Overview of drones and UAS standards landscape — 2021

Prepared by BSI and ARPAS-UK

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ARPAS-UK
The UK Drone Association

About

BSI

BSI is a global thought leader in the development of standards of best practice for business and industry. Formed in 1901, BSI was the world's first National Standards Body (NSB) and a founding member of the International Organization for Standardization (ISO). Over a century later, BSI is focused on business improvement across the globe, working with experts in all sectors of the economy to develop codes, guidance and specifications that will accelerate innovation, increase productivity and support growth. Renowned as the originator of many of the world's best-known business standards, BSI's activity spans multiple sectors including aerospace, automotive, built environment, food, healthcare and ICT.

Over 95% of BSI's work is on international and European standards. In its role as the UK National Standards Body, BSI represents UK economic and social interests across the international standards organizations ISO, IEC, CEN, CENELEC and ETSI, providing the infrastructure for over 11,000 experts to work on international, European, national and PAS standards development in their chosen fields.

ARPAS-UK

ARPAS-UK is the Association of Remotely Piloted Aircraft Systems. It is a not for profit trade association and professional body which supports and acts on behalf of the remotely piloted aircraft (RPAS) community, from start-up businesses to larger established operations. ARPAS-UK members continue to break new ground in markets where RPAS (sometimes referred to as UAVs or drones) are delivering significant benefits. On behalf of its members, ARPAS-UK works closely with industry regulators, in particular CAA (Civil Aviation Authority), as well as UK Government departments to influence and ensure that the regulatory framework for the safe and professional operation of remotely piloted aircraft is fit for purpose and encourages best practice. The Association also works with other key stakeholders in the development of national and international RPAS strategies and standards, to the benefit of its members. The Association works in the public interest, and advocates professionalism within its membership through compliance with an agreed Code of Conduct and the holding of appropriate permissions. The Association takes progressive stances on national issues to embed the RPAS profession in all end-user industries, to enable it to continue to grow in reputation and influence.

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1 Executive summary

1.1 Introduction and overview

BSI commissioned the Association of Remotely Piloted Aircraft Systems UK (ARPAS-UK) to conduct research into the drone industry to identify the state of standardisation and standards-like activity taking place in the UK and globally, in particular addressing the following areas:

- Mapping of current standards landscape to reveal areas of existing technical coverage and duplication of effort, where different industries or organisations may be pursuing standards with the same scope.
- Gaps in the standards environment where work has not yet started.
- Barriers to adoption, such as confusion around requirements, licensing, or safety issues.

Primary research was conducted using a combination of methods, including an online survey, and a series of semi-structured interviews. A wide range of stakeholders from across the uncrewed aircraft systems (UAS) sector contributed their views and expertise to this project. Primary research was supplemented by extensive domain research to identify national and international standards of relevance to the field of UAS. The survey gained more than 300 responses from across the sector, many of whom had a significant number of years' experience, augmented by 40 follow-up interviews from survey respondents representing a range of views across key stakeholders including operators, regulators, OEMs (original equipment manufacturers), academics, and analysts.

The aerial drone industry has grown to become a dynamic sector and numerous organisations are currently involved in developing regulations and standards, including BSI, ANSI (American National Standards Institute), EUSCG (the European UAS Standards Coordination Group) and AW Drones (Airworthiness of Drones). There is no agreed unified framework for categorising standards, this is exemplified by the lack of co-ordination between these key bodies. This project has collectively identified more than 650 standards in varying forms of development. However, the focus in most cases, has been on the applicability of aviation standards in the UAS cut sector.

Note: In this document the generic term drone is primarily used, although other terms are also used in the industry and in research and other sources of information, including: Uncrewed Aerial Vehicle (UAV); Uncrewed Aerial System (UAS) and Remotely Piloted Aerial System (RPAS). It has become common practice for the term Uncrewed to replace the term Unmanned, and so, in this report, Uncrewed will be used throughout. We recognise that there are referenced reports and standards which make use of the term Unmanned and so in the interests of continuity, these will remain as such. A useful link to a glossary of terms and abbreviations used in the uncrewed aviation sector is provided by the CAA [1]

1.2 Key findings

The drone market is nascent but dynamic and innovation led. A study by PwC 'Skies without limits'[2] into the impact of drones shows that, by 2030, there could be £42bn increase in UK gross domestic product (GDP); £16bn in net cost savings to the UK economy; 76,000 drones operating in the UK's skies; 628,000 jobs in the drones economy. Rather than taking any numbers as absolute, all of the forecasts were showing significant market growth pre-Covid. As a consequence of Covid-19 and in line with industry generally there has been an impact that has affected some markets (eg film, TV, videography), however, opportunities in other segments witnessed accelerated activity (eg inspection and delivery).

Before the arrival of Covid-19, MarketsandMarkets, estimated that drone deliveries would generate revenues of $800m (£640m) in 2020 and revised this to $1bn, with forecast for 2022 updated from $1.6bn to $2.2bn.[3]

According to the Business Research Company report 'Commercial Drones Global Market Report 2021: COVID 19 Growth And Change To 2030'[4] the global commercial drones market is expected to grow from $3.73 billion in 2020 to $4.48 billion in 2021 at a compound annual growth rate (CAGR) of 20.1%. This growth is mainly due to companies resuming their operations and adapting to the 'new normal' while recovering from the impact of COVID-19, which had earlier led to restrictive containment measures involving social distancing, remote working, and the closure of commercial activities that resulted in operational challenges. The market is expected to reach $9.78 billion in 2025 at a CAGR of 22%.

The central findings of the research highlighted a number of barriers that could impact this forecast growth in the UK including:

- reliability of key technology for safety critical services;
- Detect And Avoid (DAA);
- public acceptance of the technology;
- certification of UAS;
- a lack of common standards;
- poor understanding of standards in the sector
- emerging regulatory framework.

The research found that there are over 650 standards applicable to UAS many of which were developed for manned aviation and are directly transferable or will require adaptation. Further harmonisation is needed to fully address the design, testing and operation of UAS. Through the ACE/20 Committee, BSI is actively engaged in UAS standards including responsibility for the development of national standards relating to uncrewed aircraft systems including classification, design, manufacture, operation (including maintenance) and safety management of UAS and Uncrewed Traffic Management (UTM) operations.

The landscape of standards is complex and in addition to aviation standards, the research identified two additional categories of standards required to support the development and deployment of UAS:

- Enabling standards — standards that are relevant to UAS that are not specifically aviation focused. Examples include standards relating to communications regulated by OFCOM; standards relating to noise at work regulated by the Health and Safety Executive; standards relating to privacy regulated by the Information Commissioner's Office.
- Industry standards — this category of standards is currently immature and relates to the application of drones within particular industry sectors or for specific industry use cases. Presently, this tends to be limited to best practice guidance developed by industry bodies.

