Identification and Development of Coordination Procedures between Upper Class E Traffic Management (ETM) and Surrounding Air Traffic Operations

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A recent interest in novel, non-traditional vehicles / missions that plan to operate in Upper Class E (UCE) airspace at or above 60,000 ft has led to efforts by NASA, FAA and the stakeholder communities to research and develop a new concept called Upper Class E Traffic Management (ETM). ETM concept proposes to handle the influx of diverse traffic mix around FL600 and above, utilizing a new traffic management infrastructure, supported by federated service suppliers that are developed by the community stakeholders, for coordinating, monitoring, and executing vehicle operational intent in a designated airspace called ETM Cooperative Area (CA). ETM vehicles are generally expected to reach and operate in ETM CA by first transiting through Class A airspace and potentially through UCE airspace that sits outside of ETM CA. In this paper, a set of use cases have been identified and step-by-step procedures have been developed to handle nominal transitions of ETM vehicles between these operational areas, as well as additional use cases and procedures for authorization and termination of ETM CAs in Class A and/or UCE airspace. The overall research effort in this paper has revealed potential challenges and open questions related to these use cases, especially for the interactions between ETM CA and UCE in both vehicle transition and ETM CA authorization scenarios. The use cases and procedures developed in this paper will inform future ETM integration efforts, as well as research and development into decision support tools needed for the integration.

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I. Nomenclature

AC = Advisory Circular
AGL = Above Ground Level
ALTRV = Altitude Reservation
ARB = Airspace Request Builder
ARTCC = Air Route Traffic Control Center
ATC = Air Traffic Control or Air Traffic Controller
ATCE = Air Traffic Controlled Environment
ATM = Air Traffic Management
ATS = Air Traffic Service
CA = Cooperative Area
CARF = Central Altitude Reservation Function
CNS = Communications, Navigation, and Surveillance
COA = Certificate of Authorization
CONUS = Continental United States
COP = Cooperative Operating Practice
ESS = ETM Service Supplier
ETM = Upper Class E Traffic Management
FAA = Federal Aviation Administration
FIMS = Flight Information Management System
FL = Flight Level
HALE = High-Altitude Long-Endurance
IFR = Instrument Flight Rule
LOA = Letter of Agreement
MARSA = Military Authority Assumes Responsibility for Separation of Aircraft
NAS = National Airspace System
NOTAM = Notice to Air Mission
OI = Operational Intent
OP = Operation Plan
PCA = Positive Control Airspace (PCA)
PIC = Pilot-In-Command
RA = Restricted Area
RPIC = Remote Pilot-In-Command
SUA = Special Use Airspace
TCAS = Traffic Collision Avoidance System
UAS = Unmanned Aerial System
UCE = Upper Class E
UFB = Unmanned Free Balloon
UTM = Unmanned Aircraft System Traffic Management
VFR = Visual Flight Rule

II. Introduction

There has been a recent interest in novel, non-traditional vehicles and missions to operate at high altitudes around 60,000 feet and above. Innovative remotely operated, high-altitude long-endurance (HALE) vehicles, such as solar-powered aircraft or high-altitude balloons and airships, have attracted investment interests from commercial entities to provide communications services while loitering in the stratosphere. Other types of vehicles, such as supersonic / hypersonic aircraft and Unmanned Aerial System (UAS) vehicles for military operations, are also expected to occupy similar airspace, potentially creating complex traffic situations with diverse vehicle characteristics if the commercial traffic demand increases in these altitude regions, as expected [1,2,3].

These new missions seek to access previously underutilized airspace above 60,000 feet (Flight Level 600, or FL600) called Upper Class E (UCE) airspace, which sits just above Class A airspace. Unlike Class A, there is a lack of existing air traffic management (ATM) infrastructure in these altitudes and frequent operations in this airspace would require a significant new investment in ATM infrastructure and air traffic control (ATC) support that does not exist today. In addition, there are no established airspace management provisions for civil aircraft operations in UCE [4]. Although the Federal Aviation Administration (FAA) has established separation standards for surveillance and procedural operations in the UCE, these standards have been applied to military operations, typically flying under Military Authority Assumes Responsibility for Separation of Aircraft (MARSA) (). To accommodate the emerging commercial vehicles and missions in UCE, a new approach is needed to maintain safe and efficient operations for all vehicles who needs to access the airspace and support them without waiting for a significant ATM infrastructure to be in place..

To address these issues, the FAA published a concept of operation for Upper Class E Traffic Management, called ETM ConOps v1.0 [1]. ETM concept proposes to handle the influx of diverse traffic mix around FL600 and above, utilizing a new traffic management infrastructure, supported by federated service suppliers that are developed by the community stakeholders. The FAA has since added a concept for coordinating, monitoring, and executing the ETM vehicle operation plans and operational intent in a designated airspace called ETM Cooperative Area (CA).

A considerable portion of the ETM concept has been developed from research and development efforts by National Aeronautics and Space Administration (NASA), with close collaboration with the FAA and stakeholder communities. The ETM concept is derived from the earlier development of Unmanned Aircraft System Traffic Management (UTM), which created an infrastructural framework to enable multiple beyond visual line-of-sight drone operations at low altitudes (under 400 feet above ground level (AGL)) in airspace where FAA air traffic services are not provided [5,6]. One of the key design thrusts for UTM is a novel, highly automated information exchange infrastructure and a community-based, cooperative traffic management system, built upon third-party services that provide all basic functions, such as separation, flight intent, and schedule management. In this architecture, UTM operations are supported by federated service suppliers, developed mainly by industry partners, for coordinating, monitoring, and executing vehicle operational intent. The UTM archetectual framework is leveraged by ETM to handle a diverse traffic mix with much longer missions and with limited maneuverability.

Since ETM vehicles are generally expected to operate at high altitudes at or above 60,000 ft, an integration of ETM operations with the existing ATM system is needed [7]. Figure 1 illustrates a notional picture of ETM CA relative to Class A and UCE airspace. During climb and descent phases of flight, ETM vehicles transit through the Class A airspace under air traffic control regulations, in which the air traffic controller (ATC) is responsible for managing separation between the ETM vehicle and other ATM traffic. In addition, ETM vehicles may also need to transit to/from surrounding UCE airspace that do not operate under ETM rules if the ETM CAs exist only in certain areas within UCE. Limiting the size of ETM CAs could help maintain the access of the remaining UCE airspace to vehicles that are not equipped to conduct ETM operations. If ETM CAs are active only during certain time durations (e.g. peak traffic demand periods), procedures for enabling and terminating ETM CAs are needed to coordinate the transfer of operational region between Class A / UCE airspace and areas under ETM operations.

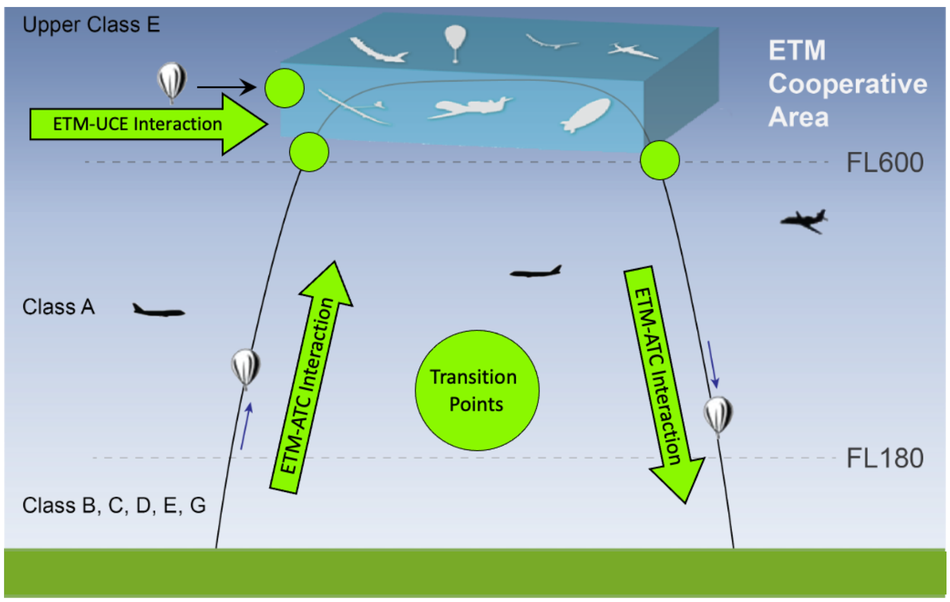

Figure 1. Notional representation of ETM CA relative to Class A and UCE airspace

The goal of this paper is to describe the coordination procedures to handle the integration of ETM operations to the surrounding Class A and UCE airspace. The following sections summarize operational assumptions associated with ETM, Class A, and UCE, followed by the detailed coordination procedures for integrating the vehicle operations across these different operational regions.

III. Types of Airspace and Air Traffic Operations

A. ETM Operations

The goal of ETM operations is to support introduction and expansion of novel commercial, state/government, and research operations for both manned and unmanned vehicles in and around UCE. The system architecture for ETM mirrors those of UTM, adopting the key design features of highly automated information exchange infrastructure and a community-based, cooperative traffic management system, built upon third-party services. Figure 2 shows the system architecture of ETM. Similar to UTM, ETM operations are supported by federated service suppliers called ETM Service Supplier (ESS), developed mainly by industry partners, for coordinating, monitoring, and executing vehicle operational intent. There are potentially multiple ESSs that provide services in a federated manner, such that inter-ESS communication and coordination mechanisms also need to be established [1,8]. Collectively, ESSs provide the coordination link between multiple ETM vehicle operators, each with a mechanism to link to the ESSs for coordination purposes. In most cases, ETM vehicles are controlled by a Pilot-In-Command (PIC) for a crewed vehicle or a Remote PIC for an uncrewed vehicle. There also exists vehicle-to-vehicle communication for conflict avoidance and/or other tactical maneuvers. Finally, the ESSs are connected to a gateway to the Air Traffic Services (ATS), that provide services to the air traffic outside of ETM. This gateway is analogous to the UTM Flight Information Management System (FIMS) that provides a similar connection between UTM and air traffic system [6].

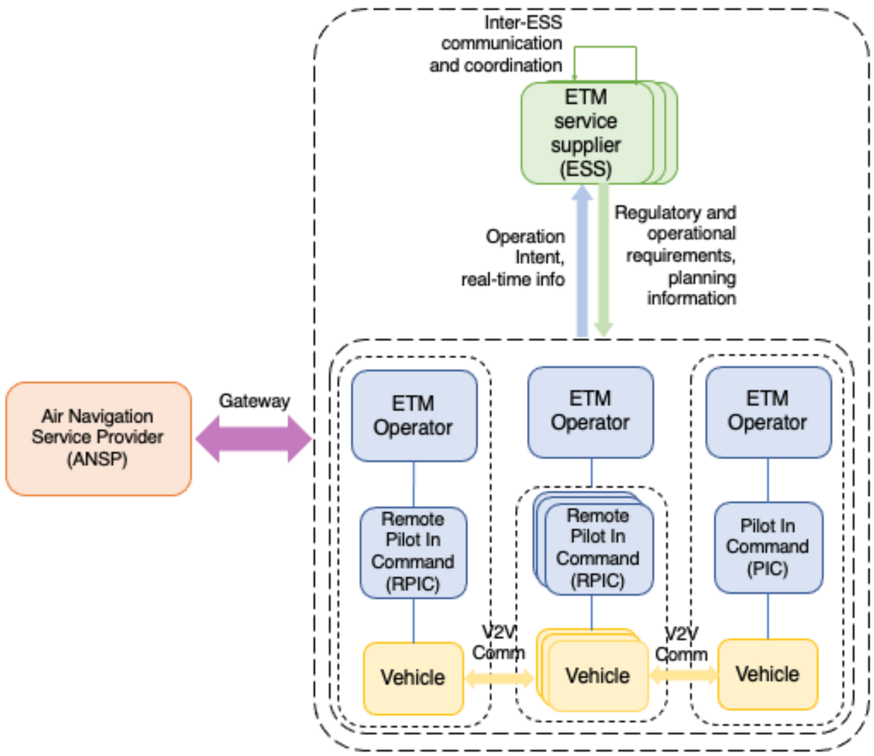

Figure 2. Notional representation of ETM system architecture

One of the core tenets of ETM concept is that ETM vehicles will operate according to Cooperative Operating Practices (COPs). COPS are defined by the industry and the ETM community as agreements about operator interactions consisting of procedures, processes, algorithms, and rules that deal with vehicle operations within the ETM domain [1,8,9]. COPs are largely community-based, cooperative traffic management practices, where the vehicle operators are responsible for the coordination, execution, and management of operations, including conflict management, equity of airspace usage, and demand/capacity balancing, within the regulations established by FAA. COPs should provide rules that allow operators to share their locations, intent, and other pertinent information to gain awareness of proximate operations, and de-conflict when necessary.

A key mechanism used for gaining awareness of vehicles and their operations that are in the vicinity of a vehicle and/or to identify potential safety-related events is the sharing of vehicle's Operational Intent (OI). OI is a four-dimensional (4D) (time and space) information that indicates, with a known level of confidence, where an aircraft will be at some given point in the future (see Figure 3). OI specifies the airspace regions that the vehicle is predicted to be operating in at a certain time or period in the future given vehicle performance model and environmental uncertainties [1,8,9]. OI can be represented as a three-dimensional airspace volume with a time duration denoted by an entry and exit time. Accurate and precise OI sharing is essential to achieve common situational awareness. ETM operators are responsible for conformance monitoring to ensure their flight trajectories stay within the active OI volume.

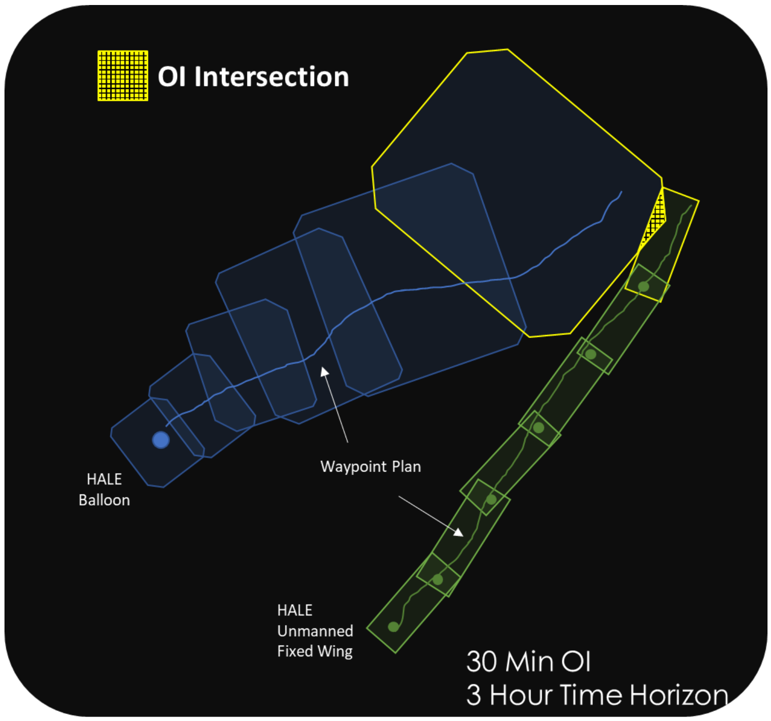

Figure 3. Operational Intents (OIs) for a balloon and a HALE fixed-wing with OI intersections

Given ETM vehicles vary widely in their speed and maneuverability, the desired method for maintaining safe distance between ETM vehicles is to strategically deconflict the vehicles' future intents rather than relying on tactical vehicle-to-vehicle deconfliction. Once the strategic conflicts between vehicles' intents are identified, the vehicle operators can engage in a negotiation process, as defined in and governed by COPs, to deconflict the vehicles' intents.

For identification of strategic conflict, a simple method based on OI intersections has been proposed for an early implementation (see Figure 3). As the operators periodically update their OIs, ESS monitors and checks for OI intersections between all vehicle pairs and share the OI intersection information to all impacted operators whenever they are triggered. Once a strategic conflict has been detected, ETM operators are responsible for deconflicting their OIs according to COPs. The detailed definitions of the COPs are yet to be determined, but they are expected to be rule-based, ad-hoc, or other methods that can guarantee vehicle safety and nominally a resolution of the conflict.

ETM operations occur in designated operational regions called ETM Cooperative Areas (CAs). FAA is responsible for defining and authorizing ETM CAs, but the ETM community has a greater flexibility in developing, maintaining, and operating ETM vehicles with greater autonomy compared to air traffic controlled environment (ATCE). If a vehicle wants to access airspace designated to ETM CAs, it must meet multiple requirements, such as minimum ETM equipage, agreement to share their location, OIs, and agreement to adhere to rules outlined in the COPs defined for the ETM CAs.

Prior to departure, ETM operators are expected to have the capability to exchange information with the ESS network to file their operational plan (OP), which contains their OIs and other mission related information. As the ETM vehicle takes off and transit through the ATCE, it is expected to update its position and its OP just prior to the entry into ETM CA. Based on the defined COPs, a network of ESS is expected to review the respective OIs prior to entry, assess potential issues and/or conflicts, and notify all impacted vehicles for a resolution, as defined in the COPs. The potential solutions could be 1) the submitted OIs need to be "conflict-free" from other vehicles' OIs, 2) ESS will alert the vehicles with OI intersections to initiate an operator-to-operator negotiation, or 3) a combination of both. Once the OIs are deconflicted, both ETM operators resume their operations and continue their missions.

B. Surrounding ETM Operations: Class A Airspace

Since ETM vehicles take off from the ground and enter ETM CA at high altitudes around FL600, they must first transit through Class A airspace. An initial development of ETM concept assumes that a transit through Class A airspace will be done under the traditional air traffic control.

Class A airspace, also referred to as positive control airspace (PCA), extends from FL180 to FL600 over the Continental United States (CONUS). Below Class A airspace are multiple other types of airspace including: Lower Class E, Class G (uncontrolled) and Classes B, C and D (airports and approach controls). According to 14 CFR 91.135, Operations in Class A airspace rules state that an operator of an aircraft in Class A airspace must conduct that operation under instrument flight rules (IFR) and in compliance with the following [10]:

- *Clearance.* Operations may be conducted only under an ATC clearance received prior to entering the airspace.
- *Communications.* Unless otherwise authorized by ATC, each aircraft operating in Class A airspace must be equipped with a two-way radio capable of communicating with ATC on a frequency assigned by ATC. Each pilot must maintain two-way radio communications with ATC while operating in Class A airspace.
- *Equipment requirements.* Unless otherwise authorized by ATC, no person may operate an aircraft within Class A airspace unless that aircraft is equipped with the applicable equipment specified in § 91.225.

Class A airspace operates under the active control of the ATCs, who are responsible for the safety and separation of aircraft operating within their assigned sector(s). Separation within Class A airspace is generally provided in accordance with radar separation rules (5 NM lateral or 1000 feet vertical between FL180-410 and 2000 feet vertical above FL410. However, in areas that lack radar coverage non-radar separation rules may be utilized. Pilots are expected to execute all clearances issued by controllers unless they endanger the safety of the aircraft, including when a pilot is executing a Traffic Collision Avoidance System (TCAS) alert instruction. Flights being operated under Visual Flight Rules (VFR) are not allowed in Class A airspace [11]. Additionally, Special Use Airspace (SUAs) may be approved by the FAA for vehicles that wish to operate outside of ATC control. These operations have historically been primarily military and research vehicles. While there are a number of different airspace designations of this type that exist, Altitude Reservations (ALTRVs) are the primary type envisioned for civilian unmanned ETM operations that wish to operate in Class A and UCE airspace [12].

For ATCs, the transfer of control for flights under their guidance happens in a couple different ways. For transfer to other control positions (ATC/Military controllers), the controller initiates a hand off to the receiving controller either by voice or using computer generated auto hand offs. When the receiving controller has accepted the hand off which designates responsibility for the aircraft coming into their airspace, the transferring controller initiates a radio change to the new frequency. For airspace that does not have a controlling authority, the operators/vehicles in the airspace assume responsibility among themselves for safe operations. In these cases, the ATC in Class A airspace and pilot work together to cancel the IFR flight plan and radar services and then the ATC clears the pilot to leave the frequency and operate in the common airspace. At this point, the ATC is no longer responsible for the flights within the designated airspace. When these aircraft want to return to base via Class A airspace, they must request a new clearance to leave the designated airspace from the ATC, in whose airspace they will initially enter.

C. Surrounding ETM Operations: Upper Class E Airspace

UCE airspace refers to airspace over the CONUS from FL600 and above. As a Class E airspace, ATC can provide separation services in UCE, but the infrastructure for Communications, Navigation, and Surveillance (CNS) is not sufficient for scale of operations. Class E airspace operates generally under VFR, but many of the vehicle types in UCE are uncrewed and cannot fly using VFR, and IFR operations are challenging without proper CNS infrastructure.

Currently, most operations in UCE airspace are conducted by military and state aircraft which normally utilize "due regard" operations which leaves the separation responsibility solely to the military/state aircraft to ensure separation from any other flights. Until recently, flights capable of operating at these flight levels in UCE were minimal. Civilian operations that wish to operate at these altitudes must obtain a Certificate of Authorization (COA) from the FAA to operate and file for ALTRAVs once they reach UCE. The COAs are approved on a flight-by-flight basis and are not scalable if commercial activities in UCE grow according to the expectations.

