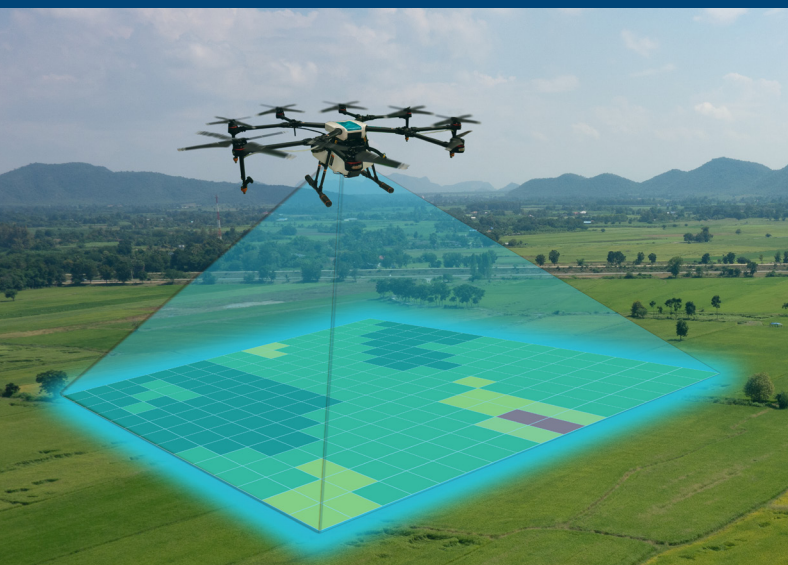




The  
Federal Government

# Unmanned Aircraft Systems and Innovative Aviation Strategies

## The Federal Government's Action Plan





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# Glossary of abbreviations

ATM	Air Traffic Management
BIM	Building Information Modeling
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMVg	Federal Ministry of Defence
BMVI	Federal Ministry of Transport and Digital Infrastructure
BMWi	Federal Ministry for Economic Affairs and Energy
BOS	Authorities and organizations with safety and security responsibilities
BVLOS	Beyond visual line of sight
DLR	German Aerospace Centre
DLRG	German Life Saving Association
DWD	German Meteorological Service
EASA	European Aviation Safety Agency
ETSI	European Telecommunications Standards Institute
EU	European Union
eVTOL	Electric Vertical Take-off and Landing
FLARM	Flight Alarm – a proprietary collision warning device used primarily on light aircraft
GDPR	General Data Protection Regulation
ICAO	International Civil Aviation Organization
LBA	Federal Aviation Office
LUC	Light unmanned aircraft system operator certificate
LuftVG	Civil Aviation Act
LuftVO	Rules of the Air Regulations
RPAS	Remotely Piloted Aircraft System
SMEs	Small and medium-sized enterprises
SORA-GER	Specific Operations Risk Assessment Germany
THW	Federal Agency for Technical Relief
UAM	Urban air mobility
UAS	Unmanned aircraft system
UBA	Federal Environment Agency
UTM	UAS Traffic Management
U-space	Term used in Europe for UTM

# Foreword

In 1889, Otto Lilienthal published his standard work on the understanding of aerodynamics and in it provided the best instructions at the time on how to construct an aircraft. Since that time, Germany has been an aviation pioneer and a trailblazer for new technologies in flying. Today, we are one of the leading aviation nations in research, development and production of aircraft. And what drives us is innovation.

We now once again stand on the threshold of a new form of air transport – and again we want to be among the leaders. Unmanned aircraft systems (UAS) are an extremely fascinating innovation. They mark the dawn of a new aviation era: electric, autonomous and quiet. This is made possible by the advancing digital transformation, innovative propulsion designs and new materials.

UAS offer a broad spectrum of possible applications. Whether in logistics, for safety and security functions, the transport of medicines, surveying, environmental protection, nature conservation, agriculture or even, in the long term, as “air taxis” – these ceased to be visions a long time ago. And the range is constantly growing. UAS provide opportunities for mobility in urban and rural areas as well as for the provision of goods and services in regions that are difficult to access. The applications and schemes can make people's lives easier and make a major contribution to more wealth creation.

The Federal Government wants drones and air taxis to be able to leave the laboratories and take to the skies. The industry knows best how that works in terms of technology. We, however, can create the framework it needs – a regulatory, societal, infrastructure and environmentally aware framework. That is what the present Action Plan is designed to do. It defines the measures to be taken by the Federal Government to pave the way for the use of automated and remotely piloted drones and air taxis. On the one hand, it takes into account the existing responsibilities within the Federal Government, and on the other hand, it makes effective use of the wide range of the many and varied interfaces



Andreas Scheuer, Member of the German Bundestag  
Federal Minister of Transport and Digital Infrastructure

between safety, security, innovation and competitiveness. In this way, Germany will remain an attractive location for industry, research and services. The Action Plan incorporates the different interests of the relevant stakeholders in order to reach a consensus and progress today a mobility mode of tomorrow.

For this to happen, we have to enjoy the support of the people. We will take legitimate concerns on the part of the public very seriously. Ensuring safety and security, noise abatement and the protection of personal data and privacy are key elements of this. We will not achieve acceptance of the new technology unless we find appropriate and legally certain solutions in these action areas.

In this way, we can succeed in establishing drones and air taxis as a new mode of transport throughout Germany. They will complement existing modes of transport in a meaningful manner and fit into the multimodal transport system of the future – safe, reliable, intelligent and clean.

A handwritten signature in black ink that reads "Andreas Scheuer". The signature is written in a cursive, flowing style.



# Preface

Drones have long since been much more than a vague vision or a gadget for hobby pilots. In the hands of professional users, drones are a strong tool from which people, the environment and society can benefit. And the drone economy is an engine of growth, creates high-value jobs and is a market with a future. Visions for innovative drone services are mushrooming worldwide. The potential is huge. All forecasts predict a constant growth of the market. Estimates range from around 90 billion euros in the next ten years to around 1.5 trillion euros by 2040. Today, just under 400 companies in the drone economy already employ 10,000 people in Germany in fields such as surveying, inspections, filming and photography.

Our highly innovative start-up scene in Germany plays an important role in the evolution of this industry. It is closely dovetailed with outstanding institutes of technology, research establishments and universities. In addition, established companies from the field of software development, the traditional aviation industry and the information and communications sector have recognized the signs of the times and are stepping up their investment in the drone economy.

The rapid growth comes as no surprise, as the civilian systems available on the market are becoming more powerful and at the same time less expensive. This is complemented by innovations in the sphere of AI-based controls and applications which, alongside the hardware, constitute the centrepiece of innovative drones.

The Federal Government wants to play its part in encouraging unmanned aerial systems to be developed and used in Germany. This technology will be a significant locational factor in the future and an opportunity for Germany to showcase its innovative capacity and innovation-friendly climate.



Thomas Jarzombek, Member of the German Bundestag  
Federal Government Coordinator of German Aerospace Policy

The Federal Government's Action Plan has benefited from an intensive dialogue and workshops between the ministries involved, industry and academia. I would like to thank the many academics, entrepreneurs and other experts who made their ideas and knowledge available. They helped us by providing good impetus and expertise and demonstrating commitment.

I hope you enjoy reading the present Federal Government Action Plan entitled "Unmanned Aerial Systems and Innovative Aviation Strategies", and I look forward to engaging in further dialogue on this important topic.

A handwritten signature in dark ink, consisting of a stylized 'T' followed by a series of loops and a long vertical stroke.





# 1. Introduction

In 2017, the Federal Government adopted rules for the operation of UAS. It was the first important step in paving the way for this emerging technology. Technological innovation also requires innovative thinking and action on the part of policymakers and the public authorities. This is the only way in which we will be able to maintain our leading role in aviation.

At the same time, it is imperative that we take account of the legitimate concerns of the public and the requirements of the environment and nature. Safety and security, noise mitigation, the protection of personal data and privacy plus the protection of public safety and order are to be ensured, including, for instance, the security of critical infrastructures.

The major provisions governing air transport are developed at international level. UAS are no exception here. For the Federal Government, getting involved at the global and European levels for the development of technical and legal standards is both a necessity and a commitment. We want to contribute our approaches to problem-solving while at the same time learning from other nations.

The digital revolution, as a driver of UAS development, is resulting in an increasing combination of two worlds with two very different sets of experiences. Manned aviation, characterized by procedures established and proven over decades and geared toward ensuring maximum safety and control of the airspace, meets an innovative start-up scene, mostly with a background in IT. Our task is to establish the regulatory framework, ensure planning certainty and thus bring both sides together. Safety will continue to be the focus of all endeavours. However, we are seeking to ensure the maximum efficiency and freedom of air transport, taking sustainability aspects into account. This also includes making new business models possible.

As an innovative driver of technology, research and development enjoy a high status in Germany. Understanding new technologies is made possible by practical applications. Digital test beds for autonomous and connected driving were the logical approach, and we want to apply this approach to UAS. We laid the foundation for this back in 2018 by establishing the National Experimental Test Centre for Unmanned Aircraft Systems. Test beds make a major contribution towards making the technology fit for everyday use – and show us where there is a need for action for further legislation.

The focus of the Action Plan takes account of the measures associated with the process of transposing the EU Regulations on unmanned aircraft – (EU) 2019/945 and (EU) 2019/947. As is the case with all new technologies, the many and varied opportunities and dynamics of the current development of UAS also face the interests of public safety and security and the concerns of nature conservation and environmental protection, including noise mitigation. It is therefore necessary to find problem-solving approaches via targeted regulation in an airspace that will be busier in the future<sup>1</sup>. Because the broad spectrum of applications of UAS on the one hand and the high dynamism of this field of technology on the other hand will not only result in a significant growth in the number of flight movements but will also further increase the complexity of the challenges faced by the safety and security authorities. In addition, the transport-related rules must be framed such that they have due regard to, in particular, territorial and species protection plus the protection of people against noise generated by UAS. This will include prohibiting illegal flying over residential property and protected areas.

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<sup>1</sup> Police *modi operandi*, capabilities and tactics in connection with the use, detection and interdiction of drones are not covered by this Action Plan.

## 2. Fundamentals

### 2.1 The road to unmanned aircraft systems

The first steps taken by aviation were unmanned; first with balloons and subsequently model aircraft to examine their basic ability to fly. Unmanned weather balloons for atmospheric and climate research have been in use since the 19<sup>th</sup> century.

Starting in the 1930s, it was primarily military uses that expedited the development of unmanned aircraft. What started in the military sphere has, since the beginning of

the 21<sup>st</sup> century, increasingly been finding its way into civil applications. If the performance of UAS was very limited in their early days, their development has advanced at a very rapid pace. The Fourteenth Act amending the Civil Aviation Act, which was passed in 2012, incorporated unmanned aircraft systems into the catalogue of aircraft in section 1 of the Civil Aviation Act. This reflected the potential developments and applications opened up by unmanned aviation. Today, there are manifold applications of UAS, and new ones are emerging every day:

- Agriculture (including the targeted use of pesticides and fertilizers);
- Medical care (including transport of pharmaceutical products, banked blood, tissues);
- Civil protection (including searching for missing persons, assessing the situation in major fires, flooding or forest fires, prevention of swimming accidents, facilitation of rescue and recovery);
- Aviation industry (including monitoring of airport grounds, maintenance of aircraft);
- Maritime transport industry (including monitoring shipping lanes after accidents and lost cargo);
- Energy supply industry (including inspection of high tension transmission lines, pipelines and wind turbines);
- Distribution logistics (including delivery UAS);
- Construction and property industries (especially through photogrammetry);
- Media production (filming and photography);
- Security and law enforcement;
- Reconnaissance;
- Provision of goods and services to rural or remote, difficult-to-access areas;
- Water protection (including identification of released pollutants);
- Surveying (including of construction sites or in the extraction of mineral resources in real time).



The range of applications of UAS already shows today that future uses will exhibit a broad spectrum of applications. Several companies throughout the world are now working on UAS for the carriage of passengers (“air taxis”). Although air taxis are no longer unmanned aerial vehicles in the narrow sense of the word, they have nevertheless to be seen as a new and innovative approach to mobility in the context of UAS.