1.3 Priority topics

The survey identified some high priority issues that need to be addressed for the sector such as certification, risk, and safety. However, several of the high priority areas such as airspace integration, public acceptance (ie life/property critical topics) were deemed by survey respondents to be more appropriate to be addressed by *regulation* rather than standards. Therefore, those topics that many would expect to see as high priority areas such as BVLOS (Beyond Visual Line of Sight) and DAA (Detect-and-Avoid) did not feature in the priorities for standards.

The principal categories that the survey has identified where standards can help shape the sector are related to safety, public acceptance and reinforcing regulations. And in terms of specific sub-topics, the survey has highlighted that ORA (Operational Risk Assessment), Maintenance and Data Capture and Processing are the most suitable specific topics.

The survey identified that, standards for drones were not expected to be any more extensive than for crewed aircraft. In terms of timescale, respondents indicated that safety related standards are the most pressing and they would like to see development, and ideally use, within the next 12 months. Based on the identified focus areas, developing standards in these priorities would support the UK's growing UAS market and provide a 'best in class' framework for a global leadership role, whilst providing important guidelines for industry stakeholders including manufacturers, operators and vertical sector user groups.

The research identified several priority areas for UAV standardisation, across the categories of industry, enabling and aviation.

Table 1 – Desired time frame for standard development

Within a year	Within two years	Within three years
• Hazard Mitigation and Management • Developing a standard set of protocols that a drone should follow when encountering hazards during operations, equivalent to those used in crewed aviation	• Power Sources	• Drones that Do (ie carry out services: inspection, delivery)
• Fire Safety • Developing a standard set of practices intended to reduce the destruction caused by fire (including fire prevention, and limiting the effects of a fire after it starts)	• Compliance Training	• Industry Training
• Noise • Establishing an acceptable standard for noise in different scenarios. Requirements to ensure the health and safety of operators and others with regards to noise/noise pollution	• Software Assurance	
• Ground Safety and Maintenance • Developing health and safety standards for all activities on the ground excluding those related to the drone from take-off to landing. This includes onsite setup and preparation, and any post flight site activities	• Design and Construction	
	• Noise (Public Acceptance)	

Some drone stakeholders confuse regulation and standards. In the UK there is a lack of awareness of existing standards and standards being developed across the aviation and industry sectors. A perceived lack of clarity around EASA (European Union Aviation Safety Agency) regulations in the UK creates uncertainty around priorities (this has been clarified during the project with the new regulations being implemented on the 1 January 2021).

Some concerns are as follows:

- There is a potential divergence between the US and Europe on some key technical standards eg conspicuity and BVLOS.
- There is duplication of standards and best practice activity across organisations within industry groups such as construction.
- CAA regulations are only applicable to outdoor use of UAS.
- There is currently a gap in both regulation and standards for indoor and hybrid (both internal and external operations) eg industrial processing plants.

Table 2 – Ranking of topics/sub-topics by suitability for standards (categorised under topics)

Topic	Ranking	Sub-topic
• **Risk Management**	1	◦ Operational Risk Assessment (ORA)
	7	◦ Hazard Mitigation and Management
	19	◦ Population Density
	22	◦ Crash Protected Airborne Recorder Systems
• **Airworthiness and Certification**	2	◦ Maintenance
	5	◦ Power Sources
	14	◦ Avionics and Electrical Systems
	16	◦ Software Assurance
	17	◦ Design and Construction
• **Data Capture and Processing**	3	◦ Data Capture
	4	◦ Data Processing
• **Health and Safety**	6	◦ Ground Safety
	11	◦ Noise (Health and Safety)
	13	◦ Fire Safety
• **Training (Industry)**	8	◦ Industry Training
• **Operations**	9	◦ Operations Manual
• **Industry and Logistics**	10	◦ Drones That Do
• **Training (Aviation)**	12	◦ Safety Training
	15	◦ Compliance Training
• **Communication and Navigation**	21	◦ Navigation Systems
	24	◦ Communication Network
	25	◦ Command and Control
• **Public Acceptance**	20	◦ Noise (Public Acceptance)
• **Airspace Integration**	23	◦ UTM

1.4 Recommendations

This project identified five recommendations to support standardisation efforts in the UK.

Recommendation	Description
1: Strategy	Review the BSI governance strategy against roadmap required to support the delivery of a coherent and high-impact UAS standards programme that aligns with the strategic priorities of the UK's UAS roadmap. Co-ordination with programmes from Department for Transport (DfT), Department for Business, Energy and Industrial Strategy (BEIS) and Innovate UK will add to the relevance of the standards programme.
2: Framework	BSI should adopt a standard framework, taxonomy and nomenclature to provide clarity and consistency across the standards landscape relating to UAS.
3: International	For Aviation Standards, BSI should identify priority areas where strengthening participation in international standards and/or collaboration with other countries would be in the UK's interest.
4: Adaptation of enabling standards	For Enabling Standards, BSI should work with relevant regulators, Standards Development Organizations and Bodies to adapt and augment existing standards to bridge the gap for the UAS sector.
5: Sectoral standards	For Industry Standards, BSI should engage actively with relevant industry groups and associations to develop best practice guidance that keeps pace with the rate of technological innovation in the UAS sector and can subsequently be developed into formal standards.

Whilst there are more than 650 standards in development, the basic foundations — such as agreed standard definitions — need to be addressed, for example, 'safety critical' vs 'safety related' and UAS Traffic Management (UTM) vs Unified Traffic Management.

2 Aims of the research study

The project was established to research the state of standards and standards-like activity taking place in the UK that relate to the use of drones.

