Assessing The Impacts and Challenges of Truck Platooning on Highway Infrastructure in Montana

TASK 1 REPORT

This report is a result of collaborative efforts, who have contributed to the research, analysis, and preparation of the findings. This report is prepared by:

Sherif M. Gaweesh, PhD. Assistant Professor
Kobena Eghan, Research Assistant
Md Ashik Mahamud, Research Assistant
Rebecca Frimpomaah, Research Assistant
Department of Civil Engineering, University of North Dakota

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Contents

List of Figures

List of Tables

Review of Truck Platooning Legislation

Introduction

The rapid advancement of transportation technologies, including the emergence of truck platooning, presents both opportunities and challenges for state transportation systems. Projections suggest that by 2050, automated driving systems could account for up to 50% of the U.S. vehicle fleet, making it imperative for transportation agencies to stay ahead of these developments. Truck platooning, which offers advantages such as improved fuel efficiency, enhanced safety, and optimized traffic flow, holds significant potential for improving the operational efficiency of the trucking industry and contributing to overall economic growth. However, to fully utilize these benefits, the uncertainties and challenges that accompany the integration of truck platooning into the state's transportation network should be addressed.

There are several technical and nontechnical challenges that could affect testing and deploying truck platooning. Technical issues could involve issues related to connectivity and communication technologies, cybersecurity, infrastructure integration, operation and connectivity in adverse weather, takeover requests, etc.

Alongside the numerous technical considerations, non-technical challenges also warrant attention. These include 1) organizational implementation challenges, 2) regulatory and legislative challenges, 3) concerns surrounding safety and liability, 4) issues regarding privacy and security, and 5) public acceptance of truck platooning. These non-technical issues could provide hurdles toward testing and deployment of truck platooning technologies. Figure 1 shows the technical and nontechnical challenges that could face the testing and deployment of truck platooning technologies.

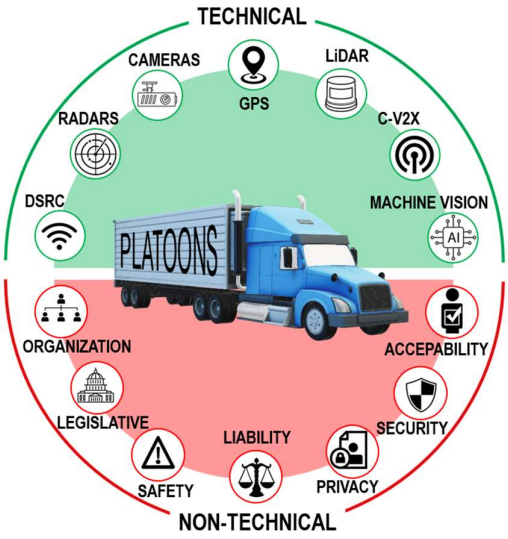

Figure 1: Technical and Non-Technical Challenges for Deploying Truck Platooning

This chapter entails a systematic review of the legislative landscape governing truck platooning across the United States. The focus is on identifying states that have implemented regulatory frameworks to facilitate the adoption of platooning technology and those that have yet to establish relevant policies. By examining legislative trends and variations, this review aims to provide a robust understanding of the regulatory environment, offering critical insights into policy readiness and potential challenges. These findings will serve as a foundational component for evaluating the implications of truck platooning on highway infrastructure, with a particular emphasis on its relevance to Montana. This chapter will also provide insights into updating existing legislation and developing new regulations that align more closely with those of other states, facilitating intra- and inter-state deployments.

Mapping Each State's Legislative Status on Truck Platooning

In this section, a state-by-state review was conducted to map the legislative status of truck platooning across the United States. The focus was on identifying states that have established regulatory frameworks to support the adoption of truck platooning technology and those that have not. The findings are presented using a color-coded map to visually depict the variations in legislative adoption, offering a clear understanding of the current regulatory landscape.

It is crucial to distinguish between Connected and Autonomous Vehicle (CAV) bills and truck platooning legislation to provide clarity on the scope of this section. CAV bills address a broad array of technologies, including vehicle-to-vehicle communication, infrastructure interaction, and fully autonomous systems. These laws generally establish frameworks for deploying advanced autonomous technologies, covering safety protocols, remote driver responsibilities, and operational parameters for vehicles capable of self-driving.

Truck platooning laws, on the other hand, focus narrowly on enabling a coordinated operation of multiple trucks through synchronized braking, acceleration, and minimal following distances. These regulations often provide exemptions from standard traffic laws, such as those governing following distances, to facilitate the safe and efficient operation of platooning systems. By centering on truck platooning legislation here, this section emphasizes the specific policies and measures tailored to the unique requirements of platooning technology, without conflating them with the broader and more general objectives of CAV regulations.

The map provided in Figure 2 presents a comprehensive depiction of the legislative status of truck platooning across the United States, with each state individually assessed to determine its position on truck platooning legislation. Using a color-coded scheme, states that have enacted truck platooning bills are shaded in green, indicating a proactive legislative framework that supports the integration of platooning technology. Conversely, states depicted in white represent jurisdictions where no specific platooning legislation currently exists, highlighting gaps in regulatory adoption. The map in Figure 3 outlines AV legislation in the U.S. States shaded in green have enacted laws, blue indicates executive orders supporting AV initiatives, yellow shows pending legislation, orange marks failed legislation, and white represents states with no specific AV laws.

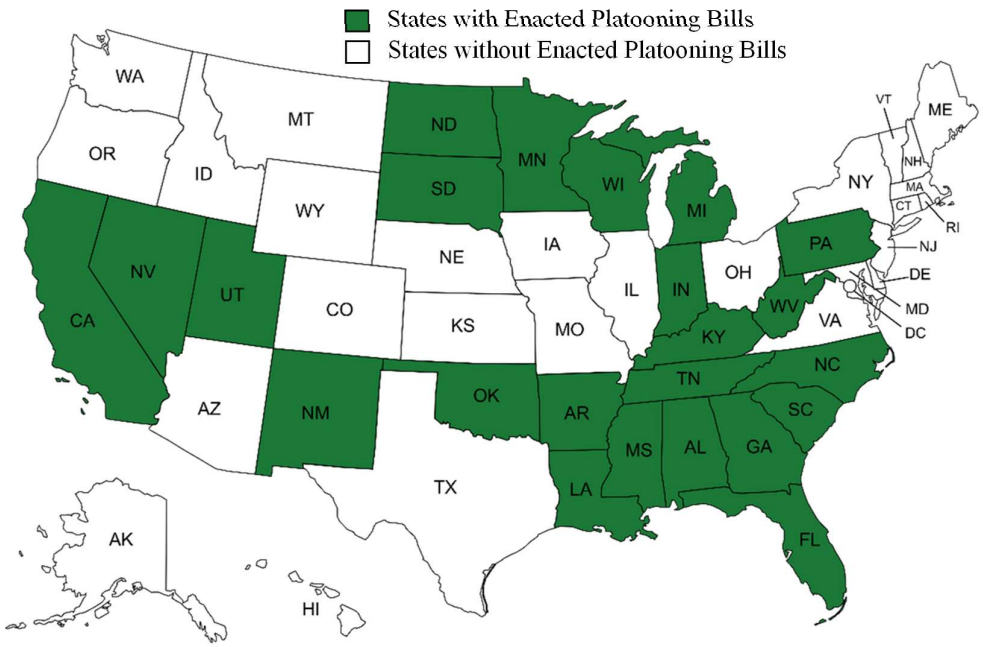

Figure 2: Enacted Truck Platooning Legislation Across the United States

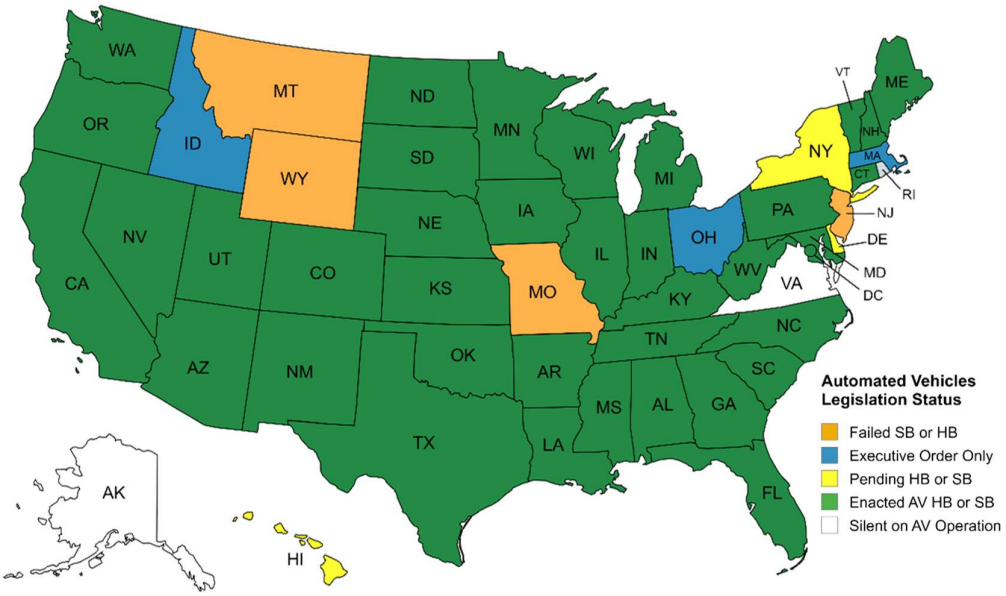

Figure 3: Automated Vehicles Legislation Across the United States

The legislative map highlights that 23 states have enacted truck platooning laws, reflecting a growing recognition of the benefits of this technology. These laws allow electronically synchronized truck operations, exemptions from traditional following distance requirements, and detailed safety protocols to enable safe implementation. The majority of the 23 states with truck platooning laws include exemptions from following distance requirements for vehicles operating in a platoon. However, there are exceptions for Florida and North Dakota, where these exemptions are not explicitly provided in their legislation

