

Copernicus and Unmanned Aerial Platforms Industry Workshop 13/09/2018

Workshop Minutes





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1 Introduction

The Copernicus programme currently relies on a set of dedicated satellites (seven Sentinels), as well as contributing missions and in-situ capacities to deliver six services (land, atmosphere, climate change, marine environment, emergency management, security). Unmanned aerial platforms, notably UASs, become increasingly reliable and robust and are already providing operational Earth observation capacities that could offer, under certain conditions, useful complementarity with satellite-based services. High Altitude Pseudo-Satellites or Platform Systems will operate quasi-stationarily over a fixed point on Earth for weeks to months at very high altitude and will soon provide additional options for Earth Observation.

The Workshop, hosted on the premises of Eurocontrol in Brussels, linked industry representatives from the Space, Earth Observation and Unmanned Aerial Systems sectors, who looked at existing and upcoming aerial observation capabilities and applications, to understand the operational and legal aspects in using unmanned aerial platforms as well as to capture potential user needs.

About 150 participants attended this workshop. The agenda of the workshop can be found in the Annex.



2 MINUTES OF THE WORKSHOP

2.1 Welcome and introduction

The workshop was opened by **Dr Philippe Brunet**, Director for Space Policy, Copernicus and Defence, European Commission, who was filmed by a drone during the first moments of his speech. During his introduction, Dr Brunet elaborated on Copernicus' interest in drones, mentioning that there is a need to develop synergies between data sources and to boost innovation. Copernicus is largely based on space infrastructure, but it will very soon have new missions and objectives, for which additional sensors need to be used or developed. Amongst these sensors, HAPS as well as drones will be the source of new data. This is a timely moment, considering the fact that there is a new proposed Space Regulation, while also the EU's Multiannual Financial Framework (MFF) and new Copernicus ambitions are also being discussed. For these ambitions, new technologies such as drones are important.

According to Mr Brunet, we are now at the "second season" of Copernicus. The first season was a success, with its seven satellites in orbit, as well as more than twenty contributing missions from ESA and Member States. The six services are fully operational, including the Copernicus Climate Change Service, which is the very first Earth Observation-based service devoted to climate change. Copernicus has created more than 4000 permanent jobs and thousands of SMEs in less than five years. Recently, Copernicus celebrated its 20th anniversary in Baveno, as well as the launch of the DIAS to improve data access by using cloud technology. This new feature will provide a real boost for innovation.

The European Commission is currently the chair of the Committee on Earth Observation Satellites (CEOS). Just the fact that the EU was chosen to chair CEOS is a recognition that it has developed one of the best EO-systems. Copernicus is now one of the largest EO data providers worldwide, with 100 PB of data generated annually.

Just some months ago, the Commission has published a proposal for a new regulation combining all the space programmes, including Copernicus. It will shape the development of Copernicus for the next years, and it was built upon a couple of principles.

The first is continuity. This involves an incremental improvement in order to keep the system up to the highest level of technology. This is necessary to preserve the autonomy of the European Union and the system in itself, and to pave the way for additional missions. In this regard, Mr Brunet stressed that Copernicus has become a public good provider. The downstream sector and different businesses (SMEs) have been developed and add value to the Copernicus data and information. Without these as a raw material, the downstream industries would be jeopardised.

Two of the new missions, which are being discussed, are very close to the highest political challenges. One is the monitoring of CO2 emissions, including the technological bottleneck related to the need to differentiate anthropological CO2-emissions from natural ones; and the monitoring of the Arctic area from an Environmental standpoint. Europe's competitors, able to monitor this area, are mainly China, Russia and the USA.

In the next Multiannual Financial Framework, the Commission has proposed to allocate 5.8 bn EUR for Copernicus, which represents 80% of the cost to maintain and further develop Copernicus, whereas 20% will be borne by ESA. These new missions are based on new needs in terms of data, and require new sensors and the use of new technologies.



For that, the Commission wants to reduce the possible gaps between the different EU policies. It is necessary to find synergies between space policy, aviation, industrial policies and to some extent horizontal policies such as standardisation and certification. One can increasingly see the emergence of a "New Space", or a new system of systems, encompassing space and including other technologies such as drones. According to Mr Brunet, this requires standardisation and certification, which is to the benefit for all EU Member States.

For drones, a recent interesting step forward has been made, as a new framework has come in place where the EU is responsible for the regulation of all civil drones. The EU will create an internal market for drones, which brings back the point on harmonisation and standardisation, but also the issue of air traffic management systems. This was even given a name: U-space.

Currently, Copernicus has two sources of data: the in-situ data and the data coming from the Space Infrastructure. According to Mr Brunet, this is by far the major and critical source of data. However, systems of systems will emerge, as the future is to the integration of different types of systems. In order to enrich the Information, data from other sources will be needed. This has been recognised with the collection of in-situ data, and a next step will be the data from airborne systems such as drones, HAPS, and balloons. These need to be integrated using new features such as artificial intelligence, robotics, and big data.

For the climate change service and its very long-term forecast, high-performance computing will be absolutely critical. One can imagine that the system of Copernicus may one day be linked to certain activities in aviation, and aircraft may be able to collect data which can be fed into the system.

Eventually, Dr Brunet suggested to think out of the box, with the example of Google Maps, which is using drones to take pictures to be fed into the database integrating multiple other data, such as the opening hours or schedules of museums and points of interest. According to Mr Brunet, Copernicus should not necessarily go into these details, but some users, such as FRONTEX, need quasi real-time data. This means that Copernicus, being a user-driven programme, needs to look into new systems of data acquisition like those discussed today.

Mr Phillippe Merlot, Director for European Civil-Military Aviation, Eurocontrol, provided a welcome word during which he introduced Eurocontrol, touching upon some points of common interest between the space and aviation activities.

Eurocontrol is an intergovernmental organisation dedicated to the integration of air traffic management in Europe. It was created fifty years ago with six founding members at that time. Today, there are 41 Member States, covering all EU-Members, as well as third countries such as Morocco and Israel, who joined several years ago. The core of the Member States is the European Union,. This is a demonstration of the necessity and power of cooperation in order to increase the efficiency and capability of all the different individual Member States.

Eurocontrol is managing one of the most important air traffic control centres of Europe, which is based in Maastricht, located in one of the most dense airspaces. The organisation's main mission is its Network Manager role, performed on behalf of the European Union. It covers 43 states, more than 68 en-route air traffic control centres, and more than 500 airports. There is a need to connect all these different individual components into a consistent network. Eurocontrol receives all the flight plans of airspace users that want to operate in Europe, enabling an anticipation of the traffic (air situation), and a detection of the overload in every sector or airport.

With this network function, Eurocontrol has developed a global vision of the air traffic in Europe, and is able to feed the Member States with this new vision, with new capabilities, and with the possibility for them to



anticipate the traffic before they enter into their own airspace. This is a strong similarity with the Copernicus objective: a global vision of Earth, independent from the national limits, in order to enable new capabilities and to feed these capabilities to all the EU Member States.

Another important mission is to federate the research and development activities. Eurocontrol is a founding member of the SESAR Joint Undertaking, the main project developing a new ATM infrastructure in Europe. The JU has more than 350 experts covering all fields of ATM, from communication to navigation and surveillance and is coordinating all the research & development efforts with many different stakeholders and members. Mr Merlo considers that this aspect is also common with Copernicus; the importance of R&D and the need to pool a critical mass of resources and expertise to increase capabilities, and the importance to define a common strategy and roadmap.

There is a growing importance of satellite applications for air traffic management. This is true for navigation (and GPS is today the major means of navigation for all aviation; very soon we will be able to rely on Galileo as well) and for communication. An important infrastructure is emerging today, namely the AIREON system, which will soon provide a full tracking capability of all flights worldwide. Of course, Earth Observation is also key for aviation (e.g. real-time winds), and it proved to be critical to solve the crisis following the ash cloud from the Eyjafjallajökull-volcano in Iceland in 2010. Earth Observation can besides also be used in order to build the obstacle maps around airports. In aviation, the requirements in terms of precision, safety and security are very high. More and more space applications will be needed, and according to Mr Merlot, Eurocontrol could become a flag user of the Copernicus services.

For Eurocontrol, drones and aerial platforms are a challenge and an opportunity. Most spectacular developments are happening at the low altitude, but there are spectacular projects for high-altitude gliders, very high-altitude balloons and low-orbit space vehicles. This is very exciting, but it is a challenge for the traditional aviation as it is necessary to make sure that a safe separation is provided with traditional flights, ensuring that the impact on the airspace capacity will not be detrimental for traditional aviation. Eurocontrol has already taken a leadership role in the challenge of integrating these new aerial vehicles into a controlled airspace, and will be happy to contribute to the European Commission's effort to develop drone activities for Copernicus.



2.2 SESSION 1: Upstream - Existing and upcoming aerial observation systems

The first session was introduced by the Chair, **Mr Andreas Veispak**, Head of the Unit of Space Data for Societal Challenges and Growth at the European Commission, who thanked the organisers, the Member States participants and Aetos Drones for the provision of the drone demonstration.

Mr Veispak subsequently reminded the audience that this workshop was being held in the context of the reflection on the next Multiannual Financial Framework and the next generation of Copernicus.

Tim McCarthy (Maynooth University)

Mr McCarthy introduced his presentation by pointing out the high versatility of drones, followed by a horizontal overview of different UAPs-related aspects.

The drones' market can be divided into different sectors, from the upstream sector (including hardware, UAS platforms and sensors that are aboard) to the downstream sector (from applications to more advanced robotics). A blockage, however, can be identified in the midstream (or the operations). This blockage deals with Beyond Line of Sight (BLOS), the issue of knowing where drones are flying. According to Mr McCarthy, this issue, which needs to be solved, has no easy solution.

Drones have different applications, ranging from cadastral mapping to precision agriculture, as well as critical infrastructure monitoring, maritime monitoring, air/water quality monitoring and emergency response. As they involve the user and generate more interactivity, drones are capable of adding an extra dimension to different areas.

For Copernicus, the interest lies in commercial or civilian drones which are improving their performances and capabilities. Mr Mc Carthy guesstimated that there are between ca. 20,000 and 30,000 drone operators in Europe, which relates to ca. 30,000 to 50,000 drones. European funding is enabled through nine Horizon 2020-projects and the SESAR-project which will be funded in 2019. In contrast, the U.S. has between ca. 103,000 and 107,000 operators, and seven FAA UAS test sites. According to Mr McCarthy, this sizeable difference indicates that Europe could be doing more; in his estimation, Europe's drone industry could generate a market of more than 1.2 bn EUR.

Touching upon the complementarity of drones with Copernicus, Mr McCarthy raised attention to the fact that Copernicus' end users have increasingly demanding needs, looking for more real-time data, for targeted operations and for data that they can use to improve performance on their jobs.

Drones are highly versatile, adaptable and configurable. In the future, people will be able to look at a screen and ask for the information to be delivered immediately. Whereas up to now, a large industry is controlling Earth Observation capabilities, drone technology and geoinformation service providers have a wider industry base participation including SMEs, both from a production and a service point of view.

In his presentation, Mr McCarthy argued that the role of artificial intelligence and machine learning will be absolutely relevant, adding that the data streams coming from drones could even be more suitable to these systems. In his view, this would not just be optical, but there would be a whole range of data types.

