

# Identifying Information Needs and Tools to Support Interactions between Upper Class E Traffic Management (ETM) Operations and the Air Traffic System (ATS)

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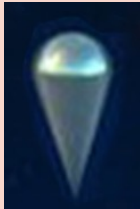
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# Supporting ETM-Air Traffic System (ATS) Interactions



# ETM Vehicles: Performance and Equipage

|                                                                                                  | <b>Slow-speed, fixed-wing, HALE vehicles</b><br> | <b>High-speed, fixed-wing, HALE vehicles</b><br> | <b>Balloons</b><br> |
|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|  Comm            | Remote Pilot-in-Command (RPIC) in radio contact with ATC                                                                          |                                                                                                                                     | X                                                                                                      |
|  Controllability | Performance capability/controllability (e.g., propulsion); can respond to ATC instructions                                        |                                                                                                                                     | X                                                                                                      |
|  Trajectory      | Vehicle develops and follows a planned trajectory                                                                                 |                                                                                                                                     | X                                                                                                      |
|  Surveillance   | Mode C/S transponder and/or ADS-B that enables the vehicle to be displayed on radar                                               |                                                                                                                                     | X                                                                                                      |

**Lateral entry into / exit from an ETM Cooperative Area via transit through Upper Class E**

**Entry into / exit from an ETM Cooperative Area through Class A**

Upper Class E

FL600

Class A

FL180

Classes B, C, D, E, G

- 
- SHAPING THE FUTURE OF AEROSPACE

# Methodology

| Vehicle Category                                                                                                                      | Roles / Responsibilities                                                                                                                                       | Info/Comm Needs                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ETM vehicles that are equipped with a transponder and/or ADS-B and are required to be on an <b>IFR Clearance</b> in Class A airspace. | <b>ETM Operator/RPIC:</b> <ul style="list-style-type: none"><li>• Filing an IFR Flight Plan</li><li>• Comm with ATC</li><li>• Adhering to clearances</li></ul> | <input checked="" type="checkbox"/> Visible on radar<br><input checked="" type="checkbox"/> IFR Flight Plan<br><input checked="" type="checkbox"/> Comm w/ ATC via radio |

# Methodology

| Vehicle Category                                                                                                                                                                                                                                              | Roles / Responsibilities                                                                                                                                                                              | Info/Comm Needs                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ETM vehicles that are equipped with a transponder and/or ADS-B and are required to be on an <b>IFR Clearance</b> in Class A airspace.                                                                                                                         | <b>ETM Operator/RPIC:</b> <ul style="list-style-type: none"> <li>Filing an IFR Flight Plan</li> <li>Comm with ATC</li> <li>Adhering to clearances</li> </ul>                                          | <input checked="" type="checkbox"/> Visible on radar<br><input checked="" type="checkbox"/> IFR Flight Plan<br><input checked="" type="checkbox"/> Comm w/ ATC via radio                   |
| Balloons and other ETM vehicles that are not equipped with a transponder or ADS-B and are <b>not</b> required to be on an <b>IFR Clearance</b> in Class A airspace. <small>*Currently balloons provide position updates every 2 hrs, via phone/email.</small> | <ul style="list-style-type: none"> <li><b>ATC controller</b> may be responsible for <b>separation for safety</b> for ETM vehicles.</li> <li><b>ETM</b> may provide “flight intent volumes”</li> </ul> | <input type="checkbox"/> <b>Vehicle</b> not visible on radar<br><input type="checkbox"/> <b>Volumes</b> not depicted on radar<br><input type="checkbox"/> No direct comm w/ ATC Controller |

