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UAS traffic management (UTM) —

Part 7: Data model for spatial data

Gestion du trafic des aéronefs sans pilote (UTM) —

Partie 7: Modèle de données pour les données spatiales

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Foreword

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This document was prepared by Technical Committee, ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 16, *Unmanned aircraft systems*.

A list of all parts in the ISO 23629 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In order to enable UAS (unmanned aircraft systems) to operate safely, there is a need to define the data model that is related to various spatial information for common use between the UAS operators and the UAS traffic management (UTM) system. Existing standards regarding spatial data for safely operating UAS including static data and dynamic data do not exist, whereas efforts are underway to establish related standards on the part of ASTM and EUROCAE.

This document can be used as a reference model. Implementations of this document can lead to cost reductions in maintenance/expansion for application developers as well as compilation/maintenance of map data for map providers.

UAS traffic management (UTM) —

Part 7:
Data model for spatial data

1 Scope

This document specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. This document specifies the names of the items for the data model, while the communication architecture and responsibilities of actors to define the items are not included.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19157, *Geographic information — Data quality*

ISO 21384-4, *Unmanned aircraft systems — Part 4: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21384-4 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
aerodrome
defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft

[SOURCE: ICAO/Annex 2]

3.2
CNS
communications, navigation, and surveillance systems, employing digital technologies, including satellite systems together with various levels of automation

[SOURCE: ICAO Doc. 9750]

3.3
time
mark attributed to an instant or a time interval on a specified time scale

Note 1 to entry: The representation rules are defined in the ISO 8601 series.

[SOURCE: ISO 8601-1:2019, 3.1.1.2, modified — The original notes to entry have been removed; a new note 1 to entry has been added.]

3.4
elevation
vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level

[SOURCE: ICAO/Annex 4]

3.5
flight route
specified route designed for channelling the flow of traffic as necessary for the provision of *UTM* (3.11)

3.6
geo-limitation
entity that represents area surrounded by virtual boundary lines in the real world

3.7
geoid undulation
height of the geoid relative to a given ellipsoid of reference

3.8
height above ellipsoid
vertical distance of a point or a level, on or affixed to the surface of the earth, measured from World Geodetic System 1984 (WGS 84) ellipsoid

3.9
shape
horizontal projection on earth of a given object

3.10
magnetic declination
angle on the horizontal plane between magnetic north and true north

3.11
UAS traffic management
UTM
set of traffic management and air navigation services aiming at safe, secure and efficient integration of multiple manned and unmanned aircraft flying inside the respective designated operational coverage of each service

4 Data model

4.1 Overall data model

Overall data model shall consist of four packages: ground map package, obstacle data package, virtual data package, dynamic data package. Figure 1 shows the overall data model. For examples of information, see Annex A. For use cases, see Annex B.

An overall, data quality management system shall prove the data quality in accordance with ISO 19157.