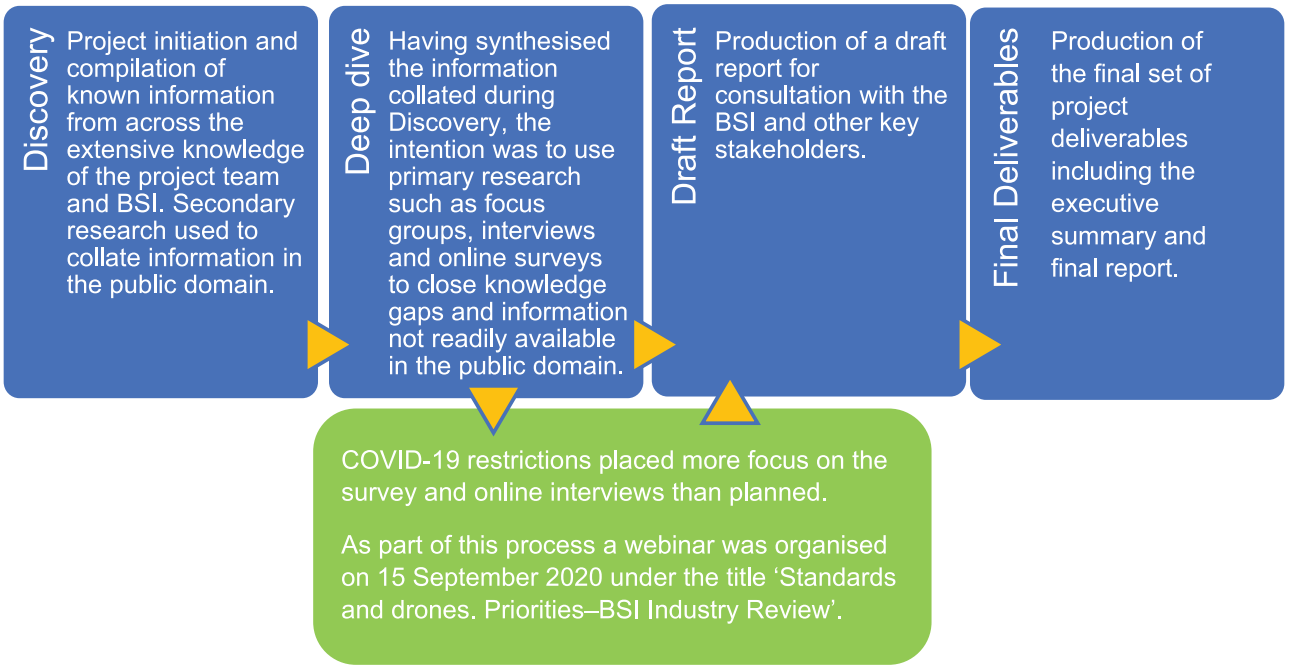
2.1 Project scope

The boundaries and assumptions of the project were defined at the project outset:

- Uncrewed aircraft systems (UAS) — other drone technologies such as uncrewed marine or land vehicles were assumed to be excluded from the scope.
- UK centric — any relevant standards that are identified from outside the UK would be touched upon only where it would be likely to influence or provide a fast track for UAS standards in the UK now or in the future.
- Civilian use — the project was limited to civilian applications of UAS technology [Note: The UK Military Aviation Authority updated their RPAS (Remotely Piloted Aircraft Systems) Regulations on 31 Dec 20 to align very closely with the new EASA categories (ie open and special categories).
- Standards — the emphasis of the project was focused on standards rather than regulation or legislation. Regulation or legislation would only be referenced where it is likely to influence standards.

2.2 Methodology

The intention was to deliver the project using the incremental and phased approach outlined below. On completion of the Discovery Phase, the project and delivery approach was adapted to work within the requirements of the COVID-19 lockdown.



3 Background

Drones are an important enabling technology for the UK's stated Industrial Strategy and are already of substantial benefit to business and the public, as referenced in the Parliamentary Under Secretary of State for Transport, Baroness Sugg's ministerial statement of 27 November 2017[5].

Uncrewed aircraft systems (UAS) are a key technology enabler for the Construction Sector Deal[6], a driving force in the Industrial Strategy, as the construction industry has led the way in adopting drones. They are identified in the Made Smarter Review[7] as an enabling technology for offshore wind and pharmaceutical industries. The government consultation on a draft drone bill closed in September 2018 and Taking flight: the future of drones in the UK[8], the government response, was published in January 2019.

The drone industry was already setting the pace for rapid applications of new technologies before COVID-19; the pandemic has acted as a catalyst for innovation and development of the drone sector with applications including delivery of medical supplies and other essential services.

Business Minister Nadhim Zahawi announced winners of the first wave of funding for ground-breaking aviation projects solving major global challenges (9 November 2020)[9] part of the Future Flight Challenge (FFC) Government-backed investment of £33.5 million — where 9 out of 20 projects were focused on developing technology to aid the response to the coronavirus pandemic. This included the development of uncrewed drones to deliver medication, reducing human contact and, consequently, transmission of the virus. (9 November 2020). The FFC is part of the Industrial Strategy Challenge Fund (ISCF), delivered by UK Research and Innovation and will distribute £125 million from the Industrial Strategy Challenge Fund (ISCF).[10]

To-date there has been considerable, albeit disparate, work in support of regulation, standardisation, and guidance for the use of drones in commercial and industrial applications. Some of the work is supported by government departments, some in the formal standards environment, and some within industrial groups or private companies. There is an opportunity for co-ordination and knowledge exchange between policy makers, manufacturers and numerous professional, industry and user groups.

4 Industry overview

All industry forecasts show growth, and according to recent data from analyst Frost & Sullivan, the commercial drones market is expected to experience steady growth of 5–10% per year globally for the next five years (Note: this 5–10% was an estimate determined after COVID-19 was notified; before that Frost & Sullivan was expecting flat growth to about 5% — mainly due to regulatory restrictions pertaining to commercial drones around the world.). Advances in autonomy and AI will be the main market drivers, whilst the COVID-19 response continues to generate increased demand for commercial drones and drones' services while helping to shape a more positive public perception. There will continue to be growth opportunities in high Return on Investment (ROI) applications and niche areas where platforms and sensors provide specialised solutions.[11]

Figure 1 – Key trends

OEM Trends	Drone-in-a-Box (DIB) Trends

• **Accelerating consolidation**
  ◦ AVAV acquired Pulse Aerospace
  ◦ FLIR acquired Aeryon Labs
  ◦ Altus Intelligence ceased operations
• **High Endurance VTOLs**
  ◦ All-electric (Terraview and Impossible Aero)
  ◦ Hybrid (Quanternium and Skyfront)
	• **Market consolidation**
	  ◦ Reforges left market
	  ◦ Aerovinci went bankrupt
	  ◦ Drone Terminus changed business models
	• **New entrants planning 2020/2021 deployments**
	  ◦ Airscort (Israel)
	  ◦ First Iz (US)

Drone Service Providers (DSP) Trends	**Transitional Drone Trends**

• **Industry consolidation/partnerships**
  ◦ Aerodyne and Measure
  ◦ Terra Drone and multiple partners
• **Investment by asset management firms**
  ◦ Sky Futures acquired by ICR integrity
	• **Landscape expanding – driven by:**
	  ◦ COVID response
	  ◦ Interest in critical item delivery pre-COVID
	  ◦ Versatility for certain applications (mapping/surveying)
	• **A focus on 'dual use'**
	  ◦ Many OEMs partnering with Federal/Govt. agencies
	  ◦ Volansi and Flightwave are examples

Source: Frost & Sullivan

With varying degrees of efficacy, aerial drones have been deployed across the world during the pandemic to spray disinfectant, broadcast messages to disperse crowds, monitor people's temperatures and deliver medical supplies.

