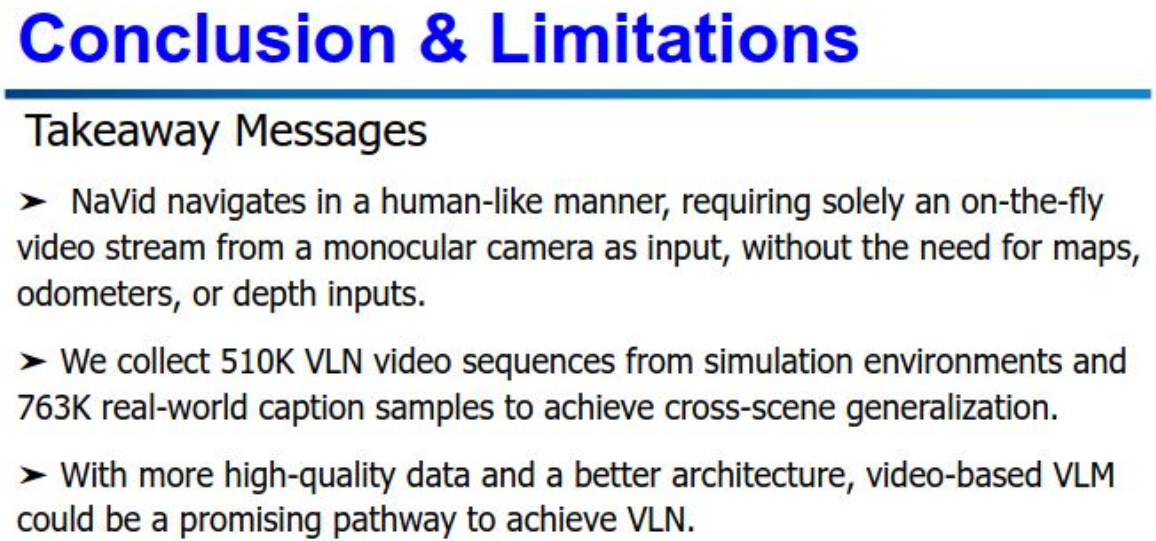
# Intersection Coordination with Priority-Based Search for Autonomous Vehicles

Team 2: Dan Vi Trinh, Alexander Brown

# Review

- NaVid: Video-based VLM Plans the Next Step for Vision-and-Language Navigation (RSS 24)