# Information and Communication Needs

| Category                                                                                                                                              | ETM-ATS Interaction Procedural Step                                                                                                                                                                        | Info                     | Comm                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| Balloons and other ETM vehicles that are not equipped with a transponder or ADS-B and are not required to be on an IFR Clearance in Class A airspace. | 1. <b>Operator</b> is responsible for providing their “flight intent volumes” to the <b>facility-level ATS (i.e., Supervisor/TMC at an ATC facility)</b> .                                                 | <input type="checkbox"/> | <input type="checkbox"/> |
|                                                                                                                                                       | 2. <b>Operator</b> is responsible for providing <b>facility-level ATS personnel (Supervisor/TMC at an ATC facility)</b> with updates on the vehicle’s location.                                            | <input type="checkbox"/> | <input type="checkbox"/> |
|                                                                                                                                                       | 3. <b>ATC controller</b> may be responsible for deconfliction for safety (e.g., providing safety advisories) with respect to non-transponder equipped vehicles that cannot provide Mode C/S position data. | <input type="checkbox"/> | <input type="checkbox"/> |
|                                                                                                                                                       | 4. <b>Operator</b> files an Informational-only airspace request with <b>CARF</b> .                                                                                                                         | <input type="checkbox"/> | <input type="checkbox"/> |
|                                                                                                                                                       | 5. <b>Operator</b> is responsible for providing <b>facility-level ATS personnel</b> (i.e., Supervisor/TMC at an ATC facility) notification of transition into the ETM CA.                                  | <input type="checkbox"/> | <input type="checkbox"/> |
| ETM vehicles that are equipped with a transponder and/or ADS-B and be on an IFR Clearance in Class A.                                                 | 6. <b>Operator</b> files a Moving ALTRV request with the <b>CARF</b> .                                                                                                                                     | <input type="checkbox"/> | <input type="checkbox"/> |
|                                                                                                                                                       | 7. <b>Operator</b> is responsible for providing <b>ATC</b> notification of transition into the ETM Cooperative Area.                                                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| All Vehicle Types                                                                                                                                     | 8. While operating in ETM Cooperative Areas, <b>Operators</b> define their intent using Operation Plans, Operational Intentions, or waypoint plans.                                                        | <input type="checkbox"/> | <input type="checkbox"/> |

# Supporting this Interaction

| Category                                                                                                                                     | ETM-ATS Interaction                                                                                                                                        | Info                     | Comm                     |
|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| Balloons and other ETM vehicles that are not equipped with a transponder or ADS-B and are not required to be on an IFR Clearance in Class A. | 1. <b>Operator</b> is responsible for providing their “flight intent volumes” to the <b>facility-level ATS (i.e., Supervisor/TMC at an ATC facility)</b> . | <input type="checkbox"/> | <input type="checkbox"/> |



**Balloon's Flight  
Intent Volumes**



Facility-level ATS (Center)  
(Area Supervisor or TMC)

# Supporting this Interaction

| Category                                                                                                                                     | ETM-ATS Interaction                                                                                                                                        | Info                     | Comm                     |
|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| Balloons and other ETM vehicles that are not equipped with a transponder or ADS-B and are not required to be on an IFR Clearance in Class A. | 1. <b>Operator</b> is responsible for providing their “flight intent volumes” to the <b>facility-level ATS (i.e., Supervisor/TMC at an ATC facility)</b> . | <input type="checkbox"/> | <input type="checkbox"/> |



## ➤ Digital Communication

**Balloon's Flight Intent Volumes**



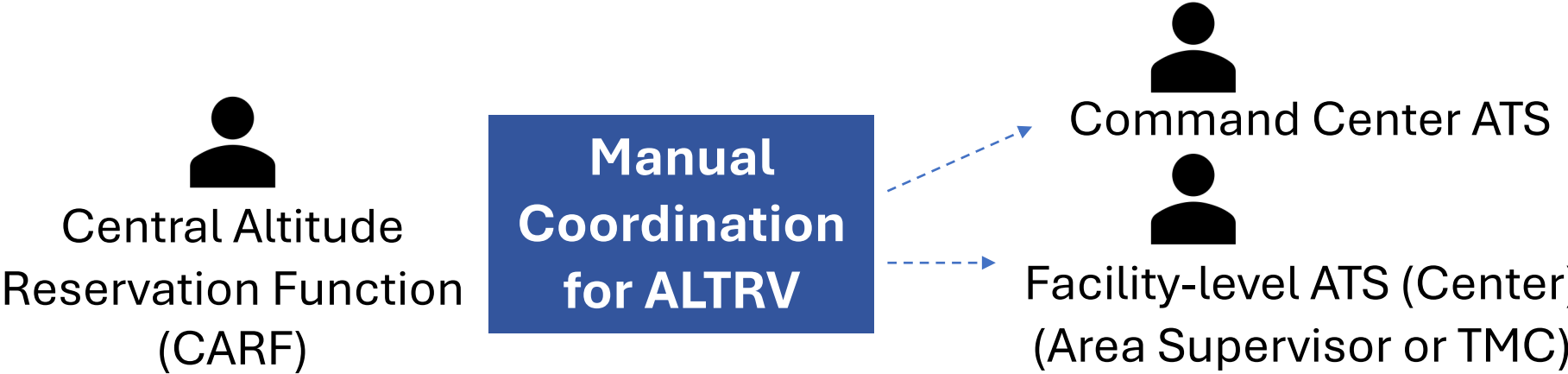
## ➤ Visualize Intent Volumes



Facility-level ATS (Center)  
(Area Supervisor or TMC)

