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 — intelligent 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
  - $\frac{1}{3}$ of all accidents
  - $\frac{1}{4}$ of all fatal accidents

- Wasteful

- Inherently complicated
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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

Peter Stone – UT Austin

Autonomous Traffic Management
“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

The graph shows the relationship between traffic load and delay for different scenarios of human presence in the traffic system. The y-axis represents delay in seconds, while the x-axis represents traffic load. The graph includes data points for 100% human, 10% human, 5% human, 1% human, and fully autonomous scenarios.

Peter Stone – UT Austin
Autonomous Traffic Management
Computer Science Challenges

- Create **intersection control policies, driver agents**
  - Handle **networks of intersection**
    - 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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Eventual Goal

- Transition to full-size autonomous cars