Geographically, states with platooning legislation are concentrated in regions that prioritize freight efficiency and agricultural economies, particularly in the South and Midwest. For example, Arkansas (House Bill 1754) and Georgia (House Bill 472) have adopted laws that facilitate vehicle-to-vehicle (V2V) communication and synchronized braking systems, aligning with their roles as major transportation hubs for agricultural produce and freight logistics (Arkansas Legislature, House Bill 1754; Georgia General Assembly, House Bill 472).

Commonalities Among States with Platooning Laws

1. Freight and Agricultural Integration: Many states with platooning laws, such as Arkansas and Georgia, rely heavily on agriculture and freight transport. Efficient freight systems enabled by platooning legislation reduce logistical costs and improve supply chain operations in these regions (NHTSA Automated Vehicles Report).
2. Strategic Interstate Networks: States like Indiana (House Bill 1290) and Michigan (Senate Bill 995) emphasize the use of interstates for freight logistics, reflecting their focus on linking agricultural production with urban markets (Indiana General Assembly, House Bill 1290; Michigan Legislature, SB 995).
3. Safety and Regulatory Innovations: Florida (House Bill 7061) demonstrates regulatory flexibility by mandating pilot studies before statewide deployment, ensuring the safety of synchronized truck operations (Florida Legislature, House Bill 7061).

Agricultural States Without Platooning Laws

Interestingly, agriculturally dominant states such as Iowa and Nebraska have not yet enacted platooning legislation. Given their reliance on agriculture and the transportation of farming goods, these states could benefit from adopting similar laws to improve the efficiency of their supply chains. The absence of such legislation may reflect different legislative priorities or a cautious approach toward new transportation technologies.

Comparison Between CAV and Platooning Legislation

Platooning and CAV laws differ significantly in focus. CAV laws, such as those in Arizona and California, emphasize urban mobility and self-driving vehicles, targeting passenger systems and urban innovation (Autonomous Vehicle Industry Association, 2024). In contrast, platooning laws, as seen in Michigan and Indiana, are tailored to freight efficiency and focus on synchronized truck operations (Michigan Legislature, Senate Bill 995).

Visual Integration and Insights

Including both the CAV and platooning maps highlights how states tailor their legislative frameworks to their economic priorities. For instance:

- Dual-focus States: Michigan and Florida support both CAV and platooning frameworks, balancing urban and freight priorities.
- Freight-centric States: Arkansas and Georgia focus on freight logistics, reflecting their agricultural economies.

These maps showcase states' strategic legislative efforts to enhance either urban mobility or freight logistics, providing a comprehensive view of legislative focus across the U.S.

Overview of Truck Platooning Legislation by State

A comprehensive review of the legislative frameworks established by states that have enacted truck platooning laws has been conducted. This review highlights the diversity in regulatory

approaches and their implications for the implementation of platooning technology. It provides a foundation for understanding legislative trends and variations across the United States.

To extract and analyze the relevant bills, a systematic approach was employed using trusted legislative resources and databases. The primary sources included official state legislative websites, LegiScan, and other credible online repositories. Keywords such as “truck platooning,” “platooning legislation,” “following distance exemptions,” “connected vehicles,” and “autonomous trucks” were utilized to identify bills specifically focused on truck platooning.

Key resources referenced during this process include:

- LegiScan: Used to retrieve detailed texts of bills such as Alabama's SB 125 (LegiScan, Senate Bill 125) and Montana's HB 339 (LegiScan, House Bill 339).
- State Legislative Websites: These were accessed to download specific bills like Michigan's SB 995 (Michigan Legislature, Senate Bill 995) and Georgia's House Bill 472 (Georgia General Assembly, House Bill 472).
- Legal Databases: Platforms such as LawServer provided summaries and legal contexts for bills like Minnesota Statutes 169.881 (LawServer, MN Statutes).

Each bill was reviewed in detail to extract information about definitions of platooning, safety protocols, operational guidelines, and exemptions from existing traffic laws. For example:

- The review of Arkansas's House Bill 1754 revealed its focus on exempting platooning vehicles from traditional following distance requirements (Arkansas Legislature, House Bill 1754).
- Kentucky’s Senate Bill 116 provided insights into state approval processes for platooning operations (Kentucky Legislature, Senate Bill 116).

Cross-referencing bills with secondary resources, such as the National Conference of State Legislatures (NCSL), provided additional legislative context and ensured the accuracy of the data. The review process involved identifying legislative intent, understanding the exemptions provided, and noting approval or reporting requirements for platooning operations.

In the following sections, the enacted bills from all states with platooning legislation are analyzed in detail, offering insights into how these laws shape the adoption and implementation of platooning technology across the United States.

Alabama

One Senate Bill, Senate Bill 125, 2018 [1], has been approved and enacted in Alabama related to platooning technologies. The enacted bill defines and governs the operation of electronically coordinated truck platoons. Truck platooning involves commercial vehicles traveling together at electronically managed speeds and shorter-than-usual following distances. Senate Bill 125 specifically exempts such vehicles from the state’s "following too closely" laws, provided they meet safety and coordination requirements set by the Department of Transportation. Typically, Alabama’s road safety rules require drivers to maintain safe distances based on speed and road conditions. For instance, trucks longer than 25 feet must maintain at least 300 feet of separation when outside business or residential areas. Exceptions for platooning allow trailing trucks to maintain reduced distances without penalties, as long as electronic brake coordination and other safety mechanisms are in place. This legislative approach reflects Alabama’s commitment to enabling technological advancements while ensuring road safety.

Arkansas

Arkansas has established regulatory measures to facilitate truck platooning through House Bill 1754 (Act 797), 2016 [2] , defining the practice, and setting operational guidelines. A "truck platoon" refers to a group of commercial trucks utilizing driver-assistive technology to synchronize speed and braking, while each vehicle's driver retains control of steering. This coordination allows the trucks to maintain a unified and efficient formation. Traditionally, Arkansas law requires motor trucks and vehicles towing trailers to maintain at least 200 feet of distance when outside business or residential areas to ensure safety. However, Act 797 exempts platooning trucks from this rule, permitting shorter following distances through electronic brake coordination. To initiate platooning operations, operators must submit a plan to the State Highway Commission. If no rejection is issued within 45 days of submission, the plan is automatically approved, streamlining the adoption of platooning systems while ensuring regulatory oversight.

Arkansas Act 797 authorized the operation of driver-assistive truck platooning systems, requiring that each truck within the platoon have an actively engaged driver in the cab. This legislation permitted trucks in a platoon to follow within 200 feet of the lead vehicle while ensuring that each driver-maintained control over steering and system monitoring. However, in 2023, Arkansas Act 94 revised the existing statute to loosen the driver requirement by removing the mandate for an engaged driver in every truck. Under the updated law, only the lead truck is required to have a driver, while the following trucks can operate autonomously using advanced vehicle technologies to maintain synchronized movement. This legislative shift represents Arkansas's commitment to advancing transportation technology, enhancing trucking efficiency, and fostering the integration of autonomous vehicle systems while maintaining safety regulations.

California

California's Senate Bill No. 431, 2015 [3], amends the state's Vehicle Code to accommodate driver-assistive truck platooning systems and vehicle automation technologies. The bill modifies requiring that determinations of reasonable and prudent following distances account for the presence of automation technologies. These systems use sensors, wireless communication, and software to synchronize acceleration and braking between vehicles while maintaining driver control over steering and commands. The bill also revises Section 21705, defining a caravan or motorcade as three or more vehicles. Vehicles in these formations must maintain a gap of no less than 100 feet when outside business or residential districts, allowing for safe overtaking or passing. An urgency clause categorizes the legislation as essential for public peace, health, and safety, enabling immediate implementation. This ensures California can leverage federal funds to test automated vehicle technologies, promoting their safe adoption while fostering innovation in transportation systems.