The rising use of drones in business and public services will be highly impactful and deliver significant benefits for the UK economy and society. Whilst forecasts vary, depending on analysts, all concur that this is a dynamic and growing market. Therefore, it should be expected that regulation and standards will play an increasingly pivotal role in the safe development of this industry.

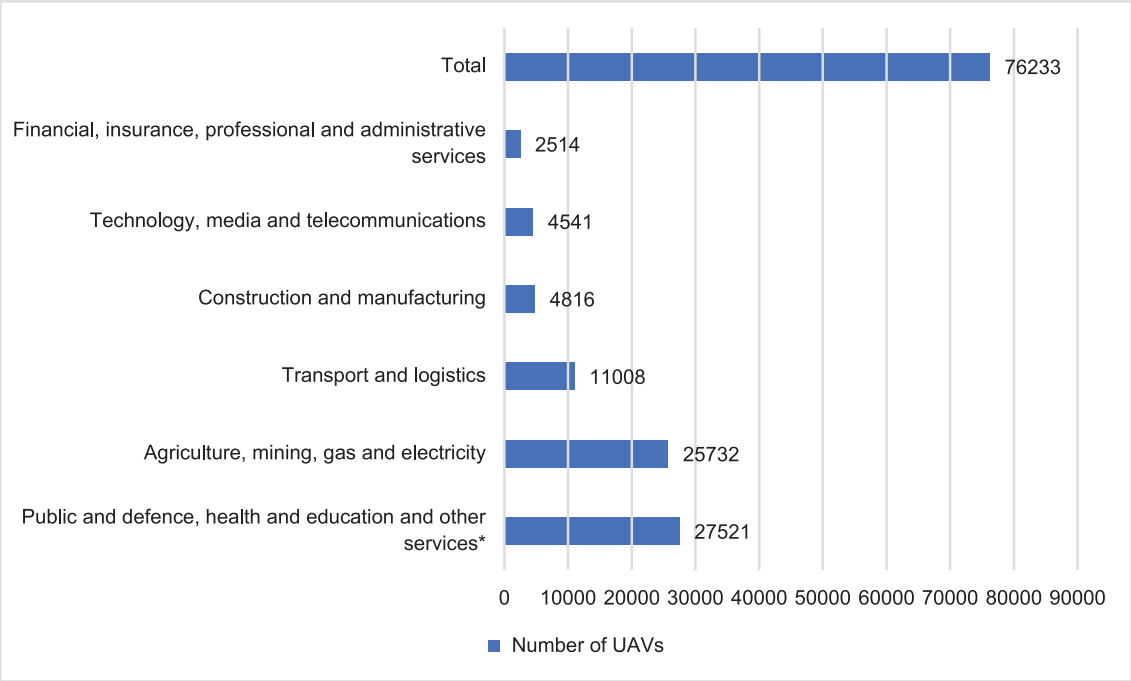
Figure 2 – Gross and net savings, and multi-factor productivity impact by 2030, by UK sector

Sector	Gross cost saving	Net cost saving	Multi-factor productivity impact by 2030
	From drones uptake		
UK wide	**£17bn**	**£16bn**	**3.2%**
Technology, Media and Telecommunications	£4.9bn	£4.8bn	12.4%
Financial, Insurance, Professional and Administrative Services	£4.1bn	£4.1bn	2.8%
Construction and Manufacturing	£3.5bn	£3.5bn	3.1%
Transport and Logistics	£2,8bn	£2.8bn	8.4%
Public and Defence, Health, Education and other services[1]	£1.3bn	£1.1bn	0.4%
Agriculture, Mining, Gas and Electricity	£0.2bn	£0.1bn	0.4%
Wholesale, Retail Trade, Accommodation and Food Services[2]	£0.0bn	£0.0bn	0.0%

[1]Other services as defined in the SIC code manual include repair of goods, activities of NGOs, charities, trade unions and political bodies.
[2]The Wholesale, retail trade, accommodation and food services sector shows no direct impact as there are no direct use cases that are captured in this sector group. Please note that typical delivery services that could be associated with retailers are captured in the Transport and Logistics sector.

Source: PwC.

Figure 3 – Forecasted number of uncrewed aerial vehicles (UAVs) used in the UK in 2030, economic sector



- The source adds the following information: "'Other services' as defined in the SIC code manual include repair of goods, activities of NGOs, charities, trade unions and political bodies."

Source: Statista

5 Mapping the current UAV standards landscape

5.1 Overview of current landscape

There are multiple Standards Developing Organisations (SDOs) developing standards for uncrewed aviation. There are approximately 650 standards that have been identified in varying stages of development. An overview of organisations involved in standards for uncrewed aviation include:

- 3rd Generation Partnership Project (3GPP)
- Airborne Public Safety Accreditation Commission (APSAC)
- American Society of Mechanical Engineers (ASME)
- American Society of Safety Professionals (ASSP)
- American National Standards (ANSI)
- ASTM International (ASTM)
- Airworthiness of mass-market drones: EU research programme (AW Drones)
- British Standards Institution (BSI) — including ACE 20 committees
- European Air Traffic Management (ATM) Standards Coordination Group (EASCG)
- European Committee for Standardisation (CEN)
- European Cybersecurity Standards Coordination Group (ECSCG)
- European Organisation for Civil Aviation Equipment (EUROCAE)
- European UAS Standards Coordination Group — Institute for Electrical and Electronics Engineers (IEEE) — (EUSCG)
- International Organization for Standardization (ISO)
- Japanese Standards Association (JSA)
- NACE International — National Association of Corrosion Engineers — (NACE)
- National Fire Protection Association (NFPA)
- Open Geospatial Consortium (OGC)
- Radio Technical Commission for Aeronautics (RTCA)
- SAE International — previously known as the Society of Automotive Engineers — (SAE)
- Telecommunications Industry Association (TIA)

The Discovery phase of the project quickly identified that in addition to the work being carried out by Standards Developing Organisations, there are multiple international projects focused on collating existing standards, gap analysis and recommendations to address gaps.

The main projects that are currently active are detailed in the table below.

