AMERICAN INNOVATORS:

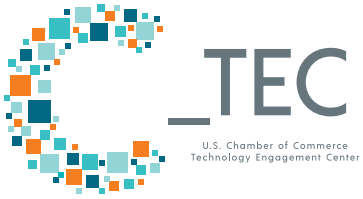
AMERICA'S NEXT TECH

UPGRADE

BUILDING THE FOUNDATION FOR THE FUTURE OF TRANSPORTATION

_TEC

U.S. Chamber of Commerce Technology Engagement Center



Our nation's future economic success, growth, and competitiveness depends on a thriving and innovative technology sector. Every company is a tech company and data-driven innovation is the foundation of businesses across the country.

The Chamber Technology Engagement Center (C_TEC) tells the story of technology's role in our economy and advocates for rational policy solutions that drive economic growth, spur innovation, and create jobs.

The U.S. Chamber of Commerce is the world's largest business federation representing the interests of more than 3 million businesses of all sizes, sectors, and regions, as well as state and local chambers and industry associations.

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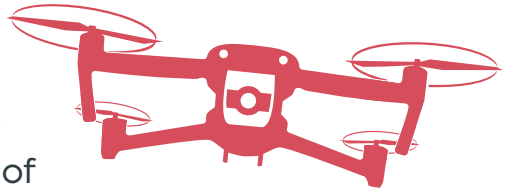
EXECUTIVE SUMMARY

Since its creation in 2015, the U.S. Chamber Technology Engagement Center (C_TEC) has advocated for rational public policies that drive economic growth, spur innovation, and create jobs. While technological innovations touch nearly every sector of the economy, the transportation sector will likely be particularly impacted due to new innovations in artificial intelligence, automation, advanced sensors, and many other foundational technologies.

Two areas of technological innovation prioritized by C_TEC are unmanned aircraft systems ("UAS") and automated vehicles ("AVs"). In addition, the emergence of urban air mobility ("UAM") has come into focus for the private sector and policymakers. UAS, UAM, and automated vehicles have the potential to transform how people travel, how packages are delivered to consumers, and how businesses in all sectors operate.

Policymakers in Washington, DC have been similarly engaged in a bipartisan manner to facilitate the safe development and deployment of these technologies through legislative and regulatory action. Congress and Federal regulators have made great strides in the last five years to work closely with the private sector in the development of legislation, regulations, and other standards for UAS and



AVs. Nonetheless, many policy challenges lie ahead to fully unlock the benefits of these emerging transportation technologies and successfully build the foundation for the future of transportation. Moreover, while the United States has long been a global leader in transportation innovation, we face increased economic and geopolitical competition from other economies that seek to write the rules of the road for the future of transportation.

This whitepaper is intended to inform Congress, regulators, and the general public about the key policy issues faced by UAS, UAM, and AVs, and provide policy recommendations on how to encourage further innovation and maintain U.S. leadership in these emerging technologies. These recommendations are outlined in two chapters, the first focusing on emerging aviation technologies such as UAS and UAM, and the second focusing on automated vehicles:

- **Emerging Aviation Technologies:** Policymakers must take a comprehensive approach to unlock the benefits of UAM and UAS. To ensure the safe integration of UAM and UAS into the national airspace, C_TEC recommends that policymakers focus on several key areas including: safely removing barriers to innovation; prioritizing the main enabling systems and infrastructure to provide for further integration; mitigating threats stemming from illicit UAS operations; and strengthening United States competitiveness in emerging aviation.

- **Automated Vehicles:** The safe development, testing, and deployment of automated vehicles is paramount to building public trust in automated vehicle technology and ensuring widespread deployment. C_TEC recommends that policymakers focus on removing barriers to automated vehicle innovation through regulatory and non-regulatory approaches; ensuring regulatory clarity; educating the public on automated vehicle technology; and strengthening research, development and testing.

ENSURING LEADERSHIP IN EMERGING AVIATION TECHNOLOGIES

INTRODUCTION

From the first Wright brother's flight in North Carolina to Lockheed Martin's F-22 Raptor, the United States has been a long-time leader in aviation technologies. As innovations in artificial intelligence, advanced communications technologies, and sensors mature, aviation will also likely advance in a manner that introduces new entrants into the national airspace ("NAS") presenting both opportunities and challenges. While emerging aviation technologies are inclusive of a number of applications, including supersonic aircraft, this paper will focus on just two: unmanned aircraft systems ("UAS") and urban air mobility ("UAM").

Unmanned aircraft systems, typically referred to as drones, are playing an increasingly high-profile role in aviation, given the relative ease of operation and low price point. While once thought of as tools only for hobbyists and the military, UAS have enormous

potential to improve productivity and enhance safety that affect a broad spectrum of industries and sectors. Today, UAS applications encompass recreational use, commercial use, as well as law enforcement and national security functions. For instance, UAS can be used in precision agriculture, land surveying, construction, movies and cinematography, utility and railroad maintenance, wildlife management, and countless other areas. As UAS technology continues to improve and regulations are modernized, new applications will emerge and become more prevalent, such as package delivery and long-range inspections.

Commercial UAS use in the United States has grown exponentially over the last decade, with the value of UAS activity rising from $40 million in 2012 to nearly $1 billion by 2017, while the total annual economic impact is estimated to be as high as $46 billion by 2026.[1] The Federal Aviation Administration ("FAA") estimates that there are over 1.7 million drones currently registered in the United States (with 495,000 of those being commercial drones), and that there are currently over 195,000 remote pilots that are certified.[2] Increased UAS integration into the NAS will produce numerous benefits to businesses and consumers, increase public safety, and help governments deliver services to citizens more efficiently.

In addition to UAS, UAM, also known as Advanced Air Mobility ("AAM") or electric vertical takeoff and landing ("eVTOL"), stands to revolutionize our transportation network and aviation. In general, UAM enables the safe transportation of passengers and goods in the low-altitude airspace of urban and suburban environments. Compared to the widespread deployment of UAS, UAM is still in its infancy, with the private sector developing and testing prototypes and partnering with the government to establish the fundamental building blocks to enable large scale UAM deployment. Nonetheless, the long-term impact of UAM will be significant, and will include benefits such as reduced emissions through electrification.[3]

1. McKinsey & Co "Commercial drones are here: The future of unmanned aerial systems." (December 2017) Available at https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems
2. UAS by the Numbers. Available at https://www.faa.gov/uas/resources/by_the_numbers/
3. Community Benefits of Urban Air Mobility (UAM). Available at https://www.communityairmobility.org/resourcefiles/benefits-of-urban-air-mobility-uam

Commercial UAS use in the United States has grown exponentially over the last decade, with the value of UAS activity rising from $40 million in 2012 to nearly $1 billion by 2017, while the total annual economic impact is estimated to be as high as $46 billion by 2026.

Moving forward, both UAS and UAM face unique and similar challenges to enable the safe integration of these technologies in the NAS. While UAS possesses a regulatory framework, it is still evolving and much needs to be addressed to facilitate faster UAS integration and mitigate any risks resulting from UAS. For UAM, a regulatory framework is also emerging, but significantly less developed compared to UAS. Lessons from UAS integration, as well as foundational systems such as remote identification and UAS Traffic Management, will serve as a critical foundation to safely integrate UAM into the NAS.

The U.S. Chamber's Center for Technology Engagement ("C_TEC") has worked closely with Congress, federal agencies, and the private sector to advocate for regulatory frameworks that promote the twin goals of safety and innovation and educate policymakers and the public on the benefits of emerging aviation technologies. This report highlights a number of key issues and recommendations for policymakers to consider to safely integrate UAS and UAM into the NAS.

REMOVING BARRIERS TO INNOVATION THROUGH EXPANDED UAS OPERATIONS

Commercial and civil UAS operations are regulated under Part 107 of Title 14 of the Code of Federal Aviation Regulations (FAR), which was finalized by the FAA in June 2016. Part 107 created a framework that established operational restrictions and rules for commercial UAS that weigh under 55 pounds.[4] Some of the main provisions of Part 107 include:

- **Operational restrictions:** Operators are prohibited from flying over anyone not participating in the operation of the UAS from a moving vehicle, unless the UAS is flying in a sparsely populated area and operating multiple UAS simultaneously.

- **Sight, speed, and altitude requirements:** UAS must be kept within sight of the operator and cannot be operated in a careless or reckless manner. Maximum allowable altitude is 400 feet, and maximum speed is 100 miles per hour.

- **Nighttime restrictions:** UAS can only be operated during daylight, which is defined as from 30 minutes before sunrise to 30 minutes after sunset.

While Part 107 established several restrictions on UAS operations, some, such as restrictions at nighttime and operations over people, can be waived under Part 107 if an operator demonstrates the operation can be conducted safely. Some activities are ineligible to receive waivers, for example, transporting hazardous materials and package delivery. The Part 107 waiver process has enabled many commercial entities to use UAS for more advanced operations, but the ad hoc approach of regulation-by-waiver creates subjectivity in the approval process and creates uncertainty for operators as to why some requests were granted while others were not. A comprehensive regulatory

4. 14 CFR Part 107 (2016).

framework that shifts away from the waiver process is imperative to ensure the long-term success of the UAS industry.

A recent report and survey from the Eno Center for Transportation underscored this issue and provided data regarding the waiver process and challenges that waiver applicants encounter when seeking approval to operate a UAS ("Eno Report").[5] Some of the key findings on waivers from the Eno Report includes:

- 88% of waivers granted were issued to allow for nighttime operations, yet only 45% of requested waivers were for nighttime operations.
- The most common uses cited in waiver applications were cinematic/photography, agriculture, inspection services, and flight-testing.
- 75% of waiver applicants identify themselves as small businesses based upon either revenue or employee thresholds.

Importantly, the FAA understands the need to move to a permanent regulatory framework for UAS. In February 2019, the FAA issued a Notice of Proposed Rulemaking ("NPRM") on Operation of Small Unmanned Aircraft Systems Over People, which is expected to be finalized by December 2020.[6] The NPRM would modify Part 107 to establish several categories to permit UAS operations over people and fully enable nighttime operations under certain conditions. This is an important step forward, but to fully realize the benefits of UAS, further actions to expand UAS operations are critical.

5. Eno Center for Transportation "Bridging the Gap: Sustaining UAS Progress While Pursuing a Permanent Regulatory Framework" (August 2020). Available at https://www.enotrans.org/wp-content/uploads/2020/08/Bridging-the-Gap-Sustaining-UAS-Progress-While-Pursuing-a-Regulatory-Framework.pdf
6. Operation of Small Unmanned Aircraft Systems over People, 84 Fed. Reg. 3856 (Feb. 2, 2019).