California's Senate Bill No. 719, 2015 [3], authorizes the California Department of Transportation (DOT) to collaborate with the California Highway Patrol to test advanced motor vehicle technologies. These technologies enable safe operation with less than 100 feet of spacing between vehicles. Participating vehicles are temporarily exempt from existing laws mandating a 100-foot gap between vehicles in caravans or motorcades on highways. The bill establishes Section 14107 of the Government Code, detailing a framework for testing. The DOT may use authorized vehicles and designated roads for testing, subject to Highway Patrol approval. Findings from the testing were to be reported to the Legislature by July 1, 2017, in compliance with Section 9795 of the Government Code. The legislation includes a sunset clause, with the provisions set to repeal on January 1, 2018, unless extended or amended. This

bill fosters innovation in transportation systems while maintaining safety oversight through collaboration with law enforcement.

California's Assembly Bill No. 669, 2017 [4], extends the California Department of Transportation's (DOT) authority to test advanced motor vehicle technologies in collaboration with the California Highway Patrol. These technologies allow vehicles to operate safely with less than 100 feet of spacing, exempting them from existing laws mandating a minimum gap between vehicles in caravans or motorcades. The bill amends Section 14107 of the Government Code, continuing authorization for DOT tests on specific vehicles and roads. Drivers participating in the testing must hold a valid license of the appropriate class. Findings were required to be reported to the Legislature by July 1, 2017, with an updated report due by July 1, 2019. The legislation postpones the repeal of these provisions to January 1, 2020, unless extended by future amendments. By extending the testing period and reporting requirements, the bill supports the evaluation and development of advanced vehicle technologies while ensuring public safety.

California's Assembly Bill No. 1671, 2019 [5], further extends provisions allowing the California Department of Transportation (DOT) to test advanced motor vehicle technologies in collaboration with the California Highway Patrol. These technologies facilitate safe vehicle operation with less than 100 feet of spacing and exempt participating vehicles from the laws requiring a minimum gap between vehicles. The bill amends Section 14107 of the Government Code, continuing authorization for DOT testing on approved vehicles and roads. Drivers involved in testing must possess a valid license of the appropriate class. Findings from testing must be reported to the Legislature by April 1, 2023, including recommendations for further action regarding the tested technologies. The bill extends the effective period of these provisions to January 1, 2024, after which they will be repealed unless extended. By continuing testing and analysis, the bill promotes the advancement of safe motor vehicle technologies while ensuring appropriate regulatory oversight.

California has passed multiple laws to enable and extend the testing of advanced vehicle technologies, particularly systems like driver-assistive truck platooning, which allow vehicles to operate safely with less than 100 feet of spacing. Senate Bill No. 431 modified state vehicle codes to account for automation, updating rules for following distances and redefining caravan spacing requirements, while ensuring immediate implementation to secure federal funds and promote innovation. Senate Bill No. 719 authorized the California Department of Transportation (DOT) and Highway Patrol to test these technologies, temporarily exempting vehicles from existing spacing laws, with findings required by July 1, 2017, and a sunset clause for repeal by January 1, 2018. Assembly Bill No. 669 2017 extended the testing period to January 1, 2020, and added further reporting requirements for 2017 and 2019. Assembly Bill No. 1671 (2019) continued this authorization through January 1, 2024, requiring a final report by April 1, 2023, with recommendations for next steps. Together, these legislative actions provide a framework for testing, oversight, and gradual integration of innovative vehicle technologies, ensuring public safety while fostering transportation innovation.

California has made significant progress in regulating autonomous vehicle technologies, including truck platooning. Initially, Senate Bill 431 (2015) sought to accommodate driver-assistive truck platooning systems by modifying state vehicle codes to account for automation in determining safe following distances. However, while this bill introduced important considerations for automation, California has since enacted more comprehensive laws that address fully autonomous trucking operations.

In 2019, the California Department of Motor Vehicles (DMV) approved regulations allowing the testing and deployment of autonomous light-duty trucks (vehicles under 10,001 pounds) on

public roads, provided they have an approved permit. This was a significant step toward integrating autonomous technology into commercial vehicle operations. However, fully autonomous heavy-duty trucks (vehicles over 10,001 pounds) without a human driver remain a subject of regulatory debate. In 2024, Governor Gavin Newsom vetoed Assembly Bill 316, which would have required a human operator to be present in autonomous heavy-duty trucks. His veto indicates a shift toward potential approval of fully autonomous truck operations, but California's regulations still require further adjustments before completely driverless truck platooning is fully authorized. Meanwhile, Assembly Bill 1777 (2024) was signed into law, outlining protocols for autonomous vehicles in emergency situations and police interactions.

Currently, California does not fully authorize driverless truck platooning for heavy-duty trucks, but legislative and regulatory discussions continue to evolve. The state remains at the forefront of testing and deployment of autonomous vehicle technologies, ensuring that safety and innovation progress in parallel.

Florida

Florida's House Bill 7061, 2016 [6] introduced forward-looking legislation to facilitate the development and testing of driver-assistive truck platooning technology. This technology integrates automation and safety systems, including sensors, wireless communication, and specialized software, to coordinate braking and acceleration between trucks while maintaining driver control over steering. The bill mandates a preliminary study to evaluate the safety and effectiveness of platooning systems. Based on the study's findings, a pilot project is authorized to test and refine the implementation of truck platooning in real-world conditions. This measured approach ensures that technology is rigorously assessed before broader adoption, balancing innovation with road safety.

The pilot project conducted by the Florida Department of Transportation (FDOT), Florida Turnpike Enterprise (FTE), and Florida Highway Patrol (FHP) in December 2017 tested driver-assistive truck platooning technology provided by Peloton Technology. Over 1,215 miles of testing, the system demonstrated effective handling of real-world conditions, including traffic cut-offs and merging scenarios, with no system-initiated hard braking events or significant safety concerns observed. The Florida Highway Patrol and state traffic officials noted smooth operations without disruptions to other motorists, and the technology successfully accommodated merging and lane changes. The findings supported the system's safety under controlled conditions. Also, it does not appear that the study or pilot project led to significant additional legislation in the nine years since House Bill 7061 was enacted. No major updates on truck platooning legislation in Florida have been reported since the pilot.

Georgia

Georgia's House Bill 472, 2017 [7] facilitated the adoption of coordinated vehicle platooning by updating traffic regulations to exempt non-leading vehicles in platoons from the "following too closely" rule. A coordinated platoon is defined as a group of vehicles operating in unison through vehicle-to-vehicle (V2V) communication technology, which automates the synchronization of braking, acceleration, and spacing. This exemption enables vehicles in a platoon to maintain shorter-than-usual following distances while ensuring safety through technological coordination. Additionally, the bill repealed conflicting provisions to provide unambiguous regulatory support for platooning operations, thereby promoting traffic efficiency and safety advancements.

Indiana

Indiana's House Bill 1290, 2024 [8] defined and regulated vehicle platooning, paving the way for integrating advanced vehicle technologies into traffic management. A "vehicle platoon" is defined as a group of vehicles traveling closely together at higher speeds, using electronic communication technology to synchronize their speed, braking, and following distances. This coordination allows platooning vehicles to maintain shorter intervals safely, exempting them from the state's standard "following too closely" rule, which typically requires a 300-foot gap between large vehicles. The legislation establishes a detailed approval process, requiring individuals or organizations to submit an operational plan to the Transportation Commissioner. The plan must include technical details of the platooning system, such as communication protocols, operational routes, speed limits, and safety protocols for handling system failures or emergencies. The Transportation Commissioner reviews these plans to ensure compliance with safety standards and state regulations before granting authorization for public road use. By modernizing traditional traffic laws and creating a clear regulatory framework, Indiana supports the safe implementation of vehicle platooning. The legislation reflects the state's commitment to embracing innovative traffic solutions while prioritizing public safety and efficient road management.

