Annex H – SORA & UTM

Jarrett Larrow, FAA AFS-408

Flight Technologies and Procedures

Dr. Marcus Johnson, NASA UTM Project

Aviation Systems Division

Annex Structure

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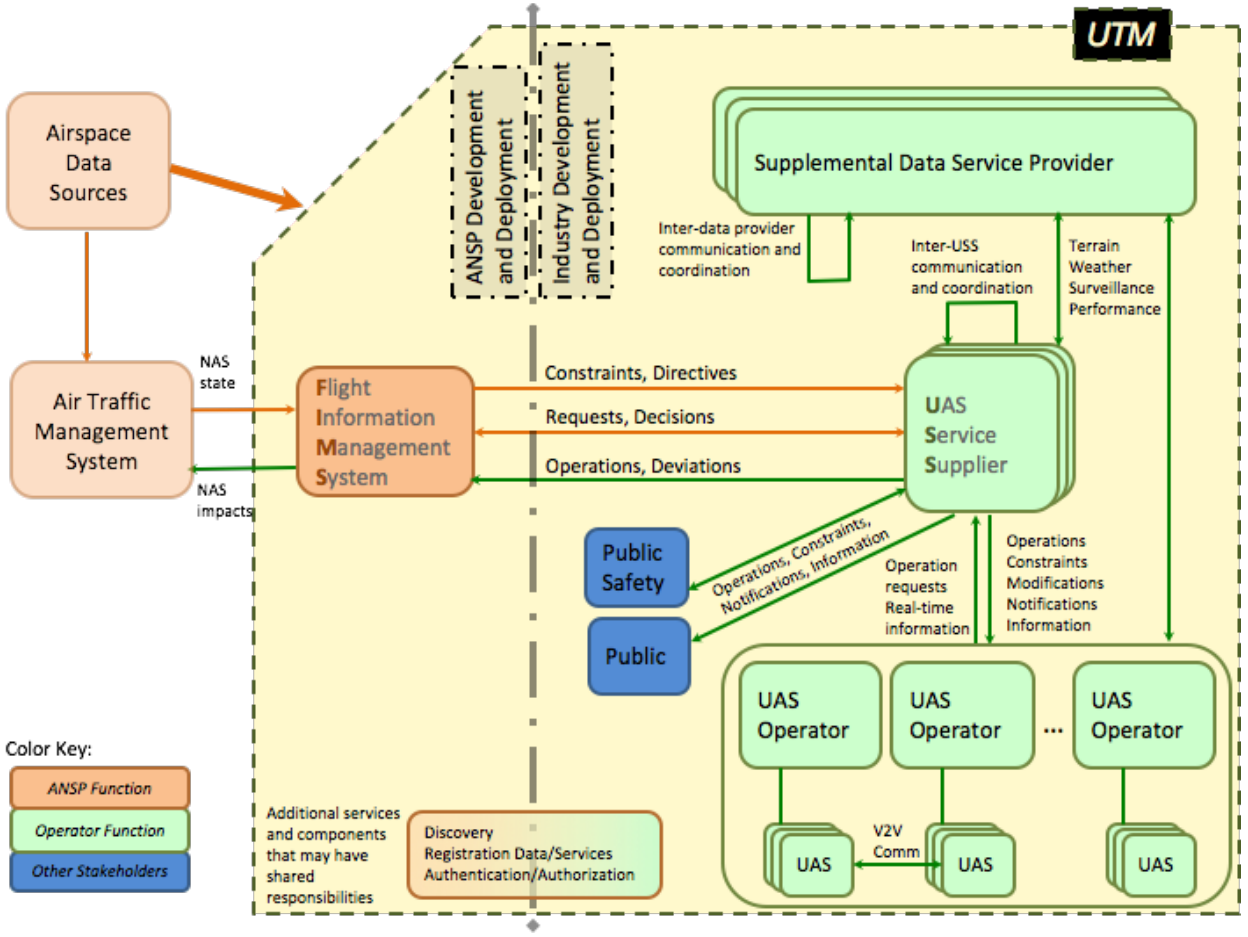
3 UTM Services Effect on Air Risk

3.1 Flight Planning Service

- 3.1.1 Robustness
- 3.1.2 Safety Credit

3.4 Strategic Deconfliction Service

UTM Overview



- The term ‘UTM’ refers to a set of federated services and an all-encompassing framework for managing multiple UAS operations.
- With UTM, the state maintains its regulatory and operational authority for airspace and traffic operations; however, the operations are not managed via the ATM system.
- They are organized, coordinated, and managed by a federated set of actors in a distributed network of highly automated systems via application programming interfaces (APIs).

Identified Services

Safety Services

- Flight Planning Service
- Flight Awareness Service
- Flight Notification Service
- Strategic Deconfliction Service
- Conformance Monitoring Service
- Conflict Advisory and Alert Service
- Dynamic Reroute Service
- Communication and Navigation Service
- Surveillance Services
- Weather Services
- Risk Reduction Service
- Dynamic Airspace Density Service
- Airspace Organization and Management Service
- Discovery Service
- Mapping Service

Other Services

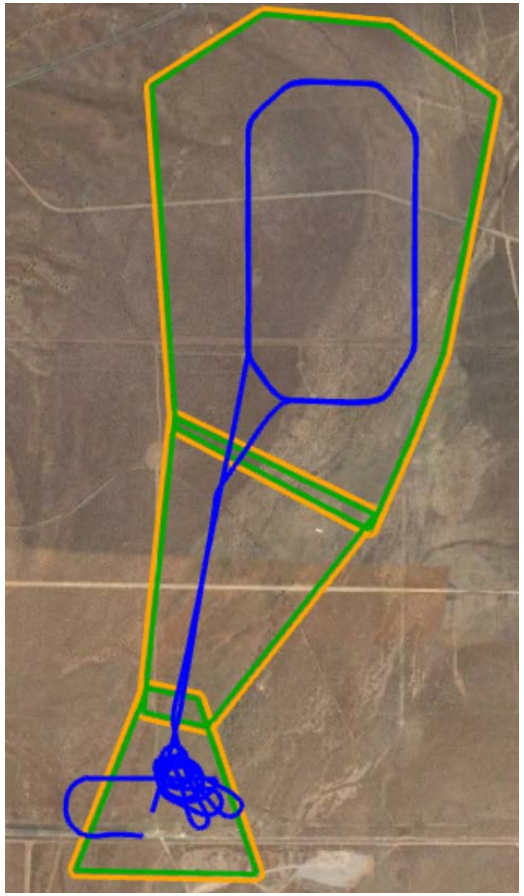
- Messaging Service
- Restriction Management Service
- Airspace Authorization Service
- Registration Service

Flight Planning Service

Objective: To support the operator in defining a flight geography that meets the needs of their mission while complying with the spatial/temporal boundaries and constraints of the Performance Authorization

Operator Use: A UAS Operator would utilize this service by submitting their flight path during pre-departure mission planning. The service would request input from the UAS Operator regarding the performance of the aircraft, communication and navigation performance, contingency actions, launch/recovery behavior, etc. The service would also utilize data from other available services (e.g. weather service).

