Electrification of Air Transportation

Keizai Silicon Valley
May 2021

Fred Borda
Aerial Innovation

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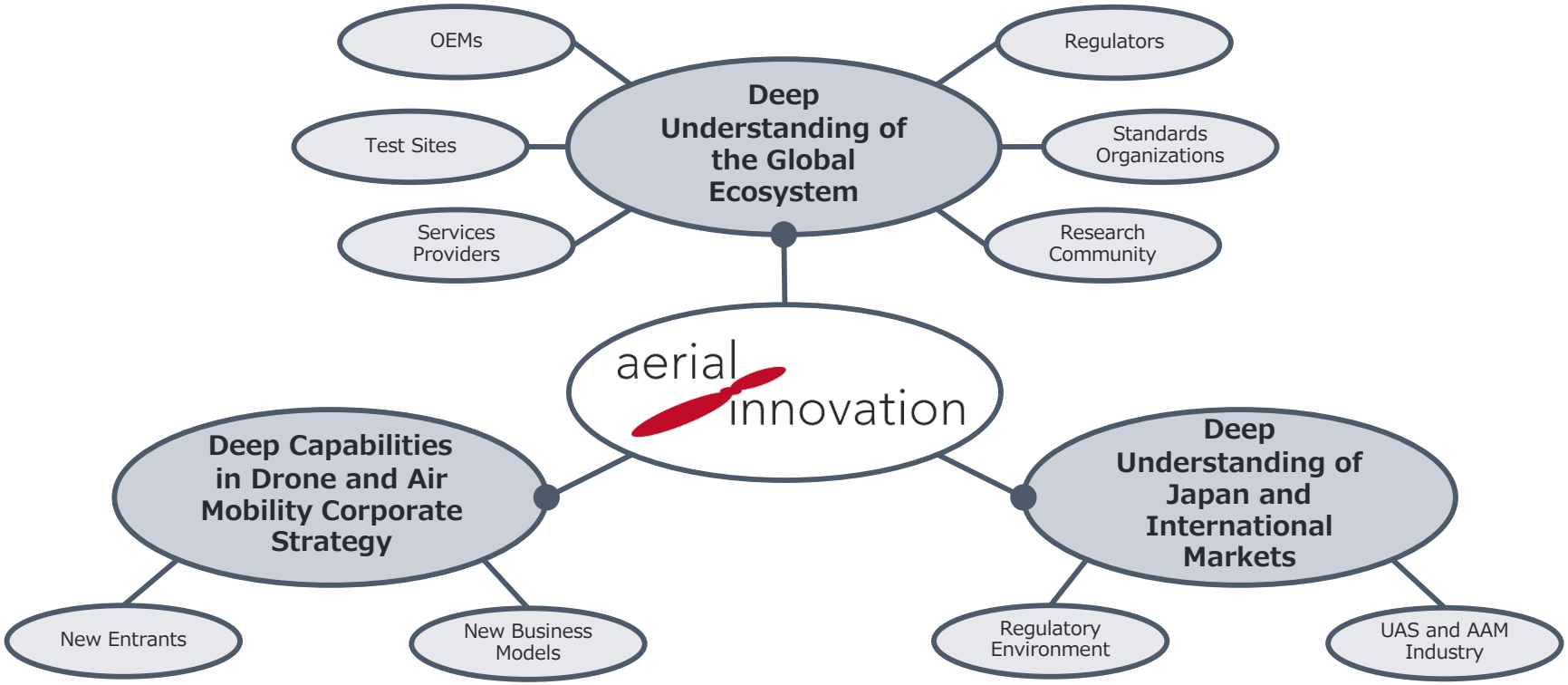
About Aerial Innovation



Principals

Ryoji Koike (小池良次)

Co-founder and C.E.O.

Ryoji Koike is a respected journalist, analyst and thought leader in Japan's IT, telecommunications and commercial drone sectors.

Based in the U.S. for over 28 years, he has covered Silicon Valley for most of that time, bringing insight and context to the rise of the Internet, cloud computing, new business models, and a host of other pivotal developments. He writes frequently for Japan's Nikkei Shimbun and other leading business publications and has authored a number of books on key trends. As a consultant, top management at Japan's industry leaders seek out Ryoji's advice on what's next and how it will affect their businesses.

