



# Automated Freight Vehicles

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Current technology, potential impacts and policy implications.

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*MASc Candidate*

*Freight Day VI*



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# Categorization of automated vehicles by SAE

	Human Driver Monitors Environment			System Monitors Environment		
	0	1	2	3	4	5
	No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
	The absence of any assistive features such as adaptive cruise control.	Systems that help drivers maintain speed or stay in lane but leave the driver in control.	The combination of automatic speed and steering control—for example, cruise control and lane keeping.	Automated systems that drive and monitor the environment but rely on a human driver for backup.	Automated systems that do everything—no human backup required—but only in limited circumstances.	The true electronic chauffeur: retains full vehicle control, needs no human backup and drives in all conditions.
Who steers, accelerates and decelerates	 Human driver	 Human driver and system	 System	 System	 System	 System
Who monitors the driving environment	 Human driver	 Human driver	 Human driver	 System	 System	 System
Who takes control when something goes wrong	 Human driver	 Human driver	 Human driver	 Human driver	 System	 System
How much driving, overall, is assisted or automated	 None	 Some driving modes	 Some driving modes	 Some driving modes	 Some driving modes	 All driving modes



# Level 2 – Partial Automation



- Adaptive cruise control
- Adaptive steering

# Level 5 – Full Automation



- Truck can be operated in any weather, traffic condition without the driver behind the wheel



# The Implications of Logistics

- Today, there are numerous applications of automated technology in logistics, providing further evidence that AV technology is improving safety, efficiency and are already successful in closed environments:
  - *Automated loading and transport in yards and warehouses*
  - *Assisted order picking in warehouses*
  - *Automated trucks in mining fields*



# Assistance in Warehouse Operations



- Enhancing operations of container terminals and warehouses.
- Reduced operating costs by eliminating labours and drivers.
- Improve safety by preventing labours' presences in the movement area.



# Assistance in Warehouse Operations



- An automated cart which follows the employees or brings the shelves to the employees
  - *Increase picking efficiency*
  - *Reduce workload for the employees*