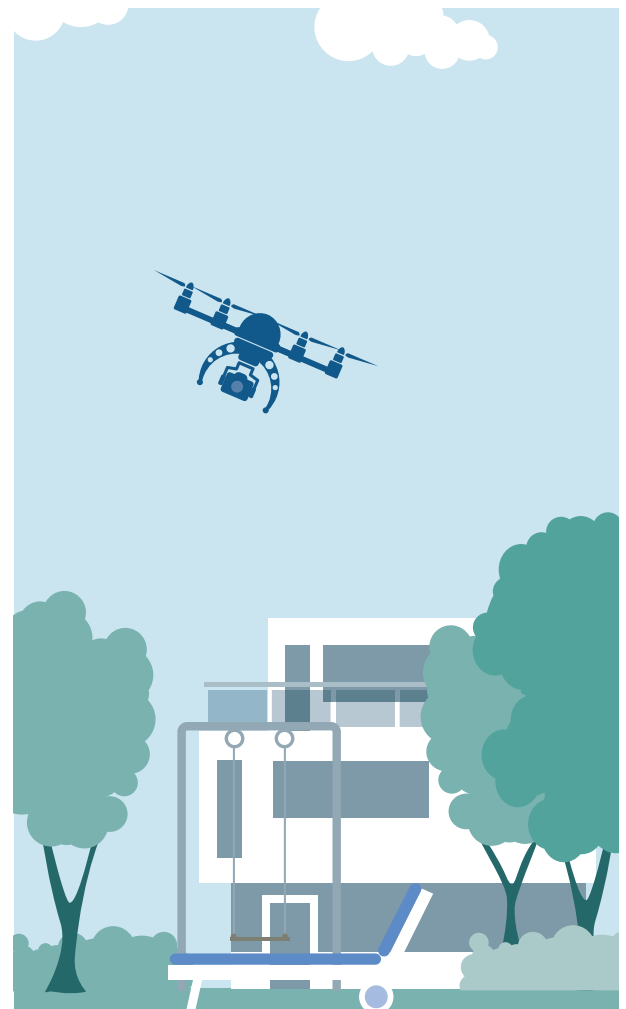
Some people may still consider air taxis to be a vision – but they ceased being that a long time ago. We have to discuss today how the designs being developed can be integrated into the airspace and the air transport infrastructure. We need to give thought today to the innovative approaches to mobility of tomorrow if we wish to be successful in international competition. Our priorities here are the promotion of the domestic industry in research and development plus a smooth transition to practical applications – but only provided that public safety and order, as our most precious asset, are simultaneously preserved. This applies in particular to environmental protection, nature conservation and noise mitigation plus the preservation of the individual’s right to informational self-determination and thus of data protection and privacy.

In the future, operation that is only remotely piloted will no longer meet the requirements of commercial UAS applications. In pursuit of the vision of autonomous UAS applications, it is first necessary to gradually establish highly automated operation so as to be able to fly a large number of UAS in a cost-efficient and safe manner. This confronts policymakers with major challenges as they address the task of preserving and protecting the aforementioned assets.

## 2.2 Regulatory framework for unmanned aircraft systems

In 2017, the new Part 5a of the Rules of the Air Regulations (LuftVO), which addressed exclusively UAS, entered into force. The principal motivation for these legal amendments was the desire of the body enacting the regulations to promote on a large scale the future-proof development opportunities of this new technology, for instance the commercial, scientific and not-for-profit use of UAS, but

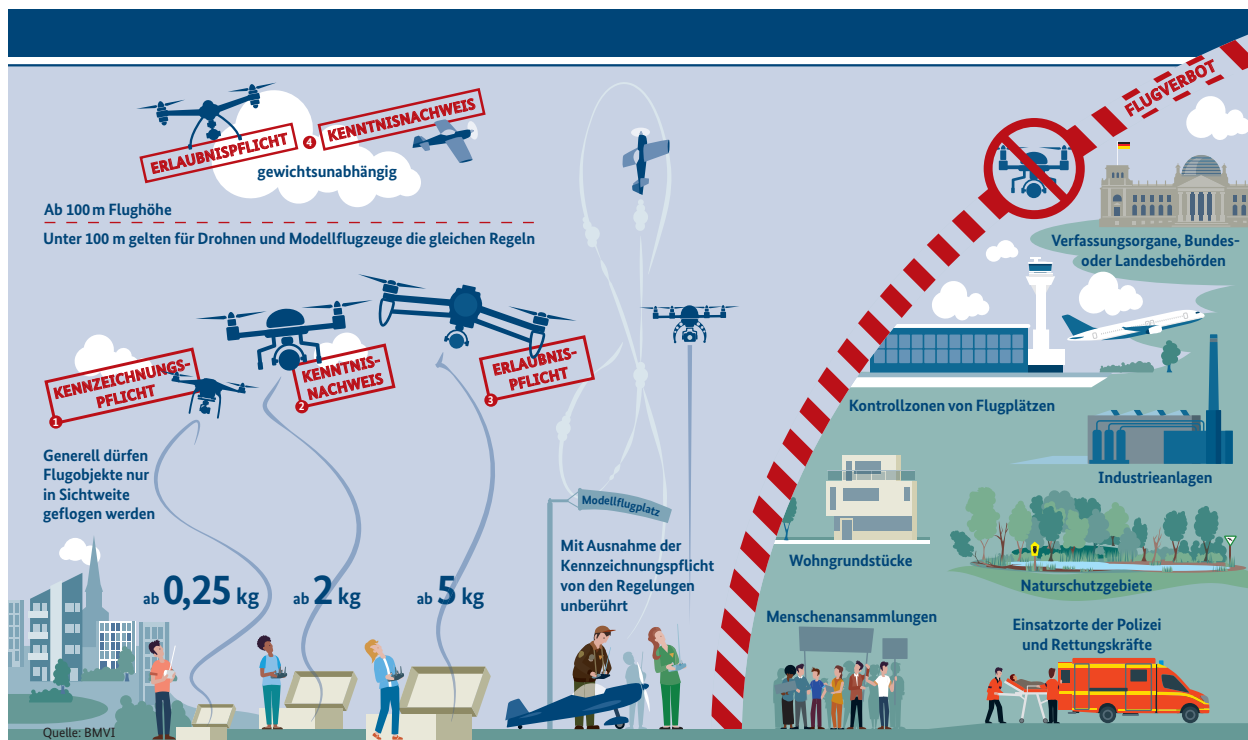
at the same time, to appropriately counteract possible threats to other airspace users or third parties on the ground resulting from the expected increase in operations, regardless of whether these threats are the result of malign intent or negligence. Since then, the commercial deployment of UAS has no longer automatically required a licence, which relieves the burden on the commercial users of the devices. At the same time, it was defined what UAS operations generally require a licence or are prohibited, for instance over certain especially sensitive sites and installations. The purpose of these restrictions is not only to maintain the safety of aviation but also to ward off dangers to public safety and order, especially nature conservation, personal data and privacy.



Section 1 of the Civil Aviation Act states that UAS are unmanned aircraft, including their control station, that are not operated for purposes of sport or recreational activities. They are deemed to be aircraft within the meaning of the Civil Aviation Act. Under current legislation in Germany, UAS can be classified in five categories on the basis of their take-off mass:

<p><b>Category 1</b></p> <p>UAS with a take-off mass &lt; 0.25 kg:</p> <p>No marking required</p>	<p><b>Category 2</b></p> <p>UAS with a take-off mass ≥ 0.25 kg:</p> <p>Marking required</p>
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<p><b>Category 3</b></p> <p>UAS with a take-off mass ≥ 2.0 kg:</p> <p>Certificate of knowledge also required ("UAS driving licence")</p>	<p><b>Category 4</b></p> <p>UAS with a take-off mass ≥ 5.0 kg:</p> <p>Plus obligation to obtain permission</p>
<p><b>Category 5</b></p> <p>UAS with a take-off mass ≥ 25 kg:</p> <p>Operating ban, exemption may be granted by competent authority</p>	



- 1 Kennzeichnungspflicht: Ab 0,25 kg muss eine Plakette mit Namen und Adresse des Eigentümers angebracht werden – auch auf Modellfluggeländen.
  - 2 Kenntnisnachweis: Ab 2,0 kg müssen besondere Kenntnisse nachgewiesen werden.
  - 3 Erlaubnispflicht: Ab 5,0 kg wird eine spezielle Erlaubnis der Landesluftfahrtbehörde benötigt.
  - 4 Ab 100 m: In dieser Höhe dürfen Drohnen nur fliegen, wenn eine behördliche Ausnahmeerlaubnis eingeholt wurde. Bei Modellflugzeugen müssen lediglich besondere Kenntnisse nachgewiesen werden.
- Weitere Überflugverbotsbereiche siehe: [www.bmvi.de/drohnen](http://www.bmvi.de/drohnen)

The **requirement to mark** UAS with a take-off mass of 0.25 kg or more was introduced so as to be able to quickly identify the owner of the device in the event of damage being caused. This marking takes the form of a sticker bearing the name and address of the owner. A **certificate of knowledge** ("drone driving licence") is required for the operation of UAS weighing 2 kg or more. Operators of UAS must have knowledge of the use and navigation of UAS, the relevant legal bases in aviation law and the organization of the local airspace. Proof has to be furnished by presenting a valid pilot's licence or a certificate issued by a body recognized by the Federal Aviation Office (also possible online) after an examination has been passed.

No official permission is required for the operation of model aircraft and unmanned aerial systems with a total mass of less than 5 kg; there is thus **exemption from permission**. Operation by or under the supervision of authorities within the scope of their functions and by organizations with safety and security responsibilities for the aforementioned purposes does not normally require permission. **Permission is required** for the operation of UAS weighing 5 kg or more and – irrespective of the take-off mass – at night. Permission is granted by the federal state aviation authorities. UAS may not be operated over especially sensitive sites and installations, such as residential property, industrial plants, prisons, hospitals, military installations, power plants, federal trunk roads and rural areas plus areas protected by the Federal Nature Conservation Act. The competent aviation authority may, in some cases, **permit exemptions from the prohibitions** if the operation does not pose any risk to aviation safety or to public safety and order, especially in the form of an infringement of the provisions governing data protection and nature conservation, and due regard is paid to protection against aircraft noise. The basis for the permission and granting of exemptions is a uniform safety assessment. This also applies to **beyond visual line of sight operations**, which may likewise be permitted by the competent federal state aviation authorities. Permissions and exemptions from the prohibition on operation may be granted on a case-by-case basis or generally for a period of up to two years.

The legislative process for all operations of unmanned aircraft has been ongoing at European Union (EU) level since 2018. The basis is Regulation (EU) 2018/1139, which established rules at EU level also governing unmanned aircraft below a take-off mass of 150 kilogrammes. When German law was re-enacted in 2017, it was already known that rules uniform throughout Europe would be applicable in the future. In view of the forthcoming EU rules, it was therefore decided not to introduce more detailed technical specifications and compulsory registration. The EU Regulations adopted so far on unmanned aircraft (2019/945 and 2019/947) entered into force on 1 July 2019 and are to be applied as of 1 July 2020 (see 5.3 for more information on new EU legislation). The UAS register that is now to be established will make it possible to quickly identify registered, cooperative and thus, as a rule, harmless UAS while also facilitating security measures, especially against uncooperative UAS over especially sensitive locations and installations, for instance in the vicinity of airports or over major events.

## 2.3 Security and law enforcement

UAS are primarily small flying objects and thus difficult to locate. In the sphere of security and protection of the public realm, this poses an enormous challenge. These challenges can be caused by technical faults in the operation or the improper use of UAS. In addition, UAS can also be used with criminal intent. In these cases, it may be necessary for the authorities to take security measures. The police forces of the Federal Government and the federal states responsible for security may deploy UAS for the performance of their statutory functions within the framework of the law applicable to them. The advantages of the deployment of UAS are evident. They can, for instance, survey scenes of crime, reconstruct the escape routes followed by perpetrators, protect railway lines against vandalism or search for missing persons. It is thus important that the right impetus be provided when fleshing out the technical and operational parameters of UAS.



# 3. Potential

## 3.1 New spectrum of applications

UAS open up a totally new and broad spectrum of applications. The advantage of UAS lies in their low-cost and flexible range of uses, as described, inter alia, in the brochure entitled “... with drones”<sup>2</sup> published by the Federal Ministry for Economic Affairs and Energy, taking actual examples from everyday practice. Most of the operating modes of UAS described below require permission or a derogation from the federal state aviation authority responsible in any given case. Because there is as yet no regulatory framework, the carriage of passengers by air taxis is addressed separately in Chapter 6.

In all the possible uses of UAS described below, we will also ensure, by means of regulation, that, especially in the case of UAS fitted with cameras, only technical systems are used that comply with the requirements set out in Article 25 of the General Data Protection Regulation (GDPR) on data protection by design and default. By doing so, we want to ensure that when UAS are used to achieve any given objective, there is no collection of personal data in the first place, because this is not necessary.

This also applies to

- UAS fitted with sensors (passive, such as visual, infrared, thermal or active, such as ultrasound, radar, lidar);
- the organization of UAS in the airspace by air traffic management (ATM) and integrated UAS traffic management (UTM, also known as U space in Europe);
- the use of artificial intelligence and “geo-fencing” which informs the operator about possible local operating bans and/or is designed to prevent drones from flying into such areas;

and all other applications mentioned in this Action Plan.

