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1. UTM – Different approaches to defining the concept

1.3 The European vision: The European Union's U-Space

The EU Single Sky Committee (SSC) indicated, as part of the agenda items for June 2016 meeting, the need to undertake research on a "drone traffic management system". The SSC expressed the view that the future UTM system should include the following features:

- A standardised data link for UAS;
- Human equivalent capability Detect-and-Avoid system;
- Contingency planning for data link loss situations;
- Cyber security resilience;
- Interoperability with normal airspace and airport operations, and
- Unique human factors aspects regarding UAS and their integration into UTM/ATM.

Following a request by the European Commission, the Single European Sky Air Traffic management Research Joint Undertaking (SJU) – whose role is to develop the new technologies and procedures for a next-generation European air traffic management system – has unveiled its blueprint to make drone use in low-level airspace safe, secure and environmentally friendly. This "U-Space" covers altitudes of up to 150 metres[1].

Registration of drones and drone operators, their e-identification and geo-fencing should be in place by 2019.

The U-Space should be:

- Safe: safety at low altitude levels will be just as good as that for traditional manned aviation. The concept is to develop a system similar to that of Air Traffic Management for manned aviation;
- Automated: the system will provide information for highly automated or autonomous drones to fly safely and avoid obstacles or collisions and
- Up and running by 2019: for the basic services like registration, e-identification and geo-fencing. However, further U-Space services and their corresponding standards will need to be developed in the future.

A high-level UTM roadmap has been produced (see tables three and four) defining target dates for the roll-out of UTM services. This has been developed in parallel with long-standing work to integrate military and large-scale, remotely piloted aviation systems (RPAS) in civil airspace.

[1] http://europa.eu/rapid/press-release_IP-17-1605_en.htm
and http://www.sesarju.eu/sites/default//files/documents/reports/U-space%20Blueprint.pdf

The European Aviation Safety Agency (EASA) is working with its Member States and industry to produce effective EU-wide safety rules that are proportionate to the risk of the operation. These rules will implement the EU's basic aviation safety regulation which the European Parliament and the Council (i.e. the EU Member States) are expected to adopt in the coming months.

The Commission, through the SESAR Joint Undertaking, will finance a range of drone projects, focusing on the integration of drones into the aviation system. Finally, an expert group will be established to act as a sounding board for the further development of European drone policy. Current common European rules only cover drones weighing above 150 kilograms. Below this threshold, Member States are responsible to regulate.

While national rules allow expertise to grow, they often diverge and cause a fragmentation of the EU internal market. Such fragmentation hampers the development of new products, the swift introduction of technologies and may also create safety risks. In December 2015, the Commission therefore proposed to create an EU-wide framework for drones as part of its Aviation Strategy. This requires the establishment of a regulatory framework, including standards, and the safe integration of drones into the airspace, on which today's blueprint delivers.

Table three - The high level European UTM roadmap

Timescale	UTM services	RPAS integration
2019 plus	U1 UTM Foundation services • e-registration • e-identification • geo-fencing	RPAS 1 – IFR in classes A-C
2022 plus	U2 UTM Initial services • flight planning • flight approval • tracking • airspace dynamic information • procedural interface with ATC	RPAS 2 – IFR in classes A-G
2027 plus	U3 UTM Advanced/enhanced services • capacity management • assistance for conflict detection	
2030 plus		RPAS 3 – IFR and VFR in classes A-G
2035 plus	U4 UTM Full services • additional new services and integrated interfaces with manned aviation	

Table four: More detailed U-Space technology levels 2019-2025

U1 (2019)
e-Registration
Electronic chip
Drone operator online registration
Drone online registration
Registration enforcement
Registration Authority
e-Identification
Drone Identification
E-identification enforcement
Identification Authority
Pre-tactical geo-fencing
Geo-limitation database
Drone operator authentication and authorisation

U2 (2021)
Tactical geo-fencing
Live airspace data feed
Area infringement notification
Flight planning management
Automated FPL validation
Operations digital authorization
Digital NOTAM
Weather information
Low-altitude wind forecast
Actual low-altitude wind info
weather info collection
Weather hazard alerts
Tracking
Radio Positioning infrastructure
Real-time tracking
Tracking data recording
Monitoring
Air situation monitoring
Flight non-conformance detection
Area infringement detection
Traffic info multicast
Alert/Report line
Drone aeronautical information management
UTM-relevant static aeronautical data
UTM-relevant dynamic aeronautical data
Procedural interface with ATC
ATC/UAS coordination procedures
Flight notification procedures
Emergency and contingency procedures
Emergency management
Emergency alert line
Emergency assistance information
Strategic de-confliction
Strategic de-confliction

