# Handling An Intersection Scenario With Dynamic Objects

Course 4, Module 5, Lesson 3

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Review – Scenario Evaluation

- 4 way Intersection
- Two lane
- Stop Sign for every direction
- Be able to travel:
  - Through the intersection
  - Left at the intersection
  - Right at the intersection

- Interactions with vehicles as dynamic objects
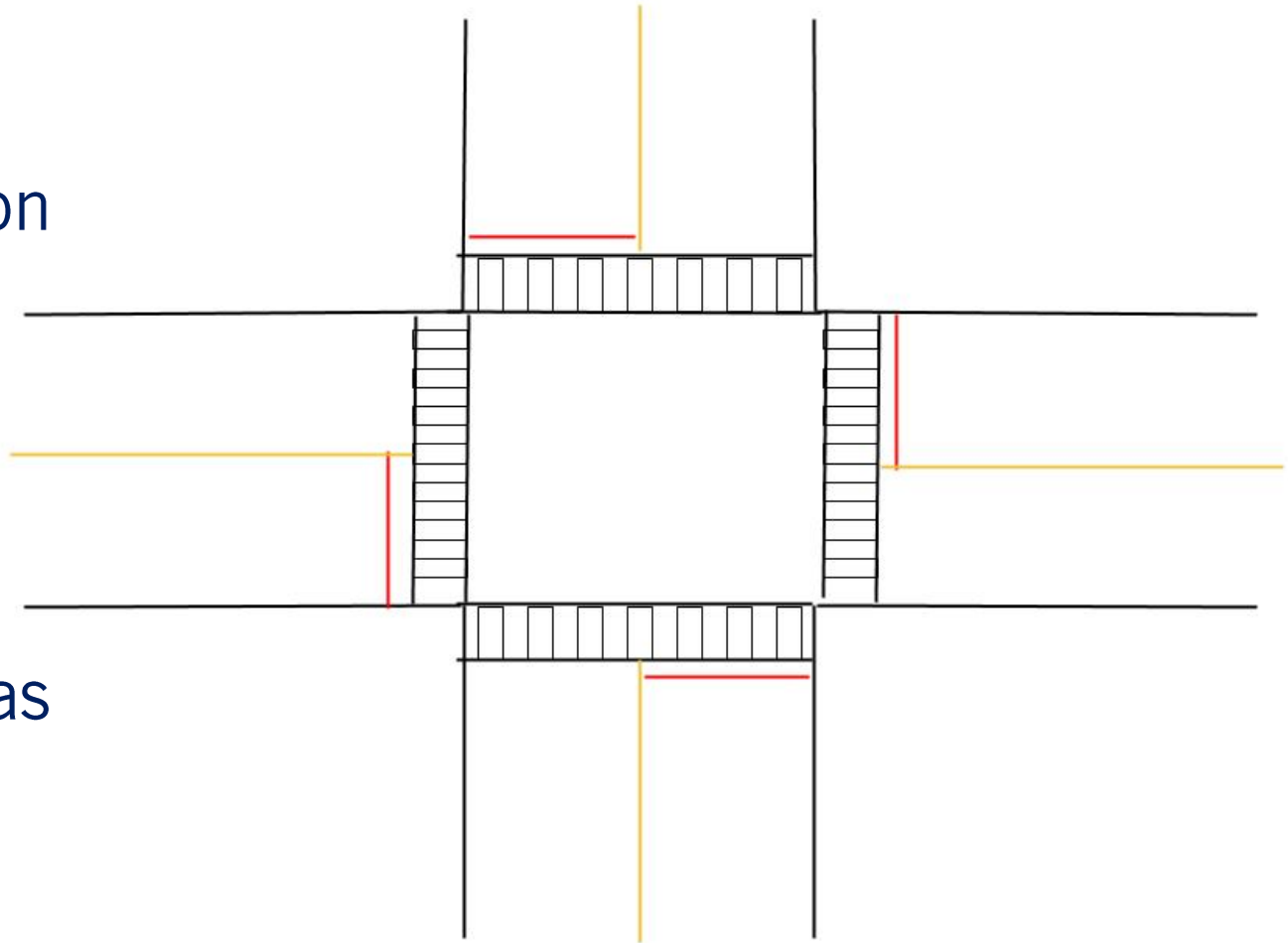
Review – Discretizing the Intersection

- Approaching an intersection

- At an intersection

- On an intersection

- Determining the size of each zone:
  - Ego vehicle velocity
  - Size of the intersection
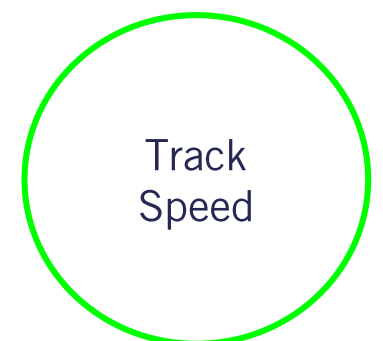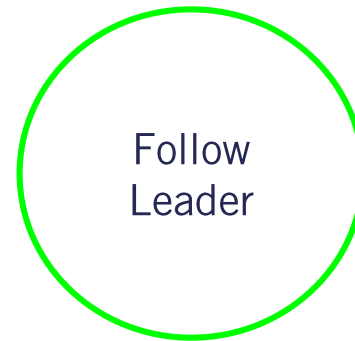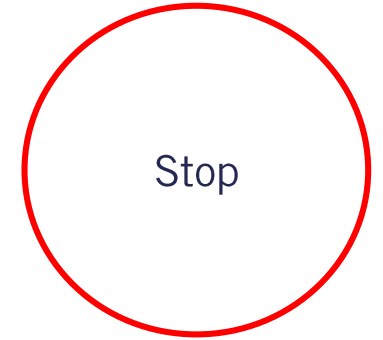 - Dynamic vehicle velocity
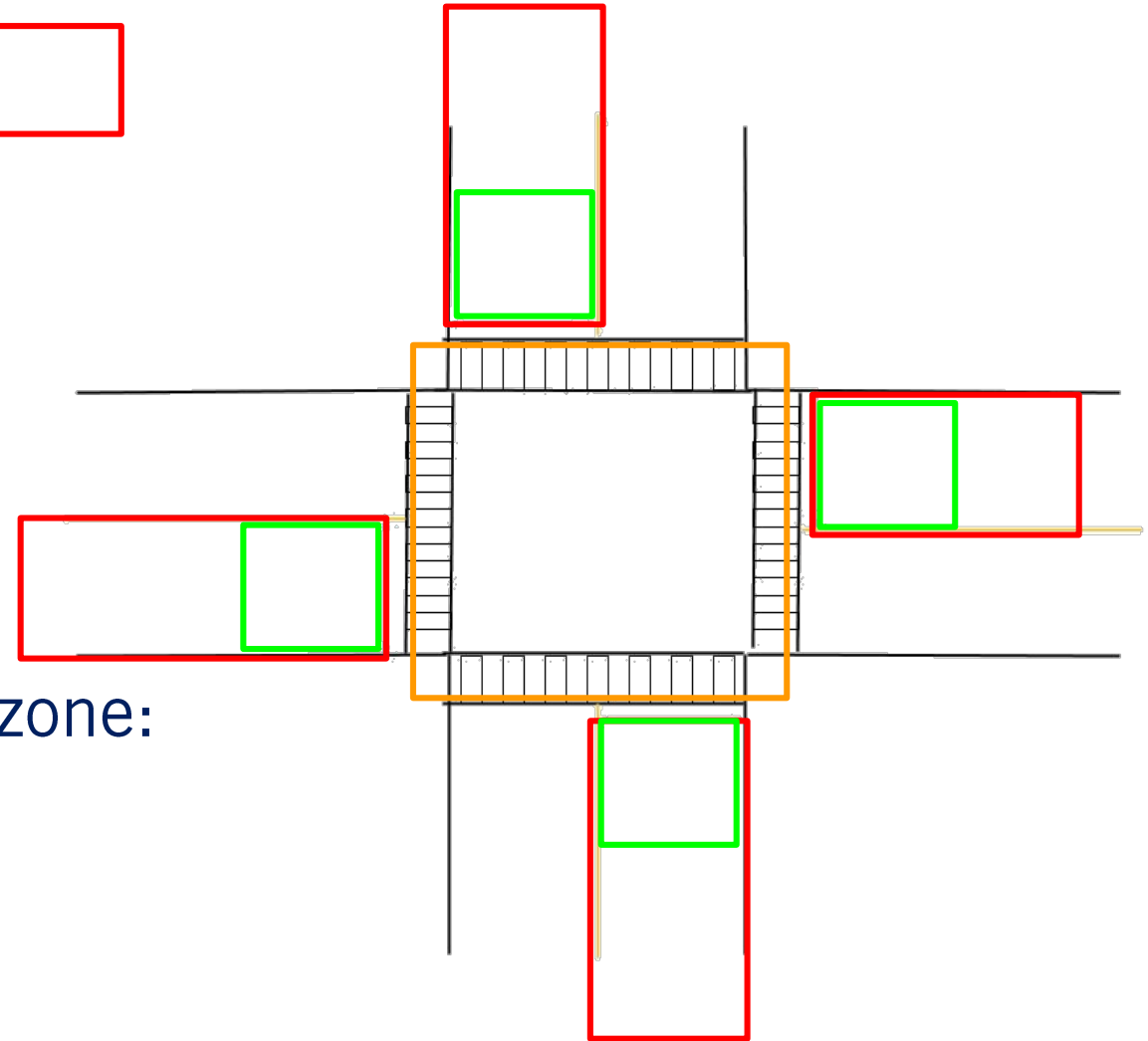
Review – Interaction With Dynamic Objects

