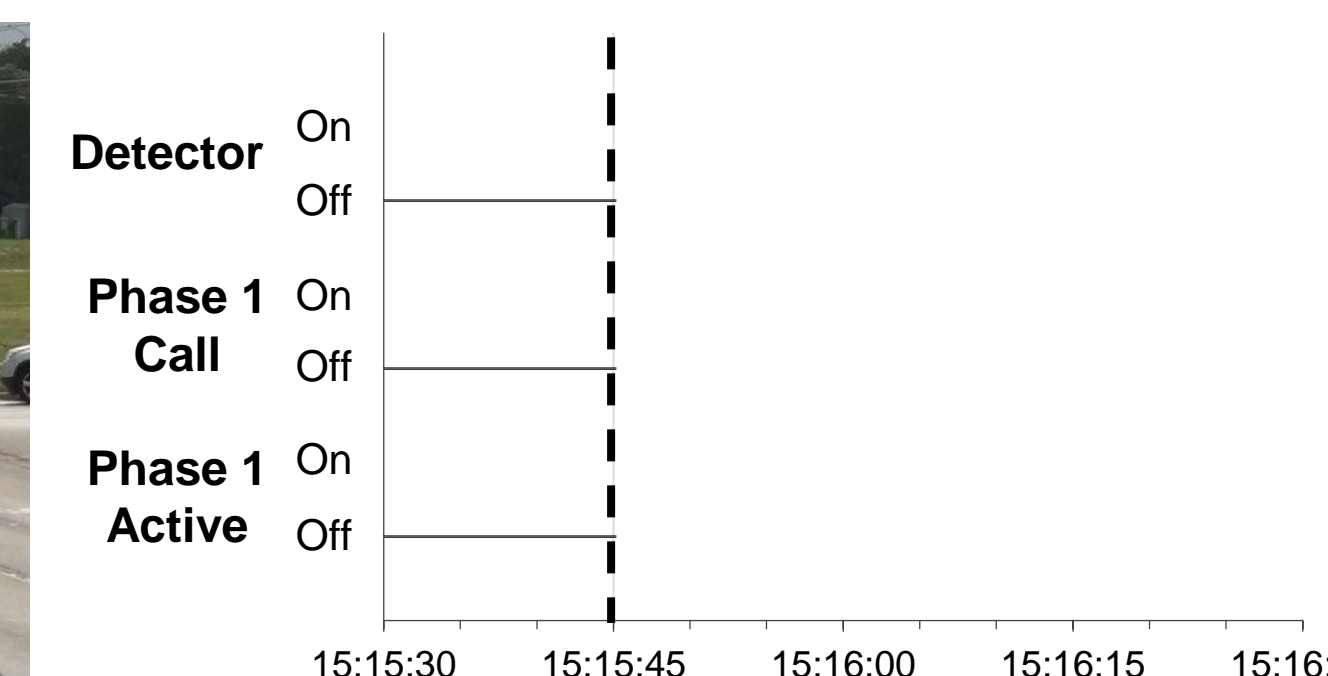


Phase 1 Not Called

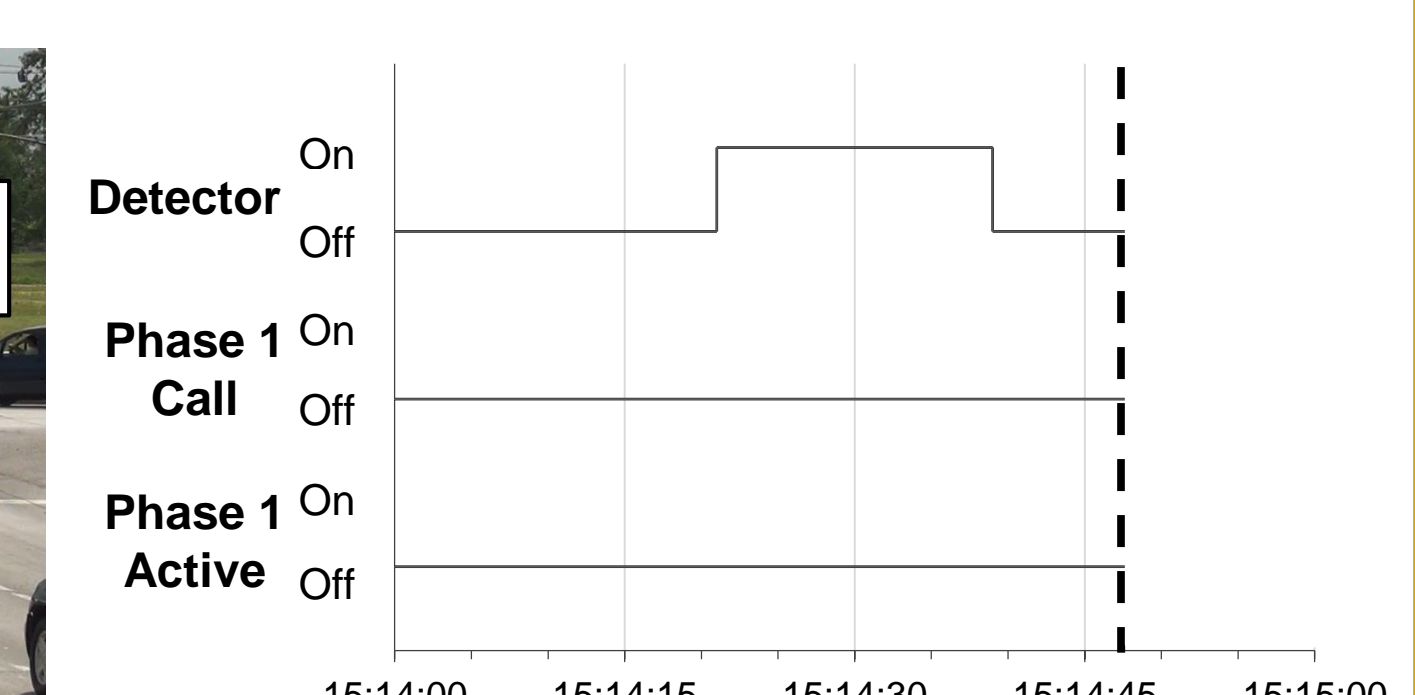
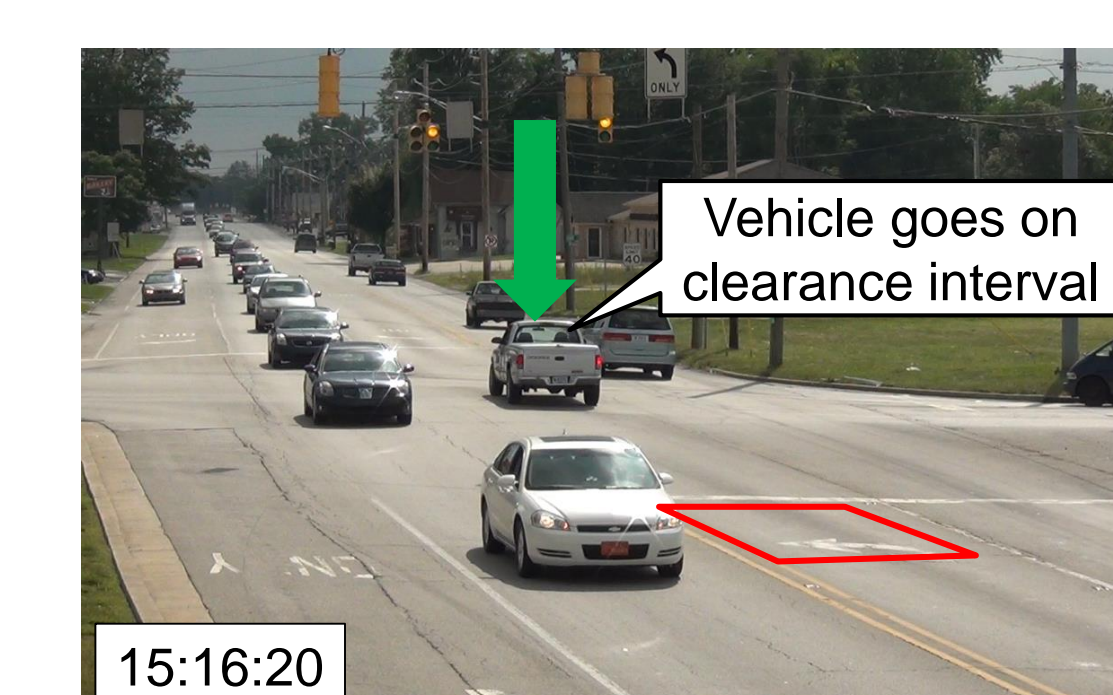
