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ICAO Drone Enable 3

Deconfliction & Separation Management

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Airspace Integration Challenge

Integration of UAS operations is a major challenge

- Low altitude airspace usage is forecasted to be orders of magnitude greater than existing commercial aviation demand

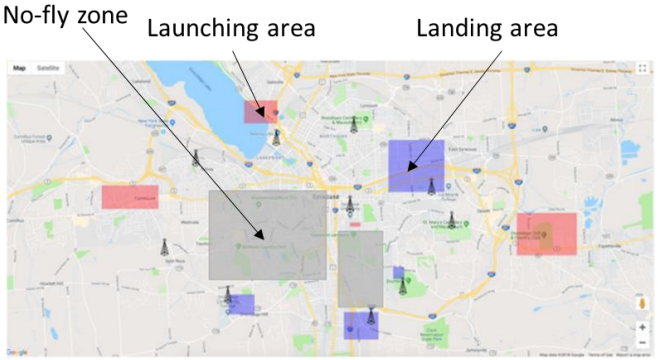
Integration of UAS into ATM must address:

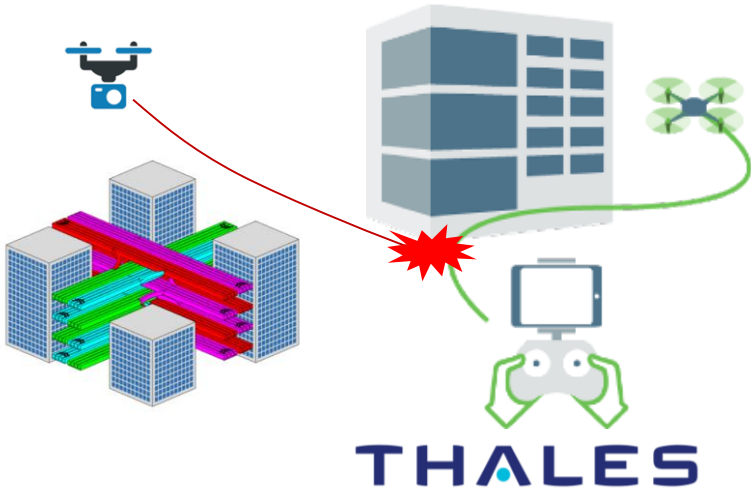
- Safety→ Communications, Navigation, Surveillance
- Efficiency→ Minimum flight energy, in-time arrival, etc.
- Cost vs. Efficiency

How? → Model the airspace

- Configurable flight environment
- User specified traffic pattern and mission style
- Gather data to improve demand vs capacity, flow, equity of traffic distribution

Implement Trust Framework for Airspace Access





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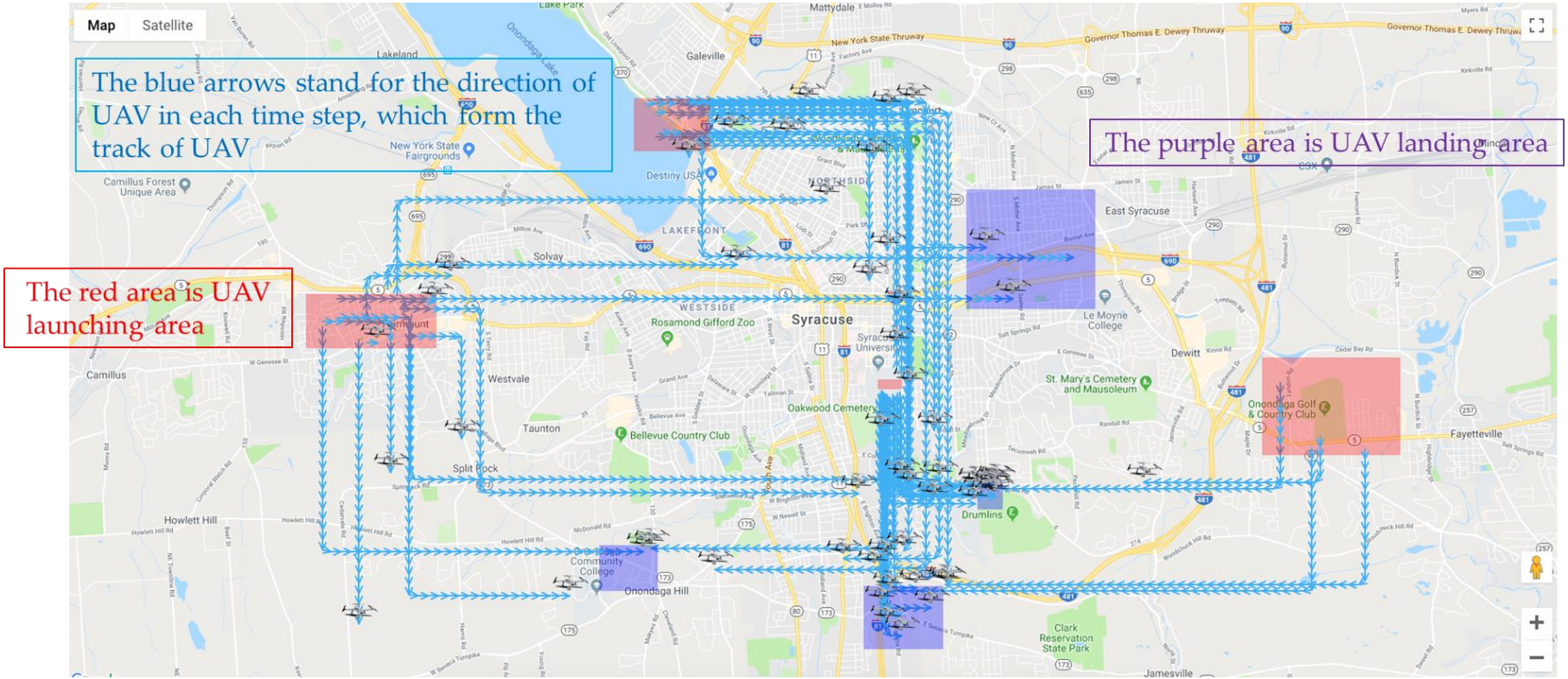
High Volume Operations Modeled for Central New York



