

Intersection Control: Future

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Outline

1 Introduction

2 Design of ADTL intersection

3 Simulation tests

Publication

Zhengbing He, Liang Zheng, Lili Lu, Wei Guan, **Erasing lane changes from roads: A design of future intersections**, IEEE Transactions on Intelligent Vehicles, 3(2):173-184, 2018

Zhengbing He, **Cooperative driving and a lane change-free road transportation system**, Chapter of IET Book Traffic Information and Control, 2020

20x0

All vehicles can be perfectly self-controlled: the era of fully automated

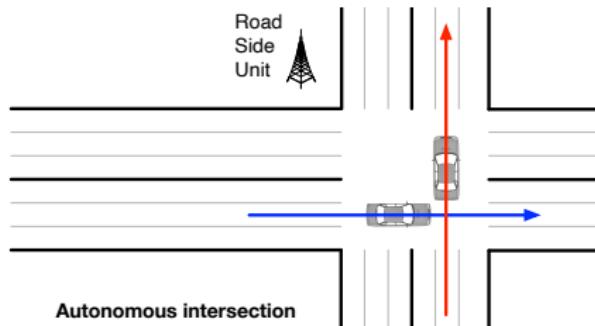


Do we still need traffic lights? NO

20x0

Substitution: Autonomous Intersection

- Vehicles coordinate for the right of way before entering intersection
- Perfectly avoid the conflicts: safely and efficiently



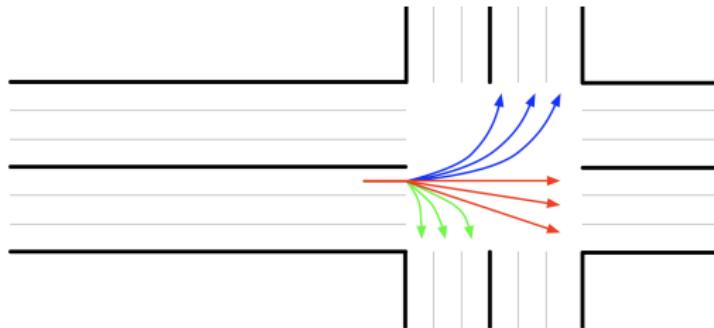
- Video
- Reservation system: make a reservation before entering the intersection

Introduction

Do we still need lane changes? NO

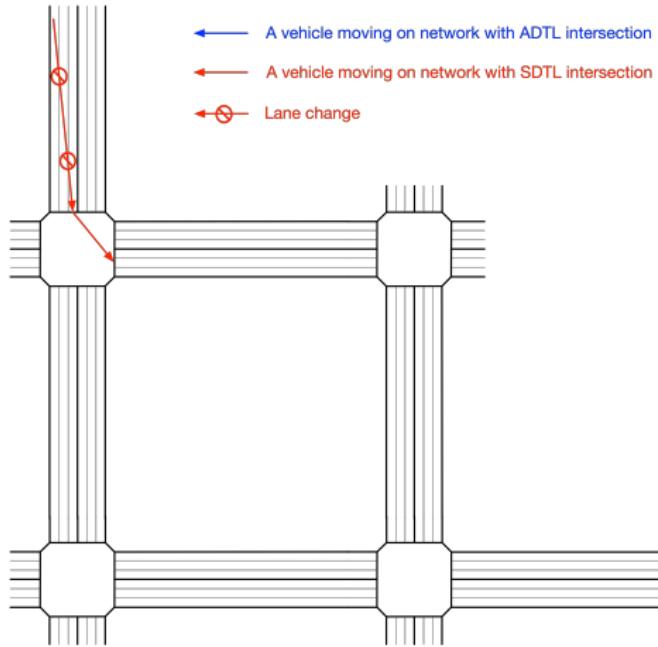
AI with All-Direction Turn Lanes (ADTL)

- Vehicle can enter intersection from any upstream lane, while leave it for any downstream lane



