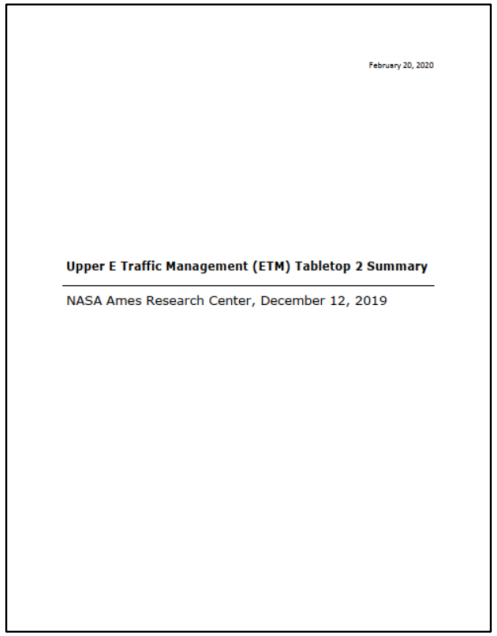
Upper E Traffic Management

March 19, 2020

Recap

- Meeting February 19
- Industry meeting March 6
- December tabletop summary sent March 9


February 20, 2020

Upper E Traffic Management (ETM) Tabletop 2 Summary

NASA Ames Research Center, December 12, 2019



Pre-decisional

Outcomes of Industry Meeting

- Scenarios
- Topic areas
- ETM ‘TCL’ equivalent

Pre-decisional

Context

In a December 2019 ETM kick-off meeting, industry and NASA agreed to focus their initial simulation efforts on nominal operations, with a focus on maximizing airspace efficiency. Industry believes that it is in everyone's best interest to first focus on nominal operations. Nominal operations represent the overwhelming majority of operations) and will ensure that the developed CONOPs and associated systems can support the highest airspace density as safely possible. The goal of these simulations is to validate the ecosystem which will enable each operator to safely achieve their mission objective with undue burden on each other's operations.

Pre-decisional

Definitions and Assumptions

Pre-decisional

HAPS (High Altitude Pseudo Satellite, or High Altitude Platform System) is used as the generic term for near geo-stationary high altitude craft; both lighter-than-air (balloons) and fixed wing. A key differentiating feature of HAPS is their extreme endurance by virtue of using the sun as their energy source (solar cells).

HALE (High Altitude Long Endurance) is used for aircraft that can fly for extended durations. All HAPS are HALE, the reverse is not true.

Input Requested

- Identify agreed-upon nominal scenario characteristics for framing discussion and simulation.
- Identify topic areas that are of key importance to be investigated early on.
- Propose draft Technical Confirmation Levels that can be used as a basis for further procedural development

