Lufthansa Innovation Hub

Osinto

# Whitepaper

# Mapping the Advanced Air Mobility (AAM) ecosystem

# Introduction

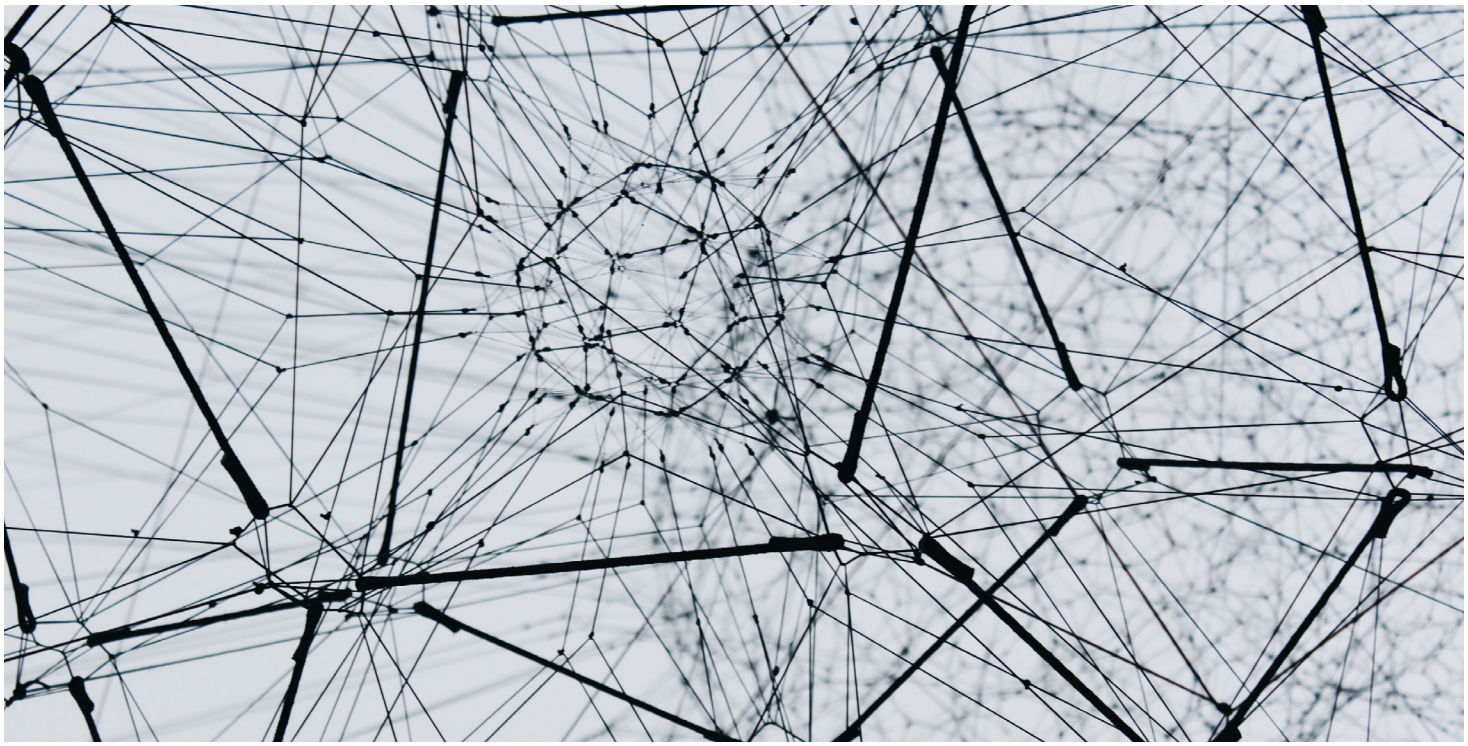
Today's major modes of transport—individually owned cars, trains and buses—are on the verge of disruption. Mobility is about to become cheaper, more convenient, a better experience, safer, and cleaner—not 50 or even 25 years from now, but within the next decade. The up-and-coming transformation has the potential to be as profound as the one that put horses to pasture and changed industries and societies worldwide. This nascent new sector continues to emerge, even as the transport and mobility industry suffers from COVID-19. It might yet prove to be the most fundamental change to the aviation industry since the advent of the jet age—our recent report on the state of air taxis confirms this view.

