Engineering Research Center for
Collaborative Adaptive Sensing of the Atmosphere

Dealing with Weather Hazards in Urban Environments – CASA's Innovation Ecosystem in Dallas Fort Worth

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NCAR Weather Forum

AUVSI XPONENTIAL

October 5, 2020

University of Massachusetts Amherst

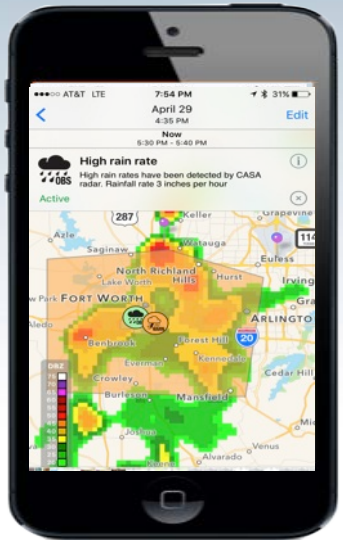
North Central Texas Council of Governments

Colorado State University

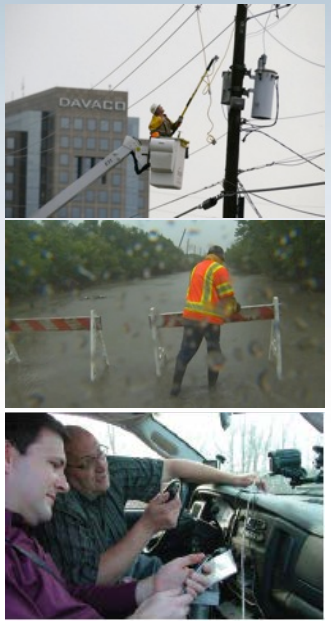
AMBASSADOR™ WRN WEATHER-READY NATION

CASA is primarily supported by the Engineering Research Centers Program of the National Science Foundation under NSF award number 0313747.
This research supported through NSF award numbers 1700967 and 1632193.

Network of weather radars and other sensors gather data



Actionable information provided to users through website, social media, existing displays and mobile app



Operational users provide feedback

- Funded through local government, industry and research grants
- Product development through focus groups, surveys, case study review
- 'Plug and Play' system for technology innovation

Companies launch and test new products

CASA Dallas Fort Worth Living Lab for Severe Weather Warning Systems in North Texas

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North Texas Urban Aviation Weather Testbed

- Working with the **NCTCOG UAS Safety & Integration Task Force** to launch the Urban Aviation Weather Test Bed in the Dallas – Fort Worth Metroplex

- Promote the safe integration of UAS technology into the DFW regional airspace

- Has identified '**UAS Weather Detection and Avoidance**' as a prioritized initiative

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Each user segment is unique

Public safety sUAS users (Police, Fire, Emergency Responders)

- Hazardous weather response
- Search and rescue
- Structure and brush fires
- Accident response
- SWAT missions

- Usually trained in severe weather preparedness and response
- Rely on communications from NWS, media
- Rely on severe weather mobile apps and ‘general purpose’ weather apps; starting to use new special purpose ‘drone weather’ apps
- Usually have many different vehicles (with varying weather tolerance)
- Will take risks – if they can save lives.

Sophisticated users that want detailed real-time micro-weather information and 2-3 hour forecasts.

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Each user segment is unique

Commercial sUAS users (typically small businesses)

- Real estate photography
- Agriculture and construction
- Roof, bridge and track inspections
- Railway/ airport surveillance

- Usually have **no formal training** in weather data interpretation (unless they are former pilots)
- Rely on ‘general purpose’ weather apps; starting to use new special purpose ‘drone weather’ apps (former pilots will use use traditional aviation weather sources)
- Will delay missions; want ‘sunny days’ for their missions
- Risk averse - small wind gusts or a drizzle can ruin their operations

Users that want precise micro-weather forecasts (2-3 days) so they can plan their operations.

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Each user segment is unique

Future AAM operators (fleet operators, vertiports, distribution centers)

- Package delivery
- Food delivery
- Medical supply delivery
- Aerial ride sharing

Currently

- Receive custom weather decision-making products from private sector to support existing **ground** logistics/ operations
- May have a meteorologist (team) on staff

Going ahead

- New entrants in the **airspace**, limited or no support from ATC
- Multiple vehicles in the air at the same time, large number of operations
- Severely impacted by icing, winds, rain, hail
- Will rely on **automated decision making** for route planning, diversion planning and weather hazard avoidance

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Developing new products and getting them in the hands of users

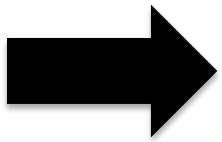
Winds

Turbulence

Rain

Hail

Icing



Products

Users

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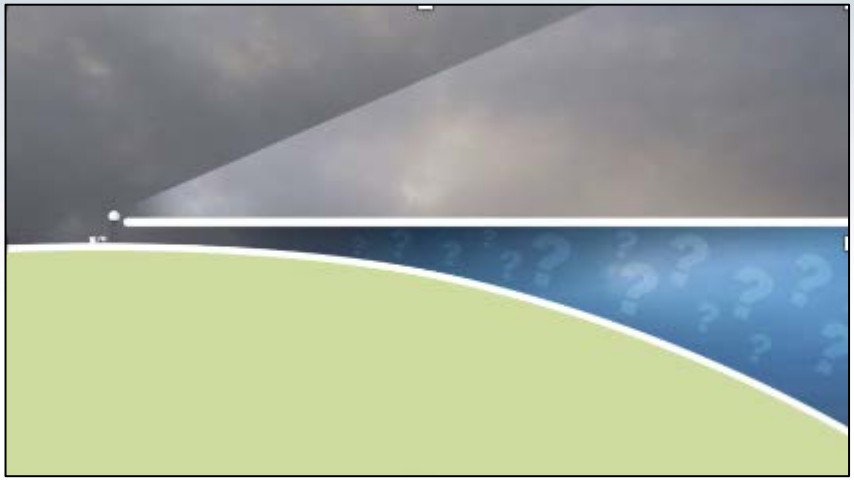
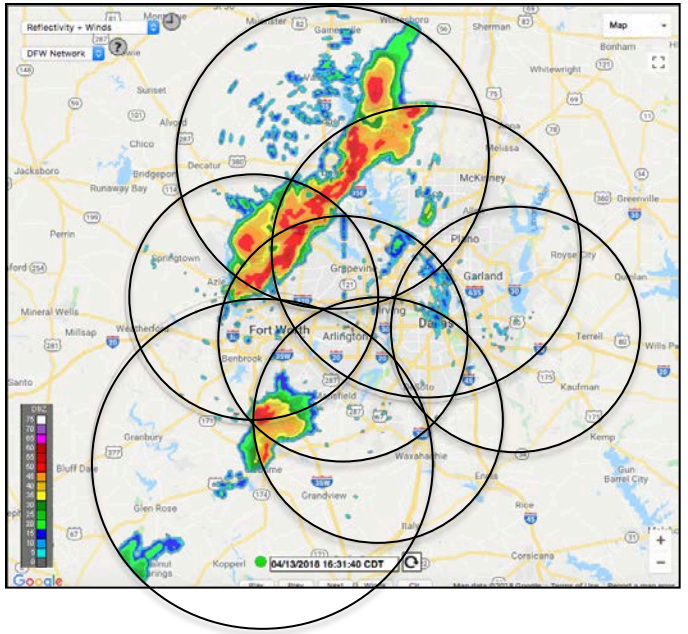
We need to fill the observation gaps