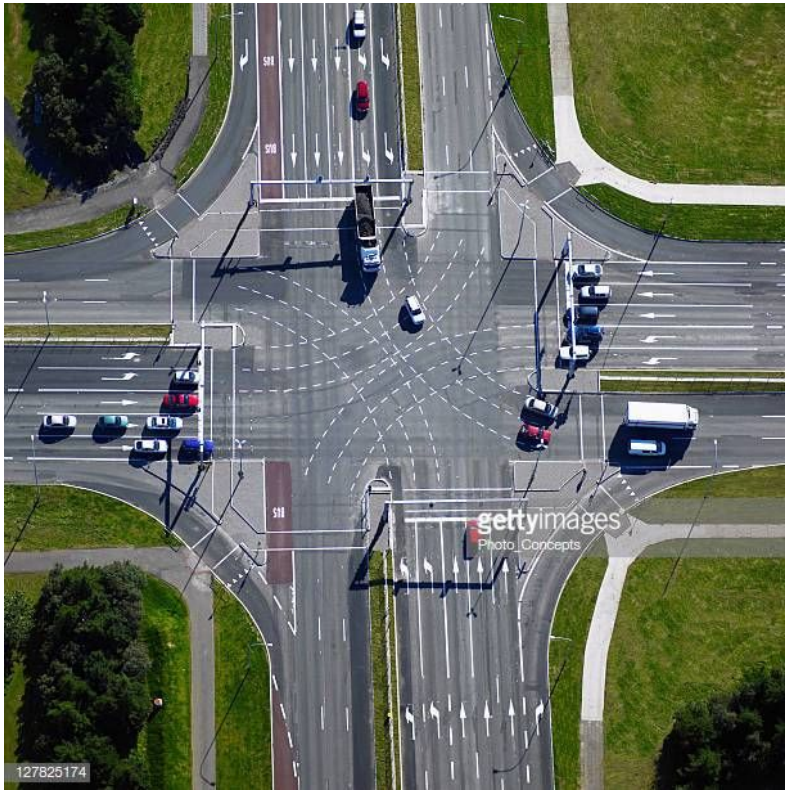


# Overview

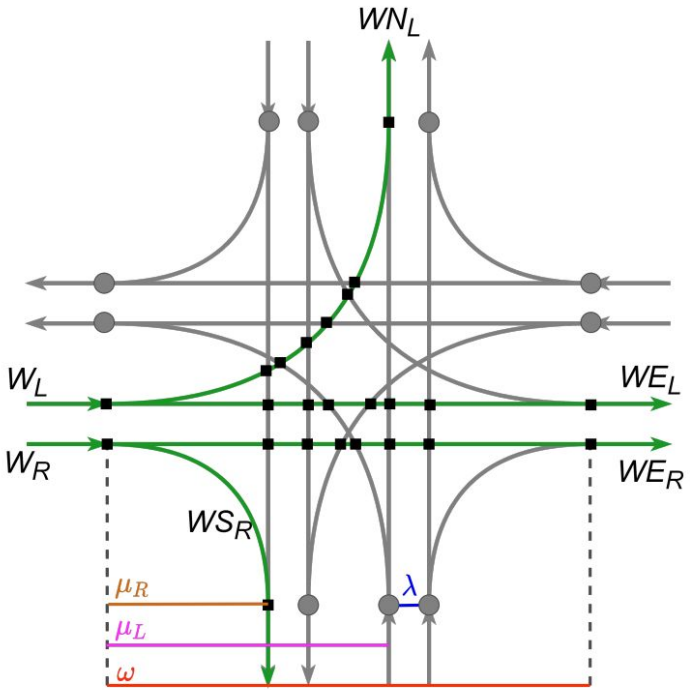
- Motivation
- Problem formulation
- Proposed method
- Evaluation
- Conclusion
- Quiz

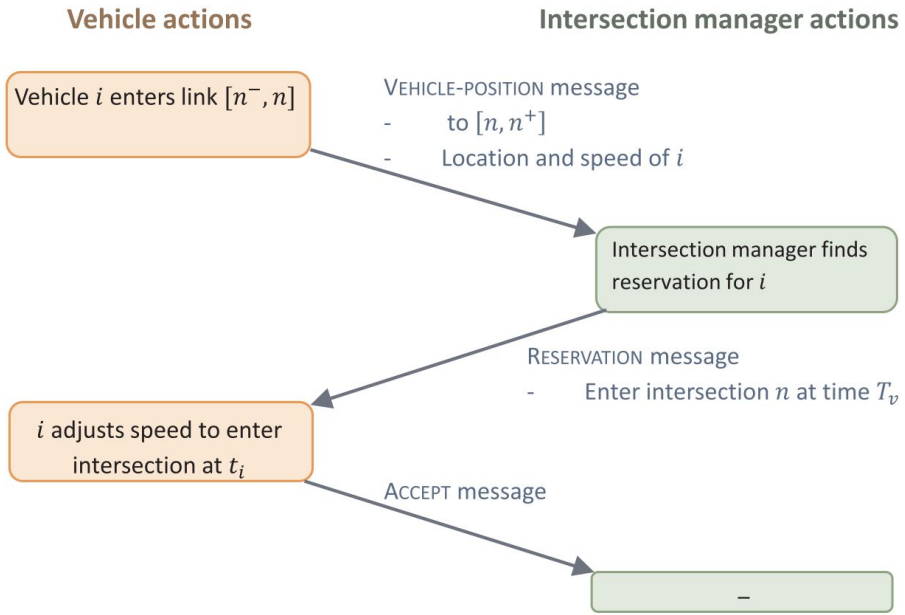
# Motivation

- Intersection coordination in fully autonomous traffic systems
- Eliminate traffic lights
- Existing methods are slow
- Existing efficient MAPF algorithms



# Problem formulation



# PBS-SIPP-LP

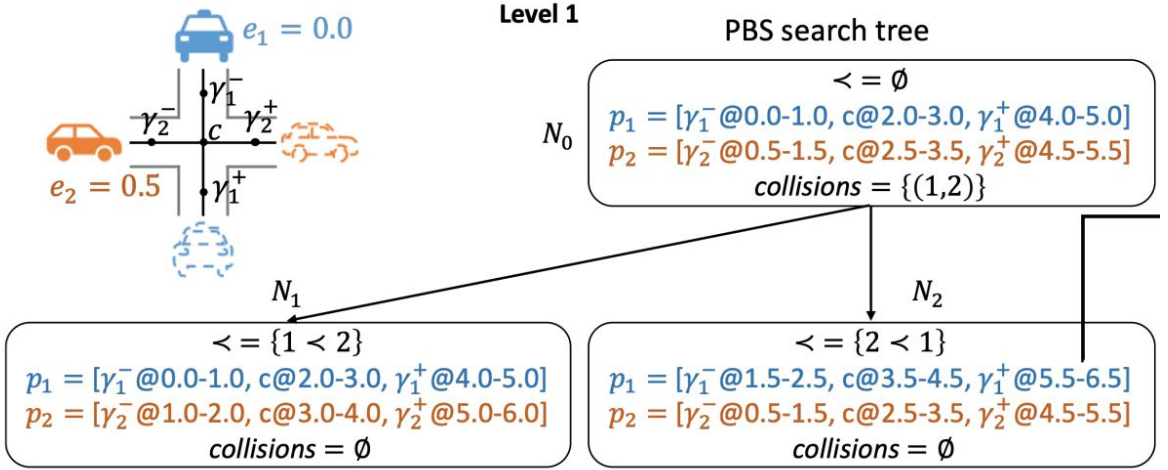
- Three level algorithm
  - Level 1: PBS, find priority ordering of agents
  - Level 2: SIPP, find safe trajectory and time intervals
  - Level 3: LP, find optimal entry time and speed

