

# Registration and Identification

Motivation, Concepts and Issues

Christopher Kucera  
Director of Air Operations  
Analytical Graphics, Inc.

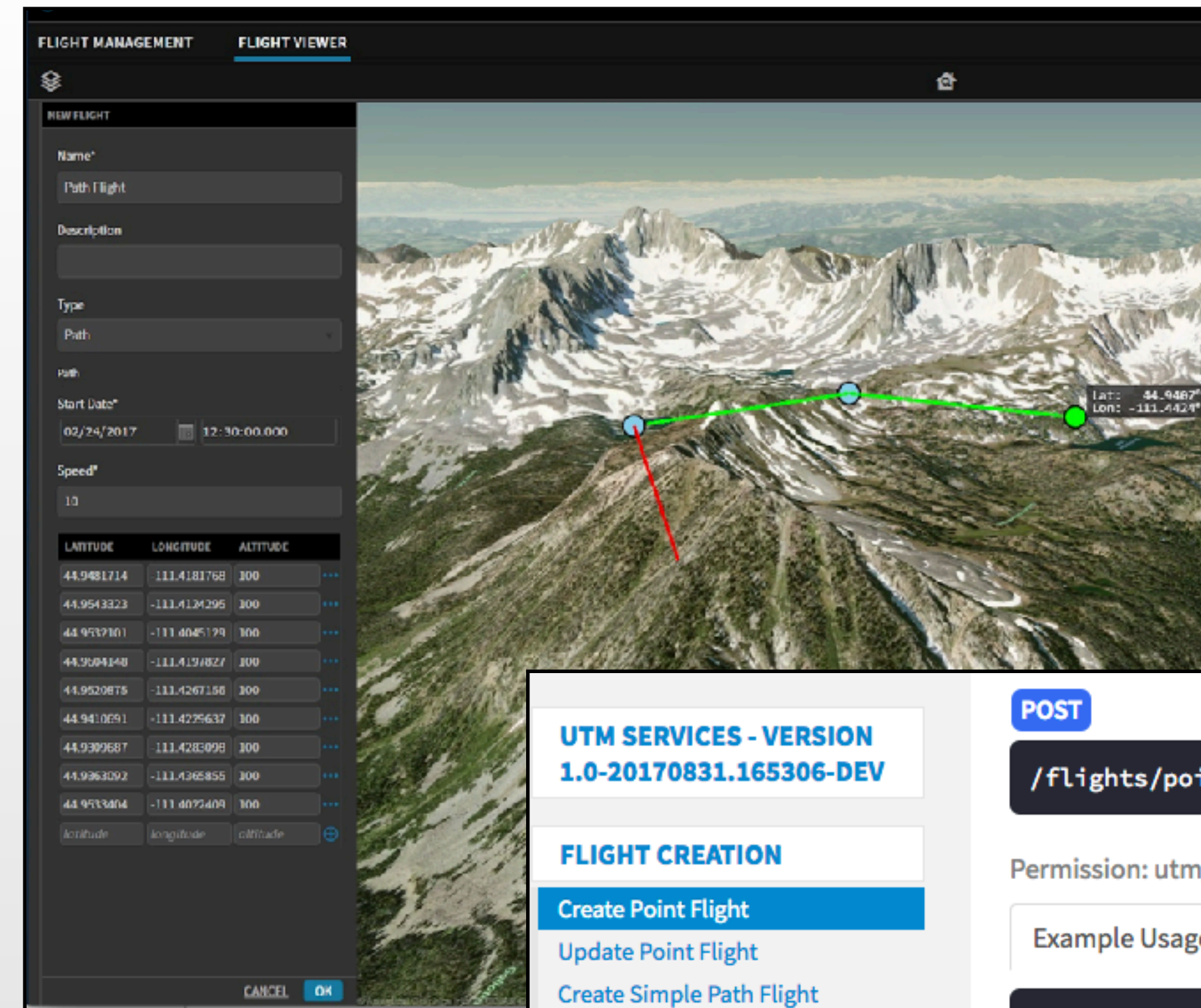


# Analytical Graphics

- Since 1989, software for land, sea, air and space
- 50,000 customers worldwide
- Framework to...
  - understand vehicle dynamics and payload performance
  - understand infrastructure coverage (CNS)



## Analytical Services



UTM

**UTM SERVICES - VERSION 1.0-20170831.165306-DEV**

**FLIGHT CREATION**

Create Point Flight  
Update Point Flight  
Create Simple Path Flight  
Update Simple Path Flight  
Create Interval Path Flight  
Update Interval Path Flight  
Create Timestamped Path Flight  
Update Timestamped Path Flight  
Create Path Flight from StkEphemeris File  
Update Path Flight from StkEphemeris File