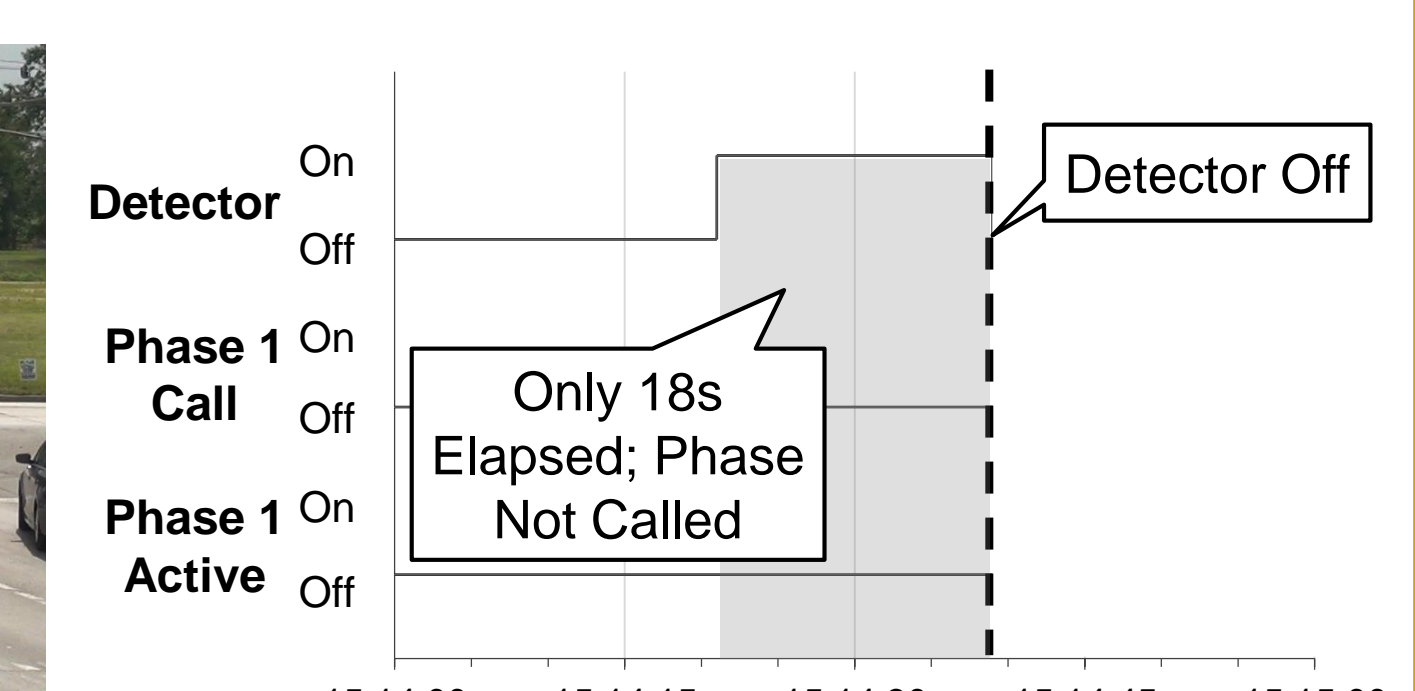
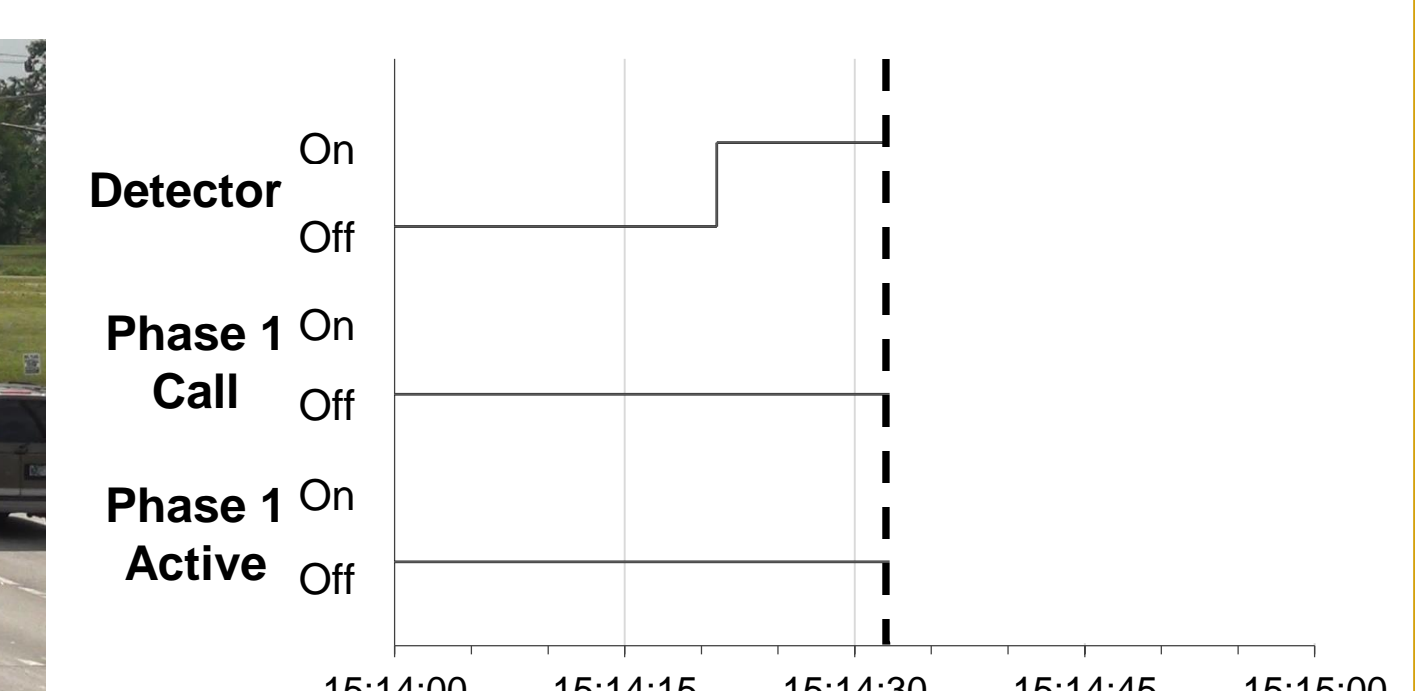
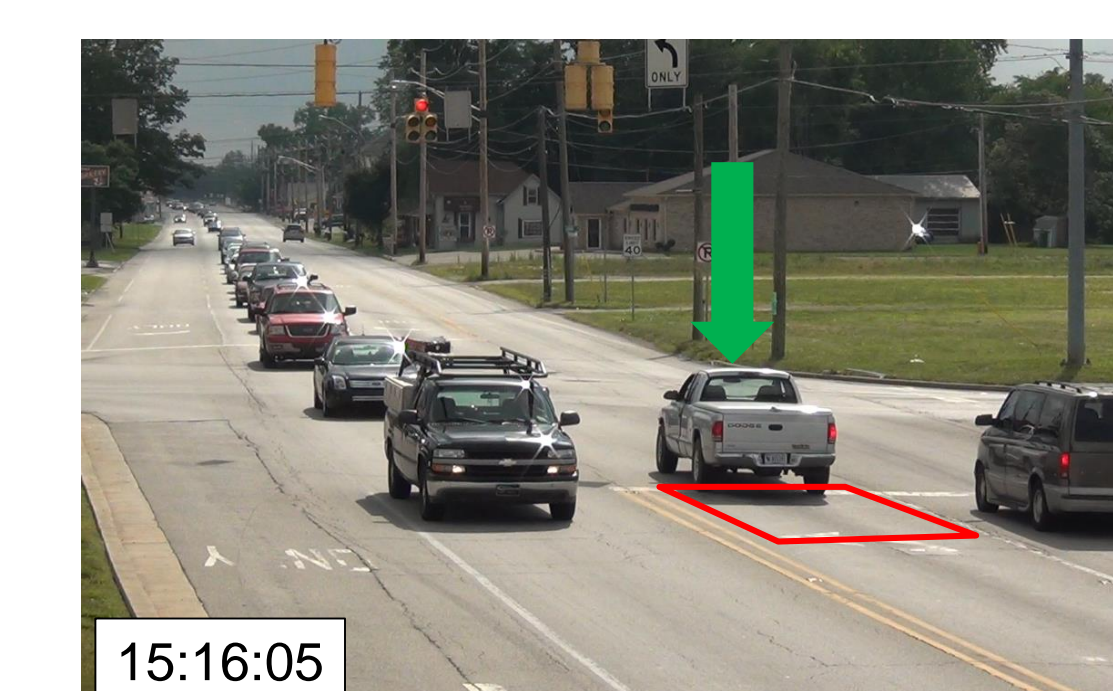
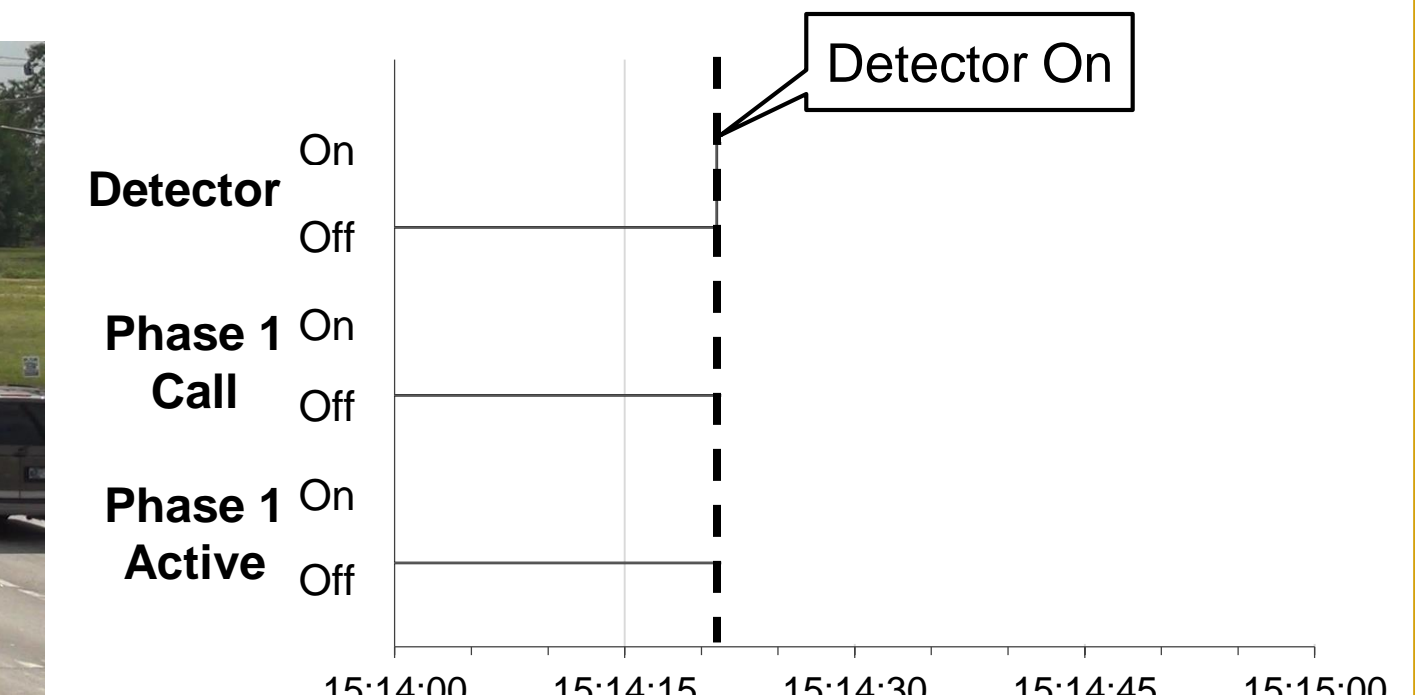