Currently, there already exists a variety of vehicle types flying in UCE under different sets of rules. Unmanned free balloons (UFB), operating part 101, are allowed to penetrate UCE airspace. There is a requirement that they notify the ATC facility nearest to the launch site 6-24 hours prior to launch. They are also required to provide updated position reports every 2 hours [13]. Manned military aircraft can operate in UCE airspace using due regard rules to avoid other traffic. Unmanned public aircraft can obtain COAs to operate in UCE airspace. Public aircraft are defined as flights in support of a public mission (firefighting, storm chasing, etc). There is a process for civil operators to request a waiver to operate in UCE, usually for experimental reasons. Using this waiver process, commercial uncrewed airships, slow HALE and fast HALE that are not state/public aircraft can access UCE on a case by case basis [13].

Although these different types of flights / missions fly in UCE today, there are currently no airspace management provisions specific to unmanned, or manned, civil (private) aircraft operations in UCE. In general, there is no traffic management mechanism or process to deconflict multiple aircraft in UCE except for procedurally authorizing airspace reservations, such as SUA, ALTRV, or Restricted Area (RA).

In UCE, the Central Altitude Reservation Function (CARF) is responsible for coordinating military and civilian ALTRVs for operations within the National Airspace System (NAS). As civilian operations expect to increase in UCE that is predominantly used by the military today, use of ALTRVs and the role of CARF may become more prevalent outside of ETM CAs. The current CARF ALTRV process is [13]:

1. Operators requesting ALTRV send CARF an email with information as required in FAA JO7610.4 Chapter 3.
2. CARF specialists enter the mission information into their computer system (C3) to identify any conflicts with other ALTRVs.
3. If there are no conflicting requests, FAA specialists coordinate with FAA facilities for approval. This is usually done by phone or email.
4. If there is a conflicting ALTRV request, the specialist decides which request has priority (based on precedence in 7610.4) and contacts the lower priority operator to change their request. If both operations have equal priority, CARF provides information back to operators for resolution. If the conflict occurs between operators with same level of priority operators and they cannot resolve the overlap, CARF uses First come/First serve to decide who gets the requested ALTRV airspace.
5. CARF specialists also have a capability to input "information only" airspace data into their computer to identify overlap with approved ALTRVs and provide notification to others of this activity.

MITRE, a federally funded research and development center, with the FAA have developed and proposed an expanded use of CARF/ALTRV procedures for supporting the UCE access in the short-term. The procedures expand and improves upon current CARF process for approving Stationary and Moving ALTRVs in UCE airspace [12,13]. Some of the recommended changes / improvements include:

1. Change the notification request time from 24 hours to 72 hours to allow for coordination process.
2. Utilize the "information only" message to coordinate UFB operations with other UCE participants. This would include notification of overlaps back to both parties, but it is not a reservation and overlaps do not have to be resolved.

3. Modify policies and procedures to issue Notice to Air Missions (NOTAMs) for moving ALTRVs in UCE and information only airspace, this includes changes that allow uncrewed aircraft the use of ALTRVs in UCE and use of ALTRVs for single aircraft.
4. Develop and provide guidance to UCE operators, develop Letter of Agreements (LOAs), advisory circulars (ACs), etc. and develop training materials.
5. Make ALTRV procedures currently in 7610.4 available to the public.

In addition, CARF recommends that the FAA deploy Phase 1 (1-2 years) web-based user portal that includes an airspace request builder (ARB) that can guide operators through the airspace request process and reduce coordination. In 3-4 years, they recommend a CARF/ARTCC interface for coordinating ALTRVs. Also, they want to enable operators to directly input updated UFB position updates that are made publicly available. Finally, they recommend developing a capability to visualize the ALTRVs and other related information, to electronically coordinate the ALTRV requests and approvals, and to enable ALTRV request to go directly into the automation.

These processes provide easier access to UCE for uncrewed vehicles, improve coordination processes, and provide improved assessment of overlapping ALTRVs/information only airspace. However, they do not greatly improve the efficient use of UCE constrained airspace. There would still only be procedural separation of airspace for vehicle use via ALTRVs/SUAs etc., and the airspace approved would be static with no ability for tactical adjustments once airborne. In addition, notification of all parties of UFB information only airspace would leave deconfliction up to operators prior to launch. Also, continuation of the voluntary nature of participation for some parties will limit any ability to guarantee separation from all vehicles, and there is no conformance monitoring capability and no equipment requirements for UFB. These limitations in UCE can be overcome with ETM operations, utilizing dynamic intent sharing and frequent OI updates for better intent predictions, along with active monitoring and deconfliction of the OIs via COPs negotiations.

IV. Coordination Procedures between ETM and Surrounding Airspace Operations

The previous section provided a high-level summary of operations that exist or are expected in ETM, Class A, and UCE. In the future, ETM operations will need to integrate and co-exist with existing operations in Class A and UCE. The following sections describe a set of use cases identified as nominal scenarios for transiting an ETM vehicle between ETM CA and surrounding airspace operations, as well as use cases that describe authorization and termination of ETM CAs.

The overall context of the interactions and the associated use cases are summarized below, followed by an Appendix that includes step-by-step procedures across thirteen different use cases in total that have been developed in our research effort.

A. Transition of ETM Vehicles between ETM and Class A Airspace Operations

When a vehicle transits through Class A airspace and flies below FL600, it remains under the control of ATC, where ATC is responsible for managing separation between the vehicle and other ATM traffic. As this applies to ETM operations, the ETM vehicle will be under ATC control during its ascent to / descent from FL600, where it will enter ETM CA or conventional UCE airspace not under ETM operations.

While an ETM vehicle is in Class A airspace, the vehicle would fly under normal IFR flight plans, and in theory is treated no different than other vehicles under ATC control. In reality, each ETM vehicle type currently flies using different special rules – e.g. balloons flying under part 101 rules instead of IFR, uncrewed HALE vehicles transiting through Class A airspace with COAs and designated airspace away from other traffic, etc. – instead of requiring ATC to maintain vehicle-to-vehicle separation between these types of vehicles and conventional air traffic. However, these operational procedures are already in place and evolving, independent of ETM concept development.

A gap in the future concepts that is needed for ETM-ATS integration is a development of procedures for ETM vehicle transiting between ETM CA and surrounding airspace operations. Procedures for the transition that an ETM vehicle must go through when it leaves Class A and enters ETM CA, as well as when it re-enters Class A from ETM CA, should be developed to identify the roles/responsibilities, coordination between parties, and potential decision support tools needed to safely manage the transition. The use cases are listed as follows:

Vehicle Transiting between ETM CA and Class A Airspace

Trigger Event	Description	Traffic
1a	Planned <u>ENTRY</u> into an ETM CA through Class A, ATC-controlled airspace during ascent	Sterile
1b		Non-Sterile i.e., conventional aircraft in Class A
2a	Planned <u>EXIT</u> out of an ETM CA through Class A, ATC-controlled airspace during descent	Sterile
2b		Non-Sterile i.e., conventional aircraft in Class A

The use cases above are described in detail in the Appendix. Each use case has detailed step-by-step procedures that outlines the roles and responsibilities by air traffic service providers, ETM vehicle operators, and ESS network during the transition.

B. Transition of ETM Vehicles between ETM and Upper Class E Airspace Operations

If an ETM vehicle transits through Class A into UCE first and then enter ETM CA, then the transition between UCE operations (e.g. ALTRVs) and ETM operations will need to be defined. Currently, there is no well-established procedures for civilian operations to operate in UCE, so the procedures that are described in this paper makes certain assumptions about the future UCE operations. In this paper, MITRE/FAA's proposal for extending CARF to use ALTRVs to procedurally separate civilian vehicles from other traffic, was assumed as the future UCE operations. All civilian vehicles in UCE were assumed to have coordinated with CARF to obtain approved ALTRVs except the UFBs that provide their updated "information only" position data, as described in the earlier UCE section. Military vehicles operating under MARSA will also be able to keep track of all other traffic via ALTRVs or "information only" position data.

Based on these assumptions, four additional use cases for UCE / ETM CA transitions, which mirror the ones for Class A / ETM CA transition, have been identified and step-by-step procedures have been developed,the use cases are listed as follows:

Vehicle Transiting between ETM CA and UCE Airspace

Trigger Event	Description	Traffic
1a (lateral)	Planned ENTRY into an ETM CA through Upper Class E airspace (during ascent from Class A to Upper Class E before entering ETM CA	Sterile
1b (lateral)		Non-Sterile i.e., conventional aircraft in Class A
2a (lateral)	Planned EXIT out of an ETM CA through Upper Class E airspace (during descent to Class A to Upper Class E after exiting ETM CA	Sterile
2b (lateral)		Non-Sterile i.e., conventional aircraft in Class A

The use cases above are described more in detail in the Appendix. Each use case has detailed step-by-step procedures that outlines the roles and responsibilities by air traffic service providers, CARF, ETM vehicle operators, and ESS network during the transition.

In two of the use cases above, ATCs need to actively deconflict vehicles in "non-sterile" Class A airspace, in which conventional traffic is in the way of the ETM vehicle and they need to be kept a safe distance away from each other. Analogous scenarios in which vehicles need to be deconflicted in UCE were not included in the use case development. Proposed procedures for CARF ALTRV reservation process assumes strategic deconfliction of airspace volumes between vehicles 24-72 hours in advance. Based on such assumption, we have inferred that the ALTRV volumes will be large enough, both spatially and temporally, that there will be no need for additional deconfliction efforts within than 1–2-hour timeframe, as assumed for both ATC and ETM operations in the use cases.

C. Initialization and Termination of ETM Cooperative Areas for ETM Operations

The second method for integrating ETM operations in the NAS is to enable ETM operations in traditionally ATC-controlled airspace in Class A airspace and relieve ATC of the responsibility of separating, managing, and communicating with the ETM operations, or to enable ETM operations in UCE. In an ETM CA, ETM operators deconflict their flight paths without air traffic service providers through COPs, so authorizing ETM CA in Class A airspace under ATC requires a process for transferring the separation responsibility from ATC to ESS Network. In contrast, authorizing ETM CA in UCE airspace requires a transition of operations from ALTRVs or other existing operations in UCE to ETM, which transitions procedural separation responsibilities from one system to another. Seven additional use cases have been identified as follows:

Airspace Authorization

Trigger Event	Description	Traffic
3A	Authorize ETM CA in Class A	Sterile
3B	Authorize ETM CA in Class A	Non-Sterile i.e., conventional aircraft
3C	Authorize ETM CA in Upper Class E	Sterile
3D	Authorize ETM operating region in Upper Class E	Non-Sterile i.e., conventional aircraft
3E	Planned release of an ETM CA back to ATS/ATC in Class A / Upper Class E (Change driven by decrease in ETM traffic tempo – all vehicles have already exited)	Sterile
3F	Planned release of an ETM CA back to ATS/ATC in Class A / Upper Class E (Change driven by decrease in ETM traffic tempo)	ETM Vehicle(s) continue to operate
3G	Modification of Existing ETM CAs: Excess ETM Demand over current capacity, ESS Requests Additional Lateral Airspace in Upper Class E / Class A (Change driven by increase in ETM traffic tempo)	Sterile

For these use cases, step-by-step procedures for initiating / authorizing a new ETM CA in both UCE and Class A airspace, as well as terminating or modifying an existing ETM CA in UCE and/or Class A airspace are detailed in the Appendix.

V. Discussions

A set of use cases and coordination procedures for the integration of ETM operations with the surrounding Class A and UCE airspace were described in the previous section. The use cases were outlined for different nominal scenarios in which an ETM vehicle takes off from the ground in ATCE, traversing through Class A airspace and either 1) entering directly into ETM CA, or 2) entering first into UCE that is not under ETM operations and then enter ETM CA from UCE. Conversely, the nominal scenarios in which the ETM vehicle exits ETM CA and enter either into Class A or UCE are also described in detail. In addition, other use cases in which a new or a modified ETM CA is authorized for ETM operations in Class A or UCE have been developed, as well as termination of an existing ETM CA and return of the airspace operations back to Class A or UCE.

Development of these use cases and procedures were done to support future concept and demonstration activities planned at NASA. These initial sets of procedures will be modified and updated as we gain more insights into the concept during upcoming simulation / demonstration activities. In the meantime, this initial development activity has led to some preliminary insights and helped to identify some potential challenges for integrating ETM CA with UCE. These challenges are described below.

A. Vehicle Transiting to/from ETM Cooperative Area to/from Upper Class E

For vehicle transition to/from Class A or UCE into and out of ETM CA, the procedures are quite similar between Class A and UCE entry/exit until the ETM vehicle reaches the transition point. At those transition points, however, the procedures differ considerably between Class A and UCE. For Class A, the transition involves ATC, who is monitoring and is responsible for the vehicle-to-vehicle separation in the ATCE until the vehicle transition into ETM CA. In contrast, UCE is not expected to have normal ATC separation support nor standard surveillance infrastructure, both currently and in the near future. Therefore, the vehicle separation is handled in alternative procedural methods, such as ALTRVs and MARSA. If the underlying assumptions in UCE outside of ETM CA will not change significantly, the transition procedures from UCE needs to be detailed and handled differently than ones from ATCE.

One of the difficulties in developing transition from UCE to/from ETM CA was that there are no clear procedures for handling commercial vehicles in UCE. UFBs can enter UCE without much coordination and other commercial vehicles have entered UCE on case-by-case basis for experimental purposes. Most of the current procedures have been exercised for military operations. In the future, these procedures would need to be modified and scaled to handle higher traffic levels of commercial vehicles. How the future UCE operations develop for commercial vehicles outside of ETM CA will impact the detailed transition procedures for ETM operations.

There are several challenges and open questions associated with UCE and ETM CA transitions. One of the issues is how UFBs are handled in UCE vs. how it is expected to be handled in ETM. Currently, UFBs can enter UCE uncoordinated. MITRE/FAA have proposed to integrate them into CARF coordination by assigning "information only" airspace to UFBs and alert any overlap with existing ALTRVs. In contrast, ETM concept assumes both UFBs and other ETM vehicles to file their OIs that provide airspace volumes that defines area of airspace in which they expect to stay within and deconflict with other vehicles' OIs. Therefore, there is a potential for a significant mismatch between vehicle spacing at the entry point, where a UFB can potentially enter ETM CA closely in sequence with a HALE fixed-wing vehicle, which would be allowed in UCE but will immediately be in conflict once they enter ETM CA. This issue can be resolved by adding requirements for ETM CA entry for UFBs, such as making sure to be sequenced far enough from surrounding vehicles upon entry to not cause an OI conflict upon entry, but UFBs might not have enough maneuverability to avoid the other vehicles unless they plan well in advance. This issue is solvable, but some attention is needed to recognize this mismatch of UFB handling.

Another challenge is the integration of ALTRV reservation with ETM operations. The timeframe of decision making is problematic in that the CARF procedures for ALTRVs predicate on requesting and approving ALTRVs 24-72 hours in advance. In contrast, transition procedures in Class A and ETM CA may start in a similar timeframe, but the vehicle's intent is expected to be modified / updated as the vehicle reaches the transition point. Given the assumption that ALTRVs are set days in advance, dynamic adjustments of ALTRVs should not be nominal occurrence. It is likely that ALTRVs would need to be large and departure and flight predictions to be accurate enough to accommodate changes in vehicle positions and predictions without dynamic changes to ALTRVs.

B. Authorization and Termination of ETM Cooperative Area in Class A and Upper Class E Airspace

For the initial implementation of ETM CA, the authorization of ETM CA in either Class A or UCE could be simple. The authorization may occur over a fixed, pre-coordinated area of airspace that is simple in its geometry to ease the communication of its boundaries (e.g. simple polygons) and they may be authorized during low traffic periods and kept active for days or months.

However, as the traffic demand increases and the airspace resources become scarce, it would make more sense to authorize ETM CAs when the traffic demand / situations warrant them and terminate them when not needed so that a wider collection of vehicles that may or may not meet the ETM equipage requirements can access the airspace without ETM operations.

Use cases were identified and procedures were developed to step through what coordination would be needed in authorization and termination of ETM CAs during midday with potential traffic in the impacted airspace (see Appendix). Working through these use cases, the resulting procedures seemed to suggest that authorization and termination process could largely be the same whether they were occurring in Class A or UCE airspace. UCE procedures were a bit simpler than those of Class A because to authorize or terminate ETM CA in an ATCE, additional coordination was needed to alert the ATCs that 1) a part of their airspace was being authorized for ETM operations during the authorization and 2) a part of ETM operations in their airspace would revert to their control in the termination process. Otherwise, the remaining steps were mostly the same between the two scenarios.

During the authorization of ETM CA in Class A airspace, if there exists conventional, non-ETM traffic that are present and/or are predicted to traverse through the ETM CA, ATC can reroute the impacted traffic around the area in order to keep non-ETM traffic away from the region. Due to the planning timeframe of ALTRV approval in UCE, such dynamic interventions seem more challenging. Therefore, any ETM CA authorization in UCE may need to be coordinated 24-72 hours in advance to match the planning horizon in UCE.

Similarly, termination of ETM CA can occur dynamically in Class A airspace by coordinating the transfer of responsibilities of ETM vehicles that still exist in ETM CA back to ATC at the time of the termination. In contrast, termination of ETM CA while ETM vehicles are still present in the airspace would be more challenging if the airspace is returned to normal UCE operations. The planning of the termination may need to be coordinated 24-72 hours in advance so that the ETM vehicles already have approved ALTRVs in UCE when the termination occurs. Such challenges would disappear if ALTRV or any other mechanisms to operate in UCE can be dynamically managed in 1–2-hour timeframe instead of 24-72 hours, which may be developed in future UCE operations.

VI. Conclusion

As a part of developing ETM concept, tools, and procedures, there needs to be an understanding on how ETM operations could be integrated into the surrounding airspace operations in Class A and UCE airspace. Prior and current research on ETM have largely focused on how ETM vehicles would operate within the ETM CA, by sharing their OIs and negotiating to strategically deconflict their future intents based on community-agreed COPs. A demonstration of the concept and procedures using prototype tools developed by NASA and industry partners are currently in plans.

The following step in ETM concept development is to demonstrate how ETM vehicles transition between ETM CA and surrounding airspace. Since ETM vehicles are generally expected to operate at high altitudes at or above 60,000 ft, they need to transit through the Class A airspace and maybe also through UCE airspace not under ETM operations. In this paper, a set of use and step-by-step procedures have been developed for nominal vehicle transitions and authorization / termination of ETM CAs. The resulting procedures have revealed potential challenges and open questions, related to the integration of ETM CA and ETM operations into UCE.

Next steps for this research are twofold. One would be to incorporate the use cases and procedures developed for the ETM vehicle transitions into NASA's upcoming concept evaluation demonstration activities. These activities involve prototype tool development for ETM operations by both NASA and industry partners.

Second is to identify gaps in current assumptions and tool development in ETM research and other air traffic system investments that could potentially be insufficient for successful implementation of the ETM concept. Depending on the identified gaps, new decision support and coordination tools could be suggested to fill those gaps to facilitate safer operations during the transition points. These gaps and tool suggestions have been captured and reported in [14]. Combined, these efforts will help propel the ETM concept forward and get it closer to a robust implementation in the future.

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Appendix

A. Coding Scheme and Terminology Definitions in the Use Case Procedures

For the use case tables below, following are descriptions of the coding schemes and the definitions of the terminologies:

- The procedural steps are numbered in sequence from the start to finish. The steps that are expected to happen in parallel are grouped together by lower-case, alphabetical letters (a, b, c).
- A couple of colors are used to highlight important differences between procedures and/or the use cases:
  - In the use case narratives and row titles, **brown** is used when describing off-nominal/unplanned events and non-standard procedures.
  - **Blue** is used when differentiating UCE from Class A procedures.
  - **Gray** is used for notes and to indicate use cases/scenarios not described or applicable to these step-by-step procedures.
- The procedures contain several terminologies that are repeated throughout the descriptions. Here are a set of terms that are most frequently use:
  - In general, we use the terms:
    - "**Operator**" to refer to the company/dispatcher who is responsible for the vehicle/planning.
    - "**RPIC**" or "**PIC**" to refer to the person piloting/controlling the vehicle/aircraft.
    - However, for the **ETM domain (balloons and airships),** where the **Operator** may also be the controlling entity, we merge these terms and refer to the "**Operator/RPIC**."
  - "**xTM Operator service supplier"** refers to a communication bridge between the xTM Operator and others in the xTM eco-system that provides tools, automation, or services to monitor the region, execute safe missions, store operational data, etc.:
    - **ESS (also referred to as "Operator ESS")**
  - "**xTM Network service supplier automation**" refers to network automation that connects multiple xTM Operator service suppliers together to share information and provide a cooperative framework for the operators:
    - **ESS Network (ETM)**
  - **Air Traffic Services (ATS):** The ESS Network also provides a communication bridge to **Air Traffic Services (ATS).** ATS is a new, FAA-provided service that enables a gateway to the ESS Network to exchange relevant xTM vehicle information between xTM and the conventional ATM system. However, in this document, **we broaden the definition of ATS to include both automation and humans involved in the information exchange between xTM and conventional ATM.** The reason for expanding the definition is that we envision that communication exchanges that center on human operators today, such as traffic management coordinators, may eventually be supplanted by ATS automation in future interactions with xTM, though it is unclear when a change like that may happen. Therefore, we describe ATS handling these information exchanges and coordination with an understanding that it may be done by the actual ATS or in conjunction with a human service provider.
  - **Air Traffic Control (ATC)** is used to signify air traffic controllers and/or other human service providers who communicate directly with the xTM vehicle's Operator/RPIC/PIC.
  - **Central Altitude Reservation Function (CARF):** Part of the Air Traffic Control System Command Center (ATCSCC) that is responsible for coordinating military and civilian altitude reservations (ALTRVs) for operations within the NAS.
    - Receives and processes ALTRV requests.
    - Deconflicts with any other ALTRV in the area and transmits ALTRV approval requests (APREQs) to relevant ATC facilities for approval.
    - Issues ALTRV approvals 48–72 hours prior to estimated time of departure.
    - Responsible for the formulation and dissemination of appropriate NOTAMs for those ALTRVs which CARF has processed and are within CARF's area of jurisdiction, as required.
    - Will notify affected facilities of any changes or cancellations after approval is sent.