U3 (2025)
Dynamic geo-fencing
Dynamic geo-fencing
Collaborative Interface with ATC
Global air situation monitoring
ATC alert notification
Tactical de-confliction
Tactical de-confliction
Dynamic capacity management
Airspace capacity monitoring
UAS traffic complexity assessment
Demand/capacity imbalance detection
UTM measures implementation

In July 2018 the SJU approved the Concept of Operation for EuROpean UTM Systems (CORUS) U-Space development programme, which describes how U-space will be implemented progressively and outlines some charging (and non-charging) principles for each iteration of the U-Space blueprint.

Within the CORUS concept there will be three classes of airspace categorised by different colours: Red Airspace is a No Drone Zone, a space that can only be entered with specific permission. Green Airspace places allows easy access but requires the remote pilot to maintain separation by maintaining visual contact with the drone at all times. Amber Airspace is introduced in U2 and provides strategic conflict resolution, but at a cost; access to this airspace requires a flight plan and tracking for all drones; even those flying in visual line of sight.

The following paragraphs are taken directly from the report and outline the principles of UTM evolution following by some remarks about charging.

"U1 is to be implemented as soon as possible. U1 will enable safe drone operations with a relatively low spatial density and with quite some limitations compared to U2. We expect that U1 will enable VLOS operations in some areas relatively easily for the operator. Beyond visual line of sight (BVLOS) will probably require explicit permission via manual processes that may take time. Separation during VLOS will be based on the visual judgement of the remote pilots. BVLOS operations in U1 will probably need "special permission" and be undertaken on the basis of reserving the airspace for the BVLOS flight using a Segregated Area or similar. This area will act as a geo-fence for the other flights and a geo-cage for the BVLOS flight. This process is may be slow due to the time required to define a Segregated Area or whatever is used. The process will require manual intervention and be costly. (Some states may find local solutions that are more efficient.) U1 includes standardisation of regulations, education and the creation of a registry for operators, pilots and to an extent, for drones.

"In U1 the existing aeronautical information systems (e.g. EAD) could possibly be used as the main channels through which geo-fencing / geo-caging are achieved, as danger areas or restricted areas – though we may see the emergence of a complementary system if the AIRAC/NOTAM cycles prove to be too much of a time constraint for safe BVLOS flights, or the number of geo-fences proves difficult for AIP.

Section three - A country-by-country and regional guide to programmes creating the procedures and protocols required for UTM

3.1 Australasia

In October 2017 Google parent company Alphabet's Project Wing began trialling merchant deliveries in **Australia**.

The test market is Queanbeyan, South Eastern Australia, where two merchants have signed up for delivery-by-drone services: Guzman y Gomez, a Mexican food chain, and Chemist Warehouse, a chain of pharmacies. These companies will receive orders from test consumers, who've purchased items using the Project Wing app on their smartphones. Project Wing's drones will then fly out and make the deliveries. According to the Google website:

"Project Wing chose the Australian market for several reasons: the drone laws and regulations are well set up and more lax than in many other countries…. (and) the typical distances that consumers have to travel to go to the store are quite large so drone deliveries offer a clear time-saving benefit."

In November 2018 Project Wing secured a warehouse in Mitchell, Canberra, as a full-time base for its drone delivery service, reports the *Canberra Times*. The paper quoted Wing as saying it will be "the first location of its kind with the world's most advanced drone delivery service". The *Times* says Wing plans to initially offer deliveries to homes and businesses in nearby Gunghalin, Palmerston, Harrison, Crace and Franklin, with a long-term view of operating flights throughout Canberra, as well as other cities and towns across Australia.

According to an October 2018 statement from the Australian Civil Aviation Safety Authority (https://www.casa.gov.au/aircraft/standard-page/trial-drone-delivery-systems)

"We have approved Unmanned Systems Australia to operate Wing drones in Bonython, a suburb in Canberra's south. Unmanned Systems Australia is a licensed and certified drone operator.They have been testing drone delivery with Wing in Australia over the past several years, refining their aircraft and systems.They have satisfied us that their operation meets an acceptable level of safety. As a result, we have permitted Unmanned Systems Australia to operate over Bonython and in closer proximity to a person, than our regulations would normally permit. As the safety regulator, the issue of privacy and noise is not in our remit. The system is automated—however a licensed drone pilot is always at the helm. Wing works within our current guidelines for commercial drone operators flying over 2kg and these approvals are aligned with regulations and in accordance with similar instruments issued to other operators.

