Federal Aviation Administration

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UTM Roadmap and Deep Dive

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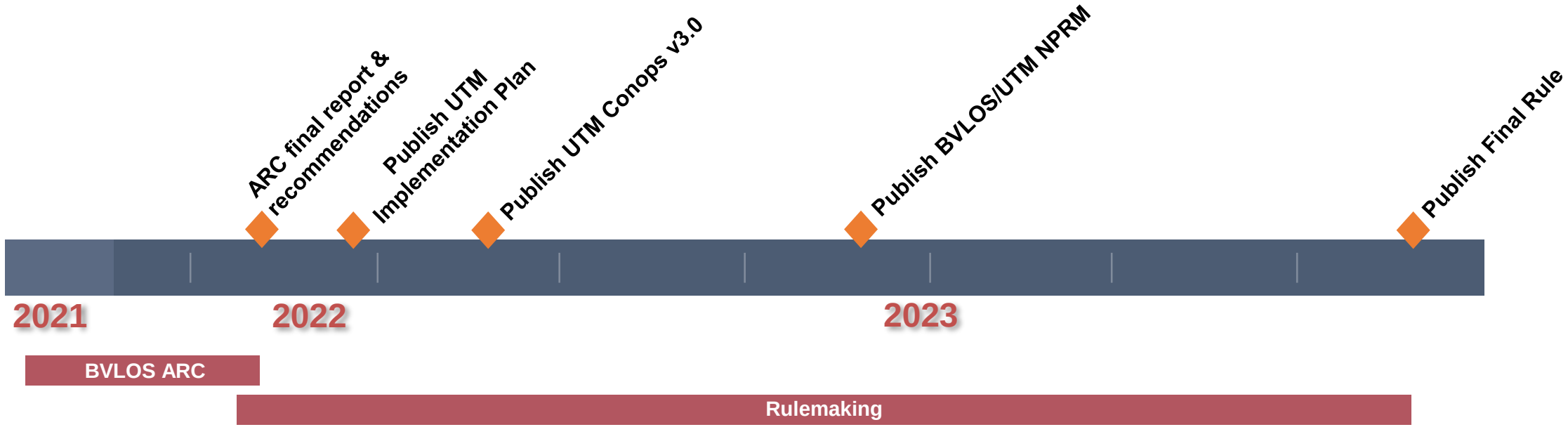
Today's Briefing

- BVLOS ARC and Rulemaking Update
- UTM Projects Underway
- Recent Research

BVLOS ARC and Rulemaking



UTM Projects

- UPP2 Progress Report and Final Report
- UTM Implementation Plan
- UTM Conops v3.0
- Technical Assists for UTM Services

UPP2 Final Report

- Density limits given altitude buffers
- Volumes didn't conform to ASTM 95% containment error bounds
- Lack of common altitude reference
- Limited ability of operators to respond to conflicts
- Human interface issues
- HITL response time issues

