Emerging Aviation Technologies - NATIONAL AVIATION POLICY ISSUES PAPER Submission

I welcome the opportunity to respond to the National Aviation Policy Issues Paper. Many countries are making significant investment in future aviation planning, policy, regulation development and innovation. In particular, I would note the United States work on Advanced Air Mobility[1], the United Kingdom's Future Flight Challenge[2], France's work on Air Mobility[3] and Singapore's Urban Air Mobility Trials[4].

Aviation has always played a significant role in Australian society and the economy. As we enter the third era of aviation[5], it will be critical for Australia to have an explicitly planned and effectively implemented policy and regulatory roadmap. Successfully implementing a well thought out roadmap for emerging aviation technologies will ensure the potential benefits for and risks to society are actively managed.

This is a personal submission and the viewpoints expressed are my own. I believe strongly in making a contribution to the future of aviation in Australia.

Dr Rob Weaver
Rob Weaver Advisory
11 October 2020

Core Principles

The core principles presented in the paper are sound, however there are some additional considerations which should be included to formulate an effective set of principles for future policy.

The principles rightly start with safety and security, however in society it is now important to consider *resilience* alongside these other attributes. Australian future aviation will be a complex system of systems. Inherent in complex systems is the characteristic of emergent behaviour[6]. Accurately predicting the negative consequences of complex systems is not always possible given their non-deterministic nature. Despite significant regulation, planning and management things will still go wrong. 737 MAX may provide an example of the challenges of ensuring safe outcomes in the complex system of aviation[7]. Things will go wrong and the future aviation system must be resilient to these events.

---

[1] https://www.nasa.gov/aam
[2] https://www.ukri.org/innovation/industrial-strategy-challenge-fund/future-flight1/
[3] https://www.reinventairmobility.com
[4] https://press.volocopter.com/index.php/volocopter-air-taxi-flies-over-singapore-s-marina-bay
[5] https://unitingaviation.com/news/general-interest/anc-talks-a-new-digital-era-of-aviation-and-the-path-forward-for-airspace-and-traffic-management/
[6] https://www.raeng.org.uk/global/international-partnerships/engineering-x/safer-complex-systems
[7] https://www.york.ac.uk/assuring-autonomy/news/blog/accidental-autonomy/

Recommendation 1: Resilience must be a core principle of the future aviation system and the organisations and services within it. It should be explicitly addressed in the Emerging Aviation Technologies Policy.

The Issues Paper correctly identifies that a market management approach to the core principles should be "Technology driven". While the innovation in emerging aviation technologies will be technology driven, the Policy approach must holistically consider all aspects of the aviation industry including governance (regulation & policy) and organisations.

The impacts of innovation in aviation and the introduction of more complex systems must be considered and managed in an integrated manner across governance, organisational and technological layers. Many of the changes that will be required will be at the governance and organisational levels. Examples of this include the need for a more dynamic regulatory framework, which can adapt to rapid changes in technology, and the ability for new entrants to the aviation industry being able to employ mature safety management practices seen across traditional aviation industry organisations.

Recommendation 2: The Emerging Aviation Technologies Policy should consider how changes can be made at the governance, organisational and technological layers in an integrated manner to ensure effective outcomes.

When considering airspace, the Core Principles should embody the full set of ICAO Key Performance Areas as defined in the Global Air Traffic Management Operational Concept (Doc 9854), ICAO 2005. These are quoted from Doc 9854 below:

"Access and equity. A global air navigation system should provide an operating environment that ensures that all airspace users have the right of access to ATM resources needed to meet their specific operational requirements; and ensures that the shared use of the airspace for different airspace users can be achieved safely. The global air navigation system should ensure equity for all airspace users that have access to a given airspace or service. Generally, the first aircraft ready to use the ATM resources will receive priority, except where significant overall safety or system operational efficiency would accrue or national defence considerations or interests dictate by providing priority on a different basis.

Capacity. The global air navigation system should exploit the inherent capacity to meet airspace user demand at peak times and locations while minimizing restrictions on traffic flow. To respond to future growth, capacity must increase, along with corresponding increases in efficiency, flexibility, and predictability while ensuring that there are no adverse impacts to safety giving due consideration to the environment. The air navigation system must be resilient to service disruption and the resulting temporary loss of capacity.