- **Distance to dynamic object**
  - distance to the center of any dynamic object
- **Distance to collision point**
  - distance to the collision point with another dynamic object
- **Time to collision (TTC)**
  - time to collision between any two dynamic objects
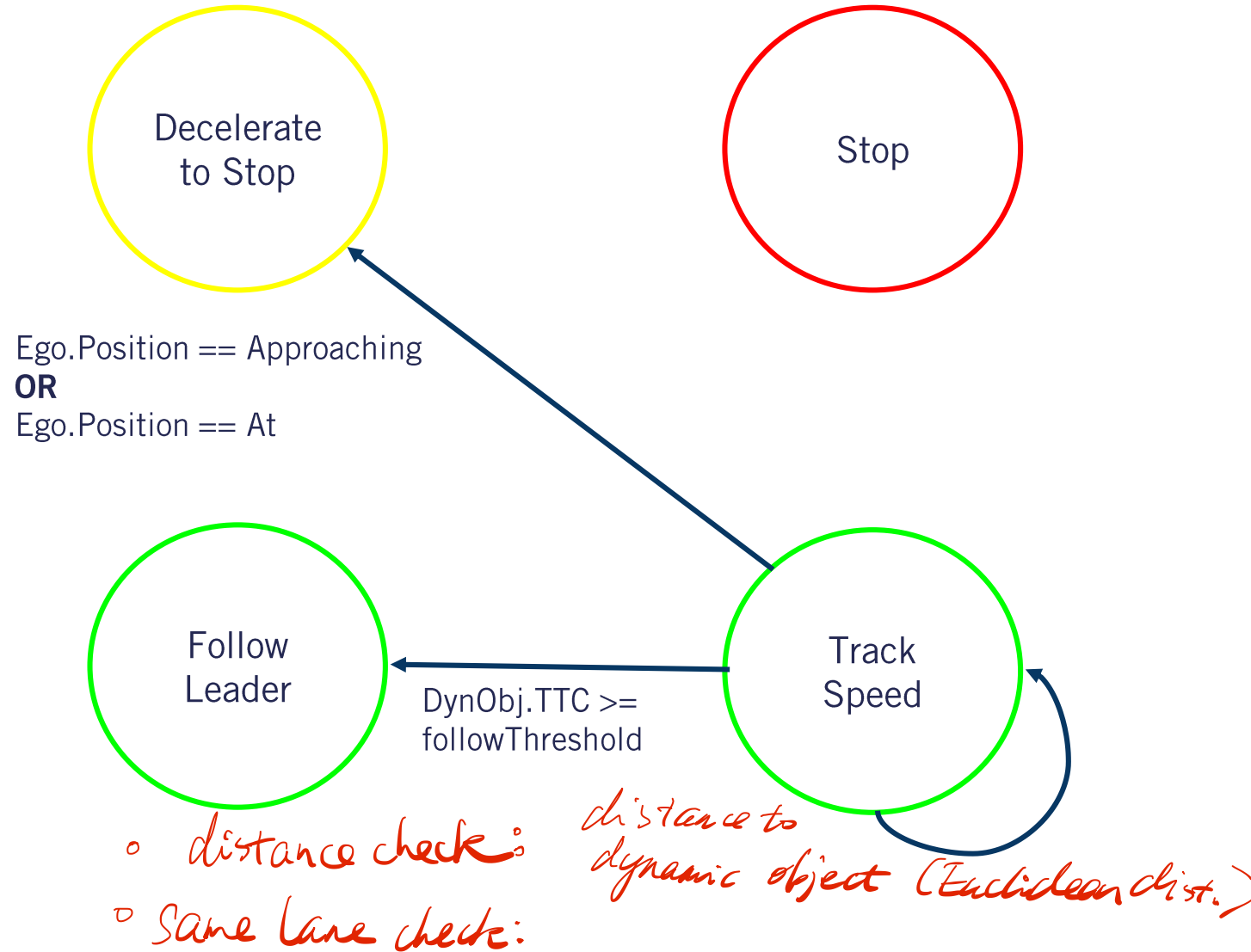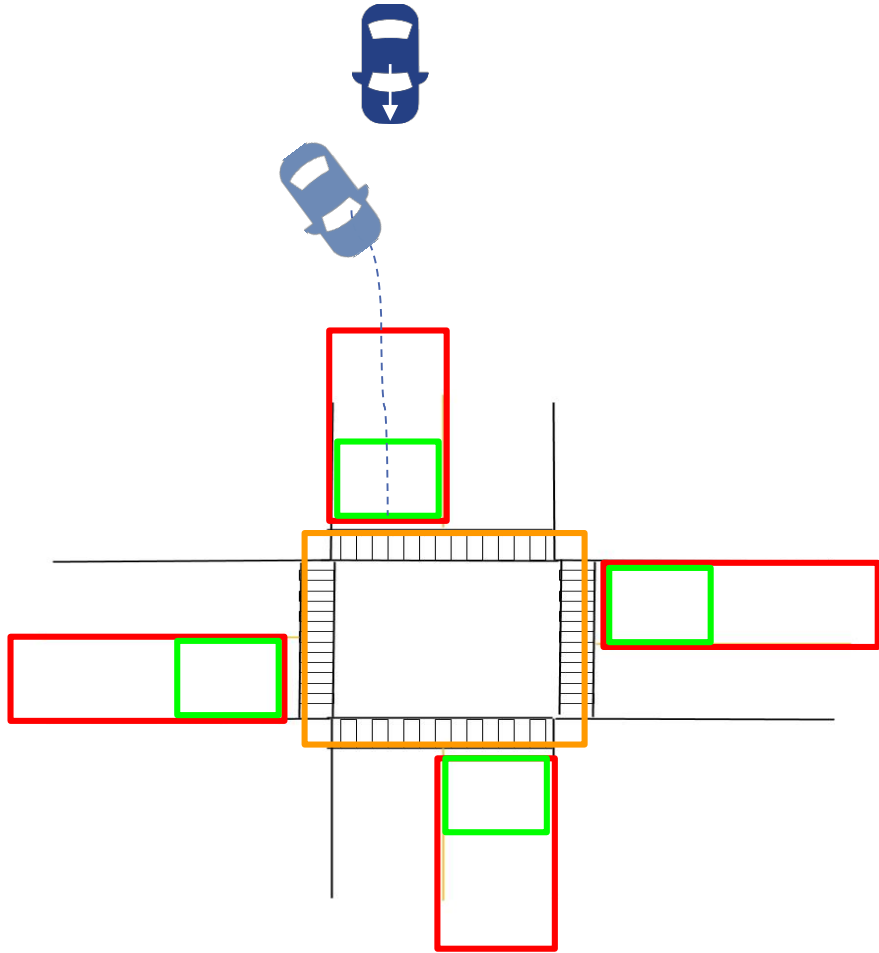
3.24 Sec

5.72 m
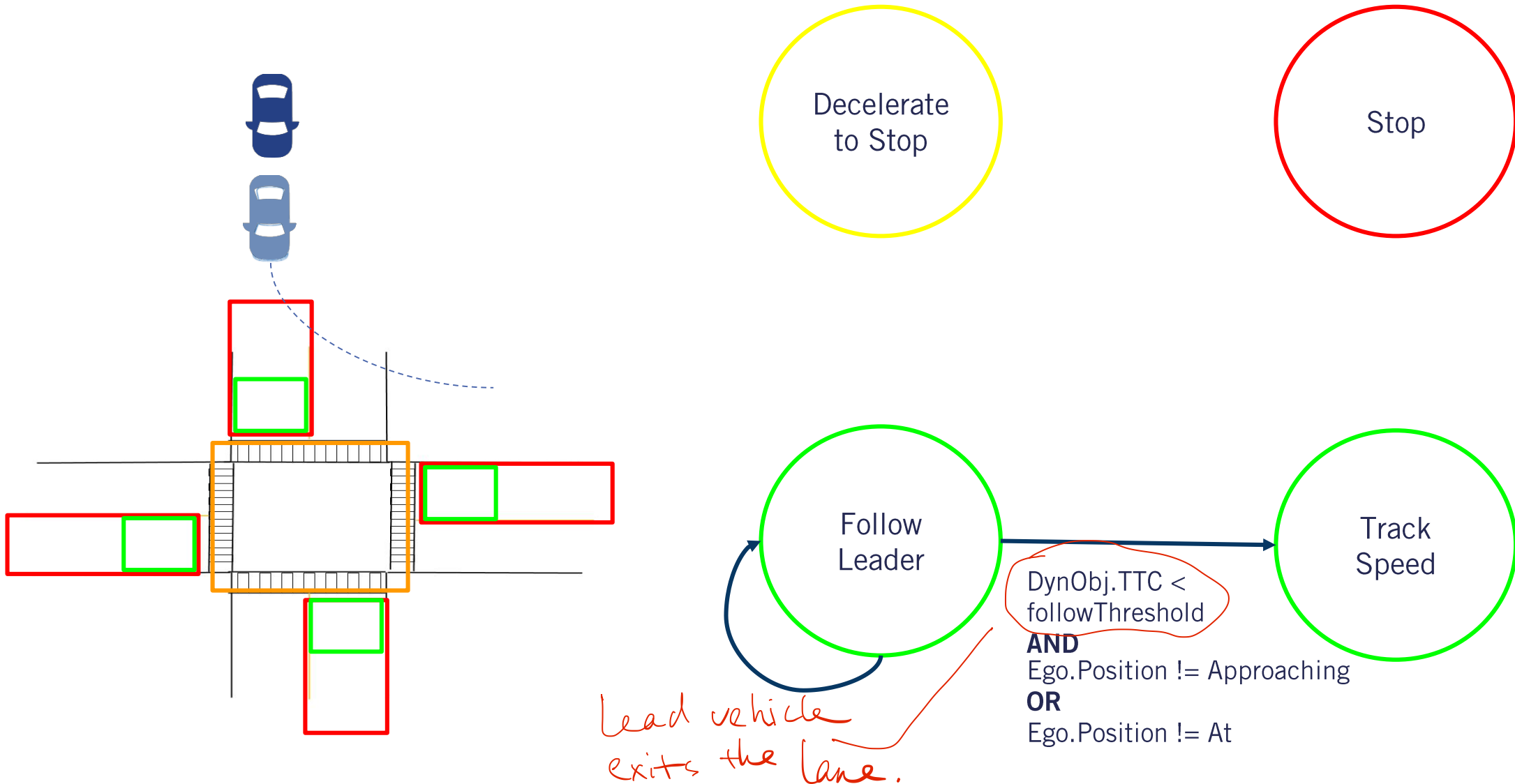
1.52 m
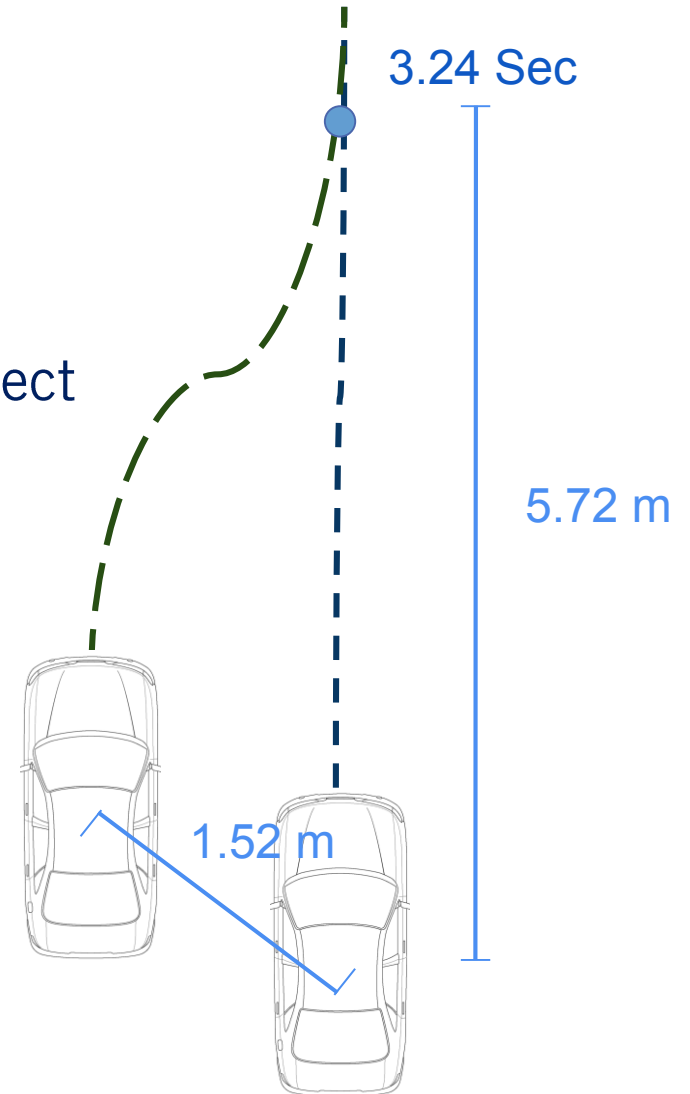
State Machine States