Table 4-7: Strategic Deconfliction Findings and Recommendations

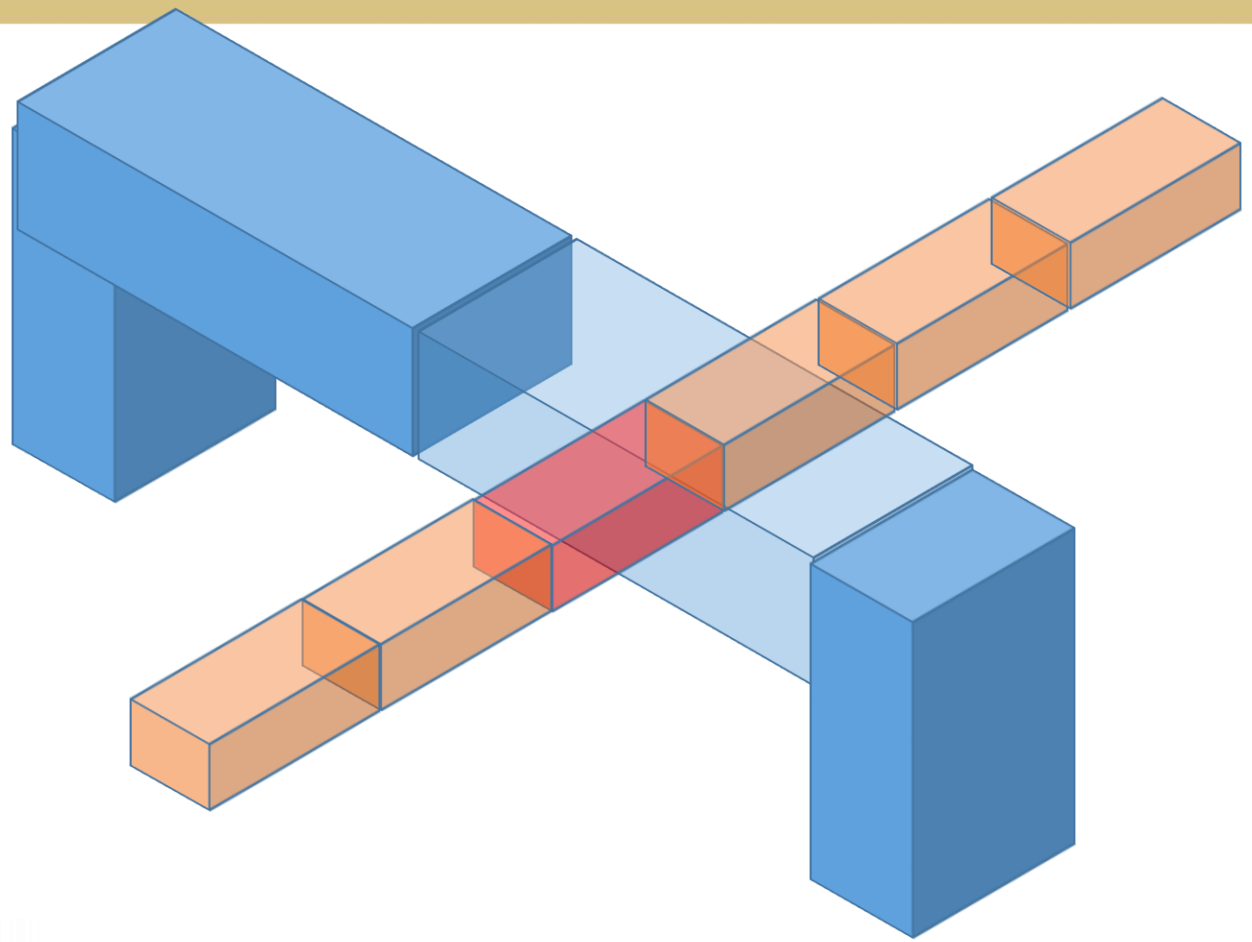
Area	Findings/Recommendations
ASTM Draft Specification for High Density Environments	During UPP2 flight activities, utilizing the current draft UTM standard requirement of 95% containment presented challenges in both deconfliction and in maintaining a high-density environment. To reach higher operational densities, altitude deconfliction is required; however, there is limited vertical space to accommodate multiple operations within the 400 feet AGL limit for UTM operations. As an example: *If there are two UA flying at 100 feet and 300 feet AGL respectively, and both utilize an altitude buffer of +/- 50 feet, it means there are operations from 50-150 feet and 250-350 feet AGL, which precludes the addition of many other aircraft (though one could fit in at 200 feet AGL with the same buffers applied).* For VT-MAAP during UPP2, many of the operational volumes did not conform with the ASTM 95% containment error bounds. If these were added, buffers for some of the aircraft may increase, which would have further complicated altitude deconfliction in the high-density environment.
Temporal Deconfliction	Because UPP2 had a mandate to increase density, and because temporal deconfliction reduces density, it was not a primary focus of activities. It could be further explored in future testing and development.
Altitude References	An inconsistent altitude frame of reference was a source of issues during UPP2 (and UPP1). While the altitude issues seen during UPP2 activities were mostly limited to individual Ground Control Station (GCS) software implementations, this did have an impact on USSs and operators during various activities, including deconfliction. Altitude frames of reference also presented problems for users as described in NASA flight test reports [11]. Difficulties were encountered due to varying altitude frames of reference used by the ground control stations and pilots. User interfaces utilized various reference frames, including altitudes expressed in AGL and above takeoff. This meant that the pilot needed to convert altitude frames of reference when determining how to deconflict. In addition, various altitude datums were used by GCS software. A common altitude reference across the various technologies and processes to support UTM operations should be recognized by standards bodies, industry (e.g., service providers, manufacturers), and other stakeholders (e.g., FAA, ICAO).
Information Sharing and Conflict Detection	The USS implementations detailed in Section 4.3.2 were in accordance with the ASTM Draft Specification for UTM [4], however the limited information provided to the operator when a conflict was detected limits the ability to perform strategic deconfliction efficiently. A recommendation is that USS deconfliction services include enough information sharing to allow operators to strategically deconflict when operations conflict for both BVLOS and VLOS operations using automated means.

