



412 TW

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



# Transitioning Innovation to Reality – Creative sUAS Use

16 May 2018

Chris Eaton, Ph.D.  
Chief Engineer, ET-CTF

**U.S. AIR FORCE**

DISTRIBUTION A. Approved for public release; Distribution is unlimited 412-TW-PA-18209

**Integrity ★ Service ★ Excellence**



# Agenda



412 TW

- **Emerging Technologies CTF**
- **Current & Completed Projects**
- **Future Projects**
- **Conclusions**



412 TW



# EMERGING TECHNOLOGIES COMBINED TEST FORCE (ET-CTF)





# Mission



412 TW

**Provide agile, innovative flight test capabilities for emerging technologies**



# Primary Objectives



412 TW

**Create test capabilities that do not currently exist**

- **Develop FTTs**
- **Develop/improve policies/regulations/procedures**
- **Provide an avenue for external organizations (research, commercial, educational)**
- **Develop/maintain relationships**

**Eliminate “strategic surprise” to 412<sup>th</sup> Test Wing**



# Current Focus Areas



- **Autonomy**
  - The next revolutionary advancement
  - How do we test an autonomous system?
- **Small UAS**
  - Rapid advances in capabilities
  - Few current programs of record
  - Regulations in major flux (FAA, HAF and AFMC)
  - USAF Small UAS Flight Plan 2016-2036
  - Counter-sUAS
- **3<sup>rd</sup> Offset (i.e., Directed Energy, Hypersonics)**