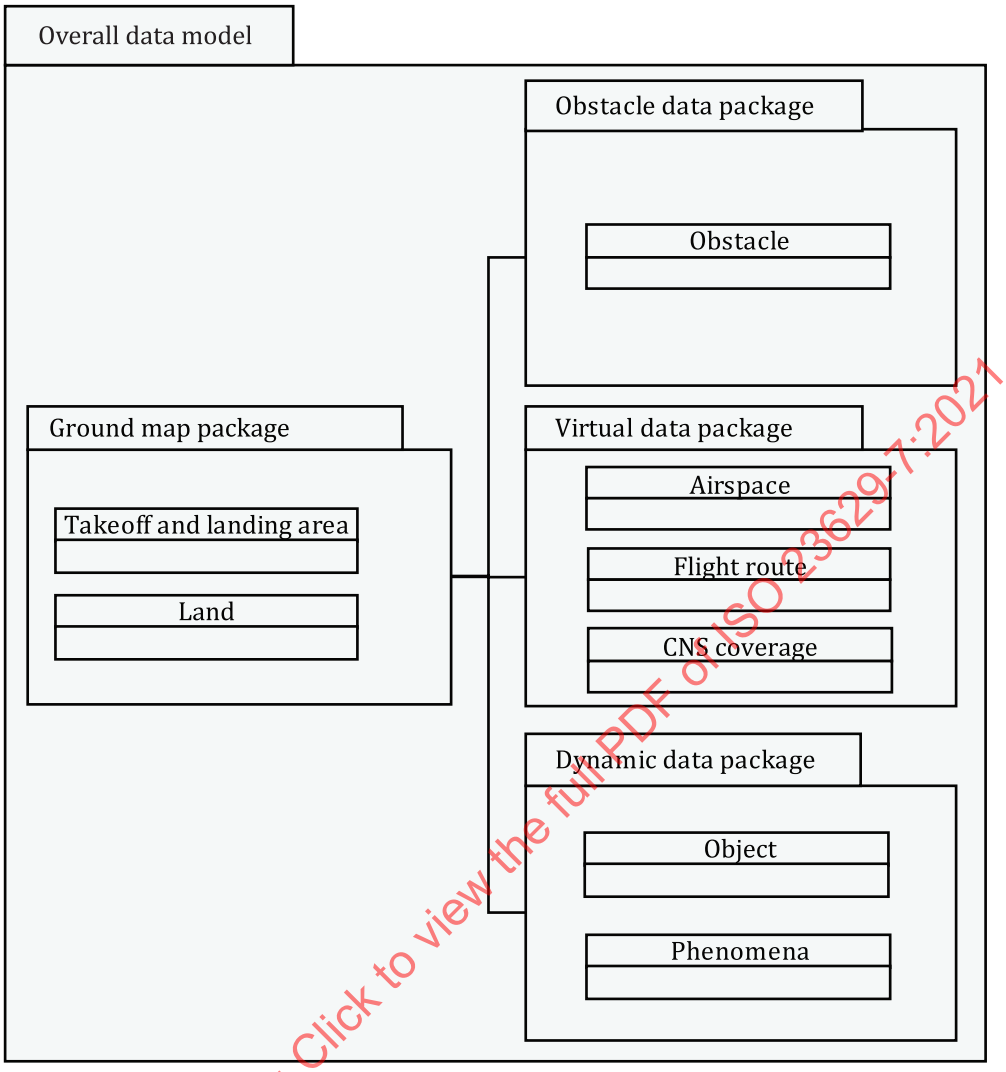


Figure 1 — Overall data model

4.2 Ground map package

4.2.1 Overview

Ground map package contains data that are defined as "geographical surface areas designed for specific activities". Ground map package shall as a minimum contain two entities: takeoff and landing areas and land.

4.2.2 Attributes of takeoff and landing area

Takeoff and landing area is an entity that represents the area designated for either takeoff or landing of a UA (unmanned aircraft) in the real world. Table 1 summarizes minimum attributes of takeoff and landing area. Magnetic declination changes over time, and it may be updated as needed. Takeoff and landing area may include vertiports using the elements of conditions for operation and resources.

Table 1 — Attributes of takeoff and landing area

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Available time interval	Information indicating the time interval the area is available
Elevation	Information indicating the elevation
Geoid undulation at elevation	Information indicating the geoid undulation at elevation
Time zone	Information indicating the time zone
Magnetic declination	Information indicating the magnetic declination
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the centroid of the entity in terms of latitudes and longitudes
Administration contact details	Information indicating the entity's administration contact details (e.g. administration's name, address, telephone)
Conditions for operation	Information indicating the conditions for operation (e.g. weather conditions, aircraft performance, operation procedures), either generally applicable to all operations, or limited to specific operations
Resources	Information indicating the equipment of the entity (e.g. energy supply, repairment, on-site staff)
Availability of emergency landing areas	Information indicating availability of emergency landing areas including dimensions and operating conditions, if any

4.2.3 Attributes of land

Land is an entity that represents artificially divided areas for specific activities in the real world. Table 2 lists minimum attributes of land. Magnetic declination changes over time, and it may be updated as needed.

Table 2 — Attributes of land

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Elevation	Information indicating the elevation
Geoid undulation at elevation	Information indicating the geoid undulation at elevation
Time zone	Information indicating the time zone
Magnetic declination	Information indicating the magnetic declination
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the centroid of the entity in terms of latitudes and longitudes
Availability of emergency landing areas	Information indicating availability of emergency landing areas including dimensions and operating conditions, if any
Type of land	Information indicating the type of land (e.g. farmland, road)

4.3 Obstacle data package

4.3.1 Overview

Obstacle data package shall contain data that are defined as “tangible objects having a temporarily or permanently fixed location in the real world and pose a potential hazard to surface or air traffic of aircraft”. Obstacle data package shall as a minimum contain two entities: static and temporal obstacle.

4.3.2 Attributes of static obstacle

Static obstacle can be used for buildings, pylons, trees, etc. Table 3 summarizes minimum attributes of static obstacle.

Table 3 — Attributes of static obstacle

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Height	Information indicating the height of the entity’s maximum vertical extent measured from a specified datum (specified in type of height)
Type of height	e.g. height above ellipsoid, height above mean sea level
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the centroid of the entity in terms of latitudes and longitudes
Type of obstacle	Information indicating the type of obstacle (e.g. building, tower, pole, antenna)

4.3.3 Attributes of temporal obstacle

Temporal obstacle can be used for short-term erections or for modifications to a static obstacle such as scaffolding. Table 4 summarizes minimum attributes of temporal obstacle.

