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Deployment of Cooperative Truck Platooning in Canada: Opportunities and Challenges

Task Force on Vehicle Weights and Dimensions Policy
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Overview

- Introduction
- First Generation Truck Platooning
- Potential Benefits
  - Fuel Savings
  - Safety
- Pilot Demonstration and Deployment Considerations

Introduction

- NRC is currently conducting a study and preparing a report for Transport Canada to highlight the necessary considerations to support pilot demonstration and eventual commercial deployment of truck platooning in Canada.
- A workshop entitled "*The Road to Cooperative Truck Platooning Systems (CTPS) Deployments in Canada*" was conducted in Ottawa on October 24, 2018. The objectives of the workshop were:
  - To raise awareness and understanding of the technologies, opportunities, benefits, value propositions, challenges, and barriers to first generation truck platooning systems;
  - To help ensure Canada will be ready for the safe pilot demonstration and eventual commercial deployment of truck platooning systems on public roadways in Canada; and
  - To help initiate dialogue, discussions and collaboration among sector stakeholders.
- A workshop primer was distributed to provide workshop participants with an overview of some key concepts and background information.

First Generation Truck Platooning

- First generation truck platooning systems use *Cooperative Adaptive Cruise Control* (CACC), which adds *Vehicle-to-Vehicle* (V2V) data communication to the in-vehicle radar and camera technologies of production ACC systems:
  - Level 1 Automation as defined in the SAE J3016 recommended practice.
- Drivers in a truck platoon operate as a team:
  - Driver of lead truck drives normally and may or may not use ACC, but *Forward Collision Avoidance and Mitigation* (FCAM) always on.
  - Driver of following truck(s) always responsible for steering and safe driving, acceleration and braking are automated (while platooning), FCAM always on.

- **A truck platoon is a temporary configuration of two or more trucks – it can be modified or terminated at any time**

Potential Benefits

- **Today:**
  - Reduced aerodynamic drag leading to fuel savings in the range of 5-15% for the platoon (primary commercial motivation), with associated reduction of emissions
  - Enhanced safety due to fast braking response, and state-of-the-art safety systems
- **In the future, with significant market penetration:**
  - Improved traffic flow dynamics (further enhancing safety and reducing energy use and emissions)
  - Greater highway throughput (reduced levels of congestion and travel time)

- **Note that Level 1 truck platooning is a stepping stone to higher levels of truck automation, and greater potential benefits (in the future).**

Fuel Savings

- Factors which affect fuel savings:
  - gap between trucks
  - speed, speed variation
  - # trucks
  - position in platoon
  - aerodynamic shape (truck, trailer)
  - lateral alignment
  - road curvature
  - wind
  - surrounding traffic
  - cut-ins
  - **time spent platooning**
- Additional factors which affect fuel consumption:
  - weight
  - air temperature
  - engine technology
  - road topography

Enhanced Safety

Are your roads "more safe" or "less safe" with truck platoons operating?

- Trucks equipped to perform platooning will also be outfitted with state-of-the-art driver assistance and safety systems.
- Connected braking (using V2V communication) is the key to safe truck platooning.
- Typical time gaps are expected to be 0.6-1.2 s (which equates to a following distance of 17-34 m @ 100 km/h).
- The gap can be dynamically adjusted by a following driver based on comfort and conditions.
- Trucks can be ordered based on braking capability.

Enhanced Safety

- The platooning system design can deal with communication errors or system faults, by gracefully dissolving the platoon and reverting to ACC or full driver control.
- Since the potential fuel savings generally increases as the distance between the trucks is reduced, the challenge is to determine the shortest acceptable gap.
- With a shorter gap, the platoon also occupies less space on the highway, and cut-ins from other traffic are less likely.

- **Truck platooning will only be conducted when and where it is safe to do so (determined by the driver, the system, and/or regulations).**

Pilot Demonstration and Deployment Considerations

- The NRC study will highlight and discuss a broad range of deployment considerations:

  - truck/trailer configuration (category, performance, payload)
  - # trucks, time gap
  - permit requirements
  - data collection, reporting
  - eligible participants
  - appropriate highways, restricted areas
  - infrastructure concerns – e.g. bridges
  - signage (road, vehicles), escort vehicles
  - traffic interaction
  - enforcement
  - performance and safety standards, certification (platooning system)
  - inspection and maintenance requirements
  - driver training, qualification
  - human factors
  - public education
  - security and privacy
  - environmental

Regulatory Considerations

- need to identify legal barriers that might slow down or impede commercial deployment
- no current legislation or regulations specific to truck platooning
  - regulatory focus has been on automated vehicles
- following distance is currently a barrier in all provinces
- creating a platooning framework is an opportunity to identify key terms, develop definitions, and harmonize their use
- balance safety with regulatory flexibility (during pilot phase)
- interprovincial harmonization

Highlights of Experience in U.S.

