flyinghigh

Drone use case briefs

Use case pack

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About this document

The following pack provides detailed, one-page briefs for 13 shortlisted use cases. Each brief identifies key benefits, and also outlines key requirements that need to be addressed for successful implementation.

ABOUT THE FLYING HIGH CHALLENGE

The **Flying High Challenge** is a collaborative engagement involving up to five selected cities across the UK which aims to shape the future of urban drones and drone systems. Run by Nesta's Challenge Prize Centre in partnership with Innovate UK, the **Flying High Challenge** is the first programme of its kind to convene city leaders, regulators, public services, businesses and industry around the future of drones in cities.

Do you represent a city interested in the Flying High Challenge? Learn more and apply at **http://flyinghigh.challenges.org/cities/**

INTRODUCTORY PACK

To support city applications to the Flying High Challenge, we've developed a downloadable **Introductory Pack** that maps out potential applications for drones in urban contexts and provides a range of use cases and examples as inspiration.

IN THIS DOCUMENT

To inform the process of identifying relevant applications for drones in urban contexts, we have shortlisted 13 specific drone use cases that could have a major positive economic and social impact if implemented in cities. We have tried to include use cases from the different applications identified in the **Introductory Pack** – namely **monitoring**, **inspecting**, **delivering goods**, **transporting people** and **intervening**. We have also tried to cover a range of sectors including **public service**, **emergency** and **commercial** applications.

As part of the shortlisting process we prioritised use cases in **extreme and challenging environments**, as these represent concrete contexts where drones could reduce risk to human life by removing the need for human intervention from hazardous settings, informing decision-making and enabling faster and more effective responses to emergency situations.

The following pack contains a detailed 1-pager on each of the 13 shortlisted use cases. It includes an overview of key **benefits** of using drones in each setting and outlines key **requirements** that need to be addressed in order to make each use case a reality.

These 1-pagers also include key **considerations** for cities to bear in mind when embracing drone technology, a **real-world example** of each use case, a number of **related use cases** that would benefit from similar drones, infrastructure and regulation, and examples of **future use cases** that could build on the capabilities of existing drones.

REQUIREMENTS

The requirements section for each case study is broken down into technology, infrastructure and regulation.

- **Technology** refers to the current state of technological innovation and the innovations needed to effectively implement the specific use case.
- **Infrastructure** considers existing facilities and networks as well as any additional infrastructure needed to implement the use case safely, at scale.
- **Regulation** reflects existing and needed policy and legislation to enable the safe and secure implementation of the use case. While for most of the use cases presented, a Permission for Commercial Operation from the CAA would be required, an efficient scale-up of the issuing process in the light of an increasing demand for commercial drones needs to be considered.

Each requirement has been given a relative score to make it easier to grasp where the key challenges for each use case lie. 1 reflects a low complexity, 2 a medium complexity, and 3 a high complexity requirement.

Tackle air pollution

Test and assess the concentration of polluting gases and particles in the air to determine pollutant emission levels from a known source, such as a flue-gas stack, or to determine air quality in a designated area, such as a residential neighbourhood.

Public services | Monitor environments | Environment

BENEFITS

How can drones help?

- Detect and model air pollution from diffuse or distributed sources more widely, more accurately and faster.
- Alert public health officials when air quality conditions in a given area pose a risk to human health.
- Monitor pollution levels and atmospheric conditions in areas beyond the reach of both ground equipment and satellites.
- Investigate interactions between contaminants and their surroundings to discover how they disperse and persist in the environment.

IMPACT

How will this use case improve your city?

Economic impact: 1 of 3

Social impact: 3 of 3

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆

Drones must be able to function in poor-visibility situations since in very polluted areas smog may obscure drones and obstacles from view. Accurate and precise geolocation and positioning capabilities are essential to plan sample collection points or paths, and to model pollution concentration and dynamics over time. Drones must also be outfitted with appropriate sensors and measurement instruments that work at a variety of temperatures, and that demonstrate consistency in different weather conditions so that data from multiple drones can be pooled.

INFRASTRUCTURE ◆

Pollution-monitoring programmes may require drones to operate in groups to maximise efficiency and reduce mapping time. This means drones will require swarming functionality or advanced traffic management to prevent collisions. Accordingly, charging stations and drone maintenance schedules will likely need to be established to maintain reliable and coordinated monitoring activity. If operating near industrial sites, relevant organisations must be informed to avoid compromising equipment and worker safety, and mechanisms for sharing collected data should be developed to help such organisations protect workers from dangerous levels of pollutants.

REGULATION ◆

Many industrial operations must adhere to emissions standards, and must conduct self-monitoring to ensure they are within mandated limits. Standards will need to be based on monitoring methods feasible for both operators and compliance representatives to undertake with readily available technologies. Pollution-monitoring programmes using drones will also need to develop procedures that ensure emissions standards are policed fairly between operators.