"Wing drones currently fly only during daylight hours. Flights are permitted in the following hours:- Monday to Saturday from 07:00 to 20:00, Sunday from 08:00 to 20:00. While an accident is unlikely to occur, pilots will know instantly if any of their drones operate outside of a standard mission. If this happens, the operator will

decide if the safest course of action is to the land the aircraft, rather than continue the flight. In the unlikely event the drone encounters a problem, it is designed to automatically land very slowly. The aircraft are equipped with flashing strobe lights."

In July 2018 Australia's Queensland Government issued a new drones strategy (https://www.premiers.qld.gov.au/publications/categories/plans/assets/queensland-drones-strategy.pdf) which includes the development of a specific commercial drone zone, a common-user site for the commercial testing of aerial drones by 2020 and the establishment of an independent body to facilitate the development of industry consensus standards to support the assessment and certification of autonomous and robotic technology.

According to the report:

"The site, to be identified and developed by the Department of State Development, Manufacturing, Infrastructure and Planning, and the DCRC TAS will support industry by significantly reducing red tape for testing drones, speeding up development of new technologies and enhancing Queensland's reputation as an attractive place to invest in new drone technology development and testing.

The local government will also monitor and evaluate other jurisdictions' use and testing of new drone applications and technology and inform Department of Transport and Main Roads' (DTMR) led trials and testing of emerging uses of drones. DTMR will engage with the Civil Aviation Safety Authority (CASA) to learn from these experiences and bring new-to-state opportunities for local industry, national and international investment.

Queensland's government will also:

"Establish an independent body to facilitate the development of industry consensus standards to support the assessment and certification of autonomous and robotic technology through the Civil Aviation Safety Authority (CASA) and the Defence Aviation Safety Authority. The Department of Environment and Science and the Department of Innovation, Tourism Industry Development and the Commonwealth Games will work with the DCRC TAS to establish the accreditation organisation, with up to AD3 million in funding available for this purpose. The organisation will be established by December 2018, with the expectation that it will operate as a self-sustaining, fee -for -service organisation able to service defence and non-defence industries by 2021."

In **New Zealand** in December 2017 AirMap joined forces with Airways New Zealand to bring digital airspace authorisation to New Zealand's drone community. According to AirMap drone flights in the country's controlled airspace have increased 20 times over the past three years.

Drone operators can now use AirMap's iOS and Android apps to request airspace approvals required by New Zealand's Civil Aviation Authority at Christchurch, Queenstown, and Wanaka airports, and on public lands in the Christchurch City, Selwyn, and Queenstown Lakes District Council, including parks and reserves.

Airways New Zealand is also working with Zephyr Airworks to integrate air taxis into the air navigation service provider's developing UTM network. Zephyr Airworks is developing its Cora air taxi in New Zealand.

The trial of the AirMap drone traffic management platform has been underway in Canterbury and Queenstown. AirMap allows drone pilots to plan their flights, seek authorisations and get information about the areas they're operating in. In the next phase Airways is planning is to develop tracking tools that allow UAVs to be accurately monitored once they are beyond the pilot's line of site and detect and avoidance capability to keep them safely separated from other aircraft.

Airways also intends to test the capability of New Zealand's existing telecommunications network to track the likes of Zephyr Airworks' autonomous vehicle Cora and UAVs in uncontrolled airspace and enable better telemetry for drone pilots.

In October 2018UNICEF reported that the **Vanuatu** Government awarded two international drone companies, Swoop Aero and Wingcopter, with commercial contracts to trial the use of drones to bring lifesaving vaccines to children living in remote rural islands.

Two contracts were awarded to Swoop Aero Pty Ltd of Melbourne, which will cover vaccine delivery to health facilities on Epi and the Shepherd Islands as well as Erromango Island. Wingcopter Holding GmbH & Co. KG of Darmstadt, Germany, was awarded the third contract to deliver vaccines to facilities on Pentecost Island.

The first phase of the drone trials took place during the week of 3-7 December when these two drone companies tested the viability of delivering vaccines to inaccessible areas.

4. The role of regulators, certification and standards agencies – likely scenarios for developing the regulatory framework for UTM

4.4 Standards organisations

There is continuing debate about what constitutes the requirement for specific aeronautical standards and what can be covered by more general standards. For example, currently drone remote control units in Europe are covered by CE Marking standards. Should they really be required to be certified by aviation agencies, too?