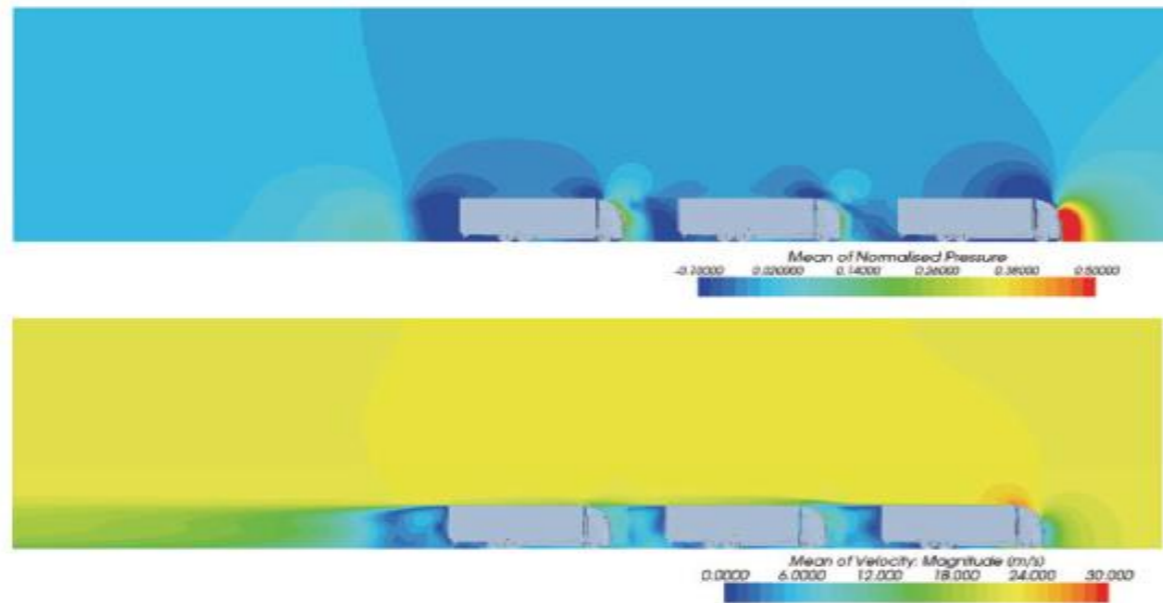


# Mining and Potentially Other Remote Jobs

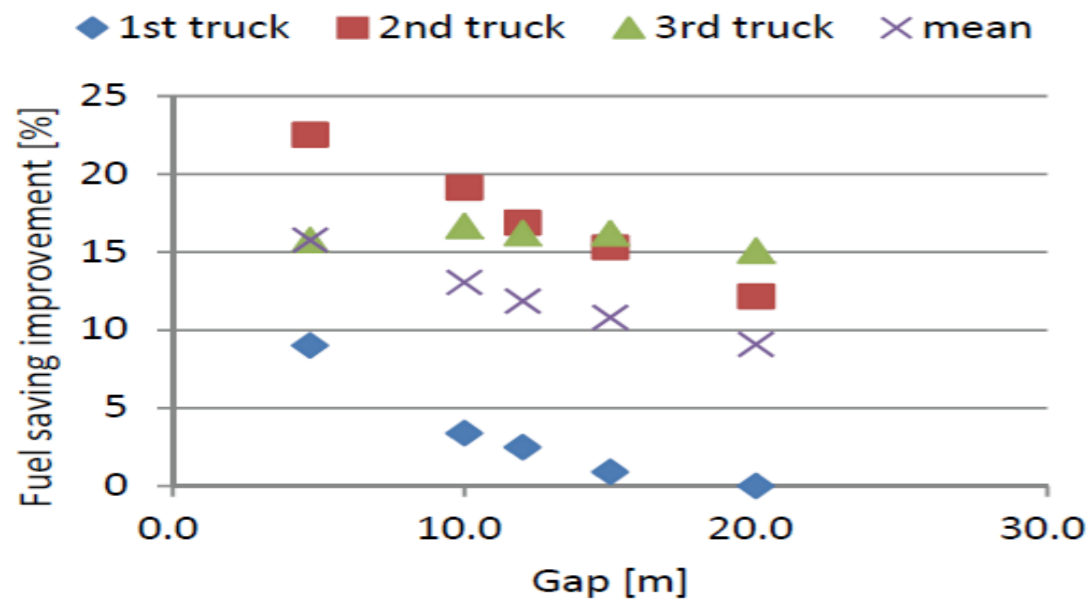


- Fills an existing job shortage
- Increases productivity by
  - *Improves schedule efficiency*
  - *Early identification of bottlenecks in the system*
  - *Significant savings in maintenance, tyre life and fuel*

# Long-haul Freight Movement



- Increase safety and reliability by reducing drivers' workload and human errors
- Increase productivity through 24/7 operation
- Enable platooning to reduce energy consumption and emissions due to aerodynamic drag reduction



# Last Mile Delivery



- Using sidewalks or airspace increases reliability and decreases traffic congestion
- Reduces the significant cost associated by last mile delivery through reduction in parking costs, labour costs, and fuel costs
- Reduces environmental side effects
- Increases productivity through 24/7 operation.

# Delivery Robots



We are ***certain*** that automated vehicles will change the way goods are moved.

But also uncertain ***when*** it will change, ***what*** it will change, and ***how*** it will change.



# Implications of AV Freight Technology

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Attempting to understand the uncertainties.



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# Importance of Efficient Freight Movements



# Economic Productivity

- Common belief is that AV Freight will improve business productivity and reduce operating costs<sup>[7]</sup>
  - *Reduction of transportation costs could in turn reduce the cost of goods for consumers*
- Biggest cost reduction will be removing the driver<sup>[8]</sup>
- Secondary cost savings would be from fuel efficiency and maintenance
- Increased working hours from 14 to 20 hours a day<sup>[8]</sup>