# Supporting this Interaction

| Category                                                                                              | ETM-ATS Interaction                                                    | Info                     | Comm                     |
|-------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------|--------------------------|
| ETM vehicles that are equipped with a transponder and/or ADS-B and be on an IFR Clearance in Class A. | 6. <b>Operator</b> files a Moving ALTRV request with the <b>CARF</b> . | <input type="checkbox"/> | <input type="checkbox"/> |



# Supporting this Interaction

| Category                                                                                              | ETM-ATS Interaction                                                    | Info | Comm |
|-------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------|------|
| ETM vehicles that are equipped with a transponder and/or ADS-B and be on an IFR Clearance in Class A. | 6. <b>Operator</b> files a Moving ALTRV request with the <b>CARF</b> . | □    | □    |

## ➤ Digital Communication

  
Central Altitude  
Reservation Function  
(CARF)

**Manual  
Coordination  
for ALTRV**

➤ **Visualize  
ALTRVs**

  
Command Center ATS

  
Facility-level ATS (Center)  
(Area Supervisor or TMC)

# Envisioned Tools



Integrated  
Visualization Tool  
for Flight Tracking  
and Airspace  
Designations



Integrated Digital  
Communication  
Tool



# Integrated Visualization Tool for Flight Tracking and Airspace Designations

- **Flights: Visual representation of *predicted* and *real-time* info.**
  - IFR Flight Plan or “flight intent volumes” for Balloons
  - ATC-managed airspace, path through ALTRV, Op Plan in ETM CA
- **Airspace Designations: Visual representation of the location, altitude, and boundaries of designated airspaces (3D).**
  - *Currently active* and those that are *scheduled*
  - Fixed airspace boundaries (sector and ATC facility boundaries)
  - ETM CA boundaries
  - ALTRVs and Informational-only airspaces (for balloons)
  - Other airspace designations, such as SUAs, MOAs, and TFRs



# Integrated Digital Communication Tool

- **Improve communications coordination between the:**
  - ETM Operator/ESS
  - ATC Controller
  - Command Center ATS
  - Facility-level ATS personnel (Center, Area Supervisor/TMC)
  - CARF (ALTRVs)
- Some communication functions may be directly integrated within the Integrated Visualization Tool.



# Integrated Digital Communication Tool

- **Balloon Operators ↔ Facility-level ATS Personnel (TMC)**
  - Approval to conduct operations, Intent Volumes, Current position (vehicles without an RPIC)
- **CARF ↔ Facility-level ATS Personnel (TMC) / ATC Controller**
  - Improve the process of manual communication, common knowledge of all approved airspace constructs (e.g., ALTRVs)
- **ETM Operator/ESS Network ↔ Command Center ATS**
  - For the request and approval process for ETM Cooperative Areas

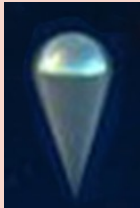
# Next Steps

- Prototyping the functionalities and the user interface
- Utilizing the ETM-ATS Interaction Use Cases
- Evaluating them in a simulated environment



Airspace Operations Lab (AOL) at NASA Ames

# ETM Vehicles: Performance and Equipage

|                                                                                                  | <b>Slow-speed, fixed-wing, HALE vehicles</b>  | <b>High-speed, fixed-wing, HALE vehicles</b>  | <b>Balloons</b>  |
|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
|  Comm            | Remote Pilot-in-Command (RPIC) in radio contact with ATC                                                                       |                                                                                                                                  | X                                                                                                   |
|  Controllability | Performance capability/controllability (e.g., propulsion)                                                                      |                                                                                                                                  | X                                                                                                   |
|  Trajectory      | Vehicle develops and follows a planned trajectory; can respond to ATC instructions.                                            |                                                                                                                                  | X                                                                                                   |
|  Surveillance   | Mode C/S transponder and/or ADS-B that enables the vehicle to be displayed on radar                                            |                                                                                                                                  | X                                                                                                   |