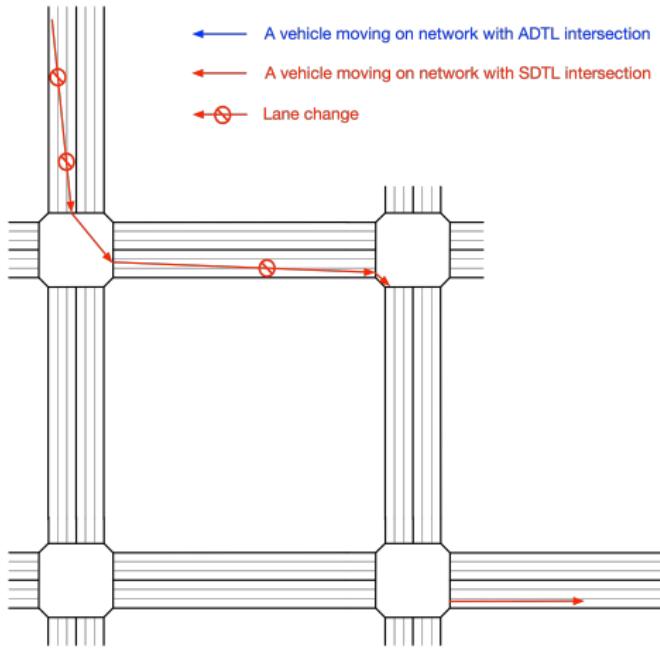
Introduction

specific-direction turn lanes



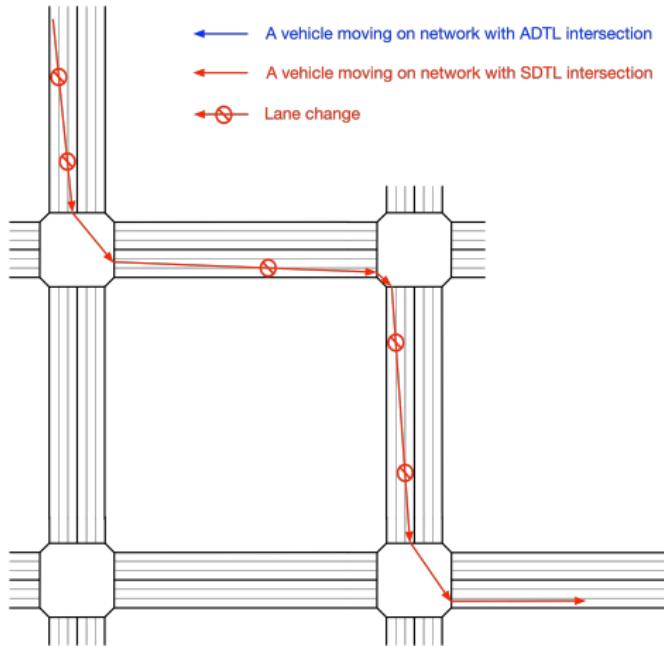
Introduction

specific-direction turn lanes



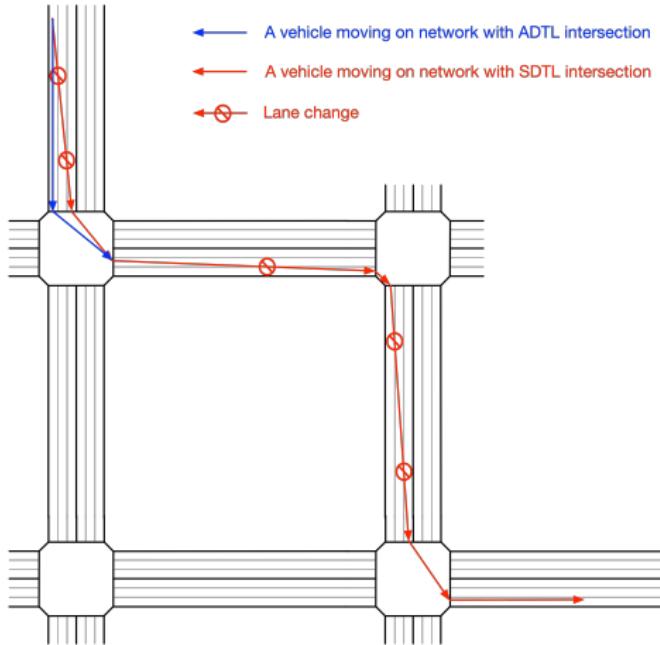
Introduction

specific-direction turn lanes



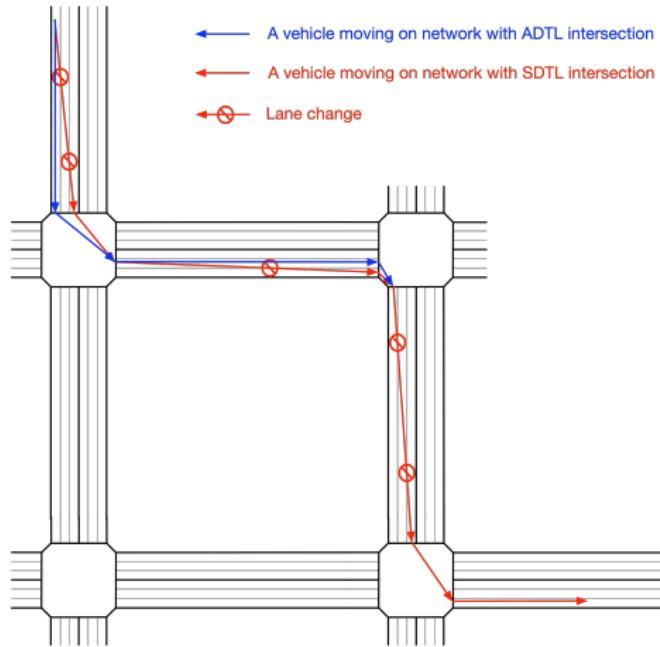
