Allianz Global Corporate & Specialty

# Rise of the Drones

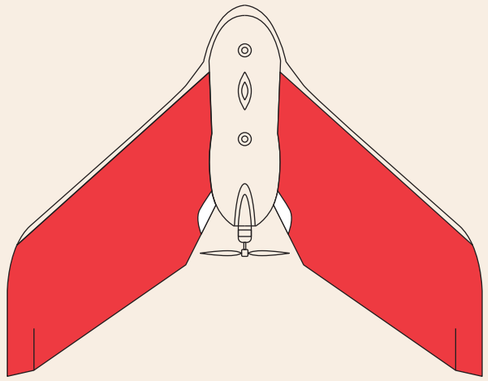
## Managing the Unique Risks Associated with Unmanned Aircraft Systems

Allianz

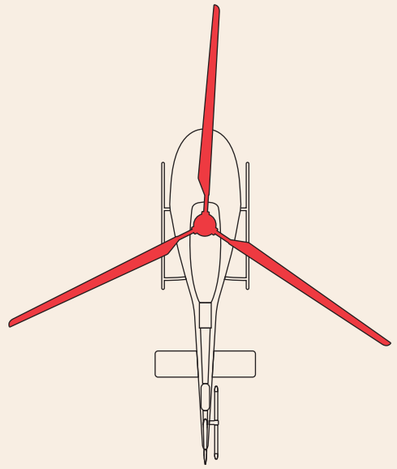
UNMANNED AIRCRAFT SYSTEMS (UAS)

# **UAS** The nuts and bolts

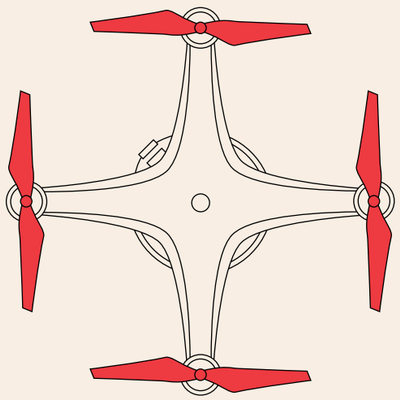
## Types of UAS



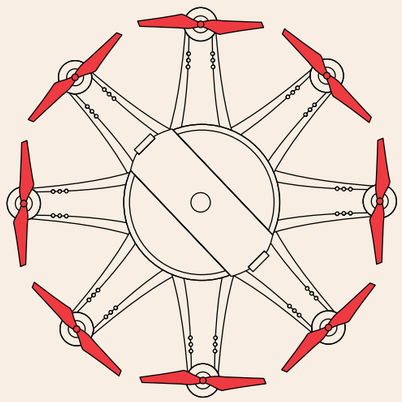
**Fixed wing**
UAS with airplane-like wings



**Rotor wing**
UAS like traditional helicopters



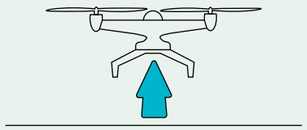
**Quad-copters**
UAS with four extensions, each with a propeller *(most popular)*



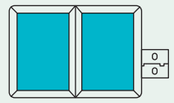
**Multi-copters**
UAS with more propellers than quad-copters

## Featured technologies

### Most UAS have:



**Auto take-off/landing**
Automated take-off and landing sequences

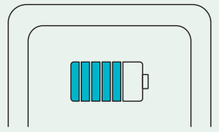


**Digital flight recorder**
Recorders to review the flight after the fact

**Satellite (GPS)**
GPS stabilization and guidance, making it easy for beginners to safely operate the unit out-of-the-box

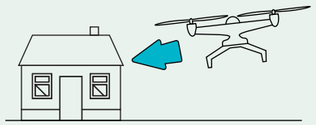
**Timer**
A clock that activates when the propellers turn on

**Map interface**
Google Maps or similar interface for real-time location and flight path



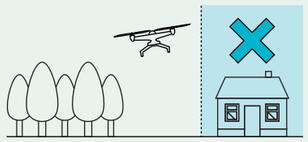
**Battery information**
Real-time battery information for usage reporting

### Some UAS have:



**Return to home**
Automatic return to home technology allowing them to retrace their flight path to home base

**Automated planning**
Flight planning software in order to program flight plan details



**Geofencing**
Software that uses GPS or radio frequency identification (RFID) to draw a virtual boundary beyond which the UAS cannot fly

## Controllers:

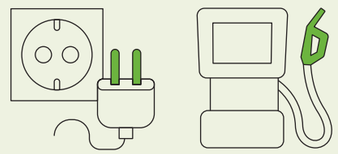
**Remote control (RC)**
Most UAS are remotely piloted by a hand-held controller device

**Digital control**
Sophisticated UAS are piloted by tablet/laptop or another digital control system

## Cameras/sensors:

**Normal/High-end**
All UAS have cameras and sensors. Some higher priced UAS have sophisticated cameras and sensors that make up the most expensive part of the UAS package (up to $500,000 for certain sensors)

## What makes them fly?



**Electricity/Gas-powered**
Smaller and lighter UAS powered by electric battery. Larger and heavier UAS powered by fuel

*According to the Federal Aviation Administration in the US, a UAS is a remotely steered, unmanned vehicle weighing up to 55lbs

Source: Allianz Global Corporate & Specialty

# Introduction

Drones or unmanned aircraft systems (UAS) used to be primarily associated with military operations. Today, compact versions are increasingly operating in everyday life and the UAS industry is fast becoming a multi-billion dollar business, as the benefits to be gained from utilizing such innovative technology become apparent.

UAS have the potential to both solve problems and save costs in future across a number of industries, throughout the developing world and in disaster relief scenarios. Growth projections for the sector are significant as UAS become cheaper to purchase, smaller in size and easier to operate. In fact, the UAS industry is regarded by many as the most dynamic growth sector of the global aerospace industry.

However, as civilian and commercial use of UAS rapidly increases and continues to evolve, the potential for misuse of this technology needs to be considered.

Advances in technology are inevitably accompanied by a host of new and little understood risks. There have already been enough incidents and near-misses to date involving UAS to generate concern that the likelihood of collisions and other loss events will grow as UAS numbers multiply.

This **Allianz Global Corporate & Specialty (AGCS)** report examines the key issues and trends underpinning rapid growth in usage of UAS and provides insight into the potential risk exposures related to their deployment in the private, public and commercial realms.

