TAKING FLIGHT

An aviation system for the automated age

Drone Integration Paper
July 2019

Contents

Our vision is to enable a thriving, innovative and safe drone sector

New Zealand is a world leader in the unmanned aircraft (drones) sector due to our good reputation as a safety regulator, our 'open for business' mentality and our risk-based regulatory regime. We want to retain these advantages and remain at the forefront of drone development by ensuring our approach to drone operations harnesses the many opportunities they bring while addressing the challenges.

Being at the forefront means maintaining a regulatory and business environment which actively supports the beneficial and safe development and use of drones to benefit New Zealand. This requires an ability and willingness to be bold, and to take a leading role in order to develop a new industry that will help to lift productivity across a range of different sectors of the economy.

This document aims to provide the sector with a clear understanding of the Government's role, and its strategic direction and priority areas, to achieve the safe integration of drones into the aviation system and broader transport system.

Outlining a pathway to integration will provide clarity to the sector about steps the Government will take to ensure risks are addressed and benefits are realised for New Zealand and the sector as quickly as possible.

What is a drone?

Drones are aircraft of all sizes that operate without a pilot on board (they can be remotely piloted or fly autonomously).

As they are aircraft they must comply with existing aviation rules. Drones can be operated recreationally (a person flying a small drone in the local park or through a model aircraft club) or they can be operated commercially (Appendix 1 provides further detail). Drones can be operated at all height levels from just above ground level to very high altitudes (above where commercial jet aircraft operate). For the purposes of this paper, when the term drone is referenced (unless otherwise described) it covers all sizes of platforms and their various use cases. Drones are also used in military applications, but these military applications are not within the scope of this report.

Increasingly, more and more people are using drones. It is estimated that in 2017 there were approximately 77,600 drones in New Zealand[1] drones. By comparison, there are estimated to be 5000 piloted aircraft operating in New Zealand. In April 2019 there were 104 drone operators certified by the Civil Aviation Authority (CAA) to conduct operations outside of standard parameters. In addition, approximately 200,000 drones were used by foreign tourists in New Zealand in the past year.[2] Estimates from the US Federal Aviation Authority indicate that use of hobby drones in the USA would grow threefold between 2016 and 2021, while commercial drone use would increase by a factor of 10 in the same time. We expect that drone usage in New Zealand may undergo comparable levels of growth.

