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Exploration of Near-term Potential Routes and Procedures for Urban Air Mobility

Savita Verma, Jillian Keeler, Tamsyn Edwards and Victoria Dulchinos

Why Urban Air Mobility?

- Improve mobility
- Decongest Road traffic
- Reduce transport time
- Reduce strain on public transit systems
- Reduce traffic accidents

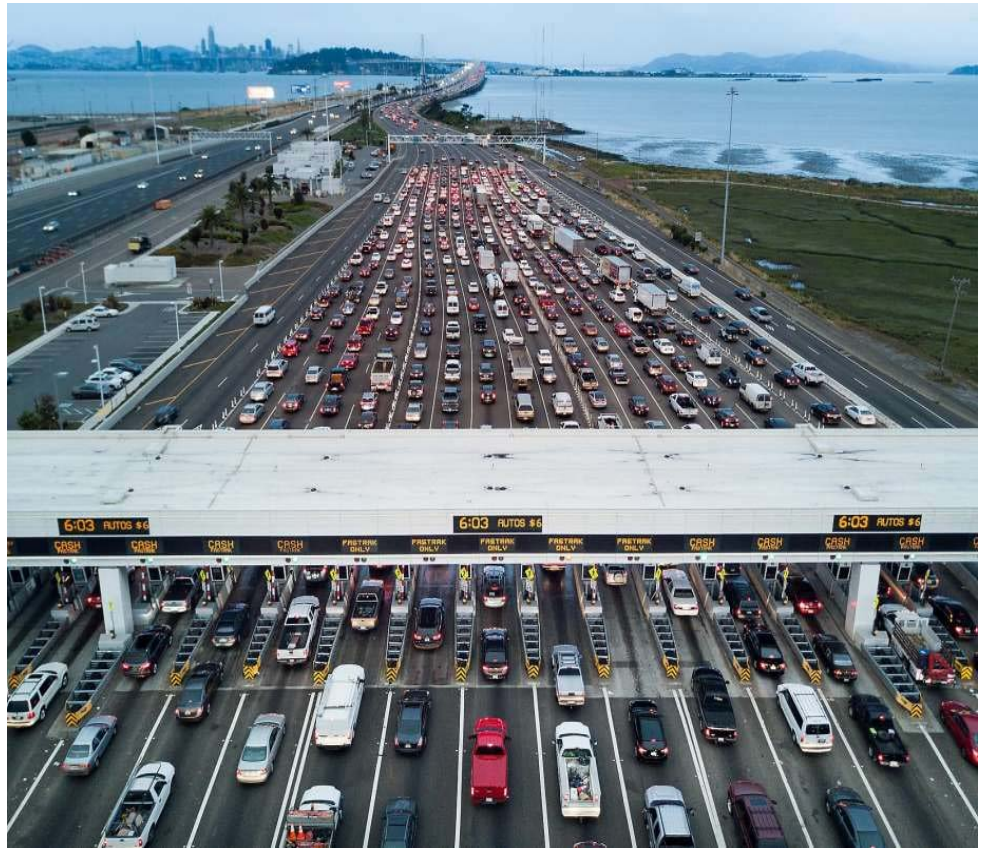


Photo: Noah Berger

What are UAM operations?

Urban Air Mobility operations involve

- electric Vertical Takeoff and Landing (eVTOL) vehicles
- Vertiports in metroplex airspace
- Low Altitude
- Passengers

Previous Studies

- Market studies focused on demand and population demographics
- Fast time simulations to evaluate separation between UAM flights
- Fast time simulations to design approach profile for eVTOLs
- Investigating air traffic management for small Unmanned Aerial Systems (sUAS)
- Vertiport design and locations for UAM
- Identify barriers and challenges to Urban Air Mobility such as noise, integration with airports and other airspace

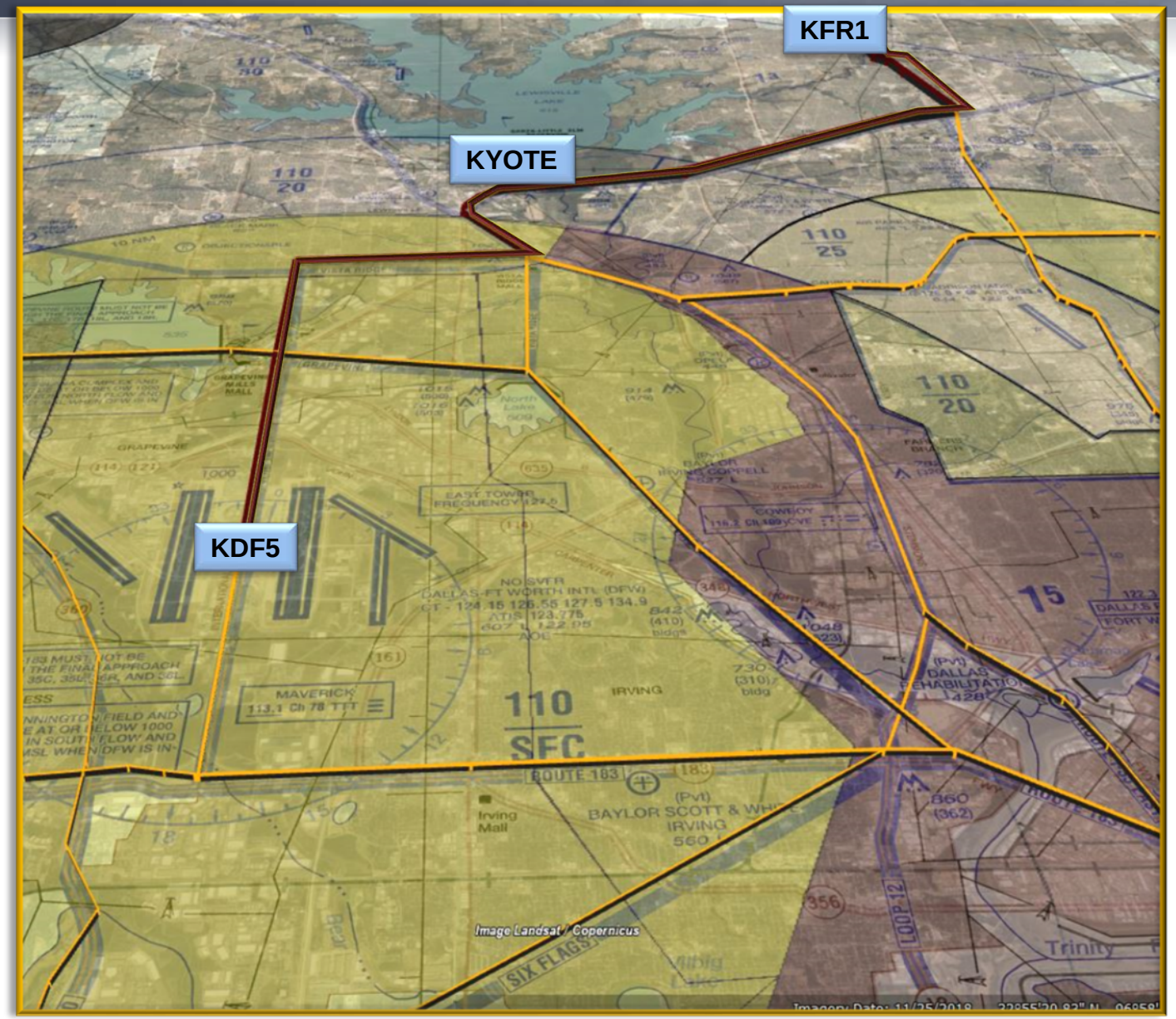
Objectives for the study

- Explore procedures for UAM traffic accessing Class B/C/D airspace
  - Current day helicopter routes and communications
  - Modified helicopter routes and reduced communications
- Evaluate different levels of UAM traffic

Experimental Matrix

Level of UAM traffic	Helicopter Routes		
	Current Routes *Current level of Communications (Baseline)*	Current Routes *Reduced Communications*	Modified Routes *Reduced Communications*
Low	Scenario C1	Scenario CL1	Scenario M1
Medium	Scenario C2	Scenario CL2	Scenario M2
High	Scenario C3	Scenario CL3	Scenario M3