**Autonomy & sUAS go hand-in-hand**



# UAV Classes



412 TW

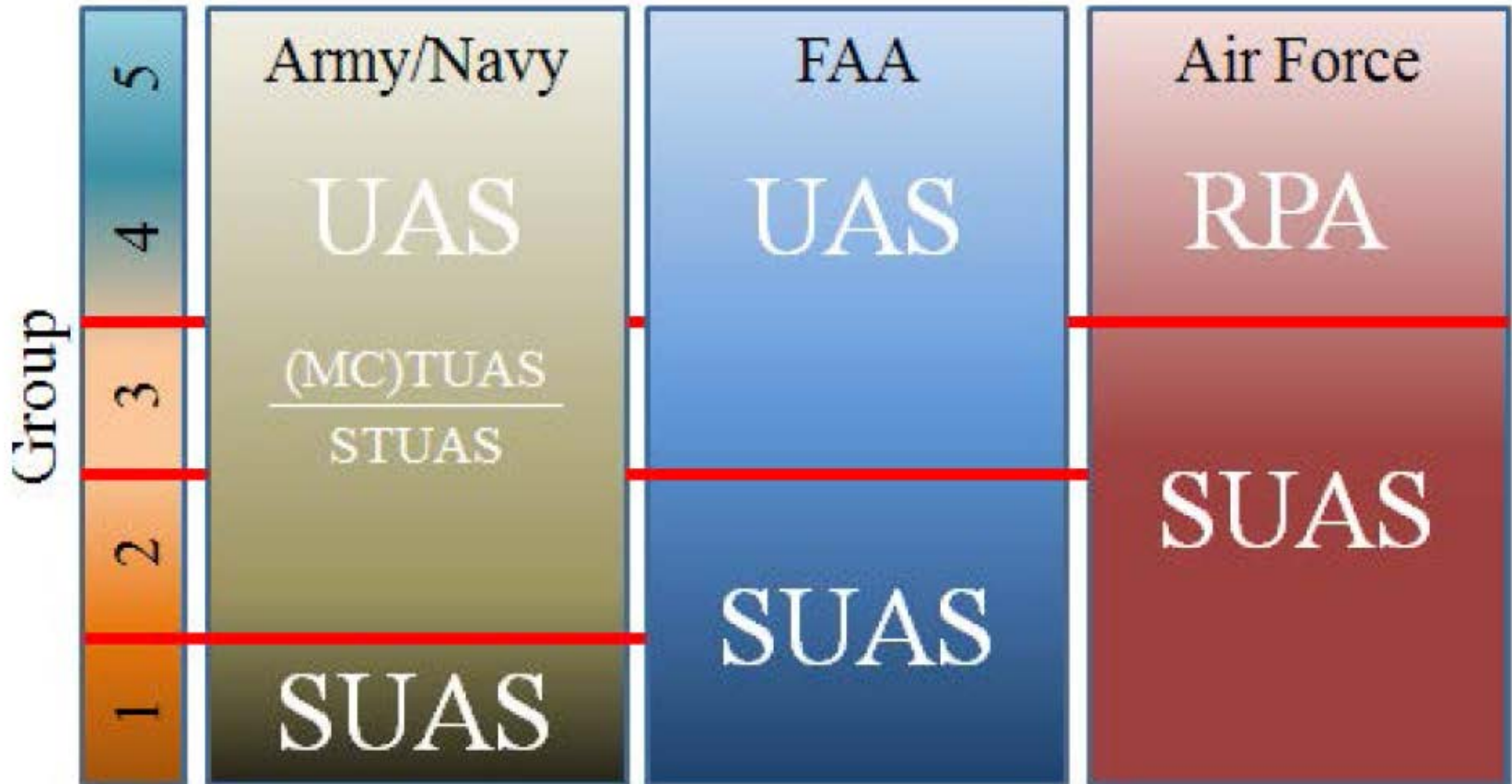


Figure 2: Different Definitions of "SUAS"

- From sUAS Flight Plan



# USAF sUAS Groups



412 TW

	Group	Max Weight (lbs)	Normal Op Alt (ft AGL)	Speed (kts)	Representative Aircraft
SUAS	1	0 - 20	<1,200	< 100	Puma AE (RQ-20A) Wasp AE (RQ-12A) Shrike <sup>TM</sup> + Raven (RQ-11B)
	2	21 - 55	<3,500	< 250	Scan Eagle* Aerosonde* Silver Fox*
	3	< 1,320	< FL 180	< 250	Blackjack (RQ-21A)** Tigershark*

\* Not a Program of Record in the USAF. Utilized for T&E or Services Contract. \*\* Participated in the CDD but not the CPD.

- From sUAS Flight Plan





# Autonomy



412 TW

- **Automation:** The system functions with no/little human operator involvement; however, the system performance is limited to the specific actions it has been designed to do. Typically these are well-defined tasks that have predetermined responses (i.e., simple rule-based responses).
- **Autonomy:** The system has a set of intelligence-based capabilities that allows it to respond to situations that were not pre-programmed or anticipated (i.e., decision-based responses) prior to system deployment. Autonomous systems have a degree of self-government and self-directed behavior (with the human's proxy for decisions).



412 TW

# CURRENT & COMPLETED PROJECTS



# Flying RF Boresight



412 TW

## OBJECTIVE

- Provide improved Telemetry Antenna RF Boresight capability utilizing sUAS
- Current methods used fixed tower or Sun

## SYSTEMS USED

- DJI Matrice
- RF Signal Generator

## TESTS PERFORMED

- EMI/C
- Calibrations of C, lower-L & Upper-L bands
- 500 ft Above Antenna, 1000/3000 laterally

## RESULTS

- As good or better than existing methods
- Winds and battery life impacts



# Flying RF Boresight



412 TW

## OBJECTIVE

- Provide improved

Tele  
Bore  
utiliz

- Cur  
fixed

- EM
- Cali
- & Up

- 500 ft Above Antenna,  
1000/3000 laterally

## SYSTEMS USED

- DJI Matrice





# Large Aircraft Tail Inspections



## OBJECTIVE

- Evaluate feasibility of using sUAS to inspect Large Aircraft Tails/Upper surfaces
- Perform sUAS ops in flightline environment

## SYSTEMS USED

- C-17 & B-52
- 3DR Solo with GoPro

## TESTS PERFORMED

- C-17 Tail/Upper surface inspection in sanitized flightline
- B-52 Tail/Upper surface on active flightline w/active maintenance on A/C

## RESULTS

- Video sufficient for preflight inspections of C-17
- Approach provides feasible way to improve safety & inspections



# Large Aircraft Tail Inspections



## OBJECTIVE

- Evaluate feasibility of using s... Large A... Tails/U... flightline
- Perform...

