Subjective Assessment of Initial and Mid-term Urban Air Mobility Operations and the Impact on Air Traffic Controller's Workload

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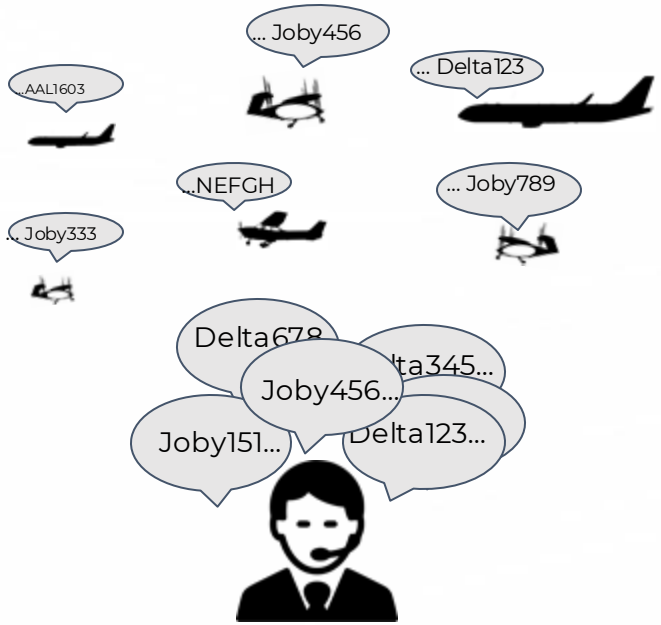
Motivation

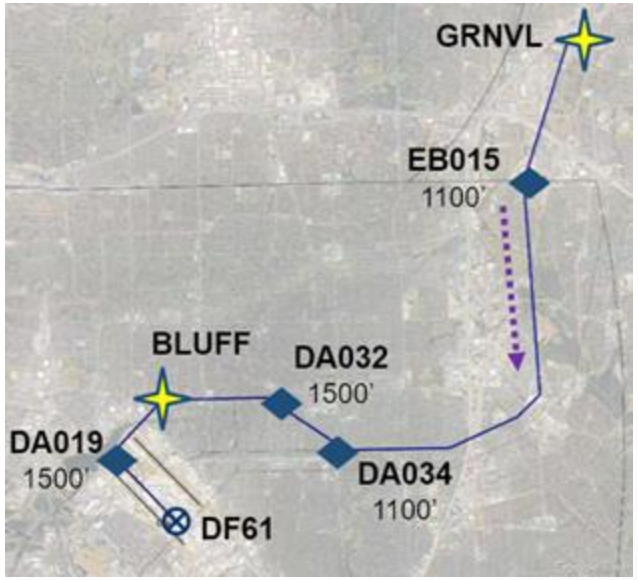
Challenge



Tower Controller

Potential Solutions

Initial Operations



Defined Routes that Streamline Communications

Mid-Term Operations

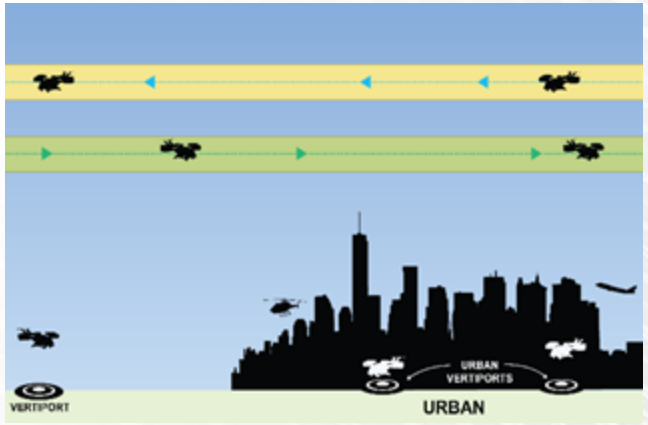


Image Source: FAA UAM ConOps, Version 2.0

Corridors

Introduction

- Air travel is expected to grow rapidly and exponentially
- Research efforts:
  - Evaluating Initial and Mid-term airspace procedures and information requirements that can reduce controller's workload
- Guiding research:
  - Federal Aviation Administration (FAA) Concept of Operations (ConOps), Version 2.0, describes the evolution of the UAM environment

UAM Operational Environments

FAA UAM ConOps, Version 2.0, April 2023

	UAM Operations	
	Initial Operations	**Mid-term Operations**
Operational Tempo	Low	Low; May Increase
Airspace Structure and Procedures	Existing Air Traffic Services and Routes	New Airspace Structure (e.g., Corridors)
Regulatory Changes	Current rules, regulations and local agreements	UAM Corridor cooperative environment

Research Objectives

To determine whether airspace procedures and information requirements would reduce ATC workload and facilitate UAM operations at Dallas Love Field airport (DAL) and Dallas-Fort Worth airport (DFW).