Pre-decisional

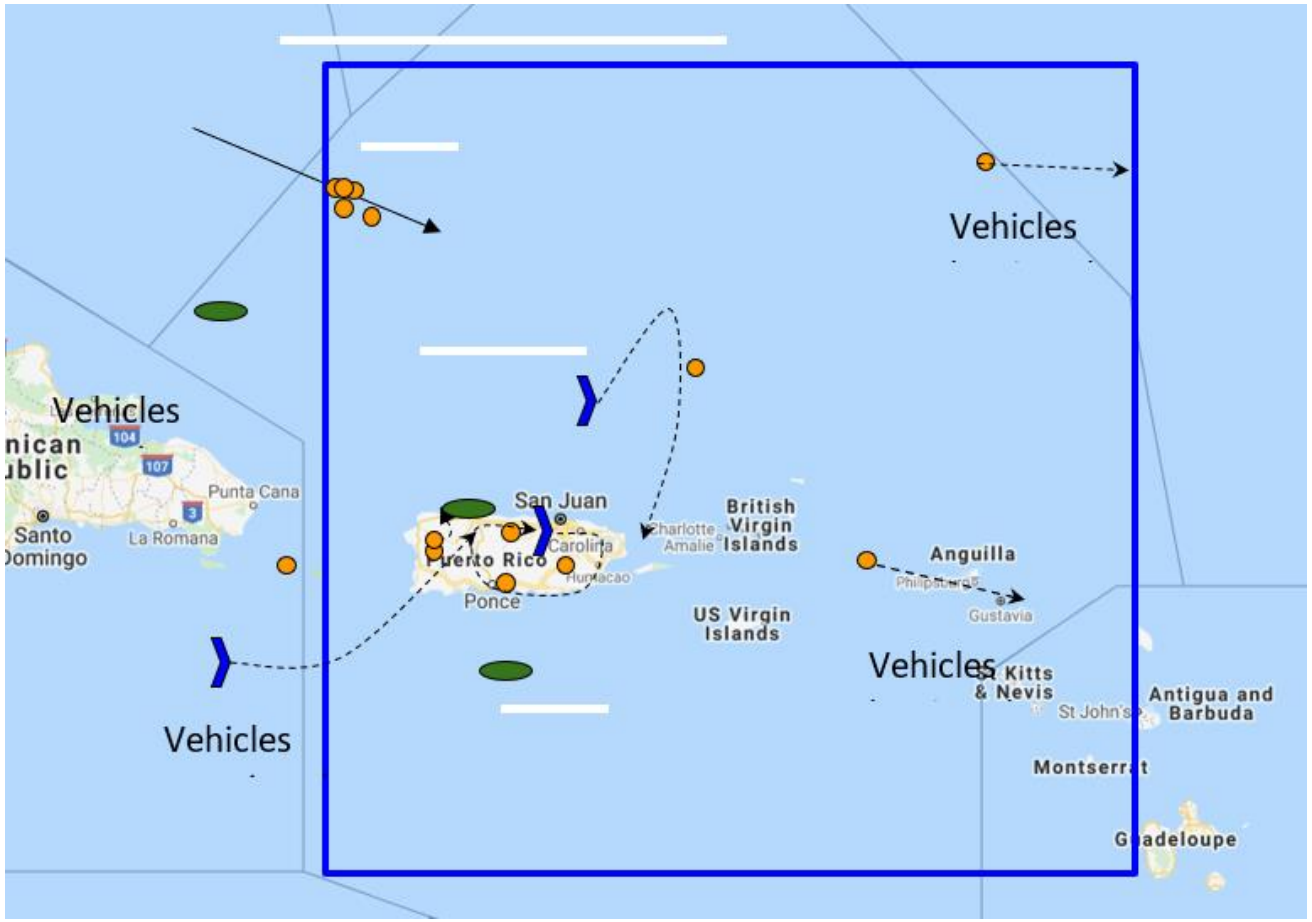
Nominal scenarios characteristics

Pre-decisional

We need to imagine here what likely scenarios could happen in nominal conditions and demonstrate through simulations that those scenarios can be managed effectively. We propose that scheduling, weather, and system performance effects should be addressed during initial simulations but that off-nominal system conditions (failures) should be left to later activity. Below are a few initial ideas for comments

Scenario 1: Multiple operators operating in a locally dense area for prolonged duration