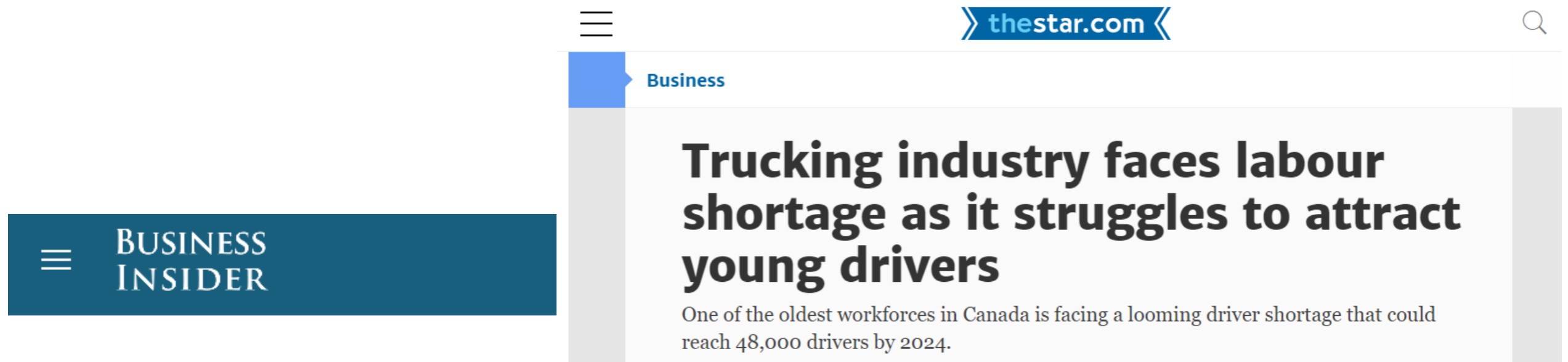
# Shift in the Job Market

- There are currently 560,000 commercial drivers employed in Canada<sup>[8]</sup>
  - *All of which could be displaced*
  - *Or slowly transitioned*
- In a report by Ticoll<sup>[7]</sup>, estimates of the change for each job sector
  - *Manufacturing; retail trade; (-2 to -15%)*
  - *Wholesale trade, truck transportation (-15 to -50%)*



# Counterpoints to the Job Market Shift

- AV can create new opportunities for business models
- “Robot Tax”
  - *Suggested by Bill Gates in a recent interview with Quartz Magazine<sup>[10]</sup>*
- Luddite fallacy
- Existing job shortage of truck drivers



The screenshot shows a news article from thestar.com. The article title is "Trucking industry faces labour shortage as it struggles to attract young drivers". The sub-headline reads: "One of the oldest workforces in Canada is facing a looming driver shortage that could reach 48,000 drivers by 2024." The Business Insider logo is visible on the left side of the screenshot.

**There's A Huge Shortage Of Truck Drivers In America – Here's Why The Problem Is Only Getting Worse**



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Image credit: Badkar, Mamta; Business Insider;  
<http://www.businessinsider.com/americas-truck-driver-shortage-2014-7?op=1>; Lowrie, Morgan; The Star;  
<https://www.thestar.com/business/2016/05/16/trucking-industry-faces-labour-shortage-as-it-struggles-to-attract-young-drivers.html>

# How soon?

Software and car manufacturing companies predict Level 3-5 AVs on road by 2019 – 2020 (Driverless Future, 2016)

Former Secretary of Transportation Anthony Foxx expects AV to be in use all over the world by 2025

Consulting firms and market analyst generally predict level 4-5 AVs will be commercially available in 2020 and commonplace by late 2020<sup>[7]</sup>

The Institute of Electrical and Electronics Engineers forecasts that 75% market penetration rate by 2040<sup>[13]</sup>



# Limitations in Literature

- Simulation of different penetration rates of CV technology to guarantee accurate MOE estimates on signalized arterials<sup>[1]</sup>
- Simulation of AV to reduce unloading time and management at seaports<sup>[2]</sup>
- Fuel savings from platooning<sup>[9, 11, 12]</sup>
- Control designs of platooning<sup>[4]</sup>
- How the use of drones for commercial purposes will impact society<sup>[3]</sup>
  
- There needs to be more research assessing impacts from multiple perspectives<sup>[5]</sup>
- Also need pilot projects to confirm assumptions



# What are others doing?

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Few governments are actively working on policies, and even fewer are working on freight-specific policies