APPROACH

Approach: Participants

Air Traffic Controllers - 5

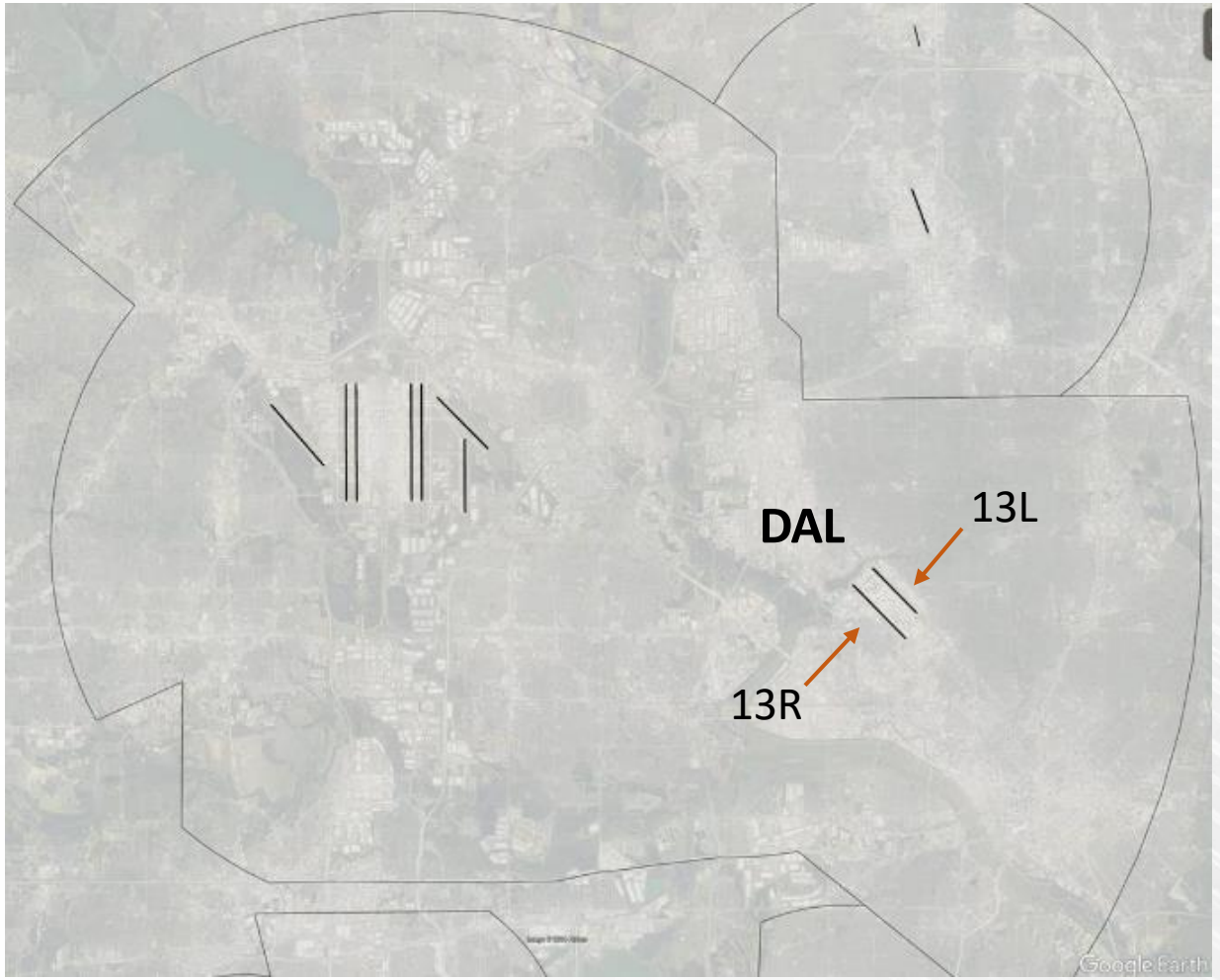
Pseudo-pilots - 11

Approach: Experimental Matrix

	Experimental Conditions	
UAM Traffic Density	**Initial Operations**	**Mid-term Operations**
Low	A	C
High	B	D

Approach: Simulation Setup

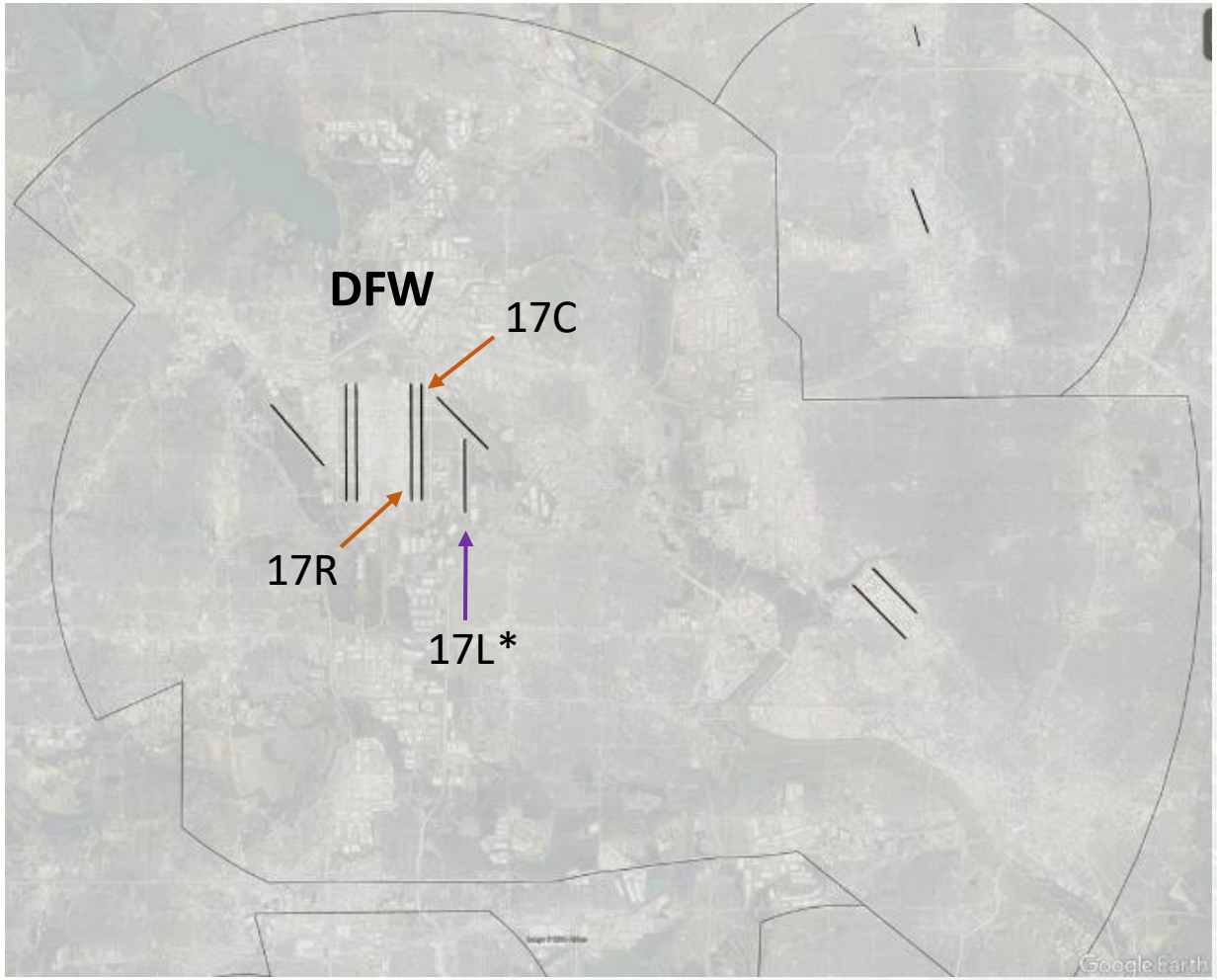
	DAL Controllers
Rotate positions	Local controller
	Helo



VFR = Visual Flight Rules

Approach: Simulation Setup

	DFW Controllers
Rotate positions	Local East-1 (DFW)
	DFW Helo (DFW)
	Local East-3 (confederate)*