Electric Vertical Take-Off and Landing or 'eVTOL' aircraft are new, exotic, and real. We will use the moniker 'air taxi' in this report, as it's the passenger-carrying vehicles we're largely focusing on in this research. Their cargo-carrying counterparts (such as from Matternet, UPS Flight Forward, and Zipline) are already demonstrating the commercial viability of small, electric "aircraft". These unmanned and largely autonomous drones are paving the way for larger, passenger-carrying aircraft—which by contrast are years, if not decades away from large-scale commercial service. In 2021, teams of aerospace engineers at start-ups and large corporations alike are on the cusp of certifying first-generation electric 'air taxis' with ranges of up to 300km and capacity for two to eight passengers.

The promise of sustainably powered, emissions-free flying machines that might transform passenger transportation is enormous, and we'll soon find out which (if any) of this new category of aircraft live up to the multi-trillion-dollar market hype.

The Advanced Air Mobility (AAM) industry is in its infancy. It is an entirely new industry in emergence with no off-the-shelf concepts and solutions available today. It's a complex ecosystem with tough problems to solve, including designing a safe vehicle, offering the service to passengers, designing safe traffic management for unmanned and manned vehicles, as well as building infrastructure that integrates with existing modes of transportation. In this research project—a joint collaboration between Osinto and the Lufthansa Innovation Hub—the aim is to contribute by providing insights into the structure of this developing industry. For that purpose, large amounts of data (e.g. patent, VC funding, news articles) have been collected to map relationships, identify patterns, and derive insights—the most salient of which are shared in this paper. This whitepaper is meant to provide a detailed, but non-exhaustive glimpse into the complexity of the current AAM ecosystem.

# Approach



**AAM ecosystem**

To find all relevant stakeholders in the global AAM industry and to identify respective business relationships between them, we analysed thousands of data points and visualised the findings in an ecosystem mapping view.

To do so, we utilised Osinto's Cloud Empire™ platform, a knowledge graph of market data collected through Open Source Intelligence (OSINT). It enables business relationships to be mapped and explored and uses a synthesis of machine learning and human intelligence to analyse information.

