Safe Operation of Automated Vehicles in Intersections Questions and Answers

Q1: Are you aware of any protocol standards for SPaT transmission, either among controller manufacturers (e.g. NTCIP) or automobile manufacturers?

A: The standard is SAE J2735 standard. Manufacturers include Traffic Technology services, Connected Signals, Live Traffic Data, Savari.

Q2: Under actuated signal control, there is uncertainty in predicting future phases and the remaining green/red times in the SPaT messages. How do you use these SPaT messages to avoid crashes at intersections with V2I/I2V communications?

A: A lot of current signals are actuated where phase duration depends on the arriving vehicles. In this case, the expected phase duration can be predicted with some accuracy. To read more on how this could be done, refer this report: Sustainable Operation of Arterial Networks Final Report. Look at Section 2.2.2 – the SPaT problem. Sensys Networks implemented this algorithm in their system.

Q3: When simulating the crash probability between a permissive left-turning car & the through car from the opposite direction, why can the opposite, through car (on the right-most lane) use the intersection while all the other straight movements on the same approach stop?

A: In the scenario that we modeled, there were cars in the middle and the right lanes because these lanes were blocked by the congestion downstream of the intersection. Right lane was not blocked, and Uber Volvo tried to cross the intersection at 38-40 mph.

Q4: What type of projects with information 2 vehicle (I2V) should we be planning for? Such as investment in on/off highway ramps with I2V investment and physical changes to the on/off ramp environment?

A: I2X (infrastructure to anything, including bikes and peds) type projects; X2I when users can request green – similar to BRT; Violation detection and response – needs precise vehicle location (lane-wise), which requires experimenting with precision GPS, e.g. GPS-RTK; I2X with actuated signals, where signal phase duration is not known n advance (see Question 2). All these are adequate for intersections adjacent to the ramps.

Q5: Can you explain where the 94% driver error comes from? In the Venn diagram, the 94% occurs together with road and also vehicle factors.

A: The 94% comes from a 2015 NHTSA memo that surveyed crash reports from 2005 to 2007. It found that in 94% of cases a human action was "the last failure in the causal chain of events leading up to the crash" but that should not be interpreted as the cause of the crash. It is simply the way car crashes work. Humans are driving, so the last action before a crash is probably the human doing something (the remaining 6% are attributed to equipment failure and the act of God – like a fallen tree). But that means nothing for what actually caused the crash. To make such a determination, it would require a thorough investigation by qualified inspectors like NTSB or from a local police department. Very few crashes undergo such thorough investigations, making it easy and convenient to blame "human error" for everything, when other factors like road design, excessive speed limits, or weather conditions may have been more important.

Q6: If the crash risks 'calculated' do not correspond with the actual, what will be your suggestions for Caltrans practitioners?

A: One should look at the calculated crash risk, not just the number of actual crashes in the past. Some intersection may be risky even though there were no reported injuries there so far. The way we compute risk is as follows: 1) Take the number of certain type crashes over a given period and divide by the estimated average traffic flow on that movement over the given period; 2) Scale to current traffic flow for this movement; 3) Extrapolate to intersections with similar characteristics that do not have actual incident data.

Q7: Need to consider the dynamic nature of SPAT. Has that been resolved now?

Yes. Please, see the answer to Question 2.

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