SEPTEMBER 2025

AI in MOTION

Securing America's Edge in
Safer, Smarter Transportation

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AI in Motion

Securing America's Edge in Safer, Smarter Transportation

September 2025

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Glossary of Terms and Definitions

Advanced Driver-Assistance Systems (ADAS): Technologies integrated into vehicles that assist human drivers by automating, enhancing, or streamlining driving functions such as lane keeping, adaptive cruise control, automatic emergency braking, and blind spot detection.

Agentic AI: Systems capable of planning, making decisions, and taking actions toward goals without continuous human input.

Artificial Intelligence (AI): A machine-based system that, for explicit or implicit objectives, infers from the input it receives how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments.

Automated Driving Systems (ADS): Technology that enables vehicles to perform driving tasks without human intervention using sensors, AI, and control systems.

Autonomous Vehicles (AVs): Vehicles equipped with systems that can perceive their environment, make driving decisions, and navigate with minimal or no human input. Depending on the level of autonomy, some AVs may still include human oversight or fallback control, but do not require continuous human operation.

Computer Vision: A form of AI that enables systems to interpret and act on visual inputs, used for object detection, infrastructure monitoring, and traffic analysis.

Critical and Emerging Technology AI Safety Institute (CAISI): A NIST-led initiative focused on evaluating and ensuring the safety, security, and reliability of advanced AI systems, particularly those with national security implications.

Deep Learning: A subset of neural networks with multiple layers of processing that extract higher-level features from raw data, enabling tasks such as object recognition, voice transcription, and real-time decision-making.

Digital Twins: Live, virtual models of physical transportation assets used for monitoring, analysis, and predictive maintenance across systems and networks.

Edge AI: AI systems deployed directly on vehicles or infrastructure that process data locally rather than in the cloud, enabling faster responses and reducing latency and bandwidth needs.

Full-Stack Exports: The comprehensive export of an entire technology stack, including hardware, software, and integrated systems, rather than individual components.

Generative AI (GenAI): A class of models capable of creating new content, including traffic simulations, technical reports, synthetic datasets, and digital assets.

Large Language Model (LLM): A type of generative AI trained on massive datasets to produce human-like text, answer questions, generate code, or structure data across domains.

Light Detection and Ranging (LiDAR): A sensing technology that emits laser pulses to measure distance and create detailed spatial maps, commonly used in AVs for detecting and classifying objects.

Machine Learning (ML): A foundational AI capability that enables systems to learn patterns from data and improve performance or accuracy over time without being explicitly programmed.

National Institute of Standards and Technology (NIST): A U.S. federal agency that develops standards, measurements, and technologies to support innovation, industrial competitiveness, and national security.

Neural Networks: AI models inspired by the structure of the human brain, designed to process complex and unstructured inputs such as video, images, or sensor data.

Quantum Computing: An emerging computing paradigm that uses quantum mechanics to process information, with potential applications in optimizing traffic flow, emergency dispatch, and route planning.

Reinforcement Learning (RL): An ML method where systems learn through trial and error by interacting with their environment, often used for adaptive signal control and autonomous navigation.

Supervised Learning: A machine learning technique that uses labeled datasets to train models to predict known outcomes, such as identifying transit delays or classifying maintenance needs.

Traffic Management Center (TMC): A facility that monitors and manages real-time traffic operations, often using intelligent transportation systems, sensors, and AI-enabled analytics.

Unsupervised Learning (UL): A machine learning method that processes unlabeled data to detect hidden patterns, often used to identify traffic anomalies, segment road users, or group mobility behaviors.

White House AI Action Plan: A 2025 policy roadmap aimed at establishing U.S. leadership in AI through deregulation, infrastructure build-out, export promotion, and international standards-setting.

Executive Summary

Artificial intelligence is advancing rapidly across transportation, delivering measurable gains in safety, efficiency, and cost. Vehicles equipped with autonomous driving systems have reduced third-party bodily injury claims by up to 92%, automated routing has decreased delivery times by 25%, and flight-path optimization saves a global airline nearly $100 million annually. These outcomes demonstrate that AI in mobility is no longer experimental. It is a strategic capability with direct implications for economic competitiveness and national security.

The United States leads in AI innovation and private investment. However, true leadership will be determined by large-scale deployment, not pilots or prototypes. Global competitors are integrating infrastructure, governance, and standards into unified strategies. In 2025, federal policy shifted to treat AI as critical infrastructure and a competitive factor, creating an opportunity to transition from experimentation to implementation. Nevertheless, international rivals are rapidly advancing, raising the stakes for the U.S. to shape global rules rather than adapt to those set by others.

Three realities define the road ahead:

- **Energy and compute are now chokepoints.** Data-center demand is accelerating, edge AI is proliferating, and transportation workloads will increasingly strain electricity supply, semiconductor capacity, and compute infrastructure.
- **Governance will decide whether innovation scales.** States are leading deployments, but fragmented procurement, oversight, and accountability threaten interoperability and delay national integration.
- **Standards are a geopolitical contest.** Rules governing safety, liability, and data will determine market access and supply chain alignment for decades.

These challenges are strategic and immediate. Without decisive action, the U.S. risks eroding competitiveness, exposing critical systems to cyber threats, and losing public confidence as adoption outpaces oversight.

To meet the moment, the United States must treat AI-enabled transportation as a strategic infrastructure priority. This requires:

INVESTING in the physical foundation—power, chips, and compute—to meet fast-growing demand and avoid future bottlenecks.

MODERNIZING regulatory frameworks to support deployment across jurisdictions while safeguarding the public interest.

LEADING in global standard-setting to ensure democratic values—transparency, accountability, and interoperability—define the future of mobility, not authoritarian alternatives.

The race ahead is about who deploys AI at scale, who governs it responsibly, and who sets the rules that others follow.

Introduction

Artificial intelligence (AI) is transforming transportation, embedding new capabilities into the movement of people and goods. From autonomous trucks and predictive traffic systems to simulation-based planning tools and real-time infrastructure analytics, AI is being embedded across every layer of mobility.

This shift is not merely incremental. It is structural and foundational to how transportation systems are designed, governed, and operated. AI is changing how networks are powered, how decisions are made, and how systems adapt to real-world conditions. As AI spreads from the cloud to the edge—from centralized data centers to the vehicles, signals, and sensors on our streets—it is making infrastructure more adaptive, more efficient, and more capable of learning from its environment. Systems that once waited for problems to occur can now anticipate them. Networks that once ran on fixed schedules can now adjust in real time. In this new era of mobility, AI promises a transportation system that is safer, smarter, more cost-effective, and purpose-built to meet the demands of the future.

Efforts to integrate AI into transportation are being driven in large part by safety. Intelligent systems powered by advanced algorithms are already improving roadway safety by predicting collisions, identifying hazardous conditions, and enabling faster, more coordinated emergency responses. Autonomous vehicles (AVs) rely on intelligent systems to detect, classify, and respond to objects in complex environments, reducing the risks associated with human error in traditional driving. State and local Traffic Management Centers use computer vision to monitor intersections and detect wrong-way drivers. These systems can trigger flashing roadside warnings, notify traffic control centers, and activate dynamic signage to alert other motorists, all within seconds of detection.

Increasingly, advanced tools are driving the next wave of safety innovation. State departments of transportation are beginning to apply systems that predict scenarios or analyze roadway images to prioritize roadwork and simulate crash scenarios before they occur, allowing agencies to identify hazardous patterns, test interventions virtually, and redesign high-risk road segments before tragedy strikes. These examples reflect a broader evolution in the tools available to achieve road safety through intelligent systems, live data, and real-time processing.

However, AI must be anchored in physical infrastructure for it to scale in transportation. Electricity, chips, and compute power are all essential, not just to process data from sensor-rich environments, but to support transportation's convergence with broader AI infrastructure. As AI-enabled transportation systems expand, they are competing for the same strained power supply, semiconductor capacity, and cloud infrastructure already in high demand across the economy. Electricity is proving to be a limiting factor. Certain high-performance chips remain in short supply due to surging global demand and constrained fabrication capacity. And the availability of computing power must expand rapidly to meet deployment needs across fleets, urban corridors, logistics hubs, and other critical nodes.

Policy, not just technology, will determine whether the nation can scale AI in transportation. In recent years, federal agencies have piloted use cases, modernized systems, and experimented with flexible procurement. Until recently, federal efforts focused on building a "responsible" governance framework, advancing pilot deployments, and developing voluntary standards but lacked a centralized strategy for scaling deployment across sectors.[1] In 2025, the federal approach underwent a sharp reorientation. The Trump Administration released a national *AI Action Plan* outlining more than 100 policy recommendations, alongside three executive orders aimed at accelerating innovation, streamlining permitting, scaling infrastructure, and asserting American leadership on the global AI stage.[2] The Plan positions AI-enabled transportation as both a national infrastructure priority and a strategic export asset, central to the economic competitiveness, energy security, and geopolitical influence of the United States.

> ***Policy, not just technology,*** *will determine whether the nation can scale AI in transportation.*

This new federal posture signals a shift from risk-based agency-led experimentation to coordinated, whole-of-government execution. While the Plan reflects a deregulatory emphasis and national security framing distinct from the previous administration, it creates new opportunities for federal agencies, state partners, and private-sector stakeholders to align around deployment. Executive action aims to catalyze permitting reform for data centers, fast-track energy infrastructure approvals, and promote full-stack technology package exports, including for transportation applications, to allies and partners.

At the same time, the underlying governance landscape remains fractured. The federal government has not yet established a consistent regulatory framework for AI in transportation, and Congress has chosen not to act on proposals to harmonize or preempt state rules. In 2025, an amendment to impose a decade-long moratorium on state-level AI regulation was debated and ultimately rejected, giving states more room to continue experimenting with their own programs, at least for now.[3] As a result, states remain at the forefront of both deployment and regulation, driving innovation but also contributing to an increasingly complex patchwork of rules around safety, liability, and data governance.

Meanwhile, global competitors are not waiting. The European Union is advancing risk-based AI governance with extraterritorial reach. China is embedding intelligent infrastructure into a centralized system of algorithmic control. These competing approaches reflect not only different regulatory philosophies but different values. As Microsoft President Brad Smith recently told Congress, "The number one factor that will define whether the United States or China wins this race is whose technology is most broadly adopted in the rest of the world."[4]

To lead in this new era of mobility, the United States must treat AI-enabled transportation as both a strategic imperative and a public good. AI-enabled systems can reduce crashes, lower liability exposure, cut fuel use, optimize routes, and extend asset life—making them not only safety solutions but business imperatives. Delivering on that potential will require more than innovation alone. It will depend on resilient infrastructure, modernized governance, and coordinated action across federal, state, and industry lines.

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[1] Note: The Biden Administration characterized its AI approach as "responsible" innovation. This terminology appeared in Executive Order 14110, the Office of Science and Technology Policy's *Blueprint for an AI Bill of Rights*, and official White House communications. See, e.g., The White House, "Fact Sheet: President Biden Issues Executive Order on Safe, Secure, and Trustworthy Artificial Intelligence," October 30, 2023.

[2] The White House, "Winning the Race: America's AI Action Plan," July 23, 2025, at 1–2.

[3] See, e.g., David Morgan and David Shepardson, "US Senate strikes AI regulation ban from Trump megabill," *Reuters*, July 1, 2025.

[4] Brad Smith, "Winning the AI Race: Strengthening U.S. Capabilities in Computing and Innovation," U.S. Senate Committee on Commerce, Science, and Transportation, 119th Congress, May 8, 2025.

The Promise of AI-Enabled Transportation

AI has moved beyond experimental pilots and isolated software tools. Today, it is embedded across the transportation system. AI systems are helping dispatch autonomous trucks along optimized routes, recalibrate signals to clear emergency pathways, anticipate maintenance needs for commercial aviation and rail, and support operational decision-making across increasingly complex networks. In freight and logistics, AI is improving equipment tracking, reducing empty miles, streamlining port operations, and enhancing compliance and load pairing, all of which contribute to greater efficiency and asset utilization.

At its core, AI refers to a set of computational techniques that allow machines to analyze data, detect patterns, and make decisions with minimal human input. The Organisation for Economic Co-operation and Development (OECD) defines AI as "a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments."[5]

[5] OECD, "Explanatory Memorandum on the Updated OECS Definition of an AI System," OECD Artificial Intelligence Papers, March 2024, at 4.

This section outlines four foundational categories of AI technologies currently deployed in transportation. While not exclusive nor collectively exhaustive, these categories represent some of the most widely used and impactful approaches today:

- **Machine learning,** which enables predictive operations such as anticipating transit delays or identifying collision risk hotspots based on historical data;
- **Neural networks and deep learning,** which enhance system-level perception and control, for example, interpreting traffic flow data or optimizing routing decisions in real time;
- **Computer vision,** which allows machines to interpret visual data, such as detecting pedestrians in crosswalks or identifying road damage from camera feeds; and
- **Generative AI,** which opens new frontiers in simulation, analysis, and decision support, for instance, generating synthetic traffic scenarios to train AV algorithms or drafting infrastructure inspection reports from sensor data.

Together, these tools are moving the sector from reactive to predictive, and from analog to intelligent.

DATA INPUTS

Artificial intelligence enables analysis of everything that is and ever was: both historical and real-time data, including:

- Traffic data
- Transit schedules and current public vehicle locations
- Weather data
- Dashcam data showing condition of roads, lights, vegetation encroachment, etc.

FIGURE 1 · Artificial intelligence.

ARTIFICIAL INTELLIGENCE

MACHINE LEARNING

Machine learning trains computers to program themselves, learning and improving through experience by ingesting large amounts of data.

- **Supervised learning** uses labeled datasets, like bus schedules.
- **Unsupervised learning** can process unlabeled data, like video footage or sensor logs.
- **Reinforcement learning** undergoes continuous adaptation through trial and error.

COMPUTER VISION

Computer vision is the perceptual aspect of AI, enabling machines to process and act on visual inputs, such as images, video streams, and LiDAR scans.

NEURAL NETWORKS & DEEP LEARNING

Neural networks are densely interconnected webs of thousands—even millions—of bits of software that identify patterns and prioritize important information within large, complex datasets.

Convolutional neural networks (CNNs) are designed for superior recognition and classification of image, speech, or audio inputs.

Deep learning refers to more elaborate neural networks that allow the system to learn increasingly abstract and complex relationships.

GENERATIVE AI

Generative AI refers to a class of large language models (LLMs), AI systems that are trained on massive datasets to generate human-like language, code, or other structured content.