# Mapping the AAM Ecosystem

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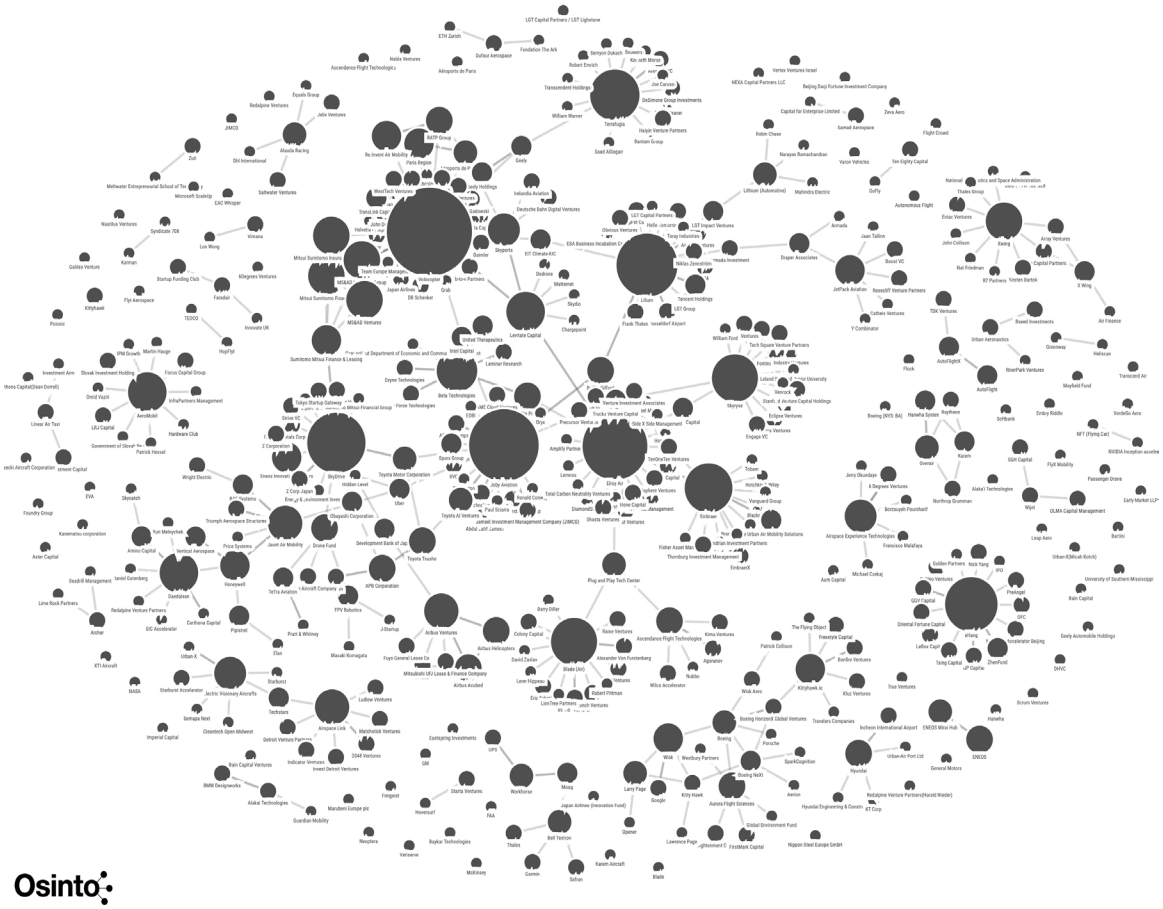
## A complex network of stakeholders



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This map is an excerpt of the heterogenous and rapidly expanding advanced air mobility ecosystem as of Q1 2021, with organisations as nodes, and commercial relationships between them as links. In this instance, a link can be a disclosed financial investment or a supplier/partner relationship, e.g. as divulged in a press release or social media post. This way of visualising the ecosystem aids novel analysis, and has reinforced that:

- The air taxi segment is already complex despite its nascent stage
- There is significant integration with both the aviation (ANA, Blade, Japan Airlines) and aerospace industries (Airbus, Boeing, Toray)
- We also witness significant integration with the automotive industry (Daimler, Geely, GM, Hyundai, Stellantis, Xpeng)
- Capital is being attracted from a very diverse range of sources: from angel investors (Larry Page) and startup accelerators (EIC Accelerator, Plug and Play) to corporates (Deutsche Bahn, Intel, Tencent, Toyota) and venture capital funds (Atomico, Levitate Capital, Zhen Fund)
- Corporate capital has come from industries as diverse as construction, defense, energy, finance, information technology, and transport