- Track Speed
  - Follow the current speed limit
- Follow Leader
  - Match the speed of the dynamic object in front
- Decelerate to Stop
  - Stop to a particular point
- Stop
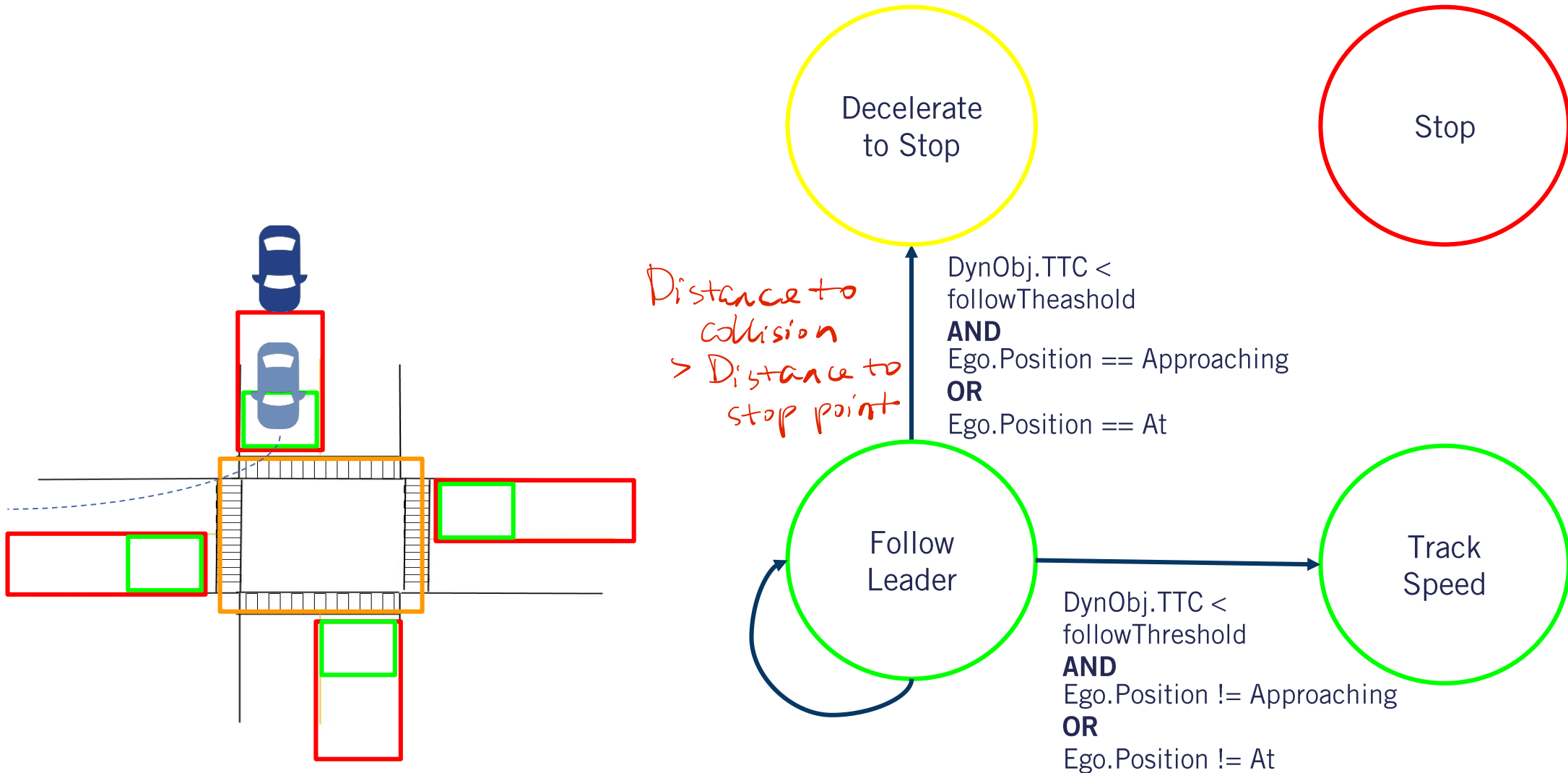 - Stay stopped at the current location

Decelerate to Stop

Stop

Follow Leader

Track Speed

State Machine Transitions - Track Speed

Decelerate to Stop

Stop

Ego.Position == Approaching
OR
Ego.Position == At

Follow Leader

Track Speed

DynObj.TTC >= followThreshold

○ distance check:
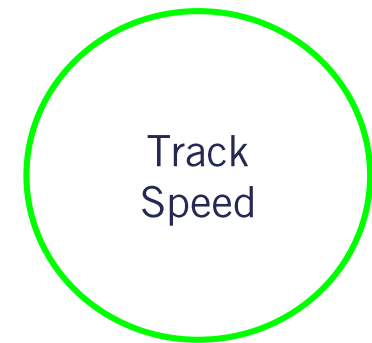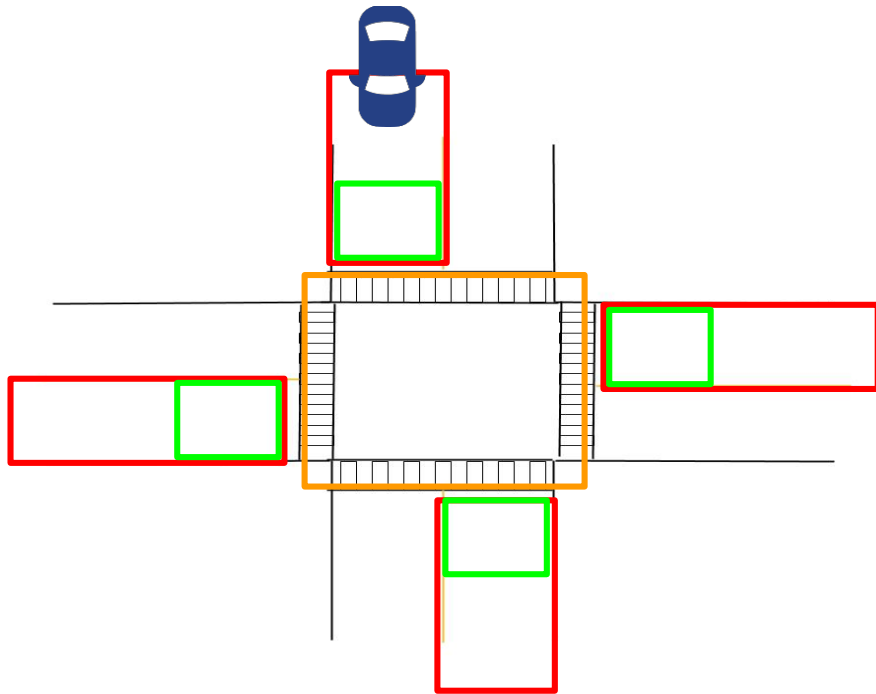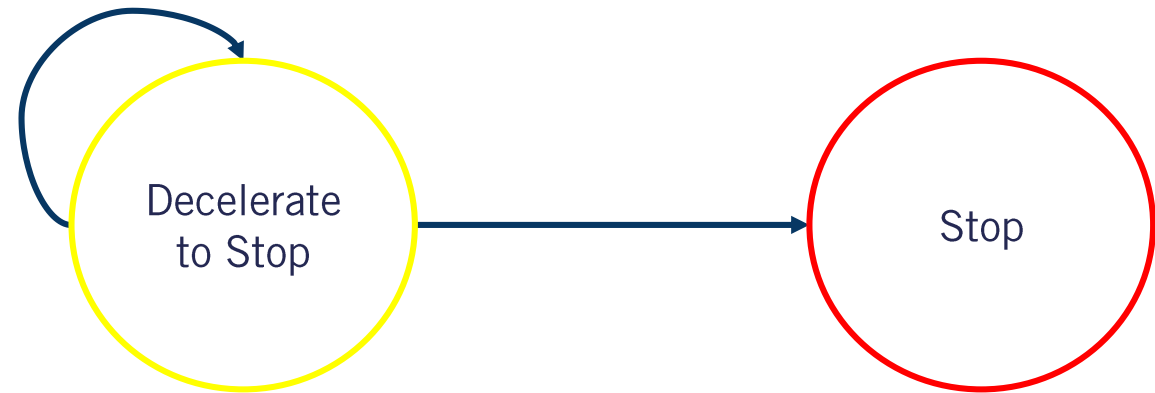○ same lane check:

distance to dynamic object (Euclidean dist.)

State Machine Transitions - Follow Leader

State Machine Transitions - Follow Leader

Decelerate to Stop

Stop

Distance to collision > Distance to stop point

DynObj.TTC < followTheashold
AND
Ego.Position == Approaching
OR
Ego.Position == At

