2020 UDOT RESEARCH PROBLEM STATEMENT

Problem Statement deadline is March 16, 2020. Submit statements to UTRAC@utah.gov

All submitted problem statements become the property of UDOT and authors are not guaranteed a contract for related work.

Title: Strategic Deployment of Drone Centers and Fleet Size Planning for Drone Delivery in Utah **No. (Office Use): 20.06.01**

Written By: David Sacharny and Cathy Liu **Organization:** University of Utah **Email:** sacharny@cs.utah.edu **Phone:** (310)936-4716

Submitted By UDOT Employee: Paul Wheeler **Email:** pwheeler@utah.gov **Phone:** 801-633-9998

UDOT Champion (if different): **Email:** **Phone:**

Select ONE Subject Group Materials/Pavements | Maintenance | Traffic Mgmt/Safety | Structures/Geotech | Planning | **Aeronautics** | Public Transportation | Other

1. Write a brief research project objective:

The motivation for this work is to provide regulators, policymakers and industry stakeholders with a data-driven framework for assessing the energy costs and trade-offs of large-scale drone delivery in the state of Utah. The objective is to produce a computer program that takes inputs of state-wide road network, the total number of (drone-deliverable) packages to deliver on a given day and their destinations, and energy and cost assumptions per vehicle, and produces a state-wide airspace network, delivery schedule, and truck/drone fleet mix. Such airspace network is optimized to ensure that drones are strategically deconflicted as required by NASA and the total energy over that day is minimized. This program will provide the state with more clarity about the energy impacts of large-scale drone delivery, as well as a viable airspace network.

2. Explain the problem and why this research is important: (*Importance reflects 50% of the statement score*)

In a 2017 report by the RAND corporation, analytical methods for calculating the total energy consumed by a mix of delivery trucks and drones were developed and shown to be highly dependent on the layout of distribution centers as well as distance traveled by delivery vehicles. This suggests that the city layout, i.e., street connectivity and other network parameters, are important considerations for energy-conscious policies. While industry stakeholders must determine the market viability of drone delivery, they are not required to calculate the external and indirect costs that may be associated with this burgeoning industry. Furthermore, the unstructured airspace proposed by some stakeholders can have an undesirable monopolistic effect caused by the computational aspects of this approach. The research proposed here will produce a state-wide drone network, and hence a structured airspace, that can potentially increase the accessibility of the airspace while ensuring a higher degree of safety.

3. Describe how the research results will be implemented and benefit Utah: (*Implementation reflects 50% of the statement score*)

The research results will be implemented as both a final report and a computer program that demonstrates the animation of the optimized airspace network. The report will help inform the UDOT Division of Aeronautics to develop policies and negotiate with industry stakeholders. The computer program will enable UDOT professionals to assess the results of different assumptions that were present in the report.

4. List the major research tasks:

1. Stakeholder meetings: assemble a group of stakeholders from UDOT, WFRC, and MAG to advise the research. A total of three meetings is envisioned: 1) kick off and introduce the project; 2) present initial data collection efforts and assumptions of proposed optimization model; and 3) present findings from modeling and analysis of the structured airspace.
2. Data collection: assemble data from multiple agencies to be used for airspace optimization. The data include but are not limited to: road network structure, commercial truck trips (origin and destination), packages demand, and energy and cost for drones and trucks.
3. Optimization model development: build an optimization model for the state-wide airspace network to produce optimal solutions of delivery schedule and truck/drone fleet mix, considering minimized energy consumption and NASA requirement for drone operation.
4. Computer program development: create a computer program to allow UDOT to assess different assumptions of the model and run "what-if" scenarios by generating animation of the optimized airspace network.

5. List the expected research deliverables (reports, manual, specification, design method, training, video, etc.):

1. A computer program that produces a state-wide airspace network, delivery schedule, and truck/drone fleet mix and generates

animation of the optimized airspace network

2. Final report documenting all results and findings of the project

6. Requested from UDOT: $50,000 **Other/Matching Funds:** $30,000 **Total Cost:** $80,000

Briefly explain funding sources: MPC

7. Outline the proposed schedule, including start and major event dates:

The schedule assumes a June 2020 start date and a 9-month research plan, with final report delivery in March 2021.

Task 1: Review analytical methods used for airspace network and drone delivery modeling – one month (July 2020).
Task 2: Stakeholder outreach – 3 meetings over 8 months:
i) Project introduction and initial findings (July 2020);
ii) Presentation of initial data collection efforts and model discussion (November 2020);
iii) Presentation of findings (February 2021).
Task 3: Data collection and integration – 2 months (July-September 2020)
Task 4: Optimization model development – 1 month (October 2020)
Task 5: Computer program development – 4 months (October 2020 - January 2021)
Task 6: Final Report – 2 months (February - March 2021)