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Unmanned Aircraft Systems Traffic Management (UTM) A Common Framework with Core Principles for National Harmonization

EDITION 1

GHANA CIVIL AVIATION AUTHORITY

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Foreword

Since the early 2000s, rapid technological advancement in the Remotely Piloted Aircraft sector has necessitated the need to rethink aviation development strategies worldwide. The pace of technological advancement and the increasing use of off-the-shelf components pose a significant challenge to the timely development of standards. In particular, the lack of standardisation in aircraft design and equipage as well as the use of non-traditional aviation-related communications and navigation technologies (e.g., artificial intelligence, automation, and robotics) challenges the traditional methods of certification and operational approval.

This phenomenon has resulted in States and regulators receiving an increased number of applications for access to low-level airspace, where the operations of manned aircraft are generally limited or restricted. Consequently, at the 39th Session of the ICAO Assembly, in 2016, States and the aviation industry, requested that ICAO urgently address the increasing number of RPA operating in low-level airspace that might conflict with manned aviation, and develop a global baseline of provisions and guidance material to harmonize regulations for RPAS operations outside the international instrument flight rules (IFR) framework.

This framework therefore is to help Ghana to develop a system that provides inter alia the following benefits:

- continued safety of all air traffic, manned and unmanned,
- safety of persons on the ground,
- complex low-level RPAS operations,
- ongoing support of technological advancements,
- evaluation of security and environmental risks, and
- provision for a national, harmonized framework for RPAS operations.

In addition, this document also seeks the harmonisation between various UTM service providers and to provide standardisation for future orderly growth.

This document does not prevent or put an end to the ongoing exploration of critical operational aspects of interoperability of certain elements of unmanned and manned aviation. Any such future results will be reflected in amendments to this document.

1 The Changing Landscape

RPAS are creating a new industry with large economic potential. They offer a vast range of capabilities and sophistication. Their associated technologies, designs, and operating concepts are evolving rapidly. The rapid growth of RPAS has caused an increasing demand for them to operate beyond visual line-of-sight (BVLOS) and in airspace open to other aircraft.

Today, manned aviation develops and improves upon ways to aid a pilot with the responsibility of flying safely. Regulations (e.g. airworthiness certification) and procedures (e.g. periodic maintenance) assure the integrity of the pilot's aircraft. Initial and recurrent training prepare the pilot for anticipated and unanticipated flight events. The pilot and perhaps others in the operator's organization assist in the preparation and planning for a safe flight. Civil Aviation Authorities (CAA) and ANSPs provide and oversee a highly organized infrastructure comprised of procedures, routes, and services to assure safe flight. All aspects of the air navigation system combine to manage the safe, efficient flow of air traffic.

The introduction of RPAS raises multiple questions that challenge the extant aviation system in the following areas:

1.1 The Regulator

The Regulator, in conjunction with other stakeholders, is required to address the following issues that have emerged due to the proliferation of RPAS technology and use in Ghana's airspace:

- **Airspace access**. Policies, rules and priorities must be developed to support equitable access to airspace.
- **Airspace classification**. The current airspace classification scheme as developed for manned aviation may not effectively support visual line-of-sight (VLOS) or BVLOS operations. Resolving this gap may require modification of current classes of airspace or potentially the creation of new classes of airspace.
- **Alerting systems**. The safety and integrity of the UTM system, failure alerting and failure management must be addressed. Policies, guidance and procedures will need to be developed to address the degradation or failure of the various UTM components

or entire UTM system as well as the restoration of systems after such degradation or failures.

- **Certification and approval standards**. Certification and approval standards are needed for the UTM system, the RPA, the RPAS operator, the RPAS pilot or RPAS PIC, the RPAS Training Organisations, RPAS maintenance facilities, etc. The standards of manned aviation and even those for RPAS envisaged under the Annexes to the Chicago Convention may be incompatible with the kind of RPAS expected to operate within this UTM Framework. The standards need to be scaled to an appropriate level based on risk(s).
- **Communications**. Remote pilot interfaces as well as capabilities and performance requirements for communications with the UTM system must be developed. These include the ability to interface or communicate with ATC and pilots of manned aircraft.
- **Contingency management**. Procedures are needed that dynamically address contingencies both of the UTM system(s) and of the aircraft operating within the UTM system.
- **Data recording**. Data recording policies and capabilities, like ATC data retention and aircraft flight recorder requirements, are needed to support accident and incident reporting and investigative requirements as well determining the effectiveness of regulatory policies.
- **Data standards**. Appropriate data standards (e.g., data quality specifications, data protection requirements) and protocols to support UTM safety-related services and the exchange of data between UTM and ATM systems, as well as between multiple UTM systems, are needed.
- **Interface between UTM and ATM**. There is a need to develop procedures and adequate tools to ensure the sharing of information, the interoperability of the two systems, and to identify roles, responsibilities and limitations.
- **Liability**. Liability and insurance implications for USPs in relation to RPAS operators have not been determined.
- **Operational procedures**. Procedures specific to the UTM system, including normal, contingency and emergency scenarios, are needed. Such procedures would need to be harmonized with ATM systems whenever UAS operations are planned near the

