National Aeronautics and Space Administration

Unmanned Aircraft Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

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UAS Traffic Management

Goal:

Safely enabling large scale visual and beyond visual line of sight operations in the low altitude airspace

Risk-based approach along four distinct Technical Capability Levels (TCL)

TCL2: *multiple BVLOS, rural*

→ Initial BVLOS

→ Intent sharing

→ Geo-fenced ops

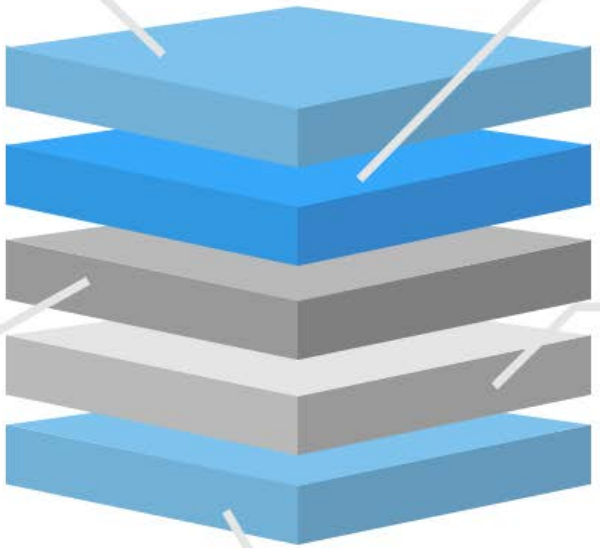
UTM TCL2: Scheduling and Executing Multiple BVLOS Operations

Conflict Alerts

Alert triggered by proximity to other aircraft

Intruder Alerts

Alert triggered from radar submitted warning regions to UTM research prototype



Contingency Alerts

Simulated in-flight emergency reported to the UTM research prototype and relayed to impacted operations

Flight Conformance Alerts

Alert triggered from departing from operational area and relayed to impacted operations

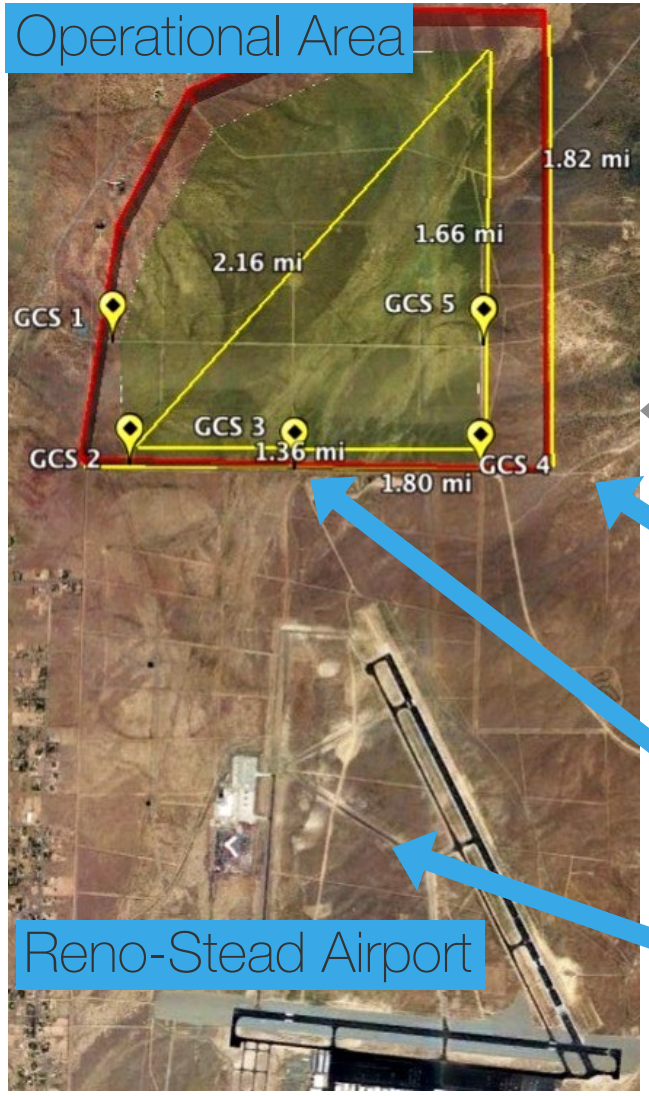
Priority Operations

Users with special privileges are given priority of the airspace and impacted operations are informed of any conflicts