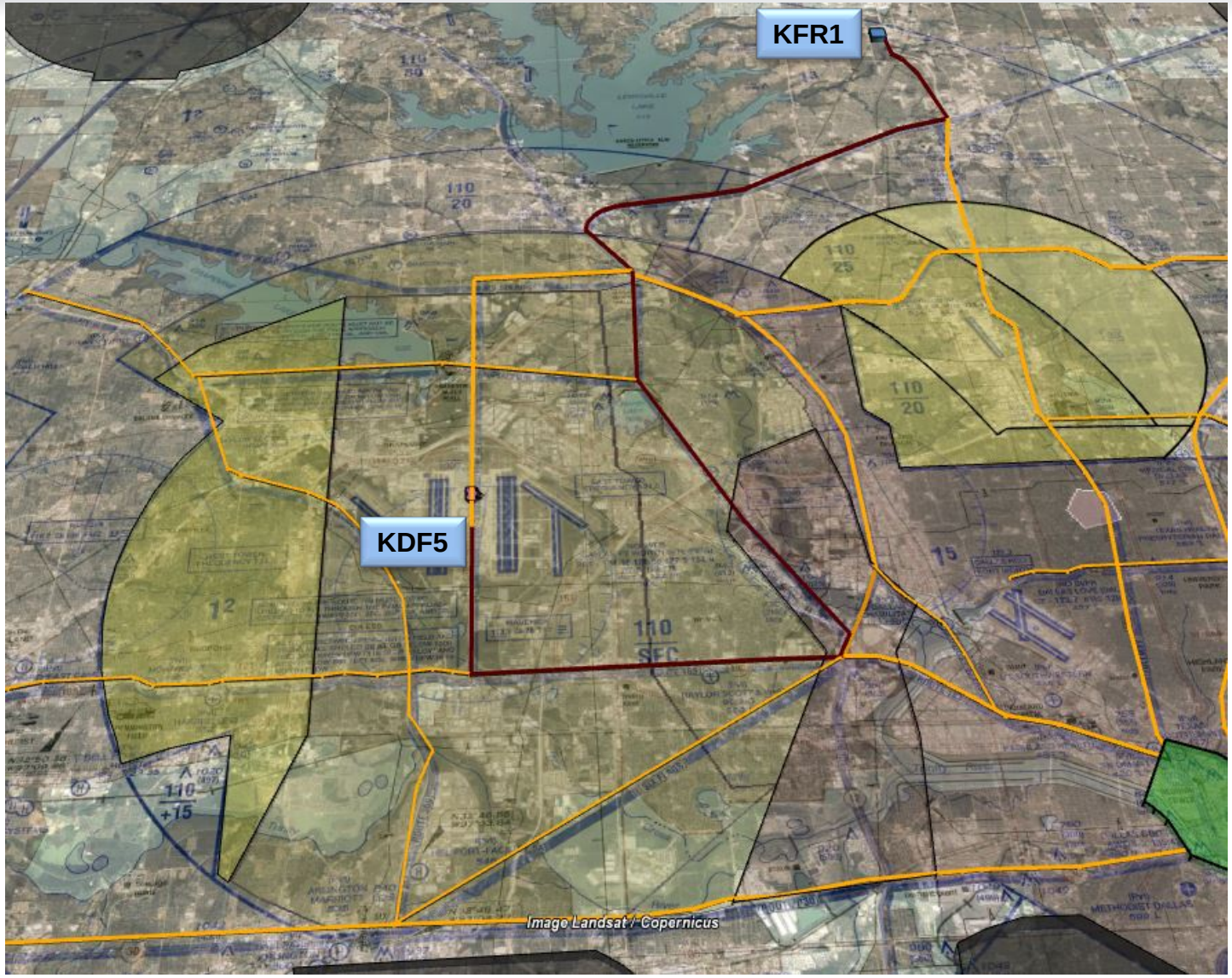
Communications when entering Class B (KYOTE)



UAM789:
DFW Tower, UAM789, at KYOTE, 1100 ft, request bravo clearance to KDF5 via Colony; I-35 East; Vista ridge; Spine Rd

DFW Local controller:
"UAM789 DFW altimeter XXXX, squawk XXXX… "Cleared to enter class bravo airspace, via *Colony; I-35 East; Vista ridge; Spine Rd* . Maintain 1100 ft

Communications while Departing at DFW vertiport (KDF5)



UAM789:
"DFW CD, UAM789 [location, ATIS] request VFR class Bravo clearance via Spine Rd; Grapevine; Vista Ridge; I-35 East"

DFW Clearance Delivery:
"UAM789 cleared to depart class Bravo via Spine Rd; Grapevine; Vista Ridge; I-35 East"

UAM789:
"DFW Tower UAM789, Ready to depart via Spine Rd; Grapevine; Vista Ridge; I-35 East"

DFW LE3:
"UAM789, DFW Altimeter XXXX, wind calm, departure from KDF5 will be at your own risk"

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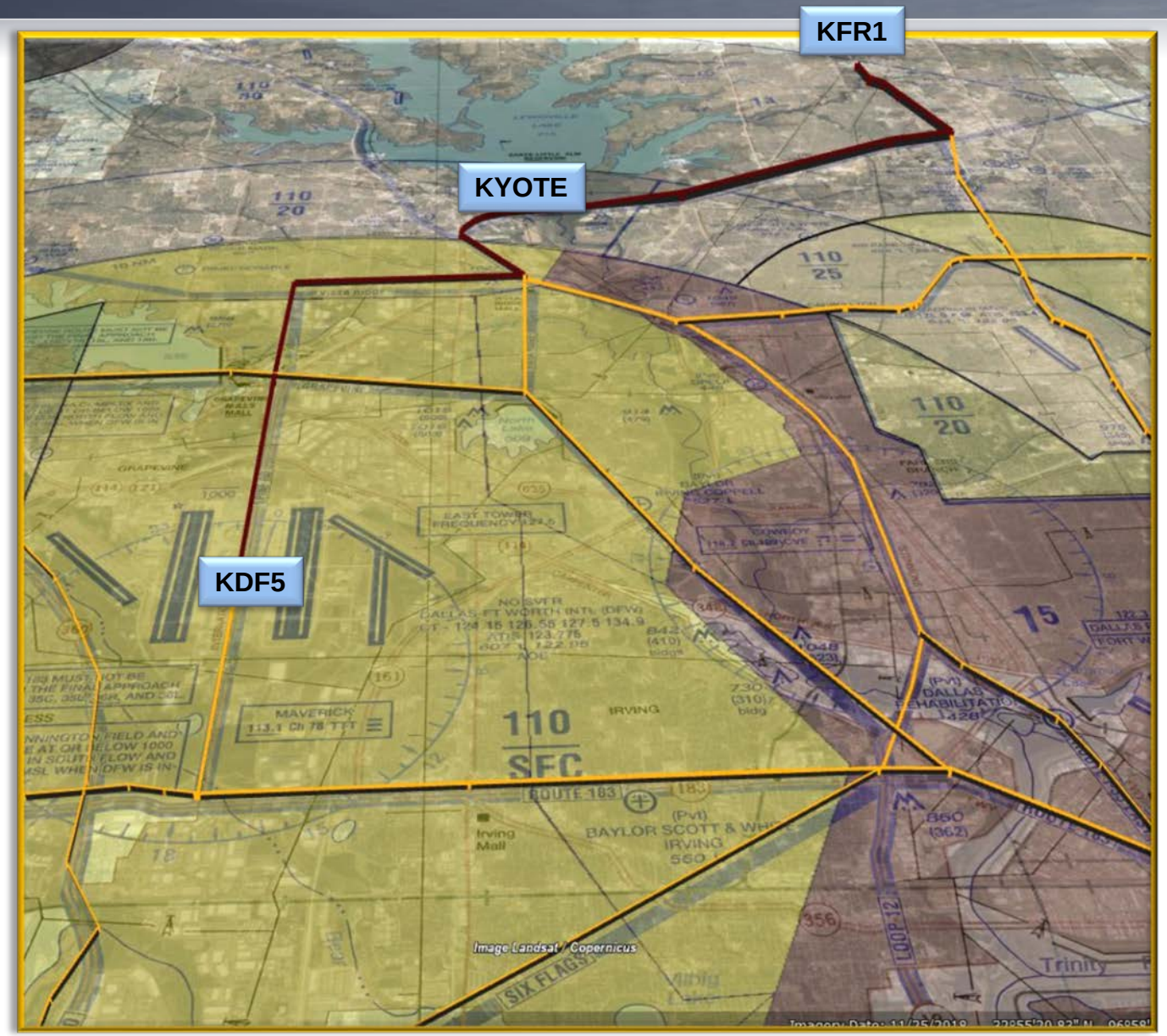
Letter of Agreement (LOA)

- Pre-assign beacon codes to signatory operators
- Create Route Codes/Names for flights to reduce the verbiage
- Define helicopter routes with waypoints and altitudes
- Pilots automatically changed frequency when exiting Class B Airspace
- Frequency changes to different sector were *not* automatic
- Point Outs were written up for UAM flights within the same facility (Example: Spine road traffic for DFW East and West Tower)

Example LOA: DALLAS THREE

Origin	Destination	Origin Name	Destination Name	Modifications from Current Routes
KFR1	KDF5	Frisco Vertiport	Dallas Fort-Worth Vertiport	• Altitude 1600’ MSL (1000 AGL) • No longer uses Vista Ridge (pushed back) Transition Point: **KYOTE**