Output: Suggestions on flight path modifications and Flight Geography Volume generated from the flight path

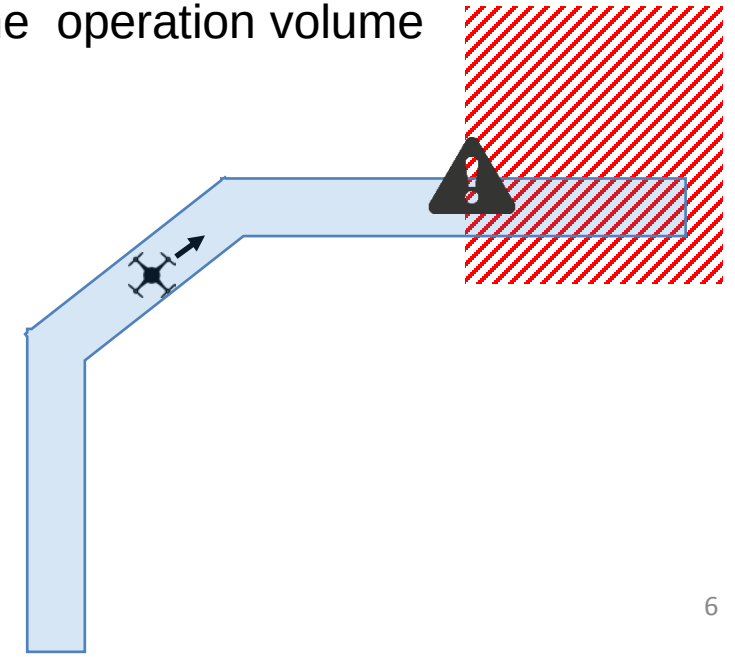


Flight Awareness Service

Objective: Flight awareness services provides a UAS operator contextual geographic information that supports an operator's awareness of areas in which flight operations and/or launch and recover are not permitted.

Operator Use: A UAS Operator would utilize this service by submitting their operation volume during pre-departure mission planning. The service would consider flight restricted and conditionally restricted areas and notify an operator of the potential hazard or restriction. This is a foundational service that is utilized by other services.

Output: Notification of existing or future known restrictions that intersect with the operation volume



Flight Notification Service

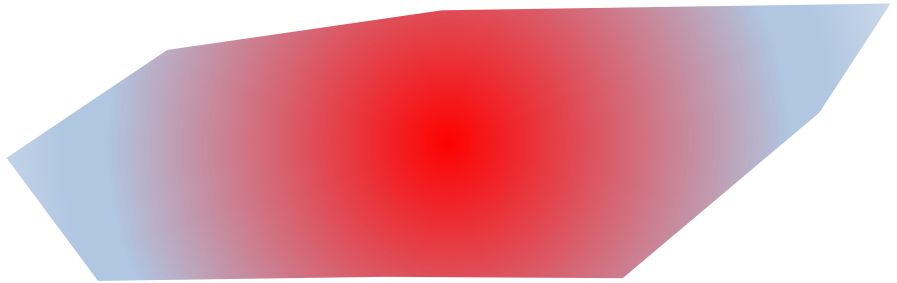
Objective: Flight notification services is intended as a means to promote transparency and disseminating information regarding UAS operations in a given geographic areas to other airspace users, non-UAS stakeholders, local, state, and tribal governments, and the general public.

Operator Use: A UAS Operator would utilize this service by submitting their operation volume during pre-departure mission planning. The UAS Operator would get an indication of the level of UAS traffic anticipated during their operation. This service would then collate the operation volume with the operation volumes of other UTM operations into a current and forecasted measures that will be published and accessible to other stakeholders.

Output: Notification of existing or future known traffic demand for a given geographic area.

Example Service Outputs:

- Density of operations
- Expected duration at given density levels
- Expected maximum UAS cruise altitudes
- Approximate launch/recovery locations



Strategic De-confliction Service

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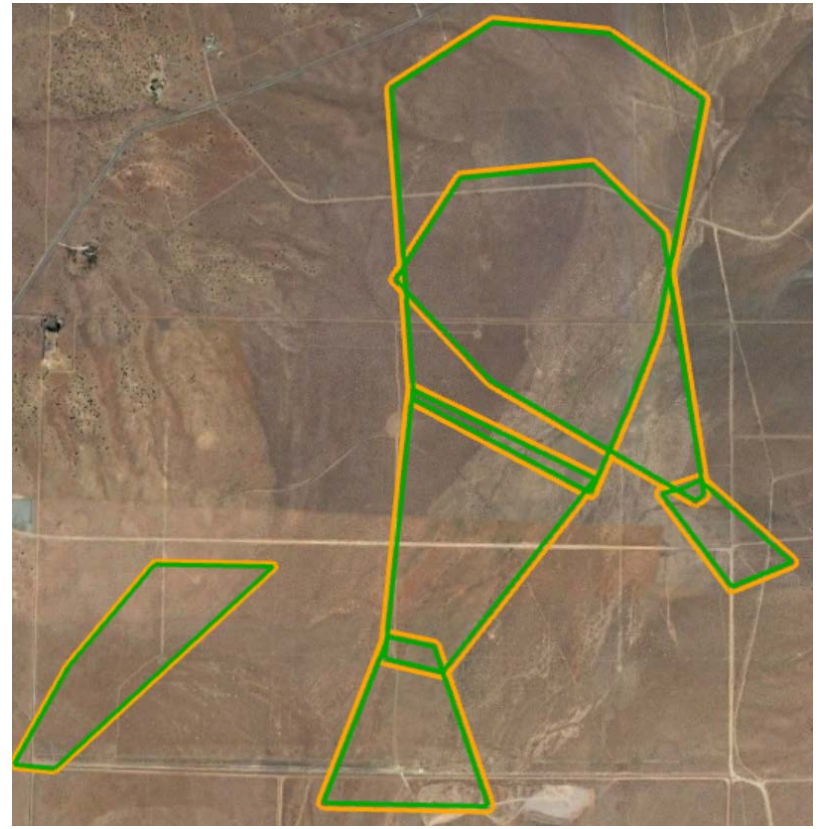


Conformance Monitoring Services

Objective: Conformance Monitoring Service supports a UAS operator with compliance to with their Operation Volume and notifying other proximal UAS operators in the event that compliance cannot be maintained.

