Transport Canada's Evaluation of Cooperative Truck Platooning Systems (CTPS)

CENTRE D'INNOVATION CENTRE

Marc Belzile

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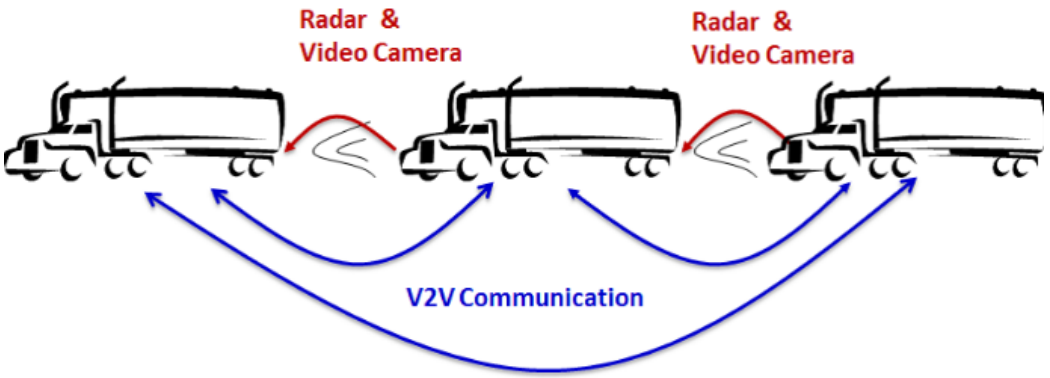
Cooperative Truck Platooning Systems (CTPS)

- Cooperative Truck Platooning Systems (CTPS) allows two or more trucks to follow closely behind one another which reduces aerodynamic drag, leading to a reduction in fuel consumption and GHG emissions.
- CTPS uses vehicle-to-vehicle (V2V) communications and forward looking sensors to automatically maintain a precise separation distance between vehicles.

- Platooning benefits:
  - Improved fuel economy
  - Reduced emissions
  - Improved road-use efficiency
  - Reduced driver workload



Source: California PATH Program

Transport Canada's Interest in CTPS

Transport Canada recognizes the benefits of CTPS technology, but recognizes there are obstacles to its commercialization.

Following a regulatory review roadmap process, the Government of Canada's 2018 Fall Economic Statement recommended working with industry to develop new regulatory approaches in support of innovation, and further noted:

> Use a truck platooning system test bed (sandbox) to support the development and adoption of platooning technologies

The CTPS pilot is expected to generate the technical evidence and information required by federal and provincial governments to develop/support:

- Industry guidance
- Guidelines
- Tools
- Regulations
- Operational and safety requirements
- Innovation and Regulatory Mandates

Goal:

- Provide technical evidence and experience necessary to support CTPS deployment on Canadian roads.

Previous Testing: Overview

Over the past several years Transport Canada has undertaken a variety of CTPS activities.

- Track Testing
  - In 2016 and 2017, on-track fuel consumption measurements were performed on a variety of platoon configurations (CTPS-capable trucks provided by University of California and Volvo Trucks)
  - 2019 track testing to measure fuel consumption effects due to lateral offsets of trucks, effect of surrounding traffic, and dynamics testing (trucks supplied by Auburn University).
- On-Road Trial
  - 2018 trial on Canadian roads (trucks supplied by Auburn University).
- Workshop
  - 2018, TC held a CTPS workshop with Industry, Government, Academia, and law enforcement agencies.
- Policy/Regulatory Study
  - 2019 study to identify key roadblocks to Canadian CTPS deployment.

Current Testing: Track Testing

CTPS Track Testing (2019)

In Summer 2019, TC partnered with Auburn University, National Research Council (NRC), National Renewable Energy Laboratory (NREL), PMG Technologies, and FPInnovations to conduct track testing at Transport Canada's Motor Vehicle Test Centre.

1) Fuel consumption measurements:

- Vehicle offset (Trucks in the platoon following each other with a lateral offset)
- Traffic configurations
- Trailer configurations (flatbed trailer platooning with dry-van trailer)

2) Vehicle Dynamic Testing:

- Demonstration of responsiveness of CTPS in dynamic braking events.
- Demonstration of CTPS performance in interactions with other vehicles.
- Learn to improve test methodology for platoon interaction scenarios.