**FLIGHT MANAGEMENT**

Get Flight  
List Flights

**POST**

**/flights/point**

Permission: utm\_user role

Example Usage

```
POST https://utm.agi.com/api/flight
{
  "name": "Hello World",
  "description": "This is a description",
  "altitudeReference": "WGS84",
  "longitude": 89.12345678,
  "latitude": 78.98765432,
  "altitude": 350,
  "radius": 500,
  "maxHeight": 120,
  "startTime": "2011-12-03T10:15:00",
  "stopTime": "2011-12-03T10:16:00"
}
```

Parameter

# Why register and track?

	Safety	Security	Privacy	Financial
➔ Stakeholder	Air Traffic Control	Law Enforcement	Public	Comptroller
Issue	Separation Assurance	Discriminate Threat	Spying	Fund ATM or UTM
Goal	Determine Position	Find Operator	Understand Operation	Collect Money
➔ Registration Benefit	Reduce Collisions	Provide Protection	Give Awareness	Generate Revenue



# We already register things...





# But not everything...



# What thresholds should be used?

	Safety	Security	Privacy	Financial
Regional Threshold	Airspace	None	Private Property Rights	None
Altitude Threshold	Airspace	Visualize Observer	Under 100ft Or Treeline	None
Distance Threshold	Airspace	Visualize Observer	BVLOS	None
Weight Threshold	None	Threat?	None	Value Based
Capability Threshold	None	Autopilot / FPV	Autopilot, FPV	Value Based



# Using carrots, not rules, for compliance

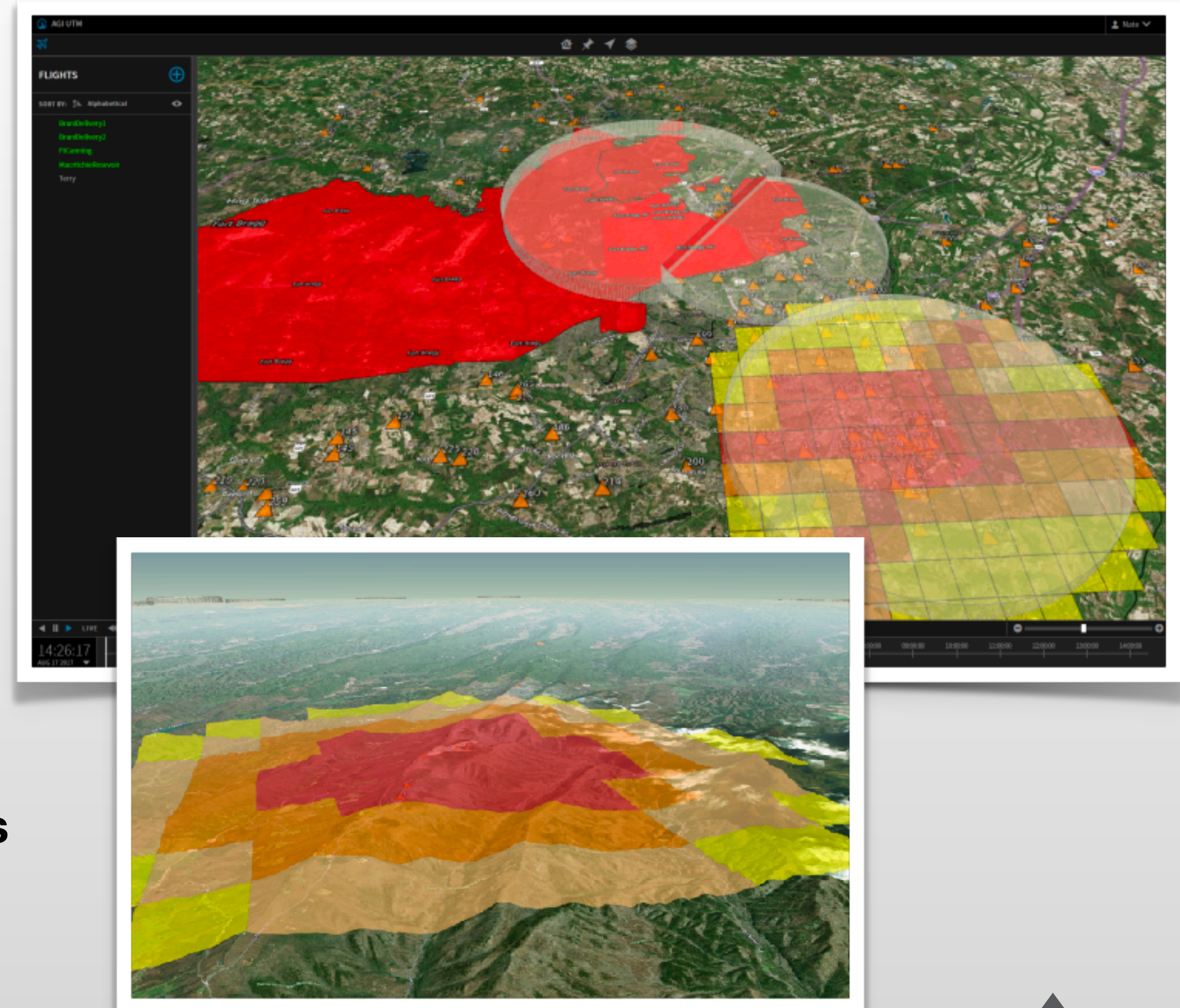
Regulators can grant approvals and waivers if people comply