Photo: microdrones

# Executive Summary

## The landscape today

**10%**

of the global civil aviation fleet could be unmanned in 10 years[4]

Use of drones or unmanned aircraft systems **(UAS)** in public airspace is increasing dramatically. In the US the Federal Aviation Administration (FAA) projects that by the end of 2016 over 600,000 UAS will be deployed for commercial use – three times the amount of manned general aviation aircraft. In addition, 1.9 million UAS are expected to be in recreational use. The number of UAS is set to triple by 2020.[1]

Globally, UAS market volume is forecast to reach 4.7 million[2] units by 2020 (other estimates are even higher), with the market for commercial application of UAS technology estimated to soar from $2bn to $127bn[3]. Such projections are driven by UAS becoming cheaper, smaller and easier to use, as well as regulatory progress.

**Page 6**

## Uses and benefits

**$1bn**

Potential value of commercial drone insurance market by 2020[5]

Piloted remotely on the ground via control stations, UAS are increasingly used for menial or dangerous tasks, potentially solving problems and overcoming challenges across numerous countries and industries, improving the safety of thousands of workers every year and significantly reducing costs.

UAS are commercially used in a variety of situations, the most popular of which are industrial inspections, aerial photography, agriculture (surveying crops) and law enforcement. As UAS technology penetrates further, a decline in workers compensation losses can be anticipated, particularly related to building inspections.

Insurers are also increasingly utilizing UAS to survey loss damage from floods and other catastrophic events, to help alleviate distress and damage to victims and property more quickly.

Emerging UAS usage includes delivering blood and vaccines to remote locations in Africa, as monitoring tools to prevent the exploitation of slave labor in Brazil, fighting grass fires and even delivering pizza and coffee. Subsidiary UAS industries are also being created, such as the emergence of third party **"drone for service"** vendors, who rent UAS to commercial operators.

**Page 7**

## The risk landscape

As recreational and commercial UAS usage increases, new risk exposures are emerging. More incidents likely will occur once regulations are finalized that encourage more widespread use. Such incidents could result in multi-million dollar claims against businesses, operators and manufacturers.

Hobbyists account for the majority of UAS owners yet remain largely unregulated in many countries, raising safety concerns, as many can be untrained and inexperienced. Insurers have already seen loss activity resulting from novice control of UAS. Regardless of technological sophistication or operator skill, however, accidents happen.

UAS raise two priority safety concerns: mid-air collisions and the loss of control. A collision can occur if the pilot cannot see and avoid manned aircraft in time. Most at risk are manned aircraft which fly below 500 feet, such as helicopters, agricultural planes and aircraft landing or departing from airports.

Loss of control can result from system failure or flying beyond signal range; a major risk that has already caused incidents involving injuries. A scenario involving a pilot losing control of a UAS during a building inspection could result in a loss easily in excess of $5m. Damage from **"foreign objects"**, such as bird strikes for example, is already an issue for the aviation sector,

[1] FAA Aerospace Forecast FY2016-2036 [2] Unmanned Aerial Vehicles Market, By Value and Volume Analysis and Forecast 2015-2020 – Research and Markets
[3] Drones will take $127bn worth of human work by 2020, PwC says – The Independent, Clarity from above – PricewaterhouseCoopers
[4] New Era for Aviation: Opening the Aviation Market for Civil Use of Remotely Piloted Aircraft Systems In A Safe and Sustainable Manner – European Commission, 2014 [5] Allianz Global Corporate & Specialty

**$1m**

Minimum amount of insurance coverage required for commercial operators to protect against risk exposures

as it is the fifth largest generator of insurance claims[6]. A collision involving a UAS striking the engine of an airliner could cause $10m in physical damage alone.

As with manned aircraft there are concerns UAS may be used for malicious acts. An emerging peril is the potential threat from UAS being used to target critical infrastructure. There have been a number of incidents of drone overflights at power stations. There are also concerns that UAS could be utilized to attack sports stadiums or other events where large crowds gather.

Other risk scenarios include the prospect of hackers **"spoofing"** a UAS radio signal, potentially leading to a crash, the potential loss or theft of valuable recorded data when the device is transmitting information to the control station or after the flight by cyber-attack when the data has been stored. In addition to data protection, there are also many public concerns around such issues as privacy and trespass and nuisance.

Increasing use of UAS is also altering the risk profile of many industries. For example, a real estate agent has little bodily injury exposure but this changes if it engages UAS to take aerial photographs.

**Page 9**

## Regulation

Regulations have been a significant barrier to more widespread use of UAS. Standards differ remarkably around the world, as evidenced by the hundreds of working groups trying to harmonize rules. Another challenge is posed by the fact that regulations cannot keep pace with technological advancement.

In most cases, the designation between commercial and recreational UAS use is the starting point. Other common standards exist such as visual line of sight (VLOS) requirements for pilots, size restrictions (usually **<55 lbs/25 kg.**), and restrictions against operating UAS near airports or outdoor venues.

New rules for commercial use in the US *(effective August 2016)* represent a milestone as they lower the barrier to entry for new commercial users and are expected to significantly increase the number of units in operation. These new regulations will likely influence other countries to adopt similar laws. The European Union (EU) is also working towards UAS rules.

**Page 12**

## Improving UAS safety: insurance and risk mitigation

As UAS ownership grows so will expectations around safety education. Operators should make this a top priority and obtain the necessary training and experience to competently pilot their UAS.

Training is crucial to reducing the number of incidents and operators should focus on flight time calculation, meteorology, security checks for aircraft navigation systems, emergency instructions, and air traffic law. For businesses, additional training should include on-board camera image uses, flight communications and planning, system maintenance and a host of other technological issues. Even basic safety checklists can help.

In many countries UAS registration is not required, causing problems for insurers and claimants.

Identification of both UAS and operator will be essential for maintaining proper liability in future. Introduction of car registration-style schemes will help.

Insurance can protect both operators and the public from risk of mid-air collision, as well as physical or property damage or injury to others. Manufacturers, owners and operators of UAS are exposed to a number of risks, as are businesses which sell and service UAS.

If growth projections for the commercial UAS industry in the US materialize, there is potential for the drone insurance market to be worth$500m+ by end of 2020. Globally, its value could be approaching $1bn[7].