3) Human Factors (early analysis):

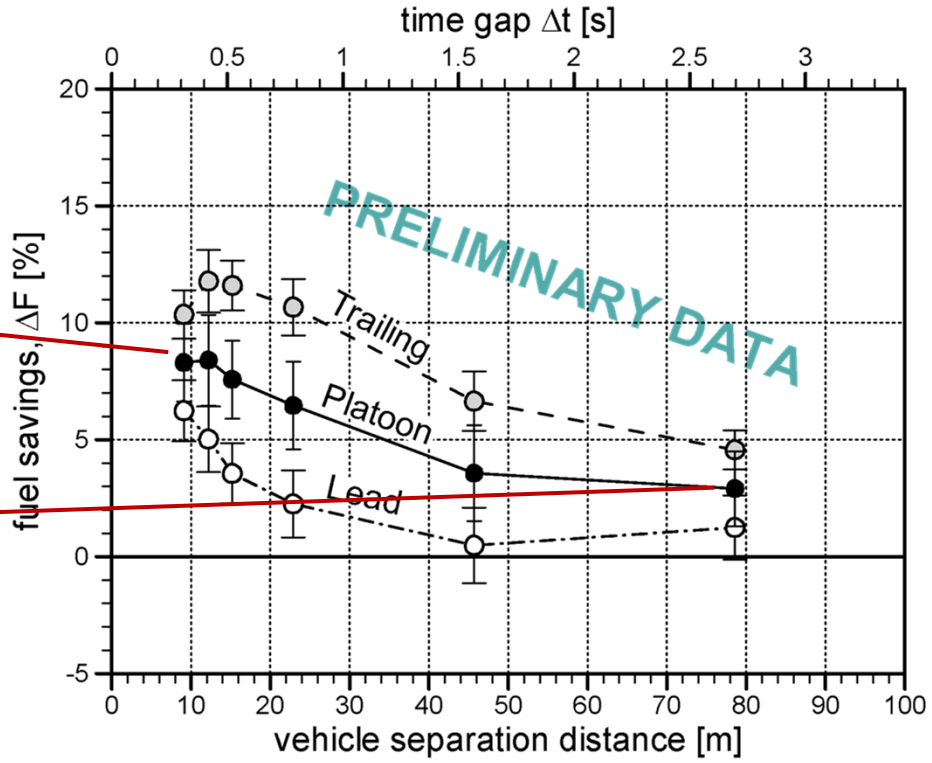
- Literature review and development of test methodology
- Testing planned to take place in 2020-21

2019 Fuel Consumption Measurements

CTPS Track Testing (2019)

