

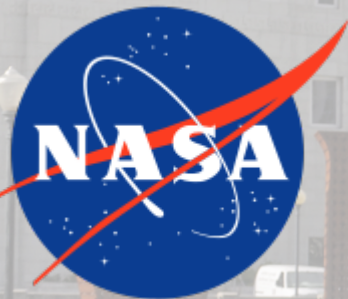
Human-system interaction issues and proposed solutions to promote successful maturation of the UTM system

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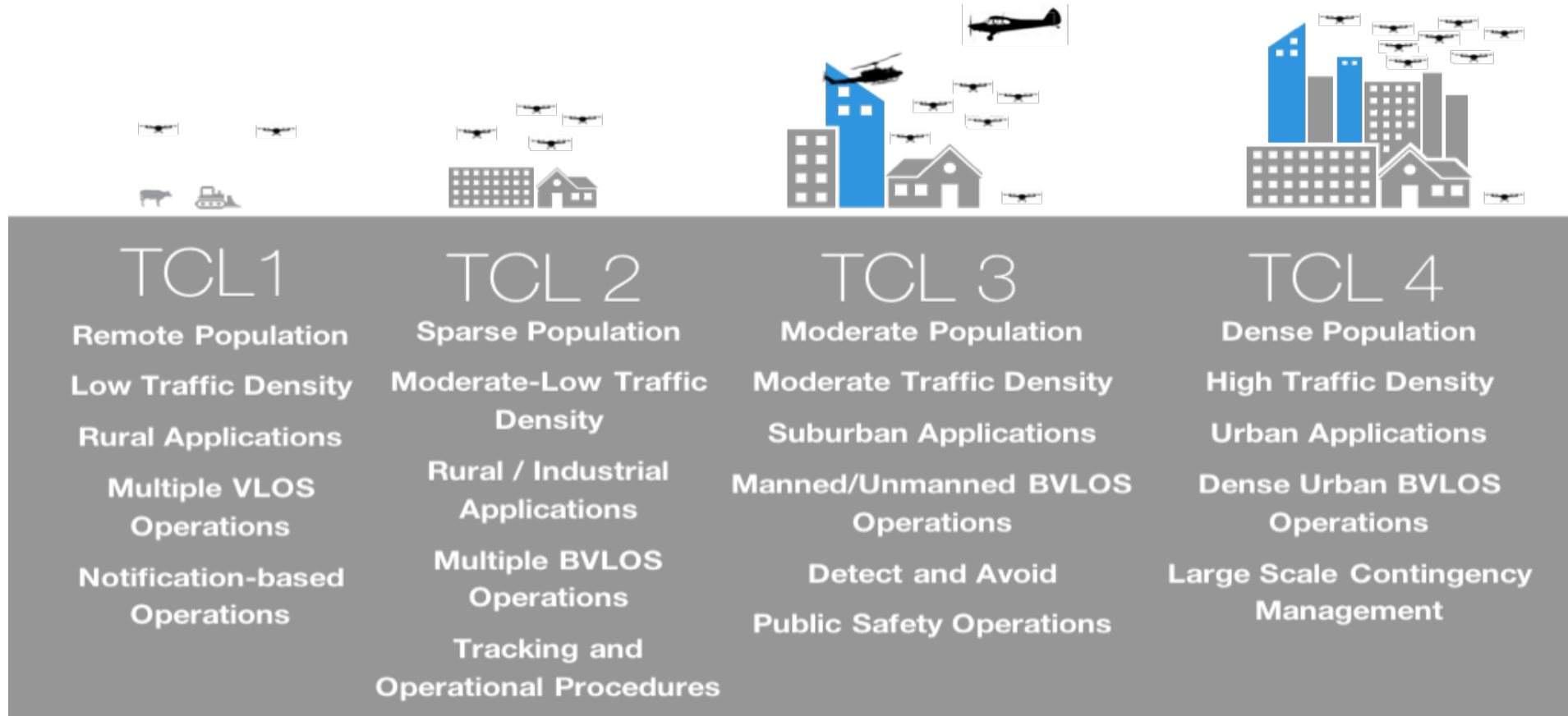
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Technical Capability Levels (TCL) and risk association

