A Framework to Determine Road Networks’ Platoonability

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Objective

Developing a framework that can identify if a roadway segment in a network is suitable for platooning. The framework considers the benefits of platooning to the trucking industry and the impacts of platooning on regular traffic. The developed framework is named Platoonability Level Analysis for Networks (PLAN) and applied to Illinois Road Network.

Important Parameters

1. Geometric Considerations
   - Platooning is most efficient at high speed and free flow conditions.
   - Roadway must have entry and exit ramps connecting to mainline.
   - Interstates, Freeways and Major arterials are selected (Functional class 1 and 2 in Illinois road network).
2. Traffic Density
   - As traffic density approaches road capacity, free flow speed is compromised. Hence, platoon's efficiency decreases.
   - Level of service of the roadway can be used as a proxy for traffic density.
3. Ramp Density
   - A platoon is more likely to interact with other vehicles near exit and entry ramps. Interactions are expected to break platoon formation or decrease efficiency.
   - These interactions are a function of ramp density and traffic.

Methodology

1. Divide Roads into 20-mile segments
   - Sections that can sustain FFS
2. Analyze Traffic Density
   - Capacity = \((2200 + 10\min(FFS/\text{limit}) - 50) \times \text{lanes}\)
   - Calculate Volume/Capacity using road traffic data
3. Analyze Interactions Near Ramps
   - Calculate the expected number of interactions between a platoon of varying configurations and regular traffic
   - \(E[\text{Interactions}] = D_t \times T_p\)
   - \(D_t = \text{number of vehicles at a ramp in a second}\)
   - \(T_p = \text{time it takes for a platoon with } N \text{ trucks, spacing } s, \text{ and speed } v \text{ to block a ramp}\)
4. Assign Platoonability Level
   - Determine the platoonability level using figure

PLAN on Illinois Road Network

- PL1-3 are assigned to be platoonable, PL4 as transition zone and PL5 as not platoonable.
- Illinois road network is assessed using PLAN and it was found that 83%, 89% and 96% of the selected roadways were platoonable during peak hours, average hours and off-peak hours.

Findings and Conclusions

- A novel framework is introduced to determine roadways suitability for platooning.
- The framework uses traffic density and number of interactions per 20-mi sections as a proxy for platoonability efficiency.
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- Illinois road network is assessed using PLAN and it was found that 83%, 89% and 96% of the selected roadways were platoonable during peak hours, average hours and off-peak hours.

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