8% at smallest separations

3% at largest separations



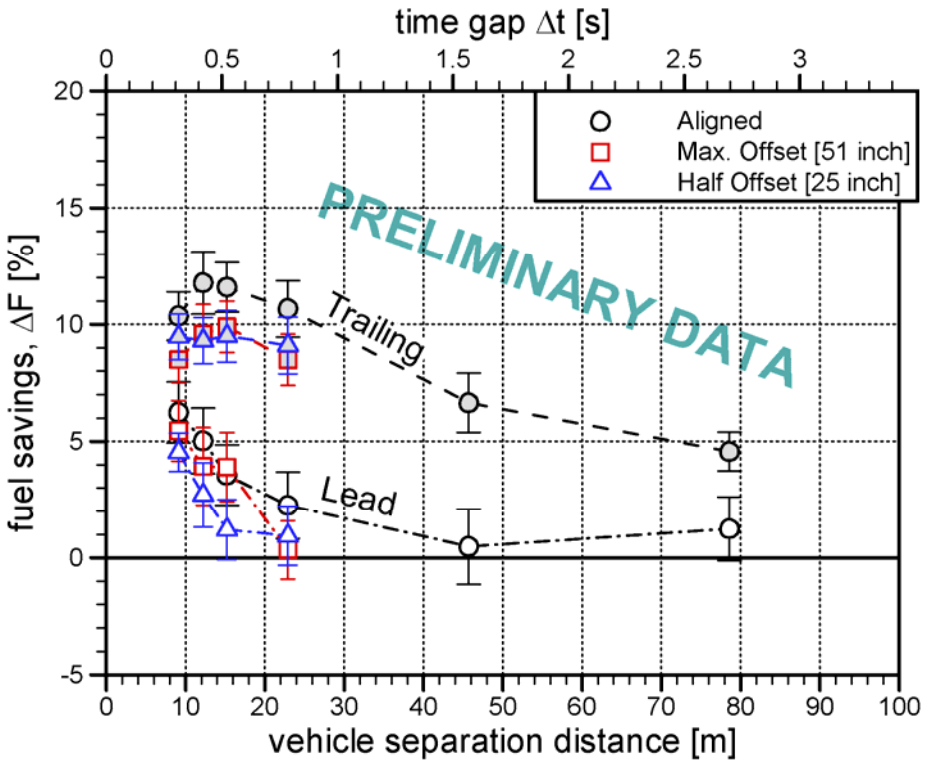
2019 Fuel Consumption Measurements

CTPS Track Testing (2019)

- Anticipated Reduced Fuel Savings with Lateral Offset

  Up to 3% reduction in savings observed

- Must analyze fuel-rate data to understand results:
- offset only achieved on straight segments (1/2 of the track)
- Cross winds different for max- and half-offset tests



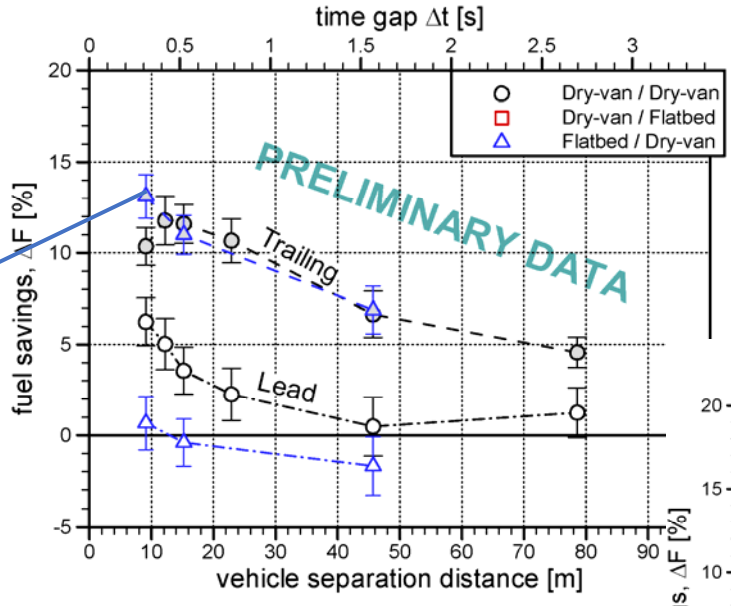
MAX OFFSET

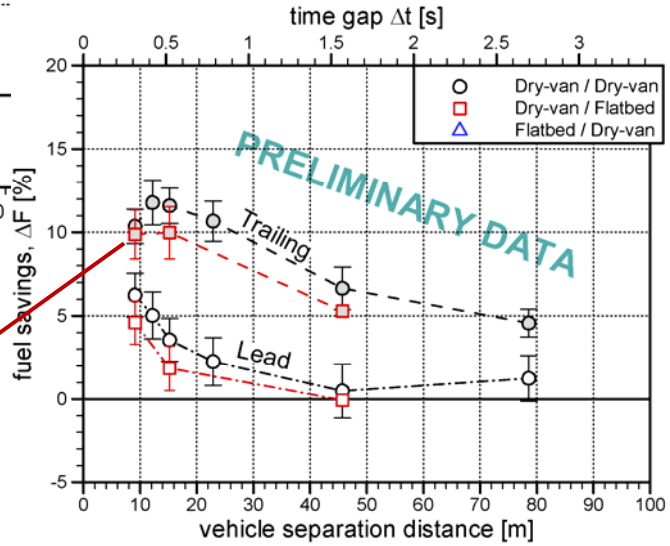
HALF OFFSET

2019 Fuel Consumption Measurements

CTPS Track Testing (2019)

- Exchanged a Dry-van for a Flatbed Trailer
- (same total weight)
- Flatbed in lead position shows greater impact
- Increased savings at 9 m for trailing truck
- Loss of savings on lead





