

The Drone Identity — Investigating Forensic-Readiness Requirements of UAVs

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The Drone Identity

<https://droneidentity.eu>



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More than 760 flights cancelled during 19-21 Dec 2018 at Gatwick Airport, affecting 150,000 passengers and having cost at least £50m, because of an **unidentified** drone.

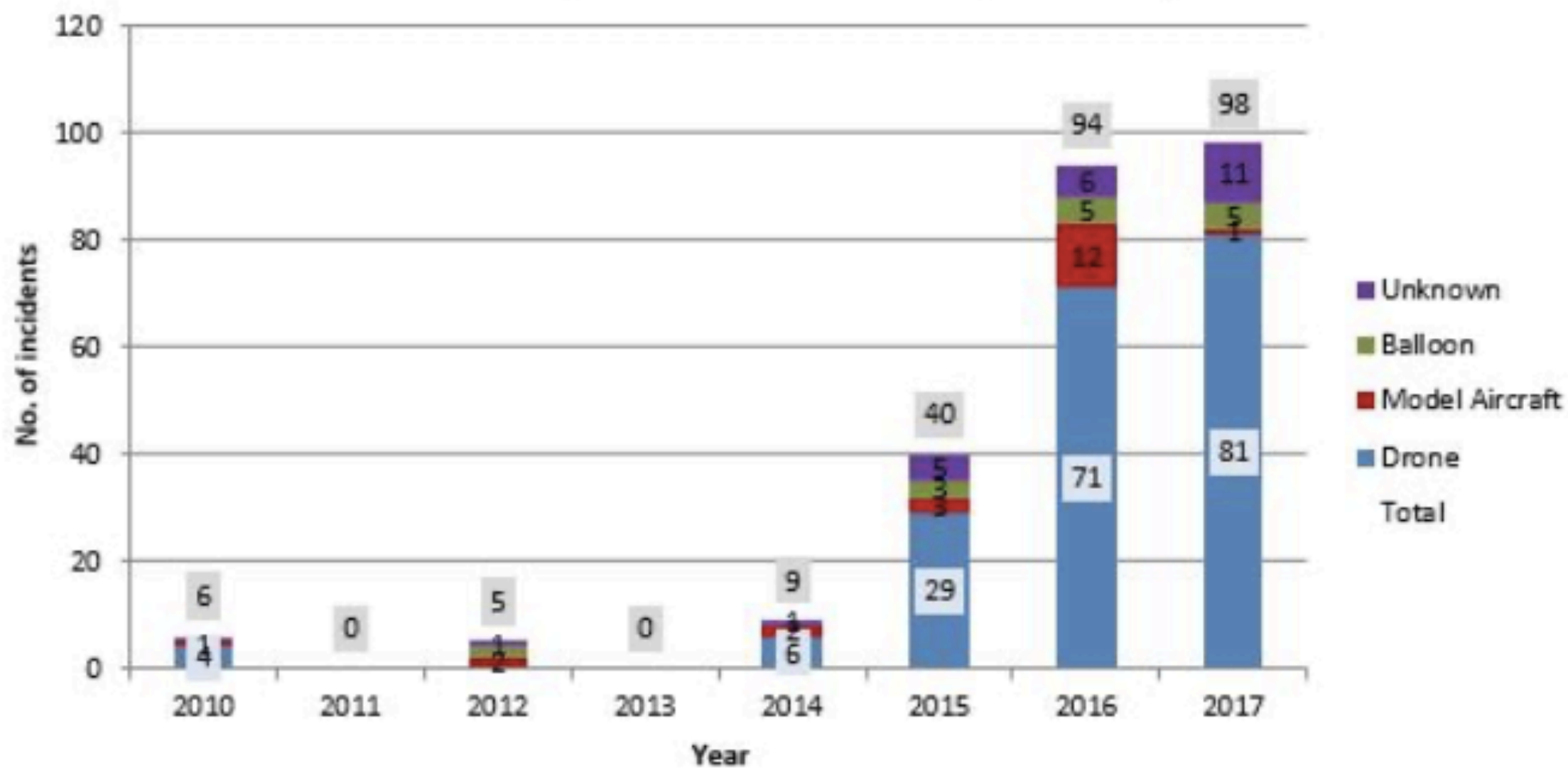
It is urgent to investigate such drone-related incidents for the future of travel.

SE Challenges

- Design “forensic-ready” infrastructure for incident investigations, at the national and European scale
- Analyse the artefacts and flight logs to identify the root causes
- Self-regulate the flight data recorders against dynamic safety and privacy constraints