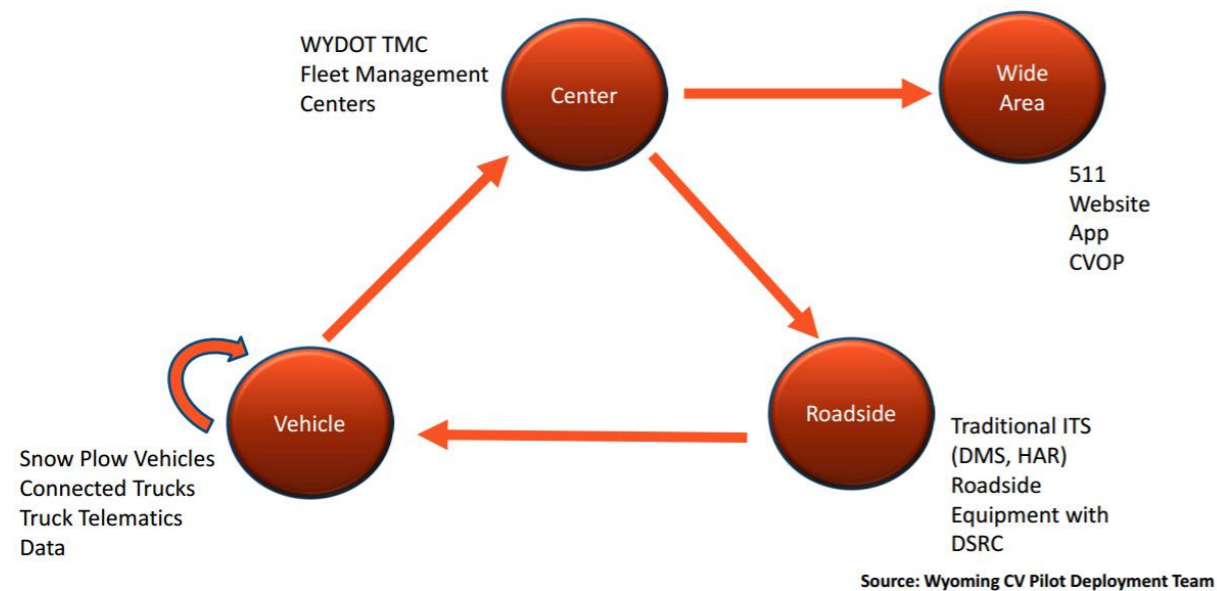


# United States



- US DOT, California, Nevada, Michigan and many other states have policies to work with AV testing
  - *In the Federal Automated Vehicles Policy report issued in September 2016 there was no mention of freight<sup>[15]</sup>*
- Nevada
  - *Licensed 2 Freightliner Inspiration Trucks for regular operation on public roads*

# United States



- Colorado
  - *Worked with Otto (Uber) on a beer run with the driver in the berth of the truck*
- Wyoming
  - *Using federal grants on V2V and V2I applications for efficient and safe freight movements<sup>[16]</sup>*
- Central North American Trade Corridor Association
  - *Was in the process of working with 6 states to create an AV-specific corridor to carry commerce*

# United States – Pilot Tests

- Texas is planning a pilot called “Truck Level 1 Platooning” on the I-45<sup>[18]</sup>
  - *Open communication between State DOT, law enforcements, and private sectors*
- Michigan is testing automated trucks on I-69 corridor<sup>[19]</sup>
  - *Finding the future infrastructure needs*
  - *Identified key areas of concern (i.e. on- and off-ramps)*
  - *Successful pilot projects require the support of governments, but also clear requirements from the manufacture or company*
- Utah is planning a pilot with Paletton<sup>[20]</sup>
  - *Truck platooning test*
  - *Working directly with a company, Utah truck association and Utah DOT*





# Europe



- Amending the *Vienna Convention on Road Traffic* to allow for AV on roads for many European countries<sup>[21]</sup>
- UK published a report, *Pathway to Driverless Cars*<sup>[21]</sup>, which does not mention freight
  - *Allows organizations to test AV on roads without special permits*
- Germany has reviewed its legislation to allow AV testing
  - *Daimler-Benz demonstrated the Mercedes-Benz Future Truck 2025 driving on a closed off section of the autobahn*
  - *Autobahn upgrades to allow for AV and communication technology*

# Europe



- Sweden has reviewed its legislation to allow AV testing
  - *Working with Volvo on platooned vehicles under the SARTRE*
  - *Project on refuse handling using semi- to fully-automated trucks and robots*
- SARTRE Project<sup>[22]</sup>
  - *Funded by the European Commission, completed in 2012*

# What are we currently doing?

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Ontario has an opportunity to shine.



