

# JOINT TRANSPORTATION RESEARCH PROGRAM

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## Evaluation of Alternative Intersections and Interchanges

### *Volume II—Diverging Diamond Interchange Signal Timing*

#### Introduction

Diverging diamond interchanges (DDIs) have been growing in usage over the past few years and have gained considerable attention and interest. The advantage of the DDI over a conventional diamond interchange is that DDIs eliminate the need for left turn phases at the two intersections of the diamond, while occupying roughly the same geometric footprint as the conventional diamond. At the beginning of this project, no DDIs had yet been constructed in Indiana, and there was a need to evaluate methods of signal timing for them. Also, at the beginning of this project there had not yet been any studies nationally on coordinating DDIs with neighboring intersections along an arterial. There is still relatively little guidance on phase configuration for DDIs, especially with pedestrians. This project report includes results from a field study of an existing DDI in Utah, a second field study of Indiana's first DDI in Fort Wayne (which is the first field study of optimizing signal offsets in a corridor including a DDI), a simulation comparison of DDI signal timing strategies, and guidelines for DDI phasing with pedestrians (including both interior and exterior pedestrian paths).

#### Findings

The Salt Lake City field study investigated operations at SR 201 and Bangerter Highway. The study looked at offset optimization within the DDI, as well as two alternative signal timing options, and demonstrated the option of prioritizing alternative movements, validated the prediction model based on high resolution data, and showed the range of possible timing options. Alternative

“two-phase” and “three-phase” schemes were examined. It was found that the three-phase scheme permitted the development of a signal timing plan that could accommodate two platoons at a downstream intersection, whereas the two-phase scheme forced a choice between either of those two platoons. Implementation of the three-phase operation increased the percentage on green from 53% to 92%.

The Fort Wayne study is the first field study to examine offset optimization in a corridor incorporating a DDI. The study examined a five-intersection system around the interchange of SR 1 and I-69 in Fort Wayne, Indiana. An existing offset optimization methodology was applied to the DDI, incorporating a method for extracting the ring displacement parameter from the suggested offset adjustments. Evaluation of the timing was done using a network of Bluetooth vehicle sensors that considered not only the arterial through movements, but also origin-destination paths leading to and coming from the freeway. An estimation of user costs related to the observed travel times and their reliability showed an annualized benefit of \$564,000. Full details are provided in the reprint included in Appendix B to the report.

The instant report includes a discussion of practical issues related to DDI signal timing. The clearance phase requirements, and how to implement these in different controller types, are discussed in detail. Guidelines for signal phasing and several draft template timing plan designs have been prepared for a variety of circumstances, including both inside and outside pedestrian crossings. Finally, software modeling for optimizing timing plans are discussed.

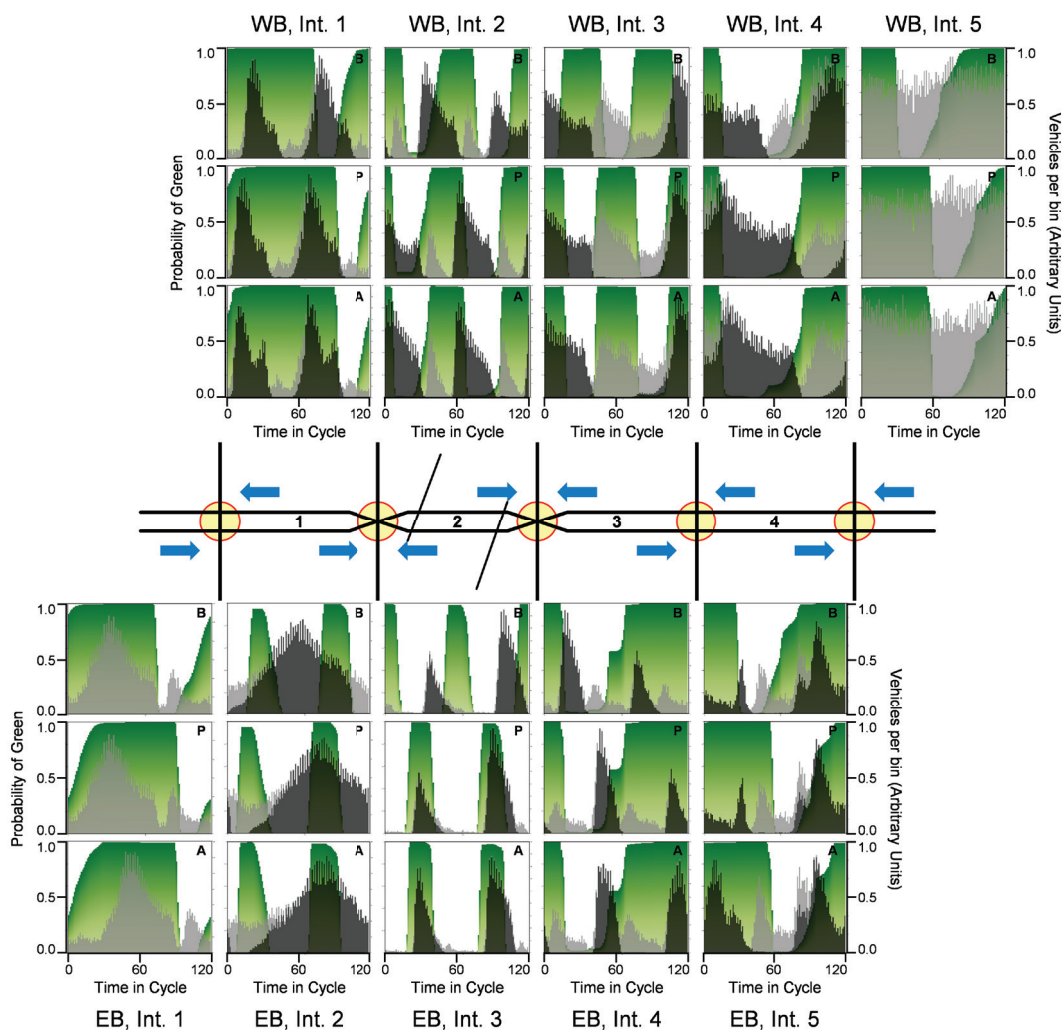
Three strategies for cycle length selection have been identified and compared with one other using a VISSIM

simulation of a DDI with two neighboring intersections under six different traffic scenarios. The study outcomes agree with the field comparison of two- and three-phase operations in Utah, in that three-phase operations improve coordination within an interchange. However, the study went further and examined overall corridor operations. When comparing overall interchange and corridor operations, a half-cycling strategy yielded the lowest user cost and the lowest average delay for most movements (although three-phase does reduce delays on the movements exiting the DDI). From this outcome, it is recommended to use a half-cycling strategy where

possible. This is the current strategy used at the Fort Wayne interchange.

## Recommended Citation for Report

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Prediction of conditions after offset and ring displacement adjustments for single-controller operation. Results are shown for the midday timing plan.