We want to turn UAS developed in Germany, not least by young entrepreneurs and start-ups, into a worldwide export winner by integrating into them data protection and data security tools. This will safeguard and create jobs in Germany.

### Transport

In the transport infrastructure sector, the use of UAS for various fields of application is not only conceivable but is already reality. Structures that are part of the **railway and road infrastructure** (bridges, overhead lines, alignments) have to be regularly subjected to a visual inspection, which is labour-intensive, time-consuming and costly. UAS can be used here to provide support. In combination with automated imagery analysis using building information modelling (BIM), fully automatic UAS are, in the future, and if the weather and traffic conditions are suitable, to swarm out and collect real-time condition data for maintenance work.

In **road transport**, UAS can be used for traffic surveillance to detect traffic disruption at an early stage and communicate this information to the traffic flow management bodies. Given the constantly growing mobility needs, it is imperative that the existing transport infrastructure be optimized. This requires highly accurate area-related micro traffic data that describe the interaction between individual vehicles and the infrastructure and between the vehicles themselves. The analysis of UAS-based video recordings can make a valuable contribution to this.

There is also potential inherent in the use of UAS for traffic surveillance on the **waterways in coastal areas and inland waterways** and for the inspection of the infrastructure on these waterways. UAS can be used to survey the condition of aids to navigation and weirs, thereby minimizing the need for time-consuming and costly inspection by ship. They can complement the vessel traffic monitoring conducted by manned aircraft by using high-resolution cameras to detect oil spills or by taking samples from emissions from sea-going ships.

<sup>2</sup> <https://www.bmwi.de/Redaktion/DE/Publikationen/Technologie/drohnen-unbemanntes-fliegen.pdf>

In **air transport**, they lend themselves to use in the inspection of runways and taxiways. Image-processing means can be used to detect foreign objects that pose a hazard to aircraft. The use of UAS for bird control is also on the increase – an important element in protecting aircraft against bird strike. UAS can perform survey flights for the obstacle situation in the approach and take-off climb surfaces and for instrument landing systems. In the repair and maintenance of aircraft, UAS provide support to the visual inspection of difficult-to-access parts of an aircraft, for instance the upper side of the fuselage or of the vertical and horizontal tail surface. In accident investigations, UAS can perform sterling service by quickly producing aerial photographs.

### **Remote sensing**

For the monitoring of the land surface and bodies of water, for instance as part of schemes to upgrade the ecological habitats on bodies of water, analyses of the vegetation cover and of surface structures are required. Here, UAS open up new perspectives. Even in difficult-to-access areas, ultra-high-resolution time and spatial data are acquired for answering vegetation-related or hydromorphological questions. In addition, UAS provide valuable information for supporting situation management activities in disaster control. UAS can be used to complement the collection of meteorological data and weather observation. They make possible targeted deployment in different altitude bands, which contributes to understanding current weather patterns. In addition, UAS operating at high altitudes allow statements to be made about climate variables in the atmosphere.

### **Surveying**

Surveying of the ground surface is made quicker and easier by the use of UAS. During the observation of major building sites or the extraction of mineral resources, UAS make it possible to depict changes almost in real time. What survey teams today have to perform on the ground in a time-consuming manner can now be done with a UAS overflight. In the future, it will be possible to survey difficult-to-access regions at low cost. UAS are now frequently also used for highly accurate surveys in the digitization of cultural monuments or in archaeological

excavations. In combination with suitable software solutions, precise georeferencing and photogrammetry, this significantly simplifies land registers and mapping.

### **Media production and aerial photography**

Today, UAS are already being successfully used in filming and photography as well as at sporting events. In many cases, they take the place of helicopter flights. UAS can also fly in places where this is not possible for helicopters, for instance under bridges. This is unlocking new potential.

### **Security and law enforcement**

Within the constraints of the legal bases applicable to them, the security authorities can use UAS as sensor carriers for the surveillance of high security areas, for the reconnaissance of sites of operation, for documentation or as radio relay. This applies, for instance, to the protection of railway lines against vandalism and theft or the production of crime scene photographs. In the case of actual security threats, it is possible, with the help of UAS, to identify and pursue relevant persons, to document evidence and coordinate the deployment of ground forces. At major events with large gatherings of people, UAS help the police to prepare up-to-date situation reports to channel flows of people, manage road traffic and coordinate with other authorities and organizations with security and safety tasks.

The Federal Government and federal state police forces may, within the scope of the functions statutorily assigned to them and within the constraints of the law applicable to them, continuously examine whether new UAS technologies are in a position to complement the operations of UAS already practised or to close other gaps in capabilities.

### **Civil protection**

One of the most exciting applications of UAS lies in their potential to save human lives and material assets.

According to figures provided by the German Life Saving Association (DLRG), 417 people drowned in swimming accidents in 2019. With UAS, people in distress can be located and life-saving appliances can be rapidly deployed



– in many cases more quickly than would be possible using helicopters, boats or lifeguards. It has already been possible to demonstrate that a drone is basically capable of lifting a person out of the water and transporting them to the shore.



The speedy provision of emergency medical treatment to people exhibiting clinical symptoms, such as those of a heart attack, is of paramount importance for the chances of survival. In such emergencies, UAS can ensure that telemedicine support is provided to the first responder by a specialist. First aid is optimized by equipping the drone with diagnosis systems to monitor vital functions and with cameras and a two-way intercom system. In addition, medical equipment such as a defibrillator can be carried by a first-aid drone.

Medical movements of banked blood, blood plasma, organs and pathological frozen sections between hospitals, banks and laboratories pose a major challenge. So far, they have been transported on the ground. Airborne transport by UAS does not involve the risk of them getting stuck in a traffic jam. Blood and plasma reach their destination more quickly, and pathological examinations of sections are accelerated, thereby making it possible to shorten exposure during an operation.

In addition, the deployment of UAS as a means of reconnaissance in major damaging events, disasters or multiple-vehicle collisions is one of the most important capabilities. Typical cases in which UAS are used in this context include major fires, flooding, forest fires or the

monitoring of beaches and dykes. UAS with infrared cameras support the search for missing persons or the detection of pockets of embers. Relevant fields of application also include the detection of hazardous substances or radiation and the documentation of operations. Rescue services, such as fire brigades, emergency medical services or the Federal Agency for Technical Relief can obtain an up-to-date and accurate picture of the situation on the ground in order to better coordinate their assistance. With the help of UAS, it is possible to provide valuable support to incident management activities, especially in difficult-to-access terrain or in complicated situations.

### **Protection of servicemen and women**

A further significant application of UAS lies in their potential to make a contribution towards protecting servicemen and women sent on operations. By means of targeted situation reconnaissance on the ground and prior to operations, the risk to servicemen and women can be reduced. In addition, during the conduct of operations, reconnaissance and active measures can better protect the lives of the servicemen and women.

### **Agriculture**

UAS ideally complement the endeavours to automate agricultural management wherever possible. UAS can be deployed to monitor and coordinate automated harvesters. Appropriate image-processing systems can be used to determine the degree of maturity of the vegetation – thereby making it possible to carry out targeted irrigation and to determine the optimum harvest date. Prior to harvesting operations, the fields can be scoured for animals, such as fawns, so that they can be removed from the danger zone. Pesticides and fertilizers can be carried on board UAS and applied in a targeted manner. This makes the use of pesticides and fertilizers simpler, especially in difficult-to-access areas such as steep vineyards. In addition, a significantly more targeted use of these agents with the help of remote sensing data has a correspondingly positive effect for the local environment.

This positive effect can also be continued right up to the harvest and may result in increases in yields. One example of this is the international GEOGLAM project. Further information can be found in the Federal Ministry of Food and Agriculture's "Remote Sensing Programme".<sup>3</sup>

### **Nature conservation and environmental protection**

Alongside the aforementioned animal welfare measures prior to agricultural activities, UAS can be deployed directly in the field in environmental protection management. This relates primarily to the counting of wild animals and the capture of habitat changes from the air.

### **Energy supply sector**

The energy supply sector already uses piloted UAS to inspect power lines and pipelines. They complement helicopter flights and make possible the targeted inspection of components. As the performance of UAS and their imagery analysis rises, their importance will increase.

Within the context of Germany's new energy strategy, there will be a new focus on difficult-to-access energy generators in the form of wind turbines. Today, these installations, which are often over 150 m tall and have wingspans of 75 m or more, can only be inspected by industrial climbers. UAS are able to inspect an entire installation from the air. Photographs and video recordings enable real-time analysis. This is especially evident for the many hundreds of turbines in the North Sea and Baltic Sea.

### **Distribution logistics**

The use of delivery UAS is among the more prominent fields of application of the technology. Indeed, companies are already working on schemes for delivering parcels to final customers. Even though this example is especially striking, UAS offer significantly more opportunities for distribution logistics. Thus UAS can transport components between production plants, for instance in automotive manufacturing, where components are taken from component suppliers to the producer.

### **Provision of goods and services to rural or remote, difficult-to-access areas**

In Germany, as in other countries, there are areas that are difficult to access by conventional means of transport. The provision of goods and services to islands and mountainous regions requires the costly deployment of ships, aircraft or helicopters. UAS bring such areas suddenly closer. They can deliver urgently required products where there is an immediate need. In addition to the provision of physical goods, the provision of digital services (e.g. Internet, communications links) by platforms flying at a high altitude plays a key role here. The targeted deployment of UAS will enhance the attractiveness of such regions. This applies not only to remote or difficult-to-access areas but to rural areas in general.

## **3.2 Enhancing safety and efficiency**

When a new mode of transport is introduced, this must not result in a lowering of the existing level of safety. This naturally also applies to unmanned aviation. In Germany, the operation of aircraft is thus governed by detailed legal rules in order to ensure the safety of the persons on board and on the ground and the safety of other airspace users in equal measure. Air carriers and authorities ensure that the safety requirements are complied with at all levels. All players are aware of the fact that UAS may cause threats that are of relevance to the police and that subsequently the police may have to get involved for reasons of security. Nevertheless, aircraft are frequently operated for purposes that have an inherent risk that can only be lowered to a certain extent. Examples include flights at night or in areas with difficult environmental conditions. UAS make it possible to reduce these risks in certain cases as, in comparison with manned aircraft, no crew is endangered and, because of the smaller mass, accidents have a lesser impact on the safety of persons on the ground.

The challenges resulting from the forecast growth in levels of passenger and freight traffic call for innovative problem-solving approaches – UAS are one such approach. In combination with mobility solutions such as autonomous and connected driving, UAS will become an element in handling the additional traffic. This applies especially to

<sup>3</sup> [https://www.bmel.de/SharedDocs/Downloads/Broschueren/Fernerkundung.pdf?\\_\\_blob=publicationFile](https://www.bmel.de/SharedDocs/Downloads/Broschueren/Fernerkundung.pdf?__blob=publicationFile)

freight traffic, which is set to rise by 38 % by 2030. The fields of application of UAS in logistics described above show the scope for efficiency enhancement: UAS can make transport operations more reliable, faster, safer and more secure. They also house the potential for reducing levels of ground traffic and partly easing the burden on the road network.

### 3.3 Reducing emissions from transport

The functions in many fields of application of UAS are today still performed by modes of transport that are fitted with internal combustion engines: be it the deployment of a helicopter for the surveillance of railway lines, the movement of parcels by goods vehicles, the provision of goods and services to islands by ships or the surveying of obstacles to aviation by aircraft.

At present, most UAS are electrically powered, with the energy mostly being supplied by batteries, although the use of fuel cells powered by hydrogen is also being examined. Electric UAS operation can thus, at least at a local level, make a contribution towards reducing (or slowing down the rise of) mobility-related emissions if conventional modes of transport powered by internal combustion engines are replaced and complemented by lower-emission vehicles.

### 3.4 Making Germany an even more attractive location for business, investment and innovative companies

The worldwide market for UAS-based services is estimated at 127 billion US dollars annually.<sup>4</sup> This figure illustrates beyond all doubt that the use of UAS will – or in some cases already has – become an economic factor that has to be taken seriously. Accordingly, two of the main issues on which the first National Aviation Conference – held in Leipzig on 21 August 2019 – focused were the opportunities presented by the drone economy and innovative urban air mobility solutions. This is also expressed in the “Leipzig Statement on the Future of Aviation”, which was signed at

the conference by the Federal Government, federal states, associations and trade unions.

The market for commercial UAS applications is still relatively young in Germany. Of the 455,000 UAS in circulation today, only around 2 % have so far been commercially used. Analyses predict that the number of commercially used UAS will have risen by 563 % by 2030. Whereas today only one in 24 UAS is operated commercially, this figure is likely to have risen to one in six by 2030. The development of the market is also expected to be correspondingly dynamic, with predicted growth rates of 16 % per annum for commercial applications<sup>5</sup>.