Introduction

all-direction turn lanes



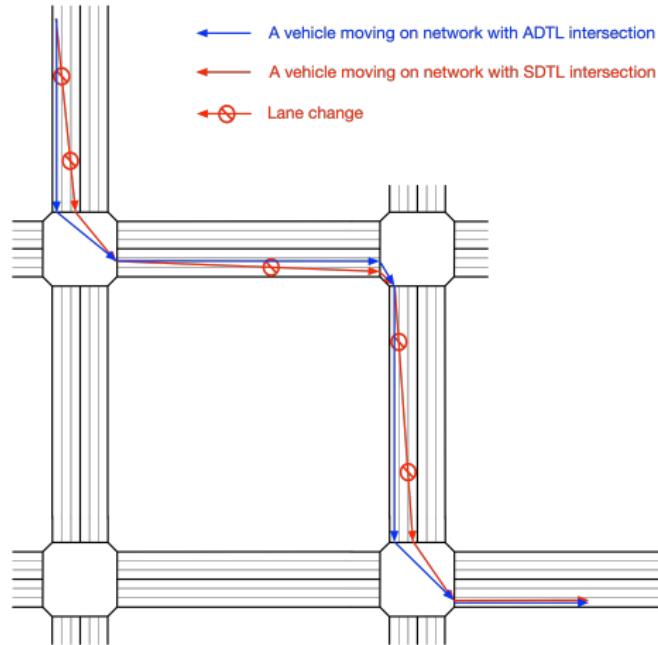
Introduction

all-direction turn lanes



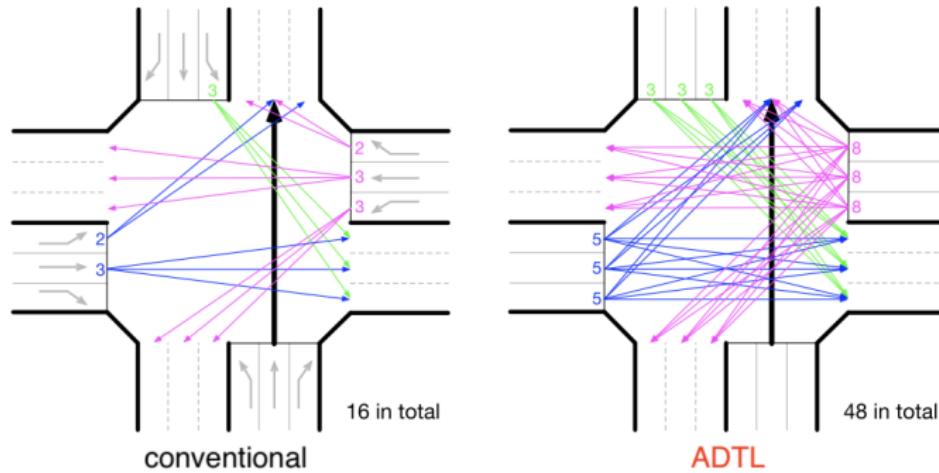
Introduction

all-direction turn lanes



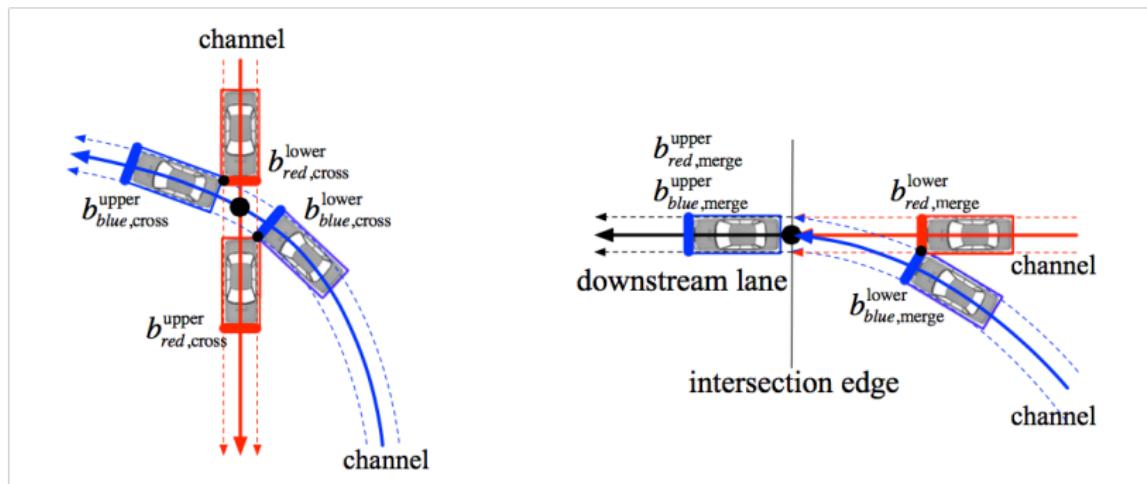
Design of ADTL intersection

More conflicts



