



Workload considerations in Urban Air Mobility

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Agenda



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- Research motivation & aims
- Method
- Results
 - Reduced communication associated with lower workload
 - Current procedures associated with fewer controlled aircraft
 - Route modification associated with increased traffic, not necessarily reduced workload
- Conclusions & Implications
- Future research



Research Motivation

- UAM receiving rapidly increasing attention across academic, research and industry domains
 - E.g. NASA 'Grand Challenge'
- Offers potential for significant benefits, but also fundamental change
- Human operator involvement remains undefined
 - Dependent on near, medium and far term operations
 - Dependent on airspace location
- UAM operations will interact heavily with traditional airspace and as such, interactions with ATCOs will occur in the near to mid-term future operations
- Investigation of the impact of UAM traffic on ATCOs' workload and performance needed to identify and mitigate potential risks to human performance and human operator roles



- Aim:
 - Investigate the effect of:
 - Task demand
 - Route modification
 - Verbal clearance procedureson workload and efficiency-related performance
- Potential Outcomes:
 - Better understanding of human operator roles
 - Contribution to the development of a human-machine interaction paradigm for UAM
 - Inform strategies to support human performance in association with UAM traffic
 - UAM traffic management
 - Interaction with air traffic controllers (ATCOs)

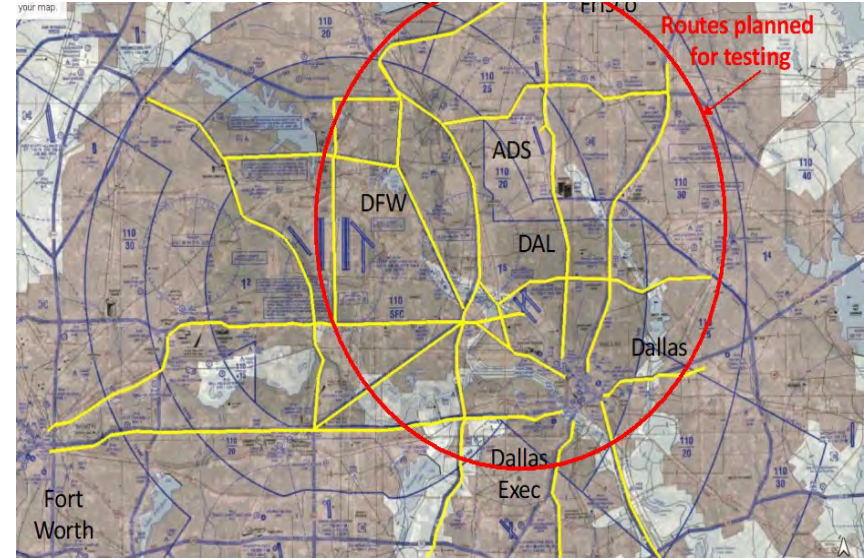




Method: Simulation



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- 3 within-measure variables
 - Task demand
 - Communications procedures
 - Routes

- Three task demand scenarios:

Scenario	Temporal spacing (seconds)	Distance spacing (miles)	Vehicle Count
Scenario 1: Low UAM density	90	3.75	115
Scenario 2: Medium UAM density	60	2.5	167
Scenario 3: High UAM density	45	1.88	225

- Pilot studies confirmed task demand variation associated with workload variation





- Two sets of communication procedure
 - Current day communications

“UAM942, Love Tower, cleared to enter class bravo. Squawk 4043 [additional instructions]”
 - Simulated letter of agreement – reduced verbal communications

“UAM173, Love Tower, cleared via [route name]”
- Two sets of routes
 - Current day helicopter routes
 - Modified routes, optimized for UAM vehicles
 - Avoided approach and departure paths for commercial or VFR aircraft
 - Avoided common temporary flight restrictions
 - Avoided heavily populated areas
 - Shorter, more direct
 - Introduced two-way routes