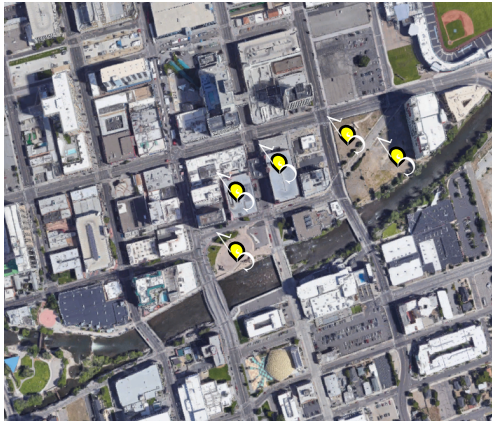
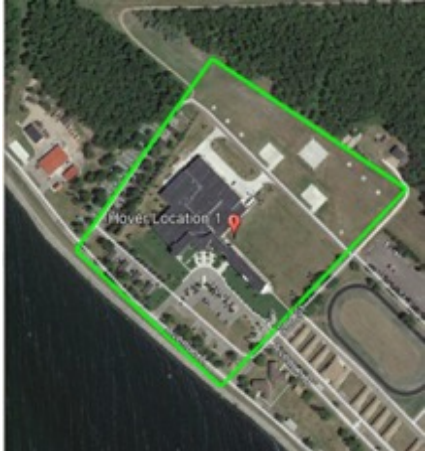