RECOMMENDATIONS

Until a comprehensive regulatory framework is established, policymakers should regularly assess and make improvements to the FAA's Part 107 waiver process. Several recommendations from the Eno Report should be adopted, including:

- Subject to FAA's Freedom of Information Act ("FOIA") policy, the FAA should make Part 107 waiver applications and decisions available to the public to identify safety trends and knowledge gaps and provide additional transparency to the waiver process.

- The FAA should develop a long-term plan to reduce reliance on Part 107 waivers to aid the transition to a permanent regulatory framework.

- The FAA should expand waiver-related resources available to applicants to improve the quality of waiver applications, including information on aeronautical safety knowledge and application instructions.

The FAA should finalize and promulgate regulatory actions to establish a permanent framework for expanded UAS operations under Part 107. These regulatory actions include:

- Finalize and implement the NPRM on Operation of Small Unmanned Aircraft Systems Over People. The final rule should allow operations over people in a risk- and performance-based approach. Moreover, the final rule should also allow operations over a moving vehicle to ensure that use cases such as newsgathering and filmmaking can be fully realized without a waiver.

- Issue an advance notice of proposed rulemaking ("ANPRM") to begin the process of enabling beyond visual line of sight operations ("BVLOS"). This would further unlock innovative uses of UAS including delivery, long-distance surveying and inspection, and wildlife monitoring. The FAA should also heed lessons from existing and future pilot programs and waivers to help establish a foundation for BVLOS.

- Promulgate an ANPRM to begin unlocking commercial autonomous operations and operations of multiple UAS by a single operator. Enabling these types of operations will allow for more frequent and efficient UAS operations in applications such as pipeline inspection, security, and construction.

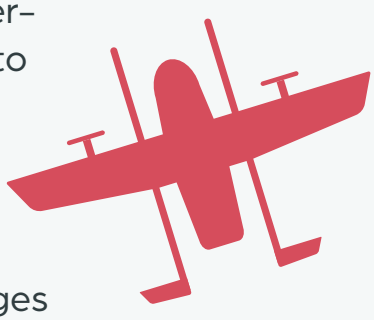
HOW SMALL BUSINESSES CAN BENEFIT FROM DRONE DELIVERY

Luke and Cassie Brugh missed the face-to-face interaction, the sound of keyboards tapping and the Christiansburg (Va.) regulars who would pop into their coffee shop each morning. Like many small business owners, the Brughs (pronounced "brew") were forced to close their doors to walk-in customers as the COVID-19 outbreak reached Southwest Virginia. The store grew quiet, sales slumped, and times got tough.

"It just felt like, for us, everything was on the up, we were getting toward the busy time of the year and it was like the chair got kicked out from under us," Luke said. "Everything just kind of came to a screeching halt real quick."

That's when Brugh adopted drone delivery as a way to continue reaching customers.

Today, very few businesses have this option. But drone company Wing selected Christiansburg as the town where it would conduct its drone package delivery trial as part of an FAA program known as the Integration Pilot Program ("IPP"), designed to advance unmanned aviation technology in the United States. Wing established a facility in the Southwest Virginia town, and in October of 2019, it launched America's first commercial drone delivery service to transport items directly to customers' homes.



Wing, established in 2012 as a project within the Google X Moonshot Factory, has developed technology focused on delivering lightweight packages to nearby neighborhoods in a matter of minutes. It has completed over 100,000 flights, including tens of thousands of commercial deliveries to real customers across three continents (in Australia, the United States, and Finland).

Wing's service was already up and running when the COVID-19 pandemic forced people to avoid human-to-human contact and many businesses to shut their doors.

First, Wing worked with Walgreens, one of its original merchant partners in Virginia, to expand its delivery catalog and cater more to families spending time at home. It began delivering food staples (like pasta), kids' activities (like sidewalk chalk), and additional health and wellness items (like soap and cleaning supplies).

Then, Wing began new partnerships with local businesses like Brugh Coffee, Mockingbird Cafe, and Gran Rodeo Mexican Restaurant. When the company was approached by a librarian with the local public schools, Wing began delivering library books to families during the extended out-of-school time.

Drone deliveries weren't the silver bullet to solve the challenges from the pandemic—but they helped.

"As a business, we're always trying to find new ways to reach our customers that makes sense and fits into our business model," Luke Brugh said. "Drone delivery does that because it helps us meet our quality standards. Somebody is able to place an order on their phone in the app, and within 10 minutes it's at their house."

Over the past several months, Brugh has sold twice as much of its cold brew coffee through drone delivery than they sold in the store *before* the lockdown. At one point during the pandemic, Mockingbird Cafe was doing about 25% of all its business through drone delivery.

The recent study "Measuring the Effects of Drone Delivery in the United States" by Virginia Tech's Office of Economic Development and Grado Department of Industrial & Systems Engineering speaks to the promise of the technology. The study modeled the effect that drone delivery would have on various metropolitan areas within 5 years of launch, finding that if the service were offered at scale, some restaurants could see sales increase by

as much as 250%. It could also support up to 66,000 people per metropolitan area who lack access to a vehicle (up to 6.6% of residents) and help up to 22,000 people with transportation challenges obtain and adhere to their prescription medication.[7]

"Our findings suggest that drone delivery can improve the lives of consumers by expanding access to services, reducing unnecessary travel and saving time," the report concludes.

ENABLING THE TIMELY IMPLEMENTATION OF REMOTE IDENTIFICATION

Remote Identification ("Remote ID") is a mechanism by which an in-flight UAS can be identified by other parties including persons on the ground, law enforcement, and other UAS operators. A Remote ID requirement is supported by a wide and diverse range of stakeholders, including the UAS industry, labor unions, manned aviation organizations, insurance, and the energy and chemicals sectors.[8]

Remote ID is expected to provide several benefits. First, Remote ID is necessary to assist the FAA as well as federal, state, and local authorities to enforce existing laws and mitigate risk from clueless, careless, or illicit UAS operations. Second, the safety of the NAS

7. "Measuring the Effects of Drone Delivery in the United States," prepared by Virginia Tech Office of Economic Development and Grado Department of Industrial & Systems Engineering, Sept. 2020, available at: https://econdev.vt.edu/content/dam/econdev_vt_edu/projects/technology/Virginia%20Tech%20%20Measuring%20the%20Effects%20of%20Drone%20Delivery%20in%20the%20United%20States_September%202020.pdf
8. U.S. Chamber of Commerce Remote ID Coalition Letter. Available at: https://www.uschamber.com/letters-congress/us-chamber-of-commerce-remote-id-coalition-letter

is enhanced by Remote ID because it will provide greater transparency and situational awareness in the NAS for manned and unmanned users. Third, Remote ID will lay the groundwork for advanced operations, including operations over people, BVLOS, and autonomous operations, all of which unlock additional innovative uses for UAS. Fourth and finally, Remote ID will also serve as a basis for the development of a UAS Traffic Management ("UTM") system.

After significant delay, the FAA issued a NPRM in December 2019 that would put in place Remote ID requirements on UAS that are operating in the NAS, which is projected to be finalized by December 2020.[9] The NPRM identifies two primary methods to achieve Remote ID—network and broadcast—and establishes three general categories for compliance with Remote ID that is dependent on the type of operation and operator. In addition, the NPRM would require full compliance three years after the effective date of the final rule, make a number of reforms related to UAS registration, and outline specifications describing how Remote ID would function. While the Remote ID final rule is near, it will be critically important to ensure the final rule will lead to sufficient compliance and is implemented quickly to maximize the benefits of the rule.

RECOMMENDATIONS

The FAA should finalize and fully implement Remote ID: Specifically, C_TEC recommends that the FAA take the following actions:

- The Remote ID NPRM is expected to be final by December 2020. The White House Office of Management and Budget ("OMB"), the FAA, and any other relevant agencies should adhere to that timeline. While C_TEC has a number of recommendations to improve the proposed rule, we generally support the approach taken, in particular the focus on network-based Remote ID, as well as ensuring that both recreational and commercial UAS operations are sufficiently covered.[10]

9. Remote Identification of Unmanned Aircraft Systems, 84 Fed. Reg. 72438 (Dec. 31, 2019).
10. U.S. Chamber Technology Engagement Center (C_TEC) Comments on Remote Identification of Unmanned Aircraft Systems NPRM. Available at: https://americaninnovators.com/wp-content/uploads/2020/04/C_TEC-Comments-on-Remote-Identification-of-Unmanned-Aircraft-Systems-NPRM.pdf.

- After the completion of the final rule, the FAA should expeditiously implement the rule to lay the groundwork for additional rulemakings on expanded UAS operations and provide immediate safety and security benefits. Moreover, the FAA should consider using the following tools to accelerate implementation recommended by the FAA Drone Advisory Committee: prioritize Part 107 waivers to applicants in compliance with Remote ID, allow airspace access to otherwise restricted areas for those in compliance, and encourage active public promotion by the FAA.[11]

- The FAA should implement Section 372 of the FAA Reauthorization Act of 2018, which requires the FAA to establish a five-year pilot program to use available Remote ID technologies to enforce safety requirements.[12] The pilot program is a key initiative that will provide policymakers with important information pertaining to Remote ID implementation and effectiveness.

FACILITATING THE DEVELOPMENT OF UAS TRAFFIC MANAGEMENT (UTM)

According to the FAA, there are 500,000 commercial and 1.2 million recreational drones registered in the United States, with significant increases projected over the coming years.[13] The current air traffic management system cannot accommodate the existing and projected growth of UAS operations, so the safe integration of UAS into the NAS will require a more decentralized and automated air traffic management system.

The development and widespread deployment of UTM is intended to address this challenge. As presently conceptualized, UTM will focus on low-altitude UAS operations and emphasize a federated system involving significant public-private sector collaboration.

11. FAA, Drone Advisory Committee eBook for 69 (Oct. 17, 2019). Available at: https://www.faa.gov/uas/programs_partnerships/drone_advisory_committee/media/eBook_10-17-2019_DAC_Meeting.pdf
12. See e.g. Section 372, FAA Reauthorization Act of 2018, Pub. L. No. 115-254 (2018)
13. UAS by the Numbers.

In addition, UTM is intended to be technology-neutral, focused on BLVOS operations in addition to less complex operations, and underpinned by Remote ID.[14]

UTM builds off other efforts such as the Low Altitude Authorization and Notification Capability ("LAANC"), which is an early example how the FAA can leverage industry investment and best practices to keep pace with a rapidly developing technology.[15] Also, public-private collaborations led by the FAA and the National Aeronautics and Space Administration ("NASA"), such as the UAS Integration Pilot Program and UTM Pilot Program, are important efforts to understand how UTM will be used in various environments. Moreover, while UTM is designed for UAS, UTM will also enable the integration of UAM as well, given that UAM operations will occur in low-altitude airspace.