Scheduling and tracking operations and contingency management

TCL 2
October 2016

Test Range



UAS Range

Elevation: 5050 feet

Desert Terrain

Missions up to 500 ft

Operations at 5 Locations

State of Nevada Test Site

Reno

Reno-Stead Airport

SRHawk Radar

Used to detect small UAS

Weather Equipment

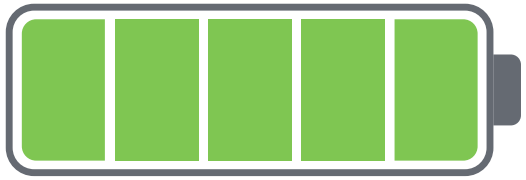
30 ft weather tower, sodar and lidar are used to measure atmospheric boundary layer

LSTAR Radar

Used to detect manned aircraft

TCL 2 Weather-related Observations

Temperature and Air Density Impacts



Nominal Aircraft Endurance

Multi-Rotors: 20-40 minutes

Fixed-Wing: 45-200+ minutes

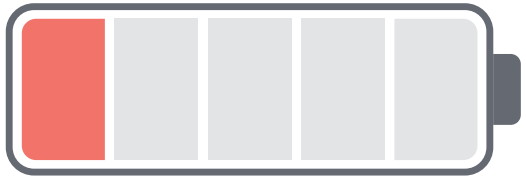
Reno-Stead Elevation: 5,050 ft

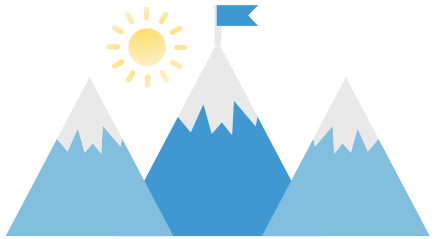
Cool Temperatures

Density Altitude: 4,000 ft

Winds: 5-35 knots

Aircraft encountered thermals, microbursts and high winds which resulted in reduced endurance and degraded flight plan conformance