Rule-making is a much lengthier process

## ATC permissions, for example...

- LAANC enables accessibility to 107.41 (ATC waiver) more rapidly (minutes vs. months)
- Benefits of registering and tracking far outweigh the cost of compliance

**Other examples include national parks, sports venues and densely populated areas**





# Tracking enforces registration

**When operators don't comply...**

- They won't broadcast an ID
- They won't end up in a UTM - like system
- They won't show up in ATC systems

**Tracking allows law enforcement to target the non compliance...**

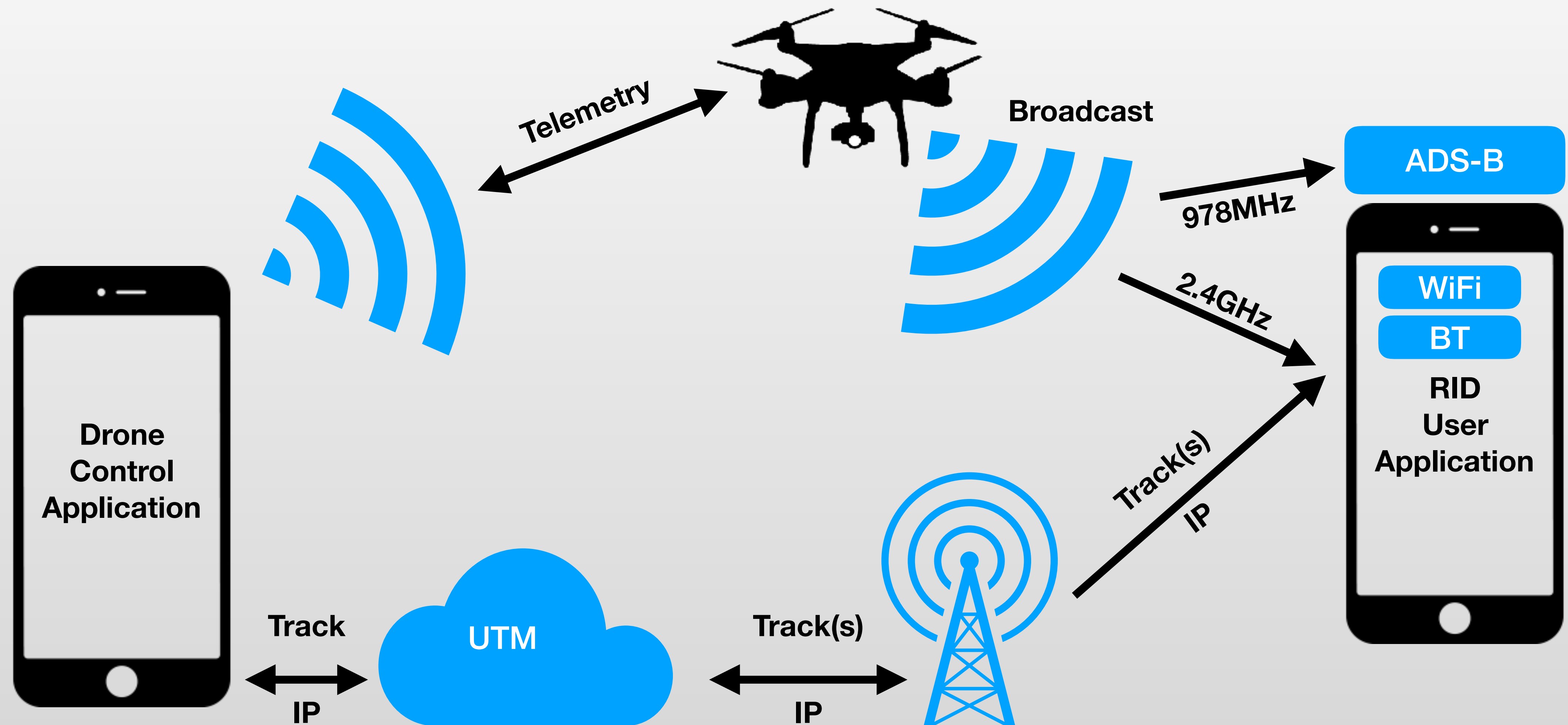


**Tracking**





# Methods for tracking

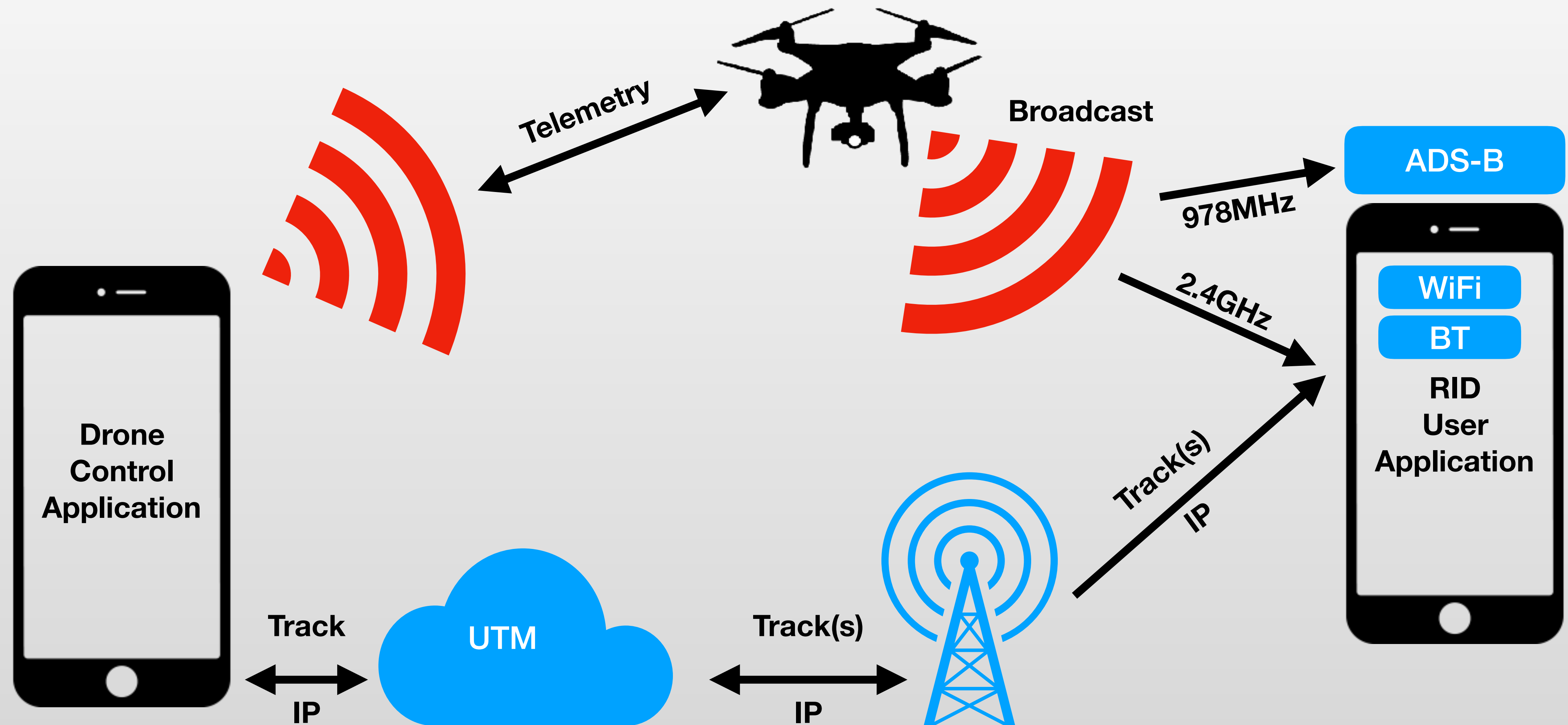


# Tracking options

	Self Declare	Broadcast	LTE	Satellite
Latency	10 min	1 sec	1 sec	> 15 secs
Coverage	Regional	Local	Regional	Global
Hardware	No	\$	\$	\$
Connectivity	\$	No	\$	\$