Operator Use: A UAS Operator would utilize this service by submitting their operation volume during pre-departure mission planning. The service monitors the UAS position and notifies the UAS Operator if they deviate from the Flight Geography. A conformance threshold is applied between the Flight Geography and Operation Volume (defined as Conformance Volume) and if the UAS crosses the threshold the service provides a traffic advisory to other proximal UAS Operators.

Output:

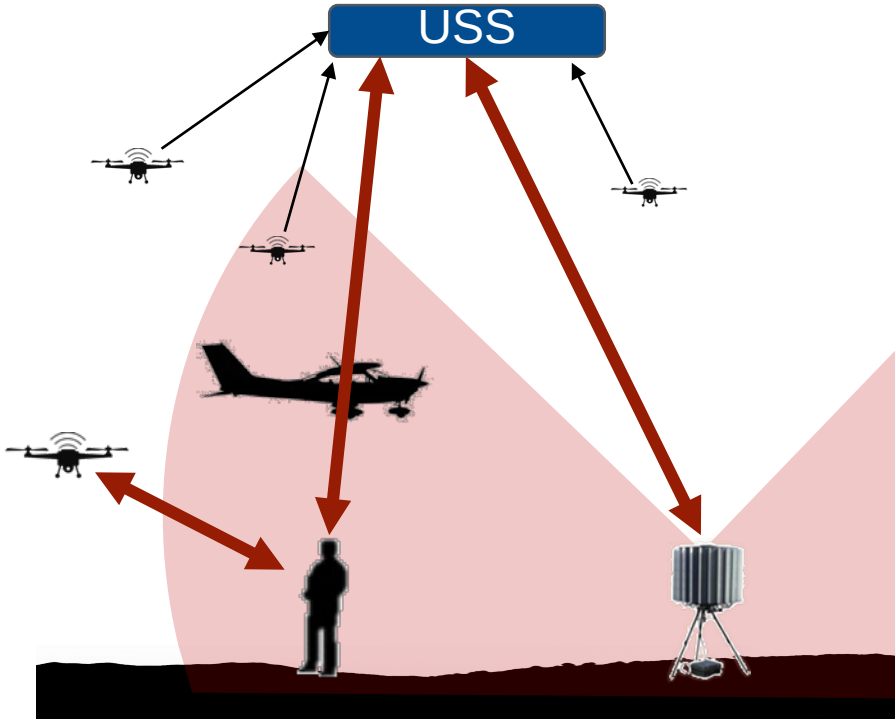
- Notification of deviation from Flight Geography
- Notification of other UAS Operators of deviation from Conformance Volume
- Position sharing to other UAS Operators if deviation from Operation Volume occurs (via a USS)

Conflict Advisory and Alert Services

Objective: Conflict Advisory and Alert Service supports a UAS operator by providing real-time or in-time data regarding the proximity to potential conflicting aircraft. The main functions of the Conflict Advisory Service is to provide a UAS Operator (or Remote Pilot in Command) informative, suggestive, or directive guidance with regards to proximal airborne hazards. This service relies on surveillance data sources to provide awareness of hazards in the airspace.

Operator Use: A UAS Operator would utilize this service by subscribing to the service and providing relevant UAS ownship information and use surveillance information to provide informative, suggestive, or directive guidance to the UAS operator when in conflict with manned and unmanned aircraft. This service helps reduce the performance burden of a onboard DAA.

Output: Informative, suggestive, and directive guidance to support the UAS Operator in conflict resolution

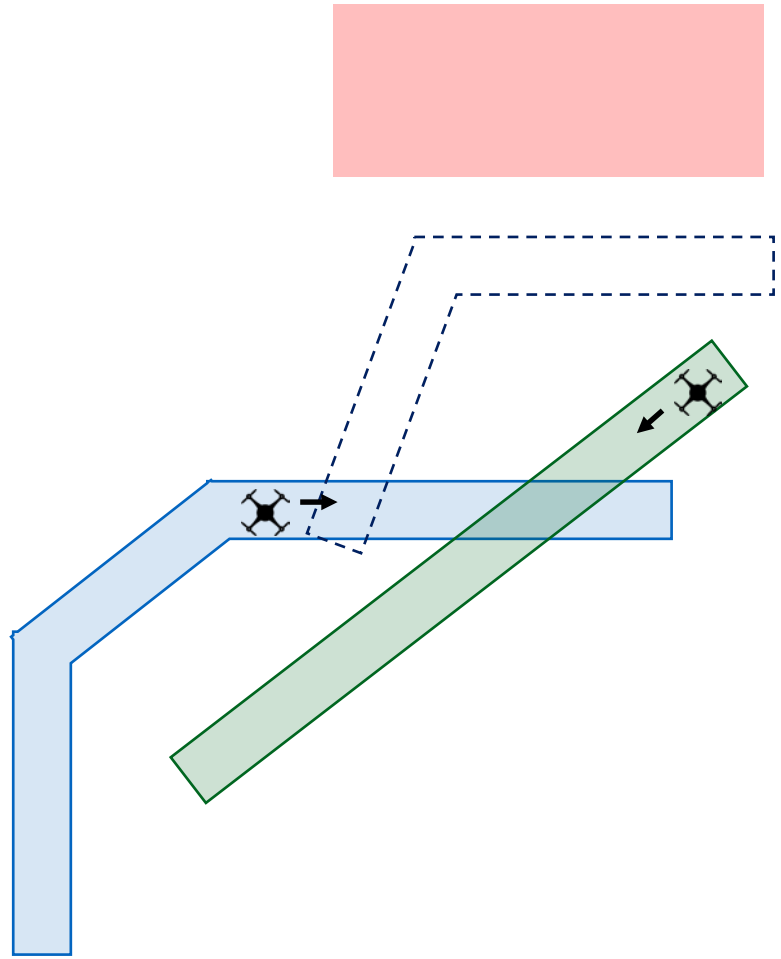


Dynamic Rerouting Services

Objective: Dynamic Rerouting Service supports a UAS operator by providing modifications to intended operation volumes and directives to changes in flight path to minimize the likelihood of airborne conflicts and maximize the likelihood of conforming to airspace restrictions and maintaining mission objectives.