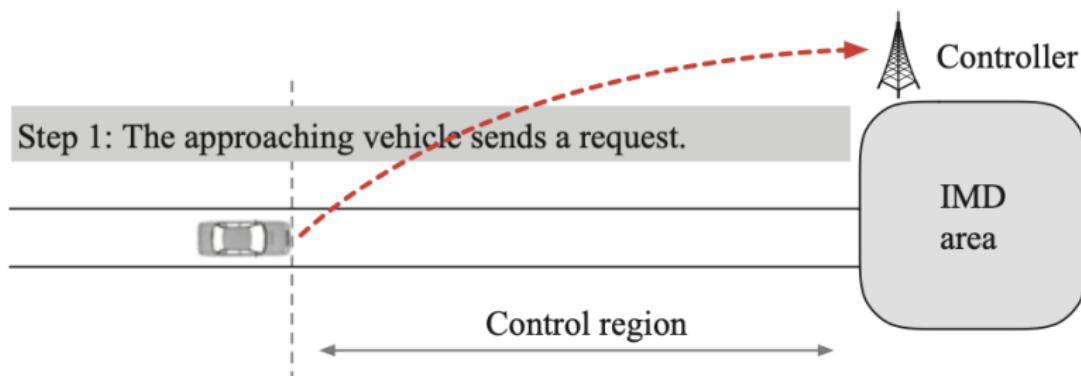
Design of ADTL intersection

Two types of conflicts: Modeling with the consideration of vehicle length



Design of ADTL intersection

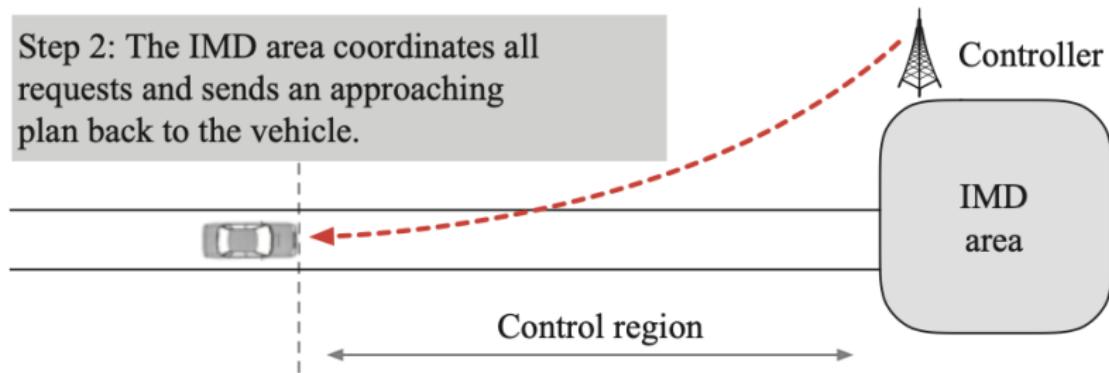
Overall process: Three steps



Design of ADTL intersection

Overall process: Three steps