boundary between UTM and ATM or if an RPA will transit from one system to the other.

- **Positional references**. Common altitude, navigation and temporal references for manned and unmanned operations are needed. Gaps in the use of reference points and equipment providing different levels of accuracy and performance in the measurement of altitude, navigation or time introduce safety concerns which must be resolved. Determining the extent to which traditional aviation standards can be used remains a work in progress. Traditional standards which address the provision of such references may be utilized whenever possible.
- **The Rules of the Air** designed for manned aviation, specifying flight rules, right-of-way, altitude above people and obstructions, and distance from obstacles are incompatible with the intended operations within UTM systems.

1.2 The Air Traffic Controller

The services being rendered by the ATC meets the needs of conventional aircraft. However, the anticipated increase in the number and diversity of airspace users presents a significant challenge for Air Traffic Control (ATC). Current human-centric methodologies may struggle to efficiently manage and support such a large-scale and diverse traffic volume without resorting to prohibitive restrictions or requiring additional resources, both of which are not viable for supporting operations at scale.

While accommodating disruptive technology is crucial for enabling new and more efficient operations, we must carefully consider how to blend these innovations with traditional systems.

The role of ATC is expected to continue to grow into managing and enabling traffic and intervening in off-nominal situations, rather than what is predominantly done today in controlled airspace where the controller performs most of the designated separator tasks and holds the liability to manage traffic safely by clearance and direct interaction. Within that context, the role of ATC will shift to critical tasks, supervising the airspace and intervening in off nominal situations.

Technology, digitization, and data offer opportunities for improved system performance, reduced workload for air traffic controllers (ATCOs), and enhanced human-system collaboration. However, as we adapt the airspace system to be more accessible and scalable to new entrants, we must maintain safety for existing operations.

1.3 The Airspace

The existing flight rules primarily aim to ensure safe separation and navigation of aircraft, minimizing risks to other airspace users and people on the ground. As we move toward increasingly automated aircraft, consideration should be given to new flight rules that augment but do not replace Visual Flight Rules (VFR) and Instrument Flight Rules (IFR). Concepts like automated flight rules (AFR) or digital flight rules (DFR) could play a role in this new operating environment.

Already, operations at altitudes in the very low-level structure (e.g., below 150 metres or 500 feet above ground level (AGL)) has become the norm rather than the exception for RPAS operations in Ghana. The increase in operations in the low-level environment and above populated areas raises questions about the sustainability and scalability of a UTM system and the ability of ATM infrastructure to accommodate these new users.

In addition, reliance on data links (either non-traditional ground-based links, C2 Links or data links associated with UTM systems), raises new challenges related to frequency spectrum, resilience and cybersecurity.

2 Concepts

2.1 Accommodation

Accommodation describes the condition when an RPAS can operate along with some level of adaptation or support that compensates for its inability to comply within existing operational constructs. This may be necessary during normal operations, abnormal or problem scenarios, and when emergency situations arise. For example, an RPA could be accommodated to operate in accordance with IFR in nonsegregated airspace using techniques such as dedicated corridors or increased spacing around the aircraft resulting in fewer restrictions on airspace usage.

2.2 Delegated UTM Service Provider

A service provider who has been delegated by the ATM Service Provider, to help manage and deconflict airspace for drone operations.

2.3 Detect and Avoid

The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.

2.4 Geofence

A virtual three-dimensional perimeter around a geographic point, either fixed or moving, that can be predefined or dynamically generated and that enables software to trigger a response when a device approaches the perimeter (also referred to as geo-awareness or geo-caging).

2.5 Geographic Airspace

Also known variously as portion of airspace, particular airspace, portion of airspace, subscribed volume of airspace etc. The geographic airspace shall be defined by both horizontal and vertical limits. Static and dynamic airspace restrictions shall also be provided when defining a geographic airspace.