- **Altitude Reservations (ALTRVs):** Authorization of airspace utilization that cannot be scheduled using existing special use airspace. ALTRVs receive special handling (i.e., priority over other traffic except for safety-related issues like emergencies, Lifeguard etc.), as well as priority over ATC-assigned airspace. Following are the different types of ALTRVs:
  - **Stationary ALTRV:** Used for activities within a fixed volume of airspace to be occupied for a specific period (e.g., Space activity, Unmanned Aircraft Systems (UAS)). FAA-defined separation standards for Stationary ALTRV as follows:
    - **Stationary Reservations or two Stationary areas (FAA Order 7610.4):**
      - Greater than 0
  - **Moving ALTRV:** Used for enroute activities and advances with the mission/vehicle(s) as it progresses (Note: UAS can now use moving ALTRV as of 2022). FAA-defined separation for Moving ALTRVs as follows:
    - **Vertical Separation (FAA Order 7110.65):**
      - Up to and including FL290: 1,000 ft
      - Above FL290 to and including FL600: 2,000 ft
      - Above FL600: 5,000 ft
    - **Longitudinal Separation (FAA Order 7610.4):**
      - Oceanic: 60 minutes
      - Domestic: 30 minutes
    - **Domestic Lateral Separation (FAA Order 7110.65):**
      - FL600 and Below: 34 nm (17 nm either side)
      - Above FL600: 50 nm
    - **Oceanic Lateral Separation (FAA Order 7110.65):**
      - 120 nm East region
      - 100 nm West region
    - **Stationary vs. moving: 1/2 the lateral separation required for two Moving ALTRVs:**
      - Domestic:
        - FL600 and Below: 17 nm
        - Above FL600: 25 nm
      - Oceanic:
        - 60 nm for East region
        - 50 nm for West region
- **Informational-only Airspace:** An airspace designation used for balloons.

B. Vehicle Transiting between ETM CA and Class A Airspace

Procedures for the transition that an ETM vehicle must go through when it leaves Class A and enters ETM CA, as well as when it re-enters Class A from ETM CA, are described in detail in the following four use cases and associated procedures. There are two use cases for transitioning from Class A into ETM CA, with and without interaction with conventional air traffic, and two use cases for transitioning from ETM CA back into Class A airspace. The use cases are summarized below.

Use Case	Description	Traffic
1A	Planned ENTRY into an ETM CA through Class A, ATC-controlled airspace during ascent	Sterile
1B		Non-Sterile i.e., conventional aircraft in Class A
2A	Planned EXIT out of an ETM CA through Class A, ATC-controlled airspace during descent	Sterile
2B		Non-Sterile i.e., conventional aircraft in Class A

Following are the step-by-step procedures for the four use cases:

Use Case 1A

<table>
<tr><td colspan="5">Planned ETM Flight
Planned <u>ENTRY</u> into an ETM CA through ATC-controlled, Class A airspace <u>without</u> ATC intervention during ascent in Class A airspace.

NOTE: Hypersonic, Supersonic, or Subsonic Aircraft: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.</td></tr>
<tr><td>Vehicle</td><td>HALE Balloon (and Airship)</td><td>HALE Slow-Speed Uncrewed Fixed-Wing</td><td>HALE High-Speed Uncrewed Fixed-Wing (e.g., Global Hawk)</td><td>High-Speed Crewed Fixed-Wing
(e.g. Hypersonic, Supersonic, or Subsonic Aircraft)</td></tr>
<tr><td>Use Case Narrative</td><td>A HALE balloon or airship Operator is planning an operation in an ETM CA.

To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds.

Note: Balloons flying short missions (e.g., 6–8 hours) may not be equipped with pressurization controls and, as a result, have very limited control.

The balloon/airship ascends through lower Class E and into Class A on its way to an ETM CA.

Nominal Use Case: No expected ATC intervention for traffic management.</td><td>A HALE slow-speed, uncrewed, fixed-wing Operator is planning an operation in an ETM CA.

Ascent is performed via a spiral pattern climb. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit.

The vehicle ascends through lower Class E and into Class A on its way to an ETM CA.

Nominal Use Case: No expected ATC intervention for traffic management.</td><td>A HALE high-speed, uncrewed, fixed-wing Operator is planning an operation through an ETM CA.

These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace (similar to subsonic operations). The vehicle ascends through lower Class E and into Class A on its way to an ETM CA.

Nominal Use Case: No expected ATC intervention for traffic management.</td><td>A high-speed, crewed, fixed-wing Operator is planning an operation through an ETM CA.

These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace*. The vehicle ascends through lower Class E and into Class A on its way to an ETM CA.

*Supersonic flights may utilize a status-driven (active/inactive) "dedicated route" beginning at a SID/waypoint.

Nominal Use Case: No expected ATC intervention for traffic management.</td></tr>
<tr><td>Step 1
ETM Operation Plan</td><td colspan="4">All Vehicles:
The Operator may use third-party services to create an initial 4DT (volume-based for Balloon/Airship and Slow-Speed Fixed-Wing; trajectory-based for High-Speed Fixed Wing) Operation Plan for the ETM CA. The Operator uses a third-party service supplier automation (ESS/ESS Network) to coordinate the vehicle's approximate entry time, location, and operational intent within the ETM CA. If needed, adjustments are made to the vehicle's entry time and location to deconflict operations within the ETM CA. Once deconflicted, the third-party service supplier (ESS Network) approves the Operation Plan.

(This initial Operation Plan is contingent upon coordination with the ATS in Step 3.)</td></tr>
<tr><td>Step 2
Operator Provides Notification to ATS</td><td colspan="4">All Vehicles:
The Operator notifies ATS (via an ATS communication system) of the intended operation and provides the required information,

HALE Balloon (and Airship):
Balloons should operate in accordance with 14 CFR Part 101.37(a).

*Note: Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37.
The Operator notifies the nearest ATC facility 6–24 hours prior to launch, per Letters of Agreement (LOA).</td></tr>
</table>

	HALE Slow-Speed Uncrewed Fixed-Wing: 24 hours prior to launch, the Operator notifies the nearest ATC facility and requests that ATC/Flight Service distribute a NOTAM. **HALE High-Speed Uncrewed Fixed-Wing:** The Operator notifies the nearest ATC facility. **High-Speed Crewed Fixed-Wing:** The Operator notifies the nearest ATC facility. *Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. A "**dedicated route**" begins at a point after takeoff (SID/waypoint) where the Supersonic flight transitions to an "**Active Supersonic route**" and continues until approach (STAR/waypoint).
Step 3 ATS Reviews Notification	**All Vehicles:** ATS utilizes this notification information to evaluate the planned departure and, if necessary, notify the Operator to alter their departure time (launch time for HALE Balloons and Airships).
Step 4 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 5 Flight Plan Filed	**HALE Balloon:** The Operator provides ATS their "**estimated flight path"** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of the ETM CA at the entry time and location to meet their Operation Plan. **HALE Airship:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of the ETM CA at the entry time and location to meet the Operation Plan. The **Airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to launch. **All Other Vehicles:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of the ETM CA at the entry time and location to meet their Operation Plan. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS. Flight plans are filed 24 hours prior to departure for HALE Slow-Speed Uncrewed Fixed-Wing and 1-2 hours prior to departure for HALE Fast-Speed Uncrewed Fixed-Wing. For Supersonics, the Operator files an **IFR Flight Plan** with ATC, 6–24 hours in advance (per 7110.65 9-2-15a), to utilize a "**dedicated route.**" An "**Active Supersonic route**" is managed by ATC.
Step 6 Request Departure Clearance	**HALE Balloon:** Not applicable. Balloon Operator does not request departure clearance. **All Other Vehicles:** When ready for takeoff, the Operator/RPIC requests departure clearance from ATC.
Step 7 ATC Provides Departure Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** ATC provides departure clearance.
Step 8	**HALE Balloon:** Upon launch, based on coordination with ATS, the Operator/RPIC notifies ATS, in accordance with 14 CFR Part 101.37(d).

Operator/Pilot Executes Clearance	**HALE Airship:** If Airship flies like a balloon, then it follows the balloon procedure. If it is flown like an aircraft, the Operator/RPIC instructs the vehicle to depart, in accordance with their IFR clearance. **All Other Vehicles:** The RPIC (PIC for crewed vehicle) instructs the vehicle to depart, in accordance with their IFR clearance.
Step 9 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. The definition of “standard IFR” may be TBD for the Balloons, Airships, Slow HALE Fixed-Wings, and Supersonics. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its ascent through lower Class E and Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during ascent. For HALE Balloon, it take ~1 hour vertical ascent to FL600. For HALE Airship, it takes ~60–90 min vertical ascent to FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~6–10+ hour vertical ascent to FL600.
Step 10 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 11 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **“tracked” target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. Note: Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. **HALE Balloon:** Note: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 12 ETM Replanning in Nominal Scenario	**HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** In a **nominal** scenario, given the vehicle’s susceptibility to wind, transit time, and depending on the conformance window needed to enter the ETM CA, it is **likely** that the Operator/RPIC will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. **HALE High-Speed Uncrewed Fixed-Wing:** In a **nominal** scenario, given the vehicle’s **short** transit time and depending on the conformance window needed to enter the ETM CA, it is **unlikely** that the RPIC will need to use the ESS to replan the entry time/location or update/create a new **Operation Plan** when the vehicle approaches ETM CA. **High-Speed Crewed Fixed-Wing:** **Supersonic:** In a **nominal** scenario, given the vehicle’s **high** speed and potential special handling, it is **unlikely** that the PIC will need to use the ESS to replan the entry time/location or update/create a new **Operation Plan** when the vehicle approaches ETM CA.
Step 13a Vehicle Approaches FL600, Prepares to Leave Class A	**All Vehicles:** As the vehicle nears FL600, the Operator/RPIC/PIC (depending on the vehicle type) prepares to transition from Class A into the ETM CA.

Step 13b Notification to ATS/ATC	**All Vehicles:** Notification that the vehicle is leaving Class A airspace and transitioning into the ETM CA is either: a) sent automatically to ATC (or to ATS for Balloon/Airship), or b) communicated to ATC Controller (or to ATS for Balloon/Airship) by the Operator/RPIC/PIC (depending on the vehicle type) *There is ***no explicit approval*** from ATS/ATC to enter the ETM Cooperative Area at FL600.
Step 13c Operator/RPIC Terminates IFR Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** Operator/RPIC/PIC (depending on the vehicle type) informs the ATC Controller that they are terminating their IFR clearance.
Step 13d ATC Controller Terminates Radar Coverage	**HALE Balloon:** ATS acknowledges the Operator/RPIC's notification that the balloon is transitioning out of Class A. **All Other Vehicles:** The ATC Controller acknowledges, "IFR cancellation received, and radar service is terminated."
Step 14 ETM Operations	**All Vehicles:** The Operator/RPIC/PIC (depending on the vehicle type) instructs the vehicle to fly the Operation Plan. **Conformance Monitoring:** The ESS monitors its own vehicle's conformance to its operational intent. The ESS Network monitors conformance in relation to the other ETM operations and the ETM CA boundaries.
Step 15 Surveillance and Communication in ETM CA	**All Vehicles:** In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponder and adhere to all applicable COPs. **Note:** The ADS-B assumption is based on ETM ConOps v1.0.

Use Case 1B

Planned ETM Flight
Planned <u>ENTRY</u> into an ETM CA through ATC-controlled airspace <u>with</u> ATC intervention during ascent in Class A airspace – ATC requests flight plan changes to manage traffic conflict.

NOTE: Hypersonic, Supersonic, or Subsonic Aircraft: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.

Vehicle	**Vehicle**	**HALE Slow-Speed Uncrewed Fixed-Wing**	**HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)	**High-Speed Crewed Fixed-Wing** (e.g. Hypersonic, Supersonic, or Subsonic Aircraft)
Use Case Narrative	A HALE balloon or airship Operator is planning an operation in an ETM CA. To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds. **Note:** Balloons flying short missions (e.g., 6–8 hours) may not be	A HALE slow-speed, uncrewed, fixed-wing Operator is planning an operation in an ETM CA. Ascent is performed via a spiral pattern climb. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit. The vehicle ascends through lower Class E and into Class A on its way to an ETM CA.	A HALE high-speed, uncrewed, fixed-wing Operator is planning an operation through an ETM CA. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace (similar to subsonic operations). The vehicle ascends through lower Class E	A high-speed, crewed, fixed-wing Operator is planning an operation through an ETM CA. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace*. The vehicle ascends through lower Class E and into Class A on its way to an ETM CA. *Supersonic flights may utilize a status-driven (active/inactive) "**dedicated**

<table>
<tr>
<td></td>
<td>equipped with pressurization controls and, as a result, have very limited control.

The balloon/airship ascends through lower Class E and into Class A on its way to an ETM CA.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC would like to temporarily halt the ascent of the HALE Balloon at FL230.

The balloon would not be able to hold the ascent for long – if at all – and would not be able to control lateral movement. Therefore, ATC would have to maneuver <u>other</u> aircraft around the balloon/high-altitude airship if there is a conflict.

The airship Operator has some propulsion control during ascent, but probably not enough for conflict maneuverability.</td>
<td>ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to temporarily halt the ascent of the HALE vehicle and hold at FL230 around waypoint 'XYZ', until traffic is clear.</td>
<td>and into Class A on its way to an ETM CA.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.</td>
<td>route" beginning at a SID/waypoint.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the PIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.

Note: Given the Supersonic's short transit time through Class A, when a potential conflict is detected, the Supersonic flight will (in order of likelihood):

1. Hold on the ground (most likely scenario)

However, if already airborne, the flight may:

2. Hold altitude (less likely scenario)

3. Reroute (least likely, least desirable scenario)

In this use case, we assume the Supersonic is already airborne when the conflict is detected. As a result, ATC instructs them to alter course (#3).</td>
</tr>
<tr>
<td>Step 1
ETM Operation Plan</td>
<td colspan="4">All Vehicles:
The Operator may use third-party services to create an initial 4DT (volume-based for Balloon/Airship and Slow-Speed Fixed-Wing; trajectory-based for High-Speed Fixed Wing) Operation Plan for the ETM CA. The Operator uses a third-party service supplier automation (ESS/ESS Network) to coordinate the vehicle's approximate entry time, location, and operational intent within the ETM CA. If needed, adjustments are made to the vehicle's entry time and location to deconflict operations within the ETM CA. Once deconflicted, the third-party service supplier (ESS Network) approves the Operation Plan.

(This initial Operation Plan is contingent upon coordination with the ATS in Step 3.)</td>
</tr>
<tr>
<td>Step 2
Operator Provides Notification to ATS</td>
<td colspan="4">All Vehicles:
The Operator notifies ATS (via an ATS communication system) of the intended operation and provides the required information.

HALE Balloon (and Airship):
Balloons should operate in accordance with 14 CFR Part 101.37(a). *Note: Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37.
The Operator notifies the nearest ATC facility 6–24 hours prior to launch, per Letters of Agreement (LOA).

HALE Slow-Speed Uncrewed Fixed-Wing:
24 hours prior to launch, the Operator notifies the nearest ATC facility and requests that ATC/Flight Service distribute a NOTAM.

HALE High-Speed Uncrewed Fixed-Wing:
The Operator notifies the nearest ATC facility.</td>
</tr>
</table>

	High-Speed Crewed Fixed-Wing: The Operator notifies the nearest ATC facility. *Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. A "**dedicated route**" begins at a point after takeoff (SID/waypoint) where the Supersonic flight transitions to an "**Active Supersonic route**" and continues until approach (STAR/waypoint).
Step 3 ATS Reviews Notification	**All Vehicles:** ATS utilizes this notification information to evaluate the planned departure and, if necessary, notify the Operator to alter their departure time (launch time for HALE Balloons and Airships).
Step 4 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 5 Flight Plan Filed	**HALE Balloon:** The Operator provides ATS their "**estimated flight path"** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of the ETM CA at the entry time and location to meet their Operation Plan. **HALE Airship:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of the ETM CA at the entry time and location to meet the Operation Plan. The **Airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to launch. **All Other Vehicles:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of the ETM CA at the entry time and location to meet their Operation Plan. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS. Flight plans are filed 24 hours prior to departure for HALE Slow-Speed Uncrewed Fixed-Wing and 1-2 hours prior to departure for HALE Fast-Speed Uncrewed Fixed-Wing. For Supersonics, the Operator files an **IFR Flight Plan** with ATC, 6–24 hours in advance (per 7110.65 9-2-15a), to utilize a "**dedicated route.**" An "**Active Supersonic route**" is managed by ATC.
Step 6 Request Departure Clearance	**HALE Balloon:** Not applicable. Balloon Operator does not request departure clearance. **All Other Vehicles:** When ready for takeoff, the Operator/RPIC requests departure clearance from ATC.
Step 7 ATC Provides Departure Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** ATC provides departure clearance.
Step 8 Operator/Pilot Executes Clearance	**HALE Balloon:** Upon launch, based on coordination with ATS, the Operator/RPIC notifies ATS, in accordance with 14 CFR Part 101.37(d). **HALE Airship:** If Airship flies like a balloon, then it follows the balloon procedure. If it is flown like an aircraft, the Operator/RPIC instructs the vehicle to depart, in accordance with their IFR clearance. **All Other Vehicles:** The RPIC (PIC for crewed vehicle) instructs the vehicle to depart, in accordance with their IFR clearance.

Step 9 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. The definition of "standard IFR" may be TBD for the Balloons, Airships, Slow HALE Fixed-Wings, and Supersonics. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its ascent through lower Class E and Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during ascent. For HALE Balloon, it take ~1 hour vertical ascent to FL600. For HALE Airship, it takes ~60–90 min vertical ascent to FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~6–10+ hour vertical ascent to FL600.
Step 10 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 11 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. Note: Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. **HALE Balloon:** Note: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 12 ATC Manages Traffic Conflict	**All Vehicles:** During ascent, ATC is forced to reroute commercial airline traffic around storm activity. **HALE Balloon (and Airship):** ATC vectors the commercial traffic well clear of the balloon/airship. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATC instructs the RPIC to temporarily hold the vehicle at FL230 around waypoint 'XYZ', for deviating traffic. **HALE High-Speed Uncrewed Fixed-Wing:** ATC instructs the RPIC to amend the assigned altitude to FL380 for deviating traffic. **High-Speed Crewed Fixed-Wing:** ATC instructs the PIC to amend the assigned altitude to FL380 for deviating traffic.
Step 13 Operator/Pilot Executes Clearance	**HALE Balloon (and Airship):** Not Applicable. **HALE Slow-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance and commands the vehicle to hold altitude while maintaining a circular flight path around the specified waypoint. **HALE High-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance, remains on course, and instructs the vehicle to level off at FL380. **High-Speed Crewed Fixed-Wing:** The PIC acknowledges the clearance, remains on course, but levels off at FL380.

Step 14 ATC Resumes Flight Plan Clearance	**HALE Balloon (and Airship):** Not Applicable. **All Other Vehicles:** After the traffic passes, ATC clears the RPIC/PIC to climb and maintain FL600.
Step 15 Operator/Pilot Resumes Flight Plan	**HALE Balloon (and Airship):** Not Applicable. **All Other Vehicles:** The RPIC/PIC acknowledges the clearance and instructs the vehicle to climb and maintain FL600.
Step 16 ETM In-Flight Replanning Due to Altered Entry Time/Location	**HALE Balloon (and Airship):** Given the vehicle's susceptibility to wind, transit time, and depending on the conformance window needed to enter the ETM CA, it is **likely** that the Operator will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. **HALE Slow-Speed Uncrewed Fixed-Wing:** Due to ATC's revised clearance and given the vehicle's susceptibility to wind, **long** transit time, and depending on the conformance window needed to enter the ETM CA, it is **likely** that the Operator/RPIC will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. **HALE High-Speed Uncrewed and Crewed Fixed-Wing:** Due to ATC's revised clearance and depending on the conformance window needed to enter the ETM CA, it is **likely** that the RPIC will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. However, if the RPIC/PIC can get back in conformance with the original **Operation Plan**, then replanning is unnecessary.
Step 17 ETM Receives New Entry Time/Location	**All Vehicles:** As necessary, the Operator ESS replans with the ESS Network for a more precise entry point and time that conforms to the current trajectory and is conflict free in the ETM CA. The ESS Network shares the new Operation Plan with the Operator/RPIC and ATS.
Step 18 Coordination of New Flight Plan with ATC (if necessary)	**HALE Balloon:** If any changes, Operator/RPIC notifies ATS**.** **All Other Vehicles:** If the new Operation Plan requires a change to the current ATC Flight Plan, the Operator/RPIC/PIC (depending on the vehicle type) would need to verbally request a change to the IFR Flight Plan from ATC before following the Operation Plan.
Step 19a Vehicle Approaches FL600, Prepares to Leave Class A	**All Vehicles:** As the vehicle nears FL600, the Operator/RPIC/PIC (depending on the vehicle type) prepares to transition from Class A into the ETM CA.
Step 19b Notification to ATS/ATC	**All Vehicles:** Notification that the vehicle is leaving Class A airspace and transitioning into the ETM CA is either: a) sent automatically to ATC (or to ATS for Balloon/Airship), or b) communicated to ATC Controller (or to ATS for Balloon/Airship) by the Operator/RPIC/PIC (depending on the vehicle type) *There is ***no explicit approval*** from ATS/ATC to enter the ETM Cooperative Area at FL600.