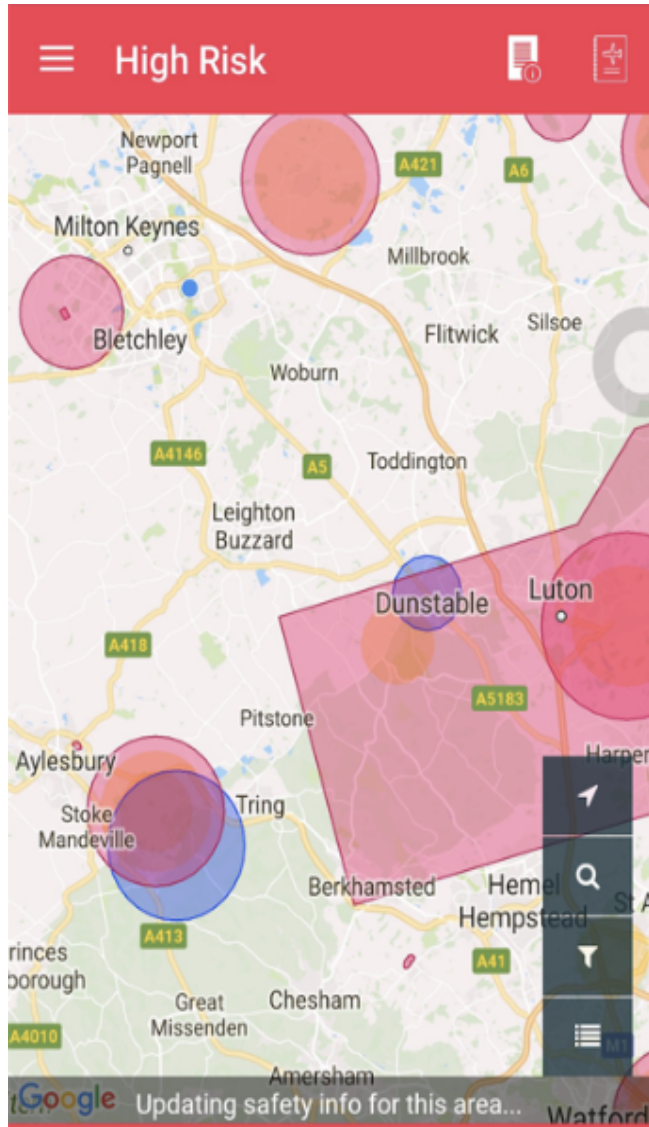


Airprox reports involving drones and other objects to September 2017

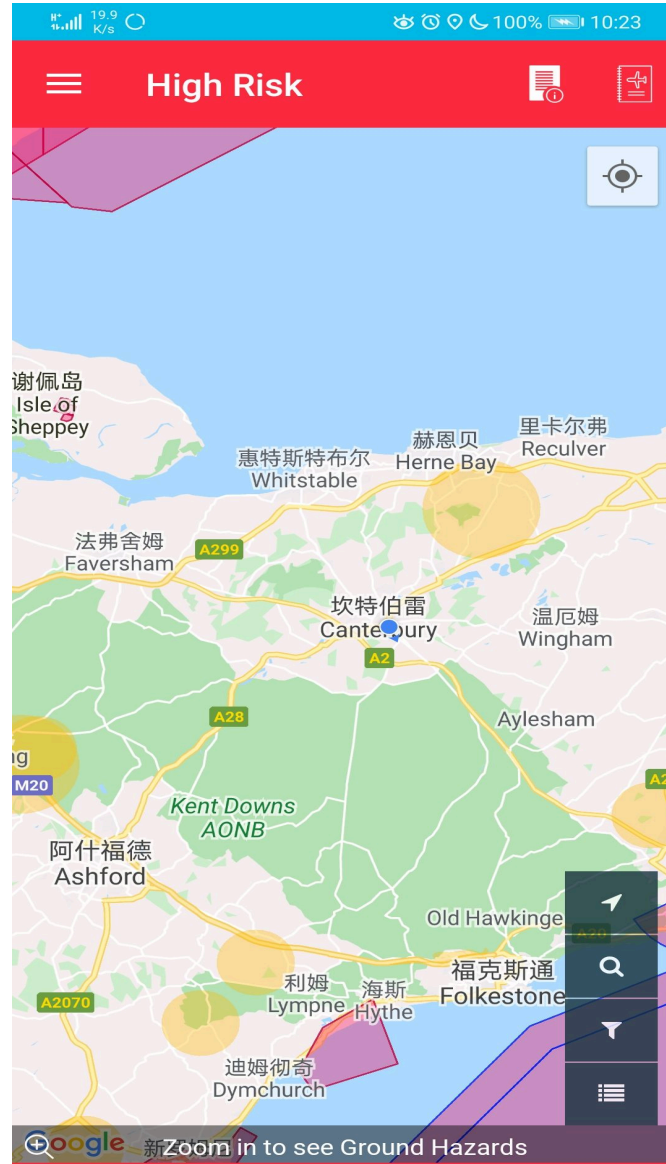


NATS/CAA Specify No-fly Zones:

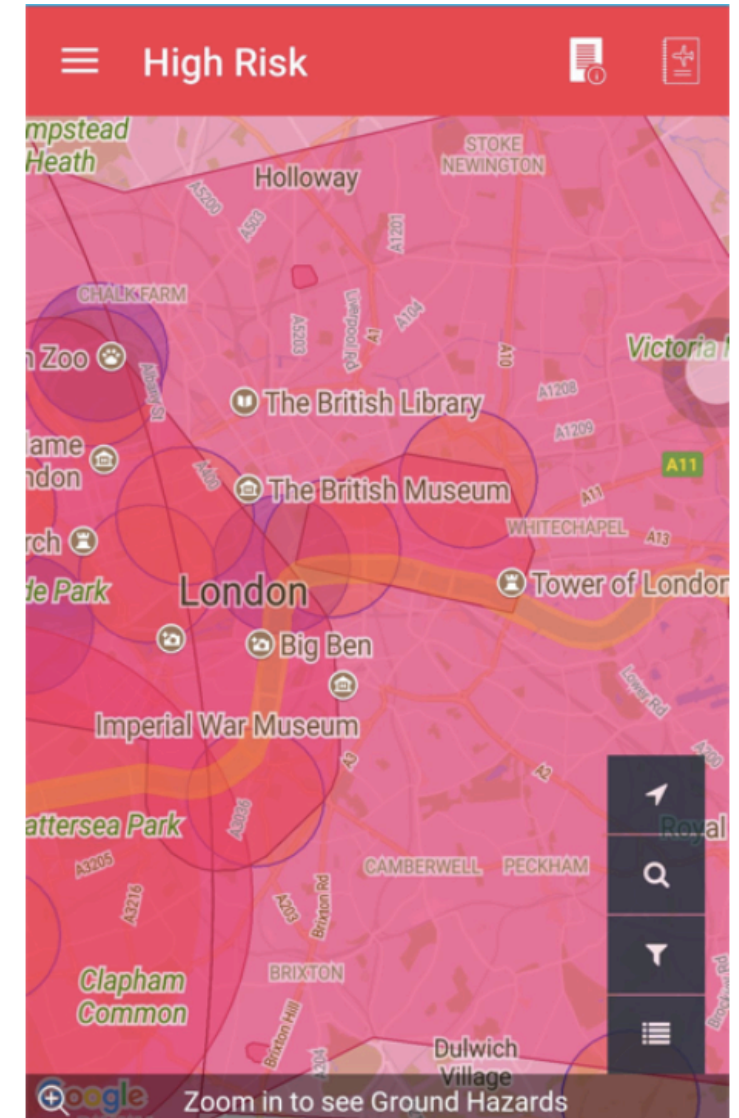
Milton Keynes



Canterbury



London



with TfL, we analysed UAVs use cases



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Flying High

This project started in December 2017 and is ongoing



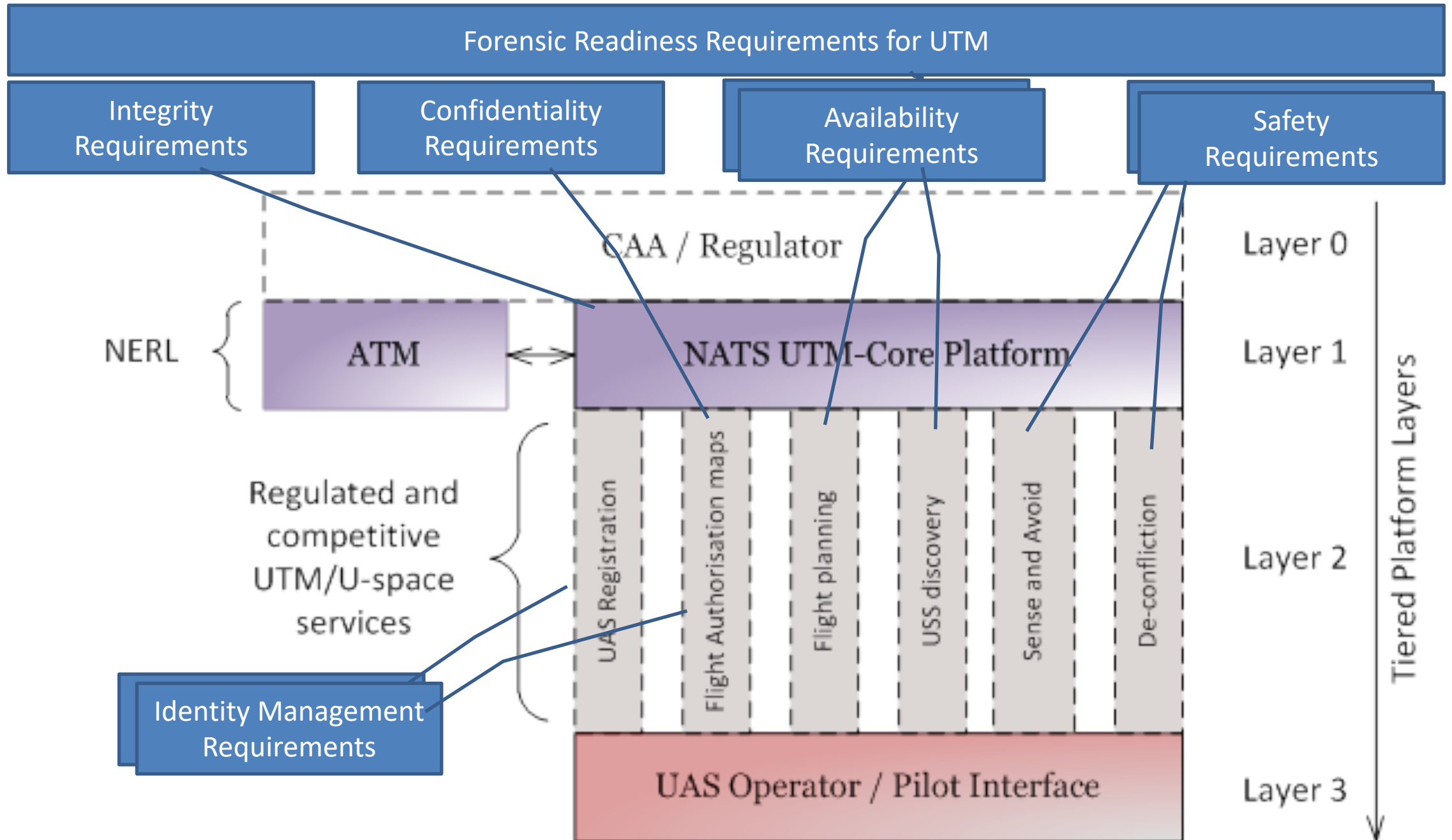
Shaping the future of drones in UK cities.

Use Cases



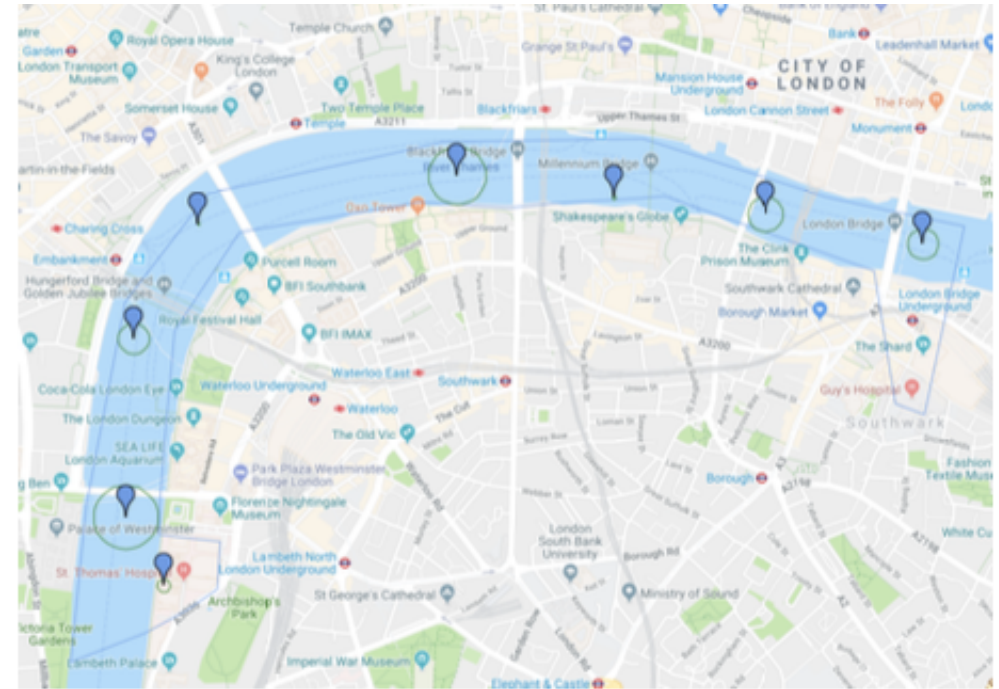
Drone Delivery (Amazon, Google Wings, etc.)