# Thank You!

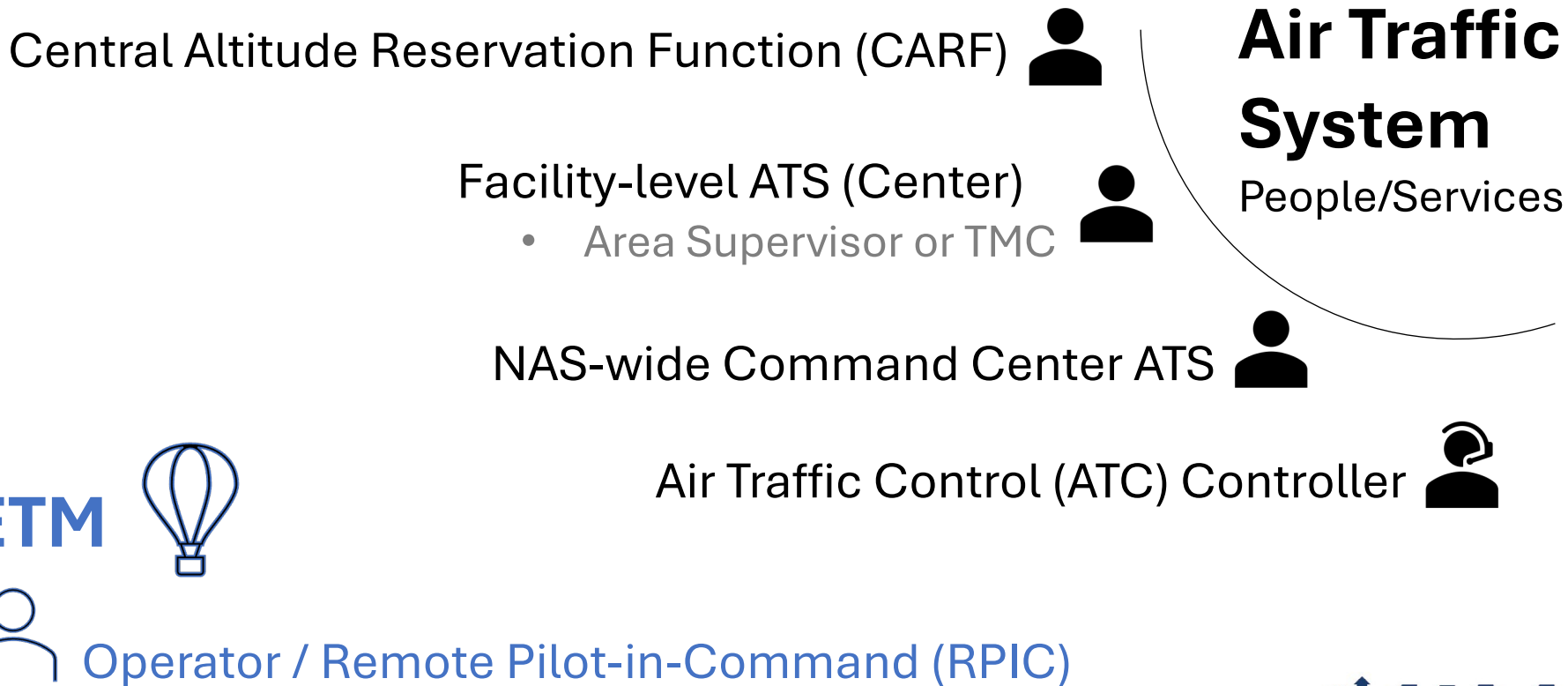
## Previous ETM-ATS Interaction Papers

- **Integrating Upper Class E Traffic Management (ETM) Operations into the National Airspace System: Use Cases and Research Questions**  
2022 41<sup>st</sup> AIAA/IEEE DASC, Portsmouth, VA, September 18–22, 2022
- **Identifying Common Coordination Procedures across Extensible Traffic Management (xTM) to Integrate xTM Operations into the National Airspace System**  
AIAA Aviation Forum, Chicago, IL, June 27–July 1, 2022
- **Identifying Common Use Cases across Extensible Traffic Management (xTM) for Interactions with Air Traffic Controllers**  
AIAA SciTech Forum, San Diego, CA, January 3–7, 2022



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# ETM-Air Traffic System (ATS) Interactions



# ETM Vehicles: Performance and Equipage

- Two vehicle/equipage categories in this discussion:

## **ETM vehicles that are:**

- Equipped with a transponder and/or ADS-B.
- *Required* to be on an IFR Clearance in Class A airspace.

