



Scotland's Drone-Based National Logistics Network for Medical Supplies

By Fiona Smith

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With 16 partners involved, Project CAELUS (Care & Equity – Healthcare Logistics UAS Scotland) brings together a wealth of knowledge and experience across a number of industries. CAELUS has received recognition across the political spectrum with a motion in the Scottish Parliament saying the project was innovative and pioneering. Project CAELUS was recently called a “game-changer” for how NHS Scotland delivers healthcare by Humza Yousaf, the Scottish Government Health Secretary.

AGS Airports leads the CAELUS Project, which will be the UK's first medical distribution network. It secured £10.1 million in funding from the Future Flight Challenge at UK Research and Innovation (UKRI) in July 2022, the second successful round of funding for the CAELUS consortium, which brings together 16 partners.

Together, the consortium partners are working to deliver what will be the first national drone network that can transport essential medicines, bloods and other medical supplies throughout Scotland including to remote communities.

Since securing £1.5 million in January 2020, the CAELUS consortium has designed drone landing stations for National Health Service (NHS) sites across Scotland and developed a virtual model (digital twin) of the proposed delivery network, which connects hospitals, pathology laboratories, distribution centres and GP surgeries across Scotland.

NHS Scotland has said it will bring its “Once for Scotland” approach to the project, the second phase of which will involve live flight trials and removing remaining barriers to safely using drones at scale within Scotland's airspace. The CAELUS project is set to revolutionise the way in which healthcare services are delivered in Scotland.

A drone network can ensure critical medical supplies can be delivered more efficiently; it can reduce waiting times for test results and, more importantly, it can provide equity of care between urban and remote rural communities.

As well as undertaking live flights, CAELUS will begin to deploy the physical infrastructure needed to support the drones across Scotland. This will involve building prototype landing bases, as well as digital and communication infrastructure. CAELUS will work with local communities to ensure they understand why and how the drones will be used.

The live flight trials will be operated by the CAELUS consortium members Skyports and Dronamics. The UK-based drone services provider is an experienced operator of medical and dangerous goods cargo flights.

The company performed early trial flights with NHS Scotland in 2020 and 2021, flying over 14 000 km in the region to date. The consortium's next live flight trials will take place in 2023.

Project CAELUS was recognised for its excellence in innovation at the Scottish Transport Awards in September 2022, and has received the Excellence in Technology and Innovation award. The project's latest phase was launched at an event at Glasgow Airport in September and received more political backing through the Public Health Minister Maree Todd, who gave the keynote speech where she said: “This innovative project will help position Scotland at the forefront of drone technologies to deliver essential healthcare supplies to people more quickly and provide equity of care between urban and remote rural communities. It also demonstrates an effective industry partnership showing that when businesses, universities and public sector work together they can deliver for Scotland and outperform the competition, attracting welcome funding at this challenging time.”

The CAELUS consortium comprises:

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|---------------------------|---------------------------|
| AGS Airports | ANRA Technologies |
| Arup | Atkins |
| Cellnex | Commonplace Digital |
| Connected Places Catapult | DGP Intelsius |
| Dronamics | NATS |
| NHS Scotland | Plane Finder |
| Skyports | The Drone Office |
| Trax International | University of Strathclyde |

AGS Airports

AGS Airports Limited was established in 2014 to invest in Aberdeen International, Glasgow and Southampton airports and is the second largest airport group in the UK. A joint venture by Ferrovial and AGS Ventures Airports Limited, an entity controlled by Macquarie European Infrastructure Fund 4 LP.

AGS Airports supports tens of thousands of jobs and contributes in excess of £2 billion in GVA to the UK economy every year. In 2021, AGS Airports launched its sustainability strategy, setting out how it will balance the undoubted economic and social benefits of aviation with its climate change responsibilities. AGS Airports has:

- Reduced its direct carbon emissions by 52% since 2018.
- Achieved carbon neutrality in 2020.
- Committed to achieving net zero for direct emissions by the mid-2030s.