Cost effectiveness. The air navigation system should be cost effective, while balancing the varied interests of the ATM community. The cost of service to airspace users should always be considered when evaluating any proposal to improve ATM service quality or performance. ICAO guidelines regarding user charge policies and principles should be followed.

Efficiency. Efficiency addresses the operational and economic cost effectiveness of gate-to-gate flight operations from a single-flight perspective. Airspace users want to depart and arrive at the times they select and fly the trajectory they determine to be optimum in all phases of flight.

Environment. The air navigation system should contribute to the protection of the environment by considering noise, gaseous emissions, and other environmental issues in the implementation and operation of the global air navigation system.

Flexibility. Flexibility addresses the ability of all airspace users to modify flight trajectories dynamically and adjust departure and arrival times thereby permitting them to exploit operational opportunities as they occur.

Global interoperability. The air navigation system should be based on global standards and uniform principles to ensure the technical and operational interoperability of air navigation systems and facilitate homogeneous and non-discriminatory global and regional traffic flows.

Participation by the ATM community. The ATM community should continuously be involved in the planning, implementation, and operation of the system to ensure that the evolution of the global air navigation system meets the expectations of the community.

Predictability. Predictability refers to the ability of the airspace users and air navigation service providers to provide consistent and dependable levels of performance. Predictability is essential to airspace users as they develop and operate their schedules.

Safety. Safety is the highest priority in aviation, and ATM plays an important part in ensuring overall aviation safety. Uniform safety standards and risk and safety management practices should be applied systematically to the air navigation system. In implementing elements of the global aviation system, safety needs to be assessed against appropriate criteria, and in accordance with appropriate and globally standardized safety management processes and practices.

Security. Security refers to the protection against threats, which stem from intentional (e.g. terrorism) or unintentional (e.g. human error, natural disaster) acts affecting aircraft, people or installations on the ground. Adequate security is a major expectation of the ATM community and of citizens. The air navigation system should therefore contribute to security and should be protected against security threats. Security risk management should balance the needs of the members of the ATM community who require access to the system with the need to protect the air navigation system. In the event of threats to aircraft or threats using aircraft, ATM shall provide responsible authorities with appropriate assistance and information."

Recommendation 3: The Emerging Aviation Technologies Policy should adopt the ICAO Key Performance Areas for Air Traffic Management as part of the Core Principles

Air Mobility

The Issues Paper provides some introductory information on Urban Air Mobility and Regional Air Mobility. A more in-depth contemporary understanding of these can be found in the recent Deakin University publication on the future of electric aviation in Australia[8].

Importantly, there are additional advances in aviation fuel technology beyond electric. There is significant work occurring in the world on other alternate sources of power, especially hydrogen[9]. These other fuel technologies will also have impacts on the future Australian aviation industry.

Recommendation 4: The Emerging Aviation Technologies Policy should consider other future aviation energy technologies such as hydrogen.

It should be noted that there are a number of air mobility use cases not explored in the Issues Paper that will be relevant in Australia. Urban Air Mobility will likely include scheduled services as well as on-demand air taxis. In remote locations, the ability to provide cheaper and more efficient air mobility solutions will be extremely beneficial where ground-based solutions are not practical or inefficient. Emergency service use of new air mobility solutions will potentially be an early use case, given that it is more likely that communities will support use for this application.

Recommendation 5: The Emerging Aviation Technologies Policy should consider the maintenance of a set of published Australian use cases and concepts of operation for air mobility to assist policy makers, regulators and organisations remaining consistent in understanding and decision making.

Drones

It should be noted that there are a number of “drone” use cases not explored in the white paper that will be relevant in Australia. Robotic function drones will become more common place – crop spraying is an example early application of this type of drone. Broadcast functions, such as telecommunications in specific circumstances (e.g. after a natural disaster) are another important application. Large scale drones, more similar to autonomous and unmanned versions of traditional cargo aircraft are likely to be a highly used application. In addition, the range of applications for High Altitude Platforms should be understood as part of the policy-making process. The use of the term “drone” in the Issue Paper, while familiar to the wider public does not capture the range of applications of unmanned and autonomous aircraft.

Recommendation 6: The Emerging Aviation Technologies Policy should consider the maintenance of a set of published Australian use cases and concepts of operation for drones and autonomous aircraft to assist policy makers, regulators and organisations remaining consistent in understanding and decision making.