AI RESULTS

For Riders
- Fewer crashes
- Smarter intersections
- More reliable commutes

For Freight Operators
- More efficient routing
- Reduced delays
- Lower operating costs

For Transportation Planners
- Unlocks scenario simulation tools
- Real-time data
- Better targeting of investment

For Taxpayers and the Public
- Reduced waste
- Longer-lasting assets

Machine Learning

Machine learning (ML) is a foundational AI capability that allows systems to identify patterns in data and improve performance over time without explicit programming. In transportation, ML supports predictive operations by learning from both historical and real-time inputs, enabling infrastructure, vehicles, and logistics systems to adapt dynamically to changing conditions. For example, the Metropolitan Transit Authority's New York City Transit partnered with the AI technology firm Preteckt to deploy a predictive maintenance system across 1,500 buses. By analyzing real-time sensor data to anticipate component failures, the system increased maintenance productivity by 43 percent and reduced material costs by 24 percent.[6] Following these results, the contract was extended another year to over 5,000 buses.[7]

> ***Machine learning** is making the transportation and mobility sector safer and more efficient.*

Several ML techniques are making the transportation and mobility sector safer and more efficient:

- **Supervised learning** uses labeled datasets, or collections of data in which each input is matched to a correct answer or outcome, to make predictions about future events. It is frequently applied to forecast road usage demand, estimate fleet and transit arrival times, and enable preventive maintenance. For example, the Golden Gate Bridge Highway and Transportation District conducted a two-year pilot ending in 2021 that fed an AI system live and historical data on scheduled and actual bus departure times. The system continuously retrained its models to forecast delays and adjust departure estimates, improving bus departure accuracy from 49 to over 87 percent during peak congestion.[8]
- **Unsupervised learning (UL),** by contrast, uses unlabeled data, which lacks predefined categories or annotations, such as video footage or sensor logs that have not been tagged with predefined categories or annotations.[9] It is especially useful when large datasets are available but labeling them would be costly or impractical. UL can surface issues that may not be anticipated in advance, such as traffic disruptions or equipment faults. In 2020, Raleigh began experimenting with unsupervised learning to automate vehicle counting using video footage from city cameras, allowing the city to leverage existing data without requiring manually labeled inputs. The pilot expanded into a broader AI integration effort, and today, Raleigh operates more than 500 AI-enabled cameras to support data-driven traffic management.[10]
- **Reinforcement learning (RL)** is often considered a third core type of ML. In RL, systems learn through trial and error: they take actions, observe the results, and adapt their strategies based on signals of success or failure, gradually improving to maximize long-term outcomes. While RL is often treated as separate, it can incorporate elements of both supervised and unsupervised learning depending on the training design. RL is especially useful in transportation settings that require continuous adaptation, such as traffic signal control or dynamic fleet routing. It is being tested to manage congestion at intersections and optimize vehicle movement across networks. In some cases, multiple RL agents, such as signals at neighboring intersections, can learn collaboratively to coordinate traffic more effectively.

Neural Networks and Deep Learning

As transportation systems evolve to handle increasingly complex, real-time environments, they require AI models capable of processing large, unstructured data streams. These include inputs like video feeds and free-form text that lack a consistent format. Unlike structured data, which

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6 Preteckt, Inc., "New York City Transit Recognized At UITP Awards For Using Preteckt's AI Software To Maintain Bus Fleet," July 10, 2023, Webpage.

7 Louis Montanti, "New York City Transit Procurements," September 2023, at 3.

8 INIT Innovations in Transportation, Inc., "Automation and AI in Public Transit," Webpage.

9 Note: While labeled datasets are typically created through manual tagging by humans or drawn from well-structured datasets, unlabeled data often comes from sensors, cameras, or traffic feeds that can be rich with data but not yet organized.

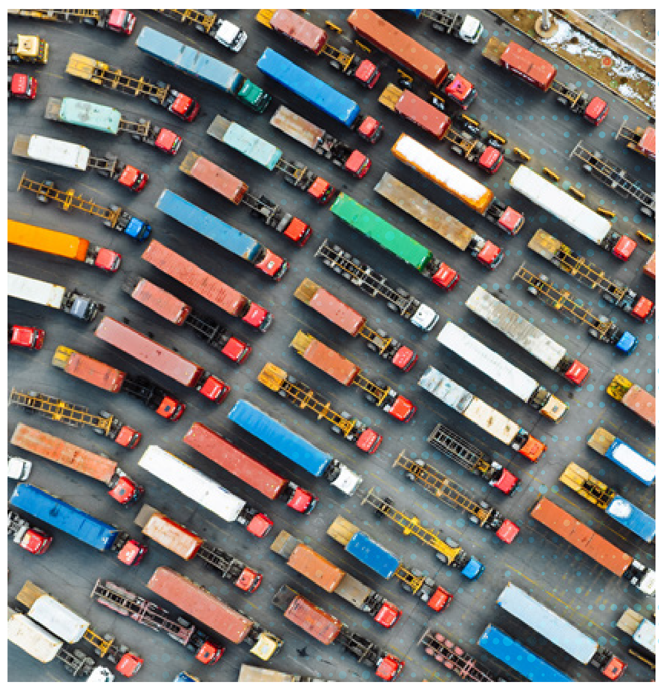
10 Adam Stone, "Street Smarts: Raleigh Drives Smart City Improvements with Traffic Solutions," *State Tech*, April 15, 2022.

> ***Neural networks and deep learning*** *provide the speed and flexibility to interpret unstructured data, enabling systems to perceive their surroundings and make decisions in real time.*

can be neatly organized in tables or spreadsheets, unstructured data originates from sources such as traffic cameras, onboard vehicle sensors, and social media feeds. **Neural networks** and **deep learning** provide the speed and flexibility to interpret this data, enabling systems to perceive their surroundings and make decisions in real time.

Neural networks are a type of ML model inspired by the structure of the human brain.[11] They are designed to identify patterns and prioritize important information within large and complex datasets. Deep learning refers to neural networks with multiple layers between input and output, called "hidden layers," which allow the system to learn increasingly abstract and complex relationships. Unlike early ML and computer vision systems that relied on manually engineered features (specific characteristics selected and programmed by humans), modern deep learning models can automatically extract insights from raw, high-volume inputs such as video feeds, LiDAR data, and connected vehicle telemetry.[12] These capabilities are particularly well-suited to transportation systems that require continuous perception and rapid decision-making, such as AVs.

Neural networks are increasingly deployed to address operational and safety challenges in transportation. For example, **deep reinforcement learning**—a technique in which algorithms learn to select optimal actions through continuous trial and error—has been applied to adaptive traffic signal control, where systems adjust signal timing based on real-time traffic conditions. In simulations, this approach has reduced average delays by more than 30 percent compared to conventional methods.[13] In roadway safety, **convolutional neural networks**—a type of deep learning algorithm specialized for visual data—have been trained on connected vehicle and traffic datasets to classify whether intersections are high-risk or prone to crashes. Some studies have reported predictive accuracy rates exceeding 90 percent.[14] These applications illustrate how neural networks can help transportation agencies make systems more adaptive, data-informed, and proactive.



[11] See, e.g., Feng Shao and Zheng Shen, "How can artificial neural networks approximate the brain?," *Frontiers in Psychology* 13, January 9, 2023.

[12] Alhassan Mumuni and Fuseini Mumuni, "Automated data processing and feature engineering for deep learning and big data applications: A survey," *Journal of Information and Intelligence*, March 2025, at 122.

[13] See, e.g., Matthew Muresan et al., "Adaptive Traffic Signal Control with Deep Reinforcement Learning: An Exploratory Investigation," January 2019; and Juntao Gao et al., "Adaptive Traffic Signal Control: Deep Reinforcement Learning Algorithm with Experience Replay and Target Network," May 8, 2017.

[14] Jiajie Hu et al., "Efficient Mapping of Crash Risk at Intersections with Connected Vehicle Data and Deep Learning Models," *Accident Analysis & Prevention* 144, September 2020.

TABLE 1 · AI-enabled devices will unlock transportation efficiencies.

TRANSPORTATION FUNCTION	LEGACY SYSTEMS	AI-ENABLED SYSTEMS
Traffic Signals 	Infrequently updated pre-timed signals lead to congestion, delays, and inefficient fuel consumption.	AI-powered adaptive traffic signals continuously adjust to real-time conditions, helping reduce congestion, shorten travel times, prioritize emergency vehicles and access to public transit, and cut fuel consumption.
Asset Monitoring 	Manual field inspections with scheduled checklists that are time-consuming, costly, and may miss early signs of deterioration.	Computer vision systems analyze images and video to flag damaged signs, faded markings, and potholes, allowing for proactive maintenance scheduling, reduced downtime, extended asset lifespan, and improved safety by identifying potential hazards early.
Freight Routing 	Routes and schedules often lack real-time adaptability, rely on outdated fuel cost estimates, and are prone to disruption when conditions change unexpectedly.	ML-based tools optimize routes dynamically based on congestion, weather, and fuel costs, leading to lower fuel consumption, reduced delivery times, optimized driver and vehicle use, and improved responsiveness to disruptions.
Road Maintenance Planning 	Reactive maintenance leads to higher repair costs and disruptions to traffic flow.	Predictive analytics use sensor and usage data to forecast failures, enabling proactive maintenance that lowers costs, improves road quality, and minimizes service disruptions.

TRANSPORTATION FUNCTION	LEGACY SYSTEMS	AI-ENABLED SYSTEMS
Public Communication 	Websites and printed notices can be static, lack personalization, and may not reach individuals affected by disruptions.	GenAI summarizes project plans, answers FAQs, translates content, and drafts communications, providing timely, accessible, and personalized information to the commuting public.
Workforce Support 	Training manuals and call centers can be time-consuming for and may not provide immediate, context-specific answers.	Intelligent chatbot assistants aid field staff with real-time information via voice or text, lowering costs and improving response quality.
Autonomous Vehicles 	Traditional vehicles rely on ADAS to aid human drivers yet they remain vulnerable to errors caused by fatigue, distraction, and delayed reaction times due to their reliance on human input.	AVs use real-time perception, decision-making, and control systems to navigate complex environments, reduce crash risks, and expand access for those unable to drive.
Emergency Response Coordination 	Manual coordination across agencies can delay response times and limit situational awareness.	AI and ITS analyzes traffic, weather, and sensor data to optimize routing, predict incident hotspots, and enable faster, more coordinated multi-agency responses.

Computer Vision

For AI-enabled transportation systems to operate safely and effectively in the physical world, they must be able to perceive and interpret their surroundings in real time. **Computer vision** fills this critical need, serving as the perceptual layer that allows vehicles, infrastructure, and control systems to understand and respond to dynamic visual environments.

Computer vision enables machines to process and act on visual inputs, such as images, video streams, and LiDAR scans, with speed and precision. It plays a foundational role in AVs, powering automation and advanced driver-assistance features like lane departure warnings, hazard detection, and traffic sign recognition. At its core, computer vision performs tasks such as image classification, object detection, and tracking. By leveraging deep learning techniques like convolutional neural networks, computer vision systems can detect and classify objects, monitor changing environmental conditions, and identify emerging safety risks. This enables vehicles to make split-second decisions, such as steering back into a lane if a driver falls asleep, braking to avoid a pedestrian, or navigating complex intersections autonomously.[15]

> ***Computer vision** enables machines to process and act on visual inputs with speed and precision.*

As a foundational capability for intelligent transportation systems (ITS), computer vision supports continuous observation of the transportation environment and enables rapid, localized decision-making across vehicles, infrastructure, and control centers. These capabilities are already being applied across a wide range of functions. In traffic operations, computer vision aids in congestion monitoring, incident detection, and wrong-way driver alerts. For example, GovComm, an ITS developer, created an AI-powered system that uses highway camera feeds and onboard video analytics to detect wrong-way drivers. The system issues immediate alerts to local transportation authorities, helping prevent potential collisions. It has been operational in Florida for over a decade, with other states and agencies adopting the technology.[16] Internationally, Sweden has used computer vision to transform air traffic operations at low-traffic airports since 2015. Saab's Remote Tower Services system employs high-definition cameras and video analytics to enable air traffic controllers at a centralized facility to manage multiple airports, providing operational flexibility and reducing operations and maintenance costs by up to 90 percent.[17]

Transit agencies and state departments of transportation are also applying computer vision to automate infrastructure inspections. By analyzing images from drones, dashcams, and fixed cameras, these systems can detect pavement cracking, fading lane markings, damaged signage, and vegetation encroachment.[18] Hayden AI, a transportation tech startup, takes this a step further by equipping buses with vision AI and edge processing systems to identify violations such as illegal parking in bus lanes, bus stops, and bike lanes. In New York City, the MTA used this technology to improve bus lane speeds by five percent and reduce collisions by twenty percent on enforced routes.[19]As these tools become more widely deployed, they will streamline infrastructure reporting, support the development of **digital twins**—virtual, evolving replicas of physical assets—and help agencies prioritize investments based on need.[20]

Generative AI

As transportation systems generate and depend on growing volumes of data, public agencies increasingly need tools that can synthesize, simulate, and make sense of complex information at scale. **Generative AI** (GenAI) offers that capability,

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[15] McKinsey and Company, "What is Machine Learning?," April 30, 2024, Webpage.

[16] GovComm, Inc., "Wrong-Way Driving," Webpage.

[17] Mike Jones, "Remote Air Traffic Control Towers," *Professional Pilot Magazine*, May 2025.

[18] See, e.g., Richard Chyfinski, "AI Transforming Transportation: Microsoft X Parsons Webinar," ITS America, March 28, 2023, Video.

[19] Jordyn Grzelewski, "How This Transportation Tech Startup Is Using AI to Improve Public Transit." Tech Brew, September 19, 2024.

[20] See, e.g., Mike Watson, "What Transportation Leaders Need to Know About AI," at Center for Transportation Studies Research Symposium's "AI-Powered Freight—Revolutionizing Transportation and Logistics" Conference, Minneapolis, MN, December 13, 2024, Video; and Krešimir Kušić et al., "A digital twin in transportation: Real-time synergy of traffic data streams and simulation for virtualizing motorway dynamics," Advanced Engineering Informatics 55, January 2023, at 2.

CASE STUDY: WAABI

Generative AI as a Development Framework for Self-Driving Trucks

Waabi is developing an end-to-end autonomous trucking system that uses GenAI to accelerate deployment and testing. The company's approach centers on Waabi World, a high-fidelity simulator that enables the Waabi Driver AI to encounter rare and complex scenarios in a controlled, closed-loop environment.

The simulator acts as both a training ground and a safety validation tool, exposing the system to edge cases that are difficult to collect through physical testing alone. By relying on simulation rather than logging millions of real-world miles, Waabi has significantly reduced development costs compared to its competitors.*

Rather than splitting the driving task into discrete modules, Waabi trains a single AI model to perceive, reason, and act across the full autonomy stack. This integrated design is intended to generalize across varied driving conditions while enabling the system to generate and evaluate fallback plans in real time.

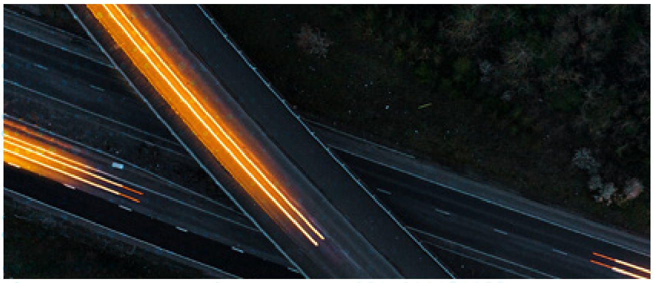
To validate the system's responses under realistic conditions, Waabi conducts "mixed-reality" testing in which simulated road agents are rendered in real time while the truck drives in the physical world. This allows the team to assess reactions to rare events, such as a stalled vehicle or an unexpected lane intrusion, without introducing real-world risk.

In 2025, Waabi announced a go-to-market partnership with Volvo Autonomous Solutions, which will integrate its system directly into factory-built trucks at Volvo's Virginia manufacturing plant. Waabi has also partnered with Uber Freight to offer autonomous freight-hauling as a service, charging by the mile.† Commercial operations in Texas, where regulations allow fully driverless trucks, are expected to begin by the end of the year, with driver-out runs planned between customer depots in high-volume corridors like Dallas to Houston.