# Ecosystem Strategy Approach 1

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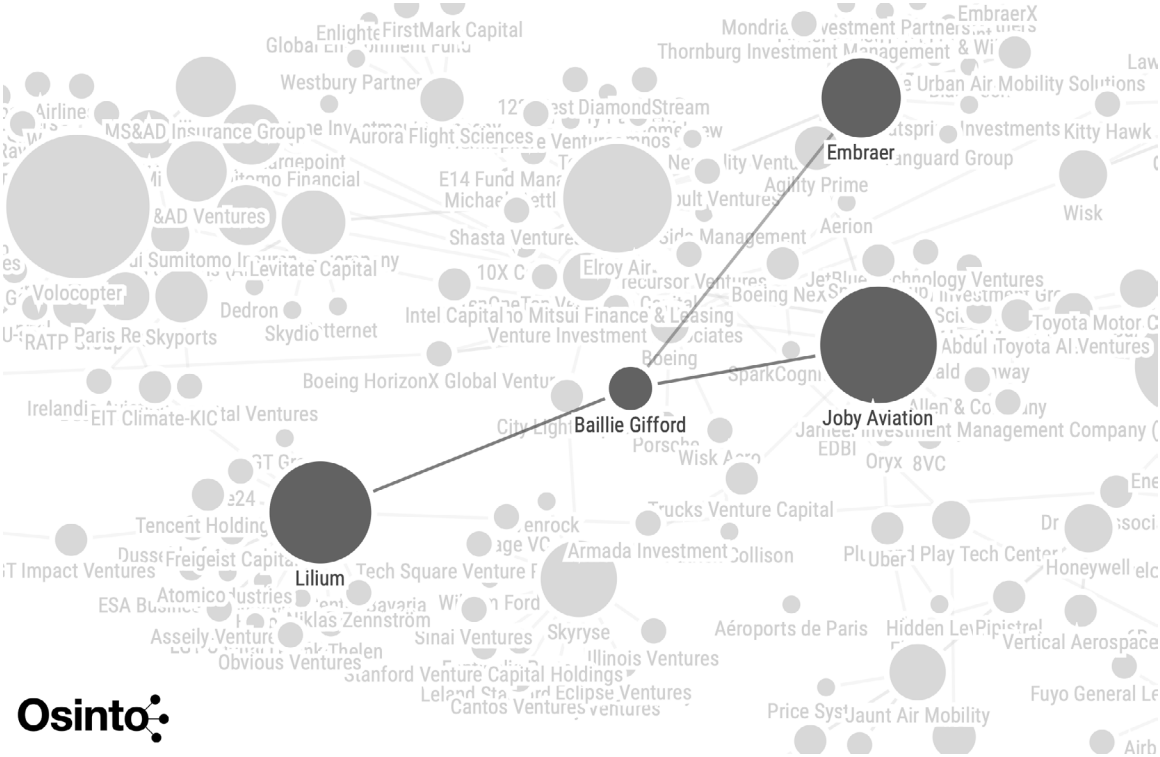
## The air taxi pureplay strategy




The visual map enables us to spot patterns of relationships between the different ecosystem players. Our analysis provides evidence of two major strategic approaches by most active stakeholders. (1) Air taxi pureplay, and (2) the AAM sector spread strategy.

Baillie Gifford's entry into the air taxi market is noteworthy, not least because they were early backers of both Tesla and SpaceX. They have taken positions in air taxi pureplay Lilium ($35m USD) and Joby Aviation (reportedly a smaller stake) and are major shareholders in Embraer, who recently spun their own Urban Air Mobility (UAM) division out into a standalone entity, Eve Air Mobility.

Hence, Baillie Gifford seem to be targeting solely air taxi manufacturers. The air taxi pureplay strategy approach places emphasis on the longer-term but higher-risk passenger-carrying segment alone, hedging against regulatory risk by investing across multiple regions with interests in Europe (Lilium), Latin America (Embraer), and North America (Joby), and technology risk through backing different vehicle architectures.