Reduction in savings observed for flatbed in trailing position

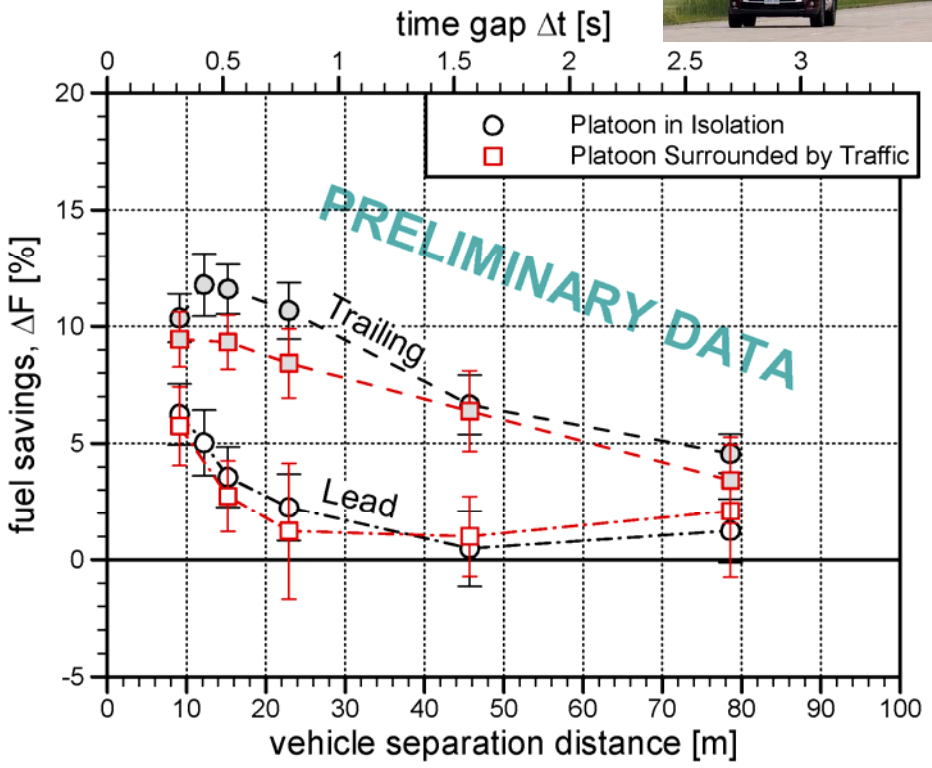
2019 Fuel Consumption Measurements

CTPS Track Testing (2019)

- Platoon Savings in 3-Vehicle Traffic Compared to Savings of Isolated Platoon

Reduction of trailing-truck savings up to 2.5%

Note:
~5% fuel savings observed for individual trucks in this traffic configuration



Summary

Preliminary observations:

- Two truck platoon saves ~8% at close separation distance (10m); ~3% at long separation distance (80m)
- Lateral offset of the trucks within a platoon reduced fuel saving by up to 3%, the difference between a smaller and larger lateral offset was very small.
- Having a flatbed trailer in a two-truck platoon reduces fuel savings by a few percent; surprisingly, the trailing truck had greater fuel savings when following the flatbed (vs a dry-van trailer).
- Our simulated “nearby passenger vehicle traffic” scenario showed ~5% fuel reduction for a single truck with same-speed traffic; the trailing truck in the platoon had reduced fuel savings of ~2.5% vs the no-traffic scenario (from the first bullet).

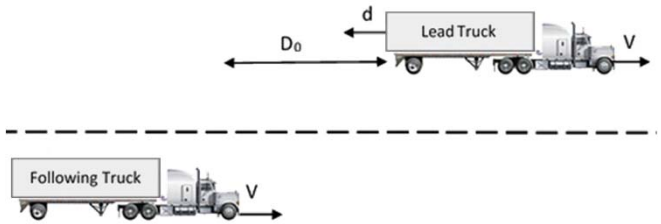
2019 Dynamic Testing

Single Truck Braking

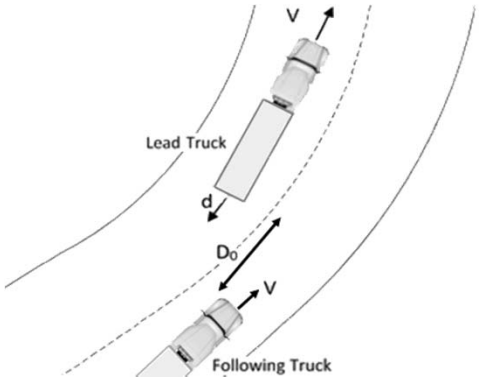
V = Truck initial speed
d = Deceleration of truck (braking)