Operator Use: A UAS Operator would utilize this service by subscribing to the service and providing relevant UAS ownship information and the service provides directive guidance in order to perform conflict resolution, excusion recovery, and return to mission. The directive guidance could be delivered to the UAS Operator or UAS depending on the mode of operation (e.g. pilot on-the-loop). Dynamic re-routing is an advanced service and relies on several other services.

Output: Directive guidance to resolve conflicts, remain clear or flight restricted areas, return to mission to support more automated UAS capabilities.



Communication and Navigation Services

Objective: Communication and Navigation Services consist of set of strategic and tactical services that can provide historical performance data during for airspace surveying during the safety development phase, coverage maps during the flight planning phase, and real-time integrity, availability, quality of service, and security monitoring during the operation phase.

Operator Use:

- **Flight Planning:** The UAS operator would utilize these coverage maps to ensure develop flight plans and contingency management procedures are consistent with the Performance Authorization limitations, the UAS performance, and the mission objectives.
- **Real-time Monitoring** support using a Communication and Navigation Service would entail the service provider supplying a monitor of the integrity and quality of service of the communication network, system and/or navigation solution over a given geographic area. Monitors would identify areas of degraded coverage, increased latency, or high probability of interference. The real-time monitoring capability would also notify the UAS operator of any reported communication blackout or jamming.

Output: Notifications and information associated with the quality of service and performance of the third party communication systems.

Surveillance Services

Objective: Surveillance Services consist of set of strategic and tactical services that can support air risk assessment for safety case development, support flight planning with airspace heat maps based on common traffic patterns, and support flight operations by providing real-time tracking information of air traffic for a given geographic area. Surveillance services consist of three primary means of collecting information regarding airborne hazards: terrestrial surveillance, airborne surveillance, and satellite surveillance.

Operator Use:

- **Flight Planning** using a Surveillance Service can provide an UAS Operator awareness of areas within locations in the airspace that would yield a higher likelihood of air traffic and develop Operation Volumes that consider the airspace structure, common routes of the airspace, and common times of day when the airspace it underutilized.
- **Real-time Monitoring** using a Surveillance Service is a capability that allows for a UAS Operator to gain a more complete awareness of the airspace they are using to conduct UAS operations. The real-time aspect of the service supports other services, like Conflict Advisory and Alert Service and Dynamic Rerouting, to provide support in conflict detection and resolution. This service in conjunction with a Authentication and Authorization service can also support the identification of aircraft that are non-participants of UTM.

Output: Density heat maps for flight planning and position information for conflict resolution.

Weather Services

Objective: The weather services supports a UAS Operators awareness of lower boundary layer atmospheric conditions in the geographic area in which they will be conducting operations.

- a Weather Service can provide support for a UAS Operator with the following capabilities:
- Near term, short term and long term forecasting of local and regional atmospheric conditions
- Real-time weather reporting
- User provided hazardous weather reports, known as UAS Reports (UREP).
- Weather advisories and alerts for a given geographic area
- Operation specific weather alerts that highlight areas in the operation volume where weather posses an elevated to risk to mission success and/or safety.
- Interfacing weather information with the Dynamic Rerouting Service to provide dynamic weather routes to avoid hazardous conditions.

Operator Use:

Historical weather data and trends can support a UAS Operator's request for a Performance Authorization, can provide support in determining whether compliance with limitations of the Performance Authorization are met prior to departure and weather can be monitored during operation and can provide situation awareness to a UAS Operator as to what conditions their vehicle is currently experiencing and will be encountering in the near future.

Linking Service Provision and Safety Benefit

Flight Planning Service

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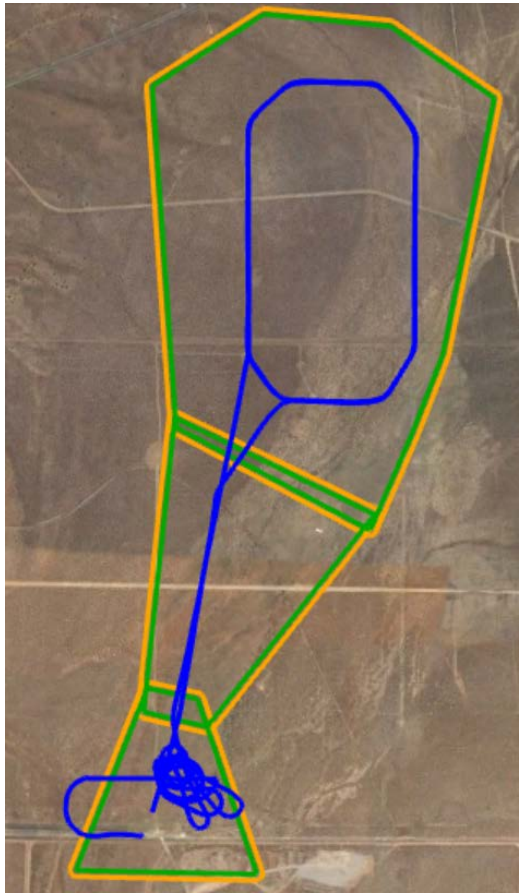


Safety Benefit – Flight Planning Service

		LEVEL of INTEGRITY		
		Low/None	Medium	High
HB#3 - Technical containment in place and effective (e.g. Emergency Recovery Function)	Criterion #1 - definition of the approved operating area	The operator needs to define: 1) The containment area. 2) A buffer to the non-approved operating area In addition, the operating crew performs route planning before each mission with up-to-date data including airspace and obstacles.	Same as low. In addition the definition of the buffer takes into consideration: • Probable malfunctions or failures (including the projection of high energetic parts such as rotors and propellers), • Meteorological conditions (e.g. wind), • Latencies, • UA behavior in case of activation of the Emergency Recovery Strategy, • UA performance.	Same as Medium

A flight planning service can reduce the likelihood of operational blundering over adjacent areas with increased population environments not accounted for in the intrinsic UAS ground risk class in section 3.2.3 of the main document. The operator may take credit for the use of flight planning service in Harm Barrier #3 – Technical Containment in place and effective and Threat Barriers #8, 11, 14, and 21.

For Harm Barrier #3, the service may:
-fulfil the obligations of criterion #1 over each level of integrity, and
-meet the obligations of criterion #2 for low level of integrity.