X-band weather radars



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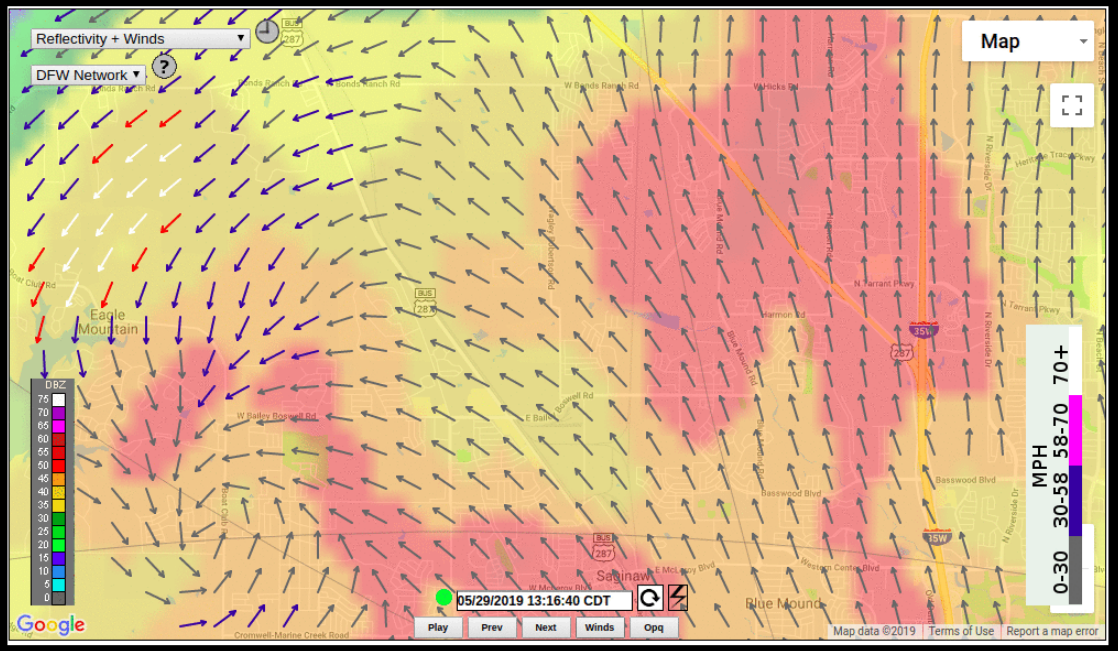
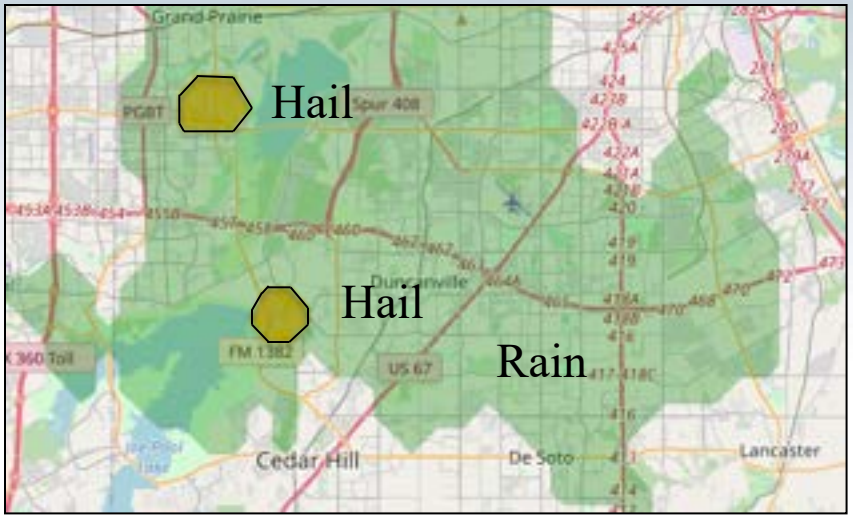


Overlapping radar network used to produce one minute updates on severe winds.

- Secure vehicles at vertiports
- Move vehicles to safety
- Keep passengers and cargo safe

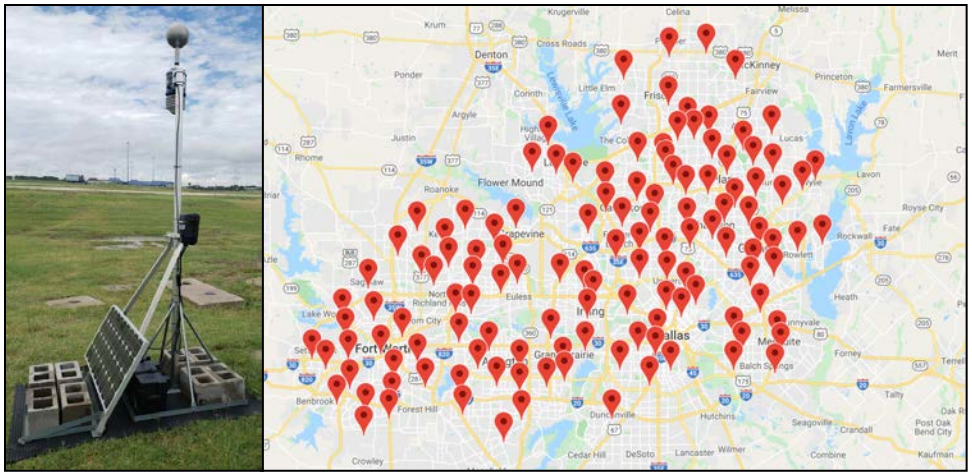
Filling observation gaps



Dual polarization radars provide unprecedented view of hydrometeor type

Ground based hail sensors measure hail size and distribution

- Secure vehicles at vertiports
- Move vehicles to safety
- Keep passengers and cargo safe



150+ Understory hail sensors in Dallas Fort Worth, including two at DFW International Airport

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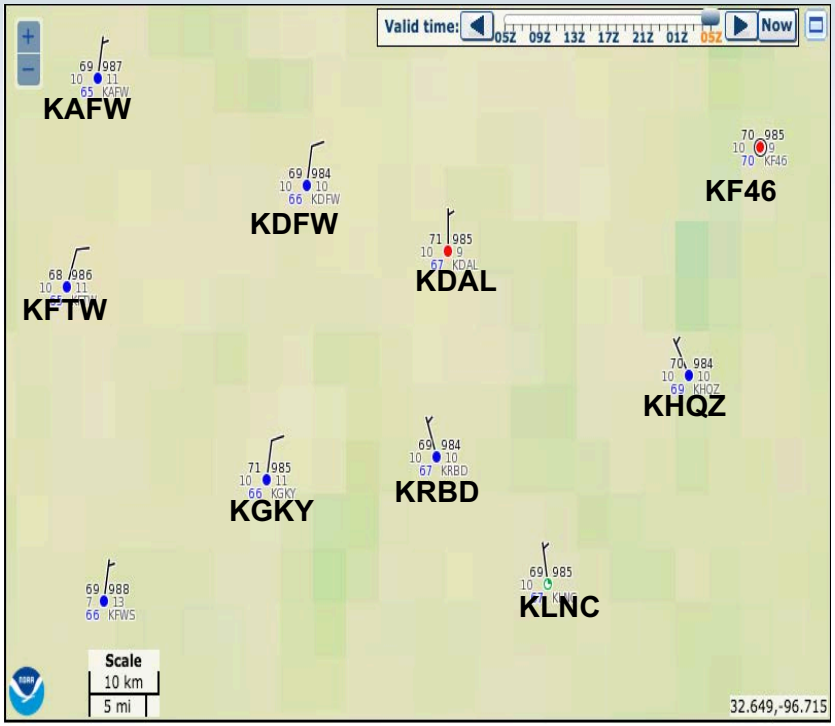
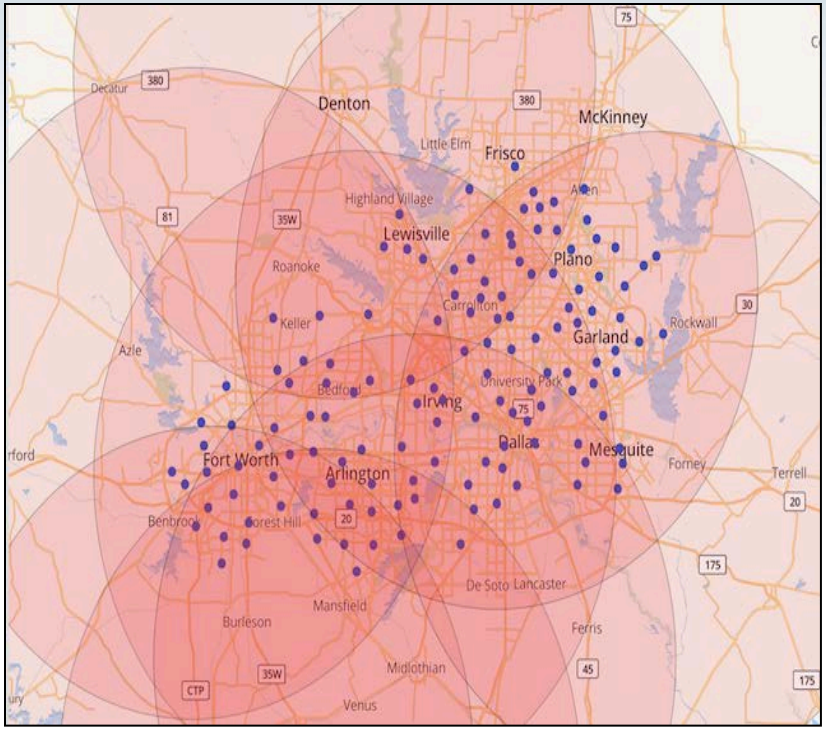
Filling observation gaps