Increasing capability
Increasing risk

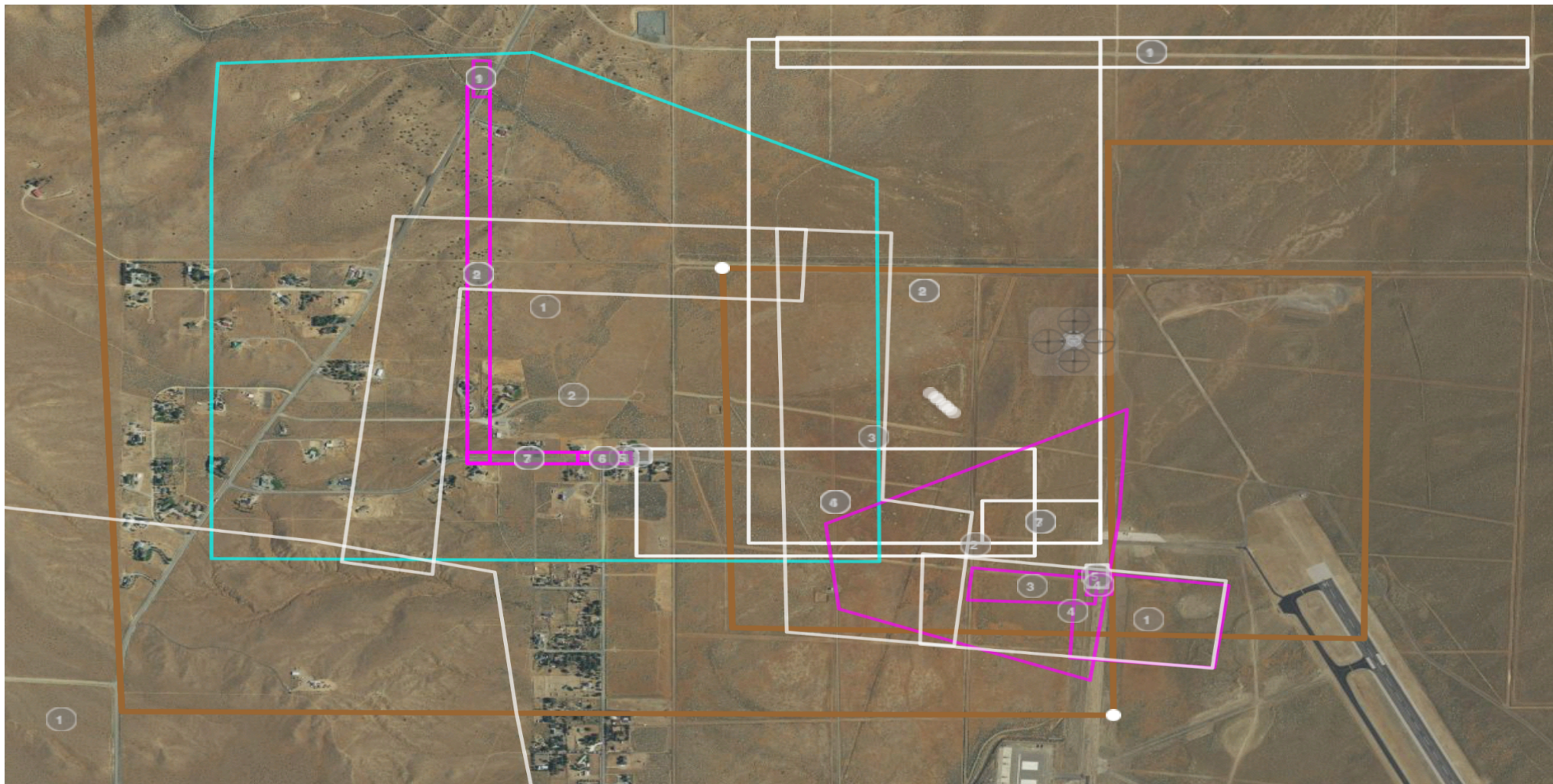


Demonstration parameters

	Flight demonstration details				
	Test 1	Test 2	Test 3	Test 4	Test 5
Technical Capability Level (TCL)	TCL1	TCL2	TCL2	TCL3	TCL4
Date	2015-16	2016	2017	2018	2019
Locations	1	1	6	4	5
Flying organizations	8	11	18	17	18
Vehicles	10	7	27	28	21*
Flight days	8	5	17	50	20*
UAS Service Supplier (USS)	3	8	7	9	7
Scenarios	3	4	17	20	5



UAS Traffic Management (UTM)



Human factors data collected across UTM project

Data collection test name	Flight demonstration level and year				
	Test 1	Test 2	Test 3	Test 4	Test 5
Technical Capability Level	TCL1	TCL2	TCL2	TCL3	TCL4
Date	2015-16	2016	2017	2018	2019
	Data collected				
Participant surveys	N/A	72	141	274	149
Interviews/ debriefs	N/A	5	18	22	19
Hours of debrief	N/A	Approx. 5 hours	Approx. 9 hours	Approx. 8.5 hours	Approx. 9 hours
Flight sessions observed	N/A	24	34	50	75

