Intersection Management with Constraint-Based Reservation System

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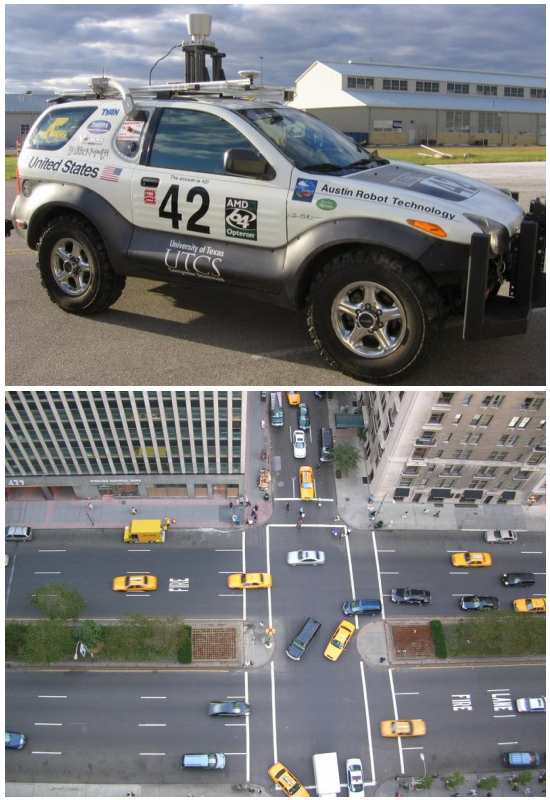
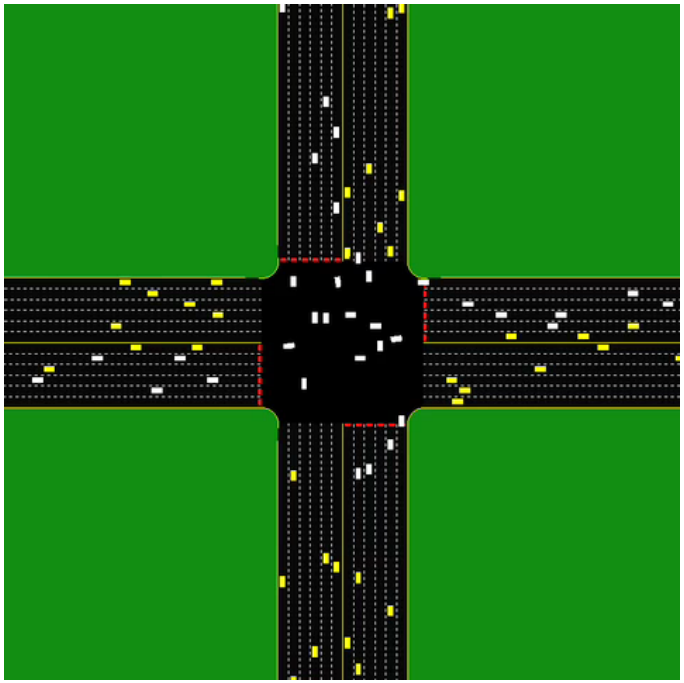
Transportation Infrastructure: Present and Future

- Todays transportation infrastructure is designed for human drivers.
- In the future: Autonomous Traffic Management
  Utilize the capacity of autonomous vehicles to improve traffic in transportation systems.