According to Mr McCarthy, Europe may need to take a bold step to become a demonstrator in BLOS-operations. Furthermore, a prediction was made that U-space or UTM-licenses would be set up to be operated similar to Telco mobile phone licenses. With regard to the drone operators, if the U-space is done right, machines could control the drones with human oversight, and the UTM might even fly the drone. Companies are currently training their own pilots and buying their own drones, but a Copernicus approach,



where the infrastructure is shared under a service model, could be interesting. One centre could collect the data, and process them into different information services to satisfy certain applications.

Pierre-Alain Bosc (Airbus)

Mr Pierre-Alain Bosc indicated that Airbus is building drones for military purposes and is using drones for Airbus' services for agriculture and maritime applications. His presentation however focused on High Altitude Pseudo-Satellites (HAPS), which fly above flight level 600. Zephyr OPAZ, Airbus' solution for HAPS, flew uninterrupted above a ranch in Texas for 25 days, 23 hours and 57 minutes in July 2018. Zephyr OPAZ is purely fuelled by solar energy, has a 25-meter span and weighs 75 kilograms.

Copernicus currently uses the Sentinel satellites and the commercial contributing missions, which are high performance satellites and new emerging constellations. These constellations provide photos, which are subject to the orbiting constraints and the time taken to deliver the information services to the customer. With HAPS, such as Zephyr OPAZ, one experiences a high persistency, making it possible to install a camera providing a photo or video on a permanent basis, which is a game-changer.

The Zephyr OPAZ payload has two cameras that can provide images. The first camera has a field of view of 400 km², with a 5 meter-resolution. It has a permanent imaging and can detect moving targets. The second camera has a field of view of 1 km² with a resolution of 15 centimeters. The cameras are able to detect individuals.

HAPS are not like a satellite, but rather like a UAV in terms of flexibility and accuracy; they can be flown wherever needed.

In his conclusion, Mr Bosc considered HAPS a game changer, although the technology is still in development and is not operational yet. There is more work that needs to be done concerning the payload, and the midstream, such as analytics, BLOS and the downloading of the data. Furthermore, the payload still needs to be integrated with the ground receiving systems, the analytics, the dissemination and this into all existing systems, or perhaps also Copernicus. By 2020, Airbus should be able to provide an operational demo for services such as Frontex or EMSA.

Pierre-Yves Dussauze (Delair)

Delair is a global provider of drone-based intelligence. Its vision is to work on the digital transformation of the world. Delair has built up experience in all the building blocks of the drone value chain, from drone designing, manufacturing, data collection, data analysis, building intelligence and providing associated services. This digital transformation is key in today's industry and in asset management, from infrastructure to resources. Accurate and precise models can assist the industry with simpler decisions, increased productivity and a better return on investment.

In terms of image collection products, Delair has produced a series of drones with the actual catalogue only including fixed-wings hardware. One of its drones, the DT18, was the first drone ever certified for BLOS-operations. The new UX11 offers an easy workflow from data collection to image processing, with simplified operations, allowing the user to fly within several minutes. The DT26 is a strong carrier, allowing heavy payloads up to 15 kilograms. It can carry a LIDAR-camera and has an autonomy of up to two hours.

When it comes to software solutions, Delair has been working on a solution to process collected images for more than two years. Last year, it created a strategic partnership with Intel on this domain, combining Delair's expertise in UAV, data science and AI with Intel's powerful and scalable cloud computing capacities. This should provide a smooth workflow, as well as a scalable solution to cope with an important amount of data



and processing. The objective of Delair's software solutions is simple, as it wants to extract information from images, mainly from drones and also other sensors and data collections (such as IoT or terrestrial sensors). The goal is hereby mainly to support asset management.

Delair executed some pilot projects with DG JRC in the framework of Copernicus between 2015 and 2017. The objective was to assess the data collection capabilities of aero-sensors in the case of disaster events, as well as how it could be integrated in the EMS operational workflow. The rationale behind the project was the fast maturing of drone systems, which are increasingly reliable, providing accurate data. Furthermore, drones fly rather low and provide a high accuracy and resolution with no constraints for the revisit and cloud coverage. The goal of the programme was to evaluate the workflow in real-life use cases, and the output of each workflow was the production of rapid mapping (auto photo and digital surface model) based on the data collected. These outputs were required to be provided 48 hours after activation by DG JRC.

Delair worked on four activations in the frame of this project:

- 1. Spain (forest fire damage assessment)
- 2. Italy (risk assessment for collapse of old mines)
- 3. France (post-flood mapping)
- 4. Portugal (pre-disaster activity to assess the risk of flooding in a coastal area)

The outcome of the study revealed that the delivery of the product was both reliable and accurate. The biggest challenge was the 48-hours window in which the product needed to be delivered. The workflow was broken down into the following phases:

- 1. DG JRC activated Delair from an area of interest (where / context of what to be mapped)
- 2. Delair did the mission planning
- 3. Seek flight authorisations (BLOS or not)
- 4. Travel on site, flight, images
- 5. Upload images (one flight often more than 10 GB of data)
- 6. Processing of all the data

The biggest obstacle was seen in the processing, which can grow exponentially as one increases the size of the coverage area and the number of images to be processed. Delair had to break the area in blocks, and in usual conditions, one week of processing would not be abnormal in this context.

A second obstacle was the authorisation applications. Regulation differs in different regions, and a lot of work needs to be done for it to be harmonised in Europe and on a global scale.

Areas of improvement have since been identified to reach the 48 hours-timeline. In terms of processing, either a capacity should be brought in the field to process data as the flight takes place, or cloud computing should be used to provide a scalable capacity to cope with large amounts of processing and data. Concerning the regulation, support from other authorities (mainly the civil security authorities) were of largely helpful, but a lot of work on this needs to be done in the Emergency Service-context to speed things up. Once these issues have been addressed, it should be possible to reach the 48 hours deadline.

In conclusion, the study revealed that UAVs are fit for EMS. They allow users to plug data pre-crisis or post-crisis for validation or recovery actions. When collecting data, the images can be collected in real time. These are systems of systems, where drones combine with other sources of information and high-level acquisitions, allowing for a real-time mapping.



Christian Lockowandt (Swedish Space Corporation)

The Swedish Space Corporation (SSC) has been working with balloons since the 1960s. It is a state-owned company, owned by the Swedish government, with revenues over 100 mn EUR and offices all over the world. Its main activity is a network of satellite ground stations, which are sold to different satellite owners and operators.

SSC's public assignment relates to stratospheric balloons. SSC has a space base in Esrange Space Centre in the north of Sweden, where stratospheric balloons are launched. The location is ideal due to the low population density and the low volumes of air traffic.

A stratospheric balloon is a large plastic envelope filled with a gas lighter than air. It usually flies between 20 to 42 kilometres of altitude. When flying at 42 km, one is at 98% of the atmosphere's height, which allows one to look down to the atmosphere. Balloons are at this moment the only platform that allows one to these altitudes, and to stay there for a certain time. This is very important for in-situ measurements in these layers, for applications such as climate change, or for the measurement of the chemistry, temperature or winds at a certain altitude.

SSC controls the altitude of the balloons, while the balloons follow the winds in horizontal directions. There are no further means to control the flight patterns in horizontal directions. There are usually stable winds in these altitudes depending on the season.

The balloons have a different direction depending on the time of the year. In the summertime they drift to the west towards Canada or Alaska, which takes a week. In the wintertime the flight goes to the east over Russia, which is politically more problematic. There is a lot of work to obtain all the permissions. During autumn and spring, winds turn, and as a consequence it is possible to fly more locally between Sweden, Norway and Finland.

The payload can carry up to three tons of instruments, and the flight time of the balloons ranges from days to weeks. Additional values include real-time data and commanding, while the experiment and data can be controlled and images can be downloaded, depending on the distance from the ground station.

The stratospheric balloons are used for a range of applications, including:

- Atmospheric physics and chemistry
- Astronomy / astrophysics
- Climate research
- Fundamental physics
- Biology (what is in the atmosphere)
- Validation of satellite instruments
- Technology tests

Looking into the future of stratospheric ballooning, all the existing projects are national, with the exception of two projects partially funded through Horizon 2020, such as the ESBO-project (trying to set up a European Stratospheric Balloon Observatory infrastructure) and the HEMERA-project (a more general balloon infrastructure to be set up at a European level).

The balloons which are used now have a limited flight time, but the evolution to super pressure balloons will allow longer-duration flight times of several months. There are improvements in real-time communication through new satellite configuration systems. SSC, NASA and CNES are trying to find new release sites in order to fly in new places. Examples include Svalbard or the United Arab Emirates.



Guy Boullenger (Thales Alenia Space)

Mr Boullenger introduced Stratobus, an airship with the length of 140 metres, propelled by electrical energy. The ship does not fly, but 'floats', as it is managed like a submarine using ballasting. The ship will remain in flight for a full year in a fixed position over a particular point, enabling a wealth of applications, in particular for Earth Observation.

Stratobus is neither a satellite, nor a drone. It offers a persistence which neither can offer. Furthermore, Stratobus can be equipped with very high-performance payloads, ranging from 250 to 450 kg, with a power of five to eight kilowatts. Therefore, in terms of Earth Observation, it host both cameras and radars, allowing for a very long range.

The ship will float far above aircrafts at an altitude of around 20 kilometres; an optimal position for a position-fixed vehicle like Stratobus due to the low-wind environment compared to lower or higher altitudes. Stratobus can also be repositioned using solar energy, which allows it to map an area at low cost or difficulty.

The ship has an effective range of 500 kilometres from its static position, which can be explored with a variety of instruments and radars. In terms of applications, Stratobus is designed and intended as a multi-use platform for military and civil applications. The most urgent applications are foreseen in the area of surveillance and defence or security, combining radar and optical instruments to permanently monitor an area with video or radar imagery. Other observation missions in the area of urban or environment monitoring, fire detection, oil spills, energy efficiency of cities, pollution and air quality can also be performed. Thales Alenia Space is working on these application fields, and Copernicus is a good environment for this.

Mr Boullenger illustrated the possibility of deploying a fleet of Stratobus over the Mediterranean to control the southern borders of Europe. A very good monitoring of the situation could be achieved with a limited number of vehicles.

The development of this project started in 2016, and is currently in a technology demonstration phase. Thales Alenia Space is working to identify and qualify the key technologies that are needed for the platform. These include the envelope, which needs to keep helium inside for a full year. This will be demonstrated early 2019. Other technologies include the solar panels (which are already quite advanced) and energy storage (making use of either batteries or regenerative fuel cells). Thales Alenia Space is testing demonstrations to validate the technologies. Next year will feature flight validations of the key technologies with a one-third scale model.

Meanwhile, Thales Alenia Space is launching the detailed design of the full-scale model for a prototype which should fly for defence and security missions in 2022. Recurrent models should be available for Copernicus and other missions starting from 2023.

Q&A-session

The Chair thanked all the speakers for their contributions and opened the floor for questions and answers.

Following a remark from Nicolas Lewyckyj (VITO) concerning the fact that fifteen years ago, different balloon systems were in development in the United States and Japan, and were stopped due to high maintenance costs, the question was raised about how Airbus would avoid making the same mistake. In response, Mr Boullenger answered that the ground operations for such big vehicles are indeed a challenge. According to Thales Alenia Space, the concept is that these vehicles are able to fly permanently, and that they should only be on the ground for a very limited period of time, for maintenance and to be refilled. Even if there is no



active mission, the vehicle should stay afloat in the atmosphere. Second, Thales Alenia Space is working to design grand facilities which are mobile and not too expensive, with for instance inflatable hangars.