77,600

Approx number of drones in use in New Zealand (2017)
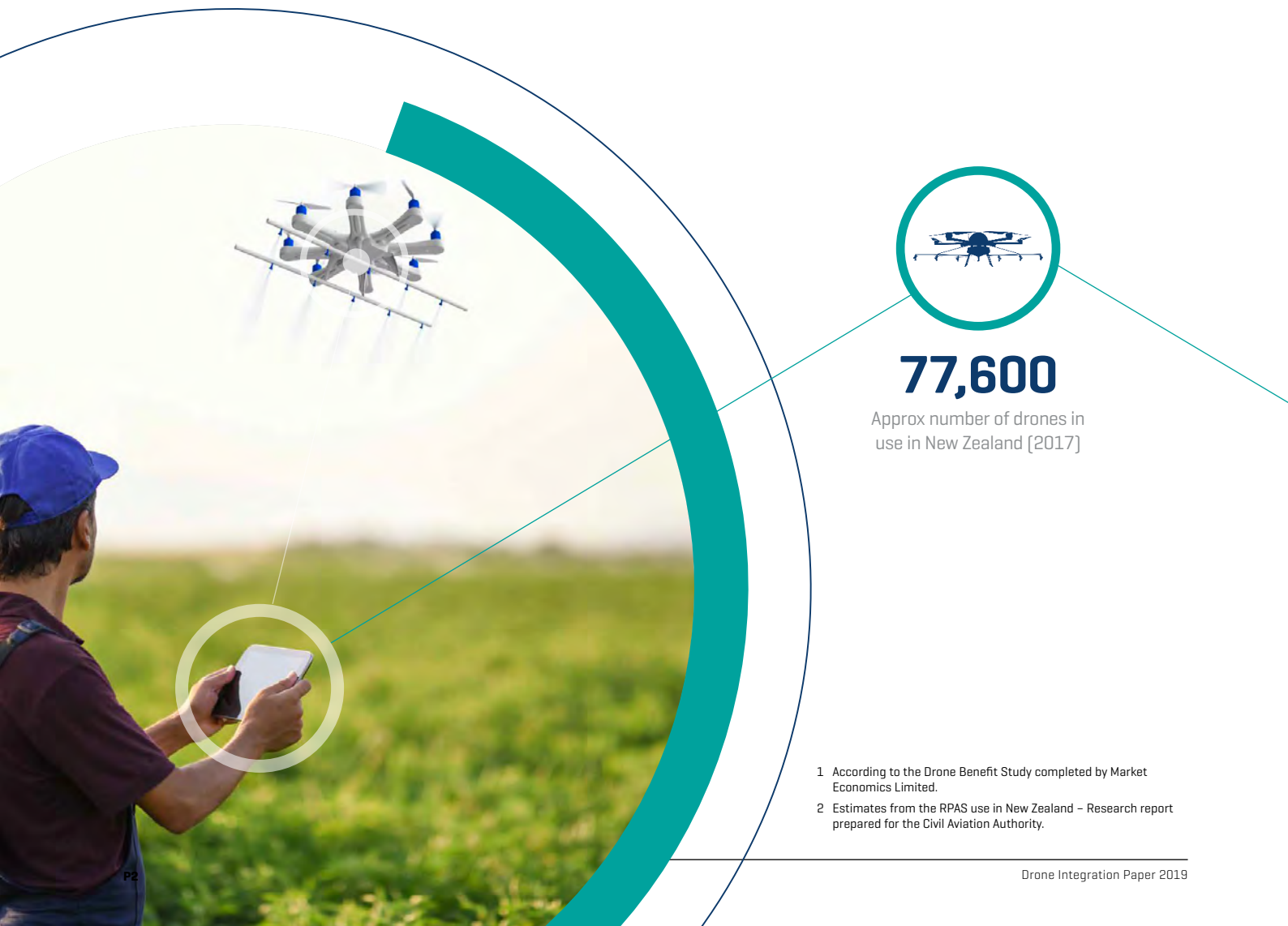
1   According to the Drone Benefit Study completed by Market Economics Limited.
2   Estimates from the RPAS use in New Zealand – Research report prepared for the Civil Aviation Authority.

New technologies are transforming aviation and can deliver significant economic and social benefits to New Zealand

Transforming aviation

Drones are part of a broader air transport sector, which already makes a significant contribution to the New Zealand economy—creating jobs and generating wealth. In 2014, the air transport industry was estimated to have contributed $6.9 billion gross value to New Zealand's GDP. These contributions come from large airlines like Air New Zealand right through to smaller general aviation operators which play an important role across a range of sectors including agriculture and tourism.

Drones provide the sector with an opportunity to take advantage of new and emerging technologies. The sector stands to gain economic benefits from other projects, such as New Southern Sky (NSS). NSS will transform New Zealand's aviation system and will deliver New Zealand around $128m of economic benefits through new performance based navigation, surveillance, communication and air traffic management technologies.

Economic and social benefits

Drones will also deliver economic benefits by undertaking tasks that are time intensive (e.g. monitoring stock and crops), expensive (e.g. power line inspection), and risky (e.g. emergency services). Numerous reports agree that drones will grow into a multi-billion dollar market globally in the next five to ten years. In New Zealand the value of the benefits of drones for the economy could be as high as $ 7.9 billion over 25 years[3].

Developments in drone technology and design could also lead to improvements in the wider aviation sector, with advancements in propulsions design, electrification, artificial intelligence, advanced computing, and imaging technology all potentially being implemented in the broader aviation sector.

In New Zealand, a number of industries will benefit from greater use of drones. For example, there is significant scope for drones in agricultural operations. New Zealand's challenging topography lends itself to drone use. Drones will allow more efficient and safe management of stock, pasture and crops, and at a lower cost. Further, New Zealand may also enjoy significant short- and medium-term benefits from the presence of companies testing and developing drone technology. This could lead to increased R&D activity and an uptake of cross-disciplinary technology across several sectors.

Drones are already being used as an inspection and surveying tool in a wide range of sectors in New Zealand. Drones are fast, efficient and capable of capturing large amounts of detailed information remotely. This means that tasks, such as routine maintenance, can be better targeted, further reducing costs.