		LEVEL of INTEGRITY		
		Low/None	Medium	High
HB#3 - Technical containment in place and effective (e.g. Emergency Recovery Function)	Criterion #2 - Emergency Recovery Strategy	1) It can be reasonably expected that the UA will stay within the containment area. 1) The remote pilot is solely responsible for ensuring containment of the UAS operation within the lateral and vertical boundaries of the approved operating area.	1) The Emergency Recovery Strategy provides for the recovery of the UA in all UAS failure modes leading to a breach of the containment area. 1) The remote pilot is responsible to check before each mission that the appropriate parameters are set on the Emergency Recovery Strategy to ensure containment of the UAS within the approved area of operation.	Same medium. In addition: • There is at least one automatic means to activate the recovery function (i.e. no reliance on datalink). • The Emergency Recovery Strategy should not leave the UAS one failure away of breaching the containment area (*). • The availability of the Emergency Recovery Strategy is provided to the remote pilot.

Service Robustness – Flight Planning Service

Flight Planning Service		LEVEL of INTEGRITY		
		Low	Medium	High
Flight Planning Service	Criteria	The flight planning service has been developed following recognized standards.		
	Comments			

- Appropriate standards body
- Who/How to capture the assurance

Flight Planning Service		LEVEL of ASSURANCE		
		Low	Medium	High
Flight Planning Service	Criteria	The service provider declares that the requested level of performance.		
	Comments	N/A	N/A	N/A

Items for broader discussion

- Capturing robustness levels for services
- Standardizing terminology on boundaries

Definitions

Flight Geography:
A geographically defined volume (or chained set of volumes), which can be spatial and temporal defined, that is wholly contained within Operation Volume. The Flight Geography represents the desired intent of the UAS Operator.

Operation Volume:
A geographically defined volume (or chained set of volumes), which can be spatial and temporal defined, that is wholly contained within the Approved Area of Operation. The Operation Volume represents the area navigation performance required to accommodate minor deviations from the Flight Geography.

Concept of Operations:
A representation of the characteristics of the proposed UAS operations, presented from the viewpoint of the UAS Operator. This would include the geographic bounds of the operation, systems used, roles and responsibilities, mode of operation, etc.

Proposed Area of Operations:
A spatially defined geographic volume defined by the UAS Operator which represents the maximum extent of airspace requested for flight operations in accordance with the concept of operations

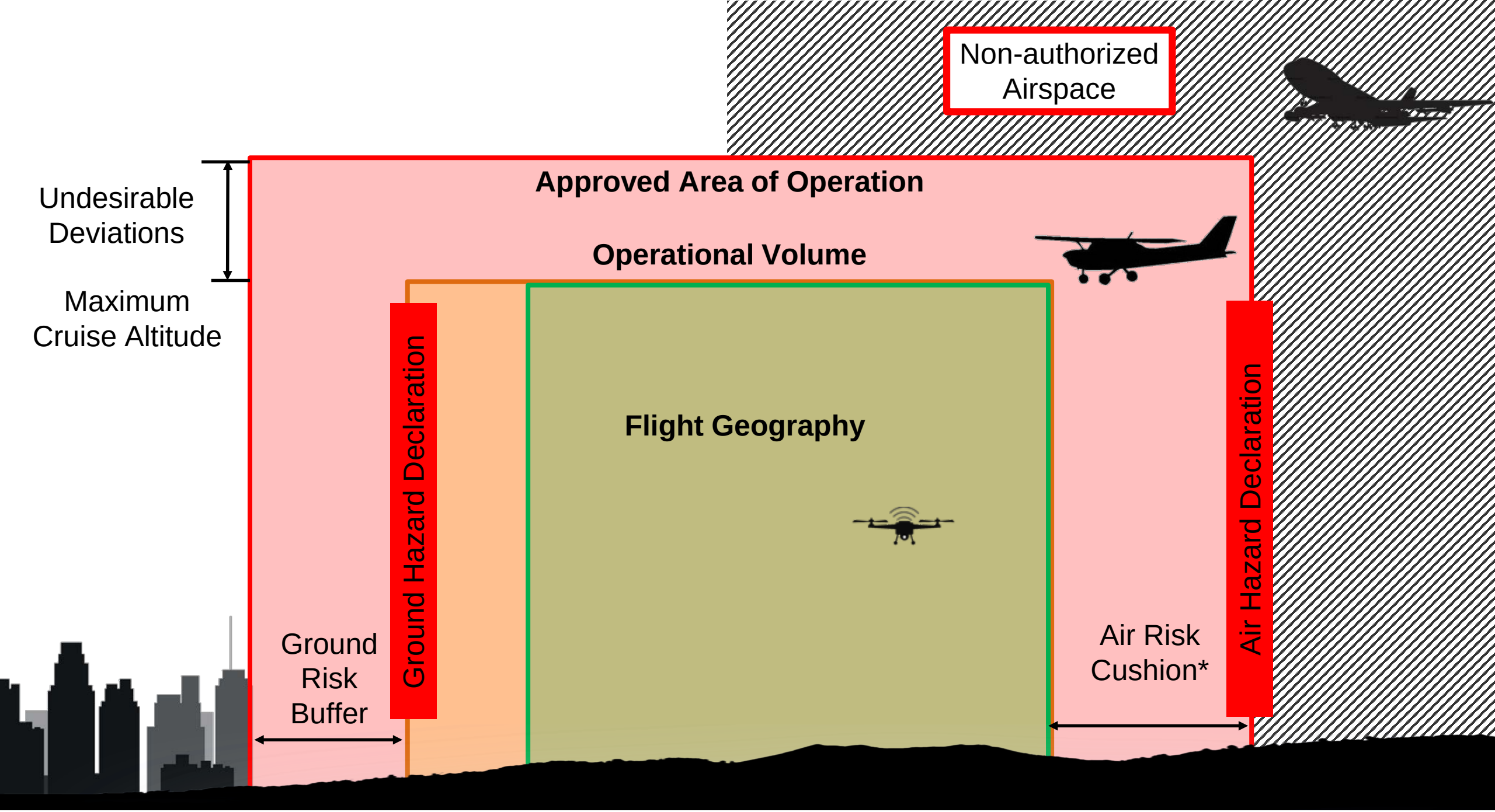
Definitions

Approved Area of Operations:
A spatially defined geographic volume whose base represents the maximum intersection of the area defining acceptable ground risk AND the area defining acceptable air risk and whose height is defined by acceptable air risk and geographic bounds of the concept of operations. The Approved Area of Operation represents the extent of airspace allowable for the UAS operation, as approved by the CAA,ANSP

Operation Conditions and Limitations
The Operation Conditions impose spatial, temporal, flight rules, equipage, procedure, and/or performance requirements that are applied to operations within the Approved Area of Operation. The Operation Limitations impose restrictions that limit the operation.