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# Ontario

- AV Pilot Program<sup>[13]</sup>
  - *Regulatory framework and availability of funding to support innovation*
  - *Current participants include: University of Waterloo, Erwin Hymer Group, and BlackBerry QNX*
- Ontario Centers of Excellence is pledging \$1 million to support innovative and commercially viable projects through the Connected Vehicle/Automated Vehicle Program
- Supporting 5G technology and next generation networking with Quebec
- **No freight projects**



# Suggestions

- A multi-tiered funding system for AV-related projects
  - *Freight is a good starting point because of the immediate economic benefits*
- An update to the regulatory framework to facilitate AV freight use
  - *Specific policies focused on safety during mixed-traffic situations<sup>[24]</sup>*

## Headway

### Headway of motor vehicles, generally

158. (1) The driver of a motor vehicle or street car shall not follow another vehicle or street car more closely than is reasonable and prudent having due regard for the speed of the vehicle and the traffic on and the conditions of the highway. R.S.O. 1990, c. H.8, s. 158 (1).

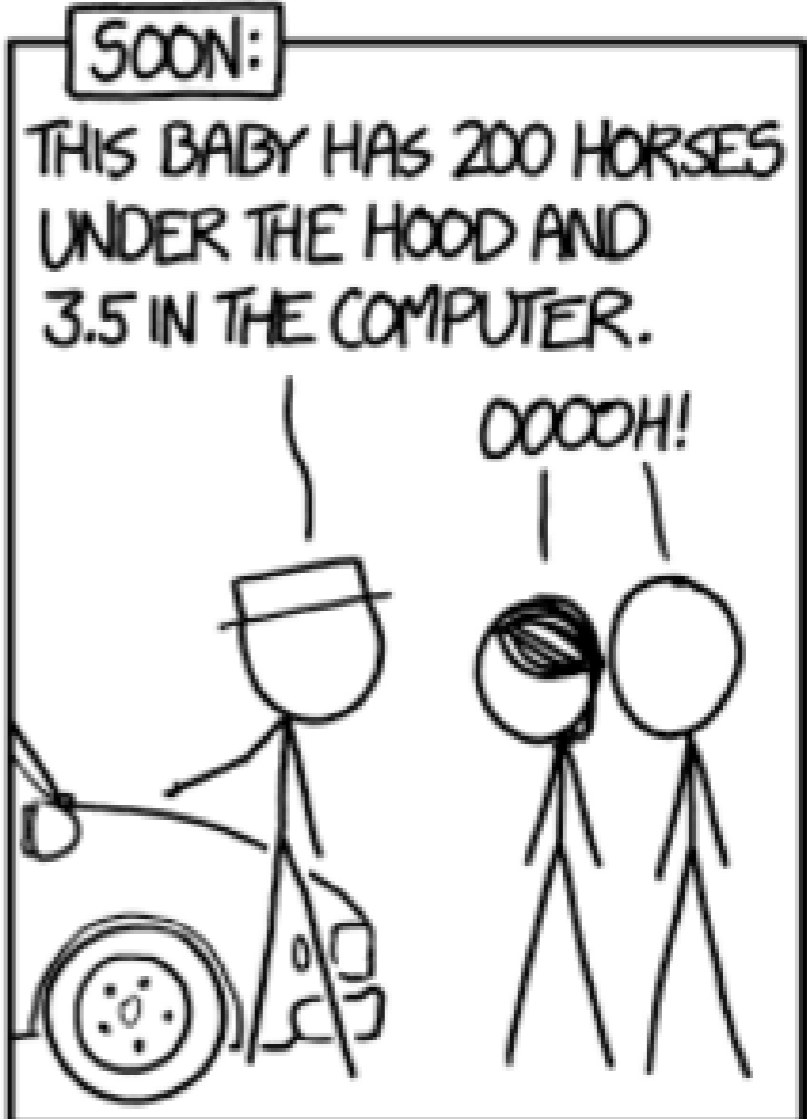
### Headway for commercial motor vehicles

(2) The driver of a commercial motor vehicle when driving on a highway at a speed exceeding 60 kilometres per hour **shall not follow within 60 metres of another motor vehicle**, but this shall not be construed to prevent a commercial motor vehicle overtaking and passing another motor vehicle. R.S.O. 1990, c. H.8, s. 158 (2).

- A need for Canada to lead in regulatory harmonization with US<sup>[23]</sup>
- Designate on-road testing sites
- Ecosystem of “hubs” to connect the isolated developments<sup>[25]</sup>



# Horses



Title text: This car has 240% of a horse's decision-making ability and produces only 30% as much poop.



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# Thanks!

## Questions?

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