**Page 14**

[6] Global Claims Review, Allianz Global Corporate & Specialty [7] Allianz Global Corporate & Specialty

**UNMANNED AIRCRAFT SYSTEMS (UAS)**

# What is a UAS?

**$1.7bn**

Generated worldwide in 2015 as a result of UAS (operations, sales, servicing, etc)[1]

**1,000+**

Number of operators granted a license in Europe[2]

**10,000**

Units of drones per month sold by Amazon[3]

Widely referred to by the public as drones, **unmanned aircraft systems (UAS**) are piloted remotely on the ground via control stations. They are also known as unmanned aerial vehicles (UAV), remotely piloted aircraft (RPA) and remotely piloted aerial systems (RPAS), to name a few of the most common terms. UAS can range in size from micro surveillance vehicles that can fit in the palm of the hand to the RQ-4 Global Hawk, a 7.5 ton jet-engine powered aircraft capable of flying 30+ hours non-stop. This paper will refer to these vehicles (singular or plural) as **UAS**.

UAS technology was rooted first in military development, remote tracking and reconnaissance applications. The first drones, unmanned balloons loaded with explosives and sent with the prevailing winds toward enemy targets, were in use around 1860.

Civilian UAS applications have grown exponentially in the last few years, especially the small (less than 3 lbs.) units that cost from $500 to $2,000.

So popular have UAS become that the US Federal Aviation Administration (FAA) projects that by the end of 2016 there will be over 600,000 UAS deployed in the US for commercial use, quite a number considering that there are only 204,408 active general aviation (GA) manned vehicles in use. By 2020, there will be 2.7 million commercial UAS – over 10 times the number of manned aircraft in the skies today *(see table)*.

The UAS industry is the most dynamic growth sector of the global aerospace industry. Hard numbers can be difficult to come by but growth projections are significant. The Association for Unmanned Vehicles International (AUVSI), the largest trade group around UAS, estimates that by 2019 more than 70,000 jobs will be created in the US with an economic impact of more than $13.6bn. Meanwhile, a third of UAS manufacturing occurs in Europe. In France the number of approved operators increased by over 400% between December 2012 (86) and February 2014 (431) while Sweden and the UK have issued more than 200 operators' licenses each in recent years[4].

Globally, UAS market volume is expected to reach 4.7 million units by 2020[5], although other forecasts predict an even higher number. UAS spending is expected to double over the next decade to $11.6bn worldwide, totaling just over $89bn in the next 10 years[6]. In addition it is estimated that the global market for commercial applications of UAS technology will soar to around $127bn by 2020 compared with $2bn today[7]. Clearly, the unmanned vehicle market is a burgeoning one, demanding the attention of companies wishing to put them to commercial use, government agencies wanting to regulate them and insurers seeing the need to mitigate their inherent risks with coverage solutions.

## Fleet size projections (millions sales of UAS units – annual)

| Vehicle type | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Hobby aircraft (incl. model) | 1.9 | 2.3 | 2.9 | 3.5 | 4.3 |
| Commercial use aircraft (excl. model) | 0.6 | 2.5 | 2.6 | 2.6 | 2.7 |
| **Total** | **2.5** | **4.8** | **5.5** | **6.1** | **7.0** |

Active US general aviation (GA) fleet: **204,408**

US general aviation deliveries (2015): **1,581** *(most of them exported)*

Source: FAA Aerospace Forecast 2016-2036, Graphic: Allianz Global Corporate & Specialty

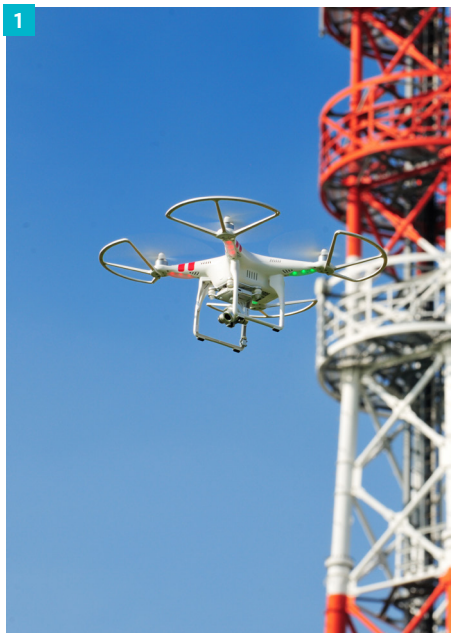
[1] KPCB [2] RPAS – Frequently Asked Questions, European Commission, April 2014 [3] The Independent: "Drones boom puts insurers at risk of multi-billion dollar bill"
[4] RPAS – Frequently Asked Questions, European Commission, April 2014 [5] Unmanned Aerial Vehicles Market, By Value and Volume Analysis and Forecast 2015-2020 – Research and Markets
[6] Teal Group Corporation [7] Drones will take $127bn worth of human work by 2020, PwC says – The Independent, Clarity from above – PricewaterhouseCoopers

# Different uses of UAS

Although UAS have been used for years, it is only today that they are coming into their own in a commercial sense. Typically, UAS work best and are most often deployed conducting dull, dirty or dangerous work that companies do not want to invest an employee to complete – risk assessment and maintenance of infrastructure such as inspections of roofs and bridges, for example *(see chart)*. UAS can be easier to use, have a lower barrier to entry and are a relatively safe and inexpensive way to take "a view from above" compared with other solutions. For example, utilizing UAS can be 17 times faster than traditional inspections[1] with some having the ability to take 1,000 aerial photos in just 15 minutes, delivered to assessment teams as a geo-referenced map.

"UAS in commercial use will increase greatly in the next decade because they're effective at carrying out menial or dangerous tasks," says **Thomas Kriesmann, Senior Underwriter General Aviation, AGCS**. They are cheaper and can replace dangerous working conditions, while supplying a convenient wide-area perspective of hard-to-reach places like swamps or mines. They can be used to survey crops, patrol borders, provide reconnaissance for search and rescue missions, report on traffic patterns or news stories, survey wildlife, patrol pipelines, provide an advance warning system for ice breakers, survey oil spills, enforce environmental law, regulate fisheries, shoot footage for movies and provide disaster relief.