It has traditionally taken about seven years to identify, develop, draft and then implement new regulations and standards for manned aviation, but the pressure is on regulators and standards organisations globally to come up with new paradigms to speed up the implementation of UTM standards and rules. Technology-agnostic performance-based standards provide greatest freedom of choice for industry to develop technology templates on which UTM systems can be based, but some prescriptive standards will also be required – for example, in areas such as frequency spectrum allocation.

In December 2017 **EUROCAE** announced its timetable for UTM regulations and standards, to which the European Aviation Safety Agency (EASA) would now work towards.

Christian Schleifer-Heingärtner, Secretary General of EUROCAE said 110 organisations and 240 individual experts had signed up to support six focus areas and develop standards in the areas of:

- Command, control and communication including security aspects (C3&S);
- Detect-and-avoid (DAA);
- Enhanced RPAS automation (ERA, including autotaxi, ATOL and emergency recovery);
- UAS Traffic Management (UTM, including geo-fencing and identification);
- Design & airworthiness standards (D&AW), and
- Specific operational risk assessment (SORA), remote pilot stations (RPS, on ATM interface aspects).

EUROCAE with its Working Group WG-105 contributes to the safe integration of all types of UAS into all types of airspace for all operations at all times.

Following the analysis of regulations and guidance related to the emerging UTM operations, WG-105 has identified the need for:

- A definition of a Workplan for the development of standards necessary to support the U-Space concept as proposed by SJU for the Air Traffic Management Master Plan (ATM MP) Addendu
- Standardisation of UTM services, with a focus on UAS Electronic Identification in accordance with the applicable safety and security requirements

The UTM Focus Team will develop a workplan to clearly identify the recommended standards for the use of UAS within the U-Space concept. This workplan should consider the full spectrum (U1 to U4) of U-Space.

5.0 Financing UTM

5.1 Likely methods of financing UTM systems

In March 2018 Italy's ANSP ENAV became the world's first ANSP to produce a public version of its UTM business plan, with proposed charging scales for UTM services for both recreational and professional drone operators.

Table twelve: ENAV's proposed UTM charging mechanism

Area	Service description	Frequency	Recreational	Professional
Regulated services	UAV registration (to ENAC)	Registration fee (per UAV) una tantum	EUR5	EUR5
Regulated services	E identification and tracking	Annual fee (per operator)	EUR5	EUR20
Regulated services	UTM box (lease for e ident and tracking)	Annual fee	EUR40 (optional)	EUR40
Regulated services	Support to mission – submission/approval	Per mission (only specific)	N/a	EUR30
Regulated services	Monitoring and alerting	Fee per hour of flight (only specific)	N/a	EUR1
Non regulated services	Premium services	Annual fee	EUR5	Included

ENAV also outlined some more details of its business plan, including its forecasts for running a profitable UTM operation in a public-private consortium with an independent UTM service provider as a minor shareholder.

- Investment and running costs sustainable in the mid-term with a ROI between third and fifth year of operations
- Total investment of EUR20 million in 10 years planned for full deployment of Italian U space to U4
- Planning EUR50-60 million of operational costs to 2028 for revenues of EUR70-75 million with an increasing positive cash flow from fifth year of operation; more than 60% of revenues generated by regulated services to support specific missions (eg BVLOS/autonomous)
- UTM Box lease in invariant in the cash flow. A built-in standard is welcome (as suggested by EASA opinion) but a temporary "e-identification add on system" solution is needed anyway.

The business case is built on the assumption that:

- The market growth estimates will be confirmed (see table below)
- The rule making process will confirm the current setting, as recently represented in the EASA opinion

Major risks are related to:

- EU legislation
- Wasting of investment for lack of standard and IOP
- Market expansion slowing down
- BVLOS/ autonomous drone services market blocked or unexploited

Concerns are related to:

- Capacity of penetration
- Compliance to legislation from operators

The universal registration of UAVs with a MTOW over 250 grams is expected to be mandatory by the end of 2019.

Table thirteen: Market for forecast for drone numbers in Italy

	2019	2020	2021	2022	2023	2024	2025	2026
Drones (000s)	41	66	103	144	160	194	216	234
Professional	19	26	28	30	31	37	39	40
Recreational	81	74	72	70	69	63	61	60

While this has given the clearest picture yet of an ANSP's vision of developing a profitable business from providing UTM services there are still a number of areas where there is considerable uncertainty. The exact configuration and operational parameters of the UTM box, for example, which would be fitted in all drones undertaking BVLOS operations and would be used for identity/tracking (by the UTM service provider, operator and security agencies?) would need to be more clearly understood. The regulator's view of these levels of charges is not known, nor is the view commercial drone operators who will be paying for the service.