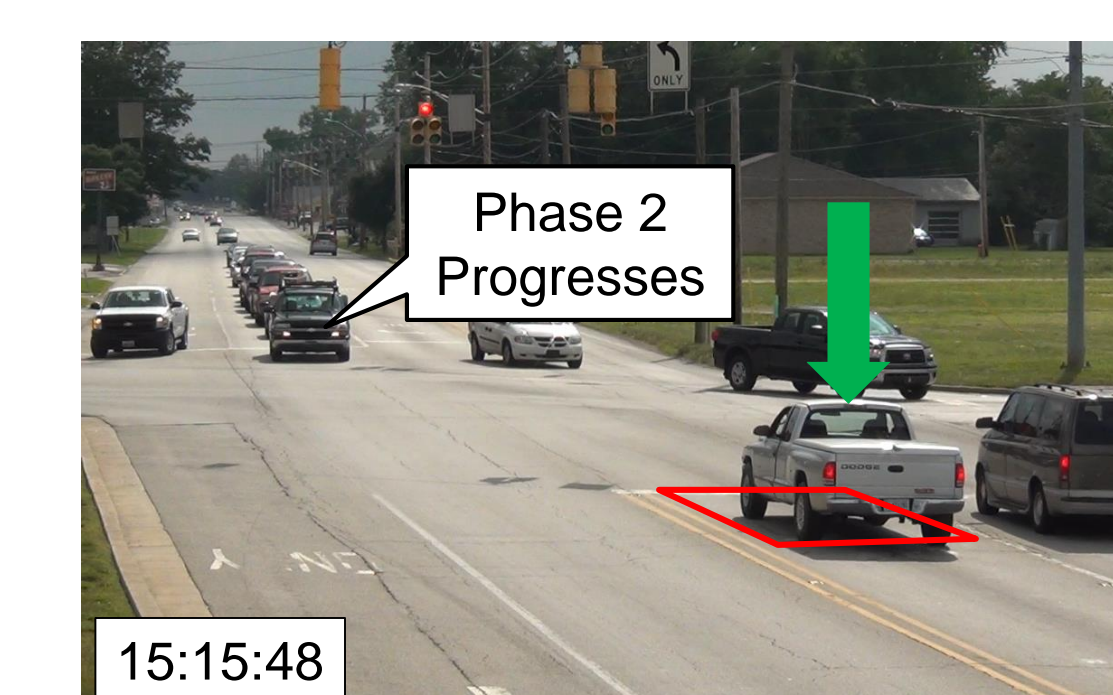
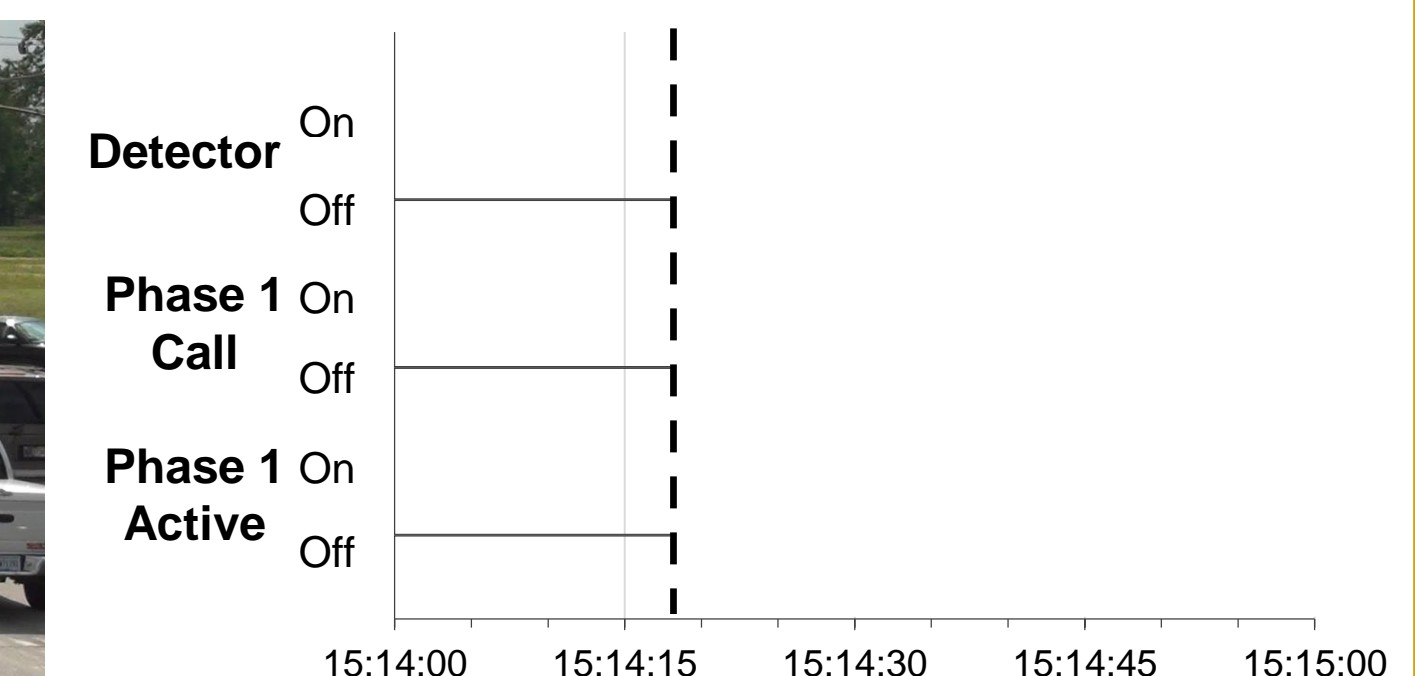
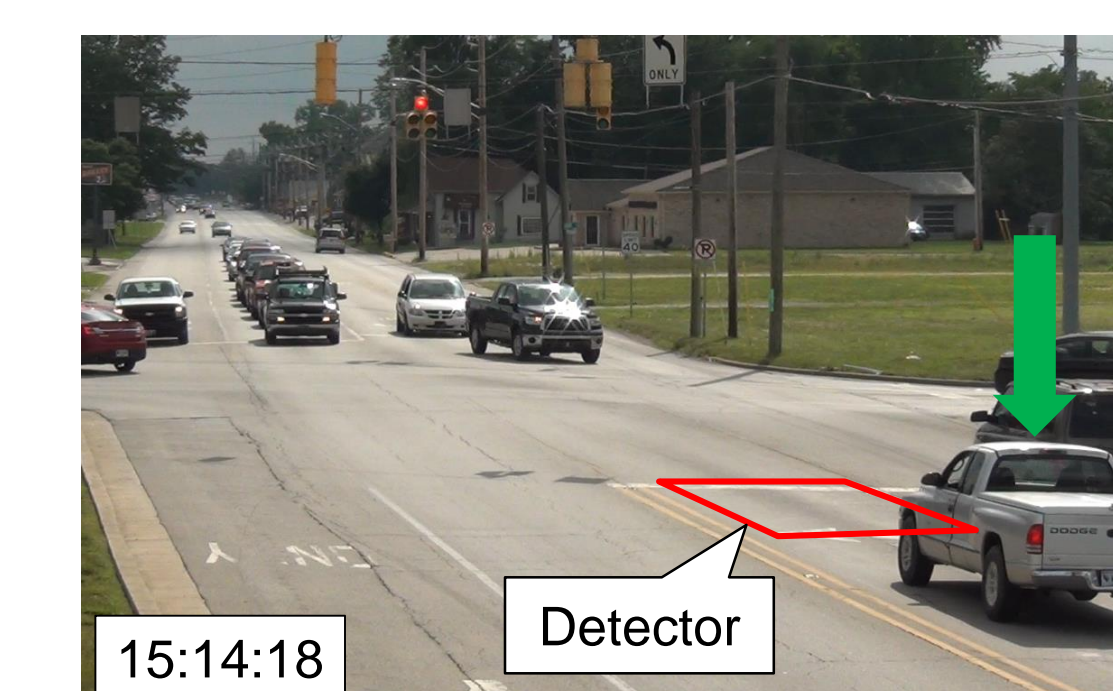