## Top 5 UAS markets (by industry)[2]





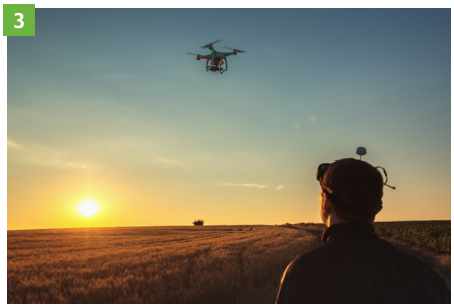
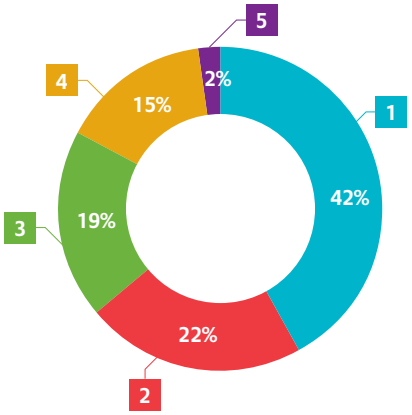





Photo: Drone Media Studio / Shutterstock.com




1 **Industrial inspection** 42%
bridges, roofs, cell towers

2 **Real estate/Aerial photography** 22%

3 **Agriculture** 19%
crop surveying and analysis

4 **Insurance** 15%
risk assessment, claims adjusting, damage determination

5 **Government** 2%
law enforcement, border surveillance, fire departments, municipalities

[1] On average building inspection times are 60 hours for onsite test engineers, as opposed to 3.5 hours for drone inspection (based on research estimate for 20 x 80 m wide façade building,) Source: Fairfleet. [2] FAA Aerospace Forecast FY2016-2036

# Emerging uses

Commercial UAS usage continues to increase and evolve: The freight company DHL piloted a test case in Germany to deliver emergency supplies and medicine from the mainland to the island of Juist in the East Frisian Islands. The first successful US pilot program of a **"ship to shore"** UAS delivery of medical supplies was recently carried out on the New Jersey coastline. A similar research project has perfected a UAS "parcelcopter" for use in the Bavarian Alps. In Singapore Airbus helicopters and the Civil Aviation Authority are working to perfect a package delivery system in urban areas, while Amazon will conduct similar trials in partnership with the government in the UK. In Brazil UAS are used as monitoring tools to prevent the exploitation of slave labor in agricultural areas, while in Africa there are plans to use them to deliver blood and vaccines to remote areas, potentially saving thousands of lives a year. Even the pizza maker, Dominos, is piloting a pizza delivery scheme in Germany, while convenience store 7-Eleven recently delivered coffee and a chicken sandwich to a family in Reno in the US.

"Use of UAS and UAS technology will cross further boundaries in the years to come," says Kriesmann. "Perhaps, we may even see their use extended to other forms of driverless vehicles, and even flying cars, as technology develops and converges."

Shorter term, insurers, such as Allianz, are also utilizing UAS. Both underwriting and claims management can be made quicker and more effective by using such systems to assess risk and survey loss damage. For example, when parts of **Tianjin, China** were rendered inaccessible after major explosions last year, high resolution images taken by UAS after the blasts were compared with previous photographs to determine how many vehicles had been destroyed. Similarly, in the event of a flood, UAS can provide the insurer with a visual overview, helping it to quickly alleviate damage and distress to victims and property.

## "Pilot in residence" for hire

Another consequence of more companies discovering the potential benefits of UAS is the emergence of third party **"drone for service"** vendors, who "rent out" systems to commercial operators who may find it more convenient and cost-effective to utilize UAS in this way. Fairfleet, an on-demand aerial inspections marketer, has created the first-ever online pilot-to-business (P2B) marketplace via cloud technology which links qualified pilots with customers in need of UAS services, offering real-time data upload and analysis to customers from a range of industries, including construction, media and insurance. According to Fairfleet, around **$400bn (€360bn)** was spent on additional construction costs in 2014[1] and the sector hopes to achieve huge efficiency gains by utilizing UAS for inspections. It also notes up to 90% of US inspectors are still using graph paper and digital cameras to document inspections and generate estimates, in a potentially costly and dangerous environment in which user experience could be challenging.

This new P2B initiative is supported by Allianz X, which helps develop new business ideas in the insurance technology space, with Allianz offering the insurance coverage and claims settlement.


Photo: DHL

UAS data could drive the future of disaster response and mitigation. They can quickly survey damage and even be utilized to transport medical supplies – companies like DHL have already piloted such schemes.

[1] TechCrunch Disrupt

# UAS: The risk landscape

UAS have the potential to solve problems across numerous industries, improve the safety of thousands of workers every year and significantly reduce costs in the future.

"As UAS technology penetrates further we could see a decline in workers compensation losses," says **James Van Meter, an Aviation Practice Leader at AGCS**. "We will definitely see fewer injuries related to building inspections, such as employees falling off roofs. It may well be several years before the data will be sufficient enough to analyze however."

## Incidents and near-misses

- A UAS caused an electricity blackout in Deyang, southwest Sichuan after crashing into power lines. It took more than six hours to resolve *January 2016*
- The world's busiest airport for international travel, Dubai International Aiport, closed its airspace for 69 minutes due to unauthorized UAS activity, causing 22 flights to be diverted *June 2016*
- At the end of 2014, China's air force shot down a UAS over a Beijing suburb after it delayed flights and triggered a security alert after flying in restricted airspace *December 2014*
- A UAS that singer Enrique Iglesias was using to film a concert struck his hand, causing injury and the need for several surgeries, as well as an interruption of several days in his concert schedule *May 2015*
- A 50lb UAS, which was being used to film an alpine skiing race in Italy, crashed to the ground within feet of a competitor. The International Ski Federation said it would ban drones after the incident *December 2015*
- Reports of UAS sightings from pilots, citizens and law enforcement have increased five-fold over the past year according to the FAA. This equates to more than three incidents a day where UAS flew too close to passenger airliners and other aircraft. There were seven incidents of near misses with aircraft at UK airports *between May 2014 and March 2015*
- A man was arrested after a UAS carrying a small amount of radioactive material landed on the roof of Prime Minister Shinzo Abe's office in Tokyo *April 2015*

Yet, as civilian and commercial UAS usage increases, new risk exposures will also emerge and the potential for misuse of UAS technology needs to be considered.

"There are many parallels between the beginning of aviation more than 100 years ago and UAS today," explains Van Meter. "When Allianz started to write aviation insurance in 1915, aviation was in its infancy. Risks were high and the general public was excited, but wary of the new technology. Today, UAS technology is similar. We're seeing the technology advance quickly and prices coming down. More and more drones are being used by neighbors, colleagues and, of course, companies.

