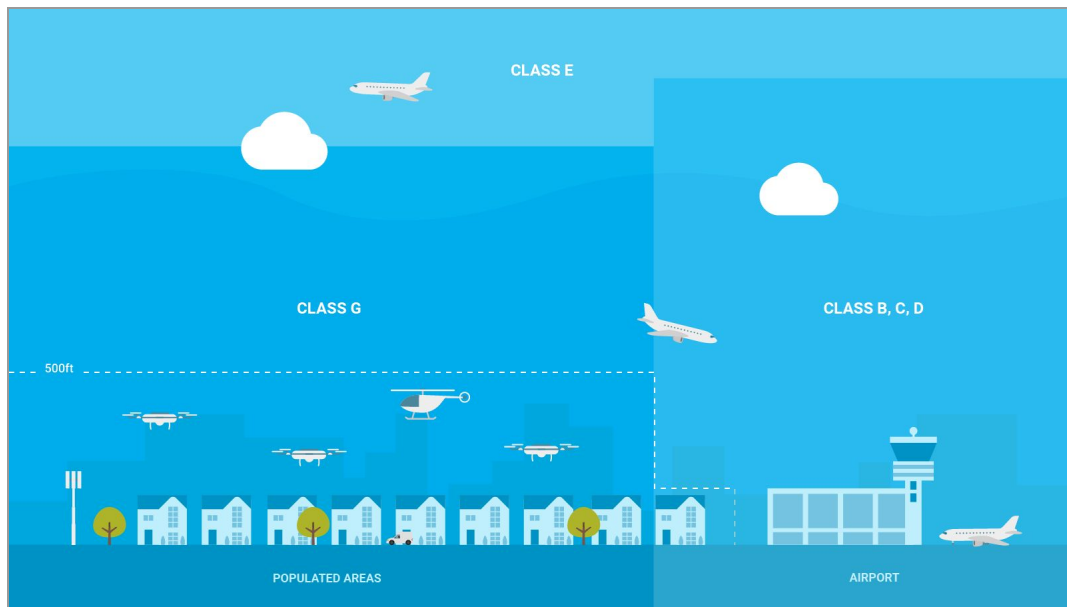
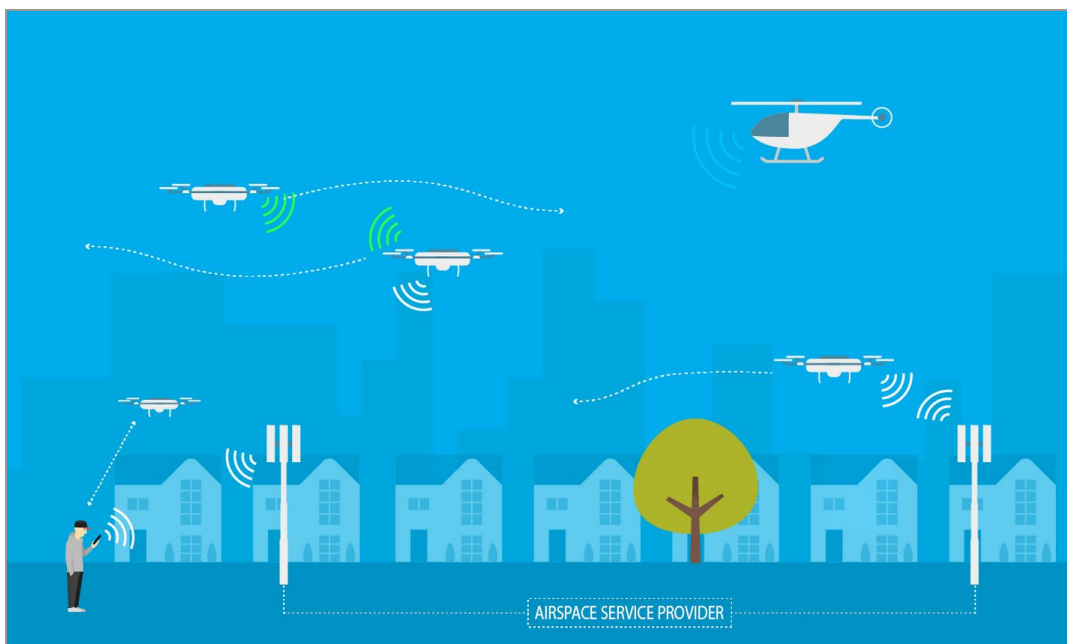


Google UAS Airspace System Overview



UAS Airspace will allow operations as shown under the dashed white line.