ASOS/ AWOS stations (FAA, NWS)



Surface stations (Earth Networks)

- Report Surface Winds, Temperature, Ceilings (Cloud heights), Visibility
- Nearest ASOS station can be 10-15 miles away
- METARs only available to the operators once an hour
- Only report surface winds

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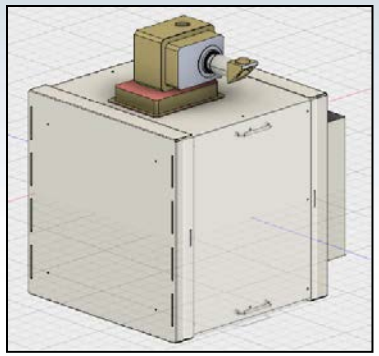
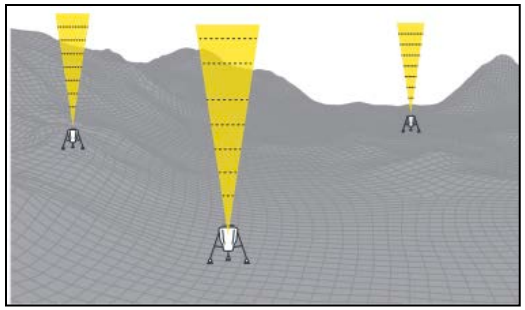
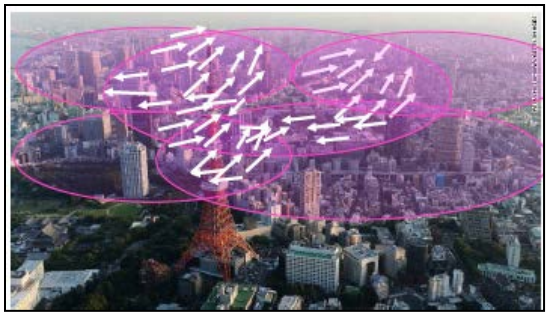
Filling observation gaps







NRG Systems 'Spidar' Direct Detect Lidar

Wind Vertical Profiles
Measurement height range: 20-200 m

Vaisala (Leosphere) 'Windcube' Scanning Wind Doppler Lidar

Wind measurement volume: 12km x12km x 300m,
Resolution: 200m x 200m x 50 m

MetroWeather Doppler Lidar

10 m resolution
2-3 hour wind predictions

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Filling observation gaps

Source: Richard Hann, NUST & UBIQ Aerospace
'Icing on UAVs', NASA AMS Seminar Series, 2020

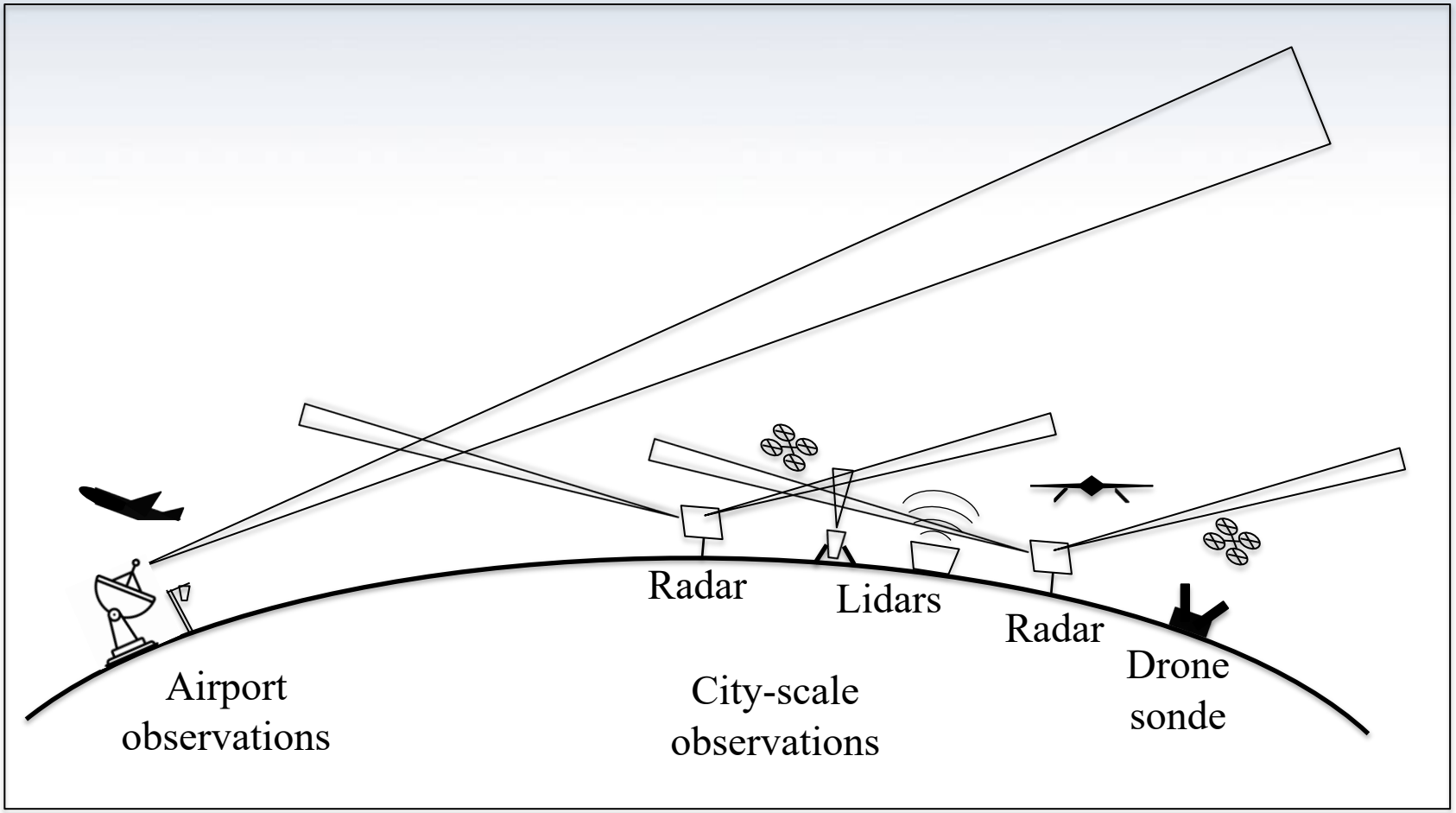
On-board ice accretion sensors

Vehicle dynamics

On-board sensing

Meteodrone - Automated weather data collection
- Wind profiles
- Forecast icing conditions (temperature, relative humidity, wind speed)