Waabi's simulation-first approach may not only improve safety outcomes but create a capital-light business model that avoids the burn rates of AV competitors.

* Note: According to CEO Raquel Urtasun, this strategy allows Waabi to "go super fast with a fraction of the cost and people" compared to traditional AV development models. Waabi has raised less than $300 million, citing its leaner, simulator-driven model as a key differentiator from competitors like Aurora Innovation and Kodiak Robotics. SAFE analysis based on data from Crunchbase and Rebecca Bellan, "Self-driving truck startup Waabi brings on Volvo VC as strategic investor," *TechCrunch*, January 18, 2023.

† Uber Technologies, Inc., "Uber Freight and Waabi introduce industry-first autonomous truck deployment solution," September 21, 2023.



enabling new forms of scenario planning, operational support, and decision augmentation. Unlike earlier AI systems designed primarily to recognize patterns or make predictions, GenAI can produce entirely new content, such as draft reports, synthetic datasets, or simulated traffic conditions, making it a powerful tool for transportation planning and management.

GenAI refers to a class of **large language models** (LLMs), which are AI systems trained on massive datasets to generate human-like language, code, or other structured content. While traditional ML models are typically designed for narrow tasks like classification or forecasting, LLMs are general-purpose systems capable of adapting across domains and interacting in natural language.[21]

Transportation agencies are beginning to explore GenAI across a range of applications, from planning and simulation to safety and operational support. In California, GenAI is being tested to prioritize high-risk crash locations for targeted interventions such as increased monitoring, maintenance, or safety upgrades. It is also being used to simulate real-time traffic conditions to inform future infrastructure planning and design.[22] Platforms like Wayve's GAIA leverage generative video modeling to expose AV systems to rare or complex scenarios that are difficult to replicate in physical testing.[23]

Transportation planners are using GenAI to model demand across varying land use and policy scenarios, allowing them to assess potential impacts and make more informed decisions about infrastructure investments, service allocation, and regulatory changes. Tools like INRIX Compass apply large datasets to deliver customized safety insights, such as improving crosswalk visibility or adjusting signal timing to reduce pedestrian risk at intersections.[24] At the state and local government levels, GenAI assistants like ChatGPT and Microsoft Copilot can support tasks such as project documentation, procurement review, and multilingual public engagement.[25] As GenAI tools become more widely deployed, agencies will need to ensure their outputs are validated, interoperable, and supported by clear safeguards to mitigate risks associated with inaccurate or unverified content.

Taken together, these AI applications lay the foundation for a broader ITS ecosystem defined by adaptivity, integration, and continuous learning. Future performance breakthroughs will depend not only on model scale but also on architectural advances. Techniques such as **agentic AI** (i.e., systems that can plan, make decisions, and invoke other tools on their own), **tree-of-thought reasoning** (which allows models to explore multiple solution paths before selecting the best one), and **hardware-software co-design** (where systems are jointly engineered to maximize efficiency and speed), are emerging as critical enablers of more interpretable, resilient, and adaptive performance. These advances could mark a shift from discrete AI applications to systems-level intelligence, where infrastructure not only supports transportation but actively shapes and improves it.

***GenAI can produce entirely new content**, such as draft reports, synthetic datasets, or simulated traffic conditions, making it a powerful tool for transportation planning and management.*

[21] See, e.g., Cole Stryker and Mark Scapicchio, "What is Generative AI?," IBM, March 22, 2024, Webpage.

[22] ITS America, "AI Decoded," June 25, 2024, at 13–14.

[23] Wayve Technologies, Ltd., "GAIA-2: Pushing the Boundaries of Video Generative Models for Safer Assisted and Automated Driving," March 26, 2025, Webpage.

[24] Bryan Mistele, "Generative AI Can Transform Traffic Chaos into Clarity: How INRIX Compass Can Improve Urban Mobility," INRIX, Inc., November 26, 2023, Webpage.

[25] Patt Talvanna, "AI Implementation and Developing Agency Policies Webinar," *Transportation Research Board*, March 12, 2025, Video.

Three Challenges to a Next-Generation Transportation Ecosystem

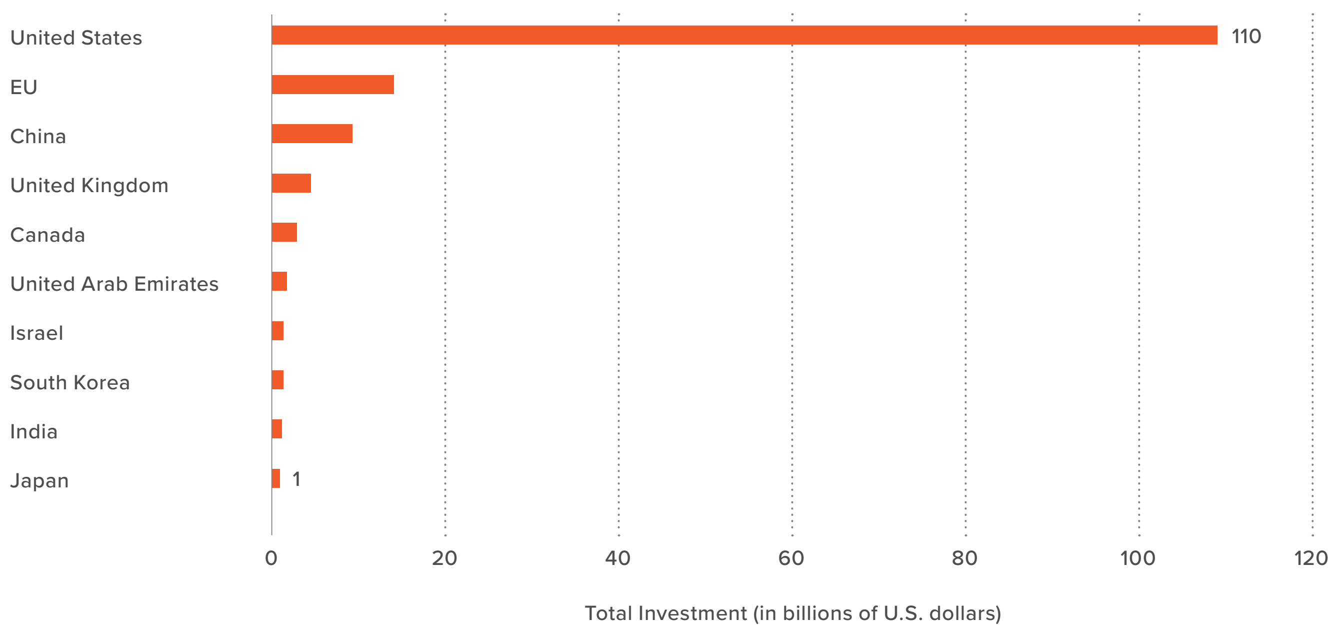
The promise of AI-enabled mobility will not be realized through innovation alone. It demands resilient energy infrastructure, effective governance, and active engagement in global standard-setting. While the United States leads in AI research and private sector investment, with more top-tier models and private capital than any country in the world, its position is under threat by strategic competitors, hindered by structural barriers that could slow growth, limit coordination, and reduce competitiveness.[26]

This section examines three strategic challenges that will shape how AI-enabled transportation develops in the United States:

1. Energy infrastructure resilience
Transportation AI systems from AVs to adaptive traffic networks are becoming increasingly reliant on high-performance chips, vast compute power, and reliable electrical infrastructure. Scaling these technologies will require new investments in grid capacity, data centers, and edge-compute systems capable of delivering low-latency, mission-critical performance. However, permitting delays, limited energy availability, and aging infrastructure are already emerging as bottlenecks. The United States risks having the models and applications to transform transportation but not the power or hardware to deploy them at scale.

[26] Epoch AI, "Notable AI Models," May 14, 2025, Database; and Nestor Maslej et al., *The AI Index 2025 Annual Report*, AI Index Steering Committee, Institute for Human-Centered AI, April 2025, at 251.

FIGURE 2 · Private investment in AI in select geographies, 2024.



Source: Stanford University Institute for Human-Centered AI, "The AI Index Report: 2025 Annual Report."

2. Fragmented deployment pathways
While the federal policy landscape is evolving, AI deployment in transportation remains shaped by a patchwork of agency initiatives, pilot programs, and non-binding guidance. Regulatory authority and resources vary widely by mode, and most rulemaking remains discretionary or in early stages. Meanwhile, state and local transportation agencies have emerged as key actors, piloting tools, experimenting with procurement models, and establishing the first wave of governance practices. This two-track dynamic of federal frameworks still forming and state deployments accelerating raises risks around interoperability, public accountability, and national scalability.

3. Federal and global standards alignment
As AI-enabled transportation systems scale, consistent regulatory frameworks will be needed to ensure deployment, liability, safety, and interoperability. Within the United States, the absence of clear federal guidance has left state and local agencies, and industry partners, navigating fragmented rules on data use, safety validation, and procurement. Globally, countries are advancing their own technical and governance standards for connected vehicles, intelligent infrastructure, and AI-powered mobility systems. While the United States may not dictate those standards, failure to engage risks misalignment that could disadvantage American technologies, restrict access to international markets, or weaken American influence around the world.

Each of these challenges introduces strategic risks to economic competitiveness, cybersecurity, and public trust. Delays in coordination or investment could weaken public confidence, increase vulnerability to adversarial threats, and slow adoption of AI-enabled systems. The race ahead is not about who invents AI, but who builds the systems, writes the rules, and delivers reliable public benefits at scale.

Infrastructure: Building AI-Enabled Systems for Power and Compute

AI is evolving faster than the infrastructure needed to support it. While much of today's demand comes from AI model training and cloud services in sectors like finance, advertising, and healthcare, transportation may soon emerge as the next major driver of AI-driven load—with unique requirements and geographic constraints.

This shift reflects the growing computational demands of AI across transportation, with autonomous mobility representing a particularly energy- and infrastructure-intensive application. Unlike static or transactional AI workloads, transportation systems operate continuously, often in real time, and must process complex sensor-rich data while relying on large-scale cloud-based training, coordination, and simulation. As a result, the sector is driving new demand not just for compute but for siting, transmission, and distributed electrical capacity.

Crucially, this evolution has little to do with highways or ports themselves and more to do with the foundational infrastructure that enables AI: reliable electrical supply, semiconductors for mobility applications, and scalable compute capacity.[27] These three elements, described here as power, chips, and compute, form the foundational three-legged stool of scalable, secure, and high-performance AI deployment across sectors. As AI adoption accelerates, success will hinge on the nation's ability to expand and modernize infrastructure to support these critical enablers.

Although transportation workloads represent a small share of total AI compute today, that share is growing quickly. One prominent example is Tesla's Cortex facility in Texas, where the company plans to expand electrical capacity from 130 megawatts (MW) to over 500 MW to support model training and inference across its electric and autonomous vehicle fleets.[28] Other companies are following suit. Waymo relies on Google Cloud to simulate billions of virtual miles for its AV platform.[29] These trends are driving demand for new data center infrastructure and capacity in regions already constrained by limited electricity supply, site availability, and permitting, and they intensify the infrastructure challenges associated with scaling AI across transportation.

AI-enabled transportation also accelerates edge-to-cloud convergence. Vehicles and intersections now carry high-powered chips for real-time perception and decision-making. Meanwhile, model training, testing, simulation, and coordination demand centralized compute and vast datasets, amplifying power and site needs. Even when individual vehicles draw modest loads, aggregate deployment across fleets introduces significant pressure on electrical capacity, connectivity, and storage, all of which hinge on permitting timelines and infrastructure readiness.

The federal government has acknowledged this urgency. In July 2025, the White House released a national *AI Action Plan* declaring that "AI is the first digital service in modern life that challenges America to build vastly greater energy generation than we have today" and that, "like most general-purpose technologies of the past, AI will require new infrastructure—factories to produce chips, data centers to run those chips, and new sources of energy to power it all."[30] To meet this moment, the plan outlines a three-phase strategy to stabilize the grid, optimize transmission, and expand dispatchable power generation, including investments in advanced nuclear, geothermal, and fusion systems.

Shortly following the release of the AI Action Plan, the President signed an executive order to accelerate permitting for large-scale AI data centers and their associated

***AI is evolving faster** than the infrastructure needed to support it.*

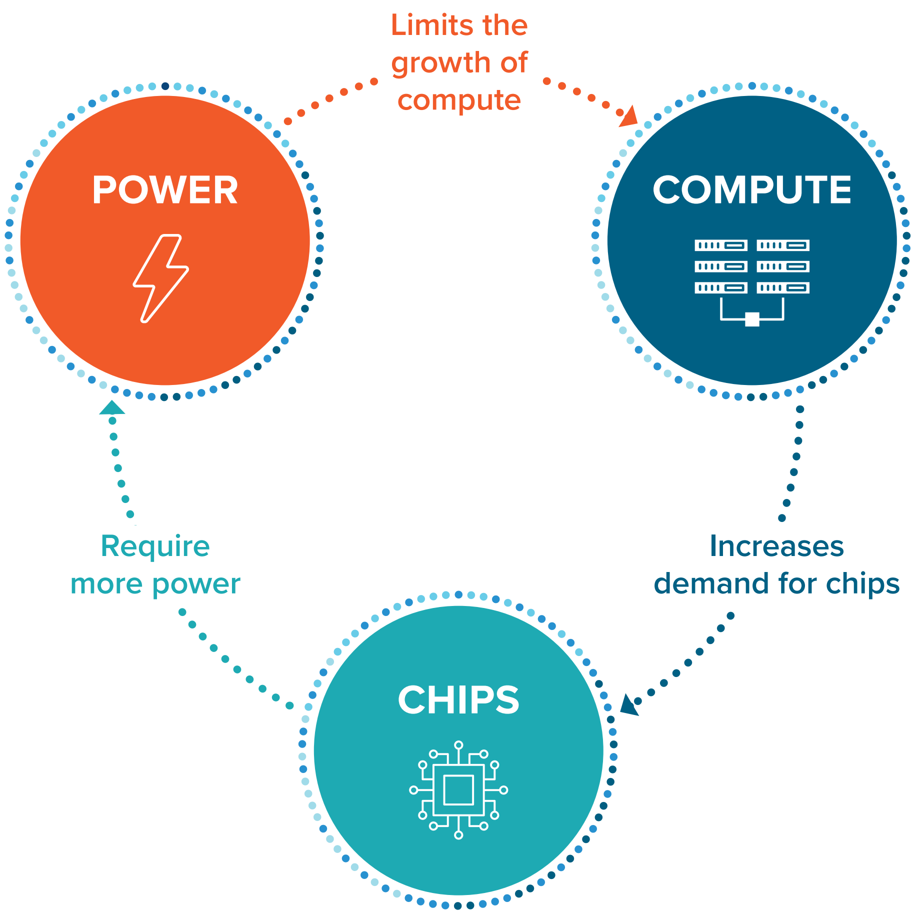
[27] Note: While training large AI models typically relies on advanced accelerator chips such as GPUs or TPUs, many transportation applications operate using a different classes of semiconductors that use lower-power processors specifically optimized for inference. High-performance mobility systems, particularly those supporting autonomous functionality, require continuous, low-latency onboard processing with strict power, thermal, and reliability constraints.

[28] This information was published on X (formerly known as Twitter) by Tesla CEO Elon Musk on June 20, 2024. SAFE analysis based on EpochAI, EPRI, and Tesla's Q4 and FY2024 shareholder updates indicates that Musk's estimate of 130 MW is too high. The facility is projected to host 100,000 H100 and H200 chips, but as of December 2024 it contained only 50,000, equating to roughly 75 MW of consumption rather than 130 MW. Source: SAFE calculations based on information in "Fourth Quarter and Full Year 2024 Financial Results," Tesla, January 29, 2025.