Step 19c Operator/RPIC Terminates IFR Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** Operator/RPIC/PIC (depending on the vehicle type) informs the ATC Controller that they are terminating their IFR clearance.
Step 19d ATC Controller Terminates Radar Coverage	**HALE Balloon:** ATS acknowledges the Operator/RPIC's notification that the balloon is transitioning out of Class A. **All Other Vehicles:** The ATC Controller acknowledges, "IFR cancellation received and radar service is terminated."
Step 20a Transition Complete	**All Vehicles:** The vehicle enters the ETM CA.
Step 20b ETM Operations	**All Vehicles:** The Operator/RPIC/PIC (depending on the vehicle type) instructs the vehicle to fly the Operation Plan. **Conformance Monitoring:** The ESS monitors its own vehicle's conformance to its operational intent. The ESS Network monitors conformance in relation to the other ETM operations and the ETM CA boundaries.
Step 21 Surveillance and Communication in ETM CA	**All Vehicles:** In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponder and adhere to all applicable COPs. **Note:** The ADS-B assumption is based on ETM ConOps v1.0.

Use Case 2A

Planned ETM Flight
Planned EXIT out an ETM CA into ATC-controlled, Class A airspace without ATC intervention during descent in Class A airspace.

NOTE: Hypersonic, Supersonic, or Subsonic Aircraft: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.

Vehicle	HALE Balloon (and Airship)	HALE Slow-Speed Uncrewed Fixed-Wing	HALE High-Speed Uncrewed Fixed-Wing (e.g., Global Hawk)	High-Speed Crewed Fixed-Wing (e.g. Hypersonic, Supersonic, or Subsonic Aircraft)
Use Case Narrative	A HALE Communications balloon/airship, on station for several months in an ETM CA, must descend for required maintenance. In accordance with 14 CFR Part 101 requirements, the Operator notifies ATS with descent information. To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds. **Note:** Balloons flying short missions (e.g., 6–8 hours)	A HALE slow-speed, uncrewed, fixed-wing Operator has completed an operation in an ETM CA and would like to land. Descent is performed via a spiral pattern. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. **Note:** Logistically, the long 10–12-hour descents for these vehicles should be done at night to	A HALE high-speed, uncrewed, fixed-wing Operator has completed their surveillance operation in an ETM CA at or above FL600 and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace (similar to subsonic operations). The vehicle descends out of the ETM CA and into Class A on its way	A high-speed, crewed, fixed-wing Operator has completed their cross-country flight through an ETM CA and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace*. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. *Supersonic flights may utilize a status-driven (active/inactive) "**dedicated route**" ending at a STAR/waypoint.

<table>
<tr>
<td></td>
<td>may not be equipped with pressurization controls and, as a result, have very limited control.

The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace.

Nominal Use Case: No expected ATC intervention for traffic management.</td>
<td>minimize interactions with IFR traffic.

Nominal Use Case: No expected ATC intervention for traffic management.</td>
<td>to lower Class E airspace.

Nominal Use Case: No expected ATC intervention for traffic management.</td>
<td>Nominal Use Case: No expected ATC intervention for traffic management.</td>
</tr>
<tr>
<td>Step 1
Ending the ETM Operation Plan to EXIT the ETM CA</td>
<td colspan="4">All Vehicles:
In a nominal scenario, the Operator uses the third-party service supplier automation (ESS/ESS Network) to continuously update <u>and coordinate</u> the vehicle’s operational intent conformance window (including time and location) to exit the ETM CA.

(The Operation Plan to exit the ETM CA is contingent upon coordination with the ATS in Step 3.)</td>
</tr>
<tr>
<td>Step 2
Operator Provides Notification to ATS to Descend into ATC-Controlled Airspace (Class A)</td>
<td colspan="4">All Vehicles:
The Operator notifies ATS (via an ATS communication system) of their intended departure from the ETM CA and provides the required information.

HALE Balloon (and Airship):
Balloons should operate in accordance with 14 CFR Part 101.37(a). *Note: Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37.
The Operator notifies the ATC facility at the expected exit location 6–24 hours prior to descent, per Letters of Agreement (LOA).

HALE Slow-Speed Uncrewed Fixed-Wing:
24 hours prior to descent, the Operator notifies the ATC facility at the expected exit location and requests that ATC/Flight Service distribute a NOTAM.

HALE High-Speed Uncrewed Fixed-Wing:
The Operator notifies ATS (via an ATS communication system) 1–2 hours prior to descent.
The Operator notifies the ATC facility at the expected exit location.

High-Speed Crewed Fixed-Wing:
The Operator notifies the ATC facility at the expected exit location.
*Supersonic flights may require authorization to utilize a “dedicated route”, which are status driven: Active or Inactive. On descent, a “dedicated route” ends at a (STAR/waypoint).</td>
</tr>
<tr>
<td>Step 3
ATS Reviews Notification</td>
<td colspan="4">All Vehicles:
ATS utilizes this notification information to evaluate the planned descent into Class A airspace and, if necessary, notify the Operator to alter their exit point/time (route and/or exit time for HALE High-Speed Crewed and Uncrewed Fixed-Wings).</td>
</tr>
<tr>
<td>Step 4
ATS Provides Authorization</td>
<td colspan="4">HALE Balloon (and Airship):
ATS provides Authorization as required, per 14 CFR Part 101.33.
*Note: Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33.

HALE Slow-Speed Uncrewed Fixed-Wing:
ATS provides Authorization in accordance with Letters of Agreement (LOA) and/or NOTAMS 24 hrs prior to planned descent with an Air Navigation Service Provider (ANSP).

HALE High-Speed Uncrewed Fixed-Wing:
ATS provides Authorization.

High-Speed Crewed Fixed-Wing:
ATS provides Authorization.
*Supersonic flights may require authorization to utilize a “dedicated route.”</td>
</tr>
</table>

Step 5 Flight Plan Filed for ATC-Controlled Airspace	**HALE Balloon:** The Operator provides ATS their "**estimated descent flight path**" to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. **HALE Airship:** The Operator files an **IFR Flight Plan** to leave ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The **airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to exiting the ETM CA. **All Other Vehicles:** The Operator files an **IFR Flight Plan** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS (for HALE High-Speed Uncrewed Fixed-Wing, the IFR Flight Plan may be submitted 1-2 hours prior to descent).
Step 6 Operator/RPIC/PIC Requests IFR Clearance to Descend into ATC-Controlled Airspace (Class A)	**HALE Balloon:** At the agreed upon time, the Operator/RPIC initiates **descent** toward Class A airspace. Based on coordination with ATS, the Operator notifies ATS/ATC. ATS/ATC provides the Operator/RPIC with a discrete beacon code to squawk – if the balloon is equipped – and acknowledges the Operator/RPIC's notification to operate in Class A airspace. **All Other Vehicles:** As the vehicle approaches the bottom of the ETM CA, the Operator/RPIC contacts the proper ATC sector and requests to pick up their IFR clearance from ATC to enter Class A airspace. **Note:** ADS-B is expected to be on in the ETM CA.
Step 7 ATC Provides IFR Clearance	**HALE Balloon:** Balloons do not receive IFR clearances. ATC scans for the balloon's discrete beacon code and, if observed, would keep everyone well clear of the balloon, to ensure no conflictions. If there is no beacon code, ATC advises other aircraft of the balloon's general location as required. **All Other Vehicles:** ATC identifies the vehicle by assigning the discrete beacon code from the IFR Flight Plan. ATC surveys traffic to ensure no conflictions and issues the IFR pick up clearance to the Operator/RPIC/PIC (Operator or RPIC for Airship; RPIC for Uncrewed HALE; PIC for crewed vehicle). Assumptions about Exit Transition: We assume that when the Operator/Pilot begins coordinating with ATC, that ATC will have ample time to review prior to the vehicle entering ATC-controlled airspace. We assume that, in most of the cases, ATC will be able to successfully complete the transition and accept the clearance.
Step 8a Transition Complete Step 8b Operator/Pilot Executes Clearance	**All Vehicles:** Vehicle enters ATC-controlled airspace. **HALE Balloon:** As the balloon descends, the Operator/RPIC monitors the vehicle, re-calculating the trajectory and predicted landing location at regular intervals, and provides updates to ATS as appropriate. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** The Operator/RPIC (or just RPIC for Slow-Speed HALE) instructs the vehicle to descend in accordance with the IFR clearance. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC (PIC for the crewed vehicle) instructs the vehicle to fly the assigned route and altitude, in accordance with the IFR clearance.
Step 9 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic.

	HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing: ATC manages traffic that is in proximity of the balloon/airship during its descent through Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during desscent. For HALE Balloon, it take ~30-60min vertical descent from FL600. For HALE Airship, it takes ~60–90 min vertical descent from FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~10+ hour vertical descent from FL600.
Step 10 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder – if equipped. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 11 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. Note: Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. HALE Balloon: Note: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 12 ATC Clears Vehicle for Approach *Note: If the flight plan takes the vehicle to another ETM CA, refer to Trigger Event #8.* *Note: IFR Flight Plan could be to loiter in ATC-controlled airspace, creating additional workload for the Controller.*	**HALE Balloon:** As the Operator/RPIC continues to update the ATS on the balloon's updated trajectory, information is shared with appropriate ATC sector(s) through which the balloon will descend. ATC notes the approximate region of the balloon's descent on radar and keeps other traffic well clear of the balloon's operating envelope during its descent. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** Depending on the arrival airport or landing site, as the airship nears its arrival airport, ATC issues the Operator/RPIC a *"minimum IFR altitude"* to maintain until established on the approach and an IFR approach clearance to the airport. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** As the vehicle nears its arrival airport, ATC clears the RPIC for the IFR (published) approach clearance to the airport.
Step 13 Operator/Pilot Acknowledges Approach Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and executes the approach clearance.
Step 14 ATC Clears Operator/Pilot to Contact the Tower	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, ATC clears the Operator/RPIC to contact the tower.
Step 15	**HALE Balloon:** Not applicable.

Operator/Pilot Acknowledges Clearance	**All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and contacts the tower for clearance to land.
Step 16 Tower Clears Operator/Pilot to Land	**HALE Balloon:** Not applicable. The balloon envelope and payload separate, and each section deploys a parachute for soft landing. **All Other Vehicles:** If applicable, the Tower issues the landing clearance and the Operator/RPIC/PIC instructs the vehicle to land.
Step 17 ATC Cancels Flight Plan	**HALE Balloon:** Not applicable. The operator may notify ATS that the balloon is on the ground. **All Other Vehicles:** If applicable, after landing, the Operator advises ATS that the vehicle is on the ground. ATC cancels the IFR Flight Plan.

Use Case 2B

Planned ETM Flight
Planned EXIT out an ETM CA into ATC-controlled, Class A airspace with ATC intervention during descent in Class A airspace – ATC requests flight plan change to manage traffic conflict.

NOTE: Hypersonic, Supersonic, or Subsonic Aircraft: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.

Vehicle	HALE Balloon (and Airship)	HALE Slow-Speed Uncrewed Fixed-Wing	HALE High-Speed Uncrewed Fixed-Wing (e.g., Global Hawk)	High-Speed Crewed Fixed-Wing (e.g. Hypersonic, Supersonic, or Subsonic Aircraft)
Use Case Narrative	A HALE Communications balloon/airship, on station for several months in an ETM CA, must descend for required maintenance. In accordance with 14 CFR Part 101 requirements, the Operator notifies ATS with descent information. To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds. **Note:** Balloons flying short missions (e.g., 6–8 hours) may not be equipped with pressurization controls and, as a result, have *very* limited control. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace.	A HALE slow-speed, uncrewed, fixed-wing Operator has completed an operation in an ETM CA and would like to land. Descent is performed via a spiral pattern. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. **Note:** Logistically, the long 10–12-hour descents for these vehicles should be done at night to minimize interactions with IFR traffic. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to	A HALE high-speed, uncrewed, fixed-wing Operator has completed their surveillance operation in an ETM CA at or above FL600 and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace (similar to subsonic operations). The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to	A high-speed, crewed, fixed-wing Operator has completed their cross-country flight through an ETM CA and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace*. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. *Supersonic flights may utilize a status-driven (active/inactive) "**dedicated route**" ending at a STAR/waypoint. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the PIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.

	ATC Manages Traffic Conflict in Class A: During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC would like to temporarily halt the descent of the HALE Balloon/Airship at FL380. The **Balloon** would not be able to hold the descent for long – if at all – and would not be able to control lateral movement. Therefore, ATC would have to maneuver <u>other</u> aircraft around the balloon/high-altitude airship if there is a conflict. The Airship Operator has some propulsion control during descent, but probably not enough for conflict maneuverability.	temporarily halt the descent of the HALE vehicle and hold at FL380 around waypoint 'XYZ', until traffic is clear.	alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.	**Note:** Given the Supersonic's short transit time through Class A, when a potential conflict is detected, the Supersonic flight may (in order of likelihood): 1. Hold altitude (less likely scenario) 2. Reroute (least likely, least desirable scenario) In this use case, we assume the Supersonic is already airborne when the conflict is detected. As a result, ATC instructs them to alter course (#3).
Step 1 Ending the ETM Operation Plan to **EXIT** the ETM CA	All Vehicles: In a **nominal** scenario, the Operator uses the third-party service supplier automation (ESS/ESS Network) to continuously update <u>and coordinate</u> the vehicle's operational intent conformance window (including time and location) to **exit** the ETM CA. (The Operation Plan to **exit** the ETM CA is contingent upon coordination with the ATS in Step 3.)			
Step 2 Operator Provides Notification to ATS to Descend into ATC-Controlled Airspace (Class A)	**All Vehicles:** The Operator notifies ATS (via an ATS communication system) of their intended **departure from** the ETM CA and provides the required information. **HALE Balloon (and Airship):** Balloons should operate in accordance with 14 CFR Part 101.37(a). *__Note:__ Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37. The Operator notifies the ATC facility at the expected exit location 6–24 hours prior to **descent**, per Letters of Agreement (LOA). **HALE Slow-Speed Uncrewed Fixed-Wing:** 24 hours prior to **descent**, the Operator notifies the ATC facility at the expected exit location and requests that ATC/Flight Service distribute a NOTAM. **HALE High-Speed Uncrewed Fixed-Wing:** **The Operator notifies ATS (via an ATS communication system) 1–2 hours prior to descent.** The Operator notifies the ATC facility at the expected exit location. **High-Speed Crewed Fixed-Wing:** The Operator notifies the ATC facility at the expected exit location. *Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. On **descent**, a "**dedicated route**" ends at a (STAR/waypoint).			
Step 3 ATS Reviews Notification	**All Vehicles:** ATS utilizes this notification information to evaluate the planned **descent** into Class A airspace and, if necessary, notify the Operator to alter their **exit** point/time (route and/or **exit** time for HALE High-Speed Crewed and Uncrewed Fixed-Wings).			

Step 4 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) and/or NOTAMS 24 hrs prior to planned descent with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 5 Flight Plan Filed for ATC-Controlled Airspace	**HALE Balloon:** The Operator provides ATS their "**estimated descent flight path"** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. **HALE Airship:** The Operator files an **IFR Flight Plan** to leave ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The **airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to exiting the ETM CA. **All Other Vehicles:** The Operator files an **IFR Flight Plan** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS. For HALE High-Speed Uncrewed Fixed-Wing, the IFR Flight Plan may be submitted 1-2 hours prior to descent. For High-Speed Crewed Fixed-Wing, the IFR Flight Plan may be submitted 6-24 hours in advance to utilize a "dedicated" route. An "Active Supersonic route" is managed by ATC.
Step 6 Operator/RPIC/PIC Requests IFR Clearance to Descend into ATC-Controlled Airspace (Class A)	**HALE Balloon:** At the agreed upon time, the Operator/RPIC initiates **descent** toward Class A airspace. Based on coordination with ATS, the Operator notifies ATS/ATC. ATS/ATC provides the Operator/RPIC with a discrete beacon code to squawk – if the balloon is equipped – and acknowledges the Operator/RPIC's notification to operate in Class A airspace. **All Other Vehicles:** As the vehicle approaches the bottom of the ETM CA, the Operator/RPIC contacts the proper ATC sector and requests to pick up their IFR clearance from ATC to enter Class A airspace. **Note:** ADS-B is expected to be on in the ETM CA.
Step 7 ATC Provides IFR Clearance	**HALE Balloon:** Balloons do not receive IFR clearances. ATC scans for the balloon's discrete beacon code and, if observed, would keep everyone well clear of the balloon, to ensure no conflictions. If there is no beacon code, ATC advises other aircraft of the balloon's general location as required. **All Other Vehicles:** ATC identifies the vehicle by assigning the discrete beacon code from the IFR Flight Plan. ATC surveys traffic to ensure no conflictions and issues the IFR pick up clearance to the Operator/RPIC/PIC (Operator or RPIC for Airship; RPIC for Uncrewed HALE; PIC for crewed vehicle). Assumptions about Exit Transition: We assume that when the Operator/Pilot begins coordinating with ATC, that ATC will have ample time to review prior to the vehicle entering ATC-controlled airspace. We assume that, in most of the cases, ATC will be able to successfully complete the transition and accept the clearance.
Step 8a Transition Complete	**All Vehicles:** Vehicle enters ATC-controlled airspace.

Step 8b Operator/Pilot Executes Clearance	**HALE Balloon:** As the balloon descends, the Operator/RPIC monitors the vehicle, re-calculating the trajectory and predicted landing location at regular intervals, and provides updates to ATS as appropriate. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** The Operator/RPIC (or just RPIC for Slow-Speed HALE) instructs the vehicle to descend in accordance with the IFR clearance. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC (PIC for the crewed vehicle) instructs the vehicle to fly the assigned route and altitude, in accordance with the IFR clearance.
Step 9 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its descent through Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during desscent. For HALE Balloon, it take ~30-60min vertical descent from FL600. For HALE Airship, it takes ~60–90 min vertical descent from FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~10+ hour vertical descent from FL600.
Step 10 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder – if equipped. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 11 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. **Note:** Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. HALE Balloon: **Note**: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 12 ATC Manages Traffic Conflict	**All Vehicles:** During descent, ATC reroutes commercial airline traffic around storm activity. **HALE Balloon and Airship:** ATC vectors the traffic well clear of the balloon/airship. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATC instructs the RPIC to temporarily hold the vehicle at Flight Level 'ABC' around waypoint 'XYZ' for deviating traffic. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** ATC instructs the RPIC/PIC to turn X degrees left/right for deviating traffic.
Step 13 Operator/Pilot Executes Clearance	**HALE Balloon and Airship:** Not applicable **HALE Slow-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance and instructs the vehicle to hold altitude while maintaining a circular flight path around the specified waypoint. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC/PIC acknowledges the clearance and instructs the vehicle to turn X degrees to the left/right.

Step 14 ATC Resumes Flight Plan Clearance	**HALE Balloon and Airship:** Not applicable **HALE Slow-Speed Uncrewed Fixed-Wing:** After the traffic passes, ATC clears the RPIC to continue descent. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** After the traffic passes, ATC instructs the RPIC/PIC to "proceed direct" to next fix. The remainder of the route is unchanged.
Step 15 Operator/Pilot Resumes Flight Plan	**HALE Balloon and Airship:** Not applicable **HALE Slow-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance and instructs the vehicle to continue descent. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC/PIC acknowledges the clearance and instructs the vehicle to proceed as cleared.
Step 16 ATC Clears Vehicle for Approach *Note: If the flight plan takes the vehicle to another ETM CA, refer to Trigger Event #8.* *Note: IFR Flight Plan could be to loiter in ATC-controlled airspace, creating additional workload for the Controller.*	**HALE Balloon:** As the Operator/RPIC continues to update the ATS on the balloon's updated trajectory, information is shared with appropriate ATC sector(s) through which the balloon will descend. ATC notes the approximate region of the balloon's descent on radar and keeps other traffic well clear of the balloon's operating envelope during its descent. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** Depending on the arrival airport or landing site, as the airship nears its arrival airport, ATC issues the Operator/RPIC a *"minimum IFR altitude"* to maintain until established on the approach and an IFR approach clearance to the airport. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** As the vehicle nears its arrival airport, ATC clears the RPIC for the IFR (published) approach clearance to the airport.
Step 17 Operator/Pilot Acknowledges Approach Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and executes the approach clearance.
Step 18 ATC Clears Operator/Pilot to Contact the Tower	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, ATC clears the Operator/RPIC to contact the tower.
Step 19 Operator/Pilot Acknowledges Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and contacts the tower for clearance to land.
Step 20 Tower Clears Operator/Pilot to Land	**HALE Balloon:** Not applicable. The balloon envelope and payload separate, and each section deploys a parachute for soft landing. **All Other Vehicles:** If applicable, the Tower issues the landing clearance and the Operator/RPIC/PIC instructs the vehicle to land.