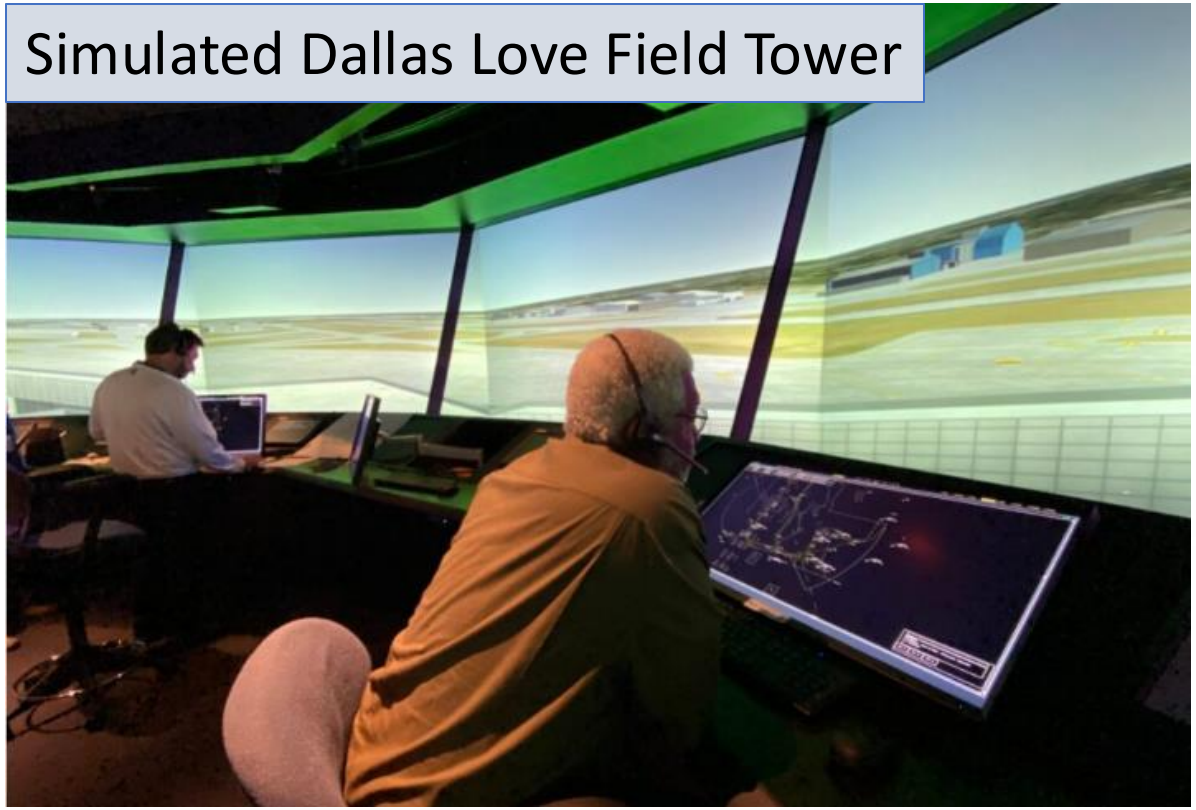


VFR = Visual Flight Rules

Approach: Simulation Environment

Future Flight Central (FFC) at NASA Ames Research Center

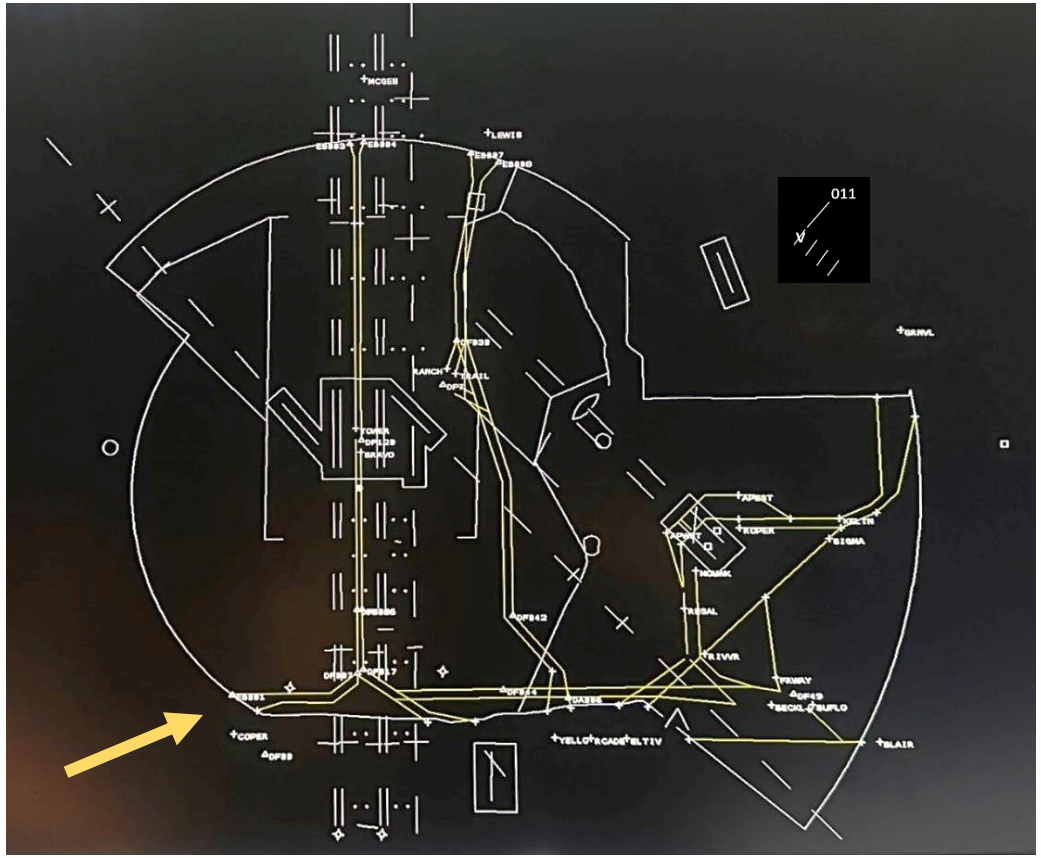
Simulated Dallas Love Field Tower



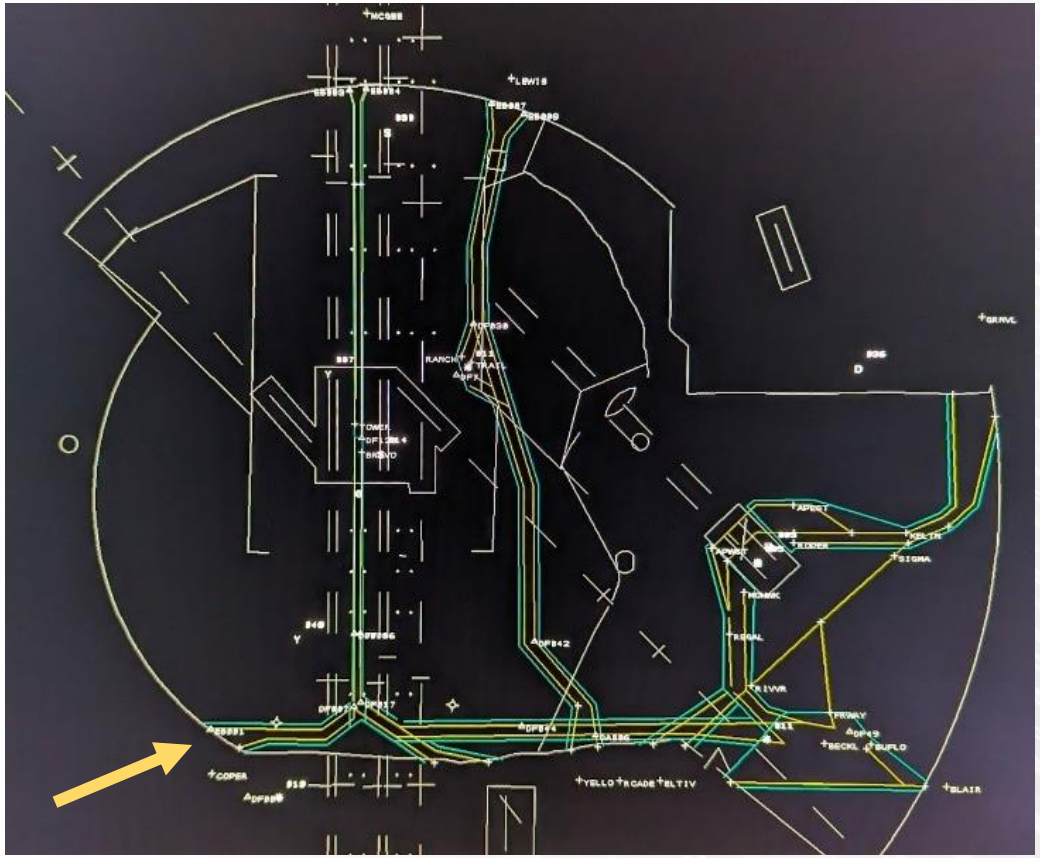
Simulated Dallas-Fort Worth Tower

Approach: Radar Simulator

Standard Terminal Automation Replacement System (STARS) consoles



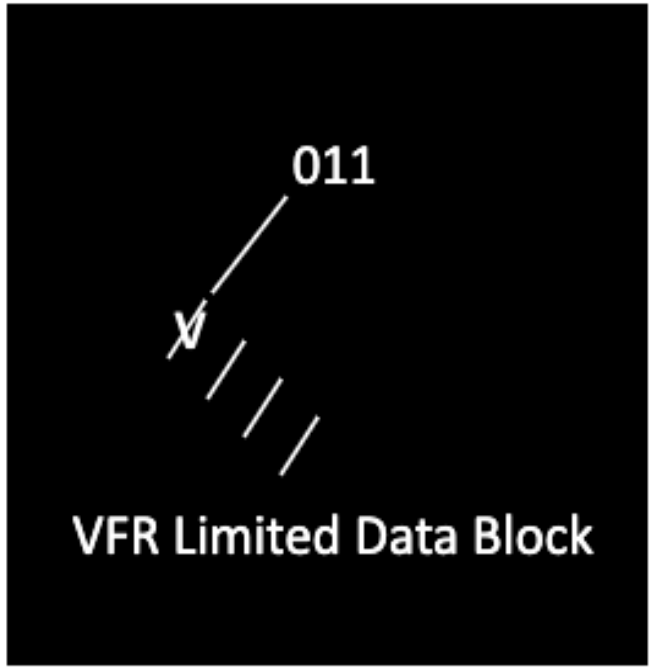
Initial operations