Table 4 — Attributes of temporal obstacle

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Height	Information indicating the height of the entity’s maximum vertical extent measured from a specified datum (specified in type of height)
Type of height	e.g. height above ellipsoid, height above mean sea level
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the centroid of the entity in terms of latitudes and longitudes
Type of obstacle	Information indicating the type of obstacle (e.g. scaffolding, construction equipment)

4.4 Virtual data package

4.4.1 Overview

Virtual data package shall contain data that are defined as “virtual objects that are intangible representations (including computer simulated representations) of attributes of particular real-world areas or objects”. Virtual data package shall as a minimum contain three entities: airspace, flight routes, and CNS coverage.

4.4.2 Attributes of airspace

Table 5 summarizes attributes of airspace. Airspace may include geo-limitations using the elements of conditions for operation and type of airspace.

Table 5 — Attributes of airspace

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Maximum height	Information indicating the altitude of the entity's maximum vertical extent measured from a specified datum (specified in type of height)
Minimum height	Information indicating the altitude of the entity's minimum vertical extent measured from a specified datum (specified in type of height)
Type of height	e.g. height above ellipsoid, height above mean sea level
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the centroid of the entity in terms of latitudes and longitudes
Administration contact details	Information indicating the entity’s administration contact details (e.g. administration’s name, address, telephone)
Conditions for operation	Information indicating the conditions for operation (e.g. weather conditions, aircraft performance, operation procedures), either generally applicable to all operations, or limited to specific operations
Availability of UTM services	Information indicating availability of UTM services (e.g. sharing of traffic information between manned and unmanned aircraft), if any
Type of airspace	Controlled airspace, uncontrolled airspace, authorized airspace, unauthorized airspace, etc.

4.4.3 Attributes of flight route

Table 6 summarizes attributes of flight route. A flight route is an entity that consists of a sequence of waypoints and tolerance from each waypoint, representing a group of coordinates in terms of latitudes, longitudes and height for a flight of a UA, which may have a temporal element if necessary.

Table 6 — Attributes of flight route

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Sequence of waypoints	Information indicating the sequence of elements the flight route entity entails, along with a time element if necessary

Table 6 *(continued)*

Attribute	Description
Tolerance of waypoints	Information indicating the tolerated deviation from the entity in terms of distance from a given waypoint, based on the same ICAO principles that are used in required navigation performance (RNP) as necessary.
Administration contact details	Information indicating the entity's administration contact details (e.g. administration's name, address, telephone)
Conditions for operation	Information indicating the conditions for operation (e.g. weather conditions, aircraft performance, operation procedures), either generally applicable to all operations, or limited to specific operations
Availability of UTM services	Information indicating availability of UTM services (e.g. sharing of traffic information between manned and unmanned aircraft), if any
Type of flight route	Controlled flight route, uncontrolled flight route, etc.

4.4.4 Attributes of CNS coverage

CNS coverage is an entity that represents the coverage of individual units composing the CNS infrastructure in the real world. Table 7 summarizes minimum attributes of CNS coverage.

Table 7 — Attributes of CNS coverage

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Maximum height	Information indicating the altitude of the entity's maximum vertical extent measured from a specified datum (specified in type of height)
Minimum height	Information indicating the altitude of the entity's minimum vertical extent measured from a specified datum (specified in type of height)
Type of height	e.g. height above ellipsoid, height above mean sea level
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the vertices or the centroid of the entity in terms of latitudes and longitudes, where vertices are indicated for polylines, polygons, and polynomial curves, and the centroid in case of circles
Type of CNS	Information indicating the type of communication (e.g. cellular network, radio), navigation (e.g. satellite navigation, radio navigation), surveillance (ADS-B, transponder) and coverage data of the entity
Administration contact details	Information indicating the entity's administration contact details (e.g. administration's name, address, telephone)

4.5 Dynamic data package

4.5.1 Overview

Dynamic data package shall as a minimum contain two sub-packages: object sub-package and phenomena sub-package.

4.5.2 Object sub-package

4.5.2.1 Overview

Object sub-package shall contain data that are defined as “objects with time-varying positions”. Object sub-package contains two entities: manned aircraft and unmanned aircraft.

4.5.2.2 Attributes of manned aircraft

Manned aircraft is an entity that represents manned aircraft in the real world. Table 8 summarizes minimum attributes of manned aircraft. Trajectory is split in to two descriptions: planned and updated. Planned trajectory include the flight planned route and airspace (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity as specified in the flight plan submitted for the entity, whereas updated trajectory include the entity’s updated and recorded route, airspace (e.g. a group of coordinates of control points for polygon or centre point with radius), and positions that consist of the updated and recorded altitudes, speeds and coordinates in terms of latitudes and longitudes of the entity, and the timestamp of the latest update. Planned trajectory and updated trajectory are linked with individual manned aircraft, as opposed to flight route defined in 4.4.3, which can be fixed independently of any specific manned aircraft. Considering that manned aircraft may not necessarily fly along a fixed flight route, planned trajectory and updated trajectory do not need to correspond to any flight route. The frequency of the update is outside the scope of this document.