Taking advantage of these transformative activities will place New Zealand in a good position to realise the economic benefits such technologies have the ability to deliver, allowing our aviation sector to continue to grow.
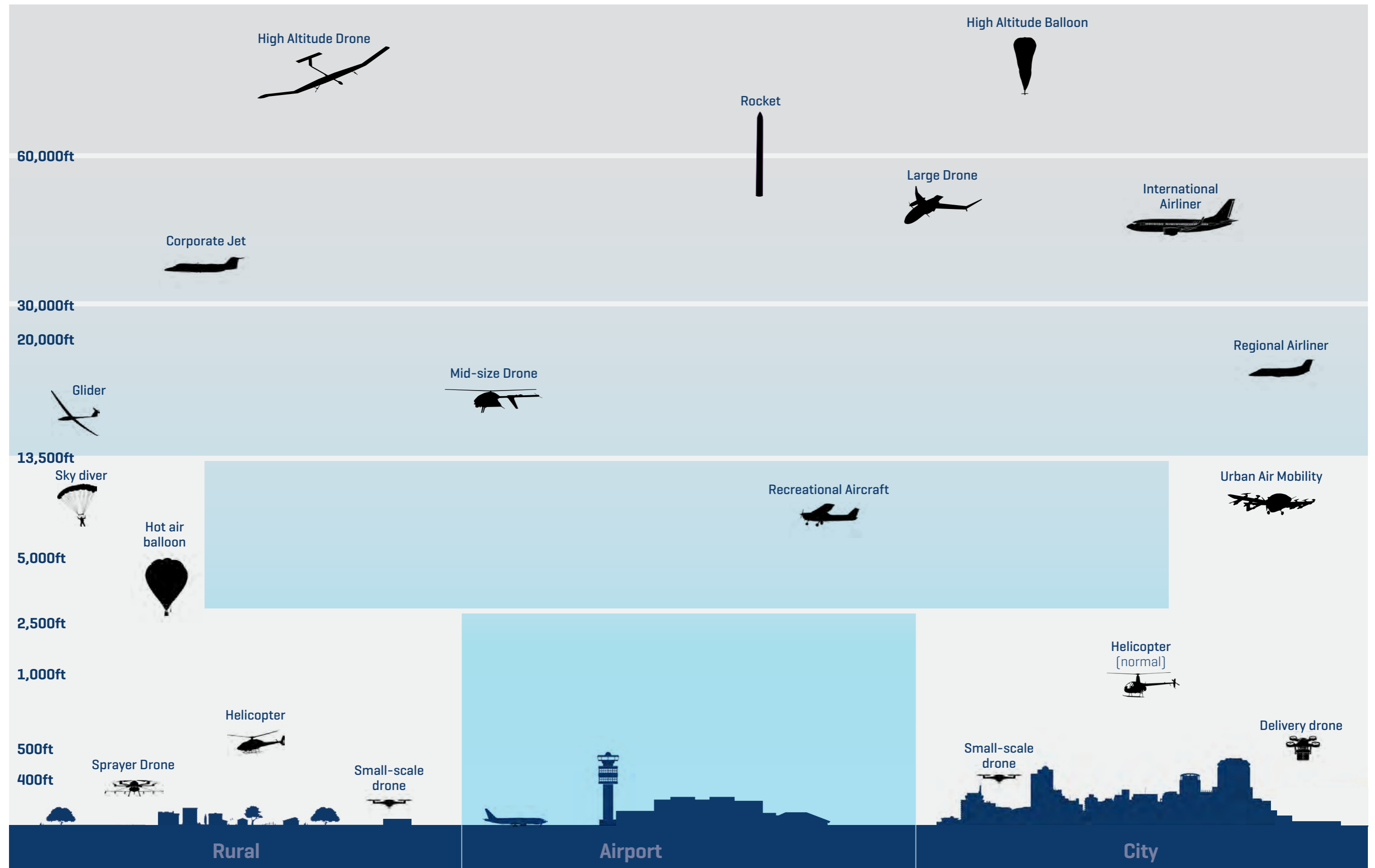
$7.9b

Value to economy of drone use over next 25 years

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3   According to the Drone Benefit Study completed by Market Economics Limited. The estimate is based on information and feedback provided by stakeholders about their current and anticipated use of drones. The value is the unconstrained high estimation of the value of the use of drones to the New Zealand economy.