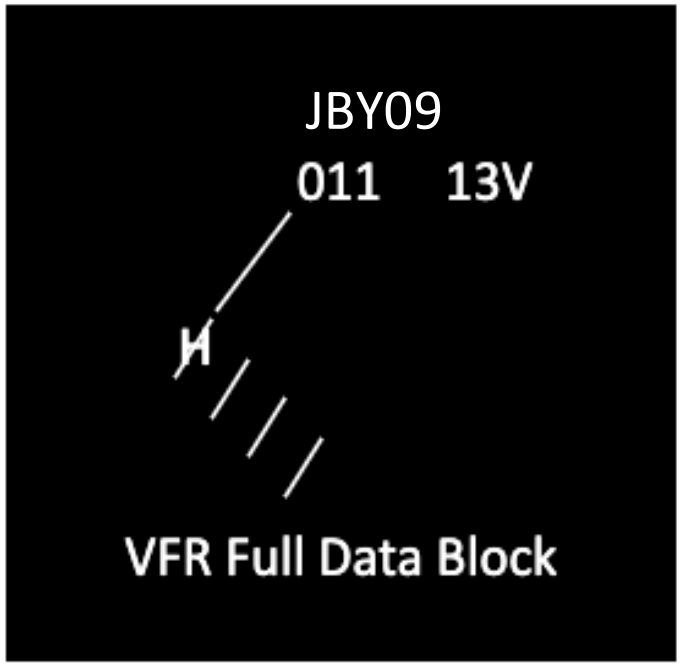
Mid-term operations

Approach: Data tags Information

Initial Operations



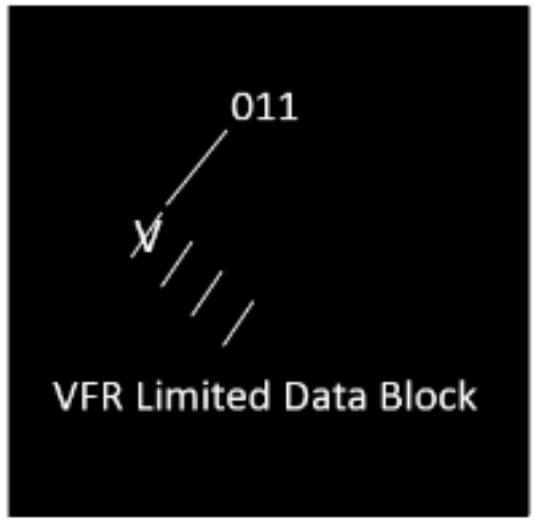
Outside Class Bravo



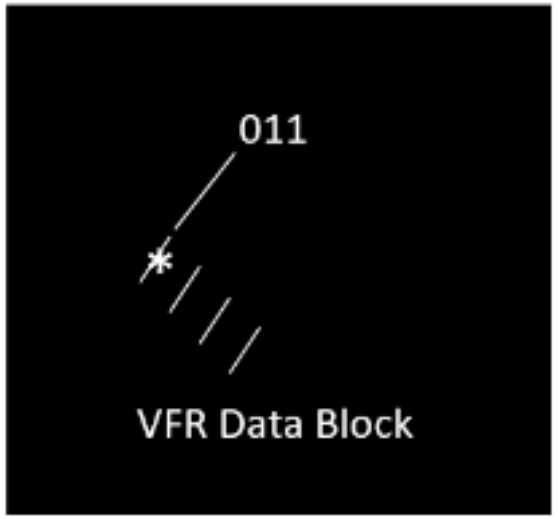
Inside Class Bravo

Approach: Data tags Information

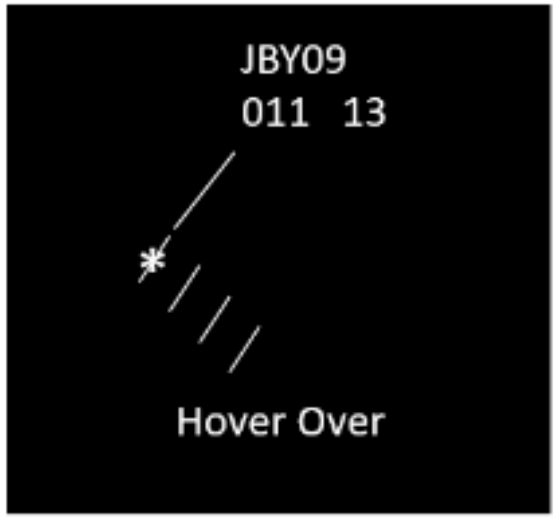
Mid-term Operations



Outside Corridor:
1200 Beacon Code



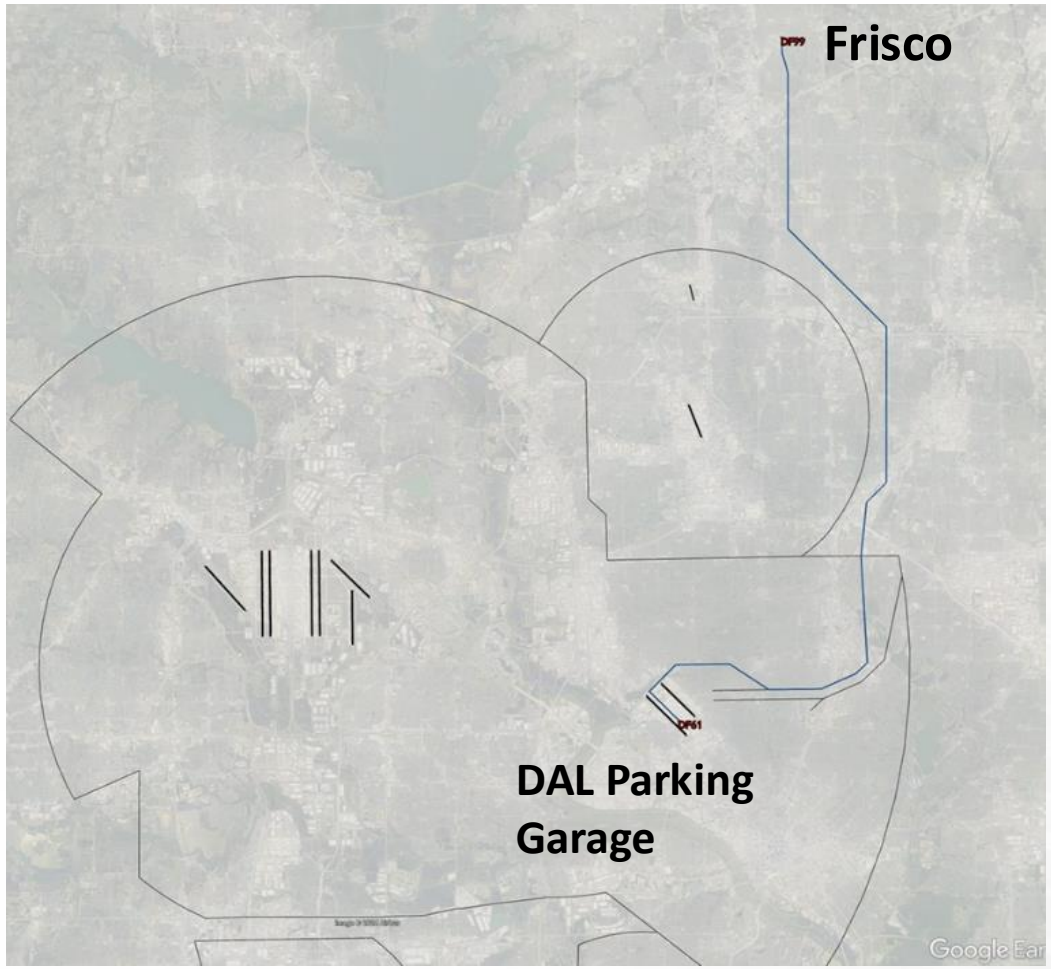
Inside Corridor:
1207 Beacon Code indicated as *



