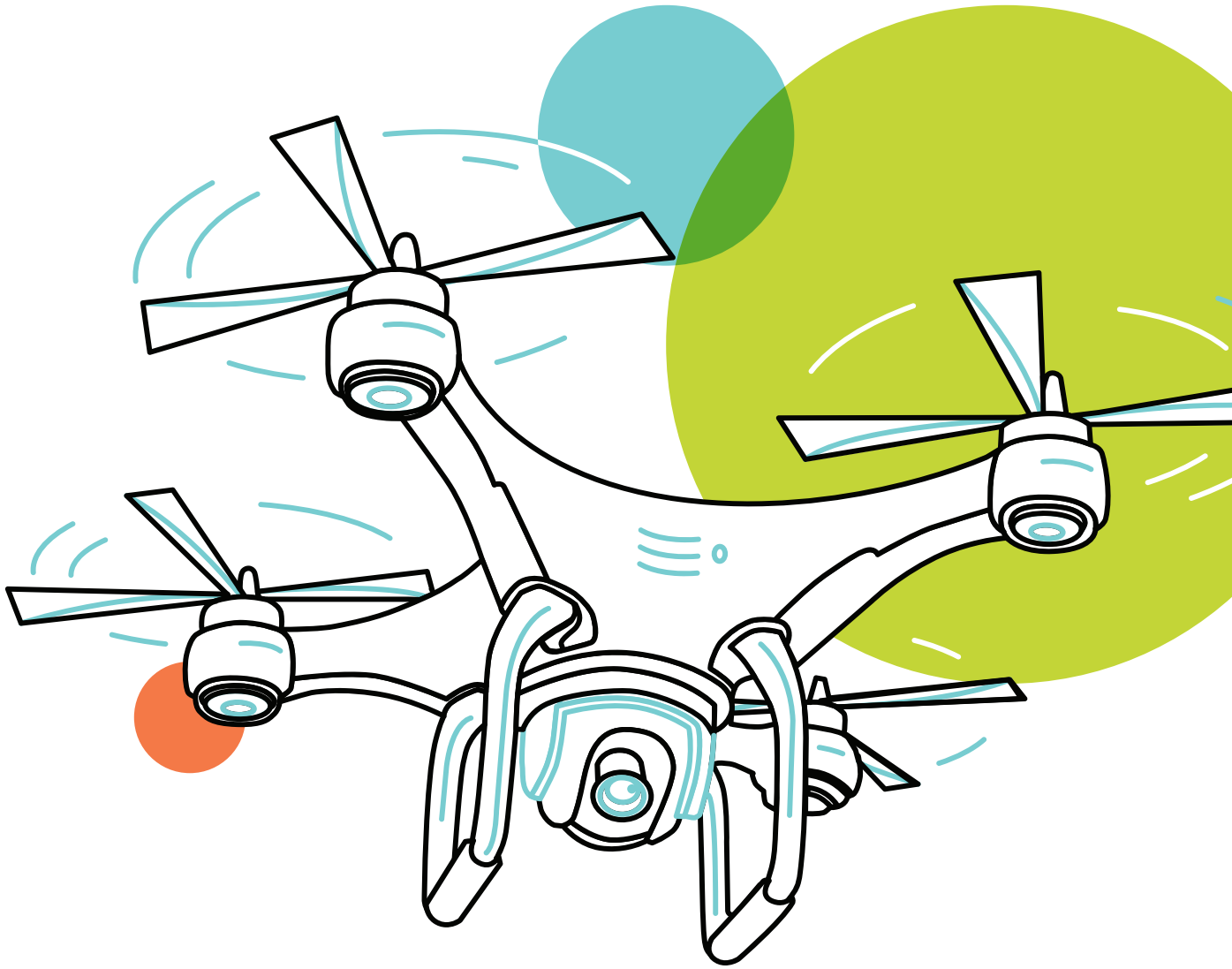


ctia™ Everything Wireless™

COMMERCIAL WIRELESS NETWORKS:

The Essential Foundation of the Drone Industry

EXECUTIVE SUMMARY

Today, more than 800,000 UAVs, otherwise known as drones, are registered in the United States.[1] While hobbyists or recreational users make up the vast majority of drone users today, commercial drone applications promise economic opportunities and broader benefits for consumers and society. In the United States alone, drone commerce is expected to add more than $80 billion to the economy and create more than 100,000 new jobs by 2025.[2]

For the U.S. to realize the full potential of drones, policymakers and industry need to work together to craft a regulatory environment that encourages commercial drone deployment. In the coming months, policymakers will address a critical issue: determining how drones will communicate—with each other, with other devices, with their surroundings—and then create standards and processes reflecting this decision.

Thankfully, the answer is clear: policymakers should endorse the use of commercial wireless networks for drone communications. These networks, powered by licensed spectrum, provide the coverage, reliability, security, and service quality needed for safe commercial drone applications.

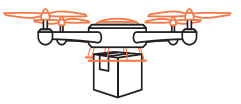
To that end, policymakers should take action in three primary areas:

- First, the FAA should endorse use of commercial wireless networks as the preferred communications platform for small, low-altitude UAVs. This begins with the FAA recommendation to use these networks as one of the viable technologies for remote tracking and identification of UAS by law enforcement, and continues with FAA recognition of wireless networks as suitable to provide safe and reliable command and control functionality for small, low-altitude UAVs.
- Second, policymakers need to work with industry to create a unified national framework for FAA management of drone airspace. A consistent, risk-based regulatory framework is essential.
- Third, policymakers should ensure that wireless network operators can build the networks needed for drones by freeing up more spectrum for licensed use, encouraging broadband infrastructure deployment, and promoting the testing of commercial wireless networks to support low-altitude UAV communications.

DRONES BENEFIT AMERICAN INDUSTRIES

AGRICULTURE

33% of American farmers will be using drones in their operations this year [3]



LOGISTICS

84% of Americans expect to see drone delivery services within the next decade [4]

ENERGY

Drone inspections of energy sites and oil rigs could cost **80% less** than traditional reviews [5]

HEALTHCARE

Blood products delivered by drones can be transported **~40 miles in 15 minutes** [6]

THE ROLE OF REGULATORY AGENCIES IN DRONES

FAA
Oversees the safety aspects of bringing drones into America's skies and has authority over drones flown for commercial and non-military governmental purposes

FCC
Plays a critical role in achieving the promise of commercial drones by allowing use of spectrum already allocated for terrestrial wireless services, and freeing additional wireless airwaves for certain drone uses, including collision avoidance

DOT
Regulates economic aspects of air carriage and is developing a regulatory framework for interstate drone service providers

NASA
Develops air traffic control-like systems to manage drones at lower altitudes. Collaborates with CTIA and its members through working groups to research traffic management

DHS
Focuses on security concerns associated with drones, including malicious use and counter-UAS measures

NTIA
Authorizes use of government spectrum, provides lessons learned from federal agency UAV operations, and considers privacy issues associated with the emergence of commercial and private use of drones

FTC
Oversees and has enforcement authority over drone privacy issues

The Transformative Power of the Wireless-Enabled Drone Industry

Unpacking How Drones Work

Drone systems, or unmanned aerial systems (UAS), typically involve two components: the UAV itself and ground control systems for remotely operating the drone.