Table 8 — Attributes of manned aircraft

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Planned trajectory	Information indicating the flight planned route and airspace (e.g. polygon, polyline, or circle) of the entity as specified in the flight plan submitted for the entity
Updated trajectory	Information indicating the entity’s updated and recorded route, airspace (e.g. a group of coordinates of control points for polygon or centre point with radius), and positions that consist of the updated and recorded speeds, headings, and coordinates in terms of latitudes, longitudes and height of the entity, and the time of the latest update
Administration contact details	Information indicating the entity’s administration contact details (e.g. administration’s name, address, telephone)
Model	Information indicating the entity’s model (e.g. manufacturer’s name, product name, version number)

4.5.2.3 Attributes of unmanned aircraft

Unmanned aircraft is an entity that represents unmanned aircraft in the real world. Table 9 summarizes attribute of unmanned aircraft. Planned trajectory and updated trajectory are linked with individual unmanned aircraft, as opposed to flight route defined in 4.4.3, which can be fixed independently of any specific unmanned aircraft. Considering that unmanned aircraft may not necessarily fly along a fixed flight route, planned trajectory and updated trajectory do not need to correspond to any flight route.

Table 9 — Attributes of unmanned aircraft

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected

Table 9 *(continued)*

Attribute	Description
Planned trajectory	Information indicating the flight planned route and airspace (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity as specified in the flight plan submitted for the entity
Updated trajectory	Information indicating the entity's updated and recorded route, airspace (e.g. a group of coordinates of control points for polygon or centre point with radius), and positions that consist of the updated and recorded speeds, headings, and coordinates in terms of latitudes, longitudes and height of the entity, and the time of the latest update
Position of the remote pilot station	Information indicating the geographical position of the remote pilot station that manipulates the flight controls of the entity, and, if needed, the geographical position of monitoring stations
Identifier of the operator	Information for identifying the operator that operates the entity
Identifier of the UTM	Information for identifying the UTM that manages the entity, if any (e.g. UTM service provider's name, service name)
Administration contact details	Information indicating the entity's administration contact details (e.g. administration's name, address, telephone)
Model	Information indicating the entity's model (e.g. manufacturer's name, product name, version number)

4.5.3 Phenomena sub-package

4.5.3.1 Overview

Phenomena sub-package shall contain data that are defined as "phenomena with time-varying status" Phenomena sub-package contains an entity: weather information.

4.5.3.2 Attributes of weather information

Weather information is an entity that represents weather in the real world. Weather is the state of the atmosphere and is described in terms of variable condition temperature and barometric pressure and includes various weather phenomena such as rain and snow. A weather information may have different types in the same package.

Weather information model consists of three packages: observation package, forecast package and warning package. Observation can be used for observed state of weather parameters such as wind, visibility, temperature; forecast can be used for the forecasting of weather parameters such as wind, visibility, temperature; warning can be used for warnings relating to weather phenomena issued by relevant authorities. Table 10 summarizes minimum attributes of weather information.

Table 10 — Attributes of weather information

Attribute	Description
Identifier	Information for identifying the entity
Generate time	Information indicating the time the entity was generated
Disappearance time	Information indicating the time the entity will be disappeared, if projected
Maximum height	Information indicating the altitude of the entity's maximum vertical extent measured from a specified datum (specified in type of height)
Minimum height	Information indicating the altitude of the entity's minimum vertical extent measured from a specified datum (specified in type of height)
Type of height	e.g. height above ellipsoid, height above mean sea level

Table 10 *(continued)*

Attribute	Description
Shape	Information indicating the shape type and boundaries data (e.g. a group of coordinates of control points for polygon or centre point with radius) of the entity
Location	Information indicating the centroid of the entity in terms of latitudes and longitudes
Weather information package identifier	Observation, forecast, and warning
Weather information type	Wind (direction/speed), temperature, humidity, atmospheric pressure, rain, etc.

Annex A
(informative)

Examples of information

Examples of information is given in Table A.1.

Table A.1 — Examples of information

Package	Sub package / Entity	Preliminary examples
Ground map	Takeoff and landing area	Vertiport, emergency landing area
	Land	Residential area, farmland, park, road, railway, sidewalk, terrain (e.g. river, mountain), tree
Obstacle data	Obstacle	Transmission line tower, distribution pole, distribution line, transformer substation, power plant, tower building, high-rise apartment building, construction crane, stadium, factory
Virtual data	Airspace	Controlled airspace, uncontrolled airspace, authorized airspace, unauthorized airspace, no-fly zones or restricted areas (e.g. public areas, aerodrome vicinities, regulation area, radio wave service area, administrative boundary, national border)
	Flight route	Flight route
	CNS coverage	Coverage of cellular network, radio network, satellite navigation, radio navigation, surveillance areas of ADS-B
Dynamic data	Object sub-package	Aircraft, unmanned aircraft
	Phenomenon sub-package	Weather