Inside Corridor:
Quick Look

Approach: Example of Traffic Scenario

Initial Operations: Frisco – DAL Parking Garage

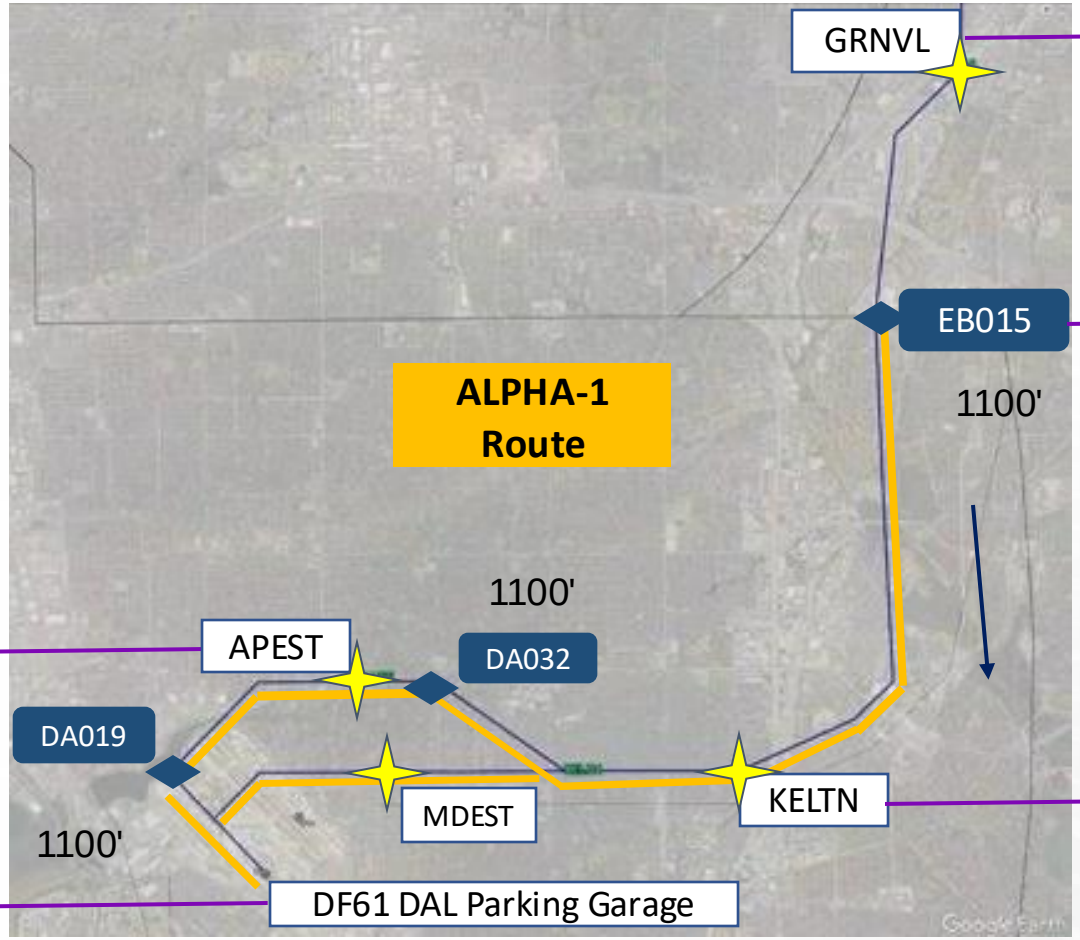


Approach: Example of Traffic Scenario

Initial Operations

Coordination Point

Waypoint



Verbal request for route

Enter Class Bravo

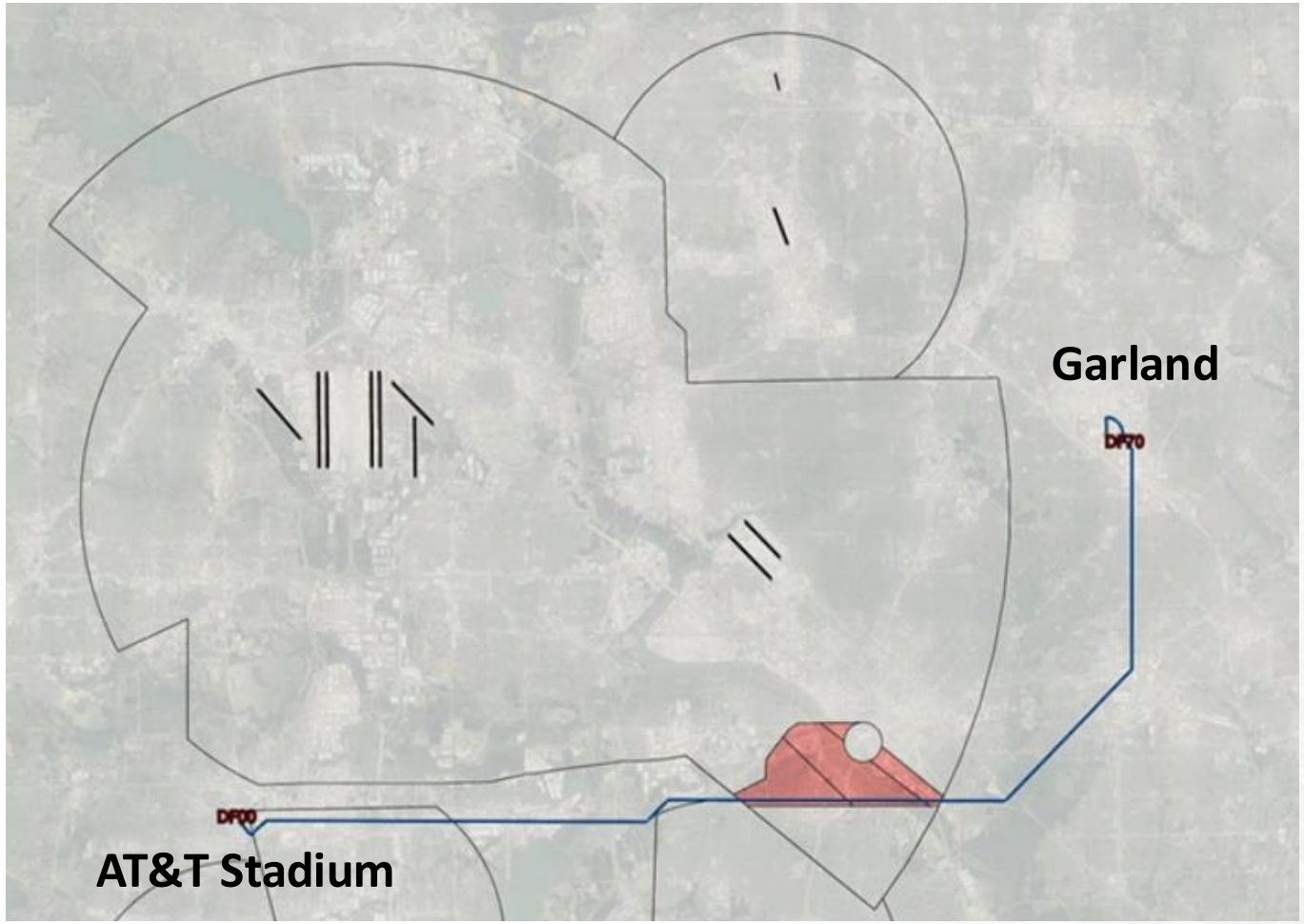
Runway Crossing Clearance

Handoff to DAL Local

Arrival

Approach: Example of Traffic Scenario

