

## Motivation

### Autonomous Driving Vehicles (ADV)

- low penetration at early market introduction stage...
- Interaction with conventional cars, use same road infrastructure
- Need to consider different reaction capabilities from conventional cars

### Current ACC/C-ACC can help avoid collisions but not useful if

- it creates collision with following vehicle downstream
- leads to collisions onto itself (rear end collisions)

### Aim: Coordinated maneuvering for rear end and front end collision avoidance

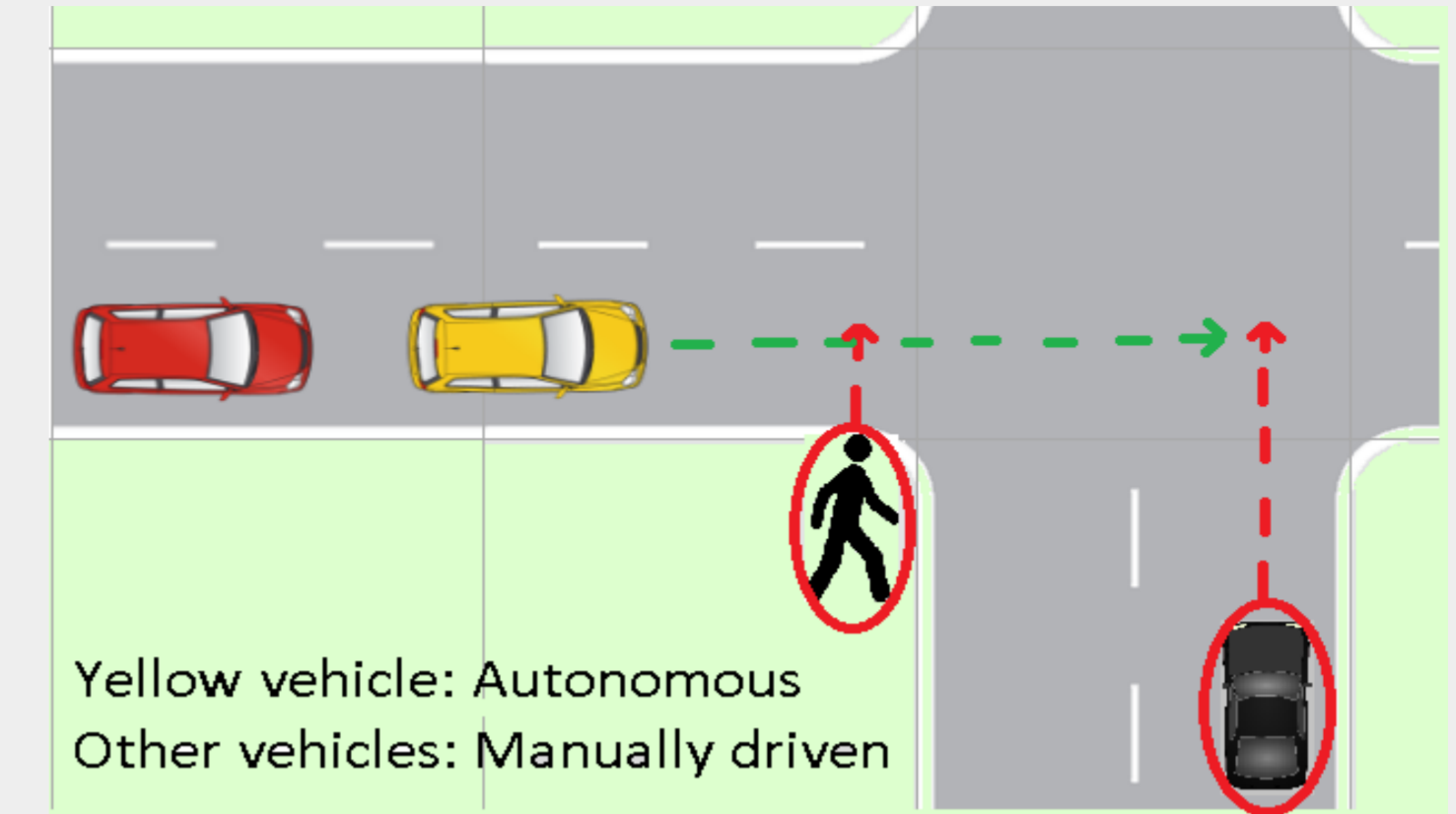


Fig. 1 A mix of conventional and autonomous vehicles

## Methodology

### Scenario:

- Mixed autonomous (A) and conventional (B) vehicles
- ADV leader, conventional vehicle follower
- Sudden road hazard:
  - Blind intersection collision
  - Blind pedestrian crossing

