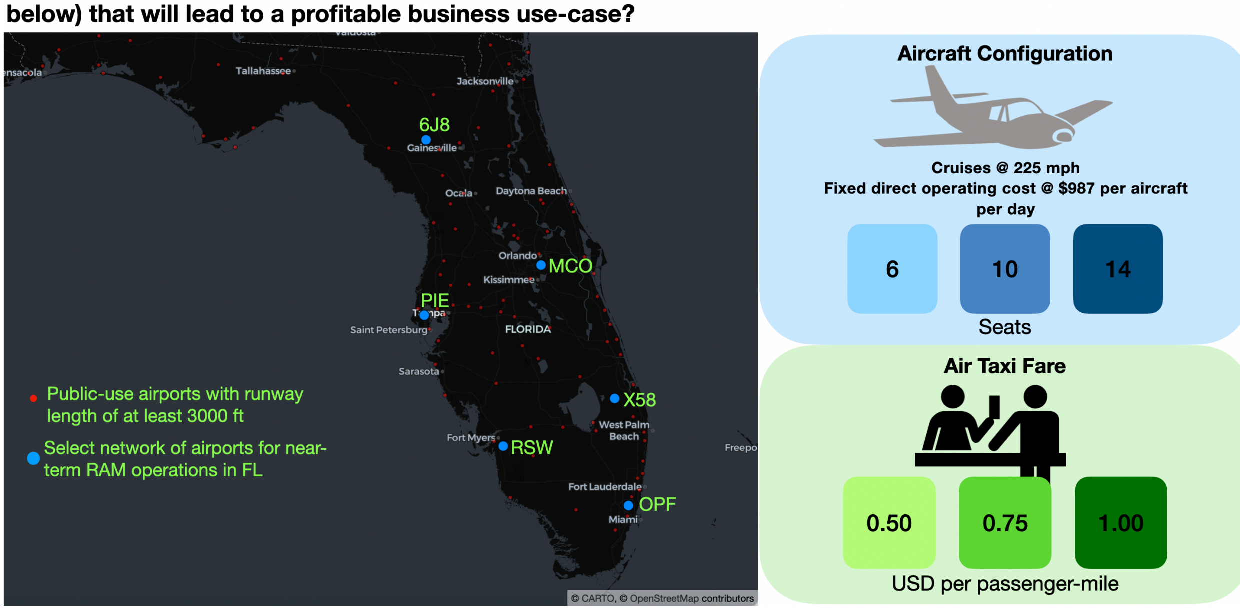
Enabling Air Taxis: A Regional Air Mobility Business Use-Case in Florida

Imagine you are an air taxi operator looking to launch on-demand (regional) air taxi service in Florida, USA.

Can you guess the right aircraft configuration and an appropriate fare for the airport network (pictured below) that will lead to a profitable business use-case?



Read on to understand how we predicted this outcome or jump to ***The Solution*** *section for the correct answer.*

Understanding Your Aircraft Options

Aircraft sizing and performance

All aircraft options in this hypothetical scenario have a fixed maximum take-off weight (MTOW) of 16,500 lbs (7484 kg) and cruise at 225 mph at 10,000 ft. Our (hypothetical) aircraft manufacturer allows you to trade off payloads (number of seats) with the battery size. That is, you, the operator, can opt for a configuration with fewer seats on-board and a larger battery (keeping the MTOW constant) to improve your range and vice-versa as demonstrated in Figure 1.

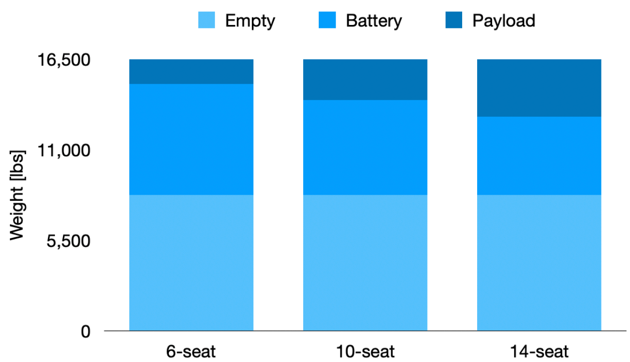


Figure 1: Payload-battery tradeoff for various aircraft configuration

	Power needed at shaft [kW]
1 Taxi-out	80
2 Take-off	1280
3 Initial Climb	1170
4 Climb to 10,000 ft	960
5 Cruise @ 225 mph	532
6 Descent	130
7 Landing	200
8 Taxi-in	80
9 IFR reserves @ 175 mph	358

Table 1: Mission power requirements

The aerodynamics and flight performance characteristics of the aircraft are modeled from the recently published report, for an Alice-like representative aircraft. The power needed during different mission segments are outlined in Table 1.