◆ Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).

CONSIDERATIONS

Bear in mind...

Modelling air pollution in geospatial contexts and over time will lead to a more comprehensive understanding of where emissions come from and how they persist in the environment. These findings will have implications for human health and ecosystems. Policymakers will have a responsibility to act on this information for the public good, even if taking action may prove unpopular with industry or require more widespread adaptation by citizens.

REAL-WORLD EXAMPLE

The Chinese government is using drones to detect illegal levels of emissions from factories.

RELATED USE CASES

Similar drones could be used to **detect, test and model water pollution**.

FUTURE USE CASES

More advanced drones could be used to **scrub polluted air by capturing and removing harmful gases and particles**.

Map fires

Identify, locate, and model fires in relation to surrounding and nearby areas to help assess fire size and intensity, anticipate hazards and predict fire progress, inform firefighting and evacuation decisions, and manage active firefighting operations.

Emergency services | Monitor environments | Contained inspection | Infrastructure

BENEFITS

How can drones help?

- Rapidly attend emergency calls and collect information before firefighting crews arrive.
- Identify the source of a fire to help target firefighting efforts and extinguish it more efficiently, and map the size and spread of a fire and identify hazards from a safe distance, reducing the risks to firefighters.
- Monitor active operations and alert firefighters to changes in conditions.
- Collect information from otherwise inaccessible locations by flying at height, in confined spaces or through restricted airspace, and by using infrared cameras to see through smokescreens.

IMPACT

How will this use case improve your city?

Economic impact £ (1 of 3)

Social impact (3 of 3)

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆

Operating in an emergency means that drones will have to be able to fly and hover for long periods, and in any weather conditions. This is currently a major obstacle as wind and rain make drones difficult to control and rapidly drain their battery power. Drones will also need to be able to capture useful data even in poor visibility (e.g. through smoke) or at night, so high-quality infrared and/or night vision cameras will be essential. If deployed in close proximity to fires, drones must be flame retardant and heat resistant.

INFRASTRUCTURE ◆◆

Firefighting drones will need to rapidly respond to emergency calls, so they may need access to priority lanes to reach their destination quickly and safely without colliding with other drones. The area surrounding a fire may need to be declared a temporary 'no-fly zone' to prevent commercial and private drones from interfering with firefighting operations. Since firefighting drones will operate in extreme environments they are relatively likely to be damaged during missions, so efficient maintenance pipelines will be essential.

REGULATION ◆

To reach their destination quickly, firefighting drones must be allowed to fly Beyond Visual Line of Sight (BVLOS). Legal BVLOS flight is also essential during firefighting missions since smoke may obscure a pilot's visibility of the drone. Drones may also need to travel through and operate within restricted airspace, particularly in close proximity to buildings and people, depending on the location of the fire. If manned aircraft are also attending a fire, airspace must be segregated to prevent collisions between aircraft and drones.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

As adoption of drone technology increases, more firefighters will request drone assistance at emergency scenes. Fire departments must have the funding to purchase drone hardware, maintain active drones and employ drone pilots to fly them. If availability of drones is limited, drone assistance may not be available at some emergency calls, putting firefighters at unnecessary risk. Increased automation of drones would reduce the need for dedicated trained pilots, allowing faster and cheaper scale-up of the technology across fire departments.

REAL-WORLD EXAMPLE

Kent fire department loaned their drone to aid with investigating the Grenfell Tower fire. ↗

RELATED USE CASES

Similar drones could be used to **map and search for survivors during floods**.
See also: **Explore hazardous environments**.

FUTURE USE CASES

More advanced drones could be used to **search for and rescue survivors from burning/smoke-filled buildings**.

Explore hazardous environments

Collect spatial, material and environmental data to support the modelling and inspection of places dangerous for in-person observation, such as condemned or damaged buildings, nuclear power plants or sewers.

Emergency services | Contained inspection | Infrastructure

BENEFITS

How can drones help?

- Remove the need for human presence in hazardous environments, thereby reducing risk to personnel.
- Enable inspection of inaccessible or confined environments where human inspection is not possible.
- Allow a wider range of experts to inspect images at leisure, improving the accuracy of inspection.
- Reduce the cost and time required to gain access to hazardous areas, allowing for more regular inspections to catch faults before they develop.

IMPACT

How will this use case improve your city?

Economic impact: £ £ £

Social impact: 2 of 3

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆

Drones operating in hazardous environments must have robust emergency landing protocols to ensure minimal damage in case of accidents or faults. In these contexts, an accident could make the environment more hazardous or cause damage that is difficult and expensive to repair. Drones should be able to monitor their own health and take emergency action if faults are detected. They may also require special measures (e.g. electrical shielding, waterproofing) to protect them from hazards like radiation or water.

