

## ABSTRACT

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Dynamic Traffic Assignment (DTA) has been extensively explored by the research community since 1970s. There are various studies improving many aspects of analytical and simulation-based DTA models. In the network analysis part, there is still a need for new analytical DTA formulations and the efficient algorithms that can solve general network problems while guaranteeing traffic realism. This dissertation develops a path-based cell transmission model (CTM) which can be embedded as the dynamic network loading (DNL) model for many DTA problems. This generalized spatial queue DNL captures link spill-back effects and shockwave propagation. Two fundamental DTA problems, i.e. Dynamic User Equilibrium (DUE) and the Dynamic System Optimal (DSO), are rigorously developed. We first propose a simultaneous route and departure time choice DUE for the networks of single OD and parallel paths. This model accounts for heterogeneous users and elastic demand and it can be solved exactly using complementarity solvers. Then a DUE formulation for general networks is developed. An heuristic algorithm based on projection method is proposed to solve the medium-sized network problems. For the DSO problems, we first study the holding-back issue in the CTM based DSO models before developing a route choice DSO model for general networks based on the proposed DNL. We then extend the formulation for the simultaneous route and departure time choice DSO problems for general networks. The path marginal cost is computed accurately using a proposed algorithm. Then the departure rate is equilibrated based on the path marginal cost to obtain DSO solution by using projection algorithm. The sec-

ond part of the dissertation studies strategic transportation problems and focuses on network inefficiency and mechanism design. The network inefficiency represents the gap in network performance between DUE and DSO solutions. By observing the trend of the network inefficiency for different road networks and with different traffic demand, we understand how much the network performance can be improved based on mechanism designs such as congestion pricing, signal control and network design. Then several mechanism design methods are studied to bridge the gap between DUE and DSO. We develop a combined dynamic user equilibrium and traffic signal control model to gain an optimal network performance while assuring the equilibrium behavior of road users. The congestion pricing schemes are proposed based on the solutions from the DUE and DSO problems. Finally, we develop a continuous network design model based on a limited budget to optimize the traffic performance. Comprehensive numerical experiments are conducted for each formulation and algorithm using various test networks and congestion levels, which validates the benefits of all models proposed in this dissertation.