One participant made the remark that the recent technological achievements have been incredible, with drones that are even commercialised. The challenge we are facing are not the drones themselves, but rather the information gathered by the drones, with more affordable and new sensors (LIDAR, thermal) and high-resolution cameras. The participant enquired as to how the panel sees these technologies expanding in the next years, considering the fact that Copernicus satellites could be combined with drones in the future to get information from even the sub-centimetre level. In response, Mr McCarthy (Maynooth University) agreed with this position, adding that the current Sentinel-constellation generates several terabytes a day, whereas these new platforms will be generating an order of magnitude in petabytes. There will not just be optical data, but also richer data streams such as LIDAR or Environmental sensors. Mr McCarthy concluded that artificial intelligence (AI), data analytics and machine learning are necessary to help automate the processing of these data streams.

Mr Dussauze (Delair) fully agreed with this, adding that these wider technological developments would hopefully be a global development of which the drone sector can benefit. On the hardware side, some improvement could be made as well, with better autonomy and reliability, and a regulatory framework which would enable the development of other ways to operate fleets of drones or totally unmanned drones.

According to Mr Bosc (Airbus), the amount of petabytes that needs to be dealt with in real time is quite a challenge. Digital platforms (such as the DIAS) prove that we will have to move forward, using Al. With regards to HAPS, in ten years from now it will be possible to have eyes on a certain area, but the question that remains is what to do with all the data. Furthermore, the current regulations are not the same throughout Europe. For UAPs flying over a flight level of 600 with less than 150 kilogrammes, there is no regulation. The question is whether a regulation will be defined surrounding the provision of services in terms of emergency, security or defence.

Mr Lockowandt (SSC) added that ballooning has been very popular, with a growing number of small projects. As with drones, one can see a problem with the current regulations.

According to Mr Boullenger, the complete model on which EO is working today will be changed with platforms such as Stratobus or Zephyr. The continuous flow of data will alter the current model where data is acquired and exploited offline. The sensors on HAPS will operate in real time like coastal or aerial radars, rather than satellite data. The challenge no longer relates to how much data to generate, but rather what tools we give to operators to automate the monitoring and to analyse the data in real-time. Storage will no longer be an issue.

A last remark by someone from the audience related to the opening session, where it was mentioned that UAVs are discussed whether Copernicus should become a system of systems. This has been done for a long time, with many services (e.g. CMEMS, CAMS) using in-situ data, aircraft data and so forth. A main specificity of Copernicus, which has been discussed at length in 2014, is the question of what Copernicus is, which is currently a service provider and an operator solely for space data. There was a decision back then that Copernicus would not get involved in funding in-situ data considering that this is the role of the Member States. The question is whether this is going to evolve or not. Should the balloons over the Southern Mediterranean be covered by Copernicus, or by Frontex or EMSA? This is, according to the person raising this question, something to consider.

In response, the Chair agreed that this is a fundamental question, which is part of the reason that this workshop was organised. The question is "What is Copernicus?" and "What is its purpose?" - with two



distinct parts, namely the space infrastructure and the service part. Should we go towards the integration of these new platforms, which is a practical implementational question: is what we are dealing with essentially data and information buy, such as the data warehouse; or is this part of the provision of individual services, moving through the vehicles which are there in the service set-up? There is currently no answer to this question, as Copernicus is a user-driven programme, executed together with the Member States and ESA. The Chair, however, added a dimension related to the core mission of Copernicus, which is to provide free, full and open data, as well as services in the areas of Environmental and Security monitoring. The question here is: what are the implications of the way in which large EU-programmes are implemented, for the development of the European industry? What do these technological developments do to the industrial and technological base in Europe? Given the fact that the European Union is a major customer, be that either through the space infrastructure or through the service provisions, one should look at how to design this to keep the European industry competitive.



2.3 SESSION 2: Downstream - Existing use of aerial observations applications

This session was opened by the Chair, **Mr Peter Spruyt** (DG JRC, European Commission), who gave an introduction to the speakers, and suggested questions to be asked immediately after each presentation.

Nicholas Lewyckyj (VITO)

Mr Lewyckyj offered a brief introduction to VITO, which is a non-profit technological research centre of 700 staff members, owned by the Flemish government. It has a turnover of 170 mn EUR in 2017, and it has five main working domains: chemistry, materials, health, environment and energy. The Department of Environment features the remote sensing unit, with 85 people working on (semi-) automatic image processing. It has more than 20 years of experience with satellite data processing, and more than 10 years of experience working with drones and RPAS, focusing on Environment, agriculture, water, infrastructure, forestry and security.

Mr Lewyckyj gave insight into three examples where drones were used to calibrate Copernicus-imagery to offer an operational service. First, the I-POT project started in 2014 and lasted for three years. Its objective was to forecast the potato growth in Belgium, with the aim to validate imagery from Sentinel-2 (S2) and Deimos, using RPAS data and ground true measurements. Very good results were observed, not only when using remote sensing imagery, as these have to be combined with meteorological data. The results were valid for different potato types. Sentinel-2 gave better data results than Deimos-data, with a particular advantage in its higher spatial resolution and free data. Eventually, a preliminary platform was established based on S2-data. Later on, a project was all-funded by VITO, to further develop the existing functionalities into a platform called WatchITgrow. This is an operational service which runs in Belgium, using only S2-data, with currently 600 users. VITO is working on an extension of the system for other countries.

A second project, in the same field, not only aims at following the crops' growth but also to determine the required fertilisation and irrigation levels. This EURANET-project partly paid by VLAIO, started in June 2017 and began from an existing service offered by the Bodemkundige Dienst Belgium, which provided the farmers with the possibility to have one sampling per field to evaluate the stress due to low fertilisation and irrigation. VITO looks at using high-resolution RPAS-data (RGB, multispectral and thermal imagery), which would provide the farmer a real full-resolution XYZ-representation of his field instead of a single measurement, applicable to both nitrogen as well as water stresses. The aim is to include this in a S2-based system.

A third and last example is a Horizon 2020-project dedicated to the detection of the wild pine nematode disease in Portuguese forests, which rapidly affects and even kills trees in three years. It started from an existing commercial service, the Sivilsense-services, which offers land classification, forest fire mapping, pine distribution mapping, and so forth, based on S2-data. VITO will add a component able to early detect the wild pine nematode within the service, using both multispectral and hyperspectral data to calibrate and validate the S2-data. This is important as nearly 100,000 jobs depend on forestry in Portugal, and currently approximately 27% of the area is already affected, with a potential danger for Spain and the rest of Europe. The project started this year, and has defined the user requirements, the system requirements and the region of interest. VITO has collected S2 historical data, has performed a multispectral flight in these zones in May and is currently analysing these preliminary data. In the next months, the project will run an extensive field campaign with ground measurements, multispectral, hyperspectral and thermal imagery. This will be validated on-site through a synchronisation with airborne hyperspectral data from apex-instruments, which will be synchronised with the path of the Sentinel-2. The aim is to offer a S2-based service, and an additional on-demand or systematic RPAS-based service. There is also an ambition to extend this service to other countries.



Mr Lewyckyj expressed his conviction that the future is in the use of HAPS, combined with satellites and drones, allowing many new applications and services.

The main problems to be tackled include:

- The upscaling of higher-resolution drones and lower-resolution S2-data;
- Of the camera which VITO bought, the red-edge band was not really suited for the application, whereas hyperspectral imagery is more time- and data-demanding;
- RPAS acquisition takes time, whereas satellite imagery can take a large area in one shot;
- The varying illumination of RPAS-imagery is an issue, as it has to be recalibrated;
- There is a problem of blurring, since the RPAS are moving;
- It is difficult to have cost-effective time series

The Chair added that VITO's presentation included many interesting examples, which could also be used for plant diseases of olive trees in Italy. As regards the EURANET-VLAIO project, VITO mentioned to use RGB, multispectral and thermal data in order to enhance the existing services. The Chair enquired about the added value of the thermal camera, compared to the RGB and red-edge camera. In response, Mr Lewyckyj stated that the thermal camera allows one to see the water stress earlier in time. The multispectral camera most of the time shows the coral which is affected, whereas with the thermal camera, one can clearly distinguish the water stress.

Oisin McGrath (DroneSAR)

DroneSAR is an Irish-based start-up which developed a software, enabling the commercially available drones with a range of rescue-specific functions, very similar to the functions aboard of certain rescue helicopter flight management systems.

In the last eighteen months, the DroneSAR software was used throughout the world in various sectors, from humanitarian disasters, disaster management, public safety awareness and beach rescue actions in respectively Chile, USA, Iceland and Norway, Belgium and Australia.

The current global civilian drone market is estimated to have a turnover of about 2 to 11 bn USD by 2020. The market of applications however, is estimated to be about 127 bn EUR. According to Mr McGrath, a lot of industry and SAR-agencies are testing drones to see whether they will work.

DroneSAR starts from a basic software, linking the pilot to the drone. It allows the pilot to see the video fees and have access to a certain amount of drone controllers. For Search and Rescue (SAR), this has been taken up a level, as SAR is a high-stress Environment. It allows drone pilots to make a fully automated flight, and to concentrate on what is important. Only the relevant information is displayed to avoid distraction.

The application has a customised grid pattern allowing pilots to fly the grid with a 10% overlap in case victims are not immediately found. Using the iPad, each pilot has a range of in-flight functions which allows the movement of the camera up and down, and the sharing of location with team members.

A second level of the application is the connectivity. Whenever the pilots choose a mission on the field, and they are flying their drone, the application shares the mission to a live browser which can be accessed from any internet browser, allowing teams, command and control and helicopter crews to log in and to view the live drone position. This can be done for multiple drones. One can also chat directly with the pilot at all times. The pilot, who was once a disconnected person within the organisation, becomes connected into the standard SAR-protocols.



Every mission is stored, and people can go back and view the archive track and the archive video for each of the missions they have flown, for any amount of missions. There is also a team map, allowing team members with their phones in their pockets to be tracked, which is displayed on the DroneSAR pilot app. One can see the location of all team members as they fly the missions, watch the live drone footage and crowdsource the video to get more eyes scanning the footage.

DroneSAR was the first company to win the ESA BIC in Ireland and has also won the Copernicus Challenges last year, as well as the Ireland-version of the European Satellite Navigation Challenge (ESNC). The concept at the time was to allow Copernicus EMS images to be brought into the pilot console, allowing pilots a more up-to-date imagery. Although it is labelled 'Search and Rescue', this also applies to pollution control, humanitarian efforts and so forth. This year, DroneSAR is part of the Copernicus Incubation Programme to further develop its ideas.

DroneSAR has partnered with Astrosat Space to fit into their rapid system, which is for recovery and protection in disasters, and for which they take regularly updated satellite images of certain areas. As the rescue teams fly, the system allows the drone pilots to directly upload their videos onto the satellite imagery. With this, DroneSAR aims to fit in the lower-end high-definition video from the bottom up, allowing HD-images of the disaster-struck areas.

DroneSAR has a number of Copernicus layers which can be added on top of each other on the pilot consol. Underneath, at the very bottom, is the DroneSAR data.