# Ecosystem Strategy Approach 2

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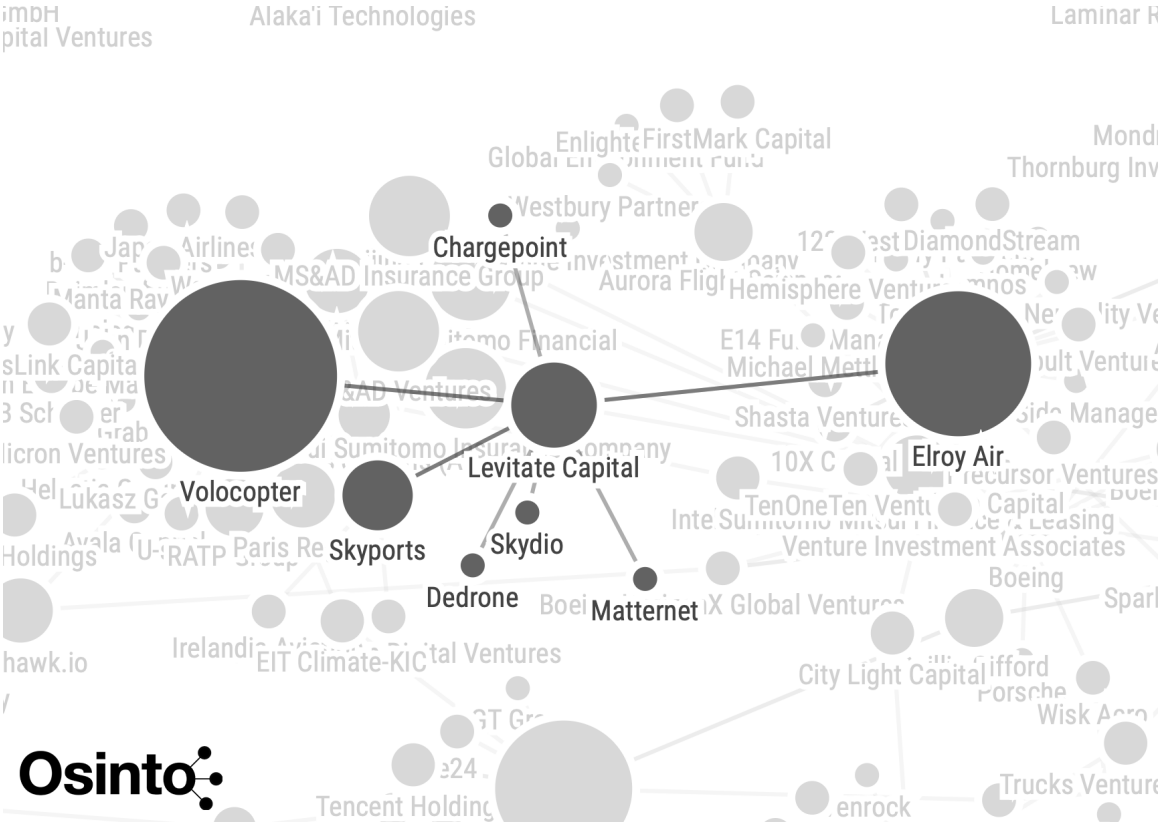
## AAM sector spread strategy




Whilst Baillie Gifford's investments in the air taxi sector are weighted towards passenger-carrying aircraft, sector-specialist VC Levitate Capital's approach sees them spread exposure across the AAM spectrum: from small commercial drones (Skydio) and last-mile delivery (Matternet) to larger aircraft for middle-mile logistics (Elroy Air, VoloDrone) and passenger-carrying air taxis (VoloCity), as well as the supporting infrastructure (Chargepoint, Skyports).

The AAM sector spread strategy entails investing in players across different sub-sectors of AAM, creating a synergistic portfolio of assets that mirrors the wider ecosystem and should provide returns through each stage of the market's development, for instance:

1. Small, short-range drones and associated enabling tech such as Unmanned Traffic Management (UTM) for Beyond Visual Line of Sight (BVLOS) flight operations.

2. Medium-sized cargo-carrying aircraft and the autonomous technologies that enable their safe integration into airspace, e.g., with single pilot, multiple-vehicle operations.

3. Through to passenger-carrying air taxi vehicles and the supporting vertiport infrastructure, from chargers and 'vertiport' landing pads to novel flight control systems / integrations that edge us cautiously towards autonomous flight.