Flight test demonstrations

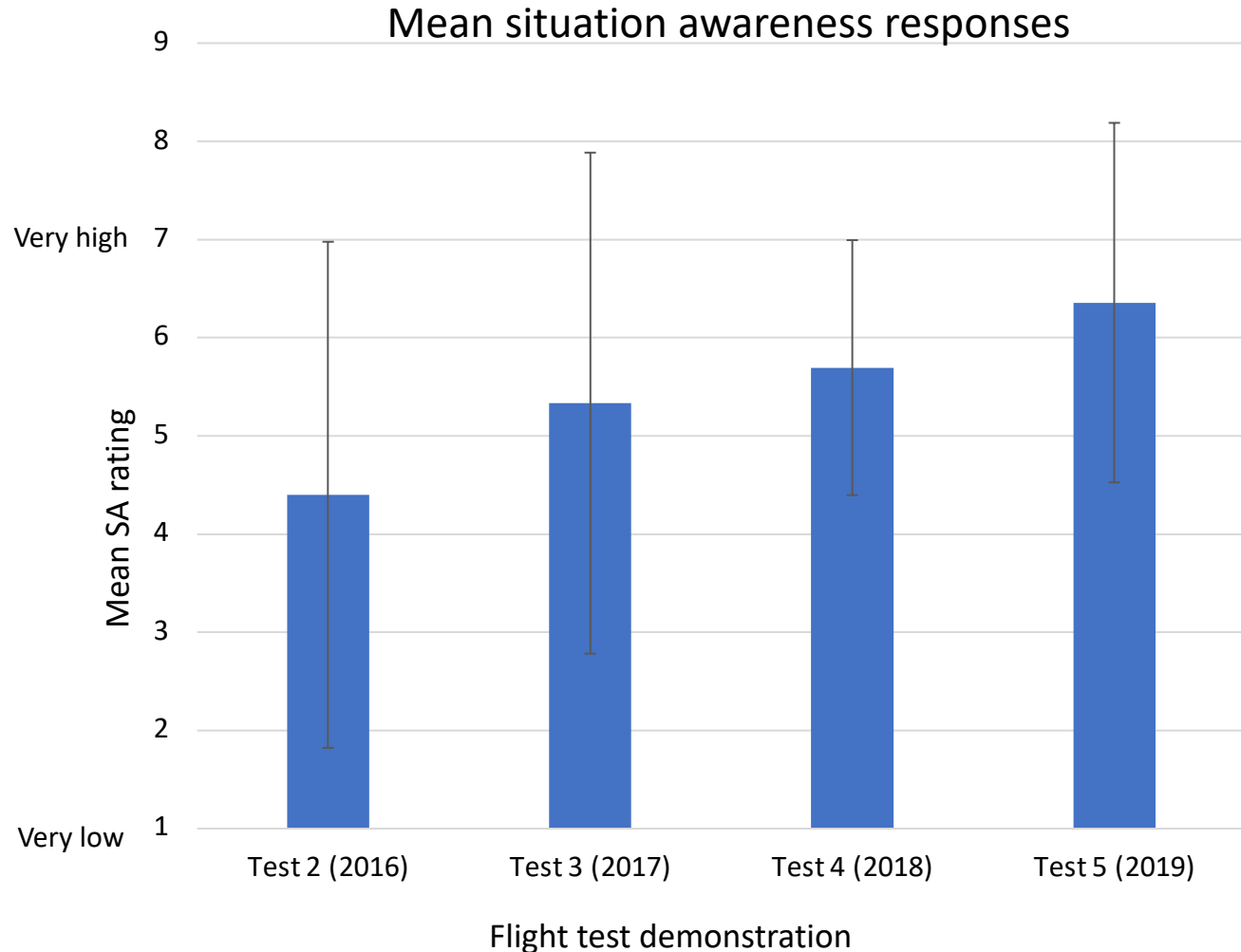
- summary

- Designed to test the UTM system in real-world settings
 - Involving many partners (as in a real-world setting)
- Successful demonstration that UTM is a viable method for communication and coordination between sUAS operations
- Successful demonstration of:
 - Data exchange through the system, bringing information from one party to another for situation awareness
 - Multiple, altitude-stratified operations
 - sUAS enacting contingency maneuvers
 - sUAS responding to newly restricted airspace (UAS Volume Restriction, UVR)



General HAI findings – Information quantity

- In earlier tests
 - Details missing in UTM information that made crew decision making more difficult
- In later tests
 - Too many messages for crew to read
 - Message labels not informative for crew