New Integrated Weather Observation Network for Urban Aviation Weather



Weather Observation Network

Adaptive Scanning

High Resolution Weather Data

Weather Data Collection System

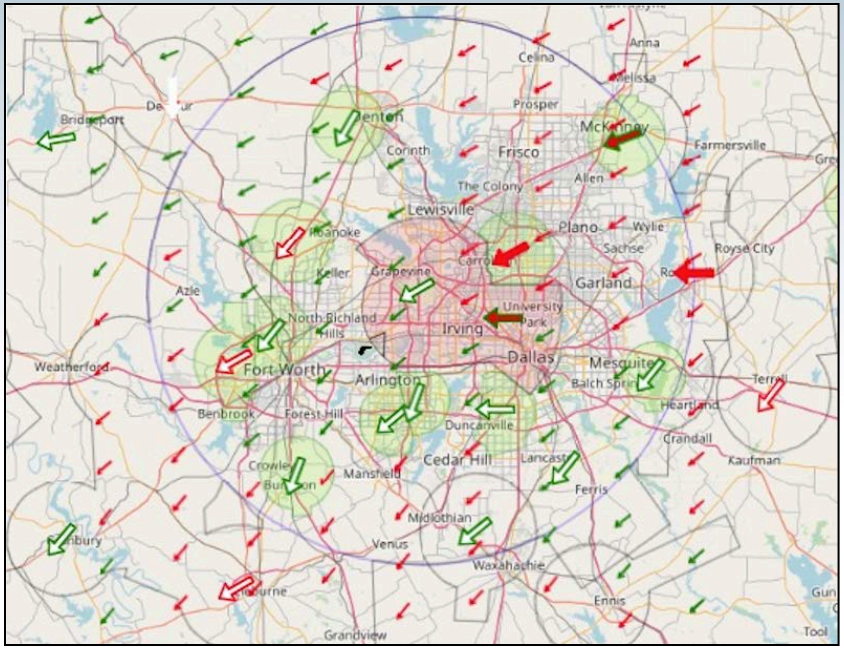
Analysis

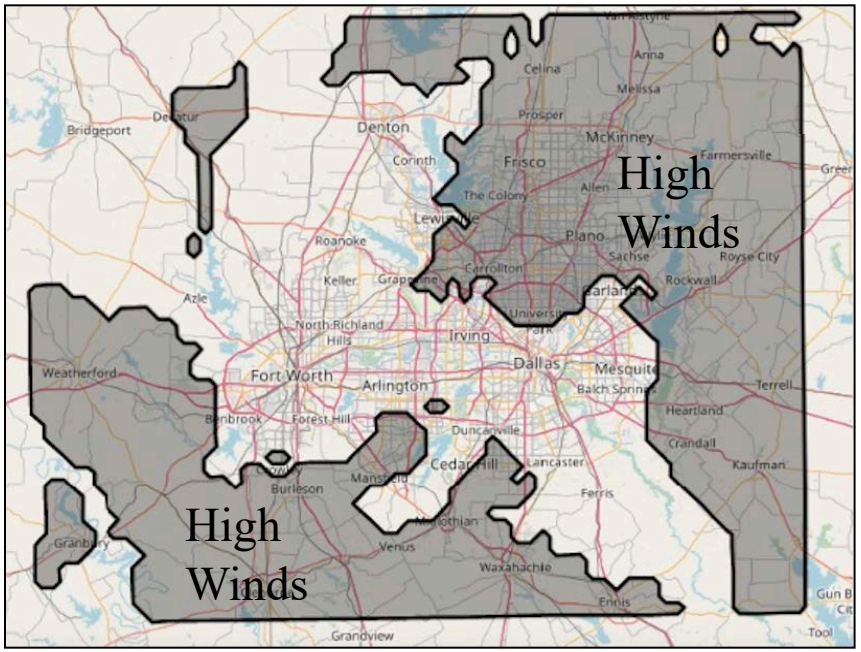
Predictions

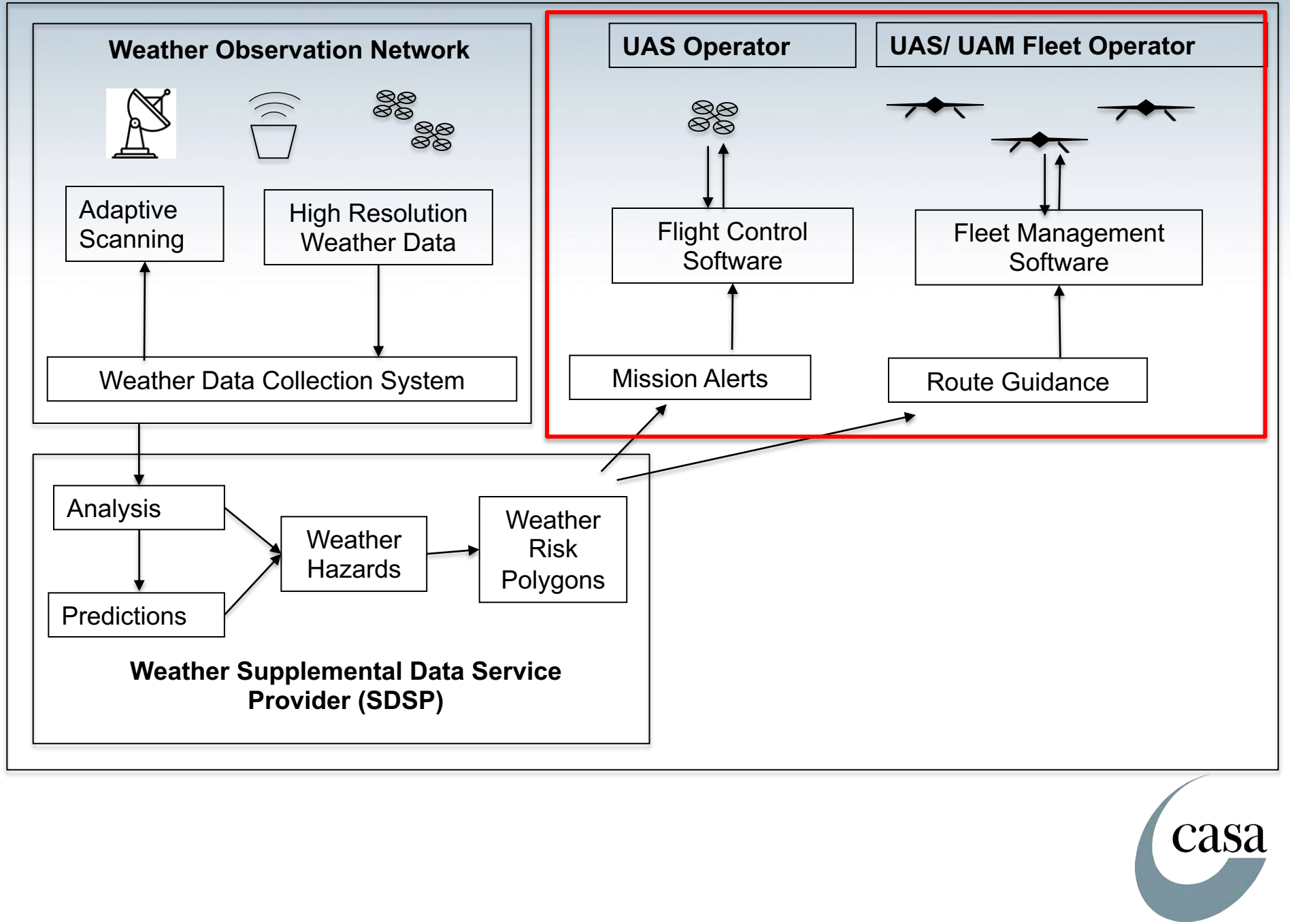
Weather Hazards

Weather Risk Polygons

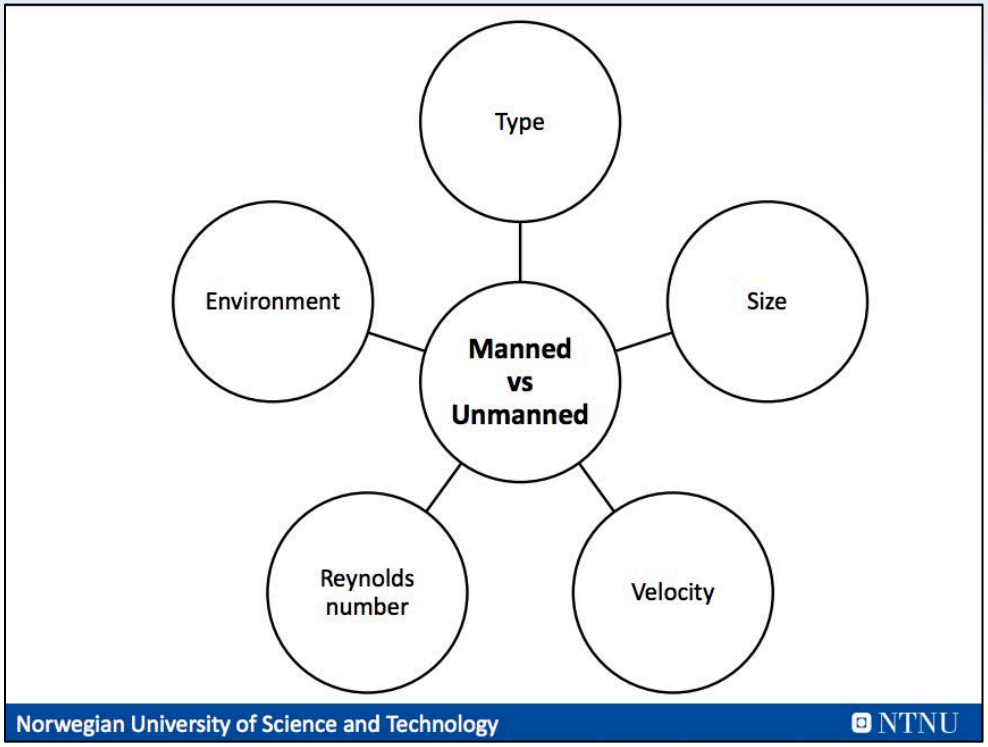
Weather Supplemental Data Service Provider (SDSP)






Weather Observation Network
Adaptive Scanning
High Resolution Weather Data