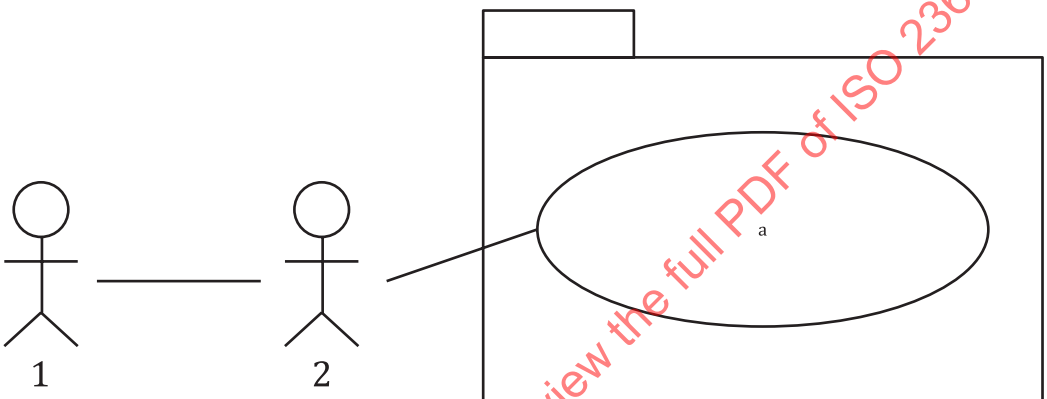
Annex B
(informative)

Use cases

B.1 Use case at pre-flight stage

B.1.1 Flight route planning

This is a use case for using map to enable flight route planning at pre-flight stage. Figure B.1 shows the use case of flight route planning. Table B.1 summarizes attributes of the use case.



Key

1 operator
2 UAS application
a Flight route planning.

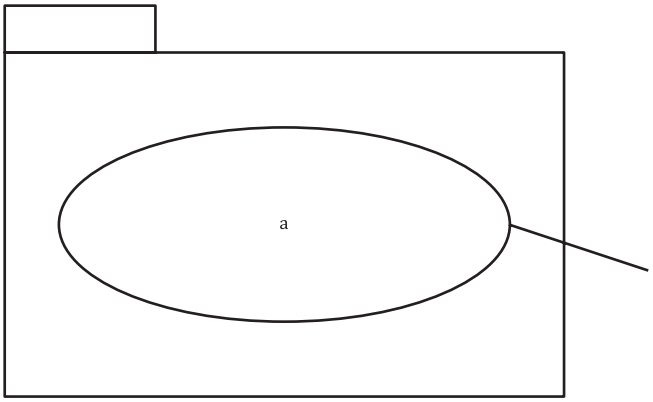
Figure B.1 — Flight route planning

Table B.1 — Flight route planning

Use case name	Flight route planning
General description	It creates a flight route
Actor	Operator, UAS application
Pre-condition	Operator had decided the starting point and the destination before UA flies
Post-condition	-
Trigger	-
Flow	1. Operator sets the starting port and the destination port. 2. UAS application assembles candidate routes. 3. UAS application represents candidate routes on map. 4. Operator determines the flight route.
Alternative flow	-
Note	-

B.1.2 Flight route display

This is a use case for using map to enable flight route display at pre-flight stage. Figure B.2 shows the use case of flight route display. Table B.2 summarizes attributes of the use case.



Key

1 UTM application

[a] Flight route display.

Figure B.2 — Flight route display

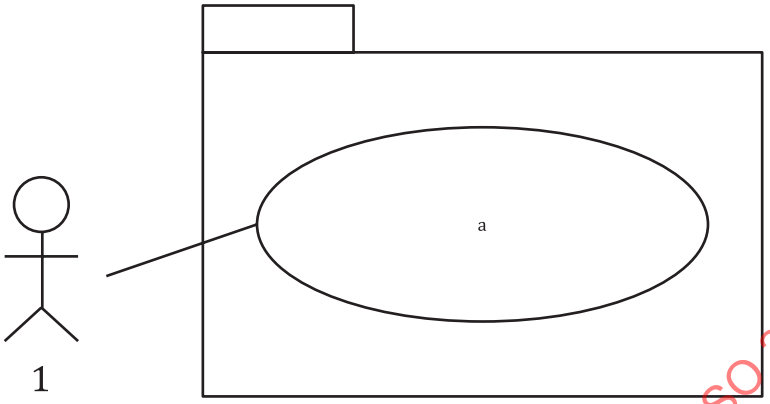
Table B.2 — Flight route display

Use case name	Flight route display
General description	It displays a flight route on UTM's map
Actor	UTM application
Pre-condition	UAS application had created a flight route
Post-condition	-
Trigger	-
Flow	1. Operator submit a flight route. 2. UTM Application display the route.
Alternative flow	-
Note	-

B.1.3 Obstacle detection

B.1.3.1 Obstacle detection (UAS)

This is a use case for using map to enable obstacle detection for UAS application at pre-flight stage. Figure B.3 shows the use case of obstacle detection. Table B.3 summarizes attributes of the use case.