With the stated assumptions in the report on the aerodynamics, weight fraction of the aircraft, and today's state-of-the-art pack-level battery specific energy of 215 Wh/kg, the range of the 10-seat Alice-like aircraft is limiting for this RAM network. With a 45-mile IFR reserves, the aircraft can only fly up to 75 nautical miles (86 statute miles) when cruising at 175 mph (152 KTAS).

But what if you want better range and to cruise even faster (225 mph)? Let's say the battery energy density does improve with time and, in this case, we let you select a battery with pack-level specific energy density of 350 Wh/kg. Figure 2A displays the new ranges that are possible under different seat configurations, and Figure 2B shows the number of routes in the network you can feasibly fly using the aircraft.

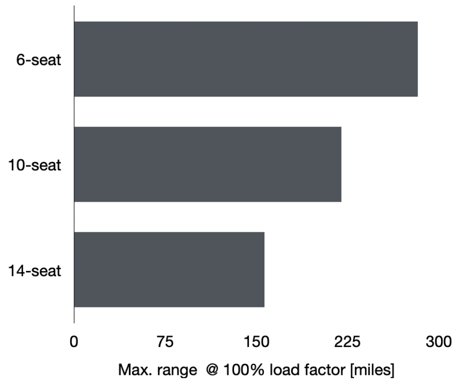


Figure 2A: New aircraft range with 350 Wh/kg pack-level battery energy density for various aircraft configurations

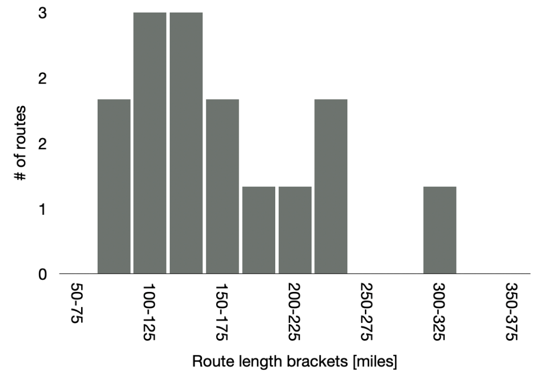


Figure 2B: Distribution of the network route lengths

Aircraft Cost

Each aircraft incurs an annual fixed direct operating cost of $360,222 ($987/day) that includes acquisition loan amount (with interests), pilot salary, insurance, inspection, and storage fee. These expenses are irrespective of if the aircraft is flying or sitting on the ground. In addition, the operator amasses a variable direct operating cost whenever the aircraft flies and is typically a function of flight distance and number of passengers on-board[1].

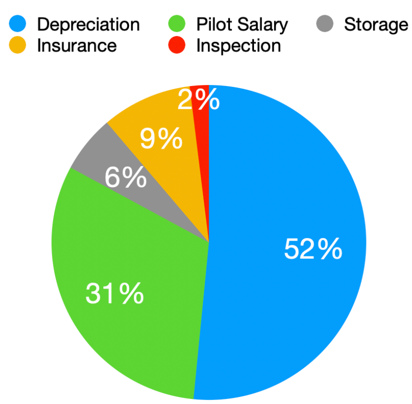


Figure 3A: Fixed direct operating cost break-up

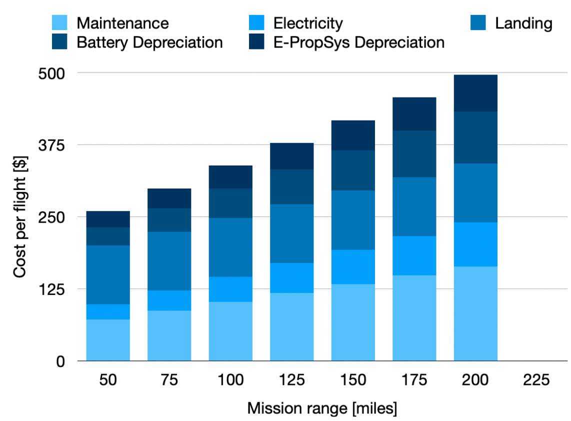


Figure 3B: Variable direct operating cost per flight with full-seat for the 10-seat configuration