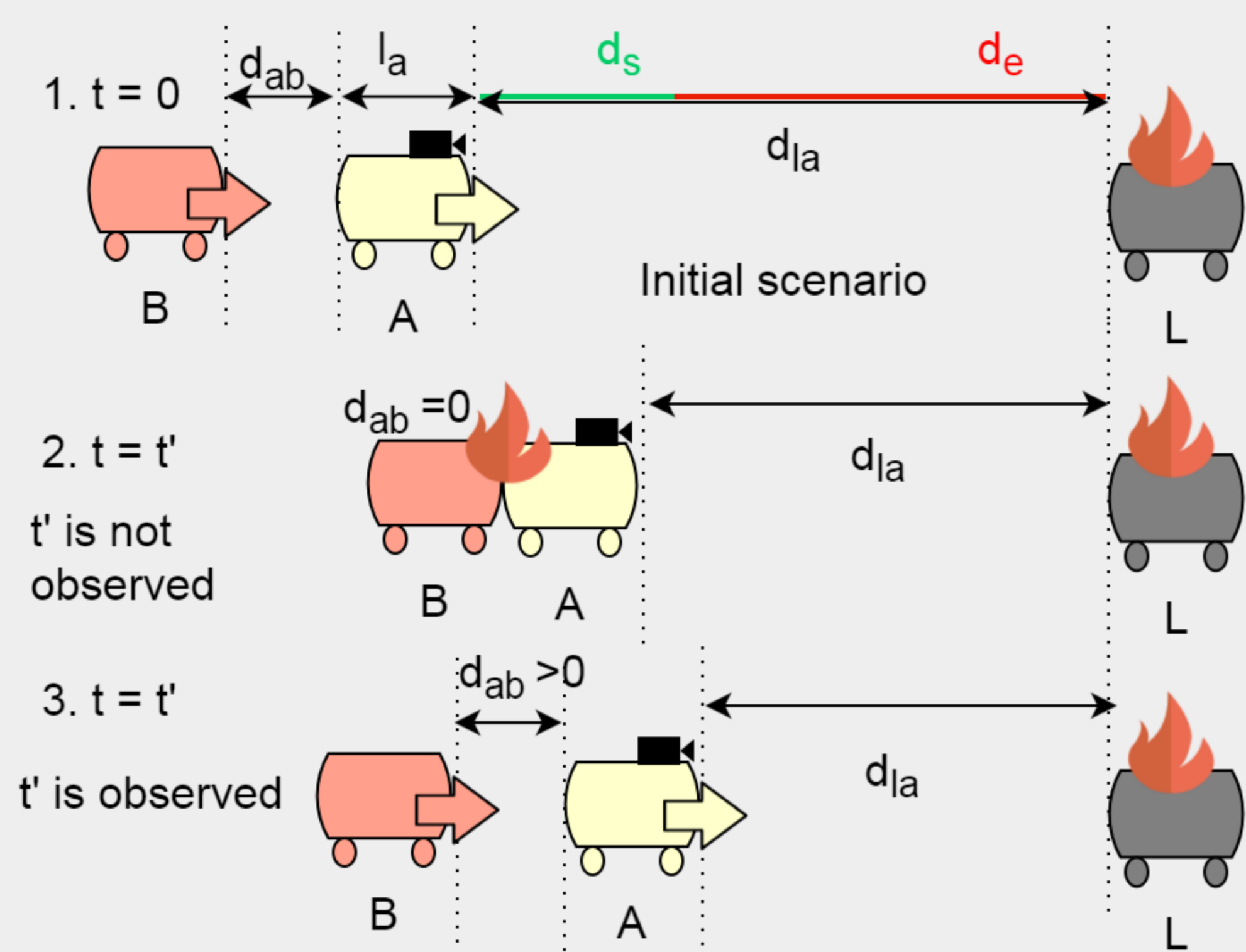


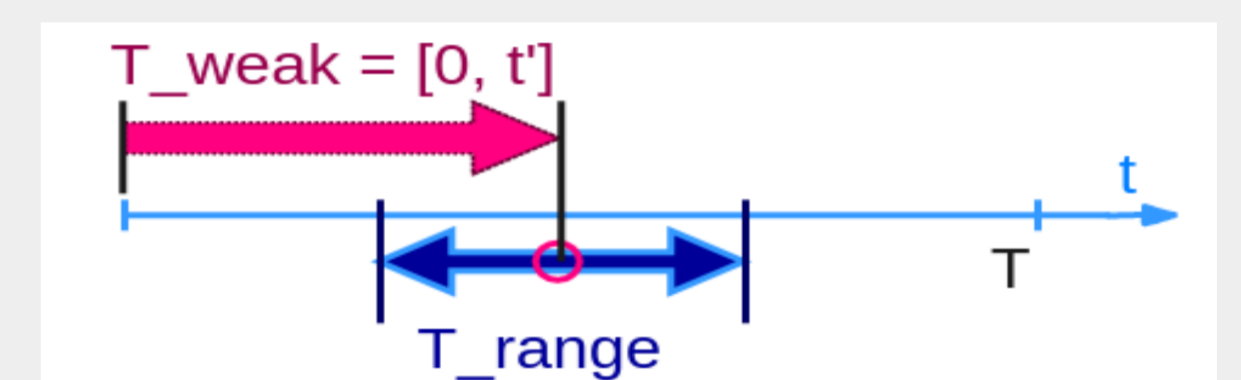
Fig. 3 Possible Scenarios

### Challenges:

- Danger Detection Issues by ADV:
  - Short range - sensors (10-20m)
  - Mid-range - V2X communication (50-100m)
  - Long-range - no detection due to V2X communication fading
- Maneuvering Issues by ADV:
  - ADV only detect hazard at short range
  - ADV has no reaction time
  - ADV hard break - collision with preceding vehicle
  - ADV low break - collision with obstacle

### Dynamic Deceleration Profile:

- T : total braking
- T\_weak: weak braking
- t' - T : maximum braking
- T\_range: range of t' for no collision



$$dece_A = \frac{dece_{max} * t}{t'} \dots t \leq t' \quad dece_B = \frac{dece_{max} * t}{t'} \dots t > t'$$