Table 4-16: Off-Nominal/Contingency Event Findings and Recommendations

Area	Findings/Recommendations
Operator Notification	Test site partners found that the ASTM Draft Specification for UTM [4] provides mechanisms and information for sharing of operational state but does not currently impose requirements on notifications for operators. Additional requirements may be needed to address the operator awareness and support informed responses.
Operator Interface	Demonstrated technologies can be applicable to production systems; however, continued improvements to interfaces and possible GCS logic could reduce instances of avoidable off-nominal events. Better user interfaces and notifications could help avoid unintentional non-conformance events due to early takeoffs or remaining in-air past the end time for an operator's 4D operation intent (e.g., close-out time for last operation volume segment in a BVLOS operation).
Conformance Monitoring	Participating USSs and operators fount that the 30 second timeout for returning to conformance before going contingent was too short in many cases. In various instances, RPICs found that their control set-ups took longer than 30 seconds to change the operating mode of the UAS so they could manually fly it back into a conforming position. Some RPICs also found that it would take longer to re-plan a flight trajectory as well, if necessary to bring it back into conformance. Participants noted a time out in the range of 120 seconds would be preferable to reduce occurrences of a contingent state.
Operator Training	Unintentional off-nominal events were largely due to operator errors in planning/initiating operations or due to issues interfacing the UASs with the USS software (e.g., sending GPS MSL altitudes when the software was expecting WGS-84). These issues are not caused by the UTM concept or the ASTM Draft Specification for UTM [4]. Rather, they serve to highlight the importance of operator training, requirements definition, application of standard/common data requirements where appropriate/needed (e.g., altitude reference), and testing of associated system interactions.

Recent Research

Strategic Deconfliction



- What is the ***safety benefit*** of using strategic deconfliction?

Safety Benefits of SD

- How good is strategic deconfliction at reducing UAS-UAS collisions?
- What happens when fewer operators participate?
- Are there densities at which strategic deconfliction isn't needed?
- At what densities does it become essential?

Iterative Research Approach

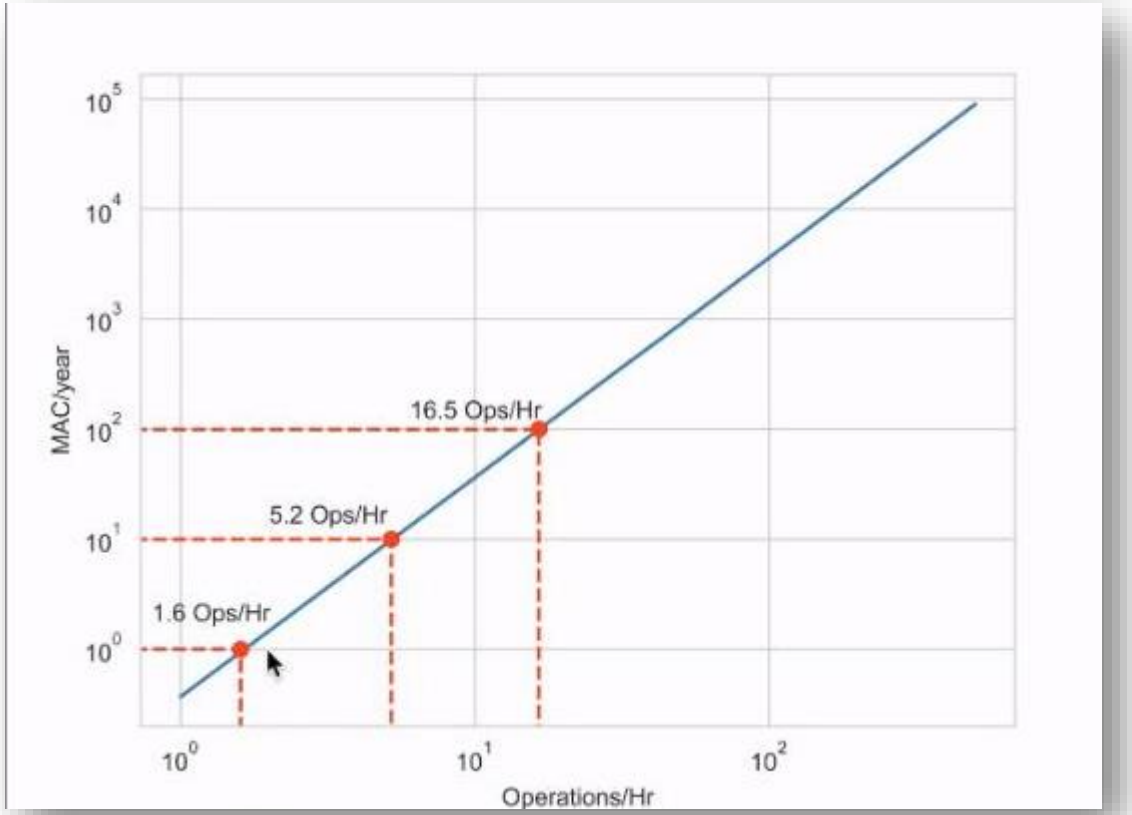
- Using existing funding at JHUAPL
- Robust simulator (multiple USSs, any airspace region, explicit bounded assumptions)
- Determined need for baseline understanding – justify need (if any) for use of strategic deconfliction