Key

1 UAS application

[a] Obstacle detection.

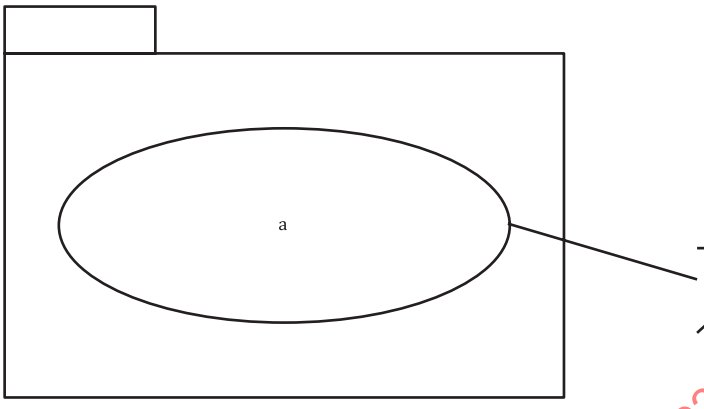
Figure B.3 — Obstacle detection (UAS)

Table B.3 — Obstacle detection (UAS)

Use case name	Obstacle detection
General description	It confirms whether there are obstacles on the flight route
Actor	UAS application
Pre-condition	UAS application assembles a candidate route
Post-condition	UAS application confirms there are no obstacles on the candidate route
Trigger	-
Flow	1. UAS application assembles a candidate route. 2. UAS application confirms whether there are obstacles (artificial structures and natural objects) on the route.
Alternative flow	If there are obstacles on the candidate route, UAS application assembles another candidate route.
Note	-

B.1.3.2 Obstacle detection (UTM)

This is a use case for using map to enable obstacle detection for UTM application at pre-flight stage. Figure B.4 shows the use case of obstacle detection. Table B.4 summarizes attributes of the use case.



Key

1 UTM application

[a] Obstacle detection.

Figure B.4 — Obstacle detection (UTM)

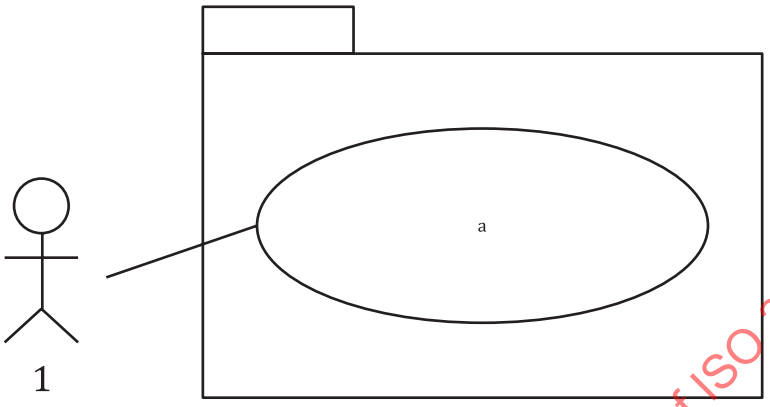
Table B.4 — Obstacle detection (UTM)

Use case name	Obstacle detection
General description	It confirms whether there are obstacles on the flight route
Actor	UTM application
Pre-condition	UAS application submits a candidate flight route
Post-condition	UTM application confirms there are no obstacles on the candidate route
Trigger	-
Flow	1. UAS application submits a candidate flight route. 2. UTM application confirms whether there are obstacles (artificial Structures and Natural Objects) on the route.
Alternative flow	1. If there are obstacles on the candidate flight route, UTM application does not permit the route to fly. 2. The UAS application assembles another candidate flight route.
Note	-

B.1.4 Regulation area detection

B.1.4.1 Regulation area detection (UAS)

This is a use case for using map to enable regulation area detection for UAS application at pre-flight stage. Figure B.5 shows the use case of regulation area detection. Table B.5 summarizes attributes of the use case.



Key

1 UAS application

a Regulation area detection.

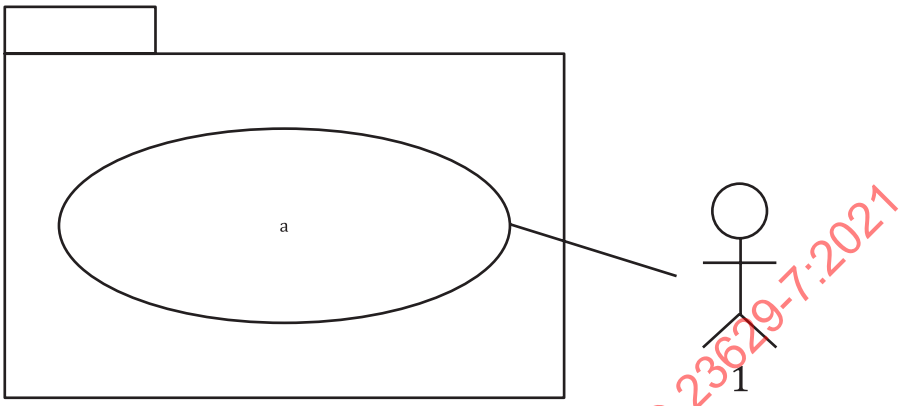
Figure B.5 — Regulation area detection (UAS)