INFRASTRUCTURE ◆◆

In contained, hazardous environments precise flight will be essential to avoid collisions which could cause further damage and potentially endanger human lives. Therefore highly skilled, on-site pilots will be essential. Improved drone automation could reduce the burden on pilots through flight stabilization and sense-and-avoid technologies. Operators will also require robust mechanisms for communicating with and controlling drones, as current methods can be impaired by distance, walls and interfering signals (e.g. radiation).

REGULATION ◆

Drones will need to fly close to and inside buildings, breaching current guidelines on flying close to structures. They must also be able to operate Beyond Visual Line of Sight (BVLOS) to allow flight in contained environments and to enable the operator to maintain a safe distance from potential hazards.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

A drone optimised for one hazardous environment (e.g. a nuclear plant) may not be suitable in another hazardous environment (e.g. inside sewers). Drones will either need to be adapted to operate in multiple situations or a number of differently designed drones will be required to cover a range of environments, both of which will carry a financial cost. Operating multiple drones gives greater capacity for simultaneous inspection at multiple sites, although it carries a greater demand for skilled pilots.

REAL-WORLD EXAMPLE

Engineers used a drone to see inside the damaged Fukushima nuclear reactor.

RELATED USE CASES

Similar drones could be used for **search and rescue inside buildings and confined spaces**.
See also: **Map fires**.

FUTURE USE CASES

More advanced drones could be used to **perform repairs** or **remove debris detected during inspections**.

Deliver goods

Deliver goods from a central vendor warehouse directly to the homes of consumers who placed product orders, either by making one-at-a-time trips or delivering multiple orders to several homes in one trip, and possibly providing product return services.

Commercial | A–X delivery | Logistics

BENEFITS

How can drones help?

- Reduce the cost of 'last-mile' delivery to retailers and couriers.
- Reduce traffic congestion on city roads, thereby also improving air quality.
- Faster and more consistent delivery times for consumers.
- Greener package delivery, due to reduced per-mile energy cost and use of electric motors compared with polluting road-based solutions.

IMPACT

How will this use case improve your city?

Economic impact: £ £ £

Social impact: 2 of 3

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆

Mass drone delivery will be most feasible if the entire pipeline is automated, from package loading to flight to delivery. Drones should therefore be capable of autonomously loading cargo, flying a defined route, dynamically avoiding unforeseen obstacles, finding and landing in a safe location, verifying the identity of the customer and delivering the package, before taking off and returning to the hub or carrying out another delivery. They must also have enough power to carry packages over long distances.

INFRASTRUCTURE ◆◆◆

Delivering packages across a city from a single hub is an unsustainable solution, so multiple drone hubs will need to be built across the city to reduce the flight time of each drone. The number of hubs required could be reduced if drones could each deliver multiple packages in one flight. Complex Air Traffic Control systems will be required to plot each drone's route from hub to home in real-time.

REGULATION ◆◆◆

Delivery drones will need to fly Beyond Visual Line of Sight (BVLOS) over residential areas and private properties to access customers' houses. This may invade the privacy of citizens' private airspace and disturb residents with any noise generated by flight, landing and takeoff. Regulation will need to outline where delivery drones can legally fly and land, whether that be freely or in restricted flight corridors above public land.

CONSIDERATIONS

Bear in mind...

For home delivery to be economically viable, companies will require thousands of drones in the sky at once. This will have widespread implications: Unmanned Traffic Management (UTM) systems acting as Air Traffic Control must have the capacity to handle high volumes of traffic following complex and interacting routes; collisions and failures will become more likely, making safety a greater concern; noise pollution may also become significant under flight paths as well as at takeoff/landing sites.

REAL-WORLD EXAMPLE

Amazon Prime Air has begun trialling package delivery by drone in Cambridge.

RELATED USE CASES

Similar drones could be used to **deliver letters and post**.

FUTURE USE CASES

More advanced drones could be used to **return packages**.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

Upgrade road networks

Identify and inspect potholes, spot debris, ice and other on-road hazards, monitor traffic congestion and response to current signals and signage, and track progress of roadworks as part of a 'smart road network' strategy.

Public services | Linear inspection | Monitor flows | Transport

BENEFITS

How can drones help?

- Respond faster to changes in congestion to improve traffic flow, reducing delays during periods of high demand.
- Enable faster, more efficient and more effective road maintenance, leading to improved safety and quality of city road networks.
- Target interventions, such as gritting during icy weather, to the worst affected areas to maximise effectiveness.
- Improve efficiency and reduce cost of roadworks by monitoring stockpiles of supplies and regularly assessing progress, minimising disruption to drivers.