Weather Data Collection System
UAS Operator
UAS/ UAM Fleet Operator
Flight Control Software
Fleet Management Software
Mission Alerts
Route Guidance
Analysis
Predictions
Weather Hazards
Weather Risk Polygons
Weather Supplemental Data Service Provider (SDSP)

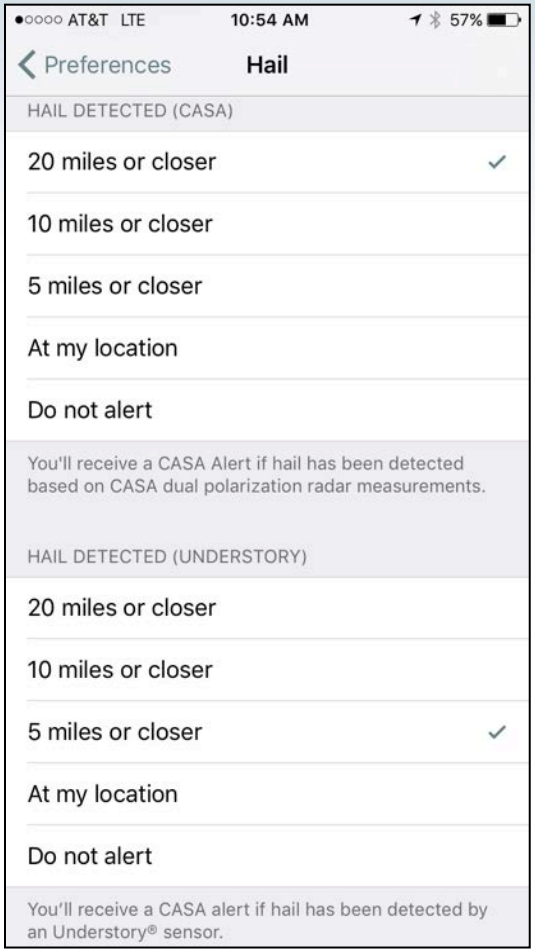
'Smart alerting' – Only alert the impacted drones and missions

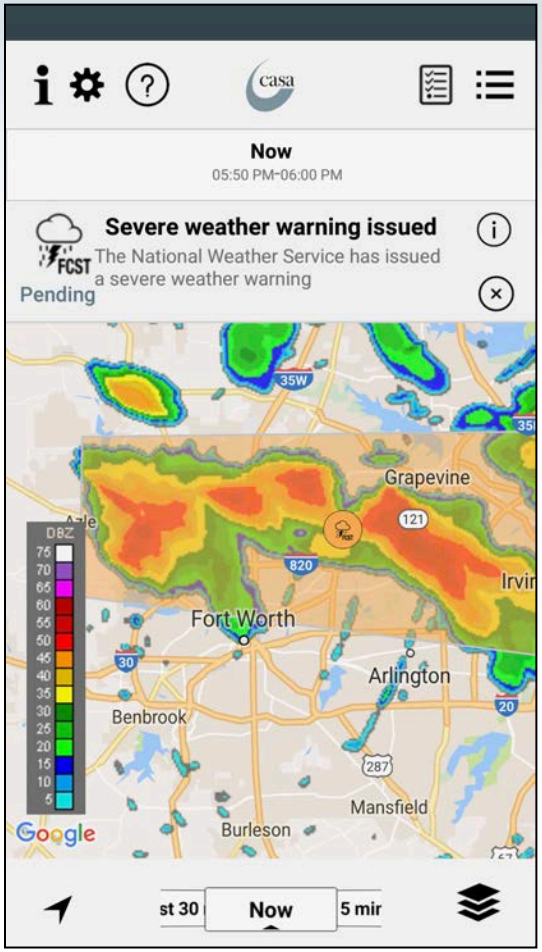


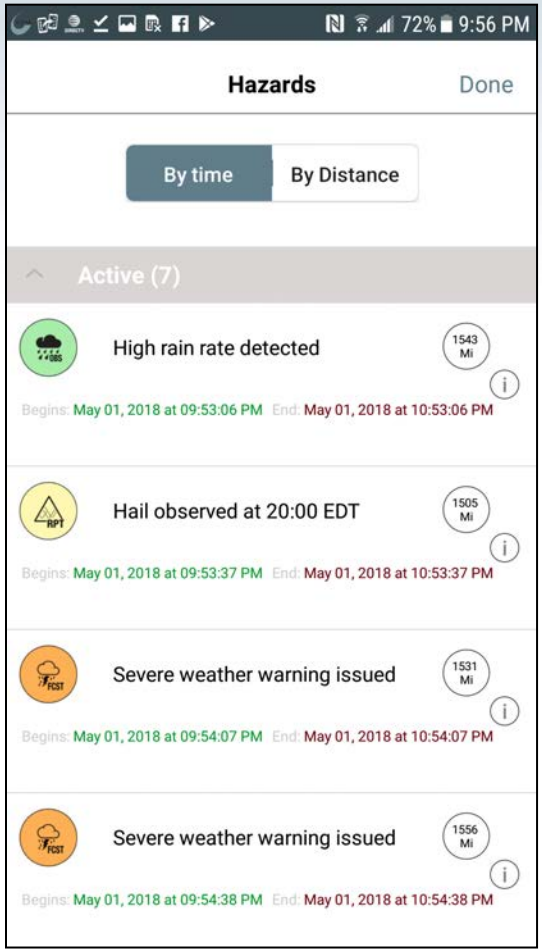
Source: Richard Hann, NUST & UBIQ Aerospace
'Icing on UAVs', NASA AMS Seminar Series, 2020