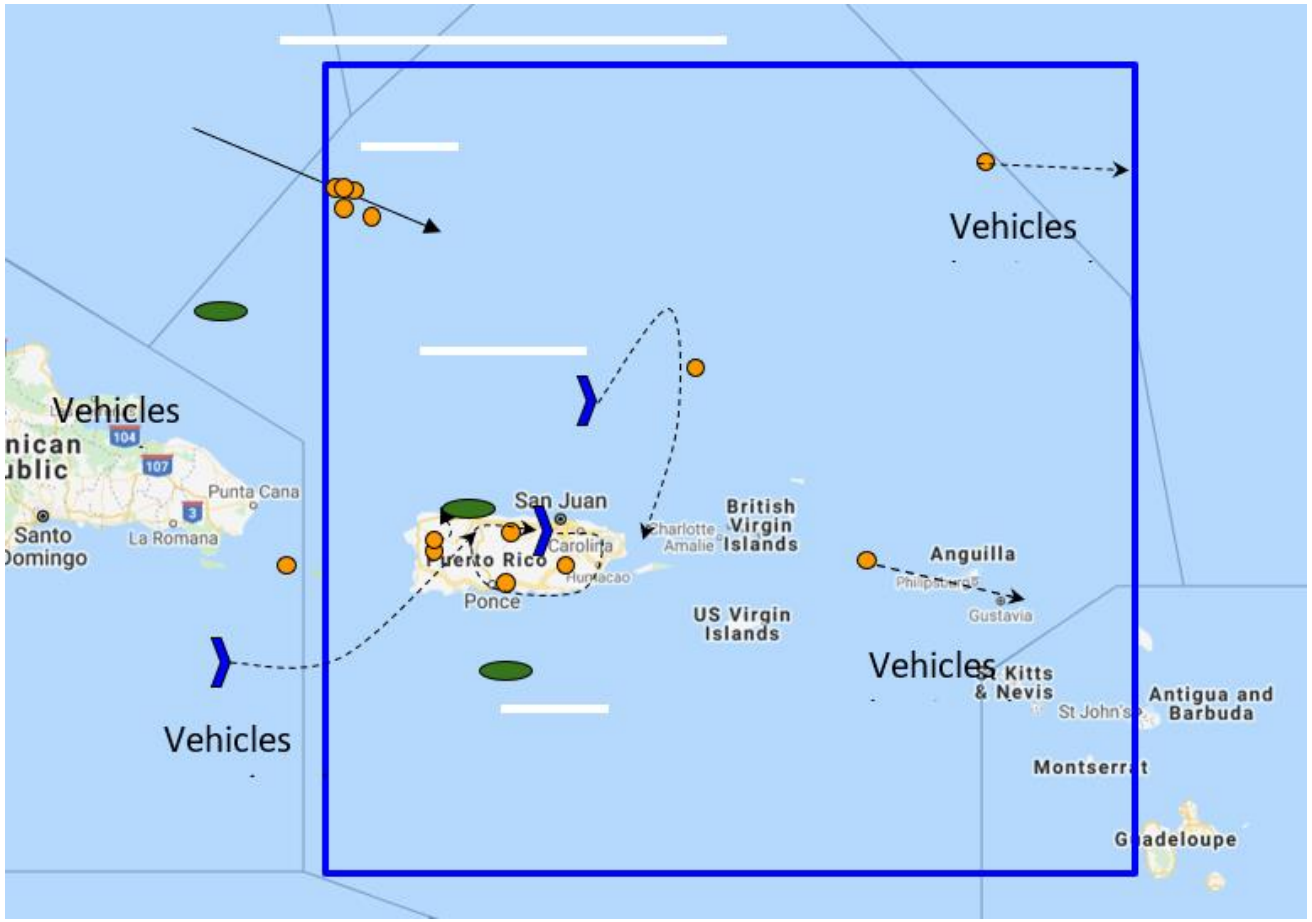
Pre-decisional



The following very plausible similar scenario could exist in the NOT DISTANT FUTURE where multiple high altitude platforms would perform missions to assist with disaster recovery in Puerto Rico.

Scenario 1: Multiple operators operating in a locally dense area for prolonged duration

Pre-decisional



In such a scenario, it is critical for all players to share the airspace as effectively as possible. Key aspects of this scenario would involve:

- Details of intent sharing
- Replanning - Change of intent
- Conflict identification (with specific focus on false alerting rates)
- Use of airspace between FL500 and FL600 and coordination with ATC
- Assess when the airspace saturates in the simulation experiment zone.
- Ensure that deconfliction solutions do not create knock-on issues and are broadly compatible with overall mission objectives.