RECOMMENDATIONS

Building a comprehensive UTM system will be essential to ensure that UAS and UAM operations effectively scale. Policymakers should take the following actions to support the successful development and deployment of UTM:

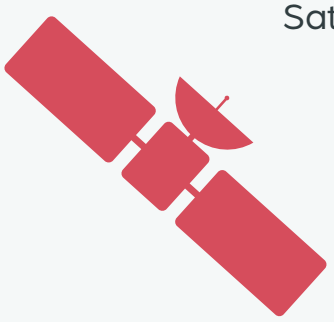
- Continue to support and advance a comprehensive UTM system that effectively integrates UAS and UTM into the NAS as well as with manned aviation through any future UTM concept of operations, regulatory actions, pilot programs budget requests, and other key strategic documents.

- Support public-private collaboration for UTM research and development for UAM and UAS. Additionally, the FAA and NASA should explore opportunities for additional public-private partnerships in areas such as metroplex-level studies across the NAS to inform airspace planning.

14. FAA, Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Concept of Operations, Version 2.0. Available at: https://www.faa.gov/uas/research_development/traffic_management/media/UTM_ConOps_v2.pdf.
15. U.S. Chamber Technology Engagement Center (C_TEC) comments on ANPRM on Safe and Secure Operations of Small Unmanned Aircraft Systems. Available at: https://americaninnovators.com/research/comments-on-the-faas-anprm-on-safe-and-secure-operations-of-small-unmanned-aircraft-systems/.

HOW IRIDIUM'S SATELLITE SERVICES OFFER SECURE C2 FOR EXPANDED UAS OPERATIONS

Iridium Communications Inc.'s satellite network keeps manned aircraft connected, efficient, and safe and is beginning to do the same for unmanned aviation. Iridium's satellites also host the Aireon® system to provide space-based global, near real-time, continuous air traffic surveillance of Automatic Dependent Surveillance-Broadcast ("ADS-B") equipped manned aircraft.



Satellite communications systems provide ubiquitous, licensed, and secure connectivity for commercial UAS concepts of operation. NASA has identified satellite as among the communications technologies suitable for UTM, and researchers are exploring how to utilize satellite communications systems in UTM around the world.

Iridium's Low-Earth Orbit satellites operate at an altitude of approximately 780 kilometers above the Earth's surface. Iridium's unique L-band satellite network provides truly global connectivity via reliable communications services to regions of the world where terrestrial wireless or wireline networks do not exist or are limited. Iridium satellite services are optimal for low-latency messages both to and from a drone. UAS operators are already using Iridium's satellite services for payload monitoring, en route communications, and C2. Iridium's transceivers are extremely small and designed to be incorporated into third-party devices.

As BVLOS operations become more common, UAS traveling significant distances will need seamless connectivity. Iridium provides "Global Line of SightSM"—the ability to establish BVLOS connectivity anywhere in the NAS. Iridium enables remote solutions for UAS anywhere, facilitating infrastructure inspection, remote package delivery, environmental monitoring, search & rescue, and disaster assessment.

Iridium is already enabling UAS over long distances. Swoop Aero uses Iridi-

um transceivers to provide networks of UAS to transport urgent supplies on demand to people in need. Iridium's transceivers help Swoop Aero to overcome spotty cellular coverage in remote areas and distance limitations to deliver vaccines and medical supplies in Vanuatu, a South Pacific Ocean nation comprised of approximately 80 islands spread across 1,300 kilometers. A 40-minute UAS mission previously required healthcare workers to hike two days through dangerous jungle terrain.

The Iridium system also connects UAS for the ReNovRisk project, which gathers hard-to-obtain data for tropical cyclone forecasts in the Indian Ocean, enabling scientists around the world to obtain valuable weather data to better determine when and where cyclones are most likely to make landfall in order to protect vulnerable populations. The project overcame the limitations of terrestrial connectivity by using UAS equipped with Iridium transceivers, enabling the UAS to collect data at low operational altitudes and up to 250 kilometers from shore.

PROTECTING AGAINST UAS THREATS

While the integration of the UAS into the national airspace will provide substantial benefits to economic growth and innovation, UAS can also present unique risks to manned aviation and people and property on the ground. These risks stem from both "clueless and careless" operators who inadvertently pose a risk, as well as criminal or terrorist activities that deliberately use UAS to generate a threat. If unchecked, the actions of both categories of actors could threaten the benefits derived from expanded UAS use and could result in overcorrection from policymakers. Consequently, policymakers must make it as much of a priority to protect against threats posed by UAS as they do towards moving forward with UAS integration.

There are two main policy approaches to addressing this challenge. The first is designating fixed site facilities to be granted an extra layer of legal protection due to the sensitive, high-risk, or critical nature of the site. Section 2209 of the FAA Extension, Safety,

and Security Act of 2016 ("FESSA") requires the FAA to establish a process to allow owners of "fixed site" facilities to petition to the FAA to prohibit or restrict UAS operations around that facility.[16] As defined in Section 2209, fixed site facilities include energy production, distribution, and transmission facilities, amusement parks, oil refineries, chemical facilities, and railroad facilities.

Policymakers must make it as much of a priority to protect against threats posed by UAS as they do towards moving forward with UAS integration.

However, since FESSA was enacted and amended in 2018, the FAA has not acted to protect these facilities in a comprehensive manner, and the Administration's most recent regulatory agenda included a NPRM for UAS Flight Restrictions near Critical Infrastructure NPRM for early 2021.[17] The implementation of Remote ID will also be important to identifying potential UAS threats and will form the basis for establishing protections for fixed site facilities. While the FAA has not moved forward to protect fixed site facilities, many states have, which has created a concerning patchwork of state laws on UAS critical infrastructure protection.[18] This increases uncertainty for UAS operators, creates gaps in protecting critical infrastructure, and adds complexity for fixed site facility owners.

16. See e.g. Section 2209, FAA Extension, Safety, and Security Act of 2016. Pub. L. 114–190. 130 Stat. 615 (2016).
17. Spring 2020 Unified Agenda of Regulatory and Deregulatory Actions, Office of Information and Regulatory Affairs. *Available at* https://www.reginfo.gov/public/do/eAgendaMain
18. National Conference of State Legislatures (NCSL), Current Unmanned Aircraft State Law Landscape. Available at: https://www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx.

The second policy approach relates to counter-UAS through the detection and mitigation of UAS. While Remote ID help identify illegal, clueless, or careless UAS operations, such operations may need to be mitigated if the UAS is uncooperative. However, counter-UAS solutions also present regulatory challenges. Consequently, only select federal agencies are authorized to use counter-UAS technologies while state and local governments and private sector actors are prohibited from using those solutions. Despite these challenges, effectively utilizing counter-UAS technologies will be essential to protecting against UAS threats.

As a first step, the FAA Reauthorization Act of 2018 included the Preventing Emerging Threats Act, which granted counter-UAS authority to the Department of Homeland Security (DHS) and Department of Justice (DOJ) to provide temporary protection for specific key assets and directed DHS to evaluate and test counter-UAS technologies.[19] Moving forward, more will need to be done to safely leverage counter-UAS to mitigate UAS threats.

RECOMMENDATIONS

The FAA should take regulatory action to protect important and critical fixed site facilities from illicit and unauthorized UAS operations.

- The FAA, in collaboration with relevant agencies, should promulgate the UAS Flight Restrictions near Critical Infrastructure NPRM. Issuing this NPRM should be prioritized in order to improve the safety and security of fixed site facilities and give certainty for UAS operators, so they can better understand existing restrictions and avoid a patchwork of state laws.

Policymakers should ensure the effective and robust implementation of the Preventing Emerging Threats Act. C_TEC recommends that policymakers take the following actions:

- DOJ and DHS should fully implement the Preventing Emerging Threats Act to enhance the federal government's counter-UAS capability. Also, Congress should fully

19. See e.g. Division H, FAA Reauthorization Act of 2018, Pub. L. No. 115-254 (2018).

fund the Act through providing sufficient appropriations to DOJ and DHS to carry out the objectives of the Act.

Counter-UAS authorities should be expanded to non-federal government stakeholders. Specifically, to ensure that this expansion is conducted in a manner that ensures safety and security while promoting innovation, policymakers should consider the following recommendations:

- Beyond the existing federal agencies, Congress should provide explicit counter-UAS authorities for state, local, and tribal governments.

- Congress should provide selected counter-UAS authorities for certain non-governmental stakeholders, including airport authorities and operators of highly sensitive and critical sites. These authorities should be granted in a risk-based and tailored manner to minimize impact on authorized UAS activity.

- In the interim, the Air National Guard should be authorized to operate counter-UAS on behalf of certain governmental and non-governmental actors to ensure the safe use of counter-UAS authorities while additional guidance and training are developed for newly authorized counter-UAS users.

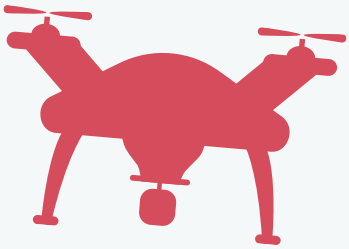
Policymakers should mitigate risks stemming from authorized and lawful counter-UAS operations. Several specific steps include:

- Require mandatory and standardized training for counter-UAS operators, utilize pre-use threat assessments, conduct risk-based responses with an escalating use of force, and provide for mitigation notification to prevent the mitigation of authorized UAS activity.

WHITEFOX CASE STUDY WITH U.S. FIRE SERVICE

UAS present unique opportunities to help society, but also unique threats posed by a spectrum of operators (the "clueless, careless, and criminal"). WhiteFox demonstrated this in a real-world deployment for the U.S. Forestry Service (USFS) fighting a wildfire in Oregon, the Riverside fire.

WhiteFox was asked to deploy on short notice a team using DroneFox Aware, a highly portable and capable drone detection system, to the Riverside Incident near Portland, Oregon. The USFS wanted to utilize air assets to drop water and fire retardant on the Riverside fire. The Air Operations branch stated that the arrival date was the first time they had an opportunity to use manned aviation due to limited visibility (smoke and cloud cover) during their deployment. Air Operations wanted to use every available hour possible to attack the fire given the very limited time frame. Non-participating drones flown within the fire temporary flight restriction ("TFR") would severely impact the ability of the USFS to utilize these very important air assets.



Wildfires increasingly occur at the suburban interface with wilderness areas. These locations make fighting the fire increasingly tactically important: infrastructure and population centers must be protected. In addition, because of the proximity to population centers, drones are an increasing and real threat to firefighting aerial operations. Firefighters will encounter more "clueless and careless" non-participating UAS operations.