Table B.5 — Regulation area detection (UAS)

Use case name	Regulation area detection
General description	It confirms whether there are regulation areas on the flight route
Actor	UAS application
Pre-condition	UAS application assembles a candidate route
Post-condition	UAS application confirms there are no regulation area on the candidate route
Trigger	-
Flow	1. UAS application assembles a candidate route. 2. UAS application confirms whether there are no regulation areas (geo-limitation) on the route.
Alternative flow	If there are regulation areas on the candidate route, UAS Application assembles another candidate route.
Note	-

B.1.4.2 Regulation area detection (UTM)

This is a use case for using map to enable regulation area detection for UTM application at pre-flight stage. Figure B.6 shows the use case of regulation area detection. Table B.6 summarizes attributes of the use case.



Key

1 UTM application

[a] Regulation area detection.

Figure B.6 — Regulation area detection (UTM)

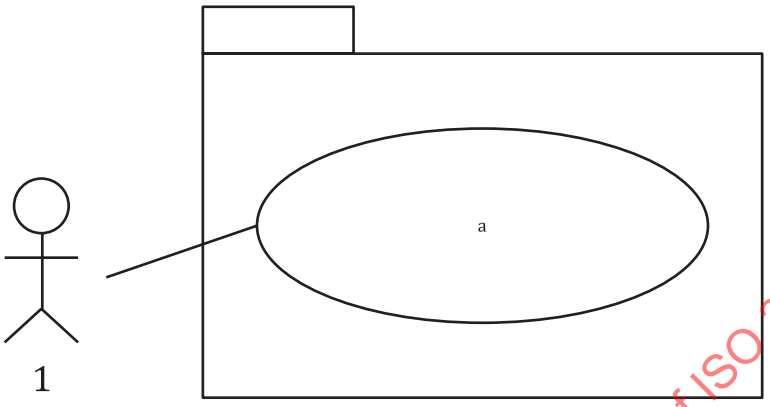
Table B.6 — Regulation area detection (UTM)

Use case name	Regulation area detection
General description	It confirms whether there are regulation areas on the flight route
Actor	UTM application
Pre-condition	UAS application submits a candidate flight route
Post-condition	UTM application confirms there are no regulation areas on the candidate route
Trigger	-
Flow	1. UAS application submits a candidate flight route. 2. UTM application confirms whether there are no regulation areas (geo-limitation) on the route.
Alternative flow	1. If there are regulation areas on the candidate flight route, UTM application does not permit the route to fly. 2. The UAS application assembles another candidate flight route.
Note	-

B.1.5 Emergency landing area confirmation

B.1.5.1 Emergency landing area confirmation (UAS)

This is a use case for using map to enable emergency landing area confirmation for UAS application at pre-flight stage. Figure B.7 shows the use case of emergency landing area confirmation. Table B.7 summarizes attributes of the use case.



Key

1 UAS application

a Emergency landing area confirmation.

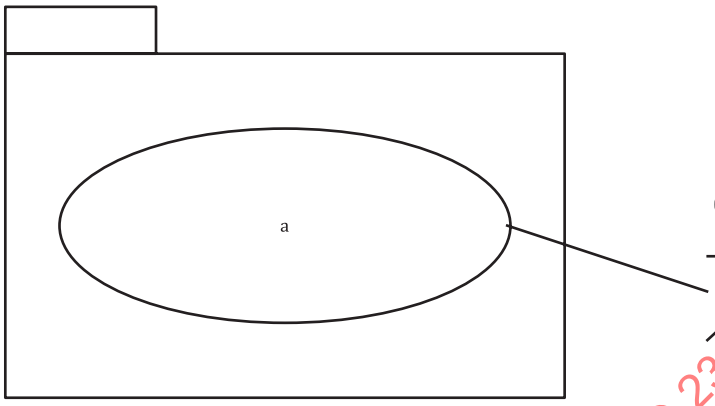
Figure B.7 — Emergency landing area confirmation (UAS)

Table B.7 — Emergency landing area confirmation (UAS)

Use case name	Emergency landing area confirmation
General description	It confirms whether there are emergency landing areas near the flight route.
Actor	UAS application
Pre-condition	UAS application assembles a candidate route
Post-condition	UAS application confirms there are emergency landing areas on the candidate route
Trigger	-
Flow	1. UAS application assembles a candidate route. 2. UAS application confirms whether there are emergency landing areas (Lands) on the route.
Alternative flow	If there are no emergency landing areas on the candidate route, UAS Application assembles another candidate route.
Note	-

B.1.5.2 Emergency landing area confirmation (UTM)

This is a use case for using map to enable emergency landing area confirmation for UTM application at pre-flight stage. Figure B.8 shows the use case of emergency landing area confirmation. Table B.8 summarizes attributes of the use case.