## SYSTEMS USED

• C-17 & B-52

GoPro



## TESTS

- C-17 Tail inspection on active flightline
- B-52 Tail/Upper surface on active flightline w/active maintenance on A/C

## TESTS

for inspections

of C-17

- Approach provides feasible way to improve safety & inspections



# Roof Inspections



412 TW

## OBJECTIVE

- Provide safe & cost effective support to manned roof inspections
- Reduce amount of on-roof time

## SYSTEMS USED

- 3DR Solo with GoPro
- DJI Phantom 4 Pro

## TESTS PERFORMED

- Inspection of 2 different roofs
- Inspection of GPS Antenna on tower of tall hangar

## RESULTS

- Significant savings in man-hours on roof
- Method being developed for regular inspection use



# 3-D Modeling for Milcon



412 TW

## OBJECTIVE

- Utilize sUAS and 3-D image modeling for Military Construction support

## SYSTEMS USED

- 3DR Solo

## TESTS PERFORMED

- Numerous aerial videos & images taken to support construction plan
- Developed 3-D model of compound

## RESULTS

- Provided current facility status to contractor without sending out a large team of personnel to survey





# T-38 Gear Door



412 TW

## OBJECTIVE

- Find Remnants of T-38 gear door that departed aircraft over lakebed
- Provide aerial footage for Safety Review Board

## SYSTEMS USED

- 3DR Solo

## TESTS PERFORMED

- Aerial Search
- Aerial Imagery with geolocation

## RESULTS

- Gear Door Debris found in wet area of lakebed
- Imagery of debris field collected for Safety Board



# B-1 Inlet Cover



## OBJECTIVE

- Aerial Search for B-1 Inlet cover that blew onto infield of Airfield

## SYSTEMS USED

- 3DR Solo

## TESTS PERFORMED

- Aerial search of infield
- Post search video review

## RESULTS

- Real time video insufficient to identify
- Post flight video review identified inlet for recovery



# B-52 Leaflet Bomb



412 TW

## OBJECTIVE

- Aerial surveillance of paper leaflet debris field from test drop

## SYSTEMS USED

- Swift Radioplanes Lynx

## TESTS PERFORMED

- Aerial Surveillance of Precision Impact Range
- Post mission creation of surveillance and ID of paper debris field

## RESULTS

- Surveillance of large range area
- Leaflet distribution map generated from collected imagery