- Below 500' AGL (above ground level) initially in uncontrolled Class G airspace
- Future allowances for some entrance into Airport Airspace (Class B, C, D, surface-level E)



The connected, cooperative UAS airspace ecosystem.

- UAS traffic separation/planning by Airspace Service Provider (ASP) using cellular networks
- UAS will give-way to manned traffic (collision avoidance via ADS-B 'in' on UAS)
- Short range UAS-to-UAS collision avoidance via a similar "ADS-B like" system.
- This ecosystem also allows hobbyists to participate.

Communications and Cooperation



Leveraging existing cellular networks, UAVs are monitored and the airspace is supervised. UAVs also perform long range traffic separation assurance aided by the airspace system.

UAVs perform collision avoidance through a lightweight location and intent transceiver similar to ADS-B.

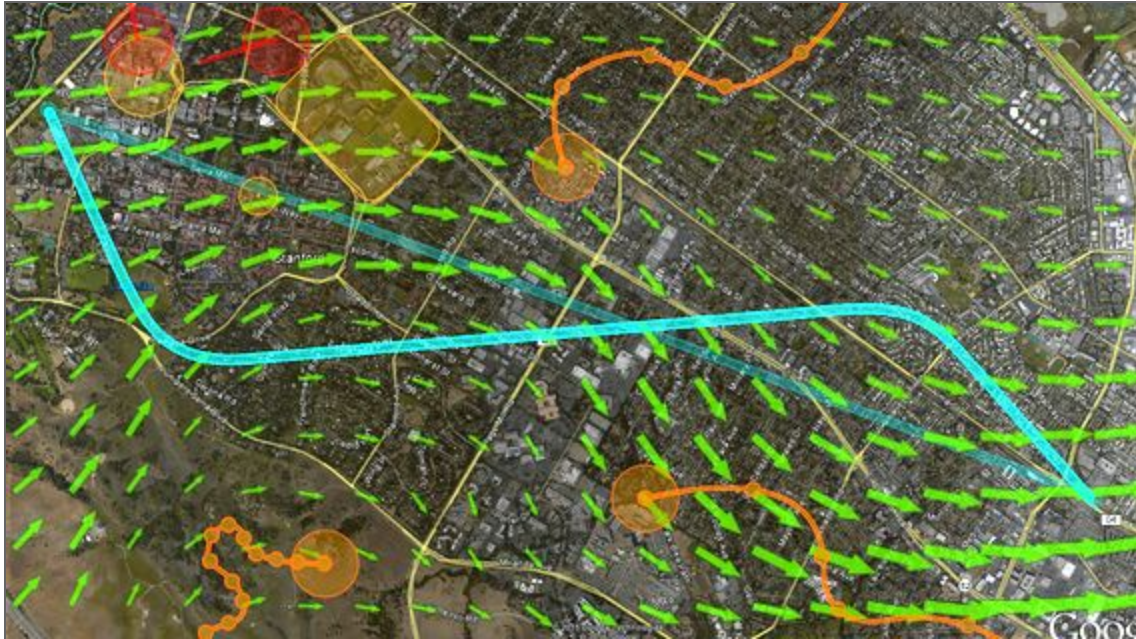
1. **ADS-B (UAT & 1090ES)**
Ultra low cost and power ADS-B for near term at low densities
2. **Cellular Device to Device (LTE)** pending technology availability
3. **Automotive Intelligent Transport Systems (802.11p)** pending market adoption and spectrum allocation



UAVs listen on existing ADS-B channels (UAT and 1090ES) to resolve position and course of cooperative manned aircraft and perform necessary avoidance maneuvers to clear the path.