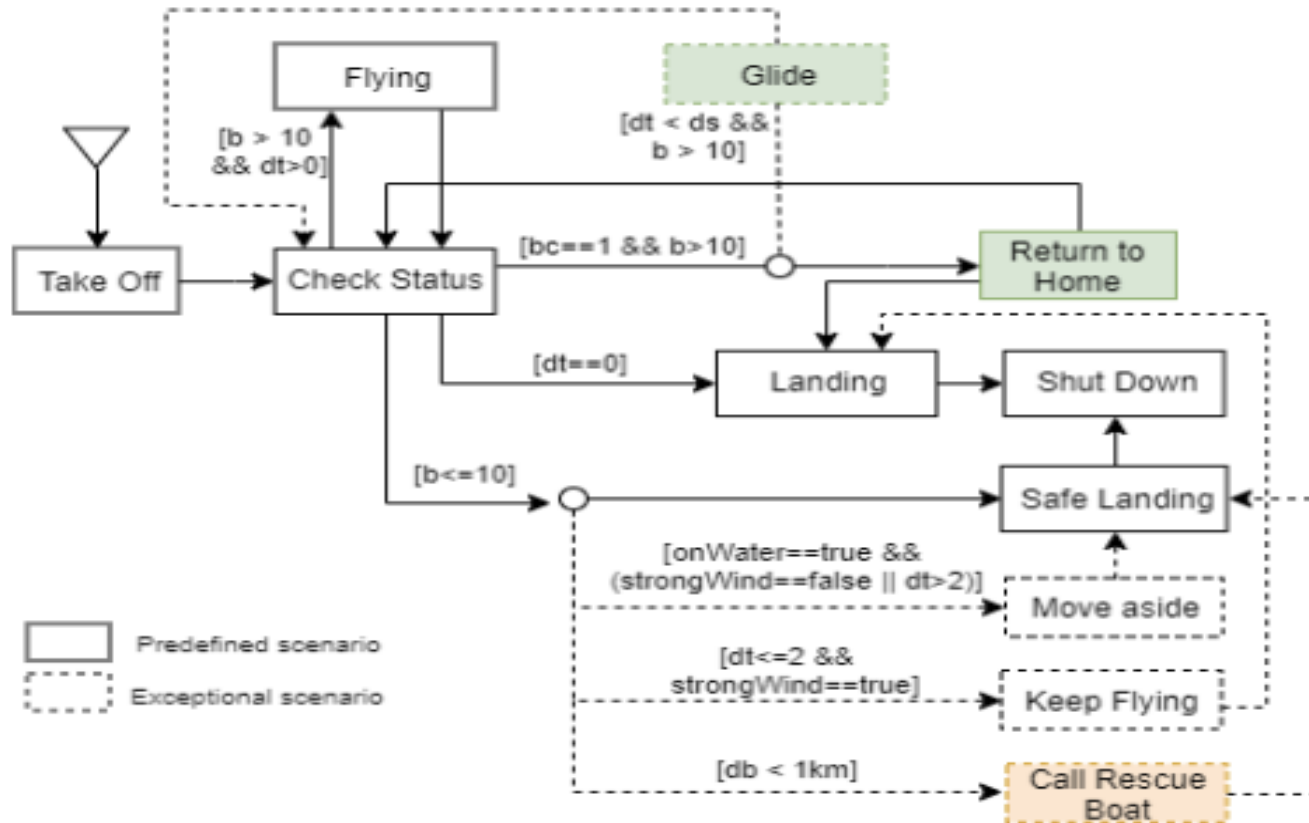
It is now 10:00am in busy London. The kidney transplant department in St Thomas' Hospital (Hospital A) has been informed that a matching kidney of a patient in Guy's Hospital (Hospital B) is now available for its patient waiting for surgery. The organ transplant department of both hospitals contact the SOSDronePayload company and make all the necessary arrangements for the organ to be transferred by drone from Hospital B to Hospital A. Drone_DR1235 is selected by SOSDronePayload to deliver the organ through its flying corridor, over the River Thames, to avoid land traffic. At a certain point during the journey the battery of Drone_DR1235 reduces dramatically and when it reaches 10%, Drone_DR1235 attempts to land before reaching its final destination (Hospital A). However, at this point, Drone_DR1235 was only 2 km away from Hospital A and, given the favourable wind conditions at the time, Drone_DR1235 could have reached Hospital A with its 10% battery capacity and delivered the critical organ.

**Use Case: Deliver Organ/blood between two hospitals
In a Flight Corridor over the Thames River.**



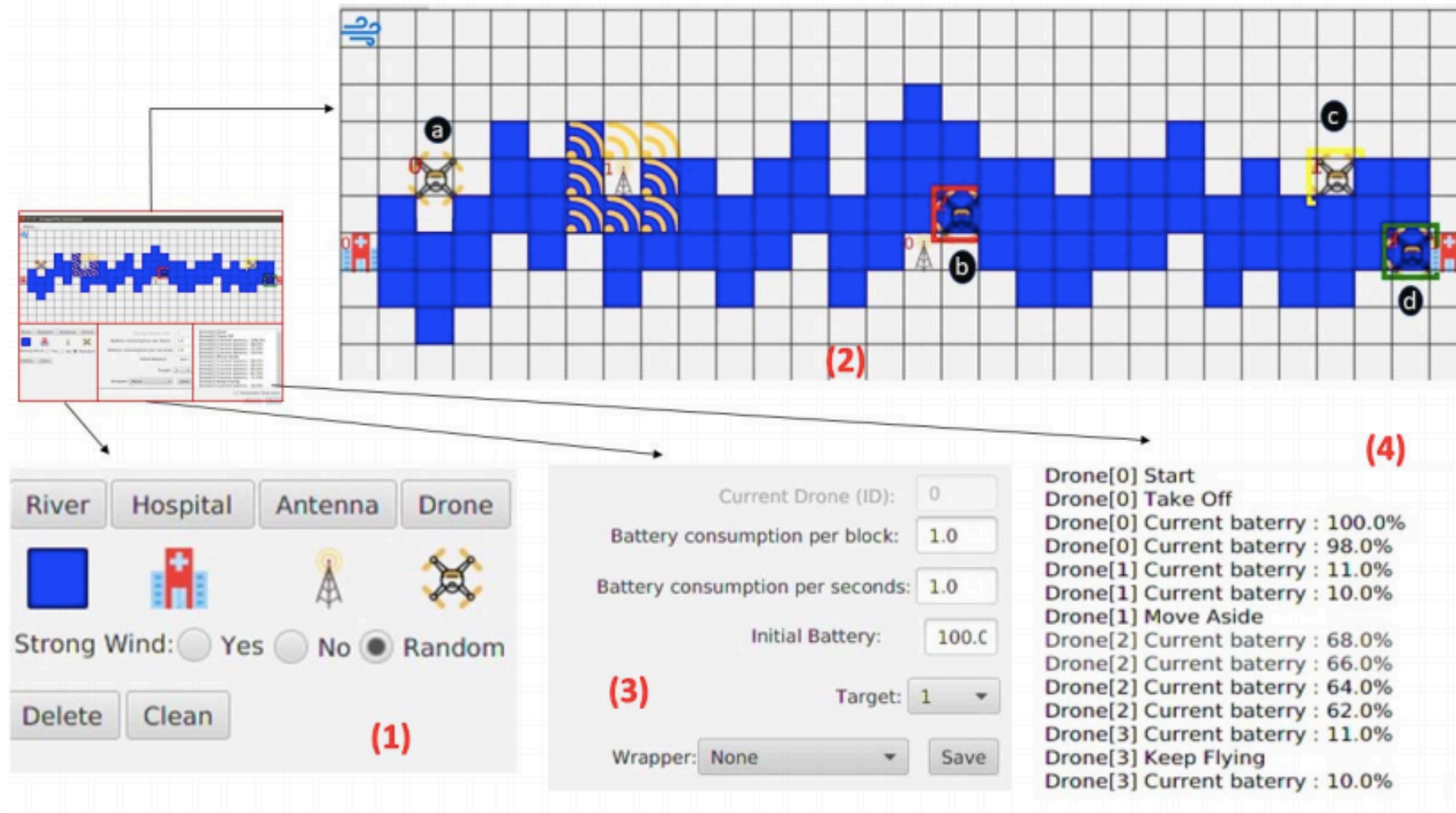
Challenge 1. Design System of Systems for Exceptional Scenarios