Today, just under 400 companies in the drone economy already employ 10,000 people in Germany. Most of them are companies that provide UAS-based services such as surveying, inspections or filming and photography. In commercial use, too, the field is dominated by off-the-shelf, mostly imported prosumer UAS. Only 5 % of the commercially used UAS in Germany have a value exceeding €10,000. Alongside this, the hardware market for UAS in Germany accounts for a share of 42 %. The high export rate of 80 % in the case of sophisticated UAS (over €10,000) suggests that German providers are in a strong technological position in this still small market segment. It is imperative that this position be consolidated. This also includes investment in software, flight control or analysis solutions, which can generate additional value creation in both the high-end UAS market and in the broad spectrum of UAS applications. With regard to the export of sophisticated UAS and corresponding components, the providers should bear in mind that these goods may be subject to export controls.

Much of the development of UAS technology and services based on it takes place in start-ups. The highly innovative start-up scene in Germany comprises more than 1,800 companies with a workforce of over 20,000.<sup>6</sup> In many cases, start-ups evolve in the areas around universities and research establishments, as a result of which decentralized

<sup>4</sup> PricewaterhouseCoopers (2016): Clarity from above – PwC global report on the commercial applications of drone technology.

<sup>5</sup> Association of Unmanned Aviation (2019): Analyse des deutschen Drohnenmarktes

<sup>6</sup> BMWi (2017): Deutscher Startup Monitor 2017.

start-up clusters have emerged. Here, Germany is in a good position compared with other countries.

The German start-up ecosystem benefits from the outstanding institutes of technology and universities. They are supplemented by national research establishments such as the German Aerospace Centre (DLR), which also make a major contribution to innovation in Germany. The availability of research aerodromes such as Oberpfaffenhofen and test environments such as Magdeburg-Cochstedt is a fundamental component for the testing of new technologies.

In addition to the start-ups, established companies have also discovered the market for UAS and their applications. These companies specialize in different fields. They come from, for instance, software development, the traditional aeronautical industry and the information and telecommunications sector.

In many spheres, UAS require innovative solutions. The hardware of the UAS platforms must have suitable electric propulsion systems combined with lightweight, high-performance and sustainable energy supply designs. In many cases, new materials are used. As a basis for the development of autonomously operating UAS, new sensors (passive, for instance visual or thermal, and active, such as ultrasound, radar, lidar) are required in order to ensure safe navigation and prevent collisions with other airspace users. In this context, new digital technologies for the organization of UAS traffic in the airspace are required – UTM (UAS Traffic Management).

The establishment of a suitable UTM system is the key to the scalability of UAS applications. If we want broadly-based uses, it would be necessary to open up the airspace to a large number of UAS. The safe operation of UAS alongside manned aviation requires integration into controlled and uncontrolled airspace. To this end, a UTM system must also operated largely “unmanned”. New technologies for

positioning, communications and decision-making will be required, as will the ensuring of safety and privacy on the ground. Artificial intelligence and geofencing could be such solutions.



The majority of the applications on the UAS platforms are new technologies that have so far not existed in this form. A new range of services is emerging. UAS are increasingly becoming automated devices that can collect data and will, in the future, be able to link up with one another and communicate, for instance via a cloud.

For Germany, as a hub of innovation, it is advantageous if companies involved in the development of UAS and UAS applications find a suitable environment for the implementation of their business ideas. The possibilities of using UAS thus become a location factor in themselves. The active promotion of unmanned, automated and connected flying will boost the competitiveness of Germany in the global economy and ensure that highly innovative companies can implement their ideas here. Germany will further stimulate the technology and digital market, safeguard and create jobs and benefit from all the advantages of the new technologies. In the mobility system of the future, UAS will be able to perform an important complementary function that will help us in making mobility faster, more reliable, quieter and environment-friendlier.

# 4. Objectives

The Federal Government will set itself three objectives in order to progress UAS applications in Germany and to safeguard our competitiveness as one of the leading innovative technology nations. They will be milestones that will act as guiding principles as we move along the road to regular UAS operations. Within this framework, we will join forces with the relevant stakeholders in the Federal Government, federal states, start-ups, industry, academia and the population to define concrete steps.

## 1. We want to become a lead market and establish high safety standards.

Germany has an active start-up scene and companies that are world leaders in the sectors of industry and services. Institutions that conduct applied research, such as the DLR, interact with a strong university and non-university aviation research community to deliver crucial technological contributions for new, innovative UAS applications. We want UAS services and technologies to be developed and used in Germany. Without this, Germany will be unable to play a significant role internationally in this growth market. The rapid introduction of UAS is a major location factor of the future and will demonstrate Germany's capacity for innovation and its innovation friendly environment. We want to safeguard Germany as an attractive location for innovative businesses and the positive contribution made by UAS to wealth creation. At the same time, we aspire to exert a crucial influence in the establishment of international safety, data protection, environmental and sustainability standards.

Ensuring public order and safety, including the security and law enforcement measures taken by the police, is absolutely essential if UAS are to be introduced nationwide and the still new technology is to gain acceptance. We want the regular operation of UAS to be as safe as possible and we do not want any

persons to be placed at risk. This applies to airspace users and to people on the ground over whom UAS fly. It is to be possible to safely remove uncooperative UAS from the airspace. In this context, we intend to lobby for the speedy introduction of a UTM system that fits seamlessly into the existing air navigation services infrastructure and the applicable regulatory framework.

## 2. We want to translate automated and connected flying into practice.

We want to move as quickly as possible from trial operations to the regular application of UAS. We have to pave the way for this by simplifying the permissions procedure while preserving present-day standards governing all aspects of public safety and order, nature conservation and environmental protection. A major element of this is the innovation-friendly and unbureaucratic simplification of processes to make applications possible throughout the territory of the Federal Republic of Germany. We want to make the regulatory framework and the administrative structures fit for the innovations of tomorrow.

## 3. We want to protect personal data, privacy and the environment.

As set out in Chapter 2 and at the beginning of Chapter 3, we want to include the legitimate concerns of the public regarding the protection of personal data, privacy and the environment. Only if we find satisfactory solutions for these action areas as well will be able to exploit the opportunities inherent in the new technology while simultaneously avoiding existing risks. In this way, we can succeed in generating genuine added value for society through UAS, thereby achieving broad-based societal acceptance.



# 5. Action areas and measures

## 5.1 Safety

It will not be possible to exhaust the enormous potential inherent in unmanned aviation unless this new form meets with broad-based public acceptance. The most important driver of societal approval is the ensuring of safety, including security and law enforcement. The Federal Government is therefore devoting special attention to both the operational safety of UAS – along the lines of the stringent requirements in manned aviation – and to aviation security in the sense of combating the risks posed by “uncooperative” UAS.

### 5.1.1 Safe flight operations

With the introduction of Part 5a of the Rules of the Air Regulations in April 2017 and the publication of the SORA-GER<sup>7</sup>, Germany has taken initial steps towards the risk-based and operations-centred granting of permission for operational scenarios.

The new EU regulatory framework enables increasingly complex UAS operational scenarios, which greatly increase the effort involved in granting permission. In the future, operational risks will always have to be permission assessed on the basis of the international SORA and no longer on the basis of the SORA-GER. The international SORA covers a large number of possible operating modes including, for instance, the operation of drones weighing several hundred kilograms, whereas SORA-GER can, as a rule, only be meaningfully used up to a take-off mass of 25 kilogrammes. The difference in complexity between the two procedures is illustrated by, among other things, the length of the documents. Whereas the SORA-GER used so far manages to accommodate its text on 18 pages, the international SORA requires 131 pages.

For many of the new and more complex permission granting procedures under EU law, we are planning to centralize the exercise of responsibility at Federal Government level.

Following the recommendations issued by the Federal Ministry of Transport and Digital Infrastructure’s UAS Advisory Council, we would like to lower the threshold as of which a certificate of knowledge is mandatory for the operation of a UAS from the original 2 kg take-off mass to a take-off mass of 250 g. The corresponding amendments to the Rules of the Air Regulations are to be undertaken in the process of implementing the new EU rules. At the same time, provision will be made for comparatively low-risk operations to be made possible with a simple online certificate of knowledge. This will ensure that the certificate of knowledge is made mandatory on a wide scale but no disproportionately high burden is imposed on operators in the case of simpler operating modes. From a police perspective, there is a significant potential for criminal use and the related risks as a result of negligent operation. To brief all operators of UAS – including those who are not required to hold a certificate of knowledge – they should at least be provided with targeted information on the effects of the improper use of UAS.

The fundamental prohibition of operating UAS without permission within a radius of less than 1.5 kilometres from aerodromes has in the past proved to be a good way of protecting taking-off and landing aircraft. At the same time, there has been an upward trend in the number of drones sighted by pilots in the take-off climb and approach zones of aerodromes. To maintain a high level of safety in the future, the Federal Government will examine the extent to which the flight restriction zones around aerodromes can be redesigned.



<sup>7</sup> Specific Operations Risk Assessment Germany

In the future, the Federal Government plans to not only continue the risk-based approach to addressing the safety of unmanned aircraft but to consistently flesh it out quantitatively. This will make it possible to document risks and their mitigation in a manner that is systematically measurable, comparable and verifiable. In doing so, we will create the basis for modern safety management in the sphere of unmanned aviation.

The Federal Government will consult with the stakeholders in Germany to develop a societally accepted and transparently communicated target level of safety that corresponds to the safety requirements of manned aviation. This pragmatic target, derived using a correct methodology, will allow manufacturers and users of UAS alike to conduct operations in a manner that is forward-looking, plannable and safe. A further safety gain will be generated by the development of qualified and quantified appraisal models relating to risks technological of failure, especially in the case of safety-critical components (propulsion, battery) on the basis of long-term testbed simulations.

#### We will

- transfer responsibility for many of the new and more complex permission granting procedures under EU law to the Federal Aviation Office and make the application procedure digital in keeping with the Online Access Act. In this context, compliance with data protection and cyber security is essential, especially because the aviation authorities process personal data of the applicant during an application process. This makes a major contribution to the uniform compliance with the European and international requirements for improving air safety. It will mean that a permanent point of contact is available at Federal Government level to operators of unmanned aircraft.

- further enhance the protection of airspace users around aerodromes and consider a redesign of the flight restriction zone.
- in the years ahead, include quantitative risk assessment models in risk assessment, make the acceptable level of safety a subject of the German Aviation Safety Plan and actively participate in the evolution of the SORA procedure.
- in the years ahead, consider how the share of cooperative aircraft<sup>8</sup> – whether manned or unmanned – can be increased.

#### Pre-flight action/weather

The German Meteorological Service (DWD) provides the weather information and advice required by UAS pilots and conducts research into specific requirements to be met by meteorological products. In the case of a remotely piloted UAS, the pilot, as is the case with any other aircraft, is responsible for the meteorological pre-flight action. For the specific flight characteristics of UAS with diverse types of propulsion and possibly special meteorological sensitivities (icing, narrow operating temperature ranges), there is a lack of experience concerning the optimum provision of meteorological information. Suppliers of UTM systems, too, require meteorological information that they can feed into the systems in real time. Such data can be acquired and provided both via satellite systems and, in the future, by UAS in the form of platforms flying at a high altitude.

The use of UAS as a metering system can make a major contribution to the safety of manned aviation. The International Civil Aviation Organization (ICAO) recommends the use of UAS in hazardous environments that are too risky for manned aviation: in the vicinity of volcanic eruptions/volcanic ash clouds, in the event of nuclear accidents or in extreme weather conditions.

<sup>8</sup> Aircraft that communicate their position (and possibly other flight data) to other airspace users and thus make themselves electronically visible.



#### We will

- continuously enlarge the aeronautical meteorological operations services for the provision of better data to UAS.
- provide weather forecasts (wind, temperature, air pressure at ground level, precipitation), meteorological radar and lightning data for making meteorological information available to U space providers.
- supplement the aviation weather training materials (online & brochure) and provide basic weather data for UAS and model aircraft on the Internet.
- examine the possible use of UAS for measuring volcanic ash and radiation (responsibilities under the German Meteorological Service Act and the Civil Aviation Act).
- progress the use of UAS in meteorological research and in operational measurement and participate in relevant working groups of the World Meteorological Organization.
- develop specific aeronautical meteorological operations services to enable accurate weather forecasting by UAS flying at high altitudes in long-term operation.