"However, as sophisticated as the technology is, accidents happen. When anything mechanical is operated by humans, there's always opportunity for error, injuries and property damage."

"When you have autonomous technology there will be autonomous judgement when a situation arises," adds Kriesmann. "Can an algorithm have intuition? Is technology fast enough to react for the UAS to respond? Going forward, there will be increasing operating risks."

UAS raise two priority safety concerns: mid-air collisions and the loss of positive control. A UAS that cannot be controlled poses a significant risk to persons, property, or other aircraft. A mid-air collision could happen if the pilot cannot see and avoid manned aircraft in time. The manned aircraft that are most at risk are those that normally fly below 500 feet, such as helicopters, agricultural aircraft and aircraft landing or departing from airports.

Loss of control can result from a system failure and if the unit flies beyond the signal range or into an area where communication is interrupted. AGCS sees a major risk in the loss of control due to frequency interferences as there have already been such incidents, including injuries.

## Liability Risks

The liability risks associated with UAS are completely different to those posed by manned aircraft as there are no occupants onboard, and the size and weight of the aircraft are usually significantly smaller. The most common UAS used by civilians in the US are around five pounds; the lightest general aviation aircraft is around 1,400 pounds. The worst case liability claim envisioned for UAS is a collision with a manned aircraft *(see page 11)*.

## War/Terrorism Perils

Such perils pose a high risk to UAS operations. Similarly to manned aircraft they may be used for malicious acts. There are concerns that UAS could be utilized to attack sports stadiums or other events where large crowds gather. One emerging peril is the potential terrorist threat from UAS targeting power and nuclear stations. After more than a dozen overflights of reactors, French authorities announced the expenditure of $1.1m to "detect, identify and neutralize small aerial drones" in 2014.[1]

Increasing use of UAS is also altering the risk profile of many industries. For example, a real estate or property broker represents little bodily injury exposure but this changes as soon as it engages UAS to take aerial photographs of property.[2]

## A realistic UAS loss scenario

### The incident

A building surveyor uses a UAS for a façade inspection in a town center in Europe. During the inspection the pilot loses control of the UAS. The UAS crashes into the windshield of a truck, which crashes into a coffee shop with 14 people in it. All suffer injuries – three of them fatal. The shop interior, including all merchandise, as well as the truck and its payload are destroyed.

### Liability Claim: Who claims for what?

**Fatal injuries**
All dependants of the fatally injured are entitled to indemnification arising from the loss of income

**3 fatalities**

**Bodily injuries**
All dependants of the bodily injured are entitled to indemnification arising from the temporary loss of their provider's income. Health care provider's claim for subrogation of medical expenses

**4 seriously injured**
**7 minor injuries**

**Shop owner**
Costs for rebuilding the shop interior and costs for replacement of the merchandise and potential business interruption

**Shop interior destroyed**

**Trucking company**
Costs for truck replacement

**Owner of the cargo**
Costs for the replacement of the goods

**Truck and cargo destroyed**

*Incident used as example only*

**Estimated total indemnity: $7.5m (€6.75m)**

[1] AGCS Global Risk Dialogue, Winter 2015-Spring 2016 Issue 2. [2] "Re:fresh Drones," Allianz Global Reinsurance

## "Spoofing" or Cyber-Attacks

Other scenarios include the prospect of hackers taking control during flight, causing a crash in the air or on the ground resulting in material damage and loss of life. The term **"spoofing"** refers to attempts to take control of a UAS via hacking the radio signal and sending commands to the aircraft from another control station. This is a very real risk for UAS since they are controlled by radio or Wi-Fi signals. Companies which claim to sell devices to specifically bring down or take control of UAS can be found online. Then there is the potential threat of loss or theft of data security. Valuable recorded data can be lost during the flight when the device is transmitting information to the control station. Data can also be obtained by cyber-attack when it has been stored by the company gathering the data.

## Privacy issues

There are many public concerns over UAS around such issues as privacy and trespass and nuisance. In a recent case in Germany, a private UAS operator was served with a cease and desist order including a fine of **$278,000 (€250,000)** if he flew over his neighbor's estate again.

## From bird strikes to UAS – the cost of aviation damage from "foreign objects"

Damage from **"foreign objects"** is a significant issue for the aviation sector, with it being the fifth highest generator of insurance claims over **$1m (€1m)** by number *(see chart)*.

**Bird strikes** are a notable cause of aviation losses and pose a significant threat to flight safety, having caused a number of accidents with human casualties. According to AGCS analysis of insurance claims[1], bird strike losses average **€16.7m ($22.8m)** every year with a total of 34 incidents (27 to airlines) in the analyzed claims. Most accidents occur when the bird hits the windscreen or flies into the engines. These cause annual damages that have been estimated from $400m to as high $900m in the US alone and up to **$1.2bn** to commercial aircraft worldwide.

The worse case liability claim envisioned for **UAS** is a similar type of collision with a manned aircraft but there are many variables to consider. If a UAS was to hit an agricultural aircraft for example, the loss could be as much as $1.6m for the aircraft itself. If the pilot was injured or killed in the US, the liability claim could be many multiples of that.

Commercial aircraft are at the greatest risk of an incident during take off and landing. In the event of an incident aircrafts could also be forced to make a precautionary or emergency landing, resulting in delay or cancellation, incurring significant economic loss. If a small UAS was to impact an airliner by hitting an engine, it could cost $5m to $10m in damage costs alone.

### Top Causes of Loss: Aviation Claims (€1m+)


**No. of Claims**
Plane crash 23%
Ground handling 18%
Mechanical failure 16%
Hard landing 9%
Damage by foreign object 8%
Other 26%

**By value**
Plane crash 37%
Over/undershot runway/taxiway 22%
Ground handling 15%
Mechanical failure 12%
Hard landing 4%
Other 10%

Source: Global Claims Review, Allianz Global Corporate & Specialty. *Data based on accident years 2009-2013*

[1] Global Claims Review, Allianz Global Corporate & Specialty


# Regulatory differences and challenges

Compared with manned aviation, global regulation of UAS is in its infancy, as evidenced by the numerous organizations and associations lobbying governments for harmonization across geographical boundaries. Standards differ remarkably by jurisdiction. According to Kriesmann, globally there are about 800 working groups trying to harmonize the regulatory process. Another challenge is posed by technology advancing faster than the regulatory process.