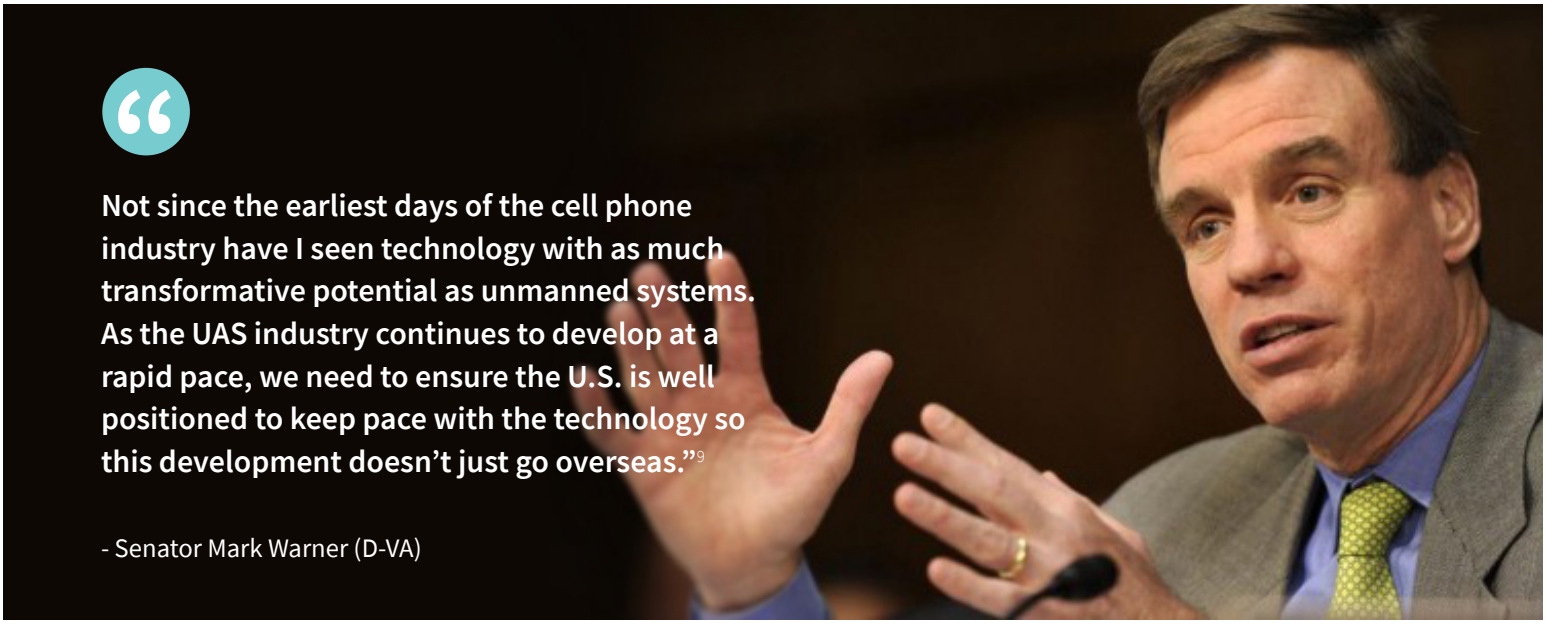
Today, drones rely on the human operator's view plane—i.e., within the visual line-of-sight, a distance of usually less than a half-mile—to detect and avoid obstacles. In the future, sensors, radar, and wireless communications technologies will detect and avoid these threats, enabling drones to navigate over much greater distances.

The safe operation of drones requires several layers of wireless communications. A drone must have secure and reliable communications links with its operator, other drones, and, soon, systems of low-altitude drone traffic management. In addition, video and other data collected and transmitted by the drone requires a wireless link for real-time communications.

Drone Uses and Applications Will be Transformative

Drones offer efficiencies, data-gathering capabilities, and increased safety, providing significant benefits for consumers, industry and law enforcement. They are poised to transform entire industries, including logistics, agriculture, insurance, industrial inspection, energy, newsgathering, real estate, and public safety. Drones can take aerial photos and video, a capability leveraged by users like the following:

- Public safety officials to assess hazards or inform search and rescue missions;
- Wireless operators, particularly post disaster, to survey cell sites and facilities and facilitate safe and efficient restoration;[7]
- News organizations to create footage or conduct reporting in dangerous situations;
- Utility companies to monitor assets like pipelines, buildings, or bridges, and estimate repairs;
- Communications companies to safely conduct tower inspections;[8]



Not since the earliest days of the cell phone industry have I seen technology with as much transformative potential as unmanned systems. As the UAS industry continues to develop at a rapid pace, we need to ensure the U.S. is well positioned to keep pace with the technology so this development doesn't just go overseas."[9]

- Senator Mark Warner (D-VA)

- Insurers to provide property and damage assessments; and
- Real estate professionals to give their clients site or home overviews.