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Airspace Deconfliction → Reactive vs. Proactive

Reactive

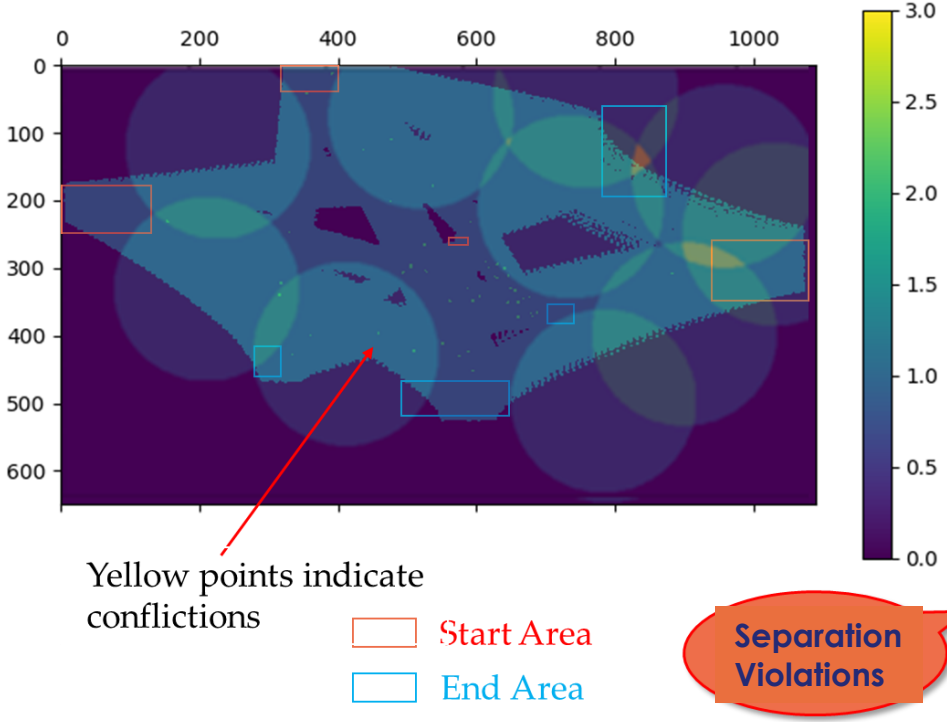
- Operator (USS) detects conflict and adjusts UAV's trajectory to avoid collision
- Each UAV senses its environment, detects conflict and adjusts its trajectory

Proactive

- For every UAS entering the flight zone, its trajectory is planned so that there will be no conflict with the UAVs in the airspace
- Airspace Manager foresees the conflict and plans the trajectory ahead of time

	Demands for computation resource	Demands for Communication resource	Resulting traffic pattern	Reliability	Flexibility
Reactive	High	High	Highly complexed, unpredictable	Low	High
Proactive	Low	Low	Regular, predictable	High	Low