IMPACT

How will this use case improve your city?

Economic impact: £ £ (2 of 3)

Social impact: 2 of 3

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆

Drones will be flying over active roads, so robust safety precautions to prevent crashes into traffic are paramount. Drones should monitor their own health and have emergency safe landing protocols to avoid traffic if errors are detected or failures occur, and must have sense-and-avoid technology to avoid bridges, trees and other low-altitude obstacles that could cause accidents. Drones must also be equipped with advanced data gathering equipment, such as thermal imaging for monitoring road icing or advanced cameras for quantifying the size of potholes from visual images and capturing high quality video during flight with minimal motion blur.

INFRASTRUCTURE ◆◆

Drones will require a fast and robust mobile link to current traffic control hubs to transmit data in real-time, allowing operators to react efficiently to changes in traffic flows and manage congestion more effectively. Since road networks are spread over large geographical areas, secure landing sites, charging ports and maintenance workshops must be distributed widely and flight routes carefully planned to ensure drones can complete tasks safely. If used regularly, a large number of drones will be required to cover a whole road network.

REGULATION ◆◆

Due to this geographical spread, Beyond Visual Line of Sight (BVLOS) flight will be essential to improve the speed at which inspection flights can be completed. Without BVLOS authorisation, drones would be tethered to the speed of a ground pilot, greatly reducing their effectiveness. Drones must also be permitted to fly above busy, high speed corridors (e.g. motorways) at low altitude. Their flight paths will be predictable but inflexible, so Air Traffic Control must divert other drones around them to avoid mid-air collisions.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

Drones monitoring roads will be collecting data about public spaces so there may be concerns about what data is captured, and how it's used and stored. In particular, potential future applications such as enforcing speed limits would have to be clearly and transparently communicated to the public as these would involve the collection of identifiable data.

REAL-WORLD EXAMPLE

The Indian government is using drones to monitor accident hotspots on the Mumbai–Pune expressway.

RELATED USE CASES

Similar drones could be used to **inspect city canals and waterways**.
See also: **Maintain Utilities**, **Respond to Traffic Accidents**.

FUTURE USE CASES

More advanced drones could be used to **enforce road speed limits**, or **repair potholes and broken streetlights**.

Inspect large infrastructure

Collect spatial, material and environmental data to support the modelling and inspection of infrastructure that is difficult, expensive or dangerous to inspect due to factors like height, proximity to high-traffic urban areas, or position over water or within sensitive environments.

Public services | Contained inspection | Infrastructure

BENEFITS

How can drones help?

- Quickly and cheaply identify problems in locations that are not easily accessible.
- Reduce interruptions to affected services due to a reduced requirement for disruptive manned inspections.
- Assess maintenance projects more accurately before projects begin, avoiding the unanticipated expansion of a project's scope or timeline after work has already begun.
- Plan targeted maintenance interventions that minimize damage to architecture and their impact on street-level activity in urban settings.

IMPACT

How will this use case improve your city?

Economic impact

Social impact

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆

Drones used to inspect infrastructure will require high levels of maneuverability and responsiveness to allow operators to image confined spaces from various angles, make second passes to verify observations and alter course in response to new information. Drones must be small enough to fit around corners and get close enough to targets to capture highly detailed images. Advanced camera equipment will be required to collect accurate data, ranging from fast frame-rate cameras which reduce motion blur to infrared cameras for imaging dimly lit areas and vertically-mounted cameras to help inspect underneath structures.

INFRASTRUCTURE ◆

Drones may be used for routine inspection or in emergency repair scenarios, so councils will need to develop in advance a framework for prioritizing urgent requests. Drone operators will need to be in real-time communication with maintenance experts – or be maintenance experts themselves – in order to facilitate observation-driven assessments in both routine inspection and emergency repair situations. As large infrastructure may be targeted by criminal activity, it may also be important to licence and/or track qualified inspection drone operators so that malicious drone activity impacting infrastructure can be more easily detected and prevented.

REGULATION ◆

Drones will likely need to fly Beyond Visual Line of Sight (BVLOS) to inspect difficult-to-access parts of large infrastructure. They will also need to fly closer to large structures than regulations currently permit.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

Although they may be able to in the future, drones cannot currently interact physically with infrastructure, so UAV technology cannot currently completely replace inspection teams. Instead, drone inspections may need to be followed by manned inspections to complete tasks like cleaning, measuring parts or running tests, as well as performing any repairs.

REAL-WORLD EXAMPLE

The cooling towers of Tihange Nuclear Power Station in Belgium were fully inspected for hairline cracks by a drone in just four days.

RELATED USE CASES

Similar drones could **inspect tall buildings**. See also: **Managing construction sites** and **Maintaining infrastructure**.