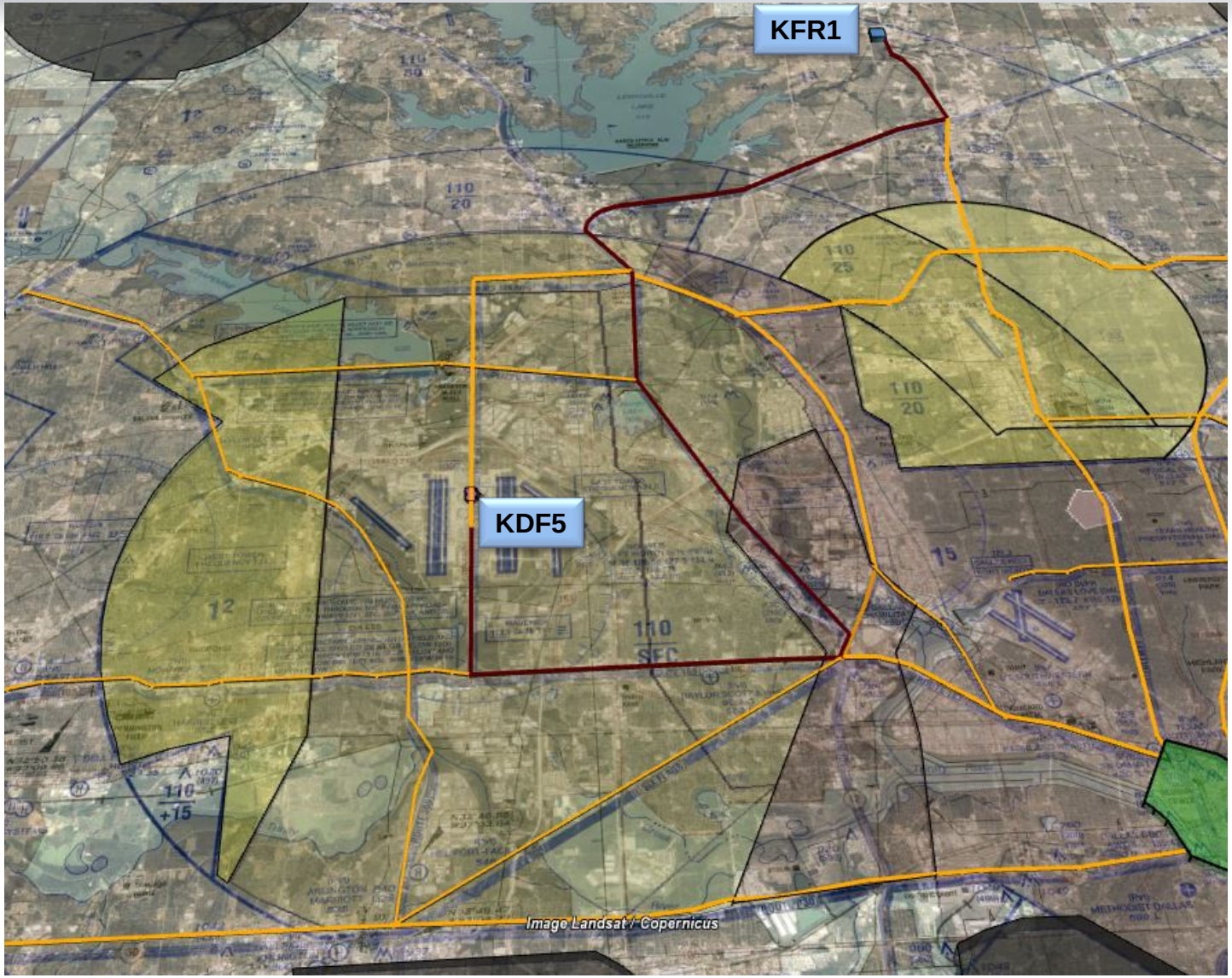
Communications when entering Class B (KYOTE)



UAM789:
*DFW Tower, UAM789, at KYOTE, 1600 ft, request Bravo clearance to KDF5 via **DALLAS3***

DFW LE3:
"UAM789 DFW altimeter XXXX, Cleared to enter class Bravo airspace, via ***DALLAS3***"

Communications while Departing at DFW vertiport (KDF5)



UAM789:
*"DFW CD, UAM789 [location, ATIS] request VFR class Bravo clearance via **FRISCO1**"*

DFW Clearance Delivery:
*"UAM789 cleared to depart class Bravo via **FRISCO1**"*

UAM789:
*"DFW Tower UAM789, Ready to depart via **FRISCO1**"*

DFW LE3
"UAM789, DFW Altimeter XXXX, wind calm, departure from KDF5 will be at your own risk"

Experimental Matrix

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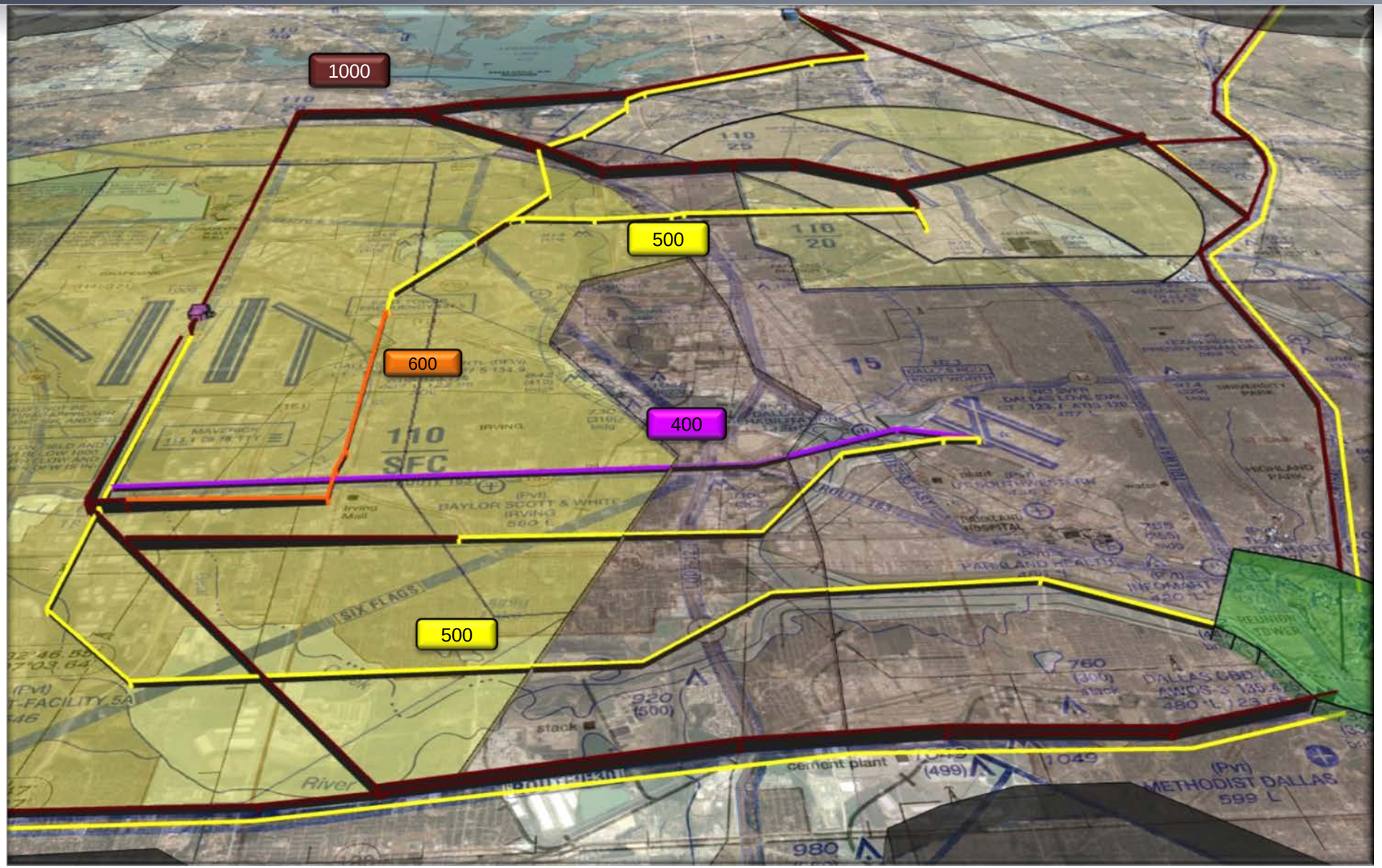
Modifications to Current Day Helicopter Routes



