EVALUATION OF THE DYNAMIC ARTERIAL-RESPONSIVE TRAFFIC SYSTEM (DARTS)

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A means for coordinating the timing of traffic-actuated signal controllers at intersections along an arterial route is needed so that progressive movement can be provided when justified, but so that normal functioning of the local controller will not be affected during those periods of time when progression for arterial traffic is not of primary importance. A practical technique for accomplishing this has been developed by Harvey J. Beierle in District 15 (San Antonio) of the Texas State Department of Highways and Public Transportation. An auxiliary solid-state electronic timing and switching unit, called DARTS for *D*ynamic *A*rterial-*R*esponsive *T*raffic *S*ystem, is connected to any modern (NEMA Standards) actuated signal controller and to a set of loop detectors near the intersection to provide timely information about the location of traffic platoons and the anticipated arrival time of the platoons at each intersection. The DARTS hardware unit, which is commercially available, is designed for mounting in the local intersection controller cabinet. Interconnection between a pair of intersections for unidirectional progression requires only a single two-conductor cable to transmit switch-closure information from the upstream intersection where a traffic platoon forms to the downstream intersection where the DARTS unit is located, but multi-conductor cable (6 to 12 pairs) is normally utilized for telephone communication and for convenience of installation when bidirectional DARTS units are used.

DARTS Functions

Progression for a platoon of vehicles on the artery is achieved by anticipating the arrival of the lead vehicle and sending a series of commands to the local actuated controller which causes the artery green indication to begin at a selected time after the beginning of artery green at the upstream intersection from which the platoon departed. Once started, the artery green indication is extended in the normal way by the actuated controller until an excessive gap occurs in artery traffic or maximum extension is reached.

The DARTS unit at an intersection performs three basic functions: (1) identifies the presence of a platoon of vehicles on the artery and monitors the green signal indication for the departing platoon; (2) receives information about the departure of a platoon from an upstream intersection and sends a series of appropriately timed force-off, phase-omit, and call signals to the local actuated controller to effect an artery green when the platoon arrives; and (3) monitors traffic demand on signal phases which conflict with artery progression and inhibits DARTS commands for progression if the demand on these conflicting phases exceeds a selected level. DARTS uses a series of strategically-located loop detectors to provide information about the presence of vehicles on the intersection approaches, and several timers to regulate the generation of commands to the controller. Figure 1 illustrates the functional relationship of vehicle detectors, DARTS functions, and the actuated signal controller utilized in a second-generation DARTS design. A specification for a more flexible unit prepared by the Texas State Department of Highways and Public Transportation is included as Appendix A in Research Report 243-1F.

Evaluation

Field studies of traffic behavior through second-generation DARTS units installed at four signalized intersections along a 1.56-mile section of Bandera Road in San Antonio were conducted for approximately three hours on each of three Wednesday afternoons during the heavy outbound traffic period in November 1978. Volume and stopped-time delay were observed by 14 persons stationed at the intersections and recorded at 1-second intervals on special tape recorders along with information about signal indications and time of day. A test car driven by a Texas State Department of Highways and Public Transportation employee made 6 or 7 round trips through the section each Wednesday to measure speed and number of stops. Three traffic control conditions were studied: (1) all DARTS units OFF (normal full-actuated control at each intersection), (2) DARTS units providing progression in outbound direction only ON, and (3) DARTS units providing both inbound and outbound progression ON.

Traffic volumes through the intersections (approximately 8,000 vph total) were very consistent during the three study periods, with outbound volumes being about twice inbound. Cross-street and left-turning volumes were also quite consistent.

Stopped-time delay data indicated that DARTS had little effect on the total stopped-time delay or on the average stopped-time delay per vehicle on the artery. A hung detector on a left-turn phase caused additional delay to outbound traffic entering the system (Wurzbach) on one day, but this did not affect the overall performance of the system. Delay to cross-street traffic was slightly higher, but not excessive, when DARTS was providing platoon progression on the artery as compared to no DARTS control. The system studied included time-waiting monitors on the cross street but did not have queue detectors.