Governments see the need for adequate regulatory control. In some jurisdictions, complex and comprehensive laws are already in place and certification is a prerequisite for commercial use. Clear distinctions are made between UAS for business use and **"model aircraft"** for recreational use. Other countries, such as the US and UK, are reviewing broader regulations to supplant guidelines currently in force, with the US *(see box)* finalizing comprehensive regulations in 2016. Restrictions can be limited elsewhere. In most cases, the designation between commercial and recreational UAS use is the key starting point. Other common standards exist such as operators must maintain a visual line of sight (VLOS) at all times and UAS must be under a certain size (usually **<55 lbs./25 kg.**) and must not be operated in close proximity to airports or large outdoor venues.

## Milestone UAS regulations in the US

Effective August 2016, new US rules **(FAA Part 107)** are set to pave the way for thousands of businesses to fly UAS legally, as operators will have to meet simpler criteria. Previous FAA stipulations required commercial operators to have a pilot's license, as well as having to apply to the authority for permission. This meant that, as of May 2016, only around 5,000 commercial applicants had been successful; a tiny percentage of UAS owned in the US.

According to the new rules UAS will be able to be flown as long as the pilot is over 16, the UAS is in sight and is not flown above 400ft. The UAS must weigh less than 55lb (25kg) with pilots having to pass an aeronautics safety test. The FAA is also to provide UAS owners with **"privacy guidelines"**. The National Telecommunications and Information Administration (NTIA) in May released best practices that promise to safely integrate large numbers of UAS into the national airspace while guaranteeing personal privacy of people on the ground.[1]

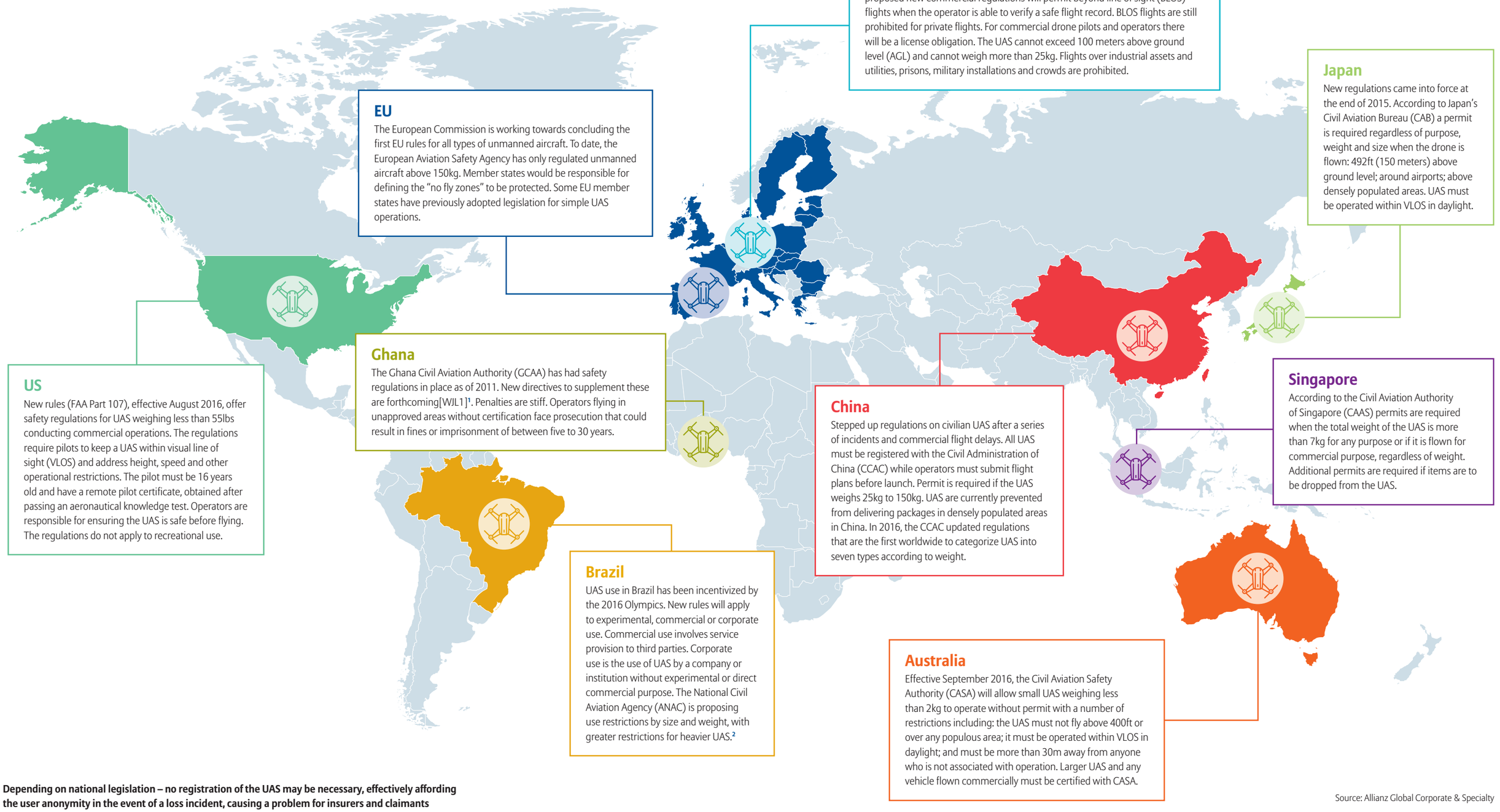
According to FAA chief, Michael Huerta, the FAA wants to ensure that "the drone industry can continue to grow 'at the speed of Silicon Valley' without being restrained by 'the speed of government.'"

"The new regulations are going to open the floodgates on the UAS industry. We are seeing companies and individuals buying UAS at an incredible pace now that there is an easy and attainable path to legal commercial options," says Van Meter.