Drone operation in New Zealand

High Altitude Drone

High Altitude Balloon

Rocket

Large Drone

International Airliner

Corporate Jet

60,000ft

Regional Airliner

30,000ft

20,000ft

Mid-size Drone

Glider

13,500ft

Sky diver

Urban Air Mobility

Recreational Aircraft

Hot air balloon

5,000ft

2,500ft

Helicopter (normal)

1,000ft

Helicopter

Delivery drone

Small-scale drone

500ft

Sprayer Drone

Small-scale drone

400ft

**Rural**

Airport

City

Drones have the potential to transform the transport system as well

Drones have the potential to change the way we move goods and people, as capabilities and operations expand to include freight delivery and passenger transport.

Acknowledging that other types of operations will continue to develop to provide services that we cannot imagine yet, the following examples outline services that could make a positive contribution to New Zealand's transport system (Appendix 2 describes a number of other drone use cases).

Example 1: Rural freight and goods delivery
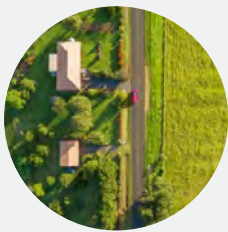
As technology continues to develop, the range and size of drones are expected to increase. This will open up new opportunities for drones to transport goods around the country. In particular, drones could play an important role transporting high-value, time-sensitive goods, particularly in rural areas. Drones offer a number of potential advantages in rural settings. Costs could be lower than land transport due to reduced labour and fuel costs. They could also provide greater flexibility in delivery schedules. Over time, the volume of goods transported by air could increase significantly, helping to connect regional businesses to their suppliers in areas where land transport infrastructure is less developed.

Example 2: Passenger carrying drones

Passenger carrying drones (often referred to as 'urban air mobility' (UAM) operations)[4] are developing quickly, and are close to becoming a reality. There are a large number of companies developing and testing technology to transport passengers in small, electric powered aircraft, which operate autonomously and can land and take off vertically. New Zealand is already at the forefront of this development, with one company already testing its aircraft here.

It is too early to know exactly what role these 'air taxis' might play in the future transport system. The combination of electric and autonomous technologies mean that the cost of travelling in these aircraft could be considerably lower than the cost of travelling in a helicopter or small aircraft today. There is speculation that these aircraft could revolutionise our urban transport systems, providing a new transport option that will be attractive for time-sensitive passengers. However, these aircraft could also play an important role connecting communities that are not large enough to sustain regular air services using existing aircraft, and reducing transport infrastructure costs.

Example 3: Emergency services

Drones can be small, more agile, and have the potential to be better equipped for emergency services. It means that they can complement traditional surveillance operations currently undertaken by various transport modes such as helicopters.

Drones have already begun to be implemented in some emergency service departments overseas and in New Zealand. Several fire and emergency departments in the USA have deployed drones for fire mapping, searches, crash site forensics, and post-disaster monitoring. Fire and Emergency New Zealand (FENZ) has also used drones for similar purposes. Research is also being conducted into the use of drone swarms for large-scale search and rescue operations.

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4   UAM is a term used to describe a system that enables on-demand, highly automated, passenger or cargo-carrying air transportation services within and around a metropolitan environment.

Safe integration of drones into an integrated transport system

Since the beginning of commercial aviation in the early 20th century, the industry has drastically improved its safety record, to the point that commercial aviation is among the safest of all transport modes.

This has been achieved largely as a result of a low tolerance for accidents, and a robust international regulatory framework overseen by the International Civil Aviation Organization. However, human error continues to be a leading cause of accidents, and some activities within the aviation sector (such as helicopters and agricultural operations) continue to have high accident rates compared to other industries. In the long term, drones have the potential to improve safety outcomes by removing the need for humans to operate in risky environments. However, in the shorter term, drones introduce new risks into the system which need to be carefully managed.

During all stages of the integration process, safety will continue to be a primary consideration. All decisions will be consistent with the principle established in the National Airspace Policy Statement that any new technologies, systems or procedures will be assessed against the benchmark of the overall safety of the system being at least maintained, and ideally, improved.