Follow Leader

Track Speed

DynObj.TTC < followThreshold
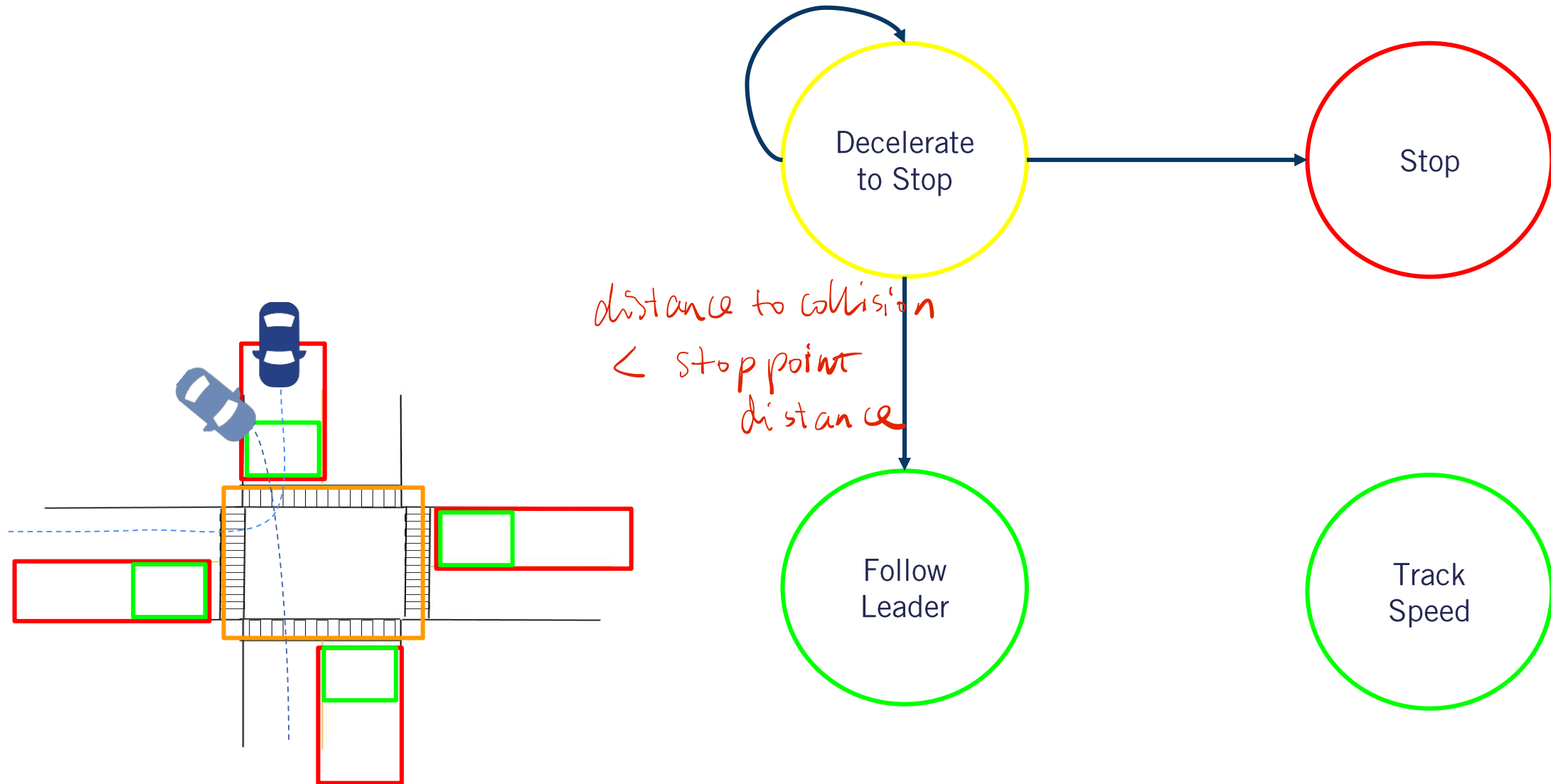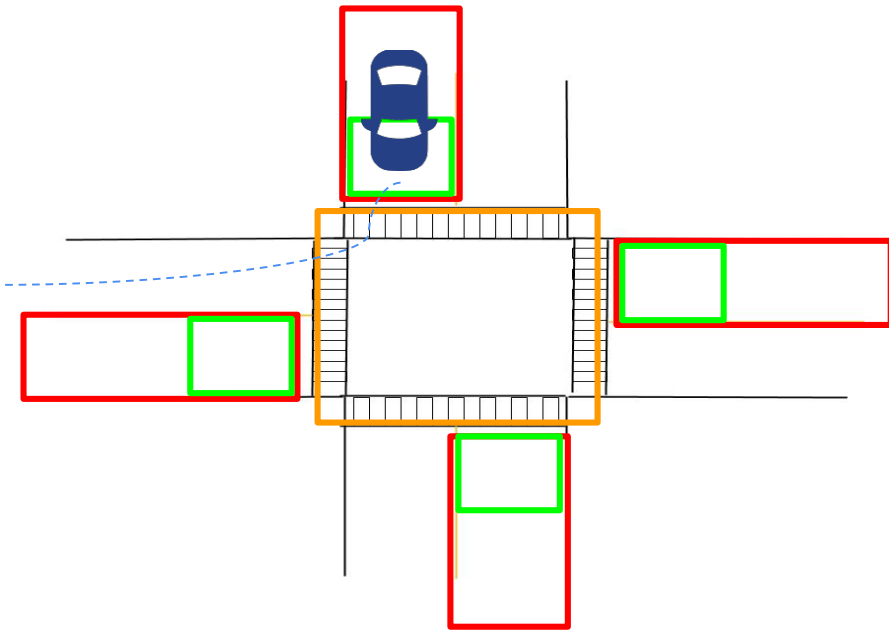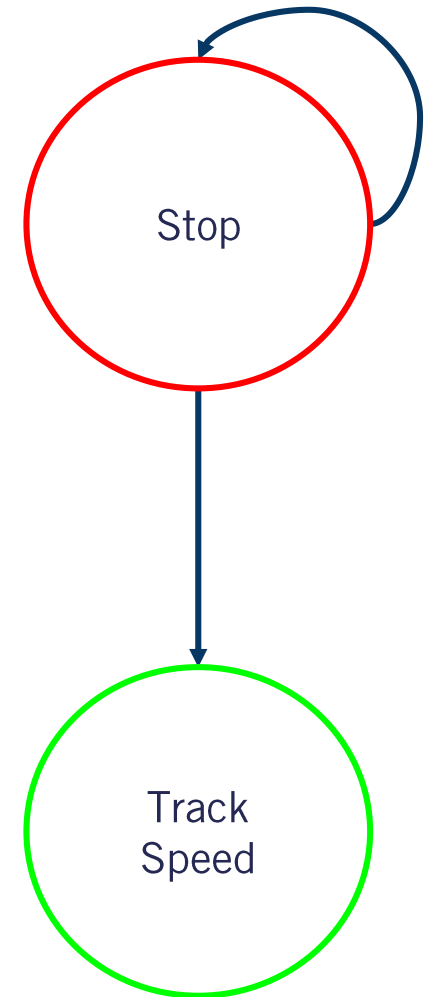**AND**
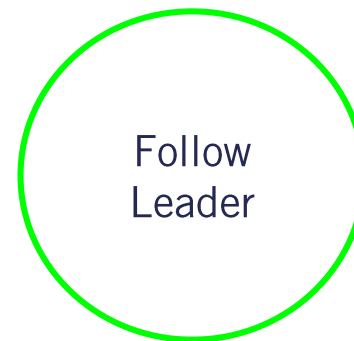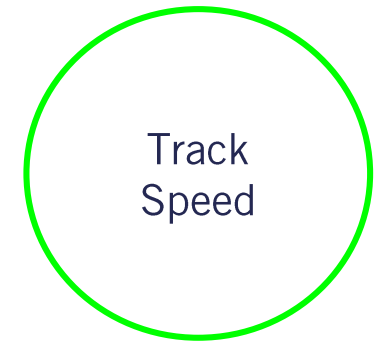Ego.Position != Approaching
OR
Ego.Position != At