In the future, Mr McGrath envisages to take the person out of the unmanned aircraft, having a command and control set-up that can take satellite images, which can be fed to the drone browsers and pilot consoles; Missions could be activated remotely, allowing AI to detect people automatically and feed that back into the command and control centres for automatic recovery and allocation of resources.

The Chair thanked Mr McGrath for his presentation and enquired about the up-link of large amounts of data which need to be uploaded to the Emergency Response and Coordination Centre in DG ECHO through satellite communications, which is rather expensive. In response, Mr McGrath mentioned that the budget of a lot of rescue teams is quite low. Therefore, DroneSAR is currently trying to reduce the amount of data to the sharing of the location with just text. This is a first step, and after the technology has further developed, the cost may be further reduced in the future.

Juan de las Heras (EMSA)

Mr de las Heras briefly introduced the European Maritime Safety Agency, which is based in Lisbon. The Agency has three main tasks, namely to:

- 1. Assist the European Commission (with technical support to draft regulations)
- 2. Work with the Member States (help to implement regulations providing services like integrated maritime surveillance, cleanseanet, CMEMS and RPAS)
- 3. Cooperation between Member States, the European Commission and third agencies such as EFCA and Frontex

EMSA is interested in anything that happens at sea and wants to collect as much information as possible to provide this to the Member States. In this sense, all illegal activities at sea are followed, from trafficking and piracy, to terrorism, safety, search and rescue, and pollution (oil spills detection and emissions).



In addition to Copernicus satellite images, EMSA procures RPAS to provide measurements of vessels' emissions and for general maritime surveillance (serving SAR, border control, fishery control and anti-piracy). The operations focus on long-endurance RPAS and flights BLOS with a system using SatCom communications.

EMSA entered into the business of RPAS to complement existing services, such as Copernicus satellite data information, EMSA vessels providing services on the sea, and other sea positioning systems. The RPAS could easily complement the information coming from these three providers. Furthermore, RPAS allow EMSA to overcome constraints from other assets, as they can be directed to a specific location, which is difficult with a satellite. Moreover, RPAS can stay in a specific location, allowing EMSA to provide aid for situations such as a pollution response.

The RPAS platform exists, but there is still more room for improvement. The key is to have sensors on board of the platform, such as maritime radars with SAR capabilities, electro-optical cameras, thermal infrared cameras, AIS-sensors and CO2-sniffers to be able to measure emissions from vessels. All the EMSA-systems have been equipped with a distress signal transponder.

EMSA is working with two contractors with fixed-wing aircraft to provide services for emissions monitoring, as well as for multi-purpose maritime surveillance. On top if this, EMSA has contracted the development of an RPAS data center, which merges the data coming from all sensors. All RPAS systems which are procured require contractors to follow the same protocols, offering one single layout to the user.

New procurements are ongoing for long endurance and long-range RPAS, for RPAS able to fly longer than twelve hours BLOS, and to carry up to 200 kilogrammes of payload. Another procurement goes to vertical take-off and landing systems, to be used for ship-based general surveillance and for sniffing. A third procurement is for small electrical multicopters to equip all the vessels with eyes in the sky for the EMSA-teams.

In practice, the interactions between Copernicus and RPAS are twofold: EMSA is using Copernicus to guide RPAS, but is also using data from Copernicus to flag suspicious activities after which RPAS are sent to the area.

The RPAS procurement and missions are set up by EMSA, but the Member States ultimately make the request to deploy them. After a request has been made, EMSA assesses the most relevant aircraft. In the end, the user is the Member State.

EMSA has received requests from over twenty Member States. Two operations have been deployed, and four are about to start, for Portugal, Spain, Greece and Croatia. The main issue here is that some operations last three months and take place in a specific site. EMSA received many requests, but these cannot all be covered with the existing capacity.

The Chair opened the floor for questions and answers. Mr Hugo de Groof (DG ENV) enquired whether EMSA knew of any cases where the evidence collected by EMSA had already been used for law enforcement. In response, Mr de las Heras stated that of the two operations mentioned, one of them was mainly for emissions, and some vessels were indeed detected to be non-compliant with the directive. It was however up to the Member State to use this information and to decide what to do. This is not followed up by EMSA.

Eventually, the Chair added that the long flight durations mentioned by Mr de las Heras exclude electric propulsion and asked what the payload for fuel was for these devices, and whether there were any safety aspects and regulations for these missions which were different from electric propulsion. Mr de las Heras answered that the regulation is the same as for manned aircraft, and that there are several procedures to



deal with this. The impact of the heavy fuel engine is taken into account by the developer of the aircraft, which is already considered from the beginning. On top of this, future payloads are getting smaller.

João Araújo (Spin.Works)

Spin.Works is a Portuguese company with two business units. The space business unit mainly works for ESA in the areas of flight control, mission vision and mechanisms applied to planetary landing, rendez-vous and docking and re-entry. A second business unit tries to re-use some of the technological developments used for space applications. It offers remote sensing services for mapping, agriculture and forestry.

The remote sensing service MAPP is an online app that provides an algorithm generated in-site to the users for the management of their field. The data are derived from satellites and drones. For satellites, the data have lower resolutions. Drone data have a very high resolution and a lower temporal resolution.

The users create an account online, receive insights based on satellite data, and order drone data, based on which MAPP takes action. The service is currently offered for mapping, agriculture and forestry for different crops and different forest types. One application example is for vineyards in the Douro-valley. This is done on a commercial basis.

The users have access to different layers. There are two types of problems when using remote sensing for agriculture and forestry, namely the continuous canopy and homogenous cultures (corn, dense forests of pines and eucalyptus), and crops or forests which are segmented, which are more challenging. MAPP is using satellite data for the canopies and crops.

MAPP shows different types of plantations, terrain, the condition of crops and other pertinent details. NDVImaps (Normalised Difference Vegetation Index) by Sentinel-imagery are offered, as well as corresponding drone images with a higher detail. The issue to solve is how to make use of the higher temporal resolution of Sentinel while dealing with a lower spatial resolution. The user wants plant-level data, for which one needs to extract the soil and provide the data of the plant itself.

Eventually, Spin.Works concluded that it is possible to make a division in these two classes using Sentinel data, and it is possible to provide more data using Sentinel and drone data together.

For forestry applications, Spin.Works offers a monitoring of the evolution of trees using Sentinel data segmented to the trees. A challenge here is viewing with a ten-meter pixel when only part of the tree is under that pixel. The development to address this is ongoing, but it is one of the interesting aspects of combining drone and Sentinel-data.

In conclusion, Spin.Works provides an operational service based on satellites for two zone classification. It provides Sentinel data for more common agricultural applications, and there is ongoing development of satellite data corrections using high resolution drone data, early warning of diseases and pests, as well as an ongoing activity with ESA for data fusion of heterogeneous data.

In the next steps, Spin. Works will integrate more data into the decision-making process, and will use machine learning techniques to extract more meaningful information using drone data, satellite data and other sources of data.

The Chair opened the floor for questions and answers. Hugo de Groof (DG ENV) asked the panel whether anyone had been using a combination of Sentinel-data, other information, and drones to identify illegal waste dumps. Although Mr Araújo agreed that this was an interesting application, Spin. Works had not done this. This application might require wider area information, whereas Sentinel by itself may not be relevant for low



scale waste dumps, considering the lower resolution. Sentinel-data have, for instance, shown a high vigour in corn fields, but when Spin.Works used drones to fly over the area, it was discovered that the corn was dying and the high vigour areas were shown due to growing grass and excessive water. Therefore, one needs to be careful with detection applications because of the resolution, but this depends on the scale.

Mr Lewyckyj (VITO) added that, since several years, VITO has been trying to use a combination of thermal and hyperspectral images on waste sites in Belgium to verify what can be seen and differentiated. If successful, VITO will have a look to see how this can be extended for a potential service integrating satellite data. This is in development.

Sven Przywarra (Live EO)

Live EO started in 2017 with the Copernicus Masters, was part of the Copernicus Accelerator, and is currently part of the Copernicus Incubator. Copernicus data are the backbone of its analysis.

Live EO analyses infrastructure grids such as big pipelines, high voltage electricity grids and railways. All of these grids need to be monitored as they power cities, industries and connect people, which is currently done in a manual manner. A lot of drone applications are also in the field of monitoring infrastructure grids, but according to Mr Przywarra the efficiency is not as good as it could be.

Live EO decided to combine different Earth Observation technologies, as Europe is on the edge of an EO-revolution, combining Copernicus data, as well as applications such as Planet, and the development of drones and autonomous drones. In the opinion of Mr Przywarra, satellites and drones are a perfect fit for each other. Where satellites offer observations of large areas, drones can offer a high detail of small regions of interest.

Live EO has a working product which currently monitors more than 40,000 km of infrastructure grids in Germany, and it is talking to other infrastructure grid providers in Europe and abroad. Its product detects vegetation alongside infrastructure grids. The product is developed in close coordination with the customers' needs. Many infrastructure companies are working with drone data, so Live EO developed a technology to integrate drones in its own service. Together with SAP and Airbus, it developed a concept of multi-drone routing, which would enable a direct integration of drones into the satellite data.

The customers who work with drones have concerns about the regulation, whereas BLOS-flights are not feasible due to legal constraints, although there is an interest in the process. According to Mr Przywarra, there is a need for a better legal framework and a communication thereof across Europe. In Berlin alone, there are more than 70 drone companies. The industry is out there, but the legal framework is lagging behind.

Mr Przywarra concluded that satellites and drones are the perfect combination for monitoring infrastructure grids, agriculture, forests and so forth, but there are still some barriers in the way.

The Chair mentioned that for infrastructure monitoring, there is a corridor mapping, which means that the BLOS is an important hurdle to overcome. This raised the question how Live EO copes with the restrictions of BLOS using spotters. In response, Mr Przywarra stated that Live EO purely develops the software solution. The BLOS-flights are executed by the operators of the grids themselves, and Live EO calculates how they can optimally route their itinerary and place their spotters.

According to Mr Hugo de Groof (DG Environment), there is another regulation that could have an impact on the business model of Live EO, if other types of data are included in the application (e.g. road networks). He enquired about the experience from the panel in obtaining the data which are often held by governmental organisations. Mr Przywarra responded that there are initiatives all over Europe to give access to datasets, but there are severe obstacles in getting in-depth data on for instance weather, to train machine learning



models. According to Mr Przywarra, if Europe wants to go further in the development of artificial intelligence, open access to big datasets is crucial.

One participant enquired whether it was possible to link information from tractors, who could also have optical instruments to monitor objects, providing additional data to UAPs. In response, Mr Przywarra mentioned that Live EO was implementing the data collected on-ground, for instance by the network operators. These reference data are integrated in the system to increase the quality of the machine learning model. Mr Lewyckyj added that the current tractors are very high-end in technology. On the basis of remote sensing, VITO is trying to provide data that they can include in their system. According to Mr Araújo, it is indeed a trend that actions are not only fed to people on the ground, but that diverse sources of data are also fed to the systems.

One participant shared the experience that whenever a permission was asked for agriculture purposes, authorities were more lenient to give this since there are no security concerns. However, for flights above airports or critical infrastructure, there are serious safety concerns. It is hard to convince the authorities to address this.