2.6 Integration

Integration refers to a future when RPA may be expected to enter the airspace system routinely without requiring special provisions.

2.7 Managed and Unmanaged Flights

If the aircraft is provided with services to prevent collision with other aircraft (Conflict Management Service), the flight should be considered managed. If the conflict management service is not provided, because of the capabilities of the aircraft or of the pilot, or due to the nature of the operations the traffic is unmanaged.

2.8 Management by Exception

Management by Exception (MbE) focuses on deviating from standard procedures only when necessary. In unmanned aviation, MbE allows for a more flexible and dynamic approach, intervening only when predefined thresholds or exceptional conditions are met.

- Automated Monitoring Systems: MbE relies on approved SOPs that continuously assess RPAS operations. Deviations from the norm trigger alerts or interventions, ensuring immediate attention to potential issues.
- Adaptive Decision-making: Instead of pre-approving every detail, MbE enables autonomous decision-making by RPAS operators and remote pilots based on real-time data.
- Resource Optimization: MbE optimizes resource utilization by intervening only when necessary. Routine and uncomplicated flights proceed without constant oversight, allowing efficient use resources.

2.9 Management by Permission

Management by Permission (MbP) is a concept that emphasizes the need for explicit authorization and approval before certain actions are taken. In the context of unmanned aviation, this involves obtaining explicit permissions and clearances for every flight operation. MbP ensures a structured approach to airspace utilization and regulatory compliance.

- Authorization Protocols: RPAS operators must seek permission from relevant aviation authorities or regulatory bodies before initiating flights. This includes obtaining clearance for airspace usage, adhering to altitude restrictions, and complying with local regulations.
- Real-time Communication: MbP necessitates real-time communication between operators and Authorities. This is facilitated through advanced communication technologies, allowing authorities to monitor and grant permissions dynamically.
- Enhanced Safety: By enforcing strict pre-flight approvals, MbP reduces the risk of unauthorized or unsafe operations. This paradigm is particularly crucial in shared airspace scenarios where coordination with manned aviation is essential.

2.10 Operational Volume

The operational volume refers to the three-dimensional space within which a drone or unmanned aircraft operates during a particular mission or flight. The operational volume or boundaries consist of the normal and contingency operating area.

2.11 Performance and Risk Based Oversight

Performance-based safety oversight (PBO) and risk-based oversight (RBO) are two different approaches to aviation safety regulation.

Performance-based safety oversight focuses on measuring and improving the safety performance of aviation service providers. This approach involves setting safety targets for service providers and then monitoring their performance against those targets. If a service provider is not meeting its targets, the regulator will work with the service provider to identify and address the problem.

Risk-based oversight focuses on identifying and managing safety risks. This approach involves assessing the risks associated with different aviation activities and then prioritizing regulatory activities accordingly.

The concept of "performance" conveys the idea of tangibly measuring the health of the system under scrutiny and ultimately assessing its overall performance. Performance indicators may specifically help to either identify risks within that system or measure safety risks or monitoring actions mitigating these risks. This means that a PBO supports the identification of areas of greater risks and serve the risk assessment and mitigation exercise.

2.12 Remain-Well-Clear

The ability to detect, analyse and manoeuvre in order to ensure that a UA is not being operated in such proximity to other aircraft as to create a collision hazard.

2.13 Remote Pilot

A person charged by the operator with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time.

2.14 Remote Pilot-In-Command

The remote pilot designated by the operator as being in command and charged with the safe conduct of the flight.

2.15 Remotely Piloted Aircraft (RPA)

An unmanned aircraft which is piloted from a remote pilot station.

2.16 Remotely Piloted Aircraft System (RPAS)

A remotely piloted aircraft, its associated remote pilot station(s), the required C2 Link and any other components as specified in the type design. RPAS are a subset of Unmanned Aircraft System (UAS).

However, in this document UAS is used interchangeably with RPAS and mean the same.

** See concept for Unmanned Aircraft System*

2.17 Restricted Area

An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

2.18 Segregated Airspace

Airspace of specified dimensions allocated for exclusive use to a specific user(s).

2.19 Separation Provision

Separation provision intervention capability refers to the quality of humans and/or systems to detect and solve a conflict and to implement and monitor the solution. Clarity regarding the party responsible for maintaining separation between aircraft in a specific airspace will remain crucial in automated operations. The ICAO Concept states that "the role of separator may be delegated, but such delegations will be temporary". However, there are specific requirements for delegation in the ICAO Concept. It is important to note that it is not reasonable to assume that separation can be "handed back" before the termination condition. It may be possible, subject to negotiation, but it is not guaranteed. An acceptance of the delegation is also an acceptance of the whole period of the delegation.