### 5.1.2 Aviation security

UAS can be used not only to the benefit of society. Uncooperative and potentially hazardous UAS have to be reliably detected and, if necessary, neutralized within the scope of applicable law. Disruption of flight operations at an airport is an especially prominent example of the disruptive effect of a drone operated unlawfully, either inadvertently or deliberately. The disruption or endangerment of other installations is basically similar. German Air Navigation Services have thus developed a road map setting out how they, as an air navigation service provider to whom statutory powers have been transferred,

manage air traffic in a safe, orderly and efficient manner and how they can detect UAS there in a timely fashion. To this end, a UAS detection system, operating with the data protection and data security level described at the beginning of Chapter 3, is to be developed and established in a defined area around those aerodromes located in their area of responsibility. These are 16 international airports in Germany where there is a recognized need for reasons of safety and transport policy interests. The decision as to the extent to which drone detection systems should also be established at smaller airports will have to be taken on the basis of the same risk-based approach that is adopted at the aforementioned international airports.

Subsequently, interfaces that are just as resilient will be defined between the detecting agencies and the aviation security authorities responsible for the actual neutralization. Activities to develop highly effective detection and neutralization measures will thus be progressed and stepped up, primarily in the industry and in DLR's research, which means that a properly functioning collaborative partnership with DFS is key to the area-wide implementation at the national level. To this end, the Federal Police with, among others, DFS, Hamburg Airport and Helmut Schmidt University, is conducting the FALKE research project, which is funded by the Federal Ministry of Transport and Digital Infrastructure within the scope of the call for ideas and applications for funding for unmanned aviation applications and in which a system solution is to be developed as a blueprint for "UAS neutralization at airports".

#### We will

- engage in a regular exchange of ideas and experience with the air navigation service providers with the aim of ensuring that the technologies used to detect UAS are as uniform as possible and state of the art.
- in cooperation with the aviation security authorities and the aerodrome operators, ensure that at every commercial airport appropriate reporting chains are set up and clear decision-making processes and effective technical solutions for the neutralization of uncooperative UAS are established.

- use the new EU regulatory framework governing the equipping and registration of UAS to improve the effectiveness of the measures to ensure the safety of manned air traffic, especially at aerodromes, by establishing interfaces with the aviation security authorities.

## 5.2 Infrastructure and connectivity

Autonomous UAS fleets should be viewed as a part of integrated approaches to mobility/integrated networks for the carriage of passengers and goods. Intermodality will play a major role in the development and validation of efficient ranges of transport services (see also Chapter 6). A sovereign data infrastructure as a basis for data sovereignty and broad-based data availability with, at the same time, high security standards and taking account of the statements on data protection and cyber security made in Chapter 3 will in the future be key to the German industry. It is imperative that a separate system emerge for connectivity and data exchange through a central digital platform for UAS (unmanned aviation digital platform) between the players involved. With a view to creating such digital platforms, the Federal Ministry of Economic Affairs and Energy in 2019 presented “GAIA-X”, a project developed in collaboration with numerous players from industry and academia, the purpose of which is to establish sovereign and open, European data infrastructure and which constitutes an essential foundation for highly interlinked UAS applications.

One part of creating UAS-related connectivity systems consists of establishing electronic conspicuity, including on the basis of frequencies allocated by the spectrum management authorities for UAS broadband communications, while simultaneously implementing data protection and cyber security (see also Chapter 3).

The aforementioned also applies to, for instance:

- the deployment of positioning technologies and mobile telephony in communications between UAS and their surroundings in the airspace;

- and if rival UTM providers obtain technology-neutral and non-discriminatory access to data.

If mobile telephony is deployed, and thus 4G and 5G technology is used, all players will have to comply with the requirements under telecommunications law and the constitutionally protected confidentiality of communications.

The statements made on data protection and cyber security in Chapter 3 will also be implemented in the UAS-based transmission of audio and video data.

### 5.2.1 Airspace management

In many of their applications, UAS operate in the uncontrolled airspace. Airspace users may operate freely in this airspace without control by and instructions from the air navigation services. The principle of “detect and avoid” with strictly defined avoidance rules applies. At the same time, manned aviation is subject to a minimum safe altitude for the protection of the public against operational hazards and noise of 500 feet (150 m) above ground level when flying over unpopulated areas. For settlements, the altitude is 1,000 feet (300 m). There is an exception in the case of aircraft approaching or departing from licensed aerodromes. It is also conceivable that, in the future, UAS (e.g. for logistics or cargo functions) will operate above this minimum safe altitude.

For the safe integration of UAS in airspace that is simultaneously used by manned aircraft, the most essential role is reliable detection and avoidance. At present, the principle is that unmanned aircraft have to avoid manned aircraft. For this avoidance to be successful, a wide variety of sensors have to be integrated into the UAS to enable them to detect manned aircraft. The spectrum of possible positioning technologies ranges from transponders, such as those that are widely found in commercial aviation, to the portable FLARM<sup>9</sup> collision warning system that is used in gliding. The better a UAS is equipped with sensors, the safer is its operation.

<sup>9</sup> FLARM stands for “Flight Alarm” and is a proprietary collision warning device used primarily on light aircraft.

Moreover, as the number of flight movements increases, it will become increasingly important for UAS to communicate their own position to other airspace users and thus behave “cooperatively”.

At the same time, it must be ensured that unmanned – as well as manned – military aircraft flying military missions which, for reasons of overriding importance, cannot behave “cooperatively” can use this airspace at no risk to themselves.

In the lowest airspace, mobile communications are also suitable for this data transmission on account of the good scalability and low-threshold technology. Given the low latencies and high data transmission rates of the new 5G mobile communications standard (see 5.2.2), it will be possible to provide positioning, location and other flight data to other network subscribers via an interface almost in real time.

The ability of UAS to detect and avoid other airspace users in their vicinity can be significantly enhanced if other airspace users become electronically conspicuous. A corresponding technological solution for all airspace users must be practicable and preferably not involve any costs for manned aircraft – account has to be taken of, for instance, glider and paraglider pilots, parachutists and other operators of air sports equipment.

In the long term, there will be a complete and fair integration into the existing airspace structures. This also includes flights in controlled airspace. The current airspace management system (ATM) will have to be replaced by an automated and integrated UTMS system. This body will have to have detection and control capabilities in order to be able to operationally control flight operations, i.e. it must have mechanisms for intervening in flight operations. The European Aviation Safety Agency (EASA) has started work on the European regulatory framework for the introduction of UTMS system (under the title of U-space).

What is needed is the establishment of a detection system for the lower airspace, more specifically in urban areas. This system, in combination with the digital register, must be able to manage, monitor and control a constantly rising number of unmanned flight operations. To this end, a

management system is to be implemented that will have to be able to act proactively in the medium term.

#### We will

- establish a central digital platform for UAS used for civilian purposes (unmanned aviation digital platform) and consolidate in it all information relevant to the control of UAS.
- enable competition between UTM providers and ensure technology-neutral and non-discriminatory access to data and competition.
- safeguard sensitive airspace with the help of the possibilities provided by new EU law and, by designating UAS geographical zones in combination with the functionality of geo-awareness, establish UAS no-fly zones, for instance for residential property, thereby preventing UAS from entering areas that are sensitive under data protection law and that serve the purpose of protecting privacy.
- establish UAS geographical zones for the protection of public security and order, including the environment and nature, and ensure that information on these areas is published in a common, uniform digital format.
- seek to introduce the fully automatic granting of permission on the basis of the current rules.
- review the current de facto requirement for UAS to have transponders at airports. A low-threshold solution for the transmission of position data such as using mobile communications could be a possible replacement.
- join forces with the players affected to develop suitable measures for making not only UAS but all the other airspace users, especially general aviation and air sports, electronically conspicuous in a manner that is as cost-neutral as possible and does not involve sophisticated additional systems. These measures must also meet the requirements set out in Article 25 of the GDPR and mentioned at the beginning of Chapter 3. This will make it possible, in the medium

term, to detect all airspace users, which is a basic prerequisite of automated collision avoidance. Initially, the principle that unmanned aviation has to avoid manned aviation will continue to apply.

- continue to be intensively involved in the activities by EASA on the regulatory framework for the U-space. We will lobby to ensure that the interfaces between ATM and UTM and between different UTM systems are clearly defined among one another. In addition, the regulatory framework must take remotely piloted, automated and autonomous UAS into account separately in order to reflect the different purposes of the applications.

### 5.2.2 Spectrum availability and broadband use

While the UAS industry is gaining momentum, the spectrum management authorities are engaged in an exchange of ideas and experience with the stakeholders affected in an attempt to improve the framework for the available spectrum. There is a whole range of challenges to be addressed before we can fully realize the growth potential inherent in UAS. One of these challenges is satisfying the corresponding need for spectrum. UAS use spectrum primarily for control, transmission of the identification and flight location parameters and payload transmission (e.g. on-board cameras that send information to the ground).

Communications solutions are also required for drone-to-drone and drone-to-infrastructure connectivity and for various sensors on board UAS (for instance radar and optical sensors). In addition, they are required for the distribution of positioning information to avoid collisions, mark restriction zones and support a UTM system. Of particular interest to governments are applications for intervention and enforcement measures (e.g. jamming a drone or its control unit).

#### Activities in Europe on the frequency spectrum for UAS

In February 2018, the Electronic Communications Committee of the European Conference of Postal and

Telecommunications Administrations<sup>10</sup> published a report on the technical and regulatory Aspects and the needs for spectrum regulation for UAS. The report states that the focus is to be on UAS in EASA's "open" and "specific" categories. The "certified" category will not initially be addressed.

In Germany, the following frequencies can be used to control UAS within the scope of general permission: 2,400-2,483.5 MHz (WLAN), 5,725-5,875 MHz, 433 MHz, 863-870 MHz, 27 MHz, 35 MHz and 40 MHz. For the transmission of audio and video data by wireless means of production, the 2.3 GHz and 2,010-2,025 MHz frequency ranges are available.

The possibilities of use within the scope of general permits are not suitable for all UAS users because the power ratings allowed are often too low. For professional and governmental UAS applications, highly reliable spectrum access is required (without the danger of jamming and with higher ranges). In such cases, individual permission is envisaged. The Electronic Communications Committee will analyse, probably by the end of 2020, the 1,880-1,900 MHz frequency band for governmental UAS, the 1,900-1,920 MHz frequency band for professional and governmental UAS and the 5,000-5,010 MHz frequency band for professional UAS.

The European Telecommunications Standards Institute (ETSI) is currently preparing a new technical report (No 103373) describing professional UAS use cases.

#### Commercial mobile communications

One option for controlling and monitoring UAS is making use of the existing mobile communications networks. Following initial tests, mobile communications have proven to be reliable, scalable and feasible using simple

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<sup>10</sup> The European Conference of Postal and Telecommunications Administrations is an organization for cooperation between 48 European states in the field of postal and telecommunications regulation. In it, the Federal Ministry of Transport and Digital Infrastructure and the Federal Network Agency jointly represent national interests in matters relating to telecommunications.

means. The effects of lifting current restrictions on ground-based radio applications are currently being examined. Efficient communication with UAS for both control and data transmission is dependent on it being interference-free and in real time. Thus, a high-quality mobile communications network is essential for the nationwide deployment of UAS. Given its large bandwidths and low latencies, 5G technology is especially interesting for this. In addition, the special quality and reliability requirements when public mobile communications networks are also used for purposes of safe flight operations have to be borne in mind.

This can be realized by either an external LTE device connected to a UAS or by implementing SIM cards in a UAS. The Electronic Communications Committee will develop a report by March 2020 covering all aspects that are of importance for the use of mobile communications networks by UAS (incl. handover, roaming, impact on networks and on the ability to achieve reliable coverage).

In the Coalition Agreement, the Federal Government committed to expediting the deployment of mobile communications coverage and making Germany a lead market for 5G. The coverage obligations from the 2019 spectrum auction and the contractual rollout commitments from implementation of the mobile communications summit will ensure that large areas will have 4G coverage and the federal highways will have 5G. On 18 November 2019, the Federal Government adopted a mobile communications strategy in the Cabinet containing a package of measures focusing on, inter alia, the removal of remaining white spots. Already, a 5G competition has been launched with which 50 5G pioneer regions can be supported in developing schemes for 5G systems of their own.



#### We will

- seek to establish a largely area-wide and highly available communications infrastructure for safe beyond visual line of sight operations and the safe operation of automated and autonomous UAS.
- expedite the expansion of mobile communications coverage in a manner compatible with the needs of nature and develop Germany into a lead market for 5G.
- continue the expansion of 4G and 5G infrastructure on transport infrastructure (federal motorways, ICE lines, federal highways and regional roads plus the core federal waterway network) in a manner compatible with the needs of nature.