Step 21 ATC Cancels Flight Plan	**HALE Balloon:** Not applicable. The operator may notify ATS that the balloon is on the ground. **All Other Vehicles:** If applicable, after landing, the Operator advises ATS that the vehicle is on the ground. ATC cancels the IFR Flight Plan.

C. Vehicle Transiting between ETM CA and the Remainder of Upper Class E Airspace

Procedures for the transition of an ETM vehicle that must go through Upper Class E airspace that is Air Traffic Controlled Environment (ATCE) before entering or exiting ETM CA are described in detail in the following four use cases and associated procedures. There are two use cases for transitioning from ATCE Upper Class E airspace into ETM CA, with and without interaction with conventional air traffic, and two use cases for transitioning from ETM CA back into ATCE Upper Class E airspace. The use cases are summarized below.

Use Case	Description	Traffic
1A (lateral)	Planned <u>ENTRY</u> into an ETM CA through Upper Class E airspace (during ascent from Class A to Upper Class E before entering ETM CA)	Sterile
1B (lateral)		Non-Sterile i.e., conventional aircraft in Class A
2A (lateral)	Planned <u>EXIT</u> out of an ETM CA through Upper Class E airspace (during descent to Class A from Upper Class E after exiting ETM CA)	Sterile
2B (lateral)		Non-Sterile i.e., conventional aircraft in Class A

Following are the step-by-step procedures for the four use cases:

Use Case 1A (lateral)

Planned ETM Flight Planned <u>**ENTRY**</u> into an ETM CA through ATC-controlled airspace and Upper Class E <u>without</u> ATC intervention during ascent in Class A airspace. The vehicle enters laterally into ETM CA from Upper Class E after transiting through Class A airspace. **NOTE: Hypersonic, Supersonic, or Subsonic Aircraft**: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.				
Vehicle	**HALE Balloon (and Airship)**	**HALE Slow-Speed Uncrewed Fixed-Wing**	**HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)	**High-Speed Crewed Fixed-Wing** (e.g. Hypersonic, Supersonic, or Subsonic Aircraft)
Use Case Narrative	A HALE balloon or airship Operator is planning an operation in an ETM CA. To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds. **Note:** Balloons flying short missions (e.g., 6–8 hours) may not be equipped with	A HALE slow-speed, uncrewed, fixed-wing Operator is planning an operation in an ETM CA. Ascent is performed via a spiral pattern climb. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit. The vehicle ascends through lower Class E, into Class A, and then into Upper Class E,	A HALE high-speed, uncrewed, fixed-wing Operator is planning an operation through an ETM CA. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace (similar to subsonic operations). The vehicle ascends through lower Class E,	A high-speed, crewed, fixed-wing Operator is planning an operation through an ETM CA. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace*. The vehicle ascends through lower Class E, into Class A and into Upper Class E. *Because these flights operate at very high speeds, it is assumed that they will have

	pressurization controls and, as a result, have *very* limited control. The Operator determines that the balloon/airship should enter the ETM CA **laterally** – through Upper Class E. The vehicle ascends through lower Class E, into Class A, and then into Upper Class E, where it enters an ETM CA from the side. **Nominal Use Case:** No expected ATC intervention for traffic management.	where it enters an ETM CA from the side. **Nominal Use Case:** No expected ATC intervention for traffic management.	into Class A, and then into Upper Class E, where it enters an ETM CA from the side. **Nominal Use Case:** No expected ATC intervention for traffic management.	their own, segregated, ETM CAs in Upper Class E. *Supersonic flights may utilize a status-driven (active/inactive) "**dedicated route**" beginning at a SID/waypoint. **Nominal Use Case:** No expected ATC intervention for traffic management.
Step 1 ETM Operation Plan	**All Vehicles:** The Operator may use third-party services to create an initial 4DT (volume-based for Balloon/Airship and Slow-Speed Fixed-Wing; trajectory-based for High-Speed Fixed Wing) Operation Plan for the ETM CA. The Operator uses a third-party service supplier automation (ESS/ESS Network) to coordinate the vehicle's approximate entry time, location, and operational intent within the ETM CA. If needed, adjustments are made to the vehicle's entry time and location to deconflict operations within the ETM CA. Once deconflicted, the third-party service supplier (ESS Network) approves the Operation Plan. (This *initial* Operation Plan is contingent upon coordination with the ATS in Step 4.)			
Step 2 Operator Requests ALTRV from CARF to Operate in Upper Class E	**High-Speed Crewed Fixed-Wing:** The Operator notifies ATS (via an ATS communication system) of the intended operation and provides the required information. The Operator notifies the nearest ATC facility. **All Other Vehicles:** The Operator files a **Moving ALTRV (**or an **Informational-only airspace** for HALE Balloons**)** request with CARF 24–72 hours before the vehicle plans to enter Upper Class E. *Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. A "**dedicated route**" begins at a point after takeoff (SID/waypoint) where the Supersonic flight transitions to an "**Active Supersonic route**" and continues until approach (STAR/waypoint).			
Step 3 CARF Reviews the Request and Approves the ALTRV	**HALE Balloons:** CARF reviews the request for the **Informational-only airspace** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, CARF notifies both parties so they can coordinate with each other. If there is no overlap, they publish the **Informational-only airspace.** **All Other Vehicles:** CARF reviews the request for the **Moving ALTRV** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, they follow standard CARF procedures. If there is no overlap, they approve the **Moving ALTRV.**			
Step 4 Operator Provides Notification to ATS	**HALE Balloons and Airships:** The Operator notifies ATS (via an ATS communication system) of the intended operation and provides the required information, in accordance with 14 CFR Part 101.37(a). *Note: Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37. The Operator notifies the nearest ATC facility 6–24 hours prior to launch, per Letters of Agreement (LOA). **All Other Vehicles:** The Operator notifies ATS (via an ATS communication system) of the intended operation and provides the required information. For HALE Slow-Speed Uncrewed Fixed-Wing, The Operator notifies the nearest ATC facility 24 hours prior to launch, and requests that ATC/Flight Service distribute a NOTAM. For Fast-Speed Uncrewed and Crewed Fixed-Wing, The Operator notifies the nearest ATC facility.			

	*Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. A "**dedicated route**" begins at a point after takeoff (SID/waypoint) where the Supersonic flight transitions to an "**Active Supersonic route**" and continues until approach (STAR/waypoint).
Step 5 ATS Reviews Notification	**All Vehicles:** ATS utilizes this notification information to evaluate the planned departure and, if necessary, notify the Operator to alter their departure time (launch time for HALE Balloons and Airships).
Step 6 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 7 Flight Plan Filed	**HALE Balloon:** The Operator provides ATS their "**estimated flight path"** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of Upper Class E airspace in accordance with the filed **Informational-only airspace**. **HALE Airship:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base Upper Class E airspace in accordance with the filed **Moving ALTRV**. The **Airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to launch. **All Other Vehicles:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of Upper Class E airspace in accordance with the filed **Moving ALTRV**. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS. Flight plans are filed 24 hours prior to departure for HALE Slow-Speed Uncrewed Fixed-Wing and 1-2 hours prior to departure for HALE Fast-Speed Uncrewed Fixed-Wing. For Supersonics, the Operator files an **IFR Flight Plan** with ATC, 6–24 hours in advance (per 7110.65 9-2-15a), to utilize a "**dedicated route.**" An "**Active Supersonic route**" is managed by ATC.
Step 8 Request Departure Clearance	**HALE Balloon:** Not applicable. Balloon Operator does not request departure clearance. **All Other Vehicles:** When ready for takeoff, the Operator/RPIC/PIC requests departure clearance from ATC.
Step 9 ATC Provides Departure Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** ATC provides departure clearance.
Step 10 Operator/Pilot Executes Clearance	**HALE Balloon:** Upon launch, based on coordination with ATS, the Operator/RPIC notifies ATS, in accordance with 14 CFR Part 101.37(d). **HALE Airship:** If Airship flies like a balloon, then it follows the balloon procedure. If it is flown like an aircraft, the Operator/RPIC instructs the vehicle to depart, in accordance with their IFR clearance. **All Other Vehicles:** The RPIC (PIC for crewed vehicle) instructs the vehicle to depart, in accordance with their IFR clearance.

Step 11 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. The definition of "standard IFR" may be TBD for the Balloons, Airships, Slow HALE Fixed-Wings, and Supersonics. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its ascent through lower Class E and Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during ascent. For HALE Balloon, it take ~1 hour vertical ascent to FL600. For HALE Airship, it takes ~60–90 min vertical ascent to FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~6–10+ hour vertical ascent to FL600.
Step 12 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 13 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. **Note:** Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. HALE Balloon: Note: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 14 ETM Replanning in Nominal Scenario	**HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** In a **nominal** scenario, given the vehicle's susceptibility to wind, transit time, and depending on the conformance window needed to enter the ETM CA, it is **likely** that the Operator/RPIC will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. **HALE High-Speed Uncrewed Fixed-Wing:** In a **nominal** scenario, given the vehicle's **short** transit time and depending on the conformance window needed to enter the ETM CA, it is **unlikely** that the RPIC will need to use the ESS to replan the entry time/location or update/create a new **Operation Plan** when the vehicle approaches ETM CA. **High-Speed Crewed Fixed-Wing:** **Supersonic:** In a **nominal** scenario, given the vehicle's **high** speed and potential special handling, it is **unlikely** that the PIC will need to use the ESS to replan the entry time/location or update/create a new **Operation Plan** when the vehicle approaches ETM CA.
Step 15a Vehicle Approaches FL600, Prepares to Leave Class A	**All Vehicles:** As the vehicle nears FL600, the Operator/RPIC prepares to transition from Class A into Upper Class E.
Step 15b Notification to ATS/ATC	**HALE Balloon and Airship:** Notification that the vehicle is leaving Class A airspace and transitioning into an **Informational-only airspace/Moving ALTRV** in Upper Class E is either: a) sent automatically to ATS/ATC or, b) communicated to the ATS/ATC Controller by the Operator/RPIC. **All Other Vehicles:** Notification that the vehicle is leaving Class A airspace and transitioning into a **Moving ALTRV** in Upper Class E is either:

	a) sent automatically to ATC or, b) communicated to the ATC Controller by the RPIC.
Step 15c Operator/RPIC Terminates IFR Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** Operator/RPIC/PIC (depending on the vehicle type) informs the ATC Controller that they are terminating their IFR clearance.
Step 15d ATC Controller Terminates Radar Coverage	**HALE Balloon:** ATS acknowledges the Operator/RPIC's notification that the balloon is transitioning out of Class A. **All Other Vehicles:** The ATC Controller acknowledges, "IFR cancellation received, and radar service is terminated."
Step 16 Upon Reaching Upper Class E, the Vehicle Enters the ALTRV	**HALE Balloon:** At the planned start time of the **Informational-only airspace**, the balloon transitions into Upper Class E and begins following the **Informational-only airspace** profile through Upper Class E. **All Other Vehicles:** At the planned start time of the **Moving ALTRV**, the vehicle transitions into Upper Class E and begins following the **Moving ALTRV** through Upper Class E.
Step 17 Vehicle Transits Through Upper Class E Airspace	**HALE Balloon:** The balloon transits through Upper Class E airspace within their **Informational-only** airspace. **All Other Vehicles:** The vehicle transits through Upper Class E airspace within their **Moving ALTRV**.
Step 18 Prepare to Enter ETM CA	**All Vehicles:** As the vehicle prepares to **laterally** enter the ETM CA, the Operator/RPIC/PIC verifies that they will be in compliance with their Operation Plan. If so, they continue into ETM; if not, they coordinate a new Operation Plan or adjust their flight path to meet the original Operation Plan.
Step 19 Prepare to Exit ALTRV	**All Vehicles:** Right now, there is no requirement to provide notification when they exit the ALTRV, but it would be a good idea to notify CARF.
Step 20a Transition Complete – Lateral Entry	**All Vehicles:** The vehicle enters the ETM CA laterally.
Step 20b ETM Operations	**All Vehicles:** The Operator/RPIC/PIC (depending on the vehicle type) instructs the vehicle to fly the Operation Plan. **Conformance Monitoring:** The ESS monitors its own vehicle's conformance to its operational intent. The ESS Network monitors conformance in relation to the other ETM operations and the ETM CA boundaries.
Step 21 Surveillance and Communication in ETM CA	**All Vehicles:** In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponder and adhere to all applicable COPs. **Note:** The ADS-B assumption is based on ETM ConOps v1.0.

Use Case 1B (lateral)

<table>
<tr><td colspan="5">Planned ETM Flight
Planned <u>ENTRY</u> into an ETM CA through ATC-controlled airspace and Upper Class E <u>with</u> ATC intervention during ascent in Class A airspace – ATC requests flight plan changes to manage traffic conflict. The vehicle enters laterally into ETM CA from Upper Class E after transiting through Class A airspace.

NOTE: Hypersonic, Supersonic, or Subsonic Aircraft: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.</td></tr>
<tr><td>Vehicle</td><td>Vehicle</td><td>HALE Slow-Speed Uncrewed Fixed-Wing</td><td>HALE High-Speed Uncrewed Fixed-Wing (e.g., Global Hawk)</td><td>High-Speed Crewed Fixed-Wing
(e.g. Hypersonic, Supersonic, or Subsonic Aircraft)</td></tr>
<tr><td>Use Case Narrative</td><td>A HALE balloon or airship Operator is planning an operation in an ETM CA.

To support control of the vehicle’s trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds.

Note: Balloons flying short missions (e.g., 6–8 hours) may not be equipped with pressurization controls and, as a result, have very limited control.

The Operator determines that the balloon/airship should enter the ETM CA laterally – through Upper Class E.

The vehicle ascends through lower Class E, into Class A, and then into Upper Class E, where it enters an ETM CA from the side.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC would like to temporarily halt the ascent of the HALE Balloon at FL230.

The balloon would not be able to hold the ascent for long – if at all</td><td>A HALE slow-speed, uncrewed, fixed-wing Operator is planning an operation in an ETM CA.

Ascent is performed via a spiral pattern climb. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit.

The Operator determines that the vehicle should enter the ETM CA laterally – through Upper Class E.

The vehicle ascends through lower Class E, into Class A, and then into Upper Class E, where it enters an ETM CA from the side.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to temporarily halt the ascent of the HALE vehicle and hold at FL230 around waypoint ‘XYZ’, until traffic is clear.</td><td>A HALE high-speed, uncrewed, fixed-wing Operator is planning an operation through an ETM CA.

These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace (similar to subsonic operations).

The Operator determines that the vehicle should enter the ETM CA laterally – through Upper Class E.

The vehicle ascends through lower Class E, into Class A, and then into Upper Class E, where it enters an ETM CA from the side.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.</td><td>A high-speed, crewed, fixed-wing Operator is planning an operation through an ETM CA.

These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft through Class A airspace*. The vehicle ascends through lower Class E and into Class A on its way to an ETM CA.

*Supersonic flights may utilize a status-driven (active/inactive) “dedicated route” beginning at a SID/waypoint.

ATC Manages Traffic Conflict in Class A: During ascent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the PIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.

Note: Given the Supersonic’s short transit time through Class A, when a potential conflict is detected, the Supersonic flight will (in order of likelihood):

4. Hold on the ground (most likely scenario)

However, if already airborne, the flight may:

5. Hold altitude (less likely scenario)

6. Reroute (least likely, least desirable scenario)

In this use case, we assume the Supersonic is already</td></tr>
</table>

	– and would not be able to control lateral movement. Therefore, ATC would have to maneuver <u>other</u> aircraft around the balloon/high-altitude airship if there is a conflict. The **airship** Operator has some propulsion control during ascent, but probably not enough for conflict maneuverability. probably not enough for conflict maneuverability.			airborne when the conflict is detected. As a result, ATC instructs them to alter course (#3).
Step 1 ETM Operation Plan	**All Vehicles:** The Operator may use third-party services to create an initial **4DT** (volume-based for Balloon/Airship and Slow-Speed Fixed-Wing; trajectory-based for High-Speed Fixed Wing) **Operation Plan** for the ETM CA. The Operator uses a third-party service supplier automation (ESS/ESS Network) to coordinate the vehicle's approximate entry time, location, and operational intent within the ETM CA. If needed, adjustments are made to the vehicle's entry time and location to deconflict operations within the ETM CA. Once deconflicted, the third-party service supplier (ESS Network) approves the **Operation Plan**. (This *initial* Operation Plan is contingent upon coordination with the ATS in Step 3.)			
Step 2 Operator Requests ALTRV from CARF to Operate in Upper Class E	**HALE Balloon:** The Operator files an **Informational-only airspace** request with CARF 24–72 hours before the balloon plans to enter Upper Class E. **All Other Vehicles:** The Operator files a Moving ALTRV request with CARF 24–72 hours before the vehicle plans to enter Upper Class E.			
Step 3 CARF Reviews the Request and Approves the ALTRV	**HALE Balloon:** CARF reviews the request for the **Informational-only airspace** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, CARF notifies both parties so they can coordinate with each other. If there is no overlap, they publish the **Informational-only airspace**. **All Other Vehicles:** CARF reviews the request for the **Moving ALTRV** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, they follow standard CARF procedures. If there is no overlap, they approve the **Moving ALTRV**.			
Step 4 Operator Provides Notification to ATS	**All Vehicles:** The Operator notifies ATS (via an ATS communication system) of the intended operation and provides the required information. **HALE Balloon (and Airship):** Balloons should operate in accordance with 14 CFR Part 101.37(a). ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37. The Operator notifies the nearest ATC facility 6–24 hours prior to launch, per Letters of Agreement (LOA). **HALE Slow-Speed Uncrewed Fixed-Wing:** 24 hours prior to launch, the Operator notifies the nearest ATC facility and requests that ATC/Flight Service distribute a NOTAM. **HALE High-Speed Uncrewed Fixed-Wing:** The Operator notifies the nearest ATC facility. **High-Speed Crewed Fixed-Wing:** The Operator notifies the nearest ATC facility.			

	*Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. A "**dedicated route**" begins at a point after takeoff (SID/waypoint) where the Supersonic flight transitions to an "**Active Supersonic route**" and continues until approach (STAR/waypoint).
Step 5 ATS Reviews Notification	**All Vehicles:** ATS utilizes this notification information to evaluate the planned departure and, if necessary, notify the Operator to alter their departure time (launch time for HALE Balloons and Airships).
Step 6 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 7 Flight Plan Filed	**HALE Balloon:** The Operator provides ATS their "**estimated flight path"** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base of Upper Class E airspace in accordance with the filed **Informational-only airspace**. **HALE Airship:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base Upper Class E airspace in accordance with the filed **Moving ALTRV**. The **Airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to launch. **All Other Vehicles:** The Operator files an **IFR Flight Plan** for ATC-controlled airspace, where ATC is responsible for separation services, to arrive at the base Upper Class E airspace in accordance with the filed **Moving ALTRV**. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS. Flight plans are filed 24 hours prior to departure for HALE Slow-Speed Uncrewed Fixed-Wing and 1-2 hours prior to departure for HALE Fast-Speed Uncrewed Fixed-Wing. For Supersonics, the Operator files an **IFR Flight Plan** with ATC, 6–24 hours in advance (per 7110.65 9-2-15a), to utilize a "**dedicated route.**" An "**Active Supersonic route**" is managed by ATC.
Step 8 Request Departure Clearance	**HALE Balloon:** Not applicable. Balloon Operator does not request departure clearance. **All Other Vehicles:** When ready for takeoff, the Operator/RPIC requests departure clearance from ATC.
Step 9 ATC Provides Departure Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** ATC provides departure clearance.
Step 10 Operator/Pilot Executes Clearance	**HALE Balloon:** Upon launch, based on coordination with ATS, the Operator/RPIC notifies ATS, in accordance with 14 CFR Part 101.37(d). **HALE Airship:** If Airship flies like a balloon, then it follows the balloon procedure. If it is flown like an aircraft, the Operator/RPIC instructs the vehicle to depart, in accordance with their IFR clearance. **All Other Vehicles:** The RPIC (PIC for crewed vehicle) instructs the vehicle to depart, in accordance with their IFR clearance.

Step 11 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. The definition of "standard IFR" may be TBD for the Balloons, Airships, Slow HALE Fixed-Wings, and Supersonics. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its ascent through lower Class E and Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during ascent. For HALE Balloon, it take ~1 hour vertical ascent to FL600. For HALE Airship, it takes ~60–90 min vertical ascent to FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~6–10+ hour vertical ascent to FL600.
Step 12 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 13 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. Note: Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. HALE Balloon: Note: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 14 ATC Manages Traffic Conflict	**All Vehicles:** During ascent, ATC is forced to reroute commercial airline traffic around storm activity. **HALE Balloon (and Airship):** ATC vectors the commercial traffic well clear of the balloon/airship. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATC instructs the RPIC to temporarily hold the vehicle at FL230 around waypoint 'XYZ', for deviating traffic. **HALE High-Speed Uncrewed Fixed-Wing:** ATC instructs the RPIC to amend the assigned altitude to FL380 for deviating traffic. **High-Speed Crewed Fixed-Wing:** ATC instructs the PIC to amend the assigned altitude to FL380 for deviating traffic.
Step 15 Operator/Pilot Executes Clearance	**HALE Balloon (and Airship):** Not Applicable. **HALE Slow-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance and commands the vehicle to hold altitude while maintaining a circular flight path around the specified waypoint. **HALE High-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance, remains on course, and instructs the vehicle to level off at FL380. **High-Speed Crewed Fixed-Wing:** The PIC acknowledges the clearance, remains on course, but levels off at FL380.