Warm Temperatures

Density Altitude: 9,000+ ft

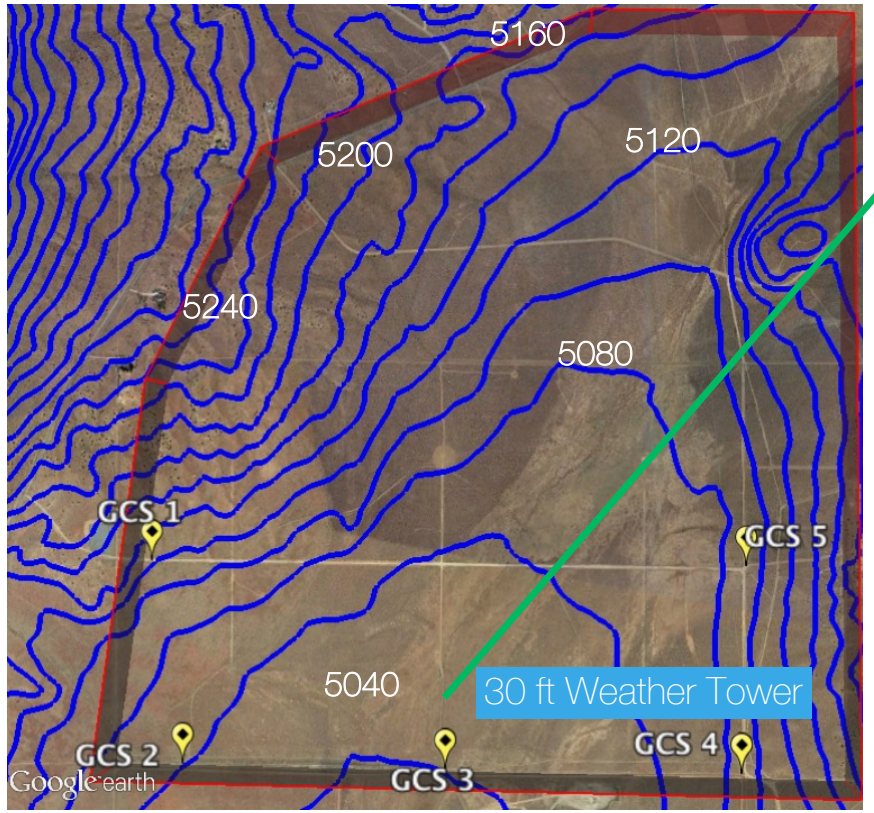
Winds: 5-15 knots

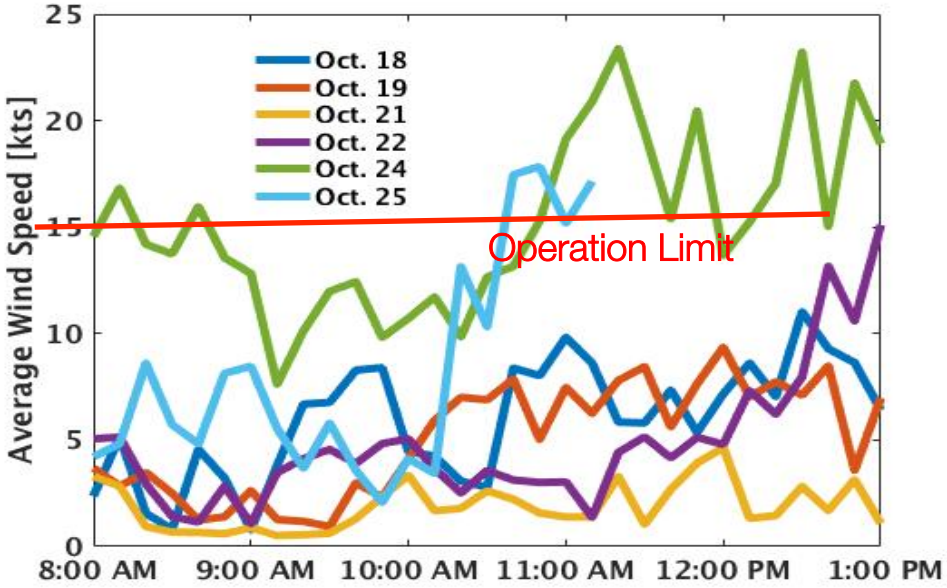
Aircraft experienced substantially shorter endurance

UAS equipment should be evaluated and rated against different operational environments

Locality and Terrain Impacts

Basin and range topography yielded local environments with observably different wind conditions





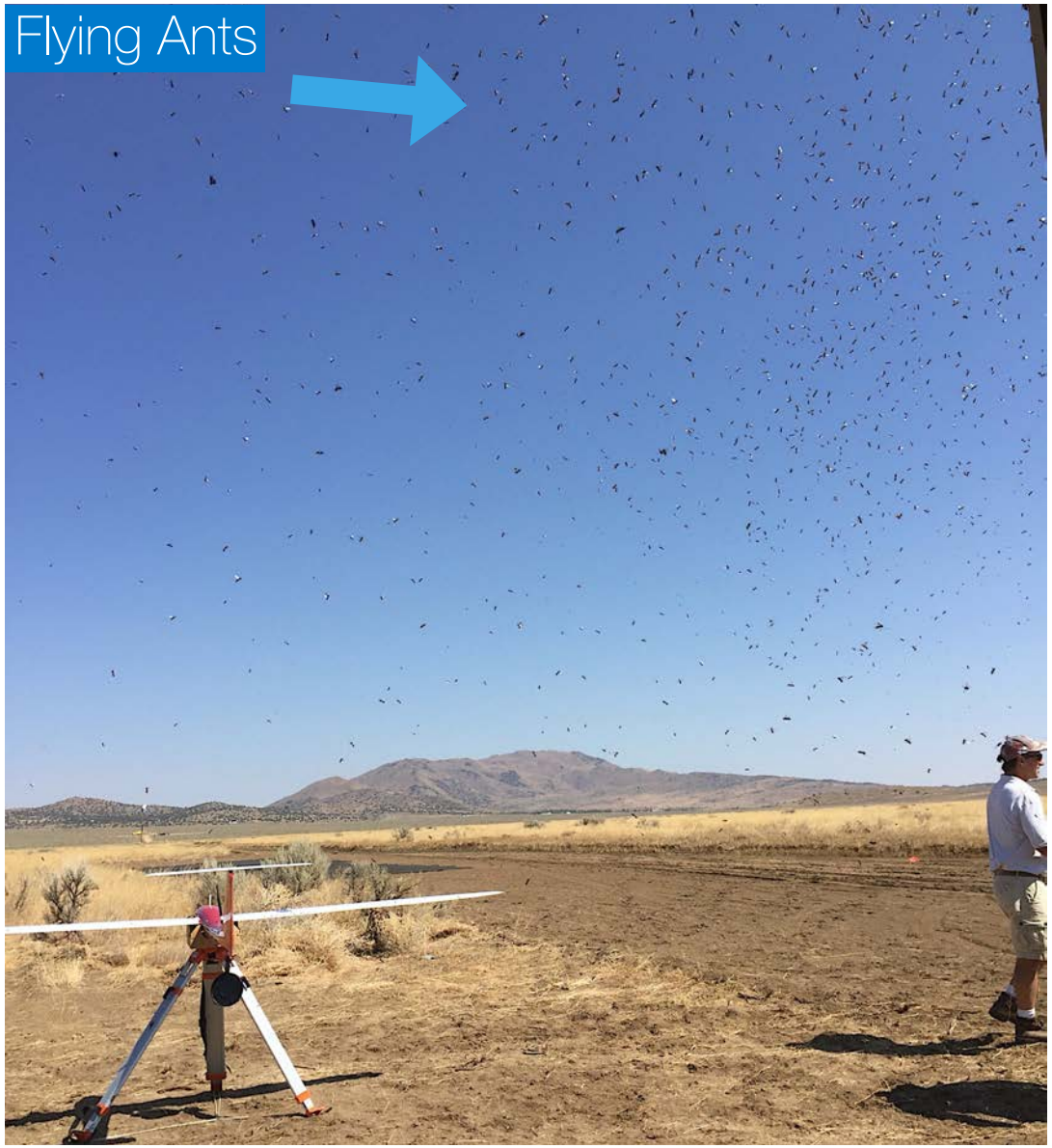
Local weather and national forecasts not indicative of observed conditions on site