FUTURE USE CASES

More advanced drones could **repair faults in large structures without requiring scaffolding or exposure of personnel to dangerous working conditions**.

Respond to traffic accidents

Attend to traffic accidents to assess victims, support first responders with medical supply delivery, collect accident data and map crash scenes, and remove crash debris once investigation is complete.

Emergency services | Support | Transport

BENEFITS

How can drones help?

- Quickly deliver medical equipment to accident scenes, saving lives by expediting medical care.
- Provide detailed photographic and thermographic images to emergency services to support decision making at the scene of a crash.
- Map and measure crash scenes for later investigation, reducing traffic disruption by allowing roads to reopen sooner.
- Reduce risks to personnel during accident investigation and removal of debris from roads.

IMPACT

How will this use case improve your city?

Economic impact: 1 of 3

Social impact: 3 of 3

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆

Emergency response drones must relay data to rescue and medical personnel in real time. Investigative drones will need to collect a large amount of highly detailed data in a short period of time, so battery life should allow drones to perform essential tasks on a single charge. Because data may be relied upon as evidence in court proceedings or insurance claims, it must be comprehensive and accurate. Drones must be fitted with high-resolution cameras capable of capturing images that can be used in a variety of contexts, including taking measurements from photos, making scale diagrams of crash scenes and generating animated models of crash events. Debris removal would require drones that are responsive, maneuverable, and capable of bearing loads.

INFRASTRUCTURE ◆◆

Drones must be ready for simultaneous deployment to multiple crash scenes in a variety of locations. Emergency response drones might originate from a central hub, whereas investigative drones may be launched by teams on site, so multiple drones with different missions may be operating simultaneously at a single crash site. Efforts will need to be coordinated to protect the safety of crash victims and responders and to ensure drone data collection complements the work of ground-level activities. A secure system for sharing images with relevant parties will need to be established. Drones need to be able to operate at night and in poor weather conditions, or backup plans must be made for instances where they cannot be used.

REGULATION ◆◆

Drones responding to traffic accidents will need to fly over and land on active roads, bringing them closer to traffic, people, and property than current regulations permit unless an exemption has been obtained in advance.

◆ Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).

CONSIDERATIONS

Bear in mind...

Regulations need to allow for the use of emergency response and investigative drones in response to traffic accidents while at the same time limit the risks associated with unauthorized parties. Interference from news media or hobbyist drone operators could compromise safety or impact the integrity of crash investigations.

REAL-WORLD EXAMPLE

Police in Ontario, Canada are using drones to help clear accident scenes more efficiently.

RELATED USE CASES

Similar drones could be used for **medical first response to attacks or disasters**. See also: **Upgrade road networks**.

FUTURE USE CASES

More advanced drones could be used to **assess and monitor the vital signs of victims from the air to inform paramedics**.

Transport people

Transport passengers between variable locations, offering a door-to-door service that meets safety requirements as well as passengers' needs for efficiency and convenience.

Commercial | X–X transport | Public transport

BENEFITS

How can drones help?

- Provide rapid, flexible, needs-based transport for citizens across an entire city.
- Reduce congestion on city roads, improving air quality and public experience at street level.
- Accelerate the transport of personnel in emergency situations.
- Create alternatives to supplement congested routes constrained by geography, such as bridges or commuter ferries.

IMPACT

How will this use case improve your city?

Economic impact

Social impact

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆◆

The safety of people-carrying drones will be of paramount importance. Drones must be able to avoid collisions with other air traffic, with fixed obstacles such as trees and buildings, and more unpredictable obstacles like birds or airborne debris. They must be able to land safely in a variety of settings (e.g. city centre vs residential, top of a building vs ground-level), without injuring either passengers or passers-by, and without damaging property. Robust and safe emergency landing protocols must be in place. Drones will need to navigate between destinations autonomously and control take-offs and landings automatically in variable weather conditions and environmental contexts.

INFRASTRUCTURE ◆◆◆

The location and design of take-off and landing infrastructure will need to be carefully considered to ensure the safety of passengers and passers-by. Despite operating autonomously, transport drones will likely need to communicate flight path and journey progress information to a monitoring system for safety and security reasons. Presenting a robust and reliable transport system will also require enough drones to ensure adequate coverage in terms of geographic area and ride availability. Battery recharging locations will need to be distributed throughout the serviced region so that drones can quickly and conveniently recharge and become available for hire again.