Scenario 1: Free Routing (Point to Point)



Launching Rate	High	Medium	Low
Avg UAV num	4010.50	1987.60	1342.90
Std UAV num	55.60	23.55	23.19
Avg flight time	381.95	381.09	381.26
Std flight time	1.69	1.77	3.34
Avg noLink time	2.68	2.66	2.83
Std noLink time	0.04	0.07	0.09
Avg poor link time	186.56	185.21	186.25
Std poor link time	1.66	2.11	2.46
Avg noLink percentage	0.74%	0.75%	0.81%
Std noLink percentage	0.02%	0.03%	0.07%
Avg poor link percentage	44.99%	44.80%	45.08%
Std poor link percentage	0.24%	0.38%	0.32%
# of UAVs that has confliction	55.1	11.0	5.2
Avg Confliction ratio	1.375%	0.546%	0.389%

Separation Violations

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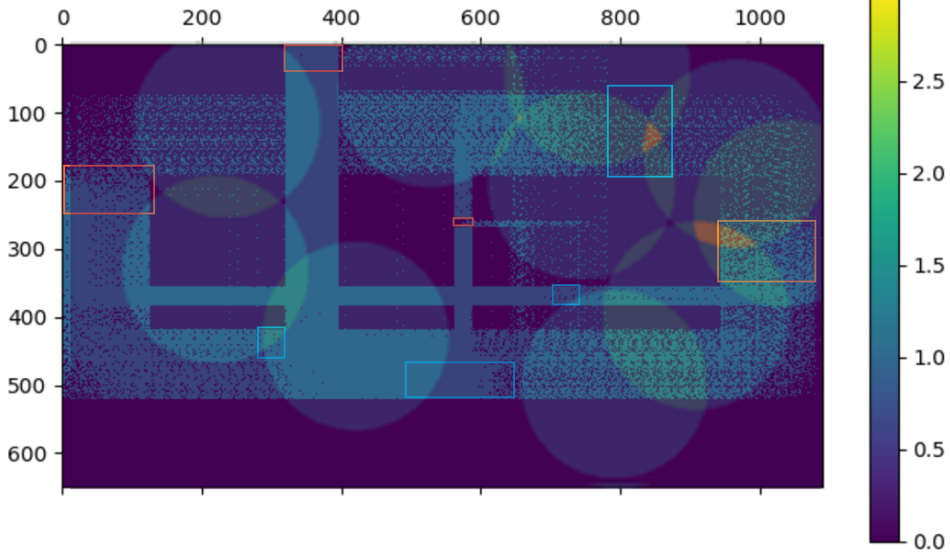
Scenario 2: With Routing



Start Area

End Area

Routing slows down the UAV launch and increases flight time

Launching Rate	High	Medium	Low
Avg UAV num	3831.67	2001.50	1342.70
Std UAV num	357.18	21.96	17.32
Avg flight time	492.25	492.03	491.50
Std flight time	2.82	2.24	3.42
Avg noLink time	2.81	2.81	2.92
Std noLink time	0.06	0.06	0.08
Avg poor link time	274.03	274.67	275.63
Std poor link time	1.94	1.99	2.98
Avg noLink percentage	0.59%	0.57%	0.60%
Std noLink percentage	0.02%	0.02%	0.03%
Avg poor link percentage	53.52%	53.63%	53.84%
Std poor link percentage	0.21%	0.27%	0.38%
# of UAVs that has confliction	0	0	0
Avg Confliction ratio	0	0	0

No Conflicts

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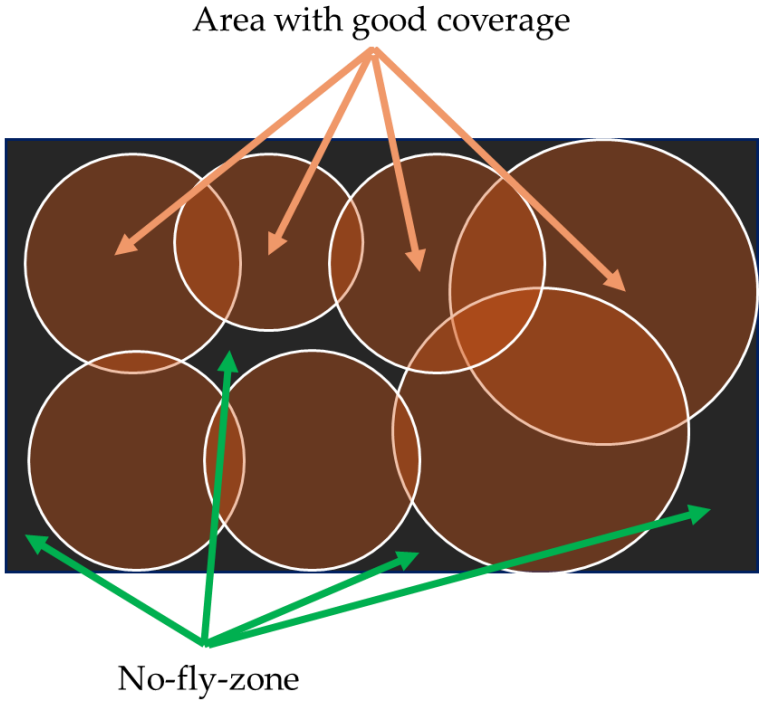
Route Structure