The separator can be the airspace user, a service provider or automation. The intent is that the best separator for a given situation is chosen.

2.20 Situational Awareness

The ability to keep track of the prioritized significant events and conditions in the environment of the subject.

2.21 Unmanned Aircraft System Traffic Management (UTM) System

A system that manages UAS operations safely, economically, and efficiently through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground or space-based communications, navigation and surveillance.

2.22 Unmanned Aircraft (UA)

An aircraft intended to be operated with no pilot on board.

Unmanned aircraft (UA) include a broad spectrum from meteorological balloons that fly freely to highly complex aircraft piloted from remote locations. The latter are part of the category referred to as “remotely piloted aircraft” or RPA that operate as part of a system, namely, a remotely piloted aircraft system (RPAS).

In this document, the term “unmanned aircraft” or “UA” is intended to refer to UA that will primarily operate within the UTM framework. It does not include those UA, including remotely piloted aircraft (RPA), operating within the traditional air traffic management (ATM) system, as captured in the Annexes to the Chicago Convention.

2.23 Unmanned Aircraft System (UAS)

An aircraft and its associated elements which are operated with no pilot on board. Unmanned aircraft (UA) include a broad spectrum from meteorological balloons that fly freely to highly complex aircraft piloted from remote locations by licensed aviation professionals. The latter are part of the category referred to as “remotely piloted aircraft” or RPA that operate as part of a system, namely, a remotely piloted aircraft system (RPAS).

2.24 Visual Line-Of-Sight (VLOS) Operation

An operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft.

3 Definition of the Problem

ICAO has primarily focused on provisions related to non-passenger carrying Remotely Piloted Aircraft (RPA) operating in an Instrument Flight Rules (IFR) environment. However, this approach does not fully align with the long-term vision of various new entrants operating across borders. Additionally, IFR separation requirements cannot be applied to low altitude, high density urban operations envisioned for small RPA delivery and other advanced air mobility concepts.

This challenge means there are aspects that affect most, if not all, sectors of the aviation system. For example, the consideration of novel ATC communication architectures, traffic management procedures, airworthiness approval of technical capability, the potential use of third-party communication service providers, and changes in the regulatory approvals and oversight regimes.

The rising number of UAS entering the airspace and increased complexity of operations of UAS beyond visual line of sight (BVLOS), initially at very low level, poses safety, security, privacy and environmental risks.

In certain areas, such as primarily in those with an expected large number of simultaneous operations of UAS or areas where UAS operate alongside manned aircraft, the safe, secure and efficient integration of UAS in the airspace necessitates the introduction of additional specific rules and procedures for their operations and the organisations involved in those operations, as well as a high degree of automation and digitalisation.

The current airspace system faces three fundamental weaknesses concerning new entrants:

1. **Centralized Clearance Requirement**:
    - All information resides with air traffic control (ATC), necessitating a clearance from a centralized source for any airspace user changes.
    - This process can be cumbersome and restricts operational flexibility.
2. **Lack of Real-Time Information for Operators**:
    - Operators do not have up-to-date information about other airspace users.
    - This limitation hinders efficient decision-making and situational awareness.
3. **Static Airspace Classification**:
    - Airspace classification is based on equipage and ATS provisions.

- This static approach limits access and does not accommodate the development of new capabilities and system needs.

Regarding segregated environments, ensuring clear delineation of segregation methodologies (such as airspace corridor boundaries) is critical. Technologies like geo-fencing and minimum navigation performance play a role in supporting segregated environments. However, understanding contingencies is essential to avoid unintended hazards to aviation safety during operations in these environments.

In summary, the aviation industry faces exciting challenges and opportunities as technology evolves. Balancing safety, efficiency, and accessibility will be key to shaping the future of airspace management.