By the start of 2018 it had become clear that the UTM models under very broad consideration by governments were vulnerable to the advance of technology, especially in an industry where disruption is seen as more-or-less a standard method of technical evolution. For example, the development of advanced algorithms to calculate the risk of a flight and generate insurance coverage per operator, per flight[2] could also be used to generate UTM service charges based on the length and complexity of the flight plan.

[2] http://www.unmannedairspace.info/uncategorized/new-smartphone-app-immediately-quantifies-risk-drone-flights/

6. Current and emerging technologies

Introduction

In the digital world of UTM, communications, navigation (including sense-and-avoid) and surveillance are all part of an integrated network. A UAS broadcasting its position report and the airspace manager requesting an urgent change to a UAS flight plan to allow emergency services access to an area through which the UAS has planned to fly are all related services. At the moment there is no clear indication which communication media will be the most appropriate media for the different services, and whether the network will be built on a nationwide or local level.

There are currently hundreds of research programmes underway by governmental and intergovernmental organisations, research agencies and private corporations into key enabling UTM technologies it is difficult to distil all these into a meaningful, concise text.

In this section we have therefore concentrated on the strategic technologies and procedures trialled within Europe, the USA, Japan, China and other drone-industry intensive areas of the world, along with the more advanced UTM models being pioneered in Dubai, where some of these core technologies are operating today. A key document for understand the technical requirements for BVLOS operations is the Pathfinder report (Focus Area 2) prepared for the FAA by PrecisionHawk which identifies four core pieces of technology[3] recommended to be incorporated for drones to safely fly BVLOS:

Key Technology	Description
1. sUAS Tracking	Hardware- and/or software-based methods of transmitting live trajectory information for the sUAS being flown.
2. Real Time Manned Aircraft Data Feed	Real-time data feeds that transmit the location and trajectory of cooperative manned traffic that includes ADSB and radar feeds with < 1 s latency. For example, the Harris NextGen Surveillance Data feeds (described further in Section 3.4.1.2).
3. Detect and Avoid System	Hardware- and software-based methods that detect non-cooperative manned traffic at a minimum distance of 3 NM and with a 360o field of regard. For example, the SARA PANCAS system, which is capable of detecting

[3] https://faapathfinderreport.com/?utm_campaign=BVLOS%20Deployment&utm_campaign=BVLOS%20Deployment&utm_source=email&utm_source=hs_email&utm_content=BVLOS%20XPO%20Announcement&utm_content=62590221&utm_medium=email&_hsenc=p2ANqtz-96xsK8PJh29zzFATa_Y2NWSUa04zKeqGOzgQzYGpCZWzphh_lBW46GAIlZ1NBGwbGiI4ZfV7suxeX7V14jdnS8s53Bs3b-vgWBhx3qq6CRmUDU2BM&_hsmi=62590221

	non-cooperative targets at 5 NM (described further in Section 3.5.2) and offers a 360o field of regard.
4. Display	A display that: provides the information in #1 to #3 above and enables algorithms to generate alerts (visible/audible) to the PIC via the display, allowing the PIC to maintain well-clear from manned aircraft and execute collision avoidance maneuvers if necessary.

"Then the above represent a set of requirements for a commercially viable localized BVLOS ConOps that can meet required NAS safety standards and is realizable near-term. The overall operational profile as captured for any particular operator in their BVLOS flight procedures will need to be conservative. Specifically, there may be multiple scenarios in which the required action is to land the sUAS to preserve airspace safety. This is not an unreasonable requirement for technologies which are relatively new to use within an aviation context, and every hour of flight heritage gained is another set of data with which to continue to develop the risk profile and innovate solutions which can lead to further expansion in the permitted operations."

7. Market forecasts for growth in the global UTM market – by value, geographic demand and sectors

The developing role of UTM service providers

At the heart of the UTM industry lies the UTM service provider industry (see appendix one). These companies broadly fall into four types:

- Technology-focused network builders – organisations focused on writing software networking a wide range of stakeholders into the UTM network, whichever form it takes;

- UTM system managers – organisations who want to run drone traffic management services on behalf of national and local governments, on their own or in partnership with ANSPs;

- UTM system builders, managers, operators – organisations who want to provide the entire UTM infrastructure, using mobile telephone communications, for example, to develop a complete network, and

- Bespoke UTM service operators – organisations who want to provide an entire, bespoke drone operational system and for whom the UTM system is merely one component in their drone operation eco-system.