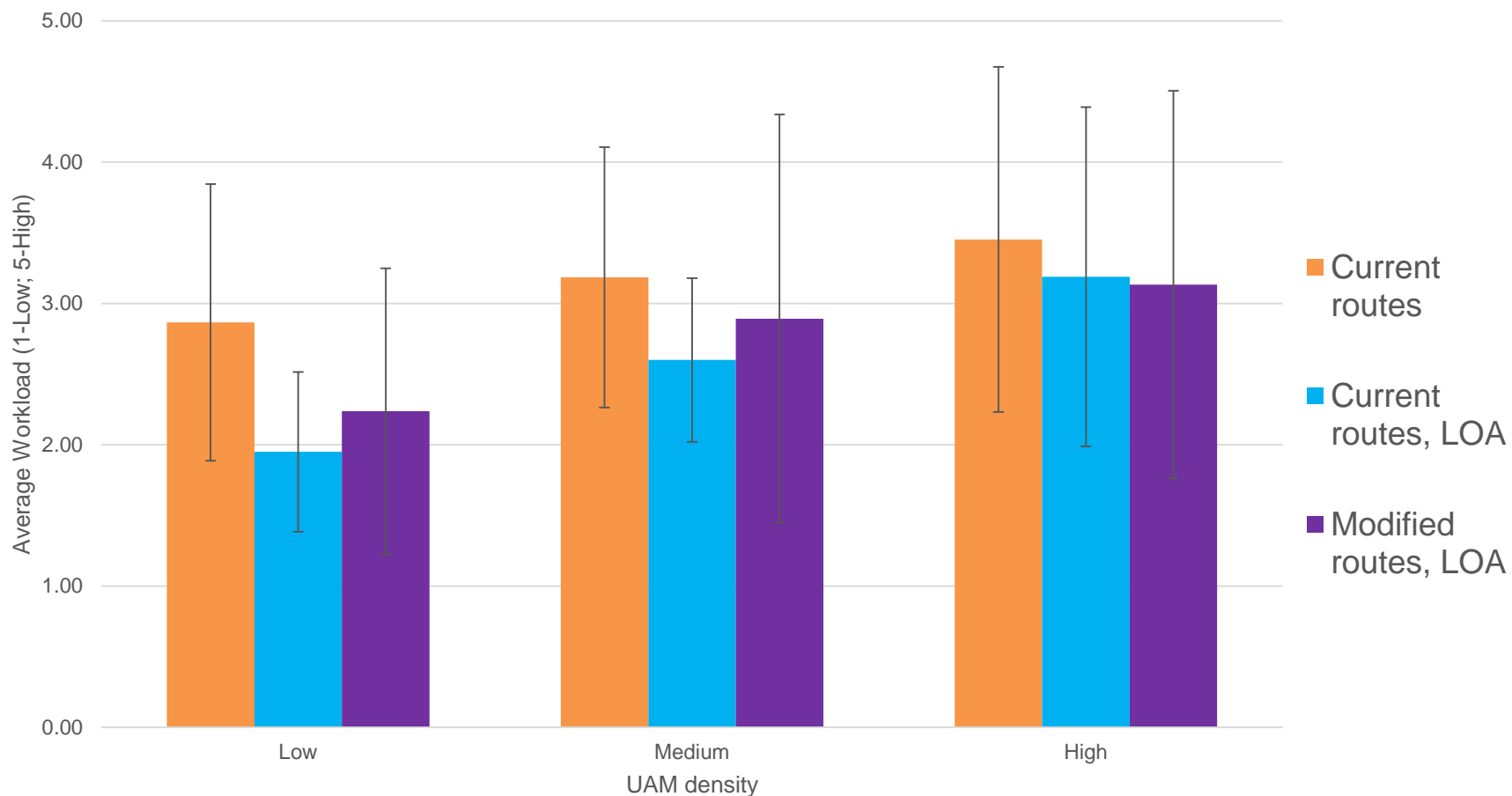
- Experimental conditions overview
 - Did not use full-factorial design

Level of UAM traffic	Helicopter Routes		
	Current Routes <i>Communications w/o LOA and ATIS</i> (Baseline)	Current Routes <i>Communications with LOA & ATIS</i>	Modified Routes <i>Communications with LOA & ATIS</i>
None	Scenario C0		
Low	Scenario C1	Scenario CL1	Scenario M1
Medium	Scenario C2	Scenario CL2	Scenario M2
High	Scenario C3	Scenario CL3	Scenario M3

- Measures
 - Workload
 - Efficiency-related performance
- Participants
 - 6 retired controllers
 - Experience with Dallas metroplex control