Performance Authorization represents the CAA/ANSP contract with the UAS Operator allowing for UAS operations in accordance with the **Concept of Operations** within the **Approved Area of Operation** subject to the CAA/ANSP prescribed **Operation Conditions and Limitations**.


Non-authorized Airspace
Area of Operations
Acceptable Ground Risk
Acceptable Air Risk



* The addition of an air risk cushion is at the discretion of the UAS operator

Operation Conditions and Limitations: Hazard Declaration

Air Hazard Declaration:

- Excursion from the Approved Area of Operation

  OR

- Prolonged exposure outside of Operation Volume

Ground Hazard Declaration:

- Excursion from the Operation Volume

Items for small team discussion

- Architectural Model
- Service Dependencies, Basic functions versus value added
- Advanced Service Description (e.g. dynamic airspace density service, airspace organization and management service)

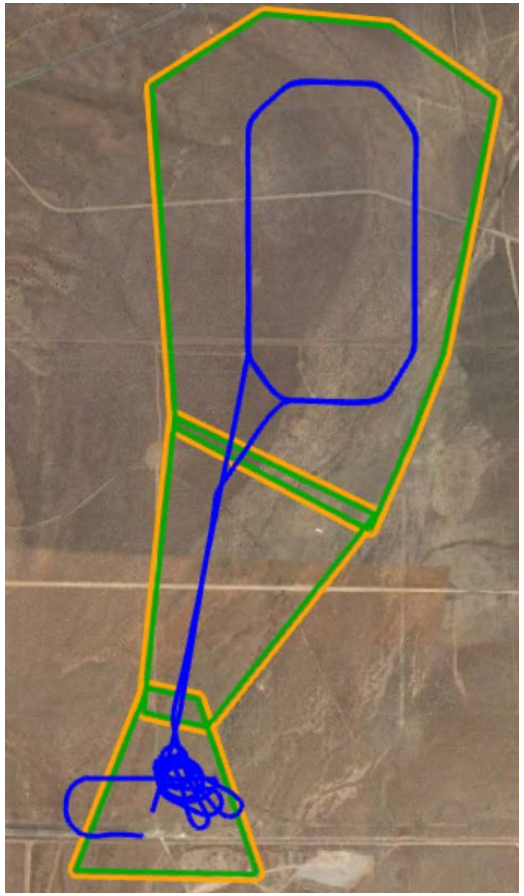
Questions?

Backup

Flight Planning Services

Service Principles:

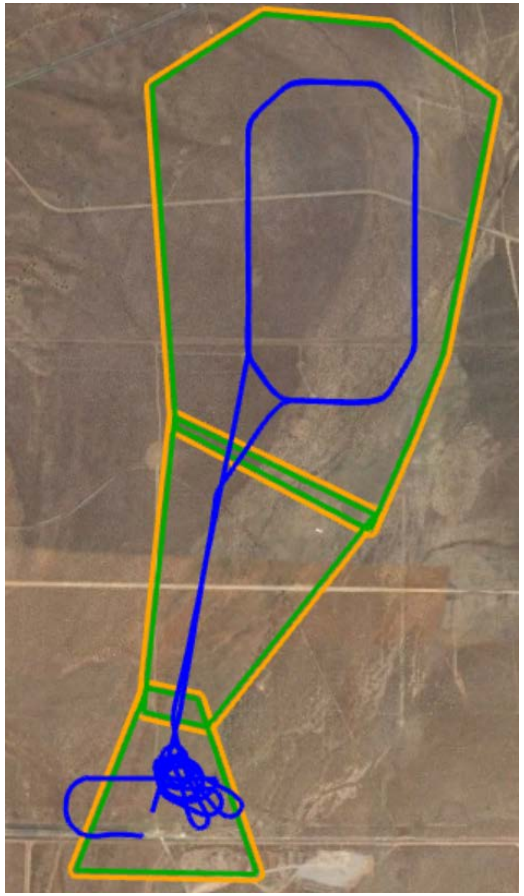
- All phases of flight of the UAS operation must be contained within a 4D volume of the Flight Geography
- Each 4D volume of the Flight Geography must have a start and end time
- Contingency locations must be identified for each volume in a Flight Geography (e.g. alternate landing location, lost link waypoint,etc.)
- Contingency locations should be contained within their respective flight volume of a Flight Geography, unless in-time Flight Geography modification is supported during flight.
- A flight planning service must promote efficient and safe use of the airspace during flight planning



Flight Planning Services

Example Service Considerations:

- Achievable flight path Trajectory
- Minimum required endurance and maximum vehicle range
- Command, control, and communication coverage range and quality of service
- UAS performance and flight behavior (e.g., turn radius, launch/recovery procedures, etc.)
- UAS navigation error
- Atmospheric conditions (e.g., direction and magnitude of wind)
- Terrain and ground hazards (e.g., Man-made Structures, Foliage)
- Airspace structure and flight rules
- Contingency management procedures
- Approved Area of Operation (e.g. Performance Authorization)
- Operation conditions and limitations (e.g. night flights)
- USS and SDSP support service coverage areas and quality of service.



Flight Awareness Services

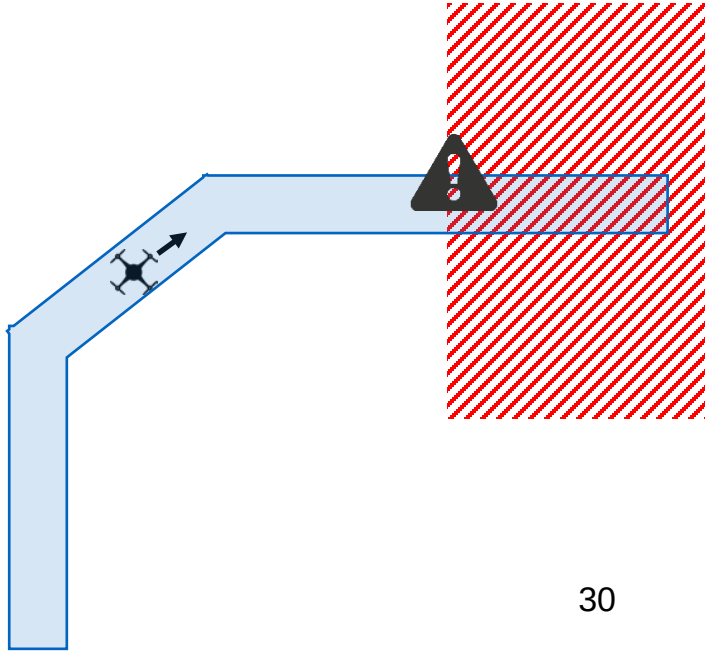
Service Functions:

- Provide information to a UAS operator regarding airspace and ground constraints to aid flight planning

- Perform constraint management by checking the proposed Flight Geography and subsequent Operation Volume against all known airspace and ground constraints

- Provide an advisory to the UAS operator when the proposed Operation Volume has an intersection in time and space with a known airspace and/or ground constraint

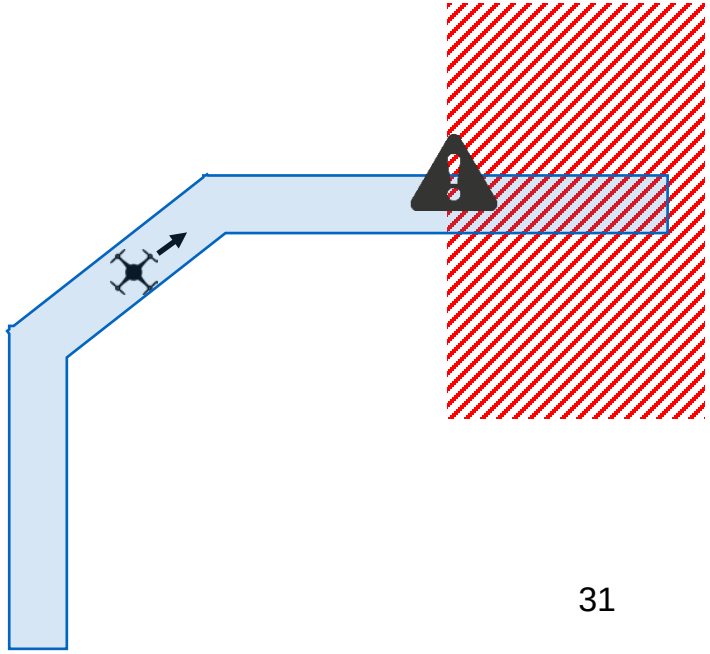
- Advanced capabilities may provide contextual spatial and/or temporal information to support the UAS operator or another service in deconfliction with a known constraint or expand constraint management to include conditional constraints (e.g. exceptions to flight restrictions).



Flight Awareness Services

Example Service Considerations:

Airspace Constraints	Ground Constraints
Dynamic Restrictions	Private Property
Controlled Airspace	Public Gatherings
Special Use Airspace	Restricted Areas (e.g. National Monument)
National Parks	Sensitive Areas (e.g. Prison)
Local Municipality Restrictions	
National Security Restrictions (e.g. Power Plant)	
Right of Way Airways (e.g. Power Transmission Facilities)	



Strategic De-confliction Services

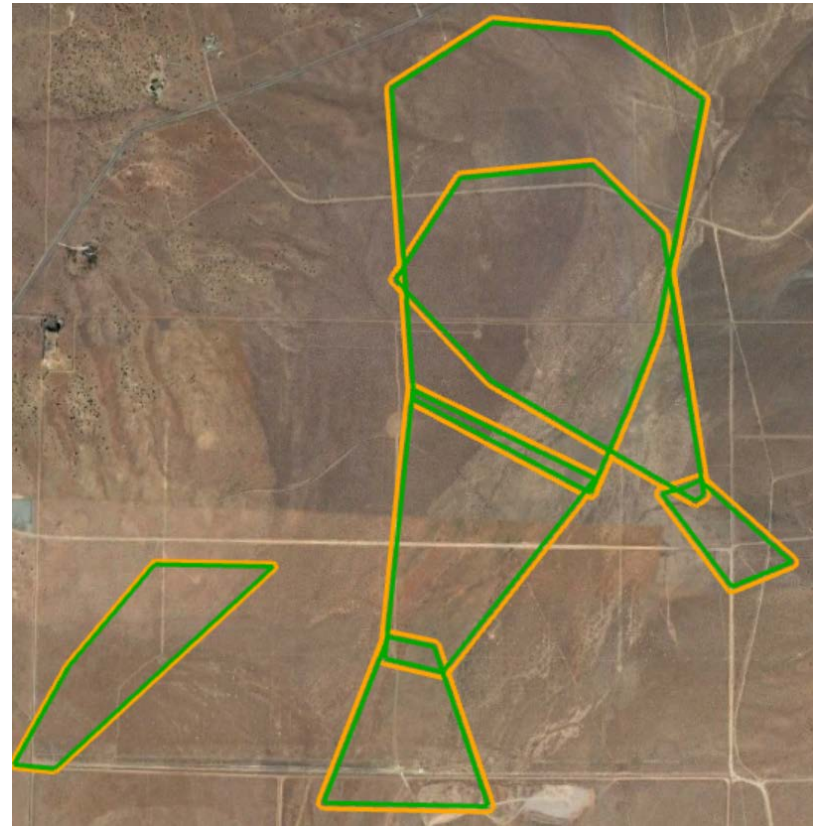
Service Principles:

- A UAS operation supported by a USS should be free of 4-D intersection (spatial and temporal) with all other known UAS Operations prior to departure.