- From 60 mph (96 km/h) to 0

Platoon Braking (150 ft gap)



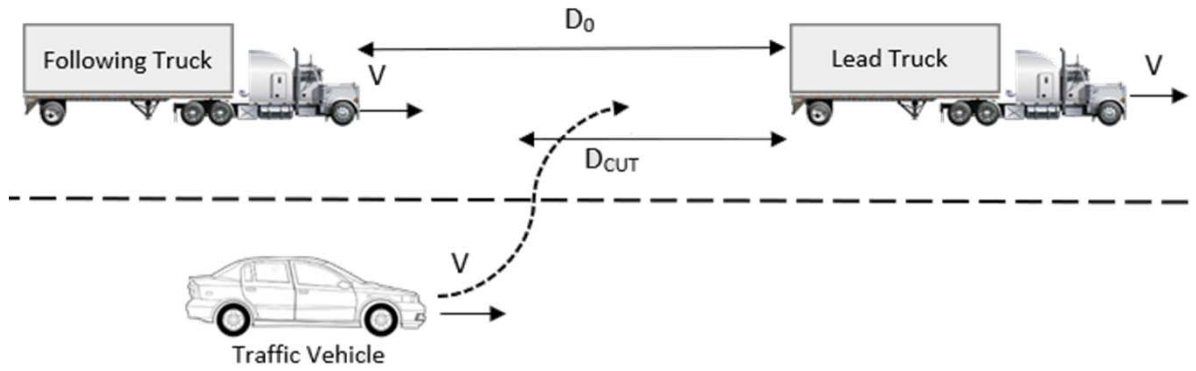
- From 60 mph and 50 mph
- Hard braking as well as gradual braking scenarios



- From 50 mph

2019 Dynamic Testing

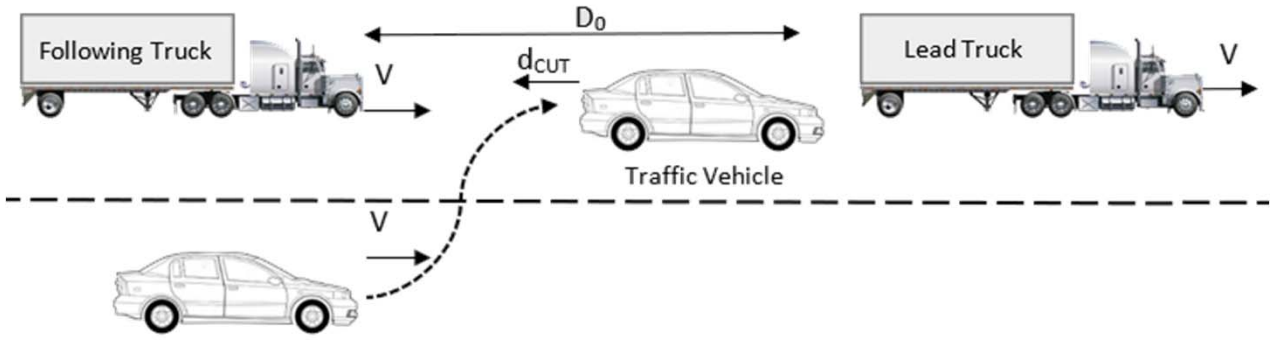
Vehicle Cut-In/Cut-Out, Same Speed



Platoon Speed (mph)	Platoon Separation Distance (ft)	Vehicle Speed (mph)	Vehicle Cut-In Distances from Lead Truck (ft)
60	150	60	15, 50, 100
60	75	60	15, 25, 40