The new FAA rules do not apply to recreational users, which account for the majority of UAS owners, although this group is regulated by Section 336 of US Public Law 112-95, which codifies the FAA's enforcement authority. A recent study by aerospace and defense firm, Aero Kinetics, concluded that toy drones posed a significant threat to manned rotocraft in all phases of flight, including cruise, based upon their typical operating altitudes.[2]

[1] NTIA "UAS Privacy Best Practices" [2] Aero Kinetics – Real Consequences of Toy Drones

# Snapshot: Around the World in UAS Regulation



## Germany

While VLOS is a requirement of all commercial UAS pilots, as of November 2015 proposed new commercial regulations will permit beyond line of sight (BLOS) flights when the operator is able to verify a safe flight record. BLOS flights are still prohibited for private flights. For commercial drone pilots and operators there will be a license obligation. The UAS cannot exceed 100 meters above ground level (AGL) and cannot weigh more than 25kg. Flights over industrial assets and utilities, prisons, military installations and crowds are prohibited.

## EU

The European Commission is working towards concluding the first EU rules for all types of unmanned aircraft. To date, the European Aviation Safety Agency has only regulated unmanned aircraft above 150kg. Member states would be responsible for defining the "no fly zones" to be protected. Some EU member states have previously adopted legislation for simple UAS operations.

## Japan

New regulations came into force at the end of 2015. According to Japan's Civil Aviation Bureau (CAB) a permit is required regardless of purpose, weight and size when the drone is flown: 492ft (150 meters) above ground level; around airports; above densely populated areas. UAS must be operated within VLOS in daylight.

## US

New rules (FAA Part 107), effective August 2016, offer safety regulations for UAS weighing less than 55lbs conducting commercial operations. The regulations require pilots to keep a UAS within visual line of sight (VLOS) and address height, speed and other operational restrictions. The pilot must be 16 years old and have a remote pilot certificate, obtained after passing an aeronautical knowledge test. Operators are responsible for ensuring the UAS is safe before flying. The regulations do not apply to recreational use.

## Ghana

The Ghana Civil Aviation Authority (GCAA) has had safety regulations in place as of 2011. New directives to supplement these are forthcoming[WJL1][1]. Penalties are stiff. Operators flying in unapproved areas without certification face prosecution that could result in fines or imprisonment of between five to 30 years.

## China

Stepped up regulations on civilian UAS after a series of incidents and commercial flight delays. All UAS must be registered with the Civil Administration of China (CCAC) while operators must submit flight plans before launch. Permit is required if the UAS weighs 25kg to 150kg. UAS are currently prevented from delivering packages in densely populated areas in China. In 2016, the CCAC updated regulations that are the first worldwide to categorize UAS into seven types according to weight.

## Singapore

According to the Civil Aviation Authority of Singapore (CAAS) permits are required when the total weight of the UAS is more than 7kg for any purpose or if it is flown for commercial purpose, regardless of weight. Additional permits are required if items are to be dropped from the UAS.

## Brazil

UAS use in Brazil has been incentivized by the 2016 Olympics. New rules will apply to experimental, commercial or corporate use. Commercial use involves service provision to third parties. Corporate use is the use of UAS by a company or institution without experimental or direct commercial purpose. The National Civil Aviation Agency (ANAC) is proposing use restrictions by size and weight, with greater restrictions for heavier UAS.[2]

## Australia

Effective September 2016, the Civil Aviation Safety Authority (CASA) will allow small UAS weighing less than 2kg to operate without permit with a number of restrictions including: the UAS must not fly above 400ft or over any populous area; it must be operated within VLOS in daylight; and must be more than 30m away from anyone who is not associated with operation. Larger UAS and any vehicle flown commercially must be certified with CASA.

**Depending on national legislation – no registration of the UAS may be necessary, effectively affording the user anonymity in the event of a loss incident, causing a problem for insurers and claimants**

Source: Allianz Global Corporate & Specialty

[1] GhanaWeb: Unauthorized flying of drones to attract 30 years jail term [2] PRIO Network: Brazil: an Emerging Southern Drone Actor

# Improving UAS safety: insurance and risk mitigation

The potential risks which accompany the anticipated increase in UAS usage highlight the need for operators to carry insurance coverage to help protect themselves and the general public.

Insurance can protect both operators and the general public from the risk of a mid-air collision as well as damage or injury to persons, property, or other aircraft. Unmanned aircraft owners and operators have an exposure for the aircraft hull and liability. Manufacturers of unmanned aircraft have a products liability exposure. Businesses that sell, service, and train operators of UAS have a general liability exposure.

## What is the insurance approach to UAS?

AGCS writes UAS insurance for commercial operators, manufacturers, distributors and repairers, flight schools and training facilities and UAS service consumers (those who hire UAS operators to fly on their behalf).

Both hull (vehicle) and liability coverage are available. Different types of liability coverage include general liability, aviation products liability, commercial general liability and non-owned aviation liability. Recent insureds include a large UAS manufacturer, a film production company and organizations with plans to help develop delivery of medicine and firefighting services. AGCS does not insure UAS used for military purposes or infringement of privacy.

However, UAS can be challenging to insure. An underwriter must look at unmanned aviation risks differently compared with manned aviation as there are significant differences that impact on the insured valuation and loss adjustment. In manned aircraft the majority of the value is in the engines and airframe. Conversely, the most expensive parts of any UAS are the electronic components and sensor payloads. At the higher end of the equipment spectrum are advanced cameras and sensors costing up to $500,000.

The primary concerns for insurers are the lack of international, regional and local regulations for the safe operation of UAS, and the risks posed from sharing the same airspace as military and civil aviation operations. In many locations, there are few or no pilot training and maintenance standards. UAS have not been largely integrated into local or global aviation networks or standards.

Another challenge is access to detailed data surrounding crash statistics, pilot experience or repair costs for UAS. Compared with manned aviation this information is not as widely available, as the UAS sector is still in its infancy. This will improve as insurers continue to assess and underwrite the risks.

However, a variety of UAS insurance products are available: physical damage (hull) for the vehicle,

Photo: microdrones

cameras, sensors, control stations, etc.; liability; aviation commercial general liability (CGL); aviation products liability; and non-owned aviation liability.

"Whether you run a coffee shop or truck delivery business you need insurance to continue running your business. Drones are no different," says Van Meter.

"Generally we see $1m as the most popular limit purchased, although we do see higher limits needed to meet contractual requirements of large corporate clients."