REGULATION ◆◆◆

Whether drones for human transport will be operated by or on behalf of city or regional transport authorities, by competing companies, or by individuals for private use will be a central concern for policy makers and regulators. Human safety is a clear priority. Drones for transport must be regularly inspected and serviced to ensure they are in good working order.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

Noise pollution and increased air traffic are other challenges that should be considered. Drones do not require roads, so they have the potential to alter the character of neighbourhoods formerly defined in relation to their proximity to ground and commercial air traffic corridors. However, restricting transport drones to defined air corridors could lessen their impact. Privacy is also a concern, because drone passengers might have a clear view of private locations which would not be visible at ground level.

REAL-WORLD EXAMPLE

Dubai is planning to have a functional drone taxi service within the next five years.

RELATED USE CASES

Similar drones could be used to **transport critically ill people to hospital by drone air ambulance**.
See also: **Deliver goods**.

FUTURE USE CASES

More advanced drones could be used to **carry multiple people as drone buses** or **transport commuters between cities**.

Manage marine ports

Watch for and respond to changes in ports by testing water quality, tracking and communicating with incoming and outgoing vessels, providing marine pilot services to large ships, and policing waters for unauthorized anchorage.

Commercial | Monitor flows | Support | Shipping

BENEFITS

How can drones help?

- Reduce the risks posed to marine pilots by reducing the need for them to board ships and guide them to port in dangerous conditions.
- Expedite police and coastguard response to accidents or illegal activity in shipping lanes.
- Collect more accurate data on water quality in ports to contribute to monitoring efforts and inform environmental policies.
- Improve operational efficiency of port services, shipping services, and the movement of marine traffic in and out of terminals.

IMPACT

How will this use case improve your city?

Economic impact

Social impact

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆

Drones patrolling sea lanes require high-definition cameras to effectively relay information about obstacles, illegal anchorages, and vessel occupation. Drone-mounted cameras could also be used to perform safety checks on vessels, cranes, and container stacks. The marine environment has changeable weather which may impact drone program operation if drones are not sufficiently sturdy and weatherproof. Drones may need to operate at night and in low visibility situations, have access to enough power to control flight and cover fair distances and ideally be recoverable from the sea should a failure occur.

INFRASTRUCTURE ◆◆

The site of drone deployment needs to be considered according to application. Drones assisting police, coastguards, and environmental monitoring agencies might need to take off and land from the water as needed, whereas drones used routinely for pilotage or customs inspection would need to travel the distance from a central hub to an incoming ship, and then make the return journey before recharging. If drones are to play a central role in marine traffic and trade management, they also need to exist in sufficient numbers.

REGULATION ◆

To add value, drones used to support marine port management will likely need to fly beyond visual line of site and closer to vessels, piers, cranes and other port structures than they are currently permitted unless an exemption has been obtained in advance. However, this means the impact of drones operated by commercial or hobbyist operators must be controlled inside port airspace to prevent collisions with people and vessels in and around waterways. Drone use by mariners also needs to be controlled to prevent illegal trade.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

Drones used for piloting and coordinating port and shipping service traffic need to operate in conjunction with standard VHF radio communication systems used by vessels of all sizes traveling in and out of ports worldwide. They should be identifiable as agents of the relevant port authority, and their function should be made clear to mariners prior to boarding vessels. This information should be easy for mariners to verify in order to prevent the unauthorized boarding of vessels.

REAL-WORLD EXAMPLE

In South Korea, the Busan Port Authority is using drones to crack down on illegally anchored ships.

RELATED USE CASES

Similar drones could be used to **staff and manage 'smart warehouses'**. See also: **Oversee construction sites**.

FUTURE USE CASES

More advanced drones could be used to **land and auto-pilot ships into port**.

Maintain utilities

Examine critical utilities infrastructure like power lines, pipelines, railways, and flood-control waterways to improve early detection of faults that could lead to interrupted service or compromised systems.

Public services | Commercial | Linear inspection | Utilities

BENEFITS

How can drones help?

- Reduce risk to personnel during inspection of hazardous sites (e.g. power lines).
- Decrease cost and time associated with routine inspections, allowing for more frequent checks to identify faults before they develop further.
- Perform inspections of inaccessible areas which might otherwise be neglected.
- Accelerate responses to emergency situations (e.g. gas pipelines leaks).

IMPACT

How will this use case improve your city?

Economic impact: £ £ (2 of 3)

Social impact: 2 of 3

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆

Utility inspection drones require cameras capable of relaying a live image stream back to the controller so that inspections can happen dynamically. Cameras should be capable of performing inspections in low-light conditions since emergency inspections may be required at night, or in low light. Depending on the application, drones should be small enough to fit in and around structures, and achieve line of sight inspection of targets hidden in enclosed spaces. In monitoring situations, drones could also generate alerts notifying authorities of damage detected, particularly for emergency situations such as gas leaks. Drones should have controlled and responsive flight, as utilities may be volatile if already damaged. Depending on the application, remote sensing technologies, infrared cameras, and GPS might also be required.

