IMPERIAL COLLEGE LONDON

DEPARTMENT OF COMPUTING

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# Drone Delivery Network Simulation on SpatialOS
## *Interim Report*

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To. Be DECIDED

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# 1  Introduction

Drone technology is becoming increasingly popular. Their agility and ability to be used remotely makes them ideal for a number of use cases in numerous industries such as film, law enforcement, emergency services, agriculture and commercial delivery.

Due to numerous advances in technology, drones are quickly advancing to the point where human input is no longer a necessity. This has led to many companies showing interest in integrating drones with their work in the coming years.

Although it may be an engineer's dream for a fully automated world, drones in particular are a harrowing reminder that there are real risks associated with them. There are already several incidents of drones crashing into planes and flying into areas they shouldn't, most notably near Heathrow airport[1]. All of this provides motivation to introduce some form of autonomous air traffic control system to navigate these drones to their respective destinations in a safe manner.

However, prior work has been done on the routing and navigation aspect of such a system. In order for drones to truly take over more aspects of our lives, we must look at how they can provide a tangible cost-benefit to specific use-cases. There is no doubt that simply removing the human element can save costs drastically, and there is none more exciting a scenario than with deliveries. For example, Amazon stands to increase their margins considerably if they can successfully pull off their Prime Air initiative[2].

## 1.1  Autonomous Systems

## 1.2  Making Money

# 2 Background

We first provide an insight into drones, and the considerations to account for when applying them in day to day life. Additionally we summarise previous work done by Imperial students on autonomous air traffic control.

We then continue to discuss modern delivery networks and introduce a mechanism by which economic value is prioritised. Finally, we give details about Improbable's SpatialOS and the reasoning for using this platform for the drone simulation.

## 2.1 Drones

As we have introduced, drones stand to be a revolutionary part of our lives as we welcome the new, incoming era of automation. However, to be practical there are a few key concepts one must understand to ensure that they remain a help and not a harm or hinderence to mankind.

### 2.1.1 No Fly Zones

No Fly Zones (which we will abbreviate as NFZs) are geographical areas where a drone is not allowed to enter or fly at any altitude. Examples of these may include Hyde Park, Buckingham Palace, airports and military locations. Typically these are static obstacles that will always remain a NFZ, however we could also consider cases when they could be created dynamically.

**2.1.2   Toll Zones**

**2.1.3   Manned Aviation**

**2.1.4   Other Drones**

## 2.2   Autonomous Air Traffic Control (AATC)

**2.2.1   What is AATC?**

**2.2.2   Global Layer**

**2.2.3   Reactive Layer**

**2.2.4   Where to take it next?**

## 2.3   Delivery Networks

**2.3.1   Planes**

**2.3.2   Trucks**

**2.3.3   Drones**

## 2.4   Prioritising Economic Value

**2.4.1   Quality of Service**

**2.4.2   Value Curve**

**2.4.3   skdbsa**

## 2.5   SpatialOS

**2.5.1   Unity SDK**

**2.5.2   Layered Simulation**

**2.5.3   Distributed Simulation**

Example text 1

Example text 2

Example text 3

# 3  Project Plan

## 3.1  Phase 1: Porting Global and Reactive Layers to SpatialOS

## 3.2  Phase 2: Implementing a Scheduling Layer

## 3.3  Phase 3: Visualising the Economic Value

## 3.4  Stretch Goals

# 4   Evaluation Plan

# References

[1] BBC News. Passenger jet approaching Heathrow in drone 'near-miss', 2017.

[2] A. Welch. A cost-benefit analysis of Amazon Prime Air A Cost-Benefit Analysis of Amazon Prime Air. page 57, 2015.