4 Requirements of the Solution

The future of airspace operations will witness a significant paradigm shift, particularly concerning trajectory authority and shared responsibility for safe separation. To address the evolving needs of airspace users, we must overcome current operational limitations, inter alia:

1. **Access to Relevant Information**:
   - The evolution of the airspace system should grant operators access to relevant information for safe and efficient mission execution.
   - There is the need to shift from a management-by-permission paradigm towards a management-by-exception approach.
   - Access to common information services shall be granted to relevant Authorities, air traffic service providers, UTM service providers, UAS operators, remote pilots and other relevant stakeholders on a non-discriminatory basis, including with the same data quality, latency and protection levels.
2. **Digital Information Sharing and Automation**:
   - Coordinated traffic deconfliction and collision avoidance require digital information sharing and automation.
   - Throughout all flight phases, operators will continuously update their flight intent to ensure safe separation.
3. **Dynamic Airspace Adjustments**:
   - The future system should dynamically adjust airspace based on demand, user capabilities, and aircraft performance.
   - Decentralized management, assisted by automated systems, will replace the current centralized approach.
4. **Low-Altitude Operations**:
   - Operators at low altitudes will self-manage their operations within known constraints. This will also be dependent on airspace risk classification.
   - Regular instructions from ATC or UTM shall be deemed necessary. The frequency and kind of instruction will be dependent on the airspace classification.
   - Unmanned Traffic Management Service Providers (USPs) will play a role in ensuring traffic de-confliction.

5. **Right of Way**:
    - Currently, most states require Visual Line of Sight (VLOS) unmanned aircraft to yield to all other aircraft.
6. **USP Capabilities**:
    - USPs are expected to provide real-time information on airspace constraints and other aircraft intentions to UA operators and traditional airspace users.

To achieve the aforementioned objectives, the UAS traffic management (UTM) concept was proposed in 2016 by members of State research organizations and industry to support the real-time or near-real-time organization, coordination, and management of UA operations, including the potential for multiple beyond visual line-of-sight (BVLOS) operations.

Through UTM, it is envisaged that civil aviation authorities (CAAs) and ANSPs, to the extent that they are involved, will be able to provide real-time information regarding airspace constraints and the intentions of other aircraft, when available, to UAS operators and remote pilots directly or through a UTM service provider1 (USP). The UAS operator would then be responsible for safely managing its operations within these constraints, without receiving positive air traffic control (ATC) services from the ANSP.

Any such UTM system must be able to interact with the air traffic management (ATM) system in the short term and integrate with the ATM system in the long term. The introduction and management of unmanned traffic as well as the development of associated UTM infrastructure should not negatively affect the safety or efficiency of the existing ATM system.

The primary means of communication and coordination between the ANSP(s), USP, supplementary data service providers (SDSP), UAS operators, remote pilots and other stakeholders may be through a distributed network of highly automated systems via application programming interfaces (APIs), and not between pilots and air traffic controllers via voice communication.

In addition, it is necessary to define a minimum set of requirements for the UAS operations in each UAS geographical zone or airspace classification. The access by UAS operators to such airspace should be conditional on the ability to meet the minimum requirements of the particular airspace. However, the final requirements, rules and procedures to be satisfied by the RPAS Operator shall be proportionate to the nature and risk of the operations and the RPAS Operator shall only be granted access upon meeting all applicable requirements.

5 Suggested Rollout of the Solution

5.1 Introduction

Digitalisation, Performance and Risked Based Approach are two of the pillars of future aviation. Performance and risk base will largely allow the capture of precursor occurrences which are more likely to occur but have a relatively minor effect. The risk-based approach should be supported by appropriate risk assessment methodologies, for both the operations and the airspace.

Automation is an essential part of both concepts, and it is important to understand how and where levels of automation can contribute to establishing the new airspace framework with the aim of reducing to minimum the airspace segregation.

A shift will occur from the present human-centric construct to a systems-centric model. To enhance the performance of the entire system, irrespective of the services offered, it is crucial that the level of automation among airspace users is compatible with the level of automation permitted in the airspace.

In summary, embracing technology, data sharing, and decentralized management will shape the future of airspace operations, ensuring safety and efficiency for all users.

For the purposes of this framework document, in the near term, UTM will be considered as a separate system with an interface to ATM, while in the long term, integration and potential convergence with ATM is seen as a realistic solution.

5.2 Principles of the UTM System

Taking cognisance of current ATM system that are applicable to UTM services, the following core principles of any proposed UTM system, should be considered:

1. Oversight of the service provision, either UTM or ATM, is the responsibility of the regulator.
2. Existing policies for aircraft prioritization, such as aircraft emergencies and support to public safety operations, should be applicable, and practices unique to UTM should be compatible with such policies.
3. Access to the airspace should remain equitable provided that each aircraft can comply with the appropriate conditions, regulations, equipage and performance requirements

and processes defined for the specific airspace in which UTM operations are proposed.