Our objective is to safely integrate drones into the New Zealand aviation system and ultimately into an integrated transport system. In an integrated system, we will have confidence that all aircraft (manned and unmanned) are appropriately equipped and meet the necessary requirements to operate safely in any given airspace. Decisions around access to airspace will be guided by the National Airspace Policy Statement, and the principle that all aircraft will be able to access such classes of airspace that the aircraft and crew are able to operate safely within (except where restrictions on airspace are necessary due to safety, operational or other reasons).

In order to achieve integration, drones will need to be able to operate beyond the visual line of sight (BVLOS) of their pilot or operator. Before widespread BVLOS operations can occur, the necessary equipment and procedures will need to be developed and proved to enable them to operate alongside other aircraft without compromising the safety of other aviation users and people and property on the ground.

In an integrated system, transport planning and policy making will also take account of the current and future applications of drones, ensuring that it is capable of operating seamlessly with other transport options. Decision making on long-term drone issues and development would also be informed by the results and information arising from the innovative testing and trialling activities of drone technologies.

The challenges and opportunities presented by drone integration are not unique to New Zealand. Integration is an iterative and phased process as we work to address the challenges presented by safety, security (physical and cyber), privacy and enforcement. Of particular importance is national security as drones can be used to conduct illegal activity (noting that not all illegal acts are a threat to national security). The risk of these types of operations needs to be appropriately managed by having practices in place to limit instances of illegal activity and stopping them quickly if they occur.

Phase 1 – Integration into the aviation system

Drone integration has the potential to increase the use of airspace in New Zealand, both in terms of the numbers of aircraft and the number of movements they make. This increase may deliver significant economic and social benefits to New Zealand[5]. However, it could also negatively impact on existing commercial and non-commercial users (and the value gained from that use).

Greater use of drones could also affect people on the ground (e.g. through a reduced sense of privacy, and noise and visual impacts), particularly in urban areas, at popular locations or in our national parks. We must be transparent in how we balance the positive and negative impacts of drones as we consider the appropriate regulatory approach to achieve integration.

We will work with the sector and the public to build our understanding of what and where drone operations are acceptable, their flight frequency, acceptable noise levels, and how privacy concerns should be addressed.

Like piloted aircraft, there may be constraints on where drones can operate, for example, having segregated flight paths or designated no fly zones.

With a significant proportion of our low level airspace being uncontrolled, prevention of collisions between piloted aircraft is predominately achieved through 'see and avoid' and the application of internationally aligned right of way rules, often supported by radio communications between aircraft. Drones cannot use visual flight rules because there is no on-board pilot on board to 'see and avoid'.

In the early stages of integration, rigid enforcement of spatial separation between aircraft will be necessary, as part of a transitional path towards dynamic airspace configurations.[6] However, the proliferation of commercial applications of drones in the medium-term using BVLOS operations is already challenging this approach.[7] As technology develops[8], we will move to a system that can incorporate more sophisticated Detect and Avoid (DAA) technology. Integration will also require appropriate and scalable levels of air traffic control - manned and unmanned - as complexity and density increase. Although this may take some time, we will continue to integrate drones that meet the appropriate safety threshold for their operations.

Integration into the aviation sector also means bringing drones and their operators fully inside the aviation regulatory system. This will require drone operators to pay their share of the costs of ensuring an integrated, safe, sustainable and responsive aviation and transport system.

A range of new or modified infrastructure is likely to be required to enable the use of drones in urban settings, including physical drone landing zones, radio towers and spectrums, mobile phone and LTE networks, external surveillance equipment that can provide alerts and the location of air users, and Unmanned Traffic Management Systems (UTM).

An associated issue with integration is considering whether all the standards and procedures developed for the aviation sector currently, should directly apply to the drone sector (for example – single GPS constellation use in general aviation (GA) versus drones using multi-constellation satellite receivers that provide a more robust and accurate geo-location). While there needs to be alignment to enable integration, direct application of standards which were originally designed for manned aircraft may not be appropriate in all cases. In considering new standards or technologies, the impact on all users of airspace will be evaluated. However, as stated in the National Airspace Policy Statement, the slow uptake of new technologies by some airspace users will not impede the early adoption of technologies that result in benefits to the overall system.

