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**
State of Nevada Test Site

Operational Area

Reno-Stead Airport

Test Range

Reno

UAS Range
Elevation: 5050 feet
Desert Terrain
Missions up to 500 ft
Operations at 5 Locations

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

SRHawk Radar
Used to detect small UAS

LSTAR Radar
Used to detect manned aircraft

TCL 2
October 2016
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

Flying Ants

Canopy Frame
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).