Ryoji holds appointments as part-time lecturer at Waseda University, visiting researcher at Waseda University's Research Institute of IT & Management, fellow at International University of Japan's Center for Global Communications (GLOCOM), and senior researcher at InfoCom Research. He is the convener of the Communications and Information Network Association of Japan's (CIAJ) seminar series on U.S. Information and Communications Technology.

Select Publications (Japanese)
Electronic Retail Management Strategy, Impress
Second Generation B2B, Impress
The Cloud, Impress
Managing Development in the Network Era, Impress
The Future of the Cloud, Kodansha
U.S. Drone Business Report, Nagai Publishing

Fred Borda (フレッド・ボーダ)

Co-founder and C.O.O.

Fred has been working with Japan's technology sector for over 20 years, advising large telecommunications and IT R&D organizations on technology and strategy. He started the Japan practice for a Silicon Valley technology trend research and consulting firm and led it for over 15 years. He has also led and grown businesses in operating roles. Fred began his career at a prominent Japanese marketing research and strategy consulting firm in Tokyo.

Fred's work has covered all facets of the IT and telecom ecosystem, from network core to cloud infrastructure, to applications and devices. He co-founded Aerial Innovation to help realize the future where commercial drones and new air mobility will unlock tremendous value for enterprises at the intersection of robotics and automation, aviation, IoT, sensors, and AI.

Fred currently serves on work groups and committees in global standards organizations including the Global UTM Association and ASTM International. He speaks at commercial drone air mobility events in the U.S. and Japan.

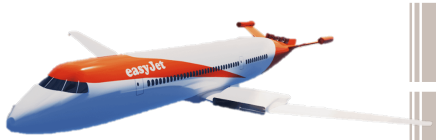
Overview

- When will the future get here?
- About the ground infrastructure for electric aircraft
- About the business models electric aircraft enable


Advanced Air Mobility (AAM) Mission
Rural Operations
Urban Operations
On Demand
Air-Taxi
Regional
Network
Inter-City
eCTOL
Cargo
Delivery
Cargo
Delivery
Airport
Transfer
Medical
Transfer
Distribution
Center/Warehouse
High Density
Corridor
Air
Ambulance
Fleet
Operations
Inter-city
eCTOL
Small
Package Delivery
Cross-metro
Transfer
UML - 4
UML - 3
UML - 2

When will the future get here?

	Single Motor	Total Power	
UAM/AAM eVTOL	80-100kW	0.5-1.5MW	2-5 seats **Battery electric**
Small Prop Aircraft	200-260kW	0.8-1MW	5-19 seats **Battery electric (incl. retrofit)** 5-19 seats **Hybrid electric** 40-60 seats **Hydrogen fuel cell electric retrofit**
Large Turbofan Aircraft	1MW+	10MW+	50-100 seats **Hybrid turbo-electric** 50-80 seats **Battery or hydrogen fuel cell electric**



2020-2025 > 2025-2030 > 2030-2035 > 2035-2040 > 2040-2045

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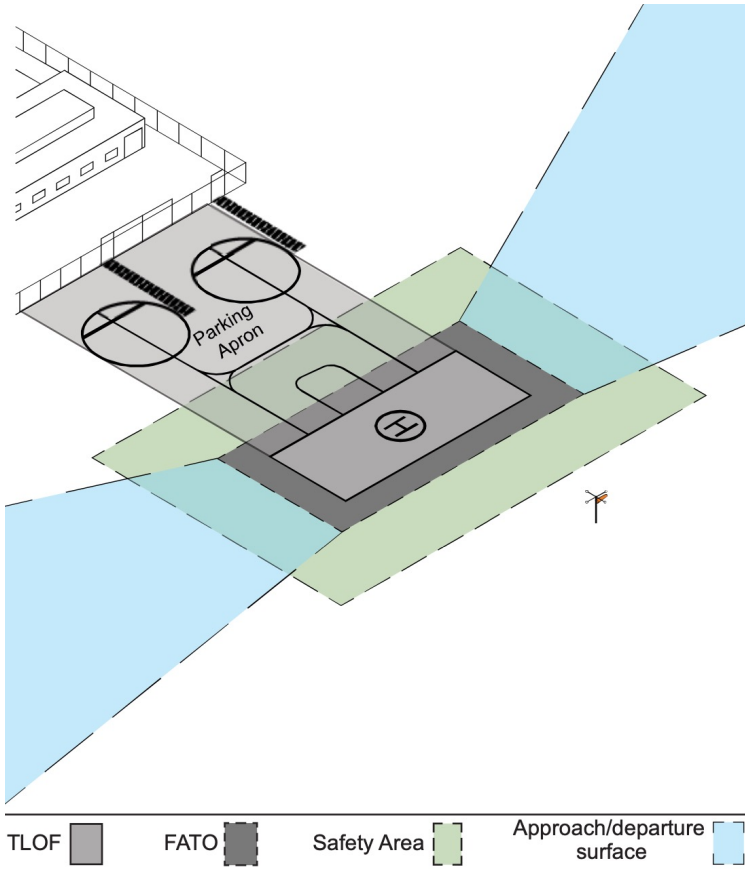
Archer Aviation, magniX, Eviation, Wright Electric, Universal Hydrogen