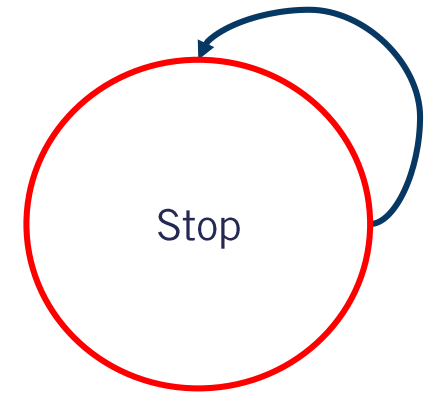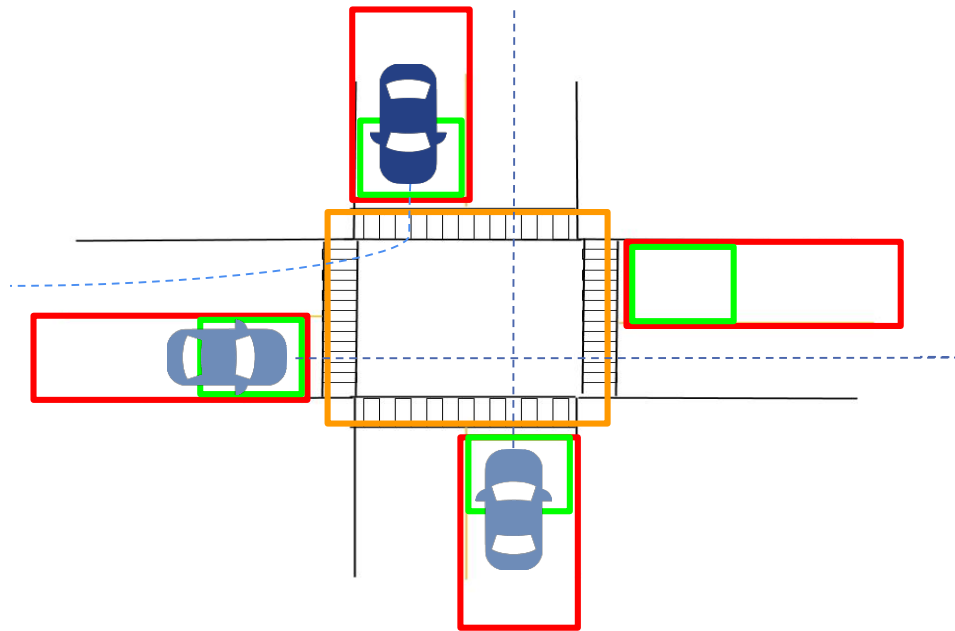# State Machine Transitions - Decelerate to Stop
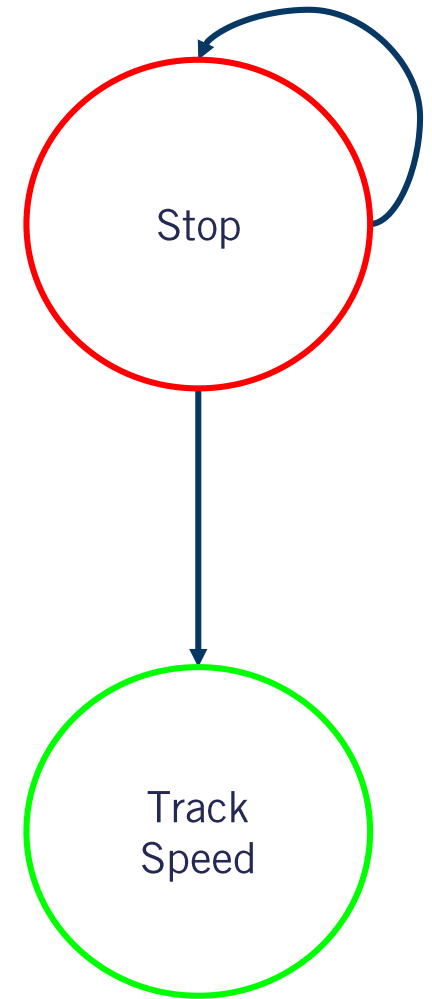
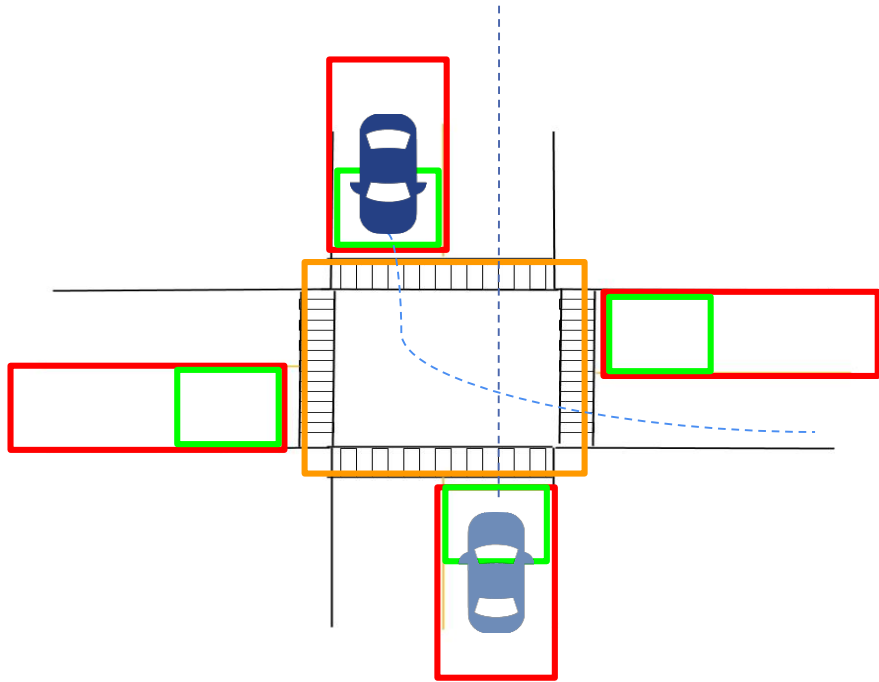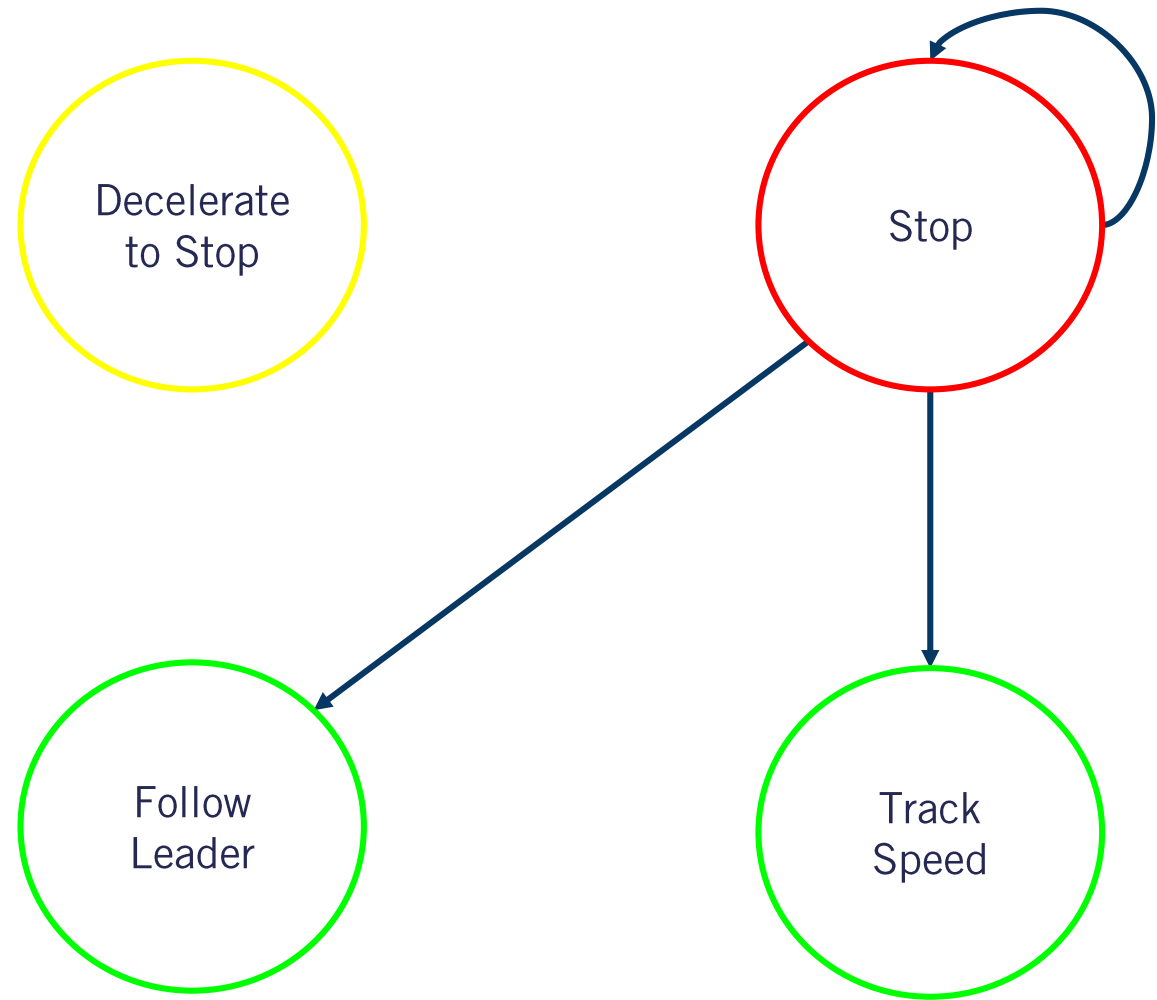# State Machine Transitions - Decelerate to Stop
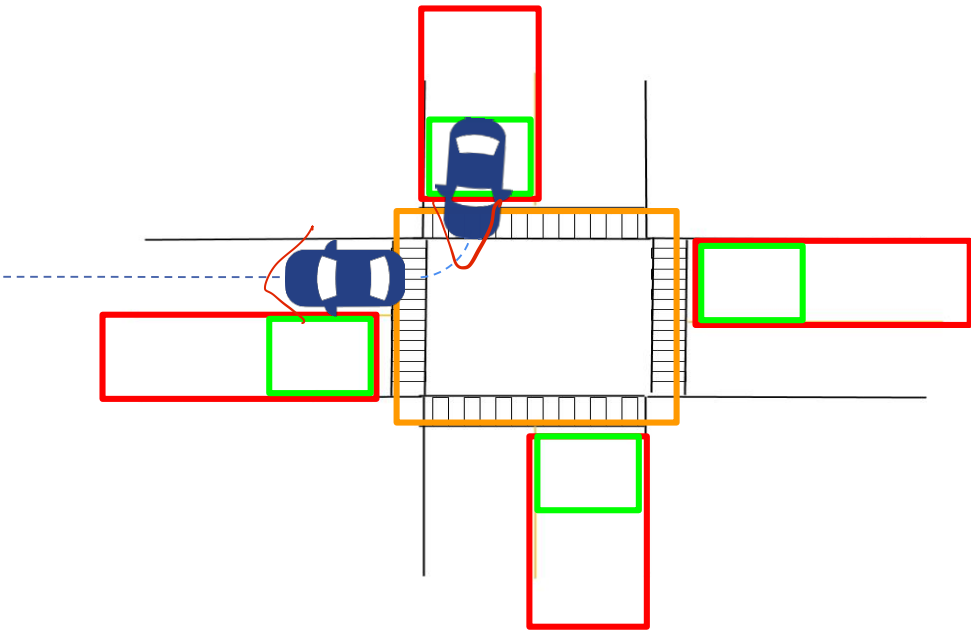
State Machine Transitions - Stop
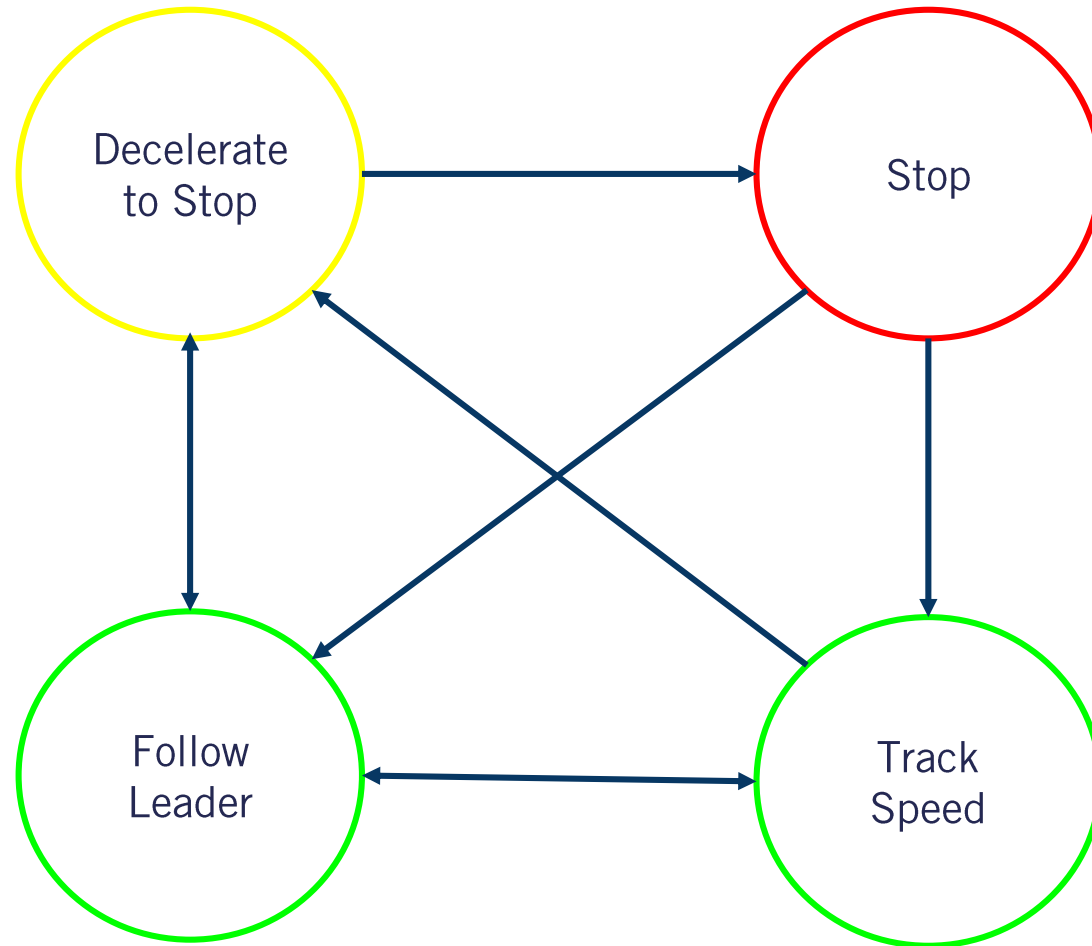
State Machine Transitions - Stop