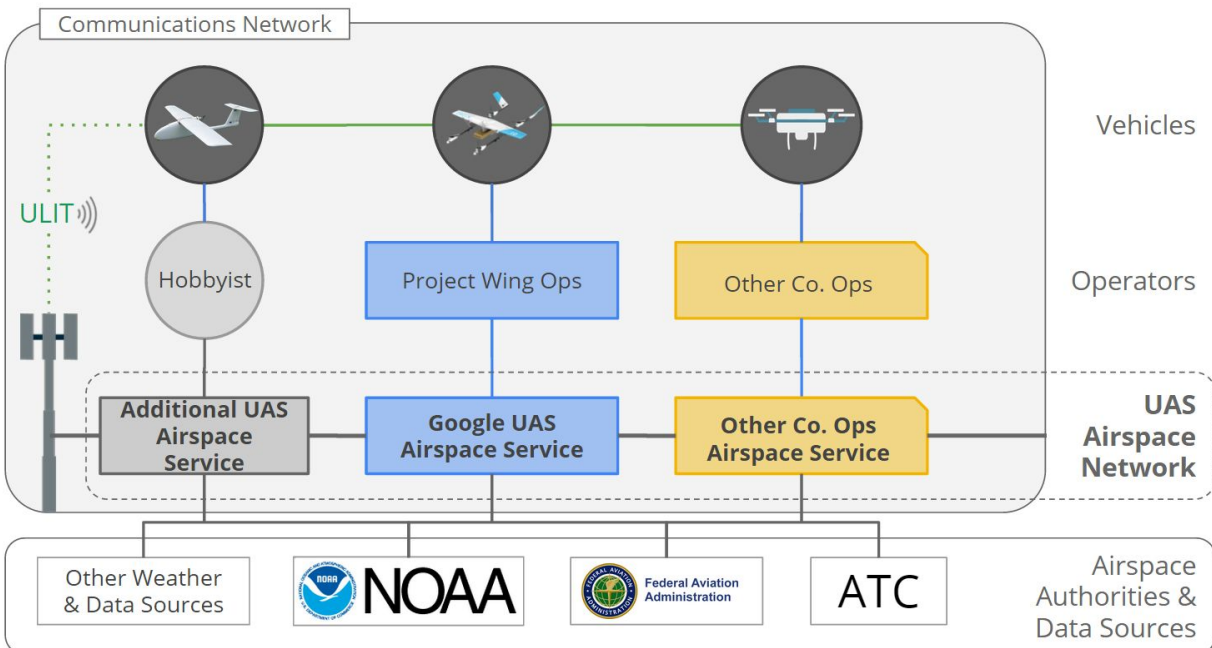
Airspace Service Providers (ASPs)

- Interface between UAS operators and Air Traffic Control
- Maintain database of TFR/No-Fly-Zones, Weather, Obstacles/Terrain, Traffic, flight plans
- Enables coordinated flight planning between all UAS airspace participants



ASPs provide data to UAS operators, including weather (green), obstacles (yellow), and unmanned (orange) and manned (red) traffic. This data is used to plan coordinated, collision-free routes (blue).

ASPs connect data and authorities (ATC) to UAS operators and vehicles over comms networks.



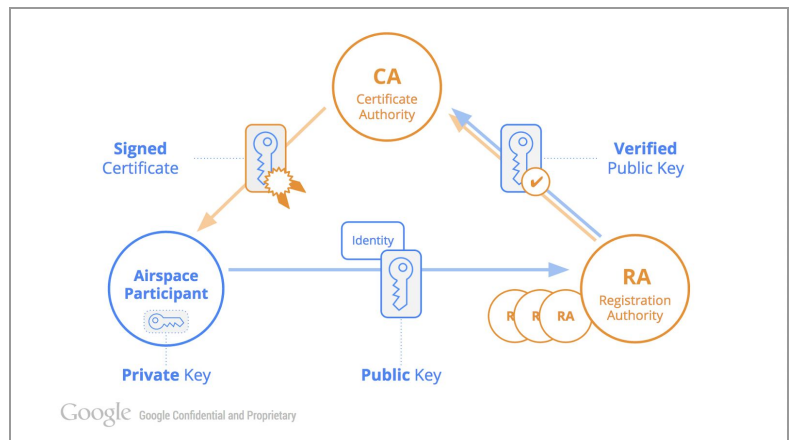
ASPs can be implemented by any qualifying organization. These ASPs comprise a federated network.