Step 16 ATC Resumes Flight Plan Clearance	**HALE Balloon (and Airship):** Not Applicable. **All Other Vehicles:** After the traffic passes, ATC clears the RPIC/PIC to climb and maintain FL600.
Step 17 Operator/Pilot Resumes Flight Plan	**HALE Balloon (and Airship):** Not Applicable. **All Other Vehicles:** The RPIC/PIC acknowledges the clearance and instructs the vehicle to climb and maintain FL600.
Step 18 ETM In-Flight Replanning Due to Altered Entry Time/Location	**HALE Balloon (and Airship):** Given the vehicle's susceptibility to wind, transit time, and depending on the conformance window needed to enter the ETM CA, it is **likely** that the Operator will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. **HALE Slow-Speed Uncrewed Fixed-Wing:** Due to ATC's revised clearance and given the vehicle's susceptibility to wind, **long** transit time, and depending on the conformance window needed to enter the ETM CA, it is **likely** that the Operator/RPIC will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. **HALE High-Speed Uncrewed and Crewed Fixed-Wing:** Due to ATC's revised clearance and depending on the conformance window needed to enter the ETM CA, it is **likely** that the RPIC will need to use the ESS to replan the entry time/location and update/create a new **Operation Plan** when the vehicle approaches ETM CA. However, if the RPIC/PIC can get back in conformance with the original **Operation Plan**, then replanning is unnecessary.
Step 19 ETM Receives New Entry Time/Location	**All Vehicles:** As necessary, the Operator ESS replans with the ESS Network for a more precise entry point and time that conforms to the current trajectory and is conflict free in the ETM CA. The ESS Network shares the new Operation Plan with the Operator/RPIC and ATS.
Step 20 Coordination of New Flight Plan with ATC (if necessary)	**HALE Balloon:** If any changes, Operator/RPIC notifies ATS. **All Other Vehicles:** If the new Operation Plan requires a change to the current ATC Flight Plan, the Operator/RPIC/PIC (depending on the vehicle type) would need to verbally request a change to the IFR Flight Plan from ATC before following the Operation Plan.
Step 21a Vehicle Approaches FL600, Prepares to Leave Class A	**All Vehicles:** As the vehicle nears FL600, the Operator/RPIC/PIC (depending on the vehicle type) prepares to transition from Class A into Upper Class E.
Step 21b Notification to ATS/ATC	**All Vehicles:** Notification that the vehicle is leaving Class A airspace and transitioning into an **Moving ALTRV** (or **Informational-only airspace for HALE Balloons**) in Upper Class E is either: a) sent automatically to ATS/ATC or, b) communicated to the ATS/ATC Controller by the Operator/RPIC.

Step 21c Operator/RPIC Terminates IFR Clearance	**HALE Balloon:** Not applicable. Balloon does not receive departure clearance. **All Other Vehicles:** Operator/RPIC/PIC (depending on the vehicle type) informs the ATC Controller that they are terminating their IFR clearance.
Step 21d ATC Controller Terminates Radar Coverage	**HALE Balloon:** ATS acknowledges the Operator/RPIC's notification that the balloon is transitioning out of Class A. **All Other Vehicles:** The ATC Controller acknowledges, "IFR cancellation received, and radar service is terminated."
Step 22 Upon Reaching Upper Class E, the Vehicle Enters the ALTRV	**HALE Balloon:** At the planned start time of the **Informational-only airspace,** the balloon transitions into Upper Class E and begins following the **Informational-only airspace** profile through Upper Class E. **All Other Vehicles:** At the planned start time of the **Moving ALTRV**, the vehicle transitions into Upper Class E and begins following the **Moving ALTRV** through Upper Class E.
Step 23 Vehicle Transits Through Upper Class E Airspace	**HALE Balloon:** The balloon transits through Upper Class E airspace within their **Informational-only airspace**. **All Other Vehicles:** The vehicle transits through Upper Class E airspace within their **Moving ALTRV**.
Step 24 Prepare to Enter ETM CA	**All Vehicles:** As the vehicle prepares to laterally enter the ETM CA, the RPIC verifies that they will be in compliance with their Operation Plan. If so, they continue into ETM; if not, they coordinate a new Operation Plan or adjust their flight path to meet the original Operation Plan.
Step 25 Prepare to Exit ALTRV	**All Vehicles:** Right now, there is no requirement to provide notification when they exit the ALTRV, but it would be a good idea to notify CARF.
Step 26a Transition Complete – Lateral Entry	**All Vehicles:** The vehicle enters the ETM CA.
Step 26b ETM Operations	**All Vehicles:** The Operator/RPIC/PIC (depending on the vehicle type) instructs the vehicle to fly the Operation Plan. **Conformance Monitoring:** The ESS monitors its own vehicle's conformance to its operational intent. The ESS Network monitors conformance in relation to the other ETM operations and the ETM CA boundaries.
Step 27 Surveillance and Communication in ETM CA	**All Vehicles:** In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponder and adhere to all applicable COPs. Note: The ADS-B assumption is based on ETM ConOps v1.0.

Use Case 2A (lateral)

Planned ETM Flight
Planned EXIT out an ETM operating region into Upper Class E without ATC intervention during descent. The vehicle exits laterally out of ETM CA into Upper Class E before transiting through Class A airspace.

NOTE: Hypersonic, Supersonic, or Subsonic Aircraft: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.

Vehicle	HALE Balloon (and Airship)	HALE Slow-Speed Uncrewed Fixed-Wing	HALE High-Speed Uncrewed Fixed-Wing (e.g., Global Hawk)	High-Speed Crewed Fixed-Wing (e.g. Hypersonic, Supersonic, or Subsonic Aircraft)
Use Case Narrative	A HALE Communications balloon/airship, on station for several months in an ETM CA, must descend for required maintenance. In accordance with 14 CFR Part 101 requirements, the Operator notifies ATS with descent information. To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds. **Note:** Balloons flying short missions (e.g., 6–8 hours) may not be equipped with pressurization controls and, as a result, have *very* limited control. The Operator determines that the balloon/airship should exit the ETM CA **laterally** – through Upper Class E. The balloon/airship **laterally** exits the ETM CA into Upper Class E, and then descends into Class A on its way to lower Class E airspace. **Nominal Use Case:** No expected ATC intervention for traffic management.	A HALE slow-speed, uncrewed, fixed-wing Operator has completed an operation in an ETM CA and would like to land. Descent is performed via a spiral pattern. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit. The Operator determines that the vehicle should exit the ETM CA **laterally** – through Upper Class E. The vehicle **laterally** exits the ETM CA into Upper Class E, and then descends into Class A on its way to lower Class E airspace. **Note:** Logistically, the long 10–12-hour descents for these vehicles should be done at night to minimize interactions with IFR traffic. **Nominal Use Case:** No expected ATC intervention for traffic management.	A HALE high-speed, uncrewed, fixed-wing Operator has completed their surveillance operation in an ETM CA at or above FL600 and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace (similar to subsonic operations). The Operator determines that the vehicle should exit the ETM CA **laterally** – through Upper Class E. The vehicle **laterally** exits the ETM CA into Upper Class E, and then descends into Class A on its way to lower Class E airspace. **Nominal Use Case:** No expected ATC intervention for traffic management.	A high-speed, crewed, fixed-wing Operator has completed their cross-country flight through an ETM CA and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace*. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. *Supersonic flights may utilize a status-driven (active/inactive) "**dedicated route**" ending at a STAR/waypoint. **Nominal Use Case:** No expected ATC intervention for traffic management.
Step 1 Ending the ETM Operation Plan to **EXIT** the ETM CA	**All Vehicles:** In a **nominal** scenario, the Operator uses the third-party service supplier automation (ESS/ESS Network) to continuously update and coordinate the vehicle's operational intent conformance window (including time and location) to **exit** the ETM CA. (The Operation Plan to **exit** the ETM CA is contingent upon coordination with the ATS in Step 3.)			

Step 2 Operator Requests ALTRV from CARF to Operate in Upper Class E	HALE Balloon: The balloon Operator files an **Informational-only airspace** request with CARF 24–72 hours before the balloon plans to exit the ETM CA. All Other Vehicles: The Operator files a **Moving ALTRV** request with CARF 24–72 hours before the vehicle plans to exit the ETM CA. Assumption: The ALTRV's temporal and spatial windows are large enough such that the ETM Operator would not need to make a change. If not, a change would need to be made.
Step 3 CARF Reviews the Request and Approves the ALTRV	HALE Balloon: CARF reviews the request for the **Informational-only airspace** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, CARF notifies both parties so they can coordinate with each other. If there is no overlap, they publish the **Informational-only airspace**. All Other Vehicles: CARF reviews the request for the **Moving ALTRV** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, they follow standard CARF procedures. If there is no overlap, they approve the **Moving ALTRV**. Note: What if CARF cannot approve the ALTRV? The choices seem to be limited to requesting a different ALTRV, giving *airborne* flights requesting ALTRVs higher priority, or descending through Class A instead. If all these are not viable then they would resort to emergency declaration and action.
Step 4 Vehicle Exits the ETM CA and Enters Upper Class E	HALE Balloon: At the planned start time of the **Informational-only airspace,** the balloon exits the ETM CA and follows the their **Informational-only airspace** profile through Upper Class E. All Other Vehicles: At the planned start time of the **Moving ALTRV**, the vehicle exits the ETM CA and enters the **Moving ALTRV** through Upper Class E.
Step 5 Vehicle Transits Upper Class E Airspace	HALE Balloon: The balloon transits Upper Class E airspace within their **Informational-only airspace**. All Other Vehicles: The vehicle transits Upper Class E airspace within their **Moving ALTRV**.
Step 6 Operator Provides Notification to ATS to Descend into ATC-Controlled Airspace (Class A)	All Vehicles: The Operator notifies ATS (via an ATS communication system) of their intended **departure from** the ETM CA and provides the required information. HALE Balloon (and Airship): Balloons should operate in accordance with 14 CFR Part 101.37(a). *Note: Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37. The Operator notifies the ATC facility at the expected exit location 6–24 hours prior to **descent**, per Letters of Agreement (LOA). HALE Slow-Speed Uncrewed Fixed-Wing: 24 hours prior to **descent**, the Operator notifies the ATC facility at the expected exit location and requests that ATC/Flight Service distribute a NOTAM. HALE High-Speed Uncrewed Fixed-Wing: **The Operator notifies ATS (via an ATS communication system) 1–2 hours prior to descent.** The Operator notifies the ATC facility at the expected exit location. High-Speed Crewed Fixed-Wing: The Operator notifies the ATC facility at the expected exit location. *Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. On **descent**, a "**dedicated route**" ends at a (STAR/waypoint).
Step 7 ATS Reviews Notification	All Vehicles: ATS utilizes this notification information to evaluate the planned **descent** into Class A airspace and, if necessary, notify the Operator to alter their **exit** point/time (route and/or **exit** time for HALE High-Speed Crewed and Uncrewed Fixed-Wings).

Step 8 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) and/or NOTAMS 24 hrs prior to planned descent with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 9 Flight Plan Filed for ATC-Controlled Airspace	**HALE Balloon:** The Operator provides ATS their "**estimated descent flight path"** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. **HALE Airship:** The Operator files an **IFR Flight Plan** to leave ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The **airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to exiting the ETM CA. **All Other Vehicles:** The Operator files an **IFR Flight Plan** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS (for HALE High-Speed Uncrewed Fixed-Wing, the IFR Flight Plan may be submitted 1-2 hours prior to descent).
Step 10 Operator/RPIC/PIC Requests IFR Clearance to Descend into ATC-Controlled Airspace (Class A)	**HALE Balloon:** At the agreed upon time, the Operator/RPIC initiates **descent** toward Class A airspace through Upper Class E via the **Informational-only airspace**. Based on coordination with ATS, the Operator notifies ATS/ATC. ATS/ATC provides the Operator/RPIC with a discrete beacon code to squawk – if the balloon is equipped – and acknowledges the Operator/RPIC's notification to operate in Class A airspace. **All Other Vehicles:** As the vehicle approaches the bottom of Upper Class E via the **Moving ALTRV**, the RPIC contacts the proper ATC sector and requests to pick up their IFR clearance from ATC to enter Class A airspace. *This is the expected UCE-to-Class A process, based on nominal ALTRV-to-ATC airspace procedures.
Step 11 ATC Provides IFR Clearance	**HALE Balloon:** Balloons do not receive IFR clearances. ATC scans for the balloon's discrete beacon code and, if observed, would keep everyone well clear of the balloon, to ensure no conflictions. If there is no beacon code, ATC advises other aircraft of the balloon's general location as required. **All Other Vehicles:** ATC identifies the vehicle by assigning the discrete beacon code from the IFR Flight Plan. ATC surveys traffic to ensure no conflictions and issues the IFR pick up clearance to the Operator/RPIC/PIC (Operator or RPIC for Airship; RPIC for Uncrewed HALE; PIC for crewed vehicle). Assumptions about Exit Transition: We assume that when the Operator/Pilot begins coordinating with ATC, that ATC will have ample time to review prior to the vehicle entering ATC-controlled airspace. We assume that, in most of the cases, ATC will be able to successfully complete the transition and accept the clearance.
Step 12a Transition Complete	**All Vehicles:** Vehicle enters ATC-controlled airspace.

Step 12b Operator/Pilot Executes Clearance	**HALE Balloon:** As the balloon descends, the Operator/RPIC monitors the vehicle, re-calculating the trajectory and predicted landing location at regular intervals, and provides updates to ATS as appropriate. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** The Operator/RPIC (or just RPIC for Slow-Speed HALE) instructs the vehicle to descend in accordance with the IFR clearance. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC (PIC for the crewed vehicle) instructs the vehicle to fly the assigned route and altitude, in accordance with the IFR clearance.
Step 13 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its descent through Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during desscent. For HALE Balloon, it take ~30-60min vertical descent from FL600. For HALE Airship, it takes ~60–90 min vertical descent from FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~10+ hour vertical descent from FL600.
Step 14 Surveillance and Communication in ATC-Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder – if equipped. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 15 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. Note: Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. HALE Balloon: Note: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 16 ATC Clears Vehicle for Approach *Note: If the flight plan takes the vehicle to another ETM CA, refer to Trigger Event #8.* *Note: IFR Flight Plan could be to loiter in ATC-controlled airspace, creating additional workload for the Controller.*	**HALE Balloon:** As the Operator/RPIC continues to update the ATS on the balloon's updated trajectory, information is shared with appropriate ATC sector(s) through which the balloon will descend. ATC notes the approximate region of the balloon's descent on radar and keeps other traffic well clear of the balloon's operating envelope during its descent. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** Depending on the arrival airport or landing site, as the airship nears its arrival airport, ATC issues the Operator/RPIC a *"minimum IFR altitude"* to maintain until established on the approach and an IFR approach clearance to the airport. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** As the vehicle nears its arrival airport, ATC clears the RPIC for the IFR (published) approach clearance to the airport.

Step 17 Operator/Pilot Acknowledges Approach Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and executes the approach clearance.
Step 18 ATC Clears Operator/Pilot to Contact the Tower	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, ATC clears the Operator/RPIC to contact the tower.
Step 19 Operator/Pilot Acknowledges Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and contacts the tower for clearance to land.
Step 20 Tower Clears Operator/Pilot to Land	**HALE Balloon:** Not applicable. The balloon envelope and payload separate, and each section deploys a parachute for soft landing. **All Other Vehicles:** If applicable, the Tower issues the landing clearance and the Operator/RPIC/PIC instructs the vehicle to land.
Step 21 ATC Cancels Flight Plan	**HALE Balloon:** Not applicable. The operator may notify ATS that the balloon is on the ground. **All Other Vehicles:** If applicable, after landing, the Operator advises ATS that the vehicle is on the ground. ATC cancels the IFR Flight Plan.

Use Case 2B (lateral)

Planned ETM Flight Planned EXIT out an ETM operating region into Upper Class E with ATC intervention during descent in Class A airspace – ATC requests flight plan change to manage traffic conflict. The vehicle enters laterally into ETM CA from Upper Class E after transiting through Class A airspace. **NOTE: Hypersonic, Supersonic, or Subsonic Aircraft**: This use case is dependent on supersonic aircraft being part of ETM; if, instead, supersonics are part of ATC-controlled airspace, this is invalid.				
Vehicle	**HALE Balloon (and Airship)**	**HALE Slow-Speed Uncrewed Fixed-Wing**	**HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)	**High-Speed Crewed Fixed-Wing** (e.g. Hypersonic, Supersonic, or Subsonic Aircraft)
Use Case Narrative	A HALE Communications balloon/airship, on station for several months in an ETM CA, must descend for required maintenance. In accordance with 14 CFR Part 101 requirements, the Operator notifies ATS with descent information. To support control of the vehicle's trajectory, pressurization controls (used on larger payload balloons and airships for long-endurance flights) enable operating altitude adjustments that take advantage of prevailing winds.	A HALE slow-speed, uncrewed, fixed-wing Operator has completed an operation in an ETM CA and would like to land. Descent is performed via a spiral pattern. Since the vehicle is susceptible to winds, route flexibility is often an important aspect of transit. The Operator determines that the vehicle should exit the ETM CA **laterally** – through Upper Class E.	A HALE high-speed, uncrewed, fixed-wing Operator has completed their surveillance operation in an ETM CA at or above FL600 and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace (similar to subsonic operations).	A high-speed, crewed, fixed-wing Operator has completed their cross-country flight through an ETM CA and would like to land. These vehicles have high-performance capabilities and are expected to operate like conventional, piloted aircraft down through Class A airspace*. The vehicle descends out of the ETM CA and into Class A on its way to lower Class E airspace. *Supersonic flights may utilize a status-driven

	Note: Balloons flying short missions (e.g., 6–8 hours) may not be equipped with pressurization controls and, as a result, have *very* limited control. The Operator determines that the balloon/airship should exit the ETM CA **laterally** – through Upper Class E. The balloon/airship **laterally** exits the ETM CA into Upper Class E, and then descends into Class A on its way to lower Class E airspace. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC would like to temporarily halt the descent of the HALE Balloon/Airship at FL380. The **Balloon** would not be able to hold the descent for long – if at all – and would not be able to control lateral movement. Therefore, ATC would have to maneuver other aircraft around the balloon/high-altitude airship if there is a conflict. The Airship Operator has some propulsion control during descent, but probably not enough for conflict maneuverability.	The vehicle **laterally** exits the ETM CA into Upper Class E, and then descends into Class A on its way to lower Class E airspace. **Note:** Logistically, the long 10–12-hour descents for these vehicles should be done at night to minimize interactions with IFR traffic. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to temporarily halt the descent of the HALE vehicle and hold at FL380 around waypoint 'XYZ', until traffic is clear.	The Operator determines that the vehicle should exit the ETM CA **laterally** – through Upper Class E. The vehicle **laterally** exits the ETM CA into Upper Class E, and then descends into Class A on its way to lower Class E airspace. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the Operator/RPIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft.	(active/inactive) "**dedicated route**" ending at a STAR/waypoint. **ATC Manages Traffic Conflict in Class A:** During descent, ATC needs to reroute commercial airline traffic around storm activity. As a result, ATC instructs the PIC to alter course (vector or level off at altitude) to avoid potential conflict with rerouted commercial aircraft. **Note:** Given the Supersonic's short transit time through Class A, when a potential conflict is detected, the Supersonic flight may (in order of likelihood): 3. Hold altitude (less likely scenario) 4. Reroute (least likely, least desirable scenario) In this use case, we assume the Supersonic is already airborne when the conflict is detected. As a result, ATC instructs them to alter course (#3).
Step 1 Ending the ETM Operation Plan to **EXIT** the ETM CA	All Vehicles: In a **nominal** scenario, the Operator uses the third-party service supplier automation (ESS/ESS Network) to continuously update and coordinate the vehicle's operational intent conformance window (including time and location) to **exit** the ETM CA. (The Operation Plan to **exit** the ETM CA is contingent upon coordination with CARF to operate in UCE (e.g., **Moving ALTRV** or **Informational-only airspace**) in Step 3.) **Note:** ADS-B is expected to be on in the ETM CA.			

