



INDOT Research

# TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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## **DEVELOPMENT OF VEHICLE PLATOON DISTRIBUTION MODELS AND SIMULATION OF PLATOON MOVEMENTS ON INDIANA RURAL CORRIDORS**

### **Introduction**

Since the 1980s, traffic volumes have experienced a rapid growth of approximately 30% in Indiana. Traffic data indicates that more than 70% of vehicles travel in platoons on Indiana highway corridors in the vicinity of urban areas. At a rural highway intersection consisting of a major road with high traffic volume and a minor road with low traffic volume, it is very common that the green time cannot be used efficiently, especially when the vehicle detectors on the major road are imbedded close to the intersection. In Indiana, most of the traffic signal timing systems operate well. However, these systems do not allow for considering the presence of vehicle platoons on major roads. For a semi-actuated or fully actuated signal control, the green on the major road is often terminated at the intersection due to the arrival of vehicles on the minor road. Vehicle platoons are often stopped to give the right-of-way to the minor traffic, even only a single vehicle. As a result,

vehicle platoons are delayed, and the green time is not efficiently used. If this can be improved, traffic delay will be reduced.

This study, as the second phase of a two-phase study of vehicle platoons, was conducted to improve traffic control at intersections on Indiana rural corridor. Major parameters of the vehicle platoon characteristics include platoon headway, inter-platoon headway, platoon size and platoon speed. Platoon behaviors and distribution patterns were identified with respect to these parameters. A platoon-based adaptive algorithm was derived for traffic signal timing. A simulation computer program was developed for analyzing the performance of platoon-based traffic control systems and effects of the key platoon related traffic measurements.

### **Findings**

The following vital variables were identified and measured – the platoon size, the average headway of vehicles within the platoon, the platoon speed, and the inter-arrival time between consecutive platoons. These four variables were utilized as a basis for the development of the platoon distribution and simulation models. The analysis of the Indiana traffic data indicates that the critical headway is 2.5 seconds, which is the vehicle headway value used to judge whether a vehicle belongs to the same platoon as the vehicle immediate preceding it. The equations were derived to determine the optimal locations for platoon detectors. The optimal distance of a platoon detector from the

stop line at an intersection can be computed using the typical values of platoon speed, size, and headway. The equations assure that the produced platoon detector location would enable the detectors to obtain sufficient platoon information without significant variations and also at limited installation and maintenance cost. The distributions of different vehicle platoon measurements were determined through statistical analysis and tests. It was found that the platoons sizes follow the negative exponential distribution, the average headways of vehicles within vehicle platoons have normal distributions, the inter-arrival times between consecutive platoons fit the lognormal

distributions, and the platoon speeds suit the normal distributions.

The platoon-based signal timing logic was established to allow detected vehicle platoons to go through an intersection before the green light for the main road approach is terminated. This logic would minimize traffic delays under the condition that the maximum waiting time for vehicles on the minor road should not be exceeded.

The computer simulation program, TraSin, was developed based on the developed signal timing logic and the distributions of platoon measurements. With this simulation program, the optimal detector locations can be determined and the potential system performance can be evaluated in terms of traffic delay. It provides an analytical tool to study various effects of platoon characteristics under different traffic conditions.

## Implementation

INDOT should work with a manufacturer of traffic control devices to design and make vehicle platoon detectors in accordance with the traffic control algorithm developed in this study. Only a few of the detectors will be needed for experimental uses in selected intersection(s). The new detectors will not be drastically different from the conventional vehicle detectors. It is believed that only some minor modifications are needed to convert the conventional detectors to the vehicle queue detectors.

Some intersections should be selected to evaluate the platoon-based traffic control system. A “before and after” performance evaluation should be conducted in each of the pilot intersections to examine the magnitude of

reductions in traffic delays. Calibration and modification of the platoon-based traffic control mechanism will be made according to the field evaluation.

The simulation program will be used in the field evaluation to determine the appropriate values of various parameters of the traffic control system. The actual and simulated performances will be compared so that the platoon-based traffic control model and the simulation program can be further modified and improved.

Based on the success of the field trial, the application of platoon-based control method would be gradually expanded in the state.

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