---

[8] https://www.deakin.edu.au/about-deakin/media-releases/articles/the-future-of-electric-aviation-in-australia-deakin-launches-comprehensive-white-paper-on-possibilities-and-next-steps

[9] https://www.rolandberger.com/en/Publications/Hydrogen-A-future-fuel-of-aviation.html

Australian Bushfire Prevention

Without doubt, there are significant potential applications for drones in bushfire early detection and prevention. Surveillance drones with the ability to detect bushfires early, and robotic drones with the ability to extinguish or reduce the consequence of bushfires early have an important future role for Australia. Australia should take global leadership in developing and implementing this technology.

Recommendation 7: The Emerging Aviation Technologies Policy should explicitly make policy for the Australian Government to invest in the development and implementation of emerging aviation technologies for bushfires and other emergency or natural disaster prevention and mitigation relevant to Australia.

New technology in current aviation systems

In addition to drones, air mobility and new forms of energy, other parts of the current aviation system will see radical change in the same timescales as discussed in the Issues Paper. This includes greater use of autonomy in the cockpit and other aviation systems. An example of this is research already undertaken on drop-in solutions to provide robotic piloting capability on current aircraft[10]. As well as autonomy, traditional aviation will see advances in the types of fuel used in the same way as Regional and Urban Air Mobility. Likely technology innovations (in particular autonomy and fuel usage) will have many impacts for the aviation industry which should be considered holistically with the innovations discussed in the Issue Paper.

Recommendation 8: The Emerging Aviation Technologies Policy should consider technology innovation in current aviation systems, especially autonomy and fuel types.

UTM

The Issues Paper uses the term UTM to mean Unmanned Traffic Management. This is different to the definition of the term by ICAO as Unmanned Aircraft System (UAS) Traffic Management[11]. While this distinction may seem inconsequential to some readers, it is extremely important to understand the meaning of the term "UTM". UTM is a term used by many organisations to mean many different things. These definitions will have an important impact on the success of Australia's future traffic management system.

UTM was originally identified as a solution for managing drones and we now see an industry of UTM service and technology providers establishing itself globally. As such, the requirements for UTM as an unmanned drone traffic management system were relatively easily defined (albeit challenging to implement). Being limited to non-passenger carrying activity, the safety assurance requirements for drones and UTM would be different in nature to those to which the operators of passenger carrying traditional aviation aircraft

[10] https://www.darpa.mil/program/aircrew-labor-in-cockpit-automation-system
[11] Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonization (Edition 2), ICAO

and the associated ATM systems are held. Simply put, the safety of life exposure risk is much lower, hence the assurance requirements are lower.

More recently, some organisations have hypothesised that UTM can be used for Urban Air Mobility in the future, often describing it as being “added in” later. Urban Air Mobility vehicles will, in the majority, be piloted aircraft for a significant period of time[12]. Urban Air Mobility vehicles will need to integrate with other airspace users (including Regular Public Transport and General Aviation) in controlled and uncontrolled airspace. They may initially fly only in Visual Meteorological Conditions (VMC) but will eventually need to fly in Instrument Meteorological Conditions (IMC). As the density of operations in the urban environment increases, it will no longer be practical to apply VFR see-and-avoid principles which are currently used in uncontrolled urban airspace. A new approach to traffic management for airspace users in a dense urban environment will be needed. Current Air Traffic Management systems will not be sufficient and cannot be easily adapted to provide sufficient services. Unmanned Aircraft Systems Traffic Management is not being designed for high density piloted IMC operations in an urban environment. This has not been designed into the architecture and approach to date. The Issues Paper states that it will somehow be added in later.

In addition, greater use of autonomy in traditional aviation and more use of High Altitude Platforms will require significant changes to be made to traditional Air Traffic Management systems and approaches. Air Traffic Management will advance at the same time as Unmanned Aircraft System Traffic Management and the necessary new traffic management approaches for dense urban IMC operations.

It will not be possible to design a successful UTM approach for Australia without consideration of all potential future users and the changes required by other aviation industry participants in a similar timeframe. Other users such as Urban Air Mobility cannot necessarily be added in later without significant rework and cost. The design of a UTM for Australia should consider all future users from initial planning and architecture. Unmanned Traffic Management and Unmanned Aircraft System Traffic Management are not appropriate terms for the future traffic management system for Australia, which will need to integrate piloted passenger carrying aircraft. The future traffic management solution should be called “Unified” or “Integrated” rather than “Unmanned” to better reflect the range of airspace users it will need to support. This traffic management solution will eventually replace ATM and this should be strategically planned for.