## **Balloons and other ETM vehicles that are:**

- Not equipped with a transponder or ADS-B.
- Not required to be on an IFR Clearance in Class A airspace.

# Information and Communication Needs

| Category                                                                                                                                              | ETM-ATS Interaction Procedural Step                                                                                                                                                                 | Info                                                                                                                                                                                                                                        | Comm                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Balloons and other ETM vehicles that are not equipped with a transponder or ADS-B and are not required to be on an IFR Clearance in Class A airspace. | 1. Operator is responsible for providing their “flight intent volumes” to the facility-level ATS (i.e., Supervisor/TMC at an ATC facility).                                                         | It would be helpful for facility-level ATS personnel to be able to visualize the “flight intent volumes.”                                                                                                                                   | Two-way communication: It would be helpful for the balloon Operator to be able to communicate digitally with facility-level ATS personnel about their “flight intent volumes”, rather than by phone.                                                          |
|                                                                                                                                                       | 2. Operator is responsible for providing facility-level ATS personnel (Supervisor/TMC at an ATC facility) with updates on the vehicle’s location.                                                   | It would be helpful for facility-level ATS personnel to be able to visualize the position information of vehicles not equipped with a transponder or ADS-B.                                                                                 | One-way communication: It would be helpful for facility-level ATS personnel to receive real-time position information about non-transponder equipped vehicles.                                                                                                |
|                                                                                                                                                       | 3. ATC controller may be responsible for deconfliction for safety (e.g., providing safety advisories) with respect to non-transponder equipped vehicles that cannot provide Mode C/S position data. | It would be helpful for ATC controllers to be able to visualize the position information of vehicles not equipped with a transponder or ADS-B.                                                                                              | Two-way communication: For vehicles without an RPIC, it would be helpful to have a digitized communication channel or messaging method (e.g., free text) to enable communication between the ATC controller and the Operator.                                 |
|                                                                                                                                                       | 4. Operator files an Informational-only airspace request with CARF.                                                                                                                                 | It would be helpful for the Command Center ATS and other entities to be able to visualize the location/boundaries of Informational-only airspaces.                                                                                          | Two-way communication: It would be helpful for CARF and the Command Center ATS to have a digital communication channel to alert the other of changes and to discuss changes via direct messaging.                                                             |
|                                                                                                                                                       | 5. Operator is responsible for providing facility-level ATS personnel (i.e., Supervisor/TMC at an ATC facility) notification of transition into the ETM CA.                                         | It would be helpful for facility-level ATS personnel to be able to visualize the position information of vehicles not equipped with a transponder or ADS-B and receive notifications about transition points (e.g., ascending above FL600). | Two-way communication: It would be helpful for the balloon Operator to be able to communicate digitally with facility-level ATS personnel about when they cross a transition point (e.g., transitioning into an ETM Cooperative Area).                        |
| ETM vehicles that are equipped with a transponder and/or ADS-B and be on an IFR Clearance in Class A.                                                 | 6. Operator files a Moving ALTRV request with the CARF.                                                                                                                                             | It would be helpful for the Command Center ATS and other entities to be able to visualize the location/boundaries of ALTRVs.                                                                                                                | Two-way communication: It would be helpful for CARF and the Command Center ATS to have a digital communication channel to alert the other of changes and to discuss changes via direct messaging.                                                             |
|                                                                                                                                                       | 7. Operator is responsible for providing ATC notification of transition into the ETM Cooperative Area.                                                                                              | It would be helpful for ATC controllers to visualize and receive notifications about when vehicles cross a transition point (e.g., ascending above FL600).                                                                                  | Two-way communication: Even though they are in radio contact with the controller, it may be helpful for the ETM Operator to be able to communicate digitally ATC about when they cross a transition point (e.g., transitioning into an ETM Cooperative Area). |