### Challenge: Optimal t' and breaking strength

## Results

### Determining t' from T\_range

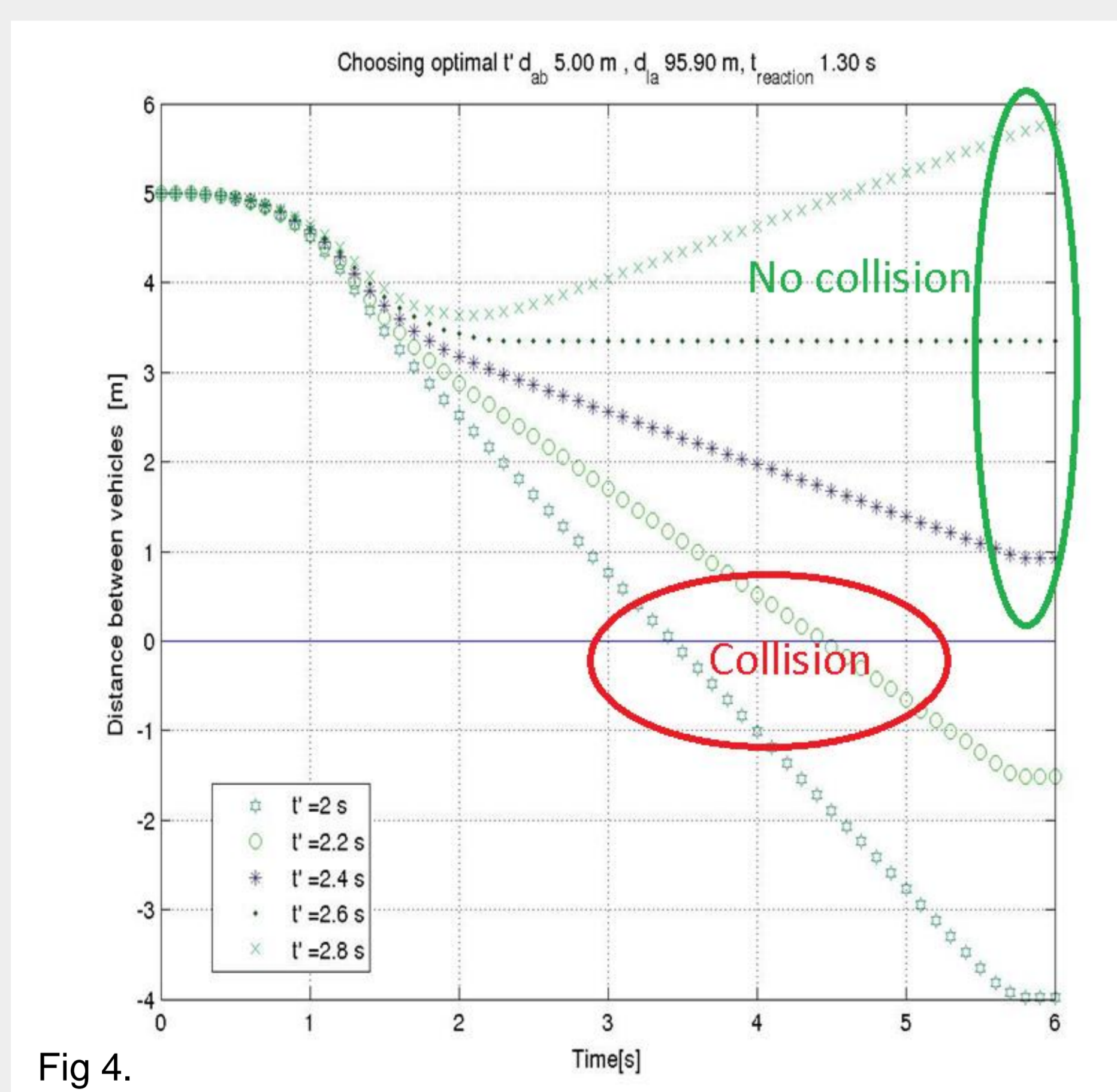


Fig 4.

- intersection with x-axis: A,B collide: t' too small
- all values of a sub-plot > 0: A, B do not collide: t' appropriate