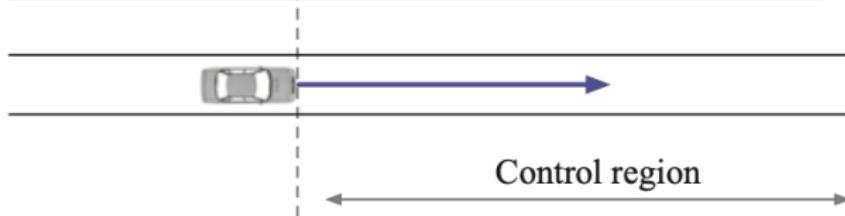
Step 2: The IMD area coordinates all requests and sends an approaching plan back to the vehicle.



Design of ADTL intersection

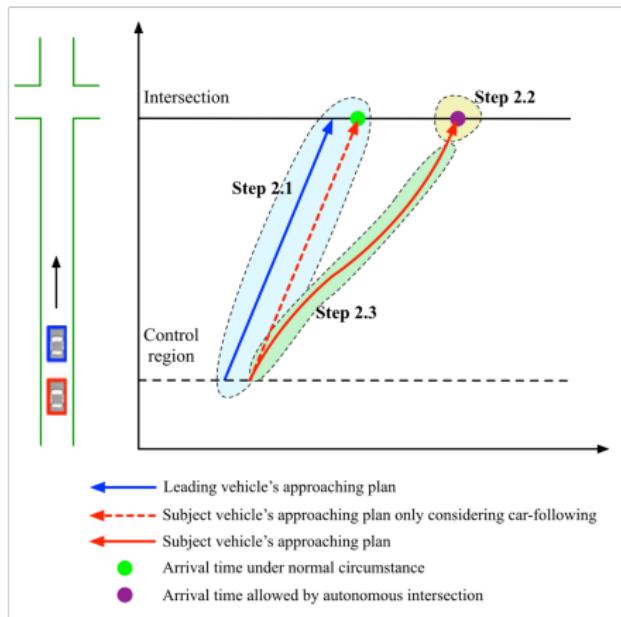
Overall process: Three steps

Step 3: The vehicle approaches the IMD area following the approaching plan.