Kentucky

Kentucky's Senate Bill 116, 2018 [9], [10] defined and regulated the operation of commercial vehicle platoons on state highways, enabling motor carriers to utilize this advanced technology under specific conditions. A "platoon" is described as a group of two commercial motor vehicles traveling at electronically synchronized speeds, allowing for closer following distances than typically permitted. To ensure safety and coordination, motor carriers must submit a general operational plan to the Kentucky State Police and the Department of Transportation. The Department has 30 days to approve or reject the plan, providing reasons for any rejection along with instructions for resubmission. The bill mandates that all platoon vehicles be operated by drivers with valid commercial driver's licenses (CDLs) and appropriate endorsements, ensuring professional oversight. Additionally, towing within platoons is prohibited, and each vehicle must display a visible marker to indicate its participation in the platoon, enhancing awareness for other motorists and law enforcement. By establishing clear guidelines and a robust approval process, Kentucky supports the safe deployment of vehicle platooning technology while maintaining high safety standards on state highways. The bill allows to utilize platooning technology, but under strict conditions that emphasize safety and oversight, which align more closely with controlled testing environments. Without towing, each vehicle in the platoon operates independently but in close synchronization with the lead truck. Drivers in all vehicles maintain control, and the technology assists primarily with coordinated acceleration, braking, and maintaining safe following distances.

Kentucky's House Bill 135, 2023 [10], though vetoed, proposed a comprehensive framework for commercial vehicle platooning in the state. The bill defined a "platoon" as a group of two or more commercial motor vehicles traveling in close proximity with electronically coordinated speeds. It required the lead vehicle in the platoon to be operated by a driver holding a valid commercial driver's license (CDL). The bill also stated that motor carriers seeking to operate platoons are required to submit a detailed operational plan to the Kentucky State Police and the Department of Transportation for review and approval. The plan would outline the specifics of platooning operations, ensuring that safety and coordination measures were adequately addressed. Additionally, each vehicle in the platoon had to display visible markers to alert other road users and law enforcement of its platooning status, and towing within the platoon was

prohibited. The bill also tasked the Department of Transportation with developing procedural regulations, including requirements for operational plans. While House Bill 135 aimed to establish a structured and safety-oriented approach to platooning, it was vetoed.

Louisiana

Louisiana's House Bill 308, 2018 [11] established a regulatory framework for vehicle platooning, defining a "platoon" as a group of trucks equipped with vehicle-to-vehicle communication technology to operate in unison at close following distances. This advanced system allows for efficient and synchronized movement while maintaining safety. The bill sets a minimum following distance of 400 feet for trucks traveling outside business or residential areas, with exceptions for overtaking and passing. Platooning operations are restricted to multilane highways and explicitly prohibited on two-lane highways, ensuring safe integration into Louisiana's road infrastructure. Additionally, the legislation limits platooning to trucks, excluding other types of vehicles from participating in such formations. The deployment of platoons requires prior approval from the Department of Public Safety and Corrections, the Office of State Police, and the Department of Transportation and Development. These agencies are empowered to develop and enforce regulations to ensure the safe operation of platooning systems. This legislation reflects Louisiana's proactive approach to integrating advanced traffic technologies while prioritizing public safety and operational oversight.

Montana

Montana's House Bill 339, 2023- Failed to pass [12] sets a foundational framework for regulating vehicle platooning, focusing on safety and collaboration before deployment. The bill defines "platooning" as the synchronized operation of trucks or truck tractors, which may be partially or fully autonomous, traveling at electronically regulated speeds and reduced following distances while ensuring safety. However, platooning on highways is prohibited until the Department of Transportation (DOT) establishes comprehensive regulations. House Bill 339 mandates the DOT to collaborate with key stakeholders—including the trucking industry, law enforcement, autonomous vehicle manufacturers, and local governments—to develop safety-focused guidelines. These rules are expected to address issues such as prohibiting platooning in adverse weather, limiting the size of platoons, and evaluating environmental and pedestrian impacts. The regulations, targeted for completion by early 2024, aim to ensure that platooning integrates safely and responsibly into Montana's transportation system. Despite passing the House, House Bill 339 was not approved by the Senate in April 2023, leaving the future of platooning legislation in the state under active discussion.

Michigan

Michigan's Senate Bill 995, 2016 [13] established a forward-looking framework for vehicle platooning and autonomous vehicle operations, balancing innovation with safety standards. A "platoon" is defined as a group of motor vehicles traveling in coordination at electronically synchronized speeds. The bill permits autonomous vehicles to operate without a person physically present, under specific conditions, and grants platoons an exemption from the 500-foot minimum following distance rule. For platooning, the lead vehicle is not considered as towing the others, and vehicles in a platoon are not classified as a combination of vehicles for regulatory purposes. However, platoons must adhere to specific guidelines. A general operations plan must be submitted to the Department of State Police and the State Transportation Department, and operations can commence if the plan is not rejected within 30 days. The legislation also maintains safety provisions for commercial motor vehicles within platoons, requiring a licensed driver with a valid commercial driver's license (CDL) and appropriate endorsements for each vehicle. Additionally, operators must allow safe lane access

for other vehicles on highways. By integrating robust regulatory measures with exemptions that facilitate technological advancements, Michigan encourages the development of autonomous and platooning technologies while ensuring road safety and accessibility.

Michigan's Senate Bill 706, 2021 [14] established a structured framework for regulating vehicle platooning on Michigan's roadways, ensuring operations are safe, efficient, and aligned with advancing vehicle technologies. The bill mandates that individuals or organizations intending to operate a platoon submit a general operations plan to the Department of State Police and the State Transportation Department. If no objections are raised within 30 days, the platoon may commence operations. Key provisions include exemptions for vehicles in a platoon, such as not classifying them as a "combination of vehicles," thereby avoiding associated regulatory restrictions. Additionally, the lead vehicle is explicitly not considered to be towing the others. For platoons involving commercial motor vehicles on non-automated roadways, the legislation requires that each vehicle be operated by a commercially licensed driver with the appropriate endorsements. This comprehensive approach reflects Michigan's commitment to integrating innovative transportation systems while maintaining road safety and regulatory clarity.

The 2021 Michigan bill expands upon the 2016 platooning legislation by introducing a structured approval process for platoon operations, requiring operators to submit a plan to the Department of State Police and the State Transportation Department. If not rejected within 30 days, platooning is automatically authorized, streamlining the regulatory process. Additionally, the new bill clarifies vehicle classifications, explicitly stating that platoons are not considered vehicle combinations, nor is the lead vehicle deemed to be "drawing" the others. Furthermore, it mandates that if a commercial motor vehicle is part of a platoon, a licensed commercial driver must be present behind the wheel, ensuring continued human oversight unless operating on an automated vehicle roadway. These updates enhance regulatory clarity, safety oversight, and operational efficiency while facilitating the broader adoption of platooning technology

Minnesota

Minnesota's House Bill 6, 2019 [15] established a comprehensive regulatory framework for vehicle platoons, prioritizing safety, efficiency, and adherence to traffic regulations. The legislation defines a "Platooning System" as driver-assisted technology enabling electronic communication between multiple commercial vehicles to synchronize speed, acceleration, and braking while requiring human drivers in each vehicle to maintain control and monitoring responsibilities. Platoons, limited to three trucks, can operate on designated highways under specified conditions. Entities must submit a detailed platoon plan to the Commissioner of Transportation for approval, valid for up to one year, detailing the platoon's length, configuration, routes, operational hours, driver licensing, and compliance with state size and weight regulations. Approved plans may include additional safety restrictions, and rejected applications receive feedback within 60 days. Trucks in a platoon are exempt from Minnesota's "following too closely" laws but must allow safe gaps for other vehicles to merge. Each vehicle requires liability insurance and must carry the approved plan. The platooning system employs adaptive cruise control and automated braking for synchronized operation, with drivers responsible for steering and manual interventions. If external vehicles merge into the platoon or a system failure occurs, drivers regain full control to ensure safety.

Mississippi

Mississippi's House Bill 1343, 2018 [16] established a regulatory framework for vehicle platoons, adapting traffic laws to accommodate technological advancements while ensuring safety and coordination. A "platoon" is defined as a group of vehicles traveling at electronically

synchronized speeds and reduced following distances, which would not be safe without such coordination. Non-lead vehicles in a platoon are exempt from the state's "following too closely" law when operating on limited-access divided highways with more than one lane in each direction and consisting of no more than two vehicles. While standard traffic laws require motor trucks and trucks towing vehicles to maintain a minimum following distance of 300 feet outside business or residential areas, these rules are adjusted for platoons due to their electronic synchronization. Operators must submit a detailed operation plan to the Department of Transportation (DOT) for review, with the DOT and the Department of Public Safety (DPS) required to approve or reject the plan within 30 days. Once approved, the platoon is authorized to operate, with the Department of Public Safety's Motor Carrier Division responsible for establishing and enforcing operational standards to ensure compliance and maintain safety.