Step 2 Operator Requests ALTRV from CARF to Operate in Upper Class E	**HALE Balloon:** The balloon Operator files an **Informational-only airspace** request with CARF 24–72 hours before the balloon plans to exit the ETM CA. **All Other Vehicles:** The Operator files a **Moving ALTRV** request with CARF 24–72 hours before the vehicle plans to exit the ETM CA. **Assumption:** The ALTRV's temporal and spatial windows are large enough such that the ETM Operator would not need to make a change. If not, a change would need to be made.
Step 3 CARF Reviews the Request and Approves the ALTRV	**HALE Balloon:** CARF reviews the request for the **Informational-only airspace** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, CARF notifies both parties so they can coordinate with each other. If there is no overlap, they publish the **Informational-only airspace**. **All Other Vehicles:** CARF reviews the request for the **Moving ALTRV** and compares it with any other ALTRVs. If there is an overlap with another ALTRV, they follow standard CARF procedures. If there is no overlap, they approve the **Moving ALTRV.** **Note: What if CARF cannot approve the ALTRV?** The choices seem to be limited to requesting a different ALTRV, giving *airborne* flights requesting ALTRVs higher priority, or descending through Class A instead. If all these are not viable then they would resort to emergency declaration and action
Step 4 Vehicle Exits the ETM CA and Enters Upper Class E	**HALE Balloon:** At the planned start time of the **Informational-only airspace**, the balloon exits the ETM CA and follows the **Informational-only airspace** profile through Upper Class E. **All Other Vehicles:** At the planned start time of the **Moving ALTRV**, the vehicle exits the ETM CA and enters the **Moving ALTRV** through Upper Class E.
Step 5 Vehicle Transits Upper Class E Airspace	**HALE Balloon:** The balloon transits Upper Class E airspace within their **Informational-only airspace.** **All Other Vehicles:** The vehicle transits Upper Class E airspace within their **Moving ALTRV**.
Step 6 Operator Provides Notification to ATS to Descend into ATC-Controlled Airspace (Class A)	**All Vehicles:** The Operator notifies ATS (via an ATS communication system) of their intended **departure from** the ETM CA and provides the required information. **HALE Balloon (and Airship):** Balloons should operate in accordance with 14 CFR Part 101.37(a). ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.37. The Operator notifies the ATC facility at the expected exit location 6–24 hours prior to **descent**, per Letters of Agreement (LOA). **HALE Slow-Speed Uncrewed Fixed-Wing:** 24 hours prior to **descent**, the Operator notifies the ATC facility at the expected exit location and requests that ATC/Flight Service distribute a NOTAM. **HALE High-Speed Uncrewed Fixed-Wing:** **The Operator notifies ATS (via an ATS communication system) 1–2 hours prior to descent.** The Operator notifies the ATC facility at the expected exit location. **High-Speed Crewed Fixed-Wing:** The Operator notifies the ATC facility at the expected exit location. *Supersonic flights may require authorization to utilize a "**dedicated route**", which are status driven: Active or Inactive. On **descent**, a "**dedicated route**" ends at a (STAR/waypoint).
Step 7 ATS Reviews Notification	**All Vehicles:** ATS utilizes this notification information to evaluate the planned **descent** into Class A airspace and, if necessary, notify the Operator to alter their **exit** point/time (route and/or **exit** time for HALE High-Speed Crewed and Uncrewed Fixed-Wings).

Step 8 ATS Provides Authorization	**HALE Balloon (and Airship):** ATS provides Authorization as required, per 14 CFR Part 101.33. ***Note:** Currently, Balloons weighing less than 12 lbs. are not required to follow Part 101.33. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATS provides Authorization in accordance with Letters of Agreement (LOA) and/or NOTAMS 24 hrs prior to planned descent with an Air Navigation Service Provider (ANSP). **HALE High-Speed Uncrewed Fixed-Wing:** ATS provides Authorization. **High-Speed Crewed Fixed-Wing:** ATS provides Authorization. *Supersonic flights may require authorization to utilize a "**dedicated route**."
Step 9 Flight Plan Filed for ATC-Controlled Airspace	**HALE Balloon:** The Operator provides ATS their "**estimated descent flight path"** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. **HALE Airship:** The Operator files an **IFR Flight Plan** to leave ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The **airship** Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS – 24 hours prior to exiting the ETM CA. **All Other Vehicles:** The Operator files an **IFR Flight Plan** to leave the ETM CA and enter Class A controlled airspace, where ATC is responsible for separation services. The Operator files the **IFR Flight Plan** with ATC manually, via a Flight Service Station (FSS), or possibly via the ESS. For HALE High-Speed Uncrewed Fixed-Wing, the IFR Flight Plan may be submitted 1-2 hours prior to descent. For High-Speed Crewed Fixed-Wing, the IFR Flight Plan may be submitted 6-24 hours in advance to utilize a "dedicated" route. An "Active Supersonic route" is managed by ATC.
Step 10 Operator/RPIC/PIC Requests IFR Clearance to Descend into ATC-Controlled Airspace (Class A)	**HALE Balloon:** At the agreed upon time, the Operator/RPIC initiates **descent** toward Class A airspace through Upper Class E via the **Information-only airspace**. Based on coordination with ATS, the Operator notifies ATS/ATC. ATS/ATC provides the Operator/RPIC with a discrete beacon code to squawk – if the balloon is equipped – and acknowledges the Operator/RPIC's notification to operate in Class A airspace. **All Other Vehicles:** As the vehicle approaches the bottom of Upper Class E via the **Moving ALTRV**, the RPIC contacts the proper ATC sector and requests to pick up their IFR clearance from ATC to enter Class A airspace. *This is the expected UCE-to-Class A process, based on nominal ALTRV-to-ATC airspace procedures.
Step 11 ATC Provides IFR Clearance	**HALE Balloon:** Balloons do not receive IFR clearances. ATC scans for the balloon's discrete beacon code and, if observed, would keep everyone well clear of the balloon, to ensure no conflictions. If there is no beacon code, ATC advises other aircraft of the balloon's general location as required. **All Other Vehicles:** ATC identifies the vehicle by assigning the discrete beacon code from the **IFR Flight Plan**. ATC surveys traffic to ensure no conflictions and issues the IFR pick up clearance to the Operator/RPIC/PIC (Operator or RPIC for Airship; RPIC for Uncrewed HALE; PIC for crewed vehicle). Assumptions about Exit Transition: We assume that when the Operator/Pilot begins coordinating with ATC, that ATC will have ample time to review prior to the vehicle entering ATC-controlled airspace. We assume that, in most of the cases, ATC will be able to successfully complete the transition and accept the clearance.

Step 12a Transition Complete	**All Vehicles:** Vehicle enters ATC-controlled airspace.
Step 12b Operator/Pilot Executes Clearance	**HALE Balloon:** As the balloon descends, the Operator/RPIC monitors the vehicle, re-calculating the trajectory and predicted landing location at regular intervals, and provides updates to ATS as appropriate. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** The Operator/RPIC (or just RPIC for Slow-Speed HALE) instructs the vehicle to descend in accordance with the IFR clearance. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC (PIC for the crewed vehicle) instructs the vehicle to fly the assigned route and altitude, in accordance with the IFR clearance.
Step 13 ATC Separation Standards	**All Vehicles:** ATC maintains standard IFR separation from other IFR traffic. **HALE Balloon, Airship, and Slow-Speed Uncrewed Fixed-Wing:** ATC manages traffic that is in proximity of the balloon/airship during its descent through Class A airspace and ensures that separation is maintained. ATC separation is maintained during the transit through Class A airspace during descent. For HALE Balloon, it take ~30-60min vertical descent from FL600. For HALE Airship, it takes ~60–90 min vertical descent from FL600. For HALE Slow-Speed Uncrewed Fixed-Wing, it takes ~10+ hour vertical descent from FL600.
Step 14 Surveillance and Communication in ATC- Controlled Airspace	**HALE Balloon:** In accordance with applicable operating requirements, the balloon transmits via ADS-B and/or transponder – if equipped. If not equipped with ADS-B and/or transponder, the balloon Operator provides updated position reports to ATC every 2 hours in accordance with Part 101. The Operator/RPIC is in contact with ATS. **All Other Vehicles:** The vehicle transmits via ADS-B and a transponder, in accordance with IFR procedures. The Operator/RPIC/PIC communicates with ATC on standard frequencies, or in the cases for Airship or Slow HALE Fixed-Wing, the Operator may be in contact with ATS.
Step 15 Information on ATC Display	**All Vehicles:** For any area with radar coverage, a **"tracked" target** is displayed on the En Route ATC scope. The **flight datablock** displays: Aircraft ID, aircraft altitude (assigned and current), ground speed, and computer ID. **Note:** Vehicles without standard surveillance equipment (i.e., a transponder) will not be tracked on the En Route ATC scope. Vehicle position information (e.g., ADS-B) may be displayed on a separate, third-party service display. However, it is unclear if position information of *all* vehicles could be displayed on this display. HALE Balloon: **Note**: Balloons less than 12 lbs. are not required to transmit via ADS-B or transponder.
Step 16 ATC Manages Traffic Conflict	**All Vehicles:** During descent, ATC reroutes commercial airline traffic around storm activity. **HALE Balloon and Airship:** ATC vectors the traffic well clear of the balloon/airship. **HALE Slow-Speed Uncrewed Fixed-Wing:** ATC instructs the RPIC to temporarily hold the vehicle at Flight Level 'ABC' around waypoint 'XYZ' for deviating traffic. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** ATC instructs the RPIC/PIC to turn X degrees left/right for deviating traffic.
Step 17 Operator/Pilot Executes Clearance	**HALE Balloon and Airship:** Not applicable

	HALE Slow-Speed Uncrewed Fixed-Wing: The RPIC acknowledges the clearance and instructs the vehicle to hold altitude while maintaining a circular flight path around the specified waypoint. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC/PIC acknowledges the clearance and instructs the vehicle to turn X degrees to the left/right.
Step 18 ATC Resumes Flight Plan Clearance	**HALE Balloon and Airship:** Not applicable **HALE Slow-Speed Uncrewed Fixed-Wing:** After the traffic passes, ATC clears the RPIC to continue descent. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** After the traffic passes, ATC instructs the RPIC/PIC to "proceed direct" to next fix. The remainder of the route is unchanged.
Step 19 Operator/Pilot Resumes Flight Plan	**HALE Balloon and Airship:** Not applicable **HALE Slow-Speed Uncrewed Fixed-Wing:** The RPIC acknowledges the clearance and instructs the vehicle to continue descent. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** The RPIC/PIC acknowledges the clearance and instructs the vehicle to proceed as cleared.
Step 20 ATC Clears Vehicle for Approach *Note: If the flight plan takes the vehicle to another ETM CA, refer to Trigger Event #8.* *Note: IFR Flight Plan could be to loiter in ATC-controlled airspace, creating additional workload for the Controller.*	**HALE Balloon:** As the Operator/RPIC continues to update the ATS on the balloon's updated trajectory, information is shared with appropriate ATC sector(s) through which the balloon will descend. ATC notes the approximate region of the balloon's descent on radar and keeps other traffic well clear of the balloon's operating envelope during its descent. **HALE Airship and Slow-Speed Uncrewed Fixed-Wing:** Depending on the arrival airport or landing site, as the airship nears its arrival airport, ATC issues the Operator/RPIC a *"minimum IFR altitude"* to maintain until established on the approach and an IFR approach clearance to the airport. **HALE High-Speed Uncrewed Fixed-Wing and High-Speed Crewed Fixed-Wing:** As the vehicle nears its arrival airport, ATC clears the RPIC for the IFR (published) approach clearance to the airport.
Step 21 Operator/Pilot Acknowledges Approach Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and executes the approach clearance.
Step 22 ATC Clears Operator/Pilot to Contact the Tower	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, ATC clears the Operator/RPIC to contact the tower.
Step 23 Operator/Pilot Acknowledges Clearance	**HALE Balloon:** Not applicable. **All Other Vehicles:** If applicable, the Operator/RPIC/PIC acknowledges and contacts the tower for clearance to land.

Step 24 Tower Clears Operator/Pilot to Land	**HALE Balloon:** Not applicable. The balloon envelope and payload separate, and each section deploys a parachute for soft landing. **All Other Vehicles:** If applicable, the Tower issues the landing clearance and the Operator/RPIC/PIC instructs the vehicle to land.
Step 25 ATC Cancels Flight Plan	**HALE Balloon:** Not applicable. The operator may notify ATS that the balloon is on the ground. **All Other Vehicles:** If applicable, after landing, the Operator advises ATS that the vehicle is on the ground. ATC cancels the IFR Flight Plan.

D. Initialization and Termination of ETM Cooperative Areas for ETM Operations

Procedures for initiating and terminating ETM CA in Class A and Upper Class E airspace are detailed in the following use cases. The procedures are described for scenarios with no vehicles in the airspace during the initiation and termination, as well as scenarios with vehicles in the airspace at the time of the initiation and termination. A final use case describes a modification of existing ETM CA instead of initiating a new ETM CA. For these scenarios, seven additional use cases have been identified as follows:

Use Case	Description	Traffic
3A	Authorize ETM CA in Class A	Sterile
3B	Authorize ETM CA in Class A	Non-Sterile i.e., conventional aircraft
3C	Authorize ETM CA in Upper Class E	Sterile
3D	Authorize ETM operating region in Upper Class E	Non-Sterile i.e., conventional aircraft
3E	Planned release of an ETM CA back to ATS/ATC in Class A / Upper Class E (Change driven by decrease in ETM traffic tempo – all vehicles have already exited)	Sterile
3F	Planned release of an ETM CA back to ATS/ATC in Class A / Upper Class E (Change driven by decrease in ETM traffic tempo)	ETM Vehicle(s) continue to operate
3G	Modification of Existing ETM CAs: Excess ETM Demand over current capacity, ESS Requests Additional Lateral Airspace in Upper Class E / Class A (Change driven by increase in ETM traffic tempo)	Sterile

Use Case 3 A/B

Planned Airspace Authorization: Change of Class A ATC-controlled airspace into an ETM CA.
Sterile (no conflicting traffic/airspace) and Non-Sterile (with conflicting traffic).
Conversion of airspace for ETM vehicle / ETM-operating needs.

Assumptions:

- The ETM CA is in **Class A airspace**.
- There may be no conflicts (sterile) or there may be conflicting ALTRVs or COAs in the requested area (non-sterile).
- Airspace for ETM CAs is **pre-coordinated**.
    - Initially, the conversion process is likely to use pre-coordinated regions (e.g., LAANC), but over time the process may become more dynamic.
- Initially, a central ATS facility, similar to the Central Altitude Reservation Function (CARF), will be responsible for this process and ETM CAs will initially resemble Stationary ALTRVs.
    - The conversion process could follow the FAA's current method for CARF to authorize ALTRVs.

General Assumptions about Accessibility of Information:

- CARF maintains the ALTRV database that can be viewable by others (i.e., ATC, ATS).
- The ETM Cooperative Area can be viewable by everyone (i.e., ATC, ATS, and CARF).
- Ideally, both data sources could be merged into a single display service.

High-Speed Crewed Fixed-Wing: Flight would continue operating in ATC-controlled airspace using traditional Flight Plans, rather than flying through ETM CAs.

Vehicle	**HALE Balloon (and Airship)** **HALE Slow-Speed Uncrewed Fixed-Wing** **HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)
Use Case Narrative	An ETM vehicle Operator would like to operate in an ETM CA in **Class A** airspace. For example, between FL500–FL600, as in the original Flex Floor concept. The requested ETM CA could be used by one, or more, vehicles/Operators who want to use the region at the same time.
Step 1 Operator Requests an ETM CA from the ETM Network Service Supplier Automation	The Operator uses their ESS to request an operation in an ETM CA from the ESS Network in **Class A** airspace. **Note:** As the number of requests from Operators increase, an ESS Network monitoring function may collect all requests for a given area and generate a single request to ATS for a larger ETM CA to accommodate multiple Operators.
Step 2 ETM Network Service Supplier Automation Evaluates and Requests an ETM CA from ATS	The ESS Network evaluates the request along with other operational requests and determines what airspace to request from ATS including lat/longs, altitudes, and times.
Step 3 ETM Network Service Supplier Automation Coordinates with ATS	The ESS Network coordinates with ATS for the activation of a new ETM CA in **Class A airspace**. **Assumption:** Coordination requests for airspace could be automated or human.
Step 4 ATS Coordinates with ATC Facility	ATS determines in which ATC facility(s) the **Class A airspace** is located, notifies them of the request, and coordinates with them to transfer operational control to the ESS Network.
Step 5 Information Displayed to ATS/ATC/CARF	ATS, ATC, and CARF control facilities have access to mapping of the proposed, pre-coordinated ETM CA. In **Class A**, this also includes ATM traffic.
Step 6 ATC Checks for Conflicts	The ATC facility checks traffic predictions and other operations (e.g., COAs and CARF-initiated ALTRVs). **Assumption about Common Awareness of Reserved Airspace:** ATS would be able to view all reserved airspace (e.g., CARF-initiated ALTRV, COAs) in Upper Class E and Class A.
Step 7a ATC Verifies that there are No Traffic Conflicts or Other Reserved Airspaces (Sterile). ATC Provides **Approval** to ATS	The ATC facility determines that there are **no traffic conflicts (sterile)** and that it is clear for the ETM CA. The ATC facility provides approval to ATS for the transfer of operational control to an ESS Network-managed operating region. **Assumption:** We assume that ATC will have time to review traffic predictions and, in the majority of cases, will approve the request for the ETM CA. If ATC does not have sufficient time to review and/or is not able to approve the request, additional steps for negotiation and replanning will be required.
Step 7b (Alternative) **Non-Sterile: Light Traffic**	The ATC facility determines that there will be **light traffic** usage during the requested time and coordinates with the traffic to alter their requested altitude during the portion of flight near the requested ETM CA. The ATC facility then provides approval to ATS for the transfer of operational control to an ESS Network-managed operating region.

ATC Manages Traffic and Provides Approval to ATS	
Step 7c (Alternative) **Non-Sterile: Moderate Traffic** ATC Denies the Request	The ATC facility determines that there will be **moderate traffic** usage during the requested time and denies the request. ATS notifies the ESS Network of the denial of the requested airspace. If feasible, the ESS Network requests different airspace and/or times from ATS.
Step 8 ATS Authorizes Class A Airspace as ETM CA	— Continued from Steps 7a and 7b — ATS authorizes the transfer of operational control of Class A airspace to an ESS Network-managed operating region.
Step 9 ATS Issues NOTAMs	ATS issues appropriate NOTAMs (or other notifications) detailing airspace status changes as appropriate. **Assumption about Common Awareness of ETM CAs**: ATS, ATC, and CARF would be able to view ETM CA(s) in Upper Class E and Class A airspace.
Step 10 ATS Notifies ETM Network Automation of the Approval	ATS notifies the ESS Network that the ETM CA in Class A has been approved.
Step 11 ETM Network Service Supplier Automation Reconfigures Airspace	The ESS Network reconfigures its assigned airspace to reflect the newly created ETM CA as eligible for use and monitoring.
Step 12 ETM Network Service Supplier Automation Shares Info about New Airspace with ETM Operators	The ESS Network shares geographical and time information about the ETM CA with all ESSs.
Step 13 ETM Network Service Supplier Automation Manages New ETM CA	The ETM cooperative-based system is now overseeing the ETM CA.
Step 14 Surveillance and Communication in ETM CA	In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponders (depending on the equipage and vehicle type) adhere to all applicable COPs. **Note:** The ADS-B assumption is based on ETM ConOps v1.0.
Step 15 Information Displayed to ATC (Class A)	For ETM CAs within Class A, ATC shall display the ETM CA to ensure that they do not allow any traffic to penetrate the area. Controllers may wish to monitor traffic in the ETM CA for awareness purposes via ADS-B. **Assumption about Common Awareness of ETM CAs**: ATS, ATC, and CARF would be able to view ETM CA(s) in Upper Class E and Class A airspace.

Use Case 3 C/D

Planned Airspace Authorization: Change of Class A ATC-controlled airspace into an ETM CA.
Sterile (no conflicting traffic/airspace) and Non-Sterile (with conflicting traffic).
Conversion of airspace for ETM vehicle / ETM-operating needs.
 	
Assumptions:
• The ETM CA is in **Class E airspace**.
• There may be no conflicts (sterile) or there may be conflicting ALTRVs or COAs in the requested area (non-sterile).
• Airspace for ETM Cas is **pre-coordinated**.
  • Initially, the conversion process is likely to use pre-coordinated regions (e.g., LAANC), but over time the process may become more dynamic.
• Initially, a central ATS facility, similar to the Central Altitude Reservation Function (CARF), will be responsible for this process and ETM Cas will initially resemble Stationary ALTRVs.
  • The conversion process could follow the FAA's current method for CARF to authorize ALTRVs.
 	
General Assumptions about Accessibility of Information:
• CARF maintains the ALTRV database that can be viewable by others (i.e., ATC, ATS).
• The ETM Cooperative Area can be viewable by everyone (i.e., ATC, ATS, and CARF).
• Ideally, both data sources could be merged into a single display service.
 	
High-Speed Crewed Fixed-Wing: Flight would continue operating in ATC-controlled airspace using traditional Flight Plans, rather than flying through ETM Cas.

Vehicle	**HALE Balloon (and Airship)** **HALE Slow-Speed Uncrewed Fixed-Wing** **HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)
Use Case Narrative	ETM vehicle Operator(s) would like to operate in an ETM CA in **Upper Class E** airspace. In Upper Class E, we expect the airspace to be non-cooperative (i.e., without an ETM CA). However, when traffic conditions are such that an ETM Cooperative Area is needed (e.g., due to increased traffic tempo, winds, etc.), we expect an ETM CA will be requested/created.
Step 1 Operator Requests an ETM CA from the ETM Network Service Supplier Automation	The Operator uses their ESS to request an ETM operation in **Upper Class E** airspace to the ESS Network. **Note:** As the number of requests from Operators increase, an ESS Network monitoring function may collect all requests for a given area and generate a single request to ATS for a larger ETM CA to accommodate multiple Operators.
Step 2 ETM Network Service Supplier Automation Evaluates and Requests an ETM CA from ATS	The ESS Network evaluates the ETM Operator request(s) and determines what airspace to request from ATS for the new ETM CA, including lat/longs, altitudes, and times.
Step 3 ETM Network Service Supplier Automation Coordinates with ATS	The ESS Network coordinates with ATS for the activation of a new ETM CA in **Upper Class E** airspace. **Assumption:** Coordination requests for airspace could be automated or human.
Step 4 Information Displayed to ATS/CARF	ATS and CARF control facilities have access to mapping of the proposed, pre-coordinated ETM CA.