State Machine Transitions - Stop

State Machine Transitions - Stop

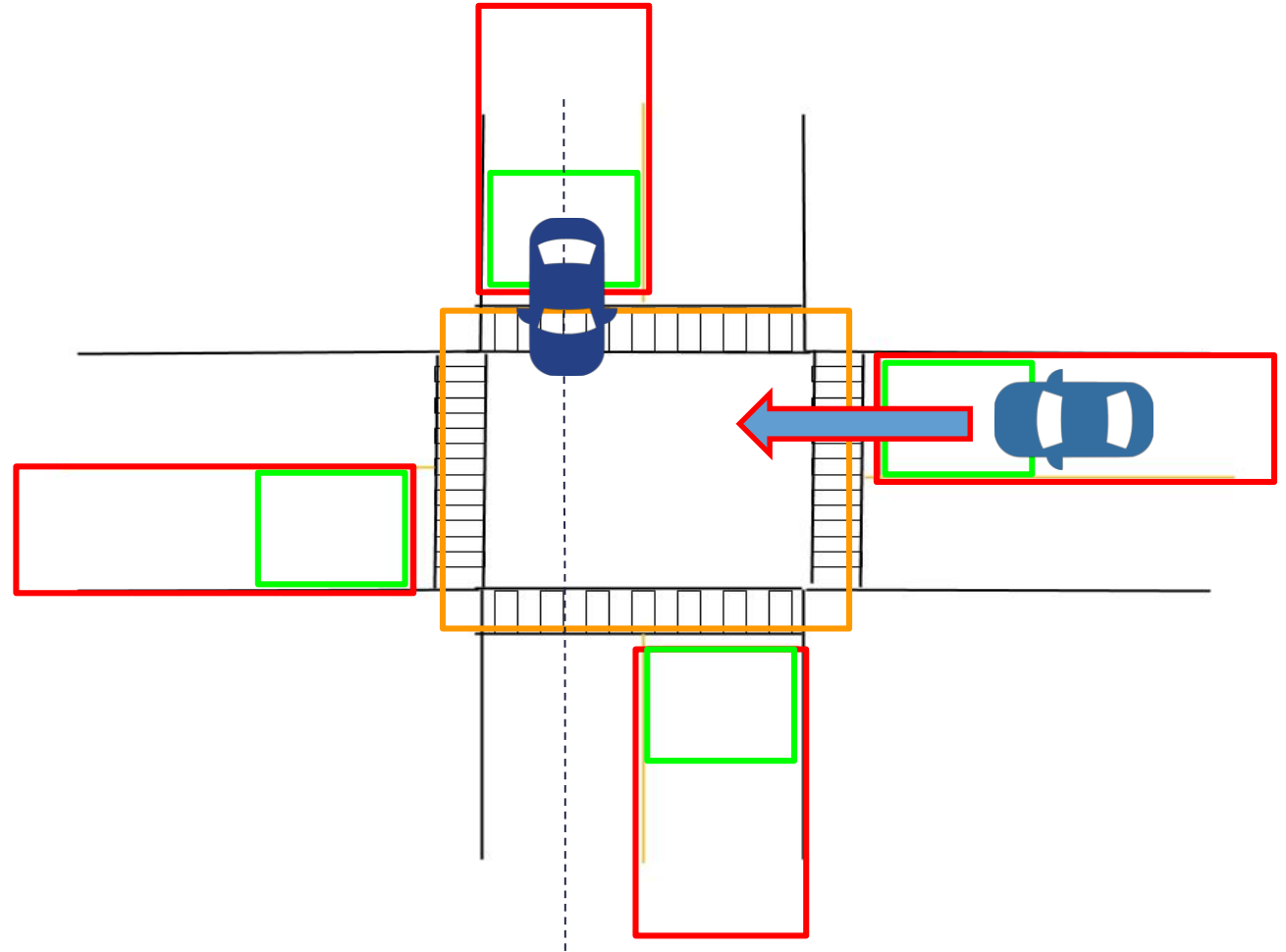# State Machine Transitions

Dynamic Object Edge Cases Not Handled

- Assumption:
  - All dynamic obstacles obey rules of the road

- Not always the case!

Summary

- Build upon the previous lesson to include dynamic objects as part of the state machine
- Developing an understanding of the complexities and edge cases when dealing with dynamic objects

- **Next**: Handling multiple scenarios

Dealing With Multiple Scenarios

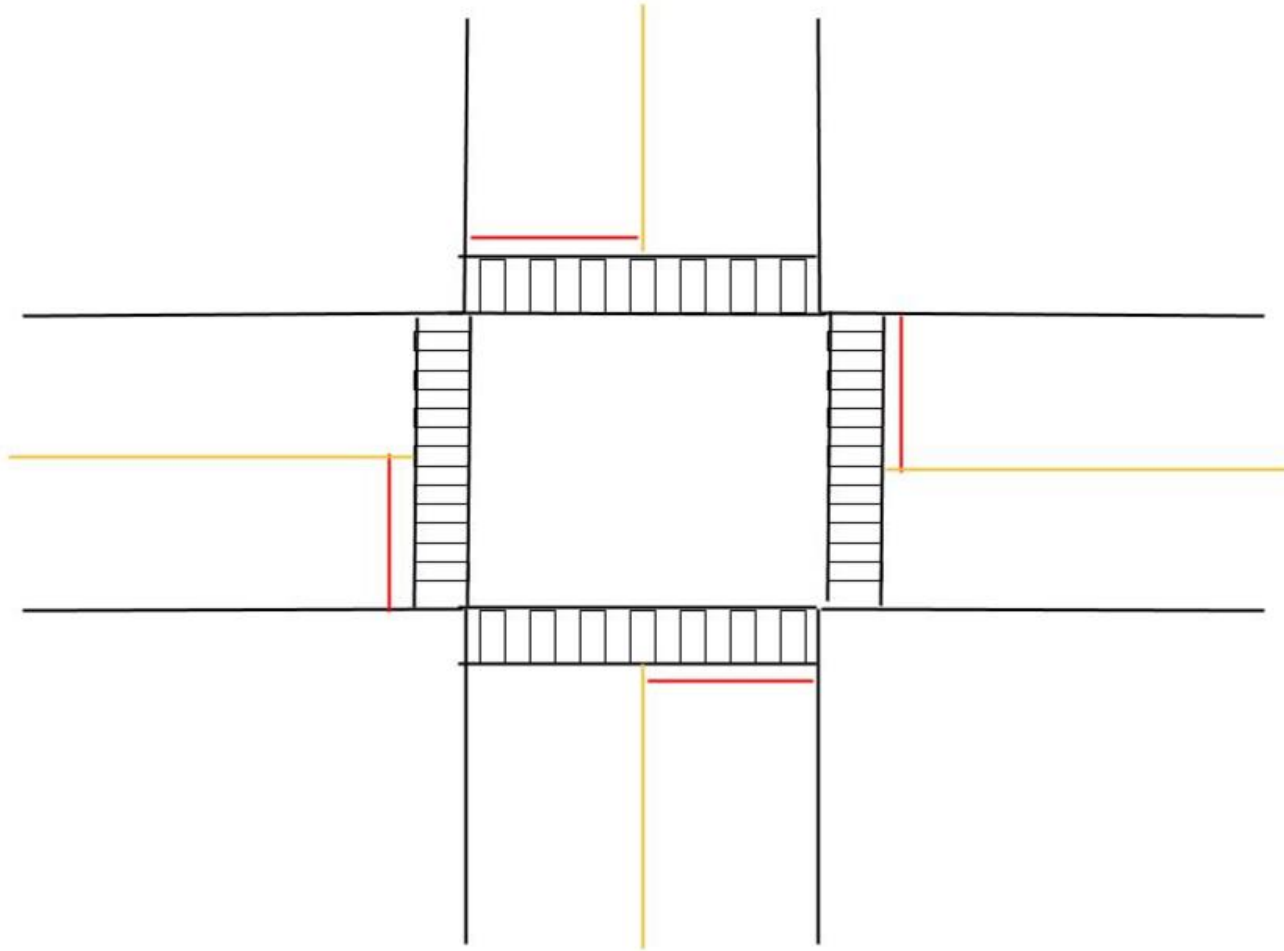**Course 4, Module 5, Lesson 4**

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Scenario Done So Far

- 4 way intersection
- Every direction has a stop sign
- Be able to travel:
  - Through the intersection
  - Left at the intersection
  - Right at the intersection