The data and images collected during drone flights can also help businesses across sectors create 3D models of their assets and compile a base level of data to compare over time, driving decision making and action plans.

Businesses are leveraging drones to conduct tasks that can be performed safely and precisely from a high vantage point, such as planting seeds, irrigating soil, or fertilizing crops in the agricultural industry. Companies are also testing the ability of drones to provide connectivity to underserved communities.

Drones will be able to make package deliveries for many consumer-facing businesses. They can also deliver humanitarian aid and emergency supplies for public safety officials and raw materials for manufacturers. Given increasing levels of automation and artificial intelligence, drones can accomplish any number of tasks more efficiently, safely, and inexpensively than techniques used today.

The Economic Impact of Drones

Drones will have a significant economic impact across a variety of commercial and civil government uses.[10] In the United States alone, drone commerce is expected to add over $80 billion to the economy and create 100,000 new jobs by 2025.[11]

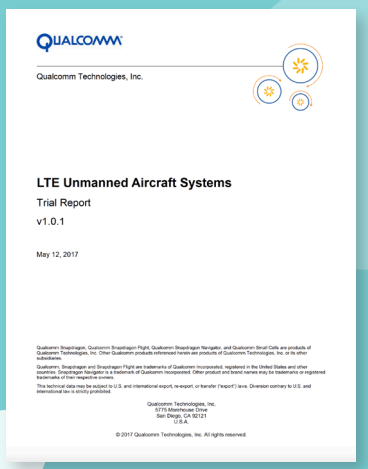
By 2020, the FAA forecasts that seven million small drones will be sold to commercial users in the United States.[12]

Drones Need Spectrum To Communicate

Drone operations depend on spectrum. Drones use wireless connectivity to communicate with ground systems and each other, and depend on radar and other spectrum technologies to detect objects in the airspace. Terrestrial wireless networks were designed to handle street or ground level traffic and over time have been used to serve buildings and other venues. Analysis and studies indicate great potential for low-altitude drones (generally less than 400 feet above sea level).

Spectrum-enabled mission-critical functions for drones include:

- **Command and Control links.** Drones need links to communicate with their operators on the ground. These links are known as "command-and-control communications." Drones today rely on human operators, but drones of tomorrow will increasingly utilize wireless-enabled automation. Maintaining a connection to the drone if the link is lost temporarily is key to ensuring safe and proper operation. While drones may rely on a GPS signal as well, maintaining command and control link connections is vital to ensure safe operations.[13]


QUALCOMM

Qualcomm Technologies, Inc.

LTE Unmanned Aircraft Systems

Trial Report

v1.0.1

May 12, 2017

CASE STUDY:

TESTED WIRELESS NETWORKS SUPPORT COMMERCIAL DRONE DEPLOYMENT

Many CTIA members have completed or are working on field tests (individually, together, and with NASA) to demonstrate the efficacy of using wireless networks to support drone communications. In 2017, Qualcomm released the findings of the first comprehensive study of drones deployed on a 4G LTE network.[14]

The study analyzed network coverage, signal strength, throughput, latency and mobility, and validated the viability of 4G LTE commercial mobile networks for drones operating beyond visual line of sight. The tests confirmed that LTE networks support safe drone operation in real-world environments. Indeed, the study demonstrated that very strong LTE signals are available at higher altitudes due to free space propagation conditions. In addition, because the downlink data rates required for drone use cases are mostly limited (e.g., command-and-control), commercial LTE networks should be able to support downlink communications requirements of initial LTE-connected drone deployment.[15]