2019 Dynamic Testing

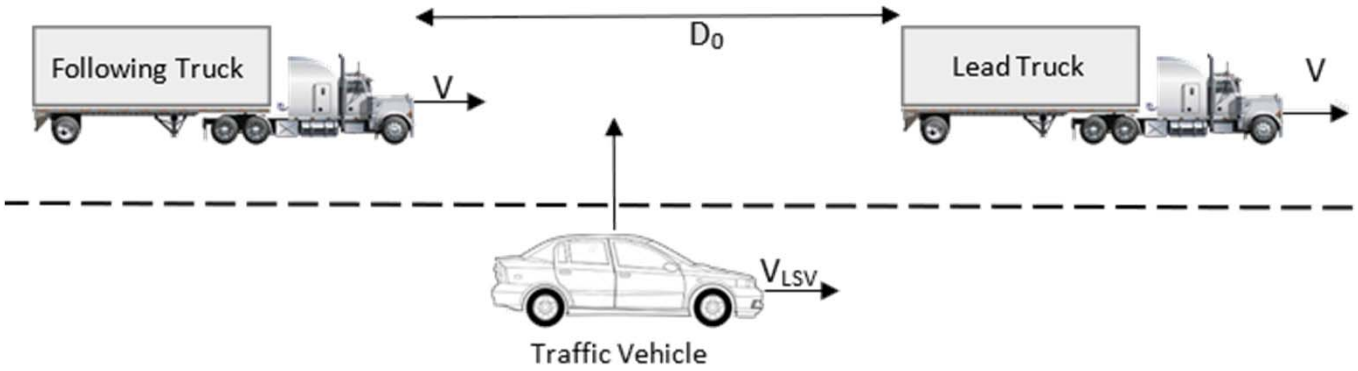
Vehicle Cut-In Then Decelerates



Platoon Speed (mph)	Platoon Separation Distance (ft)	Traffic Vehicle Speed (mph)	Traffic Vehicle Deceleration (g)
60	150	60	0.1 / 0.2 / 0.3

2019 Dynamic Testing

Lower Speed Vehicle Cut-In



Platoon Speed (mph)	Platoon Separation Distance (ft)	Traffic Vehicle Speed (mph)
60	150	55 / 50
60	195	45

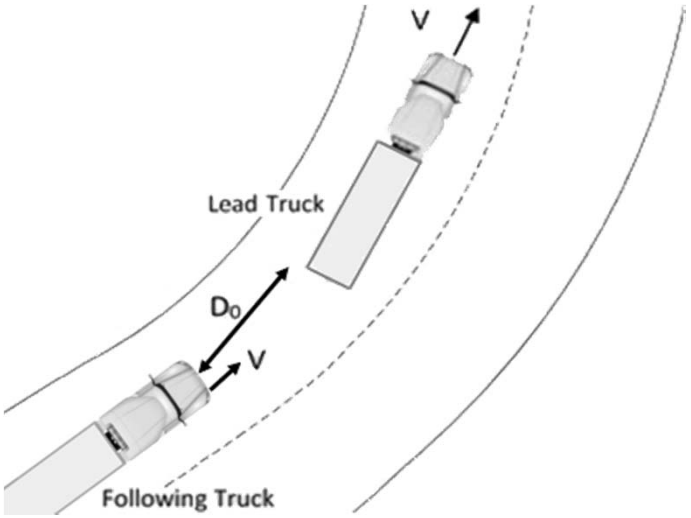
2019 Dynamic Testing

Automated Steering Assessment

Testing of automated steering capability (Following truck pursues same path as lead truck).

Testing included periods of:

- Constant speed
- Acceleration
- Deceleration
- Lane changes
- Speeds of 25 to 45 mph
- Separation distances 150 – 200 ft



2019 Track Test Partners

Canada NRC·CNRC

FPInnovations

AUBURN UNIVERSITY

CENTRE D'ESSAIS ET DE RECHERCHE PMG www.pmgtest.com TEST AND RESEARCH CENTRE

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Platoon Trial on Canadian Roads

Canadian On-road Trial, starting ~Fall 2020 (currently in planning)

- Will assess system reliability and dynamic performance on-track prior to on-road trail
- Verify fuel consumption and emissions benefits in real-world operation.
- Gather data to assess traffic impacts.
- Monitor dynamic performance of platoon such as braking events and reaction to vehicle cut-ins/merging.
- Assess human factors implications of operating in platoons.
- Understand limitations of CTPS technology and appropriate operational design domain.
- The trial experience will help identify appropriate requirements and enforcement measures for operating platoons.
- This data can help with analysis related to infrastructure impact concerns.
- Transport Canada intends to publish an RFP for administering the on-road trial in the coming months.
- We will be releasing a study authored by NRC exploring considerations to be undertaken for on-road platoon operation in Canada, anticipated December 2019.

Thank You

Marc Belzile

Senior Research Officer

Marc.A.Belzile@tc.gc.ca

Innovation Centre, Transport Canada

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