Table 3 – Key SDOs working on drone standards development AW Drones/EUSCG/ANSI

Project	Description	Further information
• **AW Drones**	◦ Producing an Open Repository of existing standards and "best practices" to support the European Aviation Safety Agency and the European Commission in their rulemaking process. ◦ AW-Drones will propose the most suitable technical standards for all relevant categories of drones operations. ◦ Focused on facilitating Specific Operations Risk Assessment (SORA) for ground and air-based risk (separate elements within a wider standard).	◦ €2.6m Horizon 2020 funding ◦ Timescales — Jan 2019 to Dec 2021 ◦ Catalogued and analysed; approximately 50 standards ◦ Identifying duplication, gaps and recommendations to other groups

(*Continues*)

Table 3 – (Continued)

Project	Description	Further information
• **EUSCG**	◦ The EUSCG is a joint coordination and advisory group established to coordinate UAS-related standardisation activities across Europe, essentially stemming from EU regulations and the EASA rulemaking initiatives. ◦ Develop, monitor, and maintain an overarching European UAS standardisation Rolling Development Plan (RDP), based on the standardisation roadmap developed by EASA and other organisations, with inputs from EUSCG members.	◦ EU funded ◦ Ongoing initiative ◦ Released Rolling; Development Plan v2 Sept 2018 ◦ Categorisation and published status
• **ANSI**	◦ The Standardization Roadmap for Unmanned Aircraft Systems was developed by ANSI's Unmanned Aircraft Systems Standardization Collaborative (UASSC), a group established to coordinate and accelerate the development of UAS standards. ◦ The roadmap clarifies the current and desired future UAS standardization landscape to help enable stakeholders to better focus standards participation resources. ◦ Most comprehensive research and extends to best practice and detailed gap analysis.	◦ 15 months project to assess gaps, and make recommendations for priority areas ◦ V2 of roadmap published June 2020 ◦ 64 categories of standards assessed identifying 60 gaps

Table 4 Key SDOs working on drone standards development: ISO standards development

In terms of existing standards, a small number have been published, however, a significant amount of development work is currently underway, primarily on international standards, undertaken mainly by the International Organization for Standardization (ISO).

The current development of ISO standards is taking place in the following areas: Product Manufacturing; Product Maintenance; Operations and Procedures; Air Traffic Management.

Standard Reference	Description
Published	
BS ISO 21895:2020	Categorization and classification of civil unmanned aircraft systems
BS 9122:2018	Qualification and approval of UAS operatives. UAS Pilot Level 1
BS ISO 21384-3:2019	Unmanned aircraft systems. Operational procedures
BS ISO 21384-4:2020	Unmanned aircraft systems. Vocabulary
BS ISO 23665:2021	Unmanned aircraft systems. Training for personnel involved in UAS operations
In development	
BS EN 4709 series	Aerospace series - Unmanned Aircraft Systems
BS ISO 4358	Test methods for civil multi-rotor unmanned aircraft system
BS ISO 5109	Evaluation method for the resonance frequency of multi-copter UAV by measurement of rotor and body frequencies
BS ISO 5110	Test method for flight stability of multi-copter UA under wind and rain conditions
PD ISO/TR 4584	Improvement in the guideline for UA testing/design of accelerated lifecycle testing (ALT) for UAS/ Sub-system/components
PD ISO/TR 4594	UA wind gust test
PD ISO/TR 4595	Suggestion for improvement in the guideline for UA testing classification

Standard Reference	Description
PD ISO/TR 5337	Environmental engineering program guideline for UA
BS ISO 21384-1	Unmanned aircraft systems
BS ISO 21895:2020	Categorization and classification of civil unmanned aircraft systems
BS ISO 21384-2	Unmanned aircraft systems. Part 2: Product systems
BS ISO 24352	Technical requirements for light and small unmanned aircraft electric energy system
BS ISO 24354	General requirements for civil small and light UAS payload interface
BS ISO 24355	General requirements of flight control system for civil small and light multirotor UAS
BS ISO 24356	General requirements for tethered unmanned aircraft system
BS ISO 5286	Test methods for flight performance of civil light weight and small fixed-wing UAS
BS ISO 5305	General requirement of noise measurement of lightweight and small multirotor unmanned aircraft systems (UAS)
BS ISO 5309	Vibration test methods for lightweight and small civil UAS
BS ISO 5312	Evaluation and test method of rotor blade sharp injury to human body for civil lightweight and small UA
BS ISO 5332	Test methods for civil lightweight and small UAS under low pressure conditions
BS ISO 5015	Unmanned aircraft systems
BS ISO 23629	UAS traffic management (UTM)

5.2 Categorisation of standards

Most of the standards activity to date has been on the development of aviation standards that parallel or supplement crewed aviation which are focused on areas such as aircraft certification, maintenance, and communication protocols. There are over 500 suggested standards relative to drones and aviation.

Uncrewed aviation has a much broader range of uses than crewed aviation and because of this UAVs are utilised across many industry sectors supporting a diverse range of use cases.

Whilst aviation standards are required to ensure safe integration of uncrewed aviation with existing airspace users, there are two further categories of standards we have identified that are required for successful commercialisation and adoption of UAVs:

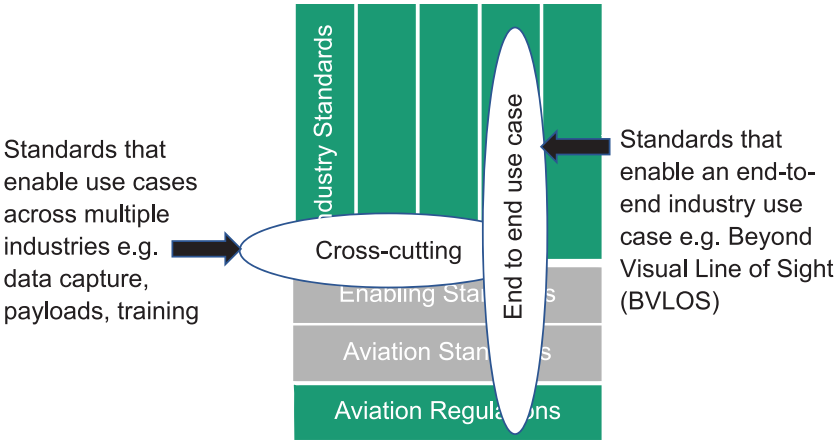
- Enabling standards — those standards that are relevant to drone operations but are not purely aviation. They will include cross cutting standards from multiple regulators. Examples will include standards from Health and Safety, OFCOM, SIA (Security Industry Authority). These may cover areas such as:
    - Communications (eg 4G. 5G, allocation of spectrum)
    - Working at height
    - Use of CCTV and cameras
    - Transportation of dangerous goods
    - Noise
    - Health and safety data standards (cross industry)
    - Security
    - Cyber security
    - Training
    - Privacy
    - Payload specifications specific to drones

- Some of the standards listed above, for example, those relating to privacy, security, training, payloads and accessories are not exclusive to the use of drones.
- Industry standards — this category will include specific industry standards and best practice. They will be specific to industry sectors or industry use cases.