The FAA declared a TFR around the wildfire to allow for USFS air assets to operate as needed over the fire without interference from manned and unmanned traffic. When unmanned traffic is seen by teams on the ground, the entire air operation is grounded for at least 30 minutes past the last sighting to ensure the UAS is on the ground and the threat is presumed departed. If the incident management teams could track the UAS directly, they could

perhaps continue both manned and unmanned operations away from the drone intrusion and resume immediately when the drone is not flying.

The WhiteFox team worked with the incident management team to quickly locate a ridge overlooking the air operations area. This location was selected for deployment of the DroneFox system. The team was onsite for eight days at the incident. The DroneFox detected an unauthorized UAS flight on one of the early days of the deployment. The DroneFox team was able to radio in a report of the UAS location, which allowed the Air Operations team to adjust flight planning in real-time. Knowing exactly where the UAS was flying could allow Air Operations to continue flights in other areas and cancel or delay flights near the UAS.

Because this UAS intrusion was flying in a location covered by a TFR, the FAA could use their authority to investigate and complete an enforcement action against the UAS pilot. DroneFox records details of the flight and UAS, which can be supplied to appropriate enforcement authorities. Important lessons learned from this deployment include that a complete response to drone incursions will need to include planning for coordination between government agencies.

Mitigation of the threat of unauthorized drone flights includes immediate actions to deal with the facts in the air but should also include actions to identify and engage pilots who are flying in airspace that threatens critical air operations.

ENHANCING U.S. COMPETITIVENESS IN ADVANCING AVIATION

As with any innovative technology, the speed at which the UAS and UAM industries is developing is rapidly outpacing existing regulatory frameworks in the United States and around the world. The United States must take a global leadership role in developing regulations for UAS and UAM that account for innovation, safety, security, and privacy. Many other countries and jurisdictions are moving quickly to establish themselves as leaders in emerging aviation technologies through increasing research and development, developing regulation, and fostering industry leaders in UAS. The European Union, China, and Japan have been particularly active in this space.

The United States still lacks a comprehensive and government-wide strategy to ensure the safe and innovative integration of UAS and UAM into the NAS, and instead has developed policy in a piecemeal fashion through multi-year FAA reauthorizations and rulemakings. However, the U.S. has been a leader in several areas, such as research and development and creation of standards. Over the next decade, American R&D investment in UAS is estimated to remain the highest in the world, growing from $2.2 billion in 2020 to $2.7 billion by 2029 (excluding classified programs).[20] In terms of standards development, organizations such as the Consumer Technology Association, ASTM International, and the American National Standards Institute have led in the development of standards on topics including cybersecurity, serial number registration, and Remote ID.

The United States has also begun to grapple with Chinese dominance in the manufacture of small unmanned aircraft, where the market share of the largest manufacturer, Da-Jiang Innovations ("DJI") is estimated to be 77%.[21] A robust and competitive UAS

20. National Defense Magazine "$98 Billion Expected for Military Drone Market" (January 2020). Available at https://www.nationaldefensemagazine.org/articles/2020/1/6/98-billion-expected-for-military-drone-market
21. Blake Schmidt and Ashlee Vance, DJI Won the Drone Wars, and Now It's Paying the Price, Bloomberg Businessweek (Mar. 26, 2020), https://www.bloomberg.com/news/features/2020-03-26/dji-s-drone-supremacy-comes-at-a-price.

and UAM market is essential to ensure continued private sector innovation and U.S. leadership in these technologies. The federal government, led by the Department of Defense ("DoD"), correctly recognizes that bolstering U.S. competitiveness in UAS is essential, and it has led the way in developing programs such as the Blue sUAS, which identifies secure and trusted UAS manufacturers, as well as the Trusted Capital Marketplace, which is intended to strengthen the UAS domestic industrial base.[22][23]

Some policymakers have also proposed imposing country of origin restrictions on Chinese manufactured UAS and certain components through executive actions and legislation. These proposed restrictions would prohibit federal agencies from purchasing, operating, or funding Chinese-produced UAS and components, and some proposals would also prohibit the operation of Chinese-manufactured UAS over federal lands. While well-intentioned, these proposals will inadvertently harm U.S. competitiveness, given their adverse impact on the operations of many American companies as well as harm to companies engaged in the broader UAS supply chain. Considering these pitfalls and the existence of alternatives to increase UAS security and strengthen the domestic UAS industrial base, it is unlikely that blanket country of origin restrictions would be ultimately beneficial to United States leadership in UAS.

RECOMMENDATIONS

The United States lacks a comprehensive strategy to ensure American leadership and competitiveness in emerging aviation technologies such as UAS and UAM. To address this issue, policymakers should take the following actions:

- Congress should direct the Administration to develop a comprehensive government-wide strategy to strengthen United States global competitiveness in UAS and UAM. The strategy should involve all relevant government stakeholders, identify key milestones and objectives, provide opportunity for non-governmental stakeholder

22. David Vergun, DOD Developing Small, Unmanned Aerial System for Warfighters, DoD News (Aug. 20, 2020), https://www.defense.gov/Explore/News/Article/Article/2318919/dod-developing-small-unmanned-aerial-system-for-warfighters/.
23. Jon Harper, Pentagon to Kick Off First 'Trusted Capital Marketplace' Event, National Defense Magazine (Oct. 18, 2020), https://www.nationaldefensemagazine.org/articles/2019/10/18/pentagon-about-to-kick-off-first-trusted-capital-marketplace-event.

engagement, and be regularly updated to accommodate technological advances and completed objectives.

- Congress should direct the Administration to conduct an assessment and subsequently develop a strategy to strengthen the domestic industrial base for UAS and UAM and support a competitive market that enables the U.S. to lead in emerging aviation technologies.

To increase United States competitiveness in emerging aviation technologies, policymakers should strengthen the domestic industrial base, make targeted investments, and provide American leadership in standards development. Specifically, policymakers should:

- Prioritize federal investments in research and development activities at entities such as the FAA, NASA, and DoD that advance American leadership in emerging aviation technologies.

- Support public–private partnerships such as DoD's Trusted Capital Marketplace and Blue sUAS programs to bolster the United States' domestic industrial base for UAS.

- Support the development of voluntary consensus–based standards through direct engagement in standards activities domestically and internationally, provide any necessary funding to support the development of key standards, and promote favorable standards internationally.

Country of origin restrictions are an overly broad and restrictive tool to address supply chain or security concerns regarding UAS.

- Avoid adopting overly broad country of origin policies through executive action, regulations, or legislation. Country of origin polices burden American companies with high compliance costs and ultimately harm the broader UAS supply chain while creating a false sense of security.

ESTABLISHING THE FOUNDATION FOR URBAN AIR MOBILITY (UAM)

Transportation systems, particularly those in dense populations, have the potential to be transformed through UAM technology in the coming decades. UAM—which can consist of piloted or automated personal aircraft—is intended to address the perennial problem of urban congestion as well as facilitate last-mile package delivery.

While UAM holds significant potential, UAM deployment is a decade or more away from widespread deployment. A NASA study from 2018 found a commercially viable market for UAM as early as 2030.[24] However, there are many barriers to commercial UAM deployment, including public acceptance, insufficient infrastructure, and lack of a regulatory framework. Consequently, policymakers will need to start considering and addressing challenges associated with UAM to ensure that it can be a beneficial and safe addition to America's transportation system. While some of these challenges, such as UTM and governance, are being contemplated in conjunction with UAS, UAM poses several unique issues as well.

RECOMMENDATIONS

While the development of UAM policy is intertwined with the integration of UAS into the NAS, policymakers should also develop UAM-specific policies, including:

- The FAA should partner with private sector stakeholders to form a regulatory framework for UAM. This would include examining how UAS informs the path for UAM; identifying the unique aspects of UAM operations in the near-term that are distinct from UAS; and enabling near-term commercial use cases for UAM, such as passenger-transportation and cargo, to be realized within the existing aviation regulatory framework.

24. National Aeronautics and Space Administration, Urban Air Mobility Market Study (Nov. 2018). Accessible at: https://www.nasa.gov/sites/default/files/atoms/files/uam-market-study-executive-summary-v2.pdf.

- Advancing infrastructure standards for UAM by building off of existing heliport and airport design standards to facilitate early infrastructure planning and investment. As part of this, Congress should consider funding pilot projects with industry stakeholders and airports to inform standards development.

ENSURING EFFECTIVE GOVERNANCE OF EMERGING AVIATION TECHNOLOGIES

Emerging aviation technologies such as UAS and UAM advanced significantly in recent years. Some 1.7 million drones have been registered in the United States, and the UAM market is projected to increase to $15.2 billion by 2030.[25][26] Consequently, the integration of these technologies into the NAS presents governance challenges on who gets to regulate these technologies and how they impact existing legal and regulatory frameworks. To effectively govern emerging aviation technologies, policymakers must adopt a comprehensive, national-wide approach that includes clear guidelines and provides regulatory certainty for consumers and businesses.

At the direction of Congress, the NAS and aviation safety have traditionally been regulated at the federal level by the FAA to promote the efficient use of the national airspace and to establish a uniform level of aviation safety. UAS, and to some extent UAM, present a unique challenge in that UAS are required under Part 107 to operate below 400 feet, more directly impacting the privacy and environment of those on the ground. The FAA acknowledges these issues, and in their "State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet" (2015 Fact Sheet), the FAA notes that state

25. UAS by the Numbers.
26. Michael Willoughby, UAM market will hit USD15.2 billion by 2030, says new study, Urban Air Mobility News (Sept. 4, 2019), https://www.urbanairmobilitynews.com/market-analysis/uam-market-will-hit-usd15-2bn-by-2030-research/.

and local governments may regulate UAS as it relates to traditional state and local police powers such as zoning, privacy, and law enforcement use.[27]

However, as UAS has become more widespread, state and local governments have been active in considering and adopting legislation relating to UAS. In 2019 alone, 18 states enacted 22 bills on UAS policy issues including prohibitions on operations over critical infrastructure sites and prisons, privacy, and the establishment of UAS-related programs.[28] Likewise, there is interest at the federal level to grant states authority to regulate certain types of UAS operations through proposals such as Senator Mike Lee's (R-UT) Drone Integration and Zoning Act (S. 2607).[29] In addition to policymakers, non-governmental bodies such as the Uniform Law Commission and the American Law Institute are contemplating proposals that would rewrite existing common law restatements to increase liability for UAS operators flying above or adjacent to private property, even though those UAS operations would be authorized by the FAA.[30]

These efforts to regulate UAS operations, either through legislation or revision of common law restatements poses a significant threat to the ability to utilize low-altitude airspace for UAS and UAM. The resulting legal patchwork and increased liability would increase uncertainty for UAS operators and would hinder the FAA's ability to develop a comprehensive regulatory framework for emerging aviation technologies.