UAM/AAM Ground Infrastructure

- Vertiport Design
- Weather Information
- Traffic Management
- Charging

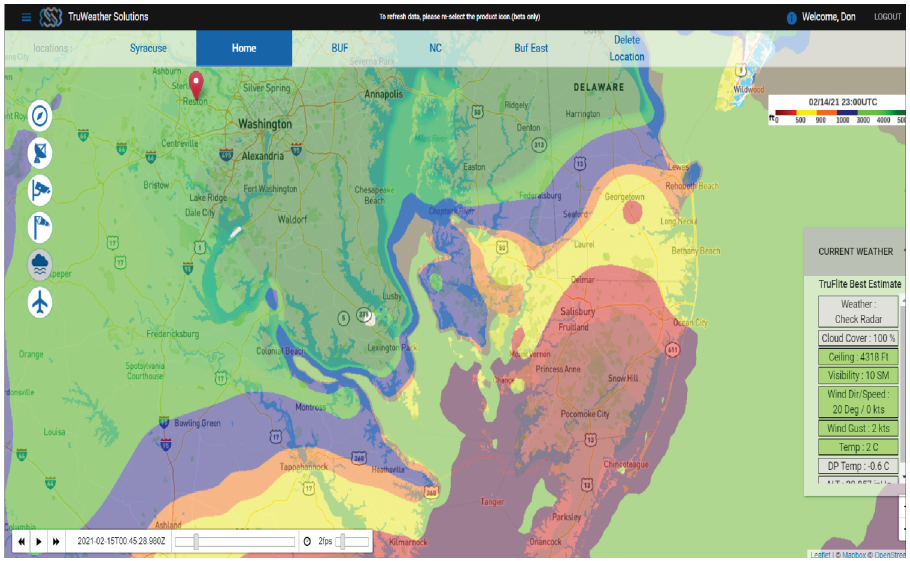
UAM/AAM Vertiport Design

- Existing heliports may not be suitable for air taxi eVTOLs
  - Landing/take-off areas
  - Approach/departure paths
  - Charging/fueling
  - Passenger operations
  - Crew operations
  - Maintenance & repair
  - Fire protection
- New transportation models → new types of landing sites
  - Urban
  - Building-tops
  - Integration with parking and ground transit