The model below (Figures 4 and 5) shows the interaction of the three categories of standards which are underpinned by the regulations of the relevant aviation authority such as the Civil Aviation Authority in the UK.

Figure 4 – Standard categories model

Figure 5 – Focus on standards covering industry sectors (cross cutting) and industry-specific use cases



6 Research findings

6.1 Findings from survey

A survey was used to elicit views from a large number of UK-based drones stakeholders. The aim of the survey was to understand:

- the priorities for standards;
- the balance of standards and regulation or legislation that would most benefit the drone industry;
- comparison of standards required compared with crewed aviation;
- timeframe for development and when standards may be needed;
- issues that may prevent adoption of drones by industry;
- areas where standards will provide the greatest economic impact; and
- how development of standards may facilitate the overall growth and development of drones.

6.2 Emerging themes

Areas identified by respondents:

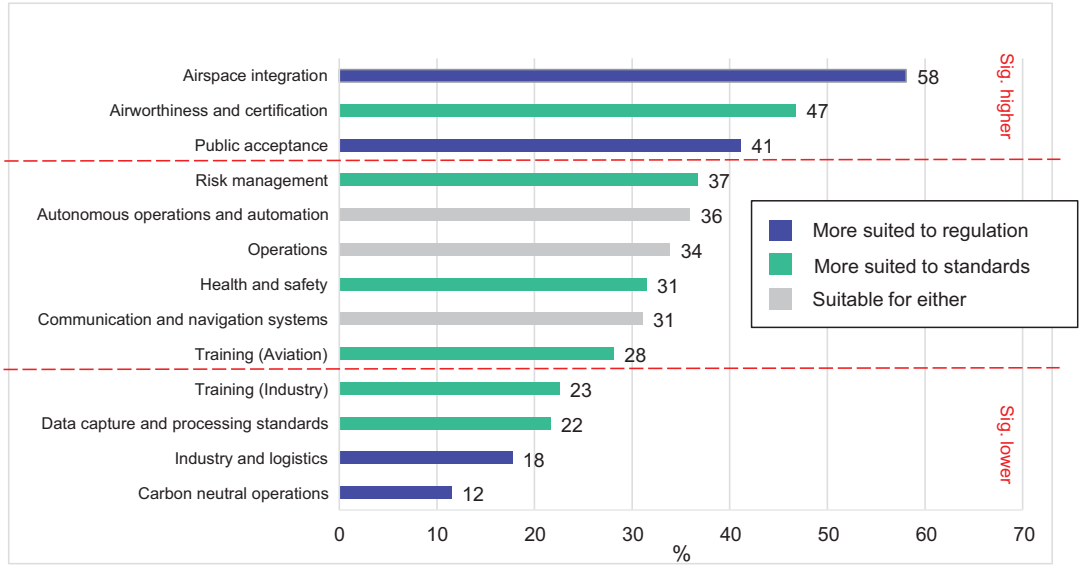
- **Safety** was the top concern, and in many respects became a default position for respondents to select regulation as the only option. HSE requirements pertaining to specific industries needed to consider the application of drones. Two fifths of drone users would prefer to see standards developed for health and safety and risk management in under a year.
- **BVLOS** was a theme that resonated with many respondents. There was a perceived lack of clarity about how it relates to specific applications. An interesting point raised by several was communications. The use of the existing 4G network and the developing 5G infrastructure for command and control and payload transmission is being tested to understand the impact on the mobile networks. This may be an area for future standards development.
- **Privacy** was not a key factor for respondents, although many acknowledged this to be a key obstacle to gaining public acceptance and potentially a brake on adoption. The professional respondents believe that the issues are caused by a small minority of hobbyists and that increased enforcement will mitigate this issue.
- **Professional vs hobbyist.** Perhaps not unsurprisingly these two groups are almost at polar opposites. Professionals recognise the need for regulations, and the introduction of relevant standards to support the growth and development of professionalism, alongside training and best practice, whilst hobbyists rarely see the need for any constraints. To some extent this argument holds true if hobbyists are restricting themselves to club or specific segregated air space zones.
- **Fear of red tape within the industry.** A concern for respondents was the perceived negative impact of bureaucracy and the need for streamlined and more agile processes. There is a need to strike a balance between a safety critical sector and facilitating innovation.

6.3 Key observations for standards suitability

Regulations versus standards and suitability

The survey was designed to test understanding of regulation versus standards and, in addition, the suitability of regulation versus standards. Respondents were asked to put the topics and sub-topics into results categories: most suited to regulation, most suited to standards, suited for both. See Figure 6.

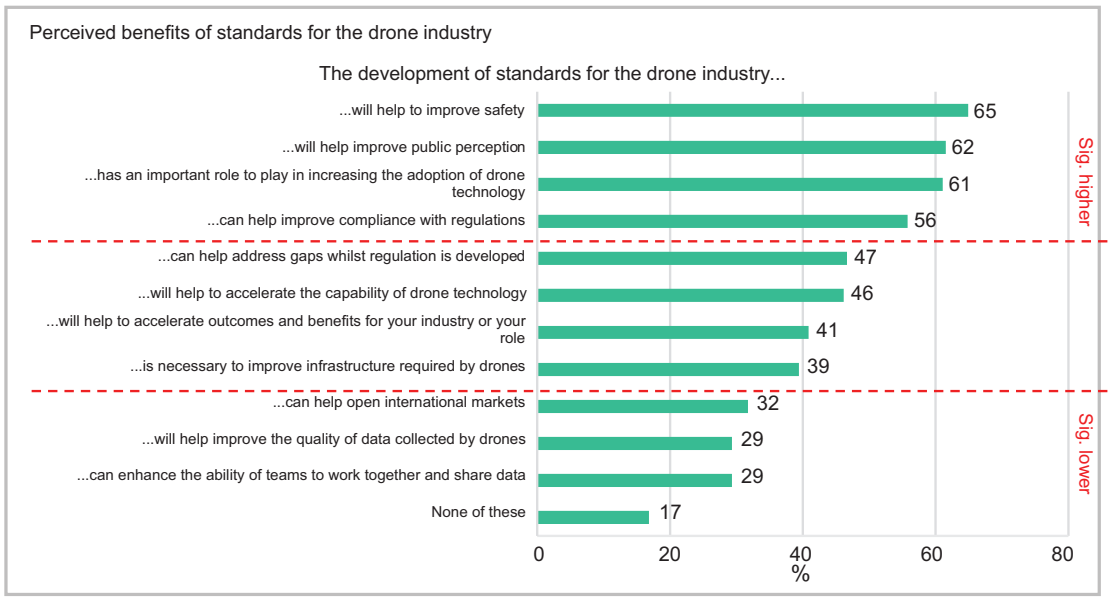
Figure 6 – Which of these topics will have the greatest economic impact and impact on the speed of adopting drone technology? [Q17]:



i) Safety and public perception are the key perceived benefits of standards

A number of statements relating to the development of standards were presented to the respondents. Safety and public perception were the highest ranked topics followed by increasing the adoption of drone technology and helping to improve compliance with regulations (see Figure 7). The lowest ranked responses covered opening international markets, improving the quality of data collected and helping teams work together and share data.