Finally, while the FAA retains authority to regulate UAS operations at the federal level, there are a number of different stakeholders within the FAA and among other federal agencies that have equities in the regulation of UAS. Within the FAA, there are a number of offices, such as Aircraft Certification and Flight Standards, which engage in ensuring UAS safety, and the UAS Integration Office, which is responsible for coordinating UAS

27. Office of the Chief Counsel, Federal Aviation Administration, State and Local Regulation of Unmanned Aircraft Systems (UAS) (Dec. 17, 2015). Available at: https://www.faa.gov/uas/resources/policy_library/media/UAS_Fact_Sheet_Final.pdf
28. NCSL, Current Unmanned Aircraft State Law Landscape.
29. Drone Integration and Zoning Act, S. 2607, 116th Cong. (2019).
30. Josh Turner and Sara Baxenberg, Game of Drones: The ULC Enters Its Final Season, WileyConnect (Jun. 17, 2019), https://www.wileyconnect.com/home/2019/6/17/game-of-drones-the-ulc-enters-its-final-season.

To effectively govern emerging aviation technologies, policymakers must adopt a comprehensive, national-wide approach that includes clear guidelines and provides regulatory certainty for consumers and businesses.

policy within the FAA. Likewise, some UAS issues, such as counter-UAS and Remote ID, involve multiple agencies, such as the DoD, NASA, DHS, and DOJ. Interagency coordination is essential to provide for continued progress on UAS integration issues.

RECOMMENDATIONS

A national approach to regulating emerging aviation technologies is imperative to ensuring that the UAS and UAM operations remain safe and preventing a patchwork of rules across the United States. In addition to promoting a comprehensive regulatory framework for UAS and UAM, policymakers should also ensure that UAS and UAM remain regulated at the federal level, including through:

- Opposing efforts by non-governmental entities, such as the Uniform Law Commission and American Law Institute, to rewrite common law that places an unnecessary burden on UAS or UAM operations.

- Opposing legislative or regulatory proposals to devolve or authorize UAS or UAM regulation to state or local governments.

- Supporting and further clarifying the federal government's responsibility to be the primary regulator of UAS and UAM through legislation, regulation, or guidance, including through updating the FAA's 2015 Fact Sheet on federal, state, and local regulatory responsibilities.

Policymakers should maximize coordination on UAS issues at the interagency level and within the FAA.

- Given that UAS intersects with a number of different federal agencies and activities, policymakers should support enhanced coordination of UAS interagency activities through existing bodies such as the UAS Executive Committee. In addition, policymakers should strengthen the role of the FAA's UAS Integration Office to ensure continued prioritization of UAS innovation within the FAA.

CONCLUSION

Emerging aviation technologies such as UAS and UAM are on the cusp of transforming the aviation industry and our transportation system. Establishing the proper regulatory frameworks and other policies are essential to facilitating the safe integration of UAM and UAS into the NAS. C_TEC looks forward to continuing our work with policymakers on developing policy solutions to advance the safe and innovative development and deployment of UAS and UAM.

ACHIEVING THE PROMISE OF AUTOMATED VEHICLE TECHNOLOGY

INTRODUCTION

Automated vehicles ("AVs"), often referred to as self-driving or driverless cars, hold the potential to revolutionize passenger transportation, the trucking industry, and our nation's cities. The United States and business community are at the forefront of this revolution and are world leaders in safely testing and developing automated vehicle technology.

Automated vehicle technology has advanced rapidly over the last decade. Today, many automobiles are equipped with sensors that help drivers avoid collisions when shifting lanes or getting too close to another vehicle. In the future, AV developers will be able to equip automobiles and commercial trucks with fully automated systems that will be able to handle all driving responsibilities. Once further integrated into the U.S. economy, automated vehicle technology will likely produce major economic, mobility, environmental, and safety benefits for consumers and the public.

First, automated vehicles will likely provide several potential economic benefits for consumers and the public at large. Research shows that the "passenger economy" brought on by AVs could be a $7 trillion global industry by the year 2050.[31] Another study looks at overall benefits of automated vehicles, including factors such as fewer accidents, better fuel efficiency, traffic reduction, and expanded access to transportation options, and estimated that the aggregate benefits is $800 billion annually.[32] Also, automated vehicles stand to benefit individuals across all income levels. A recent Securing America's Future Energy ("SAFE") report highlighted the often-overlooked cost of transportation for workers and estimated that automated vehicles could reduce total household costs by $5,600 annually.[33]

In terms of commercial trucking, AV technology has several applications that will improve delivery services, make long-haul trucking more efficient, and reduce costs for a number of industries, in particular manufacturing. A Steer Group report found that delivery services could generate an additional $3.4 trillion of economic activity in the United States between 2025–2035 and support the creation of millions of jobs.[34] Additionally, PwC has estimated that, with adoption of autonomous trucking, long-haul trucking costs for manufacturers could be reduced by 30% through 2040.[35]

Second, conventional motor vehicle designs make it challenging for certain groups in our society such as the elderly and disabled to drive and be independent. The National Highway Traffic Safety Administration ("NHTSA") noted that there are 49 million Amer-

31. Strategy Analytics "Accelerating the Future: The Economic Impact of the Emerging Passenger Economy" (June 2017). Available at https://newsroom.intel.com/newsroom/wp-content/uploads/sites/11/2017/05/passenger-economy.pdf.
32. Future Structure "Autonomous Vehicles to Have Huge Impact on Economy, Tech Sector" (June 2018). Available at https://www.govtech.com/fs/automation/Autonomous-Vehicles-to-Have-Huge-Impact-on-Economy-Tech-Sector.html
33. Securing America's Future Energy (SAFE) "Fostering Economic Opportunity through Autonomous Vehicle Technology" (July 2020). Available at https://secureenergy.org/wp-content/uploads/2020/07/Fostering-Economic-Opportunity-through-Autonomous-Vehicle-Technology.pdf
34. Steer Group "Economic Impacts of Autonomous Delivery Services in the United States" (Sept. 2020). Available at https://www.steergroup.com/sites/default/files/2020-09/200910_%20Nuro_Final_Report_Public.pdf
35. PwC "Industrial mobility: How autonomous vehicles can change manufacturing" (Feb. 2018). Available at https://www.pwc.com/us/en/industries/industrial-products/library/industrial-mobility.html

icans over age 65 and 53 million Americans who have some type of disability.[36] The introduction of automated vehicles could significantly increase mobility options for those groups. A report from SAFE and the Ruderman Foundation estimates that enabling innovative transportation technologies such as automated vehicles could allow approximately 2 million individuals with disabilities to rejoin the workforce and save over $19 billion in healthcare expenditures due to fewer missed medical appointments.[37]

Third, automated vehicle technology could produce significant environmental benefits and, especially when coupled with the growth of electric vehicles, will reduce the overall level of emissions from motor vehicles. One study from the University of Michigan estimated that the efficiencies of automated vehicles may reduce greenhouse gas

Research shows that the "passenger economy" brought on by AVs could be a $7 trillion global industry by the year 2050.[32] Another study looks at overall benefits of automated vehicles, including factors such as fewer accidents, better fuel efficiency, traffic reduction, and expanded access to transportation options, and estimated that the aggregate benefits is $800 billion annually

emissions by up to 9% and that automated vehicles with electric powertrains may have emission levels that are 40% lower than internal-combustion vehicles.[38] Another study

36. NHTSA "Automated Vehicles for Safety" Available at https://www.nhtsa.gov/technology-innovation/automated-vehicles
37. Ruderman Family Foundation and SAFE "Self-Driving Cars: The Impact on People with Disabilities" (Jan. 2017). Available at https://rudermanfoundation.org/wp-content/uploads/2017/08/Self-Driving-Cars-The-Impact-on-People-with-Disabilities_FINAL.pdf.
38. University of Michigan "Maximizing the environmental benefits of autonomous vehicles" (Feb. 2018) Avail-

from automated trucking company TuSimple and the University of San Diego found that automated trucks could reduce fuel use by 10% and thus reduce overall emissions.[39]

Fourth, automated vehicles can dramatically improve safety. NHTSA notes that 93% of accidents are caused by human error.[40] To put this into perspective, 36,560 people were killed in motor vehicle crashes in the United States in 2018.[41] The U.S. Department of Transportation ("DOT") concurs with this assessment, stating, "AVs—if developed properly— also have the potential to make our roadways safer by reducing crashes caused by human error, including crashes involving impaired or distracted drivers.[42] Other reports have suggested that the integration of automated vehicles into transportation could save nearly 600,000 lives between 2035 and 2045 and reduce public safety costs associated with accidents by $234 billion.[43]

C_TEC has worked closely with public and private sector participants to help educate policymakers and the general public about the wide range of potential benefits that automated vehicles can bring to the American public. This paper highlights a number of critical issues related to the development, testing, and deployment of automated vehicle technology as well as policy recommendations for Congress and regulators to consider to rapidly enable automated vehicle deployment in the United States.

RECENT CONGRESSIONAL AND REGULATORY EFFORTS

In 2017, the House of Representatives unanimously passed the Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution ("SELF DRIVE") Act (H.R. 3388) and similar legislation, the American Vision for Safer Transportation through Advance-

able at https://news.umich.edu/maximizing-the-environmental-benefits-of-autonomous-vehicles/

39. University of California San Diego and TuSimple. Available at https://www.sae.org/news/2019/12/tusimple-autonomous-trucks-cut-fuel.
40. Center for Internet and Society "Human Error As a Cause of Vehicle Crashes" (Dec. 2013). Available at http://cyberlaw.stanford.edu/blog/2013/12/human-error-cause-vehicle-crashes
41. NHTSA "Automated Vehicles for Safety" Available at https://www.nhtsa.gov/technology-innovation/automated-vehicles
42. "Ensuring American Leadership in Automated Vehicle Technologies" (Jan. 2020). Available at https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf
43. Strategy Analytics.

ment of Revolutionary Technologies[44] ("AV START") Act (S. 1885), was reported out of the Senate Committee on Commerce, Science, and Transportation in November 2017, both of which were strongly supported by C_TEC. While the SELF DRIVE Act and the AV START Act had some differences, both bills would provide regulatory clarity, enable DOT to safely exempt additional automated vehicles from certain standards in order to encourage deployment, and update rules on testing to allow all automated vehicle developers to test on a level playing field. These bills represented a bipartisan recognition of the importance of nationwide standards for automated vehicles and in promoting testing and innovation with these new technologies. In the 116th Congress, lawmakers attempted a bipartisan, bicameral process to produce automated vehicle legislation, but that effort did not ultimately move forward.

DOT has published several guidance documents in recent years to encourage the further development of automated technologies. These include:

- **Automated Driving Systems 2.0: A Vision for Safety**—The report, released by NHTSA in 2017, clarified the voluntary nature of certain guidelines, and that AV can begin without a "waiting period."[45] It also outlined suggested criteria for Voluntary Safety Self-Assessments, reports where automated vehicle developers outline their safety practices.