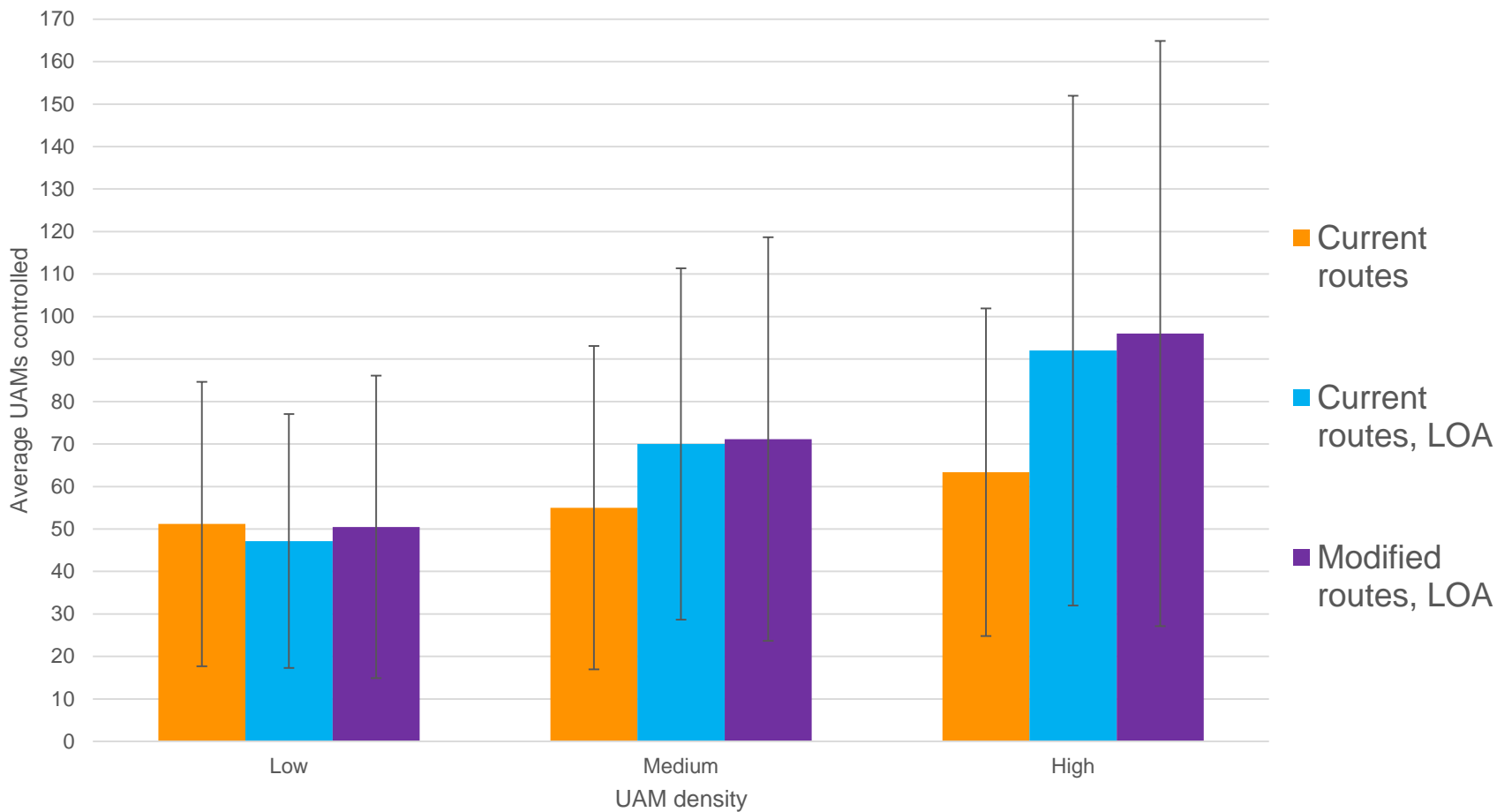


Result 1: Reduced communication is associated with lower workload



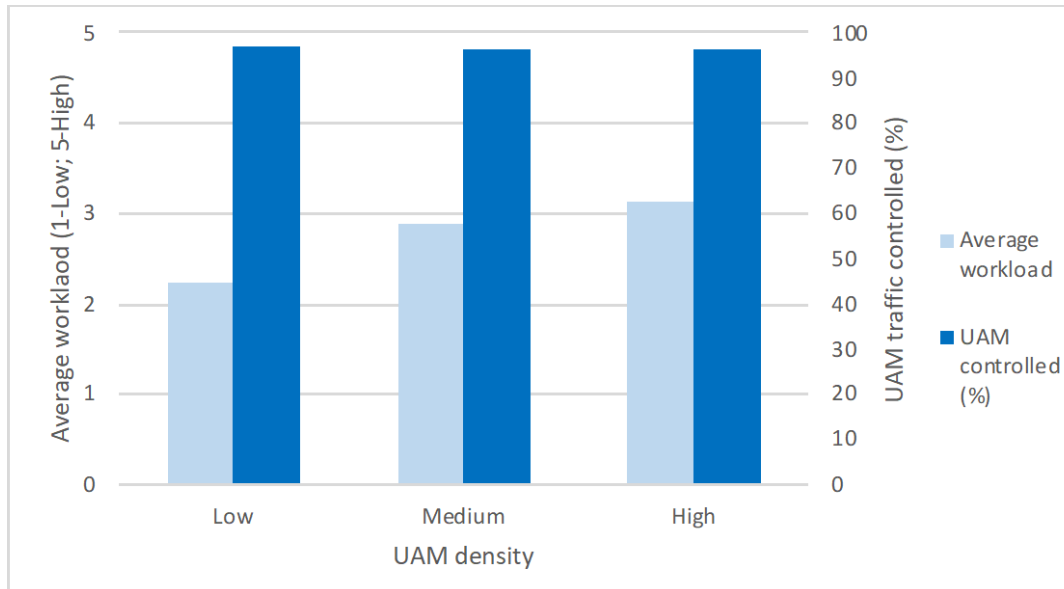
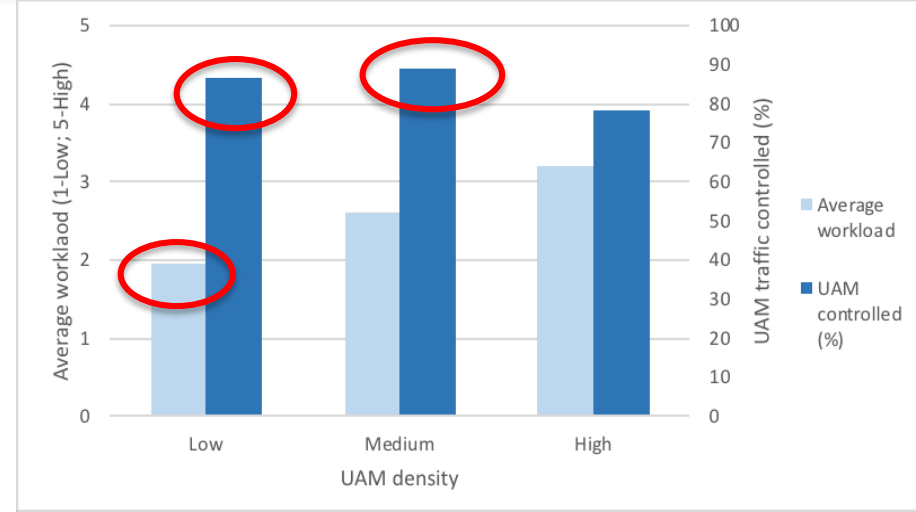
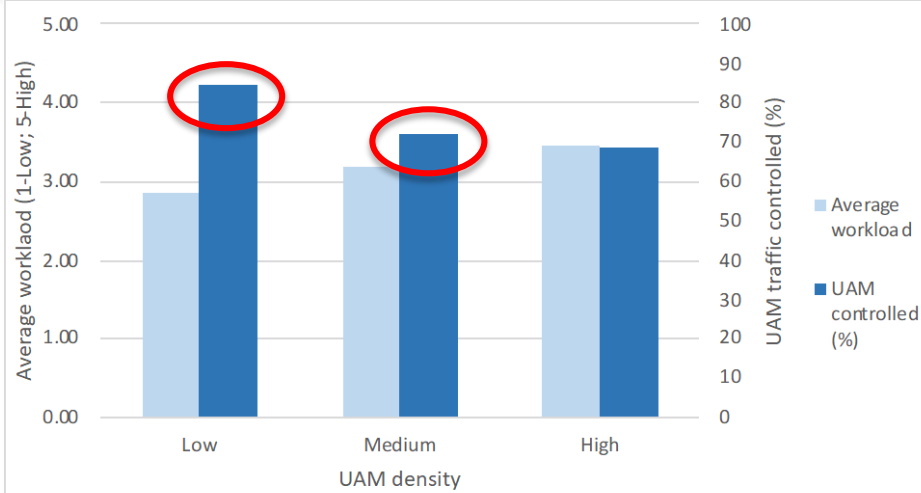


Result 2: Current day routes & procedures are associated with fewer controlled aircraft





Result 2: Route modifications are associated with increased traffic, not necessarily reduced workload



- Findings are provisional (n=6)
- Reduction of verbal communications associated with reduced workload
- Modification of routes associated with increased throughput
- But may still not be sufficient...
- UAM operations significantly restricted if controlled according to current day regulations





- Critical focus moves to development of scalable UAM operation that maintains safety
 - In ATC, ATCOs maintain safe operations
- Balance of human operator and automation in UAM traffic management
 - Dynamic response, prevention and mitigation
- Role and responsibilities of human operator
- System resilience, tolerances and graceful degradation

Thank you!
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Result 4: Positioning of UAM routes has implications for workload