Phase 1 Called

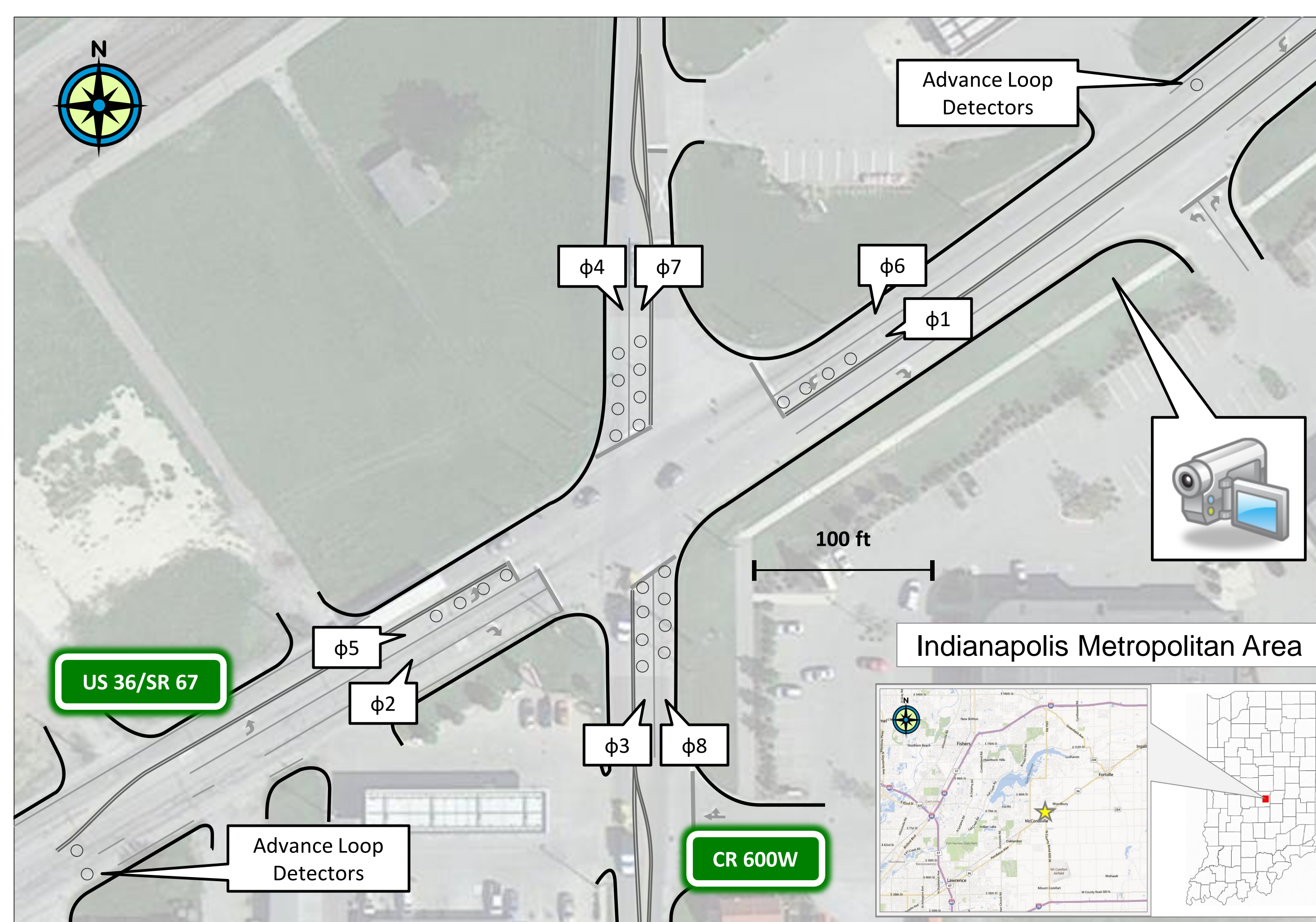
Phase 1 Called – 0s Delay Parameter



Phase 1 Not Called – 25s Delay Parameter



Study Location & Intersection Layout