- Only vehicles as dynamic objects
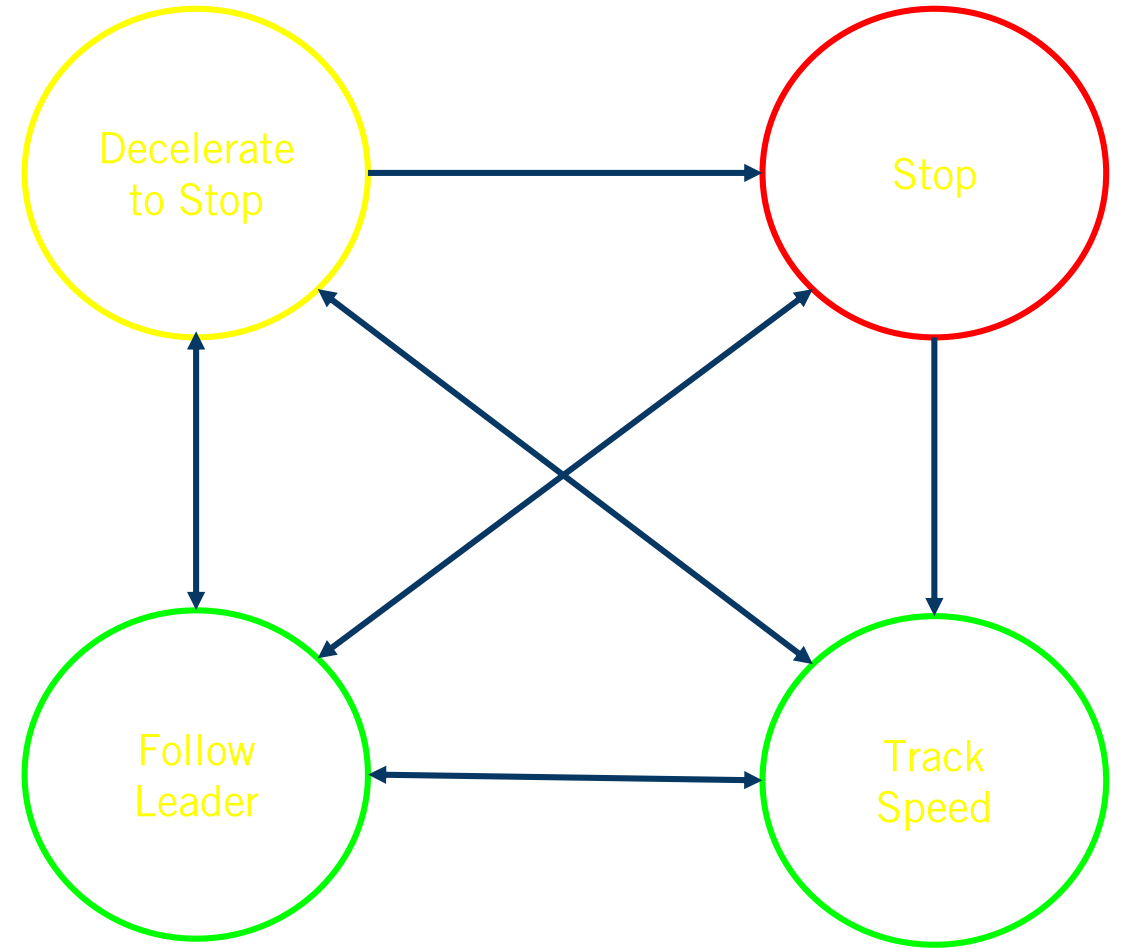 - 1, 2, 3 or 4 other vehicles
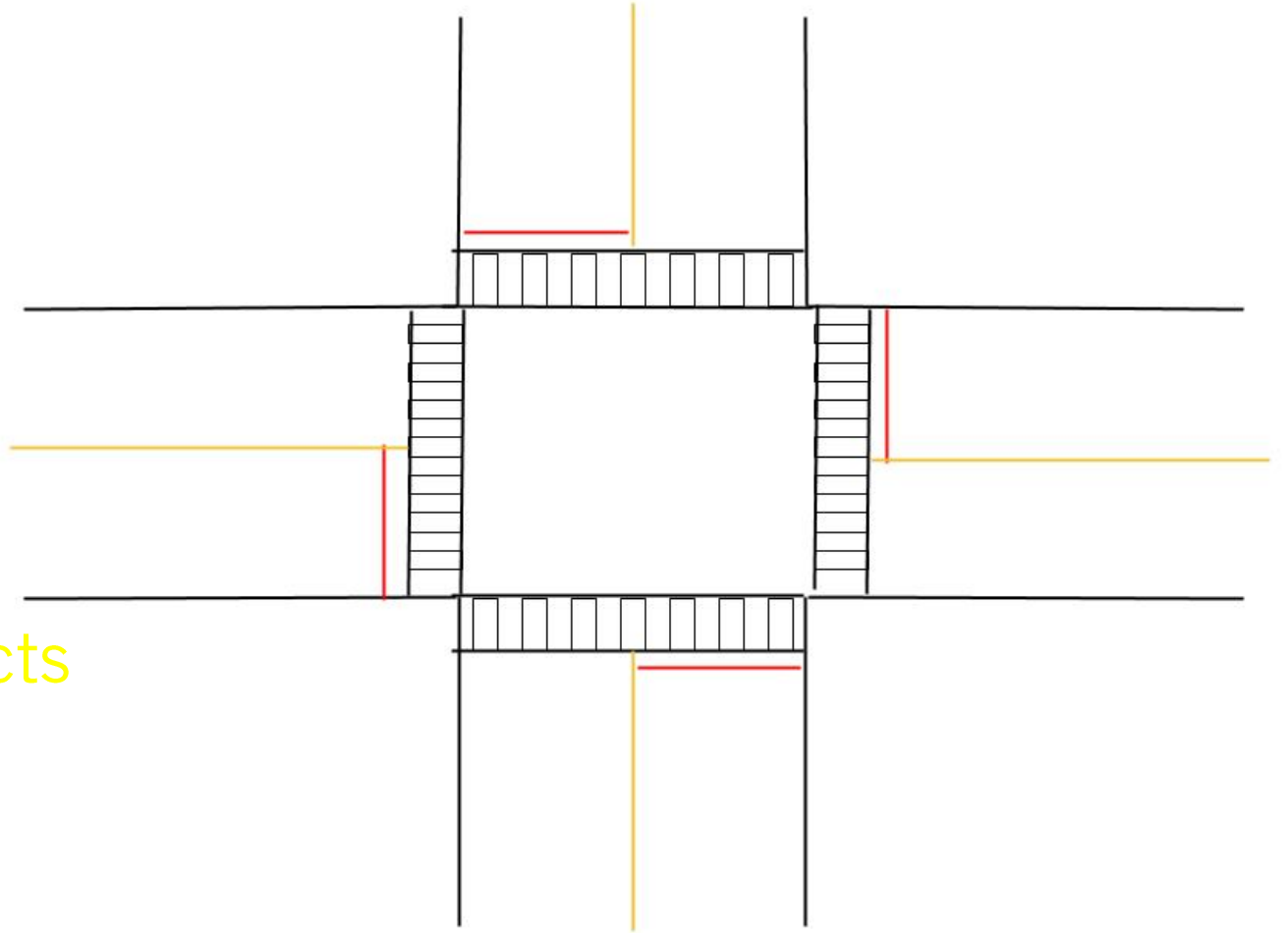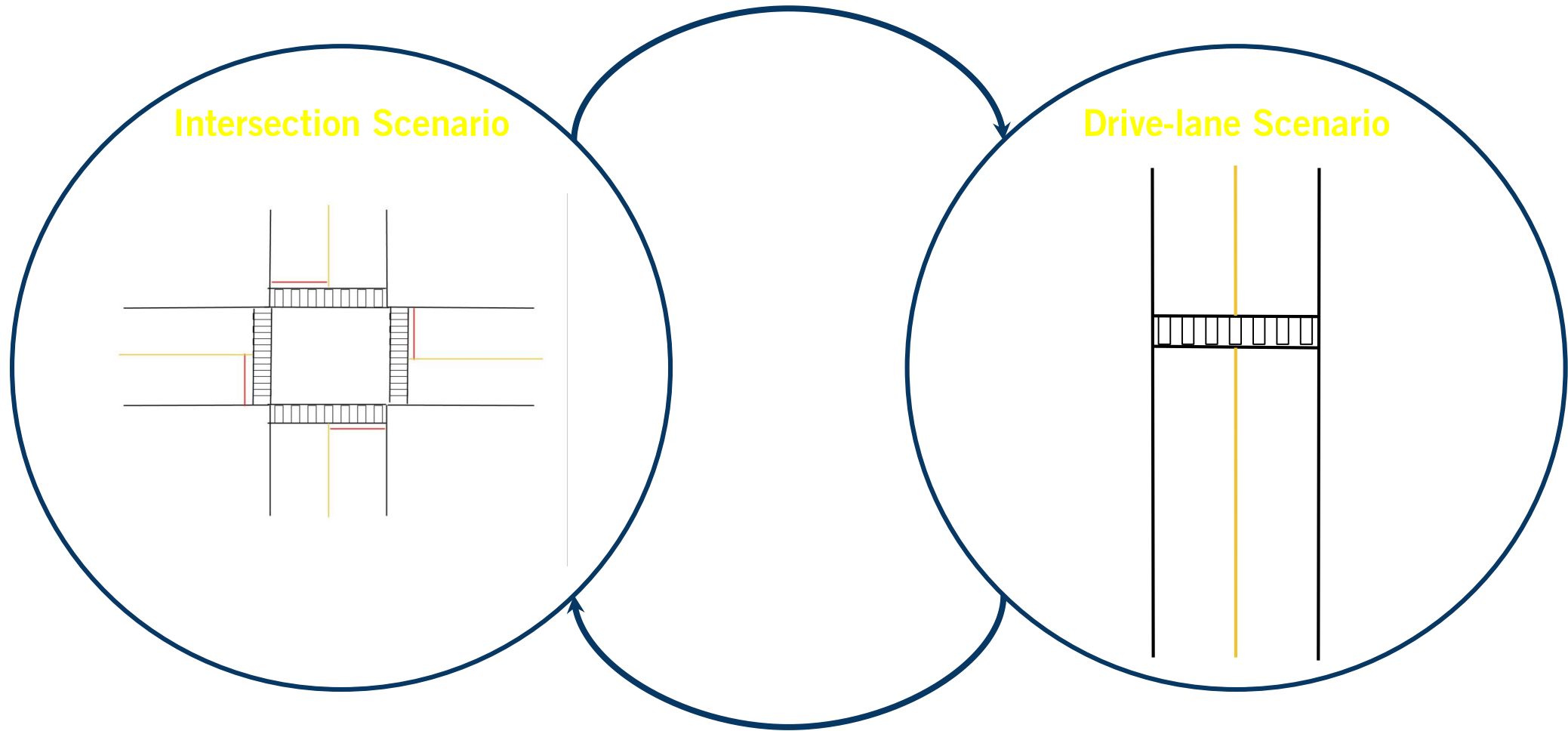
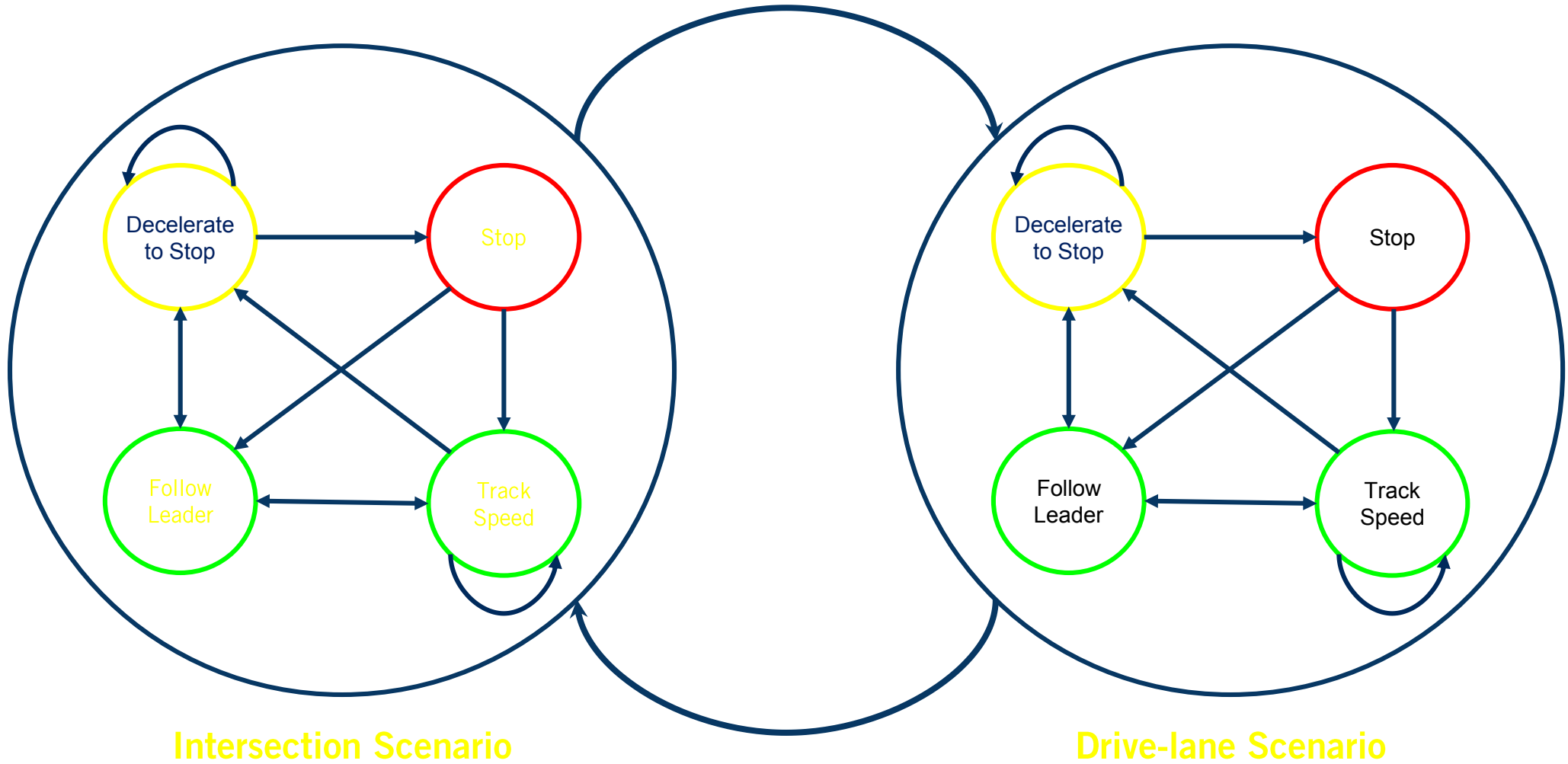**Multiple Scenarios**
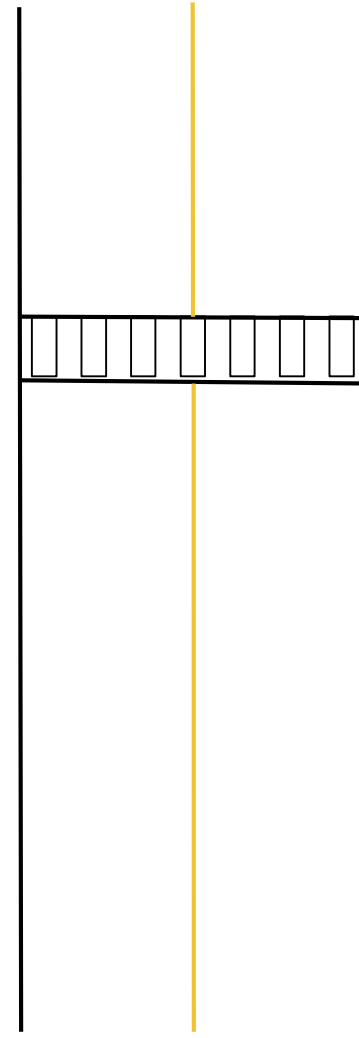
Single State Machine