Example: Icing threat varies based on many criteria

User preferences and risk communication



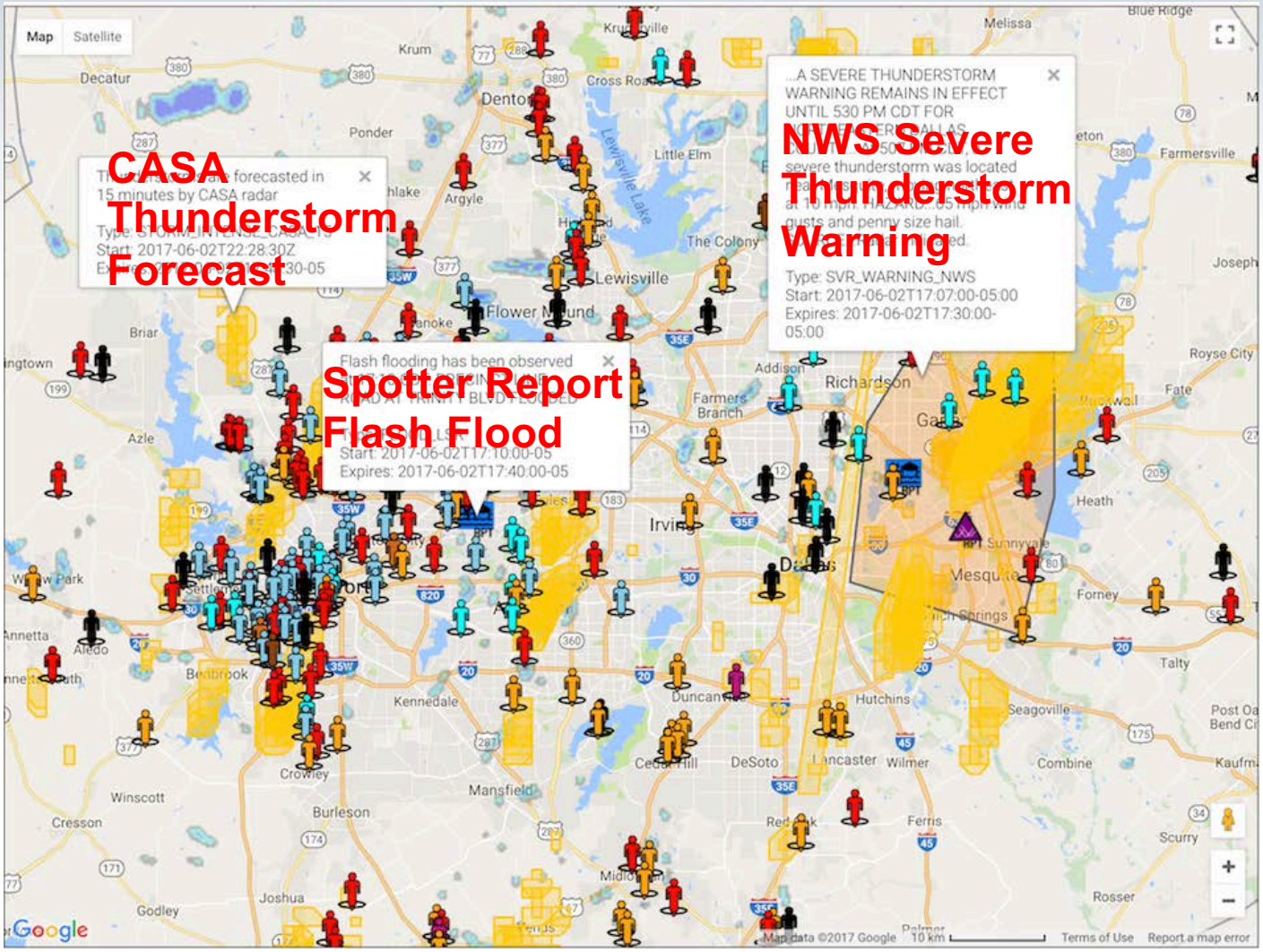




Alerting preferences

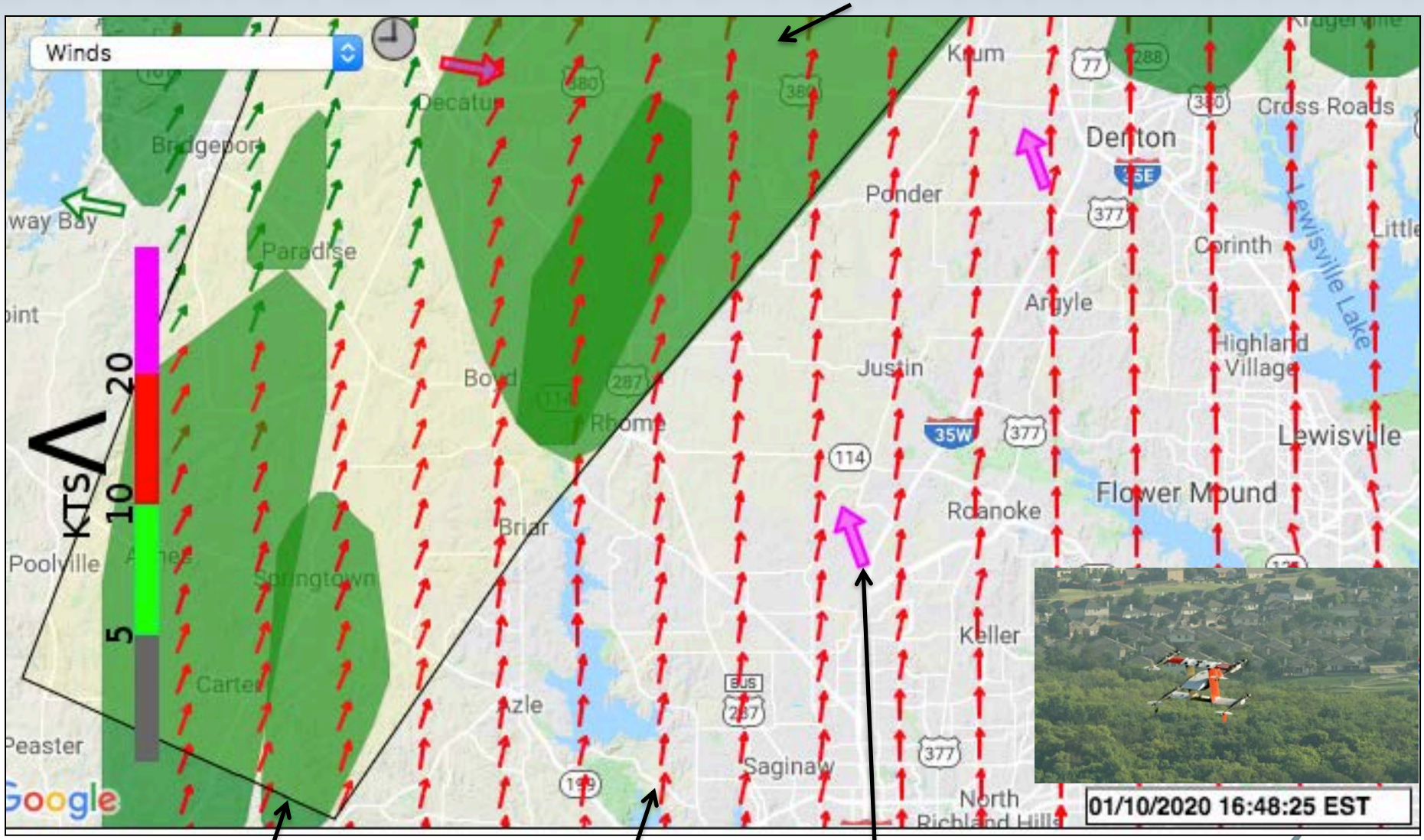
Visual Alerts and Notifications

Results from NSF PFI BIC grant, PI: Brenda Philips, 'CASA Alerts' app


CASA Thunderstorm Forecast
NWS Severe Thunderstorm Warning
Spotter Report Flash Flood
...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT UNTIL 530 PM CDT FOR
severe thunderstorm was located
gusts and penny size hail.
Type: SVR_WARNING_NWS
Start: 2017-06-02T17:07:00-05:00
Expires: 2017-06-02T17:30:00-05:00
Flash flooding has been observed
Start: 2017-06-02T17:10:00-05
Expires: 2017-06-02T17:40:00-05
Map
Satellite
Google
Map data ©2017 Google
10 km
Terms of Use
Report a map error