Figure 7 – Perceived benefits of standards for the drone industry Which of these statements do you agree with? [Q21]

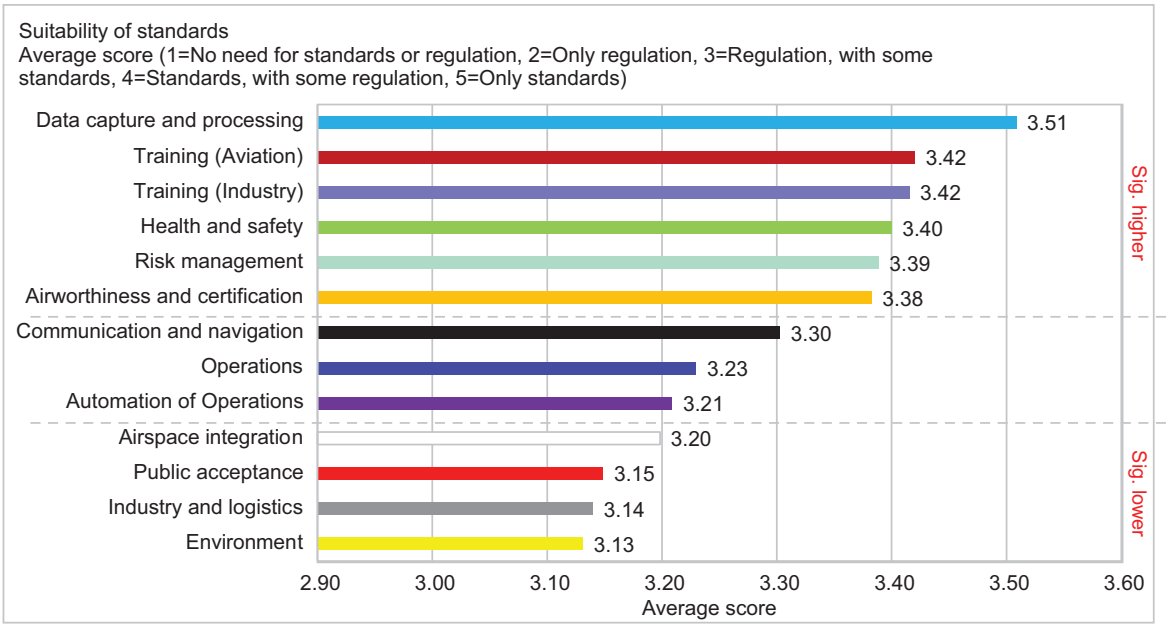


ii) Suitability of sub-topics for standards versus regulations

Standards are considered more suitable for health and safety/risk management topics (including

airworthiness and certification) which present a lower level of danger and for topics relating to business efficiency (data capture and processing/training). See Figure 8.

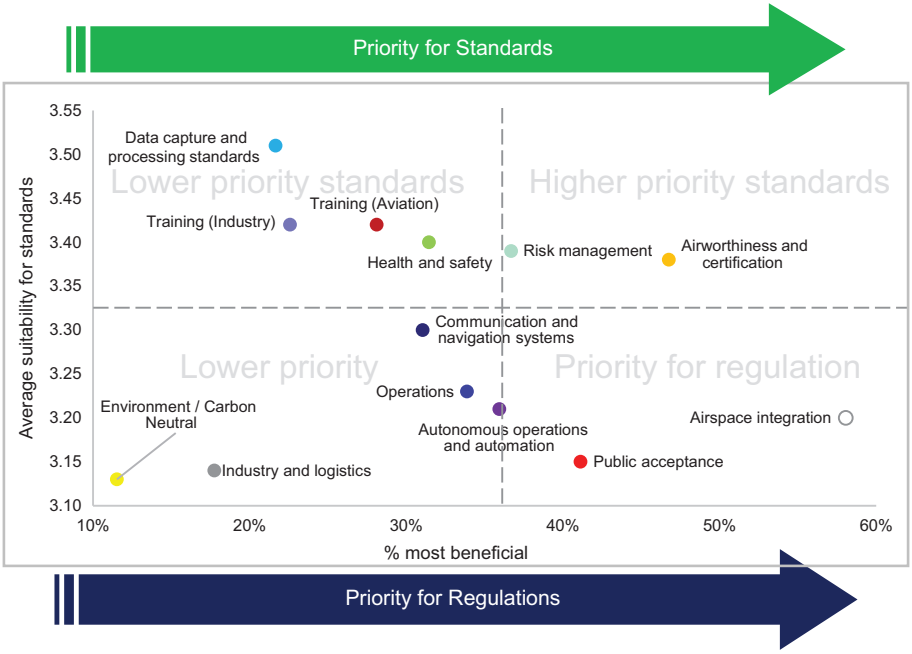
Figure 8 – For each of the topics below, please tell us what balance of standards and regulation/legislation, if any, you think would benefit the drone industry? [Q9-Q16]



iii) Priority focus for standards

Initial development of standards should focus on risk, safety and certification. Training, data capture and processing standards represent a second tranche of topic areas to address with standards, assuming existing standards cannot be repurposed. See Figure 9.

Figure 9 – Standards with the greatest economic impact and impact on the speed of adopting drone technology. Q17: / Q9-Q16: Average scores for suitability for standards



iv) Most suitable subtopics for standards

ORA (Operational Risk Assessment), Maintenance, Data Capture and Processing are the subtopics most suited to being developed as standards (see Table 5). Subtopics are broadly consistent by role, industry and whether use of drones is professional or as a hobby/interest. The bottom eight topics, ie least suited to standards, include: Communication and Navigation; Airspace Integration, Public Acceptance and Risk Management.