- Single state machine method
  - Add transitions
  - Add additional transition conditions

- Issues with single state machine method:
  - Rule explosion
  - Increase in computational time
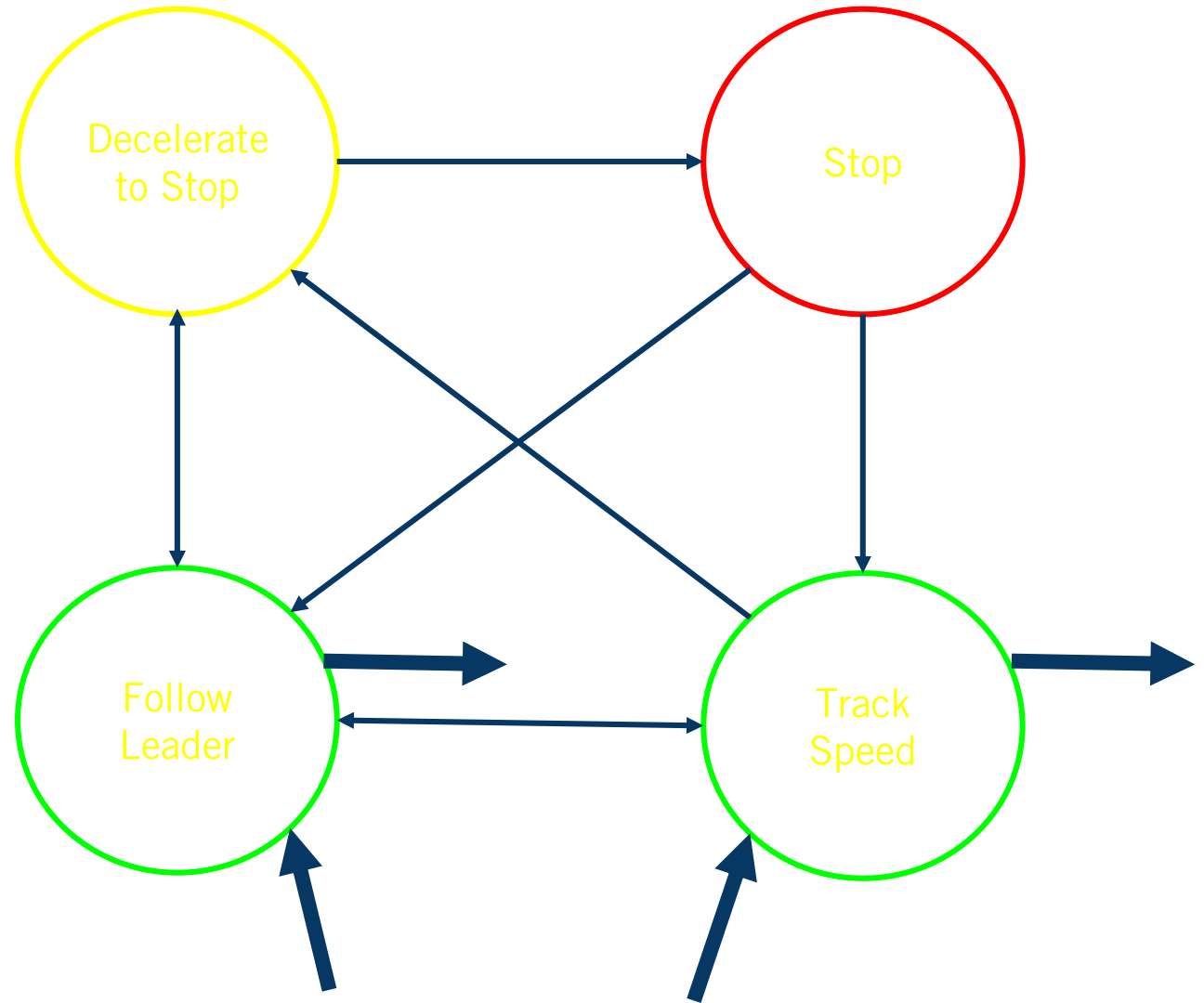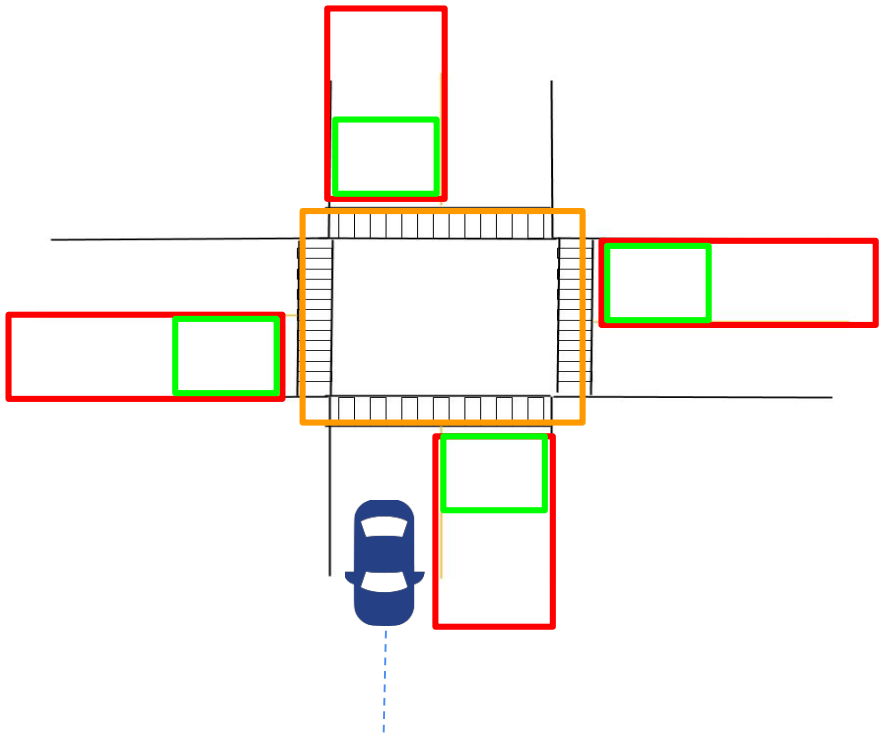 - Complicated to create and maintain

Multiple State Machine

Intersection Scenario

Drive-lane Scenario

Hierarchical State Machine

Intersection Scenario

Drive-lane Scenario

Entry and Exit Transitions - Intersection

Hierarchical State Machine

Intersection Scenario

Single lane Drive-lane Scenario

Decelerate to Stop

Stop

Follow Leader

Track Speed

Merge

Multi-lane Scenario
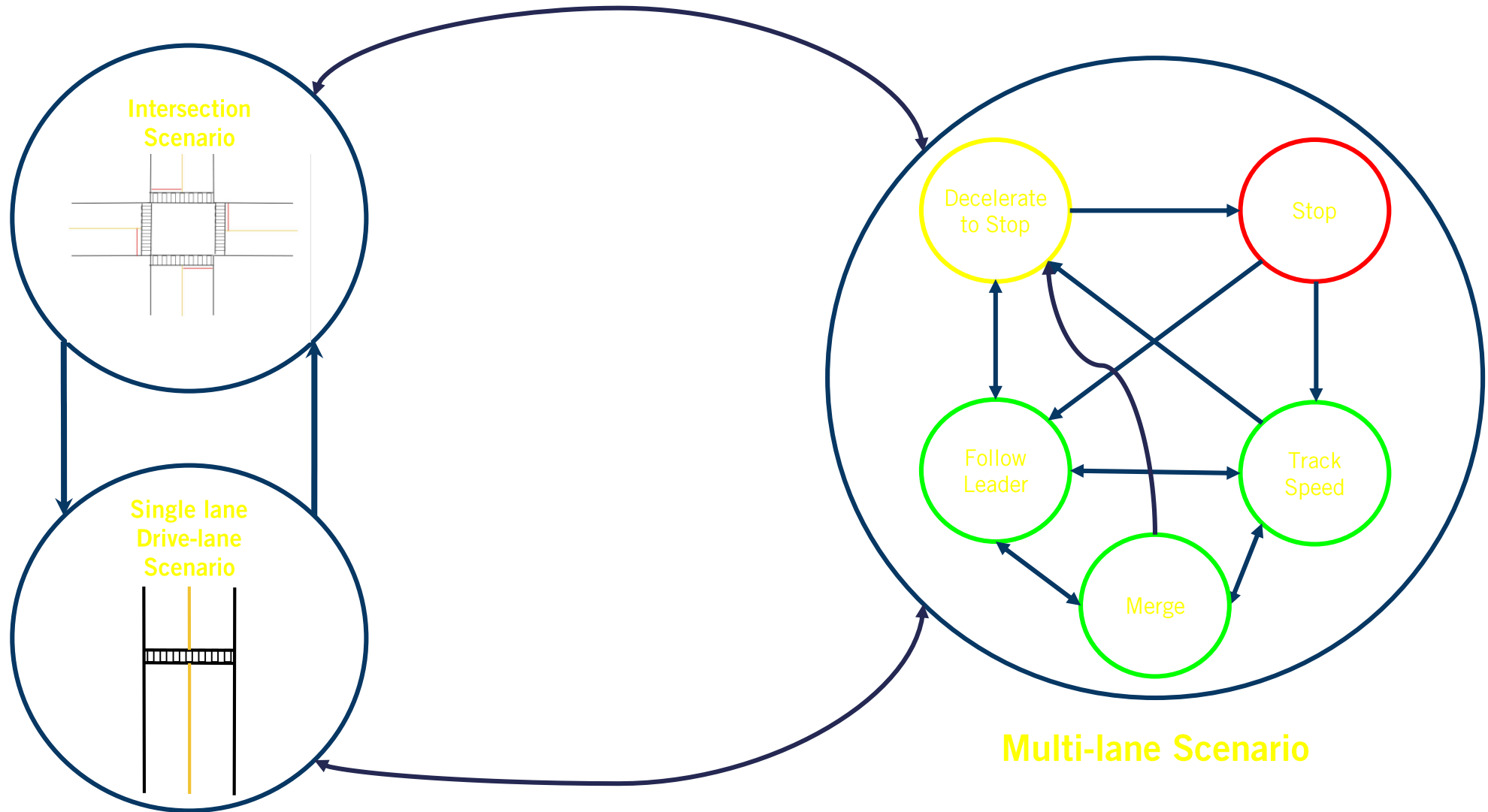
Hierarchical State Machine - Advantages and Disadvantages

- Advantages:
  - Decrease in computational time
  - Simpler to create and maintain
- Disadvantages:
  - Rule Explosion
  - Repetition of many rules in the low level state machines