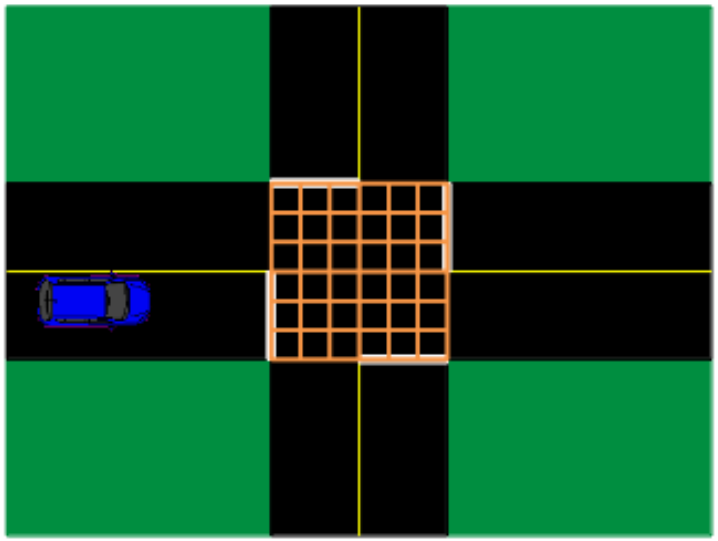


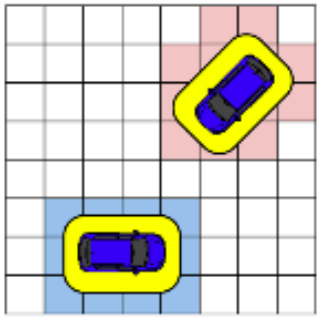
Autonomous Intersection Management



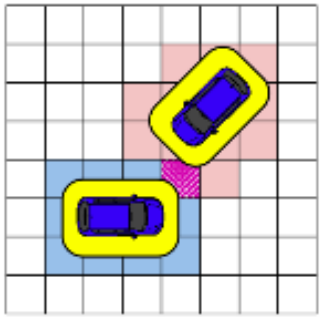
- Dramatically reduce the traffic delay.
- Reduce the overhead of fuel consumption by approximately two thirds.
  Kurt Dresner and Peter Stone. A Multiagent Approach to Autonomous Intersection Management. JAIR 2008.