- **Payload communications.** Some drones, particularly for newsgathering or public safety, use communications links to share real-time video or photos. Agricultural survey and infrastructure inspection drones use communications links to send sensor data to operators or repositories on the ground.
- **Collision avoidance.** In the future, drones will increasingly depend on spectrum to communicate their position to other aircraft, both manned and unmanned, in order to avoid collisions. Drones also will use spectrum to sense their environment and avoid colliding with other objects in the airspace including birds, buildings, and bridges.
- **Tracking and identification.** Drones will transmit information to the ground, enabling law enforcement to identify them and their owners. Drones will also transmit tracking data to systems on the ground, such as new air traffic control-like programs known as Unmanned Aerial System Traffic Management (UTM).
- **Situational awareness.** Drones will receive situational awareness information, like weather or other alerts, from ground stations and communicate the information to other drones.

Drones may rely on licensed commercial wireless networks, unlicensed spectrum, and/or aviation-specific spectrum for these communications functions.

Many recreational drones deployed today in limited, visual line of sight operational scenarios rely on unlicensed spectrum for control links and payload communications (e.g., video and audio transmission). Unlicensed networks provide only limited authentication, and may not allow for clean hand-offs between networks, making them less appropriate for emerging commercial operations, particularly if those operations are over long distances, beyond visual line of sight, in high-density airspace, or in need of secure communications.

Some drones rely on the same aviation-specific spectrum as airplanes, but only if they operate in higher altitudes and more controlled airspace (e.g., above the small drone 400-foot elevation level and near airports). Use of aviation-specific spectrum requires

special training and licensing and is necessary in order to protect aviation safety of life communications. Licensed spectrum affords the most reliable connection to support drone operations since unlicensed spectrum is subject to interference, delays, and interruptions.

Commercial Wireless Networks Offer a Superior Solution for Supporting Drones

Commercial wireless networks are well suited to form the backbone of communications systems to enable safe and reliable low-altitude drone operations. They are secure, widely available, and globally harmonized.

Cellular Wireless Networks Can Provide the Necessary Quality, Reliability, and Security for Commercial Drone Operations

As drone use increases, the security and reliability of drone communications and operations become increasingly critical. Cellular networks, which rely on secure communications and reliable licensed spectrum, can meet commercial drones' quality of service, reliability, security, and interoperability needs:

- **Quality of Service.** Wireless networks offer quality of service, with the coverage, performance, and latency required to support drone communications, both within and beyond visual line of sight.
- **Reliability.** The reliability of cellular networks will help to minimize and mitigate the risk of "lost link," when a drone loses communication with its ground station or UTM. Modern cellular networks include overlapping, adjacent cell sites that minimize the possibility of connection issues to the drone. The FAA's Drone Advisory Committee cited the reliability of cellular networks in its review of communications options for beyond visual line of sight, low-altitude drone operations.[16]
- **Authentication and Security.** The wireless industry has a long history of working to protect its customers, networks, and technology from cyber threats. As a result, wireless networks are equipped with a variety of security approaches including authentication technologies that validate and authorize users seeking to access the networks. These technologies help to protect network users—including drone operators. Drone applications and operators must secure command and control links as well as data gathered to ensure safe operation, data integrity and appropriate privacy are maintained.
- **Interoperable.** Network cellular communications can readily connect with drone traffic manager systems and central dashboards that will provide UAV situational awareness.