RQ: Can drones be repurposed when flying over water?



Cautious adaptation: all payloads can be safe when battery level is low.

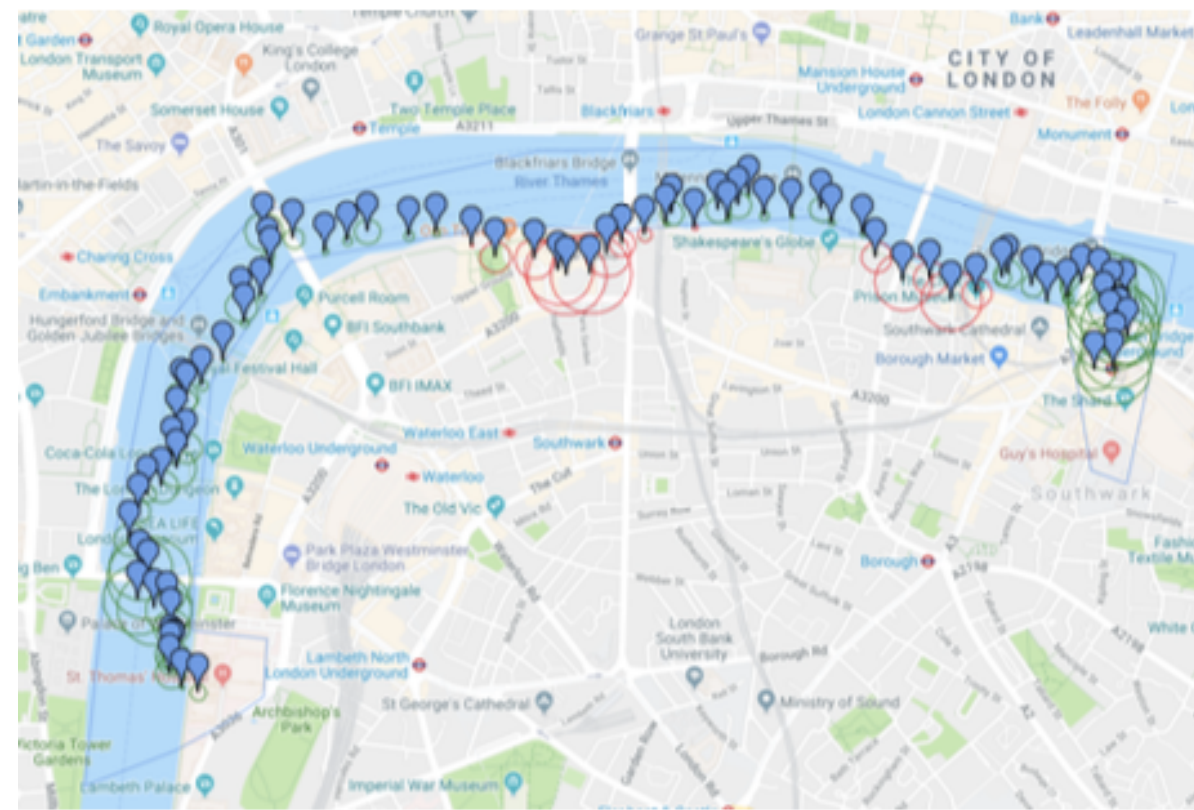
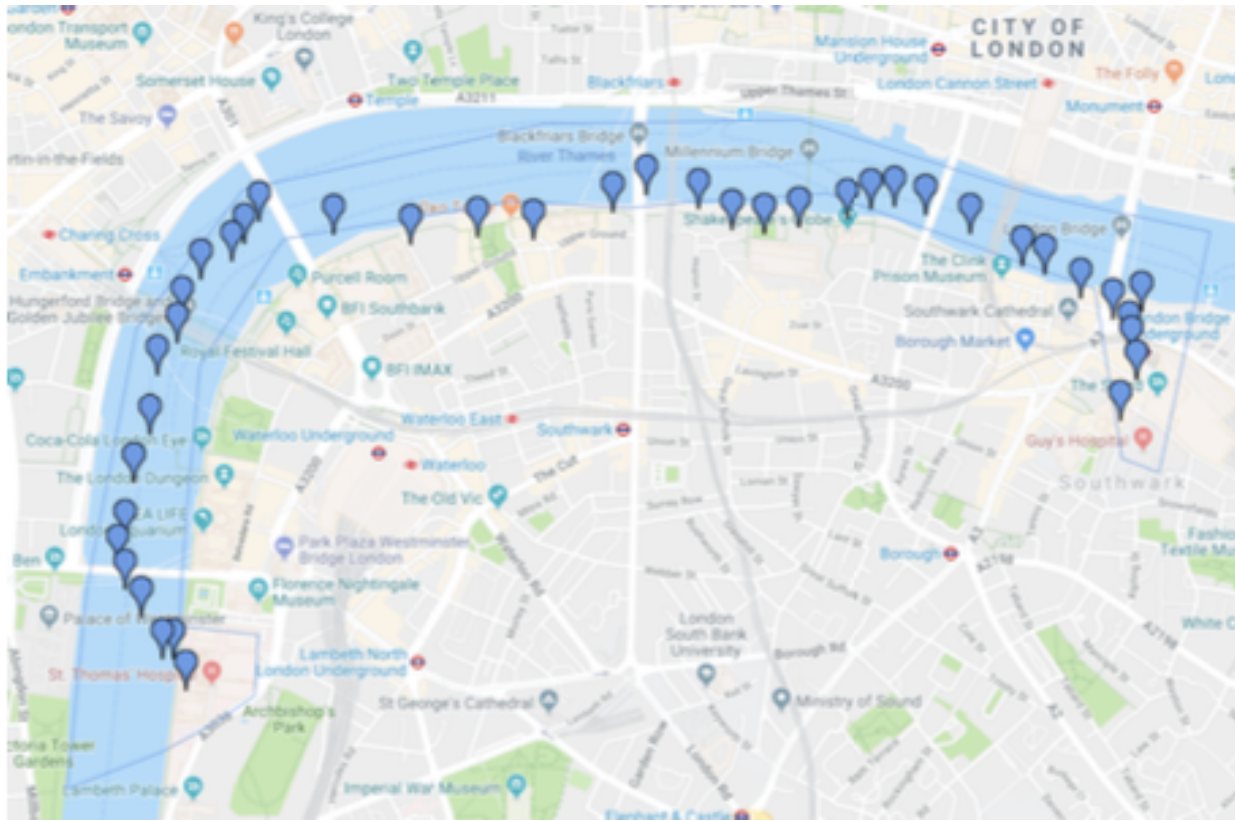
Maia, Paulo; Vieira, Lucas; Chagas, Matheus; Yu, Yijun; Zisman, Andrea and Nuseibeh, Bashar. [Cautious Adaptation of Defiant Components](#). In: The 34th IEEE/ACM International Conference on Automated Software Engineering (ASE 2019) (Lawall, Julia and Marinov, Darko eds.), 11-15 Nov 2019, San Diego, California, USA.