INFRASTRUCTURE ◆◆

Drone operators must be knowledgeable in the domain of the inspection target themselves, or work in close coordination with qualified personnel who can direct drone movement to perform inspections. In emergency repair scenarios, drones will be in high demand. Appropriate software for reviewing inspection data during and after collection will also be required.

REGULATION ◆

Current regulations require drones to keep within operator line of sight. This prevents them from taking over the tasks of manned helicopters or on-ground visits when inspecting utility infrastructure in remote locations inaccessible by road. It is also likely that drones will have to fly closer to structures and property than the current regulations allow without exemption. To meet increased interest in this application, the process of issuing permissions will have to scale up accordingly to avoid delays in implementation.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

The use of drones in utilities inspection and maintenance programs must be considered in relation to other access and observation methods, such as helicopter inspections or ground-based operations, as each method presents its own advantages. Protocols should be implemented to help inspection personnel assess which method is most appropriate for a given situation, rather than using drones by default in every situation.

REAL-WORLD EXAMPLE

The UK National Grid has begun using drones to inspect and monitor oil and gas pipelines.

RELATED USE CASES

Similar drones could be used to **inspect sewers**.
See also: **Upgrade road networks**.

FUTURE USE CASES

More advanced drones could be used to **repair leaking pipelines** or **remove debris from power lines**.

Supply hospitals

Deliver critical payloads between hospitals such as organs or blood, test samples, or urgent medical supplies quickly and efficiently while minimizing risks associated with ground transport and traffic congestion.

Emergency services | A–B delivery | Healthcare

BENEFITS

How can drones help?

- Save lives and make the most of supplies by rapidly delivering time-sensitive materials (such as blood, organs, samples, medicines, or medical equipment) between facilities without ground traffic delays.
- Enable hospitals to share blood and medicine stocks more widely, regularly and efficiently.
- Ensure stable carriage of fragile items which are sensitive to ground vehicle vibrations.
- Re-supply hospitals to support humanitarian relief efforts in response to disasters.

IMPACT

How will this use case improve your city?

Economic impact

Social impact

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆◆

Drones used for supplying hospitals must be equipped to keep payloads at the correct temperature to prevent spoilage. Payloads must be securely packaged so that they can withstand take-off and landing, and so that both their contents and passers-by are protected in the event of a collision. Loading drones should be as simple as possible for hospital staff and paramedics, and flight should be automated to remove the need for dedicated pilots. There may be several different landing locations at a given hospital, so drones will have to be programmed to know which landing location to use for each delivery.

INFRASTRUCTURE ◆◆

Hospital delivery drones will need access to protected air corridors to allow them priority over and prevent collisions with other drone traffic. Drone shipping, receiving, and processing systems will need to be implemented within hospitals so that they do not conflict with air ambulance traffic and to ensure that supplies reach their destination within hospitals as quickly as possible. Communication systems will need to keep medical personnel informed of delivery progress so that doctors can plan and prepare patient treatment accordingly. The design of the take-off and landing infrastructure should ensure the safe and secure delivery of sensitive and time-sensitive medical supplies.

REGULATION ◆◆◆

Hospital delivery drones will need to fly beyond line of sight and closer to buildings than regulations currently permit unless an exemption has been obtained in advance. Regulations will need to ensure healthcare delivery drones meet technical requirements to ensure they are appropriate for delivering sensitive materials to hospitals. Security measures will also be required to protect medical supplies and equipment from interference by unauthorized parties.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

CONSIDERATIONS

Bear in mind...

Time is crucial when it comes to organ transplants. Having a timely and effective unmanned organ delivery system could ensure organs that are already in scarce supply quickly reach patients in need. It is also likely that a broader medical supply system would have to face decisions about which deliveries are prioritized. In this case, medical professionals will be required to triage deliveries according to their urgency.

REAL-WORLD EXAMPLE

Zipline is delivering medical supplies to hard-to-reach areas in poor communities.

RELATED USE CASES

Similar drones could be used to **deliver sensitive documents between commercial or government headquarters**.
See also: **Deliver goods**.

FUTURE USE CASES

More advanced drones could be used to **shuttle vital organs directly from site of fatality to hospital for transplant**.

Boost mobile networks

Improve the capacity and speed of mobile networks and mobile internet in areas with sudden and temporary high demand, for example due to large festivals, public events or emergencies, or following damage to telecommunications infrastructure.

Commercial | Support | Telecommunications

BENEFITS

How can drones help?

- Increase mobile network capacity for consumers, providing connectivity in situations where existing infrastructure is overwhelmed.
- Cheaply boost capacity without the costs associated with building hard infrastructure.
- Patch damaged mobile and internet networks in emergency situations by rapidly deploying boosters with little preparation time needed.
- Provide access to mobile networks across geographical areas which are not otherwise serviced.