- **Preparing for the Future of Transportation: Automated Vehicles 3.0**—The "AV 3.0" report issued by DOT incorporated significant private sector feedback and focused on three core topics: 1) advancing multi-modal safety; 2) reducing policy uncertainty; and 3) outlining processes to work with DOT.[46]

44. See C_TEC letter in support of the SELF DRIVE Act, https://www.uschamber.com/sites/default/files/170906_hr3388_self_drive_act_house.pdf; C_TEC letter in support of the AV START Act, https://www.uschamber.com/sites/default/files/171003_s1885_avstartact_thune_nelson.pdf.
45. U.S. Department of Transportation, "Automated Driving Systems (ADS): A Vision for Safety 2.0" (Sept. 2017). Available at https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf.
46. U.S. Department of Transportation, "Preparing for the Future of Transportation: Automated Vehicles 3.0" (Sept. 2018) Available at https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf.

- **Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0**—The "AV 4.0" report outlined the Administration's plan to coordinate efforts across Federal agencies, states, and the private sector to ensure that the United States develops national standards and regulations and maintains its global leadership on AV technologies.[47]

RECOGNIZING FEDERAL, STATE, AND LOCAL REGULATORY ROLES

The federal government, acting largely through the DOT, regulates motor vehicle safety and the operations of commercial motor vehicles. This regulatory framework consequently extends to the regulation of automated vehicle technology in addition to conventional vehicles.

NHTSA has the sole responsibility to regulate the design, construction, and performance of motor vehicles through Federal Motor Vehicle Safety Standards ("FMVSS"). FMVSSs establishes performance standards on dozens of motor vehicle categories such as air bags, seat belts, and exterior protection. The Federal Motor Carrier Safety Administration ("FMCSA") is the primary regulator within DOT responsible for ensuring the safe operation of interstate trucking, including truck drivers and the operations of motor carriers through issuing minimum performance requirements known as Federal Motor Carrier Safety Regulations ("FMCSRs"). Overall, while both passenger and commercial motor vehicles are regulated at the federal level, the federal government has a larger role in regulating commercial motor vehicles, considering the role of FMCSA in regulating the safe operations of interstate motor carriers as well as commercial motor vehicle equipment through NHTSA.

47. U.S. Department of Transportation and the Office of Science and Technology Policy, "Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0" (Feb. 2020) ("AV 4.0"). Available at https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf.

State and local governments also have an important historical role in regulating motor vehicles, and thus will have responsibilities in regulating automated vehicle technology. In general, state and local governments regulate areas including insurance, dealerships, traffic safety laws, and driver's licenses. The introduction of automated vehicle technology will present two main challenges to the regulatory roles of federal, state, and local governments.

First, given inaction at the federal level on creating a comprehensive automated vehicle regulatory framework, state legislatures have been increasingly active on automated vehicle legislation. According to the National Conference of State Legislatures, no fewer than 41 states and the District of Columbia have considered legislation related to AVs since 2013, and 29 states plus the District of Columbia have already enacted legislation.[48] While some of these bills clearly fit into the historical roles of state governments, there is an increasing concern that state legislation may be overlapping with NHTSA and FMCSA's regulatory responsibilities.

Second, the introduction of automated vehicles may lead to a greater federal responsibility over regulating those types of vehicles. Highly automated vehicles (Levels 4 & 5) integrate the duties traditionally held by a human driver, including sensing and perceiving, predicting, and planning and deciding, into the design of the vehicle, which remains a key federal regulatory responsibility. However, this also intersects with state and local governments' roles to effectively carry out responsibilities as it relates to issues such as traffic safety laws and licensing.

As discussions on how best to regulate automated vehicle technology continues to unfold, innovators need to be certain that their technologies can be deployed on a nationwide basis, and that the actions of states will not impede the development and deployment of automated vehicle technology. It is critical that Congress and federal regulators work to create a national regulatory framework and avoid any conflicts that result from multiple sets of standards.

48. Congressional Research Services "Issues in Autonomous Vehicle Testing and Deployment" (February 2020). Available at https://fas.org/sgp/crs/misc/R45985.pdf

A second issue related to specific regulatory roles and responsibilities is ensuring that there is effective coordination within the federal government and between federal, state, and local governments on automated vehicle policy as a whole. Effective United States leadership in automated vehicles means that policymakers should provide for a whole of government approach on automated vehicle policy to leverage the resources of the entire federal government. The DOT's AV 4.0 effectively outlined various areas of responsibility of over 38 different federal entities on areas like intellectual property protection, research and development, and standards development, among other topics.[49]

As discussions on how best to regulate automated vehicle technology continues to unfold, innovators need to be certain that their technologies can be deployed on a nationwide basis, and that the actions of certain states will not impede the development and deployment of automated vehicle technology.

49. AV 4.0 (Feb. 2020).

RECOMMENDATIONS

Preserve the existing clear delineation of traditional federal, state, and local regulatory roles for automated vehicles to maintain certainty and ensure that automated vehicles can be deployed nationwide at scale.

- The federal government, acting through NHTSA, has the sole responsibility to regulate the design, construction, and performance of motor vehicles FMVSS.

- State and local governments should retain the authority to regulate in areas such as insurance, vehicle dealerships, and traffic safety laws. However, when and where appropriate, voluntary coordination of these laws in relation to automated vehicles should be encouraged to enable the sharing of best practices and efficient regulation.

- Policymakers may need to clarify that some areas of regulation may need to adapt to the introduction of automated vehicles, such as operating licenses, that may need to be governed by NHTSA if they impact the design, construction, and performance of Level 4 and 5 automated vehicles.

- FMCSA should retain its exclusive authority to regulate commercial motor vehicle operations to facilitate interstate commerce and maintain a high level of safety. Moreover, FMCSA should maintain its current position that state and local governments should not issue regulations or prohibitions on automated driving systems ("ADS") equipped commercial motor vehicles.

Policymakers should take a whole-of-government approach when considering how to ensure American competitiveness in automated vehicle technology and regularly update strategic documents as needed to further this objective.

- The Federal government, led by DOT and the Office of Science and Technology Policy ("OSTP"), should have the primary responsibility to develop automated vehicle technology policy for the United States. In doing so, DOT and OSTP should proactively engage with other federal agencies, state and local governments, and non-public stakeholders. Coordination with state and local governments is particularly important as automated vehicles are being testing and deployed in their jurisdictions.

CASE STUDY: AV 3.0 AND AUTOMATED TRUCKING

Shortly after the publication of "Automated Driving Systems: A Vision for Safety 2.0" in September 2017, DOT began development on a companion document that would expand the scope of the agency's automated vehicle guidance to include all surface transportation modalities, including automated trucks. The resulting guidance, "Preparing for the Future of Transportation: Automated Vehicles 3.0," is a landmark document that highlights the success of DOT's collaborative approach with industry.

By early 2018, investment and interest in automated trucks was growing as many in both industry and government began to understand the dramatic safety and efficiency benefits that come with automating freight trucking. However, it was unclear to both industry and government how existing FMCSRs would interact with automated trucks, including potential operation without a human on board.

In March 2018, DOT's Volpe National Transportation Systems Center issued a preliminary assessment of all existing FMCSRs, and how they might be applied to several automated truck operating concepts being considered by industry. At the same time, FMCSA issued a Request for Comment soliciting views from the public on FMCSRs that could be a barrier to the safe testing and deployment of automated commercial vehicles on public roads.

Embark, a San Francisco–based developer of automated trucks, was one of several ADS developers who filed a public comment in response to FMCSA's request. In their comment, Embark provided FMCSA with a comprehensive evaluation of the FMCSRs, directly addressing the gaps identified in Volpe's report and sharing their perspective as a company on the front line of developing cutting-edge technology. Embark explained how its operating model could coexist with existing FMCSRs while ensuring FMCSA retained its critical oversight authority to ensure the safe operation of automated commercial vehicles.

In October 2018, DOT issued AV 3.0, which has provided vital regulatory certainty for the growing automated trucking industry. In AV 3.0, FMCSA reiterated its enforcement authority over automated trucks, noted its preemptive authority over conflicting state rules for AVs engaged in interstate commerce, and clarified that human-specific FMCSRs, such as hours of service rules, would not apply to trucks that do not require a human operator.

The close cooperation Embark and other automated truck developers have fostered with FMCSA is validation of DOT's approach to work collaboratively with industry. Through the public comment process, along with public workshops and other outreach, DOT continues to gain valuable technological insight from industry, clarify its regulatory authority over AVs, and provide critical guidance that supports American innovation.

MODERNIZING REGULATIONS TO FACILITATE FASTER AUTOMATED VEHICLE DEVELOPMENT

As discussed in the preceding section, the federal government, through NHTSA and FMCSA, is responsible for regulating, respectively, motor vehicle safety and commercial motor vehicle operations. Considering automated vehicle technology is novel and still developing, federal regulations will need to be modernized to accommodate technological advances.

Automated vehicles may include unconventional designs that are incompatible with some existing FMVSS or FMCSR rules. For example, current FMVSSs require the installation of rearview mirrors and steering wheels, which are not necessarily applicable to an automated vehicle. Similarly, some FMCSRs, like that a driver should be assumed to be a human, may also not be applicable when reaching a higher level of automation.

NHTSA and FMCSA have already taken some steps to update regulations in order to reflect the growing presence of automated vehicle technologies. For example, NHTSA recently issued a proposal to modernize occupant protection safety standards for automated vehicles,[50] while the FMCSA issued an advanced notice of proposed rulemaking in 2019 seeking comment on regulations that need to be amended or eliminated to facilitate automated trucking that could serve as a basis for future regulatory actions.[51] The approach taken by both the NHTSA and FMCSA correctly recognizes that misguided or heavy-handed regulation is the wrong approach for emerging technologies, and that it is critical to seek stakeholder input on how to best update regulations to accommodate automated vehicles.[52]

Modernizing regulations is not the only tool available to facilitate the safe deployment of automated vehicles. NHTSA also has authority to issue exemptions from existing FMVSSs for unconventional motor vehicle designs. An exemption would require an automated vehicle developer to provide extensive information and data on the proposed motor vehicle design, and NHTSA would have to show that the proposed design meets or exceeds the level of safety provided by the standard for which the exemption is sought. This ensures that a high level of safety is maintained, and passengers and the public remain protected. Similarly, FMCSA may also grant exemptions from existing FMCSRs with the same safety equivalency requirements as the NHTSA process. Outside of enabling new motor vehicle designs or operational practices, exemptions also provide a way to gather additional data to demonstrate the safety of automated vehicle technology and inform future rulemakings.