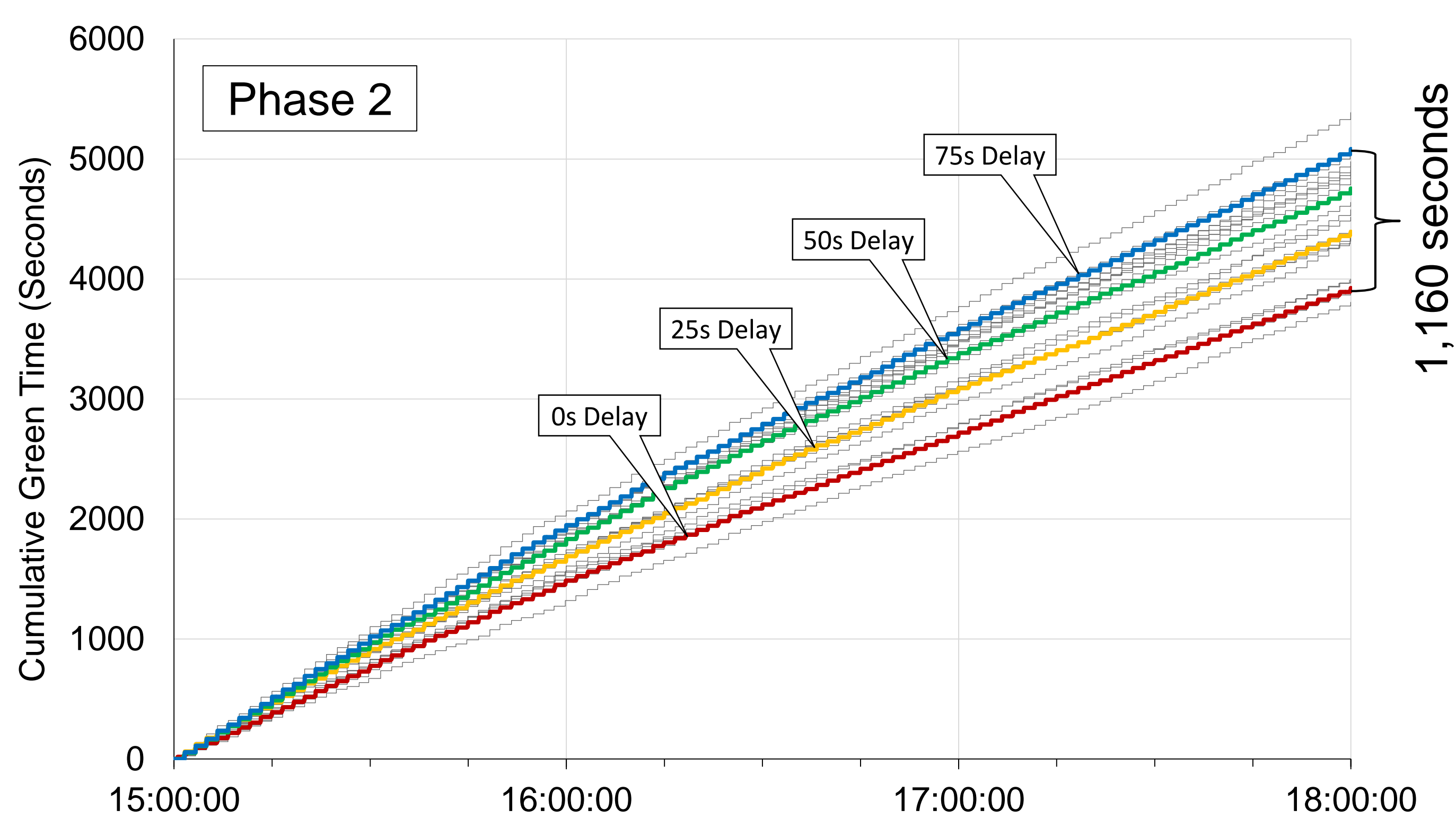
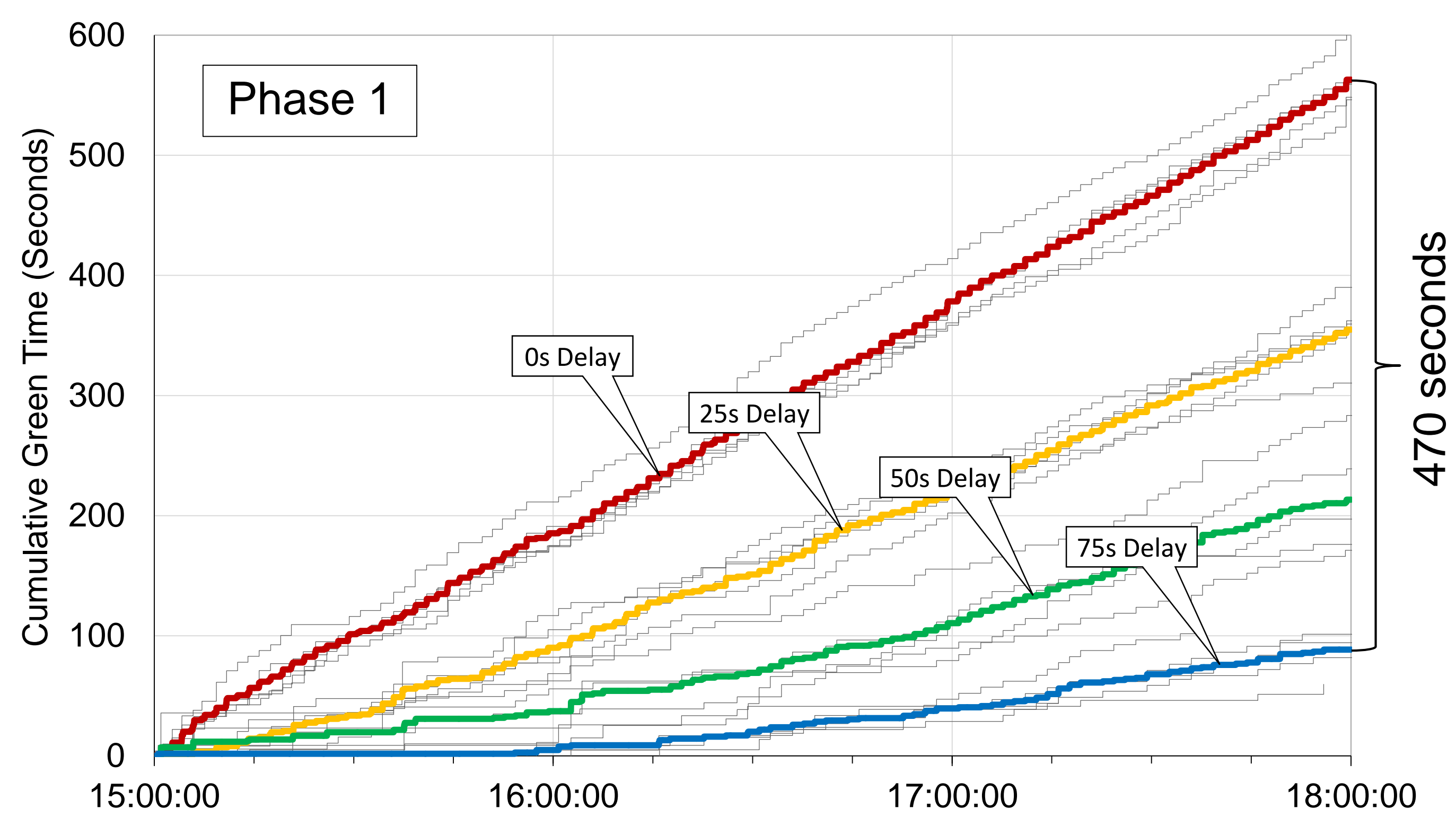
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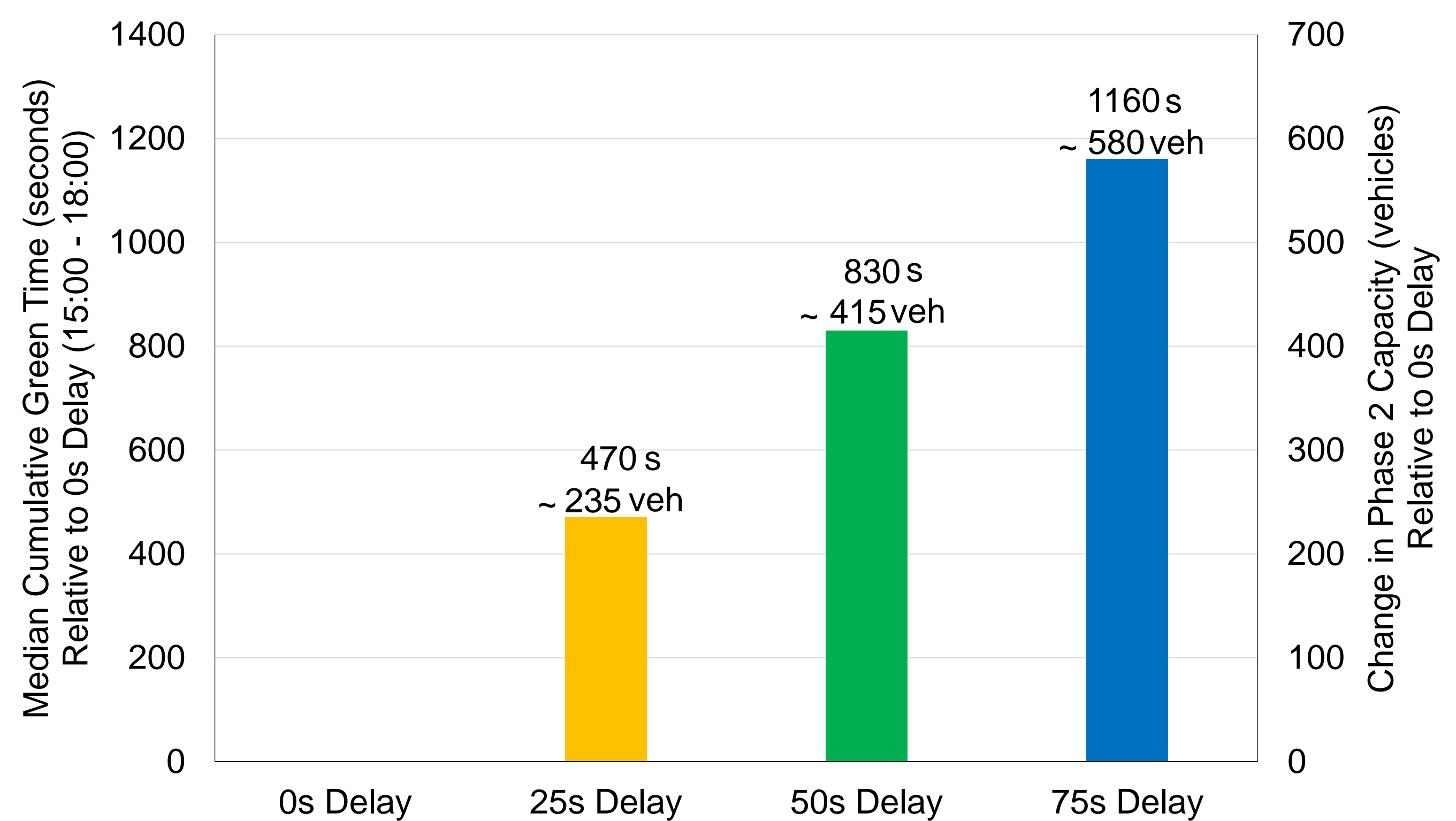
Paper No. 14-0302