Among the first group, technology-focused network builders are companies such as Unifly. This is a particularly robust business model because it is almost UTM-management-structure agnostic while the success of the other business service models will depend on how national regulators structure the UTM service delivery concept.

AirMap is an example of the second group, forging increasing numbers of partnerships with ANSPs and US states to provide early UTM services. Its flight planning service is integrated in systems developed by DJI, Intel, senseFly 3DR, and Aeryon Labs. Terra Drone, on the other hand, is a group-three company, not just developing management services but developing partnerships with cellular network providers to develop the infrastructure and management. Amazon would be an example of a group-four company.

The market for these companies is extremely complex – but essentially there are two types of commercial arrangements between UTM service suppliers and national ANSPs/civil aviation authorities under consideration: national strategic partnerships when access to airspace for drone operators is managed under a shared ANSP/USS partnership and more localised UTM markets – such as urban airspace arrangements where USS companies are working with GSM telephone network operators to deliver UTM services.

These are two separate markets requiring different but complementary skills sets.

Under the first strategic arrangements ANSPs use the airspace flight planning tools developed by USS companies to evolve national programmes to a evolve a lower airspace UTM tool which may or may not be integrated within the national ATM network.

Under the second UTM concept, the development path is entirely different, with the UTM suppliers having to be responsible for developing on-board tracking/communications tools within a localised UTM environment, based – currently – on GSM networks and kept separate from the national ATM systems.

ANSPs appear to be currently prioritising the following requirements of a UTM system:

- Scalability - so the UTM system will be able to evolve to handle BVLOS operations and a considerable increase in numbers
- Identification of rogue drones and rogue drone operators
- Communications – a system which will allow controllers and security services to alert drone operators of unscheduled manned flights for emergency and other reasons into the UTM network.
- Interaction of the UTM system with the ATM system – either to keep these two systems entirely separate or to provide an automated access system so controllers do not have reduce capacity of the ATM system as a result of drone operations.

Among the five or six market UTM service provider market leaders there is already a legacy of cooperation which suggests the market will consolidate around this group of companies plus a further group of smaller players with niche capabilities in urban UTM operations. In June 2018 five UTM service suppliers have joined together under the sponsorship of Google's Project Wing to develop a global, grid-based USS-USS open-source communications platform, called InterUSS Platform ™ as a first stage in de-conflicting drone flights anywhere in the world, no matter which USS has the authority for UTM operations in a particular country or area.

The system divides the world into 750m grids; when a drone connected to a UTM platform provided by AirMap, Altitude Angel, PrecisionHawk, Skyward, Unifly and Project Wing enters the grid a message will be sent to other USS operators to alert them. The system uses the Apache License permissive free software, to allow de-confliction operations to take place on a machine-to-machine basis, using the algorithms developed by each service provider, and will be opened up to new partners in the coming months, with Global UTM Association (GUTMA) providing support in this area.

The work builds on a NASA TCL 3 UTM research programme which took place in April 2018 where flights flown using Project Wing's and AirMap's UTM platforms were safely routed around each other. The two USSs operated in the same airspace and connected directly to share safety information for cooperative separation while protecting operator and consumer privacy.

"The research showed we could share information between USSs, second we could do without a centralised database which stored all the data in one place and third we can build it so as it grows this can scale up to accommodate future traffic," according to Kevin Hightower, Project Manager, Project Wing.

This agreement suggests a divide is now emerging between these key players and the companies below them - though this current trend could change quickly if and when major aerospace integrators such as Boeing, Thales and General Electric reconfigure their UTM offerings around more global "system of systems" market offerings.

Table fifteen: UTM service providers and commercial contracts with ANSPs, civil aviation authorities

ANSP and UTM operational partnerships				
Date	**UTM service supplier**	**Client**	**Country**	**Contract details**
April 2016	Exponent	Dubai Civil Aviation Administration	Dubai	Public launch of the Exponent Portal software which allows DCAA officials and other local authorities to track the location, speed and height of drones.
2017				
July	Unifly	DFS	Germany	UTM deployment with mobile app in July 2017
August	AirMap	Kansas Department of Transportation (KDOT)	USA	The AirMap UTM platform is deployed in Kansas where drones will be mobilized for disaster recovery, search-and-rescue, agriculture, construction, package delivery, and more.