### Rear end and front end collisions based on t'

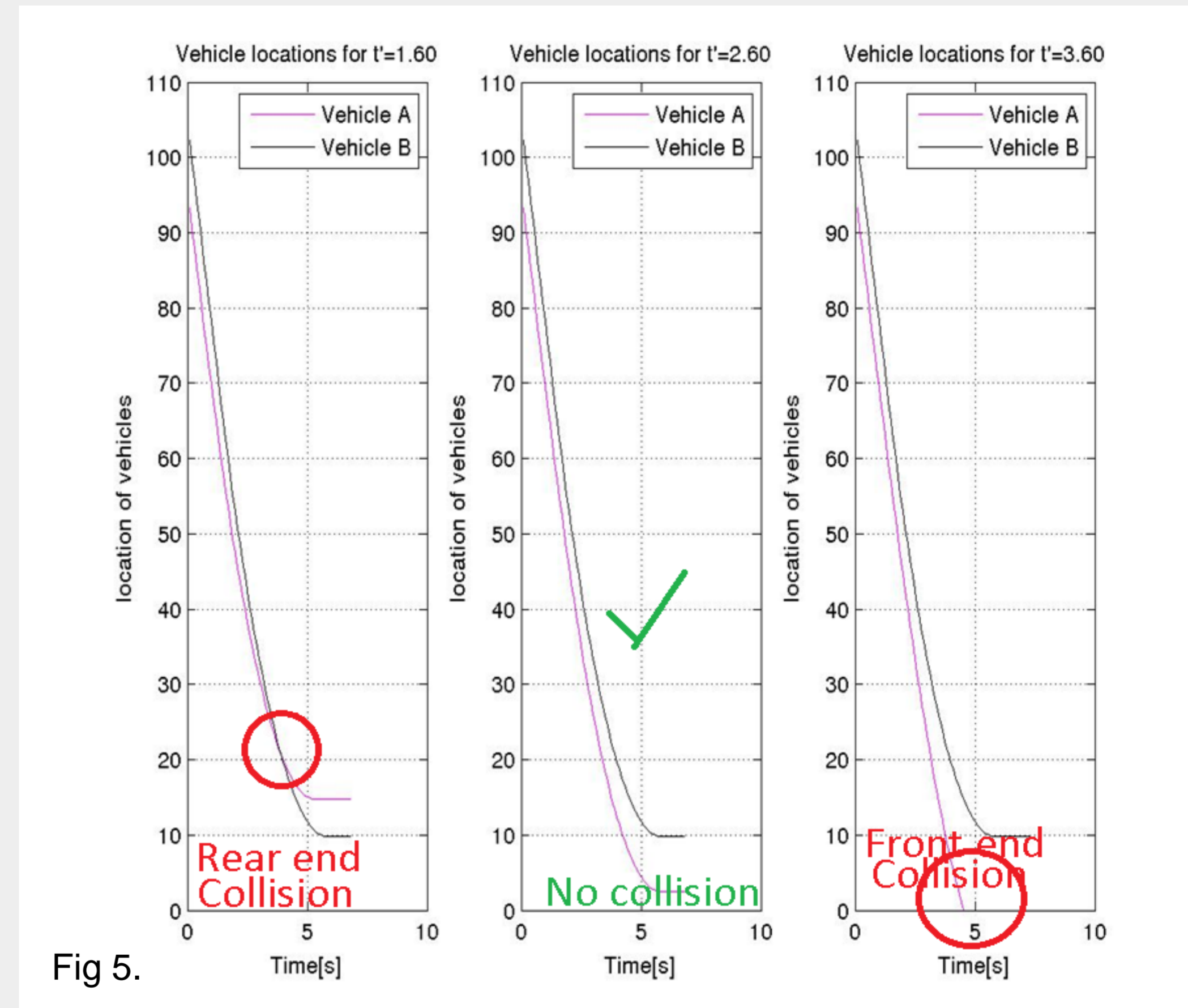


Fig 5.

- t' < T\_range: rear end collision
- t' ∈ T\_range: No collisions
- t' > T\_range: Front end collision

## Summary

- Consideration of influence of conventional vehicles onto autonomous vehicles and vice a versa: must for safe maneuvering
- Dynamic adaptation and cooperation with neighboring vehicles: possible with autonomous vehicles
- Future work: Feasibility of application on mixed platoons with multiple followers

### References:

1. Raj Haresh PATEL, Jérôme HÄRRI, "Coordinated Breaking Strategies Supporting Mixed Autonomous and Conventional Vehicles " (in preparation)