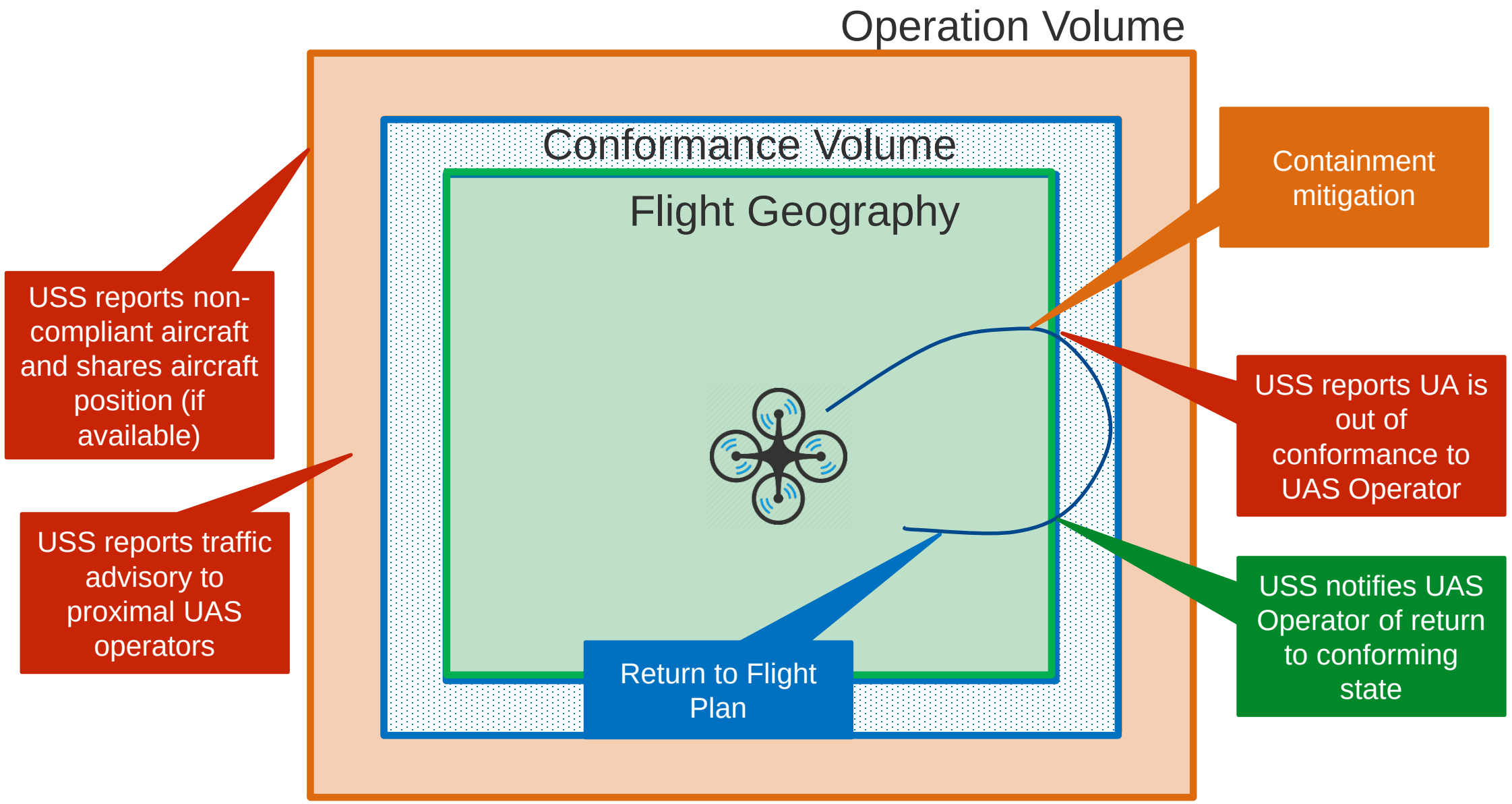
- A prioritization scheme for operations is needed within strategic de-confliction to support various types of operations within an airspace.

- Negotiation schemes should be part of a strategic de-confliction service to support mediation between conflicting UAS operations.

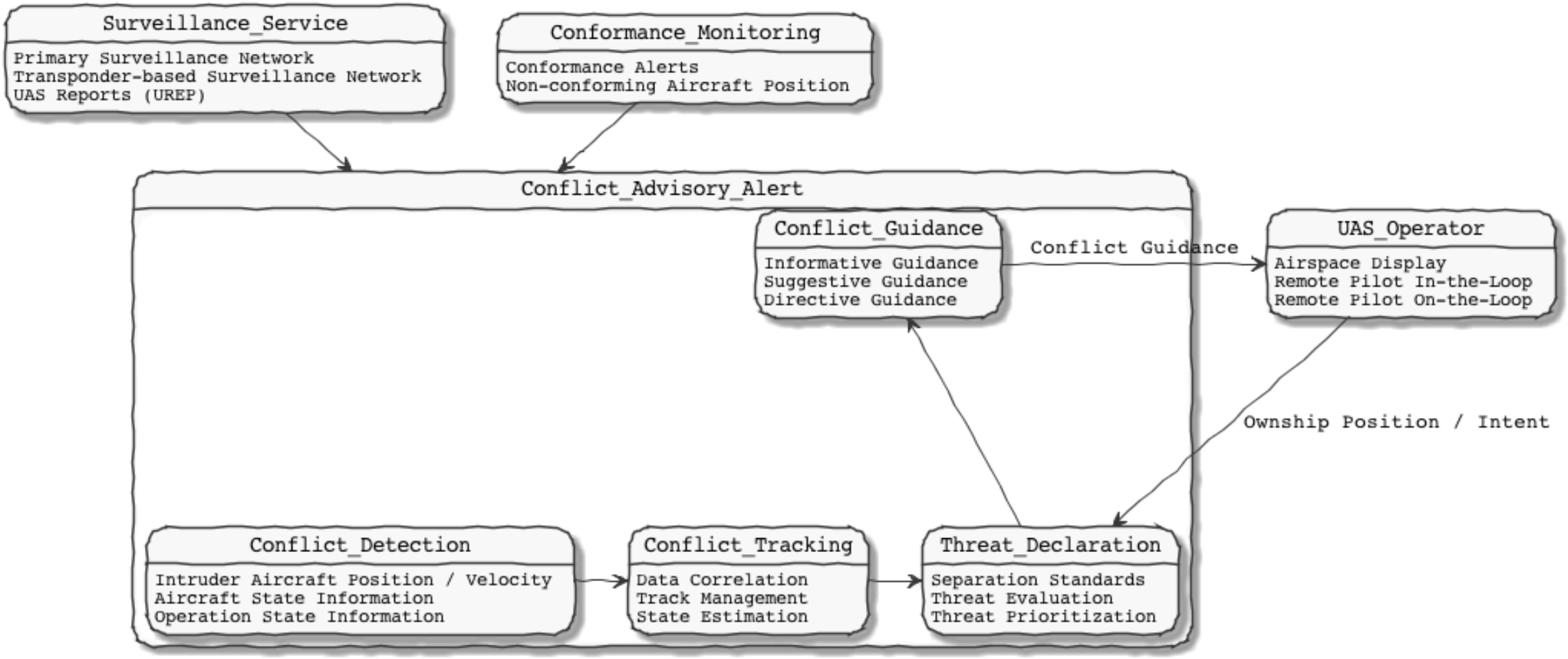
- A strategic de-confliction service shall allow for overlapping operation volumes, given that other separation mitigations are in place.



Conformance Monitoring Services



Conflict Advisory and Alert Services



Dynamic Rerouting Service