

# INTERSECTION CONTROL FOR AUTONOMOUS VEHICLES

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# MOTIVATION

- Current Technology
  - GPS Route Planning
  - Adaptive Cruise Control
  - Autonomous Steering
- Autonomous Vehicles
  - Technologically and Economically feasible in the next 5 to 10 years
  - Mercedes S Class – Intelligent Cruise Control
  - Lexus LS460, BMW – Self Parking
  - 2008 Opel Vectra – Nearly self autonomous

# MULTI-AGENT SYSTEMS

- Computer Drivers
  - More accurately sense their surroundings
  - More precise control
  - No Distraction
- Multi-Agent Systems
  - Principle for construction of complex system of Agents
  - Mechanisms for coordination of independent agents

# INTERSECTIONS

## Dangerous

- 33% of all accidents
- 25% of all fatal accidents



## Inefficient

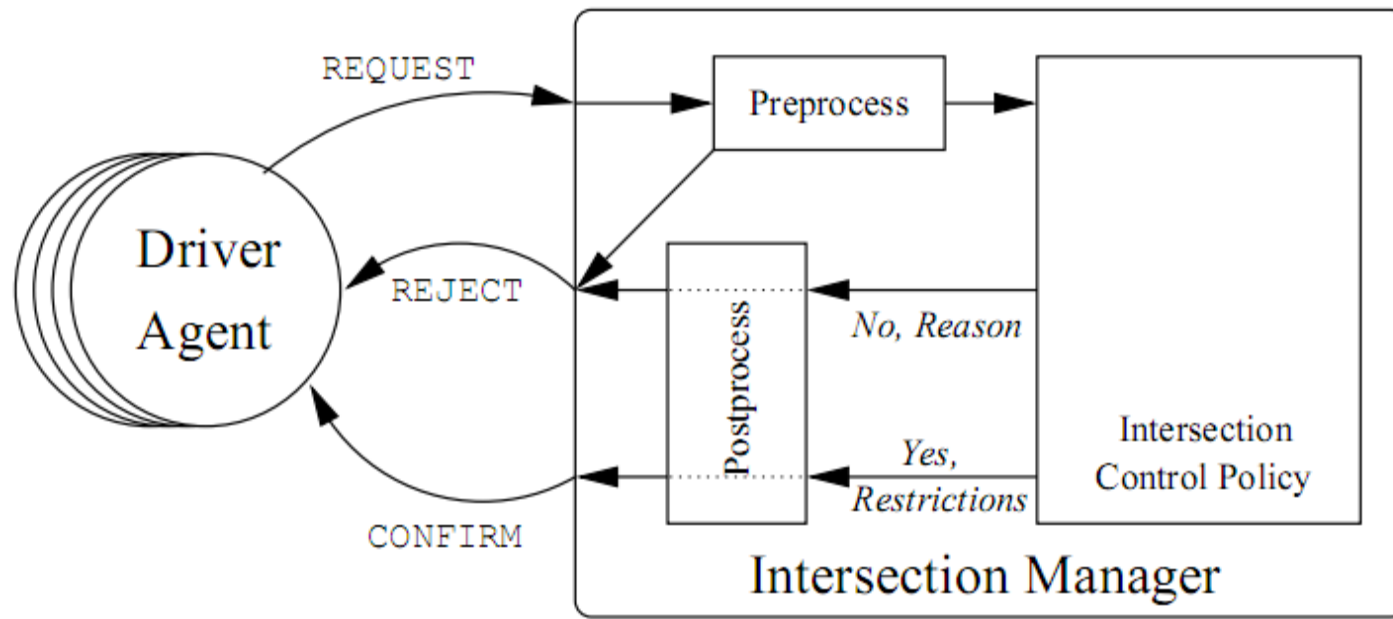
- Increase travel times
- Significantly higher emissions

# QUESTIONS

- What happens when there are lot of autonomous vehicles
  - Opportunity to develop more efficient control mechanisms
- To what extent and how can a multi-agent intersection control mechanism take advantage of the capabilities of autonomous vehicles in order to make automobile travel safer and more efficient?