Identification and Security

- **Existing identity precedent:** Pilots, Aircraft, and Operators all have some system of traceable identity (e.g. pilot licenses, aircraft/operator registration, etc).
- **Identity Tomorrow:** Build a system of trust on existing precedent with safety through Good Citizenship. Enable *compliance* and *responsibility* through Identity.
- **UAS Identity System Benefits:**
 - Scalability with the growth of sUAS.
 - Authentication between participants.
 - Traceability throughout the ecosystem.
 - Compliance and Responsibility through Identity.

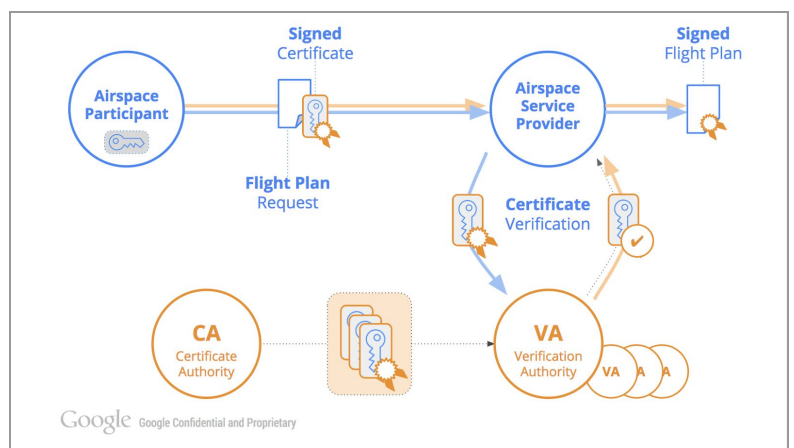
Establishing a Secure Identity using existing and proven Public Key Infrastructure (PKI)

1. An airspace participant creates a public and private 'key pair' and shares the public key and identity with a Registration Authority (RA).
2. The RA verifies the identity and provides the verification to a Certificate Authority (CA).
3. The CA uses the verified information from the RA to provide the participant with a Signed Certificate: a secure encapsulation of both the participant's and CA's identity data.



Secure Identity in operation throughout the Airspace Ecosystem

1. Airspace Participant submits a flight plan request, with their signed certificate, to the ASP.
2. ASP verifies the validity of the request using a Verification Authority (VA)
3. The VA uses the 'chain of trust' model to verify and validate the signed certificate.
4. Once the identity is established, the ASP then validates and signs the flight plan request.
5. The Airspace Participant can now use this signed flight plan for operations.



Summary & Next Steps

- **Allow ASPs to operate as manned aviation does today in uncontrolled Class-G airspace**
In uncontrolled Class G airspace, ASPs should be allowed to operate under existing rules and regulations; similar to the nearly-unrestricted access most aircraft have to class G airspace today.
- **ASPs to be open and collaborative with each other and with ATC**
To ensure openness of the airspace and spur competition, anyone should be able to create an ASP. However, all ASPs must be networked to share the traffic and flight plan data with each other and with ATC.
- **Enable ultra low cost and low power ADS-B for near term at low densities**
Enabling low-cost ADS-B solutions removes barriers to adoption and allows fully cooperative traffic between both UAS and manned aircraft.
- **Amend 2020 ruling for ADS-B to also apply to helicopters flying below 500ft AGL over populated areas**
There is limited manned traffic below 500ft in populated areas -- typically only news, police, and EMS helicopters. Ensuring this traffic is equipped with ADS-B will allow for safe and cooperative integration of manned and UAS traffic.