Mid-term Operations: AT&T Stadium - Garland

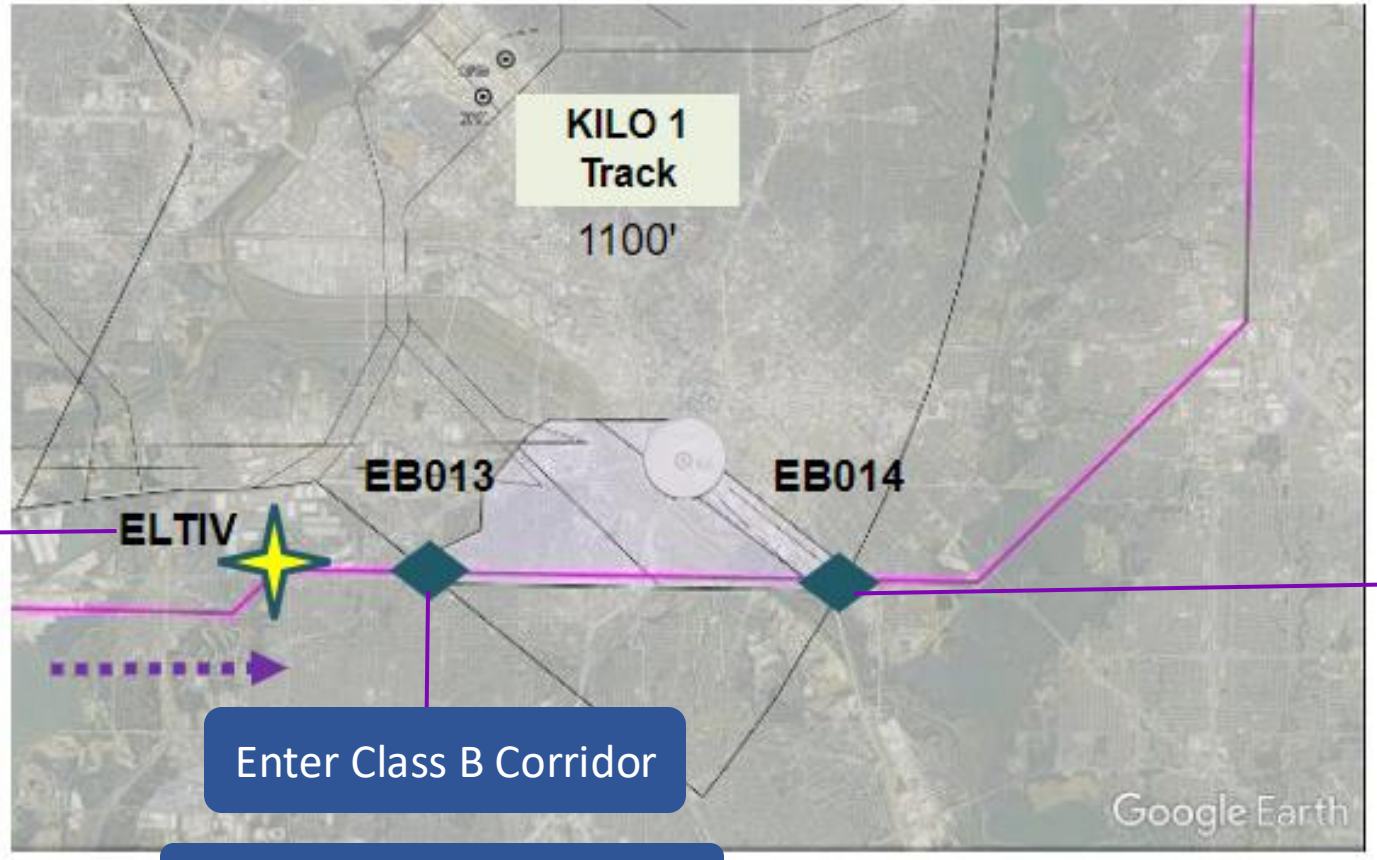


Approach: Example of Traffic Scenario

Mid-term Operations

Coordination Point

Waypoint



Pilot:
- Squawks 1207 beacon code
- Monitors Love Tower Frequency

Enter Class B Corridor

Exit Class B Corridor

ATC observes *data block

Approach: Data Collection and Metrics

Data Collection:

- Post-run
- Post-block
- Post-sim

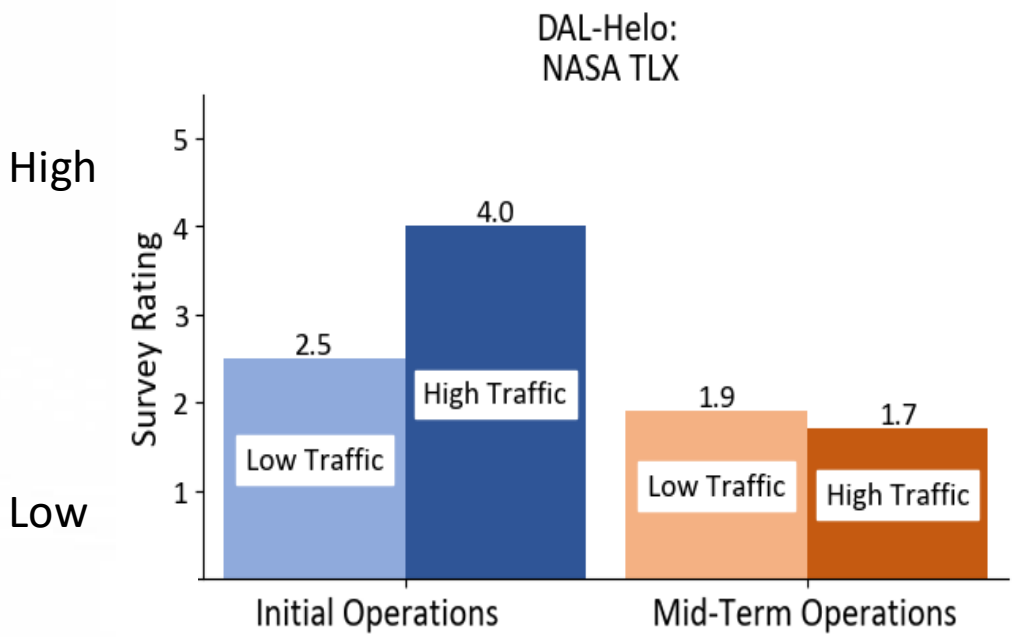
Metrics:

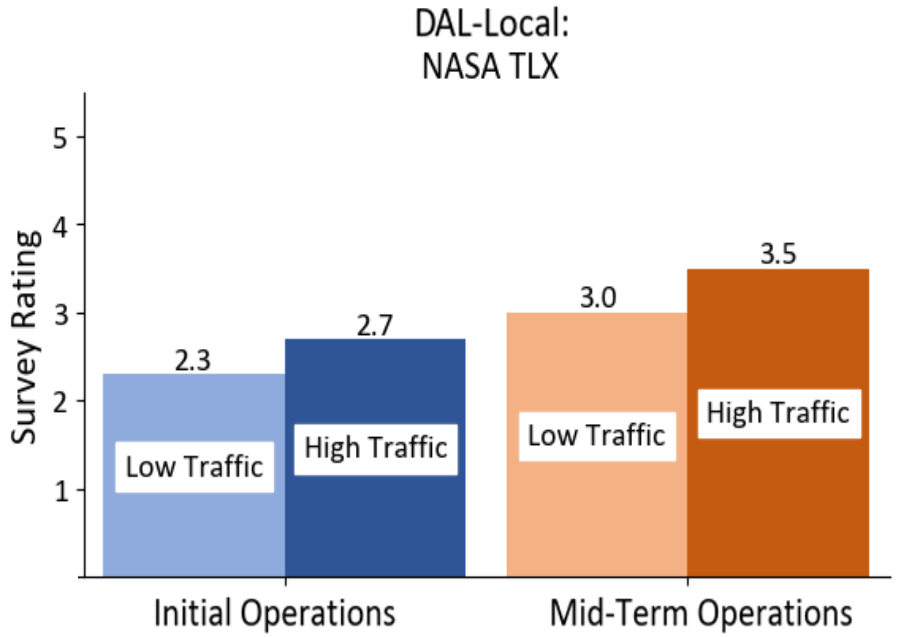
- NASA-Task Load Index (NASA-TLX)
- Surveys
- Ratings: 1 (low) - 5 (high)

Due to the small sample size in the data set, no statistical significance tests were conducted

RESULTS

DAL: NASA TLX Results

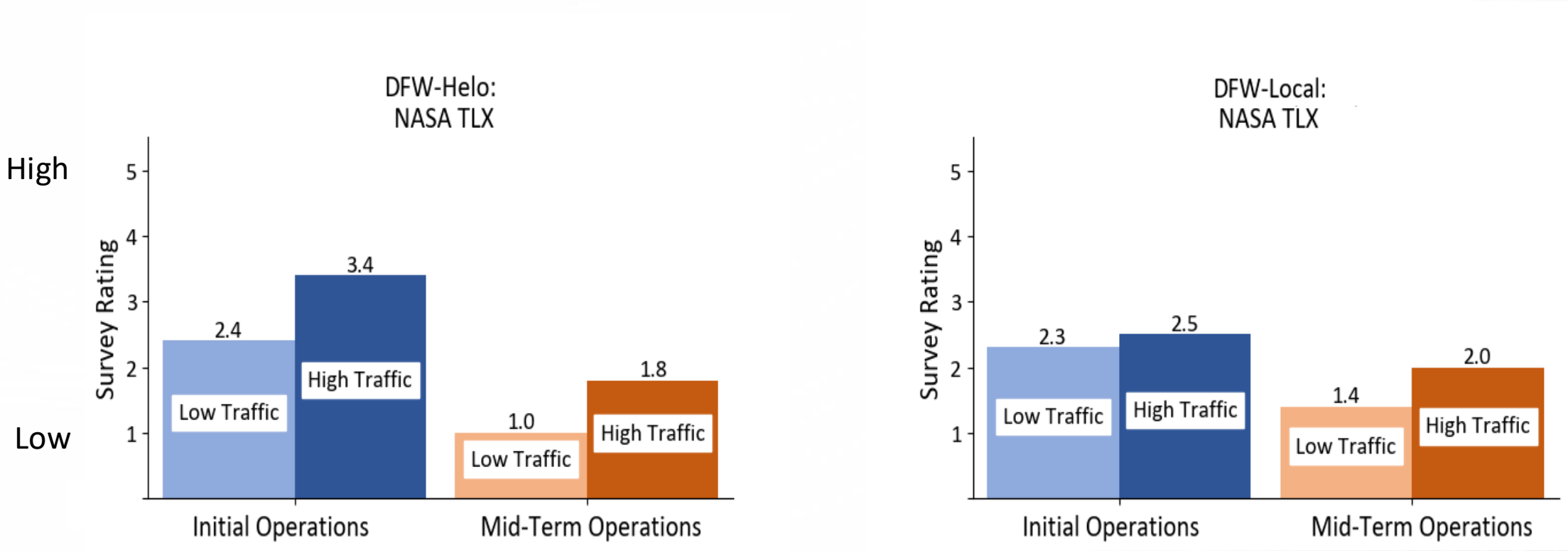




N = 2

- DAL-Helo reported lower workload during Mid-term operations
- Workload increased with increasing traffic level and complexity for DAL Local as they controlled runway crossings

DFW: NASA TLX Results



N = 2

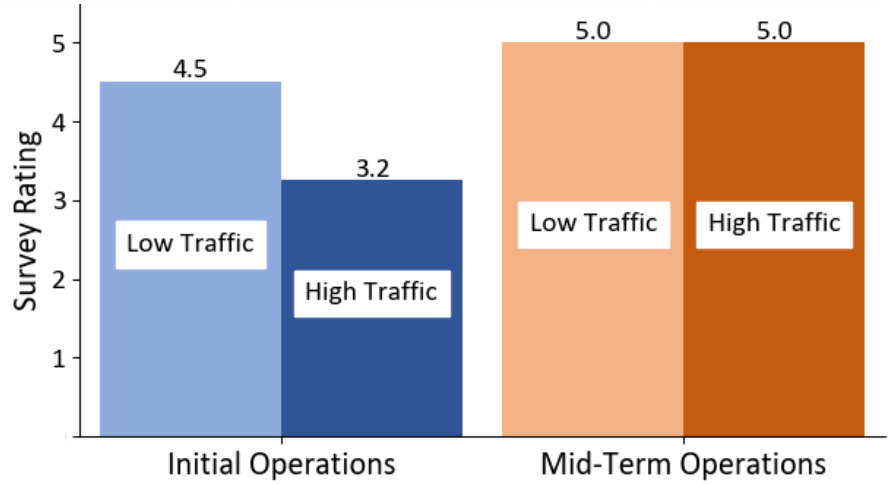
- Across conditions and positions workload is below 3.5 (on a scale of 1 to 5)
- Levels of communications were reduced during Mid-term operations

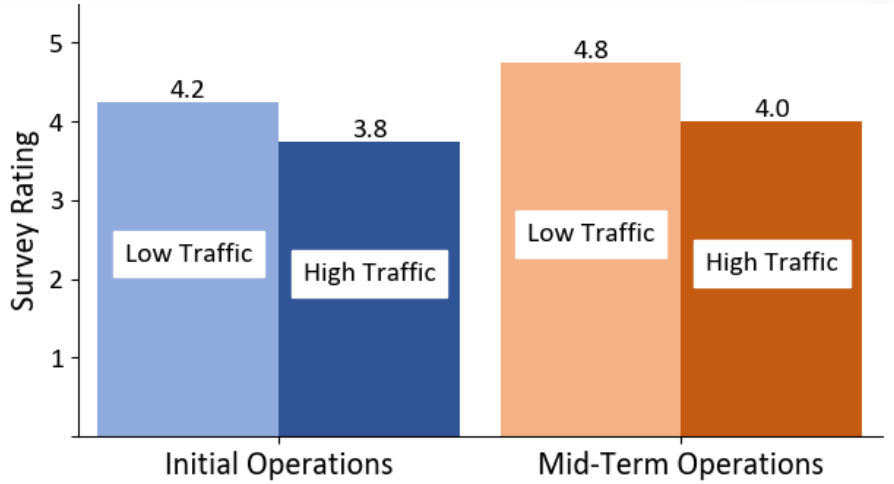
DAL Survey Results

The procedures supported my ability to provide and efficient service to all traffic