[29] Note: According to Waymo, the company's vehicles have driven more than 20 billion miles in simulation. Waymo's parent company Alphabet offers the company the necessary infrastructure for training their model. Steven Dickens, "Tesla's Dojo Supercomputer: A Paradigm Shift In Supercomputing?," *Forbes*, September 11, 2023.

[30] The White House, "Winning the Race: America's AI Action Plan," July 23, 2025, at 14.

FIGURE 3 · AI capability limits.



infrastructure, designating 100+ MW facilities as national priorities and directing agencies to fast-track environmental reviews under the National Environmental Policy Act, Title 41 of the Fixing America's Surface Transportation (FAST-41) Act, the Clean Water Act, and the Clean Air Act.[31] The order also directed expanded use of brownfield and Superfund sites and launched PermitAI, a digital platform to automate siting approvals. Together, these actions mark a turning point, linking AI-enabled transporation to the broader priorities of national infrastructure policy.

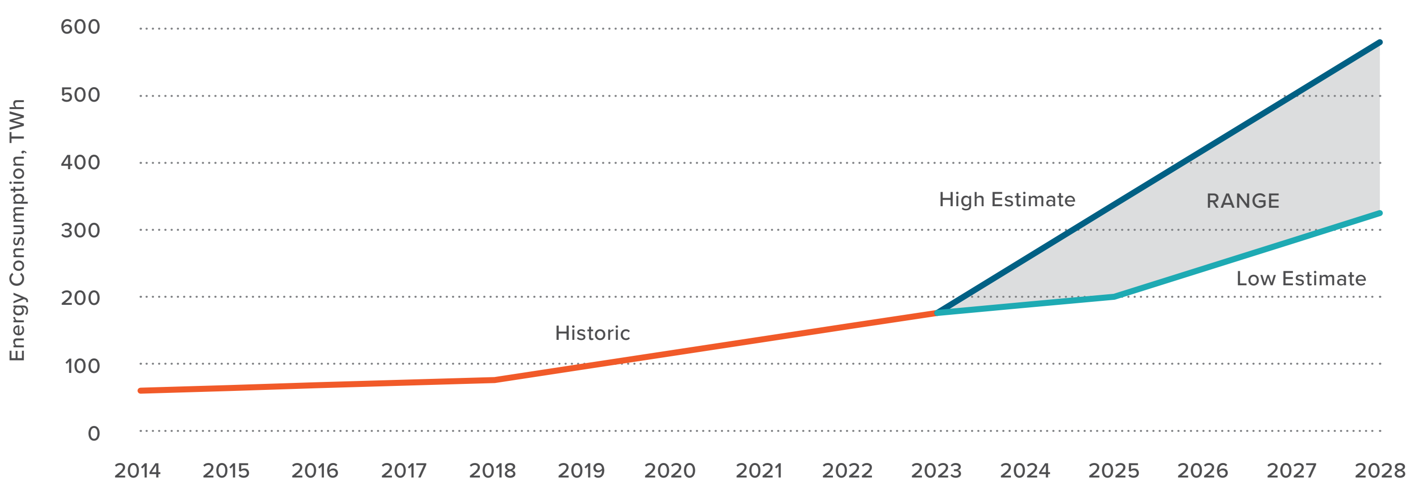
[31] Executive Order 14318, "Accelerating Federal Permitting of Data Center Infrastructure," July 23, 2025.

Power

The availability of electricity is quickly becoming an important cost driver of AI.[32] As OpenAI CEO Sam Altman told the Senate, "the cost of AI will converge to the cost of energy."[33] Nowhere is this more visible than in the nation's data center footprint. These sprawling facilities can house thousands of densely concentrated high-performance servers, advanced cooling systems, and backup power units that collectively draw gigawatts of electricity. In 2023, data centers in the United States consumed 176 terawatt-hours (TWh) of electricity, 4.4 percent of the nation's total, equivalent to more than 20 nuclear power plants.[34] By 2028, demand could reach 580 TWh, requiring the output of roughly 75 nuclear plants.[35]

Forecasts for AI-related data center electricity demand vary, reflecting uncertainty in how quickly compute, hardware, and model training can scale. On the high end, RAND projects global AI-driven power demand to grow from 68 gigawatts (GW) in 2027 to 327 GW globally by 2030.[36]
More moderately, McKinsey & Company projects total global data center capacity will reach 171 to 219 GW by 2030, with roughly 70 percent allocated to AI, equivalent to 90 to 150 GW. By comparison, research institute EpochAI estimates global

FIGURE 4 · Total U.S. data center electricity use, 2014–2028.



Source: Berkeley National Labs

[32] Laura Cozzi et al., "Energy and AI," IEA, April 10, 2025, at 60.

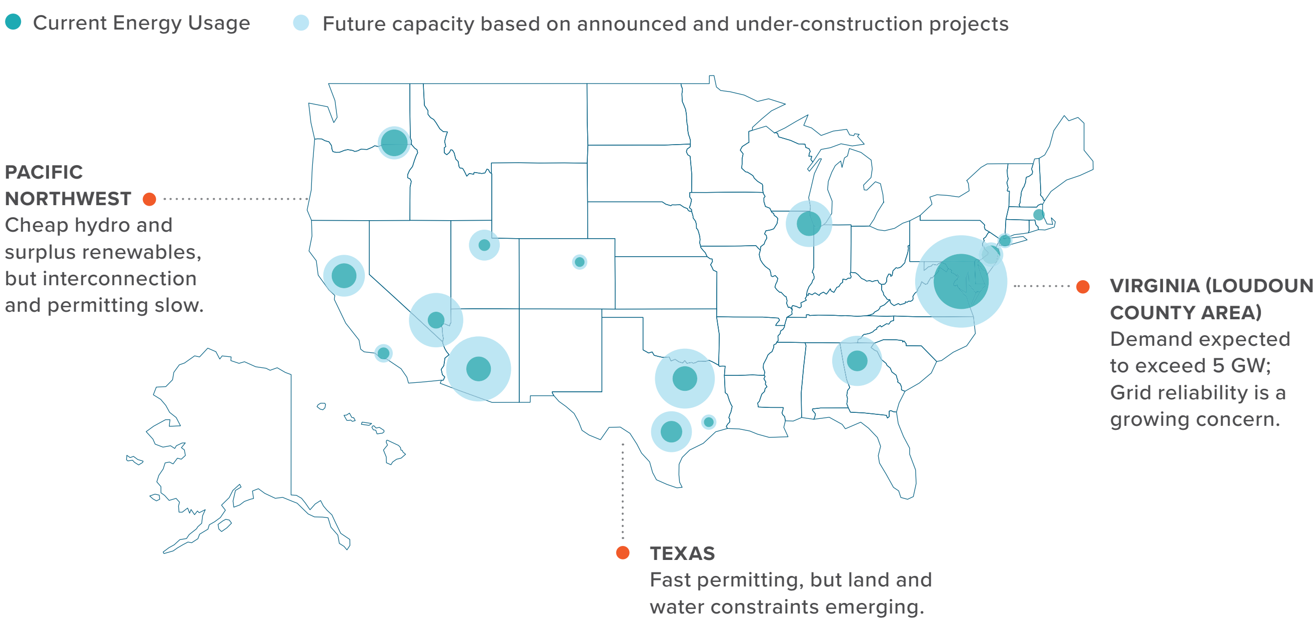
[33] Sam Altman, "Winning the AI Race: Strengthening U.S. Capabilities in Computing and Innovation," U.S. Senate Committee on Commerce, Science, and Transportation, 119th Congress, May 8, 2025.

[34] SAFE analysis based on data from the World Nuclear Association finding that a well-performing 1 GW nuclear reactor, equivalent to the average size of a U.S. plant, produces approximately 7.9 TWh of electricity per year. Arman Shehabi et al., "2024 United States Data Center Energy Usage Report," Lawrence Berkeley National Laboratory, December 2024, at 52.

[35] Ibid.

[36] Note: RAND's estimate represents a high-end scenario in which AI compute demand continues its exponential growth trajectory through 2030. The projection assumes rapid global deployment of AI chips, modest efficiency gains, and constant per-chip power draw. Konstantin Pilz et al., "AI's Power Requirements Under Exponential Growth: Extrapolating AI Data Center Power Demand and Assessing Its Potential Impact on U.S. Competitiveness," The RAND Corporation, January 28, 2025, at 2–3.

FIGURE 5 · U.S. data centers energy usage by geography.



Source: SAFE analysis based on data from Upwind Security.

demand at 100 to 140 GW.[37] As demand grows domestically, dispatchable resources such as natural gas and coal will continue to play a role in assuring grid reliability, particularly in regions facing variable renewable output or constrained transmission.

In addition, the United States hosts more than 45 percent of global data centers and faces rising demand as AI workloads scale.[38] But electricity generation grew by just 5 percent over the last decade.[39] In Virginia, data centers already consume a quarter of the state's electricity demand. As available sites near major load centers diminish, developers are turning to more remote areas where land is cheaper but grid infrastructure is often lacking. This shift increases costs and delays, requiring new investment in transmission, interconnection, and local grid upgrades to meet demand. Without targeted investment, the United States risks developing the world's most sophisticated AI systems, only to find it cannot power them.

In transportation, AI is increasingly shifting to "edge" applications, systems embedded directly into vehicles, infrastructure, and sensor networks. Unlike cloud-based models, **edge AI** processes data locally, enabling decision-making for critical functions such as autonomous driving, adaptive traffic signals, and Internet-of-Things (IoT)-enabled logistics operations that optimize routing, monitor cargo, and track vehicle conditions. While individual devices may only consume small amounts of electricity on their own, aggregate energy demand becomes significant when deployed across entire fleets, intersections, and logistics hubs. Onboard sensors in a single Level 3 vehicle, for example, can draw 200 to 250 watts, while a fully automated Level 5 vehicle can require up to 2,500 watts of continuous compute power, on top of the

[37] McKinsey & Company, "AI Power: Expanding Data Center Capacity to Meet Growing Demand," October 29, 2024, at 1-3; and Electric Power Research Institute and Epoch AI, Scaling Intelligence: The Exponential Growth of AI's Power Needs, August 11, 2025.

[38] SAFE analysis based on data from Cloudscene.

[39] SAFE calculations based on EIA, "Electric Power Monthly," April 2025, at 6 and EIA, "Electricity: Electric Power Sector: Total Net Generation," in *Annual Electric Outlook 2025*, April 15, 2025.

vehicle's existing propulsion and systems energy demands.[40] At scale, edge AI introduces a new class of distributed energy demand. While this approach helps reduce latency and cloud transmission costs, it also pushes more power consumption outward from data centers to the edge, raising new challenges for energy efficiency, resiliency, and system design.

Chips

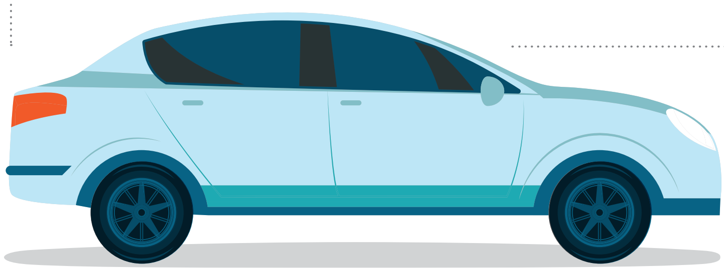
Transportation may represent a small share of AI compute today, but demand is rising. As vehicles advance from Level 2 to Level 5 automation, compute demand could grow from hundreds of billions of calculations per second to more

FIGURE 6 · Chips in vehicles.

The typical modern car contains as many as 3,000 semiconductor chips.

MONITORING & SENSING
Tire Pressure Monitoring
Digital Turn Signals

VEHICLE DYNAMICS & CONTROL
Electric Power Steering
Electronic Stability Control
Active Yaw Control
Anti-lock braking system
Parking System
Hill-Hold Control
Regenerative Braking
Active Suspension



COMFORT, INTERIOR & DRIVER EXPERIENCE
Cabin Environment Controls
Active Cabin Noise Suppression
Interior Lighting
Seat Position Control
Parental Controls
Entertainment System
Head-Up Display
Instrument Cluster
Auto-Dimming Mirror
Windshield Wiper Control
Active Exhaust Noise Suppression

POWER & EFFICIENCY
Engine Control
Electronic Throttle Control
Electronic Valve Timing
Cylinder De-activation
Idle Stop/Start
Transmission Control
Active Vibration Control
Battery Management

CONNECTIVITY & DATA SYSTEMS
Navigation System
Voice/Data Communications
DSRC
Electronic Toll Collection
Security System
Remote Keyless Entry
OBDII

SAFETY & DRIVER ASSISTANCE
Airbag Deployment
Adaptive Front Lighting
Adaptive Cruise Control
Automatic Braking
Blindspot Detection
Lane Departure Warning
Lane Correction
Driver Alertness Monitoring
Night Vision
Accident & Event Data Recorder

[40] National Academies of Sciences, Engineering, and Medicine, "Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy 2025–2035," The National Academies Press, 2021, at 258; and Kaushik Rajashekara and Sharon Koppera, "Data and Energy Impacts of Intelligent Transportation—A Review," *World Electric Vehicle Journal,* June 17, 2024, at 10.

than a quadrillion calculations per second per vehicle.[41] Under conditions simulating autonomous fleet operations, Ford found that the combined load of self-driving compute systems and passenger comfort features such as air conditioning and entertainment can reduce an electric vehicle's (EV) driving range by more than 50 percent.[42] Automakers are responding to this exponential increase in data loads with targeted investments in specialized, energy-efficient chips, all engineered to deliver high-throughput performance within strict power and space constraints.

These demands rely on semiconductors. Every AI-enabled transportation system, from onboard perception in AVs to the data center clusters used for training, depends on chips to process and act on information in real time. A single modern vehicle can contain more than 3,000 chips, many of which are critical for core functions like braking, steering, and sensors.[43] As AI becomes more embedded in transportation networks, the need for more advanced chips capable of executing complex, parallel tasks is growing.

> ***Chip efficiency*** *is less about performance and more about vehicle efficiency and operating costs.*

At the high end, AI workloads rely on specialized accelerator processing units, each consuming hundreds of watts and deployed by the thousands in dense server clusters. Some estimates suggest supporting global GenAI expansion could require up to 159 million units by 2030—a 55-fold increase over 2024 levels.[44] Even if transportation applications account for only a fraction of total AI demand, they must still compete for access to a limited pool of high-performance chips. Automotive original equipment manufacturers (OEMs) are responding by investing billions in dedicated compute and semiconductor supply chains.

Systems that operate directly in vehicles, infrastructure, or roadside units, including edge AI applications like advanced driver-assistance systems (ADAS) and embedded computer vision, create a different kind of pressure on chip design. These applications require lightweight, energy-efficient chips that can function within tight power, thermal, and space constraints. While each device may consume a relatively small amount of compute, deploying at scale across millions of vehicles or roadside units can significantly increase cumulative energy demand. In these contexts, chip efficiency is less about performance and more about vehicle efficiency and operating costs. Older chip architectures, though cheaper upfront, often lack the energy efficiency of newer designs and can require three to four times more energy per task depending on the model.[45] Over time, this inefficiency can translate to higher internal combustion engine vehicle fuel costs and reduced EV range relative to newer models.