Ms Nathalie Le Cam (DG GROW I2) asked the panel discussants about what is, according to their opinion, the main difficulty or barrier in their operations:

- All speakers raised the different legal frameworks and lack of harmonised European regulations
- In addition, Mr McGrath (DroneSAR) mentioned the limited connectivity in certain remote areas with a bad mobile connection.
- In addition, Mr Lewyckyj (VITO) added the question on how to extrapolate data to satellite data, when using cheap camera systems. There is a need for better sensors which are fitted to the application.
- In addition, Mr de las Heras (EMSA) raised the logistics that surround the EMSA-operations (hardware) as well as the framework and procedures which Member States need to set up to cope with and exploit large amounts of data.
- In addition, Mr Araújo (Spin.Works) brought a technological challenge forward. The long-term objective is to have autonomous drones, which is now hard due to their short range. This will take time, but this ultimate objective should be kept in mind. Another challenge is bandwidth and connectivity.

In conclusion, the Chair asked the question whether all these technologies, which are mature, are ready for a real operational integration as a complement to satellite imagery into the Copernicus services. For the Copernicus Emergency Management Services, there is a clear idea for an operational integration, with some promising perspectives for the future.



2.4 SESSION 3: Operational and legal framework

The Chair, **Ms Nathalie Le Cam** (Legal Officer, DG GROW I2, European Commission), introduced the Session by stressing the importance of societal acceptance of drones and of the need to reduce the risks incurred by their operations, notably the risks to safety, security, privacy environment, etc. After introducing the speakers she gave the floor to **Mr Dominique Colin (Eurocontrol)** for a preliminary clarification of the different terms used for drones: RPAS, UAVs, etc..

Mr Colin stated that so many acronyms exist that it could become confusing (chronologically LPVs, UAV, UAS, RPAS, UAS and Drone, which came with the U-Space ecosystem). The term RPAS (Remotely Piloted Aerial Systems) implies that there is a remote pilot. Instead of 'autonomous' drones, Eurocontrol suggests to use the term 'automated' or 'highly automated'.

Koen de Vos (European Commission, DG MOVE)

Mr de Vos gave the example of driverless cars, boats and trains, which are ahead of us. For driverless planes, the term 'drones' is used. In legal terms, these are called Unmanned Aerial Systems (UAS).

If one wants to discuss the rules, it is necessary to take some distance in order to define what needs to be regulated. There are an evolving technology and societal context, where we have to evolve from a traditional aviation towards a mobility service. The technology is evolving towards more digitalisation, decarbonisation. All these loose ends need to be connected into a single system of systems. The European legislation on drones should fit into this wider picture.

Political stakeholders are concerned as well as attracted by the opportunities offered by new drone technologies. At the same time, societal concerns need to be tackled with regards to e.g. privacy, noise and safety. This not only counts for big aircraft, but it should also cover smaller drones.

The drone rules need to open up the market and cater for all these concerns. Applying raditional aviation rules and procedures would indeed kill these new technologies. The standard rules and procedures are quite heavy handed, are heavily prescriptive and have heavy processes of certification. It takes several years to certify a type-rating for an aircraft, whereas the drone technology comes out with a new type every three months. This framework does not fit anymore. The approach needs to be operation-centric and based on risk.

Until 10th September 2018, the EU only had the competence to regulate drones above 150 kilogrammes. Since 11th September 2018, with the entry into force of the revised EASA Basic Regulation, the competence to regulate all drones has been transferred to the European Union. The new basic regulation, which is the legal framework for European safety rules, provides the legal basis to come up with new technical rules. The European Commission would like to have a first set of rules on drones and drone-regulations adopted by the end of 2018.

This will not completely open up the market. Not only for the smallest, but also for the biggest drones. Everyone will be covered by the drone rules. Other pieces of rules will still need to be added, since just like for aviation an ATM-system is needed. For drones this is called an UTM (Unmanned Aerial Traffic Management system) or U-space. This is a digital and automated system to keep drone operations safe and secured.

The European Commission intends to launch a European-wide network of U-space demonstrators to learn from practice, and to gain inspiration for U-space rules, which can validate the regulatory thinking on U-



space. At the moment of Mr de Vos' speech, there were 25 to 30 thousand flights over Europe. The Airbus Blueprint provides a figure of 20,000 drone flights in one hour over one single city in 2035. It is therefore necessary to implement a digital and scalable system which automates all those functions, and keeps drone operations safe.

According to Mr de Vos, the long-term intention is to create sufficient confidence for the private industry to start investing in drone operations. These can add value in the total value chain, which is why an EU network should be established. This is not, like the SESAR-network, targeting to develop technology, but to target those projects where a mature business case and technology are already acquired, but where one is struggling with regulatory issues such as risk assessment and certification processes. These are hurdles to start a business. This network will be supported by EASA (regulatory), Eurocontrol (operational) and SESAR (to make the link with their knowledge).

It is nice to have a drone, but to operate one, one must have shared access to airspace. Activities will probably start with the lower airspace, but Europe could try to open up the higher airspace, above commercial airspace, to the new system of U-space.

The Chair opened the floor for questions and answers. Mr Mc Carthy enquired what was, according to Mr de Vos, the main technology block barrier to implement U-space. In response, Mr de Vos stated that U-space wants to connect all the providers, operators, police forces and so forth. It is focused on connectivity, and the technologies with which this connectivity are of less priority; whether information is taken from satellites, traditional radars or telecom-operators. U-space is in that sense technology-neutral, as different types of technology can be used to achieve the same objective.

One participant enquired whether national legislation would still intervene with European rules, and whether a drone license in one country would be accepted in a third country. According to Mr de Vos, mutual recognition of the license will be given, if this license is based on common rules. These common rules will now be introduced. Whenever European rules are introduced, at the end of the regulation there are articles dealing with the transition and other issues. How to fly a drone, which is not yet subject to standards, will be regulated in those articles. There are three categories of drone operations (open, certified, and the huge inbetween range of operations). For this last category, an operation-specific risk assessment is required, which will lead to a range of mitigating measures. One of these relates to the competence of the pilot. A license will give a certain weight for the operation to be accepted. Until now, there is no European system of pilot licenses yet, and this will need to be further developed.

Mr Hugo de Groof (DG ENV) asked whether there will be a differentiation in the drone rules according to the application for which the drones will be used. According to Mr de Vos, the tools to introduce this have been foreseen, but there are no specific rules for these specific type of applications yet. Priority to specific types of operations could be given within UTMs, which are technologically possible. An airspace area could for instance be cleared for disaster relief operations. Different tools are in place, but it will be up to local authorities to use the most appropriate tool for these purposes.

One member of the audience asked the panel to touch upon the completely automated use of drones, which is an important factor for future productivity. In response, Mr de Vos (European Commission) agreed that automation will be important for industry in the future, and added that the objective is to open the European drone services market. A system needs to be developed to deal with the highly automated drone systems. This is foreseen in the European drone rules.



Henk Hof and Dominique Colin (Eurocontrol)

Eurocontrol is supporting European aviation and is interested in the interaction of all the different forms of airspace usage, as well as the related safety aspects.

Mr Hof presented a vertical profile of the current airspace situation, with drones and RPAS below 1,000; and new entrance (balloons, Google, Zephyr, plans for supersonic aircraft) above flight level 600. At the top, one can find commercial space. Eurocontrol is not dealing with commercial space operations but there is a growing interest in commercial space operators, which are developing space ports. These launches and returns need to go through the normal airspace and aviation traffic.

Different traffic management systems are under development to take care of this, ranging from STM (space traffic management), to higher UTM, the known ATM, and lower UTM. These developments will coexist and will need to work together. This is not an obvious task.

According to Mr Hof, there is a 'sandwich of innovation'. Between higher UTM and lower UTM (or U-space), many new companies will be brought to the field of traffic management. In the ATM-world, several concepts for the future have been developed. Trajectory-based operation (TBO) is one of the transformational concepts being worked out in the context of SESAR, which will lead to higher degrees of automation and performance. Flight and Flow Information for Collaborative Environments (FF-ICE) is about information for collaboration. SWIM will provide an intranet of information for aeronautical use. These concepts were written by new companies (e.g. Google and others), who mentioned that this is being implemented in U-space. This has been done with higher degrees of automation than in ATM, which has a more human-centred approach. With technological developments such as AI, machine learning and automation, UTM is a test case of what the future might become for ATM. However, safety levels need to be maintained.

The current developments on HAPS are an industry-led development. In this area, American companies are leading the discussion. According to Mr Hof, Europe should take actions to work more together under the existing frameworks on this. An ICAO Air Navigation Conference on these issues will take place in the near future. There are several papers on the table on higher airspace operations and new entrants. The objective here is to get recognition for the need for a new global regulatory framework, as HAPS operate worldwide. In the meantime, Eurocontrol has started working on a concept of operations. Besides balloons and solar planes, also supersonic jets are anticipated, resulting in a very challenging mix of airspace users. Trials are being planned on the US-side, and based on the experiences ICAO-provisions will be developed.

On the drone-side, today's ATM Environment is prioritising their integration into the aviation system (instead of segregation). This is done at different levels, such as the ICAO and its RPAS-panel, where amendments to the ICAO-annexes are prepared. Eurocontrol is working with EASA, the European Commission and SJU, to support this. At lower altitude, the U-space concept is being developed, and demonstrations are needed to address technical blocks. It is furthermore very important that the interface with ATM is addressed.

The Chair opened the floor for questions and answers. In response to a question from Mr Peter Spruyt (DG JRC, European Commission), on how realistic it is to segregate airspaces for certain urgent drone applications, Mr Colin stated that this is where U-space would help. Its core functionality includes a geofencing capability. The challenge is connectivity. One can define the box, but the question is how to enforce the box. The tools are available, but it is a struggle to use them efficiently.

One participant raised the question to the panel on how compliance with U-space would be enforced, as anybody could fly a drone into restricted airspace. According to Mr de Vos, when a law is conceived, one should start to think about enforcement. The European Union, competent for commercial activities, will



make sure that all the drones are well-connected, and through U-space enforcers can focus on real dangers. This enforcement should be institutionalised, and for this the European Commission is working with security services and the military to map their needs, such as access to databanks and data safety.

Koen Meuleman (Unifly)

As of today, drones are flying in very low-level airspace (mostly below 500 feet). Below this, manned aircraft are not supposed to fly. Drones are, according to the new regulations, not supposed to fly around airports, specific installations and so forth. Therefore, the situation is quite complex, and a system is required to manage these drones. In the future, drone pilots might disappear, or they may man several drones. This is where a UTM (or U-space) comes into place.

A UTM is a system-of-systems connecting all the stakeholders, including local authorities and police forces, through a mostly cloud-based technical solution, ensuring a safe integration and separation between manned & unmanned aircraft. It contains the necessary information, comprising a huge database of the physical environment, which is where Copernicus (but also drone data) comes into place. The UTM covers all types of UAS operations, from the very low airspace or even beyond in the future. A database with physical obstacles and 3D-models of the landscape and cities is a mandatory input for UTM-systems. Unifly has signed a collaboration with HERE, which is providing the GNSS-data in many cars.

Unifly has major European clients, including Belgocontrol, Deutsche Flugsicherung, Naviair and Austrocontrol. Unifly has started to implement a first phase of U-space. Controllers can monitor locations of the flights via computer screens, and the user has an interface through the smartphone. It is also possible to directly communicate with the pilot.