IMPACT

How will this use case improve your city?

Economic impact

Social impact

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆

Drones boosting mobile phone and wireless broadband coverage will need to stay airborne for long periods of time. To prevent sudden drops in coverage due to battery recharging, a replacement system will need to be implemented, or drones will need to be powered via other means, like solar energy or tethering to ground-based power sources. Drones will also need to carry and shelter signalling equipment and remain operational under variable weather conditions. Drones must also monitor their own health and be able to land safely away from crowds if failures are detected.

INFRASTRUCTURE ◆

Drones will need to stay airborne but stationary for longer periods of time, where they may be hazardous to other air traffic – particularly if they are tethered. A notification system or alert mechanism would be required to notify other air traffic of their location. If patching or boosting networks in response to emergency situations, drones must be available to launch with minimal delay if they are to be effective.

REGULATION ◆◆

New regulations would be required to allow network-boosting drones to improve service at events like football matches or music festivals, since current regulations stipulate that drones must keep 150m from crowds and built-up areas unless an exemption has been obtained in advance. Drones should also be permitted to hover autonomously whilst providing coverage to remove the need for continuous monitoring by a dedicated pilot.

CONSIDERATIONS

Bear in mind...

In cases where the demand for connectivity is high, or the area requiring service is vast, one approach to overcoming current limitations of drone battery life is to leverage swarming technologies. Integration with existing network infrastructure and, in certain cases, emergency services will need to be considered accordingly.

REAL-WORLD EXAMPLE

EE is testing the use of drones to boost mobile network coverage at festivals and other events.

RELATED USE CASES

Similar drones could be used to **boost radio signals during emergencies** or **provide mobile network coverage to support search and rescue efforts in remote areas**.

FUTURE USE CASES

More advanced drones could be used to **provide everyday mobile and internet coverage for rural areas poorly served by land-based network infrastructure**.

◆ *Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).*

Oversee construction sites

Map, survey, and supervise active construction sites to track project progress, identify unanticipated factors leading to scope change, spot hazards, and monitor the health and safety of workers on site.

Commercial | Monitor environments | Construction

BENEFITS

How can drones help?

- Protect workers by ensuring worksites meet health and safety regulations and alerting site personnel to potential hazards before they cause injury.
- Survey land and create better informed project plans.
- Provide a low-intervention data collection method to track building progress and ensure projects remain on schedule and within budget.
- Evaluate the quality of existing structures to be renovated, and support quality control of construction work using thermal imaging.

IMPACT

How will this use case improve your city?

Economic impact

Social impact

REQUIREMENTS

What needs to be done to make this happen?

TECHNOLOGY ◆

Drones operating on active construction sites will likely require sensor technology to keep a safe distance from people, structures and materials to avoid hazards on site, and to avoid becoming hazards themselves. In applications like surveying and project planning, data collected by drones will need to be compatible with building information modelling (BIM) systems and geographic information systems (GIS). Depending on the application area, infrared thermography cameras, high-resolution cameras, advanced mapping capabilities, and remote sensing technologies could be useful. Any required devices and sensors will impact on drone size and battery life.

INFRASTRUCTURE ◆

Health and safety regulations on construction sites would have to be adapted to include drone use. Health and safety meetings should inform project teams of drone use to avoid surprising construction personnel working at height or around power tools. Also, surveys completed by drone may be more accurate than previous surveys completed by ground crew, so a process for dealing with discrepancies with previous reports will need to be established.

REGULATION ◆◆

Protecting worker safety should be a priority; however, using drones to monitor construction must be considered in light of the different interests represented on a site. Who operates a drone, the nature of the data captured, and who has access to this data will have implications for relationships between owners, contractors, and labour unions. To meet increasing interest in this application, the process of issuing exemptions to current regulations restricting drone distance from people and property will have to scale up rapidly to avoid delays in implementation.

◆ Implementation complexity scores range from 1 (low complexity) to 3 (high complexity).

CONSIDERATIONS

Bear in mind...

Using drones for building inspection, land surveying, and construction management will bring monitoring drones into close contact with built-up, densely populated urban areas, with buildings and properties themselves being the target focus of drone data collection. Regulations will need to specify the nature and quantity of data that can be collected on areas surrounding the primary target of an inspection or survey. Operators will need to insure themselves against accidentally violating privacy or damaging property.

REAL-WORLD EXAMPLE

In 2016, 12% of all UK construction sites used drones to help manage operations.

RELATED USE CASES

See also: **Manage marine ports** and **Maintain utilities**.

FUTURE USE CASES

More advanced drones could be used to **perform hazardous tasks or tasks at height on construction sites**.