Impact on Cumulative Green Time & Capacity

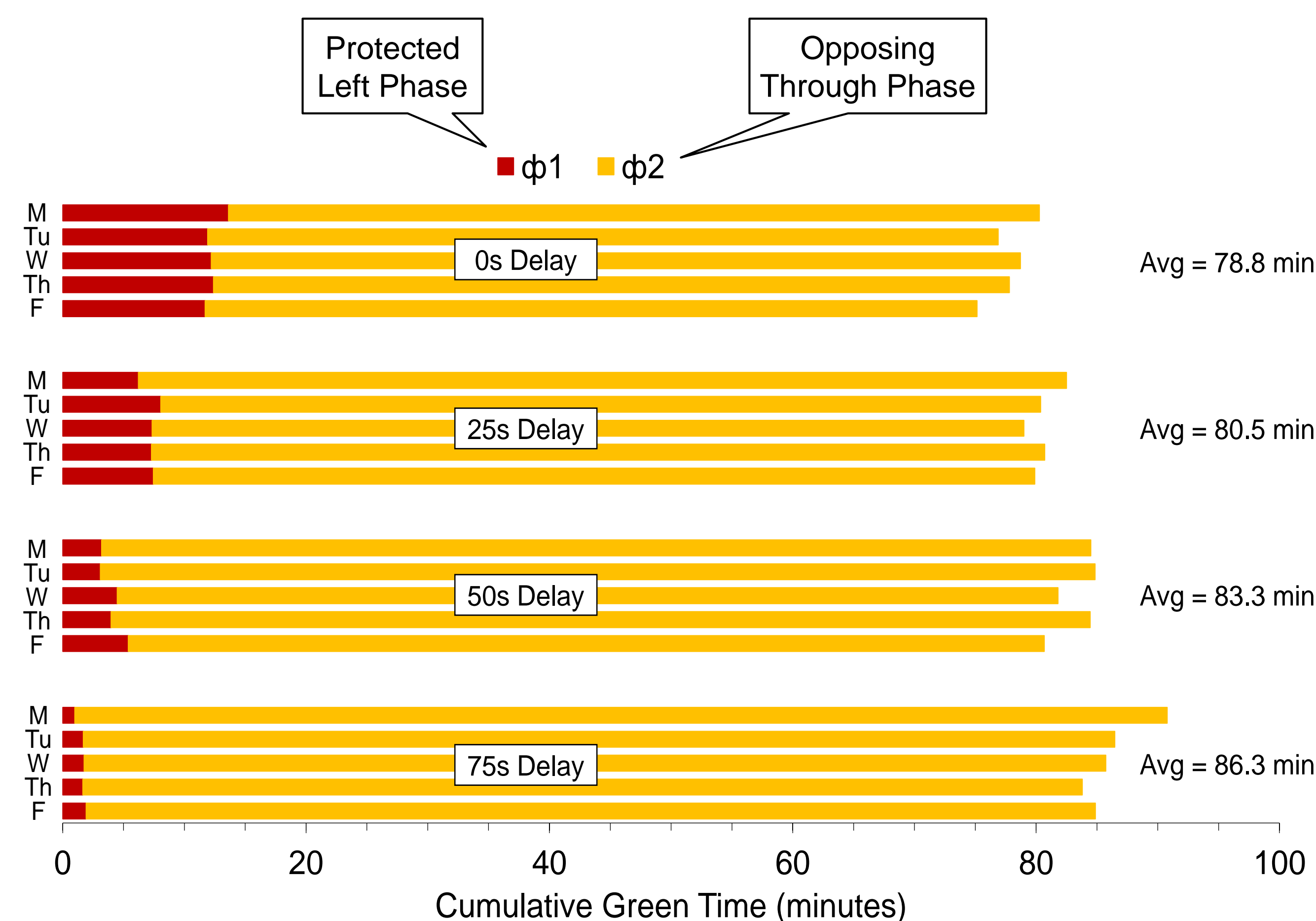


Cumulative green times for Phase 1 and Phase 2 (average cumulative time for each delay setting highlighted)