Table 5 – Top 10 sub topics most suited to standards

Top 10 sub topics	Topics
• Operational Risk Assessment (ORA)	◦ Risk Management
• Maintenance	◦ Airworthiness and Certification
• Data Capture	◦ Data Capture and Processing
• Data Processing	◦ Data Capture and Processing
• Power Sources	◦ Airworthiness and Certification
• Ground Safety	◦ Health and Safety
• Hazard Mitigation and Management	◦ Risk Management
• Industry Training	◦ Training (Industry)
• Operations Manual	◦ Autonomous Operations and Automation
• Drones that Do	◦ Industry and Logistics

v) Drones versus crewed aircraft — comparison of standards

Standards for drones are not expected to be any more comprehensive than those for crewed aircraft. Public acceptance is more polarised, as it covers aspects relating to privacy and the misuse of drones. For Operations and Certification, the expectation, on balance, would be for less comprehensive requirements. NB: Hobbyist drone users, and those in Aerial photography tend to want less comprehensive standards in all areas except Public Acceptance.

vi) Timeframe

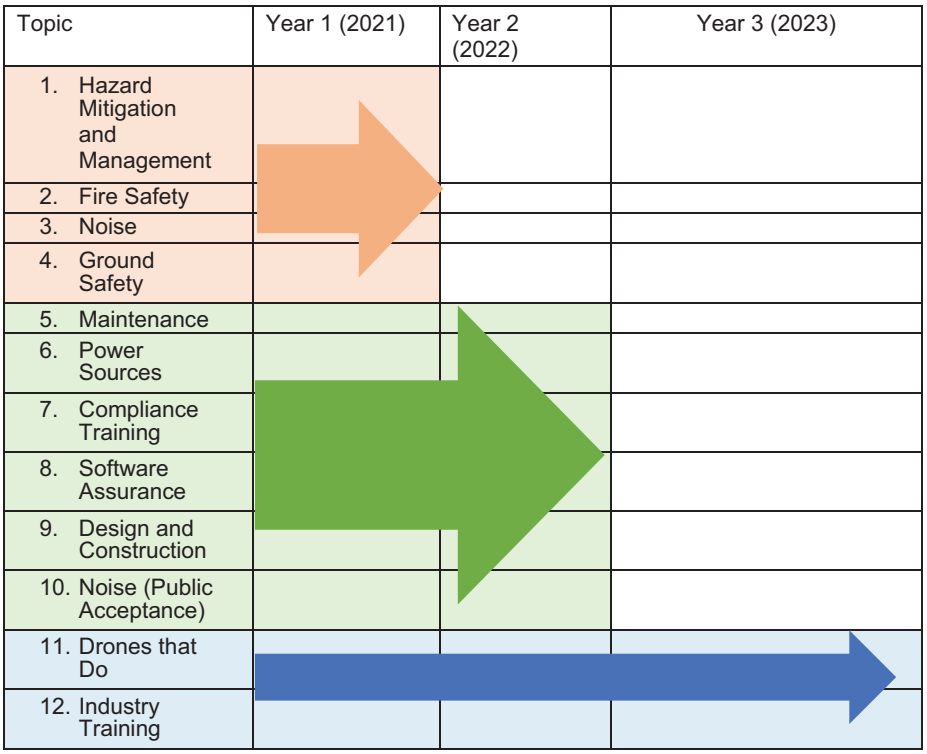
As previously noted, those standards relating to safety are considered priority. Two fifths of drone users would prefer to see standards developed for health and safety and risk management in under a year. NB: Hobbyist drone users are less likely to want standards developed quickly, especially in the areas of Certification (2.83 yrs), Operations (3.48 yrs) and Communication/Navigation (3.24 yrs).

7 Proposed standards roadmap

The survey highlighted areas where topics could be satisfied by either regulation or the development of standards: A number of the highest priority and most beneficial topics and sub-topics were more suitable for regulations than for standards, at least in the near future. See Figure 9.

Interdependencies between the prioritised standards on the roadmap below need to be considered. Standards are considered more suitable for health/risk management topics (including certification) which present a lower level of danger and for topics relating to business efficiency (data capture and processing/ training). Training, data capture and processing standards represent a second tranche of topic areas to address with standards, assuming existing standards cannot be repurposed.

Figure 10 – Roadmap illustrating *priority* candidates for standards development



The above charts illustrate how overall, respondents prioritised topics for standards development. This set of priorities need to be seen in the context of topics that have been assigned as candidate regulations, including:

- Airspace integration
- Public Acceptance
- Autonomous Operations
- Industry and Logistics
- Environment/Carbon Neutral.

Research found that the category 'Communications and navigation systems' is viewed as an area for regulation but is close to becoming a potential standards candidate.

8 Conclusions

The nascent drone market is dynamic, innovation-led and a complex subject not solely focused on aviation standards. It became apparent from the research (including the survey and interviews) that there is confusion over the role of regulations and standards.

- The industry requires guidance and support to ensure safety, professionalism, and best practice.
- Operators, especially in the SME segment, have to quickly understand and comply with changing regulations, techniques, and best practice with either limited or inadequate guidance or by relying on industry reference guides where they exist. Beyond Visual Line of Sight (BVLOS) is considered by many as the barrier that prevents the widespread commercial adoption of drone technology.
- BVLOS was highlighted in the survey as the area that would benefit most from regulation and standards.
- However, this further highlighted the confusion around regulation and standards as most respondents believed BVLOS should be addressed through regulation without the need for supporting standards.
- To enable BVLOS requires multiple technology advances such as electronic conspicuity and detect and avoid (DAA) solutions.
- Whilst BVLOS will require changes to regulation, the underpinning technology will require supporting standards.
- ANSI, EUSCG and AW Drones projects have all completed gap analysis against the standards categorisation frameworks developed respectively by each project/ Based upon the research carried out during this project, the ANSI Standardization Roadmap was identified as providing the most comprehensive gap analysis for standards across uncrewed aviation. ANSI has identified a total of 71 gaps that require standards development. Some of the gaps are significant and will require multiple standards to be developed, for example, BVLOS referred to earlier.

The top five topics perceived to have the biggest impact for industry and speed of adoption:

- Airspace Integration
- Airworthiness and certification
- Public acceptance
- Risk Management
- Autonomous operations and automation

The top five sub-topics most suitable for standards:

- Operational Risk Assessment (ORA)
- Maintenance
- Data Capture
- Data Processing
- Power Sources

Segments that will benefit from standards:

- Inspection (construction, engineering, inspection, utility infrastructure, firefighting, security)
- Data collection (drones can collect data more accurately, quickly, cheaply and safely than ever before; but need to conform to end user specification and requirements)
- Robotics (automated jobs and tasks from de-icing wind turbines to security patrols)
- Delivery

In the uncrewed aviation sector, there is considerable ***duplication*** — 650+ standards in various state of development. This is a busy space, and the valuable work of the ACE 20 committees has focused on some key areas.

The development of standards for use by industries that are not aviation focused industries is currently immature and the greatest opportunities focus on the cross-cutting intersection between Enabling and Industry standards relating to the deployment of drones in different industries.

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