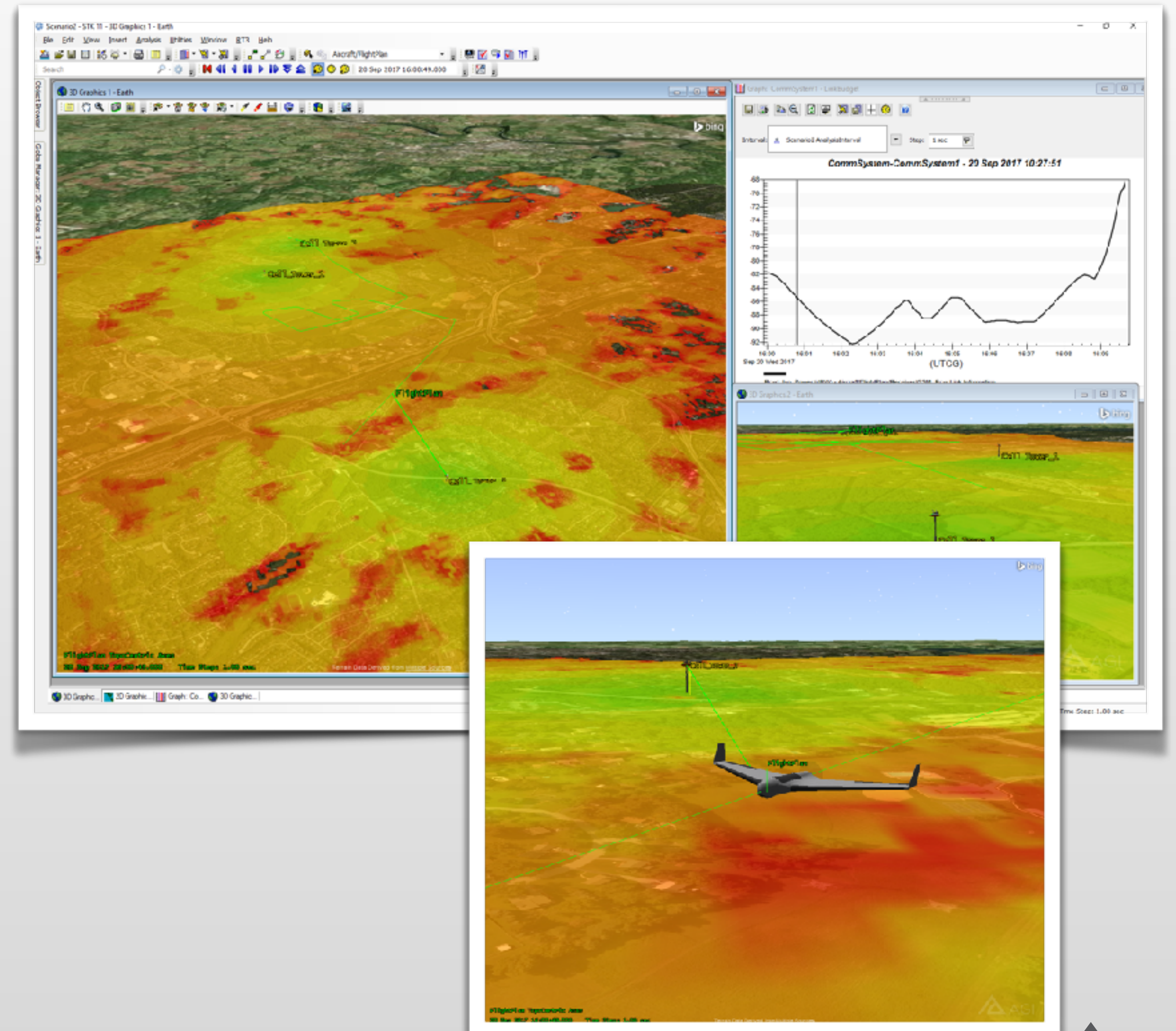
# Tracking relies on RF



# Understanding RF coverage

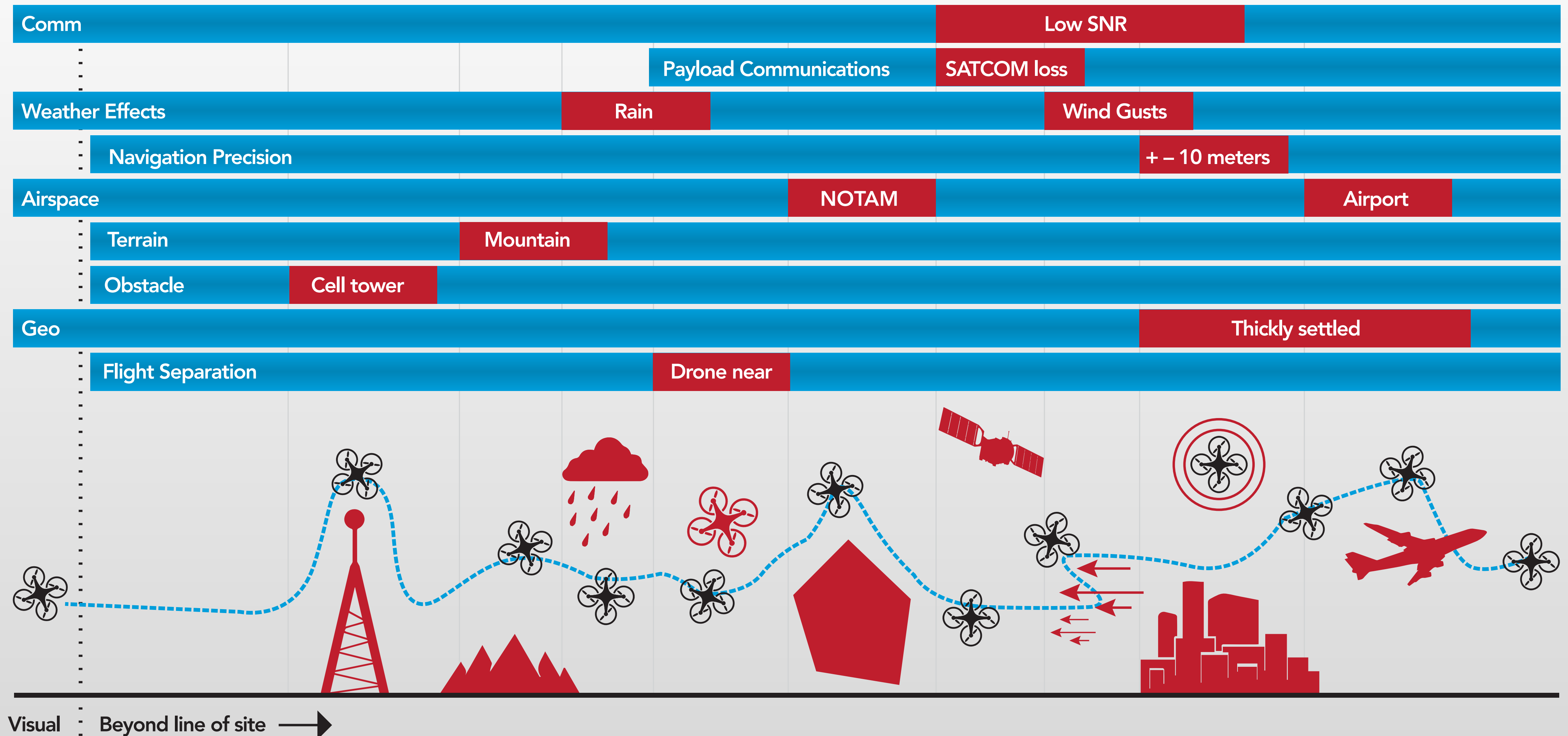
## Without RF Coverage Metrics...

- Can't understand flight risk
  - blindspots in DAA
- Can't route effectively for C2 and payload
- Can't plan effectively for contingency
- Can't prove safety case to regulator

