

Unmanned Aircraft Systems

An unmanned aircraft system is defined by statute as an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft. A UAS is the unmanned aircraft (UA) and its associated elements (including communication links and the components that control the unmanned aircraft) that are required for the safe and efficient operation of the unmanned aircraft in the National Airspace System (NAS). This forecast is primarily driven by the ongoing evolution of the UAS regulatory environment, the ingenuity of manufacturers and operators, and underlying demand. While continuing to enable the thriving UAS industry, these efforts will facilitate the safe integration of UAS into the NAS.

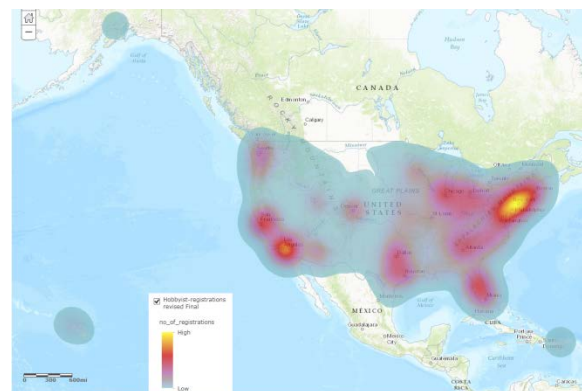
Model Aircraft and Hobbyist Forecast

On December 14, 2015, the FAA issued a rule requiring all UAS weighing more than 0.55 pounds (250 grams) and less than 55 pounds to be registered using a new on-line system (UAS weighing more than 55 pounds must be registered using the existing Aircraft Registration Process). FAA's online registration system went into effect on Dec. 21st, 2015. By December 31, 2016, 626,245 owner-hobbyists had registered. The rule allows hobbyists to register once and apply their unique registration number to multiple aircraft, unlike non-hobbyists who must obtain a unique registration number for each non-hobby aircraft. As a result, for each registration, one or more aircraft is likely to be owned (with a few exceptions of no aircraft being owned as well). For the entire online registration period up to the first week of February 2017, the cumulative registration trend has been one of growth,

with the trend slowing over time. Weekly registration currently averages between 5,000 and 7,000, with anticipated hikes during the holiday seasons.



A geographic distribution shows hobbyist UAS ownership are distributed across the country with denser ownership correlated with population centers.



In addition to information from the registration database, the Transportation Research Board (TRB) of the National Academies of Science held a UAS forecast workshop on October 25-26, 2016 involving industry, academia, and numerous modeler (hobbyist) and industry groups. The primary focus of this workshop was to understand the personalized nature and numerous applications of UAS, maturity trends and their drivers, and safety implications of the UAS fleet from gradual integration into NAS. Further-

more, the Agency engaged outside consulting firms to aid forecasting efforts for both the model and non-model UAS fleets.

The FAA recognizes that uncertainty is abundant in projecting both the model and the non-model UAS fleet. Hence, we provide a base forecast (i.e., likely) with high and low ranges in the following table for the model UAS fleet.

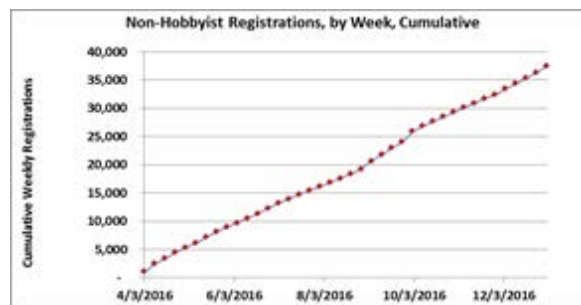
With over 626,000 hobbyists registered as of December 31, 2016, FAA estimates that there are around 1.1 million units that can be identified as distinctly hobbyist or model aircraft. By an examination of last year's data, from February 2016 to February 2017, we calculate the compound annual growth rate to be around 68%. This is a substantial growth rate as anticipated from the introduction of drones as a hobby sport facilitated by falling prices, improved technology such as built-in camera and ease of use. The registration database allowed early adopters to enroll easily. However, the trend is likely to slow as prices settle and early adopters

learn to make use of their aircraft. Given the registration trends observed, expert opinions collected during the TRB-workshop, a review of available industry forecasts, and market/industry research, FAA forecasts that the hobbyist fleet will likely (base scenario) more than triple in size over the next 5 years, from 1.1 million units in 2016 to over 3.5 million units by 2021. The high scenario may reach as high as 4.5 million units while the low scenario could be as low as 2.75 million units over the next 5 years. Growth rates underlying these numbers are fairly steady at the initial years but slowing in the last 2 years.