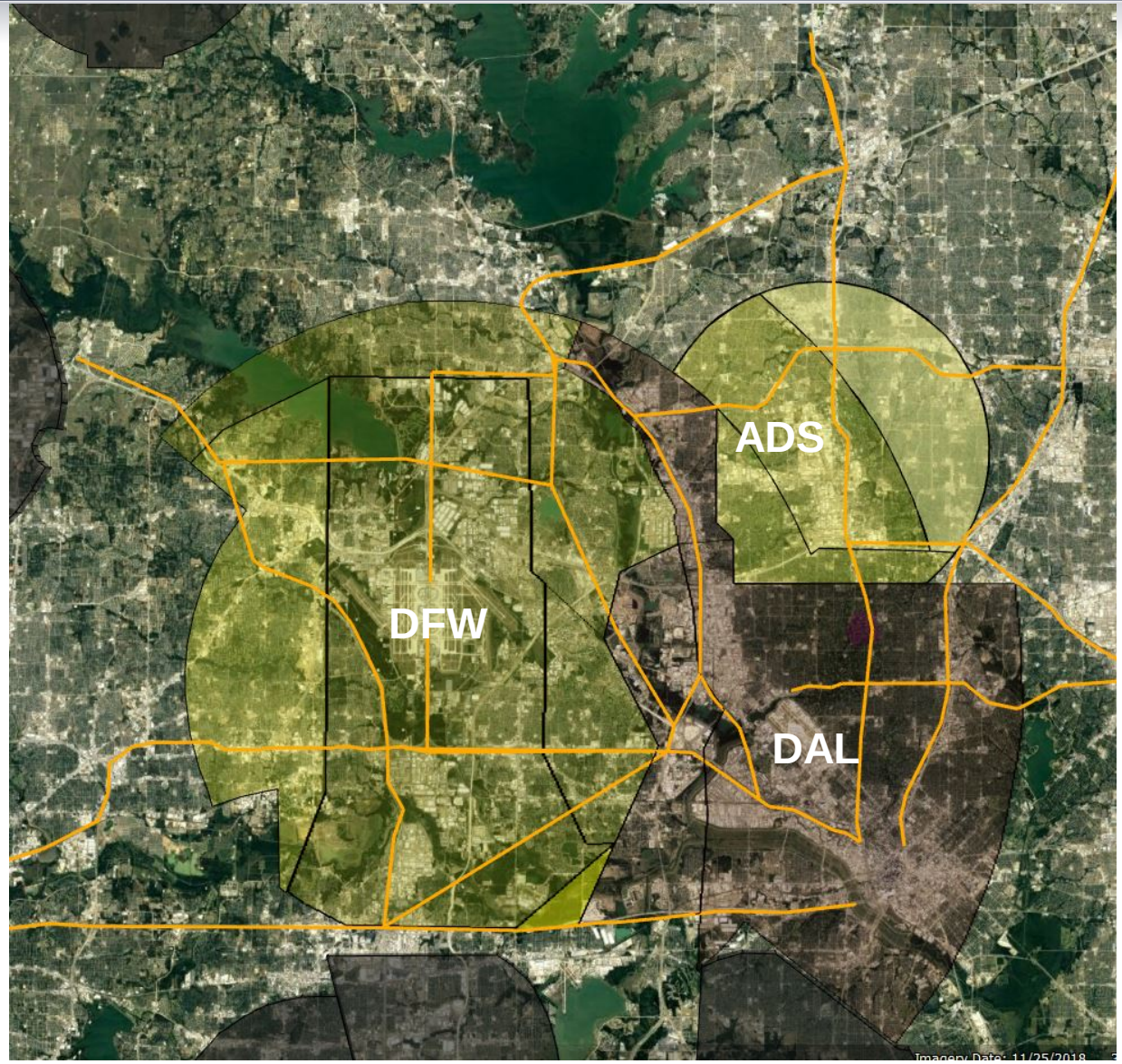
Assumptions: UAM Characteristics

- *Vehicle concepts*: Separate lift and cruise propulsion, tiltrotors, tiltwings, multi-rotors
- *Propulsion:* Electric or hybrid-electric
- *Vehicle capacity*: 4-6 passengers
- *Number of pilots on board*: One
- *Altitude*: 1100’ MSL or 1600’ MSL
- *Speed in Scenarios*: Approx. 130 kts
- *Range flying in scenarios*: About 25-50 miles

Sectors/ Positions

- Three Positions of interest (N=6)
  - DFW Tower Local East-3 (DFW-LE3)
  - DAL Tower Helicopter Position (DAL Helo)
  - ADS Tower (ADS)
- Four Confederates positions
- 13 Pseudo Pilots

DFW/ DAL/ ADS Sectors



Scenario Details

- Dallas Fort Worth Metroplex Area (DFW, DAL, ADS)
- South Flow configuration only
- Forty min run
- Same background IFR and VFR traffic (12/27/17)

UAM Traffic Levels

	Low Traffic	Medium Traffic	High Traffic
Enroute Temporal Spacing	~ 90 s	~ 60 s	~ 45 s
Enroute Spacing	3.75 mi	2.5 mi	1.875 mi
Total Number of Flights	115	167	225

Results

- Number/ Percentage of UAM flights managed by sector
- Communications
- Subjective results

Caveats on Data Analysis

- This research was a part-task simulation so data trends bring more valuable lessons than absolute numbers presented

- Average across positions are presented but they mask the differences between the different airports/positions
  - No tests of significance were performed due to lack of power (N = 2 for every position)

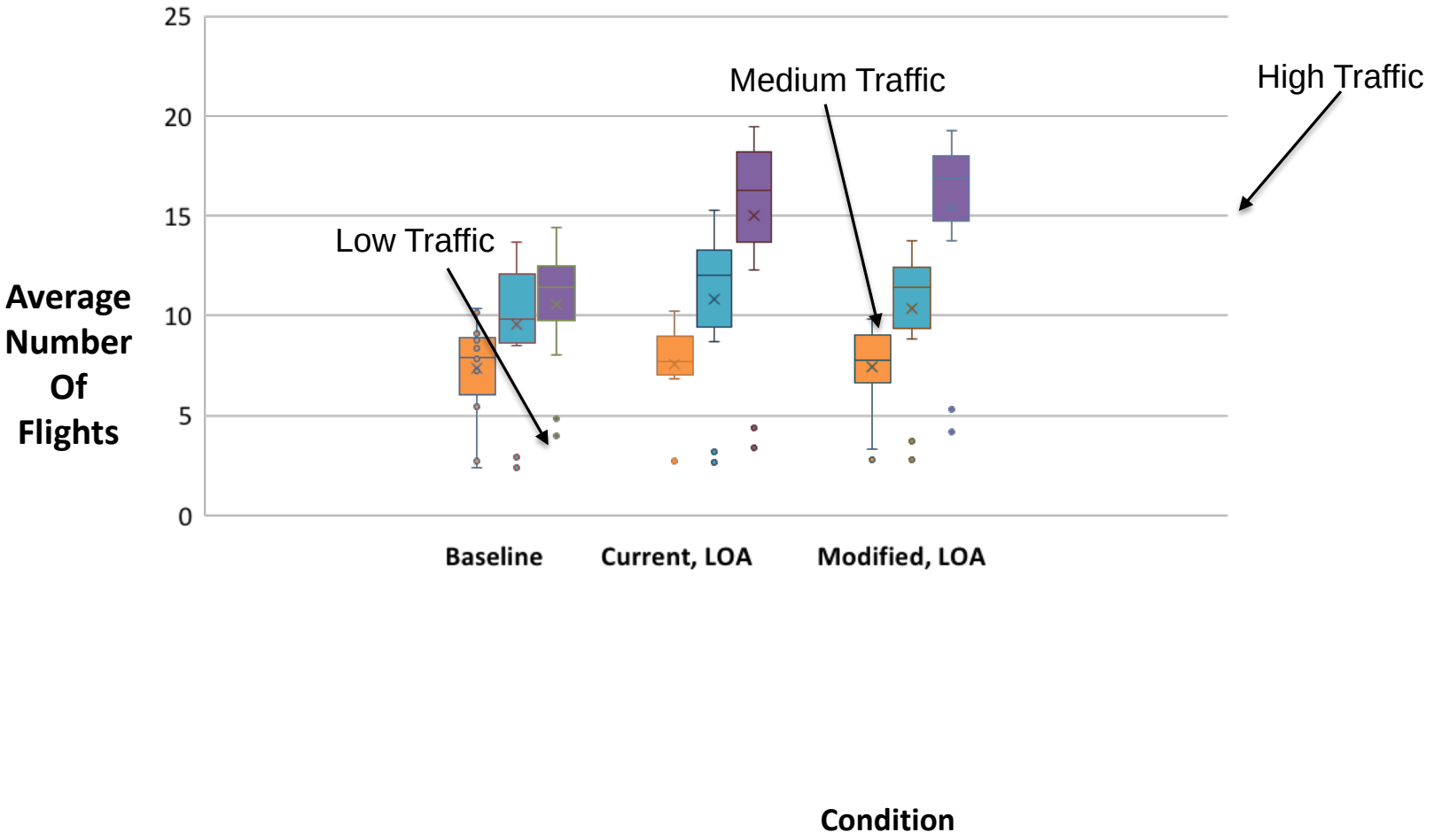
Average Number Flights managed by the Sector

- Average total number of flights managed by any sector is the average number of UAMs managed by the position at any given time

- Total Flights Planned = Total Flights managed + Flights denied

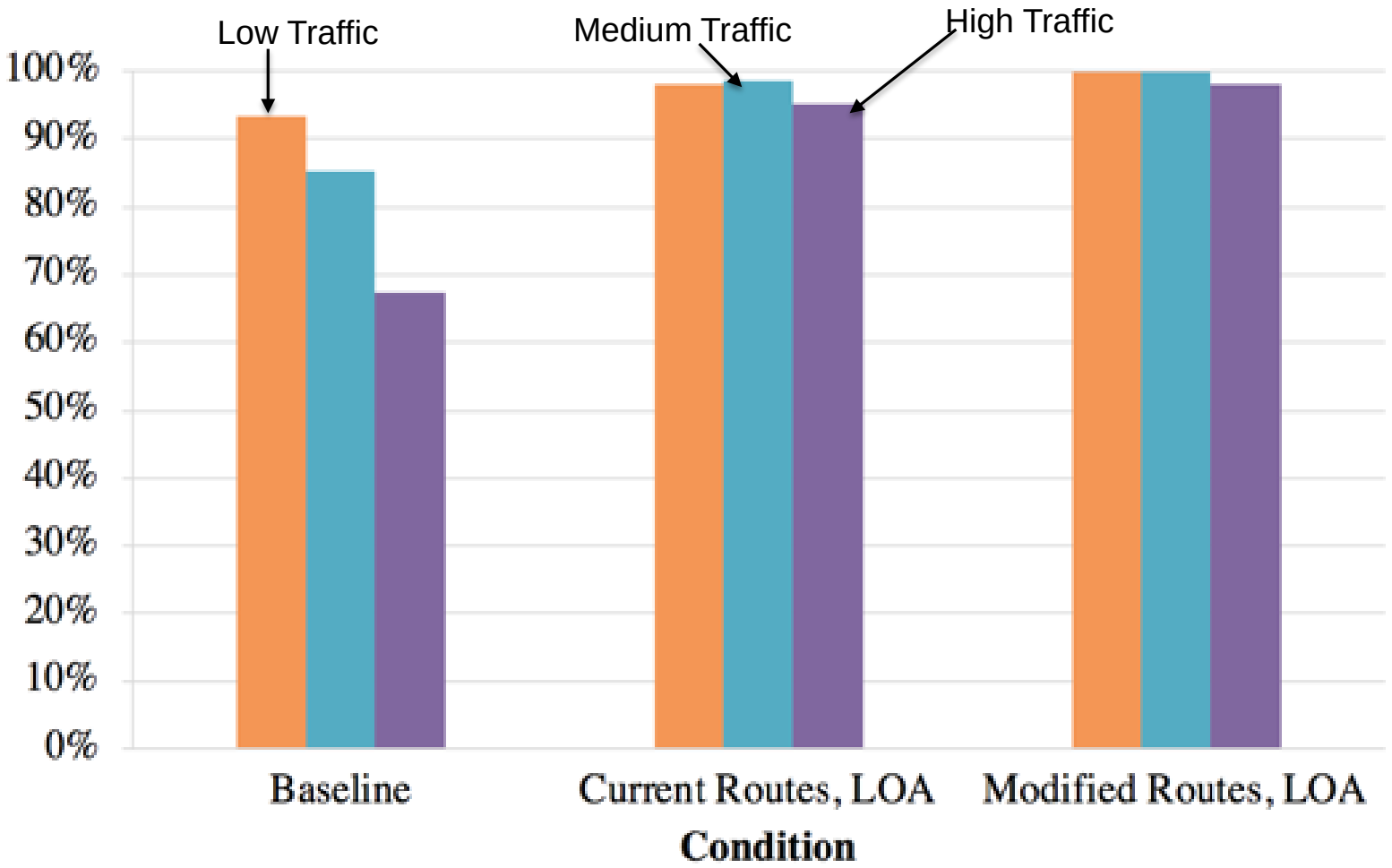
- Percentage of flights managed in the sector as of planned = ((Total flights planned – flights denied)/ Total Flights planned)*100