New Mexico

New Mexico's House Bill 270, 2021 [17] established a regulatory framework for platooning operations, adapting existing traffic laws to support advanced vehicle coordination while ensuring road safety. A "platoon" is defined as a group of vehicles traveling in synchronization via wireless communication or similar technology. The legislation modifies "following too closely" regulations, requiring drivers to maintain a reasonable distance based on speed, traffic, and road conditions. Specifically, motor trucks or vehicles towing another vehicle must keep at least 300 feet apart outside business or residential areas, except when overtaking or passing. Similarly, caravans and motorcades in non-commercial and non-residential areas must also maintain a minimum 300-foot gap. However, vehicles in a driver-assisted platoon, aside from the lead vehicle, are exempt from the 300-foot rule, acknowledging the safety provided by synchronized movement. Additional exemptions apply to funeral processions and motor vehicle escort services to maintain traffic flow and unit continuity.

Nevada

Nevada's Assembly Bill 69, 2017 [18] established regulations for driver-assistive platooning technology, enabling advanced vehicle coordination while exempting these vehicles from traditional following distance laws. The legislation defines driver-assistive platooning technology as systems that electronically synchronize speeds, allowing two or more motor vehicles to travel closely together, improving efficiency and safety. Vehicles equipped with such technology are exempt from the standard following distance requirements on highways, permitting them to maintain reduced gaps safely through electronic coordination. The bill provided 10-day period to report any crashes to the Department of Motor Vehicles. For other vehicles, including trucks and those 80 inches or wider, the law mandates a minimum following distance of 500 feet, except when overtaking or passing. This requirement, however, does not apply to platooning vehicles, recognizing the safety provided by their synchronized operations.

North Carolina

North Carolina's House Bill 716, 2017 [19] established a regulatory framework for vehicle platooning, updating traditional following distance rules to accommodate advanced transportation technologies. Drivers must maintain safe following distances by considering factors like speed, traffic, and road conditions, with additional requirements for highways outside business or residential areas to leave adequate space for merging vehicles. Funeral processions are exempt from these rules. The bill exempts non-leading commercial vehicles in a platoon from general following distance regulations, defining a platoon as a group of commercial motor vehicles traveling in close coordination using electronically linked braking systems for safe operation. Platooning operations require approval from the Department of Transportation (DOT) through a traffic ordinance, which specifies permissible routes for these

advanced systems. This legislation supports innovation while maintaining safety and clear regulatory oversight.

North Dakota

North Dakota's House Bill 1199, 2019 [20] established a comprehensive regulatory framework for vehicle platooning, balancing technological innovation with strict adherence to safety standards. The legislation mandates safe following distances for all drivers, requiring adequate spacing to account for speed, traffic, and road conditions. Trucks and vehicles towing others must maintain sufficient gaps outside commercial or residential areas to facilitate safe merging, while caravans and motorcades must allow enough space for other vehicles to maneuver. The bill defines a "platoon" as a group of motor vehicles using vehicle-to-vehicle (V2V) communication to closely coordinate their speed, braking, and following distances safely. Operators must submit detailed operational plans to the Department of Transportation and the State Highway Patrol for approval, outlining safety standards, communication protocols, and vehicle specifications. Approved plans authorize platoon operations, while rejected submissions receive feedback for corrections. Platooning is permitted on multilane, limited-access, divided roadways, ensuring its operation aligns with infrastructure designed to handle advanced transportation systems. Restrictions may be imposed on routes, speed limits, and conditions such as weather, with flexibility to evolve as technology advances. Non-compliance, including unauthorized platooning or plan violations, incurs a $100 fine, ensuring strict operational compliance and safety.

Oklahoma

Oklahoma's Senate Bill 189, 2019 [21] established regulations for vehicle platooning and safe following distances, balancing the integration of advanced technologies with road safety standards. A "platoon" is defined as a group of motor vehicles traveling in unison at electronically synchronized speeds and reduced following distances that would typically be unsafe without such technology. The bill outlines general following distance rules, requiring drivers to maintain a safe and reasonable distance based on speed, traffic, and road conditions. Specific provisions mandate trucks or towed vehicles to leave adequate space for overtaking vehicles and require heavy vehicles with six or more tires to maintain a 300-foot minimum distance unless overtaking. Caravans and motorcades in non-business or non-residential areas must maintain a 200-foot gap to allow safe merging. Non-lead vehicles in platoons of up to two vehicles are exempt from these following distance rules, as their electronically synchronized systems ensure safety and efficiency. However, lead vehicles in platoons must comply with standard regulations. The bill also centralizes regulation of driving automation systems, reserving authority for the state and preempting local laws to maintain uniformity in advanced vehicle operations.

Pennsylvania

Pennsylvania's House Bill 1958, 2017 [22] established a comprehensive regulatory framework for vehicle platooning and highly automated vehicle operations, prioritizing safety and technological innovation. A "platoon" is defined as a convoy of motor carriers, buses, or military vehicles traveling at electronically synchronized speeds to maintain closer following distances than traditional methods allow, with explicit exclusion of school buses and school vehicles. The Pennsylvania Department of Transportation (PennDOT) oversees platooning operations, granting non-leading vehicles exemptions from the state's "following too closely" rule. Each vehicle in a platoon must display visual identification as determined by PennDOT, in consultation with the Pennsylvania Turnpike Commission and State Police. Platoons are limited to three vehicles and restricted to limited access or interstate routes unless otherwise

authorized. Drivers must be present in each vehicle, and additional restrictions may apply during emergencies or for safety reasons. Operators must submit a detailed operational plan to PennDOT for approval, with the Pennsylvania Turnpike Commission and State Police assisting in evaluations. The bill also designates highly automated work zone vehicles for use in active work zones, equipped with automated driving systems or wireless coordination capabilities. To ensure oversight, House Bill 1958 establishes a Highly Automated Vehicle Advisory Committee within PennDOT, tasked with producing an annual public report detailing operations, challenges, and progress in automated vehicle implementation.

South Carolina

South Carolina's House Bill 3289, 2017 [23] established comprehensive guidelines for vehicle following distances while accommodating advancements in transportation technologies such as platooning and automated driving systems. Drivers must maintain a reasonable and prudent distance behind other vehicles, considering speed, traffic, and road conditions. Vehicles towing others outside business or residential districts must leave enough space for overtaking vehicles to merge safely. Similarly, caravans and motorcades on public roads must maintain sufficient spacing for others to merge, with funeral processions exempt from this rule. The bill introduces exemptions for platooning operations, allowing non-leading vehicles in a platoon to bypass minimum following distance requirements due to their electronically synchronized movements. Additionally, non-leading commercial vehicles equipped with cooperative adaptive cruise control or other automated technologies are exempt from federal safety regulations on following distances when traveling in a platoon, recognizing the unique safety capabilities of these systems. This legislation strikes a balance between traditional safety rules and the integration of innovative transportation systems.

South Dakota

South Dakota's House Bill 1068, 2019 [24] established a comprehensive regulatory framework for testing and operating vehicle platooning systems, with the Transportation Commission designated as the primary authority for rule-making and safety compliance. The bill defines platooning as groups of vehicles traveling at electronically synchronized speeds, allowing them to maintain closer-than-usual distances safely, exempt from standard following distance regulations under specified conditions. The Transportation Commission is tasked with ensuring the safe and efficient integration of platooning systems into the state's transportation network by developing procedures for requesting and granting operational authority, setting administrative fees (up to $100), and defining reporting protocols. The Commission may also designate permissible roadways, operational times, and traffic patterns for platooning. Additional rules may specify vehicle types, visibility markings, driver qualifications, and restrictions based on weather, special events, or emergencies. The legislation also allows the Commission to set speed, size, and operational limits, ensuring a structured and safety-focused approach to advanced transportation technologies.

South Dakota's platooning regulations establish a structured framework for testing and operating truck platoons, requiring operators to obtain a permit from the Department of Transportation (DOT). Applications must be submitted using an approved form, and annual permits may be granted for fleets operated by a single motor carrier, subject to departmental approval. A $60 application fee is required, though it is refunded if the permit is denied, while federal, state, and local government vehicles are exempt from permit requirements. Permit holders must maintain detailed records of miles platooned, routes used, number of platooning trips, and crash reports, with submission required within 15 days upon request. Platooning is restricted to the interstate highway system, with specific prohibitions on I-90 during the Sturgis Motorcycle Rally and in highway work zones with speed or use restrictions. Permits are invalid

in adverse weather conditions where visibility is reduced to less than half a mile or road surfaces are slippery due to snow, ice, or slush, and law enforcement has the authority to suspend operations if conditions are unsafe. Each vehicle must carry proof of its permit (electronic or paper) and comply with safety and operational standards, including driver qualifications. Law enforcement can suspend platooning operations due to violations or equipment deficiencies, with repeated violations leading to permit revocation. Any denied, suspended, or revoked permits may be appealed to the secretary of transportation for review. These regulations ensure that platooning operations in South Dakota are conducted safely, efficiently, and within strict regulatory oversight.