Grid-Based Collision Detection

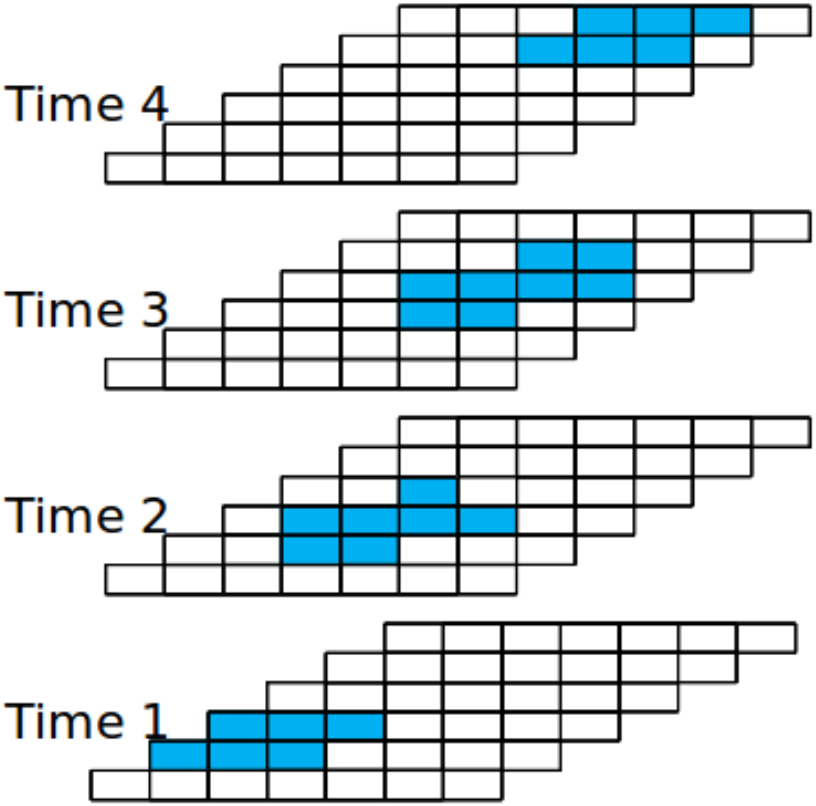




Accept



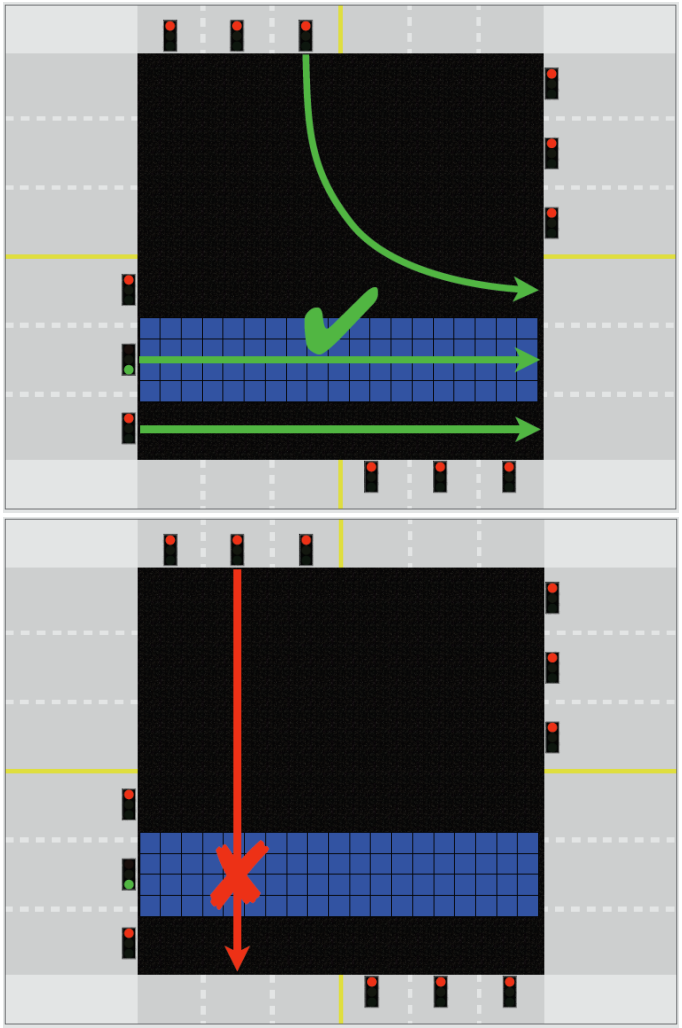
Reject



Evaluation

Sharing the Road with Human Drivers

- AIM is designed for the time when vehicles are autonomous.
- Autonomous vehicles wont displace manual-controlled vehicles in one day. Some people enjoy driving.
- One solution: FCFS-light = First-Come First-Served Policy + Traffic Signals



Definition

semi-autonomous vehicles: vehicles with limited autonomous driving and wireless communication capabilities.

They are able to follow a *limited number* of predictable trajectories at intersections more precisely than human drivers.