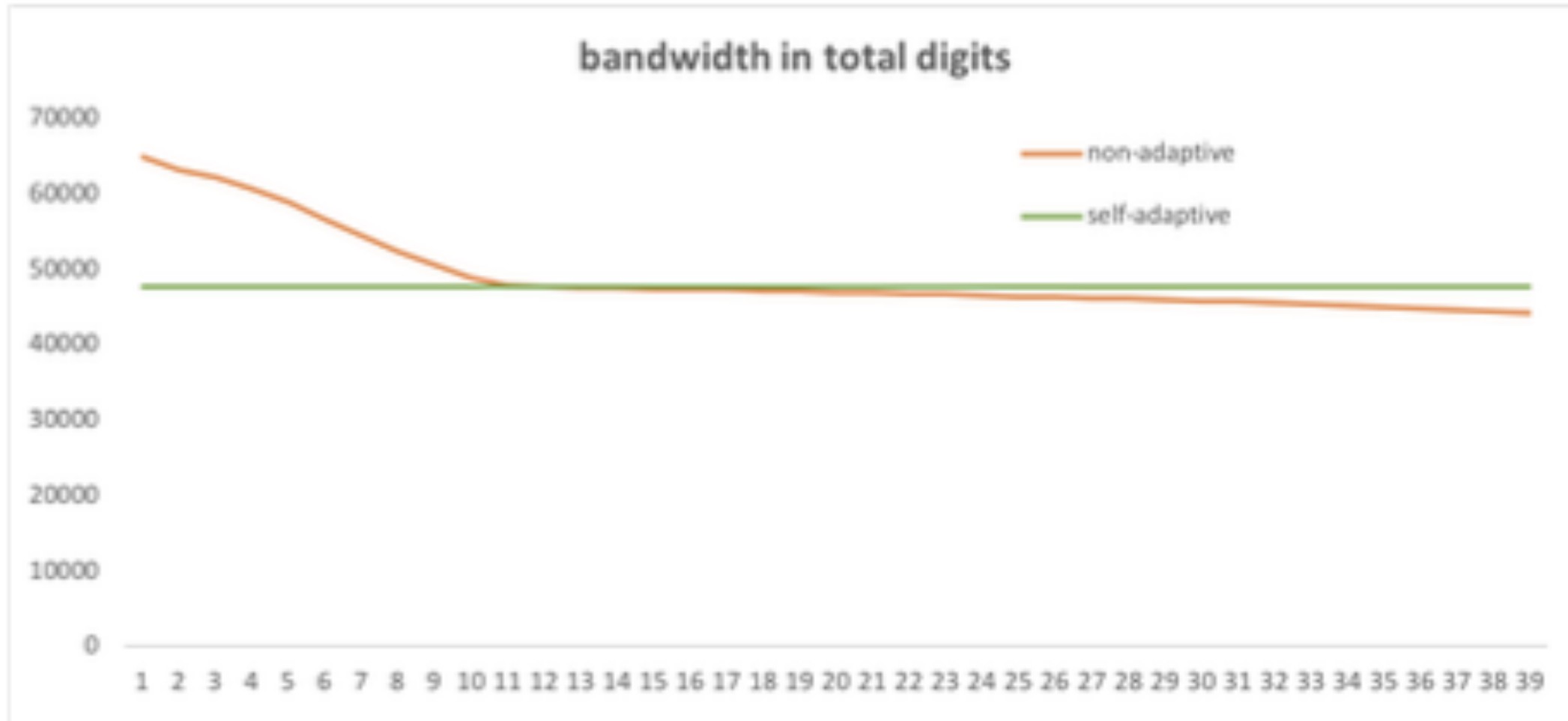


Maia, Paulo; Vieira, Lucas; Chagas, Matheus; Yu, Yijun; Zisman, Andrea and Nuseibeh, Bashar (2019). [Dragonfly: a Tool for Simulating Self-Adaptive Drone Behaviours](#). In: SEAMS '19 Proceedings of the 14th International Symposium on Software Engineering for Adaptive and Self-Managing Systems, IEEE pp. 107–113.

Challenge 2. Verification of Evidence in Cyber Physical Space

RQ: How frequent reporting evidence is sufficiently accurate?