Supply chain risk compounds the challenge of scaling semiconductors. While the United States leads in chip design, it remains heavily reliant on overseas fabrication, especially from Taiwan and South Korea, which account for virtually all of the world's advanced manufacturing capacity.[46] This concentration exposes AI-enabled transportation systems to vulnerabilities as any disruption, from geopolitical shocks to natural disasters, and could trigger broader supply chain effects. Ongoing export controls, investment restrictions, and escalatory measures, such as China's December 2024 decision to ban gallium and germanium exports to the United States, further underscore the fragility of global chip supply chains.[47]

The 2025 *AI Action Plan* instructs the CHIPS Program Office

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[41] Ibid., at 9.

[42] Aarian Marshall, "The Intersection Between Self-Driving Cars and Electric Cars," WIRED, July 13, 2020.

[43] Jack Ewing and Neal Boudette, "A Tiny Part's Big Ripple: Global Chip Shortage Hobbles the Auto Industry," *The New York Times*, April 23, 2021.

[44] Karl Smith et al., "The AI Power Surge: Growth Scenarios for GenAI Data Centers Through 2030," Center for Strategic and International Studies, March 3, 2025, at 6.

[45] Raj Varadarajan et al., "Emerging Resilience in the Semiconductor Supply Chain," Boston Consulting Group and Semiconductor Industry Association, May 2024, at 14.

[46] Ibid.

[47] See, e.g., Gregory C. Allen and Issac Goldston, "Understanding U.S. Allies' Current Legal Authority to Implement AI and Semiconductor Export Controls," Center for Strategic and International Studies, March 14, 2025; and Amy Lv and Tony Munroe, "China bans export of critical minerals to US as trade tensions escalate," *Reuters*, December 3, 2024.

to focus on return on investment, defined as faster time-to-fab, greater domestic capacity, and more secure supply chains per federal dollar, by streamlining fabrication regulations and limiting funding conditions to those that directly improve manufacturing outcomes.[48] It also proposes tightening export controls across the full fabrication stack, targeting critical subsystems in addition to chips, and deploying enforcement tools like chip geofencing and location verification. These steps reflect a broader deregulatory, security-first approach to AI policy that treats semiconductor manufacturing as a core enabler of AI dominance.[49]

Compute

AI compute requirements fall into two related categories—training and inference. **Training** refers to building models using large datasets. It is highly resource-intensive and typically carried out in centralized cloud data centers as a one-time or periodic task. **Inference** involves applying trained models to real-world data to generate predictions or decisions. This supports tasks such as detecting pedestrians in an AV camera feed, optimizing traffic signals, or predicting arrival times in fleet routing.

Today's most advanced models span billions to trillions of parameters.[50] These are the internal values that a model adjusts during training to learn patterns and make accurate predictions. While transportation systems primarily rely on pre-trained models for inference, their growing complexity drives up hardware and energy demands. According to Epoch AI, training requirements for the latest high-capacity models doubled every 5-6 months between 2010 and 2022—a ten-billion-fold increase.[51] Although inference efficiency has improved, the accelerating growth in model size and training complexity continues to increase the scale and technical requirements of compute systems needed for real-world deployment.

Transportation companies are already making compute investments. Waymo leverages Google Cloud to support its AV operations, while Zoox uses AWS, reflecting a broader integration within technology ecosystems. Chipmaker platforms such as NVIDIA DRIVE, AMD Versal AI Edge, and Qualcomm Snapdragon Ride also illustrate how the AI stack can be tailored to mobility needs.[52] Some platforms use compact, energy-efficient chips to quickly process data from multiple sensors and support responsive decision-making, which is helpful in automated driving and various traffic management applications. Others provide cloud-scale training and simulation environments to develop and deploy AI models for autonomous driving, traffic prediction, and fleet coordination.

Looking ahead, emerging technologies such as **quantum computing** could reshape the landscape. Although not yet ready for broad deployment, the U.S. Department of Transportation (DOT) has identified early use cases, such as multimodal routing, network optimization, and emergency dispatch, where quantum methods might enhance resilience and support decision-making in complex situations.[53]

Maintaining U.S. leadership in AI-enabled transportation will require more than algorithmic breakthroughs. It demands robust compute infrastructure, both centralized and edge-

[48] The White House, "Winning the Race: America's AI Action Plan," July 23, 2025, at 16, 21.

[49] Erin Bosman et al., "New Federal AI Action Plan Prioritizes Deregulation, Infrastructure, and Global Leadership," Morrison & Foerster LLP, July 29, 2025, Webpage.

[50] Epoch AI, "Notable AI Models," Updating Database.

[51] Jaime Sevilla et al., "Compute Trends Across Three Eras of Machine Learning," Epoch AI, February 16, 2022, Webpage.

[52] Nvidia Corporation, "High-Performance In-Vehicle Computing for Autonomous Vehicles," Webpage; Advanced Micro Devices, Inc., "AMD Versal™ AI Edge XA Series," Webpage; and Qualcomm, Inc., "Snapdragon Ride: A smoother automated drive," Webpage.

[53] DOT, "Quantum Technologies in Transportation," January 13, 2025, Webpage.

CASE STUDY: UPSTREAM SECURITY

AI for Threat Detection in Transportation Systems

As connectivity and software-defined systems expand across vehicles, IoT devices, and fleet operations, the cybersecurity attack surface in mobility continues to grow. Upstream Security addresses this challenge using centralized, cloud-based AI to analyze data from telematics, engine control units (ECUs), over-the-air updates, Application Programming Interface (API) traffic, and other vehicle systems, detecting and responding to cyber threats in real time. These capabilities are increasingly valuable to OEMs, EV charging stakeholders, smart mobility vendors, and fleet operators seeking to meet regulatory requirements, reduce operational risk, protect sensitive data, and manage complex, distributed vehicle networks.

Vehicles have been vulnerable to cyberattacks since at least 2011, but the scale and sensitivity of vehicle data have grown alongside advances in connectivity and intelligence. A modern vehicle can store years of data, including detailed location information and a wide range of vehicle signals. In an analysis of publicly disclosed cybersecurity incidents in mobility, Upstream found that 60 percent of cases had the potential to affect thousands to millions of users.

To manage this risk, manufacturers are turning to external cybersecurity partners with the scale and expertise to monitor evolving threats. At the core of Upstream's AI platform is a continuously updated digital twin, a live representation of each asset's behavior and state. This model enables ML-powered anomaly detection across entire fleets, identifying suspicious patterns like repeated login attempts from a single IP address or irregular braking behavior that may appear benign in isolation but signal broader risk in aggregate. ML models refine behavioral baselines over time, while personally identifiable information is stripped to maintain data privacy.

A GenAI layer allows analysts to query large-scale security datasets using natural language, reducing the need for manual coding and accelerating investigations. This human-in-the-loop approach blends structured AI and ML with expert oversight, improving response times and adaptability as threat patterns evolve.

These systems are designed to scale across diverse vehicle platforms without requiring onboard integration. The result is a cloud-based cybersecurity model well suited to a future where AI deployments are increasingly decentralized and transportation data environments continue to grow in scale and complexity.

deployed, designed to operate reliably and efficiently in real-world transportation systems.

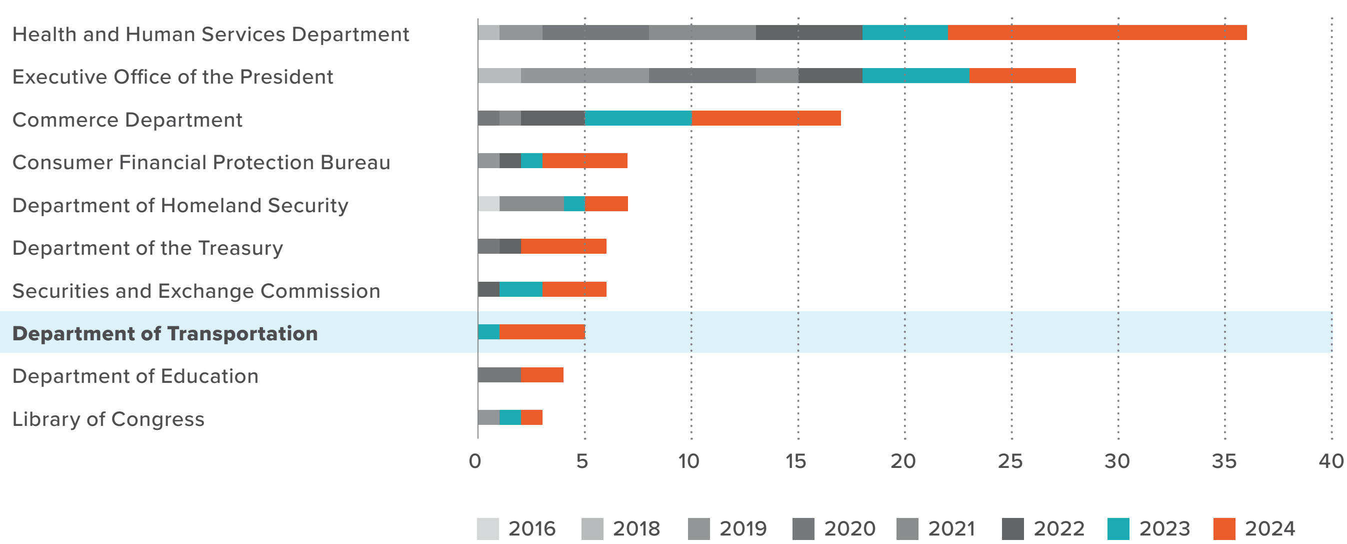
Policy: Evolving Federal Policy and State-Led Innovation

The United States continues to navigate an evolving policy landscape for AI in transportation, marked by rapid experimentation, state-led innovation, and an uneven federal architecture for deployment. While the federal government committed more than $4.5 billion to AI-related grants in 2023, this investment remains modest relative to flourishing private-sector activity, and federal governance remains defined more by agency discretion than by cohesive statutory mandates or shared frameworks.[54]

In fact, this decentralized model reflects a core strength of the American system, empowering local pilots, flexible partnerships, and early-stage deployments. But it also presents real obstacles to scale, leading to patchwork implementation, procurement friction, and fragmented oversight. These challenges are particularly acute in transportation, where safety, interoperability, and long-term investment require more consistent governance. DOT has taken meaningful steps to support AI deployment, advancing pilots, issuing risk-based guidance, and experimenting with flexible procurement. However, resource constraints hinder the Department's ability to manage AI systems at the pace and scale of technological change, particularly in areas like vehicle automation.[55]

Among modal agencies, aviation remains the furthest along. The Federal Aviation Administration (FAA) has established comparatively mature safety frameworks for integrating AI, while other modes are advancing through research programs

FIGURE 7 · AI regulation in federal agencies.



SAFE analysis based on data from the Federal Register.

[54] Nestor Maslej et al., "The AI Index 2025 Annual Report," AI Index Steering Committee, Institute for Human-Centered AI, April 2025, at 352.

[55] See, e.g., Library of Congress, Senate Report 119-47 - Transportation, Housing and Urban Development, and Related Agencies Appropriations Bill, 2026," August 12, 2025.

and targeted pilots. Still, DOT's first formal AI rulemaking only began in 2023, and oversight across most modes remains exploratory rather than standardized. Recently, broader federal policy has largely concentrated on the national security dimensions of AI, with export controls and foreign investment emerging as the primary levers of regulation.

In this environment, states have taken the lead. From traffic management and predictive analytics to infrastructure monitoring and emergency response, state and local transportation agencies are piloting AI tools and experimenting with procurement models that reflect commercial realities, such as subscription pricing, iterative development, and participation from newer vendors. These initiatives offer valuable lessons but also contribute to inconsistency in standards, governance practices, and public transparency. The result is a two-track system where a federal policy framework still evolving toward coordinated execution, and a decentralized field of state-led deployment is starting to mark a patchwork of state regulation. Bridging these tracks so that innovation proven at the local level can scale safely and responsibly nationwide, remains a critical challenge for the future of AI in transportation.

Federal Policy

The federal role in shaping AI deployment in transportation has evolved substantially over the past several years. Under the Biden Administration, the U.S. government established a comprehensive AI governance framework grounded in safety, civil rights, and public-sector capacity. Executive Order 14110 directed a whole-of-government approach to "trustworthy AI," while agencies like DOT piloted oversight models, procurement guidance, and workforce development initiatives tailored to mission-specific use.[56] These efforts prioritized risk mitigation, transparency, and responsible innovation, setting a foundation for broader national coordination.

In January 2025, the Trump Administration shifted emphasis, issuing Executive Order 14179 to accelerate infrastructure and remove regulatory barriers deemed to slow AI adoption.[57] The July 2025 *AI Action Plan* was accompanied by three additional executive orders that reframed the federal AI agenda around a three-pillar strategy to accelerate innovation, modernize infrastructure, and expand deployment.[58] Notably, the Plan places greater emphasis on streamlining permitting, scaling domestic chip manufacturing, and aligning federal activity with commercial and industrial growth.[59]

For transportation, the implications are wide-ranging and emerging. The *AI Action Plan* explicitly calls for permitting reform across sectors foundational to mobility systems, including semiconductors, data centers, and electric transmission.[60] The Plan also emphasizes reshoring chip fabrication, tightening export controls on AI subsystems, and bundling American technologies into full-stack packages for deployment, including in transportation.[61] DOT and other federal agencies must now maintain governance for high-impact AI systems while advancing policies that support the buildout of infrastructure and supply chain security.

As the new federal framework takes hold, the challenge ahead is translating national policy intent into innovation-driven outcomes across every mode of mobility.

The challenge ahead *is translating national policy intent into innovation-driven outcomes across every mode of mobility.*

[56] Executive Order 14110, "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence," The White House, October 30, 2023.

[57] Executive Order 14179, "Removing Barriers to American Leadership in Artificial Intelligence," The White House, January 23, 2025.

[58] Executive Order 14318, "Accelerating Federal Permitting of Data Center Infrastructure," The White House, July 23, 2025; Executive Order 14319, "Preventing Woke AI in the Federal Government," The White House, July 23, 2025; and Executive Order 14320, "Promoting the Export of the American AI Technology Stack," The White House, July 23, 2025.

[59] The White House, "Winning the Race: America's AI Action Plan," July 23, 2025, at 12, 14, 16.

[60] Id., at 14.

[61] Id., at 20–21.

Activities of the U.S. Department of Transportation

Over the past several years, DOT has built a solid foundation for AI integration—advancing safety pilots, modernizing procurement strategies, and strengthening internal oversight capacity. The White House's *AI Action Plan* elevates this groundwork into a broader federal priority, emphasizing speed, scale, and infrastructure integration. This marks a shift from agency-led experimentation to coordinated, cross-government execution. To fully realize the Plan's potential across permitting, cybersecurity, model validation, and procurement, DOT will need clear policy guidance, sustained leadership, and stronger interagency collaboration.

DOT's work to date offers a roadmap. The Department has issued risk-based guidance through the Highly Automated Systems Safety Center of Excellence, and the FAA's Artificial Intelligence Safety Assurance Roadmap provides a framework for incrementally integrating AI into aircraft and airspace systems.[62] These efforts now align with the *AI Action Plan*'s call to establish a federal ecosystem for model testing, benchmarking, and oversight through the National Institute of Standards & Technology (NIST) and the Critical and Emerging Technology AI Safety Institute (CAISI). DOT's work could also help shape the proposed Virtual Proving Ground for AI and autonomous systems, a concept that may build on longstanding FAA–Department of Defense (DoD) coordination on airspace management.