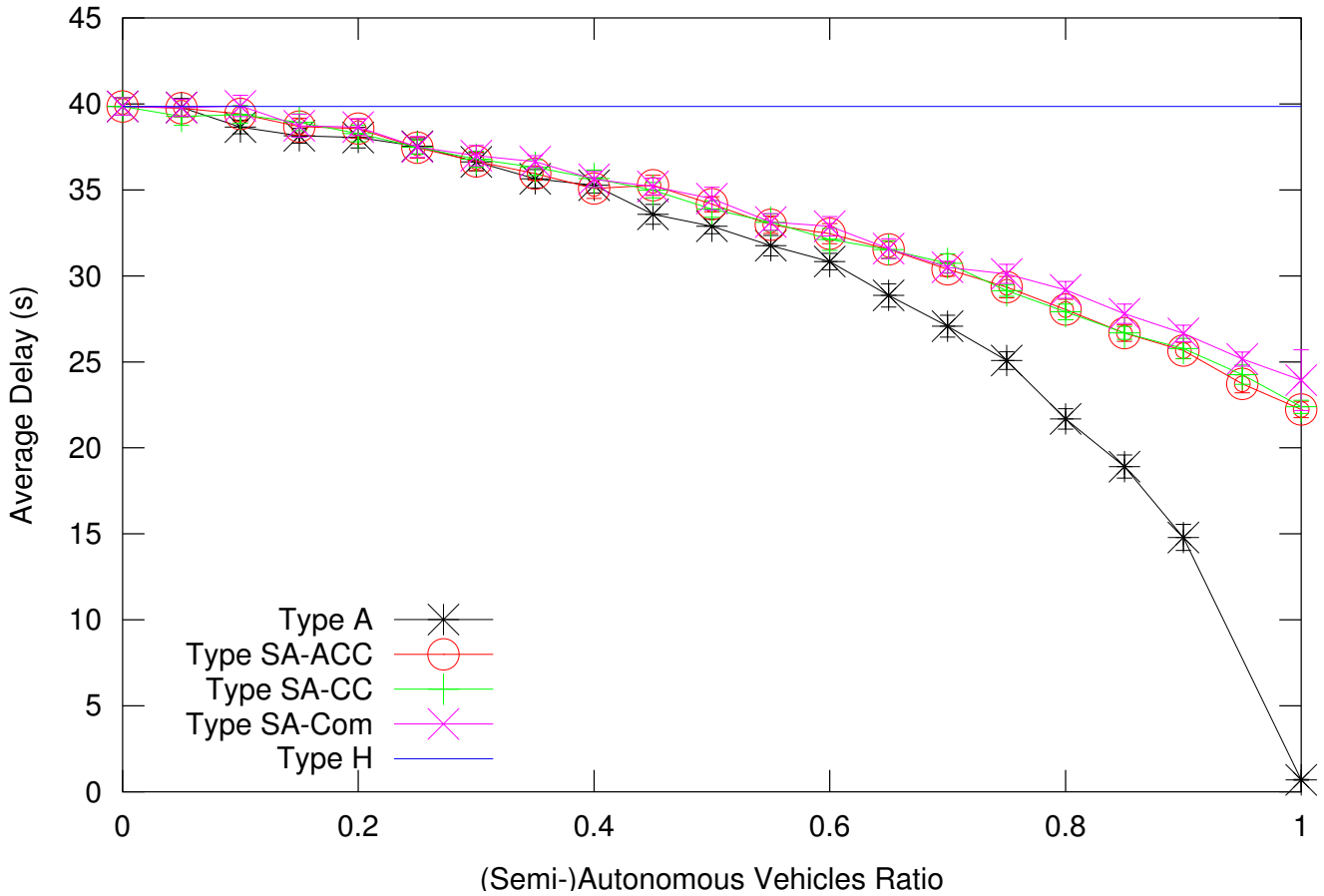
Set of Equipments

- **Communication Device (Com)**: a component in a vehicle's on-board electronic system that enables the vehicle to wirelessly communicate with the transportation infrastructure including the IM.
- **Simple Cruise Control (CC)**: An optional speed control subsystem in vehicles' drivetrain that automatically controls the vehicle speed by taking over the throttle of the vehicles.
- **Adaptive Cruise Control (ACC)**: an advanced cruise control system that automatically adjusts the speed of a vehicle in order to maintain a certain distance from vehicles ahead.