Phase 2 – Operation of drones in an integrated transport system

Ultimately, drones stand to play a unique role in urban transport systems. If regular freight deliveries with drones and Urban Air Mobility services are to become a reality, we will need to consider issues such as infrastructure requirements, and the appropriate licensing system for operators. We must first consider how drones will be deployed and what their role in various environments (including in urban areas and for regional connectivity) to inform any long-term decisions. The work programme that underpins our vision for drone integration will consider the best way to test the feasibility of these operations.

$1.4b

Value of regional passenger transport by drones over next 25 years

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5   For example, UA are typically electric (low carbon) and could provide emission reductions in the freight sector. One of the main issues with powering 'greener' UA is how the electricity is generated locally. Over time, the technology/batteries used to operate UA will continue to develop and be more efficient which may aid in any further emission reductions.

6   Currently, airspace is reconfigured to accommodate traffic demand. In the future, it is likely to reconfigure more quickly (near instantaneously) and dynamically.

7   Other considerations include UA registration; identification systems (on-board); flight planning; communications; surveillance; procedure design; geo-awareness and obstacle identification.

8   Technological developments will be required before integration can occur, many of which are outside of New Zealand's control. Until future technological developments occur to enable safe airspace integration, UA will continue to be segregated from traditional aviation.

What does success look like?

Successful integration of drones and achievement of our vision of 'a thriving, innovative and safe drone sector' will be when:

Thriving

- Our airspace is more dynamic and easy to access so both manned and unmanned aircraft can integrate effectively and can successfully contribute to our economy.

- There is practical and economic use of drones in everyday life.

- New Zealand's drone sector is growing and globally connected.

- Drones are integrated into the wider transport system, utilising the same or new infrastructure to the extent that they are applicable and appropriate.

- It is easy for New Zealand businesses and government agencies to take advantage of drones technology in their products and services.

- New Zealand has the necessary skills required to utilise the full potential of drone technology.

- New Zealand is an attractive place for international drone investors and innovators.

- Public perception of the operation of drones is positive and any concerns about lack of safety and breached privacy are reduced.

- We continue to comply with key international standards which enable New Zealand to export and connect to the world.

Innovative

- New Zealand is a destination of choice for drone business development and R&D. Drone businesses bring their R&D initiatives to New Zealand.

- We are globally recognised as having strong R&D and testing capabilities in the drone area with the necessary talent to support it.

- New Zealand is a leader in stimulating start-up activity in the drone sector.

- We have expanding applications of more advanced and valuable drone operations.

- We have an appropriately resourced regulator to support greater drone operations, and our regulatory system provides flexibility for operators to find innovative ways of meeting safety standards.

Safe

- Our aviation regulatory regime continues to be recognised as safe, secure, and enabling.

- Our regulatory regime is at the forefront and can rapidly respond and scale to evolving technologies, applications and international practices (while not compromising our existing international obligations).

- Our regulatory regime is designed to encourage compliance, and should allow for active and visible enforcement.

- If the environment and type of drone operations allow for it, our risk tolerance for certain drone operations may increase.

- Drone operators pay their share of the costs of ensuring an integrated, safe, sustainable and responsive aviation system.

- We have established an integrated national system of data, infrastructure and operating models which initially supports safe drone integration into controlled and uncontrolled airspace and then eventually into the wider transport system. This system could eventually enable real-time or rapid information sharing and inter-service cooperation.

- The New Zealand aviation regulatory regime continues to effectively protect New Zealand national security interests.

A pathway to integration

Time is a critical factor if we are to be at the forefront of drone development. To enable this the Government has initiated a cross government programme of work to achieve our vision for drone integration.

Creating the environment for integration requires a number of complementary building blocks. We have identified four building blocks where we will propose actions and necessary timeframes to achieve drone integration. Under each of the building blocks the need to maintain safety across the aviation system is paramount.

| **Regulation** | Effective drone regulation is vital for fostering and supporting effective integration and creating social licence. On the other side, poorly designed or unresponsive regulation could create potential barriers to the integration of beneficial activities. For New Zealand to fully realise the benefits of drone operations, our regulatory system needs to be flexible, enforceable, proportionate, equitable, consistent with relevant international standards and practices and have scope to evolve to respond to changing circumstances or new information on the regulatory system's performance. Regulation should be designed to support integration and be regularly reviewed and adjusted to ensure this. As with all aviation regulation, restrictions in activity will be continue to be necessary to ensure safety and security is maintained.