In February 2020, NHTSA granted Nuro a temporary exemption that will allow the company to deploy its R2X model—a low-speed, unmanned electric delivery vehicle. This

50. NHTSA "NHTSA Issues First-Ever Proposal to Modernize Occupant Protection Safety Standards for Vehicles Without Manual Controls" (March 2020). Available at https://www.nhtsa.gov/press-releases/adapt-safety-requirements-ads-vehicles-without-manual-controls
51. Advanced Notice of Proposed Rulemaking for the Safe Integration of Automated Driving Systems-Equipped Commercial Motor Vehicles, 84 Fed. Reg. 24449 (May 28, 2019) *available at* https://www.govinfo.gov/content/pkg/FR-2019-05-28/pdf/2019-11038.pdf.
52. See C_TEC's comments on the "ANPRM for the Safe Integration of Automated Driving Systems-Equipped Commercial Motor Vehicles" (Aug. 2019). Available at https://americaninnovators.com/wp-content/uploads/2019/12/082819_C_TEC_Comments_ANPRM_FMCSA.pdf.

is the first type of exemption granted that involves a SAE Level 4 technology. General Motors ("GM") and Cruise announced in October 2020 that they are seeking to the utilize exemption process to deploy the Cruise Origin that is all electric and does not have traditional vehicle controls such a steering wheel and brake pedal.[53]

However, while exemptions are a helpful tool, they have limitations. By statute, exemptions are capped at 2,500 and the duration for an exemption is two years. Both the SELF DRIVE Act and the AV START Act proposed increasing the quantity and duration of exemptions to gather additional data and facilitate additional rulemakings.

NHTSA and FMCSA have decades of experience ensuring the safety of motor vehicles and commercial motor vehicle operations, which builds a strong foundation to regulate automated vehicle technology. Some, however, propose that federal regulators should upend the existing regulatory framework and impose non-safety related requirements on the automated vehicle industry. An example of this is conditioning deployment of automated vehicle technology on workforce impact assessments or upskilling requirements. While workforce impacts are important to consider, conditioning deployment for non-safety reasons creates regulatory confusion for policymakers and industry and places roadblocks on the deployment of this lifesaving technology.

Another problematic proposal is mandating that NHTSA preapprove a motor vehicle design before it enters into commerce. NHTSA has historically allowed manufacturers to comply with FMVSS requirements through self-certification, which NHTSA can enforce through tools such as a recall authority.[54] Undermining the self-certification model would harm innovation and lead to the introduction of fewer innovative vehicle designs.

53. The Verge "The federal government just granted its first driverless car exemption" (Feb. 2020). Available at https://www.theverge.com/2020/2/6/21125358/nuro-self-driving-delivery-robot-r2-fmvss-exemption
54. National Highway Traffic Safety Administration "Understanding NHTSA's Regulatory Tools." Available at https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/understanding_nhtsas_current_regulatory_tools-tag.pdf.

RECOMMENDATIONS

The Department of Transportation should prioritize regulatory action at NHTSA and FMCSA to modernize motor vehicle regulations to accommodate advances in automated vehicle technology.

- DOT should develop and regularly update, with stakeholder input, a long-term regulatory roadmap that identifies key regulatory barriers to automated vehicle innovation and provides a timeline to modernize those regulations.

- NHTSA should accelerate its existing efforts to update FMVSSs to enable the widespread deployment of automated vehicle technology.

- The FMCSA should build off of its recent ANPRM on the "Safe Integration of Automated Driving Systems-Equipped Commercial Motor Vehicles," and move to updating FMCSRs on topics included in the ANPRM, such as the definition of a driver. However, FMCSA should continue to consult with relevant stakeholders on topics including notification and external marking requirements and remote monitoring, considering these topics are still emerging.

Policymakers should prioritize utilizing DOT's authority to issue exemptions from existing safety standards to allow for the safe deployment of motor vehicles with novel and innovative designs.

- To ensure the workability of the exemption process, DOT should ensure all exemption petitions for automated vehicle designs are reviewed in a timely manner, make the exemption process available to all petitioners on a level playing field, and consider updating any procedures to streamline the exemption review process.

- Congress should raise, incrementally, the current volume limit on the number of vehicles that may be exempted from 2,500 to 100,000 and increase the duration of an exemption from two years to four years.

- Policymakers should maintain the current requirement that exemptions should only be granted if a petitioner's data demonstrates that the proposed design provides a safety level at least equal to the safety level of the standard that it is being from exempted from.

The United States has robust and effective regulatory regime to regulate motor vehicle safety. Consequently, policymakers should avoid imposing novel and overly burdensome regulatory requirements unique to automated vehicle technology, including:

- Policies that would undermine NHTSA's self-certification model. The self-certification model has enabled manufacturers and developers to continually innovate and introduce new types of motor vehicles. Shifting away from this approach, such as requiring pre-market approval, would substantially impede the ability of developers to introduce new models into the market and limit American competitiveness in the automotive sector.

- Policies that impose non-safety related conditions on testing and deployment, such as workforce impact assessments, non-safety related data sharing mandates, and prohibitions or restrictions on revenue generating operations. Requiring federal regulators to focus on non-safety priorities would create regulatory confusion and uncertainty and undermine the overall benefits of automated vehicle deployment.

SUPPORTING ALTERNATIVE REGULATORY PATHWAYS TO ADVANCE AUTOMATED VEHICLES

New regulation is not always the answer for emerging or disruptive technologies, and often non-regulatory approaches can serve as effective tools to increase safety and allow for flexibility and innovation. Moreover, this is particularly applicable to automated vehicle technologies, considering rulemakings are still in the early stages and the technology itself is rapidly evolving. There are two primary categories of alternative regulatory pathways that policymakers should continue to support and build on.

The first category includes information-sharing mechanisms between the private and public sectors, which includes both voluntary information-sharing mechanisms as well as mandatory reporting requirements. One of the most important of these mechanisms

is DOT's Voluntary Safety Self-Assessments ("VSSAs"), which was created in AV 2.0 and allows developers to publicly disclose and assess how they are addressing automated vehicle safety.[55] 22 AV developers have submitted VSSAs to NHTSA, which has provided valuable information on how developers are addressing safety concerns.

Also, mandatory information-sharing mechanisms can be a helpful tool and provide transparency to the public on any significant vehicle accidents. DOT, for example, requires motor carriers, including automated commercial vehicles, to provide an accident register to FMCSA when a reportable crash has occurred that details information such as the number of fatalities and injuries, the location of the incident, and if there were any hazardous materials on board.[56] Nonetheless, it is important that reporting requirements should not be used to disadvantage automated vehicles compared to conventional vehicles, and that any data gathered is relevant to improve safety.

The second category encompasses public-private partnerships and multi-stakeholder forums that develop consensus on shared policy positions among key stakeholders. In general, these types of bodies are helpful to address gaps in regulation or areas that are still in development and would be premature for formal regulatory action. A couple of examples include DOT's Work Zone Data Exchange, Automotive Information Sharing and Analysis Center ("Auto-ISAC"), and the Commercial Vehicle Safety Alliance's effort on inspections for automated vehicles.

One longstanding example is the development of voluntary, consensus-based standards, which have historically been critical to the growth of many emerging technologies across sectors. The development of standards frequently involves a wide range of stakeholders and can be integrated into statute and rulemakings. A prominent example of a successful and widely used standard is the SAE International's J3016, "Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems." This standard outlines six different levels of vehicle automation ranging from zero

55. National Highway Traffic Safety Administration "Voluntary Safety Self-Assessment." Available at https://www.nhtsa.gov/automated-driving-systems/voluntary-safety-self-assessment.
56. Federal Motor Carrier Safety Administration "Accident Register." Available at https://ai.fmcsa.dot.gov/NewEntrant/MC/Content.aspx?nav=Accidents#:~:text=A%20reportable%20crash%20is%20one,The%20report%20needs%20to%20include%3A&text=Whether%20hazardous%20materials%2C%20other%20than,in%20the%20accident%2C%20were%20released.

> **New regulation is not always the answer for emerging or disruptive technologies, and often non-regulatory approaches can serve as effective tools to increase safety and allow for flexibility and innovation.**

autonomy to full autonomy, where the vehicle performs all driving tasks, and has been included in both recent legislative initiatives and adopted by DOT.[57]

Policymakers should recognize and embrace these types of alternatives and refrain from regulating or legislating when doing so would impede on existing initiatives already in place. C_TEC highlights a number of different initiatives and key issues that fit this category, but policymakers should be aware that there are many others not included in this paper that are also relevant to automated vehicles.

RECOMMENDATIONS

Governments and industry should utilize information sharing-mechanisms to foster public trust in automated vehicle technology and demonstrate a commitment to safety.

- Policymakers should continue to support the safety information-sharing mechanisms such as DOT's VSSAs. Also, VSSA's should remain flexible and voluntary, and any changes to VSSA guidance should be conducted with stakeholder consultation.

- Existing statutory reporting requirements, such as DOT-recordable accidents, are important tools to enable transparency and enhance safety. Policymakers should maintain these tools and ensure that reporting requirements are non-duplicative

57. SAE International "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (J3016_201806)" (June 2018). Available at https://www.sae.org/standards/content/j3016_201806/.

of other requirements, remains technology-neutral, protects confidential business information, and relates solely to motor vehicle safety.

- Increasingly, there is interest among governments at all levels to require mobility providers to share or transfer certain types of operational data to governments for non-safety related purposes. Policymakers should oppose provisions that impose these types of requirements. Disclosure of such information, instead of increasing safety, could actually undermine supply chain security and potentially put automated vehicle passengers in danger. The end result would be reduced investment in and slowed development of automated vehicle technology in the United States at a time when similar development is being ramped up internationally.

Policymakers should encourage and leverage public-private partnerships and multi-stakeholder forums to address novel issues related to automated vehicle technology.

- Public sector information and rules should be digitized to support safe operation of automated vehicle technology on public roads, through public-private partnerships such as Work Zone Data Exchange and other similar initiatives.

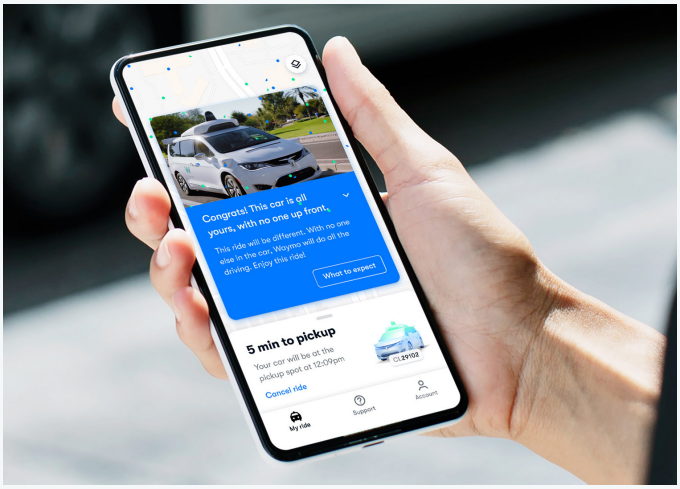
- Policymakers should recognize and support efforts of organizations like the Commercial Vehicle Safety Alliance that bring stakeholders together to modernize commercial vehicle inspections in light of advancements in AV technology.