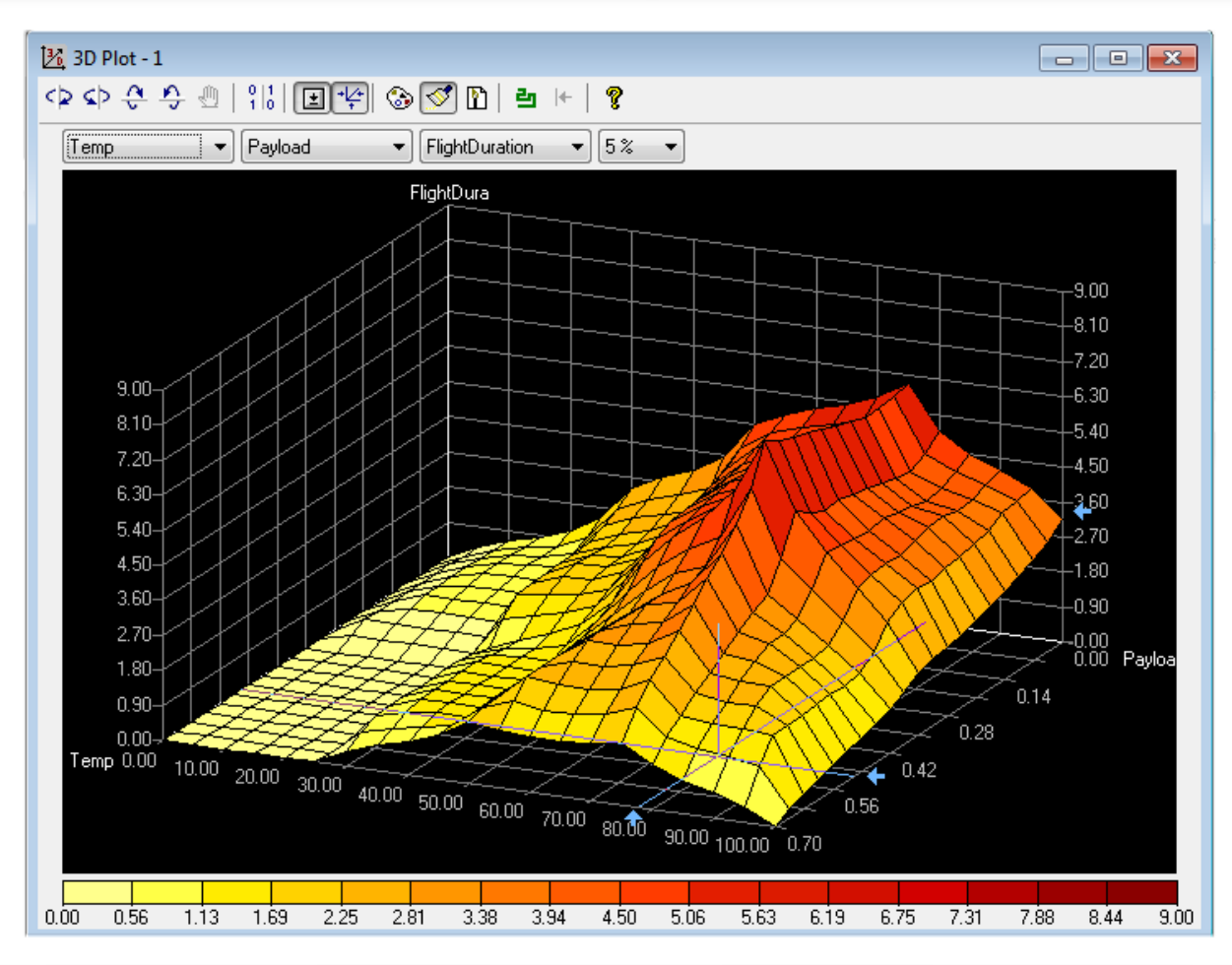
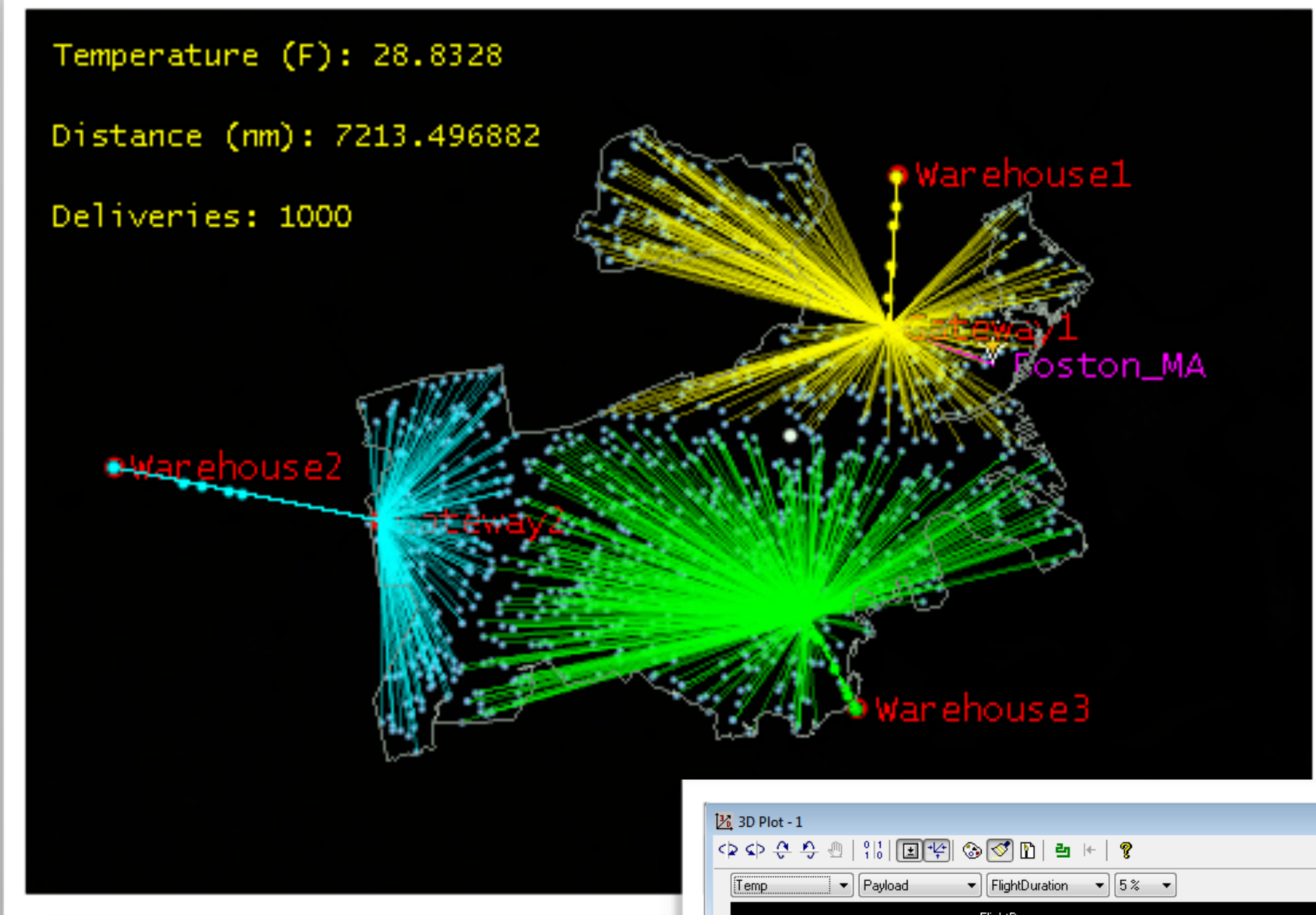