Type of Semi-Autonomous Vehicles

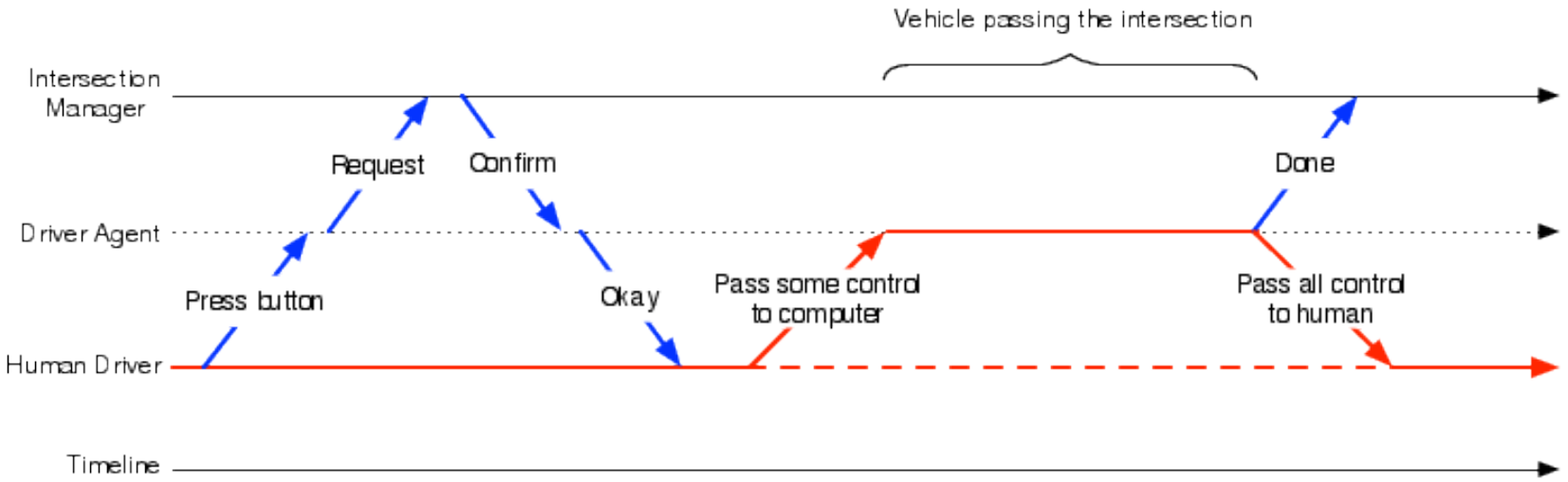
Vehicle Type	Communication Device	Cruise Control	Adaptive Cruise Control
SA-ACC	X	X	X
SA-CC	X	X	
SA-Com	X		

Evaluations



(Semi-)Autonomous vehicles vs. Human-Driven vehicles. Traffic level = 360 vehicles/lane/hour.

Interaction Model



Elements

- **Intention**: The direction in which the vehicle intends to move.
- **Vehicle Type**: The type of vehicle.
- **Entry Condition**: The condition under which the vehicle will enter the intersection.
- **Acceleration Profile List**: The list of possible acceleration schedules from among which the vehicle will choose one to follow during the traversal of the intersection.

Constant-Velocity Request

- Intent $= (l_1 \vee l_2 \vee \ldots \vee l_n)$ in which l_i is a possible lane from which the vehicle exits the intersection;
- Type is the vehicle type;
- Entry $= ((l'_1 \vee l'_2 \vee \ldots \vee l'_n), [t_1,\ t_2], [v_1,\ v_2])$ is the entry statement; and
- AP $= (\langle (t_1, 0) \rangle)$

This is particularly used by Simple Cruise Control.

Whole-Row Request

- Intent $= (l_1 \vee l_2 \vee \ldots \vee l_n)$ l_i is a possible lane from which the vehicle exits the intersection;
- Type is the vehicle type;
- Entry $= ((l'_1 \vee l'_2 \vee \ldots \vee l'_n), [t_1,\ t_2], [v_1,\ v_2])$ is the entry statement; and
- AP is the acceleration profile list.

This is particularly used by Communication Device.

An General Request

In Lisp syntax,

```
(cc-profile (v verror angle)
  (is-auto-speed-control)
  (not is-auto-steering)
  (< velocity (+ v verror))
  (> velocity (- v verror))
  (< steer-angle angle) (> steer-angle -angle))
```

Thank you!

Sources:
http://www.cs.utexas.edu/ pstone/Courses/394Rspring13/resources/index.html

http://www.cs.utexas.edu/ pstone/Courses/343spring12/resources/index.html