Design of ADTL intersection

Step 2: Coordinate right of way

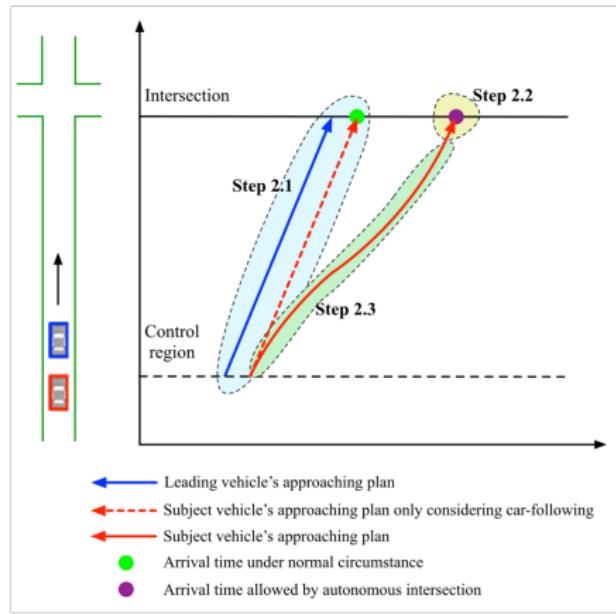


Step 2.1: Estimate the arrival time of the autonomous vehicle under normal circumstance

Since its leading vehicle has sent a request and its approaching plan has been generated by the intersection, the arrival time of this vehicle could be accordingly calculated based on the car-following models employed by the autonomous vehicles.

Design of ADTL intersection

Step 2: Coordinate right of way

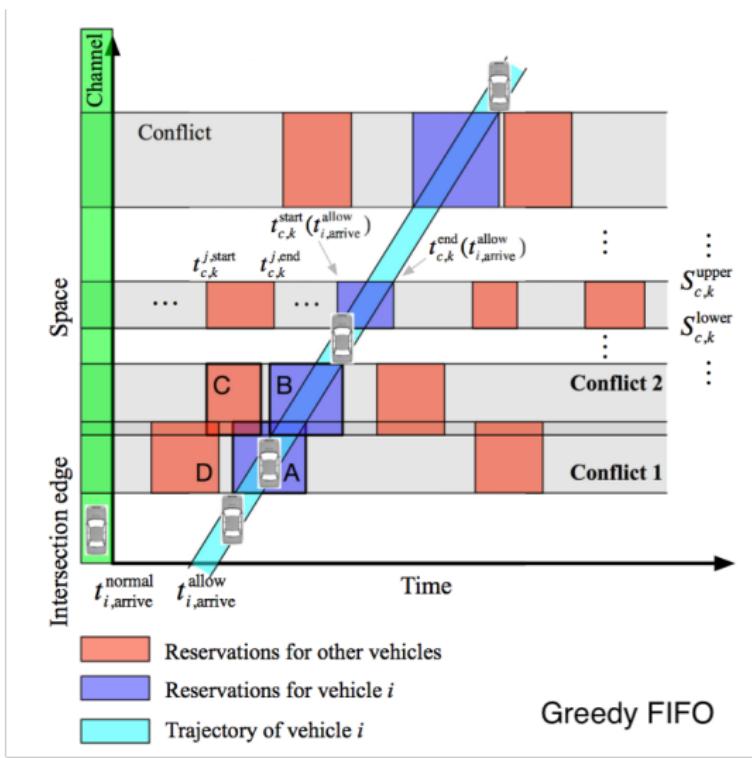


Step 2.2: Calculate the arrival time allowed by the intersection

This step checks whether or not the vehicle will conflict with other approaching vehicles around conflicts, given the time when the vehicle will arrive at the intersection.

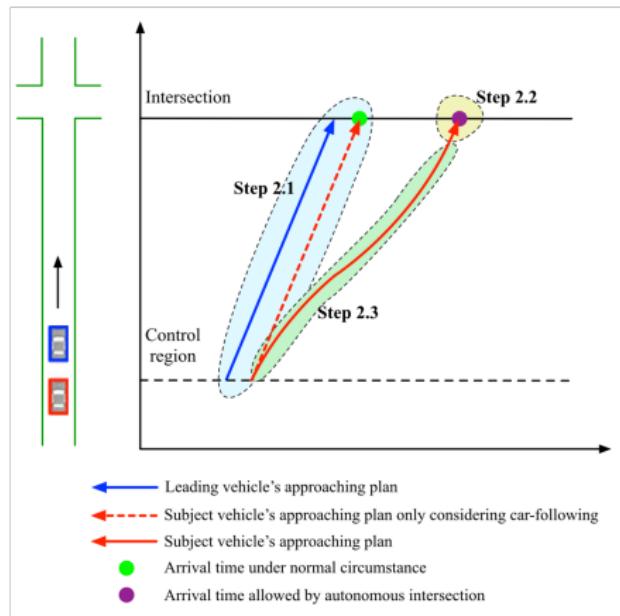
If conflicts will occur, a proper arrival time for the vehicle to avoid the conflict will be calculated as follows.