Eventhough the project's focus is on healthcare, AGS Airports is of opinion that CAELUS could pave the way

for the deployment of drone-enabled logistics in other sectors and has the potential to change the way airspace is used by manned and unmanned aircraft. It also has clear environmental benefits, as it will play a key role in reducing the carbon emissions generated by existing, road-based distribution networks within Scotland.

Atkins

Atkins is leading on the physical infrastructure of the project and, in particular, identifying and designing the different landing sites for each drone. This involves determining the size and use of each site, assessing accommodation or storage for the drones required, and how best to connect the site to essential utilities to power and fuel these electric vehicles and the site infrastructure - including exploring self-sufficient sites powered by renewable off-grid technology.

Larger drones will require a storage hangar connected to regional airports such as Aberdeen and Glasgow, whereas medium-sized drones will also need to be connected to hospital sites, meaning a landing site large enough to accommodate the drone, its battery storage and charging equipment, and allow access for any essential maintenance.

When it comes to the smaller of drones, which will be required to land in remote areas, Atkins is taking a modular approach to create a more efficient and sustainable logistics network. It is creating a “pop-up port” that could be deployed when needed, rather than creating permanent buildings in the middle of countryside. This modular, functional-mobility concept could even see temporary buildings used for a couple of weeks before being folded away and towed by electric vehicle to the next site. There is a keen focus on sustainability beyond the aircraft, for example by charging batteries using solar or wind power.

Creating this complex network of unmanned aircraft will require significant technical and regulatory aerospace work to ensure these aircraft can be safely integrated into existing airspace; develop the infrastructure to support the network; and also ensure the security of airspace management systems and cargo at every point in the network.

A large focus of the CAELUS project will be on exploring how best to overcome these challenges and operate a network of this type in Scotland – mirroring another Future Flight Challenge project that Atkins is leading with partners across the aviation industry to test and develop an end-to-end advanced mobility ecosystem.

NATS

NATS, the UK’s principal air navigation services provider, is leading the airspace management work of Project CAELUS by developing the concepts for how airspace could be safely managed, and the procedures that will be required to safely integrate a network of multiple drones with existing flight operations. Once a Concept of Operations is developed, a live trial will take place with consortium partners to test the proposals in a real-world setting.

This project has the potential to revolutionise the way in which healthcare services are delivered in Scotland – a medical drone delivery network could ensure critical medical supplies can be delivered more efficiently, reduce waiting times for test results, and improve healthcare access for rural communities. However, for this to happen, the drone network needs to be effectively integrated into the airspace structures that keep all things airborne safely separated. Developing ways of doing this is NATS’ focus for the project.

This is a great example of how uncrewed aviation can support the NHS, and shape the way our skies are used in the future by paving the way for similar integrated airspace projects across the UK.

ANRA Technologies

ANRA develops digital products used by air traffic services and drone operators to manage the operations of drones. In the CAELUS project, ANRA is leading the development of a Digital Twin of a Scottish Medical Delivery Network aimed at developing actionable data for how such a network would operate across Scotland. The purpose of the Digital Twin is to be able to demonstrate the performance and safety of operations at a network level through the use of real-world services (UTM, airspace entities, weather etc) together with drone models to simulate the system.

NHS Grampian/NHS Scotland

NHS Grampian leads the “Once-for-Scotland” approach on behalf of the NHS Territorial Health Boards alongside the Scottish Ambulance Service (SAS) to understand the benefits that UAS technology can bring to the delivery of routine and emergency activity, respectively, in the 21st healthcare delivery model.

The Scottish Ambulance Service is on the frontline of the NHS, despatching immediate emergency medical assistance or clinical advice to over 5 million people across Scotland, covering both the islands and the mainland population.

The NHS Territorial Boards provide acute and community healthcare services to the same island and mainland populations. With approximately 26% of Scotland’s population living in remote or rural areas spread across 69% of the land mass, service delivery can encounter constraints which contributes to treatment inequity.

For both SAS and NHS Scotland, equity in the delivery of healthcare is a key driver for involvement in this project as NHS Scotland considers how to remobilise and redesign services to fit the needs of Scotland’s health and social care challenges.

