Driving Should Be...

- Safer
  - 1.2 million deaths (WHO 1998)
  - 38.8 million injuries (WHO 1998)
- Easier
  - Age limits
  - Disabilities
  - Complicated routes
- More efficient
  - Time: 46 hours
  - Money: $63 billion
  - Fuel: 5.6 billion gallons

Autonomous Vehicles

- Technology exists
  - GPS route planning
  - Adaptive cruise-control
  - Autonomous steering
  - DARPA Grand Challenge

- Many current, near-future models for **individual** cars
  - Mercedes S-Class — intellgient cruise control
  - Lexus LS 460, Prius, BMW — self-parking
  - 2008 Opel Vectra — nearly autonomous!
- What happens when we have a lot of them?
  - Autonomous interactions
  - Still use current control mechanisms?

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One Example Problem: Intersections

- Dangerous
  - 1/3 of all accidents
  - 1/4 of all fatal accidents
- Wasteful
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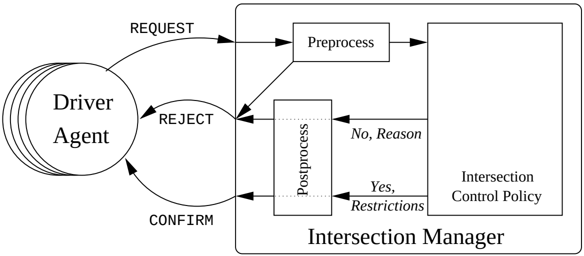
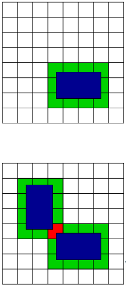
AIM Project

- Autonomous Intersection Management
- Goal: create a scalable, safe, efficient, multiagent systems framework for managing autonomous vehicles at intersections
- Previously proposed a reservation-based, MAS intersection control mechanism
- http://www.cs.utexas.edu/~kdresner/aim

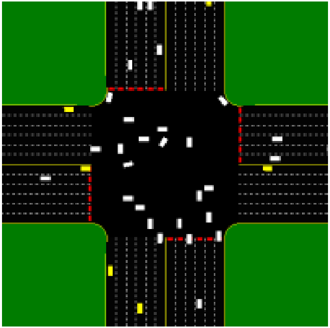
The Reservation Idea

- Driver agents "call ahead" to reserve a region of space-time
- Intersection manager approves or denies based on an intersection control policy
- Vehicles may not enter the intersection without a reservation
  - Like red lights today
- Drivers, intersection manager are **programs**





Videos



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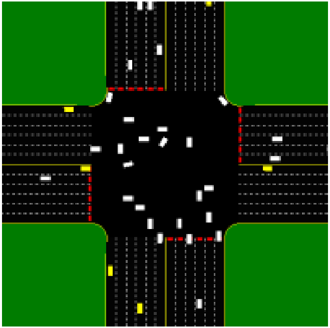
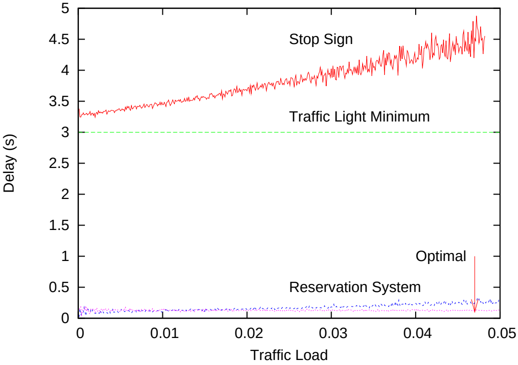


FCFS

- "First Come, First Served"
- Intersection divided into an $n \times n$ grid of reservation tiles (n is the granularity)
- Upon receiving a request, simulates the journey of the vehicle through the intersection
- At each time step of the simulation, determines which tiles are occupied by the vehicle.
- If throughout the simulation, none of those tiles are already reserved, the reservation is granted, otherwise the request is rejected

Initial Results

- 3 lanes
- 250 m square
- Speed limit: 25 m/s
- Granularity 24
- 100x delay reductions!

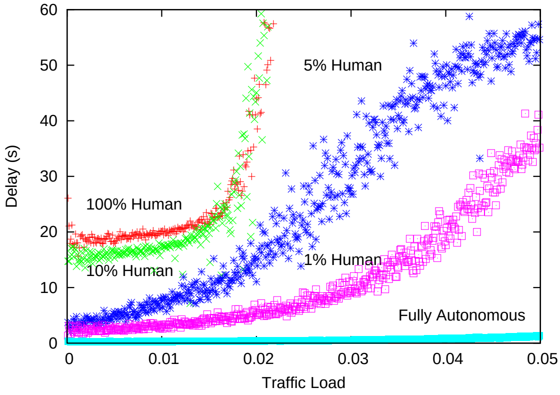


Incorporating Humans

- “Classic” cars
- Smooth transition
- Cyclists and pedestrians

- Traffic lights already deployed
- Drivers understand them
- Push-buttons for pedestrians/cyclists

The Transition



Computer Science Challenges

- Create **intersection control policies**, **driver agents**
- Handle **networks of interesection**
  - Reserve the whole trip from start to end
- Enhancements with **vehicle-to-vehicle communication**
  - Direct negotiation, traffic conditions
  - Knowledge of destinations (e.g. restaurants) with reviews from other passengers!
- Handle vehicles with different **priorities**
  - Ambulances, commuters, joy-riders, ...
- **Market-based** reservations
- **Bus scheduling**, inter-city transportation (**air travel**)

Goal: **Get people where they want to go quickly and safely**

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UTCS

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Eventual Goal

- Transition to full-size autonomous cars