Recommendation 9: The Emerging Aviation Technologies Policy should adopt the term Unified Traffic Management or Integrated Traffic Management and ensure that it is architected for all future types of user. The future traffic management system architecture should address all future airspace users and define a roadmap for integration with Air Traffic Management and eventually unification.

Recommendation 10: The Emerging Aviation Technologies Policy should consider the near-term traffic management requirements for Urban Air Mobility to ensure that the

[12] I would suggest until at least 2030

urban airspace environment remains safe and efficient and the introduction of new operations are not affected, given the inability for ATM and UTM to support the operation.

It is important to be aware of the position statement of Airbus and Boeing with respect to UTM and the need for an integrated ATM and UTM approach[13]. In particular, they call for action to be take on "**A unified air traffic management system**: New ATM concepts for all airspace users that facilitate the safe integration of new vehicles and technology are needed. UTM development must have provisions for evolution in order to support a future "integrated airspace and ATM" operating concept, not just the needs of the here-and-now small UAS sector."

It is important to be aware of the work by NASA on an architecture for UAM[14], which is in addition to the Unmanned Aircraft System Traffic Management Architecture that they have previously published. This work implies that NASA believe that the Unmanned Aircraft System Traffic Management Architecture is not sufficient to incorporate Urban Air Mobility.

Regulation

Historically, regulatory change in aviation is slow across the world. However, aviation has an extremely successful track record with respect to safety. Ensuring that regulation can be responsive to future innovation and Australia's aviation safety track record can be maintained is a challenge.

The application of outcome or goal-based standards should be analysed to understand where they can be applied in combination with Acceptable Means of Compliance. Where practical, regulation that can be applied to multiple areas (e.g. Vertiports & Helicopter Landing Sites, see-and-avoid & detect-and-avoid) should be used. However, goal-based regulation can be hard to implement for organisations which lack experience and regulatory compliance maturity. Support should be provided to new entrants to Australian aviation to ensure that maturity in safety management practices is maintained.

Recommendation 10: The Emerging Aviation Technologies Policy should consider appropriate use of goal-based regulation in combination with appropriate support to maintain safety management maturity across the new Australian aviation industry.

The regulation for UTM must be at the same standard as for Air Traffic Management where the risks managed are the of the same level. This requirement is significant and will be difficult to achieve for UTM providers. If obligations that are placed on Air Traffic Management are not placed on UTM providers but moved to operators, the loss of redundancy and/or independence in their management must be mitigated.

Recommendation 11: The Emerging Aviation Technologies Policy should ensure that regulation of traffic management systems is equitable in line with the risks they mitigate.

[13] https://www.airbusutm.com/a-new-digital-era
[14] https://nari.arc.nasa.gov/sites/default/files/attachments/UAM_ConOps_v1.0.pdf

For commercially available drones available to the public, Government should use regulation to require they are geo-blocked by manufacturers to design out the risk for the majority of “non-professional” drone users.

Recommendation 12: The Emerging Aviation Technologies Policy should ensure that use of drones by non-professionals occurs in a geo-blocked environment through regulation of manufacturers.

Governance and central co-ordination

The Issues Paper talks about governance and central co-ordination being used for managing challenges, however it is equally important for this activity to ensure that the benefits of emerging aviation technologies are realised. An issues-only focussed approach will likely lead to a slower and more cautious approach to the adoption of innovation. In doing this, many benefits for society may be lost and Australia would become a consumer of innovation undertaken elsewhere in the world. It is likely that global leadership and significant benefits will occur in nations who are able to successfully balance the challenges with an emphasis on the realisation of opportunities.

A key challenge for the co-ordination activity will be determining how costs are appropriately allocated to pay for the changes needed in regulation and supporting infrastructure, e.g. traffic management systems. How these costs are allocated will also impact the realisation of opportunities from emerging aviation technologies.

Recommendation 13: The Emerging Aviation Technologies Policy should ensure that central co-ordination manages the realisation of benefits in combination with the management of challenges. The Policy should establish a mechanism to determine how costs for regulation and supporting infrastructure of future aviation operations are allocated.