> ...4G LTE and 5G can bring [UAVs] a new dimension of **high reliability**, **robust security**, **ubiquitous coverage**, and **seamless mobility**...[17]

Cellular Wireless Networks Are Already Available and Widely Used Nationwide

Optimized drone operations require nationwide coverage to ensure essential communications and connectivity. Commercial wireless networks today match that operational need, covering 99.7% of the U.S. population.[18]

Cellular Technology's Global Standards Enable Interoperability

The wireless industry developed technology standards for 4G LTE, and are in the process of doing so for 5G, through global, industry-based consensus that is not proprietary to a particular company or entity.[19] The International Telecommunications Union recommends 4G LTE for drone communications, noting the robust coverage and evolving nature of cellular networks for traffic management.[20] Global adoption of harmonized standards and spectrum solutions for drones and drone traffic management provides the consistency and interoperability needed to allow vendors and

manufacturers to take advantage of economies of scale, thus ensuring a vibrant, global ecosystem for UAS.

Existing commercial 4G LTE networks already can support initial drone deployment,[21] and further optimization after wide scale testing may expand their potential. Looking ahead, 5G wireless networks will enable drone deployments on a larger scale. 5G will offer reduced latency, which will provide drone operations even faster and more reliable wireless network control links and in turn will be able to improve airborne collision avoidance technologies.

CTIA Member Work on Drones

CTIA members operate wireless networks, manufacture UAV components, and provide a variety of commercial and public services using drones. Member companies are preparing for commercial drone deployment by:

Readying wireless networks for drone operations: Qualcomm[22] is working with carrier partners to test how the coverage, handoff capabilities, and latency of wireless networks are impacted by drone use. AT&T[23] is testing and mapping their networks vertically to inform drone flight. Using a vetted and optimized wireless network for communications will allow for easier deployment of commercial drones and open the doors for new applications in sectors like traffic management, smart cities, and data analytics.

Testing consumer-facing drone technologies: Amazon is testing its Prime Air service, which will allow customers to receive lightweight packages via drone delivery in 30 minutes or less. Using drones for almost instant package delivery will be a customer delighter and create new opportunities for the retail and transportation industries.

Disaster recovery applications for drones: After Hurricane Harvey brought its once-in-a-lifetime rains to south Texas, both Verizon[24] and AT&T[25] utilized drones to assess their cell sites for damage in order to estimate repairs and reestablish wireless service to areas impacted by the storm. Using drones to make these inspections helped keep tower climbers safely on the ground and restored service quickly to the region.

How Policymakers Can Advance the Promise of Drones

U.S. policy leadership that strongly supports drone innovation and deployment is important to maintain U.S. competitiveness. We should not risk export of drone innovation and investment overseas.

To ensure U.S. leadership in the drone marketplace, policymakers should declare commercial wireless networks to be the preferred communications platform for small, low-altitude drones, partner with industry on federal standards and risk-based regulatory frameworks to ensure drone interoperability, and make more licensed spectrum available, while modernizing infrastructure rules to support advanced drone operations.

$6.3B

A 2015 PwC calculation identified a $6.3 billion addressable global market for drones in telecommunications.[26]

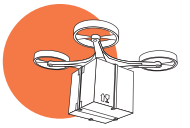
Adopting Sound, Safe, and Innovative Policies to Advance Drone Operations

Creating a regulatory structure that supports secure, reliable drone communications will encourage the development and deployment of a robust drone ecosystem. Policymakers specifically should:

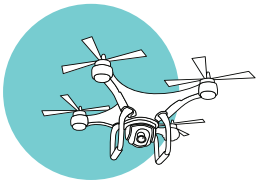
- **Recommend Commercial Wireless Networks for Drone Communications.** Beginning with their rulemaking process for remote identifying and tracking of UAS by law enforcement, the FAA should recognize the security, reliability, and coverage capabilities of commercial wireless networks by recommending them for drone communications. Long term, the FAA should recommend wireless networks for the command and control links of small, low-altitude UAVs.
- **Create Unified National Framework for Drone Airspace Management.** FAA leadership must act on their exclusive jurisdiction over our skies and set safety and operational standards for UAV deployment. CTIA welcomes the recent White House-UAS Integration Pilot Program that encourages testing new models for integrating UAS in local airspace by creating public-private partnerships with state, local and tribal governments. The program can validate use of the commercial wireless networks to support safe and reliable drone flight at low altitudes, provide the data necessary to inform reasonable policymaking, support industry self-regulation, and ultimately allow safe integration of UAS into national airspace.[27]
- **Adopt Flexible, Risk-Based FAA Drone Policies.** A risk-based approach to the FAA's safety regulatory framework will best realize the full, disruptive potential of drones. Specifically, the FAA should act quickly to expand small drone operations, including allowing operation beyond visual line of sight and allowing one pilot to command multiple drones, whenever operators demonstrate adequate risk mitigation and safety cases.
- **Continue To Partner with Industry.** The U.S. is home to a robust ecosystem of research and development in wireless technologies, infrastructure, chipsets, devices, and applications.