### 5.3 Regulatory and administrative framework

#### EU regulatory framework

The legislative process for all operations of unmanned aircraft has been ongoing at European Union (EU) level since 11 September 2018. The main European requirements to be met by unmanned aircraft are set out in Section VII of Regulation (EU) 2018/1139 (Articles 55 to 58), which entered into force on that day and is also known as the Basic EASA Regulation. With Delegated Regulation (EU) 2019/945 and Implementing Regulation (EU) 2019/947, which entered into force on 1 July 2019, further regulatory requirements were adopted that are to be applied by EU Member States starting on 1 July 2020.<sup>11</sup>

Because of the European regulatory powers, Member States will in the future no longer be able to independently shape the regulatory framework for unmanned aircraft systems at the national level. They will, however, continue to be able to make rules governing, inter alia, protection against the malicious use of UAS and protection of privacy

<sup>11</sup> Because of the COVID-19 pandemic, the European commission is currently considering postponing the start of validity of implementing acts that have already entered into force and will become applicable in the next six months. This would also cover Implementing Regulation (EU) 2019/947, whose envisaged application starting on 1 July 2020 could be postponed.



(cf. the statements in Chapter 3) and the environment, because the competences granted to the EU in the Basic EASA Regulation do not relate to these aspects. Model aircraft flying, too, will remain essentially a Member State responsibility.

The Federal Government has always taken care to strike a balance between further improvements to the operation of UAS on the one hand and ensuring safety and environmental protection, personal data and privacy on the other hand. The current rules in Part 5a of the Rules of the Air Regulations already offer legal bases and the recommendations made by the Federal Ministry of Transport and Digital Infrastructure's UAS Advisory Council provide important guidance.

As further regulations are adopted, the level of detail of the European rules will be progressively increased, and, at the same time, more room will be created for a targeted and flexible regulatory practice – without compromising safety. Accordingly, the importance of being involved in the formulation of these requirements is growing for Germany. German experts have the opportunity to do so by, for instance, participating in EASA and European Commission work groups and in the corresponding committee that was established on the basis of the Basic EASA Regulation. The same applies to the work on the non-binding means of compliance and recommendations.

#### We will

- focus on rolling forward the EU regulatory framework, which makes it possible to fully exhaust the potential inherent in the new technology and which offers sufficient flexibility for trialling innovations. We will step up our activities to support and shape the development and updating of the European regulations in the relevant bodies and create the human resources necessary for this.
- continue to lobby at European level to ensure that a balance is struck between the safety aspects, innovation friendliness and commercial market opportunities, while at the same time taking account of the “user pays principle” in cost recovery, noise

mitigation and environmental protection as well as data protection and protection of privacy.

### Rolling forward the legislation at EU and ICAO level

The new EU legislation with regard to unmanned aviation is technologically neutral, which means that even if there is a rapid technological transformation it will not have to be comprehensively revised. It will, however, be regularly adapted by an implementing act or a delegated act. Moreover, the regulations currently in force only reflect part of the entire European regulatory framework for manned aviation. The drafts regulating the “certified category”, i.e. large and heavy UAS and those used to carry passengers, and traffic management for unmanned aviation (U-space) are expected to be presented before the end of 2020.

Because the deadlines are often tight, comprehensive coordination of the drafts between the federal government departments, the federal states, trade associations and societies poses a challenge. Our objective is to use the opportunities that Germany has to exert corresponding influence in European comitology and consultation procedures in order to make an effective contribution to the work and the legal texts.

ICAO is also involved in establishing the regulatory framework for unmanned aviation. We intend to join forces with other players to develop standards and recommendations.

#### We will

- seek to establish an international regulatory framework that makes it possible to fully exhaust the potential inherent in the new technology. This framework is to offer sufficient flexibility for the trialling of innovations while simultaneously reducing risks.
- make an intensive contribution towards developing and rolling forward the European Regulations and ICAO's activities for standards and recommendations on UAS.

- make comprehensive use of the expertise in unmanned aviation that exists in Germany in the public authorities, industry and the research community in developing the German position through a regular and close exchange of ideas and experience.

### Establishing responsibilities

In Germany, it is currently the federal state aviation authorities that perform the major administrative functions, especially granting permission and exemptions from operating bans (sections 21a and 21b of the Rules of the Air Regulations). The Federal Aviation Office recognizes bodies that certify proof of sufficient qualification.

As a result of EU legislation, the German aviation administration has additional functions to perform: These include, but are not limited to:

- establishing and maintaining a register of operators of unmanned aircraft and of unmanned aircraft themselves;
- issuing certificates for operators of unmanned aircraft (LUCs); and
- participating in the procedure to grant permission to fly to an operator from another EU Member State.

### We will

- closely consult with the federal states and discuss the division of responsibilities between Federal Government and federal state authorities in order to deploy the strengths of both parties in an optimum manner. In doing so, we will be guided by the considerations that the better local knowledge of the federal state authorities is taken into account, as are the advantages of designating a central authority in one Member State, for instance in the nationwide applicability of permissions granted.
- adapt the administrative structures in Germany to the new functions in the field of unmanned aviation and

focus more on nationwide responsibilities with regard to transnational and complex operating modes.

- while implementing the statements made on data protection and cyber security in Chapter 3, progressively consolidate access to the administrative procedures on a central nationwide platform and shape this access such that the applicant has a single point of contact that obtains the necessary comments and appraisal from other entities.

### Establishment of UAS geographical zones

A UAS geographical zone is “a portion of airspace established by the competent authority that facilitates, restricts or excludes UAS operations in order to address risks pertaining to safety, privacy, protection of personal data, security or the environment, arising from UAS operations” (point (2) of the second sentence of Article 2 of Implementing Regulation (EU) 2019/947).

EU law makes it possible to establish areas, facilities or infrastructure installations that may not be overflown or only overflown with restrictions as geographically defined zones provided that this is technically feasible. The main advantage of these UAS geographical zones is their coupling with the function of geo-awareness, with which most UAS will have to be equipped in the future. With this function, the UAS can detect autonomously where and how it is allowed to fly – and where and how not.

The method used to establish UAS geographical zones is thus of great importance. Our objective is to establish UAS geographical zones to arrive at targeted and flexible UAS operations without compromising public safety.

### We will

- establish UAS geographical zones to maintain aviation safety, to neutralize threats to safety and order, including critical infrastructure, and to protect personal data, privacy and the environment. In doing so, we will be guided by the current situation regarding the obligation to obtain permission and the operating bans applicable today and make flexible use of them with the tools of European law. Here, the



principle applies: the more bans are converted into UAS zones, the more benefit can be derived from geo-awareness and the greater is the visibility of the bans to the operators.

- preserve the current high level of protection afforded by the Rules of the Air Regulations and make use as far as possible of the options for establishing UAS geographical zones.
- seek to afford even better protection to accident sites, disaster areas and other sites where authorities and organizations with security and safety tasks operate, if necessary with UAS geographical zones that can be established ad hoc.

### Standard scenarios and registers

The standard scenarios for which EU law makes provision represent a simplified procedure for operation in the “specific category” and will in the future be a great help to professional operators of UAS who repeatedly deploy their device in a similar manner. We intend to lobby in the corresponding EASA working groups for the development and publication of standard scenarios in the near future. In doing so, we will prioritize scenarios that are of particular importance for our national users. Appropriate experts – including from the business community – are to participate in the relevant working groups.

Member States are required by EU law to establish a national register in which UAS operators can register themselves. The register is to be designed such that it is user-friendly and can be connected to digital platforms for users of UAS. We will seek to make it compatible with comparable registers in other EU Member States. At the same time, it will be necessary to comply with data protection requirements and to create specific rules stipulating who may access the data collected and for what purpose. The possibility of accessing register data for purposes of security and law enforcement is of great relevance.

### We will

- closely cooperate with experts from industry, public authorities and the research community to develop standard scenarios that are of great relevance for players operating in Germany and contribute them to the decision-making process at European level.
- use an electronic process to establish the central register as a data platform that is compatible with other data platforms and electronic processes in the field of unmanned aviation. The register will be part of a digital platform.
- lobby for EU-wide compatibility of the national register platforms in the field of unmanned aviation in order to achieve optimum interoperability.

With regard to the safeguarding of data protection, we will examine the extent to which, in the entire context described above, the relevant rules in the Road Traffic Act governing the maintaining of registers by the Federal Motor Transport Authority can be used for maintaining the UAS register.

### Model aircraft flying

Model aircraft flying has a long tradition in Germany and introduces young people to aviation. Sporting and recreational activities often give birth to ideas and technologies that can be helpful in the professional use of UAS. Accordingly, during the activities to develop the EU Regulations governing unmanned aviation, the Federal Government championed rules that will benefit the preservation of the tradition of model aircraft flying in Germany.

EU law privileges model aircraft flying for sporting or recreational purposes but attaches great importance to oversight within the model aircraft associations and clubs. They can essentially take their own decisions regarding the safety of flying within the scope of their own activities. Nevertheless, the associations and clubs will be increasingly subject to supervision by the authorities.

#### We will

- make use of the opportunities opened up by EU law to flexibly flesh out model aircraft flying in Germany, while simultaneously continuing to preserve the requirements necessary, in particular, from an environmental protection and nature conservation perspective and the current level of protection.
- if model aircraft can process personal data, for instance because they are fitted with cameras and/or sensors (passive, such as visual, infrared, thermal or active, such as ultrasound, radar, lidar), also implement the statements contained in Chapter 3.
- join forces with the model aircraft associations to develop a safety strategy, uniform across all associations, in order to also use the advantages of the club and association structure to further improve the level of safety, which is already high today.
- champion modern and still unbureaucratic oversight over the associations and clubs. Because of their knowledge of local circumstances, the participation of the federal state aviation authorities is to remain ensured. The tried and tested cooperation between model aircraft flyers and the federal state aviation authorities is also to be continued within the scope of the EU requirements.

## 5.4 Innovation

We want to establish Germany as a lead market in automated and connected flying. UAS and air taxis offer new potential applications, but at the same time their safe integration into the airspace poses a major challenge. New and innovative solutions are called for. The Federal Government actively supports the national industry by means of research and pilot projects and in the establishment of test beds and real-world laboratories as it progresses along the road to the speedy attainment of commercial maturity for this new mode of transport. Creating in a timely fashion the technological conditions for the successful development of innovative products that

will contribute to a high-capacity, safe and environmentally sustainable air transport system is thus one of the key measures of the Federal Government's aviation strategy. This should involve incorporating research establishments, institutions of higher education and SMEs in a targeted manner in order to exploit their inherent potential and progress (technological developments). In Aachen, not only new development topics (propulsion systems, avionics, autonomy) are being progressed but also, and above all, the production/manufacture of new UAS, in particular air taxis, whereas the focus in Cochstedt is on the trialling of such systems and their safe integration into the airspace. The objective of such programmes is that companies find a suitable environment for implementing their business ideas in Germany.

### 5.4.1 Research funding

The development of UAS and air taxis plus the infrastructure required for their operation is undertaken by both "classic" companies in aerospace industry and young start-ups that are usually classified as SMEs.

In its different departments, the Federal Government already has a large number of instruments for funding research into UAS and air taxis. Examples include:

- Ongoing call for applications for funding VI-1 of the LuFo aeronautical research programme (total level of funding currently €175 million per annum) with funding of up to €50 million for UAS and UAM projects from 2020 to 2023. In addition, there are projects from the new aeronautical research programme on electric and hybrid flight, which will further boost the development of electrically powered air taxis. The ongoing aeronautical research projects are focusing on technologies for sophisticated automated systems that respond intelligently to their ambient conditions, other dependent subsystems and other airspace users. This means that both fully autonomous BVLOS operations and targeted support to the operator of a UAS will be possible.

- Broad spectrum of innovative projects in the Federal Ministry of Economic Affairs and Energy's technology-neutral financial assistance programmes:
  - Central Innovation Programme for SMEs.
  - Provision of institutional funding to the German Aerospace Centre by the Federal Ministry of Economic Affairs and Energy (a total of around 522 million euros in 2019) for, inter alia, aeronautical research and new institutes in the fields of digital transformation and safety/security, which are also important for UAS, and for the National Experimental Test Centre for Unmanned Aircraft Systems in Cochstedt.
  - Institutional DLR research programme entitled "Technology for Small Aircraft" (BMW contribution totals €15 million p.a.).
- Provision of institutional funding to the DLR's aeronautical research by the Federal Ministry of Defence.
- The Federal Ministry of Food and Agriculture's programme for the future entitled "A Digital Policy for Agriculture" – this programme provides financial assistance to, inter alia, digital experimental fields. In some of these experimental fields, the use of UAS to enhance sustainability in agriculture is a key aspect.
- Provision of funding by the Federal Ministry of Education and Research to projects for the development of measures to prevent and investigate terrorist attacks and identify and pursue the suspected perpetrators.
- Provision of funding to projects at the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and its executive agencies to identify the impact of the use of UAS on nature and the environment.
- Call for ideas and applications for funding for unmanned aviation applications and individual

mobility solutions launched by BMVI in 2019 with funding totalling currently €29 million. A total of just under 160 project outlines for high-speed projects (concluded in 2019) and long-term projects (to be concluded by 2022) were submitted. The call for applications for funding was incorporated into the Federal Ministry of Transport and Digital Infrastructure's mFUND (modernity fund) research initiative which, since 2016, has been supporting research and development projects addressing all aspects of digital data-based applications for Mobility 4.0. The first data-based UAS applications had already received financial assistance from the mFUND before this call.