DOT has also begun to modernize how it buys and deploys AI. Traditional procurement frameworks like the Federal Acquisition Regulation were built for fixed requirements and long-term contracts. However, AI systems can evolve rapidly. They frequently require flexible contracts, iterative deployment, and oversight mechanisms to manage concerns around data quality, bias, and privacy. Most federal procurement systems are not built for this. As a result, DOT is increasingly turning to alternative pathways. In 2024, the Small Business Innovation Research (SBIR) program awarded $2.4 million to 12 companies building AI tools for transportation planning and pedestrian safety.[63] That same year, the FAA issued a Commercial Solutions Opening (CSO) to acquire AI-powered safety analytics platforms.[64] These tools are early examples of how DOT can respond to the *Action Plan*'s call for a standardized AI procurement toolbox through the General Services Administration (GSA) and expanded interagency talent exchange. Future progress will also depend on guidance for subscription-based or modular AI products, which better reflect the pace of commercial innovation.

Pilot programs remain a core strategy for advancing transportation AI. DOT's Automated Driving Systems (ADS) Demonstration Grants support testing of AVs in everyday driving conditions.[65] SMART Grants are enabling cities to apply AI to traffic management and transit safety.[66] The Federal Transit Administration has piloted autonomous shuttles and ADAS on buses. The Federal Railroad Administration is using AI to automate inspections of tracks and grade crossings.[67] And the Maritime Administration is using its Port Infrastructure Development Program to fund projects that apply analytics and ML to optimize cargo logistics and reduce bottlenecks.[68] These efforts are directly aligned with the *Action Plan*'s call to establish transportation-specific testbeds and AI Centers of Excellence that can scale innovation responsibly.

> *The task now is to shift* ***from experimentation to execution.***

DOT has also built internal capacity to oversee AI systems. Under the Biden administration's Office of Management and Budget (OMB) memorandum, the Department designated

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[62] Huafeng Yu et al., "Understanding AI Risks in Transportation AI Assurance for Transportation Whitepaper Series," USDOT Highly Automated Systems Center for Excellence, September 2024; and FAA, "Roadmap for Artificial Intelligence Safety Assurance," July 2024, at 3.

[63] DOT, "U.S. DOT Awards $2.4 Million to 12 Small Businesses for the Complete Streets Artificial Intelligence Initiative," August 13, 2024, Webpage.

[64] Rebecca Heilweil, "FAA seeks artificial intelligence-powered safety tool," *FedScoop*, November 8, 2024.

[65] DOT, "Automated Driving System Demonstration Grants," Webpage.

[66] Note: Projects include a crash prediction camera system in Michigan, an automated driver assistance system for collision avoidance in Ohio, and development of digital twins for scenario modeling and infrastructure planning in Florida. Mass Transit, "USDOT awards $16.7 million in SMART grant funding for 11 transit projects," March 15, 2024.

[67] FRA, "Automated Video Inspection System for Grade Crossing Safety," April 2021, Webpage.

[68] See, e.g., Leigh-Ann Buchanan, "Innovative Program Propels Cargo Visibility Enhancements at U.S. Ports," *Medium*, June 28, 2024.

TABLE 2 · Select federal actions from the *AI Action Plan.*

AI ACTION PLAN	DOT RELEVANCE	STATUS	NOTES
Establish regulatory sandboxes and AI Centers of Excellence.	Can be implemented through modal pilots and AV/connected infrastructure testbeds.	● RECOMMENDED	Aligns with existing DOT initiatives like ADS and SMART grants.
Develop model benchmarking tools for accuracy and latency.	Could be adopted to evaluate transportation-specific AI (e.g., traffic prediction, AV safety).	● RECOMMENDED	NIST and CAISI tasked with leading evaluation guidance.
Modernize procurement via GSA AI procurement toolbox.	Enables flexible acquisition of AI platforms for use across modal agencies.	● UNDER DEVELOPMENT	Builds on DOT experience with CSOs and SBIR.
Streamline permitting for data centers and energy infrastructure.	Critical for siting transportation-adjacent compute infrastructure.	● RECOMMENDED	FAST-41 is cited in the *AI Action Plan.*
Adopt cybersecurity protocols for AI in critical infrastructure.	Applies to connected infrastructure and safety-critical transportation systems.	● RECOMMENDED	AI-ISAC concept could interface with DOT cybersecurity programs.
Launch domain-specific standards development efforts.	DOT could participate in defining standards for AVs, transit, freight, and aviation.	● RECOMMENDED	Led by NIST; sector coordination expected.
Create a Virtual Proving Ground for AI/autonomy.	Could integrate with FAA, FRA, and AV testing initiatives.	● EMERGING	Currently framed as a DoD initiative, but DOT partnerships possible.
Incentivize reuse and agency-to-agency transfer of AI models.	Supports shared use of AI tools like safety analytics across modes.	● UNDER DEVELOPMENT	Builds on OMB and GSA AI Use Case Inventories.

- **RECOMMENDED:** Clearly articulated policy actions with implementation pathways. While not yet standardized across government, these priorities are actionable and align with DOT's existing authorities or partnerships (e.g., NIST, GSA, DOE).
- **UNDER DEVELOPMENT:** Initiatives previewed in the AI Action Plan or recent Executive Orders but still lacking operational infrastructure (e.g., tools, guidance, funding). DOT can shape or prepare for integration.
- **EMERGING:** Forward-looking proposals currently led by other agencies (e.g., DoD) or framed in conceptual terms. While not yet formalized for DOT, they present opportunities for proactive engagement or adaptation within transportation contexts.

a Chief AI Officer, developed an internal AI use case inventory ("TrUCKR"), and embedded risk management practices within the Nontraditional and Emerging Transportation Technology Council.[69] These efforts included safeguards for systems with potential rights or safety impacts. Although many structures remain in place, the Trump administration's updated guidance may steer agencies toward a new framework, emphasizing model reuse, AI inventories, and streamlined adoption, as examples.

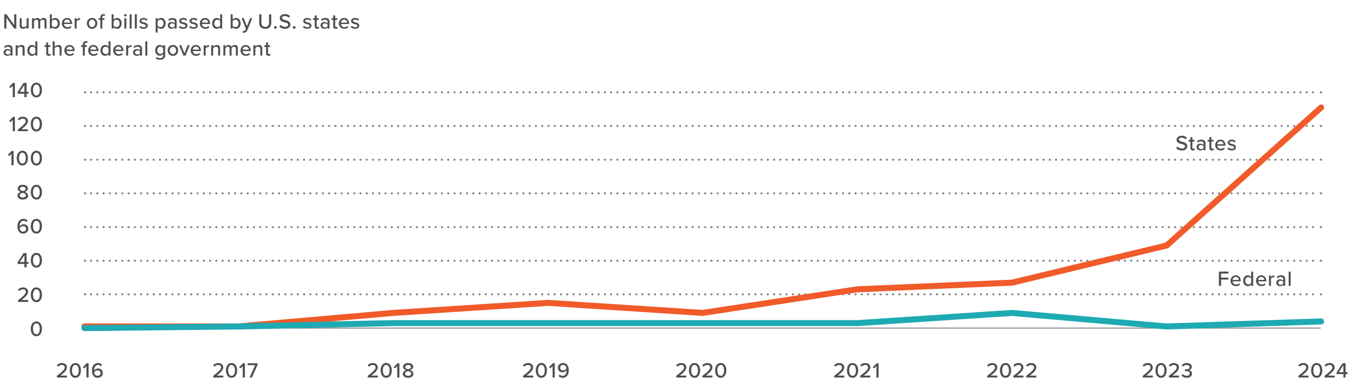
In response to the Office of Science and Technology Policy's request for input during development of the Action Plan, transportation stakeholders offered a range of recommendations focused on safety, infrastructure, and operational deployment. Many of these ideas are now reflected across its pillars. The table on the previous page highlights select federal actions from the plan that are particularly relevant to DOT, along with their current implementation status and potential alignment with existing programs.

Several of these recommendations are reflected in the final plan and now require follow-through. Opportunities for action include: permitting reforms under FAST-41 to accelerate siting of AI-supporting infrastructure like data centers and transmission lines; support for new Centers of Excellence; investment in workforce development for rail, maritime, and aviation; and new standards to secure AI-enabled transportation systems. The Plan's call for international engagement, anchored by NIST and CAISI, also matters for U.S. competitiveness, especially in port operations, connected vehicle networks, and global freight corridors. For DOT and its modal agencies, the task now is to shift from experimentation to execution, applying available tools more consistently, coordinating across agencies, and advancing the goal of safer, smarter, and more secure transportation systems.

State Policy

States are leading the way in deploying AI across transportation systems. Through agency pilots, executive orders, and partnerships with the private sector, state and local governments are setting early benchmarks for how AI can improve safety, optimize operations, and guide public investment. However, adoption remains constrained. Seventy-nine percent of state and local IT leaders said that if fewer barriers existed, their agencies would be more likely to leverage private sector innovations, like AI.[70] These efforts are not only shaping applied use cases but also building the institutional capacity and risk management frameworks that can inform

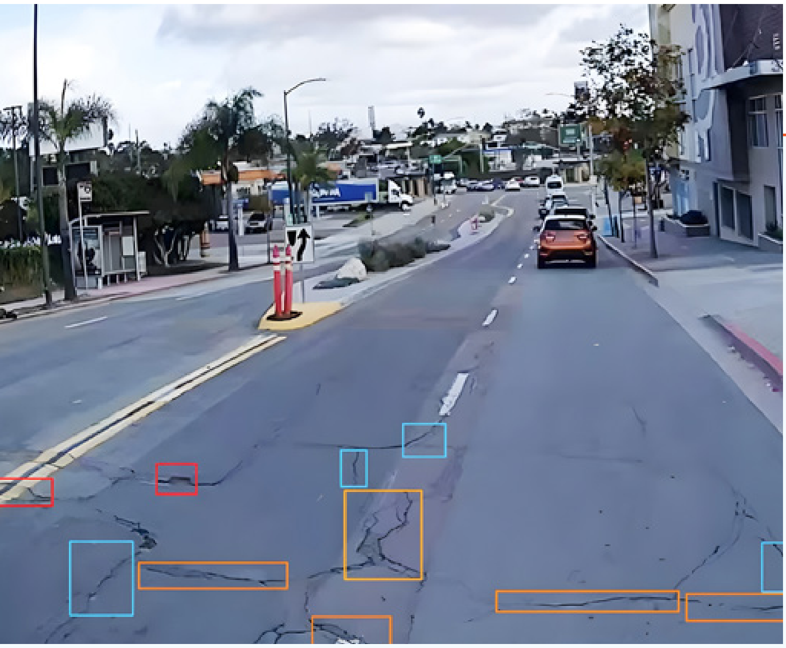
FIGURE 8 · Mapping AI legislation: State initiatives outpace federal action.



Source: Stanford University Institute for Human-Centered AI, "The AI Index Report: 2025 Annual Report."

[69] Polly Trottenberg and Mike Horton, "Compliance Plan for OMB Memorandum M-24-10," DOT, September 24, 2024.

[70] Ernst & Young, LLP, "Budget and cyber pressures impede tech upgrades by state and local governments, finds EY survey," Press Release, July 23, 2025.



CASE STUDY: BLYNCSY AI

AI for Road Maintenance: Detection and Prioritization

Blyncsy's AI-enabled infrastructure monitoring platform is helping transportation agencies shift from reactive maintenance to proactive, real-time asset management. Several states across the country have partnered with Blyncsy to detect road and roadside issues. Using computer vision and ML, their system identifies roadway issues such as potholes, faded striping, damaged signs, and vegetation encroachment. Unlike traditional inspection methods that require dedicated survey crews, Blyncsy relies on crowdsourced, anonymized video footage from dashcams across the country to passively collect imagery across broad geographies.

This crowdsourced approach enables more frequent assessments at significantly lower cost. The company estimates that they can reduce costs to about $10 per mile of road inspected from the $80 to $100 per mile typically spent on human inspectors.* Data is processed in the cloud and delivered through APIs that integrate with state DOTs' existing maintenance systems, eliminating the need for new dashboards or workflows. By increasing the speed of identification as well as predicting the urgency of maintenance, roadways are becoming safer for inspectors and roadway users, proactively identifying safety hazards to drivers and vulnerable roadway users.

Blyncsy's technology can be applied in a variety of use cases, including disaster recovery. The company partnered with North Carolina's DOT for recovery following Hurricane Helene, surveying the infrastructure of North Carolina before and after the hurricane and assisting the state in identifying infrastructure repair needs with real-time data.† Blyncsy can now expand such programs without the need for prior surveying of the infrastructure thanks to their partnership with Google Cloud and access to Google Street View.‡ By reducing reliance on complaint-driven maintenance and extending visibility across entire roadway networks, AI tools like Blyncsy are enabling a shift toward more continuous, preventative, and cost-effective infrastructure management.

* Schnitger Corporation, "Bentley goes Blyncsy for AI," April 16, 2024, Webpage.
† Blyncsy, "Faster Disaster Recovery when it matters most," Webpage.
‡ Aileen Cho, "Bentley Integrates Google Street View Into Asset Detection, Assessment Capabilities," *Engineering News-Record*, April 9, 2025.

implementation across jurisdictions. As of this year, every U.S. jurisdiction has introduced AI legislation, and 38 states have already enacted about 100 measures, a massive jump from fewer than 200 bills in 2023 to nearly 700 in 2024.[71]

Federal engagement with states is growing, with the White House's *AI Action Plan* proposing national tools for permitting, procurement, and workforce development. However, execution remains scattered across agencies and often focused on narrow use cases or sector-specific pilots. In some areas, federal policy is beginning to shift from support to direction. For example, the *AI Action Plan* calls on agencies to consider state regulatory climates when awarding AI-related federal funding and cautions against state rules it deems restrictive.[72] As a result, state leaders may face new pressures to align with federal preferences, even as they continue to define the practical impact AI adoption has on the ground.

Two of the most prominent early movers, California and Texas, offer different examples of how states operationalize AI in transportation. Each reflects its own institutional culture and governance model, but both are building pathways that test applied use cases, inform risk management strategies, and support learning.[73] Their efforts highlight the tools state agencies can use to enable innovation through policy directives, data infrastructure, or public-private collaboration, and valuable lessons for national leaders looking to scale AI across jurisdictions.

California California has taken a proactive, policy-led approach to AI in transportation, driven by Governor Gavin Newsom's Executive Order N-12-23. The directive tasks state agencies to assess GenAI's risks and benefits in public services, identify infrastructure vulnerabilities, and launch high-impact pilot projects.[74] It also calls for updated procurement guidelines, equity criteria, and workforce training to ensure safe and responsible adoption. With deep institutional research capacity and a dense concentration of AI firms, California is positioning itself to shape how public-sector AI is deployed.

