Evaluating the Impacts of Start-Up and Clearance Behaviors in a Signalized Network: A Network Fundamental Diagram Approach

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Problem Statement

Numerical simulations have shown that the network fundamental diagram (NFD) of a signalized network is significantly affected by the green ratio, and an analytical approximation of the NFD has been derived from the link transmission model. However, the consistency between these approaches has not been established, and the impacts of other factors are still unrevealed.

Project Objective

In this paper, we evaluate the impacts of start-up and clearance behaviors in a signalized network from a network fundamental diagram approach. Microscopic simulations based on Newell's car-following model are used for testing the bounded acceleration (start-up) and aggressiveness (clearance) effects on the shape of the NFD in a signalized ring road.

Findings

- NFD obtained from the microscopic simulations is shown to be consistent with theoretical results from the link transmission model, when the acceleration is unbounded, and vehicles have the most aggressive clearance behaviors.
- Both bounded acceleration at the start-up stage and different aggressiveness at the clearance stage lead to distinct network capacities and fundamental diagrams.
- These behaviors lead to start-up and clearance lost times of several seconds; and these lost times are additive.
- The start-up lost time can be reduced with larger acceleration bounds.
- The clearance lost time can be reduced with more aggressive behaviors.
- Further studies are needed to examine the impacts on start-up and clearance behaviors of connected and autonomous vehicles as well as green-driving strategies.

Key Takeaways

- The smaller acceleration bounds, the larger start-up lost time.
- The more timid clearance behaviors, the larger clearance lost time.
- The start-up and clearance lost times are additive.
- The start-up and clearance behaviors can substantially impact the shape of the network fundamental diagram.