DARTS has no pronounced effect on the percentage of vehicles required to stop on the artery. Variation in this measure of effectiveness at any given intersection for the

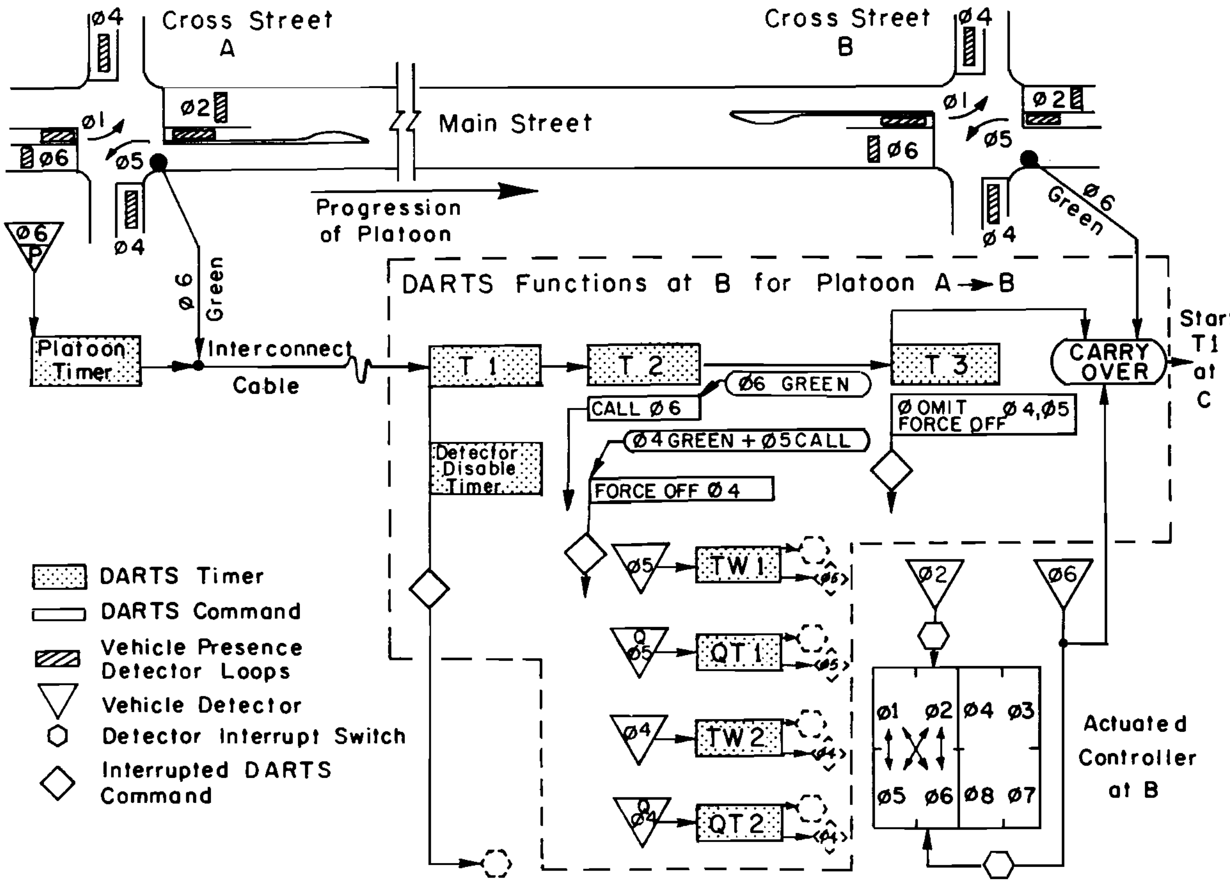

Fig 1. Functional relationship of vehicle detectors, DARTS components, and actuated signal controller.

three conditions studied was generally less than about 5 percent.

Data concerning the number of stops made by a test car were analyzed with a Chi-square statistical test. This indicated that the observed differences in the number of stops would be epxected due to chance alone 90 out of 100 times; therefore, DARTS had no significant effect on the number of stops for traffic on Bandera Road.

Average speed for outbound traffic through the system as determined from tachograph runs by the test car was about 3 to 5 mph higher when the outbound DARTS units were on than for the other conditions studied. Variations in the speed for individual runs under a given control condition ranged up to about 15 mph.

The version of DARTS that was evaluated in this study was a second-generation system, and not much experience had been gained in setting the various timers. Analysis of timing requirements and interactions indicates that these settings are quite critical. Suggestions for timing are given in the full report. Potential for the system as an inexpensive means of providing coordination for a series of actuated controllers is considerable, and further application is encouraged.

Postscript

In a postscript to the report, references to two DARTS installations that were completed and evaluated in 1981-82 by the Texas State Department of Highways and Public Transportation are cited. Dramatic improvements in traffic performance are attributed to DARTS in both situations.

KEY WORDS: DARTS, dynamic arterial-responsive traffic system, coordination, platoon progression, signal timing, full-actuated controller, traffic signals.

The research reported here was conducted for the Texas State Department of Highways and Public Transportation in cooperation with the U.S. Department of Transportation Federal Highway Administration.

The full text of Research Report 243-1F can be obtained from Mr. Phillip L. Wilson, State Transportation Planning Engineer; Transportation Planning Division, File D-10R; State Department of Highways and Public Transportation; P. O. Box 5051; Austin, Texas 78763.