- Policymakers should encourage collaboration among relevant stakeholders to facilitate, as appropriate, vehicle crash data sharing mechanisms for insurance underwriting and claims purposes to accommodate advances in AV technology.

- Voluntary, industry-led standards are essential to developing effective and consensus standards on key issues including cybersecurity, vehicle safety metrics, and safety management systems. Regulatory bodies and Congress should acknowledge the importance and relevancy of standards and standards processes when developing AV policy.

CASE STUDY: WAYMO ONE

Fully autonomous technology has the potential to improve the world's access to mobility while saving the thousands of lives currently lost to traffic crashes. Members of the public in Metro Phoenix are already experiencing this reality with Waymo One, the world's first fully autonomous ride-hailing service. Through the tap of a button in the Waymo app, riders can hail a vehicle with no human driver to take them from Point A to Point B. Thousands of riders use the service to do everything from commuting to work and school to running errands and visiting family and friends. Waymo One is powered by the Waymo Driver, which is an SAE Level 4 automated driving system comprised of advanced software and hardware, including three key sensing technologies—lidar, cameras, and radar.



To date, the Waymo Driver has completed over 20 million miles autonomously on public roads across 25 U.S. cities and conducted over 15 billion miles of simulation testing. And unlike human drivers, the Waymo Driver never gets tired, drunk, distracted, or angry, which provides Waymo One riders with added safety benefits as they get where they need to go. They also find value in the clean and consistent experience across Waymo's fully owned fleet of vehicles, the time back they get to do what they love instead of driving, and the privacy and comfort of their own space that comes with no human driver behind the wheel.

STRENGTHENING AUTOMATED VEHICLE RESEARCH, DEVELOPMENT, AND TESTING

A significant amount of time and resources are being devoted in the research, development, and testing of an automated vehicle before it is commercially available. A report from 2018 estimates that over $16 billion has been invested in the development and testing of AV technology.[58] While the private sector is, and should be, the leader in conducting automated vehicle research, development, and testing, the federal government can play an important role to ensure continued advancement in the technology.

Research and development ("R&D") by government and the private sector can help establish basic building blocks for the underlying technology, which in the case of automated vehicles includes fundamental technologies such as lidar, radar, and artificial intelligence, and advanced communication systems. The private sector, ranging from traditional automotive manufacturers to startups, also make significant investments in R&D that underlie automated vehicles. Also, the federal government has taken steps to prioritize and coordinate government R&D efforts, especially in areas with less of a private incentive to invest. AV 4.0 identified several areas where the federal government has been active in AV-related R&D, including at the Departments of Defense, Health and Human Services, Homeland Security, and many other agencies.[59]

In addition to basic research and development, automated vehicle testing is necessary to validate the safety of a vehicle. There are a number of different pathways for testing, including on-road testing and simulations. Considering there are a wide range of stakeholders engaged in automated vehicle testing, it will be critical to ensure that pol-

58. Roberto Baldwin, "Self-Driving-Car Research Has Cost $16 Billion. What Do We Have to Show for It?," *Car and Driver* (Feb. 10, 2020). Available at https://www.caranddriver.com/news/a30857661/autonomous-car-self-driving-research-expensive/.
59. AV 4.0

icies related to testing are technology-neutral. In addition, there have been proposals that would limit the ability for automated vehicle developers to receive compensation from passengers or shippers during testing. Enabling compensation allows developers to test different business models, strengthens consumer and customer acceptance of automated vehicle technology, and tests human-machine interface as it relates to automated driving.

RECOMMENDATIONS

Federally-funded research and development programs can play an important role to advance U.S. competitiveness in automated vehicle technology.

- The federal government should conduct basic research that supports the development of automated vehicle technology. Research topics should include, but is not limited to, human/machine interface, human use of other technologies, and human introduction of outside information systems sources. Also, when appropriate, research should be conducted in partnership with industry and any other relevant stakeholders.

- Policymakers should avoid using federal research programs to preclude widespread deployment of ADS-equipped commercial motor vehicles.

NHTSA should move forward with the ANPRM on the Pilot Program for Collaborative Research on Motor Vehicles with High or Full Driving Automation.

- The ANPRM, published in October 2018, will establish a pilot program for automated vehicles to be tested or deployed on public roads if the developer shares certain information with NHTSA.[60] Deployments at scale will allow NHTSA to gather important data to help inform future rulemakings and build public trust in the technology.

60. Advanced Notice of Proposed Rulemaking for the Pilot Program for Collaborative Research on Motor Vehicles With High or Full Driving Automation, 83 Fed. Reg. 50872 (October 10, 2018) available at https://www.federalregister.gov/documents/2018/10/10/2018-21919/pilot-program-for-collaborative-research-on-motor-vehicles-with-high-or-full-driving-automation.

To maximize innovation in automated vehicle technology, policymakers should ensure a level playing field for all stakeholders testing and developing automated vehicle technology.

- Congress should modify the FAST Act's (Pub. L. 114–94) provision encouraging the testing and evaluation of automated vehicles to include all developers of automated vehicle technology.

- Congress should oppose any policies that limits or prohibits the ability of a developer to get compensation while operating an automated vehicle.

CASE STUDY: VELODYNE LIDAR: DELIVERING ON THE PROMISE OF SAFER MOBILITY

Velodyne Lidar has been a leader in the lidar market for more than ten years with a diverse, high-quality product portfolio, including the Alpha Prime™, Puck™ and Velarray™. Velodyne's products are designed to help drive the autonomous strategies of automotive and robotaxi companies, and power advanced driver assistance systems (ADAS). Velodyne has 300+ customers, including nearly all of the leading global automotive original equipment manufacturers (OEMs) and leading tech companies.

Velodyne's product portfolio provides real-time perception data that enables safe and reliable operation for autonomous driving and advanced vehicle safety at up to highway speeds. The company's smart, powerful sensors deliver the range, accuracy, and resolution needed for advanced level 4 and level 5 autonomous vehicles. Velodyne's Vella™ software is a breakthrough advanced driver assistance solution.

Autonomous Vehicles on the Road

Among Velodyne's customers is Voyage, an autonomous shuttle company that is addressing the transportation needs of retirement communities. Voyage self-driving vehicles, equipped with Velodyne Alpha Prime sensors, provide residents safe, autonomous transportation throughout their community. Whether residents face mobility restrictions or just want to take a ride, Voyage takes pride in getting all its passengers to their destination safely, efficiently and affordably.

Another Velodyne customer is Local Motors, which has developed the Olli self-driving shuttle that aims to change the way the public views transportation. Olli, equipped with Velodyne Puck sensors, can be used on private and public roads. Among the locations that Local Motors has received clearance to operate the self-driving vehicle is National Harbor, Maryland.

Velodyne Advancing Safety

Velodyne's lidar sensors enable autonomous vehicles to achieve precise, reliable navigation in real time, including detection of objects, vehicles, and people that might pose a collision threat. They can help AVs navigate roadways at various speeds, traveling in a range of conditions such as rain, sleet, and snow. Equipped with Velodyne sensors, autonomous vehicles can safely and efficiently travel in unfamiliar and dynamic environments.

EDUCATING CONSUMERS AND THE PUBLIC ON AUTOMATED VEHICLES

One major challenge towards the widespread deployment of automated vehicles is addressing public concerns regarding safety and reliability. Given the high-profile nature of automated vehicles—and the tendency for any accident involving an automated vehicle to make national headlines—it is critical that policymakers and the private sector take steps to educate the public about the safety benefits that automated vehicles provide.

A recent survey and report from Motional found that 65% of consumers agree that safety is the most important consideration when deciding whether to use an automated vehicle. Additionally, 76% of consumers who believe they are "extremely knowledgeable" about AVs believe that automated vehicles are safe and reliable, while only 10% of those who consider themselves "less knowledgeable" about AVs believe they are safe and reliable. This data points to an opportunity for Congress, regulators, and the private sector to further educate consumers and the general public about the benefits and overall safety of automated vehicles.[61]

Public-private partnerships and multi-stakeholder collaborations will be essential to educate the public on AVs and build public trust in the technology. For example, a number of different stakeholders including industry, consumer organizations, and academics are members of Partners for Automated Vehicle Education ("PAVE"), to educate consumers on automated vehicles through demonstrations, events, and media engagement.[62] Also, in June 2020, NHTSA, in partnership with state and local governments, and industry launched the AV TEST Initiative to improve public awareness around automated vehicle testing occurring across the country.[63]

61. Motional Consumer Mobility Report (Sept. 2020). Available at https://motional.com/mobilityreport/
62. Partners for Automated Vehicle Education "#PAVtheWay Inaugural Report" (Sept. 2020). Available at https://pavecampaign.org/pave-releases-inaugural-report/.
63. National Highway Traffic Safety Administration "Automated Vehicle Transparency and Engagement for Safe Testing (TEST) Initiative. Available at https://www.nhtsa.gov/automated-vehicles-safety/av-test-initiative-tracking-tool.

RECOMMENDATIONS

Policymakers should encourage public–private partnerships and recognize private sector activities in educating consumers and the public on automated vehicle technology.

- Policymakers should support consumer education efforts on an automated vehicle through encouraging partnerships between the government, private sector, and other stakeholders.

- NHTSA should continue to support and initiate public–private partnerships such as the AV TEST Initiative that increase public awareness around automated vehicle testing.

CONCLUSION

Widespread and safe automated vehicle deployment will likely lead to numerous economic, mobility, environmental, and safety benefits for the American public. To fully capture these benefits, policymakers must establish a clear regulatory framework to enable innovation and avoid overregulating this critical emerging technology. C_TEC plans to continue educating policymakers and public on the benefits of safely deploying automated vehicles and advocating for commonsense policies at federal and state levels.

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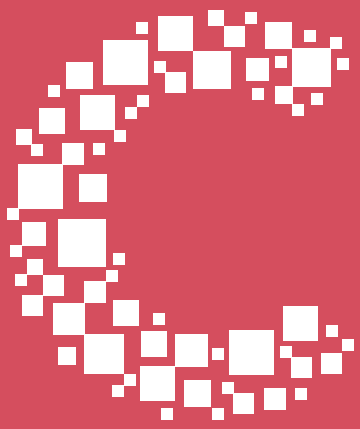

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