# RESERVATION IDEA

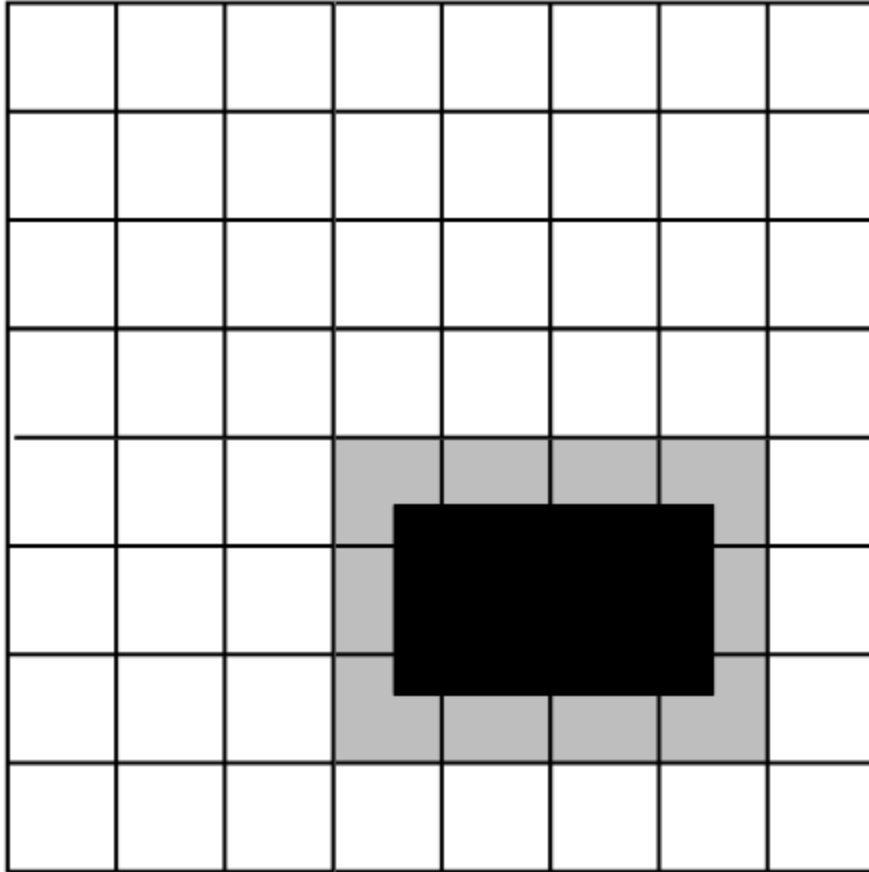
- Driver agents “call ahead” to reserve a region of space-time
- Intersection manager approves or denies based on an intersection control policy
- Vehicles may not enter the intersection without a reservation