Strongly Agree

Strongly disagree





N = 2

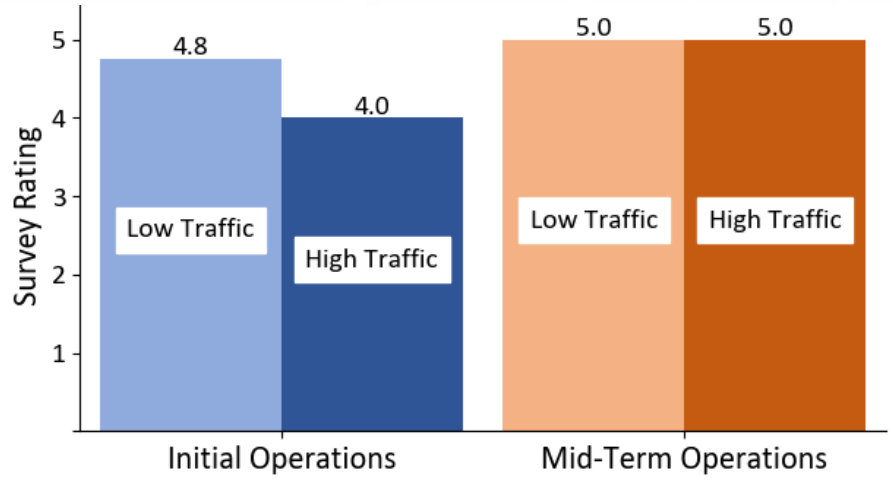
- High acceptability of procedures across all conditions and positions
- DAL-Helo – trend of better acceptability of procedures during Mid-term operations
- DAL-Local – trend of better acceptability of procedures for all conditions

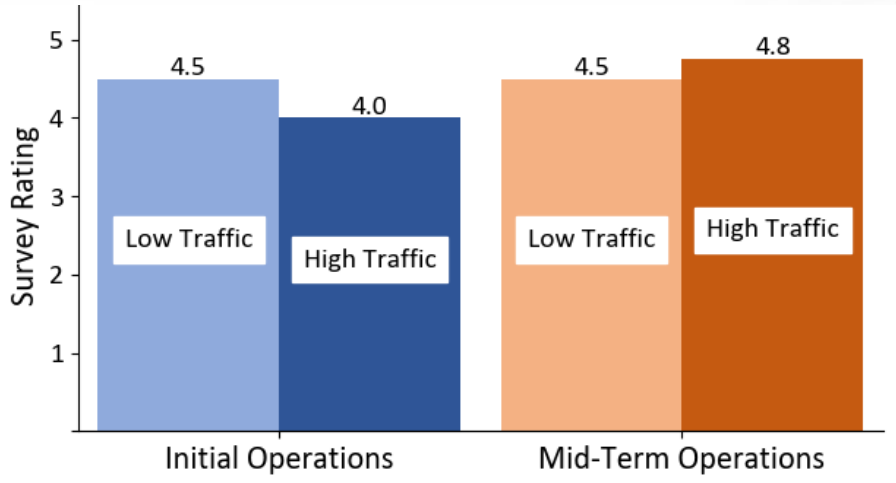
DFW Survey Results

The procedures supported my ability to provide and efficient service to all traffic

Strongly Agree

Strongly disagree





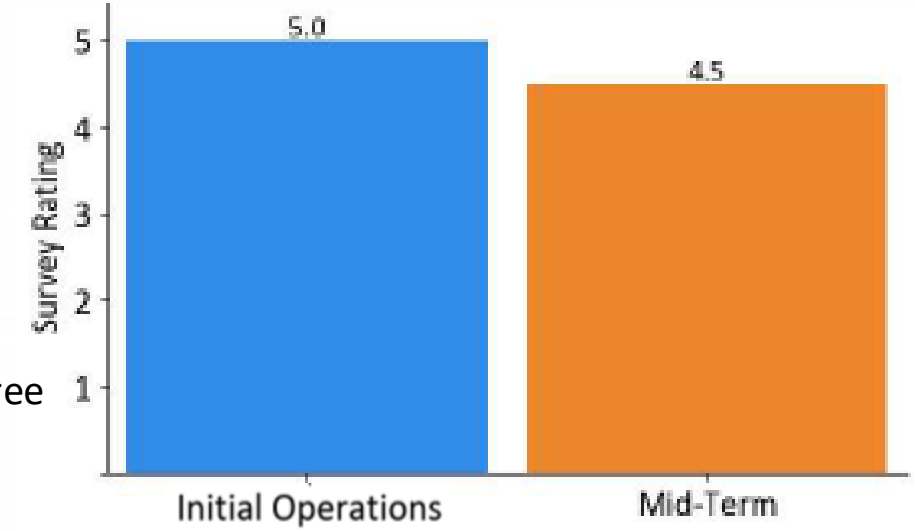
N = 2

- Acceptability of procedures for DFW - high
- Controllers comment: "*Without the procedures, UAM corridor structure and the LOA, the scenario would not even be possible*."

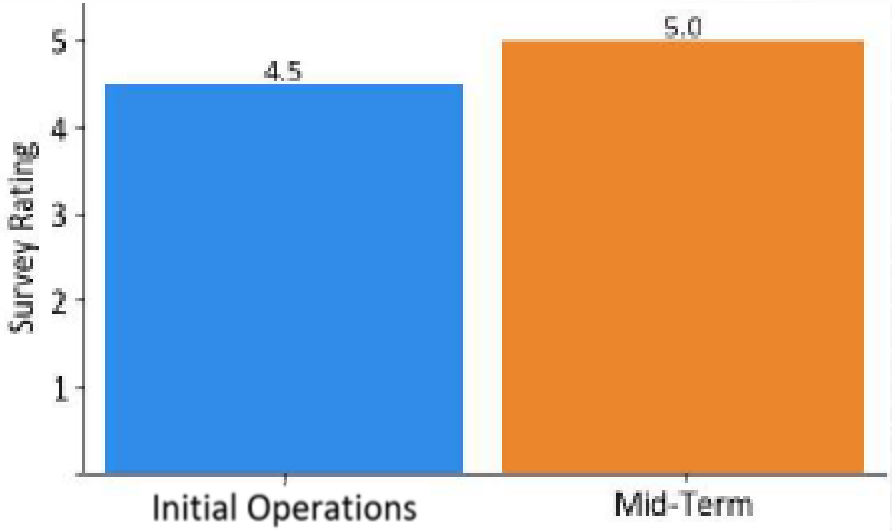
Survey Results

The information on the radar display was sufficient for me to manage traffic

DAL



DFW



- Radar display information – considered sufficient to manage traffic
- Average ratings greater than 4.5 were obtained

DISCUSSION

Discussion

Workload

- Workload was perceived manageable across conditions and traffic levels

- Trend: Slightly higher overall workload:
  - DAL Controllers
  - During Initial Operations

Discussion

Information Requirements

- Procedures, routes and letter of agreements made operations feasible
- New airspace structures (corridors) helped controllers in reducing their workload
- Information on radar display was found to be sufficient to manage traffic
- Traffic symbols were found to be acceptable

  Further suggestions:

  – Decluttering radar display

  – Using different colors for position data tags

Future Work

- Explore procedures and information requirements for *off-nominal* UAM operations

- Explore third party service functionality and messaging among third party services to ATC, fleet operator, and pilot

Acknowledgement

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Questions?

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