Tennessee

Tennessee's Senate Bill 676, 2017 [25] defined a "platoon" as a group of separate vehicles traveling in coordination at electronically synchronized speeds without physical towing. Operators intending to lead a platoon must notify the Departments of Safety and Transportation and submit a detailed operational plan. If the plan is approved within 30 days, the platoon may begin operations. The legislation distinguishes platoons from caravans or motorcades, exempting them from related rules. Additionally, the lead vehicle in a platoon is prohibited from towing others, and all commercial vehicles within the platoon must be operated by drivers holding valid commercial driver's licenses (CDL) with proper endorsements.

Utah

Utah's Senate Bill 56, 2018 [26] established a regulatory framework for connected platooning systems, integrating advanced vehicle coordination technology while maintaining safety guidelines for road users. The bill defines a "connected platooning system" as technology that electronically synchronizes the speed and braking of a lead vehicle with one or more following vehicles using vehicle-to-vehicle communication, enabling efficient and safe platoon movement. Under general vehicle following regulations, operators must maintain a reasonable and prudent distance based on vehicle speed, traffic, and road conditions, with a safe following distance defined as at least two seconds between vehicles.

Wisconsin

Wisconsin's Senate Bill 695, 2018 [27] defined a platoon as a group of motor vehicles traveling at electronically synchronized speeds, allowing coordinated and safe movement. While the general rule requires drivers to maintain a reasonable and prudent following distance based on speed, traffic, and road conditions, vehicles in a platoon are exempt from the law mandating motor trucks over 10,000 pounds maintain a 500-foot minimum following distance. This exemption recognizes the enhanced safety provided by electronic synchronization, enabling vehicles to travel more closely without compromising control or safety.

West Virginia

West Virginia's House Bill 4787, 2022 [28] enabled up to three autonomous vehicles to travel in coordinated formations on limited-access highways. A platoon consists of one lead vehicle and up to two non-lead vehicles using Automated Driving Systems (ADS) for synchronized movement, with non-lead vehicles exempt from "following too closely" violations due to the safety provided by ADS coordination. The bill legally recognizes the ADS as the driver of the vehicle, requiring all autonomous vehicles to be registered and insured before use on public roads. It also exempts equipment unrelated to autonomous driving from regulatory restrictions, offering design flexibility. To ensure uniformity, the West Virginia Department of Transportation holds exclusive authority over AV regulations, prohibiting local governments from imposing additional laws or levies. Each vehicle in a platoon must display a visual

identifier, with placement and criteria determined by the Department of Transportation in collaboration with the State Police and Division of Highways.

Summary of Legislations

The key components of truck platooning legislation, summarized in Table 1, were identified through a systematic review of state-specific bills. These components reflect the most critical regulatory, operational, and safety considerations necessary for implementing truck platooning technologies. The review focused on common elements across legislation, such as definitions of platooning and related terms, exemptions from following too closely rules and platooning operational approval processes, which were consistently highlighted as fundamental to facilitating the safe and efficient deployment of platooning systems. Additional components, including driver training requirements, and weather or route restrictions, were incorporated based on their frequent mention in state regulations and their significance in addressing practical operational challenges. Each category in the table provides a framework for assessing legislation, ensuring consistency in terminology, compliance requirements, and operational guidelines. This review also emphasizes the variations across states in addressing these components, showcasing the need for a balanced approach.

It is important to note that the check marks provided in Table1 indicate that specific requirements are explicitly stated in the enacted bills for these states. However, states without such provisions may still establish testing and deployment requirements and regulations through approvals by the transportation commission and authorized testing plans for platoons.

The presence of a driver in trucks participating in a platoon is a critical factor, as it directly impacts the safety of the platoon. Currently, no state permits platooning operations without at least one driver in the lead vehicle. Some states, such as Arkansas, explicitly mandate the presence of a driver in the lead vehicle but do not specify requirements for the following vehicles.

Several initiatives have tested truck platooning across multiple states. The majority of these tests involve a driver in both the lead and following vehicles. However, a limited number of tests have been conducted without a driver in either the lead or following trucks, instead utilizing a remote operator to control the lead vehicle. In such cases, special authorizations and approvals were obtained from the respective states to permit this type of truck platooning testing. The following section provides further details on the truck platooning initiatives ***(Currently working on developing this section).***

Table 1: State-by-State Overview of Truck Platooning Legislation Based on Identified Categories

Criterion	AL	AR	CA	FL	GA	IN	KY	LA	MI	MN	MS	MT	NM	NV	NC	ND	OK	PA	SC	SD	TN	UT	WI	WV
Definition of Platooning and Related Terms	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Following Too Closely Provisions	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Exemption From Following Too Closely Provisions	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Operational Approval Process		✓	✓			✓	✓	✓	✓	✓	✓				✓	✓		✓		✓	✓			✓
Driver Requirements			✓				✓		✓	✓								✓		✓	✓			
Visual Identifiers							✓											✓		✓				✓
Number of Vehicles Allowed in a Platoon										✓	✓						✓	✓						✓
Weight Restrictions										✓														
Reporting Requirements										✓										✓				
Route Restrictions			✓						✓		✓				✓	✓		✓		✓	✓			✓
Administrative Fees																✓				✓				
Weather Condition/ Operational Restrictions																✓				✓				
Speed, Size, and Operational Limits										✓										✓				
Operational Times																				✓			✓	

Key Components of Truck Platooning Regulatory Frameworks in the U.S.

The regulatory frameworks for truck platooning in the United States consist of several key components that collectively ensure the safe and effective deployment of this advanced transportation technology. These components address critical areas such as safety standards, operational protocols, communication requirements, and compliance mechanisms. By outlining these components, this section provides a comprehensive understanding of the foundational elements that underpin legislative approaches to truck platooning across various states.

The following outlines the key components specific to U.S. truck platooning regulatory frameworks, offering insights into their structure and practical application.

Definition of Platooning and Related Terms: Defines key terms to ensure consistency across regulations. Common definitions include: Platooning: A system where two or more vehicles operate in close formation using vehicle-to-vehicle (V2V) communication and driver-assistive technology. Lead Vehicle: The vehicle controlling the speed and direction of the platoon. Following Vehicle(s): Vehicles that follow the lead vehicle, operating semi-autonomously within the platoon. Automated Driving System (ADS): The technology used to enable partial or full automation within the platoon.

Following Too Closely Provisions: General Rule: Drivers must maintain a safe following distance, considering speed, traffic, and road conditions. Passing Distance: Drivers must leave at least 20 feet for every 10 mph when overtaking another vehicle. Truck Spacing: Trucks or towed vehicles over 25 feet must maintain at least 300 feet of distance when outside business or residential areas. Heavy Vehicles: Heavy vehicles with six or more tires must keep a 300-foot gap behind similar vehicles unless overtaking. Caravans and Motorcades: Vehicles in groups must leave 200 feet between vehicles, except for authorized processions like funerals or parades. Platooning Exception: Platooning vehicles are exempt from these rules if equipped with V2V communication and adaptive braking systems.

Exemption From the State's Following Too Closely Provisions: Explicitly exempts platooning vehicles from general traffic rules requiring a certain following distance. Provides legal protection for platooning operators against traditional traffic citations for following closely.

Platooning Operational Approval Process: Requires operators to obtain formal approval from the Department of Transportation or other regulatory authorities: operators must submit a comprehensive plan detailing safety, communication, and operational systems. Approval ensures compliance with technical and safety standards before deployment on public roads.

Pilot Programs and Testing Requirements: Encourages controlled pilot programs to test platooning systems. It requires testing under specific conditions (e.g., limited routes, reduced traffic). Collects data on safety, operational feasibility, and environmental impact. Involves collaboration between operators and regulatory bodies to refine systems before full deployment.

Communication Standards: Establishes technical standards for V2V and V2I communication to ensure safety and synchronization. V2V Communication enables real-time data sharing between platooning vehicles. V2I Communication facilitates interaction with smart infrastructure, such as traffic signals and road sensors. Requires encryption to prevent hacking and unauthorized access.

Driver Requirements and Training Standards: Establishes qualifications and training requirements for drivers. Drivers must be trained to supervise platooning systems and take control in emergencies. Lead vehicle drivers typically require additional certifications to operate platoons safely. Addresses training for system troubleshooting and emergency disengagement.

Vehicle Markings and Identification Standards: Requires platooning vehicles to display distinctive markings for recognition. Marking may include decals, lights, or electronic indicators. It could help law enforcement and other road users can easily identify platooning vehicles.

Weather Condition: Imposes limits on where and when platooning can operate restricts operations to specific road types (e.g., highways, freight corridors). May prohibit platooning during adverse weather or heavy traffic conditions.

Number of Vehicles Allowed in a Platoon: Limits the number of vehicles that can operate in a platoon. Typically provisions allow 2 or 3 vehicles, depending on state regulations and infrastructure.