# Continental Competition

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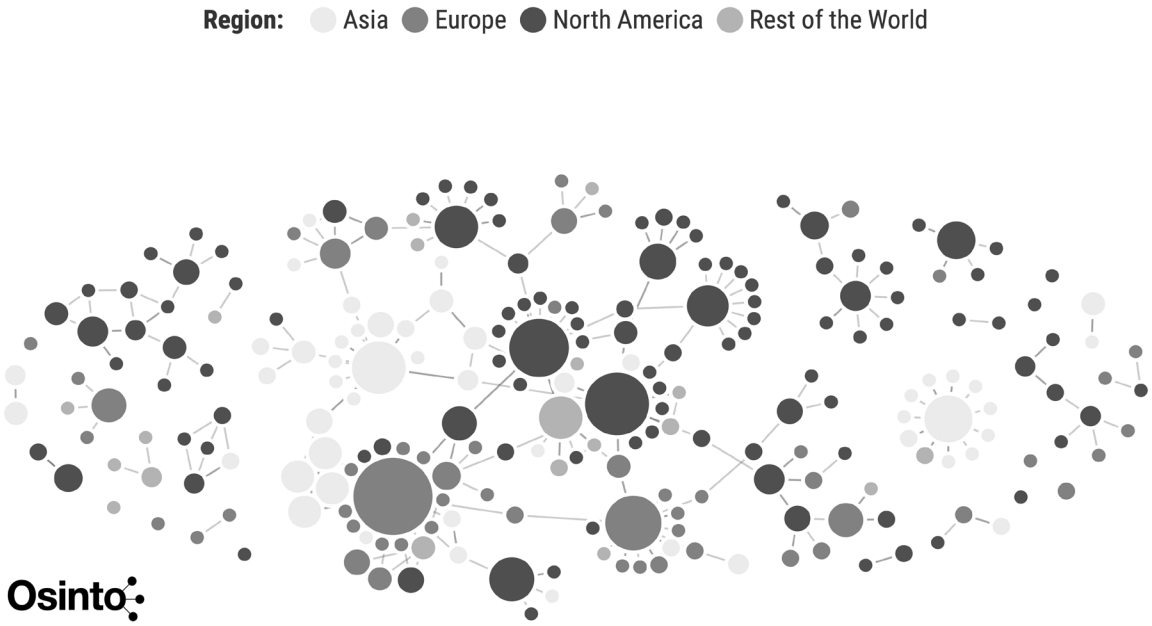
## North America dominates the AAM ecosystem




The air taxi market is a global race. Pre-production aircraft are being flight tested and seeking certification concurrently in Asia, Europe, and North America. This map shows the regional segmentation of the air taxi ecosystem with each node representing an organisation. North America dominates, followed by Europe and Asia.

There's a good degree of inter-connection between the regions, which bodes well for the long-term health of the industry. The visualisation shows the movement of foreign investment capital into air taxi aircraft manufacturers, and (to a lesser extent) the emergence of cross-border trade flows as supply chain relationships develop. Both Joby Aviation (US) and Lilium (Germany) have supply agreements for composite structures with Japan's Toray Industries, for example.

Links in this graph represent financial investments, customer/supplier, and partnership connections. As such the diversity of an organisation's corporate strategy can, to some extent, be inferred from the number of connections it has.

### The bottom line

1. **Regional leaders**
   In Europe, the most inter-connected node is Volocopter. Their corporate strategy encompasses a range of both use cases (passenger transport, logistics, crop spraying) and target markets (Germany / Europe, Japan, Singapore). Their broad partnership strategy is in stark contrast to domestic competitor Lilium, who appears focused solely on passenger transport and in building a vertically integrated business. This ambitious design-build-own-operate approach is in stark contrast to commercial aviation norms.

In North America, Joby Aviation is the most connected node. This is in large part due to their diverse cadre of global investors which includes Abdul Latif Jameel (Middle East), Baillie Gifford (UK), Geely (China), Intel (US), Uber (US), and Toyota (Japan). Their increasingly deep connection with the US Air Force and a long-standing relationship with NASA are also worthy of note.

2. **The geopolitics of electric aviation**
Fostering the development of an air taxi supply chain, due to its critical technologies, is of strategic importance to national governments. In the US, Joby Aviation and Beta Technologies are supported through initiatives like the US Air Force's Afwerx / Agility Prime and NASA's AAM National Campaign that are aiding in certification and testing.

In China, company growth is aided by signing contracts with State-Owned Enterprises (SOEs) that foreign competitors cannot compete for. eHang's framework agreement with Guangzhou Lingnan International Enterprise Group—encompassing everything from drone delivery and light shows to aerial logistics, sightseeing flights, and passenger transport—is a good example.