> ***California's technological assets are considerable,*** *enabling the state to leverage its deep pool of AI talent.*

The California Department of Transportation (Caltrans) is testing how GenAI can support transportation planning and operations through two initial pilots. One focuses on improving safety for vulnerable road users by analyzing crash data, demographic indicators, and pedestrian and bicycle volumes to identify high-risk locations in underserved communities.[75] The other, the Traffic Mobility Insights initiative, uses GenAI to interpret traffic video, sensor feeds, and data from across the state's 52,000 lane miles with the goal of improving emergency response times, reducing bottlenecks, and improving event planning, among other use cases.[76] Together, these efforts aim to shift Caltrans toward more proactive, data-driven operations. Private-sector deployments underscore the same potential. Waymo's AVs, operating millions of miles in California, have achieved insurance-verified reductions of over 90 percent in bodily injury claims and 88 percent in property damage claims compared to human-driven vehicles.[77]

However, turning these pilots into scalable systems remains a challenge. Despite issuing forward-leaning policy guidance, California lacks a cohesive procurement and governance structure to scale innovation across agencies. Local efforts often depend on individual agency resources, limiting broader adoption. This reflects a wider national trend: startups and smaller firms frequently struggle to navigate

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[71] NCSL, Artificial Intelligence 2025 Legislation, Webpage.

[72] Note: The AI Action Plan directs OMB to work with federal agencies to consider a state's regulatory climate when awarding discretionary AI-related funding and to limit support where state rules may "hinder the effectiveness" of that funding. It also instructs the FCC to evaluate whether state AI regulations interfere with its statutory authority, reinforcing broader concerns about "burdensome" state-level rules that could restrict innovation. The White House, "Winning the Race: America's AI Action Plan," July 23, 2025, at 3, 5.

[73] See, e.g., AECOM, "NJ Transit AI Pilot Program," Webpage; and Tom Stone, "Utah DOT launches AI asset management pilot with Blyncsy," *Traffic Technology Today*, May 27, 2021.

[74] Gavin Newsom, Executive Order N-12–23, September 6, 2023.

[75] GenAI for California, "Vulnerable Roadway Users Safety Project," Webpage.

[76] GenAI for California, "Traffic Mobility Insights Project," Webpage.

[77] Luigi Di Lillo et al., "Do Autonomous Vehicles Outperform Latest Generation Human-Driven Vehicles? A Comparison to Waymo's Auto Liability Insurance Claims at 25 Million Miles," 2024, at 10.

CASE STUDY: AURORA INNOVATION

AI for Long-Haul Autonomy in Texas

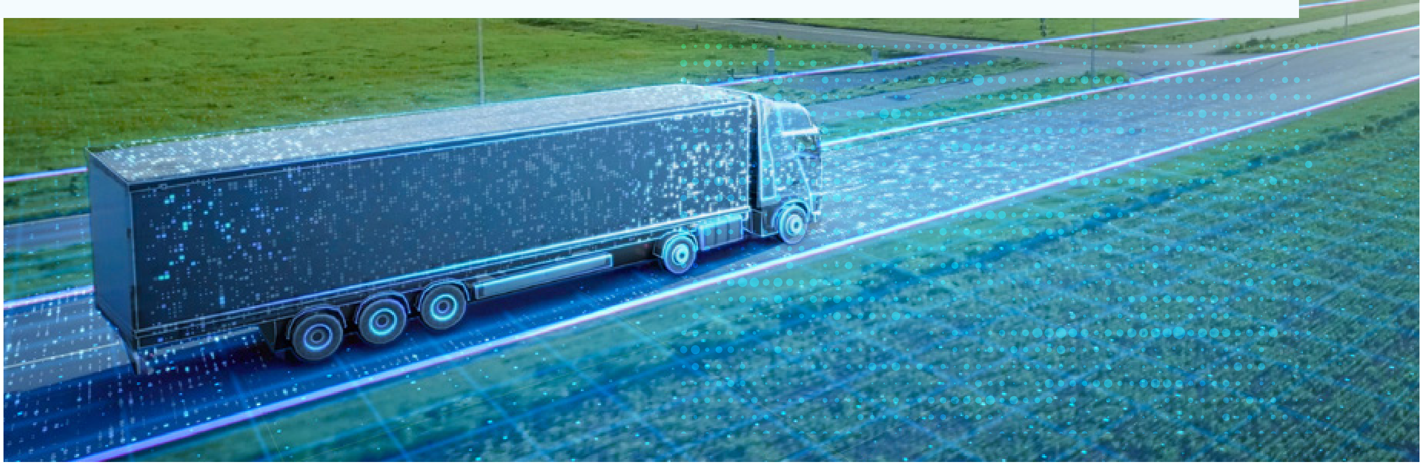
Aurora Innovation is actively operating autonomous long-haul trucks in Texas, where a flexible regulatory environment has enabled both testing and limited commercial deployment. In April 2025, the company launched a fully driverless freight service between Dallas and Houston, completing over 1,200 miles without a human in the cab.[*] While these milestone runs demonstrated full autonomy, Aurora's ongoing commercial operations across routes connecting Dallas, El Paso, Houston, and San Antonio typically include a vehicle operator on board for safety assurance.[†] Aurora expects to transition additional corridors to driverless service by the end of 2025.[‡]

In July 2025, Aurora achieved a breakthrough by expanding its operational design domain to include nighttime autonomous driving. Leveraging its upgraded LiDAR system, the Aurora Driver can now detect obstacles at distances greater than the length of three football fields, even in low-light conditions. This capability enables the vehicle to react up to 11 seconds faster than a human driver, a critical margin in preventing crashes or navigating unexpected road hazards at night.[¶]

Aurora's system employs a structured, modular approach to AI, decomposing the driving task into discrete, explainable functions, such as object detection, behavior prediction, and maneuver selection. Central to this architecture is a proposer-ranker model, which generates multiple potential driving actions and evaluates them in real time based on road context, legal constraints, and sensor data to select the safest maneuver.[§]

Human-in-the-loop processes remain vital to Aurora's development cycle. Trained annotators review and correct logged driving data, focusing especially on rare or high-risk "edge cases" like unpredictable lane changes, roadside debris, or low-visibility conditions. Aurora augments this workflow with a robust suite of simulation tools and closed-course testing. At its dedicated test tracks, the company evaluates AI performance against complex scenarios—including differentiating mannequins from debris at night to validate system behavior in edge cases that would be unsafe or impractical to test live. These simulations enable Aurora to recreate past incidents, stress-test interventions, and iteratively improve system safety.

* Esther Fung, "Texas Highways Have a New Nighttime Creature: Autonomous Trucks," The Wall Street Journal, July 30, 2025.
† Ibid.
‡ Drew Bagnell, "AI Alignment: Ensuring the Aurora Driver is Safe and Human-Like," Aurora Innovation, Inc., July 26, 2024, Webpage.



procurement systems designed for large, traditional vendors, processes that can be slow, risk-averse, and ill-suited to emerging AI capabilities.[78]

At the same time, integrated AI-supported deployments are emerging. Along San Diego's I-15 corridor, Caltrans and the San Diego Association of Governments operate a regional system that leverages micro-simulation, video analytics, and real-time data to inform multimodal traffic management.[79] The platform forecasts congestion up to an hour in advance and enables operators to evaluate interventions, such as ramp metering or signal timing changes, before deploying them.

California's technological assets are considerable, enabling the state to leverage its deep pool of AI talent. The Governor's Executive Order notes that California is home to 33 of the world's top 50 AI firms and several global research leaders.[80] The next challenge will be translating high-potential pilots into scalable, repeatable models by strengthening operational frameworks and improving procurement pathways.

Texas Texas is advancing AI in transportation through a coordinated, agency-led strategy designed to balance statewide consistency with local flexibility. The Texas Department of Transportation's (TxDOT) 2024 AI Strategic Plan outlines more than 230 use cases across traffic operations, infrastructure, internal services, and risk mitigation.[81] The strategy is supported by robust internal tools, including an Enterprise Data Platform that standardizes data across the agency and a NIST-aligned AI Risk Management Framework that promotes responsible deployment and interoperability across TxDOT's districts.[82]

Local entities are piloting AI applications tailored to their operational contexts. In Arlington, the city is expanding the use of NoTraffic's AI-powered signal optimization platform to manage congestion in preparation for the 2026 FIFA World Cup.83 In Austin, TxDOT is scaling a partnership with Rekor, an AI company focused on transportation data and roadway intelligence. The collaboration aims to enhance incident detection, work zone safety, and multi-agency response coordination, allowing TxDOT to better respond to roadway incidents, both emergency and non-emergency.[84] These deployments highlight how AI can deliver near-term benefits when supported by scalable governance and flexible implementation pathways.

TxDOT has also invested in internal capacity-building. It has created an AI Risk Management Workgroup and a cross-divisional Community of Practice to coordinate deployment and ensure human-in-the-loop validation.[85] Training programs tailored to staff roles in engineering, operations, HR, and finance support workforce readiness. Ongoing pilots explore applications including traffic signal optimization, predictive maintenance, emergency response, and GenAI for streamlining project documentation.

Texas is building a transportation AI ecosystem by investing in internal agency capacity, flexible technology tools, and workforce development programs that promote hands-on learning through pilots and cross-agency knowledge sharing.

***Texas is building a transportation AI ecosystem** by investing in internal agency capacity, flexible technology tools, and workforce development programs that promote hands-on learning through pilots and cross-agency knowledge sharing.*

[78] See, e.g., Geoff Orazem et al., "Why Startups Don't Bid on Government Contracts," Boston Consulting Group, August 22, 2017, Webpage.

[79] Richard Chylinski, "AI Transforming Transportation: Microsoft and Parsons Webinar," ITS America, March 28, 2023, Video; and Gavin Newsom, Executive Order N-12–23, September 6, 2023.

[80] Rashi Shrivastava, "Forbes 2025 AI 50 List," *Forbes*, April 10, 2025.

[81] TxDOT, "Artificial Intelligence Strategic Plan: Fiscal Years 2025-2027," September 20, 2024, at 8.

[82] Id., at 9.

[83] James Hartley, "AI systems in Arlington Entertainment District could help reduce traffic ahead of FIFA World Cup," *KERA News*, November 20, 2024.

[84] Rekor Systems, Inc., "Rekor Announces $2.1 Million Contract Expansion with Texas Department of Transportation," *Access Newswire*, January 4, 2024.

[85] TxDOT, "Artificial Intelligence Strategic Plan: Fiscal Years 2025-2027," September 20, 2024, at 10.

***As nations compete to harness its potential,** the rules that govern AI are being written now by those who move first.*

Its framework enables local experimentation while reinforcing statewide standards for governance and safety. By embedding AI into agency operations through training, data infrastructure, and inter-agency collaboration, Texas offers a model for building durable, scalable systems that can evolve with the technology.

Standards: An Emerging Global Race

AI is rapidly reshaping transportation systems, but as nations compete to harness its potential, the rules that govern AI are being written now by those who move first. China and the EU offer two models rooted in state-led industrial policy and risk-based regulation, respectively. Both aim not just to accelerate domestic adoption but to shape global norms, future innovation, and market access with them.

China has invested at least $200 billion in semiconductors since the publication of their 2014 Guidelines to Promote a National Integrated Circuit Industry.[86] The country has prioritized setting AI standards across connected vehicles and low-altitude drone corridors.[87] France has committed €109 billion to AI infrastructure, while Saudi Arabia, the UAE, Canada, and India have pledged hundreds of billions more.[88] By leveraging access to low-cost energy resources and enormous capital investments, Saudi Arabia is emerging as a future AI hub with foreign companies pledging to build up data centers within its borders. While many countries are pouring resources into infrastructure and hardware, a parallel front in the AI race is emerging around governance and safety. The United Kingdom, drawing on its history of leadership in computing, is positioning itself as a global sandbox for testing autonomy and building international consensus on AI risk.[89]

In contrast, the United States has pursued a more layered approach. The 2022 CHIPS and Science Act authorized $52.7 billion to strengthen domestic semiconductor and AI research capacity.[90] During the Biden Administration, U.S. agencies helped shape emerging global norms through voluntary frameworks like the NIST AI Risk Management Framework and Executive Order 14110 on trustworthy AI.[91] These efforts emphasized rights-based governance, transparency, and interoperability, often in coordination with allies. In 2025, the Trump Administration reoriented U.S. AI strategy around innovation, infrastructure, and international competition, aiming to position American technologies and governance models as global defaults while countering adversarial influence in standards bodies and promoting full-stack exports.[92] Soon after, China released its own *AI Action Plan*, calling for the creation of a global AI cooperation organization and embracing a multilateral governance model, signaling an intensifying competition between competing

[86] The Economist, "China is quietly reducing its reliance on foreign chip technology," February 13, 2024; and Yuan Gao, "China Creates $47.5 billion Chip Fund to Back Nation's Firms," *Bloomberg*, May 27,2024.

[87] See, e.g., Reuters, "China plans to strengthen intelligent connected vehicles' OTA upgrade," August 1, 2024; and Xinhua, "China prioritizes AI, low-altitude transport standards for 2025," *Global Times*, February 9, 2025.

[88] See, e.g., Reuters, "Details of 110 billion euros in investment pledges at France's AI summit," February 10, 2025; Adam Satariano and Paul Mozur, "'To the Future': Saudi Arabia Spends Big to Become an A.I. Superpower," *The New York Times*, April 25, 2024; Office of the Prime Minister of Canada, "Securing Canada's AI Advantage," April 7, 2024; and Reuters, "India announces $1.2 bln investment in AI projects," March 7, 2024. Details of 110 billion euros in investment pledges at France's AI summit," February 10, 2025; Adam Satariano and Paul Mozur, "To the Future': Saudi Arabia Spends Big to Become an A.I. Superpower," The New York Times, April 25, 2024; Office of the Prime Minister of Canada, "Securing Canada's AI Advantage," April 7, 2024; and Reuters, "India announces $1.2 bin investment in AI projects," March 7, 2024. Note: UAE announced more than $100 billion in investments in the past year.

[89] See, e.g., Prime Minister's Office et al., "The Bletchley Declaration by Countries Attending the AI Safety Summit, 1–2 November 2023," November 2, 2023, Webpage; and Retail Technology Innovation Hub, "DPD lays claim to UK first as company launches autonomous 'locker on wheels' robot deliveries," November 12, 2024.

[90] NIST, "Chips for America," Webpage.

[91] Executive Order 14110, "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence," The White House, October 30, 2023; and NIST, "AI Risk Management Framework 1.0," January 2023.

[92] Executive Order 14320, "Promoting the Export of the American AI Technology Stack," The White House, July 23, 2025.

visions of international AI rule-making.[93] As part of this effort, Beijing announced plans to formulate more than 50 national and industrial standards for AI by 2026.[94]

Transportation is emerging as a key battleground in the global race to set AI standards. China is deploying national data standards and intelligent infrastructure across roads, ports, and air corridors to unify its smart mobility architecture.[95] The EU's AI Act, taking effect this year and fully enforced by 2027, classifies transportation AI as "high risk," subjecting it to strict safety, transparency, and oversight requirements. The Act applies to any provider placing high-risk AI systems on the EU market, regardless of origin, meaning developers in the United States must comply even if their systems are built and trained outside Europe. While the law primarily targets developers, it also imposes clear legal obligations on deployers, particularly when high-risk AI systems are used in professional or operational contexts.[96] These efforts reflect how countries are moving forward with regulatory models shaped by their own domestic priorities, not by any single global standard. In China, accelerated deployment of advanced driving features has prompted new restrictions following high-profile safety incidents, underscoring that speed alone does not equate to a technology advantage.[97] While these pathways differ, the underlying ambition is to shape the standards that will govern future mobility systems.

__Transportation is emerging as a key battleground__ in the global race to set AI standards.

Without a national strategy and proactive global engagement, the United States risks becoming a rule-taker, not a rule-maker.