- Don’t over-regulate: Level 1 and 2 platooning are just enhanced driver assistance systems, not needing any special regulatory scrutiny for level of automation.
- Drivers should not require any special licensing, just brief training in how to use the system (~1 hour).
- Main regulatory issues involve gap selection, where there are no “right” or “wrong” answers.
  - driver preferences vary significantly, so flexibility is essential
  - define as time gap rather than distance
  - if too long, energy/emissions benefits are lost and cut-ins are too common
  - if too short, concerns re driver visibility, boredom/distraction, and emergency response
- No optimum platoon length, but control design, logistical complexity, and traffic impact increase with platoon length.

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Thank You!

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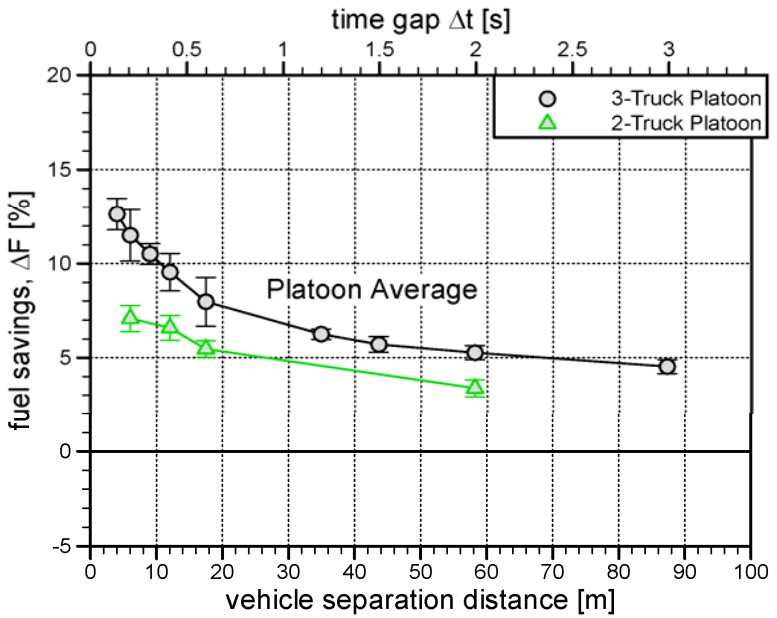
Back-up Slides

Introduction

- The workshop brought together stakeholders from government, industry and academia for both lectures and breakout group discussions:
  1. Safety: How safe is safe enough?
  2. Regulatory Framework
  3. Research and Knowledge Gaps
- A primer document prepared for the workshop provides more background information on cooperative truck platooning.
- Results of the workshop will be incorporated into the report to Transport Canada later this winter.

Potential Benefits – Fuel Savings

- Measured fuel savings during 3-truck CACC track testing at Motor Vehicle Test Centre in Blainville, QC (2016-2017)
  - prototype PATH system
  - truck weight 65,000 lbs, speed 65 mph



Comparison with Long Combination Vehicles (LCVs)

- 28% vs 7% fuel savings (at 105 km/h, 6-12 m gap, compared to two independent trucks)
- reduced capital and labour costs
- very restricted mobility – require LCV terminals, limited to approved routes
- speed limit and time-of-day restrictions
- required staging to coordinate two trailer loads

Platooning can occur when and where it is safe and practical to do so, but it can cease at any time such that the trucks operate independently.

Safety Risks and Risk Mitigation Practices

- Summary of safety risks and risk mitigation practices from breakout session at truck platooning workshop in Ottawa, October 24, 2018:

Safety Risk	Risk Mitigation Practice
• gap / following distance • brake performance • system reliability • performance standards • truck weight, type of cargo • environmental – weather, road conditions • road network – entrance/exit ramps, bridges, tunnels, grades, etc. • construction zones • emergency manœuvres – wildlife, accidents, other drivers • cybersecurity • driver qualifications, safety record • driver boredom, inattentiveness, fatigue	• pilot projects – evidence-based, iterative approach to implementation • codes and standards, robust technology, clear safety guidelines • enhanced vehicle maintenance • limiting platoon size • specific road networks, signage, geofencing • adjusting gap to suit conditions • ceasing platooning operations in unfavourable conditions • public education and awareness • driver alertness monitoring system