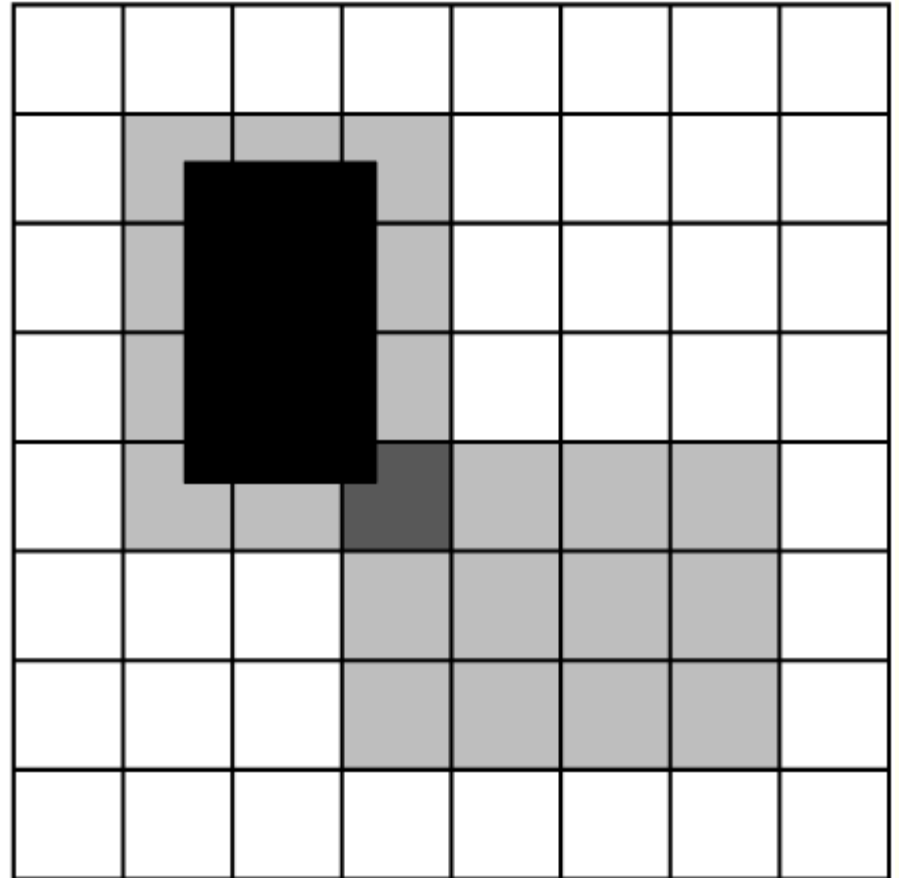
# FCFS Control Policy

- Intersection divided into an  $n \times n$  grid of reservation tiles ( $n$  is the granularity)
- Upon receiving a request, simulates the trajectory 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

# Reservation



SUCCESS



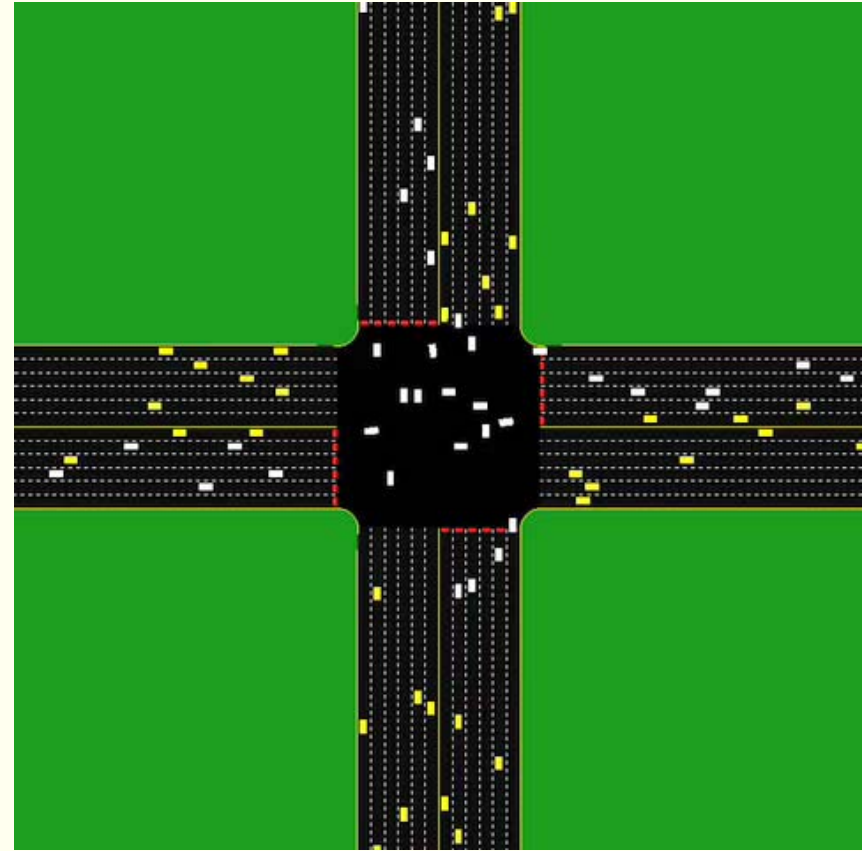
FAILURE

# MODEL FEATURES

- Autonomy
- Low Communication Complexity
- Sensor Model Realism
- Protocol Standardization
- Deadlock Avoidance
- Incremental Deployability
- Safety and Efficiency

# CUSTOM SIMULATOR

- Probabilistically spawns new vehicles
- Provides sensor input to all vehicles
- Allows all driver agents to act
- Updates position of all vehicles
- Removes vehicles that are done



# VEHICLE PRIORITIES



...becomes...



# INCREMENTAL DEPLOYABILITY

- Modeling “Classic Cars”
- Modeling existing infrastructure control logic such as traffic lights
- Realistic Modeling of Driver Behavior
  - Car Following Theory
  - Lane Change Models
- Modeling Networks of Intersections

# CONCLUSIONS

- Autonomous Vehicles can vastly improve current traffic control mechanisms
- Adoption speed will be limited by cost
- The model developed has “realistic” vehicle and sensor deployments
- Simulation results demonstrate significant improvements over current intersections

# QUESTIONS

- Webpage: Autonomous Intersection Management project.

<http://www.cs.utexas.edu/~kdresner/aim/>