CASA City Warn™ Alerting System

Radar data showing location of storms



NWS Severe Thunderstorm Warning

Gridded Forecast Winds

ASOS Observations

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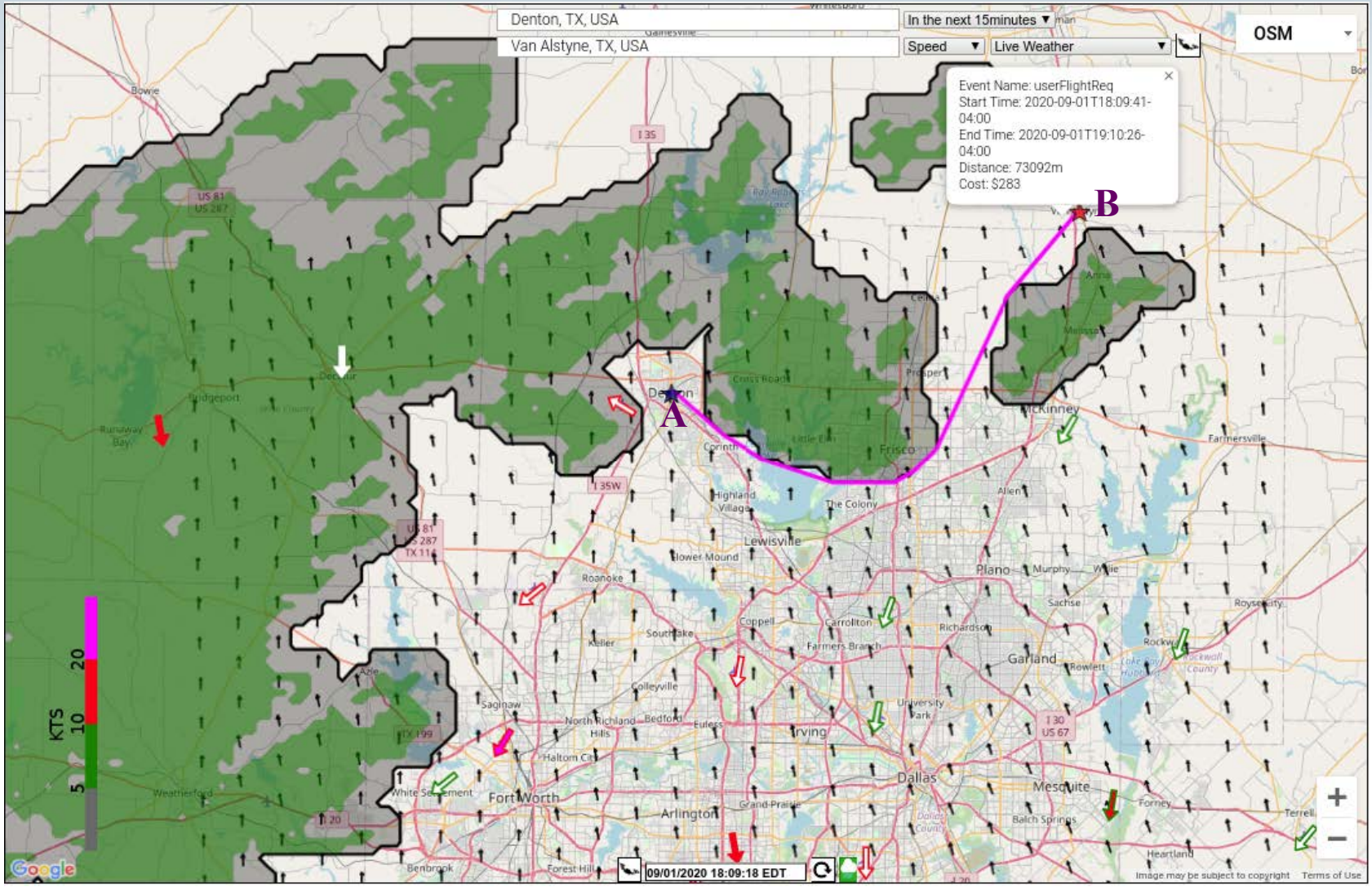
Drone route recommendation