4. The UAS operator or the remote pilot should be qualified to perform any applicable normal and contingency operating procedures based on the specific class of airspace in which operations are conducted and on the UTM services being provided.
5. To meet our security and safety oversight obligations, the Regulator shall have unrestricted, on-demand access to UAS operators, remote pilots and the position, velocity, planned trajectory and performance capabilities of each UA being managed by the UTM system.
6. To achieve an effective UTM capability, the creation, adoption and maintenance of safety culture among the UTM community is essential.
7. The free and open reporting of accidents and incidents should be facilitated for all stakeholders.
8. Where a direct link from the remote pilot station (RPS) to ATC, is anticipated, such links must be non-disruptive for ATC.
9. Manned aviation shall have the right of way.

5.3 Phased Rollout

The UTM system is a collection of services, among other features, intended to ensure safe and efficient operations of UA within the UTM-authorized volume of airspace and which complies with regulatory requirements. These services will be based on what is required in a given geographic volume of airspace as well as on the risk of operations and level of resiliency needed. Said services may require compliance with minimum performance requirements or standards.

Operational concepts have shown that these various services may be provided by third party UTM Service Providers, ANSPs, State organisations or the RPAS Operator itself in part or whole. This list of services include:

- **activity reporting**: a service that provides on-demand, periodic or event-driven information on UTM operations occurring within the subscribed airspace volume and time (e.g., density reports, intent information as well as status and monitoring information). Additional filtering may be performed as part of the service,

- **aeronautical information**: a service that enables the flow of aeronautical information and data necessary for the safety, efficiency, economy and regularity of, UAS operations,
- **airspace authorisation**: a service that provides, from the delegated State entity or automatically, depending on the airspace risk categorisation and airspace use, to the RPAS operator, authorisation to use a given airspace. A UAS flight authorisation service should ensure that authorised UAS operations are free of intersection in space and time with any other notified UAS flight authorisation within the same portion of airspace,
- **communications and geo-awareness or geo-fencing**: a service that informs the remote pilot, pilot-in-command, or the remote operator, of both permanent, ad hoc and temporary no-fly zones within their operational volume. Such geo-awareness information shall dispatch in a timely manner to allow contingencies and emergencies to be addressed by RPAS operators, and shall include its time of update together with a version number or a valid time, or both,
- **conflict management and separation**: including, inter alia:
    - **conflict advisory and alert**: a service that provides remote pilots with real-time alerting on UA proximity to other airspace users (manned and unmanned), and advice on avoiding such users,
    - **conformance monitoring**: a service that provides real-time monitoring and alerting of imminent non-conformance to intended operational volumes, routes or trajectories for a UAS operator or remote pilot. Where such alerts are ignored and a non-conformance occurs, the system should alert the relevant state agencies and other users of the geographic volume of airspace,
    - **dynamic rerouting**: a real-time service that provides modifications to intended operational volumes, routes or trajectories. This service would include the arrangement, negotiation and prioritization of operational volumes, routes or trajectories while the RPA is airborne,
    - **strategic deconfliction**: a service that provides the arrangement, negotiation and prioritization of intended operational volumes, routes or trajectories of UAS operations to minimize the likelihood of airborne conflicts,
    - **tactical information regarding manned aircraft**: a service that provides real-time information about manned aircraft so that UA remain well clear,

- **discovery**: a service that provides users of the UTM system with information on relevant services available for a specific geographical volume of airspace (e.g., provision of meteorological information),
- **flight planning**: a service that, prior to flight, arranges and optimizes intended operational volumes, routes and trajectories for safety, dynamic airspace management, airspace restrictions and mission needs. This is not intended to refer to the existing manned aircraft flight planning services,
- **identification**: a service that makes it possible to identify an individual RPA and the associated nationality and registration information while emphasising consistency between national and international developments and standards to ensure interoperability and harmonization. The identification service shall allow for the authorised users to receive messages with the following content:
    - the RPAS operator registration number,
    - the unique registration number of the RPA,
    - the geographical position of the RPA, its height above ground level and altitude above mean sea level for VLOS and BVLOS operations, respectively,
    - the route course measured clockwise from true north and the ground speed of the RPA,
    - the geographical position of the remote pilot or, if not available, the take-off point,
    - the emergency status of the RPA, and
    - the time at which the messages were generated.