Routing capabilities go beyond deconfliction

Extended to find trajectories ensuring:

- **Specific operation settings –**
  - LTE cellular signal coverage permanent no-fly-zones
  - Areas that temporarily has no cellular signal coverage due to congestion or channel saturation as dynamic no-fly-zones
  - Trajectories to avoid both permanent and dynamic no-fly-zones (local airspace mgmt.)
- **Demands by UAS operators**
- **Mission time**
- **Local conditions – ordinances, etc**
- **Weather conditions**



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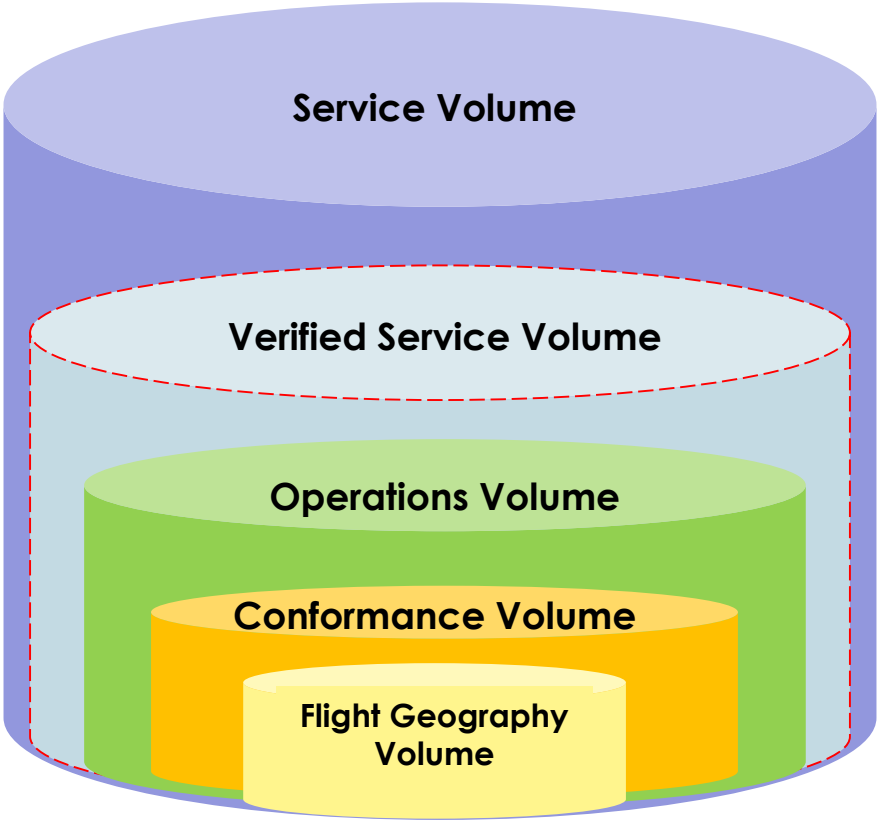
Operational Volume – Trust Framework for Airspace Access



Top Down Approach – Operations limited to where services are available

Bottoms-Up Approach – Trajectory or area-based operations and volumes are added based on risk

Area of available UTM services (CNS + Airspace Management)

Performance based services for UAS operations

Buffer around conformance for safety contingency

Buffer zone around flight plan

Intended area of UAS Operation

Concepts by: NUAIR, CAL Analytics, Thales for Local BVLOS

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Improving Low-Altitude Integration

- Study traffic and airspace metrics that best characterize the low altitude airspace (ie capacity, traffic complexity, congestion)
- Compare strategic deconfliction /routing strategies
- Compare the efficiency of airspace organization
- Develop low altitude airspace optimization algorithms
- Develop Support Decision Tool to support UTM low altitude airspace management service (what-if, optimization)

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Thank You

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