Step 5 ATS Checks for Conflicts	ATS compares the newly requested airspace in Upper Class E against other operations (e.g., COAs and CARF-initiated ALTRVs). **Assumption about Common Awareness of Reserved Airspace:** ATS would be able to view all reserved airspace (e.g., CARF-initiated ALTRV, COAs) in Upper Class E and Class A.
Step 6a ATS Verifies that there are No Other Reserved Airspaces (Sterile)	ATS determines that the requested area is **not currently being used (sterile)** and that it is clear for the ETM CA (no conflicts).
Step 6b (Alternative) **Non-Sterile: Already in Use** Other Party has the Same Priority. Determine if Other Traffic is Eligible for ETM.	ATS determines that the requested area is **already currently being used**. ATS assesses whether the existing traffic has a higher priority, such as military or public usage. Assuming they have the **same priority**, the following occurs: • ATS notifies the current traffic that an ETM CA will be activated. • In return, the current traffic notifies ATS whether they are eligible and equipped for ETM operations and have COAs in place to access the ETM CA. • If all criteria are met, ATS determines that the airspace is clear for the ETM CA (i.e., there are no immediate conflicts). • If not, ATS has to accommodate the traffic until they are able to leave the area. If ATS cannot approve the ETM CA as requested, ATS notifies the ESS Network. The Operator may use the ESS Network to determine if there is other airspace they can utilize and revises their request.
Step 6c (Alternative) **Non-Sterile: Already in Use** Other Party has Higher Priority, ATS Denies the Request	ATS determines that the requested area is **already currently being used**. ATS determines if there is a priority of usage in place. If the current user has priority (such as military or public usage), ATS notifies the ESS Network of the denial of the requested airspace. The Operator uses the ESS Network to determine if there is other airspace they can utilize and revises their request.
Step 7 ATS Authorizes Upper Class E Airspace as ETM CA	— Continued from Steps 6a and 6b — ATS authorizes the transfer of operational control of the Upper Class E airspace to an ESS Network-managed operating region. ATS notifies the appropriate underlying ATC facility(s) of the proposed operations.
Step 8 ATS Issues NOTAMs	ATS issues appropriate NOTAMs (or other notifications) detailing airspace status changes as appropriate. **Assumption about Common Awareness of ETM Cas**: ATS, ATC, and CARF would be able to view ETM CA(s) in Upper Class E and Class A airspace.
Step 9 ATS Notifies ETM Network Automation of the Approval	ATS notifies the ESS Network that the ETM CA in Upper Class E has been approved.
Step 10 ETM Network Service Supplier Automation Reconfigures Airspace	The ESS Network reconfigures its assigned airspace to reflect the newly created ETM CA as eligible for use and monitoring.
Step 11 ETM Network Service Supplier Automation Shares Info about New	The ESS Network shares geographical and time information about the ETM CA with all ESSs.

Airspace with ETM Operators	
Step 12 ETM Network Service Supplier Automation Manages New ETM CA	The ETM cooperative-based system is now overseeing the ETM CA.
Step 13 Surveillance and Communication in ETM CA	In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponders (depending on the equipage and vehicle type) adhere to all applicable COPs. **Note:** The ADS-B assumption is based on ETM ConOps v1.0.
Step 14 Information Displayed	Controllers may wish to monitor traffic in the ETM CA for awareness purposes via ADS-B. **Assumption about Common Awareness of ETM Cas**: ATS, ATC, and CARF would be able to view ETM CA(s) in Upper Class E and Class A airspace.

Use Case 3E

Planned Airspace Authorization: Planned release of an ETM CA back to ATS/ATC-controlled airspace.

Assumptions:

- After ETM traffic has already cleared and the ETM CA is already empty and no longer needed, the ETM CA is deactivated.
- The ETM CA may be in **Class A and/or Upper Class E airspace**.
- Airspace for ETM Cas is **pre-coordinated**.
    - Initially, the conversion process is likely to use pre-coordinated regions (e.g., LAANC), but over time the process may become more dynamic.
- Initially, a central ATS facility, similar to the Central Altitude Reservation Function (CARF), will be responsible for this process and ETM Cas will initially resemble Stationary ALTRVs.
    - The conversion process could follow the FAA's current method for CARF to authorize ALTRVs.

General Assumptions about Accessibility of Information:

- CARF maintains the ALTRV database that can be viewable by others (i.e., ATC, ATS).
- The ETM Cooperative Area can be viewable by everyone (i.e., ATC, ATS, and CARF).
- Ideally, both data sources could be merged into a single display service.

High-Speed Crewed Fixed-Wing: Flight would continue operating in ATC-controlled airspace using traditional Flight Plans, rather than flying through ETM Cas.

Vehicle	**HALE Balloon (and Airship)** **HALE Slow-Speed Uncrewed Fixed-Wing** **HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)
Use Case Narrative	An ESS Network is managing an ETM CA with several HALE vehicles performing various communication and internet-provider capabilities. All vehicles have completed their missions and have already exited the ETM CA. An ESS Network monitoring function may monitor traffic tempo. In a nominal scenario where the traffic tempo has decreased, the ETM CA may no longer be needed. In this use case, the ESS Network initiates deactivation of the ETM CA based on decreased traffic tempo. (Although, that process could be initiated by ATS, as well.)
Step 1 ETM Network Service Supplier Automation Sends Request to ATS/CARF to Deactivate ETM CA	The ESS Network monitors the current and predicted usage of the ETM CA and determines if ETM operations should continue. ------- Class A ------- If all ETM vehicles have exited the ETM CA and the traffic is predicted to remain low, the ESS Network notifies ATS and each Operator ESS that all vehicles have vacated the ETM CA and requests that ATS terminate ETM operations.

	------- Upper Class E ------- If all ETM vehicles have exited the ETM CA and the traffic is predicted to remain low, the ESS Network notifies ATS, CARF, and each Operator ESS that all vehicles have vacated the ETM CA and requests that ATS terminate ETM operations.
Step 2 ETM Network Service Supplier Automation Coordinates with ATS	The ESS Network coordinates with ATS for the release of the ETM CA.
Step 3 ATS Releases the ETM CA	ATS evaluates the request and determines that there is no current traffic in the ETM CA and that it is clear for release. ATS notifies the ESS Network, CARF, and appropriate ATC facilities that the ETM CA has been deactivated.
Step 4 Airspace is No Longer being Used by ETM	------- Class A ------- ATC resumes active control of the airspace. ------- Upper Class E ------- ATS indicates that the airspace is no longer being utilized.
Step 5 Notification of Airspace Changes	ATS issues appropriate NOTAMs (or other notifications) detailing airspace status changes as appropriate.

Use Case 3F

Planned Airspace Authorization: Planned release of an ETM CA back to ATS/ATC-controlled airspace with ETM traffic still present.

Assumptions:

- ETM traffic has decreased enough that an ETM CA is no longer needed, but one, or more, ETM vehicles want to continue to operate in the same area.
- The ETM CA may be in **Class A and/or Upper Class E airspace**.
- Airspace for ETM CAs is **pre-coordinated**.
    - Initially, the conversion process is likely to use pre-coordinated regions (e.g., LAANC), but over time the process may become more dynamic.
- Initially, a central ATS facility, similar to the Central Altitude Reservation Function (CARF), will be responsible for this process and ETM CAs will initially resemble Stationary ALTRVs.
    - The conversion process could follow the FAA's current method for CARF to authorize ALTRVs.

General Assumptions about Accessibility of Information:

- CARF maintains the ALTRV database that can be viewable by others (i.e., ATC, ATS).
- The ETM Cooperative Area can be viewable by everyone (i.e., ATC, ATS, and CARF).
- Ideally, both data sources could be merged into a single display service.

High-Speed Crewed Fixed-Wing: Flight would continue operating in ATC-controlled airspace using traditional Flight Plans, rather than flying through ETM CAs.

Vehicle	**HALE Balloon (and Airship)** **HALE Slow-Speed Uncrewed Fixed-Wing** **HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)
Use Case Narrative	An ESS Network is managing an ETM CA with several HALE vehicles performing various communication and internet-provider capabilities. Most of the ETM Operators have completed their mission and exited the ETM CA. An ESS Network monitoring function may monitor traffic tempo. In a nominal scenario where the traffic tempo has decreased, the ETM CA may no longer be needed. In this use case, the ESS Network initiates deactivation of the ETM CA based on decreased traffic tempo. (Although, that process could be initiated by ATS, as well.) One or more of the HALE Operators wishes to continue their mission, in the same location.

Step 1 ETM Network Service Supplier Automation Monitors Traffic Tempo	The ESS Network monitors the current and predicted usage of the ETM CA and determines if ETM operations should continue. If the pace of traffic in the ETM-operating decreases to the point that it is no longer necessary to maintain an ETM CA, the ESS Network notifies each Operator ESS that it plans to request deactivation from ATS.
Step 2 Operator(s) Notify the ESS Network of Their Intention to Continue Their Mission(s)	Via the ESS, the Operator(s) notifies the ESS Network that they intend to continue their mission(s) in the same location.
Step 3 ETM Network Service Supplier Sends Request to ATS to Deactivate ETM CA	------- Class A ------- The ESS Network sends a request to ATS to deactivate the ETM CA. Each Operator ESS is also notified of this request. ------- Upper Class E ------- The ESS Network sends a request to ATS to deactivate the ETM CA. Each Operator ESS and CARF is also notified of this request.
Step 4 ATS Coordinates with ATC Facility(s)/CARF to Manage Remaining Traffic	------- Class A ------- ATS coordinates with the appropriate ATC facility(s) to see if the remaining traffic in the ETM CA can be transitioned to ATC control in Class A airspace. ------- Upper Class E ------- ATS coordinates with CARF to see if the remaining traffic in the ETM CA can be transitioned to an ALTRV.
Step 5 ATS Approves the Release of the ETM CA	------- Class A ------- If ATC facility(s) give approval, ATS assesses the traffic and designates a time for deactivation. ATS approves the release of ETM CA at a designated time and notifies the ATC facility(s) and the ESS Network. ------- Upper Class E ------- If CARF gives approval, ATS assesses the traffic and designates a time for deactivation. ATS approves the release of ETM CA at a designated time and notifies CARF and the ESS Network.
Step 6 ETM Network Service Supplier Notifies Remaining Operators	The ESS Network notifies each Operator ESS that the ETM CA will be deactivated at a coordinated time.
Step 7 Notification of Airspace Changes	------- Class A ------- ATS issues appropriate NOTAMs (or other notifications) detailing airspace status changes as appropriate. ------- Upper Class E ------- CARF publishes the ALTRV activation Upper Class E.
Step 8 Operator Files an IFR Flight Plan / Requests an ALTRV from CARF	------- Class A ------- The Operator coordinates with ATC to file an IFR Flight Plan to continue operating in Class A airspace with ATC. ------- Upper Class E ------- The Operator coordinates with CARF to request an ALTRV to continue operating in Upper Class E. **Note:** The ALTRV process may have to be more dynamic then the requirement for 72 hours notice. If the process cannot be more dynamic, the transition point needs to be known 24–72 hours in advance.
Step 9 **IFR Clearance in Class A:** Operator/RPIC/ PIC Requests IFR Clearance to Operate in ATC-	------- Class A ------- The RPIC contacts the proper ATC sector and requests to pick up their IFR clearance from ATC to operate in Class A airspace, without an ETM CA. ------- Upper Class E ------- --

Controlled Airspace	
Step 10 ATC / CARF Check for Conflicts	------- Class A ------- ATC compares the IFR flight plan against traffic predictions and other operations (e.g., COAs and CARF-initiated ALTRVs). **Assumption about Common Awareness of Reserved Airspace:** ATC would be able to view all reserved airspace (e.g., CARF-initiated ALTRV, COAs) in Upper Class E and Class A. ------- Upper Class E ------- CARF reviews the request for the ALTRV and compares it with any other ALTRVs. **Note:** The ALTRV process may have to be more dynamic then the requirement for 72 hours notice. If the process cannot be more dynamic, the transition point needs to be known 24–72 hours in advance.
Step 11a ATC Verifies that there are No Traffic Conflicts or Other Reserved Airspaces (Sterile) CARF Verifies that there are No Other Reserved Airspaces (Sterile)	------- Class A ------- ATC determines that there are **no traffic conflicts or other reserved airspaces (sterile).** **Assumption:** We assume that ATC will have time to review traffic predictions and, in the majority of cases, will approve the request for the ETM CA. If ATC does not have time to review the request before the designated deactivation time, additional steps for negotiation and replanning will be required. ------- Upper Class E ------- CARF determines there are **no other reserved airspaces (sterile).** **Assumption:** If CARF does not have time to review the request before the designated deactivation time, additional steps for negotiation and replanning will be required.
Step 11b (Alternative) **Non-Sterile: Light Traffic in Class A Airspace** ATC Manages Traffic	--------- Class A ------- ATC determines that there will be **light traffic** usage during the requested time and coordinates with the traffic to alter their requested altitude during the portion of flight near the ETM vehicle's IFR flight plan. ------- Upper Class E ------- --
Step 12 ATC Issues IFR Pick Up Request and Starts Providing Separation Services CARF Approves ALTRV.	— Continued from Steps 11a and 11b — ------- Class A ------- ATC issues the IFR clearance to the Operator/RPIC and identifies the vehicle by assigning the discrete beacon code from the IFR Flight Plan. ------- Upper Class E ------- CARF approves the ALTRV.
Step 13 Operator Executes their Updated Operation Plan	The Operator continues to follow their OI until the coordinated time.
Step 14 ETM Network Service Supplier Automation Deactivates the ETM CA	At the coordinated time, the ESS Network deactivates the ETM CA.
Step 15 Airspace is Returned to ATS/ATC (CARF)	------- Class A ------- ATC resumes active control of the airspace. ------- Upper Class E ------- CARF begins managing the ALTRV.

Step 16 Operator Begins Operating Outside of the ETM CA	------- Class A ------- Operator/RPIC begins flying their IFR Flight Plan. ------- Upper Class E ------- Operator/RPIC begins utilizing the ALTRV.

Use Case 3G

Planned Airspace Authorization: Lateral Expansion of an ETM-Operation Region in Class A ATC-controlled airspace or ATS airspace in Class A and Upper Class E.

Assumptions:

- An ETM CA is currently being utilized in **Class A and/or Upper Class E airspace**.
- Airspace for ETM CAs is **pre-coordinated**.
    - Initially, the conversion process is likely to use pre-coordinated regions (e.g., LAANC), but over time the process may become more dynamic.
- ATS/ATC Approval process is dynamic in nature (i.e., not requiring the 24–72 hours pre-coordination as with the current CARF ALTRV process).
- Change in the requested ETM CA is due to a change in ETM traffic tempo and is communicated by the ESS Network.
- Modification can increase or decrease the overall size and configuration of the ETM CA – the two Use Cases described below are expansion.
- Airspace being requested is sterile (i.e., no conventional traffic) For non-sterile procedures, see Trigger Events 3B and 3D.

General Assumptions about Accessibility of Information:

- CARF maintains the ALTRV database that can be viewable by others (i.e., ATC, ATS).
- The ETM Cooperative Area can be viewable by everyone (i.e., ATC, ATS, and CARF).
- Ideally, both data sources could be merged into a single display service.

High-Speed Crewed Fixed-Wing: Flight would continue operating in ATC-controlled airspace using traditional Flight Plans, rather than flying through ETM CAs.

Vehicle	**HALE Balloon (and Airship)** **HALE Slow-Speed Uncrewed Fixed-Wing** **HALE High-Speed Uncrewed Fixed-Wing** (e.g., Global Hawk)
Use Case Narrative	**ETM traffic demand exceeds current capacity. The ESS Network requests additional *lateral* airspace in Class A or Upper Class E airspace.** The ESS Network receives Operational Intent data from an Operator that wants to operate within an established ETM CA. However, the request creates an overlap of OIs that cannot be resolved within the current ETM structure. The ESS Network requests additional airspace from ATS, lateral to the current ETM CA in Class A or Upper Class E to accommodate the increase in ETM traffic. Note: If the requested airspace is above FL600, the steps would follow the UCE use case. If it is below FL600, the steps would follow the Class A use case.
Step 1 Operator Requests to Utilize Existing ETM CA	Via the ESS, the Operator requests mission OIs. The ESS Network checks for OI overlaps and decides that *additional* ETM CA area will be necessary to accommodate more missions. The ESS Network notifies the Operator that it will coordinate with ATS for more airspace next to the current ETM CA in **Class A or Upper Class E airspace**. **Note:** As the number of requests from Operators increase, an ESS Network monitoring function may collect all requests for a given area and generate a single request to ATS for a larger ETM CA to accommodate multiple Operators.

Step 2 ETM Network Service Supplier Automation Coordinates with ATS	The ESS Network coordinates with ATS for the activation of a new, *additional* ETM CA that is lateral and contiguous to the current ETM location. in **Class A or Upper Class E airspace**. **Assumption:** Coordination requests for airspace from ETM side could be automated or human.
Step 3 ATS Coordinates with ATC Facility	------- Class A ------- ATS determines in which ATC facility(s) the **Class A airspace** is located, notifies them of the request, and coordinates with them to transfer operational control to the ESS Network. ------- Upper Class E ------- ATS determines which ATC facility(s) underlie the **Upper Class E airspace**, notifies them of the request, and coordinates with them to transfer operational control to the ESS Network
Step 4 Information Displayed to ATS/ATC/CARF	ATS, ATC, and CARF control facilities have access to mapping of the proposed lateral pre-coordinated airspace.
Step 5 ATS/ATC Checks for Conflicts	------- Class A ------- The ATC facility checks traffic predictions and other operations (e.g., COAs and CARF-initiated ALTRVs). ------- Upper Class E ------- ATS compares the newly requested airspace in Upper Class E against other operations (e.g., COAs and CARF-initiated ALTRVs) **Assumption about Common Awareness of Reserved Airspace:** ATS would be able to view all reserved airspace (e.g., CARF-initiated ALTRV, COAs) in Upper Class E and Class A.
Step 6 ATS/ATC Verifies that there are No Traffic Conflicts or Other Reserved Airspaces (Sterile)	------- Class A ------- The ATC facility determines that there are **no traffic conflicts (sterile)** and ATC provides approval to ATS for the transfer of the precoordinated airspace block to an ESS Network-managed operating region. **Assumption:** We assume that ATC will have time to review traffic predictions and, in the majority of cases, will approve the request for the ETM CA. If ATC does not have sufficient time to review and/or is not able to approve the request, additional steps for negotiation and replanning will be required. ------- Upper Class E ------- ATS determines that the requested area is **not currently being used (sterile)** and notifies the appropriate underlying ATC facility(s) of the proposed operations.
Step 7 ATS Authorizes the Transfer of Operational Control to the ESS Network	ATS authorizes the transfer of operational control to the **Class A or Upper Class E** airspace to an ESS Network-managed operating region.
Step 8 ATS Issues NOTAMs	ATS issues appropriate NOTAMs (or other notifications) detailing airspace status changes as appropriate. **Assumption about Common Awareness of ETM CAs**: ATS, ATC, and CARF would be able to view ETM CA(s) in Upper Class E and Class A airspace.
Step 9 ATS Notifies ETM Network Service Supplier Automation of the Approval	ATS notifies the ESS Network that the new, additional ETM CA – that is lateral to, and abuts, the current ETM location in **Class A or Upper Class E** – has been approved.
Step 10 ETM Network Service Supplier Automation	The ESS Network reconfigures its assigned airspace to reflect the newly created ETM CA – adjacent to the current ETM operating region – as eligible for use and monitoring.

Reconfigures Airspace	
Step 11 ETM Network Service Supplier Automation Shares Info about New Airspace with ETM Operators	The ESS Network shares geographical and time information about the ETM CA with all ESSs.
Step 12 ETM Network Service Supplier Automation Manages New ETM CA	The ETM cooperative-based system is now overseeing the combined ETM CA.
Step 13 Operator(s) Creates ETM Operation Plan	The Operator creates a new **4DT (trajectory-based) Operation Plan** to operate within the ETM CA using the ESS and submits the plan to the ESS Network for coordination.
Step 14 ETM Network Service Supplier Automation Approves New Operation Plan	The ESS Network returns an approval message to the ESS and approves the Operation Plan. Note: Because flights are active, COPs may require an initial time window that OIs need to be conflict free.
Step 15 Operator/Pilot Executes ETM Operation Plan	The RPIC instructs the vehicle to fly the Operation Plan and transition into the newly authorized ETM CA. **Conformance Monitoring:** The ESS monitors its own vehicle's conformance to its operational intent. The ESS Network monitors conformance in relation to the other ETM operations and the ETM CA boundaries.
Step 16 Surveillance and Communication in ETM CA	In the ETM CA, vehicles are expected to broadcast using ADS-B and/or transponders (depending on the equipage and vehicle type) adhere to all applicable COPs. **Note:** The ADS-B assumption is based on ETM ConOps v1.0.
Step 17 Information Displayed	------- Class A ------- ATC shall display the new ETM CA to ensure that they do not allow any traffic to penetrate the area. ------- Class A and Upper Class E------ Controllers may wish to monitor traffic within the ETM CA for awareness purposes via ADS-B. **Assumption about Common Awareness of ETM CAs**: ATS, ATC, and CARF would be able to view ETM CA(s) in Upper Class E and Class A airspace.