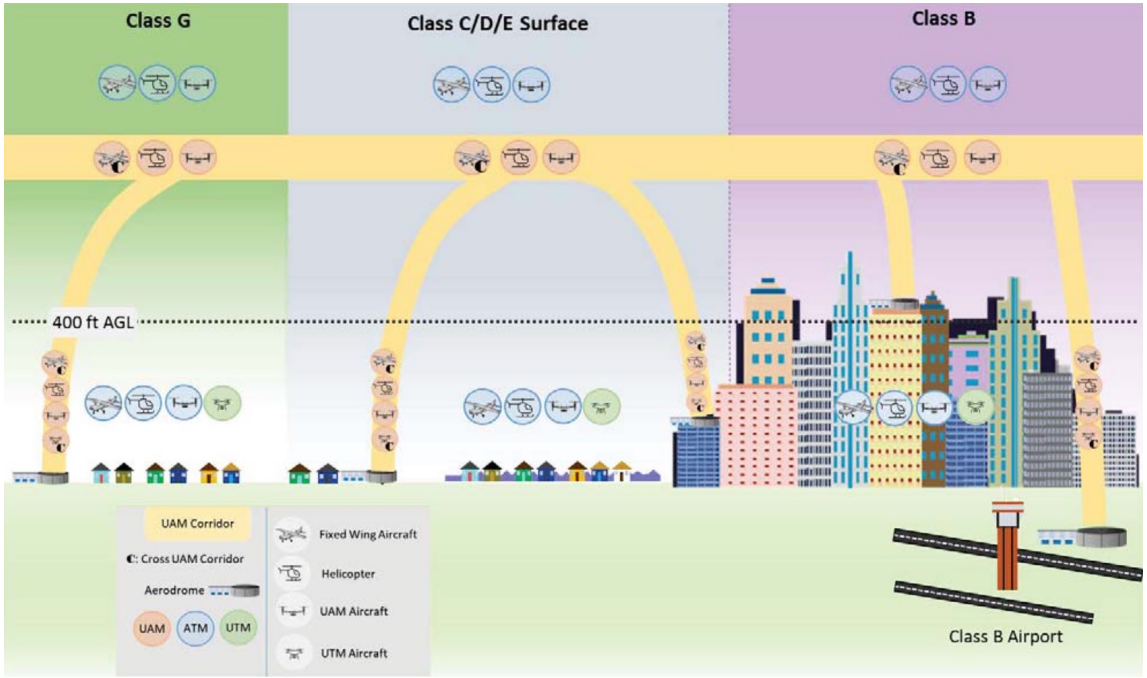
UAM/AAM Weather Information

- Low altitude (under 1000 ft) weather sensing infrastructure very sparse
- Particularly localized wind conditions and in urban areas
- Smaller aircraft are more susceptible to winds
- Not only safety: operational efficiency and route optimization issues for operators
- New aviation weather paradigm emerging:
  - New class of weather sensors
  - New weather data providers
  - New weather decision support tools



UAM/AAM Traffic Management

- Based on concepts of UAS (drone) Traffic Management (UTM)
  - Uncontrolled airspace: Minimize impact on existing air traffic management
  - Operators exchange data – between each other and with ATC
  - Airspace “corridors” or ”operating environment”

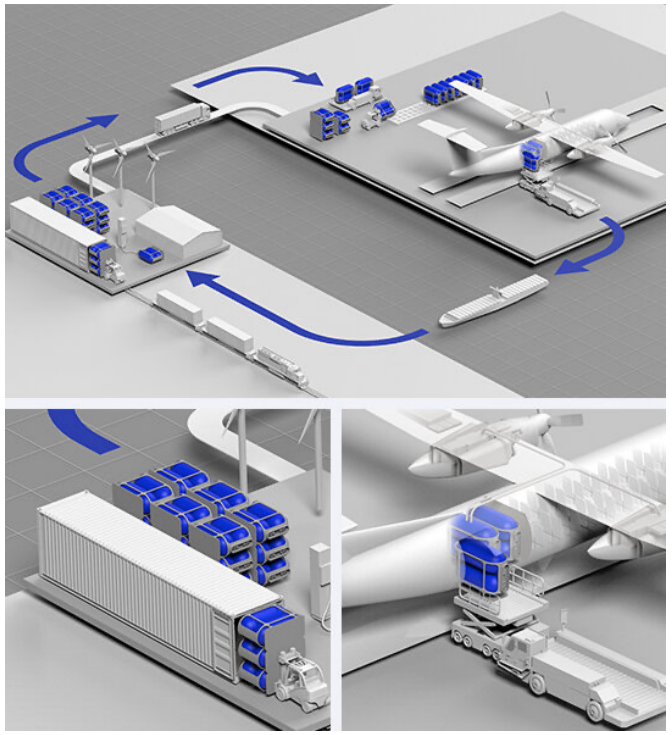


Charging

- Electrical grid impact
  - MW-level power demand at each charging site
  - Grid upgrades: New feeders (over 5MW), new substation transformers & capacity upgrades (over 10MW), new substations (over 20MW)
- UAM/AAM eVTOLs will have to fast-charge
  - 3C charging
  - Local power storage at charging sites to smooth demand peaks
- Charging equipment
  - Existing heliports would require upgrades
  - Rooftop vertiports require building upgrades
  - Size and weight a challenge
  - Thermal management a challenge