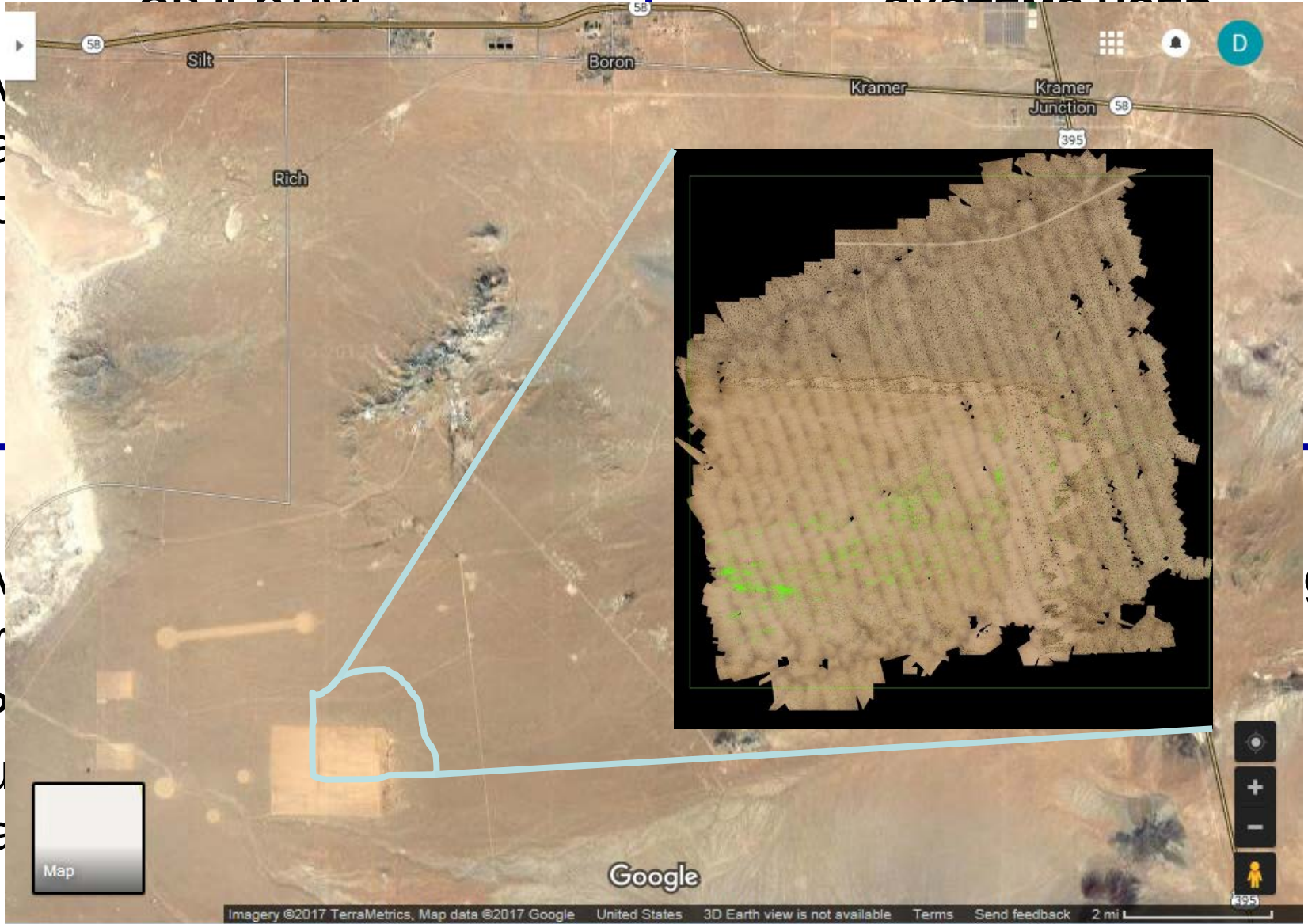
# B-52 Leaflet Bomb



412 TW

• A  
pa  
fro

• A  
Pr  
• P  
su  
pa



ge



# Emergency Management



412 TW

## OBJECTIVE

- Provide real time imagery to emergency commanders for safety and task assignment

## SYSTEMS USED

- DJI Phantom 4 Pro

## TESTS PERFORMED

- Fire/Emergency Management and Explosive device identification for simulated B-52 crash

## RESULTS

- Real time identification of location of pilots, personnel and explosives
- Significant increase in EM situational awareness during events



412 TW

# CURRENT PROJECTS



# Ready Raven



412 TW

## OBJECTIVE

- Provide High Speed, Low Level Radar target for 5<sup>th</sup>-Gen aircraft

## SYSTEMS USED

- Blade Theory
- E-Flite HABU

## TESTS PERFORMED

- Test Planning in Work

## UPCOMING TESTS

- Initial verification testing of Radar tracking capability



# Ready Raven



## OBJECTIVE

- Provide High Level Radar Gen aircraft

## SYSTEMS USED



## TESTS PERFORMED

- Test Planning

## ONGOING TESTS

Integration testing of  
 Capability







# Counter-sUAS



## OBJECTIVE

- Evaluate subsystem and system-of-system performance to detect, track, identify, and defeat sUAS
- Support Urgent Ops Need

## SYSTEMS USED

- COTS multirotor, fixed wing
- DJI family of vehicles
- Finwing Saber
- Skywalker X8
- Radjet