Automated routing based on weather and cost considerations

Results from UMass Interdisciplinary Faculty Research Award, PI: M. Zink

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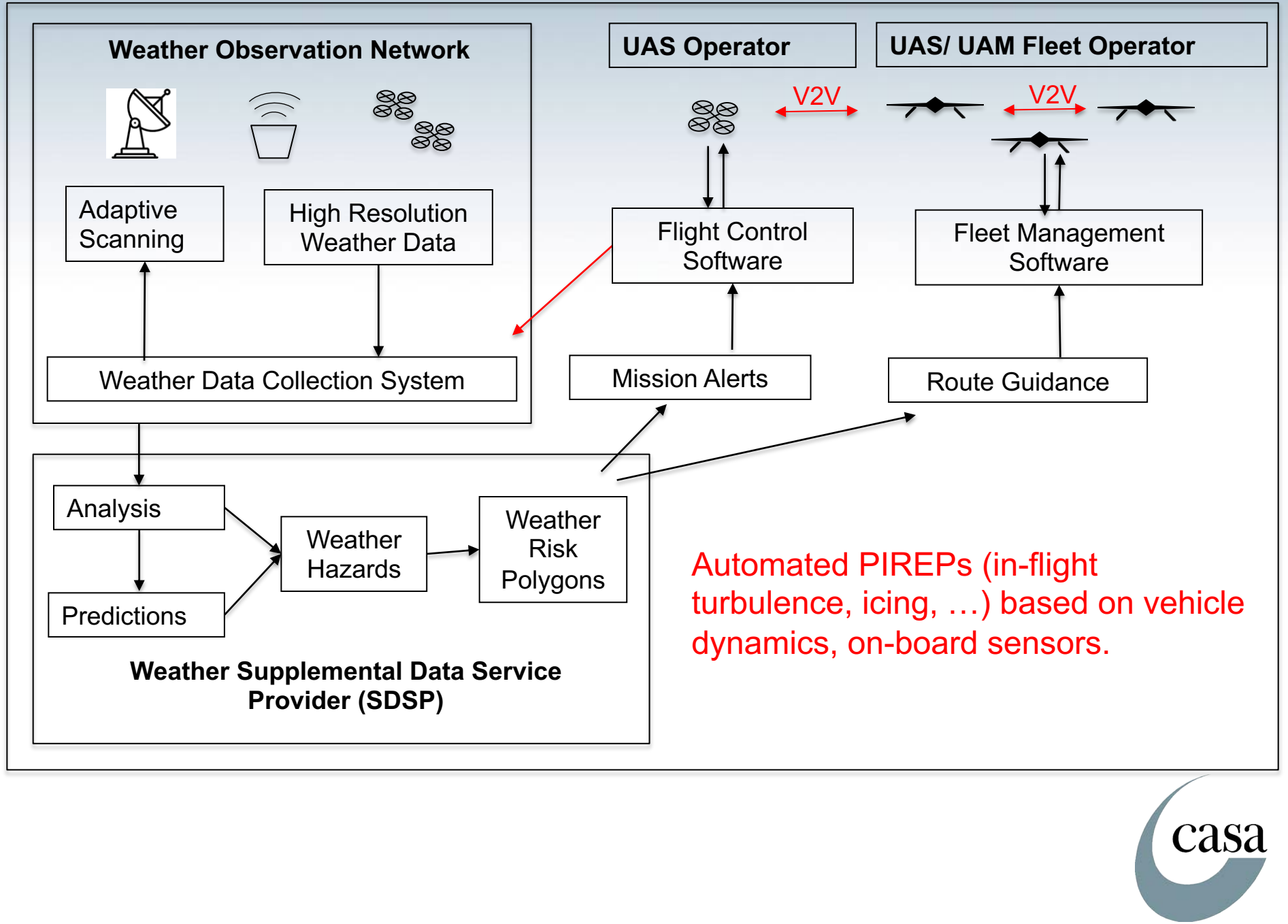
Weather Observation Network
UAS Operator
UAS/ UAM Fleet Operator
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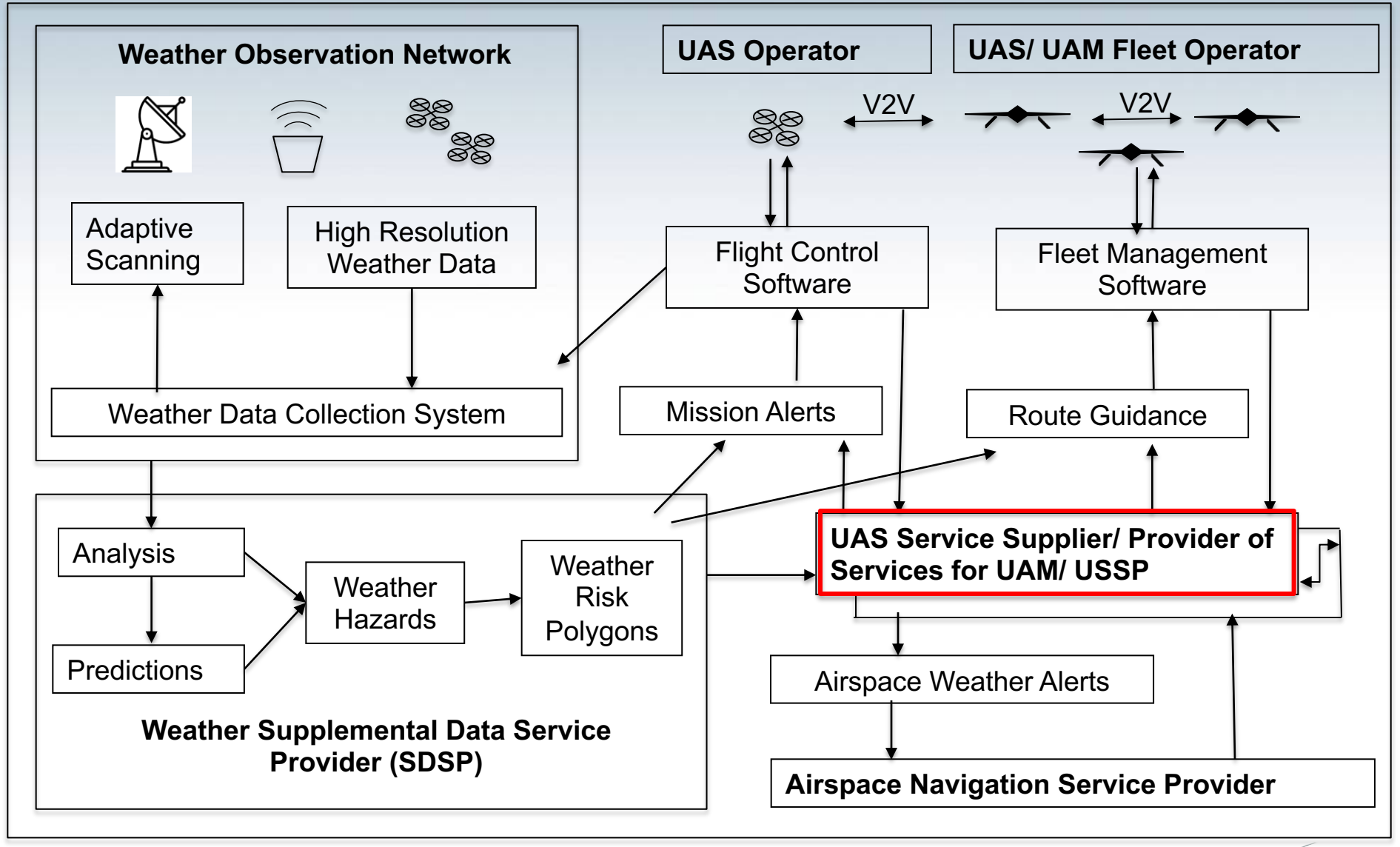
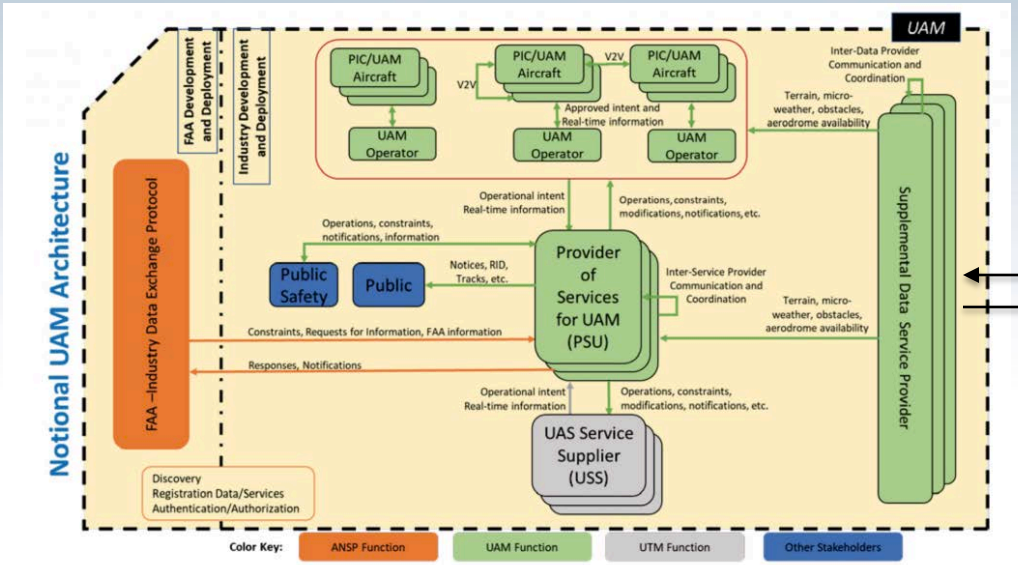
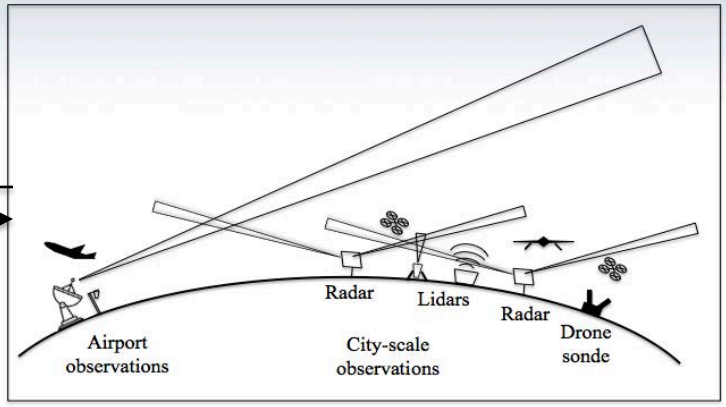
Adaptive Scanning
High Resolution Weather Data
Flight Control Software
Fleet Management Software
Weather Data Collection System
Mission Alerts
Route Guidance
Analysis
Predictions
Weather Hazards
Weather Risk Polygons
Weather Supplemental Data Service Provider (SDSP)
Automated PIREPs (in-flight turbulence, icing, …) based on vehicle dynamics, on-board sensors.



End-to-end weather observation and avoidance system for UAS and UAM operations



FAA/ NASA Notional UAM Architecture



Weather Observation Network

Role played by an Urban Aviation Weather Living Lab

- Test out new sensors and products with operational users
- Test data collection architectures and communication paths
- Inform standards development (data, interfaces, providers)
- Provide data for vehicle design and performance modeling
- Provide data for airspace simulation models
- Drive aviation weather policy
- Test out public private partnership models

"Aviation Urban Weather Test Data Ecosystem", Nancy Mendonca, NASA ARMD

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CASA is participating in NASA AAM National Campaign

TAKE-AWAYS

- We need Livings Labs to advance the UAS and UAM ecosystem.
- Join us in North Texas – bring your sensors, products and vehicles.
- Establish new Living Labs for different weather regimes and operational scenarios.

Contact: Apoorva Bajaj, Innovation Manger, CASA Engineering Research Center
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