The project provides an opportunity to transform patient experience and service delivery by reimagining the existing service models to new ones, utilising new technologies. CAELUS will also contribute to the net zero emissions ambition of the Services. By adopting the “Once-for Scotland” approach, involving the three regional NHS Innovation Hubs (North, South-East and West) the learning and benefits of this solution to develop a medical logistics network can be applied equally across Scotland.

NHS Grampian's Clinical Lead for Innovation, Dr Andy Keen said: "We are delighted to be the lead board for Scotland on this project. Our aim, from an NHS perspective, is to test the use of drone technology in urban, remote, rural and island landscapes. We want to test if using drones to will improve important aspects of our logistics service, for example, to test the transportation of laboratory samples, blood products, chemotherapy, and medicine delivery. Ultimately, we want to explore if drone technology can speed up diagnosis and treatment of medical problems. "This has the potential to improve services for those whose care is dependent on rail, ferry or airline timetables and help keep people at home where they can be supported by families and loved ones."

University of Strathclyde

The University of Strathclyde has been one of the principal drivers in steering the path of the CAELUS project since its conception in Phase 1 of Future Flight. Strathclyde's role has been to advise on and contribute to the development and demonstration of the beyond-state-of-the-art digital technologies, in support of the strategic design and the tactical operation of a large network of drones transporting medical payloads to ensure equity of care but also commercial viability and safety.

A team of academics from across the university departments of Mechanical and Aerospace, Civil & Electrical Engineering, coordinated by the Aerospace Centre of Excellence in Mechanical and Aerospace Engineering, is involved in the digital modelling, simulation, optimal planning/re-planning and reconfiguration of the network and its operation.

The work of Strathclyde will demonstrate how the digital technology can provide strategic and tactical solutions to operators and controllers that ensure maximum efficiency, reliability, and resilience of the network of drones.

These capabilities are essential to enable future Beyond Visual Line of Sight flights, in a future U-space environment. U-space is a set of specific services and procedures designed to ensure safe and efficient access to airspace for a large number of drones based on high levels of digitalisation and automation.

Strathclyde Business School and Management Science is supporting market analysis and exercises to understand the impact that the CAELUS network will have on stakeholders such as the NHS and its supply chain, the drone operators, the air traffic controllers/regulators, as well as on the general public. Ensuring the acceptance and a positive public perception is key to successfully introducing such radical and disruptive new technologies into the UK

Arup

In 2017, Arup recognised that the absence of any policies or regulation regarding the noise made by drones presented a significant barrier to social acceptance and their widespread introduction.

Since then, Arup has been developing ways of understanding public perception of drone noise. For the CAELUS project, it's approach will help identify existing barriers to accepting drones as part of the healthcare system, and work with the public and other key stakeholders to move past these obstacles.

Audio demonstrations, known as "auralisations" , have been developed using Arup's SoundLab technology. They will give people a clearer understanding of the noise generated by drones. Auralisations have previously been used to help people understand future noise levels and characteristics of a number of major road, rail and aviation projects. For the CAELUS project, they will simulate the sounds of various types of drone deliveries taking off and landing, as well as flying overhead.

The intention is that once members of the public have a better understanding of the drone-generated noise, they will be able to weigh that against the benefits of better connectivity, faster deliveries of medicines, reduced test result times, and so on – ultimately becoming more accepting of the use of drones.

Residents in areas which might be served by drones will then be invited to listen to demonstrations online before completing a questionnaire to gauge their response to the sounds (specifically in the context of improving the local provision of healthcare services).

The noise impact and social acceptability of operating drones is not well defined. Arup's previous work in this field indicates that new sources of noise can be met with increased concern from members of the public, which could compromise the development and introduction of new and emerging technologies with socially useful applications.

Building trust is at the heart of this work and interpreting the human response to noise is vital, if we are to develop impactful policies and legislation – as well as help design an ecosystem in which these technologies gain societal acceptance with minimal negative impact on daily life.

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