## TESTS PERFORMED

- Subsystem performance of sensors vs. different targets
- Subsystem performance of defeat capabilities

## UPCOMING TESTS

- Integrated system-of-system testing
- Integration of additional sensors into SOS



# Autonomy



412 TW

## OBJECTIVE

- Develop T&E capabilities, identify range and policy issues for testing & operations of Autonomy
- Support DoD autonomy development initiatives

## SYSTEMS USED

- SRP Lynx

## TESTS PERFORMED

- Initial ground integration of TACE hardware into Lynx

## UPCOMING TESTS

- TACE system verification flights on Lynx
- AFRL FAMUS manned-surrogate testing

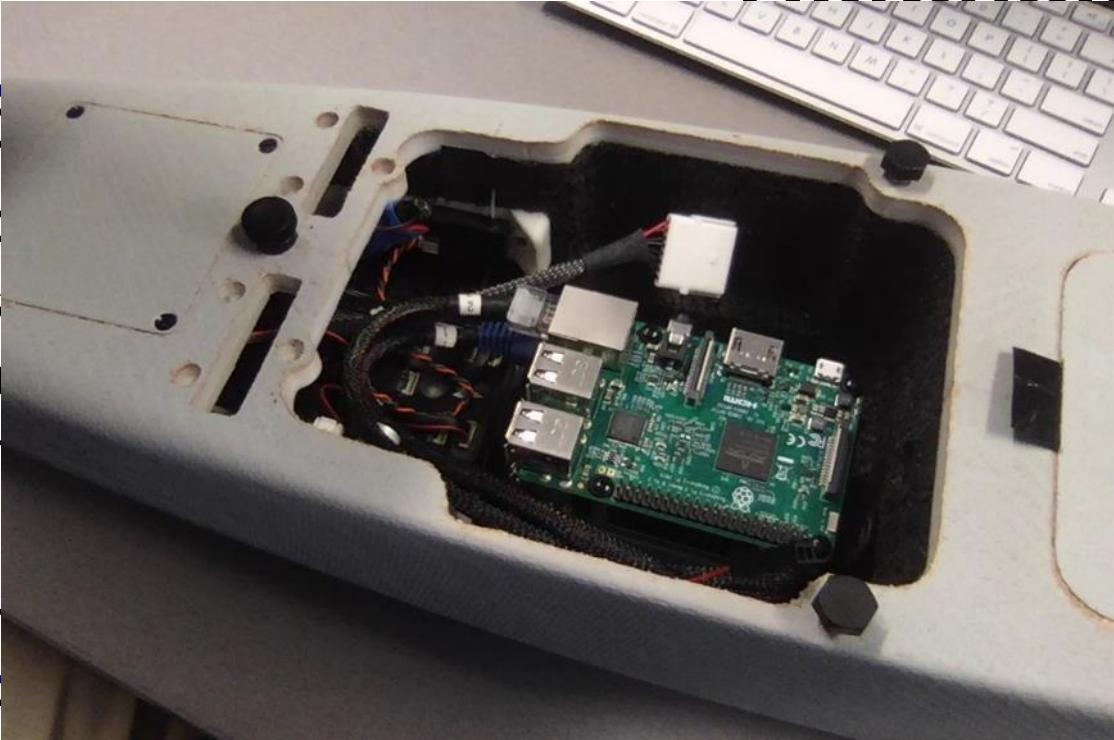


# Autonomy



412 TW

- Develop
- identify r
- issues fo
- operation
- Support
- developr



MS USED

TEST

NG TESTS

- Initial gr
- TACE ha



n verification  
x  
S manned-  
ting



412 TW

# CONCLUSIONS



# Conclusions



- **sUAS provide useful unique capability for supporting previously man-hour intensive tasks**
- **ET-CTF continues to demonstrate new uses and ways to support with sUAS**
- **Autonomy & Counter-UAS provide unique challenges to test community**
- **With significant capabilities comes the likelihood of increased operations**
  - **Airspace Issues**
  - **Safety of ground people concerns**
  - **Test Unique issues**



# Questions?



412 TW