# PBS

- Create Priority Tree with partial ordering
- Lazily adds nodes to tree
- Explores nodes in order of cost

# PBS

- Create root node {∅}
  - Find optimal path for all agents
- When conflict is found: create new nodes
  - Node 1: i > j and node 2: j > i



# SIPP

- Create new graph with state, time-interval pairs
- Limited amount of nodes -> efficient algorithm

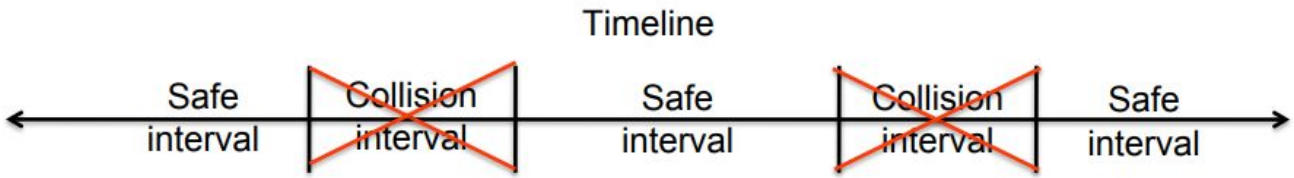
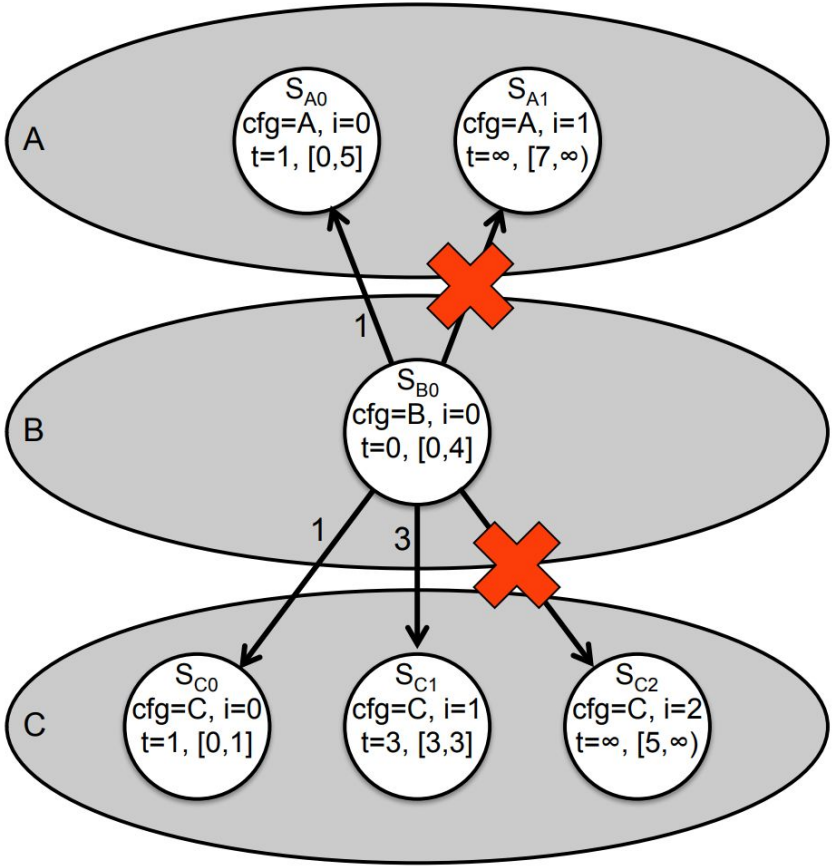