Design of ADTL intersection



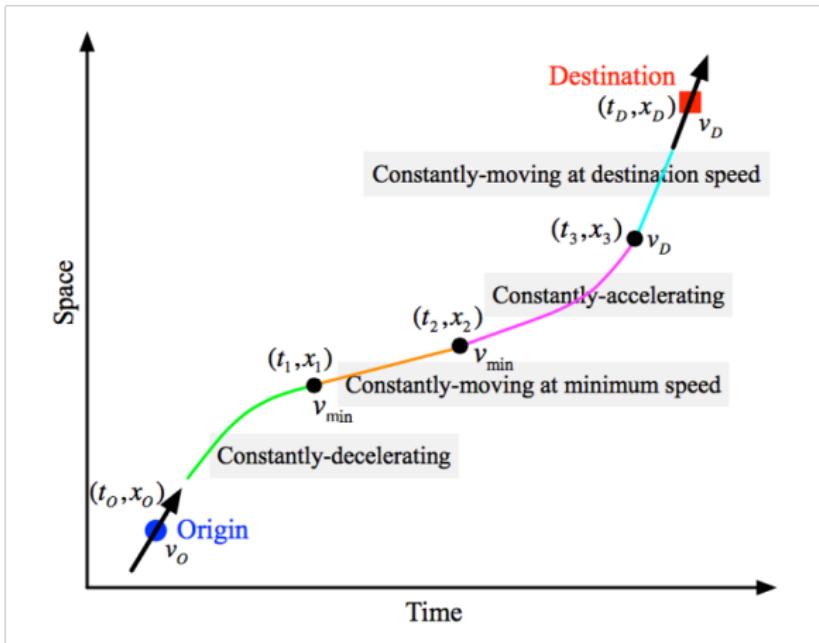
Design of ADTL intersection

Step 2: Coordinate right of way

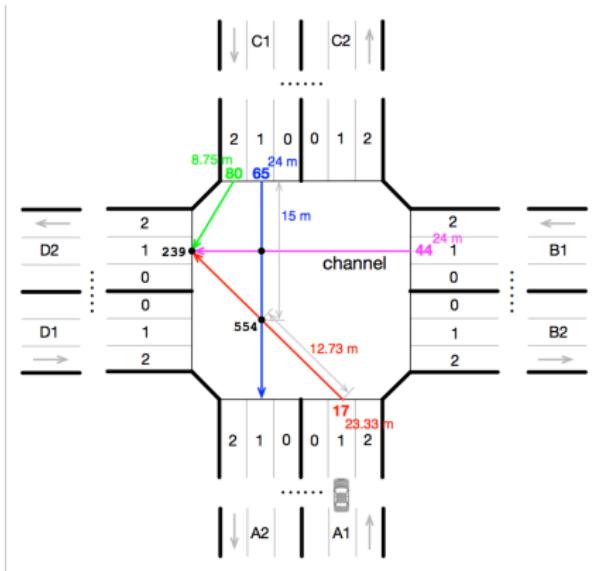


Step 2.3: Generate an approaching plan and send it back to the vehicle

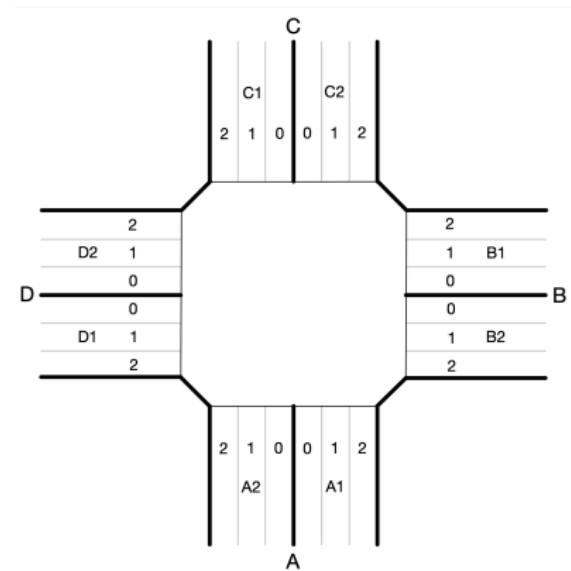