While it is too early to say definitively, assuming FAA growth projections for the commercial UAS industry in the US, there is potential for the drone insurance market in the US to be worth in excess of $150m at the end of 2016, growing to $500m+ by end of 2020. Globally, its value could approach $1bn by 2020.[2]

## UAS accident study

Increased participation of unmanned aircraft in US Air Force operations resulted in a significant rise in **"Class A mishap"** incidents, a study shows.[1]

The study describes "Class A mishaps" as non-combat accidents that result in a death, permanent disability or damage of at least **$1m**. Over 10 years there were 75 "Class A mishaps" in relation to unmanned aircraft. In 2004, UAS accounted for around 21% of all "Class A mishaps". By 2011 this had grown to 50%. Pilot/human error accounted for 28% of the mishaps with 58% due to hardware failure issues. Engine, fire and weather were not significant factors in the incidents.

## The importance of UAS risk mitigation education

As private ownership grows so will expectations for safety education. AGCS partners with two of the top US aviation universities – Embry-Riddle Aeronautical University and the University of North Dakota in the US. Both institutions are focused on training professional UAS operators with an emphasis on risk mitigation strategies and public safety awareness. AGCS is also a founding member of the UAS Insurance Association [UASIA] which will assist the industry in establishing and maintaining safety and risk management best practice and procedure. The entry point for novice operators can be so low that even small things like safety checklists and reminders to avoid airports and other areas where they might encounter low-flying aircraft are important. Training has a crucial role to play in reducing the risk of an incident occurring. To date, insurers have already seen loss activity related to novice control of UAS due to lack of appropriate training.

"In addition to regulation, education will continue to be the key to ensuring safe UAS operations," says Van Meter.

## Risk assessment considerations

- Loss history
- What is the Maximum Take-Off Mass? The higher, the more exposure
- Proximity of inhabited places
- Annual utilization (hours of use)
- Pilot experience, including level of training
- Use of high or low altitude (possible interaction with other commercial aircrafts)
- Mode of operation (within line of sight/out of sight)

[1] Risk Product Liability Trends, Triggers and Insurance In Commercial Aerial Robots – David Beyer, Donna Dulo, Gale Townsley and Stephen Wu
[2] Allianz Global Corporate & Specialty: Assumes 600,000 commercial UAS in use at end of 2016 and 2.7 million in use by end of 2020. Based on average premium and conservative take-up rate.

"Users have multiple options of manually operating UAS," adds Kriesmann. "Training should cover radio and battery technology, flight time calculation, meteorology, security checks for aircraft navigation systems, audible and visible signals, emergency instructions, and air traffic law and clearance issues.

"For corporations, additional training should include on-board camera image uses, flight communications and planning, flight rules over buildings and forests, advanced meteorology, system maintenance, and other technological issues."

"Effective training helps to ensure the conduct of safe and responsible UAS operations, while education and research provides opportunities to explore and better understand how this technology can be used to achieve efficiency gains and profitability," adds **Brent Terwilliger, Embry-Riddle Aeronautical University**. "The industry's success is directly tied to our next generation of engineers, pilots, maintainers, and entrepreneurs ability to apply what they learn in the classroom to solve challenges affecting the field."

In many locations around the world no registration of the UAS is necessary, causing a problem for insurers and claimants. "However, in future, identification of both UAS and operator will be essential for maintaining proper liability in general. Sooner or later we will have something similar to car registration and/or cell phone registration," concludes Kriesmann.

## Risk Management Checklist

### Owner/operator of UAS

- ☐ Does the owner/operator have approval to operate? Have they completed factory training from the UAS manufacturer? Do they use and apply checklists and standard operating procedures?
- ☐ If you are the owner/operator, insurance needs to be bought from a knowledgeable provider. Aviation-specific UAS coverage with hull and liability coverage is recommended for the vehicle and/or general liability coverage. Purchase adequate limits for the exposure and the type of operation.

### UAS manufacturer

- ☐ Does the manufacturer have approval for testing the vehicle and for demonstrating its capabilities at point of sale? Does it adopt high quality manufacturing standards?
- ☐ Manufacturers should require all suppliers to indemnify, include a "hold harmless" clause under which one or both parties agree not to hold the other party responsible for any loss, damage, or legal liability, and carry adequate coverage for their operation. The manufacturer should include thorough user warnings on all products in order to successfully mitigate a failure. Manufacturers should require purchasers to complete training prior to operation of the vehicle.
- ☐ Manufacturers should consider aviation-specific products liability insurance and specialty UAS coverage with no aviation exclusions. The manufacturer should encourage all purchasers to carry liability coverage, shielding the manufacturer from potential lawsuits.

### Hiring a UAS operator or service provider

- ☐ A third party operator or service provider should be required to show a copy of their approval documents and answer questions about their safety record. Additionally, they should have experienced pilots. The hiring agent should complete due diligence before hiring services.
- ☐ Require the UAS operator or service provider to carry insurance from a reputable carrier. Require high limits of liability that match the exposure ($5m to $100m) depending on the exposure.
- ☐ Purchase non-owned UAS coverage that provides coverage in excess of the operator's or provider's coverage.
- ☐ The UAS operator should recognize the hiring agent as an additional insured under their aviation insurance policy.

## Contact Us

For more information, please contact your local **Allianz Global Corporate & Specialty** Communications team.


**LONDON**

**Michael Burns**
michael.burns@allianz.com
+44 203 451 3549

**MUNICH**

**Heidi Polke-Markmann**
heidi.polke@allianz.com
+49 89 3800 14303

**NEW YORK**

**Sabrina Glavan**
sabrina.glavan@agcs.allianz.com
+1 646 472 1510

**PARIS**

**Florence Claret**
florence.claret@allianz.com
+33 158 858863

**RIO DE JANEIRO**

**Juliana Dias**
juliana.dias@allianz.com
+55 21 3850 5958

**SINGAPORE**

**Wendy Koh**
wendy.koh@allianz.com
+65 6395 3796

**SOUTH AFRICA**

**Lesiba Sethoga**
lesiba.sethoga@allianz.com
+27 11 214 7948

**GLOBAL**

**Hugo Kidston**
hugo.kidston@allianz.com
+44 203 451 3891


## Credits


**Editor:** Greg Dobie (greg.dobie@allianz.com)

**Publications/Content Specialist:** Joel Whitehead (joel.whitehead@agcs.allianz.com)

**Contributor:** Shakun Raj (shakun.raj@allianz.com)

**Design:** Kapusniak Design

All $US unless stated


## Disclaimer & Copyright




Allianz Global Corporate & Specialty SE Fritz-Schaeffer-Strasse 9, 81737 Munich, Germany

Commercial Register: Munich HRB 208312

www.agcs.allianz.com

September 2016