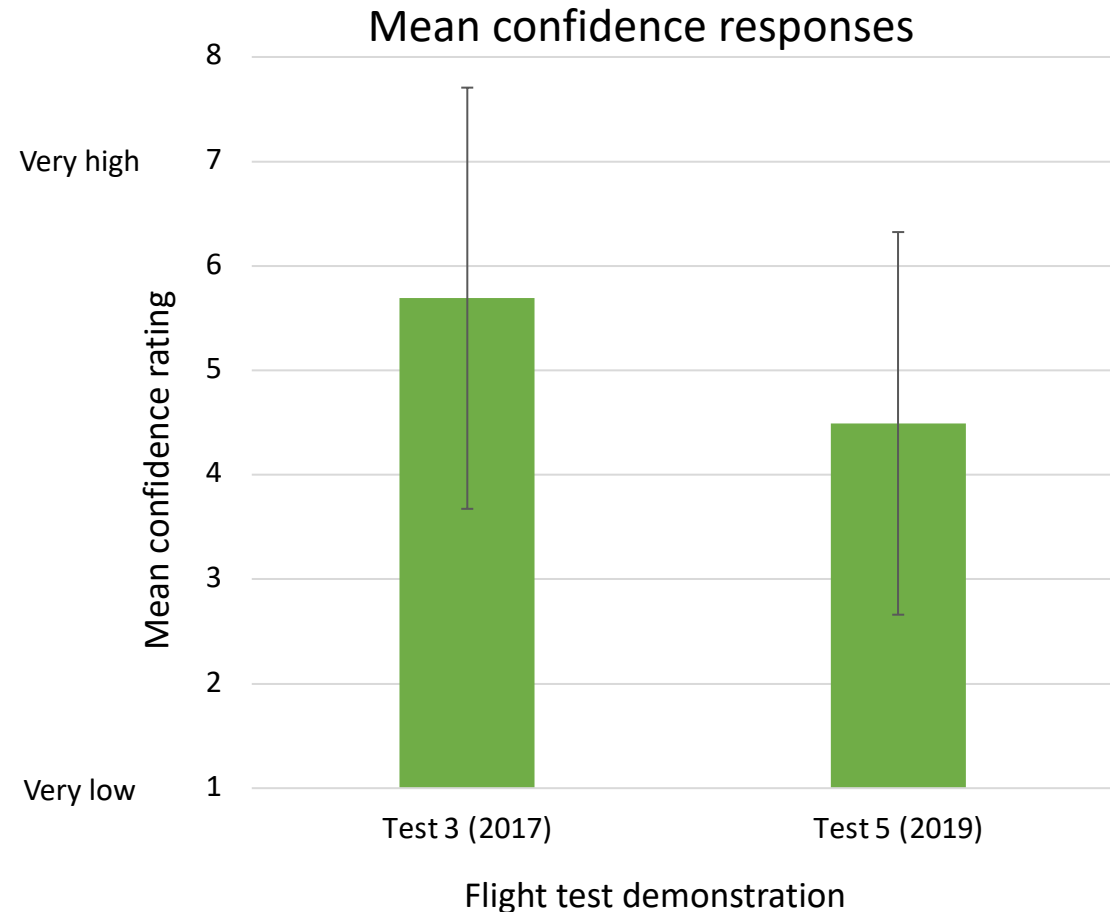
Response scale was 1 to 7, extended in chart to show standard deviations

HAI = human automation interaction

General HAI findings - Standardization

- Unfamiliar terminology
 - Information was hard for some to interpret
- Measurement consistency
 - Use of different units required crews to manually resolve issues
- Undefined procedures
 - UAS an infant industry – no standard approaches to guide users
 - Too little time for users to make complex contingency decisions

HAI = human automation interaction



Response scale was 1 to 7, extended in chart to show standard deviations

UTM as a human-automation system

- While the end-state of the system is fully automated, the interim nearer-term states require manual interaction
- Challenges for near-term usage
 - Designing displays that are easily usable in a complex urban environment
 - E.g., Messages that are filtered by criticality
 - Creating UTM training for users
- Challenges for mid-term usage
 - Automating functions in a manner that keeps remaining manual tasks as coherent activities





Summary

- Successful demonstration that UTM is a viable method for communication and coordination between sUAS operations
- Demonstration work focused on automation-to-automation interaction
- Future development should also consider the human-automation system interaction to scope nearer-term evolutions of the UTM system

Thank you!



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Questions?

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