Key

1 UTM application

[a] Emergency landing area confirmation.

Figure B.8 — Emergency landing area confirmation (UTM)

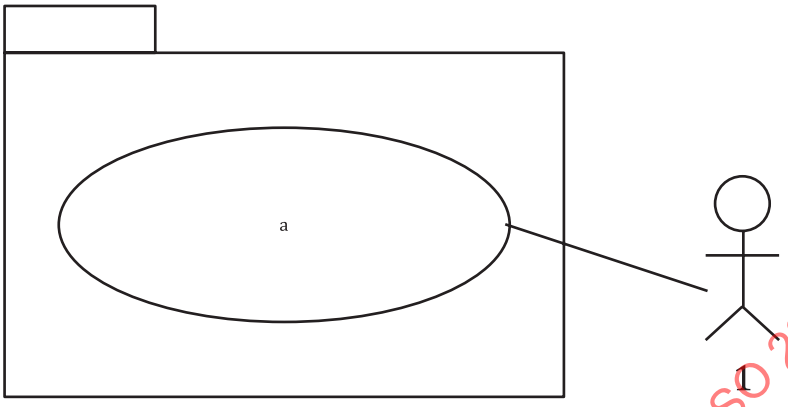
Table B.8 — Emergency landing area confirmation (UTM)

Use case name	Emergency landing area confirmation
General description	It confirms whether there are emergency landing areas near the flight route.
Actor	UTM application
Pre-condition	UAS application submits a candidate flight route
Post-condition	UTM application confirms there are emergency landing areas on the candidate route
Trigger	-
Flow	1. UAS application submits a candidate flight route. 2. UTM application confirms whether there are emergency landing areas (Lands) on the route.
Alternative flow	1. If there are no emergency landing areas on the candidate flight route, UTM application does not permit the route to fly. 2. The UAS application assembles another candidate flight route.
Note	-

B.2 Use case at in-flight stage

B.2.1 Route deviation detection

This is a use case for using map to enable route deviation detection at in-flight stage. Figure B.9 shows the use case of route deviation detection. Table B.9 summarizes attributes of the use case.



Key

1 UTM application

[a] Route deviation detection.

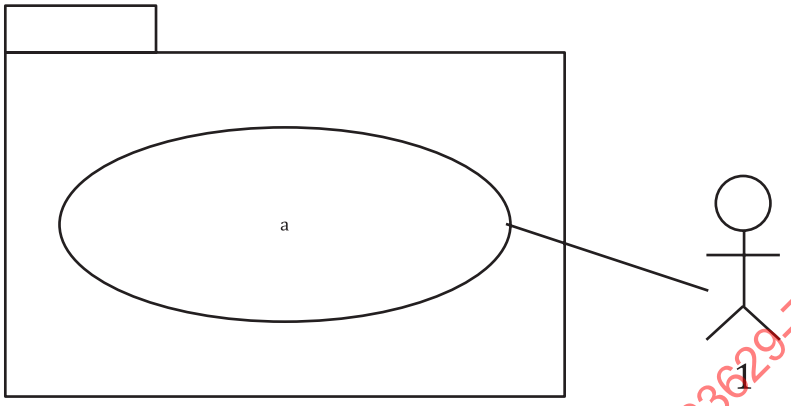
Figure B.9 — Route deviation detection

Table B.9 — Route deviation detection

Use case name	Route deviation detection
General description	It confirms whether a UA deviates from the flight route
Actor	UTM application
Pre-condition	A UA is flying on the flight route
Post-condition	-
Trigger	-
Flow	1. UTM application monitor a UA that is flying on the flight route. 2. UTM application confirms whether the UA deviates from the flight route that has approved before the flight.
Alternative flow	If the UA deviates the route, UTM application warn the UAS.
Note	-

B.2.2 In-flight situational awareness

This is a use case for using map to enable in-flight situational awareness at pre-flight stage. Figure B.10 shows the use case of in-flight situational awareness. Table B.10 summarizes attributes of the use case.



Key

1 UTM application

[a] In-flight situational awareness.

Figure B.10 — In-flight situational awareness

Table B.10 — In-flight situational awareness

Use case name	In-flight situational awareness
General description	It identifies surroundings information that affects a UA's flight
Actor	UTM application
Pre-condition	A UA is flying on the flight route
Post-condition	-
Trigger	-
Flow	1. UTM application monitor a UA that is flying on the flight route. 2. UTM application identifies surroundings information (weather information) that affects the UA flight.
Alternative flow	If there are phenomena that affect the UA's flight on the route, UTM Application warn the UAS.
Note	-