Scenario 1: Multiple operators operating in a locally dense area for prolonged duration

- A fleet of 20 balloons and *two* fixed wing solar HALE and *Y* airships create a connectivity mesh to restore connectivity. Balloons and fixed wing aircraft would be launched from outside the mission (operational) area and ingress to the mission area at high altitude. For connectivity, each HALE will maintain a fixed orbit within a 5 km diameter circle for extended periods.
  - The volume of each operation mentioned above should be varied as an input to the simulation
- Two of the fixed wing solar HALE are occasionally redeployed to assist with ground operations.
- A cooperative military aircraft operates reconnaissance missions for a different purpose.
- Balloons ascend and descend between FL500 and FL650 to navigate with winds (about 75% of the time is spent between FL500 and FL600), HALE may occasionally go to different altitudes to optimize energy use for a few hours.
- All vehicles adapt and change their intents to meet changing mission needs. Balloons adapt their plan and altitude frequently to react to observed wind conditions. Fixed wing orbits may be shifted to react to mission requirements.

Pre-decisional

Scenario 1: Multiple operators operating in a locally dense area for prolonged duration

- ***Scenario output:***
- The objective of such a scenario would be to understand how an airspace saturates as the number of vehicles is varied as input parameter. The metrics to be tracked are: < which ones? Time histories? >

Pre-decisional

Scenario 2 - Non-cooperative military operations

- One or multiple HAPS operators are maintaining a large fleet of 50 vehicles for internet connectivity over an international country. Each HAPS maintains an orbit within a nominal 5 km diameter circle. Approximately 50% of the HAPS operate between FL550 and FL650 with the remainder typically between FL600 and FL700.
- Occasionally balloons also transit through or near the mission area between FL500 and FL600.
- At the same time, the military is running operations but cannot disclose their mission or trajectory. Some military mission timing and routes change at short notice. How well can they remain clear of the cooperating stratosphere operations? How do we make a priority call?
  - Global Hawk ? Manned U2 ?
  - Maybe the statecraft is a slow, less maneuverable AV or Zephyr vehicle ?
- Key aspects of this scenario, in addition to the ones from scenario 1 are:
  - Wake generation and sensitivity
  - Coordination with ANSPs
  - Airspace FIR transition / International transition.

Pre-decisional

Scenario 2 - Non-cooperative military operations

- Scenario output:
- The objective of this scenario is to show how HAPS operators will coordinate with military users. Also how CTMS will collaborate with ANSPs.

Pre-decisional

Topic areas that are of key importance to be investigated

Investigate in the next 6 months:

- Intent sharing: The proper identification of how intents are shared by various operators is probably the core of an effective conflict detection. It will be primarily to identify adequate intent sharing that guarantees airspace safety, while minimizing false alerts, unnecessarily onerous deconfliction, and maintain the need for privacy when intent sharing is not justified for deconfliction purposes. Intent sharing includes:
  - the horizon of intent necessary to share in the future
  - The confidence of the intent
  - Protocols and templates for sharing
  - Required deconfliction criteria (eg HAPS vs supersonic to avoid wake)

Pre-decisional

Topic areas that are of key importance to be investigated

- Interaction with ANSP for operation FL500-FL600: In order to optimise system performance HALE may need to operate below FL600 (or the local ceiling of Class A airspace). Similarly, balloons will need to operate as low as approximately FL500 to enable navigation and mission area persistence. The ceiling of the large majority of conventional craft is typically below FL500 offering the potential for safe altitude deconfliction with minimal impact on any party's mission effectiveness or navigation options. To accomplish this, a flexible approach to a tactical boundary between low-altitude ATM and high-altitude CTM is necessary eg the establishment and dynamic management of a DeConfliction Flight Level (DCFL) which is not a fixed airspace class attribute. The required interplay between ANSP and a CTMS will need to be explored.
  - Conflict detection horizon: ...
  - Performance / Equipage requirement: ...
  - Risk Management - Accountability: ….
  - Architecture: The overall architecture, various PSS, discovery and synchronisation, interaction with FIMS are all key elements to validate. In the interest of initial simplicity, it is probably best to tackle the full architecture after

Pre-decisional

Topic areas that are of key importance to be investigated

Investigate (starting January 2021)