# AGI's analytical web services



# AGI's UTM simulation



UTM Simulation

STK Settings

Delivery

Packages: 1000

Max payload weight (lb): 0 5

Delivery fee/lb: 1.25

Delivery cost/lb/nm: 0.35

Commerce gateway drone pass: 0.25

Delivery offload time (sec): 120

Environment

Temperature Low/High (F): -15 100

Wind Spd (kts)/Dir (T): 180 10

Sunrise at 4832.53139302908 Sunset at 37132.48

Warehouses

Drones per warehouse: 24

Warehouse load time: 300

Drones

Speed Over Ground (kts): 20

Altitude out (ft): 100

Altitude RTB (ft): 150

Altitude variance (ft): 25

Horizontal Variance variance (ft): 25

MidPoint alt variance (ft): 75

Midpoint Horiz variance (ft): 200

Turn radius (ft): 100

Max range (nm): 25

Battery duration (hrs): 24

Recharge time (sec): 1800

Battery kWh: 300

Battery joules: 10800000

Rotor area (m^2): 0.362

mass (kg): 4.53592

☐ Use Fuzzy Logic Performance

Simulation

Delivery Period from/to: 0 57600

☒ Stop when schedules full

Simulation Summary

Avg Energy per flight (joules): 698876.974208473

LOS Distance (nm): 1558.07187027426

Average LOS distance (nm): 2.87467134736948

Total flight distance (nm): 3565.8781282722

Average flight distance (nm): 6.57911093777159

Total flight time 18h:57m:19s:517ms

- Warehouse undertasked and can deliver 310 additional packages in this period.

Totals:

Deliveries 1000

Not Delivered 0

Total LOS distance (nm): 7259.93095239794

Average flight time (min): 00h:27m:49s:589ms

Average flight distance (nm): 7.25993095239795

Deliveries

1000, Warehouse3, Drone18, Warehouse3, Drone18, 35275.018, 35575.018, 36077.31, 36620.248, 36620.248, 1045.23, 4.24097559398637, 55779.752, 1065704581.13603, 0.2, 69723762, 005969, Drone 1: Flight end > PeriodEndEpSec Drone 2: Flight end > PeriodEndEpSec Drone 3: Flight end > PeriodEndEpSec Drone 4: Flight end > PeriodEndEpSec Drone 5: Flight end > PeriodEndEpSec Drone 6: Flight end > PeriodEndEpSec Drone 7: Flight end > PeriodEndEpSec Drone 8: Flight end > PeriodEndEpSec Drone 9: Flight end > PeriodEndEpSec Drone 10: Flight end > PeriodEndEpSec Drone 11: Flight end > PeriodEndEpSec Drone 12: Flight end > PeriodEndEpSec Drone 13: Flight end > PeriodEndEpSec Drone 14: Flight end > PeriodEndEpSec Drone 15: Flight end > PeriodEndEpSec Drone 16: Flight end > PeriodEndEpSec Drone 17: Flight end > PeriodEndEpSec Drone 18: Battery remaining 55779.752 Joules 1065704581.13603

Not delivered

DeliveryID, Warehouse, Drone, WarehouseDrone, ScheduleStart, TO, Delivery, RTB, Schedule End, Flight Time, Flight Distance (nm), BatteryDurationRemainingRTB, BatteryLevelJoulesRTB, Temperature, Weight, Comment, ReasonNotDelivered

Analysis

Load Into MTO Warehouse3

Get warehouse sked

Genetic Algorithm

Population 75

Max evolutions 100

Converge 9

☒ Keep delivery list

Mutation 0.03

Eliteism 2

csc file deliveries

56448.832	986
56452.811	987
56573.724	988
56590.045	989
56612.847	990
56639.952	991
56710.282	992
56725.394	993
56802.219	994
56864.007	995
56898.532	996
56900.5 997	997
56912.466	998
57112.937	999
57149.68 1000	
57600 1000	

csc file distance flown

57492.861
7239.85343295796
57482.969
7244.6329062441
57310.7
7247.88728912394
57216.512
7250.44575906619
57330.609
7253.76441315595
57469.923
7256.57448633603
57581.378
7259.93095239795
57600
7259.93095239795

Run simulation

Crypto random

Connected to simulation



# Summary

- What are registration and identification **thresholds** the global community can accept?
- How can the regulators encourage compliance now by offering **automated** authorizations which are currently difficult to obtain?
- Analyze the **tracking system blind spots** to verify system risk
- Use **simulation** to help understand the trade space of UAS operations and performance of UTM, ATM and commercial tracking systems