Average Number of UAM Flights Managed for DFW-LE3



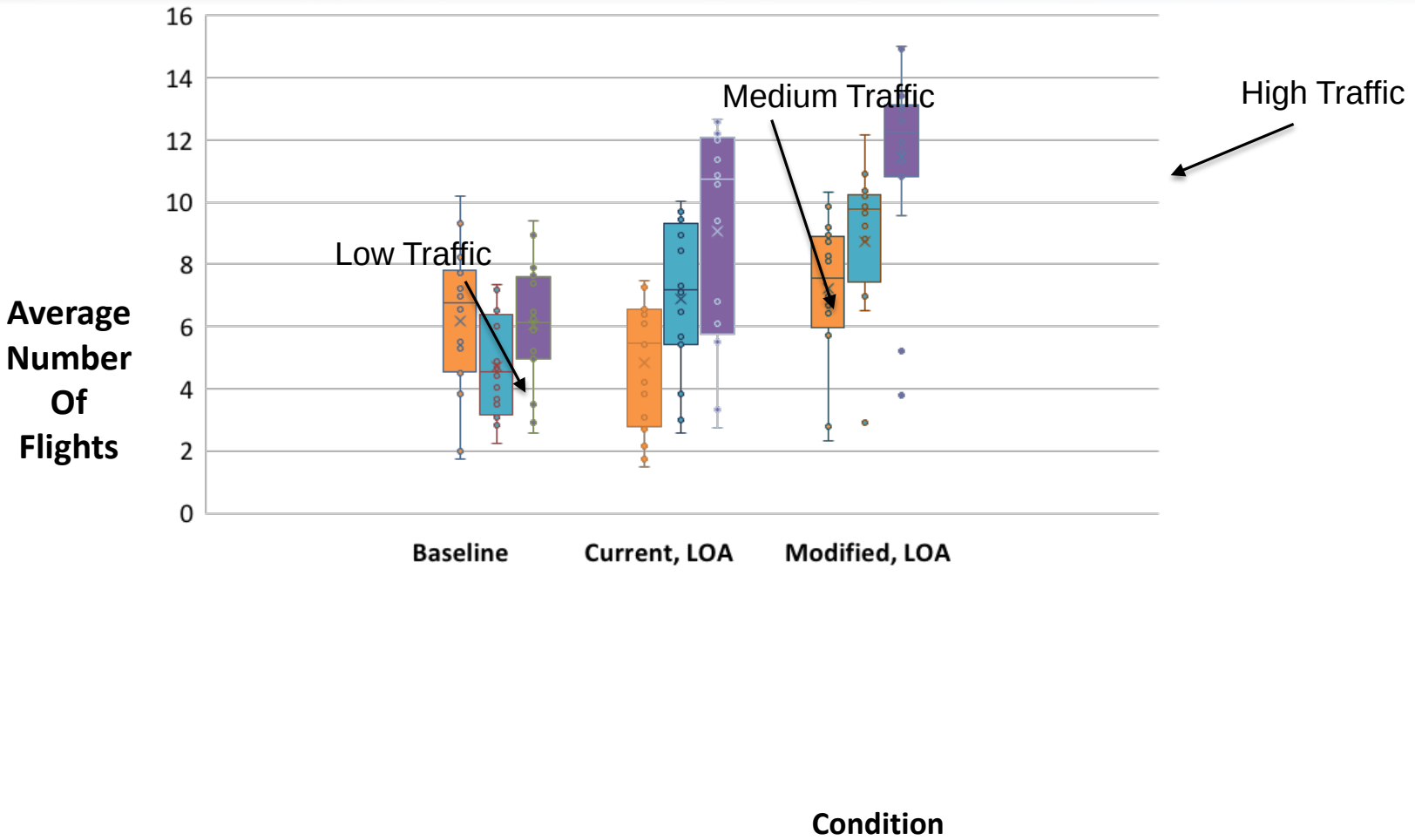
The LOA has a bigger impact than modification of routes

Percentage of UAM Flights Managed of Planned for DFW LE-3



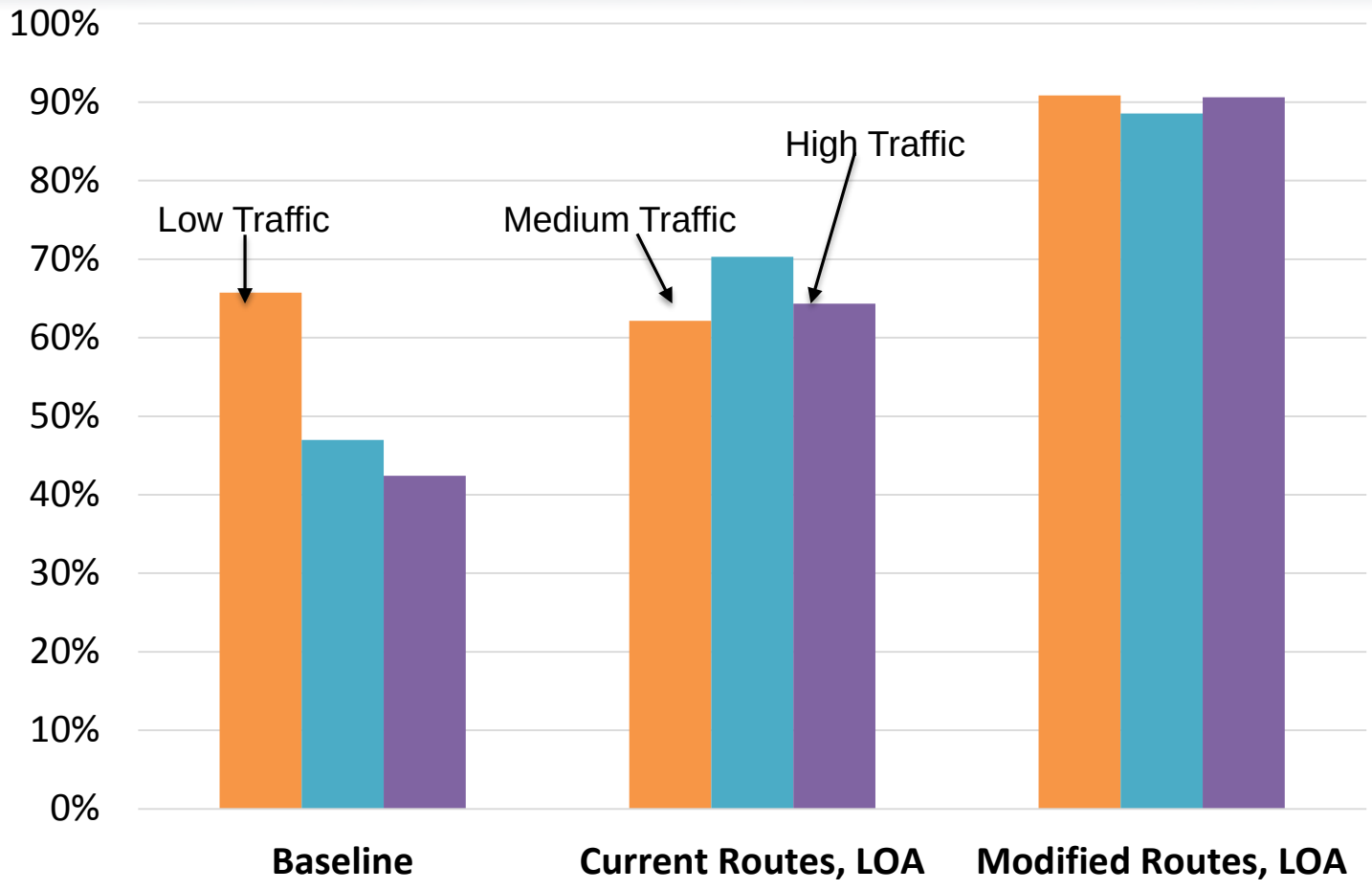
The LOA has a bigger impact than modification of routes