Year	Total Hobbyist Fleet		
	Million sUAS Units		
	Low	Base	High
2016	1.10	1.10	1.10
2017	1.94	2.15	2.31
2018	2.37	2.80	3.18
2019	2.60	3.20	3.79
2020	2.69	3.40	4.15
2021	2.75	3.55	4.47

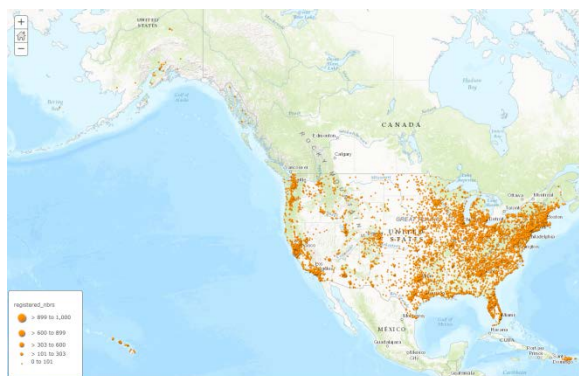
Commercial Small UAS Forecast

Prior to on-line registration, commercial UAS operators were required to register using the legacy paper-based process. Since the on-line system went live on April 1, 2016, more than 44,000 commercial UAS have been registered.



For each week on-line registration has been available, around 1,000 non-hobby units have been registered.

Similar to hobbyists, a geospatial distribution of commercial small UAS ownership shows denser areas correlated with economic or commercial activities across the country.



In June 2016 the FAA issued the Small UAS Rule (14 CFR part 107), which regulates the operation of small unmanned aircraft system in the National Airspace System. This rule, which took effect on August 29, 2016, provided a regulatory structure for the routine operation of small UAS for commercial purposes.

The commercial drone sector is very dynamic and appears to be at an early stage of growth. Unlike the hobbyist sector, FAA anticipates that growth in this sector will continue to accelerate over the next few years. Given the clarity that part 107 has provided to the industry, increasing commercial applications will become likely, which will facilitate additional growth.

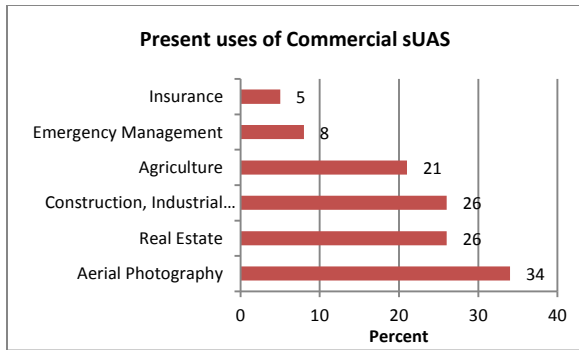
Based on the registration trends observed, expert opinions collected during the TRB-workshop, review of available industry forecasts, and market/industry research, FAA forecasts that the non-hobbyist fleet by 2021 will likely (base scenario) be ten times larger than the size of the fleet in 2016. FAA projects the number of units in the commercial small UAS fleet will exceed

420,000 by 2021, compared to 42,000 in 2016.

The forecast commercial small UAS fleet is primarily (over 95%) consumer grade off-the-shelf aircraft due to lower prices, ease of use, and availability. However, the higher-end, bigger, professional grade fleet stands to expand rapidly over time, especially as newer and more sophisticated uses are devised. Thus, while most (over 90%) of the growth in the commercial small UAS fleet will come from the consumer grade UAS, we anticipate a significant portion of commercial growth will come from professional grade UAS as well.