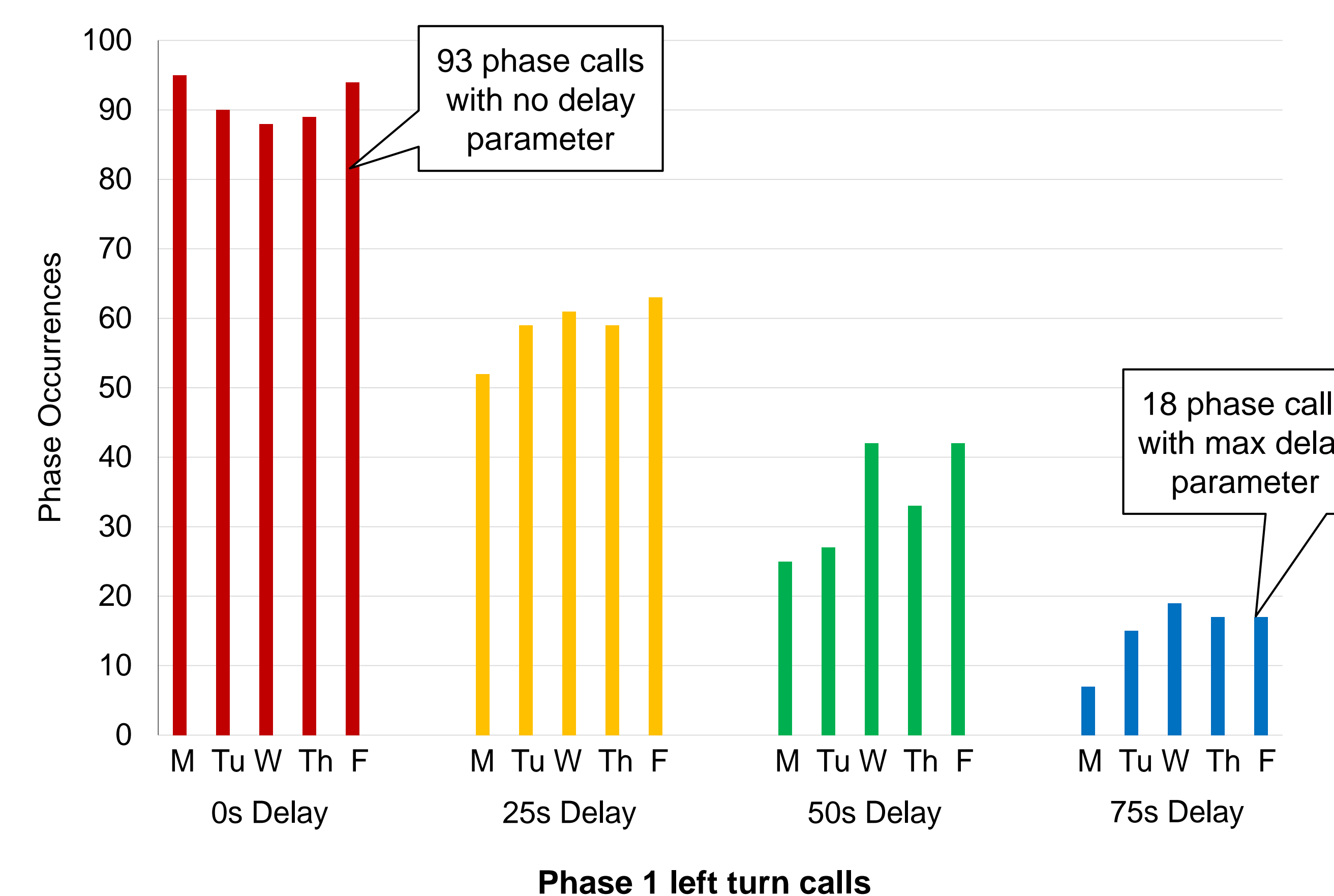


Additional green time and capacity served on the Phase 2 through movement

Impact on Cumulative Green Time & Phasing



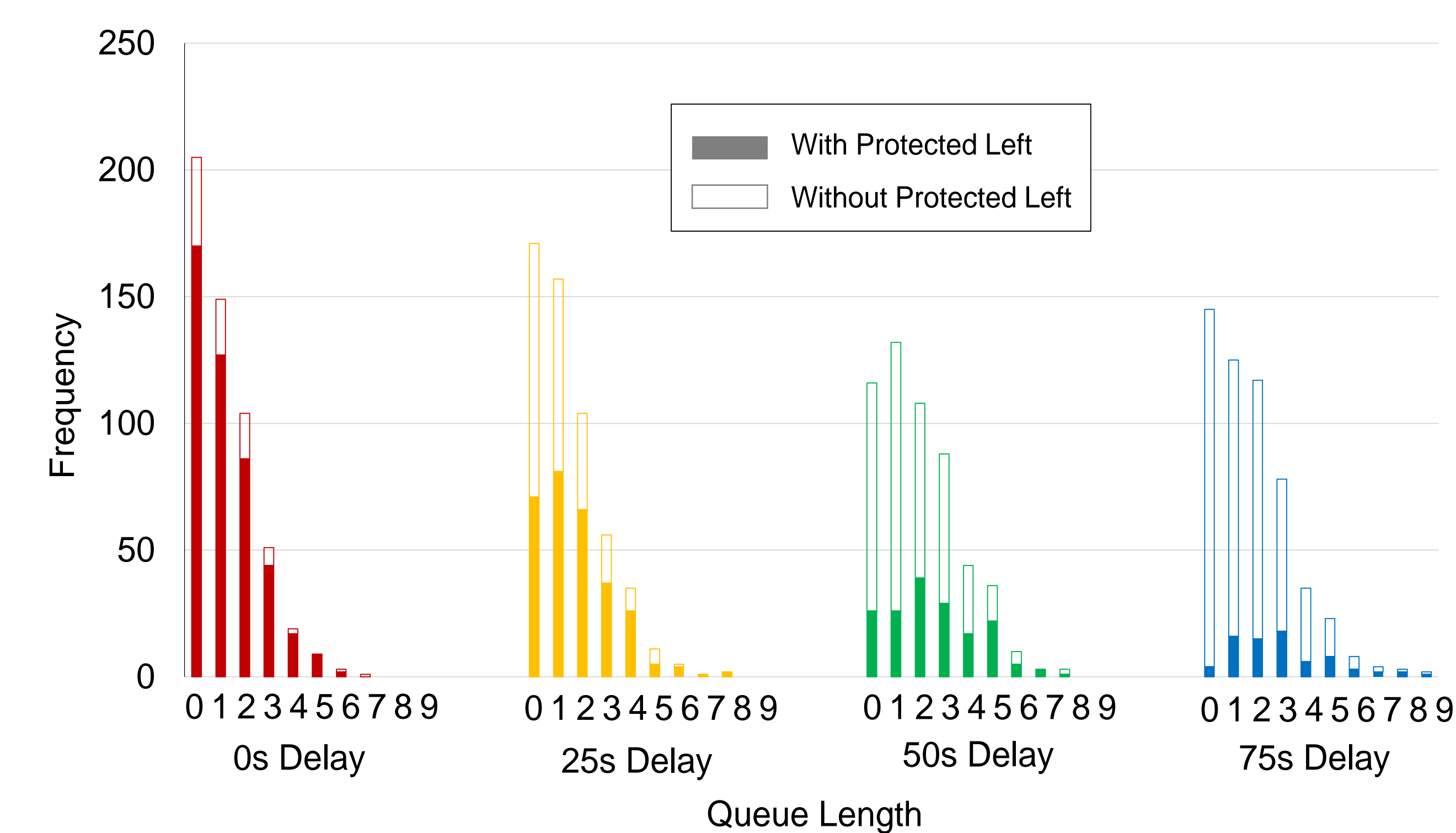
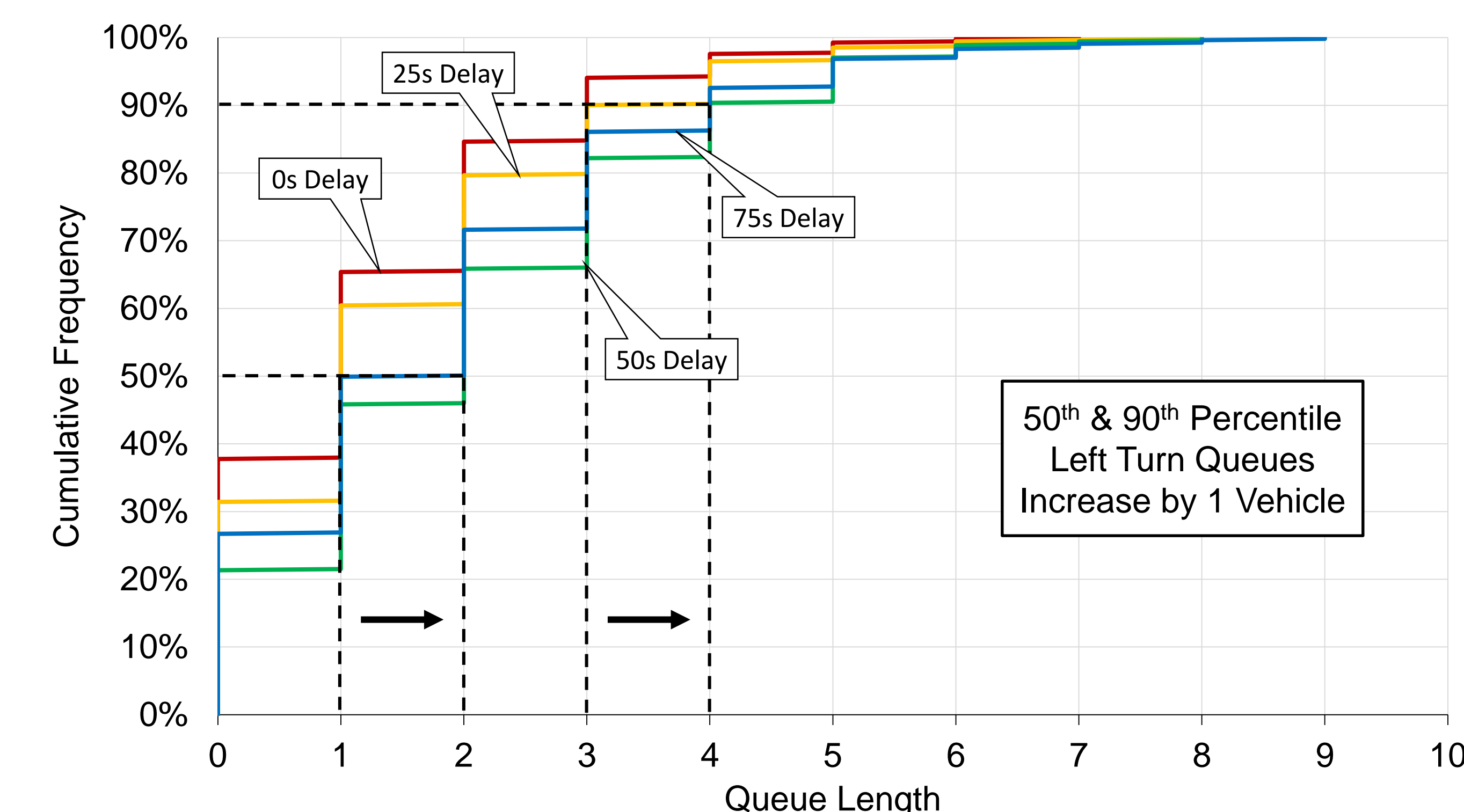
Comparison of Phase 1 and Phase 2 cumulative green time



