



# Future Flight Challenge Workshop

18 January 2019

# The Future Flight Challenge



Demonstrates aviation systems incorporating low environmental impact, electrified, increasingly autonomous air vehicles and airspace management by 2025

Pioneers an accessible airborne mass transit and service delivery system

Unlocks new aviation markets worth over \$2Tr and enhances UK prospects in the \$17Tr conventional aviation markets to 2050

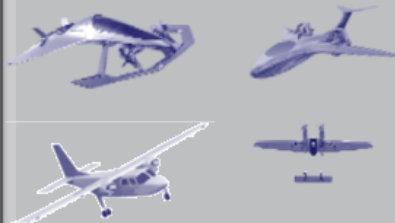
Airborne transformation of UK connectivity, exports, productivity and mobility

# Future Flight Challenge workstreams

## Future Air Transport & Services as a System of Systems

New models of  
airspace  
management and  
anticipatory  
regulation

Novel Air Vehicle  
Demonstrators



Ground Infrastructure  
Systems  
Demonstrators – city  
& sub-regional  
airport

New operating  
models for users and  
commercial operators  
of air services

Engagement of authorities is critical (including DfT, BEIS, Local and City Authorities, TfL, CAA, OFGEM)



# UKRI briefing and Q&A

# Industrial Strategy Challenge Fund (ISCF)

## Future Flight Challenge (Update 18 Jan 19)

Andrew Lawrence (EPSRC, UKRI)

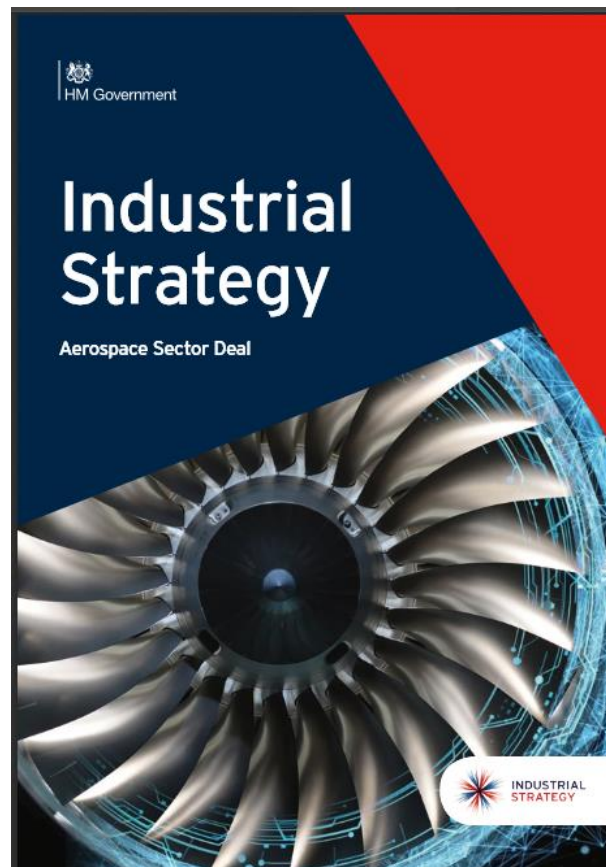
John Morlidge (InnovateUK, UKRI)

# Future Flight Challenge - Aerospace Sector Deal Ministerial Round Table (3 Dec 18)



## Electrification and autonomy

- ▶ Up to £125m Industrial Strategy Challenge Fund funding for the Future Flight programme which will implement activities to deliver a more electric, autonomous and environmentally friendly aviation and aerospace sector. It will offer new options for how people and goods could move around in the future and showcase the UK as driving new mobility solutions.