Fig. 3. A timeline for the highlighted configuration in Figure 2

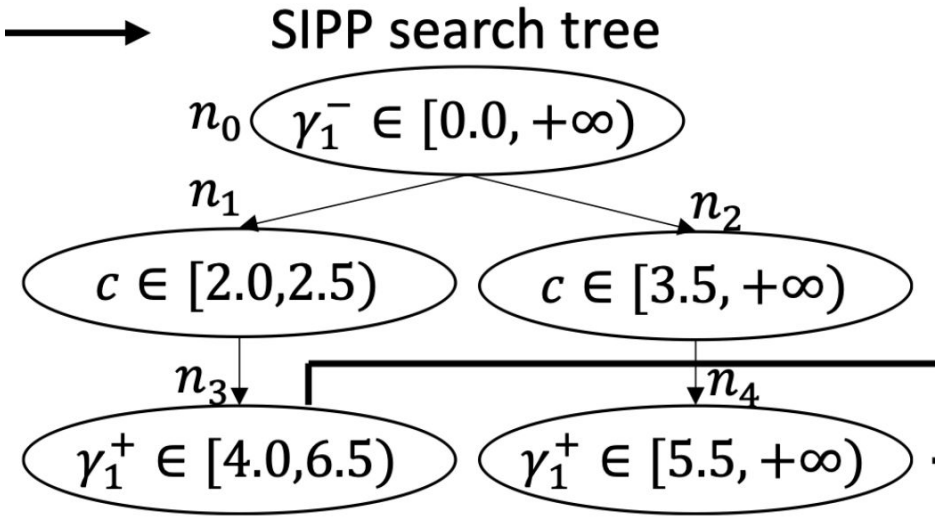
# SIPP

- Create new edges based on permitted time-intervals
- Use heuristic to estimate distance to goal
- Apply A* to find optimal path



# Linear Program

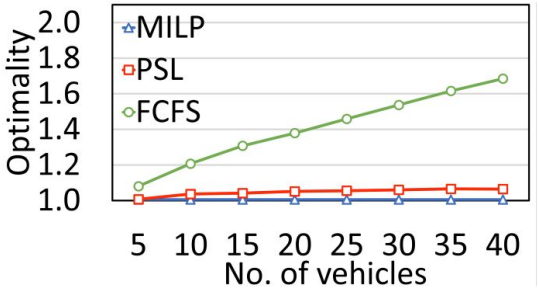
- SIPP nodes have time-intervals
- To find optimal transition times and exact speeds LP is used
- Time intervals, arrival times as constraints



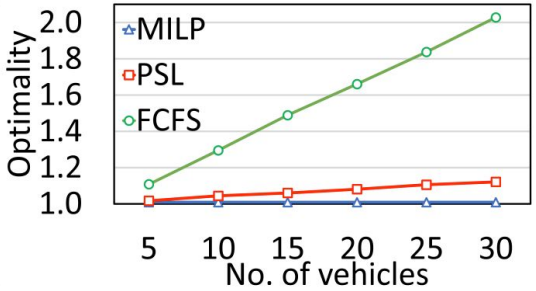
# Theoretical Evaluation

- SIPP and LP are complete and optimal
- PSL is complete and suboptimal
- Polynomial in number of vehicles but exponential in number of conflict-points

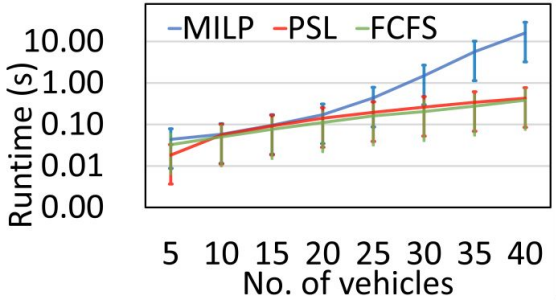
# Experimental Evaluation



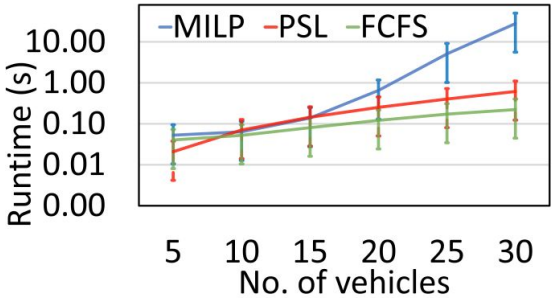

(a) 500vphpl




(b) 800vphpl




(a) 500vphpl




(b) 800vphpl

# Conclusion

- MAPF-based algorithm to coordinate autonomous vehicles at single no-signal intersections
- PSL is complete, polynomial-time in the number of vehicles, and can coordinate dozens of vehicles in real-time
- Runs faster than MIP approaches and has better solutions than rule-based heuristics

# Quiz

1) What is the goal of SIPP?
    a) Find optimal vehicle speeds
    b) Find optimal paths
    c) Determine objective value of paths

2) PSL is exponential in the number of vehicles
    a) True
    b) Fase