  The information provided by the UTM shall be updated at a frequency that the Authority shall determine.
- **mapping**: a service that provides terrain and obstacle data (e.g., GIS) appropriate and necessary for meeting the safety and mission needs of individual RPAS operations or for supporting UTM system needs for the provision of separation or flight planning services,
- **meteorology**: a service that provides RPAS operators remote pilots or remote PIC and other UTM services with the meteorological information necessary for the performance of their respective functions. It should support UAS operators during the flight planning and execution phases, as well as improve the performances of other

RPAS services provided in the geographic volume of airspace. The weather information service shall include, as a minimum:

  - wind direction measured clockwise through the true north and speed in metres per second, including gusts,
  - the height of the lowest broken or overcast layer in hundreds of feet above ground level,
  - visibility in metres and kilometres,
  - temperature and dew point,
  - indicators of convective activity and precipitation,
  - the location and time of the observation, or the valid times and locations of the forecast, and
  - appropriate QNH with geographical location of its applicability.

- **record keeping**: a service that ensures that UTM service providers establish a system of record keeping that allows adequate storage of the records and reliable traceability of all activities. All such records shall be kept for the same duration as required for an ATM Service Provider,
- **registration**: a service that enables RPAS operators to register their RPA and provide any required data related to their RPAS. The system should also include a query function enabling authorised stakeholders (e.g., regulators or police services) to request registration data,
- **restriction management**: a service that manages and disseminates in real time, directives (e.g., safety bulletins) and operational and airspace restrictions from the CAA or ANSP to RPAS operators, remote pilots or remote PIC and other UTM services, including in the form of NOTAMs, and
- **tracking and location**: a service that provides information to the UAS operator and the UTM system about the exact location of RPA, in real time, during normal operations and in contingency situations and share the relevant information with other users and stakeholders.

6 Roles, Responsibilities and Limitations of Stakeholders in the UTM Space

6.1 The Regulator

The regulator retains the ultimate responsibility for its oversight role.

The Regulator shall be solely responsible for registration services in the UTM space and update the ATM Service Provider accordingly.

The Regulator shall certify a UTM service provision after clearance from the ATM Service Provider.

The Regulator shall certify all RPAS Operators and RPAS Operations. However, the ATM Service Provider or a delegated UTM Service Provider shall issue Clearance prior to each operation in coordination with the relevant state agency.

The Regulator shall coordinate with the relevant state agency when certifying an RPAS Operator intending to operate in a no-fly, restricted, prohibited, or other similar types of zones.

The mechanism for certifying a USP is harmonised to allow the recognition of USP certification between authorities, thus promoting consistent application of UTM service provision and reducing costs and complexity. Figure 6.1 shows an example of a process for certifying and monitoring a USP.

The Regulator shall ensure that the UTM Service Provider establishes arrangements with the ATM Services Provider to ensure adequate coordination of activities, as well as the exchange of relevant operational data and information.