Vehicle Weight Limits for Platooning: Platooning vehicles must comply with state weight regulations and axle load limits. Operational plans must adhere to height, width, and weight standards. Vehicles carrying hazardous materials or loose cargo are often restricted, with possible exemptions on specific routes if infrastructure permits.

Route Restrictions: Typically restricted to specific approved routes, such as highways or freight corridors with suitable infrastructure.

Administrative Fees/ Penalties for Non-Compliance: Establishes fees (up to $100) for plan reviews, permits, and other administrative processes. It ensures funding for regulatory oversight and infrastructure development. Introduces penalties for violations, $100, for operating without an approved plan or violating operational guidelines. Includes provisions for license suspension in cases of repeated non-compliance.

Operational Restrictions: They could be prohibited during adverse weather conditions, such as heavy rain or fog, and are often limited to off-peak hours to reduce traffic disruption. Operations must cease in construction zones, significant congestion, or emergency road closures. Additionally, platooning vehicles must allow emergency vehicles to pass and disengage their systems when necessary to ensure public safety.

Speed, Size, and Operational Limits: Limits on speed, vehicle size, and operational conditions include maximum speeds (e.g., 65 mph), vehicle dimensions, and weight restrictions could be stated.

Official Requirements for Truck Platooning Trials in Canada

The regulatory statutes governing truck platooning trials in Canada are designed to ensure safety, efficiency, and compliance during testing operations. Vehicles participating in these trials must maintain a reasonable and prudent following distance, as specified in the guidelines. Testing entities are required to submit a comprehensive application packet for approval [29]. Application and Permit for Ministry of Transportation of Ontario (MTO) to Test Vehicles on Public Roadways. Permits are granted only after all criteria are met, and eligibility is restricted to motor carriers with a satisfactory safety rating.

Platooning trials are limited to approved, limited-access highways, with vehicles adhering to strict weight and size limits. Long-combination vehicle configurations are prohibited. Platooning technology must be disengaged in specific scenarios, such as entering or exiting highways, traveling through work zones, tunnels, weigh stations, toll plazas, or incident scenes. Approved routes are assessed based on factors like road geometry, highway ingress and egress points, and traffic conditions. Testing is prohibited on roads where trucks are restricted and during adverse weather conditions, including snow, ice, or low visibility. Jurisdictions retain authority to suspend trials at their discretion.

Vehicles involved in platooning trials cannot transport dangerous goods, oversized or overweight loads, fluids, loose cargo, livestock, or passengers. The lead vehicle in a platoon must be the heaviest, and platoons are limited to a maximum of three tractor-trailer combinations, with each vehicle restricted to a single trailer. Configurations like B-trains or other long-combination setups are excluded.

To ensure visibility and safety, vehicle configurations must feature identifiers to indicate when platooning technology is engaged. Escort vehicles with conspicuous lighting may be required during initial trials or when experimental systems are deployed. Additional measures, such as increased following distances or deactivation of platooning technology, may be necessary in high-traffic conditions. Signage must be displayed on all platooning vehicles to inform other road users of their presence.

Drivers participating in platooning operations must hold a valid, appropriately endorsed commercial driver's license (CDL) and complete specialized training provided by the testing entity. This training must include fault injection scenarios and complex traffic maneuvers, such as handling vehicle cut-ins. Drivers must comply with all applicable regulations and remain seated in their vehicles, ready to assume manual control when necessary. In the event of communication failures or malfunctions in the Cooperative Truck Platooning System (CTPS), drivers must increase following distances in a controlled manner to stabilize the platoon. Jurisdictions are advised not to extend hours-of-service limits for drivers, even when their role is limited to monitoring the vehicle's operations.

These comprehensive requirements reflect Canada's commitment to promoting safety, efficiency, and regulatory compliance in the development and testing of truck platooning technologies.

Overview of the Ontario Cooperative Truck Platooning Pilot Program

The Ontario Cooperative Truck Platooning Pilot Program is an ambitious initiative designed to evaluate the integration of advanced truck platooning technology into the province's transportation system. Spanning eight years, the program aims to enhance road safety, optimize freight efficiency, and reduce environmental impact, fostering economic growth through innovation [30]. The pilot involves testing Cooperative Truck Platooning, where multiple

trucks equipped with vehicle-to-vehicle (V2V) communication and advanced driving support systems travel in coordination to improve safety, efficiency, and fuel economy. Vehicles operate at SAE Levels 1 and 2 automation, requiring driver oversight for all tasks outside steering, acceleration, and braking.

Participation in the pilot is limited to approved carriers who meet stringent qualifications, including a minimum of five years of trucking experience, a satisfactory safety rating, and $5 million in public liability insurance. Drivers must possess appropriate licensing, five years of relevant experience, and a clean safety record. Eligible vehicles must comply with specific configurations, excluding long combination vehicles (LCVs) and tractor double-trailers, with the lead vehicle being the heaviest for stability. Platoons are restricted to three vehicles with a minimum following distance of 20 meters (or 1.7 seconds), disengaging for merging traffic, construction zones, or adverse conditions.

Platooning is confined to approved highway segments, such as portions of Highways 401, 403, 400, and 11, with entry and exit limited to designated rest areas and inspection stations. Operations are prohibited during inclement weather, including snow, ice, or visibility below 500 meters. Vehicles must be equipped with advanced safety systems, including ABS, ESC, V2V communication, and driver alerts for system failures. Carriers are required to maintain rigorous reporting standards, submitting annual data on performance and incidents, and ensuring cybersecurity measures to protect platooning systems. Non-compliance can lead to the suspension or revocation of approval, ensuring safety remains paramount throughout the program.

Results of Pilot Programs in Canada

The Cooperative Truck Platooning Pilot Program in Canada was conducted between October 2021 and February 2022 along the Queen Elizabeth II Highway, connecting Calgary and Edmonton. The study encompassed real-world winter conditions, with ambient temperatures ranging from −16°F to 54°F and truck weights varying between 16 and 39 tons. The on-road trials involved two SAE Level 2 Class 8 trucks, covering a total distance of 22,855 km, 14,202 miles, across 41 incident-free platooning and baseline test trips. The study demonstrated the feasibility of commercial truck platooning under winter conditions, utilizing 3–5 second time gaps. The average platoon engagement ratio was 61.6%, peaking at 88.9% under optimal conditions. Engagement levels were influenced by road surface conditions:

- Bare dry roads (76% of trips): 62.9% engagement
- Bare wet roads (20% of trips): 55.7% engagement
- Shoulder ice/snow conditions (limited data): 66.1% engagement

The lead truck maintained an average speed of 88.8 to 95.0 km/h (55.19 mph to 59.04 mph), while the follower truck traveled at 88.9 to 95.2 km/h (55.25 mph to 59.17 mph), with slightly higher speed fluctuations. Fuel consumption analysis revealed a 1.6% fuel savings for the follower truck on flat road sections. However, fuel consumption increased by up to 12.5% on hilly terrain, primarily due to powertrain inefficiencies.

The study recorded an average of 74 disengagements per trip, causing fluctuations in powertrain performance and reducing overall efficiency. In a brief period of 2 minutes and 35 seconds, the platooning system disengaged and re-engaged eight times, leading to instability in powertrain management.

Comparison of Truck Platooning Regulations: US and Canada

This section provides a comparison of the regulatory measures governing truck platooning in the United States and Canada, focusing on key aspects of their frameworks. Areas of comparison include the definition of platooning, the use of visual identifiers, route and vehicle limitations, weather-related operational restrictions, driver and operational requirements, approval processes, communication standards, and the role of pilot programs. Through this examination, the analysis seeks to identify commonalities, distinctions, and unique regulatory approaches, offering insights into the strengths and challenges of each framework. This evaluation aims to inform future policy development and support efforts toward regulatory harmonization.