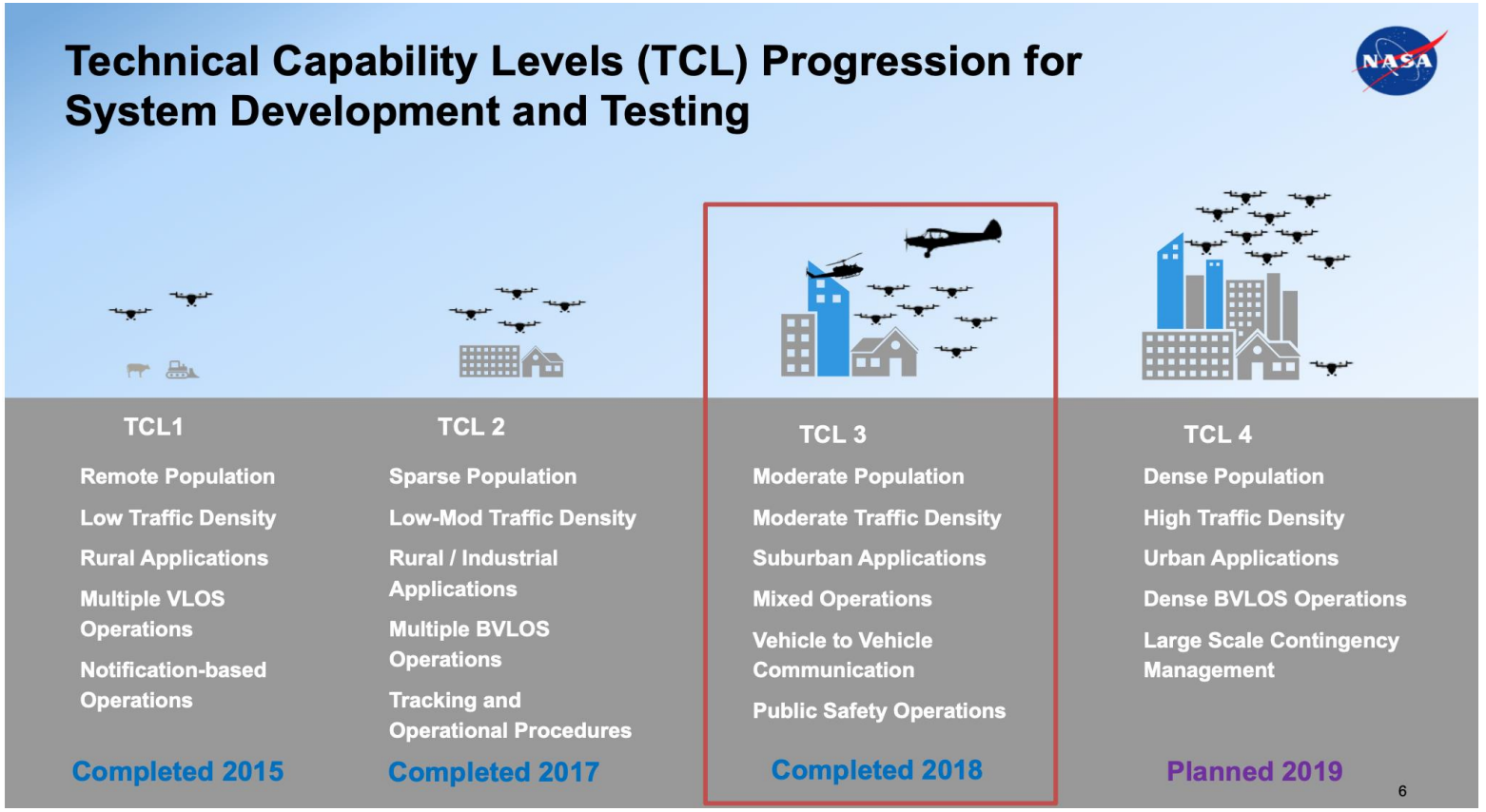
- Conflict resolution rules
- Off-nominal system conditions: defined based on additional scenarios (emergencies, climb and descent, weather)
- Launch, recovery and other prolonged operation in the troposphere (nominally below FL500)
- Equipage requirements