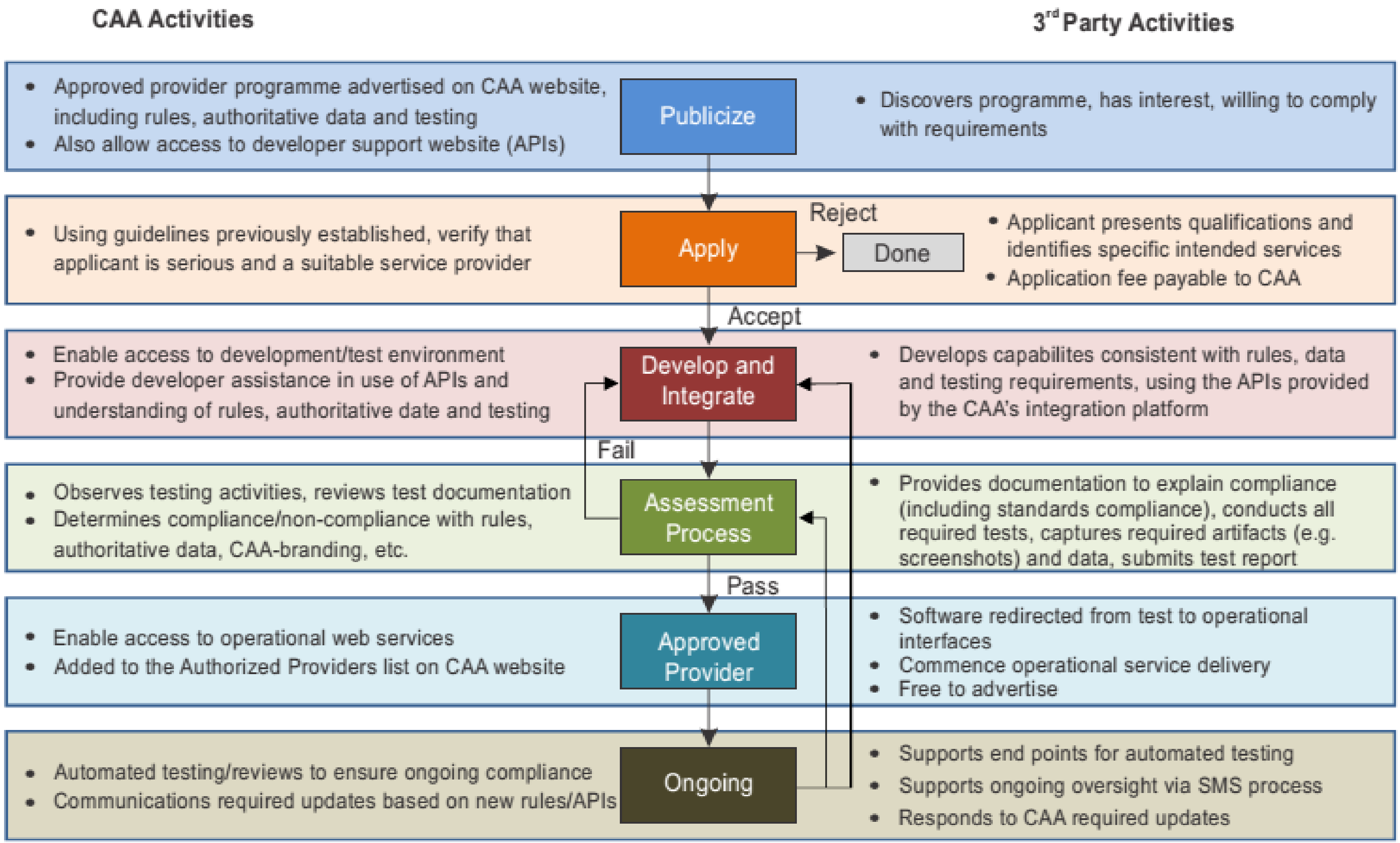

Figure 6.1 – USP Certification Process

6.2 The UTM Service Provider

The UTM service provider shall be the ANSP, and the ANSP shall delegate responsibilities in coordination with the Regulator depending on the geographic airspace or kind of RPAS operation being carried out. Irrespective of the kind of UTM service provision, the ATM service provider shall provide for contingency measures and procedures. The ATM Service Provider shall ensure adequate coordination and data exchange between UTM service providers and the ATM systems. The UTM Service Provider shall establish proper arrangements to resolve conflicting RPAS flight authorisation requests received from RPAS operators by different RPA.

Upon receipt of traffic information from the ATM Service Provider indicating the proximity of aircraft to the area of responsibility of the UTM Service Provider, the latter shall take the relevant action to avoid any collision hazard.

6.3 The ATM Service Provider

The ATM Service Provider shall be responsible for separation and deconfliction for the following RPAS operations unless such functions have been delegated to a separate UTM Service Provider by the ANSP in a specific volume of airspace:

- BVLOS operations,
- Operations over 400 ft A.G.L.,
- Operations within 10 km radius of airports, and
- Other geographic airspace considered as high risk.

The ATM Service Provider shall provide traffic information to a delegated UTM Service Provider on other known air traffic, that may be in proximity to the area of responsibility of the UTM Service Provider.

6.4 Other Relevant State Agencies

No fly-zones, restricted zones, etc. shall be communicated with their coordinates to the Authority.

The object around which the no-fly zone is erected need not be included in the communication to the Authority.

Communication of emergency no-fly zones shall be communicated directly with the ATM service provider as well as to the Authority.

Breaches of no-fly zones and other restrictions not captured by a UTM service shall be reported to the Authority.

A state agency may take emergency measures to prevent a breach or prevent further breach of a no-fly zone but shall inform the Authority afterwards.

All frequency requirements for conduct of BVLOS operations shall be coordinated with the responsible State Authority or Agency.

7 Source Documents

1. ICAO Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization, Fourth Edition.
2. JARUS Whitepaper on the Automation of the Airspace Environment.
3. ICAO RPAS Concept of Operations for International IFR Operations
4. Commission Implementing Regulation (EU) of 22.4.2021 on a regulatory framework for the U-space.