[1] The development and operation cost data are obtained from the cost models for business aircraft presented in General Aviation Aircraft Design : Applied Methods and Procedures by Snorri Gudmundsson. The electric propulsion system and the battery cost data are obtained from published research articles.

Aircraft specifics represent the supply side of the ecosystem. Now let's explore the demand side.

Know Your Customers

Who are your potential customers? How many daily long-distance (long distance defined as any journey > 100 miles) trips do they make? Where do these trips start and end, and at what time of day? How much do these individuals value their time and how much are they willing to pay to switch to your air taxi service (to reach their destination faster) from their existing mode of transportation?

These are just a few of the questions we can answer during the market research and decision-making process. Below, we provide insight into our approach.

Over 3.2 billion long distance trips originated in the U.S. in 2008 and this number is expected to increase to over 4.5 billion by 2040[2]. Of these trips, approximately 77% of them were taken solely by car. Figure 4 shows the annual long-distance trips originating in the state of Florida for different modes of transportation.

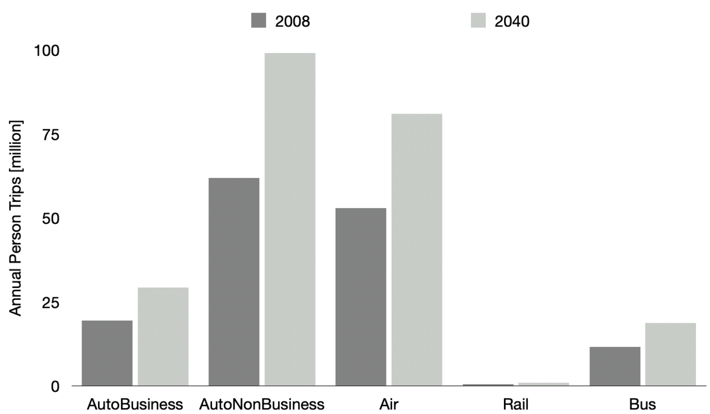


Figure 4: Annual long distance trips originating in Florida

Let's say we provide you, the operator, with the information on trip origins and destinations, along with an approximate time of the day when these trips start from any U.S. census tracts[3] of the region. We also provide you with information on how much these individuals value their time

[2] Source: U.S. Department of Transportation

[3] Census tracts are small geographic sub-divisions of a county and counties are sub-divisions of an US state

depending on the trip purpose (i.e., business or pleasure) and a realistic drive time estimate that accounts for road infrastructure and traffic information specific to the region.

With these data points, along with the ticket price information that you are planning to offer customers, you now have a reasonable estimate of door-to-door trip costs, trip times, and individuals' value of time — everything you need to compare various modes of transportation. As such, you may plug these data points into a mode-choice model to forecast demand for your air taxi service. Figure 5A shows the expected average door-to-door time savings for taking an air taxi compared to driving for all trips originating from a census tract. Figure 5B shows the daily air taxi demand for different price points and seat configurations.