# Future Flight Challenge – Ministerial Round Table (3 Dec 18)



- *Colin Smith will act as the senior industry leader for the Future Flight challenge, with the responsibility to continue negotiations with government.*
- *Lynn Gladden, Executive Chair of the Engineering and Physical Sciences Research Council, will take forward conversations with Colin, challenging and supporting him to increase industry funding and benefits to the UK.*
- *Nomination of candidates for the appointment of an interim Challenge Director – as with all challenges already operating, we want this to be a senior individual from industry.*

# Future Flight Challenge

– thoughts for today's workshop



- *how this challenge will demonstrate collaboration between companies of different enterprise sizes, including non-usual collaborations between new market entrants and more established businesses, and engagement with regulators and appropriate certification bodies.*
- *how this challenge will provide the required governance and coordination to ensure that key outputs and demonstrators are delivered at appropriate pace to be globally competitive.*
- *how this challenge promotes a global dimension and provides opportunity to engage with new global partners.*



# Future Flight Challenge


– thoughts for today's workshop



## Future Air Transport & Services as a System of Systems

- System of systems architecture
- Synthetic modelling environment
  - Assess safety, environmental and economic impact
- Public engagement and survey


### New models of airspace management and anticipatory regulation

- Synthetic environment for airspace management system
  - Airspace management demonstration – drones in cities
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### Novel Air Vehicle Demonstrators

- Drones with scalable autonomy
  - All Electric/ Hybrid VTOL
  - All Electric/ Hybrid CTOL
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### Ground Infrastructure Systems Demonstrators – city & sub-regional airport

- Drone services
  - Electric air vehicles
- 

### New operating models for users and commercial operators of air services

- Future market synthetic environment
  - Drone system services demos
  - Business models for electrified urban and sub-regional air vehicles
- 

Engagement of authorities is critical (including DfT, BEIS, Local and City Authorities, TfL, CAA, OFGEM)

# Today's workshop

- Review outcomes from last workshop
- Attendees to be divided into 5 groups aligning to the workstreams.
- Workshop outputs to include:
  - Consider critical stakeholders and collaboration opportunities for the workstream
  - Review declared deliverables and outcomes from previous workshop:
    - define what success looks like
    - identify key priorities
    - identify interdependencies with other workstreams
  - Identify global collaboration opportunities arising from this Challenge
  - Identify any specific next steps for individual working groups


# Addressing the Future Flight Challenge




## Future Air Transport & Services as a System of Systems

- System of systems architecture
- Synthetic modelling environment
  - Assess safety, environmental and economic impact
- Public engagement and survey


### New models of airspace management and anticipatory regulation

- Synthetic environment for airspace management system
  - Airspace management demonstration – drones in cities
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- A 3D visualization of a synthetic environment for airspace management, showing a cityscape with various drone flight paths and a central control interface.

### Novel Air Vehicle Demonstrators

- Drones with scalable autonomy
  - All Electric/ Hybrid VTOL
  - All Electric/ Hybrid CTOL
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- A collection of images showing various aircraft demonstrators, including a drone, a VTOL aircraft, and a CTOL aircraft.

### Ground Infrastructure Systems Demonstrators – city & sub-regional airport

- Drone services
  - Electrified air vehicles
- 
- A diagram illustrating ground infrastructure systems, showing a network of nodes and connections representing city and sub-regional airport infrastructure.

### New operating models for users and commercial operators of air services

- Future market synthetic environment
  - Drone system services demos
  - Business models for electrified urban and sub-regional air vehicles
- 
- A diagram illustrating new operating models, showing a network of nodes and connections representing the future market synthetic environment.

Engagement of authorities is critical (including DfT, BEIS, Local and City Authorities, TfL, CAA, OFGEM)

# Future Air Transport and Services System of Systems

Future electrified and autonomous air transport and services as an integrated system of systems

