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War-Winning Capabilities ... On Time, On Cost



U.S. AIR FORCE

Large Aircraft Inspections with sUAS

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Overview



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- **ET-CTF Background**
- **sUAS Operations**
- **Inspection Objectives & Results**
- **Recommendations**



ET-CTF Mission



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Provide agile, innovative flight test capabilities for emerging technologies



What are Emerging Technologies?



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- **“Emerging technologies are technologies that are perceived as capable of changing the status quo. These technologies are generally new but include older technologies that are still controversial and relatively undeveloped in potential.” (Wikipedia)**
- **Technologies and capabilities are being developed, primarily outside of DoD, far below the scope of traditional CTFs**
- **Research organizations (DARPA, AFRL, etc) involved, but not from a test perspective**



Current Focus Areas



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- **Autonomy**
 - The next revolutionary advancement
 - How do we test an autonomous system?
- **Small UAS**
 - Rapid advances in capabilities
 - Few current programs of records, but they're coming
 - Regulations in major flux (FAA, HAF and AFMC)
 - USAF Small UAS Flight Plan 2016-2036
- **3rd Offset (i.e., Directed Energy, Hypersonic)**

Autonomy and sUAS go hand-in-hand



Primary Objectives



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- **Develop FTTs**
 - Building test/training fleet
 - Partnerships with AFRL and TRMC
 - Proof-of-concept test with Range
 - NASA Support (Traveler)
- **Develop/improve policies/regulations/procedures**
 - 412 TW sUAS CONOPs in draft
 - Training plans developed in concert with TPS
 - Close coordination with AFMC/A3V, Range Safety
- **Provide an avenue for external organizations (research, commercial, educational)**
 - Build on previous experiences with Disney, Gray Eagle, etc.
 - Potential commercial customers
 - AFRL, DARPA, C-UAS, others
- **Develop/maintain relationships**
 - Conferences, meetings, symposia, etc.



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sUAS OPERATIONS





USAF sUAS Guidance



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- **Numerous new Ols and Requirements implemented**
 - Similar to manned and large UAS operations
 - Currently not conducive to quick, simple ops
 - Working updates to make more reasonable
 - Current ruleset would impact daily ops by non-rated
- **Rules on use of COTS sUAS**
 - Currently same for all UAS
 - Working updates to allow leeway for COTS
 - Operator Rqts still of concern



ET-CTF Ops



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- **Current fleet includes:**
 - (2) 3DR Solo quadcopters with GoPro Hero4+
 - (2) eFlight Apprentice fixed wing
 - (1) DJI Matrice
 - (1) DJI Phantom 4
 - (1) DJI Mavic
- **Future vehicles:**
 - (4) Swift Radioplanes Lynx fixed wing
 - Additional TBD vehicles & Sensors
- **Identification of requirements will drive additional acquisition**



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INSPECTION OBJECTIVES & RESULTS



Test Feasibility Study (TFS)



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- **TFSs created as local process to develop new operations concepts**
- **Inspection of large aircraft identified for TFS**
 - Based on Airbus, others
 - Ability to help augment inspections
- **Why UAVs?**
 - Dirty, Dull, Dangerous
 - Large Aircraft upper inspections are just that
 - Improve safety and timeliness
- **Airspace Operations Challenges**
 - Active Flightline



Aircraft Inspection TFS



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- B-52 Conducted 16 March
- On active ramp
- Maintainers working on a/c



- C-17 conducted 6 March
- Ramp inside flightline but not on active taxiways
- Initial concept test
- 3DR Solo with GoPro Hero3



Results



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- **Positive feedback from maintainers on usability of video**
 - Live stream to handheld tablet
 - Live stream NOT HD for this test
- **Quick survey**
 - ~15 minutes to do a run on the C-17
 - Battery Life limited
 - Ability to dwell on areas and adjust sensor important
 - No Zoom capability was a limfac
- **Feasible with improvements in capabilities**



Example Screen Shots



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Example Screen Shots



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Example Screen Shots



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Example Screen Shots



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Recommendations



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- **System used is not adequate as designed**
- **Need to define system requirements and more automated capability to make it useful**
- **Need better sensors with zoom**
- **Need system with longer endurance to loiter for longer periods of time**
- **Need a user community and acquisition POC**
 - **We're testers, not system developers**
 - **We can provide input, test and recommendations**
- **Regulations on flightline ops, enlisted operations, etc. will need definition**



Summary



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- **Using sUAS with adequate capabilities would provide key inspection capability for MXGs**
- **Identification of requirements will be critical**
- **Identification of lead for development necessary**
- **Feasible & useful capability!**



Publicly Available News



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- **C-17:**
 - <http://www.edwards.af.mil/News/Article/1107027/first-use-of-suas-to-inspect-plane-lessens-load-for-maintainers/>
 - <http://www.turnto23.com/news/local-news/edwards-air-force-base-flies-a-drone-around-an-aircraft-to-simulate-a-post-flight-inspection>
- **B-52:**
 - <http://www.edwards.af.mil/News/Article/1128186/small-quadcopter-test-is-first-on-active-air-force-taxiway/>
 - <http://www.turnto23.com/longform/inside-look-b-52-stratofortress-at-edwards-air-force-base>



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Questions?



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