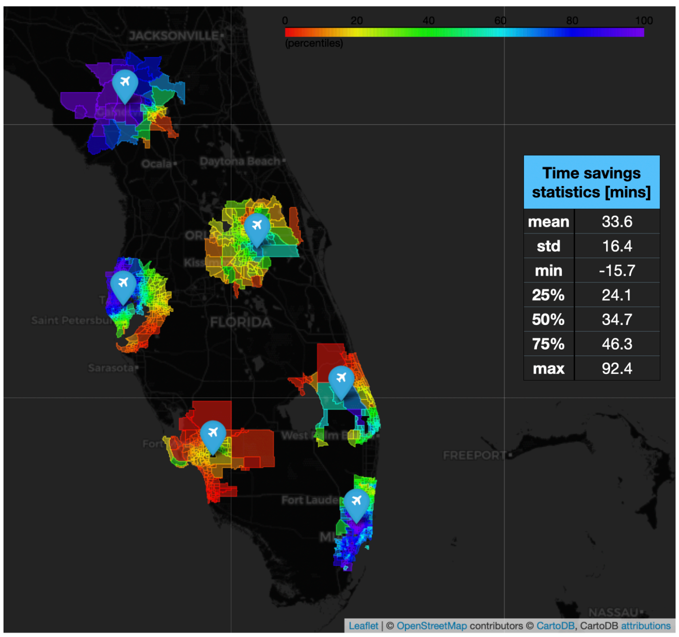


Figure 5A: Average door-to-door time savings for taking air taxi compared to driving for all originating trips from a census tract

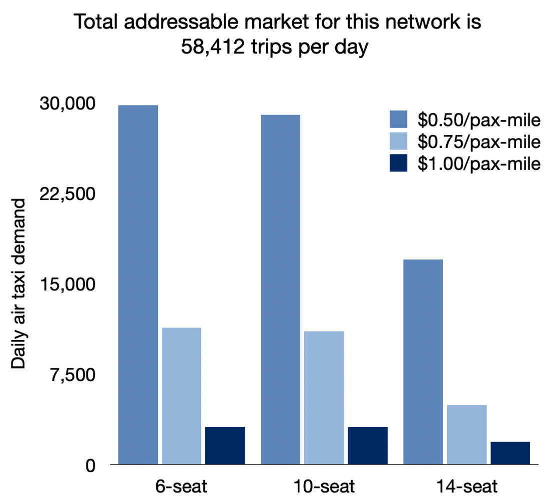


Figure 5B: Expected air taxi demand for different aircraft options and price points

Finding Product-Market Fit

Now that you understand your aircraft options, how do you plan to provide a service that meets demand while remaining profitable – especially when these demands can originate anywhere and at any time of day?

Ask yourself:
-How many aircraft do I really need?
-How do I plan to aggregate these passengers efficiently to fill seats, while obliging to their trip

preferences (trip start/end times)?
-How do I ensure I am minimizing the number of repositioning or non-revenue generating (deadheads) flights to keep operating expenses low?
-Can I ensure airports in the network are equipped with charging/fuel stations and staffed appropriately to support daily operations?

These are all critically important questions yet finding the answers can feel exceptionally complicated. Without further complicating things, what if you had a digital fleet management tool that mimics how a real-world air taxi operator would operate its fleet of aircraft? The tool is a variant of what DayJets, an air taxi operator based out of Florida, used to solve their flight dispatching problems. With this fleet management tool, you could dispatch your fleet with confidence, knowing which aircraft would serve which trip requests throughout the day.

Now, what if we could streamline this entire discovery process with a software?