European Union

The EU's AI Act represents the most comprehensive regulatory framework for AI to date. Using a tiered, risk-based model, the Act mandates requirements for developers and deployers based on each system's potential societal impact.98 Transportation-related applications, particularly AVs and AI-powered safety components, are designated as "high risk" and subject to stringent obligations, including risk assessments, high-quality training data to mitigate bias, activity logging, and detailed technical documentation to facilitate oversight.[99] High-risk systems must also incorporate human oversight and ensure decision-making processes are explainable to authorities and end users.[100] While not all transportation technologies fall within scope, motor vehicles and related components remain under national regulation, critical infrastructure like road management systems are covered. By standardizing liability rules and clarifying responsibilities for developers and operators, the Act strengthens cross-border regulatory cohesion and lays the foundation for more consistent AI oversight across the EU.

[93] Ministry of Foreign Affairs, "Global AI Governance Action," People's Republic of China, July 26, 2025, Webpage.

[94] Xinhua, "China to formulate over 50 standards for AI sector by 2026," July 2, 2024.

[95] National People's Congress, "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035," *Xinhua News Agency*, March 12, 2021, Translation by Center for Security and Emerging Technology, May 13, 2021, at 41.

[96] Note: Deployers of high-risk AI systems are required to follow usage instructions, maintain human oversight, monitor system performance, ensure input data quality, notify individuals when AI affects them, and cooperate with regulators. In some sensitive domains, such as credit, insurance, or employment—they must also conduct a fundamental rights impact assessment prior to use.

[97] Liu Miao, "China's MIIT Tightens Regulations on Autonomous Driving Features, Banning Key Functions," *CarNewsChina*, April 17, 2025.

[98] European Union, Regulation (EU) 2024/1689, Artificial Intelligence Act, Article 6(2); Recital 26.

[99] European Union, Regulation (EU) 2024/1689, Artificial Intelligence Act, Annex III, points 1(a) and 1(b); Recitals 49 and 55.

[100] European Union, Regulation (EU) 2024/1689, Artificial Intelligence Act, Articles 13–14; Recital 73.

This approach is particularly significant given the high costs and uncertainty associated with product liability, an issue even more pronounced in the United States, where litigation exposure can be substantially greater than in Europe. In 2021, the European Parliamentary Research Service estimated that failure to address these gaps could cost up to €275 billion in GDP and more than 6 million unrealized jobs by 2030.[101]

China

In China, AI-enabled transportation is not only a technological breakthrough, but a strategic tool for state coordination, industrial modernization, and geopolitical influence. At the core of this vision is the pursuit of "embodied AI," a model of intelligence physically integrated into the infrastructure of daily life. Nowhere is this more apparent than in China's "vehicle-road-cloud" framework, which seeks to unify vehicles, roadside sensors, and cloud platforms into a single, coordinated system by 2026.[102] Backed by billions in investment and policy mandates under the 14th Five-Year Plan, this architecture reflects China's longstanding belief that physical infrastructure, not just algorithms, can serve as a foundation for national strength.

The rollout is well underway. Over 20 cities, including Beijing, Shanghai, and Shenzhen, are hosting pilot zones that combine AVs with intelligent intersections, cloud-based decision-making, and system-wide coordination.[103] Chinese authorities report that more than 20,000 miles of road have been opened for AV testing, with over 16,000 licenses issued as of August 2024.[104] Companies like Baidu and Pony.ai are expanding their fleets both domestically and internationally. Baidu's Apollo Go platform now operates more than 400 fully driverless vehicles in Wuhan and is preparing for pilot deployments in Turkey and Switzerland.[105]

The speed of deployment is a product of political and economic design. Intelligent intersections are expensive to build and maintain, and their safety benefits remain limited to narrow edge cases. But they serve other purposes: they give local governments a reason to invest in smart infrastructure, provide firms like Baidu with public contracts, and ensure that data generated by AVs flows back into government-managed systems. They also boost local land values and stimulate real estate-linked revenue, a central incentive for municipal governments that rely on land finance rather than direct transfers from Beijing. These data streams support broader surveillance and urban management systems, reinforcing state capacity for social monitoring and control. In contrast to the West's decentralized model, where AV firms retain most operational data, Chinese cities require private operators to submit detailed logs, including safety driver interventions. This reflects China's broader model of algorithmic governance, which relies on top-down control and strict regulatory adherence to state-defined priorities.

This logic extends beyond roadways into China's logistics networks. Firms such as JD.com and Alibaba are applying AI to warehouse automation, freight routing, and last-mile delivery, often within government-backed "smart logistics zones."[106] In ports like Rizhao and Tianjin, intelligent terminals powered by BeiDou, 5G, and AI-enabled cranes have increased cargo throughput and reduced labor costs.[107] The Ministry of Industry and Information Technology has set a national target to fully automate key ports and inland waterways by 2027, supported by cross-modal AI integration strategies.[108]

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[101] Tatjana Evas and Aleksandra Heflich, "Artificial intelligence in road transport: Cost of non-Europe report," European Parliamentary Research Service, January 13, 2021, at 26.

[102] See, e.g., Reuters, "China designates pilot areas for 'vehicle-road-cloud integration' for smart cars," July 3, 2024.

[103] National People's Congress, "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035," *Xinhua News Agency*, March 12, 2021, Translation by Center for Security and Emerging Technology, May 13, 2021, at 22.

[104] Xinhua News Agency, "16,000 test licenses for autonomous vehicles issued in China," August 27, 2024.

[105] PR Newswire, "Baidu Launches China's First 24/7 Robotaxi Service," March 8, 2024.

[106] ARC Group Worldwide, Inc., "China's Role in Revolutionizing Automation and Logistics," October 8, 2024.

[107] Ibid.

[108] PR Newswire, "China Accelerates Construction of Intelligent Ports," February 6, 2024.

FIGURE 9 · China vs. U.S. leaderboard.

Standards Development Organization (SDO) Model

United States
Industry-led, market driven, and voluntary consensus-based. Frameworks like the *AI Action Plan* guide, but don't dictate.

China
Top-down and state-directed through initiatives like Made in China 2025, China Standards 2035, and the Standardization Reform Plan (2015), some of which explicitly call for increased participation in standards leadership and drafting roles, and for China to be a standards "power."

Participation and influence

United States
Historically led global standards development (GSM to LTE to 4G), but influence is gradually eroding.

China
Most active global SDO participant, surpassing major Western nations over the last decade.

Public Investment in AI

$190B China

$60B United States

Private Investment in AI

$109B United States

$9.3B China

Public Investment in Chips

$53B United States

$97.5B China

Available AI Compute Power

67M TFLOPS United States

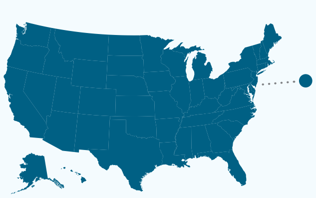
2.8M TFLOPS China

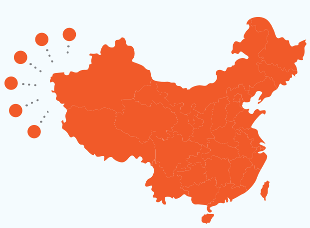
Power

4.3M GWh United States

9.5M GWh China

Global AV Presence





United States
Of 40 U.S. AV companies testing or transporting, **only one (Waymo) operates outside the U.S.**

China
At least 6 out of China's 20 AV companies are testing outside of China, in the U.S., Europe, and the Middle East.

AI Journal Publications

193,400 United States

319,960 China

AI Patents Granted

54,122 United States

170,756 China

These efforts show how transportation AI is embedded in China's broader development and governance strategy. Initiatives like Hangzhou's "City Brain," an AI-enabled traffic and public services platform developed with Alibaba, demonstrate how transportation systems are being reengineered as instruments of urban management. These platforms combine video analytics, cloud computing, and municipal data to orchestrate everything from traffic flow to emergency response. They embody a vision of AI as a tool for managing complexity at scale. While the Hangzhou model reflects strong governmental control, its emphasis on efficiency, responsiveness, and data integration may hold appeal for cities globally, including in the United States, particularly in areas like emergency response and traffic management.

However, while China's model enables speed and scale, there are tradeoffs. The system relies on substantial public investment, prescriptive standards, and top-down integration that may limit flexibility and slow adaptation in rapidly evolving AI domains. Despite strong support from central and local governments, China faces persistent bottlenecks in high-end software engineering talent, a constraint that could limit the scalability and robustness of its AI systems over time. And the model's reliance on deeply embedded infrastructure raises not only questions of openness and oversight, but also deeper concerns about surveillance, autonomy, and the omnipresent role of the state in public life.[109]

China is also exporting elements of this approach through global infrastructure projects, technology partnerships, and standards-setting forums.[110] In physical infrastructure, for example, nearly 80 percent of port cranes operating in the United States are supplied by ZPMC, a Chinese state-owned manufacturer whose equipment includes embedded software and supplier-coded components.[111] These systems represent more than just hardware; they are a governance architecture built on state-managed integration and control of data, one that diverges sharply from Western values of transparency, accountability, and privacy.

Without a national strategy and proactive global engagement, ***the United States risks becoming a rule-taker, not a rule-maker.***

[109] Jian Xu, "Opening the 'black box' of algorithms: regulation of algorithms in China," *Communication Research and Practice*, June 5, 2024, at 293–294.

[110] See, e.g., Brad Templeton, "Chinese Robotaxis Have Government Black Boxes, Approach U.S. Quality," Forbes, April 14, 2025.

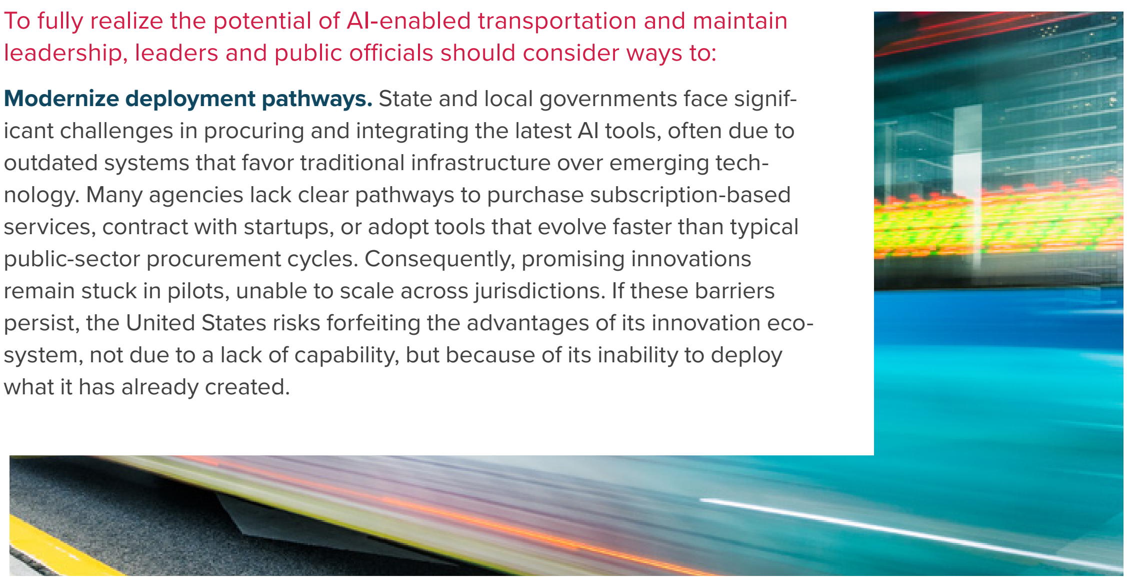
[111] Aruna Viswanatha et al., "Pentagon Sees Giant Cargo Cranes as Possible Chinese Spying Tools," *Wall Street Journal*, March 5, 2023; and Coalition for Reimagined Mobility, "Regulatory Comments: Notice of Proposed Action in Section 301 Investigation of China's Targeting of the Maritime, Logistics, and Shipbuilding Sectors for Dominance," May 16, 2025.

Conclusion

The United States remains the world's innovation engine for AI in transportation, leading in AV technology, AI-driven logistics, and next-generation transportation services. While the United States leads in AI innovation, global influence will be shaped by deployment. The nations that translate AI capabilities into large-scale transportation systems—on roads, in fleets, and across infrastructure—will define the standards, shape the markets, and set the rules of the road for decades to come. American technology firms like Waymo and Aurora are pioneering commercial deployments, while DOT and state-led infrastructure pilots demonstrate a growing public sector commitment to intelligent transportation.

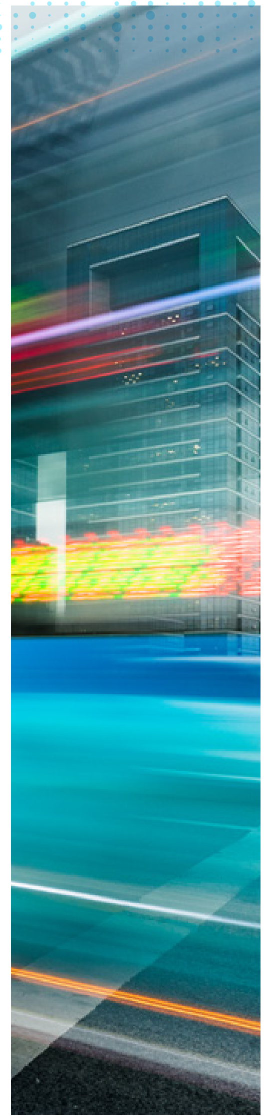
To fully realize the potential of AI-enabled transportation and maintain leadership, leaders and public officials should consider ways to:

Modernize deployment pathways. State and local governments face significant challenges in procuring and integrating the latest AI tools, often due to outdated systems that favor traditional infrastructure over emerging technology. Many agencies lack clear pathways to purchase subscription-based services, contract with startups, or adopt tools that evolve faster than typical public-sector procurement cycles. Consequently, promising innovations remain stuck in pilots, unable to scale across jurisdictions. If these barriers persist, the United States risks forfeiting the advantages of its innovation ecosystem, not due to a lack of capability, but because of its inability to deploy what it has already created.



Earn and maintain the public trust. As agencies adopt and private operators deploy AI systems that detect collisions, interpret live video feeds, and recommend traffic interventions, they introduce tools that make decisions with real-world consequences. The deeper these systems are embedded in public infrastructure, the more scrutiny they will face. Communities will expect transparency, explainability, and accountability not just from the technologies themselves but from the public institutions that deploy them. Just as procurement systems must evolve to accommodate new tools, governance frameworks must also evolve to ensure these tools earn and maintain public confidence.

Compete through democratic governance. If the United States does not lead in deploying AI within a framework of public accountability, transparency, and rule of law, other nations will. China is advancing an AI-enabled transportation ecosystem at an unmatched scale, rooted in algorithmic control and centralized surveillance. In contrast, the United States can demonstrate how democratic systems govern emerging technologies—through rules on safety, liability, privacy, and oversight—ensuring that AI deployment aligns with public values and institutional trust.



As AI becomes embedded in vehicles, intersections, and logistics networks, it will blur the line between digital and physical infrastructure. Securing American leadership will require more than cutting-edge technologies; it demands power, compute, and connectivity at scale, all supported by a unified policy framework that enables seamless, nationwide integration. Without this foundation, the United States risks ceding ground in the global race for smart mobility, and missing a generational opportunity to save lives, improve energy efficiency, and build safer transportation systems.

In the race for AI leadership, the stakes are not just technological; they are strategic, economic, and, above all, human.

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