Operational Rules and Guidelines

CNS Requirements

Airspace Management Requirements

UAS Requirements

Data Services, Interfaces, and Architecture Requirements

Field Demonstration Objectives
TCL 1: August 2015
Line of Sight Operations
Low Risk Environment
Airspace Reservation
Geo-fencing for Separation
No Fly Zones
User Authentication

TCL 2: October 2016
Beyond Line of Sight Operations
Low Risk Environment
Segmented Flight Plans
Weather and Traffic Advisories
Altitude Stratification
Contingency Management (Alerting)
System Health Monitoring
TCL 1 UAS Operations

Manufacturing:
- EM Tower Inspection
- Wind Turbine Inspection
- Bridge Inspection
- Power Line Inspection
- Solar Panel Inspection
- Rail Inspection
- Landfill Inspection
- Pipeline Inspection
- Dam Inspection
- Canal Inspection

Farming:
- Aerial Application
- Precision Agriculture
- Livestock Monitoring
- Invasive Plant Monitoring

Other:
- Forest Management
- Mosquito Monitoring
- Wildlife Conservation
- Archaeology
- Anthropology
- Prospecting

Oceanic:
- Maritime Surveillance
- Maritime Scouting
- Ocean Research
- Anti-Piracy

Recreation:
- Animal Spotting for Hunting
- Nature Photography
- Adventure Sports Photography

Typical Operation Limitations
- Line of Sight Operations
- Sparsely Populated Areas
- Typically <400 ft AGL
- VMC Conditions & Daylight
- UAS < 55lbs
- 500 ft away from structures
TCL 1 Demonstration Overview
Simultaneous UAS Operations

~ 108 Flights
~18 Flight Hours
Duration: 2-38 minutes
Avg. Flight Time: ~ 11 min

Crows Landing, CA

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Demonstration Objectives

Objective 1: Demonstrate UTM Capabilities

Objective 2: Collect Data on UAS Navigation Performance Error

Objective 3: Collect Data on Aircraft Tracking Performance

Objective 4: Collect Weather Observations for Forecasting Models

Objective 5: Collect Data on Noise Signature of UAS Vehicles
UTM Vehicles

8 multi-rotors and 2 fixed wing

Maximum Take-off Weight

- ~ 4 lbs
- ~ 40 lbs

Endurance

- 15 min
- 60 min
UTM Manager Displays

Java-based Desktop Display

iOS Application
UTM Field Equipment: Weather

32m Weather Tower

Data Collected
- Temperature
- Pressure
- Wind Direction
- Wind Speed
- Altitude
- Turbulent Kinetic Energy

Remote Automated Weather Station

Radiosonde Weather Balloon
UTM Field Equipment: Surveillance and Acoustics

Data Collected:
- Latitude
- Longitude
- Altitude
- Sound magnitude and frequency

Acoustic Measurement:
- Nicolet Vision XP
- B&K Nexus
- 4-Ch Power Supply
- ½” B&K Microphone + Wind Screen

Ground Situation Awareness Display (ADS-B In, En Route radar, Terminal Radar, ASDE-X, ASSC)
Flight Profiles:
• Free Flight
• Horizontal Trajectory Conformance
• Vertical Trajectory Conformance
• Sound Recording
• System Identification Maneuvers

Operation Area 1

Operation Area 2

Altitude: up to 400 ft AGL
Duration: 8-30 minutes
Simultaneous Aircraft: 2
Observations of Operational Use

- **New Airspace Users will require training and UTM needs to be intuitive**
  - **Observation:** UAS Operators submitting an operational plan to the system that differs from what was input into the GCS or a willingness to violate an operational plan.
  - **Recommendation:** Operator training and integration of flight planning and traffic management services into ground control stations

- **The right equipment for the operational environment**
  - **Observation:** High temperatures had impact on ground equipment. C2 interference occurred with local farming equipment. Degradation of GPS signals impacted flight operations.
  - **Recommendation:** UAS and ground systems and instruments are “qualified” by operational environment and performance.

- **Situation awareness is key for safe operations**
  - **Observation:** sUAS varies with size and line of sight (LOS) can be easily lost (e.g. sUAS looked like birds during operation). Weather reported on the ground isn't always indicative of weather experienced at operational altitude. Tracking of sUAS needs to occur at sufficiently fast update rates.
  - **Recommendation:** Improvements are needed in weather forecasting, modeling, and sensing at low altitudes. Tracking UAS infrastructure will need to be built to scale and with sufficient bandwidth. Airspace users should be given a common picture of their environment for safe operations.
Next Steps:
TCL 2 Demonstration
TCL 2 Demonstration Characteristics

• Flight Operations:
  – Operate 5 simultaneous operations
  – Operate two aircraft beyond visual line of sight (BVLOS)
  – Operate two aircraft in an altitude separated operation in visual line of sight (VLOS)
  – Operate two aircraft in an altitude-separated operation in BVLOS
  – Demonstrate Live-Virtual-Constructive Operations

• UTM Functionality:
  – Alerting UAS operators of threat aircraft based on data from surveillance system
  – Monitoring UAS operations for flight plan conformance
  – Alerting UAS Operators due to weather disruption
  – Alerting and contingency management procedures initiated by *simulated* in-flight emergencies of UAS operations
  – Dynamic requested flight plan rerouting
  – Public safety operations
TCL 2 Demonstration: Reno-Stead Airport

**Dates:** Oct. 17\textsuperscript{th} - 26\textsuperscript{th}

**Reno-Stead Airport:**
- Part of UAS Test Site
- Public and military general aviation airport located 10 nautical miles northwest of Reno, Nevada.
- Location of the Reno Air Races
- Elevation: 5050 ft (AMSL)

**14+ Partners:**
- BVLOS Vehicles
- Surveillance and Weather Equipment
Questions?