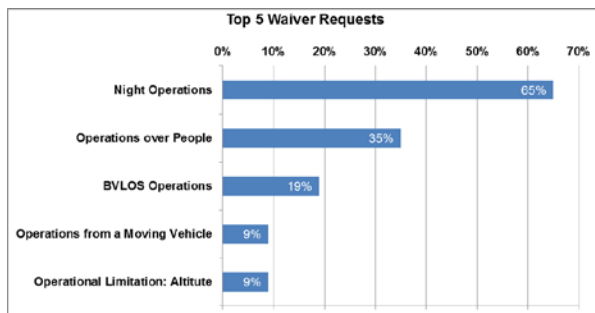
Year	Total Non-Hobbyist (Commercial) Fleet		
	Million sUAS Units		
	Low	Base	High
2016	0.042	0.042	0.042
2017	0.095	0.108	0.235
2018	0.133	0.167	0.445
2019	0.173	0.242	0.742
2020	0.207	0.327	1.133
2021	0.238	0.422	1.616

Commercial small UAS are presently used for numerous applications. A review of available industry/market research (e.g., AUVSI (2015), Bard Primary Use in 2015, Bard Likely Use in 2016, Fredonia (2015), and other reports (2016)) reveals their overall present (2015-2016) uses in the following chart:



Major applications of commercial small UAS are aerial photography (34%), construction, industrial and utility inspection (26%), real estate (26%) and agriculture (21%). Many of these UAS have multiple uses, and hence, the sum of the percentages in the above chart exceeds 100%.

One way to understand trends in commercial small UAS is to analyze the waiver applications that are filed by commercial UAS operators. Both the magnitude and relative composition of the types of waiver requests may indicate the direction of the commercial UAS sector as a whole. A breakdown of the top 5 waiver requests is given in the chart below:

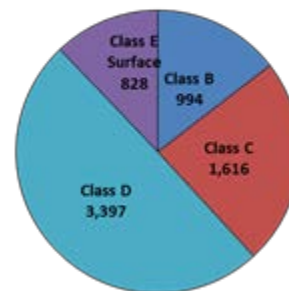


Beyond what is presently allowed under part 107, expanding commercial applications further would require waivers for night operations (65%), operations over people (35%), and beyond visual line of sight or BVLOS (19%). Many of these waiver applications request relief for multiple types of operations, and hence, the above total exceeds

100%. The Agency issues waivers to facilitate case-by-case commercial activities beyond the scope of what is allowed under part 107. Future regulatory development will allow these types of operations on a more routine basis. Meanwhile, analysis of these waiver applications allows us to understand industry trends, one of many metrics that is essential for projecting both the trajectory and growth trends of the sector.

Finally, more than 6,800 airspace waiver requests were submitted for operations in controlled airspace by the end of December, 2016. While almost half of them were for operations in class D airspace (i.e., smaller airports with control towers), other classes were also requested and regularly flown.

Airspace Waiver/Authorization Requests



Remote Pilot Forecast

The other important metric to understand trends in the commercial small UAS industry is remote pilot certifications. The FAA issues Remote Pilots Certificates to individuals who have passed an aeronautical knowledge test or completed online training (current part 61 airmen) under part 107. At present (December, 2016), the FAA has issued more than 29,000 Remote Pilot Certificates. Over 90% of individuals who took the part 107 aeronautical knowledge exam passed, as of February, 2017.

The forecast for remote pilots (RPs) is thus based on two data sources: (a) trends in Remote Pilot certificates issued; and (b) trends in commercial small UAS registration and forecasts. For projecting Remote Pilot growth rates, we assume a ratio of the number of remote pilots to the number of aircraft in the non-hobbyist fleet.

Using these assumptions and the base scenario of commercial small UAS forecast, we

project the number of Remote Pilots will grow significantly following the growth trends of commercial small UAS sector.

	Estimated Number of RPs					
	2016	2017	2018	2019	2020	2021
1 UAS per RPA	20,362	107,800	166,800	241,800	327,000	422,000
1.5 UAS per RPA	20,362	71,867	111,200	161,200	218,000	281,333
2 UAS per RPA	20,362	53,900	83,400	120,900	163,500	211,000