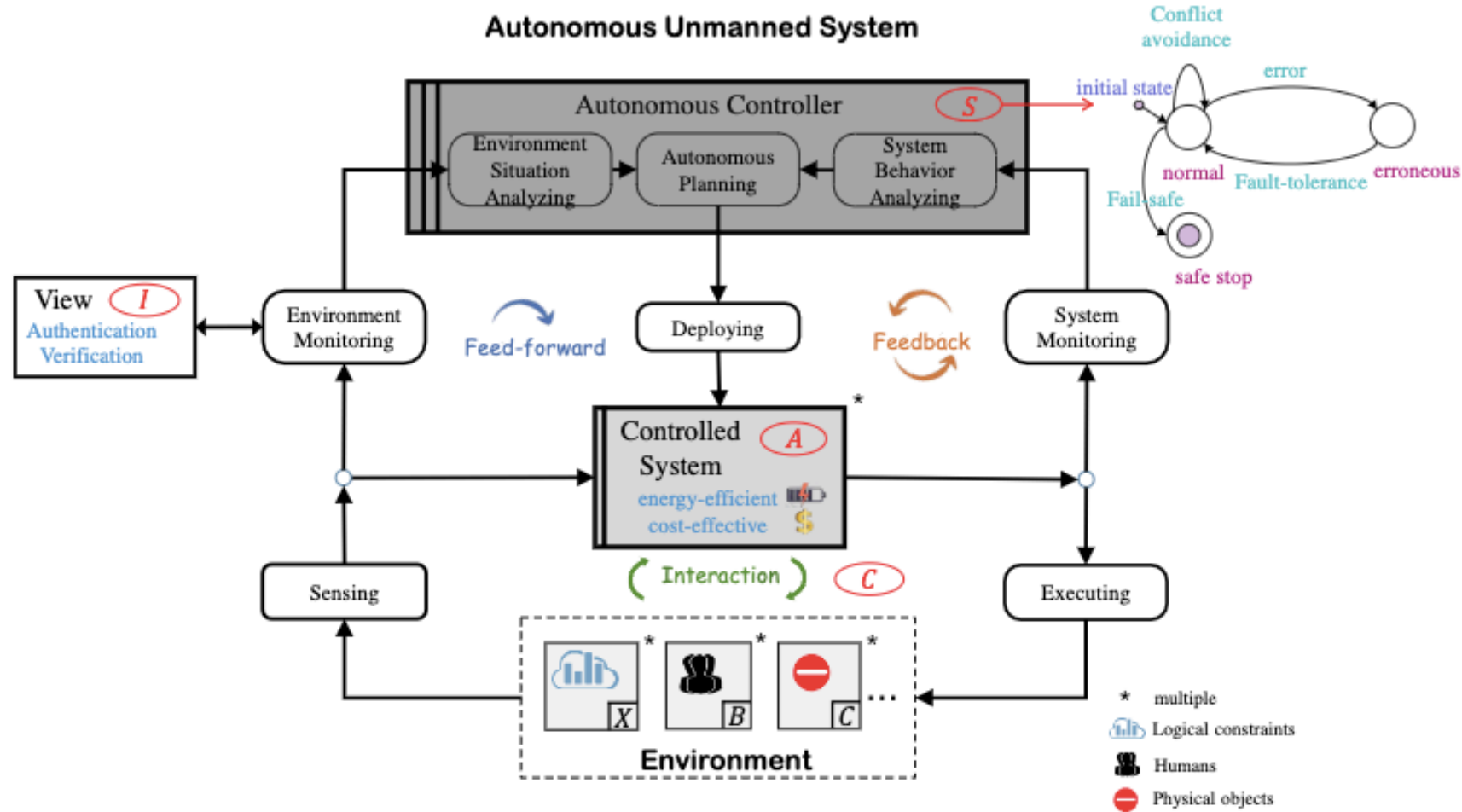


self-adaptive: 46% reduction of reporting

Y. Yu, D. Barthaud, B. A. Price, A. K. Bandara, A. Zisman and B. Nuseibeh, "[LiveBox: A Self-Adaptive Forensic-Ready Service for Drones](#)," in IEEE Access. doi:10.1109/ACCESS.2019.2942033


Challenge 3. Requirements of AUS

RQ: How to make tradeoffs amongst Safety, Security, Privacy, and Forensic goals?



Luo, Yixing; Yu, Yijun; Jin, Zhi and Zhao, Haiyan (2019). [Environment-Centric Safety Requirements for Autonomous Unmanned Systems](#). In: 27th IEEE International Requirements Engineering Conference (RE'19), 23-27 Sep 2019, Jeju, Korea, IEEE.

Example 1: Integrity is key to forensic-readiness. However, it may cause scalability or efficiency problems in real world uses.



RINKEBY (CLIQUE) TESTNET

Search by Address / Txhash / Block / Token / Ens

GO

HOME

BLOCKCHAIN

TOKEN

CHART

MISC

Contract Address

0xF5Af90a987f4B61b0e4FF65b5F030700570b4145

Home / Contract Accounts / Address

Contract Overview

ETH Balance:

0 Ether

No Of Transactions:

3 txns

Misc

Contract Creator

0x92d81ce4d4aa8a... at txn 0x0a0ae2d9a3b1cb...

More Options

Transactions

Code

Events

Latest 3 txns

TxHash	Block	Age	From		To	Value	[TxFee]
0x9998b4a7a96c3d...	2200369	22 secs ago	0x92d81ce4d4aa8a...	IN	0xf5af90a987f4b61b...	0 Ether	0.000267404
0x97a424530d6371...	2200363	1 min ago	0x92d81ce4d4aa8a...	IN	0xf5af90a987f4b61b...	0 Ether	0.000267532
0x7505428e6a3415...	2200350	5 mins ago	0x92d81ce4d4aa8a...	IN	0xf5af90a987f4b61b...	0 Ether	0.000297532
0x0a0ae2d9a3b1cb...	2200257	28 mins ago	0x92d81ce4d4aa8a...	IN	Contract Creation	0 Ether	0.00284144

