Extending Link Pivot Offset Optimization to Arterials With Single Controller Diverging Diamond Interchange

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OPTIMIZATION METHODOLOGY DETAILS

Performance Measures for Arrival Profiles

- Actual Vehicle Arrivals
  - The trajectory view contains all the relevant information
  - Arrival times measured by a setback detector
  - Phase times measured by the local controller

- Combined Link
  - Combined Arrival
  - Combined Departure

Distribution

This decouples the two phases measured by the local controller.

Purdue Coordination Diagram

- Originally described by Day et al. (2009), DOI: 10.3141/2192-04
- Shows individual vehicle arrivals in relation to the duration of green
- Visualizes arrival characteristics for various times of day in a single graphical representation

Cyclic Flow Profile

- Introduced in the 1960s as core component of TRANSYT
- Shows average cyclic distribution over a time period
- Useful for optimization

Link Pivot Algorithm for a Simple Arterial Corridor

- Originally described by Day and Bullock (2011), DOI: 10.3141/2259-04
- Based on “Combination Method” developed in the 1960s
- Start from one intersection and moves to other end of the system
- Each intersection offset is optimized to achieve best performance for two directions on the next link
- Previously optimized link flows are preserved by adding new adjustments to all of the previously optimized intersections

Application to Single-Controller Diamond

a) Existing Offsets
   - Offsets are defined by relation to the cyclic reference points
   - Ring displacement (Δ) determines the effective offset of the sub-intersection within the single-controller diamond

b) Adjustment to Diamond Controller
   - This adjustment (Δ) moves the green bands for both intersections within the single-controller diamond
   - Ring displacement remains the same (R1 = R2), but the effective offset of Int. 3 is now different

c) Counter-Adjustment to “Undo” the Previous Step
   - To independently adjust the two intersections within the single-controller diamond, we can apply the conceptual adjustment to undo the previous step
   - This adjustment (−Δ) is applied to the ring displacement, and restores the effective offset of Int. 3 to its original state

d) Independent Adjustment of the Offset at Int. 3
   - It is now possible to apply a completely independent adjustment (Δ3) to Int. 3
   - This decouples the two intersections within the single-controller diamond, enabling conventional optimization methods to be applied
   - The key formulas are:
     - \( Q_{\text{max}} = (Q_{\text{max}} + R) \mod c \)
     - \( R_{\text{new}} = (R_{\text{old}} - \Delta_{\text{old}} + \Delta_{\text{new}}) \mod C \)
     - \( Q_{\text{new}} = (Q_{\text{old}} + \Delta) \mod C \)
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BEFORE/AFTE COMPARISON OF VEHICLE ARRIVALS

CHANGE IN ANNUALIZED USER COSTS

RESULTS

- Existing offset optimization methodology was applied to single controller diamond with DDI
- Significant improvements in Percent on Green within the DDI and elsewhere in the arterial corridor
- Net annualized user benefit of $563,841
  - AM Peak saw net degradation, with marginal improvements in the dominant arterial route, at the cost of worsened performance on other routes
  - Midday and PM Peak both mostly improvements across most routes
- The methodology could be rather easily extended to other single-controller interchange types