Drone operations could contribute to Copernicus and bring high resolution Earth Observation imagery. The nature of these flights is BVLOS-flights, which currently are not allowed by the authorities, except for special circumstances. UTMs are a solution for this, as a key enabler to unlock the drone market. At the same time, UTM-systems need very accurate geographical data, on land use and 3D-information, to be able to validate operations. These data are largely provided through the use of remote sensing via satellites as well as drones.

The Chair opened the floor for questions and answers. Mr Tim McCarthy enquired whether, besides static data sources, Unifly also made use of dynamic data sources. In response, Mr Meuleman added that Unifly uses static as well as dynamic data sources, for example when important events are happening. All this will be included. Mr McCarthy also enquired whether, in the future, drone operators would fly the drones or whether the UTM would. According to Mr Meuleman and Unifly, UTMs provide information to the pilots and later also the machines. The UTM would not control the drones per se. The information would be fed to the pilot, or the ground control systems. The flight controller would then decide which actions to take, not the UTM.

One participant wondered whether the available airspace for drones would be a certain surface, or a highway or band in the air. According to Mr Colin (Eurocontrol), the concept of highways was proposed in the first UAS concept of operations, which was refused by some Member States. If highways are created, there is a lot of noise and potential problems with the people below. The traffic will be concentrated, so it is important to be careful where to position these highways.



Anna Masutti (University of Bologna)

Ms Masutti introduced her presentation, dealing with the legal issues in the current and future use of HAPS, with specific regard for the issue of the civil liability and insurance.

Civil liability means that we need to see which framework regulation should be applied when an accident is caused by the use of HAPS. In order to design a framework regulation for a new subject, jurists require a definition of the technology. For HAPS, there are several definitions which are not very consistent. According to ESA, HAPS are 'platforms that float or fly at high altitude like conventional aircraft but operate more like satellites'. This does not provide clarity whether they are satellites or aircraft, which is crucial for the development of a suitable framework regulation, and to decide whether to apply air or space law. If the legal framework is clear, it is easier to develop these technologies, market them and insure them.

There is a more specific definition, given by ESA, where it is established that HAPS are aircraft, namely: 'HAPS are aircraft positioned at or above 18 km altitude (i.e. FL 600), in the stratosphere, for very-long duration flights counted in weeks and even months. These unmanned aircraft may be airplanes, airships or balloons'. However, there is no official definition of HAPS from international organisations such as ICAO. The question is whether the above definition is the correct definition of HAPS, and whether we have to apply the current regulation for manned aircraft. In order to answer this question, one needs to consider the main characteristics of HAPS, which are controlled from ground control stations and are able to take off or land without runway or airport.

This brings the argument to the definition of 'aircraft' and the definition of 'space object' to locate HAPS in one category or the other, in order to establish the application of one of the two regimes, air law or space law. A space object is 'any man-made object which is at least attempted to be physically brought into outer space'. The definition of outer space is the space above 100 kilometres. As a consequence, any object flying above 100 kilometres can be considered a spacecraft. Below, they are aircraft.

HAPS are therefore an aircraft, subject to existing regulation established for aircraft. According to Ms Masutti, new technologies, developed in the market, should not be overregulated. The best thing is to use the existing regulation, with appropriate amendments. In view of the possible content of the future drone regulation, it can be said that HAPS belong to the 'certified' category of UAVs.

The EASA Basic Regulation is applicable for HAPS as unmanned aerial vehicles. Still, there is a persisting lack of rules for civil liability and insurance for these platforms.

Several questions need to be answered for this, namely:

- 1. Who will be the responsible party?
- 2. How will the damaged party be compensated?
- 3. In which jurisdiction or court can the damaged party sue the liable party?

The Rome Convention 1952, as well as the European regulation for compulsory insurance for aircraft operations are, according to Ms Masutti, both applicable for HAPS. The Rome Convention for example attributes the liability for damages to third parties to the operator. This liability is strict, meaning that the operator is liable regardless of his negligence. Because of this severe regime, it benefits of the limits of the liability to a certain amount, with a minimum compulsory insurance cover per accident.

For HAPS, the liable party would be the aircraft operator, and the registered owner of the HAPS shall be presumed to be the operator, which is a different entity of the remote piloting commander, who will be



responsible for the violation of the rules of the air under criminal law, while the registered owner will be responsible under civil law for compensations.

The compensation for victims should be rethought, as the Rome Convention established a cap, linked with a maximum take-off mass, which is not suitable for light aircraft such as HAPS.

Also the jurisdiction is established by the Rome Convention, namely the State where the damage occurred. Considering the complexity of HAPS (with aircraft in the air and ground infrastructures), a clear identification of the applicable jurisdiction may avoid uncertainties in the case of accidents occurring outside the country where the ground station is based.

In conclusion, the main principles of the Rome Convention could be applied. However, this Convention has been ratified by only four EU Member States, with 51 States who have ratified it globally. This is due to the low amount of compensation. According to Ms Masutti, EU Member States have ratified several international conventions on civil liability with the same principles of the Rome Convention.

An example is Italy, which already has a civil liability and insurance regime in place for unmanned vehicles. Italian legislation has expanded the definition of manned aircraft, including the unmanned aircraft, adding that all the regulations for manned aircraft are applicable for drones. Furthermore, the liability for damage on the surface caused by an aircraft is subject to international law in force in Italy, namely the Rome Convention.

The Chair enquired whether the EU regulations for drones will be applicable to HAPS. Ms Masutti confirmed that this will be the case. For the rest, the regulations for manned aircraft could also be applied for unmanned aircraft and HAPS.

Anna Donovan (Trilateral Consulting)

Ms Donovan started her presentation with a definition of privacy, which is the right of individuals to be left alone and not to be monitored or surveilled, especially when they are in a private setting. This is a broad right, encompassing all situations in which people have an expectation not to be observed by equipment, for instance when they are on private property.

The right to privacy and data protection are two rights that are protected by a number of laws, such as the General Data Protection Regulation (GDPR) and the EASA Regulation which lays down rules and procedures for the operation of unmanned aircraft.

Drones can impact privacy and data protection, in particular when they are operated near and around people. Commercially, drones can be used in a variety of contexts, but they still have the potential to impact the privacy or the personal data of people on the ground. This is for a number of reasons:

- 1. Drones are highly manoeuvrable this means that previously inaccessible spaces can now be accessed and observed or recorded.
- 2. Drones' size and design sometimes they may remain unnoticed by individuals on the ground, and become silent observers of their behaviour.
- 3. Drones have extremely diverse capabilities depending on the payload they can capture photos, videos, thermal, location and audio data. Some software can empower drones to track and monitor individual behaviour.

When the captured data features information of individuals that could lead to their identification, privacy and personal data considerations arise.



Often individuals have no way of knowing who is operating the drone, for what purpose it is operated, what type of data they are collecting, and whether the sensors are pointed in their direction.

The question to be considered is whether data protection laws and privacy concerns apply to the use of UAS for Earth Observation, as they could be used by Copernicus. The data protection law has a clearly defined scope of application, which is whenever personal data are processed. It is necessary to consider whether the data captured for Copernicus will be considered personal data. This means any data that directly relate to an identifiable person or allow for the identification of a person through, for example, the correlation of a number of different data points. Whether this is the case needs to be assessed in each individual case, depending on the images captured.

There appears to be a low risk of people to be identified in the context of Copernicus, but this risk can increase due to a number of factors, such as:

- 1. Powerful sensors and more detailed data;
- 2. Quasi-stationary UAS;
- 3. Copernicus' open data policy, which leads to a diverse user base, increasing the risk of an individual to be identified by one of the data recipients;
- 4. Big data, which increases opportunities to identify people by allowing the data from multiple sources to be correlated

If the data collected by drones for Earth Observation includes personal data, then the requirements of GDPR apply. This does not necessarily imply a heavy burden, as many of the GDPR-requirements are risk-based. Data collected by high-altitude drones is unlikely to raise significant risks to individuals, even if they could be identified. GDPR-principles would only apply to the extent proportionate to the risk. The GDPR and some of its requirements specifically provides for more lenient rules where data is processed for scientific research and for statistical purposes. A simple solution to avoid the scope of GDPR altogether is to anonymise data before making it available to the public.

A second question is whether UAS for Earth Observation could be impacted by privacy — not just personal data but the broader concept of privacy. EASA is currently discussing the regulation laying down rules and procedures for the operation of unmanned aircraft. Under this regulation, the operation of UAS at a high altitude would be considered a specific category mission, which poses higher risks and has its own requirements. A specific category drone flight either needs to comply with one of a set of standard scenarios — which are being developed — or an operational risk assessment will need to be conducted. One of the aspects of such assessment is the impact on privacy.

Privacy concerns can arise only when people are captured by UAS or when they are near its operation. Specific privacy concerns can arise when there is interference with the private lives of individuals, when they are for example captured in their private homes or gardens. Privacy concerns can also arise when individuals are systematically tracked, monitored or surveilled. The fact that some UAS will be quasi-stationary increases the chance that individuals will be captured multiple times over a longer period of time, which will accumulate information about them, similar to surveillance systems with the use of CCTV cameras.

There are a number of resources being developed regarding the impact of drones on privacy and data protection. Some already exist, and they are available on the website www.dronerules.eu. Ms Donovan has worked on two COSME-funded projects which seek to provide drone users with information about how to operate drones in a manner which complies with privacy and data protection law. The ongoing Drone Rules PRO project develops a set of tools which are specifically tailored to commercial drone companies, their operators, pilots and manufacturers. This course will teach drone professionals how to comply with GDPR



and privacy laws. The project is developing a comprehensive e-learning course tailored to different groups of learners, a privacy impact assessment and a data protection impact assessment template, a privacy code of conduct, a pre-flight checklist for pilots and a privacy-by-design guide for manufacturers.

The Chair opened the floor for questions and answers. One participant asked whether, with a resolution of 30 cm and an individual covering three pixels, this could be considered as a breach of privacy or not. According to Ms Donovan, the risk is proportionate to the extent to which the person is identifiable or can be identifiable. This depends on the granularity of the pixels. If personal data are not needed, Ms Donovan suggests anonymising these. It may however be worth looking into the more lenient rules for scientific purposes.

The Chair concluded with four takeaways from this session:

- 1. Regulation and harmonisation are on the way, which should facilitate operations in the new future.
- 2. New developments, new comers new concepts and new systems are coming, including U-space. This should also facilitate these operations.
- 3. There are increasing interactions between drones and Copernicus, with a mutual dependency between both drones and Copernicus.
- 4. HAPS can be considered as a category of drones and EU regulations on drones will likely apply to them



2.5 SESSION 4: The way forward - Future user needs and requirements

The Chair, **Ms Dinka Dinkova**, Deputy-Head of the Unit Space Data for Societal Challenges and Growth at the European Commission, introduced the panel for an interactive session to discuss future user needs and requirements for UAPs in the Copernicus-context:

- Mr Malcolm Davidson (ESA)
- Ms Federica Mastracci (EARSC)
- Mr Vincent-Henri Peuch (ECMWF)
- Mr Hugo de Groof (DG ENVIRONMENT, European Commission)

The audience was able to participate to this session through the use of the Mentimeter-tool, for which a series of questions were asked and answered, followed by a discussion from the panel.

To start the discussion, the Chair asked the panel whether there is any need within the Copernicus ecosystem (upstream, downstream and end users) for the use of unmanned aerial platforms, and what their added value would be.