Example 2. Motion Planning for Privacy Risk aware UAVs in real world flights

Self-Configuration based Motion Planning
for Privacy Risk Aware Flight of UAVs

Experiment Results in 20 grid scale

Safe drone flight

Assuring telemetry data integrity in U-Space scenarios

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NATS

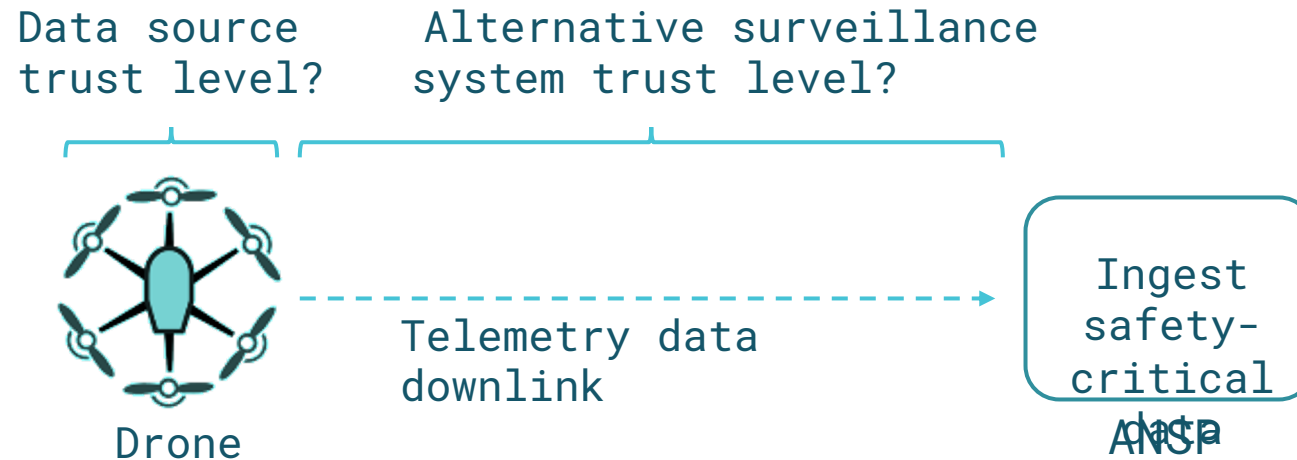
Research Challenge




How can we trust safety-critical data over insecure systems?

Conventionally, telemetry data from aircraft is generated, processed and transmitted using safety-assured, secure flight surveillance systems from the point of creation to ingestion into an ANSP.

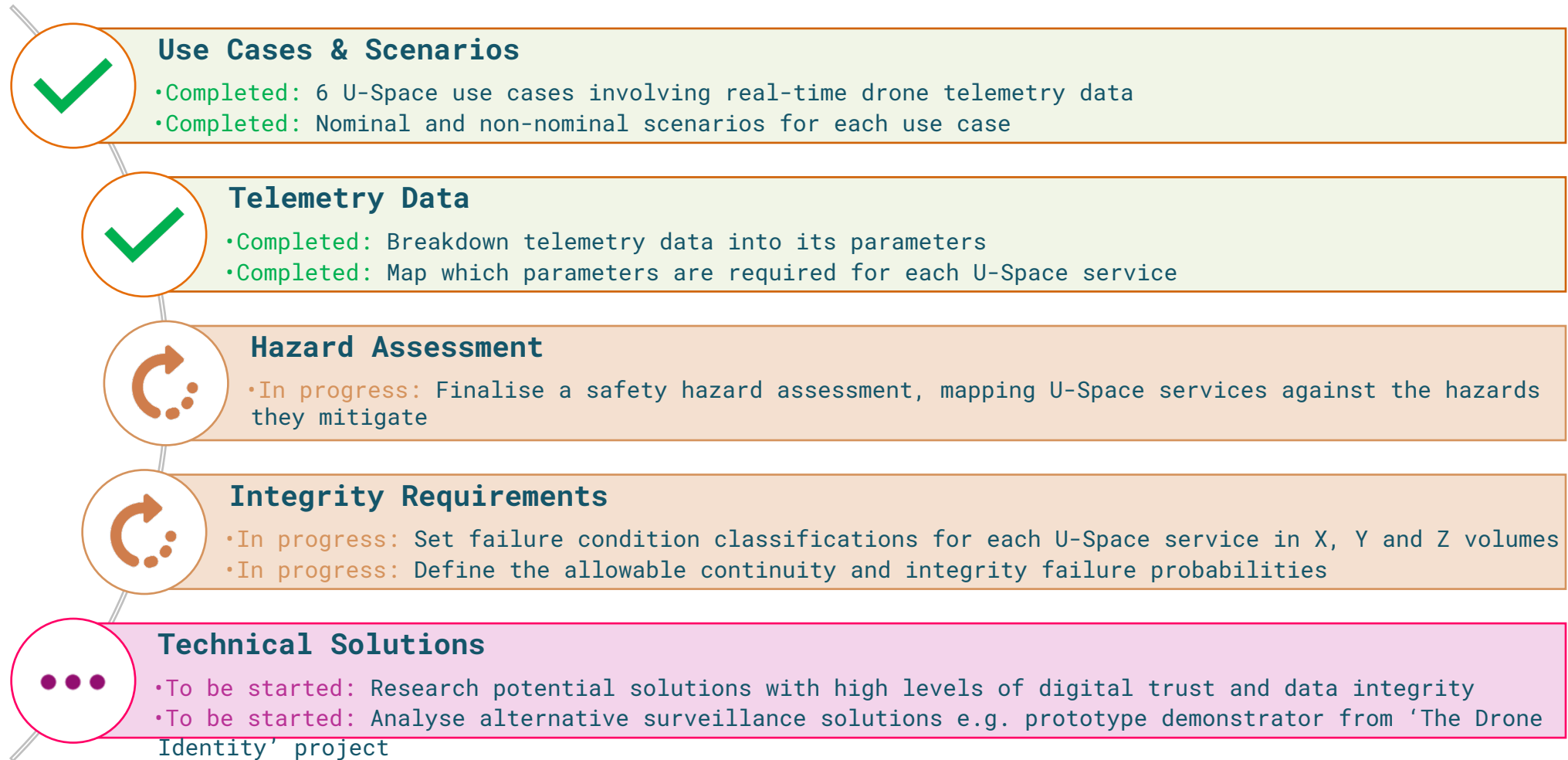
Conventional surveillance systems are unsuitable for drones, so how can we assure that incoming data has a highly level of integrity when sent over insecure systems and from sources with unknown trust levels?



Project Purpose



Enhance security of future CNS/ATM system & support efforts to enable BVLOS drone operations
Ascertain requirements on telemetry data and transmission systems for safe drone flights in U-Space & investigate solutions
For each U-Space volume (X, Y, Z) and phase (U1-U4), determine the integrity requirements on real-time drone telemetry data and transmission systems to enable provision of safety-related and safety-critical U-Space services to mitigate hazards.
Research potential technical surveillance solutions which comply with the integrity requirements set and establish a high level of digital trust



Software in The World

We investigate and develop systematic approaches for engineering secure, adaptive and usable software systems in a complex and changing socio-technical World.