Whether the mature aerospace supply chains in Europe that feed into Airbus, Bombardier, and Rolls-Royce can take advantage of the strong cluster of air taxi expertise growing in Germany in the same way, remains to be seen. Certainly, there are projects—especially those involving ADP in France and Deutsche Bahn in Germany—that hold great promise.

Notable by their apparent absence from the sector in any meaningful way are nearly all of Europe's major automotive groups (Renault Group, BMW Group, JLR Group), with the exception of Daimler who are investors in Volocopter; Stellantis (FCA Group / Groupe PSA), who have just announced a partnership with Palo Alto air taxi startup Archer; and Porsche, who partnered with Boeing to develop a premium flying car.

Perhaps the wild card of the sector are South Korea's Hyundai who are hoovering up air taxi talent in the US into their Urban Air Mobility division and plan to enter the market with a second-generation vehicle as they reposition the business from car maker to mobility-as-a-service provider.

# Deep-Dive: The Keiretsu are coming

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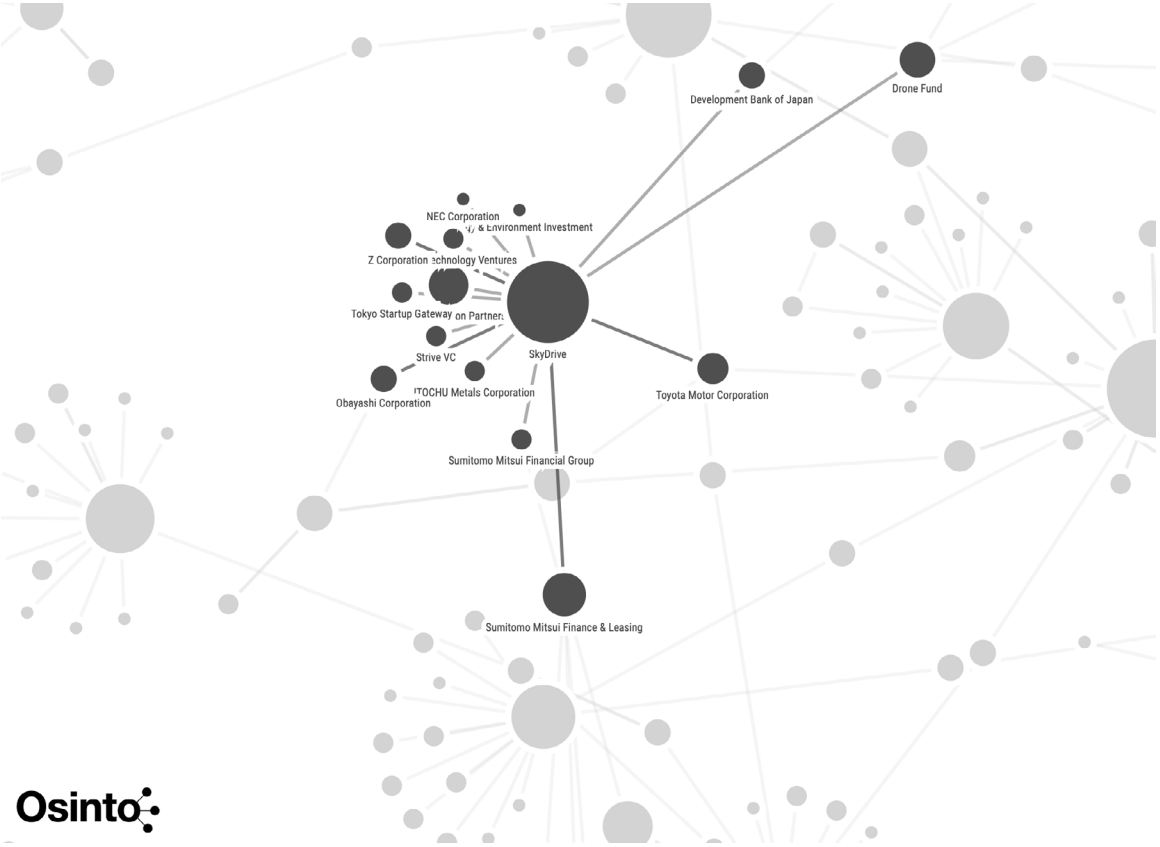
## The highly connected Japanese AAM ecosystem

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There's good coverage of the air taxi industry in the US and Germany, so we decided to look instead at the somewhat under-reported activity in Japan, a nation whose large financial and industrial conglomerates have been quietly pouring capital into air taxi startups both at home and abroad.