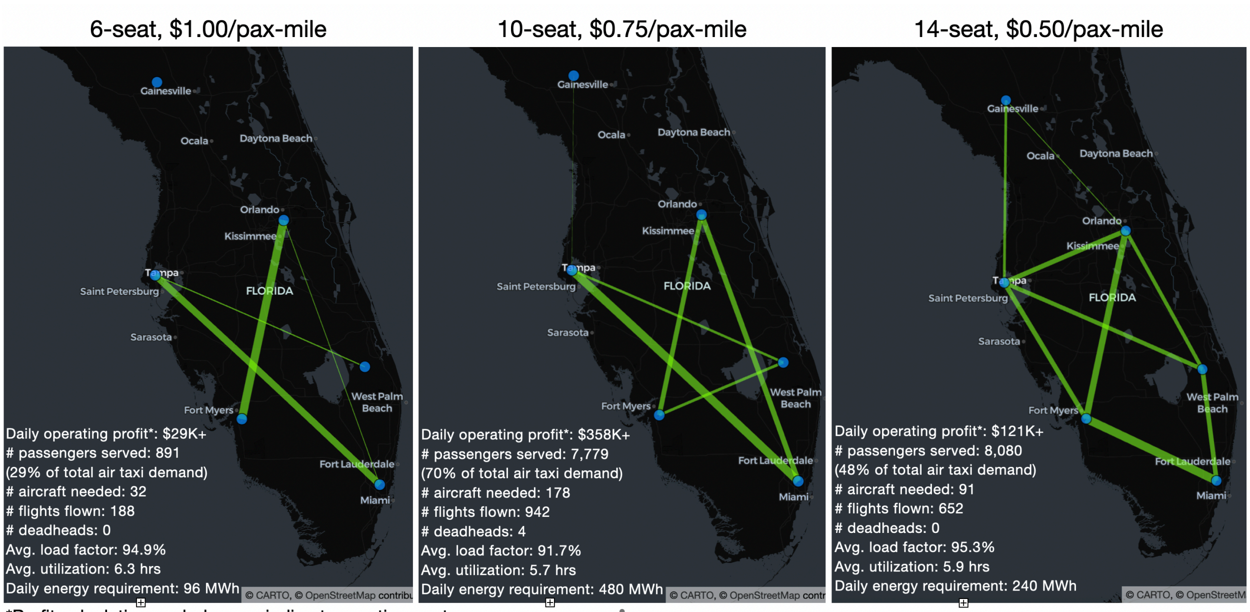
A software platform that simulates the air taxi operations with a fleet of aircraft of your choice using a data-driven holistic approach and understand the network-level performance of the aircraft from an operator's perspective. So that *understanding your aircraft options*, *knowing your customers, air taxi network simulation, and many more* are all part of this single software package.

Unlike the traditional simplified excel-based network analysis that may take weeks or even months to find answers, our technology can run multiple scenarios, with any combinations of input parameters you'd like, within a few hours of runtime.

Can you now provide answers to the questions we asked at the start of the paper?
Maybe yes! If not, don't worry; let us know explore the solutions.

The Solutions

Here we present three solutions (one for each aircraft configuration) out of the nine possible seat and ticket price combinations, looking at profitable routes only.



*Profit calculation excludes any indirect operating cost

Figure 6: Network analysis solutions for three different aircraft configurations at their optimal price points

The 10-seat configuration, given its capability to fly longer ranges, serves the majority of the high-volume air taxi traffic connecting Miami-Orlando and Miami-Tampa routes. While the 14-seat aircraft, due to its limited range, re-routes this traffic via South-West Florida International (near Fort Myers) and Indiantown (near West Palm Beach) airports with one stop-over at these locations.

Is cheaper price always better?

It is difficult to establish a viable business use-case with a 6-seat aircraft at the low price point of $0.50/pax-mile, because the extra range capability of the aircraft does not compensate for the loss in revenue due to the limitation of carrying only 6 passengers on-board while keeping fares low. You could charge higher premiums (i.e., $0.75 or $1.00 per pax-mile) for the 6-seat configuration, but note that the increase in ticket price drives down the overall air taxi demand (see Fig. 5B above), leaving primarily the time-sensitive business travelers as a viable target demographic.

Is longer range always better?
The solution reveals that a 14-seat configuration flying a maximum range as low as 150 miles presents a viable business use-case for a regional air market in Florida. Conversely, increasing range to 280 miles, without the right configuration (i.e., 6-seat configuration) and pricing scheme, would not be a good choice on this network.

Opportunities Ahead

Imagine you can simulate your future network operations, learn about your customers and your infrastructure needs, while the aircraft is still in the design and development phase, and leverage the insights gained about the performance of the aircraft on the network to come up with a better design solution, way before the aircraft actually enters in the service — *It is all possible now with modern-day engineering simulation!*

To learn more about the promise of Regional Air Mobility (RAM) in the U.S., NASA's white paper, which my colleagues and I helped author, on RAM provides a comprehensive overview of what is possible in the near future.

About the author

Dr. Satadru Roy is the founder and CEO at ALCIFO. He has led several government/industry-funded efforts in his decade-long research career on topics related to advanced air mobility, system-of-systems design, and multidisciplinary design optimization.

Aryn Sperandio copyedited this white paper. She is a business writer and the founder of True Story Consulting. She provides content strategy, ghostwriting, and editing services to a wide range of clients across North America.

Any feedback or suggestions are welcome.
Email us info@alcifo.com