There is a need to continue raising awareness of the rules, regulations and safety requirements for drone operations (through education and improving the way in which we communicate with the public and through visible enforcement of regulations). There is also a need to better understand what drone operations (commercial and recreational) the public is comfortable with. This is likely to help address any public concerns about drone operations. |
|---|---|
| **Funding and investment** | Through integration, the requirements of our aviation and transport system will change. We will consider what investment may be needed to support our vision and who should fund this investment (local and central government, drone operators, third party or public private partnership). |

Infrastructure and technology	In the short term, it is likely that investment in new technology (e.g. transponders) and infrastructure (e.g. ground stations, transport connections and drone ports) will be required. Any decisions on the type of technology or infrastructure will require robust analysis and stakeholder engagement. This would include considering the modernisation of any existing systems for example the NOTAM system (a notice to airmen) and other future technology developments like machine learning and artificial intelligence. We must be aware that the decisions we undertake may change the way we fund our transport revenue system and the design and management of transport corridors across New Zealand.
Research and development	The drone sector is R&D intensive, with a focus on technology areas (e.g. automation, energy management, noise and configuration, positioning, detect and avoid systems, and air traffic management) that are also applicable to a range of other sectors. To fully realise the benefits of the regulatory interventions and investments in infrastructure and technology, governments also have a key role to play in supporting the development of domestic R&D capabilities and talent.

Leadership and collaboration

Integration requires a coordinated cross-government (both local and central) and industry approach to fully consider and address all the potential benefits and risks associated with drone integration. The UA Integration Leadership Group[9] will provide strategic guidance and oversight of the work to achieve the safe integration of drones into New Zealand's aviation and transport systems (Appendix 3 provides further detail).

Supporting this will be a cross-government group which provides a forum for agencies collaborate and coordinate on drone integration issues, and also regular engagements with the industry to provide operational and technical advice on drone integration matters.

We also have the opportunity to influence the global direction on drone operations and should be deliberate about which international standards we want to influence to help us achieve our vision.

9   Made up of senior officials from the Ministry of Transport (Chair), CAA, Airways and MBIE.

Being a responsive and responsible global citizen

We must be a responsive and responsible global citizen in aviation. Globally, New Zealand is often recognised for its progressive and risk-based approach to aviation regulation. We are well regarded for our pragmatic solutions, and the integrity of our regulatory system due to our commitment to safety and security.

To maintain this position we must continue to collaborate with the domestic and international drone stakeholders (including the Joint Authorities for Rule Making on Unmanned Systems (JARUS) and the International Civil Aviation Organization (ICAO)) to carefully consider other international standards and ensure their appropriateness and applicability to the New Zealand context, while also ensuring harmonisation and global interoperability.

For all drone regulatory work, care must also be taken to ensure we do not interfere or infringe upon existing international treaties to which New Zealand is a party.

This vision is living and evolving

This vision for drone integration is intended to be an evolving framework. As technology continues to rapidly develop this in turn will influence our knowledge and view of what "integration" could be and what it could look like in practice. As work progresses, this document and any associated strategy and work programme will be reviewed and updated accordingly. The strategy should also consider how we monitor and evaluate interventions we have undertaken (particularly regulatory interventions), to ensure we are achieving our intended outcomes.

Appendix 1 – How we are currently enabling safe drone operations in our aviation system

In New Zealand, the principal regulatory control for the aviation system is the Civil Aviation Act 1990 and associated Civil Aviation Rules. New Zealand's current regulatory framework for drone operations is risk-based and flexible; it permits innovative uses of this technology, while supporting a high standard of safety.

At present, most small drone operations occur under Rule Part 101 and its set of prescriptive rules to manage risk and help protect existing aviation users and the public. Those wanting to operate larger drones or undertake operations outside of Part 101 can apply for operator certification to the CAA based on a safety case under Rule Part 102.

Part 102 has attracted a range of international and domestic companies to develop, test, trial and manufacture drone technology in New Zealand, which has increased economic development here. Operators can conduct R&D under Part 102 in a manner whereby restrictive limitations are initially placed on them, such as conducting activities in Restricted Airspace. As they demonstrate the safety of their aircraft and operation, these limitations are incrementally reduced.

