

CTIPS

*Center for Transformative
Infrastructure Preservation
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USDOT Region 8 University Transportation Center

RESEARCH BRIEF

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Improving Compatibility of
Truck Platooning with Existing
Infrastructure via Development
of Dynamic Operational Rules
on Highway Networks



the **ISSUE**

Long automated truck platoons on two-lane undivided highways create dangerous moving bottlenecks, severely restricting passing opportunities and elevating collision risks for human-driven vehicles. Static regulations fail to address these mixed-autonomy conflicts, necessitating dynamic platoon sizing and active cooperative gap-opening controls to safely integrate heavy freight without sacrificing mobility.

the **RESEARCH**

This research investigated the safe integration of automated truck platoons in mixed-autonomy traffic on two-lane undivided highways through a multi-tiered methodological approach. First, analytical overtaking models were developed to quantify the constraints long platoons impose on human-driven vehicles, measuring the exponential increases in required passing time and distance. Next, a stochastic approximation algorithm was designed to establish dynamic platooning rules, actively restricting platoon lengths based on real-time geometric conditions such as hills and curves and opposing traffic flow.

The operational and safety impacts of these dynamic rules were then evaluated using microscopic traffic simulation. Surrogate safety measures were extracted to analyze localized traffic friction, revealing a trade-off between macroscopic network fluidity and microscopic rear-end or lane-change conflicts caused by segmented platoons. To resolve these conflicts, the study developed an active gap-opening control algorithm leveraging cooperative adaptive cruise control. This control strategy utilizes kinematic trajectory prediction to actively sense approaching human drivers and proactively split platoons, creating safe, temporary harbors for step-by-step overtaking. Together, this combination

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Project Title

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the **RESEARCH** continued

of macroscopic dynamic regulation and microscopic cyber-physical control provides a comprehensive framework for balancing freight efficiency with passenger vehicle safety.

the **FINDINGS**

The research demonstrated that while long automated truck platoons optimize efficiency on divided highways, they create severe mobility bottlenecks and elevate collision risks on two-lane undivided roads by exponentially increasing the time and distance required for human-driven vehicles to overtake. Implementing dynamic platooning rules through a stochastic approximation algorithm successfully mitigated these macroscopic delays by actively restricting platoon sizes based on local road geometry and opposing traffic flow. However, microscopic simulation revealed a critical operational trade-off: segmenting large convoys increased localized traffic friction, slightly elevating rear-end and lane-change conflicts among eager passing drivers. To resolve this, an active gap-opening control algorithm leveraging cooperative adaptive cruise control was developed. By anticipating human driver trajectories, this cooperative system proactively opens internal platoon gaps to create safe, temporary harbors, neutralizing localized conflicts while successfully preserving overall network fluidity.

To drive implementation, these findings were disseminated directly to stakeholders through two journal articles, two conference papers, two academic presentations, and a dedicated briefing to WYDOT.

the **IMPACT**

This research provides a blueprint for safely deploying automated truck platoons on rural, two-lane highways. Dynamic, cooperative cruise control allows agencies to maintain the 5%-10% aerodynamic fuel savings of platooning without sacrificing passenger safety. The active gap-opening system eliminates moving bottlenecks and neutralizes collision risks, empowering transportation departments to maximize corridor throughput and delay costly physical road expansions.

For more information on this project, download the Main report at <https://www.ugpti.org/resources/reports/details.php?id=1282>

For more information or additional copies, visit the Web site at www.ctips.org, call (701) 231-7767 or write to Center for Transformative Infrastructure Preservation and Sustainability, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.



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