- **Requirements (2021)**
  - Cardinal points specifications for demonstrators (2019) / System Architecting (by mid-2022)
  - Development of new concepts of operation for new urban air transport systems and planning applications underway for infrastructure developments / Revenue earning services covering different concepts of use for novel air transport systems
- **Options for air transport system and services (2020)**
  - Integration into existing or planned ground and air transport eco-systems / Market segmentation and market analysis studies / Develop guidelines for route to Certification / Inter-modality of systems of systems
  - Operational parameters for drone use clarified and UTM drone trials initiated (by 2021) / Coexistence of drones and UATs with GA and civil air transport, including rules and procedures (by 2022) / Initial roll-out of services on a trial basis (by 2023)
- **Public survey and engagement to shape the future air transport and services system (2023)**
- **Synthetic Environment (2022)**
  - Definition of sub-models required for synthetic environment implementation (i.e., UTM, vehicles, env. impact, infrastructure, economics, etc)
  - National, accessible, open synthetic test and modelling environment / Definition and testing of operating systems models
- **Safety, Security, Environmental Impact and Sustainability Models (2023)**
  - Safety requirements and safety case, assurance and management definition for future aviation / Regulatory framework
  - Enterprise architecture approach to cyber security
  - Cost, benefit and trade-off studies / Socio-environmental impact understanding and considerations for public acceptance

# New Models of Airspace Management and Regulation

New models for airspace management and anticipatory regulation in which remotely piloted and/or autonomous air vehicles would be fully operational across a spectrum of complex environments

- **Creation of a synthetic environment to enable demonstration of an artificial intelligence airspace management system (2021)**
  - Requirements Capture
  - Large scale UTM demonstrations
  - Agreed UK regulatory approaches / standards with a view to gaining international recognition
  - Determine levels of integration separating UAVs less than 500 feet with commercial airliners with current ATM
  - Determine levels of autonomy in vehicle and management
- **Scaling and integration of the synthetic artificial intelligence airspace management system with traditional air vehicles (by 2023)**
- **BVLOS autonomous drone services operating in UK airspace (2023)**
  - Regulatory development by the CAA alongside dialogue with overseas aviation regulatory bodies EASA, ICAO, etc
  - Study on Human Factors and Legal considerations
  - Study on two-way communications from drones
- **Demonstration of an autonomous passenger carrying aircraft capable of BVLOS operations in UK airspace (2023)**
  - Regulatory development by the CAA alongside dialogue with overseas aviation regulatory bodies EASA, ICAO, etc
  - Study on Human Factors and Legal considerations

# New Air Vehicle Demonstrators

Novel air vehicle designs featuring autonomous and electrical technologies producing clean, quieter, and cost-effective aircraft for regional and urban use.

- **Drones fit for certification with high levels of automation for BVLOS operation in non-segregated airspace to deliver goods and perform services (by 2021)**
  - Establish state-of-the-art and down-selection of demonstrators and environments (2019)
  - Define system of systems requirements for vehicles, infrastructure and regulation
  - Use of COTS platforms for flight demo for repeatability of operations in non-segregated airspace using virtual and physical test enviro.
  - (beyond 2021) Integration of outcomes from other workstreams to demonstrate repeatability in other environments, roles, missions
- **Design, manufacture and flight demonstration of passenger carrying hybrid electric/electric VTOL air vehicles**  
Short definition stage limited to 4-cardinal points (<1 month)
  - Unfunded competition to paper conceptual design stage (3-6 months)
  - Down-select to two concepts
  - Research projects to design and built of 2 concepts to flight demonstration in 12-18months (1) Basic air vehicle and propulsion system (2021), and (2) Single pilot and autonomous operation (2023) (Follow a competitive process similar to JSF for VTOL HE/E vehicle)
- **Design, manufacture and demonstration of single pilot capable passenger carrying *sub-regional* electric/hybrid air vehicles**  
(Two separate streams required – goals economics and environment including noise with on-shoring of capability)
  - Electrification of existing conventional aircraft to demonstration (Focus on power-train development and integration with regulatory/infrastructure interaction) (2021)
  - Demonstration of an optimised vehicle design – set by PLR and cardinal point challenge (Intent competitive approach similar to VTOL/JSF to optimised electrified CTOL demonstrator ) (2023)

# Ground Infrastructure Systems Demonstrators

Infrastructure systems enabling innovative aviation-based technology and service models, integrated with multi-modal transport links and local take-off and landing points equipped to accommodate new forms of aviation