Hydrogen

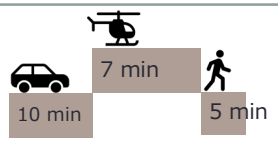
- The most weight efficiency of any energy
- Power fuel cells or burn directly
- Storage technologies
- New ground infrastructure
- New aircraft power trains
- Progress from retrofit to new integrated designs

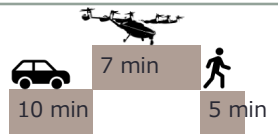


Business Models: UAM/AAM

- UAM/AAM Air Metro/Air Taxi
  - Intra-city
  - 5-15 min. flights
  - New electric aircraft (eVTOL)
    - Joby Aviation
    - Archer Aviation
    - Wisk
    - Beta (& 300 more...)
  - New infrastructure
  - Network model
    - Scheduled service (Air Metro)
    - On demand (Air Taxi)
  - Multimodal coordination
  - Very high throughput increases passenger load, reduces price, induces demand

Mode	Zero Emissions	Passenger Price	Total Time
Personal Vehicle	No	Operating cost	60 min
Uber X	No	$76	70 min
Uber Pool	No	$59	77 min
Helicopter	No	$1,175	22 min
UAM Service	Yes	$50	22 min





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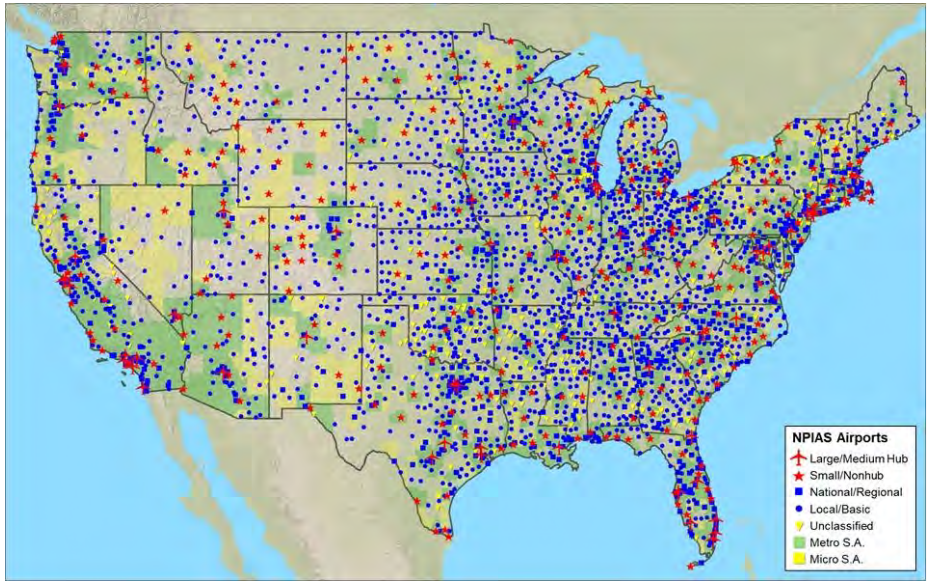
Business Models: UAM/AAM

Value Chain Functions	OEM	Operator	MRO	Vertiport Operator	MaaS App Provider	Fully Integrated Player
Aircraft Design & Certification	✅					✅
Manufacturing	✅					✅
Flight Operation		✅				✅
Traffic Management		✅				✅
Terminal Operations		✅				✅
Maintenance & Repair			✅			✅
Vertiport Operation				✅		✅
Demand Aggregation					✅	✅
Payment					✅	✅

Business Models: Thin Haul

- Short haul/thin haul transport
  - Hub-and-spoke air travel constrained resources: airspace and gates
  - Over 5,000 public-use airports in the U.S.
    - Long tail of sub-200 mi. routes
  - Players like Cape Air, Surf Air, Mokulele Airlines already active
  - Constraints on growth today
    - Dispersed demand
    - High operating costs
  - One solution
    - Demand aggregation networks
      - On demand or scheduled service
      - Multimodal service coordination
    - Dramatically lower costs of eCTOL/eSTOL aircraft (est. 80%+ energy cost reduction, reductions in maintenance, etc.)
  - Lower per-seat prices induce more demand



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Thank you

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