- The Federal Agency for Cartography and Geodesy is planning the provision of near-real time data of orthophotos by manned image flights as part of the "DOPdirekt" project. This approach is also to be transferred accordingly to UAS-based orthophotos. The findings from the project will support the Crisis and Situation Service (SKD) operated by the Federal Agency for Cartography and Geodesy. The "DOPdirekt" project is currently being launched by the Agency and is due to start in 2021. The outcome of the project – the georeferencing of aerial photographs in near real time – will be of interest to many spheres (including authorities and organizations with security and safety tasks, disaster control, environment, et al.).

This selection of examples shows that the Federal Government takes the funding of UAS very seriously and has recognized the benefits of the technology for various fields of application in the individual government departments. However, given the large number of activities, it is obviously necessary to provide the relevant stakeholders with suitable and effective information on the various research possibilities. This is relevant to SMEs in particular, because their human resources generally do not allow them to have a sufficient time budget to gain a complete overview of the research landscape. In addition, the calls for applications for funding have impressively illustrated that targeted addressing by means of a dedicated support measure for UAS applications meets with great approval.

#### We will

- continue and, in the medium term, step up our research funding in the existing programmes of the federal government departments with regard to UAS and air taxis and to support new applications in the mobility sector. In doing so, we will give high priority to avoiding overlaps with existing Federal Government financial assistance programmes.
- lobby to ensure that in the Federal Funding Advisory Service on Research and Innovation, a new focus is established to provide advice on the funding of UAS and air taxis. UAS/air taxis are to be added to the Federal Government's catalogue of support measures, which is a database of concluded and ongoing projects.
- ensure that aforementioned funding projects exhibit the level of data protection and cyber security described at the beginning of Chapter 3. This also applies to the development of relevant projects generated out of the research. Facilities for trialling exist, for instance, at the DLR's Cochstedt site.

#### 5.4.2 Test beds, real-world laboratories and practical trialling

Test beds and real-world laboratories for trialling UAS and air taxis are indispensable if we want to further progress our innovation friendliness and keep up in the global technological competition. Thus, as early as the end of 2016, the Federal Ministry for Economic Affairs and Energy launched an initiative establishing real-world laboratories as a new instrument of economic, innovation and digital transformation policy. On the basis of this example, further action areas have to follow, and we will ensure that the level of data protection and cyber security described in Chapter 3 is complied with in an unbureaucratic manner. This also applies in the field of cross-border cooperation.

Trial flights and pilot projects are currently the most important instrument for technological development and for testing the practical application possibilities. They

are also an important means for identifying any need for regulatory adaptation. Here, it is crucial that the local federal state aviation authority, which is responsible for granting operation permission, and the Federal Aviation Office are involved at an early stage. In densely populated areas or in certain parts of airspace, trialling may not be conducted until the proof of safe operation is sufficient.

The UAS Advisory Council at the Federal Ministry of Transport and Digital Infrastructure currently defines the following objectives of trialling at test beds:

- develop new technologies (aircraft, payload and ground-based technology);
- develop safe operational deployments with various payloads in a wide variety of specific applications;
- identify and minimize risks;
- furnish proof of the cyber security of UAS;
- furnish proof of the safe deployment of UAS, including for official permits;
- promote cooperation between all stakeholders for safety in the airspace;
- safety-related testing opportunities;
- beyond visual line of sight (BVLOS) operations, including autonomously;
- integration into the airspace (including common situational awareness for unmanned and manned aviation, especially in the lowest airspace and, building on this, new types of procedures for coordinating UAS among one other and ensuring that they maintain sufficient distance from manned aviation);
- surveillance and tracking of UAS, geofencing, detect and avoid, rescue systems such as parachutes;
- combination of UTM and UAS detection systems for uncooperative UAS;

- UAS test sites with low safety requirements and ground-based infrastructure;
- special structures such as towers, tanks, bridges and the like for UAS applications such as power line routes, waterways, railway lines or agricultural land;
- highly structured terrain (mountains);
- city centre sites including interaction with other transport users.

Test beds of various shapes and sizes have already been or are being established. They are often located on existing civil or military aerodromes. These cordoned-off areas permit trialling in safe conditions with appropriate open spaces and obstacle clearances. An infrastructure specifically for UAS applications can be built there.

Since 2019, the DLR, in cooperation with the State of Saxony-Anhalt and within the scope of its institutional funding by the Federal Ministry for Economic Affairs and Energy, has been constructing the “National Experimental Test Centre for Unmanned Aircraft Systems” at Magdeburg Cochstedt Airport. This centre addresses, inter alia, research and development on the safe integration of UAS into the airspace. Under the auspices of the National Experimental Test Centre, the DLR, together with other airports and ongoing UAS/UTM activities, is establishing a network whose objective is to boost research and development. This is to involve the creation or funding of outstanding clusters of innovation and new small and medium-size businesses, especially at the participating sites. The shape that the network assumes will result not only from the connectivity of the nationwide UAS test beds but also from the close exchange of ideas and experience with the relevant ministries and authorities at federal state and Federal Government level.

In addition, we can also have recourse to existing research airports in Germany such as Braunschweig and Oberpfaffenhofen. Research and development on civil UAS and air taxi applications is also being conducted at military aerodromes. One example is Manching Airport, where Airbus is exploring the possibility of establishing a

drone test centre. Just how cooperation between the civil and military aerodromes and the UAM initiatives can be fleshed out will be evaluated within the scope of the implementation of this action plan.

Unmanned flight also plays a key role in the Federal Ministry for Economic Affairs and Energy’s strategy entitled “Real-World Laboratories for Innovation and Regulation”. The strategy seeks to boost the time-limited trialling of digital innovations in real-world laboratories, to create more (legal) scope, for instance in the form of experimentation clauses, and ensure that active use is made of the practical trials to evolve the legal framework such that it is conducive to innovation. The strategy pursues a multi-focus approach and seeks to exploit synergies and lessons learned from various spheres of innovation in order to lower the entry barriers that hamper the complex implementation of real-world laboratories. To this end, an extensive network has already been established, a manual on the implementation of real-world laboratories has been published, and in December 2019 the first Real-World Laboratories Innovation Prize was launched. Unmanned aviation applications play a major role in these measures. An interministerial real-world laboratories working group is to formulate the possibilities for more legal flexibility for testing.

Alongside cordoned off test beds and real-world laboratories, particular attention will also be devoted to practical applications in urban areas. This is the very focus of the Urban Air Mobility (UAM) initiative, which is being conducted with the context of the European Commission’s “European Innovation Partnership” for “Smart Cities and Communities”. The cities of Aachen, Hamburg, Ingolstadt, Münster and the Bad Hersfeld/Northern Hesse regions are taking part in this scheme. The Federal Government and the DLR are providing support to and are involved in the initiatives taken by these German towns and cities.

In the near future, it will be necessary to temporarily permit trials in areas that place special demands on the operation of UAS (for instance over the territorial sea or in the mountains). Specific applications may necessitate test sites tailored to their needs.

#### We will

- establish at the Federal Ministry of Transport and Digital Infrastructure a coordinating body for UAS test beds along the lines of the Coordinating Body for Automated and Connected Driving, supplementing the network function of the DLR's National Experimental Test Centre for Unmanned Aircraft Systems in Cochstedt. It will be available to UAS pilot projects as a technical point of contact and ensure the continuous exchange of ideas and experience between the players and their connectivity in order to make optimum use of synergies and translate innovative air mobility schemes into practice. The coordinating body will support the implementation of this Action Plan and merge the findings of UAS pilot projects with the activities of the UAS Advisory Council. In this context, we will take care to ensure close coordination with the DLR and the existing network of the National Experimental Test Centre, which addresses the UAS test activities of the industry and research community at national, European and international level.
- support the federal states' test activities by providing professional expertise. The Federal Government believes that initiatives by the federal states make a major contribution towards making Germany a more attractive place to do business.
- continue to support the European Commission's UAM initiatives and the cities and regions associated with them. The Federal Government is monitoring initiatives taken by the cities of Aachen and Ingolstadt and offering its expertise as a specific contribution.
- lobby for the establishment of cross-border test beds with interested neighbouring countries in order to ensure transnational interoperability.
- join forces with the Federal Aviation Office and DFS Deutsche Flugsicherung GmbH to actively support the establishment of specific temporary test beds, in coordination with the federal state aviation authorities. Proof of safe operation must guarantee that public safety and order will be maintained.
- continue as a regular event the network meeting, first staged by the Federal Ministry of Transport and Digital Infrastructure in 2019, on national UAS testing activities, including the UAM initiative.
- examine, on the basis of the outcomes of the interministerial real-world laboratories working group, the extent to which it will be possible, in the future, to create even more flexibility for trialling in the regulation of unmanned aviation.

## 5.5 Public procurement and international support

Each year, the German public sector procures goods and services worth up to 500 billion euros. This means that, in numerous spheres, public procurement has to set an example of good practice. In the drone economy, too, public institutions can be an early adopter of innovative solutions, for instance as a user or purchaser. This benefits both sides. UAS have the potential to improve processes and make them more efficient and less expensive for public clients. Whether it be the police or the fire brigade, in surveying or structural assessment – in numerous fields of applications, there are today corporations, SMEs and start-ups nationwide that offer bespoke UAS solutions for the public sector.

However, one major challenge continues to be the naturally great regional and substantive differences in the procurement landscape. There are an estimated 30,000 contracting entities at Federal Government, federal state and local authority level and they have different profiles regarding needs and requirements. Reconciling supply and demand – for instance by providing targeted information on the opportunities presented by UAS – continues to be an important task for fully exploiting the leverage effect of public procurement in the sphere of the drone economy.

The nature of the drone economy is especially international. German companies and start-ups regularly compete with suppliers from throughout the world. A systematic internationalization perspective is thus often crucial to the market success of German innovations. For this reason, the Federal Government is already supporting innovative UAS technologies today – especially with regard



to international growth markets – through, for instance, offers in the Federal Ministry for Economic Affairs and Energy’s market development programme or through visits by delegations to international UAS events.

#### We will

- explore ways of better interconnecting supply and demand by providing targeted information for public procurement entities and clients. To this end, we will deploy both existing instruments (for instance Federal Government stands at trade fairs) and new formats.
- ensure that, especially in the case of the procurement of UAS fitted with cameras, the requirements set out in Article 25 of the General Data Protection Regulation (GDPR) regarding data protection by design and by default are complied with. This will be done with due regard to the statements made on data protection and cyber security in Chapter 3.
- continue to support the German drone economy by means of tailor-made offers in the development of international markets. Particular focus will be on SMEs and innovative UAS start-ups.

## 5.6 Environment, personal data and privacy

As discussions progress on climate change mitigation, as mentioned in Chapter 3.3, UAS, as a new form of mobility in the sphere of environmental protection and with regard to UAM in the sphere of air quality improvement, must advance the development of alternative and sustainable drivetrains. The development of new drivetrains as a possible pioneer for disruptive aircraft configurations with an extremely low ecological footprint is one of the key research topics funded within the scope of the LuFo VI programme entitled “(Hybrid) Electric Manned Flight” and is also at the centre of ongoing aeronautical research topics. Despite all the positive effects that we expect from UAS, we must not fail to address their possible adverse impact. Only in this way will be able to state whether genuine added value will be created for society.

The area-wide deployment of UAS for a very wide range of application purposes may potentially result in their being perceived as a source of noise. When the Regulations Governing the Operation of Unmanned Aircraft were introduced in 2017, this was taken into account and corresponding prohibitions were incorporated into the Rules of the Air Regulations. Permission to operate UAS may only be granted, inter alia, if due regard is paid to protection against aircraft noise.

The way in which UAS noise is perceived will depend, among other things, on the ambient conditions – in rural areas, people will notice noise much more than over a busy road. Electrically powered UAS exhibit lower levels of noise emissions compared with conventional aircraft such as helicopters with an internal combustion engine. As is the case in manned aviation, technological advances are likely to result in further reductions in acoustic emissions.

Since UAS may scare and disturb animals, various restrictions have been incorporated into the Rules of the Air Regulations to protect wildlife. Thus, the operation of UAS (and aircraft models) over nature reserves, national parks and other areas as defined in the Federal Nature Conservation Act is normally prohibited. Only in justified cases may the competent authority permit exceptions from the operating bans.