- **Demonstrators of UK airports capable of operating a commercial sub-regional electric aircraft (2023)**
  - Physical demonstration of airfield and heliport capability for sub-regional use via a UK regional network of shared infrastructure for multi-use airspace operations – outcomes will be standards defined for physical and non-physical infrastructure requirements.
  - Demonstration in controlled environment by 2021;
  - Commercial demonstration in open environment by 2023.
  - Demonstration of large scale UK airports capable of operating conventional large passenger aircraft operations alongside commercial sub-regional operations – outcome will be a study on scalability to aid in accommodating increased number of sub-regional aircraft in large airports. Project to set requirements and standards for increased traffic and electrification infrastructure needs.
- **Demonstrations of Infrastructure developments that could support complex, multi-functional operations**
  - Virtual demonstration of landing/take-off and infrastructure for drones operating between warehouse/storage and urban environment – outcome is a virtual model that will inform regulation and standards for infrastructure use and operation.
  - Drone services (2021)
  - Drones in operation in cities (2023)
- **Demonstration of Infrastructure for urban air passenger vehicles in complex city environment**

# New Operating Models for Users and Operators

New operating models for users and commercial operators of socially acceptable autonomous, low-environmental impact air vehicle services, including passengers, freight and information services

- **Digital, Analytical model to simulate, develop and evaluate commercial service markets (by 2021)**
  - Study into modal shifts (which, how and how much new entrants will displace or complement existing models)
  - Research project to develop a digital platform as synthetic environment to model flow, frequency, routes, costs, etc / Knowledge capture of existing transport models (Car/Rail/Air) to see how they can be re-purposed for urban air modelling / Identification of minimum commercially viable routes/services / Value chain analysis – where can the UK become a leader/follower/exporter
  - How is security addressed? (Airport security for air taxis is not appropriate)
  - Capacity modelling: Study to understand the capacity of the airspace and what are the physical restrictions using today's ATM technology and predicted future ATM technologies
- **Establishment of business models for commercial operations of electric/hybrid Urban VTOL and sub-regional aircraft (2022)**
  - Study on potential new business models enabled by urban and sub-regional aircraft including: operators of fleets, infrastructure providers, etc
  - Pilot schemes to prove new business models
  - Study to examine difference governance frameworks (Culpability – Government agencies / private companies / pilots / operators / ATM) / Enabling regulation of new model
  - Report identifying specific use cases and targeted specific applications / Study to identify how existing networks can be revamped (eg NHS pathology system can be overhauled using urban air solutions).
- **Sand Pit Demonstrator projects for multi-functional urban and regional drone system delivered services operating across several UK cities (2023)**
  - Variables affecting sand pit demonstrator: Platform size; Communications capability (level of autonomy); Flight frequency; In rough chronological order: One-off unique flights; Regional test beds; High rate services.
  - Test beds in urban environments



# Initial mapping for Working Groups

Stakeholder type	Air Transport system	Air Management and Regulation	Air Vehicle	Infrastructure	Business Models
ACADEMIA	X	X		X	X
AIRPORT	X	X	X	X	
ATI	X	X	X	X	X
GOVERNMENT POLICY	X	X		X	X
LOGISTICS GROUP	X				X
NATS	X	X		X	
PRIME	X				
REGULATOR	X	X	X		X
LOCAL AUTHORITY	X			X	X
SYSTEMS & SERVICES PROVIDER	X	X	X	X	X
TRANSPORT SYSTEMS CATAPULT	X			X	
DRONE MANUFACTURER			X		
DRONE OPERATIONS	X		X	X	
DRONE OPERATOR			X	X	X
URBAN AIR VEHICLE MANUFACTURER			X		
URBAN AIR VEHICLE OPERATIONS	X		X	X	
URBAN AIR VEHICLE OPERATOR			X	X	X
SUB REGIONAL AIR VEHICLE MANUFACTURER			X		
SUB REGIONAL AIR VEHICLE OPERATIONS	X		X	X	
SUB REGIONAL AIR VEHICLE OPERATOR			X	X	X