According to **Mr Vincent-Henri Peuch (ECMWF)**, there are a range of use cases of UAVs and HAPS in the context of the Copernicus Atmosphere Monitoring Service (CAMS) and air quality measurements. One of the key applications for the atmosphere composition is the monitoring of emissions and pollutions such as NO2 and CO2. Deriving emissions from ground-based monitoring or satellites is still a big challenge and resolution is an issue. HAPS would be extremely useful to pinpoint emissions and to serve as a backbone for satellite-based observations. A second application area is routine regular monitoring above 50° North. Copernicus is waiting for the Sentinel-4, but its capacity will be limited at high latitude. HAPS could have a capacity to bridge this gap. Third, there could be exceptional situations such as volcanic eruptions or large fires, where drones or HAPS would have an added value in addition to the existing observation capabilities. Fourth, there are a range of applications, such as the surveillance of leaks along pipelines, of illegal burning, and of illegal fracking, for which the ground-based and satellite applications only fulfil part of the need.

Mr Hugo de Groof (DG ENVIRONMENT) reminded the audience of a key question that was asked during the morning session: what is part of Copernicus and what is not? We have often heard that in Copernicus, there are Space observations and the rest is in-situ, whether this is airborne or more static geospatial data. It is necessary for Copernicus, but it is not really part of Copernicus, although without it there would be no Copernicus services. This is not a simple question to answer. From DG ENVIRONMENT's Environmental Compliance Assurance (ECA) activity, this is closely related to statutory reporting on the implementation of environmental law. Currently, not a lot of the parameters which are reported are directly provided by the Copernicus programme. There is a great potential to do so, to reduce the burden on the Member States and to improve the quality of the statutory reporting. Reporting is something which is done under a legal obligation. Environmental compliance assurance has a slightly different meaning, as the root of the initiative lies in the fact that the EU is still facing an enormous gap in implementation which costs society 50 bn EUR per year. This gap has not closed since the implementation is not sufficiently monitored and enforced.

In the programme on compliance assurance, DG ENVIRONMENT wants to use Copernicus to empower the duty holders, those that have to live up to the regulation, for them to meet the agreed target. An entire other user community which is not yet served by Copernicus, are the institutions in the Member States in charge of inspections on agricultural facilities, industrial facilities or even policing for environmental crimes. They are not equipped to use Copernicus information to improve the efficiency and effectiveness of their inspections. In terms of scale of observation and detail of information, drones would play a very important role in this. A third category are the prosecutors and the judges. One needs evidence or solid facts in court,



for which the Copernicus programme can be extremely useful. This year, it has proven its use, being used for a case of illegal logging in Poland on the historical site of Bialowieza, where there was a court ruling. DG Environment's interest in Copernicus is not only in the satellites, but it is part of an action in the compliance assurance action plan, which relates to building up a European capacity for geospatial intelligence. In that, the DG will use imagery intelligence, measurements and observations, human intelligence, open source intelligence, and all that will be brought together to empower duty holders, inspectors, and lawyers and judges, to close this gap in implementation.

Ms Federica Mastracci (EARSC) shared a perspective of the downstream industry. According to Ms Mastracci, the data source of UAPs is very interesting and could complement the already existing data source in a continually growing sector where geoinformation is increasingly an integration of many data sources. We are already facing the integration of social media, with concerns for privacy, and there is an interest to integrate these data sources into the services. Many examples were shown in the morning. The operational integration of drone data into existing Copernicus services is not as evolved. A lot of work is to be done, and today there is some experimentation in for instance the CEMS. Today, drones are mostly used for a validation of Copernicus maps, in particular for emergency mapping and for land products.

Besides, several obstacles should be addressed before these data sources can be integrated into the Copernicus services. First, the regulation is a main obstacle and second, if we want to upscale the use of drones and UAVs, it is important to solve the logistical problem to deploy a network of drones wherever or whenever they need to be used. Third, the cost-benefit ratio still needs to be optimised. Fourth, a standardisation in the type of data is important. The business of geoinformation is evolving into service platforms such as the DIAS where many data are integrated and post-processed with AI, and to produce information products based on what the user wants. In this respect, UAV data should be analysis-ready data, standardised and integrable in the value chain. There are high expectations of this type of technology. EARSC wants to participate to the roadmap which will bring this technology into a real operational framework. One suggestion could be to start a federation activity of all the UAV operators, which is an SME-based sector. To accelerate the development of the regulation, the operational aspect and the standardisation aspect, a federation could be useful to have a voice at the European level. EARSC is open to start a dedicated task on this.

Mr Malcolm Davidson (ESA) shed light on the technological dimension of the discussion. For drones, Mr Davidson saw a continued use on a commercial basis. For Copernicus, there are three pillars, namely the space-based observations, the in-situ component and the services. Drones are an extremely useful tool for monitoring, enforcement and the validation of satellite products. The European Space Agency does have airborne activities as they play an important role in several ways. First, ESA uses airborne platforms to test new satellite technology, measurement principles and potential applications behind it before making a large investment into the spaceborne satellite systems. HAPS, with access to near space and counterparts which are from the Space industry, are an important tool to accelerate and improve this process. Second, there are applications which are either made possible or enhanced by the combination of EO and HAPS. This is still at an early stage, and the diverse challenges (technical, algorithmic, scientific) are considerable and need to be addressed before it becomes operational. Looking at artificial intelligence (AI), a lot of the AI-work depends on very good training datasets and on representative measurements. HAPS could be a tool to provide this information. In terms of timeline, Mr Davidson foresaw 2020 to 2025 for the ESA-programmes, and he hoped to see a higher maturity in the platforms, the observations, the payloads and the users taking up those data.

The Chair gave the floor to Mr Peuch (ECMWF), who shared some final thoughts with the audience. According to Mr Peuch, the morning sessions unveiled a challenge with regard to the data flow and big data as a consequence of these new UAPs. This new stream of information, different from satellites and ground-based infrastructure, is a solution to solve some issues such as the vertical profile. HAPS have a potential to become



a real pillar. The vision is one where satellites, ground-based data and HAPS are combined, using a model to deliver integrated information products.

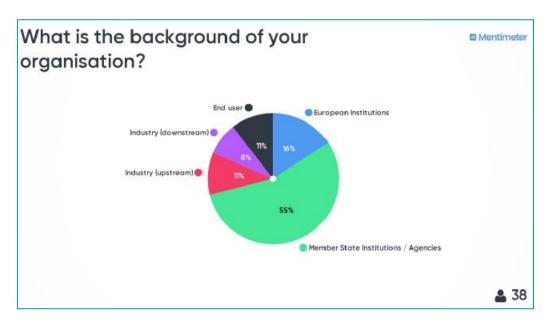


Figure 1: first question

The Chair introduced the Mentimeter-tool, and invited the audience to answer the first question, which informed about the background of the participants' organisations, resulting in a fairly good representation of industry, end users and with a prevalence of institutions and public agencies.

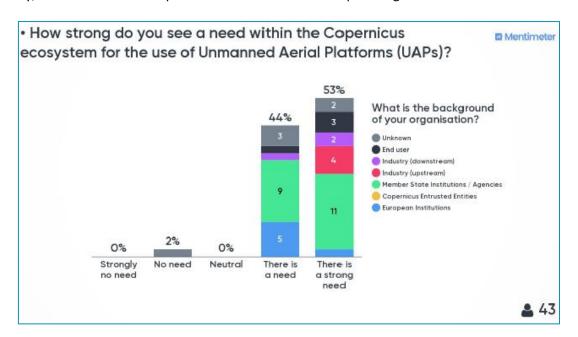


Figure 2: second question

A second question asked participants how strong they saw a need within the Copernicus ecosystem to use UAPs, as indicated in Figure 2. According to Mr de Groof (DG Environment), it is indeed quite clear that these platforms are needed in the ecosystem, and not just for the reasons as mentioned by ESA and ECMWF. If we have the ambition to build up this service capacity, for the benefit of all European Member States. In case of forest fires, natural disasters, cross-border environmental issues and so forth, we should be able to have a capacity in place that allows us to observe and to send the necessary equipment over there. It is likely that a small Member State would not be able to afford this. We should not just see this as Copernicus being a Space



programme, but together with the other policies and services in the Commission, it is important to make sure that this capacity is available on demand, as is now the case for the Emergency Services.

Ms Mastracci commented that this poll is a confirmation of the fact that there is a deep expectation from this technology, and that there is a request from the Copernicus Ecosystem to deal with this, and to push the process of integrating these new technologies to an operational level. According to Ms Mastracci, this is a strong message to the Copernicus programme and to the Commission, which is supported by the industry.

A member of the audience, who saw no need for the use of UAPs in the Copernicus Ecosystem, stated that the Copernicus Ecosystem encompasses three components, as well as the core services and downstream applications. According to this person, low-altitude drones are mostly useful for downstream applications (agriculture and so forth). Besides, UAPs can be used for some services for validation as an example. Copernicus Ecosystem is a large concept, and there is a difference between wanting it to be part of the core services (for which it has to be paid by Copernicus), or whether it should be encouraged for downstream applications.

The Chair agreed that this is a valid point, adding that the question did not intend to ask whether Copernicus should pay for the use of UAPs, but whether it makes sense to reflect on the complementarities and a possibility for fusing data for some of the core services as well as the downstream services. Ms Mastracci agreed with this point, arguing that this is the very beginning of this roadmap. The first thing to be defined is 'what does it mean to have this technology in the Copernicus Ecosystem?'. It should be considered as a third stream of data, such as the third-party missions of commercial satellites. These are external to Copernicus in terms of assets, but they provide very useful data to use. This could be the entry level for this technology, but after some years Copernicus could maybe decide to own part of these assets. This is the beginning of a discussion.

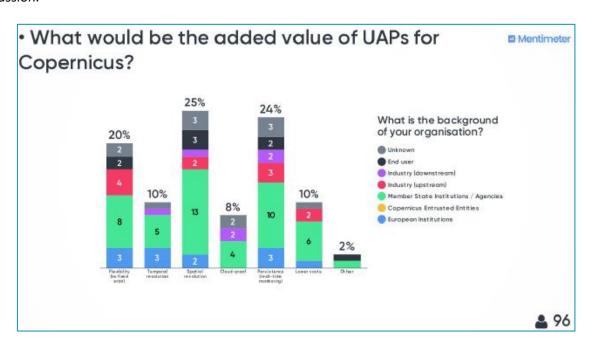


Figure 3: third question

The Chair introduced a third question (see Figure 3), which asked about the added value of UAPs for Copernicus. According to Mr Davidson (ESA), this was a very interesting question, indicating that three main advantages came forward, namely: flexibility, spatial resolution and persistence of UAPs. This reflects the presentations from the previous sessions. UAVs can indeed offer an extremely high spatial resolution, which is very useful in a number of contexts.



According to Mr Davidson, the question related to the lower costs is interesting, but this needs to be broken down further. The cost per square meter is different to the cost of placing a drone in a certain location above a flooded area. This is a complex discussion.

Mr Mastracci suggested that one advantage of UAPs is missing in this question, as they can carry a larger variety of sensors compared to a satellite mission.