Looking at corporations affiliated with Japan's front-running 'flying car' company, SkyDrive, begins to reveal the diversity of interests and actors in the ecosystem. Participants in the company's ¥3.9B JPY / $37.5m USD Series B fundraise in August 2020 included:

- Development Bank of Japan (owned by Tokyo's Ministry of Finance) who also invested in Airbus Ventures Fund III alongside Fuyo General Lease and Mitsubishi UFJ
- Drone Fund, whose backers include SoftBank and mobile operator NTT DoCoMo, and whose portfolio also includes Hidden Level and Sabrewing in the US and Canadian SkyX
- ENEOS Innovation Partners, the oil/petroleum conglomerate's fund that was established in 2019 with ¥15 billion JPY / $145m USD to invest over three years in mobility and renewable energy—they're also working with all-polymer lithium-ion battery specialists APB Corporation

- Obayashi Corporation are working with SkyDrive on drone delivery to construction sites and they too have an interest in APB Corporation, alongside Toyota Tsusho, Sanyo Chemical, and (through a licensing agreement) Nissan

- Sumitomo Mitsui (through their Finance & Leasing subsidiary) who are also investors in Drone Fund and (through MS&AD Ventures, and other subsidiaries) in Volocopter

- Z Corp, who were originally Yahoo! Japan's corporate VC arm, now part of Softbank

Outside of the SkyDrive deal, there's plenty of other activity, with Toyota having invested in Joby Aviation (through their AI Ventures arm) alongside Sparx, a fund originally setup with capital from Toyota and Sumitomo Mitsui.

Japanese airlines are also active in the sector. ANA view air taxis as a potential "new industry" and an opportunity to extend air travel services "...from the airport and beyond". Japan Airlines have invested directly into Volocopter through their $70m USD Innovation Fund, which is (at least partly) administered by Palo Alto VCs Translink Capital. The airline envisages a mobility-as-a-service business "centered on aviation" that, similarly to ANA, will offer "a seamless end-to-end travel experience" using air taxis "from the airport to destinations".

**The bottom line**

There's direct Japanese corporate interest in air taxi market leaders in Asia, Europe, and North America. For a market typified by a conservative business and investment culture, it's striking just how seriously large Japanese conglomerates seem to be taking the prospect of eVTOL aircraft and 'air taxis' specifically. This region should not be neglected, but rather put into focus by players active in the air taxi industry—especially since Japan is an ideal AAM market due to enormous urban centers, a topography that makes additional transportation infrastructure expensive, and limited space for new transportation infrastructure, to name but a few reasons. The transition from piloted to autonomous systems could potentially help an aging population and further accelerate the AAM space in this market.

# Future Outlook

In this paper, we conducted a systematic market analysis to better understand the state and complexity of the overall AAM ecosystem and the current commercial relationships between the various players.

As such, three broad insights were identified, namely: (1) the ecosystem is expanding, (2) markedly different investment strategies are emerging, either a pure air taxi player or sector spread strategy, and (3) geographical variations exist.

We envisage the discussions in this paper to rekindle debates and draw new researchers and practitioners to push forward the development of even more granular AAM market ecosystem studies, but foremost, to enable the formation of partnerships of previously unknown players.

The limitations of this paper lie in its simplistic approach. It was not our objective to provide a detailed, all-encompassing overview of the AAM market, but rather to provide a snapshot in time, using exemplary pre-selected data, and to highlight the importance of building a strong ecosystem.

Further work should therefore provide a more granular and detailed look into the AAM business ecosystem, covering the entire supply chain. This would enable the discovery of blind spots and offer the opportunity to connect various players who (potentially) don't know each other yet.

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