Average Number of Flights Managed - DAL Helo



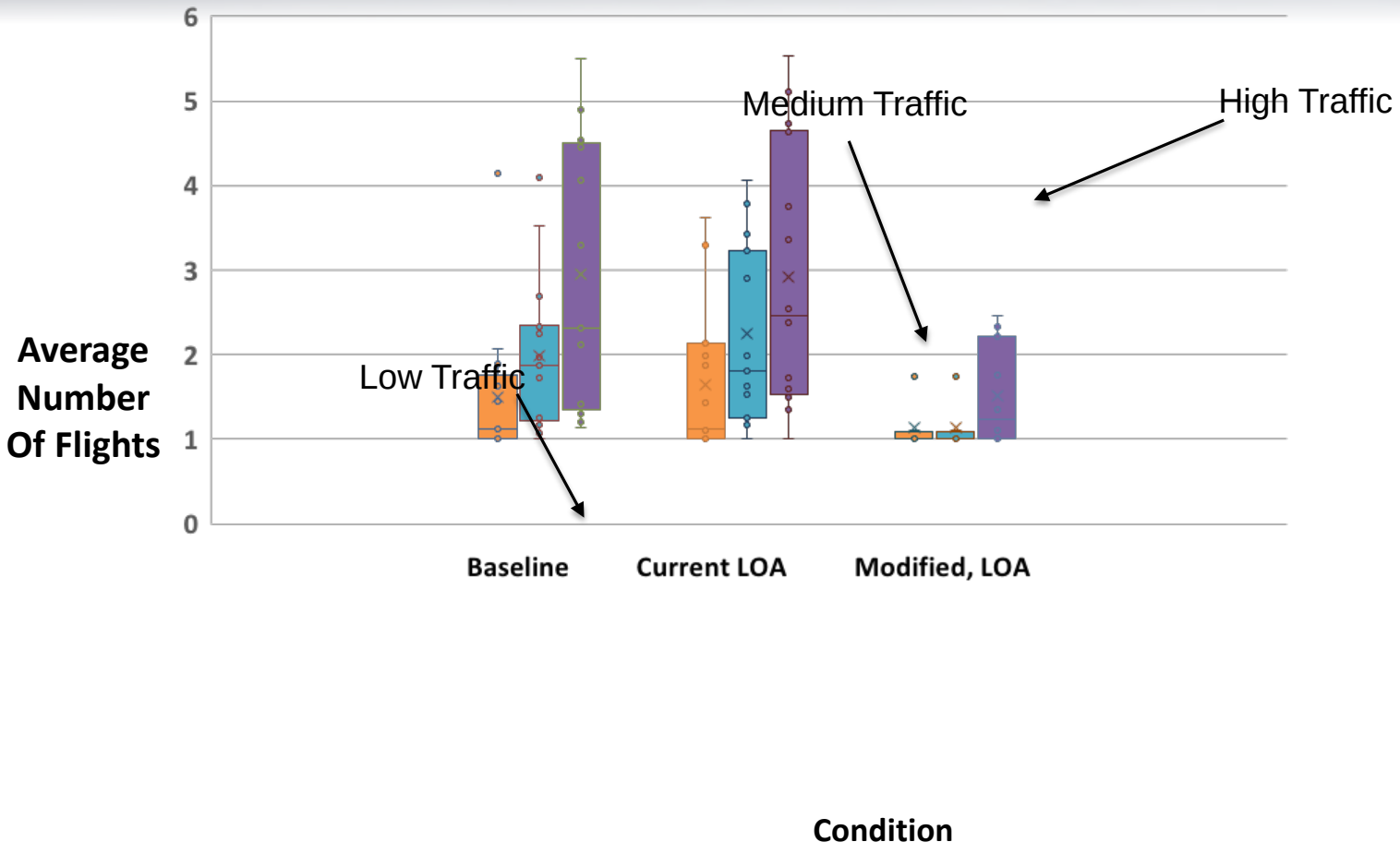
Unusable routes in current day operations affect number of flights managed

Percentage of UAM Flights Managed of Planned for DAL Helo



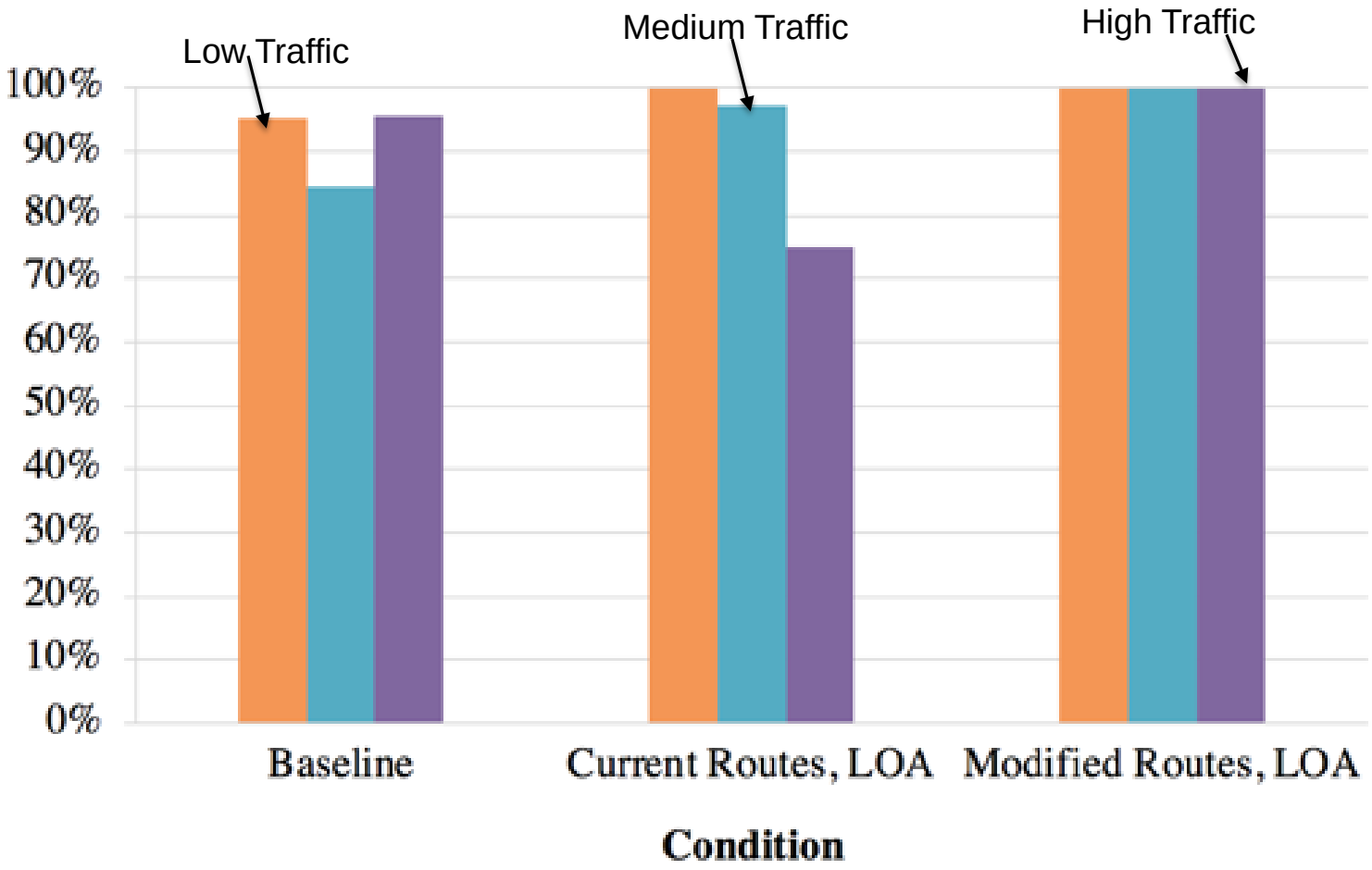
Least number of flights were denied in Modified Routes

Average Number of Flights Managed - ADS Local



Average number of UAM flights managed is low in Modified Routes due to change in route structure

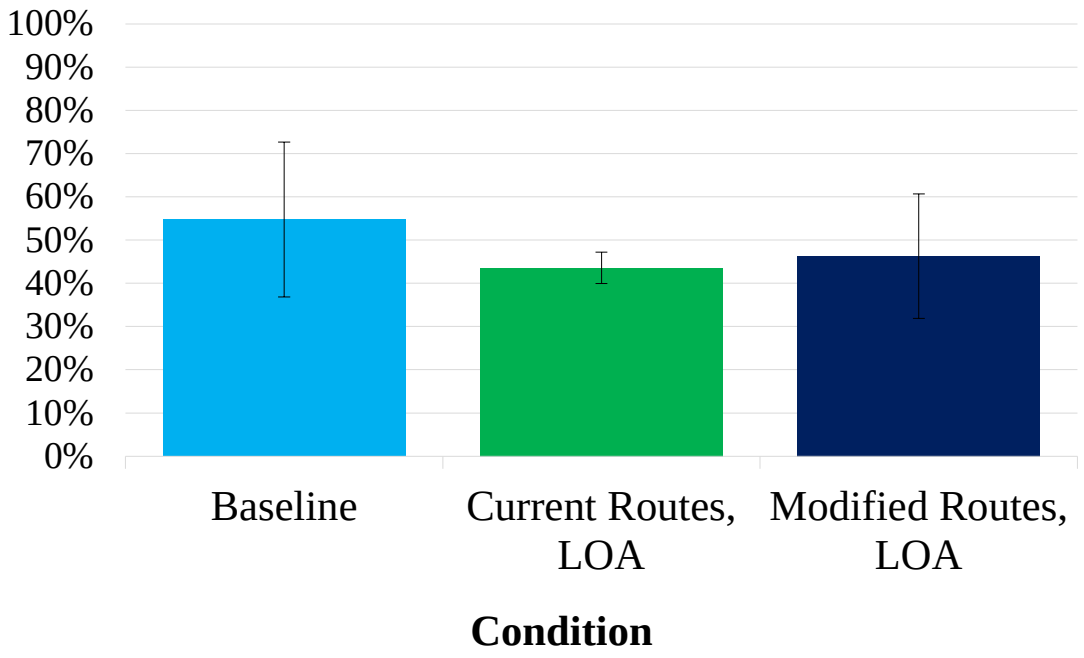
Percentage of UAM flights Managed of Planned for ADS