Table 2: Comparison of Criteria Between the United States and Canada

Criterion	United States	Canada	Comparison
Definition of Platooning	Provides detailed definitions for terms like Lead Vehicle, Following Vehicle(s), and ADS.	Integrates definitions (e.g., V2V and Cooperative Truck Platooning) into operational guidelines.	US is more explicit in defining terms, while Canada focuses on functionality within regulations.
Visual Identifiers	Requires markings, decals, or lights for law enforcement and public awareness.	Mandates external identifiers and signage; suggests escort vehicles with lighting for early trials.	Canada adds escort vehicle requirements, enhancing visibility during trials.
Route Restrictions	Exempts platooning vehicles from general traffic following distance rules; relies on V2V for safe spacing.	Limits platoons to three vehicles; requires increased following distance during communication failures.	Canada specifies a platoon size limit and includes explicit rules for handling system failures.
Vehicle Limitations	State-specific rules often allow long-combination vehicles; typically permits single-trailer setups.	Prohibits long-combination setups (e.g., B-trains); only single tractor-trailer units are allowed.	Canada imposes stricter limits on vehicle configurations, ensuring uniformity and safety.
Weather Restrictions	Operations may be prohibited during adverse weather (e.g., snow, rain, fog) but vary by state.	Uniform restrictions ban operations on snow-covered, icy roads or during reduced visibility.	Canada enforces stricter national rules on adverse weather conditions.
Operational Requirements	Disengagement required in construction zones, emergencies, or congestion. Prohibits certain cargo types.	Requires disengagement at tunnels, weigh stations, toll plazas, and incident scenes. Prohibits dangerous goods and loose loads.	Both hazardous cargo; Canada specifies disengagement for additional zones.
Driver Requirements	Drivers must have specialized training and lead drivers often require additional certifications.	Drivers must hold a CDL, complete fault scenario training, and remain seated to take control if needed.	Both prioritize driver readiness; Canada prohibits extending hours of service, ensuring driver alertness.
Operational Approval	State-specific approval through DoT; requires safety and operational plans tailored to local regulations.	Centralized approval process requiring detailed application packets reviewed at federal/provincial levels.	Canada has a more uniform and centralized approval process; US is more flexible, varying by state.
Communication Standards	Incorporates V2V and V2I communication; mandates encryption to prevent hacking.	Focuses solely on V2V communication for vehicle coordination.	US includes V2I, enhancing integration with infrastructure, while Canada is limited to V2V.
Pilot Programs	Encourages pilot programs with route-specific safety and environmental data collection.	Pilot testing tied to approved routes with ongoing evaluations for feasibility and operational impact.	Both require pilots, but US emphasizes public-private collaboration for refinement.

Recommendations for Future Legislation on Truck Platooning

Based on a comprehensive review of enacted legislation and regulatory frameworks, the following recommendations are proposed to guide the development of new policies supporting the testing and deployment of truck platooning technologies. These recommendations outline key aspects and provisions that should be incorporated into future legislative efforts to ensure safe, efficient, and scalable implementation of truck platooning systems.

Regulatory Framework

It is essential to define truck platooning within state and federal transportation laws, distinguishing it from other automated vehicle technologies. While truck platooning incorporates specific AV technologies, it remains fundamentally different due to its unique safety measures, operational requirements, coordinated vehicle dynamics, and commercial freight-specific regulations. These distinctions necessitate a dedicated regulatory framework tailored to the specific needs of truck platooning operations.

Licensing and certification requirements for truck platooning must ensure that all operators, including drivers, remote controllers, and fleet managers, are adequately trained and qualified. Establishing specialized training programs and certification standards will enhance safety and operational efficiency. Additionally, incorporating a platooning authorization within commercial driver's license (CDL) regulations will help standardize qualifications for drivers managing platooning systems. These measures will ensure that platooning operations comply with safety protocols while promoting seamless integration into the freight industry.

Insurance and liability frameworks for truck platooning should clearly define responsibility in the event of an incident. In manually controlled platooning, liability should primarily rest with the driver, while failures in automated systems may fall under the manufacturer or technology provider.

Harmonizing regulations among neighboring states will ensure consistency in operational standards, safety protocols, and permitting requirements. Collaboration between the U.S. and Canada is particularly crucial for cross-border freight movement, especially along major trucking corridors.

Real-time data collection should be mandated to track system performance, including disengagements, failures, and safety incidents. Reporting requirements should also cover near-miss events, fuel efficiency, and emission reduction metrics to assess platooning's environmental and economic benefits. Additionally, collected data should be shared with the Department of Transportation (DOT) for further investigation and analysis, enabling data-driven policy improvements and informed decision-making for future platooning regulations.

General Provisions for Truck Platooning Legislations

- Definitions: Platooning, Lead Vehicle, Following Vehicles, Platooning Operational Plan, Smart Infrastructure, etc.
- Penalties for Non-Compliance: Violations of operational plans incur fines of up to $500 per violation.
- Permit Suspension: Repeated violations may result in suspension or revocation of platooning permits.
- Fuel Efficiency and Emissions Reporting: Operators must annually report fuel savings and emissions reductions achieved through platooning.
- Review and Updates: The DOT will evaluate legislation every 3 years to incorporate advancements in technology.

- Stakeholder Feedback: Annual feedback sessions will involve operators, communities, and enforcement agencies.
- Infrastructure Funding: Fees collected will fund the development of smart corridors and connected infrastructure.

Traffic Operation Provisions for Truck Platooning Legislations

- Platooning Operational Approval: Approval Requirement: Operators must submit a Platooning Operational Plan to the Department of Transportation (DOT) and the state transportation commission for review, including routes and operational hours, safety measures for emergencies, compliance with weight, size, and cargo restrictions, and driver training standards. The plan should be approved or rejected within 30 days, providing guidance for revisions if necessary.
- Following Too Closely Provisions: Vehicles in a platoon are exempt from standard following distance laws.
- Minimum Distance: Vehicles must maintain a safe gap of 50-100 feet within the platoon, depending on speed and road conditions. Platooning vehicles must also ensure sufficient space for merging or overtaking by non-platooning vehicles.
- Number of Vehicles Allowed in a Platoon: A maximum of 3 vehicles per platoon, unless authorized for testing on specific conditions.
- Overtaking and Lane Change Provisions: Platooning vehicles should follow clear rules for overtaking and lane changes, ensuring safe spacing during maneuvers. Lead vehicles must signal intentions to the following vehicles to maintain synchronization and safety.
- Speed, Size, and Operational Limits: Platooning vehicles are limited to 65 mph, regardless of posted limits. Operations are restricted to off-peak hours to minimize congestion.

Traffic Safety Provisions for Truck Platooning Legislations

- Safety Provisions and Emergency Protocols: Adaptive braking, V2V communication, and real-time monitoring are mandatory for all platooning vehicles.
- Emergency Response: Systems must allow for immediate manual disengagement during emergencies, including loss of synchronization or system failures.

Driver Requirements Provisions for Truck Platooning Legislations

- Driver Requirements for Lead Vehicles: Trained and licensed driver must be physically present in the lead vehicle at all times.
- Lead Vehicle Driver: Must hold a valid Commercial Driver's License (CDL) with platooning endorsements. Trained in emergency protocols, system overrides, and manual disengagement.
- Following Vehicle Drivers: if presented, they must hold a CDL and monitor synchronization, ready to assume manual control during emergencies.
- Driver and Industry Training: Training programs for commercial drivers could be required for safe and efficient operation of truck platoons accounting for cases where system failures occur to comply with a fail-safe plan.

Currently, no state permits the operation of truck platoons without a driver in the leading vehicle. To facilitate the adoption of this technology, it is recommended that regulatory bodies evaluate the feasibility of allowing fully autonomous platooning under controlled conditions and the presence of a remote operator.

Vehicle Requirements Provisions for Truck Platooning Legislations

- Allowable Commodities and Materials: Platooning vehicles may transport general freight and non-hazardous materials. Trucks transporting Hazardous Materials might be allowed only with prior DOT approval and adherence to federal safety standards. Loose cargo, oversized loads, and unstable materials are prohibited unless explicitly approved by the DOT.
- Vehicle Weight and Size Limits: Vehicles must adhere to state-mandated gross and axle weight limits.
- Vehicle Markings: Platooning vehicles should display distinctive markings, such as decals, lights, or indicators, to ensure easy recognition by law enforcement, emergency responders, and road users, enhancing safety and accountability.
- Inspection and Maintenance Standards: Platooning vehicles must undergo regular inspections for system functionality and safety compliance. Operators must maintain detailed records of inspections and repairs.
- Noise and Vibration Standards: Vehicles must comply with state noise and vibration regulations to minimize community impact.

Testing Environment and Location Provisions for Truck Platooning Legislations

- Weather Restrictions: Platooning operations are prohibited during heavy rain, fog, snow, or other adverse weather conditions. Operators must provide safe procedures for dissolving a platoon when a vehicle within the platoon exits due to mechanical issues or traffic conditions.
- Operations are restricted in residential and commercial areas unless specifically authorized.
- Smart Infrastructure Integration: Platooning vehicles must interact with smart infrastructure, such as adaptive traffic signals and V2I systems, to optimize traffic flow.
- Public Awareness and Education: The DOT must fund campaigns to educate the public about platooning technology and its benefits. Operators shall hold public forums in areas near approved routes to address concerns.

Communication and Cybersecurity Provisions for Truck Platooning Legislations

- Communication and Cybersecurity Standards: V2V communications and encrypted systems are mandatory to ensure safety and synchronization between the vehicles in the platoon.
- Cybersecurity Measures: Regular penetration testing and compliance with federal cybersecurity standards are required to prevent cyberattacks and hacking.

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