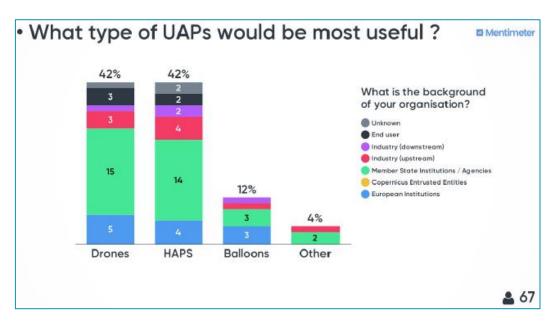


Figure 4: fourth question

The Chair raised the question which UAP is most useful (Figure 4), which is directly linked to type of needs one has. According to Mr de Groof, this all depends on the application and the choices that are made. A farmer who wants to monitor his potato fields will need a drone flight a number of times per year, whereas if an area needs to be monitored for illegal water abstraction, fixed monitoring over a certain period when the area is at risk is needed.

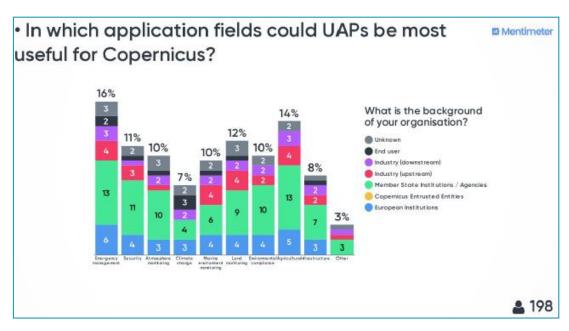


Figure 5: fifth question

A fifth question (see Figure 5) asked the audience in which application fields UAPs could be most useful for Copernicus. This vote varied amongst the different application areas, with the highest scores for emergency



management services, agricultural applications, land monitoring and security services. During a discussion with the audience, several other applications fields were mentioned, such as cultural heritage and water quality monitoring.

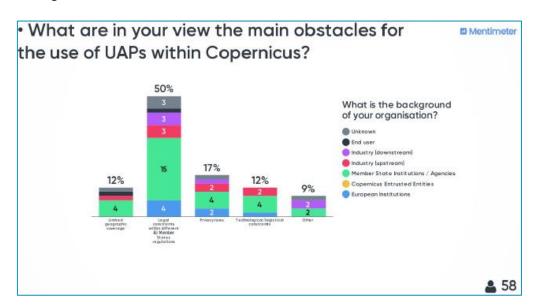


Figure 6: sixth question

When asked about the main obstacles for the use of UAPs within Copernicus, the respondents indicated that the lack of harmonized regulations is the main obstacle. One audience member pointed to the fact that data come from different sources and that it is important to make sure to have the metadata. If a picture is taken with a camera, and there is no certainty about the geometry of the camera, its exposure and its resolution, it is very difficult to compare products. With Sentinel, it is known precisely at what time of the day an image was taken, its resolution and so forth. Whenever dealing with drone, it is important to know those parameters in order to be able to compare products. Ms Mastracci echoed this statement, adding that this is what was meant with analysis-ready data. Finding a standardised format for these data is quite a challenge due to variety of sensors and platforms. Besides, and as indicated by Figure 6, the legal aspect is currently the main obstacle.

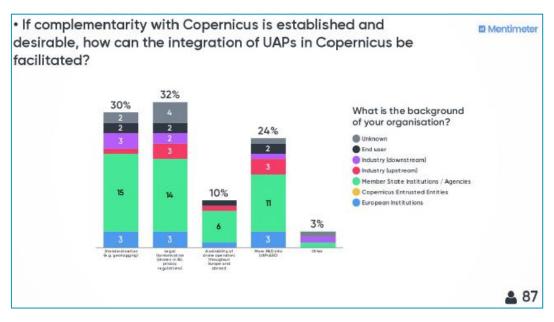


Figure 7: seventh question



A last question asked the audience about ways to facilitate the integration of UAPs into Copernicus, based on the assumption that this is considered to be desirable (Figure 7). Standardisation of datasets came forward as an important element to consider. According to Mr Davidson (ESA), legal harmonisation and standardisation are crucial, and the ways in which to combine these data streams is a study in itself. The frequency with which to collect drone data, the way to integrate it, and how to use different data with different spatial resolutions together, is an R&D-subject in itself. This can lead to new and enhanced products and services which are not yet possible based on exiting systems. More R&D is needed from a data use point of view. Besides, further research could be done into sensors, new missions and new types of measurements which could be done from space.

Mr de Groof (DG Environment) missed one element in the poll, namely the INSPIRE-directive, which started in 2007 to create a European spatial data infrastructure, where all the governmental data on a wide variety of subjects – including Earth Observation data – would be served for wider applications. Nowadays, when one thinks about the massive volumes of data, this distributed system of services would actually move into a cloud environment. If Europe wants an integration of UAPs for (near) real-time applications or post analysis, these data should become available in a cloud infrastructure together with Copernicus data and in-situ data. With the DIAS in Copernicus, there are five clouds, but there should be a cloud coverage. There is a European high-performance cloud infrastructure initiative at the moment, and according to Mr de Groof this should be made UAP-ready. Early in the process, public-private partnerships should be sought with the operators of UAPs, as this infrastructure should also be open for industry, to combine governmental data and capacities with theirs.

One person (from the UK met office) shared a comment concerning the middle-response availability of drone operators. The Commission has experience with how to coordinate access to national assets and capabilities through the civil protection mechanism (coordinated by DG ECHO), which has been in place for many years. An exchange with DG ECHO on how this process was managed and which lessons were learned would be recommendable. This could be useful to understand how DG ECHO provides access to the availability of national and private sector assets and how this could be transferred across Copernicus.

A member of the audience (Swedish agency for marine and water management) suggested to look at what could be learned from the integration of in-situ data into Copernicus. This is a similar challenge, as in-situ data are the Member States' responsibility. There is a similarity in the challenge of integrating UAPs into Copernicus.

In response, Mr de Groof commented that from the early onset of GMES, a symbiosis between DG Environment and Copernicus was established. There was even the head of the Copernicus GMES-unit who is chairing the INSPIRE working groups, since everyone realised that it would not work without having the two together. It remains an issue that today, there is no availability of the right types of in-situ data across borders. These are furthermore still not sufficiently and efficiently available, also to the Copernicus core services. For the Copernicus programme and for the greater benefits, these in-situ data should be made available to the Copernicus services. If there are gaps that prevent the Copernicus services from delivering the benefits they could deliver, investments should be made in closing these gaps.

The Chair opened the floor for questions to the panel. One person commented on the discussion, which mainly touched upon unmanned platforms. In the reflection concerning the complementarity with Earth Observation, it is important to have a full landscape to see, drones, UAPs, airborne observations and satellites. The whole landscape should be considered when Copernicus is discussed. Furthermore, when considering in-situ data, one could pose the question where the limits of Copernicus are concerning finances: are the drones to be paid by Copernicus or by an agency? For oil spills, it would be very interesting to have drones to validate satellite data, but whether Copernicus or EMSA should pay this should be discussed.



In response, the Chair clarified that there are no implications that Copernicus should pay for this, but it is necessary to reflect on what Copernicus could become in 10-15 years from now.

Mr De Groof stated that this comes down to what Copernicus is and what it is not. The civil protection collaboration mechanism was first established in DG Environment, and it is this DG which put the requirements for emergency services in Copernicus before it moved to DG ECHO. What is part of Copernicus needs to be complemented, or other things need to complement Copernicus. The source of the origin of EMSA lies with the oil tanker, The Prestige, which sank in front of the Spanish coast. Just recently, there were all the forest fires in Portugal. An app showed the data taken from satellites, over a given area, and fed them into the Emergency Service. The question is whether this information was useful for the firefighters on the ground, whether it was timely enough, or whether it would have been more efficient for them to have a HAPS available, continuously monitoring the situation, and combining these data with meteorological observations. It comes down to this complementarity, not only of instruments, but also of policies. The question also arises as to whether Portugal would be in a position to afford the deployment of a particular HAPS or drone. If not, the cross-border solidarity comes in and a European programme could potentially facilitate this.

The Chair concluded the session and workshop and thanked the participants as well as the panel for their contributions to the discussion. Many new developments and research are taking place, and unmanned aerial platforms are becoming increasingly reliable and robust. Some already provide an operational capacity which could provide a useful complementarity to the Copernicus data and information services. In the future, HAPS will provide some additional options. There is definitely an interest in the part of the users, but some issues still remain to addressed, such as the geographical coverage of drones, legal constraints in Member States, privacy issues, standardisation for data fusion and so forth. One main takeaway, however, is the fact that the platforms are there, and the technology is developing very rapidly. They can therefore not be ignored when the future of Copernicus is discussed, although it is important to draw the line where Copernicus begins and ends. There are a range of application areas where synergies could be useful.

In a last question, the audience rated this industry workshop as shown in Figure 8.

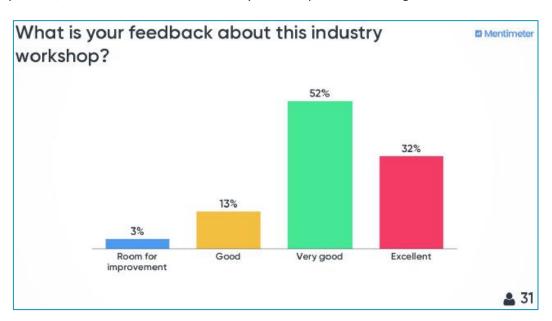


Figure 8: feedback about the industry workshop



ANNEX: WORKSHOP AGENDA



09:30 - 10:00 Registration and welcome coffee

10:00 - 10:30 Welcome and introduction

- Philippe Brunet, Director for Space policy, Copernicus and Defence, DG GROW, European Commission
 Philippe Merlo, Director, European Civil-Military Aviation, EUROCONTROL

10:30 - 11:30 SESSION I: Upstream - Existing and upcoming aerial observation systems

Moderator: Andreas Veispak, DG GROW, European Commission

- · Tim McCarthy, Maynooth University
- Pierre-Yves Dussauze, Delair
 Pierre Alain Bosc, Airbus
- Christian Lockowandt, Swedish Space Centre
- Guy Boullenger, Thales Alenia Space

11:30 - 12:15 Coffee break

Drone demo and group photo

12:15 - 13:30 SESSION II: Downstream - Current use of aerial observations applications

Moderator: Peter Spruyt, Joint Research Centre, European Commission

- Nicolas Lewydkyj, VITO
 Olsin McGrath, DroneSAR
- Juan de las Heras, European Maritime Safety Agency
- João Araújo, Spinworks
- Sven Pizywarra, Live EO

13:30 - 14:30 Lunch break

14:30 - 15:45 SESSION III: Operational and legal framework

Moderator: Nathalie Le Cam, DG GROW, European Commission

- Koen de Vos, DG MOVE, European Commission
- Dominique Colin and Henk Hof, EUROCONTROL
 Koen Meuleman, Unifly
- Anna Masutti, University of Bologna
- Anna Donovan, Trilateral Consulting

15:45 - 16:00 Cofee break

16:00 - 17:15 SESSION IV: The way forward - Future user needs and requirements

Moderator: Dinka Dinkova, DG GROW, European Commission

- Malcolm Davidson, European Space Agency
- Federica Mastracci, Telespazio, representing EARSC
 Vincent-Henri Peuch, Copernicus Atmosphere Monitoring Service, ECMWF
 Hugo de Groof, DG Environment, European Commission

17:15 - 17:30 Wrap up and conclusions