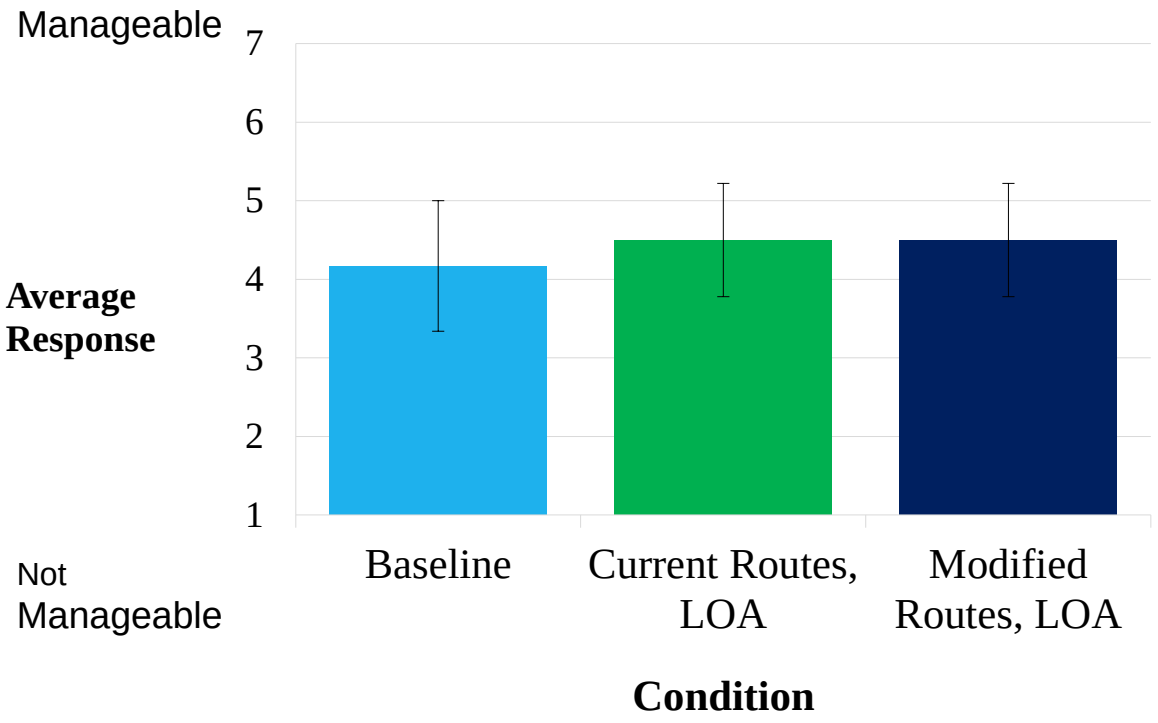
All flights planned for Modified routes were managed

Communications

Percentage of time spent on communications

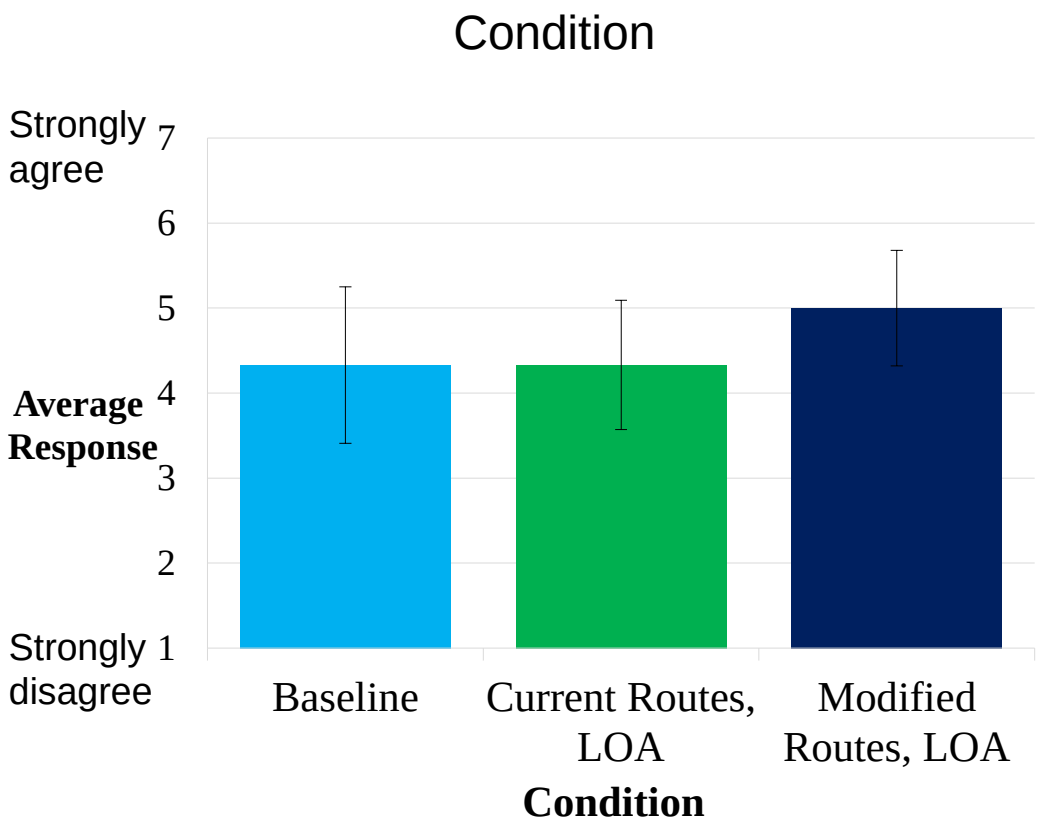


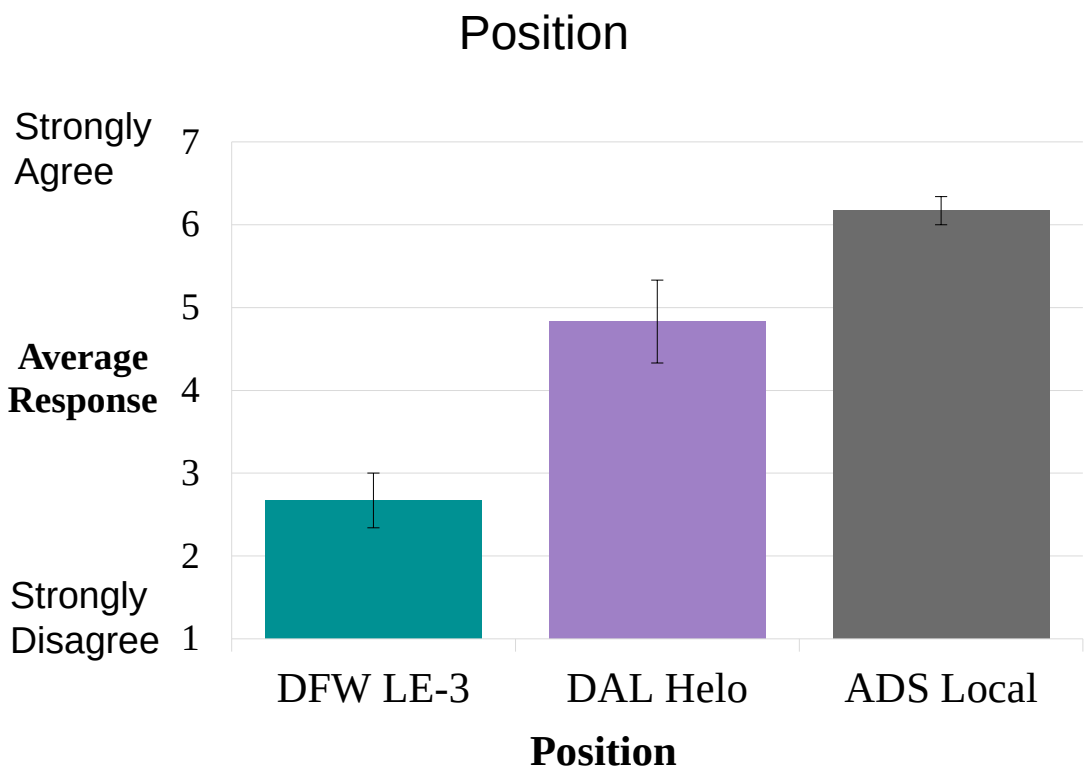
"My communications were manageable"



LOA reduced communications by about 10-15% as compared to Baseline
Controllers reported communications manageable across conditions but they managed more traffic in the Modified Routes with LOA