With the likely growth in the use of medium and large drones (e.g. for passenger transport), there will be a need to ensure the entire suite of Civil Aviation Rules are reviewed and updated appropriately to accommodate such operations. For example, in the long-term Part 102 is not currently well-suited to certify a large, passenger carrying operation similar to traditional aircraft certified under Part 121. Similarly, there is likely to be a need to review airspace classifications, particularly in the very low levels, should goods delivery by smaller drones become commonplace.

Appendix 2 – Other drone use cases

Sector	Potential uses
Agriculture	Precision application of fertilisers and treatments
	Inspection, monitoring, and mapping
	Rural delivery
	Pest detection via infrared sensors
	Herd mustering
Infrastructure	Lines Inspection
	Bridge Inspection
	Road Inspection and condition monitoring
	Building inspections
	Mapping
Civil and National Defence	Post-disaster recovery and repair
	Resource and border monitoring
	Fire monitoring
	Forensic searches
Commercial uses	Videography and photography
	Urban delivery
	Urban Air Mobility
	Tourism
Education	Pilot and operator training
New sectors	Development of a drone manufacturing sector
	Development of a drone design sector
	Development of a drone research sector
	Export of output of above sectors

Appendix 3 – Government Department and Agency Roles and Responsibilities

To provide clarity and for coordination purposes, the section below shows what the drone working arrangements are and describes the role and responsibilities of each of the departments in the UA Integration Leadership Group.

UA Integration Leadership Group

Ministry of Transport

The Ministry is the Government's principal transport advisor. The Ministry has a system leadership and regulatory stewardship role. In relation to drones, the Ministry's key role is to provide strategic direction to other participants in the sector. This includes working with other agencies to understand the impact of drones on the aviation system and the role that drones can play in our broader transport system, and ensuring that our regulatory system strikes the right balance between enabling innovation and addressing risks to the public and other aviation participants.
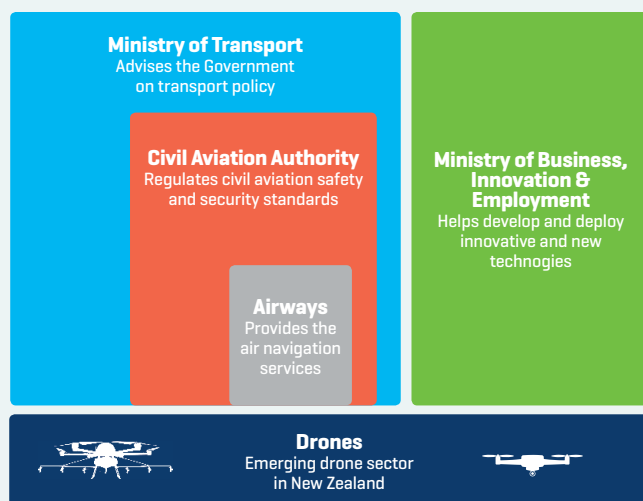
Civil Aviation Authority (CAA)

The CAA is responsible for the safety and security regulatory oversight of the civil aviation system, and the enforcement of the relevant regulations for that system. The objective of the CAA is to undertake its safety, security and other functions in a way that contributes to the aim of achieving an integrated, safe, responsive and sustainable transport system. This purpose and objectives will continue to apply in an integrated system as outlined in this Vision paper.

Airways New Zealand

A state-owned enterprise, Airways is New Zealand's sole air navigation service provider (ANSP) and is certificated and regulated by the CAA. Airways role is to operate the required airspace management and supporting infrastructure to enable safe and efficient integrated drone flight into the New Zealand aviation and transport system. Airways also actively supports international efforts to bring innovation and R&D to support safe and efficient drones into New Zealand.

Ministry of Business, Employment and Innovation

MBIE is the Government's principal economic development advisor. Its goal is to create a resilient and high-performing economy. Through its Innovative Partnerships programme it seeks to build New Zealand's competitive advantage as a location to develop and deploy innovative and new technologies. In relation to drones, its objective is to position New Zealand as a location of choice for the emerging global drone sector.

New Zealand Government