Ground reports were not indicative of conditions UAS experienced aloft

Ground reports local to GCS location was not indicative of conditions UAS experience while BVLOS

Improvements in weather products are needed to support BVLOS

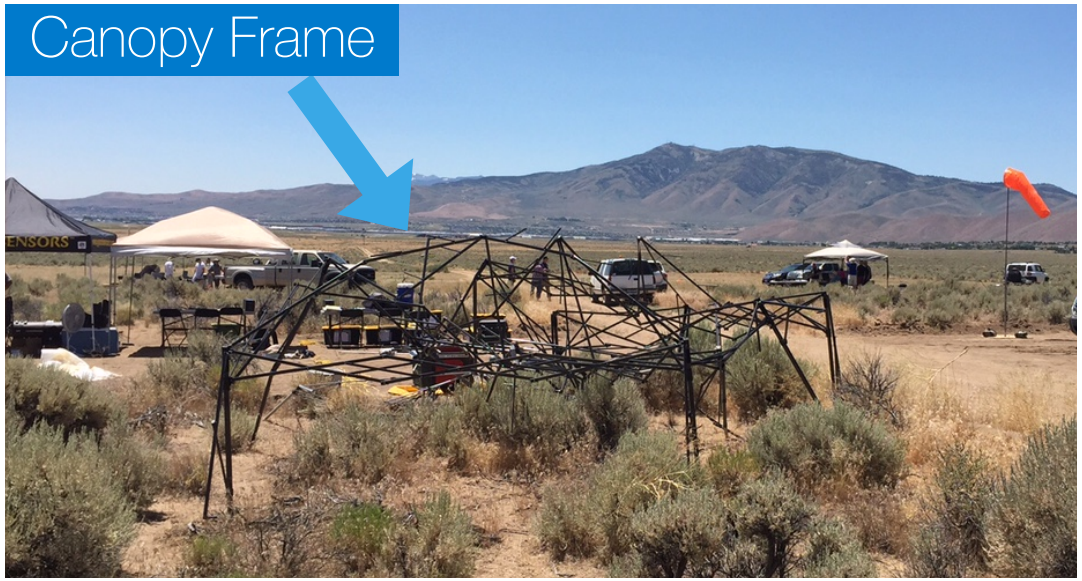
Other Ground Hazards



Dust devil launched canopy into the air

Rain induced swarms of mating flying ants

Dry climate / hot temperatures caused brush fire



Weather impacts to UAS Traffic Management

Unplanned or **emergency landings** due to **improper UAS testing** in relevant atmospheric conditions can be **hazardous** and cause disruption to other operations

Performance variations of different UAS in given atmospheric conditions should be **considered during scheduling and planning**

Initial BVLOS should **avoid altitude stratification**, until improvements in weather products

In the absence of acceptable weather products, **atmospheric conditions** should be **self-reported** from **GCS** and **UAS** (e.g. UREP)