Pre-decisional

Propose Technical Capability Levels

Pre-decisional

UAS Traffic Management TCLs as reference starting point



Propose Technical Capability Levels

Pre-decisional

TCL1 (now - March 2021)

- Low Risk:
  - Air Traffic density below CTMS operations
  - Low population density below CTMS operations
  - Low-Medium vehicle density in CTMS
- Mostly slow moving operations
- No manned vehicle in collaborative environment
- Manual (Human - Human) conflict resolution
- Deconfliction flight level demonstration (operations FL500-FL650)
- Multiple BVLOS operations, multiple operators.
- Local operation (100 x 100 km?)
- Fly-in, fly-out of CTMS airspace (no launch and recoveries in the simulated operational area)

TCL2 (Spring 2022)

- Medium risk
  - Medium-High air traffic density
  - High-High population density
  - High Local Unmanned vehicle Density
- Cross-FIR/state boundary
- Manual Emergency Management
- Manned aviation (biz jet, supersonic) managed via ALTRAV - FAA command center
- 50% automated conflict resolution
- Climb and descend into/out of CTMS airspace

TCLY (Spring 2023)

- Commercial Space transition
- Supersonic temporary reservation & negotiation
- 90% Automated conflict resolution
- Automated Emergency integration with ATM
- High Traffic density
- Large scale contingency management
- All vehicle classes including Hypersonics and sub-orbital
- 98% automated conflict resolution
- Certified integration with ATM

Follow up

Pre-decisional

Performance Characteristics Input (Part 1)

Item	Description	Values
Model Name	Aircraft Name	
Model Type	Aircraft Type	
Default Weight class	Weight Class	
Max Climb Rate	Maximum Climb Rate	
Max Descent Rate	Maximum Descent Rate	
Eng Type	Engine Type	
Max Mach	Maximum Mach	
Min IAS	Minimum Indicated Air Speed	
Max IAS	Maximum Indicated Air Speed	
Max Alt	Maximum Altitude	
Default Climb Speed	Nominal Climb Speed	
Default Descent Speed	Nominal Descent Speed	
Default Climb Mach	Nominal Climb Mach	
Default Descent Mach	Nominal Descent Mach	
Max Apprch speed	Maximum Approach Speed	
Minimum CAS	Minimum Calibrated Air Speed	
Maximum CAS	Maximum Calibrated Air Speed	
Minimum Cruise CAS	Minimum Cruise Calibrated Air Speed	
Maximum Cruise CAS	Maximum Cruise Calibrated Air Speed	

Item	Description	Values
Maximum Takeoff	Maximum Takeoff Weight	
Operating Weight	Operating Weight Empty	
Typical Descent	Typical Descent Weight	
Approach Speed	Approach Speed Slope	
Max Approach Weight	Maximum Approach Weight Speed	
Max Weight FLAP	Maximum Weight Deflect Calibrated Air Speed	
Min Weight FLAP	Minimum Weight Deflect Calibrated Air Speed	
Gross Wing	Gross Wing Area	
Engine Name	Engine Name	
Engine Thrust	Engine Thrust Model	
Airframe Drag	Airframe Drag Model	
Number Of Engines	Number Of Engines	
Effective Number	Effective Number Of Engines	
Descent Drag	Descent Drag Scale Factor	
Decel Factor	Decel Factor (0.5-1.5)	
Descent Ratio Scale	Descent Ratio Scale	

Going forward

- Next meeting: Week of April 6
- Consider in-person tabletop in the summer (if possible)
- Topic items for Industry feedback
  - Nature of intent and uncertainty
  - Further fleshing of Scenario 1
  - Flexible floor

Pre-decisional

Pre-decisional

Questions?

jeffrey.r.homola@nasa.gov