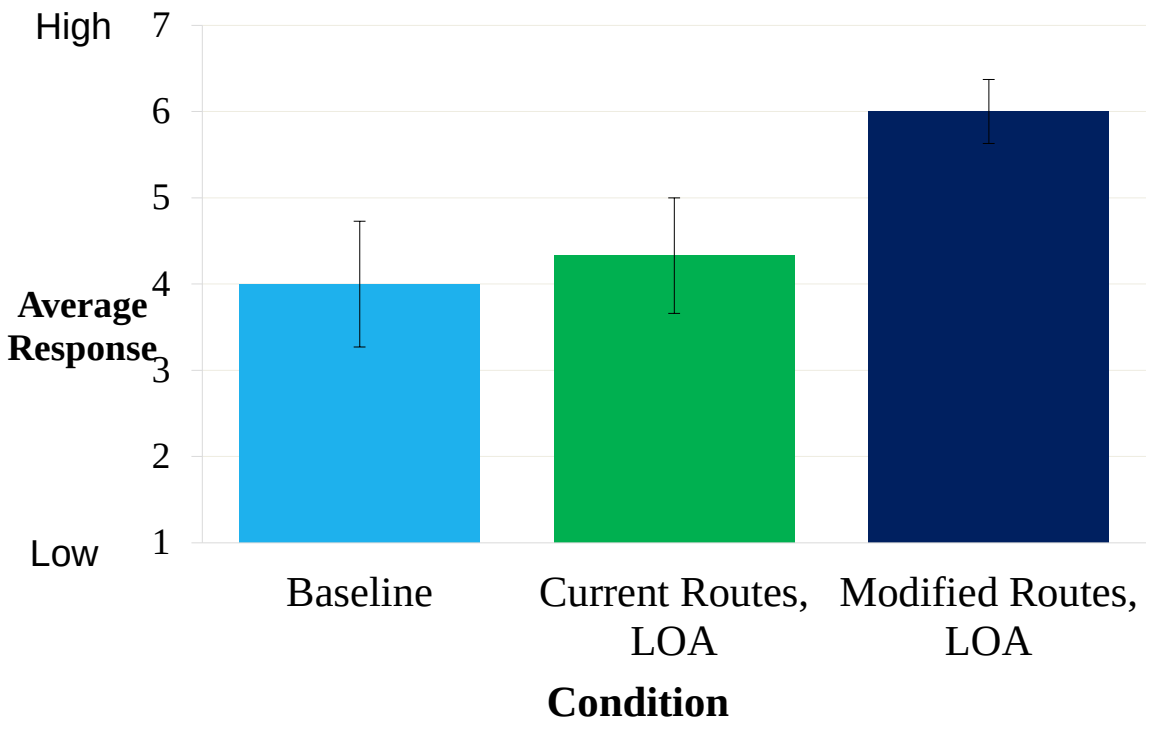
“Workload was operationally acceptable”

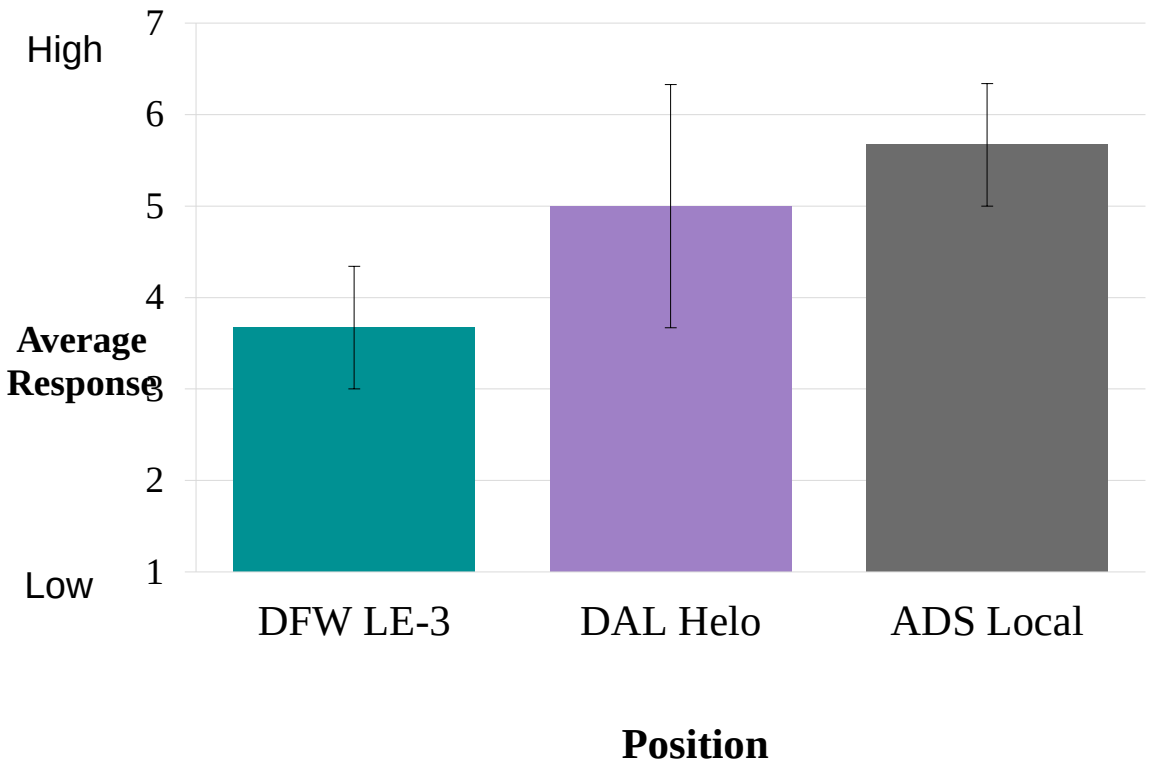




Modified routes had better workload acceptability, DFW-LE3 did not find their workload acceptable

Did UAM Routes support Efficiency?





Routes were reported as efficient for Modified Condition, but DFW LE-3 did not find them efficient

Summary

- Current day routes and communication procedures can support UAM operations but are not likely to be scalable especially for large airports.
- LOA reduced communications approximately 10-15% compared to Baseline communications.
- Modifications of helicopter routes made them more acceptable and reduced workload.

Next Steps

Explore UTM paradigm for UAM operations

Bibliography (Images)

San Francisco Traffic by Noah Berger, Source: https://www.sfgate.com/traffic/article/bay-area-worlds-worst-traffic-study-2018-13614431.php. Image used by permission of creator, text applied on bottom of image on slide 2.

Questions?

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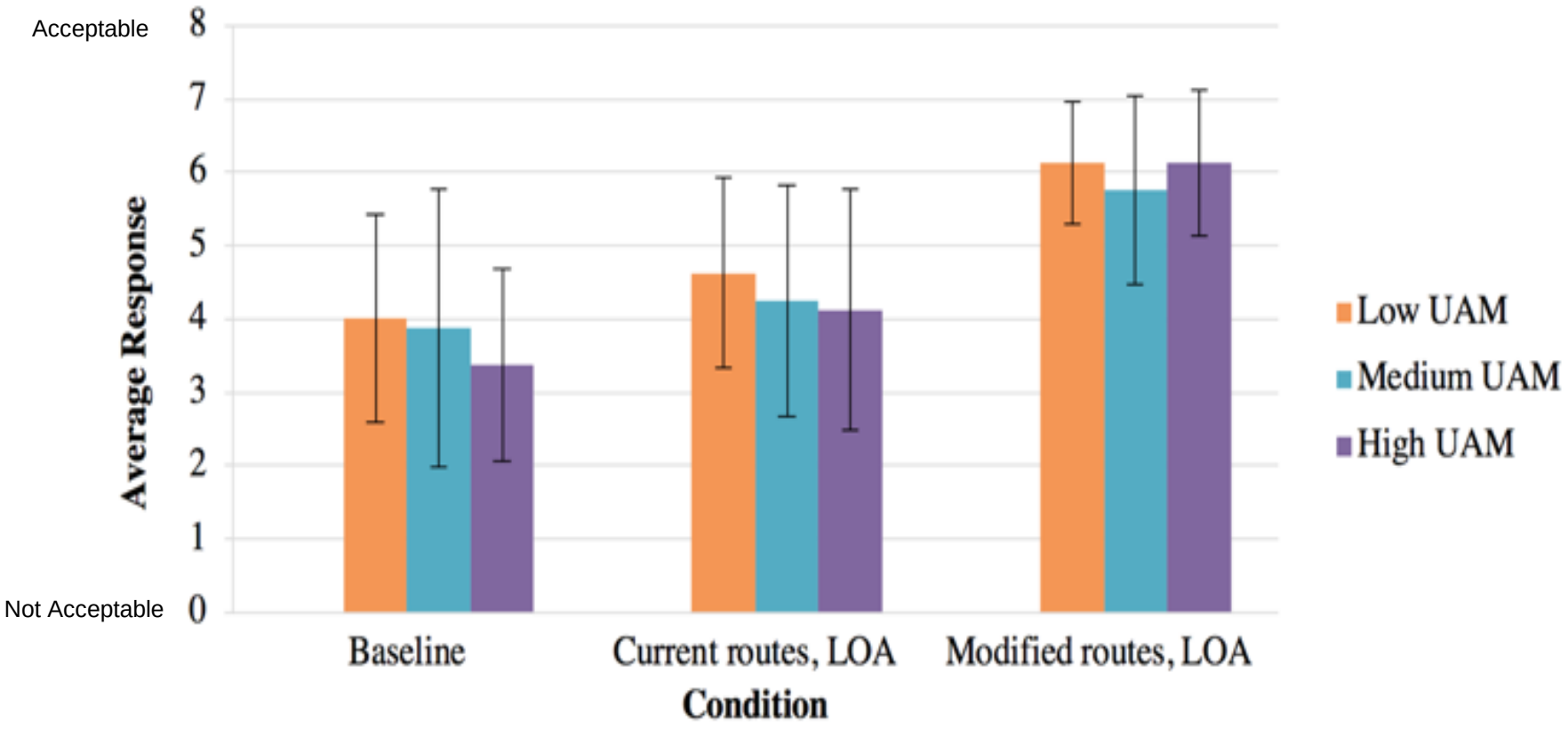
Bibliography (images):

Back up slides

Routes Operationally Acceptable?



Trend shows that Modified Routes with LOA were the operationally acceptable as compared to the Current Routes (Baseline)