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COOPERATIVE EXTENSION

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Security of Distributed Cyber-Physical Systems (CPS) with Platoon Applications

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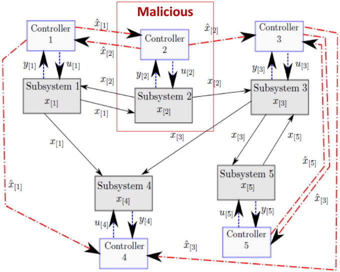
Problem Statements

- **Compromised subsystem in a distributed CPS**
  - One or more than one subsystem are malicious and acting against a global goal.



- **Strategy**
  - Game theory approach.
  - Design controller for rest of subsystems in the distributed CPS to keep the performance of the whole CPS close to normal.

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Platoon Models

- Centralized Control: All vehicles send information to a centralized controller that makes the optimal decision to minimize total fuel consumption.
- Decentralized Control: Each vehicle makes its own decision based on local information to minimize its own fuel consumption.

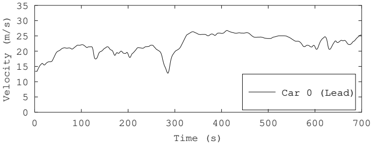
Controller Design

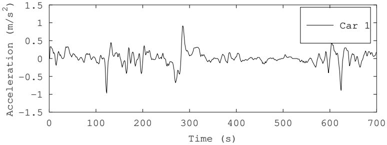
- **Objective Function**:

$$L_i(t) = \underbrace{w_1 \int_{\Delta t} \frac{\text{Fuel}}{v_i(t)}}_{\text{fuel consumption}} + \underbrace{w_2 R^2_{\text{error}} + w_6 R^2_{\text{error}'}}_{\text{distance}} + \underbrace{w_3(v_{i-1}(t+1) - v_i(t+1))^2}_{\Delta\text{v between car}_{\text{i-1}} \text{ and car}_{\text{i}}}$$

$$+ \underbrace{w_4 a_i^2(t)}_{\text{acceleration}} + \underbrace{w_5(v_{i+1}(t+1) - v_i(t+1))^2}_{\Delta\text{v between car}_{\text{i}} \text{ and car}_{\text{i+1}}}$$

- Solve $\dfrac{\partial L_i(t)}{\partial a_i(t)} = 0$





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Introducing Noise

Kalman Filter

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