This means that although the operation of UAS in areas that are in particular need of ecological protection is not entirely ruled out, it is subject to stringent requirements. Decisions as to whether these requirements are complied with will have to be taken on a case-by-case basis. This may constitute a barrier to UAS applications conceivable in the future, such as inspections of power lines. The same applies to UAS used for purposes of nature conservation itself, for instance for counting wild animals or for recording changes in habitats by means of UAS remote sensing systems. Our objective is to make it possible to deploy UAS where it is appropriate without affecting assets that require nature conservation.

The protection of public safety and order also covers protection of the population against unnecessary noise



exposure, for instance in “quiet areas” within the meaning of the Environmental Noise Directive and unwanted light influence. For this reason, noise and light emissions from UAS must be comprehensively addressed by aeronautical research and serve as a basis for the creation of broadly based societal acceptance.

UAS fitted with cameras have the potential to invade the privacy of other people. UAS are, initially, comparable to every other means of image, sound and data recording (e.g. digital cameras, sensors). This means that the data protection provisions already in place apply. The flexible possibilities of using UAS in all three dimensions makes it necessary to pay particular consideration to the data protection needs of persons (cf. the statements on data protection and cyber security in Chapter 3).

EU law also makes it possible to establish, where technically feasible, UAS geographical zones for reasons of safety and security, protection of privacy and personal data or of the environment. Given the advantages of such an arrangement, use is to be made of this option. To safeguard people’s right to informational self-determination and thus data protection, care is to be taken to ensure that UAS operating bans, for instance for residential property, are complied with. At the same time there will be requirements that restrict the operation of UAS but that cannot, for practical reasons, be represented in the form of precisely defined geographical zones.

The purpose of restrictions on UAS operation currently in place is to protect the population against noise nuisance caused by UAS. The extent to which additional measures will have to be taken if UAS are operated on a large scale in the future will have to be explored. One option could be operating hour rules that impose restrictions on operation in noise-sensitive areas at certain times. For this to happen, the effects of UAS have to be quantified by, among other things, research projects. In addition, certification of a drone with a CE marking in accordance with Delegated Regulation (EU) 2019/945 will, in the future, not be granted unless proof is furnished that the drone complies with noise limits.

#### We will

- incorporate the areas for environmental protection and nature conservation mentioned in section 21b of the Rules of the Air Regulations into the list of UAS geographical zones.
- lobby to ensure that, in the future, noise limits in accordance with the advances made in the state of the art are established for all noise-relevant UAS on the basis of measuring methods that have been further fleshed out.
- launch suitable research projects to investigate what noise and light emissions are caused by UAS, how they can be reduced and what nuisance they cause to the public. In 2020, for instance, the Federal Environment Agency will award a contract for a research project entitled “Environmental Noise Impact of the Use of UAS” within the scope of the departmental research plan.
- lobby to ensure that there is sufficient flexibility for cases in which it is absolutely essential that UAS can be operated in environmental protection areas while simultaneously ensuring that appropriate measures are taken to counter an unlawful UAS operation.
- provide the users of UAS with as much relevant information as possible about restrictions on operation from a central source, taking data protection and technical feasibility into account.
- between these conflicting interests, join forces with data protectors, users and authorities to develop solutions in order to continue to maintain the high level of the protection of privacy and data protection while simultaneously facilitating new application possibilities for meaningful operating modes. Here, the designation of UAS geographical zones will also be of key importance. This will also involve considering options of flexible multiple restrictions (location, time/duration, type of operation).

- lobby to ensure that the market surveillance methods currently used in the Federal Republic of Germany also provide for the checking of noise limits within the scope of certifying a drone with a CE marking in accordance with Delegated Regulation (EU) 2019/945.

## 5.7 Societal acceptance

UAS are a new mode of transport, and so naturally people do not have very much experience of it at present. They generally know too little about the capabilities and possible applications of UAS to form a rounded opinion.

A study <sup>12</sup>conducted by the DLR in 2018 comes to the conclusion that the term “drone” has mainly negative associations, regardless of the gender and age of the interviewees. According to the survey, the interviewees have concerns, among other things, about the possible misuse of UAS. However, there is clear approval of UAS applications for the protection and saving of human life plus research. A survey conducted by the German Aviation Association reaches similar conclusions.<sup>13</sup>

If we are to have widespread use of UAS, we also have to have broadly based societal acceptance. We will not be able to fully exhaust the potential unless we can convince the public of the benefits of the new technology and its safe operation. Alongside the practical trials in real-world laboratories and on test beds (cf. 5.4.2), the brochure published by the Federal Ministry for Economic Affairs and Energy entitled “... with drones”, also serves this purpose. It takes actual examples to show the added value that drone applications have for people, nature and society.

The support measures relating to UAS (cf. 5.4.1) require the applicants to make provision for targeted measures likely to appeal to the general public in order to intensify societal dialogue in the projects.

Both industry and government must take the concerns of the public seriously. It is a communal task to provide suitable information on UAS to explain to people what they are all about, while simultaneously taking account of legitimate demands of society. We are called upon to join forces and illustrate the added value of innovative unmanned aviation applications.

The measures described in the Environment, Data and Privacy section (cf. 5.5) are closely connected to the measures to improve societal acceptance. A crucial criterion for gaining acceptance is implementation of the statements on data protection and cyber security in Chapter 3.

### We will

- allow the findings from acceptance surveys to inform our future decisions on unmanned aviation. The Federal Government welcomes relevant projects in industry and the research community.
- join forces with the Federal Ministry of Transport and Digital Infrastructure’s UAS Advisory Council to include societal acceptance as a key area of activity. Our objective is the joint development of a suitable information strategy to provide information on UAS applications and on measures to protect the public.
- boost the practical trialling of new technologies and business models addressing all aspects of unmanned aviation on test beds and in real-world laboratories to enable people to experience them in real-life situations, to promote societal dialogue and enhance acceptance – for instance by means of exemptions applicable nationwide (see Chapters 5.3 and 5.4).

<sup>12</sup> The study on the acceptance of unmanned aircraft was prepared by the DLR Institute of Flight Guidance and the DLR Institute of Aerospace Medicine in cooperation with the Institute for Applied Social Sciences (infas). It involved conducting telephone interviews with 832 persons aged between 14 and 94 years.

<sup>13</sup> <https://www.bdl.aero/de/publikation/zivile-UAS-chance-oder-grund-zur-sorge/>

## 6. Air taxis

The carriage of passengers by means of innovative approaches to air mobility is the next logical step in the use of unmanned aircraft. Throughout the world, companies are developing vertical take-off and landing aircraft with battery or hybrid electric propulsion systems. These aircraft are known as air taxis or eVTOL<sup>14</sup> aircraft.

Unlike helicopters, which also have a vertical take-off and landing capability, the developers hope that eVTOLs will have lower operating and manufacturing costs. As a result of their planned operation at low altitudes and with a reduced range, eVTOLs differ significantly from the much more powerful helicopters.

Two basic types of propulsion are currently emerging. Multicopters use fixed rotors designed for vertical flight for thrust as well, while “lift and cruise” systems have a swivel mechanism for wings or propellers that exhibit properties of a conventional fixed-wing aircraft during cruising. What all designs have in common is that they use a large number of rotors and/or propellers in addition to their electric propulsion.

The fact that air taxis are a mode of transport to be taken seriously in the near future is shown not least by the fact that EASA has already published the certification framework for eVTOLs<sup>15</sup>, which provides for the following parameters:

- person-carrying vertical take-off and landing heavier-than-air aircraft;
- lift/thrust units used to generate powered lift and control;
- battery or hybrid electric propulsion;
- passenger seating configuration of nine or less;
- maximum take-off mass of 3,175 kg.

The certification framework constitutes an important first step towards the introduction of air taxis. However, there are still a wide range of issues to be resolved before regular operation that is ultimately autonomous, i.e. without a pilot on board, is conceivable. The commercial carriage of passengers and the protection of third parties being overflown are subject to very stringent safety requirements. For the operation of air taxis, provision has to be made for take-off and landing sites, especially in urban areas, in order to guarantee orderly passenger transport. One issue to be resolved concerns the demand placed by eVTOLs on aerodrome infrastructure. At the same time, however, consideration should be given to using the existing aerodrome infrastructure for trials and possibly also regular flight operations.

Air taxis are to facilitate improved connectivity between transport hubs such as airports or railway stations. One challenge here is integrating eVTOLs into the existing aerodrome traffic as well as transport and urban infrastructure schemes. It is imperative that procedures be developed that affect neither the capacity nor the safety of other transport modes. In addition to the integration of eVTOL on the airside, the landside should also be considered as an alternative. Air taxis can make a contribution to the localized relief of ground traffic congestion. Nevertheless, it is assumed that they will not be a means of mass transport in the short to medium term. They can, however, perform a complementary function to other modes of transport, which means that their integration into the existing transport system and mobility services is of not insignificant importance. Their deployment makes it possible to generate intermodal transport chains in an appropriate and efficient manner. If business models for air taxis are to be realized, it is also necessary to take into account a possible new transport mode at an early stage in urban and spatial planning.

Alongside commercial passenger transport, the possible use in air rescue for the transport of emergency physicians is being studied. Rescue helicopters are used for this purpose in around 70 % of cases – only just under one third of the flights have patients on board. This situation lends itself to the use of UAS that are designed not for the transport of patients but exclusively for the rapid transport of an emergency physician to the site of the incident. As a result

<sup>14</sup> eVTOL = electric Vertical Take-off and Landing

<sup>15</sup> Special Condition for small-category VTOL aircraft.

of the expected less costly operation of eVTOLs compared with helicopters, the costs of an emergency physician call could be reduced with no deterioration in the provision of medical care.

#### We will

- join forces with the industry to monitor the development of requirements for eVTOL aerodromes at ICAO and EU level in order to guarantee safe and orderly flight operations, especially in urban areas. The existing provisions governing heliports could form a starting point for this. eVTOL aerodromes should, as far as possible, be interoperable for a wide range of eVTOLs in order to minimize the number of aerodromes that are necessary.
  - exploit synergies and avoid additional effort and expenditure by lobbying to ensure that existing aerodromes can, as far as possible and practicable, also be used by eVTOLs.
- progress the development of eVTOL approach procedures to and departure procedures from airports without this having an impact on the frequency of arrivals and departures. The specific local situation of the airports is to be taken into account here. In addition to the integration of eVTOLs on the airside, this is also conceivable on the landside.
  - make an intensive contribution to the activities at EASA concerning the provisions governing the certification of eVTOLs.
  - create the regulatory framework for combining mobility services with one another such that customers can use a multimodal transport chain into which eVTOLs are integrated. The creation of a common platform as an interface with clients for route selection and invoicing is key to success.
  - implement the statements on data protection and cyber security (see Chapter 3) with regard to air taxis as well.



# 7. Implementation

Implementation of this action plan will be monitored across departmental boundaries and strategically controlled by the Federal Government. Where there are different departmental responsibilities, the Federal Government will closely coordinate them. This will not affect the lead responsibility of the departments for individual sectors affected.

In addition, the Federal Government will establish a **UAS programme group** at working level to implement individual measures of this Action Plan so that there can be an effective exchange of ideas and experience on UAS-related topics. Relevant executive agencies will be involved at the discretion of the departments concerned.

With the Federal Ministry of Transport and Digital Infrastructure's **UAS Advisory Council**, a think-tank has been established that links all stakeholders from the fields of aviation, the digital revolution and applications for a cross-sectoral exchange of ideas and experience. The UAS Advisory Council has proved to be successful as a central platform for involving the relevant players. It has made a major contribution towards identifying technical, legal and societal action areas that have informed the present Action Plan. The members of the UAS Advisory Council and the Federal Ministry of Transport and Digital Infrastructure are in agreement that they will continue their successful activities and provide support to the implementation of

the Action Plan. The Federal Ministry of Transport and Digital Infrastructure's UAS Advisory Council is open to all interested government departments.

A close exchange of ideas and experience with the federal states is required for the implementation of this Action Plan. In consultation with the federal states, the Federal Ministry of Transport and Digital Infrastructure will establish a **Federal Government/federal state project group** which, in addition to the priority objective of applying the EU regulatory framework governing unmanned aircraft, is also to discuss relevant questions as this Action Plan is implemented. Interested government departments are invited to participate in the project group.

The measures set out in this Action Plan will also be taken into account during the forthcoming revision of the Federal Government's Aviation Strategy, for which the **Ministry for Economic Affairs and Energy** has lead responsibility.

Implementation of the Action Plan is subject to the availability of appropriated funds. Consideration will also be given to how costs incurred for individually allocatable public services in connection with the control and monitoring of UAS and the necessary frequency protection can be apportioned on the basis of the "user pays" principle.

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