BY THE NUMBERS

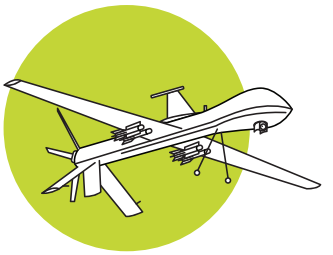
Between now and 2020 the drone industry presents a **$100 billion global market opportunity:**[29]



$13B
commercial drones



$17B
consumer drones



$70B
government drones

In order to maintain American leadership in this emerging industry here at home, our country needs a regulatory framework that encourages innovation while ensuring airspace safety."[30]

- Michael Kratsios, Deputy Assistant to the President, Office of Science and Technology Policy

The public sector should continue to partner with the private sector to unleash these technologies.[28] NASA's partnership with industry members to develop UTM is a prime example of how public-private partnerships will best enable safe, efficient low-altitude operations.

Promoting Next-Generation Communications Infrastructure to Enable Drone Operations

Repurposing spectrum for wireless broadband and smarter infrastructure and siting policies are essential to develop and deploy the state-of-the-art networks that will best support commercial UAS activities. To ensure that next-generation networks meet drones' connectivity needs, policymakers specifically should:

- **Free Up Additional Spectrum.** Policymakers must recognize the importance of licensed commercial spectrum for the continued development of the UAS industry. In collaboration with stakeholders, policymakers should work to identify new bands for auctioning and develop a timetable for those auctions. Additional low- and mid- band spectrum in particular will enable 5G technology to keep pace with growth and enable deployment of the latest technology throughout wide coverage areas[31] —in turn, providing the connectivity needed for future drone uses and development.
- **Modernize Infrastructure Rules.** Sound infrastructure policy is a necessary complement to sound spectrum policy. Deploying the network capacity to support widespread drone operations depends, in part, upon removing barriers to the deployment of cell sites, towers, and antennas that extend out next-generation wireless coverage and capacity. Policymakers should continue to explore reasonable, predictable siting processes, such as adopting a deadline for federal agencies to act on wireless siting applications and further streamlining small cell and distributed antenna system environmental processing.[32]

Drones present transformative opportunities for the U.S. economy. Safe commercial drone operations depend on spectrum, and commercial wireless networks can best meet the spectrum security and reliability needs for small, low-altitude drones. To ensure U.S. leadership in the drone marketplace and unlock drones' full potential, policymakers should remove regulatory barriers to drone deployment and promote the use and deployment of next generation communications infrastructure that will enable advanced drone operations. Wireless networks are up and running, and ready to power the next flying wireless device.

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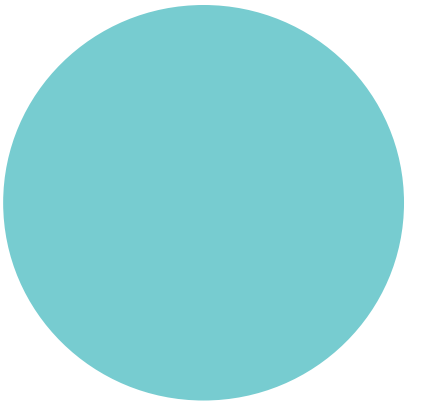

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