# Feedback from the groups

# Working Group 1 feedback:

## Air Transport & Services as a System of Systems

- Key priorities
  - Importance of defining a clear **vision** of future air transport system
  - Need to identify specific **use cases** which can drive capability development
  - Define **approach** for how system should be developed
  - **Buy-in** of existing stakeholders in air transport, new stakeholders and public (UK and RoW)
  - Support development of **business models** for the use cases
  - Virtual environment and development of **digital twin** will be key to implementation and growth
  - Importance of understanding **data** – what is available now and what specifically is needed

# Working Group 2 feedback:

## Airspace Management & Regulation

- Key priorities
  - **Rules of the air** to be established specifically below 500ft but need to consider wider airspace
    - How do we link the 'urban air' airspace to other airspace
    - Study to identify the **existing rules of the air** and see where they can be challenged and how they should be developed
    - What are the type of rules required for an urban environment?
  - Identification and **review of existing models around** airspace management and regulation
    - How can these models be harmonised?
  - Identify **use cases** that cover the majority of potential **scenarios**
    - Scenario scoping → Pareto analysis
    - Use of synthetic environments
  - **Feasibility studies** which consider **human factors** associated with urban transport
  - **Right to left planning** needed to establish critical path activities to deliver identified milestones

# Working Group 3 feedback:

## Novel Air Vehicle Demonstrators

- Key priorities
  - Need to identify specific **use cases** which can drive capability development taking account breadth of different users
  - Specific **technology themes** include electrified powertrains (including thermal management), autonomy (and interaction with UTM/ATM), air vehicles structures (cost and weight)
  - Importance of using currently existing best practice capabilities – avoid reinvention
  - **Cross ISCF challenge workstream coordination** (Driving the Electric Revolution, Faraday, Made Smarter) is key
  - Some gaps identified in current network of **stakeholders** (e.g. users of the air vehicles, operators such as regional airlines or equivalent to rail companies, property management services...). *Forthcoming conference being developed by Transport Systems Catapult in March is an opportunity to help this.*
  - **Global collaboration opportunities** will be important but need to be mapped out. **Technology roadmaps** would help to coordinate this.
- Next steps
  - Define use cases which develop majority of UK capability across different types of air vehicles
  - Consider how national demonstrator programmes might be established
  - Opportunity to use ADS UAM vehicles group to continue engagement

# Working Group 4 feedback:

## Ground Infrastructure Systems Demonstrators

- Key priorities
  - Understand **requirements** and how these deliver specific **benefits**
  - **Capture knowledge** from existing airport planning and regulatory implications
  - **Closed airport demo environment** required to protect public perception
  - **Physical urban air mobility infrastructure demo** rather than virtual environment
  - Solutions need to demonstrate **scalability/repeatability/ interoperability**
  - **Drones infrastructure** to consider **multifunctional** - services / goods / passengers
  - Importance of considering **wider infrastructure implications** – not just operational requirements
  - Infrastructure to enable efficient **multimodal transport systems solutions**
  - **Digital infrastructure systems** required for connectivity
  - Many **critical stakeholders** not identified and need to be mapped

# Working Group 5 feedback:

## New operating models for users and commercial operators

- Key priorities
  - **Market sizing** for the use cases to be developed
  - **Define the vision** to clearly identify needs for business models
  - **Public engagement** and user acceptance will need **physical demonstration**
  - **Right to left planning** needed to establish critical path activities to deliver identified milestones
  - Identify **use cases** that cover the majority of potential **scenarios**
  - Understand and identify who the likely 1<sup>st</sup> customers are



# Closing Remarks



# Wrap-up

- Clearly identified importance of identifying and developing **use cases** and **vision**
- Re-affirmation of 5 workstreams
- Need to maximise UK benefit of £125m - current assumption is 50:50 industry / government investment
- CAA are looking at strengthening engagement and support of initiatives such as the Future Flight Challenge
- UKRI/BEIS/DfT/ATI partnership continuing to develop Future Flight Challenge programme

# Next steps

1. ATI to share presentation material and outcomes from the workshop
2. Request for sharing of workshop participant contact details will be formalised to comply with GDPR
3. UKRI to maintain communications with wider stakeholder network to signpost updates as progress is made towards launch of the Future Flight Challenge programme in April.