Preliminary Baseline Results

- No strategic deconfliction
- Varying operational densities
  - (flights per day, 10 hours per day of ops)
- Synthetic 25km x 25km region – no airspace restrictions
- Random vehicle routes
- Average flight 10 minutes
- Thousands of Monte Carlo simulated flight hours

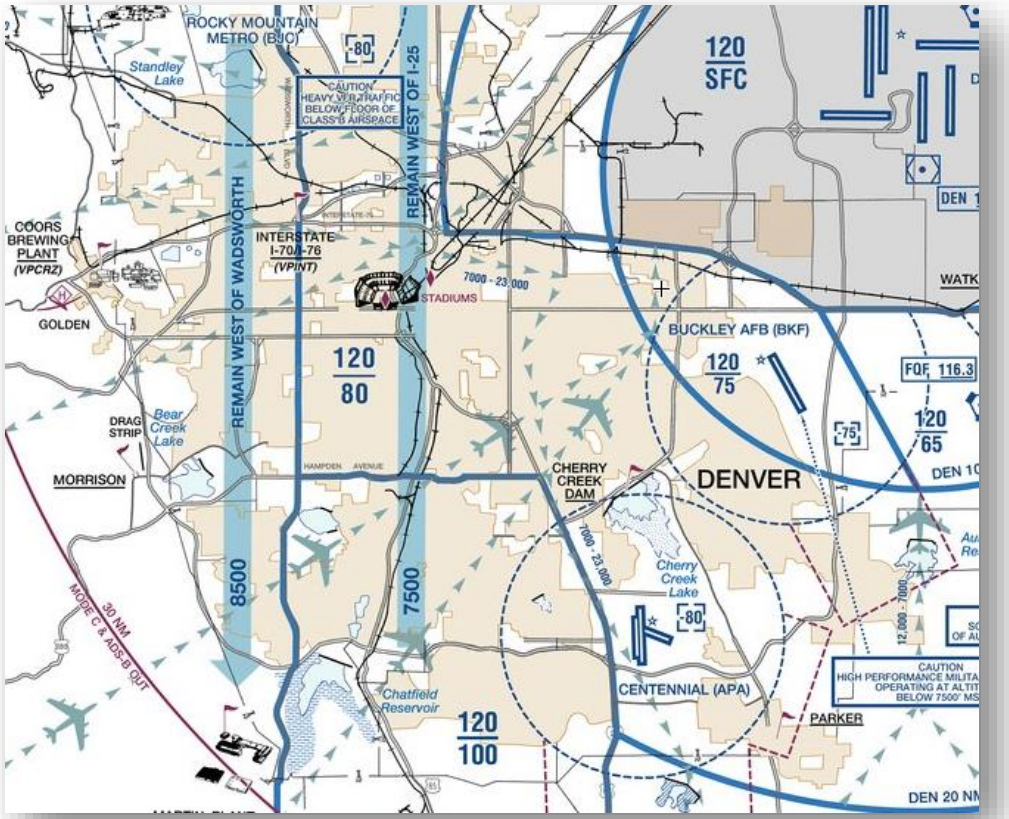
Preliminary Baseline Results

- If we do nothing, expect 10 MACs per year over a given city at just 52 total operations per day!
  - How many resulting lethalities?
  - What about public perception?



Next Simulation Scenarios

- Varying UAS participation in strategic deconfliction
- Incorporate operational intents
- More realistic airspace
- Add underlying population



Questions?