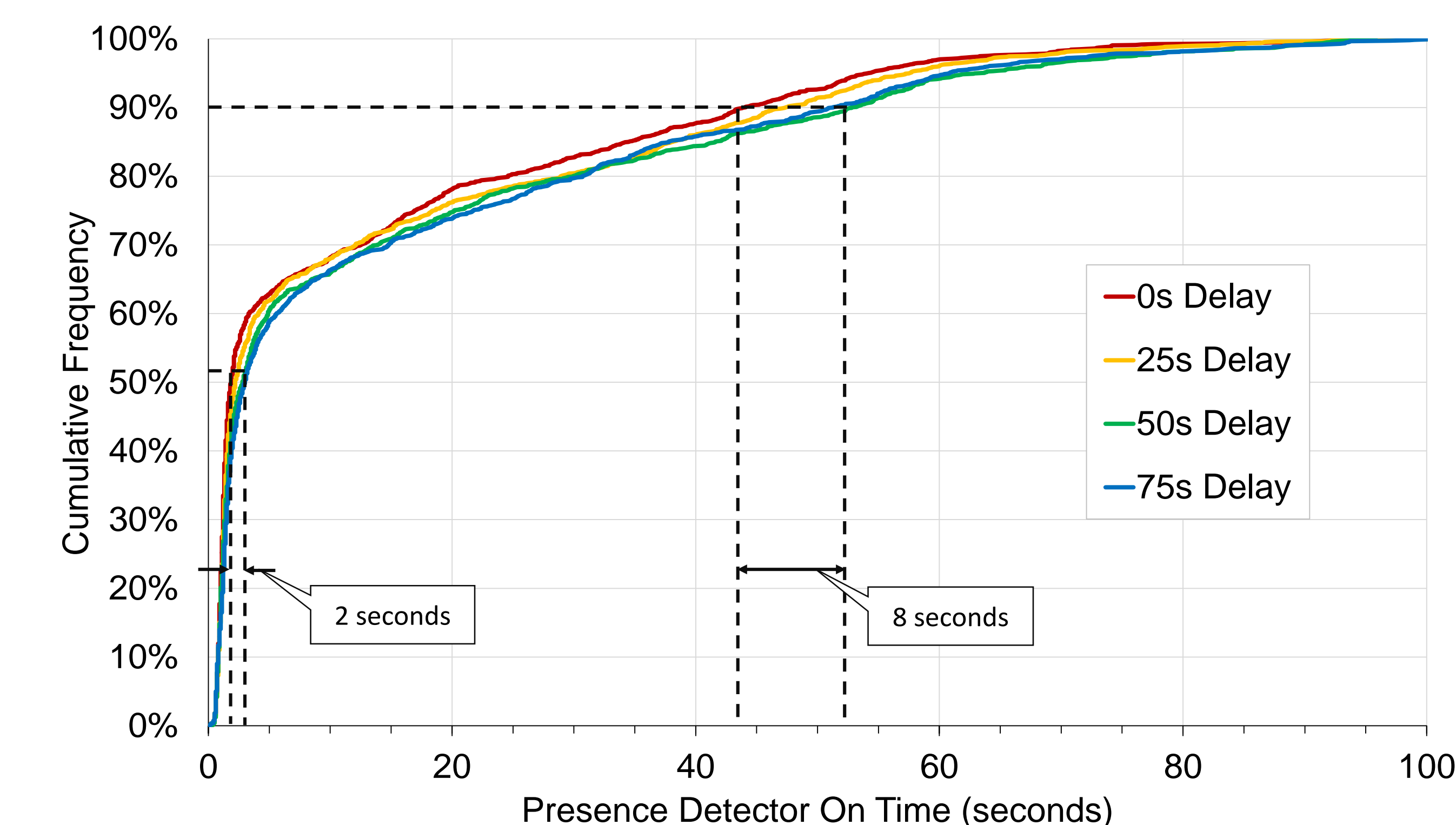
Conclusions

- Detector delay for protected/permissive left turns can be effective where a lightly traveled left turn has a saturated opposing through movement.
- Increasing detector delay does not significantly increase left turn wait times; most drivers were able to complete turns on the permissive phase
- Increasing detector delay on the Phase 1 approach resulted in capacity increase of 235, 415, and 580 vehicles on the Phase 2 through movement for delay values of 25s, 50s, and 75s, respectively.
- Groundtruthing tools, including time lapse photography and high resolution controller data can be used to verify intersection performance.

Wait Times & Queuing for Left Turning Vehicles



Cumulative distribution (top) and histogram (bottom) of Phase 1 left turn queue lengths



Front detector presence times on Phase 1 for 0s, 25s, 50s, and 75s detector delay values