Design of ADTL intersection



Simulation tests

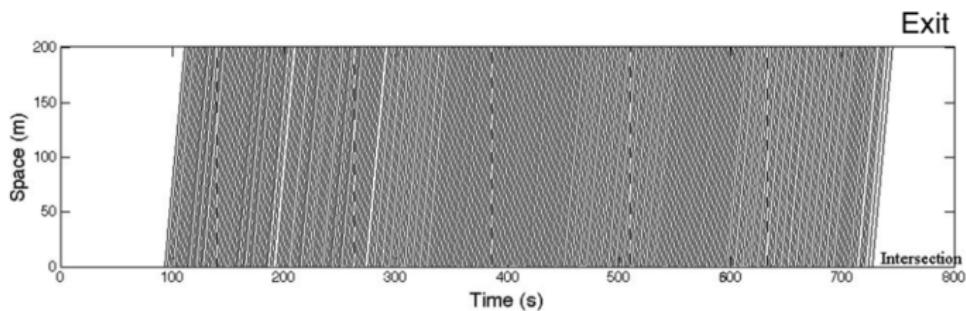
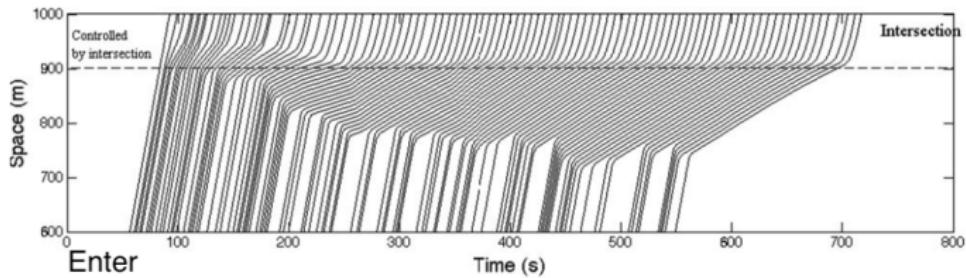


Scenario: Simple

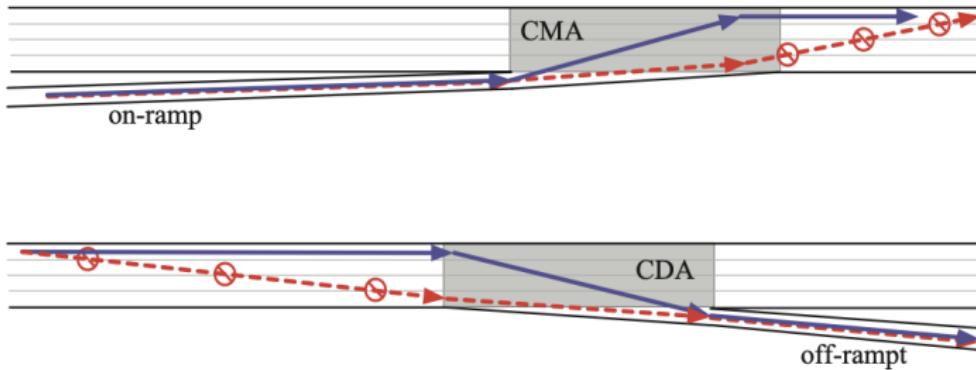


Scenario: Complex

Simulation tests



Extension to Freeway



Videos

Thank you!